Instructions for Use

English

Release 12.2

MR 5300

3000 139 72881

PHILIPS

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1 Introduction

1.1 Publication Details

Published by Philips Medical Systems Nederland B.V.

Philips Medical Systems Nederland B.V. reserves the right to make changes to both these Instructions for Use and to the product they describe. Product specifications are subject to change without notice. Nothing contained within these Instructions for Use is intended as any offer, warranty, promise or contractual condition, and must not be taken as such.

Unauthorized copying of this publication may infringe copyright and reduced the ability of Philips to provide accurate and up-to-date information to users.

1.2 About these Instructions for Use

1.2.1 Supported MR System

This document is applicable to the following systems:

- MR 5300
- MR 5300 with upgrade package **Upgrades dStream to R12**

All information in this document applies to the above-mentioned systems, unless explicitly stated otherwise.

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1.2.2 Supported Configuration

These Instructions for Use, describe the most extensive configuration of the system, including all options and accessories. Not every function described in the Instructions for Use may be available on your system.

Contact your Philips representative to discuss available options.

Contact your local Philips representative for an overview of available options, accessories and other supporting materials.

1.2.3 Responsibility of Users and Operators

These Instructions for Use assist Users and operators in the safe and effective operation of their Philips MRI system.

The ‘User’ is considered to be the body with authority over the system; ‘operators’ are those persons who actually handle the system.

Before you operate the system:

- Read, note and strictly observe all danger notices and safety markings on and around the MRI system.

- Read these Instructions for Use thoroughly. Pay particular attention to all warnings, cautions and notes. Pay special attention to all the information and procedures described in the safety chapter.

Safe operation of the MR equipment, as installed and maintained according to Philips' instructions, requires adherence to all warnings in this IFU. When adhered to, the residual safety risk of the use of Philips MR equipment is evaluated by the manufacturer to be acceptable.

1.2.4 Safety Messages in the Instructions for Use

WARNING

Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazard with a low level or risk which, if not avoided, could result in minor or moderate injury.

NOTICE

Used to highlight information that is considered important but that is not hazard related, such as unusual points or hints for efficiency.

1.3 Other Instructions

Technical Description

The Technical Description provides additional data essential for safe operation, and measures or conditions necessary for installing the MR system. A PDF of the Technical Description is located in the User Documentation folder on the console. The Technical Description is also included in the online Help menu.

Help system

The Help system contains the Instructions for Use, the Technical Description, and gives basic and advanced scanning information. The Help system is embedded in the software and can be accessed on the operator's console or when you press the **F1** key.

In some parts of the user interface, e.g. imaging parameters, the Help system is context-sensitive. This means that the Help shows directly information which is relevant to what you are currently doing in the application. If context-sensitivity is not available, the home page of the Help system will open.

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About function

A summary of relevant hardware and software information is available in the About function. To access the About function:

- Click **Help icon**, then **About**.

Addendum

With these Instructions for Use a separate addendum may be available. This addendum contains latest information about your system, which is not included in these Instructions for Use. It is important to read and familiarize yourself with the content of the addendum, when available. To access the addendum:

- On the menu bar, click **Help**, then **User Documentation**.
- Select **Addendum**.

⇨ A PDF of the addendum opens.

PDF documents

To access PDF documents of the Instructions for Use, Addendum, Technical Description, DICOM Conformance statement, and IHE Integration statement, on the menu bar, click **Help**, then **User Documentation**. Links will be provided to the PDF documents in the user interface language.

If you require PDF documents of any of these documents in another language than the user interface language:

- Press the **Windows** key.
- Select **All programs**, then **MR Applications**, then **User Documentation**.
- Select the required language.
- Select the required document.

Info text for ExamCards and protocols

An editable info text window is available for each scan protocol and ExamCard.

1.4 About the system

General and Principle of operation

Your Philips MR system is a digital broadband Magnetic Resonance Imaging system.

The operation of Magnetic Resonance Imaging systems is based on the principle that certain atomic nuclei present in the human body will emit a weak relaxation signal when placed in a strong magnetic field and excited by a radio signal at the precession frequency.
The emitted relaxation signals are analyzed by the system and a computed image reconstruction is displayed on a video screen.

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Philips MR systems are designed to create images of the head, body or extremities of any patient (prenatal to geriatric) referred to an MR study by a trained physician.
Exceptions to admissible patients relate to their physical characteristics (circumference, mass) in relation to system capabilities (magnet bore size: 60 cm or 70 cm; mechanical strength of the patient support, allowing 150 kg or 250 kg) and taking into account pre-screening results and contraindications.

Clinical benefits and undesirable side effects

The following clinical benefit descriptions are representative for all Philips MRI systems and are included in the associated Risk-Benefit Analysis documents as part of the Risk Management file.

The clinical benefits are:

- Images, spectra, and measurements of physical parameters obtained by an MR scan may, when interpreted by a trained physician, provide information that may assist patient diagnosis and therapy planning.
- Image contrasts can be tailored to specific clinical applications required for a specific patient, to emphasize dedicated types of pathology.
- Images can be obtained in numerous planes without repositioning the patient.
- Patients do not need to be subjected to ionizing radiation in order to obtain an MR scan and there is no need to administer contrast agent to patients in order to generate tissue-specific contrasts.

The following undesirable side effects are identified:

Undesirable Side Effect	Patient	MR Operator or other personnel inside the MR examination room
Peripheral Nerve Stimulation (PNS)	X	X
Heating	X	X
Anxiety (due to e.g. claustrophobia)	X	-
Tinnitus (due to acoustic noise)	X	X

Frequently used functions

The following functions are frequently used.

- Patient preparation.
- Patient positioning.
- System preparation.
- Selecting ExamCard.
- Performing First Scan.
- Scan preparation.
- Perform Scan.
- Review Result.

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- Post Processing.
- Archiving and Networking.

1.5 Indications for Use

Philips Magnetic Resonance (MR) systems are Medical Electrical Systems indicated for use as a diagnostic device.
This MR system enables trained physicians to obtain cross-sectional images, spectroscopic images and/or spectra of the internal structure of the head, body or extremities, in any orientation, representing the spatial distribution of protons or other nuclei with spin.

Image appearance is determined by many different physical properties of the tissue and the anatomy, the MR scan technique applied, and presence of contrast agents. The use of contrast agents for diagnostic imaging applications should be performed consistent with the approved labeling for the contrast agent.

The trained clinical user can adjust the MR scan parameters to customize image appearance, accelerate image acquisition, and synchronize with the patient's breathing or cardiac cycle.

The systems can use combinations of images to produce physical parameters, and related derived images. Images, spectra, and measurements of physical parameters, when interpreted by a trained physician, provide information that may assist diagnosis and therapy planning. The accuracy of determined physical parameters depends on system and scan parameters, and must be controlled and validated by the clinical user.

In addition the Philips MR systems provide imaging capabilities, such as MR fluoroscopy, to guide and evaluate interventional and minimally invasive procedures in the head, body and extremities.

MR Interventional procedures, performed inside or adjacent to the Philips MR system, must be performed with MR Conditional or MR Safe instrumentation as selected and evaluated by the clinical user for use with the specific MR system configuration in the hospital. The appropriateness and use of information from a Philips MR system for a specific interventional procedure and specific MR system configuration must be validated by the clinical user.

NOTICE

MR image data may be distorted and can lead to improper representations when used to generate 3D printed volumes.

1.6 Compatibility

Do not use your Philips MRI system in combination with other equipment or components, unless the equipment or components are expressly labelled as MR Safe or MR Conditional (see chapter "Auxiliary Medical equipment" on page 76).

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Changes and/or additions to the system should only be carried out by a Philips service engineer, or by third parties expressly authorized by Philips. Such changes and/or additions must comply with all applicable laws and regulations that have the force of law within the jurisdiction(s) concerned, and with best engineering practice.

Changes and/or additions to the system that are carried out by persons without the appropriate training and/or using unapproved spare parts may lead to the Philips warranty being voided. As with all complex technical systems, maintenance by persons not appropriately qualified and/or using spare parts that do not meet Philips' specifications carries serious risks of damage to the system and of personal injury. Please be aware that Philips does not validate the use of non-Philips provided parts with this system. Validation is done to ensure product performance will meet its specification and Instructions for Use. System performance issues arising from parts not meeting the above requirements will be the responsibility of the User as its use is not validated by Philips.

Technical information to facilitate testing of compatibility of auxiliary equipment, is provided in the Technical Description.

Philips is performing dedicated compatibility testing for selected combinations of MRI systems and other equipment. The results of these tests are captured in compatibility statements. Ask your Philips Representative or go to www.philips.com/IFU for the available compatibility statements.

1.7 Compliance

Philips MRI systems comply with relevant international and national standards and laws. Information on compliance will be supplied on request by your local Philips Healthcare representative.

In particular, the MR system is designed in compliance with IEC60601-2-33 (Basic Safety and Essential Performance of MR Systems), which includes IEC60601-1 (Basic Safety and Essential Performance of Medical Electrical Equipment and Systems) and its collaterals.

IEC-60601-2-33 is the MR Safety standard published by the International Electrotechnical Commission.

Philips MRI systems comply with relevant international and national law and standards on EMC (electromagnetic compatibility) for this type of equipment when used as intended. Such laws and standards define both the permissible electromagnetic emission levels from equipment, and its required immunity to electromagnetic interference from external sources.

Use and operation of this system is subject to the law in the jurisdiction(s) in which the system is being used. Both users and operators must only use and operate the system in such ways as do not conflict with applicable laws or regulations which have the force of law. Both users and operators must be trained appropriately and have taken notice especially of the safety paragraphs in these Instructions for Use.

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CAUTION

In the United States, Federal law restricts this device to sale by or on the order of a physician.

1.8 Training

Before you attempt to operate the Philips MRI system described in these Instructions for Use, you must have received adequate training on its safe and effective use. Training requirements for this type of device will vary from country to country. Training must be adequate and in accordance with local laws or regulations which have the force of law.

Training for the following emergency procedures must be included:

- Medical emergency
- Fire
- Using the Emergency Magnet Off button
- (Unauthorized) access to the Controlled Access Area

Philips provides application training for safe and effective use of general system functions and for dedicated application packages. If you require further information about training, contact your Philips application specialist.

1.9 Installation, Maintenance and Repair

Installation, maintenance and repair instructions for the system described are supplied by Philips Healthcare in separate documentation.
Installation, maintenance and repair must be performed by appropriately trained personnel.

The user is responsible to (at least weekly) check the integrity of system and coil covers, coil cables, and accessories. Contact Philips Healthcare for information on the system maintenance program.

Philips Healthcare can only accept responsibility for basic safety, reliability and (essential) performance, if:

- qualified personnel carry out assembly operations, extensions, readjustments or repairs,
- the electrical installation of the technical room complies with the appropriate requirements, and
- the system is used in accordance with the Instructions for Use.

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WARNING

The MR equipment/system must emit electromagnetic energy in order to perform its intended function. When installed according to Philips guidelines, electromagnetic emission will be compliant to IEC60601-1-2. The Responsible Organization is advised to evaluate any nearby electronic equipment for the need of additional shielding or repositioning to ensure proper operation. Guidance for such evaluations may be found in e.g. AAMI TIR18:2010.

1.10 Equipment classification

EQUIPMENT CLASSIFICATION	
Classification according to IEC-60601-1	
According to the type of protection against electrical shock:	Class I equipment.
According to the degree of protection against electric shock:	Type B and type BF applied parts.
According to the degree of protection against harmful ingress of water:	Ordinary equipment (enclosed equipment without protection against ingress of water, IPX0).
According to the methods of sterilization or disinfection:	Non sterilizable. Use of Liquid surface disinfectants only.
According to the mode of operation:	Continuous operation.

The following (electrical component containing or weight bearing) parts of the system are considered suitable for direct contact with the patient in normal use conditions, i.e. are considered Applied Parts per IEC60601-1:

- Tabletops.
- VCG sensors and module.
- PPU sensors and module.
- All cord-connected RF coils.

1.11 Security and Privacy

1.11.1 Implemented Features

It is the policy of Philips Healthcare to adhere to all required standards and regulations. To assist the hospital, the following functionality has been added to the system:

Access control

Intended to restrict access to the system to authorized users only:

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- Customizable on/off, a user log-on/log-off procedure is required to gain access to the system.
- Access to the system is granted according to a customizable list of authorized users.
- Username/Password authentication is supported for Active Directory and Local users. 2-Factor authentication is supported for Philips Engineers only.
- The system provides functionality to synchronize with customer central user account administration, LDAP only.
- The system supports only single user sessions. It does not provide functionality to register multiple simultaneous users or to switch between users other than via log-off / log-on.
- The system does not support single sign-on for situations where the system works together with other (optional) systems or is part of another system, e.g. extra workstations. Single sign-on is also not for some optional software components that require additional login.

Audit trail

Required to log user activities which are information-security critical:

- Applies to logging-on, reading and/or modifying clinical information.
- Requires that means be provided for auto-backup on a hospital server, e.g. the use of an external standard 'Syslog' server.
- The creation of an audit trail on the local system is not supported.

Network time synchronization

Intended to synchronize system time to an external time-standard:

- Uses a standard Network Time Protocol (NTP).
- The coupling is configured by Field Service during system installation.

Security and node authentication

Intended to secure the exchange of clinical data and restrict this exchange to pre-determined nodes:

- Applies to RIS/CIS and PACS nodes, e.g. archives and viewers
- Does not apply to Field Service access
- Uses standard Transport Layer Security Protocol
- The user can decide at installation to use encryption on a per node basis (this may result in reduced performance).

Computer systems cannot be guaranteed to be safe in an insecure network. The user should provide some level of network protection e.g. installing firewalls.

Implementation

In order to meet the requirements described above, the system implements the solution defined by the Integrating the Healthcare Enterprise (IHE) year 4 Basic Security profile.

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- The Basic Security Integration Profile establishes security measures which, together with the Security Policy and Procedures of the Enterprise, provide patient information confidentiality, data integrity and user accountability. For more information see the DICOM Conformance Statement.

Field Service

Field Service is used to enable the following configuration items based on information supplied by the hospital:

- Authentication and encryption
- Time synchronization
- Configuration of the 'Syslog' server
- Configuration of any other programs, e.g. tools used to install certificates.

Certificates

Certificate requests should be handled by the hospital. The hospital should decide on a procedure to create the Certificate request and import the certificates.

The hospital should also define the types of certificates required, for example:

- The certificate of the machine itself
- The certificates of the machines it chooses to trust
- The certificate of the Certificate Authority (CA).

Certificates should always be signed by someone else, i.e. no self-signed are allowed. However, the signer of the certificate need not be present on the system. Self-signed certificates are the certificates required by the Integrating the Healthcare Enterprise (IHE).

The following should also be specified:

- The location of the certificates (local machine)
- The location of the tools for certificate installation.

Certificates should be used between nodes to enable them to validate the identity of each other.

It is the responsibility of the Healthcare Enterprise (HE) to define the maximum validity period of certificates in its security policy.

1.11.2 Other Security and Privacy Features Addressed

HIPAA defines a number of physical and technical safeguards which are either required or addressable. Some features that could implement these functions are differently or not implemented for reasons mentioned below.
This section also lists other information related to security features that are not implemented and that the owner of the systems should be aware of.

Backup procedure

It is not the intended use of the system to permanently store (sensitive) personal information. Information should be exported to a storage device as soon as possible.

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Emergency Access Procedure

The system allows the creation of multiple users. A user account that serves as a generic emergency account can be created. However the user should be aware that the knowledge of this generic account and access to the system should be restricted to avoid unwanted access to (sensitive) personal information. Note that there is no built in function that will allow or enforce the user of such an account to enter their real name. Also it is not possible to clearly mark data output (e.g. screen, print-out, exported data to DVD) as being created during emergency access operation.

Automatic logoff

An auto-logoff feature is not implemented since it contradicts the intended use of the system. Manual logoff using a 'short-cut' key combination is not implemented for the same reason. A configurable screen save function with password protection is available.

Encryption

The system supports encryption of personal data on hard-drive and removable media (USB devices). Hard drive encryption can be activated by Philips Service Engineers.

Physical access to system

Some parts of the systems are located in the technical area of a system. Access to these locations is assumed to be restricted. Usually, the components in the operator or examination room are more readily accessible and therefore the following characteristics shall be taken into account for system operation and access control:

- The computer case is 'service friendly'; opening and removal of e.g. hard disk without use of tools may be possible; computer case can be locked (e.g. by cable lock etc.); there are no front side accessible drives etc.
- The boot order for the system is DVD - Hard Disk. By inserting a bootable CD/DVD the system may start up from those and thus access may be gained to the system including information stored in it.
- There is no detection of unauthorized physical access into the system e.g. via tamper proof seals.
- The integrity of most of the Philips application software is checked when the systems starts, for data this is not done.
- By default the system BIOS is not password protected and can be accessed during startup of the system if unauthorized access to the system is possible.
  On request Philips Service Engineers are instructed by guidelines how to password protect the BIOS

1.11.3 Network Firewall Configuration

If the system is placed behind a network firewall (this is preferred), then the following ports should be allowed to pass through for the system to operate correctly in a network under normal operating conditions:

- Clinical use: ICMP:Echo, ICMP:Echo-Reply, TCP:104[1)]

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- emote service: TCP:22[2)], TCP:5900[2)], TCP:9903, TCP:9044 or outbound: TCP:443[2)]

[1)] *default port might be reconfigured. It is assumed that outbound traffic is unrestricted.*
[2)] *depending on configuration of the system (ISSLLink or VPN) .*

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2 Safety

This Safety chapter covers general MRI Safety. Make sure you read, understand and know all safety information in this chapter before you use the MRI system.

Safety instructions for specific workflows or MRI components are presented in the relevant chapters of these Instructions for Use.

The User is responsible to ensure adequate training and oversight over all safety matters related to the MRI system. Local regulations may apply.

NOTICE

Any serious incident that has occurred in relation to the device should be reported to the manufacturer.

In the European Economic Area (EEA), the incident should also be reported to the Competent Authority that the Member State, in which the user and/or patient is established, has designated responsible for the implementation of Regulation (EU) 2017/745 of the European Parliament and of the Council of 5 April 2017 on medical devices.

In the United States of America, the Medical Device Reporting regulation contains mandatory requirements for manufacturers, importers, and device user facilities to report certain device-related adverse events and product problems to the FDA.

Follow the applicable laws or regulations on reporting device-related incidents or adverse events in the jurisdiction(s) in which the system is being used.

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2.1 Safety Before Scanning

2.1.1 Prescreening

The User must ensure that everybody is adequately screened before they are allowed near MRI equipment. Screening is essential to prevent injury which may result from exposure to the MRI equipment or an MRI examination.

This specifically applies to patients and MRI personnel who could be at risk of injury due to:

- Their present medical condition.
- Their past medical history.
- Their past or current occupation.

See chapter “Risk factors for MRI-related adverse events” on page 32.

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When prescreening patients, exercise particular caution for those patients with:

- A contraindication for MRI examination (see chapter “Contraindications” on page 28).
- An MR Conditional implant (see chapter “MR Conditional implants” on page 30).

- A higher than normal likelihood of requiring emergency medical treatment due to their present medical condition (see chapter “Risk factors for MRI-related adverse events” on page 32).
- A higher than normal likelihood of requiring emergency medical treatment as a result of strong electromagnetic fields when the system operates in first level controlled operating mode, such as anesthetized patients or patients with restricted thermoregulatory capacity (see chapter “Operating modes” on page 38).

If patient eligibility for an MRI scan is unclear, do not scan the patient. Consult the responsible physicians. A qualified physician must evaluate the risk:benefit ratio of the MRI examination for every patient before scanning.

2.1.2 Contraindications

In general, an MRI examination is contraindicated for patients with:

- An active or passive medical device (for example an implant) unless the medical device is explicitly marked as MR Safe or MR Conditional.
- A body core temperature greater than 38.5 °C, unless the responsible physician approved the patient for MR scanning.

Local regulations may specify additional contraindications. See chapter “MR implant labeling” on page 29 for more information about labels of implants and other medical devices.

For medical devices that are labeled MR Conditional, make sure that both these conditions are met before scanning:

- The responsible physician approved the patient for MR scanning.
- The conditions specified by the implant manufacturer are strictly adhered to.

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WARNING

The MRI system may cause malfunction or displacement of medical devices.

Risk of injury or death.

- **Do not allow persons with a medical device, for example an implant, to enter the Controlled Access Area unless they have specific approval to do so.**

MR scanning or the MRI system itself can:

- Cause the dislodgement of metallic implants through strong attraction or torque.
- Interfere with the operation of electronically, magnetically or mechanically activated implants.
- Cause excessive (local) heating of implants.

  These effects can cause tissue damage, loss of physiologic function, serious injury, or death.

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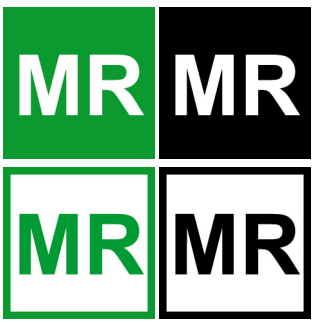
Presence of implants may also cause significant MR image artifacts due to magnetic field distortion. All these effects may also apply to patients and personnel who rely on electrically, magnetically or mechanically activated external life support systems.

2.1.3 MR implant labeling

According to current FDA definitions (21CFR812.3), an implant is defined as “a device that is placed into a surgically or naturally formed cavity of the human body if it is intended to remain there for a period of 30 days or more. FDA may, in order to protect public health, determine that devices placed in subjects for shorter periods are also ‘implants’ for purposes of this part.”

It is the responsibility of the implant manufacturer to declare an implant MR Safe, MR Conditional, or MR Unsafe. Refer to the table for definitions of the MR implant labels. Implants without adequate labeling are considered MR Unsafe. For MR Conditional implants, the general contraindications regarding implants as listed in chapter “Contraindications” on page 28, may not be applicable in their entirety.

Warning label	Source	Definition*
	IEC 62570 1st edition 2014	MR Safe An item that poses no known hazards resulting from exposure to any MRI environment. MR Safe items are composed of materials that are electrically nonconductive, nonmetallic, and nonmagnetic.
	IEC 62570 1st edition 2014	MR Conditional An item with demonstrated safety in the MRI environment within defined conditions. At a minimum, address the conditions of the static magnetic field, the switched gradient magnetic field and the radiofrequency fields. Additional conditions, including specific configurations of the item, may be required. Also see chapter “MR Conditional implants” on page 30.
	IEC 62570 1st edition 2014	MR Unsafe An item which poses unacceptable risks to the patient, medical staff, or other persons within the MRI environment.

Tab. 1: Icons used to label medical devices and other items, to ensure safe use in the MRI environment. * As defined by: ASTM F2503-13. Standard Practice for Marking Medical Devices and Other Items for Safety in the Magnetic Resonance Environment. ASTM International (2013) and by IEC62570 1st edition 2014.

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More about MR Safe and MR Conditional Implants

Implantable medical devices labeled MR Safe or MR Conditional have been cleared, approved and/or licensed by the Competent Governmental Authorities and/or labeled by the manufacturer. For such devices, the general contraindications may not be applicable in its entirety.
It is the responsibility of the implant manufacturer to declare an implant MR Safe or MR Conditional and to define the conditions (restrictions) that allow for safe MR scanning. It is the obligation of the MR operator to be aware of these conditions and to assure that they are strictly adhered to.
Refer to the user documentation of the implant or contact the implant manufacturer to obtain these specific conditions. The system provides options to restrict whole body and head SAR and dB/dt, and to review other system characteristics, as specified in the Technical Description.
Philips does not assume responsibility or liability for the operation of their MRI system with any implantable medical device.

2.1.4 MR Conditional implants

It is the responsibility of the manufacturer of passive and active medical devices, for example implants, to define the conditions that allow for safe MR scanning of an MR Conditional medical device. It is the obligation of the MRI operator to be aware of these conditions and to ensure that these conditions are strictly adhered to.

Refer to the user documentation of the medical device or contact the manufacturer to obtain the MR scanning conditions.

Your Philips MRI system provides options through ScanWise Implant, also known as MROC, to restrict whole body or head SAR or B1+rms, in addition to options to restrict dB/dt, and gradient slew rate, and to review other system characteristics, as specified in the Technical Description. See chapter “Pregnant Patients” on page 383. Philips does not assume responsibility or liability for the operation of their MRI system with any implant other than restricting the system to such implant-specific values entered.

WARNING

Most implants have only been tested for field strengths up to 1.5T

Risk of patient injury

- **Make sure that implant documentation states that scanning is allowed at the field strength of your system.**

Refer to the table for parameters typically specified for MR Conditional implants and their possible risks.

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Conditional parameter (unit)	What is it?	Possible implant-related risk
Main field strength (T)	Strength of the magnetic field at isocenter.	Dislodgement of the implant due to torque.
Spatial field gradient Also called static field gradient, MSG, SFG, SGF (G/cm or T/m)	Measure of how quickly the fringe field of the magnet changes over a given distance. The fringe field of the magnet varies with spatial location inside and around the magnet. 1 T/m = 100 G/cm Note: The spatial field gradient is always present, even when not scanning, because it is related to the magnet, not the gradient coils.	Dislodgement of the implant due to attraction.
SAR value (W/kg) Whole body SAR or head SAR (W/kg, for 15 min)	The RF power absorbed by the patient per unit mass. Note: This value is only valid at the main field strength specified on the implant label.	Excessive (local) heating.
B1+rms (µT)	Average RF deposition in the patient	Excessive (local) heating.
dB/dt (T/s)	The rate of change of the magnetic field generated by the switching gradients used for imaging. The value is specified at a radial distance of 20 cm about the central axis of the magnet bore. Note: this value varies spatially, but the 20-cm nominal value is used for implant labeling.	Malfunction of active implants.
Gradient slew rate (T/m/s)	Measure of the rate of ascent or descent of a gradient from zero to the maximum amplitude.	Malfunction of active implants.

Tab. 2: Typical MR Conditional parameters for implants

The implant manufacturer may specify other conditions, including, but not limited to:

- Use of a specific coil.
- Configuration of the implant itself.
- Special patient preparation (such as no sedation, good communication, etc.).

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NOTICE

The maximum dB/dt on the info page does not take the maximum dB/dt for automatically inserted prescans into account. However, if a maximum dB/dt has been specified in ScanWise Implant and MROC, all scans, including prescans, will be restricted to the dB/dt value specified. For more information, refer to the paragraph 'Gradients' in the Technical Description.

WARNING

Patient has bilateral MR Conditional orthopedic implants.

Risk of skin or internal burns

- **If scanning of bilateral orthopedic implants is approved by the implant manufacturer, use positioning aids to ensure adequate distance between body parts.**

2.1.5 Risk factors for MRI-related adverse events

Certain patient conditions are not a contraindication, but could increase the risk of an adverse event during an MRI examination.

Therefore, exercise particular caution for patients:

- With MR Conditional implants.
- With microscopic pieces of metallic materials in the body (such as shrapnel or metallic splinters) (see next sections).
- With cardiovascular impairment of any sort.
- Who are or may be pregnant (see next sections).
- Who have compromised bone strength (see next sections).
- With extensive dark tattoos, including permanent make-up tattoos (see next sections).
- Susceptible to seizures or claustrophobic reactions.
- Unable to sense or communicate adverse events (such as unconscious, sedated, anesthetized, paralyzed, pediatric, or confused patients) (see next sections).
- With fever.
- Who are thermally insulated (for example due to a plaster or fiberglass cast).
- With impaired thermoregulation (see next sections), which can occur in:
  - Neonates or low birth-weight infants
  - Elderly patients
  - Sedated or anesthetized patients
  - Obese patients
  - Hypertensive patients
  - Patients with diabetes

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- Patients with impaired ability to perspire
- Patients with a type of cancer that impairs thermoregulation
- Patients on certain drug regimes, such as diuretics, tranquillizers, vasodilators

Microscopic pieces of metal

Patients engaged in certain occupations or activities, such as metal welding or military activities, may have embedded metal fragments. These fragments may move and cause damage or patient discomfort (for example in the eye). In addition, these fragments may cause image artifacts.

If there is a suspicion of accidentally embedded metallic fragments, always check with an X-ray before the MRI examination.

If metal fragments are present, a qualified physician must evaluate whether the benefit of the MRI scan outweighs the potential risk.

Pregnancy

No documented adverse fetal effects of MRI examination have been reported. However,

- The fetus is especially thermally vulnerable during the first trimester.
- Scanning is not recommended in the first trimester or if pregnancy status is unknown.
- When scanning a pregnant patient, it is recommended to limit Whole Body SAR level to 2W/kg (normal operating mode). Refer to chapter “Specific Absorption Rate (SAR)” on page 44.
- Local regulations may consider the fetus as a member of the general public and strict exposure limits may apply.

Compromised bone strength

Patients with compromised bone strength are at higher risk for bone injuries. The combination of the patient's weight, muscle relaxation and examination time can cause stress fractures of the ribs or sternum during prone-positioned breast imaging. To prevent injuries:

- Careful position the patient.
- Ensure that the patient does not experience severe pressure.
- Use positioning aids to minimize pressure points.
- Only use the tumble switch at low speed to move the patient to isocenter.
- Do not use the automatic tabletop movement or auto-iso.
- Ensure that the patient's back does not touch the bore.
- Terminate the scan when the patient calls for attention via the nurse call.
- Minimize the total examination time.

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Tattoos & permanent make-up

WARNING

Tattoos, permanent eye-liner, and facial make-up may contain metallic particles.

Risk of burns

- **Warn patients that scanning may cause heating of the tattooed tissue, resulting in a burning sensation or skin irritation.**
- **Instruct patients to immediately press the Nurse Call when any discomfort is experienced during scanning.**
- **Place a cold compress or ice pack on the tattoo to decrease the potential for RF heating.**

Inability to sense or communicate adverse events

WARNING

Patient is unable to sense adverse events or is unable to notify the operator of an adverse event during scanning.

Risk of patient burns, severe PNS or hearing damage

- **Make sure optimal hearing protection is in place.**
- **Examine patient between individual scans to detect potential burns before they progress.**

Impaired thermoregulation

The risk of RF energy-related injuries is higher in patients with impaired thermoregulation. To prevent injuries, do the following in addition to medical supervision:

- Make sure that airflow in the bore is not obstructed.
- Remove any added insulation such as blankets or warm clothing. Insulation interferes with the ability to dissipate heat.
- Monitor physiological signs.
- Avoid scanning in first level controlled mode.
- Limit the whole body SAR to maximum 1 W/kg whenever possible.
- Avoid SED >3.0 kJ/kg, preferably keep SED <2.0 kJ/kg.
- Examine the patient between individual scans to detect potential burns before they progress.

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2.1.6 Clothing and other removable risk factors

WARNING

Clothing or other objects on the patient can lead to local excessive heating.

Risk of burns

- **Remove all metallic and other risk-enhancing items from the patient.**

Objects on the patient:

- Can increase the risk of local excessive heating due to RF energy.
- Influence the homogeneity of the magnetic field.
- Lead to artifacts.

Remove metallic and other risk enhancing items from the patient. These items include:

- All clothing containing metallic thread or components such as zips, metal buttons, hooks, underwire (bras).
- Clothing made of microfibers that may contain undetectable conductive fibers.
- All other metallic objects, such as:
  - Spectacles, dentures, prostheses, hearing aids, insoles
  - Watches, jewelry, medallions, piercings
  - Hairpins, safety pins
  - Face masks
  - Buckles, belts
  - Wigs, hairpieces.
- Transdermal patches for medicine delivery

  Transdermal patches for medicine delivery (for example, nitroglycerin transdermal delivery patch) may contain metallic foil and cause burns to the underlying skin during scanning. Consult the prescribing physician whether the patch can be removed during the examination.
- Damp clothing

  Damp clothing (for example due to perspiration) may facilitate formation of current loops and consequent excessive local heating. Make sure patient clothing is dry before scanning is started.
- Clothing made of synthetic fibers which trap heat. Examples are polyester, polyamide or polypropylene.

Advise patients to wear light, 100% cotton, or linen clothing during the MRI examination or provide MRI compatible garments.

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2.1.7 Controlled Access Area – MR Environment

The Controlled Access Area, also referred to as MR environment, is the area around the MR system to which access is controlled to prevent harm from the main magnetic and RF field. The core of the Controlled Access Area is the B0 hazard area.

The magnetic fringe field can:

- Cause injury to certain people (see chapter “Contraindications” on page 28).
- Attract objects made of ferromagnetic material (see chapter “Static magnetic field” on page 43).

The Controlled Access Area must therefore be protected by both administrative and physical barriers.

The perimeters of the B0 hazard area is within the Faraday cage, the RF shielded MR examination room. Inside this RF shielded volume:

- Elevated RF levels or the magnetic fringe field may disturb electronic equipment other than equipment tested and approved by Philips.
- The presence of electronic equipment may interfere with the operation of the MR system.

When the perimeters of the B0 hazard area exceed the walls of the Faraday cage, additional administrative and physical barriers are required. This can be applicable for the technical room, the area around a trailer or the space above or below the MR examination room.

WARNING

The magnet attracts objects made of iron or other magnetic materials.

Risk of injury or death.

- **Do not bring objects made of iron or other magnetic materials into the Controlled Access Area.**

Examples of iron or other magnetic materials include, but are not limited to:

- Scissors, pocket knives, lighters, keys, coins, hair pins
- Vacuum cleaners, floor polishers
- Mobile phones, pagers, tablets
- Magnetic wheel chairs, patient trolleys, iron stretchers
- MR Unsafe fire extinguishers
- Life supporting devices, vital sign monitoring, or emergency equipment

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WARNING

Unauthorized or unintentional access to the Controlled Access Area.

Risk of injury or death, in particular for patients with a medical device.

- **The User must ensure that:**
  - **All points of entry into the Controlled Access Area are marked with a Safety Marking Plate.**
  - **Adequate rules for controlling access to the Controlled Access Area are established.**
  - **Local statutory requirements concerning access to the Controlled Access Area are followed.**

It is advised to ensure that the operator always has visual oversight of the entrance (Kanal E, Barkovich AJ, Bell C, et al. ACR guidance document on MR safe practices: 2013. J Magn Reson Imaging. 2013; 37(3): 501–530).

The distances from the magnet in which 0.5 mT is exceeded, are shown in the table and diagram.
The values apply to Ingenia Ambition and MR 5300 systems.

Field Strength	X direction	Y direction	Z direction
1.5T	2.4 m	2.4 m	4.0m

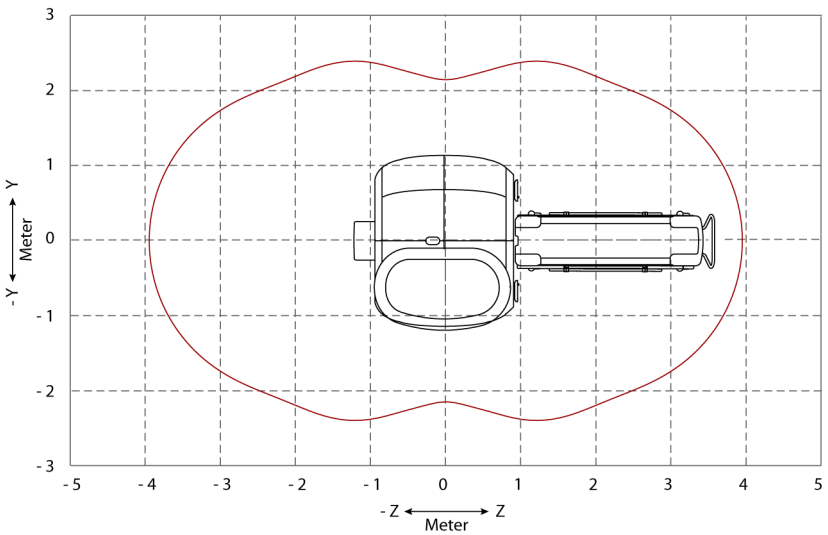

Fig. 1: Top view with 0.5 mT (5 gauss) lines.

Philips MRI systems comply with the requirements of applicable electromagnetic compatibility (EMC) standards. Other electronic equipment exceeding the limits defined in these EMC standards could, under unusual circumstance, affect the operation of the system.

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The operation of electronic equipment (such as mobile phones) or auxiliary devices (such as vital sign monitoring, life supporting devices, and emergency care equipment) which are not labeled MR Safe or MR Conditional can be affected by MR scanning or the MRI system itself. These devices can also affect the proper functioning of the MRI equipment and cause hazardous situations and artifacts. Only use and permit devices labeled as MR Safe or MR Conditional within the Controlled Access Area. See chapter “Auxiliary Medical equipment” on page 76 for more information.

2.1.8 Operating modes

All Philips MRI systems comply with the IEC 60601-2-33 standard, which defines separate operating modes.

Operating mode	Explanation
Normal	No physiological stress factors are expected. Routine patient observation is required during scanning.
First level controlled	MRI scanning may cause physiological stress. Medical supervision during scanning is required.
Second level controlled	This operating mode is not accessible.

The type of scanner (static magnetic field) and the scan protocol (gradient output and SAR levels) determine the operating mode. The levels of exposure for the normal operating mode and the first level controlled operating mode are specified in IEC 60601-2-33 and are based on current scientific literature related to safety.

Alerts before entering first level controlled mode

Before an examination enters first level controlled mode for the first time, the operator:

1. Is alerted by the system.
2. Is instructed to ensure medical supervision is in place.
3. Must actively accept this mode of system operation.

2.1.9 Patient observation and medical supervision

It is the responsibility of the User to establish a program to ensure that appropriate patient observation and medical supervision of patients is available when required.

Routine patient observation	Verbal contact with or visual observation of the patient in the MRI examination room.

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Medical supervision	Adequate medical management under responsibility of a qualified physician, to ensure safety of patients who can be at risk from exposure to the MRI system either because of their medical condition, the levels of exposure, or a combination of both. MR Conditional auxiliary devices* may be used to monitor various physiological states (such as heart rate, ECG trace, pulse oximetry), in addition to routine patient observation.

*See Chapter **Other MRI Safety -> Auxiliary Medical Equipment** for more information about the use of auxiliary devices.

Medical supervision is always indicated when a patient:

- Is exposed to a first level controlled scan. See chapter “Operating modes” on page 38.
- Is at an increased risk of MRI-related adverse events. See chapter “Risk factors for MRI-related adverse events” on page 32.

A qualified physician must evaluate the risk:benefit ratio of the MRI examination for every patient before scanning. The physician must include the need for medical supervision in this evaluation.

2.1.10 Emergency procedures

The User is required to establish emergency procedures for the following situations:

- A medical emergency
- A fire
- An emergency that requires immediate removal of the magnetic field

Philips MRI systems have an Emergency Table Stop button in case there is an emergency during tabletop movement.

Medical emergency

It is the responsibility of the User to make sure that precautions and appropriate procedures are established for medical emergencies during scanning. Especially for patients:

- At risk of cardiac arrest.
- Predisposed to seizures or claustrophobic reactions.
- Who are very sick, sedated, confused, or unconscious.
- Incapable of reliable communication.

A procedure must be in place to remove a patient rapidly from the MRI examination room. Safe and effective use of electronic or other metallic emergency equipment may be impossible near the magnet. Only bring emergency equipment that is MR Safe or MR Conditional into an MRI examination room. If necessary, use the Emergency Magnet Off button (see chapter “Emergency Magnet Off button” on page 41).

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WARNING

An MR system failure may occur

Risk of delay in diagnosis

- **Ensure that an appropriate hospital protocol is established to complete the diagnosis without the availability of the MR system.**

The system cannot be used until a repair has been made by a Philips service engineer. Some repair actions take longer than a day.

A procedure must be in place in case an unexpected implant or foreign body is found during scanning. A slow removal from the magnet, while the patient remains lying down, may be the most appropriate method. In principle, all patients must be adequately screened for implants before they are allowed near MRI equipment (see chapter “Prescreening” on page 27 and chapter “Contraindications” on page 28).

WARNING

When the MR system is used for interventional procedures, the hospital must establish procedures to complete the intervention or adequately stabilize the patient in case of MR system failures.

NOTICE

The system is not designed to withstand cardiac defibrillation procedures. If cardiac defibrillation is required, remove the patient from the table and outside the 5 gauss line. If an MRI system part or coil has been exposed to a defibrillation pulse, do not use the system. A Philips service engineer must replace the affected part.

Fire

It is the responsibility of the User to:

- Establish fire precautions and fire emergency procedures.
- Discuss all fire precautions with the local fire department.
- Comply with all applicable fire regulations.

All operators must be fully aware of and trained in:

- The use of fire extinguishers and other fire-fighting equipment.
- All fire precautions and fire emergency procedures.

Policy for fire extinguishers

When selecting fire extinguishers, make sure you:

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- Provide extinguishers for both electrical and chemical fires.
- Choose extinguishers that suit your site.
- Use MR Safe extinguishers.
- Cannot mix-up the MR Safe extinguishers with MR Unsafe extinguishers.

WARNING

Flammable gases or vapors (such as certain anesthetics) near the MRI system can lead to fire or explosion.

Risk of burns or serious injury

- **It is not allowed to use flammable anesthetic mixtures with air, oxygen or nitrous oxide near the MRI system.**
- **Philips MRI systems are not AP (Anesthetic-Proof) or APG (Anesthetic-Proof-Category G) tested.**
- **Consult an anesthetist if you are not sure whether a certain anesthetic is allowed near the MRI system.**

WARNING

Oxygen rich environment can lead to fire or explosion

Risk of burns or serious injury

- **If ventilation or anesthesia equipment detects an error condition, immediately stop the scan and remove the patient from the MRI system.**

Immediate removal of the magnetic field

Emergency Magnet Off button

Your MRI system has two Emergency Magnet Off buttons:

- Inside the examination room.
- Outside the examination room.

Use the Emergency Magnet Off button to immediately remove the static magnetic field within 20 seconds.

Only use the Emergency Magnet Off button when:

- A person is trapped by an object that is attracted by the magnet.
- Fire or another event occurs, that demands immediate entry of emergency personnel or equipment into the examination room.

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- Any other emergency occurs that requires immediate removal of the magnetic field.

For normal and controlled ramp-down, call the number in the **Otherwise** box on the label or contact your Philips service engineer. This is applicable when:

- Material is attracted and stuck to the magnet and needs to be removed.
- Other situations occur where non-urgent removal of the static magnetic field is required.

To immediately remove the static magnetic field:

1. Lift the front cover of the protective cap.
2. Press the red Emergency Magnet Off button fully.

Fig. 2: Emergency Magnet Off button and label.

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NOTICE

After an emergency magnetic field removal, the magnet needs time to recover (cool-down). Typical duration is approx. 48 hours. Contact Philips Service or Philips-certified in-house engineer to restore the magnetic field.

Magnet field removal or loss

In an emergency event, you can remove the static field immediately by pressing the Emergency Magnet Off button.
Please note that in rare occasions also a spontaneous magnet field loss can occur.

When this occurs, the following notification appears at the bottom of the user interface: "The MR resonance frequency cannot be found". To confirm that the magnet is off-field and that no attractive force is present, carefully bring a securely held ferromagnetic coin or key close to the magnet.

Contact call Philip service to restore the magnet field.

Emergency Table Stop

Your MRI system has an **Emergency Table Stop** button on each side of the magnet bore:

On the VitalScreen

Fig. 3: Emergency Table stop button (1) and the Resume button (2) (Tumble switch serves to resume tabletop movement).

Depending on the configuration of your system, the patient-operator intercom in the control room may also have an **Emergency Table Stop** button.

To stop tabletop movement and the current scan immediately:

- Press the **Emergency Stop** button.
  - ⇨ The tabletop is released.
  - ⇨ Manual tabletop movement in and out of the bore is possible.
  - ⇨ The red light on the Emergency Stop button switches on.
- To reset the tabletop and re-enable normal operation, press the **Resume** button.

NOTICE

To stop tabletop movement controlled by software during scanning, press the **F12 key** or press the **Emergency Table Stop** button on the patient-operator intercom.

2.2 Safety During Scanning

2.2.1 Exposure to EMF

Static magnetic field

The magnetic field strength of the system and the applicable IEC standard are stated in the About function. To access the About function, on the menu bar, click **Help**, then **About**.

Information about the spatial field gradient can be found in the Technical Description.

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WARNING

Working near or inside the magnet bore (e.g. interventional procedures) may affect task performance of medical staff.

Reduced attention can be the effect of movement in the magnetic field or peripheral nerve stimulation. It is recommended that medical staff will evaluate their sensitivity to such effects, prior to performing the medical procedure.

Specific Absorption Rate (SAR)

The scan procedures always involve the emission of radio frequency (RF) energy. This RF energy can heat the patient, and hence, is of concern. The Specific Absorption Rate (SAR) is the RF power absorbed by the patient per unit mass expressed in Watts per kg (W/kg).

NOTICE

Personnel working inside or very close to the magnet during scanning may experience heating due to RF exposure. Relative SAR levels for occupational exposure can be derived from the spatial distribution provided in the Technical Description. Exposure can be reduced by keeping distance from the magnet or by selecting Normal Operating Mode.

SAR Types

There are different SAR types each with its own limit:

Whole body SAR	the SAR averaged over the total mass of the patient.
Head SAR	the SAR averaged over the mass of the patient's head.
Local torso SAR	the SAR averaged over any 10g of tissue of the patient.
Local extremities SAR	the SAR averaged over any 10g of extremity tissue of the patient.

The system determines the limiting SAR type of a scan (whole body, head, local torso, or local extremity) based on the applied coil, table position, and patient orientation. This SAR type is the first to reach its maximum allowed value and thus poses the strongest restriction on the scan.

All limiting SAR types can produce:

- Local warming sensations.
- Core temperature increases.

  The severity of these effects depends on the SAR value, patient positioning, and the condition of the patient. To ensure proper patient care, consider both effects.

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The predicted SAR is calculated for each scan and is a conservative estimate. Information on the limiting SAR type and expected SAR values for the scan is displayed on the Scan Dashboard and on the info page:

• SAR / limiting SAR type:	x %
• Whole body / level:	y W/kg / n

Limiting SAR type = whole body, head, local torso or local extremities.
x % = The predicted SAR expressed as a percentage of the maximum for the limiting SAR type.
y W/kg = The predicted whole body SAR.
n = Operating mode (normal or first level)

SAR correlates with the average RF deposition in the patient, also denoted as B1+rms. SAR and B1+rms can be found on the scan information page. Labeling of MR Conditional implants may specify an upper limit for SAR or B1+rms to control the MR exposure conditions. B1+rms is a more direct measure of RF-related heating induced in implants than SAR. See chapter ScanWise Implant for more information about scanning patients with MR Conditional implants and the ScanWise implant wizard.

The maximum value for B1+rms can be limited through ScanWise Implant, see ScanWise Implant.

Operating modes for SAR

The system recognizes three operating modes.

SAR Operating mode	SAR limits for Volume Transmit Coils	SAR limits for Transmit Surface Coils	Safety measures
Normal	Whole body SAR ≤ 2 W/kg Head SAR ≤ 3.2 W/kg	Local torso SAR ≤ 10 W/kg Local extremities SAR ≤ 20 W/kg	Patient observation.
First level controlled	Whole body SAR > 2 W/kg and ≤ 4 W/kg Head SAR ≤ 3.2 W/kg	Local torso SAR ≤ 20 W/kg Local extremities SAR ≤ 40 W/kg	Patient monitoring with medical expertise.
Second level controlled	Whole body SAR > 4 W/kg Head SAR > 3.2 W/kg	Local torso SAR > 20 W/kg Local extremities SAR > 40 W/kg	The system is limited, second level controlled operating mode cannot be reached.

More information about SAR first level controlled operating mode:

The SAR limitations for normal and first level controlled operating mode are based on current scientific knowledge that relate RF power deposition (SAR) to increase of core temperature and local temperature.

When SAR first level controlled operating mode is reached, a warning message is given, and medical supervision of the patient is required.

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- If the patient's condition cannot be monitored, or the risk is too high (for example due to elevated baseline core temperature or reduced thermoregulatory capabilities of the patient, anesthesia, or unconsciousness), the scan parameters must be changed to lower the SAR to normal operating mode.
- If the risk is acceptable, start the scan.

NOTICE

The patient's temperature rise depends on the total RF energy delivered during the examination (SED). Information on the total (delivered + scheduled) SED is available at the user interface to support evaluation of the patient's warming.

WARNING

Room temperature too high

Risk of excessive patient heating

- **Scan in normal mode if the examination room temperature exceeds 22 °C (72 °F).**
- **Monitor room temperature using MR Safe or MR Conditional equipment.**
- **Reassess medical benefit of the scan versus potential risk to the patient.**

The system is specified for use with examination room temperatures 18–22 °C (64–72 °F). Exceeding the upper limit must be a medical judgment as to the patient's benefit versus potential risk. High examination room temperature may lead to excessive patient heating, especially in combination with high RF exposure.

Check the examination room temperature twice a day. If it exceeds 22 °C (72 °F):

- Take action to reduce the examination room temperature.
- Reevaluate the medical judgement of the benefit of scanning versus the potential risk to the patient.
- Restrict scan SAR values to normal operating mode (whole body SAR < 2W/kg).
- Apply patient ventilation.

NOTICE

The consequence of SAR-induced increase of the patient's core temperature is that scanning a patient with an initial core temperature >38.5 °C is contra-indicated, while a patient with an initial core temperature >38 °C can only be scanned in Normal Mode. Scan duration shall be limited, and monitoring of the core temperature is recommended.

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Guidance for Specific Absorption Rate (SAR)

Restricting all scan protocols of an examination to normal operating mode for SAR

- To restrict all scan protocols of an examination to Normal Operating Mode for SAR, set **Allowed SAR Mode** to **Normal** in the **New Patient** window.

Alerts before entering first level controlled mode

When the Allowed SAR mode or PNS mode is not restricted to the normal operating mode and when the examination enters the first level operating mode, the operator:

1. Is alerted by the system prior to the start of the first scan that exceeds the SAR limit or the gradient output limit for Normal Operating Mode.
2. Is instructed to ensure medical supervision is in place.
3. Must actively accept First Level Operating Mode for the rest of the examination, separately for SAR and for gradient output.

These alerts are given once per examination.

Pop-ups requesting the operator to actively accept first level controlled mode

High Whole Body SAR	
English	**Your language**

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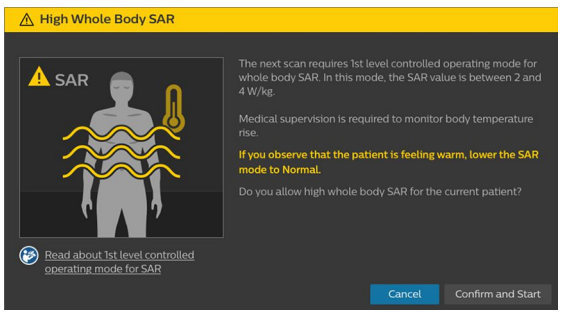
High Whole Body SAR	
High Whole Body SAR	**High Whole Body SAR**
The next scan requires 1st level controlled operating mode for whole body SAR. In this mode, the SAR value is between 2 and 4 W/kg.	The next scan requires 1st level controlled operating mode for whole body SAR. In this mode, the SAR value is between 2 and 4 W/kg.
Medical supervision is required to monitor body temperature rise.	Medical supervision is required to monitor body temperature rise.
If you observe that the patient is feeling warm, lower the SAR mode to Normal.	If you observe that the patient is feeling warm, lower the SAR mode to Normal.
Do you allow high whole body SAR for the current patient?	Do you allow high whole body SAR for the current patient?
Read about 1st level controlled operating mode for SAR.	Read about 1st level controlled operating mode for SAR.
Cancel **Confirm and Start**	**Cancel** **Confirm and Start**

Medical supervision of the patient is required. Whole Body SAR of scan is between 2 and 4 W/kg.

This message is displayed when the scan exceeds SAR limits of the Normal Operating Mode. The system enters the First Level Controlled Operating Mode and the following safety measures apply:

- Patients need to be monitored with medical expertise.
- Particular caution for patients at risk.
  Press **cancel** to lower SAR by modifying the scan(s) and operate within Normal Operating Mode.
  Press **Confirm & Start** to continue the examination in First Level Controlled Operating Mode.

For more information about SAR please refer to section *Specific Absorption Rate (SAR)*.



High Whole Body SAR (applies for Italy)	
English	**Your language**

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High Whole Body SAR (applies for Italy)

High Whole Body SAR

The next scan requires 1st level controlled operating mode for whole body SAR. In this mode, the SAR value is between 2 and 4 W/kg. The SAR level exceeds the limits set by Italian regulation (D.M 3-8-93).

Medical supervision is required to monitor body temperature rise.

If you observe that the patient is feeling warm, lower the SAR mode to Normal.

Do you allow high whole body SAR for the current patient?

Read about 1st level controlled operating mode for SAR.

Cancel
Confirm and Start

High Whole Body SAR

The next scan requires 1st level controlled operating mode for whole body SAR. In this mode, the SAR value is between 2 and 4 W/kg. The SAR level exceeds the limits set by Italian regulation (D.M 3-8-93).

Medical supervision is required to monitor body temperature rise.

If you observe that the patient is feeling warm, lower the SAR mode to Normal.

Do you allow high whole body SAR for the current patient?

Read about 1st level controlled operating mode for SAR.

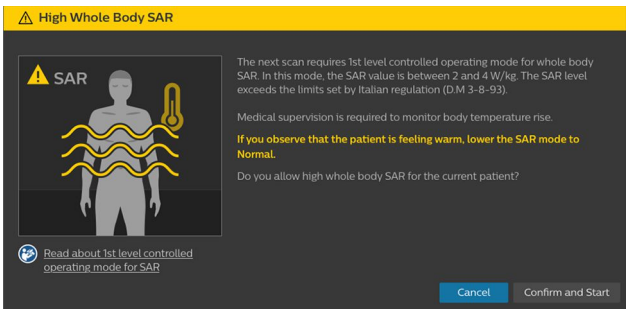
Cancel
Confirm and Start

Medical supervision of the patient is required. Whole Body SAR of scan is between 2 and 4 W/kg.

This message is displayed when the scan exceeds SAR limits of the Normal Operating Mode. The system enters the First Level Controlled Operating Mode and the following safety measures apply:

- Patients need to be monitored with medical expertise.
- Particular caution for patients at risk.
  Press **cancel** to lower SAR by modifying the scan(s) and operate within Normal Operating Mode.
  Press **Confirm & Start** to continue the examination in First Level Controlled Operating Mode.

For more information about SAR please refer to section *Specific Absorption Rate (SAR)*.



If you decide to cancel, scanning is interrupted to allow you to restrict operation to Normal Operating Mode. This can be done for each scan:

- Set the imaging parameter **SAR allow first level** on the Contrast tab to **No**.
- Set the imaging parameter **PNS mode** on the Contrast tab to **Moderate** or **Low**.

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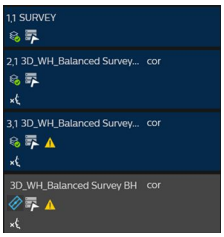
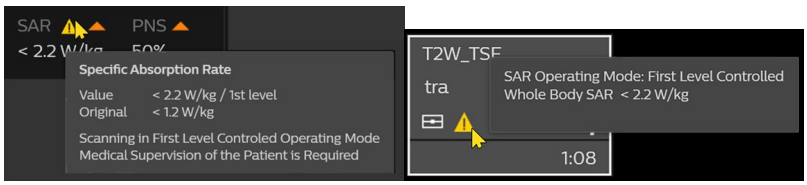
If you intend to restrict all scans to Normal Operating Mode for SAR, re-registration of the patient allows to select the checkbox for Normal Operating Mode in the New Examination window.

Warning icon during planning

When a planned scan protocol requires operation in First Level Controlled Operating Mode, the warning icon is shown on the user interface, so that you can prepare medical supervision. The warning sign indicates that the system will be operating in First Level Controlled Operating Mode.

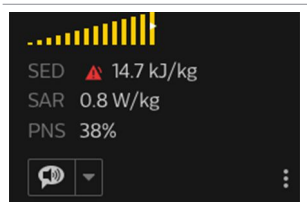


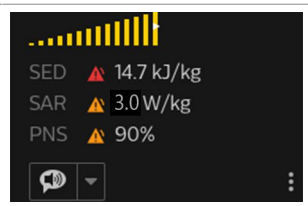
Hovering over the warning icon shows the SAR, SED and PNS values for the planned scan.



Alerts during scanning

When the scan is active, the numerical values for SAR and gradient output are displayed together with the warning sign if the output is in First Level Controlled Operating Mode, independently for SAR or gradient output.





Exam Dashboard with SED, SAR and PNS values for the running scan.
The alarm icon is displayed if the value corresponds to First Level Controlled Mode, to remind of the need of medical supervision.

High SAR scanning

It is advised to use high whole-body SAR levels only if absolutely necessary. For patient comfort lower SAR levels are preferred. Scanning in high SAR mode may result in perspiration and discomfort of the patient.

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WARNING

For High SAR scanning it is required to use the patient ventilation system.

WARNING

Patients who are exposed to high SAR values must be dressed in light clothing (e.g. light pajamas, nightshirt or T-shirt).

WARNING

For scanning a baby in an incubator it is advised to only scan in normal operating mode.

This will avoid a too high SAR value for the baby in the warm and humid incubator environment.

NOTICE

For high SAR scanning it is advised to plan breaks between the scans for the patient to cool down.

Breaks can be created by planning low SAR scans between the high SAR scans.

WARNING

Medical supervision is required for all scans in first level controlled mode.

Special attention is required for young, pregnant and elderly patients to prevent increase of body core temperature. Select low SAR sequences whenever possible.

Specific Energy Dose (SED)

SED is also known as SA (Specific Absorption) or SAE (Specific Absorbed Energy).

During an MRI examination, RF energy is transferred to the body, potentially resulting in warming sensations. The patient temperature rise is proportional to the total energy delivered to the patient (SED, expressed as kJ/kg). It is determined by the SAR and scan duration. SAR is the rate of delivered energy expressed in Watts/kg, represented as W/kg. Limiting the amount of RF energy (SED) delivered to the patient, limits the temperature rise in the patient.

Specific Energy Dose is a comfort measure and provides feedback on the RF energy delivered to the patient. In general, a delivered SED value > 3.5 kJ/kg may be uncomfortable for some patients. The Philips recommended maximum for SED is 7.0 kJ/kg. Patient comfort during scanning is affected by the condition of the patient and must be taken into account. A rise in body temperature can be a hazard to a patient with impaired thermoregulation.

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Recommended maximum SED for this group is 3 kJ/kg although preferably SED is kept below 2 kJ/kg. Serious discomfort is reported by healthy volunteers at values greater than 7.0 - 8.5 kJ/kg.

Delivered SED	The SED of the completed scans including the SED of the currently running scan.
Scheduled SED	The SED of the scans that are scheduled for the examination.
Total SED	The total amount of the delivered and scheduled SED.

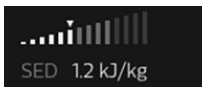
NOTICE

Adequate patient cooling (for example by using in-bore patient ventilation and making sure examination room temperature is within the specified range) is necessary in order to keep patient comfort within desired limits. Also see chapter “Clothing and environmental conditions” on page 54.

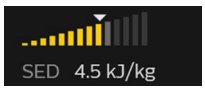
Guidance for Specific Energy Dose (SED)

The SED status is visible as SED bar on the Exam Dashboard.

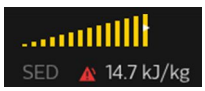
- The SED bar has a scale of 0.0 to 7.0 kJ/kg.
- The SED bar shows the scheduled SED in white and the delivered SED in light grey.
- Once the delivered SED exceeds 3.5 kJ/kg, the color changes to yellow.
- Once the delivered SED exceeds 7.0 kJ/kg, the red warning icon displays besides the SED value.



- Light grey: The total scheduled SED for this examination.
- White: Delivered SED of 1.2 kJ/kg.



- Yellow: Delivered SED exceeds 3.5 kJ/kg.



- Red alarm icon: Delivered SED exceeds 7.0 kJ/kg.

Information about SED is also available during planning on the Scan Dashboard, and the SED of each scan is available on the info page.

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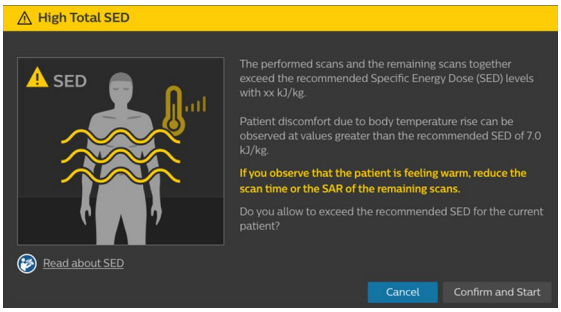
Once the total SED exceeds 7.0 kJ/kg, a pop-up appears:

High Total SED	
English	**Your language**
High Total SED	**High Total SED**
The performed scans and the remaining scans together exceed the recommended Specific Energy Dose (SED) levels with xx kJ/kg. Patient discomfort due to body temperature rise can be observed at values greater than the recommended SED of 7.0 kJ/kg.	The performed scans and the remaining scans together exceed the recommended Specific Energy Dose (SED) levels with xx kJ/kg. Patient discomfort due to body temperature rise can be observed at values greater than the recommended SED of 7.0 kJ/kg.
If you observe that the patient is feeling warm, reduce the scan time or the SAR of the remaining scans. Do you allow to exceed the recommended SED for the current patient?	If you observe that the patient is feeling warm, reduce the scan time or the SAR of the remaining scans. Do you allow to exceed the recommended SED for the current patient?
Read about SED.	Read about SED.

This message pops up when the total SED for the current patient exceeds 7.0 kJ/kg when the scan is started.

- **Confirm and Start** immediately starts the scan.
- **Cancel** sets the scan back to **ready to run** and allows you to adjust parameters.

  Cancel is the default value.



Once the delivered SED exceeds 7.0 kJ/kg:

- A pop-up informs you that the recommended SED maximum value will be exceeded with the next scan.
- A red alarm symbol appears in front of the SED value.

Recommended Maximum SED Will Be Exceeded	
English	**Your language**

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Recommended Maximum SED Will Be Exceeded

Recommended Maximum SED Will Be Exceeded

In the next scan and the remainder of the examination the SED exceeds 7.0 kJ/kg, which leads to patient discomfort. Medical supervision is required to monitor the patient temperature rise. Specific Energy Dose (SED) is a comfort measure about the RF energy delivered to the patient. Serious discomfort is reported at values greater than 7.0 kJ/kg.

If you observe that the patient is feeling warm, stop scanning to avoid serious discomfort. Confirm that the clinical benefit exceeds the risk of high SED. Do you allow to exceed the recommended SED for the current patient?

Read about SED.

Recommended Maximum SED Will Be Exceeded

In the next scan and the remainder of the examination the SED exceeds 7.0 kJ/kg, which leads to patient discomfort. Medical supervision is required to monitor the patient temperature rise. Specific Energy Dose (SED) is a comfort measure about the RF energy delivered to the patient. Serious discomfort is reported at values greater than 7.0 kJ/kg.

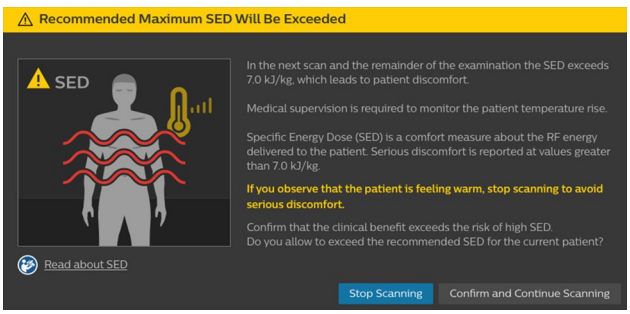
If you observe that the patient is feeling warm, stop scanning to avoid serious discomfort. Confirm that the clinical benefit exceeds the risk of high SED. Do you allow to exceed the recommended SED for the current patient?

Read about SED.

This message pops up when the Delivered SED for the current patient exceeds 7.0 kJ/kg when the scan is started.

- To continue scanning, click **Confirm and Continue Scanning**.
- To stop scanning, click **Stop Scanning**.

  Stop Scanning is the default value.



Clothing and environmental conditions

Increased examination room temperature and humidity hinder the body's ability to dissipate excess heat. Likewise, thick clothing and clothing made of synthetic fibers hinders heat dissipation.

Examination room:

- Room temperature must be kept to 18 - 22°C (64 - 72°F).
  Recommended room temperature is 21°C (70°F) .
- Relative humidity must be kept to 40 - 70%.

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WARNING

Take appropriate action to prevent severe perspiration of the patient.

Severe perspiration of the patient may result in the formation of unintended RF circuits between body parts and ultimately in burn injuries.

WARNING

Remove any added insulation (such as blankets).

Added insulation prevents satisfactory dissipation of body heat.

WARNING

Verify that the patient ventilation system is working. Pads and accessories must never obstruct patient airflow in the bore.

Patient core temperature rise can be minimized by adequate ventilation of the patient space.

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NOTICE

Avoid direct contact of the patient with the magnet bore covers or Transmit-Receive Coils.

This may cause local heating of the patient.

Gradient System

Effects of Gradient Output

The use of fast switching and high gradients may lead to peripheral nerve stimulation (PNS) during the scan. The location and nature of the PNS differs for each individual. PNS can cause a tingling sensation or superficial twitching. Some patients may report such sensations as pain, when scanning in first level controlled operating mode.

NOTICE

Very high gradient output could even cause cardiac nerve stimulation.

Literature indicates that threshold levels for cardiac stimulation are much higher than for peripheral nerve stimulation. Peripheral nerve stimulation is possible. Cardiac stimulation is never induced by the exposures from the gradient switching.

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Calculation of Gradient Output

During the scan definition, the gradient output is calculated for this scan (PNS) and compared with mean threshold level. This mean threshold PNS is defined as the onset of sensation, and refers to the level at which 50% of the people start to experience PNS.

The expected PNS level is displayed on the info page and expressed as a percentage of the mean threshold level for PNS as calculated by the system for the sequence prepared for the patient.

PNS/level	x % / n

x % = The predicted PNS value is expressed as a percentage of the mean threshold level for PNS.
n = Operating mode ('Normal' or 'Level I')

PNS Levels

This MR system employs a Whole Body Gradient System, and the Gradient Output related to potential peripheral nerve stimulation is defined in a cylinder of 20 cm radius around the magnet bore's center line.

The system recognizes three PNS levels, corresponding to chapter "" on page 56:

IEC Operating mode	Gradient output	Safety measures
Level 0 (Normal)	Gradient output ≤ 80% of the mean threshold level	• Routine patient observation
Level I (First level controlled)	80% of the mean threshold level < Gradient output ≤ 100% of the mean threshold level	• Patient monitoring with medical expertise • Particular caution for patients at risk
Level II (Second level controlled)	Gradient > 100% of the mean threshold level	The system is limited to a maximum gradient output of 100% of the mean threshold level. Level II cannot be reached

Guidance for Peripheral Nerve Stimulation (PNS)

In Level 0, the probability of PNS is very low.

When Level I is reached (predicted gradient output exceeds 80% of the mean threshold level) a warning message is displayed:

High Peripheral Nerve Stimulation	
English	**Your language**

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High Peripheral Nerve Stimulation

High Peripheral Nerve Stimulation

The next scan requires 1st level controlled operating mode for Peripheral Nerve Stimulation (PNS). In this mode the PNS value is above 80%. Medical supervision is required to monitor patient comfort.

If you observe that the patient feels a tingling sensation or superficial twitch, lower the PNS mode to Normal.

Do you allow a high PNS level for the current patient?

Read about 1st level controlled operating mode for PNS.

High Peripheral Nerve Stimulation

The next scan requires 1st level controlled operating mode for Peripheral Nerve Stimulation (PNS). In this mode the PNS value is above 80%. Medical supervision is required to monitor patient comfort.

If you observe that the patient feels a tingling sensation or superficial twitch, lower the PNS mode to Normal.

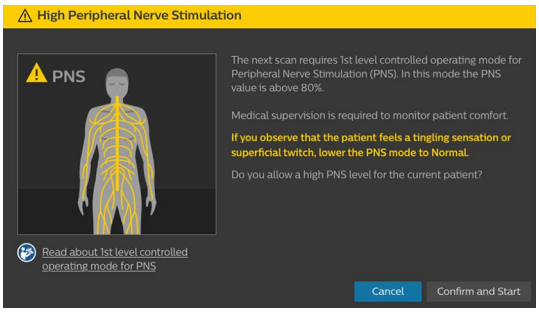
Do you allow a high PNS level for the current patient?

Read about 1st level controlled operating mode for PNS.

The message pops up when the PNS exceeds 80%, and high PNS was not confirmed for the current examination.

- **Cancel** sets the scan back to **ready to run** and allows you to adjust the parameters.
- **Confirm and Start** immediately starts the scan.

  All scans for the current patient which require medical supervision due to high PNS are allowed.
- **Cancel** is the default value.



Safety Measures

For scans which may produce peripheral nerve stimulation attention must be paid to the following:

- Inform the patient that peripheral nerve stimulation may occur and describe the nature of the sensation.
- Maintain permanent contact with the patient during the scan either directly or via an observation monitor and intercom.
- Terminate the scan when the patient calls for attention via the nurse call.
- Patients should be positioned with the arms alongside the body to reduce the likelihood of Peripheral Nerve Stimulation.

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PNS Safety Measures

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- Maintain permanent contact with the patient during the scan either directly or via an observation monitor and intercom.
- Terminate the scan when the patient calls for attention via the nurse call.
- Patients should be positioned with the arms alongside the body to reduce the likelihood of Peripheral Nerve Stimulation.

NOTICE

Personnel working inside or very close to the magnet during scanning may experience Peripheral Nerve Stimulation. Occupational exposure can be derived from the spatial distribution of the Gradient Output (dB/dt) provided in the Technical Description.

Exposure can be reduced by keeping distance from the magnet or by scanning in Normal Operating Mode.

Controlling the Maximum Allowed Gradient Output

The potential for peripheral nerve stimulation depends on the maximum gradient strength, slew rate and timing of the scan. When defining a scan, the parameter 'PNS mode' is used to control the maximum allowed gradient output. The actual gradient output is displayed on the Scan Dashboard and on the Info page and is dependent on other parameters.

Three levels are available:

- "low": the maximum allowed gradient output will be limited to 60% of the mean threshold level, i.e. the system will always operate in normal operating mode and the probability of PNS is very low.
- "moderate": the maximum allowed gradient output will be limited to 80% of the mean threshold level, i.e. the system will always operate in normal operating mode. The probability of PNS is low and if experienced it is mostly not painful.
- "high": the maximum allowed gradient output will be limited to 100% of the mean threshold level, i.e. the system may operate in the first level controlled operating mode. The probability of PNS is about 50% and may be experienced as painful. However, the patient may have more tolerance for PNS when properly informed and motivated.

Acoustic Noise

All persons present in the examination room during scanning must wear adequate hearing protection. Without hearing protection, noise levels may be high enough to cause discomfort, tinnitus or result in temporary or permanent hearing loss.

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Adequate hearing protection are appropriately fitted earplugs with a rated value which is sufficiently high to ensure that it reduces the A-weighted r.m.s. sound pressure level below 99 dB(A).

WARNING

High levels of acoustic noise during scanning.

Risk of hearing impairment.

- **Always apply hearing protection with a protection level of 30 dB to the patient and anyone else present in the examination room during scanning.**

Rated hearing protection is usually specified as NRR, SNR or SLC80. The required minimum rated hearing protection value is 30 dB.
Correct placement of the earplugs is critical to obtain the maximum hearing protection.

The use of dual-hearing protection (earplugs as primary means of protection and headset as second means of protection) can help mitigate damping loss in case of poor fit. Protection levels (as found on the label) for the two means of protection cannot be added. The second means of protection can account for an additional 5 dB(A) protection to the primary means of protection.

NOTICE

The headsets provided with the system do not have a rated hearing protection value.

For scanning of sensitive individuals (e.g. those suffering from tinnitus, or under certain drug regimes, sedated, unconscious, newborns, young children and elderly) to whom earplugs cannot be applied adequately, additional hearing protection or other precautions is required to obtain maximum hearing protection for these patients.

It is the responsibility of the User to:

- Select appropriate means of hearing protection for all persons that can be present in the examination room during scanning.
- Establish precautions and procedures to scan patients to whom earplugs cannot be applied adequately.
- Establish a hearing protection program to protect the operators in compliance with local regulations.
- Establish dedicated training for the OPERATOR to ensure proper application of hearing protection on the patient
- Follow the fitting instructions of the earplug manufacturer to assure maximum noise protection.

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Hearing Protection for Every Patient

WARNING

Always apply hearing protection to the patient and anyone else present in the examination room before start scanning.

Acoustic Noise Level Measurement Method

Sound level meter settings:

- Detector: r.m.s.
- Time weighting: fast or slow.
- Frequency weighting: A-weighting.
- Measurement duration: >20s.

Occupational Exposure to EMF

All MRI Workers

NOTICE

All personnel that need to enter the MR examination room must be screened and instructed concerning the risk factors associated with working in the MR environment. Specific risk factors include magnetic materials, pacemakers, pregnancy and sensitivity to movement in high magnetic fields.

Similarly, keeping distance when possible will limit exposure to the main magnetic field.

Workers shall be informed that occupational exposure to RF and gradient fields is limited to those present in the examination room when the system is scanning.

Current scientific evidence does not indicate harm related to occupational exposure, but exposure can be limited by keeping distance from the MR system.

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NOTICE

In some countries legislation may exist covering occupational limits for exposure to EMF (Electro Magnetic Fields).
These regulations may be stricter than those adopted by the IEC (International Electrical Committee) and used to design the MR systems.

Refer to the Technical Description for applicable EMF exposure values in and around the MR system.

Further information related to exposure and Directive 2013/35/EU can be found in the Technical Description.

Pregnant MRI Workers

Whereas no epidemiological evidence exists to date concerning adverse health effects on the fetus, it is prudent for pregnant workers to minimize exposure to the magnetic fields.

NOTICE

Local regulations may consider the fetus as member of the general public, and strict exposure limits may prohibit pregnant workers to approach the MR System.

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2.2.2 Patient, Coil, and Cable Positioning

General coil safety

Only coils that have been proven safe and compatible on the Philips MR system shall be used. Coded connectors and software keying are provided to control the use of coils. Refer to the Instructions for Use of the coil for further safety instructions.

Safety and performance considerations

Receive coils have safely been used to investigate any anatomy. The coil insulation prevents accidental contact with the conductive metal parts. Each coil has been specially designed for prolonged safe and reliable operation.

Safety measures

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WARNING

Never use surface coils, cable traps and cables which are damaged.

A damaged cable or connector is hazardous because of high voltage across the cable during the transmit phase of the system. Sharp edges may cause injury to patient's skin.

Coils must be returned to the manufacturer's Customer Support for replacement if there is any suspected damage to either the external covering or the coil's internal components. The patient must never be allowed to come into contact with the internal coil connections.

WARNING

Do not simultaneously touch the coil connector contacts and the patient to prevent potential harm for the patient.

WARNING

Do not scan with an incomplete base coil. The protective lids on the contacts of base coil must be present at all times.

These lids can be removed for cleaning purposes.

Risk Factors

The MR system dissipates energy from various sources. This can lead to a temperature rise of components surrounding the patient such as cables and RF coils. Usually the end temperature of these components does not exceed body temperature. In these situations there is no concern regarding patient safety.

The most important source of energy is the RF energy emitted by the transmit coil. Safety issues on the direct deposition of RF energy into the patient are described in the section *Safety during Scanning -> Specific Absorption Rate*.

When electrical cables are close to the patient (e.g. RF coil cables) or connected to the patient by electrodes (e.g. ECG cables), care must be taken to avoid situations of components heating up to high end temperatures.

Risk Reduction Measures against Thermal Injuries

WARNING

To help safeguard against thermal injuries or burns, pads meeting the MR system manufacturer's specifications should be placed between the patient's skin and any transmit RF coil. These pads protect the patient from proximity to the transmit RF coil, to ensure spacing between the transmit coil and the patient's tissues.

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WARNING

Avoid placing cable loops and twisted cables (RF coil cables and ECG leads) inside the body coil (RF area).

Loops can cause excessive heating of the cables which may result in burns upon contact to patient's skin. The cables must be routed parallel to the axis of the bore.

WARNING

Avoid routing of the RF coil cable assembly in proximity to the RF transmit coil. Avoid direct contact of the patient's skin with the RF coil cable assembly.

Failing to do so may result in excessive local heating and ultimately in skin burns. Positioning of the RF coil cable assembly must be done with care. Keep a distance to the patient's skin of at least 2 cm. Use the special spacer or pads of the standard accessory set where the cable assembly may touch the skin.

WARNING

The combined use of RF coils, high SAR levels and direct skin contact of the coils cables may cause local cable heating and can lead to skin burns.

WARNING

Leave a 2 cm distance between the patient's skin and the RF cables and interface boxes. Use pads from the accessory set.

WARNING

Always run the cable directly away from the region of interest.

Patient positioning measures against thermal injuries

Risk of thermal injuries will be minimized by careful positioning of the patient:

- Prevent contact with the bore wall.
- Prevent touching of hands and upper legs.
- Prevent contact points at the inside of the legs.

Preventing contact points is particularly important when scanning in the torso and pelvic area. Pay careful attention with liver, heart, lumbar spine, prostate/female pelvis, hips and upper legs in the isocenter.

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The picture below indicates potential risk areas (red fields) where adequate spacing must be ensured to prevent skin-to-skin and skin-to-bore contact.
The green areas in the picture represent the body area in the isocenter.

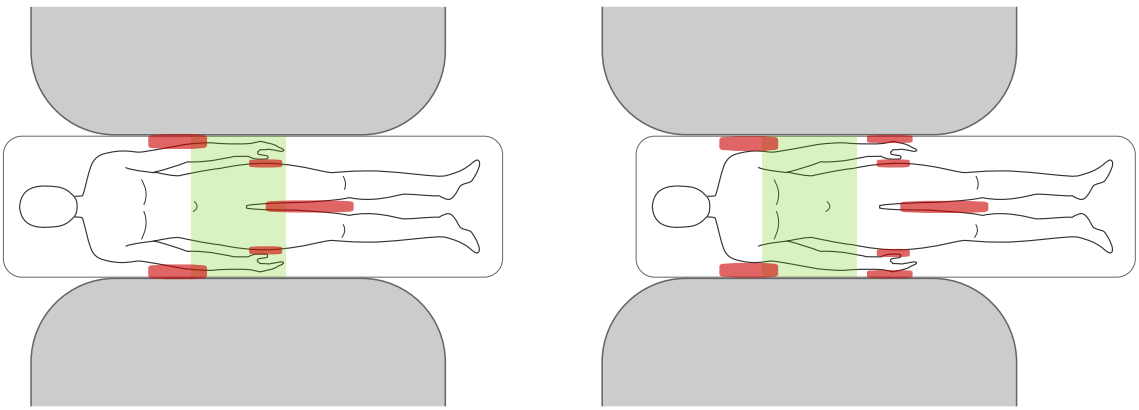

Fig. 4: Top cross-sectional view of the system. Potential risk areas.

Avoiding Loops

Ensure clearance between body parts and the bore wall, primarily for air flow. Avoid large area contact between body parts and the bore wall.
A dry, small rolled towel (made from non-conductive material, for example linen or cotton) can be used to create a clearance of more than 5 mm between body parts and bore. This ensures only a minimum disruption of airflow through the bore.
Wrapping in sheets is inadequate, because it does not ensure air flow over the body part and traps in heat.

WARNING

If patient body parts touch, high-frequency current loops may form within the body.

Risk of patient burns

- **Secure a minimum of 2 cm clearance between body parts.**
- **When necessary, use the positioning aids to obtain sufficient clearance.**

Current loops are formed when two parts of the human body come into contact (skin to skin) or almost come into contact, e.g.:

- Both thighs are in contact.
- Both knees are in contact.
- Both ankles are in contact.
- Arms and hands touching other body parts.
- Both hands are in contact. This especially is possible for scanning with breast coils when patients are imaged lying prone with both arms extended above the head.

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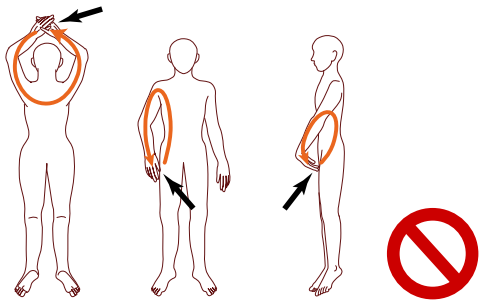
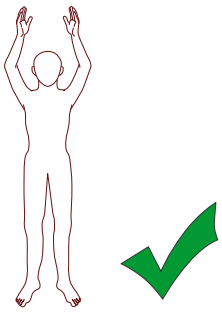
The picture shows current loops (curved arrows) and locations where heating can occur (black arrows).



Contact between body parts must be prevented.

A minimum of 2 cm clearance must be secured. When necessary, use the positioning aids to obtain sufficient clearance.

Example: Positioning the patient appropriately. No skin-to-skin contact.



Risk Reduction Measures against Coil Damage

WARNING

Unconnected coils on the tabletop while scanning.

Risk of patient injury and damage to unconnected coils.

- **Connect all coils on the tabletop to the system before scanning, even if the coils are not used for scanning.**

WARNING

Never position heavy objects or let patients sit on the posterior coil cover of the patient support.

Heavy weight load can damage the coil, which may result in excessive heating and patient burns when scanning. The posterior coil cover is visible when the tabletop is removed or moved into the magnet bore.

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Cable Routing

WARNING

Position and secure the cable in the grooves of the tabletop.

WARNING

Always position the cables of the coils parallel to the direction in which the table moves. A minimum of 2 centimeters clearance must be secured between the cable and the bore covers (as well as between the cable and the patient).

2.2.3 Patient Support and Tabletop

Safe Working Load

The safe working load for FlexTrak and Patient support is 250 kg.

NOTICE

The safe working load as labelled on patient support and trolley is based on the sum of the maximum allowable patient weight and the mass of accessories and coils. The weights mentioned above are equal to the safe working load.

- The maximum weight load allowed for horizontal and vertical movement of the tabletop on the patient support is 250 kg.
- The maximum allowed weight load of the tabletop on the FlexTrak is 250 kg.

Safety when Moving the Patient into the Magnet Bore

NOTICE

The operator must be aware that the patient may have claustrophobic reactions when moved into the magnet.

A panicking patient may hurt itself or damage equipment.

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WARNING

Before starting a scan which initiates tabletop movement, always check that nothing can get caught or hit during tabletop movement.

Check patient, patient extremities, clothing, equipment and positioning aids. Guide cables and intravenous lines.

WARNING

Verify if an urine bag is present at the patient. Empty the urine bag before starting an examination.

Spilled urine can form a conductive path possibly resulting in an electric shock.

WARNING

Verify that no blankets, sheets, pillows or clothing hang over the front and end side of the tabletop or are wrapped around it.

These objects may get caught between tabletop and patient support during table movement. This can block tabletop movement even when in manual mode.

WARNING

Due care must be taken to verify that no part of the patient's body, hair, clothing, cables or infusion lines can get trapped or injured by any part of the equipment.

WARNING

Verify that the hand of the patient are on the tabletop before moving the tabletop into the magnet, to avoid finger pinching.

Fingers can get pinched between the tabletop and the system covers.

- **The special arm supports (see Positioning Aids) can be used to avoid finger pinching. The arm supports prevent the patient from grabbing around the table sides, avoiding finger pinching during tabletop movement.**

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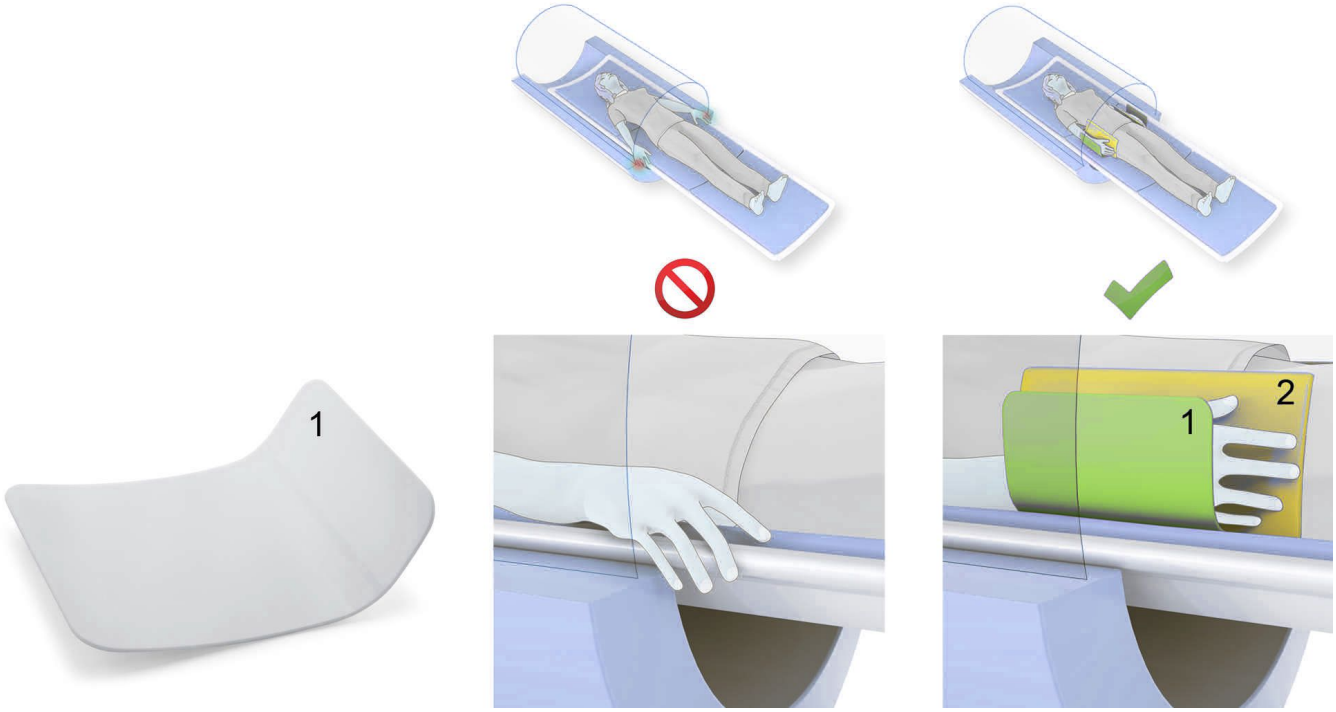

Fig. 5: Left: Arm support. Middle: Incorrect patient positioning. Right: Advised patient positioning with arm support (1) and padding (2).

WARNING

In prone position support the lower legs in such a way that the patient's toes are positioned higher than the tabletop surface.

If the patient's feet are positioned over the end of the tabletop, verify that the feet cannot be caught between tabletop and system parts when moving into the magnet.

WARNING

Special care must be taken that no objects or body parts (e.g. patient in a wheelchair) are present near the patient support while lowering the patient support.

Objects can get trapped between patient support and floor which may lead to damage or personal injury.

Guidance for Tabletop Movement

The following message is displayed before table movement is initiated.

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Automatic Tabletop Movement	
English	**Your language**
Automatic Tabletop Movement The tabletop will move. Check that the patient, patient extremities, clothing, equipment, cables and intravenous lines cannot get trapped. Verify that nothing can get trapped during the tabletop movement. Allow the tabletop to move automatically for • this scan? • all scans? Read about tabletop movement.	**Automatic Tabletop Movement** The tabletop will move. Check that the patient, patient extremities, clothing, equipment, cables and intravenous lines cannot get trapped. Verify that nothing can get trapped during the tabletop movement. Allow the tabletop to move automatically for • this scan? • all scans? Read about tabletop movement.

This message pops up when the scan requires tabletop movement after **Start scan**.

- To not initiate tabletop movement, click **Cancel**.

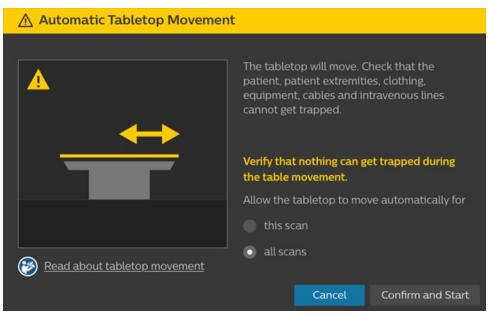
  The scan will be aborted if it the scan status is dispatched. The scan will be cancelled if the scan status is **ready to run**.

  Cancel is the default value.

- To start tabletop movement and then start the scan, click **Confirm and Start**.
  - If you select for **this scan**, tabletop movement takes place only for the current scan.

  The message pops up again for the next scan that requires tabletop movement.
  - If you select for **all scans**, tabletop movement takes place for all scans where it is required or recommended.

  Allow for **all scans** is the default value.



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NOTICE

If you allow automatic tabletop movement for all scans, you still have to confirm tabletop movement in some special cases.

The permission for automatic tabletop movement is withdrawn:

- when a local movement (manual table movement or toggle-switch controlled, or finger pinching) is performed or occurs at the magnet, or
- when a scan or movement is stopped from the operator console.

The next automatic movement must be confirmed again.

The following message is displayed before fast table movement is initiated.

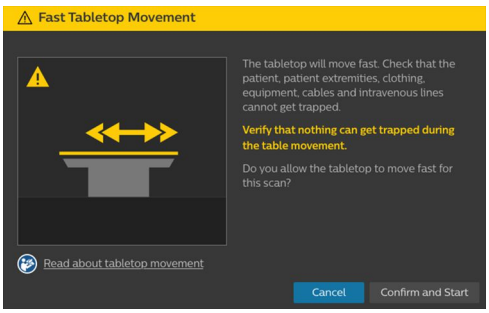
Fast Tabletop Movement	
English	**Your language**
Fast Tabletop Movement The tabletop will move fast. Check that the patient, patient extremities, clothing, equipment, cables and intravenous lines cannot get trapped. Verify that nothing can get trapped during the table movement. Do you allow the tabletop to move fast for this scan? Read about tabletop movement.	**Fast Tabletop Movement** The tabletop will move fast. Check that the patient, patient extremities, clothing, equipment, cables and intravenous lines cannot get trapped. Verify that nothing can get trapped during the table movement. Do you allow the tabletop to move fast for this scan? Read about tabletop movement.

This message pops up when the scan requires fast tabletop movement.

- To not initiate tabletop movement, click **Cancel**.

  The scan will be aborted if it the scan status is dispatched. The scan will be cancelled if the scan status is **ready to run**.

  Cancel is the default value.
- To start tabletop movement and then start the scan, click **Confirm and Start**.



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Emergency Stop Button

Your MRI system has Emergency Table Stop buttons. For more information, see *Safety before Scanning -> Emergency Procedures -> Emergency Table Stop*.

Tabletop Movement in the Event of an Electrical Power Failure

In the event of an electrical power failure, the tabletop is automatically released. The tabletop can be moved manually out of the magnet.

When electric power is re-established the tabletop is engaged again.

Note that there might be events where table movement is not possible even in manual mode.

Horizontal Tabletop Movement in Manual Mode

If horizontal tabletop movement is not functioning properly the patient support switches automatically into 'manual mode': The Manual mode button on the UIM flashes.

Move the tabletop manually out of the system into its end position. The patient support is reset and the button stops flashing.
Press the ‘Manual mode’ to switch to motorized movement again: horizontal movement of the tabletop is re-enabled.

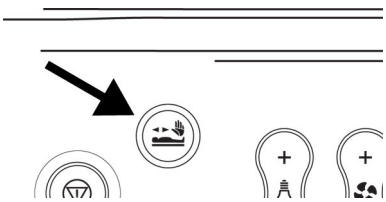

Fig. 6: Manual mode

Manual Override Switch

If the control electronics break down, it will still be possible to move the patient support to the highest position and continue scanning. The ‘Manual override’ switch is located at the magnet end under the patient support.

If the switch is activated the patient support will move up and stop at its highest position.

Fig. 7: Manual override switch.

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2.2.4 Laser Radiation Safety

Light Visor

Philips MR systems have a laser type Light visor system.
The laser light visors is in compliance with laser standards *IEC60825-1: 2007* and *21 CFR 1040:10* .

The Light visor should only be used under supervision of medical trained personnel, who are acquainted with hazards implied by the use of laser light.

It is the user's responsibility to meet local safety regulations.

Risk Reduction Measures

WARNING

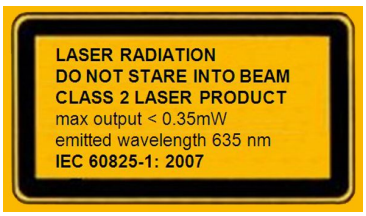
Avoid laser light shining in the patient's eyes.

Instruct the patient not to look into the laser beam. Direct laser light may cause irreversible damage to the eyes.

- Use the light visor for its intended use only. Avoid unnecessary exposure to laser radiation.
- For non-responsive patients (babies, anesthetized patients) provide adequate protection to avoid direct laser light in the eyes.
- Use of controls, adjustments or procedures other than those specified in this manual may result in hazardous radiation exposure.

Labels

Depending on the type of laser (Class 1 or Class 2) installed on your system, the following warning labels are put on the system:

Outside front cover	
	*Caution label* Laser radiation Do not stare into beam Class 2 Laser product Max output< 0.35 mW Emitted wavelength 635 nm IEC 60825-1: 2007
At the laser aperture (outside front cover)	

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Laser warning symbol

If your system has a Class 1 laser only the label at the laser aperture is present.
The characteristics of the Class I laser are:

CLASS 1 LASER PRODUCT
Max output < 0.35 mW
Emitted wavelength 635 nm
IEC 60825-1

If your system has a Class 2 laser both the label at the laser aperture and the outside cover are present.
The characteristics of the Class II laser are:

CLASS 2 LASER PRODUCT
Max output < 0.35 mW
Emitted wavelength 635 nm
IEC 60825-1:2007

2.2.5 High Bore Temperature

Messages in case of High Bore Temperature

The system calculates the possible bore surface temperature for each scan.
When the calculated temperature of the bore surface may exceed the maximum allowed level, a warning message pops up.

For more information, see chapter *Safety -> Important Messages and Indications*.

2.2.6 Communication with the Patient

Nurse Call and Operator-Patient Intercom

The Nurse Call is a safety device and part of the routine patient observation. It enables the patient to attract the attention of the operator during an examination. By pressing the Nurse Call, a buzzer sound is activated that is audible in the examination and control room.

When the Nurse Call is pressed more than once within 4 seconds or for more than 1.5 seconds, it triggers an audible and a visual alarm. The operator must be in the examination room or the control room to be notified by this alarm.

You must give and demonstrate the Nurse Call to every patient who is able to use the Nurse Call.

During each examination, the system checks whether the Nurse Call is tested. A pop-up window appears if the Nurse Call was not tested. The pop-up disappears when the Nurse Call is tested or when the user acknowledges to be responsible for patient observation.

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It is advised to communicate when the system gradients are off.

WARNING

Instruct the patient on using non-verbal communication signs.

Because of acoustic noise levels in the examination room verbal communication with the patient may be impaired.

2.3 Other MRI Safety

2.3.1 Image quality

The resulting appearance of anatomical structures on images may be dislocated or distorted. Also non-uniform intensities or contrasts can occur. These image deviations may lead to misinterpretation. More information on typical MR artifacts, including examples, is provided in the MR Help system.

WARNING

MR images may demonstrate structures that are not present in the patient (artifacts), which may lead to misinterpretation.

These structures may occur as a result of technological and physiological factors or can be introduced by metallic or magnetic objects in the patient.
Technological factors can be spurious signal generated by system components or other source in the immediate area of the system.

Intrinsic artifacts

MR technical capabilities and patient physiology may result in artifacts which appear in the image.
These artifacts may be caused by e.g.:

- Magnet homogeneity.
- Gradient non-linearity.
- RF inhomogeneity.
- Truncation.
- Aliasing.
- Motion.
- Flow.
- Chemical shift.
- Susceptibilities.

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Extrinsic artifacts

Magnetic objects or non-magnetic metallic objects such as jewelry, hairpins, buttons, prosthetics will disturb the RF signal or will influence the homogeneity of the magnet field and will interfere with the imaging capabilities of the system. This may lead to clinical misdiagnoses.

WARNING

Do not allow magnetic objects or non-magnetic metallic objects to be brought into the magnet, unless this is needed for the specific study and properly controlled (e.g. biopsy needles).

NOTICE

MR image data may be distorted and can lead to improper representations when used to generate 3D printed volumes.

2.3.2 Imaging Techniques

WARNING

Applying imaging techniques must always be done with great care to avoid any unwanted effects like artifacts.

Correct parameter optimization is essential for optimal image quality.

SENSE

The SENSE/CLEAR parallel imaging technique must be applied carefully to avoid unexpected and possibly unidentified image artifacts. The technique can be used successfully to speed up the scan technique, get a ideal homogeneity correction or optimize the protocol in a number of other ways (SAR reduction, acoustic noise reduction, resolution improvement, etc.).

A number of specific warnings and notes are given in the following.

WARNING

With CLEAR and SENSE significant artifacts may occur in case of gross patient motion between the reference scan and the CLEAR or SENSE scans.

The patient must to be instructed not to move head or limbs between scans.

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Geometry compensation

WARNING

For comparing images the same type of geometry compensation must be used.

Erroneous distance, area and volume measurements may lead to misinterpretations. Stereotaxy guidance can be distorted which may lead to personal injury.

2.3.3 Auxiliary Medical equipment

Only use Philips-approved Multiple Socket Outlet (MSO) to power auxiliary equipment, as approved for connection through MSO by Philips.

WARNING

Assessment of compatibility and use of auxiliary devices for physiological monitoring or sensing inside the MR Examination room is the responsibility of the User. Always follow the guidance of the manufacturer of the auxiliary equipment.

WARNING

All accessories used with the MR system must be labeled MR Safe or MR Conditional Safe, see table below for labeling.

Third parties claims about MR compatibility of accessories must be interpreted with care: Philips does not verify these claims.

WARNING

After an upgrade of the system, e.g. to higher gradients, do not use auxiliary medical equipment approved for use with the system configuration before the upgrade, unless recognized as tested for use with this configuration after the upgrade.

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WARNING

Changes and/or additions to the MR system that are carried out using untested auxiliary medical equipment may lead to the Philips Healthcare warranty being voided. Do not use unapproved auxiliary medical equipment.

This equipment carries serious risks to cause damage to the system or personal injury.

WARNING

Third party RF coils cannot be used in combination with Philips RF coils nor with SENSE and CLEAR.

WARNING

The physiology sensing devices of the MR scanner are only intended for sequence triggering purposes.

Patient monitoring of physiological signals and application of sensing devices is subject to requirements and specifications of the monitoring equipment manufacturer.
It is the responsibility of the hospital and the operator to implement necessary safety provisions and to understand potential interferences with monitoring reliability introduced by the MR scanner.

WARNING

Patient ventilator error.

Risk of serious injury or death.

- **When a patient is supported by a ventilator or under anesthesia , any error condition detected by the auxiliary device shall immediately be followed by stopping the MR scan, and moving the patient outside the MR system until the error condition is removed.**

WARNING

The use of auxiliary equipment, such as physiological monitoring and gating equipment and radio frequency coils, which have not been specifically tested and approved for use with Philips MR systems may result in burns or other injuries to the patient.

WARNING

Auxiliary devices labeled as MR Conditional may cause injury if the manufacturer's instructions, especially with respect to electrically conducting lead positioning, are not followed.

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WARNING

Auxiliary devices labeled as MR Conditional may only be used in combination with Philips MR systems when the conditions specified in the manufacturer's instructions for use are fulfilled.

WARNING

Auxiliary devices not labeled as compatible with MR equipment may be affected by electromagnetic interference (EMI).

This may influence the proper functioning of the Auxiliary device.

CAUTION

Portable RF communications equipment (including peripherals such as antenna cables and external antennas) should be used no closer than 30 cm to any part of the MRI system, including cables specified by the manufacturer. Otherwise, degradation of the performance of this equipment could result in decreased electromagnetic immunity of this equipment and result in improper operation.

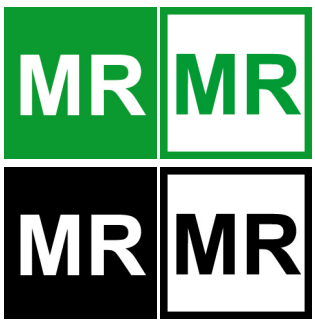
NOTICE

For description and further Instructions for Use on compatibility test protocols, see the Technical Description of the system.

MR compatibility labels on third party equipment

The compatibility of third party equipment in combination with the MRI systems is regulated via special warning labels (see below). These warning signs indicate whether the third party equipment is MR Safe, MR Unsafe or MR Conditional.

When the equipment is marked as MR Conditional these conditions must be described in the instructions for use of this equipment.

Warning label	Category
	MR Safe

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Warning label	Category
	MR Conditional
	MR Unsafe

WARNING

Do not start an examination with the system when the examination-room door is open.

Operation of the system with the examination-room door open can cause malfunction of other (medical) devices outside the examination room and consequently may lead to personal injury.
Other (medical) devices could also interfere with the MR system, possibly resulting in image artifacts.

NOTICE

Compatibility of tools and devices will depend on the magnetic field strength of the MR system.

Contact the supplier when using tools or devices at different systems than specified.

NOTICE

It is advised to carefully secure monitoring equipment to the wall of the examination room, using a chain and/or other anchorage device of sufficient strength.

This will prevent the equipment to be pulled into the system.

2.3.4 Mobile telephones & similar products

Philips MRI systems comply with the requirements of applicable electromagnetic compatibility (EMC) standards. Other electronic equipment exceeding the limits defined in these EMC standards could, under unusual circumstance, affect the operation of the system.

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CAUTION

Do not allow radio frequency transmitting devices (such as mobile telephones) into the examination room. Even when switched off.

These devices could exceed EMC radiation standards and, under unusual conditions, interfere with the proper functioning of the system. This could lead to clinical misdiagnoses.

2.3.5 Electrical safety

Philips MR systems may be operated on a permanent 24-hour basis without adversely affecting its safety or performance.

WARNING

To avoid risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

WARNING

Do NOT open cabinets. Do NOT remove system covers.

The system and all subsystems remain powered. Danger of an electric shock.

WARNING

Covers or cables should only be removed by a qualified and authorized service engineer.

WARNING

Do not allow water or other liquids to enter the equipment as they may cause short-circuits or corrosion.

Only use the MR system in rooms or areas that comply with all applicable law (or regulations having the force of law) concerning electrical safety for this type of equipment.

Auditory signal in the technical room

Power outage

In case of a power outage the internal batteries of the UPS (Uninterruptible Power Supply) takes over the power supply for critical magnet functions only. A buzzer signal in the technical room alerts the operator.

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Applied Parts

The following electrical or weight bearing parts of the MR system are designed for patient contact during normal use (known as Applied Parts):

- Tabletop.
- VCG.
- PPU.
- All RF coils and their coil parts, see their respective instructions for further details.

2.3.6 Spectroscopy

NOTICE

The system supports export to a proprietary file format. However, since this is not a published standard, Philips makes no claims about the correctness of this file.

NOTICE

Do not use the coils in an unloaded situation.

When the load (normally the patient) is removed from the coil, or vice versa, the voltages may damage the capacitors of the spectroscopy coils.

The PlanScan Metabolite and Shifted Metabolite boxes displayed during scan set-up, can be used to determine which voxels lie in the overlap region for two metabolites of interest, both in-plane (for 2D and 3D CSI) and in the slice direction for 3D CSI. Choosing higher bandwidth RF pulses (such as the "sharp" excitation pulse) can help to minimize the mismatch.

An alternate for 2D CSI is to use spin-echo slice localization (plus multiple REST slabs if necessary) instead of PRESS or STEAM volume localization, this method eliminates in-plane chemical shift displacement and associated peak ratio distortions.

2.3.7 Liquids in Phantoms

This chapter provides the following information:

Description of used phantoms.

Including handling, toxicity, and emergency procedures.

Phantoms for 1.5T systems

Liquid in Body 530 mm, Body 400 mm and Head 200 mm phantoms	
Personal protection	• Eyes: safety goggles

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Liquid in Body 530 mm, Body 400 mm and Head 200 mm phantoms	
Constituents in weight percent	• 99.6 - 99.96% water • 0.02 - 0.37% sulfuric acid • 0.03 - 0.08% copper(II)sulphate
Toxicity	• LD-50: 300 mg/kg (ORL-RAT, copper (II) sulfate) • LD-50: 2.14 mg/kg (ORL-RAT, sulfuric acid)
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

Liquid in Bottle phantoms	
Personal protection	• Eyes: safety goggles
Constituents in weight percent	• 99.717% water • 0.005% sulfuric acid • 0.077% copper(II)sulphate • 0.2% sodium chloride • 0.001% dialkyl-1-dimethyl ammonium chloride
Toxicity	• LD-50: 300 mg/kg (ORL-RAT, copper (II) sulfate). • LD-50: 2.14 mg/kg (ORL-RAT, sulfuric acid). • LD-50: 3 g/kg (ORL-RAT, sodium chloride).
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

Liquid in AC-PC Bottle phantoms	
Personal protection	• Eyes: safety goggles
Constituents in weight percent	• >99.0% water • >0.25<1.0% Nickel Chloride-6-Water
Toxicity	• LD-50: 175 mg/kg (ORL-RAT, Nickel Chloride-6-Water).
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.

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Liquid in AC-PC Bottle phantoms	
First aid	• Skin contact: immediately remove contaminated clothes. Immediately remove residue substance (e.g. rinse with plenty of water). In case of serious exposure call a doctor. • Ingestion: Let victim drink 1 or 2 glasses of water. In case of general disorder call a doctor. • Inhalation: Bring victim immediately into fresh air, let rest and if necessary call a doctor. • Eyes: Rinse for a long time with plenty of water. In case of eye-sight disturbance consult a doctor.

Spectroscopy Phantoms

Proton phantoms

Liquid in proton sphere phantoms A	
Personal protection	• Eyes: safety goggles
Constituents	• 5 ml/l 98% acetate (CH3COOH) • 10 ml/l 80% ethanol (CH3CH2OH) • 8 ml/l 98% Phosphorus acid (H3PO4) • 1 ml/l 1% arquad solution + 120 mg/l CuSO4 in demi water.
Total contents	• 524 ml
Emergency actions	• Spillage: Absorb the liquid in dry sand, diatomite, vermiculite etc. Shovel the mixture into plastic bags and remove to a chemical waste depot.
First aid	• Skin contact: Rinse for a long time with plenty of water, then wash with soap and water. • Eyes: Rinse for a long time with plenty of water.

2.3.8 Liquid in Gradient System

Gradient amplifier	
Constituents	• Distilled water 50% • Dowtherm SR1 9 (dyed pink) 50%, consisting of: – Ethylene glycol CAS#000107-21-1 (>95%) – Dipothassium Phosphate CAS#007758-11-4 (<3%) – Water CAS#007732-18-5 (<3%)
Toxicity	The coolant may irritate the skin by contact.

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Gradient amplifier	
Emergency actions in case of a leakage	• Absorb the liquid with an appropriate absorbent (e.g. powersorb, dry sand, diatomite etc.). • Dispose the used absorbent of (in plastic bags) according local legislation for chemical waste. • After a leakage, the gradient amplifier cooling system needs topping up. Contact Philips Customer Support.
First aid	• Skin contact: Immediately remove contaminated clothing and rinse the skin with plenty of water. • Eyes: Rinse for a long time with plenty of water.
Gradient coil coolant	
Constituents	• Distilled water (approximately 30 l) • Inhibitor, AZ8104 from Betz Dearborn (6ml) • Biocide, Spectrus NX 1164* or Spectrus 1106* from Betz Dearborn (2.7 ml)
Toxicity	The coolant may irritate the skin by contact.
Emergency actions in case of a leakage	• Absorb the liquid with an appropriate absorbent (e.g. powersorb, dry sand, diatomite etc.). • Dispose the used absorbent of (in plastic bags) according local legislation for chemical waste. • After a leakage, the gradient coil cooling system needs topping up. Contact Philips Customer Support.
First aid	• Skin contact: Immediately remove contaminated clothing and rinse the skin with plenty of water. • Eyes: Rinse for a long time with plenty of water.

* Biocide, Spectrus NX 1164 or Spectrus 1106 is depending on your region.

2.3.9 Network safety, security and privacy

Customer Role in the Product Security Partnership

We recognize that the security of Philips Healthcare products is an important part of your facility's security-in depth strategy. However, these benefits can only be realized if you implement a comprehensive, multilayered strategy (including policies, processes, and technologies) to protect information and systems from external and internal threats.

Following industry-standard practice, your strategy should address physical security, operational security, procedural security, risk management, security policies, and contingency planning. The actual implementation of technical security elements varies by site and may employ a number of technologies, including firewalls, virus-scanning software, authentication technologies, etc.

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As with any computer-based system, protection must be provided such that firewalls and/or other security devices are in place between the medical system and any externally accessible systems.

Although the system incorporates state-of-the-art protection mechanisms to protect it against the intrusion of malware (viruses etc.) a remote probability remains that a system can become infected. In all circumstances system safety remains secure, but the user might notice unfamiliar system behavior and/or performance. If this happens repeatedly, e.g. also after the system has been switched off and on again, the user is advised to call Philips Customer Service to have the system checked and if needed cleaned from malware.

The USA Veterans Administration has developed a widely used Medical Device Isolation Architecture for this purpose. Such perimeter and network defenses are essential elements in a comprehensive medical device security strategy.

NOTICE

The internal electronic log files generated by this product as a part of its normal operations, will contain the names of storage folders created by the user, and therefore will include any patient, clinician or other personal identifying information used in such folder names.

In the course of maintenance, monitoring or repair of this product or of related development and other product-related activities, Philips may access, store or otherwise use those log files.

Any connection of a device to a hospital network should be done with appropriate risk management for safety, effectiveness, and data and systems security. For guidance on risk management, see the IEC-80001-1 standard.
Additional security and privacy information can be found on the Philips product security website at http://www.philips.com/productsecurity. Please review Philips product security policies regarding remote service, patch management, anti-virus software and more in the “Product Security Policy Statement” and additional information sources available through this website.

CAUTION

The internal electronic log files generated by this product as a part of its normal operations, will contain the names of storage folders created by the user, and therefore will include any patient, clinician or other personal identifying information used in such folder names. In the course of maintenance, monitoring or repair of this product or of related development and other product-related activities, Philips may access, store or otherwise use those log files.

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2.3.10 Gradient coil

Gradient malfunction detection

The Severe Gradient Malfunction Detection feature is integrated in the MR System. It powers off the relevant part of the system when a severe gradient malfunction is detected. When the Severe Gradient Malfunction is detected:

- The power to the Gradient Amplifier is switched off.
- A message is displayed on the user interface with the following instructions:

  – Scanning is disabled until Philips service has checked the system. Do not attempt to continue scanning.

  – Contact Philips Service.

SmokeDetector Interlock

Your MR system is equipped with a SmokeDetector Interlock and, depending on the gradient coil type, a Heat Detector. These sensors detect critical temperatures of the gradient coil or smoke developing in your MR system.

WARNING

The SmokeDetector or Gradient Coil Heat Detector Alarm is displayed on the user interface.

Risk of patient injury.

- **Evacuate the patient from the examination room.**
- **Follow the instructions as displayed on the user interface.**

The SmokeDetector Interlock feature is integrated in the MR System. It powers off the relevant part of the system when smoke is detected to prevent further development of smoke or fire.

When the SmokeDetector Interlock detects smoke in the Examination Room:

- The power to the gradient amplifier is switched off.
- A message is displayed on the user interface with the following instructions:

  – Evacuate the patient from the Examination Room.

  – Check Examination Room for a developing fire.

  – Adhere to established fire emergency procedures, which may include switching off power to the complete system and/or removing the magnet field by using the Emergency Magnet Off button.

  – Scanning is disabled until Philips service has checked the system. Do not attempt to continue scanning.

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– Contact Philips Service.

2.4 Alarms Overview

Auditory alarms at the operator's console

Auditory alarms that can occur at the operator's console are:

1. Nurse call (medium priority)
   This alarm is triggered when the patient presses the nurse call twice or longer than 1.5 sec. A buzzer alarm alerts the operator.

The sound pressure of the Nurse call is designed to be at least 80 dB(A).

During patient preparation, explain the function of the nurse call to the patient. Test that the nurse call functions properly for each new patient.
The operator must be in the examination room or the control room to be notified by this alarm.

Visual alarms that can occur at the operator's console are:

1. Nurse call (medium priority)
   When the patient presses the nurse call twice or longer than 1.5 sec, a light on the operator-patient intercom switches on.
2. Tabletop moves (medium priority)
   When the system automatically moves the tabletop, a pop-up indicates that the tabletop is moving.
3. High SAR (low priority)
   When a scan is performed in first level controlled operating mode based on SAR, an alarm symbol is shown on the user interface in front of the scan SAR value.
4. High risk of PNS (low priority)
   When a scan is performed in first level controlled operating mode based on PNS, an alarm symbol is shown on the user interface in front of the scan PNS value.
5. High SED (medium priority)
   When delivered SED exceeds 7.0 kJ/kg, an alarm symbol appears in front of the SED value in the Patient Status Area.
6. Emergency Field Shut Down unit Alarm (low priority)
   When the self-checks for the Emergency Magnet Off circuit fails, a message with an alarm symbol is shown in the message center.
7. SmokeDetector Alarm (medium priority)
   A popup with an alarm symbol indicates that smoke is detected in the Examination Room. Related instructions are also displayed.

The operator must be at the console to be notified by these alarms.

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2.5 Important Messages and Indications

Important messages and indications are displayed in the language of the user interface. The table displays the English messages and their translation.

Nurse Call Check	
English	**Your language**
Nurse Call Check	**Nurse Call Check**
Please ask the patient to press the Nurse Call to close this pop-up.	Please ask the patient to press the Nurse Call to close this pop-up.
This patient cannot use the Nurse Call.	This patient cannot use the Nurse Call.
This message pops up when the first scan of an examination is started and the Nurse Call was not tested during the examination. • To close the pop-window without confirmation, click **Cancel**. • To acknowledge your responsibility for patient observation, click **Confirm and Start**. **Cancel** is the default value.	

Nurse Call Check (VitalScreen)	
English	**Your language**
Nurse Call Check	**Nurse Call Check**
Please ask the patient to press the Nurse Call to close this pop-up.	Please ask the patient to press the Nurse Call to close this pop-up.
This patient cannot use the Nurse Call.	This patient cannot use the Nurse Call.
This message pops up when the TTS button is used and the Nurse Call was not tested for more than 10 minutes. • To close the pop-window without confirmation, click **Cancel**. • To acknowledge your responsibility for patient observation, click **Confirm**. **Cancel** is the default value.	

Tabletop is Moving Automatically	
English	**Your language**
Tabletop is Moving Automatically	Tabletop is Moving Automatically
Check patient, patient extremities, clothing, equipment, cables and Intravenous lines cannot get trapped.	Check patient, patient extremities, clothing, equipment, cables and Intravenous lines cannot get trapped.

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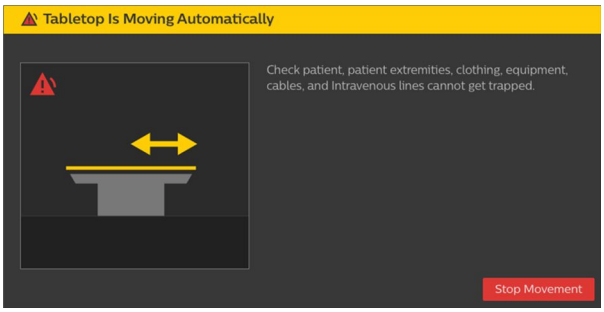
Tabletop is Moving Automatically

The message pops up when tabletop movement is requested.

- **Stop movement** immediately stops the tabletop movement.

  Stop movement is the default value.



Enable Remote Desktop Session

English	Your language
A Remote Desktop session has been requested.	A Remote Desktop session has been requested.
If you accept this Remote Desktop request, you confirm that you know that this is an authorized Remote Desktop session.	If you accept this Remote Desktop request, you confirm that you know that this is an authorized Remote Desktop session.
You further confirm that you are the responsible local operator for the system during this Remote Desktop session and have been fully informed about the possible consequences regarding Safety, Security and Privacy arising from permitting remote operation of the system, including those discussed in the system's Instructions for use.	You further confirm that you are the responsible local operator for the system during this Remote Desktop session and have been fully informed about the possible consequences regarding Safety, Security and Privacy arising from permitting remote operation of the system, including those discussed in the system's Instructions for use.
During a single windows Take Over session, you must stay at the system console and monitor the activities performed by the remote user. You can end the Remote Desktop session any time by pressing the **STOP** button on your screen. As the operator of the system, you are responsible for the safe and secure use of the system.	During a single windows Take Over session, you must stay at the system console and monitor the activities performed by the remote user. You can end the Remote Desktop session any time by pressing the **STOP** button on your screen. As the operator of the system, you are responsible for the safe and secure use of the system.
Note that certain private information, including electronic Protected Health Information (ePHI) about patients, will become accessible to the remote operator. Be sure to stay within your institution's policy regarding disclosure of confidential information to third parties.	Note that certain private information, including electronic Protected Health Information (ePHI) about patients, will become accessible to the remote operator. Be sure to stay within your institution's policy regarding disclosure of confidential information to third parties.

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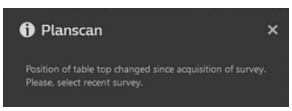
Enable Remote Desktop Session
This message pops up when a Remote Desktop session is requested. • To enable the Remote Desktop session, click **I Agree**. • To not allow the Remote Desktop session, click **Exit Session**. **Exit Session** is the default value.

Remote Desktop session enabled	
This button pops up when a Remote Desktop session is enabled. • To terminate the Remote Desktop session, click the red button.	

Planscan: Position of the tabletop changed	
English	**Your language**
Planscan Position of the tabletop changed since acquisition of survey. Please select recent survey.	**Planscan** Position of the tabletop changed since acquisition of survey. Please select recent survey.
This message pops up when the movement of the tabletop invalidates the current survey. • To set the scan back to **Ready to run**, click **Close**. This action allows you to adjust parameters. **Close** is the default value.	



Unsupported configuration	
English	**Your language**
Configuration Check Failed This computer may be running an unsupported configuration! Either there is PMS approved patch software installed, or there is non PMS approved software installed. If there is PMS approved patch software installed press **CANCEL** to dismiss this popup. Else press **OK** to display the version discrepancy report and contact your local Philips Medical Systems service center.	**Configuration Check Failed** This computer may be running an unsupported configuration! Either there is PMS approved patch software installed, or there is non PMS approved software installed. If there is PMS approved patch software installed press **CANCEL** to dismiss this popup. Else press **OK** to display the version discrepancy report and contact your local Philips Medical Systems service center.

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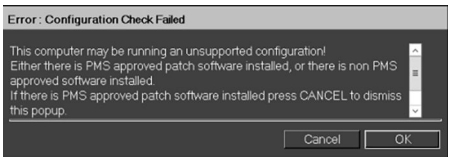
Unsupported configuration

This message pops up when unsupported software is detected.

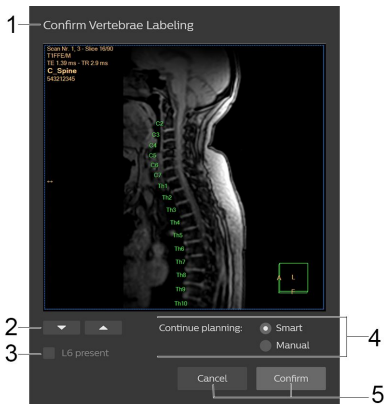
- To display the version discrepancy report, click **OK**.
- To dismiss the pop-up, click **Cancel**.

  Cancel is the default value.



SmartExam Spine

An explicit confirmation of the planning results by the operator is required.



1. Window **Confirm Vertrebrae Labeling**
2. Arrows to fine-tune the vertebrae labeling
   - **Smart**

   To enable Smart planning.
   - **Manual**

   To enable Manual planning.
3. **Cancel** to quit without changes, or **Confirm** to confirm the current vertebrae labeling.

Remote Control Permission

English	Your language
Remote control permission	**Remote control permission**
You are giving remote control permission to a remote user.	You are giving remote control permission to a remote user.
Sharing control allows the remote user to initiate a scan and table movement.	Sharing control allows the remote user to initiate a scan and table movement.
Risk of injury	Risk of injury
I confirm that:	I confirm that:
• I will stay at the MRI console to monitor the patient. • I am aware that remote users have access to patient private data.	• I will stay at the MRI console to monitor the patient. • I am aware that remote users have access to patient private data.

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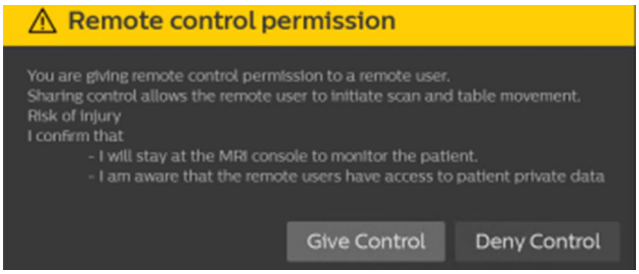
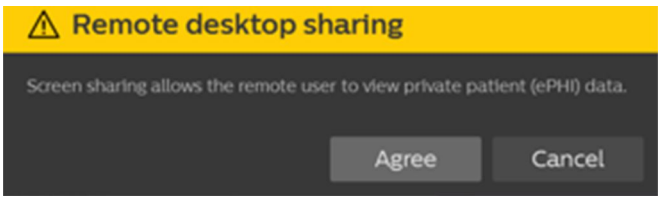
Remote Control Permission

This message pops up when you activate Collaboration Live, and then initiate Remote Desktop Sharing.

- To share the desktop, click **Give Control**. Then click **Agree**.
- To exit without sharing the desktop, click **Deny Control**.

  Give Control is the default value.





Implants

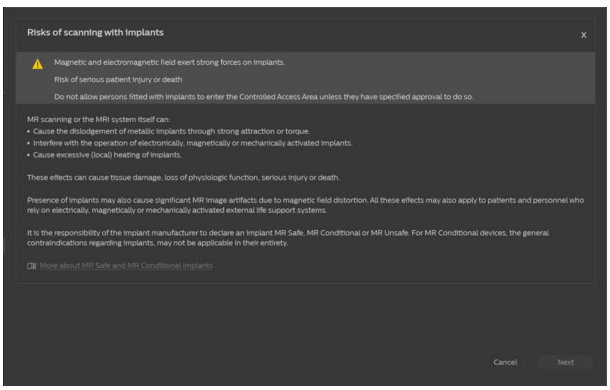
English	Your language

3000 139 72881/782 * 2025-05

Implants	
Magnetic and electromagnetic fields exert strong forces on implants. **Risk of serious patient injury or death** Do not allow persons fitted with implants to enter the Controlled Access Area unless they have specific approval to do so. MR scanning or the MRI system itself can: • Cause the dislodgement of metallic implants through strong attraction or torque. • Interfere with the operation of electronically, magnetically or mechanically activated implants. • Cause excessive (local) heating of implants. These effects can cause tissue damage, loss of physiologic function, serious injury or death. Presence of implants may also cause significant MR image artifacts due to magnetic field distortion. All these effects may also apply to patients and personnel who rely on electrically, magnetically or mechanically activated external life support systems. It is the responsibility of the implant manufacturer to declare an implant MR Safe, MR Conditional or MR Unsafe. For MR Conditional devices, the general contraindications regarding implants, may not be applicable in their entirety. More about MR Safe and MR Conditional Implants.	Magnetic and electromagnetic fields exert strong forces on implants. **Risk of serious patient injury or death** Do not allow persons fitted with implants to enter the Controlled Access Area unless they have specific approval to do so. MR scanning or the MRI system itself can: • Cause the dislodgement of metallic implants through strong attraction or torque. • Interfere with the operation of electronically, magnetically or mechanically activated implants. • Cause excessive (local) heating of implants. These effects can cause tissue damage, loss of physiologic function, serious injury or death. Presence of implants may also cause significant MR image artifacts due to magnetic field distortion. All these effects may also apply to patients and personnel who rely on electrically, magnetically or mechanically activated external life support systems. It is the responsibility of the implant manufacturer to declare an implant MR Safe, MR Conditional or MR Unsafe. For MR Conditional devices, the general contraindications regarding implants, may not be applicable in their entirety. More about MR Safe and MR Conditional Implants.

This message pops up when you select **What are the risks of scanning patients with implants?** in the MR Label screen of the implant guidance.

- To display more information about implants, click **More about MR Safe and MR Conditional Implants**.



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More about MR Safe and MR Conditional Implants	
English	**Your language**
More about MR Safe and MR Conditional Implants	**More about MR Safe and MR Conditional Implants**
Implantable medical devices labeled MR Safe or MR Conditional have been cleared, approved and/or licensed by the Competent Governmental Authorities and/or labeled by the manufacturer. For such devices, the general contraindications may not be applicable in its entirety.	Implantable medical devices labeled MR Safe or MR Conditional have been cleared, approved and/or licensed by the Competent Governmental Authorities and/or labeled by the manufacturer. For such devices, the general contraindications may not be applicable in its entirety.
It is the responsibility of the implant manufacturer to declare an implant MR Safe or MR Conditional and to define the conditions (restrictions) that allow for safe MR scanning.	It is the responsibility of the implant manufacturer to declare an implant MR Safe or MR Conditional and to define the conditions (restrictions) that allow for safe MR scanning.
It is the obligation of the MR operator to be aware of these conditions and to assure that they are strictly adhered to.	It is the obligation of the MR operator to be aware of these conditions and to assure that they are strictly adhered to.
Refer to the user documentation of the implant or contact the implant manufacturer to obtain these specific conditions. The system provides options to restrict whole body and head SAR and dB/dt, and to review other system characteristics, as specified in the Technical Description.	Refer to the user documentation of the implant or contact the implant manufacturer to obtain these specific conditions. The system provides options to restrict whole body and head SAR and dB/dt, and to review other system characteristics, as specified in the Technical Description.
Philips does not assume responsibility or liability for the operation of their MRI system with any implantable medical device.	Philips does not assume responsibility or liability for the operation of their MRI system with any implantable medical device.

This message pops up when you select **What are the risks of scanning patients with implants?** in the MR Label screen of the implant guidance, and then **More about MR Safe and MR Conditional Implants**.

More about MR Safe and MR Conditional Implants

Implantable medical devices labeled MR Safe or MR Conditional have been cleared, approved and/or licensed by the Competent Governmental Authorities and/or labeled by the manufacturer. For such devices, the general contraindications may not be applicable in its entirety.
It is the responsibility of the implant manufacturer to declare an implant MR Safe or MR Conditional and to define the conditions (restrictions) that allow for safe MR scanning. It is the obligation of the MR operator to be aware of these conditions and to assure that they are strictly adhered to.
Refer to the user documentation of the implant or contact the implant manufacturer to obtain these specific conditions. The system provides options to restrict whole body and head SAR and dB/dt, and to review other system characteristics, as specified in the Technical Description.
Philips does not assume responsibility or liability for the operation of their MRI system with any implantable medical device.

Maximum dB/dt	
English	**Your language**

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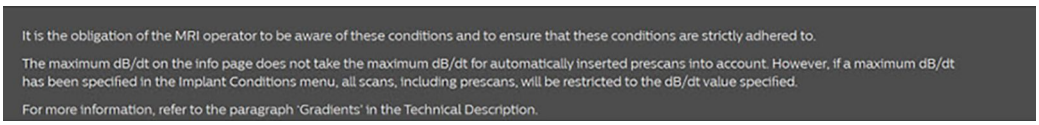
Maximum dB/dt

The maximum dB/dt on the info page does not take the maximum dB/dt for automatically inserted prescans into account. However, if a maximum dB/dt has been specified in the Implant Conditions menu, all scans, including prescans, will be restricted to the dB/dt value specified. For more information, refer to the paragraph Gradients in the Technical Description.	The maximum dB/dt on the info page does not take the maximum dB/dt for automatically inserted prescans into account. However, if a maximum dB/dt has been specified in the Implant Conditions menu, all scans, including prescans, will be restricted to the dB/dt value specified. For more information, refer to the paragraph Gradients in the Technical Description.

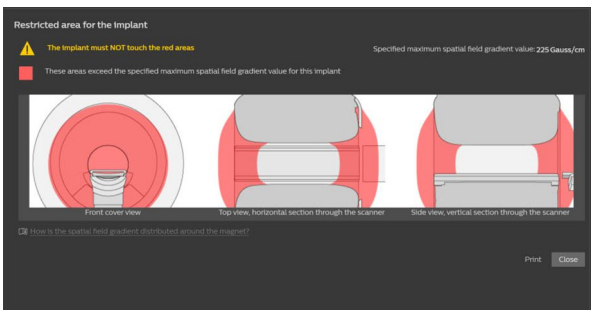
This message pops up when you click the **Which conditions are typically provided by the manufacturer of the implant?** link in the **Which MR label does the implant have?** screen in the Implant Conditions menu.



Implant and spatial field gradient

English	Your language
⚠ The implant must NOT touch the red areas These areas exceed the specified maximum spatial field gradient value for this implant.	⚠ The implant must NOT touch the red areas These areas exceed the specified maximum spatial field gradient value for this implant.

This message pops up in the Spatial Field Gradient screen of the implant guidance when you enter a maximum spatial field gradient value. It also pops up when you click the **Details...** button.



Maximum SAR for scanning Pregnant Patients

English	Your language

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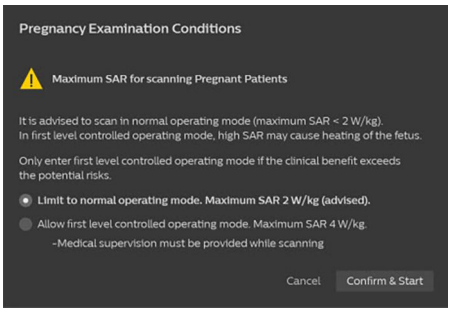
Maximum SAR for scanning Pregnant Patients	
Maximum SAR for scanning Pregnant Patients	**Maximum SAR for scanning Pregnant Patients**
It is advised to scan in normal operating mode (maximum SAR < 2W/kg).	It is advised to scan in normal operating mode (maximum SAR < 2W/kg).
In first level controlled operating mode, high SAR may cause heating of the fetus. Only enter first level controlled operating mode if the clinical benefit exceeds the potential risks.	In first level controlled operating mode, high SAR may cause heating of the fetus. Only enter first level controlled operating mode if the clinical benefit exceeds the potential risks.
Limit to normal operating mode. Maximum SAR 2W/kg (advised).	Limit to normal operating mode. Maximum SAR 2W/kg (advised).
Allow first level controlled operating mode. Maximum SAR 4 W/kg. Medical supervision must be provided while scanning.	Allow first level controlled operating mode. Maximum SAR 4 W/kg. Medical supervision must be provided while scanning.

This message pops up in the New Exam window when you set **Patient gender** to **female**, **Pregnancy** to **Yes**, **SAR mode** to **1st level**.

- To select normal operating mode or first level controlled operating mode, click the corresponding button.



Energizing the magnet	
English	**Your language**

3000 139 72881/782 * 2025-05

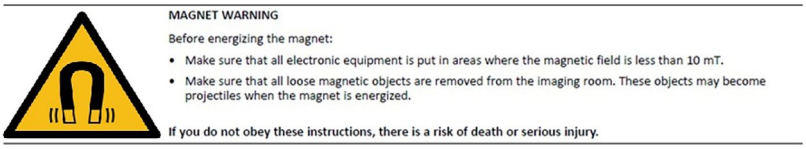
Energizing the magnet

MAGNET WARNING	**MAGNET WARNING**
Before energizing the magnet: • Make sure that all electronic equipment is put in areas where the magnetic field is less than 10 mT. • Make sure that all loose magnetic objects are removed from the imaging room. These objects may become projectiles when the magnet is energized.	Before energizing the magnet: • Make sure that all electronic equipment is put in areas where the magnetic field is less than 10 mT. • Make sure that all loose magnetic objects are removed from the imaging room. These objects may become projectiles when the magnet is energized.
If you do not obey these instructions, there is a risk of death or serious injury.	If you do not obey these instructions, there is a risk of death or serious injury.

This message pops up when the magnet is about to be energized by the trained operator or your service provider.

- To start the process of energizing the magnet and to remove the precondition text, click **Next** .

  Also inform other relevant persons that the magnet goes on field again.
- To remove the precondition text without starting the process of energizing the magnet, click **Cancel**.

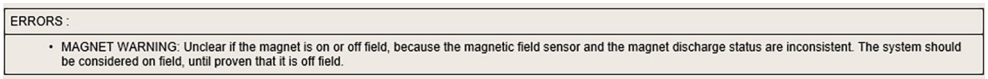


Inconsistent magnet sensors

English	Your language
Unclear if the magnet is on or off field, because the magnetic field sensor and the magnet discharge status are inconsistent. The system should be considered on field, until proven that it is off field.	Unclear if the magnet is on or off field, because the magnetic field sensor and the magnet discharge status are inconsistent. The system should be considered on field, until proven that it is off field.

This message pops up at the end of the procedure Corrective Maintenance-Magnet-Magnet Discharge if the magnetic field sensor and the magnet discharge status are inconsistent.

- To remove the message, close the pop-up window.



Patient Position Undefined

English	Your language

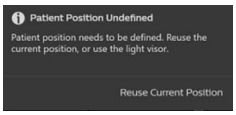
3000 139 72881/782 * 2025-05

Patient Position Undefined	
Patient Position Undefined	**Patient Position Undefined**
Patient position needs to be defined. Reuse the current position, or use the light visor.	Patient position needs to be defined. Reuse the current position, or use the light visor.

This message pops up when the patient position is unknown to the system.

- To continue the examination, select **Reuse Current Position**.

  Reuse Current Position is the default value.

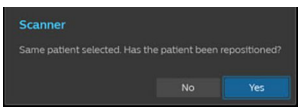


English	**Your language**
Scanner	**Scanner**
Same patient selected. Has the patient been repositioned?	Same patient selected. Has the patient been repositioned?

This message pops up when you create a new examination selecting the same patient.

- To reset the patient reference point, click **Yes**. Then use the light visor to reposition the patient. Re-plan of the patient examination is required.

  Yes is the default value.
- To continue the examination, click **No**.



Implant responsibility	
English	**Your language**
I confirm that: • All values for the implant are entered correctly. • The responsible physician approves this patient for MR scanning.	I confirm that: • All values for the implant are entered correctly. • The responsible physician approves this patient for MR scanning.

This message pops up in the **Confirm** screen of the implant guidance.

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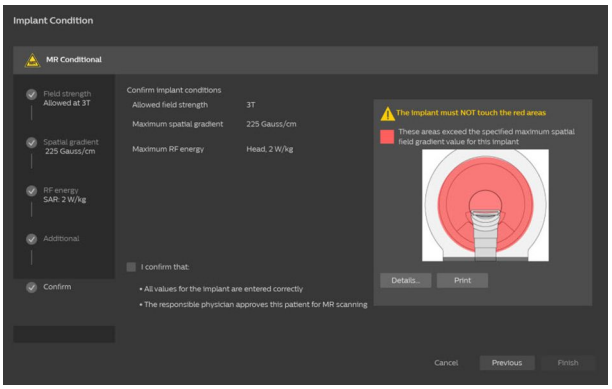
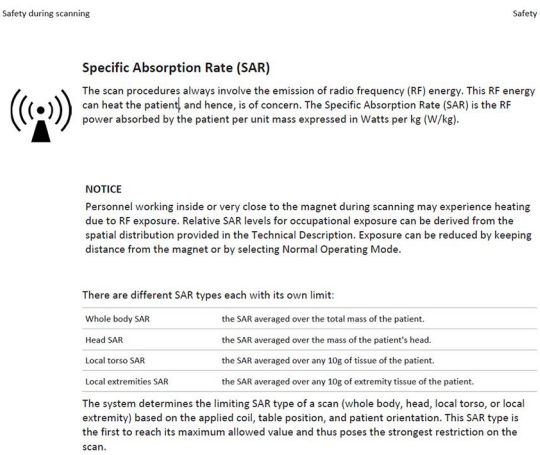


Direct link to the Help page for SAR

English	Your language
Help menu page for Specific Absorption Rate (SAR).	Help menu page for Specific Absorption Rate (SAR).

This message pops up in the SAR screen of the implant guidance when you select the link **What should I know about SAR, B1rms and patient heating?**



Safety during scanning Safety

Specific Absorption Rate (SAR)

The scan procedures always involve the emission of radio frequency (RF) energy. This RF energy can heat the patient, and hence, is of concern. The Specific Absorption Rate (SAR) is the RF power absorbed by the patient per unit mass expressed in Watts per kg (W/kg).

NOTICE

Personnel working inside or very close to the magnet during scanning may experience heating due to RF exposure. Relative SAR levels for occupational exposure can be derived from the spatial distribution provided in the Technical Description. Exposure can be reduced by keeping distance from the magnet or by selecting Normal Operating Mode.

There are different SAR types each with its own limit:

Whole body SAR	the SAR averaged over the total mass of the patient.
Head SAR	the SAR averaged over the mass of the patient's head.
Local torso SAR	the SAR averaged over any 10g of tissue of the patient.
Local extremities SAR	the SAR averaged over any 10g of extremity tissue of the patient.

The system determines the limiting SAR type of a scan (whole body, head, local torso, or local extremity) based on the applied coil, table position, and patient orientation. This SAR type is the first to reach its maximum allowed value and thus poses the strongest restriction on the scan.

Scanning of implants depending on the field strength

English	Your language
Scanning not allowed at XX Tesla.	Scanning not allowed at XX Tesla.
It is not safe to continue scanning this patient. The field strength of this system is too high for the implant.	It is not safe to continue scanning this patient. The field strength of this system is too high for the implant.

This message pops up in the Field Strength screen of the implant guidance. XX indicates the magnetic field strength of the system.

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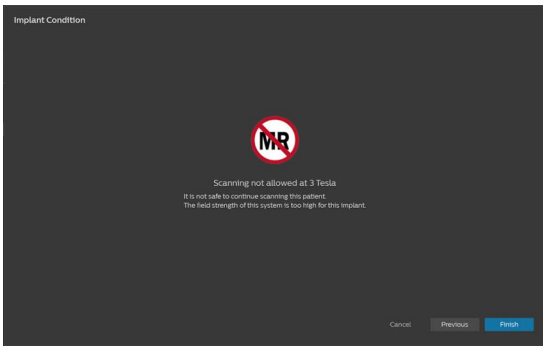
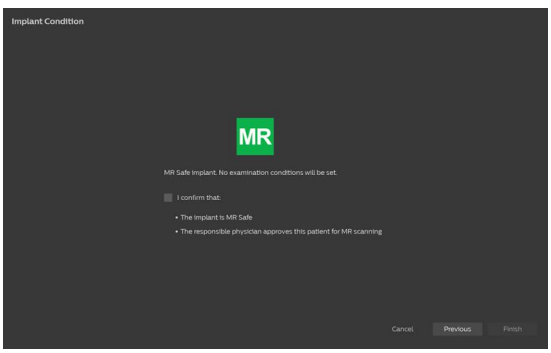


MR Safe implant	
English	**Your language**
MR MR Safe implant. No examination conditions will be set. I confirm that: • The implant is MR Safe. • The responsible physician approves this patient for MR scanning.	MR MR Safe implant. No examination conditions will be set. I confirm that: • The implant is MR Safe. • The responsible physician approves this patient for MR scanning.
This message pops up in the screen of the implant guidance when you selected MR Safe.	



Multiple VCG modules	
English	**Your language**
Wireless Physiology Multiple VCG modules detected. Only one must be powered on.	**Wireless Physiology** Multiple VCG modules detected. Only one must be powered on.
This message pops up when multiple VCG modules are detected. • To close the pop-up window, click **Close**. **Close** is the default value.	

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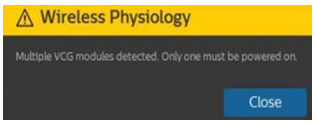


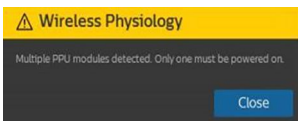
Multiple VCG modules

English	Your language
Wireless Physiology	**Wireless Physiology**
Multiple PPU modules detected. Only one must be powered on.	Multiple PPU modules detected. Only one must be powered on.

This message pops up when multiple PPU modules are detected.

- To close the pop-up window, click **Close**.

  Close is the default value.



High Whole Body SAR

English	Your language
High Whole Body SAR	**High Whole Body SAR**
The next scan requires 1st level controlled operating mode for whole body SAR. In this mode, the SAR value is between 2 and 4 W/kg. Medical supervision is required to monitor body temperature rise. If you observe that the patient is feeling warm, lower the SAR mode to Normal. Do you allow high whole body SAR for the current patient?	The next scan requires 1st level controlled operating mode for whole body SAR. In this mode, the SAR value is between 2 and 4 W/kg. Medical supervision is required to monitor body temperature rise. If you observe that the patient is feeling warm, lower the SAR mode to Normal. Do you allow high whole body SAR for the current patient?
Read about 1st level controlled operating mode for SAR.	Read about 1st level controlled operating mode for SAR.

This message pops up upon **Start Scan** when 1st level controlled operating mode for SAR and high SAR are not confirmed for the current examination.

- **Confirm and Start** immediately starts the scan.

  All scans for the current patient which require medical supervision due to high SAR are allowed.
- **Cancel** sets the scan back to **ready to run** and allows you to adjust parameters.

  Cancel is the default value.

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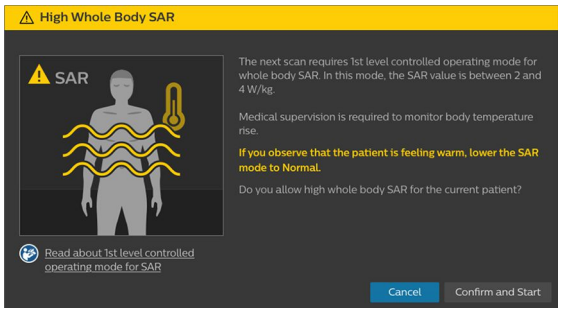


High Whole Body SAR (applies for Italy)

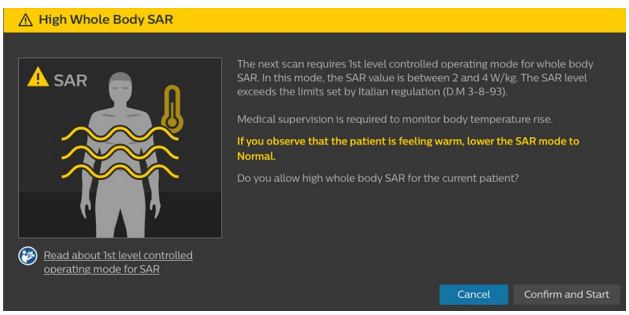
English	Your language
High Whole Body SAR The next scan requires 1st level controlled operating mode for whole body SAR. In this mode, the SAR value is between 2 and 4 W/kg. The SAR level exceeds the limits set by Italian regulation (D.M 3-8-93). Medical supervision is required to monitor body temperature rise. If you observe that the patient is feeling warm, lower the SAR mode to Normal. Do you allow high whole body SAR for the current patient? Read about 1st level controlled operating mode for SAR.	**High Whole Body SAR** The next scan requires 1st level controlled operating mode for whole body SAR. In this mode, the SAR value is between 2 and 4 W/kg. The SAR level exceeds the limits set by Italian regulation (D.M 3-8-93). Medical supervision is required to monitor body temperature rise. If you observe that the patient is feeling warm, lower the SAR mode to Normal. Do you allow high whole body SAR for the current patient? Read about 1st level controlled operating mode for SAR.

This message pops up upon **Start Scan** when 1st level controlled operating mode for SAR and high SAR are not confirmed for the current examination.

- **Confirm and Start** immediately starts the scan.

  All scans for the current patient which require medical supervision due to high SAR are allowed.
- **Cancel** sets the scan back to **ready to run** and allows you to adjust parameters.

  Cancel is the default value.



3000 139 72881/782 * 2025-05

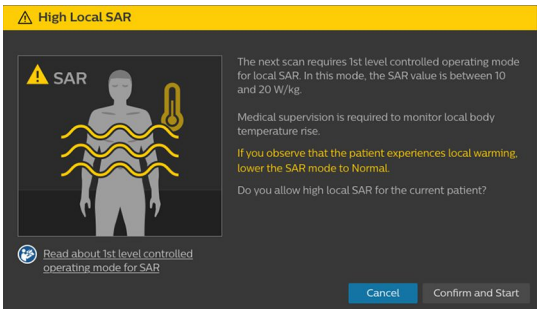
High Local SAR	
English	**Your language**
High Local SAR The next scan requires 1st level controlled operating mode for local SAR. In this mode, the SAR value is between 10 and 20 W/kg. Medical supervision is required to monitor local body temperature rise. If you observe that the patient experiences local warming, lower the SAR mode to Normal. Do you allow high local SAR for the current patient? Read about 1st level controlled operating mode for SAR.	**High Local SAR** The next scan requires 1st level controlled operating mode for local SAR. In this mode, the SAR value is between 10 and 20 W/kg. Medical supervision is required to monitor local body temperature rise. If you observe that the patient experiences local warming, lower the SAR mode to Normal. Do you allow high local SAR for the current patient? Read about 1st level controlled operating mode for SAR.

This message pops up upon **Start Scan** when 1st level controlled operating mode for SAR and local high SAR are not confirmed for the current examination.

- **Confirm and Start** immediately starts the scan.

  All scans for the current patient which require medical supervision due to high SAR are allowed.
- **Cancel** sets the scan back to **ready to run** and allows you to adjust parameters.

  Cancel is the default value.



High Local SAR (applies for Italy)	
English	**Your language**

3000 139 72881/782 * 2025-05

High Local SAR (applies for Italy)

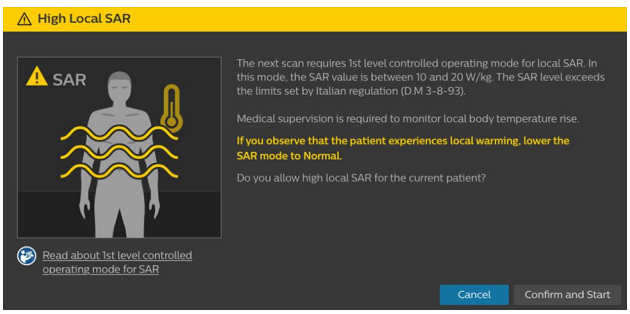
High Local SAR The next scan requires 1st level controlled operating mode for local SAR. In this mode, the SAR value is between 10 and 20 W/kg. The SAR level exceeds the limits set by Italian regulation (D.M 3-8-93). Medical supervision is required to monitor local body temperature rise. If you observe that the patient experiences local warming, lower the SAR mode to Normal. Do you allow high local SAR for the current patient? Read about 1st level controlled operating mode for SAR.	**High Local SAR** The next scan requires 1st level controlled operating mode for local SAR. In this mode, the SAR value is between 10 and 20 W/kg. The SAR level exceeds the limits set by Italian regulation (D.M 3-8-93). Medical supervision is required to monitor local body temperature rise. If you observe that the patient experiences local warming, lower the SAR mode to Normal. Do you allow high local SAR for the current patient? Read about 1st level controlled operating mode for SAR.

This message pops up upon **Start Scan** when 1st level controlled operating mode for SAR and local high SAR are not confirmed for the current examination.

- **Confirm and Start** immediately starts the scan.

  All scans for the current patient which require medical supervision due to high SAR are allowed.
- **Cancel** sets the scan back to **ready to run** and allows you to adjust parameters.

  Cancel is the default value.



Automatic Tabletop Movement

English	Your language

3000 139 72881/782 * 2025-05

Automatic Tabletop Movement	
Automatic Tabletop Movement The tabletop will move. Check that the patient, patient extremities, clothing, equipment, cables and intravenous lines cannot get trapped. Verify that nothing can get trapped during the tabletop movement. Allow the tabletop to move automatically for • this scan? • all scans? Read about tabletop movement.	**Automatic Tabletop Movement** The tabletop will move. Check that the patient, patient extremities, clothing, equipment, cables and intravenous lines cannot get trapped. Verify that nothing can get trapped during the tabletop movement. Allow the tabletop to move automatically for • this scan? • all scans? Read about tabletop movement.

This message pops up when the scan requires tabletop movement after **Start scan**.

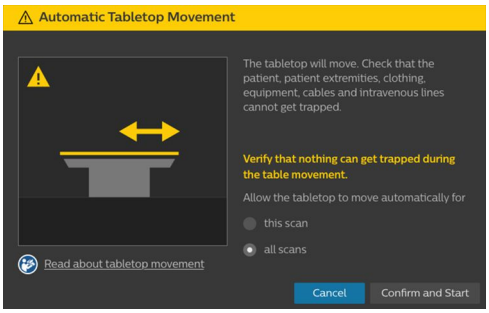
- To not initiate tabletop movement, click **Cancel**.

  The scan will be aborted if it the scan status is dispatched. The scan will be cancelled if the scan status is **ready to run**.

  Cancel is the default value.
- To start tabletop movement and then start the scan, click **Confirm and Start**.
  - If you select for **this scan**, tabletop movement takes place only for the current scan.

  The message pops up again for the next scan that requires tabletop movement.
  - If you select for **all scans**, tabletop movement takes place for all scans where it is required or recommended.

  Allow for **all scans** is the default value.



Low Bore Ventilation	
English	**Your language**

3000 139 72881/782 * 2025-05

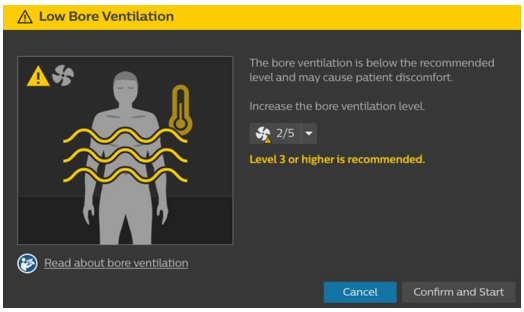
Low Bore Ventilation

Low Bore Ventilation	**Low Bore Ventilation**
The bore ventilation is below the recommended level and may cause patient discomfort. Increase the bore ventilation level.	The bore ventilation is below the recommended level and may cause patient discomfort. Increase the bore ventilation level.
Level 3 or higher is recommended.	Level 3 or higher is recommended.
Read about bore ventilation	Read about bore ventilation

This message pops up when the bore ventilation is below the recommended level after **Start scan**.

- **Confirm and Start** immediately starts the scan.
- **Cancel** sets the scan back to **ready to run** and allows you to adjust parameters.

  Cancel is the default value.



Fast Tabletop Movement

English	Your language
Fast Tabletop Movement	**Fast Tabletop Movement**
The tabletop will move fast. Check that the patient, patient extremities, clothing, equipment, cables and intravenous lines cannot get trapped.	The tabletop will move fast. Check that the patient, patient extremities, clothing, equipment, cables and intravenous lines cannot get trapped.
Verify that nothing can get trapped during the table movement.	Verify that nothing can get trapped during the table movement.
Do you allow the tabletop to move fast for this scan?	Do you allow the tabletop to move fast for this scan?
Read about tabletop movement.	Read about tabletop movement.

This message pops up when the scan requires fast tabletop movement.

- To not initiate tabletop movement, click **Cancel**.

  The scan will be aborted if it the scan status is dispatched. The scan will be cancelled if the scan status is **ready to run**.

  Cancel is the default value.
- To start tabletop movement and then start the scan, click **Confirm and Start**.

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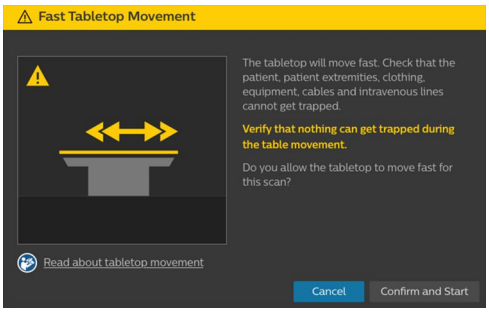


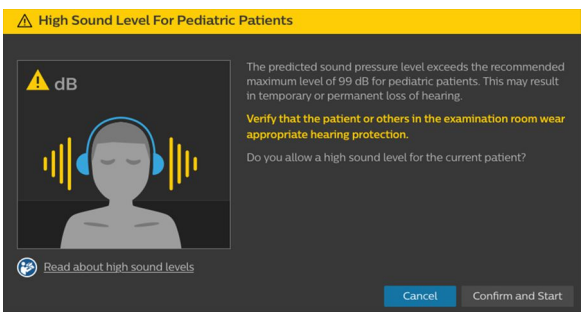
High Sound Level For Pediatric Patients

English	Your language
High Sound Level For Pediatric Patients	**High Sound Level For Pediatric Patients**
The predicted sound pressure level exceeds the recommended maximum level of 99 dB for pediatric patients.This may result in temporary or permanent loss of hearing.	The predicted sound pressure level exceeds the recommended maximum level of 99 dB for pediatric patients.This may result in temporary or permanent loss of hearing.
Verify that the patient or others in the examination room wear appropriate hearing protection.	Verify that the patient or others in the examination room wear appropriate hearing protection.
Do you allow a high sound level for the current patient?	Do you allow a high sound level for the current patient?
Read about high sound levels.	Read about high sound levels.

The message pops up
when the predicted sound pressure level of the scan to be started is above the allowed level for pediatric patients (age < 3 years).

- The sound pressure level starts for each patient at 99 dB. It can be increased to higher value via this pop-up.
- **Cancel** sets the scan back to **ready to run** and allows you to adjust the parameters.
- **Confirm and Start** immediately starts the scan.

  The allowed limit is set to the new, higher, value.
- **Cancel** is the default value.



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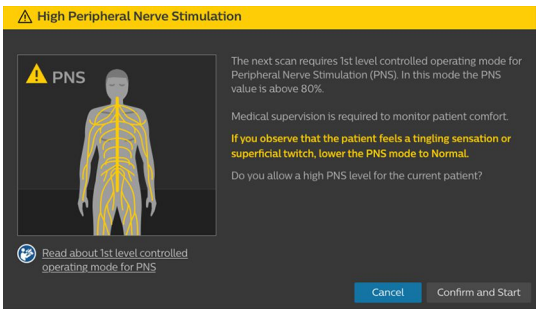
High Peripheral Nerve Stimulation

English	Your language
High Peripheral Nerve Stimulation The next scan requires 1st level controlled operating mode for Peripheral Nerve Stimulation (PNS). In this mode the PNS value is above 80%. Medical supervision is required to monitor patient comfort. If you observe that the patient feels a tingling sensation or superficial twitch, lower the PNS mode to Normal. Do you allow a high PNS level for the current patient? Read about 1st level controlled operating mode for PNS.	**High Peripheral Nerve Stimulation** The next scan requires 1st level controlled operating mode for Peripheral Nerve Stimulation (PNS). In this mode the PNS value is above 80%. Medical supervision is required to monitor patient comfort. If you observe that the patient feels a tingling sensation or superficial twitch, lower the PNS mode to Normal. Do you allow a high PNS level for the current patient? Read about 1st level controlled operating mode for PNS.

The message pops up when the PNS exceeds 80%, and high PNS was not confirmed for the current examination.

- **Cancel** sets the scan back to **ready to run** and allows you to adjust the parameters.
- **Confirm and Start** immediately starts the scan.

  All scans for the current patient which require medical supervision due to high PNS are allowed.
- **Cancel** is the default value.



High Total SED

English	Your language

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High Total SED

High Total SED

The performed scans and the remaining scans together exceed the recommended Specific Energy Dose (SED) levels with xx kJ/kg. Patient discomfort due to body temperature rise can be observed at values greater than the recommended SED of 7.0 kJ/kg.

If you observe that the patient is feeling warm, reduce the scan time or the SAR of the remaining scans. Do you allow to exceed the recommended SED for the current patient?

Read about SED.

High Total SED

The performed scans and the remaining scans together exceed the recommended Specific Energy Dose (SED) levels with xx kJ/kg. Patient discomfort due to body temperature rise can be observed at values greater than the recommended SED of 7.0 kJ/kg.

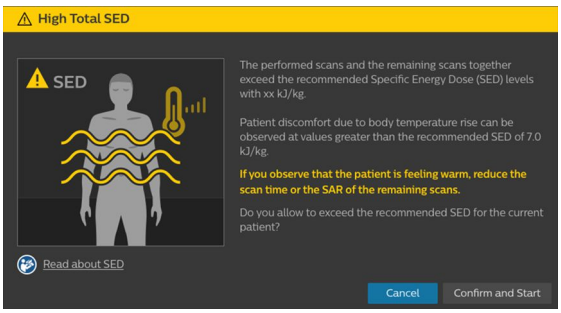
If you observe that the patient is feeling warm, reduce the scan time or the SAR of the remaining scans. Do you allow to exceed the recommended SED for the current patient?

Read about SED.

This message pops up when the total SED for the current patient exceeds 7.0 kJ/kg when the scan is started.

- **Confirm and Start** immediately starts the scan.
- **Cancel** sets the scan back to **ready to run** and allows you to adjust parameters.

  Cancel is the default value.



Recommended Maximum SED Will Be Exceeded

English	Your language

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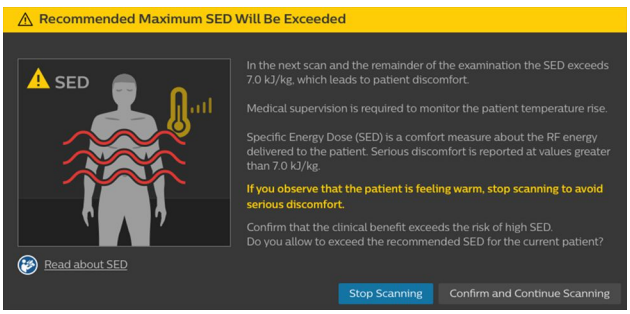
Recommended Maximum SED Will Be Exceeded

Recommended Maximum SED Will Be Exceeded	**Recommended Maximum SED Will Be Exceeded**
In the next scan and the remainder of the examination the SED exceeds 7.0 kJ/kg, which leads to patient discomfort. Medical supervision is required to monitor the patient temperature rise. Specific Energy Dose (SED) is a comfort measure about the RF energy delivered to the patient. Serious discomfort is reported at values greater than 7.0 kJ/kg.	In the next scan and the remainder of the examination the SED exceeds 7.0 kJ/kg, which leads to patient discomfort. Medical supervision is required to monitor the patient temperature rise. Specific Energy Dose (SED) is a comfort measure about the RF energy delivered to the patient. Serious discomfort is reported at values greater than 7.0 kJ/kg.
If you observe that the patient is feeling warm, stop scanning to avoid serious discomfort. Confirm that the clinical benefit exceeds the risk of high SED. Do you allow to exceed the recommended SED for the current patient?	If you observe that the patient is feeling warm, stop scanning to avoid serious discomfort. Confirm that the clinical benefit exceeds the risk of high SED. Do you allow to exceed the recommended SED for the current patient?
Read about SED.	Read about SED.

This message pops up when the Delivered SED for the current patient exceeds 7.0 kJ/kg when the scan is started.

- To continue scanning, click **Confirm and Continue Scanning**.
- To stop scanning, click **Stop Scanning**.

  Stop Scanning is the default value.



Phantom Scanning Only

English	Your language

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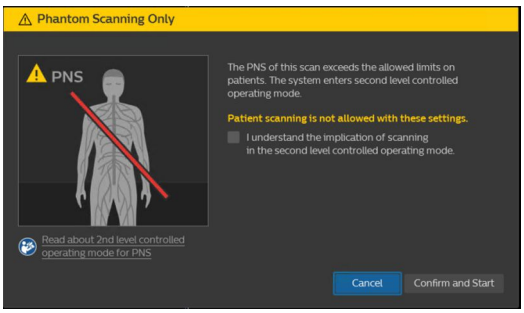
Phantom Scanning Only	
Phantom Scanning Only	**Phantom Scanning Only**
The PNS of this scan exceeds the allowed limits on patients. The system enters second level controlled operating mode. Patient scanning is not allowed with these settings.	The PNS of this scan exceeds the allowed limits on patients. The system enters second level controlled operating mode. Patient scanning is not allowed with these settings.
I understand the implication of scanning in the second level controlled operating mode.	I understand the implication of scanning in the second level controlled operating mode.
Read about 2nd level controlled operating mode for PNS.	Read about 2nd level controlled operating mode for PNS.

The message pops up
when the scan exceeds the PNS limits of 1st level controlled mode.

- **Cancel** sets the scan back to **ready to run** and allows you to adjust parameters.
- **Confirm and Start** immediately starts the scan.
- **Cancel** is the default value.



EasySwitch: Before Discharging	
English	**Your language**
The complete discharge and magnet stabilize time takes about 2 hours.	The complete discharge and magnet stabilize time takes about 2 hours.
WARNING	**WARNING**
Attracted objects may suddenly fall down or move due to magnetic field discharge. Attraction of magnetic objects and malfunction of active implants.	Attracted objects may suddenly fall down or move due to magnetic field discharge. Attraction of magnetic objects and malfunction of active implants.
Risk of death or serious injury. Do not allow anyone in the examination room.	Risk of death or serious injury. Do not allow anyone in the examination room.
Click **Start** to initiate discharging the magnet.	Click **Start** to initiate discharging the magnet.

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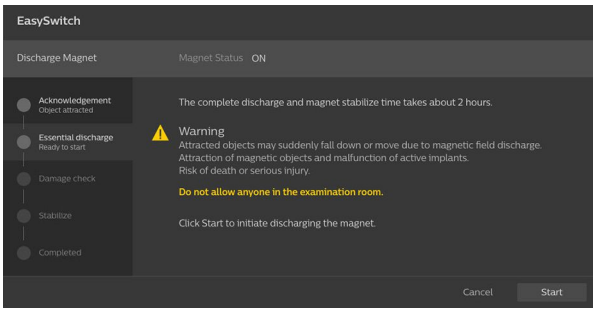
EasySwitch: Before Discharging

This message pops up before discharging the magnet with EasySwitch.

- To start the discharge procedure, click **Start**.
- To close the window without starting the discharge procedure, click **Cancel**.

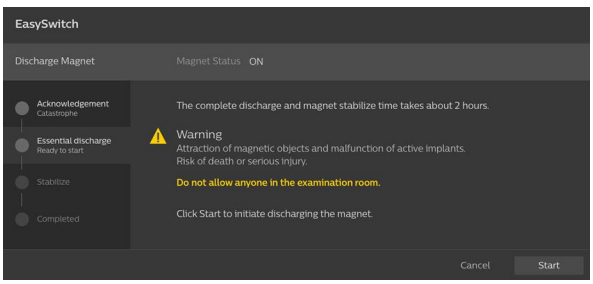


EasySwitch: Before Discharging

English	Your language
The complete discharge and magnet stabilize time takes about 2 hours.	The complete discharge and magnet stabilize time takes about 2 hours.
WARNING	**WARNING**
Attraction of magnetic objects and malfunction of active implants.	Attraction of magnetic objects and malfunction of active implants.
Risk of death or serious injury. Do not allow anyone in the examination room.	Risk of death or serious injury. Do not allow anyone in the examination room.
Click **Start** to initiate discharging the magnet.	Click **Start** to initiate discharging the magnet.

This message pops up before discharging the magnet with EasySwitch.

- To start the discharge procedure, click **Start**.
- To close the window without starting the discharge procedure, click **Cancel**.



English	Your language

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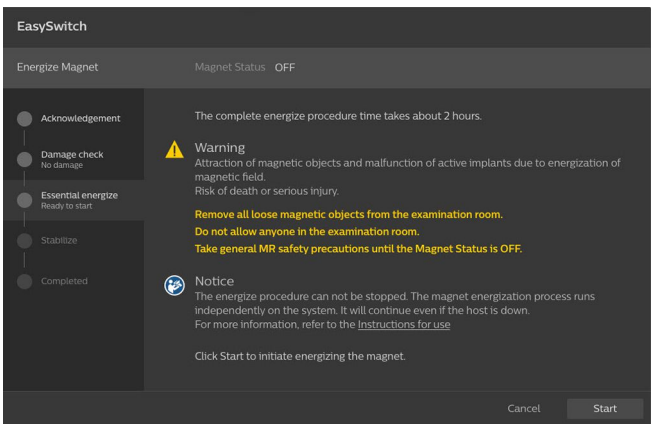
The complete energize procedure time takes about 2 hours.	The complete energize procedure time takes about 2 hours.
WARNING	**WARNING**
Attraction of magnetic objects and malfunction of active implants due to energization of magnetic field.	Attraction of magnetic objects and malfunction of active implants due to energization of magnetic field.
Risk of death or serious injury.	Risk of death or serious injury.
Remove all loose magnetic objects from the examination room. Do not allow anyone in the examination room. Take general MR safety precautions until the Magnet Status is OFF.	Remove all loose magnetic objects from the examination room. Do not allow anyone in the examination room. Take general MR safety precautions until the Magnet Status is OFF.
NOTICE The energize procedure can not be stopped. The magnet energization process runs independently on the system. It will continue even if the host is down.	NOTICE The energize procedure can not be stopped. The magnet energization process runs independently on the system. It will continue even if the host is down.
For more information, refer to the Instructions for Use.	For more information, refer to the Instructions for Use.
Click **Start** to initiate energizing the magnet.	Click **Start** to initiate energizing the magnet.

This message pops up before energizing the magnet with EasySwitch.

- To start the energize procedure, click **Start**.
- To close the window without starting the energize procedure, click **Cancel**.



EasySwitch: Discharge unsuccessful	
English	**Your language**

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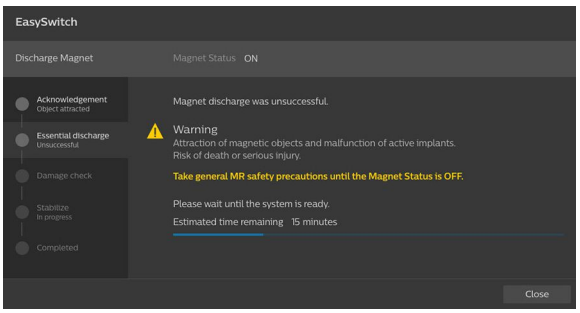
EasySwitch: Discharge unsuccessful	
Magnet Discharge was unsuccessful. **WARNING** Attraction of magnetic objects and malfunction of active implants. Risk of death or serious injury. Take general MR safety precautions unless the Magnet Status is Off. Please wait until the system is ready. Estimated time remaining: x minutes.	Magnet Discharge was unsuccessful. **WARNING** Attraction of magnetic objects and malfunction of active implants. Risk of death or serious injury. Take general MR safety precautions unless the Magnet Status is OFF. Please wait until the system is ready. Estimated time remaining: x minutes.
This message pops up when the discharge procedure with EasySwitch was unsuccessful. • To close the window, click **Close**.	



English	**Your language**
WARNING Risks of discharging and energizing the magnet using EasySwitch. Risk of death or serious injury. Read the section on EasySwitch in the instructions for use to understand related risks.	WARNING Risks of discharging and energizing the magnet using EasySwitch. Risk of death or serious injury. Read the section on EasySwitch in the instructions for use to understand related risks.
This message pops up before discharging or energizing with EasySwitch.	

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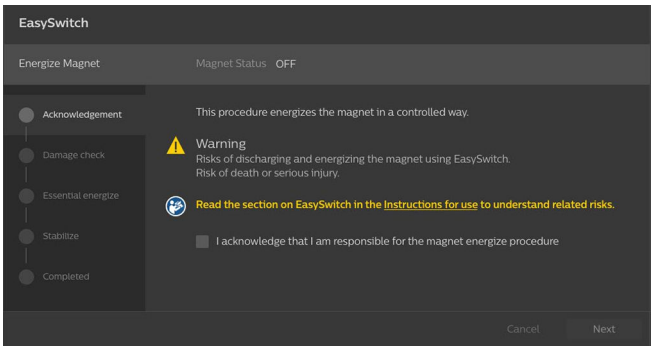
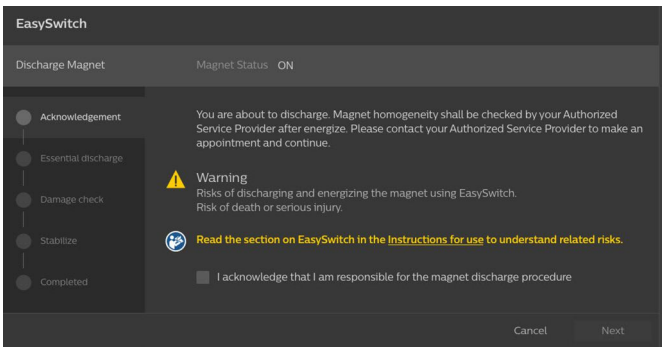
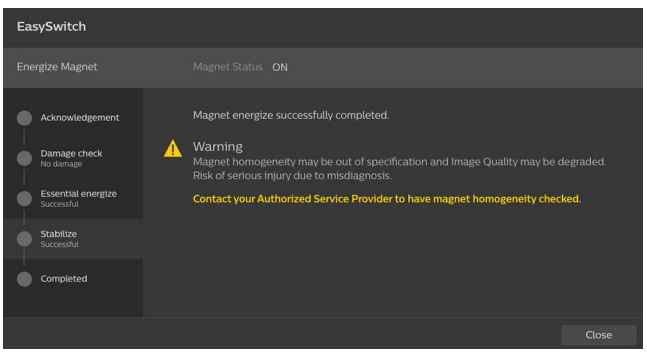




English	Your language
Magnet energize successfully completed.	Magnet energize successfully completed.
WARNING	**WARNING**
Magnet homogeneity may be out of specificaton, and Image Quality may be degraded. Risk of serious injury due to misdiagnosis.	Magnet homogeneity may be out of specificaton, and Image Quality may be degraded. Risk of serious injury due to misdiagnosis.
Contact your Authorized Service Provider to have magnet homogeneity checked.	Contact your Authorized Service Provider to have magnet homogeneity checked.

This message pops up after energizing the magnet with EasySwitch.



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English	Your language
WARNING: Contact an Authorized Service Provider to have the magnet homogeneity checked!	**WARNING**: Contact an Authorized Service Provider to have the magnet homogeneity checked!
This message pops up in the status line after energizing the magnet with EasySwitch. It remains in the status line until the homogeneity is checked.	

Severe Gradient Malfunction detected	
English	**Your language**
Severe Gradient Malfunction detected	**Severe Gradient Malfunction detected**
Scanning is disabled until Philips Service has checked the system.	Scanning is disabled until Philips Service has checked the system.
Do not attempt to continue scanning.	Do not attempt to continue scanning.
Contact Philips Service	Contact Philips Service

Smoke detected	
English	**Your language**
Smoke detected - Evacuate the patient	Smoke detected - Evacuate the patient
Smoke is detected in the Examination Room. Evacuate the patient from the Examination Room.	Smoke is detected in the Examination Room. Evacuate the patient from the Examination Room.
Check Examination Room for a developing fire.	Check Examination Room for a developing fire.
Adhere to established fire emergency procedures, which may include switching off power to the complete system and/or removing of the magnet field by using the Emergency Magnet Off button.	Adhere to established fire emergency procedures, which may include switching off power to the complete system and/or removing of the magnet field by using the Emergency Magnet Off button.
Scanning is disabled until Philips Service has checked the system. Do not attempt to continue scanning.	Scanning is disabled until Philips Service has checked the system. Do not attempt to continue scanning.
Contact Philips Service	Contact Philips Service

Emergency Run Down Unit (ERDU) self-check fails	
English	**Your language**
Failure in Emergency Magnet Off circuit!	Failure in Emergency Magnet Off circuit!
Scanning not possible. Contact Philips Service.	Scanning not possible. Contact Philips Service.

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2.6 Symbols on System, Coils and Accessories

The following symbols may be used on your Philips system, on accessories and packaging, as well as at the examination room.

Applied part symbols	Source	Meaning
	IEC 60417-5840	Type B applied part. To identify a type B applied part complying with IEC 60601-1.
	IEC 60417-5333	Type BF applied part. To identify a type BF applied part complying with IEC 60601-1.
	IEC 60417-5336	Defibrillation-proof type CF applied part. To identify a defibrillation-proof type CF applied part complying with IEC 60601-1 .

Mandatory Action symbols	Source	Meaning
	ISO 7010-M002	Refer to instruction manual/booklet. To signify that the instruction manual/booklet must be read.
	ISO 7010-M003	Wear ear protection. To signify that ear protection must be worn.
	n.a.	ONLY screened and approved devices allowed in scanning room.

Prohibition symbols	Source	Meaning
	ISO 7010-P007	No access for people with active implanted cardiac devices. To prohibit people with active implanted cardiac devices from entering a designated area.

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Prohibition symbols	Source	Meaning
	n.a.	Metallic implants prohibited.
	ISO 7010-P014	No access for people with metallic implants.
	ISO7010-P008	No metallic articles or watches.
	n.a.	Loose ferromagnetic objects and mechanical watches prohibited.
	n.a.	Loose ferromagnetic tools prohibited.
	n.a.	Wheel chairs and equivalent metal objects prohibited.
	n.a.	Magnetic media prohibited (credit cards, diskettes, magnetic tapes).
	ISO 7010-P012	No heavy load. To prohibit the placing of heavy objects on a surface.
	n.a.	Do not scan pediatric patients under 15 kg (33 lbs) with this coil.

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Warning symbols	Source	Meaning
	ISO 7010-W001	General warning sign.
	ISO 7010-W006	Warning: Magnetic field.
	ISO 7010-W005	Warning; Non-ionizing radiation.
	ISO 7010-W024	Warning: Crushing of hand.
	n.a.	Danger of clamping.
	ISO 7010-W004	Warning: Laser beam.
	IEC 60825-1	Laser radiation: Do not stare into beam. Class 2 Laser Product .

Alarm symbols	Source	Meaning
	IEC 60417-5307	Low priority alarm.
	IEC 60417-5308	Medium priority alarm.

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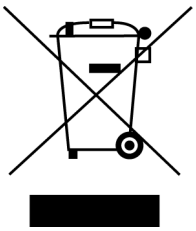
Other symbols	Source	Meaning
	IEC 60417-6193	RF coil, receive only
	IEC 60417-6192	RF coil, transmit and receive
	SJ/T 11364-2014 Figure 2, Mark II	The environment-friendly use period of this product is 50 years. (according to People's Republic of China Electronics Industry Standard SJ/T11364-2014)
	Directive 2012/19/EU WEEE Symbol	Waste electrical and electronic equipment.
	ISO7000-2498	Serial number
	ISO7000-2493	Catalogue number
	ISO7000-3082	Manufacturer
	ETL listed	Intertek ETL recognized component
	ISO 7000-1641	Consult Instructions for Use or consult electronic Instructions for Use

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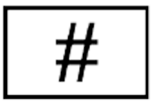
Other symbols	Source	Meaning
	2017/745/EU	Medical Device
	European Commission	CE Marked Device
	ISO7000-0434B	Caution To indicate that caution is necessary when operating the device or control close to where the symbol is placed. To indicate that the current situation needs operator awareness or operator action in order to avoid undesirable consequences.
	2017/745/EU	UDI
	ISO 7000-3725	Importer To indicate the entity importing the medical device into the locale.
	IEC60417 - 6049	Country of Manufacture
	IEC60417 - 6050	Model Number
	IEC60417- 5172	Class II equipment

Philips Markings		Meaning
	n.a.	Person trapped by an object that is attracted by the magnet.

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Philips Markings		Meaning
	N.A.	FlexTrak Marking
	N.A.	Total Mass and safe working load
	N.A.	Magnetic Field Strength

Safety marking plate	Explanation
	Examination room door safety marking plate. The individual symbols are explained in other parts of this section. Text on the safety marking plate: 1. This 1.5T (3.0T) magnet is ALWAYS ON 2. System use and scanning room access for MR Authorized personnel ONLY 3. ONLY screened and approved devices allowed in scanning room 4. While scanning: RF fields and acoustic noise

Medical symbols	Meaning
	ECG

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Medical symbols	Meaning
	Peripheral pulse/blood pressure

Referenced standards for symbols on the system

- IEC 60417:2002 DB, Graphical symbols for use on equipment.
- ISO 7010:2011, Graphical symbols – Safety colours and safety signs – Registered safety signs.
- ISO 7000:2014 (ed. 5.0), Graphical symbols for use on equipment - Registered symbols.
- EN 50419:2006, Marking of electrical and electronic equipment in accordance with Article 11(2) of Directive 2002/96/EC (WEEE).
- IEC TR 60878:2015 (ed. 3.0), Graphical symbols for electrical equipment in medical practice.

You can find definitions of used symbols in the symbol glossary on the following website: https://www.symbols.philips.com

2.7 Devices and Controls essential for System Safety

The following devices on the system and in the examination room are considered to be essential for system safety and should therefore never be removed, modified, over-ridden or disabled:

- Emergency Magnet Off buttons.
  Buttons are located inside and outside the examination room.
- Nurse call button.
- Emergency Table Stop buttons on the UIM and the keyboard.
- RF door switch.
- RF examination room configuration.
- Patient ventilation.

2.8 Accessories list

The following Accessories are provided with the system to enable specific procedures or to ensure safety:

- RF coils.
- MR Elastography.
- PPU Sensor for wireless physiology.
- Pediatric PPU Sensor.
- Acoustic Hood.

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Philips

3 Your MRI System

3.1 System Overview

Identifier	Component or Item
1	**MR Scanner**
2	**Headset and nurse call**
3	**RF Coils and dS Interface** The image shows only a subset of the commercially available coils for your MRI system.
4	**Positioning aids**
5	**Wireless Physiology**
6	**Operator's Console**

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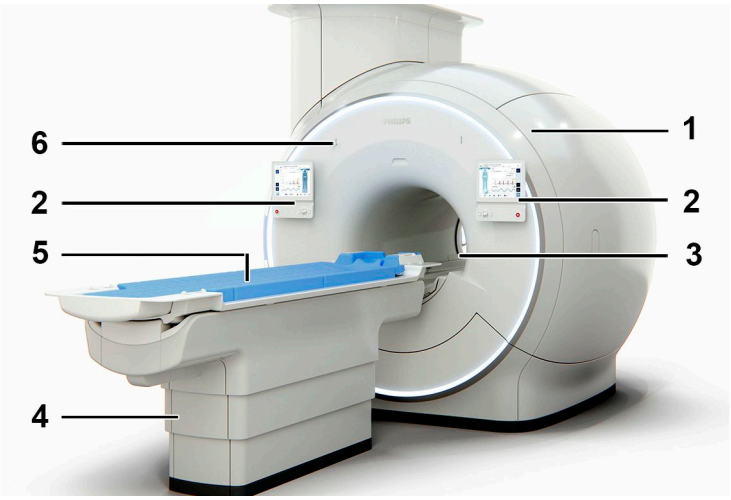
3.2 Components of your MRI Scanner



1. Magnet with Ambient ring
2. User Interface Module (UIM) or VitalScreen.
3. Magnet bore with gradient coils and System Body coil
4. Patient support
5. Tabletop
6. Retractable hooks for infusion bags or bottles

Magnet and magnet bore

During an examination, the patient is positioned in the magnet bore. Gradient coils and the System Body coil are integrated in the gantry around the magnet bore.
For patient comfort, a bore ventilation system and lights to illuminate the bore are available.

Your MRI system has a sealed Magnet with only a small amount of helium gas closed (sealed) into the magnet during manufacturing, for the lifetime of the device. In the event of a spontaneous magnet field loss or with a controlled magnet field removal, the helium remains in the magnet vessel, helium cannot escape into the examination room.

Gradient system

Gradient coils are integrated in the system. They provide the relative small magnetic field variations which are needed for the localization of the MR signals emitted by the human body.

Philips MRI systems are available with different gradient field strengths.

See **Technical Description** for information about gradient type, gradient performance and gradient stray field distribution,

Radio Frequency (RF) system

- RF coils.

  A transmit coil transmits the RF pulses into the patient. A receive coil receives the MR relaxation signals subsequently emitted by the patient. Available coil types on your MRI system are transmit-/receive-coils and receive-only coils.
- RF transmitter.
  The RF transmitter generates the RF pulses.
- RF receiver and spectrometer.

  They analyze the MR signals emitted by the patient.

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Retractable hooks for infusion bags or bottles

There is an retractable hook on the left and right side of the magnet front.
You can fold out the hook by pushing the protruding end at the bottom. The hook flips out from the top and you can pull it out completely.

Ambient ring (and bore illumination)

To switch the Ambient ring and the bore illumination on or off, use the panels at the MR gantry.

3.3 User Interface Module (UIM)

3.3.1 Functional Description

The UIM is fastened to the MR gantry. This panel comprises buttons and switches for patient support control, acquisition control and patient comfort.

There is a UIM located on both sides of the magnet bore. Both panels have the same functionality, but the layout is mirrored.

The UIM allows you

- to move the tabletop, and if needed to switch to manual table control.
- to position the patient in the isocenter.
- to start, stop and pause scans.
- to enable AutoStart, so that the scan starts automatically when you close the door of the examination room.
- to adjust music volume, bore ventilation and the bore illumination for patient comfort.
- to stop tabletop movement in case of an emergency (with the physical **Emergency Table Stop** button).

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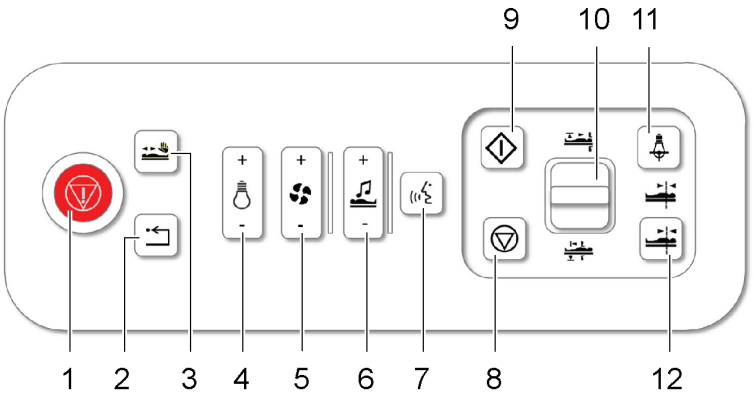
3.3.2 Components

In this section, only the UIM at the left side of the magnet bore is displayed.



1. Emergency Table Stop
2. Resume
3. Manual mode
4. Bore illumination / Ambient ring
5. Ventilation
6. Music volume
7. Talk
8. Stop scan
9. Start scan/Pause scan
10. Tumble switch
11. Light visor
12. Travel to scanplane (TTS)

You can find definitions of used symbols in the symbol glossary on the following website: https://www.symbols.philips.com

3.3.3 Routine Procedures

Tabletop Movement

Tumble switch

The Tumble switch initiates all motorized movements of patient support and tabletop.

Horizontal and vertical movement

With the Tumble switch, the patient support is moved:

- up or down when the tabletop is totally moved out of the magnet bore. The vertical speed is fixed.
- in or out the magnet bore when the patient support is at its highest position. Two speeds are available.

Operating the Tumble switch

- ► Push the Tumble switch up for the up or in movement of the tabletop.
- ► Push the switch down for the out or down movement.

The up/in and out/down symbols above and below the Tumble switch are only visible when this function is available.

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Manual mode

Use **Manual mode** to toggle between motorized and manual (tabletop movement) mode. The LED next to the button illuminates when the tabletop is in manual mode. Tabletop position information is available in manual mode.

Resume

The **Resume** button resets the tabletop after an emergency stop of the tabletop movement.

Isocenter Positioning and Start of Acquisition

Light visor

NOTICE

Before operation, read and familiarize yourself with the warnings in the safety chapter how to use the light visor.

When you press this button, a laser light beam is projected onto the patient.
This laser light beam allows to select the anatomic area of interest which will be positioned in the isocenter of the magnet, in the following referred to as *patient reference point*.

- The laser light will automatically switch off after 60 seconds.
- Typical use of the light visor is only once for every patient.
- Use of the light visor during the execution of scan or ExamCard will be ignored: a new patient reference point cannot be defined.

Travel to scanplane (TTS)

The TTS button travels the patient into the bore so that the *patient reference point* is located exactly in the isocenter.

► First select the patient reference point with the light visor.

► Then do any of the following.

- Press the TTS button once to select the travel-to-scanplane mode.

  Raise the tumble switch to the 'up/In' position. Hold it until the tabletop automatically stops and the patient reference point has reached the isocenter.

- Press the TTS button for 2 seconds to initiate automatic tabletop movement (without using the tumble switch). The tabletop stops when the patient reference point has reached the isocenter.

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Patient reference point

All scans are planned with the information of the patient reference point. All tabletop movements which are required for optimal image quality are deduced from this point.

NOTICE

Do not leave the patient unattended until the tabletop has reached the isocenter.

Coils with fixed position and Auto-iso

Coils that have a fixed position do not require the use of the light visor. Instead traveling to scan plane can be initiated immediately: the isocenter is traveled to automatically based on coil characteristics. When the table reaches the isocenter, the green Travel-to-Scanplane button lights up.

Coils with fixed position: Light visor is not needed for isocenter positioning	
• dS HeadSpine	Only when the coil top is used The Auto-iso functionality positions the dS HeadSpine coil always at the head position.

You can disable the automatic isocenter positioning, for example in head and neck examinations.

- ► To manually set the isocenter position with the light visor, press the light visor button.
  - ⇨ The green TTS light is OFF. The light visor light is ON.
- ► Only when the light of the light visor button is not switched ON, press the TTS button followed by the light visor button.
- ► Then use the light visor beam to define the isocenter position.

Start scan / Pause scan

Use this button to start, or pause a scan in the examination room.

When you press this button during a scan, you pause the current scan. To resume the scan, press the button again.

This button also initiates tabletop movement and starts the scan automatically.

Starting scan automatically (AutoStart)

The AutoStart functionality automatically starts the next item of the ExamCard, mostly the Survey scan, when you close the door to the examination room. AutoStart also works for paused dynamic scans.

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▷ Prerequisite: Centering with the light visor is completed and the traveling to scanplane procedure is initiated. Consequently the **Start scan/Pause scan** button is active.
Coils that have a fixed position (see table below) do not require using the light visor.

► To enable AutoStart, press the **Start scan/Pause scan** button.

⇨ To indicate that AutoStart is enabled, the **Start scan/Pause scan** button starts blinking.

Note: press the **Stop scan** button to stop AutoStart. The scan will not abort but return to active.

► Close the door to the examination room.

⇨ The next item of the ExamCard automatically starts.

AutoStart while in the examination room

You can also enable AutoStart when staying in the examination room during scanning.

▷ Prerequisite: Centering with the light visor is completed and the traveling to scanplane procedure is initiated. Consequently the **Start scan/Pause scan** button is active.
Coils that have a fixed position (see table below) do not require using the light visor.

► Close the examination room door.

► To enable AutoStart, press the **Start scan/Pause scan** button.

⇨ To indicate that AutoStart is enabled, the **Start scan/Pause scan** button starts blinking.

Note: press the **Stop scan** button to stop AutoStart. The scan will not abort but return to active.

► Press the **Start scan/Pause scan** button again.

⇨ The next item of the ExamCard automatically starts.

Stop scan

The **Stop scan** button stops the currently running scan.

The **Stop scan** button stops tabletop movement during a multistation (moving-bed) scan.

Pressing the **Stop scan** button twice also stops image reconstruction.

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Patient Comfort and Communication

Bore illumination and Ambient Ring

This button allows you to switch on or off the Ambient Ring, and to adjust the bore illumination incrementally.

The Ambient ring is also switched on when the operator logs in to the system and switched off at logout.

During acquisition, the operation of the Bore illumination and Ambient Ring button is ignored.

- To increase the bore illumination, briefly press the plus side (+) of the button. Repeat if needed.
- To decrease the bore illumination, briefly press the minus side (-) of the button. Repeat if needed.
- To switch on the Ambient Ring, press the plus side (+) of the button for 2 seconds.
- To switch off the Ambient Ring, press the minus side (-) of the button for 2 seconds.

Ventilation

You control the amount of ventilation through the magnet bore with the **Ventilation** button, or on the operator's console.

Music volume

Use this button to adjust the music volume for the patient. There are 5 levels available.

Talk

The **Talk** button enables communication between the operator in the examination room and the patient wearing a headset.

The **Talk** button connects the magnet microphone to the patient headset (the button lights green), and switches off the music speakers in the examination room. Once pressed, the **Talk** button remains active until pressed again (the button light goes off).

The **Talk** button on the intercom at the console can temporarily overrule the magnet microphone, but cannot switch it off.

3.3.4 Emergency Stop

Emergency Table Stop

To stop tabletop movement and the current scan immediately:

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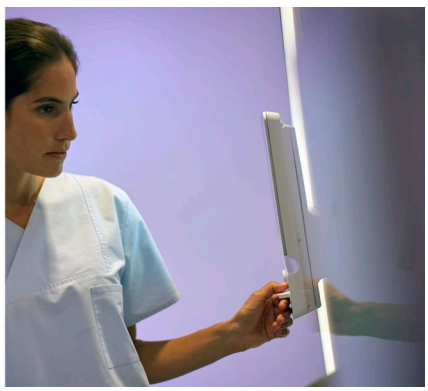
- ► Press the **Emergency Stop** button.
  - ⇨ The tabletop is released.
  - ⇨ Manual tabletop movement in and out of the bore is possible.
  - ⇨ The red light on the Emergency Stop button switches on.
- ► To reset the tabletop and re-enable normal operation, press the **Resume** button.

3.4 VitalScreen

3.4.1 Functional Description

VitalScreen is a display and operating unit that is fastened to the MR gantry. It consists of two touch screen devices (on each side of the bore) with physical buttons and a tumble switch. The two devices are mirrored horizontally.



What are the main features of VitalScreen?

- In the examination room, VitalScreen provides you with essential information about the current MR examination. As such it guides you in setting up the patient for an examination:
  - It provides you with patient and examination information.
  - It provides you with visuals about how to position the patient for the various examinations (all clinical areas) and for different patient positions (supine or prone, head first or feet first),
  - It displays information about the connected coils including cable routing advice.
  - It provides you with visuals about how to place physiological sensors.
  - It displays physiological signals in the examination room.
- VitalScreen allows you
  - to adjust music volume, bore ventilation and the bore illumination for patient comfort.
  - to select and adjust the display of the physiology signals.

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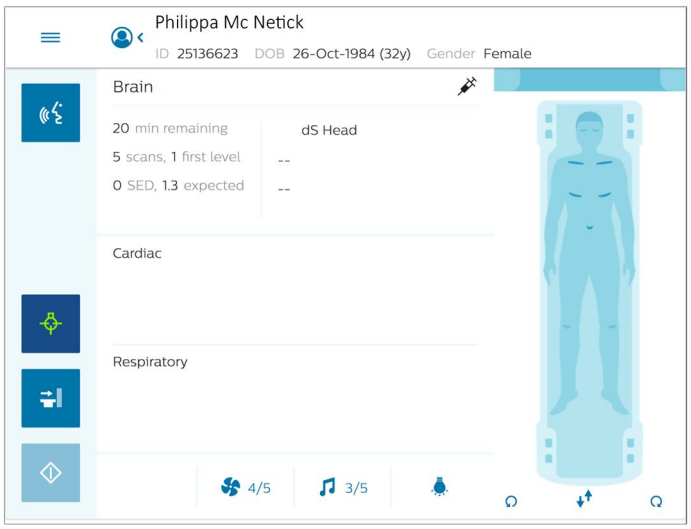
  - to enable AutoStart, so that the scan starts automatically when you close the door of the examination room.
  - to move the tabletop, and if needed to switch to manual table control.
  - to stop tabletop movement in case of an emergency (with the physical **Emergency Table Stop** button).
  - to perform manual VCG calibration from the VitalScreen.
- You can operate the touch screen with bare hands and with plastic gloves.



Touch screen device of the VitalScreen

VitalScreen physical buttons and tumble switch

1. **Emergency Table Stop** button
2. **Travel to isocenter** button (also available in touch screen device)
3. **Tumble switch**
4. **Light visor** button (also available in touch screen device)

3.4.2 User Interface

Patient and examination information at the VitalScreen

The VitalScreen shows patient data and information of the examination currently selected for scanning.

This information is automatically transferred from the operator's console to the VitalScreen, when an examination is entered or selected for scanning.

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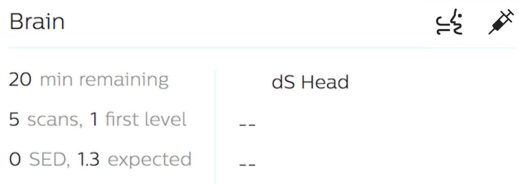
How is patient privacy secured when changing over patients in the examination room?

- You have to activate the display of patient and examination information at the VitalScreen before every new patient.
- When the first scan of an ExamCard is finished, the patient data of this examination is automatically hidden at the VitalScreen to protect patient's privacy.
  The information stays hidden till another examination is selected for scanning.

Which information is displayed on the VitalScreen?

	Patient data with: • patient name • patient ID • birth date (age) • gender • patient weight To edit or enter the patient weight at the VitalScreen, tap the patient weight and enter the correct value with the numeric pad. Alternatively enter the patient weight in the ExamCard Properties at the operator's console.
	Examination data with: • remaining examination duration • remaining number of scans • remaining number of scans with high SAR • current and expected SED • coil information (connected, not connected) • breathhold required: yes/no • injection of contrast agent required: yes/no
	ECG signal In the **Signal Settings** menu, you can select the signal trace for display.
	Respiratory signal In the **Signal Settings** menu, you can select the signal trace for display.

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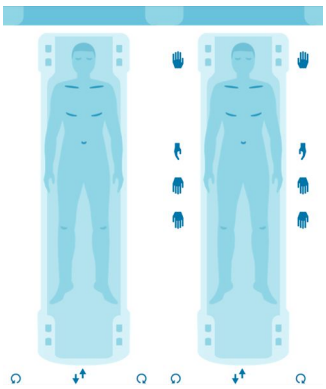
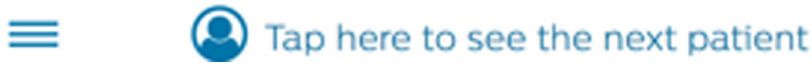
	Positioning examples for the selected examination. • Left: Example of any examination except hand or wrist. • Right: Example of hand or wrist examination. For more information, see VitalScreen buttons and Adapting display and examination to current positioning at the VitalScreen.

Displaying information of an examination at the VitalScreen

▷ Prerequisite: an examination is selected for scanning.

▷

► Tap the VitalScreen **patient field** to activate the display of examination and patient information.



⇨ Patient data and information of current examination are displayed.

VitalScreen buttons

	Menu button allowing to: • **Update patient weight...**, • Enable **Manual table mode**, • **Clean screen mode**, • Adjust the **Signal settings...** of the physiology signals.
	Talk
	Light visor
	Travel to scanplane
	AutoStart
	Adjust **Bore ventilation**

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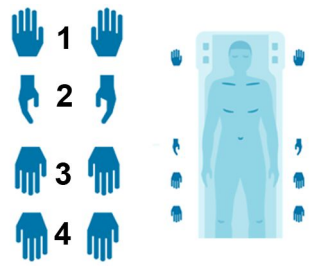
	Adjust **Music volume**
	Adjust **light** of **light ring** and/or **bore light**
	Adjust **patient orientation** (HeadFirst, FeetFirst) according to current patient positioning and save setting as ExamCard property in the examination
	Adjust **patient position** (Supine, Prone, DecubRight and DecubLeft (decubitus right and left) according to current patient positioning and save setting as ExamCard property in the examination
	Only for hand and wrist examinations: Adjust **hand position** in examination according to current patient positioning and save setting as ExamCard property in the examination: 1. Superman (overhead) 2. Neutral 3. EndoRotation 4. ExoRotation

Positioning guidance at the VitalScreen

At the VitalScreen, an image is displayed that shows if the patient is to be positioned head- or feet-first, supine, prone or decubitus. This positioning example depends on the anatomy of interest and the ExamCard properties (patient orientation and patient position) of the examination.

- Position the patient in orientation and patient position as shown in the positioning example.
- Only if patient conditions do not allow the proposed patient position and patient orientation, adjust ExamCard properties (patient position and orientation) at the VitalScreen to get another proposal suiting your patient best.

  For more information, see chapter “Adusting ExamCard properties at the VitalScreen” on page 141.

Schematic images: patient orientation and patient position

These schematic images show how to position the patient with respect to patient orientation and patient position.

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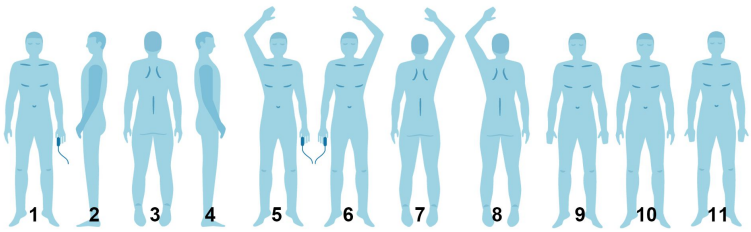
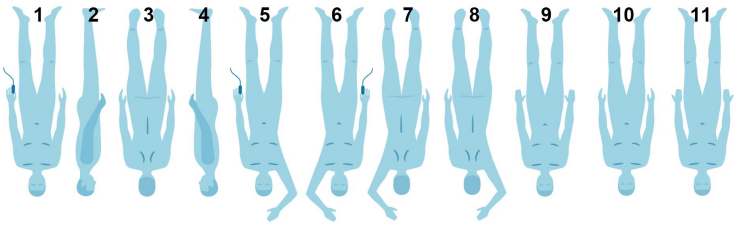
Head-first patient orientation



Feet-first patient orientation



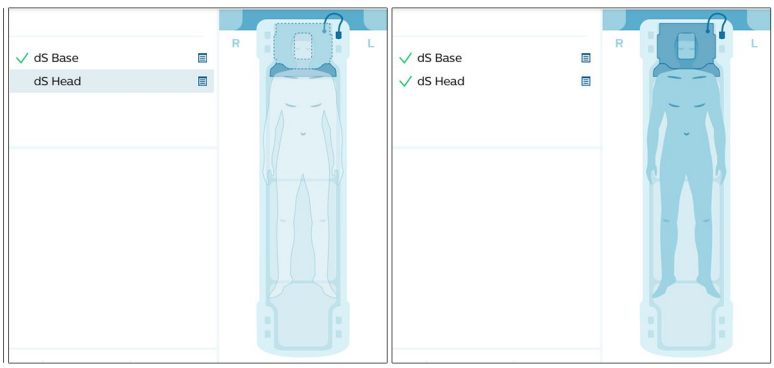
Patient position

1. supine
2. right decubitus
3. prone
4. left decubitus
5. superman supine for right hand/wrist
6. superman supine for left hand/wrist
7. superman prone for right hand/wrist
8. superman prone for left hand/wrist
9. endo-rotation of the hand/wrist
10. neutral position of the hand/wrist
11. exo-rotation of the hand/wrist

Schematic images: coils and positioning aids

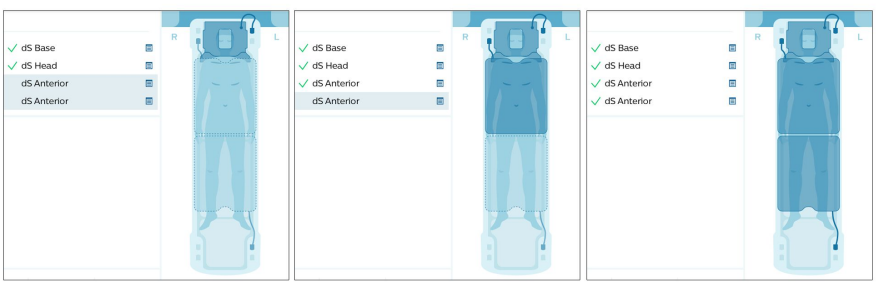
The schematic images also show how to position the patient with coils and positioning aids for a specific type of examination.

Brain examination



Whole Body examination

showing the different stages of positioning



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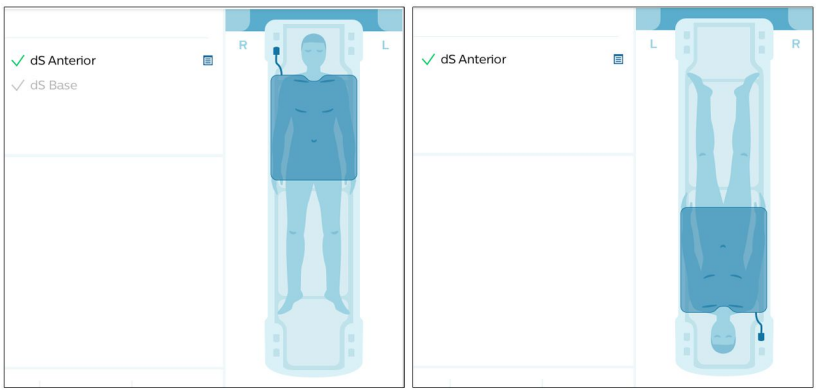
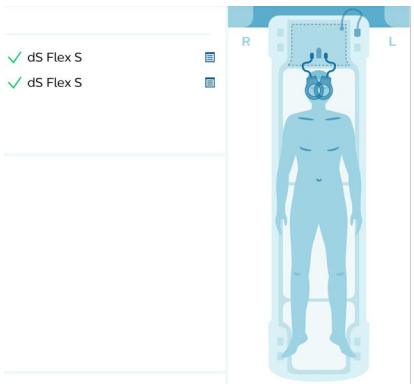
Thorax examination

with different patient orientations

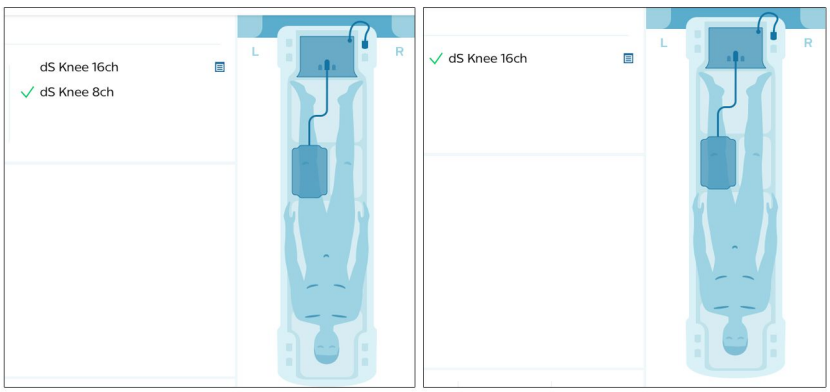


Orbit examination



Knee examination

with different coils



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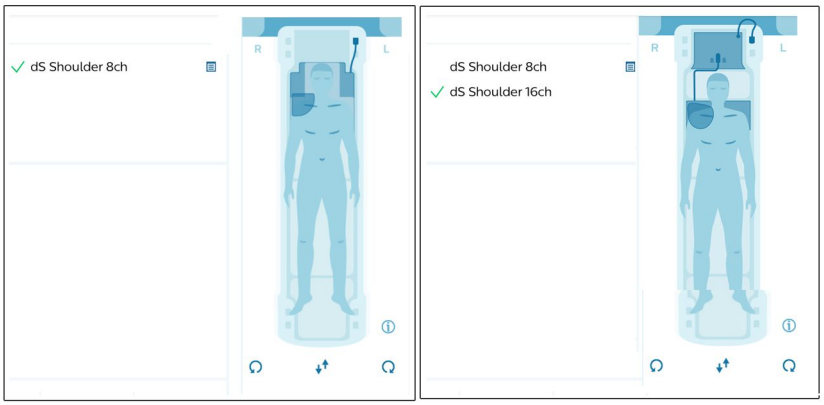
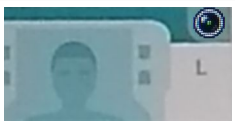
Shoulder examination with different coils	

For more information about correct patient positioning, see Instructions for Use, Positioning and Safety chapter.

Physiology signals

When an ExamCard requires the use of physiology devices, the following icons and pictograms indicate which device is needed.

	**VitalEye** icon: • indicating that VitalEye is in use
	VCG pictogram: • indicating that VCG is required for this ExamCard • indicating how to place the electrodes on the patient's chest
	Respiratory belt pictogram: • indicating that the respiratory belt is required for this ExamCard Only visible on MRI systems without VitalEye, because it is recommended to always use VitalEye if available.
	PPU pictogram: • indicating that PPU is required for this ExamCard

Operating the VitalScreen

Since the VitalScreen is a touch-screen device, you operate it with your fingers. Preferably you work with bare hands. Alternatively you wear plastic gloves.

Touchscreen gestures needed to operate the VitalScreen

- **Tapping**:
  You tap to
  – select an option,

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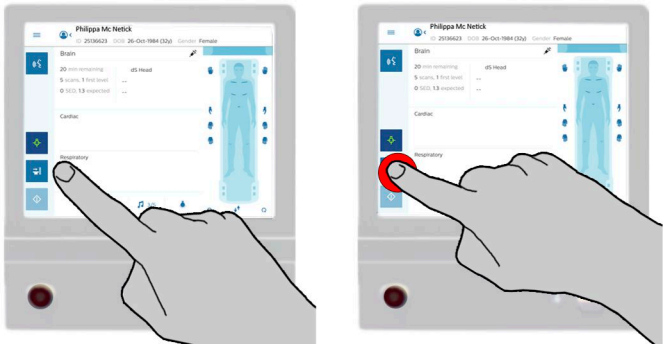
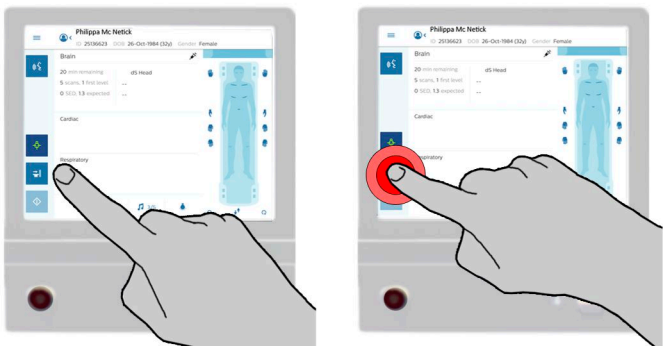
– toggle on/off a feature.



- **Tapping and holding** (long tapping):

  You tap and hold to

  – move the patient to isocenter with **Travel-to-scanplane** button.



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3.4.3 Routine Procedures

Adusting ExamCard properties at the VitalScreen

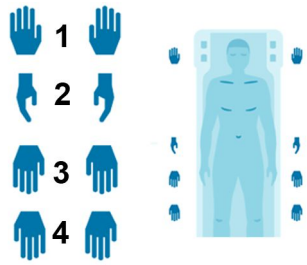
Only if patient conditions do not allow to position the patient as proposed in the positioning example, adjust ExamCard properties (patient position and orientation) at the VitalScreen to get another position proposal suiting your patient best.

When you change ExamCard properties at the VitalScreen, you also change ExamCard properties of the current examination at the operator's console. In such a way the correct display of the imaging series in all reviewing and analysis packages is ensured.

► To change the patient position to supine, left or right decubitus or prone, tap one of the **patient position** buttons as often as needed (depending on the initial setting).

► To change the patient orientation to head-first or feet-first, tap the **patient orientation** button.

► To change the hand position in a hand/wrist examination, tap any of the **hand** buttons (where 1 - Superman/overhead, 2 - Neutral, 3 - EndoRotation, 4 - ExoRotation).



Only when the ExamCard property **Laterality** is set to a value other than **Unpaired**, you can set the **Patient Position** to their specific values (for example, **Exorotation**).

Tabletop Movement

Moving the tabletop into and out of the magnet bore

You move the tabletop into and out of the magnet bore to position the patient for or to release the patient after the examination.
You move the tabletop to its end stop to lower the patient support for easy patient access.

- You can only move the tabletop horizontally when it is at its highest position.
- You have to wait 2 seconds between two tabletop move actions (for example: raising the talbetop, interval of 2 s, then moving into magnet bore).

VitalScreen with **Tumble switch**
to move the tabletop up/down and into/out of magnet bore

Three speeds are available, depending on the position of the **Tumble switch**.

▷ Prerequisite: The tabletop is at its highest position.

▷ At the VitalScreen:

► To move the tabletop into the magnet bore, push and hold the **Tumble switch** up.

⇨ Only when the tabletop is at its highest position, it moves into the magnet bore.

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- ► To move the tabletop out of the magnet bore, push and hold the **Tumble switch** down.
  - ⇨ When tabletop initially is at a position other than the end stop, it moves out of the magnet bore.
- ► To move the tabletop to its end stop, push and hold the **Tumble switch** down until the tabletop automatically stops at the end stop.

Lowering and raising the tabletop

You lower the tabletop for easy patient access.
You raise the tabletop to bring the tabletop to working level and to position the patient in the isocenter.

- You can only move the tabletop vertically when it is at its end stop.
  The end stop is the position where the tabletop is moved totally out of the bore.
- You have to wait 2 seconds between two tabletop move actions (for example: moving table up, interval of 2 s, then moving into magnet bore).
- To ensure optimum vertical and horizontal table movement, do not exceed the maximum allowed patient weight.

VitalScreen with **Tumble switch**
to move the tabletop up/down and into/out of magnet bore

Three speeds are available, depending on the position of the **Tumble switch**.

▷ Prerequisite: The tabletop is at its end stop.

▷ At the VitalScreen:

- ► To lower the tabletop, push and hold the **Tumble switch** down until the appropriate height is reached.
- ► To raise the tabletop, push and hold the **Tumble switch** up.
- ► To raise the tabletop to working level, push and hold the tumble switch up until the tabletop stops moving.
  Then the tabletop is at working level.

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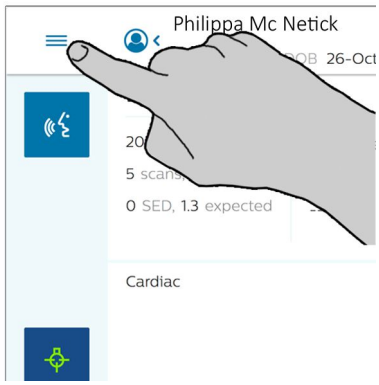
Switching to manual table control (Moving tabletop manually)

You can only manually move the tabletop when it is in manual mode.
Tabletop position is available in manual and motorized mode.

▷ At the VitalScreen:

► Tap the menu button.



► Tap **Manual table mode**.

⇨ You can now move the tabletop manually (for example in interventional MRI): hold on to the tabletop handle and pull or push the tabletop.

► To disable manual mode, tap **Manual table mode** again.

Isocenter Positioning and Start of Acquisition

Moving the patient to the isocenter

You move the patient to the isocenter when positioning is complete: the patient is positioned with coils, positioning aids, hearing protection and nurse call.

This workflow consists of:

- Centering by means of the light visor
- Traveling to scanplane

1. **Travel-to-scanplane** button
2. **Tumble switch**
3. **Light visor** button
4. **AutoStart** button

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Centering with the Light Visor

Before operation, read and familiarize yourself with the warnings in the Safety chapter (Instructions for Use) how to use the light visor.

The light visor is used to define the *patient reference point*.
The plane of the patient reference point is positioned in the isocenter of the magnet when the function **Travel-to-scanplane (3)** is used. During an examination, all subsequent scans are planned related to the patient reference point. All tabletop movements which are required for optimal image quality are deduced from this point.

▷ With the tabletop on working level:

► Push and hold the **Tumble switch (2)** up to horizontally move the tabletop until the area of interest is near the magnet bore or at the magnet bore.

► Press the **Light visor (1)** button to switch on the light visor beams.

- The light visor beams indicate the mid-sagittal and a transverse plane.
- The laser light automatically switches off after 60 seconds.
- Typically you use the light visor only once for every patient.
- During the execution of a scan or an ExamCard, the use of the light visor is ignored.

NOTICE

Once the light visor is pressed, an icon is displayed reminding you to use arm supports to avoid finger pinching.

Click the "**i**" to display more information about how to use the arm supports.

► Push and hold the **Tumble switch (2)** up until the area of interest lies within the light visor beams.
The closer the area to be imaged is to the middle of the beams, the better the image quality.

Traveling to Scanplane

Before operation, read and familiarize yourself with the warnings in the Safety chapter (Instructions for Use).

When light visor positioning is completed, travel the patient to scanplane.

▷ The patient is positioned and ready to scan (patient data entered at console, ExamCard selected and ready):

▷ The light visor has been used to define the patient reference point.

► Briefly press the **Travel-to-scanplane (3)** button. Then push and hold the **Tumble switch (2)** up until the tabletop automatically stops and the isocenter is reached.

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- ► Alternatively, press and hold the **Travel-to-scanplane (3)** button for about 2 seconds. This action initiates automatic tabletop movement without the use of the tumble switch. The tabletop stops when the isocenter is reached.
  - Care should be taken that cables (coils, VCG) or tubes (IV drip, catheter) do not get caught.
  - Verbal or physical contact is reassuring to a patient.
  - If the **Tumble switch (2)** is touched before table motion has ceased, the table will stop before reaching the isocenter.
    The indicator for isocenter positioning flashes green to indicate that the isocenter has not been reached yet. In this case, push and hold the **Tumble switch (2)** again and the tabletop will resume its predefined travel.

NOTICE

Do not leave the patient unattended until the tabletop has reached the isocenter.

NOTICE

To stop automatic tabletop movement, touch the tumble switch or press the 'Travel-to-scan plane' button.
To stop tabletop movement in case of an emergency, press the 'Emergency Table Stop' button.

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Coils with fixed position and Auto-iso

Coils that have a fixed position do not require the use of the light visor. Instead traveling to scan plane can be initiated immediately: the isocenter is traveled to automatically based on coil characteristics. When the table reaches the isocenter, the green Travel-to-Scanplane button lights up.

Coils with fixed position: Light visor is not needed for isocenter positioning	
• dS HeadSpine	Only when the coil top is used The Auto-iso functionality positions the dS HeadSpine coil always at the head position.

You can disable the automatic isocenter positioning, for example in head and neck examinations.

- ► To manually set the isocenter position with the light visor, press the light visor button.
  - ⇨ The green TTS light is OFF. The light visor light is ON.

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- ► Only when the light of the light visor button is not switched ON, press the TTS button followed by the light visor button.
- ► Then use the light visor beam to define the isocenter position.

Starting scan automatically (AutoStart)

The AutoStart functionality automatically starts the next item of the ExamCard, mostly the Survey scan, when you close the door to the examination room. AutoStart also works for paused dynamic scans.

The **AutoStart** button has different states:

	Disabled: **AutoStart** button cannot be pressed. This is the default situation.
	Active: **AutoStart** button can be pressed when travelling to scanplane is initiated.
	Armed: **AutoStart** button has been pressed. Next item of the ExamCard starts on door close. Next to the AutoStart button a (smaller)**Stop AutoStart** button is displayed to stop AutoStart.

▷ Prerequisite: Centering with the light visor is completed and the traveling to scanplane procedure is initiated. See chapter “Moving the patient to the isocenter” on page 144. Consequently the **AutoStart** button is active.

► To enable AutoStart, tap the **AutoStart** button.

⇨ To indicate that AutoStart is enabled now, the AutoStart button starts blinking:

Note: tap the (smaller) **Stop AutoStart** button to stop AutoStart. The scan will not abort but return to active.

► Close the door to the examination room.

⇨ The next item of the ExamCard automatically starts.

AutoStart while in the examination room

You can also enable AutoStart when staying in the examination room during scanning.

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Prerequisite: Centering with the light visor is completed and the travelling to scanplane procedure is initiated. See chapter “Moving the patient to the isocenter” on page 144. Consequently the **AutoStart** button is active.

- ► Close the door to the examination room.
- ► To enable AutoStart, tap the **AutoStart** button.

⇨ To indicate that AutoStart is enabled now, the AutoStart button starts blinking:

Note: tap the (smaller) **Stop AutoStart** button to stop AutoStart. The scan will not abort but return to active.

- ► Tap the **AutoStart** button.

⇨ The next item of the ExamCard automatically starts.

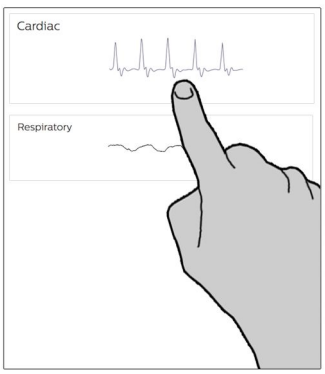
Physiology Signals

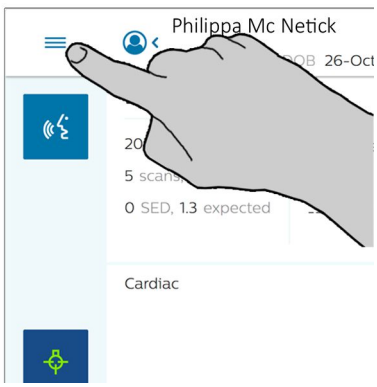
Selecting physiology signals for display at the VitalScreen

You can select the physiology signals for display and adjust the time range for display in the **Signal settings** window.

▷ At the VitalScreen:

- ► To access the **Signal settings** window, do any of the following:
  - Tap the display area of the physiology signals.
  - Tap the menu button, then tap **Signal settings...**





⇨ The **Signal settings** window opens.

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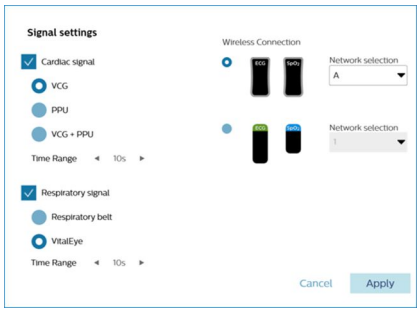
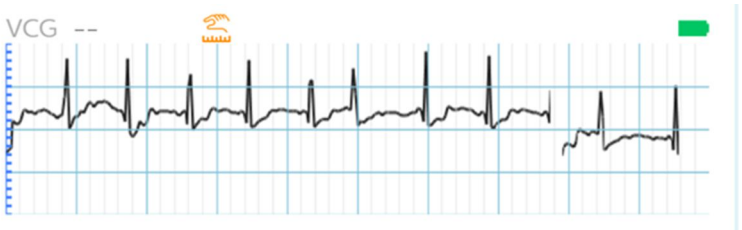
⇨ 

- ► Tap to select or deselect a signal type for display:
  - first **Cardiac signal**, then **VCG**, **PPU**, or **VCG+PPU**
  - first **Respiratory signal**, then **Respiratory belt** or **VitalEye**
- ► Tap on the arrows to select a **time range** for display.
- ► Tap the **Wireless Connection** to select the wireless module and the network.
- ► Click **Apply** to leave with changes.
  Or click **Cancel** to leave without changes.

Calibrating the VCG signal on the VitalScreen

Starting and executing manual calibration

- ▷ You have entered the examination data of the patient.
- ▷ You have positioned the patient on the tabletop with nurse call, hearing protection, coil, VCG, PPU (recommended, but not mandatory) and respiratory belt.
- ▷ The tabletop is still outside the bore, since this position is recommended for manual VCG calibration.
  Alternatively you can perform manual VCG calibration inside the bore.
- ▷ The icon on the VCG signal on the VitalScreen indicates that calibration is required.
- ► Tap the VCG signal. Select **Calibrate VCG**.



⇨ The **Calibrate VCG** window opens.

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- ► Select **Manual Calibration**.
  This setting is persistent over examinations.
  - Trigger markers are not yet displayed on the VCG signal in the **Physiology Display**, but only when VCG calibration is complete.
  - The patient's measured heart rate is not yet displayed.
- ► Tap **Calibrate**.

  Alternatively, on the MR console click the blinking **measured HR** icon in the **Physiology Display**.

  ⇨ A message is displayed indicating that VCG calibration is requested and the duration of the calibration is 15 seconds.
- ► Instruct the patient to lie still and to breathe regularly.
- ► To start VCG calibration, tap **Proceed**.
  Alternatively to stop the VCG calibration, tap **Cancel**.

  ⇨ During calibration, a message pops up telling that VCG calibration is in progress and indicating the remaining time.:

  VCG calibration in progress, please wait... Time remaining

Calibration results

Upon completion of manual VCG calibration, the results are automatically analyzed and displayed as:

- Signal **Strength** (as color scale and expressed in mV)
- Trigger **Quality** (as color scale).

The effects of manual VCG calibration are immediately visible:

- In the **Physiology Display**
  - The results of the calibration are applied immediately to allow visual inspection of the VCG triggering quality.
  - The patient's measured heart rate is displayed.
  - Trigger markers are overlaid on the VCG signal.
- In the **Extended Physiology Display**
  - The VCG calibration icon indicates successful manual VCG calibration.

Performing clinical scans based on the calibration results

- ► Continue depending on the quality of the results.

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If the results are good, very good or excellent	If the results are sub-optimal or bad
► Click **Accept**. ⇨ The results are stored with their tabletop position. You can access the stored calibrations results in the **Physiology Properties** window. ► To switch between different VCG calibration results (if available), enable in- or out-bore results for display. ► Move the tabletop to the isocenter and start the examination. ► Control if the measured heart rate corresponds with the entered heart rate in the **Exam Setup**. ► To update the entered heart rate with the current heart rate (if needed), click (**Update heart rate**). Alternatively, enter the value in the text field or in the **Exam Setup**.	► Click **Cancel** to discard the results. Previous results (if available) are applied for this scan. OR ► Take corrective actions. For more information, see chapter "Calibration Results" on page 939. ► Click **Repeat** to discard the results and repeat the calibration.

Usage of manual VCG calibration results

Stored manual VCG calibration results are applied until the operator:

- initiates a new VCG-calibration.
- recalls a previously stored VCG-calibration.
- disables manual calibration.

Repeating manual VCG calibration

Repeat a manual VCG calibration in case of

- unsatisfactory results of the recent VCG calibration (e.g. low signal, low quality)
- change in patient conditions during the examination (e.g. size of MHD-artifact disturbs triggering, change in heart rhythm / breathing conditions during stress)

Patient Comfort

Adjusting the bore illumination

Bore illumination consists of bore lights and if available the light ring.

▷ At the VitalScreen:

► Tap the **bore illumination** button.

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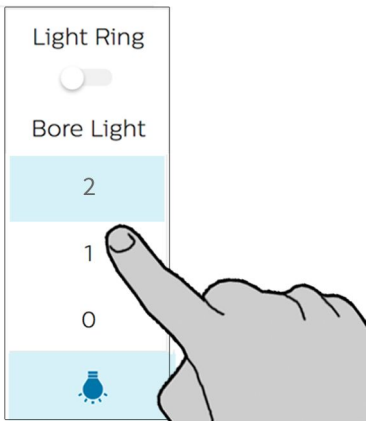
- To switch the light ring **on**, tap the right side of the slider.
  To switch the light ring **off**, tap the left side of the slider.
- To switch the bore light **off**, tap 0.
  To set the bore light to **dimmed**, tap 1.
  To switch the bore light **on**, tap 2.



Adjusting the bore ventilation

The MR system has a recommended ventilation level. This is a static level based on average scans and system specific conditions.
The system does not change the recommended ventilation level for e.g. high SAR scans, examination room temperature and patient weights, clothing and conditions. It is solely the responsibility of the operator to determine the level of ventilation for different scans and conditions together with the patient.

▷ At the VitalScreen:

- Tap the **bore ventilation** button.

- To adjust the bore ventilation, tap a value on the scale of **0 to 5** with an additional setting of **Fan**.

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When you set the ventilation to a value marked with a caution sign, you are warned that the patient might get too warm and that you need to pay attention.

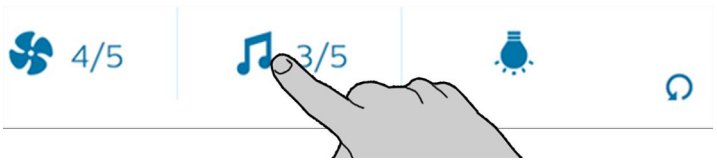
You can also adjust the bore ventilation at the operator's console.

Adjusting the music volume

During the examination the patient can listen to music in the magnet bore.

▷ At the VitalScreen:

► Tap the **music** button.



► To adjust the music volume, tap a value on the scale of 0 to 10.

Enabling communication in the examination room

This action enables communication between the operator in the examination room and the patient who is wearing a headset. It connects the magnet microphone to the patient headset, and switches off the music speakers in the examination room.

▷ Prerequisite: Patient is wearing the headset. Headset is plugged in.

▷ At the VitalScreen:

► Tap the **Talk** button.

Once pressed, the **Talk** option remains active until pressed again.

- When Talk is active, the Talk button lights green.
- When Talk is inactive, the Talk button light goes off.

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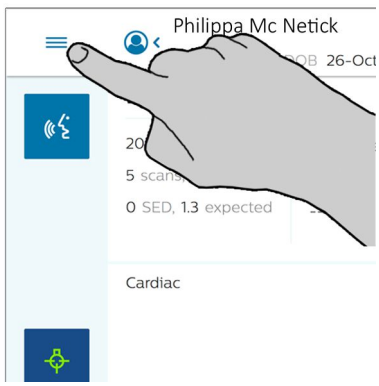
The **Talk** button on the operator-patient intercom at the console can temporarily overrule the magnet microphone, but cannot switch it off.

Cleaning the screen

You execute this workflow when you want to clean the screen.

▷ At the VitalScreen:

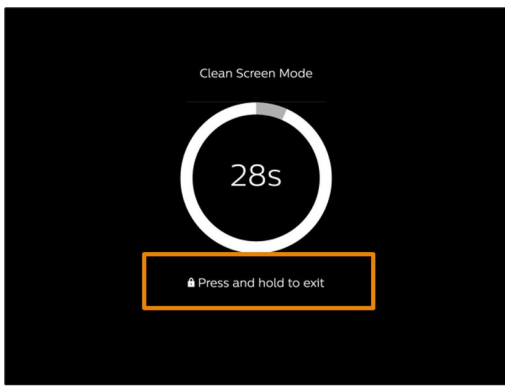
► Tap the menu button.



► Tap **Clean screen mode**.

⇨ The screen enters Clean Screen Mode: it turns dark and stays inactive for 30 seconds. It is ready for cleaning.

⇨



► Clean the screen as described in the Cleaning Chapter, see Cleaning: other parts.

After 30 seconds the screen goes on again.

► To exit Clean Screen Mode before the expiration of 30 seconds, press and hold within the orange rectangle.

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3.4.4 Emergency Stop

Executing an emergency stop (stopping tabletop movement in case of an emergency)

To stop tabletop movement and the current scan immediately:

- Press the **Emergency Stop** button.
  - ⇨ The tabletop is released.
  - ⇨ Manual tabletop movement in and out of the bore is possible.
  - ⇨ The red light on the Emergency Stop button switches on.
- To reset the tabletop and re-enable normal operation, press the **Resume** button.

On the VitalScreen

Fig. 8: Emergency Table stop button (1) and the Resume button (2) (Tumble switch serves to resume tabletop movement).

NOTICE

Alternatively press the Emergency Stop button on the Audio module at the operator's console.

To stop remote software controlled moves, press the F12 key on the keyboard at the operator's console.

For more information, see Instructions for Use, Safety chapter. chapter “Emergency Table Stop” on page 43

3.5 Patient Support and Tabletop

3.5.1 Functional Description

During an MR examination, the patient is positioned on a tabletop which is carried by the patient support.

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The tabletop can be moved longitudinally to transport the patient into the magnet. It can also be moved vertically for convenient patient transfer. You control the tabletop movement with the panels at the MR gantry.

The patient support has an integrated Posterior coil.

Coil, headset and nurse call sockets are located on the tabletop.

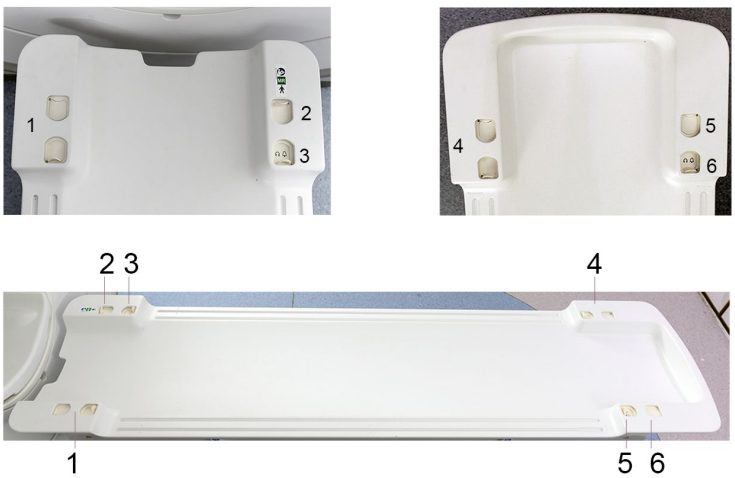
3.5.2 Sockets on the Tabletop

Types of Sockets and their Location

The MR system provides different kinds of coil sockets:

- FlexConnect sockets on the tabletop.
- dS sockets on the tabletop.

For specifc information about which socket is required for a specific coil, see section chapter “Available Coils and Coil Solutions” on page 165.



1. dS socket (to connect the dS Interface)
2. FlexConnect socket (to connect the dS Base coil)
3. Headset and Nurse call socket
4. dS socket (to connect the dS Interface)
5. Headset and Nurse call socket
6. Not used

FlexConnect Sockets

These sockets are to be used to connect the dS Base coil.

For proper functioning of the connected coil, it is essential that the lenses of FlexConnect sockets and coil connectors are clean.

3.6 Patient Observation System

The Patient Observation System (POS) is an option that is available for all Philips MRI systems. It allows you to observe the patient using a camera and a monitor which is useful when direct visual contact is not possible. The POS has no interaction with the MRI system.

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The camera is positioned in the examination room so that the image provides full view of the patient in the magnet bore. The monitor, together with the camera interface box, is positioned near the operator's console.

The camera is always on. You can switch the monitor on or off.

If the image from the camera is not clear, contact your service provider.

3.7 Coils and Coil Solutions

This chapter describes the coils and the coil solutions available for your system.

NOTICE

As most of the photographs in this chapter have been taken in a non-clinical environment, it is possible that in some of the photographs the patient’s clothing is not suited for a real MR examination.

Patients may also be shown without headset and nurse call.

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More Information

- Refer to the Maintenance chapter for full information on cleaning of the system and coils.
- Refer to the Safety chapter for full information on safety for coils.

3.7.1 About Coils

The most important aspects of coils are described in the following paragraphs.

Built-in Body Coil

The built-in Body coil acts as the RF transmitter for receive-only coils: it transmits the RF signal to the patient. It works in conjunction with the dStream Coils.

dStream Coils

dStream coils are:

- The term for all available coils on your system.
- Phased-array coils and as a consequence compatible with CLEAR and dS-SENSE.
- Receive-only coils if not otherwise labeled.
  A 'T/R' in the coil name identifies a coil as Transmit/Receive coil.

dStream coils are available as integrated or dedicated coil solution.

- **Integrated Coil Solution**
  Combination of coils with the dS Posterior coil for multiple applications.

- **Dedicated Coil Solution**

  Single coil designed for a single application, for example a dedicated breast coil.

  Dedicated coils require the dS interface.

3.7.2 About Coil Solutions

Coil choice is crucial in obtaining optimum image quality in all MR examinations.

SmartSelect

SmartSelect and the coil solutions facilitate this important choice.

SmartSelect is a method that selects the best suited coils and coil elements for each examination:

- The MR system automatically detects the connected coils.
- By default it selects the best-suited coil and coil elements for optimal signal-to-noise ratio for the current stack and/or scan.

dS Coil Solutions

A dS coil solution is a recommended coil combination for a specific MRI application.

You can connect multiple coils to the system which then work

- in conjunction with the integrated dS Posterior coil, or
- in conjunction with each other, or
- as dedicated (stand-alone) coils.

3.7.3 Integrated Posterior coil

The patient support of your system has an integrated dS Posterior coil. The dS Posterior coil automatically repositions in the patient support according to the desired isocenter and Field-of-View.

There are three markers on each side of the tabletop representing the range of the dS Posterior coil.

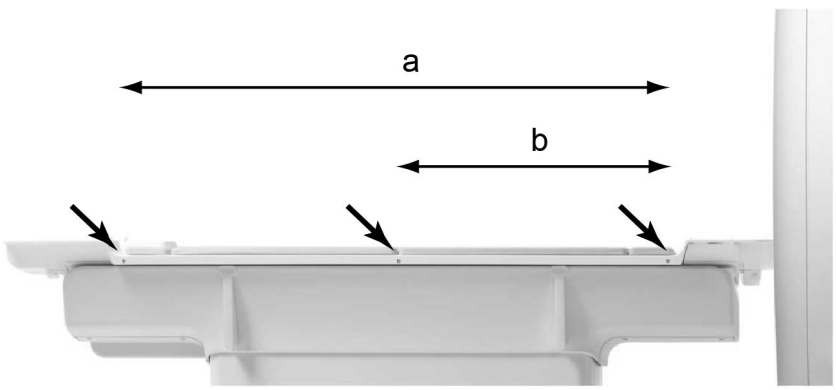

Fig. 9: dS Posterior coil range markers

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Range a.

The markers represent the maximum available range of the tabletop in which the dS Posterior coil can be used for scanning.

Range b.

This is the range between the middle marker and the marker at the magnet end side of the tabletop. It represents the maximum available range with which scanning is possible without using the dS Posterior coil.
Any point within this range can be positioned in the isocenter.

Disengage coil

The dS Posterior coil can be disengaged by means of the eponymous parameter in the **ExamCard Properties** window.

3.7.4 dS Interface

Functional Description

The dS Interface consists of a digital interface box with digital connector pin, and a cable with balun and connector.

- The digital connector pin plugs directly into the tabletop.
- The connector serves to connect coils to the system.

The dS Interface is available in two variants: with a long cable and a short cable.

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Purpose of the dS Interface

You use the dS Interface to connect the following coils to the MRI system:

- dS TorsoCardiac coil 1.5T
- dS MSK M and S coil 1.5T
- dS Breast 7ch coil 1.5T

The dS Interface allows to connect two coils at the same time to one dS Interface.

You can attach two dS Interfaces to the tabletop, one at the magnet end of the tabletop, and the other one at the handgrip side of the tabletop.

Once the dS Interface is attached to the tabletop, it remains on the tabletop, even when it is not connected to a coil.

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Safety

Safe Cable Storage when the dS Interface is not in Use

The dS Interface remains on the tabletop, even when it is not in use and not connected to a coil.

- To safely store the dS Interface cable, put the balun in the handle of the dS Interface.

NOTICE

Prevent the dS Interface cable from falling off the tabletop.

The cable on the ground could lead to damage of the dS Interface, and to insecure situations for the operator who stumble over the cable.

Carrying the dS Interface

- To carry the dS Interface, detach it from the tabletop.

  Put the balun in the handle of the dS Interface.

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NOTICE

Never carry the dS Interface at its pin and the cable as shown here.

Indicators of Connection Status

The lights on the dS Interface indicate the status of the connections to tabletop and coil:

Light		Status of connection
No light		The dS Interface is not connected to the tabletop.
Yellow light		The dS Interface is connected to the tabletop. The coil is not connected to the dS Interface.

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Light		Status of connection
Blue light		The dS Interface is connected to the tabletop. The coil is connected to the dS Interface.

Attaching the dS Interface to the Tabletop

You attach the dS Interface to the dS socket of the tabletop.

You attach the dS Interface only once. Then the dS Interface remains on the tabletop, even when it is not in use.

- ► Place the dS Interface above the dS socket.

  To open the socket, move the slider. Then plug the dS interface into the socket.

⇨ The yellow light indicates a correct interface-to-tabletop connection.

Detaching the dS Interface from tabletop

- ► Hold on to the dS Interface with both hands.
- ► Carefully lift the dS Interface up.
  with one hand at the interface box (cable exit end) and the other hand at the top of the dS Interface on the other side.

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NOTICE

Pulling on the cable

Do not pull on the cable to remove the dS Interface. This action damages the dS Interface.

Connecting and Disconnecting Coils to the dS Interface

Connecting coils to the dS Interface

You connect the dS TorsoCardiac and the dS MSK M and S coils directly to the dS Interface.

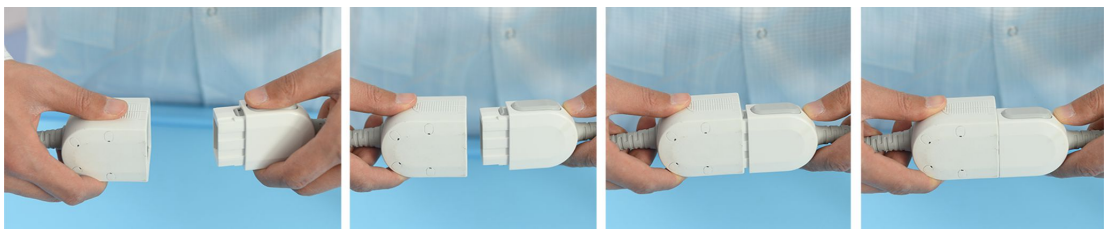
You connect the dedicated coils (for example the dS Breast 7ch coil) to the dS Interface with the adaptive connector.

▷ Prerequisite: A yellow light indicates that the dS Interface is correctly attached to the tabletop.

▷

► Do any of the following:

- To connect the dS TorsoCardiac and the dS MSK M and S coils, plug the dS Interface connector into the mini connector of the coil with an audible click.



- To connect a dedicated coil, plug the dS Interface into the adaptive connector, and then the adaptive connector into the miniconnector of the coil.

⇨ A blue light indicates a perfectly connected ready-to-scan coil.

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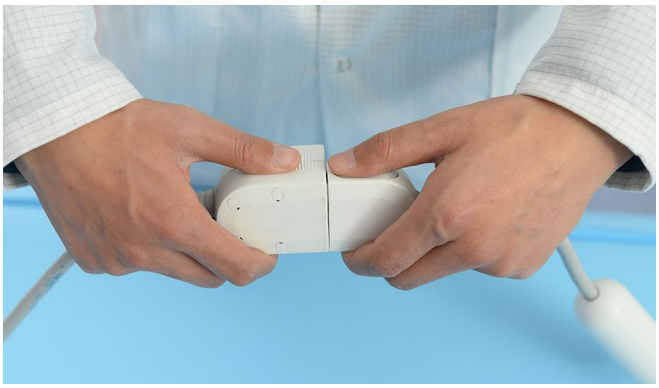
⇨

Disconnecting coils from dS Interface

- ► Hold on to the two connectors.
- ► Push in the release buttons on either side of the dS Interface connector and carefully pull apart.



3.7.5 Available Coils and Coil Solutions

dS System Body coil

Fig. 10: Built-in dS System Body coil in the bore.

Type of coil	Transmit/Receive coil
Design	Built-in cylindrical volume coil

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dS-SENSE-compatible	No
CLEAR-compatible	No
Applications	Imaging large parts of the body
General remarks	All receive-only coils use the dS System Body coil for transmission.

User Interface Name	Q-Body
Connector	not applicable

dS HeadSpine

1. dS Base
2. dS Head top coil (top view)
3. Patient positioned on dS Base coil with dS Head top coil and mirror attached
4. Tabletop with built-in dS Posterior coil

Type of coil	• Phased-array detection • Receive coil solution
Design	• Volume coil • Integrated coil solution including the dS Posterior coil, the dS Base coil and the dS Head top coil.
Coverage	• 30 cm (head examinations) • 90 cm (total neuro examinations)
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes

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Applications	• Head and brain examinations • Spine examinations: cervical, thoracic, lumbar and total spine • Total neuro
User Interface Name	Posterior, Base, Head
dS Interface	not required
Connector	FlexConnect socket/connector

dS TotalSpine

Type of coil	• Phased-array detection • Receive coil solution
Design	• Surface coil. • Integrated coil solution including the dS Base coil and the dS Posterior coil.
Coverage	90 cm
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
Applications	• Spine examinations: cervical, thoracic, lumbar and total spine
User Interface Name	Base, Posterior
dS Interface	not required
Connector	FlexConnect socket/connector

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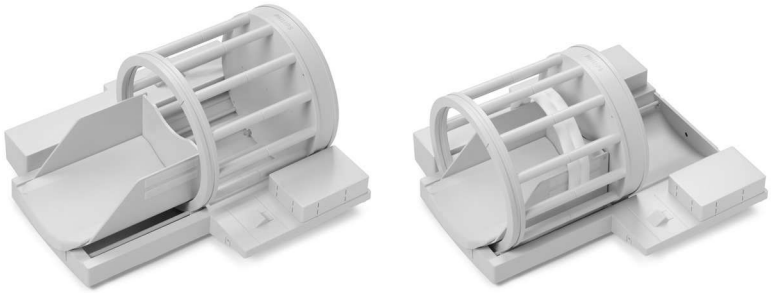
T/R Head coil



Type of coil	• Quadrature detection • Transmit/Receive coil solution
Design	Volume coil
Coverage	Head down to C3
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	No
CLEAR-compatible	No
Applications	Head and brain examinations
Markers on the coil	In the middle of the coil (FH direction) for light visor positioning
User Interface Name	T/R Head
dS Interface	Not required. Connects to FlexConnect socket/connector.

dS WholeBody

Type of coil	• Phased-array detection • Receive coil solution

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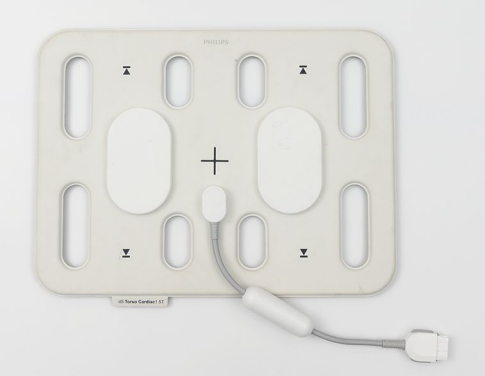
Design	• Volume coil • Integrated coil solution including the dS Posterior coil, the dS Base coil, the dS Head top coil and two dS TorsoCardiac coils.
Coverage	200 cm
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
Applications	• Whole Body • DWIBS (Diffusion Weighted Whole Body Imaging with Background Body Signal Suppression) • Peripheral Vascular examinations
User Interface Name	Posterior, Base, HeadNeck, TorsoCardiac
dStream Interface	not required
Connector	FlexConnect socket/connector

dS TorsoCardiac Coil 1.5T

In the following referred to as: **dS TorsoCardiac coil**



Type of coil	• 8 channel phased-array detection • Receive coil solution
Design	• Volume coil (dS Base and dS Head Top) and surface coils (dS Posterior coil, TorsoCardiac) • Integrated coil solution including the dS Posterior coil and the TorsoCardiac coil, with or without dS Base coil.
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
dS-SENSE-compatible	Yes
CLEAR-compatible	Yes

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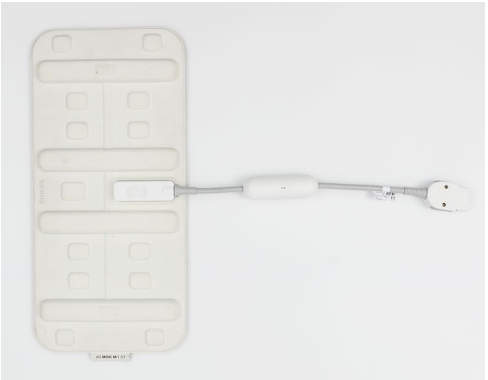
Applications	• Body applications: Thorax, Abdomen, Pelvis • Cardiac Imaging • Peripheral Vascular examinations • Long Bones
General remarks	The coil can be used with the longest expansion in FH or in RL direction, depending on its orientation.
Marker	In the middle of the coil (FH direction) for light visor positioning.
User Interface Name	
dS Interface	Required
Connector	dS Interface

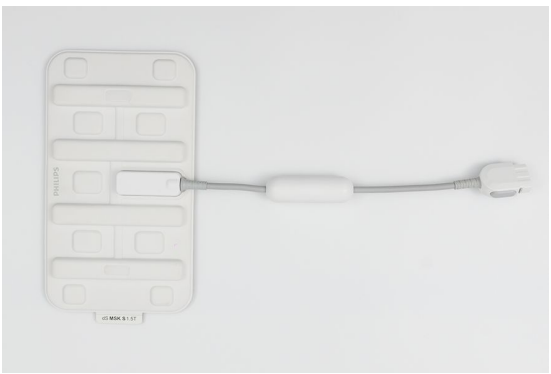
More information

- About positioning: chapter “Positioning with the dS TorsoCardiac coil” on page 300

dS MSK M and dS MSK S Coil 1.5T

In the following referred to as: **dS MSK S coil** and **dS MSK M coil**





Type of coil	• Multi-element phased-array coils • Receive-only
Design	Flexible surface coils designed to wrap around the anatomy of interest The dS MSK coils are available in two different sizes: M (medium) and S (small).
Available for	On the sticker on the coil, you see the MRI system type and field strength your coil is suited for.
Coverage	• dS MSK M coil: 23 cm • dS MSK S coil: 19 cm
dS-SENSE-compatible	Yes

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CLEAR-compatible	Yes
Applications	MSK applications depending on the different sizes of the MSK coils, for example: • Small joints (for example, elbow, wrist, ankle) • Hand and foot • Large joints (for example, shoulder, hip, knee) • Pediatric imaging • Posterior triangle (combined with dS Base, dS Head Top and dS Posterior) • Neck (combined with dS Base, dS Head Top and dS Posterior)
General remarks	• Wrap the coil as tightly as possible around the anatomy of interest. • Use the coil with the dedicated positioner which helps immobilize the patient (or body part).
Marker	No
User Interface Name	
dS Interface	Required
Connector	dS Interface

NOTICE

Always store the coil flat.

dS Breast 7ch Coil 1.5T

In the following referred to as: **dS Breast 7ch coil**

Type of coil	• 7 channel phased-array coil • Receive-only
Design	Volume coil with an aperture in which the breasts can be positioned. A separate head support is provided.

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dS-SENSE-compatible	Yes
CLEAR-compatible	Yes
Applications	• Breast Imaging (both breasts simultaneously) – Also with bilateral immobilization – Including biopsy with the biopsy kit
General remarks	Do not combine this coil with other coils.
User Interface Name	
dS Interface	Required
Connector	dS Interface

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Philips

Breast Pads and Connectors

Item	Photo	Use
Cover pad for the Breast 7ch coil		Designed for patient comfort. • There is no padding between the two breasts in order to reduce the pressure on the sternum.
Head support		Height adjustable for patient comfort.
Ramp pad with velcro on the bottom		Designed for patient comfort.
Lower leg pad with velcro on the bottom		Designed for patient comfort.
Head support pad		Designed for patient comfort. • To be placed around the head support.

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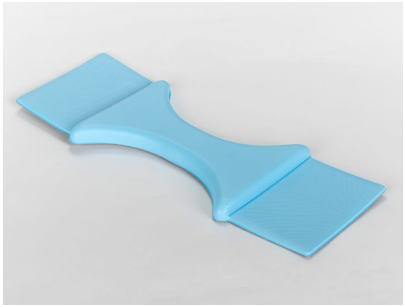
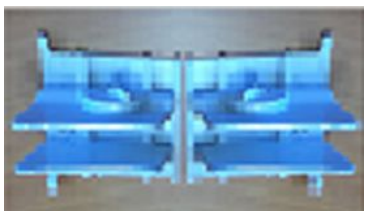
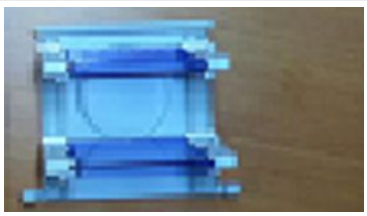
Item	Photo	Use
Chest support pad		Designed for patient comfort. • To be placed underneath the patient's chest.

Delivery Contents

In the delivery of the dS Breast 7ch coil solution, the following kits are included:

Figure of the kit	Kit	Purpose of the kit
	Bilateral CC immobilization kit	Diagnostic imaging only
	Bilateral M-L immobilization kit	Diagnostic and interventional imaging
	Unilateral CC immobilization kit	Interventional imaging
	Interventional biopsy kit	Breast biopsy

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3.7.6 SmartExam and Coils

SmartExam is a tool that automates planning, scanning and processing in brain, knee, shoulder, breast, cervical and lumbar spine examinations.

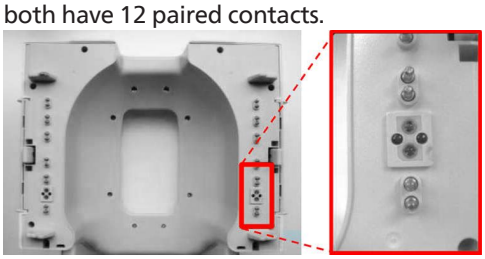
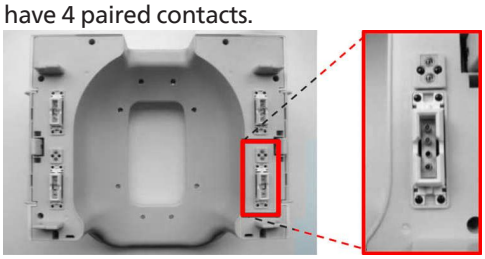
Supported coils for SmartExam

For optimum quality of SmartExam, use the supported coils:

Anatomic area	Supported coils
Brain	• dS Base and dS Head top • dS Base and dS HeadNeck top,
Cervical spine	• dS Base and dS Posterior
Lumbar spine	• dS Posterior
Breast	• dS Breast 7ch
Knee	• dS Knee 8ch

3.7.7 Coil compatibility

The below list provides an overview of coil/system compatibility. Some legacy coils can only be used on Ingenia systems.

	Ingenia only	All dStream systems
dS Base and dS Head or dS HeadNeck tops	• dS Base and dS Head or dS HeadNeck tops both have 12 paired contacts.  • 1.5T 12NC numbers: dS Base; 4510-010-0047x or 4598-001-7121x dS Head; 4510-010-0831x or 4598-001-7122x dS HeadNeck; 4510-010-0048x or 4598-001-7123x	• dS Base and dS Head or dS HeadNeck tops have 4 paired contacts.  • 1.5T 12NC numbers: dS Base; 4598-000-9794x dS Head; 4598-000-9795x dS HeadNeck; 4598-000-9796x
Tilting device for the Base	• Allowed.	• NOT allowed. • NOT supported.

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3.8 Positioning Aids

This chapter shows the positioning aids that are delivered with your system: the basic set and the optional positioning aids. For most of them, application examples are given and their purpose is explained.

NOTICE

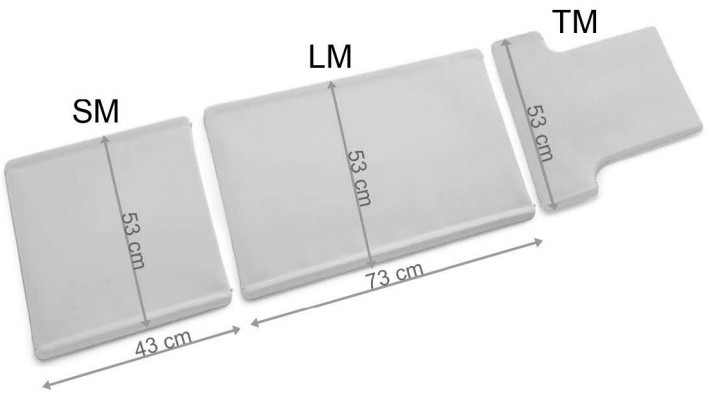
Philips' positioning aids are not made with natural rubber.

3.8.1 Basic Set

Mattresses

Three different types of mattresses are available:

Item	Quantity
Large Mattress	2
Small Mattress	2
T-Shape Mattress (Endpiece)	1



- Large mattress (LM)
- Small mattress (SM)
- T-shape mattress (TM)

Comfort Plus Pack

The Comfort Plus pack is a set of memory foam mattresses for full table coverage.

Three different types of mattresses are available:

Item	Quantity
Large Mattress	2
Small Mattress	2
T-Shape Mattress (Endpiece)	1

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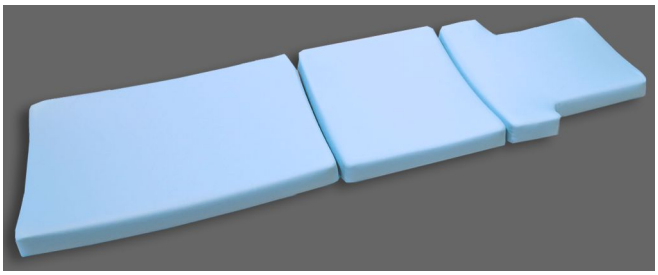
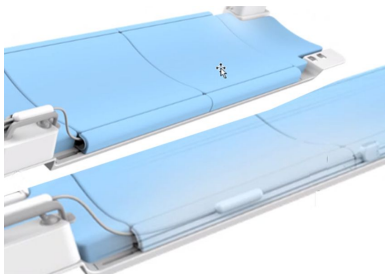


Comfort Mattress Partner

Item/Purpose	Quantity	Photo	Application Example
Comfort mattress partner Sleeve around comfort mattress • To be used for all examinations. • Allows to safely route cables of coils, nurse call and headset.	2		

NVC Stability Pad

Item/Purpose	Quantity	Photo	Application Example
NVC Stability pad and NVC stability pad - thin Pad to aid in positioning • for all types of head and spine examinations with the dS Base coil. • for all types of examination with the TMJ holder.	1		

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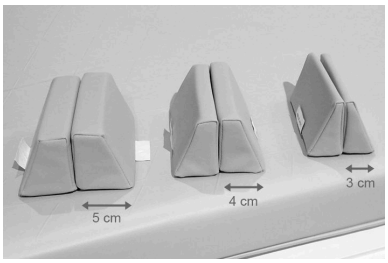
Sandbags and Wedges

Item/Purpose	Quantity	Photo	Application Example
Sandbag 3.6 kg MR Safe non-magnetic artifact-free sandbags of different weights to aid in patient positioning. Strong, durable and sealed to prevent leakage. Stain-resistant coating.	2		
Wedges 30° **Wedge 15°** Wedges of different shapes to aid in patient positioning. Stain-resistant coating.	2 2		
Foam Wedges Foam wedges in different sizes to aid in patient positioning.	6		

Straps

Item/Purpose	Quantity	Photo	Application Example
Extremity Strap, medium **Extremity Strap, large** To strap around an extremity to fix e.g. a coil.	2 3	 	

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Item/Purpose	Quantity	Photo	Application Example
Head/Orbit Strap To strap around the head to fix e.g. a coil.	2		
Shoulder/Hip Strap To strap around the shoulder or hips to fix e.g. a coil.	3		
Soft Body Strap To slide into the grooves of the tabletop on both sides and strap above the body to fix e.g. a coil.	1		
Immobilization Strap To immobilize the patient and reduce breathing artifacts, and to fix the respiratory belt.	1		

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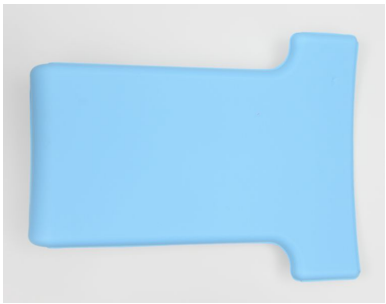
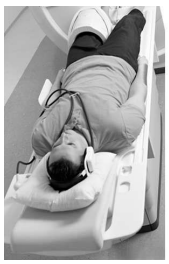
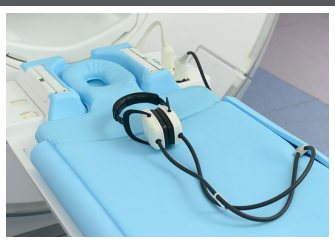
Supports

Item/Purpose	Quantity	Photo	Application Example
Knee Support To support the lower extremities while maintaining hip flexion, and to help relieve lower back stress and pain. Stain-resistant coating.	1		
Head- / Leg Support To extend the tabletop as head or leg support for very tall patients. Stain-resistant coating.	1		
Arm Support To ensure secure hand and arm positioning during table movement.	2		

Headsets and Nurse Call

Active Headset

Item/Purpose	Quantity	Photo	Application Example
• Allows for communication between the patient and the operator. • Second means of hearing protection. Earplugs are the primary means of hearing protection.	1		

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Passive Headset

Purpose	Quantity	Photo
Second means of hearing protection. Earplugs are the primary means of hearing protection. **Properties** • Allows placement of sanitary covers on the ear shells of the headset. The rim around the outer ear shell prevents the sanitary covers from sliding off. • Contains components for replacement. Contact your service provider for replacement of the outer ear pad assembly.	1	 Outer ear pad assembly

Nurse Calls

Item/Purpose	Quantity	Photo	Application Example
Nurse Call • Allows communication between the patient and the operator at all times.	1		
Extended Nurse Call • Allows communication between the patient and the operator at all times. • Allows for feet-first prone imaging with breast solutions.	1		

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Combined Headset and Nurse Call

Connectors

Item/Purpose	Quantity	Photo	Application Example
Adaptive Connector Required to connect dedicated coils (for example dS Breast 7ch coil)	1		

3.8.2 Angiography Package

Item/Purpose	Quantity	Photo	Application Example
Feet Immobilizer To ensure patient immobilization (to obtain good subtraction images) To reduce venous enhancement by positioning the lower legs higher than the upper legs and increasing flow to the capillary bed.	1		

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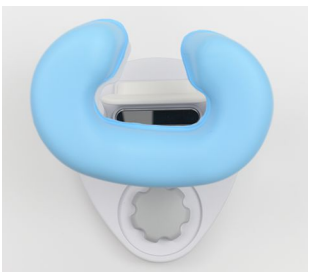
3.8.3 Breast Pads

Breast Pads and Connectors

Item	Photo	Use
Cover pad for the Breast 7ch coil		Designed for patient comfort. • There is no padding between the two breasts in order to reduce the pressure on the sternum.
Head support		Height adjustable for patient comfort.
Ramp pad with velcro on the bottom		Designed for patient comfort.
Lower leg pad with velcro on the bottom		Designed for patient comfort.
Head support pad		Designed for patient comfort. • To be placed around the head support.

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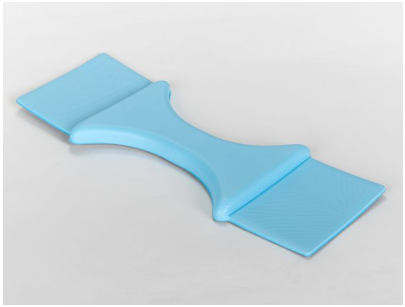
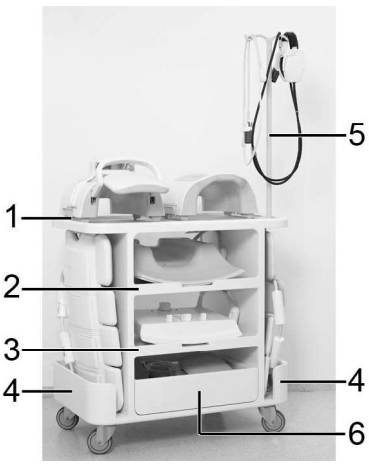
Item	Photo	Use
Chest support pad		Designed for patient comfort. • To be placed underneath the patient's chest.

3.8.4 Coil Caddy

The Coil Caddy can be used to store the coils and positioning aids.

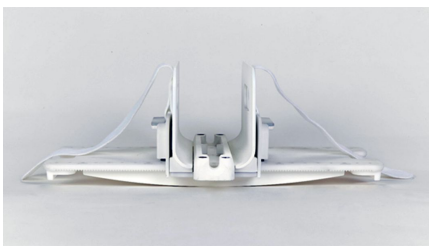


Coil Caddy with:

1. Shelf space for Head top and Head/Neck top coils.
2. Shelves for dS Base coil.
3. Shelf for dS interface.
4. Side shelf for the dS TorsoCardiac coil.
5. Drip stand.
6. Drawer for positioning aids.

3.8.5 Positioners

These optional positioners are designed to facilitate positioning in musculo-skeletal imaging with the MSK M and S coils.

Item	Photo	Use
Universal positioner		• Knee, foot and ankle • Elbow and wrist on small patients

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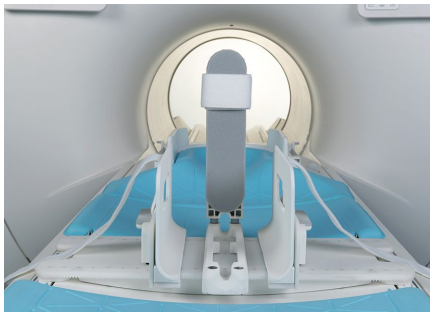
Item	Photo	Use
Universal positioner and foot holder		• To be used for examinations of foot and ankle • To help maintain flexion of the ankle
Shoulder positioner		• Dedicated positioner for shoulder examinations • To be used for supine head-first wrist and elbow examinations with the arm at side

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3.9 Physiology Equipment

This chapter describes features and components of Wireless Physiology and gives relevant workflow information.

3.9.1 Functional Description

- *Wireless Physiology* provides synchronization of the MRI sequences with the physiology signals.
- The physiology signals are displayed in the **Exam Dashboard** on the operator's console.
- If correctly used, *Wireless Physiology* reduces image artifacts caused by breathing, pulsatile flow and cardiac motion.
- *Wireless Physiology* utilizes sensors for
  - Respiration,
  - VCG (VectorCardioGraphy),
  - Plethysmography (Peripheral Pulse Unit PPU).

3.9.2 Safety

WARNING

Do not use the physiology signals for monitoring or diagnostic purposes.

The physiology signals are distorted when the patient is inside the magnet.

3.9.3 Components Overview

Your physiology equipment consists of the following components:

- PPU and VCG module.
  Available as one of the listed options:
  - Wireless physiology 2.0 modules.
  - Wireless physiology 3.0 modules.
- Battery charger.
- SpO_2 grip sensors for PPU.
- Respiratory belt.
- Basic Triggering Unit (located in the magnet room).

3.9.4 Wireless Physiology 2.0 Modules

Wireless VCG and PPU 2.0 Modules

The wireless-PPU and the wireless-VCG modules are essential in connecting physiological sensors to your MRI system.

These modules look identical with two exceptions:

1. Indication of the device type: VCG or SpO_2 (in case of PPU).
2. The connectors on the modules.

	Connectors on wireless battery module		
Module	**for VCG**	**for SpO_2 sensors (PPU)**	**for respiratory belt**
Wireless-VCG battery module	**yes**	**no**	**yes** (Might not be available in some cases)
Wireless-PPU battery module	**no**	**yes**	**yes**

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Wireless-PPU battery module

1. Connector of respiratory belt
2. Connector of Peripheral Pulse Unit (PPU)
3. Indicator of the device type: VCG or SpO_2 (in case of PPU)
4. Indication of current network
5. Indicator of battery status

Status Indicators

The table below lists the LED indications for battery and communication status.

Color	Solid or Blinking	Battery Status	Communication Status
No color	Solid	No battery inserted or too low battery power	Not applicable
Green	Blinking	Battery power is okay	No communication with wBTU
Green	Solid	Battery power is okay	Good communication with wBTU
Red	Blinking	Battery power is low	No communication with wBTU
Red	Solid	Battery power is low	Good communication with wBTU

Tab. 3: Battery and Communication Status

Selecting the wireless network

The wireless network has to be selected only once by the Philips service engineer during device installation.

The wireless network selection is persistent.

The wireless network has to be selected in the **Physiology Properties** window on the MR console.
See chapter “Physiology Display” on page 241.

- ► Press on the battery levers to slide the battery a bit out of the wireless battery module.
- ► Reinsert the battery into the battery compartment.
  - ⇨ The network LED’s start blinking.

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Fig. 11: Left: Reinserting the battery into the battery compartment. Right: Pressing on the text field to go through the networks.

- Press on the text indicating the type of the device (SpO_2 or VCG) to enable the network selection procedure.
- Press again on this text field to go through the networks A to E.

  ⇨ The current network is indicated by the blinking LED.
- To confirm the selection of the current network, press on the text field a little bit longer until the LED doesn't blink anymore, but burns constantly.

Exchanging the battery

Exchange the battery of the battery module when the LEDs are red (solid or blinking) to indicate that the battery is low.

- Press on the battery levers and slide the battery out of the wireless battery module.
- To insert a battery, slide the battery into the battery compartment.

Fig. 12: Left: Pressing on battery levers and sliding battery out of wireless battery module. Right: Wireless battery module from the back with battery removed.

NOTICE

When a battery is inserted into the battery compartment, you can select the wireless network A, B, C, D or E as adjusted in the wBTU so that wireless communication is enabled.

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3.9.5 Wireless Physiology 3.0 Modules

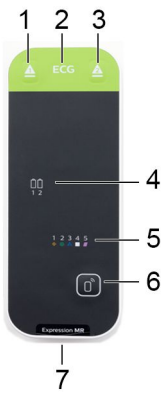
Connectors on the Physiology Modules

The wireless-ECG and the wireless-SpO_2 modules are essential in connecting physiological sensors to your MRI system.

	Connectors on wireless battery module		
Module	for ECG/VCG	for SpO_2 sensors (PPU)	for respiratory belt
Wireless-ECG module	**yes**	**no**	**no**
Wireless-SpO_2 module	**no**	**yes**	**yes**

Wireless-ECG 3.0 Module (w-ECG)

The w-ECG module transmits measured ECG signals to your MR system. There the ECG signal can be displayed and used for cardiac synchronization of MR scans.



1. Eject button for battery bay 1
2. Batteries
3. Eject button for battery bay 2
4. Battery indicators
5. Network channel indicators (1–5)
6. Network selection button
7. ECG lead cable connector

The wireless module is battery-powered. It has two battery bays, battery bay 1 and 2.

The number of installed batteries and their battery status determines the operational features of the w-ECG module, see table.

Number of installed batteries	Functionality of w-ECG module
2	Fully operational with both batteries sufficiently charged.

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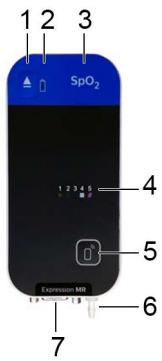
Number of installed batteries	Functionality of w-ECG module
2	Fully operational with one battery sufficiently charged. One battery provides power until its charge is exhausted. Then the w-ECG module switches automatically to the second battery for continued operation, as long as sufficient power is provided by the second battery.
1	Fully operational with one battery sufficiently charged. Before its charge is exhausted, you must install a second battery to continue ECG synchronization. An exhausted battery can be replaced at any time without interruption of ECG synchronization, provided that sufficient charge is present in the remaining battery.
0	Not operational.

Wireless-SpO2 3.0 Module (w-SpO2)

The w-SpO_2 module transmits measured peripheral pulse data and the respiratory signal to your MR system. There the information can be displayed and used for synchronization of MR scans with peripheral pulse and respiratory signal.



1. Battery eject button
2. Battery indicator
3. Battery
4. Network channel indicators (1–5)
5. Network selection button
6. Connection for respiratory belt
7. SpO_2 probe connector

The wireless module is battery-powered. It has one battery bay.

The w-SpO_2 module is only operational when a sufficiently charged battery is installed.

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Indicators on the Wireless Modules

Battery Indicators

Battery indicators indicate the charge status for each battery in the w-ECG and w-SpO_2 module.

Battery indicator	Color	Charge status
(ECG battery 1)	White on black	Battery not installed, or Battery charge insufficient
(ECG battery 2)	White on black	
(SpO_2 battery)	White on blue	
	Green	Battery charge sufficient
	Red	Battery charge low

Network Channel Indicators

The network channel indicator indicates the selected network channel and the communication status of the wireless modules to your MR system.

Network channel indicator	Channel selected	Communication status
	1	• Steady: good communication • Flashing: no communication
	2	
	3	
	4	
	5	

Batteries

Properties of the Battery

Batteries provide power to the w-ECG and w-SpO_2 modules. These batteries are interchangeable, non-magnetic, and can be handled in the MR magnet room.

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NOTICE

To minimize the chance of image artifacts, never place module batteries in the field of view.

- The batteries must be charged in the Philips-specified battery charger. Before initial use, the batteries must be charged for at least 4 hours.
- A battery needs to be replaced when its battery charge is exhausted. You identify an exhausted battery when its indicator is red.

Installing Batteries

You install a battery in the wireless module before initial use and to replace an exhausted battery.
Replace a battery when the battery indicators are red (solid or blinking) to indicate that the battery is low.

- ► To install a battery in its battery bay, hold the battery so that its arrow aligns with the arrow on the wireless module.
- ► Then slide the battery into the battery bay, and press until it seats completely.

⇨ When the battery is correctly inserted, the arrows on the battery and the wireless module point to each other.

Removing Batteries from the Wireless Modules

You remove a battery from the wireless module to replace an exhausted battery by a fully charged battery.

- ► To remove a battery from the wireless module, press a battery eject button:

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- For battery 1 of the w-ECG module, press

.
- For battery 2 of the w-ECG module, press

.
- For the battery of the w-SpO_2 module, press

.

► Then grasp the partially ejected module battery and pull:

- For battery 1 of the the w-ECG module:
- For battery 2 of the the w-ECG module:
- For the battery of the the w-SpO_2 module:

Selecting the wireless network

Your service provider selects the wireless network during device installation. The wireless network selection is persistent.

The procedure of selecting another network channel requires you:

- To turn off the wireless module and then on again.
- To select the preferred network channel with the network selection button.

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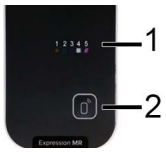

1. Network channel indicators
2. Network selection button
   - To enter network change mode.
   - To go through the network channels.
   - To save the current network.

1. On the MR console in the **Physiology Properties** window, select the preferred wireless network.
2. Remove the batteries from the wireless module.
3. Install the batteries again in the wireless module.

   The network channel indicators flash briefly. Then the current network channel indicator illuminates.
4. To enter network change mode, press and hold until the current network channel indicator begins to blink rapidly.

NOTICE

If you do not enter network change mode within 10 seconds after module power-up, network changes are not allowed.

In this case, restart this workflow.

5. To go through the network channels, press and hold repeatedly until the preferred network channel indicator blinks.
6. To save your network channel, press and hold for approximately 5 seconds until the preferred network channel indicator illuminates.

   During these 5 seconds, the preferred network channel indicator turns off. Then it illuminates (not blink) to indicate that the network channel is saved.

⇨ Now the wireless module uses the selected network channel.

When this workflow is not correctly completed, the previous network channel is still used.

3.9.6 Battery Charger

Device Description

The battery charger is not MR compatible; however, it charges batteries that are used in MR patient monitoring products.

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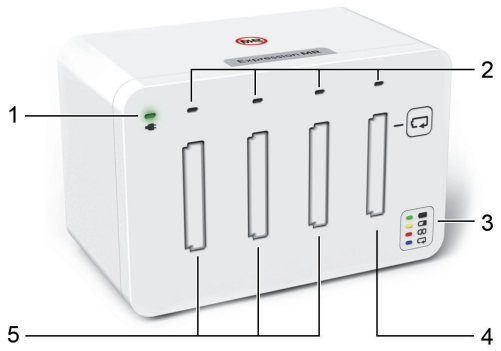

1. LED for Power On/Off
2. LEDs for battery status
3. Legend for LEDS
4. Reconditioning and charging bay (with reconditioning icon)
5. Charging bays

Charging Bays

Four charging bays allow you to charge from 1 to 4 batteries singularly or at the same time. The LED above each charging bay displays the battery charge status. One of the four bays allows you to recondition a battery if needed.

Mains Power Options

A power adapter connects between the AC mains and the 5 VDC power input port at the back of the battery charger through a detachable line cord.

Compatible Batteries

Batteries are included and delivered with the wireless physiology modules.

Batteries are not included with the battery charger.

Compatible batteries are the following Lithium Polymer Batteries 3.7 V.

Model 989803191341 or equivalent

NOTICE

Only these compatible rechargeable batteries should be charged in the battery charger.

Do not charge other vendor's batteries in this device.

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Reconditioning

These batteries are batteries with a gas gauge that interprets the available charge capacity. As these batteries age, their gas gauge and charge capacity decreases. Battery reconditioning allows you to re-adjust the gas gauge. Reconditioning is not required, but batteries that are not reconditioned may not give an accurate indication of their available battery life. You recondition batteries with the battery charger.

Powering On the Battery Charger

The battery charger does not have a Power On/Off switch.

- ► To power the battery charger on, connect the power cord to power.

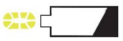
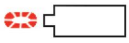
⇨ The green LED for Power On/Off indicates that the device is ready to use.

⇨

When the battery charger is connected to power for the first time, it performs a self-check. During the self-check, the LEDs of the empty charging bays change color from blue, to green, to red and then Off.

Indicators of the Charging Status

LEDs on the battery charger indicate the charging status.

Charging Bay LED		Status Explanation / Recommended Action
LED = Off (no color)		No battery inserted
Solid Green		Battery charged > 95% (complete)
Flashing Green		Battery charged > 70% (medium)
Flashing Yellow		Battery charged < 70% (low)
Solid Blue		Battery being reconditioned
Flashing Blue		Battery recondition recommended
Solid Red		Defective battery Discard the battery following local regulations
Flashing Red		Remove and reinsert battery, or charger malfunction

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Charging a Battery

You can charge one or more batteries simultaneously in any bay of the battery charger. The rightmost charging bay also allows you to recondition a battery.

A compatible 3.7 V battery receives 95% of full charge in 4-6 hours, depending on the age and condition of the battery.

- ► Carefully insert the battery to be charged into any empty charging bay until it is firmly seated.

  The four charging bays are keyed so that the batteries cannot be inserted incorrectly.

  ⇨ The charger automatically evaluates and begins charging a battery or multiple batteries upon insertion into a charging bay.

- ► Leave the battery in the charging bay until the LED turns solid green (95% or greater charge capacity reached).

  ⇨ The battery is ready to use.

You can use batteries sooner (flashing green or yellow LED) without a full charge, if needed.

Batteries can remain in the charger after the charge LED has turned green.

NOTICE

If the LED flashes blue with the battery in the bay, the battery needs reconditioning before charging.

Then start the reconditioning procedure within 30 seconds:

- Move the battery into the reconditioning bay.
- If the battery is not moved for reconditioning within 30 seconds after the LED begins flashing blue, a normal charge cycle begins.

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Reconditioning a Battery

You recondition a battery when its battery status LED flashes blue. Only reconditioned batteries provide you with an accurate indication of their available battery life.

The reconditioning time depends on battery age and condition. Generally 3.7 V batteries recondition in approximately 6 hours.

▷ Precondition: The LED of a battery in a charging bay flashes blue (battery recondition recommended).

► Insert the battery in the reconditioning bay (the rightmost charging bay).

⇨ The LED of the battery in the reconditioning bay flashes blue.

(battery recondition recommended),

► Press the reconditioning button located next to the reconditioning bay.

⇨ The LED of the battery in the reconditioning bay changes from flashing blue to solid blue (battery being reconditioned).

⇨ Reconditioning takes place.

► Leave the battery in the recondition bay until the LED changes from solid blue to another color.

⇨ Reconditioning is completed. A normal charge cycle begins.

NOTICE

Reconditioning can be interrupted with no negative impact on the battery, but the next time the battery is installed in the charger reconditioning will again be indicated.

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3.9.7 Respiratory Belt

Property	Description
Purpose	To detect the patient's breathing through abdominal or chest wall motion
Applications	• Respiratory Compensation: to reduce motion artifacts due to breathing • Visualization of the patient's breathing
Limitations	The respiratory signal cannot be used for monitoring or diagnostic purposes other than determining the respiration wave for MR imaging

3.9.8 VitalEye

The VitalEye is a camera that is used to detect respiratory motion. The camera is located at the back end of the magnet bore. VitalEye is delivered with additional infrared bore lights for better lighting conditions.

Purpose	To detect the patient's breathing through abdominal or chest wall motion.
Applications	• Respiratory Compensation: to reduce motion artifacts due to breathing • Visualization of the patient's breathing

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Limitations	• The respiratory signal can only be used to determine the respiration wave to synchronize MR scans with. • The VitalEye only works properly when the line of sight of the camera is not obstructed.

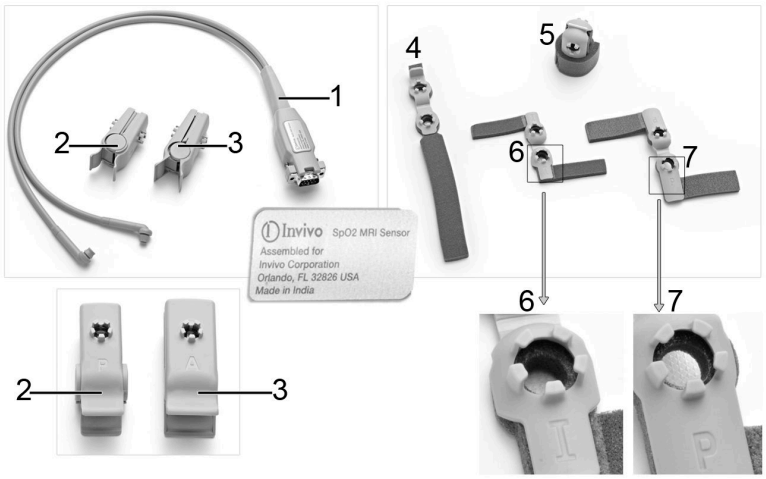
3.9.9 Peripheral Pulse Sensor

Property	Description
Purpose	Cardiac Triggering: Acquisition of imaging data at defined moments in the cardiac cycle. The trigger signal is derived from changes in capillary blood flow during the cardiac cycle. It is transmitted via fiber optics.
Applications	• Suppression of artifacts caused by flow of blood or CSF in the spine • Pulse rate monitoring
Limitations	May alternatively be used for cardiac imaging or angiography, although there is an inherent delay from the time of the R-peak until flow change is registered in the finger.

SpO_2 and Pulse Rate Accuracy

Pulse oximetry measurements are statistically distributed.

Quick Connect SpO_2 MRI Sensor: components and applications



1. Sensor cable
2. Reusable grip sensor Pediatric (P)
3. Reusable grip sensor Adult (A)
4. Disposable grip sensor Neonatal (N)
5. Disposable grip sensor Adult (A)
6. Disposable grip sensor Infant
7. Disposable grip sensor Pediatric (P).

   For more information about these sensors, see the dedicated Instructions for Use.

The sensor cable has two legs, a receiver side (no light when powered) and an emitter side (illuminates red when powered). Both fiber optic tips of the cable legs are identical in size and can be snapped into either of the two retainers on the attachments.

The SpO_2 attachments for PPU are delivered in two different types and in up to four different sizes.

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Attachment	Application	Preferred location	Alternate locations
Reusable Clip A	Adult: more than 40 kg	Any adult finger, preferably index	-
Reusable Clip P	Pediatric: between 10 kg and 50 kg	Any pediatric or small adult finger, preferably index	-
Disposable Grip A	Adult: more than 40 kg	Any adult finger, preferably index	Toe
Disposable Grip P	Pediatric: between 10 kg and 50 kg	Any pediatric or small adult finger, preferably index	Toe
Disposable Grip I	Infant: between 5 kg and 15 kg	Any infant or small pediatric's finger, preferably index or thumb	Big toe
Disposable Grip N	Neonate: between 1 kg and 5 kg	Any neonate's foot	Hand or wrist

NOTICE

The patient weights above are given for orientation only. The size of the chosen limb is more important in determining the attachment type to use.

Depending on the system configuration, different grip sensors may be available.

3.9.10 VCG (VectorCardioGraphy)

VCG Functional Description

Property	Description
Purpose	Cardiac Triggering: Acquisition of imaging data at defined moments in the cardiac cycle.
Applications	• Imaging of the heart at various phases of the cardiac cycle • Suppression of artifacts caused by heart motion • Suppression of artifacts caused by flow of blood or CSF • Imaging arteries with TRANCE

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Property	Description
Limitations	The VCG signal cannot be used for monitoring or diagnostic purposes.

With VCG, the electrical activity of the heart is modeled as a vector. During the cardiac cycle this vector changes magnitude and orientation. The vector's projection on to a plane gives a spatial plot of the heart's electrical activity.

By connecting the tips of the vector at different moments loops are generated describing the different cycles of the electrical activity of the heart: P-, QRS- and T-loop. Thus, using spatial information of the ECG the QRS-loop can be differentiated from the loops of the artifacts.

Safety

WARNING

Do not use the physiology signals for monitoring or diagnostic purposes.

The physiology signals are distorted when the patient is inside the magnet.

WARNING

Only use the appropriate InvivoMDE™ battery pack with the VCG module.

This battery pack may only be charged with the InvivoMDE™ battery charger.

VCG Signal and VCG Calibration

Factors affecting the VCG signal

For successful cardiac triggering of MR scans, a good VCG signal with a clearly detectable R-peak is a prerequisite.

However the VCG signal and the calibration of the VCG signal are affected by several factors:

Position of the electrodes and the distance between electrodes

Wrong electrode placement leads to disturbances in the VCG signal.

- Make certain that the electrodes are positioned correctly. See chapter "Connecting VCG to the patient" on page 366.

Patient respiration

Some trigger loss may occur during inspiration. The severity depends on the position of the electrodes.

- Make certain that the electrodes are positioned correctly. See chapter "Connecting VCG to the patient" on page 366.

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Flowing blood and magnetic field

The VCG signal changes in the presence of a static magnetic field, since flowing blood (especially in the aortic arch) induces voltages that are superimposed on the measured VCG-signal.
Alterations of the VCG-signal are mainly seen in the baseline and are usually superimposed on the T-wave. The distortion is referred to as T-wave artifact or the Magneto-hydrodynamic effect (MHD). The strength of the induced voltages increases with higher field strength, and is more severe with the patient inside the bore.

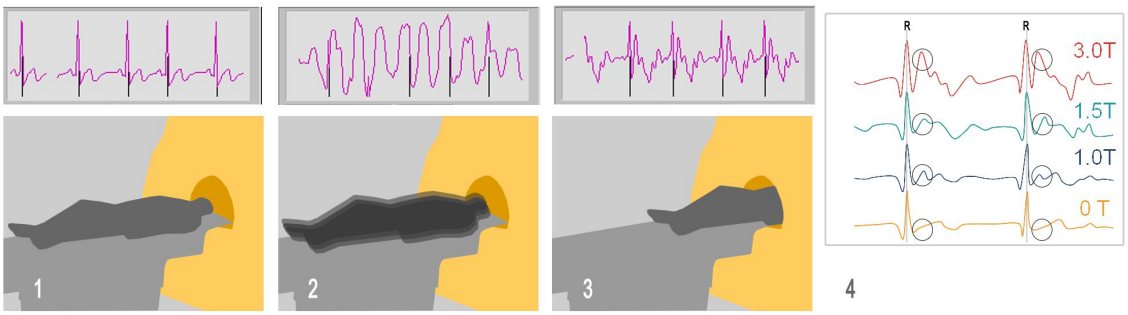
- To reduce this artifact, avoid measurement of the VCG in the area of the aortic arch.

Motion

Table motion, as well as patient motion causes the VCG signal to rapidly change. For cardiac triggered scans, patient motion negatively impacts the reliability of VCG triggering.

- Avoid table motion at all times. Instruct the patient to lie still to avoid motion.

Effects of magnetic field and motion on the VCG signal



1	Patient outside the bore. Lying still. Perfect VCG signal.
2	Patient outside the bore. Moving. Disturbed VCG signal.
3	Patient inside the bore. Lying still. Disturbed VCG signal.
4	T-wave artifact (indicated by circle) in VCG. Most likely occuring with the patient inside the bore.

VCG calibration

In all scans that make use of VCG, VCG calibration is required to ensure correct triggering.

VCG calibration analyzes the detected ECG-signal to determine the R-peak in the QRS-complex: A trigger algorithm determines which peak in the detected ECG-signal is marked as R-peak. A trigger marker is assigned to the signal (and displayed in the **Physiology Display**) if all criteria of the trigger algorithm are met.

Factors affecting the VCG calibration

When the VCG calibration is disturbed, it can happen that trigger markers are assigned to the incorrect signal or are not assigned at all.

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VCG calibration results are affected by the same factors as the VCG itself. For more information, see chapter “Factors affecting the VCG signal” on page 202.

Methods of VCG calibration

VCG calibration can be performed in two ways:

1. It is recommended to use manual VCG calibration for problem-free cardiac triggering in all patients.
   For more results, see chapter “Manual VCG calibration” on page 205.

2. Continuous VCG calibration is easy to use. It is the default VCG calibration method.
   For more information, see chapter “Continuous VCG calibration” on page 204.

Continuous VCG calibration

Continuous VCG calibration is designed to automatically determine the R-peak for the purpose of correct triggering of all scans where VCG is used. Continuous VCG calibration requires no user interaction. Consequently results cannot be optimized. It is the default VCG calibration. Alternatively you can use manual calibration. For more information, see chapter “Manual VCG calibration” on page 205.

What are the main features of continuous VCG calibration?

- It analyzes and calibrates VCG data continuously.
- The VCG calibration data of the 7 seconds prior to the start of each scan is used throughout the scan.
  This leads to a forced delay of 7 seconds for each scan.
- When calibration data is available, trigger markers and the patient's heart rate are displayed in the **Physiology Display** panel.
- The disadvantages of continuous VCG calibration are:
  - Different VCG calibration results for each scan lead to differences in triggering efficiency between scans.
  - It is not possible to determine the conditions under which VCG calibration is performed.
  - You cannot change the trigger threshold. It is always **high**.

Enabling continuous VCG calibration

Continuous VCG calibration automatically takes place when manual VCG calibration is disabled.

► Deselect **Manual Calibration** in the **Physiology Properties** window or on the **VitalScreen**.

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Continuous versus manual VCG calibration

	Manual VCG calibration	Continuous VCG calibration
Calibration duration	• single calibration of 15 seconds prior to first scan • valid for all subsequent scans	• continuous calibration: 7 seconds prior to each scan
Triggering efficiency	• predictable for all scans	• possibly different between scans
User interaction	• required	• not required
VCG calibration conditions	• can be defined	• cannot be defined (because it is fixed)
Location of calibration	• recommended: outside bore • alternatively: inside bore	• always inside bore (last 7 seconds prior to scan)
Patient instructions	• can be given	• cannot be given
Trigger threshold	• can be modified • can be set to high, medium or low	• cannot be modified • is always high
Display of trigger markers / heart rate	• only after manual calibration	• immediately after 7 seconds of calibration

Manual VCG calibration

You can either perform manual or continuous VCG calibration. It is recommended to use manual VCG calibration for smooth cardiac triggering in all patients.

What are the main features of manual VCG calibration?

- Manual VCG calibration allows you to determine the conditions under which the VCG calibration is performed.
- Manual VCG calibration analyzes 15 seconds of VCG data to ensure accurate detection of R-peaks in all patients, also in patients at low heart rate or in arrhythmic patients.
- Manual VCG calibration can be initiated at any moment in the workflow. It is recommended to execute it before moving the patient to the isocenter.
- You start and adjust Manual VCG calibration in the **Physiology Properties** window, or on the VitalScreen.
- You can adjust the trigger threshold during cardiac triggered scans to adjust the sensitivity for the detection of R-peaks.
- When calibration data is available, trigger markers and the patient's heart rate are displayed in the **Physiology Display** panel.
- Calibration data that is collected, is applied to all subsequent scans until
  - you initiate a new VCG calibration,
  - you recall a previously stored VCG calibration,

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– you disable manual calibration.

- Results of manual VCG calibration depend on the tabletop position.
- The VCG calibration results are provided with an indication of Signal **Strength** (amplitude of the R-peak in mV) and Trigger **Quality** (number of false positive and false negative signals).
- All VCG calibration results are reset when you start a new examination.

Influence of the tabletop position on VCG calibration

The tabletop position affects VCG calibration, leading to different VCG calibration results depending on the tabletop position:

Icon	Tabletop position	Description	Results stored as
	Outside the bore recommended edge of tabletop < 450 mm in the magnet bore	The patient is positioned and ready to be moved to the isocenter. This is the recommended tabletop position, because flow artifacts, induced by the presence of the magnetic field, are minimized.	**Outside bore**
	Inside the bore edge of tabletop > 450 mm in the magnet bore	The patient is positioned at isocenter position.	**Inside bore**
-	**Unknown position**	If patient support is not powered.	**Inside bore**
-	no information about tabletop position	VCG calibration is not yet performed.	No results are stored yet.

The tabletop position is defined relative to the edge of the head end of the tabletop and NOT to the light visor. This definition allows for a new **outside bore** calibration during an examination when moving the patient bed partially out of the bore.

Use of VCG calibration results

- If both types of calibration results are available, you can select which calibration results are used to detect R-peaks.
- The type of calibration results used is displayed in the **Physiology Properties** window and in the **Extended Physiology Display**.
- The calibration results are overwritten when you start a new calibration on the same tabletop position.

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3.10 Operator's console

3.10.1 Functional Description

The Operator's Console consists of the following items:

- Computer system (Windows operating system and MR system software) and an external DVD recorder.
- A wide-screen display unit with USB connectors.
  The operator's console monitor is not a Primary Diagnostic Monitor. Image appearance does conform the DICOM GSDF standard
- Keyboard and mouse.
- Patient-operator intercom.

3.10.2 Logging on and off

Guidelines

Keep the computer running permanently.

It is sufficient to exit the system software and to switch off the display. When the computer runs, the system remains available for remote servicing and performs scheduled tasks (quality checks).

- A restart of the computer once a week is strongly advised to remain optimal performance of the system.
- Only switch off the computer if a system hang up occurs.
- Never exit the system software while a background process (such as hard copy, DVD recording, or Network) is still running.
- Switch off the display unit on the operator's console at night.

Start the Application Software (Log on)

To log on:

1. Press the **Ctrl**, **ALT**, and **Delete** keys on the keyboard.
2. In the logon dialog box, type in the user name and password.
3. Click **OK** or press the **Enter** key.

   ⇨ The application software starts.

NOTICE

After first logon, enter a different password of at least seven characters.

Initial settings for username and password are "MRuser" and "Philips".

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Exit the Application Software (Log off)

via Settings -> Exit

To exit the application software:

1. On the **System** menu, click **Exit**.
2. In the Exit Confirmation window, click **Yes** to exit the software. Click **No** to cancel.

The **Stop** status box is displayed until the software has been logged off.
The logon dialog box is displayed.

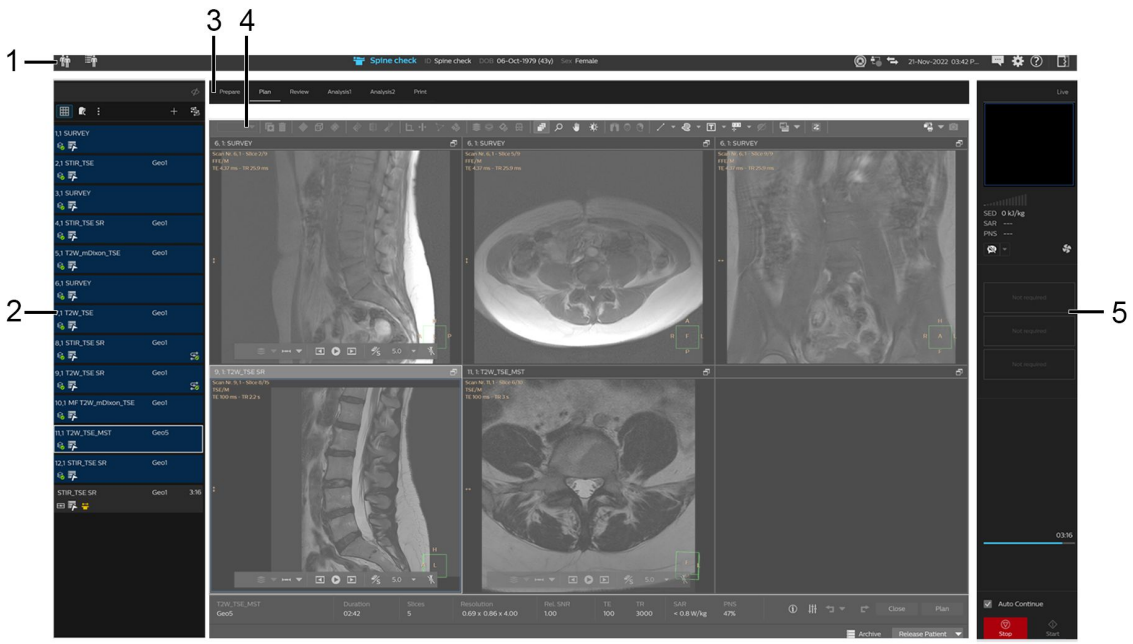
3.10.3 Introduction to the User Interface

The User Interface is designed around the examination workflow.

This section describes the most important UI elements.

General Setup

The User Interface consists of generic main elements that are always on top and of other elements that vary depending on the current patient task.



Number	Description	More information
1	Navigation Bar • Always on top	chapter “Functional Description” on page 211
2	Exam Overview • Always on top	chapter “Functional Description” on page 228

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Number	Description	More information
3	Patient Tasks Bar • Always on top	chapter “Functional Description” on page 227
4	Variable content depending on current Patient Task:	
	• **Prepare**	• chapter “Prepare Tab” on page 377
	• **Plan**	• chapter “Plan Tab” on page 435
	• **Interactive** Only when Interactive Scanning is available and launched.	• chapter “Interactive Scanning” on page 462
	• **Review**	• chapter “Review Tab” on page 479
	• **Analysis1** • **Analysis2**	• chapter “Analysis Tabs” on page 551
	• **Print**	• chapter “Print Tab” on page 726
5	Exam Dashboard • Always on top	chapter “Functional Description” on page 238

UI Elements

In the user interface, the following UI elements are used:

UI element	How to use	Example
Tooltip	A tooltip provides you with a short explanation about a UI element. • To display the tooltip, hover over a button or another UI element.	
Button	A button represents an action you can perform. • To perform the action, click the button once.	
Context menu	A context menu offers a set of choices which are relevant for the current image and situation. • To display the context menu, right-click on an image. Then select any of the options.	

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UI element	How to use	Example
Text field	Text fields allow you to enter (and edit) texts.	Patient name
Date field	Date fields allow you to pick a date.	Date of birth
Checkbox	A checkbox allows to select one or more options of a limited number of choices. The checkbox is shown as a square box that is ticked (checked) when activated. • To activate the checkbox, click in the checkbox. • To deactivate the checkbox, click again.	
Radio button	A radio button allows to choose only one option of a limited number of choices.	
Drop-down list	The drop-down list allows to choose one option from a list. It displays the current option and a down-arrow right beside it. • To open the drop-down list, click the down arrow. • To select an option from the drop-down list, click this option.	
Slider	A slider allows you to set a value by moving an indicator, usually horizontally.	Movie
Icon	An icon is a symbol that indicates the status of something. It provides you with information.	Planned icon in Exam Overview icon that shows the function of the mouse
Progress bar	A progress bar shows the status of an action.	Progress of the examination
Notification	possibly also alert	
Message box	A message box displays a message in a small window. This message prompts for a response.	An alert is displayed which requires acknowledgement that the message has been read, usually by clicking **OK**, or if a decision is needed by clicking **OK** or **Cancel**.

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UI element	How to use	Example
Modal window	A modal window is subordinate to an application's main window. When it is active, it disables the main window but keeps it visible with the modal window on top. You must interact with the modal window before you can return to the main application.	Tabletop is moving. Confirm ... SAR messages ... confirm
Scroll bar		

3.10.4 Navigation Bar

Functional Description

The Navigation Bar is the major navigation component and as such it is always available. It is composed of informational components and buttons that provide access to generic functions.

- The Navigation Bar gives access to the **Patient Dashboard** and the **Patient Directory**.
- The Navigation Bar allows you to check the status of the MRI system and of jobs.
- The Navigation Bar displays iformation about the current patient.
- The Navigation Bar allows you to open the **Help (F1)**.
- To change your settings, the Navigation Bar provides **Settings and Tools (F10)**.

Number	Description	More information
1	**Patient Dashboard**	chapter “Functional Description” on page 224
2	**Patient Directory**	chapter “Functional Description” on page 216
3	**Patient name**	
4	**Patient ID**	
5	**Date of Birth & Age**	Date of Birth and in brackets the age in years
6	**Sex**	
7	Status of MRI system, **System Health**	chapter “Status of MRI System” on page 212
8	**Job Viewer (F6)**	chapter “Job Viewer” on page 213

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Number	Description	More information
9	Current date and time	
10	**Message Center**	chapter “Message Center” on page 214
11	**Settings and Tools (F10)**	chapter “Settings and Tools” on page 214
12	**Help (F1)**	chapter “Help” on page 216

Components of the Navigation Bar

Patients and Examinations

These buttons allow you to display the patient directory in list or thumbnail view as exam schedule. From the **Patient Directory**, you select an examination to review, analyze, or print the available imaging series.

Buttons	Description	More information
	Patient Dashboard	chapter “Functional Description” on page 224
	Patient Directory	chapter “Functional Description” on page 216

Status of MRI System

The status of the MRI System is displayed in the Navigation bar in **System Health**. **System Health** informs about possible issues and actions that you have to take.

Button	Description
	(MRI) **System Health**

There are four types of messages, which are also indicated by the icon in the Navigation bar.

Icon	System Status	Description
	Normal	The system is running normally without any issues, and no action is required.
	Effect on future functionality	Issues have arisen that affect the future functionality of the system. For example: **Patient database 80% full.**
	Action required / background process running	A background process is in progress. You have to wait and take action when the process is complete. For example: **Patient reference position missing.**

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Icon	System Status	Description
	System servicing required	An error has occurred that you cannot solve. Contact your service provider. For example: **Data Acquisition System not reachable.**

Job Viewer

The **Job Viewer (F6)** shows the status of background jobs, for example importing, exporting or printing of imaging series. The **Job Viewer (F6)** is available on the Navigation bar.

Button	Description
	Job Viewer (F6)

In the **Job Viewer (F6)**,

- you can select which job types are displayed in the job list.
- you can sort the jobs by different criteria.
- you can prioritize jobs to speed them up.

The job list displays the following information for each job.

Column Title	Short Description
Name	Patient name
Type	Job types • **All Jobs** • **Import/Export**jobs • **Print** jobs • **Postprocessing** jobs • **MPPS** (Modality Performed Procedure Step) jobs
Location	Where the job is executed, imported from or exported to
Date	Time stamp of the job
Status	• **Processing** • **Completed** • **Failed** • **Canceled** • **Submitted**
Progress	Progress of job completion in %.
Details	

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Editing the Jobs

In the **Job Viewer (F6)**, you have the following options to edit the jobs:

Button	Short Description
Remove	Remove jobs from the job list.
Cancel	Cancel a submitted job or a job in processing without removal from the job list.
Redo	Restart a failed or canceled job.
Prioritize	Set a submitted job or a job in processing as priority. The prioritized job is next in line.

Message Center

The **Message Center** is a log of messages and operator actions or decisions. In the **Message Center**, you can trace the sequence of events that lead to the current state of the system.

The **Message Center** is available on the Navigation Bar.

Button	Description
	Message Center

The **Message Center** notifies you about unread messages with a number on its icon . The number stands for the number of unread messages.

Each message contains a time stamp, the area you worked in, and the message itself or your decision.

The **Message Center** can log 256 messages. If the number of messages exceeds the limit, the oldest messages are deleted first.

The log of the **Message Center** is cleared when you log out or shut down the system.

Settings and Tools

The **Settings and Tools (F10)** are available on the Navigation Bar. From here, you can access the settings and configurations for the functions of your system.

Button	Description
	Settings and Tools (F10)

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In the menu	Short Description	More information
Settings • **Auto export** • **Patient Dashboard Settings** • **Mapped Drives** • **Screen Capture** • **SmartExam** • **Start Scan**	• To enable or disable **Auto export**. • To adjust the display of the **Patient Dashboard**. • To display the mapped drives, and to map a network drive. • To enable or disable the **Capture Screen** function for the whole screen. • To specify the settings for **SmartExam**. • To enable or disable **Automatic Start Scan** which starts scans automatically when planning is done.	• chapter “Enabling the Auto Export Function” on page 757 • chapter “Adjusting the Patient Dashboard” on page 226 • chapter “Mapping a Network Drive” on page 760 • chapter “Capture Screen” on page 280
Contrast Preset Settings	To set up and manage presets for contrast agent administration.	chapter “Functional Description” on page 258 chapter “ContrastCards for Contrast Administration” on page 417
AutoVoice Settings	To set up pre-recorded, automated instructions to the patient.	chapter “Functional Description” on page 262
Image Display Settings	To specify the default display settings for images, and to create customized settings for specific anatomies.	chapter “Functional Description” on page 268
ExamCard Manager(Ctrl+K)	To edit and create ExamCards.	chapter “Functional Description” on page 274
Data Monitoring	• To inspect the results of preparation phases for MR imaging and MR spectroscopy • To review MR spectroscopy data during the acquisition (depending on the system configuration).	-
Navigator Display	To enable/disable the display of navigator data.	-
Dicom Configuration	To add DICOM nodes to your system.	chapter “Functional Description” on page 763
SPT	To access the **System Performance Tests**.	-
Edit Scan Control Parameters	To edit technical parameters which control the scan. Only applicable for advanced operators and your service provider.	-
System Tuning...	Only applicable for advanced operators and your service provider.	-

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In the menu	Short Description	More information
Activate Research Patch	Only applicable for MR Research users and your service provider. Password-Protected.	-
Exit	To exit the software.	

Help

On the Navigation Bar, you access information about the MRI system.

Menu Entry	Description
User Documentation	Here you access the Instructions for Use and the Technical Description of your MRI system.
Help Topics (F1)	The Help system opens in a separate window. To access the Help system, click **Help Topics (F1)** or press the **F1** key. • The Help system contains the Instructions for Use, the Technical Description, and gives basic and advanced scanning information. • In some parts of the user interface, e.g. imaging parameters, the Help system is context-sensitive. This means that the Help shows directly information which is relevant to what you are currently doing in the application. If context-sensitivity is not available, the home page of the Help system will open.
About - MR	A summary of relevant hardware and software information is available in the **About - MR** function.
Send Feedback	To give customer feedback and report an issue to Philips. chapter “Customer Feedback”

3.10.5 Patient Directory

Functional Description

The **Patient Directory (F3)** displays a list of the available patient data with their exam status.
It allows you

- To select which patients are displayed:
  - **Scheduled**: Patients whose examinations are scheduled for an examination, but the examination has not yet taken place.
  - **All**: Patients where examination data is already available.
  - Patients in an external database (for example RIS or DICOM nodes).

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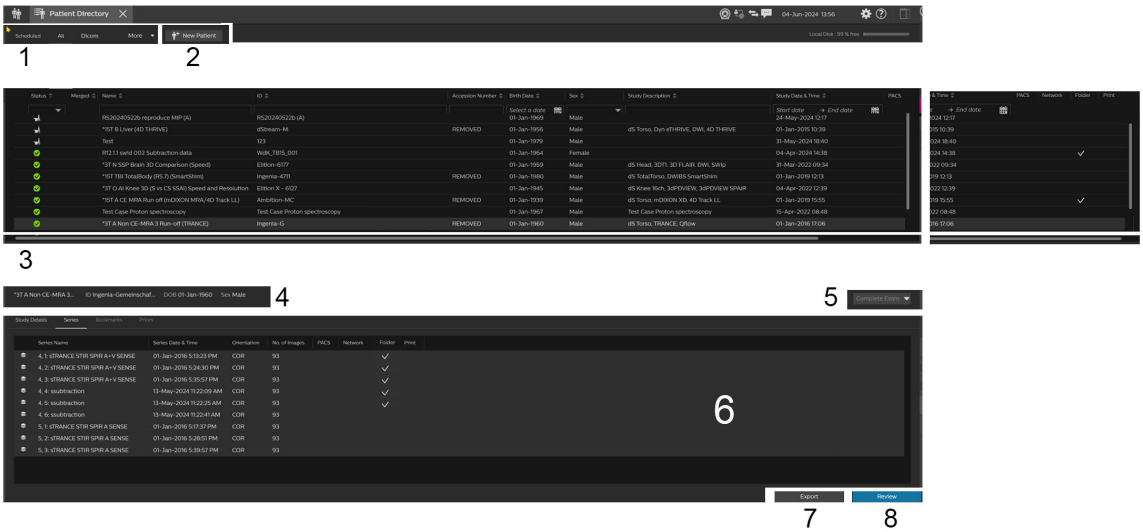
- To sort the patients based on the available criteria, for example **Status**, **Name**, and **ID**.
- To open an examination in the **Review** tab.
- To lock an examination so that it cannot accidentally be deleted.
- To delete an examination.
- To modify the examination data.
- To export an examination.
- To merge or split examinations.
- To display patient studies from an external database.

User Interface

Main Elements of the Patient Directory



Number	Name	Description	More information
1	Patient list tabs	Select which patients to view:	
2	**New Patient**	Add new patient manually	chapter “Entering New Patient Data Manually” on page 378
3	Patient list	List with patients of selected tab • With information about the export status of each examination (PACS, Network, Folder, Print) with checkmarks The horizontal scrollbar allows you to scroll you from left to right.	
4	Patient info	Quick information on selected patient	

Number	Name	Description	More information
5	Exam button	Complete or discontinue the exam, or Release patient	
6	Detailed patient data	Details about the study including the imaging series that was used and if applicable bookmarks and prior studies of the patient • With information about the export status of each imaging series (PACS, Network, Folder, Print) with checkmarks	chapter “Detailed Patient Data” on page 218
7	**Export**	Export selected data (only possible for prepared examinations)	chapter “Exporting Exam Data Manually” on page 758
8	**Review**	Go to Review task	

Detailed Patient Data

The lower part of the Patient directory provides detailed information about the selected patient.

- **Study Details**: Patient data with details, for example weight, height, allergies or study comments.
- **Series** (if available): Information on the ExamCards or Scan Items used in the examination, geometry settings, and export location

  You can also
  - export selected series or the whole study in Classic MR format (see chapter “Exporting Exam Data Manually” on page 758),
  - delete selected series,
  - refresh the list.
- **Bookmarks**: bookmarks of scans in the current study
- **Priors**: Information about previous examinations

Routine Procedures

Locking and Unlocking of Patient Data

You lock patient data that is on the system to prevent accidentally deleting the data.

► To lock a patient entry, right-click on a patient entry and click **Lock**.

⇨ The lock symbol appears in front of the patient entry.

⇨ The patient entry cannot be deleted, a message appears describing the reason.

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► To unlock a patient entry, right-click on a patient entry and click **Unlock**.

⇨ The lock symbol disappears in front of the patient entry.

⇨ The patient entry can be deleted.

Filtering the Patient Directory

You can filter the patient list by certain criteria.

► To specify your filter criteria, do any of the following:

- Click in the field under the column header and select your filter criteria.

Example: Select any (Examination) **Status**.

- Click in the field under the column header and type the criteria.

Example: Type the (Patient) **Name**.

► To delete a filter, click the **x** behind the filter criteria.

Selecting and Deselecting of Entries in the Patient Directory

You can select single or multiple entries in the Patient Directory.

► Do any of the following:

- To select a single entry, click this entry.
- To select multiple consecutive entries, click the first entry. Then press and hold **Shift**, and click the last entry.
- To select multiple individual entries, click the first entry. Then press and hold **CTRL**, and click the other individual entries.
- To select the entire list, press **CTRL+A**.

To deselect an entry from the entire list again, click this entry.

Changing the Sorting Order

You can sort the entries of the Patient Directory differently.

► Click a column header.

► Click the Down-arrow to sort in descending order,
click the Up-arrow to sort in ascending order.

- The entries are sorted in alphabetical, chronological or numerical order depending on the selected column. For example, select the **Name** header, the entries are sorted by Patient name from A to Z or Z to A.
  - **Status**
  - **Merged**
  - **Name**
  - **ID**

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- **Birth Date**
- **Sex**
- **Study Description**
- **Study Date & Time**

Refreshing the Patient Directory

You refresh the Patient Directory to display the most recent changes, for example to see the recently finished examinations.

► Right-click on the **Patient Directory**, and select **Refresh List**.

This does not change the selection state. Open exams will stay open.

Modifying Examination Data

Patient examination data of local and retrieved examinations can be modified.

Note that patient data cannot be modified during an examination.

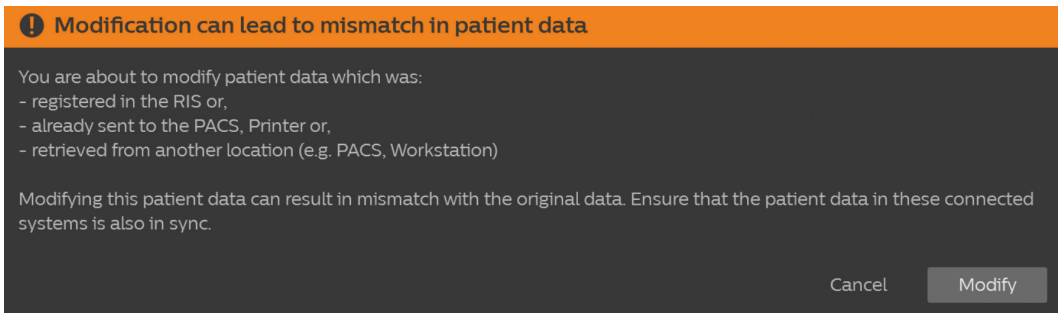
▷ In the **Patient Directory**:

1. Select the examination to be modified.
2. Right-click on a patient entry and click **Modify**.

⇨ If local examination data has been exported or the data derives from RIS, the following warning is displayed.

⇨ **Modification can lead to mismatch in patient data**

⇨



3. Click **Modify** to proceed.
4. Modify the examination data, for example delete existing data, enter new data.
5. Do any of the following:
   - Click **End Modification** to save the modification and go back to the **Patient Directory**.
   - Click **Undo** to reset the patient data.

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Displaying Patients from External Database

In the **Patient Directory**, you can select to display **Scheduled** or **All** patients. However, you can also select to display the patients from an external database. A column is reserved for this external database.

► Click **More**, then select any of the available options:

- **PACS/Network** with **iSite**
- **RIS**
- **This Computer**
- **Browse Path**

⇨ The tab between **All** and **More** displays the patients from the selected external database.

⇨ To change the external database that is displayed in the tab, repeat this workflow.

See also chapter “Using Patient Data from RIS” on page 380 and chapter “Importing Patient Data from External Sources” on page 759.

Merging Studies

In the **Patient Directory**, you can merge up to 5 studies from the RIS.

You merge studies when there are more than one requests per patient, and when it is more efficient to combine these requests in one session.
When the examination is finished, you split the single exam into multiple exams in line with the requests.

▷ Prerequisites:

- You can only merge studies before the examination is performed.
- The studies have the same **Patient name**, **Patient ID**, **Date of Birth & Age** and **Referring physician**.
- The examinations are from RIS, or originates from RIS and is copied to the local database.
  You can not merge patient studies which you created locally with **New Patient**.

► Select multiple studies from the **Scheduled** list.

► Right-click and select **Merge**.

⇨ The studies are merged.

⇨ The Study Description of the merged study displays as: *<first study description> + <number of added studies>*.
Example: When a C-spine, T-spine and L-spine study are merged, the study description displays as: *C-spine +2*

⇨

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To easily find the merged studies in the **Patient Directory**, open the **All** list and sort all entries with the **Merged** sorting criteria.

Splitting Examinations

Split Exam allows you to separate an exam acquired during a single scan session into multiple exams. This allows for correct association of imaging series to ordered/ scheduled examinations to facilitate proper reporting, data handling and billing activities.

Before you start

To ensure proper handling of the Split Exam functionality, establish the proper workflow in regards to MPPS (Modality Performed Procedure Step) with the facility defined RIS administrator.
Note that **Send initial MPPS** is enabled by default.

NOTICE

If you split a merged study, in the resulting split studies the Exam Accession Number and the **Series Name** are automatically set to their previously defined values.

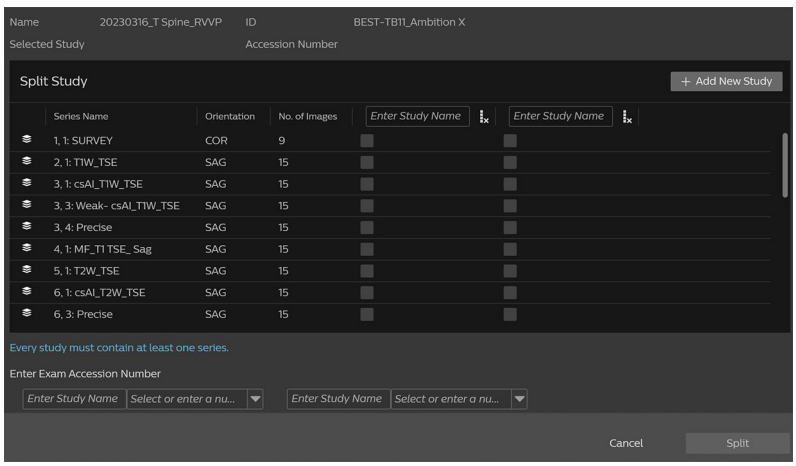
Split Exam

▷ Prerequisite:

- The examination is not in scan progress.

► In the **Patient Directory**, right-click the examination that you wish to split, and select **Split**.

The **Split Study** window opens. The **Split Study** window shows all scans of the current examination with the following information in columns: **Series Name**, **Orientation**, and **No. of Images**. The right columns allow you to enter a name for the new studies, and to select scans for these new studies.



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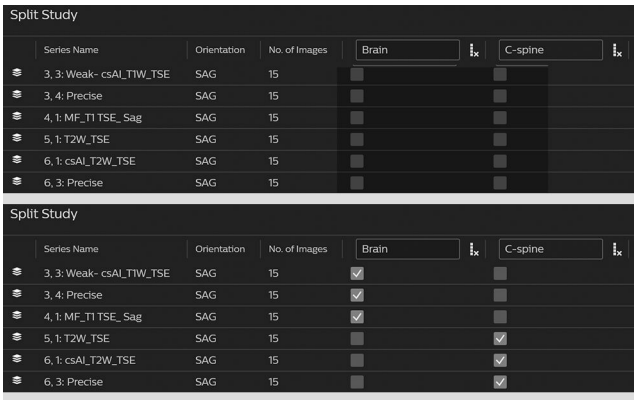
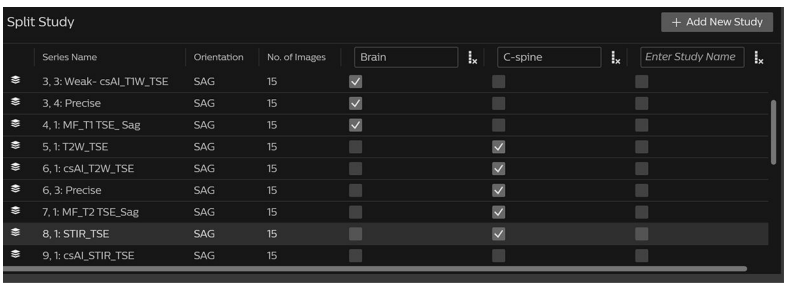
- Enter names for the new studies in the **Enter Study Name** field.
- Assign imaging series to the studies in the columns with the new study names. You can assign imaging series to none of the exams or to multiple exams.

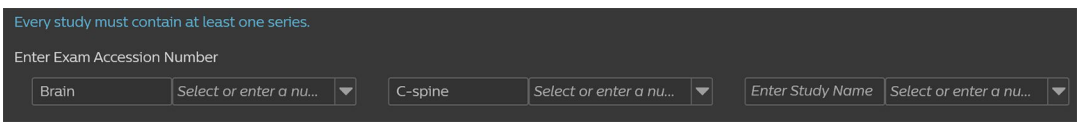
  Every study must contain at least one series.



- Optional:
  - To add another column for a third or fourth new study, click **+ Add New Study** (for example, for brain, C-spine, T-spine, and L-spine).



  - To remove a newly added column, click the button .
- Enter an Exam Accession Number for each study in the field **Enter Exam Accession Number**.



- Click **Split**.

  Cancel closes the window without splitting the examination.

  The **Patient Directory** displays the new examinations immediately.

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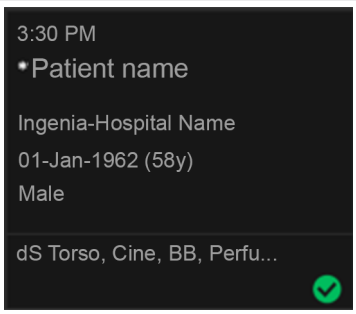
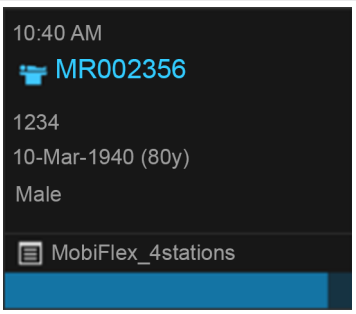
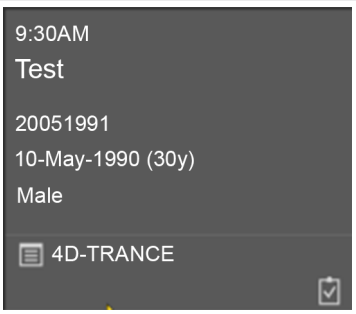
3.10.6 Patient Dashboard

Functional Description

The **Patient Dashboard (F4)** provides a quick and easy overview for the exam schedule. You can see the **Previous** patients, the **Current Patient** and the **Scheduled** patients in this order from left to right.

Each patient is represented by a patient card. The color scheme of the patient cards indicate their state on the **Patient Dashboard**.

Previous	Current Patient	Scheduled
		

On the **Patient Dashboard**, you can

- Open the examination of a patient with one click.
- Start the exam of a scheduled patient (function is available when you hover over the patient card)
- Add a new patient manually (see chapter “Entering New Patient Data Manually” on page 378).
- Refresh the patient list.
- Scroll through all entries of the dashboard.

In **Settings and Tools (F10)**, you can adjust the **Patient Dashboard** (see chapter “Adjusting the Patient Dashboard” on page 226).

Patient Cards

On the **Patient Dashboard**, each patient card displays patient data (name, ID, date of birth and age, sex) and information about patient and examination:

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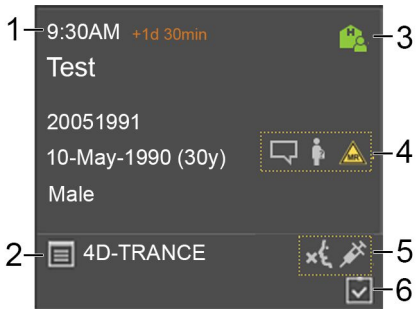

1. Scheduled time, and if applicable the delay time relative to the scheduled time
2. Current ExamCard (if assigned)
3. Patient availability
4. Safety related patient information
5. Exam information icons
6. Exam workflow icons

Patient on tabletop. If applicable, this icon appears in front of the patient name.

Patient Availability

Icon	Description
	In-patient (Patient admitted to the hospital)
	In-patient arrived
	Out-patient (OPD patient, not admitted to the hospital)
	Out-patient arrived

Safety related patient information

Icon	Description
	Pregnancy
	MR Safe implant
	MR Conditional implant
	MR Unsafe implant

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Exam information icons

Icon	Description
	Breathhold
	Contrast agent
	Contrast agent unprepared

Exam workflow icons

Icon	Description
	Prepared exam
	Enter Required Information (Unprepared exam)
	Exam **In progress**
	Patient released
	Exam discontinued
	Archiving in progress
	Archive completed
	Archive failed
	Examination Completed

Adjusting the Patient Dashboard

You can select which type of patient studies are displayed for which time frame, and you can specify the refresh rate of the **Patient Dashboard**.

- On the navigation bar, click **Settings and Tools (F10)** , then **Settings** and then select **Patient Dashboard**.

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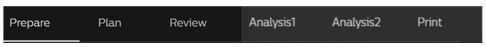
- ► Select whether to refresh the **Patient Dashboard** manually or automatically.

  If you select **Automatic refresh**, enter a starting time and an interval for refreshing the **Patient Dashboard**.
- ► Select the period from which the patients are displayed:
  - Select **Show only exams of today**.
  - If needed, also select **Additionally show exams of yesterday and tomorrow**.
- ► Select the type of examination that is displayed.
  - To show only upcoming and current exams, disable **Show completed and discontinued exams** .
  - To include these exams in the **Patient Dashboard**, enable **Show completed and discontinued exams**.
  - To show only the exams scanned on your MRI system, enable **Show only exams for this system**.
- ► Close the window to save the settings.

3.10.7 Patient Tasks Bar

Functional Description

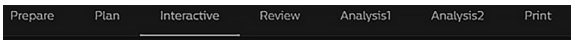
The Patient Tasks Bar guides you through the examination.



Each tab on the Patient Tasks Bar represents a task:

- **Prepare**
- **Plan**
- **Interactive**

  Only when Interactive Scanning is available and launched.

- **Review**
- **Analysis1**

  When an analysis package is open in this tab, the tab is renamed to the name of the analysis package.

- **Analysis2**

  When an analysis package is open in this tab, the tab is renamed to the name of the analysis package.
- **Print**

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- The Patient Tasks Bar displays which task is currently performed for the selected examination.
  The current task is underlined.
  When a task is already completed, it might be grayed out or not available anymore on the Patient Tasks Bar, e.g. Prepare or Plan might be inactive.
- The Patient Tasks Bar allows you to directly access a task by clicking on it.
- To support your workflow, the central part of the screen changes according to the current task and provides you with the functionality needed.

3.10.8 Exam Overview

Functional Description

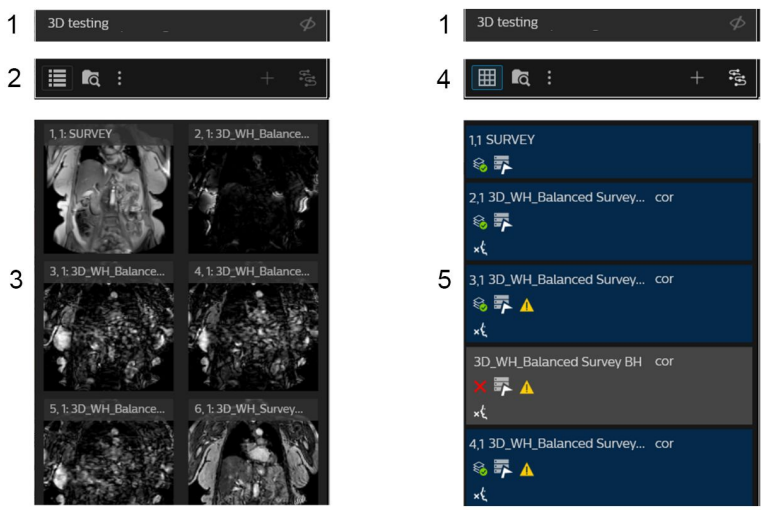
The Exam Overview is always visible, independent of the current patient task (**Prepare**, **Plan**, **Review**, **Analysis1**, **Analysis2**, **Print**), as it is essential for each examination.

- The Exam Overview gives an overview of the current examination.
- It guides you through the current examination (ExamCard).
- It gives you quick access to completed imaging series, and allows to access review and analysis packages from here in the tabs **Review**, **Analysis1** and **Analysis2**.
- It allows to switch between the **Thumbnail View** and the **List View**.

User Interface

UI Elements

The **Thumbnail View** and the **List View** provide you with buttons, drop-down menus and a context menu to control the course of an examination.



1. Header of the Exam Overview with the ExamCard name
2. Toolbar of the **Thumbnail View**
3. Example **Thumbnail View**
4. Toolbar of the **List View**
5. Example **List View**

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Buttons and other UI controls	Description
	Name of the current ExamCard
	Button to **Show Exam Overview** or **Hide Exam Overview** (Grayed out and not applicable in **Prepare** and **Plan** tab)
	Button to display **List View**
	Button to display **Thumbnail View**
	Prior Studies allows to access prior studies of the selected patient, if these priors are available in the local database.
	More Options: • **Save ExamCard** allows you to save the scan items of the current examination as ExamCard. • **Copy ExamCard** allows you to make a copy of the current ExamCard. To paste the ExamCard, use the **Paste** function from the context menu. • **Delete ExamCard** allows you to delete the current ExamCard. • **Exam Info** displays information about the current EC item in a separate window. • **Exam Setup** allows to specify generic parameters that are valid for a complete ExamCard (for all ExamCard items). Here you define patient-dependent information, for example patient positioning and heart rate, but also the network nodes to transfer the resulting imaging series to upon completion.
	Button to **Add Scans** to the current ExamCard.
	Show all postprocessing steps displays all postprocessing steps per EC item above the Exam Overview. Only available in **List View**.

Thumbnail View

The **Thumbnail View** shows one thumbnail (representative image) per imaging series of the current examination in **Review**. It provides you with a preview of all types of imaging series which includes scans, reformats and any type of series created by a post-processing step.

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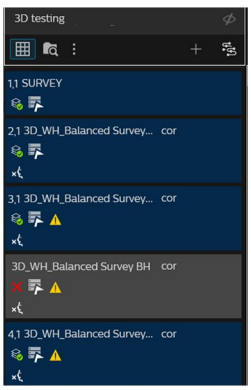
Each thumbnail shows the scan number and the scan name. When you hover of the thumbnail, more information is displayed.

From the **Thumbnail View**,

- You drag images into the viewports of the **Plan**, **Review**, **Analysis1** and **Print** tab.
- You open **Review** and **Analysis1** packages for the selected imaging series.
- You export the selected imaging series to a network node.
- You add the selected imaging series to the **Print** Preview.

List View

The **List View** shows the items of the current ExamCard and their status.



In the **List View**, you control the course of the current examination:

- You add new EC items for scanning.
- You change the order of the EC items.
- You add a pause before the selected EC item.
- You add a contrast agent injection for the selected EC item.
- You change the laterality of the selected EC item.
- You add GeoLinks and you select Geonames.
- You propagate the coverage from one EC item to the others.

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- You repeat prescans.

Icons in List View

Status of EC items during planning

Icon	Tooltip	Explanation
	New	The scan item is new and needs planning.
	Invalid	The scan item is invalid and cannot be executed (e.g. because it originates from an older release).
	Unplanned	The scan item needs planning. Except for the survey, all scans are in an unplanned state when the exam is started.
	In conflict	The scan item contains a parameter in conflict.
	Being modified	The scan item is being modified (in planning).
	Conflict (being modified)	The scan item containing a parameter conflict is being modified.
	Await update	The scan item awaits update, when • it shares the same geometry with the scan item which is currently modified. • it waits for an outstanding shim request and shim values. • it waits for sufficient reconstruction resources.
	Conflict (await update)	The scan item containing a parameter conflict awaits update.
	Ready to run	The item is ready to run as it is fully planned.
	Repeat Prescans	**Repeat Prescans** is enabled for the current scan item.

Archiving

Icon	Tooltip	Explanation
	Marked for archive	The item will be archived upon completion.
	Archive completed	The item is completely archived.

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Icon	Tooltip	Explanation
	Archive error	Archiving failed.
	Archive in progress	Archiving of the current item is in progress.

Safety and Tabletop

Icon	Tooltip	Explanation
	Safety warning	When a scan item has high SAR, high SED or high PNS, the tooltip of this Safety icon gives information about SAR, SED and PNS.
	Table movement normal	Table moves before scanning or in between stacks within the scan.
	Table movement active The tooltip gives information about tabletop movement, e.g. **12.6mm in** or **Multiple Positions**.	While the table is moving, it is indicated in yellow warning color.

Geometry: Links, Names and Propagation

Icon	Tooltip	Explanation
• • •	**A**, **B**, **C**	**GeoLink**: The selected GeoLink is indicated. You assign a **GeoLink** to a scan item in the context menu of the **List View**.
Drop-down of all geonames	Example: cervical, thoracic, lumbar	**Geoname** The selected Geoname is indicated. You assign a **Geoname** to a scan item in the context menu of the **List View**.
• • •	**Both Left & Right** **Right** **Left**	**Laterality** The selected Laterality is indicated as B, R or L. If nothing is displayed, the laterality is set to **Unpaired**. You assign the laterality to an examination in the **Exam Setup**. You assign the laterality to a scan item in the context menu of the **List View**.

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Icon	Tooltip	Explanation
•	• **Volume + Slice Geometry**	**Propagation** Geometry: The selected type of geometry propagation is indicated. • If propagation is not enabled (**No Propagation**), then nothing is displayed. • For **Volume + Slice Geometry**, the size and slices parameters are being propagated to other scan with same geoname. You enable **Propagation** in the context menu of the **List View**.

Contrast agent injection, pause, manual start and breathhold

Icon	Tooltip	Explanation
	Scan pauses to inject x ml of <contrast agent name>.	Patient requires contrast and contrast is prepared. You enable contrast agent injection in the context menu of the **List View**.
	Click to specify mandatory information	Patient requires contrast, and contrast is not prepared. Enter the required information in the **Contrast Injection Parameters** window which opens automatically, when you enable **Contrast**.
	Pause before scan	Scan pauses after the completion of previous scan when **Auto Continue** is enabled. You enable the pause in the context menu of the **List View**.
	Breathhold	The scan item requires one or more breathholds. You enable breathholds in the **Advanced Parameters**.
	Manual start	Scan pauses after the preparation phases before the actual image acquisition. You enable **Manual start** in the **Advanced Parameters**.

SmartExam

Icon	Tooltip	Explanation
	Smart learned	Geometry is smart and learned.
	Smart learned disabled	Geometry is smart and learned, but Smart is disabled as system option, or the smart survey is missing.
	Smart learned locked	Geometry is smart, learned and locked for further learning.
	Smart learning	Geometry is smart and still learning (not validated).

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Icon	Tooltip	Explanation
	Smart learning disabled	Geometry is smart and still learning, but Smart is disabled, or the smart survey is missing.
	Smart learning locked	Geometry is smart, still learning, but locked for further learning.
	Spine smart learned	Geometry is smart spine and learned.
	Spine smart learned locked	Geometry is smart spine, learned, but locked for further learning.
	Spine smart learning	Geometry is smart spine and still learning (not validated).
	Spine smart learning locked	Geometry is smart spine and still learning but locked for further learning.
	Smart name conflict	Geometry is smart, but given a name that already exists for a non-smart geometry.
	Smart name unknown	Smart geometry name is unknown.
	Smart planning	The smart geometry is applied: the smart survey is analyzed and the smart geometries are planned.
	Smart spine planning	The smart spine geometry is applied: the smart spine survey is analyzed and the smart geometries are planned.

Scan progress

Icon	Tooltip	Explanation
	Prescan	Waiting for prescan to start.
	Scan in progress	Acquisition of the scan item is ongoing.
	Recon in progress	Acquisition is complete, reconstruction is in progress.
	Awaiting recon	The item awaits resources and is started as soon as sufficient resources are available.
	Completed	Acquisition is complete, reconstruction is complete.
	Aborted	Scan is aborted.
	Postprocessing	Scan has postprocessing steps attached.

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Icon	Tooltip	Explanation
	Postprocessing in progress	New series are being generated. The progress is shown using a horizontal progress bar in %. This bar is placed at the bottom end of the processing icon.
	Postprocessing in conflict	Postprocessing parameters are in conflict.
	Postprocessing aborted	Postprocessing failed or was cancelled by the operator.
	Postprocessing completed	All postprocessing steps are executed.

Context menus in Exam Overview

The context menu provides different functions depending on the status of the EC items (or already completed imaging series) in the **Thumbnail View** or **List View**.

Functions available for completed EC items (imaging series)

Function	Description	More information
Export	Allows you to export the selected imaging series.	See Administration
Add To Print	Allows you to add the selected imaging series to the Print procedure.	See Printing
Copy Ctrl+C	Allows you to copy the selected imaging series, or the scan item, or the postprocessing step.	
Split Series	Allows you to split series according to their image attributes (for example, dynamics, phases, image type) Allows you to split multistack series into separate single-stack series. Split Series opens in one of the Analysis tabs.	See Analyzing Images

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Function	Description	More information
2D **3D** **Slab** **OrthoView** **MobiView** **PicturePlus**	Allows you to open the selected imaging series in a Review package.	See Reviewing
T1Perfusion **Permeability** **NeuroPerfusion** **Diffusion** **DiffusionRegistration** **Image Registration** **FiberTrak** (As part of the Diffusion analysis package) **IViewBOLD** **QFlow** **MR Subtraction** **Echo Accumulation** **ADA** (Advanced Diffusion Analysis) **Cartilage Assessment** (Advanced Diffusion Analysis)	Allows you to open the selected imaging series in an Analysis package.	See Analysis

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Function	Description	More information
Interactive	Allows you to launch the **Interactive** package.	
Reconstruction	Allows you to add a delayed reconstruction postprocessing step to the scan item. You start the delayed reconstruction with Manual start in this postprocessing step.	
Convert to SmartExam...	Allows you to convert the scan geometry to a SmartGeometry. This function opens the **SmartGeometries** Editor.	
Save Protocol to Text File..	Allows you to save the protocol with its parameter settings in a text file.	

Functions available for EC items during planning

Function	Description	More information
Repeat Prescans	**Repeat Prescans** allows to repeat previously performed prescans for the current ExamCard, and to save them to the ExamCard. Prescans are automatically performed in the course of an examination. However, in some cases it might be useful to repeat the prescans, e.g. the automatically performed B1 calibration.	
Mark for archive	Allows you to mark the selected EC item for archive so that it is automatically archived once completed.	See Administration
Transfer sequence		See Administration
Convert to SmartExam...	Allows you to convert the scan geometry to a SmartGeometry. This function opens the **SmartGeometries** Editor.	See SmartExam

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Function	Description	More information
Copy **Cut** **Paste** **Delete**	Allows you to copy, cut, paste, or delete scan items or postprocessing steps. Allows you to paste a previously copied ExamCard.	See Changing Scan Items during Scanning
GeoLink	Allows you to link scans with different geometry parameters to each other.	See Assigning GeoLink
Geoname	Allows you to assign a scan geometry to a scan item. The scan geometry is saved under the geoname. Allows you to delete obsolete geonames. To delete the geoname, right-click. Then select .	See Assigning a scan geometry to a scan item
Laterality		See Listed ExamCard properties
Pause before scan		See Inserting a pause prior to a scan item
Contrast		See Registering contrast injection
Save Protocol to Text File..	Allows you to save the protocol with its parameter settings in a text file.	
Reconstruction	Allows you to add a delayed reconstruction postprocessing step to the scan item. You start the delayed reconstruction with Manual start in this postprocessing step.	

3.10.9 Exam Dashboard

Functional Description

The Exam Dashboard gives access to information and functionality which is needed during scanning.

The Exam Dashboard is a vertically aligned dashboard located on the side of the screen.

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1. Header with patient name and Toggle Button:
   - **Maximize current examination (F9)** opens the examination in the **Plan** tab.
   - **Minimize current examination (F9)** closes the **Plan** tab and returns to the previous display.
2. **AutoView (F7)**
3. Information about patient safety and patient comfort
4. Physiology display
5. Exam and scan progress
6. Scan controls

User Interface

AutoView

The **AutoView (F7)** shows the latest reconstructed image of the scan currently in progress.

AutoView allows you to:

- Refresh the display and display the **Live** scan status.
- Navigate through imaging series of the current examination in maximized view.
- Modify the position and the size of the **AutoView** window:
  - Maximize (and minimize) **AutoView**.
  - **Dock** the **AutoView** window in the lower right viewport.
  - Set the window to **Float** , and move to any location on the screen.

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The image information (displayed in **AutoView**) is different in minimized and maximized view.

	Minimized view	Maximized view
Information displayed along with the images	Information of the completed scan: • Series number. • Reconstruction number. • Scan name.	Information of the completed scan: • Patient name. • Image information as provided in the Review environment. • Series number. • Reconstruction number. • Scan name.

Patient Safety and Comfort

This section of the Exam Dashboard displays safety-related information of the current scan, and the status of **AutoVoice** and of the **Ventilation** (airflow) in the bore.

It also allows to:

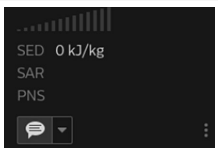
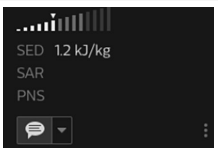
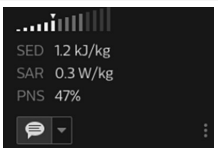
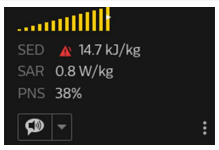
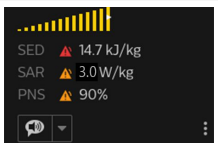
- Enable (or disable) and adjust **AutoVoice** for the current examination: ,
  - Select the **AutoVoice** language.
  - Set **AutoVoice** to **Manual** or **Automatic**.
- Adjust the **Ventilation** settings.

Safety-related Information

The **SAR** and **PNS** values are displayed for each scan in progress. The **SED** value increases over time with the acquisition of each scan. The bar indicates the **SED** status:

- The bar shows the scheduled SED in light grey and the delivered SED in dark grey.
- Once the delivered SED exceeds 3.5 kJ/kg the color changes to yellow.
- White color (with a downward arrow) shows the current **SED**.

If **SED**, **SAR** or **PNS** exceed the upper limit, a warning icon is displayed besides the value.

				
• **SED**, **SAR** and **PNS** with no data	• Regular **SED**	• Regular **SED** (medium), **SAR** and **PNS**	• **SED** exceeded	• **SED**, **SAR** and **PNS** exceeded

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More Information in the tooltips

When you hover over the parameter **SAR**, the tooltip displays the **Whole Body SAR**.
When you hover over the parameter **SED**, the tooltip displays detailed information about **SED**:

Patient Specific Energy Dose (SED)

- **Delivered**(kJ/kg)
- **Scheduled** (kJ/kg)
- **Total** (kJ/kg)

For more information about **SAR** and **SED**, see chapter “Safety” on page 27.

Status of the Ventilation in the bore

- Ventilation is on or above the recommended ventilation level.
- Ventilation is below the recommended ventilation level.
- Ventilation is off.

When you hover over the icon, the current ventilation level is displayed, e.g. **Ventilation Level 3**

Status of AutoVoice

- **AutoVoice** is enabled.
- **AutoVoice** is disabled.

When you hover over the icon, the **AutoVoice** status and selected language are displayed, e.g. **AutoVoice English (US)**

Physiology Display

The **Physiology Display** is available on the Exam Dashboard. It allows you to

- View physiology signals, and select their source.
- Adjust the display of the physiology signals.
- Adjust the heart rate.
- Manage Breathhold scanning and Breathhold instructions (related to **AutoVoice** sets if **AutoVoice** is set to **Manual**).
- Open the **Physiology Properties** window where you can access more functionality. For more information, see chapter “Physiology Properties” on page 244.

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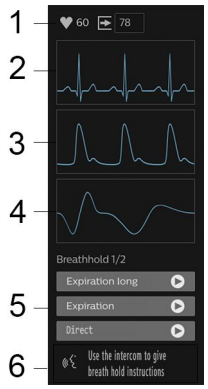
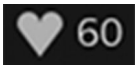
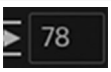


Number	Item	Explanation
1	 **Heart rate**	• Displays the patient heart rate in beats per minute. • Allows to start **Manual Calibration** from here.
	Update heart rate in **Exam Setup**	• Copies the current heart rate to the **Exam Setup** of the current ExamCard.
	 **Enter heart rate manually**	• Displays the heart rate as entered in the **Exam Setup**. You can edit this text field and enter a heart rate value, if the current heart rate differs too much from the entered heart rate.
2	(Reserved for) **VCG** signal or **External**	• Displays the physiology signals. • Allows to select another physiology signal. • Displays icons that indicate the battery level, the connectivity of the wireless battery module, the status of VCG calibration, and the status of a Manual Breathhold. If no physiology sensors are connected, these slots are empty and the following message is displayed: **Sensor(s) not detected or wrong network selected**
3	(Reserved for) **PPU** signal or **External**	
4	(Reserved for) respiratory signal • **Respiratory Belt** • **VitalEye** (if available) • **External**	
5	Only available when **AutoVoice** is set to **Manual**.	Select any **AutoVoice** set for your manual breathhold scanning. • **Expiration-long**: Breathe in... Breathe out... Breathe in... Breathe out... Hold your breath • **Expiration**: Breathe in... Breathe out... Hold your breath • **Direct**: Hold your breath

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Number	Item	Explanation
6	**Use the intercom to give breath hold instructions**	Displays the advice to use the intercom for breath hold instructions.

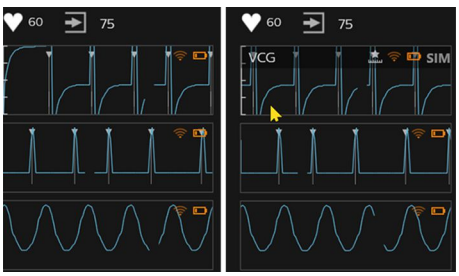
Context menu

The context menu allows you to select the physiology signals for display. It also provides you with more functionality:

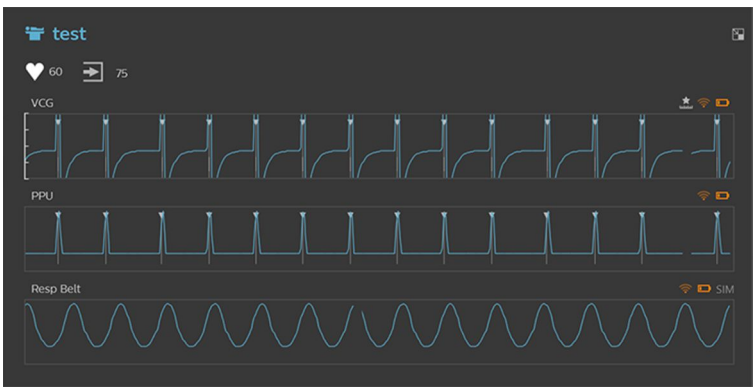
Item	Explanation
Time range	Allows you to set the time range to 1, 2, 5, 10, 15 or 25 seconds.
Physiology properties	Allows you to access the **Physiology Properties** window

Physiology Signals with Status Information

In the Physiology Display, icons indicate the battery level, the connectivity of the wireless battery module, the status of VCG calibration, and the status of a Manual Breathhold.



When you click the Physiology Display, the Extended Physiology Display opens. It displays the same icons in a larger window. You can reposition or resize the Extended Physiology Display when you drag the header or the borders.



Icon	Explanation
	WiFi signal: more than 33%
	WiFi signal: 33% and less

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Icon	Explanation
	Battery state: more than 50%
	Battery state: 50% - 26%
	Battery state: less than 26%
	VCG: Auto Calibration
	VCG: Manual Calibration
	In bore manual VCG Calibration
	Out bore manual VCG Calibration
	Table docked manual VCG Calibration
	Manual Breathhold: Playing
	Manual Breathhold: Stop
	Manual Breathhold: Talk

Physiology Properties

Physiology Properties allow you to

- Check the status of wireless communication (not applicable for Wired Physiology).
- Select the VCG calibration method (automatic or manual), and start the VCG calibration if set to manual.
- View the battery status of the currently used VCG or PPU module (which is only indicated if low).
- View the status of the wireless communication (which is only indicated if low) (not applicable for Wired Physiology).
- View and adjust the signal strength of the VCG signals.

Display Options

Item	Explanation
View Gridlines	To enable or disable the display of gridlines with the physiology signals.

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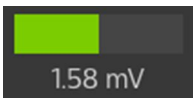
Item	Explanation
Scale	To select the scale of the signal: With **AutoScale**, the scale is automatically adapted to the maximum detected signal in the displayed time span (after a complete sweep of the signal). With **VCG 0.5mV VCG 1mV VCG 2mV VCG 5mV VCG 10mV**, a fixed scale is used. These settings are only available for VCG: • Signals higher than the maximum value are skipped. • The mV values represent the full peak-peak dynamic range. • The mV-indicator in the Physiology Display is modified according to the selected scale.

VCG Calibration

Item	Explanation
Manual Calibration	To enable or disable Manual VCG calibration. With manual calibration, you can retrieve calibration results and select the trigger threshold for VCG R-peak detection.
Start Calibration	To start manual calibration.
Outside bore 	To inspect the results of manual calibration: Signal **Strength** Displayed immediately after manual calibration as color scale and expressed in mV. 
Inside bore 	To inspect the results of manual calibration: Trigger **Quality** Displayed immediately after manual calibration as color scale.
Trigger threshold	To change the trigger threshold. Possible values: **Low**, **Medium**, **High** **Only applicable for VCG:** Allows you to adjust the sensitivity for the detection of R-peaks.

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Color scale	Description	Signal strength	Trigger quality (Percentage of false signals)
	Excellent results. Proceed.	>2.0 mV	<5%
	Very good results. Proceed.	1.5 mV - 2.0 mV	between 5% and10%
	Good results. Proceed.	1.0 mV - 1.5 mV	between 10% and 15%
	Sub-optimal results. Corrective actions recommended.	0.6 mV - 1.0 mV	between 15% and 20%
	Bad results. Corrective actions strongly recommended.	<0.6 mV	>20%

NOTICE

When you change any setting of VCG calibration, this change has immediate effect on the R-peak detection.

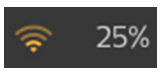
This is valid for: manual or continuous VCG calibration, inside or outside bore VCG calibration and change of the trigger threshold.

Battery Level

Icon	Explanation
	Indicates the battery level of the **VCG** and **PPU/Resp** module. • Green: Fully charged, or sufficiently charged for operation. • Orange: Needs to be charged. The **VCG** or **PPU/Resp** signal may deteriorate.

Communication Strength

Only applicable for Wireless Physiology, and not for Wired Physiology.

Icon	Explanation
	Indicates the strength of the wireless communication signal. • Green: Sufficient signal. • Orange: Insufficient signal. The **VCG** or **PPU/Resp** signal may deteriorate.

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Wireless Connection

For Wireless Physiology, you need to select the wireless network. .

Icon	Explanation
Expression MR200	**Network Selection** To select the wireless network for your type of **VCG** and **PPU/Resp** module.
Expression MR400	

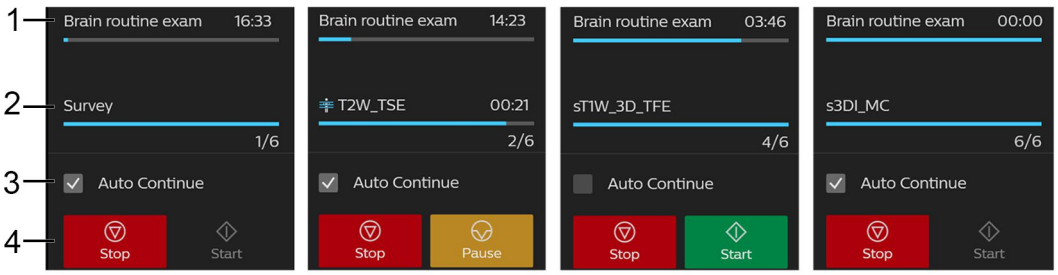
Help opens the Help about this window.

NIBP (non-invasive blood pressure) allows you to view the results of the non-invasive blood pressure measurement

Close closes this window.

Exam Progress and Scan Controls

On the Exam Dashboard, you see the progress of the current examination, and you start, stop, pause and resume the examination.



Number	Item	Description
1	Information about current ExamCard	Once the ExamCard is selected, this ExamCard information is displayed are: • Name of ExamCard • Remaining examination duration

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Number	Item	Description
2	Information about current scan protocol	Once the ExamCard is started, this scan protocol information is displayed here: • Name of scan protocol • Remaining scan duration • Number of scan protocol in ExamCard as <current number/total number of all scans in ExamCard>
3	**Auto Continue** button	When **Auto Continue** is enabled, all scan protocols proceed automatically one after the other. When **Auto Continue** is disabled, each scan protocol needs to be started manually.
4	**Start**, **Stop**, **Pause**, **Resume** buttons	The **Stop** button is always available. Depending on the scan status, **Start**, **Pause** or **Resume** are available. • **Start** is available when the next scan of an ExamCard is planned and ready to run. • **Pause** is available when a scan is running. • **Resume** is only available for previously paused scans.

Routine Procedures

VCG calibration

In all scans that make use of VCG, VCG calibration is required to ensure correct triggering.

VCG calibration analyzes the detected ECG-signal to determine the R-peak in the QRS-complex: A trigger algorithm determines which peak in the detected ECG-signal is marked as R-peak. A trigger marker is assigned to the signal (and displayed in the **Physiology Display**) if all criteria of the trigger algorithm are met.

Factors affecting the VCG calibration

When the VCG calibration is disturbed, it can happen that trigger markers are assigned to the incorrect signal or are not assigned at all.

VCG calibration results are affected by the same factors as the VCG itself. For more information, see chapter “Factors affecting the VCG signal” on page 202.

Methods of VCG calibration

VCG calibration can be performed in two ways:

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1. It is recommended to use manual VCG calibration for problem-free cardiac triggering in all patients.
   For more results, see chapter “Manual VCG calibration” on page 205.

2. Continuous VCG calibration is easy to use. It is the default VCG calibration method.
   For more information, see chapter “Continuous VCG calibration” on page 204.

3.10.10 ExamCards

Functional Description

ExamCards are essential for successful MR examinations.

What are the main features of ExamCards?

- An ExamCard (EC) is the electronic version of a clinical MRI examination procedure. It has to be defined once and can then be reused for other patients with similar examinations to simplify the daily routine.
- An ExamCard consists of ExamCard items:
  - Scan protocols (for example survey, T1- and T2-weighted scans in different orientations).
  - SmartLine processing steps
    which are postprocessing presets that are automatically performed as part of an ExamCard.
    For more information, see SmartLine Processing.
- An ExamCard contains
  - Geometry reuse:
    Scan protocols within an ExamCard can share the same geometry settings.
    If you plan one scan protocol with a specific geometry, all scan protocols with the same geometry are planned automatically.
    Geometries are mapped by name.
  - Information about the ExamCard and the scan protocols:
    A short description is available with an example image.
  - ExamCard Properties:
    ExamCard Properties are parameters that are valid for the complete examination, such as **Patient position** (for example: supine or prone).
    For more informatiation, see chapter “Functional Description of the Exam Setup” on page 396.
- ExamCards are organized in ExamCard databases.
- You can create your own ExamCards according to your specific needs.
- You can search through ExamCards and scan items by name.

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Organization of ExamCards

ExamCard Databases

You find examples of ExamCards and scan protocols in the ExamCard databases (EC databases), and you can store your own ExamCards here.

An EC database can be locked or unlocked:

- Locked EC databases cannot be changed, deleted, or overwritten.
- A lock is indicated by the **Lock** icon besides the EC database name.

EC database	Database contents	Properties of the EC database
Philips	Philips ExamCards and scan protocols	• ExamCards and scan protocols in this database can only be used for scanning. • The **Philips** EC database is always locked and cannot be changed or overwritten. • Some ExamCards are delivered as an example and as starting point for the creation of your own ExamCards. You find them in the **Philips** EC database in the folder **ExampleCards**.
Hospital	Hospital ExamCards and scan protocols	• ExamCards and scan protocols in this database can be used for scanning. They can be changed, deleted, and overwritten. • You can lock the **Hospital** EC database using password protection. For more information, see password protection.
Other	Reserved for *Import and Export* of ExamCards and scan protocols	• ExamCards and scan protocols can always be stored in this database. • You cannot lock the **Other** EC database.

Password Protection of the EC Hospital database

To ensure consistency and to protect the quality of the ExamCards, only authorized operators can modify the contents of the **Hospital** database.

NOTICE

The default password is: Philips

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With Central Protocol Management (CPM) being used in your institution, your Hospital ExamCard database is locked and you cannot edit it.
For more information about CPM, see chapter "Central Protocol Management (CPM)" on page 251 and the Instructions for Use of CPM.

Automatic storage and retrieval of ExamCards

ExamCards are saved to and retrieved from the patient database with the examination.

- Saving an examination will also save the corresponding ExamCard
  - when saving into any patient database;
  - when exporting to devices.
- Retrieving an examination will also retrieve an ExamCard
  - when retrieving from any patient database;
  - when importing from devices.

NOTICE

ExamCards are not retrieved from datasets acquired with previous software releases.

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Automatic ExamCard backup

- A backup of ExamCards is automatically generated and preserved for 3 hours. This can be especially helpful after crashes.
  - Simply reselect the examination and the ExamCard will be restored including planned geometry.
  - Double-click on the ExamCard to confirm.

Central Protocol Management (CPM)

Central Protocol Management (CPM) is a software cloud solution which is part of PerformanceBridge and which you enter via the **PerformanceBridge portal**. CPM is to support the MRI operator in the standardization of MRI ExamCards that are used on connected MRI systems of the same field strength, system type, gradient, and software level.

CPM aims at improving workflow efficiency and standardization of ExamCards:

- It provides a central repository for all *Hospital ExamCards* for all connected MRI systems.
- It enables editing of ExamCards in the central repository (with validity check).
- It makes central ExamCards available for the use on local MRI systems.

The CPM service solution is compatible with Philips MRI systems on software release 5.4 and higher.

For more information, see Instructions for Use of CPM.

How does CPM affect your work?

With CPM,

- the *Hospital ExamCard (EC) database* is locked for any ExamCard editing on your local MRI system.
  - You cannot unlock the *Hospital EC database*.
  - Authorized operators edit *Hospital ExamCards* only centrally, but not on the local MRI systems.
- the *Other EC database* is not locked.
  - To edit local ExamCards on your MRI system, save the ExamCard to the *Other EC database*.
  - Distribute the validated ExamCard to connected MRI systems via CPM.

ExamCards Restart (EC Restart)

ExamCards are automatically restarted when a failure in the ExamCards application occurs. This prevents the need of restarting the complete application software and consequently saves time.

What are the main properties of ExamCards restart?

- During EC restart, the system's functionality is restricted.
  - Planning and scanning cannot be performed

    If an ExamCard is running, it aborts.
  - In the planning viewports the planning geometry (lines) is cleared.
  - Reviewing and analyzing of images is still possible.

    However it is not possible to generate new imaging series.
- After restart, the ExamCards application is functional again.

  ExamCards are restored to the last saved state.
  - The aborted ExamCard is populated and available after EC restart.
  - The ExamCard items retain their state (completed, aborted, not started yet).
  - The previous planning and reviewing sessions are restored.
    Any parameter modifications made to non-executed scans during that examination may be lost.
  - The ExamCard items show the previously opened analysis and review packages as inline steps (stippled).

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  - A previously completed QuickSurvey is retained. It is not necessary to acquire a new QuickSurvey.
  - When you were editing an ExamCard independently of a patient examination (in Prep mode without entering patient data), after EC restart this ExamCard is not restored for editing.
- You are notified about the EC restart and about its progress.

How are you notified about the ExamCards restart?

- By a message in a pop-up window.

  The message is cleared once the process is restored.
- By an icon on the system tray of the main menu bar.

  The icon is cleared once the process is restored.
- The progress of restart is also indicated on the system tray.

What is not restored by ExamCards restart?

Anything that is not restored by EC restart, has to be redone:

- You have to plan the non-executed scans to make them ReadyToRun.

  You can still use the already performed survey for planning.
- To continue with Smart Planning, you have to redo the SmartSurvey.
- Since any parameter modifications made to non-executed scans may be lost, you have to check and probably modify these parameters again.

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3.10.11 SmartExam

This section describes the main features of SmartExam, and also covers SmartExam Spine and SmartExam Breast.

Functional Description

SmartExam is a tool that automates planning, scanning and processing in brain, knee, shoulder, breast, cervical and lumbar spine examinations. Automatic planning and scanning is realized by SmartPlan, automatic processing by SmartLine Processing.

Prerequisites for SmartExam

There are several prerequisites for SmartExam in an ExamCard.

SmartSurvey

- The Smart ExamCard has to start with a SmartSurvey. The SmartSurvey is a dedicated 3D survey scan covering the anatomic region completely.

  You cannot change the parameters of the SmartSurvey.

SmartGeometries

- In a Smart ExamCard, only SmartGeometries can be planned automatically.
- Existing 'normal' geometries need to be
  - replaced with existing SmartGeometries
  - converted into SmartGeometries.

NOTICE

SmartGeometries can be locked to protect them against being overwritten.

For more information, see Lock and unlock Smart geometries.

Refer to the Coils chapter to find out which coils can be used and are supported for SmartExam.

SmartPlan

SmartPlan is available for head, knee, shoulder, breast, cervical and lumbar spine examinations. It is a tool that helps in automatically planning scans with respect to the geometry parameters **offcenter** and **angulation**.

SmartPlan makes use of an algorithm that automatically detects some typical anatomic structures in a Smart survey, e.g. corpus callosum for brain examinations, but also symmetry aspects are taken into account. These typical structures are recognized, stored and used as a reference for further automatic planning.

SmartGeometry Database

SmartPlan makes use of a SmartGeometry database. In this database, anatomy-specific SmartGeometries are stored. These SmartGeometries are predefined with the most common way of planning and allow for the immediate use of SmartExam. If another way of planning is preferred, user-specified Smart geometries can be created:

In the Philips geometry database, all angulations are set to zero for shoulder, breast, cervical and lumbar spine. This is also referred to as 'Snap-to-table'.

NOTICE

If you mirror or flip the source images, SmartPlan cannot analyze the images properly.

In this case, SmartLine processing steps (such as calculation of Maximum Intensity Projections or Multiple Planar Reformats are not performed.

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SmartLine Processing

SmartLine Processing performs intelligent background processing of multiple image datasets in parallel with image acquisition which saves time.

SmartLine Processing applies for the following **Review** render modes:

- **Slab** and **3D**
- **OrthoView**
- **MobiView**
- **PicturePlus**

Once a new imaging series is created with a **Review** package,

- a new imaging series is created,
- a postprocessing item is added to the ExamCard.

  The performed operation is part of the current ExamCard and in such a way automatically performed whenever the ExamCard is executed again.

NOTICE

- The maximum number of SmartLine processing steps is 6.

Smart MPR

If a 3D scan is planned using SmartExam, angulations are stored relative to the volume in the Smart MPR.

This means that every MPR will have the same orientation if this ExamCard is stored with the SmartLine MPR, .

Troubleshooting after a software upgrade

When SmartLine processing steps do not work anymore after the installation of a new software release, delete these SmartLine processing steps, re-create them manually and save them with the ExamCard.

SmartExam Spine

A SmartExam Spine examination requires additional features to cope with variations in planning procedures compared to head, knee and shoulder examinations.

Every spine examination is unique. It is not always known beforehand at which disc level the transverse scans need to be positioned. SmartExam Spine comes with a unique graphical user interface. A schematic drawing of the spine allows easy definition of the precise levels for each stack.

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Often a high resolution scan is necessary to determine the precise locations at which the transverse stacks must be planned. A Philips-unique snapping mechanism is implemented: dragging a stack in the graphical PlanScan user interface from one disc level to another results in the stack snapping precisely to the new disc level. This snapping occurs according to the user preferred planning as learned during the training phase.

If necessary, all stacks can be freely manipulated to tweak and train SmartExam planning better. The graphical PlanScan user interface automatically differentiates between manual fine tuning of individual stacks and dropping stacks at different levels.

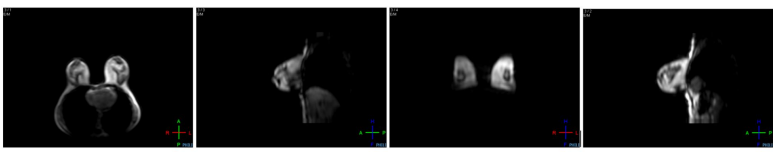
NOTICE

Severe pathology or metal might cause SmartExam Spine to fail.

SmartExam Breast

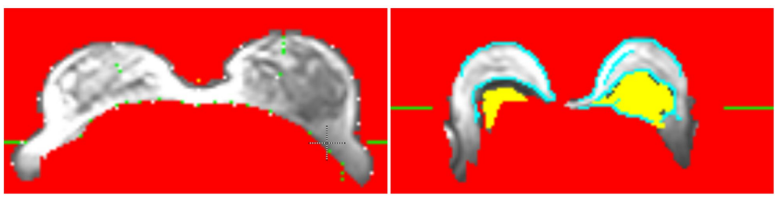
Different to other anatomies, Image Based (IB) Shimming is automatically performed as part of SmartExam Breast, based on the **SmartBreast shimming** algorithm.

SmartBreast shimming requires that a SmartBreast survey is performed. The SmartBreast survey is designed to acquire the entire volume of tissue placed in the breast coil. It is important to position the patient so that they are in the center of the chosen coil. As with other Smart Surveys, first 3D images are acquired, then orthogonal reconstructions (including both left and right breasts) are created and automatically updated in the view ports upon completion of the SmartExam analysis.



Smart Surveys with the orthogonal reconstructions.

To provide optimal shimming for the tissue of interest, **SmartBreast shimming** uses the 3D volume acquired during the SmartBreast Survey: an automatic segmentation is performed that excludes the lungs, heart, arms and silicone if present.



Segmentation of the breasts to exclude lungs, heart, arms and silicone.

Shimming is performed on the remaining breast and axillae, leading to a uniform flip angle in the areas of interest and uniform fat suppression. Optimal shimming is obtained by calculating a B0 map before shimming and making adjustments to the shim in order to optimize the B0 in the segmented area.

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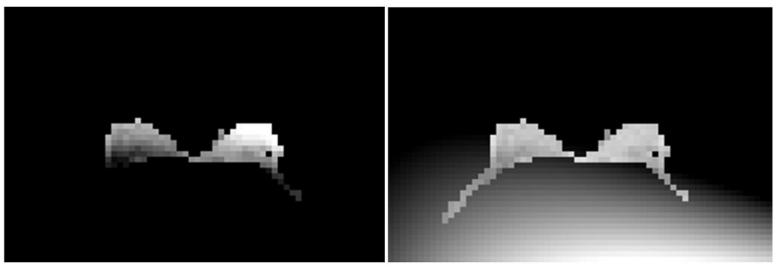


B0 maps.

Once calculations are completed they are available to the system to be applied to any sequence in which **SmartBreast shimming** is the enabled shim parameter.

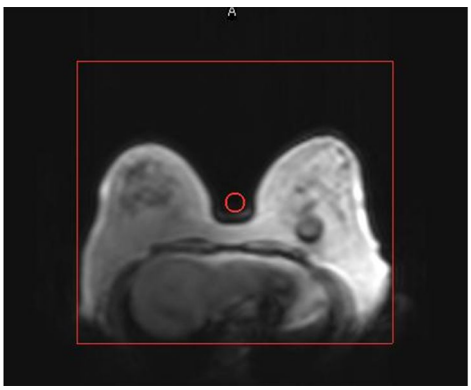
NOTICE

To utilize the segmentation algorithm for the SPIR and SPAIR sequences, enable SmartBreast shimming by the 'Shimming' parameter on the 'Contrast' tab.

A shim box is not visualized, and the values calculated by SmartBreast shimming are used.

A system with SmartBreast enabled is delivered with trained Smart Geometries. The SmartBreast geometries are trained at 0 angle, covering the breasts:

- Cor_PH –centered right to left
- Sag_PH – centered foot to head according to the breast tissue
- Tra_PH – centered to just anterior to the subcutaneous adipose tissue and chest wall, midway right and left between the breasts.



Planning example.

If the provided Smart Geometries do not meet the user's individual needs, site specific geometries can be trained. For more information, refer to the section SmartExam: Workflow ‘Set up a Smart ExamCard’.

Related parameters

- Shim (values relevant for SmartExam Breast: IB-Volume, SmartBreast)
- RF Shim (values relevant for SmartExam Breast: IB-Volume, SmartBreast)
- Interactive F0

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3.10.12 Settings and Tools

Contrast Preset Settings

Functional Description

Presets for contrast administration store contrast-agent specific attributes. Use these presets to avoid repetitive typing when you enter mandatory contrast agent information.

The **Contrast Preset Settings** are available in the **Settings and Tools (F10)** on the Navigation Bar.

You can add new presets and you can modify, delete and share them among MRI systems. The presets are password-protected.

Each contrast preset contains the following information.

Contrast-agent specific attributes stored in presets	Possible values
Commercial name (of contrast agent)	Free text uniquely identifying the preset such as • Magnevist
Ingredient	Drop-down menu, for example with • **Air** • **Barium** • **Gadolinium** (which is the default setting) • **Iron** • **Oxygen** • **Xenon**
Agent	Drop-down menu, for example with • **Gadodiamide** • **Gadolinium** • **Metrizamide** • **Oxygen** • **Radiopaque medium** • **Sodium diatrizoate**
Route	Drop-down menu, for example with • **intravenous** (which is the default setting) • **intra-arterial** • **intramuscular** • **subcutaneous** • **intracutaneous** • **intraperitoneal**

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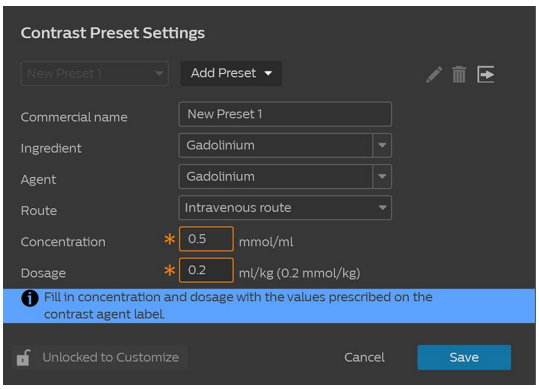
Contrast-agent specific attributes stored in presets	Possible values
Concentration	numerical value in **mmol/ml**
Dosage	numerical value in **ml/kg** and **mmol/kg**

Guidance

Carefully read the contrast agent label and look up the maximum dosage prescribed. The **Contrast Preset Settings** window guides you with the message:



Fill in concentration and dosage with the values prescribed on the contrast agent label.

Routine Procedures

Adding a New Contrast Preset

The goal of this workflow is to add a new contrast preset for the registration of contrast agent injection.

- You add new presets independent of an examination.
- During an examination, you select the preset instead of manually entering all mandatory contrast-agent specific attributes.

► To open the **Contrast Preset Settings**, click **Settings and Tools (F10)** in the Navigation Bar and then **Contrast Preset Settings**.

► To unlock the preset database, click **Unlock to Customize** and enter the password.

► Click **Add Preset** (1), then do any of the following:

- Select **Create Preset** (2) from the drop-down menu.

This option allows to create a new preset from scratch.

- Select **Duplicate Current Preset** (3) from the drop-down menu.

This option allows to modify a duplicate of the current preset and save with a different name.

- Select **Import Presets...** (4) from the drop-down menu.

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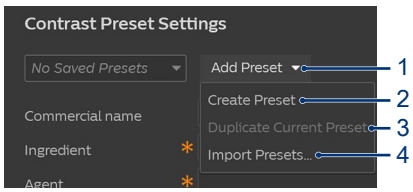
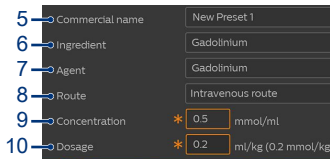
This option allows you to import presets from other systems to your system. For more information on importing contrast presets, see chapter “Importing presets” on page 262.



► Enter or select values for all contrast-specific attributes. All fields are mandatory, missing fields are marked by an orange asterisk.
For more information about contrast-agent specific attributes, see chapter “Functional Description” on page 258.



- Specify a unique **Commercial name** (5).
  The commercial name is also used as preset name.
- Select an **Ingredient** (6) from the drop-down menu.
- Select an **Agent** (7) from the drop-down menu.
- Select the **Route** (8) from the drop-down menu.
- Enter the **Concentration** (9) in **mmol/ml**.
- Enter the **Dosage** (10) in **ml/kg**.

► Do any of the following:

- To save the preset when all mandatory fields are entered correctly and to close the window, click **Save**.
- To close the window without saving, click **Cancel**.

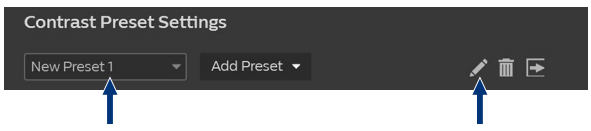
Editing a Contrast Preset

The goal of this workflow is to edit a preset for the registration of contrast agent injection.

▷ In the **Contrast Preset Settings** window:

► To unlock the preset database, click **Unlock to Customize** and enter the password.

► Select the preset you want to modify from the preset drop-down menu, then click **Edit**.



► Edit the values for the contrast-specific attributes you want to change. All fields are mandatory, missing fields are marked by a red asterisk.
For more information about contrast-agent specific attributes, see chapter “” on page 258.

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► Do any of the following:

- To save the preset when all mandatory fields are entered correctly and to close the window, click **Save**.
- To close the window without saving, click **Cancel**.

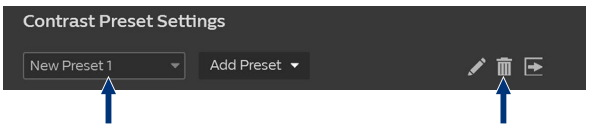
Deleting a Contrast Preset

The goal of this workflow is to delete a preset for the registration of contrast agent injection.

▷ In the **Contrast Preset Settings** window:

► To unlock the preset database, click **Unlock to Customize** and enter the password.

► Select the preset you want to delete from the preset drop-down menu, then click **Delete**.



⇨ A query pops up: "**Are you sure you want to delete** <preset name>?"

► Do any of the following:

- To delete the preset, click **Yes**.
- To still keep the current preset, click **No**.

Sharing Contrast Presets

You can share contrast presets among your MRI systems. By this there is no need to manually enter identical presets at all systems.

To copy contrast administration presets from one MRI system to other MRI systems:

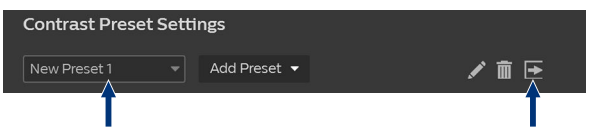
- First you export your presets to a USB stick.
- Then at the other MRI systems you import these presets from the USB stick.

You can also use the Export/Import functionality to backup your presets.

Exporting presets

▷ In the **Contrast Preset Settings** window:

► To export all contrast presets, click **Export**.



► To select the destination, browse to the desired folder (possibly located on a USB stick).

► To start the export procedure, click **Export**.

- Every preset is saved as a separate file.

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- The name of the preset is used as name of the file.
- If a file of the same name already exists, it is overwritten by the newest version.

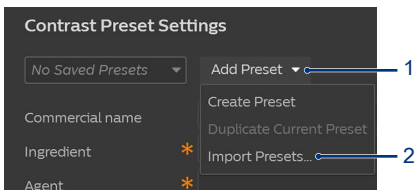
⇨ When the export is completed, the message "Successfully exported x presets" is displayed. "x" is the number of exported presets.

Importing presets

▷ In the Contrast Preset Settings window:

► To unlock the preset database, click **Unlock to Customize** and enter the password.

► To import contrast presets from a folder, click **Add** (1) and select **Import Presets...** (2) from the drop-down menu.



► To select the source, browse to the desired folder (possibly located on a USB stick).

► Select the presets that you want to import.

- To select one preset, click on its name.
- To select multiple consecutive presets, hold **Shift** while dragging over the presets.
- To select multiple individual presets, hold **Ctrl** while clicking on the presets.

► To start the import procedure, click **Import**.

If a preset of the same name already exists, it is overwritten by the newest version.

⇨ When the import is completed, the message **Successfully imported x presets** is displayed. "x" is the number of imported presets.

AutoVoice Settings

Functional Description

AutoVoice provides the option to give pre-recorded, automated instructions to the patient during scanning. Use AutoVoice to instruct or inform the patient about:

- Breathholds
- Scan duration
- Tabletop movement

Preferred instruction settings can be set at system level. Settings related to language and breathholds can also be customized at examination level or scan level. **AutoVoice Settings** are available in the **Settings and Tools (F10)** on the Navigation Bar.

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Displaying preset instruction sets

Presets of AutoVoice instructions are delivered with the MRI system. These Philips presets are available in various languages and cannot be changed.

To view the instructions that are available in the presets:

- ► Click **Settings and Tools (F10)** , then **AutoVoice Settings**.
- ► In the **AutoVoice** window, click the **Customize instruction sets** tab.
- ► Click the arrow next to the drop-down menu and select the language you want to view.

⇨ The list with instructions available within the chosen set is shown.

A brief description of each instruction is listed:

Description	Type of instruction: Breathhold, scan duration, tabletop movement
Instruction label	Name of the specific AutoVoice instruction
Duration	Time (in seconds) required to play the instruction
Instruction text <language>	Actual text of the instruction (displayed in the selected UI language).

You can also create your own presets and save them as a new set of instructions, see chapter "Customizing Instruction Sets" on page 264.

Breathhold Settings on Scan Level

For each breathhold scan, settings are displayed on the **Physiology Display** in the Exam Overview (see table). All or some of these settings can be adjusted, depending on the type of scan.

Breathhold mode	Indicate whether breathholds must be done during inspiration or expiration.
Slices/Breathhold	Set the number of slices that must be scanned during a single breathhold.
Duration	Set the duration of the breathhold in seconds.
Voice instruction (AutoVoice only)	Select the type of instruction that must be played: direct, normal, or long duration.
Breath hold guidance (AutoVoice only)	Select the type of breathhold guidance. Select **Use AutoVoice settings** to use the system level settings (when enabled on system level), AutoVoice will be used. Select **Manual** to force a manual instruction, even when AutoVoice is enabled on system level.

Tab. 4: Breathhold parameters on scan level.

Routine Procedures

Setting AutoVoice on System Level

To enable AutoVoice on system level and to define which features of AutoVoice to use:

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- ► Click **Settings and Tools (F10)** in the Navigation Bar and then **AutoVoice Settings**.
  - ⇨ The **AutoVoice** window opens.
- ► On the **Settings** tab, click the **AutoVoice** check box, to enable or disable AutoVoice.

Once AutoVoice is enabled, select the type of instructions or information you want AutoVoice to provide.

- ► Click the check box in front of an instruction to enable or disable it. You can select:
- Guide all patients through breathhold scans.
- Inform all patients about the duration of the scan before the start of each scan.
- Warn all patients before the table moves.

Setting the default language for AutoVoice

To select the default AutoVoice language:

- ► Click on the **Select Language** drop-down menu.
- ► Select the desired default language for AutoVoice.

The selected instructions are played for all patients during all scans.

You can still change language settings for individual examinations, see chapter “Setting AutoVoice on Examination Level” on page 391.

If language is changed at examination level, the system will reset to the default language for the following new examination.

Setting the default recovery time for breathholds

The recovery time controls the interval between successive breathhold instructions in a single scan. To set the recovery time:

- ► Click the drop-down list next to **Recovery time for all patients, between successive breathholds in a single scan**.
- ► Select the preferred recovery time from the preset list (5–30 seconds).

You can still change the recovery time between successive breathholds for individual examinations, see chapter “Setting AutoVoice on Examination Level” on page 391.

Customizing Instruction Sets

The AutoVoice preset instructions are listed in the AutoVoice window. To view the presets:

- ► Click **Settings and Tools (F10)** in the Navigation Bar and then **AutoVoice Settings**.
- ► Select the **Customize instruction sets** tab.
  - ⇨ The list with all available instructions within a set are displayed.

The Phillips presets are available in various languages. To select a different language:

- ► Click the arrow next to the language drop-down menu.

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► Select the language you want to use.

► To play an instruction, click the **Play** icon in front of the instruction.

Creating a customized set

To create a customized set of AutoVoice instructions:

► Click **Add Set**, then do one of the following:

- To create a whole new set, click **Create new set**.
- To copy the current set and make adaptations to it, click **Duplicate current Set**.
- To import a set from another location, click **Import set from a file**.

The Philips presets cannot be changed but they can be duplicated and then customized. The Philips presets are indicated by a lock icon in front of the preset name.

Create a new set

When you click **Add Set** and **Create new set**, a pop-up window appears.

► Enter a name for the new set.

► Click **Create**.

⇨ A new list with all required instructions appears. The description shows a window for the new instruction text that can be entered in the **Edit & Record instruction** window and the text used in the last selected preset.

⇨ The new name is added to the language drop-down menu.

- Each instruction must be recorded manually.
- Instructions without recording are indicated with an orange asterisk.
- Instructions with an orange asterisk must be recorded before the set can be used during scans.
- Instructions with a recording are indicated with a **Play** button.
- The notice 'Incomplete' is added behind the name of a set for which not all instructions are recorded.

► Click the instruction you want to edit. The instruction line is highlighted.

► Click the **Edit** button at the right-end of the instruction.

⇨ The **Edit & Record instruction** window opens (see chapter “Editing and Recording Instructions” on page 267).

Duplicate and adapt a current set

When you click **Add Set** and **Duplicate current Set**, a pop-up window appears.

► Enter a name for the duplicate set. The system provides a name suggestion.

► Click **Duplicate**.

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⇨ A copy of the list you duplicated appears. The description shows both the text of the original set and a window to contain the text for the adapted set.

⇨ The new name is added to the language drop-down menu.

To play a recording, click **Play** in front of an instruction.

To edit or record an instruction:

- Click the instruction you want to edit. The instruction line is highlighted.
- Click the **Edit** button at the right-end of the instruction.

⇨ The **Edit & Record instruction** window opens (see chapter “Editing and Recording Instructions” on page 267).

Import a set from a file

Once you click **Add Set** and **Import set from a file**:

- Navigate to the location of the set you want to import. Select the file.
- Click **Select**.
- If the name of the file is already present in the preset list, you are prompted to either type another name or to overwrite the existing file. Click **Import** to import the file under the selected name.

  When the import is complete, the message **Import successful** is displayed.
- Click **OK**.

⇨ The set is imported and the name of the file is added to the drop-down menu.

Renaming a set

Philips preset instructions cannot be renamed. These presets are indicated with a lock icon in front of the name.

- Select the set you want to rename.
- Click **Edit** above the instruction list.
- Enter a new name for the instruction set.
- Click **Rename**.

Deleting a set

Philips preset instructions cannot be deleted. These presets are indicated with a lock icon in front of the name.

To delete a customized set:

- Select the set you want to delete.

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- ► Click **Delete**.
- ► Confirm that you want to delete the set and click **Yes**.

Export a preset

To export a preset for back-up or use on other systems:

- ► Select the preset you want to export.
- ► Click the **Export** button.
- ► Choose the location where you want to save the preset.
- ► Click **Select**.

⇨ The preset is saved as a zip-file.

Editing and Recording Instructions

▷ In the **Edit & Record instruction** window:

- ► Click in the **Instruction text** box.
- ► Type the text of the new instruction.

To make a new recording:

- ► Click **Record**.
- ► Press **Talk** on the operator-patient intercom. The recording starts when **Talk** is pressed.
- ► Speak the instructions into the microphone of the operator-patient intercom.
- ► To stop the recording, release **Talk** on the operator-patient intercom.
- ► To hear the new instruction, click **Play**.
- ► If you want to re-record the instruction, repeat the steps above.
- ► Click **OK** to save and go back to the instruction set.

While recording the instruction, the sound waves are indicated in blue in the **Edit & Record instruction** window. You can increase or decrease the period of silence before and after an instruction. To do so

- ► Hover the cursor over one of the two vertical blue lines. The cursor changes to a horizontal arrow.
- ► Click the blue line and drag to the left or right.

⇨ The silent period is indicated with a horizontal blue line. Silent periods are increased (or decreased) per second. The number of seconds is indicated underneath the vertical line. Once you release the vertical line, the silent period is set. You can see the total duration of the instruction underneath the right vertical blue line.

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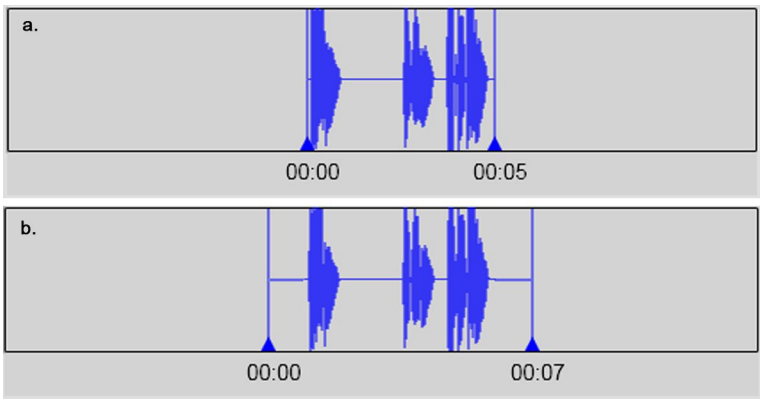

Fig. 13: Sound waves indicated in the Edit & Record window. Without (a) and with (b) an extra silent period before and after the instruction.

Image Display Settings

Functional Description

In the **Image Display Settings**, you can change the way you look at the images (image orientation) and the way images are numbered (slice order) at system level. You can:

- Change the default display settings.
- Create customized settings for specific anatomies.

Settings apply to the operator's console, remote workstations and PACS systems after system restart.

NOTICE

Ensure that information regarding patient position, patient orientation and anatomic region is entered correctly in the ExamCard Properties. Only then the image display is correct for each anatomy and each way of positioning.

The **Image Display Settings** are available in the **Settings and Tools (F10)** on the Navigation Bar.

The **Display settings for** field shows for which anatomies the displayed settings are applicable.

The display settings and slice order are indicated by an image for each plane, sagittal, coronal and transverse.

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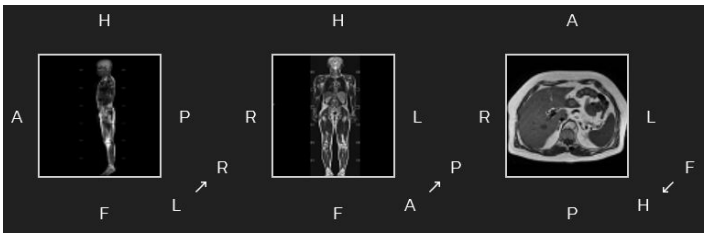

You can change the default settings using the buttons described in chapter “Changing Image Display Settings” on page 269.

When you create customized settings for specific anatomies, a new field is added underneath the default field (see chapter “Setting Anatomy-Specific Image Display Settings” on page 271). The top field always displays the default settings.

Routine Procedures

Changing Image Display Settings

The image display settings are locked and require a password to change.

To change the image display settings:

▷ In the **Image Display Settings** window:

► Click **Unlock to Customize** and enter the password.

► At the bottom, click the **Select Anatomy** drop-down menu to select an anatomy to change.

⇨ If you hover over the images, buttons to change the image display appear underneath each plane.

Mirror button (sagittal orientation only)	**Flip** button	**Change slice order** button

Tab. 5: Image display change buttons

Mirror or flip image

► Point the cursor in the field that requires a change. Buttons appear underneath each plane.

► Click the **Mirror** button (sagittal only) or **Flip** button under the plane you want to change.

The images that indicate display settings change direction accordingly.

► Click the button again to return to the previous setting.

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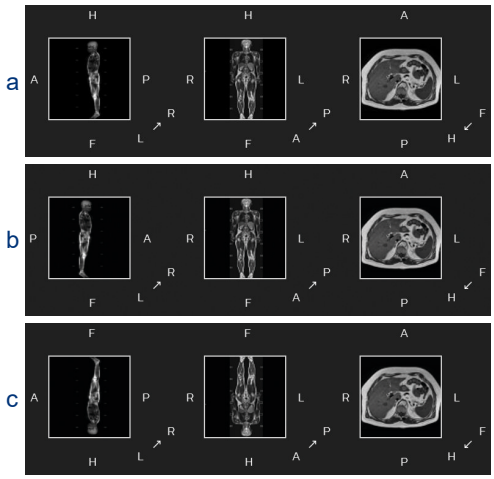

Fig. 14: The images indicate the selected display settings. a. Original settings. b. Sagittal plane image display settings are mirrored. c. Sagittal and coronal plane image display settings are flipped.

Slice order

- To change slice display order, click the **Change slice order** button under the plane for which you want to change the reviewing slice order.

  The direction of the arrow indicating the slice order changes. The arrow on the slice order button also changes direction.

- Click the **Change slice order** button again to return to the previous setting.

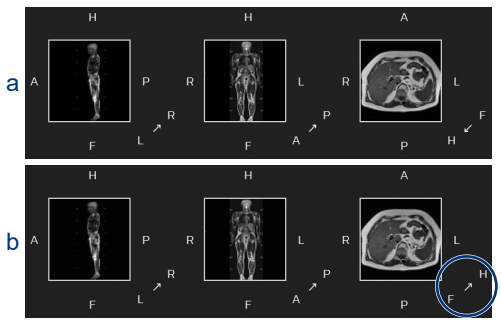

Fig. 15: Change of slice order. a. Original settings. b. Slice order change for transverse orientation. The arrow indicating the slice order and the arrow on the slice order button both change direction.

Save changes

- Click **Save** to save changes you made to the image display settings.

- Click **Reset** at the left top, to remove all changes and to return to previously saved settings but to remain within the **Image Display Settings** window.

  After reset, you go back to the earlier settings.

- Click **Cancel** to close the Image Display Settings window without saving changes.

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Setting Anatomy-Specific Image Display Settings

You can set display settings for specific anatomies.

▷ In the **Image Display Settings** window:

► Click **Unlock to Customize** and enter the password.

► Do one of the following:

- In the **Display settings for** field, click the required anatomy.

In the pop-up window, click **Customize display settings for <selected anatomy>***.

- At the bottom of the window, click the **Select Anatomy** drop-down arrow.

Select the required anatomy.

⇨ A new field appears underneath the default field.

► To customize the display settings for the selected anatomy, use the buttons as described in chapter "Changing Image Display Settings" on page 269.

** The name of the selected anatomy appears here.*

To ensure consistency, the sagittal slice order of unpaired anatomies (head, neck, spine, thorax, abdomen, breast, and pelvis) can only be set in the default settings at the top. To change the sagittal slice order for unpaired anatomies, first change the default settings, then create the required anatomy-specific settings.

NOTICE

When display settings are already customized for an unpaired anatomy, sagittal slice order can no longer be changed at default level. To change the sagittal slice order for unpaired anatomies, remove anatomy-specific settings for unpaired anatomies first. The sagittal slice order for paired anatomies such as knee and elbow can always be customized.

Anatomy-specific settings that differ from the default settings are highlighted in blue.

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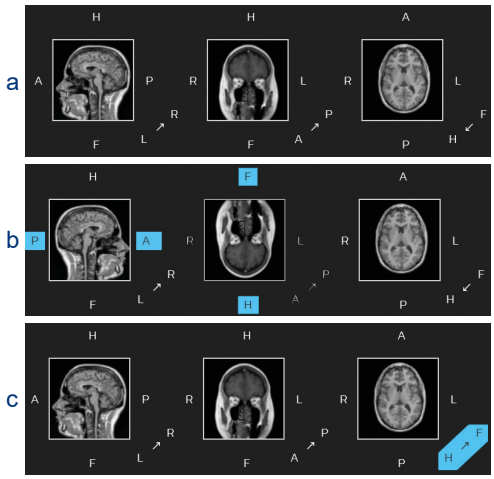

Fig. 16: Image display settings that are different from default settings are highlighted in blue. a. Default settings. b. Mirrored settings for sagittal head images, flipped settings coronal head images. c. Slice order change for transverse head images.

To assign multiple anatomies to a customized display setting:

- Click the **Add Anatomy** drop-down arrow within the customized field.
- Select the required anatomy from the drop-down menu
- To add additional anatomies, repeat the process.

NOTICE

Customized settings cannot be combined for all anatomies. Paired anatomies (hips, knees, ankles, feet, shoulders, elbows, wrists, and hands) cannot be combined with head, neck, thorax, spine, abdomen, breast, and pelvis anatomies.

Examinations with paired anatomies

When you create a custom setting for a paired anatomy, the new field automatically shows left and right settings. For sagittal images, it is possible to mirror or change the slice order settings for the left or the right side only. Flipping an image is always applied to both sides, as are slice order changes for coronal and transverse images.

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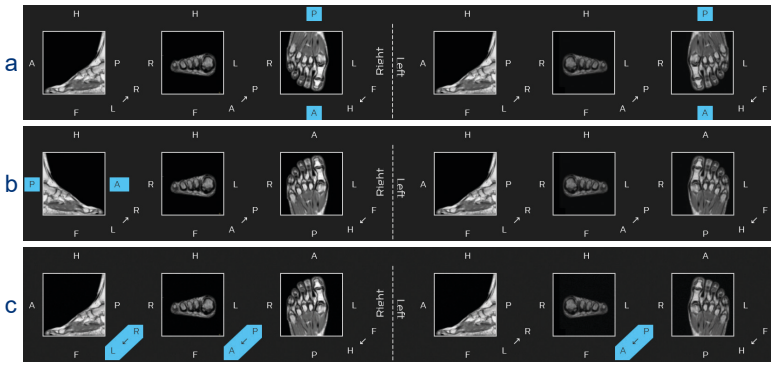

Fig. 17: Image display settings that are different from default settings are highlighted in blue a. Flipped images for transverse foot images, applicable for both sides. b. Mirrored sagittal images for the right foot only. c. Slice order change for sagittal images of right foot and coronal images, applicable for both sides.

Removing display settings for specific anatomies

To remove an anatomy with customized Image Display Settings:

- ► Click on the anatomy name.
- ► In the pop-up window, click **Remove customization**. The anatomy reappears in the default field.

Save settings

- ► To save changes to Image Display Settings, click **Save**.
- ► To close the Image Display Settings window without saving changes, click **Cancel**.

Exporting and Importing Image Display Settings

You can export customized image display settings to:

- Load settings onto another scanner.
- Create a back-up.

To export Image Display settings:

▷ In the **Image Display Settings** window:

- ► Click **Export** at the top right of the **Image Display Settings** window.
- ► Click **Browse** and navigate to the location where you want to save the settings.
- ► Click **Select**.
- ► Click **Export** to finalize the export. The Image Display settings are saved under file name "Export.preset".

To import Image Display Settings:

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▷ In the **Image Display Settings** window:

► Click **Import** , at the top right of the **Image Display Settings** window.

► Click **Browse** and navigate to the location where previously stored settings are saved.

► Select the required file and click **Select**.

► Click **Import** in the **Import Preset** window to start the import.

ExamCard Manager

This section describes the ExamCard Manager and how to edit ExamCards independently of the current examination.

Functional Description

The **ExamCard Manager** is available in **Settings and Tools (F10)** on the Navigation Bar.

With the **ExamCard Manager**, you modify the **Hospital** ExamCard database independently of the current examination. The **ExamCard Manager** allows you:

- To create a new ExamCard.
- To edit (copy, modify, rename, delete, import and export) an existing ExamCard in the same way as during an examination.
- To edit EC items (scan protocols) in the **Advanced Parameters**.
- To reorder EC items.
- To filter ExamCards based on their RIS code.
- To assign a popularity to the ExamCard. ExamCards with a higher popularity appear higher on the list of ExamCards (with similar RIS code).
- To save this ExamCard so that you can reuse it in the examinations.
- To manage **SmartGeometries** in the **SmartGeometries Database**.
- To search through ExamCards and scan items by name.

The **ExamCard Manager** provides you with

- Realistic information about *SED (Specific Energy Dose)*.

  The calculation of the SED is based on the knowledge of the patient weight, and the values on the *scan information page* are coil dependent. For a calculation as accurate as possible, you must enter a patient weight and select the coil you are going to use.
- The *scan information page*.
  For more information, see chapter “Scan Information Page” on page 473.

Password Protection of the EC Hospital database

To ensure consistency and to protect the quality of the ExamCards, only authorized operators can modify the contents of the **Hospital** database.

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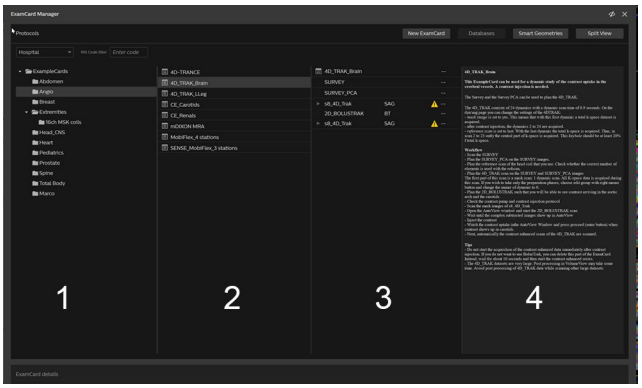
NOTICE

The default password is: Philips

Hospital administrators or your service provider can change or reset the **ExamCard Manager** password.

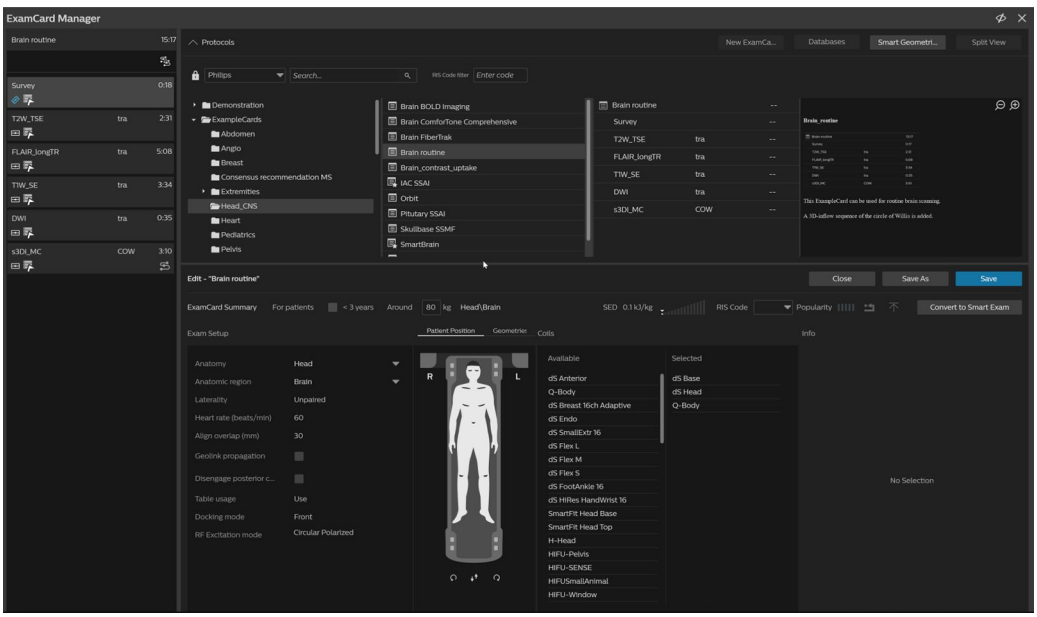
User Interface

The **ExamCard Manager** opens with four columns where the left-most column displays the ExamCard databases. Initially the other three columns are empty and only filled from left to right when an ExamCard database is selected.



1. ExamCard databases and (sub-)anatomy folders with the **RIS Code filter**
2. ExamCards in selected (sub-)anatomy folder
3. ExamCard items of selected ExamCard
4. Information for selected ExamCard or ExamCard item

When you edit or create an ExamCard, the Exam Setup and the Scan Overview are displayed and allow to work in the usual way.



When you edit an ExamCard item, the Scan Overview and the **Advanced Parameters** are displayed and allow to work in the usual way.

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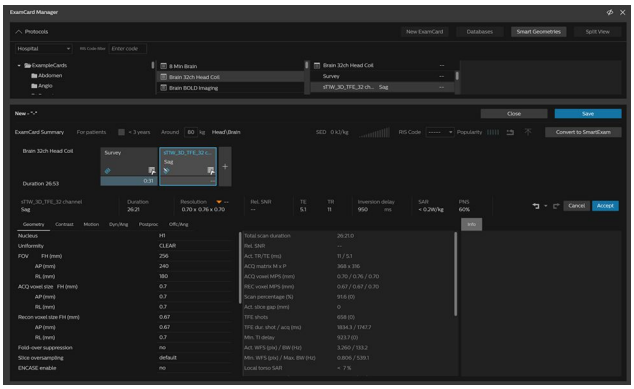

ExamCard Summary

The **ExamCard Summary** provides you with information about the ExamCard. It allows you to assign characteristics to the selected ExamCard which help you in finding the best-suited ExamCard for your examination.

From left to right, the **ExamCard Summary** displays:

- Validity of the ExamCard related to the patient's age (**< 3 years**) and weight (**around ... kg**).
- Anatomy and Anatomic Region.
- Safety information (SED as indicated by value and approximate level).
- **RIS Code**
- **Popularity** of the ExamCard (The more light gray bars, the higher the popularity).
- A button to adjust Smart Exam: depending on the ExamCard either **Convert to SmartExam** or **Manage SmartExam**

Managing ExamCards

You create and edit ExamCards independently of the current examination with the **ExamCard Manager**.

Starting up the ExamCard Manager

► On the Navigation bar, click **Settings and Tools (F10) (F10)**. Then select **ExamCard Manager**.

Alternatively press **Ctrl+K**.

► To unlock the **ExamCard Manager**, enter the password. Then click **Unlock**.

⇨ The ExamCard manager opens in a new window.

Setting up or editing an ExamCard

► Do any of the following:

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- To create a new ExamCard, click **New ExamCard**.
- To edit an existing ExamCard, browse to the ExamCard, and double-click it.

Alternatively filter the existing ExamCards based on their RIS code, and use the **RIS Code filter**.

► To add a scan protocol from the database to the ExamCard, browse to the scan protocol and select it. You can also search through ExamCards and scan items by name.

Then click **Add Scan** .
Repeat this step as often as needed.

► To remove a scan protocol from the ExamCard, right-click the scan protocol and select **Delete**.

► Set up the ExamCard in the usual way:

- To adjust the ExamCard properties, modify the **Exam Setup**.
- To adjust an ExamCard item in the **Advanced Parameters**, double-click the ExamCard item. Then change the parameters.
- To change the order of the ExamCard items, drag the items in the Scan Overview.
- To add a pause, contrast agent injection or breathhold, right-click the items in the Scan Overview.

You can also edit an ExamCard in **Split View**. **Split View** provides you with two views of EC databases and ExamCards. It allows you to drag and drop ExamCards and protocols from one view to the other. As such, **Split View** simplifies the workflow.

Saving the ExamCard

► First assign ExamCard characteristics to the ExamCard. To do so, enter the following data into the **ExamCard Summary**:

- **RIS Code**
- **Popularity**

To set the ExamCard to the highest popularity, click (**Set Highest Popularity**).

To reset the ExamCard popularity, click (**Reset Popularity**).

- Validity of the ExamCard based on patient's age and patient weight: **For Patients** of **< 3 years** and **around ... kg**.
- Anatomy and anatomic region.

► Then do any of the following:

- Click **Save** to save the ExamCard under the initial name.
- Click **Save As** to save the ExamCard under a different name. Then browse to the new destination, and enter a name for the ExamCard.

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Managing SmartGeometries

The **ExamCard Manager** allows you:

- To view the existing SmartGeometries for all anatomic regions: the Philips prelearned ones and the user defined ones;
- To delete a user defined SmartGeometry or to delete all samples of a user defined SmartGeometry.
- To import or export SmartGeometries.
- To lock the **SmartGeometries Database**.

NOTICE

Philips prelearned SmartGeometries are grayed out and cannot be deleted.

▷ Prerequisite: You are in the **ExamCard Manager**.

► Click **SmartGeometries**.

The **SmartGeometries Database** window opens.

► To browse to the **SmartGeometries** that you want to change, select the anatomy and anatomic region from the drop-down list.

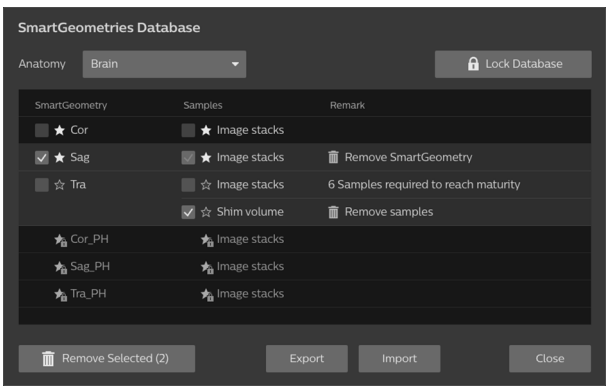
► To delete a **SmartGeometry**, select the geometry. Then click **Remove Selected**.

► To delete samples of a **SmartGeometry**, select the **Samples**. Then click **Remove Selected**.

► To import or export a **SmartGeometry**, click **Import** or **Export**. Then select the destination.

► To lock the **SmartGeometries Database**, click **Lock Database**.

► To leave the **SmartGeometries Database**, click **Close**.



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Managing ExamCard Databases

You import and export ExamCards, and you lock or unlock the Hospital ExamCard Database with the **ExamCard Manager**.

Locking and Unlocking ExamCard Databases

You lock the Hospital ExamCard Database to write-protect it and to prevent it is overwritten by mistake.

▷ You are in the password-protected **ExamCard Manager**.

► Click **Databases**.

► To lock the **Hospital** database, right-click it. Then select **Lock Database**.

► To unlock the **Hospital** database, right-click it. Then select **Unlock Database**.

Exporting of ExamCards

You export or import ExamCards to reuse the ExamCard on another Philips MRI scanner.

In this case, always make sure that the configurations of the systems are identical. Otherwise the ExamCard(s) possibly do not work or provide lower quality than expected.

▷ You are in the **ExamCard Manager**.

► To select an ExamCard or multiple ExamCards for export, click the ExamCard(s) in an ExamCard database.

Multiple selection is possible with the **Shift** or **Ctrl** keys.

► Right-click the selection. Then select **Export ExamCards...**.

► Browse to the destination folder.

To confirm, click **Export**.

If you want to import or export a complete ExamCard database, contact your service provider.

Importing of ExamCards and EC Databases

You export or import ExamCards to reuse the ExamCard on another Philips MRI scanner.

In this case, always make sure that the configurations of the systems are identical. Otherwise the ExamCard(s) possibly do not work or provide lower quality than expected.

Importing specific ExamCards

Make sure that the releases are the same or newer for the system where you want to import an ExamCard to.

▷ You are in the ExamCard Manager.

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▷ Prerequisite: The software release of the import destination folder is the same as or newer than the source folder.

1. Right-click any ExamCard database, then select **Import ExamCards...**.
2. Browse to the ExamCard which has to be imported. Then click **Import**.

⇨ The Import destination always is the **InBox** of the **Other** ExamCards database.

⇨ During the import of ExamCards, geometry filtering removes the unused geometries from the ExamCards.

If you want to import or export a complete ExamCard database, contact your service provider.

Capture Screen

Functional Description

The function **Capture Screen** allows you to capture the whole screen of the current examination when you view images. Due to privacy reasons, this function is not available for the **Patient Dashboard** or the **Patient Directory**.

The function **Capture Screen** is available in the **Settings and Tools (F10)**.
It has the following requirements:

- To use the function, you must enable it first for easy access.
  This function is password-protected.
- Every time that you take a capture of the whole screen, you must confirm that only information from one patient is visible.

Enabling (Whole) Screen Capture

Before you can use the **Capture Screen** function to capture the whole screen, you must enable it.

► On the navigation bar, click **Settings and Tools (F10)** , then **Settings** and then select **Screen Capture**.

► To unlock the feature, click **Unlock to Customize** and enter the password.

► Click **Enable Screen Capture**.

You use this toggle button to enable and to disable **Capture Screen**.

⇨ When the checkbox is checked, the **Capture Screen** function is enabled.

⇨ When the checkbox is unchecked, the **Capture Screen** function is disabled.

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Capturing the Whole Screen

Before you use this workflow, make sure that the **Capture Screen** function is enabled. Only then it is available.

▷ Prerequisite: You view images on the **Plan**, **Review**, **Analysis1**, the **Analysis2** or the **Print** tab.

► On the navigation bar, click **Settings and Tools (F10)** , and then select **Capture Screen**.

⇨ The **Screen Capture** window opens. It shows the content of the screen capture.

⇨ On the bottom line, a message displays:
By saving this Screen Capture, you confirm that information from only one patient is visible.

► To confirm and save the screen capture, click **Save**.

Cancel cancels the screen capture.

⇨ The **Message Center** notifies you that the screen capture has been saved.

⇨ The saved screen capture is available in the Exam Overview (**Review** tab).

3.10.13 Customer Feedback

Providing Feedback

When you face problems during your daily operation, you provide feedback with the **Send Feedback** tool. This tool is available from the Navigation Bar on the operator's console of your MRI system.

Inform your service provider when you submitted feedback: The service provider must read out your feedback and forward it to Philips.

Preparing DICOM images

If you want to include DICOM images in your feedback, prepare these images first.

► Clean the *Disk Files* partition first:

- In the **Patient Directory**, browse to the E:\DICOM folder.
- Right-click the contents of this folder, then select **Refresh List**.
- Right-click again, then select **Delete**.
- Select all examinations, then click **Delete**.

► Select the images you want to include. Then choose the destination:

- In the **Patient Directory**, click **All**.
- Select the images to be included.
- Right-click the selected images, then select **Export**.

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- Select the E:\DICOM folder as destination.
- Optional: Select **De-identify Patient Name**.
- Click **Export** to confirm.

⇨ The selected images are available in a zip file on the *Disk Files* partition.

⇨ A message indicates the successfully completed export of the images. Also the **Job Viewer (F6)** displays the status of this export.

Providing customer feedback

1. On the Navigation bar, click . Then select **Send Feedback**.
   The *Customer Feedback* window opens.
2. Click the **Send Feedback** tab, if it is not active. Fill in the empty data fields:
   - **Hospital Name**:

     Is filled in automatically. You cannot change the value.
   - **System ref number**:

     Is filled in automatically. You cannot change the value.
   - **Occurrence date/time**:

     Enter date and time when the problem occurred, or select the date from the calendar drop-down list.
   - **Submitter**:

     Enter your name.
   - **Description**:

     Give a short description of the error case.
   - **Actions prior to error**:

     Describe which actions were done just before the error occurred.
3. Check the box **Include DICOM images** if you want to include the prepared images (see workflow 'Prepare DICOM images') with the problem report.

NOTICE

If DICOM images were not prepared, an error message is displayed.

In this case, follow the instructions given to include DICOM images.

4. Click **Proceed** to submit your feedback.
5. Inform your service provider that feedback was submitted.

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3.10.14 Operator-Patient Intercom

The Operator-Patient Intercom enables communication with the patient, it provides music to the patient and signals when the patient uses the nurse call.

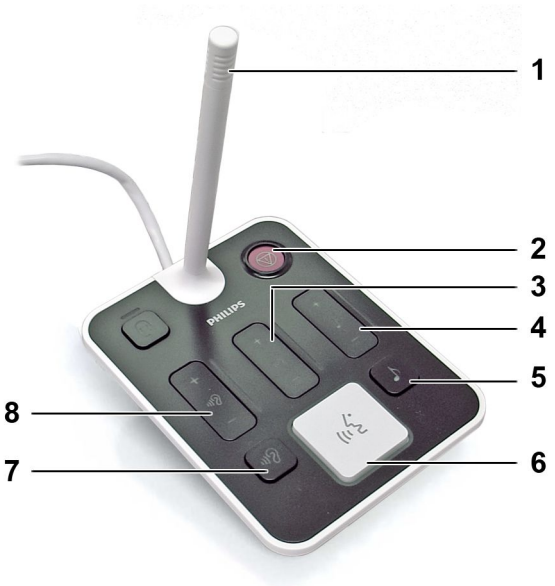

Fig. 18: Operator-Patient intercom

Number	Description
1	Microphone
2	Emergency Table Stop button*
3	Talk volume
4	Music volume
5	Patient music on/off
6	Talk and Nurse call light ring
7	Listen on/off
8	Listen volume

You can find definitions of used symbols in the symbol glossary on the following website: https://www.symbols.philips.com

Emergency Table Stop button*

This button has the same functionality as the Emergency Table Stop button on the UIM. Pressing the Emergency Table Stop button will stop the tabletop movement. This can be reset using the Resume button.

Talk volume +/- button

Use this button to adjust the talk volume to the patient. The level is indicated on the LED bar next to the button.

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Music volume +/- button

Use this button to adjust the music volume for the patient. The level is indicated on the LED bar next to the button.

Patient music on/off Button

Use this button to toggle the music for the patient on and off. The button icon lights up when music is turned on. Music is muted while the talk button is pressed.

Talk and Nurse call light ring

Press and hold this button to talk to the patient, releasing it will stop communication. Music is muted while the talk button is pressed.

When the pinch ball of the nurse call is pressed more than once within 4 seconds or for more than 1.5 seconds, a beep sounds and the light ring around the talk button flashes to attract the attention of he operator. Press the talk button to stop the beep and the flashing of the light ring.

Listen on/off Button

Use this button to toggle the listen function on and off. The button icon lights up when the listen function is turned on. The listen function is muted while the talk button is pressed.

Listen volume +/- button

Use this button to adjust the speaker volume of the intercom. The level is indicated on the LED bar next to the button.

3.10.15 Monitor and Keyboard

Keyboard and Shortcut Keys

The keyboard is used to enter text such as patient data and annotations.

At times, keyboard entry is disabled by the system. When this occurs, all new keystrokes are ignored and an audible signal is sounded. To rectify this, click on the window to make it active.

A keyboard overlay shows the functions of all function keys on your keyboard in the system application software.

F1		**Help (F1)**
F2		**New Patient**
F3		**Patient Directory**

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F4		**Patient Dashboard**
F5		**Refresh**
F6		**Job Viewer (F6)**
F7		**AutoView**
F8		**Start** (scan) **Pause** (scan)
F9	 	**Minimize current examination** **Maximize current examination**
F10		**Settings and Tools (F10)**
F11	not used	
F12		**Stop** (scan)
Print Sc		**Capture Screen**
Scroll Lock	not used	
Pause		Movie: **Play** / **Stop**

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4 Preparing the Examination

The preparation of an MRI examination consists of patient preparation, patient positioning (with coils, physiology sensors and peripherals) and patient registration.

Before you start with the preparation of the patient and the examination:

- Verify patient identity.
- Prescreen the patient for contraindications.
- Inform the patient over the course of the examination, e.g. scan and exam duration, noise, communication, tabletop movement, breathhold commands).
- If applicable, prepare the intravenous line.

4.1 Preparing the Tabletop

Note that for every new patient the following items must be replaced (if applicable):

- Mattress paper.
- Ear plugs.
- ECG pads.

4.1.1 Preparation of the tabletop

This section describes the workflows needed to prepare the tabletop for an examination including:

- Moving the tabletop to its end stop,
- Lowering the tabletop.

Moving the Tabletop to its End Stop

The end stop is the position where the tabletop is moved totally out of the bore.The tabletop can only be lowered when it is at the end stop.

- ► **Under motor control**: Press the tumble switch down to the `Out/down' position and hold it there until the tabletop automatically stops at the end stop.
- ► **Under manual operation** (alternatively): Press the `Manual' button and move the tabletop out of the magnet manually until the end stop is reached. The tabletop then locks into place automatically.

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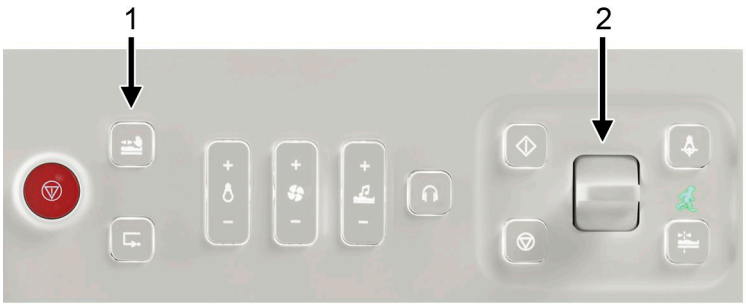

Fig. 19: User Interface Module (UIM). 1: 'Manual' button, 2: Tumble switch.

Lowering the Tabletop

The tabletop needs to be lowered so that the patient can get on it easily.

- ► Lower the tabletop to the appropriate height by pressing the tumble switch down to the 'Out/down' position and holding it there until the appropriate height is reached.
  - The table should not be at its lowest position when a heavy patient is placed upon it. It should be raised at least 15 cm from its lowest point to ensure ease of vertical movement.
  - To ensure optimum vertical and horizontal table movement, don't exceed the maximum allowed patient weight.

  Refer to the Instructions for Use for the maximum allowed patient weight for table and trolley.

4.2 Patient Positioning and Setup of Coils

This chapter provides some general information about positioning and describes the positioning procedures for the various MRI examinations.

4.2.1 About Positioning in general

The first consideration in positioning is patient comfort to minimize motion artifacts.

Generic Guidelines

- Use positioning cushions, MR Safe sandbags and immobilization straps for comfort and stability.

  Ensure the used positioning aids are MR Safe, non-magnetic and artifact-free.
- Ensure that patients fit easily into the system when positioned off-center or semi-sitting.

  If positioned semi-obliquely for a shoulder examination, the patient's raised shoulder may impede passage into the system.
- Use the arm supports to prevent the patient from grabbing around the table sides and pinching the fingers during horizontal table motion.

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Use of Arm Supports

WARNING

Verify that the hand of the patient are on the tabletop before moving the tabletop into the magnet, to avoid finger pinching.

Fingers can get pinched between the tabletop and the system covers.

- **The special arm supports (see Positioning Aids) can be used to avoid finger pinching. The arm supports prevent the patient from grabbing around the table sides, avoiding finger pinching during tabletop movement.**

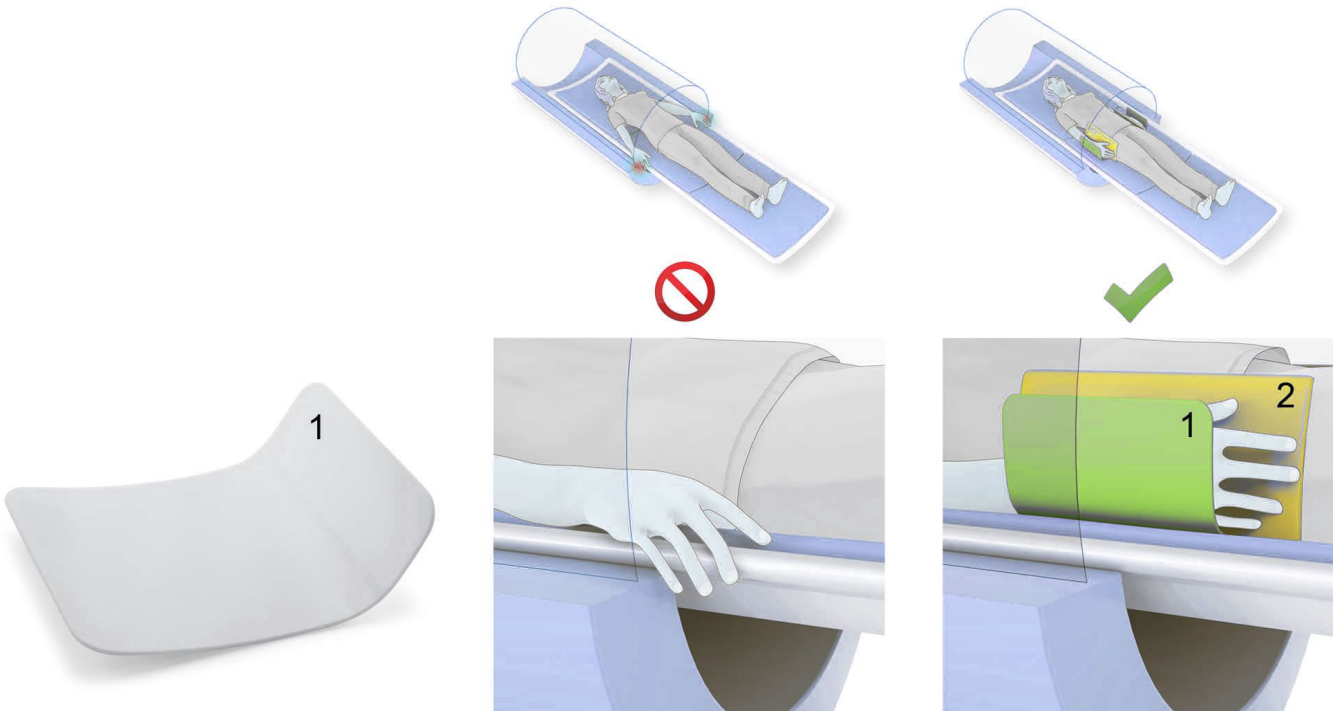

Fig. 20: Left: Arm support. Middle: Incorrect patient positioning. Right: Advised patient positioning with arm support (1) and padding (2).

Headset

You use the headset as second means of hearing protection to the patient. Earplugs are the primary means of hearing protection.

For more information, see chapter “Acoustic Noise” on page 58.

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Nurse Call

You give the nurse call to the patient.

For more information, see chapter “Nurse Call and Operator-Patient Intercom” on page 73.

If the nurse call is pressed quickly twice or once for a longer period, the alarm bell will be heard, and the light will be activated on the intercom.

Observation

Observation of the patient is reassuring for patient and operator. It may be directly from the console or via a video camera or mirror. Voice contact via the intercom should be demonstrated to each patient.

Mattress and Coil Concept

Optimum patient positioning is crucial for a successful MR examination. The setup of coils and mattresses is an essential part of patient positioning. Understanding the mattress and coil concept allows for a smart setup of every MR examination.

Mattresses and coils on the patient support

For the setup of all MR examinations, the following principle applies at all times:

The patient support is fully covered by mattresses and coils for any examination.

The coils and the small and large mattresses are designed such that they completely fill up the space on the patient support when they are combined in the correct way:

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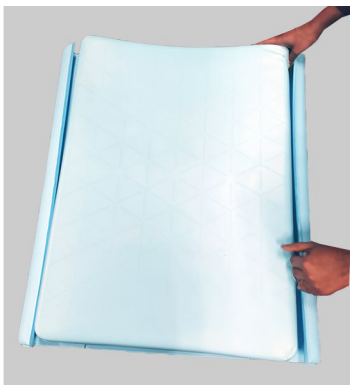
- Always leave the dS Base coil on the tabletop.
- Always leave the dS Interface on the tabletop.
- Use the comfort mattresses with the comfort mattress partner at all times: put the comfort mattress in the comfort mattress partner.

  The comfort mattress partner surrounds the comfort mattress and provides secure space for cable positioning.



- Safely place all cables in the space of the comfort mattress partner.

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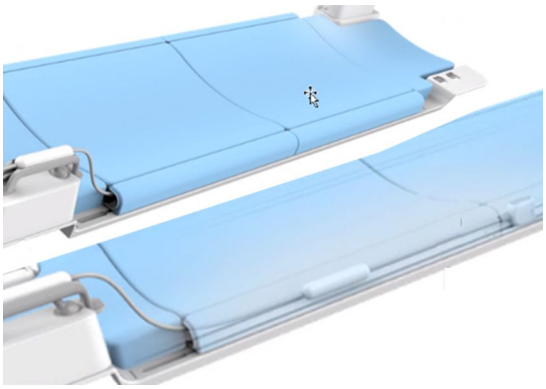

4.2.2 Head and Spine Examinations

Positioning for Head and Spine

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the handgrip side of the tabletop.

► Position the patient on the tabletop with their head on the dS Base coil.

► Put arm supports on both sides under the patient's lower arms to have the arms safely positioned during tabletop movement.

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⇨ For spine examinations, move the patient to the isocenter.

► Attach the dS Head top coil to the dS Base coil.

► Attach the mirror to the dS Head top coil.

► Move the patient to the isocenter.

Positioning for Head Examinations with the T/R Head coil

The examination with the T/R Head coil is a Head-First examination with the patient supine.

► Place the coil and the mattresses on the tabletop.

Make sure the head support is secure.

► Connect the coil to the T/R socket.

► Position the patient with their head in the head support.

- If the patient has a short neck, it is advisable to place some padding under the shoulders.
- Use the small wedges to immobilize the head by placing them firmly between the head and the sides of the support.
- Use the head fixation strap for extra immobilization.

► Pull the sliding part gently over the head and face.

- Pull gently on both sides of the coil, close to the base.

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- Pull the coil all the way down so that it 'clicks' into position: this may not be possible with patients with large shoulders or a short neck. In this case, the coil will function normally, although the head appears lower in the survey image.

► Attach the optical mirror to the coil or use the comfort zone so that the patient can look outside the bore.

This can be reassuring for patients.

Fig. 21: Ready for a head/brain examination with the T/R Head coil.

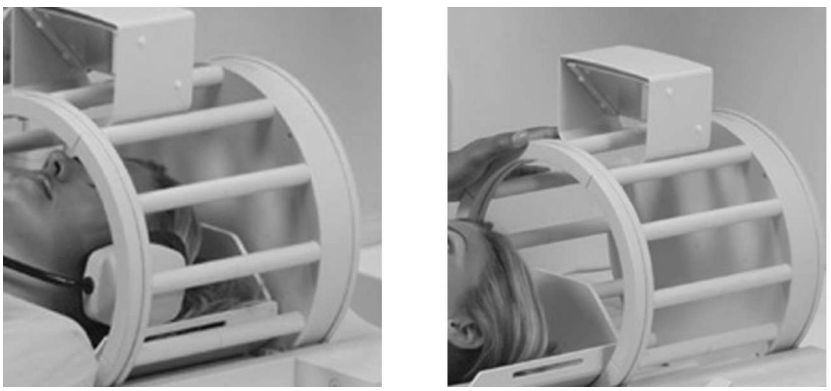

Fig. 22: T/R Head coil with mirror.

4.2.3 Head and Neck Examinations

Positioning Options

You perform this examination with the patient supine head-first.

You use the dS MSK S or M coil, or the dS TorsoCardiac coil.

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With the dS MSK M coil	
With the dS TorsoCardiac coil	

Positioning with the dS TorsoCardiac or the dS MSK M coil

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the handgrip side of the tabletop.

► Position the patient on the tabletop with their head on the dS Base coil.

► Attach the dS Head top coil to the dS Base coil.

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- Attach the mirror to the dS Head top coil.

- Put arm supports on both sides under the patient's lower arms to have the arms safely positioned during tabletop movement.

  Place the dS MSK M coil or the dS TorsoCardiac coil on the neck region.

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► Fix the coil with straps.

► Connect the coil to the dS Interface.

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- Place pads between patient and cables.

- Move the patient to the isocenter.

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4.2.4 Thorax, Abdomen and Pelvis Examinations

Positioning Options

You perform thorax (including cardiac imaging), abdomen and pelvis examinations supine.

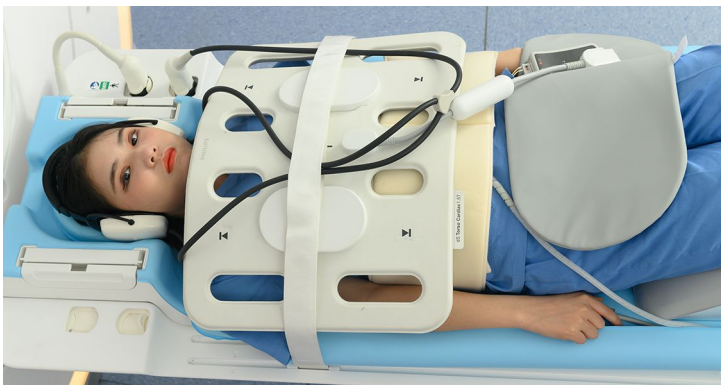
Both head-first and feet-first positions are suitable.

With tall patients,

- Cardiac imaging may not be possible feet-first, but only head-first.
- Pelvis imaging may need to be done feet-first.

Coil Choice

You use one dS TorsoCardiac coil.

dS TorsoCardiac coil: supine head-first and feet-first positioning	
Thorax with VCG and respiratory belt	
Abdomen with respiratory belt	
Pelvis head-first	

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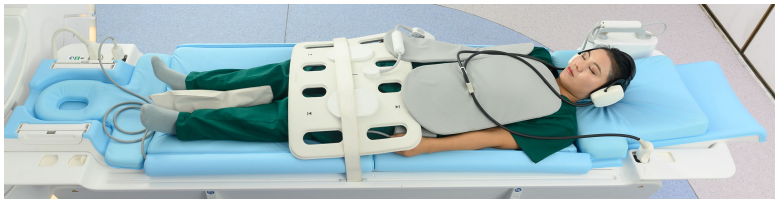
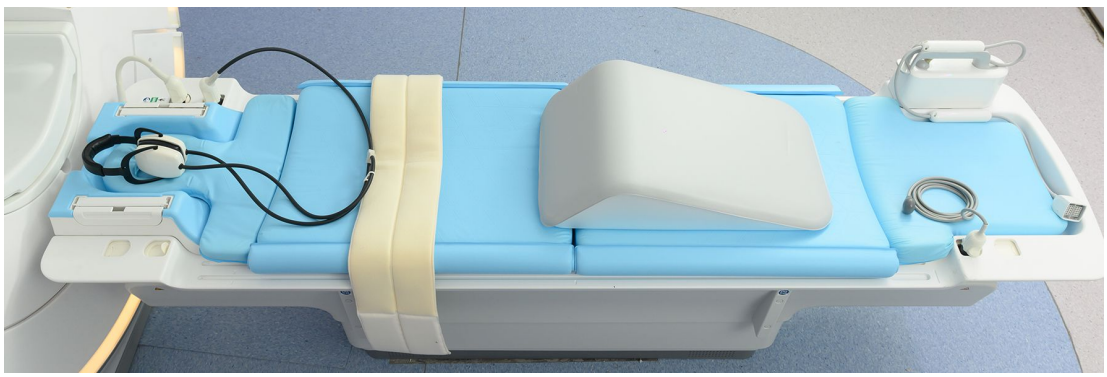
dS TorsoCardiac coil: supine head-first and feet-first positioning	
Pelvis feet-first	

Positioning with the dS TorsoCardiac coil

▷ The dS Interface is attached to the Digital Connector at the handgrip side of the tabletop.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.



1. Position the patient supine on the tabletop
   - For *head-first examinations*: with their head on the dS Base coil.

   - For *feet-first examinations*: with their head on the T-shape mattress, or if used the Head/Leg support.
     Put a pillow under the patient's head for patient comfort.
2. For cardiac imaging, place VCG electrodes and connect the leads properly.

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3. For chest and abdomen imaging, place the respiratory belt on the patient's abdomen and fix it with a strap.

4. Place the coil on the patient's chest, abdomen or pelvis.

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5. Route the cable from the coil towards the dS Interface.
6. Strap the coil around the patient.

7. Connect the coil to the dS Interface.

8. Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.

9. Put arm supports on both sides under the patient's lower arms to have the arms safely positioned during tabletop movement.

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10. Move the patient to the isocenter.

4.2.5 Whole Body Examinations

Positioning Options

You perform this examination with the patient supine head-first.

You use the dS Whole Body coil solution with its components dS Base, dS Head top and two dS Torso Cardiac coils.

Supine head-first

Positioning with the dS Whole Body coil solution

The described workflow applies for:

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- Whole Body
- DWIBS (Diffusion Weighted Whole Body Imaging with Background Body Signal Suppression)

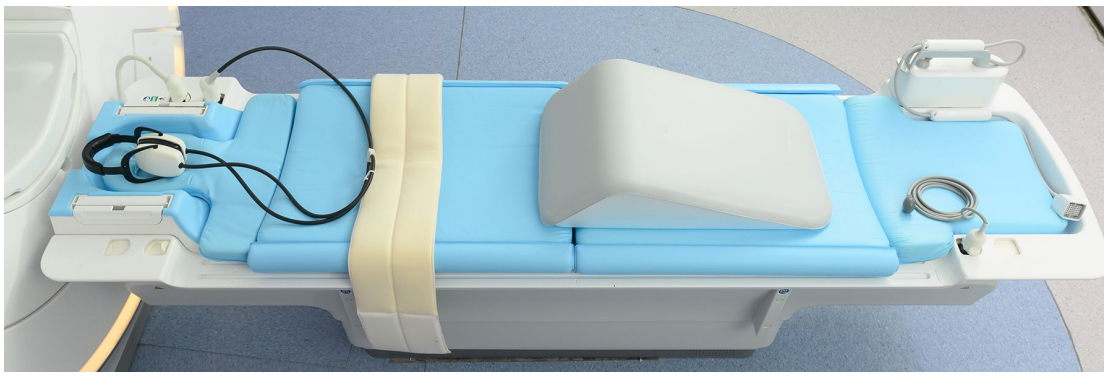
▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the handgrip side of the tabletop.

▷ For patient comfort, the spacer mattress lies on the dS Base coil.

▷



1. Position the patient supine on the tabletop with their head on the dS Base coil.
2. Place the respiratory belt on the patient's abdomen and fix it with a strap.

3. Attach the dS Head top coil to the dS Base coil.

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4. Attach the mirror to the dS Head top coil.

5. Place one dS TorsoCardiac coil on the patient's thorax. Fix the coil with a strap.

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6. Place the second TorsoCardiac coil on the patient's pelvis. Fix the coil with a strap.

Preferably let the coils overlap.
The arrows on the coil indicate the maximum allowed overlap.

7. Connect the coils to the dS Interfaces.

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8. Place pads between the coils and the cables to avoid direct contact.

   Put arm supports on both sides under the patient's lower arms to have the arms safely positioned during tabletop movement.

9. Move the patient to the isocenter.

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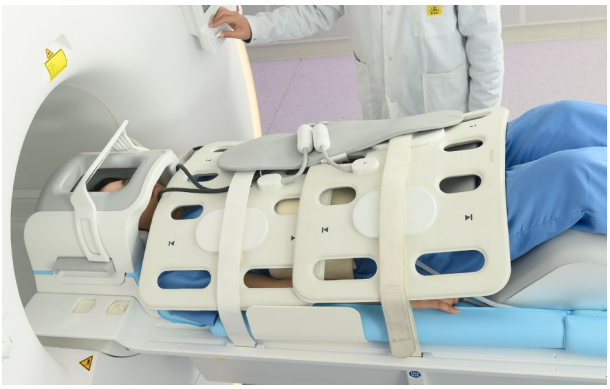

4.2.6 Peripheral Vascular Examinations

Positioning Options

You perform this examination with the patient supine head-first or feet-first.

You use the dS Peripheral coil solution with its components dS Base, dS Posterior and two dS TorsoCardiac coils.

	Peripheral Angiography (Lower Leg MRA)
Head-first	
Feet-first	

Positioning for Peripheral MRA with the Patient Feet-First

- ▷ The dS Base coil is on the tabletop.
- ▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.
- ▷ The dS Interface is attached to the Digital Connector at the handgrip side of the tabletop.
- ▷ The feet immobilizer is on the tabletop towards the dS Base.

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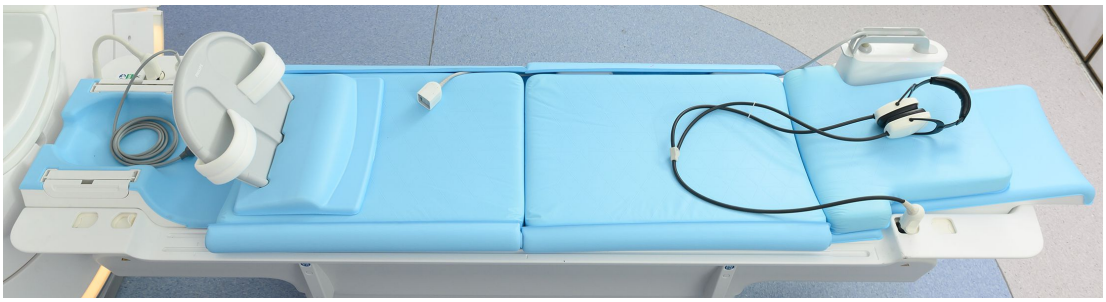

1. Position the patient supine on the tabletop with their head on the foot mattress (or if available Head/Leg support) and their feet on the feet immobilizer.
   Put a pillow under the patient's head for patient comfort.

2. For cardiac-triggered images, place VCG electrodes and connect the leads properly.
   See chapter “Connecting VCG to the patient” on page 366.
3. Place the coils on the lower legs, upper legs and pelvis. Fix them with a strap.

   Preferably let the coils overlap.
   The arrows on the coil indicate the maximum allowed overlap.

   To achieve the optimum coverage, place the coils:

   - Both transversally.

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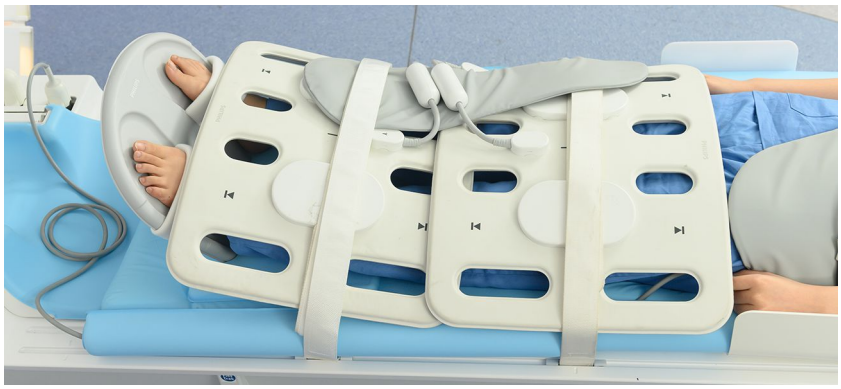

- Both longitudinally.

- One longitudinally, and the other one transversally.

4. Connect the coils to the dS Interface.

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5. Place pads between the patient's extremities, or between cables and patient, or between cables and coils.

   Put arm supports on both sides under the patient's lower arms to have the arms safely positioned during tabletop movement.

6. Move the patient to the isocenter.

Positioning for Peripheral MRA with the Patient Head-First

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the handgrip side of the tabletop.

1. Put the feet immobilizer on the tabletop towards the handgrip side.
2. Position the patient supine on the tabletop with their head on the dS Base and their feet on the feet immobilizer.
3. For cardiac-triggered images, place VCG electrodes and connect the leads properly.
   See chapter “Connecting VCG to the patient” on page 366.
4. Place the coils on the lower legs, upper legs and pelvis.

   Preferably let the coils overlap.
   The arrows on the coil indicate the maximum allowed overlap.

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To achieve the optimum coverage, place the coils:

- Both transversally.

- Both longitudinally.
- One longitudinally, and the other one transversally.

5. Fix the coils with straps.

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6. Connect the coils to the dS Interface.

7. Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.

   Put arm supports on both sides under the patient's lower arms to have the arms safely positioned during tabletop movement.

8. Move the patient to the isocenter.

4.2.7 Breast Examinations

Positioning Options

You perform this examination with the patient prone feet-first.

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Prone feet-first with the arms overhead	
Prone feet-first with the arms at the side	

Positioning with the Breast 7ch Coil

▷ Prepare the patient as usual for an MR examination.

▷ It is advisable to have the patient strip to the waist and to remove any zip fasteners in the waist area.

▷ The dS Interface is attached to the Digital Connector at the magnet end of the tabletop.

► Place the head support pad and the head support on the tabletop (at the handgrip side of the tabletop).
Place the dS Breast 7ch coil next to the head support pad.

► Connect the coil to the dS Interface with the adaptive connector.

► Put the ramp pad and the lower leg pad on the tabletop. Route the cable underneath these pads.

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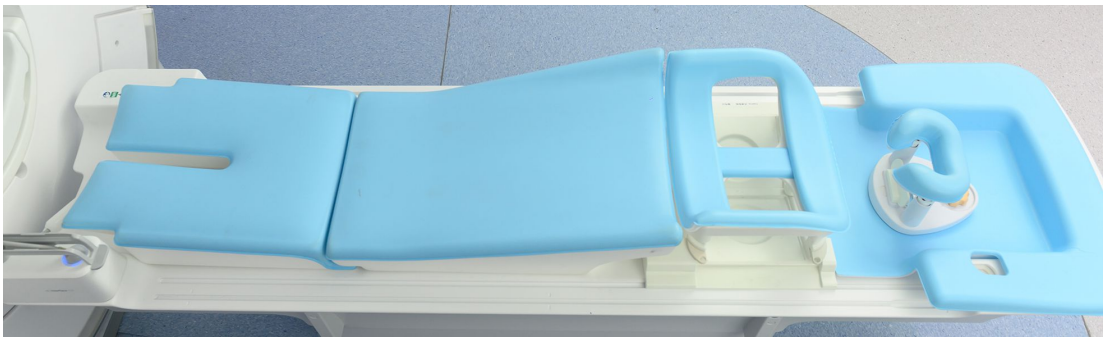

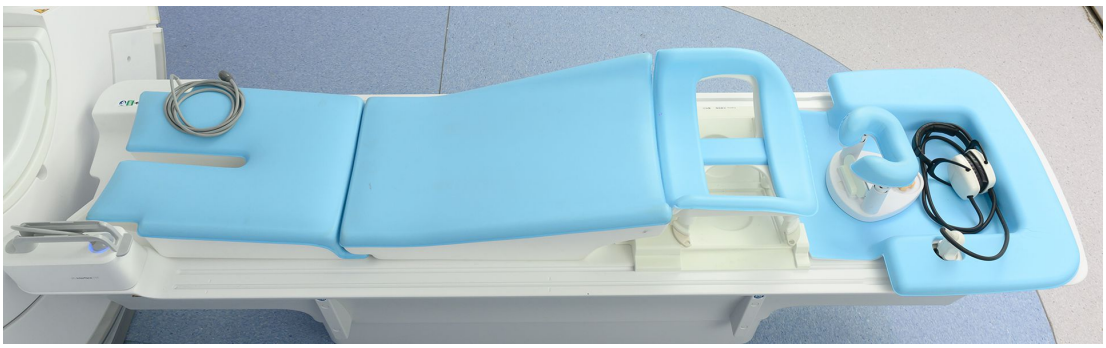

- Position the patient prone on the coil, with the head on the head support.
- Put the chest support pad underneath the patient's chest for patient comfort.
- To adjust the height of the head support, turn the knob at the head support base plate.

- Ask the patient to place the arms either next to their head or alongside their body.
- Ensure that the breasts are hanging freely in the coil, and that the breasts and the axilla area are free of folds.
- Move the patient to the isocenter.

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Breast Immobilization with dS Breast 7ch Coil

Breast immobilization can be used to reduce motion artifacts. Additional advantage of immobilizing the breast in cranial-caudal direction is the reduction of the breast volume and the number of slices required to cover the breast tissue in scanning procedures. This helps in reducing the scan time.

In the delivery of the dS Breast 7ch coil, different optional immobilization kits are included for diagnostic and/or interventional purposes. This section describes each kit with its components, its purpose and a workflow description.

Bilateral CC Immobilization kit

The Bilateral CC Immobilization kit is provided with the dS Breast 7ch coil solution for diagnostic imaging only. It consists of a base plate and two cranio-caudal compression plates. The compression plates are to be mounted on the base plate. The complete setup is to be inserted into the coil and locked in place.

Workflow

- Place the compression plates close to each other before inserting the base plate into the coil.
- Insert the base plate into the coil.
- Lock the base plate lockers.
- Position the patient as usual.
- Adjust the compression plates and lock the position of the compression plates.

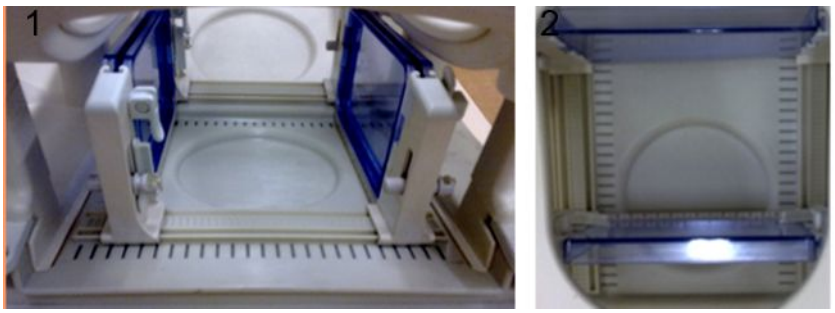

Fig. 23: Left: Base plate and cranio-caudal compression plates. Right: complete setup placed in the coil with the base plate lockers and the compression plate lockers.

Bilateral M-L Immobilization kit

The Bilateral M-L Immobilization kit is provided with the dS Breast 7ch coil solution for diagnostic imaging and for lateral and/or medial breast biopsy. It is compatible with both, the grid and the pillar method.

It consists of a base plate and two medio-lateral compression plates. The compression plates are to be mounted on the base plate. The complete setup is to be inserted into the coil and locked in place.

Workflow

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- Insert the base plate into the coil.
- Lock the base plate lockers.
- Slide the medial plate in.
- Position the patient as usual.
- Slide the lateral plate in.
- Adjust the compression plates and lock the position of the compression plates.

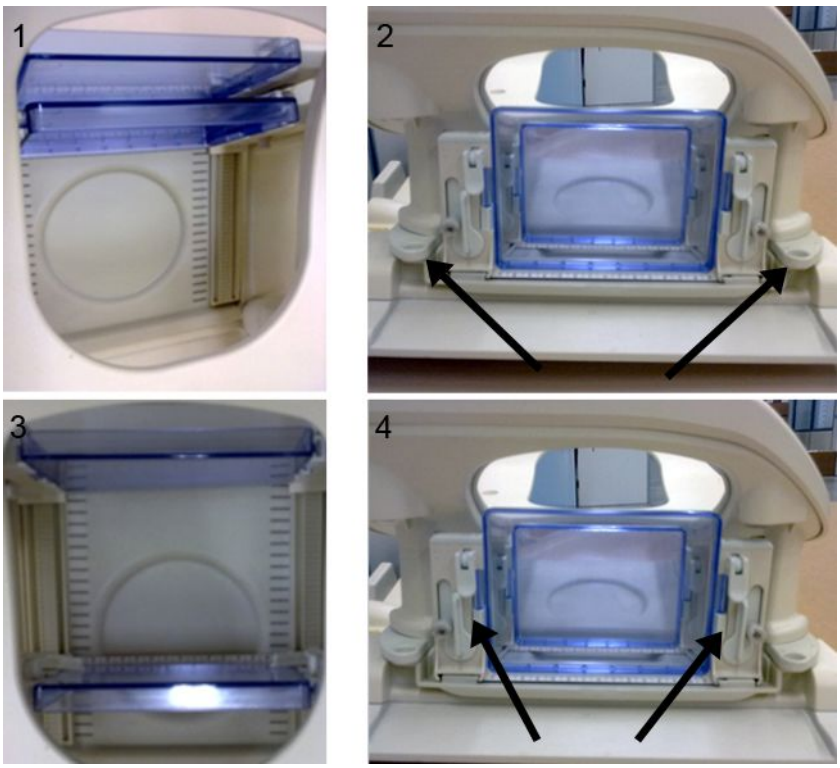

Fig. 24: 1: Compression plates on base plate, inserted into coil. 2: The arrows indicate the base plate lockers. 3: Compression plates adjusted. 4: The arrows indicate the compression plate lockers.

Unilateral CC Immobilization kit

The Unilateral CC Immobilization kit is provided with the dS Breast 7ch coil solution for cranial interventional purposes only. It is compatible with both, the grid and the pillar method.

It consists of a base plate and two cranio-caudal compression plates. The compression plates are to be mounted on the base plate. The complete setup is to be inserted into the coil and locked in place.

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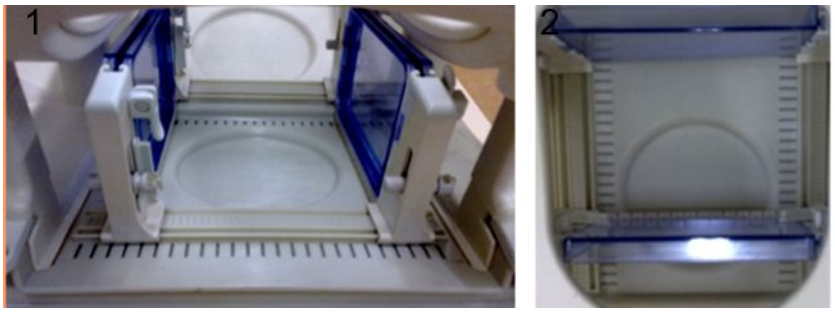

Fig. 25: Left: Base plate and cranio-caudal compression plates. Right: Base plate and medio-lateral compression plates.

Use of the cranio-caudal compression plates

- Place the compression plates close to each other before inserting the base plate into the coil.
- Insert the base plate into the coil.
- Lock the base plate lockers.
- Position the patient as usual.
- Adjust the compression plates and lock the position of the compression plates.

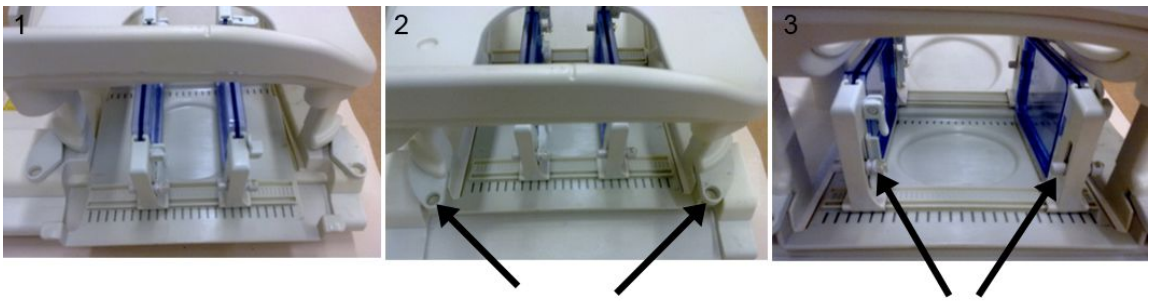

Fig. 26: 1: Compression plates on base plate, inserted into coil. 2: The arrows indicate the base plate lockers. 3: The arrows indicate the compression plate lockers.

Breast Biopsy with dS Breast 7ch Coil

Breast Biopsy Components

The coil can be used for biopsy in combination with the corresponding biopsy kit. For information about content and assembly of the biopsy kit, please refer to the user documentation provided with the biopsy kit.

Breast Biopsy Methods

Immobilization is required when localization or biopsy procedures are intended. Unilateral or bilateral breast immobilization can be performed.

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There are two different biopsy methods:

- Grid method (lateral or medial access)
- Pillar method (lateral or medial access)

Both methods can be performed either with lateral or medial access.

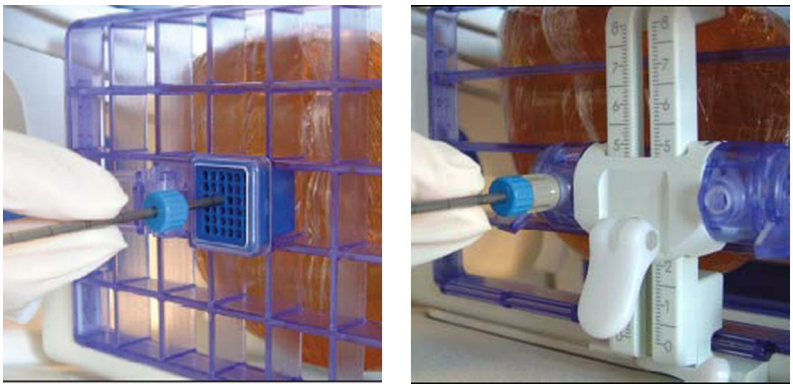

Fig. 27: Left: Grid method. Right: Pillar method.

Breast Biopsy Device Preparation

For information about content and assembly of the biopsy kit, please refer to the user documentation provided with the biopsy kit.

Breast Biopsy Workflow

Make sure that you are familiar with the set up and function of the biopsy device prior to use with a patient.

Preparation

1. Prepare the patient as usual for an MR examination:
   It is advisable to have the patient strip to the waist and to remove any zip fasteners in the waist area.
   Imaging is best performed when the breasts can hang freely in the coil aperture.
2. Prepare the tabletop in the same way as for Breast imaging.

Patient Positioning

1. Position the patient prone on the breast coil, with the head on the head support. Adjust the height of the head support by turning the knob.
2. Place the medial plate in all the way prior to patient positioning. Wait until the patient is lying down to place lateral rail.
3. Ask the patient to place the arms either next to their head or alongside their body.
4. Ensure that the breasts are hanging freely in the coil, and that the breasts and the axilla area are free of folds.

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5. Use compression from both medial and lateral sides:
   Tissue should be slightly pushing through the immobilization system. Do not over-compress since this will constrict arteries.
6. Place a vitamin E capsule (serves as marker) onto the immobilization system, away from suspected lesion location.
7. Center the light visor to the middle of the breast, and move the patient into the isocenter.

Determine needle entry point - Imaging Protocol and Calculation

The determination of the needle entry point requires the acquisition of a number of imaging series. The calculation based on these series can be performed with a DynaCAD system or manually.

1. Acquire a survey scan.
2. Make sure the marker (vitamin E capsule) is included in the FOV.
3. Perform a dynamic e-THRIVE protocol, containing 3 dynamics.
   The first dynamic serves as a mask.
   Proceed as usual with regular dynamic breast imaging.

Calculation of FH- and AP-offset and needle depth

- If a DynaCAD system is available, the needle entry point (relative to the position of the marker) and needle depth needed to target the lesion are calculated automatically.
- If a DynaCAD system is not available, then manual targeting has to be performed in the following way:

1. Find the lesion on the dynamic e-THRIVE sequence. Draw a region-of-interest (ROI) over the lesion. Copy the ROI to all slices. Note the slice number of the slice containing the lesion.
2. Find the marker (vitamin E capsule). Draw a region-of-interest (ROI) over the marker. Note the slice number of the slice containing the marker.
3. The FH offset is given by the number of slices between the marker and the lesion multiplied by the slice thickness.
4. Draw straight lines between the ROI of the marker and the ROI of the lesion. There should be a 90 degree angle between both lines.
5. The vertical line length specifies the needle entry point relative to the marker in AP direction.
6. The horizontal line length specifies the required needle depth.

Performing Breast Biopsy

1. Place the needle block in the grid.
2. Place the needle block holder in an adjacent grid slot.
3. Lock the needle block holder by depressing the tab. This will prevent the needle block from coming out when the needle is withdrawn.

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4. Insert the needle to the required depth and rescan at this location to verify the proper needle placement.
5. Once verified, obtain lesion sample.

4.2.8 Shoulder Examinations

Positioning Options

You perform this examination with the patient supine head-first.

You use the dS MSK coil(s).

- You can use two dS MSK coils for better image quality.

dS MSK coil: Supine head-first positioning of the right shoulder

dS MSK coil: Supine head-first positioning of the left shoulder

Shoulder Positioning with a Single Coil

The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the magnet end of the tabletop.

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- Attach the soft body strap to the tabletop.

- Position the patient on the tabletop with their head in the dS Base coil and with the affected shoulder on the dS MSK M coil.
  Alternatively position the patient just below the dS Base coil and provide them with a pillow.

- Wrap the coil around the shoulder. Then fix it with the soft body strap.
- Put two wedges under the contralateral side of the patient.

  Place the knee support under the patient's legs for patient comfort.

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- Connect the coil to the dS Interface.

- Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.
- To immobilize the patient's arm, put a sandbag on the lower arm.

- Move the patient to the isocenter.

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Positioning for the right shoulder

Shoulder Positioning with Dual Coil

The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector:

- **For the right shoulder** at the magnet end of the tabletop.

- **For the left shoulder** at the handgrip side of the tabletop.

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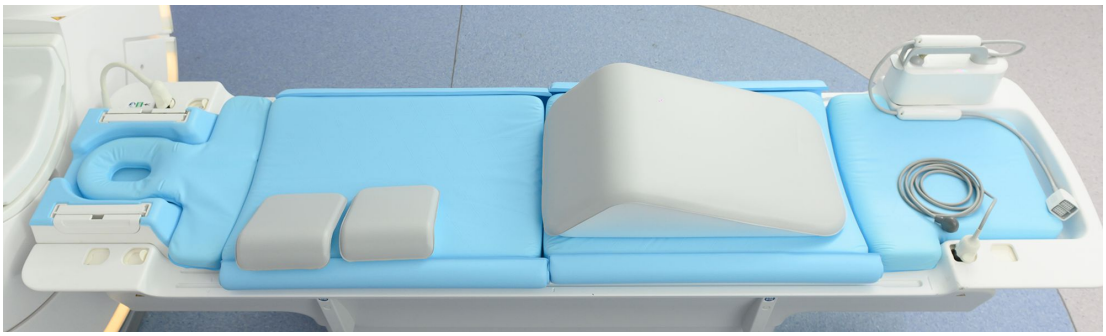
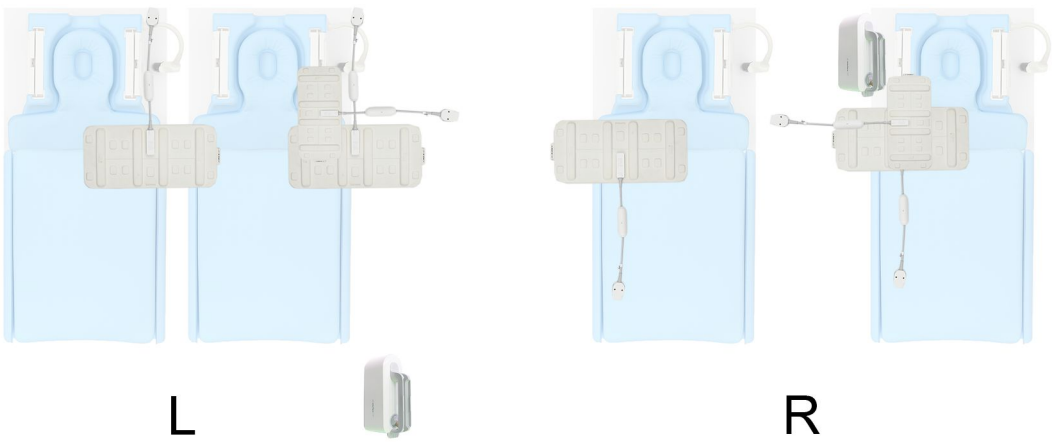


- Attach the soft body strap to the tabletop.

- Place the dS MSK M and dS MSK S coils on the tabletop as shown here for the left (L) or right (R) shoulder.



- Position the patient on the tabletop with their head in the dS Base coil and with the affected shoulder on the coils.
  Alternatively position the patient just below the dS Base coil and provide them with a pillow.
- Put two wedges under the contralateral side of the patient.

  Place the knee support under the patient's legs for patient comfort.
- Wrap the dS MSK S coil around the top of the shoulder.

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- Then wrap the dS MSK M coil around the shoulder, the upper arm and the dS MSK S coil.

- Fix the coils with the soft body strap.

- Connect the coils to the dS Interface.

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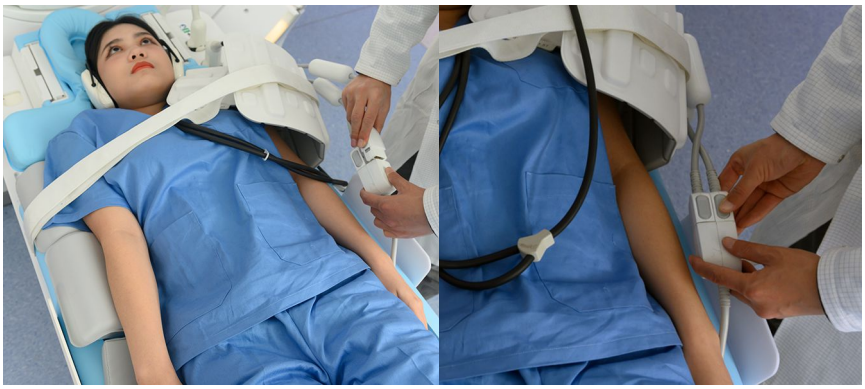

- Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.
- To immobilize the patient's arm, put a sandbag on the lower arm.

- Move the patient to the isocenter.

Shoulder Positioning with the Shoulder Positioner

The workflow for the examination with and without the positioner are identical.

The only differences are:

- You prepare the tabletop with the positioner.
- You use the positioner to securely fixate the coil around the patient's joint.
- You use the positioner to support the patient's joint.

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4.2.9 Elbow Examinations

Positioning Options

You perform the examination with the patient:

- supine head-first, or
- prone head-first.

For elbow imaging with fat saturation series, the overhead position is recommended.

You use the dS MSK M or dS MSK S coil solution.

Prone head-first with the arm overhead (superman)	Supine head-first with the arm at the side

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Elbow with the Arm at the Side

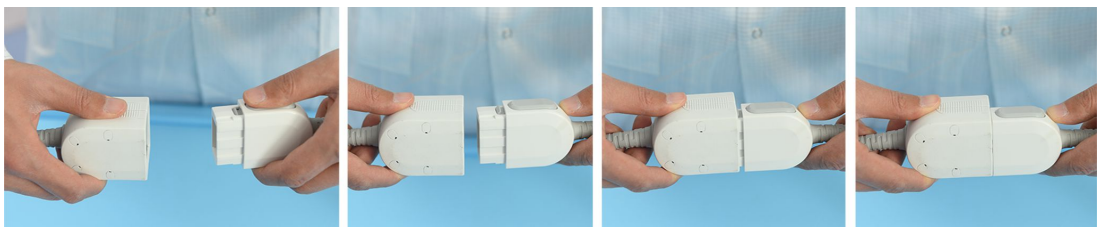
The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the magnet end of the tabletop.

1. Select either the MSK M or MSK S coil solution depending on the size of the anatomic region of interest.
2. Connect the coil to the dS Interface.



3. Position the patient on the tabletop with their head on the dS Base coil. Alternatively position the patient just below the dS Base coil and provide them with a pillow.
4. Position the patient's arm by their side as close to the isocenter as possible.

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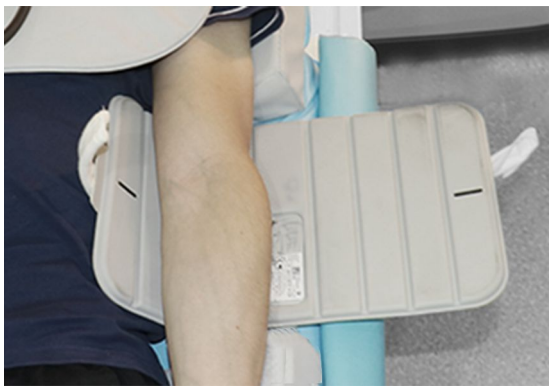
5. Wrap the coil around the elbow to be examined.



6. Use fixation straps to secure the coil.

Use sandbags above the lower arm to immobilize the arm.

7. Place wedges underneath the patient's lower arm.
Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.

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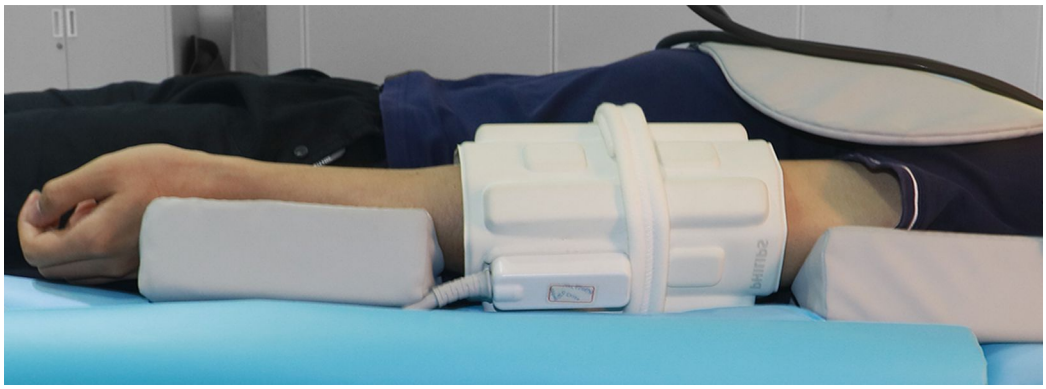

8. Place the knee support under the patient's legs for patient comfort.

9. Move the patient to the isocenter.

Positioning of the right elbow

Elbow Overhead (Prone Head-First Examination)

The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

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▷ The dS Interface is attached to the Digital Connector at the magnet end of the tabletop.

1. Position the patient prone on the tabletop with their hand on the dS Base coil.
2. Put a pillow or cushions and wedges underneath the patient for comfort.
3. Select either the MSK M or MSK S coil solution depending on the size of the anatomic region of interest.
4. Wrap the coil around the patient's wrist.
5. Use fixation straps to secure the coil.
6. Put a sandbag on the lower arm for immobilization.
7. Connect the coil to the dS Interface.

8. Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.
9. Optionally place the knee support under the patient's lower legs for patient comfort.
10. Move the patient to the isocenter.

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Elbow Positioning (at the Side) with the Universal Positioner

The workflow for the examination with and without the positioner are identical.

The only differences are:

- You prepare the tabletop with the positioner.
- You use the positioner to securely fixate the coil around the patient's joint.
- You use the positioner to support the patient's joint.

4.2.10 Hand and Wrist Examinations

Positioning Options

You perform the examination with the patient:

- supine head-first, or

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- prone head-first.

You use the dS MSK M or dS MSK S coil solution.

Supine head-first with the arm at the side	Prone head-first with the arm overhead (superman)
Left side	
Right side	Right side

Wrist (Hand at the Side) Positioning with the dS MSK Coil

The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector:

- **For the right hand and wrist** at the magnet end of the tabletop.

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- **For the left hand and wrist** at the handgrip side of the tabletop.

  - ► Position the patient on the tabletop with their head on the dS Base coil.
    Alternatively position the patient just below the dS Base coil and provide them with a pillow.
  - ► Position the patient's arm by their side as close to the isocenter as possible.
  - ► Select either the MSK M or MSK S coil solution depending on the size of the anatomic region of interest.
  - ► Place the knee support under the patient's legs for patient comfort.

    Place pads between the patient's body and arms or between legs. Also place pads in both hands.
  - ► Wrap the coil around the patient's wrist.

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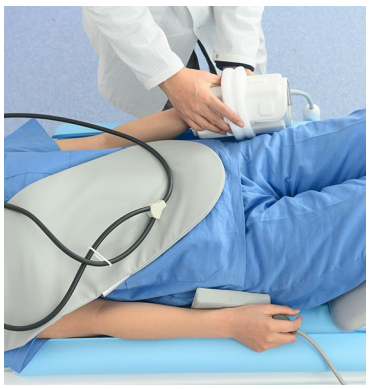
- Use fixation straps to secure the coil.



- Connect the coil to the dS Interface.

- Use sandbags to immobilize the arm.

- Move the patient to the isocenter.

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Wrist (Hand Overhead) Positioning with the dS MSK Coil

The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the magnet end of the tabletop.

► Position the patient prone on the tabletop with their hand on the dS Base coil.

► Put a pillow or cushions and wedges underneath the patient for comfort.

► Select either the MSK M or MSK S coil solution depending on the size of the anatomic region of interest.

► Wrap the coil around the patient's wrist.

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- Use fixation straps to secure the coil.
- Put a sandbag on the lower arm for immobilization.
- Connect the coil to the dS Interface.

- Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.
- Optionally place the knee support under the patient's lower legs for patient comfort.
- Move the patient to the isocenter.

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Wrist (Hand at the Side) Positioning with the Universal Positioner

The workflow for the examination with and without the positioner are identical.

The only differences are:

- You prepare the tabletop with the positioner.
- You use the positioner to securely fixate the coil around the patient's joint.
- You use the positioner to support the patient's joint.

4.2.11 Hip Examinations

Positioning Options

You perform this examination with the patient supine head-first.

You use the dS MSK coil(s).

- You can use two dS MSK coils for better image quality.

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Single Hip Exmination: Single coil	Single Hip Examination: Dual Coil

Hip Positioning with a Single Coil

The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

- ▷ The dS Base coil is on the tabletop.
- ▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.
- ▷ The dS Interface is attached to the Digital Connector at the handgrip side of the tabletop.

- ► Position the patient on the tabletop with their head on the dS Base coil and the hip on the dS MSK M or dS MSK S coil.
  Alternatively position the patient just below the dS Base coil and provide them with a pillow.

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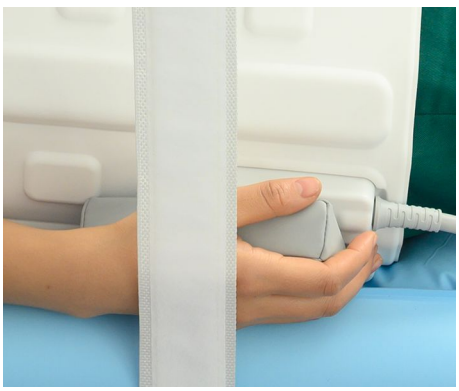
- Wrap the dS MSK M or MSK S coil (depending on the patient size) around the hip to be examined.

- Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.
  Place pads between the coil and the patient's lower arms to avoid skin-to-coil contact.



- Use fixation straps to secure the coil.

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► Connect the coil to the dS Interface.

► Move the patient to the isocenter.

Hip Positioning with Dual Coil

The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the handgrip side of the tabletop.

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- Position the patient on the tabletop with their head on the dS Base coil and the hip on the dS MSK M coil.
  Alternatively position the patient just below the dS Base coil and provide them with a pillow.

  Then put the dS MSK S coil lengthwise on top of the hip.

- Wrap the dS MSK M coil around the hip and the dS MSK S coil.

  Use fixation straps to secure the coils.

- Place pads between the coil and the patient's lower arms to avoid skin-to-coil contact.

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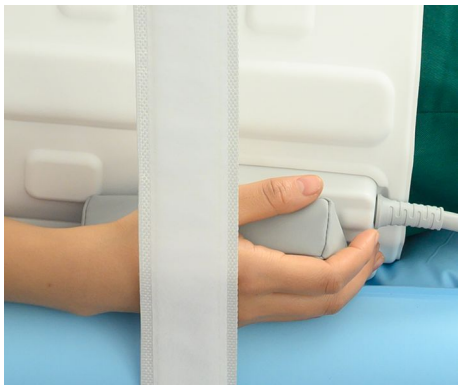

- Connect the coils to the dS Interface.

- Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.

  Move the patient to the isocenter.

4.2.12 Knee Examinations

Positioning Options

You perform this examination with the patient supine feet-first.

You use the dS MSK coil(s).

- You can use two dS MSK coils for better image quality.

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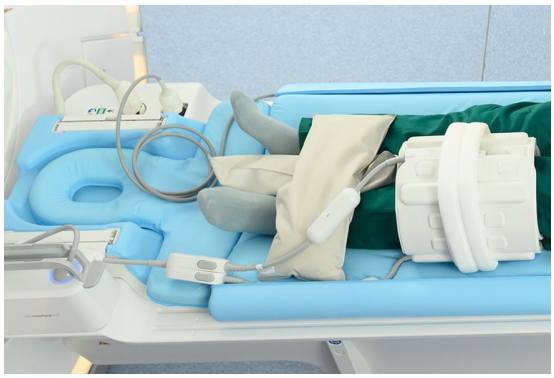
- You can position the patient with or without the universal positioner, depending on the availability of the positioner, the size of the joint and the condition of the patient.

Knee examination: Single coil without positioner	Knee examination: Dual coil without positioner
	

Knee Positioning with the dS MSK coil

The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the magnet end of the tabletop.

► **Only if you use the general purpose positioner:** Place the universal positioner on the mattress.

► Put the coil on the tabletop, and if available in the positioner.

► Position the patient on the tabletop with their feet on the dS Base coil and with the affected knee on the coil.

► Use positioning aids for patient comfort and to support the legs, the upper body and the head.

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- Wrap the coil around the knee.

- Fit the coil with a strap.

- **Only if you use two dS MSK coils:** First wrap the dS MSK M around the joint, then wrap the dS MSK S coil around the joint.
  Fix both coils with a strap.

- Connect the coil(s) to the dS Interface:

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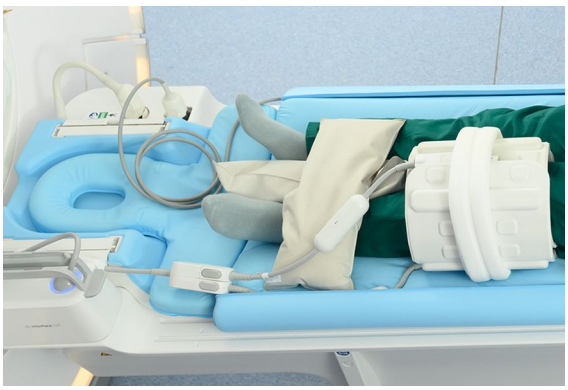
- Put a sandbag on the patient's lower legs.



- Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.

- Move the patient to the isocenter.

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Knee Positioning with the Universal Positioner

The workflow for the examination with and without the positioner are identical.

The only differences are:

- You prepare the tabletop with the positioner.
- You use the positioner to securely fixate the coil around the patient's joint.
- You use the positioner to support the patient's joint.

4.2.13 Foot and Ankle Examinations

Positioning Options

You perform this examination with the patient supine feet-first.

You use the dS MSK coil(s).

- You can use two dS MSK coils for better image quality.
- You can position the patient with or without the universal positioner, depending on the availability of the positioner, the size of the joint and the condition of the patient.

Foot and ankle examination: Single coil without positioner	Foot and ankle examination: Dual coil without positioner

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Foot and Ankle Positioning with a Single Coil

The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the magnet end of the tabletop.

► **Only if you use the general purpose positioner:** Place the universal positioner on the mattress.

► Select either the MSK M or MSK S coil solution depending on the size of the anatomic region of interest.

► Put the coil on the tabletop, and if available in the positioner.

► Position the patient on the tabletop with the anatomic region of interest on the coil.

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- *Without the general purpose positioner:* wrap the coil around the foot or ankle and fix it with a strap.

- *With the general purpose positioner:* close the positioner so that the coil is around the foot or ankle.
- To immobilize the feet and ankles, place sandbags on both sides of the lower leg.

- Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.
- Connect the coil to the dS Interface.

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► Move the patient to the isocenter.

Foot and Ankle Positioning with Dual Coil

The images in this section show the workflow of a bilateral joint for only one side. The workflow itself is valid for both joints.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

▷ The dS Interface is attached to the Digital Connector at the magnet end of the tabletop.

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- Put the MSK M coil on the tabletop.
- Position the patient on the tabletop with the anatomic region of interest on the coil.

- Place the MSK S against the bottom of the foot and around the foot (perpendicular to the MSK M coil).

- Close the MSK M coil. Take care that the MSK S coil stays in place.

- Fix both coils with a strap.

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- Connect the coils to the dS Interface.

- Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.

- To immobilize the feet and ankles, place sandbags on both sides of the lower leg.

- Move the patient to the isocenter.

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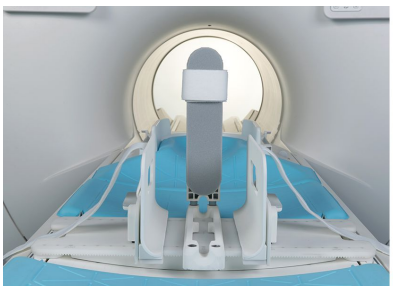
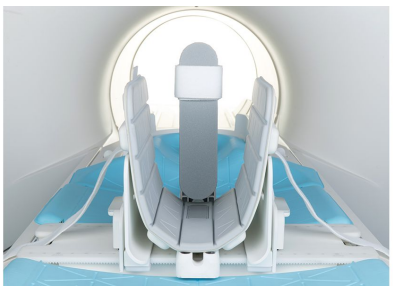
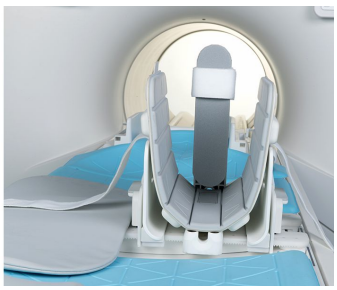
Foot and Ankle Positioning with the Universal Positioner

The workflow for the examination with and without the positioner are identical.

The only differences are:

- You prepare the tabletop with the positioner.
- You use the positioner to securely fixate the coil around the patient's joint.
- You use the positioner to support the patient's joint.

4.2.14 Long Bones Examinations

Positioning Options

You perform this examination with the patient supine head-first or feet-first.

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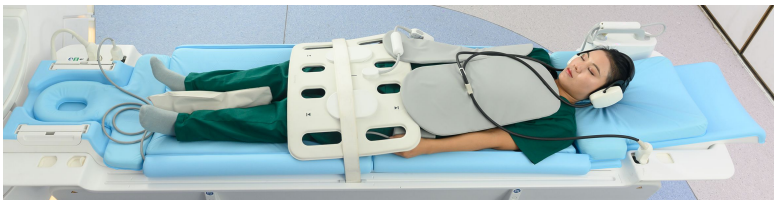
You use one dS TorsoCardiac coil.

dS TorsoCardiac coil: Supine head-first and feet-first	
Feet- first	
Head-first	

Positioning Head-First with the dS TorsoCardiac Coil

- ▷ The dS Interface is attached to the Digital Connector at the handgrip side of the tabletop.
- ▷ The dS Base coil is on the tabletop.
- ▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

1. Position the patient supine on the tabletop with their head on the dS Base coil.
2. Place the coil on the patient's upper legs.

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3. Strap the coil around the patient.
4. Route the cable from the coil towards the dS Interface.

5. Connect the coil to the dS Interface.

6. Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.

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7. Put arm supports on both sides under the patient's lower arms to have the arms safely positioned during tabletop movement.
8. Move the patient to the isocenter.

Positioning Feet-First with the dS TorsoCardiac Coil

▷ The dS Interface is attached to the Digital Connector at the handgrip side of the tabletop.

▷ The dS Base coil is on the tabletop.

▷ The tabletop is covered with mattresses. For patient comfort, the spacer mattress is placed in the dS Base coil.

1. Position the patient supine on the tabletop with their head on the T-shape mattress, or if used the Head/Leg support.
   Put a pillow under the patient's head for patient comfort.
2. Place the coil on the patient's upper legs.

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3. Strap the coil around the patient.

4. Route the cable from the coil towards the dS Interface.
5. Connect the coil to the dS Interface.

6. Place pads between the patient's body and arms or between legs to avoid skin-to-skin contact.

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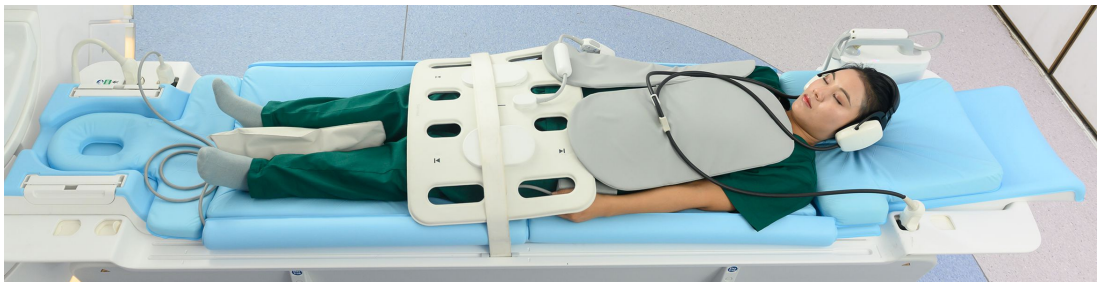


7. Put arm supports on both sides under the patient's lower arms to have the arms safely positioned during tabletop movement.
8. Move the patient to the isocenter.

4.3 Applying Physiology Sensors

4.3.1 Positioning of the Respiratory Belt

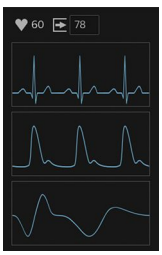
- Place the belt on the patient's upper abdomen or lower chest (whichever expands most during inspiration - preferably the area to be scanned).

  For optimal signal, place the belt directly under the coil in longitudinal direction.
- Use a positioning strap to fix the sensor.
- Connect the flexible tube to the wireless module (or to the UIM).

NOTICE

Avoid excessive bending of the flexible tube as this may impair detection of the patient's respiration.

- Check the respiratory signal in the **Physiology Display** window.



- Position the patient in the magnet.

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If the Respiratory Signal appears to weaken

Instruct the patient, between scans, to breathe more deeply during the scan (thus creating more movement at the sensor).

Related Parameters

- Respiratory Compensation

For more information, refer to the system's **Help Topics**.

4.3.2 Detecting respiratory motion with the VitalEye

This workflow applies to detect respiratory motion with the VitalEye and to visualize the respiratory signal at the physiology display units (**Physiology Display** window, VitalScreen).

- You do not need to switch the VitalEye on or off. It is always ready to use.
- The infrared bore lights switch on automatically.
- ► Enter a **New Examination**. Select an ExamCard with at least one respiratory triggered scan or one breathhold scan.

  With any ExamCard, you can enable the display of the VitalEye respiratory signal

  Once patient and ExamCard are selected at the console, a message is displayed at the physiology display units:
  “Move patient to isocenter to view the respiratory signal”.
- ► Position the patient with coils and positioning aids on the tabletop.
- ► Travel the patient to the isocenter.

  When the tabletop reaches the isocenter, the VitalEye camera switches on automatically and the VitalEye respiratory signal gets displayed.
- ► Verify that the line of sight of the camera is not obstructed.

  If the line of sight of the camera is obstructed, also apply the respiratory belt.

The line of sight is possibly obstructed when you use

- the head-and-arm support (when the patient is positioned with the arms up),
- the knee support with patient feet-first,

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- the FlexTilt device with the dS HeadSpine or the dS HeadNeckSpine coil solution,
- the anterior coil frame,
- anything that significantly covers the patient's chest.

► At the physiology display units, select **VitalEye** and check the quality of the VitalEye respiratory signal.

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Display of respiratory traces

- The respiratory signal that is selected for display is always used for respiratory triggering (without the need of an imaging parameter to select the respiratory trigger device).
- The display of the VitalEye respiratory signal is paused during tabletop movement.

  In this case, the respiratory trace is replaced by the tabletop movement icon.
- It is not possible to display the respiratory traces from the VitalEye and the respiratory belt at the same time.
- Dependent on the physiology enabled in the ExamCard and the physiology sensors connected to the patient, default signal traces are displayed at the physiology display units:

Physiology enabled in ExamCard	Physiology connected to patient	Default signal traces at physiology display units
• Respiratory compensation (triggering or breath-hold)	nothing	• Respiratory signal of VitalEye
• Respiratory compensation (triggering or breath-hold) • but not PPU triggering	Wireless-PPU battery module (which has a connection for the respiratory belt)	• Respiratory signal of respiratory belt
• Respiratory compensation (triggering or breath-hold) • PPU triggering	Wireless-PPU battery module (which has a connection for the respiratory belt)	• Respiratory signal of VitalEye (The respiratory belt signal is not replacing the VitalEye signal at the physiology display units.) • PPU signal

To override the default signal traces, manually select another signal trace.

4.3.3 Positioning of the Peripheral Pulse sensor

NOTICE

Do not place the wireless unit in proximity of the System Body coil.

- ► Push the fiber optic tip into the retainer of the attachment firmly until you hear the click. Assure the sensor cable is snug on the attachment and does not fall off. It may swivel but not wiggle.
- ► Repeat for the other cable leg.
- ► Attach to limb. Light may shine on top or on bottom of the limb.

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NOTICE

Failure to insert the tip properly will compromise the measurement accuracy, and may cause error messages to be displayed on the monitor or prevent a reliable measurement.

- ► Select the proper attachment for the application.
  - Always select the attachment that provides a snug fit.
  - Make sure the sensor windows are completely covered by skin or nail.

NOTICE

Avoid placing the sensor on extremities with an arterial catheter, intravascular venous infusion line, or inflated blood pressure cuff. Failure to do so may result in inaccurate readings or false alarm indications.

- ► Apply the attachments.

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NOTICE

Fit the sensor while the patient is outside the magnet.

NOTICE

The finger must not be moved during the scan.

Reusable Clips

- ► Press the clip to open.
- ► Push the clip over a finger so either fiber head is on the top over the root of the nail and the other fiber head opposite to it. It does not matter which head is on top.
- ► Assure that the finger is touching the stop at the cushion and lays nicely centered in the clip.

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NOTICE

You may swivel each fiber head into a position that provides most comfort to the patient and bends the cable least.

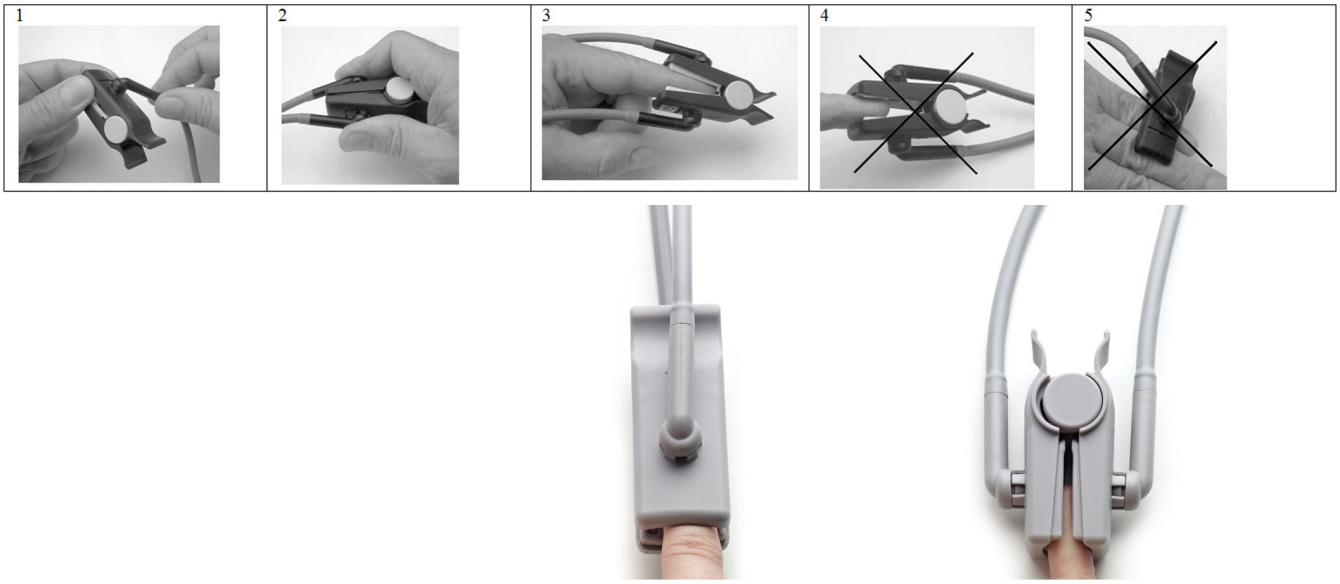

Fig. 28: PPU SpO_2 attaching reusable clip A.

Disposable Grips A, P and I

- Lift off the release liners that protect the adhesive.
- Put the finger or toe onto either side of the attachment - they are symmetrical - such that the tip covers the window completely and the finger does not protrude over the hinge.
- Close the grip.
- If the fit is good, press the attachment firmly on the finger or toe. If the fit is not good, reposition the attachment.
- Wrap the foam wings around the finger and attachment and stick to the opposing grip side. Do not stretch the foam to apply excessive pressure.

NOTICE

You may swivel each fiber head into a position that provides most comfort to the patient and bends the cable least.

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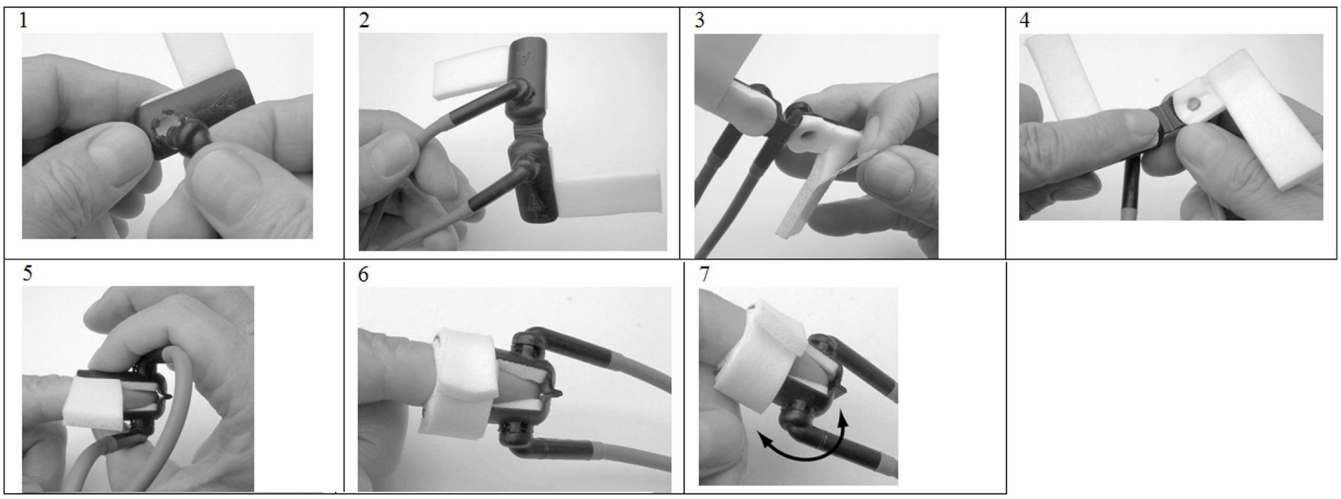

Fig. 29: PPU SpO_2 attaching disposable clip A.

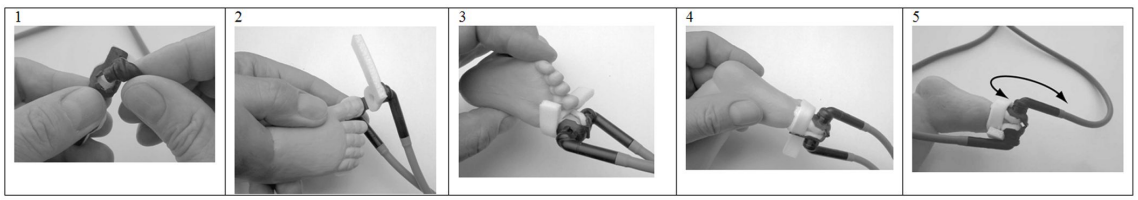

Fig. 30: PPU SpO_2 attaching disposable clip I.

Disposable Grip N

- Lift the release liners that protect the adhesive part.
- Foot application: Align the hinge on the outside facing ridge of the foot. Make sure the attachment is as far as possible toward the small toe but never over it.
  Hand/wrist application: Align the hinge on the outside facing ridge of the hand or wrist. You may have to swivel the fiber heads to an optimal position to ease the application.
- If the hinge is in line with the ridge of the foot/hand/wrist, press one side to the skin.
- Wrap the other side around the limb pulling the long foam piece gently.
- Press both fiber heads gently to attach the adhesives.
- Secure the longer foam piece by pressing it firmly to the foam/adhesive of the opposing side.
- Assure the two fiber heads are opposing and have good skin contact. The angle between the two fiber heads should be as small as possible not exceeding 45°. If the attachment opens too much, reattach or try another side.

NOTICE

You may swivel each fiber head into a position that provides most comfort to the patient and bends the cable least.

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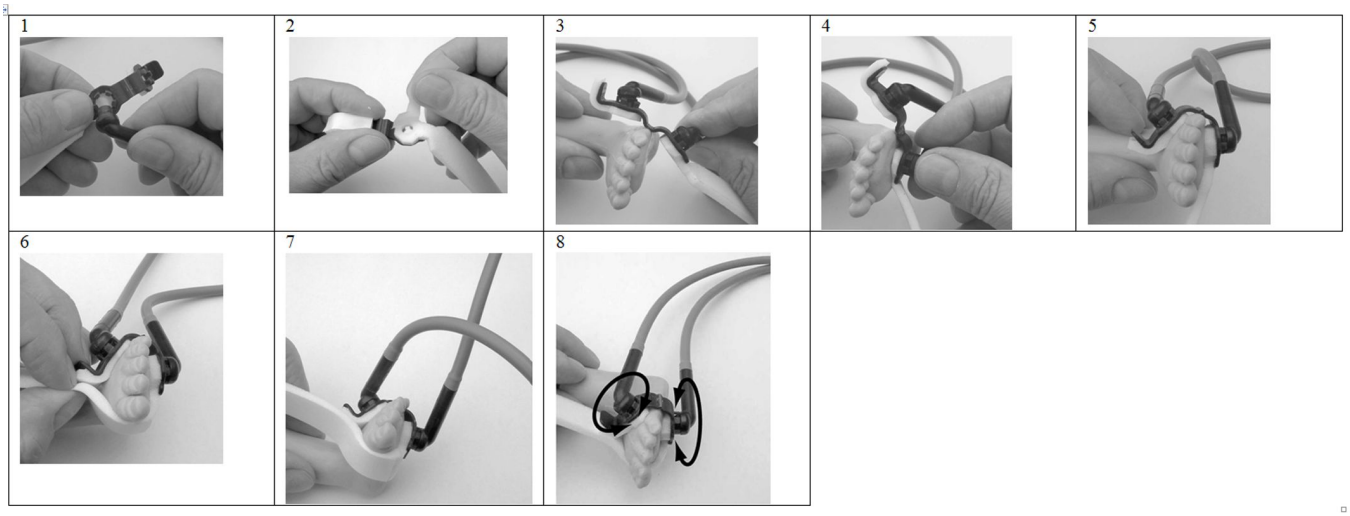

Fig. 31: PPU SpO_2 attaching disposable clip N.

Displaying the PP sensor signal

► Check the PP sensor signal and the trigger pulses in the Physiology Display.

NOTICE

Instruct the patient that the finger must not be moved during the scan.

If the signal is too weak,

- fit the sensor to another finger on the same hand or on the other hand.
- keeping the finger warm may help.
  Excessive pressure on the finger will decrease the blood flow and weaken or suppress the signal.

4.3.4 Connecting VCG to the patient

Patient preparation and electrode positioning play an important role in obtaining high quality VCG signals. The recommended workflow is described in this section.

The quality of the VCG signal is also influenced by other factors. For more information, see chapter “Factors affecting the VCG signal” on page 202.

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WARNING

Wrong usage of ECG electrodes.

Risk of patient skin burns

- **When positioning ECG electrodes for the VCG module:**
  - **Only use MR Conditional electrodes and leads.**
  - **Make sure electrodes have not passed their expiration date. ECG electrodes can dry out resulting in bad electrical contact.**
  - **Properly prepare the patient and apply electrodes correctly.**
  - **Never reposition or reuse electrodes. Always use new electrodes.**
  - **Always carefully read and strictly follow the Instructions for Use of the electrode manufacturer.**

NOTICE

For best results, it is recommended to use the Philips M2202A radio translucent foam monitoring electrode.

(https://shop.medical.philips.com)

WARNING

Do not use pediatric ECG electrodes on adults or Adult ECG electrodes on pediatric patients.

The use of wrong ECG electrodes may result in skin burns.

Position the electrodes

NOTICE

Position the electrodes as described in this section.
Do not use the alternative lead placements that are described in the manuals of InVivo monitoring equipment (e.g. Expression, Expression MR400). Do not use the lead placement instruction as indicated on the label of the VCG-cable.

These alternative lead placements are not optimized for the purpose of cardiac synchronization in MRI-sequences.

► Prepare the patient's skin according to the electrodes manufacturer's Instructions for Use.

To reduce skin impedance and to ensure good contact between electrodes and skin, proper skin preparation is required. Proper skin preparation

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- prevents electrodes from coming loose and consequently avoids signal loss.
- prevents high skin impedance that leads to noise in the VCG and to warming of the skin.

► Position the first electrode below the first intercostal space, just left of the sternum.

► Position the second electrode just left of xiphoid, approximately 10 cm to 15 cm below the first one.

► Position the third electrode at the patient's left side, forming a 90° angle with the other two electrodes. Keep the distance between black and red similar to the distance between white and black. If positioned correctly, the imaginary line (between the second and the third electrode) runs under the nipple line.

► Position the fourth electrode just below the second electrode.

► Connect the leads to the electrodes.

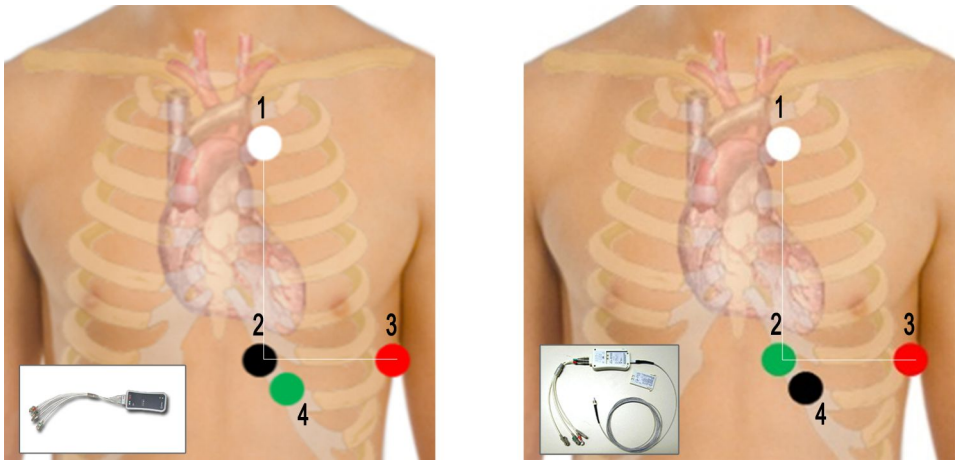

Fig. 32: The black and green electrodes are exchanged from wireless physiology to wired physiology, while white and red are identical.

► Make certain that the cables are correctly inserted into the VCG module.

4.3.5 Color Codings of the ECG/VCG clips

Color of the Clip	Function with Wireless Physiology	Function with Wired Physiology	Physiology Display
white	active 1	active 1	upper trace VCG1

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Color of the Clip	Function with Wireless Physiology	Function with Wired Physiology	Physiology Display
red	active 2	active 2	lower trace VCG2
green	common ground	common active	
black	common active	common ground	

NOTICE

The color coding is compliant with international standards.

The recommended lead positioning provides proper interoperability with the Precess monitor of Invivo.

NOTICE

Color coding as described above follows the AAMI/AHA (American standard) color coding standard. With Expression MR400 monitor, cables may be provided that follow the IEC (European standard) color coding Standard.

Function of the clips in the IEC color coding standard:

- Red = active 1 /upper trace VCG1
- Green = active 2 / lower trace VCG2
- Black = common ground
- Yellow = common active

4.3.6 Deviations from the recommended electrode positioning

Under certain conditions, you can deviate from the recommended electrode positioning.

1. **In patients with sternal wires:**
   - Position the white and black electrodes more towards the patient's right side.
   - Alternatively position them on the patient's back.
   - Take care that you do not place the leads too high on the back (consider the imaginary nipple line).
2. **Patient dependent in case of insufficient VCG signal:**
   - The optimal distance between the electrodes varies per patient.
   - A greater distance increases the SNR of the QRS-complex, but also noise and baseline distortions (T-wave artifact).
   - A smaller distance decreases the SNR of the QRS-complex, and also decreases baseline distortions (T-wave artifact).

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NOTICE

When using InVivo monitoring equipment (e.g. Expression, Expression MR400) in an MRI-environment, ensure that the monitor is in Magnet mode. This ensures that the scanner controls the Module Filter settings.
The warning 'Interoperability Mode Disabled' is displayed in the PSA when Magnet mode is disabled

For more information about magnet mode, see the InVivo user documentation.

4.3.7 Placing the VCG battery module

▷ The electrodes are positioned. The leads are connected. The cables are correctly inserted in the VCG battery module.

- ► Put the VCG battery module on the tabletop either between the legs or to the side.
- ► If you put the VCG battery module to the side, you can place the knee cushion on top of the VCG module.
- ► Place the cable in a straight line and fixate it with a positioning strap. You can use one strap for VCG battery module and respiratory belt.
  Make certain that the cable is not under tension.
- ► Let the patient deeply breathe in and out to make certain that leads and cables don't move during deep inspiration and expiration.
  If leads and cables move, fix them with straps.
- ► Make certain you adhere to the following warnings.

WARNING

Do not place the VCG battery module (VCG or PPU unit) directly on the patient's skin.

Direct contact may cause heating of the skin. Keep a distance to the patient's skin of at least 1 cm using pads of the standard auxiliary set.

WARNING

Do not place the VCG battery module (VCG or PPU unit) close to the imaging volume.

This may cause image artifacts.

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WARNING

Avoid cable loops and twisted cables.

Loops can cause excessive heating of the cables which may result in burns upon (full or partial) contact to patient's skin.
Special attention is needed when VCG is used with Transmit-Receive coils.

4.3.8 Adjusting the Display of the Physiology Signals

When physiology sensors are applied to a patient, the physiology signals are displayed in the Physiology Display of the Exam Dashboard.

You adjust the display of the physiology signals in the Physiology Display, in the Extended Physiology display and in the **Physiology Properties** window.

If available on your MRI system, you can also adjust the display of the physiology signals on the VitalScreen. See chapter Your MRI System -> VitalScreen -> Routine Procedures.

- ► To access the **Physiology Properties** window, right-click the Physiology Display and select **Physiology properties**.
- ► To access the Extended Physiology Display, click any of the physiology signals in the Physiology Display.

Selecting (or changing) the physiology sensor for display

▷ In the Physiology Display:

- ► Right-click the slot reserved for physiology signals, and select: **VCG**, **PPU**, **Respiratory Belt**, **VitalEye** (if available) or **External**.

Entering and updating the heart rate

In examinations with **VCG** or **PPU** (or a similar **External** device), you enter the heart rate for the examination in the **Exam Setup**. Cardiac synchronization uses this entered heart rate for the calculation of triggers and no-trigger periods. When the entered heart rate differs too much from the current heart rate, proper cardiac synchronization is not possible anymore.

▷ In the Physiology Display:

- ► Check the entered heart rate and the current heart rate.
  If the difference is large, do any of the following to update the entered hear rate:
  - Click **Update heart rate**.
  - Click the text field of the entered heart rate (tooltip: **Enter heart rate manually**), and enter the heart rate.

Adjusting the time range for display

▷ In the Physiology Display:

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- ► Right-click the physiology signals, and select **Time range**.
- ► Select **1s**, **2s**, **5s (default)**, **10s**, **15s**, or **25s** seconds.

Adjust the Display Options of the Physiology Display

▷ In the **Physiology Properties** window:

- ► Enable or disable to **View Gridlines**.
- ► Enable or disable the display on the **Magnet Display**.
- ► Set the **Scale** of the physiology display to **AutoScale**, or (only available for VCG only) to a fixed value (in mV).

4.3.9 Checking Connectivity and Battery Level

The physiology sensors work with a battery module. In case of a wireless battery module, the module needs to connect to a network. For proper functioning of the physiology equipment, battery level and connectivity are crucial.

You check connectivity and the battery level in the Physiology Display, in the Extended Physiology Display or in the **Physiology Properties** window.

If available on your MRI system, you can also check connectivity and the battery level on the VitalScreen. See chapter Your MRI System -> VitalScreen -> Routine Procedures.

- ► To access the **Physiology Properties** window, right-click the Physiology Display and select **Physiology properties**.
- ► To access the Extended Physiology Display, click any of the physiology signals in the Physiology Display.

Checking battery status and communication strength

▷ **Only applicable for wireless modules!**

▷ You are in the Physiology Display, in the Extended Physiology Display or in the **Physiology Properties** window.

- ► Visually check the battery status (**VCG** and/or **PPU/Resp**).
- ► Visually check the communication strength (**VCG** and/or **PPU/Resp**).

Selecting the wireless network

For wireless physiology, you need to select the wireless network.

- ► To open the **Physiology Properties** window, right-click the Physiology Display and select **Physiology properties**.
  For compatibility with InVivo monitoring equipment (e.g. Expression), ensure that all components (VCG or PPU battery module, operator's console and InVivo monitor) are on the same wireless network.

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► To select the wireless network, select **A, B, C, D, E**, or **1** - **10**, under **Network selection**.

Module type and related network selection must be selected if interoperability with **Expression MR400** is provided.

4.3.10 Calibrating the VCG signal manually

This workflow describes the manual VCG calibration on the MR console.

If available on your MRI system, you can also manually calibrate the VCG signal on the VitalScreen. See chapter Your MRI System -> VitalScreen -> Routine Procedures.

Starting and executing manual calibration

▷ You have entered the examination data of the patient.

▷ You have positioned the patient on the tabletop with nurse call, hearing protection, coil, VCG, PPU (recommended, but not mandatory) and respiratory belt.

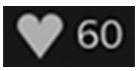
▷ The tabletop is still outside the bore, since this position is recommended for manual VCG calibration.
Alternatively you can perform manual VCG calibration inside the bore.

► To open the **Physiology Properties** window, right-click in the **Physiology Display** panel and select **Physiology properties**.

► Select **Manual Calibration**.
This setting is persistent over examinations.

- Trigger markers are not yet displayed on the VCG signal in the **Physiology Display**, but only when VCG calibration is complete.
- The patient's measured heart rate is not yet displayed.

► Click **Start Calibration**.

Alternatively click the blinking **measured HR**  icon in the **Physiology Display**.

⇨ A message is displayed indicating that VCG calibration is requested and the duration of the calibration is 15 seconds.

► Instruct the patient to lie still and to breathe regularly.

► To start VCG calibration, click **Proceed**.
Alternatively to stop the VCG calibration, click **Cancel**.

⇨ During calibration, a message pops up telling that VCG calibration is in progress and indicating the remaining time.:

VCG calibration in progress, please wait... Time remaining

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Calibration results

Upon completion of manual VCG calibration, the results are automatically analyzed and displayed as:

- Signal **Strength** (as color scale and expressed in mV)
- Trigger **Quality** (as color scale).

The effects of manual VCG calibration are immediately visible:

- In the **Physiology Display**
  - The results of the calibration are applied immediately to allow visual inspection of the VCG triggering quality.
  - The patient's measured heart rate is displayed.
  - Trigger markers are overlaid on the VCG signal.
- In the **Extended Physiology Display**
  - The VCG calibration icon indicates successful manual VCG calibration.

Performing clinical scans based on the calibration results

► Continue depending on the quality of the results.

If the results are good, very good or excellent	If the results are sub-optimal or bad
► Click **Accept**. ⇨ The results are stored with their tabletop position. You can access the stored calibrations results in the **Physiology Properties** window. ► To switch between different VCG calibration results (if available), enable in- or out-bore results for display. ► Move the tabletop to the isocenter and start the examination. ► Control if the measured heart rate corresponds with the entered heart rate in the **Exam Setup**. ► To update the entered heart rate with the current heart rate (if needed), click (**Update heart rate**). Alternatively, enter the value in the text field or in the **Exam Setup**.	► Click **Cancel** to discard the results. Previous results (if available) are applied for this scan. OR ► Take corrective actions. For more information, see chapter “Calibration Results” on page 939. ► Click **Repeat** to discard the results and repeat the calibration.

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Usage of manual VCG calibration results

Stored manual VCG calibration results are applied until the operator:

- initiates a new VCG-calibration.
- recalls a previously stored VCG-calibration.
- disables manual calibration.

Repeating manual VCG calibration

Repeat a manual VCG calibration in case of

- unsatisfactory results of the recent VCG calibration (e.g. low signal, low quality)
- change in patient conditions during the examination (e.g. size of MHD-artifact disturbs triggering, change in heart rhythm / breathing conditions during stress)

4.4 Travelling to scan-plane

4.4.1 Moving patient to isocenter

This workflow describes how to position the patient in the isocenter. This includes the workflows:

- Raising the tabletop to working level
- Centering by means of the light visor,
- Travelling to scanplane,
- Return to scanplane after moving the tabletop out of the magnet.
- Manual operation.

Related User Interface Module (UIM) Buttons

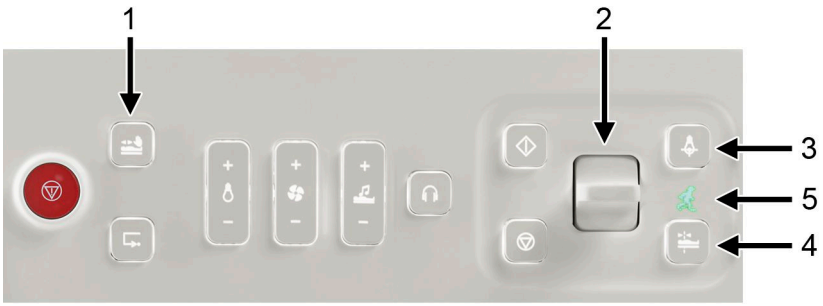

Fig. 33: User Interface Module (UIM) at the magnet, with 1: 'Manual' button, 2: Tumble switch, 3:'Light visor' button, 4: 'Travel-to-scanplane' button, 5: Indicator for isocenter positioning.

Raising the Tabletop to Working Level

▷ The patient is positioned on the tabletop with the coils and all required positioning aids. The tabletop is still lowered.

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- ► Raise the tumble switch (2) to the `Up/in' position and hold. Release the switch when the tabletop is in its highest position.

⇨ The tabletop is now at working level.

NOTICE

When holding the tumble switch continuously in the up/in position, the tabletop movement continues in horizontal direction after reaching its highest position.

Centering by means of the Light Visor

- ► Raise and hold the tumble switch (2) again to the `Up/in' position to horizontally move the tabletop until the area of interest is near the magnet bore or at the magnet bore.
- ► Press the 'Light visor' button (3) once to switch on the light visor beams.
  The light visor beams indicate the mid-sagittal and a transverse plane.
- ► Raise the tumble switch (2) to the 'Up/In' position and hold it until the area of interest lies within the light visor beams.
  Coil and area of interest do not have to be in the middle of the beams. The closer the area to be imaged is to the isocenter, the better the image quality.

  The indicator for isocenter positioning (5)
  - lights green when isocenter positioning is possible with the current light visor position.
  - flashes green when isocenter positioning is not possible with the current light visor position.
    Reposition the patient feet-first or move him/her closer to the magnet.

Travelling to Scanplane

NOTICE

The examination/patient data must be entered before the 'Travel-to-scanplane' button can be used.

- ► Press and hold the 'Travel-to-scanplane' button (4) for about 2 seconds.
  Alternatively, briefly press the 'Travel-to-scanplane' button (4) and raise the tumble switch (2) to the 'Up/In' position and hold it until the isocenter is reached.

⇨ The tabletop will automatically be moved into the magnet until the isocenter is reached.

- Care should be taken that cables (coils, VCG) or tubes (IV drip, catheter) do not get caught.
- Verbal or physical contact is reassuring to a patient.

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- Note that if the 'travel-to-scanplane' tumble switch (2) is released before table motion has ceased, the table will stop before reaching the isocenter.

  The indicator for isocenter positioning flashes green to indicate that the isocenter has not been reached yet. In this case, raise the switch again and the tdfletop will resume its predefined travel.

NOTICE

In order to stop automatic table movement, touch the tumble switch or press the 'Travel-to-scanplane' button.

Return to scanplane after moving the tabletop out of the magnet

This function makes it possible to return to the original position after the table has been moved. This feature is especially helpful for studies with contrast agent administration.

- ► Use the tumble switch to move the table out of the magnet after the scans have been performed.
- ► After administering contrast agent, simply press and hold the 'Travel-to-scanplane' button (4) again for about 2 seconds.

  The tabletop will stop at the previously indicated isocenter position.

NOTICE

Do not move the table right out to the end stop, and do not press the 'Light visor' button.

These actions would reset the isocenter position.

For manual operation

- ► Release the tabletop by pressing the 'Manual' button (1).
- ► Move the tabletop manually towards the magnet until the area of anatomical interest lies within the light visor beams.
- ► Press the 'Manual' button (1) again to lock the tabletop.
- ► Press the 'Travel-to-scanplane' button (4).
- ► Raise the tumble switch (2) to the 'Up/In' position and hold it until the isocenter is reached.

4.5 Prepare Tab

The **Prepare** tab includes all workflow steps which are needed for the successful preparation of an examination on the operator's console.

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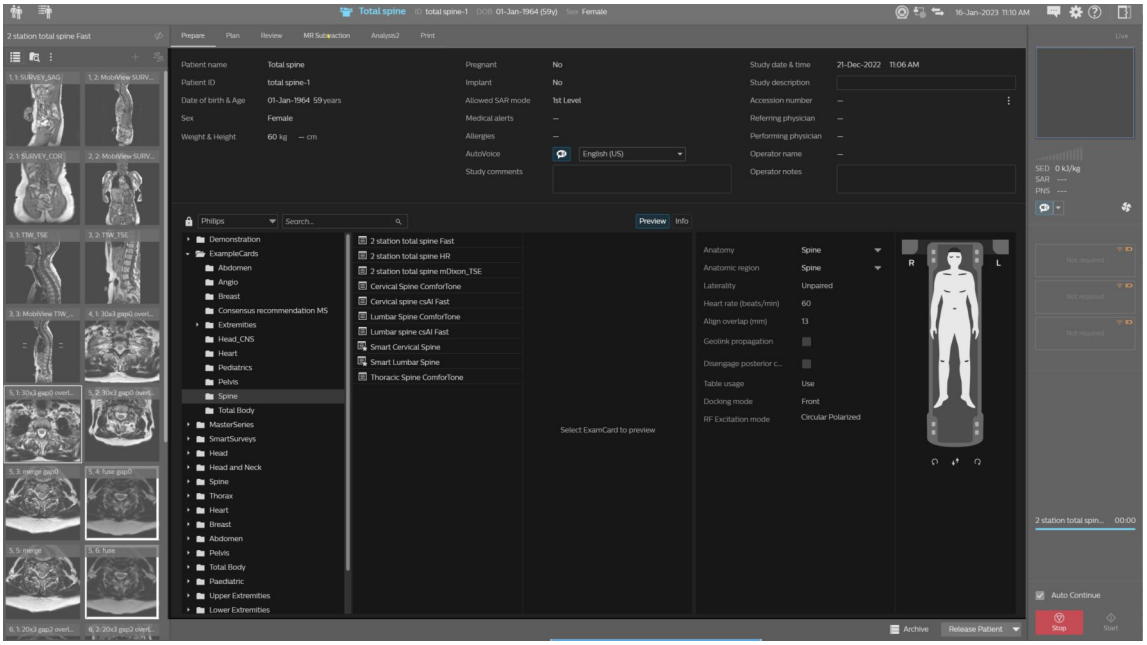
- You get the patient from the RIS, or enter the patient and examination data manually.
- You select the ExamCard for the examination.
- You specify the examination setup.



4.6 Patient Registration

This section describes the different possibilities of how to enter patient data, or how to select a patient from RIS for an examination.

4.6.1 Entering New Patient Data Manually

If you cannot import patients from RIS or other sources, you can also manually enter a new patient. With this process, the patient data is stored locally on your computer.

► In the Navigation Bar, select either **Patient Dashboard** or **Patient Directory**, then click **New Patient**.

⇨ The **Prepare** tab opens.

► In the **Prepare** tab, enter the examination data.

- To proceed to the next data field, press **Tab** or click on a field to make it current. The pointer identifies the active data field.
- All fields with an asterisk (*) and highlighted in orange are mandatory.

⇨ Patient data is saved automatically and added to the **Patient Dashboard**, if the preparations are not completed, or to the **Scheduled** tab in the **Patient Directory**, if the patient is ready for scanning.

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For information on how to add an ExamCard and further patient preparations, see chapter "Selecting an ExamCard" on page 393.

WARNING

Verify that the patient date of birth is filled-in correctly.

Sound levels may be unacceptable for patient of below 3 years of age and a warning is displayed.

WARNING

Verify that the patient weight is filled-in correctly.

Incorrect weight leads to incorrect SAR values. SAR values are calculated based on patient weight.

Format of the examination data

Examination data	Format / comment
Patient name	Maximum of 64 characters.
Patient ID	Maximum of 64 characters.
Date of Birth & Age	The format of the date is configured at system installation. Correct format for the date is shown in the input field. Age is calculated based on the entered date of birth and can not be changed.
Sex	Male, Female, or Phantom.
Weight & Height	The unit of weight and height (kg/cm or lbs/in) is configured at system installation. Weight value cannot be greater than 400 kg (881 lbs). Hight value cannot be greater than 300 cm (120 in). Alternatively enter the patient weight in the ExamCard Properties or at the VitalScreen if available.
Pregnant	**Yes**, **No**, **Possibly**. See chapter "Pregnant Patients" on page 383.
Implant	**Yes**, **No**. See chapter "Pregnant Patients" on page 383.
Allowed SAR mode	**Normal**, **1st Level**. If you select Normal, the SAR for all scans for this patient will be restricted to normal operating mode.
Medical Alerts	Maximum of 64 characters.
Allergies	Maximum of 64 characters.

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AutoVoice	On/Off; and default language or select a different language for this examination only.
Study Comments	Use this input field to provide any additional information relevant to this patient (for example if a patient is claustrophobic).
Study date & time	Current date and time is selected by default, select different date and time if the examination is later.
Study description	Maximum of 64 characters.
Accession number	Maximum of 16 characters. **Worklist** opens the Worklist (RIS).
Referring physician	Maximum of 64 characters.
Performing physician	Maximum of 64 characters.
Operator name	Maximum of 64 characters.
Operator notes	Use this input field to provide any additional information about the course of the examination.

NOTICE

Date format, weight and height unit are set at system installation.

To change the date format, weight or height unit, contact your Philips service engineer.

4.6.2 Using Patient Data from RIS

If the operator console is connected to the Radiology Information System (RIS), you can use data from the RIS on the operator console.

- ► In the **Patient Directory**, click the **More** tab.
- ► Select **RIS**.

⇨ The tab for external sources shows **RIS**.

⇨ You can use the patient data from RIS for examinations without importing it to the system.

4.6.3 Entering Asian Patient Names

If your system is set to Japanese or Simplified Chinese, it is automatically possible to enter patient names in the selected language. If your system is set to another language, use the *Windows© Input Method Editor (IME)* to enter Chinese, Japanese or Korean names.

Refer to the Microsoft (MS) Windows help for more information.

For Asian languages, the **Patient name** line consists of three fields.

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Patient name in three fields

The asterisks indicate mandatory fields. For the **Patient name**, it is mandatory to enter a value in one of the three fields.

1. Name in ideographic characters, maximum 30 characters.
2. Name written phonetically, maximum 30 characters.
3. Name in Latin characters, maximum 64 characters.

Changing MS Windows input settings

Change the MS Windows input settings when your patient name language is different than your system language.

1. Press the **Windows** key on your keyboard to show the Windows task bar.
2. Select **Start > Control panel**.
3. Double-click the **Region and Language** icon.

   The Region and Language window is displayed.
4. Click **Change keyboards...**.

NOTICE

Do not change the default input language.

5. In Installed Services:

   Check your keyboard layout (Chinese, Japanese or Korean).

   If your keyboard layout is not present in the field, click **Add...**:
   - On the 'Add Input Language' window select the input language from the top scroll list and your keyboard layout.
   - Confirm by clicking **OK**.
6. Confirm by clicking **OK** to close the window..
7. Click **OK** to close the 'Region and Language' window.

   The IME is displayed on your screen. If the IME is not visible press the **Windows** key on your keyboard.
8. Select the patient name language on the IME.
9. From the main menu bar, select **Patients > New Examination**.
10. Enter the patient name as described below.

Entering Japanese patient names

1. Field 1: Enter the patient name in Latin characters.

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2. Field 2 and 3:
   - Open the IME (Input Method Editor): right-click in the field and select **Open IME** or press **Alt + ~**.
   - Enter the patient name.
   - Press the **Space Bar**, open the scroll list with the **arrow-down** key. To select the correct writing:
     - Use the arrow keys and press **Enter**
     - Right-click, select the correct writing with the cursor and press **Enter**.
3. To close the IME, right-click in a field and select **Close IME** or press **Alt + ~**.

Reconversion

If an incorrect writing is chosen in field 2 or 3 it can be corrected:

- Highlight the name to be changed.
- Right-click in the field and select **Reconversion**
- Select the new writing and press **Enter**.

Entering Chinese names

1. Field 1: Enter the patient name in Latin characters.
2. Field 2:
   - Right-click in the field to open the IME (Input Method Editor) and select **Open IME** or use shortcut keys **Alt + ~**.
   - Enter the required character(s).
   - Press **Enter** or the **Space Bar** to confirm or press the **Arrow-back** key to open a list with proposed characters. Select the correct character and press **Enter** to confirm.
3. Field 3: Enter the patient name phonetically in Pinyin.

NOTICE

To close the IME, right-click in any field of the IME and select **Close IME** or use shortcut keys **Alt + ~**.

NOTICE

When the IME is active click **Ctrl + Space Bar** or **shift** to switch between entering Latin and ideographic characters.

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Entering Korean names

1. Field 1: Enter the patient name in Latin characters.
2. Field 2 and 3: Enter the patient name in Korean characters.

4.6.4 Patient Conditions

During patient registration, you are requested to enter information about the medical condition of the patient. Your input determines the examination conditions for patients with risk factors for MRI-related adverse events.

It is mandatory to select whether the patient:

- Is pregnant (female patients only).
- Has an implant.

It is optional to restrict the Whole Body SAR to normal operating mode for patients with impaired thermoregulation, or otherwise at risk for thermal injuries.

System restrictions may be required to scan these patients.

NOTICE

System restrictions for pregnant patients or patients with an MR Conditional implant may have a negative impact on image quality or increase scan time.

For all patient conditions, to proceed with the examination you must confirm your entries.

The user interface provides you with guidance for these patient conditions.

Patient condition	Type of help
Pregnant patient	• Pop-up windows • **Examination Conditions** banner
Patient with implants	• **Implant Conditions (MROC)** wizard • **MROC Examination Conditions** banner
Patients with impaired thermoregulation or at risk for thermal injuries	• **Examination Conditions** banner

Pregnant Patients

For a patient who is or may be pregnant:

► Select **Pregnant**: **Yes** or **Possibly**.

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⇨ **Allowed SAR mode** is automatically set to **Normal**. The **Examination Conditions** banner turns gray and shows the SAR restriction for normal operating mode (< 2W/kg).

It is advised to restrict SAR to normal operating mode (maximum <2 W/kg). In first level controlled operating mode (maximum SAR <4 W/kg), high SAR may cause local heating of the fetus. Scanning is not recommended in the first trimester of pregnancy.

It is still possible to scan a pregnant patient in first level controlled mode. Only enter first level controlled operating mode if the clinical benefit exceeds the potential risks. To scan in first level controlled mode:

- For **Allowed SAR mode**, select **1st Level**.

  ⇨ A pop-up window about the maximum SAR for pregnant patients appears (see table).

- Select whether the examination should be limited to normal operating mode (maximum SAR < 2 W/kg), or whether first level controlled operating mode (maximum SAR < 4 W/kg) is allowed.
- Click **OK** to proceed.

⇨ The **Allowed SAR mode** selection is set to **1st Level**. The **Examination Conditions** banner turns yellow and shows the SAR restriction for first level operating mode (< 4W/kg).

Maximum SAR for scanning Pregnant Patients

English	Your language
Maximum SAR for scanning Pregnant Patients	**Maximum SAR for scanning Pregnant Patients**
It is advised to scan in normal operating mode (maximum SAR < 2W/kg).	It is advised to scan in normal operating mode (maximum SAR < 2W/kg).
In first level controlled operating mode, high SAR may cause heating of the fetus. Only enter first level controlled operating mode if the clinical benefit exceeds the potential risks.	In first level controlled operating mode, high SAR may cause heating of the fetus. Only enter first level controlled operating mode if the clinical benefit exceeds the potential risks.
Limit to normal operating mode. Maximum SAR 2W/kg (advised).	Limit to normal operating mode. Maximum SAR 2W/kg (advised).
Allow first level controlled operating mode. Maximum SAR 4 W/kg. Medical supervision must be provided while scanning.	Allow first level controlled operating mode. Maximum SAR 4 W/kg. Medical supervision must be provided while scanning.

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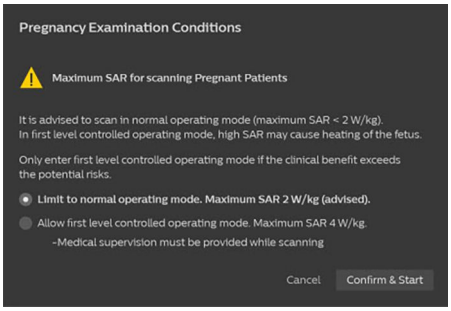
Maximum SAR for scanning Pregnant Patients

This message pops up in the New Exam window when you set **Patient gender** to **female**, **Pregnancy** to **Yes**, **SAR mode** to **1st level**.

- To select normal operating mode or first level controlled operating mode, click the corresponding button.



Patients with Implants

Under certain circumstances, it is possible to scan patients with an implant, refer to chapter “MR implant labeling” on page 29.

The user interface provides you with guidance in the **Implant Conditions (MROC)** wizard and the **MROC Examination Conditions** banner.

► Select **Implant**: **No**, for a patient without an implant.

► Select **Implant**: **Yes**, for a patient with an implant.

⇨ The **Implant Conditions (MROC)** wizard opens.

► Indicate which MR label the implant has: MR Safe, MR Unsafe, or MR Conditional.

- If you click **MR Safe**, you can scan the patient without further conditions.
- If you click **MR Conditional**, you are asked to verify and enter specified conditions for the implant in the **Implant Conditions (MROC)** wizard.
- If you click **MR Unsafe**, you are not allowed to perform an MRI scan.

To proceed with the examination, you must confirm your entries about the implant at the end of the **Implant Conditions (MROC)** wizard.

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NOTICE

If the implant is labeled MR Conditional, refer to the user documentation of the implant or contact the implant manufacturer to obtain the implant-specific conditions.

For **implants without adequate MR labeling**, a **medical decision** may declare such devices MR Conditional. In all other case, implants are considered MR Unsafe.

For every patient, a qualified physician must evaluate the risk-benefit ratio of the MRI examination before scanning.

MROC Implant Conditions Wizard

If you select **MR Conditional**, the **Implant Conditions (MROC)** wizard opens. The wizard facilitates compliance with the implant-specific conditions, as specified by the implant manufacturer.
For implants without adequate MR labeling, a medical decision may declare such devices **MR Conditional**.

A short outline of the **Implant Conditions (MROC)** wizard is provided in the table.

- On the user interface, a red asterisk indicates conditions for which it is mandatory to provide information.
- Click on any specific condition on the left side of the wizard to go directly to the input screen for that condition.

Explanation of the Implant Conditions (MROC)/Implant Conditions wizard	
Field strength	Confirm that the implant documentation states that scanning is allowed at the field strength of your system. If the field strength of your system is different than what is specified for the implant, scanning is not allowed. You are taken back to the new examination window.
Spatial field gradient	Enter a spatial field gradient value, if the implant documentation specifies one. A red area appears in the field map on the screen. The red areas indicate the areas around the system where the specified spatial field gradient value is exceeded. Click **Details...** to view more detailed field maps. Make sure that the implant does not touch the red areas indicated on the field maps. Click **Print**, to print a paper copy of the field maps. Note that, to print a copy of the field map, a printer must be connected to the operator's console.

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Explanation of the Implant Conditions (MROC)/Implant Conditions wizard	
RF energy (on 1.5T systems)	Select the RF energy control type specified in the implant documentation: **SAR - Whole body (W/kg)**, **SAR - Head (W/kg)** or **B1+rms (µT)**. NOTE: Do not confuse the different RF energy control types. • Even if you perform a head scan, the specified SAR type for the implant may still be whole body. • Make sure that you do not enter a B1+rms value when a SAR control type is selected. Check that the unit on the UI (µT or W/kg) is the same as the unit for the value that you copy from the implant documentation. • If both SAR and B1+rms are specified, choose B1+rms as RF control type. Enter the maximum RF energy value specified for the implant. The RF energy will be restricted to the value entered for the RF energy control type that you selected.
Additional	If dB/dt is specified in the implant documentation, enter the value on this screen. The dB/dt of all scans, including all prescans, will be limited to the value entered. If dB/dt is not specified in the implant documentation, keep the option **Not specified** selected. If maximum gradient slew rate is specified in the implant documentation, enter the value on this screen. The gradient slew rate of all scans, including all prescans, will be limited to the value entered. If gradient slew rate is not specified in the implant documentation, keep the option **Not specified** selected. If any other conditions are specified in the implant documentation, enter them in the **Additional comments** text box. NOTE: the system is not restricted based on text entered in this text box. Additional conditions or comments that the implant documentation specifies may include, but are not limited to: • Use of a specific coil. • Configuration of the implant itself. • Special patient preparation (such as no sedation, good communication, etc.).

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Explanation of the Implant Conditions (MROC)/Implant Conditions wizard	
Confirm	This screen provides an overview of all the implant-specific data that have been entered. Double-check all the data. Check the box to confirm that: • All data was entered correctly. • The physician who is responsible for scanning this patient, approves the patient for MR scanning. To proceed, click the **Confirm** checkbox, and then **Finish**. To go back in the **Implant Conditions (MROC)** wizard and to change the entered values, cick **Previous**. To print a paper copy of the implant conditions summary, click **Print**. A printer must be connected to the operator's console. To exit the **Implant Conditions (MROC)** wizard, click **Cancel**.

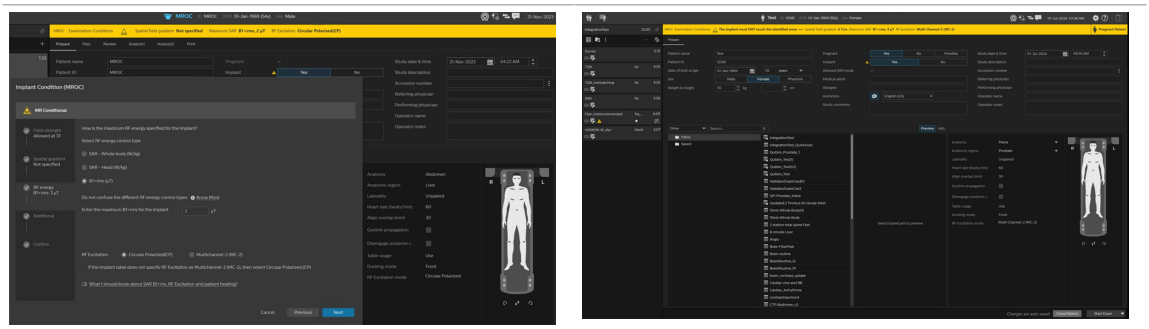
- Specified conditions are shown in the yellow **MROC Examination Conditions** banner.
- If a spatial field gradient value has been specified, click the **...** button to view the field maps that indicate the areas which the implant must not touch.
- Click **Implant Yes** to reenter the **Implant Conditions (MROC)** wizard and make changes if necessary.

Once you start scanning, the conditions are also shown in the yellow **MROC Examination Conditions** banner.

Examination Conditions Banner

The **Examination Conditions** banner alerts you and provides you with safety-related information in examinations of patients with implants, or pregnant patients. In examinations of patients with implants, the banner is called **MROC Examination Conditions**.

The banner appears under the navigation bar. It remains visible as long as the acquisition is in progress.



A yellow banner pops up when you select the following patient conditions:

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Patient Condition	Message in banner
You set **Implant** to **Yes**.	• For MR Safe implants: **MR Safe Implant. No system restriction will be set. Maximum SAR x W/kg**. • For MR Unsafe implants: **MR Unsafe Implant. It is not allowed to perform an MR examination.Maximum SAR x W/kg**. • For MR Conditional implants: **The implant must NOT touch the identified areas. Spatial field gradient: x Gauss/cm. Maximum SAR x W/kg**.
You set **Pregnant** to **Yes** or **Possibly**, and **Allowed SAR mode** to **1st Level**.	**Maximum SAR x W/kg**. **Pregnant Patient**.

A gray banner pops up when you select the following patient conditions:

Patient Condition	Message in banner
You set **Allowed SAR mode** to **Normal**.	• **Maximum SAR x W/kg**.
You set **Pregnant** to **Yes** or **Possibly**, and **Allowed SAR mode** to **Normal**.	**Maximum SAR x W/kg**. **Pregnant Patient**.

There is no banner if the above listed conditions are not met.

Finalize New Examination Data Entry

► If all entered examination data are correct, click **Finish** to proceed.

4.7 Adapting patient comfort settings

4.7.1 Adjusting Ventilation in Bore

The MR system has a recommended ventilation level. This is a static level based on average scans and system specific conditions.
The system does not change the recommended ventilation level for e.g. high SAR scans, examination room temperature and patient weights, clothing and conditions. It is solely the responsibility of the operator to determine the level of ventilation for different scans and conditions together with the patient.

The ventilation in the bore can be adjusted from the UIM as well as from the Exam Dashboard on the console.

If your MRI system is equipped with a VitalScreen instead of a UIM, you can adjust the ventilation in the bore from the VitalScreen and from the console.

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NOTICE

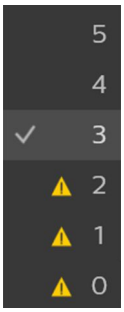
For interventional procedures it is advised to scan with patient ventilation switched off and in normal operating mode. Recommended examination room temperature is 21 °C (70 °F).

▷ On the Exam Dashboard:

► Click .

The Ventilation Control opens and shows the available options, where

- **0 (off)** means ventilation off.
- **1** and **2** stand for levels below the recommended ventilation level.
- **3** is the recommended ventilation level.
- **4** and **5** are levels above the recommended ventilation level.



► Select a ventilation level.

The Ventilation Control closes.
The button indicates the current ventilation status:

- Ventilation is on or above the recommended ventilation level.
- Ventilation is below the recommended ventilation level.
- Ventilation is off.

NOTICE

Once ventilation is set to a level below the recommended level in an examination, the set level is accepted for the current scan and all subsequent scans of the current patient.
The Patient Ventilation Warning will not be displayed anymore for this patient.

With a new patient and ventilation set below recommended level, the Patient Ventilation Warning is displayed again when a scan is started.

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4.7.2 Setting AutoVoice on Examination Level

AutoVoice button

Use the **AutoVoice** button in the **Exam Dashboard** to:

- Enable or disable AutoVoice for the current examination only.
- Change the AutoVoice language for the current examination only.
- Adjust the breathhold settings for the current examination only. Breathhold settings that can be adapted at examination level are:
  - Breathhold guidance (automated or manual)
  - Recovery time between successive breathholds in a single scan

AutoVoice button in **Prepare** tab

AutoVoice button in **Exam Dashboard**

The **AutoVoice** button can appear in three different states.

	AutoVoice is disabled.
	AutoVoice is enabled.
	AutoVoice is enabled and an instruction is playing.

Enable or disable AutoVoice on examination level

To enable or disable AutoVoice for an individual patient:

- ► In the **Exam Dashboard**, click the **AutoVoice** button.
- ► Click **AutoVoice - On** or **AutoVoice - Off**, depending on the current AutoVoice settings
- ► Select whether you want AutoVoice on or off for this examination.

If AutoVoice is disabled at system level, but enabled at examination level, the instructions that are selected at system level will be played.

For example:

- At system level both **Guide all patients through breathholds** and **Warn all patients before table moves** are selected but AutoVoice is disabled.
- You then enable AutoVoice at examination level.
- Both the breathhold instruction and the information about table movement will be played during the examination.

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Changing AutoVoice language at examination level

To change the AutoVoice language for an individual patient:

- ► In the **Exam Dashboard**, click the **AutoVoice** drop-down menu.
- ► Do one of the following:
  - Click on a frequently used language, listed in the drop-down menu.
  - Click **Select Language** and select a language from the displayed list of languages.

The selected language is used for the current examination only. For subsequent examinations, the system will use the default language again.

Setting breathhold guidance at examination level

The AutoVoice button allows you to set **Breath hold guidance** to **Automated** or **Manual**. The current selection for breathhold guidance is shown in the **AutoVoice** button drop-down menu.

- **Automated**: The system gives the breathhold instructions to the patient without your input. If the respiratory belt is connected, initiation of the instructions is based on the signal from the respiratory belt. Once the breathhold instruction is played, the system starts the scan automatically.
- **Manual**: a pop-window appears before the start of the breathhold (see chapter "Breathhold interaction window in the Exam Dashboard" on page 392). You can provide the instruction yourself or let AutoVoice play an instruction. Once the patient has started the breathhold, you are required to manually initiate the scan.

To select breathhold guidance mode:

- ► Do one of the following:
  - In the **Exam Dashboard**, click the **AutoVoice** drop-down menu.
  - In the **Prepare** tab, click the **AutoVoice** drop-down menu.
- ► In the sub-area **Breath hold guidance**, select either **Automated** or **Manual**

The selected Breathhold guidance mode is applied to the whole examination for the current patient but can be changed between scans of an examination, if required.

When AutoVoice is disabled at system level but enabled in the Exam Dashboard, breathhold guidance will automatically be set to **Manual**.

Setting recovery time at examination level

Some patients require a longer or shorter period of time to recover between breathholds, than the time set at system level. For these patients, you can set the recovery time on an individual basis. To do so:

- ► In the **Exam Dashboard**, click the **AutoVoice** drop-down menu.
- ► Select the preferred **Recovery time** from the list (5–30 seconds).

Breathhold interaction window in the Exam Dashboard

The Breathhold interaction window appears in the **Exam Dashboard** when:

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- A breathhold scan is started with AutoVoice disabled.
- Breathhold guidance is set to **Manual**.

You can choose to give the breathhold instruction yourself or to use one of the pre-recorded breathhold instructions for this scan.

To give the breathhold instruction yourself:

► Provide the breathhold instruction by using the operator-patient intercom.

► Once the patient holds his/her breath, click **Resume**.

To use one of the pre-recorded breathhold instructions for this scan:

► Click the **Play** button on the instruction you want to use (direct, normal or long).

► Once the patient holds his/her breath, click **Resume**.

4.8 ExamCard Selection

You select an ExamCard for your convenience, or as an advanced operator you create an ExamCard from scan protocols from scratch.

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4.8.1 Selecting an ExamCard

Ideally you select an ExamCard for the anatomy of interest

- Which contains all the scan protocols needed.
- Which only needs graphical planning of the stacks.
- Which does not need further modifications.

Checking examination and patient data

► Before you select the ExamCard, first check that the examination data is correct in the **Prepare** tab.

If you need to modify patient data, see chapter “Modifying Examination Data” on page 220.

WARNING

Verify that the patient date of birth is filled-in correctly.

Sound levels may be unacceptable for patient of below 3 years of age and a warning is displayed.

WARNING

Verify that the patient weight is filled-in correctly.

Incorrect weight leads to incorrect SAR values. SAR values are calculated based on patient weight.

ExamCard Selection

The feature **ExamAssist** supports you in finding the correct ExamCard easily. Based on the RIS code of your examination, the most-suited ExamCards are proposed to you automatically. **ExamAssist** removes the need of browsing to the required ExamCard.

1. Select an ExamCard database from the drop-down list: **Philips** or **Hospital**.
2. To browse to the required ExamCard, select a folder of the required anatomy and anatomic region.

   ⇨ The list of ExamCards in this folder shows up.

   ExamCards are indicated by the ExamCard icon: .
3. To select the ExamCard for the examination, do any of the following:
   - Double-click the ExamCard.
   - Hover over the ExamCard, then click the blue plus icon **Add ExamCard**.
   - Drag and drop the ExamCard into the Exam Overview.

   ⇨ The ExamCard with its scan items is displayed in the Exam Overview.

   ⇨ The Exam Setup pops up and provides guidance on how to position the patient with the selected ExamCard.

   ⇨ You can adapt the Exam Setup now, if needed. Or you can start the examination.

4.8.2 Selecting Multiple Scan Protocols

You select multiple scan protocols from the **Hospital** or **Philips** ExamCard database.

1. Select an ExamCard database from the drop-down list: **Philips** or **Hospital**.
2. To browse to the required scan protocols, select a folder of the required anatomy, anatomic region and type of scan (for example Survey, T1W, T2W).

   ⇨ The list of scan protocols in this folder shows up.

   Scan protocols are indicated by the scan protocol icon: .
3. To select the scan protocol for the examination, do any of the following:

   Repeat this step as often as needed for all scan protocols.

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- Double-click the scan protocol.
- Hover over the scan protocol, then click the blue plus icon .
- Drag and drop the scan protocol into the Exam Overview.

⇨ The scan protocols are displayed in the Exam Overview.

⇨ In the Exam Overview, you can save the scan protocols as an ExamCard.

⇨ The Exam Setup pops up and provides guidance on how to position the patient with the selected scan protocol.

⇨ You can adapt the Exam Setup now, if needed. Or you start the examination.

4.8.3 Searching an ExamCard (and Scan Items) by name

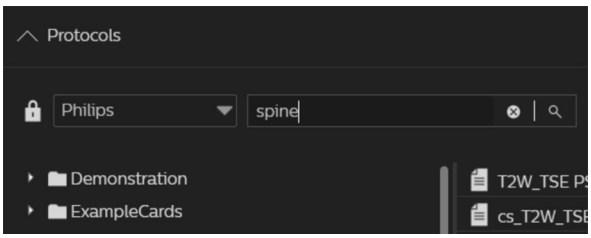
To quickly find specific ExamCards or scan items, you search in the ExamCard database by name.

▷ Prerequisite: You are on the **Prepare** tab, or in the **ExamCard Manager**.

► From the drop-down list, select the ExamCard database you want to search through.

► Type a search term in the Search field.

For example: spine.



► To start the search, do any of the following:

- Press the **Enter** key.
- Click .

⇨ The results list shows the folders which contain ExamCards or scan items that match the search term.

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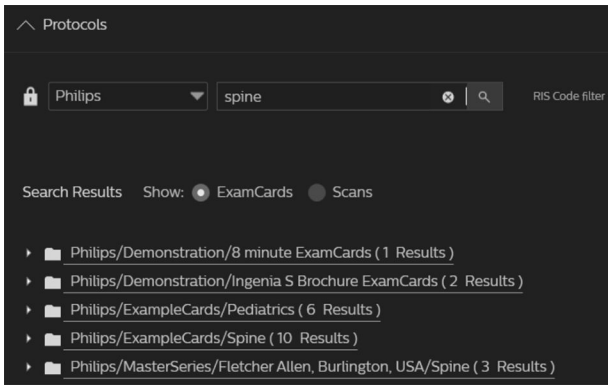
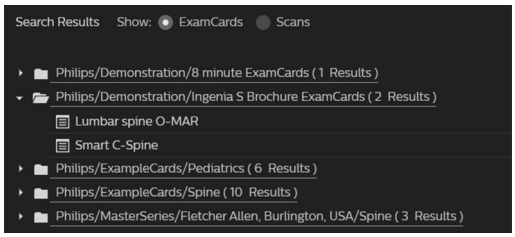
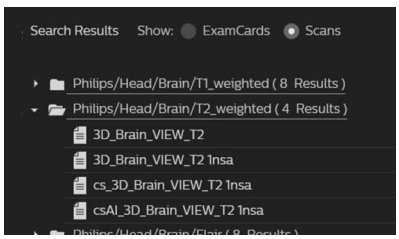


- To show ExamCards or scan items that match the search term, enable **ExamCards** or **Scans**.
- To show the results per folder, click the arrow (Expand button).





- To select any of the search results, double-click the ExamCard or scan item.
- Only when you search in the **ExamCard Manager**, a pop-up message alerts you that **Changes will not be saved. Do you want to proceed? Yes** or **No**?

4.9 Adapting the Exam Setup

This section provides you with information about the **Exam Setup** and about how to change the settings.

4.9.1 Functional Description of the Exam Setup

The **Exam Setup** provides you with generic ExamCard properties such as patient positioning and heart rate.

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These ExamCard properties are saved with the ExamCard. When you select an ExamCard, the ExamCard properties are retrieved from the ExamCard and displayed in the **Exam Setup**. You can leave the ExamCard properties unchanged, or you can modify them.

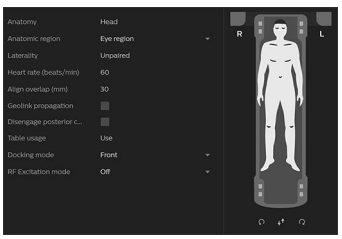
The **Exam Setup** allows you

- To specify the properties of the **Exam Setup** once for the complete ExamCard.
  These settings are valid for all ExamCard items. The settings are saved with the ExamCard.
- To specify the positioning-related ExamCard properties graphically.
- To specify the other ExamCard properties numerically, or you select the values from a drop-down menu.

Accessing the Exam Setup

You access the **Exam Setup** in two different ways:

1. In the Exam Overview, click and then select **Exam Setup**.
2. The **Exam Setup** opens automatically when you select an ExamCard.



4.9.2 Listed ExamCard Properties

When you select an ExamCard, the ExamCard properties are retrieved from the ExamCard and displayed in the **Exam Setup**.

Anatomy

Possible values	Description
DICOM values in alphabetical order: for example • **Abdomen** • **Head**	The value of this parameter is used: • To display the images correctly. For more information, see chapter “Functional Description” on page 268. • To select the default **Review** or **Analysis** packages.

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Anatomic Region

Possible values	Description
DICOM values in alphabetical order: for example • **Brain** • **Circle of Willis**	The value of this parameter is used: • To display the images correctly. For more information, see chapter “Functional Description” on page 268. • To select the default **Review** or **Analysis** packages.

Laterality

Possible values	Description
• **Left** • **Right** • **Unpaired** • **Both** • **Mixed**	This parameter is primarily used for paired anatomies such as knee, shoulder, ankle, and so on. This parameter is mandatory for elbow, hand and wrist examinations. Only when **Laterality** is set to a value other than **Unpaired**, you can set the **Patient Position** to their specific values (for example, **Exorotation**). The laterality value is used by PACS systems. • **Left** or **Right** - To be used for left or right joint. • **Unpaired** - To be used for unpaired anatomies, for example in abdomen examinations. • **Both** - To be used when both joints are scanned within one scan. • **Mixed** - To be used when both joints are scanned within one ExamCard, but in different scans.

Heart rate (beats/min) [bpm]

Possible values	Description
<numerical value: beats per minute>	The heart rate value you enter here is used for cardiac synchronization. You can update the value in the Exam Dashboard during the examination if necessary.

Align Overlap (mm)

Possible values	Description
<numerical value>	**Align Overlap (mm)** is needed for multistation scans such as Whole body. • For sagittal and coronal scan protocols, use a 30 mm overlap between the stations. • For transverse scan protocols, change **Align Overlap (mm)** to 0 prior to scanning (to avoid that the transverse scans are scanned with 30 mm overlap).

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GeoLink propagation

Possible values	Description
• **No** (Default) • **Yes**	**GeoLink propagation** propagates the SmartLine processing steps to all scans of the same GeoLink. **Use case 1: Running a SmartLine postprocessing step** • With **GeoLink propagation** set to **No**, a SmartLine postprocessing step is only added to the current scan. • With **GeoLink propagation** set to **Yes**, a SmartLine postprocessing step is added to all geo-linked scans (scans with the same GeoLink as the current scan). **Use case 2: Loading imaging series into Review packages (for example, VolumeView)** • With **GeoLink propagation** set to **No**, only the current imaging series is loaded into these packages. • With **GeoLink propagation** set to **Yes**, all geo-linked imaging series (scans with the same GeoLink as the current scan) are loaded into these packages. For more information about GeoLinks, see GeoLinks. For more information about SmartLine processing, see SmartLine processing.

Disengage posterior coil

Possible values	Description
• **No** • **Yes**	• **No** means that the posterior coil moves with the connected coil into the bore. • **Yes** means that the posterior coil is disengaged. To indicate that the posterior coil is hold back on its home position outside the bore, the Posterior coil is 'unchecked' and grayed out. – You use this scenario if you want to force the posterior coil to remain on its home position outside the bore. – If the posterior coil is in conflict with other connected coils, and if the table is completely moved out, the MR system automatically holds back the posterior coil (**Disengage posterior coil** = **Yes**). – For a few coils, **Yes** is the mandatory setting.

Error handling

In case of errors, you will be asked to move the table completely out to disengage the posterior coil.

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Table Usage

Possible values	Description
• **Use** • **Ignore**	

Docking mode

Possible values	Description
• **Front** • **Rear**	This parameter applies for patient trolleys.

RF Excitation mode

The parameter is available on 3.0T systems.

Possible values	Description
• **Circular Polarized (CP)** • **Multi Channel-2 (MC-2)**	• **Circular Polarized (CP)** is the default selection. It enables quadrature RF excitation. • **Multi Channel-2 (MC-2)** enables MultiTransmit RF excitation. Select Multi Channel-2 (MC-2) only if Multi Channel-2 (MC-2) is specified on the implant labeling.

4.9.3 Graphical ExamCard Properties

The Exam Setup automatically displays the recommended positioning for the selected ExamCard regarding **Patient Orientation** and **Patient Position**.

- In general, follow these recommendations and position the patient accordingly.
- Only if the medical state of the patient does not allow this recommended positioning, position the patient in a different way and modify the settings.

Patient Orientation

The value of this parameter is used to display the images correctly.

Possible values are: **Head-First** and **Feet-First**.

Patient Position

The value of this parameter is used to display the images correctly. Possible values are:

- For all kinds of examinations, except for elbow, hand, and wrist:
  - **Supine**
  - **Prone**
  - **DecubitusRight**

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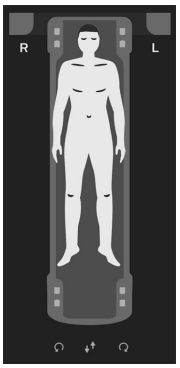
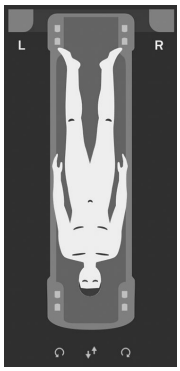
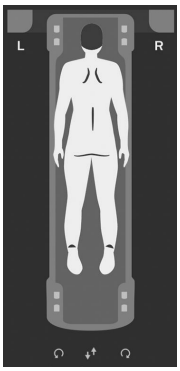
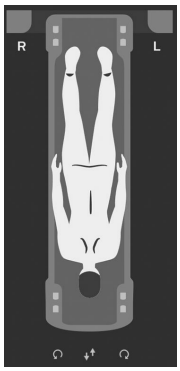
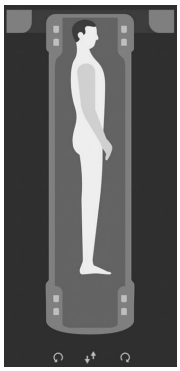
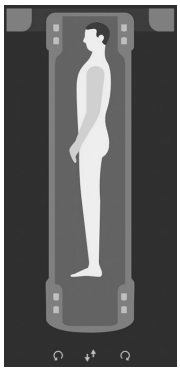
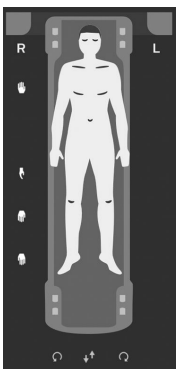
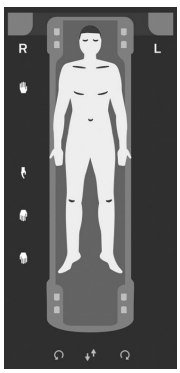
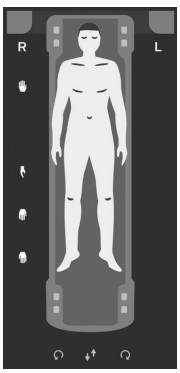
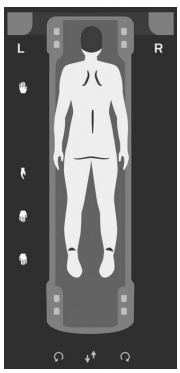
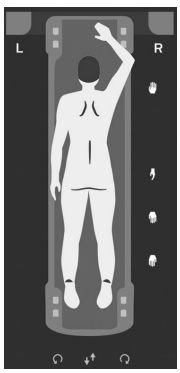
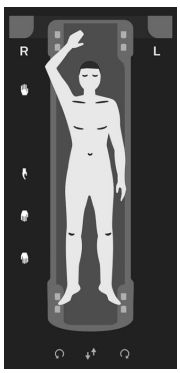
  - **DecubitusLeft**
- For elbow, hand and wrist (only available when **Laterality** is set to a value other than **Unpaired**):
  - **Neutral**
  - **Endorotation**
  - **Exorotation**
  - **Superman**

Example Images

Head-first Supine	Feet-first Supine	Head-first Prone	Feet-first Prone	Head-first Decubitus Left	Head-first Decubitus Right
					

Head-first Supine Endorotation	Head-first Supine Exorotation	Head-first Supine Neutral	Head-first Prone Neutral	Head-first Prone Superman	Head-first Supine Superman
Examination of the right hand or wrist	Examination of the right hand or wrist	Examination of the right hand or wrist	Examination of the left hand or wrist	Examination of the right hand or wrist	Examination of the right hand or wrist
					

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4.9.4 Adjusting the ExamCard Properties

When you select an ExamCard, the ExamCard properties are retrieved from the ExamCard and displayed in the **Exam Setup**.

- ► To change any of the listed properties, do any of the following:
  - Enter another value for any of the listed properties.
  - Select another value from the drop-down list.
- ► To change any of the graphical properties, do any of the following:
  - To change the **Patient Orientation** from **Head-First** to **Feet-First** and vice versa, click .
  - To change the **Patient Position** from **Supine**, to **Prone**, or **DecubitusRight** or **DecubitusLeft**, click or , if needed repeatedly.
  - To change the orientation of the hand for hand and wrist examinations, click the hand buttons.
    Neutral, **Endorotation** , **Exorotation** or **Superman** (overhead) .

Depending on the current **Patient Position** and **Patient Orientation**, the hand buttons change and possibly represent different hand positions. Check out the tooltips of the hand buttons for guidance.

Only when the ExamCard property **Laterality** is set to a value other than **Unpaired**, you can set the **Patient Position** to their specific values (for example, **Exorotation**).

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5 Performing the Examination

5.1 Starting, Running and Stopping

5.1.1 Starting and Running the Examination

When you start the examination, the examination progresses into the **Plan** task. The Exam Overview and the Exam Dashboard are displayed which support you in your workflow and provide you with important information about the examination.

▷ Prerequisite: The scan protocols for the selected examination are available in the Exam Overview.

▷ Prerequisite: The patient is positioned in the isocenter and ready for the examination.

► Click **Start Exam**.

► Click **Start** to start the survey.

⇨ The survey and the reference scans start. Once the survey is completed, the survey images show up in the Plan viewports.

► To plan the scan protocols on the survey images, click **Plan**. When planning of a geometry is completed, click **Accept**.

For information about planning, see the Planning chapter.

► Click **Start** to start the scan protocols which are ready to run.

► To load images of finished scans, drag and drop the imaging series from the Exam Overview into the Plan viewports.

► To plan the remaining scan protocols, click **Plan**. When planning of a geometry is completed, click **Accept**.

Repeat this step as often as needed.

► Click **Start** to start the scan protocols which are ready to run.

► Inspect the imaging series and check their image quality and diagnostic value.

► When the scan protocols are completed, release the patient from the tabletop and click **Release Patient**.

► When the examination is complete, click **Complete Exam** to mark it as complete on the RIS.

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Tabletop movement during scanning

If an ExamCard issue requires tabletop movement for optimum isocenter positioning, a message will pop up asking if tabletop movement can be performed. If this is confirmed, another message will pop up indicating that the tabletop is moving automatically. In order to stop this automatic tabletop movement, click **Stop**.

Moving TableTop

The tabletop is moving automatically.

- Stop

For more information, see Safety chapter.

5.1.2 Discontinuing an Examination

The examination is ready to run: The examination data are entered, the scan protocols are selected.

But still you have to discontinue the examination.

► Select **Discontinue Exam** from the drop-down list of the workflow state button.

You confirm that the current exam is to be discontinued. Archiving is started for all series that are marked for archive, but have not been archived yet. A MPPS Discontinue message is sent to RIS along with the reason for discontinuation.

► Select a reason for discontinuation from the drop-down list. Then click **Discontinue**.

5.1.3 Stopping reconstruction

Image reconstruction takes place during and at the end of every scan. Under certain circumstances image reconstruction blocks scanning of the next scans, since it uses scan resources.

You only stop the reconstruction when reconstruction is not beneficial and hinders your workflow:

Scenario	Consequences
• You stop a scan. Acquisition is not completed. Reconstruction of the partially acquired data is still ongoing. • You stop the reconstruction.	Acquisition data are partially or completely lost. **To obtain all images, rescanning is needed.** • Depending on the scan type and the moment that you stop the reconstruction, some images might be available in the examination database, for example the first dynamic series of a dynamic scan. • A message in the scanner status bar informs you about the status.
• A scan aborts. Acquisition is not completed. Reconstruction of the partially acquired data is still ongoing. • You stop the reconstruction.	If the imaging parameter **Save raw data** is enabled, you can perform delayed reconstruction to calculate as many images as possible of the partially acquired data.

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Scenario	Consequences
• The acquisition of the current scan is completed. The reconstruction is ongoing, but takes very long and hinders the next scan to start. • You stop the reconstruction.	Acquisition data are partially or completely lost. **To obtain all images, rescanning is needed.** • Depending on the scan type and the moment that you stop the reconstruction, some images might be available in the examination database, for example the first dynamic series of a dynamic scan. • A message in the scanner status bar informs you about the status. **To prevent rescanning of the scans where you foresee long reconstruction times:** • enable the imaging parameter **Save raw data**, • and perform delayed reconstruction when the acquisition is completed.

How do you stop the reconstruction?

► Right-click on the ExamCard item (scan protocol) in the List View.

► Click **Stop reconstruction**.

- When EC items are grouped, you can only stop the reconstruction of single EC items of this group, when the acquisition of the group is completed.
- You cannot stop suspended scans.

⇨ **Stop reconstruction** switches off the automatic start of the next scans.

5.1.4 Repeating Prescans of the Current ExamCard

Prescans are automatically performed in the course of an examination. However, in some cases it might be useful to repeat the prescans, e.g. the automatically performed B1 calibration.

Repeat Prescans allows to repeat previously performed prescans for the current ExamCard.

▷ You are in the **List View**.

► Right-click a scan item, then select **Repeat Prescans**.

⇨ **Repeat Prescans** is enabled.

⇨ The scan item displays the icon .

The context-menu item **Repeat Prescans** shows a checkmark.

⇨

⇨ When you start the scan item, the prescans are scanned again.

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You can save the **Repeat Prescans** as part of the ExamCard.

5.2 Preparation Phases

5.2.1 B0 Shimming

B0 shimming is used to optimize the B0 magnetic field homogeneity:
Shimming involves a preparation phase or a B0 prescan in which small inhomogeneities in the anatomy are measured and corrected.

Applications

- Fat- or water-suppressed scans.
  - For optimal fat or water suppression, the homogeneity should be better than 3.4 ppm (frequency difference water and fat) over the volume of interest.
- Scans with large offcenters
- EPI and GRASE sequences
- Balanced FFE / TFE

Overview of Shimming Methods

Depending on the configuration of your MRI system and depending on the selected scan type (MR imaging or MR spectroscopy), not all shim methods are available.

Default

Automatic shimming is automatically performed in scans utilizing:

- Water or fat suppression techniques (SPIR, SPAIR, and ProSet), and/or
- Balanced FFE / TFE.

Only first order shim corrections are performed.
In all other kinds of scans, shimming is not performed.

Auto

Auto(matic) shimming is done over the whole volume representing the stacks in a scan.

- In multistack scans, autoshim is applied separately to each stack.
- Autoshim cannot be combined with radial stacks.
- Only first order shim corrections are performed.

Volume

Volume shimming allows to draw a user defined volume targeting first order optimization to that region, no matter how many stacks are defined.

- During planning, a shim volume VOI appears inside the FOV frame. The size and shape of this VOI can be manipulated and optimized.
- Volume shimming can be combined with parallel and radial stacks.
- Only first order shim corrections are performed.

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SmartShim

SmartShim performs an image-based B0 shim, based on an automatically inserted B0-Prescan.

- On 3.0T systems, higher order shim correction (second order) is applied.
  (Most 3.0T systems are equipped with the higher order shim hardware).

  In multistack scans, only first order shim corrections (linear) are applied.
- On 1.5T systems, only first order shim corrections (linear) are applied.
- Shimming is performed over the whole imaging volume. A volume shim box is not applied for the B0 shim.
- SmartShim is only recommended for whole body diffusion imaging (DWIBS).
- When SmartShim is combined with another technique also requiring a B0-Prescan, an extra prescan is inserted.

SmartBreast

SmartBreast is an Image Based shimming technique. The shim volume is selected based on a "Smart" (derived from SmartExam) segmentation. This setting is applicable for SmartExam Breast examinations.

IB-volume

IB-volume is an Image Based shimming technique.

- Shimming is only performed in the user defined shim volume.
- Higher order shim correction (second order) is applied on 3.0T systems.
  (most 3.0 T systems are equipped with the higher order shim hardware).
- On 1.5T systems, only first order shim corrections (linear) are applied.
- A B0 field map calibration scan is required for IB-volume. (**B0 field map = calibrate**)

PB-auto

Uses multiple pencil beam acquisitions to compute shim values.

- Higher order correction (first and second order) is possible.
- A separate shim volume is not defined. Optimization is targeted on the center of the Spectro VOI.

PB-volume

Uses multiple pencil beam acquisitions to compute shim values.

- Higher order correction (first and second order) is possible.
- Optimization is targeted on the center of the planned shim volume.

For MRI only:

- PB volume shimming can be combined with parallel and radial stacks.
- PB volume shimming for MRI is available on 3.0T systems only.

Iterative VOI

Uses an iterative shimming algorithm optimizing the T2-decay of the water FID.

- The FID signal of unsuppressed water is measured, and field homogeneity is optimized using the gradient coils.

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- A separate shim volume is not defined. Optimization is targeted on the center of the Spectro VOI.

Iterative volume

Uses an iterative shimming algorithm optimizing the T2-decay of the water FID.

- The FID signal of unsuppressed water is measured, and field homogeneity is optimized using the gradient coils.
- Optimization is targeted on the center of the planned shim volume.

More information

- In Online Help (**F1**): Enabling shimming

5.3 Raw Data Acquisition and Delayed Reconstruction

5.3.1 Delayed Reconstruction

In general, MRI scans are automatically reconstructed immediately after their acquisition. However the automatic reconstruction can be switched off, and a manual reconstruction can be performed instead.

Such a delayed reconstruction can be performed at anytime, and the reconstruction parameters can be defined according to the user's personal preference. This offers the possibility to generate multiple imaging series with different reconstruction settings and compare them on completion.

Parameters that can be defined during the delayed reconstruction are e.g. :

- Uniformity,
- Recon voxel size,
- Reconstruction matrix,
- Preset window contrast,
- Multichannel images.

Delayed reconstruction is integrated in the Exam Overview.

A prerequisite for delayed reconstruction is that raw data are saved during scanning.

5.3.2 Performing Delayed Reconstruction of Raw Data

This workflow applies for scans where raw data were acquired.

▷ The parameter **Save raw data** (**Postproc** tab of the **Advanced Parameters**) was set to **Yes**.

► After scan completion, right-click on the scan in the Exam Overview.

► Right-click the ExamCard item, then select **Reconstruction** and **Delayed Reconstruction**.

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A Delayed Reconstruction processing step is automatically added to the current ExamCard under the corresponding scan.

- ► Rename the delayed recon processing step so that it can easily be identified.
- ► Double-click the delayed recon processing step.

  The Delayed Recon Parameter Editor opens with the subset of parameters available for delayed reconstruction.
- ► Edit the parameters as usual in the ExamCard environment.

  The user interface is identical to the Advanced Parameters Editor.
- ► Click **Accept** to confirm the parameters.
- ► To start the reconstruction, click **Pause before scan** in the delayed recon processing step.

  Delayed reconstruction is performed as background process and does not affect the performance of the system, e.g. the acquisition of further scans.

Reuse of Delayed Reconstruction processing steps

Once a Delayed Reconstruction processing step is defined, it can easily be reused:

- Simply drag and drop it to another scan in the same ExamCard.
- Or right-click on the source to copy this step,

  and then right-click on the destination scan to paste it.

Note that the result may depend on the source data.

It is recommended to rename copied processing steps immediately for ease of identification.

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NOTICE

You can also copy/paste or drag/drop a delayed recon processing step to another ExamCard in the Hospital dababase.

5.4 Display of Physiology Signals and AutoView

5.4.1 Changing the Display of AutoView

By default, **AutoView** shows up in minimized view, and displays an image of the scan currently in progress.

Minimizing and maximizing AutoView

- ► To maximize **AutoView**, double-click the minimized view.
  - On the **Review** tab, the maximized **AutoView** opens in a floating window.
  - On the **Plan** tab, the maximized **AutoView** is docked to the lower right viewport.

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- To undock the maximized **AutoView** on the **Plan** tab, click **Float** . Then move the window to any location on the screen.

  When you switch from the **Plan** tab to the **Review** tab with a floating **AutoView** window, the floating window disappears. To unhide the window, go back to the **Plan** tab, or click **F7**.
- To dock the maximized **AutoView** on the **Plan** tab to the lower right viewport, click **Dock** .
- To resize the maximized **AutoView**, drag its edges and corners.
- To move the maximized **AutoView**, drag its header.
- To minimize the maximized **AutoView**, click .

Changing the image display in AutoView

- To refresh the **AutoView** with the latest reconstructed images, click **Go Live**.

  The text **Live** indicates that **AutoView** is up to date.
- To display the next imaging series (in maximized view only), click .

  To display the previous imaging series (in maximized view only), click .

  In examinations which make use of **Fast next scan**, the and button are not available.

Just as in the **Review** tab, you can zoom, pan, window and scroll through images, and reset the settings if needed.

5.4.2 Adjusting the Display of the Physiology Signals

When physiology sensors are applied to a patient, the physiology signals are displayed in the Physiology Display of the Exam Dashboard.

You adjust the display of the physiology signals in the Physiology Display, in the Extended Physiology display and in the **Physiology Properties** window.

If available on your MRI system, you can also adjust the display of the physiology signals on the VitalScreen. See chapter Your MRI System -> VitalScreen -> Routine Procedures.

- To access the **Physiology Properties** window, right-click the Physiology Display and select **Physiology properties**.
- To access the Extended Physiology Display, click any of the physiology signals in the Physiology Display.

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Selecting (or changing) the physiology sensor for display

▷ In the Physiology Display:

► Right-click the slot reserved for physiology signals, and select: **VCG**, **PPU**, **Respiratory Belt**, **VitalEye** (if available) or **External**.

Entering and updating the heart rate

In examinations with **VCG** or **PPU** (or a similar **External** device), you enter the heart rate for the examination in the **Exam Setup**. Cardiac synchronization uses this entered heart rate for the calculation of triggers and no-trigger periods. When the entered heart rate differs too much from the current heart rate, proper cardiac synchronization is not possible anymore.

▷ In the Physiology Display:

► Check the entered heart rate and the current heart rate.
If the difference is large, do any of the following to update the entered hear rate:

- Click **Update heart rate**.
- Click the text field of the entered heart rate (tooltip: **Enter heart rate manually**), and enter the heart rate.

Adjusting the time range for display

▷ In the Physiology Display:

► Right-click the physiology signals, and select **Time range**.

► Select **1s**, **2s**, **5s (default)**, **10s**, **15s**, or **25s** seconds.

Adjust the Display Options of the Physiology Display

▷ In the **Physiology Properties** window:

► Enable or disable to **View Gridlines**.

► Enable or disable the display on the **Magnet Display**.

► Set the **Scale** of the physiology display to **AutoScale**, or (only available for VCG only) to a fixed value (in mV).

5.5 Showing Information and Postprocessing Steps

5.5.1 Showing the Postprocessing Steps of the Current ExamCard

You can get an overview of all postprocessing steps within an examination.

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▷ You are in the **List View**.

► Click **Show all postprocessing steps**.

⇨ All postprocessing steps are displayed per EC item (below each EC item).

5.5.2 Displaying the Information for a Scan Item or ExamCard

Philips ExamCards and scan protocols are delivered with application information in English language.

▷ You are in the **List View**.

► To display this information, click **More Options**. Then select **Exam Info**.

5.6 Customizing the Examination

5.6.1 Changing Scan Items during Scanning

Selecting a Scan Item in the Exam Overview

You can only modify a scan item when you select it first. You can select multiple scan items if needed.

▷ You are in the **List View**.

► To select one scan item, click the scan item.

► To select multiple consecutive scan items, pres and hold **Shift**. Then drag over the scan items.

► To select multiple individual scan items, press and hold **Ctrl**. Then click the scan items.

► To deselect, click the selected items.

Cutting, Copying and Pasting

You can paste a previously copied ExamCard. You can cut, copy and paste scan items and postprocessing steps:

- Within the current ExamCard.
- From a previous examination to the current ExamCard.

▷ You are in the **List View**.

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▷ Prerequisite: One or more scan item(s) are selected.

► To copy a scan item, do any of the following:

- Press **Ctrl+C**.
- Right-click the scan item, select **Copy**.

⇨ The scan item is copied to the Clipboard.

► To cut a scan item, do any of the following:

- Press **Ctrl+X**.
- Right-click the scan item, select **Cut**.

⇨ The scan item is copied to the Clipboard, but removed from the Scan Overview.

► To paste a scan item from the Clipboard, do any of the following:

- Press **Ctrl+V**.
- Right-click the scan item, select **Paste**.

⇨ The item is moved from the clipboard to the current examination (Scan Overview). It will be inserted after the currently selected item.

Duplicating Scan Items

There is a better option to duplicate scan items than to Copy and Paste scan items.

▷ You are in the **List View**.

▷ Prerequisite: One or more scan item(s) are selected.

► To duplicate a scan item, press and hold Ctrl. Then drag the scan item to another location.

⇨ A duplicate is available now at this location.

Moving Scan Items

You can change the order of scan items.

▷ You are in the **List View**.

▷ Prerequisite: One or more scan item(s) are selected.

► To move an item, simply drag the item to the desired position.

Items can only be moved if they are not yet executed (prepared, running, in reconstruction or similar).

Otherwise a copy will be created.

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Deleting Scan Items

▷ You are in the **List View**.

▷ Prerequisite: One or more scan item(s) are selected.

► To delete a scan item, do any of the following:

- Press the **Delete** key.
- Right-click the scan item, then selecte **Delete**.

⇨ The item is deleted from the current ExamCard.

Items can only be deleted if they are not yet executed (prepared, running, in reconstruction or similar).

5.6.2 Managing Geometry of Scan Items

Assigning a Scan Geometry to a Scan Item

The **Geoname** is used to simplify planning.

Scans sharing the same **Geoname** by default have:

- The same slice orientation.
- The same number of stacks.
- Each stack with identical angulations and offcenters.

▷ You are in the **List View**.

► To assign a **Geoname** to a scan item, right-click the scan item. Then select a **Geoname** from the list.

► To remove a **Geoname** from a scan item, right-click the scan item. Then select **No Geoname** from the list.

For survey scans, the geometry name can be deleted. Doing so indicates that the scan does not need further planning and is ready to run.

Applying a GeoLink

The **GeoLink** (Geometry Link) between scans includes that scans with different geometry parameters are linked to each other. The linked protocols are combined within a geometrically linked group.

A **GeoLink**

- Groups scans that are planned at once within Graphical PlanScan.
- Aligns scans within the **GeoLink** group (which is applied constantly when planning the **GeoLink** until it is switched off).
- Includes that all scans within a geometrically linked group get the same scan number.

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- Is only possible for scans of the same scan type.
- Can be defined only once under a specified name.
  For example, if a scan of a **GeoLink** is stopped or aborted, the remaining scans of this same link have to be updated to another link name.

Typical applications are examinations with a large Field-of-View in Feet-Head direction, such as *MobiFlex* and *whole body imaging*. These examinations are performed in multiple stations with table movement between the stations to cover the complete area.

▷ You are in the **List View**.

► To apply a **GeoLink**, right-click a scan item. Then select **GeoLink**.

Select any **GeoLink** (**A**, **B**, **C**, ...).

► Repeat this step for the scan items that need to be linked.

► To remove a GeoLink from a scan item, right-click the scan item. Then select **No GeoLink**.

Propagating the Coverage

Scans sharing the same **Geoname** by default have:

- The same slice orientation.
- The same number of stacks.
- Each stack with identical angulations and offcenters.

When **Propagation** is enabled, these scans also share:

- The FOV (including RFOV and fold-over direction)
- The slice coverage (volume in slice direction):
  - In 3D scans, the number of slices will be adapted.
  - In 2D scans, the slice thickness will never be touched, but only the FOV, the rectangular FOV and the fold-over direction.
  - In M2D and MS scans, it depends on the kind of scan from which the geometry has to be taken over. Refer to the table below for more informations.

The following parameters are affected by **Propagation**:

- Number of stacks and slices
- FOV in measurement, phase and slice direction
- Slice thickness and gap
- Fat shift direction
- Fold-over direction and the amount of fold-over suppression

  When you use **Propagation**, always be aware that the fold-over direction is taken over.

Take over geometry	What happens?
3D scan -> M2D or MS	• The number of slices will be adapted such that the coverage of the M2D or MS scan is identical to the 3D scan.

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Take over geometry	What happens?
M2D or MS -> M2D or MS	Number of slices • The number of slices will always be taken over to guarantee comparable slices. Slice thickness and slice gap • If the slice thickness has initially been the same, it will stay the same and changes to this parameter will be taken over, i.e. increasing the slice thickness from 5 mm to 6 mm, all other scans will also increase from 5 mm to 6 mm - if their initial value has been 5 mm. The slice gap will be adapted also. • If the slice thickness has initially NOT been the same, the slice thickness and the slice gap will be adapted to the new slice distance (distance between adjacent slice centers) where the thickness / gap ratio stays the same. I.e. changing the slice thickness from 5 mm to 4 mm, in a scan with initially 4 mm / 0.8 mm will change to 4.58 mm / 0.92 mm. This is done in such a way with respect to IR scans where typically a slice gap of 20% of the slice thickness is used.

Workflow

1. Select multiple ExamCard items with the same geometry name in order to propagate the coverage.
   To select multiple successive items, press and hold **Shift**, then click to select.
   To select multiple items, press and hold **Ctrl**, then click to select.
2. Right-click and select **Propagation**.
3. Select propagation if required:
   - For **Volume + Slice Geometry**, the size and slices parameters are being propagated to other scan with same **Geoname**.
4. Open one of the scan items (with **Propagation** enabled) in the **Advanced Parameters** Editor.
5. Change geometry parameters as needed.
6. Click **Accept** to confirm planning.
7. Automatically all other scan items with **Propagation** enabled will have the same coverage settings.

5.6.3 Scan Pause and Contrast Agent

Inserting a Pause prior to a Scan Item

Some scans require a manual start. In this case, you need to insert a pause prior to a scan item.

▷ You are in the **List View**.

1. To insert a pause, do any of the following:

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- Right-click the scan item, then select **Pause before scan**.
- Press **Ctrl+U**.

⇨ The scan item displays the Pause icon. Now the scan item stops before acquisition and requires a manual start.

ContrastCards for Contrast Administration

ContrastCards facilitate the administration of contrast agent injections in post-contrast and dynamic scans. Contrast Cards allow you to store data of the contrast agent injection with the examination. The contrast agent injection itself is not affected by ContrastCards.

ContrastCards allow the registration of

- the type of contrast agent
- the concentration of the contrast agent
- the recommended dosage
- the volume of the contrast agent for injection
  Based on patient's weight and dosage, contrast agent administration calculates and proposes a volume for injection (body weight x ml/kg dosage = ml volume).
- the contrast agent route (e.g. intravenous)
- and the point in time of injection:
  - for dynamic scans: the dynamic scan number of contrast agent administration
  - for non-dynamic scans (pre- and post-contrast) if contrast agent injection occurs at start of scan

ContrastCards work with presets for contrast administration.

- These presets allow you to predefine and easily apply contrast agent scripts. For more information about contrast administration presets, see chapter “Functional Description” on page 258.
- You can share the presets for contrast administration among your MRI systems.

ContrastCards make use of a timer which facilitates the timing of the injection related to the start of the scan.

The implementation of ContrastCards meets the DICOM requirement.

Implementation of ContrastCards

ContrastCards are implemented in scan items of the **Exam Overview**. The **Contrast Injection Parameters** window opens when

- you enable contrast injection for a scan item in an ExamCard.
  This allows you to select a preset for contrast administration.
- you click the contrast injection icon of a scan item in an ExamCard.
  This allows you to enter and edit mandatory contrast agent information.

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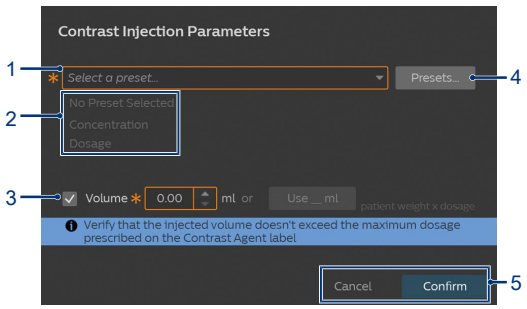
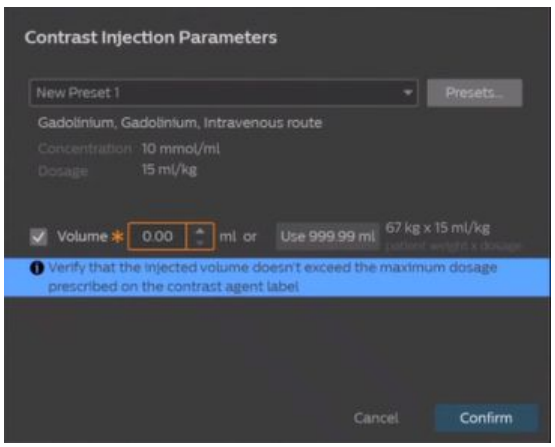
Contrast injection is enabled from the right-mouse menu.

Contrast Injection Parameters window



1. Drop-down menu for the selection of presets for contrast agent injection
2. Display of data of selected preset:
   - contrast agent and route
   - concentration (mmol/ml)
   - dosage (ml/kg)
3. Entry field for volume
   - either enter value manually,
   - or accept automatically calculated proposal (body weight x ml/kg dosage = ml volume)
4. Drop-down menu for the selection when contrast agent is injected:
   - Inject at: start of scan,
   - Inject at: start of dynamic number X,
   - if user confirmation is needed for contrast agent injection.
5. Presets button to create/edit presets
6. **Confirm** to accept, **Cancel** to close window without changes



Message about injected volume

Carefully read the contrast agent label and look up the maximum dosage prescribed.

The dialog guides you with the message:

"Verify that the injected volume doesn't exceed the maximum dosage prescribed on the contrast agent label."

Identification of images with Contrast Administration

- Images where Contrast Administration was used, are labeled **Contrast** on the top right of an image (1).
- The contrast delay time (time between injection and scan start) is shown on the next to the **Contrast** label.

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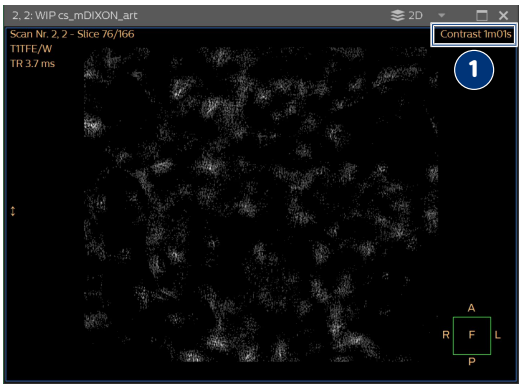

Registering contrast injection

You execute this workflow to register data of the contrast injection (such as contrast agent, injected volume)

- in post-contrast scans,
- in dynamic scans.

Enabling contrast injection in post-contrast scans

▷ In the current ExamCard on the **Exam Overview**:

► Right-click the post-contrast or dynamic scan item of the ExamCard, then select **Contrast**.

⇨ The **Contrast Injection Parameters** window opens:

- Contrast agent data is retrieved from the preset (which is stored with the ExamCard) and displayed.
- Based on patient's weight and dosage, contrast administration calculates and proposes a volume for injection (body weight × ml/kg dosage = ml volume).

► Fill in the mandatory contrast information now or later.

► Select a contrast preset from the drop-down menu.

► Verify that all contrast-agent specific attributes are entered correctly.
If needed, select another preset from the preset drop-down menu.

► To enter the volume in ml, do any of the following:

- Click **Use x ml** to accept the automatically calculated volume in ml.
- Enter a user-defined volume in ml at the red asterisk.

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NOTICE

Carefully read the contrast agent label and look up the maximum dosage prescribed.

The dialog guides you with the message: "Verify that the injected volume doesn't exceed the maximum dosage prescribed on the contrast agent label."

- Click **Confirm** and close the window.

⇨ The injection icon indicates that contrast injection is enabled and that all contrast injection information is entered. The scan is now ready to run.

⇨ The orange asterisk indicates that some contrast injection information is still missing.

- To disable contrast injection, right-click on the scan item and de-select **Contrast**.

Running an ExamCard with contrast injection enabled

- Select an ExamCard with contrast injection enabled.
- Execute the ExamCard as usual:
  Start ExamCard, run survey scan and plan scans.

  Before the contrast agent scan is going to start, the ExamCard pauses and the **Contrast Injection** window opens with the messages:

  "Scan is paused to inject x ml of <contrast agent>."
- Inject contrast agent, and at the same time do any of the following:
  - Click **Start Timer**.

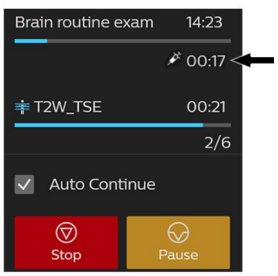
  The timer (see location below) starts and indicates how much time elapsed since contrast agent injection.

  Start the scan when sufficient time elapsed.

  The current scan starts immediately and the ExamCard proceeds as usual.
  - Click **Start Scan And Timer**.

  The timer (see location below) starts and indicates how much time elapsed since contrast agent injection.

  The current scan starts immediately and the ExamCard proceeds as usual.



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- Click **Cancel**.

The **Contrast Injection** window closes.

The contrast agent information is stored as DICOM attribute.

Retrieving contrast agent of previously performed scans

You need to retrieve the contrast agent information of a previously performed scan.

► On the **System** menu, click **Open for Review...** and select the previously performed examination.

► In the List View, hover over the Injection enabled icon of the previously performed contrast agent scan.

⇨ The contrast agent information is displayed such as:

⇨ "Completed - Injection of 16 ml of Magnevist-Gadopentetate at start of dynamic 2."

⇨ "Completed - Injection of 12 ml of Magnevist-Gadopentetate."

Alternatively you retrieve contrast agent information in the Image information of an imaging series.

5.6.4 Grouping and Splitting

Grouping and Ungrouping Scan Items

The main purpose of grouping scans is to make sure that a scan is not started before another one is planned. Grouped items cannot be modified after one of them was started.

This is especially relevant for contrast uptake studies e.g. BolusTrak where the pre-contrast scan, the 2D real-time reconstructed scan and the post-contrast scan are typically grouped. In such a way, the subtraction results will be reliable due to identical pre- and post-contrast scans.

Grouping

▷ You are in the **List View**.

1. Select multiple consecutive items.
2. Then do any of the following:
   - Right-click the selection. Then select **Group/Split**, and then **Group**.
   - Press **Ctrl+G**.

Ungrouping

▷ You are in the **List View**.

1. Click on the group to select it.

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2. Then do any of the following:
   - Right-click the group. Then select **Group/Split**, and then **Ungroup**.
   - Press **Ctrl+G**.

Split Dynamics

You use this function to split dynamic scans that consist of multiple dynamic series into single scans.

▷ You are in the **List View**.

1. Right-click on the dynamic scan. Then select **Group/Split**, and then **Split**.

⇨ The current dynamic scan will be split up in single scans.

5.6.5 Saving the Current ExamCard

You can save an ExamCard during your daily routine, and not only in the **ExamCard Manager**.

NOTICE

The maximum number of ExamCard items is 250. The maximum number of inline postprocessing steps is 6.

▷ You are in the **List View**.

► Click **More Options**. Then select **Save ExamCard**.

► Enter a name for the ExamCard, and click **Save** to confirm. .

The ExamCard will be saved in the **Saved** folder of the **Other** database.

5.6.6 Working with SmartExam

SmartGeometries Editor

The **SmartGeometries** Editor

- Allows you to create and modify a Smart ExamCard.
- Allows you to add a Smart survey to the current ExamCard.
- Allows you to assign existing SmartGeometries to scans or to create new SmartGeometries.
- Indicates if the name of a SmartGeometry is known, unknown, or if a name conflicts with an existing SmartGeometry name.

You access the **SmartGeometries** Editor from the context menu of the **List View** with **Convert to SmartExam...** or **Manage SmartExam...**.

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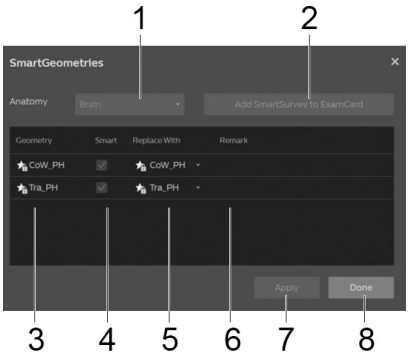

1	Drop-down menu for the selection of the anatomic region
2	To enable or disable **Add SmartSurvey to ExamCard**
3	Name of the non-Smart geometry
4	To convert the geometry to a SmartGeometry
5	SmartGeometry name
6	Reserved for remarks like **New Smart Geometry** or similar

Related Tools

- In the **SmartGeometries Database** (available in the **ExamCard Manager**), you delete SmartGeometries or samples, or you lock the complete database.
- In the **SmartExam Settings**, you enable or disable **User-Confirmation Mode**, and **Add Sample Data Allowed**.

SmartExam Settings

You specify the SmartExam Settings in **Settings and Tools (F10)** -> **Settings** -> **SmartExam**.

User-Confirmation Mode

This option allows to ask for confirmation of the Smart planning in a Smart ExamCard.

- With **User-Confirmation Mode** enabled, the ExamCard stops so that you can inspect the planning, and modifiy if needed.
- With **User-Confirmation Mode** disabled, a validated Smart ExamCard is executed automatically. A confirmation of the planning is not needed.

Add Sample Data Allowed

This option adjusts how newly planned samples are treated.

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NOTICE

Samples are never automatically added to a SmartGeometry.

User confirmation is always required in the Add Sample dialog.

Add Sample Data Allowed	Effect
If **Unchecked**	• You are not prompted to add samples to the SmartGeometry Database. • Samples are not added to a SmartGeometry. This is the default setting.
If **Checked**	• You are prompted to add manually planned samples to the SmartGeometry Database at the end of the examination: **Adding manually planned samples to the SmartGeometry database? OK or Cancel?** • To add the samples to a SmartGeometry, click **OK**. To discard the samples, click **Cancel**. The dialog is only displayed if any of the SmartGeometry plannings is modified and confirmed.

SmartExam Icons

The SmartExam icons indicate the status of a scan item:

- In the Exam Overview.
- In the **ExamCard Manager**.
- In the **SmartGeometries Database** Editor.
- In the **SmartGeometries** Editor.

Icon	Tooltip	Explanation
	Smart learned	Geometry is smart and learned.
	Smart learned disabled	Geometry is smart and learned, but Smart is disabled as system option, or the smart survey is missing.
	Smart learned locked	Geometry is smart, learned and locked for further learning.
	Smart learning	Geometry is smart and still learning (not validated).
	Smart learning disabled	Geometry is smart and still learning, but Smart is disabled, or the smart survey is missing.
	Smart learning locked	Geometry is smart, still learning, but locked for further learning.

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Icon	Tooltip	Explanation
	Spine smart learned	Geometry is smart spine and learned.
	Spine smart learned locked	Geometry is smart spine, learned, but locked for further learning.
	Spine smart learning	Geometry is smart spine and still learning (not validated).
	Spine smart learning locked	Geometry is smart spine and still learning but locked for further learning.
	Smart name conflict	Geometry is smart, but given a name that already exists for a non-smart geometry.
	Smart name unknown	Smart geometry name is unknown.
	Smart planning	The smart geometry is applied: the smart survey is analyzed and the smart geometries are planned.
	Smart spine planning	The smart spine geometry is applied: the smart spine survey is analyzed and the smart geometries are planned.

Setting up a Smart ExamCard

Converting an ExamCard into a Smart ExamCard

With this workflow, you convert an existing ExamCard into a Smart ExamCard.

This conversion includes that you add a SmartSurvey to the ExamCard, and that you use SmartGeometries in the ExamCard.

▷ Prerequisite: You are in the **List View**, or in the **List View** of the **ExamCard Manager**.

▷ Prerequisite: The current ExamCard is the ExamCard that you want to convert into a Smart ExamCard.

► To access the **SmartGeometries** Editor, right-click on a ExamCard item and select **Convert to SmartExam...**.

The **SmartGeometries** Editor opens.

► Select an anatomic region from the drop-down list.

- **Brain**
- **Knee**
- **Shoulder**
- **Breast**
- **Cervical spine**

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- **Lumbar spine**

⇨ Only for **Cervical spine** and **Lumbar spine**, one more column shows up in the **SmartGeometries** Editor window: the **Grid Snap** column.

► To add a SmartSurvey to the current ExamCard, click **Add SmartSurvey to ExamCard**.

► To enable SmartExam, first select a SmartGeometry from the **Replace With** drop-down list, or enter a name for a new SmartGeometry.

Then select **Smart** in the **Smart** column.

NOTICE

Each SmartGeometry name must refer to a unique planning.

Use unique geometry names throughout all anatomic regions.

► Only for **Cervical spine** and **Lumbar spine**, enable or disable **Grid Snap**.

- Set **Grid Snap** to **No** for the SmartGeometries where acquisition is always done for a the same range, for example in the sagittal spine.
- Set **Grid Snap** to **Yes** for the SmartGeometries where acquisition is done on different levels, for example in the transverse spine.

► To apply your changes to the ExamCard, click **Apply**.

To leave the Editor without changes, click **Done**.

Validating a new Smart ExamCard

A newly defined SmartGeometry has to be planned and executed several times before it turns into a validated SmartGeometry and does not require planning anymore.

▷ Prerequisite: The option **Add Sample Data Allowed** is enabled in **Settings and Tools (F10)** -> **Settings** -> **SmartExam**.
This option allows to add samples to a newly defined SmartGeometry.

► Start the Smart ExamCard that needs to be validated.
The SmartSurvey and the reference scan are executed automatically.

► When the SmartSurvey is completed, double-click on the EC items of the diagnostic scans to plan them.

► Plan as accurately as possible. Keep in mind that the planning contributes to the SmartGeometry samples.

► Start the planned diagnostic scans.

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► After completion of the last scan, you are prompted to add manually planned samples to the SmartGeometry Database:
Adding manually planned samples to the SmartGeometry database? OK or Cancel?
To add the samples to a SmartGeometry, click **OK**. To discard the samples, click **Cancel**.

NOTICE

First add samples to the SmartGeometry database. Only then move the patient out of the bore.

Otherwise the samples are lost and cannot be added to the SmartGeometry Database anymore.

Adding Samples to a SmartGeometry

To improve your SmartGeometries, you can add samples (relevant plannings from other examinations) to your SmartGeometry.

▷ Prerequisite: The option **Add Sample Data Allowed** is enabled in **Settings and Tools (F10)** -> **Settings** -> **SmartExam**.
This option allows to add samples to a newly defined SmartGeometry.

▷ Prerequisite: The option **User-Confirmation Mode** is enabled in **Settings and Tools (F10)** -> **Settings** -> **SmartExam**,
This option prompts you to confirm that samples are added to the SmartGeometry.

► Execute the Smart ExamCard.

Upon completion of the ExamCard, you are prompted to confirm the update of the SmartGeometries with new samples.

► Confirm to update the SmartGeometries.

Executing a Smart ExamCard

Executing a Smart ExamCard

A Smart ExamCard can contain Smart items in different states. Depending on the status of the Smart items, the workflow is different.

Executing a Smart ExamCard with Smart items in validating mode

1. Select an ExamCard.
2. Start the ExamCard (to acquire survey images).

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3. Plan the items of the ExamCard geometrically, or fine-tune the suggested planning and confirm.
4. Resume the ExamCard.
5. When the ExamCard is completed, you are prompted to add (or not to add) the samples to the SmartGeometry database.

Executing a Smart ExamCard with validated Smart items

1. Select an ExamCard.
2. Start the ExamCard (to acquire survey images).

- With **User-Confirmation Mode** disabled, a validated Smart ExamCard is executed automatically. A confirmation of the planning is not needed.
- With **User-Confirmation Mode** enabled, the ExamCard stops so that you can inspect the planning, and modifiy if needed.
-

Executing a Smart Spine ExamCard

For SmartExam Spine acquistions, two features are available:

- Vertebrae labeling and
- (Disc) Level specific scanning.

Vertebrae labeling

You have to confirm vertebrae labeling to allow level-specific scanning.

1. Start the SmartExam Spine ExamCard.
2. When the SmartSurvey is finished, the **Confirm Vertrebrae Labeling** window pops up.

   It displays the sagittal survey image with vertebrae labels on the image: ... T10, T11, T12 L1, L2, L3, L4, L5, ...
3. Select **L6 present**, if L6 exists in a patient.

   The labels on the image change, and L6 is added.
4. Now you have the choice to accept or to change the proposed vertebrae labeling.
   Do any of the following:

   - To accept the proposed vertebrae labeling, click **Confirm**.
   - To change the vertebrae labeling and move the vertebrae labels up or down, click the **UP** or **DOWN** arrow

     Select **Manual** to continue with manual planning. Click **Confirm** to continue.

SmartExam Spine
An explicit confirmation of the planning results by the operator is required.

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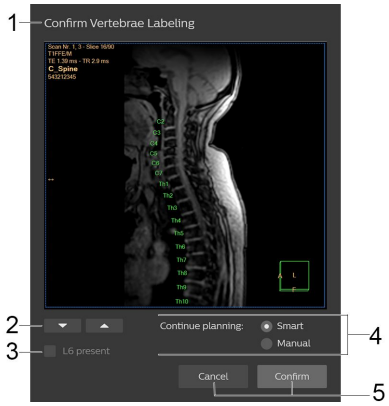
SmartExam Spine



1. Window **Confirm Vertrebrae Labeling**
2. Arrows to fine-tune the vertebrae labeling
   - **Smart**

   To enable Smart planning.
   - **Manual**

   To enable Manual planning.
3. **Cancel** to quit without changes, or **Confirm** to confirm the current vertebrae labeling.

Level-specific scanning

You can define the disc levels to be scanned beforehand or after scanning the high resolution sagittal scan.

Defining the disc levels beforehand

► In the Advanced Parameters Editor, click the **smartstacks** tab.

In all scans with a level-specific Smart Geometry (if **level-specific** is enabled), the **smartstacks** tab is available: **Geometry** - **Contrast** - **Motion** - **Dyn/Ang** - **Postproc** - **smartstacks**

⇨ The level-specific PlanScan window opens. It provides you with:

- An indication of the current SmartGeometry and the disc levels (for example L5-S1).
- A schematic drawing of the lower and upper sagittal spine with vertebrae labeling. and lines for the transverse stacks.
- Red lines for the current transverse stack, and gray lines for proposed transverse stacks.
- Up and down arrows to move the transverse stacks.
- A window with guidance.

► To change the stacks and the planning, do any of the following:

- To add a stack, click on the gray lines.
- To remove a stack, click on the red lines.
- To shift a stack up or down, click the UP or DOWN arrow.

► Start the ExamCard.

Defining the disc levels after scanning the high resolution scan

1. On the high resolution T2w sagittal scan, drag the stacks to the desired scanning location.

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The snapping mechanism (**Grid Snap**) recognizes the levels automatically and snaps the transverse stacks to the required levels.

2. Resume the ExamCard.

NOTICE

During the validating phase, fine tuning adjustments can be made without snapping.

SmartLine Processing in Practice

Adding a postprocessing step to an ExamCard

You can add a postprocessing step (SmartLine processing) to an ExamCard. Each time you execute this ExamCard, the postprocessing step is executed automatically.

SmartLine Processing applies for the following **Review** render modes:

- **Slab** and **3D**
- **OrthoView**
- **MobiView**
- **PicturePlus**

► Execute the ExamCard.

► Then process the imaging series with a Review or Analysis package.

- MIP, MPR etc

► Create a new imaging series with the results.

⇨ The postprocessing step is added to the ExamCard.

► Close the Review or Analysis package as usual.

► Save the ExamCard to the database.

⇨ The next time that this ExamCard is executed, the postprocessing step is carried out automatically as soon as the source images are available. No operator interaction is required.

⇨ In some cases, user interaction is required. In this case, double-click the processing step to open the processing step. This allows for customization of the parameters, and allows to add a pause before the execution of the processing step.

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5.6.7 Quick Surveys

Functional Description

Survey images of sufficient image quality are required to plan an examination. For time efficiency, you need survey images in a very short time.

What are the main features of Quick Surveys?

- Quick Surveys skip certain preparation phases and pre-scans with the purpose of speeding up.
- Quick Survey scans provide you with adequate image quality which is very well suited for planning.

Requirements of a Quick Survey

You can only convert a survey scan into a Quick Survey, if it meets the following requirements:

- It is the first (non-aborted) scan after the light visor is (re)set.
- It has no named geometry defined.
- The scan time does not exceed 15 seconds per stack (on average) before converting into a Quick Survey.
- It is no SmartSurvey scan.
- It is not a spectroscopy, but an imaging survey.
- It is no pre-scan.
- It is no interactive scan.
- The scan produces modulus images only.
- It does not use SENSE, CLEAR, k-t BLAST, k-t SENSE.
- It does not use CS-SENSE.

Preparation phases, pre-scans and imaging parameters affected by Quick Surveys

In a Quick Survey, certain preparation phases and pre-scans are skipped. This is realized by automatically setting certain imaging parameters to well-defined values. The affected imaging parameters are hidden and you cannot change them.

The table lists which preparation phases and pre-scans are skipped, what is performed instead and which imaging parameters are affected.

Skipped	Instead performed	Affected imaging parameter
Preparation phases	Automatic preparation is performed.	**Preparation mode** is set to **auto**.
SENSE reference scan	Classic uniformity is used.	**Uniformity** is set to **classic**.
B0 pre-scan	B0 compensation is switched off.	**Shimming** is set to **no**.
B1 pre-scan	B1 shimming is switched off.	Not applicable

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Skipped	Instead performed	Affected imaging parameter
Coil survey pre-scan	Preferred coils are automatically selected by an algorithm based on the connected coils. If this algorithm cannot be used, the coil survey pre-scan is executed.	Not applicable

Behavior of Quick Survey scans

Survey scans that meet most of the Quick Survey requirements behave differently based on their position in the ExamCard or execution list (List View).

Example of two identical Quick Surveys at position 1 and position 2

1. Quick Survey (referred to as QSurvey-1)
2. Quick Survey (referred to as QSurvey-2)
3. T2W
4. and so on

- Since QSurvey-1 is at position 1 in the execution list, it is fully qualified as Quick Survey.
  - Preparation phases and pre-scans are skipped.
  - Imaging parameters affected by Quick Survey are neither visible nor accessible.
- Since QSurvey-2 is at position 2 in the execution list, it is not qualified as Quick Survey.
  - Preparation phases and pre-scans are not skipped.
  - The imaging parameters affected by Quick Survey are visible and accessible.
- Since QSurvey-1 and QSurvey-2 are executed differently with different total scan times, the resulting image quality is of comparable, but not of identical quality.

Converting a survey into a Quick Survey

The purpose of this workflow is to convert a conventional survey into a Quick Survey. The workflow covers both situations:

- The survey is part of an ExamCard.
- The survey is a separate scan protocol in your protocol database.

▷ In the **ExamCard Manager** or in the ExamCard of the current examination:

► Browse to the survey scan you want to convert into a Quick Survey and double-click. This survey scan can be part of an ExamCard or can be a separate scan protocol in your database.

The **Advanced Parameters** open.

► Verify that the survey scan meets the requirements of a Quick Survey, see chapter “Functional Description” on page 431.

► When all requirements are met:
open the Postproc tab, set the imaging parameter **Quick Survey** to **yes** or to **default**.

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- ► Save the survey as Quick Survey.
  It is recommended to save the Quick Survey under a new name.
- ► To save the ExamCard with the Quick Survey, click **More Options** in the Exam Overview and select **Save ExamCard**.
  It is recommended to save the ExamCard under a new name.

Running an ExamCard with a Quick Survey

The purpose of this workflow is to run an ExamCard which uses a Quick Survey instead of a conventional survey.

▷ Prerequisite: AutoStart is enabled.

- ► Position the patient on the tabletop.
- ► Move the patient to the isocenter.
- ► Press **Start scan** at the UIM or **Start** at the VitalScreen (depending on your system configuration).
- ► Leave the examination room and close the door.

  With AutoStart enabled, the survey automatically gets started now, if no table movement is required.

  ⇨ When you reach the operator's console, the survey is running or first images are already available.
- ► Start planning and proceed as usual.

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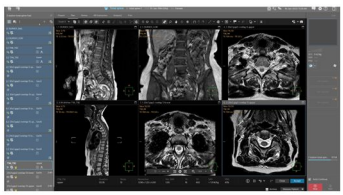
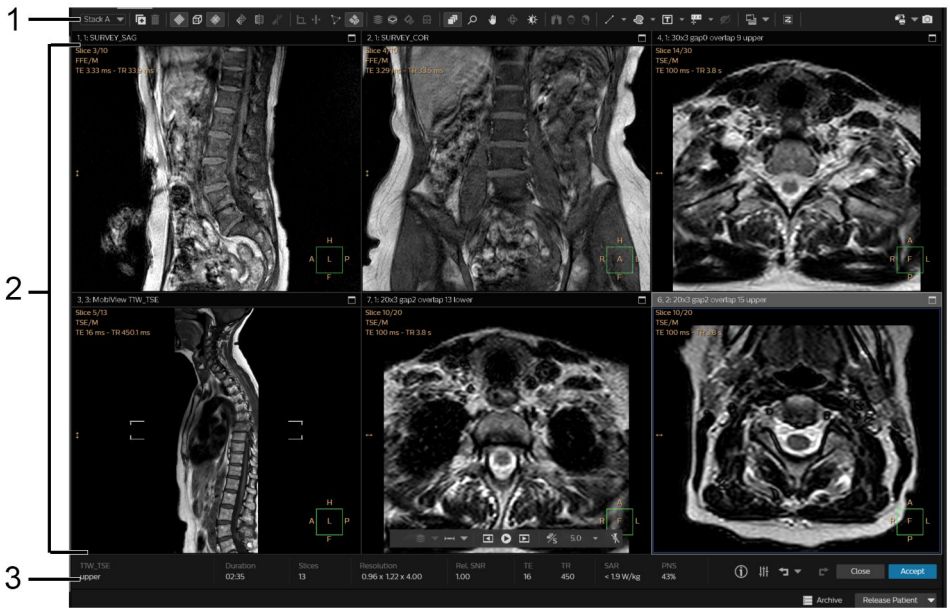
6 Planning the Examination

6.1 Plan Tab

In the **Plan** tab, you plan the examination (e.g. stacks and slabs) graphically. If needed, you change advanced imaging parameters. The following UI elements support you:

1. Plan toolbar which allows you to adjust the display of imaging series, stacks and slabs according to your preference, and which gives access to advanced planning features.
2. Viewports for planning.
3. Scan Dashboard which provides you with important information about the currently planned scan.





6.2 Plan Toolbar

6.2.1 Functional Description

The Plan Toolbar is available on the **Plan** tab.
It is composed of buttons and drop-down menus that provide access to generic functions to plan an examination. For drop-down menus, always the currently selected button is visible.

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Number	Button or button group description	More information
1	Selection of a Geometry Management of the Geometries	chapter “Geometry” on page 436
2	Display of the Imaging Volume	chapter “Display of the Imaging Volume” on page 436
3	Advanced Planning	chapter “Advanced Planning” on page 437
4	Left Mouse Behavior: Scroll, Zoom, Pan, Window	chapter “Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...” on page 482
5	Orientation (Orthogonal planes)	chapter “Orientation (Orthogonal Planes)” on page 439
6	Measurements and Annotations	chapter “Measurements and Annotations” on page 439
7	Image Information	chapter “Image Information” on page 441
8	Image View Settings	chapter “Image View Settings” on page 442

6.2.2 Geometry

These controls allow you to add or delete stacks and slabs, and to switch between stacks and slabs during planning.

Only the current stack or slab can be edited.

Drop-down menu	Short Description	More information
	Selected Geometry: To switch between stacks and slabs.	• chapter “Managing Geometries” on page 449
	Duplicate Geometry: To create and insert a copy of the selected stack or slab.	• chapter “Managing Geometries” on page 449
	Remove Geometry: To delete the selected stack or slab.	

6.2.3 Display of the Imaging Volume

These buttons allow you to adjust the display of the planned imaging volume.

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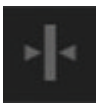
Button	Short Description	Instructions
	Show Slices: To display the planned imaging volume as slices.	• chapter "Changing the Display of the Stack" on page 452
	Show 3D Box: To display the planned imaging volume as a 3D box.	
	Show Midplanes: To enable/disable the display of all midplanes.	
	Hide/Show Stack	
	Hide/Show Volume	
	Hide/Show Slab	

6.2.4 Advanced Planning

These buttons provide access to advanced planning settings.

Button	Short Description	Instructions
	Set Orthogonal: To plan the current stack or volume orthogonal to the slice in the selected viewport.	• chapter "Planning Orthogonal to the Selected Slice" on page 453
	**Set Center**: To plan the current stack or volume with the same offcenter values as the slice in the selected viewport.	• chapter "Planning a Stack or Volume with Current Offcenter Values" on page 453
	3-Point Planning: To enable/disable 3-Point Planning and define an irregular plane.	• chapter "Defining an Irregular Plane with 3-Point Planning" on page 453

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Button	Short Description	Instructions
	ScanAlign: To align scans, especially with table movement to cover long anatomical areas.	• chapter "Aligning Scans with ScanAlign" on page 454

Button	Description
All in MPR	Sets all viewports to **MPR** viewing mode, and thus enables **Easy Scan Plan**.
All in 2D	Sets all viewports to **2D** viewing mode, and thus disables **Easy Scan Plan**.
Plan Link	Allows you to align a stack with one of the orthogonal MPRs. The stack follows with every update of the MPR. • By default, **Plan Link** is enabled. • You disable **Plan Link** to check the stack coverage.
Planar Mode	Allows you to toggle between orthogonal MPRs and non-orthogonal MPRs in the **MPR** viewing mode. • By default, **Planar Mode** (orthogonal MPRs) is enabled. • **Planar Mode** becomes disabled if one or more viewports are in 2D-mode.

6.2.5 Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...

When you drag (with left mouse button) in a viewport, by default you scroll through images.

Click any of these buttons to change this behavior, and then use the drag function to perform any of the actions listed below:

Button	Short Description	Instructions
	Scroll (default setting): Drag to scroll through the imaging series (when this button is enabled).	• chapter "Scrolling through Images" on page 496
	Zoom: Drag to magnify or reduce the image (when this button is enabled).	• chapter "Zooming in and out of an Image" on page 499

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Button	Short Description	Instructions
	Pan: Drag to pan a magnified image (when this button is enabled).	• chapter "Panning an Image" on page 499
	Window: Drag to adjust brightness and contrast of an image (when this button is enabled).	• chapter "Windowing: Adjusting Brightness and Contrast" on page 498
	Roll/Rotate: Drag to roll or rotate the image (when this button is enabled). • Available only in **Slab**, **3D** and **OrthoView**.	• chapter "Rolling and Rotating an Image" on page 536

6.2.6 Orientation (Orthogonal Planes)

In EasyPlan, the orientation buttons allow you to reset the orientation to any orthogonal plane.

Button	Short Description
	Axial: To select an axial orientation for the imaging series.
	Coronal: To select a coronal orientation for the imaging series.
	Sagittal: To select a sagittal orientation for the imaging series.

6.2.7 Measurements and Annotations

These buttons allow you to perform measurements on the imaging series and overlay the images with the measurement results and other annotations.

- Depending on the type of graphical object chosen, different numeric results are provided.
- Every graphical object is defined by one or more anchor points. The anchor points are visible upon creation, when the mouse hovers over the object, and when the object is selected.
- To select a graphical object, click on it.
- To resize or reshape a graphical object, drag any of its anchor points.
- To move a graphical object or a measurement label, drag it to the desired location.
- Dedicated context menus offer more functionality such as the calculation and display of histograms and profiles.

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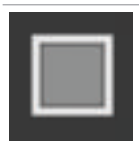
Measurements based on lines

Drop-down menu	Short Description	Instructions
	Distance: To measure the distance of two points on an image.	• See Measuring with Lines in this chapter
	Smooth Polyline: To measure the length of a smooth polyline defined by several points on an image.	
	Polyline: To measure the length of a polyline defined by several points on an image.	
	Angle: To measure the angle defined by three points on an image.	
	Open Angle: To measure the open angle defined by four points on an image.	
	XY Line: To display the differences of X-coordinates (Delta X) and Y-coordinates (Delta Y) of two points which define a line.	

Measurements based on Regions of Interest (ROIs)

Results include the size, diameter and perimeter of the ROI.

Drop-down menu	Short Description	Instructions
	Freehand Contour: To measure an area based on a Freehand contour ROI.	• See section Measuring with ROIs in this chapter
	Smooth Polygon: To measure an area based on a ROI with the shape of a smoothed polygon.	
	Ellipse: To measure an area based on a ROI with an elliptical shape.	
	Circle: To measure an area based on a ROI with a circular shape.	
	**Rectangle**: To measure an area based on a ROI with a rectangular shape.	

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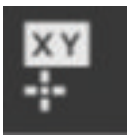
Text Annotations

Drop-down menu	Short Description	Instructions
	Text Annotation: To overlay a text box to an image.	• Annotating Images
	Arrow + Text Annotation: To overlay an arrow with a text box to an image.	

Measurements per Voxel

Drop-down menu	Short Description	Instructions
	Pixel Value: To extract the pixel value from a voxel. • Not available on RGB (SC) images	• Extracting Values from Images
	**Image Location**: To extract the image location value from a voxel.	
	Patient Location: To extract the patient location value from a voxel. • Available only when patient coordinates are known. • Not present for most SC images/screen captures.	

Hide and Show Measurements and Annotations

Button	Short Description	Instructions
	Hide Annotations: To show or hide all types of graphical objects (including lines, ROIs, text, annotations, arrows, results of measurements).	• chapter "Toggling the Display of Graphical Objects" on page 520

6.2.8 Image Information

These buttons allow you to adjust the amount of information given for images and imaging series. Image information includes: scan number and image number, scan date, information about scanning settings and duration.

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Drop-down menu	Short Description	Instructions
	Full Image Information: To display the maximum amount of information about the image.	• chapter "Extending or Restricting the Image Information" on page 502
	Intermediate Image Information: To display much, but not all image information.	
	Limited Image Information: To display only basic image information.	
	No Image Information: To display no image information.	

6.2.9 Image View Settings

This button provides access to image sorting settings and scrolling settings.

Button	Short Description	Instructions
	Sort Images: To adjust how the different image types are sorted and to configure scrolling with mouse and keyboard.	• Adjusting Image Sorting and Scrolling (Image View Settings)

6.3 Viewports in Plan tab

6.3.1 Viewports in Planning

On the **Plan** tab (also referred to as PlanScan), you have six squared viewports (3 x 2).

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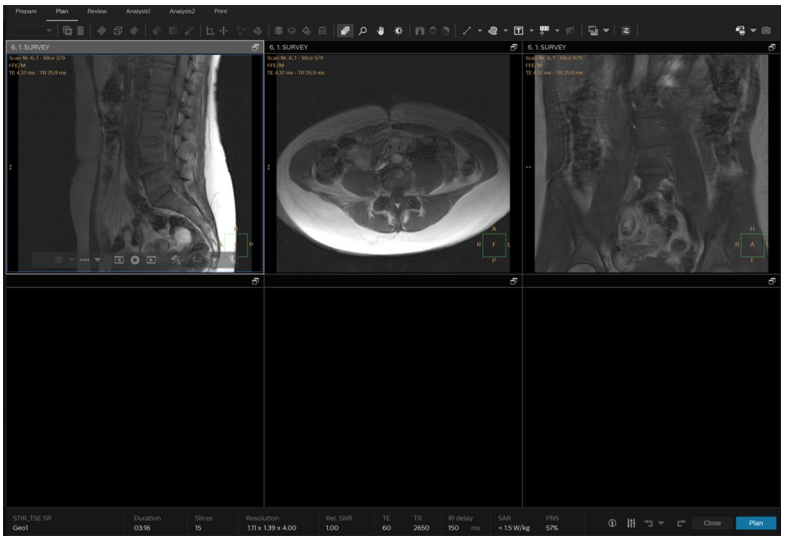

You use the upper three viewports for images of the three standard orientations transverse, sagittal, and coronal.
You use the lower three viewports for other images.

A viewport is a window dedicated to the display of images, e.g. MR slices, reformats or parameter maps.

- You can maximize or minimize a viewport.
  - To maximize the left four viewports into one large square viewport, maximize (, or double-click) any of these viewports.
  - To maximize the right two viewports into one large vertical viewport, maximize (, or double-click)any of these viewports.

- Each viewport provides you with information about the image in the viewport.
- To display images in viewports differently, use the toolbars and the context menus.

  Context menus are available for each viewport upon right click.

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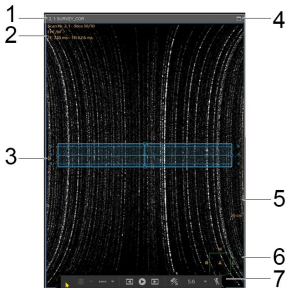

1. Scan number and scan name, e.g. **1,1** or **2,1** or **3,2**
   where the first digit increases for the scan and the second digit for a postprocessing step (and a newly created imaging series).
2. Image information
   For more information, see Toolbars.
3. Fold-over indicator
   indicating the fold-over direction in which typically MR artifacts occur.
4. **Maximize** button
5. Caliper
6. 3D coordinate system
   indicating the directions Head-Feet Anterior-Posterior and Left-Right (LR), and the slice orientation in this 3D coordinate system.

7. **Movie Bar**: only available when you hover over the bottom of the viewport.
   Allows you to plan on movies.

6.3.2 Context Menu in Planning

Context menus are available throughout all applications to facilitate the use of the system and to offer various interaction possibilities.

To access the context menu, simply right-click on any viewport (or other screen area).

Available Options	Description	More information
• **Scroll** • **Zoom** • **Pan** • **Window**	To change the left mouse behavior: When you drag (with left mouse button) in a viewport, by default you scroll through images. These options (and possibly others depending on the render mode) allow you to change this behavior.	chapter “Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...” on page 482
Rotate/Mirror	To **Rotate Clockwise**, **Rotate Counter-ClockwiseMirrorFlip** images.	chapter “Rotating or Mirroring an Image” on page 500
Reset Window **Reset Zoom/Pan** **Reset All**	To reset window, zoom/pan to the initial settings after you have changed these settings.	chapter “Resetting All Changes” on page 502

EasyPlan

Only when EasyPlan is enabled, the following two options are available on the context menu:

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2D	Sets the current viewport to **2D** viewing mode, and thus disables **Easy Scan Plan**. • if you change the viewing mode of a viewport, the state of the button on the toolbar changes accordingly. • For a viewport in **2D** viewing mode, the context menu options **Save Geometry** and **Load Geometry** are not available.
MPR	Sets the current viewport to **MPR** viewing mode, and thus enables **Easy Scan Plan**. • if you change the viewing mode of a viewport, the state of the button on the toolbar changes accordingly.

6.3.3 Stacks and Other Graphical Objects in Planning

On the **Plan** tab (also referred to as PlanScan), you plan all objects of a scan graphically. These objects are overlaid to the (survey) images in the viewports.

- Rectangular shapes with border lines and round and square anchor points represent the stack, and if applicable the REST slab, the shim box and the navigator. The anchor points serve as handle for adjustments of the shapes.
- Initially all graphical objects are displayed as predefined in the selected scan protocols of the ExamCard.
- Stacks (when selected for planning) are displayed with the midplanes, the border lines and the number of slices.
- On the Plan toolbar, you can change the display of the stacks and select to **Show Slices**, **Show 3D Box** or **Show Midplanes**.

Object displayed	Color
Stack (imaging volume)	blue
REST saturation slab (if **REST** is enabled)	green
Shimbox (if **Shimming** is enabled)	yellow
Navigator (if **Navigator respiratory compensation** is enabled)	pink
Oversample area (if **Fold-over suppression** is set to **oversampling**)	blue
Point Markers for 3-Point Planscan	blue

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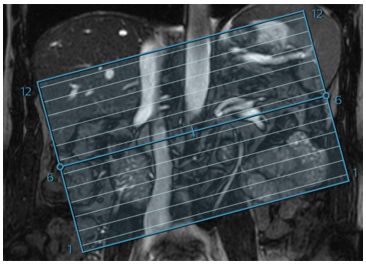
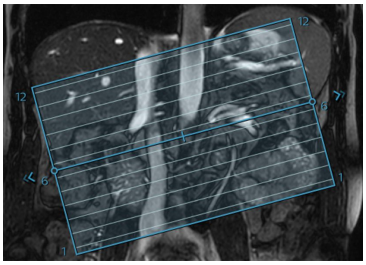
Examples

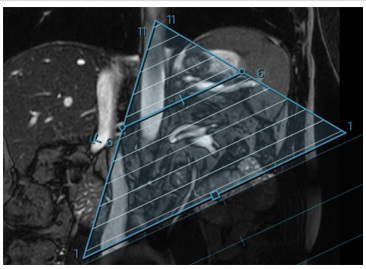
Stack

displayed with

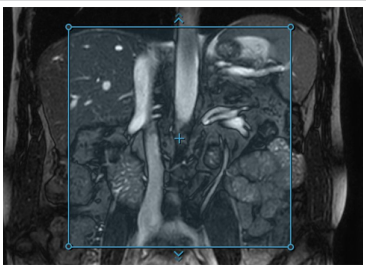
- Number of slices
- Fold-over indicator (double-arrow icon in **Fold-over direction** outside of the stack)





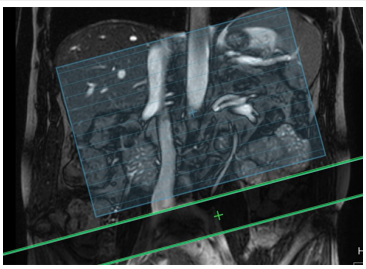


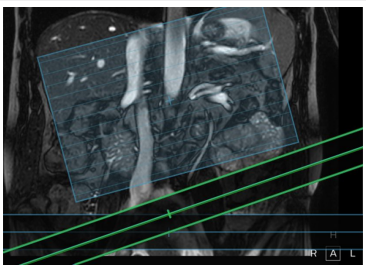
Truncated stack with planning which is angulated to the displayed slice



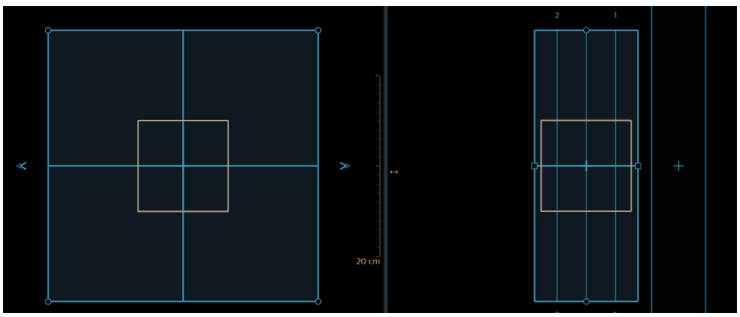
Stack displayed as **Field of View** when planned parallel to the displayed slice

REST saturation slab

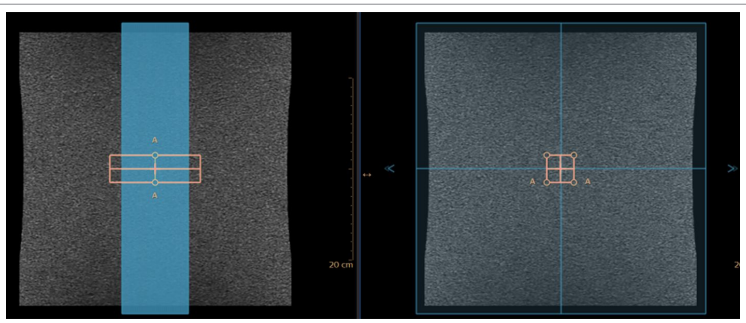




Shimbox



Navigator



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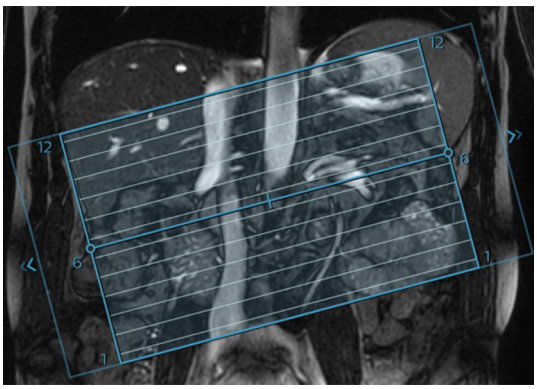
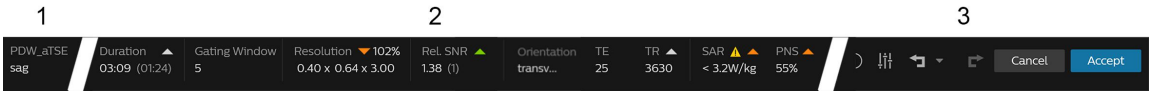
FOS Oversample area Displayed outside of stack in fold-over direction Only applicable if **Fold-over suppression** is set to **oversampling**	

6.4 Scan Dashboard

6.4.1 Functional Description

The Scan Dashboard is available on the **Plan** tab. It assists you in planning.

- It shows the effects on important scan parameters immediately during planning.
- It allows to access information about scan protocols.
- It allows to access **Advanced Parameters**.
- It allows to undo, redo, reset, cancel or accept your planning.



Number	Description	More information
1	Scan name and scan orientation	-

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Number	Description	More information
2	Important information about: • Scan **Duration** Format: actual scan duration (initial scan duration) • **Resolution** Format: actual Acquisiiton voxel size • **Rel. SNR** (Relative Signal-to-NoiseRatio) Format: Factor actual SNR relative to initial SNR (1) • **Orientation** Transverse, coronal, or sagittal • **TE** Format: in ms • **TR** Format: in ms • **SAR** (Specific Absorption Rate) Format: in W/kg • **PNS** (Peripheral Nerve Stimulation) iFormat: in %	Arrows indicate visually if the value has been increased or decreased. Their colors indicate if the change is critical or uncritical. • Critical change with decreased value, e.g. **Rel. SNR** or **Resolution**. • Critical change with increased value, e.g. **SAR** or **PNS**. • Improvement, e.g. • No or only minor effect. • Safety notification, e.g. for **SAR** or **PNS**. When you hover over the Scan Dashboard, tooltips are displayed which provide you with more information about the displayed information. Example: **Acquisition Voxel Size** **Value 0.90x1.53x4.00mm** **Original 0.90x1.53x4.00mm (100%)** **Smaller voxel size leads to higher resolution.**

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Number	Description	More information
3	Buttons: • **Info** Displays more information about the use and typical application of a scan protocol or ExamCard. • **Advanced Parameters** Allows to access the advanced parameters. This is recommended for experienced operators only. • : **Undo** reverses your last action. **Reset** resets all changes and goes back to the initial values. • **Redo**: Redoes something you have undone. • **Cancel**: Resets all changes made to the planning, and closes the current planning session. • **Accept**: Accepts the planning. Next step is to start the planned scan or to continue planning of other scans.	

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6.5 Routine Procedures

6.5.1 Managing Geometries

During planning, you edit the planning volumes (stack, slab, shim box, navigator) to adjust them to the patient's anatomy.

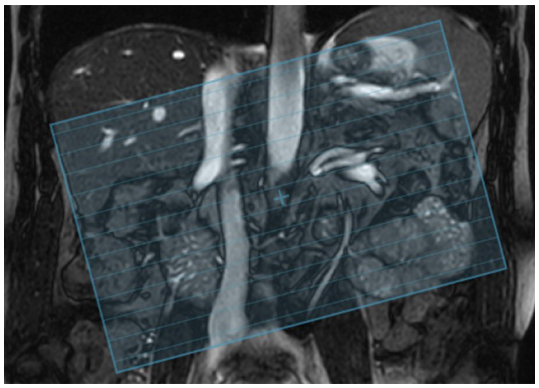
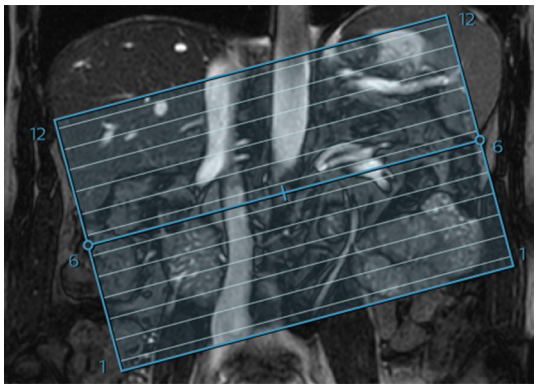
- You can only modify the selected geometry (stack, slab, shim box, navigator).
- In some cases, you need to duplicate or delete the selected geometry.

Selecting a Geometry

► Hover over a planning volume in a viewport, then click on it.
Alternatively select the planning volume from the **Selected Geometry** drop-down menu on the Plan Toolbar

.

⇨ On the Plan Toolbar, the **Selected Geometry** is indicated as: **Stack A** or **Stack B**, **Slab 1** or **Slab 2**, **Navigator A** or **Navigator B**, **Shim volume**, **FOS A** or **FOS B** (only applicable if the parameter Fold-Over Suppression is set to oversampled).

Unselected stack	Selected stack
	
• without anchor points • without slice numbers • without midlines	• with anchor points • with slice numbers • with midlines

Duplicating the currently selected geometry

► On the Plan Toolbar, click **Duplicate Geometry** .

⇨ A copy of the selected geometry is created and can now be used for planning.

Deleting the selected geometry

► On the Plan Toolbar, click **Remove Geometry** .

⇨ The selected geometry is deleted.

6.5.2 Graphical Planning

For accurate planning, you adapt the planning volumes to the patient's anatomy. You plan ExamCard items graphically on the previously performed scans (e.g. on survey images or other scans). You can also plan on movies which is especially helpful in Cardiac imaging.

- You can only edit the geometry of the current planning volume (stack, REST slab, shim box, or navigator).
- You can undo changes step by step or reset the planning with the Reset button .

► Hover over the current planning volume (stack, REST slab, shim box or navigator).

The mouse pointer changes and indicates which action you can perform.

► Drag the planning volume, the anchor point or the border line to change the geometry of the planning volume.

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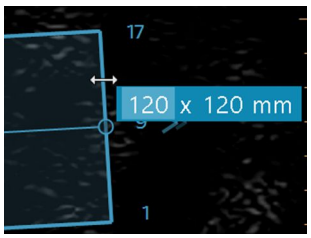
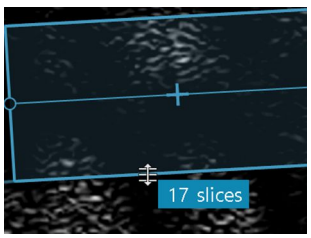
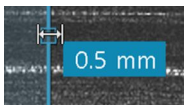
Purpose	Hover over	Mouse pointer	Affected imaging parameters
To move the planning volume	The center area of the planning volume		The values of the Offcenter parameters are automatically adapted.
To rotate the planning volume	A round anchor point of the planning volume		The values of the Angulation parameters are automatically adapted.
To change the size of the planning volume	A border line of the planning volume		If you resize the stack, the value of the Field-of-View is automatically adapted.  If you resize any other planning volume (REST slab, shim box, navigator), the value of the corresponding size is automatically adapted.
To change the number of slices	A border line of the stack		The number of slices are automatically adapted. 
To change the slice gap Only possible when slice gap is set to manual/user defined.	A square anchor point of the stack		The slice gap is automatically adapted. 

NOTICE

These parameter changes could affect the scan duration or the signal-to-noise ratio.

Check out the Scan Dashboard. It provides you with immediate information about the effects of your planning.

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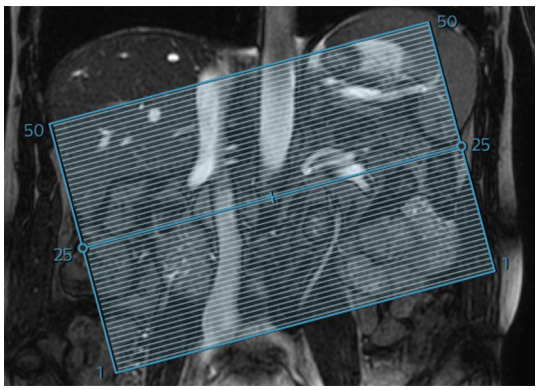
To modify other imaging parameters (such as slice thickness), open the **Advanced Parameters** window.

6.5.3 Changing the Display of the Stack

In planning, you can choose how to display the imaging volume of the stack.

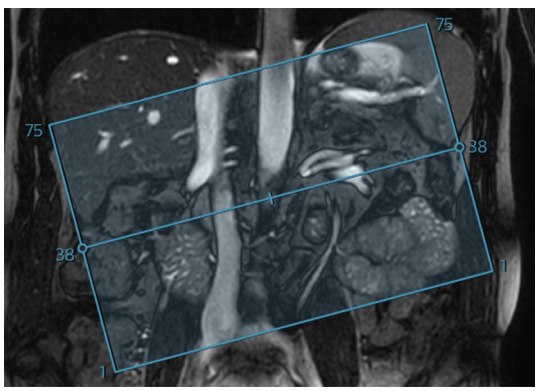
► On the Plan toolbar, do any of the following:

- To display the imaging volume as slices, click **Show Slices** .



- To display the imaging volume as 3D box, click **Show 3D Box** .

- To display of all midplanes, click **Show Midplanes** .



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6.5.4 Copying Geometry Parameters from an Image to the Stack

When you need to plan the current scan identical to a previously scanned image, you copy the geometry parameters from this previously scanned image to the current stack.

- ► On the **Plan** tab, right-click the image from which you want to copy the geometry values, and select **Copy From Image**.
  - ⇨ A submenu opens.
- ► Do any of the following:
  - To copy the position (i.e. offcenter, angulation and orientation), click **Position**.
  - To copy the position and the field of view, click **Position + FOV**.
  - To copy the position, the field of view and the slice thickness, click **Position + FOV + Slice Thickness**.

⇨ The selected geometry parameters are copied and applied to the stack.

6.5.5 Planning Orthogonal to the Selected Slice

This option allows you to plan the current stack orthogonal to the slice in the selected viewport. It copies the angles from the image in the selected viewport.

- ► In a planning viewport, scroll to the slice which you want to plan the stack orthogonally to.
- ► On the Plan Toolbar, click **Set Orthogonal** .

⇨ The planning of the current stack or volume is updated immediately.

6.5.6 Planning a Stack or Volume with Current Offcenter Values

This option allows you to plan the current stack or volume with the same offcenter values as the slice in the selected viewport. It copies the offset values from the image in the selected viewport.

- ► In a planning viewport, scroll to the slice which you want to use to center the stack.
- ► On the Plan Toolbar, click **Set Center** .

⇨ The planning of the current stack or volume is updated immediately.

6.5.7 Defining an Irregular Plane with 3-Point Planning

3-Point Planning (also referred to as 3 Points PlanScan, 3PPS) is a tool which helps to define an irregular plane. The plane is determined by the placement of three points on two or more images of different orientations.

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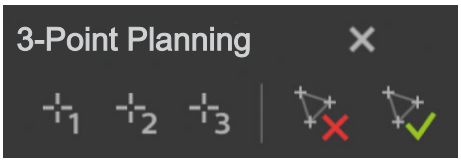
- On the Plan Toolbar, click **3-Point Planning** .

  ⇨ The **3-Point Planning** window opens.

- To place the three points, click three times in any of the three images selected in the planning view ports.

  To change a point, click on the corresponding button on the **3-Point Planning** window, then click in the image to define the new point.

- To restart, click **3-Point Planning** .

- To create the plane based on the 3 points, click **3-Point Planning** .

6.5.8 Aligning Scans with ScanAlign

ScanAlign allows you to align scans which have been acquired in multiple stations with table movement to cover long anatomical areas. Typical applications are Whole Body and MobiFlex or MobiTrak scans.

- Select a scan which has been acquired in multiple stations with table movement.

- On the Plan toolbar, click **ScanAlign** .

If you align stations with different geometries, the **ScanAlign** button notifies you with a warning sign that the slices are not aligned. Also a pop-up message notifies you.

English	Your language
Scan Align Validation	Scan Align Validation
Aligned scans may not be suitable for MobiView, the slices are not aligned.	Aligned scans may not be suitable for MobiView, the slices are not aligned.
Ensure that scans have • Same orientation with parallel stacks. • Same slice distance (slice thickness plus slice gap).	Ensure that scans have • Same orientation with parallel stacks. • Same slice distance (slice thickness plus slice gap).

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6.5.9 Planning on Movies

You can plan on movies which is especially helpful in Cardiac imaging.

- On the **Plan** tab, hover over the bottom of a viewport.

  ⇨ The Movie Bar appears at the bottom of all viewports:

- To start the movie, click **Play** .

Button	Description
	Set the dimension that is played, e.g. slices , echoes or phases .
	Set repeat/bounce options: • **Cycle Forward** : The images are displayed in a loop in the order 1 ... n, 1 ... n etc. • **Cycle Backward** : The images are displayed in a loop in the order n ... 1, n ... 1 etc. • **Bounce** : The images are displayed in the order 1 ... n, n ... 1, 1 ... n, etc.
	Previous Image: Step backwards through the images of the selected dimension.
	Play: Start movie playback.
	Pause/stop movie playback.
	Next Image: Step forwards through the images of the selected dimension.
	Frame Rate: Set movie playback speed.
	Toggle **Auto Hide**: • If activated, the movie bar disappears when you move the mouse away from it, and reappears when you move the mouse near its place. • If deactivated, the movie bar keeps visible. • The button shows the current setting.

Tab. 6: Movie bar buttons

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6.6 Easy Scan Plan

6.6.1 Functional Description

Easy Scan Plan is a MPR-based planning tool (where MPR stands for MultiPlanar Reformat) which is seamlessly integrated in Planscan (the **Plan** tab).

Easy Scan Plan is available for use in all applications. However, it is mainly useful for complex planning, for example, double-oblique planning in cardiac and MSK imaging.

- **Easy Scan Plan** allows you to preview the planned scan plane.
- **Easy Scan Plan** allows you to modify the current planning (to capture the right planes).
- **Easy Scan Plan** allows you to save the final planning under a geometry name, and to load an existing geometry into your current **Easy Scan Plan** session.
- **Easy Scan Plan** provides you with orthogonal or non-orthogonal MPRs depending on your preference.
- **Easy Scan Plan** allows you to show all PlanScan objects on the MPR, for example, shim volume and REST slab.
- **Easy Scan Plan** allows you to switch between **MPR** and **2D** mode for each viewport.

Prerequisite for Easy Scan Plan imaging series

- Single orientation.
- Single stack.
- More than five slices.

6.6.2 Easy Scan Plan and ExamCard Geometries

Easy Scan Plan allows you to save the final planning under a geometry name. Also in the ExamCard, you save planned geometries under a geometry name.

The table lists what is saved under a geoname in **Easy Scan Plan** and in the ExamCard.

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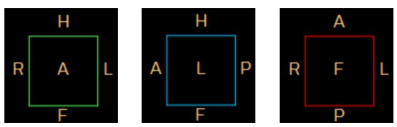
Save with Easy Scan Plan	Save the planning by clicking Accept (ExamCard)
• You save the offcenter and angulations of the MPR preview. In PlanScan, these values are applied to the stack. • You save the position of the reference lines of the other MPRs. Consequently, the orthognal views load back in the exact same way if you select **Load Geometry**.	• You save the stack offcenter and angulation values. • You save the offcenter and angulation values of all other PlanScan objects. • It is possible to update the in-plane stack offcenter and angulation values without impact on the calculated scan plane. However, any update of the angulation of the scan plane overwrites the stored values of the saved MPR preview and the position of the reference lines of the other MPRs. Consequently, the orthogonal views do not load back in the exact same way if you select **Load Geometry**.

6.6.3 User Interface

Viewports

Easy Scan Plan displays the 3D volume scan and MultiPlanar Reformats in the upper three viewports where each viewport displays a different orientation. For your convenience and to support your planning, you can drag any other imaging series into the lower three viewports.

- The left-most viewport shows the original 3D volume scan.
  The other two viewports show the automatically generated MultiPlanar Reformats. By default, these MPRs are orthogonal to the 3D volume scan.
- The reference squares in the lower right corner of each viewport indicate the (radiological) view.



  – When all viewports are set to **2D** mode, all reference squares have the same color.
  – When at least one of the viewports is set to **MPR** mode, the reference squares are displayed in green, blue and red to indicate which reference line corresponds to which viewport.
- The reference lines indicate the current slice position in the 3D volume.
  For example, the blue reference line corresponds to the image with the blue reference square.

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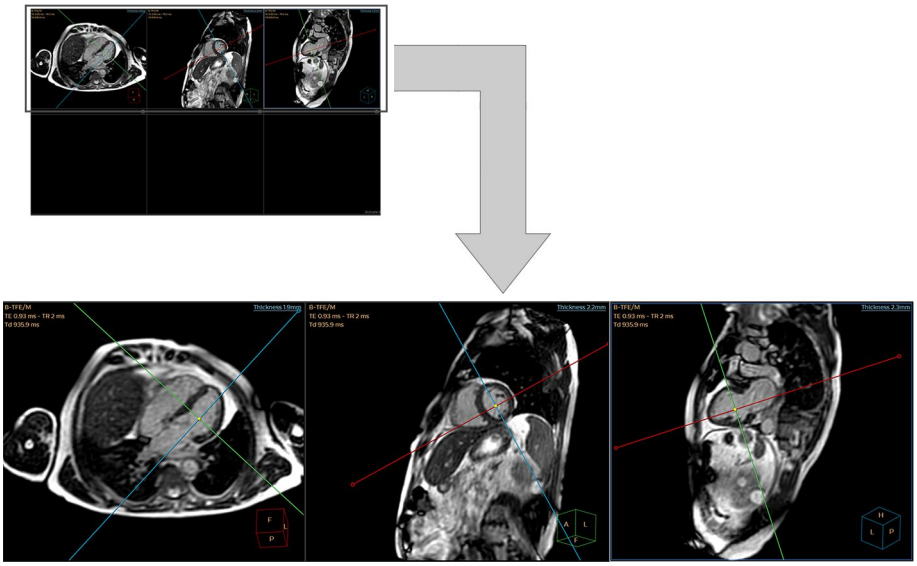

Easy Scan Plan on the Plan Toolbar

Easy Scan Plan comes with dedicated buttons on the **Plan** toolbar.

Button	Description
All in MPR	Sets all viewports to **MPR** viewing mode, and thus enables **Easy Scan Plan**.
All in 2D	Sets all viewports to **2D** viewing mode, and thus disables **Easy Scan Plan**.
Plan Link	Allows you to align a stack with one of the orthogonal MPRs. The stack follows with every update of the MPR. • By default, **Plan Link** is enabled. • You disable **Plan Link** to check the stack coverage.
Planar Mode	Allows you to toggle between orthogonal MPRs and non-orthogonal MPRs in the **MPR** viewing mode. • By default, **Planar Mode** (orthogonal MPRs) is enabled. • **Planar Mode** becomes disabled if one or more viewports are in 2D-mode.

Context Menu

The **Easy Scan Plan** context menu provides you with the following specific functionality.

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Viewing modes

2D	Sets the current viewport to **2D** viewing mode, and thus disables **Easy Scan Plan**. • if you change the viewing mode of a viewport, the state of the button on the toolbar changes accordingly. • For a viewport in **2D** viewing mode, the context menu options **Save Geometry** and **Load Geometry** are not available.
MPR	Sets the current viewport to **MPR** viewing mode, and thus enables **Easy Scan Plan**. • if you change the viewing mode of a viewport, the state of the button on the toolbar changes accordingly.

Loading and saving geometries under geonames

Load Geometry	Allows you to load a previously saved geometry. A geometry that is not yet saved, is grayed out in the Load-context menu.
Save Geometry	Allows you to save the current geometry in two different ways: • With a geoname which exists in the ExamCard. You select an already existing geoname from the list. All ExamCard items which use this geoname, are planned automatically. • As new geometry with a geoname that you specify. You select **Save New Geometry**.
Save New Geometry	Allows you to save the current geometry as a new geometry. • You are requested to specify a new geoname. • All ExamCard items which use this geoname, are planned automatically.

The **Save New Geometry** window allows you to enter a geoname for a new geometry. or to select an already existing geometry from the list.

- The checkmark in front of a geoname indicates that the geometry is already saved for the current ExamCard.
- Geometries in the upper part (above the separator line) are part of scans in **List View**.
- Geometries in the lower part (below the separator line) are part of the ExamCard, but not used by any of the scans in **List View**.

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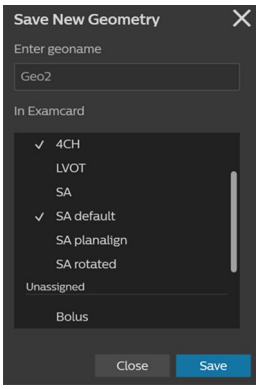


6.6.4 Routine Procedures

Planning with Easy Scan Plan

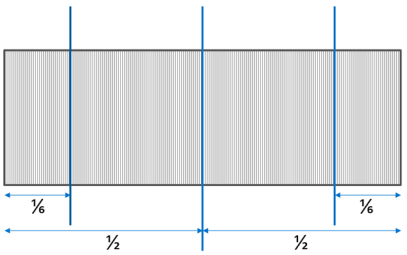
You plan your scans with **Easy Scan Plan** (and with all viewports in **MPR** mode) in anatomies where double angulation is needed.

▷ Prerequisite: The imaging series for planning are suitable for MPR display.

► To open **Easy Scan Plan**, do any of the following:

- Start and run a 3D survey without geoname.

  Once completed, the first three viewports are automatically loaded with images of the 3D survey:
  Viewport 1 shows the mid slice of the 3D survey, viewport 2 and 3 show slices with a distance of 1/6th of the volume to the outer slices).



- On the **Plan** tab, drag a 3D survey with geoname into the first viewport, into the second viewport, and also into the third viewport.

► To display all viewports in MPR mode, click **All in MPR**.

► To navigate through the viewports, drag the reference lines till all viewports show the required planning and views.

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NOTICE

To verify that the scan that you plan fulfills the requirements of the Radiological View, check the reference squares before you save the geometry.

The reference squares indicate the orientation of the current viewport, and thus the newly planned scan.

► To take care that the final images are in an upright position, do any of the following:

- Click **Roll/Rotate**, or press and hold the left and right mouse simultaneously.
  To rotate the image to the upright position, move the pointer to the edge of the FOV.
  To roll the image, move the pointer in the center of the FOV.
- Modify the in-plane rotation of the stack in PlanScan.
- Enable the **PlanAlign** parameter on the **Geometry** tab.

► To save the geometry, do any of the following:

- To save the geometry under an existing geometry name, right-click on any viewport and select **Save Geometry**. Then select the name of the existing geometry.
- To save the geometry under a new geometry name, right-click on any viewport and select **Save Geometry**. Then select **Save New Geometry**.

The **Save New Geometry** window opens.

Enter a geometry name. Then click **Save**.

⇨ All ExamCard items that use a saved geometry name, are immediately **Ready to run**, if all other planning objects (for example, shim volume, navigator, REST slab) are also planned.

If all other planning objects are not yet planned, the scans do not change to **Ready to run**.

► To plan the planning objects that are not yet planned, open the ExamCard item in PlanScan. Then plan the other planning objects.

► To check the stack coverage in PlanScan, do any of the following:

- Click on the slices in the stack so that the MPR preview jumps to the slice.
- Scroll through the MPR preview with PlanLink disabled.

► To confirm the planning, click **Accept**.

⇨ All ExamCard items are now **Ready to run**.

⇨ Proceed with further planning of other geometries. Start the ExamCard with the ExamCard items that are **Ready to run**.

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6.7 Interactive Scanning

6.7.1 Functional Description

Interactive scanning allows you to interactively define the scan plane for a real-time scan. It can be used in combination with 3D-navigation of MR-data. Interactive Scanning enables you to perform interventional procedures under MR guidance.

Interactive scanning is especially useful for real-time applications in cardiac imaging, because the required geometry angulations can be found in real time for the different cardiac views.

Prerequisite for 2D real-time interactive scan

- Single slice.
- With parameter **Interactive scanning** set to **yes**.

Prerequisite for 3D scan for MPR navigation

To facilitate planning, you use this imaging series for navigation in MPR view.

- Single orientation.
- Single stack.
- More than five slices.

6.7.2 User Interface

Interactive Tab

Interactive Scanning opens in its own tab on the Patient Tasks Bar. When Interactive Scanning is enabled, the following tabs are available: **Prepare**, **Plan**, **Interactive**, **Review**, **Analysis1**, **Analysis2** and **Print**.

The **Interactive** tab opens under the following conditions:

- With a current scan that meets the requirements for Interactive Scanning, you launch **Interactive** from the context menu in Exam Overview.
- The **Interactive** tab opens automatically when a (dynamic) scan is in progress with the parameter **Interactive scanning** set to **yes**.

Interactive Buttons

Interactive Scanning provides you with three buttons underneath the viewports, and one button in the header of the Exam Overview.

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Clear	Deletes all real-time images from the viewports, including all images in the buffer of **Interactive** (up to 100). • Without 3D navigation (no 3D scan was loaded previously), **Clear** deletes all images from the viewports. • With 3D navigation (3D scan was loaded previously, **Clear** still displays the MPR-view of the 3D scan in the last-scanned orientation.
Reset	Resets the geometry in all viewports to the original values. • Real-time images are reset to their original value (their original planning). The other viewports are reset to planes orthogonal to the real-time images. • The 3D navigation (3D scan was loaded previously) is reset to its original scan orientation. The other viewports are reset to planes orthogonal to the 3D scan.
Exit	Closes the **Interactive** tab.
 In the header of the Exam Overview	Allows you to hide the Exam Overview and thus provides you with more space for the **Interactive** viewports.

Viewports in Interactive Scanning

In Interactive Scanning, three viewports are available to plan three different geometries.

Interactive Scanning allows you to toggle between regular and enlarged view. You can toggle between these views from the context menu, or from the toolbar

.

- In regular view, three vertical viewports of the same size are displayed.

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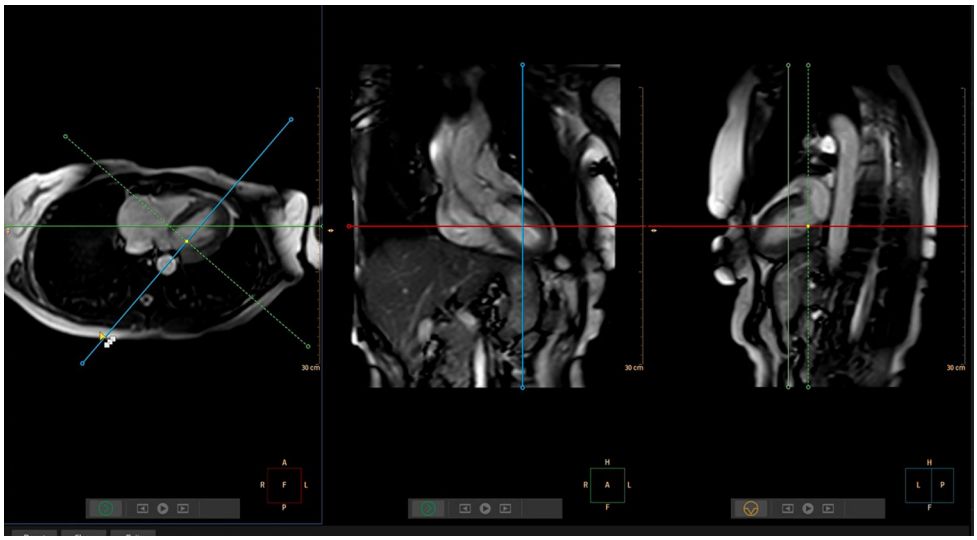

- In enlarged view, one large viewport and two small viewports are displayed.

  When you switch from to the regular to the enlarged view, the active viewport (with the blue border around it) gets enlarged.

Every viewport with an image shows reference lines and reference squares, and a control bar in the lower part of the viewport.

- The reference squares in the lower right corner of each viewport indicate the (radiological) view.

  The reference squares are only shown in a viewport when it contains an image.

- The reference lines indicate the current slice position.
  For example, the blue reference line corresponds to the image with the blue reference square.
  - A solid line indicates the actual orientation (position) of the image in the corresponding viewport.
  - A dotted line indicates the new slice orientation (position) of the corresponding viewport.

    The dotted line only appears when you interact with a reference line while the corresponding viewport is in a paused state. The dotted line disappears when scanning is resumed, because then the actual orientation is updated.

    The viewports and the display of the lines (dotted or solid) are automatically updated once you release the reference line.

  The reference line is only shown if more than one viewport contains an image.

- The control bar allows you to **Start** and **Resume** , or to **Pause** real-time scanning for each viewport separately.

  The color of the **Resume** button changes from green to blue when the image in a viewport is no longer current, for example due to interaction with reference lines, or due to 2D in-plane rotation.

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Interactive Scanning on the Toolbars

Interactive Scanning comes with dedicated buttons on the **Interactive** toolbar and on the control bar (in the lower part of the viewports).

Viewing modes

Button	Description
Toggle Regular/Enlarged View 	Allows you to toggle between the regular view and the enlarged view. • Where the regular view is the three default viewports, also referred to as 1x3. • Where the enlarged view is one large and two small viewports, also referred to as 1+2. **Behavior** • When you switch from regular to enlarged view, the view changes from 1x3 to 1+2. The current viewport gets enlarged. • When you switch from enlarged to regular view with the large viewport as current viewport, the view changes from 1+2 to 1x3. • When you switch from enlarged to regular view with one of the small viewports as current viewport, the view remains 1+2. But the image in the current small viewport and the image in the large viewport get exchanged.
Planar Mode 	Allows you to toggle between orthogonal and non-orthogonal planes for both real-time scanning and 3D MPR. • By default, **Planar Mode** (orthogonal planes) is enabled. • With **Planar Mode** enabled, an update of a plane (scan or MPR) always results in an updated view in a second (orthogonal) viewport. • You disable **Planar Mode** when you want to update a plane without impact on the other planes.

Orientation

Button	Tooltip	Description
	Axial	To select an axial orientation for the imaging series.
	Coronal	To select a coronal orientation for the imaging series.
	Sagittal	To select a sagittal orientation for the imaging series.

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Advanced planning

Button	Description
3-Point Planning	To enable (or disable) 3-Point Planning and define an irregular plane. In Interactive Scanning, **Compute Plane** updates the scan plane of the viewport that was active when 3 PPS was started.
In Plane 2D Rotate	To modify the in-plane angulation and offcenter values of the real-time scan. When In Plane 2D Rotation is enabled, the reference lines (for example, blue and green line in the red viewport) get replaced by a reference cross (for example, red cross in the red viewport). The axes of the cross indicate the axes of the Field of View in the selected viewport. • To modify the in-plane angulation, rotate the cross on the viewport. • To modify the in-plane offcenter values, drag the cross to another location. • To apply the updates to the scan plane, release the mouse button.

Control

Button	Location of the button	Description
Pause	On the control bar, only when the interactive scan is resumed and running.	Allows you to pause the interactive scan. Alternatively, use the Space key on your keyboard. The Space key does not work when you are typing text in annotation mode.
Start Scan / **Resume**	On the control bar, only when the Interactive scan is paused.	Allows you to start the interactive scan, or resume the paused interactive scan. Alternatively use the Space key on your keyboard. The Space key does not work when you are typing text in annotation mode. The start of an interactive scan in a viewport automatically stops the previously started interactive scan in another viewport. The color of the **Resume** button changes from green to blue when the image in a viewport is no longer current, for example due to interaction with reference lines, or due to 2D in-plane rotation.

Context Menu in Interactive Scanning

The context menu provides you with the following dedicated functionality for Interactive Scanning.

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Viewing modes

Toggle Regular/Enlarged View 	Allows you to toggle between the regular view and the enlarged view. • Where the regular view is the three default viewports, also referred to as 1x3. • Where the enlarged view is one large and two small viewports, also referred to as 1+2. **Behavior** • When you switch from regular to enlarged view, the view changes from 1x3 to 1+2. The current viewport gets enlarged. • When you switch from enlarged to regular view with the large viewport as current viewport, the view changes from 1+2 to 1x3. • When you switch from enlarged to regular view with one of the small viewports as current viewport, the view remains 1+2. But the image in the current small viewport and the image in the large viewport get exchanged.
In Plane 2D Rotate 	To modify the in-plane angulation and offcenter values of the real-time scan. When In Plane 2D Rotation is enabled, the reference lines (for example, blue and green line in the red viewport) get replaced by a reference cross (for example, red cross in the red viewport). The axes of the cross indicate the axes of the Field of View in the selected viewport. • To modify the in-plane angulation, rotate the cross on the viewport. • To modify the in-plane offcenter values, drag the cross to another location. • To apply the updates to the scan plane, release the mouse button.

Artifact prevention

Auto fold-over direction	Allows you to change the fold-over direction of the Interactive scan in a viewport, to reduce fold-over artifacts. • When **Auto fold-over direction** is enabled, the fold-over direction is automatically selected: AP for transverse, AP for sagittal, RL for coronal orientation. • When **Auto fold-over direction** is disabled, the fold-over direction is changed to the alternative value: RL for transverse, FH for sagittal, FH for coronal orientation.

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Real-time images

Store Image	Allows you to store the displayed real-time image in the selected viewport. • All stored images from the same Interactive scan are stored in the same imaging series. • Stored images are ordered according to their dynamic scan time. Interactive Scanning has a buffer for 100 images. • It allows you to scroll through the last 100 frames of the interactive scan. • It also allows you to store images in the buffer.
Clear real-time images	Deletes the real-time images from the current viewport. The buffers of the other viewports are not affected. You can still scroll through the last 100 frames of these interactive viewports. • Without 3D navigation (no 3D scan was loaded previously), **Clear real-time images** deletes all images from the current viewport. • With 3D navigation (3D scan was loaded previously, **Clear real-time images** still displays the MPR-view of the 3D scan in the last-scanned orientation.

Loading and saving geometries under geonames

Load Geometry	Allows you to load a previously saved geometry. A geometry that is not yet saved, is grayed out in the Load-context menu.
Save Geometry	Allows you to save the current geometry in two different ways: • With a geoname which exists in the ExamCard. You select an already existing geoname from the list. All ExamCard items which use this geoname, are planned automatically. • As new geometry with a geoname that you specify. You select **Save New Geometry**.
Save New Geometry	Allows you to save the current geometry as a new geometry. • You are requested to specify a new geoname. • All ExamCard items which use this geoname, are planned automatically.

The **Save New Geometry** window allows you to enter a geoname for a new geometry. or to select an already existing geometry from the list.

- The checkmark in front of a geoname indicates that the geometry is already saved for the current ExamCard.
- Geometries in the upper part (above the separator line) are part of scans in **List View**.
- Geometries in the lower part (below the separator line) are part of the ExamCard, but not used by any of the scans in **List View**.

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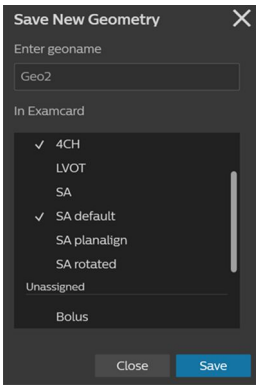

6.7.3 Routine Procedures

Starting Interactive Scanning without 3D Navigation

This workflow describes interactive scanning without a previously acquired 3D imaging series, and consequently without 3D navigation on the reconstructed MPRs of this 3D imaging series.

You start the Interactive scan. You only see 2D-realtime images in the viewports.

- ► Drag the 2D real-time interactive scan into the Exam Overview.
- ► Plan the scan. To confirm the planning, click **Accept**.
- ► In the Exam Dashboard, click **Start Scan**.
  - ⇨ When the preparation phases of the scan are complete, the **Interactive** tab opens.
  - ⇨ In the first viewport, a real-time acquisition starts automatically, and then pauses automatically.
    The orientation of this real-time acquisition is identical to the orientation of the previously planned interactive scan.
- ► To resume scanning in the same orientation, click **Start**/**Resume** in this first viewport.
- ► To resume scanning in the first orthogonal plane, click **Start**/**Resume** in the second viewport.
- ► To resume scanning in the second orthogonal plane, click **Start**/**Resume** in the third viewport.

Starting Interactive Scanning with 3D Navigation

This workflow describes interactive scanning with a previously acquired 3D imaging series, and consequently with 3D navigation on the reconstructed MPRs of this 3D imaging series.

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You drag the previously acquired 3D imaging series into the viewports. You navigate to the most qualified MPR view. Then you start the 2D real-time Interactive scan in that exact MPR orientation.

▷ In Exam Overview (**List View** or **Thumbnail View**):

- Right-click the completed 3D scan for MPR navigation, then select **Interactive**.
  - ⇨ The **Interactive** tab opens with three images in MPR view.
    The orientation of each viewport predefines the orientation of the 2D real-time interactive scan.
- To change the predefined (default) orientation of each viewport, navigate through the 3D data till you find the required scan orientation.
- Drag the 2D real-time interactive scan into the Exam Overview.
- Plan the scan. To confirm the planning, click **Accept**.
- In the Exam Dashboard, click **Start Scan**.
  - ⇨ When the preparation phases of the scan are complete, a real-time acquisition starts automatically in the defined orientation.
- To stop the real-time acquisition, click **Pause** in this viewport.
- To resume scanning in the MPR orientation of another viewport, select the viewport. Then click **Start**/**Resume**.

Optimizing the Interactive Scanning

You are in Interactive Scanning. You start/resume and pause real-time scanning on the three viewports which show either MPRs or real-time images.

To optimize your planning, repeat the following steps as often as needed.

- Drag the reference lines on an MPR to the desired position and angulation.

  To start the interactive scan again, click **Resume**.
- Drag the reference lines on a real-time image to the desired position and angulation.
  - ⇨ When you release the mouse button, the viewports are updated after continuous scanning of 500 ms. Eventually all viewports show an image that corresponds to the reference lines.
- To pause the interactive scan when the real-time image in the current viewport is sufficient for further planning, click **Pause**.
- To modify the in-plane angulation, rotate the cross on the viewport.

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To modify the in-plane offcenter values, drag the cross to another location.

To start real-time scanning after the in-plane modifications, release the mouse button

Storing Images and Saving the Geometry

You are in Interactive Scanning.

- ► To store your planning images once your planning is complete, right-click the viewport. Then select **Store Image**.
- ► To save the geometry, do any of the following:
  - To save the geometry under an existing geometry name, right-click on any viewport and select **Save Geometry**. Then select the name of the existing geometry.
  - To save the geometry under a new geometry name, right-click on any viewport and select **Save Geometry**. Then select **Save New Geometry**.

  The **Save New Geometry** window opens.

  Enter a geometry name which is used in your ExamCard. Then click **Save**.

  ⇨ All ExamCard items that use a saved geometry name, are immediately **Ready to run**, if all other planning objects (for example, shim volume, navigator, REST slab) are also planned.

  If all other planning objects are not yet planned, the scans do not change to **Ready to run**.

⇨ All ExamCard items are now **Ready to run**.

⇨ Proceed with further planning of other geometries. Start the ExamCard with the ExamCard items that are **Ready to run**.

Finalizing the Interactive Scanning Session

You can end the Interactive Scanning session in two different ways.

Option 1

- ► In the Scan Dashboard, click **Start Next Scan [F8]**.

⇨ The Interactive scan stops and gets marked as completed. The **Interactive** tab remains open.

⇨ You can still use the **Interactive** tab to review real-time images in the buffer, to store images, or to navigate in the 3D series that may still be loaded. But you cannot start, resume and pause an interactive scan.

⇨ If you now start a new Interactive scan, this scan starts in the last used orientation of the **Interactive** tab.

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Option 2

► To close Interactive Scanning, click **Exit** on the **Interactive** tab under the viewports.

⇨ The Interactive scan gets marked as completed. The **Interactive** tab closes, and the **Plan** tab displays automatically.

⇨ If you want to start Interactive Scanning again, you have to start from the beginning.

6.8 Advanced Parameters

6.8.1 Functional Description

The **Advanced Parameters** allow you to edit all imaging parameters. Only experienced operators should edit the **Advanced Parameters**.

You access the **Advanced Parameters** from the Scan Dashboard: .

- You can modify the position and the size of the **Advanced Parameters** window:
  - Maximize (and minimize) **Advanced Parameters**.
  - **Dock** the **Advanced Parameters** window in the two lower left viewports.
  - Set the window to **Float** , and move to any location on the monitors.
- The **Advanced Parameters** window displays the imaging parameters in groups.
- Besides the imaging parameters, detailed information about the currently planned scan is given on the scan information page.

6.8.2 Parameter Groups

In MRI, there is a high number of imaging parameters. These**Advanced Parameters** are divided in different groups:

- **Geometry**

  All geometry-related parameters.
- **Contrast**

  All contrast-related parameters.
- **Motion**

  All motion- and motion compensation-related parameters.
- **Dyn/Ang**

  All parameters related to dynamic and angio imaging.
- **Postproc**

  All parameters related to postprocessing.
- **Offc/Ang**

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All offcenter and angulation parameters.

- **Coils**

  Coil-specific information.

To display the parameters of a group, click on the tab with the group name.
The selected parameter group is displayed on one or more pages. A scroll bar indicates if more parameters are available.

6.8.3 Scan Information Page

The Scan Information Page (also referred to as Info Page) is automatically displayed in the **Advanced Parameters** window. The Scan Information Page displays the scan characteristics of a planned EC item.

The table lists the most important scan characteristics applicable for every kind of scan.

Item displayed	Description
Total scan duration	Scan duration of the current ExamCard item.
Rel. SNR	Relative Signal-to-Noise Ratio, more info see below.
ACQ heart phases	Actual number of acquired heart phases.
REC heart phases	Actual number of reconstructed heart phases
ACQ matrix M x P	Acqusition matrix Measurement x Preparation direction.
ACQ voxel MPS (mm)	Acquisition voxel size in Measurement, Preparation and Slice selection direction in millimetres.
REC voxel MPS (mm)	Reconstruction voxel size in Measurement, Preparation and Slice selection direction in millimetres.
Scan percentage (%)	Current scan percentage considering all imaging parameters.
WFS (pix) / BW (Hz)	Actual Water-Fat Shift in pixels and Bandwidth in Hertz.
SAR / head	Specific Absorption Rate / head in %. Depending on the anatomy scanned, the SAR could also be indicated as e.g. **Local torso SAR** or **Local Extremities SAR**.
Whole body SAR / level	Whole Body SAR in W/kg, and the level indicated as normal or first level controlled operating mode.
SED	Specific Energy Dose in kJ/kg.
Coil Power	in %
B1+rms	Average RF deposition in the patient, also denoted as B1+RMS in uTesla.
Max B1+rms	Maximum Average RF deposition in the patient, also denoted as Max B1+RMS in uTesla.
PNS / level	Peripheral Nerve Stimulation, and the level indicated as normal or first level controlled operating mode..

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Item displayed	Description
dB/dt	The strength of the switching gradient used for imaging.
Sound Pressure level (dB)	Sound pressure level. The sound pressure level is given with respect to an internal acoustic reference level which can be understood as the standard system noise level. Accordingly, negative/positive values indicate that the actual sound pressure level is below/above this reference level.

For more information on SAR, SED, B1, PNS and dB/dt, see Safety chapter of the Instructions for Use.

Extended Functional Options on the Scan Information Page

If functionality of the commercial package EFO (Extended Functionality Options) is being used, an informational parameter **EFO Options used** is shown on top of the Info Page. This parameter indicates the number of EFO SW Options used.

Relative SNR

The Relative SNR

- shows the effects on the SNR (Signal-to-Noise Ratio) when modifying parameters.
- is displayed as factor where a value of 1.0 is identical to the SNR of the original scan protocol.
- is not an absolute value, but relative to the SNR of the initial scan protocol.

It is important to realize that the Relative SNR is based on a relative calculation.

Example

If the original slice thickness is halved, the displayed Relative SNR will be 0.5 (relative to the original procedure).
If this procedure is saved and retrieved again, the Relative SNR will still be displayed as 0.5. Modifications are always relative to the starting point which is the original scan protocol.

The **Reference Tissue** parameter is also included in the RSL-calculation, but it does not affect the SNR of the image. It can be set to e.g. white matter, muscle, liver, bone marrow and CSF. The T1- and T2-values of the tissues are taken into account to give a more realistic interpretation of the SNR changes.

6.8.4 Editing Advanced Parameters

When you want to edit a parameter, you have to select this parameter first. Once the parameter is selected, you can enter a new value manually, or select a value from a drop-down menu or update the current value stepwise.

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Selecting a parameter for editing

► To navigate to the parameter for modification, do any of the following:

- In the selected parameter group, scroll with the **Down Arrow** or **Up Arrow** keys.
- In the selected parameter group, scroll with the scrollbar.
- Search for a parameter:
  Type in the first letter of the required parameter's name. The cursor jumps to the first parameter starting with this letter.
  Type in the first letter of the required parameter's name again. The cursor jumps to the next parameter starting with this letter.
  Example (for English UI): Type R. First time cursor jumps to Respiratory compensation. Type R again. Cursos jumps to REST.

► Click to select the parameter for modification.

Editing the current parameter

There are different ways of how to change the value of the current parameter:

1. Enter the value manually:
   – Click into the value field to make it current.
   Click again to position the cursor in the value field.
   – Delete with the **Delete** or **Backspace** key, then enter the value with the keyboard.
2. Select the value from the drop-down menu (applicable for parameters with text strings):
   – Click to open the drop-down menu.
   – Select the value.
3. Increase or decrease the parameter values (especially used for numerical values) with arrow keys or buttons as shown in the table:

Effect	Keyboard arrow keys	buttons
To increase parameter value by one	Press **[Right Arrow]** key.	Click the **Up Arrow** button.
To increase parameter value to highest possible value	Press **[Shift+Right Arrow]**.	Press and hold **[Shift]**, then click the **Up Arrow** button.
To decrease parameter value by one	Press **[Left Arrow]** key.	Click the **Down Arrow** button.
To decrease parameter value to lowest possible value	Press **[Shift+Left Arrow]**.	Press and hold **[Shift]**, then click the **Down Arrow** button.

Restoring the original value

► To restore the original (or last stored) value of the selected parameter, press **[Shift+Enter]**.

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- To restore the values of all parameters, click and select **Reset**.

Undoing previous changes

- To undo previous changes, press **[Ctrl+Z]**, or
  click and select **Undo**.

The **Undo** function does not work after having clicked **Accept** (to accept the planning and the changes made).

Display helptext for selected parameter

- Press **F1** to display the information about the selected parameter.

NOTICE

Not all combinations of parameter values are possible.

In case of conflicts, . To solve the conflict, refer to the 'Conflicts' tab and the 'Assistance'.

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6.8.5 Parameter benefits and trade-offs

NOTICE

For information about all MR imaging parameters, refer to the Parameter Help.

Press **F1** or select **Help (F1)** from the Navigation bar.

The relationships between MR imaging parameters are complex. The table shows the effects of increasing or enabling a parameter (set to "Yes") on scan time, resolution, signal-to-noise ratio (SNR) and artifact level for some parameters.

↓ lower, ↑ higher, = unchanged, * more information available in following table

PARAMETER	Scan time	Resolution	SNR	Artifacts
NSA	↑	=	↑	↓
REST	↑	=	=	↓
Voxel Size	↓	↓	↑	↓/↑

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PARAMETER	Scan time	Resolution	SNR	Artifacts
FOV (in combination with fixed matrix size) *	=	↓	↑	=
FOV (in combination with fixed voxel size) *	↑	=	↑	=
Rectangular FOV (%)	↑	=	↑	=
Scan percentage (%)	↑	↑	↓	=
Slice thickness	=	↓	↑	=
Scan matrix	↑	↑	↓	=
Halfscan	↓	=	↓	↑
SMART	=	=	=	↓
Water Fat Shift	=	=	↑	↑
3D Slices	↑	=	↑	=
SE Flip Angle	=	=	↓	=
Flowcomp FFE, TSE	=	=	↓	↓
Flowcomp SE	=	=	=	↓
Partial Echo	=	=	↓/↑	↓/↑
SPIR / ProSet	↑	=	=	↓
SENSE	↓	=	↓	=

The effect of the parameter FOV can differ depending on the way of working: you can either adjust the **matrix size** or the **voxel size**. The table illustrates the effects.

Way of working	FOV	Scan matrix	Pixel size	TE	TR	Scan time	SNR
Matrix size	↓	=	↓	↑ 1)	↑ 2)	↑	↓ 3)
Voxel size	↓	↓	=	=	=	↓	↓ 4)

Footnotes:

1. This is valid in case of TE = shortest.
   For TE = user defined, this could lead to a conflict
2. This is valid in case of TR = shortest.
3. This is caused by smaller voxels.
4. This is caused by the reduction of scan time.

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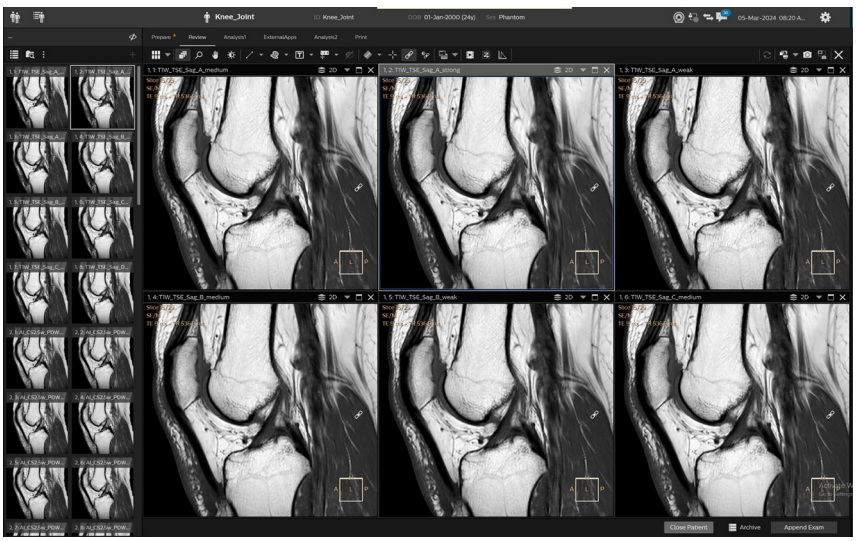
7 Reviewing Images

7.1 Review Tab

In the **Review** tab, you review the imaging series and you can choose to display the imaging series differently, e.g. as Maximum- or Minimum-Intensity-Projection, or as Multiple Planar Reformat. The following UI elements support you:

- Review toolbar which allows you to optimize the display of the images, and to perform measurements.
- Viewports for reviewing.



7.2 Opening an Imaging Series in the Review Tab

There are various ways of how to open and review imaging series in the **Review** tab.

▷ From the **Patient Directory**:

► Do any of the following:

- Double-click an examination.
- Right-click an examination, then select **Review**.
- Click an examination, then click the **Review** button.

⇨ The examination opens in the default layout of 3x2 and displays the center slice of the first 6 imaging series.

▷ From the **Exam Overview**:

► Drag an imaging series from the **Thumbnail View** (or **List View**) into a **Review**viewport.

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⇨ The center slice of this imaging series is displayed in the viewport.

A previously displayed imaging series is replaced by the new one.

▷ From the **Exam Overview**:

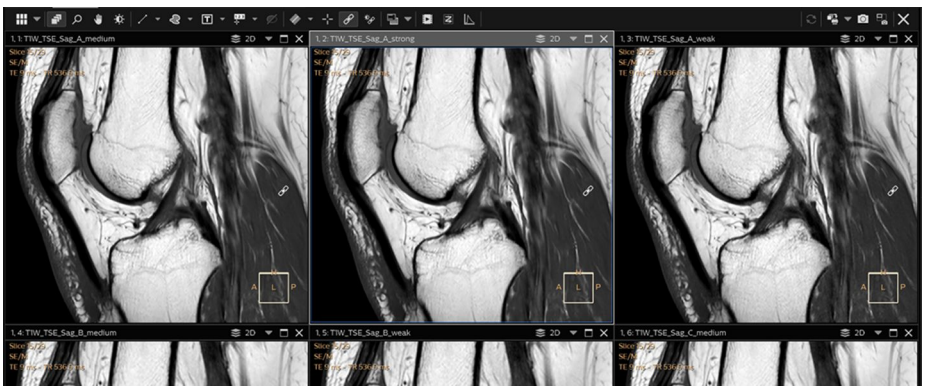
► Right-click an imaging series in the **Thumbnail View** (or **List View**), then select any of the render modes for review, where **2D** is the default viewer.

⇨ The imaging series opens in the default layout of 3x2 and displays the center slice of the first 6 imaging series.

7.3 Closing Imaging Series

► To close a single imaging series in a viewport, click in the upper right corner of the viewport.

► To close all imaging series, click in the right corner of the Review toolbar.



7.4 Review Toolbar

7.4.1 Functional Description

The Review Toolbar is available on the **Review** tab.
It is composed of buttons and drop-down menus that provide access to generic functions to review imaging series. For drop-down menus, always the currently selected button is visible. The toolbar changes with the selected render mode.

The Review Toolbar allows you to:

- Adjust the complete viewing area, including layout selection and the level of image information.
- Scroll through images, and zoom, pan and window images.
- Perform measurements on images and add annotations.

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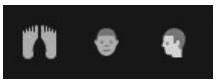
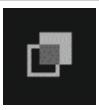
- Access advanced functionality, such as image sorting, time-intensity diagrams or fibers.
- Capture, export and print images.

When you access the **Review** tab, the default render mode is **2D**.

When you switch to other render modes (**Slab**, **3D**, **OrthoView**, **PicturePlus**, **MobiView**), optional buttons become available.

Number	Button or button group description	More information
1	Layout	chapter “Layout” on page 482
2	Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...	chapter “Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...” on page 482
3	Measurements and Annotations	chapter “Measurements and Annotations” on page 483
4	Interaction between Imaging Series	chapter “Connecting Viewports and Comparing Imaging Series” on page 485
5	Image Information	chapter “Image Information” on page 487
6	Other Ways of Reviewing Imaging Series	chapter “Other Ways of Reviewing Imaging Series” on page 487
7	Refresh Display	chapter “Refresh Display” on page 488
8	Print and Capture Images	chapter “Print and Capture Images” on page 488

Optional buttons and button groups

Button or button group	Description	Availability	More information
	Orientation of imaging series	• **Slab** (MPR) • **3D** (MIP) • **OrthoView**	chapter “Orientation” on page 489
	Roll/Rotate	• **Slab** (MPR) • **3D** (MIP) • **OrthoView**	chapter “Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...” on page 482
	Plane Opacity	• **OrthoView**	chapter “Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...” on page 482
	**Opacity**	• **OrthoView**	chapter “Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...” on page 482
	Enhance PicturePlus	• **PicturePlus**	chapter “Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...” on page 482

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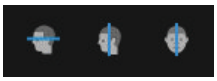
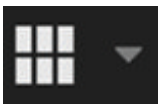
Button or button group	Description	Availability	More information
	**Hide Axial Plane** **Hide Coronal Plane** **Hide Sagittal Plane**	• **OrthoView**	chapter "Hide Planes" on page 489
	Show Fibers	• **OrthoView**	chapter "Other Ways of Reviewing Imaging Series" on page 487
	Set Center	• **Slab** (MPR) • **3D** (MIP)	chapter "Connecting Viewports and Comparing Imaging Series" on page 485

7.4.2 Layout

The **Layout** drop-down menu allows you to select how many viewports are distributed over the screen in rows and columns.

Drop-down menu	Short Description	Instructions
	**Layout:** To select any of the layouts from the drop-down menu.	• chapter "Selecting a Layout for the Review Screen" on page 493

7.4.3 Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...

When you drag (with left mouse button) in a viewport, by default you scroll through images.

Click any of these buttons to change this behavior, and then use the drag function to perform any of the actions listed below:

Button	Short Description	Instructions
	Scroll (default setting): Drag to scroll through the imaging series (when this button is enabled).	• chapter "Scrolling through Images" on page 496
	Zoom: Drag to magnify or reduce the image (when this button is enabled).	• chapter "Zooming in and out of an Image" on page 499

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Button	Short Description	Instructions
	Pan: Drag to pan a magnified image (when this button is enabled).	• chapter "Panning an Image" on page 499
	Window: Drag to adjust brightness and contrast of an image (when this button is enabled).	• chapter "Windowing: Adjusting Brightness and Contrast" on page 498
	Roll/Rotate: Drag to roll or rotate the image (when this button is enabled). • Available only in **Slab**, **3D** and **OrthoView**.	• chapter "Rolling and Rotating an Image" on page 536
	Plane Opacity: Drag to change the opacity of all planes (when this button is enabled). • Available only in **OrthoView**.	• chapter "Changing the Plane Opacity" on page 538
	Opacity: Drag to change the opacity of the fused overlay image (when this button is enabled). • Available only in **OrthoView**.	• chapter "Changing the Opacity of Fused Overlay Images" on page 538
	Enhance PicturePlus: Drag to adjust the PicturePlus filter settings (when this button is enabled). • Available only in **PicturePlus**.	• chapter "Enhancing an Image with PicturePlus" on page 501

7.4.4 Measurements and Annotations

These buttons allow you to perform measurements on the imaging series and overlay the images with the measurement results and other annotations.

- Depending on the type of graphical object chosen, different numeric results are provided.
- Every graphical object is defined by one or more anchor points. The anchor points are visible upon creation, when the mouse hovers over the object, and when the object is selected.
- To select a graphical object, click on it.
- To resize or reshape a graphical object, drag any of its anchor points.
- To move a graphical object or a measurement label, drag it to the desired location.
- Dedicated context menus offer more functionality such as the calculation and display of histograms and profiles.

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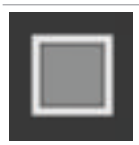
Measurements based on lines

Drop-down menu	Short Description	Instructions
	Distance: To measure the distance of two points on an image.	• See Measuring with Lines in this chapter
	Smooth Polyline: To measure the length of a smooth polyline defined by several points on an image.	
	Polyline: To measure the length of a polyline defined by several points on an image.	
	Angle: To measure the angle defined by three points on an image.	
	Open Angle: To measure the open angle defined by four points on an image.	
	XY Line: To display the differences of X-coordinates (Delta X) and Y-coordinates (Delta Y) of two points which define a line.	

Measurements based on Regions of Interest (ROIs)

Results include the size, diameter and perimeter of the ROI.

Drop-down menu	Short Description	Instructions
	Freehand Contour: To measure an area based on a Freehand contour ROI.	• See section Measuring with ROIs in this chapter
	Smooth Polygon: To measure an area based on a ROI with the shape of a smoothed polygon.	
	Ellipse: To measure an area based on a ROI with an elliptical shape.	
	Circle: To measure an area based on a ROI with a circular shape.	
	**Rectangle**: To measure an area based on a ROI with a rectangular shape.	

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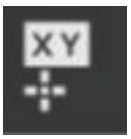
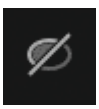
Text Annotations

Drop-down menu	Short Description	Instructions
	Text Annotation: To overlay a text box to an image.	• Annotating Images
	Arrow + Text Annotation: To overlay an arrow with a text box to an image.	

Measurements per Voxel

Drop-down menu	Short Description	Instructions
	Pixel Value: To extract the pixel value from a voxel. • Not available on RGB (SC) images	• Extracting Values from Images
	**Image Location**: To extract the image location value from a voxel.	
	Patient Location: To extract the patient location value from a voxel. • Available only when patient coordinates are known. • Not present for most SC images/screen captures.	

Hide and Show Measurements and Annotations

Button	Short Description	Instructions
	**Hide Annotations**: To show or hide all types of graphical objects (including lines, ROIs, text, annotations, arrows, results of measurements).	• chapter "Toggling the Display of Graphical Objects" on page 520

7.4.5 Connecting Viewports and Comparing Imaging Series

These buttons provide several ways to connect the display of the viewports in order to compare imaging series of the same examination.

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These buttons allow you to connect the display of the imaging series in relation to other imaging series of the same examination.

Show Cross-Reference Lines

Cross-reference lines visualize how the imaging series correlate to each other and to the planned volume.

Drop-down menu	Short Description	Instructions
	Show Cross-Reference Lines (Single Slice): To show the displayed slice of the selected view as reference line.	• chapter "Displaying Cross-Reference Lines" on page 520
	Show Cross-Reference Lines (Box): To show the outline of the whole scanned volume, and the mid slice and the current slice.	
	Show Cross-Reference Lines (All Slices): To show all slices.	
	Show Cross-Reference Lines (3D Mode): To show how the intersection is oriented in 3D space.	

Set Center

Button	Short Description	Instructions
	Set Center: To set the center of the rendering volume in **Slab** and **3D** render mode.	• chapter "Creating a New Series in Slab Render Mode" on page 531 • chapter "Creating a New series in 3D Render Mode" on page 533

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Relate Views

Button	Short Description	Instructions
	Relate Views: To relate the viewports so that the images in all viewports follow and show the same position.	• chapter "Relating the Views" on page 497

Link Imaging Series (SmartLink)

Button	Short Description	Instructions
	Link: To apply a link between imaging series of the current examination so that the viewports synchronize during activities.	• chapter "Linking Imaging Series (SmartLink)" on page 521
	Window Link: To apply a link between imaging series of the current examination so that the window settings of the viewports synchronize during activities.	

7.4.6 Image Information

These buttons allow you to adjust the amount of information given for images and imaging series. Image information includes: scan number and image number, scan date, information about scanning settings and duration.

Drop-down menu	Short Description	Instructions
	Full Image Information: To display the maximum amount of information about the image.	• chapter "Extending or Restricting the Image Information" on page 502
	Intermediate Image Information: To display much, but not all image information.	
	Limited Image Information: To display only basic image information.	
	No Image Information: To display no image information.	

7.4.7 Other Ways of Reviewing Imaging Series

These buttons provide access to other ways of reviewing imaging series.

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Button	Short Description	Instructions
	Movie Bar: To display the movie bar and play an imaging series as a movie.	• chapter “Playing Movies” on page 523
	Image View Settings: To adjust how the different images of a series are sorted in the viewport and to configure scrolling with mouse and keyboard.	• Adjusting Image Sorting and Scrolling (Image View Settings)
	Time-Intensity Diagram: To calculate a Time-Intensity Diagram based on 1 or more ROIs.	• chapter “Calculating a Time Intensity Diagram (TID)” on page 525
	Show Fibers: To display the result of Fiber Tracking. • Available only in Orthoview	• chapter “Displaying Fibers” on page 538

7.4.8 Refresh Display

This button allows you to refresh the display when new images are available.

Button	Short Description	Instructions
	Refresh: To refresh the display.	• chapter “Refreshing the Display“ on page 503

7.4.9 Print and Capture Images

These buttons allow you to print images or create and save screen captures.

Print Images

Drop-down menu	Short Description	Instructions
	Add Series To Print: To add an imaging series to the print jobs.	• chapter “Adding Images to Print” on page 521
	Add Images To Print: To add single images to the print jobs.	

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Capture Images

Button	Short Description	Instructions
	Capture Screen: To create a secondary capture of the viewing area where the image data is displayed.	• chapter "Capturing the Screen" on page 522
	Advanced Capture: To create a secondary capture image of the selected viewport as images or series (including reference lines if applicable), and give the capture a name.	

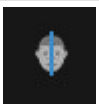
7.4.10 Orientation

Only in **Slab**, **3D** and **OrthoView**, these buttons allow you to select the orientation (axial, coronal, or sagittal) for the imaging series.

Button	Short Description
	Axial: To select an axial orientation for the imaging series.
	Coronal: To select a coronal orientation for the imaging series.
	Sagittal: To select a sagittal orientation for the imaging series.

7.4.11 Hide Planes

In OrthoView, these buttons allow you to hide the plane of the corresponding orientation (axial, coronal, or sagittal).

Button	Short Description	Instructions
	Hide Axial Plane: To hide the axial plane. • Available only in Orthoview	• chapter "Hiding Planes" on page 539
	Hide Coronal Plane: To hide the coronal plane. • Available only in Orthoview	
	**Hide Sagittal Plane**: To hide the sagittal plane. • Available only in Orthoview	

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7.5 Viewports in Review Tab

7.5.1 Viewports in Reviewing

On the **Review** tab,

- you select the number of viewports with the **Layout** button, and the number of images per viewport with the **Inner Layout** functionality.
- the viewports provide you with a dedicated button to access the review packages **Slab** (previously **MPR**), **3D** (previously **MIP**), **OrthoView**, **MobiView** and **PicturePlus**.

A viewport is a window dedicated to the display of images, e.g. MR slices, reformats or parameter maps.

- You can maximize or minimize a viewport.
  - To maximize the left four viewports into one large square viewport, maximize (, or double-click) any of these viewports.
  - To maximize the right two viewports into one large vertical viewport, maximize (, or double-click)any of these viewports.

- Each viewport provides you with information about the image in the viewport.
- To display images in viewports differently, use the toolbars and the context menus.

  Context menus are available for each viewport upon right click.

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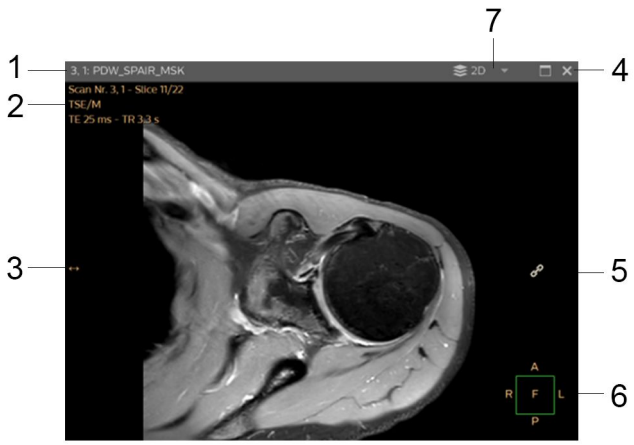

1. Scan number and scan name, e.g. **1,1** or **2,1** or **3,2**
   where the first digit increases for the scan and the second digit for a postprocessing step (and a newly created imaging series).
2. Image information
   For more information, see Toolbars.
3. Fold-over indicator
   indicating the fold-over direction in which typically MR artifacts occur.
4. **Maximize** and **Close** buttons
5. **Link** icon
6. 3D coordinate system
   indicating the directions Head-Feet Anterior-Posterior and Left-Right (LR), and the slice orientation in this 3D coordinate system.

7. Render mode drop-down menu:

   Allows you to access the review packages **Slab**, **3D**, **OrthoView**, **MobiView** and **PicturePlus**.

7.5.2 Render Modes Overview

Different render modes (algorithms) are provided to perform review operations and calculate projections and / or reformats of the original data set.

Button	Render Mode	Short Description
	2D	To perform standard review operations (default mode).

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Button	Render Mode	Short Description
	Slab	MultiPlanar Reformat: • To create new imaging series with a redefined orientation from the original scan data. • To create minimum Intensity Projections (new imaging series based on the voxels with the minimum intensity).
	3D	Maximum Intensity Projection: • To create new imaging series based on the voxels with the maximum intensity.
	OrthoView	To review automatically calculated orthogonal MPRs in a multilayer environment. Orthoview is an advanced viewer that helps to combine results from different packages. You can combine color overlays like f-MRI blobs along with other objects like fibers from the FiberTrak application.
	PicturePlus	To apply a filter that reduces the visibility of noise and artifacts, thereby enhancing the anatomical structures in the images.
	MobiView	To create one image from multiple images acquired at several stations.

Tab. 7: Available Render Modes

The current render mode is displayed as a button on the viewport toolbar in the upper right of the viewport. Clicking it opens the drop-down menu for the render modes. Only those render modes that can be applied to the selected imaging series are displayed in the menu.

7.5.3 Context Menu in Reviewing

Context menus are available throughout all applications to facilitate the use of the system and to offer various interaction possibilities.

To access the context menu, simply right-click on any viewport (or other screen area).

Available Options	Description	More information
• **Scroll** • **Zoom** • **Pan** • **Window**	To change the left mouse behavior: When you drag (with left mouse button) in a viewport, by default you scroll through images. These options (and possibly others depending on the render mode) allow you to change this behavior.	chapter “Left Mouse Behavior: Scroll, Zoom, Pan, Window, ...” on page 482
Inner Layout	To select the inner layout for a viewport.	chapter “Changing the Inner Layout of a Viewport” on page 494

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Available Options	Description	More information
Apply Window To	To copy the window settings of the selected image to other images.	chapter "Windowing: Adjusting Brightness and Contrast" on page 498
Rotate/Mirror	To **Rotate Clockwise**, **Rotate Counter-ClockwiseMirrorFlip** images.	chapter "Rotating or Mirroring an Image" on page 500
Color Map	To select a color map for display,	chapter "Changing the Color Scheme of an Image" on page 500
Invert Gray Scale	To invert the gray scale.	chapter "Changing the Color Scheme of an Image" on page 500
Reset Window **Reset Zoom/Pan** **Reset All**	To reset window, zoom/pan to the initial settings after you have changed these settings.	chapter "Resetting All Changes" on page 502

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7.6 Routine Procedures

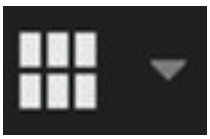
7.6.1 Setting up the Review Screen

On the **Review** tab, you specify the **Layout** and the **Inner Layout**:

- The **Layout** specifies the number of viewports.
- The **Inner Layout** specifies the number of images in a viewport (rows by columns).

Selecting a Layout for the Review Screen

You select the number of viewports (in rows by columns) that suits your examination and its number of imaging series.
One viewport is reserved for one imaging series.

► On the Review Toolbar, select a layout from the **Layout** drop-down menu:

> **1x1** ... **4x4**.

- The default layout is **2x3**, i.e. 2 rows and 3 columns.
- It is not possible to drag and resize the viewports.

- If there are more imaging series than viewports on the screen, viewport tabs provide access to the surplus series.

Changing the Inner Layout of a Viewport

You can apply a predefined layout to a viewport, have a layout applied automatically, or add and remove rows and columns manually.

To apply any of the standard layouts

► Right-click a viewport and select **Inner Layout** > **1x1** to **4x4**.

To apply a layout automatically (Auto Layout)

► Right-click a viewport and select **Inner Layout** > **Auto Layout** .

- Auto Layout is based on the number of images in the current imaging series.
- Auto Layout shows as many rows and columns as possible, but does not exceed 4x4.
- Auto Layout preferably shows square-shaped tiles and avoids empty rows or columns.

To add or remove rows and columns

► Right-click a viewport and select **Inner Layout** .

► Do any of the following:

- To add a row (below), select **Add Row [Ctrl+Down Arrow]** .
- To add a column (to the right), select **Add Column [Ctrl+Right Arrow]** .
- To remove a row, select **Remove Row [Ctrl+Up Arrow]** .
- To remove a column, select **Remove Column [Ctrl+Left Arrow]** .

Alternatively use the keyboard shortcuts:

- To add a row, press **Ctrl+Down Arrow**.
- To add a column, press **Ctrl+Right Arrow**.
- To remove a row, press **Ctrl+Up Arrow**.
- To remove a column, press **Ctrl+Left Arrow**.

To quickly maximize an image in a viewport with inner layout

► In a viewport with inner layout applied, double-click the desired image.

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⇨ The inner layout of the viewport changes to 1x1 with the selected image displayed.

To restore the previous inner layout of the viewport, press **Esc**.

To change the sorting order within a viewport

► See chapter “Image Sorting in the Tile Layout” on page 524.

Maximizing One Image or Viewport

You can maximize the size of an image or viewport. The viewport then covers the whole viewport area. The other viewports are moved to tabs. The toolbars and the Exam Overview remain visible.

There are 2 ways of maximizing images or viewport: by using the **Maximize** button or by double-clicking an image. Note that double-clicking an image changes the inner layout of its viewport to 1x1. If the inner layout already is 1x1, both ways lead to the identical result.

To maximize one viewport and preserve its inner layout

1. Click **Maximize** in the upper right of the viewport.

⇨ The selected viewport is maximized.

To return to the previous display:

1. Do any of the following:
   - Click **Restore** in the upper right of the viewport.
   - Press **Esc**.

To maximize one image of a viewport with inner layout applied

1. Double-click the desired image.

⇨ The inner layout of the viewport changes to 1x1 with the selected image displayed.

2. To maximize, do any of the following:
   - Double-click the image again.
   - Click **Maximize** in the upper right of the viewport.

⇨ The selected viewport is maximized.

To return to the previous display:

1. Do any of the following:
   - Double-click the image.
   - Click **Restore** in the upper right of the viewport.
   - Press **Esc**.

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⇨ The previous screen layout is restored. The inner layout of the viewport remains 1x1.

2. Press **Esc**.

⇨ The previous inner layout of the viewport is restored.

Changing the Order of the Viewports

Viewports are automatically filled with imaging series in the order of their scan number (e.g. 1.1, 2.1, 2.2, 3.1, 4.1, 4.2). You can change the order of the viewports in various ways.

► Do any of the following:

- To close obsolete viewports, click **Close** .
- To replace the current imaging series in a viewport, drag another imaging series from the Exam Overview into this viewport.

It is not possible to drag and move the viewports.

7.6.2 Navigating through Images

Scrolling through Images

You scroll through images via direct mouse actions or with Arrow keys on the keyboard.

- Direct mouse actions must start in the current viewport. Mouse movement is not limited to this viewport but to the viewing area of the screen.
- The way of scrolling through images depends on the **Image View Settings** and the number of image dimensions (e.g. image type, slices, phases, echoes, dynamics).
For more information, see chapter “Specifying scrolling direction” on page 525.

► To scroll through images, use the mouse or the keyboard keys and do any of the following:

- On the Plan or Review Toolbar, click **Scroll** .

Click the image and drag to scroll.

- Right-click an image and select **Scroll** .

Click the image and drag to scroll.

- With the pointer in the image viewport, press the left and right mouse button and drag to scroll.
- Click the viewport to make it active.

Press the arrow keys on the keyboard to scroll.

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Overview of Mouse and Arrow Keys for Scrolling

To scroll through ...	Press the arrow keys	Mouse movement	Effect on image dimension
1st image dimension	**Right Arrow** **Left Arrow**	right + / left -	Movement to the right increases (to the left decreases) the number of the image dimension.
2nd image dimension	**Up Arrow** **Down Arrow**	up + / down -	Upwards movement increases (downwards decreases) the number of the image dimension.
3rd image dimension	**Ctrl+Shift+Up Arrow** **Ctrl+Shift+Down Arrow**	not applicable	Upwards movement increases (downwards decreases) the number of the image dimension.

Further function keys:

- **Pos1**: 1st image in upwards direction.
- **End**: Last image in downwards direction.

Example: Scrolling in a scan with only one image dimension

The image dataset has only slices.

► In the image viewport, do any of the following:

- Drag upwards or downwards.
- Press the **Up Arrow** and **Down Arrow** keys.

Example: Scrolling in a scan with two image dimensions

The dataset consists of multiple dynamics with multiple slices. The first image attribute are the dynamics, the second one are the slices. First all slices for the first dynamic are displayed, then all slices for the second dynamic and so on.

Through dynamics

► In the image viewport, drag to the left or to the right.

Through slices

► In the image viewport, drag upwards or downwards.

You can configure the scrolling behavior in the **Image View Settings**.

Relating the Views

You relate the views when you want to display images with the selected target voxel in all viewports. This is a fast way of navigating to a specific voxel (e.g. anatomic area) with only one click.

When the views are related, all viewports show the selected voxel (from their perspective).

► On the Review Toolbar, click **Relate Views** .

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► Click in an image to define the target voxel.

⇨ All viewports change accordingly and show an image with the selected target voxel.

7.6.3 Changing the Display of Images

Windowing: Adjusting Brightness and Contrast

Windowing affects the window level (brightness) and the window width (contrast).

Windowing is performed via direct mouse actions. Direct mouse actions must start in the current viewport. Mouse movement is not limited to this viewport but to the viewing area of the screen.

► Do any of the following:

- With the pointer in the image viewport, press the middle mouse button and drag to adjust brightness and contrast.
- On the Plan Toolbar or Review toolbar, click **Window** .

  Click the image and drag to adjust brightness and contrast.
- Right-click an image and select **Window** .

  Click the image and drag to adjust brightness and contrast.

Mouse behavior for windowing

- To set the brightness to a darker level, drag the mouse upwards.
- To set the brightness to a brighter level, drag the mouse downwards.
- To apply less contrast to an image, drag the mouse to the right.
- To apply more contrast to an image, drag the mouse to the left.

To apply the windowing settings to all images of a dimension

► Right-click the image and select **Apply Window To**.

⇨ A submenu opens.

► Select the desired dimension from the submenu.

For example:

- **All Slices**
- **All Phases**
- **All Image Types**

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This setting also applies to the selection of color maps and inverting the gray scale. It remains active until you deactivate it by clicking the same menu item again.

To reset an image to its original window level and width

► Right-click the image and select **Reset Window**.

This also resets an inverted gray scale. If **Apply Window To** is active for a dimension, the current color map is applied to all images of this dimension in the current series.

Zooming in and out of an Image

Zooming is performed via direct mouse actions. Direct mouse actions must start in the current viewport. Mouse movement is not limited to this viewport but to the viewing area of the screen.

► Do any of the following:

- With the pointer in the image viewport, press the middle and right mouse button and drag to zoom.
- On the Plan Toolbar or Review Toolbar, click **Zoom** .

Click the image and drag to zoom.

- Right-click an image and select **Zoom** .

Click the image and drag to zoom.

Mouse behavior for zooming

- To zoom in (with a maximum zoom factor of 15), move the mouse upwards.
- To zoom out (with a minimum zoom factor of 0.13), move the mouse downwards.

To reset an image to its original zoom and pan values

► Right-click the image and select **Reset Zoom/Pan**.

Panning an Image

Panning is performed via direct mouse actions. Direct mouse actions must start in the current viewport. Mouse movement is not limited to this viewport but to the viewing area of the screen.

► Do any of the following:

- With the pointer in the image viewport, press the middle and left mouse button and drag to pan.

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- On the Plan Toolbar or Review Toolbar, click **Pan** .

Click the image and drag to pan.

- Right-click an image and select **Pan** .

Click the image and drag to pan.

To reset an image to its original zoom and pan values

► Right-click the image and select **Reset Zoom/Pan**.

Rotating or Mirroring an Image

You can rotate an image clockwise or counter-clockwise, mirror it (horizontally) or flip it (vertically).

To rotate the image in a viewport

► Right-click the image and select any of the following:

- **Rotate/Mirror** **> Rotate Clockwise**
- **Rotate/Mirror** **> Rotate Counter-Clockwise**

To mirror or flip the image in a viewport

► Right-click the image and select any of the following:

- **Rotate/Mirror** **> Mirror**
- **Rotate/Mirror** **> Flip**

Changing the Color Scheme of an Image

You can display a negative image (invert the gray scale) of the current viewport or apply a color map to the image.

To display a negative image

Displaying a negative image sets all the pixel values to their opposite value on a color wheel: white becomes black, and vice versa.

► Right-click the image and select **Invert Gray Scale** .

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To return to the default gray scale, right-click the image and select **Invert Gray Scale** again.

To apply a color map

By applying a color map, the image is colorized: pixel values are set to a corresponding color in the color map.

▷ You are in **2D** render mode.

► Right-click the image, select **Color Map** , and choose a color map.

To return to the default gray scale, select **Original Grayscale** from the **Color Map** submenu.

► To show (or hide) the color scale of the selected color map, right-click the image and select **Show Color Scale** .

By default, changes in window level are applied to the whole series (e.g. all slices).

To deactivate or activate the application to all images, right-click the image, select **Apply Window To**, and choose a dimension from the submenu.

Enhancing an Image with PicturePlus

You can enhance an image with **PicturePlus** by mouse actions or by entering numeric values for **Smooth** and **Edge**.

▷ You are in **PicturePlus** render mode.

▷ In **PicturePlus**, the left mouse behavior is automatically set to **Enhance PicturePlus**.

► To change edge enhancement and smoothing with the mouse, drag horizontally and vertically.

Horizontal movement changes edge enhancement (increasing values from left to right). Vertical movement changes smoothing (increasing values from the bottom up).

⇨ The numeric values of **Smooth** and **Edge** are displayed in real time in the top row of the viewport.

► To change edge enhancement and smoothing by entering numeric values, click the values **Smooth** and **Edge** in the top row of the viewport. Then enter numeric values in the input fields, or use the Up and Down arrows next to the input fields.

► To save the images as new imaging series, enter a series name first. Then click **Generate**.

⇨ The **Generate** button changes to **Submitted**, and the **Job Viewer (F6)** notifies you about this new job.

⇨ A new imaging series is created within the current examination.

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To reset the changes

► Right-click the image and select **PicturePlus Presets** > **Smooth0 Edge0**.

⇨ Edge enhancement and smoothing are reset to 0.

Resetting All Changes

Resetting all changes sets the image back to its original state.

- Zooming, panning, windowing, and similar actions, are undone.
- Graphical objects (measurement lines, ROIs, annotations) are deleted.
- Mouse behavior is set to **Scroll**.
- **Apply Window To** is activated for all dimensions.

This action applies to all images of the current series.

To reset all changes

► Right-click the image and select **Reset All**.

Extending or Restricting the Image Information

Images are displayed with Image Information in the upper left corner of each viewport. By default, **Limited Image Information** is displayed which provides the regular information. You can extend or restrict the image information in the viewports.

This setting applies to all the viewports, not one single viewport only.

► On the Plan Toolbar or Review Toolbar, do any of the following:

- To display full image information, click **Full Image Information** .
- To display an intermediate amount of image information, click **Intermediate Image Information** .
- To display limited image information, click **Limited Image Information** .
- To hide all image information, click **No Image Information** .

No Image Information	Image information is hidden.

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Limited Image Information	• Scan number (e.g. **2,1** or **3,2** where the first digit increases for the scan and the second digit for a postprocessing step (and a newly created imaging series). • Slice number/total number of slices (e.g. 7/15 stands for slice 7 of 15 slices) • Scan technique/image type e.g. (T)SE - (Turbo) Spin Echo, FFE - Fast Field Echo, (B-)TFE - (Balanced) TFE e.g. M - Modulus, P - Phase, R - Real, I - Imaginary, SW_M,R,I,P - Susceptibility Weighted-M,R,I,P • TR, TE • Dt (dynamic time) - only applicable for dynamic imaging series • Td (Trigger delay) - only applicable for triggered imaging series • Ec1, Ec2 - only applicable for multi-echo imaging series
Intermediate Image Information	**Limited Image Information** PLUS: • Date and time • Flip angle • FOV • Slice thickness and gap
Full Image Information	**Intermediate Image Information** PLUS: • NSA (Number of Signals Averaged) • TF (Turbofactor), if applicable • Scan duration • Acquired voxel size • Geometry Correction, if applicable

Refreshing the Display

This button is only active when new images become available in the selected series after the reviewing started.

► On the Review Toolbar, click **Refresh** .

7.6.4 Measuring with Lines

You measure distances and angles with lines which are defined by anchor points. The more anchor points, the more precise the definition of an irregular line. Once the lines (for distance or angle) are confirmed, you can still reposition or resize the lines when you drag any of the anchor points.

You can move a line or an angle by dragging it.

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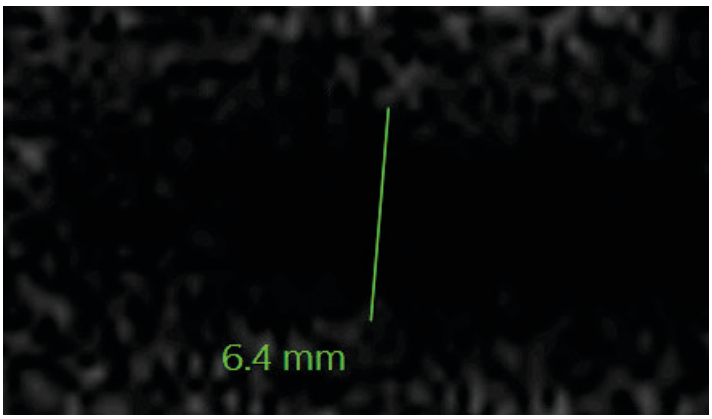
Measuring a Distance

- ► On the **Plan** or **Review** toolbar, select **Distance** from the **Measurements** drop-down menu.
- ► Do any of the following:
  - Click in an image to define the start point, click again to define the end point of a line.
  - Click and drag in an image to define a line.

⇨ The length of the line is displayed.

⇨ 

To hide or show the length

- ► Right-click a line and select **Properties > Length**.

⇨ The length of the line is hidden or shown.

Measuring the Length of a Polyline

- ► On the **Plan** or **Review** toolbar, do any of the following:
  - To draw a smooth polyline, select **Smooth Polyline** from the **Measurements** drop-down menu.
  - To draw a polyline, select **Polyline** from the **Measurements** drop-down menu.
- ► To define the line by anchor points, click several times in the image.
- ► Double-click to end drawing and to confirm the shape.

⇨ The length of the line is displayed.

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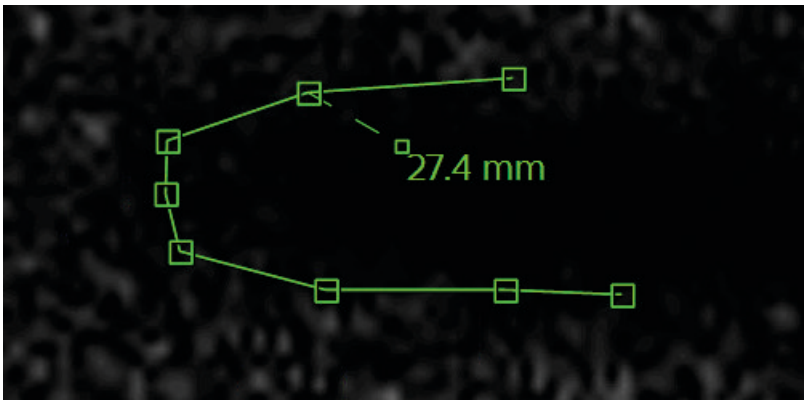
⇨ 

To add anchor points

- ► Click the polyline to select it.
- ► Click on the line where a **+** symbol is displayed at the cursor.

⇨ A new anchor point is added to the line.

⇨ You can drag any anchor point to change the shape.

To extend a polyline or smooth polyline

- ► Right-click the polyline and select **Extend Curve**.
- ► To extend the line, click in the image.

⇨ A new anchor point is added to the line.

The line is extended from the end that is closest to the new anchor point.

- ► Double-click to end drawing and to confirm the shape.

To hide or show the length

- ► Right-click a line and select **Properties > Length**.

⇨ The length of the line is hidden or shown.

Displaying the Profile of a Line

The profile of a line is displayed as a line graph of **Pixel Value** versus **Millimeters**.

▷ Prerequisite: You have already drawn a line (e.g. to measure a distance).

- ► Right-click the line and select **Show Profile**.

⇨ The profile is displayed within the image.

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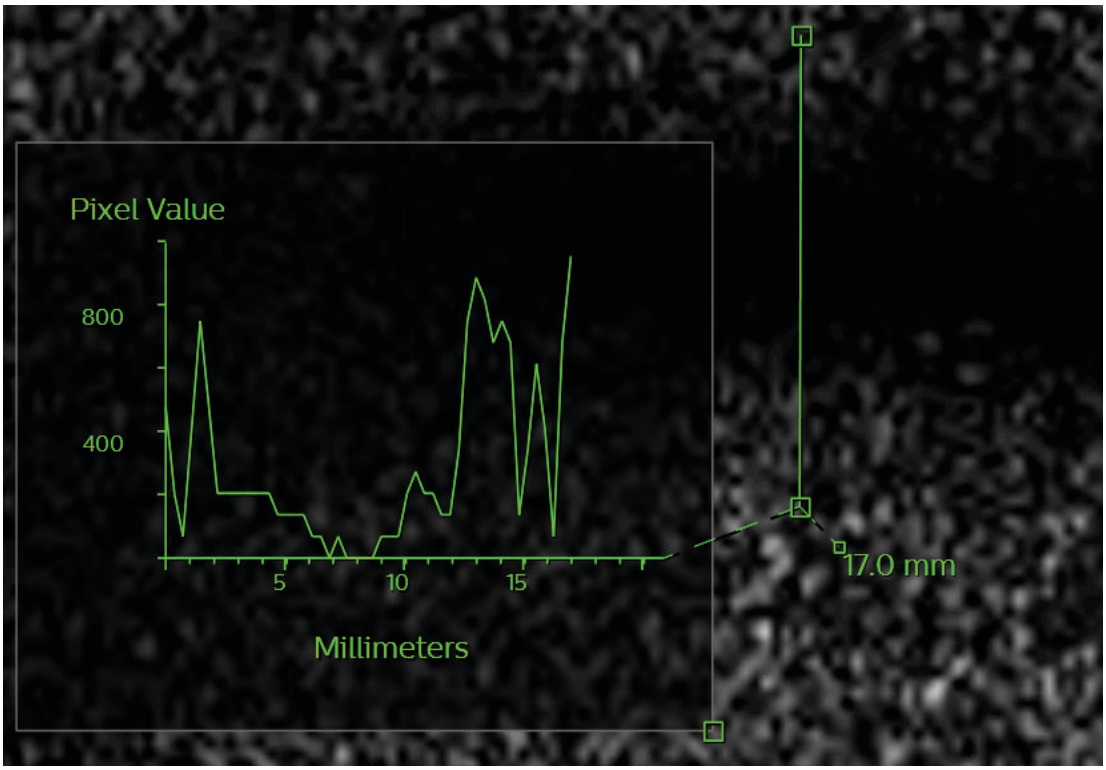

To hide the profile

- Right-click the line and select **Hide Profile**.

Measuring an Angle between Three Points

- On the **Plan** or **Review** toolbar, select **Angle** from the **Measurements** drop-down menu.
- To define the angle, click three times in an image.

⇨ The angle is displayed.

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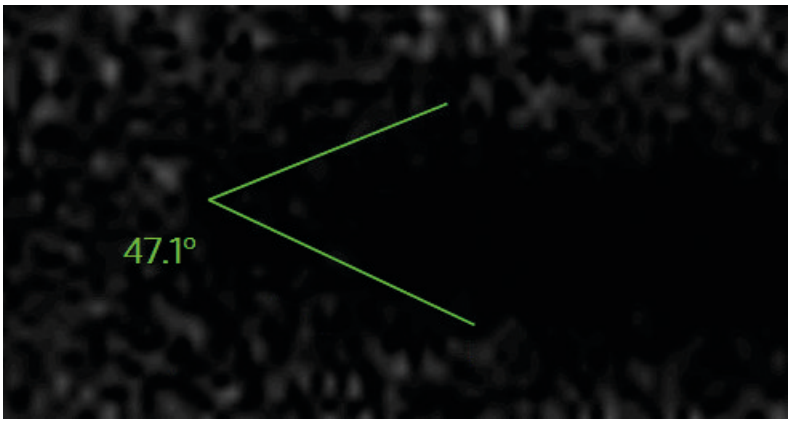
⇨ 

To display the length of the angle sides

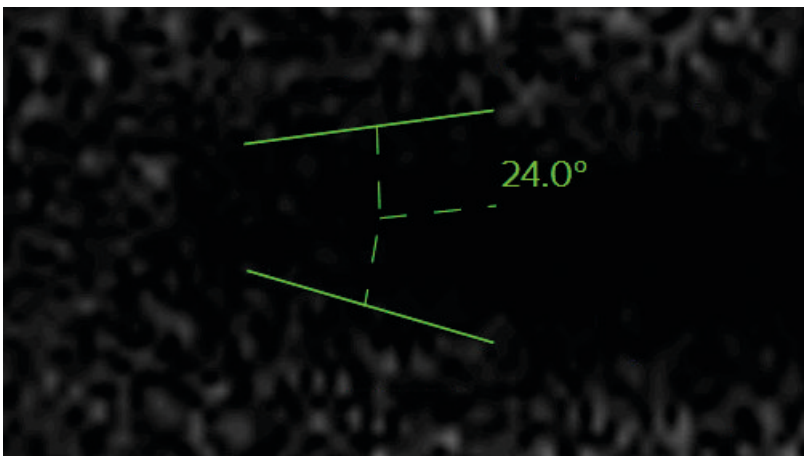
- Right-click a line and select **Properties** > **Length**.

⇨ The lengths of the side lines are displayed.

Measuring an Open Angle

- On the **Plan** or **Review** toolbar, select **Open Angle** from the **Measurements** drop-down menu.
- To define the open angle, click four times in an image.

⇨ The angle is displayed.

⇨ 

To display the length of the angle sides

- Right-click a line and select **Properties** > **Length**.

⇨ The lengths of the side lines are displayed.

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Measuring the Differences of X- and Y-Coordinates on a Line

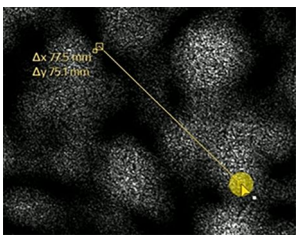
The XY line provides you with the difference between the X- coordinates (Delta X) and the Y-coordinates (Delta Y) of two points which define a line.

- ► On the **Plan** or **Review** toolbar, select **XY Line** from the **Measurements** drop-down menu.
- ► Do any of the following:
  - Click in an image to define the start point, click again to define the end point of a line.
  - Click and drag in an image to define a line.

⇨ The differences between their X-coordinates and between their Y-coordinates of the two points are displayed.

⇨ Delta X indicates the difference (in mm) between the end-points of the line in horizontal direction.

⇨ Delta Y indicates the difference (in mm) between the end-points of the line in vertical direction.



7.6.5 Measuring with ROIs

Measuring with Regions of Interest (ROIs) allows you to retrieve information about a delimited area within an image. These ROIs are defined by anchor points. The more anchor points, the more precise the ROI can be drawn. Once the ROI is confirmed, you can still reposition, edit or resize the ROI when you drag any of the anchor points.

You can move a ROI by dragging it.

Measurement Results

When you perform measurements with ROIs, the results are displayed with the ROI. The table gives an overview of the possible results.

Abbreviation	Description
Ar	Area (mm^2)
Av	Average value
SD	Standard Deviation
Perim	Perimeter (mm)

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Abbreviation	Description
MaxD	Maximum diameter (mm) [optional]
MinD	Minimum diameter (mm) [optional]
LA	Long axis (mm) [optional]
SA	Short axis (mm) [optional]
LA via centroid	Long axis / Long axis via centroid (mm) [optional]
SA via centroid	Short axis / Short axis via centroid (mm) [optional]
AAD	Average Absolute Deviation [optional]

Tab. 8: Legend for Measurement Results

Optional information can be displayed via the context menu > **Properties**. Not every type of optional information is available for every type of ROI.

To move the measurement result (closer to the ROI or further away), drag the result.

Selecting Measurement Results for Display

- ► Right-click the ROI and select **Properties**.
- ► In the submenu, do any of the following:
  - To hide or show the maximum (MaxD) and minimum (MinD) diameter, select **Max/Min Diameter**.
  - To hide or show the length of the long (LA) and short (SA) axes, select **Long/Short Axes**.
  - To hide or show the length of the long and short axes using the centroid, select **Long/Short Axes using Centroid**.
  - To hide or show the average absolute deviation (AAD), select **AAD**.

⇨ The corresponding information is hidden or shown.

Not every type of optional information is available for every type of ROI.

Measuring with a Freehand ROI

- ► On the Plan Toolbar or Review Toolbar, select **Freehand Contour** from the **ROI** drop-down menu.
- ► To draw the freehand contour, click an image and drag.
- ► To finish the contour, release the mouse button.

⇨ The start and end points of the contour are connected by a straight line.

⇨ The measurement results are displayed.

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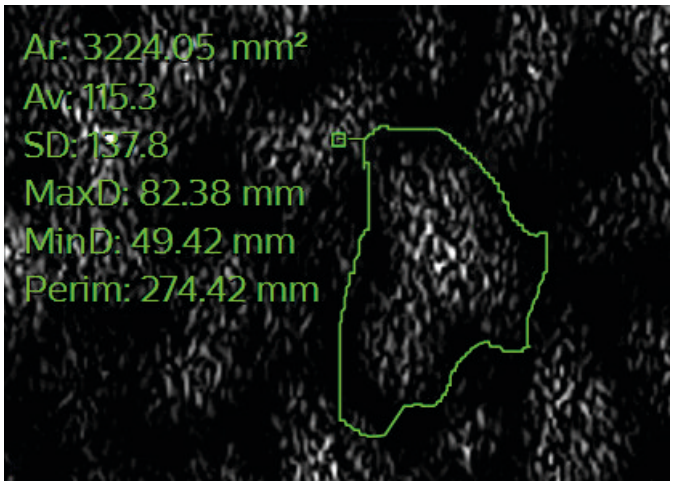

⇨

- To show the diameter lines, right-click the ROI and select **Graphics Properties** > **Show Diameters**.

To modify the shape of a freehand ROI

- ► Hover over the ROI to select it.
- ► Click where a **+** symbol is displayed at the cursor and drag to draw a line.
- ► To finish the modification, release the mouse button.

⇨ Areas that are cut off by the line are deleted from the ROI.

Areas that are added by the line are included into the ROI.

Measuring with a Smoothed Polygon ROI

- ► On the Plan Toolbar or Review Toolbar, select **Smoothed Polygon** from the **ROI** drop-down menu.
- ► To define the polygon, click as often as needed (no dragging).

  To cancel the entire contour, press **Esc**.
- ► Double-click to end drawing and to confirm the shape.

⇨ The measurement results are displayed.

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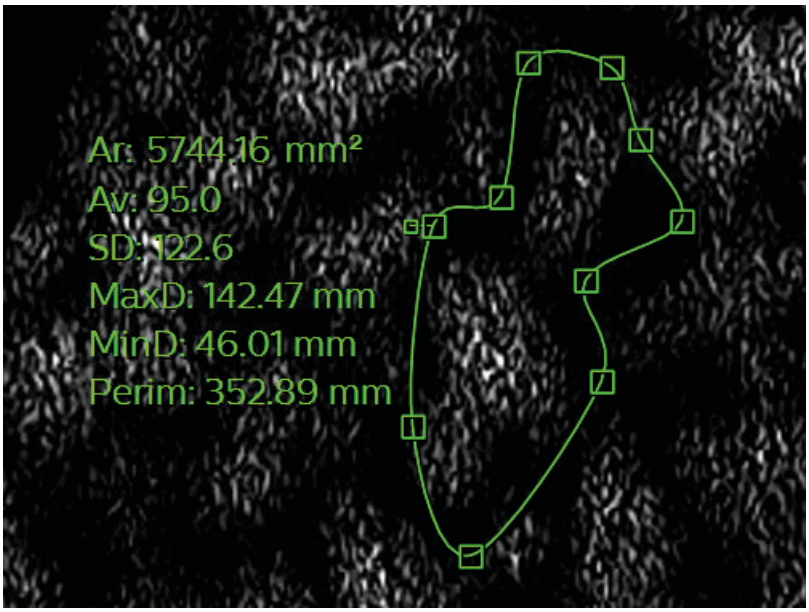

- To show the diameter lines, right-click the ROI and select **Graphics Properties** > **Show Diameters**.
- To modify the shape of a ROI, click it to select it. Then drag any of the anchor points available on the contour.
- To add anchor points to a smoothed polygon ROI, click it to make it active and click on the contour where a 'plus' symbol is displayed at the cursor.

Measuring with an Elliptical ROI

- ► On the Plan Toolbar or Review Toolbar, select **Ellipse** from the **ROI** drop-down menu.
- ► To define the ellipse, click in an image and drag.
- ► To finish the ellipse, release the mouse button.

⇨ The measurement results are displayed.

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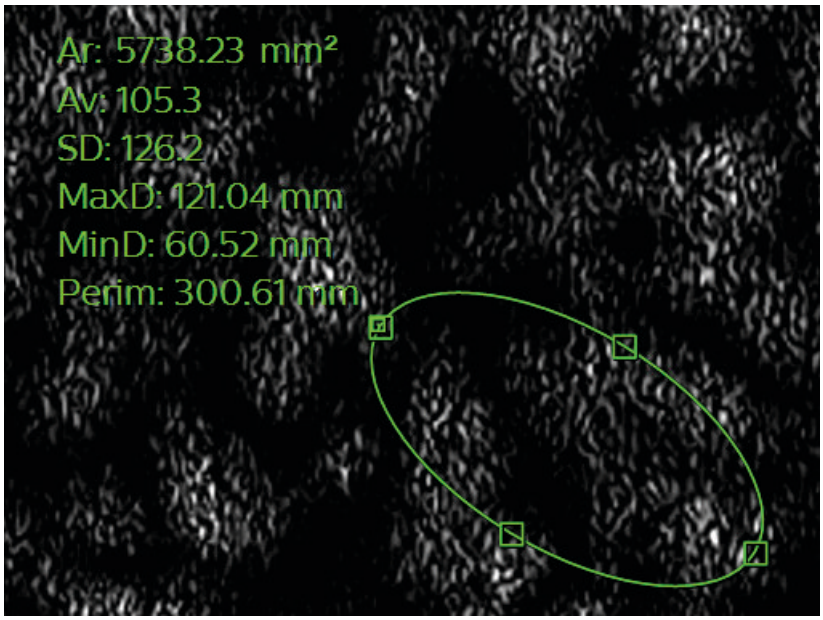

⇨

- To modify the shape of a ROI, click it to select it. Then drag any of the anchor points available on the contour.
- To rotate the shape:
  - Right-click the shape and select **Rotate**.
  - To rotate the shape, drag any of the anchor.

    Take care because the shape changes while rotating.
- To show the diameter lines, right-click the ROI and select **Graphics Properties** > **Show Diameters**.

Measuring with a Circular ROI

- ► On the Plan Toolbar or Review Toolbar, select **Circle** from the **ROI** drop-down menu.
- ► To define the circle, click in an image and drag.
- ► To finish the contour, release the mouse button.

⇨ The measurement results are displayed.

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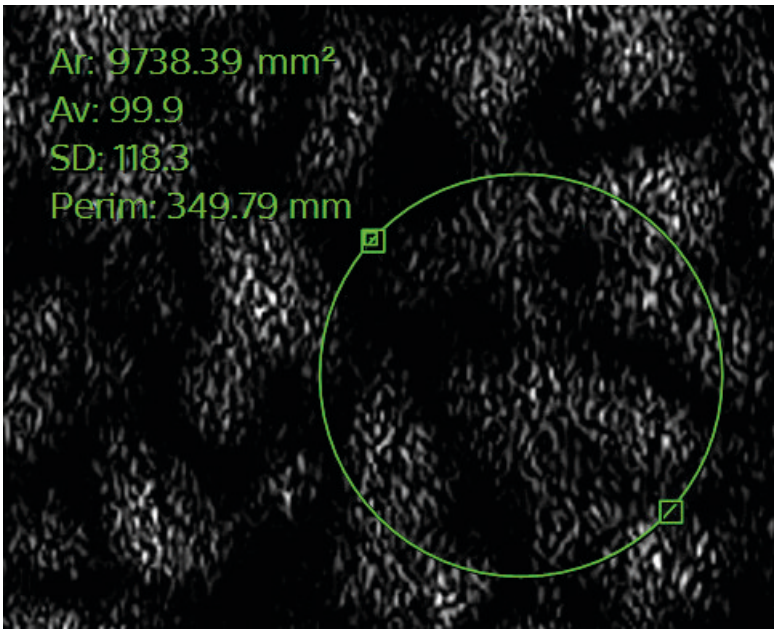
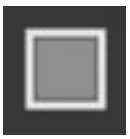


⇨

- To modify the shape of a ROI, click it to select it. Then drag any of the anchor points available on the contour.

Measuring with a Rectangular ROI



- ► On the Plan Toolbar or Review Toolbar, select **Rectangle** from the **ROI** drop-down menu.
- ► To define the rectangle, click in an image and drag.
- ► To finish the contour, release the mouse button.

⇨ The measurement results are displayed.

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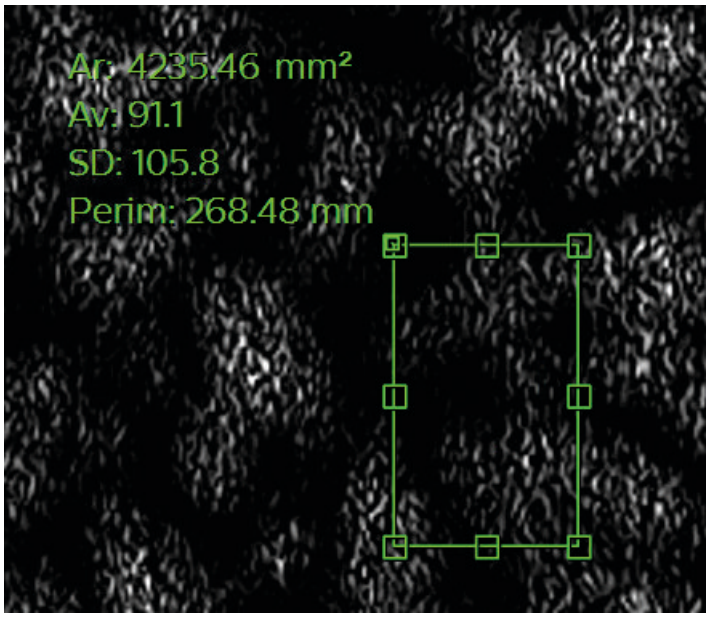
⇨ 

- To modify the shape of a ROI, click it to select it. Then drag any of the anchor points available on the contour.
- To rotate the shape:
  - Right-click the shape and select **Rotate**.
  - Drag any of the corner points to rotate.

    Take care because the shape changes while rotating.

Calculating a Histogram from a ROI

The histogram shows the distribution of Pixel Values within the area defined by the ROI.

► Right-click the ROI and select **Show Histogram**.

⇨ The histogram is shown inside the image.

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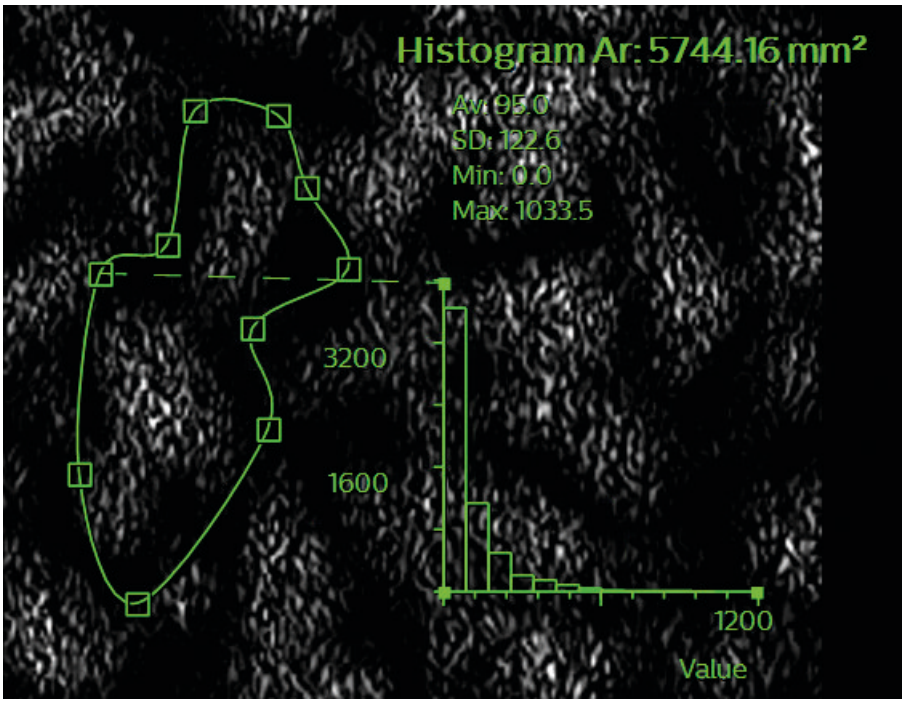

- To move the histogram, drag it.
- To resize the histogram, click it to select it. Then drag the anchor points at the vertical and horizontal axes.
- To hide the Histogram, right-click the ROI and select **Hide Histogram**.

7.6.6 Annotating Images

You can insert a text box or an arrow with text box at any place in an image, or you can add an annotation to an existing line or ROI.

You can move a text box or the arrowhead by dragging it.

Inserting an Annotation Text Box

- ► On the Plan Toolbar or Review Toolbar, select **Text Annotation** from the **Annotations** drop-down menu.
- ► Click in an image to create a text box.
- ► Type text into the text box.
- ► Press **Enter** to confirm.

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Inserting a Text Box with an Arrow

- ► On the Plan Toolbar or Review Toolbar, select **Arrow + Text Annotation** from the **Annotations** drop-down menu.
- ► Do any of the following:
  - Click in an image to set the arrowhead, click again to create a text box at that position.
  - Click in an image to set the arrowhead and drag to the position for the text box.
- ► Type text into the text box.
- ► Press **Enter** to confirm.

You can leave the text box empty and use the arrow only.

Adding an Annotation to a Line or a ROI

You can add an intrinsic text box to a ROI or line.

- ► Right-click the line or ROI and select **Edit**.

  ⇨ A text box appears in the image.
- ► Type text into the text box.
- ► Press **Enter** to confirm.

This type of annotation can be edited. It can only be deleted as part of the ROI or line, or by removing the text from this intrinsic text box.

7.6.7 Extracting Values from Images

You can perform measurements per voxel and extract the value of a pixel (intensity value), the value of the patient location, or the value of the image location.

Extracting the Pixel Value (Intensity Value)

- ► On the Plan Toolbar or Review Toolbar, select **Pixel Value** from the **Measurements per Voxel** drop-down menu.
- ► Click in an image to mark a point.

⇨ The intensity value for this point is displayed.

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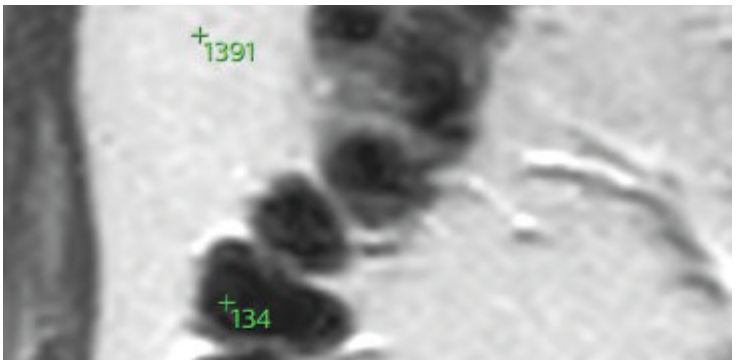
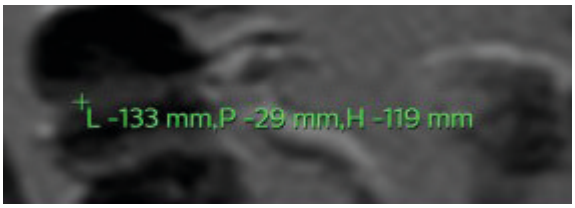


Extracting the Patient Location Value

- On the Plan Toolbar or Review Toolbar, select **Patient Location**

from the **Measurements per Voxel** drop-down menu.
- Click in an image to mark a point.

⇨ The patient location value for this point is displayed (**L**-**R** = left-right, **A**-**P** = anterior-posterior, **H**-**F** = head-feet).



Extracting the Image Location Value

- On the Plan Toolbar or Review Toolbar, select **Image Location**

from the **Measurements per Voxel** drop-down menu.
- Click in an image to mark a point.

⇨ The image location value for this point is displayed (**X** = horizontal, **Y** = vertical coordinate value).

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⇨

7.6.8 Editing Graphical Objects

Graphical objects are objects drawn on images: measurement lines, ROIs, or annotations. This section explains how to perform general operations with graphical objects, such as copying, deleting, changing font size or line width.

Changing the Font Size of Graphical Objects

- Right-click the text on the image and select **Graphics Properties** > **Font Size**.

  ⇨ A submenu opens.

- Select a font size from the submenu.

Changing the Width of a Line

- Right-click the line drawn on the image and select **Graphics Properties** > **Line Width**.

  ⇨ A submenu opens.

- Select a line width from the submenu.

Copying a Graphical Object

Copy to all slices of the current series

- To copy a graphical object to all slices of the current series, right-click the object and select **Copy to All**.

⇨ The object is copied to all the other slices in the current series. These objects now form a group.

It is not possible to copy a graphical object to all the other viewports that way. To copy a object to all the other viewports, copy and paste the object into every viewport separately.

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Copy to another image

► To copy a graphical object to another image, right-click the object and select **Copy**.

⇨ The object is copied to the clipboard.

► Right-click the target image and select **Paste Graphics**.

⇨ The object is inserted into the target image.

Cutting a Graphical Object

► Right-click the object on the image and select **Cut**.

⇨ The object is deleted from the current image, but it is kept in the clipboard.

To insert a graphical object from the clipboard:

► Right-click the target image and select **Paste Graphics**.

Deleting a Graphical Object

To delete a single graphical object

▷ The object is not part of a group. If it is part of a group, see: To delete a graphical object from a group.

► Right-click the object and select **Delete**.

⇨ The object is deleted from the current image and is not kept in the clipboard.

To delete a graphical object from a group

► Right-click the object and select **Remove from Group**.

► Right-click the object again and select **Delete**.

⇨ The object is deleted from the current image. The other objects of the group still exist.

To delete an object group

► Right-click an object that belongs to the group and select **Delete Group**.

⇨ All objects that belong to the object group are deleted from the series.

Hiding a Graphical Object

► Right-click the object and select **Hide**.

⇨ The object is hidden.

There is no option to show a single hidden object. Toggle the display of all graphical objects to display hidden elements.

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Toggling the Display of Graphical Objects

You can hide, and show, all graphical objects at once, or hide single objects.

To toggle the display of all graphical objects

Graphical objects include lines, ROIs, textual annotations, arrows, and results of measurements.

This action affects all viewports.

- ► On the Plan Toolbar or Review Toolbar, click **Show/Hide Annotations** .
  - ⇨ If the graphical objects were displayed before, they are now hidden.
  - ⇨ If the graphical objects were hidden before, they are now displayed.

To hide a single graphical object

- ► Right-click the object and select **Hide**.
  - ⇨ The object is hidden.

There is no option to show a single hidden object. Toggle the display of all graphical objects to display hidden elements.

7.6.9 Relations between Imaging Series

Displaying Cross-Reference Lines

Cross-reference lines visualize how the imaging series correlate to each other and to the planned volume.

- ► On the Review Toolbar, do any of the following:
  - To display cross-reference lines for a single slice, click **Show Cross-Reference Lines (Single Slice)** .
  - To display cross-reference lines in box mode, click **Show Cross-Reference Lines (Box)** .
  - To display cross-reference lines for all slices, click **Show Cross-Reference Lines (All Slices)** .

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- To display cross-reference lines in 3D mode, click **Show Cross-Reference Lines (3D Mode)** .

Linking Imaging Series (SmartLink)

► To link imaging series for scrolling, zoom and pan, on the Review Toolbar, click **Link** .

⇨ SmartLink is activated. The imaging series are now linked.
When imaging series are linked, scrolling, zooming or panning in one viewport affects the other viewports in the same way.

⇨ A graphic link button is displayed in every view that is linked to the current view.

► To stop SmartLink and unlink imaging series, do any of the following:

- To stop SmartLink for all viewports, click **Link** on the Review Toolbar.
- To unlink an individual series, click the graphic link button in its viewport.

► To link imaging series for their window settings, on the Review Toolbar, click **Window Link** .

⇨ SmartLink is activated. The window settings of the imaging series are now linked.
When the windows of imaging are linked, windowing in one viewport affects the other viewports in the same way.

⇨ A graphic link button is displayed in every view that is linked to the current view.

7.6.10 Print and Secondary Capture

Adding Images to Print

► Select images:

- To select 1 image, click it.
- To select non-consecutive images, press **Ctrl** and click the images.

► On the Plan Toolbar or Review Toolbar, do any of the following:

- To print the selected imaging series, select **Add Series To Print** from the drop-down menu.

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- To print the selected images, select **Add Images To Print** from the drop-down menu.

⇨ The selection is added to the Print tab.

► Change to the Print tab: On the Patient Tasks Bar, click **Print**.

► Configure the print output as desired: see chapter “Functional Description” on page 727.

► Click **Print**.

If you want to print the entire examination, you have to add all series to the Print tab.

If you want to print a series with a color map applied, you have to create an advanced capture of this series and add this capture to print.

Capturing the Screen

You capture images to save them as part of the examination.

When Capture is completed, you get a message **New series is available for viewing**. You can also track this job in the Job Viewer.

To create a secondary capture of the current viewing area

► On the Plan Toolbar or Review Toolbar, click **Capture Screen** .

⇨ The capture is added to the current exam and can be accessed via the Thumbnail Overview of the Exam Overview.

Capture Screen is disabled if series from multiple studies are loaded into review.

To create a secondary capture with advanced options

► On the Review Toolbar, click **Advanced Capture** .

⇨ The **Advanced Capture** window opens.

► At **Type**, select the type of the new capture.

- **Images**: Capture the selected image(s).
  This choice captures the full content of the selected viewport. If you just want to capture a single image of a viewport with inner layout, first maximize the image within the view.
- **Series**: Capture the selected imaging series.
  This choice captures the series with the color map applied and send the capture to PACS or print.
- **Screen**: Capture the viewing area (all viewports).

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- ► Only if you selected the type **Series**, select what to include (e.g. All slices, All dynamics, All image types).
  The options available depend on the selected imaging series.
- ► At **Name**, type the name of the capture series.
- ► To select the viewport that you want to capture, click the corresponding viewport number.
- ► Click **Capture**.

⇨ The capture is added to the current exam and can be accessed via the Thumbnail Overview of the Exam Overview.

7.6.11 Movies

You play movies to get an overview of all images available. You can play a movie for all image types, for example slices, phases or dynamics.

Playing Movies

Imaging series that consist of more than 1 image can be displayed as movies.

- ► On the Review Toolbar, click **Movie Bar** .
- ► Hover over the bottom of a viewport.

⇨ The Movie Bar appears at the bottom of all viewports:

- ► To start the movie, click **Play** .

Button	Description
	Set the dimension that is played, e.g. slices , echoes or phases .
	Set repeat/bounce options: • **Cycle Forward** : The images are displayed in a loop in the order 1 ... n, 1 ... n etc. • **Cycle Backward** : The images are displayed in a loop in the order n ... 1, n ... 1 etc. • **Bounce** : The images are displayed in the order 1 ... n, n ... 1, 1 ... n, etc.
	Previous Image: Step backwards through the images of the selected dimension.

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Button	Description
	Play: Start movie playback.
	Pause/stop movie playback.
	Next Image: Step forwards through the images of the selected dimension.
	Frame Rate: Set movie playback speed.
	Toggle **Auto Hide**: • If activated, the movie bar disappears when you move the mouse away from it, and reappears when you move the mouse near its place. • If deactivated, the movie bar keeps visible. • The button shows the current setting.

Tab. 9: Movie bar buttons

7.7 Image View Settings

The **Image View Settings** window hat two tabs:

- **Display Sorting**:
  To set how imaging series and dimensions are displayed in the viewports.
- **Scrolling Directions**:
  To set which dimensions are controlled when scrolling horizontally and vertically with the mouse or keyboard.

Note that all changes made in these settings take effect immediately, they do not have to be confirmed or saved.

7.7.1 Image Sorting in the Tile Layout

Here you specify how the images are sorted in the tile layout. This setting is useful for all imaging series with more than one imaging dimension (e.g. image type, slices, phases, echoes, dynamics).

- ► On the Plan Toolbar or Review Toolbar, click **Image View Settings** .
  - ⇨ The **Image View Settings** window opens.
- ► Click **Display Sorting**.
- ► At **Image Sorting in the Tile Layout**: Select the image sorting.
  - **1 Dimension**: One imaging dimension is shown in the viewport. All images are displayed in one row (X direction) which is wrapped to fill the entire screen.

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- **2 Dimensions (Matrix Layout)**: Two imaging dimensions are shown in the viewport area, one along the X-direction, one along the Y-direction and in case of more than 2 dimensions as layers in the Z-direction.
- **All Images (Sequentially)**: All images (all dimensions) are ordered in a line.

► At **Displayed Dimension**: Select the dimension(s) to be displayed (e.g. Image Type, Slices, Phases)

► At **Reverse Slice Order**: Choose whether to reverse the order of the slices.

► To close the window, click .

7.7.2 Specifying scrolling direction

Here you specify the scrolling directions (horizontal or vertical scrolling) for imaging series with multiple dimensions (e.g. image type, slices, phases, echoes, dynamics).

► On the Plan Toolbar or Review Toolbar, click **Image View Settings** .

⇨ The **Image View Settings** window opens.

► Click **Scrolling Directions**.

► Configure the settings.

The availability of settings depends on the configuration in the **Display Sorting** tab.

- At **Horizontal mouse/keyboard function**: Select the dimension to control.
- At **Vertical mouse/keyboard function**: Select the dimension to control.
- At **Additional keyboard function**: Select the dimension to control.

► To close the window, click .

7.8 Time Intensity Diagram (TID)

7.8.1 Calculating a Time Intensity Diagram (TID)

You calculate a TID to review the signal intensity change over time. The TID functionality provides you with a graph and a table of results.

▷ Prerequisite: A dynamic imaging series with multiple dynamics is displayed in the current viewport.

► On the Review Toolbar, click **Time-Intensity Diagram** .

⇨ The **Time-Intensity Diagram** window opens.

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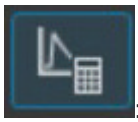
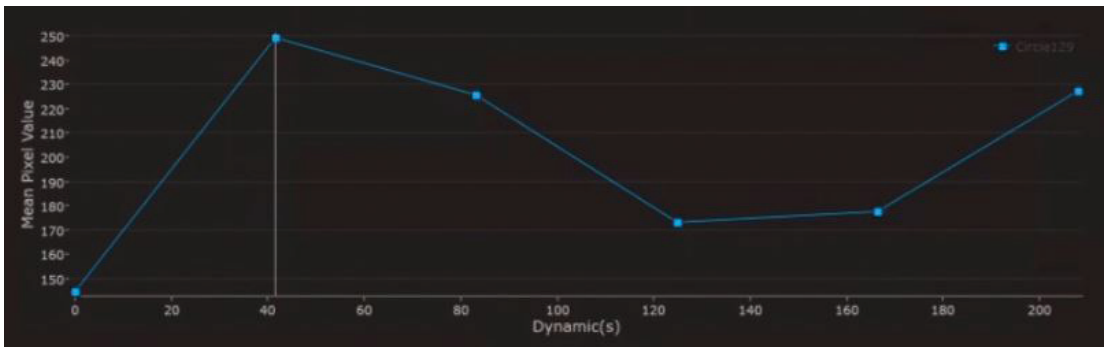
- At **Draw ROI** : Select the type of ROI to be drawn from the drop-down menu:
  - **Circle**
  - **Freehand Contour**
- Draw the ROI in an image.

  ⇨ The shape is automatically copied to all images of the (dynamic) series.

- At **Show Graph**  : Select whether to show or hide the TID.
  - Button active: The TID is displayed at the bottom of the viewport area.
  - Button inactive: The TID is hidden.
- At **X-axis**: Select the dimension for the x-axis from the drop-down menu.

  The options available here depend on the scan data. The dimension of the y-axis is the mean pixel value (intensity).



  - In the line graph, each data point corresponds to the mean pixel value (intensity) of the ROI in a scan phase.
  - A vertical bar in the diagram signals the current phase and time. If you click a scan phase image, the bar moves to the corresponding time. If you drag the bar, the corresponding scan phase image is highlighted. The bar can only be dragged to data points, not between them.
- To export the TID, click **Export**
- In the **Export Time Intensity Graph As ..** window, browse to the export location. Specify the name and type of the export file. Then click **Save**.
- To close the **Time-Intensity Diagram** window, click **Exit Window** . To reopen it, click **Time-Intensity Diagram** on the Review Toolbar again.

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ROIs in the TID calculation

- You can draw more than one ROI on the images.
- To move a ROI, drag it.
- To modify the shape of a ROI, click it to select it. Then drag any of the anchor points available on the contour.
- Changes made to a ROI in one image automatically apply to the ROIs in the other images. The results and the TID are updated automatically according to the new position and shape of the ROI.

7.9 Slab (MPR) and 3D (MIP) Render Modes

7.9.1 Functional Description of Slab Render Mode (MPR)

Slab render mode allows you to calculate:

- MultiPlanar Reformats (**Slab**).
  - **Slab** calculation converts a volume that is acquired in a certain plane, into another plane.
  - Suitable scans are 3D scans, preferably high-resolution scans with thin slices and isotropic voxels.
- Minimum Intensity Projections (**MinIP**).
  - With **MinIP**, you visualize structures with low intensity in an acquired volume.
  - Suitable scans are Black blood scans, and VENBOLD (PRESTO based) scans.
- Slab Maximum Intensity Projections (Slab **MIP**).
  - A Slab **MIP** is a Maximum Intensity Projection from only a few images (whereas the volume **MIP** is calculated from the complete acquired volume).
  - Suitable scans are Susceptibility weighted scans and M2D balanced-FFE scans.

What are the main features of MPR render mode?

- In **Slab** render mode, you review the selected imaging series in another plane than initially acquired, or in the same plane as initially acquired but with another slice thickness. **Slab** render mode provides you with an image display which allows to scroll through the newly created images (projections or reformats).
- **Slab** render mode allows you to calculate images (projections or reformats) in any required orientation, orthogonal, oblique, double oblique, or radial.
- You exclude (or include) regions from the calculation to focus on the anatomy of interest.
- You review the newly calculated images in real-time mode, or you create new imaging series consisting of **Slab**s.

7.9.2 Functional Description of 3D Render Mode (MIP)

3D render mode allows you to calculate:

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- Volume Maximum Intensity Projections (**MIP**):
  - You visualize structures with high intensity in an acquired volume.
    The volume MIP is calculated from the complete acquired volume (whereas a Slab MIP is a MIP from only a few images).
  - Suitable scans are 3D PCA scan, 3D/M2D Inflow scan and Contrast-Enhanced MRA scans.
- Volume Rendering (**Vol.Rend.**):
  - Volume Rendering is a visualization technique which creates a 2D projection from a 3D scan.
  - Suitable scans are 3D scans, preferably high-resolution scans with thin slices and isotropic voxels.
- In **3D** render mode, you review the selected imaging series in a volumetric display as rotating **MIP** or as rotating volume rendered projection.
- **3D** render mode allows you to calculate projections in any required orientation, orthogonal, oblique, double oblique, or radial.
- You exclude (or include) regions from the calculation to focus on the anatomy of interest.
- You review the newly calculated images in real-time mode, or you create new imaging series consisting of (MIP or volume rendered) projections.

7.9.3 User Interface

Slab render mode provides you with one large and three small viewports, and a **Generate New Series** panel. Furthermore, the **Review** toolbar has additional buttons dedicated to the calculation of MultiPlanar Reformats. .

Viewports

By default, the render modes **Slab** and **3D** open with four viewports.

- The large viewport shows a 3D view calculated in real-time.
  - The default image for **Slab** render mode is an image of the same orientation as the selected imaging series.
  - The default image for **3D** render mode is a projection.
- The three small viewports show three orthogonal views that serve as reference views (from top to bottom: axial, coronal, and sagittal).
  - One of the reference views shows the center image of the selected scan.
  - The other two reference views show real-time reconstructions in the remaining two orientations.
  - Colored lines on the reference views indicate the position of the calculated image in the large viewport and of the reference views.

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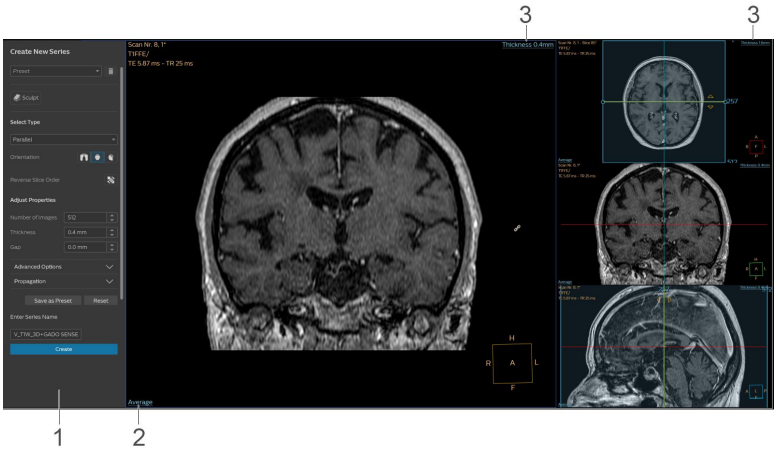
- You can change the layout when you right-click on any viewport, and select **Inner Layout**: **References on Right**,**References at Bottom**, **1x1**, **1x2**, **2x2**.
- Each viewport indicates the original or reconstructed slice thickness in the upper right corner. The reconstructed slice thickness always is a quarter of the original slice thickness.
- In the lower left corner of the viewport, you see the selected algorithm:

Render mode	Selectable Algorithms	Calculation of
Slab	**Average**	MultiPlanar Reformats
	MinIP	Minimum Intensity Projections
	MIP	Slab Maximum Intensity Projections
3D	**MIP**	Volume Maximum Intensity Projections
	Vol.Rend.	Volume Rendering



Viewports in MPR render mode

1. **Generate New Series** panel
2. Selected algorithm: **Average**
3. Indication of the slice thickness (available in all 4 viewports)

Generate New Series panel

The **Generate New Series** panel in **Slab** and **3D** render mode allows you to:

- Generate and save new imaging series out of the original dataset.
- Specify geometrical properties of the new imaging series.
- Set up, edit and save presets for the calculation of slab and volume Maximum intensity Projections, MultiPlanar Reformats and Volume Rendering.
- Select and reuse the saved presets for any other dataset.
- Delete presets.

Parameters	Description
Preset drop-down menu	To select a **Preset**.
Delete	To delete a **Preset**.

Parameters	Description
Sculpt Only available in **Slab** **Sculpt and Clip** Only available in **3D**	• To specify the volume of interest for the **Slab** with different ROI types: – **Include Freehand ROI** or **Exclude Freehand ROI** – **Include Rectangle ROI** or **Exclude Rectangle ROI** – **Include Circle ROI** or **Exclude Circle ROI** – **Include Polygon ROI** or **Exclude Polygon ROI** • To clip the volume (Only available in MIP).
Parallel or **Radial**	To define the stack type of the new imaging series. • For **Slab**: preferably parallel. • For **MIP**: only **Radial** is available.
Orientation	To specify the orientation of the new imaging series: **Axial**, **Sagittal**, or **Coronal**
Reverse Slice Order Only available in **Slab**	To create a new imaging series with the slices in reverse order (when the button is enabled).
Number of Images	To specify the number of images of the new imaging series.
Thickness (mm)	To specify the thickness of each reformat.
Gap (mm)	To specify the gap between the reformats. Applicable for parallel stack only.
Total Angle or **Step Angle** Only available in **3D**	To specify the • **Step Angle**: radial angle between the projections. • **Total Angle**: angle covered by all projections.
Advanced Options	To enable **Generate Reference Views** which calculates three orthogonal images additionally to the new imaging series.
Propagation	To specify if and how the render settings are propagated. • For **Dynamics**, you can select to propagate the settings of the current dynamic to the **Preceding** or **Following** dynamics, or to a specific **Range from ... to** of dynamics. • For the others (e.g. **Phases**, **b-values**, **Diffusion Directions**, **Image Types**), or **Stations**, you only enable or disable **Propagation**.
Reset	To reset all changes and go back to the initial settings.
Save as Preset	To save the current settings as preset which can be reused with other examinations and imaging series.
Enter Series Name	To enter a name for the new imaging series.
Generate	To start the creation of the new imaging series.

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7.9.4 Routine Procedures

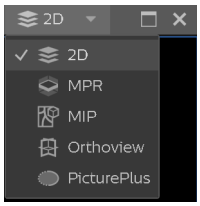
Creating a New Series in Slab Render Mode

You start up **Slab** render mode when you want to calculate MultiPlanar Reformats, Minimum Intensity Projections or a Slab MIP (Maximum Intensity Projection).

▷ Prerequisite: The selected imaging series is suitable for the render mode.

- For MPR: 3D scan, preferably with thin slices and isotropic voxels.
- For MinIP: Black blood scans, and VENBOLD (PRESTO based) scans.
- For Slab MIP: Susceptibility weighted scans and M2D balanced-FFE scans.

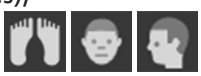
1. To access **Slab** render mode, do any of the following:
   - In the ExamOverview, right-click a suitable scan, and then select **Slab**.
   - From the render drop-down menu on a **Review** viewport, select **Slab**.



⇨ **Slab** render mode opens.

2. To select the algorithm, click in the lower left corner of the viewport, and select **Average**, **MinIP** or **MIP**.
3. Select a preset from the **Preset** drop-down menu in the **Generate New Series** panel.

⇨ The parameters and the viewports change according to the selected preset.

4. To change the orientation (of the image in the large viewport and the new imaging series),
   click  in the **Generate New Series** panel.

⇨ The large viewport displays an image of the selected orientation.

5. To scroll through the images, drag on the large viewport.
6. To navigate to other locations, drag the colored lines (red, green, blue) which indicate the current position.
7. To rotate the volume, hover over a round anchor point and then drag.
   To move the volume, hover over a center line and then drag.

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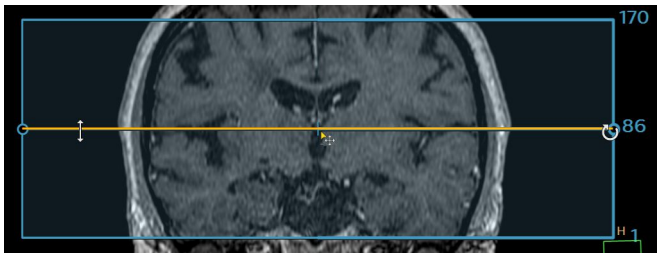
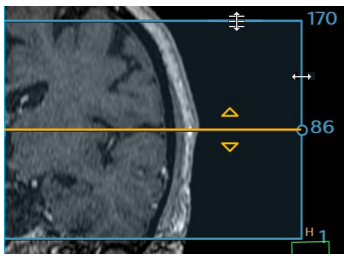


8. To change the number of slices, hover over any of the lines which represent one of the outer slices.
   Alternatively enter the number of slices numerically, or use the Up and Down arrows in the **Generate New Series** panel.

   To change the image area (comparable to FoV), hover over any of the border lines.



9. To set the center of the render volume, do the following:

   - To enable the centering function, click **Set Center** on the toolbar. Then click into a viewport.

     The viewports update their display immediately.
   - Click again into a viewport until all viewports show the center of the render volume at the desired location.
   - To disable the centering function, click **Set Center** again.

10. To change the slice thickness (and the slice gap), hover over the large yellow arrows, and then drag.
    Alternatively enter the slice thickness numerically, or use the Up and Down arrows in the **Generate New Series** panel.

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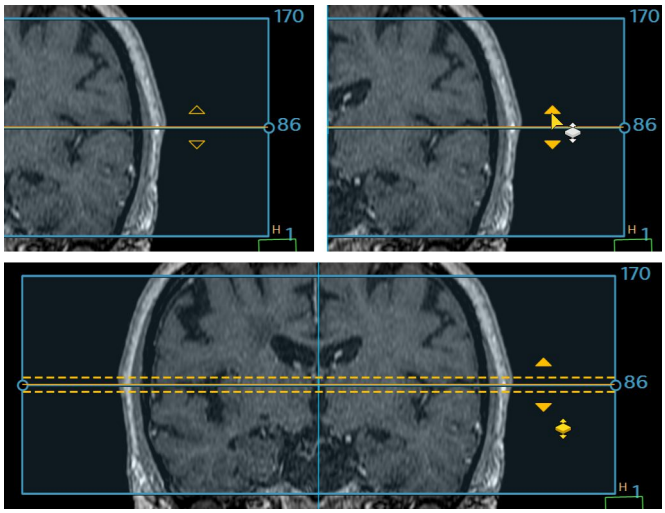


11. To undo changes, right-click and select **Reset All**.
12. Adjust the **Propagation** parameters.
    These parameters are not saved with the preset and need to be specified in scans with more than one attribute (**Dynamics**, **b-values** etc).
13. To save the images as new imaging series, enter a series name first. Then click **Generate**.
    ⇨ The **Generate** button changes to **Submitted**, and the **Job Viewer (F6)** notifies you about this new job.

⇨ A new imaging series is created within the current examination.

Creating a New series in 3D Render Mode

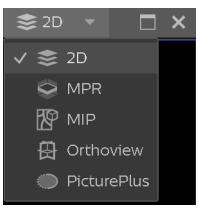
You start up **3D** render mode when you want to calculate a Maximum Intensity Projection (volume MIP) or volume rendered projections.

▷ Prerequisite: The selected imaging series is suitable for the render mode.

- For Volume Rendering: 3D scan, preferably with thin slices and isotropic voxels.
- For MIP: 3D PCA scan, 3D/M2D Inflow scan and Contrast-Enhanced MRA scans.

► To access **3D** render mode, do any of the following:

- In the ExamOverview, right-click a suitable scan, and then select **3D**.
- From the render drop-down menu on a **Review** viewport, select **3D**.



⇨ **3D** render mode opens.

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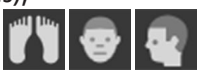
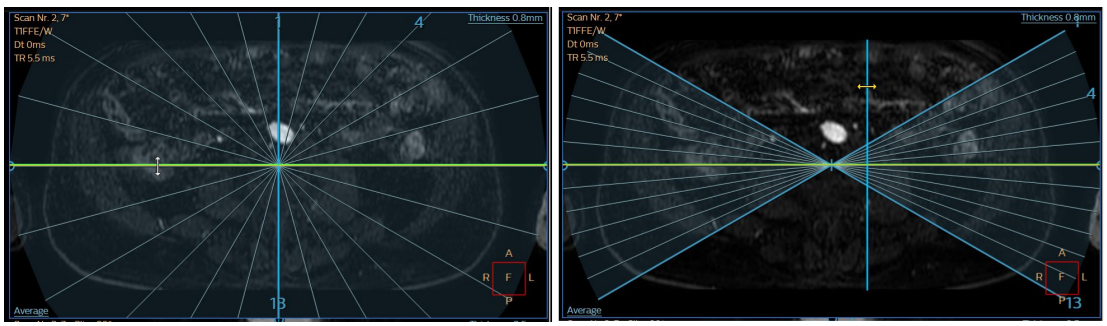
- ► To select the algorithm, click in the lower left corner of the viewport, and select **MIP** or **Vol.Rend.**.
- ► Select a preset from the **Preset** drop-down menu in the **Generate New Series** panel.
  - ⇨ The parameters and the viewports change according to the selected preset.
- ► To change the orientation (of the image in the large viewport and the new imaging series),
  click  in the **Generate New Series** panel.
  - ⇨ The large viewport displays an image of the selected orientation.
- ► To view the projections from different angles in MIP render mode, drag on the large viewport.
- ► To navigate to other locations, drag the colored lines (red, green, blue) which indicate the current position.



- ► To set the center of the render volume, do the following:
  - To enable the centering function, click **Set Center** on the toolbar. Then click into a viewport.

  The viewports update their display immediately.
  - Click again into a viewport until all viewports show the center of the render volume at the desired location.
  - To disable the centering function, click **Set Center** again.
- ► To change the number of images, enter the number of slices numerically, or use the Up and Down arrows in the **Generate New Series** panel.
- ► To change the angle (either the step angle between the projections or the total angle covered by all projections), drag the outer projection.
  Alternatively enter the Total angle or step angle numerically, or use the Up and Down arrows in the **Generate New Series** panel.

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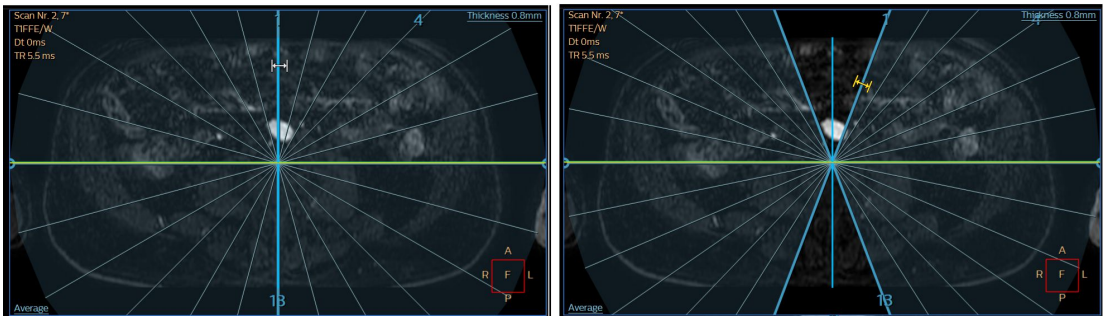

- To undo changes, right-click and select **Reset All**.
- To save the MultiPlanar Reformats as imaging series, proceed with the workflow Creating new MPR imaging series.
- Adjust the **Propagation** parameters.
  These parameters are not saved with the preset and need to be specified in scans with more than one attribute (**Dynamics**, **b-values** etc).
- To save the images as new imaging series, enter a series name first. Then click **Generate**.

  ⇨ The **Generate** button changes to **Submitted**, and the **Job Viewer (F6)** notifies you about this new job.

⇨ A new imaging series is created within the current examination.

Sculpting and Clipping of the Volume of Interest

When you want to focus on a specific anatomic region only, you restrict the imaging volume to a smaller part by sculpting or by clipping.

You can sculpt any volume in **Slab** and **3D** render mode, but you can only clip volumes in **3D** render mode.

Sculpting

- To sculpt, click **Sculpt** or **Sculpt and Clip** from the **Generate New Series** panel.
- Then you use ROIs to select which anatomic region to exclude and which anatomic region to include. Select a ROI type:
  - **Include Freehand ROI** or **Exclude Freehand ROI**
  - **Include Rectangle ROI** or **Exclude Rectangle ROI**
  - **Include Circle ROI** or **Exclude Circle ROI**
  - **Include Polygon ROI** or **Exclude Polygon ROI**
- Draw a ROI to include or exclude an anatomic region.
- Repeat the previous steps as often as needed.

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Clipping

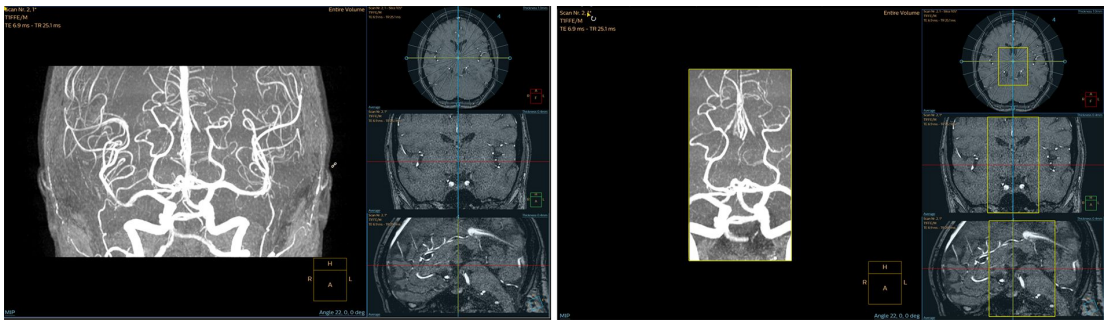
▷ Only available in **3D** render mode.

► To clip, select **Sculpt and Clip**.

⇨ A yellow rectangle is superimposed to the viewports. This rectangle defines the volume of interest.

► Resize the yellow rectangle:

- Drag the borders and corners to make the rectangle smaller (or larger again).
- Drag the round anchor points to angulate the rectangle.



Rolling and Rotating an Image

By rolling or rotating an image you change the perspective of the display.

▷ You are in **Slab**, **3D**, or **OrthoView** render mode.

► On the **Review** Toolbar, click **Roll/Rotate** .

► To roll, click the center of the image and drag in any direction.

► To rotate, click the corner of the image and drag in any direction.

Managing Presets

For the calculation of reformats and projections, you set up presets for specific anatomies which you can reuse for any similar examination.

Prerequisite: You are in **3D** or **Slab** render mode.

Selecting an existing preset

► To select an existing preset, click the **Preset** drop-down menu.

► Select a preset.

⇨ The preset name is displayed as selected preset.

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⇨ Now you can create a new imaging series based on this preset, or you can edit the preset or delete it.

Setting up (or editing) and saving a preset

- ► Specify the parameters under **Select Type** and **Adjust Properties** in the **Generate New Series** panel, e. g. **Orientation**, and **Number of Images**.

  Only these parameters (**Select Type** and **Adjust Properties**) are saved in a preset.
  The **Propagation** parameters are not saved with the preset.
- ► To save the current parameters as a preset for reuse, click **Save as Preset**.
- ► Then enter a name for the preset. Confirm with **Save**.

⇨ The preset is saved under the entered name and available in the **Preset** drop-down menu.

Deleting a preset

- ► Select the preset from the **Preset** drop-down menu in the **Generate New Series** window.
- ► Click .

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7.10 OrthoView

7.10.1 Functional Description

OrthoView allows you to review automatically calculated orthogonal MPRs in a multilayer environment. **OrthoView** is an advanced viewer that helps to combine results from different packages. You can combine color overlays like f-MRI blobs along with other objects like fibers from the FiberTrak application.

- You process an imaging series in any of the **Analysis** packages **IViewBOLD**, or **FiberTrak**. You save the fibers or parametric maps or segmentations in the **Analysis** package.
- Then you open **OrthoView** and load the saved fibers, maps or segmentation as overlay.

7.10.2 Routine Procedures

Starting up Orthoview

- ► To access **OrthoView** render mode, do any of the following:
  - In the ExamOverview, right-click a suitable scan, and then select **OrthoView**.

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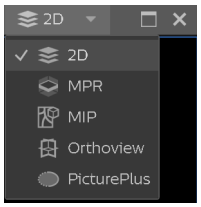
- From the render drop-down menu on a **Review** viewport, select **OrthoView**.



Displaying Fibers

▷ You are in **OrthoView** render mode.

► On the **Review** Toolbar, click **Show Fibers** .

Changing the Plane Opacity

Changing the plane opacity affects the axial, coronal and sagittal planes at once.

▷ You are in **OrthoView** render mode.

► On the **Review** Toolbar, click **Plane Opacity** .

► Click the image and drag horizontally to adjust the plane opacity.

Movement to the right increases and movement to the left decreases the opacity.

Changing the Opacity of Fused Overlay Images

This function is only available with fused images. **Opacity** controls the opacity, or transparency, of the overlay. It is displayed as Alpha factor when **Full Image Information** is selected.

▷ You are in**OrthoView** render mode.

► On the **Review** Toolbar, click **Opacity** .

► Click the image and drag horizontally to adjust the opacity.

Movement to the right increases and movement to the left decreases the opacity.

Rolling and Rotating an Image

By rolling or rotating an image you change the perspective of the display.

▷ You are in **Slab**, **3D**, or **OrthoView** render mode.

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- ► On the **Review** Toolbar, click **Roll/Rotate** .
- ► To roll, click the center of the image and drag in any direction.
- ► To rotate, click the corner of the image and drag in any direction.

Hiding Planes

▷ You are in **OrthoView** render mode.

► Do any of the following:

- To hide the axial plane, click **Hide Axial Plane** .
- To hide the coronal plane, click **Hide Coronal Plane** .
- To hide the sagittal plane, click **Hide Sagittal Plane** .

7.11 MobiView

7.11.1 Functional Description

MobiView allows you to combine multistation or multi-stack datasets into one overall dataset. Typically, MobiFlex (or MobiTrak), Whole Body and Total Spine datasets are viewed in this way.

MobiView offers the following algorithms:

- **Stitch 2D** (Stitch SC 2D where SC stands for Secondary Capture).
- **Stitch Slab**.
- **Stitch Slab and Display in 3D**.
- **Fuse Transverse Scans**.
- **Merge Transverse Scans**.

Depending on the type of dataset or datasets, only a subset of the algorithms is available. **MobiView** automatically opens with the best suited algorithm for the selected dataset. You can select another algorithm with **Modify Stitch Results**.

MobiView allows you to generate a new series of the overall volume which results from stitching, fusing or merging. You can view the new series as any other series, except the Stitch SC 2D generated result.

On the stitched images, markers indicate the stitching area.

You start **MobiView** manually, or automatically as SmartLine processing step.

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7.11.2 Safety

WARNING

After applying the fusion operation, double-check whether the result of the fusion operation is correct. Always keep the original images.

Horizontal lines on the image indicate where the operation took place. Check for any artifacts that could indicate a fusion error, like cut-off objects or anatomy. The fused images must be of the same acquired plane. Be aware that the resolution at the edges of a station can be lower than in the center.

NOTICE

Unfuse the images in case of artifacts.

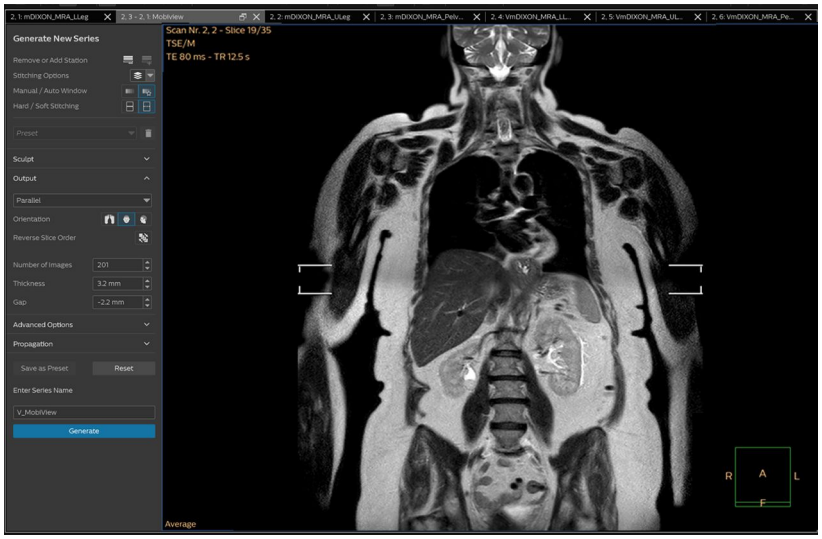
This is to make sure that previously present artifacts which have not been visible on screen prior to fusing are not mistakenly interpreted as pathologies.

7.11.3 User Interface

Viewports

The default layout is depending on the selected algorithm.

With the **Stitch 2D** algorithm, **MobiView** opens with the **Generate New Series** panel and one viewport.



- This viewport displays a stitched image where the default settings are applied (**Soft Stitching** and **Auto Window**).
- On the viewport, markers indicate the Stitch area.

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- You can change the layout when you right-click on any viewport, and select **Inner Layout**: **1x1**, **2x2**, **3x3**, **4x4** and **Auto Layout**.

When **Stitch Slab** and **Stitch Slab and Display in 3D** is selected, **MobiView** opens with one larger viewport and 3 reference viewports.

Generate New Series panel

The **Generate New Series** panel in **MobiView** allows you to:

- Generate and save new imaging series out of the original dataset.
- Modify the stitch results.
- Specify geometrical properties of the new imaging series.
- Select and reuse the saved presets for any other dataset.
- Delete presets.

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Stitch Parameters

Parameters	Description	More Information
Remove or Add Station	To remove a station from or add a station to the stitched result images. • **Remove Station** • **Add Station**	You remove or add a station from or to the bottom. To remove a station, right-click this station in the viewport and select via the context menu **Remove Station**. It is not possible to remove the middle station. To add or replace one or more valid stations, drag and drop a station form the **ExamOverview** to the **MobiView** viewport.
Stitching Options	To select the way the images of the multiple stations are stitched. • **Stitch 2D** (Stitch SC 2D where SC stands for Secondary Capture) • **Stitch Slab** • **Stitch Slab and Display in 3D** • **Fuse Transverse Scans** • **Merge Transverse Scans**	chapter “Routine Procedures” on page 544
Manual / Auto Window	To specify how to window the images. • Either window manually: **Manual** • Or use automatically determined window settings: **Auto**	**Manual** is not available for **Fuse Transverse Scans** and **Merge Transverse Scans**.

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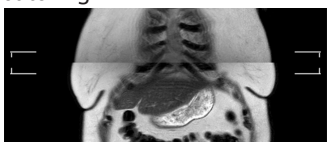
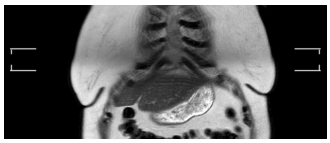
Parameters	Description	More Information
Hard / Soft Stitching	To specify how to treat the overlapping area of the multiple stations. • **Hard Stitching** • **Soft Stitching** To disable stitching in the preview (no **Hard Stitching**, no **Soft Stitching**), deselect both options.	Examples of hard and soft stitching:  

Presets and Sculpting

Parameters	Description
Preset drop-down menu	To select a **Preset**.
Delete	To delete a **Preset**.
Sculpt	To specify the volume of interest with different ROI types. • **Include Freehand ROI** or **Exclude Freehand ROI** • **Include Rectangle ROI** or **Exclude Rectangle ROI** • **Include Circle ROI** or **Exclude Circle ROI** • **Include Polygon ROI** or **Exclude Polygon ROI**
Undo last action or **Redo last action**	To undo the last action, click **Undo last action**. To redo something you have undone before, click **Redo last action**.
Reset all sculpting actions	To set all sculpting actions to their initial values, click **Reset all sculpting actions**.

Output

Parameters	Description
Parallel or **Radial**	To define the stack type of the new imaging series. • For **Slab**: preferably parallel. • For **MIP**: only **Radial** is available.
Orientation	To specify the orientation of the new imaging series: **Axial**, **Sagittal**, or **Coronal**
Reverse Slice Order	To create a new imaging series with the slices in reverse order (when the button is enabled).

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Parameters	Description
Number of Images	To specify the number of images of the new imaging series.
Thickness (mm)	To specify the thickness of each reformat.
Gap (mm)	To specify the gap between the reformats. Applicable for parallel stack only.
Total Angle or **Step Angle** Only available in **3D**	To specify the • **Step Angle**: radial angle between the projections. • **Total Angle**: angle covered by all projections.

Advanced Options, Propagation, Generic Buttons

Parameters	Description
Advanced Options	To enable **Generate Reference Views** which calculates three orthogonal images additionally to the new imaging series.
Off-center	To specify the offcenter values of the reference views.
Relative Angulation	To specify the relative angulation values of the reference views.
Propagation	To specify if and how the render settings are propagated. • For **Dynamics**, you can select to propagate the settings of the current dynamic to the **Preceding** or **Following** dynamics, or to a specific **Range from ... to** of dynamics. • For the others (e.g. **Phases**, **b-values**, **Diffusion Directions**, **Image Types**), or **Stations**, you only enable or disable **Propagation**.
Reset	To reset all changes and go back to the initial settings.
Save as Preset	To save the current settings as preset which can be reused with other examinations and imaging series.
Enter Series Name	To enter a name for the new imaging series.
Generate	To start the creation of the new imaging series.

7.11.4 Routine Procedures

Stitching 2D (Stitching Secondary Capture 2D)

You use **Stitch 2D** for datasets in sagittal and coronal orientation which meet the following conditions:

- Acquired series of multiple stations or multiple stacks.
- Identical orientation and angulation.
- Same slice thickness and slice gap.
- No inter-station gap.

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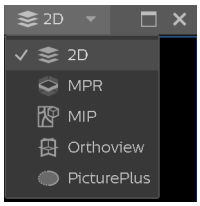
- The stations are co-planar (two parallel planes with their perpendicular distance less than 5% of their slice thickness).

For transverse orientation, **Stitch 2D** is not available.

▷ Prerequisite: The selected imaging series is suitable for **MobiView**.

1. To access **MobiView**, do any of the following:
   - In the ExamOverview, right-click a suitable scan, and then select **MobiView**.
   - From the drop-down menu on a **Review** viewport, select **MobiView**.



   ⇨ **MobiView** opens and presents you with stitched images (created based on default settings).
2. To scroll through the images and to check the image quality, drag on the viewport.
3. To change the stitching parameters, select another stitching method in the **Generate New Series** panel.

   Then check the results on the viewport.
4. To save the images as new imaging series, enter a series name first. Then click **Generate**.

   ⇨ The **Generate** button changes to **Submitted**, and the **Job Viewer (F6)** notifies you about this new job.

⇨ A new imaging series is created within the current examination.

NOTICE

When the image geometries of the datasets do not match (different angulation, non co-planar datasets, different slice thickness or gaps), MobiView opens with **Stitch Slab**. In this case, select the algorithm **Stitch SC 2D** (where SC stands for Secondary Capture).The generated secondary capture series (with the prefix SC) does not contain geometrical information of orientation, and does not allow for meaningful common measurements.

Stitching Slab (and Display in 3D)

You use **Stitch Slab** and **Stitch Slab and Display in 3D** for volumes in sagittal and coronal orientation which meet the following conditions:

- The inter-station angulations are within the specified limits:
  - For sagittal orientation, LR and FH angulation difference less than 5°, AP angulation difference less than 45°.

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  - For coronal orientation, AP and FH angulation difference less than 5°, LR angulation difference less than 45°.
- The inter-station gaps in FH direction are less than 10 mm at both edges of the images.

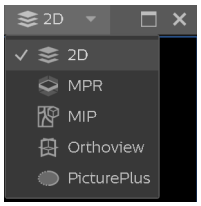
  Since the gap may result in a black area in the fused image, the maximum height of the fused series may be greater than the sum of the individual series.

For transverse orientation, **Stitch Slab** and **Stitch Slab and Display in 3D** are not available.

- **Stitch Slab** accesses **Slab (Average)** render mode. It allows you to calculate MultiPlanar Reformats in any direction and to scroll through them.
- **Stitch Slab and Display in 3D** accesses **3D** render mode. It allows you to calculate Maximum Intensity Projections and to review them from different angles.

▷ Prerequisite: The selected imaging series is suitable for **MobiView**.

1. To access **MobiView**, do any of the following:
   - In the ExamOverview, right-click a suitable scan, and then select **MobiView**.
   - From the render drop-down menu on a **Review** viewport, select **MobiView**.



   ⇨ **MobiView** opens and presents you with stitched images (created based on default settings).
2. To scroll through the images and to check the image quality, drag on the large viewport.
3. To change the stitching parameters, select another stitching method in the **Generate New Series** panel.

   Then check the results on the viewport.
4. To save the images as new imaging series, enter a series name first. Then click **Generate**.

   ⇨ The **Generate** button changes to **Submitted**, and the **Job Viewer (F6)** notifies you about this new job.

⇨ A new imaging series is created within the current examination.

⇨ The stitched imaging series opens in **Slab(Average)** or in **3D** render mode.

Fusing Transverse Scans

You use **Fuse Transverse Scans** for scans in transverse orientation which meet the following conditions:

- Same slice thickness and slice gap.
- No angulation between scans.
- Same Feet-Head offset of overlapping images between scans.

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- The offcenter position of all the slices in the stations shall be multiples of slice thickness with slice gap.
- A (possible) gap between the scans shall be in multiples of slice thickness with slice gap.

For sagittal and coronal orientation, **Fuse Transverse Scans** is not available.

Merging Transverse Scans

You use **Merge Transverse Scans** for transverse scans which meet the following conditions:

- Same resolution (same number of rows & columns).

For sagittal and coronal orientation, **Merge Transverse Scans** is not available.

Sculpting the Volume of Interest

When you want to focus on a specific anatomic region only, you restrict the imaging volume to a smaller part by sculpting.

► To sculpt, click **Sculpt** or **Sculpt and Clip** from the **Generate New Series** panel.

► Then you use ROIs to select which anatomic region to exclude and which anatomic region to include. Select a ROI type:

- **Include Freehand ROI** or **Exclude Freehand ROI**
- **Include Rectangle ROI** or **Exclude Rectangle ROI**
- **Include Circle ROI** or **Exclude Circle ROI**
- **Include Polygon ROI** or **Exclude Polygon ROI**

► Draw a ROI to include or exclude an anatomic region.

► Repeat the previous steps as often as needed.

Managing Presets

For the calculation of reformats and projections, you set up presets which you can reuse for any similar examination.

Selecting an existing preset

► To select an existing preset, click the **Preset** drop-down menu.

► Select a preset.

⇨ The preset name is displayed as selected preset.

⇨ Now you can create a new imaging series based on this preset, or you can edit the preset or delete it.

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Setting up (or editing) and saving a preset

- ► Specify the parameters under **Select Type** and **Adjust Properties** in the **Generate New Series** panel, e. g. **Orientation**, and **Number of Images**.

  Only these parameters (**Select Type** and **Adjust Properties**) are saved in a preset.
  The **Propagation** parameters are not saved with the preset.
- ► To save the current parameters as a preset for reuse, click **Save as Preset**.
- ► Then enter a name for the preset. Confirm with **Save**.

⇨ The preset is saved under the entered name and available in the **Preset** drop-down menu.

Deleting a preset

- ► Select the preset from the **Preset** drop-down menu in the **Generate New Series** window.
- ► Click .

7.12 PicturePlus

7.12.1 Functional Description

PicturePlus applies a filter that reduces the visibility of noise and artifacts, thereby enhancing the anatomical structures in the images. It uses an intelligent algorithm of smoothing and edge enhancement, e.g. background noise is smoothed while vessels are sharpened.

PicturePlus can be used for most image types (including modulus, real, flow) and all processed images (MPR, MIP, subtracted images).

Preferred combinations of edge enhancement and smoothing can be saved as **PicturePlus Presets**. These presets allow you to enhance images exactly in the same way for each imaging series.

7.12.2 Routine Procedures

Enhancing an Image with PicturePlus

You can enhance an image with **PicturePlus** by mouse actions or by entering numeric values for **Smooth** and **Edge**.

▷ You are in **PicturePlus** render mode.

▷ In **PicturePlus**, the left mouse behavior is automatically set to **Enhance PicturePlus**.

- ► To change edge enhancement and smoothing with the mouse, drag horizontally and vertically.

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Horizontal movement changes edge enhancement (increasing values from left to right). Vertical movement changes smoothing (increasing values from the bottom up).

⇨ The numeric values of **Smooth** and **Edge** are displayed in real time in the top row of the viewport.

► To change edge enhancement and smoothing by entering numeric values, click the values **Smooth** and **Edge** in the top row of the viewport. Then enter numeric values in the input fields, or use the Up and Down arrows next to the input fields.

► To save the images as new imaging series, enter a series name first. Then click **Generate**.

⇨ The **Generate** button changes to **Submitted**, and the **Job Viewer (F6)** notifies you about this new job.

⇨ A new imaging series is created within the current examination.

To reset the changes

► Right-click the image and select **PicturePlus Presets** > **Smooth0 Edge0**.

⇨ Edge enhancement and smoothing are reset to 0.

Saving a PicturePlus Preset

You can save the current **PicturePlus** settings as preset.

► Right-click the image and select **PicturePlus Presets** > **Save PicturePlus Preset...**.

⇨ The **Save PicturePlus Preset...** window appears.

► Enter a name for the new preset.

► Click **Save** to confirm.

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8 Finalizing the Examination

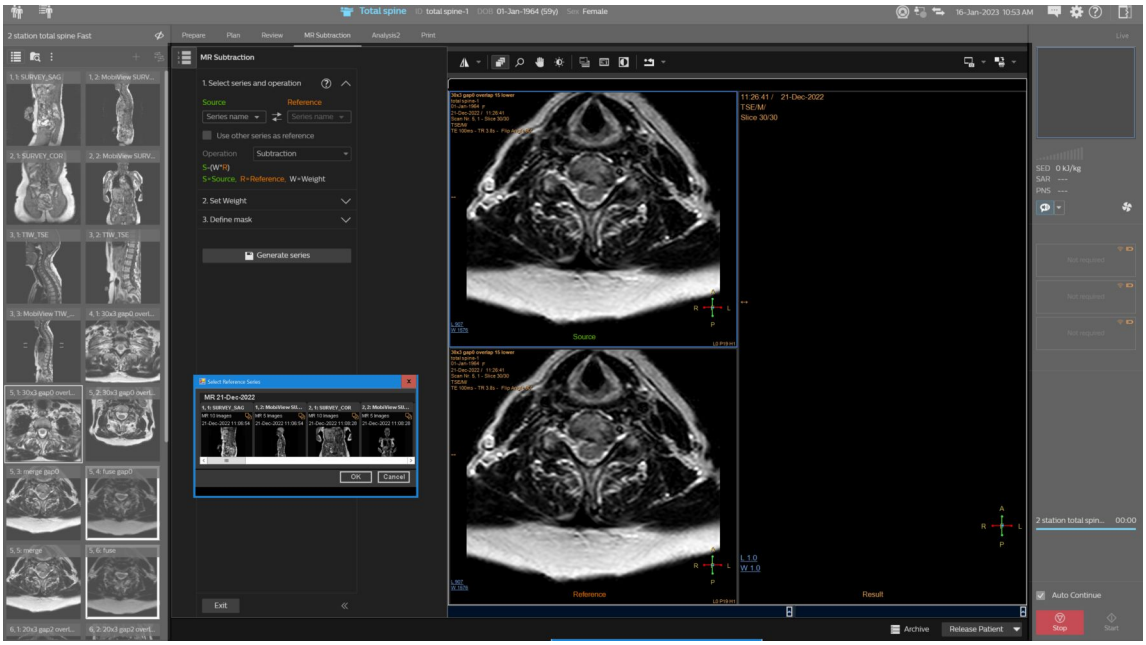
8.1 Analyzing Images

8.1.1 Analysis Tabs

To perform parallel analysis in different analysis packages, two Analysis tabs are available.

In the **Analysis1** and **Analysis2** tab, you perform advanced analysis of your imaging series. The Analysis packages come with a Task Guidance which supports your workflow. The screen setup is optimized for each analysis package.

Once an analysis package is open in one of the tabs, this tab is renamed to the name of the analysis package, for example **MR Subtraction**.



8.1.2 Opening an Imaging Series in the Analysis Tab

You open an imaging series in the **Analysis1** or in the **Analysis2** tab from the **Exam Overview**.

If both **Analysis** tabs are already in use, you are prompted which tab should be replaced by the current imaging series.

▷ From the **Exam Overview**:

► Right-click an imaging series in the **Thumbnail View** (or **List View**), then select any Analysis package.

⇨ The imaging series opens in the dedicated layout, by default in the first empty **Analysis** tab.

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▷ From the **Analysis** tab:

► Click any of the **Analysis** tabs: **Analysis1** or **Analysis2**.

► Select an imaging series.

⇨ The empty tab shows the suitable analysis packages.

► Select an analysis package.

⇨ The imaging series opens in the dedicated layout, by default in the first empty **Analysis** tab.

8.1.3 General information

NOTICE

The results of analysis depend on the quality of the acquisition. Ensure that the scan settings are set correctly for the patient at the time of acquisition to assure best results.

NOTICE

Attention is needed for operator instructions displayed on the viewing screen.

NOTICE

The color scheme of the UI described in this manual may be different from the color scheme on the product as it appears on the screen. However, this does not affect the functionality or usability of the system in any way.

Definitions

The following terms are used throughout this documentation:

Term	Description
Patient	The 'Patient' directory contains the studies of a patient over time.
Study	A 'Study' consists of an MRI imaging series.
(Imaging) Series	A series consists of one or more images. A typical image is a slice.

The various controls

These controls are:

- a package-specific **Task Guidance panel**
  Follow the steps of the task guidance for ease of use and optimum results.

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- the **Package/Bookmarks** switch button

  This button can be used to switch between the Task Guidance panel and the Bookmarks.
- **Right mouse menus**

  Right mouse menus are available to facilitate the use of the postprocessing packages and to offer various interaction possibilities. They are available for image and map viewports, and for graphs.

  – Simply right-click on any viewport to access the right mouse menu.
- **keyboard functions**

  Keyboard functions can be used for several purposes, e.g. for scrolling through images by means of the arrow keys.

Most of the functions in an analysis package can be performed via all controls. It's purely a matter of taste which control is going to be used.

Right mouse menus

In the MR packages, the most important functions can be performed via the toolbar and the generic control panel. However, there are more functions to be performed. You can find these in the right mouse menus.

Dedicated right mouse menus are described in the 'More functions' of the corresponding package.

The universally valid right mouse menu functions are described here:

Define the mouse usage

1. Right-click on the source image or the maps.
2. Select any option:

Option	Icon	Description
Scroll		Drag to scroll through the dataset.
Pan		Drag to pan the source image or map.
Zoom		Drag to zoom the source image or map.
Windowing/Gray Level		Drag to adjust the level and width (or contrast and brightness).
Mask		Drag to adjust the mask.
Select Mask Color	no icon	

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Option	Icon	Description
Draw ROI	no icon	Drag to draw a freehand ROI.
Opacity (only available on maps)		Drag to adjust the intensity of the color overlay.

NOTICE

This table lists all options for the left mouse usage.

Note that not all options are available in all packages.

Reset the source image or the maps

1. Right-click on the source image or the maps.
2. Select any option:

Option	Icon	Description
Reset Zoom/Pan		The source image or the maps will be displayed with their original zoom and pan settings again.
Reset Windowing		The source image or the maps will be displayed with their original window settings again.
Reset All		Applies Reset Zoom, Pan, Windowing and removes all graphics, including ROIs.

Modify the Results Display

These functions are available in the MR T1 Perfusion, MR Neuro Perfusion and the MR Permeability packages.

1. Right-click on the graph viewport.
2. Click to select one of the options (see table) to modify the display.

Function	Possible values
ROI Average	Enabled/Disabled: If enabled, the graph displays the ROI average.
Auto Scale	Enabled/Disabled: If enabled, the graph will be automatically scaled.
Dynamic Time	Enabled/Disabled. Allows to toggle between dynamic time and dynamic number.

Select a series and launch an analysis package

It's easiest to launch an MR analysis package in the **Directory** tab of the activity bar.

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1. Click **Directory** on the activity bar.
2. Click to select a study from the list of studies.
   ⇨ The series panel will show all series and reconstructions from the selected study.
3. Launch MR Review. Select the series and right click on the series to view available applications. Select an application.
   ⇨ The package opens with the selected series.

Scrolling through images

The way of scrolling through images depends on the view settings and the number of image attributes.

You can use the mouse or the arrow keys to scroll through images.

To scroll through ...	Press the arrow keys	Mouse movement	Effect on image attribute
1st image attribute: slice position			Mouse movement increases or decreases the number of the image attribute.
2nd image attribute: e.g. dynamic, phase, echo number, b-value.			Movement to the right increases (to the left decreases) the number of the image attribute.

Example: Scrolling in a series with only one image attribute (single dimension series)

The series has only slices.

Through slices (or resulting) maps

1. In the image (or map) viewport, drag to the left or to the right.
2. Alternatively use the left and right arrow keys.

Example: Scrolling in a series with two image attributes

The series consists of multiple dynamics with multiple slices. The first image attribute are the slices, the second one are the dynamics.

Through dynamics

1. In the image viewport, drag to the left or to the right.

Through slices

1. In the image viewport, drag up- or downwards.

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Draw ROI

You can draw a ROI to focus on a specific area, e.g. a lesion.

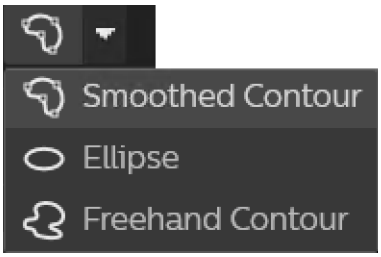

Fig. 34: Drop-down menu for ROI type selection. 1- Click on the icon to draw a ROI of the current ROI type.; click on the arrow to open the drop-down menu, 2 - Option: 'Smoothed Contour', 3 - Option: 'Ellipse', 4 - Option 'Freehand Contour'.

1. Click on the arrow in the task guidance to open the drop-down menu for ROI type selection .
2. Select a ROI type:
   - Spline Contour (suited for any type of contour)
   - Ellipse (suited for any type of round or oval-shaped contour)
   - Freehand Contour (suited for any type of contour)
3. Draw the ROI:

   After ROI confirmation, immediately the graphical and numerical results will appear.
   - **For a Spline Contour:** click once to define one point of the ROI contour. Repeat this till the contour is completed. When finished, double-click to confirm the ROI.
   - **For an Ellipse:** click twice to define the width of the ROI. Click once more to define the height of the ROI and in such a way to confirm the ROI.
   - **For a Freehand Contour:** click and drag to define the contour. Upon releasing, the ROI is confirmed automatically.

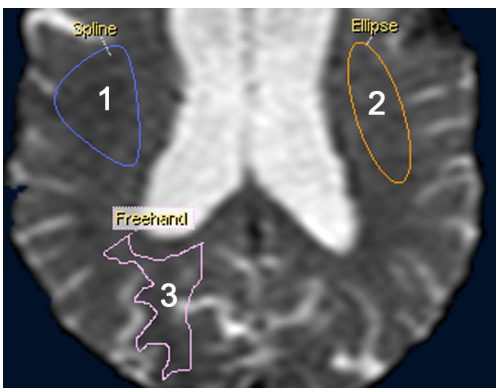

Fig. 35: Three different ROI types: 1 - spline contour, 2 - ellipse and 3 - freehand contour.

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Once you've confirmed a ROI (or line), you can still adjust its shape, its position and rename or delete it.

Adjust ROI shape and position

1. Click on an anchor point and drag to adjust the ROI shape.

2. Click between anchor points and drag to adjust the ROI position.

Rename a ROI

1. Double-click the name (by default ROI1, ROI2, ROI3 etc).
2. Delete characters where needed and type the new name.

- It is advised to rename the ROIs for easier identification (e.g. left breast, right breast, tumor, cyst).
- If multiple ROIs are renamed to the same name, automatically a numerical extension is added to this name, e.g. Hemisphere, and Hemisphere 2

Delete a ROI

1. Right-click on the ROI and select 'Delete' or delete from table.

Copy data

All data displayed on the screen can be copied into text editors and spreadsheet applications. To copy the data:

1. In any viewport: Use the shortcut key 'Ctrl' 'C' or select 'Copy' from the right mouse menu.
2. In the text editor or in the spreadsheet application: Use the shortcut key 'Ctrl' 'V' or select 'Paste' in the text editor or spreadsheet application.

8.1.4 Split Series

Functional Description

The functionality **Split Series** allows you to extract images from an imaging series according to their image dimensions, for example dynamics, phases, image type, stacks.

Typical Examples

- You extract the transverse images of a multistack survey.

  The result is a new imaging series with transverse images only.
- You extract dynamic scan #5 of a dynamic study into a single scan.

  The result is a new imaging series with all images of dynamic scan #5 only.
- You extract the images of image type Modulus of an imaging series which contains multiple image types.

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The result is a new imaging series with Modulus images only.

Split Series opens in **Analysis1** or in **Analysis2**.

Splitting Imaging Series

You extract images of a specific image dimension from an imaging series with multiple dimensions.

▷ From the Exam Overview:

► Right-click a suitable imaging series in the **Thumbnail View** (or **List View**), then select **Split Series**.

⇨ The imaging series opens in the **Split Series** analysis package.

► From the drop-down list, select the dimension that you want to get as separate imaging series.

► To select the images for extraction, drag the slider **Selected Value** to the desired value.

- The slider allows you to select a single value for image extraction.
- The slider corresponds with the number of images in the current imaging series.

For a dynamic study of 2 dynamic scans, the **Selected Value** can be 1 or 2.

For an imaging series of 60 slices, the **Selected Value** can be anything between 1 and 60.

For an imaging series of multiple image types, you select one of the possible values, for example W, F, IP or OP in a mDIXON imaging series.

For a multistack imaging series, you select any of the available orientations. In this case, all slices are automatically included.

► Enter a new series name, or modify the proposed series name.

► Click **Generate**.

8.1.5 MR T1 Perfusion

This postprocessing package is meant to evaluate T1 perfusion studies and generate numerical and graphical results and maps.

T1 perfusion studies are based on the fact that contrast agent shortens the T1 relaxation times of tissues.

Valid imaging series

A valid imaging series for the MR T1 Perfusion package is a T1w dynamic perfusion imaging series where a stack of slices is repeatedly acquired over time. It is a series that holds slices and dynamics. The MR T1 Perfusion package requires at least 4 dynamics.

This type of series allows to observe the changes of the T1 relaxation time and in such a way the contrast-uptake.

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Functional Description

The MR T1 Perfusion post-processing software is indicated to evaluate the Time Intensity Curves (TIC) of a MR T1 signal enhancement series for patients with oncological lesions (including brain, prostate, and breast cancer) or inflammatory process (including musculoskeletal disorders, Crohn's disease).

User Interface

Screen layout

The MR T1 Perfusion package has a default layout of task guidance panel and toolbars, and four viewports. The viewports display the following views:

- Source image in the middle of the imaging volume.
- In real-time calculated Parametric T1-maps.
- Subtracted Image Series, Table Viewer (numerical results), or Anatomical Viewer (reference imaging series).
- Graph Viewer (graphical results) or Anatomical Viewer (reference imaging series).

Switch between Subtracted Image Series and the Table Viewer

1. Click the right or left arrow in the upper right corner of the viewport.

Switch between Graph Viewer and Anatomical Viewer

1. Click the 'Graph Viewer' tab to switch to the Graph Viewer.
2. Click the 'Anatomical Viewer' tab to switch to the Anatomical Viewer.

More information on the Graph Viewer can be found in the chapter “Results” on page 566.

More information on the Anatomical Viewer can be found in the chapter “Workflow” on page 561.

Task Guidance

The MR T1 Perfusion package provides a Task Guidance panel in the left part of the screen.

Toolbar

Color LUT (Look-Up Table)

- To select the color look-up table for the maps.
  Possible settings are: 'Blue to Red', 'ASIST LUT' and 'Gray'.

Color LUT	Minimum value				Maximum value
Blue to Red	Blue	Green	Yellow	Orange	Red

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Color LUT	Minimum value				Maximum value
Gray	Black		Gray		White
ASIST LUT	Black	Light blue	Green	Yellow/ Orange	Red

The ASIST LUT is a LUT specifically designed for acute stroke imaging. The Acute Stroke Imaging Standardization Group - Japan (ASIST-Japan) is a group that conducts medical research projects dedicated to the standardization of brain computed tomography (CT) and magnetic resonance imaging (MRI) in the clinical setting of acute cerebral stroke.

Layout

To select another screen layout, click **Layout** and select a layout option. You can also edit the current layout and save it as a preset using the **More** menu. Custom layouts that you have saved as presets are also available in the **Layout** list.

Follow Mouse

Once enabled, this function displays real-time results for the current voxel (indicated by the current position of the cursor).

Viewing Tools

Mirror

This function mirrors the image(s) (Right <-> Left)

Flip

This function flips the image(s) (Up <-> Down)

Rotate Clockwise

This function rotates the image(s) clockwise

Rotate Counter-Clockwise

This function rotates the image(s) counter-clockwise

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More Functions within the Perfusion packages

In the MR packages, the most important functions can be performed via the Task Guidance and the toolbar. However there are more functions which you can access via the right mouse menus.

For more information, see chapter “Right mouse menus” on page 553.

Right Mouse Menu for T1 Perfusion

NOTICE

The 'Modify the Results Display' function is only available in the Permeability and the two perfusion packages.

Set as Subtraction Reference

- To select a dynamic other than the first one as subtraction reference.

For subtraction purposes, by default the first dynamic (precontrast) is selected as reference. A different dynamic can be used as reference via this function.

NOTICE

This function is applicable only to T1 Perfusion.

Workflow

Launch the MR T1 Perfusion package

1. Select a suitable perfusion series from the series list and right click for the context menu.
2. Click ‘MR T1 Perfusion’.

   The MR T1 Perfusion package opens.

Scroll through images

Through dynamics

1. In the image viewport, drag to the left or to the right.

Through slices

1. In the image viewport, drag up- or downwards.

Through maps

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1. In the map viewport, drag to the left or to the right.

NOTICE

For the further workflow, utilize the task guidance in order to make optimal use of the package.

The Task Guidance window is in the left part of the screen.

Spatial Smoothing

- To spatially smooth the resulting maps.

Possible settings are: None (no smoothing), Weak, Medium or Strong.

The strength of the smoothing setting determines the size of the kernel used to average neighboring voxels.

Spatial smoothing smooths the maps and the original images. In such a way, spatial smoothing has an effect on the numerical results.

Define the Mask

This workflow step serves to adjust the mask and to enable the display of the mask while adjusting.

Setting a threshold mask will exclude background pixels from the functional map calculations. All pixels with values below the mask value will be displayed blue. Only pixels with intensity above the mask value are used for the calculations, colored areas will be excluded from the calculation.

1. Drag the slider to define the mask.

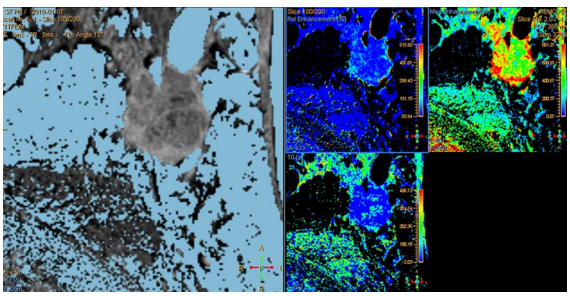

Fig. 36: Step 2: The mask is overlaid to the current source image.

Alternatively:

You may also drag the right mouse button in the images to change the mask.

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Select the Desired Maps

You can select the maps in the task guidance panel for real-time calculation and display, and for the generation of new imaging series.

1. Click the checkbox of a map to select/deselect this map.

   The display of the real-time calculated maps will be updated accordingly.

Select Series for Anatomical Viewer

Upon startup of the package, the Anatomical Viewer is empty. However an additional imaging series in the Anatomical Viewer might help during navigation through the data set and in order to draw ROIs.

Any type of imaging series can be loaded into the anatomical viewer. The orientation of the series in the Anatomical Viewer is always identical to the orientation of the source image and the map. This might require the calculation of real-time Multiple Planar Reformats.

NOTICE

When you load an imaging series with an orientation different to the source image into the Anatomical Viewer, the series in the Anatomical Viewer will be a real-time Multiple Planar Reformat (MPR).

Always be aware that the imaging parameter of this series determine the image quality of the resulting MPR. Low resolution imaging series will result in blurry MPRs and might hamper the workflow.

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To load an imaging series into the Anatomical Viewer

1. Click the **Anatomical Viewer** tab to switch to the **Anatomical Viewer**.
2. Right-click the **Anatomical Viewer** and click **Select Series** from the right mouse menu.
3. Click on a series in the **Select Series** window and click **OK** to confirm the selection.
4. You can also load a series by dragging and dropping a series.

TIP

When you save a layout, the series displayed in the viewer at that time is saved with the layout. When you reload the layout for another case, the same series is also reloaded in the viewer. You can save a layout using the More menu in the task guidance panel.

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Draw ROI

You can draw a ROI to focus on a specific area, e.g. a lesion.

For information on how to draw, modify and rename a ROI, see chapter “Draw ROI” on page 556.

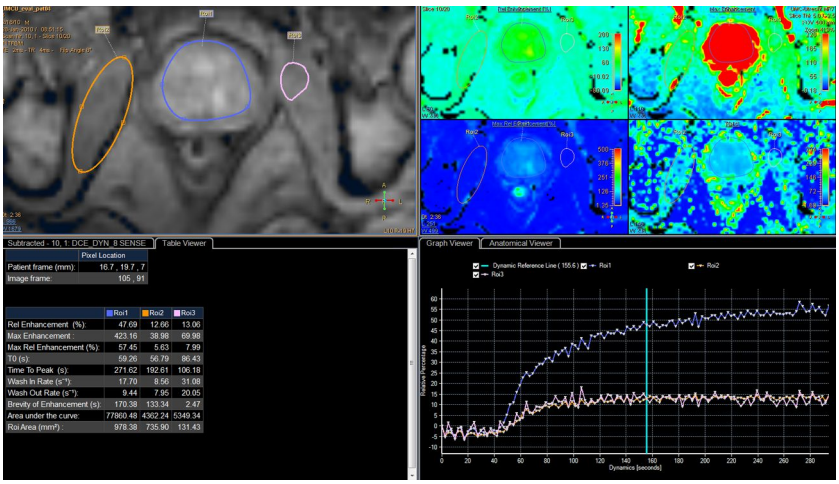

Fig. 37: Three different ROI types with numerical and graphical results. ROI1 - Spline Contour, ROI2 - Ellipse, ROI3 - Freehand Contour.

If desired, you can remove the last drawn ROI. Do one of the following:

- Press Ctrl+Z.
- Right-click the ROI and then click **Delete** in the shortcut menu.
- Right-click the image and then click **Delete Last Drawn ROI** in the shortcut menu.

More options

You can enable/disable the display of curves in the Graph Viewer.

1. Check the checkbox 'Roi1', 'Roi2' or any 'Roi' in the Graph Viewer to enable the display of the related graph.
2. Uncheck the checkbox 'Roi1', 'Roi2' or any 'Roi' in the Graph Viewer to disable the display of the related graph.
3. To view the results with a fitted curve, right-click the Graph Viewer and click **Fitted Curve**.

Select Underlay

You can select an MR series as underlay of the parametric maps allowing for better allocation.

In order to optimize the display you can also adjust the opacity of the overlaying parametric maps.

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NOTICE

MR series are suitable source images. Secondary captures are not suitable because they are lacking in general geometry information.

The underlay is automatically reformatted to the geometry of the overlay. The resolution is determined by the resolution of the overlay in the preview viewer.

Select Underlay

1. Select an option:
   - **None**

     The parametric maps will be displayed without underlay.
   - **Source as Underlay**

     The source series will be displayed as underlay.
   - **Select Other Underlay**

     Browse to the series you would like to use as underlay and click **OK** to confirm. You can also load a series by dragging and dropping a series.

TIP

When you save a layout, the series displayed in the viewer at that time is saved with the layout. When you reload the layout for another case, the same series is also reloaded in the viewer. You can save a layout using the More menu in the task guidance panel.

NOTICE

There can be a mismatch between underlay and overlay also in the Anatomical viewer if there was any patient motion between the acquisitions of these series.

Adjust the opacity of the overlay

1. Drag the slider to adjust the opacity of the parametric maps.

You may also drag the right mouse button in the color maps to change the opacity of the overlay.

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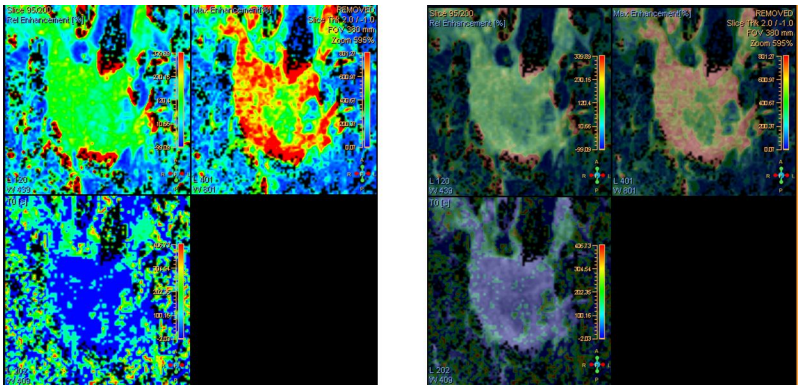

Fig. 38: Left: 100% opacity of the parametric maps. Right: 20% opacity of the parametric maps.

Generate Series

You can generate a new imaging series containing the parametric maps and results as defined in the previously described workflow.

1. To generate a standard DICOM-compatible series, select **Generate Series** using the Secondary Capture option.
2. Enter the name of the new imaging series in the **Name** box.
3. To generate a series as RGB images (high resolution color maps), select **Generate Series** using the Secondary Capture RGB option.

Register Data While Saving

Once enabled, this function performs registration when generating actual maps. In such a way image quality will most likely improve in the maps.

NOTICE

If the input data is unregistered, there can be a mismatch between the previewed and generated maps as the generated maps are calculated after registering the input.

Results

The package calculates the following results:

Graphical and numerical results

- The graphical results present a **Time-Intensity Diagram** (intensity versus time).

  In 'Follow Mouse' mode, the graph correlates to a specific pixel and shows the intensity value (intensity) over the time for this pixel.
- The results will be provided as **parametric maps** and in a **table of results**.

  Scrolling through the maps, the type of the map is indicated in the map's series type field.

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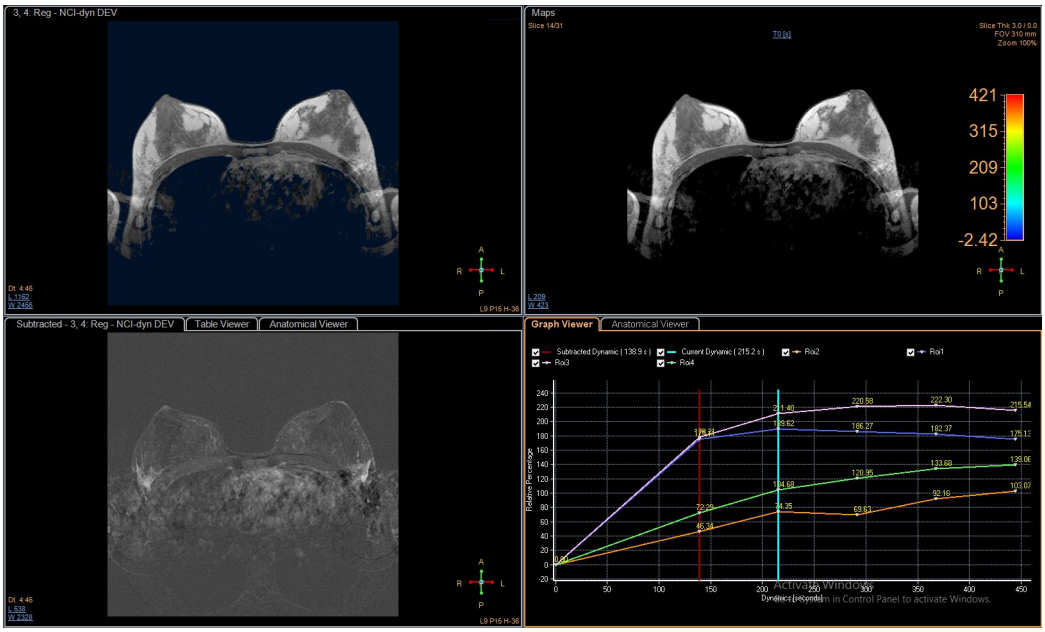

Fig. 39: Results screen: source image and maps with ROIs, Table Viewer and Graph Viewer. The vertical lines in the graph represent the variable dynamic and the reference dynamic

To draw a windowing ROI, right-click a map and then click **Draw Windowing ROI**. The color scale of the map is recalculated to display maximum color heterogeneity inside the ROI. You can draw windowing ROIs on each map independently.

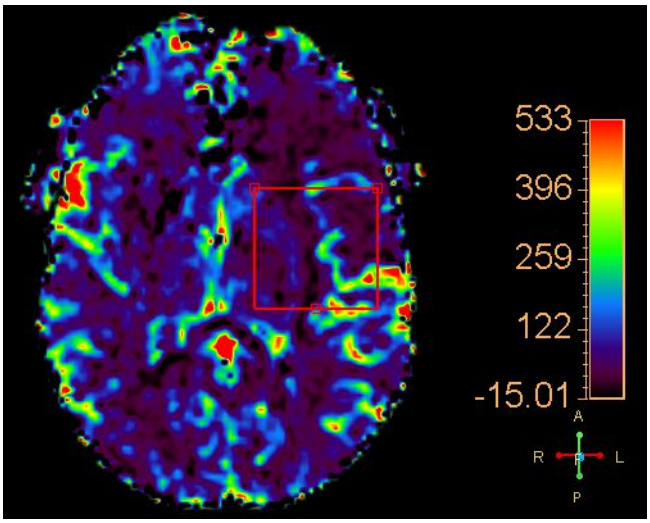

Fig. 40: Drawing a windowing ROI

Measurement Type Selection

To change the type of measurement for all parametric maps, right-click the results summary table and select an option.

- **Region Parameters (Factory default)**: The application calculates T1 parameters using the time intensity curve for the drawn ROI and displays the values in the table viewer.
- **Mean Voxel Parameters**: The application calculates the mean of all the voxels inside the ROI of the output parameters and displays the values in the Table Viewer.

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The table heading is updated based on the selected type.

Show ROI Statistics

You can right-click the results summary table and choose to show ROI voxel statistics (or) select from More menu.

An additional numerical results table is displayed as floating window and display Maximum, Minimum, Median, Average and Standard deviation of the quantitative parameters for the ROI voxels with in the parametric maps.

When the number of columns in the table viewer exceeds default width or number of rows exceeds default height, the auto scroll is visible to allow the user to scroll to see all the columns and rows

Exporting Table Results

To export table results:

1. Select **Copy**, open either Microsoft Word or Excel and paste the contents from your clipboard into the application.
2. Select secondary capture. A dialog box is displayed allowing you to select a file name, file format, and destination. You can save the series in DICOM format, or in non-DICOM format. If you select a non-DICOM format, you should additionally select a file system destination for exporting the table results.

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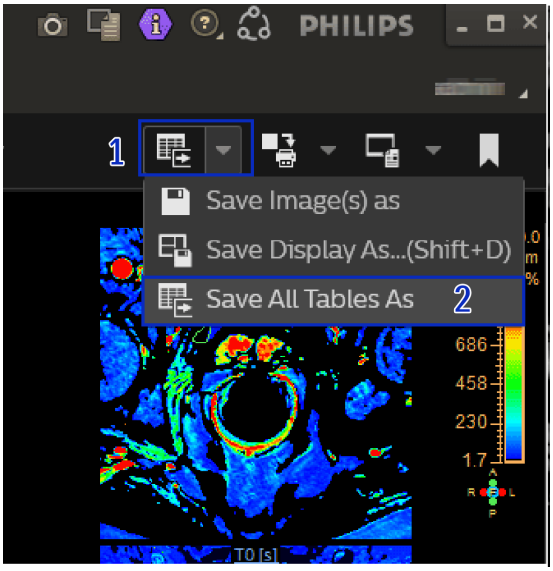
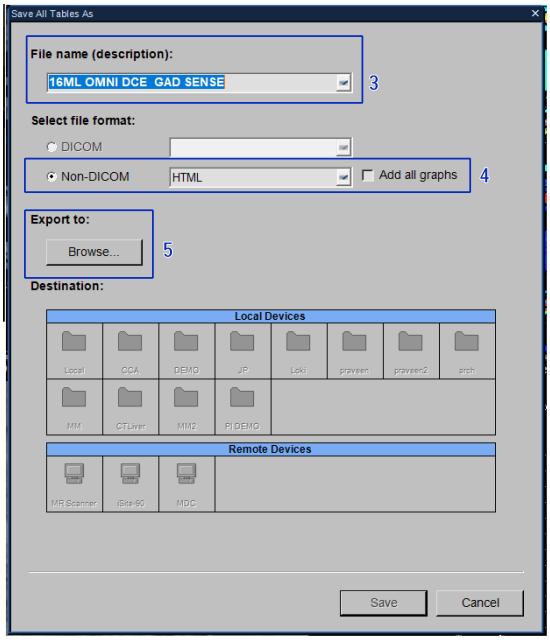
To export table content with ROI dynamic values in HTML or CVS format:





1. From the Save menu (#1), select **Save All Tables As** (#2).

   The **Save All Tables As** window opens.
2. Type a **File name** (#3).
3. Select Non_DICOM file format and optionally, enable **Add all graphs** (#4).
4. Select a file destination for exporting the table results and graphs (#5).
5. Minimize the application and navigate to the selected destination to view results.

Relative Enhancement [%] (RELENH)

- The signal enhancement of a pixel of certain dynamic relative to that same pixel in the reference dynamic. The reference dynamic is normally the first, pre-contrast dynamic. The reference dynamic can be set to another dynamic via the right mouse menu function 'Set as Subtraction Reference'.

$$\text{Relative Enhancement} = \left[\frac{I(D)}{I(Dref)} - 1 \right] \times 100$$

- where I(D) stands for pixel intensity of current dynamic and I(Dref) stands for pixel intensity of reference dynamic.

Maximum Enhancement (MAXENH)

- Difference between peak intensity S1 and S0.

Maximum Relative Enhancement [%] (MAXRELENH)

- Maximum of all relative enhancements over all dynamics.

T0 - Time of Arrival [s] (T0)

- Time at which the signal intensity increases for at least 20% compared to the baseline (referred to as initial signal intensity S0).

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The baseline is the average of the signal intensities of all timepoints before the contrast uptake starts.

- As long as the signal intensity doesn't exceed more than 20 % from the baseline, it will not yet be identified as the start of the contrast uptake (T0).

S0 - Initial Signal Intensity

- The baseline signal intensity S0 is the average of the signal intensities of all timepoints before the contrast uptake starts.

Time to Peak [s] (TTP)

- Time till contrast agent bolus reaches peak intensity.

Wash-In Rate [l/s] (WASHIN)

- If the dataset has eight or less dynamics, the wash-in rate is computed as the maximum slope between T0 and time of peak intensity T1 as:

$$\mathbf{WASHIN} = \boldsymbol{Maximum}\left[\frac{\boldsymbol{I(D) - I(D-1)}}{\boldsymbol{T}}\right]$$

where I(D) stands for the pixel intensity at dynamic number D and I(D-1) stands for the pixel intensity at the previous dynamic number D-1.

If the dataset has more than eight dynamics, the wash-in rate is the slope of the wash-in line extracted from a bi-linear fitting.

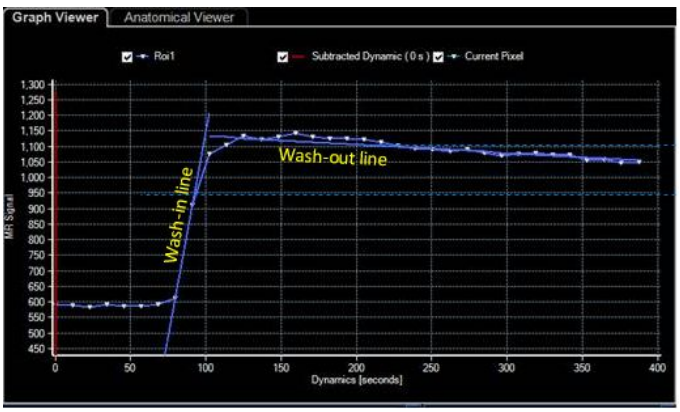

Fig. 41: Wash-in and wash-out lines computed from the bilinear fitting method (for datasets with more than 8 dynamics)

Wash-Out Rate [l/s] (WASHOUT)

- If the dataset has 8 or less dynamics, the wash-out rate is computed as the maximum slope between time of peak intensity T1 and the end of the measurement:

$$\mathbf{WASHOUT} = \boldsymbol{Maximum}\left[\frac{\boldsymbol{I(D-1) - I(D)}}{\boldsymbol{T}}\right]$$

where I(D) stands for the pixel intensity of at dynamic number D and I(D-1) stands for the pixel intensity at the previous dynamic number D-1.

If the dataset has more than eight dynamics, the wash-out rate is the slope of the wash-out line extracted from a bi-linear fitting (see above figure).

Brevity of Enhancement [s] (BREVENH)

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- If the dataset has eight or less dynamics, Brevity of Enhancement is defined as the time between points of maximum wash in rate and maximum wash out rate.
- If the dataset has more than eight dynamics, Brevity of Enhancement is defined as the time between the midpoints of wash-in and wash-out lines extracted from a bilinear fitting.

Area under the curve (AREACURV)

Sum of all intensities under the curve.

Graph characterizing parameters

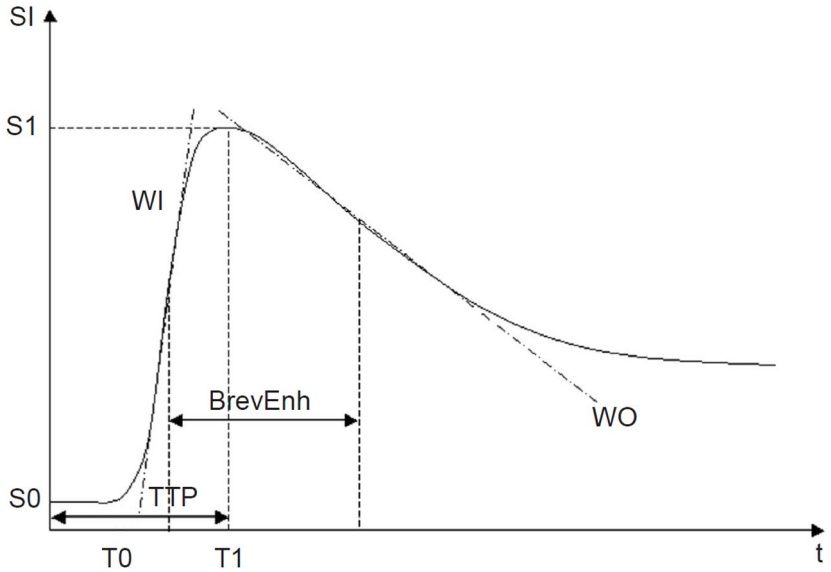

Fig. 42: T1 Perfusion - Results.

Abbreviation	Description
SI	Signal intensity
t	Time
S0	Initial intensity
S1	Peak intensity
T0	Time of Arrival (time of initial intensity)
T1	Time of peak intensity
WO	Wash-Out Rate
WI	Wash-In Rate

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Abbreviation	Description
TTP	Time to Peak
BrevEnh	Brevity of Enhancement

References

C. Kuhl, "The Current Status of Breast MR Imaging Part I. Choice of Technique, Image Interpretation, Diagnostic Accuracy, and Transfer to Clinical Practice" Radiology. 2007 Aug;244(2):356-78. doi: 10.1148/radiol.2442051620

Kim et al "Role of semi-quantitative dynamic contrast-enhanced MR imaging in characterization and grading of prostate cancer", Eur J Radiol. 2017 Sep;94:154-159. doi: 10.1016/j.ejrad.2017.06.021. Epub 2017 Jul 6.

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Jackson et al, "Semi-quantitative parameter analysis of DCE-MRI revisited: monte-carlo simulation, clinical comparisons, and clinical validation of measurement errors in patients with type 2 neurofibromatosis", PLoS One. 2014 Mar 4;9(3):e90300. doi: 10.1371/journal.pone.0090300. eCollection 2014.

8.1.6 MR T2* Neuro Perfusion

This postprocessing package is meant to evaluate T2* perfusion studies and generate numerical and graphical results and maps.

Paramagnetic contrast agents influence the local magnetic field and reduce the T2* relaxation time of surrounding tissue.

If a valid Diffusion input series is available with the loaded study, Diffusion-Perfusion Mismatch can be performed.

Valid imaging series

A valid imaging series for the Neuro Perfusion package is a series which is sensitive to T2* changes over time. In other words a series where a stack of slices is repeatedly acquired over time (dynamics). The MR Neuro Perfusion package requires at least 5 dynamics.

Functional Description

The MR T2* Neuro Perfusion application is a post processing software application supporting the analysis of Dynamic Susceptibility Contrast (DSC) T2* perfusion studies to generate numerical and graphical results of TTP, T0, MTT, rCBV, corrected rCBV, rCBF, Tmax and K2 (leakage). Four methods are available for analysis, including Gamma Variate, Model Free, Leakage Correction and manual Arterial Input Function (AIF). AIF also enables Perfusion-Diffusion Mismatch analysis if a Diffusion input dataset is available in addition to the Perfusion series.

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The MR T2* Neuro Perfusion application is indicated for the evaluation of stroke, or assessment and follow-up of brain tumors.

The Diffusion-Perfusion Mismatch in the application is not intended to be used for acute ischemic stroke patient triage for treatment allocation (e.g., for extended time window for recanalization therapies according to: *Berge, E. et al. (2021) 'European Stroke Organisation (ESO) guidelines on intravenous thrombolysis for acute ischaemic stroke', European Stroke Journal, 6(1), p. I–LXII. doi:10.1177/2396987321989865*, and/or to Powers, W.J. *et al.* (2018) *2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association, Stroke. doi:10.1161/STR.0000000000000158.)*

User Interface

Screen layout

The MR Neuro Perfusion package has a default layout of task guidance panel and toolbars, and four viewports. The viewports contain the following views:

- Source image in the middle of the imaging volume.
- In real-time calculated parametric perfusion maps.
- Table Viewer (numerical results) and Anatomical Viewer
- Graph Viewer (graphical results) and Anatomical Viewer

Switch between Graph Viewer, Table Viewer and Anatomical Viewer

1. Click the 'Graph Viewer' tab to switch to the Graph Viewer.
2. Click the 'Anatomical Viewer' tab to switch to the Anatomical Viewer.
3. Click the 'Table Viewer' tab to switch to the Table Viewer.

More information on the Graph Viewer and the Table Viewer can be found in the Results section.

More information on the Anatomical Viewer can be found in the Workflow section.

Task Guidance

The MR Neuro Perfusion package provides a Task Guidance panel in the left part of the screen. The task guidance panel provides the following steps:

- Select the Desired Maps
- Select Underlay
- Analysis
- Generate Maps
- Optional step: Diffusion-Perfusion Mismatch - this step can be performed if a valid Diffusion input series is available.

Follow the steps of the Task Guidance to make optimal use of the package.

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The following workflow description is based on this Task Guidance.

Toolbar

Color LUT (Look-Up Table)

- To select the color look-up table for the maps.
  Possible settings are: 'Blue to Red', 'ASIST LUT' and 'Gray'.

Color LUT	Minimum value				Maximum value
Blue to Red	Blue	Green	Yellow	Orange	Red
Gray	Black		Gray		White
ASIST LUT	Black	Light blue	Green	Yellow/ Orange	Red

The ASIST LUT is a LUT specifically designed for acute stroke imaging. The Acute Stroke Imaging Standardization Group - Japan (ASIST-Japan) is a group that conducts medical research projects dedicated to the standardization of brain computed tomography (CT) and magnetic resonance imaging (MRI) in the clinical setting of acute cerebral stroke.

Layout

To select another screen layout, click **Layout** and select a layout option. You can also edit the current layout and save it as a preset using the **More** menu. Custom layouts that you have saved as presets are also available in the **Layout** list.

Follow Mouse

Select this option to display real-time results for the current voxel (indicated by the current position of the cursor).

More Menu

Show Skip Dynamics Step

Select this option to display an additional step in the **Analysis** task guidance panel. If desired, you can skip the first dynamics in a study to ignore the initial dynamics in which the steady state has not yet been reached. To skip dynamics, enter the number of dynamics that you want to skip in the box in the Skip Dynamics step.

Save Layout Preset

Select this option if you want to save a custom layout that you have created. Enter a name in the **Create New Preset** dialog box that is displayed when you select this option, and then click **Save**. Your layout is now available in the drop down list of the **Layout** button in the toolbar.

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Delete Layout Presets

Select this option if you want to delete one or more custom layouts that you have previously saved. Select the layouts to be deleted in the **Layout** dialog box that is displayed when you select this option, and the click **Delete**.

TIP

You can only delete custom layouts. You cannot delete system layouts. Additionally, you cannot delete a custom layout if it is currently selected. First select a different layout, and then delete it.

Viewing Tools

Mirror

This function mirrors the image(s) (Right <-> Left)

Flip

This function flips the image(s) (Up <-> Down)

Rotate Clockwise

This function rotates the image(s) clockwise

Rotate Counter-Clockwise

This function rotates the image(s) counter-clockwise

More Functions within the Perfusion packages

The most important functions can be performed via the Task Guidance and the toolbar. However there are more functions which you can access via the right mouse menus.

For more information, see chapter “Right mouse menus” on page 553.

Workflow - MR Neuro Perfusion

MR Neuro Perfusion supports analysis workflows with and without using AIF (Arterial Input Function). The following analysis techniques can be used:

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- **Gamma Variate**: This workflow is based on the assumption that the ideal shape of a passing contrast bolus as acquired in a T2* perfusion series is highly comparable to the gamma variate function.
- **Model Free**: This workflow does note require a specific shape or model. The analysis detects the start and the end of the bolus passage by determining a baseline at the front and at the end.
- **Manual AIF** (Deconvolution): The AIF analysis workflow uses a deconvolution algorithm based on the knowledge of the Arterial Input Function to calculate the perfusion values. The AIF describes the input of contrast agent into the tissue of interest. When using this workflow, you define the AIF by selecting voxels (typically in or around an artery) that show the T2* effect as induced by the passage of the contrast agent bolus. The average of the selected voxels represents the shape of the arterial input function. This arterial input function is used to calculate the parametric maps.
- **Leakage Correction**: This workflow allows you to assess brain perfusion curves that have been corrected for leakage of contrast agent into the brain tissue. Leakage Correction in MR Neuro Perfusion uses the Boxerman – Weisskoff approach.

You can choose between these techniques in the **Analysis** task guidance step (instructions are provided in the procedural steps later in the this section). The other task guidance steps are the same for all techniques.

Launch the MR Neuro Perfusion package

1. Select a suitable perfusion series from the series list and right click for the context menu.
2. Click 'MR NeuroPerfusion'.

   The MR Neuro Perfusion package opens.

Scroll through images

1. To scroll through dynamics, drag to the left or to the right in the image viewport.

2. To scroll through slices, drag upward or downward in the image viewport.

3. To scroll through maps, drag to the left or to the right in the map viewport.

Analysis

CAUTION

MR perfusion acquisition and analysis are not standardized. It is recommended to use the same software when comparing two different perfusion scans.

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1. In the **Analysis** list in the task guidance panel, select one of the following methods:
   - **Gamma Variate** (non-AIF workflow)
   - **Model Free** (non-AIF workflow)
   - **Manual AIF**
   - **Leakage Correction** (non-AIF workflow)
2. Set the mask by dragging with the right mouse button in the source data. For details, see chapter “Define the mask” on page 580.
3. If you selected a non-AIF workflow, continue to the section "Creating a ROI".
4. If you selected **Manual AIF** analysis, you should first define the AIF. The **Define AIF** window is displayed automatically when you select **Manual AIF** analysis. The **Define AIF** window displays the middle slice.

   ⇨ A red square is displayed in the image viewport. The red square spans the size of 7x7 voxels. In the right viewport the dynamic curves of these 7x7 voxels are shown.

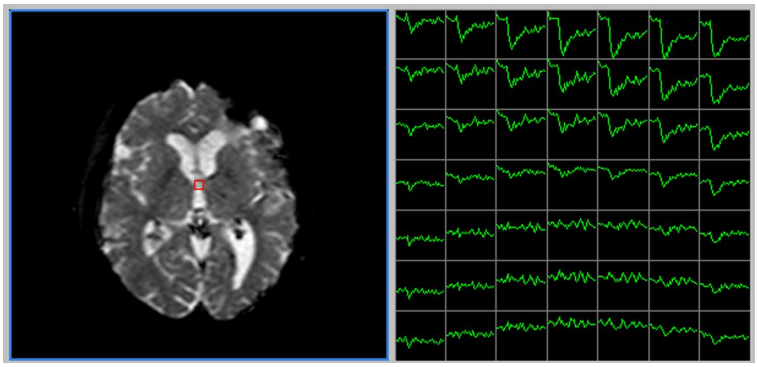

Fig. 43: Define AIF window. Left: Middle image with rectangular ROI of 7x7 voxels. Right: Time-Intensity curves of these voxels.

5. Navigate to the slice with the vessel relevant for Manual AIF definition.
6. Zoom, pan and window the slices so that this vessel is clearly visible.
7. Drag the red box over this vessel.

   The display of the curves will automatically be updated.
8. Click on individual graphs to include them in the definition of the AIF.

   The selected graphs are yellow. For best results, the selected voxels should show an AIF curve with a narrow and high peak.

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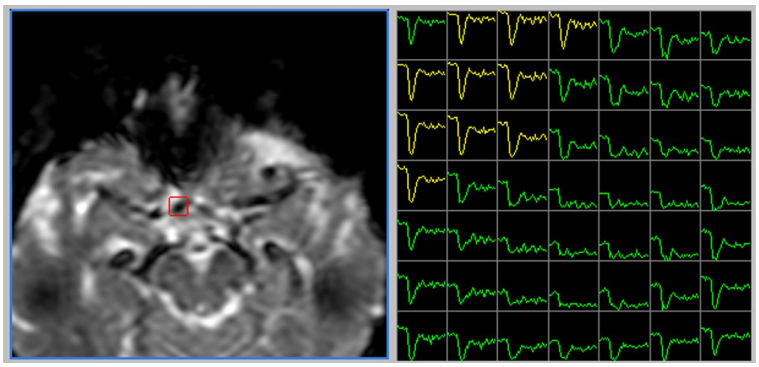

Fig. 44: The AIF is defined

⇨ To exclude a voxel that you previously included, click the graph again.

9. Click **Apply** to confirm.

   The AIF is identified and the resulting maps are displayed.

TIP

To open the Define AIF window again and adjust the AIF definition, click Define AIF in the task guidance panel.

Manual AIF Results

NOTICE

Using the AIF function, the relCBF and the relCBV are also displayed with units: relCBF [ml/100g/min] and relCBV [ml/100g].

The calculation is based on known delay-insensitive deconvolution techniques and results may be influenced by incorrect assumptions in such a model.

Manual AIF analysis measures relCBF (relative Cerebral Blood Flow) and relCBV (relative Cerebral Blood Volume) using a deconvolution between the time courses of tissue signal and an Arterial-Input-Function (AIF).

The results of deconvolution perfusion analysis may under- or overestimate the true perfusion depending on various factors:

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WARNING

Inaccurate definition of the AIF: The AIF may suffer from partial-volume effects. Due to the limited temporal resolution, the AIF is not very accurately sampled. A very sharp high peak is in general not well represented by the user-defined AIF. For this reason the AIF time course will not correctly represent a 100% blood signal.

WARNING

Patient motion: Patient motion during the scan may introduce irregularities in the definition of the AIF and individual tissue signal time courses, causing deviations from the correct relCBF and relCBV.

NOTICE

Temporal resolution: The temporal resolution of the measurement may be too low, causing difficulty to identify the bolus curve giving poor results.

NOTICE

Poor bolus injection: If the contrast bolus is too slow, the relCBF and relCBV may be incorrectly calculated. Results may be influenced by the assumptions in such a model.

Delay maps with AIF algorithm

If the AIF algorithm has been chosen for processing, the Generate Series window provides the possibility of enabling the calculation of a Delay map. For each pixel, the delay map shows the time between the AIF peak concentration, and the tissue peak concentration. The time is measured in seconds, with accuracy defined by the dynamic scan time of the acquisition sequence. The delay time is often referred to as Tmax.

Spatial Smoothing

- To spatially smooth the resulting maps.

Possible settings are: None (no smoothing), Weak, Medium or Strong.

The strength of the smoothing setting determines the size of the kernel used to average neighboring voxels.

Spatial smoothing smooths the maps and the original images. In such a way, spatial smoothing has an effect on the numerical results.

Temporal Smoothing

- To temporally smooth the resulting maps.

Possible settings are: None (no smoothing), Weak, Medium or Strong.

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The temporal smoothing makes use of a uniform filter with user-adjustable width. The width describes the total number of dynamics contributing to the filter; the applicable sizes are 1, 3, 5, and 7.

Define the mask

This optional workflow step serves to adjust the mask and to enable the display of the mask while adjusting.

Drag with the right mouse button on the source image to adjust the mask.

Leakage Correction

When you adjust the mask, the reference voxels are affected. If you are using **Leakage Correction** analysis, this may have some effect on the results.

Select the Desired Maps

You can select the maps in the task guidance panel for real-time calculation and display, and for the generation of new imaging series.

1. Click the checkbox of a map to select/deselect this map.

   The display of the real-time calculated maps will be updated accordingly.

Leakage Correction

If you are using the **Leakage Correction** analysis method, you can enable advanced maps in the **More** menu in the toolbar. This option adds the following additional information:

- **R^2** is added to the parametric maps and the results page.
- **Ref Voxels** are added to the parametric maps.

Select Series for Anatomical Viewer

Upon startup of the package, the Anatomical Viewer is empty. However an additional imaging series in the Anatomical Viewer might help during navigation through the data set and in order to draw ROIs.

Any type of imaging series can be loaded into the anatomical viewer. The orientation of the series in the Anatomical Viewer is always identical to the orientation of the source image and the map. This might require the calculation of real-time Multiple Planar Reformats.

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NOTICE

When you load an imaging series with an orientation different to the source image into the Anatomical Viewer, the series in the Anatomical Viewer will be a real-time Multiple Planar Reformat (MPR).

Always be aware that the imaging parameter of this series determine the image quality of the resulting MPR. Low resolution imaging series will result in blurry MPRs and might hamper the workflow.

To load an imaging series into the Anatomical Viewer

1. Click the **Anatomical Viewer** tab to switch to the **Anatomical Viewer**.
2. Right-click the **Anatomical Viewer** and click **Select Series** from the right mouse menu.
3. Click on a series in the **Select Series** window and click **OK** to confirm the selection.
4. You can also load a series by dragging and dropping a series.

TIP

When you save a layout, the series displayed in the viewer at that time is saved with the layout. When you reload the layout for another case, the same series is also reloaded in the viewer. You can save a layout using the More menu in the task guidance panel.

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Creating a ROI

1. You can draw a ROI to focus on a specific area, for example, a lesion.

   For information on how to draw, modify, and rename a ROI, see chapter “Draw ROI” on page 556.

2. To display a mirror line, select **Show Mirror Line**.

   A vertical mirror line will show up in the middle of the image. If desired, drag the line to move it to another position.

3. To create a contra-lateral ROI when you draw the first ROI, select **Create contra-lateral ROI automatically**.
4. Draw a ROI.

   When finished, the drawn ROI will be mirrored and the contra-lateral ROI will be created automatically.

5. Drag the mirror line to change the position of the contra-lateral ROI.

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NOTICE

You should manually align the brain center-line to get exact mirroring between both sides.

⇨ Lesion/reference ratio values are displayed in the results panel.

6. If desired, you can remove the last drawn ROI. Do one of the following:
   - Press Ctrl+Z.
   - Right-click the ROI and then click **Delete** in the shortcut menu.
   - Right-click the image and then click **Delete Last Drawn ROI** in the shortcut menu.

Setting a Reference ROI

As an alternative, you can mark a single ROI as a reference ROI, and view the ratios of all other ROIs in relation to the selected reference ROI.

1. Right click the ROI that you want to set as the reference ROI and click **Declare as reference ROI** in the shortcut menu.

   ⇨ The label "-ref" is added to the name of the ROI to indicate that it is currently selected as the reference ROI.

   ⇨ The ratio table in the table viewer displays the ratio of all other ROIs in relation to the reference ROI.

   ⇨ If you create a bookmark, the selection of the reference ROI is maintained in the bookmark.

2. You can change the reference ROI at any time.

   ⇨ All ratio results are updated automatically when you change the reference ROI.

NOTICE

Mirrored ROIs are not included in the ratio results for a reference ROI. Results for a mirrored ROI only show the ratio in relation to the ROI that it is mirrored from. However, if you break the link for a mirrored ROI, then both ROIs are included in ratio results for a reference ROI. Note that there can only be one reference ROI.

Displaying Curves in the Graph Viewer

You can enable/disable the display of curves in the Graph Viewer.

1. Check the checkbox 'Roi1', 'Roi2' or any 'Roi' in the Graph Viewer to enable the display of the related graph.
2. Uncheck the checkbox 'Roi1', 'Roi2' or any 'Roi' in the Graph Viewer to disable the display of the related graph.

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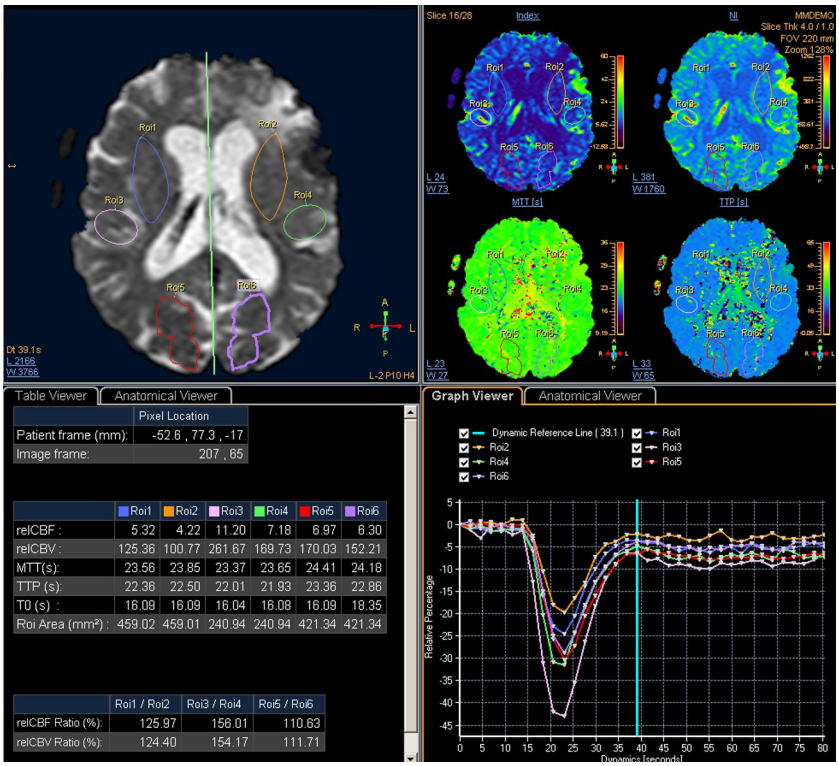

Fig. 45: Three different ROI types mirrored from left to right hemisphere with graphical and numerical results.

Select Underlay

You can select an MR series as underlay of the parametric maps allowing for better allocation.

In order to optimize the display you can also adjust the opacity of the overlaying parametric maps.

NOTICE

MR series are suitable source images. Secondary captures are not suitable because they are lacking in general geometry information.

The underlay is automatically reformatted to the geometry of the overlay. The resolution is determined by the resolution of the overlay in the preview viewer.

Select Underlay

1. Select an option:
   - **None**

     The parametric maps will be displayed without underlay.
   - **Source as Underlay**

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The source series will be displayed as underlay.

- **Select Other Underlay**

  Browse to the series you would like to use as underlay and click **OK** to confirm. You can also load a series by dragging and dropping a series.

TIP

When you save a layout, the series displayed in the viewer at that time is saved with the layout. When you reload the layout for another case, the same series is also reloaded in the viewer. You can save a layout using the More menu in the task guidance panel.

NOTICE

There can be a mismatch between underlay and overlay also in the Anatomical viewer if there was any patient motion between the acquisitions of these series.

Adjust the opacity of the overlay

1. Drag the slider to adjust the opacity of the parametric maps.

You may also drag the right mouse button in the color maps to change the opacity of the overlay.

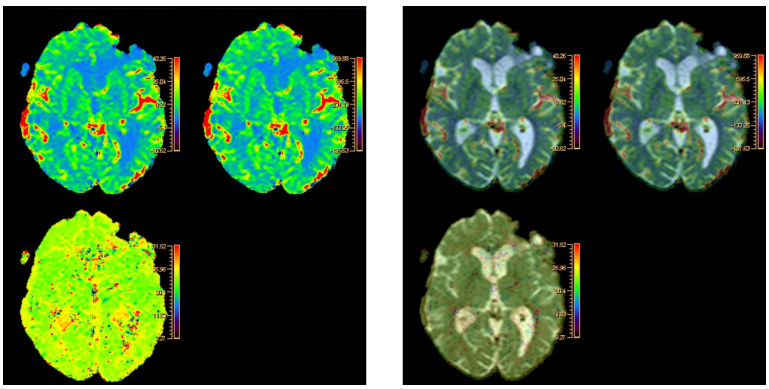

Fig. 46: Left: 100% opacity of the parametric maps. Right: 20% opacity of the parametric maps

Generate Series

You can generate a new imaging series containing the parametric maps and results as defined in the previously described workflow.

1. To generate a standard DICOM-compatible series, select **Generate Series** using the Secondary Capture option.
2. Enter the name of the new imaging series in the **Name** box.
3. To generate a series as RGB images (high resolution color maps), select **Generate Series** using the Secondary Capture RGB option.

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Register Data While Saving

Once enabled, this function performs registration when generating actual maps. In such a way image quality will most likely improve in the maps.

NOTICE

If the input data is unregistered, there can be a mismatch between the previewed and generated maps as the generated maps are calculated after registering the input.

Results

The package calculates the following results:

Graphical and numerical results

- The graphical results present a **Time-Intensity Diagram** (intensity versus time).

  In 'Follow Mouse' mode, the graph correlates to a specific pixel and shows the intensity value (intensity) over the time for this pixel.
- The results will be provided as **parametric maps** and in a **table of numerical results**.

  Scrolling through the maps, the type of the map is indicated in the map's series type field.

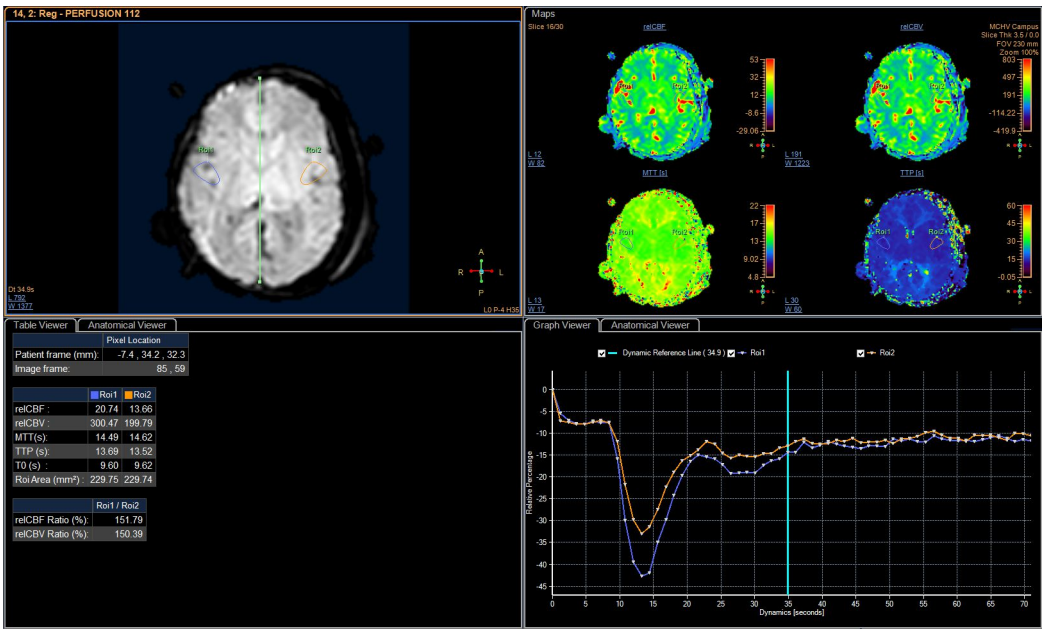

Fig. 47: Results screen: source image and maps with ROIs, Table Viewer and Graph Viewer. The dynamic reference line indicates the currently shown dynamic.

Measurement Type Selection

To change the type of measurement for all parametric maps, right-click the results summary table and select an option.

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- **Region Parameters (Factory default)**: The application calculates T2 parameters using the time intensity curve for the drawn ROI and displays the values in the table viewer.
- **Mean Voxel Parameters**: The application calculates the mean of all the voxels inside the ROI of the output parameters and displays the values in the Table Viewer.

The table heading is updated based on the selected type.

Show ROI Statistics

You can right-click the results summary table and choose to show ROI voxel statistics (or) select from More menu.

An additional numerical results table is displayed as floating window and display Maximum, Minimum, Median, Average and Standard deviation of the quantitative parameters for the ROI voxels with in the parametric maps.

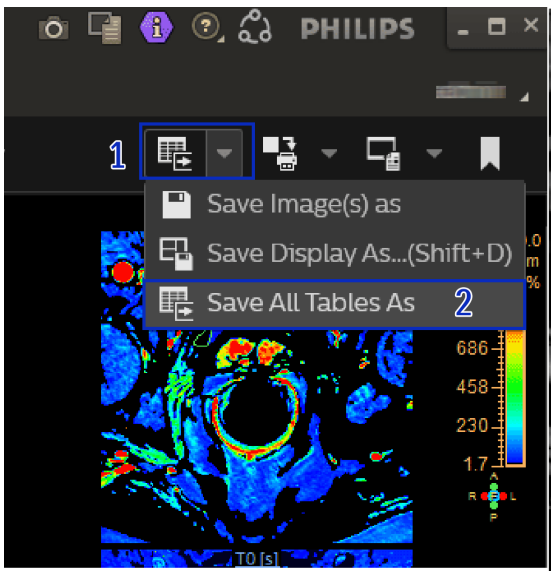
When the number of columns in the table viewer exceeds default width or number of rows exceeds default height, the auto scroll is visible to allow the user to scroll to see all the columns and rows

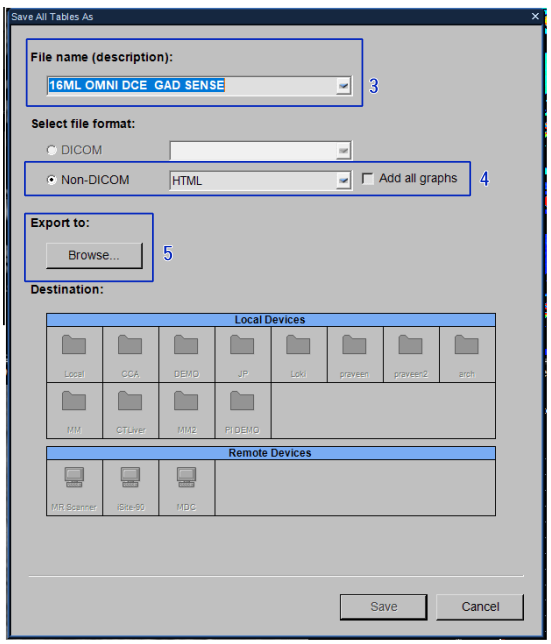
Exporting Table Results

To export table results:

1. Select **Copy**, open either Microsoft Word or Excel and paste the contents from your clipboard into the application.
2. Select secondary capture. A dialog box is displayed allowing you to select a file name, file format, and destination. You can save the series in DICOM format, or in non-DICOM format. If you select a non-DICOM format, you should additionally select a file system destination for exporting the table results.

To export table content with ROI dynamic values in HTML or CVS format:





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1. From the Save menu (#1), select **Save All Tables As** (#2).

   The **Save All Tables As** window opens.
2. Type a **File name** (#3).
3. Select Non_DICOM file format and optionally, enable **Add all graphs** (#4).
4. Select a file destination for exporting the table results and graphs (#5).
5. Minimize the application and navigate to the selected destination to view results.

To draw a windowing ROI, right-click a map and then click **Draw Windowing ROI**. The color scale of the map is recalculated to display maximum color heterogeneity inside the ROI. You can draw windowing ROIs on each map independently.

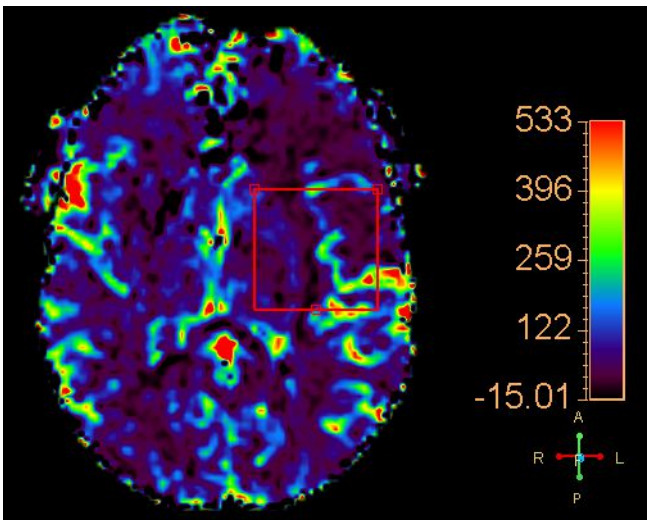

Fig. 48: Drawing a windowing ROI

Gamma Variate Results

The figure below gives an overview of the Neuro Perfusion results when using gamma variate analysis.

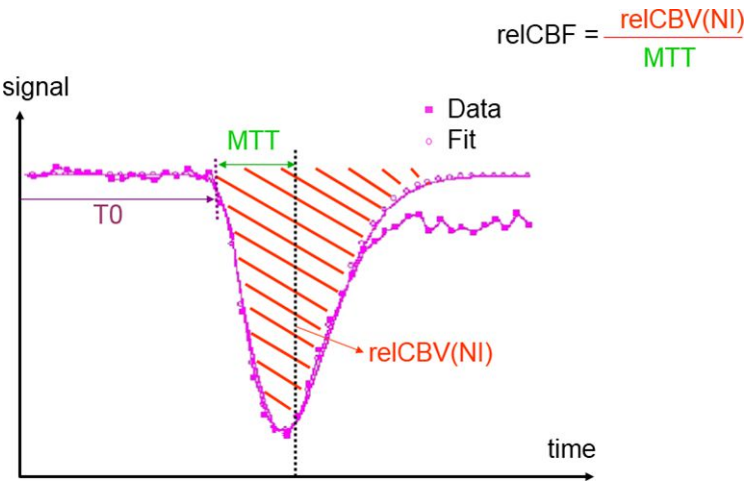

Fig. 49: Time Intensity Diagram for Gamma Variate Analysis

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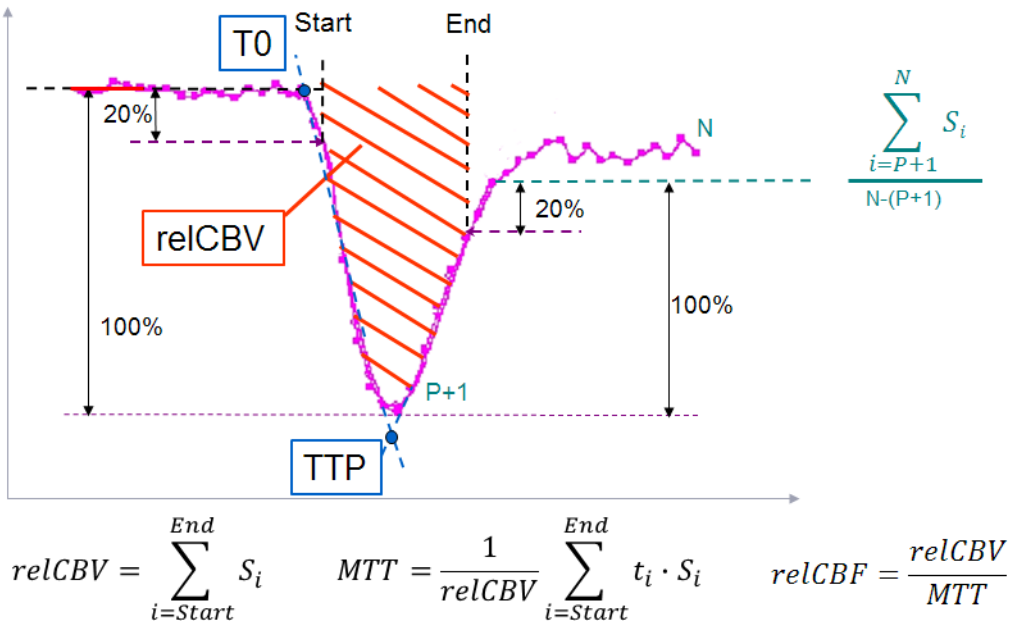
The relCBV is determined by calculation of the area under the curve.

The Mean transit time is derived as MTT = Σ (Si * ti)/ Σ Si.

The CBF is calculated based on central volume principle CBF = CBV / MTT.

Model Free Results

The figure below gives an overview of the Neuro Perfusion results when using model-free analysis.



$$relCBV = \sum_{i=Start}^{End} S_i \qquad MTT = \frac{1}{relCBV} \sum_{i=Start}^{End} t_i \cdot S_i \qquad relCBF = \frac{relCBV}{MTT}$$

Fig. 50: Time Intensity Diagram with definitions of relCBV, T0, TTP, MTT.

Mean Transit Time [s] (MTT)

- MTT = Area (S*t) / Area (S)
- The time the bolus spends in the region of interest before leaving.

T0 - Time of Arrival [s] (T0)

- Arrival of the contrast agent, i.e. begin of the enhancement curve.

Time to Peak [s] (TTP)

- Time till contrast agent bolus reaches peak intensity.

relCBV (relCBV)

- The calculated area under the curve.

relCBF (relCBF)

- relCBV divided by the MTT.

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Leakage Correction Results

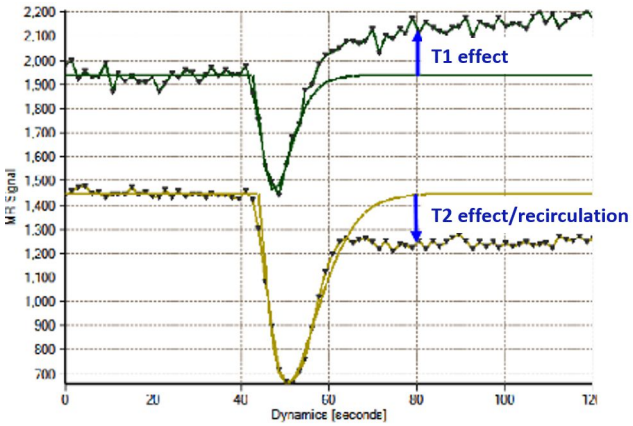

Fig. 51: Time Intensity diagram, showing T1 and T2 effects, and the effect of recirculation

Graphical results provide a best-fit curve for the time signal.

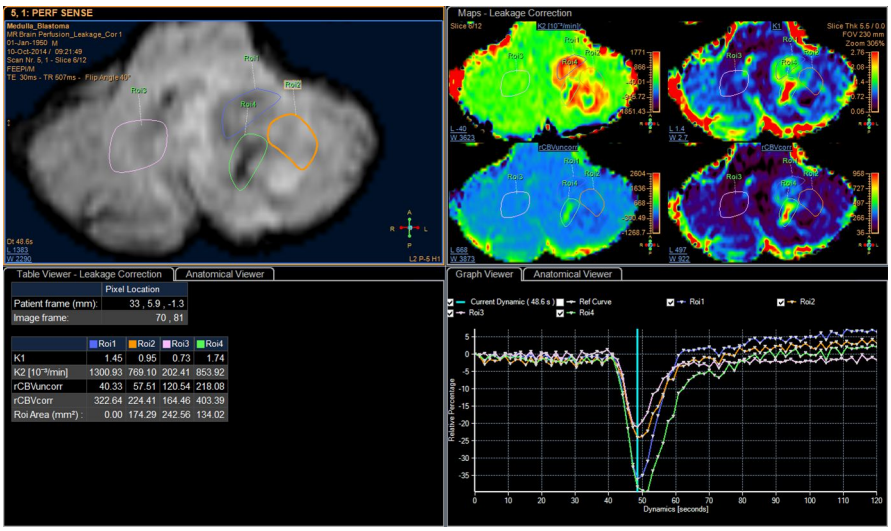

Fig. 52: Leakage Correction graphical results and results table

Leakage Correction analysis provides the following results for all defined ROIs:

- relCBV$_{uncor}$: Uncorrected relative cerebral blood volume.
- relCBV$_{corr}$: Corrected relative cerebral blood volume.
- K1: This is the scaling factor to fit the contrast passage signal of the reference voxels to the bolus passage of a voxel.
- K2: This is the scaling factor needed for an optimal fit of the leakage term. The leakage term is derived from the reference curve. The reference curve is the average of all non-enhancing or reference voxels. The leakage term is the time integral of the reference curve. It is specified in [1/min] and is a measure for the leakage.
- Reference curve: This is the reference signal used to fit with the help of linear regression K1 and K2 to match the acquired signal: K1 scales to bolus passage peak (typical range [0 -2]), K2 scales the leakage tail, K2 is positive in case of T1 dominance (the tail of the actual curve is higher than the tail of the reference curve), K2 can be negative in case of T2/T2* dominance (the tail of the actual TID is lower than the tail of the reference curve).

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- R^2: (Advanced map, available from the **More** menu in the toolbar.) This represents the goodness of the fit.
- Ref Mask: (Advanced map, available from the **More** menu in the toolbar.)The reference mask show all pixels that have been used to determine the reference signal, which is assumed to be the signals from the voxels that don't show leakage/signal enhancement.

If **Follow Mouse** mode is enabled in the **More** menu, you can view real-time results for the voxel at the current pointer position.

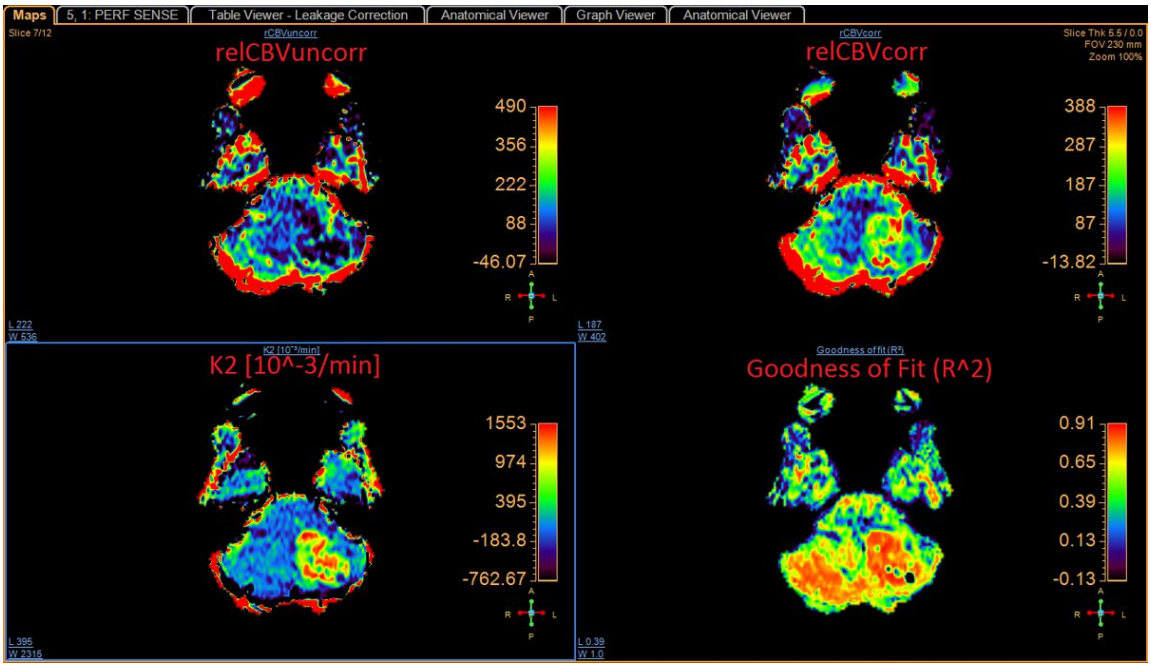

Fig. 53: Leakage Correction maps

References

Gamma Variate Analysis

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Belliveau, JW., Rosen, BR., Kantor, HL., Rzedzian, RR. "Functional cerebral imaging by susceptibility-contrast NMR". *Magn Reson Med*, No. 14(3): 538-546, 1990.

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Model-Free Analysis

Meyer-Bäse, A., Lange, O., Wismüller, A., Hurdal, M. K. "Analysis of Dynamic Susceptibility Contrast MRI Time Series Based on Unsupervised Clustering Methods". *IEEE Transactions on Information Technology in Biomedicine*, Vol. 11, No. 5: 563-573, 2007.

Leakage Correction Analysis

Boxerman J. L., Schmainda K. M., Weisskoff R. M. "Relative cerebral blood volume maps corrected for contrast agent extravasation significantly correlate with glioma tumor grade, whereas uncorrected maps do not". *AJNR Am J Neuroradiol.* 2006 Apr; 27 (4): 859-67.

Tmax

Calamante, F., Christensen, S., Desmond, P. M., Østergaard, L., Davis, S. M., Connelly, A. "The Physiological Significance of the Time-to-Maximum (Tmax) Parameter in Perfusion MRI". *Stroke*, No. 41: 1169-1174, 2010.

Deconvolution

Wu, O., Ostergaard, L., Weiskoff. R. M., Benner, T., Rosen, B. R., Sorensen, A. G. "Tracer arrival timing-insensitive technique for estimating flow in MR perfusion weighted imaging using SVD with a block-circulant deconvolution matrix". *Mag Res Med* No. 50: 164-174, 2003.

MR Diffusion-Perfusion Mismatch

The Diffusion-Perfusion Mismatch stage of the MR Neuro Perfusion application uses the perfusion-weighted image (Tmax map) and the diffusion-weighted image (ADC map) to support stroke patient management. The Diffusion-Perfusion Mismatch in the application is not intended to be used for acute ischemic stroke patient triage for treatment allocation (e.g., for extended time window for recanalization therapies according to: *Berge, E. et al. (2021) 'European Stroke Organisation (ESO) guidelines on intravenous thrombolysis for acute ischaemic stroke', European Stroke Journal, 6(1), p. I–LXII. doi:10.1177/2396987321989865*, and/or to Powers, W.J. *et al.* (2018) *2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association, Stroke. doi:10.1161/STR.0000000000000158.)*"

Performing Diffusion-Perfusion Mismatch

WARNING

If the anatomical data sets are not in the same frame of reference, the anatomical image might be mispositioned.

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WARNING

Volume construction may require interpolation.

NOTICE

For DTI/DWI series, ADC iso and/or EADC iso maps are automatically generated when you launch the Diffusion-Perfusion Mismatch stage. This allows you to analyze mismatch without having to perform MR Diffusion analysis first.

NOTICE

In the Diffusion-Perfusion Mismatch application, the first volume of the perfusion series is automatically registered to the b0 volume of the diffusion series. Since the contrast of the b0-volume and the first dynamic of the T2* series are very similar, the co-registration makes use of the local correlation algorithm by default.

1. Click **MR Diffusion-Perfusion Mismatch**.

   ⇨ A 2x2 layout is displayed:

- The upper-left viewport contains the latest diffusion maps and series in tabbed viewports.
- The upper-right viewport contains perfusion maps and series that you created in the perfusion workflow.
- The table and graph viewports are empty.

   ⇨ The diffusion viewports and the perfusion viewports are registered and linked for position, zoom, and pan interactions. If desired, you can edit the registration using any diffusion series with the perfusion series as a reference.

   ⇨ If desired you can select a 2x3 layout using the **Layout** tool in the toolbar. You can also edit the current layout and save it as a preset.

2. To perform mismatch analysis, you can choose between Manual analysis and Automatic analysis. Both options are described below.

Co-Registration Inspection

When co-registration is performed, you should verify the accuracy of the registration. You can inspect and edit the registration using the **Review & edit co-registration** step.

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NOTICE

If you edit and accept the registration, the results are updated accordingly in the mismatch stage of the application.

1. Click **Review co-registration** in the toolbar to open the **Review & edit co-registration** step.
   ⇨ The input series and the reference series are displayed as fusion views in three orthogonal orientations. You can change the orientation of the view, if desired.
   ⇨ The initial alignment is calculated using the **Normalized Mutual Information** algorithm.
2. To change the alignment algorithm, select an option from the drop-down list in the task guidance panel.
3. You can make the following manual adjustments to the registration using tools in the task guidance panel:
   - **Translation Tools**: Click an arrow to nudge the registration in the corresponding direction, or use the **Translate** tool to move the registration manually.
   - **Rotation Tools**: Click an arrow to rotate the registration clockwise or counter-clockwise, or use the **Rotate** tool to rotate the registration manually.
4. To undo an adjustment, click **Undo**.
5. To reapply an adjustment that you have undone, click **Redo**.
6. To reset the registration to the original position, click **Reset All Alignment**.
7. To save the registration and continue with the analysis, click **Save co-registration**.
8. To ignore the changes, go back to analysis.

Manual Mismatch Analysis

1. Click **Manual** in the task guidance panel if it is not already selected.
2. Select a **Diffusion ROI** type and draw an ROI on the diffusion series.

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⇨ The ROI is propagated to the other diffusion series and maps, and to the perfusion series and maps.

3. Select a **Perfusion ROI** type and draw an ROI on the perfusion series.

⇨ The ROI is propagated to the other perfusion series and maps, and to the diffusion series and maps.

Automatic Mismatch Analysis

1. Click **Automatic** in the task guidance panel if it is not already selected.

2. In **Apply segmentation** click to mark a seed point on the ADC or Delay map.

⇨ After you mark a seed point, segmentation is calculated according to the threshold ranges indicated in the task guidance panel.

⇨ The threshold deficit mismatch is displayed as an overlay in the anatomical viewer.

⇨ The corresponding volume measurements are displayed in the tables.

⇨ Signal intensity plots corresponding to the perfusion and diffusion deficits are displayed in the graph.

3. To adjust the default threshold values, enter new values in the task guidance panel and click **Apply Resegment**.

4. To segment additional regions, add additional seed points from the task guidance panel on the map.
5. To edit the segmented regions, draw an ROI to exclude the area in the segmentation that you want to erase.

⇨ After you edit the segmentation, the results viewers are automatically updated.

Adjust Segmentation Color Opacity

From the right click context menu, select **Segmentation Opacity** and adjust Segmentation color opacity independently in different view ports (ADC map, Delay map and Anatomical view- ports).

Results

The type of results generated depends on the type of analysis that your performed:

- Manual analysis mode generates area results (ROIs).
- Automatic analysis mode generates volume results (segmentation).

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When you have created diffusion ROIs/segmentation and perfusion ROIs/segmentation, mismatches are calculated. The results are displayed as penumbra in the anatomical views, and numerical results are displayed in the table viewport and graph viewport.

Anatomical Viewers

Penumbra is displayed in the anatomical viewers with details of the ROIs, the amount of mismatch, and the mismatch ratio.

1. Click the **Anatomical Viewer** tab in one of the lower viewports.
2. Drag a series from the **Series** panel to the anatomical viewer.
   - ⇨ The series in the anatomical viewer is displayed as MPR images and is automatically co-registered with the perfusion input series. ROIs in the diffusion and perfusion viewers are propagated to the anatomical viewer.
   - ⇨ You can scroll over dimensions in the anatomical viewer (up to a maximum of three dimensions). Scrolling is linked to the diffusion and perfusion viewers.
3. To view penumbra as a color overlay in the anatomical viewers in manual segmentation, select **Fill Color Overlay** in the task guidance panel.

Tables

The table viewport displays the following tables:

- Table 1 displays details about each ROI/segmentation and ADC for each item. Clicking a column in the table displays the corresponding slice.
- Table 2 displays mismatch information and mismatch ratio (%) for each pair of analyzed diffusion/perfusion results. The mismatch ratio is calculated as (Perfusion-Diffusion)/ Perfusion.

Graph

The graph viewport displays a signal intensity graph corresponding to the perfusion ROIs/ segmentation. You can select or deselect results as desired using check boxes.

8.1.7 MR Permeability

Functional Description

The MR Permeability application is designed to visualize T1 Weighted Dynamic Contrast-Enhanced (DCE) 3D datasets and assist in analyzing the tissue response. The MR Permeability application supports any related conditions for which permeability analysis is indicated as part of patient management, in the oncology or vascular domain.

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Overview

The MR Permeability package allows the analysis of a contrast bolus passing through the tissue. The package assesses the permeability differences between tissues according to the Tofts Model.

The purpose of the package is twofold:

1. Generating parametric maps

   The package generates parametric maps (in color or grayscale and with or without an underlay) that reflect different parameters describing the time intensity curve per pixel.

2. Detailed analysis of parametric maps calculated by the Permeability package

   Based on Regions Of Interest (ROI's) in different parts of the area under examination, numerical results can be calculated and presented in graphs.

Valid imaging series

MR Permeability has the following acquisition requirements.

Three series are required as follows:

- A Dynamic Contrast-Enhanced (DCE) series with 20 dynamics or more is needed, typically with high temporal resolution and flow artifact reduction.
- Two reference series.

To calculate the baseline T1 relaxation time per pixel (baseline T1 map), two T1-FFE reference series with different flip angles (for example, 5 and 15 degrees) are required.

The two reference series should be identical to the DCE series in terms of, for example, field of view, orientation, resolution, slice thickness, number of slices.

The two reference series should fulfill the following criteria:

- They should not be a dynamic series.
- TR about 10 ms (should be identical for reference series 1 and reference series 2).
- TE about 2 ms (should be identical for reference series 1 and reference series 2).
- Reference series 1 has a flip angle of 5 degrees.
- Reference series 2 has a flip angle of 15 degrees.

In exceptional cases a single reference series can also be used. But in that case the TR and the TE of the reference series and the DCE series have to be identical. They still need to have different flip angles.

Perfusion model for result calculation

The pharmacokinetic calculation is done on a pixel-by-pixel basis using a 2-compartment model. The calculation is based on the Extended Tofts Model (ETM):

$$C(t) = v_{\mathrm{p}}\, C_{\mathrm{a}}(t) + K^{\mathrm{trans}}\, e^{-tk_{\mathrm{ep}}} * C_{\mathrm{a}}(t)$$

where:

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C(t)	Contrast concentration in tissue
v_p	Fractional value of blood plasma (also referred to as Volume fraction of plasma space)
$C_a(t)$	Arterial Input Function (Contrast concentration in feeding artery) see explanation in the section below
K^{trans}	Transfer constant between blood plasma and extravascular extracellular space (EES)
k_{ep}	Rate constant between EES and blood plasma

For more details refer to “Quantitative MRI of the Brain” by Paul Tofts; Ch 10: T1-W DCE-MRI: T1-Weighted Dynamic Contrast-Enhanced MRI (pages 341–364).

For the population average AIF a bi-exponential analytical model is used (this is a mathematical equation instead of, for example, a list of numbers), which makes the model suitable for any temporal resolution. Furthermore, the bi-exponential Weinmann plasma curve is used, which means that the model shape is very simple and does not incorporate recirculation effects after the first bolus passage (this may be seen in other more complicated models as described by, for example, Fritz-Hansen or Parker).

Arterial Input Function (AIF)

The calculation of permeability characteristics can be done based on a model based AIF or based on a manual AIF.

The **model based AIF** can have 3 different bi-exponential shapes. The different shapes are controlled by the user selected **injection duration** which is a property of the injection preset and can be set to:

- short (less than 5 s)
- medium (from 5 to 10 s)
- long (longer than 10 s)

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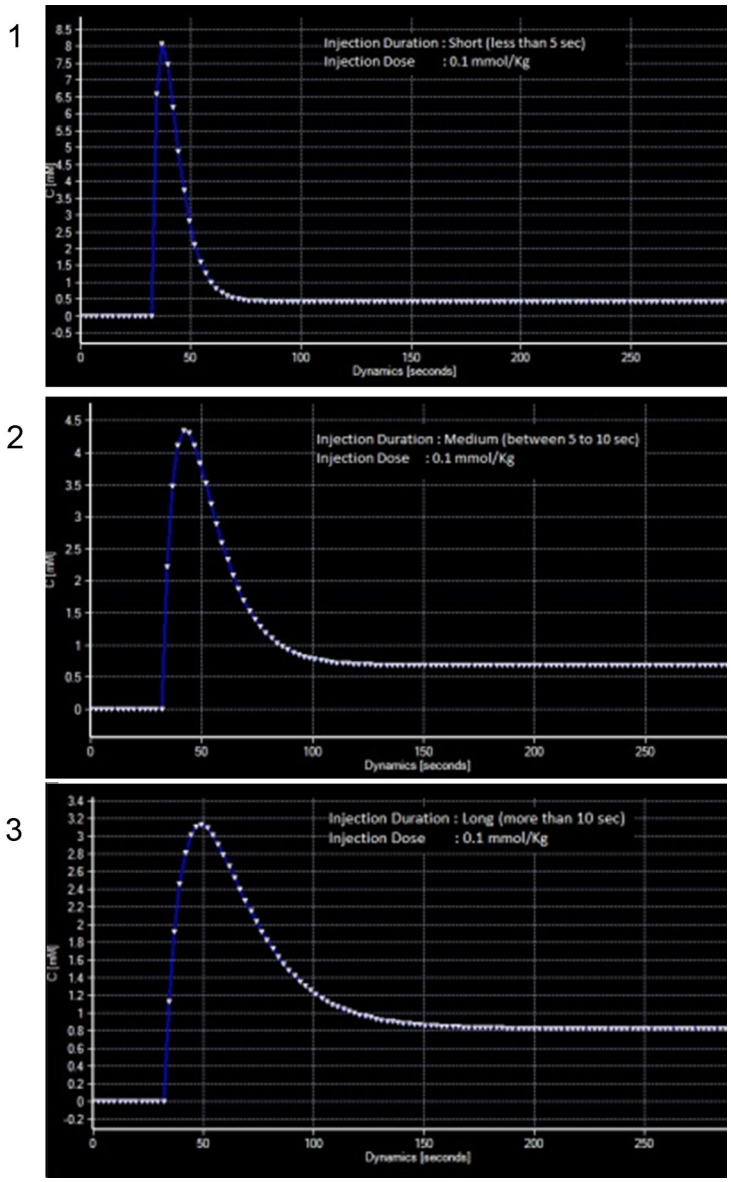

Fig. 54: The 3 different bi-exponential shapes used for the model based AIF: 1 - short, 2 - medium, 3 - long.

The values in the Philips injection presets serve as an example and are based on a common contrast agent Gd-DTPA, a commonly used injection dose of 0.1 mmol/kg, typical medium injection duration (between 5 s and 10 s) and a normal hematocrit value of 45%. However every hospital has to define their own injection protocols, that match their contrast agents and injection characteristics.

The **manual AIF** requires manual placement of a square of 7x7 pixels on a user selectable vessel. Based on a user selected collection of about 5 pixels out of the 7 x 7 matrix that in shape and timing best match an expected AIF, the system will determine an average AIF function to calculate the permeability characteristics.

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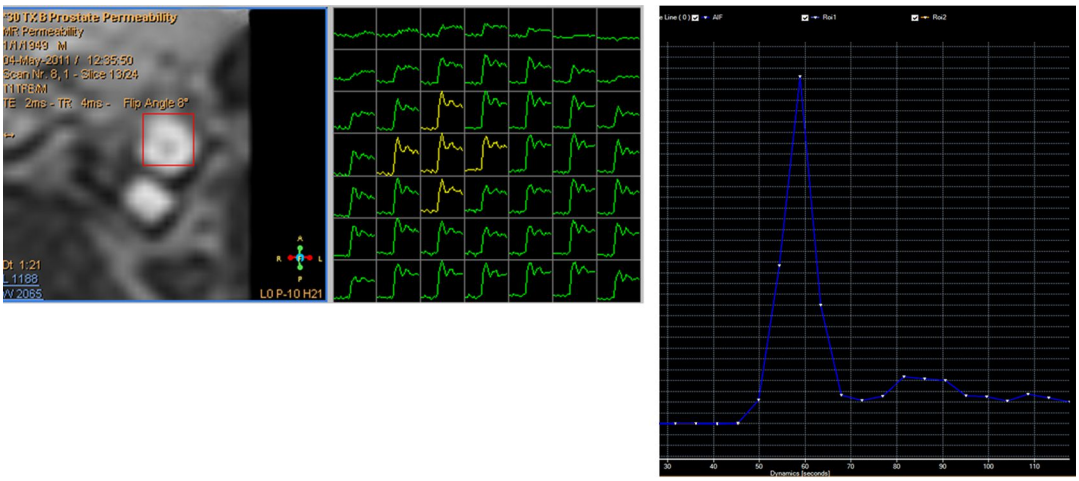

Fig. 55: Defining the Manual AIF. Left: ROI over the feeding artery and the corresponding curves of each pixel. Right: Average AIF.

Other properties affecting the results

Other hospital dependent injection properties affecting the calculation of permeability characteristics are the **contrast relaxivity** which depends on the contrast agent in use, and the **injection dose**. Since the **contrast relaxivity** is field strength and contrast agent dependent, per field strength and contrast agent a different injection preset is required if applicable. The hematocrit value is a patient dependent parameter, that has a default value of 45%.

User Interface

Screen layout

The MR Permeability package has a default layout of four viewports with toolbar, control panel and task guidance. The viewports display the following views:

- Source image in the middle of the imaging volume.
- In real-time calculated Parametric Permeability maps.
- Table Viewer (numerical results) and Anatomical Viewer.
- Graph Viewer (graphical results) and Anatomical Viewer.

Switch between Graph Viewer, Table Viewer and Anatomical Viewer

1. Click the 'Graph Viewer' tab to switch to the Graph Viewer.
2. Click the 'Anatomical Viewer' tab to switch to the Anatomical Viewer.
3. Click the 'Table Viewer' tab to switch to the Table Viewer.

More information on the Graph Viewer and the Table Viewer can be found in the chapter “Results” on page 609.

More information on the Anatomical Viewer can be found in the chapter “Workflow” on page 601.

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Task Guidance

The MR Permeability package provides a task guidance in the left part of the screen.

Follow the steps of the task guidance to make optimal use of the package.

The following workflow description is based on this task guidance.

Toolbar

Color LUT (Look-Up Table)

- To select the color look-up table for the maps.

  Possible settings are: 'Blue to Red', 'ASIST LUT' and 'Gray'.

Color LUT	Minimum value				Maximum value
Blue to Red	Blue	Green	Yellow	Orange	Red
Gray	Black		Gray		White
ASIST LUT	Black	Light blue	Green	Yellow/ Orange	Red

The ASIST LUT is a LUT specifically designed for acute stroke imaging. The Acute Stroke Imaging Standardization Group - Japan (ASIST-Japan) is a group that conducts medical research projects dedicated to the standardization of brain computed tomography (CT) and magnetic resonance imaging (MRI) in the clinical setting of acute cerebral stroke.

Layout

To select another screen layout, click **Layout** and select a layout option. You can also edit the current layout and save it as a preset using the **More** menu. Custom layouts that you have saved as presets are also available in the **Layout** list.

Follow Mouse

Once enabled, this function displays real-time results for the current voxel (indicated by the current position of the cursor).

Select Reference Series

By default, during analysis suited reference series are automatically detected and used. The function 'Select Reference Series' allows to use other series as reference series if required.

1. Click 'Select Reference Series' from the 'More' drop-down menu in the toolbar.
2. Then browse to the series you would like to use as reference series (Reference 1 and Reference 2) and click **OK** to confirm.

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NOTICE

By default, the application uses the reference series with minimum and maximum available flip angle to compute the permeability maps.

According to literature, it is best to use reference series with flip angle of 5° and 15°. More information can be found in the article: Optimizing the Precision in T1 Relaxation Estimation Using Limited Flip Angles By Henry Z. Wang e.a. MRM 5, 399-416 (1987).

Viewing Tools

Mirror

This function mirrors the image(s) (Right <-> Left)

Flip

This function flips the image(s) (Up <-> Down)

Rotate Clockwise

This function rotates the image(s) clockwise

Rotate Counter-Clockwise

This function rotates the image(s) counter-clockwise

Workflow

Launch the MR Permeability package

1. Select a suitable perfusion series from the series list and right click for the context menu.
2. Click 'MR Permeability'.

   The MR Permeability package opens.

Scroll through images

Through dynamics

1. In the image viewport, drag to the left or to the right.

Through slices

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1. In the image viewport, drag up- or downwards.

Through maps

1. In the map viewport, drag to the left or to the right.

Analysis

In the Analysis list in the task guidance panel, select one of the following methods:

- Model based AIF

  For additional information see chapter “Co-Registration Inspection” on page 592.
- Manual AIF

Optional: Define Manual AIF

Manual AIF allows applying the manual AIF method in the result calculation, instead of the model based AIF that is performed depending on the injection parameters.

1. Select 'Manual AIF' from the 'More' drop-down menu in the toolbar.

   The 'Define AIF' window opens.
   Moreover the analysis step 'Define AIF ...' will be added to the Task Guidance as part of the step 'Analysis' allow to easily access the 'Define AIF' window.

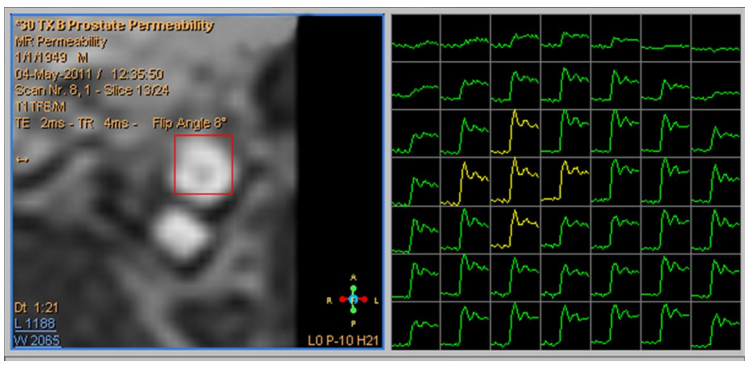

Fig. 56: 'Define Manual AIF' window. The left part of the window shows the anatomical image with the red box for vessel definition. The right part shows the corresponding Time-Intensity diagrams of each pixel.

2. Navigate to the slice with the vessel relevant for Manual AIF definition.
3. Zoom, pan and window the slices so that this vessel is clearly visible.
4. Drag the red box over this vessel.

   The display of the curves will automatically be updated.
5. Click the pixels where the curve shape best represents the expected AIF (i.e. high amplitude and/or steep upslope).

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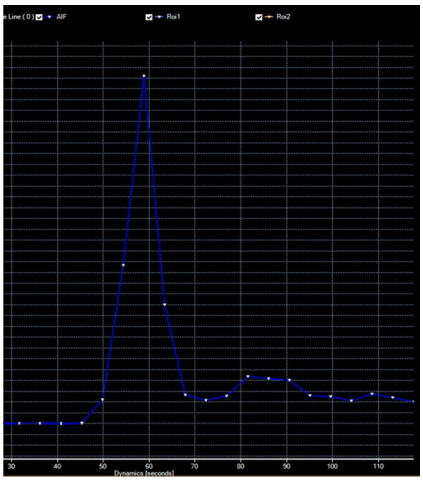

Fig. 57: Average AIF of selected pixels: contrast concentration curve reconstructed from the above selected signal intensity curves (yellow after selection).

6. Click 'Apply' to confirm this selection and in such a way start the calculation. Clicking 'Cancel' leaves the window without any change.

   Clicking 'Undo Changes' resets the position of the red box to its previous position.

NOTICE

Unreliable AIFs should be avoided to guarantee that the analysis works within its limitations. In particular, AIF with strong shape distortion should be avoided.

The Tofts model designed is based on a proper AIF.

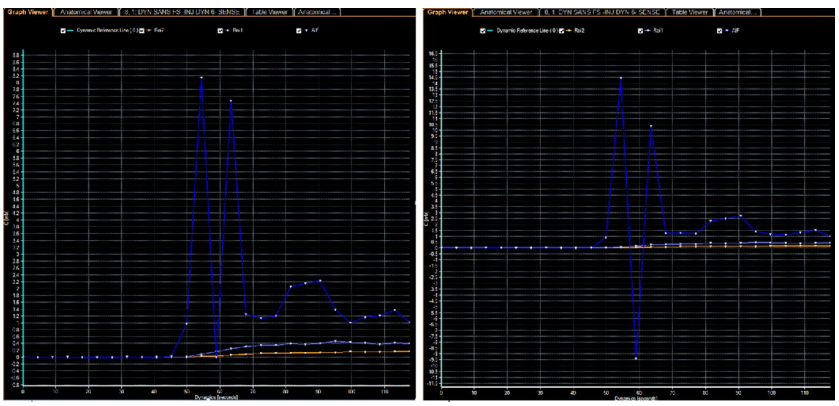

Fig. 58: Example of unreliable AIFs.

Select Input Parameters

1. Select an injection preset from the drop-down menu in the Task Guidance.

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If a suitable injection preset is not yet available, an injection preset needs to be created. See the "More" functions description in chapter “Toolbar” on page 600 for details.

WARNING

Verify that the selected preset matches the injection conditions during acquisition.

NOTICE

The Blood T1 values used for the calculations are different depending on the used magnetic field strengths.

The table gives the used values. More information can be found in the following article: Blood longitudinal (T1) and transverse (T2) relaxation time constants at 11.7 Tesla. Ai-Ling Lin e.a. Magn Reson Mater Phy; DOI 10.1007/s10334-011-0287-2.

Magnetic Field Strength (Tesla)	Blood T1 value (millisecond)
1.0	1345 ms
1.5	1412 ms
3.0	1613 ms
7.0	2149 ms

You can select what injection protocol is used depending on the tissue which was scanned. The preset details of each protocol can be viewed and edited with the 'view' option.

Create New Preset ...

This function allows to create analysis presets that match the injection protocols used.

During the analysis, you can select the preset corresponding to the current injection characteristics via the Task Guidance function "Select Input Parameters".

For ease of use, these presets can be saved under a user defined name. However, it is recommended to create a new preset only when necessary.

1. Click 'Create New Preset ...' from the More drop-down menu in the toolbar.
2. Enter a name for this preset.
3. Select the *Magnetic Field Strength* of the used MR system in Tesla.
4. Enter the *Contrast relaxivity* in s^{-1} x $mmol^{-1}$.
5. Enter the *Injection dose* in mmol/kg.
6. Set the *Injection duration* to *short*, *medium* or *long*.

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Select *Short* when the bolus takes less than 5 s; select *Medium* when the bolus takes 5 s to 10 s; select *Long* when the bolus is longer than 10 s.
With 'Manual AIF' the injection duration is not applicable. Instead the 'Manual AIF' is used for the calculation.

7. Enter the *Hematocrit* in %.

Delete Presets ...

This function allows to delete injection protocol presets.

Spatial Smoothing

- To spatially smooth the resulting maps.

Possible settings are: None (no smoothing), Weak, Medium or Strong.

Spatial smoothing smoothes the maps and the original images. In such a way, spatial smoothing has an effect on the numerical results.

Apply Temporal Smoothing

- To temporally smooth the resulting maps.
  Possible settings are: None (no smoothing), Weak, Medium or Strong.

Temporal Smoothing

- To temporally smooth the resulting maps.
  Possible settings are: None (no smoothing), Weak, Medium or Strong.

Select the Desired Maps

You can select the maps for real-time calculation and display, and for the generation of new imaging series.

1. Click the checkbox of a map to select/deselect this map.
   The display of the real-time calculated maps will be updated accordingly.

Display T1 and Delay Maps

- To display T1 and Delay maps in the maps viewport.

Select Series for Anatomical Viewer

Upon startup of the package, the Anatomical Viewer is empty. However an additional imaging series in the Anatomical Viewer might help during navigation through the data set and in order to draw ROIs.

Any type of imaging series can be loaded into the anatomical viewer. The orientation of the series in the Anatomical Viewer is always identical to the orientation of the source image and the map. This might require the calculation of real-time Multiple Planar Reformats.

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NOTICE

When you load an imaging series with an orientation different to the source image into the Anatomical Viewer, the series in the Anatomical Viewer will be a real-time Multiple Planar Reformat (MPR).

Always be aware that the imaging parameter of this series determine the image quality of the resulting MPR. Low resolution imaging series will result in blurry MPRs and might hamper the workflow.

To load an imaging series into the Anatomical Viewer

1. Click the **Anatomical Viewer** tab to switch to the **Anatomical Viewer**.
2. Right-click the **Anatomical Viewer** and click **Select Series** from the right mouse menu.
3. Click on a series in the **Select Series** window and click **OK** to confirm the selection.
4. You can also load a series by dragging and dropping a series.

TIP

When you save a layout, the series displayed in the viewer at that time is saved with the layout. When you reload the layout for another case, the same series is also reloaded in the viewer. You can save a layout using the More menu in the task guidance panel.

Select Underlay

You can select an MR series as underlay of the parametric maps allowing for better allocation.

In order to optimize the display you can also adjust the opacity of the overlaying parametric maps.

NOTICE

MR series are suitable source images. Secondary captures are not suitable because they are lacking in general geometry information.

The underlay is automatically reformatted to the geometry of the overlay. The resolution is determined by the resolution of the overlay in the preview viewer.

Select Underlay

1. Select an option:
   - **None**

     The parametric maps will be displayed without underlay.
   - **Source as Underlay**

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The source series will be displayed as underlay.

- **Select Other Underlay**

  Browse to the series you would like to use as underlay and click **OK** to confirm. You can also load a series by dragging and dropping a series.

TIP

When you save a layout, the series displayed in the viewer at that time is saved with the layout. When you reload the layout for another case, the same series is also reloaded in the viewer. You can save a layout using the More menu in the task guidance panel.

NOTICE

A warning is displayed if the selected series does not match the geometry, which may cause the anatomical image to be mispositioned.

NOTICE

There can be a mismatch between underlay and overlay also in the Anatomical viewer if there was any patient motion between the acquisitions of these series.

Adjust the opacity of the overlay

1. Drag the slider to adjust the opacity of the parametric maps.

You may also drag the right mouse button in the color maps to change the opacity of the overlay.

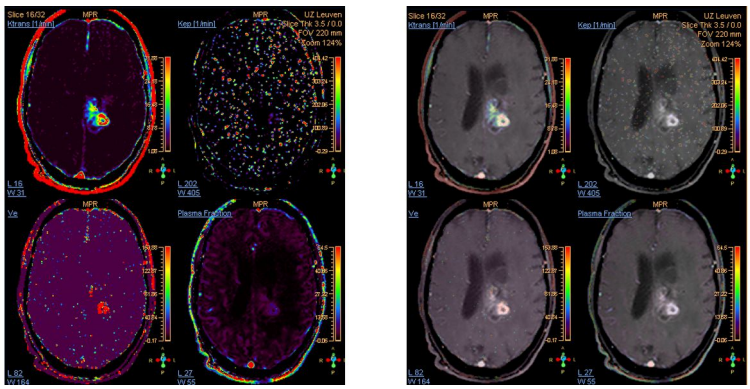

Fig. 59: Left: 100% opacity of the parametric maps. Right: 20% opacity of the parametric maps.

NOTICE

The image registration is disabled which may cause undesired results.

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Draw ROI

1. If desired, draw a ROI to focus on a specific area.

   For information on how to draw, modify, and rename a ROI, see chapter “Draw ROI” on page 556.

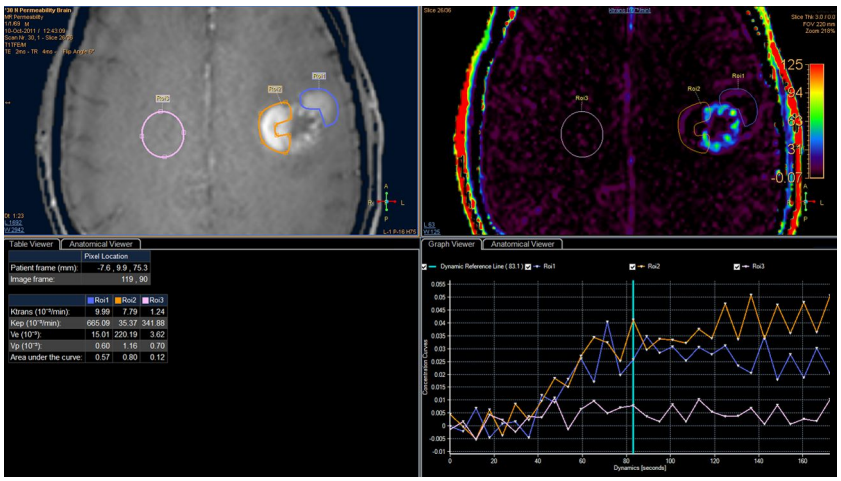

Fig. 60: Different ROI types with numerical and graphical results.

2. If the current series is a brain scan, you can display a mirror line and create contra-lateral ROIs automatically. If desired, select the following options in the task guidance panel:
   - **Show mirror line**
   - **Create contra-lateral ROI automatically**
3. If desired, you can remove the last drawn ROI. Do one of the following:
   - Press Ctrl+Z.
   - Right-click the ROI and then click **Delete** in the shortcut menu.
   - Right-click the image and then click **Delete Last Drawn ROI** in the shortcut menu.

More options

You can enable/disable the display of curves in the Graph Viewer.

1. Check the checkbox 'Roi1', 'Roi2' or any 'Roi' in the Graph Viewer to enable the display of the related graph.
2. Uncheck the checkbox 'Roi1', 'Roi2' or any 'Roi' in the Graph Viewer to disable the display of the related graph.

Generate Series

You can generate a new imaging series containing the parametric maps and results as defined in the previously described workflow.

1. To generate a standard DICOM-compatible series, select **Generate Series** using the Secondary Capture option from the drop-down list, and then click the button.

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2. Enter the name of the new imaging series in the **Name** box.
3. To generate a series as RGB images (high resolution color maps), select **Generate Series** using the Secondary Capture RGB option.

Register Data While Saving

Once enabled, this function performs registration when generating actual maps. In such a way image quality will most likely improve in the maps.

NOTICE

If the input data is unregistered, there can be a mismatch between the previewed and generated maps as the generated maps are calculated after registering the input.

Results

NOTICE

Various factors like inaccurate definition of AIF, patient motion, temporal resolution, and bolus injection conditions influence permeability values.

NOTICE

From synthetic validation studies it has been shown that for small extracellular extravascular space and large transfer constant of diffusable tracer from the vessel to the EES, the fitted results are not accurate. Therefore note that in parametric area the measured results should be interpreted with caution.

The package calculates the following results:

Graphical and numerical results

- The graphical results present a **Time-Intensity Diagram** (intensity versus time).

  In 'Follow Mouse' mode, the graph correlates to a specific pixel and shows the intensity value (intensity) over the time for this pixel.
- The results will be provided as **parametric maps** and in a **table of results**.

  Scrolling through the maps, the type of the map is indicated in the map's series type field.

NOTICE

Please note that the pixel location remains in the table viewer, even after moving out of the image frame.

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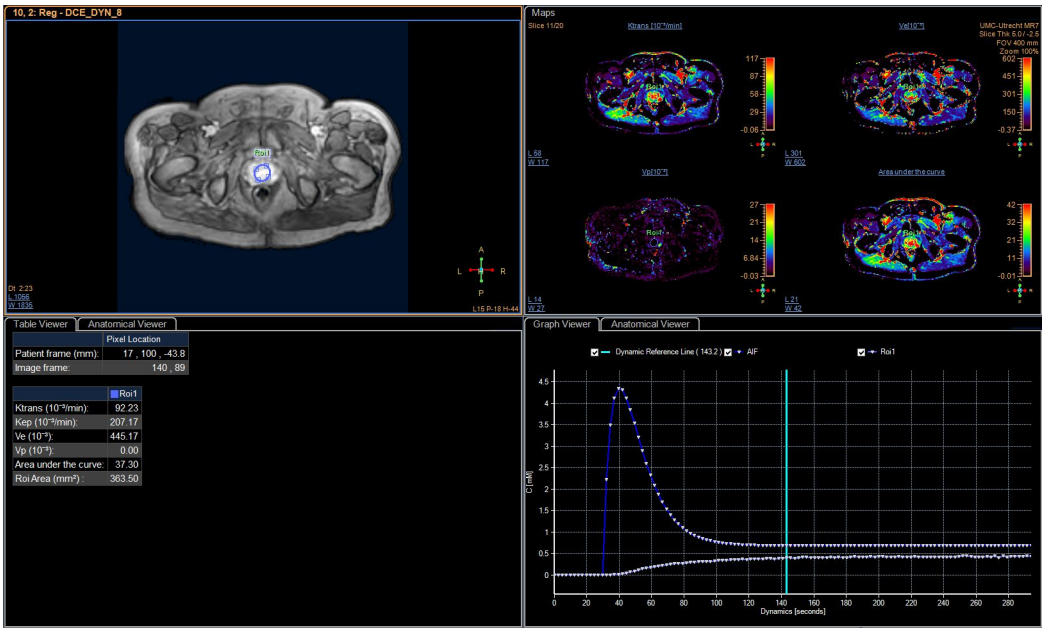

Fig. 61: Results screen: source image and maps with ROIs, Table Viewer and Graph Viewer. The dynamic reference line indicates the currently shown dynamic

NOTICE

If you hide the dynamic reference line, you can display it again by right-clicking in the Graph view and selecting it from the context menu.

To draw a windowing ROI, right-click a map and then click **Draw Windowing ROI**. The color scale of the map is recalculated to display maximum color heterogeneity inside the ROI. You can draw windowing ROIs on each map independently.

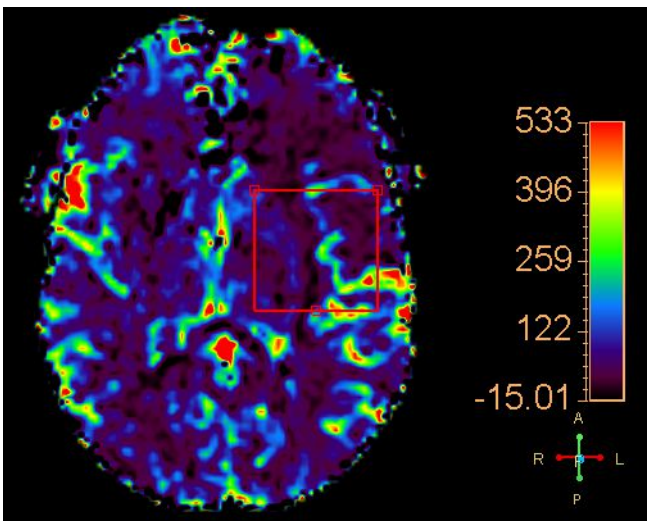

Fig. 62: Drawing a windowing ROI

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Measurement Type Selection

To change the type of measurement for all parametric maps, right-click the results summary table and select an option.

- **Region Parameters (Factory default)**: The application calculates T1 parameters using the time intensity curve for the drawn ROI and displays the values in the Table Viewer.
- **Mean Voxel Parameters**: The application calculates the mean of all the voxels inside the ROI of the output parameters and displays the values in the Table Viewer.

  The table heading is updated based on the selected type.

Show ROI Statistics

You can right-click the results summary table and choose to show ROI voxel statistics (or) select from the **More** menu.

An additional numerical results table is displayed as a floating window and displays Maximum, Minimum, Median, Average and Standard deviation of the quantitative parameters for the ROI voxels within the parametric maps.

When the number of columns in the Table Viewer exceeds thr default width, or number of rows exceeds default height, the auto scroll is visible to allow the user to scroll to see all the columns and rows.

Exporting Table Results

To export table results:

1. Select **Copy to Clipboard** an open either Microsoft Word or Excel and paste the contents from your clipboard into the application.
2. Select secondary capture. A dialog box is displayed allowing you to select a file name, file format, and destination. You can save the series in DICOM format, or in non-DICOM format. If you select a non-DICOM format, you should additionally select a file system destination for exporting the table results.

To export table content with ROI dynamic values in HTML or CVS format:

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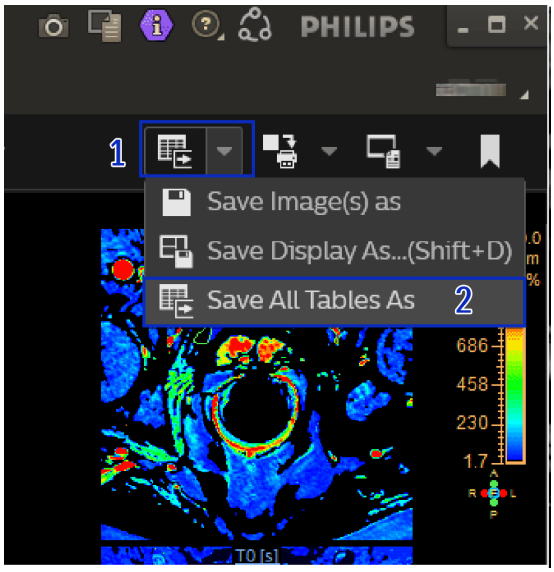

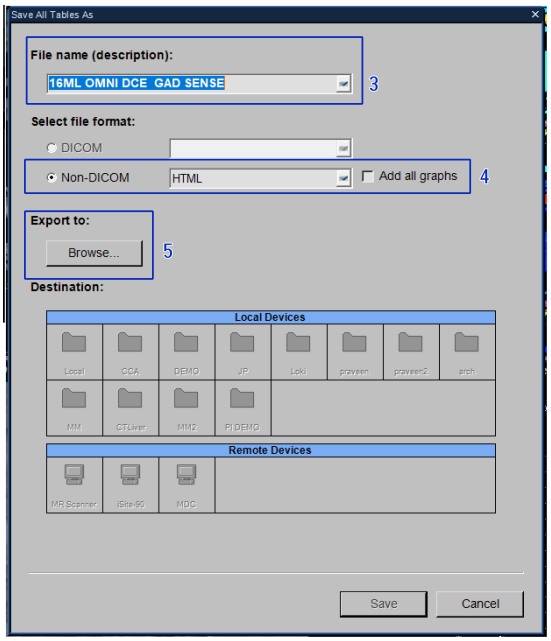

1. From the Save menu (#1), select **Save All Tables As** (#2).

   The **Save All Tables As** window opens.
2. Type a **File name** (#3).
3. Select Non_DICOM file format and optionally, enable **Add all graphs** (#4).
4. Select a file destination for exporting the table results and graphs (#5).
5. Minimize the application and navigate to the selected destination to view results.

Parameters

K^{trans}

- Transfer constant between blood plasma and Extravascular Extracellular Space (EES), also called vascular permeability

k_{ep}

- Rate between EES and blood plasma (also called Tracer Efflux Rate)

v_e

- Extravascular Volume fraction (Leakage space)
- Defined as K^{trans} / k_{ep}

v_p

- Plasma Volume fraction (Vp)

AUC

- Area Under the Curve of all time curves

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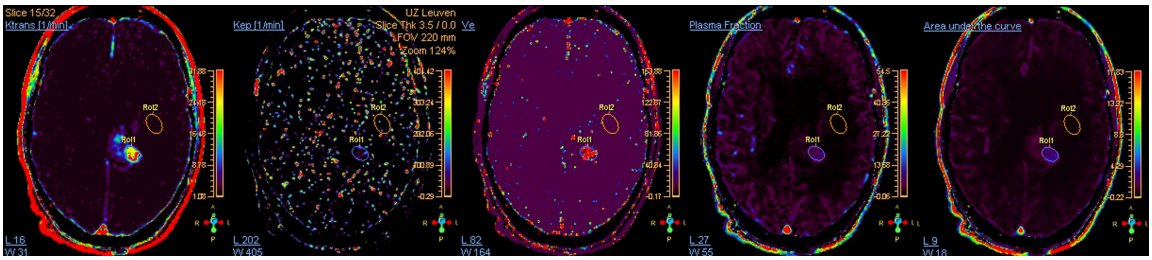

Fig. 63: Result maps of the Permeability package.: K^{trans}, k_{ep}, v_e, v_p, Area under the curve.

T1 and Delay map

The T1 and the Delay map are added for quality control purposes.

8.1.8 MR Diffusion

This postprocessing package is meant to evaluate Diffusion studies and generate parametric maps.

The process of diffusion of water molecules through tissue can be measured using MRI Diffusion imaging.

Valid imaging series

A valid imaging series for the Diffusion package is a Diffusion weighted series containing multiple b-values.

NOTICE

To calculate the Apparent Diffusion Coefficient (ADC map), diffusion weighted images acquired using at least 2 different b-values are needed.

NOTICE

Anisotropy maps (FA or Directional FA) need an acquisition with at least 6 different diffusion directions in addition to a diffusion weighting (b=0).

Functional Description

The MR Diffusion application is designed to assist in evaluation of MR Diffusion Weighted Imaging (DWI) and Diffusion Tensor Imaging (DTI) data to analyze diffusion and anisotropic properties of tissue. The MR Diffusion application supports any oncology and neurology conditions for which diffusion and anisotropic properties of tissue are indicated as part of patient management.

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NOTICE

For acute stroke patients, the MR Diffusion application can only be used in combination with perfusion-weighted MR images. For DWI-PWI mismatch on acute stroke, please refer to the MR T2* (Neuro) Perfusion chapter “MR Diffusion-Perfusion Mismatch” on page 591 section.

User Interface

Screen layout

The MR Diffusion package has a default layout of task guidance panel and toolbars, and two viewports. The viewports display the following views:

- Source image in the middle of the imaging volume.
- In real-time calculated Parametric Diffusion maps.

Task Guidance

The MR Diffusion package provides a Task Guidance panel in the left part of the screen.

Follow the steps of the Task Guidance to make optimal use of the package.

Toolbar

Color LUT (Look-Up Table)

- To select the color look-up table for the maps.
  Possible settings are: 'Blue to Red', 'ASIST LUT' and 'Gray'.

Color LUT	Minimum value				Maximum value
Blue to Red	Blue	Green	Yellow	Orange	Red
Gray	Black		Gray		White
ASIST LUT	Black	Light blue	Green	Yellow/ Orange	Red

The ASIST LUT is a LUT specifically designed for acute stroke imaging. The Acute Stroke Imaging Standardization Group - Japan (ASIST-Japan) is a group that conducts medical research projects dedicated to the standardization of brain computed tomography (CT) and magnetic resonance imaging (MRI) in the clinical setting of acute cerebral stroke.

Map Layout

- To select another screen layout.

Click **Map Layout** and select:

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- 1x1 map layout.
- 2x2 map layout.

Select b-values

Use this function to select at least 2 b-values for processing.

Advanced Diffusion Tensor Maps

Select this option to allow additional maps to be selected in the **Diffusion Tensor Maps** section of the task guidance panel. The following advanced diffusion tensor maps are available:

- Axial Diffusivity
- Radial Diffusivity
- Relative Anisotropy

Register Data While Saving

This function performs registration between diffusion directions when generating actual maps. In such a way image quality will most likely improve in the maps.

NOTICE

If the input data is unregistered, there can be a mismatch between the previewed and generated maps as the generated maps are calculated after registering the input.

NOTICE

The newly generated registered series can be recognized by the prefix 'Reg' in Series description.

Mask

Once enabled, this function displays the mask on the source image(s).

Mirror

This function mirrors the image(s) (Right <-> Left)

Flip

This function flips the image(s) (Up <-> Down)

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Rotate Clockwise

This function rotates the image(s) clockwise

Rotate Counter-Clockwise

This function rotates the image(s) counter-clockwise

More Functions within the Diffusion package

The most important functions can be performed via the Task Guidance and the toolbar. However there are more functions which you can access via the right mouse menus.

For more information, see chapter “Right mouse menus” on page 553.

Workflow

Launch the MR Diffusion package

1. Select a suitable diffusion series from the series list and right click for the context menu.

2. Click ‘MR Diffusion’.

   The MR Diffusion package opens.

Scroll through images

Through slices (or resulting) maps

1. In the image (or map) viewport, drag up- or downwards.
2. Alternatively use the up and down arrow keys.

Through b-values

1. In the image viewport, drag to the left or to the right.
2. Alternatively use the left and right arrow keys.

Select the Desired Maps

In the task guidance panel you can select the maps for real-time calculation and display, and for the generation of new imaging series.

1. Click the checkbox of a map to select/deselect this map.

   The display of the real-time calculated maps will be updated accordingly.

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NOTICE

Depending on the imaging parameters, not all types of parametric maps might be available.

Parametric maps that cannot be calculated with a specific dataset are grayed out, and a message is displayed in the bottom line of the view ports.

NOTICE

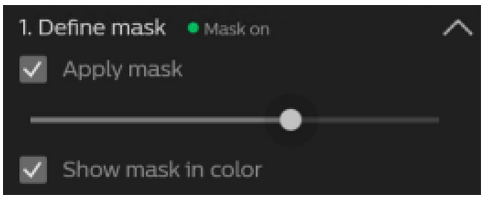
The preview of ADC, EADC and DWI iso maps is not available; however they can be generated and reviewed.

Define the Mask

This workflow step serves to adjust the mask and to enable the display of the mask while adjusting.

Setting a threshold mask will exclude background pixels from the functional map calculations. All pixels with values below the mask value will be displayed blue and will be excluded from the calculation. Only pixels with intensity above the mask value are used for the calculations.

1. Drag the slider to define the mask.



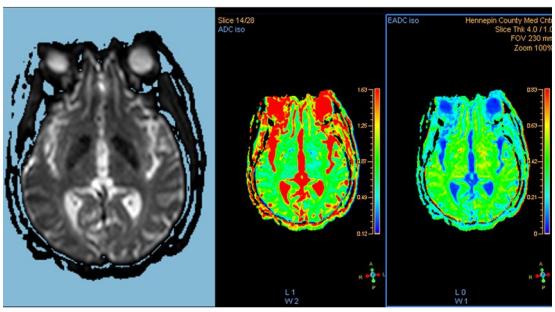


Fig. 64: The mask is overlaid to the current source image.

Alternatively:

You may also drag the right mouse button in the images to change the mask.

Generate Maps

You can generate a new imaging series containing the parametric maps and results as defined in the previously described workflow.

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1. To generate a standard DICOM-compatible series, select **Generate Series** using the Secondary Capture option.
2. Enter the name of the new imaging series in the **Name** box.
3. To generate a series as RGB images (high resolution color maps), select **Generate Series** using the Secondary Capture RGB option.

Parametric Maps

The results will be provided as parametric maps. The type of the map is indicated in the map's series type field.

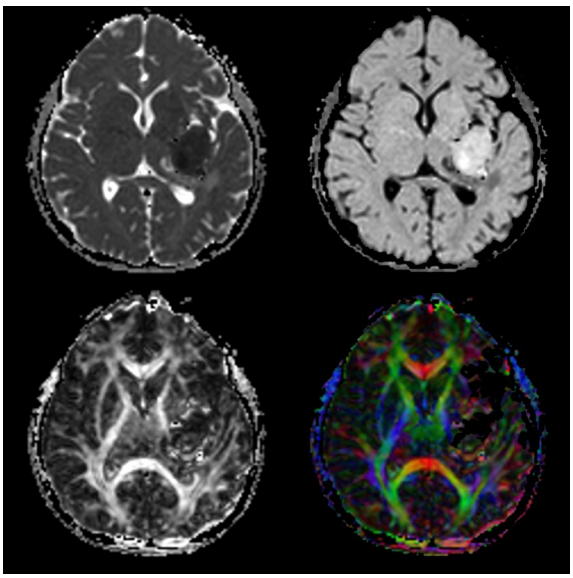

Fig. 65: Examples of maps. Clockwise from upper left: ADC map, eADC map, FA direction map, FA map

Scrolling through the maps shows which types of maps are available for the current series (not all types of maps are suitable for every type of diffusion series).

If an ADC iso and eADC iso map are available, directional ADC and directional eADC maps can also be generated (even though they are not available in the preview).

DWI iso

The DWI iso map is calculated by first finding the net ADC from all of the available gradient directions.

This net ADC is then used together with the b=0 image to create the DWI iso map. Since this uses all available directions, the SNR of the DWI iso map is improved especially with DTI series.

- The DWI iso images show a better image quality when the number of diffusion directions increases. The DWI iso images will have less noise. There is an increase in signal when more than 16 directions are acquired. The higher signal gives a sharper appearance.
- The option to create DWI iso images is not available for diffusion series that are acquired with gradient overplus as the P_oblique, M_oblique and S_oblique directions are not saved in the database. The DWI iso option is also only available when 2 b values are selected.

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ADC and ADC iso

The Apparent Diffusion Coefficient (ADC) identifies the average diffusion as measured by the diffusion imaging sequence.

The ADC is given in 'mm^2/s' and can be expected to have an order of magnitude of 0.6 to 1.0 x 10^{-3} mm^2/s for a tissue like white matter.

The ADC can be obtained for each separate diffusion direction (identified as 'ADC') but also the average or isotropic ADC (ADC iso) can be obtained when enough non-colinear diffusion directions were acquired.

Tissue characteristics	Signal DW images	Signal ADC maps	Signal eADC maps
High ADC (rapid diffusion)	hypointense, more signal attenuation	High signal intensity	Low signal intensity
Low ADC (slow diffusion)	hyperintense, less signal attenuation	Low signal intensity	High signal intensity

Tab. 10: Signal in ADC and eADC maps

ADC maps provide anisotropic information and are available for each diffusion direction: S, M, P.

eADC and eADC iso

The exponential-ADC or eADC is used to show the diffusion weighting effect of a tissue. The eADC is calculated as exp(-b*ADC). In the eADC maps, CSF has very low signal so that subtle periventricular (e)ADC differences are more easily noticed.

FA (Fractional Anisotropy) map

Fractional anisotropy (FA) maps can be calculated from the DTI information. The FA values indicate the degree of anisotropy and range from 0 to 1. In case of no anisotropy (or normal isotropic diffusion, e.g. in grey matter tissue) the FA equals 0. For most white matter regions the FA value is much higher (for example, in the corpus callosum the FA value is around 0.6).

At least six different diffusion directions are needed to uniquely describe the diffusion pattern and to calculate the diffusion tensor matrix per pixel. From this calculation, the fractional anisotropy can be displayed in a FA map. High signal intensity corresponds to high fractional anisotropy and low signal intensity to low anisotropy.

Two different types of FA map are available: FA greyscale map (also referred to as FA map) and FA direction map.

FA (greyscale) map

Directional information is not provided.

FA Direction map

The color indicates the most important diffusion direction of a voxel:

- Blue for FH-direction.
- Red for RL-direction.

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- Green for AP-direction.

Advanced Diffusion Tensor Maps

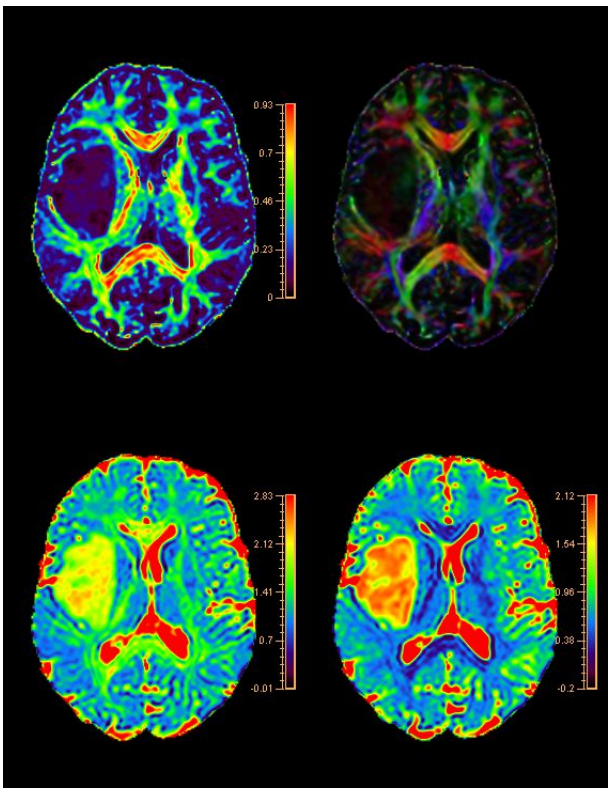

Fig. 66: Clockwise from upper left: FA, FA direction, Axial Diffusivity, Radial Diffusivity

Axial Diffusivity

The Axial Diffusivity map displays diffusivity along the principal axis. It is also called the longitudinal diffusivity or the parallel diffusivity. It is associated with neuro-degenerative diseases.

Radial Diffusivity

The diffusivities in the two minor axes are often averaged to produce a measure of radial diffusivity: $\lambda_\perp = (\lambda_2 + \lambda_3)/2.$

This quantity is an assessment of the degree of restriction due to membranes and other effects, and proves to be a sensitive measure of degenerative pathology in some neurological conditions. Radial diffusivity is used as a measure of myelin of white matter. It is also called the perpendicular diffusivity.

Relative Anisotropy (RA)

The RA maps appears very similar to the FA map. However, the RA map uses a slightly different calculation: $RA = \sqrt{\left((\lambda_1 - \overline{\lambda})^2 + (\lambda_2 - \overline{\lambda})^2 + (\lambda_3 - \overline{\lambda})^2\right)/3\overline{\lambda}}$

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8.1.9 MR FiberTrak

This postprocessing function provides an additional step in the Diffusion package, and is meant to visualize diffusion tensor data in the form of white matter tracts in Diffusion studies.

NOTICE

Visualization of fibers can be used to visualize the white matter structure in the brain. Together with other forms of MRI data it can give a more complete diagnosis.

Valid imaging series

A valid series for the FiberTrak step of Diffusion package is a Diffusion Tensor series containing at least 6 diffusion directions and a minimum of 2 b-values.

Functional Description

The MR FiberTrak application supports the user with the viewing, processing and analysis of Diffusion Tensor Imaging (DTI) data from MR diffusion imaging and with the creation and visualization of white matter tracks (or diffusional structure) in the brain and spinal tracts.

The MR Fibertrak application supports any related conditions for which tractography analysis is indicated to assist in therapeutic guidance, clinical decision making, or surgery preparation for central nervous system cancers, traumatic injuries and neurological disorders.

User Interface

Screen layout

The MR FiberTrak step of the MR Diffusion package has a default layout of a main viewport with three reference viewports to the right, and a toolbar, and task guidance panels to the left.

Main viewport

The large viewport contains a view of the selected dataset as a combination of three orthogonal slices. Rotating, panning and zooming this view allows viewing of white matter tracts from all angles.

Reference viewports

The small viewports each contain an orthogonal view and serve as reference views (from top to bottom: transverse, coronal, sagittal view). Each of the views is overlaid by colored lines indicating the position of the shown slices. The slices in the main viewport are linked to the slices in the orthogonal views.

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NOTICE

Please note that DTI and tractography are based on certain biophysical assumptions and mathematical approximations; their results should be interpreted in conjunction with conventional anatomical imaging as well as other clinical data including physical examination and, if clinically indicated, intraoperative subcortical stimulation.*

*ASFNR Guidelines for Clinical Application of Diffusion Tensor Imaging, 3/8/2012

Task Guidance

The MR FiberTrak step provides a task guidance panel in the left part of the screen. The task guidance panel provides the following steps:

- Select Underlay & Overlay
- Track Fiber Bundle
- Save Fiber Bundles

The Workflow section later in these Instructions for Use is based on this Task Guidance. For details, see chapter “Workflow” on page 625.

NOTICE

Follow the steps of the Task Guidance to make optimal use of the FiberTrak function.

Guidance

While you are locating fiber bundles, a guidance panel is optionally available on the right side of the main display area. The guidance panel provides information about locating common fiber bundles. Details of how to use this panel are provided in the following workflow description.

Toolbar

Orientation

Click the arrow next to the **Orientation** tool to display the slices in the main viewport in one of the following predefined orientations:

- **Axial Feet**
- **Anterior** (frontal)
- **Sagittal Left**

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View Slices

Click a slice indicator to show or hide any of the following slices in the main viewport:

- **Transversal Slice**
- **Coronal Slice**
- **Sagittal Slice**

Layout

Click the arrow next to the **Layout** tool to select one of the following layouts for the main display area:

- **Layout 1x1**
- **References at Right**

Each of the reference views displays one orthogonal slice. The other 2 orthogonal slices are represented by lines. The color of the lines indicates the plane of the slice.

In the reference views, you can adjust the position of slices by using the **Plane Position** interactor on the displayed slice, or by dragging the lines of the other slices. The position of the slice is shown in the upper-right corner of each reference view.

The plane of the slice is also shown in the upper-right corner of each reference view, and indicates the direction of fibers perpendicular to the slice.

Fiber Bundle Settings

1. The **Fiber Bundle Settings** dialog box is displayed. You can modify the following settings:
   - Minimum FA
   - Maximum Angle Change
   - Minimum Fiber Length

Optimum settings for the FiberTrak algorithm

It is difficult to define the best settings for tracking fibers. They depend on the quality of the data, the curvature of the expected tracts, and many other qualities of the underlying data. Lowering the FA and enlarging the Angle options will yield more fibers. This should only be done as long as the resulting tracts are shown as a coherent fiber bundle. Erroneous fibers will be shown when these values are too low.

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WARNING

When fibertract settings are changed to low values (meaning no signal threshold, very low FA, and very high curvature acceptance) the white matter tracts may include erroneous results.

This may consequently lead to misdiagnoses. It is advised to use default settings whenever possible.

NOTICE

Low SNR in the DTI dataset can influence the results, leading to limited or no tracts.

Follow Mouse

You can use the single point fiber tracking, also known as fiber probing.

To probe fibers, move/hover the mouse in the main viewer.

A fiber strand is displayed for the voxel at the current pointer position in the main viewer. Statistical values of the fiber strand are displayed beneath the main viewer (coordinates, fractional anisotropy (FA), and apparent diffusion coefficient (ADC)).

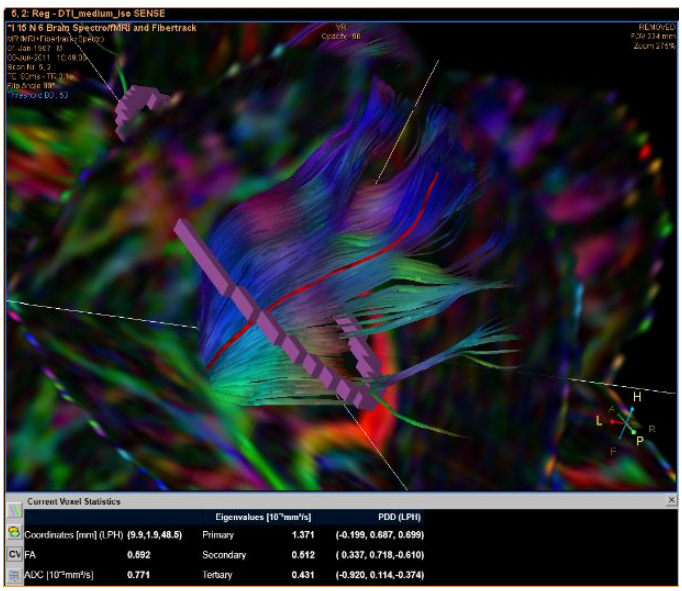

Fig. 67: Fiber probing with the Follow Mouse function

Single ROI in high density

An alternative fiber tracking algorithm uses neighbor voxels (high density) when tracking fibers with a single ROI. The default fiber tracking algorithm does not use neighbor voxels.

Tracking fibers with high density turned on is beneficial if you plan to exclude sections of the fiber bundle using an "exclude" ROI. In this case, use the **More** menu to select **Apply high density for all new single ROIs** to provide more consistent results.

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NOTICE

This option is for use when tracking fibers with a single ROI only. If you track fibers with multiple ROIs, the default fiber tracking algorithm is recommended.

Delete From Guidance

You can use the **More** menu to delete a fiber bundle from the guidance panel.

1. Click the arrow besides **More**.
2. Click **Delete From Guidance** in the **More** menu.
   ⇨ The **Delete Fiber Bundles From Guidance** dialog box is displayed.
3. Select the fiber bundles that you want to delete and click **Delete**.

More Functions within the FiberTrak step

The most important functions can be performed via the Task Guidance and the toolbar. However there are more functions which you can access via the right mouse menus.

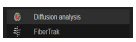
For more information, see chapter “Right mouse menus” on page 553.

Workflow

Launch the MR FiberTrak step from the MR Diffusion package

1. Select a suitable diffusion series from the series list and right click for the context menu.

2. Click 'MR Diffusion'.
   The MR Diffusion package opens.



3. Select FiberTrak from the task guidance panel on the left.
   ⇨ The MR FiberTrak step opens.

Select Underlay & Overlay

In this step of the FiberTrack process you can select an underlay and an overlay, if desired.

1. To show an underlay, select the check box next to the underlay selector to show the underlays.
   ⇨ A list of available underlays is displayed.
2. Select an underlay from the list, or click **Select Anatomical Series** at the top of the list.
   ⇨ If you clicked **Select Anatomical Series**, a dialog box is displayed with available anatomical underlays. Select an anatomical underlay and click **OK**. The anatomical series is automatically co-registered with the diffusion input series.

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⇨ If you clicked **Select Anatomical Series**, a dialog box is displayed with available anatomical underlays. Select an anatomical underlay and click **OK**. The anatomical series is automatically fused with the diffusion input series.

⇨ When used, an underlay adds additional anatomical information to the slices in the main display area.

NOTICE

When changing an anatomical underlay with results, all computed results are deleted. A message appears. Select **Continue** or **Cancel**.

If **Continue** is selected, all results are deleted. The new underlay is applied and is automatically registered with the overlay.

NOTICE

When changing an anatomical underlay with results, a message appears with two options: **Continue with removing previous registration of DTI and deleting fibers** or **Continue with previous registration of DTI and keeping fibers**.

Select an option and then select **Continue** or **Cancel**.

3. To select an overlay, select the check box next to the overlay selector in the task guidance panel.
4. Select an overlay from the list, or click **fMRI Statistical Parametric Maps** at the top of the list.

⇨ **FA Directional overlay**: The colors used in a directional map indicate the direction of diffusion:

- Blue: head and feet
- Green: anterior and posterior
- Red: right and left

⇨ If you clicked **fMRI Statistical Parametric Maps**, a dialog box is displayed with available fMRI maps. Select a map and click **OK**. The map is automatically co-registered with the diffusion input series.

⇨ If you clicked **fMRI Statistical Parametric Maps**, a dialog box is displayed with available fMRI maps. Select a map and click **OK**.

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Track Fiber Bundle

In this step of the FiberTrack process you draw ROIs in the main display area to track fiber bundles. A guidance panel is optionally available to help you locate and identify common fiber bundles.

Using the Guidance Panel

1. To display the guidance panel, select **Show guidance** in the task guidance panel.

   ⇨ The guidance panel is displayed on the right side of the main display area. It provides information about specific fiber bundles.

2. To show guidance for a different fiber bundle, click the fiber bundle name at the top of the guidance panel and select a fiber bundle from the list.
3. The guidance panel can be collapsed or expanded, to accommodate your workflow requirements.

   ⇨ In expanded mode, all text and image guidance panel for the selected fiber bundle is displayed in one scrollable panel.

- Click to collapse the guidance panel.

  ⇨ In collapsed mode, the guidance panel displays only images to indicate the location of the ROIs to track that fiber bundle.

- Click to view the text guidance associated with the currently displayed image.

  ⇨ Images are displayed in sequence, according to the actions needed to locate and identify a fiber bundle. Pause the pointer at the bottom edge of the guidance panel to display thumbnails of the images in the sequence, and then click an image thumbnail to display the image.

- Click to expand the guidance panel.

Tracking a fiber bundle

1. Manipulate the slices in the main display area to display the location of the start of the fiber bundle.

   To manipulate the slices, you can use the following tools in the right mouse menu:

   - **Plane Position**
   - **Pan**
   - **Zoom**
   - **Roll/Rotate**

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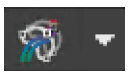
- **Gray Level**
- **Threshold**
- **Plane Opacity**

2. To change the position of a slice, you can also use the reference views: use the **Plane Position** interactor on the displayed slice, or by drag the lines of the other slices.
3. To display a predefined orientation, select an orientation using the **Orientation** tool in the toolbar.

   You can also select a predefined orientations using the **Switch To View** command in the right mouse menu.
4. To hide or show a slice, click one of the **View Slices** buttons in the toolbar.

   You can also hide or show slices using the **View Slices** command in the right mouse menu.
5. When the location of the fiber bundle is displayed, click one of the ROI tools in the task guidance panel.
   - **Multi ROI Manual Tracking**: This tool allows you to identify multiple ROIs and then manually start tracking them.
   - **Single ROI Auto Tracking**: This tool allows you to identify a single ROI and track it automatically.
6. 

   If the selected ROI tool does not display the type of ROI that you want to use, click the down arrow next to the tool and select one of the following ROI tools:
   - **Smoothed Polygon**
   - **Ellipse**
   - **Freehand Contour**
   - **Seed 2D**
   - **Seed 3D**
7. Create an ROI at the location of the fiber bundle.

   To create an ROI using the polygon, ellipse, or contour tool, select the tool and do the following:

   To create an ROI using one of the seed tools, select the tool and then click at the location of the fiber bundle.
   - Click at the edge of the fiber bundle location.

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- Move the pointer and click around the edge of the fiber bundle location.
- Double-click to complete the ROI.

⇨ If you used **Single ROI Auto Tracking**, the ROI is automatically tracked. If you are manually tracking multiple ROIs, continue with this procedure from the fiber tree.

8. If desired, you can remove the last drawn ROI. Do one of the following:
   - Press Ctrl+Z.
   - Right-click the ROI and then click **Delete** in the shortcut menu.
   - Right-click the image and then click **Delete Last Drawn ROI** in the shortcut menu.
9. If desired, modify the shape of the ROI by pausing the pointer over the edge of the ROI and then dragging.
10. To create another ROI, do the following:
    - Manipulate the slices to display the next location that the fiber bundle passes through.
    - Click the ROI tool in the Fiber bundles panel.
    - Draw the next ROI.
11. When you have finished drawing ROIs, click **Track** under the fiber bundle to track the fiber.

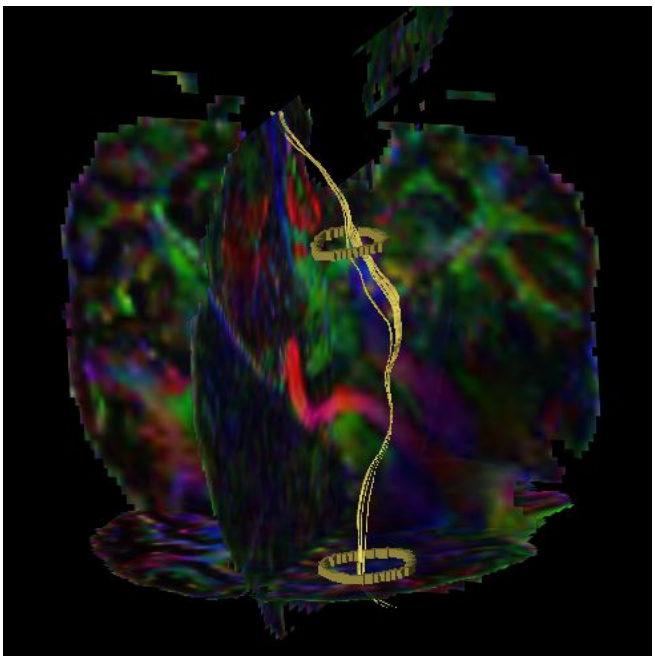

Fig. 68: Tracked fiber bundle

⇨ The tracked fiber bundle is displayed.

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Modifying the current fiber bundle

After creating a fiber bundle, you can edit it, or modify its appearance.

1. Right-click the current fiber bundle and then select an option from the shortcut menu.
   - **Edit**

     Use this option to modify or add ROIs.
   - **Hide**

     Use this option to hide the ROI in the display. You can show the ROI again at a later stage using the **Manage Fibers and ROIs** panel in the task guidance panel.
   - **Show ROIs**
   - **Use Directional Color**
   - **Color**

     Select a color from the submenu. This option is not available if **Use Directional Color** is selected.
   - **Delete**
   - **Edit settings**

     This option displays the **Fiber Bundle Settings** dialog box, which you can use to set configuration options for the fiber bundle.
   - **Rename**

Managing fiber bundles

You can manage fiber bundles that you have created using the **Fiber bundle** panel in the task guidance panel.

1. Click the down arrows in the task guidance panel.
   ⇨ The **Fiber bundle** panel is displayed automatically when a fiber is created. This panel contains color-coded entries for each fiber bundle and associated ROIs that you have tracked.
   ⇨ The **Fiber bundle** panel is displayed. This panel contains color-coded entries for each fiber bundle and associated ROIs that you have tracked.
2. To view the ROIs associated with a fiber bundle, expand the fiber bundle.
3. To display a fiber bundle or ROI in the main display area, click the item in the **Manage Fibers and ROIs** panel.
4. To turn the visibility of a fiber bundle or an ROI on or off, select or clear the check box next to the item.
5. To rename a fiber bundle or an ROI, right-click the item, click **Rename**, and then enter a new name.

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6. To delete a fiber bundle (and associated ROIs), right-click the fiber bundle and then click **Delete**.
7. To delete an ROI without deleting the fiber bundle, right-click the ROI and then click **Delete**.
8. To exclude an ROI from the calculation of the fiber bundle track, select **Exclude the new ROI**, before adding a new excluded ROI or right-click the ROI and then click **Exclude**.

   The ROI is not deleted, but it is marked as 'excluded', and the fibers contained in the ROI are not included in the tracked fiber bundle.
9. To include an ROI that you have previously excluded, right-click the ROI and then click **Include**.
10. To change the color of a fiber bundle, right-click the fiber bundle and select one of the following options:
    - **Use Directional Color**
    - Select a custom color from the **Color** submenu.
11. To add another ROI to a tracked fiber bundle, do the following:
    - Select the fiber bundle and click **Edit** in the task guidance panel, or right-click the fiber bundle and click **Edit**.
    - Manipulate the slices to locate the desired position of the ROI.
    - Draw the ROI.
    - In the task guidance panel, click **Track**.

Excluding fibers

You can explicitly exclude some fibers from a tracked fiber bundle.

1. Select the fiber bundle and click **Edit** in the task guidance panel, or right-click the fiber bundle and click **Edit**.
2. Manipulate the slices in the main display area to display the location of the fibers that you want to exclude.
3. Select an ROI tool in the task guidance panel.
4. Draw an ROI around the location of the fibers that you want to exclude, and double-click to complete the ROI.
5. Right-click the ROI and click **Exclude**.
6. Click **Track** in the task guidance panel to track the fiber bundle.

   ⇨ All fibers in the new ROI are excluded from the tracked fiber bundle.

Save Fiber Bundles

In this step of the FiberTrak process you can save fiber bundles with the series for review in a Viewer.

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Fiber Statistics

1. To show statistics about fibers and ROIs that you have created, click **Show fiber statistics**.
   ⇨ The statistics panel is displayed below the main viewport.

2. Click **Show Fiber Statistics** to display details of fibers.

3. Click **Show ROI Statistics** to display details of ROIs.

4. To export the statistics for fibers and ROIs, click **Export**, and then save the statistics file using the **Save As** dialog box..
   ⇨ The statistics file is saved in CSV format, which can be opened in a spreadsheet application.

5. To close the statistics panel, click the **Close** button in the panel's title bar.

Review and Edit Co-registration

When co-registration is performed, you should verify the accuracy of the registration. You can inspect and edit the registration using the **Inspect/Correct Data Alignment** step.

NOTICE

If you edit the registration and save your adjustments, all computed results are deleted.

1. Click **Review co-registration** in the toolbar to open the **Inspect/Correct Data Alignment** step.
   ⇨ The input series and the reference series are displayed as fusion views in three orthogonal orientations. You can change the orientation of the view, if desired.
   ⇨ The initial alignment is calculated using the **Normalized Mutual Information** algorithm.
   ⇨ The initial alignment is fusion of underlay and overlay.
2. To change the alignment algorithm, select an Auto-registration algorithm option from the drop-down list in the task guidance panel.
3. You can make the following manual adjustments to the registration using tools in the task guidance panel:

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- **Translation Tools**: Click an arrow to nudge the registration in the corresponding direction, or use the **Translate** tool to move the registration manually.
- **Rotation Tools**: Click an arrow to rotate the registration clockwise or counter-clockwise, or use the **Rotate** tool to rotate the registration manually.

4. To undo an adjustment, click **Undo**.
5. To reapply an adjustment that you have undone, click **Redo**.
6. To reset the registration to the original position, click **Reset All Alignment**.
7. To save the registration and continue with the analysis, click **Save**.
8. To ignore the changes, return to the Analysis application without saving changes.

WARNING

Before Analysis Alignment between functional and anatomical series, series should be inspected and corrected using the registration inspection step in IViewBOLD and FiberTrack. When saving changes performed in registration, all earlier computed results are deleted.

Creating and Saving Batches

You can create a batch of images and export from a volume using the Batch option in the Task panel.

The following batch types can be created:

Parallel: Creates a set of parallel slabs, in the current orientation of the slab displayed in the main image.

Freestyle: Creates a freestyle batch based on user-defined key-frames.

Creating a parallel batch

1. Select the **Batch/export to surgical navigation** icon (or via the **Batch** dropdown in the Task guidance panel.)
2. Select viewport in the viewing area and click **Parallel**.

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3. Navigate to the start point in the view and click **Start**.
4. Navigate to the end point in the view and click **End**.
5. If desired, select **Axial**, **Sagittal** or **Coronal** batch preset to create a parallel batch covering the entire volume.
6. If desired, modify the batch properties:
   - **Number of Images**: Number of images to be generated.
   - **Increment (mm)**: The incremental step size in terms of the distance between the centers of the slabs. Initially this is equal to the current slab thickness of the image in the viewport.
   - **Thickness (mm)**: The slab thickness of the images to be generated. This is always equal to the current slab thickness of the image in the view. This helps in previewing the quality of the final result.

   ⇨ The effect of the selected range is visible by means of reference lines in the reference images indicating the positions of the images that are to be generated.

   ⇨ The number of images and the incremental step size are linked. For example, increasing the number of images decreases the incremental step size, keeping the distance between the center of the first slab and the last slab constant.
7. To preview the batch, do one of the following:

   Click **Play/Stop** to preview the batch automatically.

   Click **Batch scroll interactor** to scroll through the batch manually.

   Clear batch is used for resetting the parameters for all kinds of batches, including parallel, radial and freestyle.

Creating a freestyle batch

1. Select the **Batch/export to surgical navigation** icon (or via the **Batch** dropdown in the Task guidance panel.)
2. Click **Freestyle**.
3. Navigate to the start point in the view and click **Add Key-frame**.
4. Manipulate the view to display the next point that you want to capture in the batch and click **Add Key-frame** again.

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5. Optional step: To remove the last Key-frame that you added, click **Remove last Key-frame**.
6. Continue to add Key-frames as desired.
7. To remove all Key-frames and start over, click **Remove all Key-frames**.

NOTICE

When creating a freestyle batch, reference lines of batch image positions are not displayed.

8. To preview the batch, do one of the following:
   - Click **Play/Stop** to preview the batch automatically.
   - Click **Batch scroll interactor** to scroll through the batch manually.
9. To adjust the speed of the move, drag the slider between **Slow** and **Fast**.
10. Enter a number in the **Playing time** box (measured in seconds) to set the duration of the movie.
11. Choose between setting a number of frames per second, or setting a total number of frames for the movie.

NOTICE

The speed and duration of the movie, and the number of images used are linked, and as you change one parameter, the other parameters are adjusted to achieve the requested result. Select one parameter that you wish to define and allow the application to configure the other parameters.

Saving a batch

1. To save the batch, click **Save as batch**.
2. The **Save Batch As** dialog is displayed, allowing you to select a file name, file format, and destination. You can save the series in DICOM format, or in non-DICOM format. If you select a non-DICOM format, you can additionally select a file system destination for exporting.
   - Select the Original (DICOM) option for a batch without fibers and overlay annotations.
   - Select the Secondary Capture (DICOM) option for a batch with fibers.
3. When saving the batch in Movie format, the following settings are available:

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- **Quality**: Drag the slider between **Low** or **High**. The higher the quality, the larger the size of the saved movie file.
- **De-identify**: When selected, the De-identify Patient dialog box is displayed, allowing you to manually typing new patient details (this function removes patient information before saving the movie).

4. Click **Save**.

⇨ The batch is automatically previewed once in the main display area before it is saved.

8.1.10 MR IViewBOLD

This processing package helps to identify active regions of the brain, relying on local metabolic and hemodynamic changes that occur in activated cortical brain. MR IViewBOLD indicates those pixels with a significantly increased signal intensity.

Contrast mechanisms

- **BOLD** (Blood Oxygen Level Dependent): During brain activation (increase of metabolism), the oxygen consumption of local tissue increases by approximately 5%.
- **Vasodilatation**: Vasodilatation occurs resulting in a local increase of blood volume and flow by 20% to 40%.

The above hemodynamic response to brain activation leads to an increased local oxygen level resulting in a signal increase in T2*W sequences.

Valid imaging series

- Heavily T2*weighted sequence. With matrices of around 64 - 96, this will yield a TR of 2 s to 4 s depending on the number of slices used.
- Dynamic study, e.g. 80 dynamics or more: Acquisition of 10 dynamics in rest, 10 dynamics during activation until a minimum number of dynamics (e.g. 80 is obtained).
- Basic fMRI BOLD scans typically take 4 min. to 5 min with typically 25 slices, 80 dynamics of 3 s each.
- Also the 3D PRESTO is often used for BOLD imaging (utilizing phase navigation). With this type of acquisition high temporal resolution can be produced by applying SENSE-factors in both phase and slice encoding directions.

Functional Description

The MR iViewBOLD application assists users in the processing, viewing and analysis of fMRI Data. The application is designed to support the user to identify and visualize functional regions of the brain, relying on local metabolic and hemodynamic changes that occur in activated brain areas.

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User Interface

Screen layout

The MR IViewBOLD package has a default layout of viewport displaying source images and panels to the left.

Task Guidance

The MR IViewBOLD package provides a Task Guidance panel in the left part of the screen.

The Workflow section later in these Instructions for Use is based on this Task Guidance. For details, see chapter “Workflow” on page 640.

NOTICE

Follow the steps of the Task Guidance to make optimal use of the IViewBOLD function.

Task guidance depends on the computation method that you want to use from Analyze SPMs in the left task guidance.. The available methods are described below.

Compute Using "Block" Paradigm

The block paradigm is typically used to detect correlations between brain activation and a task that the subject performs during the scan. A block paradigm requires that the subject perform a certain task in time blocks that are interleaved with time blocks of rest.

- Set Smoothing Width
- Select Anatomical Underlay
- Select Paradigm
- Compute SPMs
- Save SPMs

A block paradigm calculates statistical parameter maps based on activation and control tasks performed for a duration of at least a few dynamics.

Compute Using "Event" Paradigm

The event paradigm is used to discover correlations with specific cognitive states that are induced in the subject, such as memory and recognition. Typically this is done by randomly offering the subject a known visual stimulus, such as a picture.

- Set Smoothing Width
- Select Anatomical Underlay
- Select Paradigm
- Compute SPMs
- Save SPMs

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An event paradigm calculates statistical parameter maps using randomized stimuli (not task based, as with the block paradigm).

Compute Using "Resting State" Data

Brain activity is present even in the absence of an external task, and the resting state paradigm evaluates such interactions that occur in the brain when the subject is resting. This activity represents the functional connectivity of a number of networks which are consistently found in healthy subjects, and which represent specific patterns of synchronous activity. The resting state paradigm is useful for exploring whether the functional organization of the brain is altered in neurological or psychiatric diseases.

- Set Smoothing Width
- Select Anatomical Underlay
- Draw a ROI to automatically generate a paradigm
- Save SPMs

Compute using resting state data allows you to draw a contour on the anatomy to set the reference area for SPM calculation. Fluctuations in the BOLD signal during resting state (as a result of tissue vascularization, for example) can be indicators for disease.

More Functions within the MR IViewBOLD package

In the MR packages, the most important functions can be performed via the Task Guidance and the toolbar. However there are more functions which you can access via the right mouse menus.

For more information, see chapter “Right mouse menus” on page 553.

The following functions are available:

- Manage Paradigms
- Use Smoothing Step
- Show Skip Dummy Dynamics Step
- Series selection for multi sessions

Manage Paradigms

A paradigm is a set of instructions that are given to the patient during acquisition. These instructions are focused on delineating a certain area of brain function.

The **Manage Paradigms** function allows you to add, edit, or delete paradigms using the **Manage Paradigms** dialog box.

1. To add a new paradigm, click **New** in the **Manage Paradigms** dialog box.

   ⇨ The **Paradigm Editor** is displayed. The Paradigm Editor consists of the following two steps:

- Step 1: Select the paradigm type and provide a name for the new paradigm.
- Step 2: Configure the paradigm tasks.

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2. To create a block paradigm, do the following in Step 1 of the Paradigm Editor:
   - Select **Block Paradigm**.
   - Select whether to measure the duration in **Seconds** or **Dynamics**.
   - Enter a unique name for the paradigm.
3. Click **Next** to move to Step 2 of the block paradigm process in the Paradigm Editor.
4. At the top of Step 2 of the Paradigm Editor, select whether blocks will run sequentially or whether they can run in parallel.
5. Click the down arrow in the first task box, and select a rest period.
6. Continue to add tasks and rest periods as desired.
7. To assign or change color overlay, click on the color legend next to the added task and select from the predefined color presets.
8. Continue adding tasks or rest periods until the block paradigm is configured.
9. To change the duration of a task or rest period, drag the end sliders to the corresponding block.
10. To remove a block, click **Delete** next to the block.
11. Click **Save** to save the block paradigm.
12. To create an event paradigm, do the following in Step 1 of the Paradigm Editor:
    - Select **Event Paradigm**.
    - Click **Browse** and select the event file that you want to use.

      Presentation files can be selected for analysis of events created with Presentation software.
    - Enter a unique name for the paradigm.
13. Click **Next** to move to Step 2 of the event paradigm process in the Paradigm Editor.

    ⇨ Tasks for the event paradigm are configured according to the events file specified in Step 1.
14. Click **Save** to save the event paradigm.
15. To modify an existing paradigm, select the paradigm in the **Manage Paradigms** dialog box and click **Edit**.

    Modify the settings of the paradigm using the Paradigm Editor (you can't change the type of paradigm).
16. To create a copy of an existing paradigm, select the paradigm in the **Manage Paradigms** dialog box, click the down arrow next to the **New** button and then click **Copy**.

    ⇨ A copy of the selected paradigm is added to the paradigm list as a new paradigm. You can then modify the new paradigm using the Paradigm Editor.
17. To delete an existing paradigm, select the paradigm in the **Manage Paradigms** dialog box and click **Delete**.

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Show Smoothing Step

This function is enabled by default and is available in the task guidance panel when you start IViewBOLD. If desired, you can hide this function. For details, see chapter “Set Smoothing Width” on page 641.

Show Skip Dummy Dynamics

Selecting the **Show Skip Dummy Dynamics** option in the **More** menu adds an optional step to the task guidance panel called **Skip Dummy Dynamics**.

Skipping dynamics allows you to ignore a number of the initial dynamics, in which the steady state may not have been reached. This may be apparent as "dummy scans" in the Time Intensity Display. Skipping these dynamics improves the analysis. After skipping dynamics, you need to compute the SPMs again.

This optional step is available for all computational methods.

Series selection for multi-sessions

Use this function to add series to the selection when you are performing a multi-session analysis. When you select this item, the **Select Series** dialog box is displayed, allowing you to select additional series.

Workflow

Launch the MR IViewBOLD package

1. Select a suitable fMRI series from the series list and right click for the context menu.

2. Click ‘MR IViewBOLD’.

   The MR IViewBOLD package opens.

Review and Edit Co-registration

When co-registration is performed, you should verify the accuracy of the registration between the functional and anatomical series. You can inspect and edit the registration using the **Review and edit co-registration** step.

NOTICE

If you edit the registration and save your adjustments, all computed results are deleted.

1. Click **Review co-registration** in the toolbar to open the **co-registration** step.

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⇨ The input series and the reference series are displayed as fusion views in three orthogonal orientations. You can change the orientation of the view, if desired.

⇨ The initial alignment is calculated using the **Normalized Mutual Information** algorithm.

⇨ The initial alignment is fusion of underlay and overlay.

2. To change the alignment algorithm, select an Auto-registration algorithm option from the drop-down list in the task guidance panel.
3. You can make the following manual adjustments to the registration using tools in the task guidance panel:
   - **Translation Tools**: Click an arrow to nudge the registration in the corresponding direction, or use the **Translate** tool to move the registration manually.
   - **Rotation Tools**: Click an arrow to rotate the registration clockwise or counter-clockwise, or use the **Rotate** tool to rotate the registration manually.
4. To undo an adjustment, click **Undo**.
5. To reapply an adjustment that you have undone, click **Redo**.
6. To reset the registration to the original position, click **Reset to default registration**.
7. To save the registration and continue with the analysis, click **Save**.
8. To ignore the changes, return to the Analysis application without saving changes.

Set Smoothing Width

Selecting the **Show Smoothing Step** option in the **More** menu adds an optional step to the task guidance panel called **Set Smoothing Width**. Smoothing reduces noise level while retaining the underlying signal.

NOTICE

If very small activation regions are expected, smoothing should not be performed to avoid signal reduction.

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This step is optional, but it is enabled by default when you start IViewBOLD. If desired, you can hide this function.

This step is available for all computational methods.

1. To adjust the smoothing width, drag the slider in the task guidance panel.
   ⇨ An appropriate setting for the smoothing width is twice the in-plane resolution (voxel size) of the images.
   ⇨ To fine-tune the smoothing width by small increments, click the slider control and then use the left and right arrow keys on the keyboard.
   ⇨ Increasing the smoothing width smooths the boundaries of calculated areas. This reduces noise in the image, but also reduces spatial resolution.

WARNING

Software does not recognize wrong correlation between tasks specified by input paradigm and acquired data. Correlation can be manually checked by users using time intensity display.

Anatomical Series

If desired you can select an underlay to provide additional anatomical information in the image.

1. To display an anatomical underlay, select **Use anatomical series as underlay** in the task guidance panel.
   ⇨ Select a different anatomical series from the drop down list using select anatomical series dialog box.
2. Select a series from the dialog box and click **OK**.
   ⇨ The anatomical series is loaded as an underlay in the main viewport with co-registration. The name of the series used is displayed in the task guidance panel.

NOTICE

When changing an anatomical underlay with results, all computed results are deleted.

The new underlay is applied and is fused with the overlay. When changing an anatomical underlay without results, the previous underlay registration is discarded and the new underlay is applied and is fused with overlay.

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3. To hide the underlay, clear the **Use anatomical series as underlay** check box in the task guidance panel.
   ⇨ The underlay remains available in the task guidance panel. To display it, select the check box again.
4. To use a different series as the underlay, click the **Select** dropdown list and choose an alternative series, if available.

Analyze SPMs

NOTICE

This task is applicable to block and event paradigms only. For Resting State Data, continue to the "Compute SPMs" task.

1. Click the down arrow in the **Select Paradigm** box in the task guidance panel and select the paradigm that you want to use for the analysis.
2. Optional step for Event paradigms: you can override the configured event file for the paradigm and use a file with different timepoints. Select **Change the Event File** and click **Browse** to select an alternative file.
3. In the **Select SPMs** tasks for display box, select the statistical parameter maps that you want to calculate.
4. To assign or change color overlay, click on the color legend next to the added task and select from the predefined color presets.

Compute SPMs

1. Additional step for Resting State Data only: Select an ROI tool in task guidance panel and draw a contour on the anatomy to set the reference area for SPM calculation.

   Click the arrow next to the ROI tool to access the following options:

   - Smoothed Polygon
   - Ellipse
   - Freehand Contour
2. If desired, you can remove the last drawn ROI. Do one of the following:
   - Press Ctrl+Z.

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- Right-click the ROI and then click **Delete** in the shortcut menu.
- Right-click the image and then click **Delete Last Drawn ROI** in the shortcut menu.

3. For all paradigms or Resting State Data: In the Compute SPMs section of the task guidance panel, select the masks to be used for the computation. The following masks can be used separately or together:
   - Select **Apply Default Mask** to use the default correction algorithm. This mask suppresses calculation and display of activation areas outside the brain. It also provides faster calculation.
   - Select **Suppress Motion Related Artifacts** to use the motion correction algorithm. However, if the motion has a similar pattern to the stimulus, it may also reduce interesting activation.

NOTICE

When analyzing series that have been registered on the MR console, the option to suppress motion-related artifacts option is not available.

4. Click **Compute SPMs** to start the analysis and display the statistical parameter maps in the main viewport.

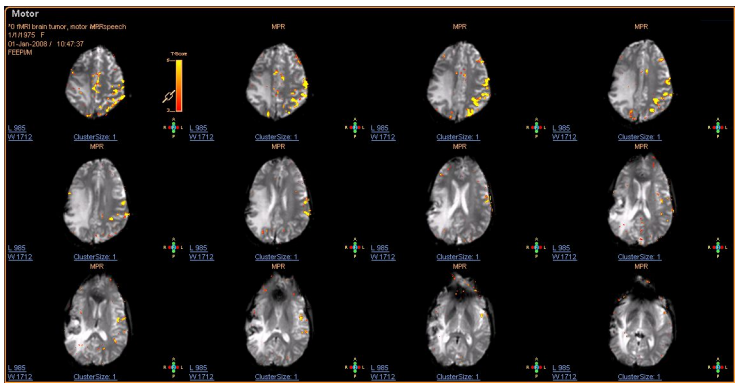

Fig. 69: Statistical parameter maps after computation

5. To change the layout of the tiled viewports, right-click a viewport and select a new layout in the right mouse menu.
6. To change SPM (Statistical Parameter Map) color overlay, right click on the image, select **Color** and select from the predefined color presets.
7. To change the T-score of the colormap, move the pointer over the upper threshold or the lower threshold, and drag up or down to change that threshold.

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⇨ The T-score range is indicated in the colormap legend in the viewport. Changing the T-score allows you to increase or decrease the range of pixels included in the color overlay.

8. To change the blending (transparency) of the SPMs, right-click the image and click **Alpha Blending** in the right mouse menu.
   - Drag up or down to adjust the blending. The level of blending is displayed as a percentage at the top of the viewport.
9. Double-click a viewport to view a single slice in detail.
10. To view the Time Intensity Display (TID) for an activation area, right-click the activation area and click **Show TID** or select Mark activation area for TID and place the seed point on the image at the center of the activation area.
11. **Limit TID Computation to Marked Slice Only**: By default the Time Intensity Display shows the average value of the total 3D activation volume. Set this option to limit the computation to the 2D area in the selected plane.

⇨ The TID is displayed below the viewport, with the average TID displayed in the graph on the left.

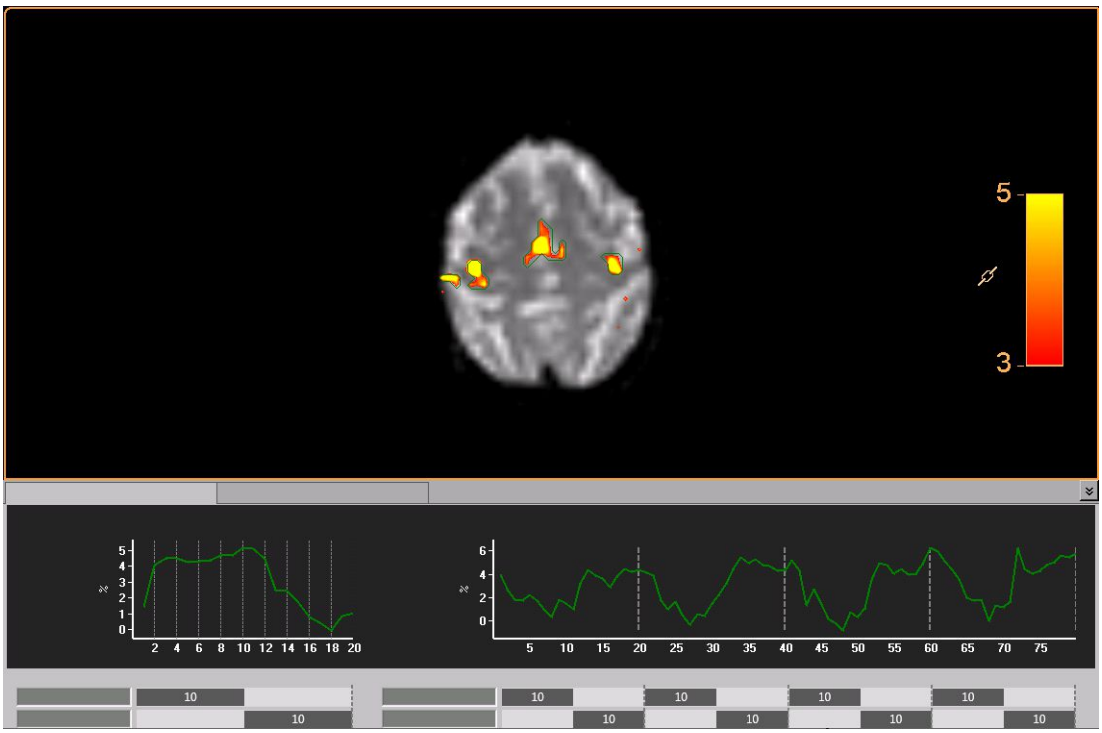

Fig. 70: Time Intensity Display for a picked activation area

⇨ If the signal response was taken from a region of interest with a high statistical value, the response should closely follow the applied paradigm.

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⇨ You can hide or show the TID by clicking the double arrow in the upper-right corner of the TID.

⇨ The colormap scale is displayed on the right side of the viewport. By default, only positive values are displayed.

12. To view negative values, right-click the viewport and click **Also Show Negative T-Scores**.

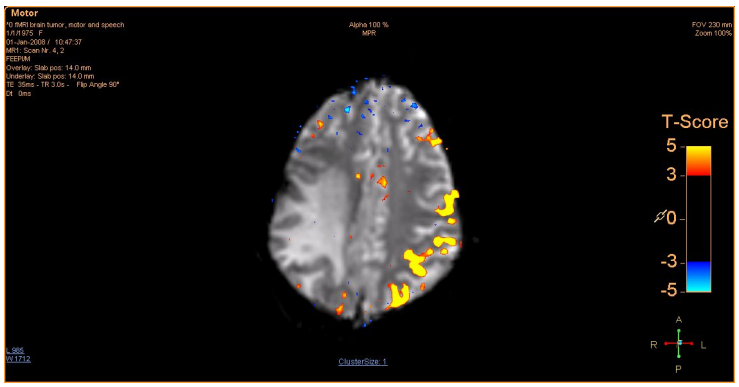

Fig. 71: Displaying negative T-Scores

13. To view the Quality Check graph, click the **fMRI Quality Check Graph** tab above the TID display.

⇨ The Quality Check graph is displayed below the viewport.

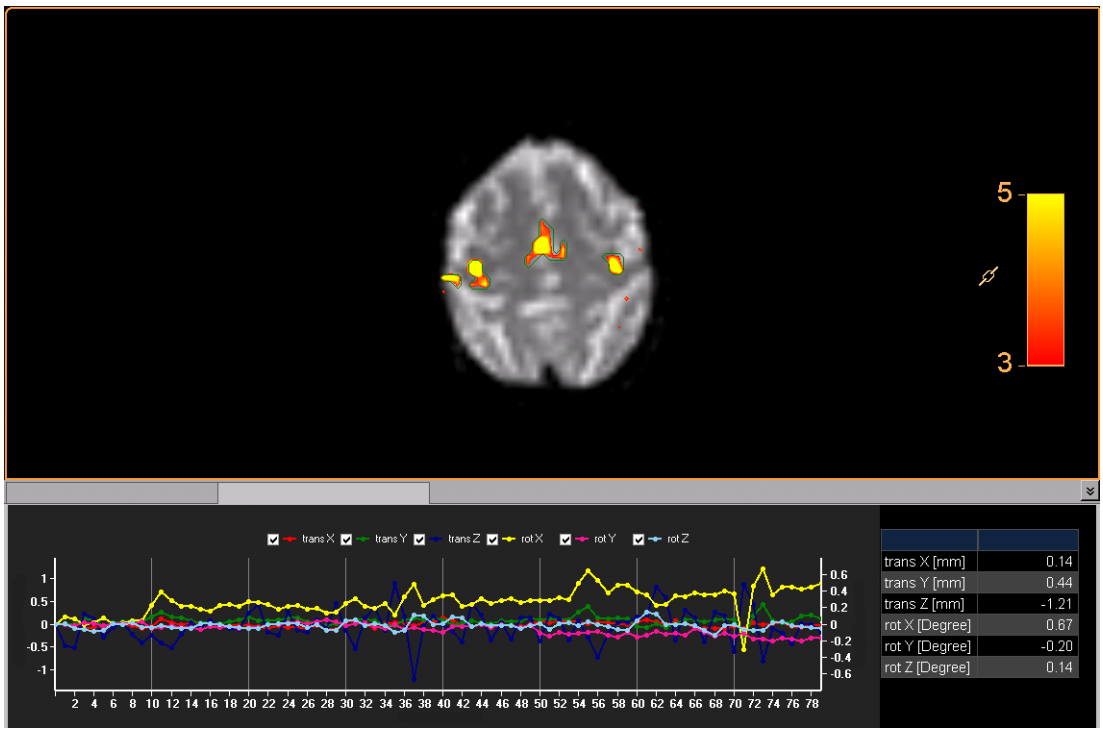

Fig. 72: fMRI Quality Check Graph

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⇨ The left axis of the Quality Check graph displays the translation in mm symmetric around zero, and the right axis displays the rotation in degrees symmetric around zero. The graph uses the following colors:

⇨ You can show or hide individual plots using the check boxes above the graph.

- Red: **trans x** (representing the shift in the x direction)
- Green: **trans y** (representing the shift in the y direction)
- Dark blue: **trans z** (representing the shift in the z direction)
- Yellow: **rot x** (representing the rotation around the x-axis)
- Pink: **rot y** (representing the rotation around the y-axis)
- Light blue: **rot z** (representing the rotation around the z-axis)

14. To change the cluster size, click the **ClusterSize** viewport control and enter a value.

⇨ Changing the cluster size allows you to filter out smaller activation areas or "false positives".

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WARNING

Before Analysis Alignment between functional and anatomical series, series should be inspected and corrected using the registration inspection step in IViewBOLD and FiberTrack. When saving changes performed in registration, all earlier computed results are deleted.

Save SPMs

1. To save the statistical parameter maps, enter a name in the **Save SPMs** section of the task guidance panel and click **Save**.

⇨ The saved SPMs are saved with the series and are available from the **Series** panel.

8.1.11 MR Cartilage Assessment

The Cartilage Assessment package can be used for the quantitative analysis of cartilage and cartilage lesions. It is based on the difference between T2 relaxation times of healthy and damaged cartilage.

Valid Imaging Series

A Multi-Echo Spin-Echo series with all echoes is required to analyze the T2 times in the Cartilage Assessment package. The analysis also requires a calculated T2 map, but if map calculation was not enabled in the ExamCard when scanning, a T2 map is automatically calculated when a series is opened.

In order to provide good results, a certain minimum quality of data is needed. A preset procedure is available to generate such data (anatomy folder 'Knee Other').

Functional Description

The MR Cartilage Assessment application is intended to assess the integrity of cartilage on MRI Data.

User Interface

Screen layout

The Cartilage Assessment (CA) package has a default layout of four viewports with toolbar and panels. The viewports display the following views:

- Source image in the middle of the imaging volume, 1st echo.
- In real-time calculated Parametric CA maps with color bar:
  - Shortest T2 values: dark red to red,
  - intermediate T2 values: yellow to green,
  - longest T2 values: blue.
- Numerical results.
- Graphical results.

Task Guidance

The Cartilage Assessment package provides a Task Guidance panel in the left part of the screen. The task guidance panel provides the following functions:

- Rectangular layered ROI
- Curved layered ROI
- Optimize Color Overlay
- Generate Series

Follow the steps of the Task Guidance to make optimal use of the package.

The following workflow description is based on this Task Guidance.

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NOTICE

The Task Guidance contains the most important functions, but not in a step-by-step procedure. Perform the required steps for optimal results for your scan and your needs.

NOTICE

Standard Measurements like retrieving a pixel value or measuring a distance can be performed via the Common Tools panel.

Toolbar

The toolbar functions are meant to customize the presentation of the T2 maps. The T2 values in the parametric maps are directly related to specific colors, and the color coding can be set to predefined values, but can also be adjusted according to everyone's needs.

Color Map

- To select the color look-up table for the maps.

  Possible settings are: 'Rainbow', 'Reversed Rainbow' and 'Autumn'.

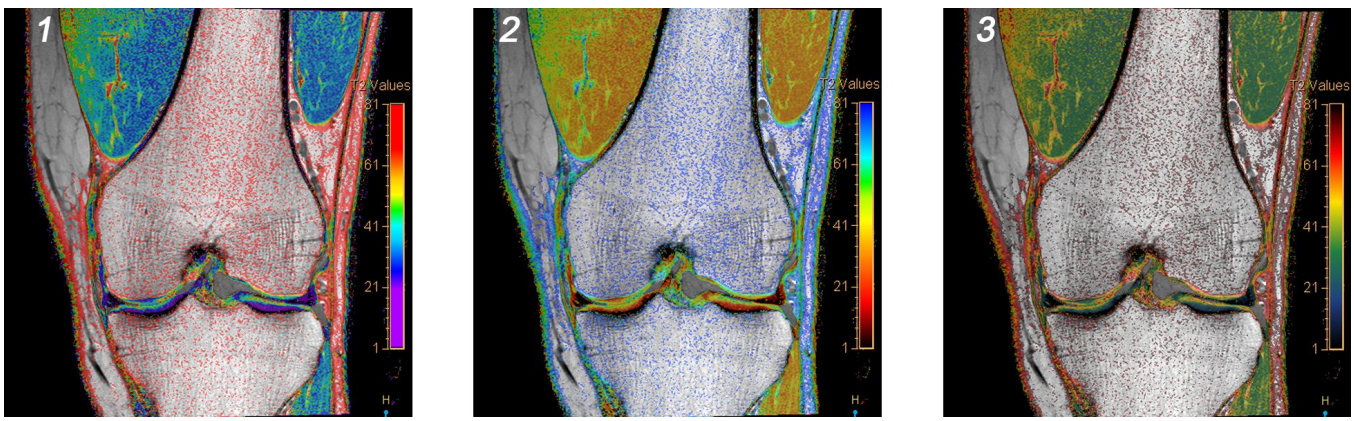

Fig. 73: Examples of the color maps. 1 - Rainbow, 2 - Reverse Rainbow, 3 - Autumn.

Color LUT	Minimum value				Maximum value
Rainbow	Violet	Blue	Lightblue/ Green	Yellow/ Orange	Red
Reverse Rainbow	Black/Red	Orange	Yellow	Green	Blue
Autumn	Black/Blue	Green	Yellow	Orange	Red/Black

Color Range

- To select a predefined color range or to adjust the color range according to the own preferences.

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Possible settings are: '1-81', '0-100' and 'Modify Range'.

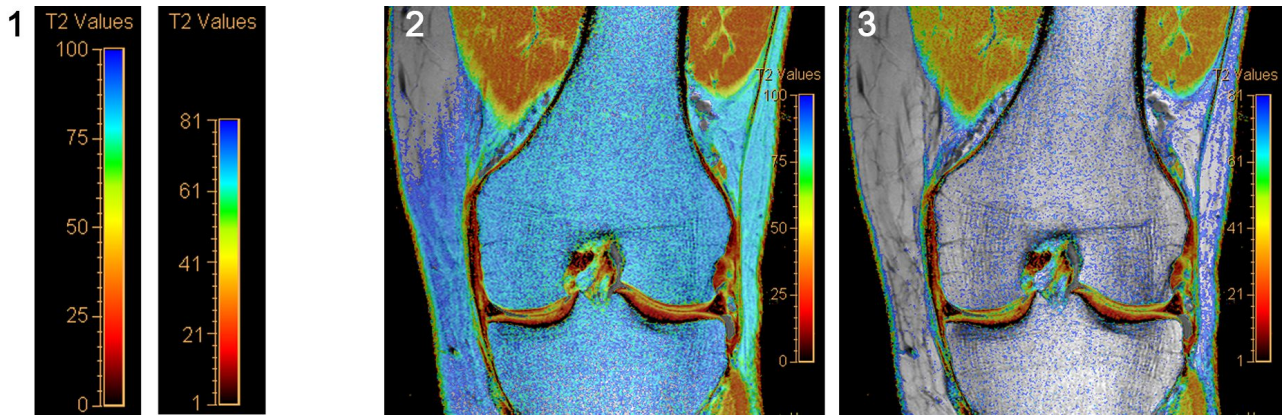

Fig. 74: 1: Color bars of 0-100 and 1-81 besides each other to visualize the effect on the color display. 2: Reversed Rainbow color map with color range 0-100 . 3: Reversed Rainbow color map with color range 1-81.

More Functions within the Cartilage Assessment package

The most important functions can be performed via the Task Guidance and the toolbar. However there are more functions which you can access via the right mouse menus.

For more information, see chapter “Right mouse menus” on page 553.

Export the results

1. Press CTRL+C to export the results as CSV file (Comma Separated Values) to the clipboard.
2. In a spreadsheet application, press CTRL+V to paste the CSV file.

Workflow

Launch the MR Cartilage Assessment package

1. Select a suitable cartilage multi-echo series and right click for the context menu.

2. Click ‘MR Cartilage Assessment’.

   The MR Cartilage Assessment package opens.

Scroll through images

Through echoes

1. In the image or map viewport, drag to the left or to the right.

Through slices

1. In the image viewport, drag up- or downwards.

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Standard Measurements

Standard ROIs can be used to quickly analyze focal lesions. For each ROI, the average relaxation time and standard deviation is calculated and displayed on screen. Additionally, it is possible to measure distances and read the pixel values. The standard measurements are available via the Common Tools panel.

1. In the Common Tools panel, click on the arrow to open the Standard Measurement drop-down menu.

   This menu offers the options:

   - Point
   - Smoothed Contour
   - Rectangle
   - Ellipse
   - Distance

2. Select any of the Standard Measurements and proceed as described below.

Point

1. Select 'Point'.
2. Click any pixel in the source image and/or in the map.

   The pixel value for this pixel will be displayed.

3. Click any pixel in the map.

   The calculated T2 relaxation time in milliseconds for this pixel will be displayed.

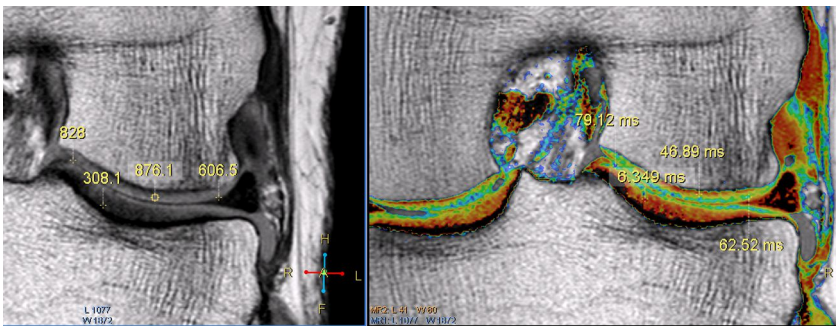

Fig. 75: Pixel value measurement. Left: on source image. Right: on map.

Smoothed Contour

1. Click once to define one point of the ROI contour. Repeat this till the contour is completed. When finished, double-click to confirm the ROI.
2. Do this on the source image and/or on the map.

   The results will be displayed per ROI:

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- the area in mm^2
- the mean value (pixel value on the source image and relaxation time on the map)
- the standard deviation (pixel value on the source image and relaxation time on the map)
- the minimum value (pixel value on the source image and relaxation time on the map)
- the maximum value (pixel value on the source image and relaxation time on the map)

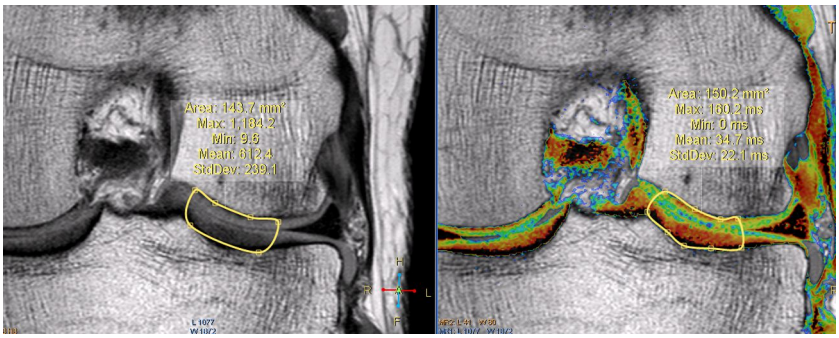

Fig. 76: Freehand measurement. Left: on source image. Right: on map.

Rectangle

1. Click once to define the first vertex of the rectangular ROI.
2. Click again to define the second vertex.
3. Move the mouse to enlarge/reduce the immediately displayed rectangular ROI.
4. Click to confirm the opposite border and in this way the rectangular ROI.
5. Perform the previous steps on the source image and/or on the map.

   The results will be displayed:

   - the area in mm^2
   - the mean value (pixel value on the source image and relaxation time on the map)
   - the standard deviation (pixel value on the source image and relaxation time on the map)
   - the minimum value (pixel value on the source image and relaxation time on the map)
   - the maximum value (pixel value on the source image and relaxation time on the map)

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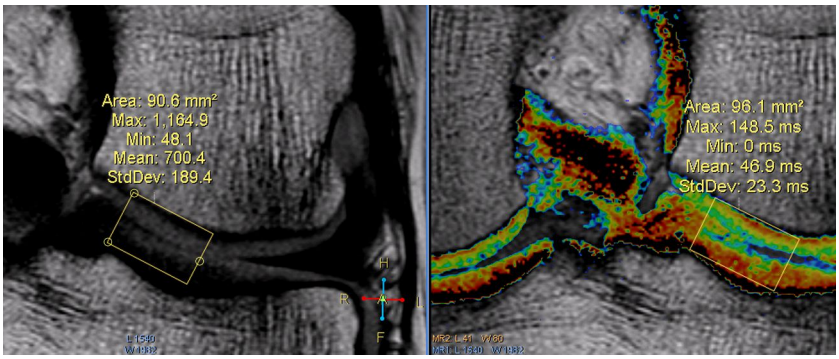

Fig. 77: Standard Measurement Rectangular on source image and on map with results. On the map the 3 anchor points (2 vertices and the 3rd one to define the opposite border) are visible.

Ellipse

1. Click once to define the first point of the ellipse.
2. Click once more to define the width of the ellipse.
3. Move the mouse to enlarge/reduce the immediately displayed ellipse.
4. Click to confirm the ellipse.
5. Perform the previous steps on the source image and/or on the map.

   The results will be displayed:

   - the area in mm^2
   - the mean value (pixel value on the source image and relaxation time on the map)
   - the standard deviation (pixel value on the source image and relaxation time on the map)
   - the minimum value (pixel value on the source image and relaxation time on the map)
   - the maximum value (pixel value on the source image and relaxation time on the map)

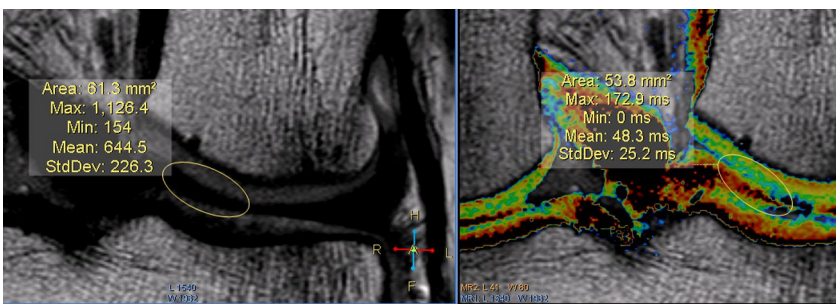

Fig. 78: Standard Measurement Ellipse on source image and on map with results. On the map the 4 anchor points (defining length and width) are visible.

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Distance

1. Click to define the first point.
2. Click to define the second point.

   The result in mm is displayed immediately.

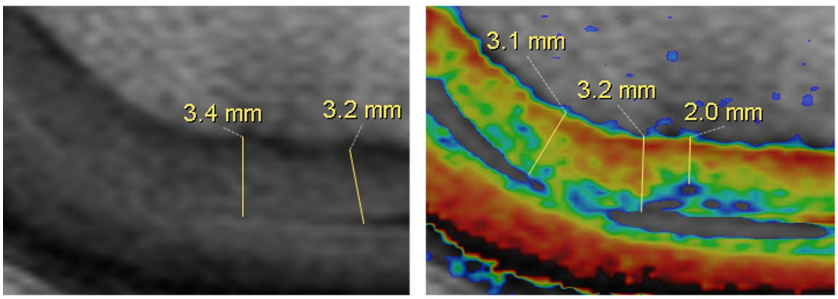

Fig. 79: Standard Measurement Distance on source image and on map.

Rectangular Layered ROI

Rectangular layered ROIs can be used to analyze focal lesions. A ROI is divided into layers. For each layer the average relaxation time is calculated. Place the first two points on the bone interface and the final point at the cartilage surface.

▷ You can draw a rectangular layered ROI on the map and on the source image.

1. Zoom the images for best cartilage visualization.
2. Optionally: drag the slider to reduce the number of layers from 3 to 1 or 2.
3. Click 'Draw layered ROI'.
4. Click on the bone interface to define the first vertex of the rectangular layered ROI.
5. Click once more on the bone interface to define the second vertex.
6. Move the mouse to resize the immediately displayed rectangle.
7. Click to define the third anchor point on the opposite border of the ROI and in this way to confirm the ROI.

   The ROI is automatically divided in the three layers (depending on the layer slider this might also be two or one): Deep, Intermediate and Superficial, and the numerical and graphical results are displayed.

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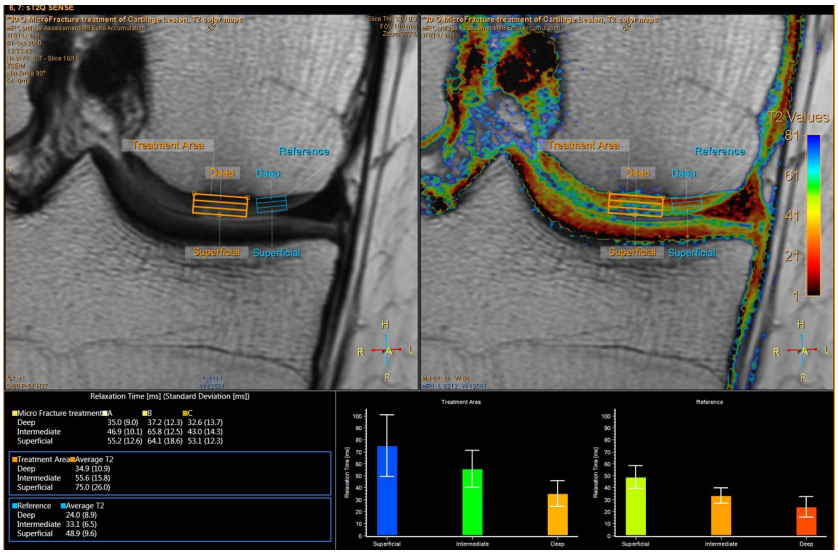

Fig. 80: Rectangular Layered ROI on map and source image with results. The 3 anchor points are visible on both images.

8. **To modify a current ROI**
   - Move the cursor over the ROI to make it current.

     The ROI lines will show up thicker and the anchor points will be displayed.
   - Then click any of the anchor points to resize or angle the ROI.
   - Click and drag in the center of the ROI to move it.

9. **To draw multiple ROIs**
   - Click 'Draw layered ROI' to enter drawing mode again.
   - Then repeat the above mentioned steps.

Curved Layered ROI

Curved Layered ROIs can be used to analyze complete cartilage structures. A ROI is divided into layers and segments. For each cell the average relaxation time is calculated.

A ROI is defined by drawing two curves. The first curve is drawn along the bone interface, the second along the cartilage surface. Draw curves by placing multiple points and close the drawing by double-clicking the last point.

▷ You can draw a curved layered ROI on the map, on the source image and even on the map AND the source image.

NOTICE

Entanglements are automatically disentangled.

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1. Zoom the images for best cartilage visualization.
2. Optionally: drag the slider to reduce the number of layers from 3 to 1 or 2.
3. Optionally: drag the slider to reduce the number of segments from 3 to 1 or 2.
4. Optionally: reduce the opacity of the color map to better visualize the cartilage structure.
5. Optionally: select a source echo that best depicts the cartilage structure and or lesion.
6. Click 'Draw bone interface'.
7. Click several times to define multiple points along the bone interface.
8. Double-click to confirm this contour.
9. Click 'Draw cartilage surface'.
10. Click several times to define multiple points along the cartilage surface.

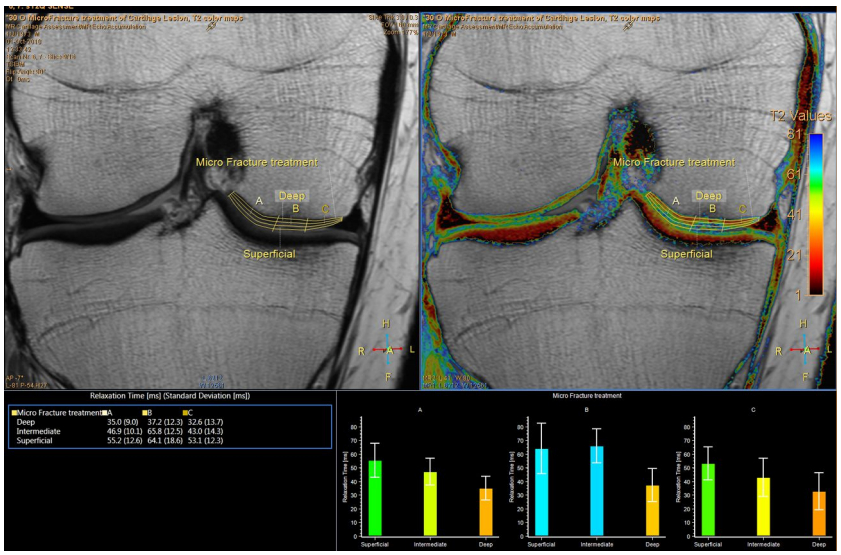

Fig. 81: A: Drawing bone interface. B: Drawing cartilage surface. The anchor points are visible for both workflow steps.

11. Double-click to confirm this contour and in such a way the ROI.

    The curved layered ROI is automatically divided into multiple cells (layers and segments).

    The numerical and graphical results are displayed immediately.

12. **To draw multiple ROIs**

    - click 'Draw bone interface' and 'Draw cartilage surface' to enter drawing mode again.
    - Then repeat the above mentioned steps.

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Modify a ROI (or line)

Once you've confirmed a ROI (or line), you can still adjust its shape, its position and rename or delete it.

Adjust ROI shape and position

1. Click on an anchor point and drag to adjust the ROI shape.
2. Click between anchor points and drag to adjust the ROI position.
3. Press and hold 'Ctrl' while clicking between anchor points to add an anchor point.

Rename a ROI

1. Double-click the name (by default ROI1, ROI2, ROI3 etc).
2. Delete characters where needed and type the new name.

- It is advised to rename the ROIs for easier identification (e.g. lesion, healthy). It might be helpful to add the slice number to the name so that navigation to the respective ROI is facilitated.

Delete a ROI

1. Move the cursor over the ROI to make it current.
2. Right-click on the ROI and select ‘Delete’.

Optimize Color Overlay

The presentation of the color maps can be customized by limiting color display to relevant areas and by adjusting the color opacity.

1. Click the checkbox in the task guidance to enable (or disable) 'Suppress Colors outside ROIs'.

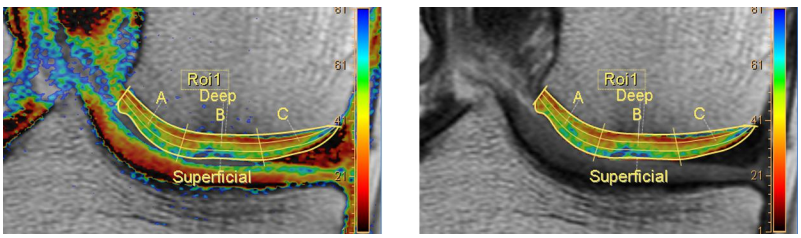

Fig. 82: Left: No suppression of colors outside ROIs. Right: Suppressed colors outside ROIs.

2. Click 'Draw color cut-out region' to enter drawing mode.
3. Click several times to define a color cut-out ROI.
4. Double-click to close and confirm the ROI.

   Colored areas outside the ROI will be displayed without color overlay immediately.

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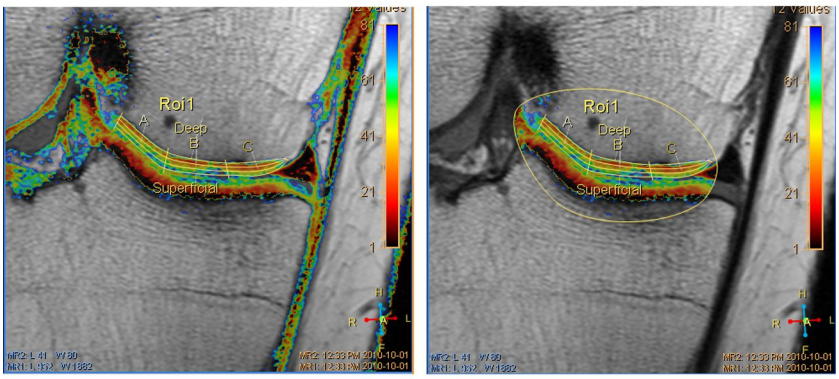

Fig. 83: Left: No cut-out ROI. The colors outside the ROI are not yet suppressed. Right: Cut-out ROI drawn and colors outside the ROI are suppressed.

Generate Series

You can generate a new imaging series containing the parametric maps and results as defined in the previously described workflow.

1. Click 'Generate Series'.
2. Enter the name of the new imaging series.

NOTICE

Once maps are generated via 'Generate series', these maps behave differently when viewing them.

Generated Maps cannot be used anymore for measurements. ROIs are not displayed. If a cut-out ROI is drawn to supress colors outside, the outline of that ROI will be supressed.

NOTICE

Newly generated series can easily be compared in the Viewer.

Results

The package calculates the T2 relaxation times per voxel (using Ratio Least Squares method) and presents them as:

- parametric Cartilage Assessment map
- as numerical results in a table
- as graphical results in a bar chart display.

Parametric Cartilage Assessment map

The parametric color overlay represents the values of the T2 relaxation times per voxel.

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In the parametric map, each color stands for a specific value/range of the T2 relaxation time. The vertical color bar serves to decode the color values into relaxation times. Different color maps can be used which also influence the display of the bar chart.

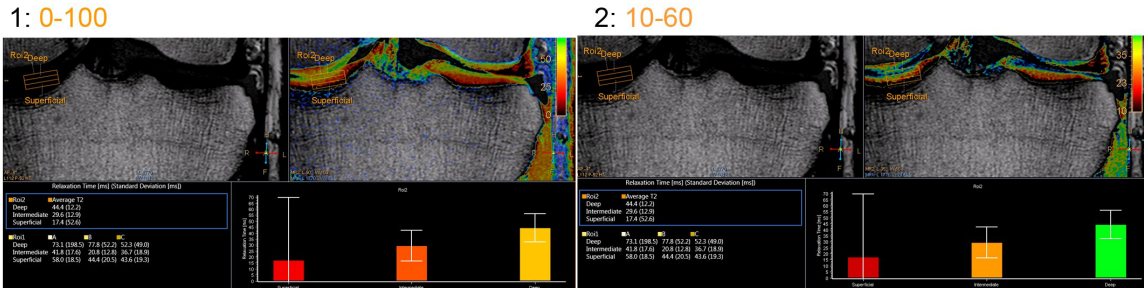

Fig. 84: Comparison of results display with different color ranges: 1 - Reverse Rainbow color map with 0-100 color range, 2 - Reverse Rainbow color map with 10-60 range.

Numerical results and graphical results

The calculation of the numerical and graphical results is based on the segments and layers of the ROIs.

The rectangular and curved ROIs are both automatically divided in three layers: Deep, Intermediate and Superficial. Furthermore the curved ROIs are divided in the segments A, B and C (from left to right).

- The table lists the calculated T2 relaxation times with standard deviation for each layer and segment.
- The graphical results in the diagram plot the T2 relaxation time (in milliseconds) versus the relative cartilage depth.

  The white lines at the upper part of each bar indicate the standard deviation.

The numerical results in the table and the graphical results use the same colors as for the ROIs so that they can easily be recognized.

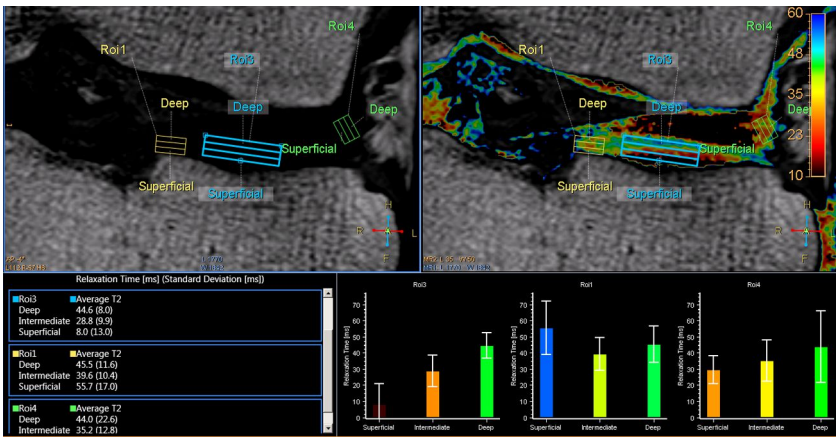

Fig. 85: Results with rectangular ROIs (Average T2 values per layer).

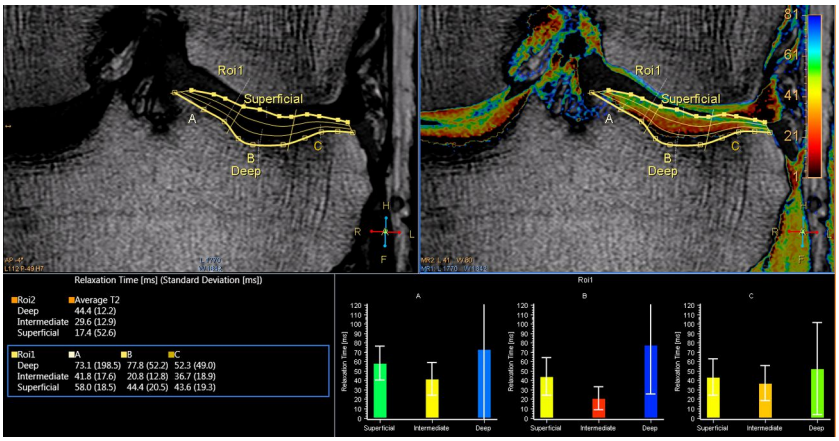

Fig. 86: Results with curved ROIs (Average T2 values per layer and segment).

NOTICE

Graphical results are only shown for the ROIs on the current slice.

The numerical results of all ROIs are however displayed in the table.

Display the slice of any drawn ROI

1. Click on a ROI name in the table.

   The display will automatically be changed and the slice will be shown with the ROI that has been double-clicked before.

8.1.12 MR Subtraction

The MR Subtraction package intended for visualization purpose only. The package allows the user to perform pixel-wise image calculations, e.g. subtracting a pre-contrast dynamic scan from the consecutive post-contrast dynamic scans in order to observe the contrast-uptake. A preview is available, which shows the resulting image for the current scan/scans. New derived imaging series can be easily generated and stored.

Functional Description

MR Subtraction is a post-processing application enabling basic calculations between two volumes, including addition, subtraction and ratio from within a single dynamic MRI series. The MR Subtraction application supports any related conditions or anatomies for which image enhancement or image calculations prior to image analysis is indicated as part of patient management.

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Available Calculations

The package provides the possibility to perform different calculations for two e.g. (groups of) slices or dynamic scans, being referred to as source (S) and reference (R) and Weight Factor (W).

It is possible to apply a weighting factor, depending on the type of calculation for source or reference.

Addition of images

- **S+(W*R)**

Subtraction of images

- **S-(W*R)**

Relative subtraction of images

- **(S – (W * R))/(S + (W * R))/2**

Ratio calculations

- **S / R**

Magnetization Transfer Ratio

- **((R – (S * W)) / R) * 100**

NOTICE

The selected series can be swapped easily to perform the calculations vice versa.

To swap the series, use the ' Swap' option from step 1 of the Task Guidance.

Requirements for MR Subtraction datasets

The components Source (S) and Reference (R) can be images of one scan, but also images of different scans. In order to perform calculations with R and S, they have to have the same slice distance (slice thickness and slice gap), FOV and patient position.

NOTICE

Ensure that the selected and launched dataset includes the same slice distance (slice thickness and slice gap), FOV and patient position prior to subtraction.

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User Interface

Screen layout

The MR Subtraction package has a default layout of three viewports with toolbar and panels. The viewports display the following views:

- Source image in the middle of the imaging volume (by default: dynamic 2).
- In real-time calculated subtracted image.
- Reference image in the middle of the imaging volume (by default: dynamic 1).

Task Guidance

The MR Subtraction package provides a Task Guidance panel in the left part of the screen.

Follow the steps of the Task Guidance to make optimal use of the package.

The following workflow description is based on this Task Guidance.

NOTICE

Dependent on the selected type of operation, not all workflow steps might be available in the Task Guidance.

With the 'Ratio' type of operation, the workflow step 'Set Weight' is not available.

Toolbar

Subtraction

- To select a type of operation for the source and the reference imaging series:
  - Subtraction
  - Addition
  - Ratio
  - Magnetization Transfer Ratio
  - Relative Subtraction.

Viewing Tools

Mirror

This function mirrors the image(s) (Right <-> Left)

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Flip

This function flips the image(s) (Up <-> Down)

Rotate Clockwise

This function rotates the image(s) clockwise

Rotate Counter-Clockwise

This function rotates the image(s) counter-clockwise

More Functions within the Subtraction package

The most important functions can be performed via the Task Guidance and the toolbar. However there are more functions which you can access via the right mouse menus.

For more information, see Right mouse menus.

Workflow

Launch the MR Subtraction package

You can perform MR Subtraction either on a single dynamic scan or on two different scans. This requires the selection of one or two scans

1. Select a suitable series and right click for the context menu.
2. Click 'MR Subtraction'.

   The MR Subtraction package opens.

Select the type of calculation

1. Click the **Operation** drop-down menu from Task Guidance.
2. Click to select the required type of calculation.

Select Series (Source and Reference)

By default, the current imaging series is used as source and as reference series. You can however select different series for both.

Scaling Method

Defines a weight factor (f) to the pixel values when subtracted.

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- **Absolute**: Uses the exact pixel values when two images are subtracted. It is recommended for a single series (dynamic scan). f = 1.
- **Normalized**: Compensates for difference in signal intensities when two different series are subtracted.

  f is automatically calculated and displayed in the user interface.

Select Multi-dimensional Type for Dataset

For multi-dimensional datasets, use **Select primary dimension** to select the image type on which the selected operation shall be applied.

Click on the drop-down to select the primary dimension for processing.

Select Another Source Series

To replace the source series, drag-drop another series from the Exam Overview in the Source Viewport.

Select Another Reference Series

To replace the reference series, drag-drop another series from the Exam Overview in the Reference Viewport.

Swap the series

1. Click the 'Swap' icon to swap the source and the reference series.

Select Range for Source

By default, all dynamics (except for the first one) and other data such as "all echoes" and "'all diffusion value" are selected.

Select any of the following options:

- **All**: to select all dynamics (echoes, b-values etc) of the primary dimension
- **Range**: to define a range of dynamics (echoes, b-values etc) of the primary dimension
- **Single**: to select a single dynamic (echo, b-value etc) of the primary dimension

If there is single series with multiple dimensions, the application loads and the system selects primary dimensions in the below order:

- Diffusion B-values
- Dynamics
- Echoes
- Image Types
- Label Types
- Phases

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If B-values and Dynamics overlap, only B-values are selected as a common dimension.

Set range for subtraction

1. Drag the outer edges of the bar to define the range.

   The selected dynamics or other data such as "all echoes" and "'all diffusion value" is indicated by a number on the bottom of the bar.

2. Alternatively scroll through dynamics, from the context menu (right click) and click 'Set Start Dynamic' to confirm the first dynamic.

   Scroll again and click 'Set End Dynamic' to confirm the last dynamic.

Select Reference

You may define the dynamic being used as reference.

▷ By default, the 'First Dynamic' will be used as reference.

1. Drag the slider selection to select any other dynamic as reference.
2. Or scroll through dynamics, and from the context menu, click 'Set Reference Dynamic' to make the current dynamic the reference.

Select Other Dimension

To select the source and reference for subtraction for Image Types, select the relevant radio button.

For multi-dimensional datasets (e.g. dynamic scan with multiple image types), the other dimension can be defined by using the radio buttons.

Set Weight (Apply Weight Factor)

1. Check the checkbox 'Use weight factor' to enable the slider.
2. Define the weighting factor by dragging the slider.

   The image in the preview will be updated in real-time.

Define Mask

1. Apply mask individually on Source and Reference by selecting source or reference.
2. Enable link to sync the mask threshold edits on both Source and Reference.

Generate Series

You can generate a new imaging series containing the results as defined in the previously described workflow.

1. Click 'Generate Series'.

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2. Enter the name of the new imaging series.

Reset

Select the Reset option to reset to default loading.

8.1.13 MR Echo Accumulation

The MR Echo Accumulation package can be used to perform pixelwise echo cumulations. A preview is available which shows the resulting image for the current series. New imaging series can be easily generated and stored.

The package provides the possibility to perform echo accumulation for imaging series with multiple echoes.

Cumulation

- Result = Sum of multiple echoes

Valid imaging series

A valid imaging series is a series with multiple echoes.

Functional Description

MR Echo Accumulation enables the calculation of new images based on the selected sum of echo times, of MRI series with multiple echoes.

User Interface

Screen layout

The MR Echo Accumulation package has a default layout of two viewports with toolbar and panels. The viewports display the following images:

- Source image in the middle of the imaging volume.
- In real-time calculated image.

Task Guidance

The MR Echo Accumulation package provides a Task Guidance panel in the left part of the screen. The task guidance panel provides the following steps:

- Set Range for accumulation
- Generate series

Follow the steps of the Task Guidance to make optimal use of the package.

The following workflow description is based on this Task Guidance.

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Toolbar

Mirror

This function mirrors the image(s) (Right <-> Left)

Flip

This function flips the image(s) (Up <-> Down)

Rotate Clockwise

This function rotates the image(s) clockwise

Rotate Counter-Clockwise

This function rotates the image(s) counter-clockwise

More Functions within the MR Echo Accumulation package

The most important functions can be performed via the Task Guidance and the toolbar. However there are more functions which you can access via the right mouse menus.

For more information, see chapter “Right mouse menus” on page 553.

Workflow

Launch the MR Echo Accumulation package

The Echo Accumulation package requires a data set with multiple echoes.

1. Select a suitable series and right click for the context menu.
2. Click ‘MR Echo Accumulation’.

   The MR Echo Accumulation package opens.

Select Range for Accumulation

You may either choose to do the operation using all echoes or you may select a range of echoes.

By default, all echoes will be accumulated.

Set Range for Echo Accumulation

1. Drag the outer edges of the slider bar to define the range.

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The selected echoes will be indicated by number on the bottom of the bar.

Generate Series

You can generate a new imaging series containing the results as defined in the previously described workflow.

1. Click 'Generate Series'.
2. Enter the name of the new imaging series.

8.1.14 Advanced Diffusion Analysis (ADA)

Introduction

The Advanced Diffusion Analysis (ADA) application is post-processing software to be used as an advanced visualization application of diffusion MRI medical images. The ADA application is intended to perform image viewing, process and analysis of MRI Diffusion Weighted Images (DWI).

The ADA application can display images acquired at different b-values, where the b-value is a factor that reflects the strength and timing of the gradients used to generate diffusion-weighted images. The ADA application provides advanced supportive analysis and visualization tools of diffusion MRI images and parametric maps, which can be used by the physician for further analysis. The physician retains the ultimate responsibility for making the final diagnosis.

Key Features

ADA application has the following key features:

1. Support visualization and processing of isotropic diffusion-weighted MRI data.
2. Calculate and display a computed Diffusion Weighted Image (cDWI) at a b-value of choice.
3. Support input image registration in a pre-processing step.
4. Present a default analysis model based on the available original DWI images and provide a selection of alternative available models.
5. Provide diffusion analysis models, as well as parametric maps of Perfusion fraction (f), Pseudo Diffusion coefficient (D*), Diffusion coefficient (D) and Kurtosis (K).
6. Provide a ‘Goodness of fit’ map, 'Goodness of fit’ value, and fitted curve showing the fitting quality of the selected model.
7. Display parameter values from user defined ROI’s (Regions of Interest).
8. Display the ROI results in tabular and graphical formats.
9. Support export of the parametric maps as grayscale or RGB images for visualization in other viewers or PACS systems.

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Functional Description

The Advanced Diffusion Analysis (ADA) application can be used to perform image viewing, process and analyze MRI Diffusion Weighted Images (DWI). The ADA application supports any oncology and neurology conditions for which diffusion and/or perfusion analysis are indicated as part of patient management.

Limitations for Use

Rx Only

CAUTION

In the United States, Federal law restricts this device to sale, distribution and use by or on the order of a physician.

NOTICE

When using a virtualization solution, images should be reviewed by a responsible physician to ensure appropriate clinical image quality.

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ADA Application Operation Manual

The Advanced Diffusion Analysis (ADA) application is post-processing software to be used as an advanced visualization application of diffusion MRI medical images.

The ADA application provides advanced supportive analysis and visualization tools of diffusion MRI images and parametric maps, which can be used by the physician for further analysis.

The Advanced Diffusion Analysis (ADA) application consists of two main analysis modes:

- "**Compute DW Image" (cDWI) mode**: This mode allows to calculate the expected signal intensity for unscanned b values based on the scanned b values and the selected diffusion analysis model and produce computed DW images. This mode provides calculated b-value contrasts to the user according to the b value selected with the slider.
- "**Analyse Diffusion Signal" mode**: Depending on the available b values and the selected analysis model, this mode provides the following parametric maps:
  - Diffusion Coefficient (D)
  - Perfusion fraction (f)
  - Pseudo Diffusion coefficient (D*)
  - Kurtosis (K)
  - Goodness of fit

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Using Compute DW Image (cDWI) Mode

1. Click **MR ADA** to start the application.
2. In the task guidance panel, select **Compute DW image**.

⇨ A 2x1 viewport layout is displayed:

- The left image shows the source data (input image).
- The right image shows the cDWI calculated for a selected b value for the selected model.

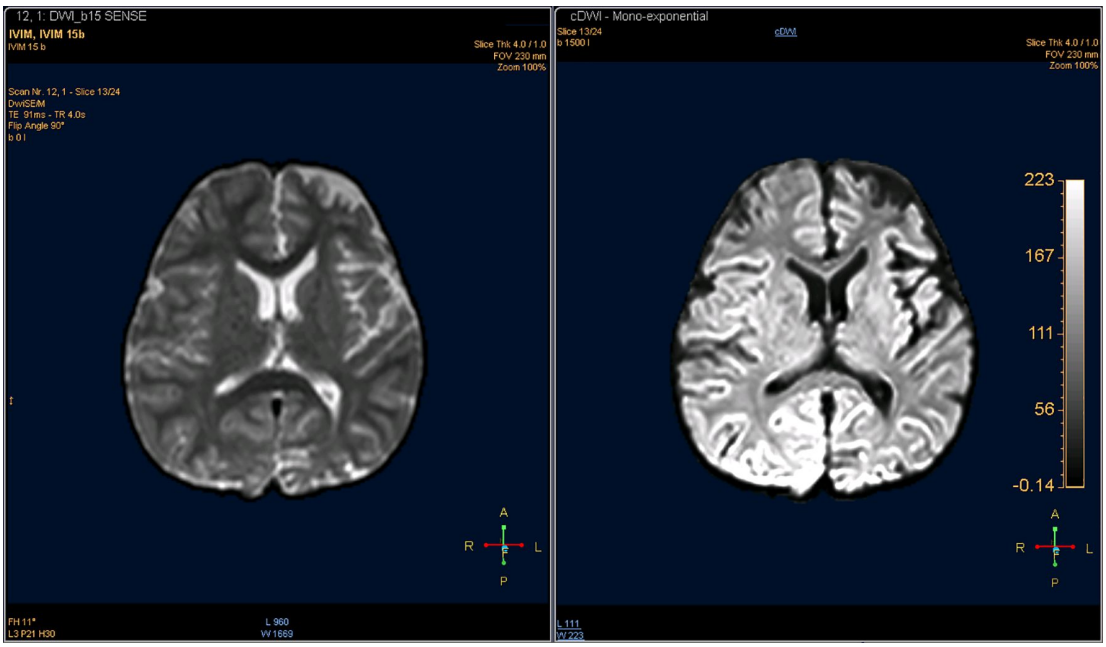

Fig. 87: cDWI Mode in ADA

⇨ The application selects the **Mono-exponential** diffusion model by default.

3. If you want to use an alternative diffusion model, select a model from the drop-down list in the task guidance panel, **Select Model**.

   Depending on the number of b values that are available in the study, you can use the following diffusion models with cDWI mode:

   - **Mono-exponential**: This model is based on two b values.
   - **Simplified IVIM**: This model requires at least three b values.
   - **Bi-exponential**: This model requires at least four b values.

   ⇨ The list displays diffusion models that are appropriate for the available b values in the study.

4. To change the b values used for the analysis, do the following:

   - Click **Edit input b-values** in the task guidance panel.
   - In the **Select B-values** dialog box, select the b values to be used and click **Apply**.

   ⇨ The cDWI image is recalculated using the selected b values.

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NOTICE

Depending on the selected diffusion model, some b values in the **Edit input b-values** dialog box may be grayed out, in which case their setting cannot be changed. Additionally, the minimum number of b values required for the selected diffusion model is always maintained. For example, if four b values are required for the selected model, you cannot clear further selections if only four b values remain selected.

NOTICE

The user may adjust the thresholds for including and excluding b values from analysis models. For more information, see chapter “Setting B-Value Thresholds” on page 676.

5. Select a b value to calculate by dragging the b value slider in the task guidance panel, **Select b-value for computation**.
   ⇨ The computed cDWI is displayed in the right image. The slider moves in increments of 100. Specific values can be entered directly in the box by the user.
   ⇨ By default, the application automatically adjusts the window width and window level for the calculated b value. However, you can change this behavior using the **Control WW/WL adaptation** function.
6. To use ADC-based segmentation to view the CDWI image, select the **Control WW/WL adaptation** check box and, if desired, set the threshold (the default value is 600).
   ⇨ The application adjusts the WW and WL settings such that pixels below the threshold ADC are intensified as you select higher b values, while pixels above the threshold ADC reduce in intensity as you select higher b values.
7. To apply a mask to hide unwanted pixels in the calculation, set the mask from task guidance or via the context menu by right-clicking the image.
8. To generate a series for the cDWI image, click **Generate series** in the task guidance panel.
   ⇨ The generated series and images can be opened in MR Viewer or sent to a PACS. The file name of the generated series contains details of the mode name (cDWI), the applicable diffusion model, and registration indication (if applicable). Independent of the series name, full information is available in the DICOM tag.

Using Analyse Diffusion Signal Mode

1. In the task guidance panel, select **Analyse Diffusion Signal**.

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⇨ A 2x2 viewport layout is displayed:

- The upper-left viewport displays the DWI image used as input. Scrolling vertically displays anatomical slices and scrolling horizontally displays the acquired b values.
- The upper-right viewport displays parametric maps. The type of maps that are displayed depends on the selected diffusion model. To change the displayed maps view in the upper-right viewport (from all selected parametric maps to one parametric map), into presentation of only one parametric map, double click one of the parametric maps. To change the displayed map, click the title of the map viewport and select a different map.
- The lower-left viewport displays results in the **Table Viewer**.
- The lower-right viewport displays the **Graph viewer**.

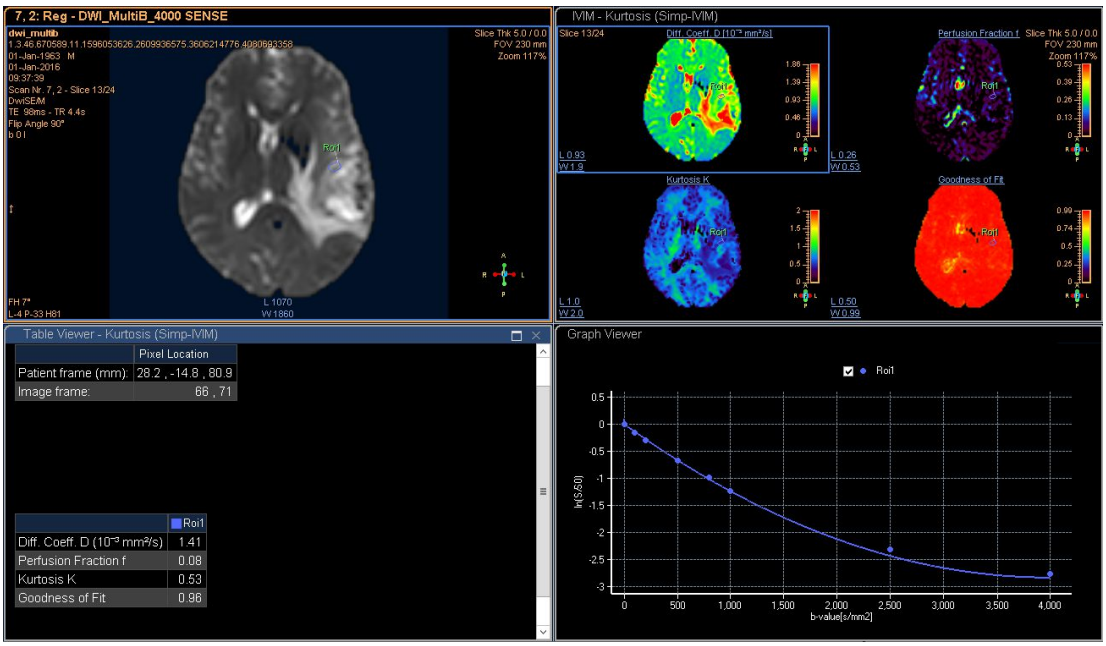

Fig. 88: IVIM analysis in MR ADA

⇨ For any given set of b values, the application presents a default diffusion model.

2. The user may choose an alternative diffusion model from the drop-down list in the task guidance panel as suggested by the application. The alternative models in the drop-down list depend on the number and range of the b values which were acquired for the study, **Select Model**.

   The following diffusion models are available in the Analyse Diffusion Signal mode:

   - **Mono-exponential**: This model is based on at least two b values and generates diffusion coefficient map comparable to routine ADC map.

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- **Simplified IVIM**: This model is based on at least three b values and creates diffusion coefficient map and perfusion fraction map.
- **Bi-Exponential**: This model is based on at least four b values and creates diffusion coefficient map, perfusion fraction map and pseudo diffusion coefficient map.
- **Kurtosis (Mono-exponential)**: This model requires at least three b values and creates diffusion coefficient map and kurtosis map.
- **Kurtosis (Simp-IVIM)**: This model is based on at least four b values and creates diffusion coefficient map, perfusion fraction map and Kurtosis map.

⇨ The models that are suggested by the application are also affected by default thresholds for the applicable b value range (the IVIM threshold and the Kurtosis threshold), these thresholds may be manually adjusted by the user.

⇨ The list displays only diffusion models that are appropriate for the available b values in the study.

3. To change the b values used for the analysis, do the following:
   - Click **Edit input b-values** in the task guidance panel, **Select Model**.
   - In the **Edit input b-values** dialog box, select the b values to be used.

   ⇨ The output parameters are recalculated using the selected b values.

NOTICE

Depending on the selected diffusion model, some b values in the **Edit input b-values** dialog box may be grayed out, in which case their setting cannot be changed. Additionally, the minimum number of b values required for the selected diffusion model is always maintained. For example, if four b values are required for the selected model, you cannot clear further selections if only four b values remain selected.

NOTICE

The user can adjust the thresholds for including and excluding b values from analysis models. For more information, see chapter “Setting B-Value Thresholds” on page 676.

4. Select the parametric maps that you want to generate in the task guidance panel, **Select Maps**.

NOTICE

The parametric maps that are available depend on the selected diffusion model.

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5. To apply a mask to hide unwanted pixels in the calculation, set the threshold of the mask from the task guidance or the context menu by right-clicking a map.
6. To view real-time values of pixels in the maps, use **Follow Mouse**.
   ⇨ When this option is enabled and you move the pointer over an image, the pixel value at the mouse pointer position is indicated in the table viewer, and the graph viewer displays a curve of the signal intensities of the pixel across the b values.
7. To draw an ROI, click the ROI tool in the task guidance panel, **Measure ROIs**.
   You can draw up to ten ROIs across different slices in the study.
   ⇨ The application calculates the average value of the output parameters inside the ROI and displays the value in the **Table Viewer**. The color of the ROI corresponds to the color of the curve in the **Graph Viewer**.
   ⇨ Click the top of a column in the **Table Viewer** to display the slice containing the corresponding ROI in the input DWI image.
   ⇨ Click a curve in the **Graph Viewer** to highlight the corresponding b values.

NOTICE

If you change the mode at any time (to **Compute DW image**) any ROIs that you have created are removed.

Before changing the mode, bookmark your progress in the current mode if you want to return to it later.

⇨ The generated series and images can be opened in MultiModality Viewer or sent to a PACS system. The file name of the generated series contains details of the parametric map name, the diffusion model, RGB indication (if applicable), and registration indication (if applicable). Independent of the series name, full information is available in the DICOM tag.

Register Data While Saving

Once enabled, this function performs registration when generating actual maps. In such a way image quality will most likely improve in the maps.

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NOTICE

If the input data is unregistered, there can be a mismatch between the previewed and generated maps as the generated maps are calculated after registering the input.

Generate Series

You can generate a new imaging series containing the results as defined in the previously described workflow.

1. To generate a standard DICOM-compatible series, select **Generate Series** using the Secondary Capture option from the drop-down list, and then click the button.
2. Enter the name of the new imaging series in the **Name** box.
3. To generate a series as RGB images (high resolution color maps), select **Generate Series** using the Secondary Capture RGB option.

Measurement Type Selection

To change the type of measurement for all parametric maps, right-click the results summary table and select an option.

- **Region Parameters (Factory default)**: The application calculates T1 parameters using the time intensity curve for the drawn ROI and displays the values in the Table Viewer.
- **Mean Voxel Parameters**: The application calculates the mean of all the voxels inside the ROI of the output parameters and displays the values in the Table Viewer.

  The table heading is updated based on the selected type.

Show ROI Statistics

You can right-click the results summary table and choose to show ROI voxel statistics (or) select from the **More** menu.

An additional numerical results table is displayed as a floating window and displays Maximum, Minimum, Median, Average and Standard deviation of the quantitative parameters for the ROI voxels within the parametric maps.

When the number of columns in the Table Viewer exceeds thr default width, or number of rows exceeds default height, the auto scroll is visible to allow the user to scroll to see all the columns and rows.

To export table results:

1. Select **Copy to Clipboard** an open either Microsoft Word or Excel and paste the contents from your clipboard into the application.
2. Select secondary capture. A dialog box is displayed allowing you to select a file name, file format, and destination. You can save the series in DICOM format, or in non-DICOM format. If you select a non-DICOM format, you should additionally select a file system destination for exporting the table results.

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Setting B-Value Thresholds

For advanced workflows, users can adjust the b-value threshold settings. The two b-value threshold values described below control the availability of the different models.

- **Simplified IVIM Threshold**
  - This threshold is applicable to the models that use Simplified IVIM: a) Simplified IVIM and b) Kurtosis (simplified-IVIM).
  - Any b-value between 0 and this threshold is eliminated from the data for processing. The default value of the simplified IVIM threshold is 100 mm2/s.
- **Kurtosis Threshold**
  - This threshold is applicable to the models that support Kurtosis analysis: a) Kurtosis (mono exp) and b) Kurtosis (simplified-IVIM).
  - The dataset should contain diffusion-weighted images at this b-value threshold or above, for processing. The default value of the Kurtosis threshold is 800 mm2/s.

The below table summarizes the conditions (to be satisfied by a dataset) under which the suitable models become active.

Model	Diffusion Parameters (output)	Conditions and Recommendations
Mono-exponential	D	**Required** Minimum number of b-values: 2 **Recommended** IVIM threshold (Default 100) ≤ b-values < Kurtosis threshold (Default 800)
Simplified IVIM	D, f	**Required** • Minimum number of b-values: 3 • b-value = 0 is present • Excluded: 0 < b-values < IVIM threshold (Default 100) **Recommended** b-values < Kurtosis threshold (Default 800)
Bi-exponential	D, f, D*	**Required** Minimum number of b-values: 4 **Recommended** • b-value = 0 is present • At least 1 b-value in the range 0 < b < IVIM threshold (Default 100) • b-values < Kurtosis threshold (Default 800)

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Model	Diffusion Parameters (output)	Conditions and Recommendations
Kurtosis + Mono exponential	D, K	**Required** • Minimum number of b-values: 3 • At least 1 b-value ≥ Kurtosis threshold (Default 800) **Recommended** b-values ≥ IVIM threshold (Default 100)
Kurtosis + Simplified IVIM	D, K, f	**Required** • Minimum number of b-values: 4 • b-value = 0 is present • Excluded: 0 < b-values < IVIM threshold (Default 100) • At least 1 b-value ≥ Kurtosis threshold (Default 800)

To set threshold values:

1. To adjust the b-value threshold settings, click **Model Threshold editing from the More menu.**.
2. To set the **Simplified IVIM** threshold, enter a value in the corresponding box.
   ⇨ B values above this threshold will be included when the **Simplified IVIM** model is selected.
3. To set the **Kurtosis** threshold, enter a value in the corresponding box. Note that the Kurtosis threshold cannot be set below 600 mm^2/s.
   ⇨ B values above this threshold will be included when one of the kurtosis models is selected.
4. Click **Apply** to confirm your settings and close the dialog box.

NOTICE

Changes to the thresholds are not stored and will revert to default values the next time that the application is launched.

8.1.15 QFlow Analysis

Functional Description

The **QFlow** (Quantitative Flow) Analysis package calculates quantitative information from QFlow scans.

The **QFlow** Analysis package allows you:

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- To calculate numerical and graphical results based on user defined ROIs.
- To add a color overlay with flow information to the images.
- To export the result view to a CSV file.

Suitable Scans

Suitable scans are Quantitative Flow scans (which are triggered PCA scans):

- With at least **PCA/P** images and **FFE/M**, and optionally **PCA/M** images.
- Acquired perpendicular to the vessel of interest.

In the acquired QFlow images, the gray value (or the color value if color overlay is used) indicates the flow direction:

- Positive flow is flow into the plane (maximum positive: displayed white), for example in Feet-to-Head direction and in Right-to-Left direction.
- Negative flow is flow out of the plane (maximum negative: displayed black), for example in Head-to-Feet direction and in Left-to-Right direction.

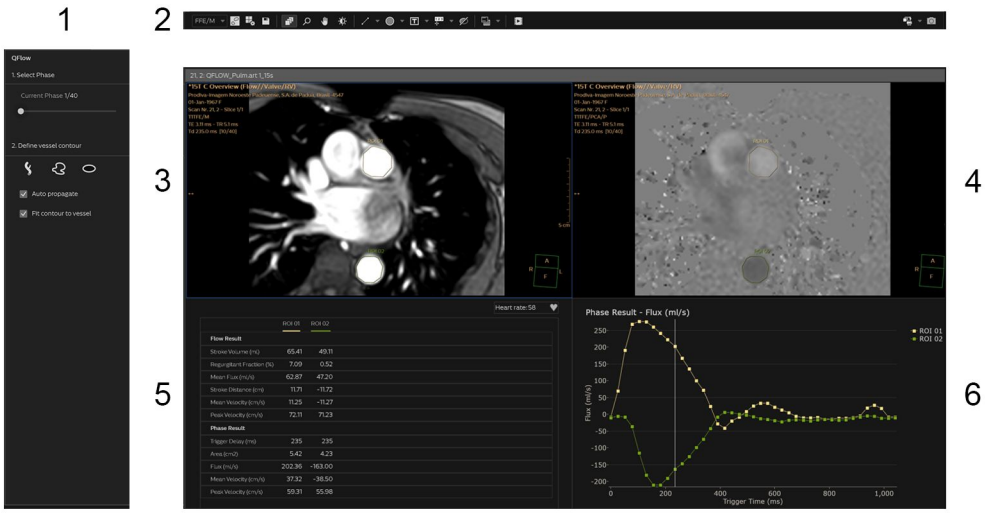
WARNING

For Q-Flow measurements the field-of-view (FOV) must be positioned in the isocenter of the magnet to avoid misinterpretations due to incorrect Q-Flow calculations.

User Interface

Viewports

QFlow opens with four viewports, the QFlow panel, and the QFlow toolbar.



1	QFlow panel

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2	**Review** toolbar with dedicated QFlow buttons
3	Image, by default: **FFE/M**
4	image, by default: **PCA/P**
5	Numerical results (table)
6	Graphical results (graphs versus **Trigger Time (ms)**)

Context Menus

The Context Menu of the viewports allows you:

- To change the default behavior of the left mouse (scroll, zoom,window, pan).
- To reset window and zoom settings.
- To rotate, mirror of flip an image.
- To add color overlay to the images in the viewports.
- To start drawing a freehand ROI.
- To delete ROIs or to propagate ROIs.

The Context Menu of the graphical results allows you to modify the results display.

QFlow Panel

The QFlow panel allows you:

- To select the phase for display.
  You use this function to select the best-suited phase to draw a ROI, and you scroll through the phases to display all phase results.
- To define the vessel contour.
  You use this function to draw a ROI. Available ROI types are: **Single Click Contour**, **Freehand Contour**, and **Ellipse Contour**.
- To enable the automatic propagation of a ROI to all phase images (**Auto propagate**).
- To enable automatic contour detection and adaptation (**Fit contour to vessel**).

QFlow Toolbar

Dedicated QFlow Buttons on Review Toolbar

The QFlow toolbar is the **Review** toolbar with dedicated QFlow buttons.

- Drop-down list for image type selection: **FFE/M**, **PCA/M** or **PCA/P**.

  To select the image type for display in the current viewport (upper left or upper right viewport).

- **Show/Hide color overlay**
  To add a color overlay to the image in the current viewport (in the upper left or upper right viewport).

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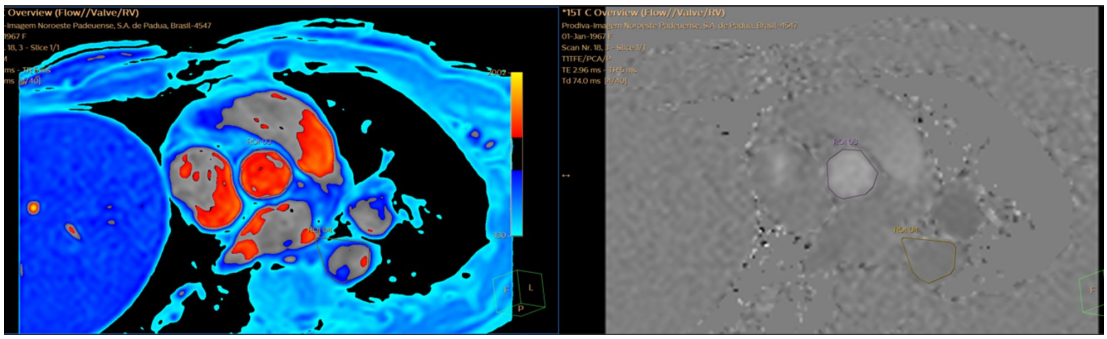

- **Result setting**
  To access the **Table and Unit Settings** window and adjust the results display.
- **Export Result view to CSV file**
  To store the QFlow results in a format easily accessible independent of the MR console.

Routine Procedures

Analyzing QFlow Imaging Series

You analyze a QFlow imaging series to obtain quantitative results.

▷ From the Exam Overview:

► Right-click a suitable imaging series in the Thumbnail Overview (or Scan Overview), then select **QFlow**.

⇨ The imaging series opens in the **QFlow** Analysis package.

► To navigate to the best image to draw a ROI, do any of the following:

- Drag on the phase images.
- Drag the **Current Phase** slider in the QFlow panel.
- Drag the vertical slider in the graphical results viewport.

Usually the end diastolic FFE/M image shows the largest diameter which is best for the automatic contour detection.

► Optionally: To enable PCA/P color overlay, do any of the following:

- On the toolbar, click **Show/Hide color overlay**.
- Right-click on an image. Select **PCA/P Color**.

► Before you draw a ROI, verify that **Auto propagate** and **Fit contour to vessel** are enabled.

- **Auto propagate** enables the automatic propagation of a ROI to all phase images.
- **Fit contour to vessel** enables the automatic contour detection and adaptation.

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► To draw a ROI, first select a ROI type in the QFlow panel: **Single Click Contour**, **Freehand Contour**, or **Ellipse Contour**.

For correct contour detection, a **Freehand Contour** is best suited. A **Single Click Contour** works best with large vessels.

Then draw the ROI:

- For **Single Click Contour**, click once within the vessel.
- For **Freehand Contour** or **Ellipse Contour**, drag to define the contour. Release to close the contour.

When the ROI is completed, the numerical and graphical results are displayed immediately.

NOTICE

Repeat this step if more ROIs are needed.

► To check the ROIs on all images, click **Show/Hide movie bar** on the **Review** toolbar.

Then click **Play** on the movie bar. Click **Stop** when done.

► To manage your ROIs, do any of the following:

- To edit an existing ROI, right-click the ROI and select **Edit**. Then drag the ROI to move it or drag the contour to reshape it.
- To delete a ROI, right-click the ROI and select **Delete**.
- To delete propagated ROIs, right-click the ROI and select **Delete Propagated Contours**. Then select the direction (**Delete Left**, **Delete Right**, **Delete All**).
- To propagate a ROI that was not propagated automatically, right-click the ROI and select **Propagate**. Then select the propagate direction (**Propagate All**, **Propagate Left**, **Propagate Right**).

► Inspect the results. Possibly modify the results display.

► To export the results as CSV (Comma-Separated Values) file, click **Export Result view to CSV file**. Browse to the export destination. Then click **OK** to confirm.

To view the results of the CSV file, open the file in Microsoft Excel.

Modifying the QFlow Results Display

The numerical **Phase results** always display the results for the current phase image.
By default, the **Flux (ml/s)** graph is displayed versus the **Trigger Time (ms)** .

► To display the **Phase results** of another phase, scroll to another phase image. Do any of the following:

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- Drag on the phase images.
- Drag the **Current Phase** slider in the QFlow panel.
- Drag the vertical slider in the graphical results viewport.

► To display another result as graph versus **Trigger Time (ms)** , right-click the graphical results. Then select a result type:
Area, **Flux**, **Mean Velocity**, or **Peak Velocity**.

► To enable or disable the display of a graph, right-click the graphical results. Then select **Show/Hide ROI**, and select or deselect the ROI from the list.

► To select the default results for display and to specify their default units, click (**Result setting**) on the toolbar.

⇨ The **Table and Unit Settings** window opens.

► In the **Table and Unit Settings** window, adjust the settings:

- Enable or disable the display of flow (analysis) results and phase results.
- To specify the (default) unit, select the unit from the drop-down list.
- To display forward flow as positive flow in the graph, enable **Display Forward Flow as Positive**.

Dependent on your QFlow acquisition, this setting possibly inverts the graph.

► To save the settings as your default, click **Save**.
To leave the window without changes, click **Cancel** .

Result	Available units	Default unit
Area	mm^2, cm^2	cm^2
Distance	cm, mm, m	cm
Flux	mm^3/s, ml/s, ml/min, 1/min	ml/s
Trigger Delay	ms, s	ms
Velocity	mm/s, cm/s, m/s	cm/s
Volume	mm^3, ml, cc, cm^3	ml

Results

Graphical and Numerical Results

Graphical results and numerical results are presented in the lower viewports.

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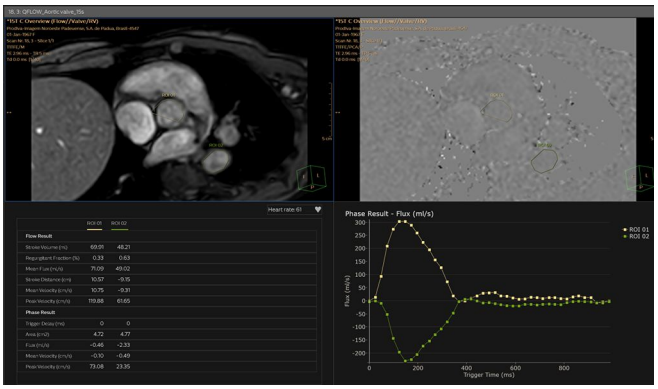
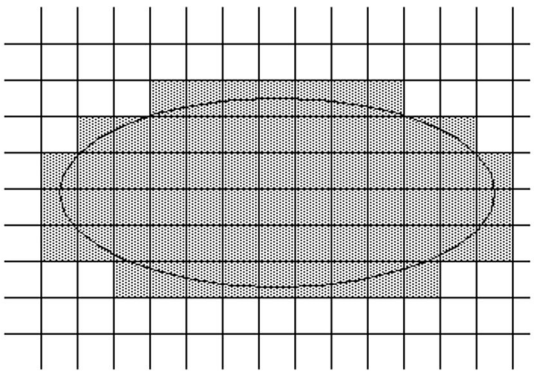
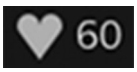


All voxels which partly or fully contribute to the drawn ROI, are considered for quantitative flow calculations.



Numerical Results

The shown **Heart Rate**  is derived from the acquisition.

The **Flow Results** are valid for the complete imaging series.

Stroke Volume (ml)	• Absolute value of the difference between forward and backward flow.
Regurgitant Fraction (%)	• Fraction of backward to forward flow.
Mean Flux (ml/s)	• Stroke volume x heartbeat / 60
Stroke Distance (cm)	• Netto distance the blood proceeds in the vessel in 1 RR-interval.
Mean Velocity (cm/s)	• Stroke distance x heartbeat / 60
Peak Velocity (cm/s)	• Either maximum velocity or minimum velocity, whichever has the highest absolute value.

The **Phase Results** differ from phase to phase.

Trigger Delay (ms)	• Time between R-peak and acquisition of the specific slice.
Area (cm2)	• Area of the pixels that are partially or fully included in the contour. To visualize this area, right-click in an image viewport and select 'Filled graphics'.

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Flux (ml/s)	• Blood volume that passes the contour per second. Flux is identical to 'mean velocity * area'. This value is only calculated if the flow direction is perpendicular to the image.
Mean Velocity (cm/s)	• Mean blood flow velocity.
Peak Velocity (cm/s)	• Highest measured positive or negative flow in the contour.
Velocity Standard Deviation [cm/s]	• Standard deviation of the mean velocity.
Number of pixels	• Pixels that are partially or fully included in the contour.

Graphical Results

Results (from one or more ROIs) of one type are displayed as graphs versus the **Trigger Time (ms)** .

You can select any of these results for display: **Area**, **Flux**, **Mean Velocity**, or **Peak Velocity**.

8.1.16 SpectroView

Functional Description

The **SpectroView** package is used to present spectroscopy data after processing. Single Voxel (SV) and Chemical Shift Imaging (CSI) datasets can be analyzed. **SpectroView** handles both time and frequency domain data presented in the following form possibilities.

- Graphs
  - Processed spectra
  - Fitted spectra
- Tables providing information on
  - Peak position including label
  - Amplitude
  - Ratios
- Metabolite images (in color overlay)
- Ratio images (in color overlay)
- Spectral grids on reference images
  - Display of user-selected subset from an array of spectra

Pre-processing scripts allow you to apply additional apodization and processing steps for time domain data.

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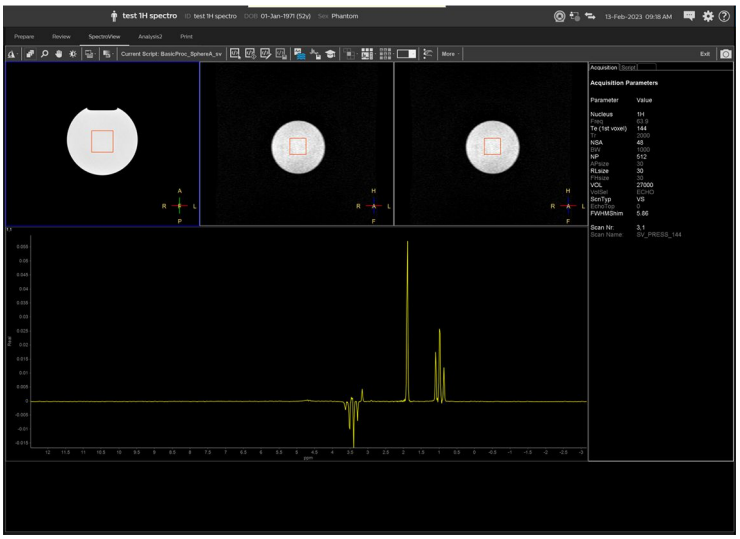
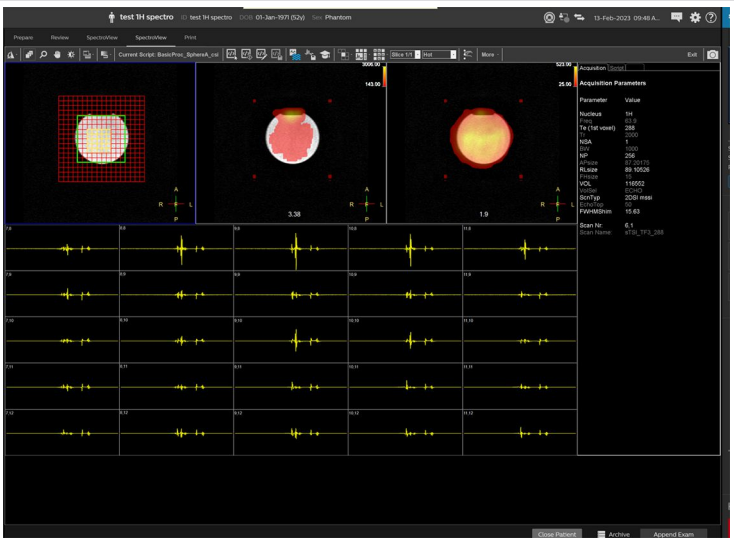
User Interface

Screen Layout

SpectroView layout for Single Voxel (SV).



SpectroView layout for Chemical Shift Imaging (CSI).



For wide screen consoles, the **SpectroView** package has a default layout of three small viewports for anatomical images and maps, one large viewport for the graph of the spectrum (spectra) and two tables.

The results table is shown below the graph.

In the viewport on the right hand side of the screen, the tabs allow to toggle between acquisition parameters, script parameters and status information.

The Status tab appears when an error has been detected after the last script has been run. It will be colored red and be brought to the front. It contains information about failing voxels where only the first 5 failing voxels are identified, followed by a " multiple errors occurred" message if more voxels failed.

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The PlanScan images are overlaid by the position and orientation of the single voxel or spectral grid.

Dual Viewer

SpectroView allows you to view two spectroscopic imaging series next to each other, for example, for comparison purposes.

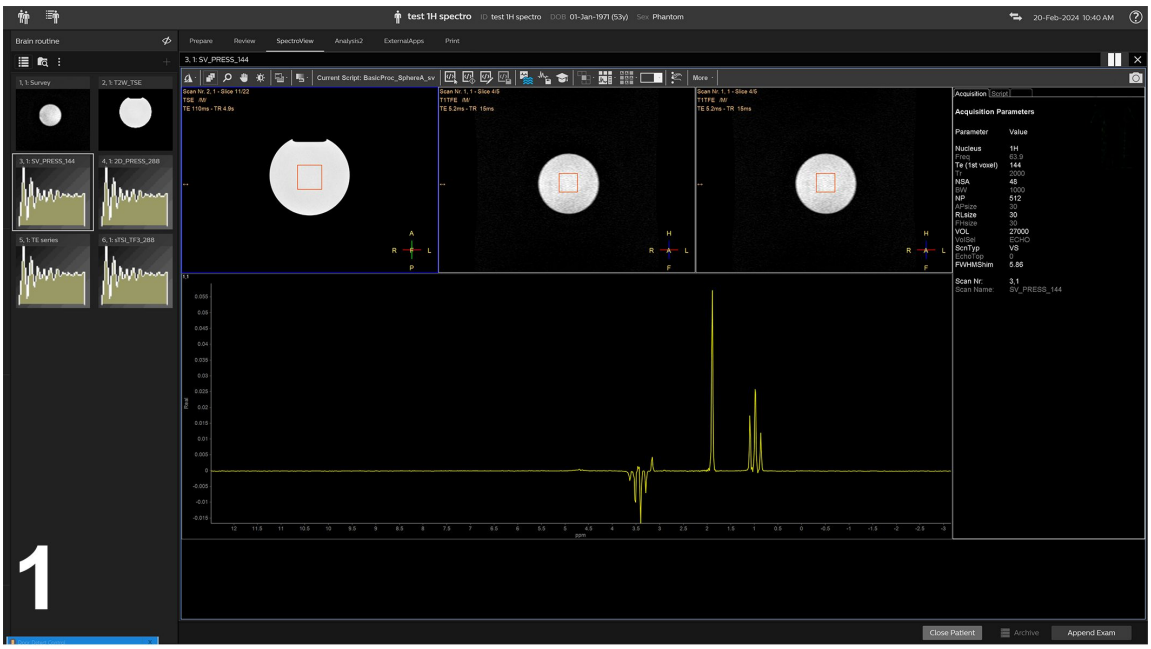
- ► To enable the dual viewer, click the button next to the **Close** button.

⇨ Then the current viewport displays on half of the screen.

- ► Drag and drop a spectroscopic series into the empty half of the screen.

⇨ You view both spectroscopic series next to each other, both with their own toolbar.

To go back to a single viewer, close one of the two viewers.



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SpectroView Toolbar

The **SpectroView** toolbar allows easy and quick access to the most important functions of the **SpectroView** package. Depending on the selected dataset (SV or CSI), the toolbar is slightly different. The table lists the icons used with an explanation.

Button	Tooltip	Description
	Select Script	Allows you to select a script. See chapter “Script Handling” on page 709.
	Run Script	Allows you to run a script. See chapter “Script Handling” on page 709.
	Edit Script...	Allows you to edit a script. See chapter “Script Handling” on page 709.
	Save Script	Allows you to save an edited script. See chapter “Script Handling” on page 709.
	Process Unsuppressed Water Data	Allows you to switch between the suppressed and unsuppressed datasets (applicable for a series which contains unsuppressed water data). See chapter “Process Unsuppressed Water Data” on page 722.
	Store Processing Parameters	Allows you to store the processed FD (frequency domain) spectrum and the corresponding script parameters. For CSI, the selected voxels are stored to the database.
	Expert Mode	Allows you to access advanced features in **Expert Mode**.
	Select Individual Voxels	Allows you to select the voxels for result display.
	Layout	Allows you to modify the layout.
	Graph Display Mode	Allows you to modify the display of the graph.
None	Select Slice	Allows you to toggle between slices in multislice 2D- or 3D-SI datasets. Processing is performed slice by slice.

As part of the toolbar, a **More** drop-down menu is available. It offers the following options:

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Corresponding icon	Menu item text	Description
	Delete Script	Allows you to delete a script. See chapter “Script Handling” on page 709.
	Peak Editor...	Opens the peak editor. See chapter “Customization using the Peak Editor” on page 717.
	Delete Series Preferences	Allows you to erase all Series Preferences for this series. See chapter “Series Preferences Database” on page 721.
	Enable CSV Output	Allows output to a spreadsheet application (CSV file). The results are exported as a CSV (Comma-Separated Values) file. To present the results, open this file type with Microsoft Excel.

More Functions within SpectroView

Right mouse menus and keyboard functions are available in order to facilitate the use of the postprocessing package and to offer various interaction possibilities.

Keyboard functions

Keyboard functions can be used in the same way as in other postprocessing packages, e.g. scrolling through images can be done by means of the arrow keys or the mouse.

Right mouse menus

They provide many of the functions which are also available via the menu, toolbar or which are used throughout all postprocessing packages.

► Right-click on any image to access the right mouse menus.

Right-mouse menus in **SpectroView** are described in this section. They are available for:

- Anatomical image (overlaid grid)
- Map
- Spectrum for CSI dataset
- Spectrum for SVS dataset

Anatomical image (overlaid grid)

Available options	Description
Scroll	These options can be used in the same way as throughout the complete user interface.
Zoom	
Pan	
Gray Level	
Show Grid	To show/hide the grid overlay per viewport.

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Available options	Description
Use for Underlay Image	To select a different anatomical underlay image.
Running Attribute	To select the running attribute if more attributes are present in the anatomical series.
Reset Window	These options can be used in the same way as throughout the complete user interface.
Reset Zoom/Pan	

Map

Available options	Default	Description
Adjust blending and threshold	OFF	If selected, dragging the left-mouse up and down changes the threshold of the color overlay. Dragging the left-mouse left to right changes the opacity of the color overlay
Show Grid		To show/hide the grid overlay per viewport.
Interpolated Maps		Allows to display map images calculated by SpectroView in non-interpolated mode (color reflects metabolite value or ratios for the corresponding voxel) or interpolated mode (colors/values are "smoothed" across voxel boundaries).
Display Map		To select different maps for display.
Reset Window		These options can be used in the same way as throughout the Advanced Viewing Environment.
Reset Zoom/Pan		

Spectrum for CSI dataset

Available options	Default	Description
Show Annotation	ON	Enables the display of the voxel x,y (format column, row). Enables the display of an abbreviated list of spectrum qualities in the upper right corner of the spectrum viewport (^{1}H- spectroscopy).
CSI Graph Annotation	NAA/Cr and Cho/Cr	Specifies which quantities are displayed in the upper right corner of each spectrum box, Choices include whatever metabolite map quantities are currently displayed in the middle and in right viewports as well as some standard peak area ratios: NAA/Cr, Cho/Cr, NAA/Cho, Cho/NAA, and (if applicable) Cho/Ct and (Cho+Cr)/Cit.
Spectrum Display Options		Allows to optimize the spectrum display: • Show Spectrum: Enables the display of the original spectrum. • Show Metabolite Labels: Enables the display of the metabolite names in the spectrum. • Show Fitted Spectrum: Enables the display of the fitted spectrum. • Show Fitted Baseline: Enables the display of the fitted baseline. • Show Residual: Enables the display of the difference spectrum.
Subtract Baseline From Graph Display	OFF	Subtracts the fitted baselines from both the original and fitted spectrum.

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Available options	Default	Description
Display Graph: x,y		To select the spectrum from voxel x,y for display only. Disabling the step switches back to the last used selection.
Display Time Domain Data for Voxel x.y	OFF	Allows inspection of the time-domain data within a pop-up window.
Graph Display Mode	Geometrical	Sets the type of display for selected spectra: • Horizontal: displays spectra horizontally. • Stack displays spectra vertically. • Geometrical: displays spectra corresponding to the arrangement of voxels. • Compressed: displays spectra in a square or rectangle array with a minimum of blank entries.
Phase Mode	Modulus for CSI max. echo, Real for CSI half echo	Defines which part of the spectrum is displayed. • Real: real component. • Imaginary: imaginary component. • Phase: phase information. • Modulus: magnitude. • Power: modulus squared spectral signal.
Display Average	OFF	Computes and displays an average of all selected spectra in single voxel format, if enabled. The table of results will be updated to show the values of the average spectrum. Choosing this entry runs the script again for the selected set of voxels and then displays the average with fitted spectrum in single voxel format. Clicking this entry again returns to multi-voxel display, with only that spectra, that contributed to the average selected. Screen layout matches SVS layout.
Line Display	OFF	Active only for stack display. Enables or disables display of a vertical line that follows the position of the mouse, for comparing peak positions in different spectra.
Set Spectrum Limits	---	Specifies left/right values for X-axis and minimum/maximum for Y-axis.
Display Full Width	OFF	Displays the full spectrum if enabled.
Display Full Height	---	Scales the spectrum amplitude so that the tallest peak fills the spectrum viewport.
Reset View	---	Restores default chemical shift limits and adjusts the spectrum amplitude to display its full height. Note: The default display range is defined in the selected script. An autoscale mechanism is used to zoom the spectrum to fill the entire spectrum display area.

The **Graph Display Mode** is also accessible via the main toolbar. For more information on horizontal, vertical, geometrical and compressed display, refer to the section 'Modify Layout.

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Spectrum for SVS dataset

Available options	Default	Description
Show Annotation	OFF	See table above: 'Spectrum for CSI dataset'.
Spectrum Display Options		Allows you change the display of the spectra: • Allows you to enable (or disable) the display of spectrum, fitted baseline, fitted spectrum, residual or metabolite labels. • Allows yo to specify the spectrum limits with the Override X and Y range. • Allows you enable or disable the spectrum annotation on the screen. You can also access these functions in the context menus of the graphs
Subtract Baseline From Graph Display	OFF	See table above: 'Spectrum for CSI dataset'.
Display Time Domain Data for Voxel x.y	OFF	
X-axis Units	ppm	Changes the X-Axis units to Hz or ppm.
Phase Mode	Real for SVS	See table above: 'Spectrum for CSI dataset'.
Difference Mode	OFF	Enables or disables the possibility of adding vertical lines which can serve as markers for comparison. Two nr's for each line indicate peak position and amplitude. Dx and Dy represent the difference in position and the difference in amplitude between the selected points. The integral of the spectrum between 2 markers is displayed as well.
Set Spectrum Limits	---	See table above **Spectrum for CSI dataset**.
Display Full Width	OFF	
Display Full Height	---	
Reset View	---	

Scripts

A script is a set of (pre-)processing steps that are performed to analyze and display a spectrum (or set of spectra).

You can edit a script according to your preferences, and save it under a user-defined name.

The possibilities within a script are different depending on the type of the selected dataset.

There are different types of scripts:

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Script type	Purpose	Characteristics
Pre-processing - Basic	• To define the steps for the conversion of time-domain data into frequency domain data.	• For ^{1}H, the **Basic** script is the only type of pre-processing script. It is automatically executed when time-domain data is opened in **SpectroView**.
Pre-processing - Initial	• To convert time-domain data into frequency-domain data without manual interactions. The **Initial** script is a variant of the **Basic** script where all manual interactions are disabled.	The **Initial** script is executable only in MultiNuclei MRS. It is automatically executed when MultiNuclei-time-domain data is opened in **SpectroView**.
Peak Fitting	• To define the processing steps for the generation of fitted spectra of the frequency-domain data.	For more information about peak fitting scripts, see chapter "Processing steps" on page 692.

You recognize the different scripts by their font color in the Script Selection window:

- Pre-processing scripts have a blue font color.
- Peak fitting scripts have a black font color.

Name	Description	Nucleus	Anatomy	Field	TE
BasicProc_SphereA_sv	Basic Processing for SphereA Phantom (1...	1H	Phantom	1.0T, 1.5T, 3.0T, 7.0T	short
SphereAPhantom_sv	Sphere A Phantom (1H SV)	1H	Phantom	1.0T, 1.5T, 3.0T, 7.0T	short

Default processing script

When you open a spectroscopic dataset in SpectroView, the system automatically comes up with a default processing script, dependent on the selected dataset. In the toolbar, this default script is indicated as **current script**.

- The default script depends on the selected **Anatomy**.
- In case of a time domain dataset, this is a pre-processing script (Basic or Initial).

Processing steps

This section describes the processing steps which can be performed within a pre-processing script or peak fitting script.

Overview of Processing Steps

Once a processing step is enabled, a page of parameters associated with this step is displayed in the **Script Editor**.

Processing steps in **pre-processing Basic** processing script for Single Voxel Imaging	Processing steps in **peak fitting** script.

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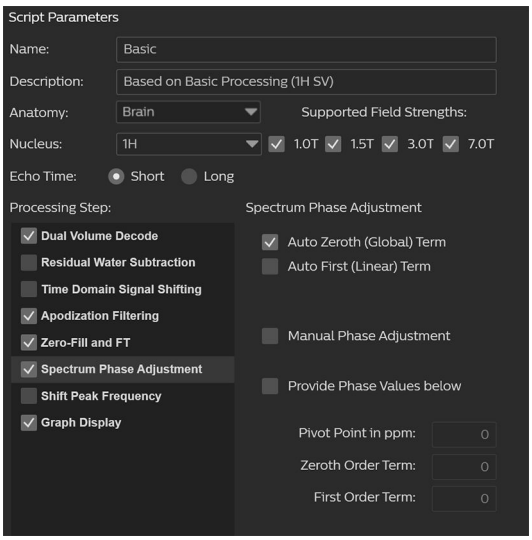

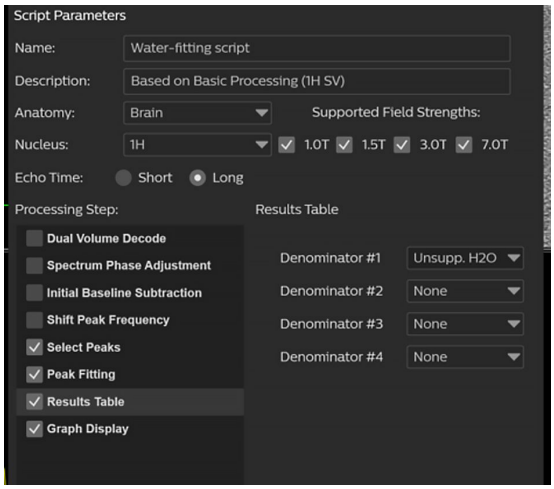

Available Processing Steps in Scripts

The table show which processing steps are available for SVS or CSI, and for which script type.

Processing step	Available for script type: Pre-processing SVS	Pre-processing CSI	Peak fitting SVS	Peak fitting CSI
Dual Volume Decode	✓	✗	✓	✗
Residual Water Subtraction	✓	✓	✗	✗
Time Domain Signal Shifting	✓	✓	✗	✗
Apodization Filtering	✓	✓	✗	✗
Zero-Fill and FT	✓	✓	✗	✗
Spectrum Phase Adjustment	✓	✓	✓	✓
Initial Baseline Subtraction	✗	✗	✓	✓
Shift Peak Frequency	✓	✓	✓	✓
Select Peaks	✗	✗	✓	✓
Peak Fitting	✗	✗	✓	✓
Correct for DSA Filter For Proton-CSI only	✗	✗	✗	✓

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Processing step	Available for script type: Pre-processing SVS	Pre-processing CSI	Peak fitting SVS	Peak fitting CSI
Integration Ranges for Maps	✗	✓	✗	✗
Generate Maps	✗	✗	✗	✓
Results Table	✓	✓	✓	✓
Graph Display	✓	✓	✓	✓

Dual Volume Decode

Dual Volume Decode is required to decode the (A+B) and (A-B) encoding in Dual Volume acquisitions. There are no adjustable parameters for this script step.

Although the step is enabled for all SV scripts, the decoding is only executed if the dataset is a dual volume acquisition.

Residual Water Subtraction

- removes residual water signal by applying a high pass filter over which data points are combined and subtracted from the original signal.
- gives the possibility to adjust the high pass filter by means of a slider.

Typical application

If the water suppression applied during acquisition is imperfect, the residual water peak can at times interfere with the metabolite peaks of interest. One way to minimize its effect is to apply a high pass filter in the time domain.

High Pass Filter

The filter works by first smoothing the input time-domain signal using Gaussian convolution. Each point is replaced by the average over a Gaussian-weighted window of points with a user adjustable width. The smoothed version of the input signal is then subtracted from the original signal to leave only the higher frequency "wiggles."

Slider values

The slider defines the width in points (specifically the FWHM) of the Gaussian-weighted window of time-domain points.

Narrow window - broad filter

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Only a few neighboring points are averaged together to replace each input point. Only the highest frequency wiggles are smoothed away. When this function is subtracted from the original, only the highest frequency wiggles remain: a broad filter has been applied in the frequency domain.

Wide window - narrow filter

Many points are averaged together, resulting in a very smooth function. When this is subtracted from the original, only frequencies very close to resonance will be affected: a narrow filter had been applied in the frequency domain

Time Domain Signal Shifting

- Can be used to shift the time domain signal to either remove spurious signals or to align spectra. It will not be applied with standard acquisitions.
- Can be done with
  - Shift with zero padding

    This is a function to shift a time domain signal with an integer number of sample points by inserting zeroes. The point index for each point is changed by the parameter shift. The shift can be negative. Points that fall outside the array will be lost. If shift is greater than the total number of points N the result will be all zeroes. Typical use of the function is to remove spurious signals at the beginning of a FID that can cause baseline distortions in the spectrum.
  - Cyclically shift

    This is a function to shift a time domain an integer number of sample points. The point index for each point is changed by the parameter shift. The shift can be negative. Points that fall outside the array will be appended at the other end. If shift is greater than the total number of points N, the result will be identical to a cyclic shift with parameter <shift> = (<shift> - k *N) points where k is any integer number. Typical use of the function is to align spectra.

Note that the default shift is zero.

Apodization Filtering

- improves the signal-to-noise in a dataset by partially filtering out the noise in a MRS signal prior to Fourier transform (FT):
  - before the Fourier transform (FFT) there is a decaying signal in a constant background of noise. This means that the signal to noise in the first points of the signal is better than in the last points of the signal. A weighting function can be applied to emphasize the points with good signal to noise. The best weighting function is one that follows the decay of the signal. Because the peak areas should not be changed, the function must not change the data point of the FID corresponding to time zero. The intensity of this point before FFT is proportional to the total of the peak areas.
- allows to choose more than one filter if requested.

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- The choice of filters includes the following:

Available Filters	Description of Filter
Gaussian Multiplication	• Applied to transform a Lorentzian line shape to a more compact Gaussian shape (the foot of a Gaussian is smaller than Lorentzian shape, thus overlap of peaks is reduced). • This can only be positive apodization. • It causes a line broadening effect.
Exponential Multiplication	• Applies a decaying exponential to increase the apparent SNR at the cost of a reduction in resolution. • Can be applied as an apodization or negative (for cancellation of T_2 decay). • Use of a positive value gives a an effect equal to 'Lorentzian line broadening'.
Convolution Difference	• Can be used as a method for broad line suppression. • The signal is multiplied with an exponential filter as in the exponential multiplication function. The result of this operation is subtracted from the original filter. • The difference is then scaled.
Lorentzian-to-Gaussian	• To change a line shape that is naturally Lorentzian, to a Gaussian line shape (if this is preferred for analysis or presentation) • The signal is first multiplied with a Lorentz window with a negative line width parameter. Then the signal is filtered with a Gaussian function.
Broad Line Suppression	• Multiplies the time domain signal with a function that has low intensity in the first few data points and is unity for all other points. • Filters out broad line components
Sine Window	• Applies a filter for suppressing artifacts in spectroscopic images. • Usually not applied to the time domain of chemical shift data, but on the spatially encoding dimensions in a one or two-dimensional spectroscopic imaging
Sine Squared Window	• This is the squared sine function. It is equivalent to 1/2 times a sine function of double width plus a lift of 1/2. • This is known as the Hanning window.

It is often easier to use the exponential multiply and Gaussian multiply functions rather than the LG function. Performing the function in two steps allows more flexibility. It is therefore the most commonly used form of apodization filtering.

Use the Exponential multiplication with a negative line broadening value to get a line sharpening (or de-convolution of the Lorentzian line shape). Combine this with a gaussian multiplication with a positive line broadening value. This positive line broadening must exceed the (negative) EM line sharpening value to have a noise filtering effect.

An example that should work for most proton spectra:

- Gaussian +3Hz, Exponential -1.5 Hz

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This will result in an effective line broadening of 1,5 [Hz].

Related parameters

This section describes all related parameters of this script step, for all selectable filters.

Symmetry point

- Is a value between 0.0 and 100.0 % giving the relative position of the echo top in the FID.
- Is the point where the filter function should have the value one and should correspond with time point zero.
  - For a half echo FID (echo acquisition = half) it is at the start of the FID: the symmetry point = 0%.
  - For a full or symmetric echo (echo acquisition = symmetric) the echo top position will be in the middle at 50 %.
  - For maximum echo (echo acquisition = maximum) the position of the echo top will be somewhere between 0 and 50 %.

The symmetry point can either be selected at "echo max": the echo top position is automatically defined, or at "xxx%", to manually specify the echo top position.

Gaussian mult [Hz], Exp mult [Hz]

- sets the line broadening values for the respective filters.

Line broadening [Hz]

- Appears when the Convolution Difference (CD) filter is selected. The purpose of the CD filter is to selectively remove broad underlying features in the spectrum, leaving only sharp lines.
- Is the estimated line width of the broad component. Broad peaks decay quickly in the time domain; hence the CD filter has a small value at the echo center (as defined by the symmetry point). Away from the echo center, it climbs quickly to a value of unity. As a result, broad signal components are suppressed, whereas narrow components (which decay slowly in the time domain) are only slightly affected.
- The filter function is defined as follows:

  Wi = 1 - SC exp[-N |i/N - SP| pi LB / (2 BW)]

  where

  Wi = weighting factor for time point i

  i = time point index

  N = number of acquired time-domain points

  SP = symmetry point of filter

  SC = scale factor (0.0 < SC < 1.0)

  LB = line width of the broad component

  BW = bandwidth

Scale factor

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- Appears when the Convolution Difference (CD) filter is selected. The purpose of the CD filter is to selectively remove broad underlying features in the spectrum, leaving only sharp lines.
- Controls how completely the broad component is minimized. Allowed values for SC lie between zero and one.

Peak width [Hz]

- Appears when the Lorentz-Gauss Multiply (LGM) filter is selected. The purpose of the LGM filter is to convert Lorentzian lineshapes to Gaussian lineshapes to improve resolution. (Lorentzian lines have broader "tails" than Gaussian lines with the same full width at half-maximum).
- Should be set to the line width for which the user desires the filter to work best.

Suppression factor

- Appears when the Broad Line Suppression (BLS) filter is selected. The purpose of the BLS filter is to selectively remove broad underlying features in the spectrum, leaving only sharp lines.
- Controls how completely the broad component is minimized.

Cut-off frequency

- Appears when the Broad Line Suppression (BLS) filter is selected. The purpose of the BLS filter is to selectively remove broad underlying features in the spectrum, leaving only sharp lines. (As such, it is similar to the Convolution Difference filter.)
- Is the estimated dividing line in Hz that separates the width of broad components from the width of narrow components. Broad peaks decay quickly in the time domain; hence the BLS filter has a small value at the echo center (as defined by the symmetry point). Away from the echo center, it climbs quickly to a value of unity. As a result, broad signal components are suppressed, whereas narrow components (which decay slowly in the time domain) are only slightly affected.
- The filter function is defined as follows:

  Wi = 1 / { 1 + SF exp[-N |i/N - SP| pi Fc / (2 BW)] }

  where

  Wi = weighting factor for time point i

  i = time point index

  N = number of acquired time-domain points

  SP = symmetry point of filter

  SF = suppression factor

  Fc = cut-off line width between broad and narrow features

  BW = bandwidth

Add description for parameter percent signal in the filters ‘Sine Window’ and ‘Sine squared Window’: “The percentage of the signal width used in applying a sine squared or sine window”

Percent signal

- Is the percentage of the signal width used when applying a sine squared or sine window.

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Final points to zero

- Allows the user to zero out a selected number of points at the end of the time-domain signal -- the ultimate filter. Choosing 200, for example, will set the last 200 time-domain signal points equal to zero.

Multiple filters: workflow

1. Define first set of filter parameters.
2. At the top of the parameter panel, set ‘Number of Filters’ from ‘1’ to ‘2’.
3. At the top of the parameter panel, set ‘Edit Filter’ to ‘2’.
4. All the parameters should be "reset" and you can now set them for ‘Filter 2’.
5. To change the parameters for ‘Filter 1’, change ‘Edit Filter’ to ‘1’.
6. For only 1 filter, change ‘Number of Filters’ to ‘1’.

Note that the order of filter selection doesn't matter as they are all multiplication filters.

Zero-Fill and FT

FT

- This processing step cannot be disabled, FT is always performed.To view time domain signals, select right mouse menu item ‘Display time domain signal for voxel x,x’.

DC correction

- Enables or disables the use of DC correction (to remove DC offset). A DC offset can be caused by hardware imperfections, or by the presence of a non-relaxed low-frequency signal (typically water), and will be presented as a spike.
- The window width is defined as a percentage of the total acquisition window, and is selectable between 1 and 15%.

Zero-Fill

- Is used to increase the number of points in a spectrum to a user defined value. The apparent digital resolution of the spectrum will be increased by increasing the digital number of points.

More about zero-fill

The acquisition time should be set to record the FID or echo until well past the point where the signal disappeared into the noise. Rather than recording a signal with nothing in it but noise, some additional resolution may be obtained by zero filling.

Doubling the signal length by appending zeros will actually add information present in the imaginary part of the complex points to the absorption spectrum. Zero filling more than a factor two will just interpolate the spectrum without adding any more real definition.

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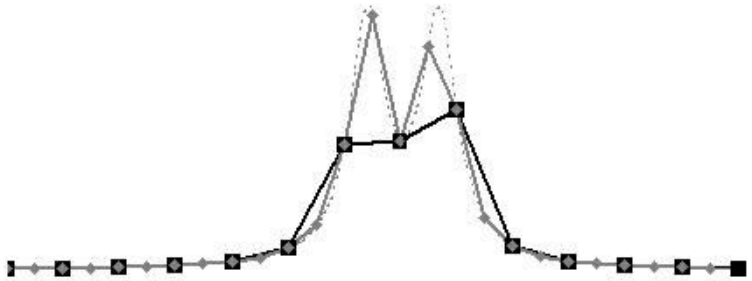

Zero-filling results in interpolation in the frequency domain. The black line is a two peak spectrum with a low resolution. Zero-filling the data to double the amount of points reveals two resolved peaks (gray line). The dashed thin grey line shows the smoothing effect of further zero filling. The resolution can improve significantly and a zero filled spectrum will look better.

Zero-fill the spectral transform to

- defines the total number of points in the spectrum (= acquired number of points + zero-filled number of points)
  - Recommended value: twice as high as the acquired nr of points.
  - If zero-filling is not required, the number selected should be equal to the acquired number of points.

Spectrum Phase Adjustment

- Allows the user to correct the phase of the spectrum using both zero-order (global) and first-order (linear) terms.
- Both auto phasing and manual phasing can be selected.

  Although any spectrum can be adjusted, this capability is most relevant for:
  - Proton spectra acquired without an unsuppressed reference scan.
  - MultiNuclei spectra.

Autozeroth (global) term

- Zero order phase correction; being used if there are small delays between the transmit and reception of the signal in which the phase error has an influence on all peaks.
- Correction on a voxel-by-voxel basis (for CSI).

Autofirst (linear) term

- First order phase correction in the case of phase differences which are present over various resonance frequencies.
- Correction on a voxel-by-voxel basis (for CSI).

Manual Phase Adjustment

If enabled,

- The selection of the above options is disabled.

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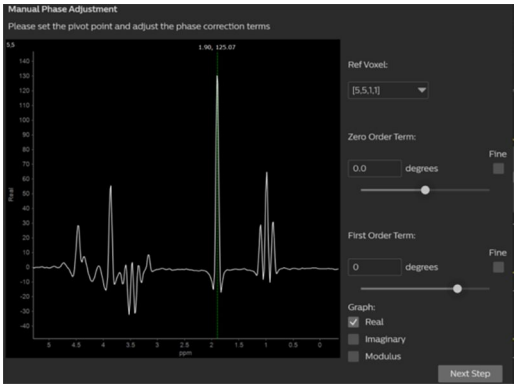
- The script will stop once phase adjustment is required, popping up a separate window in which both global and linear phase correction can be manually adjusted by the user:



Window 'Manual Phase Adjustment'.

Sliders are to interactively change the phase. Radio buttons are available for fine adjustments: the step size is reduced. Once phasing is completed, press 'Next Step' to resume the execution of the Basic Processing script.

Provide phase values below

- Allows you to program exact values into the script itself. The default values shown here represent the values specified during the last Manual Phase Adjustment, as supplied by the Series Preferences database. As in Manual Adjustment, these values are applied to all selected voxels. This option can be used for experiments requiring you to process the same dataset with the same parameters multiple times.

Initial Baseline Subtraction

Distortion of the spectral baseline, caused by broad line resonances or missing data points, can be corrected for visual presentation with **Initial Baseline Subtraction**.

Initial Baseline Subtraction is used to remove large distortions from the spectral baseline as they might confound later processing steps.

in this initial step, the variables are adjusted without knowledge of peak position. The step is therefore omitted by default for short-TE-brain spectra.

Baseline estimation occurs again during the fitting process, where it is done more accurately.

Baseline Terms

The baseline is modeled as a function of position x across the analysis range (e.g. 4.5 ppm to 0.0 ppm) with x defined from -1.0 to 1.0. The baseline is assumed to be a polynomial of x; for example:

$c_3x^3 + c_2x^2 + c_1x + c0.$

Using a slider, the user can choose the degree of the polynomial - the highest power of x to be considered and in such a way the number of terms. The ci variables are adjusted for the best fit - quickly and without knowledge of peak choices here in this step - and later with more care during the peak fitting process.

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Shift Peak Frequency

If peaks are not located at their anticipated ppm-position, a manual assignment of peak positions can be performed. If peaks are assigned to their correct value, it will improve the fitting of the lesser, more difficult peaks.

- You select **Specify shift interactively** to manually assign a ppm-position to a selected peak.
- When you deselect **Specify shift interactively**, you have to specify the frequency shift value in ppm in the supplied textbox.

  The default values shown in the textbox represent the values specified during the last interactive **Shift Peak Frequency**, as supplied by the **Series Preferences database**.

Workflow: Shifting the Peak Frequency

If **Shift Peak Frequency** is set to **Specify Shift Interactively**, the execution of the script is stopped, and a pop-up window allows the user to manually assign a ppm-position to a selected peak. Once completed, the processing script is resumed.

The workflow is the same for SVS and CSI, but in SVS there is no "reference voxel" (step 2):

1. From the **Peak** ComboBox, select the peak to shift.
2. If CSI, select the reference voxel from the **Ref Voxel** ComboBox. To find a voxel that has a good spectrum that can be used to set the shift, refer to the graphs in the graph area.

   Alternatively, select the average-voxel for display.
3. A graph of the reference voxel is displayed and the cursor is labeled with the selected peak and positioned at a point determined by the **Peak Fitting** algorithm. The annotation in the graph describes the X and Y coordinates of the peak, as located by **Peak Fitting**.
4. Examine the X coordinate and verify that it is located on the correct ppm value.
5. If the cursor is not on the correct X ppm value yet, use the mouse to move the cursor to the correct value.
6. To continue processing, click **Next Step**.

NOTICE

User definition of peaks is mainly important for multi-nuclei spectroscopy, where ppm-positions are usually assigned/changed for e.g. PCr.

In general, this step is not required for proton spectroscopy.

Select Peaks

The next step for processing is to select and/or deselect the peaks that need to be fitted and quantitated.

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Metabolites

A list of metabolite peak names is provided in which the user can select or deselect the peaks of choice.

Note that the default ON/OFF settings for peak selection are defined by the target anatomy and TE as conveyed by the choice of the script.

Peak Fitting

An iterative nonlinear least-squares technique is used to fit spectra as the sum of a set of peaks (each modeled as a linear combination of a Gaussian and a Lorentzian function) plus a baseline (modeled as a polynomial function of position). In particular, an algorithm developed by Marquardt and Levenberg is used that efficiently searches for the best fit. This fitting process generates a list of optimized peak heights, widths, positions, and areas.

Definitions

Brief definitions are as follows:

Term	Explanation
Iterative	The fitted spectrum is not calculated in one shot. Rather, the initial estimate of the fitted spectrum is refined over a series of steps (typically 6 to 10).
Nonlinear	Some of the variables in the fitted spectrum are not simply scaling factors (like the variables that describe the baseline), but rather are incorporated within the model functions used for the fit. An example is the set of peak width variables, these appear in the expressions for Gaussian and Lorentzian line shapes in complicated ways.
Least-squares fit	The least-squares fit minimizes the sum over the analysis range of $(p_i - f_i)2$, where • p_i is the value of the initial spectrum at point i • f_i is the value of the fitted spectrum at point i.

Parameters

Analysis Range

These parameters refer to the range of chemical shifts (expressed in ppm). which has to be considered while fitting the spectrum. The start and end value of this range can be entered as left and right analysis limit.

The selected analysis range must:

- Be defined such that the ppm-values of the selected peaks are included in the range.
- Lie within the actual range of the data.
  Some Multi-Nuclei scans are acquired with a frequency offset, in which case the selected peaks are not displayed at their anticipated ppm-position.
  To correct the offset and the actual range of the data, use a basic pre-processing script before the peak fitting script is performed.

Display Range

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These parameters refer to the default range of chemical shifts (in ppm) to be displayed after the script is run.

To modify the limits, right-click in the spectrum viewport. Then change the limits.

Baseline Terms

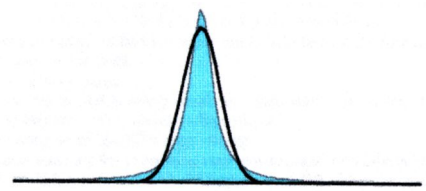
This parameter specifies how many polynomial terms are used to model the baseline during the peak fitting process. A similar parameter is used in the 'Initial Baseline subtraction' step. Both functions correct for distortions of the spectrum baseline.

However, the initial baseline subtraction is to remove large variations in the baseline so that automatic peak assignment is more likely to succeed. It is done quickly without any prior knowledge where the peaks are. It's too crude a technique for short TE spectra, because it can't readily distinguish between broad J-coupled (or lipid) peaks and rolls in the baseline. It is much better at long TE where the difference between peak and baseline is more obvious.

During the actual fitting process, the baseline (or the "residual baseline," if it has been trimmed in the residual baseline subtraction step) needs to be included as part of the overall spectrum fit. Otherwise the peaks will not be modeled properly. The baseline function should be flexible enough to follow the baseline, but not so flexible that it interferes with fitting the peaks themselves. As noted above, the Baseline Terms slider controls this flexibility by specifying the number of polynomials terms used during the fitting process.

Gaussian Character

This parameter defines the percentage of Gaussian character of the fitted peak lineshapes. In general, metabolite peaks for in vivo proton spectroscopy are more Gaussian in nature than Lorentzian. An example of both lineshapes is presented in figure.

Gaussian Percentage	Effect
0 %	Pure Lorentzian line.
100%	Pure Gaussian line.
	Lorentzian (shaded area) versus Gaussian (black line) lineshape. The two peaks shown have the same integral area.

The Gaussian line is broader near the resonance frequency but trails off to zero more rapidly than the Lorentz line.

Phase

Either the real spectrum or the modulus spectrum can be used in the fitting process. "Real" is the default for single-voxel acquisitions, and "Modulus" is the default for CSI. However, if the CSI echo acquisition type was set to half echo instead of maximum, this phase parameter should be changed to "Real."

Lock Relative Frequency

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When this fitting parameter is enabled, the number of free variables used to model the positions of N peaks is reduced from N to one. It makes use of the fact that peak positions are usually not independent of each other. For example, if the NAA peak position is known, one expects creatine to be 1.01 ppm away, choline to be 1.20 ppm away, etc. Reducing the number of free variables typically makes for a more robust fit.

Lock Releative Frequency	Effects
ON	• More robust fit. • Less chance of peak functions moving away from their initial positions to fit baseline features.
OFF	• Better fine control of the fitting. If peak positions are free to move a little bit, then J-coupled lineshapes and moderately misshapen singlet peaks can be modeled more precisely. • Safer in general, when spectrum quality is high (i.e. minimal baseline variation, minimal peak shape distortion and good SNR).

Lock Widths

This feature is similar to locking relative peak frequencies and is intended primarily for long TE spectra. It is well known that the linewidths of NAA, Creatine and Choline are inherently similar. They should widen together when the shim is bad and narrow together when the shim is good. Based on this knowledge it is possible to replace three separately adjustable widths with one overall width parameter.

Lock Widths	Effects
ON	• Useful when the SNR is low and peak shapes are distorted by noise in the spectrum. • Ignores any possible differences between peak widths. • The peak area ratio value is not likely to be distorted by baseline noise on peak shapes. • All resulting peak area ratios will equal the corresponding peak height ratios.
OFF	• Better fine control of the fitting.

Parameters for the processing step Peak Fitting

Parameter(s)	How to change the parameter value
Left analysis limit	Enter value in data entry box.
Right analysis limit	Enter value in data entry box.
Left display limits	Determines which part of the spectrum is displayed initially.
Right display limits	Determines which part of the spectrum is displayed initially.
Baseline terms	Slider to change the number of baseline polynomials. Maximum: 15.
Gaussian character	Slider to change this percentage.

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Parameter(s)	How to change the parameter value
Phase	Real / Modulus Determines phase aspect during peak fitting
Lock relative frequency	Click in checkbox to select or deselect. Default: ON.
Lock widths	Click in checkbox to select or deselect. Default: OFF.

Peak Editor

The Peak Editor allows to add peaks into the **Peak fitting** table. This peak will show up in the **Edit script** environment.

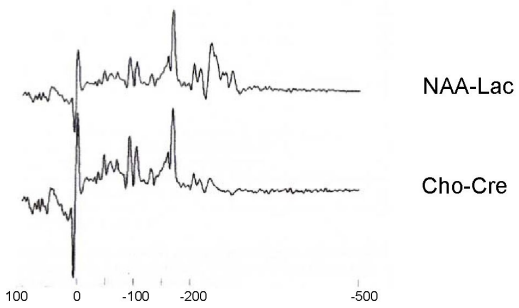
Correct for DSA Filter

The processing step **Correct for DSA Filter** is only available for Proton CSI datasets. It is disabled in all Philips Scripts.

This processing step

- Is available for CSI data sets only and is only applicable if a DSA filter was applied during reconstruction.
- Corrects for the intensity distorting effects of the DSA filter used by the reconstructor.

The DSA filter is a method to reduce residual water signals during reconstruction. The DSA filter works by shifting all FIDs over n points and subtracting these from the originals. The signals with zero frequency (water frequency) will then be nulled. The other frequencies are also attenuated except for an optimum frequency. Depending on the selected optimum frequency, the appearance of spectra, extracted from a CSI data set will be different as different weighting is applied to the various points in the spectrum. This will also have an influence on peak fitting and the results.



Effect of DSA filter with different optimum frequency on the appearance of a spectrum.

The upper row shows a spectrum from a CSI data set with DSA filter optimized for NAA and lactate. The lower row shows the same spectrum with DSA filter optimized for choline and creatine.

During reconstruction, the DSA filter is applied by default, because it removes large residual water peaks. The DSA filter correction step in the script does not change the appearance of spectra. Instead, when enabled, it compensates for the frequency-dependent effect of the filter. It corrects the reported values of peak heights, peak areas, peak height ratios, and peak area ratios. It also corrects how these quantities are displayed in metabolite maps and ratio maps.

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Integration Ranges for Maps

Allows the upper and lower bounds of a peak to be selected (in ppm) to which the estimated metabolite map is created

Generate Maps

This step is used to generate maps based on individual metabolites or ratios between metabolites.

Individual metabolite maps

Once a metabolite has been selected a choice can be made whether to generate metabolite maps:

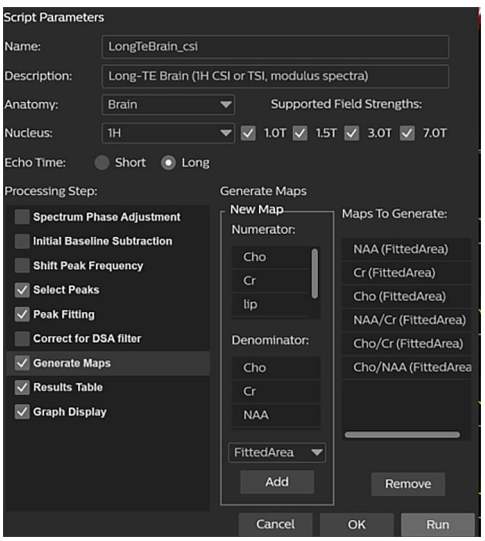
- Based on the fitted area where fitted area is based on FWHM, or
- Based on the fitted height where fitted height is based on the overall intensity of the peak.

Ratio Maps

To create a ratio map, select a single metabolite in both the numerator and denominator. Multiple selections of metabolites in both/either the numerator or denominator can also be utilized for grouped ratios.

To add or remove a map

- Select the metabolites of interest (maps) in either one or both columns. Then click **Add** or **Remove**.



Results Table

You may specify up to 4 different denominators (or none at all), including unsuppressed water which will be provided in the Results Table ratio calculations. The Results Table will contain the height and area ratios for each denominator. Your selection of denominators is determined by the peaks specified in the Select Peaks script step.

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Graph Display

This function enables or disables the display of graphs with the spectral results. It also configures the layout. It allows to define the following:

- Display mode: geometrical, compressed, horizontal or stack
- Layout: default, full-screen graph or full-screen table
- Spectrum display options: enables/disables display of spectrum, fitted baseline, fitted spectrum, residual or metabolite labels
- Spectrum limits: Override X and Y range
- Show annotation: enabled or disabled.

You can also access these functions in the context menus of the graphs.

SpectroView Workflow

Overview SV Workflow versus CSI Workflow

The table summarizes the workflow for processing of spectral data:

	Single Voxel Spectroscopy (SVS)	Chemical Shift Imaging (CSI)
1	• Start up SpectroView	• Start up SpectroView
2	• Select a script	• Select a script
3		• Select relevant voxels
4	• Run the script • If necessary: zooming and panning.	• Run the script
5	• Optimize the spectrum display	• Optimize the spectrum display
6	• Modify the layout	• Modify the ayout
7	• Create screen captures • Storage and export of data	• Create screen captures • Storage and export of data

Starting up SpectroView

► Do any of the following:

- Right-click a suitable spectroscopic dataset in the Thumbnail View.

  Then select **SpectroView** .
- Double-click a spectroscopic dataset.
- Drag a spectroscopic dataset into the viewports.

⇨ The SpectroView package opens.

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NOTICE

If voxels fail, a pop-up gives information about the error(s) after all voxels have been processed.

In this case, you find more information in the 'Status'-tab.

Anatomy and spectroscopic datasets

- When a dataset is selected for the first time, a window pops up to select the **Anatomy**.
- Based on the selection, the corresponding pre-processing script is automatically executed which processes time-domain data.
- The selected **Anatomy** is saved with the dataset: it is not required to reselect it when the dataset is opened again.
- The selection is kept until the series preferences are deleted.
  For more information, see chapter "Series Preferences Database" on page 721.

Script Handling

Selecting a Script

1. On the **SpectroView** toolbar, click **Select Script** .

   The **Script Selection** window opens. It shows the list of available scripts.

   By default, only those scripts are displayed which are compatible with the selected dataset.

2. To display also the scripts which are not compatible with the current dataset, disable one of the filters **Nucleus**, **Anatomy**, **Field** and/or **TE**:
   - Close the **Script Selection** window.
   - On the **SpectroView** toolbar, click **Expert Mode** .
   - To re-enter the Script Selection window again, click **Select Script** again.
   - Enable any of the filters on the right side of the window: **Nucleus**, **Anatomy**, **Field**, or **TE**.

     The list of available scripts changes accordingly.
3. To select a script, double click it, or click once and then click **OK**.

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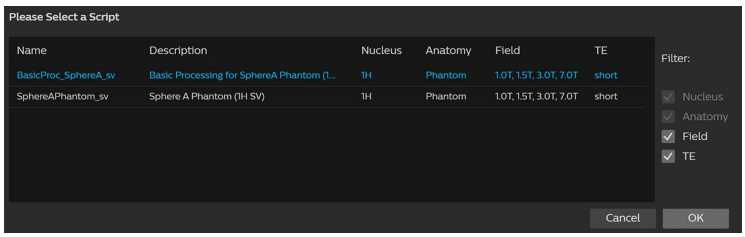	Script selection window (English only). Only scripts that are compatible to the filter critera are listed. For example, if you disable **Anatomy**, the scripts for all anatomies are shown.

Running the Script

1. On the SpectroView toolbar, click **Run Script** .

   Alternatively click **Run** in the script editor.

Zoom, Pan and Window for SpectroView

If necessary, zooming and panning can be performed now.

To zoom the spectrum,

- press middle and right mouse simultaneously. Move the mouse up and down to increase or decrease the displayed peak heights. Move the mouse left and right to increase or decrease the displayed chemical shift range.

To pan the spectrum,

- press middle and left mouse simultaneously. Move the mouse to pan the spectrum.

To change color range and threshold of color overlays,

- Press <CTRL> and middle mouse simultaneously to change the color settings. OR
- Select "adjust blending and threshold" from the image viewport menu to adjust treshold or opacity of the color overlay. If selected, dragging the left-mouse up and down changes the threshold of the color overlay. Dragging the left-mouse left to right changes the opacity of the color overlay.

The color range and threshold of color overlays are only relevant for CSI data where metabolite maps are generated:

Editing a Script

It is possible to define user defined scripts. This can be done by editing an existing script:

1. On the SpectroView toolbar, click **Edit Script...** .

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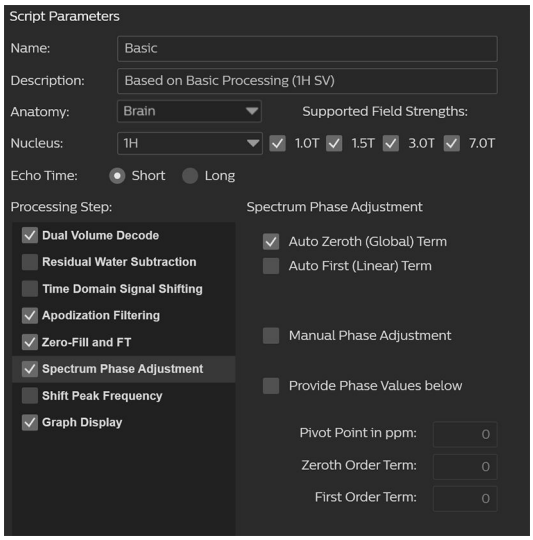

The script editor displays

- The **Name** of the current script.
- A **Description** of the script and its purpose.
- **Anatomy**, **Nucleus**, **Echo Time** and **Supported Field Strengths**.
- A list with all possible processing steps, each with a checkbox to allow the user to enable or to disable the corresponding step.

2. Select a nucleus: for example ^{1}H.
3. Set the **Echo Time** property to **Short** or **Long** (longer than 75 ms).
4. Click in the **Supported Field Strengths** checkboxes to select the field strength the script is tuned for. Multiple selections are possible.

NOTICE

The properties **Nucleus**, **Echo Time** and **Supported Field Strengths** are only used to drive the Script Selection Dialog filtering.

Changes to these properties do not impart any automated tuning to an existing script.

5. Click on the checkbox of a processing step to enable or disable the step for the script.

   The enabled step will be highlighted. Once a step is highlighted, a page of parameters associated with the step will be displayed.
6. Set the parameters to the desired values. For more information on the processing steps and corresponding parameters, see chapter “Processing steps” on page 692.

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NOTICE

Edited scripts are renamed using the following format: <unnamed>date-time.

7. To close the dialog box without applying the changes made, click **Cancel**.

   To apply the script immediately and to exit the script editor, click **Run**.

   Click **OK** when a script has not been saved yet. **OK** closes the dialog box, and stores the edited script temporarily until another script or spectroscopic data set is selected. The edited script can still be run or edited later. So you can judge the quality of a script prior to saving.

8. To save the script, click **Save Script** on the toolbar.

   Enter a name (when editing a Philips supplied script) and optionally a script description.

   The script is only saved, but not applied in this case.

Deleting a Script

You can only delete your own scripts. Philips scripts are write-protected.

- ► To delete a script, select **Delete Script** from the **More** drop-down menu on the **SpectroView** toolbar.
  - ⇨ The **Script Selection** window opens with the list of saved scripts.
- ► Select a script to delete. Then click **OK**.

  Multiple selections are possible when you select the scripts whil you press **Ctrl** or **Shift**.
- ► Do any of the following:
  - To confirm the deletion, click **Yes**.
  - To cancel the operation (without deleting), click **No**.

Selecting Relevant Voxels

You select voxels before you run the fitting script, to specify which voxels get processed.
If you do not select voxels before you run the fitting script, a default grid of 5x5 voxels in the spectro volume is displayed after processing.

This workflow is only valid for:

- CSI datasets.
- Dynamic single voxel datasets.
- Parameter series.

There are two possibilities of how to select relevant voxels, either by clicking on voxels or by drawing a ROI.

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Selecting voxels by drawing a ROI

- On the toolbar from the drop-down menu of the **Voxel selection** button, select **Select Voxels by Drawing** .
- To draw a freehand ROI, drag around the region over which you want to investigate.

  The voxels are automatically included based on the ROI drawn.

Selecting individual voxels

- On the toolbar, click **Voxel selection** .
  This operation enables the default, and the default is to select individual voxels.

  Alternatively select **Select Individual Voxels** from the drop-down menu of the **Voxel selection** button.

  ⇨ In voxel selection mode, the left mouse behavior in the spectral grid changes.
- To select a single voxel, click on this voxel.

  The corresponding spectrum and the table of results will be displayed. The screen layout matches the SVS screen layout.
  (Note that the table of results will only be shown if a fitting script has been run before)).

  A new single click selects a new voxel, and deselects the previously selected voxel. The spectrum and the table of results are updated.
- To add an individual voxel to the current selection, press the <CTRL> key while you click another voxel.

  ⇨ This voxel is selected additionally to the previously selected voxel. The spectra from the selected voxels are displayed.
- To select multiple voxels within a box, press the <Shift> key while you click two voxels.

  The two points define a box. All voxels in this box are selected. The spectra from the selected voxels are displayed.
- To reselect previously processed voxels on the image, right-click the image. Then select **Select All Processed Voxels**.

NOTICE

You can modify the selection as long as the script has not been changed.

When the selection is complete, select 'Run Script' from the toolbar to (re-)execute the current script.

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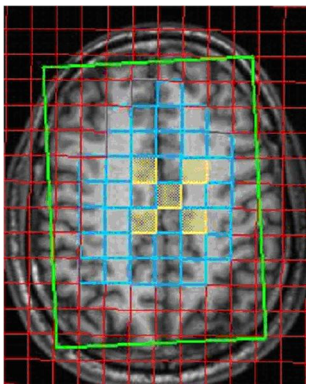
Voxel color description

To facilitate further processing, the voxels are overlaid by a colored grid to indicate their current processing state:

- Blue outline: Voxels have been included in processing steps.
- Yellow shaded voxels: Voxel is currently displayed.
- Red outline: Voxel failed processing.



Optimizing the Spectrum Display

You can modify any single spectrum display: SVS, one voxel CSI or one average of CSI.

1. To access the **Spectrum display** context menu, right-click on the spectrum display area. Select any of the available options.
2. To access the context menu for multi-voxel display, right-click on the spectrum grid area. Select any of the available options.

Modifying the Layout

1. To change the screen layout, do any of the following:
   - For SVS, click the **Layout** button, and select any option.
   - For CSI, click the **Graph Display Mode** button, and select any option.

Available display options for SVS

	Default Layout Layout with three image viewports at the top of the screen, a graph display area and a result display area.
	Full-screen Graph Layout with spectra only. The graph display area will be enlarged to fill the entire screen.

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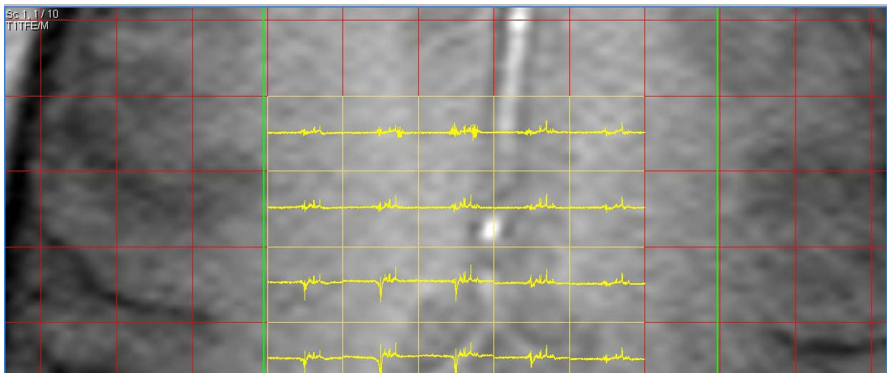
	Full-screen Table Layout with a table of results only. The result display area will be enlarged to fill the entire screen.
	Spectra on Image Layout with spectra on the image. 

Available display options for CSI

	Horizontal: The graphs are displayed horizontally. This is a multiple graph area mode.
	Stack: The graphs are displayed vertically in one box with no dividing lines. This is a multiple graph area mode. Spacing between spectra in stack display mode can be changed as follows: Press <Shift> and simultaneously, press both middle and right mouse icons. Moving the mouse upwards increases the space between spectra; moving the mouse down decreases the spacing between spectra. This does not affect the spectra themselves and is not applicable in other CSI display modes.
	Geometrical (default layout): The graphs are displayed in viewports being structured in the same layout as in the CSI grid. Voxels that are not selected in the CSI grid have an empty corresponding graph.
	Compressed: The graphs are displayed one by one in a square or rectangular array with a minimum of blank entries.

Creating Screen Captures

On the SpectroView toolbar, click **Capture Screen** .

Storage and Export of Data

There are three different data formats for the storage of data:

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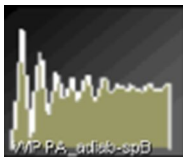
1. DICOM-format.
   - Purpose: You store MRS data in the patient database.
   - To store time-domain data in the patient database, select **Administration** from the **Patient Menu**.

     The new entry appears as (time-domain data) thumbnail in the **Thumbnail View**:

     For more information, see Administration chapter.
   - To store a processed spectrum, click **Store Processing Parameters** on the **SpectroView** toolbar, after the completion of a pre-processing script.

     The new entry appears as (processed spectrum) thumbnail in the **Thumbnail View**:

2. non-DICOM export.

   Purpose: You export data in SPAR/SDAT-formal (or XML-SDAT-format as research option). For more information, see Non-DICOM Export in the Administration chapter.
3. Output to a spreadsheet application.
   - On the **Spectroview** toolbar, click **More**. Then select **Enable CSV Output**.
   - Each time you run a fitting script, the following files are placed in E:\Export:
     [name].Fdd.csv:
     Frequency Domain Data from the BasicProcessing Script [name]Baseline.csv.
     Fitted baseline data [name]Fitted.csv.
     Fitted peak data [name]ScaledRaw.csv.
     Scaled unfitted data [name]Script.txt.
     A textual description of the script used to produce the results [name]Table.csv.
     Table of Processing Results.
   - Each time you run a pre-processing script, only the files Fdd.csv and Script.txt are created.
   - By default, **Enable CSV Output** is disabled to prevent unnecessary pollution of the export directory. Each time you close **SpectroView**, **Enable CSV Output** is disabled again.

These files use the naming scheme:

<patient name>-<DICOM Study ID>-<DICOM Series ID>-<Date>-<Time>filename.ext

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- <patient name> = the patient name with all the illegal filename characters and whitespace removed
- <DICOM Study ID>
- <DICOM Series ID>
- <Date> = the date of the script run
- <Time> = the time of the script run

The ".csv" files can be opened directly in Microscoft Excel and contain headers identifying each column. The data will contain X, Y, Z and T (time for dynamics) voxel coordinate columns (voxels are 4-dimensional objects).

- For single slice data sets, the Zcoord column will always be "1"
- For non-dynamic data sets, the Tcoord column will always be "1"
- For single voxel data sets, the coordinates will always be (1,1,1,t).
- In CSI data sets, the voxel with coordinate (-1,1,1,t) is the "average voxel", it contains the average of all the currently selected voxels.
- Spectrum values in these files are expressed in PPM

A maximum of 20 datasets can be present in the folder. If more than 20 sets are in the folder, SpectroView deletes the oldest set, as determined by the timestamp in the filename.

SpectroView: Advanced Workflows

This section provides more information about the SpectroView package in order to achieve best results and to optimally handle the package.

It covers:

- User Interface
- Scripts and script handling
- Processing steps
- Customization using the Peak Editor
- Series Preferences Database

Customization using the Peak Editor

Functional Description of the Peak Editor

The Peak Fitting algorithms in **SpectroView** use a database of known peaks with attributes to drive the fitting, display and calculation results.

- The database contains commonly accepted peak definitions. They may not be modified or deleted.
- The Peak Editor allows you to add your own peak definitions to the database.

  It also allows you to edit, copy or delete these peak definitions.

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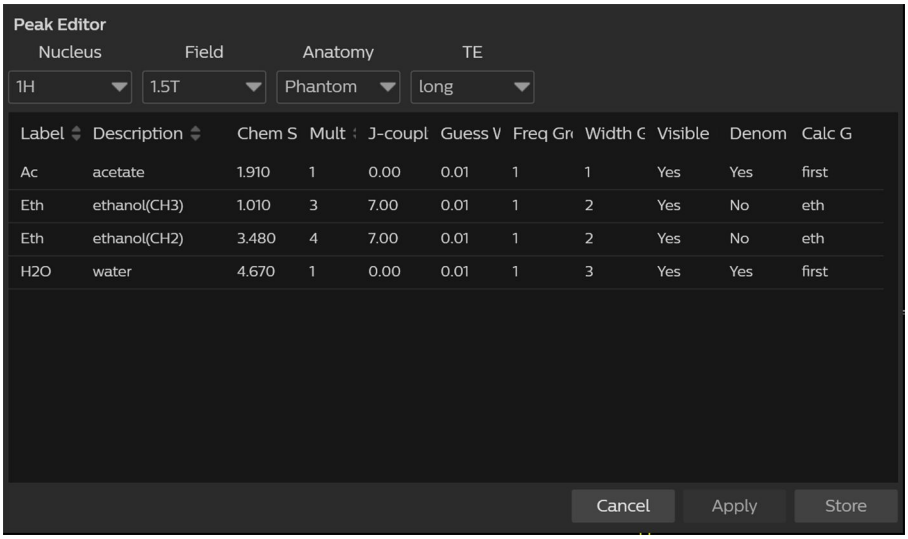
User Interface

▷ On the **SpectroView** toolbar:

1. To open the Peak Editor, select **Peak Editor...** from the **More** menu.

   The Peak Editor opens.
   (The Peak Editor opens with blank values when no peak is selected.)



Filter combo box: **Nucleus** Filter combo box: (Magnetic) **Field** Filter combo box: **Anatomy** Filter combo box: Echo time **TE**	When a dataset is loaded, appropriate peaks are selected from the peak database according to the **Nucleus**, **Field** strength, **Anatomy** and **TE** of this dataset. These filters are set to the values found in the currently loaded dataset. However, these filters may be changed at any time.
Peak table	The peak table shows all peaks which are part of the peak database: the commonly accepted write-protected peak definitions, and the user-defined peak definitions. You recognize user-defined peaks by the * in front of the name label.
Apply	Applies changes to the database and exits the Peak Editor, but does not save the database to disk. The peak changes are immediately available for the next script run, but if you exit **SpectroView** without saving, all applied changes will be discarded.
Store	Saves the updated database to disk and exits the Peak Editor. Once changes are saved to disk, they will be permanent, even across software updates.

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Cancel	Exits the Peak Editor and discards all changes made in the current instance of the dialog. Changes made in previous instances of the dialog (by using the Apply button) remain in effect.

Peak Database

The table below lists the peak attributes which are supported in the peak database.

Label	Name for the peak as shown in the **Select Peaks** window, and as metabolite label in the fitted spectrum.
Description	Provides additional information about the peak.
Chem. Shift	The ppm value of the peak.
Mult.	Number to express if the signal splits into a multiplet. 1. Singlet 2. Doublet 3. and so on
J-Coupling	J-coupling value for the multiplet in Hz.
Guess Width	Initial guess width that is used for fitting.
Freq. Group	Frequency group value for the peak.
Width Group	To limit the number of free parameters, peaks are assigned to different **width groups**. Peaks within the same width group are modeled by just one **peak width** parameter. They widen or narrow together through the fitting process. As an example, the seven Glx peaks are all in the same width group. When the **Lock Widths** option is turned on from the Peak Fitting script page, all peaks are put in the same width group, overriding these table settings.
Visible	If this parameter is set to **0**, the label will not appear on the graph peak to avoid crowding.
Denom.	If this parameter is set to **1**, this peak is allowed to appear in the denominator of a ratio calculation.
Calc. Group	Specifies how metabolites with multiple peaks are used to make maps, ratios and results. For calculations, all peaks with the same **calc name** are "lumped together". If the calc name reads **first**, the first peak in the table is used (read from top to bottom). • For metabolite maps, grouped peaks all influence the map. • For the **Processing Results** table, the height, width and shift are those for the highest peak in the group. The reported area is the sum of all peaks in the group. • For the **Graph Annotation** Mini-Table, the height is the height of the highest peak in the group. The area is the sum the areas for all the peaks in the group.

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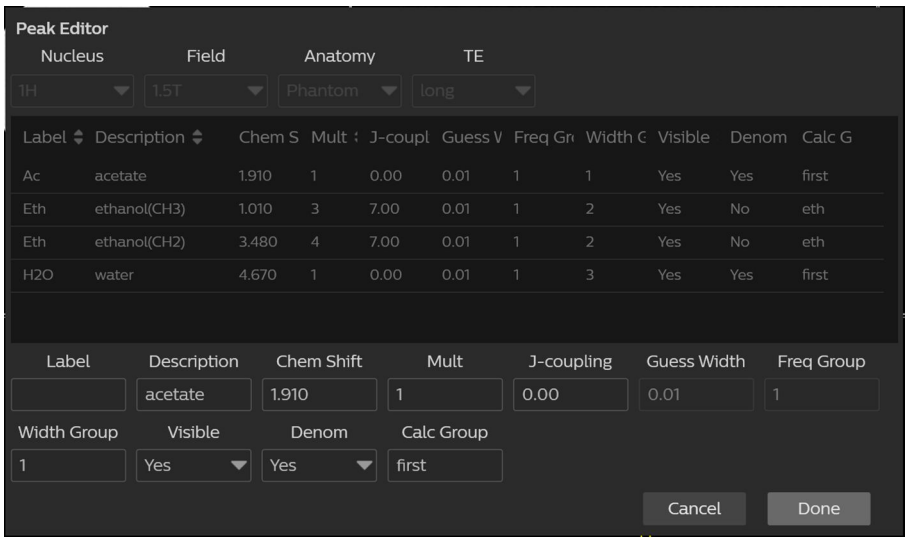
Adding a Peak Definition

▷ Prerequisite: You are in the **Peak Editor...**.

► To add a peak definition, right-click in the peak table. Then select **New Peak**.

⇨ The peak attributes of the highlighted peaks are copied into the Peak Editor.

► Specify the label name, and the other attributes.



► Do any of the following:

- To confirm that you add the peak to the database, click **Done**.
- To discard the changes, click **Cancel**.

Modifying Peak Definitions

The Peak Editor allows you to edit, copy or delete user-defined peak definitions.

▷ Prerequisite: You are in the Peak Editor.

► Select a peak definition.

► Do any of the following:

- To duplicate the selected peak definition, right-click on the list of peak definitions. Select **Copy Peak**. The right-click the list again, and select **Paste Peak**.
- To edit the selected peak definition, right-click on the list of peak definitions. Then select **Edit Peak**.
- To delete an obsolete peak definition, right-click on the list of peak definitions. Then select **Delete Peak**.

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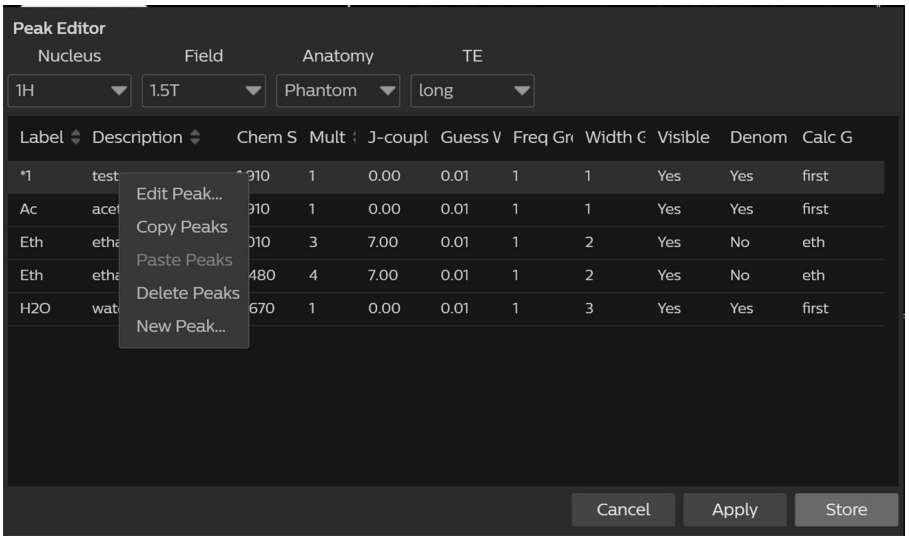

Series Preferences Database

SpectroView maintains a **Series Preferences Database**. This database contains your preferences for the last series (approximately last 100 series) that were processed. When a series is reloaded, these preferences are also reloaded and applied to the **Script Editor**.

For each series, the following information is captured:

- Anatomy
- Expert Mode On/Off
- Shift Peak Frequency Reference Voxel
- Shift Peak Frequency Shift Value
- Shift Peak Frequency Reference Peak
- Shift Peak Frequency Graph Cursor Position
- Shift Peak Frequency Graph X and Y Axis Scaling
- Manual Phase Adjust Reference Voxel
- Manual Phase Adjust Pivot Point
- Manual Phase Adjust Zeroth Order Correction
- Manual Phase Adjust First Order Correction
- Manual Phase Adjust Graph Phase Real/Imaginary/Modulus
- Manual Phase Adjust Graph X and Y Axis Scaling

To clear all preferences for the current series, select **Delete Series Preferences** from the **More** menu item on the **SpectroView** toolbar.

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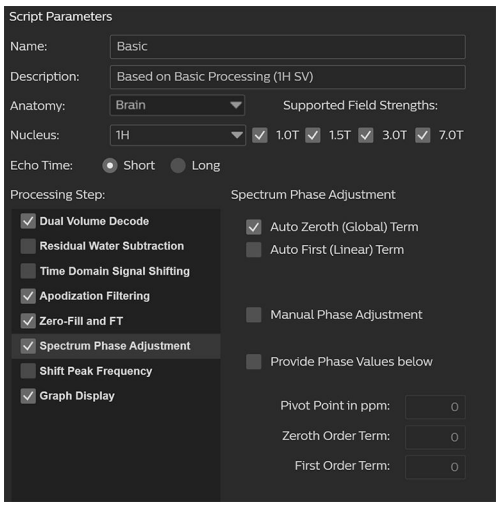
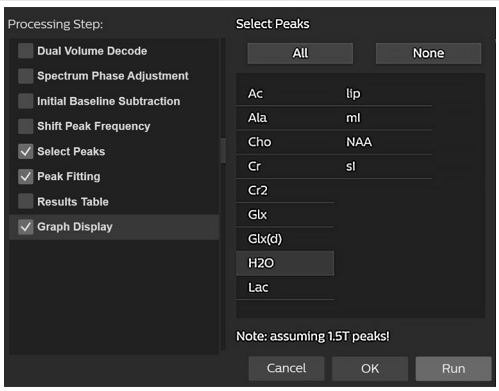
Process Unsuppressed Water Data

Required Scripts

The workflow *Processing unsuppressed water data* requires several scripts. Each script has specific requirements. The table lists the required scripts and their requirements.

Script and requirements	Example image
Pre-processing script (Basic) Optimized for unsuppressed brain water. • Residual Water Subtraction: Off • Spectrum Phase Adjustment: On, and set to Auto Zeroth Order • Use the same apodization filter settings for water and for metabolites	
Water fitting script for the brain Standard water-fitting script and change its anatomy to **Brain**. Typical settings are: • Dual Volume Decode = off. • Spectrum Phase Adjustment = off. • Initial Baseline Subtraction = off. • Shift Peak Frequency = off. • Select Peaks = on. Peak Fitting = on. • Results Table = off. Graph Display = on.	

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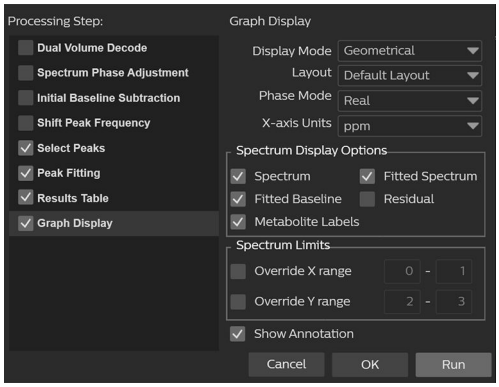
Script and requirements	Example image
Generalized brain-fitting script To display metabolite ratios with respect to unsuppressed water. Make sure that 'Unsupp. H_2O' is selected as one of the denominators on the **Results Table** script page.	 Processing step: Results Table. In this example, NAA has been selected as "Denominator #3" as well.

NOTICE

If you start off with Unsuppressed Water in SpectroView, you might need to create these new scripts.

Verify that the scripts are available and fulfill the requirements:

- Pre-processing script optimized for unsuppressed brain water.
- Water fitting script for the brain.
- Generalized brain-fitting script.

Workflow Processing Unsuppressed Water Data

▷ Prerequisite: **SpectroView** is open with a suitable dataset.

1. To start the analysis, click **Process Unsuppressed Water Data** on the toolbar.
   ⇨ The icon remains highlighted. The dataset reloads, now with the unsuppressed water data information.
2. To select a pre-processing script which is optimized for unsuppressed brain water, click **Select Script** on the toolbar.
   Then select a script according to the requirements listed in the table at the beginning of this workflow.
3. To execute the script, click **Run Script** on the toolbar.

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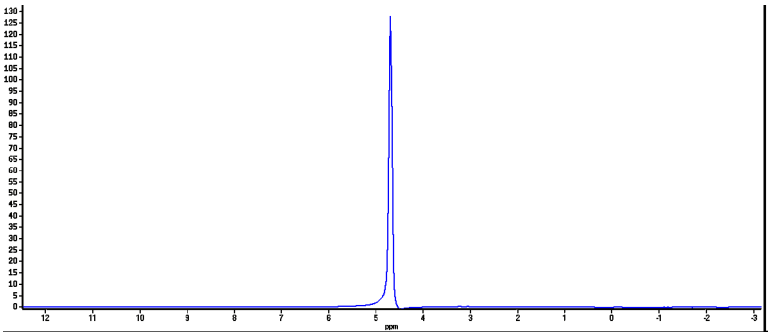
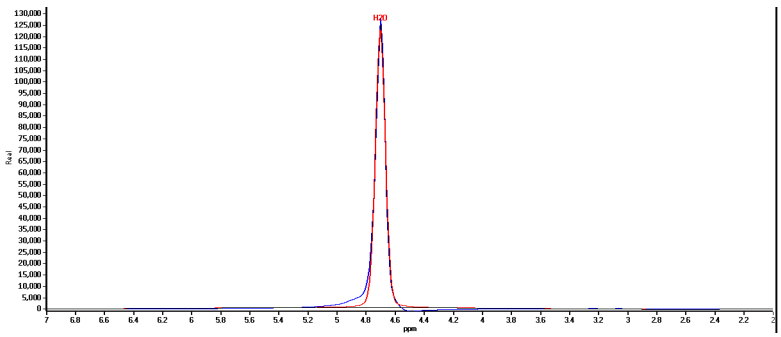
⇨ The figure shows the resulting spectrum: unsuppressed water, auto-phased and undistorted by “residual” water subtraction.



4. To select a water-fitting script for the brain, click **Select Script** on the toolbar.
   Then select a script according to the requirements listed in the table at the beginning of this workflow.
5. To execute the script, click **Run Script** on the toolbar.
   ⇨ The figure shows the resulting spectrum: Peak fitting results for the analysis **Unsuppressed water**. Although the peak area and peak height are the quantities needed for ratio calculations, the peak width is also valuable as a measure of shim quality.



6. To return to the usual water-suppressed spectrum when the analysis of the unsuppressed water is done, click **Process Unsuppressed Water Data** on the toolbar.
   ⇨ The icon is non-highlighted now.
7. To select a generalized brain-fitting script, click **Select Script** on the toolbar.
   Then select a script according to the requirements listed in the table at the beginning of this workflow.
8. To execute the script, click **Run Script** on the toolbar.

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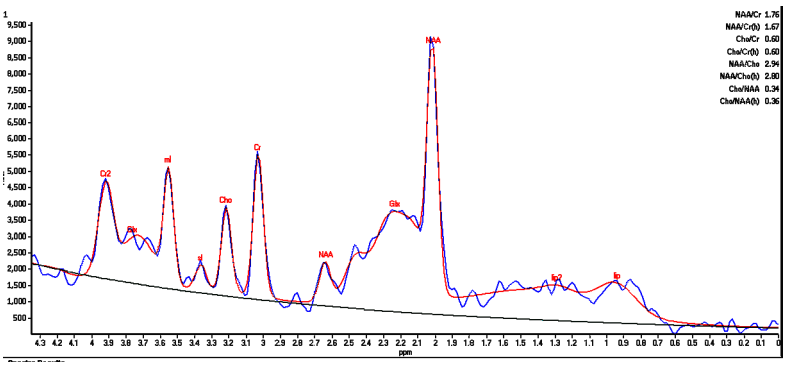
⇨ The figure shows the resulting spectrum: Metabolite ratios with respect to unsuppressed water.

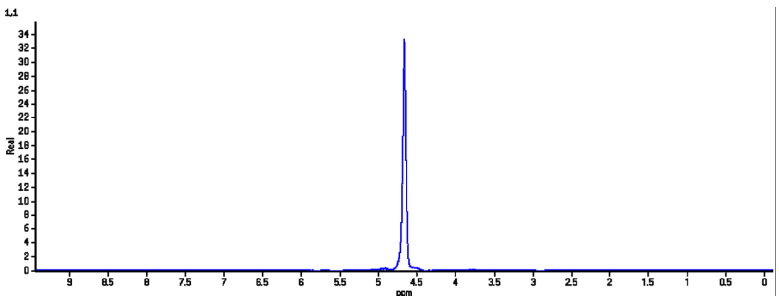
⇨ A table is also displayed providing the ratios in numeric values.



Truncate Graph Peak

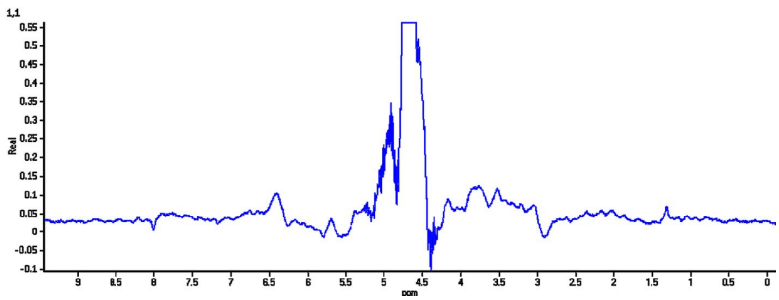
When you process unsuppressed water data, the resulting spectra often shows an overwhelming water peak.

To overcome this situation, you use the option **Truncate Graph Peak**. This option only appears when **Expert Mode** is enabled, since careless use can cause misleading results.



Spectrum after processing unsuppressed water data, prior to Truncate Graph Peak

The overwhelming water peak causes smaller peaks and ripples to be scaled down to a flat line.



Spectrum after Truncate Graph Peak

Now the details of the “noise” surrounding the water peak can be visualized.

► On the **SpectroView** toolbar, click **Expert Mode** .

► Right-click on the graph. Select **Truncate Graph Peak**.

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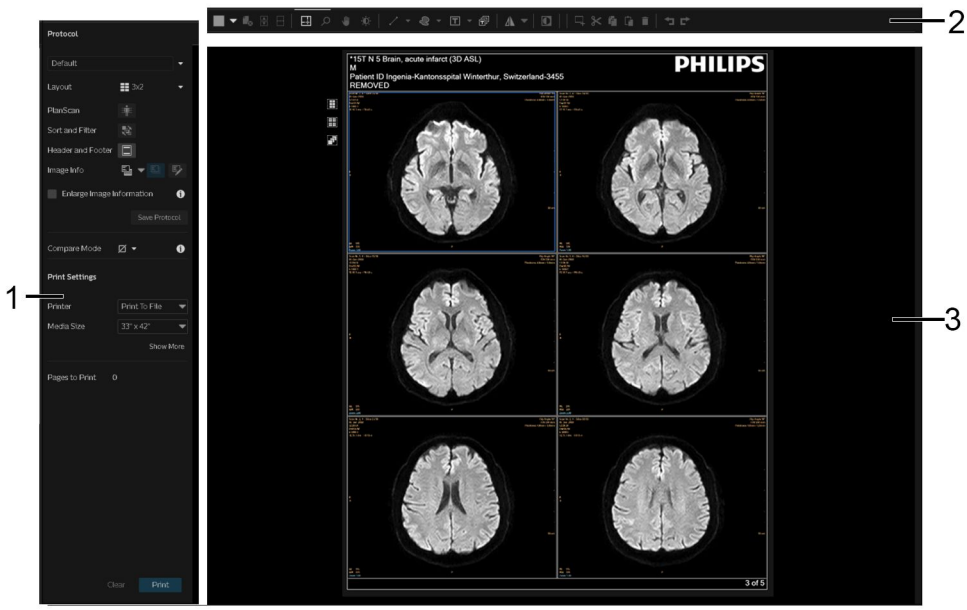
8.2 Printing

8.2.1 Print Tab

In the **Print** tab, you set up the images and imaging series for print output. The following UI elements support you:

1. Protocol panel.
2. Print toolbar.
3. Print preview.



8.2.2 Opening an Imaging Series in the Print Tab

There are various ways of how to open and review imaging series in the **Print** tab.

▷ From the **Exam Overview**:

► Drag an imaging series from the **Thumbnail View** (or **List View**) into the Print Preview.

⇨ The center slice of this imaging series is displayed in the viewport.

A previously displayed imaging series is replaced by the new one.

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▷ From the **Plan** or **Review** tab:

► Click **Add Series To Print** .

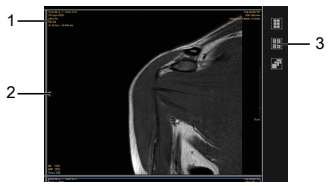
⇨ The imaging series is added to the Print Preview.

► To go to the Print tab, click **Print**.

8.2.3 Print Preview

The Print Preview displays an exact preview of how the print output will look like (WYSIWYG: What you see is what you get). The Print Preview displays 1, 2, or 4 print pages next to each other. The default layout of a print page is 3x2 image viewports. You can modify this layout and save your changes as a new printout protocol (on the **Protocol** Panel) for later reuse.

To display images in the Print Preview differently, use the Print Toolbar, the Protocol Panel and the context menus.



1. Image information
   as configured in the Image Information settings.
2. Fold-over indicator
   indicating the fold-over direction in which typically MR artifacts occur.
3. Buttons for the selection of images.

Buttons for the selection of images

Button	Short description	More information
	Select all images on this page: To select all images on the currently selected print preview page.	chapter “Selecting Images on Print Pages” on page 742
	Select all images on all pages: To select all images on all print preview pages.	
	Select all images of this series: To select all images of the currently selected series on the print preview pages.	

8.2.4 Print Toolbar

Functional Description

The Print Toolbar is available on the **Print** tab. It is composed of buttons and drop-down menus that provide access to generic functions to print single images and whole imaging series. For drop-down menus, always the currently selected button is visible.

The Print Toolbar allows you to:

- Configure the print page layout

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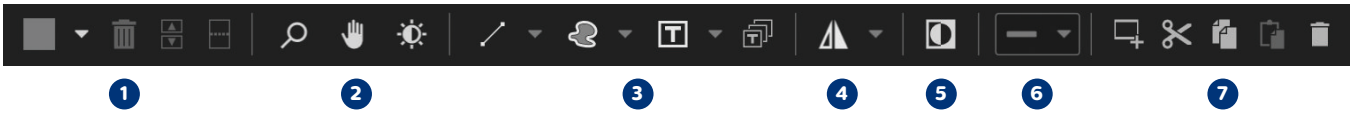
- Adjust the images or image details (Zoom, Pan, Window Level)
- Include annotations and measurement information into the images

The following buttons are available in the Print Toolbar.



Number	Button or button group description	More information
1	Print Preview and Print Page Layout	chapter “Setting the Number of Print Pages in the Print Preview” on page 737 chapter “Adjusting the Layout of the Print Page” on page 737
2	Image Display	chapter “Changing the Display of Images on Print Pages (Zoom, Pan, Window)” on page 744
3	Measurements and Annotations	chapter “Measuring and Annotating Images on Print Pages” on page 744
4	Image Rotation	chapter “Mirroring, Flipping, and Rotating Images on Print Pages” on page 744
5	Invert Gray Scale	chapter “Displaying a Negative Image on Print Pages” on page 746
6	PlanScan Drawing Tool	chapter “Adding a PlanScan Image to the Images on the Print Page” on page 741
7	Edit Images (Copy, Paste etc.)	chapter “Changing the Display of Images” on page 741

Tab. 11: Print Toolbar: Buttons and button groups

What do you want to do?

- Insert or delete page breaks
- Delete pages
- Select a screen layout
- Adjust an image or image detail (Zoom, Pan, Window)
- Mirror, flip or rotate an image
- Display a negative image
- Cut, copy, paste or delete images
- Perform measurements with lines or angles
- Perform measurements with ROIs
- Insert annotations
- ...

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Layout of Print Preview and Print Pages

These buttons allow you to select the number of pages displayed in the print preview area, and to organize the print page layout by inserting page breaks or deleting whole print pages.

Print Preview Area

Drop-down menu	Short Description	Instructions
	Single Page Mode: To display 1 page in the print preview area.	• chapter "Setting the Number of Print Pages in the Print Preview" on page 737
	2-Page Mode: To display 2 pages in the print preview area.	
	4-Page Mode: To display 4 pages in the print preview area.	

Print Page Layout

Buttons	Short Description	Instructions
	Delete Page: To delete the current page.	• chapter "Adjusting the Layout of the Print Page" on page 737
	Insert Page Break: To insert a page break before the current image.	
	Remove Page Break: To delete the page break before the current image.	

Left Mouse Behavior: Zoom, Pan, Window

When you drag (with left mouse button) in a viewport, by default you scroll through images. Click any of these buttons to change this behavior, and then use the drag function to perform any of the actions listed below:

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Button	Short Description	Instructions
	Zoom: Drag to magnify or reduce the image with the left mouse (when this button is enabled).	• chapter "Changing the Display of Images on Print Pages (Zoom, Pan, Window)" on page 744
	Pan: Drag to pan a magnified image with the left mouse (when this button is enabled).	
	Window: Drag too adjust brightness and contrast of an image with the left mouse (when this button is enabled).	

Measurements and Annotations

These buttons allow you to perform measurements on the imaging series and overlay the images with the measurement results and other annotations.

- Depending on the type of graphical object chosen, different numeric results are provided.
- Every graphical object is defined by one or more anchor points. The anchor points are visible upon creation, when the mouse hovers over the object, and when the object is selected.
- To select a graphical object, click on it.
- To resize or reshape a graphical object, drag any of its anchor points.
- To move a graphical object or a measurement label, drag it to the desired location.
- Dedicated context menus offer more functionality such as the calculation and display of histograms and profiles.

Measuring and annotating work as described in the instructions for reviewing. Annotating with predefined annotations is a feature available on the Print Toolbar only.

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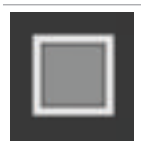
Measurements based on lines

Drop-down menu	Short Description	Instructions
	Distance: To measure the distance of two points on an image.	• See Measuring with Lines in this chapter
	Smooth Polyline: To measure the length of a smooth polyline defined by several points on an image.	
	Polyline: To measure the length of a polyline defined by several points on an image.	
	Angle: To measure the angle defined by three points on an image.	
	Open Angle: To measure the open angle defined by four points on an image.	
	XY Line: To display the differences of X-coordinates (Delta X) and Y-coordinates (Delta Y) of two points which define a line.	

Measurements based on Regions of Interest (ROIs)

Results include the size, diameter and perimeter of the ROI.

Drop-down menu	Short Description	Instructions
	Freehand Contour: To measure an area based on a Freehand contour ROI.	• See section Measuring with ROIs in this chapter
	Smooth Polygon: To measure an area based on a ROI with the shape of a smoothed polygon.	
	Ellipse: To measure an area based on a ROI with an elliptical shape.	
	Circle: To measure an area based on a ROI with a circular shape.	
	**Rectangle**: To measure an area based on a ROI with a rectangular shape.	

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Text Annotations

Drop-down menu	Short Description	Instructions
	Text Annotation: To overlay a text box to an image.	• Annotating Images
	Arrow + Text Annotation: To overlay an arrow with a text box to an image.	

Predefined Annotations

Button	Short Description	Instructions
	Predefined Annotations: To overlay a predefined text to an image.	• chapter "Using Predefined Annotations" on page 745

Edit Images on Print Pages (Insert, Cut, Copy, Paste and Delete)

These buttons allow you to perform basic editing operations with images: cutting, copying, pasting, and deleting. Furthermore, blank images can be inserted into the print pages.

Button	Short Description	Instructions
	Insert blank image: To insert a blank image.	• chapter "Changing the Display of Images" on page 741
	Cut selected images: To cut the selected image(s).	
	Copy selected images: To copy the selected image(s).	
	Paste images: To insert the image(s) you cut or copied.	
	Delete selected images: To delete the selected image(s).	

Image Rotation

These buttons allow you to rotate, mirror and flip images.

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Drop-down menu	Short Description	Instructions
	Mirror: To mirror an image (horizontally).	• chapter "Mirroring, Flipping, and Rotating Images on Print Pages" on page 744
	Flip: To flip an image (vertically).	
	Rotate Clockwise: To rotate an image 90° clockwise.	
	Rotate Counter-Clockwise: To rotate an image 90° counter-clockwise.	

Invert Gray Scale

This button allows you to display a negative image where all the pixel values are set to their opposite value on a color wheel: white becomes black, and vice versa.

Button	Short Description	Instructions
	Invert Gray Scale: To display a negative image.	• chapter "Displaying a Negative Image on Print Pages" on page 746

PlanScan Drawing Tool

These buttons allow you to display the reference lines to the planned volume.

Drop-down menu	Short Description	Instructions
	Defaults: To display the reference lines in default mode.	• chapter "Displaying Reference Lines on Print Pages (PlanScan Drawing Tool)" on page 747
	Box Mode: To display the reference lines in box mode.	
	Slice Mode: To display the reference lines in slice mode.	
	3D Mode: To display the reference lines in 3D mode.	

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8.2.5 Protocol Panel

Functional Description [Protocol Panel]

The Protocol Panel is available on the **Print** tab.

The Protocol Panel allows you to:

- Select and save print layouts.

  You set up a print layout once, and you select this layout for all similar examinations.
- Select and save print protocols.

  You set up a print protocol once, and you select this protocol for all similar examinations.

  In the print protocol, you specify:
  - if PlanScan images are included in the printout.
  - Which images of the selected imaging series are included or excluded in the printout (by a filter) and how these images are sorted.
  - The amount of image information on the printout.
- Set up a print-out which shows two imaging series side by side and which allows to compare these imaging series.
- Set the Printer settings and specify your printer preferences.

The Print Preview supports you in setting up your printout, as it shows you *What You See Is What You Get.*

UI Elements in Protocol Panel

The table lists the buttons and drop-down menus which are available on the Protocol Panel.

UI Element	Short description	More information
<Protocol selection drop-down menu>	To select a protocol for print.	chapter "Saving and Loading Print Protocols (Printout Protocols)" on page 750
Layout	Drop-down menu which allows: • To select a layout for the printout. • To apply the selected layout to all pages or to the selected page. • To select the filling order: **Horizontal Filling**, **Vertical Filling**, and user defined: **Select Filling Order**.	chapter "Adjusting the Layout of the Print Page" on page 737

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UI Element	Short description	More information
PlanScan	To add a PlanScan image to the printout.	chapter “Adding a PlanScan Image to the Images on the Print Page” on page 741
Sort and Filter	• To specify the sorting order of the images on the printout. • To filter and restrict the images for the printout by setting an image range. • To specify page breaks between films based on the number of images.	chapter “Filtering and Sorting the Images in a Print Page Viewport” on page 740
Header and Footer	To change the header and footer and specify the type of information displayed in the header and footer.	chapter “Adjusting Header and Footer of a Print Page” on page 751
Image Info	• To select the amount of image information in the same way as on the Review tab. • To hide the image information for the selected series. • To access **Image Information Settings** where you adjust the amount of information per image (**Image Level Info**) and per imaging series (**Series Level Info**).	chapter “Managing the Information on the Print Page” on page 747
Enlarge Image Information	To enlarge the font size of the image information on the Print Preview. displays information about this feature: This info is only displayed on the preview The font size is enlarged **only on the preview to identify essential information such as the slice number.** It is not enlarged on the print output.	chapter “Enlarging the Image Information on the Preview” on page 749
Save Protocol	To save current layout settings as a printout protocol.	chapter “Saving and Loading Print Protocols (Printout Protocols)” on page 750

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UI Element	Short description	More information
Compare Mode	To view series side by side (else: sequentially) and compare the images. displays information about the feature.	chapter “Printing in Compare Mode” on page 740
Printer	To select a printer.	chapter “Configuring Printer and Print Output” on page 751
Media Size	To set the media size of the output.	
Show More	To show the following print settings from **Orientation** to **Edit Default Print Settings** on the Protocol Panel, which are hidden by default.	
Orientation	To set the page orientation (Portrait, Landscape).	chapter “Configuring Printer and Print Output” on page 751
Copies	To set the number of copies to print.	
Pages	To define which pages to print.	
Collate	To collate print pages.	
Life-Size Printing	To activate life-size printing.	
De-Identify	To automatically render the print output anonymous.	chapter “De-identifying Patient Data in Print Output” on page 749
Edit Default Print Settings	To configure and save the Print Preferences.	chapter “Configuring Printer and Print Output” on page 751
Show Less	To hide the print settings from **Orientation** to **Edit Default Print Settings**.	
Pages to Print	No interaction. The number at **Pages to Print** is the current number of pages in the Print Preview.	
Clear	To delete all images from all print pages.	chapter “Cut, Copy, Paste and Delete of Images” on page 742
Print	To start the print job.	chapter “Printing Images and Imaging Series” on page 736

8.2.6 Routine Procedures

Printing Images and Imaging Series

During planning, reviewing or analyzing, you can send single images and whole imaging series to the **Print** tab. In the **Print** tab, you can

- Open an imaging series in the **Print** tab.

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- ► Configure the page layout and print settings before printing the images.
  Use the functions available on the Print toolbar and the Protocol Panel.
- ► In the **Protocol** Panel, click **Print**.

Print History

The Print history can be looked up in the Job Viewer. There, you can also cancel a running print job or redo a previous print job.

Navigating through Print Pages

Setting the Number of Print Pages in the Print Preview

Imaging series with more than 16 images do not fit on one print page.

To get an overview of all print pages, change the display mode.

- ► On the Print Toolbar, select a layout from the screen modes drop-down menu:
  - To display one page, click **Single Page Mode** .
  - To display two pages, click **2-Page Mode** .
  - To display four pages, click **4-Page Mode** .

Scrolling through the Print Pages

If there is more than one print page, use the mouse wheel or the keyboard to navigate through the pages.

- ► With the keyboard, do any of the following:
  - To navigate to the previous page, press **Up Arrow**.
  - To navigate to the next page, press **Down Arrow**.

Unless deactivated in the header and footer configuration, the current page number and the total number of print pages are displayed at the bottom right of each page preview.

The total number of print pages is also displayed in the **Protocol** panel, at **Pages to Print**.

Adjusting the Layout of the Print Page

The default layout of a print page is 3x2 images with all images sorted sequentially. You can adjust that layout and display more or less images on a page, or insert page breaks. The viewports of the Print Preview can be resized by dragging.

Furthermore, you can use the compare mode and split the print page horizontally or vertically to display images or imaging series next to each other for comparison.

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Changing the Layout

The Print Preview displays one or more (maximum 16) viewports with images of one imaging series next to each other.

- You can apply a layout to the Print Preview.
  You select either a standard predefined layout, or you select a previously saved anatomy-specific layout.
- You can select a predefined layout for a viewport.
- You can individually resize a viewport.

Applying a predefined layout to the Print Preview

► In the Protocol Panel, select a predefined layout.

Selecting a predefined layout for a viewport

► Right-click a viewport and select **Inner Layout** > **1x1** to **4x4**.

Resizing a Viewport

You resize a viewport of the Print Preview individually to adjust it to the anatomy of interest.

► Drag the viewport border until the viewport has the desired size.

- You can only drag borders that adjoin to other viewports.
- If you drag horizontally, the whole column is resized.
- If you drag vertically, the single viewport within the row is resized.

Saving a layout

► To save a layout for reuse, click **Save Layout** on the Protocol Panel.

This button is only available when the current layout of the Print Preview deviates from the already saved layouts.

► Enter a name for the layout, then click **Save**.

Inserting and Removing Page Breaks

To insert a page break

► Do any of the following:

- On the Print Toolbar, click **Insert Page Break** .

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- Right-click an image and select **Insert Page Break** .

⇨ A page break is inserted before the current image.

To remove a page break

▷ There is a manually inserted page break before the current image.

► Do any of the following:

- On the Print Toolbar, click **Remove Page Break** .
- Right-click an image and select **Remove Page Break** .

⇨ The page break before the current image is deleted.

Deleting Print Pages

If you delete a page from the print preview, all the images on that page are removed from the **Print** tab.

► On the Print Toolbar, click **Delete Page** .

⇨ The current page is deleted.

Changing the Number of Images on a Print Page

► In the **Protocol** Panel, open the **Layout** drop-down menu.

► Do any of the following:

- To apply the new layout to all print pages, click **Apply the layout to all pages** .
- To apply the new layout to the current page only, click **Apply the layout to the selected page** .

► Select a layout: **1x1** ... **4x4**.

⇨ The new layout is applied instantly.

Changing the Filling Order of Print Pages

► In the **Protocol** panel, open the **Layout** drop-down menu.

► At **Filling Order**, do any of the following:

- To fill the images by rows on the page, click **Horizontal Filling** .

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- To fill the images by columns on the page, click **Vertical Filling** .
- To apply an individual filling order, click **Select Filling Order** , click the images on the print preview in the desired order, and confirm with **OK**.

⇨ The new layout is applied instantly.

Printing in Compare Mode

Use Compare mode to view series side by side when active, else sequentially.
The Compare mode allows you to compare series with each other, e.g. series of the same orientation but with different contrast.

Different setups are available: 1-1, 2, 2-2, 1-1-1, 2-2-2, 1-2 (and 1-2-2, 2-1, 2-2-1, 2-1-2, which are not shown here).

- ► Select any setup for the Print Preview from the **Compare Mode** drop-down menu on the **Protocol** Panel.
- ► From the Thumbnail overview of the Exam Overview, drag imaging series into the viewports of the Print Preview.

To reset the page layout

- ► Select **Off** from the **Compare Mode** drop-down menu in the **Protocol** Panel.

Filtering and Sorting the Images in a Print Page Viewport

You can set the slice order and sorting dimensions, and filter the images to be displayed.

The filtering and sorting settings are configured individually for every imaging series. Some of the options are only active when the current imaging series has more than 1 dimension.

- ► In the **Protocol** Panel at **Sort and Filter**, click **Sort and Filter Images** .

⇨ The **Filtering and Sorting** window opens.

- ► To set the slice order, do any of the following:
  - To have the slices ordered from 1 to n, select **Ascending Slice Order** .
  - To have the slices ordered from n to 1, select **Descending Slice Order** .
- ► At **Sorting Dimensions**, set the primary and secondary dimension for sorting as desired.

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- ► At **Filter**, specify the range of images to be displayed for every dimension: Enter the numbers of the first and last image to be displayed into the text fields.
  Alternatively, use the arrow buttons to increase or decrease the numbers by 1.
- ► At **Show Every Nth Image**, enter the value for N into the text field to display only every Nth image.
  Alternatively, use the arrow buttons to increase or decrease the number by 1.
- ► At **New Film Every**, select a dimension to automatically insert a page break when the selected dimension changes.
- ► To confirm, click **Apply**.

Adding a PlanScan Image to the Images on the Print Page

You can add a PlanScan image to the imaging series that is selected on the print page.

There are 2 ways of adding a PlanScan image. Both ways can be combined:

- Insert the PlanScan image at the start or the end of the selected series.
- Inset the PlanScan image in each viewport that shows an image of the selected series.

▷ A PlanScan image is available: The **PlanScan** button is enabled.

- ► In the **Protocol** Panel, click **PlanScan** .
  - ⇨ The **PlanScan** window opens.
- ► To insert the PlanScan image at the start or the end of the selected series:
  - Activate the checkbox at **PlanScan Image**.
  - At **Placement**, select whether to insert the image at the start or the end of the series.
  - At **Select PlanScan Image**, select the PlanScan image you want to insert.
  - ⇨ The setting is applied instantly.
- ► To inset the PlanScan image in each viewport that shows an image of the selected series:
  - Activate the checkbox at **Inset Planscan**.
  - At **Position**, select the viewport corner in which to inset the image.
  - At **Inset PlanScan Image**, select the PlanScan image you want to inset.
  - ⇨ The setting is applied instantly.
- ► To confirm, click **Done**.

To remove the PlanScan images, deactivate the corresponding checkboxes in the **PlanScan** window.

Changing the Display of Images

You can change the display of each individual image. You can mirror, flip and rotate images. You can perform basic operations such as copy, paste and delete. You can insert blank images. Prior to performing any of these operations, select an image or select multiple images.

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Selecting Images on Print Pages

► Do any of the following:

- To select an image, click it.
- To select non-consecutive images, press **Ctrl** and click the images.
- To select consecutive images, click the first image, press **Shift**, and click the last image with **Shift** pressed.
- To select all images on the currently selected print page, click **Select all images on this page** on the Print Preview.
- To select all images on all pages, click **Select all images on all pages** on the Print Preview.
- To select all images of the currently selected series, click **Select all images of this series** on the Print Preview.

- If more than one image is selected, the selected images are marked by a yellow square icon at their right border: .
- To deselect the images, click any image.

Cut, Copy, Paste and Delete of Images

Cutting Images from Print Pages

► Select at least 1 image.

► Do any of the following:

- On the Print Toolbar, click **Cut selected images** .
- Right-click an image and select **Cut Selected Images** .
- Press **Ctrl+X**.

⇨ The selected images are deleted from the current page, but are kept in the clipboard.

Copying Images on Print Pages

► Select at least 1 image.

► Do any of the following:

- On the Print Toolbar, click **Copy selected images** .

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- Right-click an image and select **Copy Selected Images** .
- Press **Ctrl+C**.

⇨ The selected images are copied to the clipboard.

Pasting Images on Print Pages

▷ At least 1 image is in the clipboard.

► Select a target viewport.

► Do any of the following:

- On the Print Toolbar, click **Paste images** .
- Right-click the viewport and select **Paste Images** .
- Press **Ctrl+V**.

⇨ The images are inserted. The former content of the target viewport and subsequent viewports is shifted backwards.

Deleting Images from Print Pages

► Select at least 1 image.

► Do any of the following:

- On the Print Toolbar, click **Delete selected images** .
- Right-click an image and select **Delete Selected Images** .
- Press the **Del** key.

⇨ The images are deleted from the current page and are not kept in the clipboard.

To delete all images from all print pages

► In the **Protocol** Panel, click **Clear**.

► To confirm, click **Remove Images**.

Inserting Blank Images on a Print Page

► Select a target viewport.

► Do any of the following:

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- On the Print Toolbar, click **Insert blank image** .
- Right-click the viewport and select **Insert Blank Image** .

⇨ A blank image is inserted. The former content of the target viewport and subsequent viewports is shifted backwards.

Mirroring, Flipping, and Rotating Images on Print Pages

► Select an image.

► On the Print Toolbar, do any of the following:

- To mirror the image, click **Mirror** on the Mirror/Flip drop-down menu.
- To flip the image, click **Flip** on the Mirror/Flip drop-down menu.
- To rotate the image 90° clockwise, click **Rotate Clockwise** on the Mirror/Flip drop-down menu.
- To rotate the image 90° counter-clockwise, click **Rotate Counter-Clockwise** on the Mirror/Flip drop-down menu.

Changing the Display of Images on Print Pages (Zoom, Pan, Window)

On the Print Preview, you can zoom in and out of the images, pan the images, and apply windowing to the images. Use the corresponding button on the Print Toolbar or the context menu to activate the desired action. Zooming, panning and windowing work as described in the instructions for reviewing:

- chapter “Zooming in and out of an Image” on page 499
- chapter “Panning an Image” on page 499
- chapter “Windowing: Adjusting Brightness and Contrast” on page 498
- chapter “Resetting All Changes” on page 502

Measuring and Annotating Images on Print Pages

On the Print Preview images, you can perform measurements with lines, angles, and ROIs, and insert annotations. Use the corresponding button on the Print Toolbar to activate the desired action. Measuring and annotating work as described in the instructions for reviewing:

- chapter “Measuring with Lines” on page 503
- chapter “Measuring with ROIs” on page 508

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- chapter “Annotating Images” on page 515

  Apart from using annotations as in reviewing, in the Print Preview you can also use predefined annotations: chapter “Using Predefined Annotations” on page 745

Using Predefined Annotations

You can insert predefined annotations from a list via drag and drop, and you can add predefined annotations to the list.

To insert a predefined annotation into an image

► On the Print Toolbar, click **Predefined Annotations** .

⇨ The **Predefined Annotations** window opens.

► At **Annotation Type**, do any of the following:

- To insert the annotation as text only, click **Text only** .
- To insert text with an arrow, click **Text + Arrow** .

► At **Select Category**, select the fitting category from the drop-down menu.

⇨ The list of predefined annotations of the selected category is displayed.

► Drag an annotation to the desired target image.

If the annotation type **Text + Arrow** is selected, releasing the mouse sets the arrowhead, and clicking again sets the annotation text.

To add an annotation to the predefined list

► At **Select Category**, select the desired category from the drop-down menu.

► Right-click an existing annotation.

⇨ The context menu opens.

► In the context menu, do any of the following:

- To insert an annotation before the selected annotation, click **Add Before**.
- To insert an annotation after the selected annotation, click **Add After**.

► Enter the annotation text.

► To confirm, press **Enter**.

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To delete a predefined annotation from the list

► Right-click the annotation and select **Delete** from the context menu.

To delete the last remaining annotation of a category, you have to delete the category.

To edit a predefined annotation in the list

► Right-click the annotation and select **Edit** from the context menu.

► Edit the annotation text.

► To confirm, press **Enter**.

To add a category

► At **Select Category**, select **Add New** from the drop-down menu.

► Enter the category label.

► To confirm, press **Enter**.

To edit a category label

► Right-click the category label and select **Edit** from the context menu.

► Edit the text.

► To confirm, press **Enter**.

To delete a category

► Right-click the category label and select **Delete** from the context menu.

► To confirm, click **Confirm**.

Displaying a Negative Image on Print Pages

You can display a negative image (invert the gray scale) of the selected image. Displaying a negative image sets all the pixel values to their opposite value on a color wheel: white becomes black, and vice versa.

► Do any of the following:

- Select the image you want to modify and click **Invert Gray Scale** on the Print Toolbar.
- Right-click the image and select **Invert Gray Scale** .

To return to the default gray scale, perform any of these actions again.

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Displaying Reference Lines on Print Pages (PlanScan Drawing Tool)

The reference lines visualize the planned volume.

► On the Print Toolbar, do any of the following:

- To display default reference lines, click **Defaults** .
- To display reference lines in box mode, click **Box Mode** .
- To display reference lines in slice mode, click **Slice Mode** .
- To display reference lines in 3D mode, click **3D Mode** .

Managing the Information on the Print Page

Extending or Restricting the Image Information on Print Pages

There are 4 preset configurations of image information that can be displayed along the images in the viewports, ranging from no information to all information available.

This setting applies to all the images and imaging series on the print pages.

► In the **Protocol** Panel at **Image Info**, do any of the following:

- To display full image information, select **Full Image Information** from the drop-down menu.

The amount of information displayed depends on the image information settings. Default for **Full Image Information** is: scan and image type, slice number, contrast-related information such as TR, TE, flip angle, date and time, slice thickness and gap, FOV, PLUS turbofactor (if applicable), scan duration, acquired voxel size.

- To display an intermediate amount of image information, select **Intermediate Image Information** from the drop-down menu.

The amount of information displayed depends on the image information settings. Default for **Intermediate Image Information** is: scan and image type, slice number, contrast-related information such as TR, TE, flip angle, date and time, slice thickness and gap, FOV.

- To display limited image information, select **Limited Image Information** from the drop-down menu.

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The amount of information displayed depends on the image information settings. Default for **Limited Image Information** is: scan and image type, slice number, contrast-related information such as TR, TE, flip angle.

- To hide all image information, select **No Image Information** from the drop-down menu.

Configuring the Image Information Settings per Series

The image information settings are managed in the **Image Information** window. It has two tabs to configure image information for images (**Image Level Info**) and imaging series (**Series Level Info**). In each tab, the list of available information labels is displayed on the left and an image preview is displayed on the right.

These settings apply to the current imaging series. They have to be configured for each series.

- In the **Protocol** Panel at **Image Info**, click **Image Information Settings** .
  - ⇨ The **Image Information** window opens.
- Do any of the following:
  - To configure settings on image level, select the **Image Level Info** tab.
  - To configure settings on imaging series level, select the **Series Level Info** tab.
- To remove all information labels from the image preview, click **Remove All**.
- To apply the default settings, click **Defaults**.
- To add or move an information label, drag it to the desired area of the image preview.
- To remove an information label from the image preview, drag it to the list.
- Repeat these steps until the image information is configured as desired.
- To confirm, click **Save**.
- To cancel editing, click **Cancel**.

Toggling the Display of Image Information for the Selected Series

- In the **Protocol** Panel at **Image Info**, click **Hide Image Information Level** .
  - ⇨ If the image information for the currently selected series was displayed before, it is now hidden.
  - ⇨ If the image information for the currently selected series was hidden before, it is now displayed.

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Enlarging the Image Information on the Preview

You can enlarge the font size of the image information on the preview to identify essential information such as the slice number. Note that the font size is enlarged **only on the preview, not in the print output**.

- ► In the **Protocol** Panel, activate the **Enlarge Image Information** check box.

  ⇨ The font size on the preview is enlarged.

To reset the font size, deactivate the **Enlarge Image Information** check box.

De-identifying Patient Data in Print Output

De-Identify is a feature to automatically render the print output anonymous.

Disclaimer: When de-identifying patients, you are obliged to consider any privacy laws in force and must not include any information that may be used to identify an individual patient.

- ► In the **Protocol** Panel, at **Print Settings**, click **Show More**.
- ► Activate the checkbox at **De-Identify**.
  - ⇨ Patient data is de-identified instantly.
  - ⇨ In the **Protocol** Panel, a disclaimer text concerning the de-identification of patient data, and the text field **New Name** appear.
    The text field **New Name** is pre-filled with the text '**De-Identified**'.
- ► At **New Name**: Enter a new, anonymized patient name, if desired.

  ⇨ The name on the print output is replaced by the content of the text field **New Name**. The Patient ID is replaced by a newly generated random ID. Any other patient data in the header or footer of the print pages and in the image information in the viewports is removed.

To redisplay patient data, deactivate the checkbox at **De-Identify**.

Managing Print Protocols

You can select the amount of information to display on all images and series, configure which information to display per image series, toggle the information display per series, and enlarge the text size in the preview.

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Saving and Loading Print Protocols (Printout Protocols)

You can save your current layout settings as a printout protocol for later reuse and you can load previously saved protocols. In a protocol, the configuration of these settings is saved: **Layout** (page layout), **PlanScan** (inclusion of PlanScan images to the image viewports), **Header and Footer** (information displayed in the header and footer of each print page), and **Image Information Settings** (information displayed in each image viewport).

In the **Protocol** Panel, the topmost drop-down menu displays the name of the currently selected protocol. An asterisk at the name (e.g. '**Default***') indicates that unsaved changes have been made to the protocol settings.

To save print layout settings as a printout protocol

- ► In the **Protocol** Panel, click **Save Protocol**.
  - ⇨ The **Save Protocol** window appears. The current protocol name (**Name**) and category (**Category**) are already filled in.
- ► At **Name**, do any of the following:
  - To overwrite the current protocol, do not change the pre-filled name.
  - To create a new protocol, enter a new name.
- ► At **Category**, select a category for the protocol.
- ► To confirm, click **Save**.
  - ⇨ The current layout settings are saved and can now be loaded from the protocols drop-down menu.

To load a printout protocol

- ► In the **Protocol** Panel, select the desired protocol from the topmost drop-down menu.
  - ⇨ The protocol is applied instantly.

Note that the protocols are organized in categories. Look for the fitting category for the protocol you want to load.

To undo unsaved changes made to a printout protocol

- ► In the **Protocol** Panel, select any but the current protocol from the topmost drop-down menu.
  - ⇨ The protocol is applied instantly.
- ► Select the previous protocol from the topmost drop-down menu.
  - ⇨ The original previous protocol is applied without changes.

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Note that the settings that are saved in the protocols comprise **Layout** (page layout), **PlanScan** (inclusion of PlanScan images to the image viewports), **Header and Footer** (information displayed in the header and footer of each print page), and **Image Information Settings** (information displayed in each image viewport). Other settings persist when loading a protocol and have to be changed manually.

To delete a saved printout protocol

- In the **Protocol** Panel, open the topmost drop-down menu.
- At the desired entry, click **Delete** .
  The delete button appears when you hover over the entry.
- To confirm, click **Yes**.

Specifying Generic Print Settings

Adjusting Header and Footer of a Print Page

You can select which information to include in the headers and footers of the print pages.

- In the **Protocol** Panel, click **Header and Footer** .
  - ⇨ The **Header and Footer** window opens. It displays the list of available information labels on the left and a print page template (**Preview**) on the right.
- To remove all information labels from the **Preview** page, click **Remove All**.
- To apply the default settings, click **Defaults**.
- To add or move an information label, drag it to the desired area of the **Preview** page.
- To remove an information label from the **Preview** page, drag it to the list.
- Repeat these steps until the header and footer is configured as desired.
- To confirm your changes, click **Save**.
- To cancel editing, click **Cancel**.

Configuring Printer and Print Output

You can configure and save your Print Preferences as the default. Notwithstanding this, print settings can also be configured individually for each print job. General print settings are: selection of printer and media size, specification of page orientation, number of copies and page selection, and activation of page collating. Furthermore, you can activate life-size printing.

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The following settings can only be configured in the Print Preferences: **Auto Print Zoom Factor**, **Auto Clear Images after Print**, **Print Page Count Warning**.

The following settings can only be configured individually for each print job: **Pages**, **Collate**, **Life-Size Printing**, **De-Identify**.

To edit the default print settings (Print Preferences)

You can configure and save the default print settings to make them correspond to your usual requirements.

- ► In the **Protocol** Panel, at **Print Settings**, click **Show More**.
- ► Click **Edit Default Print Settings** .
  - ⇨ The **Print Preferences** window appears.
- ► Configure the Print Preferences as desired:
  - At **Default Printer**, select a default printer.
    If you select **Print To File**, the output file will be saved in E:\Export.
  - At **Default Media Size**, select a default media size.
  - At **Default Layout**, select a default layout for the print output.
  - At **Number of Copies**, enter the default number of copies to be printed.
  - At **Orientation**, select the default page orientation.
  - At **Auto Print Zoom Factor**, select the default zoom factor for printing.
  - At **Auto Clear Images after Print**, choose whether to automatically remove all images from the Print preview after printing has finished.
  - At **Print Page Count Warning**, enter the number of print pages from which on a warning should be issued.
  - Adjust the page header and footer by dragging information labels from **Patient Details**, **Examination Details**, or **Page Details** to the desired areas of the **Preview** page template.
    To remove all information labels from the **Preview** page, click **Remove All**.
    To apply the default settings, click **Defaults**.
- ► To confirm your changes, click **Save**.
- ► To cancel editing without saving, click **Cancel**.

To select a printer

- ► In the **Protocol** Panel, at **Print Settings**, select a printer from the **Printer** drop-down menu.

If you select **Print To File**, the output files will be saved in E:\Export.

To set the media size

- ► In the **Protocol** Panel, at **Print Settings**, select a media size from the **Media Size** drop-down menu.

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To set the page orientation

► In the **Protocol** Panel, at **Print Settings**, click **Show More**.

► At **Orientation**, select a page orientation.

To set the number of copies to be printed

► In the **Protocol** Panel, at **Print Settings**, click **Show More**.

► At **Copies**, enter the desired number of copies into the text field.

Alternatively, use the arrow buttons to increase or decrease the number of copies by 1.

To define which pages to print

► In the **Protocol** Panel, at **Print Settings**, click **Show More**.

► At **Pages**, do any of the following:

- To print all pages, select **All**.
- To print selected pages, enter the selection into the text field.
  Example:
  Enter **1-5** to print pages 1 to 5.
  Enter **8** to print page 8.
  Enter **1-5, 8** to print pages 1 to 5 and 8.

To collate print pages

► In the **Protocol** Panel, at **Print Settings**, click **Show More**.

► At **Collate**, do any of the following:

- Select **Yes** to print all pages of each copy before printing the next copy.
- Select **No** to print all copies of each page before printing the next page.

To activate life-size printing

► In the **Protocol** Panel, at **Print Settings**, click **Show More**.

► Activate **Life-Size Printing**.

To de-identify patient data

This feature is described in a separate section: chapter “De-identifying Patient Data in Print Output” on page 749

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8.3 Administration

8.3.1 Ways of Exporting and Archiving

Archiving is used for long term storage (in PACS).
Exporting is used for sharing of data (over Workstations or USB).

Depending on the data size, the individual exam requirements (for example time pressure) and personal preference, you use any of the following methods:

Method	Use when	Format and Storage Destination	Keep in mind
Auto Export See chapter "Enabling the Auto Export Function" on page 757	• Unlimited storage space. • Images do not need to be reviewed. • All image series or only from selected ExamCard shall be archived.	in PACS	Review of images is not possible.
Archive selected image series before completing the examination (Flag for archive + Archive button)	• You want to archive only selected image series of an examination. • You have to provide the images as soon as possible. The first scans are already archived while the later scans are still running.	in PACS	
Archive selected image series when completing the examination (Flag for archive + Complete Exam button)	• You want to archive only selected image series of an examination. • You want to review the images first.	in PACS	
Export selected examination manually See chapter "Exporting Exam Data Manually" on page 758	• You want to store only selected image series of an examination. • You want to review the images first. • You want to select the storage destination.	Operator can choose.	Can only be done for one examination at a time.

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Method	Use when	Format and Storage Destination	Keep in mind
Save selected image series as other format manually See chapter "Saving Exam Data as Selected File Format" on page 760	• You want to store only selected image series of an examination. • You want to review the images first. • You want to select the storage destination. • You want to save the images in a certain file format, for example PNG, MP4, PAR-REC.	Operator can choose.	Can only be done for one examination at a time.

WARNING

To limit the output size for non-DICOM image storage, the system uses lossy compression.

This compression can result in loss of detail.

8.3.2 DICOM Export: Series Split Functionality

Imaging series with multiple dimensions (such as echoes, dynamics, or b-values) can be split into multiple series during DICOM export. This allows for an image sorting order based on the series number and is especially useful for those PACS/Workstations that cannot sort on these dimensions.

Each new series can easily be identified since its series number is derived from the series number of the original dataset.

Splitting is done in case of

- MultiEcho scans (resulting in a series per echo)
- Dynamic scans (resulting in a series per dynamic)
- Diffusion scans (resulting in a series per b-value)
- conventional DICOM MR images
- SC (Secondary Capture) images, e.g. screen grabs
- Private images (imaging protocols, ExamCards)

With the Series Split functionality, the presentation states will not be exported.

During import on the MR console, the new split series will be merged into one series again.

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NOTICE

For automatic Series Split functionality you need a special configured network node.

The network nodes can be configured according to your needs together with your Customer Support Organization.

8.3.3 Storage Destinations

The following storage devices can be available on the system.

NOTICE

Contact your local Customer Support Organization for setup.

Icon	Storage device
	Examinations on **This Computer**: • Local Patient Database (or folders on your computer), containing the patient examination list • **DICOM**: Disk files in a Local DICOM directory. By default, files are written to E:\DICOM. It is also possible to browse to a different destination folder, create a new folder or copy to a PC via a network connection. • **non DICOM**
	Examinations on the **Network** • DICOM Network Node contents of the currently configured DICOM network node. Remote (DICOM) patient databases. Accessible via drop-down menu in the **Network** destination. • **iSite** • **IntelliSpace Portal (ISP)** • **PACS**, contents of the currently assigned PACS • Remote (DICOM) patient databases.

DICOM

Please see the DICOM Conformance Statement.

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NOTICE

Prior to examination transfer to PACS, make sure that the examination is not in use in the viewing and/or scanning environment.

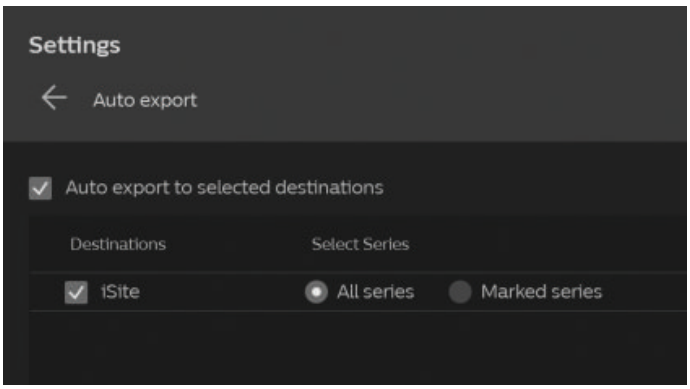
Otherwise it (or parts of it) could be locked and not be transferred. In this case, a message appears describing the cause of the problem.

8.3.4 Routine Procedures

Enabling the Auto Export Function

The purpose of this workflow is to enable **Auto export**. **Auto export** archives all scan data automatically.

- To open the **Auto export** window, click **Settings and Tools (F10)** , then **Settings** and then select **Auto export**.



- To enable **Auto export**, click the checkbox next to **Auto export to selected destinations**.
- Select a destination and choose whether to include **all series** or only **marked series** (marked with **Flag to archive**) .

⇨ After the scan is finished, the system automatically archives all series or only selected series to the chosen destination.

Using Flag for Archive and Archiving

The goal of this workflow is to archive selected image series. First, you have to mark the series for archiving and then archive them either before or with completion of the exam.

Setting Flag for archive

- In the Exam Overview, right-click on a scan item.
- To mark a scan item for archive, click on **Flag to archive**.

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⇨ A check mark appears in front of the menu entry **Flag to archive**.

⇨ On the scan item, the **Marked for archive** icon appears.

Archiving selected series

► To archive the marked series, do one of the following:

- Click **Archive** to archive the image series in their current state, for example when you have to provide the images as soon as possible.
- Follow the exam workflow. When you click **Complete Exam**, the selected image series are exported.

Setting the order of the image series for archiving/exporting

You can choose the order of the image series that you marked for archiving.

► In the Exam Overview area, right-click on a scan item.

► Click on **Transfer sequence**.

► In the **Transfer sequence** window, use the arrow buttons to set the order of the images for the export.

For example:

Order	Description
Slices Echoes …	• Slice 1 with Echo 1 and 2 • Slice 2 with Echo 1 and 2 • Slice 3 with Echo 1 and 2 • ...
Echoes Slices …	• Echo 1 with all slices • Echo 2 with all slices

TIP

Save your settings with the ExamCard.

If you want to use your archiving settings for other examinations, you can save the ExamCard including the settings you made.

Exporting Exam Data Manually

There are multiple ways to manually export patient data to a selected destination. If you want to export the data as a research file-format, see chapter “Saving Exam Data as Selected File Format” on page 760.

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► In the **Patient Directory**, select the patients whose data you want to export.

To select multiple patients, do one of the following:

- Keep **Ctrl** pressed and select multiple single examinations.
- Keep **Shift** pressed and click on two examinations successively to select these two examinations AND the examinations which are between them in the list.

► To export the selected patient data, do one of the following:

- Right-click on the selected patients, then click **Export**.
- Click **Export** in the right lower corner.

► In the **Export** window, select a destination and the format, see chapter "Storage Destinations" on page 756.

► Depending on the format, you can select

- Include DICOM Viewer
- Other Series Split (Classic MR only)
- LUT to RGB (Classic MR only)
- Combine MR Rescaling (Classic MR only)
- ADC Correction

► If you want to store the exported data anonymously, enable **De-identify Patient Name** and enter a new file name.

► Click on **Export**.

⇨ Next to the **Job Viewer (F6)** icon, the message appears **Preparing to export the data from LocalDatabase**.

⇨ The patient data is exported to the selected destination in the selected format.

Importing Patient Data from External Sources

The goal of this workflow is to import patient data from external sources, for example PACS or USB drives, to the system.

► In the **Patient Directory** in the **More** tab, select the source from which you want to import patient data.

⇨ The source is set as a tab in the **Patient Directory** and the patient data from the selected source is displayed.

► In the list, select the patients whose data you want to import.

To select multiple patients, do one of the following:

- Keep **Ctrl** pressed and select multiple single examinations.
- Keep **Shift** pressed and click on two examinations successively to select these two examinations AND the examinations which are between them in the list.

► To import the selected patient data, do one of the following:

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- Right-click on the selected patients, then click **Import**.
- Click **Import** in the right lower corner.

⇨ The imported patient data is added to the system.

⇨ The imported data is added to the patient list on the **All** tab and can be used.

Saving Exam Data as Selected File Format

To export scan data for research purposes, you can select certain file formats. This is not possible with the regular export functions.

► In the **Plan**, **Review** or **Print** tab, right-click on an image series that contains scan data.

► Click on **Save as**.

► In the **Save As** window, select in the **Selection** menu whether to save only the **Selected Series** or the **Whole Study**.

► Click on **Set Ranges** to select an **Image Type** and the number of **Slices** you want to save.

Do one of the following:

- Click **Reset to Default** to restore default settings.
- Click **Set** to save your settings and close the window.
- Click **Cancel** to close the window without saving the settings.

► Select a destination for storing the data.

Note that not all destinations support saving research files, for example iSite does not support storing research data.

► Select **Research** as **Format** and select the formats that needed for the research data.

► By default, the data is stored under the patient name. Type in a new file name to change the name.

► Click on **Export**.

⇨ Next to the **Job Viewer (F6)** icon, the message appears **Export job completed successfully**.

⇨ The patient data is exported to the selected destination in the selected format.

Mapping a Network Drive

The purpose of this workflow is to map a network drive. A mapped network drive allows you to store data on from any browser in the user interface.
You access a mapped network drive, for example, from the **ExamCard Manager**, and from the **Export** windows.

▷ Before you start, contact your IT department to get to know the path (folder) of the mapped drive. You also need the user name and password of the drive that you want to map.

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- ► Click **Settings and Tools (F10)**, then **Settings**.
- ► In the **Settings** window, click **Mapped Drives**.
  - ⇨ The **Mapped Drives** window opens. If applicable, it shows the already mapped drives.
- ► To add a drive, click **+ Map New Drive**.
- ► To unlock the **Map Network Drive** functionality, enter the password. Then click **Unlock**.
  The default password is **Philips**.
- ► Select the drive name that you want to map from the drop-down menu.
- ► Enter the folder name (path name) that you want to map to the selected drive name.
- ► To be able to access the mapped drive, enter the **Username** and the **Password** of this drive.
- ► To allow automatic connection to the mapped drive after each login, check **Remap automatically at next login** (which is the default setting).
- ► To map the drive, click **Map Drive**.
  To leave the window without changes, click **Cancel**.
- ⇨ The mapped network drive is visible and accessible in all browser applications.

Using USB storage devices

NOTICE

Using USB devices might be disabled by your system administrator.

Using USB storage devices can be enabled by the Hospital Admin.

USB storage devices (flash drives, hard drives) are recognized by the system and can be used for exchanging data. The operating system automatically assigns a drive letter to the device.

CAUTION

Do not remove the USB storage device without using the "Safely Remove Hardware" option.

Removing the device without using this option can corrupt the data on the USB memory device.

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NOTICE

The USB storage device may contain confidential information.

Take appropriate measures to protect this information. It is not possible to prevent the transfer of data to removable media.

Enable USB Devices (by Hospital Admin)

- Logon as Hospital Admin.
- Click on the Windows **Start Button** and select **MR System Management** followed by **System Management** and **Enable or Disable Removable Media.**
- Click **Yes** to enable or **No** to disable the use of USB devices.

Using "Safely Remove Hardware" option

1. Close all applications that access the USB storage device.
2. Select 'system' -> 'show taskbar' or press the |windows| key on your keyboard to show the Windows taskbar.

3. left click once on the 'Safely Remove Hardware' icon in the notification area of the taskbar and select 'Safely remove USB Mass Storage Device - Drive (<drive letter>:)'.
4. You can safely remove your USB storage device when the 'Safe To Remove Hardware' message appears.

Troubleshooting USB Hard Drives

CAUTION

Connecting a USB-powered external hard drive may cause the USB ports of the host computer to stop working. All USB connected devices will not work anymore.

The hard drive may consume too much power causing the host computer to shut down the USB ports.

When this occurs the USB ports can be reactivated by:

1. Disconnect the USB hard drive.
2. Shut down the host computer and remove the power for 10 seconds.
3. Reconnect the power and start up the host computer.
   The USB ports are reactivated.

The problem can be prevented by using an external USB drive with an external power connection or using an external drive with a data USB cable and a power-to-USB cable.

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When using a power-to-USB cable:

- ► First connect both USB cables to the computer.
- ► Connect the power-to-USB cable to the external device.
- ► Connect the USB data cable to the device.

8.3.5 DICOM Configuration

Functional Description

This functionality enables you to set up a DICOM node.

What are the main functions of DICOM Configuration?

- **DICOM Configuration** shows the **Host Name**, the **Port number**, and the **Scanner AE Title** of your own MRI system.
- **DICOM Configuration** shows the available network nodes connected to the MR console as part of the hospital network, and gives you information about their status.
- It allows you to add new nodes, modify existing nodes and delete obsolete network nodes from the list.
- Furthermore, you can test the connection with this functionality.

Password Protection

DICOM Configuration is password-protected. The password is requested when you access or edit the **DICOM Configuration**.

NOTICE

The default password is: Philips

DICOM Node Settings and Options

The following DICOM **Node Settings** and **Node Options** are available:

- **Host name/IP Address**
- **Port number**
- **AE Title**

  The **AE Title** consists of numbers and letters, is case-sensitive and has a maximum of 16 characters.

Classic or Enhanced MR

For the **DICOM Transfer mode**, **Classic** is recommended for multi-vendor applications, **Enhanced MR** for Philips applications.

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Disable presentation state

The presentation state is a DICOM property that describes how to display the images. It contains the viewing data:

- windowing and rescaling information,
- zooming, panning, rotation and mirroring settings,
- slice order, mirroring, rotation settings,
- ROIs, annotations, lines and graphics.

If the presentation state (and consequently all viewing data) is transferred to the DICOM node, you view the images with the same viewing settings on the MR console and the DICOM node.

If you select **Disable presentation state**, these viewing data are not transferred. For **Classic** format, only a limited set is transferred to the DICOM node: window width, window level, ROIs, annotations and lines.

MR Combine Rescaling

DICOM Nodes which do not understand the rescale information in Philips MR Images, can display Images too light or too dark. Enable **MR Combine Rescaling** option for such Nodes. Be aware that you lose quantitative information such as ADC values, if you enable this option.

This setting only applies for **Classic DICOM Transfer mode**.

ADC Correction

- The ADC values are very small values (in the range of 10^{-3} mm^2/s) which are not received well by all DICOM nodes.
- To display correct values on the DICOM node, **ADC Correction** rescales the windowing/ rescaling values to 1000 times higher values.

LUT-2-RGB Conversion

- Not all Classic MR DICOM nodes receive color images (for example, parametric maps with color LUT) correctly with color. Therefore MR images that contain color LUT information are automatically converted and exported as secondary capture color RGB images. In general, conversion can lead to the loss of DICOM attributes such as geometry information.
- If your Classic MR DICOM node does not need this automatic conversion, disable **LUT-2-RGB Conversion**. When **LUT-2-RGB Conversion** is disabled, monochrome images will be sent.

This setting only applies for **Classic DICOM Transfer mode**.

Split series

Split series is only applicable in series that consist of multiple echoes, multiple dynamics or multiple b-values.

If **Split series** is enabled and **Echo / dynamic / Diffusion** is selected, the following happens:

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- In a multi-echo acquisition, the slices of each echo are transferred separately.
  This results in multiple series on the DICOM node: series 1 = echo 1, series 2 = echo 2, and so on.
- Each dynamic scan of a dynamic series is transferred separately.
  This results in multiple series on the DICOM node: series 1 = dynamic 1, series 2 = dynamic 2, and so on.
- In a diffusion series, the slices of each b-value are transferred separately.
  This results in multiple series on the DICOM node: series 1 = b-value 1, series 2 = b-value 2, and so on.

If **Split series** is enabled and **Image type / Scanning sequence** is selected, the following happens:

- In a acquisition with multiple image types, the series with different image types are transferred separately.
  This results in multiple series on the DICOM node: series 1 = image type 1, series 2 = image type 2, and so on.
- In a acquisition with multiple sequences, each sequence is transferred separately.
  This results in multiple series on the DICOM node: series 1 = sequence 1, series 2 = sequence 2, and so on.

To transfer a multi-echo, dynamic or diffusion imaging series as one series (independently of their image attributes), deselect **Split series**.

This setting only applies for **Classic DICOM Transfer mode**.

Adding a New DICOM Node or Editing an Existing DICOM Node

▷ A prerequisite is that a workstation, PACS- or RIS-system is connected to your hospital network just like the MR console.

▷ Before you start, contact your IT department to get to know technical data of the DICOM node (host name or IP address, port number, AE Title).

► To open the **DICOM Configuration**, click **Settings and Tools (F10)** in the Navigation Bar and then **Dicom Configuration**.

► To unlock **DICOM Configuration**, enter the password. Then click **Unlock**.

⇨ The **DICOM Configuration** window opens. It displays the available **DICOM Nodes** with **Node Name** and **Status**.

► To add a new DICOM node, click **+ Add New**.

To modify an existing DICOM node, select the DICOM node. Then click **Edit** in the same line.

► Select the node **Type**: **PACS**, **Network** (workstation) or **RIS**.

► Enter a **Name** for the new node.
Use a name that represents the node and its characteristics best, such as *IntelliSpace*, or *PACS split*.

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- ► Enter the **Host name/IP Address**, the **Port number** and the **AE Title** of the node.
- ► Set the **DICOM Transfer mode** to **Classic** or **Enhanced MR**.
- ► To transfer the imaging series with presentation state, deselect **Disable presentation state**. This is the default setting and the preferred situation.
- ► Only applicable if you transfer to non-Philips DICOM nodes that do not support scaling information:
  To maintain the scaling of your MR images, select **MR Combine Rescaling**.
- ► Switch on **ADC Correction**, if your DICOM node does not receive the windowing/rescaling values of ADC data correctly.
- ► To switch on the automatic conversion of color Look-Up Tables (LUT) to RGB color secondary capture, select **LUT-2-RGB Conversion**.
- ► If applicable: To split series according to their image attributes, select **Split series**.
- ► Do any of the following:
  - To save the current settings of the node and to test the connection, click **Save**.
  - To close the window without saving, click **Discard**.
- ► To test the setup of the DICOM node, click **Send Test Series**.
- ► To update the status display of the current node, click **Refresh** in the **Node Status**. This takes up to 5 seconds.

⇨ For correctly set up nodes. the **Node Status** shows **Dicom Ping-OK**.

- ► To make the newly added node visible as DICOM node in all windows (also **Patient Directory**), restart the system.

⇨ The new DICOM Node is successfully connected to the system.

Testing a Configured Node

You send test series to test if the DICOM node is correctly configured. This test takes place in the Preview window.

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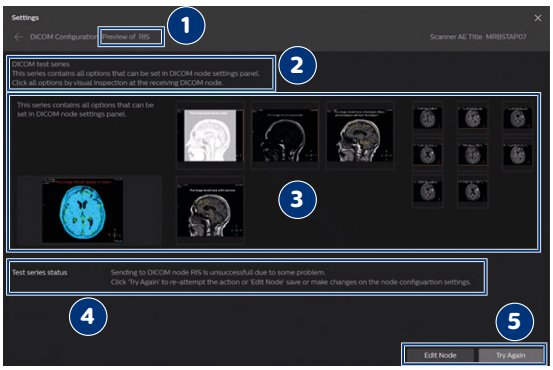
Preview window



1. Name of the configured DICOM node
2. Information about the test series
3. Thumbnail images of the test series
4. Status of sending test series
5. Buttons

   The buttons vary according to the status of the node.

- ► To test if the connection is correctly configured, click **Send Test Series**.
  The Preview window opens.
- ► Select a test series.

  There are three different test series available. They contain different types of images and all options that can be set in the DICOM node **Settings** panel. Additional secondary captures of the test series are also provided and sent along for reference. The transfer of test series can take up to a few minutes.
- ► Check if the test series have been sent to the receiving DICOM node correctly:
  - Check if the series have arrived at the DICOM node.
  - Visually inspect the images at the receiving DICOM node.
- ► If the test was successful, click **Done** to close the window.

  If the test was unsuccessful, do any of the following:
  - To change the settings, click **Edit Node**.
  - To restart the test, click **Try Again**.

Deleting an Obsolete DICOM Node

- ► To open the **DICOM Configuration**, click **Settings and Tools (F10)** in the Navigation Bar and then **Dicom Configuration**.
  - ⇨ The **DICOM Configuration** window opens.
- ► Select a DICOM node from the list.
- ► To remove this network node from the list, click **Delete** .

  A query pops up: **Are you sure, you want to delete the node permanently from the configuration list?**
- ► Do any of the following:
  - To delete the DICOM node, click **Delete**.

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- To keep the DICOM node, click **Cancel**.

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9 Advanced Operation

9.1 MR Angiography

9.1.1 Functional Description MRA

MRA is a method of visualizing vessels,

- either non-invasive (without the use of contrast media)
- or invasive (with the use of contrast media: Contrast-Enhanced MRA).

Maximum and Minimum Intensity Projection

MRA scans provide you with many slices which can be viewed one by one. To view the complete vessel tree in a convenient way, calculate Maximum and Minimum Intensity Projections from the MRA slices.

The Maximum Intensity Projection (MaxIP) is an algorithm, which is commonly used in MR Angiography. Based on the projection direction, the voxels of a 3D dataset (acquired by the M2D, MS or 3D scan mode) are examined along the projection rays. Each projection ray will select the maximum voxel intensity along that ray. The maximum value of each ray corresponds to a specific pixel in the projection image.

The calculation of a Minimum Intensity Projection is comparable, but in this case each projection ray will select the minimum voxel intensity along that ray. This Minimum Intensity Projection is to be calculated for Black Blood imaging.

9.1.2 MRA Techniques

Inflow MRA

Inflow MRA is based on enhancement of flowing blood and suppression of stationary tissue.

Applications

- Intra- and extracranial vessels,
- Carotid arteries,
- Origins of vertebral and carotid arteries, pulmonary vessels,
- Depiction of the aortic arch and neck vessels,
- Femoral and popliteal arteries and the vessels in the hand,
- Screening vascular anomalies all over the body.

Preparing the patient for an inflow MRA scan

M2D-, 3D-, Multichunk 3D-Inflow and TONE do not require special patient preparation.

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► For Gated, Dual-Gated and Turbo Inflow MRA, connect VCG to the patient.

Planning Inflow MRA scans

Inflow MRA techniques are performed without contrast agent. You can perform these MRA scans as part of every MR examination.

▷ With the patient positioned in the isocenter,

▷ with a current ExamCard,

▷ with survey or anatomical images to plan on,

► Select a MRA inflow scan protocol and add it to your ExamCard.
Skip this step, if an angio scan protocol is already part of your ExamCard.

- **3DI**: 3D Inflow
- **M2DI**: M2D Inflow

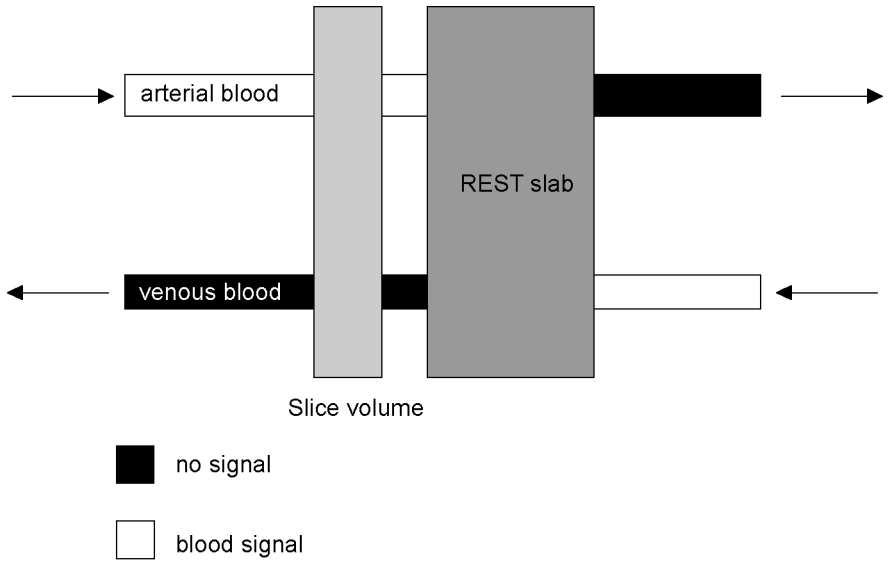
► Select suitable images for planning.

Scroll to the slice best suited for planning. Window, zoom and pan to optimize the display of anatomic structures needed for planning.

► Plan the stack/volume as perpendicular as possible to the vessels of interest.

► Verify that the REST slab is placed correctly to selectively suppress arterial or venous blood.

If a free REST slab is used, drag this REST slab to the vessels that need to be suppressed.



Analysis of MRA datasets

- Use **MIP and MPR Render mode** for the calculation of MaxIPs.
- Use **PicturePlus** for image enhancement.

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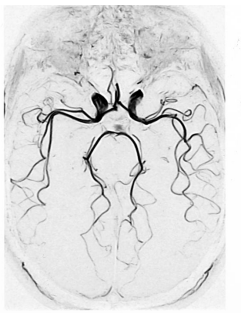
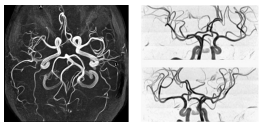
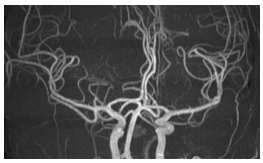
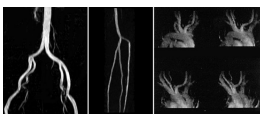
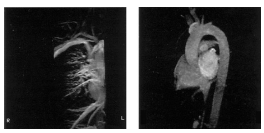
Maximum Intensity Projections of inflow images

3D-Inflow (inverse display)	**Multichunk 3D-Inflow**	**TONE** in Multichunk 3D-Inflow
		
M2D Gated Inflow (inverse display)	**Turbo Inflow**	
		

More information

- About artifacts, see chapter Troubleshooting -> Artifacts -> MRA Inflow Artifacts

Phase Contrast Angiography (PCA)

PCA is based on phase differences of flowing spins compared to spins of stationary tissue. A flow sensitive and a flow compensated (reference) scan are acquired. An automatic complex subtraction of these scans is performed.

PCA provides two types of images:

- PCA-M images (suppressed background, bright vessels).
- FFE-M images (soft tissue images).

Applications

- Intra- and extracranial vessels
- Carotid arteries
- Origins of vertebral and carotid arteries, pulmonary vessels
- Depiction of the aortic arch and neck vessels
- Screening vascular anomalies all over the body.

Preparing the patient for an inflow MRA scan

2D- and 3D PCA do not require special patient preparation.

► For Gated and Cine PCA, connect VCG to the patient.

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Planning PCA scans

PCA techniques are performed without contrast agent. You can perform these MRA scans as part of every MR examination.

▷ With the patient positioned in the isocenter,

▷ with a current ExamCard,

▷ with survey or anatomical images to plan on,

► Select a PCA scan protocol (with **PCA** in the name) and add it to your ExamCard.
Skip this step, if an angio scan protocol is already part of your ExamCard.

► Select suitable images for planning.

Scroll to the slice best suited for planning. Window, zoom and pan to optimize the display of anatomic structures needed for planning.

► Plan the stack/volume on the vessels of interest:

- Scan orientation may be the same as the vessel plane. Benefit: Fewer slices are needed to cover the entire vessel.
- This means that you can plan the stack/volume in vessel plane, perpendicular to them or in any other plane.

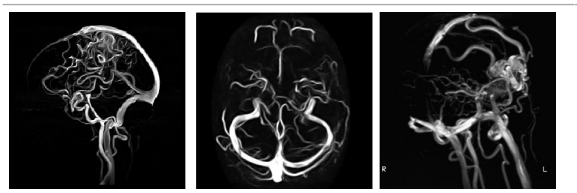
► If you use a REST slab in the scan protocol, drag this REST slab to the vessels that need to be suppressed.

Analysis of MRA datasets

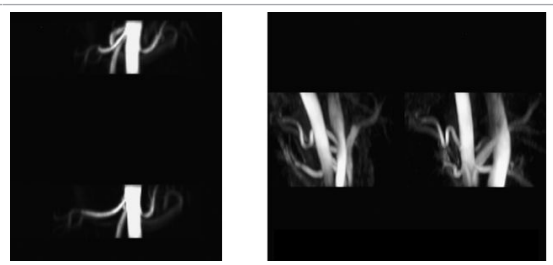
- Use **MIP and MPR Render mode** for the calculation of MaxIPs.
- Use **PicturePlus** for image enhancement.

Maximum Intensity Projections of PCA images

3D PCA of the brain: PC velocities 50 cm/s, 15 cm/s, 30 cm/s.



Gated PCA of renal arteries



More information

- About artifacts, see chapter Artifacts -> Aliasing Artifacts -> Aliasing in PCA.

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Quantitative Flow (QFlow, QF)

Quantitative Flow measurements are performed as 2D- or 3D-Phase Contrast Angiography (PCA) technique with data acquisition synchronized to the heart cycle.

Cardiac synchronization (retrospective triggering, alternatively also prospective or gating) with VCG is needed.

Applications

- Flow measurement in any vessel.

Sequence

- A flow sensitive and a flow compensated (reference) scan are acquired.
- Phase subtraction is done resulting in a flow image.

Properties

- Multiphase acquisition providing
  - PCA-M images (suppressed background, bright vessels).
  - FFE-M images (soft tissue images).
  - PCA-P images (flow images).
- Quantitative results as velocity (cm/s) or flow rate (ml/s).

Preparing the patient for a QFlow scan

► For QFlow measurements, connect VCG to the patient.

Planning QFlow scans

▷ With VCG connected to the patient,

▷ with the patient positioned in the isocenter,

▷ with a current ExamCard,

▷ with survey or anatomical images to plan on,

► Select a QFlow scan protocol (with **QFLOW** in the name) and add it to your ExamCard. Skip this step, if an angio scan protocol is already part of your ExamCard.

► Select suitable images for planning.

Scroll to the slice best suited for planning. Window, zoom and pan to optimize the display of anatomic structures needed for planning.

► Plan the stack/volume *perpendicular* to the vessel of interest.

QF measurements should always be made in a plane orthogonal to the vessel. Otherwise the area covered will be larger and the QF measurement overestimated.

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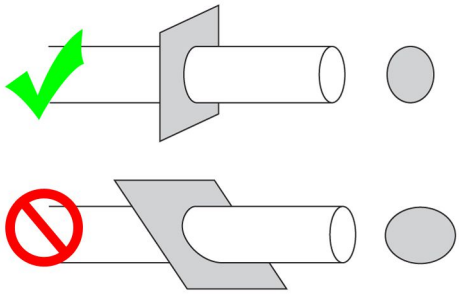
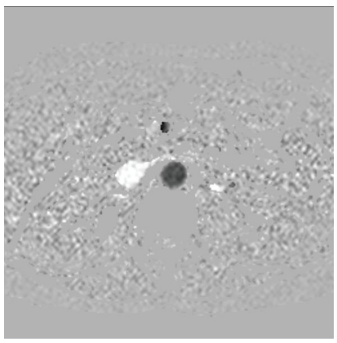
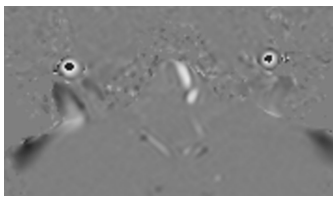


- If a REST slab is used, drag this REST slab to the vessels that need to be suppressed.

QFlow Analysis

- Use the **QFlow Analysis** package for the calculation of various results.

Examples of QFlow images

QFlow (PCA-P image)	**QFlow with aliasing artifact** (PCA-P image)
	

More information

- About artifacts, see chapter Troubleshooting -> Artifacts -> Aliasing Artifacts -> Aliasing in PCA.
- About VCG, see chapter Preparing the Examination -> Applying Physiology Sensors -> Connecting VCG to the Patient.
- About the QFlow analysis package, see chapter Reviewing Images -> QFlow Analysis.

TRANCE Techniques

TRANCE, b-TRANCE and 4D-TRANCE

TRANCE, b-TRANCE and 4D-TRANCE are techniques for non-contrast enhanced angiography.

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Comparison of the TRANCE techniques

Application	Femoral arteries, popliteal arteries and hand vessels	Renal arteries	Brain
MRA technique	**TRANCE**	**b-TRANCE**	**4D-TRANCE**
Description	3D-TSE technique for non-contrast enhanced peripheral angiography. Subtraction technique.	3D-balanced-TFE technique for non-contrast enhanced renal angiography. Inflow technique. b-TRANCE suppresses parenchyma and venous structures with a slab-selective inversion prepulse and a REST slab inferior to the imaging slab overlying the abdomen wall. Free breathing is enabled by the use of navigator gating.	3D-TFE/EPI sequence visualizing vascular morphology and dynamic blood flow without the use of a contrast agent by labeling circulating protons in arterial blood with an Arterial Spin Labeling (ASL) technique. 4D-TRANCE can be performed • non-selectively. • selectively, focusing on a targeted vessel.
Cardiac synchronization	Triggering with VCG is needed.	Triggering with VCG is needed.	Not needed.
Data acquisition in cardiac cycle	It is important to consider diastole or systole during acquisition, since the contrast is determined by the flow velocity.	It is not necessary to consider diastole or systole during acqusition, since the contrast is determined by the inversion delay time.	Not applicable
Appearance of vessels	The blood flow velocity **in arteries** varies, depending on the cardiac phase: • Data acquisition in systole results in signal voids in the arteries (due to dephasing). • Data acquisition in diastole results in hyperintense signal in the arteries (hardly any dephasing). The blood flow velocity in **veins** is slow and stays relatively constant over time. • Data acquisition in systole and in diastole results in white veins.	The arteries appear bright due to the inflow of non-saturated blood from the aorta within the inversion delay time.	The arteries appear bright and the veins dark, since the signal of labeled blood fully decays by the time it enters the veins.
Analysis	Use **VolumeView** for the calculation of MaxIPs.	Use **VolumeView** for the calculation of MaxIPs.	Use **VolumeView** for the calculation of MaxIPs.

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Application	Femoral arteries, popliteal arteries and hand vessels	Renal arteries	Brain
Analysis	**ImageAlgebra** is needed.	**ImageAlgebra** is not needed, since the background is suppressed during acquisition and does not need to be subtracted afterwards.	

Inversion Prepulse in b-TRANCE

NOTICE

Due to the selective inversion prepulse, only a relatively small volume can be acquired.

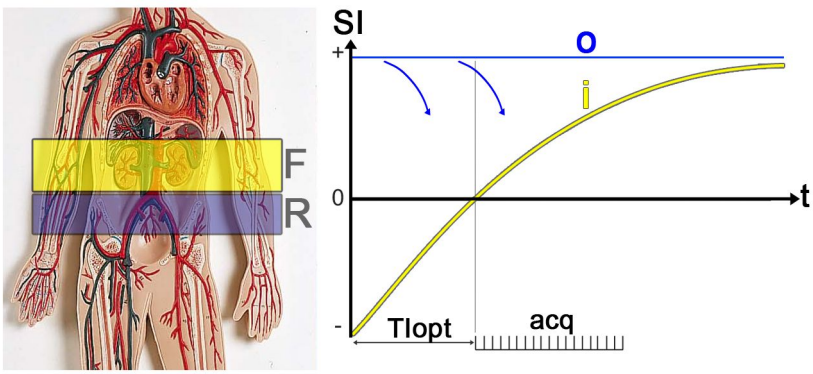

Fig. 89: Left: The selective inversion prepulse coincides with the FOV (F). The REST slab (R) prevents venous inflow. Right: Signal Intensity (SI) versus time (t). With the optimal TI (TIopt), the acquisitoin (acq) takes place after zero crossing of the curve inside FOV (i). Inflow of fresh spins from outside the FOV (o) occurs.

Arteriovenous TRANCE

Property	Description
Pulse Sequence	Arteriovenous TRANCE is a non-contrast-enhanced MRA technique which makes use of relaxation enhancement. Arteriovenous TRANCE is a 3D mDIXON TFE sequence with T2 prep and a non-selective inversion prepulse. • mDIXON reduces the fat signal. • The T2 prep and a non-selective inversion prepulse (with short inversion delay) suppress static background tissue, e.g. muscle and organs with a relatively short T1 and T2.

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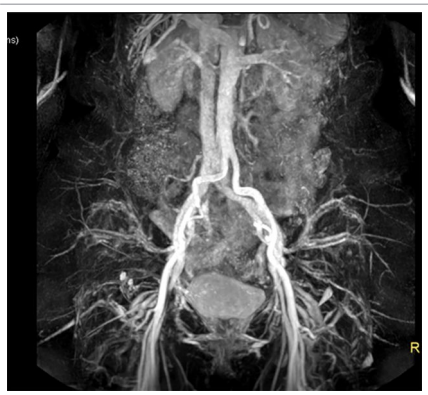
Property	Description
Properties	• Flow independent, because it relies on native T1 and T2 relaxation times. • Robust and easy to use: – No contrast agent required. – No cardiac or respiratory triggering required. But can be combined with cardiac or respiratory triggering. – No subtraction performed. – No need to plan based on vessel direction. • Can be performed in 3D isotropic resolution. Allows for the calculation of high quality MIP/MPRs.
Limitations	• Arteriovenous TRANCE does not suppress tissues with a long T1 and/or T2 sufficiently, for example CSF, which is why it is not meant for brain. An exception is fat signal which is suppressed by the mDIXON technique. • Both arteries and veins are visible in Arteriovenous TRANCE due to the relatively small differences in T1 and T2 relaxation times between arterial and venous blood.
Applications	• Whole Body, especially chest to pelvis, except brain.

Example Images

Upper thorax and neck	Pelvis
	

Without Respiratory Triggering	With Respiratory Triggering

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Enabling Arteriovenous TRANCE

► To enable Arteriovenous TRANCE, set the parameter **Angio/Contrast enhanced** in the Dyn/Ang group to **relaxation enh.**.

With Arteriovenous TRANCE enabled, many contrast parameters are automatically set to fixed values for optimum image quality and minimum water-fat artifacts. You cannot change these parameters anymore.

Philips imaging protocols that use Arteriovenous TRANCE are delivered with the MR system. It is recommended to use the default Philips protocol without changing any parameters. When you change parameters, the signal-to-noise ratio may decrease.

Routine Procedures

Running a TRANCE scan in the Lower Extremities

Recommended Analysis packages:

- Q-Flow for flow measurement,
- ImageAlgebra for subtraction.

To obtain an image with arteries only

1. Perform two TRANCE data acquisitions:
   - one with systolic triggering, and
   - one with diastolic triggering.
2. Determine the trigger delay with a flow measurement in the vessel of interest.

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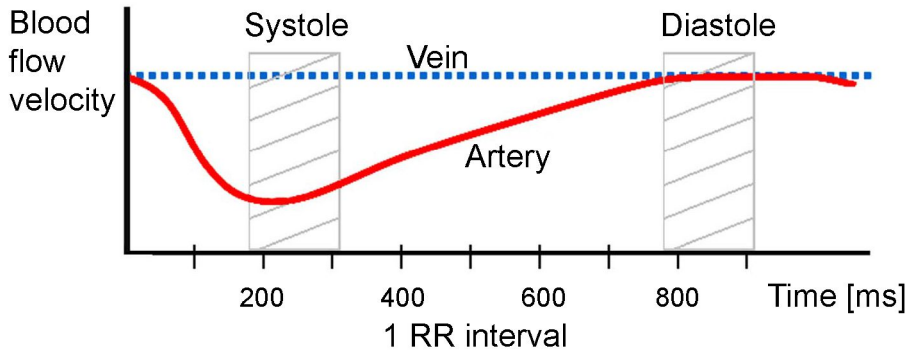

Fig. 90: Schematic example of a flow measurement with correct trigger delay times: in this case, the systolic trigger delay would be about 175 ms. The diastolic trigger delay would be about 775 ms or 'longest'.

3. Subtract the resulting images. Because the veins and the background have the same signal intensity in both the diastolic and systolic images, they are not visible after subtraction. The result of the subtraction is an image with arteries only.

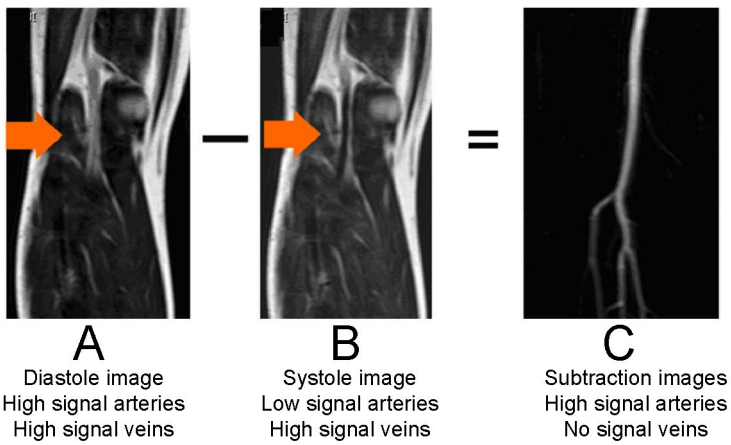

Fig. 91: Diastole image (A) minus systole image (B) results in a subtraction image (C).

4. Process the subtracted data in **3D** render mode to obtain a MIP of the total 3D-dataset. Multiple stations are possible. The example shows a 2 station TRANCE of the peripheral arteries.

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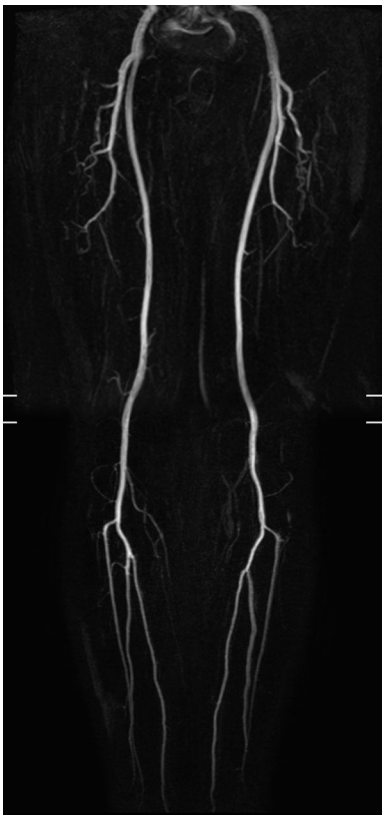

Fig. 92: 2-station TRANCE scan acquired on a 1.5 T system.

Running a 4D-TRANCE scan

▷ The patient is already positioned on the tabletop. The examination is already entered or selected. (Cardiac synchronization is not needed.)

► Select and start the Philips 4D-TRANCE ExamCard.

An anatomical survey is performed.

► Plan the sagittal and coronal PCA surveys on the anatomical survey.

► Start and run the PCA surveys.

► Plan the 3D Inflow scan on the survey images.

► Start and run the 3D Inflow scan.

► Select the 4D-TRANCE scan of your preference:

- selective (with parameter **ASL label type: free**), or
- non-selective.

► Plan the 4D-TRANCE scan on the images of the PCA scan and the 3D-Inflow scan.

► Check the Scan Information page for the **Label delays 1st/delta/last** in milliseconds.

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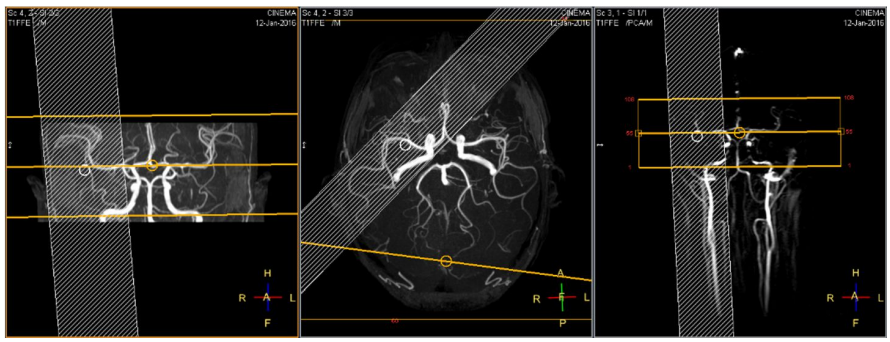
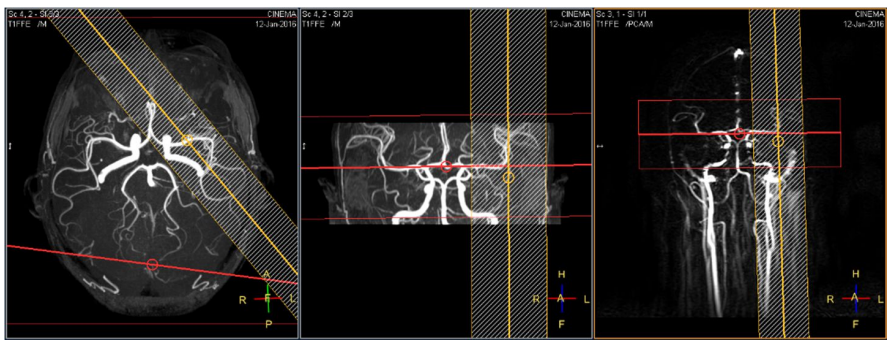
When the **Label delay: last** is much longer than the T1 relaxation time of blood, blood signal has already decayed during the last measurements.

To decrease the **Label delay: last**, reduce the number of phases.

► Open the 4D-TRANCE imaging series in **3D** render mode and calculate Maximum Intensity Projections.

Examples of how to plan the 4D-TRANCE scan

Non-selective planning	
Selective planning of the right internal carotid artery	
Selective planning of the left internal carotid artery	

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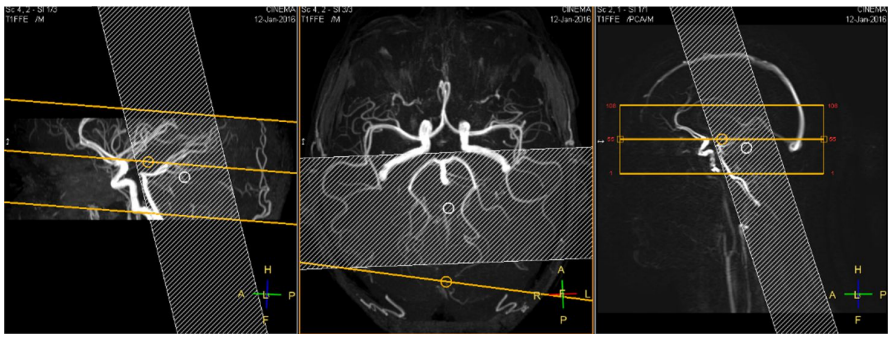
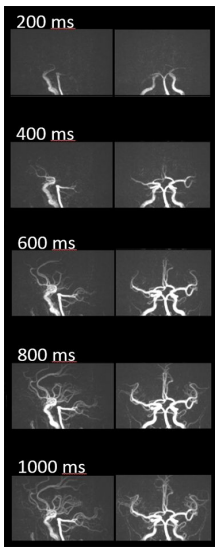
Selective planning of the vertebrobasilar artery



Resulting imaging series



Non-selective 4D-TRANCE:

sagittal and coronal Maximum Intensity Projections,

acquired with an phase interval of 200 ms

More information

- Instructions for Use -> Advanced Operation -> Perfusion Imaging -> **Arterial Spin Labeling**
- In the Online Help/Parameters: parameter **Arterial Spin Labeling**
- In the Online Help/Parameters: **Reference tissue** (about the T1 relaxation time of blood)

Contrast-Enhanced MRA (CE-MRA)

Functional Description

Contrast-enhanced MRA is based on T1 shortening of blood by means of contrast agent.

Contrast agent is injected as a bolus. The CE-MRA scan is started when the bolus arrives at the region of interest.

Applications

- Carotid arteries,

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- thoracic and abdominal vessels,
- peripheral vessels from abdominal aorta down to pedal arch,
- Whole Body MRA.

Properties of CE-MRA

- Is minimally invasive (intravenous contrast injection).
- Provides short single breath-hold scan times.
- Can be acquired parallel to a vessel for large coverage.
- Short scan times (slices can be acquired in vessel plane).
- VCG triggering is not required in areas of pulsatile flow.

Routine Procedures

Running a CE-MRA scan upon bolus arrival (BolusTrak)

The BolusTrak functionality offers the possibility to track the bolus and immediately start the CE-MRA scan on bolus arrival. Part of the realization are real-time reconstruction and -viewing.

1. Select a BolusTrak ExamCard which typically consists of:
   - Survey scan.
   - Preparation-only scan or Pre-contrast scan.
   - 2D Real-Time reconstructed scan (BolusTrak scan).
   - Post-contrast scan (diagnostic scan).
2. Start the ExamCard.

   The survey is performed.
3. Plan the ExamCard items.
4. Resume the ExamCard.

   The Preparation-only scan or Pre-contrast scan is performed.

   Then the ExamCard pauses.
5. Start the contrast agent injection as a bolus simultaneously with the 2D real-time reconstructed scan:

   Click **Resume** to do so.
6. Check the arrival of contrast agent in real-time in the **AutoView**.
7. To interrupt the 2D real-time reconstructed scan and to start the post-contrast scan, click **Proceed** when you see the bolus arrive.

   You can execute the post-contrast scan with breath-hold commands.
8. Perform postprocessing, e.g. subtraction of pre-contrast mask, Maximum Intensity Projection (MaxIP).

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The total procedure can be run first without contrast agent to make the patient familiar with the examination procedure.

Time schedule of 3D high spatial resolution scan

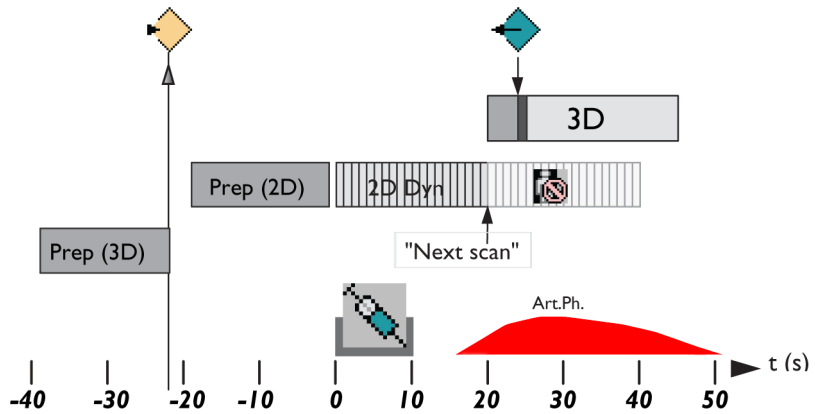

Fig. 93: Time schedule for 3D high spatial resolution.

Text/Icon	Description	Text/Icon	Description
Prep (3D)	Preparation phases of 3D scan (Prep-only or Pre-contrast scan)	**BolusTrak**	Preparation phases of 2D Dyn scan
BolusTrak	2D real-time reconstructed scan	**3D**	Post-contrast scan
Art.Ph.	Arterial Phase	**Start Next Scan [F8]**	You press **Start Next Scan [F8]** to stop the BolusTrak scan and start the next scan immediately.
	Store Preparation		Restore preparation
	Injection		Aborted scan

Running a MobiTrak scan

Schematic timing diagram of the MobiTrak technique:

First, three mask stacks are acquired, then the three contrast-enhanced (CE) stacks.

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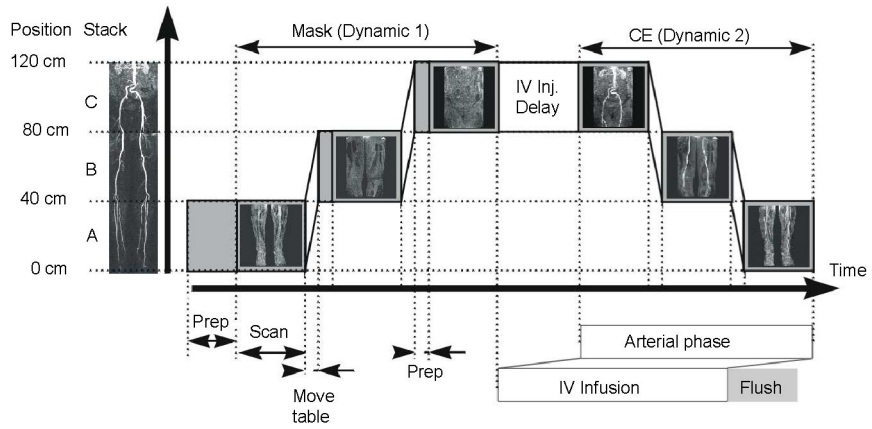

1. Patient preparation and patient and coil positioning.
2. Start the MobiTrak ExamCard:

   Transverse survey scan in three stacks is performed with tabletop movement during stacks. MaxIPs are automatically calculated.

   - Two dynamic scans, each consisting of three stacks: Stack A: lower legs, Stack B: upper legs, Stack C: abdomen. Abdominal stack with breathhold commands.
3. Plan the MobiTrak scan on the sagittal MaxIPs of the survey scan. Easiest is to align the stacks and define a stack overlap.
4. **Resume** the ExamCard.

   Contrast bolus timing scan and test bolus injection are performed:

   - Dynamic coronal scan (for visualization of entire aorta) started together with the test bolus injection.
   - To be planned just before the abdominal aortic bifurcation.
     Reset the geometry.
   - To determine the acquisition delay between the contrast injection and the second dynamic scan. It equals the contrast bolus arrival time just before the abdominal aortic bifurcation.
5. Perform MobiTrak scan first dynamic
   - Acquires pre-contrast images in three stacks with table movement.
   - To be used for subtraction.
6. Start the contrast agent infusion
7. MobiTrak scan second dynamic
   - To be started after the acquisition delay (see contrast bolus timing scan).
   - Acquires contrast-enhanced images in three stacks with table movement.

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NOTICE

Always allow automatic table movement.

In this way, the scan will be started as soon as the table has reached the optimal position without prompting for an additional |Proceed|.

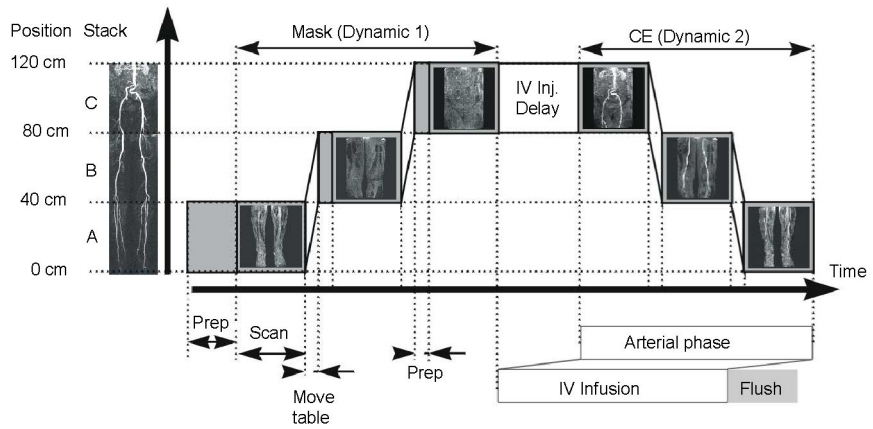
8. Use the **MobiView** render mode to calculate multistation MPRs.

   MobiView allows you to navigate through these MPRs in **Slab** render mode or to review them from different angles in **3D** render mode.

Running a MobiFlex scan

Schematic timing diagram of the MobiFlex technique:

First, three mask stacks are acquired, then the three contrast-enhanced (CE) stacks.



MobiFlex ExamCard

The table summarizes the scans of a typical MobiFlex ExamCard with e.g. their item properties and their GeoLinks.

Scan	EC Item properties	Geo Link	Part of anatomy	Comparable to
1		A	Lower Legs	Scan 1, dyn=1
2		A	Upper Legs	Scan 2, dyn=1
3		A	Abdomen	Scan 3, dyn=1

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Scan	EC Item properties			Geo Link	Part of anatomy	Comparable to
4				BolusTrak scan in order to track the bolus arrival		
5				A	Abdomen	Scan 3, dyn=2
6				A	Upper Legs	Scan 2, dyn=2
7				A	Lower Legs	Scan 1, dyn=2

Workflow

1. Patient preparation and patient and coil positioning
2. Setup or select a MobiFlex ExamCard including Geometrical Links.
   - 6 scans for 3 stations (8 scans for 4 stations on 3.0T) plus a BolusTrak scan.

     All stations need to have the same GeoLink (same bookmark behind the sequence).
   - BolusTrak scan prior to post-contrast scans (injection enabled).
   - Abdominal stack with breathhold commands.
   - Manual start for post-contrast scans.

NOTICE

If you like to have pre-contrast source images, integrate your subtraction postprocessing into your ExamCard. Three types of images will be available.

To do so, disable the imaging parameter 'Immediate subtraction' in the sequence.

3. Perform the transverse survey scan in three stacks
   - Table movement during stacks.
   - Automatically calculated MIPs.
4. Fuse the automatically calculated MIPs.
5. Plan the scans on fused sagittal MIP's of the survey scan.
   - Use the **Scan Align** button to align the scans (comparable to **Stack Align**).
   - For shorter scan times, reduce the number of slices and increase the slice thickness.

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6. Perform MobiFlex scans pre-contrast
   - Acquires pre-contrast images in three scans with table movement.
   - To be used for subtraction.
7. Perform the BolusTrak scan with the start of the contrast agent infusion.
8. Check the bolus arrival in the **AutoView** window.
9. Press **Start Next Scan [F8]** upon arrival of the bolus in the abdominal aorta to abort the BolusTrak scan.

   MobiFlex scans post-contrast are automatically started due to the 'Fast next scan' functionality.
   - Acquires contrast-enhanced images in three scans with table movement.

NOTICE

Always allow automatic table movement. In this way, the scan will be started as soon as the table has reached the optimal position without prompting for an additional |Proceed|.

10. Use the **MobiView** render mode to calculate multistation MPRs.

    MobiView allows you to navigate through these MPRs in **Slab** render mode or to review them from different angles in **3D** render mode.

NOTICE

Undo subtraction can be done by means of a weighting factor of +1 after a subtraction having been performed with a weighting factor of -1 .

Running a 4D-TRAK scan

4D-TRAK (4D Time-Resolved Angiography using Keyhole) brings a new dimension to CE-MRA. It provides drastic scan speed increases for high spatial and temporal resolution CE-MRA scans. 4D-TRAK utilizes the 3D-FFE scan technique and combines the advantages of dS-SENSE, Keyhole and CENTRA.

4D-TRAK might be used to aid in evaluation of brain AVM, congenital heart diseases, cardiac function, hemodialysis shunts and in diabetes patients with short arterio-venous transit time in lower legs/feet.

Examples of 4D-TRAK MaxIPs

4D-TRAK: 4 dynamics. From left to right: early to late dynamic.

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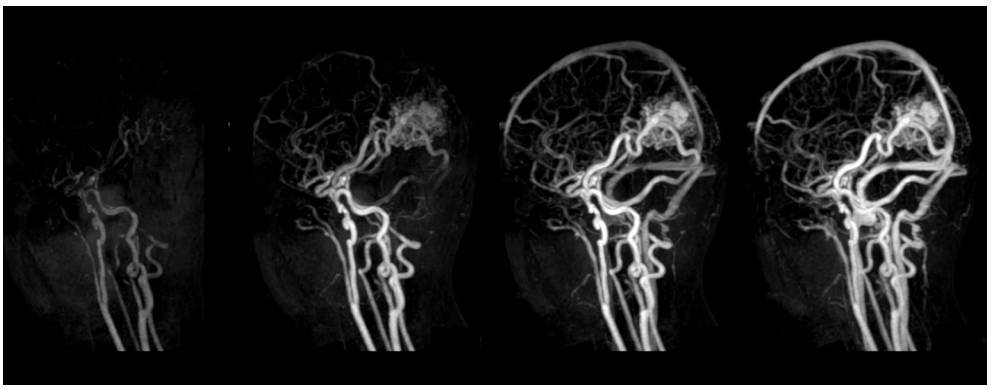
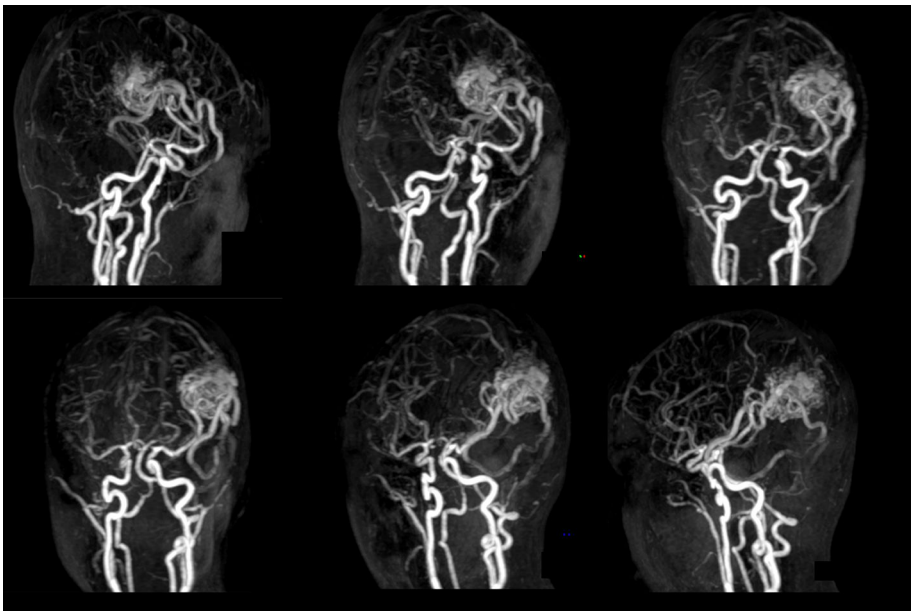


4D-TRAK: Different Maximum Intensity Projections of the same dynamic.



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9.2 Diffusion Imaging

9.2.1 Functional Description

Diffusion sequence	• Excellent non-invasive method of measuring the diffusion characteristics of biological tissue. • Based on Spin Echo.
Properties	• Incorporates Diffusion Weighted Imaging (DWI) and Diffusion Tensor Imaging (DTI). • Very sensitive to motion (for Multishot scanning)

Scan methods	• Single-Shot sequences (without PPU) • Multishot sequences (with PPU for cardiac synchronization and fewer artifacts)
Applications	• Neuro imaging • Abdominal imaging

The process of diffusion of water molecules through brain tissue can be measured using MRI with diffusion weighted scanning. The actual diffusion properties depend on the local tissue. Furthermore, the water diffusion can be anisotropic: fast diffusion in one direction and slow diffusion in other directions.

Dedicated diffusion sequences

For the dedicated diffusion sequences, Philips imaging protocols are delivered with the system. It is recommended to use these protocols.

Diffusion sequence	Short description	More information
DWIBS	Diffusion Weighted Whole Body Imaging with Background Body Signal Suppression	• Instructions for Use: Positioning for Whole Body • Instructions for Use: MobiView analysis package
IRIS	Multishot diffusion with zoom imaging for spine examination The abbreviation stands for: Image Reconstruction using Image-space Sampling.	-

Computed DWI (cDWI)

cDWI is a mathematical computation technique which calculates high b-value image from DWI MR Images acquired with at least two different lower b-values. cDWI indirectly reduces the total acquisition time by creating synthetic high b-value images based on the input of acquired low-b value images rather than spending time in acquisition.

The synthetic b-value image is generated using the mono-exponential model.

In cDWI the acquired b-values are used to extrapolate synthetic high b-value images. This extrapolation is based on a mono-exponential signal decay model. This means that from the acquired b-values the diffusion coefficient (D) is estimated via a mono-exponential fit, similar to what is done in the ADC post-processing package. Together with fitting the diffusion coefficient D, the signal without diffusion weighting (S0, for b=0) is estimated. With those estimated values (D and S0), synthetic high b-values are extrapolated with the formula:

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$$S(b) = S_0 e^{-bD}$$

Philips imaging protocols suited for cDWI are provided with your system.

► To calculate the high b-value cDWI images, use the **Diffusion** package.

Quality improvements

To improve the quality of diffusion sequences, use any of the following packages/techniques:

- The Diffusion registration package allows you to correct for patient movement which occurred during a dynamic scan.
  - Application: Diffusion imaging in the brain.
- **EPIC Brain** allows you to enable EPI geometry correction in the brain in dynamic FFE- and SE-EPI scans, and in diffusion EPI scans.
  - Application Brain only: especially DWI, DTI and BOLD imaging.
  - To enable EPIC Brain, set the parameter **EPI Geometry Correction** to **yes**.

    More information in the Online Help **(F1)**

9.2.2 Scanning DWI and DTI sequences

Preparing the patient for a diffusion scan

► Since DW sequences tend to be very sensitive to e.g. motion of the head and brain tissue due to blood pulsation, patient preparation and good immobilization are crucial for good results.

► For Multishot sequences, connect PPU to the patient.

NOTICE

When you scan DW sequences with the patient's head on a tilting device, be aware of the following:

DWI images acquired with the head tilted to the maximum possible angle will be blurred compared to images acquired without tilt.

Selecting diffusion scans

► Select a diffusion scan protocol (with DWI or DTI in the name) and add it to your ExamCard.
Skip this step, if a diffusion scan protocol is already part of your ExamCard.

- **DWI**: Diffusion Weighted Imaging
- **DTI**: Diffusion Tensor Imaging

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WARNING

For ADC measurements the field-of-view (FOV) must be positioned in the isocenter of the magnet to avoid misinterpretations due to incorrect ADC calculations.

Analysis of diffusion datasets

- For the registration of the datasets as preparation of the analysis, use the **DiffusionRegistration** package.
- To calculate parametric maps (e.g. ADC-, eADC-, FA-map), use the **Diffusion** package.
- To track fibers for diffusion tensor data with at least 6 diffusion directions, use the **FiberTrak** package.

9.3 Perfusion Imaging

9.3.1 Functional Description

The term perfusion refers to the process of nutritive delivery of arterial blood to a capillary bed in tissue.

There are different methods in MRI to measure tissue perfusion in vivo:

1. One method is based on the injection of a paramagnetic contrast agent that changes the magnetic susceptibility of blood.
   - Contrast agent will be injected as a bolus.
   - Simultaneously, a fast dynamic scan will be started.
   - This dynamic scan will be evaluated with postprocessing packages.
   - Temporal resolution of the acquisition influences slope and peak amplitude of the bolus passage.
2. The other method is based on Arterial Spin Labeling (ASL) where arterial blood is magnetically tagged before it enters the tissue of interest. The amount of labeling is measured and compared to a control obtained without spin labeling.

9.3.2 Basic T1 Perfusion

T1 perfusion studies are based on the fact that gadolinium-based contrast agent shortens the T1 relaxation times of tissues.

Acquisition

To observe the changes of the T1 relaxation time and in such a way the contrast-uptake, run a dynamic T1w scan, e.g. 3D T1-FFE or -TFE scan.

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Applications

Typical applications are contrast-uptake studies in the body, e.g. abdomen and thorax, and neurology.

Contrast agent bolus injection

Contrast agent has to be injected as a bolus.

Analysis

Use the **Basic T1 Perfusion** package for evaluation of the scan.
See chapter Finalizing the Exam -> Analyzing Images -> MR T1 Perfusion.

This package calculates functional and parameter maps for any kind of contrast-uptake dynamic study. New imaging series can be easily generated and stored.

Analyses are stored in the current ExamCard and performed automatically when the ExamCard is executed again. For more information, see chapter Your MRI System -> Operator's console -> SmartExam -> SmartLine Processing.

9.3.3 Neuro T2* Perfusion

Paramagnetic contrast agents influence the local magnetic field and reduce the T2* of surrounding tissue.
Neuro T2* Perfusion is also referred to as Dynamic Susceptibility Contrast (DSC) imaging.

Acquisition

To observe the changes of the T2* relaxation time, a sequence which is sensitive to T2* changes has to be executed, e.g.:

- PRESTO scan (TE larger than TR).
- Multishot FFE-EPI scan with relatively long TE.

Bolus passage in the brain takes approximately 10 s. The minimum temporal resolution should be 2 s.

Properties

With such a sequence, it is possible to image microscopic flow, i.e. flow at the capillary level.

- Signal decreases during bolus passage (due to reduced T2* of surrounding tissue).
- Signal restores partially directly after the passage.
- Contrast changes are proportional to the concentration of contrast agent.

Applications

Typical applications are cerebral perfusion studies:

- Assessment of tissue viability and function.
- Characterization of disease processes with microvascular alterations as e.g. lesion characterization.

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Contrast agent bolus injection

Contrast agent has to be injected as a bolus.

Analysis

Use the **MR T2* Neuro Perfusion** package for evaluation of the scan.
See Chapter Finalizing the Examination -> Analyzing Images -> MR T2* Neuro Perfusion.

This package calculates functional and parameter maps for any kind of contrast-uptake dynamic study. New imaging series can be easily generated and stored.

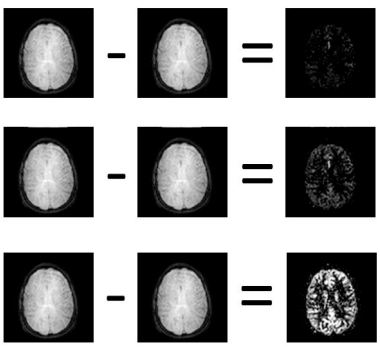
Analyses are stored in the current ExamCard and performed automatically when the ExamCard is executed again. For more information, see chapter Your MRI System -> Operator's console -> SmartExam -> SmartLine Processing.

9.3.4 Arterial Spin Labeling (ASL)

Arterial Spin Labeling (ASL) is a method to obtain brain perfusion imaging without the use of contrast agent. ASL uses magnetically labeled blood in the arterial blood stream as an endogenous trace.

The ASL sequence consists of a labeling and a control part. Perfusion images are automatically generated by subtracting the label images from the control images.

Control - Label = Perfusion (example of 3 dynamics)



Perfusion estimation relies on the signal changes (1%-2%).

Applications

- Cerebral perfusion studies.
- MR Angiography in the brain.

Basic ASL-sequence

The ASL sequence is a dynamic sequence. Depending on the clinical question, you can perform ASL as single-phase or as multi-phase sequence using different ASL techniques.

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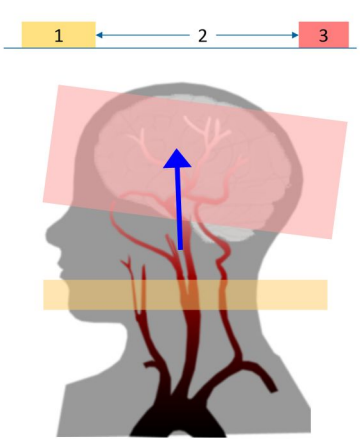
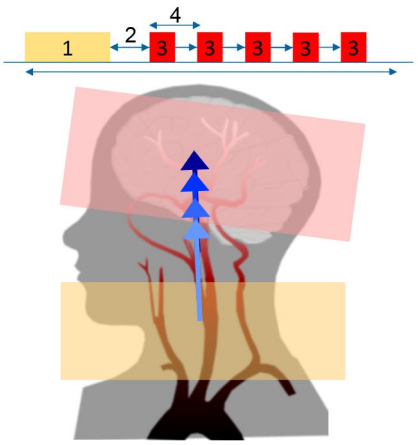
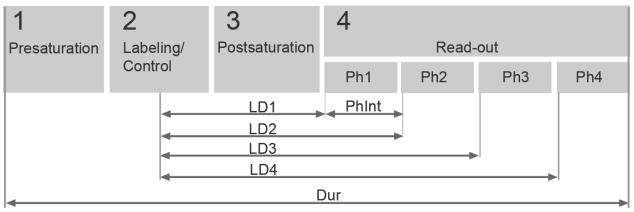
Single-Phase ASL - using the pCASL method	Multi-Phase ASL - using the STAR method
	
1. Labeling and control 2. Post-label delay 3. Image acquisition	1. Labeling and control 2. Label delay 3. Image acquisition 4. Phase interval In multiphase ASL, perfusion is measured at multiple time points after labeling: the same area is imaged multiple times after labeling (or control). This results in multiple perfusion images.
	
1. Pre-saturation 2. Labeling/Control 3. Post-saturation 4. Read-out • post LD - post label delay • Lab Dur - Label duration	1. Pre-saturation 2. Labeling/Control 3. Post-saturation 4. Read-out • Ph1, 2, 3, 4 - Phase 1, 2, 3, 4 • LD1, 2, 3, 4 - Label delay 1, 2, 3, 4 – where LD1 is displayed as **Label delay 1st** on the Scan Information page – where LD4 is displayed as **Label delay last** on the Scan Information page • PhInt - Phase interval where the phase interval is displayed as **Label delay delta** on the Scan Information page • Dur - Duration of label and acquisition cycle

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Reconstruction

Depending on the settings of ASL imaging parameters, different types of images are reconstructed and available for viewing.

Image type	Available?	How to proceed?
Subtracted imaging series	ASL scans automatically provide subtracted imaging series.	Evaluate the subtracted imaging series with **ImageView**.
ASL source images	ASL source images (label, control) are not available by default.	To have these ASL source images available, set the parameter **ASL source images** on the **Postproc** tab to **last control** or **all**. Evaluate the ASL source images with **ImageView**.
Normalized pCASL images (Perfusion data is normalized by a proton density weighted scan.)	ASL normalized pCASL images are not available by default.	To acquire normalized pCASL images, set the parameter **ASL -> normalized** on the **Dyn/Ang** tab to **yes**. This is the default setting in Philips 3D pCASL preset procedures.

More information

- In the Online Help/ Parameters: Parameter **Arterial Spin Labeling**.

9.3.5 Planning and running Single-Phase ASL using pCASL

This workflow applies for:

- **3D pCASL**:

  3D pCASL acquisition with GRASE read-out, providing normalized images, using a 4 pulse background suppression scheme.
- **pCASL**:

  Multislice pCASL with EPI read-out, using a 2 pulse background suppression scheme.

▷ The patient is already positioned on the tabletop. The examination is already entered or selected. (Cardiac synchronization is not needed.)

► Select, start and run a multi-stack anatomical survey.

► Select, start and run a 2D-PCA survey.

► Select and plan the pCASL scan on the sagittal images of the 2D-PCA and the anatomical survey:

Make sure to exclude the carotid siphon (indicated by the white arrow in the image).

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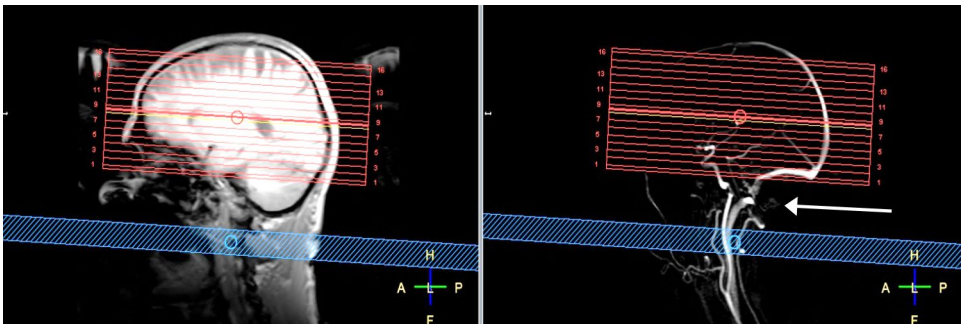
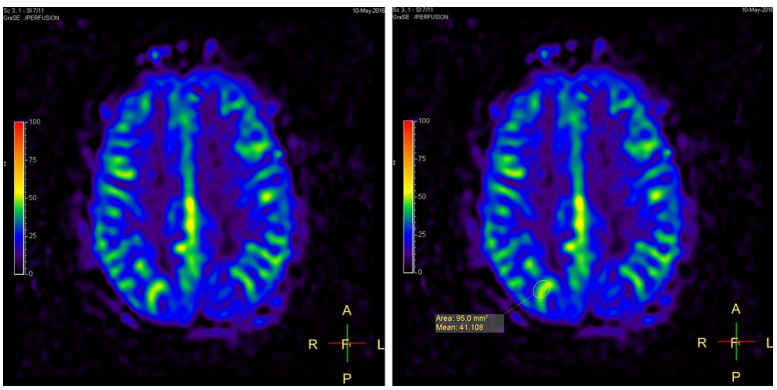


- ► If needed, adjust the value of the parameter **ASL post label delay** according to the recommended values in the table below.
- ► Start and run the pCASL scan.
  - ⇨ When the scan is finished, subtracted imaging series are automatically calculated.
- ► View the subtracted images with ImageView.
  Depending on the setting of the ASL parameters **ASL normalized** on the **DynAng** tab and **ASL source images** on the **Postproc** tab, subtracted images with or without normalization are available, and possibly also ASL source images.
- ► If ASL normalized images are available,
- • you can view them in color or in black and white. Right-click on the image to change the display.
- • you can get numeric results. Draw a ROI on the normalized image.



Recommended values for the post label delay in pCASL

neonates	2000 ms
children	1500 ms
healthy subject < 70 years	1800 ms
healthy subject > 70 years	2000 ms
Adult clinical patient	2000 ms

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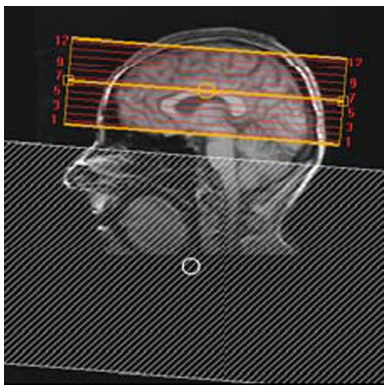
9.3.6 Planning and running Multi-Phase ASL using STAR

▷ The patient is already positioned on the tabletop. The examination is already entered or selected. (Cardiac synchronization is not needed.)

► Select, start and run a multi-stack anatomical survey.

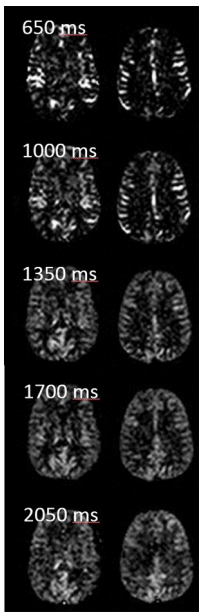
► Select, start and run a 2D-PCA survey.

► Select and plan the STAR scan on the sagittal images of the 2D-PC and the anatomical survey:



► Adjust the value of the parameters **ASL label delay** and **ASL phase interval**.

Example images with different label delays:



► Start and run the STAR scan.

⇨ When the scan is finished, subtracted imaging series are automatically calculated.

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► View the subtracted images with ImageView.
With STAR, background suppression varies over slices due to different label delay times depending on the slice position.

9.4 Cardiac Imaging

9.4.1 Planning the Cardiac Views

Planning the cardiac views is complex, because angulations in the three different directions could be necessary to visualize the different connections between chambers.

Here you find guidelines for planning the cardiac views and for using the planning tools. Useful tools to facilitate planning are 3-Point Planning, and PlanAlign. You can also plan on movies.

Important is to follow a systematic way to create the different views: Always plan perpendicular on the previous scan.

Guidelines for the Basic Views

This illustration shows how to obtain the different basic views.
S stands for Setup, C for Chambers & Outflow, and V for Valves.

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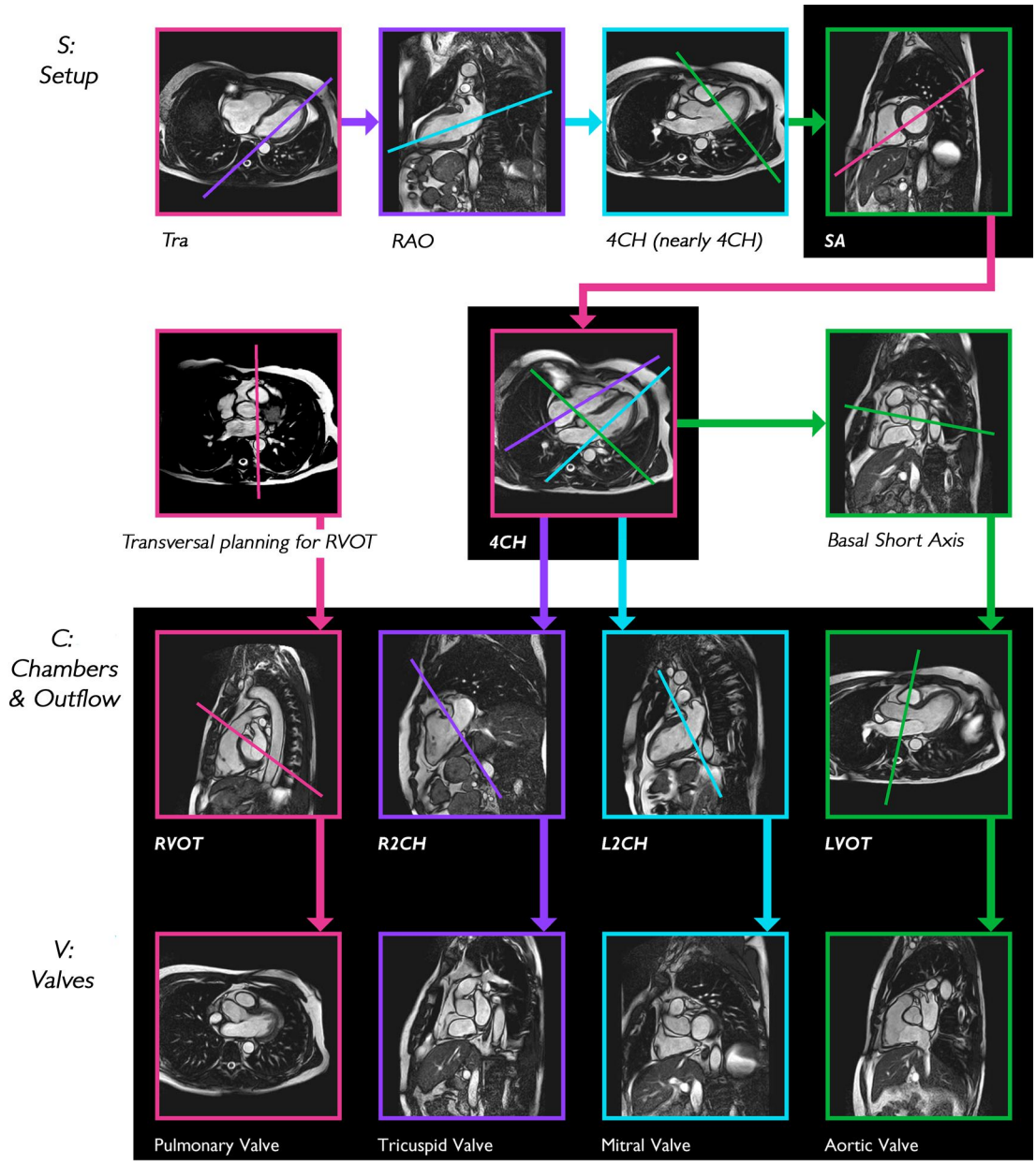

- Start with a transverse image through the left ventricle.
- Define the RAO (Right Anterior Oblique) or VLA (Vertical Long Axis) view on the transverse image by selecting a line through apex and centre of mitral valve.
- Define an approximate Four Chamber or HLA (Horizontal Long Axis) view on the RAO by defining a line through the apex and centre of the mitral valve.
- Define the Short Axis view, three methods are available:

  Place a line orthogonal to the (long axis) line through the apex and the centre of the mitral valve (this is the most accurate method).

  Place a line parallel to the mitral valve (this method makes it easier to decide whether to include the basal slice/s during post-processing).

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Place a line orthogonal to the septum (this is the best method for Right Ventricle view).

► From the Short Axis view, the true Four Chamber view can be defined by placing a line through the centre of the Left Ventricular Cavity and the inferior margin of the right ventricle.

Guidelines for the Outflow Tracts

Right Two Chamber (R2CH) view

- Can be derived from the true Four Chamber view.
- Can be defined by placing a line through the tricuspid valve parallel to the septum.

Left Two Chamber (L2CH) view

- Can be derived from the true Four Chamber view.
- Can be defined by placing a line through the apex and the center of the mitral valve.

Left Ventricular Outflow Tract (LVOT)

- Can be derived from the true Four Chamber view.
- An additional basal short axis scan can be defined which is used to plan the Left Ventricular Outflow Tract (LVOT) by placing a line through the Left Ventricle and Aorta.

Right Ventricular Outflow Tract (RVOT)

- Is best planned on a transverse view that shows the pulmonary artery valves.

Pulmonary valve

- Is planned on the RVOT by placing a line through the pulmonary valve seen already on the RVOT view.

Tricuspid valve

- Is planned on the R2CH by placing a line through the tricuspid valve seen on the R2CH view.

Mitral valve

- Is planned on the L2CH by placing a line through the mitral valve already seen on the L2CH view.

Aortic valve

- Is planned on the LVOT by placing a line through the aortic valve already seen on the LVOT.

Abbreviations of Cardiac Anatomy

Image sets (Black blood or white blood in 3 orientations: Sag, Cor, Tra).

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Abbreviation	Explanation
AA	Ascending aorta
Arch	Aortic arch
DA	Descending aorta
IVC	Inferior vena cava
LA	Left atrium
LB	Left bronchus
LPA	Left pulmonary artery
LPV	Left pulmonary vein
LSPV	Left superior pulmonary vein
LV	Left ventricle
MPA	Main pulmonary artery
PA	Pulmonary artery
RA	Right atrium
RB	Right bronchus
RPA	Right pulmonary artery
RPV	Right pulmonary vein
RV	Right ventricle
SVC	Superior vena cava

Tab. 12: List of Abbreviations

PlanAlign

PlanAlign is developed for applications which require double-oblique scans, for example cardiac imaging.

PlanAlign is a powerful tool to avoid in-plane rotation and to avoid SENSE artifacts.

You access **PlanAlign** as an imaging parameter on the **Geometry** tab.

With **PlanAlign** enabled, any modification of the angulations results in a recalculation of the angulations such that the resulting images show no in-plane angulation.

- Transverse scans are aligned such that the horizontal image direction (RL) is in a non-angulated coronal plane.
- Sagittal scans are aligned such that the vertical image direction (FH) is in a non-angulated coronal plane.
- Coronal scans are aligned such that the vertical image direction (FH) is in a non-angulated sagittal plane.

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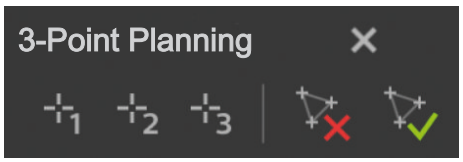
Double angulated coronal scans tending to sagittal are aligned like sagittal scans. This means that the scans are aligned such that the vertical image direction (FH) is in a non-angulated coronal plane.

Defining an Irregular Plane with 3-Point Planning

3-Point Planning (also referred to as 3 Points PlanScan, 3PPS) is a tool which helps to define an irregular plane. The plane is determined by the placement of three points on two or more images of different orientations.

- On the Plan Toolbar, click **3-Point Planning** .
  - ⇨ The **3-Point Planning** window opens.



- To place the three points, click three times in any of the three images selected in the planning view ports.

  To change a point, click on the corresponding button on the **3-Point Planning** window, then click in the image to define the new point.

- To restart, click **3-Point Planning** .

- To create the plane based on the 3 points, click **3-Point Planning** .

Planning on Movies

You can plan on movies which is especially helpful in Cardiac imaging.

- On the **Plan** tab, hover over the bottom of a viewport.
  - ⇨ The Movie Bar appears at the bottom of all viewports:

- To start the movie, click **Play** .

Button	Description
	Set the dimension that is played, e.g. slices , echoes or phases .

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Button	Description
	Set repeat/bounce options: • **Cycle Forward** : The images are displayed in a loop in the order 1 ... n, 1 ... n etc. • **Cycle Backward** : The images are displayed in a loop in the order n ... 1, n ... 1 etc. • **Bounce** : The images are displayed in the order 1 ... n, n ... 1, 1 ... n, etc.
	Previous Image: Step backwards through the images of the selected dimension.
	Play: Start movie playback.
	Pause/stop movie playback.
	Next Image: Step forwards through the images of the selected dimension.
	Frame Rate: Set movie playback speed.
	Toggle **Auto Hide**: • If activated, the movie bar disappears when you move the mouse away from it, and reappears when you move the mouse near its place. • If deactivated, the movie bar keeps visible. • The button shows the current setting.

Tab. 13: Movie bar buttons

9.4.2 Cardiac Function

Suited Scans

Cine scans are typically used to study wall motion and ventricular function. A variety of scan methods are available for cine scans. However, balanced FFE is the preferred method for breath-hold cine scans.

Stress-Test (Physical or Dobutamine)

The workflow as presented here is based on the standardized acquisition guidelines by the SCMR (Society for Cardio-vascular Magnetic Resonance). More information can be found on the website of the SCMR: www.scmr.org

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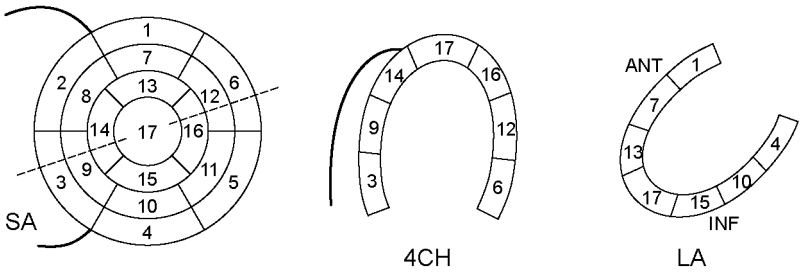
The intention of this section is only to give an illustration of how the workflow may look like in clinical practice. Philips Healthcare cannot take liability for dose regimen, infusion schemes etc.

Coronary artery disease can result in inducible ischemia. One of the first signs for myocardial ischemia is myocardial wall motion abnormality that occurs much earlier than ECG changes or anginal pain. Cine scans acquired under stress conditions can therefore help to identify these inducible ischemic areas.

The left ventricle is divided into 17 segments following the standards suggested by the American Society of Echocardiography. For all the segments the wall motion is classified as normal, hypokinetic, akinetic or dyskinetic.



Label	Heart segment	Label	Heart segment	Label	Heart segment
1	basal anterior	7	mid anterior	13	apical anterior
2	basal anteroseptal	8	mid anteroseptal	14	apical septal
3	basal inferoseptal	9	mid inferoseptal	15	apical inferior
4	basal inferior	10	mid inferior	16	apical lateral
5	basal inferolateral	11	mid inferolateral	17	apex
6	basal anterolateral	12	mid anterolateral		

Tab. 14: Labeling of Heart Segments

Examining the Cardiac Function

All 17 segments can be covered using a combination of three SA slices, a 4CH slice and a L2CH slice.

Step	Scan / Action
1	Survey scan
2	L2CH- and 4CH-scans
3	Three-slice SA scan
4	Dobutamine infusion
5	Three-slice SA-, L2CH- and 4CH-scans
6	Dobutamine infusion

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Step	Scan / Action
7	Three-slice SA-, L2CH- and 4CH-scans
8	Next stress levels: Repeat the steps 7 and 8 for each stress level.

Tab. 15: Workflow Overview

Workflow Step-by-Step

- ► Perform the survey scan.
- ► Plan and perform the L2CH- and 4CH-scans following the approach as described in the section Planning the cardiac views .
- ► Plan the three-slice SA scan on the 4CH view such that the most apical slice covers segments 13-16, the mid slice covers segments 7-12 and the most basal slice covers segments 1-6.
  - Set the number of slices to five for planning purposes only.
  - Select an end-systolic image.
  - Position the slices: first one on apex, fifth through mitral valve.
  - Set the number of slices back to three: leaving the slice position and slice gap unchanged, these three slices now cover the desired cardiac segments.
- ► Perform this scan.

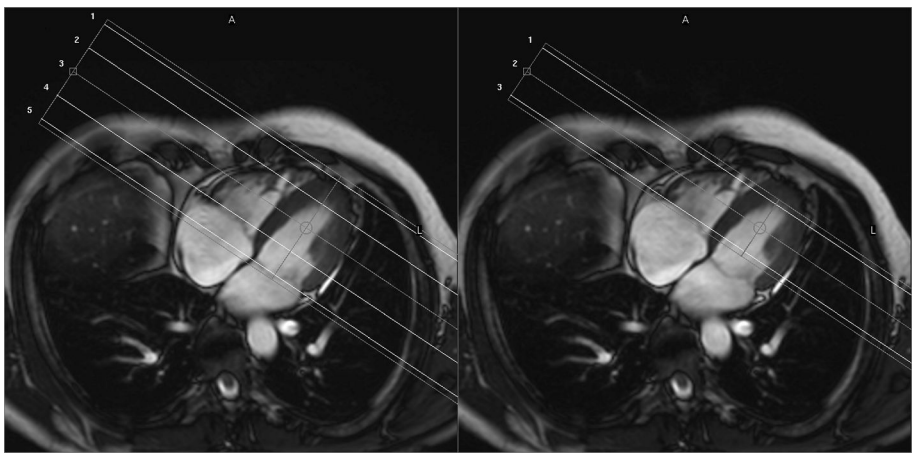

Fig. 94: Planning three SA slices on end-systolic 4CH view.

- ► Start the Dobutamine infusion to stress the patient' s heart.
- ► Repeat the Three-slice SA-, the 4-CH- and the L2CH-scans after 3 min. of infusion.
- ► Increase the Dobutamine infusion rate to reach the next stress level.
- ► Repeat the Three-slice SA-, the 4-CH- and the L2CH-scans after 3 min. of infusion.
- ► Repeat the two previous steps for each stress level.
- ► If at the maximum stress level the sub-maximum age-predicted heart rate (= 0.85 x (220 - age)) is not reached, give atropine and repeat the three scans again.

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NOTICE

The patient's cardiac frequency will most likely vary depending on the stress level.

For each stress level the cardiac frequency should be adjusted.

When the TFE shot mode is set to 'default' this change in heart rate will not lead to a change in breath-hold duration or number of phases.

Make sure that the cine scans tolerate a certain variation in heart rate. This can be achieved by setting the R-R window range to 25%, 35%.

9.4.3 Myocardial Perfusion (Temporal Enhancement)

Functional Description

MRI can be used to analyze myocardial perfusion using first pass contrast passage enabling the detection of perfusion abnormalities.

To perform good quality perfusion scans with a high temporal resolution, dynamic slices have to be acquired as quickly as possible. In order to carefully study the contrast uptake all dynamic scans belonging to one slice should be performed at the same moment within the cardiac cycle. That is the reason that cardiac perfusion scans are cardiac triggered.

Obvious compromises have to be made regarding the image quality, or more specific, spatial resolution. The aim is now to find the right balance between the number of slices, the spatial resolution and the temporal resolution.

Following the standards suggested by the American Society of Echocardiography the left ventricle can be divided into 17 segments.

A three-slice approach as presented in the Cookbook is sufficient to cover 16 out of those 17 segments: the highest possible spatial resolution is chosen where three slices fit in a single heart beat. The number of dynamic scans and thus the number of R-R intervals determine the total scan time.

The aim of perfusion scanning is to identify inducible ischemia areas which often (in the presence of coronary artery stenoses) only occurs under stress conditions. Therefore the perfusion scan should be done both in rest and during stress, such as pharmacological vasodilatation. This can be achieved using e.g. adenosine or dipyridamole.

Examining Myocardial Perfusion

The workflow as presented here is based on the standardized acquisition guidelines by the SCMR (Society for Cardio-vascular Magnetic Resonance). More information can be found on the website of the SCMR: www.scmr.org

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The intention of this section is only to give an illustration of how the workflow for myocardial perfusion may look like in clinical practice. Philips Healthcare cannot take liability for dose regimen, infusion schemes etc.

Survey scan

► First perform a survey scan followed by a 4CH view and a L2CH view under rest conditions. Plan the three-slice SA scan such that each slice covers six segments of the left ventricle .

Stress perfusion

The next step is first to perform the stress perfusion. Stress is done first to have the best image quality for the most important scan since there is no enhancement yet due to earlier contrast injections.

► Plan the perfusion scan exactly the same as the three-slice SA scan to cover 16 out of the 17 segments.

- To make sure that no backfolding occurs and to avoid fold-over artifacts, first run the scan without contrast agent. This is especially important if a (b)TFE SENSE scan is used. If necessary, increase the FOV.
- During the test scan also the breath-hold instruction can be practiced with the patient.

Although adenosine mainly acts as a vasodilator also the heart rate increases. Therefore perform the scan with an entered heart rate higher than the initial heart rate. The simplest choice available is reducing the in-plane resolution. Decreasing the matrix size ensures that all three slices still fit into the R-R interval.

Adenosine infusion

After the test scan the infusion of adenosine is started to stress the patient's heart. In the Cookbook an infusion rate of 140 ig/kg/min is suggested for maximum six minutes. During stress examinations, monitoring of the patient is mandatory. Among blood pressure, pulse oximetry and symptoms also the heart rhythm is monitored.

Contrast injection

The best results for contrast uptake curves are obtained when a short compact bolus injection is used. The Cookbook suggests a Gd-DTPA contrast dosage 0.05 mmol/kg body weight applied with an injection rate of 4 ml/s. A saline flush of 20 ml with the same injection rate is necessary to facilitate a compact bolus passage.

Performing perfusion scan

► Start the perfusion scan 4 minutes after the start of the adenosine infusion.

When the perfusion scan is running and the first images appear in the **AutoView** window, start the contrast injection.

► Carefully monitor the contrast arrival. At the desired moment give a breath-hold instruction.
The breath-hold command is needed to ease postprocessing afterwards.

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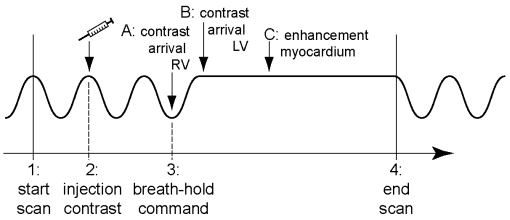
Ask the patient to hold their breath as long as possible when the contrast agent is to arrive in the right ventricle which in most of the patients happens roundabout after twice inhaling and exhaling. If the patient cannot hold breath anymore, let them breathe once and then hold breath again. Alternatively, let the patient breathe shallowly after they cannot hold breath anymore.



1	Start scan
2	Injection contrast
3	Breath-hold command
4	End scan
A	Contrast arrival RV (right ventricle)
B	Contrast arrival LV (left ventricle)
C	Enhancement myocardium

Fifteen minutes after termination of the adenosine infusion the heart has recovered from the applied stress. Then the perfusion scan can be repeated during rest.

Example of myocardial perfusion scans at rest and at adenosine stress

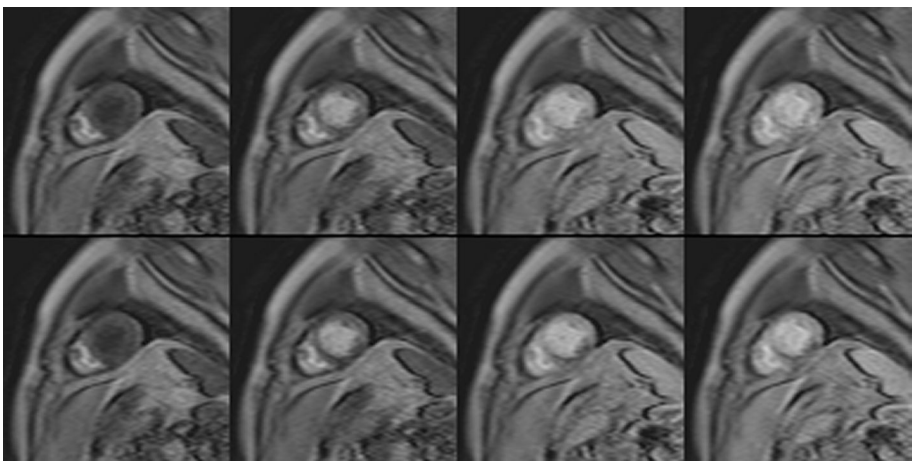


Image analysis and postprocessing

After excluding the left ventricular cavity and the pericardium, the myocardium is divided into 6 equiangular segments per slice following the standards suggested by the American Society of Echocardiography.

9.4.4 Late Enhancement (Spatial Enhancement)

Functional Description

Different MRI techniques can be used to visualize injured myocardium.

- Cine scans are used to look at wall thickness.

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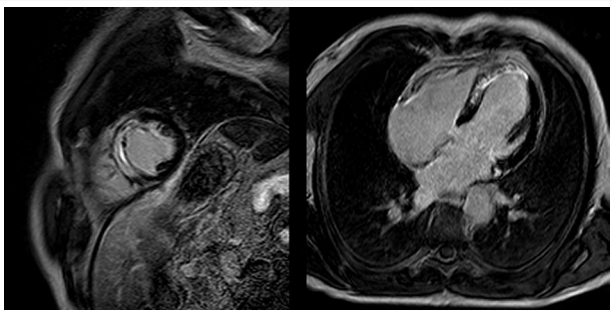
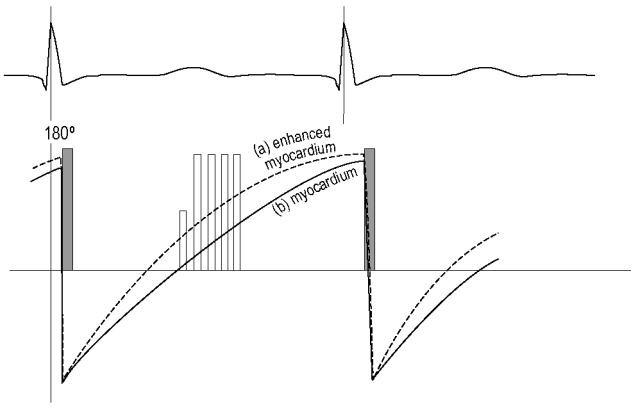
- Low doses dobutamine stress examinations have the potential in differentiating between viable myocardium (stunned and hibernating) and non-viable myocardium.
- Only the late contrast enhancement scans have the potential of visualizing the transmural extend of an infarction.

Damaged cells take up contrast agent while in viable myocardium the contrast agent stays extracellular. The contrast washout for damaged cells evolves much slower than the washout of the extracellular contrast only. After a while the contrast concentration for viable myocardium is much lower than for injured myocardium. And thus the T1 relaxation rates evolve at different rates. An inversion pulse is then applied and the inversion time is chosen such that the normal myocardium appears black, maximizing the contrast between normal (black) and injured (white) myocardium.



Example of late enhancement scans.



The inversion pulse is used to cancel out any signal from the myocardium. Infarcted areas where still contrast is visible show high signal intensities.

a - Enhanced myocardium curve

b - (unenhanced) myocardium

Late Enhancement Sequence

The intention of this section is only to give an illustration of how the workflow for viability examinations using late contrast enhancement looks like in clinical practice. Philips Healthcare cannot take liability for dose regimen, infusion schemes etc.

Prior to performing the viability scan, it is necessary to wait until the contrast agent has cleared from the (non-damaged) myocardium. This usually takes 10 minutes. During this time any kind of other scans can be performed, such as series of cine scans. 10 minutes after the (last) contrast injection the late enhancement scans can be performed.

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Characteristics of the Late Enhancement sequence

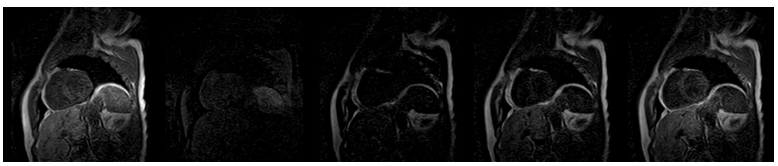
This sequence is a single-phase multishot TFE scan that utilizes a single 180º-inversion prepulse.

- Acquire the shots in mid-diastole to keep the cardiac motion as small as reasonable.
- The inversion delay time to cancel the normal myocardium is patient dependent and can not be calculated on beforehand. It also depends on the time after the contrast injection. A longer time after injection results in a slower T1 relaxation and less contrast in the (non-damaged) myocardium. Longer inversion times should be used. Usually the inversion time varies in a range of 200 to 300 ms.

There are three ways to find out the patient specific inversion time:

1. Use a "Look-Locker" sequence.
   This cine scan utilizes a single inversion pulse applied once every heart beat immediately after the R-peak. T1 relaxation is made visible over the individual cardiac phases.
2. By trial and error: Start with a TI of 200 ms, then increase the TI using small steps of 20 or 30 ms.
3. Change the inversion delay in real-time during an interactive scan. Make sure that the scan is running in continuous mode. The inversion time depends on the steady state that is reached over multiple heartbeats.

Remember that the inversion time found is valid only for a small period of time. Due to the washout of the contrast media from the myocardium the T1 relaxation rate decreases slowly over time.



'Look-Locker' technique to quickly find the zero crossing point of the myocardium within a breath-hold.

Troubleshooting Late Enhancement Sequence

Depending on the parameter settings, specific effects could occur:

Effect / Appearance	Cause	Measure
Speckled appearance of the myocardium: appears as suppressed myocardium interspersed with white spots.	It occurs if the TI is very close to the optimal inversion delay.	Increase the TI by just 10 ms to attain optimal suppression.
Dark signal at the endocardial boundary	It is caused by a slightly shorter effective TI of the tissue at the blood-myocardial interface (especially with large voxels).	Increase the TI to obtain uniform suppression of the myocardium.
Insufficient suppression / lack of contrast of myocardium over a broad range of TI	This indicates that the contrast has either washed out (i.e. the scanning is done much later, e.g. more than 30-min. after injection) or insufficient amount of Gd-DTPA was injected.	It may be helpful to check if the entire double dose of Gd-DTPA was given (check for leaks etc.).

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Effect / Appearance	Cause	Measure
The blood-pool appears too dark	The TI is too short.	Increase its value to allow sufficient recovery.
Less contrast between blood-pool and injured myocardium	The TI is too long.	Decrease its value.
SNR is too low	Due to the inversion prepulse, the SNR will be relatively low, especially if the heart rate is high and magnetization cannot recover completely before the next TFE shot is acquired (in the next RR-interval).	To increase SNR, the TFE shot interval can be set to 'user defined' and then to 2 beats to allow for more recovery, but the scan will take longer.

Phase Sensitive Inversion Recovery (PSIR)

The PSIR ("AutoViability") IR-TFE sequence can be used for late enhancement assessment. The advantage of this technique is that it is less sensitive to suboptimal inversion delays.

PSIR is a 2 heart-beat sequence

PSIR needs 2 cardiac cycles (per inversion prepulse).

- It is more robust against variations in heart rate, and the SNR and CNR will both be better compared to a single heart-beat technique.
- It is intrinsically slower than single heart-beat techniques.
- The loss in imaging speed can be compensated for by using SENSE.

In the PSIR sequence, the second heartbeat is used for determination of the phase. The inversion pulse is given only once every two heartbeats, so that the acquisition in the second heartbeat has had more time for relaxation (so that the magnetization of all tissues should be positive again), and can be used as a reference.

PSIR provides Corrected Real Images

The "CR" image type (Corrected Real) is the desired final phase corrected image.

NOTICE

PSIR and imaging parameters: not all can be combined, others are mandatory.

Halfscan and partial echo cannot be used with PSIR.

SENSE can be used with PSIR.

CLEAR is mandatory with PSIR.

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Related parameters

- TFE prepulse (no, saturate, invert)
- PSIR (no, yes)
- Flip angle (default: 5°)

  The flip angle parameter "Flip angle (deg)" specifies the flip angle of the 2nd TFE shot in the 2nd heart beat, which is typically taken smaller than the flip angle in the 1st heart beat (to prevent saturation).

Tips & Tricks

Optimal inversion delay time

PSIR uses two RR intervals per inversion pulse. Compared to enhancement techniques which use a single RR interval per inversion pulse, a longer TI should be used for PSIR (because there is more time for relaxation). It's always better to use an inversion delay time which is a bit too long (with positive myocardium). This will result in optimal contrast between normal and scarred myocardium. This is less important for PSIR scans, where a too short TI still results in optimal contrast between the normal and scarred myocardium in the CR-image.

2D versus 3D

PSIR can be used for 2D and 3D, but for practical reasons, PSIR is mainly useful for 2D imaging. This is mainly because of breathhold times.

Navigator echo technique and PSIR

When using navigators with PSIR, the following happens with respect to the acceptance of RR intervals.

- If the first RR interval is accepted, also the second one will be accepted.
- If the first RR interval is rejected, also the second one will be rejected.

High Bandwidth IR

Functional Description

Standard late enhancement scans cannot be performed in patients with cardiac implants (for example, with pacemaker or Implantable Cardioverter-Defibrillator), because the implants cause hyperintense signal which mimic diseased tissue.

High Bandwidth IR allows you to perform late enhancement scans in these patients due to a wideband inversion prepulse.

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Enabling High Bandwidth IR

▷ Prerequisite: Your current imaging protocol is a late enhancement protocol with the parameter **TFE prepulse** set to **invert**.

► To enable High Bandwidth IR, in the Contrast group set the parameter **TFE prepulse** -> **pulse type** to **high bandwidth**,

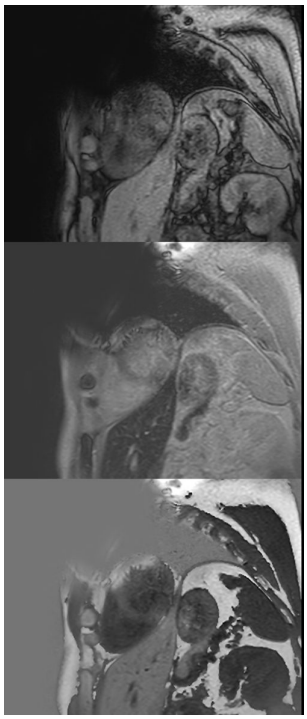
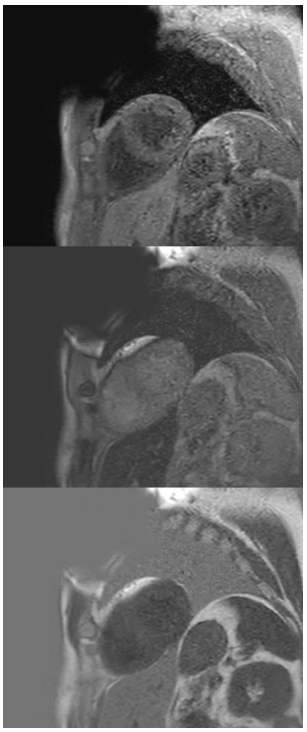
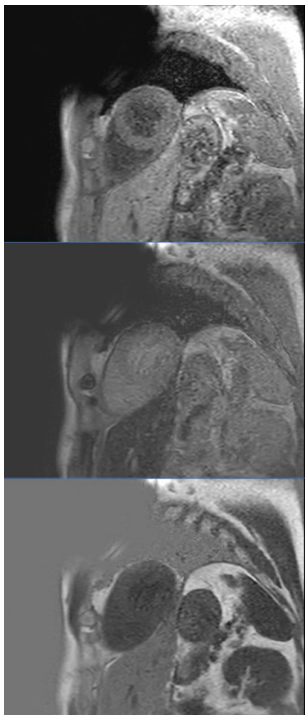
⇨ Then the parameter **offset** appears which allows you to adjust the offset of the inversion prepulse.

► To optimize the inversion prepulse, use multiple different values for the **offset** parameter, for example in a dedicated survey.

The offset parameter allows you to optimize the prepulse for each patient depending on the type and location of the cardiac device. The default value is 750 Hz.

► For your High Bandwidth IR protocol, use the optimal offset parameter as found in the dedicated survey.

Image Comparison: 2D PSIR with and without High Bandwidth IR

	2D PSIR with WFS of 0.7 px	2D PSIR with WFS minimum (0.14 px)	2D PSIR with WFS minimum (0.14 px) and with High Bandwidth IR (with the default offset of 750 Hz)
From top to bottom: • Reference image • Modulus image • Caldulated Real image			

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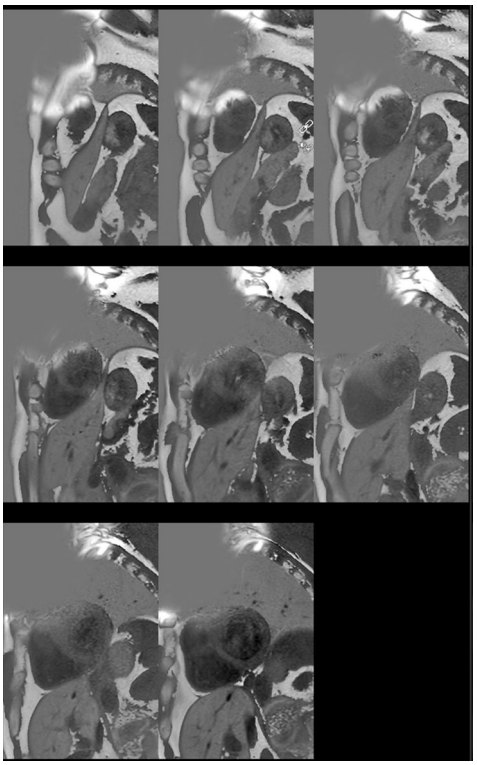
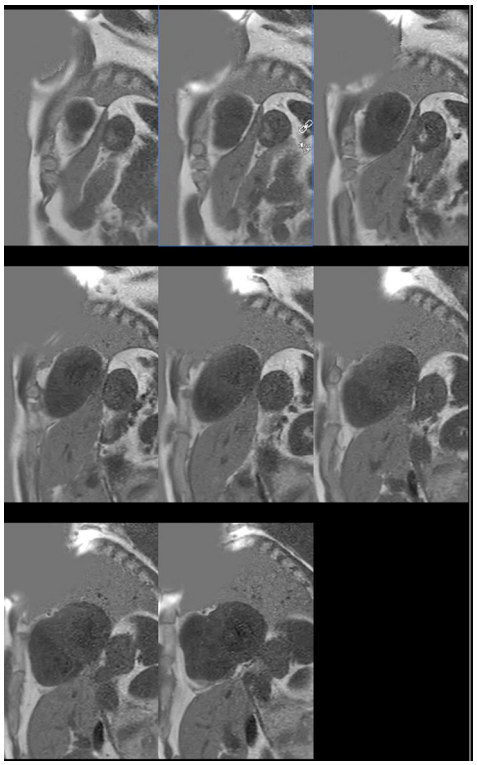
Without High Bandwidth IR Calculated Real (CR) images	With High Bandwidth IR (with the default offset of 750 Hz) Calculated Real (CR) images
	

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9.4.5 T1 Mapping

Functional Description

T1 mapping is a method that provides T1 maps of the myocardium. It is based on the Modified Look-Locker Inversion Recovery (MOLLI) technique.
T1 maps are parametric images calculated pixel-wise where the pixel value represents the T1 value per pixel.

Application

- Myocardial tissue.

Diffuse myocardial fibrosis and other remodeling of the extracellular space are common pathological features of many cardiac diseases. These changes can be measured non-invasively with MRI through changes in **native** and **enhanced** myocardial T1 relaxation times.

What are the main properties of T1 mapping?

- T1 maps are provided for native and enhanced scans.
  Optimized acquisition schemes are available which take the different T1 values in native and enhanced scans into account.

- Images are usually acquired in standard cardiac planes.
- Cardiac triggering and breathhold technique are used to compensate for cardiac and respiratory motion.
- T1 mapping is enabled with the imaging parameter **T1 mapping**.
- Philips native and enhanced imaging protocols utilizing T1 mapping are delivered with the MR system (Folder: *Heart->Function non-cine->Mapping*). It is recommended to use these protocols. They make use of acquisition schemes that are optimized for long (native) and short (enhanced) T1 times based on literature findings.

References

For more information about T1 mapping, see literature.

More information

- Imaging parameter **T1 mapping** in Online Help system (F1 key)
- Background information in Online Help system (F1 key)

Performing an Examination with T1 Mapping

Patient positioning

- ► Position the patient on the tabletop with VCG, respiratory belt, cardiac coil, headset, and nurse call.
- ► Explain and practice the breathhold procedure with the patient.
  The quality of the T1 maps directly depends on the quality of the breathhold.
- ► Instruct the patient not to touch the VCG module and cables.
- ► Check the quality of the VCG signal prior to scanning.

Running the native T1 scan

- ► Enter the examination data at the console.
- ► Select a cardiac ExamCard with native and enhanced T1 mapping imaging protocols, preferably in more than one imaging plane.
  Images are usually acquired in standard cardiac planes.
- ► Enter the cardiac frequency in the Exam Dashboard.
- ► Start, and eventually plan and resume the ExamCard.
  The survey and the cardiac scans are performed.
- ► Give breathhold instructions during the native T1 mapping scan.
  The quality of the T1 maps directly depends on the quality of the breathhold.
  - The breathhold takes around 11 seconds.
    Since the number of ECG triggered images must be a whole number, the acquisition and recovery periods are rounded to the nearest multiple of the RR-period to ensure an adequate duration and hence the breathhold time is 11 to 12 seconds. The resulting number of images is different depending on the heart rate of the patient.

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- For patients with a heart rate of 60 beats per minute and a RR-interval of 1 second, 8 images are acquired with the native acquisition scheme.
  With a higher heart rate, the RR interval is shorter, and more images are acquired during the breathhold.

Administering contrast agent

► Inject the contrast agent.

Running the enhanced T1 scan

► Wait at least 15 minutes before you start the enhanced T1 mapping scan.

► Give breathhold instructions during the enhanced T1 mapping scan.
The quality of the T1 maps directly depends on the quality of the breathhold.

- The breathhold takes around 12 seconds.
  Since the number of ECG triggered images must be a whole number, the acquisition and recovery periods are rounded to the nearest multiple of the RR-period to ensure an adequate duration and hence the breathhold time is 11 to 13 seconds. The resulting number of images is different depending on the heart rate of the patient.
- For patients with a heart rate of 60 beats per minute and a RR-interval of 1 second, 9 images are acquired with the enhanced acquisition scheme.
  With a higher heart rate, the RR interval is shorter and more images are acquired during the breathhold.

Viewing the parametric maps

► View the native and the enhanced T1 mapping imaging series.
These series contain:

- acquired images with different inversion delay times,
- calculated T1 maps, labeled **/T1map**,
- confidence maps (goodness-of-fit map) as overlay of the T1 maps.
  The confidence maps indicate the quality of the T1 maps.

► *To scroll through the images with different inversion delay times*, drag to the left or to the right on the image viewport.
Alternatively use the left and right arrow keys.

► *To scroll to the T1 maps*, drag diagonally on the image viewport.
The T1 maps and the confidence maps are displayed right behind the first inversion delay time image.
A checkerboard pattern indicates the areas with too low reliability in the data. The confidence map provides the best representation of the reliability of the acquired data. If the confidence map shows poor quality, the scan needs to be acquired again.

Obtaining T1 values

To obtain the T1 values, draw a ROI on a T1 map with confidence overlay.

► Right-click the T1 map with confidence overlay and select the desired ROI type from the provided options.

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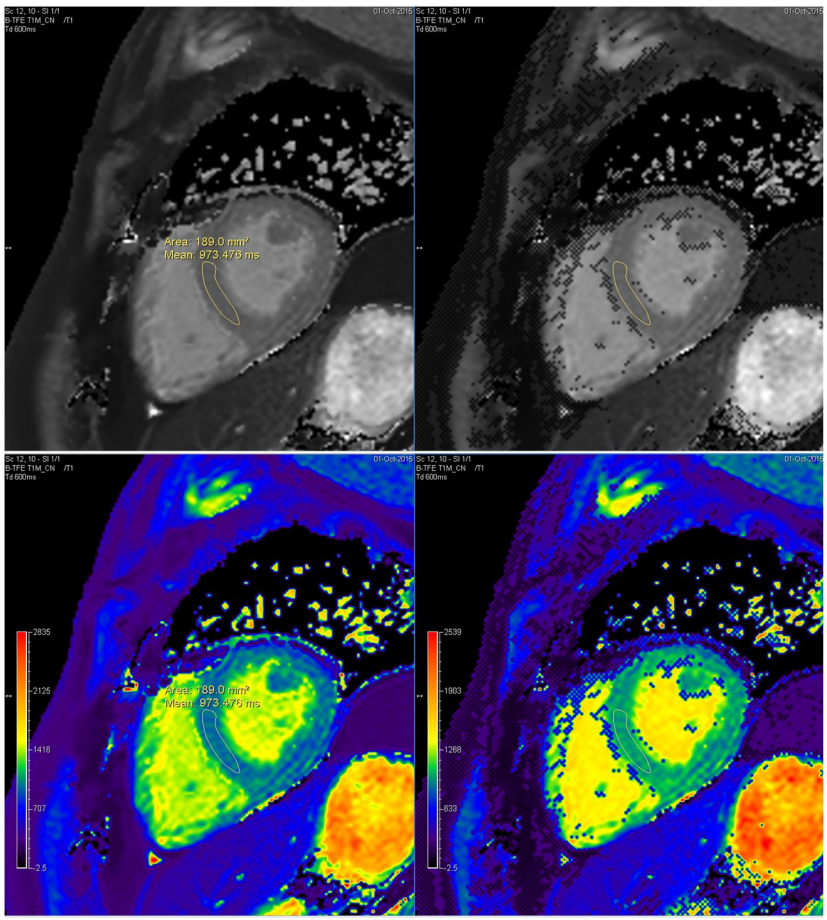
- Draw a ROI.
  Do not include areas of low confidence such as the checkerboard areas and vascular structures.
- Copy and paste the ROI to the T1 map without confidence overlay.
- Note the mean value of the ROI on the T1 map without confidence overlay as the T1 value.

  The numerical T1 values are displayed in milliseconds (ms).

NOTICE

Possibly false results

To avoid any possible bias in the results, DO NOT use T1 values from the T1 map with confidence overlay, because the pixels with low confidence are not automatically excluded.



Optional: Obtaining time-intensity diagram

- On the Review toolbar, click **Time-Intensity Diagram** .

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Then follow the instructions in the chapter Reviewing Images -> Time-Intensity Diagram.

9.4.6 Coronary Angiography

MRI of the coronary arteries, with the advent of the MotionTrak method is now feasible in a clinical setting.

This chapter will introduce the various aspects needed to perform a successful coronary examination. Covered here will be the utilization of MR methods, scan parameters, a recommended clinical scan procedure and angulation techniques.

Functional Description

Coronary scans can be made with a variety of techniques:

Balanced TFE is the most frequently used method because it is fast due to the very short TR's that are used and it gives a nice strong signal from blood. Other methods include TFE and Black Blood TSE.

Breath holding could be used for respiratory motion reduction, but the total breath-hold time available is not sufficient to achieve good quality images. Another problem for breath-hold approaches is the high risk of unwanted movement of the diaphragm during breath holding.

The best way to acquire high-resolution images is to correct for any respiratory motion using navigators. Navigators correct for sub-millimeter motion and allow for longer scan times, more data acquisition and thus a higher spatial resolution. In the past these scans could easily exceed 10 minutes of scanning, but good results can be obtained in scans that last for a more practical 3 to 5 minutes of effective scan time.

There are two different approaches: the whole heart approach and the targeted approach where typically one scan is needed to catch the right coronary artery (RCA) in one scan, and a second scan is needed to catch the left coronary artery (LCA) and circumflex (LCX) together.

Remark

The most frequently made mistake is to determine the spatial resolution of coronary scan from the voxel size only (FOV and scan matrix), totally ignoring the influences of respiratory motion to the resolution. In other words, decreasing the acquisition resolution from 0.7 mm to 0.5 mm does not improve the resolution if the total amount of respiratory blurring is more then 0.7 mm. Try not to focus too much on the voxel size alone. Focussing on patient comfort is more important, reducing the risk of patient motion gives much better results!

Performing Coronary Angiography

The best results are achieved when the patient is not moving at all since very small vessels are to be imaged. The slightest movement of the patient during scanning results in blurred images. It is therefore important to make sure that the patient lays very comfortable inside the magnet. Music through the headset can help to create a more relaxed atmosphere. Explain to the patient the importance of keeping still during the whole examination.

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This procedure describes the targeted approach for the coronary arteries and the whole heart examination.

Multistack survey

- can best be performed in a breath hold (expiration).

  This allows for better planning of the navigator beam that is used for respiratory gating and motion tracking.

High Temp Cine scan

- is a b-FFE cine scan with a sufficient number of phases (40 or more) to allow the precise determination of the trigger delay and shot duration.

► Position the scan in transverse orientation through the left and right ventricle. The idea is that this scan shows the motion of RCA and thus the precise moment that diastole starts and early systole begins.

► Acquire this scan in free breathe as breath-hold might affect the patient's heart rate. It is important to define the precise start of diastole during free breathe since the actual coronary scan is acquired in free breathe too (navigator).

Coronary survey (only needed for the targeted appraoch)

- is a high-resolution survey scan that covers the whole heart and that is needed for planning of the coronary scans.
- utilizes SENSE b-TFE to speed up the image acquisition.
- uses a navigator for respiratory gating and motion tracking. Position the navigator on the right hemi diaphragm.
- uses a trigger delay set to mid-diastole (if higher heart rates result in conflicting parameters, the trigger delay could also be set to longest).

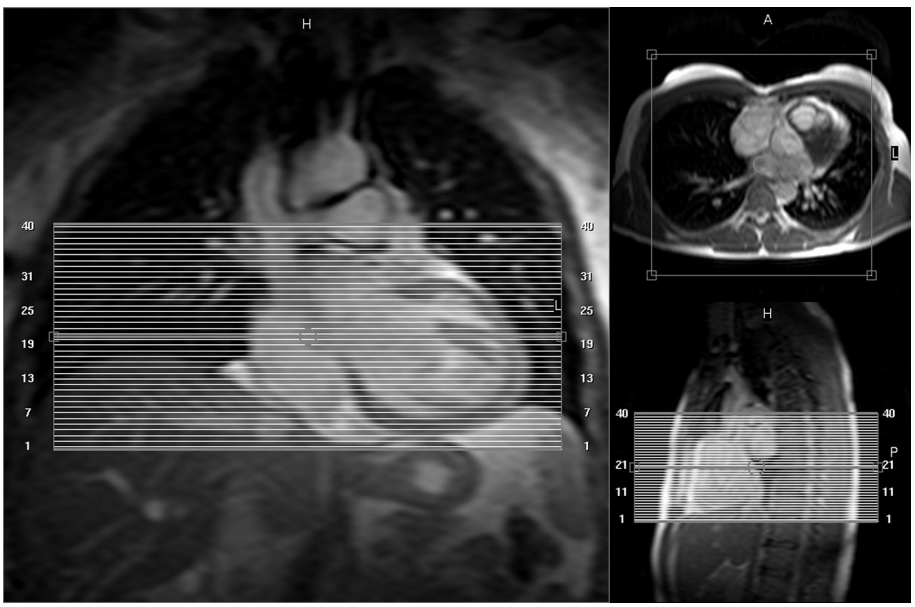

Fig. 95: Coronal image that shows the main pulmonary artery: position the stack such that the first slice is located halfway the pulmonary artery, including as much of the heart as possible.

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While this scan is running, the precise trigger delay and shot duration can now be determined from the previous high temp cine scan:

- ► Browse through the phases and find out at what moment diastole starts. This should be the start of the TFE acquisition.
- ► Browse through the phases to find the precise moment that the right coronary artery starts moving again at early systole. The difference between this moment and the previously mentioned trigger delay is the acquisition duration. The acquisition duration is displayed on the info page and can be controlled by changing the TFE factor.
- ► Alternatively, the TFE shot duration can be set in milliseconds directly on the 'Contrast' tab. The TFE factor is automatically calculated and displayed on the info page.

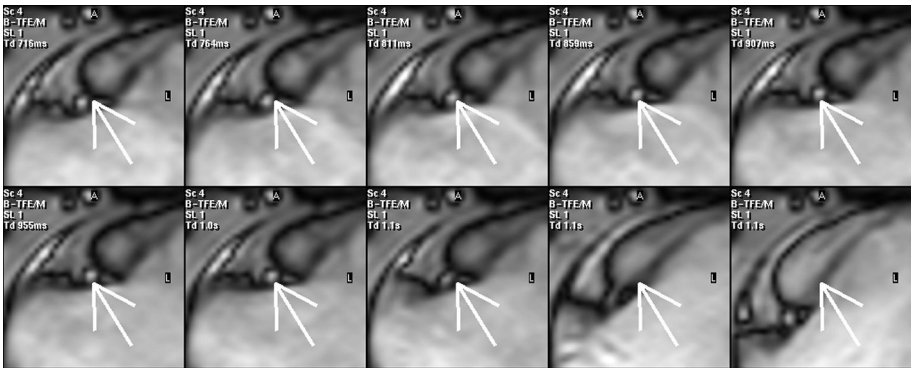

Fig. 96: Browse through the phases of the high temp cine scan to find out the precise moments where the coronary motion starts and stops.

Coronary scan

Coronary scan	Approach
Whole Heart Coronary scan	for whole heart approach
Right Coronary scan (RCA)	for targeted approach

Tab. 16: Use one of these coronary scans

- ► To calculate the trigger delay, do any of the following.
  - For low-high profile order, the trigger delay is the time at which diastole starts.
  - For linear profile order, add half of the shot duration to the value found using the High Temp cine scan.
- ► Enter this trigger delay in your scan protocol.
- ► Adjust the TFE factor or the TFE shot duration on the **Contrast** tab.

When the images of the previous scan (coronary survey) are loaded into the main planning viewport, three-points-planscan can be used to position the stack of slices such that they cover the whole right coronary artery at once. To avoid any risk of respiratory ghosting artifacts over the image select a feet-head fold-over direction.

For the whole heart approach, the examination would be finished by now. For the targeted approach, another scan for the LCA could be necessary.

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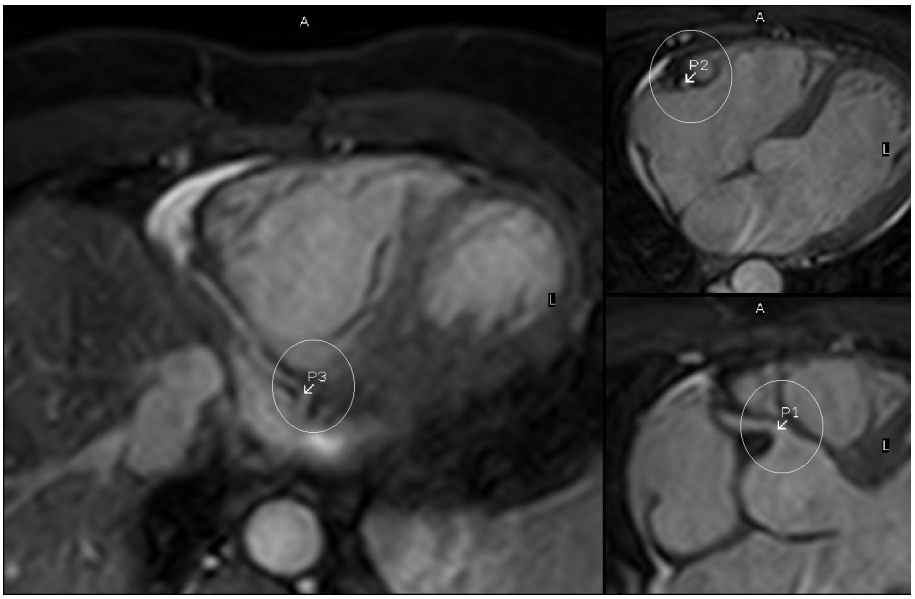

Fig. 97: Place the first point at the origin of the RCA, the second point more lateral at the most apical position and the third point at the most distal, inferior position.

Left coronary artery (LM, LAD and LCX) scan - for targeted approach

- The left main (LM), left anterior descending (LAD) and the left circumflex (LCX) can be acquired in a single 3D volume.
- Use three-points-planscan to position the stack.
- Fold-over direction should be set to LR to avoid any risk of respiratory ghosting artifacts.

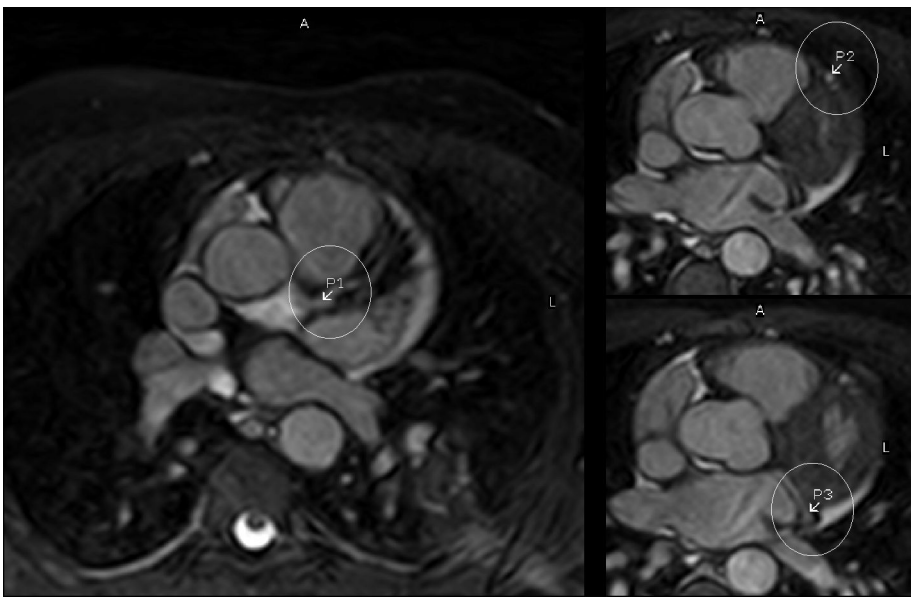

Fig. 98: Place the first point at the origin of the LM, the second point more distal in the LAD and the third point at the LCX.

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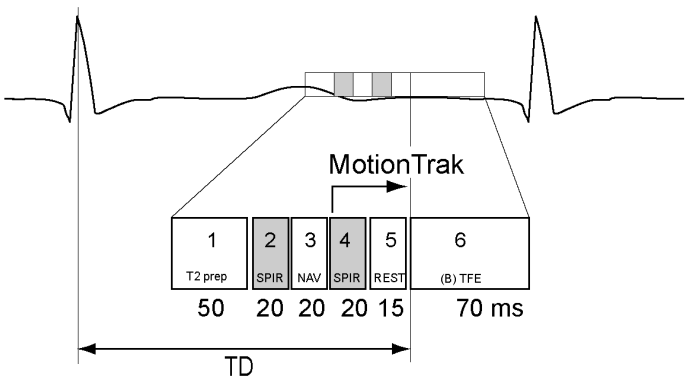
Sequence description

- The coronary scans make use of the **3D-K-space shutter** which saves 20% of the scan-time and increases signal to noise. The technique utilizes a radial profile order, which means that the outer corners of 3D K-space are not acquired during acquisition resulting in improved image quality. As a result of this radial profile order, each individual TFE shot starts at the center of 3D K-space (low-high profile order). Because of this REST and SPAIR or SPIR pulses become more effective. Therefore it is also allowed to select fold-over suppression with only 1 NSA (implicit use of REST slabs).
- A SPAIR or SPIR **fat suppression** pulse is used to enhance the contrast between the coronary artery and the surrounding epicardial fat.
- A **T2Prep** pulse is used to further enhance the contrast between the coronary arteries and the myocardium. The T2Prep pulse is a non-selective pre-pulse that suppresses tissues with short T2 relaxation's using a train of refocusing pulses over a short period of time. Both the number of refocusing pulses (1, 2 or 4) and the period of time (echo time) can be adjusted for the T2Prep pulse.
- It is recommended to use volume **shim**, which is done selectively over a volume that can be freely chosen, but is restricted to a minimum value. Large transitions as air/tissue boundaries should be excluded from the selected volume and also areas where large homogeneity variations occur. When 'ShimAlign' is set to 'yes', any modification of the stack off-centers and angulations will result in a recalculation of the shim volume such that the shim volume will be aligned to the stack:
  - Off-centers are adjusted such that the volume will be inside the stack.
  - Angulations will be equal to the stack.
  - The volume will be slightly thicker than the stack allowing easier selection in planscan mode.

In order to eliminate the contribution of fat signal into the navigator beam, a second SPIR pulse is implemented to suppress the fat in the navigator beam. This results in a steady navigator signal. The excitation of the navigator is moved close to the acquisition train to ensure a minimum amount of residual motion. The order of pulses is:



Navigator coronary sequence:

1. T2 prep pulse
2. SPIR for navigator
3. Navigator
4. SPIR for image acquisition
5. Implicit REST for fold-over suppression
6. Acquisition train (Balanced TFE, TFE or TFE-EPI)

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9.4.7 SENC (Strain Encoding)

Functional Description

Property	Description
Pulse Sequence	SENC (Strain ENCoding) is a technique to image the contracting heart muscle in a quantitative way. • The SENC acquisition takes place at the Philips MRI system. • The acquisition data is intended to be processed with the *MyoStrain* application by the company *Myocardial Solutions* (http://www.myocardialsolutions.com/).
Properties	• SENC provides modulus images which are needed to calculate the SENC strain images. These strain images contain the quantitative information. • SENC scans also provide SENC anatomy images. They can be used to check the planning, arrhythmia, motion artifacts, and image quality in general.
Applications	• Cardiac imaging: SENC supports strain measurements in the left and right ventricle.
Scan modes	• Single-Shot TFE-Spiral

What is SENC?

SENC (Strain ENCoding) is a technique to image the contracting heart muscle in a quantitative way.

One SENC scan results in time series of images (typically 20 heart phases) of a single slice, where the pixel value in each image represents strain (contraction or expansion relative to some reference point in the cardiac cycle). Strain is a dimension-less number (expressed as a percentage) and can be directly interpreted as a quantitative measure. Only strain in a direction perpendicular to the slice orientation is measured. By scanning a few well-defined cardiac views, enough information can be collected to image strain in all relevant directions covering the whole heart.

SENC can be considered as a form of cardiac tagging – however it does NOT require elaborate processing by way of tracking line or grid patterns.

- SENC measures strain directly.
- SENC does not rely on phase information and avoids difficulties with phase unwrapping.
- SENC has an extremely fast acquisition (1 single heartbeat per slice orientation).
  - One slice acquired in a single heartbeat, providing typically 20 cardiac phases, triggered to an R wave.
  - The readout technique is spiral, with typically 3 spiral interleaves per cardiac phase.
- SENC does not require breath holding. It can be performed with respiratory triggering.

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The most critical success factor is planning accuracy: the better the SENC images are planned, the better the strain images.

How does SENC work?

SENC applies a tagging pulse complex at the start of the cardiac cycle, immediately after the R-wave. The tagging pulse complex produces a sinusoidal modulation of Mz magnetization, in a direction perpendicular to the slice. The modulation typically consists of a few full periods across the slice thickness. During subsequent signal readout, the sinusoidal modulation must be demodulated in order to see a net signal. That demodulation is effected by applying a kz decoding gradient, much like a kz phase encoding gradient. In order to measure relative deformation (compression or expansion of the sinusoidal pattern), it is useful to demodulate not at the exact modulation frequency, but instead at two slightly different frequencies called the low and high tuning respectively. The combination of the two differently tuned images allows a calculation of real strain.

The tagging process itself provides a volume selective excitation. Since only tagged tissue is imaged, this prevents backfolding in spiral imaging and allows to use a small Field of View, planned closely around the heart.

References

For more information about SENC, see literature.

SENC Images

SENC provides different image types at different heart phases covering the complete cardiac cycle:

SENC image type	SENC modulus images	SENC anatomy images
Purpose/description	Needed to calculate the SENC strain images. They do not provide useful visual information. Instead use the SENC anatomy images to judge image quality.	Meant to judge image quality of the SENC scan: • check for SNR (signal-to-noise ratio) • possible patient movements
Provided where	• Outcome of acquisition • Need to be pushed to computer with analysis software for the calculation of the strain images.	• Outcome of acquisition

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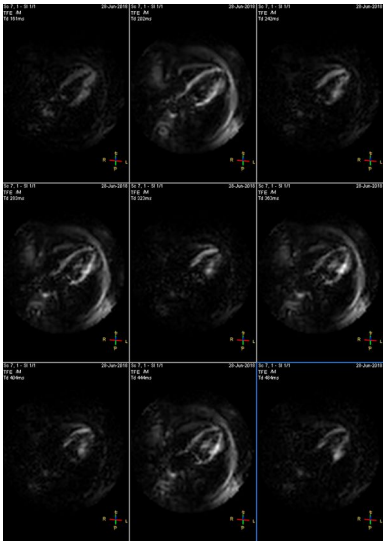
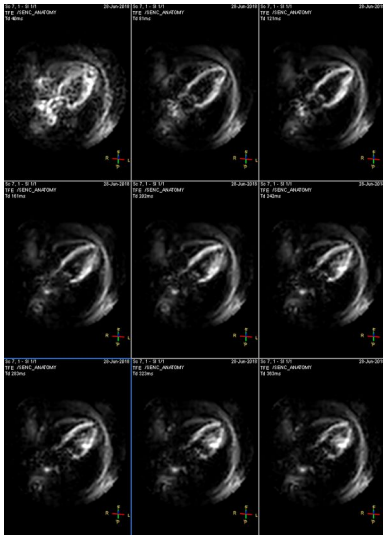
SENC image type	SENC modulus images	SENC anatomy images
Example images		

Scanning with SENC

Use SENC in cardiac imaging to evaluate, for example, left ventricular function.

Patient positioning

- ► Position the patient on the tabletop with VCG, respiratory belt, cardiac coil, headset, and nurse call.
- ► Instruct the patient not to touch the VCG module and cables.
- ► Check the quality of the VCG signal prior to scanning.

Selecting the ExamCard for SENC

- ► Enter the examination data at the console.
- ► Select the cardiac ExampleCard SENC.
  This ExampleCard provides guidance on planning. It contains the following Philips imaging protocols:

Imaging protocol	Number of breathholds
Multistack survey (3 planes)	
Pseudo 2CH CINE scan	1
Pseudo 4CH CINE scan	1
Short axis CINE (5 planes including the valves)	5
True long axis CINE 2CH	1

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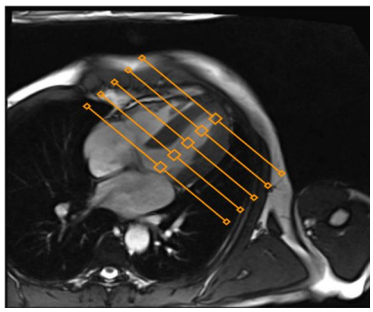
Imaging protocol	Number of breathholds
True long axis CINE 3CH	1
True long axis CINE 4CH	1
SENC long axis views 2CH, 4CH, 3CH	3
SENC short axis basal SAB	1
SENC short axis mid SAM	1
SENC short axis apical SAA	1

Planning and scanning

- ► Start the ExamCard and as such the Multistack survey.
- ► Do one of the following to update the cardiac frequency:
  - Enter the cardiac frequency in the **Exam Dashboard**. Regularly check and update throughout the complete examination.
  - To update the cardiac frequency, click **Update heart rate** on the **Exam Dashboard**.
- ► Plan all scans as shown in the following.
  Start, and eventually plan and resume the ExamCard.

Imaging protocol	How to plan?	Planning example
Pseudo 2CH CINE scan	• Center on left ventricle utilizing all 3 planes of the Multistack survey.	-
Pseudo 4CH CINE scan	• Cut plane parallel on long axis 2CH bisecting the blood pool equally.	-
Short axis CINE (5 planes including the valves)	• Use Pseudo 4CH as reference. • Select end-systolic time frame centered on the left ventricle. • Increase the distance factor to image from the base to the apex of the heart.	

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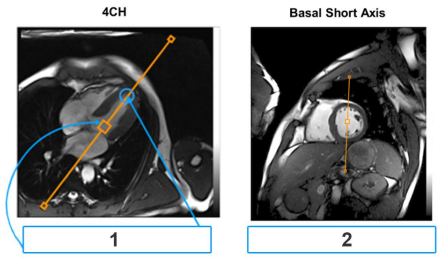
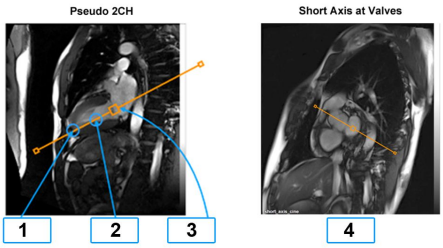
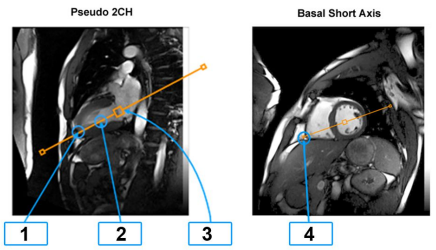
Imaging protocol	How to plan?	Planning example	
True long axis CINE 2CH	• FOV centered on the left ventricle. • The slice must bisect the apex in the Pseudo 2CH view. • Parallel to the septum and equidistantly away from right ventricle insertion points.		1. Cut plane should bisect LV apex and mitral valve. 2. Cut plane parallel to ventricular septum on short axis view.
True long axis CINE 3CH	• FOV centered on the left ventricle. • Bisect the apex in the 2CH view. • Bisect the LV outflow tract on the short axis view.		1. Cut plane to bisect the apex. 2. Avoid papillary muscle. 3. Cut plane to bisect mitral valve. 4. Bisect LV outflow tract on Basal Short Axis.
True long axis CINE 4CH	• FOV centered on the left ventricle. • The slices must bisect the apex in the 2CH and 3CH views.		1. Rotate to go through the apex. 2. Avoid papillary muscle. 3. Cut plane to bisect mitral valve. 4. Place center of the plane on the most angled portion of the right ventricular wall.
SENC long axis views 2CH, 4CH, 3CH	• Use same geometry names as for Cine 2CH, Cine 3CH and Cine 4CH . • Move the center of the LV to the center of the FOV (away from the FOV edges). • Capture the cardiac cycle.	-	

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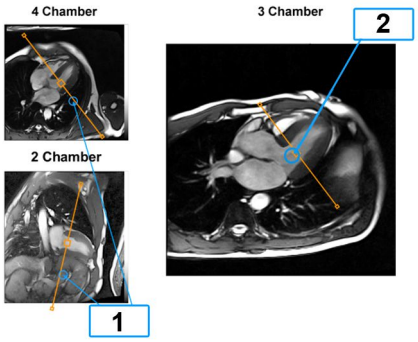
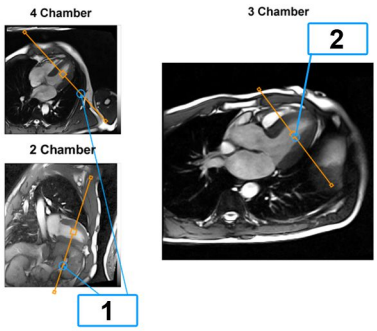
Imaging protocol	How to plan?	Planning example	
SENC short axis basal SAB	• Plan on the 3CH view at the end-systolic time frame. • Place the slice just below the plane of the valves. • Check the slice orientation on 2CH, 3CH and 4CH views. Check that the plane is orthogonal to all walls in the long-axis views (2CH, 3CH, 4CH).		1. All planes should be orthogonal to LV walls. 2. Place slice just below open leaflets of valves.
SENC short axis mid SAM	• Use the same geometry name as for the SAB scan. • Change the geometry name to SAM. This action takes over the slice position of the SAB scan. • Plan on the 3CH view at the end-systolic time frame. • Adjust the plane mid-distance to the apex. • Ensure the plane is orthogonal to walls in the long axis views (2CH, 3CH, 4CH). • Capture the cardiac cycle.		1. All planes should be orthogonal to LV walls. 2. Move plane towards apex.

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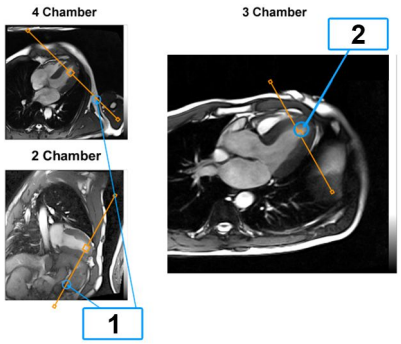
Imaging protocol	How to plan?	Planning example	
SENC short axis apical SAA	• Use the same geometry name as for the SAM scan. • Change the geometry name to SAA. This action takes over the slice position of the SAM scan. • Plan on the 2CH view at the end-systolic time frame. • Move the plane close to the apex. • Ensure the plane is orthogonal to walls in the long axis views (2CH, 3CH, 4CH). • Capture the cardiac cycle.		1. All planes should be orthogonal to LV walls. 2. At ES, towards tip of the blood pool.

Reviewing the images

- ► Review the SENC anatomy imaging series, preferably as movie.
- ► To scroll through the image types, drag to the left or to the right on the image viewport. Alternatively use the left and right arrow keys.
- ► To scroll through the heart phase images, drag diagonally on the image viewport.

Typical SENC parameter settings

- To automatically calculate the SENC anatomy images, the Philips SENC imaging protocols have the imaging parameter **Calculated images** set to **SENC anatomy**.
- Since one slice is measured within one heartbeat, there are no problems with variations of the cardiac cycle. **Arrhythmia rejection** is not needed.
- The recommended values of the **SENC strain range parameter** are +5% , -30%.

9.5 BOLD Imaging

9.5.1 Functional Description

BOLD imaging	• Helps identifying active regions of the brain relying on local metabolic and hemodynamic changes which occur in activated cortical brain.

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Contrast mechanisms	• BOLD (Blood Oxygen Level Dependent): During brain activation (increase of metabolism), the oxygen consumption of local tissue increases by approximately 5%. • Vasodilatation: Vasodilatation occurs resulting in a local increase of blood volume and flow by 20% to 40%. The above hemodynamic response to brain activation leads to an increased local oxygen level resulting in a signal increase in T2*W sequences.
Scan methods	The BOLD effect is visible in heavily T2*weighted scans.
Properties	• The BOLD contrast mechanism will benefit from high field strengths. • Signal changes are typically in the order of 1% to 4%.
Analysis	• To indicate those pixels with a significant increased signal intensity. • Can be performed with**MR IViewBOLD** Analysis package.

Quality improvements

To improve the quality of BOLD MRI, use EPIC Brain:

- **EPIC Brain** allows you to enable EPI geometry correction in the brain in dynamic FFE- and SE-EPI scans, and in BOLD scans.
  - Application Brain only: especially DWI, DTI and BOLD imaging.
  - To enable EPIC Brain, set the parameter **EPI Geometry Correction** to **yes**.

    More information in the Online Help **(F1)**: Enabling EPIC Brain

WARNING

Misinterpretation of the results of the IViewBold technique is possible due to several causes on the system for which operator attention and training is required.

Overlaying the resulting parameter maps from the BOLD analysis on anatomical images, is very helpful in finding the anatomical location of specific areas in the parameter maps. However the anatomical location of these areas should be verified using the source images from the dynamic scan at all times. This verification is required since various factors (like patient movement and differences in scan techniques) may disturb the geometrical correspondence between the overlaid parameter map and the anatomical image resulting in an under/over estimation of the activation area.

WARNING

Attention is needed for operator instructions displayed on the viewing screen.

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WARNING

For the interpretation of the displayed correlation values and its threshold, the user is referred to the literature. Interpretation is the sole responsibility of the interpretor.

Correlation of the functional images and their underlying anatomical images may be influenced by patient motion and therefore depends on the accuracy of fixation of the patient. The operator is responsible for the correspondence between the programmed paradigm and the actually applied paradigm.

9.5.2 Paradigms

In general in BOLD imaging, instructions need to be given to the patient. These instructions are focused on delineating a certain area of brain function. As an example, the instruction could be to move the right thumb or to hold still. In this case, the instruction would be "move" or "hold still". This set of instructions is called a paradigm.

A paradigm

- is the pattern of brain activation (a stimulus is presented or a task is executed).
- consists of blocks (of fixed duration) of brain activation alternating with blocks of rest (or with a control task).
- is characterized by
  - the length of activation(s) and rest in dynamics
  - the task being performed.
- may be more complicated
  - consisting of different tasks, even of different intensities
  - with varying length of the activation or rest blocks.
- is called block paradigm if the activation and control tasks are performed for a duration of at least a few dynamics.
- is called event-related paradigm if the stimuli and the applied instructions or events will only last for a very short period. For example, the instruction to identify a picture of a person as known or unknown only activates the brain for a very short period.

Example

Brain activation can be detected with a very wide range of paradigms. Simple paradigms can be visual (different hemifields, flickering or static, moving or static), silent- or overt speech to identify Broca's and/or Wernicke's area, depicting motor activity of the different hand digits, listening to auditory stimuli etc.

More advanced paradigms focus on memory (by showing "new" versus "old" faces and places), attention (the "no-go" tasks) etc.

Motor tasks

The patient is asked to perform a motoric task e.g. to tap his/her index finger.

Visual stimulation

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The patient is confronted with visual stimulation e.g. a flashing checkerboard.

Auditory stimulation

The patient is confronted with auditory stimulation e.g. auditory presentation of words.

9.5.3 Paradigm Synchronization with the Scanner

The purpose of a BOLD examination is to analyze brain activity as a response to the applied paradigm. In order to do this, it is essential to know the timing of the paradigm with respect to the acquisition of the T2*weighted dynamic scan.

Correct timing can be obtained by using stimulus presentation devices that can automatically synchronize with the scanner. In this case, the scanner will provide a start signal to the paradigm system (or software) so that both scanner and paradigm apparatus start at the same time.

Paradigm synchronization can be facilitated by the use of the Esys system and/or the FBI box.

Functional Brain Imaging box (FBI box)

The FBI box generates trigger pulses (TTL pulse of 4 V of around 5 microseconds) for an external device to identify the start of the next instruction for the patient.

The trigger signals must be set by the user with the imaging parameters "Start at dyn" and "Interval (dynamics)" which appear when "Synch. external device" has been set to "Yes" (dyn/angio page).

The paradigm is started and thus synchronized automatically with help of the FBI box.

Example

Visual stimulation is presented to the patient via a projection screen in the magnet room. The patient display is controlled by the device (either Esys or a third party system) connected to the FBI box.

NOTICE

The FBI trigger device can often not be connected to a PC directly.

In this case, use a converter that translates the FBI signal to a chosen keyboard signal. These converters are offered by various companies.

Each time the (next) trigger is detected, the next visual input is given (e.g. by the next powerpoint slide).

The image shows the schematic presentation of the trigger with respect to the dynamic sequence. An example is given of a simple block paradigm whereby dynamics of a resting state are interleaved with blocks of scanning whereby the patient has to perform a certain task. Both the resting and task related blocks take 10 dynamics of scanning. The first trigger is given at the 11th dynamic in order to have the first automated instruction last during the first 10 dynamics. For example: a slide saying "Do Nothing" could have been started even before

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the start of the scan. After the scan has started, and finished the first 10 dynamics the FBI box will trigger the next instruction providing the correct instruction. Also it can be seen that the following triggers will be obtained at each 10th dynamic.

WARNING

Manufacturer recommends the proper use of the Functional Brain Imaging box in connection with external devices that are compliant with IEC 60950 class I or class II equipment.

Only devices that are compliant with the aforementioned IEC standards may be connected to the box outside the examination room.

NOTICE

Place the Functional Brain Imaging box in a location where Electro-Static Discharges (ESD) are unlikely to occur.

A false trigger could temporarily invalidate synchronization of the fMRI acquisition and the paradigm display, resulting in minor loss of statistical power.

Esys

The Esys system is a turnkey fMRI stimulus system that can be used to provide any visual or auditory stimulus, and is able to handle patient responses using button boxes.

It includes an LCD visual display, crystal clear audio system, and button response unit for data collection. The software provides for experiment creation, precise delivery of brain stimulation, protocol planning, behavioral data analysis and patient management.

Esys is the only fMRI stimulus delivery system that has been tested and certified for compatibility with Philips MRI scanners. For more information on the Esys system, refer to the 'Esys Instructions for Use'.

See section 'Esys synchronization' for more information on how to use the Esys with the Philips MRI system.

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9.6 MR Spectroscopy

Magnetic Resonance Spectroscopy (MRS) works on the same basic principles as MR Imaging (MRI): the real differences are in the manipulation of the signal during and after acquisition. Certain atomic nuclei in the human body, such as the protons (of water and other compounds with hydrogen atoms), have a net magnetic field as a result of their spinning motion. When these spinning nuclear magnets are placed in an external magnetic field the rotation is changed into a precession around the external magnetic field.

For more information about MR Spectroscopy, press **F1** to open the Online Help and browse to Scan Methods and more/MR Spectroscopy.

9.6.1 Proton Spectroscopy: Clinical Applications

MR spectroscopy can be used in all anatomical regions. It is a non-invasive study that can provide information on chemical composition and metabolism of an area of interest, that might be useful for diagnostic purposes. Literature discusses the predictive value of MR spectroscopy in the course of some diseases.

General Considerations

This section gives some general tips and hints with respect to planning and scanning for MR Spectroscopy.

Coil choice

All Ingenia coils can be used for MR proton spectroscopy.

Planning Offcenters and Angulations

- In SI scans (2DSI and 3DSI) only the slice angulation and the in-plane offcenters of the VOI can be planned independently from the stack. The other offcenters and angulations are equal to the stack.
- It is possible but not recommended to use the same geometry name for SV and SI scans, because a SV scan can not change all the VOI offcenters and angulations in a SI scan. Some of these parameters are fixed by the stack.

Propagate Coverage

- Only if 'Propagate Coverage' is enabled, the VOI sizes are shared between scans with the same geometry name.
  - Exception: The VOI thickness (slice coverage) in 2DSI scans can not be changed by another scan with the same geometry name, because it is determined by the stack coverage. So SV and 3DSI scans can reuse the VOI thickness of a 2DSI scan via 'Propagate Coverage', but a 2DSI scan can not use the VOI thickness of SV and 3DSI scans.

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VOI Alignments

- The VOI offcenter and angulation alignment settings are shared over all scans with the same geometry name.
- SV scans (where VOI alignment is not applicable, so disabled) switches off the VOI alignments in SI scans with the same geometry name.

Imaging and Spectro

- Imaging scan and SV scan with the same geometry name do not share anything.
- Imaging scan and SI scan with the same geometry name have the same stack geometry. The stack sizes are only shared if 'Propagate Coverage' is enabled.
- If an imaging scan and SI scan have the same geometry name, and the geometry of the imaging stack is changed, then also the stack in the SI scan and the VOI geometry will change (because some VOI parameters are related to this stack).
  - If alignments are switched ON in the SI scan, then all offcenters and angulations are changed in the VOI.
  - If alignments are switched OFF, then the VOI receives the through-plane offcenter and the in-plane angulations of the stack.

SmartPlan

- SmartPlan learns the VOI offcenters, angulations and sizes.
- SmartPlan automatically plans the VOI offcenters and angulations of scans using a smart named geometry.
- SmartPlan only plans the VOI sizes in a spectro scan.
- VOIs automatically planned by SmartPlan must always be confirmed in the PlanScan environment, because planning a VOI is very criticial.

Hold Geometry

- If the user starts planning a spectro scan with a geometry name for the first time (so the named geometry does not yet contain a planned VOI), then at the start of planning the VOI offcenters and angulations of the latest planned VOI are copied to this scan. This latest planned VOI is stored in the so called 'hold geometry'.

Scanning and default script for SpectroView postprocessing

- SpectroView comes up with a default script for postprocessing. This default script depends on the setting of the general imaging parameter 'Anatomic Region'.

Scanning with the Phantom

Phantom scanning can be useful for training or test purposes. The results can be used as a reference for spectral quality to test the system's stability.

The spectroscopy package includes a phantom, phantom A, and a positioning plate.

The phantom can be placed

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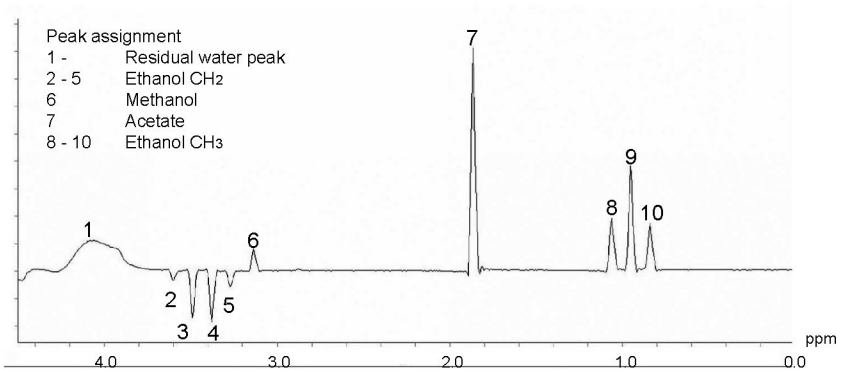
- On the positioning plate in the load ring of the Q-Head coil, the H-Head coil or the Transmit/Receive Head coil.
- On the head rest of the SENSE Head coil.
- On top of Surface or SENSE coils.

Phantom A is a sphere of 10 cm diameter, containing the following compounds resolved in water:

- 5 ml 98% acetate (CH_3OOH)
- 10 ml 80% ethanol (CH_3 CH_2OH)
- 8 ml 98% phosphoric acid (H_3PO_4)
- 1 ml 1% arquad solution + 120 mg/ml $CuSO_4$

Because the phantom contains high concentrations of alcohol and acetate, a good signal-to-noise spectrum can be obtained in only a few measurements.

The image shows the water-suppressed spectrum of phantom sphere A.



The ethanol CH_2 signal is a J-coupled signal, with a J-coupling constant very similar to that of lactate (~ 7Hz). The peaks will have positive sign at very short TE and at TE = 288 ms, but will be inverted at the echo time of 144 ms, which was used in this figure.

Preset Procedures

Preset procedures for spectroscopy are present in the Philips database. They are grouped together in spectro folders per anatomy. Subfolders can be present in the spectro folder for separate applications.

The Philips database contains ExamCards with spectroscopy scans for various anatomical regions. ExamCard features like sharing geometry are implemented for optimal workflow.

Example of Spectroscopy procedures for the head

- Spectroscopy_1H
  - with subfolders Brain, Hippocampus
- optional: Spectroscopy_31P

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Naming in MRS Preset Procedures

Term in name	Standing for
SV	Single Voxel
2D	Two dimensional Spectroscopic Imaging (Chemical Shift Imaging)
TSI	Turbo Spectroscopic Imaging
3D	Three dimensional Spectroscopic Imaging
MS	Multislice
PRESS / STEAM / SE / sLASER	Indicating the VOI selection method
'Number'	Indicating the echo time

Brain

Applications

Proton spectroscopy in the brain is currently the most common spectroscopy application. It might be used to aid in evaluation of e.g. tumors, abcesses, white matter diseases (like Alzheimer), temporal epilepsia etc.

More specific, spectroscopy may help in the evaluation of

- Tumor grading / assessment
- Typing (benign / malignant / recurrent / necrosis)
- Assessment of response to therapy

Spectroscopy findings in tumor analysis might show:

Metabolite	Related to
Increased choline	rapid cell turnover in solid portion of the tumour
Decreased choline	necrosis if in central portion
Decreased NAA	non-neuronal origin of tumour
Decreased Cr/PCr	compromise energy state of tumour tissue
Increased lactate	product of anaerobic glycolysis

Coil Choice

All coil solutions available can be used to perform spectroscopy.

A dedicated head coil is preferred for brain spectroscopy for optimal signal-to-noise ratio, shortest possible echo times and least chemical shift displacement in volume selection at high field strengths.

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Choice of TE

The choice of TE is based on the metabolites of interest: if T_2-relaxation times of the metabolites of interest are relatively short (eg. Myo-Inositol), the TE must be kept short to detect the signal before T_2-decay is complete.

The TE determines much of the appearance of the spectrum: signals with short T_2 generate broad peaks in the spectrum (Fourier Transform on a fast decaying signal), and can even disappear in the baseline. On the other hand, they will become invisible at long TE, leaving a spectrum with fewer peaks and a smoother baseline.

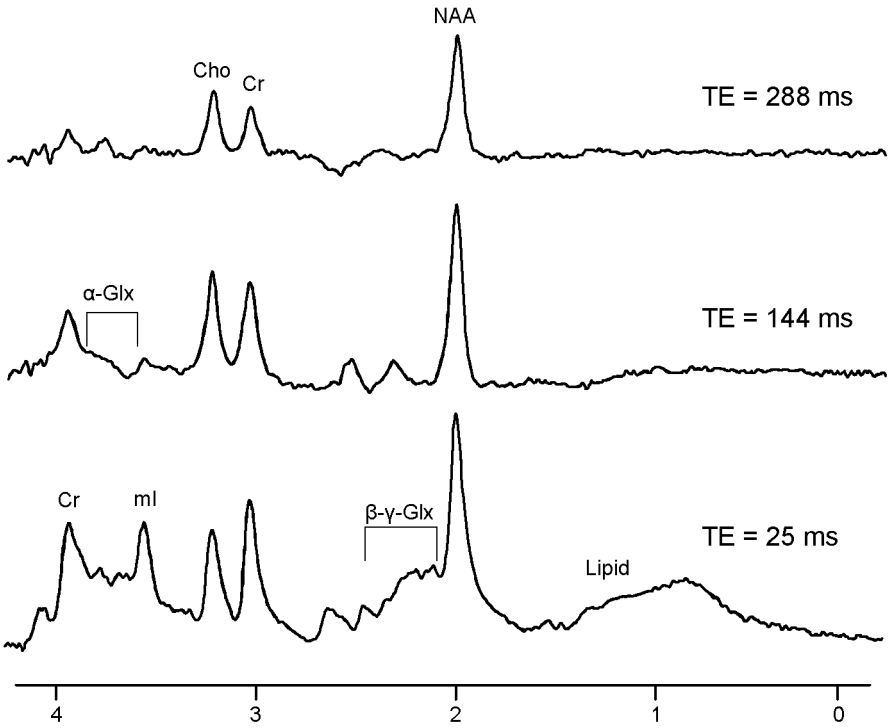

Fig. 99: Proton echo volume brain spectra with different echo times.

Effects of TE on J-coupling

The spin coupling patterns of proton spins can cause phase twists and inversion of peaks (or groups of peaks). A clear example is the CH_3-group of lactate, which gives rise to a doublet at ~1.3 ppm.

The scalar coupling gives rise to a phase evolution of the methyl doublet, which is in-phase every 144 ms (= 1/J = 1/7 s). For TE = 144 ms the resonance shows a phase of 180° leading to a negative in-phase doublet, whereas an echo time of 288 ms gives rise to a positive in-phase doublet. Since only in-phase resonances can be quantified, the signal of lactate is best detected at TE = 144 ms or TE = 288 ms.

At TE = 1/J, the phase of the lactate doublet is opposed to the phase of the other metabolites.

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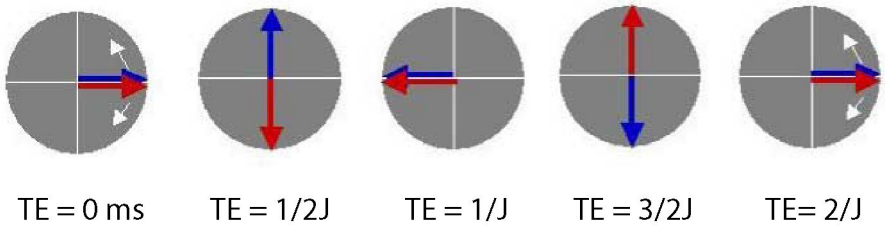

Fig. 100: Evolution of lactate signal.

NOTICE

The real signal aspect of a spectrum must be measured to observe the negative phase of the lactate peak.

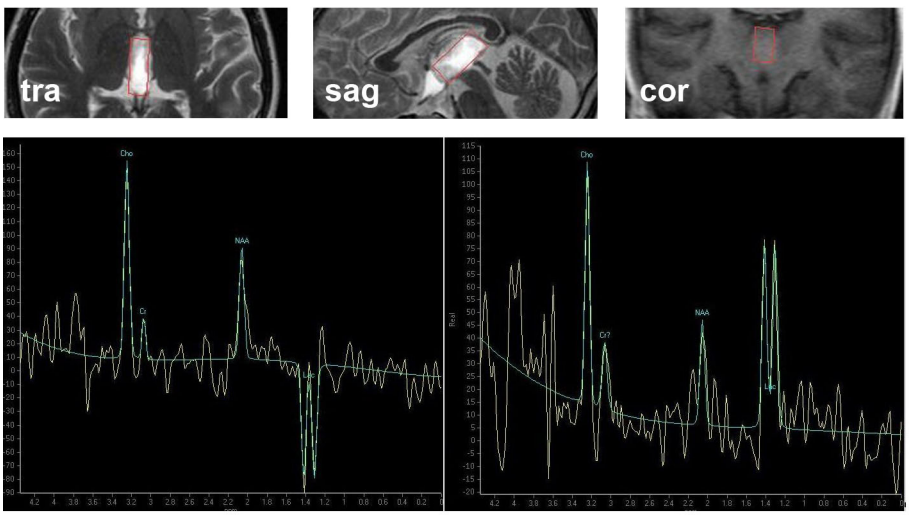

Fig. 101: SVS with different TE's. Left: TE=144ms. Sign of lactate signal is opposed to rest of spectrum. Right: TE=288ms. Sign of lactate signal is inverted and in phase with rest of spectrum.

Very short TE may be used to get the lactate peak nearly in phase, but the lactate signal will often be difficult to quantify because of the underlying lipid resonances.

Scan Method

Both, Single Voxel Spectroscopy and Spectroscopic Imaging are widely used in brain applications.

	Single Voxel Spectroscopy (SVS)	Spectroscopic Imaging
Advantages	• Good signal to noise spectrum in relatively short scan time, and • Shimming is usually much better due to smaller volume size.	Information about metabolic distribution is available in a larger region.

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	Single Voxel Spectroscopy (SVS)	Spectroscopic Imaging
Disadvantages	• Only one spectrum from a block-shaped volume is acquired: – no spatial information is available. – partial volume effects can occur.	A relatively long scan time is required for generally lower SNR per spectrum. Note that scan time reduction can be achieved by using TSI and/or SENSE, at the cost of spectral resolution and/or signal to noise.

Tab. 17: SVS versus SI

Fast Imaging Mode

Spectroscopic imaging scans have long scan times, as spatial encoding is performed with phase encodings only.

Fast imaging mode can be used to reduce scan time, where the selected TSI factor is the scan time acceleration factor.

The readout time of the signal is restricted by the echo spacing selected.

	CSI	TSI
Scan time	• long	• reduced
Tacq	• long Tacq allowed	• limited to ES
Spectral resolution	• higher due to long Tacq	• lower due to limited Tacq
Half echo	• possible due to long Tacq	• impossible due to limited Tacq
Resulting spectra	• Real spectra due to half echo	• Modulus spectra

Tab. 18: CSI versus TSI

Fast imaging mode is best used for long-T_2-metabolites, and therefore very useful for brain spectroscopic imaging.

More information

- More information on Spatial Localization can be found in the Help.

SENSE in Spectroscopic Imaging

SENSE can be used to reduce scan time. As phase encodings are performed in two dimensions in spectroscopy, SENSE reduction factors can be applied in two directions simultaneously. Note that the information from a reference scan is required to perform SENSE. As spectroscopy in general is part of a comprehensive brain examination, the refscan data from the examination is valid for spectroscopy as well.

For brain spectroscopy in general the SENSE Head Coil will be used. SENSE in this coil is allowed in the AP- and RL-direction. This is optimal for transverse slices.

Tips and hints

- Avoid intrinsic fold-over in all directions in which SENSE is applied.

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- Recommended SENSE factors: not higher than 2 in both directions. Note that SNR reduces with increasing SENSE factors.
- Both full PRESS, sLASER, or SE-slice selection can be used:
  - Full PRESS or sLASER will have less foldover artifacts.
  - REST slabs for outer volume suppression can equally be used.

Example

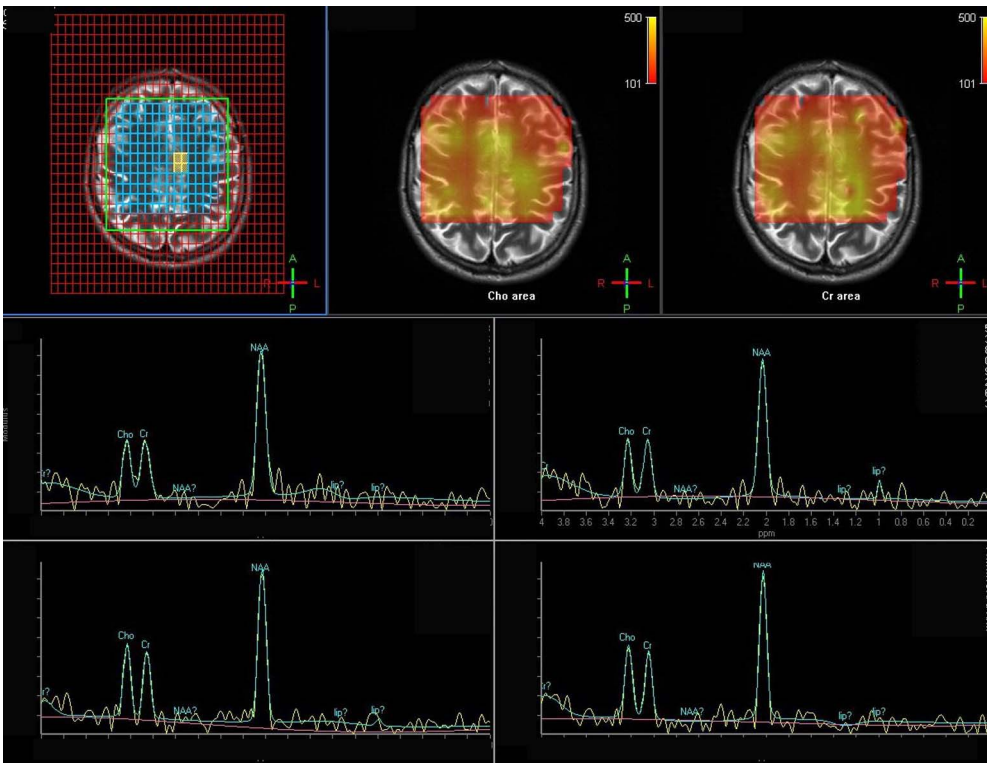

Fig. 102: 3D TSI in the brain. SENSE factor 2x2, TSI factor 3, scan time 1:30 min.

Volume Selection Method

If short TE spectra are to be acquired, STEAM, PRESS, and sLASER can be used as a volume selection method.

PRESS

The shortest possible TE is limited by the fact that three RF pulses and slice selection gradients must be applied for full volume selection. Depending on (amongst others) the system's field strength and the used B1-transmit field, the shortest possible TE in a PRESS sequence is ~ 22 ms.

sLASER

sLASER is a variation of the PRESS technique.

For the dS Head 32ch 3.0T coil, the minimum TE is around 30 ms.

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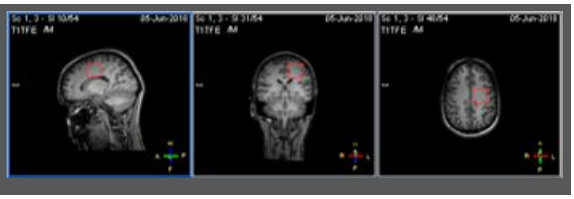
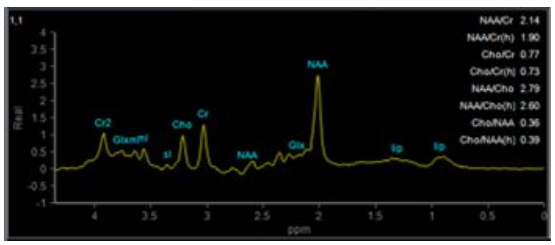
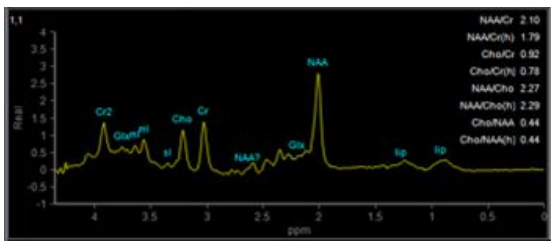
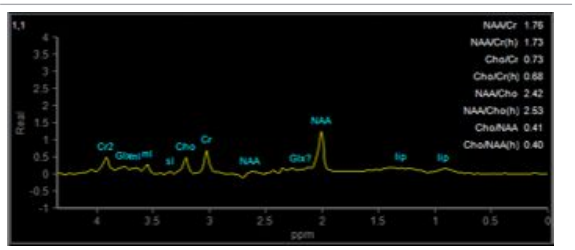
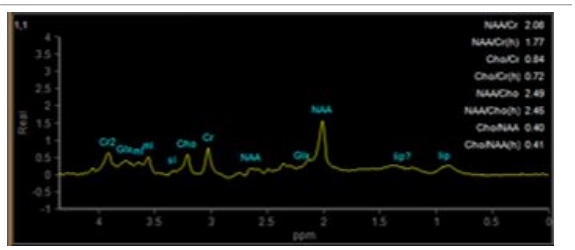
STEAM

As in PRESS, also three RF pulses and slice selection gradients are applied. However, as the magnetization is flipped back in the longitudinal plane between the second and third RF pulse, the effective TE is much shorter with an approximate value of 7 ms.

STEAM has a relatively low signal-to-noise ratio. However, shorter TE on the other hand results in increased signal-to-noise ratio again, and extra signals of tissues with short T_2 relaxation times.

Note that, with shorter TE, water suppression might be less optimal: At longer TE, residual water signal is reduced due to T_2-decay, that is relatively fast for water in comparison to the T_2-decay of brain metabolites.

Comparison	
SV PRESS TE 35 ms	
SV sLASER TE 35 ms	
SV STEAM TE 35 ms	
SV STEAM TE 9 ms	

- The comparison SV PRESS TE 35 ms and SV sLASER TE 35 ms show equal SNR.

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- The comparison SV PRESS TE 35 ms and SV STEAM TE 35 ms show reduced SNR for the latter spectrum.
- The comparison SV STEAM 35 ms and SV STEAM 9 ms show increased SNR for the latter spectrum due to reduced T2 relaxation in all metabolites.

More information

- In the Online Help (**F1**): Imaging parameter **VOI selection method**
- In the Online Help (**F1**): Overview of volume selection techniques in **Scan Methods -> MRS -> Volume selection methods** Backgound information

Volume Selection for CSI

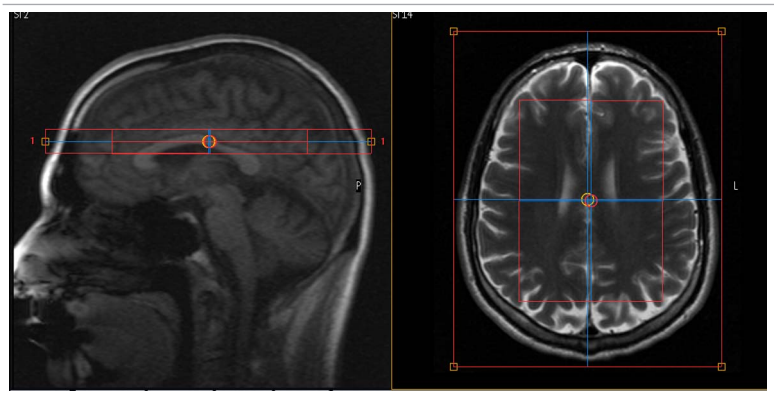
Full volume selection

Full volume selection can be used for spectroscopic imaging in the brain.

It can be combined with PRESS, sLASER and STEAM.

The VOI selected is the signal generating area and should include only tissue of interest (no air-tissue interfaces, no fat from surrounding skull.) Outer volume suppression is optimal, as no signal is selected.

The drawback of full volume selection is that the size of the VOI in general is limited, as it is a box-shaped volume that doesn't correspond well with the shape of the brain. If combined with circular REST, then the VOI may be larger.



PlanScan example full volume selection.

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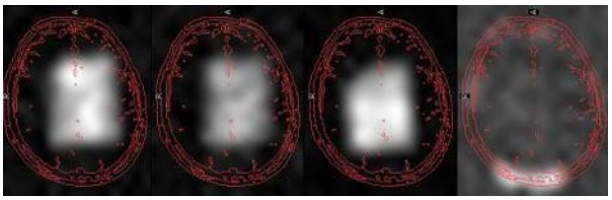
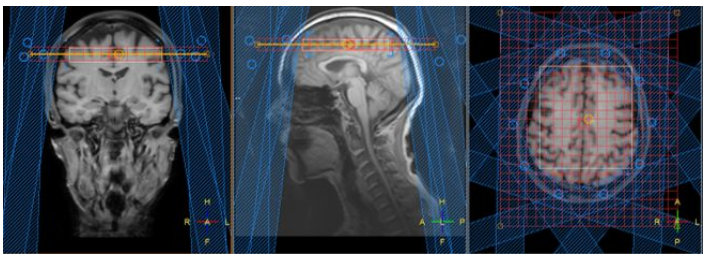
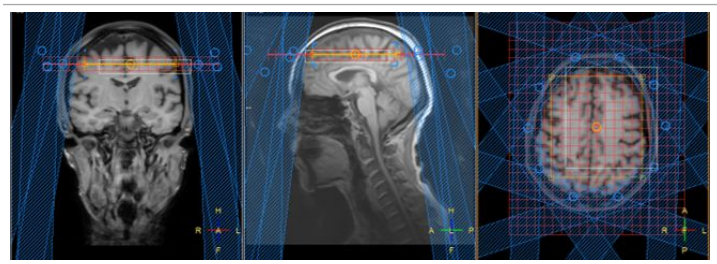
	Full PRESS volume selection centered on NAA (3rd image). The maps of choline (1st) and creatine (2nd) come from a slightly different position due to chemical shift displacement. Note that the signal from outside the volume is hardly generated. Lipid image (4th) is almost empty. Note: volume selection by sLASER reduces inplane chemical shift displacement at 3T.
	Chemical shift displacement sLASER
	Chemical shift displacement PRESS

Chemical shift displacement

- Chemical shift displacement occurs in all three dimensions as slice selective gradients are applied in three dimensions if full volume selection is enabled.
- The adiabatic refocusing pulses in sLASER significantly reduce chemical shift displacement in the refocusing directions at 3T (see figures). Recommendation: use sLASER for 2DSI on brain at 3T.

Slice selection

Slice selection can be performed instead of full volume selection (as in MR imaging).

It cannot be combined with STEAM.

The VOI in PlanScan determines the shim volume, but everything within the selected slice will generate signal.

To avoid fold-over, it is important that the slice FOV is large enough: all signal generating areas must be included in the selected FOV.

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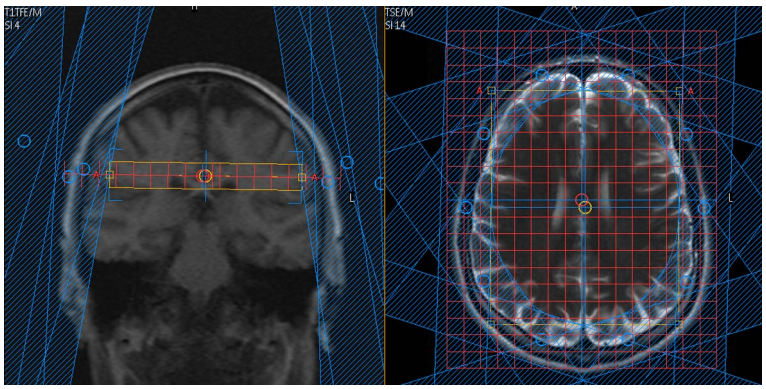
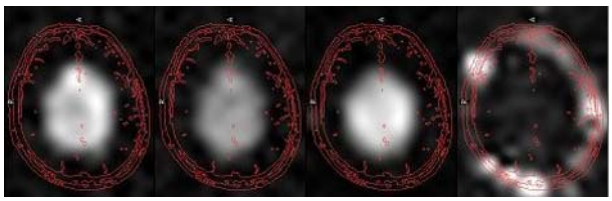
With SE technique, REST slabs are to be used for outer volume suppression. Use of circular REST is optimized for brain spectroscopic imaging, as the REST slabs nicely define a circular-shaped volume, that corresponds with the shape of the brain.



PlanScan example with circular REST.

Chemical shift displacement

- only occurs in the direction in which a slice selective gradient is applied. This is in the 'through-plane' direction.



Slice selection combined with circular REST for outer volume suppression. Chemical shift displacement is not seen in plane, but outer volume suppression by REST slabs only is less complete.

Spectral Resolution

The spectral resolution (Δv) is expressed as the smallest frequency difference that can be separated in the resulting spectrum, and is determined by the received bandwidth and the number of samples.

In practice, the spectral resolution in Hz must be at least twice as high as the chemical shift to be detected, to clearly resolve the two peaks.

In brain, choline (~3.2ppm) and creatine (~3.0ppm) are two of the main metabolites of interest. The chemical shift of these metabolites is very small (0.158 ppm, from "proton NMR chemical shifts and coupling constants for brain metabolites", by Govindaraju et al. NMR Biomed. 2000; 13: 129-153) and high spectral resolution is required to resolve the two peaks.

Example

On 1.5T, a ppm value of 0.158 ppm corresponds to 10 Hz.

To accurately separate choline and creatine, a spectral resolution of < 5Hz is required. To obtain this, the Tacq must be > 200 ms (number of samples / BW < 0.2).

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Bandwidth

The selected bandwidth must be large enough to include all frequencies present in the spectrum of interest to avoid fold-over.

Increasing spectral resolution results in

- Better spectral separation
- Lower signal-to-noise ratio (but only if sampling continues after T_2 has decayed)
- Longer Tacq

The Tacq is checked against the repetition time. Repetition time in brain spectroscopy is usually in the order of 1500 - 2000 ms to allow sufficient T_1-relaxation and long Tacq can be used without any problems.

Shimming Method

Shimming is required for each spectroscopy scan. The shim methods available are described in more detail in the chapter on 'Preparation phases'.

Single voxel

Small volumes in non-moving tissue are usually relatively easy to shim. Both PB-shim and iterative VOI can be used and the results for both techniques will be equally good. Advantage of PB-shim is the reduced preparation time with respect to iterative VOI.

Note that if the shim volume is located close to air-tissue interfaces, PB-shim might be less effective and Iterative VOI could be used instead.

2DSI / 3DSI

The effectiveness of PB-shim tends to increase with increasing VOI size and it is the method of choice for the larger volumes which are used in 2DSI. As field homogeneity varies more over larger volumes, the use of higher order shimming (3.0T only) is recommended.

Water Suppression

The available water suppression methods are listed in the table below.

Water suppression method	Characteristics
VAPOR	• T1 and b1 insensitive • Slightly increased shortest TR (when compared to excitation) • Recommended for brain
Excitation	• Requires AWSO (Automated Water Suppression Optimization), therefore has longer scan time than VAPOR (which does not require AWSO)
Inversion	• Increased shortest TR • Optimal for 'one' water component only

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Water suppression method	Characteristics
BASING pulse	• Not recommended for brain • Not in combination with STEAM

More information

- In the Online Help (**F1**): Imaging parameter **Water suppression**
- In the Online Help (**F1**): Overview of water suppression techniques in **Scan Methods -> MRS -> Preparation phases** Backgound information

Coverage: Multislice versus 3D

If coverage of a larger volume is required, both 3D spectroscopic imaging and multislice spectroscopic imaging can be used.

Multislice spectroscopic imaging

This technique is time-efficient as the acquisition of the second (and other) slices is performed during the remainder of the repetition time of the first slice. The number of slices that can be added to a single-slice acquisition is limited to the Tacq (and the time required for prepulses) for the first slice and the TR of the sequence.

Example

- TR 2000 ms, minimal TR 800 ms
  - a second slice can be added to the sequence without any cost.
  - to add a third slice, the TR must be increased to ~2400 ms.

Multislice is especially beneficial for those volumes that have large dimensions in-plane and relatively small dimension through-plane which is mainly the case in brain spectroscopic imaging.

- Slice gaps can be used.
- Slice definition is improved in comparison to 3D.

3D spectroscopic imaging

This technique can be selected to cover a larger volume. Phase encodings are performed in 3 dimensions for spatial resolution. Scan time increases linearly for each slice added to the sequence. 3D also provides a higher SNR.

3D is mainly beneficial for those volumes that have comparable dimensions in all directions.

Performing Proton Spectroscopy in the Brain

SVS workflow

1. Acquire anatomical images in at least two orthogonal directions with an intersection to the area of interest.

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2. Select procedure for SVS.
3. Graphically resize and position the VOI in PlanScan.
4. Start scan.
5. Open monitoring window to view the results in real-time.
6. When reconstruction is complete, open the series in SpectroView. Do any of the following:
   - Double-click on the scan in the planning list.
   - Drag and drop the scan from the planning list into the viewing window.
7. Run appropriate script for processing.
8. Create DICOM screen capture.

Spectroscopic Imaging workflow

1. Acquire anatomical images in the imaging plane required for CSI with an intersection to the area of interest.
   - Position center slice of the stack in the required position of the CSI-scan: the geometry used for this scan can be used to plan the CSI-scan
2. Select preset procedure for CSI.
3. Select geometry of the required anatomical, to copy the planning.
4. Change in-plane VOI size and position REST slabs.
5. Start scan.
6. When reconstruction is complete, open the series in SpectroView. Do any of the following:
   - Double-click on the scan in the planning list.
   - Drag and drop the scan from the planning list into the viewing window.
7. Run appropriate script for processing.
8. Create DICOM screen capture.

Alternative workflow

A possible workflow is to acquire a set of fast spectroscopic images, that serve as a kind of metabolic screening. One or more high-resolution single voxel scans are planned on these metabolite maps.

The FOV and scan matrix define the spatial resolution of the resultant spectroscopic image, while the VOI size (and the REST slabs surrounding the VOI) define the signal generating area.

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Hippocampus

Challenges

Spectroscopy is regularly performed in the hippocampus region. As the hippocampus is located close to the petrous bones, the maxillary sinus, larger arteries like the carotids, and close to the caudate nuclei (high iron content), susceptibility can give rise to problems. Good shim is more difficult to obtain, as a result water suppression is harder to achieve and spectral lines can become wider.

Scan Method

Both Single Voxel Spectroscopy and Spectroscopic Imaging can be performed in the hippocampus.

- Single Voxel Spectroscopy is most commonly used as volume positioning is most easily performed. A spectrum is usually acquired on the right and left side for comparison reasons.
- Spectroscopic Imaging will generate spatial information and allows for inclusion of both hippocampi in one measurement. It is however more difficult to perform the planning, as air-tissue interfaces can not be excluded always, and pulsatile flow of the large arteries, crossing the CSI-slice, might generate some artifacts.

Shimming

The standard preset procedures are optimized to generate good results. However, in spectroscopy, large differences over the patient population exist and shim results can greatly vary over patients (e.g. due to the larger size of the maxillary sinus).

Iterative VOI

Iterative VOI might be the method of choice as it is less sensitive to susceptibility changes than PB-shim. The shim results can be examined already during preparation, by popping-up the monitoring window ("windows"-key, click monitoring in taskbar).

If shimming is completed, the FWHM of the water peak is displayed. If this value is larger than usual, the water suppression window should be widened, to obtain full water suppression of the entire water peak.

The position of the metabolites of interest should be taken into account: the signal of choline, at a distance of ~1.4 ppm on the right of water, should NOT be hit by the water suppression pulses.

Inspect monitoring during iterative VOI shimming to judge the water peak's width.

REST slabs can be used to add extra outer volume suppression to reduce spurious signals of non-suppressed water.

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Planning the Volume

Planning of the spectroscopy volume is critical in the hippocampal region and determines the outcome of the resultant spectra to a great extent.

Single Voxel

1. Acquire anatomical images parallel and orthogonal to the hippocampus.
2. Avoid positioning the VOI close to air-tissue boundaries as much as possible (1mm of distance can make all the difference!).
3. Select "shifted metabolite displayed" in post-proc to display the selected volumes of the other metabolites, to check if these volumes are not including air-tissue interfaces.
4. If required, change the chemical shift direction (geometry) to manipulate the position of the shifted VOI.
5. Use RF transition pulse "sharp" for improved voxel definition.

   Note that "sharp" increases the shortest possible TE. For long TE spectra, the TE is not affected.
6. Use volume selection method sLASER to reduce chemical shift displacement at 3T.
7. REST slabs can be used to cover areas of susceptibility.

2D Spectroscopic Imaging

1. Acquire anatomical images in the imaging plane required for CSI with an intersection to the area of interest.
2. Avoid positioning the VOI close to air-tissue boundaries as much as possible (1mm of distance can make all the difference!).
3. Use full volume selection, not SE-slice.
4. Select "shifted metabolite displayed" in post-proc to display the selected volumes of the other metabolites, to check if these volumes are not including air-tissue interfaces.
5. If required, change the chemical shift direction (geometry) to manipulate the position of the shifted VOI.
6. Use RF transition pulse "sharp" for improved voxel definition.

   Note that "sharp" increases the shortest possible TE. For long TE spectra, the TE is not affected.
7. Use volume selection method sLASER to reduce chemical shift displacement at 3T.
8. Circular REST slabs with a high REST angulation can be used to cover areas of susceptibility (skull base).

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Prostate

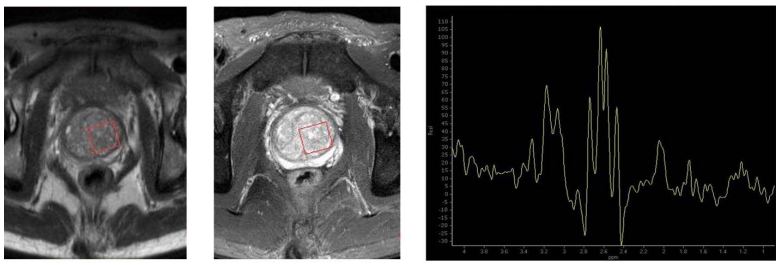
Applications

In MR imaging of the prostate, the differentiation between benign hyperplasia and malignant carcinoma is not always easy. Additionally, normal appearing prostate MRI does not always exclude presence of cancer.

MR spectroscopy is considered a helpful tool as a non-invasive monitoring of metabolite changes that might precede anatomical changes in pathological processes.

The main metabolite of interest in prostate spectroscopy is citrate (~2.6 ppm), that is the most dominant signal in normal prostate tissue. Changes in citrate level and, additionally, in choline levels, are said to be indicators of pathological changes:

- High level of choline, reduced level of citrate in tumors.
  - Possibly caused by cells that produce citrate being replaced by malignant epithelial cells.
- High level of choline-containing metabolites can be seen in BPH (benign prostate hyperplasia), while citrate level remains constant.
  - Possibly caused by increased rate of cell proliferation.



SVS, TR 1200 ms, TE 132 ms at 3.0T.

Patient Preparation

The prostate is a relatively small structure, and its position in the abdomen can slightly vary due to bowel motion, bladder filling etc.

If the position of the prostate changes during the spectroscopy scan, partial volume effects occur, and the resultant spectra will not be optimal.

It is therefore important to prepare the patient:

- Make sure patient has empty bladder
- Avoid scanning directly after lunch (bowel motion)
- Consider use of intra-muscular glucagon immediately before acquisition to reduce effects of bowel peristaltis
- If the Endo-coil is used: cleanse rectum prior to examination
- Timing: post-biopsy haemorrhage can obscure MR images of the prostate, complicating MRS planning: avoid scanning within 3 weeks after biopsy.

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Coil Choice

Since all Ingenia coils can be used for MR spectroscopy, coil selection will depend on the imaging coil used, as it is most convenient to use the same coil for both imaging and spectroscopy. For prostate examinations, the dS Torso coil solution is applicable

Choice of TE

The echo time chosen determines the appearance of the spectrum and mainly is of influence on the appearance of J-coupled systems. Citrate is a strongly coupled system, splitting into a quartet. The appearance of the citrate peak rapidly changes with varying echo times, and its behaviour is field strength dependent.

Reference article for 3T:"optimizing PRESS localized citrate detection at 3T", from A. Trabesinger et al, MRM 54:51-58 (2005)

Optimal TE

Citrate has a positive sign.

- for 1.5T: 120 ms - 130 ms.
- for 3.0T: 132 ms

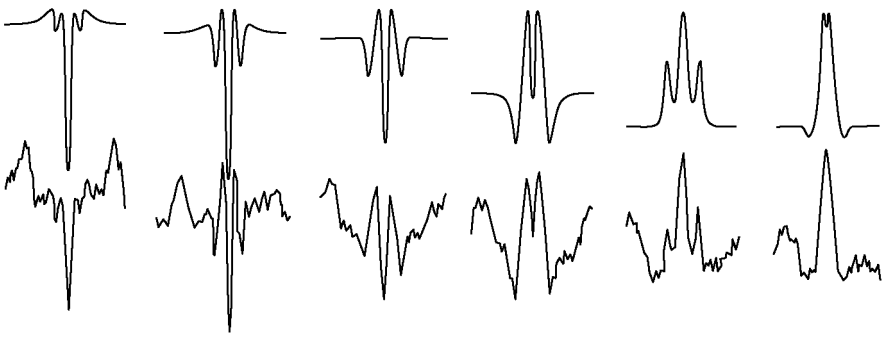

Fig. 103: Citrate peak appearance.

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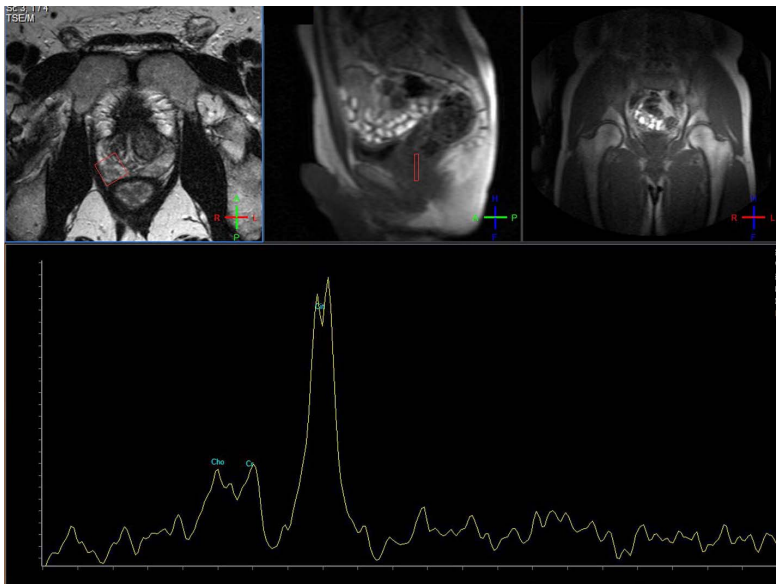
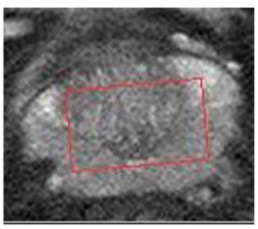
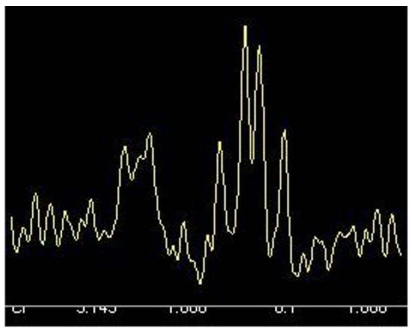
Examples



SVS prostate in a volunteer on a 1.5T system: TE 120 ms.





SVS prostate in a volunteer on a 3.0T system: TE 132 ms.

Scan Method

Single Voxel Spectroscopy

Can easily be performed in the prostate to acquire a good signal-to-noise spectrum in a few minutes.

In general CSI (2D or 3D) is preferred, as spatial information can be obtained.

2DSI

- Small volume, thin slice for good spatial resolution
- FOV not large enough to prevent fold-over: full PRESS volume selection
- Large number of phase encodings required for optimal point spread function: lots of "empty" voxels outside the selected (PRESS) volume.
- Single slice not optimal for coverage of prostatic gland.

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NOTICE

Multislice should not be used as a full PRESS volume selection is required.

3DSI

- block-shaped volume can best be adapted to the size / shape of the prostate.
- Number of phase encoding steps in-plane reduced, and increased in slice direction: total number of steps sufficient for good voxel delineation.

Once planning of 2DSI / 3DSI is finished, one can acquire a quick SVS with equal volume positioning to make sure that spectrum quality is edequate before spending long scan times on CSI.

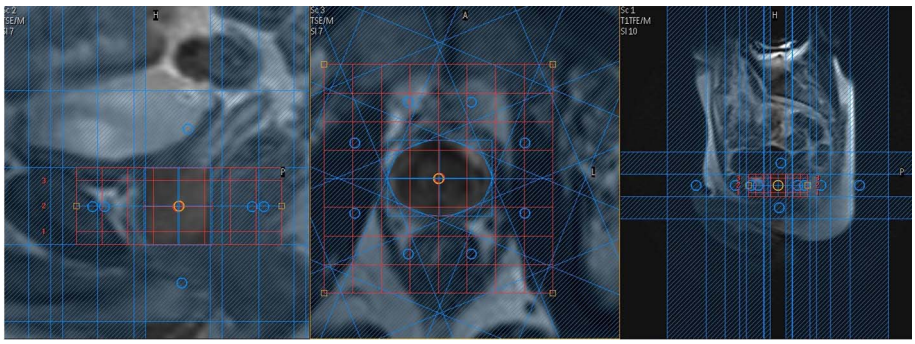

Fig. 104: Examples.

Water Suppression

Water suppression can be performed using either a water suppression prepulse, like excitation, or using the BASING pulse, or using a combination of both techniques.

If SPAIR and WS excitation are combined, the water suppression prepulses are the first pulses of the sequence. WS excitation angle is such that both water and fat signals will be nulled at the start of the excitation.

Fat Suppression

Fat suppression is required for prostate spectroscopy if the volume is larger than the prostate gland. This is usually the case in CSI.

SPAIR fat suppression

- is used best to obtain homogeneous fat suppression, independent of B1-variations.
  - The SPAIR IR delay is to be set such that fat signal is nulled at the time of the excitation. The optimal delay is related to the SPAIR-TR, that can be found on the info page.
  - If SPAIR-TR is sufficiently long to allow (nearly) complete T_1-relaxation of the fat signal, the SPAIR-IR delay is equal to the STIR-inversion delay time for fat suppression.

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At field strength	SPAIR-IR delay
1.5T	+/- 165 ms
3.0T	+/- 200 ms

Tab. 19: Guideline for optimum abdominal fat suppression

- The SPAIR offset determines the transition between non-suppressed and suppressed tissue, and should be chosen such that the adjacent metabolites of interest are not suppressed. The closest metabolite of interest is citrate, at ~2.6 ppm. Suppression can safely be performed up to ~2.0 ppm, leading to a frequency offset of +/- 0.7 ppm.

BASING pulse

The BASING pulse can also be added to the sequence for (additional) fat suppression. Optimization is not required. Additional pulses and gradients are placed in the sequence, thereby increasing the shortest TE. As the optimal TE in prostate spectrscopy is usually long, the pulse will easily fit in.

Frequency offset of the pulse must be set to the fat frequency.

Advantage

- no prepulse
- doesn't add to minimal TR

Disadvantage

- Fat suppression might be less complete

Planning the Volume

Volume positioning in prostate spectroscopy is critical, and should be performed very carefully:

- Include only prostate tissue in the VOI for optimal shimming (surrounding fat causes susceptibility changes).
  - Optimal shimming is required to separate choline, creatine (and spermine), and to separate J-coupling of citrate.

NOTICE

If fat tissue is completely excluded from the VOI, fat suppression is not required.

- Use anatomical (T2) image with fat suppression in at least one plane: the (high signal of) prostate gland is nicely separated from the suppressed fat.
- REST can be used
  - for additional volume definition
  - to suppress unwanted signals of surrounding fat

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– to define a smaller volume within an overprescribed volume (to reduce chemical shift displacement).

Breast

Applications

Breast spectroscopy is regularly performed, mainly to measure choline levels (and choline/fat or choline/creatine ratios) in the volume of interest.

Coil Choice

Since all breast coils can be used for MR spectroscopy, coil selection will depend on the imaging coil used, as it is most convenient to use the same coil for both imaging and spectroscopy.

Choice of TE

The recommendations for the TE are:

- Use a long TE for choline detection of ~288 ms.
- Use a short TE to measure water/fat or choline/fat ratios.

Water and Fat Suppression

All available suppression techniques can be used for water and fat suppression. For more information refer to the section on prostate.

NOTICE

Multiple suppression techniques can be combined to suppress a specific tissue's signal.

Example

Use SPAIR and BASING pulse for fat suppression.

Planning the Volume

Single Voxel Spectroscopy is most commonly performed. Two approaches for SVS planning are described below.

First approach

Plan the volume size such that only lesion is included, leading to no partial volume effects with fatty tissue, but also leading to a (slight) underestimation of the metabolite levels, as the lesion is not completely included.

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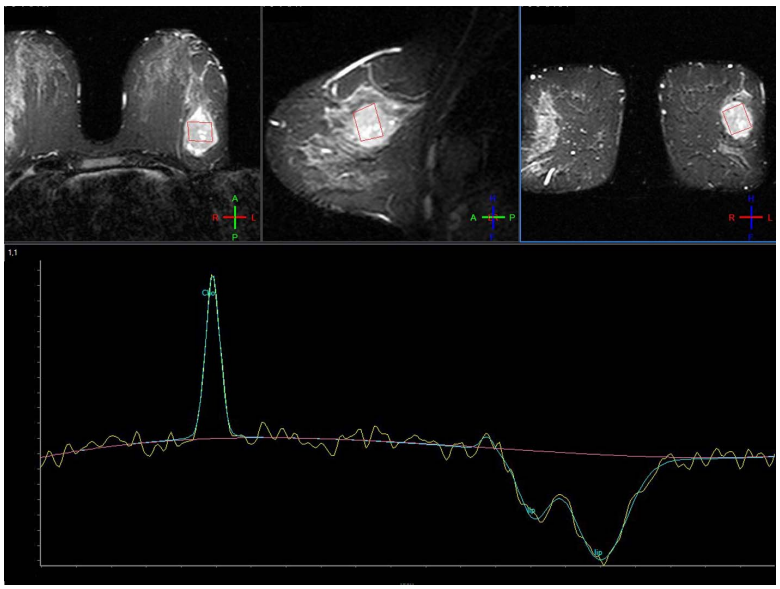
Advantages

- As surrounding fatty tissue is not included in the VOI, fat suppression might not be required. This allows for detection of free lipids.
- Shimming is easy, no susceptibility changes in the VOI.

Second approach

Plan the volume size such that the complete lesion is included, including some of the surrounding fat tissue. Better estimation of metabolite levels in the lesion. Fat suppression should be applied to suppress fat tissue.



SVS in breast tumor: TR 1500 ms, TE 270 ms. Elevated choline level.

Liver

Applications

The main application of liver spectroscopy is measuring water/fat ratios to detect fatty liver. Additionally, evaluation of lesions can be performed. In this case, choline and creatine are the main metabolites of interest.

Coil Choice

Since all Ingenia coils can be used for MR spectroscopy, coil selection will depend on the imaging coil used, as it is most convenient to use the same coil for both imaging and spectroscopy. For liver examinations, the dS Torso coil solution is applicable.

Choice of TE

A short TE should be used as fat has a relatively short T_2 relaxation time. At long TE, the fat signal has decayed to a greater extent as the signal of water, leading to incorrect ratio values.

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The recommendations for the TE are:

- Use a short TE to measure choline/creatine, creatine/fat or choline/fat ratios.

Note that STEAM could be used to achieve shortest possible TE.

Water and Fat Suppression

All available water and fat suppression techniques can be applied for liver spectroscopy as well. In examination of fatty liver, however, suppression is not used as the main metabolites of interest are water and fat. Concentrations of water and fat are high, and the number of measurements to obtain good signal-to-noise ratio is relatively low.

For more information refer to the corresponding section on prostate.

Respiratory Compensation

Free breathing experiments are mainly performed. As liver tissue moves in and out of the selected volume, partial volume effects can be present. Depending on the voxel position this can be more severe. The least motion will occur when the volume is positioned more posterior or more inferior.

Breathhold imaging by means of dynamic scans

Dynamic scanning can be used to divide the acquisition into several breathholds.

In this case, it is advised to use PB-autoshim instead of iterative VOI shimming, as the preparation phase can be performed in breathhold as well.

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Planning the Volume

Single Voxel Spectroscopy is most commonly performed. Two approaches for SVS planning are described below.

Complete liver evaluation

- Plan a large volume including a large part of the liver.
- Avoid to position the VOI close to the rims of the liver to ensure that surrounding tissue (lungs!) will not move in and out of the selected volume during breathing.

Lesion evaluation

- Adapt the VOI size to the lesion.
- Avoid partial volume effects with surrounding liver tissue.

Muscle

Applications

Proton spectroscopy in muscle tissue is performed to measure intra-and extra-myocellular lipids and energy metabolism disorders.

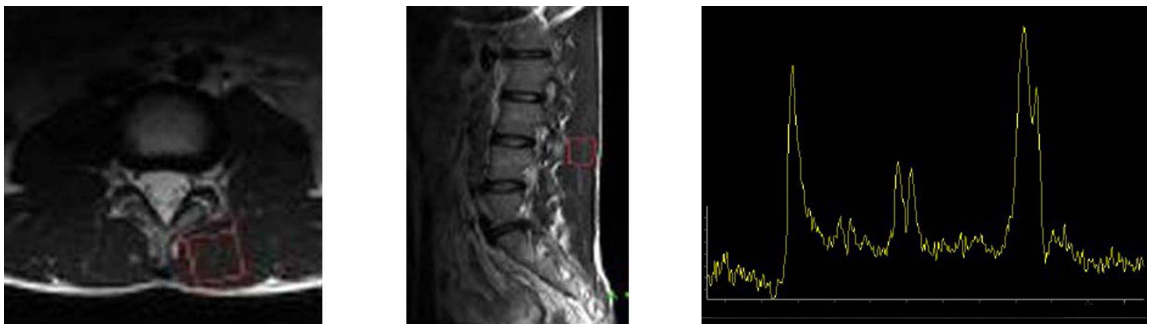
Since muscle fibers are parallel to the magnetic field, the fat peak of muscle tissue can be split.

Coil Choice

Coil selection depends on the imaging coil used, as it is most convenient to use the same coil for both imaging and spectroscopy.

Choice of TE

- To detect the fat signal, use a short TE (of approximately 40 ms).
- To detect creatine and TMA (trimethylammonium), use a long TE (of approximately 288 ms).



The left images show the VOI in the spine muscle. The right image shows the zoomed spine muscle spectrum. Acquisition at 3.0T, TR 2,000 ms, TE 40 ms. Elevated choline level.

Planning the Volume

- Single-voxel and CSI techniques are applicable.
- The main metabolite of interest is fat being present in the muscle. Therefore exclude surrounding fat signals from the volume of interest.
- The presence of vessels (especially pulsatile flow) can cause ghosting artifacts in phase-encoding direction. As two phase-encoding directions are used in spectroscopy, ghosting could occur in two directions.
- Position REST slabs around the volume of interest to suppress the signals of flowing blood and to reduce possible ghosting.

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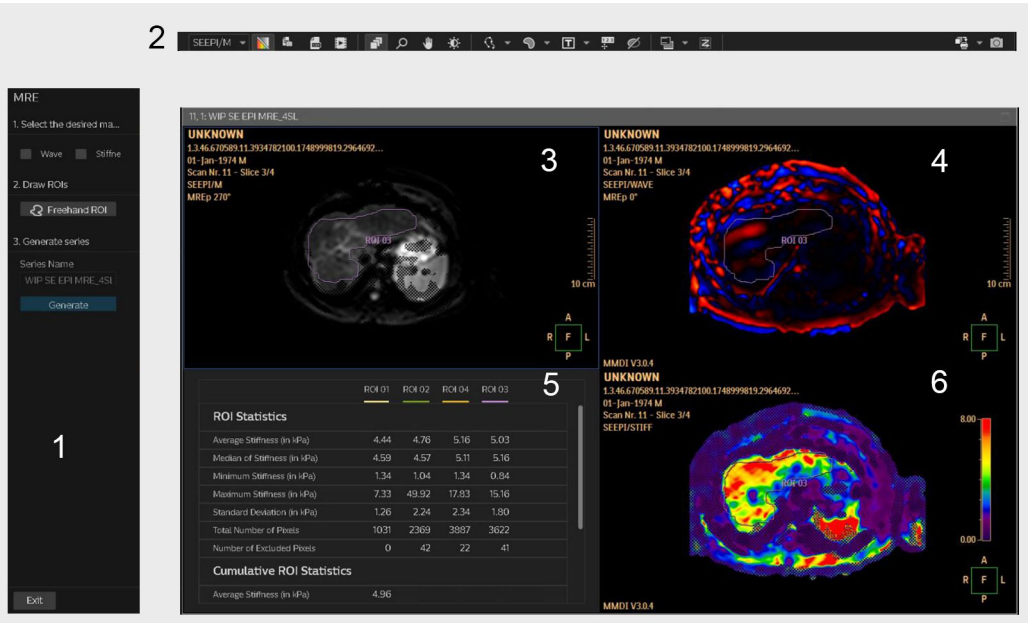
9.7 MR Elastography

9.7.1 Acquisition

9.7.2 Reviewing the Results

User Interface

The MRE Review package contains four viewports. Three viewports provide images created from the acquired MRE data. The fourth viewport provides numeric results of the drawn ROIs and associated values.



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1. MRE panel
   - The panel provides workflow guidance.
2. Toolbar
   - The toolbar provides generic functions.
   - It allows you to select the image type in the left upper viewport:
     FFE or SE-EPI Modulus (**FFE/M**, **SEEPI/M**) or MRE Phase (**MRE/P**) image.
3. Modulus or Phase images of MRE acquisition
   - They provide the anatomic information of the obtained slices, based on the acquired data.
   - Draw ROIs in this image.
4. MRE Wave maps
   - They represent the shear waves created in the target tissue.
   - These maps provide a visual check that the driver was enabled.
5. Numeric results from the drawn ROIs.
6. MRE Stiffness maps
   - These color images come with a scale of 0-8 kPa and a goodness-of-fit confidence overlay.

   The context menu allows you to change the color scale to 0 to 20 kPa.
   - The confidence overlay provides the best representation of the reliability of the acquired data.
   - A checkerboard pattern indicates the areas with too low estimation reliability in the data to provide an accurate representation of the tissue stiffness.
   - The display of the confidence overlay is optional.

Reviewing MRE Scans

You perform these workflows to review MRE wave and stiffness images with confidence overlays, and to obtain stiffness values for the drawn ROIs.

Opening MRE Review package

▷ From the **Exam Overview**:

► Right-click an MRE imaging series in the **Thumbnail View** (or **List View**), then select **MRE**.

⇨ The imaging series opens in the MRE Review package.

Inspecting images and maps with and without confidence overlay

► To make sure that shear waves are present, inspect the MRE wave maps in a movie:

- Select the viewport with the MRE wave maps.
- On the Review toolbar, click **Movie Bar**.
- On the Movie Bar, click **Play**.

⇨ Alternating red and blue bands on the MRE Wave images indicate the presence of shear waves necessary for evaluation of MRE data.

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⇨ Absence of these alternating red and blue bands could indicate that the passive driver was improperly placed or disconnected, or that the Resoundant device was not active during the acquisition.

⇨ Check that the passive driver is connected and properly placed, and that the Resoundant device is active. Then reacquire the data.

► To review the confidence overlay, right-click the viewport with the MRE stiffness maps. Select **View**, then **Confidence overlay**.

To remove the confidence overlay, right-click the viewport with the MRE stiffness maps. Select **View**, then **Source image**.

Generating a new imaging series with maps and ROIs

The MRE Review package allows you to save the newly created maps with the ROIs as a new imaging series.

▷ On the MRE panel:

► Select the map type that you want to save in the new imaging series: **Wave**, or **Stiffness**.

► To save the maps as a new imaging series, enter a name for the new series in the **Generate series** section of the MRE Panel. Then click **Generate**.

⇨ During the calculation, the **Job Viewer (F6)** displays the progress.

⇨ Upon completion, the new imaging series is available in the **Patient Directory**.

Drawing ROIs

► Click **Draw ROIs** -> **Freehand ROI**.

► From the drop-down list on the toolbar, first select the correct image type for the anatomic image: **SEEPI/M**.

► Draw a freehand ROI on the anatomic image.

- Draw the ROI in the liver parenchyma.

To facilitate this process, the confidence overlay is also shown.

- Include the areas of tissue that demonstrate high estimation reliability.
- Avoid the checkerboard areas and vascular structures.

They can result in an over- or underestimation of the calculated stiffness value for the drawn ROI.

NOTICE

To ensure that only reliable pixels are used in the stiffness calculation, areas of low estimation reliability in the drawn ROI are removed from the reported stiffness values.

Although vascular structures are generally marked as area of low estimation reliability, some vascular structures may remain.

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⇨ All drawn ROIs propagate to the MRE stiffness maps and MRE Wave maps.

⇨ Upon completion of the ROI, the data table reports the numerical results.

► To draw as many freehand ROIs as needed, repeat the previous workflow step.

A maximum of 10 ROIs is possible.

Capturing the results

► To capture slices and tables, click **Analyze and capture** on the toolbar.

► Enter a name for the DICOM capture. Then click **Save**.

⇨ This action saves a DICOM capture of each of the slices of the MRE Stiffness maps, with ROIs and associated table.

Results

The MRE Review package provides you with the MRE Wave maps and the MRE Stiffness maps, and with **ROI Statistics** and **Cumulative ROI Statistics** for all ROIs drawn.

- Average Stiffness (in kPa)
- Median of Stiffness (in kPa)
- Minimum Stiffness (in kPa)
- Maximum Stiffness (in kPa)
- Standard deviation (in kPa)
- Total Number of Pixels
- Number of Excluded Pixels:

  The number of pixels within the ROI that fall outside of the areas of high estimation reliability.

WARNING

Misinterpretation due to wrong stiffness values

Risk of inappropriate or lack of treatment

- **Verify that liver signal is as expected, by carefully inspecting the quality of the MRE Modulus images in the MREView package.**
- **Verify presence of alternating red and blue bands on the MRE Wave Images by using the movie function of the MREView package.**
- **Do not determine stiffness values outside the MREView package. This may cause incorrect estimation of stiffness values, in particular when voxels with low confidence are included.**

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Typical MRE measurements on a Philips MRI system vary by 10-15% when repeated in individuals. Proper ROI placement, as described, avoids stiffness estimates with low estimation confidence. When measurements above the confidence threshold are compared, reproducibility is similar to that reported in published literature.

Typical stiffness values for normal liver are 2.2 ± 0.3 kPa. ROI values above 2.93 kPa are indicative of fibrosis (Yin et. al. Clin Gastroent Hep, 2007).

9.8 Smart Reading

9.8.1 Functional Description

Smart Reading provides you with external apps which allow you to perform advanced analysis of your MR data. These external apps support various applications in different anatomies, for example, in the brain or in the prostate.

- The workflow of the external apps is embedded in the user interface of your operator's console.
- Smart Reading is included as an inline step in the ExamCards.

  Smart Reading ExampleCards are available in your Philips ExamCard database.
- The external apps provide you with different types of reports which are sent to and saved on your configured DICOM node. Your configured DICOM node can be the PACS system (default location), a workstation, or the operator's console,
- The external apps are of two types: interactive or non-interactive.
  - Non-interactive and interactive apps, both, calculate the results automatically.
  - Interactive apps allow you to change analysis settings (for example, segmentation).

    Interactive apps allow you to customize the reports on the operator's console without cloud login.
- Every external app requires specific protocols of specific parameter settings within an ExamCard.
- Smart Reading is executable in automatic or manual mode. Automatic mode is the default mode.

	Automatic mode	Manual mode
Image transfer	Starts automatically after image reconstruction.	Starts automatically after image reconstruction.
Analysis on the cloud	Starts automatically after image transfer.	Starts after a manual start.
Editing of the inline step	Is possible as long as the image reconstruction is in progress.	Is possible until the manual start of the analysis.
Review of image quality before the analysis	Is not possible since the analysis starts automatically.	Is possible since you start the analysis manually.

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	Automatic mode	Manual mode
Switching between modes	From automatic to manual mode, is possible as long as the image transfer is in progress (until it is complete).	From manual to automatic mode, is possible at any time.

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9.8.2 Smart Reading Principle - An Overview

1. Acquisition of an ExamCard with Smart Reading inline step.
2. Immediate transfer of the images to the cloud via the Application Gateway (only the images relevant for the external app).
3. Analysis of the images.
   – In automatic mode: Automatic analysis of the images.
   – In manual mode: Analysis after a manual start which allows you to check the image quality.
4. Automatic report generation with results on your configured DICOM node (PACS system, the operator's console, a workstation).
   Status information is available in the **Message Center** and the **Job Viewer (F6)**.
5. Check the image quality of the scans before releasing the patient.
6. Only for interactive external apps: To view the results, open the external app in its tab viewer. For the patient in acquisition, the results of the first inline step are automatically uploaded in the tab view.

   If needed, change the analysis settings, and recalculate the results. Then save the results again.
   Save is only available if you change the analysis settings.

9.8.3 Requirements

Before you start, your MRI system and the ExamCard must fulfill the following requirements.

Technical requirements

- Since the external apps are in the cloud, your operator's console has a functioning network connection.
- Your service provider configured the external apps so that they are functional.

  Your service provider configured the Application Gateway as DICOM node to allow for image transfer.
- Your service provider configured the storage location of the external app on the Application Gateway. The storage location can be a PACS system, the operator's console, or a workstation.

ExamCard requirements

You have an ExamCard that fulfills all requirements for your external app. Get started with one of the ExampleCards on your operator's console. Once you are familiar with the workflow, convert one of your Hospital ExamCards into a suitable ExamCard which fulfills all requirements.

- The ExamCard contains all the required protocols.
- All types of protocols have the required parameter settings.
- The external app is configured as an inline step in the ExamCard.

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- For longitudinal studies that involve repeated examinations over long periods of time, external apps have special requirements. For more information, refer to the dedicated Instructions for Use of the external app.

9.8.4 Results

The external apps provide you with results on your preferred destination (any DICOM node as configured by your service provider, for example, PACS system, the operator's console, or a workstation).

Different types of results in different formats are available, for example, results as parametric maps, or a summary of segmentation results as screen captures.

For more information, see the dedicated Instructions for Use of the external app.

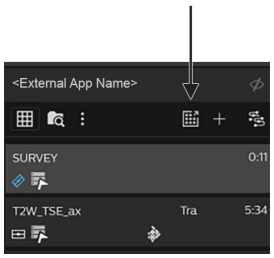
9.8.5 User Interface

UI Elements

Smart Reading provides you with UI elements which only appear when an ExamCard with a Smart Reading inline step is in progress, or after the button **Start Exam** is clicked.

Smart Reading in the Exam Overview

When Smart Reading is installed on your MR system, the Exam Overview provides you with a dedicated button after you click the **Start Exam** button.



External Apps Settings	This button opens the **External Apps Settings** window. This window allows you to configure the Smart Reading inline step of the current ExamCard.

External Apps Settings

Functional Description

The **External Apps Settings** window allows you to configure your ExamCard for use with an external app.

- You configure your current ExamCard (in acquisition or review).
- You prepare and save an ExamCard for later use.
- You add an inline step of an external app to the scan items that are required for the external app.

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- You edit the inline step of an external app in the ExamCard.
  Possible actions are to add, to remove, or to replace scan items for the external app.

Opening the External Apps Settings window

► Select the ExamCard that you want to edit or convert.

► In the **Exam Overview**, click (**External Apps Settings**).

⇨ The **External Apps Settings** window opens.

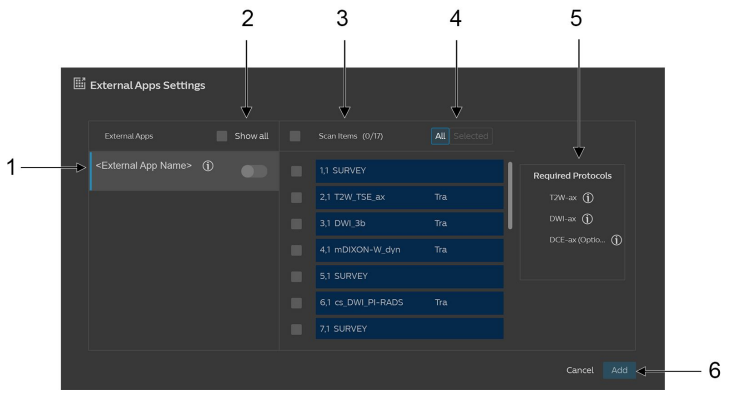
The External Apps Settings window

The **External Apps Settings** window has the following features:

- It displays the available external apps.

  By default, based on the anatomy of the current ExamCard, the **External Apps Settings** window shows only the external apps that are suitable for the current ExamCard.
- It checks the selected scan items against the requirements of the selected external app.
- When the selected scan items do not meet the requirements of the selected external app, warning symbols and tool tips notify you.

  The tooltip and the information button provide guidance on how to resolve the issue.



The information buttons of the **External Apps** and the **Required Protocols** display further information in another window.

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1. The section **External Apps** shows the available external apps suitable for your ExamCard.

   To select a suitable External App, click on the external app.
2. **Show all** shows all external apps and not only the ones suitable for the anatomy of the current ExamCard. **Show all** is a toggle button.
   - Enable **Show all** to show all external apps.
   - Disable **Show all** to show only the external apps suitable for the current ExamCard.
3. The **Scan Items** show all scan items of the ExamCard depending on the filter **All** or **Selected**.
4. **All** shows all scan items of the current ExamCard. **Selected** shows the already selected scan items for the external app.
5. The **Required Protocols** show the mandatory scan items that you must have in your ExamCard for the selected external app. The **Required Protocols** also show the optional scan items.

   The **Required Protocols** notify you about issues and guide you in resolving them.
6. **Add** and **Cancel** buttons:
   - The **Add** button adds the specified inline step to the ExamCard.

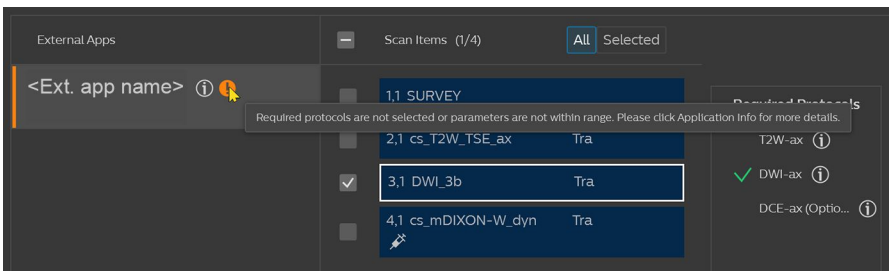
   It is active when any single scan is selected.

   It closes the **External Apps Settings** window.
   - **Cancel** leaves the window without change.

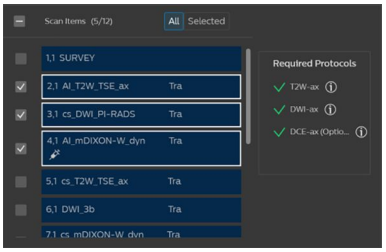
Guidance in the External Apps Settings window

The selected **External app** indicates if the selected scan items fulfill the requirements.

The tooltip of the warning icon provides you with more information, for example: **Required protocols are not selected or parameters are not within range. Please check Application info for more details.**



The **Required Protocols** indicate if the selected scan items fulfill the requirements.

Icon	Description	Example of warning icon and tooltip
Green checkmark	The selected scan item fulfills the requirements.	

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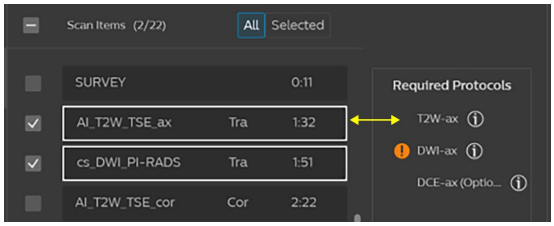
Icon	Description	Example of warning icon and tooltip
No check mark	The selected scan item does not fulfill the minimum requirements. Validation of the scan item is not possible because it is not considered a required scan. Click for information on how to resolve the issue.	 The tooltip of the warning icon provides you with more information, for example: **Slice Thickness, ACQ voxel size parameters are not within the range ...**
Orange warning icon	The selected scan item fulfills the most important requirements. However, a few parameters need modification. Click for information on how to resolve the issue.	

Error messages in the External Apps Settings window

The table lists the most important error messages in the External Apps Settings window.

Error message	Explanation
No External Application available to display	A suitable external application is not configured on your MRI system.
Please select the External App to display Scan Items	A suitable external application is not yet selected.
No scans are available for selection	For the selected external application, no scans are available in the current examination.

Smart Reading in the ExamCard

Smart Reading is included as an inline step in the ExamCards.

- An external app requires more than one protocol in the ExamCard.
- All required protocols must be linked to the Smart Reading inline step.
  - In the ExamCard, the last protocol linked to the external app comes with the Smart Reading inline step.
  - All protocols selected for the current external app are indicated by the Smart Reading icon. They are linked to the Smart Reading inline step.
  - If you have more than one instance of an inline step, then numbers (2, 3, 4, ...) are added to the name of the inline step.

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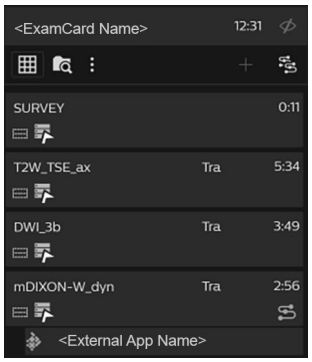
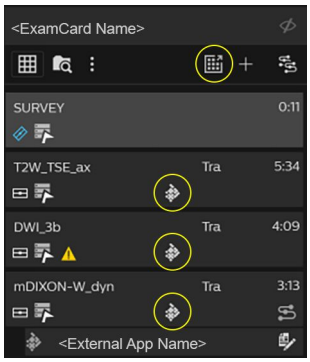
	• Indicates that the protocol is linked to the Smart Reading inline step. All protocols linked to the external app show this icon. Every external app has its own Smart Reading icon.
	• Indicates that the images of this scan are successfully transferred to the cloud for analysis in the external app.
	• Indicates that the Smart Reading inline step is in progress.
	• Indicates that any scan item linked to the Smart Reading inline step, or the Smart Reading inline step is not valid.
	• Indicates that the Smart Reading inline step failed.
	• Indicates network problems.

The Smart Reading icons in the ExamCard only appear when a Smart Reading ExamCard is in progress, or when the examination is in review (with images available).

ExamCard in preparation mode (before Start button is clicked)	ExamCard when the examination is in progress or in review
	 The yellow circles indicate the differences.
• No icons that indicate the link to the Smart Reading inline step. • The Smart Reading inline step (lowest row) is available. • The button **External Apps Settings** is not available.	• The icons that indicate the link to the Smart Reading inline step are available. • The Smart Reading inline step (lowest row) is available. • The button **External Apps Settings** is available.

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Context menus

Context menus in the List View of the ExamCard provide you with the following functionality.

Icon	Function	Description
Indicates that a manual start was added.	**Manual Start**	To add a manual start to the current Smart Reading inline step. A manual start allows you to check the image quality of all images before you transfer the images to the cloud. **Manual Start** starts the manual mode (instead of the automatic mode).
	Start	To start a previously added Smart Reading inline step. This function is available in scan items with a **Manual Start** when the image transfer to the cloud is completed.
	Delete (Delete)	To delete the current inline step.
	Edit	To edit the current inline step.
	Duplicate	To duplicate the current inline step.
	Edit Name (Ctrl+E)	To edit the name of the current inline step.
	View Results	To view the results in the Tab view of the external app once they are generated. This function is available only for Interactive applications.

Smart Reading Tab

Only for interactive external apps, Smart Reading provides you with a tab view. This tab view shows the contents (for example, results) from the provider of the currently used external app.

- This tab view allows you to review the imaging series and the results of the external app once the analysis is completed.
- The name of the Smart Reading inline step is the name of the tab view.
- The external app provides you with the following UI elements in the tab view:
  - A toolbar with various tools, for example, to optimize the display of the images, to change analysis settings (for example, segmentation), and for measurements.
  - Viewports for reviewing.
  - Context menus.

For more information, see the dedicated Instructions for Use of the external app.

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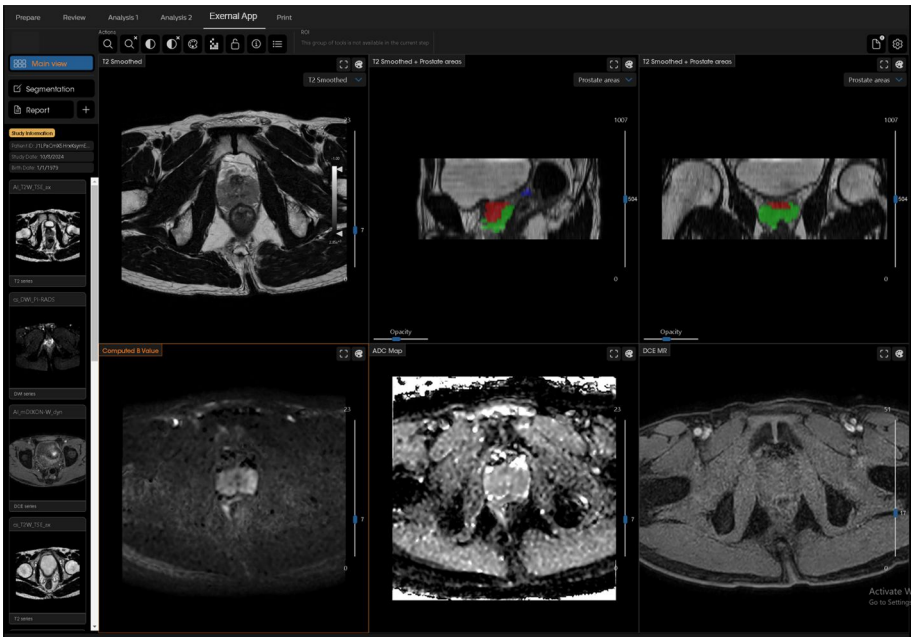

Smart Reading in Job Viewer and Message Center

In the **Job Viewer (F6)**, there is an additional tab for the external apps which shows the status and the progress of the Smart Reading inline step.

The transfer status is visible in the **Import/Export** tab of the **Job Viewer (F6)** as usual.

The **Job Viewer (F6)** allows you to redo a previously executed or aborted job.

Message Examples in the Job Viewer (F6)

- **External application launch requested**.
- **External application validation completed**.

  External application validation failed.

  Where the validation checks if the input scans and images are valid and fulfill all requirements.
- **External application processing completed**.

  External application processing failed.

  Where processing includes the analysis and the report generation.

Message Examples in the Message Center

- Results of <External App Name> application are available. Results are generated for <External App Name> application. It will be transferred to configured DICOM location.

The **Message Center** notifies you when the auto-generated results are available. It also provides you with information about the validation status. Validation of the images and the protocols is automatically done by the external app on the cloud. .

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9.8.6 Routine Procedures

Running a Smart Reading ExamCard in Automatic Mode

In automatic mode, the analysis of the images starts automatically. This workflow is the default workflow.

▷ Prerequisite: Your Smart Reading ExamCard contains all the required types of scans with the requested parameter settings.

▷ Prerequisite: The Smart Reading inline step and the External App icon in the ExamCard do not show a warning. Any warning may result in the non-execution of the analysis.

► Start the Smart Reading ExamCard.

⇨ When any of the scans relevant for the external app is completed, the images are automatically transferred to the cloud. The image transfer happens for every scan relevant for the external app.

⇨ When the last scan relevant for the external app is transferred, the analysis starts automatically. The first processing step is the validation.

⇨ A message notifies you about the validation status of the Smart Reading inline step. For example:

⇨ **Compatibility check of <StepName>is successful. Please verify image quality of input scans before releasing patient.**

⇨ **Compatibility check of <StepName> is failed. Please check the image quality, then rerun the input scans and repeat the process.**

⇨ **Required inputs are received for <StepName> and reports will be generated. Please verify image quality of inputs before releasing the patient.**

► Check the image quality of all scans.

- If insufficient, duplicate the scan item and the inline step.

A new inline step is required because the previous inline step was started already and is obsolete now.

- If sufficient, release the patient.

⇨ When the report generation is complete, a message pops up to notify you.

⇨ The **Message Center** and the **Job Viewer (F6)** notify you about the status of the report generation.

Running a Smart Reading ExamCard in Manual Mode

In manual mode, you start the analysis. This workflow allows you to inspect all images before the analysis, and to edit the analysis settings.

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▷ Prerequisite: Your Smart Reading ExamCard contains all the required types of scans with the requested parameter settings.

▷ Prerequisite: The Smart Reading inline step and the External App icon in the ExamCard do not show a warning. Any warning may result in the non-execution of the analysis.

▷ Prerequisite: The Smart Reading inline step is set to **Manual Start**.

► Start the Smart Reading ExamCard.

⇨ When any of the scans relevant for the external app is completed, the images are automatically transferred to the cloud. The image transfer happens for every scan relevant for the external app.

⇨ When the last scan relevant for the external app is transferred to the cloud. The analysis does not start automatically. A manual start is needed.

► Check the image quality of all scans.

- If insufficient, duplicate the scan items to repeat them.

Edit the inline step to replace the old scan item by the new scan item.

- If sufficient, manually start the analysis. Then release the patient.

⇨ When the report generation is complete, a message pops up to notify you.

⇨ The **Message Center** and the **Job Viewer (F6)** notify you about the status of the report generation.

Reviewing Results

You review the results on your preferred storage location (on the PACS or on the operator's console).

► For interactive apps:

To review the results on the operator's console, open the tab view of the external app.

For the patient in acquisition, the results of the first inline step are automatically uploaded in the tab view.

For the other inline steps, select **View Results** from the context menu. The results open in the tab view.

► For non-interactive apps:

If the DICOM storage location is configured as operator's console:

To review the screen capture results on the operator's console , use the **Review** tab and the thumbnail view.

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Resolving Issues in the External Apps Settings window

When the scan items in an ExamCard do not fulfill the requirements of the selected external app, you are notified in the ExamCard with warning icons. You are also notified in the section **Required Protocols** of the **External Apps Settings** window.

- ► In the **External Apps Settings** window, hover over the warning icon to display the tooltip.
- ► Click the button for more information about the issue and the requirements that must be fulfilled.

  Drag the window to a location on the screen that allows you to see and access the following windows:

  - The information to resolve the issue.
  - The imaging parameters.
  - And for your convenience, the **External Apps Settings** window where you see immediately see the effects of your changes.
- ► With the **External Apps Settings** open, double-click the affected scan item in the **Plan** tab.

  Edit the required parameters.
- ► Click **Accept** to save the scan item with the updates.
  - ⇨ If all parameter values are as required, the green checkmark shows that the requirements are fulfilled.
- ► Resolve all conflicts in the **External Apps Settings** window. Then click **Add** to add the Smart Reading inline step to the ExamCard.

Converting an ExamCard to a Smart Reading ExamCard

To convert an ExamCard to a Smart Reading ExamCard, you add an external app as an inline step to an ExamCard.

- ▷ Prerequisite: Your Smart Reading ExamCard contains all the required types of scans with the requested parameter settings.
- ► Click (**External Apps Settings**) in the **Exam Overview**.
  - ⇨ The **External Apps Settings** window opens. By default, based on the anatomy of the current ExamCard, the **External Apps Settings** window shows only the external apps that are suitable for the current ExamCard.
- ► Optionally: To display all available external apps, click **Show All**.
- ► To verify that your ExamCard indeed contains all requested types of scans, compare the **Scan Items** with the **Required Protocols**.
- ► To create an inline step for the external application, do the following:

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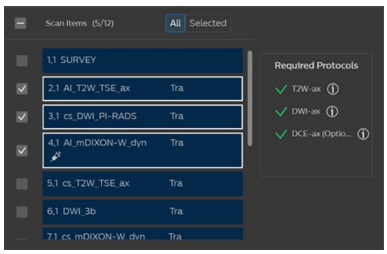
- To select a suitable **External App**, click on the external app name.
- Then select the required **Scan Items** based on the list in the **Required Protocols**.

Scans labeled as **optional** are not required.

The icon changes to indicate that the scans are selected for the selected external app.

- Verify that all **Required Protocols** show a green checkmark.



When one or more of the **Required Protocols** do not show a green checkmark, resolve the issue.

- To add the inline step to the ExamCard, click **Add**.

Add is active when any scan item is selected from the list.

⇨ The icons in the **Scan Items** column indicate that the external app is available as an inline step.

⇨ In the ExamCard, the last scan item linked to the external app comes with the Smart Reading inline step. All other required scans show an icon that indicates that the scan is linked to the inline step.

Editing a Smart Reading Inline Step

You perform this workflow to edit an existing Smart Reading inline step of an external app in an ExamCard.

▷ Prerequisite: A Smart Reading ExamCard is in progress, or an examination is in review (with images available).

▷ Prerequisite: The Smart Reading inline step is not yet in progress on the cloud.

► Right-click on a scan item that is linked to the inline step.

► To edit the inline step, expand the inline step. Then right-click and select **Edit**.

⇨ The **External Apps Settings** window opens.

► Edit the inline step as required.

► To save the updated inline step, click **Update**.

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Duplicating a Smart Reading Inline Step

This workflow allows you to duplicate an existing step. The purpose is to repeat a previously processed or failed inline step with the same or with different input.

▷ Prerequisite: A Smart Reading ExamCard is in progress, or an examination is in review (with images available).

► Right-click on a scan item that is linked to the inline step.

► To duplicate the current inline step, click **Duplicate**.

⇨ The **External Apps Settings** window opens.

⇨ The settings of the inline step are identical to the original inline step.

► Do any of the following:

- To add the inline step as is to the ExamCard, click **Add**.

A duplicate is added to the ExamCard under the original inline step.

- To add an updated inline step to the ExamCard, deselect the scans which need to be replaced. Select the newly added scan items. Then click **Add**.

A new inline step is added to the last scan that is selected for the external app.

Deleting or Renaming a Smart Reading Inline Step

This workflow allows you to delete, or to rename an existing Smart Reading inline step.

▷ Prerequisite: A Smart Reading ExamCard is in progress, or an examination is in review (with images available).

▷ Prerequisite: The Smart Reading inline step is not yet in progress on the cloud.

► Right-click on the inline step that you want to delete.

► Do any of the following:

- To delete the current inline step, click **Delete**.
- To rename the current inline step, click **Edit Name** (Ctrl+E). Then type the new name.

Editing the Analysis Settings of an Interactive External App

You perform this workflow only for interactive external apps. Non-interactive external apps do not support this workflow.

This workflow allows you to edit the analysis settings of the external app, for example, the segmentation.

▷ Prerequisite: You have completed an ExamCard with an external app configured as Smart Reading inline step.
You review the results in the tab view of the external app.

► To change the analysis settings, use the functions on the toolbar of the tab view.

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► Then recalculate the results and save them. To download the updated results, login to the cloud.

For more information, see the dedicated Instructions for Use of the external app.

9.8.7 Troubleshooting

Network Error

If a network error occurs due to a network connection error, a message appears in the Smart Reading inline step. In the Exam Overview, the external app icon indicates a network error.

English	Your language
External Application server is not available. Network Connection Error. Please check LAN connection or reach out to Local IT.	External Application server is not available. Network Connection Error. Please check LAN connection or reach out to Local IT.

You have the following limitations.

- External apps are not visible in the **External Apps Settings** window.
- Existing inline steps show a conflict in the **External Apps Settings** and in the ExamCard.
- Images cannot be transferred to the cloud.

To redo a previously executed or aborted job, click **Redo** in the **Job Viewer (F6)**.

Internet Disruption

If the Internet is disrupted, you can still execute and configure Smart Reading ExamCards.

- In automatic mode, finite retrials take place to execute the inline step. When the allowed time limit is exceeded, the inline step aborts. In this case, duplicate the failed inline step. Start the analysis when the Internet is back.
- In manual mode, wait and start the inline step when the Internet is back.

To redo a previously executed or aborted job, click **Redo** in the **Job Viewer (F6)**.

Non-Conformities in Scans

Scans not suitable for an external app are ignored. An error message notifies you.

English	Your language
Some optional sequences will not be considered since non-conformities were found. Non-conformity criteria have been found.	Some optional sequences will not be considered since non-conformities were found. Non-conformity criteria have been found.

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Contrast-Enhanced Scans

Some external apps check the contrast enhancement status of scan items based on their order in the ExamCard related to the contrast agent icon .

Consider the order of scan items when you duplicate a non-contrast-enhanced scan:

- When you repeat a non-contrast-enhanced scan *before contrast agent injection*, your results are as expected.
- When you repeat a non-contrast-enhanced scan *after contrast agent injection*, it is a contrast-enhanced scan now. The results of the external app differ.

English	Your language
Scan will be considered as post-contrast scan as it is stacked below a contrast scan. Results may slightly vary due to contrast enhancement.	Scan will be considered as post-contrast scan as it is stacked below a contrast scan. Results may slightly vary due to contrast enhancement.

9.9 Imaging Techniques

9.9.1 SyntAc

SyntAc is a dynamic fast imaging method which produces multi-contrast data of the brain that is intended to be processed with the SyMRI processing application by SyntheticMR AB, Sweden:

http://www.syntheticmr.com

What are the main properties of SyntAc?

- SyntAc provides a single MR scan with multiple contrast weightings as input for SyMRI processing software.
- SyntAc is available as 2D SyntAc and as 3D SyntAc.
  - 2D SyntAc acquires slices in four dynamics with two echoes.
  - 3D SyntAc acquires five images of a 3D volume with different contrast weightings.

    3D SyntAc allows for postprocessing in all 3 orthogonal directions.
- 2D SyntAc acquisitions provide you with Modulus and Phase images.

  3D SyntAc acquisitions provide you with Modulus images.
- SyntAc can only be used in brain imaging of pediatric and adult examinations.

SyntAc scanning and postprocessing

- Philips imaging protocols utilizing SyntAc are delivered with the MR system. It is recommended to use these protocols.
- Always check the individual SyntAc images for gross artifacts.
- SyntAc images are intended for processing with the SyMRI application, product of SyntheticMR AB, Sweden.

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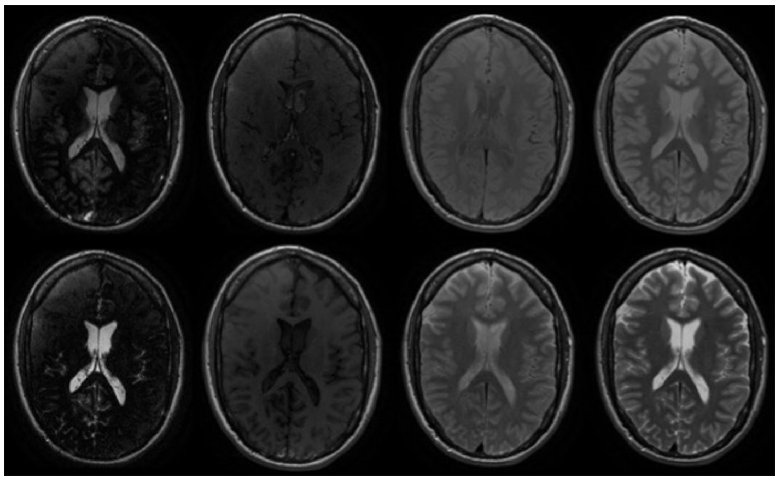
- SyMRI calculates T1, T2 and PD parameter maps and generates synthetic images (T1W, T2W, FLAIR).
- Refer to the SyMRI User Manual for further instructions and image quality considerations.
- It is recommended to process the data with SyMRI for a quality check prior to releasing the patient from the MR system.
- To generate synthesized 2D SyntAc images in multiple orientations, 2D SyntAc must be scanned in each orientation separately.

Acquired images

2D SyntAc:

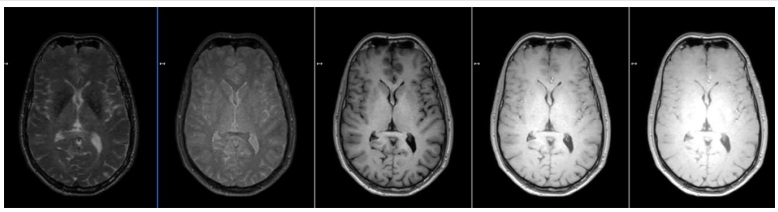
- 4 dynamics (relevant for T1 information).
- 2 echoes (relevant for T2 information).



3D SyntAc:

- 5 images

  where the first image provides T2 information and the later images provide more T1 information.



Synthesized images

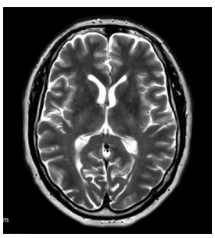
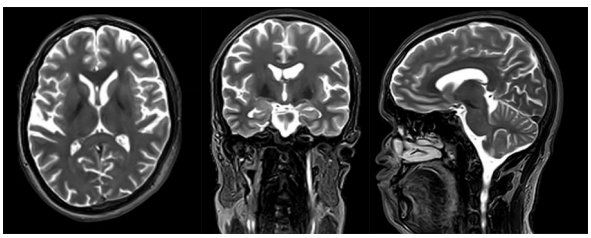
Image type	2D SyntAc	3D SyntAc
T2W images		

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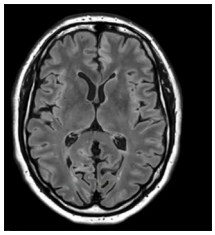
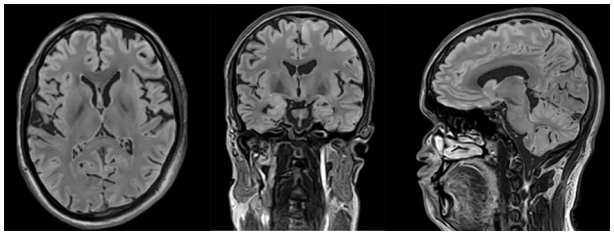
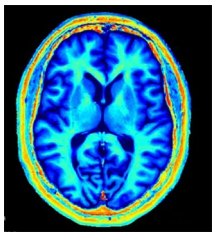
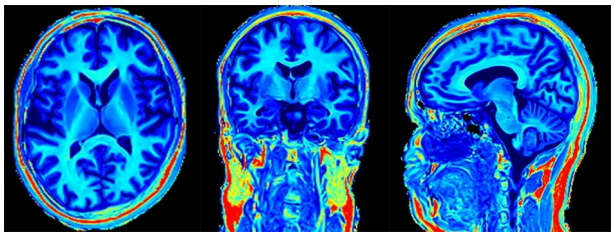
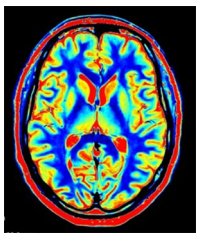
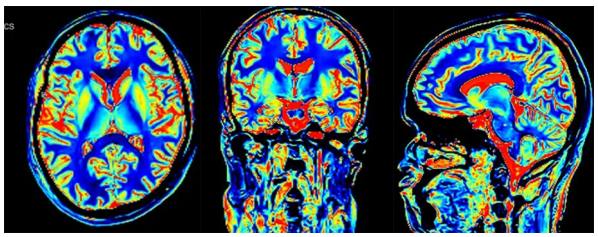
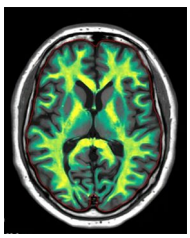
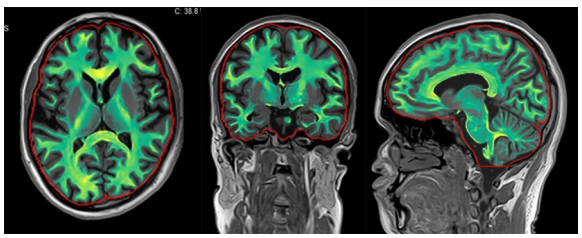
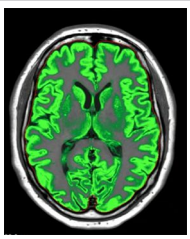
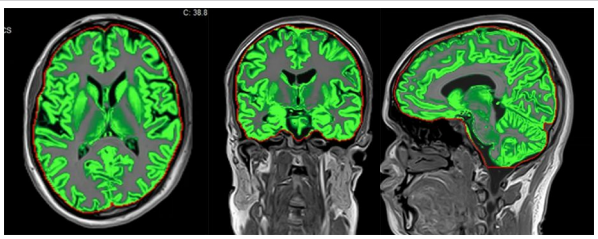
Image type	2D SyntAc	3D SyntAc
FLAIR images		
R1 maps		
PD maps		
Myelin maps		
Gray matter segmentations		

More information

- In the Online Help/Scan Methods: How does SyntAc work?
- In the Online Help/Parameters: How to enable SyntAc? (**SyntAc** imaging parameter)

9.9.2 Compressed SENSE

This section provides information about Compressed SENSE (**CS-SENSE**) and AI Compressed SENSE (**AI CS-SENSE**).

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Functional Description

Property	Description
Pulse Sequence	• Compressed SENSE is an acceleration technique that is less sensitive to noise breakthrough than SENSE at high reduction factors. It allows to increase resolution and/or coverage without a scan time penalty.
Properties	• Can be used with all SENSE compatible coil solutions. • Can be used in Turbo Field Echo, Fast Field Echo, Turbo Spin Echo and Spin Echo. • Can be performed as **CS-SENSE** (without Artificial Intelligence), or as **AI CS-SENSE** (with Artificial Intelligence). – Compared to similar scans with (dS-)SENSE, **CS-SENSE** and **AI CS-SENSE** provide shorter scan times, or higher signal-to-noise ratio, or higher spatial resolution or larger coverage. – Compared to similar scans with **CS-SENSE**, **AI CS-SENSE** provides shorter scan times, or higher signal-to-noise ratio, or higher spatial resolution or larger coverage.
Applications	• All clinical areas.
Limitations	**With all SmartSpeed options available on your MRI system:** • Cannot be used in MR Spectroscopy. • Cannot be used with dedicated temporal sub-sampling methods (such as k-t BLAST). **Without SmartSpeed option(s) available on your MRI system:** • Cannot be used in EPI scans and Multislice-TSE when Partial NSA is used. • Cannot be used in non-cartesian scans such as MultiVane. • Cannot be used with OMAR when set to SEMAC+VAT. • Cannot be used in MR Spectroscopy. • Cannot be used with dedicated temporal sub-sampling methods (such as k-t BLAST).
Contrast is determined by	• Contrast parameters of the imaging sequence being combined with Compressed SENSE.
Scan modes	• 3D, MS, 2D, M2D Compressed SENSE allows for highest acceleration in 3D scans.

What is Compressed SENSE?

Compressed SENSE accelerates imaging, because it undersamples k-space and consequently saves time. Undersampling k-space leads to incoherent aliasing in the image domain. This aliasing is resolved by **Compressed SENSE**, a non-linear iterative reconstruction technique

More information

- In the Online Help **(F1)**: Enabling Compressed SENSE

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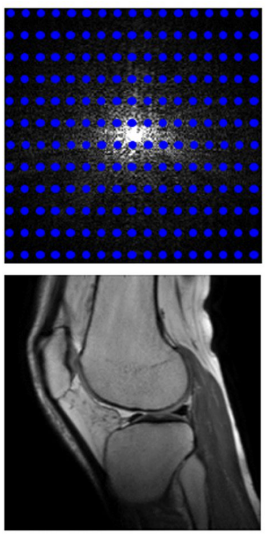
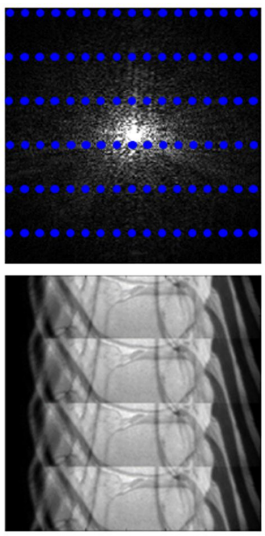
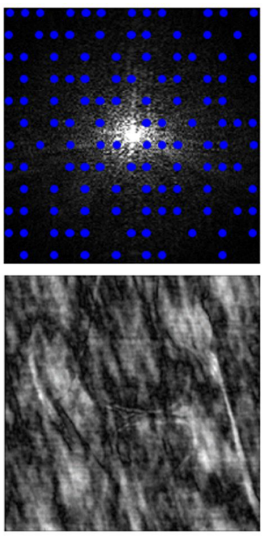
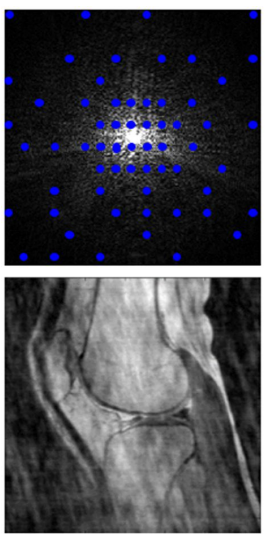
The **Acceleration** parameter on the **Geometry** tab allows you to select CS-SENSE or AI CS-SENSE.

- In the Online Help **(F1)**: Controlling Compressed SENSE with the imaging parameter **reduction factor**
- In the Instructions for Use: Flame artifact and how to overcome?

How does Compressed SENSE work?

Compressed SENSE makes use of *incoherent undersampling of variable density* in combination with *iterative (non-linear) reconstruction*.

Incoherent undersampling of variable density compared to other sampling strategies

Uniform sampling	Uniform undersampling	Incoherent undersampling of fixed density	Incoherent undersampling of variable density
• k-space is sampled in a uniform way.	• k-space is sampled in a regular way with fixed density.	• k-space is sampled in a random way with fixed density.	• k-space is sampled in a random way with variable density. • Resulting in an image with incoherent noise-like aliasing
k-space and corresponding image: 	k-space and corresponding image: 	k-space and corresponding image: 	k-space and corresponding image: 

Iterative (non-linear) reconstruction

The purpose of non-linear iterative reconstruction is to get rid of the incoherent noise-like aliasing and to produce a clean artifact-free image.

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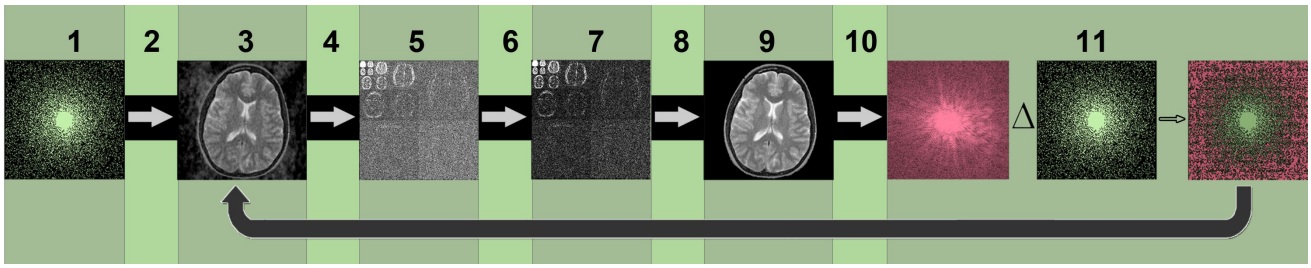
For that reason, the image needs to be transformed to the wavelet space. MRI image information in the wavelet space is sparse, which allows to identify noise quite easily and consequently enables denoising. After denoising, the data is tranformed back to image space, then to k-space and eventually checked against the originally measured k-space data. This procedure is repeated in a loop:



1. Incoherently undersampled k-space
2. Fourier transform (k-space to image) using coil-sensitivity data and regularization information
3. Reconstructed image (corresponding to incoherently undersampled k-space)
4. Wavelet transform (image to sparsity)
5. Corresponding sparsity presentation
6. Denoising
7. Denoised sparsity presentation
8. Inverse wavelet transform (sparsity to image)
9. Reconstructed image (after denoising)
10. Comparison with originally acquired k-space
11. Output of comparison is used as input for next reconstruction round.

This is repeated iteratively till convergence is reached and the resulting image is free of aliasing artifacts.

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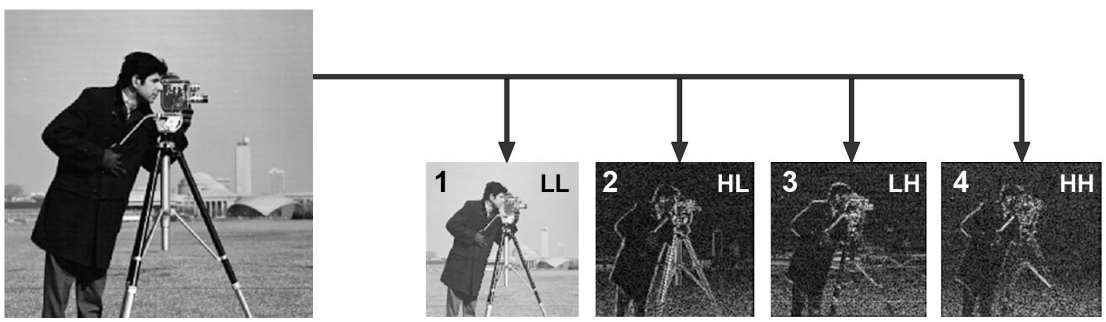
Wavelet transform and sparsity: from image to wavelet space

The wavelet transform transforms the image to wavelet space. The wavelet transform is equivalent to a series of special high- and low pass filters followed by downsampling, along the rows and the columns. In this way details are extracted at various wavelet scales. The full image is split up into four image types one-quarter of the original image size:



1. A low resolution image or average image (low-low **LL** filter).

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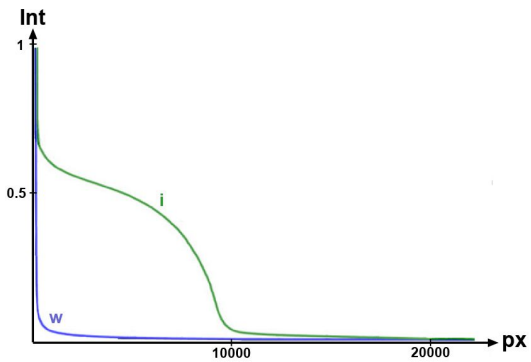
2. Vertical details image for the original image scale (high-low **HL** filter).
3. Horizontal details image for the original image scale (low-high **LH** filter).
4. Diagonal details image for the original detail scale (high-high **HH** filter).

The low resolution image (**LL**) is split further into its own average, horizontal, vertical and diagonal coefficients. As such the image information is split into details and contrast information at multiple scales. This is a multi-resolution analysis.

Most of the high-value “pixels” (correctly wavelet coefficients) in this wavelet space diagram are in the top left, and a lot of the diagram is dark. The representation is sparse. The wavelet space diagram has the same number of values as the image, but the information is contained in fewer values.



Scaled signal intensity (Int) versus pixel count (Px)

- w - wavelet
- i - image

Since the distributed aliasing (as a result of random k-space undersampling) is noise-like in this domain, it can be removed by using a threshold. With such a threshold, some values are dropped and, along with them, the low-intensity artifact from the random undersampling, without losing much image information.

If the threshold is too low, aliasing is not completely removed. If the threshold is too high, signal from the object could be suppressed. In both cases, artifacts could occur in the resulting images. The threshold is automatically derived and optimized depending on each individual scan

Comparison SENSE, CS-SENSE, and AI CS-SENSE

Cardiac Imaging T2W STIR BB

Acquisition with the same acceleration factor, the same resolution, and the same scan time:

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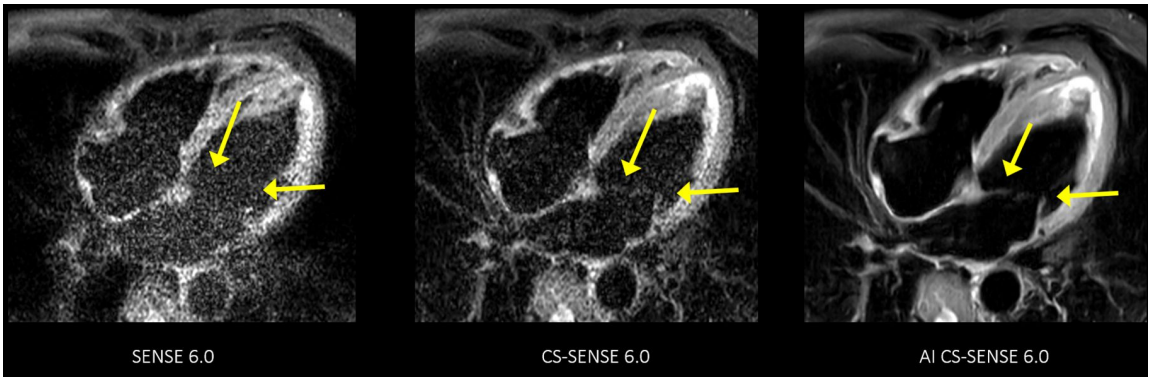
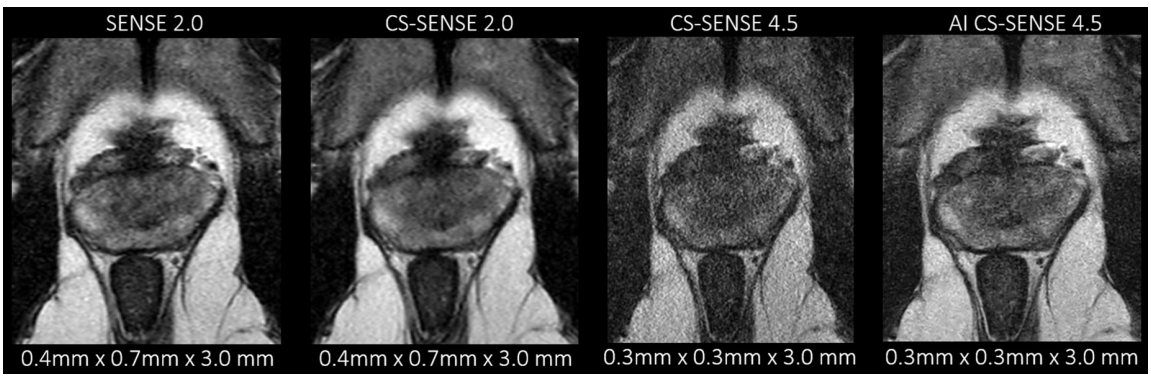
- **SENSE** image with serious noise breakthrough and an unacceptable image quality.
- **CS-SENSE** image still with noise breakthrough.
- **AI CS-SENSE** image without noise breakthrough, but improved image quality.



Prostate T2W axial

Acquisition of the same resolution and of the same scan time (despite different acceleration factors):

- SNR gain from **SENSE** to **CS-SENSE**.
- Noise breakthrough in **CS-SENSE** with higher acceleration factor and increased resolution.
- **AI CS-SENSE** with higher resolution, and good image quality.



Prostate T2W ProstateVIEW

AI CS-SENSE with higher acceleration factors than **CS-SENSE**, reduced scan time by almost 40%, and good image quality.

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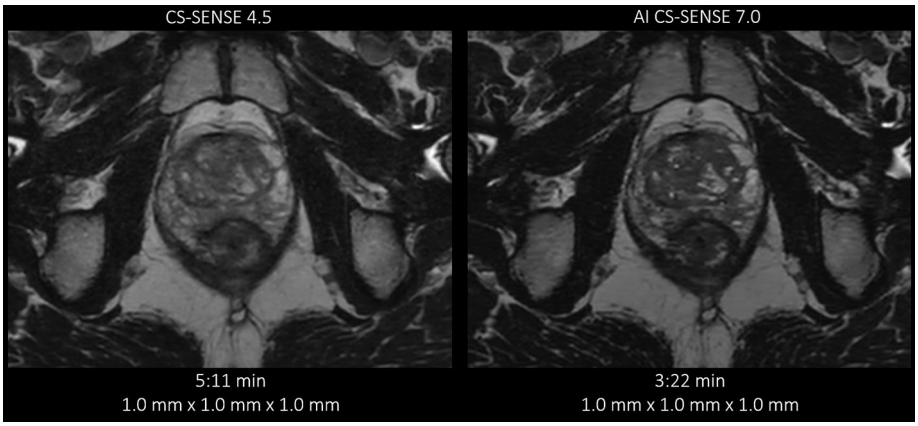
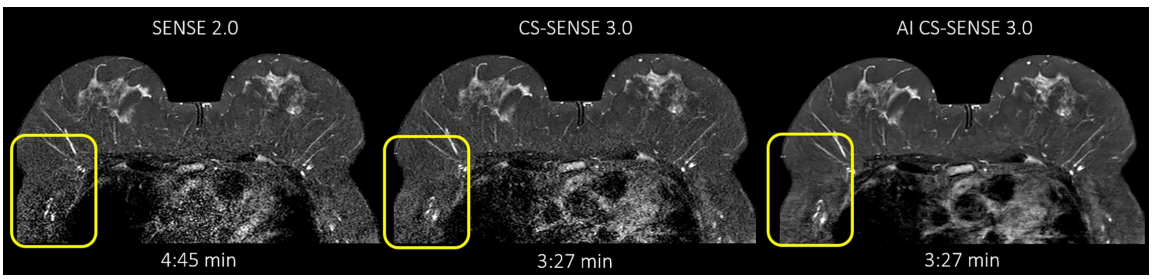


Breast T2W SPAIR TSE

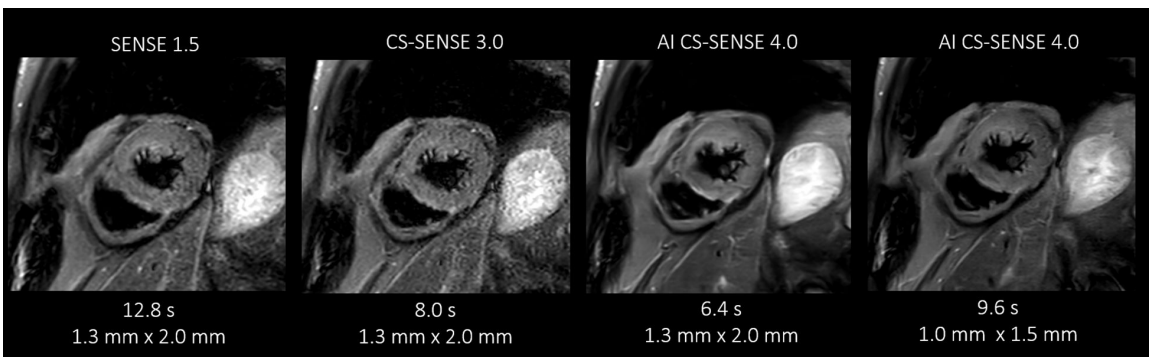
Improved image quality with **AI CS-SENSE** in a shorter scan time.

- **SENSE** with noise breakthrough, especially in the axilla area.
- SNR gain from **SENSE** to **CS-SENSE**. Shorter scan time with **CS-SENSE** due to the higher acceleration factor.
- **AI CS-SENSE** with improved image quality in the same scan time as **CS-SENSE**.



Cardiac Imaging T2W STIR BB

Shorter breathholds, or higher resolution due to the higher acceleration factor in **AI CS-SENSE**.



Cardiac Imaging 3D bTFE Whole Heart

Shorter scan times in 3D scans with **AI CS-SENSE**, with the same resolution.

- SNR gain with **AI CS-SENSE** which allows for higher acceleration factors, and therefore leads to shorter scan times.

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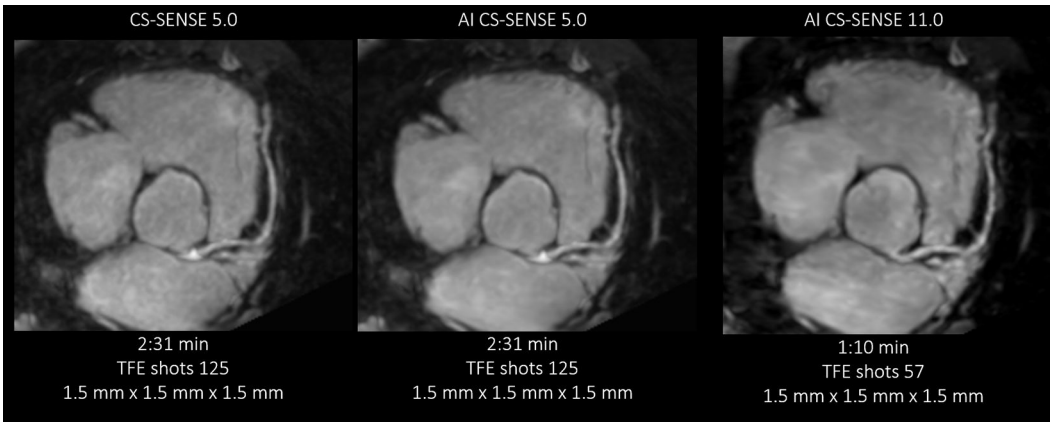
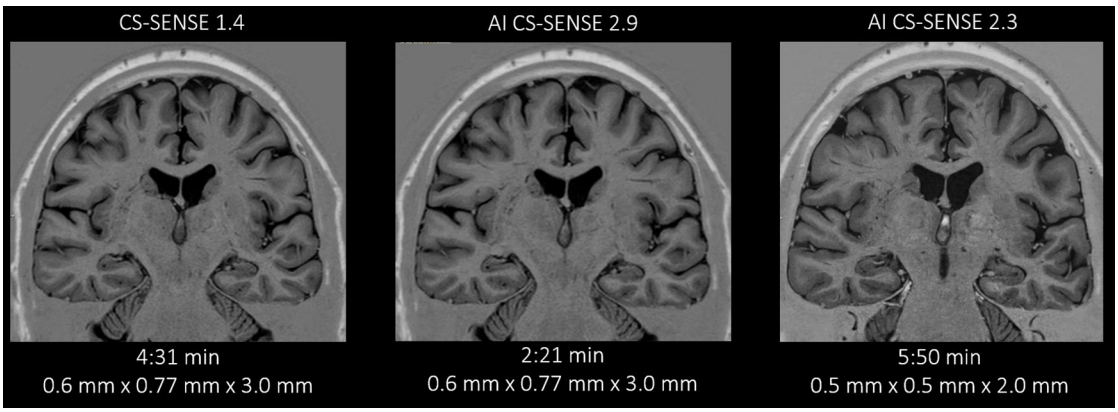


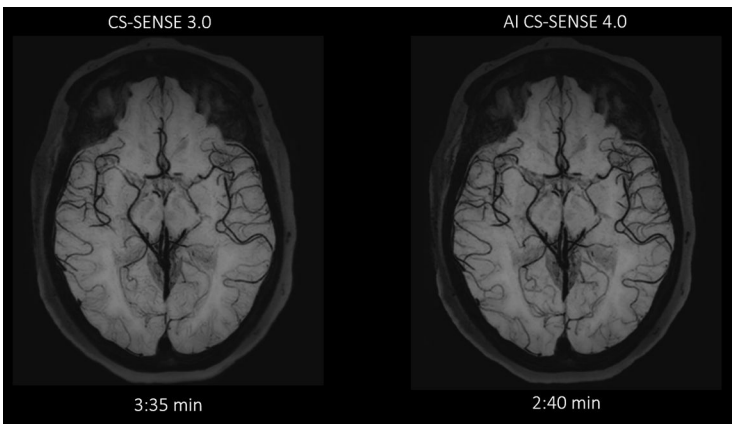
Hippocampus T1W IR

Different use cases of **AI CS-SENSE**: either to speed up a scan protocol, or to achieve a higher resolution.



Brain 3D T1W TSE Black Blood

Higher acceleration factor in 3D **AI CS-SENSE**, and therefore a shorter scan time than with **CS-SENSE**.



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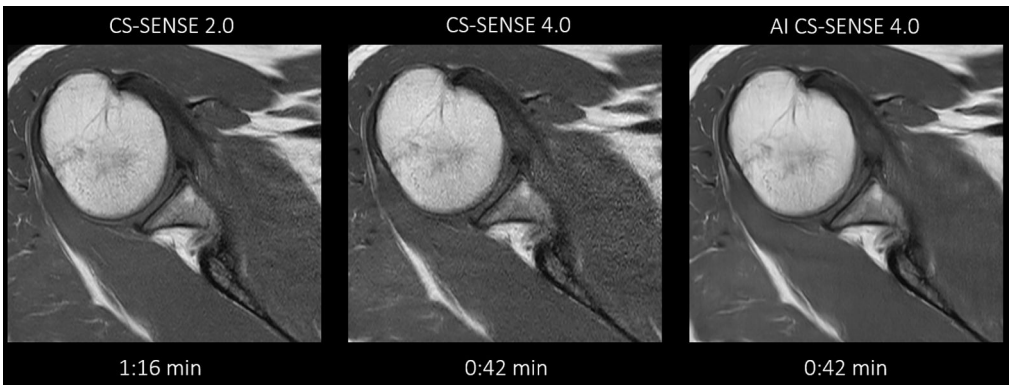
Shoulder T1W TSE

Better image quality in shorter scan times.

- Noise breakthrough in **CS-SENSE** with an acceleration factor of 4.
- Signal gain and image improvement in **AI CS-SENSE** with the same high acceleration factor of 4.



Scanning with Compressed SENSE

Use Compressed SENSE

- to scan faster with virtually equivalent image quality, preferably in 3D-scans, or
- to gain spatial or temporal resolution due to higher signal-to-noise ratio with similar scan times.

NOTICE

Gaining confidence

When you get started with a new acceleration technique, perform the same scans in different clinical areas with and without this new technique. Compare the results, and decide how to proceed.

For information about possible artifacts and how to deal with them, see **Artifacts** in the Troubleshooting chapter.

Scanning and viewing

▷ ✔ The patient is registered and selected for scanning.

► Do any of the following:

- Select an ExamCard with a **Compressed SENSE** imaging protocol.
- Add a **Compressed SENSE** imaging protocol to the current ExamCard.

Philips imaging protocols utilizing **Compressed SENSE** are delivered with the MR system. It is recommended to use these protocols and use them as a starting point for own hospital-specific protocols.

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- ► Start the ExamCard.
- ► Plan the ExamCard items on the images.
- ► Run the ExamCard.
- ► Review the images in the **Review** tab.

⇨ **Compressed SENSE** scans provide the same images and image types as scans without **Compressed SENSE**.

9.9.3 Zoom Imaging

Functional Description

Zoom is a reduced-FOV method.

Zoom behaves differently dependent on the parameter **scan mode**.

With scan mode MS	With scan mode 2D, M2D, 3D
• enables non-coplanar **zoom imaging**. (by means of non-coplanar excitation and REST slabs which are not visible in PlanScan) • provides (relative to small FOV acquisitions without **zoom imaging** enabled): – Excellent outer volume suppression, enabling small FOV acquisitions without oversampling, thus enabling low EPI factors. – possibly increased SAR, – possibly increased PNS.	• enables orthogonal zoom. A smaller FOV is excited in phase-encoding direction where the excitation pulse is orthogonal to the slice selective refocusing pulses. • enables fast dynamic TSE and GRASE imaging by measuring a smaller number of profiles in one single shot or in multiple shots. – The smaller number of profiles is realized by using a smaller FOV in fold-over direction. • Backfolding is avoided as selective RF excitation refocusing pulses are used to limit the FOV in fold-over direction. NOTE: FH fold-over direction in combination with Zoom (scan mode 2D, M2D, 3D) is not recommended
Application: high resolution DWI and DTI images in brain, spine and prostate. To acquire single-shot and multi-shot SE-EPI high-resolution DWI or -DTI images with small FOVs and limited distortion. Zoom imaging reduces distortion artifacts.	**Application:** high-resolution cardiac imaging. To acquire 2D, M2D (or 3D) Single Shot or MultiShot TSE or GraSE images with small FOV in fold-over direction. Zoom enables a shorter (single) shot, and/or shorter scan time.
IRIS (Image Reconstruction using Image-space Sampling) Multishot diffusion technique with zoom imaging for spine examination. Philips imaging protocols are delivered with the system. It is recommended to use these protocols.	

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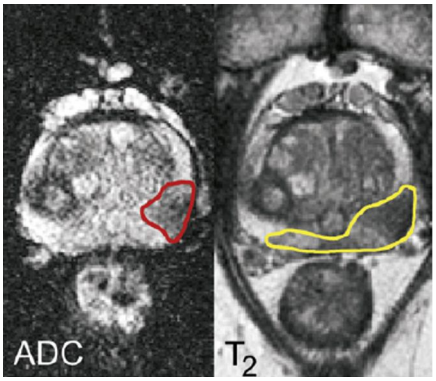
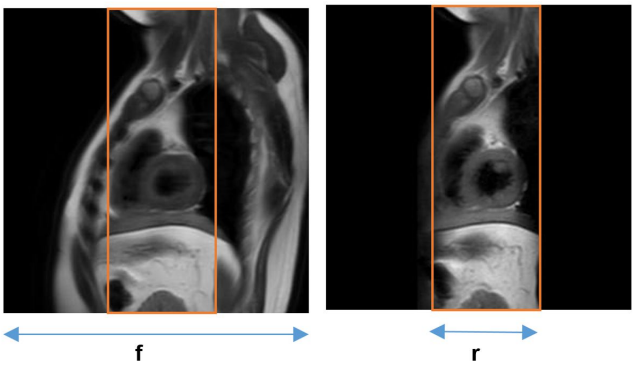
With scan mode MS	With scan mode 2D, M2D, 3D
	
European Journal of Radiology 80 (2011) e34-e41	f = full FOV, r = reduced FOV

More information

- Imaging parameter **Fold-over suppression** in Online Help system (**F1** key)

Planning a scan with Zoom

▷ In the Parameter Editor:

- ► Open a MS SE-EPI diffusion imaging (DWI and DTI) scan protocol, or a 2D/M2D TSE/GRASE scan protocol .
- ► Click the **Geometry** tab to display the geometry parameters of the scan protocol.
- ► Set the parameter **Fold-over suppression** to **zoom**.
- ► Reduce the FOV in fold-over direction, either graphically or numerically.
- ► Depending on the scan protocol, a conflict may pop up to force the scan into 2 packages.

NOTICE

With zoom imaging in MS SE-EPI diffusion imaging, scanning of at least 2 packages is mandatory.

- ► When complete, press **Proceed** to save your scan protocol.

9.9.4 Black Blood Imaging

Functional Description

Black blood imaging is a method where the signal of flowing blood is suppressed.

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Most black blood methods rely on intrinsic flow phenomena.
On your MR system, two additional black blood methods are available:

1. Double Inversion Recovery,
2. MSDE (Motion Sensitized Driven Equilibrium).

Applications

- Brain,
- Nerve imaging in brachial and lumbar plexus,
- Liver (flow ghost suppression of aorta).

More information

For more information about these methods, see the parameter help texts.

MSDE

MSDE stands for Motion Sensitized Driven Equilibrium and is a black blood method.
It applies a magnetization preparation sequence that causes moving spins to dephase, and thereby suppresses signal from blood vessels with sufficient flow. This is achieved by additional flow crushing gradients.

You can use MSDE in 2D-, M2D- and 3D-TSE and -TFE sequences.

You can either select one of the predefined MSDE modes designed for specific applications, or you can set up your own MSDE sequence by setting the parameter **MSDE mode** to **user defined**.

Enabling Black Blood Imaging

- ► Open a 2D-, M2D- or 3D-TSE or -TFE scan protocol.
- ► Click the **Contrast** tab to display the parameters related to the contrast of the scan protocol,
- ► In the TSE scan protocol:
  - set the parameter **BB pulse** to **yes** or **MSDE**.
- ► In the TFE scan protocol:
  - set the parameter **TFE prepulse** to **black-blood**, and
  - set the parameter **bb pulse type** to **default** or **MSDE**.

9.9.5 3D NerveVIEW

3D NerveVIEW allows to image the nerves in the brachial and lumbar plexus. It is the recommended technique for nerve imaging in combination with

- MSDE to suppress blood,
- STIR or SPAIR to suppress fat.

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Philips

Brachial plexus as 3D NerveVIEW (Nerve STIR) with MSDE and Refocusing control	Brachial plexus as 3D NerveVIEW (Nerve STIR)

9.9.6 MultiBand SENSE

Functional Description

MultiBand SENSE is indicated for use in Magnetic Resonance Imaging of the brain for:

- BOLD fMRI
- Diffusion Weighted Imaging

MultiBand SENSE consists of an acquisition and reconstruction technique allowing simultaneous excitation of multiple volumes to accelerate imaging acquisition times, or increasing coverage, or number of diffusion directions without increasing scan time.

How does MultiBand SENSE work?

The MultiBand SENSE technique enables simultaneous excitation and acquisition of multiple volumes for multislice single-shot EPI sequences. The simultaneous volume excitation is done using a multi-band RF pulse. The simultaneously acquired volumes are unfolded by means of the SENSE algorithm. The image unfolding is improved by introducing a linear phase in k-space in the phase direction depending on the volume position. This results in a spatial shift of the aliased pixels in imaging space.

MultiBand SENSE allows for shorter TRs with the same in-plane resolution and coverage in the slice direction and consequently leads to shorter scan times. Alternatively the time savings by the MultiBand acquisition can also be used to keep the TR unchanged and acquire more slices in the same time.

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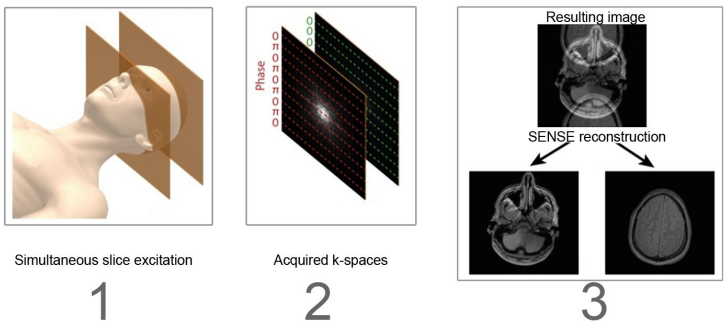

Principle of MB SENSE with MultiBand x2.

1. Simultaneous excitation of 2 slices.
2. Acquired k-spaces of these 2 slices.
3. one resulting image before SENSE reconstruction, two resulting images after SENSE reconstruction.

MB SENSE makes use of a B0 prescan to optimize the SENSE algorithm.

Application

Multislice single-shot EPI brain scans:

- BOLD fMRI
- Diffusion Weighted Imaging

Restrictions

- You can only use MB SENSE with the
  - dS Head 32ch 3.0T coil.
  - dS HeadSpine coil 1.5T and 3.0T
  - dS HeadNeckSpine coil 1.5T and 3.0T
- Implants that are MR Conditional cannot be scanned using MB SENSE.
  Instead a conflict occurs, since the B0 prescan is not compatible with implants.

Applying MultiBand SENSE

MB SENSE in MRI examinations

Philips imaging protocols utilizing MB SENSE are delivered with the MR system. For ease of use, it is recommended to use these MB SENSE protocols.

MB SENSE Imaging Parameters

MB SENSE can be enabled, disabled and adjusted by means of the imaging parameters **MB SENSE** and **MB factor** on the *Geometry* tab.

Parameter	Possible values	Effect
MB SENSE	• No • Yes	• MB SENSE is disabled. • MB SENSE is enabled.

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Parameter	Possible values	Effect
MB factor	• **2 ... 4** for SE-EPI (Diffusion)	Multiple slices are acquired per excitation, depending on the MB factor. • Only integer numbers can be used. • The higher the factor, the faster the scan. • The number of acquired slices has to be a multiple of the **MB factor**. A **MB factor** of 3 acquires 3 slices per excitation. This allows for multiples of 3 slices (e.g. 6, 9, 12). • This range only applies for the dS Head 32ch 3.0T coil. For the other coils, **MB factor** is restricted to 2.
MB factor	• **2 ... 8** for FFE-EPI (BOLD fMRI)	See above.

When MB SENSE is combined with SENSE, the two SENSE factors multiply. The higher their product, the higher the likelihood of artifacts. It is therefore advised to carefully select the SENSE factors used.

Related parameters MB SENSE

- MB SENSE
- MB factor

9.9.7 4D-TRAK XD

Functional Description

4D-TRAK XD (4D Time-Resolved Angiography using Keyhole) provides high spatial and temporal resolution CE-MRA scans.

4D-TRAK XD utilizes the 3D-FFE scan technique and combines the advantages of dS-SENSE, Keyhole, CENTRA and Viewsharing.

4D-TRAK might be used to aid in evaluation of brain AVM, congenital heart diseases, cardiac function, hemodialysis shunts and in diabetes patients with short arterio-venous transit time in lower legs/feet.

NOTICE

4D-TRAK XD is not available in Japan.

Related parameters 4D-TRAK XD

- Keyhole parameters
- Viewsharing parameters

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- CE-angio profile order parameters
- CENTRA parameters
- Mask parameter

Running a 4D-TRAK XD scan

▷ The patient is positioned on the tabletop with the best-suited coil for the anatomy of interest and all required positioning aids (see Coils chapter in the Instructions for Use for information on coil choice).

▷ The images of the survey scan and the anatomical scans are available for planning.

► Add a 4D-TRAK XD scan to your current ExamCard.

► Plan the slices, preferably in plane with the vessels.
As such less slices are needed to cover the vessels.

► Start the scan.
The first dynamic (which serves as a non-contrast scan) is performed.
After its completion, scanning is paused for contrast agent injection.

► Inject contrast agent as a bolus.

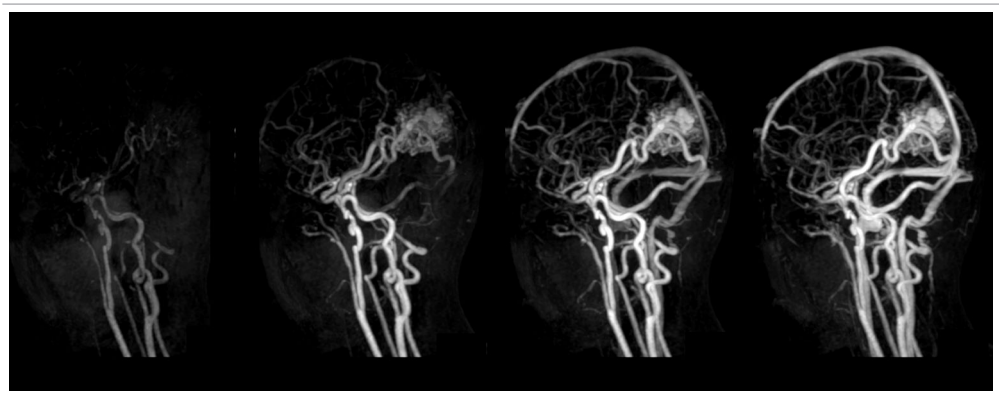
► Resume the scanning.
The dynamic series are acquired automatically, one after the other.

► Review the resulting images.

► Calculate Maximum Intensity Projections.

Examples of 4D-TRAK XD Dynamics and MaxIPs

4D-TRAK XD (without the use of Viewsharing) 4 dynamics. From left to right: early to late dynamic.



4D-TRAK XD (without the use of Viewsharing): Different Maximum Intensity Projections of the same dynamic.

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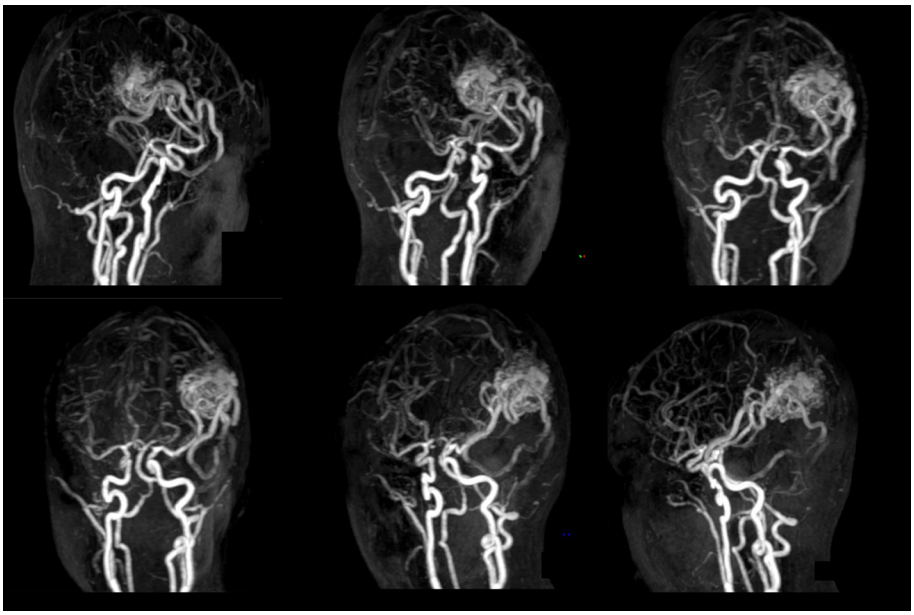
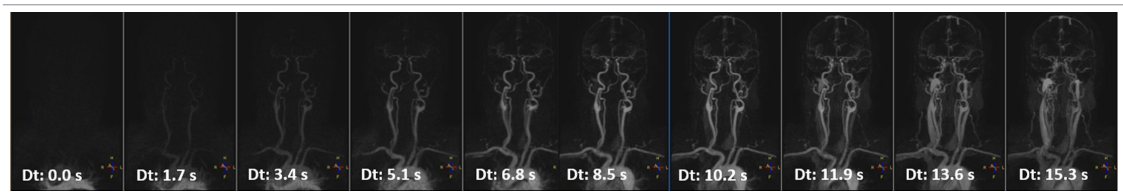


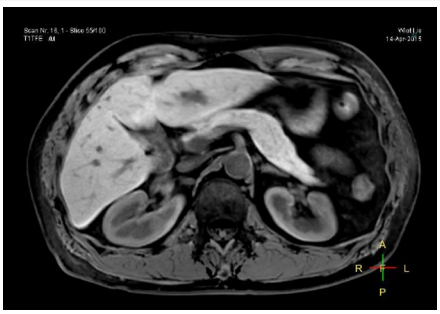
4D-TRAK XD: 10 dynamics in carotid arteries, from early to late dynamic.



9.9.8 3D VANE XD

3D VANE XD is a free breathing acquisition method to achieve distortion-free images in 3D/FFE and 3D/TFE body imaging.

You can use it for late enhancement scans, especially in patients who cannot hold their breath as long as needed.
You cannot use it for dynamic acquisitions.



3D Free Breathing e-THRIVE

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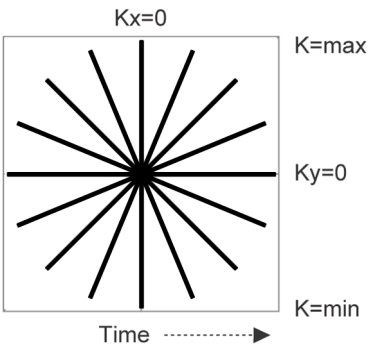
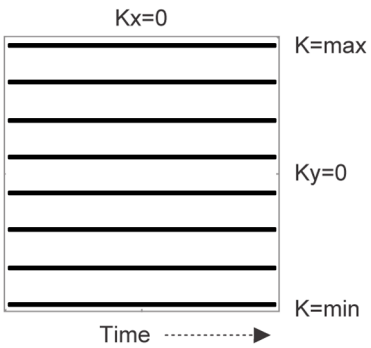
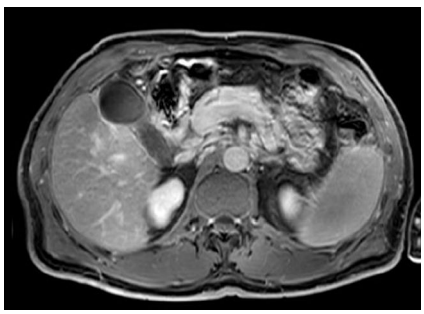
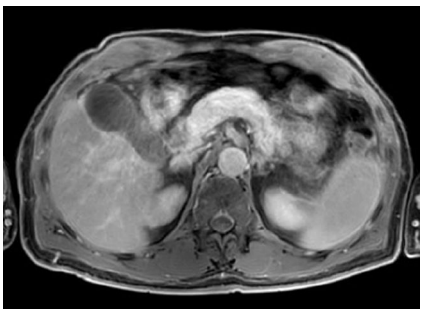
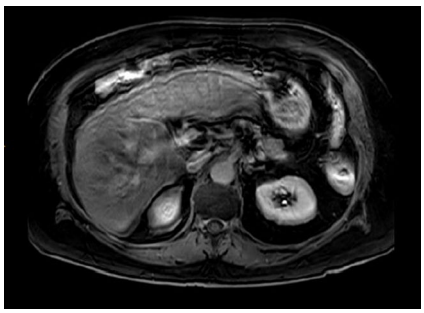
Comparison of 3D Free Breathing versus 3D Breathhold

	3D Free Breathing (FB)	3D Breathhold (BH)
Suited for patients	that cannot hold the breath as long as needed in a Breathhold sequence.	that can hold the breath as long as needed.
Use	• pre-/post-contrast acquisition, • late enhancement, • not suited for dynamic acquisition due to too long scan times.	• dynamic acquisition, • pre-contrast acquisition, • late enhancement.
Can be combined with	e-THRIVE and mDIXON (3D/T1-TFE, 3D/T1-FFE)	all 3D/FFE and 3D/TFE acquisitions
Imaging parameter **Acquisition mode**	**radial** 	**cartesian** 
Example of good image quality		
Likelihood of breathing artifacts	Depending on the breathing pattern, blurring can still be induced. 	When the breathhold cannot be hold, blurring is induced. 

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Imaging parameter: Acquisition Mode = Radial

The **radial acquisition mode** in 3D Free Breathing provides a higher robustness to motion due to:

- intrinsic oversampling of the center of k-space,
- benign undersampling behavior,
- phase correction of the closest radial reversed radial profiles.

Radial Pseudo golden angle sampling is performed.

Imaging parameter: Number of Signals Averaged (NSA)

The parameter NSA allows you to define the number of radial profiles (and as such the radial percentage). You enter the NSA as decimal value where for example 1.0 corresponds to a 100% measurement, and 1.3 for a 130% measurement.

A higher NSA value

- improves SNR,
- decreases undersampling streaking artifacts,
- but increases scan time.

9.9.9 4D FreeBreathing

Functional Description

Property	Description
Pulse Sequence	• Free-breathing motion-robust 4D contrast-enhanced MRI • Available on 1.5T and 3.0T
Properties	• Allows to follow T1 contrast enhancement in the organs of interest by continuous acquisition over a period longer than a breath-hold. • Continuous coverage of the arterial phase. • Motion-robust imaging reduces artifacts due to breathing motion, cardiac pulsation and intestinal motion. • Free-breathing technique making use of either VitalEye, or respiratory sensor or intrinsic navigators. • Real-time reconstruction for direct assessment of image quality in pre-contrast dynamic series. • Variable phase definition. • To be used with SPAIR.
Applications	• Abdomen (e.g. liver).
Contrast is determined by	• Contrast parameters of the imaging sequence being combined with 4D FreeBreathing.
Scan modes	• Dynamic 3D/TFE

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What is 4D FreeBreathing?

4D FreeBreathing is a motion-robust imaging technique (extension of 3D VANE XD) now allowing for the acquisition of dynamic 3D/TFE contrast-uptake studies.

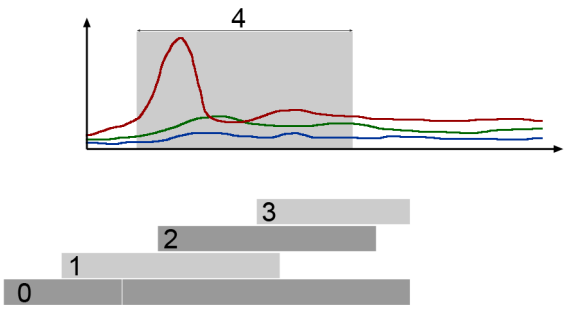
How does 4D FreeBreathing work?

4D FreeBreathing is a motion-robust sampling method due to an intrinsic oversampling of the center of k-space. It offers the unique advantage of capturing contrast uptake efficiently independent of the scan geometry.

4D FreeBreathing makes use of:

Variable-Density Golden-Angle Radial Stack-of-Stars Acquisition

- The 3D-acquisition is performed in a sliding window fashion (making use of overlapping dynamic blocks).
- k-space sampling is optimized for scan time and optimal contrast visualization.



Acquisition with overlapping dynamic blocks for continuous coverage of the arterial phase

- 0 = Pre-contrast phase
- 1 = Dynamic 1
- 2 = Dynamic 2
- 3 = Dynamic 3
- 4 = Arterial phase

Respiratory Soft Gating

- The respiratory cycle is continuously sampled by either intrinsic navigators, by VitalEye (if available) or by the respiratory belt.
  VitalEye has the advantage of continuously detecting motion over time with potentially sharper images.

  From the respiratory cycle, the different breathing states are determined.
- k-profiles are measured continuously and weighed retrospectively according to their breathing state (smart weighting).

The advantage of respiratory soft gating (compared to conventional gating techniques) is that the dynamic scan times are independent of the respiratory cycle.

More information

- In the Online Help **(F1)**: Enabling 4D FreeBreathing (with the parameter Dynamic study)
- Related parameters in the Online Help **(F1)**:
  - Dynamic study: dynamic scans per phase
  - Dynamic study: phase duration

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  - Dynamic study: phase start
  - Respiratory soft gating
  - Respiratory soft gating: motion detection type
  - Respiratory soft gating: oversample factor
- In the Instructions for Use: 3D VANE XD

Scanning with 4D FreeBreathing

Use 4D FreeBreathing for motion-robust imaging in contrast-enhanced MRI.

The workflow is identical to any other dynamic contrast-enhanced MRI with a stop between pre- and post-contrast dynamic series.

NOTICE

Philips imaging protocols utilizing 4D FreeBreathing are delivered with the MR system. It is recommended to use the default Philips protocol without changing any parameters.

Changing parameters can degrade SNR and negatively affect image quality.

9.9.10 O-MAR (Orthopedic Metal Artifact Reduction)

Functional Description

Property	Description
Pulse Sequence	• Acquisition and reconstruction technique that helps reduce susceptibility artifacts caused by the presence of metal in both in-plane and through-plane dimensions compared to conventional MR imaging techniques. • Turbo Spin Echo method in combination with VAT (View Angle Tilting). • For O-MAR with SEMAC: Slice-selective TSE acquisition with multiple encodings per excited slice (also known as SEMAC) to recover off-resonant signal caused by magnetic field inhomogeneities, and to reduce through-plane distortions.

Properties	• O-MAR improves visualization of tissue in the vicinity of passive MR Conditional and MR Safe orthopedic implants.
	• O-MAR reduces image distortions due to magnetic field inhomogeneities, caused by the presence of metal.
	  – O-MAR without SEMAC reduces in-plane distortions.
	  – O-MAR with SEMAC reduces in-plane and through-plane distortions.

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Property	Description
Limitations	• With larger VAT view angles (which correspond to small readout bandwidths), edges along the slice selection direction might appear more blurry. • The amount of artifact reduction is limited by the chosen SEMAC distortion correction factor which in turn affects scan time. • O-MAR is not compatible with Uniformity correction. • Only O-MAR without SEMAC can be combined with mDIXON TSE.
Applications	• Anywhere where the presence of metal affects image quality, especially MSK. E.g. knee, hip, cervical and lumbar spine. Always use ScanWise Implant in combination with O-MAR for safe scanning of patients with implants.
Contrast is determined by	Contrast parameters of the imaging sequence being combined with O-MAR.
Scan modes	• 2D, M2D, MS

More info

- How to enable O-MAR? (Imaging parameter in Online Help)
- Distortion correction (Imaging parameter in Online Help)

How does O-MAR work?

O-MAR is based on the Turbo Spin Echo method in combination with VAT (View Angle Tilting) to reduce in-plane distortions due to magnetic field inhomogeneities, caused by the presence of metal. To further reduce in-plane and through-plane distortions a slice selective TSE acquisition with multiple encodings per excited slice (aka SEMAC) is used to recover off-resonant signal caused by magnetic field inhomogeneities.

Since metallic orthopedic implants are increasingly common in patients, the need to apply MRI techniques in the vicinity of embedded metallic hardware is growing. However, MRI images acquired in the close proximity to metal suffer from artifacts. O-MAR addresses this problem by offering advanced encoding algorithms that help reduce susceptibility artifacts.

O-MAR produces images which represent a combination of signals acquired at different off-resonant frequencies, with the purpose to reduce the susceptibility related distortions in patients with MR Safe and MR Conditional metal implants.

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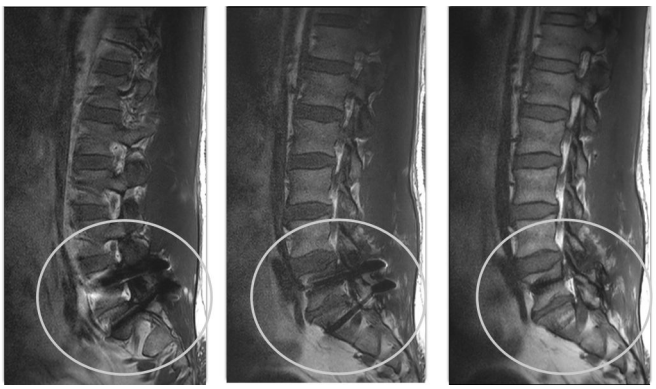

Comparison

Left: Standard Spin Echo, middle: VAT Spin Echo.

Right: Through-Plan Corrected image.

Comparison

Left: Standard-TSE.

Right: SEMAC.

O-MAR supports all clinically relevant contrasts such as T1W, T2W, STIR (from left to right), but also PDW.

Compatibility for MR Safe and MR Conditional Implants Only

Compatibility for MR Safe and MR Conditional implants only

For information about safety related to MR Safe and MR Conditional implants, refer to the Safety chapter.

NOTICE

MR Safe and/or Conditional Implants

Prior to examining patients with MR Safe and/or MR Conditional metal implants, always check the implant's MR compatibility as given by the implant's manufacturer. In case of doubt, contact the implant's manufacturer.

Different O-MAR Methods

O-MAR can be done in different ways:

TSE-based SENSE reference scan

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In O-MAR scans, the SENSE reference scan is TSE-based in order to increase the robustness of the SENSE unfolding algorithm in the presence of susceptibility artifacts.

MARS

A slice-selective TSE scan with high readout bandwidth and high resolution is used.

SEMAC

Acquisition relies on the SEMAC (Slice Encoding for Metal Artifact Correction) technique which uses a slice selective TSE acquisition. Multiple z-encodings per excited slice are used to recover off-resonant signal caused by magnetic field inhomogeneities. The output image for each slice represents a combination of the signal acquired at different off-resonant frequencies.

VAT

VAT (View Angle Tilting) technique is used to reduce in-plane distortions due to magnetic field inhomogeneities. For this, the gradient applied during slice selection is reapplied during the signal readout.

SEMAC in more detail

SEMAC is a multi-spectral sequence which acquires additional off-resonant data in order to recover signal and to reduce signal-voids and through-plane distortions. The number of additional z-encodings, the SEMAC factor, used for that purpose is defined by the chosen distortion correction and is indicated on the Info page. In reconstruction, the off-resonant signal of each slice is combined into one final image per slice.

Effects of choosing SEMAC

- The scan time is increased as a result of the additional z-encodings.
- A minimum number of 2 packages is required.
- The signal is increased as a result of the combination of multiple images into one.
- RF shimming is not allowed in combination with SEMAC.

Effects on the number of slices

- The minimum number of slices is equal to the SEMAC factor.
- If the number of slices is equal to the SEMAC factor, only the central slice of the image stack will be corrected optimally.
- If the number of slices is larger than the SEMAC factor, more slices around the center of the image stack will be corrected optimally.

Multistack imaging

For multistack imaging, all stacks need to contain the same number of slices.

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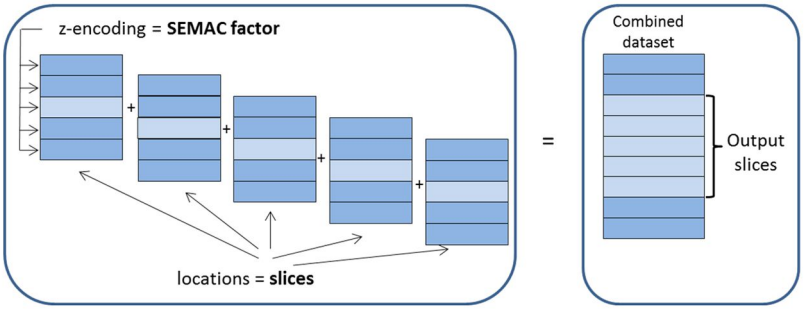
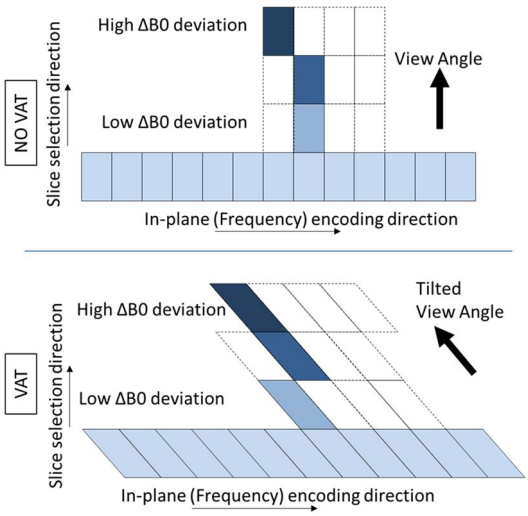


More about VAT

The VAT functionality consists of reapplying the selection gradient during the signal readout and thereby tilting the viewing angle. The view angle is proportional to the ratio of the selection and readout gradient.

Effects of choosing VAT

- With larger view angles which correspond to small readout bandwidths, edges along the slice selection direction might appear more blurry.
- No change in scan time.
- No change in SNR.



Imaging Parameters

O-MAR Imaging Parameters

To enable O-MAR

O-MAR can be enabled or disabled by means of the imaging parameter **O-MAR** on the *Geometry* tab.

This parameter can be set to:

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Possible values	Effect
No	O-MAR is disabled.
MARS+VAT	O-MAR is enabled making use of MARS and VAT techniques.
SEMAC+VAT	O-MAR is enabled making use of SEMAC and VAT techniques.

When O-MAR by means of SEMAC+VAT is enabled, another parameter pops up:

Parameter	Possible values	Effect
Distortion correction	weak, medium, strong	Parameter controls the level of distortion correction for SEMAC+VAT. Changing this parameter could affect the scan time, since it controls the number of z-encodings per slice.

9.9.11 bFFE XD

bFFE XD is a technique to reduce banding artifacts in balanced FFE sequences for inner-ear imaging.

More information

- Imaging parameter **Banding Reduction** in Online Help system (**F1**)
- Imaging parameter **Contrast Enhancement (=Balanced)** in Online Help system (**F1**)
- Scan method **balanced FFE** in Online Help system (**F1**)

9.9.12 3D non-selective FFE and TFE

Allows you to enable the use of a non-selective block pulse (without the use of a slice selection gradient). Compared to the standard situation, which has selective pulses, this means:

- Shorter repetition times, or a better SNR with the same TR.
- Shorter echo times.
- Better volume definition and less signal drop in the outer slices.

Application

- Neuro imaging
- Cardiovascular imaging

More information

- Imaging parameter **3D non-selective** in Online Help system (**F1**)

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10 Troubleshooting and Prevention

10.1 Error Procedures

This chapter provides information about error procedures for computer malfunction, defective hardware, malware detection and error messages possibly occurring when scanning is not possible.

10.1.1 Dealing with Error Messages

During your daily work, error messages may pop up due to operator errors, conflicts, or defects.
An example are error messages during the preparation phase of a scan or during measurement that **Scanning is not possible**.

When an error message appears, proceed as follows:

- Carefully read the error message. Make sure you understand the error message.
- Thoroughly follow the instructions given in the error message.
- Correct the errors according to the error message.
- Only if the error persists, contact your service provider for assistance.
- Enter the error message with the error number, date, and time in the system logbook.

10.1.2 Defective Hardware

If any part of the equipment or system is known (or suspected) to be defective or incorrectly-adjusted, DO NOT USE the system until a repair has been made.

WARNING

Never use surface coils, cable traps and cables which are damaged.

A damaged cable or connector is hazardous because of high voltage across the cable during the transmit phase of the system. Sharp edges may cause injury to patient's skin.

Coils must be returned to the manufacturer's Customer Support for replacement if there is any suspected damage to either the external covering or the coil's internal components. The patient must never be allowed to come into contact with the internal coil connections.

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NOTICE

Damaged coils which are returned to Philips Healthcare must be cleaned by the user as well as practically possible.

For Japan: please contact us for instructions before returning damaged coils.

10.1.3 Malware detection

If the virus scanning software has detected infection by malware, there is no possibility to use automatic repair utilities because the integrity of the repaired software cannot be guaranteed.

In case of infections, always contact your service provider to assess and repair the system.

Be sure to also adhere to local procedures regarding malware infection of customer systems.

10.1.4 Computer Malfunction

If the application software does not respond, the application needs to be closed and the computer restarted.

Exit the application software:

1. On the **System** menu, click **Exit**.
2. In the Exit Confirmation window, click **Yes** to exit the software.

Restart the computer and logon:

- Press the **Windows** key on your keyboard to show the Windows taskbar.
- Click **Start**, then click the arrow next to the **Shut down** button (the button may also say **Log off**).
- Select **Restart** to restart the computer.
- When the computer has restarted, logon as described in chapter “Start the Application Software (Log on)” on page 207.

Switching power off

In the exceptional case that the software does not react (hang up), the computer needs to be reset by switching the power off.

Computer in control room

- Press the **Power Button** until the computer is turned off.
- Startup the computer and logon as described in chapter “Computer start up” on page 956

Computer in technical room

- Follow the instructions described in chapter “Computer start up” on page 956.
  Note that the startup procedure describes switching the power off and on, and logon.

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10.2 Artifacts

Artifacts can occur in MRI for a number of reasons, degrading the image quality and sometimes hindering diagnosis. They may be caused by technical problems and data handling or by physiological effects from the patient. Since most artifacts can be reduced, it is important to recognize them, and to know what can be done to prevent them.

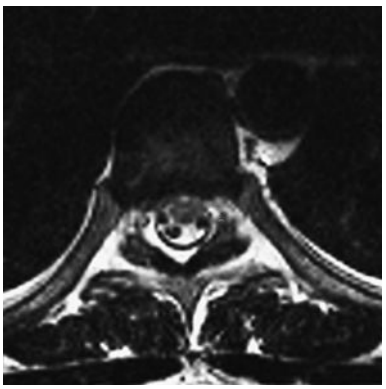
This includes methods of correcting or mitigating such artifacts (e.g. changing bandwidth, gradient moment nulling, pre-saturation, B0 and RF shimming, etc.).

10.2.1 Motion Artifacts

Patient motion is the largest physiological effect that causes artifacts. Motion during the acquisition results in inconsistencies in phase and amplitude, which lead to blurring and ghosting. These artifacts appear in the phase encoding direction, independent of the direction of the motion. The different motion artifacts and their remedies are shown below.

Cardiac Motion Artifact

Artifact appearance	Blurring and ghosting.
Caused by	Signal variation during data collection due to movement of the heart.
Countermeasures	• Cardiac Synchronization. • Triggering in combination with Flow Compensation and REST provides maximum artifact reduction.
Related topics	• Cardiac Synchronization • REST
Preset Procedures	Cardiac Synchronization is used in all heart and thorax procedures to suppress these artifacts.



T-spine image without cardiac triggering.

Artifact Caused by Breathing

Artifact appearance	Blurring and ghosting.

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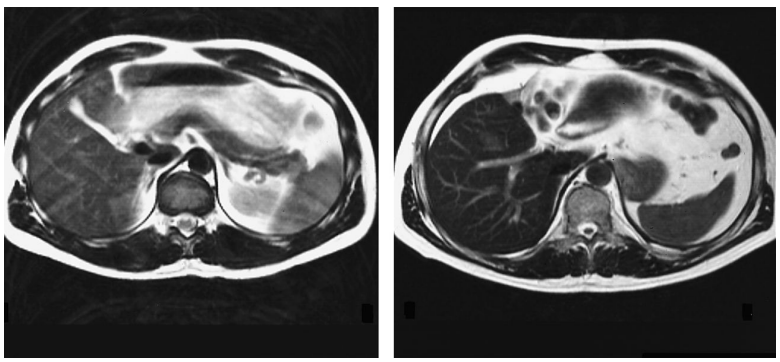
Caused by	Signal variation during data collection due to movement of the chest and the abdominal wall.
Countermeasures	Respiratory Compensation techniques: • Respiratory Triggering: for TSE and TFE scans with a long TR (1800 ms ... 2500 ms). • Breathhold techniques: to be used in FFE- and TFE. • PEAR to be used in SE, FFE and IR. Navigator echo technique
Related topics	• Respiratory Triggering. • Breathhold techniques. • PEAR. • SMART.



Respiratory compensation

Transverse abdomen, left: without RC, right: with RC.

Respiratory compensation:

- is the recommended method for abdominal scans.
- is of minor importance in the thorax area. Most artifacts are caused by cardiac motion.
- should be combined with Cardiac Synchronization in lung imaging.
- is not necessary in the pelvic area, but improves SE images.

Artifact due to Blood Flow

Artifact appearance	Repeated ghost signal in the phase encoding direction or unwanted high blood signal.
Caused by	Flowing blood due to a misregistration effect of blood flowing within or through the image plane, because of the difference in time between the preparation and read-out gradient.

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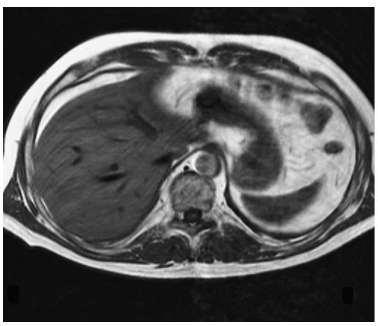
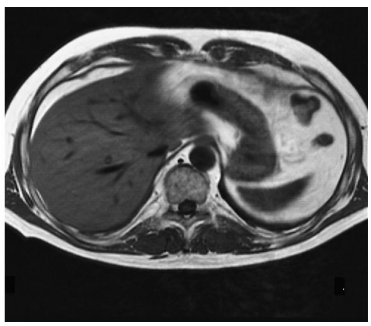
Countermeasures	• REST and Shared REST: especially useful when applying two parallel REST slabs in transverse imaging to saturate the signal of blood flowing through plane. Blood will appear as a signal void instead of high signal intensity. • REST in combination with Flow Compensation (FC) for optimum results. • REST in Inflow MRA to suppress venous or arterial flow. • Cardiac Synchronization in MRA to get rid of pulsation artifacts of vessels.
Related topics	• REST (Regional Saturation Technique).





Transverse scan of abdomen:
Left: without REST and FC.
Right: with REST and FC.

CSF Pulsation Artifact

Artifact appearance	Ghost artifacts superimposed in the image.
Caused by	Signal variations during data collection due to pulsatile CSF flow.
Countermeasures	• Flow Compensation has proved to be very useful in sagittal spine images and axial liver images. • Cardiac Triggering is an additional option if Flow Compensation is applied and there are still flow artifacts. • Inherently compensated: b-FFE (balanced FFE).
Related topics	• Flow Compensation. • Cardiac Triggering. • b-FFE.

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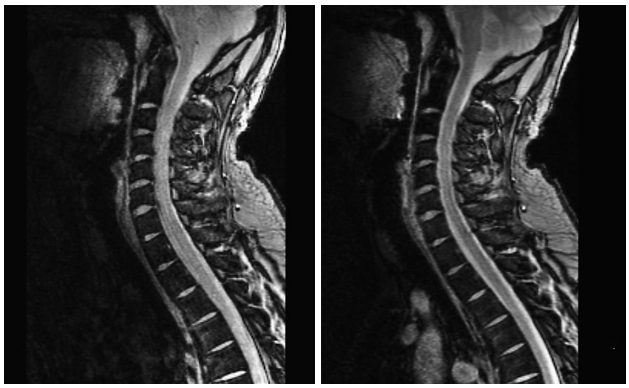
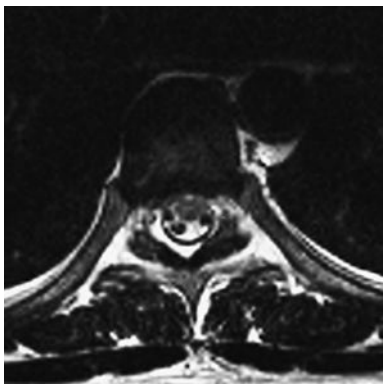


C-spine.

Left: without FC.
Right: with FC.

Flow Void Artifact

Artifact appearance	Black hole like artifacts in axial and sagittal T2W TSE scans with a high TSE-factor.
Caused by	Fast flowing CSF.
Countermeasures	• Increasing the TSE-factor (minimize echo spacing) so that the scans are less sensitive to flow. • Flow Compensation. • Cardiac Triggering. • Use of b-FFE (balanced FFE). • Performing a 3D TSE multichunk instead of a MS TSE scan.
Related topics	• Flow Compensation. • Cardiac Triggering.



Transverse TSE spine with flow voids.

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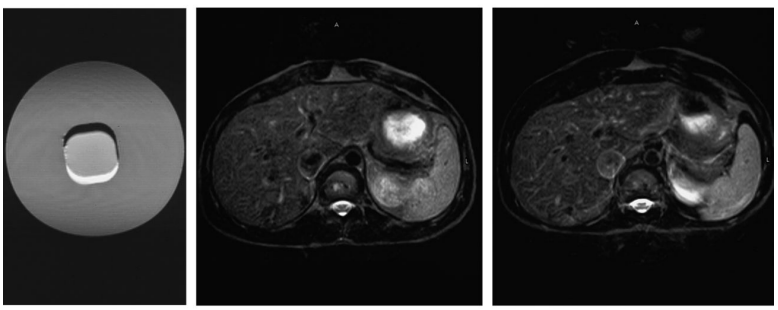
10.2.2 Chemical Shift Artifacts

Water-Fat Shift

Artifact appearance	Hypo- and hyperintense lines between tissue boundaries • in frequency encoding direction for non-EPI/GRASE scans • in phase encoding direction for EPI/GRASE scans.
Caused by	Resonance frequency diffference between water and fat resulting in displacement between water and fat by a number of pixels. The hypointense lines are originated by empty voxels and hyperintense lines by superimposed signals.
Countermeasures	• Set the parameter WFS (Water-Fat Shift) to a user defined value. Note that using a smaller WFS decreases the artifact at the cost of SNR. • Change the Fat-Shift direction.
Related topics	• Water-Fat Shift. • Fat-Shift Direction.



From left to right:
WFS on phantom.
Small WFS.
Large WFS.

NOTICE

The chemical shift artifact increases with the field strength.

Water-Fat Dephasing

Artifact appearance	Signal dephasing in voxels containing both water and fat showing up as black lines around anatomic structures.
Caused by	• Resonance frequency differences between water and fat AND • Use of an 'out of phase TE' (water and fat signals are out of phase).

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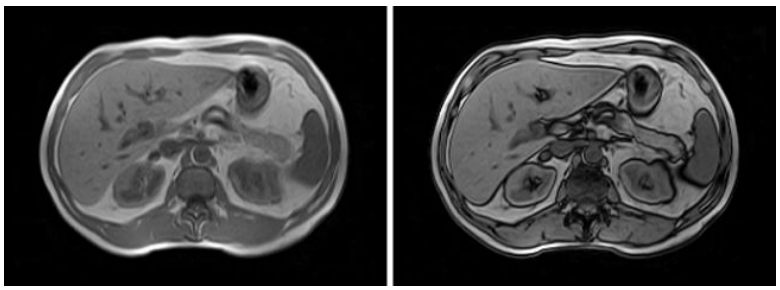
Countermeasures	• Choose an 'in phase echo time' (field strength dependent). See table below.
Related topics	• Water-Fat Shift. • Fat Shift Direction.



Left: water and fat are in phase.

Right: water and fat are out of phase.

In Phase and Out of Phase Echo Times

	1.0T	1.5T	3.0T
In phase TE [ms]	6.9	4.6	2.3
	13.8	9.2	4.6
	20.7	13.8	6.9
	27.6	18.4	9.2
		23.0	11.5
Water and fat are in phase when the TE is a multiple of ... [ms]	6.9	4.6	2.3
Out of phase TE [ms]	3.45	2.3	1.15
	10.35	6.9	3.45
	17.25	11.5	5.75
	24.15	16.1	8.05
		20.7	10.35

NOTICE

These values are based on calculations.

Actual values depend on fat characteristics.

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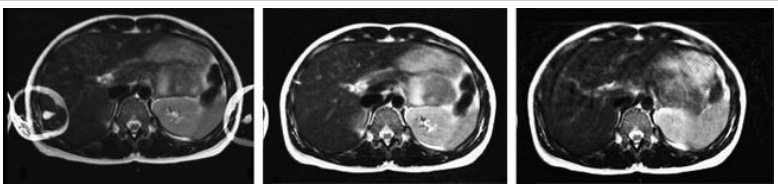
10.2.3 Aliasing Artifacts

Aliasing

Aliasing artifacts are also referred to as fold-over artifact.

Artifact appearance	Tissue outside the FOV which is folded back into the image, most commonly occuring in fold-over direction (phase encoding direction). • In 3D scans also possible in slice direction.
Caused by	The spins within the FOV acquire a maximum phase shift of n x 360°. Spins just outside the FOV have a phase shift of more than one cycle. This results in misregistration of those spins.
Countermeasures	• Fold-over suppression: Signal from outside the FOV is suppressed. • Increase RFOV so there is no tissue outside the FOV. • Change the fold-over direction if possible so there is no tissue to fold back. This also depends on other artifacts that might occur. • Use REST slabs to saturate tissue outside the FOV.
Related topics	• Fold-over suppression. • REST. • RFOV. • SENSE.



Transverse scan.

Left: Fold-over Direction=LR, no Fold-over Suppression.
Middle: Fold-over Direction=AP, no Fold-over Suppression.
Right: Fold-over Direction=RL with Fold-over Suppression.

Aliasing in PCA

Artifact appearance	Decreased signal intensity in the centre of the vessel. If a scan is made with a PC velocity smaller than the peak blood velocity, the signal in the middle of the vessel is aliased and presented as backward flow.
Caused by	Aliasing.

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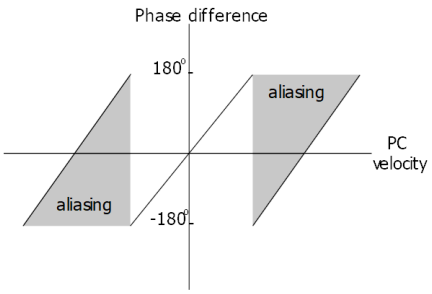
Countermeasures	► Select the maximum (peak) velocity in the vessel somewhat higher. • Start with a flow measurement in the vessel of interest. • Draw a ROI in the vessel and generate a Time Intensity Diagram (TID). • Select the appropriate velocity encoding by means of this TID. ► Make the scan with a lower PC velocity to get a good impression of the vessel lumen. *The aliasing artifacts in the centre are in this case not important and might not even be noticed in a MaxIP.*
Related topics	• PCA.
	• QFlow.

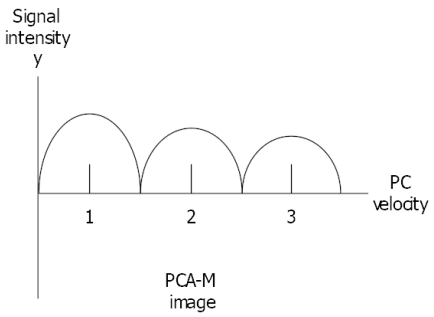
Relation between signal intensity and velocity encoding in PCA-M image

The signal intensity depends on the PC velocity: it increases to a maximum PC velocity 1, drops then and increases again until PC velocity 2. Then the maximum signal intensity at PC velocity 2 is smaller than that compared to PC velocity 1, due to spin dephasing.

Linear relation between phase (difference) and PC velocity

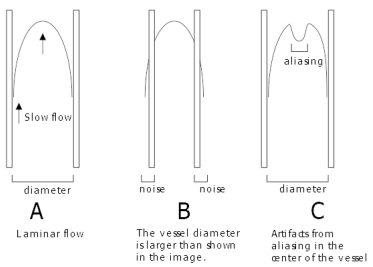


Signal intensity and PC velocity encoding in PCA-M image

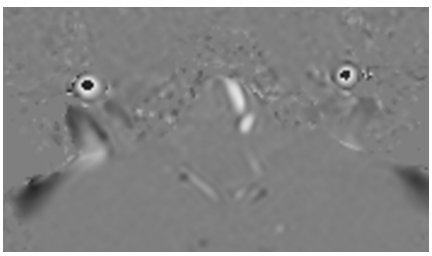


PCA cross section through vessels:

In a straight vessel, there is only laminar flow.
The velocity differs over the lumen: in the centre the highest, at the vessel wall much slower. This difference in velocities is seen as phase dispersion: the signal intensities are a mixture of the velocities over the vessel lumen.Phase dispersion might result in a decrease of signal intensity.



QFlow: Aliasing in the center of the vessels



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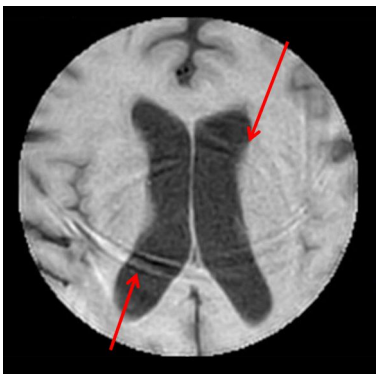
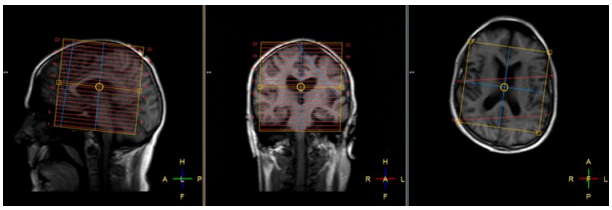
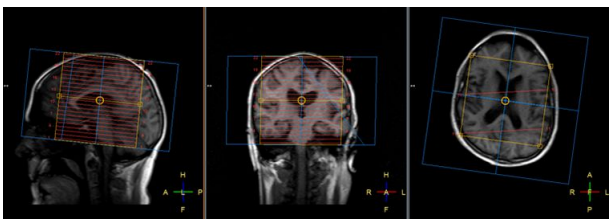
Spiral Fold-Over Artifact

Artifact appearance	Fold-over artifacts when using Spiral Brain. 
Caused by	Planning with an FOV that is too small and without fold-over suppression. 
Countermeasures	Use fold-over suppression: Only one value needs to be filled out, this value will be distributed symmetrically. Example of a symmetric distributed fold-over value (in this case AP and LR have the same fold-over value): 
Related topics	• Imaging parameter **Fold-over suppression** • Imaging parameter **Acquisition mode = spiral**

Flame artifacts

Artifact appearance	Hypo- and hyperintense lines in flame shape, especially at tissue borders.
Caused by	High-intensity signal from tissue outside the FOV is folded back into the image, mostly caused by arms positioned alongside the body.

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Countermeasures	• Use ENCASE in coronal 3D-FFE/-TFE scans. • Increase the FOV so there is no tissue outside the FOV. • Change the fold-over direction if possible so there is no tissue to fold back. This also depends on other artifacts that might occur. • Use REST slabs to saturate tissue outside the FOV.
Related topics	• Fold-over suppression. • REST. • ENCASE.

More information

- In the Online Help: How does ENCASE work?
- In the Online Help: How to enable ENCASE? Imaging parameter **ENCASE enable**

10.2.4 SENSE Artifacts

Intrinsic Backfolding

Artifact appearance	Backfolding in the center of the image or or the 3D volume: • in-plane (fold-over direction) in M2D and MS scan mode, • also in slice direction in 3D scan mode
Caused by	FOV, RFOV or 3D volume have been planned too small. Special attention has to be given to double-oblique cardiac scans.
Countermeasures	Enlarge FOV, RFOV or 3D volume. Increase the flexible fold-over suppression area.

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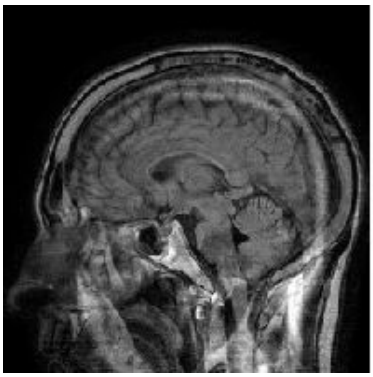
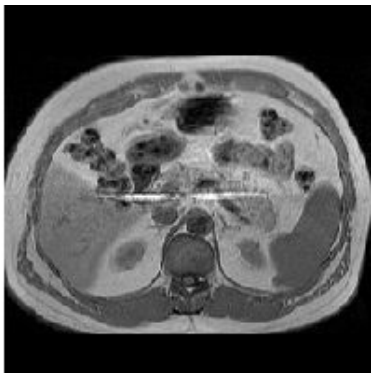
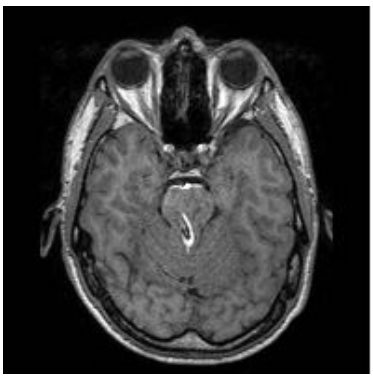
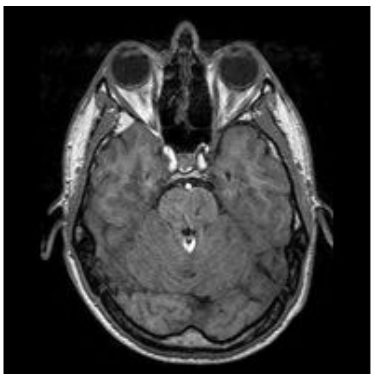




Left: 3D - intrinsic backfolding in slice direction.

Right: MS - intrinsic backfolding in plane.





Left and right: The ear folds back in MS scan.

Intrinsic Backfolding of Artifacts

Artifact appearance	Fold-over of ghost artifacts from just outside the FOV.
Caused by	FOV, RFOV or 3D volume have been planned slightly too small.
Countermeasures	Enlarge FOV, RFOV or 3D volume. Increase the flexible fold-over suppression area.

Cut-Line Artifacts

Artifact appearance	Dark area separated from a bright area by a cut-line.
Caused by	The coil elements move during the scan due to breathing.
Countermeasures	Right mouse: repeat prescans.

Single-Shot Sequences and Fat Shift Direction

Artifact appearance	Susceptibility related artifact in single-shot EPI sequences with SENSE, fold-over direction AP and fat shift direction A(nterior): • E.g. high signal at the border of the frontal sinus. • Especially in b0 images in diffusion weighted scans. Less pronounced in high-b images which in turn might result in low signal in the calculated ADC-map.

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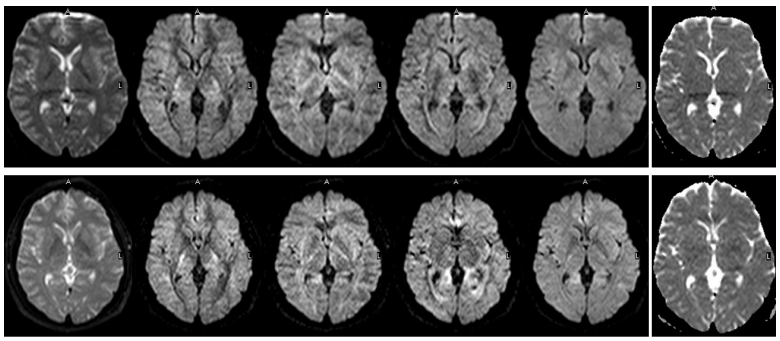
Caused by	Fat shift direction set to A(nterior) in these scans.
Countermeasures	Set the 'Fat shift direction' to 'P(osterior)' in all cases.
Related topics	SENSE. Fat shift direction.



Upper row: Fat Shift Direction = Anterior.

Lower row: Fat Shift Direction = Posterior.

10.2.5 Compressed SENSE Artifacts

This chapter describes the artifacts which occur for Compressed SENSE based techniques like CS-SENSE and AI CS-SENSE.

The following terminology is used in the following sections:

- **Compressed SENSE** refers to generic behavior of Cmpressed SENSE based reconstruction.
- The terms **CS-SENSE** and **AI CS-SENSE** refer to specific characteristics of each of these techniques.

Overview

AI CS-SENSE

In **AI CS-SENSE**, the same artifacts can occur as in **CS-SENSE**.

However, the artifact level can differ, because **AI CS-SENSE** removes the noise to a higher extent than **CS-SENSE**. In **AI CS-SENSE**, artifacts can be visible that are hidden just below the noise level in **CS-SENSE**.

CS-SENSE and AI CS-SENSE versus SENSE

CS-SENSE, AI CS-SENSE and SENSE behave very much alike with respect to acceleration, patient motion and aliasing artifacts.

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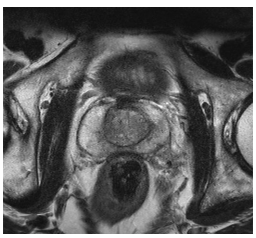
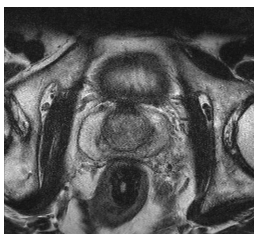
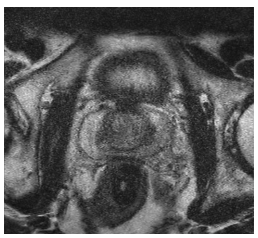
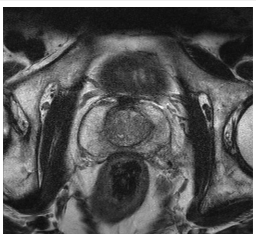
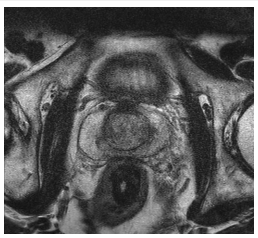
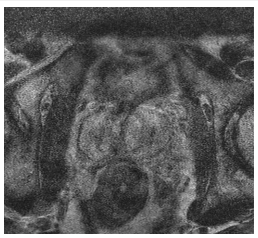
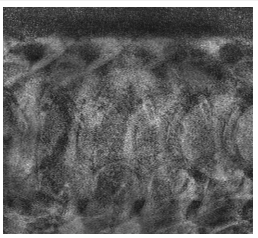
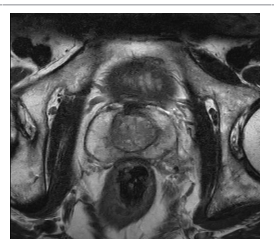
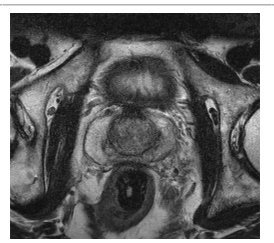
Acceleration and Effects of the Reduction Factor

With high acceleration in CS-SENSE, AI CS-SENSE and SENSE scans, noise breaks through, and aliasing artifacts may occur.
The images below show that the CS-SENSE and AI CS-SENSE images are equally affected as SENSE images: The higher the reduction factor, the noisier the images, and the more aliasing artifacts appear.

- To improve SNR, decrease the **reduction factor**, or increase the **denoising factor**.
- To reduce aliasing artifacts, decrease the **reduction factor**.

Similarly, to SENSE, when the operator selects a too high **reduction factor** there is a potential loss of information possible due to the reduction in SNR and increased artifacts. In the images below it can be seen that there is a gradual decrease in image quality and that artifacts appear when the **reduction factor** is too high. The default **reduction factors** provided with the device are optimized for the specific protocol and cover a range from 1-32 depending on the application.

For contrast-enhanced applications, gradual loss of SNR may be more difficult to identify, especially with high **reduction factors**. Do not use **reduction factors** higher than 8 for contrast-enhanced applications.

Comparison without the use of contrast agent	Reduction factor 1	Reduction factor 2	Reduction factor 5	Reduction factor 10
CS-SENSE				
SENSE				
AI CS-SENSE				

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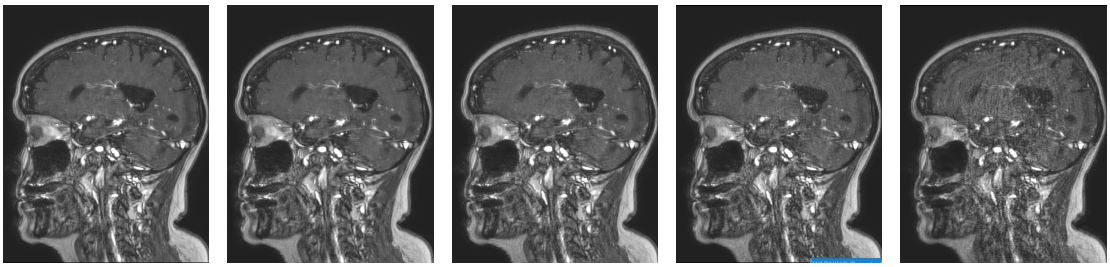
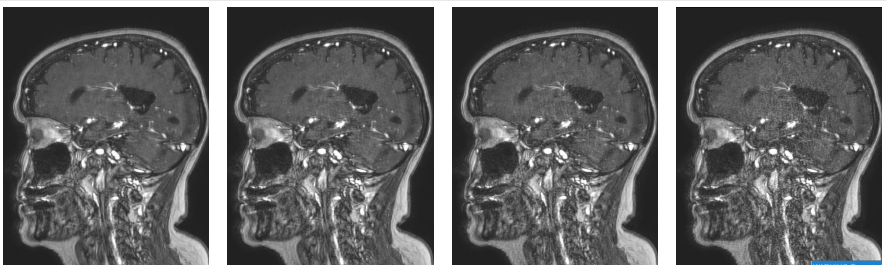
Comparison with the use of contrast agent	Reduction factor 1	Reduction factor 2	Reduction factor 4	Reduction factor 8	Reduction factor 12
Compressed SENSE					
SENSE					

Noise Appearance and Denoising

The **Denoising** imaging parameter allows you to qualitatively specify the amount of denoising in image reconstruction.

Possible values are:

- For **CS-SENSE**: **no**, **weak**, **medium**, **strong** and **user defined**.
- For **AI CS-SENSE**: **no**, **weak**, **medium**, **strong**, **max** and **user defined**.
  - When set to **no**, denoising does not take place.
  - When set to **weak**, **medium**, **strong**, or **max**, denoising takes place with increasing strength.
    This means less noise in the images, but more artificial smoothing.
  - When set to **user defined**, you can specify the **denoising level** numerically.

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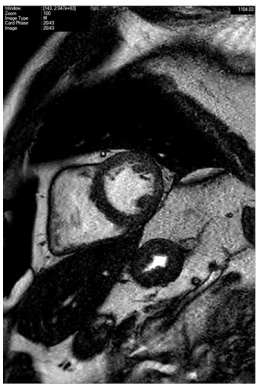
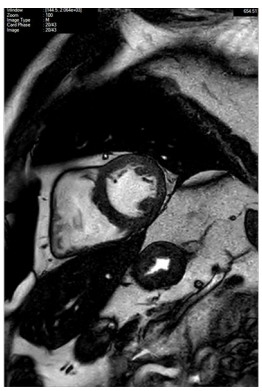
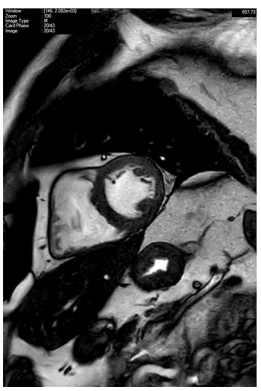
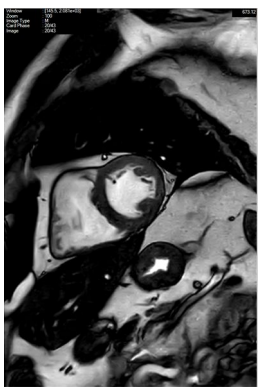
CS-SENSE		
Weak denoising	**Medium denoising (system default)**	**Strong denoising**
		

AI CS-SENSE		
Weak denoising	**Medium denoising (system default)**	**Strong denoising**
		

Use the **Denoising** parameter to set a balance between the amount of noise and the smoothness of images, according to your preference.

- To improve SNR, increase **Denoising**, for example from medium to strong.
- To reduce blurring, decrease **Denoising**, for example from medium to weak.

Patient motion and Aliasing Artifacts

Aliasing artifacts in Compressed SENSE based techniques may occur due to patient motion during the reference scan, between the reference scan and the clinical scan, or during the clinical scan.

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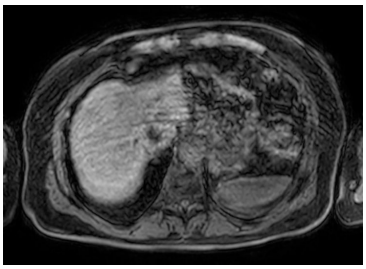
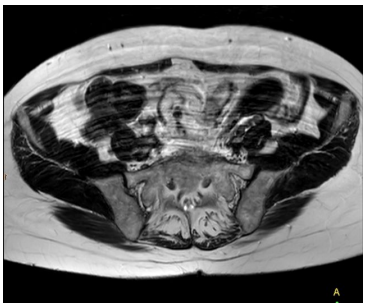
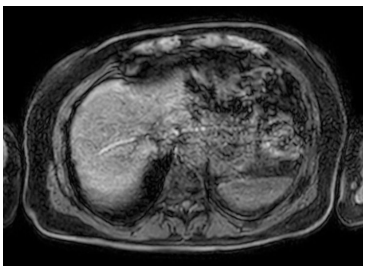
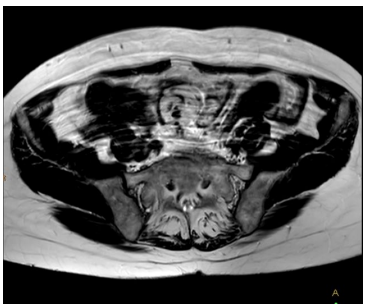
The table below compares aliasing artifacts in CS-SENSE, AI CS-SENSE and SENSE scans with similar **reduction factors**:

- It shows that aliasing artifacts are similar in CS-SENSE, AI CS-SENSE and SENSE when similar **reduction factors** are used.
- It provides you with countermeasures.

Comparison with similar reduction factors	Resulting image when patient motion occurs during the reference scan or between reference scan and clinical scan	Resulting image when patient motion occurs during the clinical scan
CS-SENSE		
SENSE		
Countermeasure	Repeat the reference scan.	Repeat the clinical scan.

Flame Artifact

Artifact appearance	Stripes
Caused by	Caused by difference in imaging sequence between SENSE reference scan and clinical scan.
Countermeasures	• Decrease the **reduction factor**. • Use REST slabs.
Related topics	• SENSE • CS-SENSE, and AI CS-SENSE

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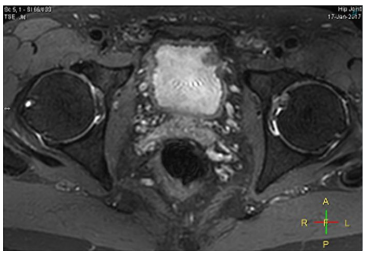
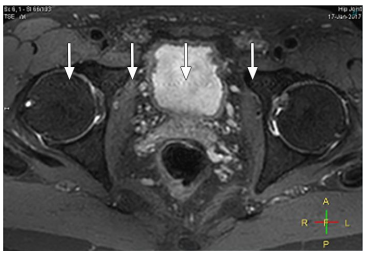
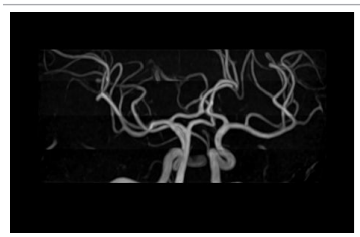
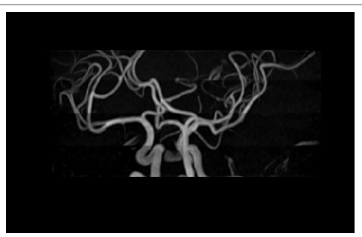
Influence of the reduction factor in Compressed SENSE based techniques

SENSE	Compressed SENSE based technique Low reduction factor	Compressed SENSE based technique High reduction factor
		
Identical scan and reconstruction resolution, same NSA		
Scan time: 6:39 min	Scan time: 4:39 min	Scan time: 3:29 min

10.2.6 MRA Inflow artifacts

Venetian Blind Artifact

Artifact appearance	Dark bands (signal decrease) at the end of a volume in the MIP's (Maximum Intensity Projection) of a multichunk 3D Inflow MRA-technique. The larger the volume, the more prominent this effect.
Caused by	Saturation effects.
Countermeasures	• TONE. • CHARM. The artifact doesn't occur anymore with CHARM being introduced with Release 9.
Related topics	• TONE. • CHARM.

Left and right: MIP oblique Multichunk scan.

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Staircase Artifact

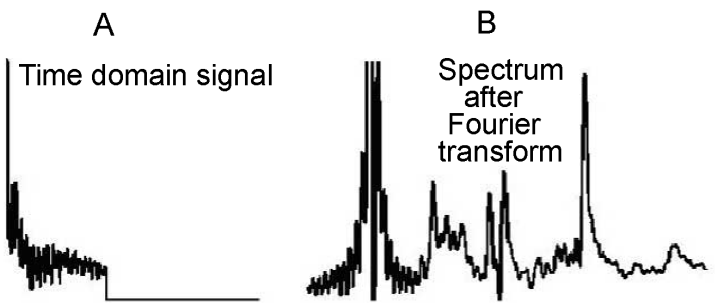
Artifact appearance	Staircase in the MIPs of an M2D Inflow technique.
Caused by	Saturation effects.
Countermeasures	• Use a slice gap with a negative value. Normally an overlap of 25% - 30% is sufficient.

10.2.7 MR Spectroscopy Artifacts

Like MR-imaging, MR-spectroscopy techniques can suffer from artifacts. Some of these artifacts are hard to recognize, but can completely alter the outcome of the spectrum. It is important to recognize the artifacts and to know how to avoid them.

Truncation at the End of the Signal

Artifact appearance	Artifacts presented as sinc wriggles around the peaks appear in the spectrum. The wriggles are mainly seen around the residual water peak.
Caused by	Signal sampling is stopped before the signals have decayed to (close to) zero resulting in abrupt signal intensity changes which cannot be handled well by the Fourier transform.
Countermeasure / Solution	Re-acquisition with increased Tacq is the best solution, but time is not always available to do so. For signal to decay completely to zero, the Tacq should be at least 5 x T_2* relaxation time. Increase Tacq by: • Increased number of sampled with equal bandwidth. • Reduce bandwidth with equal number of samples. If re-acquisition is not an option, filtering of the time domain signal is used to influence the signal such that abrupt signal intensity changes are removed. Note that linewidth increases by applyingfilters.



Time-domain signal (A) that is cut off before signal has decayed, and the resulting spectrum (B). The baseline is distorted by sinc wriggles.

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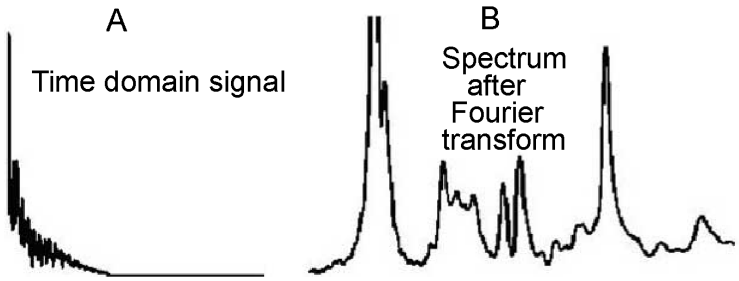


Same time domain signal (A), with additional Gaussian filtering applied (6Hz). No truncation artifacts in resulting spectrum (B), at the cost of spectral resolution.

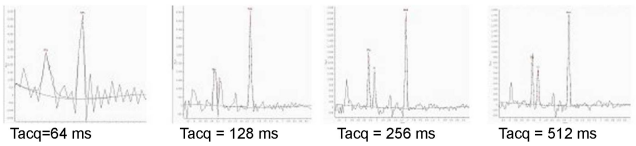
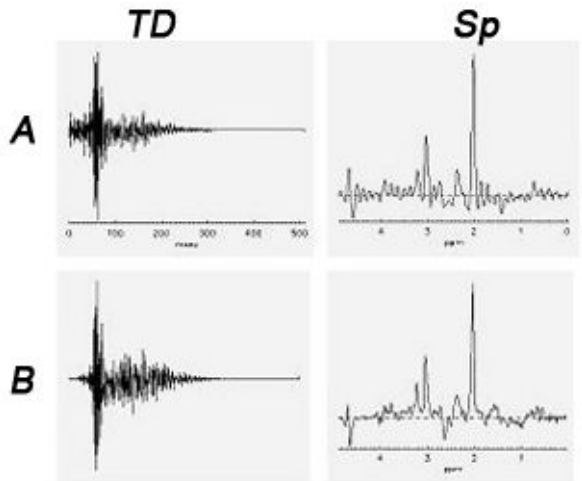


Image examples in healthy volunteer:

SVS TE 144 ms. Different Tacq's.

Truncation with Maximum Echo Sampling

Artifact appearance	Artifacts presented as sinc wriggles appear around the baseline of the spectrum.
Caused by	If maximum echo signal sampling is used and signal sampling only starts close to the echo top position, abrupt signal intensity changes which cannot be handled well by the Fourier transform will occur at the start of signal sampling. This will mainly happen if maximum echo is used with short TE.
Countermeasure / Solution	Asymmetric filtering is applied with the symmetry point set to the echo top position.



A: Unfiltered signal,

versus

B: filtered signal (asymmetric filter) where TD is the time domain signal and Sp thespectrum: truncation effect is seen in the unfiltered time domain signal, resulting in wriggles in the baseline of the spectrum whereas the artifacts are minimized when applying an asymmetric filter.

Saturation

Artifact appearance	Saturation effects in the spectrum.

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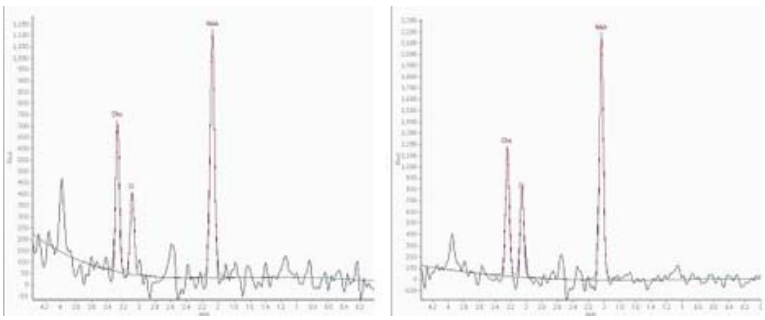
Caused by	Incomplete T_1 relaxation. To maximally measure the metabolite signals, full T_1-relaxation is required before the next excitation is performed. Saturation effects are seen if T_1-relaxation is not complete. The amount of saturation is different for the various metabolites and saturation effects will affect the values found during peak fitting. Even though the saturation effect is not hindering spectral quality, it is mentioned in the artifact section, as it something to be aware of.
Countermeasure / Solution	To allow full T_1-relaxation, the TR used should be ^{3} 5*T_1 of the metabolite of interest. As T_1-relaxation times of metabolites are long, scan times would increase tremendously.



Brain spectra (inverted) from a healthy volunteer.

The Cho/Cre ratio is changed from 1.69 (1000 ms) to 1.44 (4000 ms).

NOTICE

If full T_1-relaxation is not achieved within the TR chosen, it is important to acquire some start-up acquisitions.

These shots are used to place the spin system into steady state.

Frequency Drift

Artifact appearance	Increased linewidths. Peaks smear out.
Caused by	Frequency drift. As part of the preparation phases, a f0 determination is performed. During the long spectroscopy scan, this f0 frequency could change slightly,
Countermeasure / Solution	• Save each FID separately, correct for the drift in post-processing.

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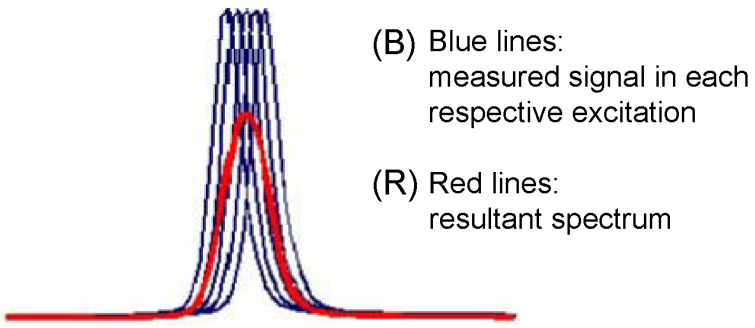

As the frequency of the peak slightly changes over time, the resultant spectrum will show up as a broader peak with reduced amplitude.

- Blue lines (B): Measured signal in each respective excitation.
- Red lines (R): Resultant spectrum.

Ghosting

Artifact appearance	Distorted spectra in row of voxels with equal phase encoding gradient. For CSI: even in two directions as phase encodings is done in two directions.
Caused by	(Pulsatile) through-plane flow: Like in MR imaging, (pulsatile) through-plane flow can cause ghosting in the phase encoding drections in spectroscopic imaging.
Countermeasure / Solution	To reduce the signal intensity of through-plane flow, parallel REST slabs can be positioned above and below the stack of CSI-slices.

Baseline Distortions

Artifact appearance	Baseline distortions, mainly seen in short TE spectra.
Caused by	Signals of fast realaxing macromolecules and/or signals of unsuppressed water which are still present in the first few points in the time domain signal. These baseline distortion hamper good fitting and quantification.
Countermeasure / Solution	• In time-domain: take out the first points of the FID with shift with zero padding. • In frequency-domain:fit polynomial spline.

It is caused in the first few points in the time-domain signal, where signals of fast-relaxing macromolecules and/or signals of non-suppressed water are still present.

These baseline distortion hamper good fitting and quantification.

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DC-Offset

Artifact appearance	Spike signal in the spectrum at zero frequency.
Caused by	Time domain signal decay to a constant, but not to zero.
Countermeasure / Solution	• Phase cycling, to cancel the effect in subsequent measurements. • Subtract the last 10% of the FID.

Incomplete Water Suppression

Artifact appearance	Wriggle artifacts around the (residual) water peak.
Caused by	Incomplete water suppression: residual water signal from outside of the volume of interest gives rise to stimulated echoes, causing artifacts.
Countermeasure / Solution	• Phase cycling (is already implemented in preset procedures). • REST slabs around the VOI to suppress non-suppressed water. • Longer duration of the spoiler gradients.

Residual Signals

Artifact appearance	Signals around -2ppm and +10ppm in corrected spectra.
Caused by	Presence of high fat signal in the reference measurement.
Countermeasure / Solution	Reprocess without use of reference measurement.

Stimulated Echo Artifact

Artifact appearance	Additional unwanted peaks and noise on the spectrum (top image: see arrow).
Caused by	Unwanted echoes are formed by a combination of the RF pulses in the sLASER sequence. These signals can originate from regions outside the selected VOI.
Countermeasures	• Enable strong crushers (contrast tab). • Increase the number of phase cycles (motion tab) as high as possible (32 phase cycles is possible for sLASER).
Related topics	• -

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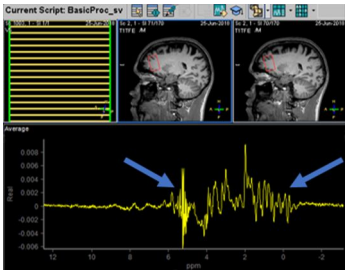
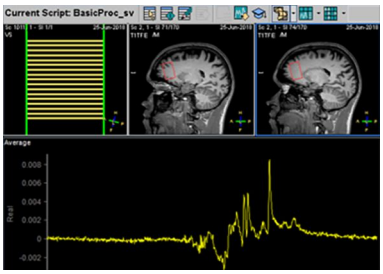
Philips

	Spectrum with stimulated echo artifacts. The blue arrows indicate the unwanted peaks and the noise on the spectrum.
	Spectrum without stimulated echo artifacts.

10.2.8 Metal Artifacts

Magnetic Material Artifacts

Artifact appearance	Signal loss around ferromagnetic material or metallic material.
Caused by	• Magnetic field distortions by ferromagnetic metal implants such as hip prostheses, surgical wires and clips, and also some eye cosmetics and small metallic particles. • Eddy currents induced in non-ferromagnetic metallic material by switching gradients.
Countermeasures	• Remove any kind of ferromagnetic and metallic material.

Susceptibility Artifacts

Artifact appearance	• Signal dephasing resulting in misregistration at interfaces of tissues with different magnetic susceptibility. • in FFE- and EPI-scans.
Caused by	• Different magnetic susceptibility (different local magnetic fields). For example, at interfaces between air and tissue, inhomogeneities are induced.
Countermeasures	• Larger matrix size or smaller FOV (smaller pixels). • Shorter TE. • A smaller WFS value and control of Fat Shift Direction. • Full acquisition (scan percentage 100%).

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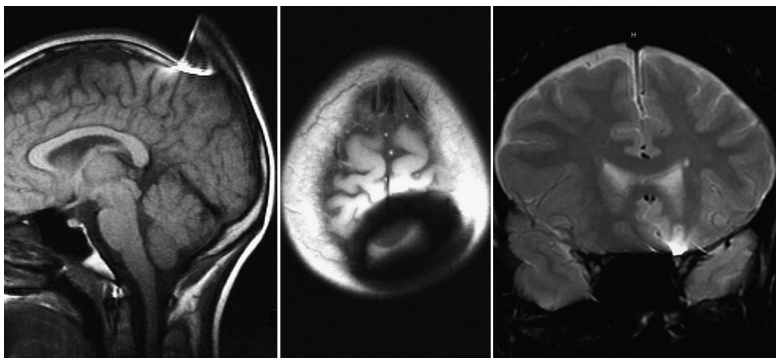
Related topics	• FFE and EPI. • Fat Shift direction.

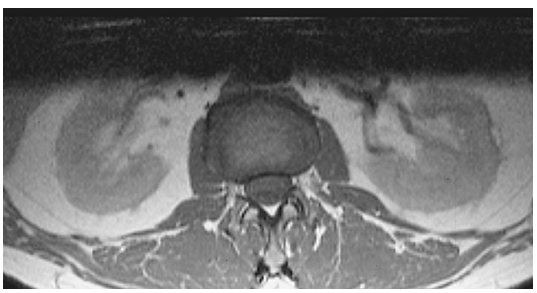


Left: Sagittal brain with magnetic field distortion (hairpin).
Middle: Same patient, transverse scan.
Right: Susceptibility artifact in EPI scan.

10.2.9 Signal Cancellation (Suboptimal Planning)

REST Artifact

Artifact appearance	Signal distortion in the region where the REST has been applied.
Caused by	Two free REST slabs which intersect each other.
Countermeasures	Applying the REST slabs such that they do not overlap.
Related topics	REST.



Multiple Stack Artifact

Artifact appearance	Black line artifacts in a multistack scan where slices of the different stacks overlap or cross over.
Caused by	When the stacks are measured in one package, the measurement is done in an interleaved manner. Interference between the different slices occurs which results in signal loss.

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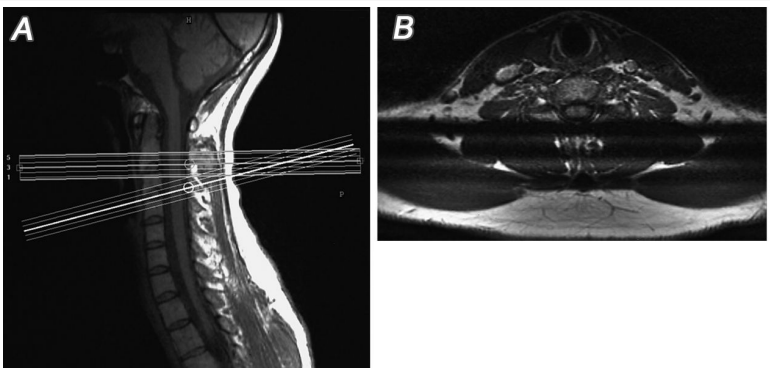
Countermeasures	• Planning the stacks in different packages (Parameter 'Stacks as packages'). • Changing the position or angulation of the stacks such that they do not overlap.
Related topics	• Stacks.



A: Planscan of B.

B: Transverse spine imamge with multistack artifact.

10.2.10 Fat-Related Artifacts

Fat Suppression Artifact

Artifact appearance	Fat is not completely suppressed using the SPIR-, SPAIR- or ProSet-technique.
Caused by	• locally distorted magnetic field (B0): water could partially be suppressed instead of fat. and/or • locally distorted RF field (B1): the flip angle used for the SPIR- and ProSet-pulse could slightly vary over the FOV.
Countermeasures	• There are several ways for complete fat suppression. See following list.
Related topics	• STIR. • SPIR. • SPAIR. • ProSet. • Shimming.

NOTICE

SPAIR, SPIR and ProSet are critical with regard to the magnetic field homogeneity.

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Countermeasures

Patient preparation

- Remove all metal (also dentures, dental devices) from the patient.
- Ask the patient to remove eye make-up (often containing metallic particles).
- Make sure the patient has been to the toilet, because high signal intensities (e.g. full bladder) may disturb the autoshim.

Positioning

- Ensure that the area of interest is as close as possible to the isocenter (less than 80 mm in any direction).
- Always move the table whenever 'travel to scan plane' is prompted.
- Avoid placing two objects (knees, ankles) in one FOV.
- In some cases, the use of pads made out of special material (e.g. satpads®) may help. Note that by putting the pad between surface coil and patient, the SNR may adversely be affected (larger coil-patient distance).

Parameter settings

- Adjust the FOV to the anatomy of interest.
- Use volume shimming and select the area that needs to be fat suppressed.

Alternative

Do not use spectral fat suppression on anatomies that suffer from large susceptibility effects (neck, cervical spine, thoracic spine). Use STIR instead.

STIR-sequence

- IR or IR-TSE with a short TI.
- providing good fat suppression.
- not useful in combination with contrast agents since they will suppress all tissues with a short T1 including contrast enhanced tissues.

Quadrupole Artifact

Artifact appearance	Signal intensity variations with SPIR, especially in abdomen and pelvis.
Caused by	Eddy currents in the patient. This results in B1 disturbance from left to right and from anterior to posterior.
Countermeasures	STIR or SPAIR instead of SPIR.
Related topics	• STIR. • SPIR. • ProSet. • Shimming.

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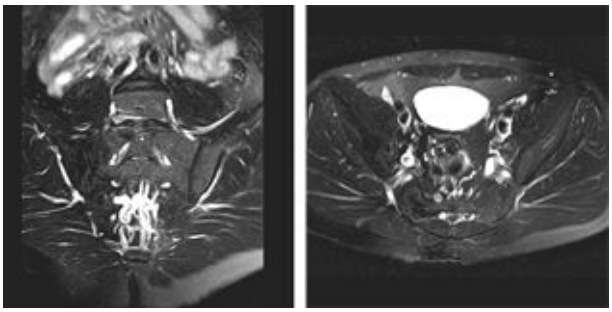


Left: Coronal oblique.

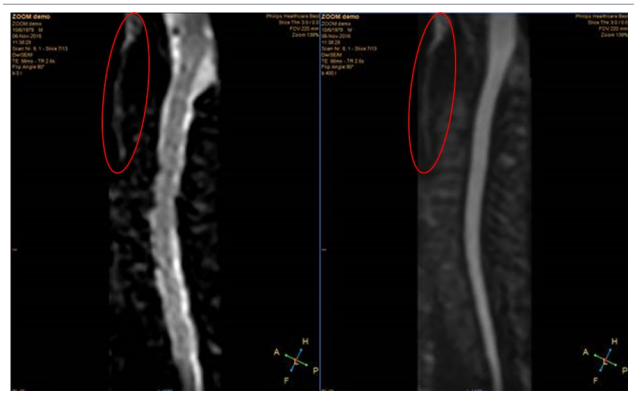
Right: transverse.

NOTICE

Both, SPIR and ProSet are very critical with regard to the magnetic field homogeneity.

Fat Ghosting in Zoom Imaging

Artifact appearance	Fat outside the FOV which is superimposed to the image as ghost artifact, most commonly occuring in fold-over direction (phase encoding direction). • In 3D scans also possible in slice direction.
Caused by	Different resonance frequencies of fat and water. This leads to phase differences and consequently to ghost artifacts.
Countermeasures	• Shimming. • Change the fold-over direction if possible. • Use REST slabs to saturate fat outside the FOV. • Use a fat suppression technique such as SPIR or SPAIR.
Related topics	• Fat suppression. • REST.



Sagittal DWI spine scans utilizing zoom imaging with ghosting artifacts from fat.

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10.2.11 Gibbs (Truncation) Artifacts

Ringing (Gibbs) artifacts

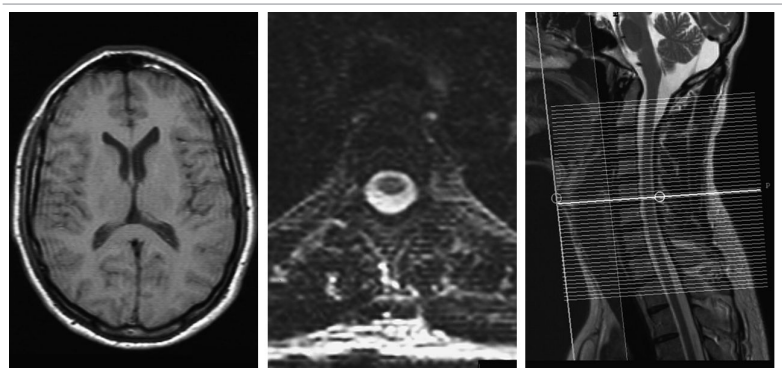
Artifact appearance	Ring like or linear truncation artifact, also called Gibbs artifact.
Caused by	Reduced acquisition. The artifacts are induced by high contrast transitions, and are particularly common with scan percentages below 80%.
Countermeasures	• Ringing filtering: Pre-reconstruction filter which also smooths the image. • Higher 'Scan Percentage' value.
Related topics	• Scan Percentage.

Zebra Stripe Artifact

Artifact appearance	Zebra stripes.
Caused by	REST saturation pulse interfering with the data acquisition in 3D-TSE scans.
Countermeasures	• Change the number of REST slabs. • Decrease the TSE factor. • Use an even number of 'true' NSA.

NOTICE

This artifact does not occur anymore in TSE scans with more than 1 'true' NSA.



Left: 60% scan percentage without ringing filter.

Middle: Zebra stripe artifact.

Right: Planscan 3D-TSE.

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10.3 VCG Calibration

10.3.1 Calibration Results

Upon completion of manual VCG calibration, the results are automatically analyzed and displayed as:

- Signal **Strength** (as color scale and expressed in mV)
- Trigger **Quality** (as color scale).

Color scale	Description	Signal strength	Trigger quality (Percentage of false signals)
	Excellent results. Proceed.	>2.0 mV	<5%
	Very good results. Proceed.	1.5 mV - 2.0 mV	between 5% and10%
	Good results. Proceed.	1.0 mV - 1.5 mV	between 10% and 15%
	Sub-optimal results. Corrective actions recommended.	0.6 mV - 1.0 mV	between 15% and 20%
	Bad results. Corrective actions strongly recommended.	<0.6 mV	>20%

If the VCG calibration results are sub-optimal or bad, corrective actions are recommended:

10.3.2 Low signal strength

Problem	The main cause of low signal strength is a sub-optimal lead placement (for example skin preparation, position of electrodes, distance between electrodes). A message is displayed when the detected signal strength is 1.0 mV or lower. Patient condition can also lead to low signal strength.
Message on screen	**VCG calibration completed.** • **Signal strength-1.00 mV** • **Trigger quality** **Check the electrode setup. Correct if possible.**

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Countermeasures	► Check, and if possible, correct the electrode set-up. See chapter "Connecting VCG to the patient" on page 366. ► Click **Repeat** to start a new calibration. **Alternatives** • Click **Accept** to continue with the sub-optimal results, or • click **Cancel** to discard the results and continue with a previously stored VCG calibration results.

10.3.3 Low signal quality

Problem	During the evaluation of the results, a percentage of false positive, false negative and not-classified signals is calculated. False positive and false negative signals are more likely to occur in case of patient motion. A message is displayed when the percentage of detected false signals is > 15%.
Message on screen	**VCG calibration completed.** **Patient may have moved. Recommended to repeat.**
Countermeasures	► Instruct the patient to lie still before repeating the calibration. ► Click **Repeat** to start a new calibration. ► If false positive or false negative signals occur during calibration, change the **Trigger threshold** parameter for the cardiac triggered scans to avoid the false positive and negative signals. In the **Physiology Properties** window, set the **Trigger threshold** to: • **Low**: With a low threshold for trigger detection, more waves in the waveform are marked as R-peak. A low threshold reduces the possibility of missed triggers (false negatives). • **Medium**: This is the recommended setting and by default used for each new examination. An average threshold value is used. • **High**: With a high threshold for trigger detection, less waves in the waveform are marked as R-peak. A high threshold reduces the possibility of false positive triggers (for example triggers on T-wave) **Alternatives** • Click **Accept** to continue with the sub-optimal results, or • click **Cancel** to discard the results and continue with a previously stored VCG calibration results.

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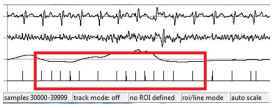
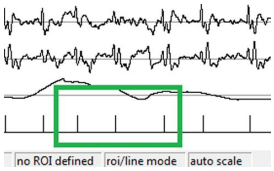
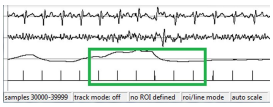
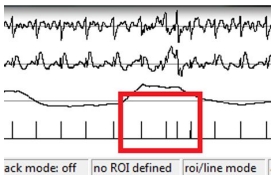
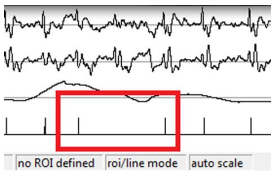
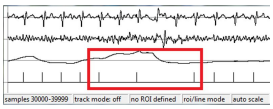
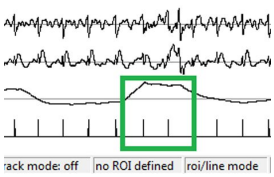
Effects of trigger threshold

Trigger threshold	Patient 1	Patient 2	Patient 3
Low	 false positive signals		 no false positive or false negative signals
Medium	 no false positive or false negative signals	 false positive signals	 false negative signals
High	 false negative signals	 no false positive or false negative signals	

NOTICE

When you change any setting of VCG calibration, this change has immediate effect on the R-peak detection.

This is valid for: manual or continuous VCG calibration, inside or outside bore VCG calibration and change of the trigger threshold.

10.3.4 Arrhythmia detected

Problem	During the evaluation of the results, the number of RR-intervals with different duration than the average RR-interval is determined. A message is displayed if more than 25% of the RR-intervals have a different duration than the other RR-intervals.
Message on screen	**VCG calibration completed.** **Arrhythmia detected** **Consider different imaging strategy (Single shot).**

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Countermeasures	For mild to average arrhythmia: • In prospective triggered scans, disable arrhythmia rejection. • Modify the entered heart rate: enter the high value from the observed heart-rate range, so that triggers are detected even at short RR-intervals. For average to severe arrhythmia: • Use prospective triggered cine sequences instead of retrospective triggered cine sequences. • Use Single shot sequences. The temporal and spatial resolution is lower, but all image data is acquired in one single RR-interval. • Use real-time (dynamic sequences) for function-cine. The sequence is not cardiac triggered. It is meant to visualize the heart motion over multiple cardiac cycles.

10.3.5 VCG calibration failed

Problem	VCG calibration can fail due to several reasons: • VCG calibration cancelled by the operator, • very low VCG signal, • high noise levels in the VCG baseline, • bad electrode contact (loose electrode).
Message on screen	**VCG calibration failed.** **Check the electrode setup. Correct if possible.** **Patient may have moved. Recommended to repeat.** **Switch to PPU if calibration can't be completed successfully.**
Countermeasures	► Check, and if possible, correct the electrode set-up. See chapter "Connecting VCG to the patient" on page 366. Alternatively continue without manual VCG calibration and use PPU-triggering instead. The R-peak detection is delayed compared to R-peak detection with VCG, but the duration of the detected RR-interval is comparable. ► Connect PPU. In the scan protocols, change the **Trigger device** from **ECG** to **PPU**. ► To make sure that the displayed heart rate is based on the PPU signal, select **PPU** for display in the **Physiology display**. ► For retrospective triggered scans, the first image of the cine loop is not at end-diastole but occurs in mid-diastole. For prospective triggered scans, the timing occurs at *trigger delay time* + *R-peak detection-delay*. If desired, this can be compensated for: Change the **Trigger delay** to **user defined** and reduce the trigger delay with the R-peak detection-delay.

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10.3.6 Sensor not detected

Problem	If the system detects a problem with the sensor or the network when a manual calibration is started, a message is displayed.
Message on screen	**Sensor(s) not detected or wrong network selected.** **Check battery, check wireless connection.**
Countermeasures	► Check if the battery is correctly inserted, and if the correct network is selected. ► Rectify the problem. ► Click **Proceed** to continue with the calibration.

10.3.7 Lead off detected

Problem	If the system detects a lead-off situation when manual calibration is started, a message is displayed.
Message on screen	**Lead-off detected. Check electrode setup. Correct if possible.**
Countermeasures	► Check, and if possible, correct the electrode set-up. See chapter "Connecting VCG to the patient" on page 366. ► Click **Proceed** to continue with the calibration.

10.3.8 VCG calibration not performed

Problem	You can not start a cardiac triggered scan if manual VCG calibration is enabled, but not performed. When you click **Start**, the scan does not start, but the calibration is requested instead.
Message on screen	**To start calibration, instruct the patient to lie still. Then click Proceed. Duration of calibration is 15 seconds.**
Countermeasures	► Start VCG calibration.

10.4 Collaboration Live

10.4.1 Functional Description

Collaboration Live is a nondiagnostic feature powered by Philips Reacts technology. This integrated collaborative solution allows you to securely communicate with colleagues or with technical or clinical support personnel by text, audio, and video between a compatible Philips MRI system and a remote destination. With Collaboration Live, you can do the following:

- Confer remotely with your peers or experts during an exam.
- Share your screen and images with a remote user.

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- Activate remote takeover of the screen.

The Collaboration Live server is a secure, web-hosted, enterprise solution that provides contact management, secure connectivity, and streaming services for Collaboration Live text, audio, and video features. The server is accessed from the Philips MRI system and remote-client end points over the Internet, using an industry-standard TLS-encrypted method of connectivity.

10.4.2 Data Security

Privacy

Philips collects the names and e-mail addresses of Collaboration Live users. That information is used only for the administration of Collaboration Live accounts and for the delivery of the Collaboration Live service. Philips does not share this information with any third parties, except for the purpose of administration and delivery of Collaboration Live.

To request a change or deletion of your user information, contact your local Philips representative or Collaboration Live administrator.

Links to the Philips privacy notice are at the bottom of each page on the Philips website:

www.philips.com

Links to the Reacts privacy notice are in the tutorials and at the bottom of each page on the Reacts website:

www.reacts.com

Chat Privacy

NOTICE

Philips advises against sharing protected health information (PHI), or other sensitive data, in chat.

The chat feature allows text-based communication between Collaboration Live enabled Philips MRI systems and paired Reacts users, and between Reacts users. Text messaging is transmitted via the signaling service, and is secured with transport layer security (TLS).

Text History

Collaboration Live stores text chat history between users. The history is not visible to anyone other than the users involved in the chat.

On your Philips MRI system, the chat persists until the chat window is closed. When the chat window is closed, the chat text is removed.

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The Reacts client stores chat history on the server. The data storage uses the AES256 advanced encryption standard. The servers used for storage are located in a sub-network that is not exposed to the Internet except through the Reacts application programming interface (API). The Reacts API is secured via an authentication mechanism and communicates using TLS.

Chat history can be deleted by anyone in the chat using the Reacts client.

10.4.3 Important Considerations

NOTICE

The performance of Collaboration Live depends on local connectivity and network performance.

Interruption in connectivity or poor network performance could adversely affect a Collaboration Live session.

- All Collaboration Live users should follow the applicable patient privacy and data security policies required by their country and institution.
- Images remotely streamed via Collaboration Live are intended only for reference and must not be used for diagnostic purposes.

  When you share the screen or give control of your Philips MRI system to a remote user, you must acknowledge the disclaimer that appears before you can proceed.

10.4.4 User Interface

Collaboration Live Controls

Control	Description
	Mutes or unmutes the microphone.
	Mutes or unmutes the speaker.
	Answers an incoming call.
	Ends the current call.
Call	Calls the selected contact.
Chat	Starts a chat session with the selected contact.

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Control	Description
Give Control	Enables system control for the remote user.
Resume Call	Resumes a call.
Send	Sends a message during a chat session.
Share	Enables display sharing,
Stop Sharing	Disables display sharing.
Take Control	Disables system control for the remote user.

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Collaboration Live Icons

Icon	Description
	Collaboration Live is connected.
	A new message has been received.
	Collaboration Live is disconnected.
	The contact is online.
	The contact is busy.
	The contact is offline.
	The microphone is unmuted or muted.
	The speaker is unmuted or muted.
	The network quality is good. Normal operation is expected for all Collaboration Live features.
	The network quality is fair. Audio, video, and screen sharing may be degraded or lost.
	The network quality is poor.

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Collaboration Live Settings

Select **Settings** to view the Collaboration Live connectivity settings.

- **Server** provides the server URL that the system is connected to.
- **Proxy Settings** provides the proxy mode, if used.

Collaboration Live Automatic Backup and Restore

NOTE

After a system software upgrade, the Collaboration Live machine certificate must be reset. Contact your local Philips representative for assistance.

Collaboration Live settings on your Philips MRI system are backed up and restored automatically. You cannot manually back up or restore Collaboration Live settings. During system software upgrades, the system maintains the following settings:

- Authentication key (for the Reacts server)
- Network proxy

10.4.5 Routine Procedures

Starting Collaboration Live

1. On the navigation bar, click .
2. Select an available contact from the contact list.
3. Do one of the following:
   - To start a chat session, select **Chat** to open the **Chat** window. Type a message in the chat window, and select **Send**.
   - To start an audio call, select **Call**.
   - To minimize the window, select **–** in the upper right corner of the window.

Starting a Chat Session

NOTICE

Philips advises against sharing protected health information (PHI), or other sensitive data, in chat.

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1. Select an available contact from the contact list.
2. To open the **Chat** window, select **Chat**.
3. Type a message in the chat window, and select **Send**.
4. Do any of the following:
   - Make an audio call.
   - Share the screen.
5. To end the session, click .

Viewing a New Message or Answering a Call

When you receive a new message or call, the Collaboration Live icon blinks.

► To view an incoming message or to answer the call, click .

Making an Audio Call

1. Select an available contact from the contact list.
2. Select **Call**.
3. To adjust the microphone or the speaker, change their Collaboration Live settings.
   For more information, see chapter “Collaboration Live Controls” on page 945.
4. Do any of the following:
   - Share the screen.
   - Share video.
5. To end the session, click .

Sharing the Screen

You are requested to confirm a remote desktop session in which you share your screen with others. Only after confirmation, you share the screen.

▷ Prerequisite: You are in a chat session or in an audio call.

1. To share the screen, select **Share**.

   ⇨ A message pops up that notifies you that you start a remote desktop session.

   You are requested to confirm this remote desktop session.
2. Select **Continue to share desktop**.
   (**Exit without sharing** aborts the screen share.)

   ⇨ The display border blinks to indicate that you are sharing the screen.
3. Do any of the following:

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- Enable remote takeover.

  The remote user can add a pointer or graphic elements, such as images, videos, and 3D objects, to the display.

- Display images that allow the remote user to assess the quality of the shared image, select **Monitor Test**.

4. To stop sharing the display, select **Stop Sharing**.
5. To end the session, click .

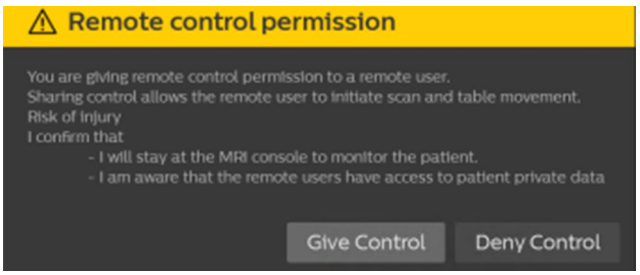
Message about Remote Desktop Sharing

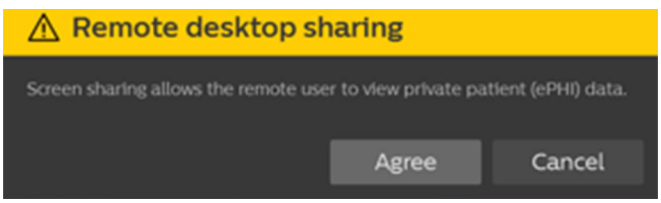
Remote Control Permission	
English	**Your language**
Remote control permission	**Remote control permission**
You are giving remote control permission to a remote user.	You are giving remote control permission to a remote user.
Sharing control allows the remote user to initiate a scan and table movement.	Sharing control allows the remote user to initiate a scan and table movement.
Risk of injury	Risk of injury
I confirm that:	I confirm that:
• I will stay at the MRI console to monitor the patient. • I am aware that remote users have access to patient private data.	• I will stay at the MRI console to monitor the patient. • I am aware that remote users have access to patient private data.

This message pops up when you activate Collaboration Live, and then initiate Remote Desktop Sharing.

- To share the desktop, click **Give Control**. Then click **Agree**.
- To exit without sharing the desktop, click **Deny Control**.

  Give Control is the default value.





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Enabling Remote Takeover of the System

Before you enable remote takeover of your system, consider the following safety aspects:

- During a Collaboration Live session, properly trained and qualified healthcare professionals must be present at your Philips MRI system and the remote client.
- When the screen is shared, both the remote user and the local Philips MRI system user can operate the system controls. Both users should communicate with each other to coordinate control of the system.
- The remote user can manipulate all system parameters. However, the remote user cannot power off your Philips MRI system.
- During multiparty sessions, only one participant can manipulate the system at a time.

1. During an audio call with a shared screen, select **Give Control**, and then select **Continue** on the disclaimer message.
2. Do any of the following:
   - To end remote user takeover, select **Take Control**.
   - To stop sharing the display, select **Stop Sharing**.
3. To end the session, click .

10.5 Remote Desktop

This section describes the Remote Desktop application of your system.

10.5.1 Functional Description

Remote Desktop enables remote access on your system for support or assistance purpose. Example: In case of a system failure or a problem, the service engineer may want to view your system desktop while you are scanning or access it to remotely service your system.

Remote access allows to remotely view (ViewOnly) or control (TakeOver) your system desktop.

You allow remote access for a single session, or for a fixed duration.

- In a **Single Session**, you allow remote access for one session only to view (ViewOnly) or to control (TakeOver) your system desktop.
  - After a session is stopped or after a log-off or reboot of your system, the remote connection has to be re-enabled by the local user.
- In a session of a **Fixed Duration**, you allow remote access to control your system desktop for a limited time period, from 1 to 60 hours (TakeOver).

  A **Fixed Duration** session may be used to service your system during the time that it is not used.

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– The remote user can access your system independently for the complete duration of the session by using a password protected connection. This password is set at the connection start up.
– After starting a Fixed Duration session, the assistance of the local user is not required.
– When a reboot of the system is necessary, it can be done by the remote user.

NOTICE

Every Remote Desktop session is logged by your system with start and stop time, and the identity of the remote user.

10.5.2 Safety

Every session can be stopped at all times by the local user. The remote connection is then closed and has to be re-enabled by the local user if necessary. This also applies to a Fixed Duration session.

A Fixed Duration session shall only be performed with appropriate safety, security and privacy measures taken according to hospital policies.

Only expert users are allowed to run a TakeOver session.

Responsibilities of the local user

- The local user has to agree to the remote desktop session by clicking the **I agree** button in the Remote Desktop session dialog box.
- During a single TakeOver session, the local user must stay at the operator's console and monitor the activities performed by the remote user.
- It is advised to keep contact on the phone for the complete length of the session.
- The local user must be present at the console at all times during scanning of a patient in a Remote Desktop session.
- The local user is responsible for the safe and secure use of the system and for the safety of his patient.
- During a TakeOver Fixed Duration session where the local user is not present, the local user has to verify that no person is present in the examination room. Take appropriate measures to inform people that a TakeOver session is running.

  Remember that scanning is only possible when the door of the examination room is closed.

10.5.3 Allowing a Remote Desktop Session

1. Click the **Windows Start** button, then go to **MR user**.
2. To start the Remote Desktop application, select **Enable Remote Desktop**.

⇨ A dialog box appears with the following text:

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⇨ Enable Remote Desktop Session
A Remote Desktop session has been requested.
If you accept this Remote Desktop request, you confirm that you know that this is an authorized Remote Desktop session.
You further confirm that you are the responsible local operator for the system during this Remote Desktop session and have been fully informed about the possible consequences regarding Safety, Security and Privacy arising from permitting remote operation of the system, including those discussed in the system's "instructions for use".
During a single windows Take Over session, you must stay at the system console and monitor the activities performed by the remote user. You can end the Remote Desktop session any time by pressing the "STOP" button on your screen. As the operator of the system, you are responsible for the safe and secure use of the system.
Note that certain private information, including electronic Protected Health Information (ePHI) about patients, will become accessible to the remote operator. Be sure to stay within your institution's policy regarding disclosure of confidential information to third parties.
I Agree or **Exit Session**

3. Do any of the following:
   - To cancel the remote desktop session, click **Exit Session**.
   - To confirm the remote desktop session, click **I agree**.

   ⇨ The **Enable Remote session** window opens.
4. Select **Single Session**, or **Fixed Duration**.
   In case of **Fixed Duration**, specify the amount of time (1 to max. 60 hours) of the remote access.

   Then click **OK**.

   ⇨ To indicate that the application is active, a **VNC** icon shows up in the tray of your Windows taskbar.

   ⇨ The background color of the VNC icon in the tray of your Windows taskbar changes from white to black.

   ⇨ For a single session, a red **Stop** button appears on the screen.

   This button allows you to stop the session. The button always stays on top and can be placed anywhere on the screen.

   ⇨ For a fixed duration session, a dialog box appears on the screen with a **Stop** button and input fields to enter a password.

   ⇨ The password has to be entered by the remote user (your service provider).
   Error messages may appear on the screen when the password is not entered correctly. These messages are for the remote user only.
5. Inform the remote user (your service provider) that the VNC application is active.

   ⇨ The service engineer will start up the remote connection, and a **VNC server acceptance** box appears on the screen.

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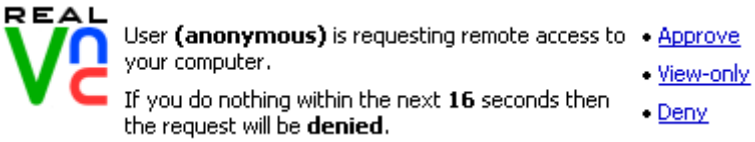

6. Do any of the following:
   - To confirm a TakeOver session, click **Approve**.
   - To confirm a ViewOnly session, click **View only**.

⇨ The Remote Desktop session starts.

⇨ The Stop button shows up and always stays on top. You can place it anywhere on the screen.

The remaining session time is displayed in the header of the button.

10.5.4 Stopping a Remote Desktop Session

You (the local user) as well as the remote user can stop the Remote Desktop session at all times.

► To stop a remote desktop session, click the red **Stop** button.

⇨ A confirmation window appears: **Are you sure you want to stop the remote session?**

► Click **OK** to confirm.

⇨ The session stops.

10.6 System start up and switch off

This section describes how to switch off and start up your computer system.

10.6.1 When do you power off and on again?

You use this procedure to restart the system when it does not respond:

- when computer shut down and start up doesn't work and/or the scanner does not respond,
- after a site mains power failure,
- after a chilled water failure.

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10.6.2 Safety

Powering and system startup must be performed by a Philips service engineer. This includes final adjustments of hardware compensation and control settings.
Under normal circumstances it is not possible to switch off the system completely or partly. When not in use the system will switch into standby mode after approximately two hours of inactivity. Power consumption is then minimized.

Contact your Philips service engineer if a serious reason exists that requires the complete system to be switched off.

WARNING

The system and all subsystems remain powered.

Danger of an electric shock.

10.6.3 Which type is your Mains Distribution Unit (MDU)?

Your system is delivered with a global Mains Distribution Unit (gMDU) or a universal Mains Distribution Unit (uMDU).
For the correct start up procedure it is important to know which type you system has. The MDU is located in the technical room.

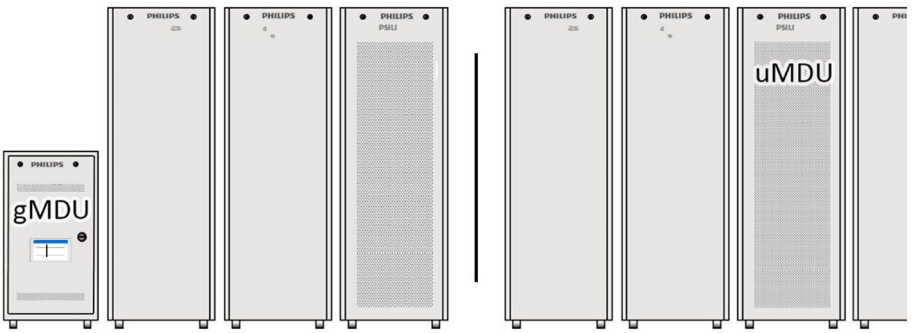

Fig. 105: On the left: large and small-size cabinets with a gMDU. On the right: only large cabinets with a uMDU.

- If your system has a small-size cabinet next to large cabinets, it has a global Mains Distribution Unit (gMDU) located in the small cabinet.
- If your system has only large cabinets, it has a universal Mains Distribution Unit (uMDU) located in the cabinet with the perforated door.

10.6.4 Computer shut down

It is strongly recommended to keep the computer running permanently.
Note that in the exceptional case that the application software does not react, the power of the computer needs to be switched off, please refer to **Switching power off** in chapter “Computer Malfunction” on page 910.

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Shutting down the computer can be done in two ways.

From the windows start menu

- Press the **Windows** key on your keyboard to show the Windows taskbar.
- Click the **Shut Down** button (the button may also be labeled **Log off**)

  If the button is labeled **Log off**, click the arrow next to the button and select **Shut down** from the menu.

From the application software

- Exit the application software as described in chapter "Exit the Application Software (Log off)" on page 208 to display the logon screen.
- Press the **Ctrl**, **ALT** and **Delete** keys on the keyboard to display the logon dialog box.
- Click **Shut down**.

10.6.5 Computer start up

Depending on your system configuration, the computer is located in the control room or in the technical room.

Computer start up in control room

- Make sure that there is no (bootable) CD or DVD in your computer. The system may try to start up from the CD drive.
- Use the **power button** to turn the computer on.

Computer startup in technical room (and reset)

Note that the described procedures should also be followed for a computer reset in case of malfunction.

Systems with uMDU

- To open the front door of the DACC cabinet, tilt the lever of the locks upwards and rotate them to unlock the door.

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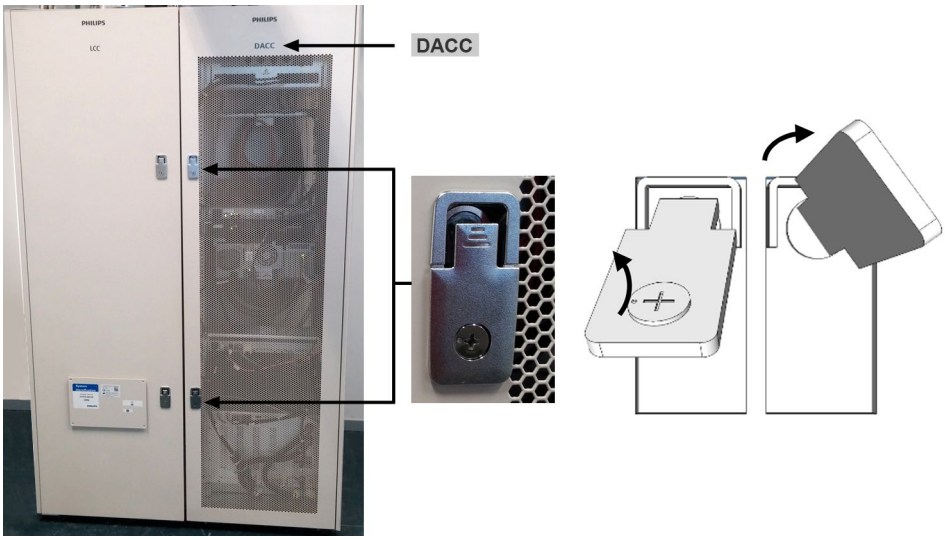
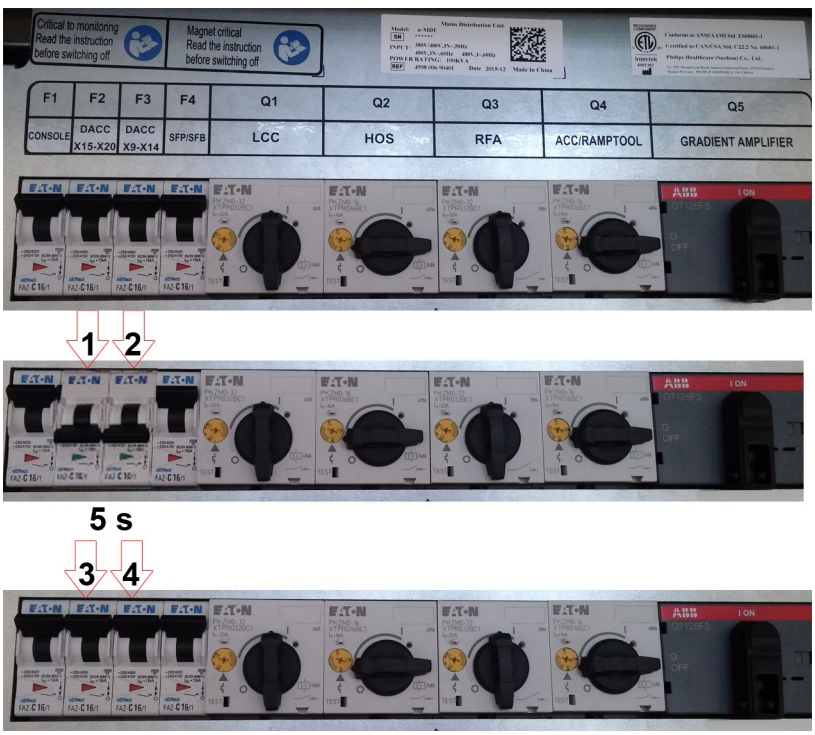


- On the universal Mains Distribution Unit (uMDU), set the switches F2 and F3 to OFF in the right sequence:
- Wait 5 seconds.
- On the uMDU, set the switches F2 and F3 to ON in the right sequence:



- Close the cabinet.

Step number	Switch	Affected unit	Action
1	F2	DACC (X15-X20)	• Set to OFF

Step number	Switch	Affected unit	Action
2	F3	DACC (X9-X14)	• Set to OFF • Wait 5 seconds
3	F2	DACC (X15-X20)	• Set to ON • Wait 5 seconds
4	F3	DACC (X9-X14)	• Set to ON

Tab. 20: Sequence of switching

Systems with gMDU

- ► Open the global Mains Distribution Unit (gMDU).
  Do NOT remove the red panel.
- ► Flip the DACC switch (check the service key sticker to locate the correct switch) to the off position.
- ► Wait for 30 seconds and flip the switch back on again.

  ⇨ The computer is started.
- ► Close the gMDU cabinet when finished.

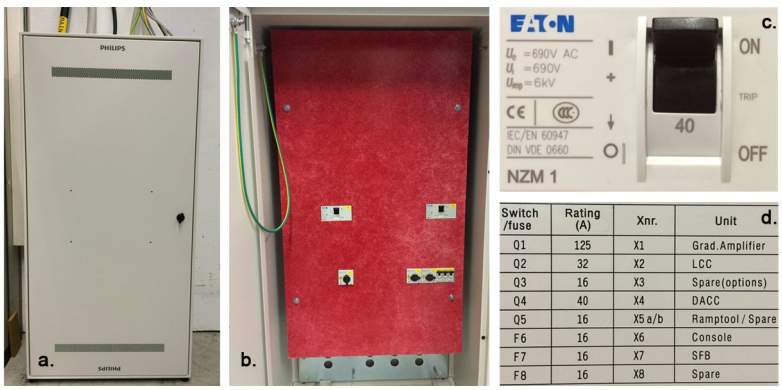


Fig. 106: Examples of: (a) a closed gMDU, (b) the red panel inside a gMDU, (c) a DACC switch and (d) a service key sticker.

Computer logon

Once the computer is started up, the logon screen appears.

To log on:

- ► Press the **Ctrl**, **ALT**, and **Delete** keys on the keyboard.
- ► In the logon dialog box, type in the user name and password.
- ► Click **OK** or press the **Enter** key.

⇨ The application software starts.

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10.7 EasySwitch

10.7.1 Functional Description

EasySwitch is a guided magnet discharge and energize function. It allows the trained operator to discharge and energize the magnet in a controlled way. EasySwitch consists of the following procedures:

- **Discharge Magnet**: The magnet discharge and stabilize procedure requires about 2 hours.
- **Energize Magnet**: The magnet energize and stabilize procedure requires about 3 hours. Additional time is required for your Service Provider to check magnet homogeneity.

EasySwitch shall be used only in very specific cases:

- Discharge the magnet if an object was attracted to the magnet.

  This allows a quick response to an attraction event to restore a safe situation by removing attracted objects, and then inspect and repair damage if needed.
- Discharge the magnet in case of a potential catastrophe that could impact system integrity (for example, a flooding or a hurricane).

  This prevents magnetic attraction hazards when the system's location is impacted (for example, flooding in the examination room or structural building damage).
- Energize the magnet after discharge using EasySwitch or if the system was automatically discharged due to a power outage or loss of magnet cooling.

For all other situations where the magnet needs to be discharged or energized, such as after the **Emergency Magnet Off** button has been pressed or after loss of field, please contact your Service Provider.

Password Protection

For safety and security, access to the EasySwitch function is protected by a password. The password is configured by a service engineer and held by a trained operator who is assigned to performing the EasySwitch procedure.

Operator Responsibilities

At the start of the magnet discharge and energize procedures, the assigned operator is required to acknowledge responsibility for the procedure. Acknowledging responsibility for the EasySwitch procedures means that you are aware of the following:

- General MR safety precautions.
  - No one should enter the examination room during the EasySwitch procedures.
  - If the examination room is provided with a lock, it should be locked to prevent staff or patients entering the room.
  - For safety information about the EasySwitch procedures, see Safety chapter.
  - For information about general MR safety precautions, see Safety chapter.
- Schedule a visit by your Service Provider as soon as the decision to discharge the magnet is taken, so that they can check the magnet homogeneity after energizing.

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- If the magnet was discharged because an object was attracted to it, carefully inspect the system for damage and, if necessary, call your Service Provider to repair the system before energizing.

NOTICE

It is strongly recommended that the entrance door to the examination room is provided with a lock to enable EasySwitch operators to ensure that no one enters the room while they are discharging or energizing the magnet.

EasySwitch Dialog Box

Fig. 107: EasySwitch dialog box

Legend			
1	Current EasySwitch procedure	3	Procedure steps
2	Magnet status	4	Step guidance

10.7.2 Safety

WARNING

Trapped person by an object attracted by the magnet.

Risk of death or serious injury.

- **Press the Emergency Magnet Off button to immediately remove the magnet field.**
- **Do NOT use EasySwitch.**

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WARNING

Only use the Emergency Magnet Off button when:

- **A person is trapped by an object that is attracted by the magnet.**
- **Fire, smoke or another event occurs, that demands immediate entry of emergency personnel or equipment into the examination room.**
- **Any other emergency occurs that requires immediate removal of the magnetic field.**

WARNING

Attraction of magnetic objects and malfunction of active implants due to unauthorized use of EasySwitch.

Risk of death or serious injury.

- **The Controlled Access Area must be protected at all times.**
- **EasySwitch shall not be used to (temporarily) bring magnetic objects into the examination room.**

WARNING

Attraction of magnetic objects and malfunction of active implants due to unknown magnet status during use of EasySwitch.

Risk of death or serious injury.

- **Do not allow persons to enter the examination room.**
- **Restart the console and EasySwitch to check the Current Status.**
- **Assume the Magnet is On until the Current Status is set to Magnet is Off.**

NOTICE

When a magnet discharge or magnet energize has been started, the process runs independently from the host computer. Be aware that the discharge or energize process continues to run even if the EasySwitch dialog box is not visible or if the host computer is switched off. If the EasySwitch dialog box is not visible, assume that the magnet is on until the EasySwitch dialog box is visible again and you can check the actual status of the magnet. You may need to reopen the EasySwitch dialog box from the **System** menu.

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WARNING

Electric shock due to damaged system parts.

Risk of death or serious injury.

- **Inspect the system and report non-cosmetic damage to Philips service.**
- **Do not energize the system in case of non-cosmetic damage.**

WARNING

Stay away from attracted objects while the magnet is discharged using EasySwitch.

Risk of harm due to sudden movement of attracted object.

NOTICE

If an object is attracted by the magnet, damage to the system can occur. After discharging the magnet and removing the attracted object, you should inspect the system for any damage. If no damage can be observed visually or if observed damage is limited to scratches on cover parts, the magnet may be energized again. If there is any damage that goes beyond scratches on cover parts or in case of doubt, contact your Service Provider to inspect the system.

WARNING

Use of EasySwitch may result in magnet homogeneity that is out of specification causing degraded image quality, mostly visible in scans with large Field of View and off-center scanning (e.g. shoulder imaging).

Risk of serious injury due to misdiagnosis.

- **Contact an Authorized Service Provider to have magnet homogeneity checked.**
- **It is recommended not to use the system until magnet homogeneity was checked and restored.**

10.7.3 Discharging the Magnet

Workflow: Discharge Magnet

Workflow Step	Description
Acknowledgement	The operator assigned to the EasySwitch procedure should acknowledge that they understand their responsibilities and the risks involved. The operator should indicate the reason for the discharge.

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Workflow Step	Description
Acknowledgement Status: **Object attracted**	This status is displayed if the operator indicates that an object was attracted into the system.
Acknowledgement Status: **Catastrophe**	This status is displayed if the operator indicates that a catastrophic event is impending.
Essential discharge Status: **Ready to start**	This status is displayed when the system is ready to begin discharging the magnet.
Essential discharge Status: **In progress**	This status is displayed after the operator has started the discharge. A progress bar is displayed with an indication of the time remaining. If the system indicates that it has encountered an error, read the information in the EasySwitch dialog box and contact your Service Provider.
Essential discharge Status: **Successful**	This status is displayed when the discharge has completed successfully.
Damage check	This phase is only displayed if the operator indicated in the **Acknowledgement** step that the reason for the discharge is because an object was attracted into the system. The operator should inspect the system and indicate if the system has been damaged (**Yes** or **No**). If the operator indicated that the reason for the discharge is an impending catastrophe, this phase is not applicable and the workflow continues straight to the **Stabilize** phase after the **Essential discharge** phase has completed. (See below.)
Damage check Status: **System damaged**	This status is displayed if the operator indicated that the system has been damaged. The operator is instructed to contact their Service Provider to repair the system.
Stabilize Status: **In progress**	This status is displayed automatically after the **Essential discharge** phase completes. If the **Damage check** phase is displayed, this status starts concurrently in the background while that phase is still active. If the system indicates that it has encountered an error, read the information in the EasySwitch dialog box and contact your Service Provider.
Stabilize Status: **Successful**	This status is displayed when the magnet has cooled sufficiently for the energize workflow to be initiated (if appropriate).
Completed	This phase indicates that the **Discharge Magnet** workflow has completed.

Important messages and indications

Important messages and indications are displayed in the language of the user interface. The table below displays the English messages and their translation.

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Discharging the Magnet

English	Translation
Initial screen	**Initial screen**
MAGNET ON	MAGNET ON
Discharge Magnet	**Discharge Magnet**
Energize Magnet	**Energize Magnet**
Step: **Acknowledgement**	*Step:* **Acknowledgement**
MAGNET ON	MAGNET ON
You are about to discharge. Magnet homogeneity shall be checked by your Authorized Service Provider after energize. Please contact your Authorized Service Provider to make an appointment and continue.	You are about to discharge. Magnet homogeneity shall be checked by your Authorized Service Provider after energize. Please contact your Authorized Service Provider to make an appointment and continue.
WARNING	WARNING
Risks of discharging and energizing the magnet using EasySwitch.	Risks of discharging and energizing the magnet using EasySwitch.
Risk of death or serious injury.	Risk of death or serious injury.
Read the section on EasySwitch in the instructions for use to understand related risks.	**Read the section on EasySwitch in the instructions for use to understand related risks.**
See Instructions for use	See Instructions for use
[check box] I acknowledge that I am responsible for the magnet discharge procedure	[check box] I acknowledge that I am responsible for the magnet discharge procedure
The following options are displayed after you acknowledge responsibility for the procedure.	*The following options are displayed after you acknowledge responsibility for the procedure.*
Reason for discharge	Reason for discharge
[check box] An object got attracted into the system	[check box] An object got attracted into the system
[check box] A potential catastrophe like a hurricane or flood	[check box] A potential catastrophe like a hurricane or flood
Cancel / **Next**	**Cancel** / **Next**

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English	Translation
Step: **Essential discharge**	*Step:* **Essential discharge**
MAGNET ON	MAGNET ON
Step status: **Ready to start**	*Step status:* **Ready to start**
The complete discharge and magnet stabilize time takes about 2 hours	The complete discharge and magnet stabilize time takes about 2 hours
WARNING	WARNING
Attracted objects may suddenly fall down or move due to magnetic field discharge.	Attracted objects may suddenly fall down or move due to magnetic field discharge.
Attraction of magnetic objects and malfunction of active implants.	Attraction of magnetic objects and malfunction of active implants.
Risk of death or serious injury	Risk of death or serious injury
Do not allow anyone in the examination room.	**Do not allow anyone in the examination room.**
Click **Start** to initiate discharging the magnet.	Click **Start** to initiate discharging the magnet.
Cancel / **Start**	**Cancel** / **Start**
Step status: **In progress**	*Step status:* **In progress**
Estimated time remaining [minutes]	Estimated time remaining [minutes]
Cancel / **Next**	**Cancel** / **Next**
Step: **Damage check**	Step: **Damage check**
This step is only displayed if you indicated that an object was attracted to the magnet.	*This step is only displayed if you indicated that an object was attracted to the magnet.*
MAGNET OFF	MAGNET OFF
NOTICE	NOTICE
The essential discharge phase has been successfully completed.	The essential discharge phase has been successfully completed.
It is safe to enter the examination room.	It is safe to enter the examination room.
Inspect the system for any damage by the object.	Inspect the system for any damage by the object.
For more information, refer to the Instructions for use.	For more information, refer to the Instructions for use.
See Instructions for use	See Instructions for use
Has the system been damaged?	Has the system been damaged?
Yes / **No**	**Yes** / **No**
If you answer **Yes**:	*If you answer* **Yes**:
Step status: **System damaged**	*Step status:* **System damaged**
Contact your Authorized Service Provider	Contact your Authorized Service Provider
Cancel / **Next**	**Cancel** / **Next**

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English	Translation
Step: **Stabilize**	*Step:* **Stabilize**
Step status: **In progress**	*Step status:* **In progress**
MAGNET OFF	MAGNET OFF
Step: **Completed**	*Step:* **Completed**
MAGNET OFF	MAGNET OFF
Magnet discharge successfully completed.	Magnet discharge successfully completed.
Make sure an appointment has been made with your Authorized Service Provider to inspect any damage.	Make sure an appointment has been made with your Authorized Service Provider to inspect any damage.
OK	**OK**

Discharging the Magnet if an Object is Attracted

This procedure guides you through discharging the magnet if an object was attracted to it, allowing you to check the system for damage. This procedure should be performed by a trained operator.

NOTICE

To avoid delays, it is recommended to schedule a visit by your Service Provider as soon as it is decided to discharge the magnet. This visit is required so that your Service Provider can check the magnet homogeneity after energizing.

NOTICE

If an object is attracted by the magnet, damage to the system can occur. After discharging the magnet and removing the attracted object, you should inspect the system for any damage. If no damage can be observed visually or if observed damage is limited to scratches on cover parts, the magnet may be energized again. If there is any damage that goes beyond scratches on cover parts or in case of doubt, contact your Service Provider to inspect the system.

NOTICE

During the EasySwitch procedure, a beeping sound can be heard from the magnet and in the technical room. This sound is by design and does not require any action.

NOTICE

If the system encounters an error during this procedure, read the safety information provided in the EasySwitch dialog box and contact your Service Provider.

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1. On the **System** menu, select **EasySwitch**.
   ⇨ The EasySwitch **Password** dialog box is displayed.
2. Enter your password and select **OK**.
   ⇨ The EasySwitch dialog box is displayed. The status of the magnet is indicated at the top of the EasySwitch dialog box.
3. Select **Discharge Magnet**.
4. Read the safety information about discharging the magnet and select the check box to acknowledge that you are responsible for the procedure.
   ⇨ Reasons for the discharge are displayed as options in the EasySwitch dialog box.
5. Select **An object got attracted into the system**.
   ⇨ The status of the **Acknowledgement** step on the left changes to **Object attracted**.

NOTICE

It is not possible to select more than one reason for the discharge. If you do not select a reason, magnet discharge will not be permitted.

6. To move to the next step in the discharge procedure, select **Next** in the lower-right corner of the EasySwitch dialog box.
7. Read the safety information about starting the discharge procedure.
8. To start discharging the magnet, select **Start** in the lower-right corner of the EasySwitch dialog box.
   ⇨ The status of the **Essential discharge** step on the left changes to In progress.
   ⇨ A progress bar is displayed, with an indication of the time remaining to complete the discharge step.
   ⇨ When the discharge is complete, the status of the **Essential discharge** step on the left changes to **Successful**, and the procedure moves to the next step, **Damage check**.
9. Read the information in the **Damage check** screen.
10. When the EasySwitch dialog box indicates that it is safe to enter the examination room, carefully inspect the system for damage.

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WARNING

Electric shock due to damaged system parts.

Risk of death or serious injury.

- **Inspect the system and report non-cosmetic damage to Philips service.**
- **Do not energize the system in case of non-cosmetic damage.**

11. If the system has been damaged, select **Yes**. The status of the **Damage check** step on the left changes to **System damaged**. Read the information about inspection and repair of the system and call your Service Provider after you complete this procedure.
12. If the system has not been damaged, select **No**. The status of the **Damage check** step on the left changes to **No damage**.
13. Select **Next** in the lower-right corner of the EasySwitch dialog box to move to the next step, **Stabilize**.
    - ⇨ After discharging the magnet, the system needs to stabilize as the magnet cools down. A progress bar is displayed with an indication of the time remaining to complete the stabilization step.
    - ⇨ When stabilization is complete, the status of the **Stabilize** step changes to **Successful**.
14. Select **Next** in the lower-right corner of the EasySwitch dialog box. The EasySwitch dialog box indicates that the magnet discharge has completed.
15. Select **OK** to close the EasySwitch dialog box.
16. If the system has been damaged, call your Service Provider for inspection and repair before energizing the magnet again.

Discharging the Magnet Prior to Catastrophic Event

This procedure guides you through discharging the magnet if a catastrophic event in your area is expected. This procedure should be performed by a trained operator.

NOTICE

To avoid delays, it is recommended to schedule a visit by your Service Provider as soon as it is decided to discharge the magnet. This visit is required so that your Service Provider can check the magnet homogeneity after energizing.

NOTICE

During the EasySwitch procedure, a beeping sound can be heard from the magnet and in the technical room. This sound is by design and does not require any action.

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NOTICE

If the system encounters an error during this procedure, read the safety information provided in the EasySwitch dialog box and contact your Service Provider.

1. On the **System** menu, select **EasySwitch**.
   ⇨ The EasySwitch **Password** dialog box is displayed.
2. Enter your password and select **OK**.
   ⇨ The EasySwitch dialog box is displayed. The status of the magnet is indicated at the top of the EasySwitch dialog box.
3. Select **Discharge Magnet**.
4. Read the safety information about discharging the magnet and select the check box to acknowledge that you are responsible for the procedure.
   ⇨ Reasons for the discharge are displayed as options in the EasySwitch dialog box.
5. Select **A potential catastrophe, like a hurricane or flood**.
   ⇨ The status of the **Acknowledgement** step on the left changes to **Catastrophe**.

NOTICE

It is not possible to select more than one reason for the discharge. If you do not select a reason, magnet discharge will not be permitted.

6. To move to the next step in the discharge procedure, select **Next** in the lower-right corner of the EasySwitch dialog box.
7. Read the safety information about starting the discharge procedure.
8. To start discharging the magnet, select **Start** in the lower-right corner of the EasySwitch dialog box.
   ⇨ The status of the **Essential discharge** step on the left changes to In progress.
   ⇨ A progress bar is displayed, with an indication of the time remaining to complete the discharge step.
   ⇨ When the discharge is complete, the status of the **Essential discharge** step on the left changes to **Successful**, and the procedure moves to the next step, **Stabilize**.

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⇨ After discharging the magnet, the system needs to stabilize as the magnet cools down. A progress bar is displayed with an indication of the time remaining to complete the stabilization step.

⇨ When stabilization is complete, the status of the **Stabilize** step changes to **Successful**.

9. Select **Next** in the lower-right corner of the EasySwitch dialog box. The EasySwitch dialog box indicates that the magnet discharge has completed.
10. Select **OK** to close the EasySwitch dialog box.
11. If the system has been damaged, call your Service Provider for inspection and repair before energizing the magnet again.

10.7.4 Energizing the Magnet

Workflow: Energize Magnet

Workflow Step	Description
Acknowledgement	The operator assigned to the EasySwitch procedure should acknowledge that they understand their responsibilities and the risks involved.
Damage check	The operator should indicate that the system is ok, or if damage was discovered, that it has been repaired (**Yes** / **No**).
Damage check Status: **No damage**	This status is displayed if the operator indicated that the system is ok.
Essential energize Status: **Ready to start**	This status is displayed when the system is ready to begin energizing the magnet.
Essential energize Status: **In progress**	This status is displayed after the operator has started the energize process. A progress bar is displayed with an indication of the time remaining. If the system indicates that it has encountered an error, read the information in the EasySwitch dialog box and contact your Service Provider.
Essential energize Status: **Successful**	This status is displayed when the energize process has completed successfully.
Stabilize Status: **In progress**	This status is displayed automatically after the **Essential energize** phase completes. If the system indicates that it has encountered an error, read the information in the EasySwitch dialog box and contact your Service Provider.
Stabilize Status: **Successful**	This status is displayed when the magnet has cooled sufficiently for the system to be used.
Completed	This phase indicates that the **Energize Magnet** workflow has completed.

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Important messages and indications

Important messages and indications are displayed in the language of the user interface. The table below displays the English messages and their translation.

Energizing the Magnet

English	Translation
Initial screen	**Initial screen**
MAGNET OFF	MAGNET OFF
Discharge Magnet	**Discharge Magnet**
Energize Magnet	**Energize Magnet**
If the magnet is not yet ready to be energized, the following message is displayed:	*If the magnet is not yet ready to be energized, the following message is displayed:*
System is not ready to start energizing. Please wait.	System is not ready to start energizing. Please wait.
Estimated time remaining: [minutes]	Estimated time remaining: [minutes]
Close	**Close**
Step: **Acknowledgement**	*Step:* **Acknowledgement**
MAGNET OFF	MAGNET OFF
This procedure energizes the magnet in a controlled way.	This procedure energizes the magnet in a controlled way.
WARNING	WARNING
Risks of discharging and energizing the magnet using EasySwitch.	Risks of discharging and energizing the magnet using EasySwitch.
Risk of death or serious injury.	Risk of death or serious injury.
Read the section on EasySwitch in the Instructions for use to understand related risks.	**Read the section on EasySwitch in the Instructions for use to understand related risks.**
See Instructions for use	See Instructions for use
[check box] I acknowledge that I am responsible for the magnet energize process.	[check box] I acknowledge that I am responsible for the magnet energize process.
Next	**Next**

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English	Translation
Step: **Damage check**	*Step:* **Damage check**
MAGNET OFF	MAGNET OFF
NOTICE	NOTICE
If the system was damaged, please make sure it has been repaired before energizing the magnet.	If the system was damaged, please make sure it has been repaired before energizing the magnet.
For more information, refer to the Instructions for use.	For more information, refer to the Instructions for use.
See Instructions for use	See Instructions for use
Is the system alright?	Is the system alright?
Yes / **No**	**Yes** / **No**
Next	**Next**
Step: **Essential energize**	*Step:* **Essential energize**
Step status: **Ready to start**	*Step status:* **Ready to start**
MAGNET OFF	MAGNET OFF
The complete energize procedure time takes about 2 hours.	The complete energize procedure time takes about 2 hours.
WARNING	WARNING
Attraction of magnetic objects and malfunction of active implants due to energization of magnetic field.	Attraction of magnetic objects and malfunction of active implants due to energization of magnetic field.
Risk of death or serious injury.	Risk of death or serious injury.
Remove all loose magnetic objects from the examination room.	**Remove all loose magnetic objects from the examination room.**
Do not allow anyone in the examination room.	**Do not allow anyone in the examination room.**
Take general MR safety precautions unless the Magnet Status is OFF.	**Take general MR safety precautions unless the Magnet Status is OFF.**
NOTICE	NOTICE
The energize procedure cannot be stopped. The magnet energization process runs independently on the system. It will continue even if the host is down. For more information, refer to the Instructions for use.	The energize procedure cannot be stopped. The magnet energization process runs independently on the system. It will continue even if the host is down. For more information, refer to the Instructions for use.
See Instructions for use	See Instructions for use
Click **Start** to initiate energizing the magnet.	Click **Start** to initiate energizing the magnet.
Cancel / **Start**	**Cancel** / **Start**
After clicking **Start**:	*After clicking* **Start**:
Step status: **In progress**	*Step status:* **In progress**
Estimated time remaining: [minutes]	Estimated time remaining: [minutes]
Cancel / **Next**	**Cancel** / **Next**

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English	Translation
Step: **Stabilize**	*Step:* **Stabilize**
Step status: **In progress**	*Step status:* **In progress**
MAGNET ON	MAGNET ON
NOTICE	NOTICE
The essential energize phase has been successfully completed.	The essential energize phase has been successfully completed.
The magnet is ON.	The magnet is ON.
The remaining magnet stabilization time takes about 90 minutes.	The remaining magnet stabilization time takes about 90 minutes.
The stabilization cannot be stopped.	The stabilization cannot be stopped.
For more information, refer to the Instructions for use.	For more information, refer to the Instructions for use.
See Instructions for use.	See Instructions for use.
Estimated time remaining: [minutes]	Estimated time remaining: [minutes]
Cancel / **Next**	**Cancel** / **Next**
Step: **Stabilize**	*Step:* **Stabilize**
Step status: **Successful**	*Step status:* **Successful**
MAGNET ON	MAGNET ON
Step: **Completed**	*Step:* **Completed**
MAGNET ON	MAGNET ON
Magnet energize successfully completed.	Magnet energize successfully completed.
WARNING	WARNING
Magnet homogeneity may be out of specification and iIamge Quality may be degraded.	Magnet homogeneity may be out of specification and iIamge Quality may be degraded.
Risk of serious injury due to misdiagnosis.	Risk of serious injury due to misdiagnosis.
Contact your Authorized Service Provider to the magnet homogeneity checked.	**Contact your Authorized Service Provider to the magnet homogeneity checked.**
OK	**OK**

Energizing the Magnet

This procedure guides you through energizing the magnet after a discharge. This procedure should be performed by a trained operator.

NOTICE

During the EasySwitch procedure, a beeping sound can be heard from the magnet and in the technical room. This sound is by design and does not require any action.

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NOTICE

If the system encounters an error during this procedure, read the safety information provided in the EasySwitch dialog box and contact your Service Provider.

1. On the **System** menu, select EasySwitch.
   ⇨ The EasySwitch **Password** dialog box is displayed.
2. Enter your password and select **OK**.
   ⇨ The EasySwitch dialog box is displayed. The status of the magnet is indicated at the top of the EasySwitch dialog box.
   ⇨ If the magnet has not yet cooled sufficiently to start the energizing procedure, an indication of the time remaining is displayed. The **Energize Magnet** function is not available until the system is ready. If desired, select **Close** in the lower-right corner of the EasySwitch dialog box to close EasySwitch. You can return to EasySwitch when the remaining time has elapsed.
3. When the system is ready, select **Energize Magnet**.
4. Read the safety information about energizing the magnet and select the check box to acknowledge that you are responsible for the procedure.
5. To move to the next step in the energize procedure, select **Next** in the lower-right corner of the EasySwitch dialog box.
6. Read the safety information.
7. To confirm that the system is not damaged (or has been repaired by your Service Provider after damage), select **Yes**.
   ⇨ The energize magnet procedure cannot be started until you indicate that the system is not damaged or that it has been repaired.
   ⇨ The status of the **Damage check** step on the left changes to **No damage**.
8. Select **Next** in the lower-right corner of the EasySwitch dialog box to move to the next step in the energize procedure, **Essential energize**.
9. Read the safety information in the EasySwitch dialog box about energizing the magnet.
10. To start energizing the magnet, select **Start** in the lower-right corner of the EasySwitch dialog box.
    ⇨ The status of the **Essential energize** step on the left changes to **In progress**.
    ⇨ A progress bar is displayed, with an indication of the time remaining to complete the energize step.

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11. When the magnet has been energized, select **Next** in the lower-right corner of the EasySwitch dialog box to move to the next step, **Stabilize**.
    ⇨ After energizing the magnet, the system needs to stabilize. A progress bar is displayed with an indication of the time remaining to complete the stabilization step.
    ⇨ When stabilization is complete, the status of the **Stabilize** step changes to **Successful**.
12. Select **Next** in the lower-right corner of the EasySwitch dialog box. The EasySwitch dialog box indicates that the magnet has been energized.
13. Read the safety information in the EasySwitch dialog box about magnet homogeneity and ensure that your Service Provider will check the magnet.
    ⇨ It is recommended not to use the system until magnet homogeneity has been checked and restored.
14. Click **OK** to close the EasySwitch dialog box.

WARNING

Use of EasySwitch may result in magnet homogeneity that is out of specification causing degraded image quality, mostly visible in scans with large Field of View and off-center scanning (e.g. shoulder imaging).

Risk of serious injury due to misdiagnosis.

- **Contact an Authorized Service Provider to have magnet homogeneity checked.**
- **It is recommended not to use the system until magnet homogeneity was checked and restored.**

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11 Maintenance and Quality Assurance

Planned maintenance, Quality assurance and routine user checks are necessary to keep the system operating safely, effectively and reliably.

Philips offers service agreements that include maintenance and repair support. For more details, contact your Philips representative.

11.1 Routine User Checks Program

11.1.1 Schedule of Routine User Checks

The scheduled routine user checks are as follows:

Routine check	Daily	Weekly	Time (min.)
Nurse call	+	+	1
Check Emergency Table Stop buttons on both UIM's*	+	+	1
Patient support	+	+	5
Coils and positioning aids	+	+	10
Magnet check		+	5
Check virus scanner definition date. The last update should not be older than one week.	+		2
Operator's console		+	5
Printer		+	5
Periodic Image Quality Test (PIQT)		+	15

* When pressed, the **Emergency Table Stop** button lights up. Press the **Resume** button to exit the stop mode. When a failure occurs the following message appears on the console: "Possible failure of Emergency Table Stop button at magnet <location of the button>. Press the **Emergency Table Stop** button fully. If this does not resolve the issue, call your Philips service engineer."

** Check coils and positioning aids for damage to coverings and connectors.

11.1.2 Antivirus Updates

Functional Description

Your MRI system is equipped with antivirus software. This software is designed to detect viruses on your system and to deny access to infected files, before they can do any damage.

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Antivirus definitions should be updated regularly, usually every day. The Antivirus software looks for updates at a pre-configured time (as set by your service provider or hospital administrator) and installs the updates, if available.

Checking the Expiry Date of the Antivirus Software

You check the expiry date of the Antivirus software every day to verify that it is still up to date.

- ► Right-click on the virus scan icon in the tray of the windows task bar. Then select **About...**.
  - ⇨ A window opens with information about the antivirus software.
- ► Check the **DAT Created ON** date.

If the date of the definitions is older than seven days (compared to the actual date), an update is necessary.

Updating the Antivirus software

You update the antivirus software when the current antivirus software is not up to date anymore.

- ► Right-click on the virus scan icon in the tray of the windows task bar. Then select **Update Now...**.
  - ⇨ The antivirus definitions are automatically updated.
- ► After the completion of the update, recheck the date of the definitions.

11.1.3 Periodic Image Quality Test (PIQT)

Functional Description

NOTICE

It is advised to use the PIQT over any other quality assurance program.

PIQT offers an automated and consistent test procedure.

A regular (weekly) execution of predefined scans to monitor the system performance enables early detection of any system deterioration.

PIQT is based on three scans made with the 200 mm head phantom. The scans and analyses are performed automatically and the results are stored. The service engineer can (remotely) access the results of the PIQT.

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NOTICE

Apart from the automatic evaluation, it is recommended that the images are visually inspected by the operator or a physicist.

NOTICE

Further options for evaluation and inspection are available in PIQT. For more information please contact your Philips service representative.

The scans are performed with the following coils:

- Q-Body
- dS Head

Performing the PIQT Test

The PIQT test takes approximately 15 minutes. Instructions on how to position the coil with the phantom are provided on the screen during the PIQT test.

The PIQT results are logged. Your service provider can access the results if needed.

1. Click **Settings and Tools (F10)**. Then select **SPT**.
   ⇨ The **System Performance Tests** window opens.
2. Select **PIQT-piqt** from the drop-down list.
3. To start the test, click **Perform Test...**.
   ⇨ The test window opens with instructions on the screen.
4. Follow the instructions of the workflow step **Set-up coils and phantom**.
5. When coil and phantom are set up correctly and moved to the isocenter, click **Next** to proceed.
6. To start the test scans, click **Start Test**.

   All test scans will be performed automatically.
   During the test, it will not be possible to execute an acquisition exam.
   ⇨ During the test scans, the progress is displayed: **Performing scan X of Y**.
   ⇨ The test program analyzes the images in the background, and evaluates the results.
7. View the results and compare them with previous results.
8. Upon completion of the acquisition, remove the phantom, positioning aids, and the coil from the scanner and safely store them.

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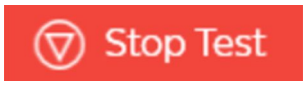
Stopping the PIQT Test

You may need to stop the test to perform an emergency examination.

- In the **System Performance Tests** window, click **Stop Test**.



- The message **Test stopped**. **Test aborted by the user** is displayed.
- Close the **System Performance Tests** window.
- Remove the phantom, positioning aids, and the coil from the scanner and safely store them.

11.1.4 Quality Assurance (QA) Tool for (BOLD) Stability

Functional Description

In order to make sure that the very small BOLD (fMRI) signal is not superimposed by noise, all noise contributions need to be minimized for optimum BOLD results.

The QA Tool provides means to measure stability based on an ACR method. It calculates all *Function Biomedical Informatics Research Network (FBIRN)* metrics based on a predefined protocol according to FBIRN guidelines:
Friedman L, and Glover GH. "Report on a multicenter fMRI quality assurance protocol" JMRI 23:827–839 (2006) .

NOTICE

It is advised to run the QA Tool on a regular base, preferably once a week.

Items Needed for QA Tool Stability

The following items are needed:

- Sphere A phantom

  The Sphere A phantom is a 10 cm diameter sphere with a water-based solution. The second choice is the FBIRN gel phantom which is a bigger (17 cm diameter) sphere. The air bubble in the phantom needs to be as small as possible.
- Foam Pads
- Straps
- MR Safe sandbags

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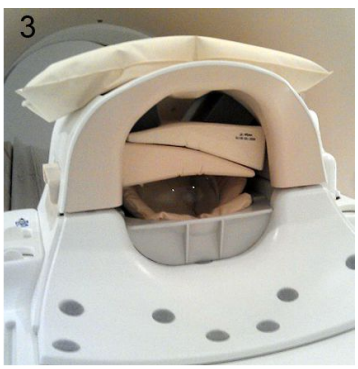
Workflow QA Tool Stability

- Click **Settings and Tools (F10)**. Then select **SPT**.
  - ⇨ The **System Performance Tests** window opens.
- Select the FMRI-NVC_HEAD test from the drop-down menu.
- To start the test, click **Perform Test...**.
  - ⇨ The test window opens with instructions on the screen.
- Follow the instructions of the workflow step **Set-up coils and phantom**.
- Position the phantom in the isocenter:
  - Set up the phantom in the Head coil, using foam pads to raise it close to the center of the coil.
  - Secure it with foam wedges or straps.
  - Do not use a sandbag in the Head coil. A sandbag can be used on top of the coil to ensure proper connection of the coil.
  - Landmark to the center of the phantom. Then move the tabletop to the scan plane.



- When coil and phantom are set up correctly and moved to the isocenter, click **Next** to proceed.
- To start the test scans, click **Start Test**.

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All test scans will be performed automatically.
During the test, it will not be possible to execute an acquisition exam.

NOTICE

The scan starts after a waiting period to avoid fluid motion artifacts. Do not skip this waiting time

Skipping the waiting time can result in automatic plan scan problems and can have negative influence on the IQ results.

⇨ During the test scans, the progress is displayed: **Performing scan X of Y**.

⇨ The test program analyzes the images in the background, and evaluates the results.

► View the results and compare them with previous results.

► Upon completion of the acquisition, remove the phantom, positioning aids, and the coil from the scanner and safely store them.

Results

The following results will be provided:

- Residual Noise graph
  RMS Stability graph
- SFNR image
- Static spatial noise
- Numeric results, e.g. Drift, Standard deviation, SNR summary value, SFNR summary value, Noise spectrum peak

No additional actions are needed when all parameters are within specifications.

If parameters are out of specification, repeat PIQT the next day to determine if this is consistent.
If parameters are still out of specification request support from your service organization. No additional actions are needed when all parameters are now within specifications.

11.1.5 ACR Accreditation

Functional Description

Accreditation by the American College of Radiology requires phantom data acquisition and analysis, which can be a challenging and time-consuming process. The ACR test software has been developed to provide setup guidance and to automatically perform the acquisition and analysis.

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The ACR test software performs the acquisition, position checking, and analysis for the ACR weekly and triennial phantom testing. Weekly tests will typically be performed at the same time each week by a MR technologist; the triennial tests will be performed once every three years by a MR physicist or scientist.

Benefits of the ACR test software are that it

- Saves valuable system time by performing the analysis automatically.
- Simplifies the acquisition by using acquisition parameters matching those required by the ACR guidelines.
- Reduces test failures from incorrect positioning by providing setup instructions and feedback if the ACR phantom is incorrectly positioned.
- Strengthens the QA program by reducing variability of results through a repeatable analysis method.
- Provides center frequency (CF) and transmit gain (TG) values required for Weekly QC.
- Reports values needed for both Weekly QC and Triennial tests for records and accreditation submission.
- Provides another tool to help Philips personnel on-site to troubleshoot ACR-related issues.

Overview of available ACR Weekly and Triennial Tests

	Weekly Tests	Triennial Tests
Purpose	Weekly Quality Control requirement	Submission for re-accreditation
Frequency	Weekly, at the same time each week	Once every three years
Who runs this test?	MR technologist	MR physicist or scientist
Tests that are run	• Geometric Accuracy • High-Contrast Spatial Resolution • Low-Contrast Detectability (LCD) • Transmit Gain (TG) • Table Position Accuracy (TPA) • Center Frequency (CF)	• Geometric Accuracy • High-Contrast Spatial Resolution • Low-Contrast Detectability (LCD) • Slice Thickness Accuracy • Slice Position Accuracy • Image Intensity Uniformity (IIU) • Percent Signal Ghosting (PSG)

Acquisition information

The table lists the scans that are performed as part of the weekly or triennial tests.

Scan type	Weekly or Triennial
Sagittal Scout	Weekly and Triennial
Axial Scout	Weekly and Triennial

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Scan type	Weekly or Triennial
Coil Survey Scan	Weekly and Triennial
SENSE Reference Scan	Weekly and Triennial
ACR Sagittal Locator	Weekly and Triennial
ACR Axial T2 Dual Echo	Triennial
ACR Axial T1	Weekly and Triennial

Performing the ACR Test

Before You Begin

- Your system should always be up to date with its preventive maintenance.

  Additionally, it is recommended to run a Periodic Image Quality Test (PIQT) prior to ACR testing to ensure system performance is within the manufacturer's specifications.
- Make time available for the ACR test: Approximately 20 to 30 minutes are needed to complete the ACR tests.

  When an ACR test is cancelled, it cannot be resumed, but it must be started from the beginning.

Equipment Needed

- dS HeadSpine coil (dS Base and dS Head top)
- NVC-ACR Phantom holder
- ACR Phantom
- Nonferrous level used to align the phantom
- Positioning pads- Small (3cm) grey foam wedge set
- ACR Log Sheet: this may be an online spreadsheet, or in paper form
- (Optional) USB storage drive: If you plan to email or store the test results in a location other than the MR system, you can use a USB data drive to copy the test results.

Setting up the ACR Test

- ► Click **Settings and Tools (F10)**. Then select **SPT**.
  - ⇨ The **System Performance Tests** window opens.
- ► Select **ACR-TRIENNIAL** or **ACR-WEEKLY** from the drop-down menu.
- ► To start the test, click **Perform Test...**.
  - ⇨ The test window opens with instructions on the screen.
- ► Follow the instructions of the workflow step **Set-up coils and phantom**.

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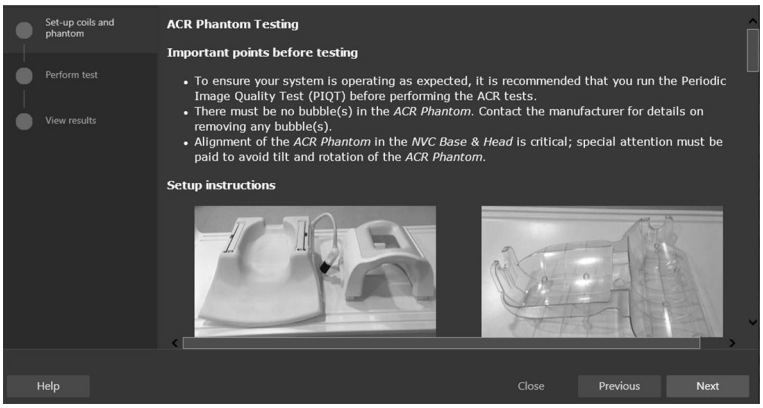
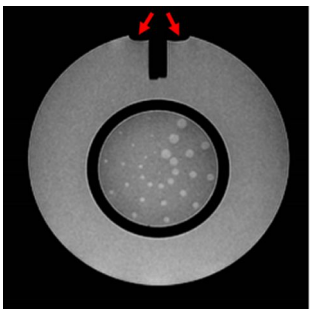


- When coil and phantom are set up correctly and moved to the isocenter, click **Next** to proceed.

Setting up the Phantom

- Before you work with the phantom, carefully read the Safety section about Liquids in Phantoms.
- Check the phantom for air bubbles.
  If you find air bubbles in the phantom, ACR tests cannot be run. Instead contact the phantom manufacturer for phantom fluid replenishment.
  Large air bubbles would appear as a void at the top of the axial image (red arrows):



- With the dS Base of the dS HeadSpine coil on the tabletop: remove the base padded liner from the base.
- Place the NVC-ACR phantom holder into the dS Base coil.
- Position the ACR phantom in the NVC-ACR phantom holder.

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- Collect these items:
  - *NVC Base* & *Head* (Photo 1)
  - *NVC-ACR Phantom Holder* (Photo 2)
  - *ACR Phantom* and non-ferrous miniature *Level* (Photo 3)
  - The two small *Grey Foam Wedges* (Photo 4)

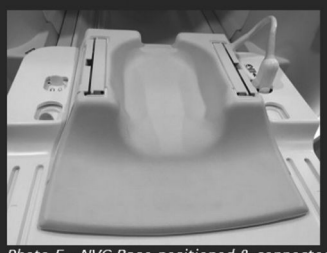

Photo 5 - NVC Base positioned & connected to the table

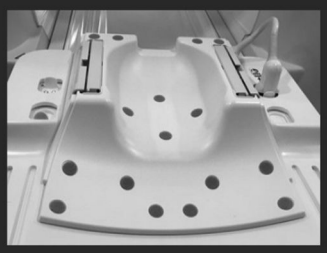

Photo 6 - Padded liner removed from NVC Base

- Place the *NVC Base* into position and connect to the head end of the table (Photo 5).
- Remove the padded liner from the *NVC Base* (Photo 6).

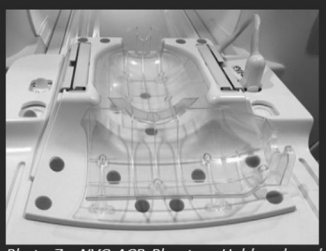

Photo 7 - NVC-ACR Phantom Holder placed in NVC Base

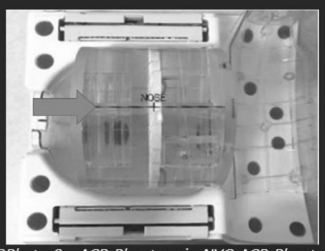

Photo 8 - ACR Phantom in NVC-ACR Phantom Holder

- Attach the NVC Head coil top portion to the NVC base.
- Slide the ACR Phantom to the correct position in the coil.
- Use the non-ferrous leveling tool to ensure the phantom is level.
- Insert the small grey foam wedges to secure the phantom in the head coil.

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- Place the *NVC Base* into position and connect to the head end of the table (Photo 5).
- Remove the padded liner from the *NVC Base* (Photo 6).

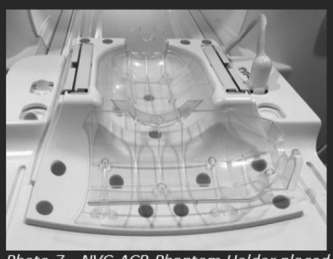

Photo 7 - NVC-ACR Phantom Holder placed in NVC Base

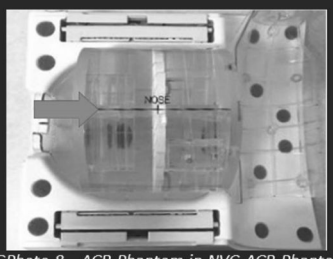

Photo 8 - ACR Phantom in NVC-ACR Phantom Holder

- Position the *NVC-ACR Phantom Holder* securely in the *NVC Base* (Photo 7).
- Place the *ACR Phantom* in the *NVC-ACR Phantom Holder* (Photo 8). Position the *ACR Phantom* with the NOSE section facing up and the CHIN section facing the foot end of the table. Ensure the phantom is pushed all the way towards the foot end of the holder.

Photo 9 - Attach NVC Head to NVC Base

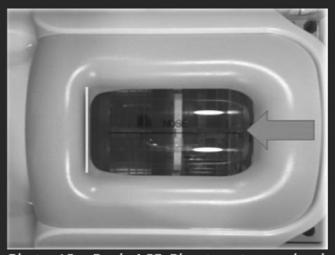

Photo 10 - Push ACR Phantom to mechanical s

- Verify phantom rotation using the non-ferrous level.
- Position the light visor cross-hairs on the edge of white grid structure, then move setup to isocenter.

- Use a non-ferrous miniature *Level* on the ledge on the CHIN surface of the *ACR Phantom*. Rotate the *ACR Phantom* until it is level (Photo 11).
- Carefully insert small *Grey Foam Wedges* between the *NVC Head* and *ACR Phantom* - one on each side as shown in Photo 12 - to reduce vibration and movement.

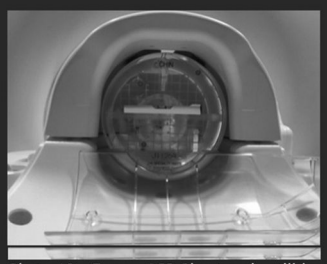

Photo 13 - Ensure ACR Phantom is still level

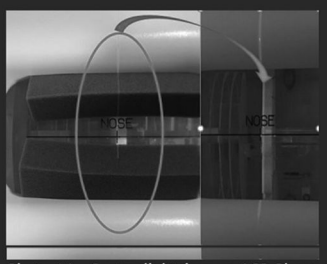

Photo 14 - Center lightvisor on ACR Phantom

- Ensure the *ACR Phantom* is still level (Photo 13). Remove the *Level*.
- Use the tumble switch to position the *NVC Head* & *Base* and *ACR Phantom* under the lightvisor. Check that the lightvisor cross-hairs are on the edge of the white grid structure also indicated by a line drawn on the phantom (Photo 14).
- Use the Travel to Scanplane button to move the setup to isocenter.

Running the ACR Test

- To start the test scans, click **Start Test**.

  All test scans will be performed automatically.
  During the test, it will not be possible to execute an acquisition exam.

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⇨ The acquisition starts.

⇨ During the test scans, the progress is displayed: **Performing scan X of Y**.

⇨ The test program analyzes the images in the background, and evaluates the results.

► Upon completion of the acquisition, remove the phantom, positioning aids, and the coil from the scanner and safely store them.

⇨ After the acquisition is complete, the data set automatically begins analysis and generates a report.

- If the phantom is correctly positioned, the test runs until completion.
- If the phantom is not correctly positioned, an error message describes the problem and recommends how to correct the positioning.

Stopping the ACR Test

You may need to stop the test to perform an emergency examination.

► In the **System Performance Tests** window, click **Stop Test**.

► The message **Test stopped**. **Test aborted by the user** is displayed.

► Close the **System Performance Tests** window.

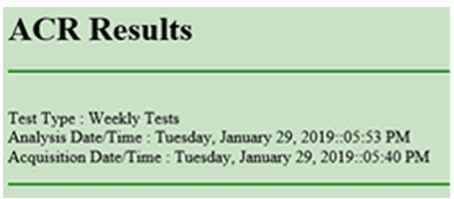
► Remove the phantom, positioning aids, and the coil from the scanner and safely store them.

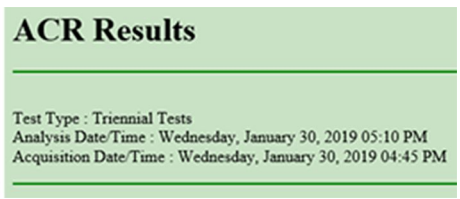
Analyzing the ACR Data Set

ACR Test Results

The results are displayed when the analysis has completed.

Examples





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Slice Position Accuracy:

Region of Interest (ROI) Signal Intensity Measurement Table:

Scan	Slice/Echo	Mean Value	WL	WW
ACR-T1	SI1 / E1	1839	919	1
ACR-T1	SI11 / E1	1820	910	1
ACR-T2	SI1 / E2	953	476	1
ACR-T2	SI11 / E2	933	466	1

Geometric Measurement Table:

Scan	Slice/Echo	Left Bar	Right Bar	Offset
ACR-T1	SI1 / E1	0.0	1.0	1.0
ACR-T1	SI11 / E1	0.0	3.9	3.9
ACR-T2	SI1 / E2	0.0	1.0	1.0
ACR-T2	SI11 / E2	0.0	2.9	2.9

Slice Thickness Accuracy:

Region of Interest (ROI) Signal Intensity Measurement Table:

Scan	Slice/Echo	Mean Top	Mean Bottom	Dev.[%]	WL	WW
ACR-T1	SI1 / E1	310	314	1.1%	156	1
ACR-T2	SI1 / E2	159	163	2.2%	80	1

Distance Measurement Table:

Scan	Slice/Echo	Top	Bottom	SI Th
ACR-T1	SI1 / E1	53.7	53.7	5.4
ACR-T2	SI1 / E2	49.8	50.8	5.0

Image Intensity Uniformity:

Max Min Mean Intensity Value Table:

Scan	Slice/Echo	Max.Mean	Min.Mean	PIU[%]
ACR-T1	SI7 / E1	1979	1777	94.6 %
ACR-T2	SI7 / E2	1031	937	95.2 %

% Signal Ghosting:

Region of Interest (ROI) Measurement Table:

Scan	Slice/Echo	Center	Top	Bottom	Left	Right
ACR-T1	SI7 / E1	1861	2.2	1.7	3.0	3.6

Calculated Ghosting Level Table:

Scan	Slice/Echo	Ghosting[%]
ACR-T1	SI7 / E1	0.074

Geometric Accuracy:

Window Width / Level Table:

Scan	Slice/Echo	Mean Value	Window Width	Window Level
ACR Sag Localize	Slice 1 / E1	1142	1142	571
ACR-T1 Axial	Slice 1 / E1	1340	1340	670
ACR-T1 Axial	Slice 5 / E1	1539	1539	769

Geometric Measurement Table:

Scan	Slice/Echo	Axis	Measured
ACR Sag Localize	Slice 1 / E1	Top-Bottom	147.46
ACR-T1 Axial	Slice 1 / E1	Top-Bottom	189.45
ACR-T1 Axial	Slice 1 / E1	Left-Right	190.43
ACR-T1 Axial	Slice 5 / E1	Top-Bottom	189.45
ACR-T1 Axial	Slice 5 / E1	Left-Right	188.48
ACR-T1 Axial	Slice 5 / E1	Diag-UL	190.59
ACR-T1 Axial	Slice 5 / E1	Diag-UR	190.59

High-Contrast Resolution:

Region of Interest (ROI) Signal Intensity Measurement Table:

Scan	Slice/Echo	Evaluation	1.1 mm	1.0 mm	0.9 mm
ACR-T1	Slice 1 / E1	UL Hor(row)	1 (4)	1 (1,2,3,4)	0
ACR-T1	Slice 1 / E1	LR Ver(Col)	1 (1,2,3,4)	1 (1,2,3,4)	0
ACR-T2	Slice 1 / E2	UL Hor(row)	1 (1,2,3,4)	1 (1,2,3,4)	0
ACR-T2	Slice 1 / E2	LR Ver(Col)	1 (1,2,3,4)	1 (1,2,3)	0

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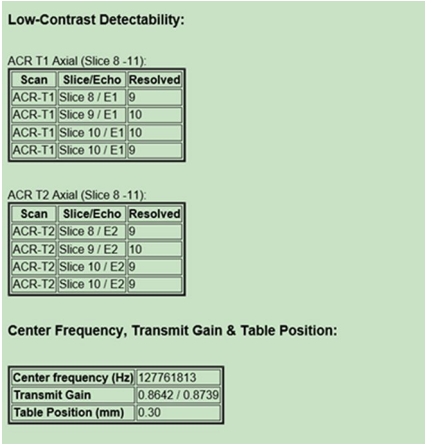

Low-Contrast Detectability:

ACR T1 Axial (Slice 8 -11):

Scan	Slice/Echo	Resolved
ACR-T1	Slice 8 / E1	9
ACR-T1	Slice 9 / E1	10
ACR-T1	Slice 10 / E1	10
ACR-T1	Slice 10 / E1	9

ACR T2 Axial (Slice 8 -11):

Scan	Slice/Echo	Resolved
ACR-T2	Slice 8 / E2	9
ACR-T2	Slice 9 / E2	10
ACR-T2	Slice 10 / E2	9
ACR-T2	Slice 10 / E2	9

Center Frequency, Transmit Gain & Table Position:

Center frequency (Hz)	127761813
Transmit Gain	0.8642 / 0.8739
Table Position (mm)	0.30

Saving the Results as PDF File

The report data is automatically saved and can be viewed at any time.

- ► To save the report, for both weekly and triennial, as a PDF file which can be printed, click in the test report window.
- ► Press the **ALT** key on the keyboard.
  The menu toolbar displays.
- ► Do any of the following:
  - Click **File -> Print**.
  - Press **CTRL+P**.
- ► Select **Printer: Microsoft print to pdf**.
- ► Select the destination of the file.
  To save to the USB drive, in the **Devices and drives** section, click the drive.
- ► Enter a file name and click **Save**.

Transferring the Results to the ACR Test Log

NOTICE

To view the ACR large Phantom Weekly QC Form, visit the ACR website

https://www.acraccreditation.org

To store the ACR test data in online files, follow the following workflow:

- ► Locate the log file or sheet.
- ► Copy the test result data to the log file.

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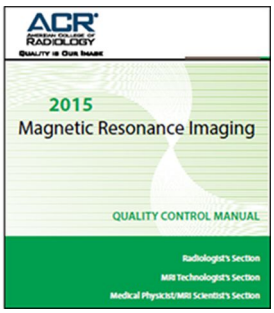
► Save or store the log file as directed by your organization.

If test results do not meet ACR requirements

The ACR Weekly QC Log includes the acceptable range of test results. Acceptable test result ranges for both the Triennial and Weekly tests can be found in the Phantom Test Guidance for Use of the Large MRI Phantom for the MRI Accreditation Program document and the 2015 MRI Quality Control Manual. Both guides are available on the ACR website.

If the test indicates the system fails to meet the ACR requirements, you should contact your Philips Service Representative.



Managing Report Data

After the tests are analyzed, the results are displayed. Report data includes text and screen shots of the phantom test images for the most recent Weekly and Triennial test.

Datasets of ACR Test

When the test report dataset is saved, it is separated and stored in different locations:

Type of dataset	File type	Location of storage
Exam (source) images	DICOM	patient database
Analysis results	xml	
Screen shots of exam images (optionally)	pdf	

Available previous exam results

You can view results from previous tests:

- **Latest report**: this includes
  Analysis test data of the most recent Weekly or Triennial test.
- **All reports**: this includes
  - Analysis test data from the most recent Weekly or Triennial test.
  - Analysis test data from all the previous Weekly or Triennial tests.

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Viewing Previous Exam Results

- In the **System Performance Tool** window, click **View previous results...**.
- In the **Patient name** column, click the data set to be viewed.

  ACR datasets are labeled:
  - ACR_triennial
  - ACR_weekly
- From the **Tools** menu, select **Generate Reports...**

  ⇨ The **SPT report selection** window opens:
- In the Patient area, verify that the dataset to view is Weekly or Triennial **(A)**.
- From the **Section** dropdown menu, select **ACR (B)**.
- In the **History** list **(C)**:
  - Click **Latest** to view the report from the most recent test.
  - Click **All** to view all reports from the tests.
- Click **Ok (D)**.

  A report is generated.

Error messages

If there are problems during scanning, an error message is displayed.

The table lists the error messages with possible resolutions.

Error message	Possible resolution
"**Tabletop needs to be moved in order to disengage posterior coil for scanning.** Move tabletop remotely to disengage the posterior coil? Press Yes to move tabletop remotely. Press No to move tabletop at magnet."	Click **Yes** to move the tabletop remotely.
"Analysis failed for ... **ERROR: Wrong phantom is detected.** Possible cause(s): Phantom other than ACR phantom was used. Possible solution(s): Use the ACR phantom."	Use the ACR Phantom.
"Analysis failed for ... **ERROR: The phantom is incorrectly rotated.** Possible cause(s): Phantom is not positioned correctly. Possible solution(s): Please reposition the phantom following on-screen instructions and run the test again."	Reposition the ACR Phantom and verify with the non-ferrous level.
"Batch terminated- Scan not performed; scan definition failed. Press Proceed and close Batch Interpreter UI to continue."	Plug in the coil.

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Error message	Possible resolution
"Scanner Error- Cannot determine optimum RF power"	Advance the tabletop to the isocenter.
"Batch Interpreter Error- Aborted" Possible cause: RF door Open during scanning.	Close the RF door.
"SPT Error- Spectrometer not available"	Cycle power, restart the system. If this doesn't resolve the error, call Philips Service.

Troubleshooting the ACR test results

The ACR test results may be inaccurate due to some common issues that can be easily remedied.

Troubleshooting

Issue	Area	Cause of issue	Relevant for
Phantom positioning error	Phantom setup	Philips phantom holder was not used.	weekly and triennial tests
Phantom rotated	Phantom setup	Phantom was not leveled accurately.	weekly and triennial tests
Excessive vibration	Phantom setup	Small grey foam wedges were not used to stabilize the phantom.	weekly and triennial tests
First slice much lower intensity	Phantom setup	Phantom is not advanced into coil until mechanical stop.	weekly and triennial tests
Test failure	High-Contrast Spatial Resolution	Phantom placement is incorrect.	weekly and triennial tests
Test failure	Low-Contrast Detectability (LCD)	Phantom placement is incorrect.	weekly and triennial tests
Different number of spokes	Low-Contrast Detectability (LCD)	Differences in user perception led to selection of a more discriminating algorithm. Use the number of spokes counted manually on the ACR sheet.	weekly and triennial tests
Bright artifacts on the edge of the FOV in Spin Echo sequences	Artifacts	Spurious echo. Expected artifact with Spin Echo NSA =1.	weekly and triennial tests

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Issue	Area	Cause of issue	Relevant for
Center frequency cannot be determined	Center Frequency determination	System issue. Contact Philips Service.	weekly test
Transmit Gain cannot be determined	Transmit Gain determination	Inaccurate positioning of the light visor on the edge of the grid portion of the phantom.	weekly test
Measurement failure	Table Position Accuracy	Air bubbles in phantom	weekly test
Measurement failure	Table Position Accuracy	Difference in table calibration. Contact Philips Service.	weekly test
Measurement failure	Geometric Accuracy	Air bubbles in phantom	triennial test
Test failure	Slice Thickness Accuracy	Gradient or RF Chain issue. Contact Philips Service.	triennial test
Test failure	Slice Position Accuracy	Phantom placement is incorrect.	triennial test
Test failure	Image Intensity Uniformity (IIU)	Coil malfunction. Shim issue. Contact Philips Service.	triennial test
Test failure	Percent Signal Ghosting (PSG)	Possible RF shielding issue. Ancillary euipment interference. Contact Philips Service.	triennial test

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11.2 Cleaning and Disinfection

Cleaning and disinfection of your MRI system must comply with all applicable laws and regulations which have the force of law within the jurisdiction(s) in which your system is located.

- Cleaning and disinfection may only be performed by appropriately trained personnel.
- Before cleaning and disinfecting the MRI system, system components and positioning aids, it is essential that you read and familiarize yourself with all Warnings and Cautions given in this Instructions for Use.

11.2.1 Cleaning agents and disinfectants

Only use the cleaning agents and disinfectants that are listed in this section.
Philips cannot be held liable for damage caused by the use of different products or compositions.

Philips

Recommended for cleaning

Use a soft damp cloth. Do not apply large amounts of water.

Recommended for disinfection

Only the described disinfectants are tested and recommended by Philips.

Tested and recommended disinfectant	Disinfection level
Isopropanol 70%	Intermediate
Ethanol 70%	Intermediate
Chlorhexidine 0.5% in 70% ethanol	Intermediate
1:200 Bleach solution (250 ppm chlorine) (5 ml household bleach in 1 L water)	Low

Guidelines for the use of cleaning agents and disinfectants

- Always adhere to the safety instructions of the cleaning agents.
- If a premixed solution is used, be sure to observe the solution expiration date.

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NOTICE

Inappropriate cleaning agents or disinfectants may cause discoloration, damage or structural weakening of the equipment.

- Check the constituents and concentration of cleaning agents and disinfectants before use.
- Never use aggressive detergents, organic solvents or abrasive cleaning agents.
- Never use iodine or colored disinfectants.
- Never use a bleach solution of more than 250 ppm.
- Never use bleach wipes.
- If you are not sure about the properties of a disinfectant agent, do not use it.

- Never mix different cleaning and disinfecting solutions because hazardous gases may develop.

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WARNING

Ignition of disinfecting spray.

Risk of serious injury or death.

- **Do not use flammable or potentially explosive disinfecting sprays.**

Factors affecting the efficacy of a disinfectant solution

- Duration of exposure
- Age of the solution
- Concentration of the disinfectant
- Way of storage
- Resistance of the contaminant
- Organic matter on the item to be disinfected

11.2.2 General cleaning instructions

- Use soft cloths, disposable tissues and wipes.
- Only use commercially available MR Safe and MR Conditional equipment and tools. Strictly follow the manufacturer's instructions.
- Never use cleaning equipment that contains ferromagnetic material.

Preventing residue on MRI system

Use sheets or MR compatible examination table paper to cover the tabletop before positioning a patient. Be aware that the use of sheets and paper without actual cleaning and disinfection does not prevent the spread of infectious agents.

Protecting yourself and others

As an operator, wash and disinfect your hands (hand sanitizer) after each patient.

WARNING

Infectious residue

Risk of cross-infection

- **Always clean and disinfect the bore, tabletop, mattresses, positioning aids, coils, physiology sensors and cables after each examination of (injured or infectious) patients where contamination may have occurred.**
- **Use proper personal protection and precautions when removing blood or residual contrast medium.**

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Handling liquids

WARNING

Electrical conductive path due to excessive liquid

Risk of electric shock

- **Never allow water or other liquids to enter the system, system components, coils, coil contacts (of separable coils) and connectors.**
- **Verify that all parts of the system, coils and positioning aids are completely dry before starting an examination.**

If liquid has entered the system, contact your Philips service engineer.

See the table in section **Components, procedures and frequency** for cleaning frequencies.

11.2.3 Components, procedures and frequency

The following table gives an overview of system components and cleaning and disinfection procedures.

Three different procedures have been identified for cleaning and disinfection. These are:

1. **Regular** procedure: applicable for hard and soft closed-cell surfaces.
2. **Other** procedures: applicable for other surfaces and components.
3. **Fabric and foam** procedure: applicable for soft open-cell surfaces.

Component of MR system	Cleaning	Disinfection	Procedure	Frequency
• Magnet covers / Gantry • Ambient ring • Patient support • Trolley (FlexTrak)	Yes	Yes	Regular	Weekly *
• Magnet bore • Tabletop	Yes	Yes	Regular	After each patient **
• UIM panel • VitalScreen	Yes	Yes	Other	Weekly *

Coils	Cleaning	Disinfection	Procedure	Frequency
• Rigid coils • Soft and flexible coils • Coil cables	Yes	Yes	Regular	After each patient **
• Coil connectors and sockets	Yes	No	Other	Weekly *

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Coils	Cleaning	Disinfection	Procedure	Frequency
• Endo coil with disposable probe	Yes	Yes	Other	After each patient **

Positioning Aids	Cleaning	Disinfection	Procedure	Frequency
• All positioning aids, except for straps and foam wedges	Yes	Yes	Regular	After each patient **
• Straps • Foam wedges	Yes	No	Fabric and foam	After each patient **

Physiology Equipment	Cleaning	Disinfection	Procedure	Frequency
• Leads and cables • Respiratory belt • Wireless-PPU and Wireless-VCG battery module	Yes	Yes	Regular	After each patient **
• PPU and reusable clips	Yes	Yes	Other	After each patient **

Operator's console	Cleaning	Disinfection	Procedure	Frequency
• Monitor displays • Printer	Yes	No	Other	Weekly *
• Keyboard • Operator-patient intercom	Yes	Yes	Other	Weekly *

Examination room	Cleaning	Disinfection	Procedure	Frequency
Coil cabinet and coil caddy	Yes	Yes	Regular	Weekly *
Examination room floor	Yes	No	Other	Weekly *

* Or as required.
** Recommended.

Full system cleaning

Clean all components of the MRI system before first use of the system and after maintenance.

11.2.4 Cleaning and disinfecting: regular procedure

This cleaning procedure applies for:

- All components of the MRI system, except for the VitalScreen
- All coils, except for coil connectors and sockets, and the Endo coil with disposable probe
- All positioning aids, except for straps and foam wedges

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- Leads, cables, respiratory belt of physiology equipment
- Coil cabinet and coil caddy

Inspection

- ► Inspect coils and cables for damage such as cracks, splitting, sharp edges, or projections. If damage is evident, discontinue use of the coils or cables and contact Philips Customer Service.
- ► Inspect the surface of positioning aids like supports, wedges, mattresses and sandbags regularly for breaches, tears or frays.
- ► In case of damaged material:
  - Remove and replace breached, torn or frayed mattresses, supports, wedges, and sandbags immediately.
    The internal spongy structure cannot be cleaned and disinfected adequately.
  - Do not use patches to repair tears and holes.
    Patches do not provide an impermeable surface.
- ► To easily detect biological material, inspect the surfaces using black light.
  A black light provides ultraviolet light that is especially sensitive in detecting biological material such as blood, prints and body fluid. This material lights up under black light exposure.

  If biological material remains after proper cleaning, it may indicate the surface is breached, frayed or torn allowing fluids to enter the structure.

Cleaning: regular procedure

1. Take a soft damp cloth. Do not apply large amounts of water.
2. Only applicable for tabletop: Thoroughly remove any solid matter in the grooves of the tabletop using a soft cloth or a tissue.
3. Use a swab or toothpick to remove dirt from hardware joints and parts difficult to reach.
4. Wipe hard surfaces with the soft cloth until all visible signs of surface contaminants are removed.
5. Remove remaining particulate and cleaning residue with a cloth dampened with clean water.
6. Towel dry with a soft cloth.
7. Dispose of any used cleaning materials in accordance with your facility's disposal protocols.

Disinfecting: regular procedure

1. Clean the surface according to the instructions above.
2. Wipe the surface with a soft cloth dampened in a recommended disinfectant.
3. When alcohols are used: air dry the surface.
4. When bleach solution is used:

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- Allow at least 1 minute contact time for bleach solution.
- Always wipe surfaces with a cloth dampened with clean water to remove the bleach solution.
- Air dry or dry with a clean cloth.

5. Dispose of any used disinfection materials in accordance with your facility's disposal protocols.

11.2.5 Cleaning and disinfecting: other procedures

Examination Room and Computer

Examination Room

► Clean the floor according to your facilities' cleaning protocol.

FlexConnect sockets and connectors

For proper functioning of dStream coils it is essential that the lenses of FlexConnect sockets and coil connectors are clean.

Clean the lenses by using the special cleaning kit, which is provided with the system.

Keyboard and UIM

1. Remove any solid matter around keys and buttons with a swab or toothpick.
2. Clean by wiping the keys with damp soft cloth or tissue and wipe dry.
3. Disinfect the surface by wiping the keys and the sides with a soft cloth or tissue dampened in a recommended disinfectant.
4. When alcohols are used: air dry the surface.
5. When bleach solution is used: wipe the surface with a cloth dampened with clean water to remove the bleach solution. Air dry or dry with a clean cloth.

Monitor displays

▷ Before cleaning turn off the display and unplug the power if possible.

► Wipe with a soft cloth moistened with water. Alternatively use a window cleaner.

Printer

► Clean the printer according to the manufacturer's instructions.

PPU sensor and reusable clips

Cleaning PPU sensor and reusable clips

To clean the sensor (cable) and the reusable clips complete the following steps:

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- ► Disconnect the PPU sensor from the Wireless-PPU battery module.
- ► To remove dirt and dust, wipe the surface with a lint-free cloth, moistened with warm water (40°C/104°F maximum) for 30 seconds to 1 minute to ensure proper cleaning. To remove stains, scrub briskly with the moistened cloth.
- ► Inspect the PPU sensor and reusable clips for any cracks, holes, tears, cuts, etc. that could affect operation and replace as necessary.

Disinfecting PPU sensor and reusable clips

1. Clean the surface according to the instructions above.
2. Only use the recommended liquid surface disinfectants:
   - CaviWipes.
   - Alcohol (70%).
   - Antibacterial soap (10% Triclosan).

NOTICE

Do not sterilize any part of the PPU sensors and reusable clips.

Sterilizing may damage the equipment.

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11.2.6 Cleaning: fabric and foam procedure

Foam wedges and straps have an open structure surface and can not be disinfected.

1. Wash the straps.
   Straps are also machine washable at 40°C.
1. Rinse with clean water.
2. Air dry the straps until they are completely dry.

11.3 Planned Maintenance

The operator should always take all practical steps to make sure that the planned Maintenance Program is fully up to date and that all routine user checks have been satisfactorily completed before using the system to examine a patient.

Planned maintenance may only be carried out by qualified and authorized Customer Support technicians. Philips provides a full planned maintenance and repair customer support on both a call basis and a contract basis. Full details are available from your Customer Support Organization.

11.4 Daily Self-Test

Your MRI system automatically performs a daily self-test.

- This self-test is scheduled for 3:00 AM local time.

  Only if the computer is switched off at 3:00 AM, the self-test will start automatically after the system startup.
- The elapsed time is up to 3 minutes, depending on the hardware configuration of your MRI system.
- The self-test consists of various small tests.
- The results of the self-test are logged. Your service provider can access the results if needed.

Effects on your examinations

In general, the self-test does not affect your daily routine, since it takes place during the night.

However, if you scan at 3:00 AM during the night, the self-test can delay the start of your first scan by 35 seconds. When the first scan of the examination is performed, the self test will be suspended almost immediately. It will be resumed after entering or selecting the next examination (with the **New Exam** workflow step).

11.5 Philips Software Update installation

This section describes the Philips Software Update functionality.

11.5.1 Functional Description

Your system may receive software updates to improve system performance. The system notifies you when updates are available.

You can perform software update installation yourself. When required, the permission for the software installation can be assigned to the hospital administrator or service administrator only. Contact your service provider.

11.5.2 Notification about Available Software Updates

Notification for the Hospital or Service Administrator

At system login, a notification pop-up window is shown to inform you that software updates are available for installation.

The notification pops up at every new login until updates are installed successfully.

When you log in with a hospital or service administrator account, you see the following message:

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English	Your Language
Philips Software Update is available to install.	**Philips Software Update is available to install.**
Approximate installation time <X> minutes. Where X is the approximate installation time including reboot and restarts. Where the displayed approximate installation time includes reboot and restarts.	**Approximate installation time <X> minutes.** Where X is the approximate installation time including reboot and restarts. Where the displayed approximate installation time includes reboot and restarts.
Archive patient data and finalize jobs in the current Job Queue before installation.	**Archive patient data and finalize jobs in the current Job Queue before installation.**
Do you want to install it now?	**Do you want to install it now?**
Buttons: **Remind Me Later**, or **Install**.	Buttons: **Remind Me Later**, or **Install**.

Notification for the Operator

At system login, a notification pop-up window is shown to inform you that software updates are available for installation.

The notification pops up at every new login until updates are installed successfully.

When you log in with a normal operator account, you do not have the permission to start the update installation. Then you see the following message.

English	Your Language
Philips Software Update is available to install.	**Philips Software Update is available to install.**
Approximate installation time is <X> minutes.	**Approximate installation time is <X> minutes.**
Where X is the approximate installation time including reboot and restarts.	Where X is the approximate installation time including reboot and restarts.
Where the displayed approximate installation time includes reboot and restarts.	Where the displayed approximate installation time includes reboot and restarts.
Archive patient data and login in with a Hospital or Service admin account to install the updates.	**Archive patient data and login in with a Hospital or Service admin account to install the updates.**
Buttons: **Learn More**, **Close**.	Buttons: **Learn More**, **Close**.
Where **Learn More** provides you with a list of available updates and the expected duration of the installation time.	Where **Learn More** provides you with a list of available updates and the expected duration of the installation time.

Your MRI system is available for use, even though it awaits the installation of software updates.

Operator to Notify the Admin

When you see the notification that software updates are available, but you do not have the permission to install them, proceed as follows:

- ► Click **OK** -> **Close** to close the pop-up window.

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- ► Inform the Hospital or Service administrator that updates are available.

11.5.3 Software Installation

Before you begin

Before you begin with the update installation, proceed as follows:

- ► Archive your patient data.
- ► Terminate the jobs in the **Jobs Queue**, or wait till they are completed.

Installing the Updates

- ► Click **Install**.
  - ⇨ The **Software Update** window opens. It shows the list of available updates and the expected duration of the installation time.
- ► To postpone the installation, click **Remind Me later** and close the window.
- ► To start the installation, first select **I Confirm that** all patient data is archived and the jobs queue finalized.

  Then click **Install Now**.

NOTICE

When software update installation cannot be initiated, a popup window displays:

Available updates cannot be installed. Contact Philips Service to resolve the issues.

  - ⇨ During installation, the Installation window shows the progress of the installation:

    Software installation is in progress.

    Preparing for installation...

    About <X> minutes remaining.

    The computer may restart more than once during the installation process.

    Do not power off the computer during installation.
- ► Wait till the software installation is successful.

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⇨ After successful installation, the message appears:

The installation was successful.

The computer will restart in 30 seconds...

You can use the system after login.

Button: **Restart Now**.

► To force an immediate computer restart, click **Restart Now**.

► After the restart, log on to your system again.

⇨ The window opens:

Philips Software Updates installed successfully.

Your application software is updated to version ... .

Button: **OK**.

► To close the window, click **OK**.

⇨ Your MRI system is ready for use.

⇨ If needed, restore your patient data from the archive.

Starting the Software Update Installation after Postponing

When you select **Remind me later** in the **Software Update** window), you postpone the software installation.

► To start a postponed software update installation, press the **Windows key**.

⇨ The Windows taskbar appears.

► Double-click the **Philips Software Update icon** on the Windows Taskbar.

⇨ The **Software Update** window opens.

► Proceed with the software installation as described in the workflow *Installing the Updates*.

11.5.4 Troubleshooting

Maintenance required

After the successful installation, in a few cases a window opens with the advice to contact your service provider.

Sometimes maintenance of your MRI system is required.

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English	Your language
Maintenance is required.	**Maintenance is required.**
Your system needs additional maintenance. **Contact Philips Service.**	**Your system needs additional maintenance.** **Contact Philips Service.**
You can continue using your system.	**You can continue using your system.**
Button: **OK**.	Button: **OK**.

- Contact your service provider.
- To close the window, click **OK**.

Your MRI system is ready for use.

Installation failed

After the successful installation, in a few cases a window opens with the advice to contact your service provider.

In case of a failed installation, the following message appears after the unsuccessful installation:

English	Your language
! Software updates could not be installed.	**! Software updates could not be installed.**
The software remains unchanged. The recovery process will start in a moment. **You can continue using your Philips system after the recovery process.** **Contact Philips Service to install the updates.**	**The software remains unchanged. The recovery process will start in a moment.** **You can continue using your Philips system after the recovery process.** **Contact Philips Service to install the updates.**

In case of a failed installation, the following message appears when you log in:

English	Your language
Philips Software Update could not be installed.	**Philips Software Update could not be installed.**
A problem occurred and updates could not be installed. **You can continue using your system as usual.** **Contact Philips Service.**	**A problem occurred and updates could not be installed.** **You can continue using your system as usual.** **Contact Philips Service.**
Button: **OK**.	Button: **OK**.

- Contact your service provider.
- To close the window, click **OK**.

When the software update installation fails, your MRI system is recovered to the previous software version.

Your MRI system is ready for use.

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12 Product Disposal

12.1 Final disposal

Final disposal: the system is disposed of in such a way that it can no longer be used for its intended purpose.

The User is responsible for proper disposal of the system.

Philips MRI systems are designed and manufactured to comply with relevant guidelines for environmental protection. As long as the system is properly operated and maintained, it presents no environmental risks. However, the system contains materials that could be harmful to the environment if disposed of incorrectly.

Do not dispose of the MRI system, or any parts of the system, with industrial or domestic waste. During disposal, special attention must be paid to:

- Cooling fluids
- Phantom fluids
- Batteries
- Helium

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NOTICE

Lithium battery cells of type CR2032 used in the host computer contain perchlorate material, special handling may apply.

See https://www.dtsc.ca.gov/perchlorate.

The system software stores sensitive personal information. Disposal of the MRI system is therefore also subject to privacy related (local) legislation.

For advice and information regarding proper disposal of your MRI system, contact your Philips Healthcare representative or go to https://www.philips.com/a-w/about/sustainability/sustainable-planet/circular-economy/product-recycling-services.html.

Philips can assist in:

- Recovery of reusable parts.
- Recycling of useful materials by competent disposal companies.
- Effective and safe disposal of the MRI system.

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NOTICE

The system complies with the WEEE Regulations

Magnet cryostat

WARNING

The magnet cryostat is a pressure vessel that can contain pressurized gasses when warmed up.

Improper treatment may cause injury during disposal.

12.2 Passing the product on to another user

If this product passes to another user, it must be in its complete state, including all product support documentation.
Make the new user aware of the support services that Philips provides for installing, commissioning and maintaining the product.
Before passing on the product or taking it out of service, all patient data must be (backed up elsewhere if necessary, and) unrecoverable on the product.

It must be remembered by all existing users that passing on medical electrical products to new users may create serious technical, medical and legal risks (including, but not limited to privacy). Such risks can arise even if the product is given away. Existing users are strongly advised to seek advice from their local Philips representative before committing themselves to passing on any product. Alternatively, contact the manufacturer.

Once the product has been passed on to a new user, a previous user may still receive important safety-related information, such as bulletins and field change orders. In many jurisdictions, there is a clear duty on the previous user to communicate such safety-related information to new users. Previous users who are not able or prepared to do this should inform Philips about the new user, so that Philips can provide the new user with safety-related information.

12.3 Toxic or hazardous substances and elements

REACH Declaration

REACH requires Philips Healthcare (PH) to provide chemical content information for Substances of Very High Concern (SVHC) if they are present above 0.1% of the article weight.

Components within electric and electronic equipment may contain phthalates above the threshold Bis(2-ethylhexyl)phthalate (DEHP), CAS nr.: 117-81-7 .

The SVHC list is updated on a regular basis. Therefore, refer to the following Philips REACH website for the most up-to-date list of products containing SVHC above the threshold: https://www.philips.com/about/sustainability/REACh.page.

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Philips Medical Systems Nederland B.V.
Veenpluis 6
5684 PC Best
The Netherlands

CE 0344

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Printed in The Netherlands
3000 139 72881/ 782 * 2025-05 - en-US