Manufacturer’s notes:
This product bears a CE marking in accordance with the provisions of regulation 93/42/EEC of June 14, 1993 for medical products.
The CE marking applies only to medico-technical products/medical products introduced in connection with the above-mentioned comprehensive EC regulation.
Overview of Contents

Measurement A
Post-processing B
Index C
A Measurement
   A.1 Overview of orthopedic imaging concept
   A.2 Large Joint Dot Engine
   A.3 High-resolution fast 2D imaging
   A.4 Isotropic 3D imaging
   A.5 Parametric mapping with syngo MapIt

B Post-processing
   B.1 Fusing biochemical maps and images

C Index
Introduction

In order to operate the MR system accurately and safely, the operating personnel must have the necessary expertise as well as knowledge of the complete operator manual. The operator manual must be read carefully prior to using the MR system.

Your complete operator manual is split up into several volumes to improve readability. Each of these individual operator manuals covers a specific topic.

- Hardware components (system, coils, etc.)
- Software (measurement, evaluation, etc.)

Another element of the complete operator manual is the information provided for the system owner of the MR system.

The extent of the respective operator manual depends on the system configuration used and may vary.

All components of the complete operator manual may include safety information that needs to be adhered to.

The operator manuals for hardware and software address the authorized user. Basic knowledge in operating PCs and software is a prerequisite.
The current operator manual

This manual may include descriptions covering standard as well as optional hardware and software. Contact your Siemens Sales Organization with respect to the hardware and software available for your system. The description of an option does not infer a legal requirement to provide it.

The graphics, figures, and medical images used in this operator manual are examples only. The actual display and design of these may be slightly different on your system.

Male and female patients are referred to as “the patient” for the sake of simplicity.

References to “Siemens Service” include service personnel authorized by Siemens.

Configuration

This manual consists of multiple parts (Part A, Part B, etc.). A comprehensive Table of Contents can be found at the beginning of each part.
Important icons

For readability, certain contents are highlighted. In the following sections, you will find the symbols and their contents used:

✓ Prerequisites for the operating steps to follow
◆ Request for action
■ Item in list

! Notes for optimal use of the MR system.

i Remarks that facilitate work with the system.

?! Problem
Description of possible source of errors
◆ Requests for action to solve problems
Intended use

Your MAGNETOM MR system is indicated for use as a magnetic resonance diagnostic device (MRDD) that produces transverse, sagittal, coronal and oblique cross sectional images, spectroscopic images and/or spectra, and that displays the internal structure and/or function of the head, body, or extremities. Other physical parameters derived from the images and/or spectra may also be produced. Depending on the region of interest, contrast agents may be used. These images and/or spectra and the physical parameters derived from the images and/or spectra when interpreted by a trained physician yield information that may assist in diagnosis.

Your MAGNETOM MR system may also be used for imaging during interventional procedures when performed with MR compatible devices such as in-room displays and MR-safe biopsy needles.

The MAGNETOM MR system is not a device with measuring function as defined in the Medical Device Directive (MDD). Quantitative measured values obtained are for informational purposes and cannot be used as the only basis for diagnosis.

For the USA only: Federal law restricts this device to sale, distribution and use by or on the order of a physician.
Authorized operating personnel

The MAGNETOM MR system must be operated according to the intended use and only by qualified persons with the necessary knowledge in accordance with country-specific regulations, e.g. physicians, trained radiological technicians or technologists, subsequent to the necessary user training.

This user training must include basics in MR technology as well as safe handling of MR systems. The user must be familiar with potential hazard and safety guidelines the same way the user is familiar with emergency and rescue scenarios. In addition, the user has to have read and understood the contents of the operator manual.
A.1 Overview of orthopedic imaging concept

- High throughput—high-resolution imaging
- Advanced imaging techniques
- Dedicated orthopedic phased array coils

A.2 Large Joint Dot Engine

- Overview
- Knee Dot Engine
  - Planning the examination and measuring the localizer
  - Adjusting the slices and performing the measurements
  - 3D examinations with integrated MPR planning
  - Configuring MPR views (optional)
- Hip Dot Engine
  - Planning the examination and measuring the localizer
  - Adjusting the slices and performing the measurements
  - Bilateral 3D hip examinations with integrated MPR planning
- Shoulder Dot Engine
  - Planning the examination and measuring the localizer
  - Adjusting the slices and performing the measurements
  - 3D shoulder examinations with integrated MPR planning
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Optimizing echo time
Optimizing echo train length (ETL)
Optimizing fat saturation
BLADE technique

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3D TrueFISP
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MEDIC
Image examples

A.5 Parametric mapping with syngo MapIt

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T2 or R2 mapping: protocol parameters
Examples in cartilage repair therapies (microfracture therapy vs MACT therapy)
T2* or R2* mapping with syngo MapIt
T2* or R2* mapping: protocol parameters
Clinical use in cartilage repair therapies (microfracture therapy)
Fast T1 mapping with syngo MapIt
T1 mapping with B1 correction
T1 mapping: protocol parameters
Overview of orthopedic imaging concept

Orthopedic imaging is a comprehensive clinical applications package focusing on the following areas.

**High throughput—high-resolution imaging**

- **High-resolution fast 2D imaging**
  To deliver extremely high in-plane 2D resolution within clinically acceptable examination times. ([Page A.3-1 High-resolution fast 2D imaging](#))

- **Isotropic 3D imaging**
  To deliver enhanced workflow and increased diagnostic quality. ([Page A.4-1 Isotropic 3D imaging](#))

**Advanced imaging techniques**

For helping in early diagnosis of osteoarthritis or monitoring of cartilage repair therapy.

- **Parametric mapping (syngo MapIt)**
  For improved diagnostic capabilities and therapy planning. ([Page A.5-1 Parametric mapping with syngo MapIt](#))
Dedicated orthopedic phased array coils

The advances in resolution, image quality, workflow, scan speed and new imaging fields (biochemical) are only possible due to the dedicated orthopedic phased Array coils and the flexible coils.

Siemens coils:
- Flex Large 4 (knee, shoulder, hip, ankle, pediatric MSK imaging)
- Flex Small 4 (wrist, elbow, pediatric MSK imaging)
- Body 18 (hip)
- Hand/Wrist 16 (hand, wrist)
- Foot/Ankle 16 (foot, ankle)
- Shoulder Large 16 (large shoulders)
- Shoulder Small 16 (small shoulders)
- CP Extremity Coil (not capable of parallel imaging)

QED coil:
- Tx/Rx 15-Channel Knee Coil
Large Joint Dot Engine

Overview

The **Large Joint Dot Engine** provides a consistent workflow for all large joints. It consists of three Dot Engines:

- **Knee Dot Engine** ([Page A.2-2 Knee Dot Engine](#))
- **Hip Dot Engine** ([Page A.2-16 Hip Dot Engine](#))
- **Shoulder Dot Engine** ([Page A.2-26 Shoulder Dot Engine](#))
Knee Dot Engine

The Knee Dot Engine is intended to simplify and speed up the examination workflow. It provides guidance and easy adaption of the examination strategy.

For 3D measurements the creation of MPRs is integrated into the workflow and supported by a guidance step for MPR planning. (Page A.2-9 3D examinations with integrated MPR planning)

The Dot Engine user interfaces shown in this operator manual are examples only. The actual guidance texts and the design may be slightly different on your system.
Planning the examination and measuring the localizer

- Patient has been registered
- Knee Dot Engine has been selected

Adapting the examination to the patient

After registration, the Patient View opens automatically. The default examination parameters are loaded.
**Selecting the examination strategy**

- From the list: Select a suitable **Exam Strategy** for the patient.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard</strong></td>
<td>For standard procedures.</td>
</tr>
<tr>
<td><strong>Speed focus</strong></td>
<td>Provides fast protocols for when the patient cannot stay in the scanner for a longer period of time.</td>
</tr>
<tr>
<td><strong>Limited patient capability</strong></td>
<td>For uncooperative/moving patients. Provides motion-insensitive protocols.</td>
</tr>
<tr>
<td><strong>High Bandwidth</strong></td>
<td>Provides protocols with reduced sensitivity to susceptibility artifacts if the patient has MR conditional implants.</td>
</tr>
</tbody>
</table>

Please adhere to all safety instructions regarding implants. (⇒ Operator Manual - MR System)

The pending protocols of the measurement queue are updated upon your selection.
Starting the measurement of the scout

The AAscout is used to determine anatomical structures.

- To start the Knee Dot Engine workflow, confirm the settings in the Patient View.

Results:

- The AutoAlign Scout is automatically measured and displayed.
- The localizer is the basis for the AutoAlign functionality, which provides consistent slice positioning of knee protocols without user interaction. (For a detailed description of the AutoAlign feature, please refer to: Operator Manual - System and data management.)
- The next protocol opens.
**Changing the examination strategy subsequently**

**Accessing the Patient View**
You can access the **Patient View** at any time during the examination.
- To open the view, click the icon.
- To confirm the settings and close the view, click the icon.

**Modifying parameters of measured protocols**
Changes in the **Patient View** only apply to pending protocols in the measurement queue.
- To change the status of a protocol from measured to pending, select the measured protocol.
- Select **Rerun from here** from the context menu (right-click with the mouse).
- Open the **Patient View**.
  
or
- Select **Rerun from here with** from the context menu (right-click with the mouse)

The **Patient View** opens automatically.
- Enter the requested modifications.
**Adjusting the slices and performing the measurements**

✓ Localizers are displayed

In the GSP segments, the slices for the following protocol are positioned by AutoAlign Knee. (For a detailed description of the AutoAlign feature, please refer to: (Operator Manual - System and data management).) Sample images with typical slice positioning are displayed in the Guidance View.

Example: **Guidance View** for sagittal slice positioning.
Check the slice positions for all subsequent measurements and adjust them, if necessary.

You can also modify several sequence parameters of the current protocol using the Parameter View. Here you find the most important sequence parameters, e.g. the number of slices.

To display the complete sequence parameters of the Routine parameter card, click the icon.

Start the measurement.

The measurement is performed. The next protocol opens.

Repeat the above steps for all subsequent measurements.
3D examinations with integrated MPR planning

The 3D Knee Dot Engine provides an integrated planning step for MPR post-processing. MPRs of one or multiple 3D measurements are calculated immediately after each measurement. The MPR planning opens after the 3D measurements have been started. You are able to plan multiple MPR views with different orientations while the 3D measurements are running.

✓ During registration, the 3D Knee Dot Engine was selected
✓ 3D measurement has been started and the MPR planning step has opened

Example: Guidance View for sagittal MPR view.
Select the desired MPR view from the list on the left side of the Guidance View.

The corresponding MPR slice positions and orientations are displayed in the GSP segments.

Adapt the slice positioning, if necessary.

In the Parameter View: You can also modify the view parameters alpha-numerically, e.g. the FoV.

Repeat the above steps for all MPR views.

Save the MPR settings.

As soon as the 3D measurements have been concluded, the reconstruction of the MPRs is started automatically. For each 3D measurement, the defined MPR views are generated.
The names of the resulting image series are a combination of the protocol name and the MPR view. For example:

- First 3D measurement: T1_SPC_FS
- Planned MPR views:
  - transversal
  - coronal
  - sagittal
- Reconstructed MPR image series:
  - T1_SPC_FS_MPR_tra
  - T1_SPC_FS_MPR_cor
  - T1_SPC_FS_MPR_sag

If you repeat a 3D measurement, a new set of MPRs is calculated.

You may use the resulting MPR views for the slice planning of subsequent measurements.
**Configuring MPR views (optional)**

**Dot Engine Step**
The **Dot Engine Step** defines which strategies, decisions and global parameters are valid for the complete Dot Engine workflow examination. (For a detailed description, please refer to: ( Operator Manual - System and data management).)

**Dot add-ins**
**Dot add-ins** are predefined add-ins for **Dot Engine Steps** and program steps. Depending on the selected **Dot add-in**, you can configure different parameters of the **Dot Engine Step**.

**Knee Dot add-ins**
- Generic Views
- MPR Assignment
- MPR Planning
Assigning 3D measurements to the integrated MPR post-processing

Using the MPR Assignment Dot add-in you can define, for which 3D protocols the MPR post-processing is performed.

- In the Exam Explorer: Select a 3D protocol.
- Open the Protocol Properties dialog window (right-click with the mouse).
- Select the Dot add-in subtask card.
- Select the MPR Assignment add-in.
Adding MPR views

Using the MPR Planning add-in, you can add new MPR views.

◆ In the Exam Explorer: Select the MPR planning program step.
◆ Open the Protocol Properties dialog window (right-click with the mouse).
◆ Select the Dot add-in subtask card.
◆ Select the MPR Planning add-in.
◆ Open the Parameter Configuration parameter card with Edit Configuration....
◆ Select the Set-up/MPR Planning Config subtask card.

◆ Add the MPR view by clicking Add MPR Range.

A new default MPR view is added to the list of available views.
Renaming views

- Right-click the added view with the mouse.

- From the context menu: Select Rename.

- Enter the new name.

- Set the Guidance and Parameter Views. (⇒ Operator Manual - System and data management)

Removing views

- Right-click the view with the mouse.

- From the context menu: Select Remove.
**Hip Dot Engine**

The **Hip Dot Engine** is intended to simplify and speed up the examination workflow. It provides guidance and easy adaption of the examination strategy.

The **Hip Dot Engine** offers three workflows:

- Two standard conventional 2D-workflows (unilateral and bilateral) and
- One bilateral 3D-workflow

For 3D measurements the creation of MPRs is integrated into the workflow and supported by a guidance step for MPR planning. (➡ Page A.2-23 Bilateral 3D hip examinations with integrated MPR planning)

The Dot Engine user interfaces shown in this operator manual are examples only. The actual guidance texts and the design may be slightly different on your system.
Planning the examination and measuring the localizer

✓ Patient has been registered
✓ **Hip Dot Engine** has been selected

Adapting the examination to the patient

After registration, the **Patient View** opens automatically. The default examination parameters are loaded.
## Selecting the examination strategy

*From the list: Select a suitable **Exam Strategy** for the patient.*

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard</strong></td>
<td>For standard procedures.</td>
</tr>
<tr>
<td><strong>Speed focus</strong></td>
<td>Provides fast protocols for when the patient cannot stay in the scanner for a longer period of time.</td>
</tr>
<tr>
<td><strong>Limited patient capability</strong></td>
<td>For uncooperative/moving patients. Provides motion-insensitive protocols.</td>
</tr>
<tr>
<td><strong>High Bandwidth</strong></td>
<td>Provides protocols with reduced sensitivity to susceptibility artifacts if the patient has MR conditional implants.</td>
</tr>
</tbody>
</table>

⚠️ Please adhere to all safety instructions regarding implants. (Operator Manual - MR System)

The pending protocols of the measurement queue are updated upon your selection.
Starting the measurement of the scout

The AAHip_Scout is used to determine anatomical structures.

- To start the Hip Dot Engine workflow, confirm the settings in the Patient View.

Results:

- The AutoAlign Scout is automatically measured and displayed.

- The localizer is the basis for the AutoAlign functionality, which provides consistent slice positioning of hip protocols without user interaction. (For a detailed description of the AutoAlign feature, please refer to: [Operator Manual - System and data management].)

- The next protocol opens.
Changing the examination strategy subsequently

**Accessing the Patient View**

You can access the Patient View at any time during the examination.

- To open the view, click the icon.
- To confirm the settings and close the view, click the icon.

**Modifying parameters of measured protocols**

Changes in the Patient View only apply to pending protocols in the measurement queue.

- To change the status of a protocol from measured to pending, select the measured protocol.
- Select **Rerun from here** from the context menu (right-click with the mouse).
- Open the Patient View.

or

- Select **Rerun from here with** from the context menu (right-click with the mouse)

The Patient View opens automatically.

- Enter the requested modifications.
Adjusting the slices and performing the measurements

✓ Localizers are displayed

In the GSP segments, the slices for the following protocol are positioned by AutoAlign Hip. Sample images with typical slice positioning are displayed in the Guidance View.

Example: Guidance View for coronal slice positioning.

◆ Check the slice positions for all subsequent measurements and adjust them, if necessary.
To modify several sequence parameters of the current protocol, open the Parameters View.

Here you find the most important sequence parameters, e.g., the number of slices.

To display the complete sequence parameters of the Routine parameter card, click the icon.

Start the measurement.
The measurement is performed. The next protocol opens.
Repeat the above steps for all subsequent measurements.
**Bilateral 3D hip examinations with integrated MPR planning**

The 3D workflows of the *Hip Dot Engine* provide an integrated planning step for MPR post-processing. MPRs of one or multiple 3D measurements are calculated immediately after each measurement. The MPR planning opens after the 3D measurements have been started. You are able to plan multiple MPR views with different orientations while the 3D measurements are running. For a detailed description of configuring MPR views, please refer to: (➡ Page A.2-12 Configuring MPR views (optional)).

- During registration, a 3D workflow was selected
- 3D measurement has been started and the MPR planning step has opened

Example: **Parameters View** for sagittal left MPR planning.
Select the desired MPR view from the list on the left side of the Parameters View. The corresponding MPR slice positions and orientations are displayed in the GSP segments.

Adapt the slice positioning, if necessary.

In the Parameters View: You can also modify the view parameters alpha-numerically, e.g. the FoV.

Repeat the above steps for all MPR views.

Save the MPR settings.

As soon as the 3D measurements have been concluded, the reconstruction of the MPRs is started automatically. For each 3D measurement, the defined MPR views are generated.
The names of the resulting image series are a combination of the protocol name and the MPR view. For example:

- **First 3D measurement**: PD_SPC_FS
- **Planned MPR views**:
  - transversal
  - coronal
  - sagittal
- **Reconstructed MPR image series**:
  - PD_SPC_FS_MPR_tra
  - PD_SPC_FS_MPR_cor
  - PD_SPC_FS_MPR_sag

⚠️ If you repeat a 3D measurement, a new set of MPRs is calculated.

ℹ️ You may use the resulting MPR views for the slice planning of subsequent measurements.
Shoulder Dot Engine

The **Shoulder Dot Engine** is intended to simplify and speed up the examination workflow. It provides guidance and easy adaptation of the examination strategy.

The **Shoulder Dot Engine** offers two workflows:
- Standard conventional 2D-workflow and
- 3D-workflow

For 3D measurements the creation of MPRs is integrated into the workflow and supported by a guidance step for MPR planning. ([Page A.2-33 3D shoulder examinations with integrated MPR planning](#))

![Warning](#) The Dot Engine user interfaces shown in this operator manual are examples only. The actual guidance texts and the design may be slightly different on your system.
Planning the examination and measuring the localizer

- Patient has been registered
- Shoulder Dot Engine has been selected

Adapting the examination to the patient

After registration, the Patient View opens automatically. The default examination parameters are loaded.
## Selecting the examination strategy

- From the list: Select a suitable **Exam Strategy** for the patient.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard</strong></td>
<td>For standard procedures.</td>
</tr>
<tr>
<td><strong>Speed focus</strong></td>
<td>Provides fast protocols for when the patient cannot stay in the scanner for a longer period of time.</td>
</tr>
<tr>
<td><strong>Motion Insensitive (BLADE)</strong></td>
<td>For uncooperative/moving patients. Provides motion-insensitive protocols.</td>
</tr>
<tr>
<td><strong>High Bandwidth</strong></td>
<td>Provides protocols with reduced sensitivity to susceptibility artifacts if the patient has MR conditional implants.</td>
</tr>
</tbody>
</table>

*Please adhere to all safety instructions regarding implants. ([Operator Manual - MR System](#)).

The pending protocols of the measurement queue are updated upon your selection.
Starting the measurement of the scout

The AAShoulder_Scout is used to determine anatomical structures.

- To start the Shoulder Dot Engine workflow, confirm the settings in the Patient View.

Results:

- The AutoAlign Scout is automatically measured and displayed.
- The localizer is the basis for the AutoAlign functionality, which provides consistent slice positioning of shoulder protocols without user interaction. (For a detailed description of the AutoAlign feature, please refer to: Operator Manual - System and data management.)
- The next protocol opens.
Changing the examination strategy subsequently

**Accessing the Patient View**
You can access the Patient View at any time during the examination.

- To open the view, click the icon.
- To confirm the settings and close the view, click the icon.

**Modifying parameters of measured protocols**
Changes in the Patient View only apply to pending protocols in the measurement queue.

- To change the status of a protocol from measured to pending, select the measured protocol.
- Select **Rerun from here** from the context menu (right-click with the mouse).
- Open the Patient View.

or

- Select **Rerun from here with** from the context menu (right-click with the mouse)

The Patient View opens automatically.

- Enter the requested modifications.
Adjusting the slices and performing the measurements

✓ Localizers are displayed

In the GSP segments, the slices for the following protocol are positioned by AutoAlign Shoulder. Sample images with typical slice positioning are displayed in the Guidance View.

Example: Guidance View for coronal slice positioning.

◆ Check the slice positions for all subsequent measurements and adjust them, if necessary.
To modify several sequence parameters of the current protocol, open the Parameters View.

Here you find the most important sequence parameters, e.g., the number of slices.

To display the complete sequence parameters of the Routine parameter card, click the icon.

Start the measurement.

The measurement is performed. The next protocol opens.

Repeat the above steps for all subsequent measurements.
3D shoulder examinations with integrated MPR planning

The 3D workflow of the Shoulder Dot Engine provides an integrated planning step for MPR post-processing. MPRs of one or multiple 3D measurements are calculated immediately after each measurement. The MPR planning opens after the 3D measurements have been started. You are able to plan multiple MPR views with different orientations while the 3D measurements are running. For a detailed description of configuring MPR views, please refer to: (➡ Page A.2-12 Configuring MPR views (optional)).

✓ During registration, the 3D workflow was selected
✓ 3D measurement has been started and the MPR planning step has opened

Example: Parameters View for sagittal MPR planning.
Select the desired MPR view from the list on the left side of the Parameters View.

The corresponding MPR slice positions and orientations are displayed in the GSP segments.

Adapt the slice positioning, if necessary.

In the Parameters View: You can also modify the view parameters alpha-numerically, e.g. the FoV.

Repeat the above steps for all MPR views.

Save the MPR settings.

As soon as the 3D measurements have been concluded, the reconstruction of the MPRs is started automatically. For each 3D measurement, the defined MPR views are generated.
The names of the resulting image series are a combination of the protocol name and the MPR view. For example:

- First 3D measurement: PD_SPC_FS
- Planned MPR views:
  - transversal
  - coronal
  - sagittal
- Reconstructed MPR image series:
  - PD_SPC_FS_MPR_tra
  - PD_SPC_FS_MPR_cor
  - PD_SPC_FS_MPR_sag

⚠️ If you repeat a 3D measurement, a new set of MPRs is calculated.

ℹ️ You may use the resulting MPR views for the slice planning of subsequent measurements.
High-resolution fast 2D imaging

Imaging of the musculoskeletal (MSK) system requires high resolution with the necessary contrast for precise detection of small and complex structures.

Optimization with TSE sequence

The flexible TSE sequence is optimized for a maximum matrix size and small FoV. This TSE sequence, together with parallel imaging techniques, delivers extremely high in-plane 2D resolution within clinically acceptable examination times, allowing for a more accurate diagnosis.

Alternative protocols with faster scan times are also available in the Siemens protocol tree.
The concept of high-resolution fast imaging utilizing the TSE sequence. The high-resolution fat-suppressed PD-weighted TSE image is a tool helping in accurate diagnosis.

**Advantages**

By using new reordering techniques, the TSE sequence allows for:

- a more flexible choice of TE for better optimization of contrast
- a more flexible choice of echo train lengths to maintain image contrast while optimizing protocols
- a flexible choice of fat suppression techniques (WEAK, STRONG, SPAIR, STIR)
Optimizing echo time

PD-weighted contrast is the “gold standard” in differentiating cartilage defects. Contrast is optimized by varying the echo time (the preferred TE varies from physician to physician).

(1) TE 20 ms
(2) TE 40 ms
Optimizing echo train length (ETL)

Increasing the ETL will reduce the scan time while the contrast is mostly maintained. The flexible reordering scheme allows greater flexibility (even and odd ETL, reduced blurring).

(1) TE 24 ms; ETL 5; 4 min  
(2) TE 24 ms; ETL 7; 3 min  
(3) TE 24 ms; ETL 10; 2 min  
(4) TE 24 ms; ETL 15; 1:20 min
Optimizing fat saturation

Fat saturation is useful when imaging suspected bone trauma or edema. It allows good differentiation of surface cartilage lesions.

**FatSat**

Uses a spectrally selective pulse to saturate the fat spins before the imaging sequence. Has 2 settings: (a) STRONG which delivers a darker fat than (b) WEAK.

**SPAIR**

Uses an adiabatic spectrally selective pulse which is insensitive to dielectric effects. Useful at 3 Tesla in the hip.

**STIR**

Uses a spatial inversion pulse with a short inversion time to null fat. Only recommended where fat suppression is difficult due to B0 issues, i.e., with MR conditional implants.

Example: A cartilage tear can sometimes be better visualized using FatSat techniques (right) as shown above.
**BLADE technique**

The BLADE technique is available for all MSK regions and can be configured for T1, T2, and PD contrasts. It is compatible with multi-channel coils, and iPAT can be employed. Any orientation can be used (sagittal, coronal and axial). BLADE is fully integrated in the TSE sequence.

For a detailed description, please refer to: (➡ Application Brochure “Pulse Sequences”)

Advantages of oversampling:
- Wrap-around artifacts (streaking) avoided
- Good results with respect to movement artifacts
- Increased SNR

(1) Knee coronal: FoV 130 × 130, 0.4 mm × 0.4 mm, TE = 47 ms
(2) Wrist: FoV 100 × 100, 0.3 mm × 0.3 mm, TE = 47 ms
Isotropic 3D imaging

High-resolution fast isotropic 3D imaging is becoming increasingly more important as a means of enhancing workflow and providing more accurate diagnosis. Isotropic 3D imaging allows for fully flexible examination, i.e. depending on the suspected diagnosis, images can be reformatted in any plane.

Isotropic sequences

Using an isotropic 3D sequence, the images can be reformatted with high in-plane and through-plane resolution. Utilization of such a sequence introduces further improvements in the workflow by acquiring one 3D series that can be reformatted in the different planes needed for precise diagnosis.

Siemens provides five different sequences with specified contrasts:

- 3D SPACE (Page A.4-2 3D SPACE)
- 3D TrueFISP (Page A.4-3 3D TrueFISP)
- 3D DESS (Dual Echo Steady State) (Page A.4-5 3D DESS)
- 3D MEDIC (Page A.4-7 MEDIC)
- 3D FISP

For a detailed description of the sequences, please refer to:
(Application Brochure "Pulse Sequences")
3D SPACE

Concept

Different planes can be reconstructed from the isotropic data set for high-resolution diagnosis of cartilage, ligaments, and meniscus in the knee joint.

(1) PD-weighted SPACE, isotropic resolution 0.5 mm
(2) PD-weighted SPACE with FatSat, isotropic resolution 0.5 mm
**3D TrueFISP**

The TrueFISP sequence is used for balanced steady state imaging. On each of the gradient axes the net gradient moment is zero. It has a good SNR, but is prone to banding artifacts in regions of compromised homogeneity, i.e., MR conditional implants.

1. RF
2. Slice selection
3. Phase encoding
4. Frequency encoding
5. Signal (SS-FID/SS-echo)
Minimize TR by selecting a high readout bandwidth to avoid interference streaks in the image.

Ankle, isotropic resolution 0.3 mm, reformatted below in sagittal, coronal, and axial direction.
**3D DESS**

In the steady state, two signals are produced—an FID signal and an echo. With DESS (Dual Echo Steady State) these two signals are measured and combined to produce a single image.

(1) RF  
(2) Slice selection  
(3) Phase encoding  
(4) Frequency encoding  
(5) Signal (SS-FID/SS-echo)
Use primarily in orthopedic imaging with good contrast between synovial fluid and cartilage. A non-selective excitation pulse is activated beforehand for fat suppression at a short TR.

(1) Shoulder, isotropic resolution 0.7 mm
(2) Knee, isotropic resolution 0.6 mm
The MEDIC sequence is a multi-echo GRE sequence where up to 6 echoes are combined to produce a single image.

(1) RF
(2) Slice selection
(3) Phase encoding
(4) Frequency encoding
(5) Signal (dashed line: $T_2^*$ decay)

* Gives very good contrast for meniscus evaluation.*
Measurement

(1) Shoulder coronal
(2) Knee sagittal

Image examples

Example: 10 minute knee exam

Isotropic data set 0.5 mm.
Reformat along x diagnosis-based planes:
(1) Meniscus reformat
(2) ACL reformat
(3) Coronal reformat
(4) Patella reformat
Example: Precise localization of anatomy (meniscus)
Example: Complex geometry—simple reformatting (radial reformats for hip imaging)
Parametric mapping with *syngo* MapIt

Parametric mapping with *syngo* MapIt may improve both the accuracy of diagnosis and planning and also may monitor the effectiveness of therapy.

At present, the main focus is on:
- T2 and T2* mapping
- T1 mapping
T2 or R2 mapping with syngo MapIt

Clinical use to aid in:

- Cartilage repair therapies (microfracture therapy vs MACT therapy). (MACT = Matrix-associated Autologous Chondrocyte Transplantation).
- Cartilage repair therapies (MACT therapy follow up)
- Early OA detection (femoral acetabular impingement). (OA = Osteoarthritis).

T2 provides information on structural changes in the collagen within the cartilage. T2 depends on the orientation as a function of the “magic angle” effect.

T2 provides information on changes in the water content of the cartilage. Compressed areas show less water content—lower T2. Less compressed areas show greater water content—higher T2.

T2 has been used to study cartilage repair therapies and to provide information on cartilage softening.

T2 is measured using a multi-echo spin echo with up to 32 echoes. Each echo produces an image. The map is produced by a pixel-by-pixel analysis.

Instead of T2, R2 = 1/T2 can optionally be calculated.
**T2 or R2 mapping: protocol parameters**

For T2 or R2 mapping use the "se_mc" sequence. Use the Inline MapIt parameter card.

![Parameter Card](image-url)
### Measurement

<table>
<thead>
<tr>
<th><strong>MapIt</strong></th>
<th>Select T2 or R2 to turn on the Inline technology.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurements</strong></td>
<td>Are set to 1.</td>
</tr>
<tr>
<td><strong>Contrasts</strong></td>
<td>Up to 32 echoes possible. More echoes provide a better fit.</td>
</tr>
<tr>
<td><strong>TE</strong></td>
<td>Set the echo time for each echo. Keep maximum TE to less than or similar to expected T2 values.</td>
</tr>
<tr>
<td><strong>TR</strong></td>
<td>Use TR values &gt; 1000 ms.</td>
</tr>
<tr>
<td><strong>Noise threshold</strong></td>
<td>Echoes with signals less than this value will be ignored in the fit. If in doubt, leave at default value.</td>
</tr>
<tr>
<td><strong>Save original images</strong></td>
<td>Keeps the morphological base images in the database.</td>
</tr>
</tbody>
</table>
Examples in cartilage repair therapies (microfracture therapy vs MACT therapy)

MFX therapy creates microfractures in the bone. Cartilage regeneration is promoted by the released blood and marrow.

These are the characteristics of this method:

- Reduced T2 in the region of MFX therapy.
- Matrix-associated autologous chondrocyte transplantation (MACT).
- An operative procedure using a cell seeded collagen matrix.
- Used for the treatment of localized full thickness cartilage defects.
Measurement

Courtesy of S. Trattnig, Dept. Radiology, University Vienna.
**T2* or R2* mapping with syngo MapIt**

T2* is the apparent transverse relaxation rate and has a T2 component. It can be used as a substitute for T2 mapping. Instead of T2*, R2* = 1/T2* can optionally be calculated.

T2* also has a component which depends on the field change within the voxel, resulting from:

- Macroscopic field changes, i.e. main field homogeneity, large susceptibility fields from implants.
- Macroscopic field changes due to susceptibility variations, i.e. bone-cartilage interface.
- Microscopic field changes from the microstructure within the voxel.
T2* is measured using a multi-echo gradient-echo sequence. Each TE gives an image. A pixel-by-pixel analysis produces the T2* map.

(1) RF
(2) Slice selection
(3) Phase encoding
(4) Frequency encoding
(5) Signal (dashed line: T2* decay)
**T2* or R2* mapping: protocol parameters**

For T2* or R2* mapping use the "gre" sequence. Use the Inline MapIt parameter card.
<table>
<thead>
<tr>
<th>Measurement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MapIt</td>
<td>Select T2* or R2* to turn on the Inline technology.</td>
</tr>
<tr>
<td>Measurements</td>
<td>Are set to 1.</td>
</tr>
<tr>
<td>Contrasts</td>
<td>Up to 12 echoes possible.</td>
</tr>
<tr>
<td>TE</td>
<td>Set the echo time for each echo. Keep maximum TE to less than or similar to expected T2 values.</td>
</tr>
<tr>
<td>Noise threshold</td>
<td>Echoes with signals less than this value will be ignored in the fit. If in doubt, leave at default value.</td>
</tr>
<tr>
<td>Save original images</td>
<td>Keeps the morphological base images in the database.</td>
</tr>
</tbody>
</table>
In the **Sequence Part 1** parameter card:

- **Contrasts**: Up to 12 echoes possible.
- **Bandwidth**: Must be entered for each echo. Use the same bandwidth for all echoes.
- **Flow comp.**: Useful in the abdomen
- **Readout mode**: Select mono or bi-polar
Clinical use in cartilage repair therapies (microfracture therapy)

MFX therapy creates microfractures in the bone. Cartilage regeneration is promoted by the released blood and marrow. T2* is reduced in the region of MFX therapy. A small patient study suggests that variability is better with T2*.
Fast T1 mapping with syngo MapIt

Clinical use to aid in:
- dGEMRIC
- Pre-operative staging
- Prediction of therapy outcome
- Therapy follow up

T1 mapping is used in cartilage to track proteoglycans. The gold standard was multiple IR spin echo measurements. However, the very long acquisition time of up to 30 minutes makes it clinically difficult.

Fast T1 mapping with syngo uses a 2 angle VIBE measurement. The acquisition time is significantly reduced to 3 minutes. To calculate T1, this technique utilizes 2 spoiled GRE measurements, each identical except for different flip angles.

syngo MapIt calculates T1 on a pixel-by-pixel basis.
**T1 mapping with B1 correction**

Variable flip angle techniques used by syngo MapIt are intrinsically sensitive to inhomogeneities of the transmit RF field (B1). syngo MapIt can perform B1 corrections to improve the spatial homogeneity and the reproducibility of the acquired T1 maps. This reduces also the dependency on adjustments. To enable this feature, run the Siemens **B1mapForT1mapping** protocol prior to the T1 mapping protocol. The three-dimensional FoV of the **B1mapForT1mapping** protocol should be greater or equal to the FoV of the T1 mapping protocol. B1 corrections will be performed. The image series with the corrected T1 maps is marked as T1_Images_B1corr instead of T1_Images.

---

Please note: The resulting T1 map values may overestimate the absolute T1 values! This behavior is expected due to the used technique – the variable flip angle method. Thus a relative comparison of T1 values within tissues should be made.
**T1 mapping: protocol parameters**

For fast T1 mapping use the “vibe” sequence. Use the Inline MapIt parameter card.

<table>
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<th>MapIt</th>
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<th>T1 estimate</th>
<th>Flip angle 1</th>
<th>Flip angle 2</th>
<th>Measurements</th>
<th>Contrasts</th>
<th>TE</th>
<th>TR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1000 ms</td>
<td>5 deg</td>
<td>30 deg</td>
<td>2</td>
<td>1</td>
<td>1.3</td>
<td>15</td>
</tr>
</tbody>
</table>

**MapIt**

- Select T1 map.

**Auto angle calculation**

- Select, if required.

**T1 estimate**

- Two optimum angles will be automatically calculated, based on the estimated T1.

**Flip angle**

- Alternatively, select two flip angles.
B.1 Fusing biochemical maps and images

- Loading the data
- Optimizing the image display
- Visualizing the cartilage
- Saving and filming the images
Post-processing
Fusing biochemical maps and images

The following example describes how to overlay T2/T2* maps generated with syngo MapIt with their corresponding anatomical images. Subsequently, manual cartilage segmentation is performed.

The same procedure applies when using T1 maps. In this case, two series containing the morphological base images for the two flip angles are stored together with the T1 map series.

Loading the data

- T2/T2* maps have been generated with syngo MapIt
- Anatomical base images are available (Save original images activated during mapping)

Loading the maps

- Select the mapping series in the Patient Browser.
- Click the 3D MPR icon to start image processing as MPR.
- Window the mapping images to optimize their contrast and brightness.
Post-processing

Loading the original images

The series preceeding the T2/T2* maps contains the morphological base images for all echoes.

◆ Select the morphological series in the Patient Browser.
◆ Load the data to 3D Fusion with the icon.

◆ In the 3D Series List, select the echo images you want to use.

The Fusion Registration dialog window is displayed. Registration is not needed in this case.

◆ Skip Fusion Registration with OK.
**Optimizing the image display**

- Open the **Fusion Definition MPR** dialog window with **Fusion > Fusion Definition**.
- In order to get access to the mask menu, click **Advanced**.

- Hide the background noise in the mapping images by increasing the L value for **Masking** to “1” (left spin box).
- Select suitable **Color Lookup Tables** for the map and the morphological images to optimize their view.

**Recommended settings:** **Rainbow** for mapping images (left selection list), **Gray Scale** for morphological images (right selection list).
Post-processing

- Set the T2/T2* baseline map **Window Level** to a default value by changing the left \( C \) and \( W \) values (e.g. “45” each).

**Visualizing the cartilage**

It is easier to segment the cartilage if you work on the morphological images.

- In the **Fusion Definition MPR** dialog window, move the **Mixing Ratio** slider to the right to display the morphological image only.
- Activate **VOI Punch Mode** with the icon in the **Settings** subtask card.

The **VOI Punch Mode** dialog window opens. VOI drawing is activated automatically.

- Trace the cartilage in the morphological image. Double-click to finish.
Fusing biochemical maps and images

- Remove the non-cartilage part of the mapping image with the Keep Inside icon.
- In order to provide for good fusion, set a Mixing Ratio of 50% in the Fusion Definition MPR dialog window.

Saving and filming the images

- Select the respective segment for saving or filming.
- Save the images as a new series with the icon.
- To film the images selected, click the icon.
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