Diffusion MRI (dMRI) Sequence Settings

In this article, we will review the settings of the diffusion (dMRI) MRI sequence. Spin Echo (SE) Echo Planer Imaging (EPI) single shot (SS) sequence is mainly used for dMRI acquisition by the PBS researchers. We have also installed the same sequence, but highly customizable WIP by CMRR also. Thus, we have the generic Siemens' version and the versatile CMRR version of the same sequence. With CMRR dMRI sequence, we can acquire diffusion data with high accuracy b-values and multi-shell data.

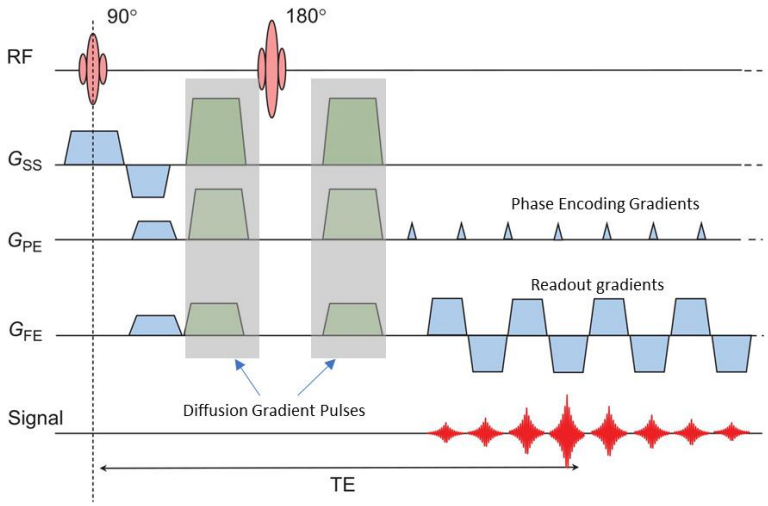


Figure 1: SE-EPI SS sequence diagram

The SE-EPI-SS diffusion sequence is ultra-fast and can acquire the whole brain within one repetition time (TR) for a given diffusion direction. We will lay out important parameters in the sequence and show how someone would see it on the sequence card at the console computer.

Number of slices, FOV

In general, field of view (FOV) and number of slices are chosen to cover the interested region of the brain. Researchers usually acquire the whole brain. The number of slices depends on the slice thickness and the slice gap (if any) to cover the interested region. In the case of simultaneous slice acquisition, the number of slices must be divisible to an integer by the multi-band acceleration factor (MB or SMA).

Figure 2: Geometry – slices, slice gap (Dist. factor), slice thickness, FOV

Echo time (TE) and Repetition Time (TR)

Echo Time (TE) is set to the minimum for dMRI scans. Value of TR depends on the number of slices and the simultaneous multiband factor (SMA/MB). TR can also be set to the minimum value the sequence

can take. The SMA factor is equal to how many slices the sequence acquires simultaneously during each TR.

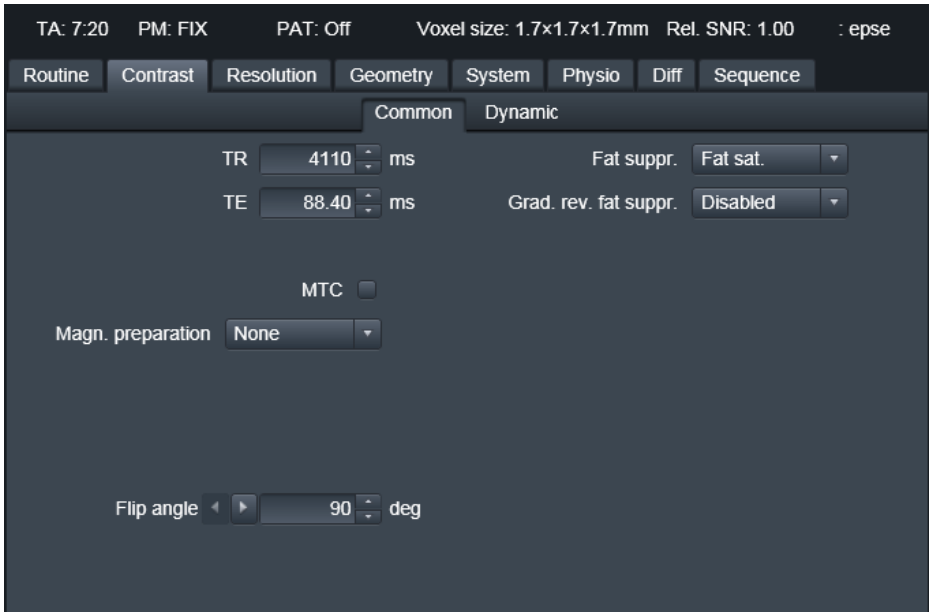


Figure 3: TE, TR,

Flip Angle

For the most experiments, the flip angle is set to 90 degrees for the excitation pulse and 180 degrees for the refocusing pulse.

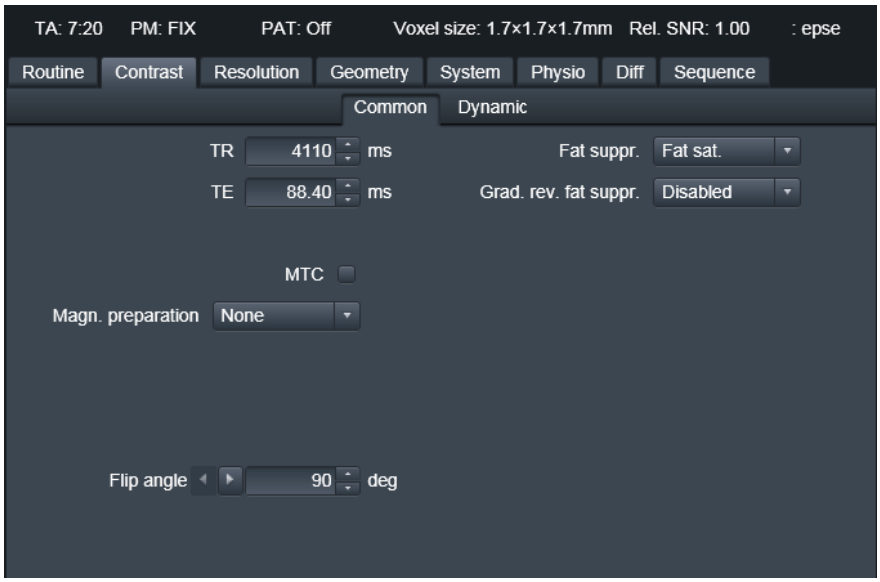
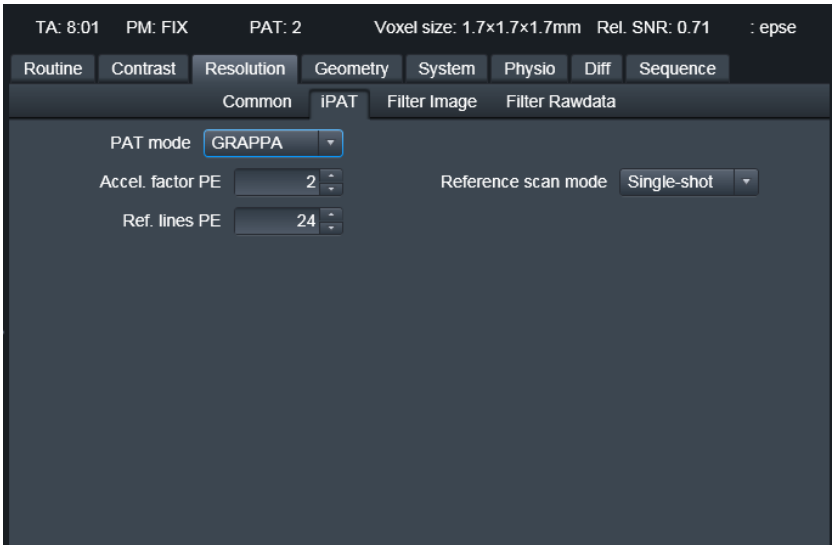


Figure 4: Flip Angle

Acceleration Techniques: GRAPPA, multiband factor (MB/SMA) and partial Fourier factor

GRAPPA is the in-plane acceleration factor; GRAPPA of 2 will reduce scan time almost by half. Multiband factor (SMA) is the slice acceleration factor; SMA of 4 will reduce scan time almost by ¼. Partial Fourier cuts back some of the k-space lines along Phase Encoding direction to accelerate acquisition; if used, most studies use factor of 6/8. We can apply all these acceleration techniques simultaneously if needed with a compromise to the image quality. Most studies use GRAPPA of 2 with SMA of 2 or 4. Some researchers just use SMA of 8 only. With SMA, some researchers also save reference scans for post-processing.


TA: 7:20 PM: FIX PAT: Off Voxel size: 1.7×1.7×1.7mm Rel. SNR: 1.00 : epse
Routine Contrast Resolution Geometry System Physio Diff Sequence
Slice group 1 + -
Slices 81
Dist. factor 0 %
Position Isocenter ...
Orientation Transversal ...
Phase enc. dir. A >> P ...
Phase oversampling 0 %
FoV read 240 mm
FoV phase 100.0 %
Slice thickness 1.70 mm
TR 4110 ms
TE 88.40 ms
Multi-band accel. factor 3
Filter None
Coil elements HEA;HEP


TA: 8:01 PM: FIX PAT: 2 Voxel size: 1.7×1.7×1.7mm Rel. SNR: 0.71 : epse
Routine Contrast Resolution Geometry System Physio Diff Sequence
Common iPAT Filter Image Filter Rawdata
PAT mode GRAPPA
Accel. factor PE 2
Ref. lines PE 24
Reference scan mode Single-shot

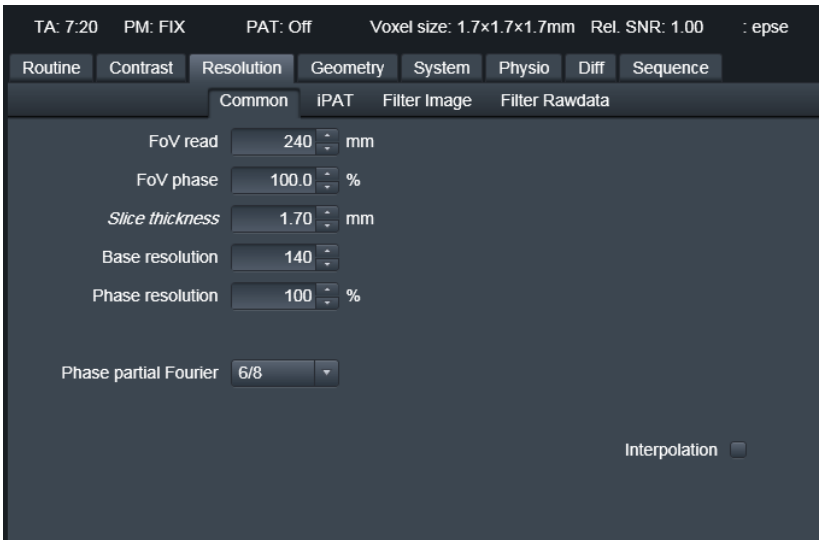
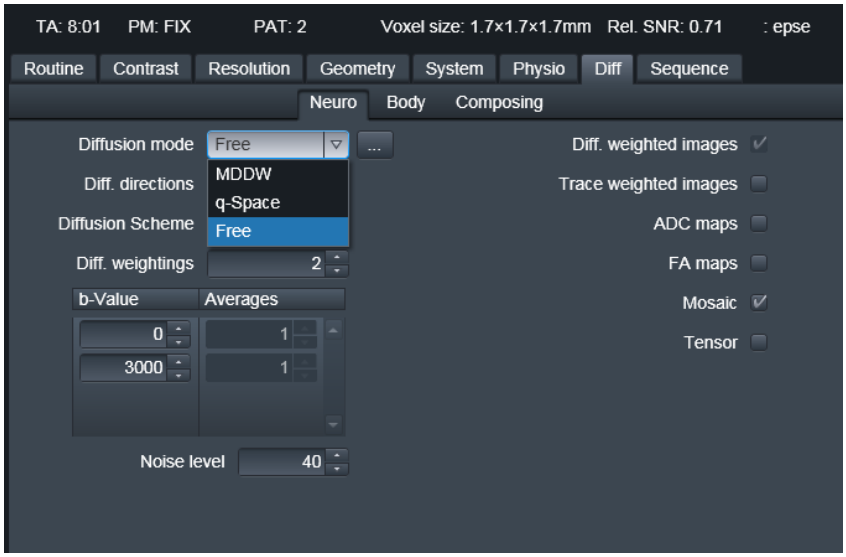
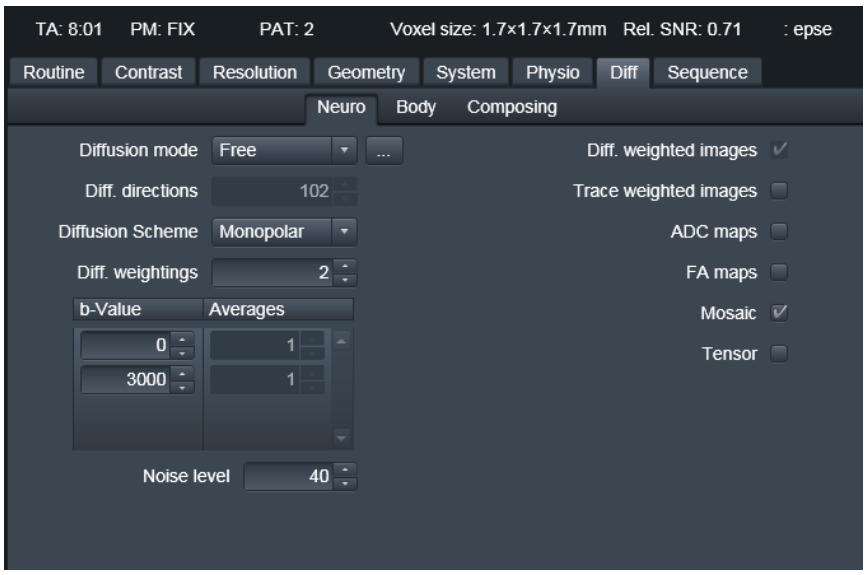


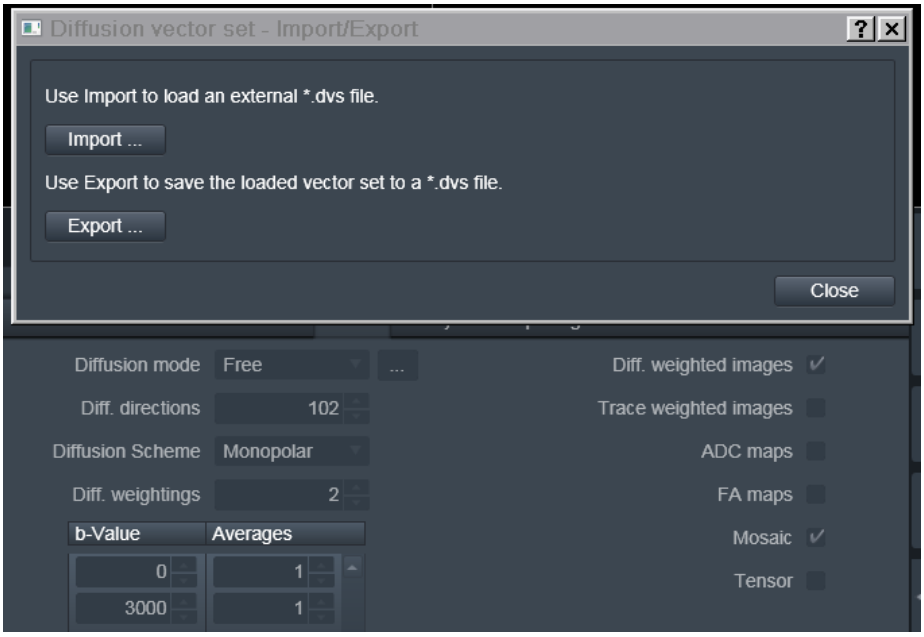
Figure 5: GRAPPA, MB/SMA, pF

Diffusion Gradient Schemes: Diffusion Mode

If you are planning to do to Diffusion Tensor Imaging, you can choose 'MDDW' diffusion mode and select the desired number of diffusion gradient directions and a value for the b-value. For DTI, b-value of 1000 is common. If you need to acquire multi-shell diffusion data, a diffusion gradient scheme (diffusion vector set, DVS) must be imported by choosing 'Free' option. This .dvs file contains diffusion vectors for your experiment and your Physicist can help you get created one and set up the examcard.


TA: 8:01 PM: FIX PAT: 2 Voxel size: 1.7×1.7×1.7mm Rel. SNR: 0.71 : epse
Routine Contrast Resolution Geometry System Physio Diff Sequence
Neuro Body Composing
Diffusion mode Free ...
Diff. directions
Diffusion Scheme
Diff. weightings 2
MDDW
q-Space
Free
b-Value Averages
0 1
3000 1
Noise level 40
Diff. weighted images
Trace weighted images
ADC maps
FA maps
Mosaic
Tensor


TA: 8:01 PM: FIX PAT: 2 Voxel size: 1.7×1.7×1.7mm Rel. SNR: 0.71 : epse
Routine Contrast Resolution Geometry System Physio Diff Sequence
Neuro Body Composing
Diffusion mode Free ...
Diff. directions 102
Diffusion Scheme Monopolar
Diff. weightings 2
b-Value Averages
0 1
3000 1
Noise level 40
Diff. weighted images
Trace weighted images
ADC maps
FA maps
Mosaic
Tensor



Coil Elements Selections

It's necessary and utmost important to make sure the receiver head coil is correctly plugged into the scanner before collecting data. We have three different head coils: 32CH, 64CH and 20CH. You can see if the head coil is correctly plugged on the screen of the scanner itself or check on the examcard tab shown below. Make sure both HEA and HEP parts are plugged in.

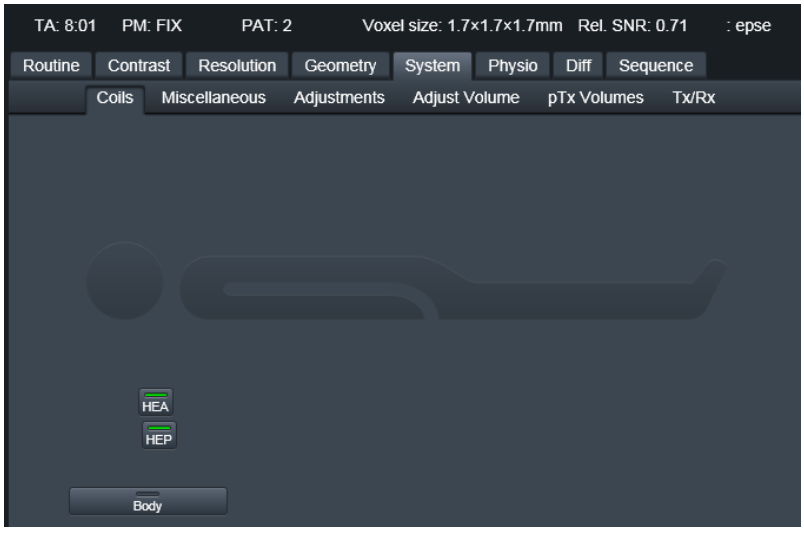


Figure 7: Head coil elements