ESMI

European Spinocerebellar Ataxia Type 3/Machado-Joseph Disease Initiative

MRI Manual

JPND research

EU Joint Programme – Neurodegenerative Disease Research

ESMI MRI Manual

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1 ESMI MRI - overview

1.1 ESMI MRI main protocol in vivo

Before scanning:

Please place a marker on the left head side of the patient, e.g. vitamine capsule.

Please position the participant straight within the scanner and head coil. Avoid reclination, inclination and turning sideways of the head.

ESMI MRI main protocol in vivo				
No.	**Sequence**	**Duration [min]***	**Alignment**	**Instruction**
1.	**dzne_localizer**	00:10*	-	
2.	**dzne_MPRAGE_1iso_PAT2**	05:08*	Sagittal Todo: **Center FOV midsagittal** (same distance left and right) **Whole brain including cerebellum should be covered**	Eyes closed.
3.	**dzne_DTI_V2.1_2iso_b0**	01:14*	**Todo: Set Alignment to AC-PC using MPRAGE** **Manually adjust FOV: whole brain including cerebellum**	Eyes closed.
4.	**dzne_DTI_V2.1_2iso_b700**	06:41*	Alignment is automatically copied from first DTI (whole brain, incl. Cerebellum, AC-PC).	
5.	**dzne_DTI_V2.1_2iso_b0**	01:14*		
6.	**dzne_DTI_V2.1_2iso_b1000**	06:41*		
7.	**dzne_DTI_V2.1_2iso_b0**	01:14*		
8.	**dzne_DTI_V2_2iso_revPE**	00:50*	Alignment is automatically copied from first DTI (whole brain,incl. Cerebellum, AC-PC) **Todo: Adjust PE direction to +180°** = should be reverse PE to DTI change in Routine > Phase enc. dir > change from 0° to 180° degrees (P>> A)	Eyes closed.
9.	**dzne_RestingState_3.5iso**	07:54*	Alignment is automatically copied from first DTI (whole brain, incl. Cerebellum, AC-PC)	Please keep your eyes closed and stay awake. Let your mind wander!
10.	**sportax_gre_field_mapping_2iso**	02:56*	Alignment is automatically copied from first DTI (whole brain,incl. Cerebellum, AC-PC) **Todo: Copy adjust volume from RestingState**	Eyes closed.
11.	**sportax_IR-EPI_3.5iso**	00:30*	Alignment is automatically copied from first DTI (whole brain,incl. Cerebellum, AC-PC) **Todo: Copy adjust volume from RestingState**	Eyes closed.
12.	**dzne_FLAIR_1iso**	07:02*	Alignment is automatically copied from MPRAGE (sagittal, whole brain, incl. cerebellum)	Eyes closed.
				*duration time can slightly vary depending on the software version of different scanner!

1.2 ESMI MRI quality assurance (QA) protocol for phantom

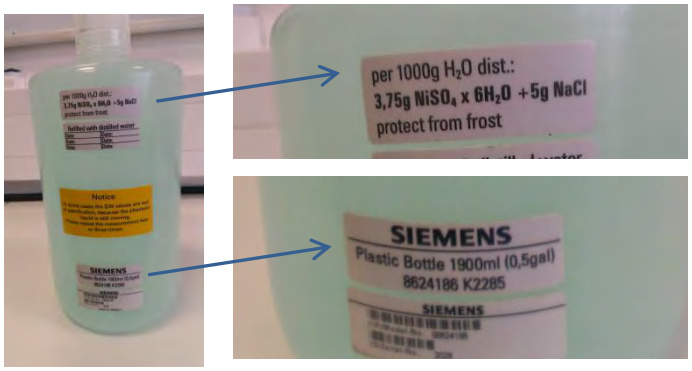
The QA protocol should be measured on a **weekly basis**. That means one QA-scan per week is optimal.

In weeks when also ESMI-in-vivo is measured (subjects or controls), at least one QA-scan is mandatory.

Before scanning:

Please us the cylindrical SIEMENS Phantom:
Plastic Bottle 1900ml (0,5gal)
Containing per 1000g H2O dist.:
3,75g $NiSO_4$ x $6H_2O$ + 5g NaCl

8624186 K2285



Please place the phantom in the middle (same distance left and right) and bottom first in the head coil. The bottom should be as deep as possible within in the "z-axis" of the head coil. Pads can be helpful to stabilize the center position (same distance left and right). The fastening should be outside of the head coil.

Please move the table very slowly into the scanner to prevent turbulences in the liquid within the phantom.

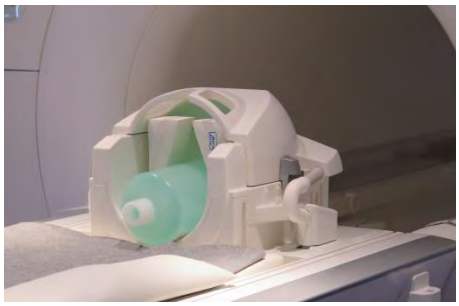


Fig. Phantom placement within head coil.

ESMI MRI QA protocol			
No.	**Sequence**	**Duration [min]**	
1.	Waiting	>10:00	Please wait minimum 10min so that the liquid within the phantom calms. Turbulences in the liquid have an influence on the signal and have an impact on the image quality.
2.	dzne_localizer	00:10	
3.	snr_AC_2iso	01:06	
4.	snr_BC_2iso	01:06	
5.	dzne_RestingState_3.5iso_QA	5:01	

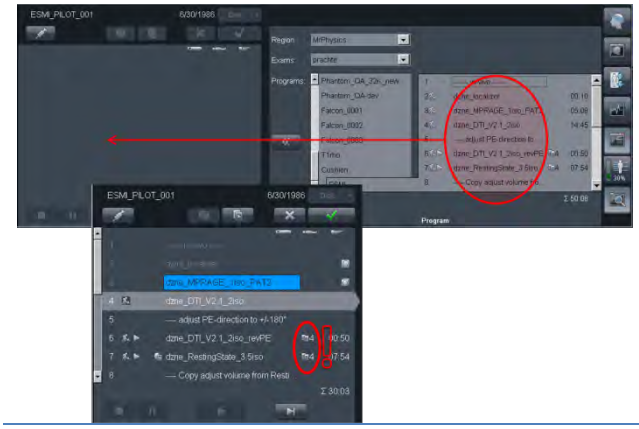
2 Detailled description and scanning instructions for the ESMI MRI main protocol in vivo

Before scanning:

Please place a marker on the left head side of the patient, e.g. Vitamine capsule.

Please position the participant straight within the scanner and head coil. Avoid reclination, inclination and turning sideways of the head.

Please fill in the Checklist_ESMI_MRI to document all relevant issues and completeness of scans.



Copy the whole protocol at once to ensure that the references are available and copied.

Figure 1: Measuring the protocol.

General instruction: If a SAR warning/error appears: Do always change TR. Please *never* change the number of slices/images!! (Document changes on the Checklist_ESMI_MRI)

2.1 Localizer

Name: **dzne_localizer**

Duration: 00:10min

Positioning/Orientation:

The head should be positioned straight within the head coil. Please avoid reclination and inclination as well as a turning sideways. Please correct the position if the head is placed oblique.

Please assure that the vitamine-capsule is visible and positioned on the left side.

Sagittal **Koronar** **Transversal**

Figure 2: Examples for wrong positioning. In that case: Please correct position of subject.

2.2 MPRAGE (3D-T1)

Name: **dzne_MPRAGE_1iso_PAT2**
Duration: 05:08min
Positioning/Orientation: **sagittal, center FOV midsagitall (same distance left and right)**
Acquisition sagittal. No rotation allowed! Please adjust empty volumes (without head/brain) in a way that the amount of empty volume is the same on every lateral side, frontal and occipital as well as superior.
Caution: The **whole brain, including the cerebellum**, has to be within the measured volume!
Instruction: Eyes closed.

After the acquisition: Please check images. If motion artifacts occurred: Please inform and motivate the participant to try to avoid motion.
In case of considerable artifacts: Please repeat measurement.

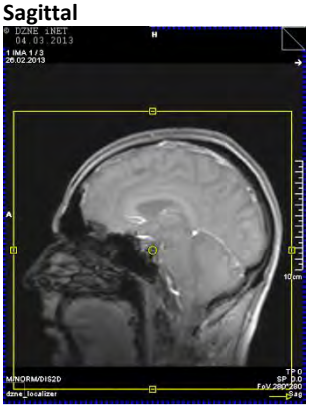
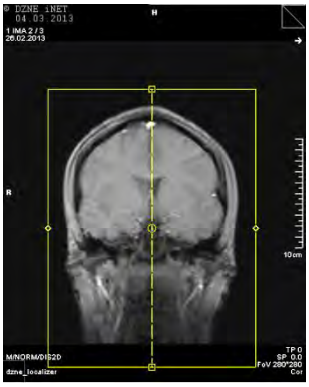
Sagittal	**Coronar**	**Transversal / axial**
		
Correct position. Neither back of head nor nose are cut off.	Correct position. Scullcap not cut off, whole brain within measured volume.	Correct position: Head centered, no turning sideways, midline centered and straight forward.

Figure 3: Positioning for MPRAGE.

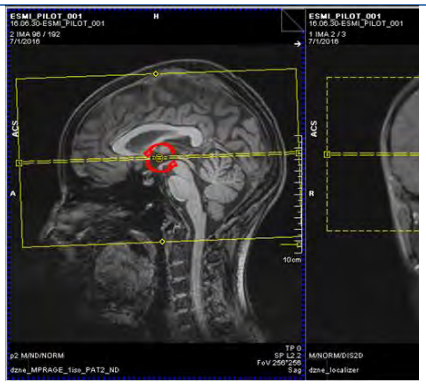
2.3 DTI

Name: **dzne_DTI_V2.1_2iso_b0**
Duration: 01:14min
Positioning/Orientation: **Set alignment to AC-PC using MPRAGE, manually adjust FOV (whole brain incl. Cerebellum)**
Please orient/align the FOV based on the previously acquired MPRAGE:

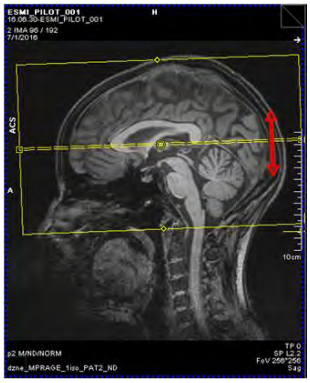
1. Load MPRAGE to the window for planning
2. Alignment along anterior and posterior commissure (AC-PC). For details see chapter 3 “AC-PC Alignment”.
3. Adjust Volume by moving up/down without changing the AC-PC-Alignment to cover the whole brain, including cerebellum. Sometimes scrolling through the sagittal view is helpful to assure the coverage of the whole brain and cerebellum.

Caution: The whole brain, including the cerebellum, has to be within the measured volume!!
Instruction: Eyes closed.

1. drag&drop MPRAGE to the window for plannig

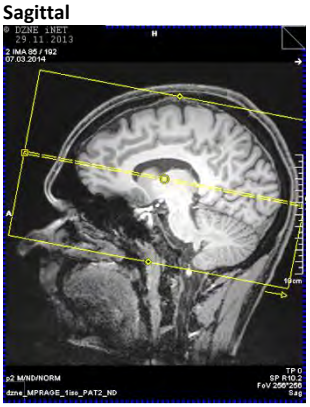


2. Rotate FOV to align AC-PC



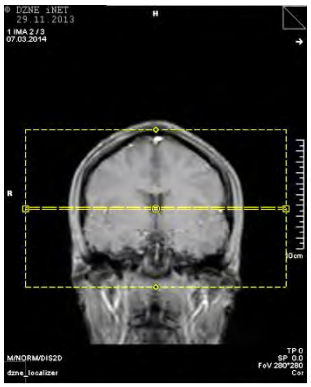
3. Move FOV up/down along z-axis to cover whole brain incl. cerebellum.

Sagittal



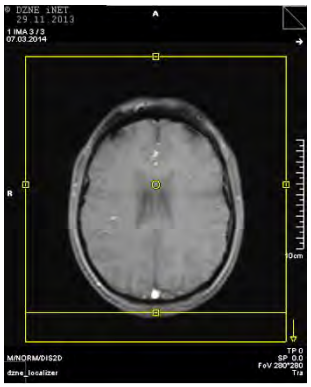
Correct position:
Parallel to AC-PC, no cut off frontal or at the back of the head. Whole brain and cerebellum included.

Coronar



Correct position:
Whole brain and cerebellum included.

Axial



Correct position:
Central position of the head.

(note: phase encoding direction is anterior to posterior, as indicated by the arrows next to the FOV)

Figure 4: AC-PC Alignment for DTI (for details see also 3 AC-PC-Alignment,Figure 9)

Name: **dzne_DTI_V2.1_2iso_b700**
Duration: ~06:41min
Name: **dzne_DTI_V2.1_2iso_b0**
Duration: ~01:14min

Name: **dzne_DTI_V2.1_2iso_b1000**
Duration: ~06:41min
Name: **dzne_DTI_V2.1_2iso_b0**
Duration: ~01:14min

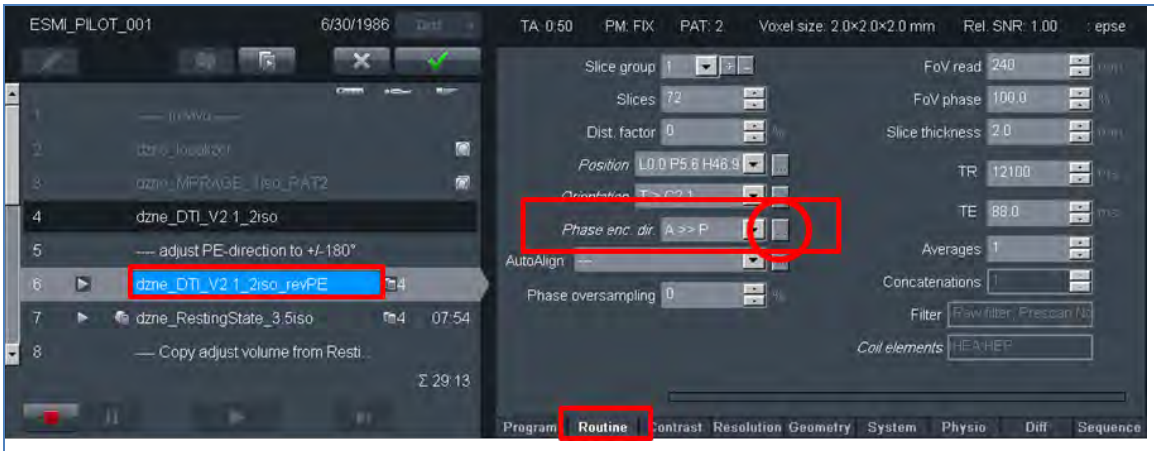
Positioning/Orientation: Alignment is automatically copied from first DTI (whole brain, incl. Cerebellum, AC-PC). Nothing todo.

2.4 DTI_revPE

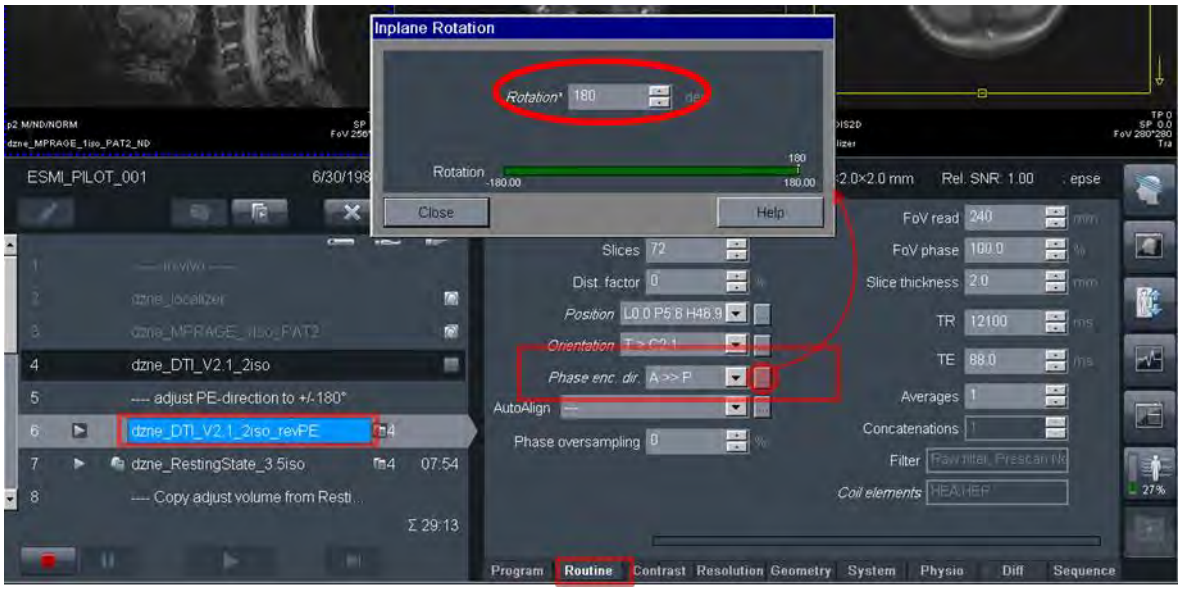
Name: ***dzne_DTI_V2.1_2iso_revPE***
Duration: 00:50min
Positioning/Orientation: alignment is automatically copied from DTI (whole brain, AC-PC); **adjust phase encoding (PE) direction to +180 degrees**

Alignment is automatically copied from first DTI (AC-PC, whole brain, incl. Cerebellum).
The phase encoding (PE) direction has to be changed. It should be reverse to the direction of the DTI. Therefore the PE direction has to be adjusted to 180 degrees.
This is done by opening the sequence, within "Routine" you find "Phase enc. dir.": click to the "..."-button and change the degree from 0 to + 180.
After that the "Phase enc. dir." will be set to "P >> A". You can doublecheck this within the planning window: the arrow indicating the phase encoding direction shows in the opposite direction (posterior to anterior) as the one within the DTI scan (anterior to posterior).

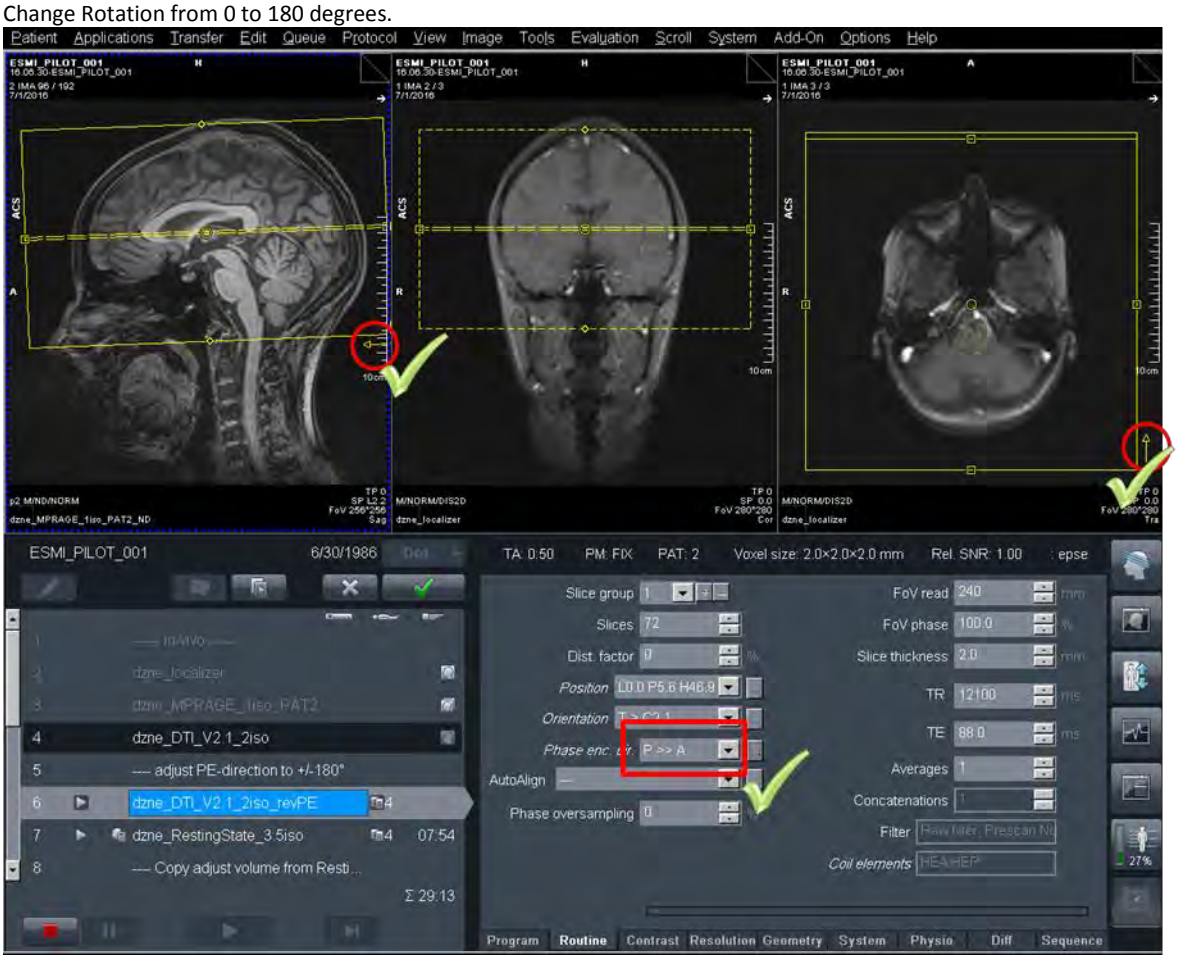
Instruction: Eyes closed.



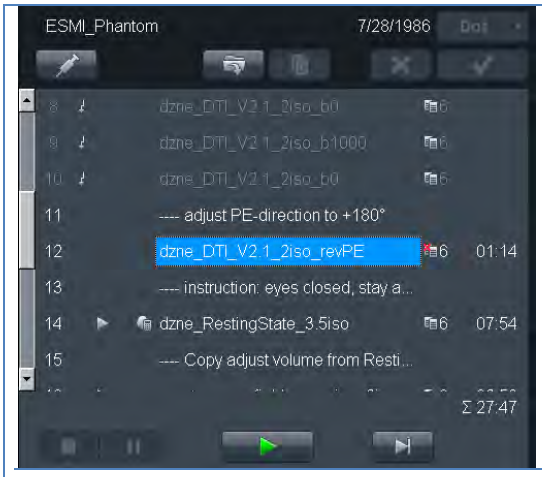
Open the sequence; then open sheet "Routine". There you find Phase enc. dir.
Click to the "..." button and the window for the implane rotation will open.



Change Rotation from 0 to 180 degrees.



Phase encoding (PE) direction (Phase enc. dir.) has now changed to P >> A (posterior to anterior). You can doublecheck that within the planning window: Arrows next to the FOV are showing the phase encoding direction and should be directed from posterior to anterior. This is reverse to the PE of the DTI (see above).



After changing the PE, a red cross might appear upon the sign for the copy reference, because of the changes you applied!

Figure 5: Change phase encoding direction to 180 degrees

2.5 RestingState

Name: **dzne_RestingState_3.5iso**
Duration: 07:54min
Positioning/Orientation: Alignment is automatically copied from first DTI (whole brain, incl. Cerebellum, AC-PC)

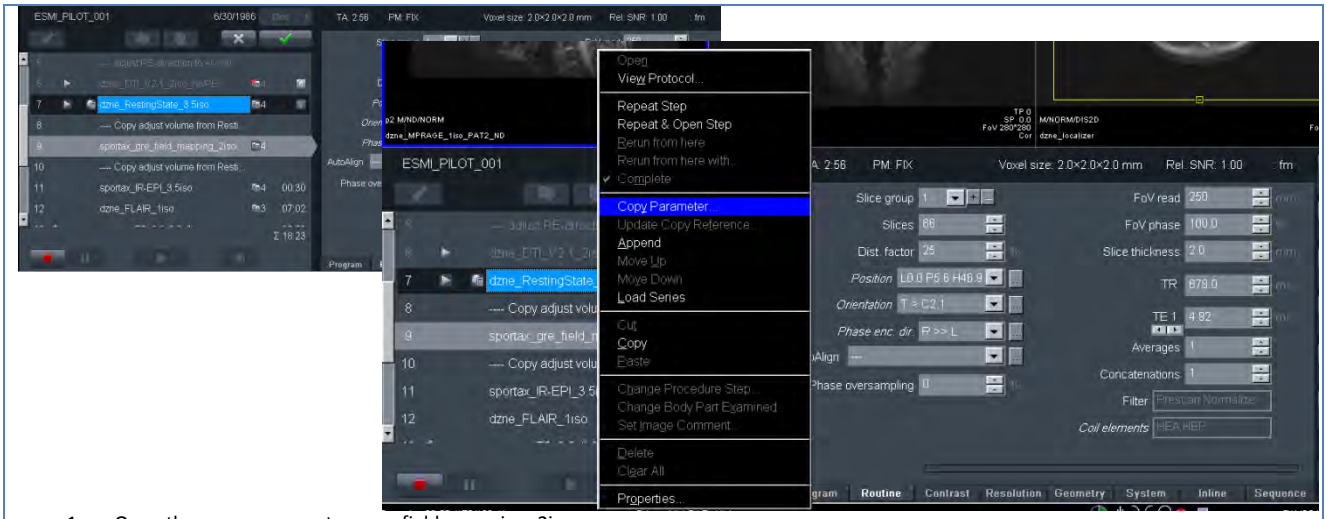
Alignment is automatically copied from DTI (AC-PC, whole brain, incl. Cerebellum). Manual adjustment like moving up/down/left/right should not be necessary! Please report if manual adjustment is necessary to cover the whole brain (you can find the contact person at the beginning of this document!).

Instruction: Please keep your eyes closed but stay awake. Let your mind wander.

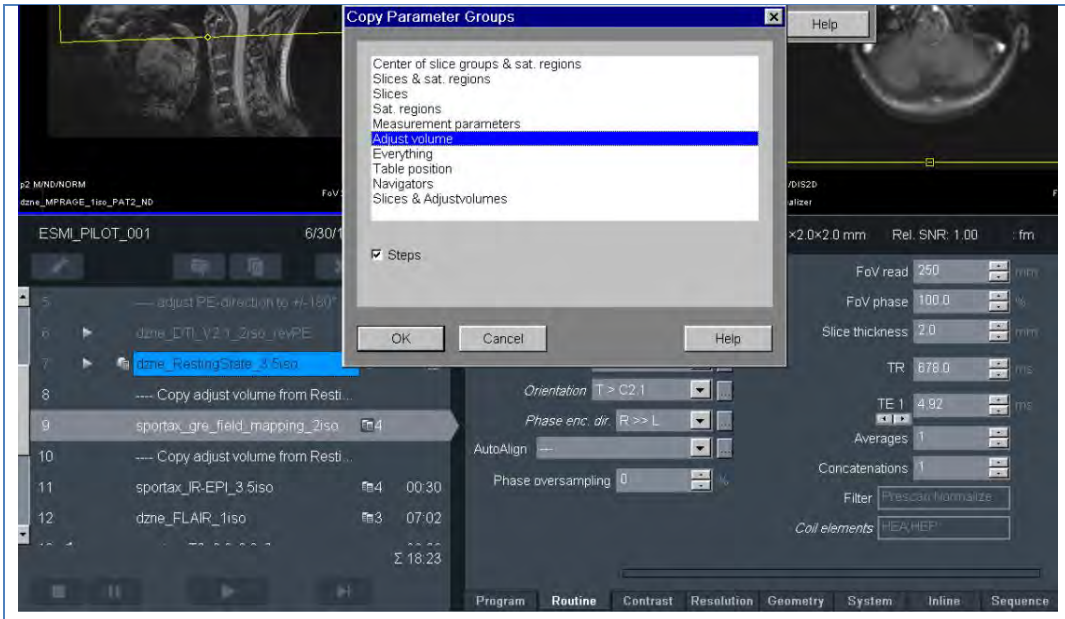
2.6 GRE Field-Map

Name: sportax_gre_field_mapping_2iso
Duration: 02:56min
Positioning/Orientation: Alignment is automatically copied from first DTI (whole brain, incl. Cerebellum, AC-PC), **copy adjust volume from RestingState**
Alignment is automatically copied from DTI (whole brain, incl. Cerebellum, AC-PC). Please copy the adjust volume from RestingState. Therefore, open the sequence, then right click on the RestingState-Sequence, choose “Copy parameter”.
In the window now displayed choose “Adjust Volume” and confirm with “OK”.

Instruction: Eyes closed.



1. Open the sequence sportax_gre_field_mapping_2iso
2. then right click on dzne_RestingState_3.5iso
3. Choose “Copy parameter”.



4. Choose “Adjust Volume”
5. Confirm with “OK”

Figure 6: Copy adjust volume from RestingState

2.7 IR-EPI

Name: **sportax_IR-EPI_3.5iso**
Duration: 0:30min
Positioning/Orientation: Alignment is automatically copied from first DTI (whole brain, incl. Cerebellum, AC-PC), **copy adjust volume from RestingState**

Alignment is automatically copied from DTI (whole brain, incl. Cerebellum, AC-PC). Please copy the adjust volume from RestingState. Therefore, follow the instructions described in “2.6 GRE Field map” and Figure 6.

Instruction: Eyes closed.

2.8 FLAIR

Name: **dzne_FLAIR_1iso**
Duration: 7:02min
Positioning/Orientation: sagittal, alignment is copied from MPRAGE.

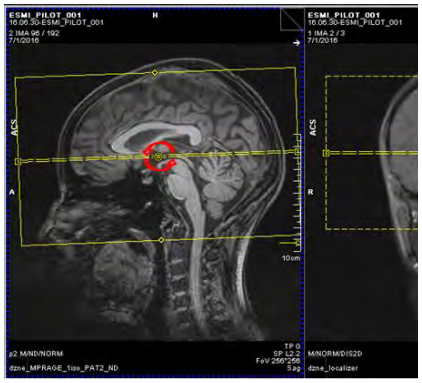
Alignment is automatically copied from MPRAGE (sagittal, whole brain, incl. Cerebellum). Manual adjustment like moving up/down/left/right should not be necessary! Please report if manual adjustment is necessary to cover the whole brain (you can find the contact person at the beginning of this document).

Instruction: Eyes closed.

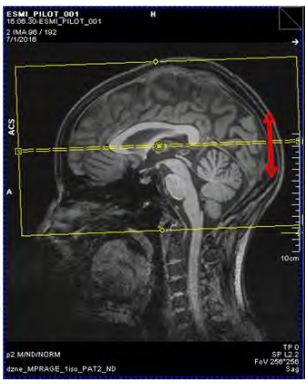
3 AC-PC Alignment

Use MPRAGE (high resolution T1) for AC-PC-Alignment.
Therefor drag&drop MPRAGE to the window for planning (see Fig.

drag&drop MPRAGE to the window for plannig



Rotate FOV to align AC-PC

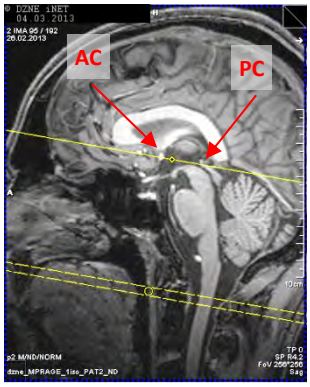


Move FOV up/down along z-axis to cover whole brain incl. cerebellum.

Figure 7: Overview of AC-PC Alignment: Use MPRAGE.

In the sagittal view choose one slice where you can identify clearly the anterior and posterior commisure (AC, PC).

Sagittal



Sagittal (detail)

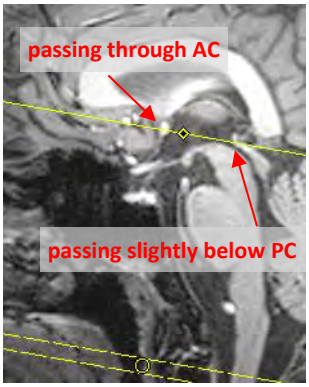


Figure 8: Positioning of AC-PC Alignment

4 Checklist and Data upload

ESMI MRI

Checklist

Please fill out the “Checklist_ESMI_MRI” for every scan (download via the owncloud).
You only have to fill in the Pseudonym and acquisition date and - if the measurement was without problems - tick every scan that has been performed.
If any problems occured (a lot of movement, scan could not be completed etc.) please document it.
Please feel free to complete/modify the document for your purposes. E.g. you maybe would like to add some tick-boxes for "Patient gave written informed consent" or "ear protection", etc.

Data upload

Every site has access to a server for transferring the MRI data to Bonn.
Detailed instructions can be found in the manual “ESMI_MRI_data_upload”.

For any questions do not hesitate to contact us: jennifer.faber@ukbonn.de

Checklist ESMI MRI in vivo

Site:

subjects-ID	
Date and Time	

	✓
Marker placed on the **left** head side of the patient?	

ESMI MRI main protocol in vivo

No.	Sequence	Dura-tion [min]*	Alignment	Instruction	
1.	**dzne_localizer**	00:10*	-		
2.	**dzne_MPRAGE_1iso_PAT2**	05:08*	Sagittal Todo: **Center FOV midsagittal** (same distance left and right) **Whole brain including cerebellum should be covered**	Eyes closed.	
3.	**dzne_DTI_V2.1_2iso_b0**	01:14*	**Todo: Set Alignment to AC-PC using MPRAGE** **Manually adjust FOV: whole brain including cerebellum**	Eyes closed.	
4.	**dzne_DTI_V2.1_2iso_b700**	06:41*	Alignment is automatically copied from first DTI (whole brain, incl. Cerebellum, AC-PC).		
5.	**dzne_DTI_V2.1_2iso_b0**	01:14*			
6.	**dzne_DTI_V2.1_2iso_b1000**	06:41*			
7.	**dzne_DTI_V2.1_2iso_b0**	01:14*			
8.	**dzne_DTI_V2_2iso_revPE**	00:50*	Alignment is automatically copied from first DTI (whole brain,incl. Cerebellum, AC-PC) **Todo: Adjust PE direction to +180°** = should be reverse PE to DTI change in Routine > Phase enc. dir > change from 0° to 180° degrees (P>> A)	Eyes closed.	
9.	**dzne_RestingState_3.5iso**	07:54*	Alignment is automatically copied from first DTI (whole brain, incl. Cerebellum, AC-PC)	Please keep your eyes closed and stay awake. Let your mind wander!	
10	**sportax_gre_field_mapping_2iso**	02:56*	Alignment is automatically copied from first DTI (whole brain,incl. Cerebellum, AC-PC) **Todo: Copy adjust volume from RestingState**	Eyes closed.	
11	**sportax_IR-EPI_3.5iso**	00:30*	Alignment is automatically copied from first DTI (whole brain,incl. Cerebellum, AC-PC) **Todo: Copy adjust volume from RestingState**	Eyes closed.	
12	**dzne_FLAIR_1iso**	07:02*	Alignment is automatically copied from MPRAGE (sagittal, whole brain, incl. cerebellum)	Eyes closed.	

*duration time can slightly vary depending on the software version of different scanner!

MRI stored/archived locally?	
MRI uploaded to the owncloud?	

Remarks:

Date

Name MTRA/operator

ESMI MRI
Data upload

Every site has access to a server for transferring the MRI data to Bonn.
In Table 1 you find a list of all persons with an account.

For the data upload:

1 Save MRI dicom and the corresponding checklist

In-vivo scans: One session from one subject should be **zipped into one folder**.
QA-scans (Quality Assessment) should be acquired optimal on a weekly basis and at least in every week when also in-vivo scans are performed (optimal directly before/after an in-vivo scan). QA-scans should be **zipped separately each in one folder**.

Please **name** the folders as follows:

- For subject (patients and controls) data:
  ESMI_*three letters of center name_pseudonym_date of acquisition in yyyy-mm-dd*
  e.g. ESMI_BON_BN-123-456-789_2016-07-14
  Note: The „three letters of center name“ can be choosen by every site (e.g. the first three letters of the city or the University abbreviation), but should be consistent over time. Please find them listed in table 1 at the end of this document.

- For QA data:
  ESMI_*1st three letters of center name*_QA_*date of acquisition in yyyy-mm-dd*
  e.g. ESMI_BON_QA_2016-07-14

Please fill out a Checklist_ESMI_MRI for every scan.
You will find the template document on the owncloud.
You only have to fill in the Pseudonym and date and - if the measurement was without problems - tick every scan that has been performed. If any problems occured (a lot of movement, scan could not be completed etc.) you can document this.
The checklist should be uploaded as a .pdf-file to the owncloud and it should be named as follows:
Checklist_"same-name-as-according-MRIscan".pdf

2 Upload of MRI data and checklist

Open URL: https://owncloud.dzne.de

Enter your user name and password.

Open the folder “Shared”.
There you will find the following folder:

- ESMI – .edx, manual
- ESMI – MRI data

Within the folder called “ESMI - .edx, manual” you will find the .edx-file for implementing the protocol on your scanner as well as this manual and the manual containing the guideline for the MRI measurement.

a) Upload:
The zip-files of the MRI data and the corresponding chechlist-pdfs acquired at your site should be uploaded into the folder called “ESMI – MRI data”.

b) Email:
Whenever you upload data: Please send an email with the information which data has been uploaded to Jennifer Faber (study coordinator), Eberhard Pracht (MR Physicist), Anke Ruehling (MTRA) and Nanette Range (research assistant):
jennifer.faber@dzne.de, eberhard.pracht@dzne.de, anke.ruehling@dzne.de, nanette.range@dzne.de

This should assure that we can doublecheck if every data set arrives completely and correct and proceed the QA checks prompt to your upload.

Note: We will regularly download the data you have uploaded. Afterwards your data will not be available on the owncloud-Server for you!
To give you a report about that, you will find within the folder “ESMI – MRI data” a textfile listing all data sets that we have already downloaded.

If you have any difficulties or open questions, please do not hesitate to contact us!!

Contact:
Study related issues:
Dr. Jennifer Faber
Jennifer.Faber@dzne.de

MR Physics:
Dr. Eberhard Pracht
Email: Eberhard.Pracht@dzne.de

Site		Email	User Name	Name
Bonn	BON	thomas.klockgether@ukb.uni-bonn.de		Thomas Klockgether
		jennifer.faber@ukb.uni-bonn.de	faberj	Jennifer Faber
London	UCL	p.giunti@ucl.ac.uk	paola.giunti	Paola Giunti
		m.yiannakas@ucl.ac.uk	marios.yiannakas	Marios Yiannakas
		c.wheeler-kingshott@ucl.ac.uk	claudia.wheeler	Claudia Gandini Wheeler-Kingshott
		e.devita@ucl.ac.uk	enrico.devita	Enrico De Vita
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Table 1: ESMI MRI