

SOP for spine generic MRI acquisition protocol

This Standard Operating Procedure (SOP) accompanies the protocol for spinal cord MRI acquisition available at <https://osf.io/tt4z9/>.

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The source of this SOP is available here:

https://docs.google.com/document/d/1cCVcMQddQcR9NuvyDApr8KTAy_2F8CRwIRkBzGHrYbE

Subject preparation

Coil

Siemens

- Skyra/Prisma: 64ch head/neck (preferred) or 16+4ch. If thoraco-lumbar, use spine array.
- Trio/Verio: 12ch brain + 4ch neck array. If thoraco-lumbar, use spine array.

Philips

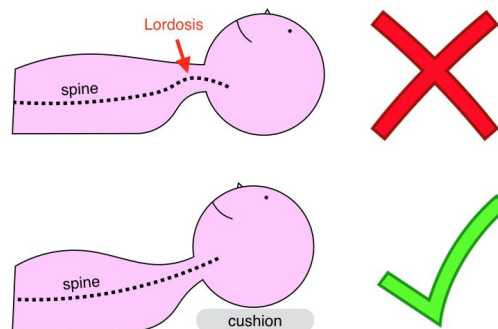
- 16ch neurovascular

GE

- 16ch Head Neck Spine (HNS) Array (on MR750 systems). If not available, use 8ch Cervical Thoracic Lumbar (CTL) Array.

Installation

Cushion, padding: limit head tilting and lordosis in order to exhibit a quasi-straight spine in the imaging region: this will enable prescription of thick slices (~5mm) orthogonal to the cord with minimum partial volume effect.



Inform subject

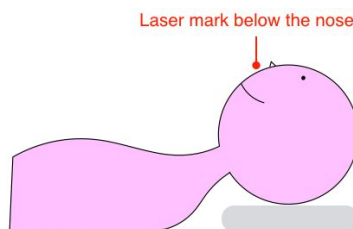
Tell the subject not to move. About swallowing: show the subject how to swallow without moving the head.

Pulse oxymeter

Don't forget to install the pulse oxymeter for cardiac gating on the DWI scan.

Laser marker

If you are doing brain & cervical cord imaging, mark isocenter right below the nose:

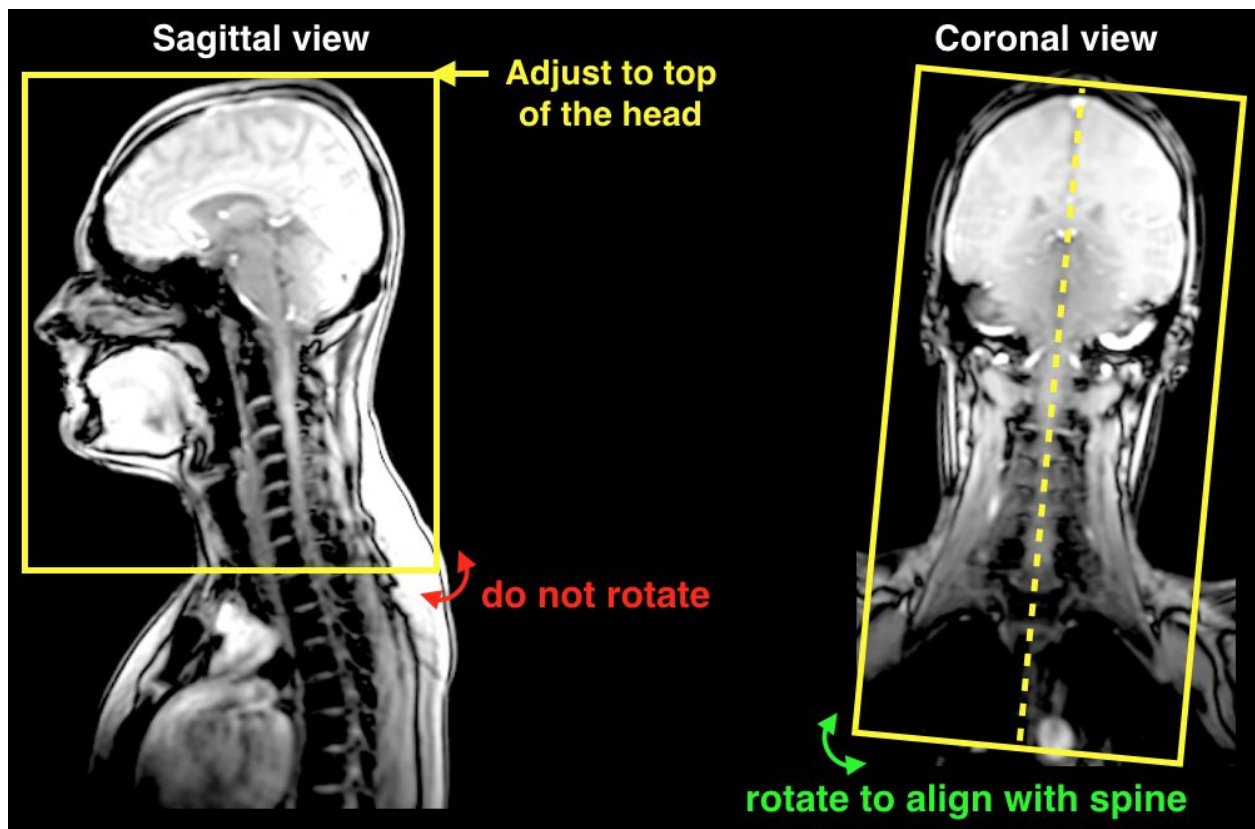


T1w

Adjust the FOV so as to enclose the whole head, as shown in the Figure below.

GE users:

- To avoid confusion in slice orientation, the protocol is saved as “sagittal”. Please click on “oblique” to be able to rotate the slice in the coronal plane.
- **OPTIONAL:** To have the images reconstructed at the proper matrix size, click on “Save Rx → “Scan”, then click on “Research” → “Download”. Then Click on “Research” → “Display CVs”. Then, modify the following CVs accordingly¹:
 - rhimsize=320
 - rhrcxres=320
 - rhrcyres=256



Fig_T1w: Positioning of FOV for T1w scans.

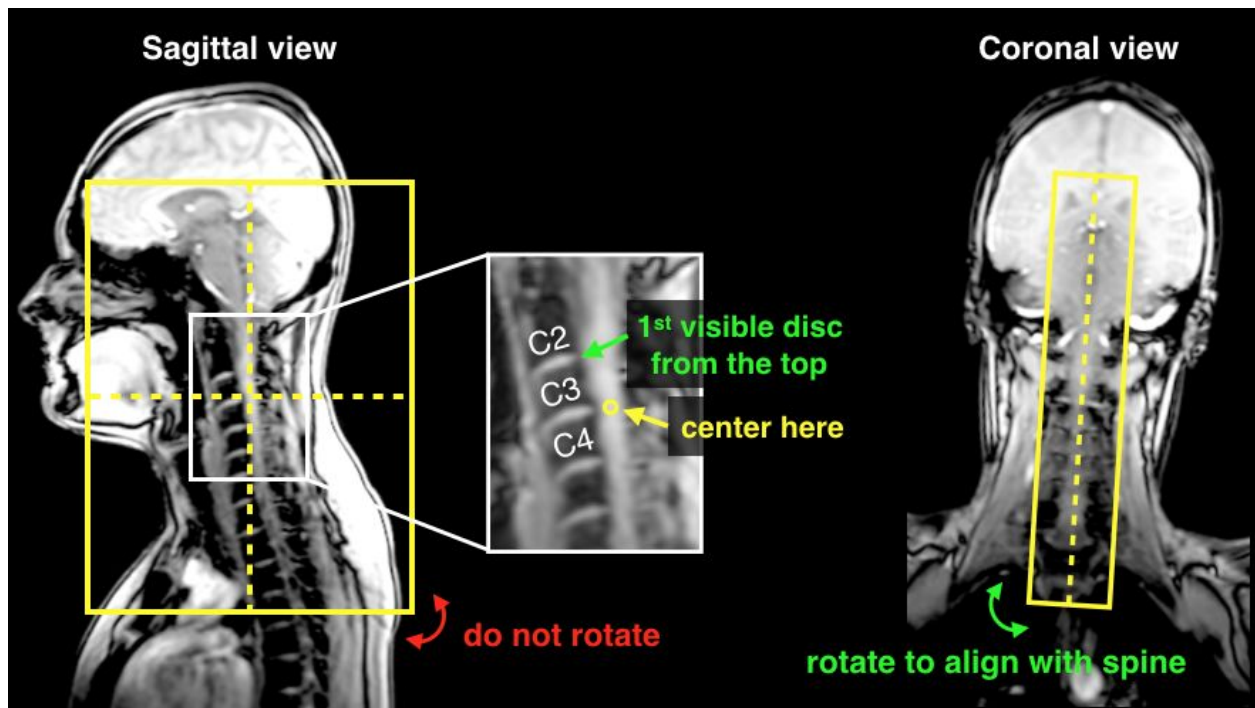
¹ You can check on the console if the field was modified appropriately, by looking at the “image header”, after reconstruction. You should get: (0x0028, 0x0010)=192; (0x0028, 0x0030)=1\1

T2w

Center the FOV at C3-C4 as shown in the Figure below. Align along the spine (see coronal view).

GE users:

- To avoid confusion in slice orientation, the protocol is saved as "sagittal". Please click on "oblique" to be able to rotate the slice in the coronal plane.
- **OPTIONAL:** To have the images reconstructed at the proper matrix size, click on "Save Rx → "Scan", then click on "Research" → "Download". Then Click on "Research" → "Display CVs". Then, modify the following CVs accordingly:
 - rhimsize=320
 - rhrcxres=256
 - rhrcyres=256



Fig_T2w: Positioning of FOV for T2w scans.

DWI

- 1) Center FOV in the cord at the level of C3/C4 disc
- 2) Rotate FOV such that slices are orthogonal to the spinal cord, in both the sagittal and coronal plane.

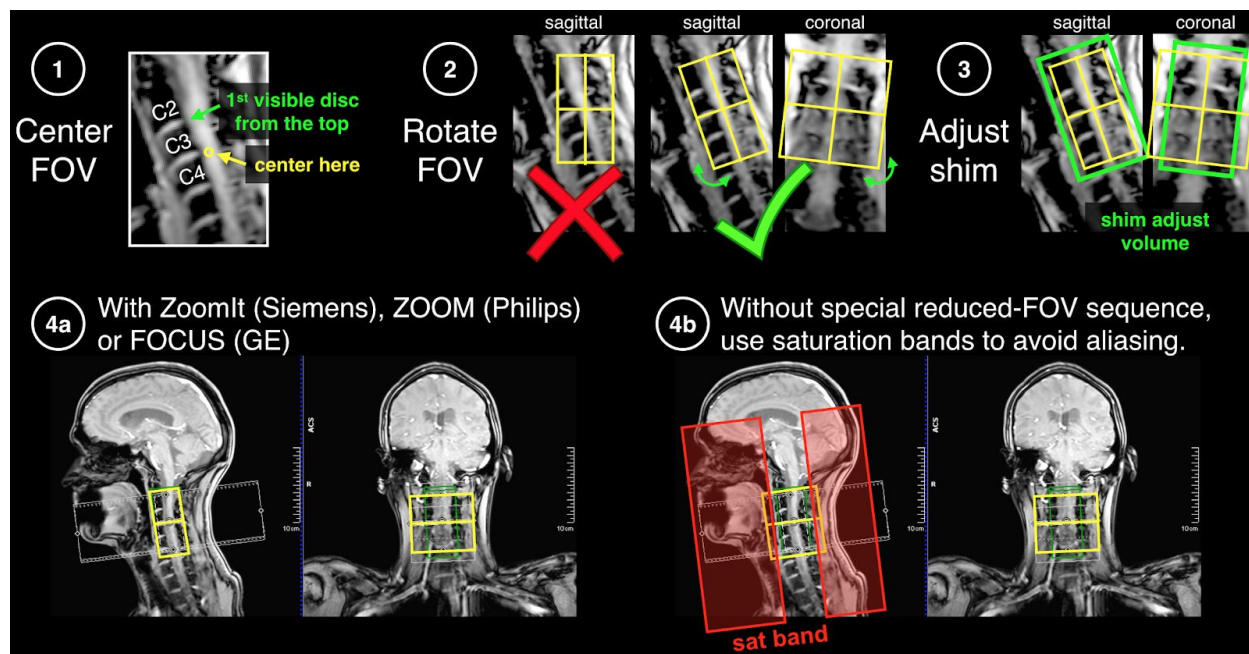
GE users: change the “axial” to “oblique” to be able to rotate the FOV. When tilting the slice, the TE might increase by a few ms. If you wish to use the same TE throughout an entire study, we suggest you try tilting the FOV in the coronal and sagittal plane, and report what the minimum TE is. The more you tilt, the bigger the TE will be (hence lower SNR) but the more conservative you will be in keeping a fixed TE throughout the entire study.

- 3) Adjust shim volume as shown in the Figure (green box).

GE users: click on “shim volume” and then center on the spinal cord. If you cannot modify the size of the shim box, don't worry.

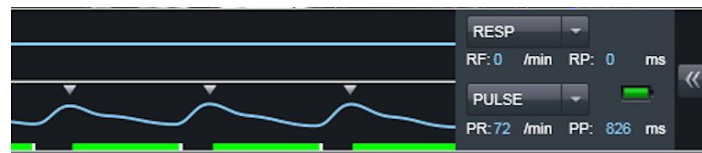
Note: Phase-encode should be A-P.

- 4) Refer to the appropriate figure below depending on your sequence/license:
 - a) If you have ZoomIt (Siemens), ZOOM (Philips) or FOCUS (GE) license (preferred method)
 - b) If you don't have the license, use saturation bands for aliasing suppression.

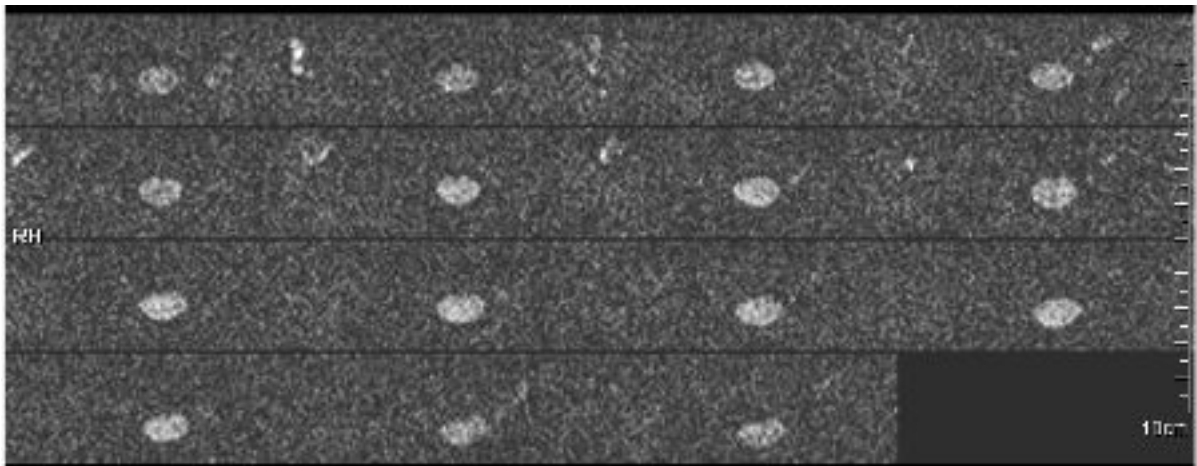


Fig_DWI: Positioning of FOV, shim box and saturation bands for the DWI scan.

Before starting the acquisition, make sure the PulseOx trigger is working. It should look like the figure below:



During acquisition, look at the images to make sure everything is OK. Images should look like this:



GE users:

- The current protocol (v2) is currently saved without pulseOx gating. We recommend you add it (select "PG gating").
- **OPTIONAL:** To have the images reconstructed at the proper matrix size, click on "Save Rx" → "Scan", then click on "Research" → "Download". Then Click on "Research" → "Display CVs". Then, modify the following CVs accordingly²:
rhimsize=96, rhrcxres=86, rhrcyres=43

² You can check on the console if the field was modified appropriately, by looking at the "image header", after reconstruction. You should get: (0x0028, 0x0030)=0.9\0.9

MT1, MT0, T1w

FOV center and orientation should be the same as for the DWI scan. Normally, if you imported the full protocol, the FOV should be copied automatically from DWI. If not, please do “copy parameters” (center of FOV and orientation).

Shimming: Use “auto” mode.

SAR: If you get a SAR limitation on the MT scan, then increase the TR to the minimum suggested (e.g., going from 35ms to 36ms). In that case, it is very important that you also change the TR on the GRE-MT0 sequence (TR should be the same on the MT1 and MT0 scans).

GE users:

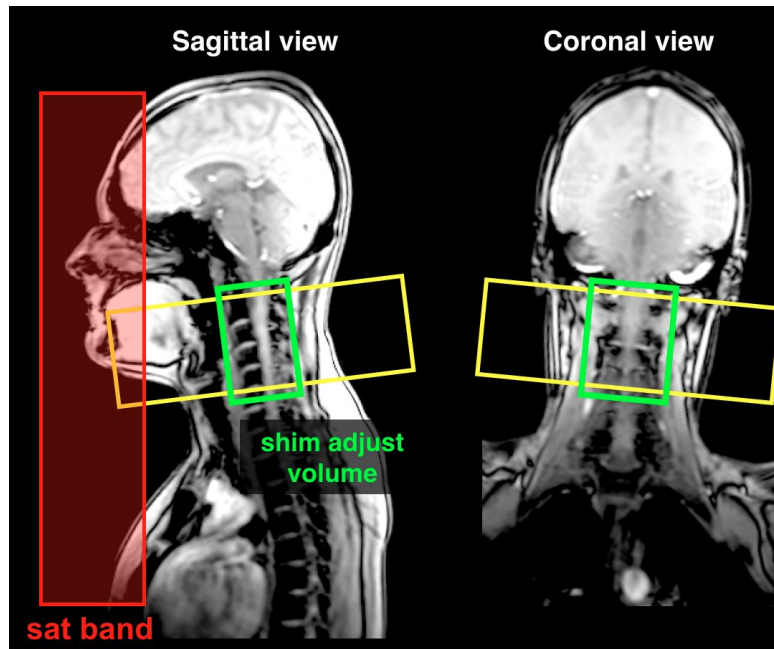
- *To avoid confusion in slice orientation, the protocol is saved as “axial”. Please click on “oblique” to be able to rotate the slice in the sagittal and coronal planes.*
- *To match RF freq of other vendors, modify the CV **off_rfmt***
- **OPTIONAL**: *To have the images reconstructed at the proper matrix size, click on “Save Rx → “Scan”, then click on “Research” → “Download”. Then Click on “Research” → “Display CVs”. Then, modify the following CVs accordingly³:*
rhimsize=192, rhrcxres=172, rhrcyres=172

³ You can check on the console if the field was modified appropriately, by looking at the “image header”, after reconstruction. You should get: (0x0028, 0x0030)=0.9\0.9

GRE-ME

FOV center and orientation should be the same as for the DWI scan. Normally, if you imported the full protocol, the FOV should be copied automatically from DWI. If not, please do “copy parameters” (center of FOV and orientation).

Shimming: Adjust shim box tight to the spine, as shown below:



Positioning of FOV, shim box and saturation bands for the GRE-ME scan. Siemens and GE users: the saturation band is already automatically positioned, so you don't have to worry about it. For Philips users: the saturation bands are “invisible” on this sequence, but are nevertheless applied, so you don't need to add one.

GE users:

- To avoid confusion in slice orientation, the protocol is saved as “axial”. Please click on “oblique” to be able to rotate the slice in the sagittal and coronal planes.
- **OPTIONAL**: To have the images reconstructed at the proper matrix size, click on “Save Rx → “Scan”, then click on “Research” → “Download”. Then Click on “Research” → “Display CVs”. Then, modify the following CVs accordingly⁴:
GRE-ME: rhimsize=448, rhrcxres=224, rhrcyres=224

⁴ You can check on the console if the field was modified appropriately, by looking at the “image header”, after reconstruction. You should get: (0x0028, 0x0030)=0.5\0.5