MI.	T OpenCourseWare
htt	p://ocw.mit.edu

HST.583 Functional Magnetic Resonance Imaging: Data Acquisition and Analysis Fall 2008

For information about citing these materials or our Terms of Use, visit: http://ocw.mit.edu/terms.

2. T1, T2 and T2* Measurements

Background

To calculate T1 values of the tissue we will be using an inversion recovery turbo spin echo sequence. We will be sampling the magnetization as a function of the inversion time (TI). The observed signal intensity is given by the following equation:

$$S(t) \propto \left[1 - 2\exp(-TI/T1)\right] \tag{1}$$

To obtain the transverse relaxation time, T2, values in the brain a series of spin echo images will be acquired by stepping through a range of TEs. The image intensity is given by the following equation:

$$S(t) \propto \exp(-TE/T2)$$
 (2)

T2star (T2*) is the time constant that describes the decay of the transverse magnetization including local magnetic field inhomogeneities. T2* is an important relaxation time for functional studies because it is related to the amount of deoxygenated hemoglobin present in the brain. To determine the T2* values in gray, white matter and CSF, we will be using a gradient echo sequence and the signal is described by:

$$S(t) \propto \exp(-TE/T2^*) \tag{3}$$

Experiments

In this exercise we will acquire and evaluate human data in order to characterize T1, T2 and T2* values in brain tissue compartments. Various sequences will be used with the imaging parameters manipulated so that they provide the appropriate contrast weightings.

T1 measurements

Acqusition: Total scan time: 5m 38sec

- A. Inversion Recovery Turbo Spin Echo (tse_IR) sequence with TR=3000ms, FOV=240x240, matrix=96x128, repeated for multiple inversion times TI=200, 300, 400, 500, 600, 700, 800, 1000, 1300, 1500, 1700, 2000, 2200 ms.
- 1. Load all the images on the viewer.
- 2. Draw ROIs in gray matter areas.
- 3. Record the mean signal values in Table 1 for each inversion time and ROI.
- 4. Repeat steps 1-3 for regions of white matter and CSF.
 - ❖ Lab Question 6: Draw the measured signal as a function of inversion time for each of the tissue compartments. Calculate the T1 for gray, white matter and CSF by fitting Eq. (1) to your data. Hint: you will need to use a nonlinear fitting function such as nlinfit in matlab to accomplish this.

T2 measurements

Acqusition: Total scan time: 9m 42sec

- B. SE sequence with TR=4000ms, FOV=220x220, matrix=192x192, 8 echo times in a range between 14.3ms and 114.4ms and inter-echo spacing 14.3 ms.
- 5. Load all the images on the viewer.
- 6. Draw ROIs in gray matter areas.
- 7. Record the mean signal values in Table 2 for each echo time and ROI.
- 8. Repeat steps 1-3 for regions of white matter and CSF.
 - ❖ Lab Question 7: Draw the measured signal as a function of echo time for each of the tissue compartments. Calculate the T2 for gray, white matter and CSF by fitting Eq. (2) to your data.

T2* measurements

Acqusition: Total scan time: 11sec

- C. 2D FLASH sequence with TR=100msec, FOV=256x256, matrix=128x128, and multi contrast with echo times TE=6, 10, 15, 20, 30, 50, 70, 80 msec.
- 9. Load all the images on the viewer.

- 10. Draw ROIs in gray matter areas.
- 11. Record the mean signal values in Table 3 for each echo time and ROI.
- 12. Repeat steps 1-3 for regions of white matter and CSF.
 - ❖ Lab Question 8: Draw the measured signal as a function of echo time for each of the tissue compartments. Calculate the T2* of gray and white matter and CSF by fitting Eq. (3) to your data.
 - **❖ Lab Question 9 :** According to your measurements how do T2 and T2* compare for the same tissue compartment? Did you expect these findings? Explain why.

Table 1 – T1 Measurements

TI (ms)	Gray	White	CSF
	Matter	Matter	
200			
300			
400			
500			
600			
700			
800			
1000			
1300			
1500			
1700			
2000			
2200			

Table 2 – T2 Measurements

TE (ms)	Gray	White	CSF
	Matter	Matter	
14.3			
28.6			
42.9			
57.2			
71.5			
85.8			
100.1			
114.4			

Table 3 – T2* Measurements

TE (ms)	Gray	White	CSF
	Matter	Matter	
6			
10			
15			
20			
30			
50			
70			
80			

3. Distortion in EPI due to B0 Inhomogeneity

Background

The echo-planar image (EPI) is distorted due to local field gradients present in the head during imaging. Since the acquisition of k-space data is very asymmetric in EPI, with the readout direction points (kx) collected quickly and the phase encode steps (ky) relatively slowly, the distortion is essentially entirely in the y direction (phase encode direction).

The relative distortion between the two directions can be estimated from the relative speed of the acquisition. In kx, at a typical readout BW (say 2.2 kHz/pixel or 140 kHz in frequency across the 64 pixel image), the dwell time (time between kx samples) is $7.1 \mu s$. The ky sampling rate is slower because of the zig-zag trajectory, and is about 64 times slower. This gives a sampling spacing of $64 * 7.1 \mu s = 0.45 ms$. We call this .the "echospacing", (esp), of the sequence, the time between gradient echos (acquisition of the kx=0 point).

The effective "bandwidth" in the phase encode direction is therefore $\frac{1}{esp}$ across the

image or 1/64*esp = 34.7Hz/pixel. Therefore a B0 shift which induces a 34.7Hz frequency shift will induce a shift in this region of 1pixel. The frequency shifts in the "bad susceptibility" regions of the brain are easily in the 100Hz range. Therefore, the principle metric of how distorted the EPI sequence will be is its effective echo-spacing. For conventional echo-planar imaging, this is basically limited by the gradient slew rate and amplitude. Using parallel acceleration such as SENSE or GRAPPA effectively decreases the esp by a factor of the acceleration factor, (i.e. 2 or 3 fold).

Experiments

In this lab we will acquire images with different effective esp and compare the distortion in the brain.

Acquisition:

- 1) epi_esp730: voxel size = $3.1 \times 3.1 \times 3.1$, Matrix size = 64×64 , BW=1502Hz/px, ESP=0.73ms, effective esp = 0.73ms
- 2) epi_esp460: voxel size = 3.1 x 3.1 x 3.1, Matrix size = 64x64, BW=2520Hz/px, ESP=0.46ms, effective esp =0.46ms
- 3) epi_esp480_grappa: voxel size = 3.1 x 3.1 x 3.1, Matrix size = 64x64, BW=2520Hz/px, ESP=0.48ms, effective esp =0.46ms
 - ❖ Lab Question 10: Estimate the distortion in frontal lobes by measuring distance on the scanner to some reference feature. Plot the distortion in mm as a function of effective esp.

 $\verb|\USER\INVESTIGATORS\HST_583\Physics2\tse_IR1| \\$

TA: 0:26 P	AT: Off Voxel size: 1.9×1.	9×5.0 mm Rel. SNR: 1.00	SIEMENS: tse
Properties		Raw filter Elliptical filter	Off Off
Prio Recon	Off		OII
Before measurement		Geometry	
After measurement		Multi-slice mode	Interleaved
Load to viewer	On	Series	Interleaved
Inline movie	Off	Special set	None
Auto store images	On	Special sat.	None
Load to stamp segments	Off	System	
Load images to graphic	Off	System	Off
segments		Body HEP	On
Auto open inline display	Off	HEA	On On
AutoAlign Spine	Off	I I E A	OII
Start measurement without	On	Positioning mode	REF
further preparation		Table position	Н
Wait for user to start	Off	Table position	0 mm
Start measurements	single	MSMA	S - C - T
Routine		Sagittal	R >> L
Slice group 1		— Coronal	A >> P
Slices	1	Transversal	F >> H
Dist. factor	50 %	Save uncombined	Off
Position	R0.7 A10.8 H12.2	Coil Combine Mode	Adaptive Combine
Orientation	T > C-10.3	Auto Coil Select	Default
Phase enc. dir.	R >> L	Shim mode	Tuno un
Rotation	90.00 deg		Tune up
Phase oversampling	0 %	Adjust with body coil	Off Off
FoV read	240 mm	Confirm freq. adjustment Assume Silicone	Off
FoV phase	75.0 %		Oπ 337.166 V
Slice thickness	5.0 mm	Ref. amplitude 1H	337.166 V Auto
TR	3000 ms	Adjustment Tolerance	Auto
TE	12 ms	Adjust volume Position	Isocontor
Averages	1		Isocenter Transversal
Concatenations	1	Orientation	Transversal
Filter	None	Rotation R >> L	0.00 deg 350 mm
Coil elements	HEA;HEP	A >> P	263 mm
	,	F >> H	350 mm
Contrast	0"		550 mm
MTC	Off	Physio	
Magn. preparation	Slice-sel. IR	1st Signal/Mode	None
TI	200 ms	Dark blood	Off
Freeze suppressed tissue	Off		OII
Flip angle	180 deg	Resp. control	Off
Fat suppr.	None	Inline	
Fat sat. mode	Strong	Subtract	Off
Water suppr.	None		Off
Restore magn.	Off	Std-Dev-Sag Std-Dev-Cor	Off
Averaging mode	Short term	Std-Dev-Cor Std-Dev-Tra	Off
Reconstruction	Real	Std-Dev-Tra Std-Dev-Time	Off
Measurements	1		Off
Multiple series	Each measurement	MIP-Sag MIP-Cor	Off
·		MIP-Cor MIP-Tra	Off
Resolution	400	MIP-Tra MIP-Time	Off
Base resolution	128	Save original images	On
Phase resolution	100 %	Jave Original images	Jii
Phase partial Fourier	Off	Sequence	
Trajectory	Cartesian	Introduction	On
Interpolation	Off	Dimension	2D
PAT mode	None	Compensate T2 decay	Off
Matrix Coil Mode	Auto (CP)	Reduce Motion Sens.	Off
	· · · · · · · · · · · · · · · · · · ·	Contrasts	1
Image Filter	Off	Bandwidth	130 Hz/Px
Distortion Corr.	Off	Bandwidth Flow comp.	130 Hz/Px No

Define Turbo factor

Turbo factor 15
Echo trains per slice 7
RF pulse type Normal
Gradient mode Fast

 $\verb|\USER\INVESTIGATORS\HST_583\Physics2\se_mc| \\$

e.		Distortion Corr.	Off
roperties		Prescan Normalize	Off
Prio Recon	Off	Normalize	Off
Before measurement		Raw filter	On
After measurement		Intensity	Weak
Load to viewer	On	Slope	25
Inline movie	Off	Elliptical filter	Off
Auto store images	On	Liliptical litter	Oli
Load to stamp segments	Off	Geometry	
Load images to graphic	Off	Multi-slice mode	Interleaved
segments		Series	Interleaved
Auto open inline display	Off		
AutoAlign Spine	Off	Special sat.	None
Start measurement without	On	System	
further preparation	011	Body	Off
Wait for user to start	Off	HEP	
Start measurements			On
Start measurements	single	HEA	On
outine		Positioning mode	REF
Slice group 1		Table position	H
Slices	1	Table position	0 mm
Dist. factor	100 %	MSMA	S - C - T
Position	R0.7 A10.8 H12.2		R >> L
Orientation	T > C-10.3	Sagittal Coronal	R >> L A >> P
Phase enc. dir.	A >> P	Transversal	F >> H
Rotation	0.00 deg	Save uncombined	Off
Phase oversampling	0 %	Coil Combine Mode	Adaptive Combine
FoV read	220 mm	Auto Coil Select	Default
FoV phase	100.0 %	Chim made	Tuna un
Slice thickness	5.0 mm	Shim mode	Tune up
TR	4000 ms	Adjust with body coil	Off
TE 1	14.3 ms	Confirm freq. adjustment	Off
TE 2	28.6 ms	Assume Silicone	Off
TE 3	42.9 ms	Ref. amplitude 1H	337.166 V
TE 4	57.2 ms	Adjustment Tolerance	Auto
TE 5	71.5 ms	Adjust volume	
TE 6	85.8 ms	Position	Isocenter
TE 7		Orientation	Transversal
	100.1 ms	Rotation	0.00 deg
TE 8	114.4 ms	R >> L	350 mm
Averages	1	A >> P	263 mm
Concatenations	1	F >> H	350 mm
Filter	Raw filter		330 11111
Coil elements	HEA;HEP	Physio	
ontrast		1st Signal/Mode	None
MTC	0#		
	Off	Dark blood	Off
Magn. preparation	None	Inline	
Flip angle	180 deg		Off
Fat suppr.	None	Subtract	Off
Fat sat. mode	Strong	Liver registration	Off Off
Water suppr.	None	Std-Dev-Sag	Off
Avaraging	Chart tares	Std-Dev-Cor	Off
Averaging mode	Short term	Std-Dev-Tra	Off
Reconstruction	Magnitude	Std-Dev-Time	Off
Measurements	1	MIP-Sag	Off
Multiple series	Each measurement	MIP-Cor	Off
esolution		MIP-Tra	Off
	400	MIP-Time	Off
Base resolution	192	Save original images	On
Phase resolution	100 %	Jave Original Illiages	Oil
Phase partial Fourier	6/8	Sequence	
Interpolation	Off	Introduction	On
	NI	Contrasts	8
PAT mode	None	Bandwidth	202 Hz/Px
Matrix Coil Mode	Auto (CP)	Allowed delay	0 s
Image Filter	Off	Allowed delay	
	∵ .ı	RF pulse type	Normal

Gradient mode

Fast

\\USER\INVESTIGATORS\\HST_583\\Physics2\\T2star_8echos

TA: 0:11

PAT: Off

Voxel size: 2.0×2.0×5.0 mm Rel. SNR: 1.00

SIEMENS: gre

Proportios		Prescan Normalize	Off
Properties	0#	Normalize	Off
Prio Recon	Off	Raw filter	On
Before measurement		Intensity	Weak
After measurement	0.5	Slope	25
Load to viewer	On Off	Elliptical filter	Off
Inline movie	Off	i ·	
Auto store images	On O"	Geometry	On support of
Load to stamp segments	Off	Multi-slice mode	Sequential
Load images to graphic	Off	Series	Interleaved
segments	0"	Saturation mode	Standard
Auto open inline display	Off	Special sat.	None
AutoAlign Spine	Off		
Start measurement without	On	System	
further preparation		Body	Off
Wait for user to start	Off	HEP	
Start measurements	single		On On
outine		HEA	On
		Positioning mode	REF
Slice group 1	1	Table position	H
Slices Diet feeter	1	Table position	0 mm
Dist. factor	20 %	MSMA	S - C - T
Position	R0.7 A10.8 H12.2	Sagittal	R >> L
Orientation	T > C-10.3	Coronal	A >> P
Phase enc. dir.	A >> P	Transversal	F >> H
Rotation	0.00 deg	Save uncombined	Off
Phase oversampling	0 %	Coil Combine Mode	Adaptive Combine
FoV read	256 mm	Auto Coil Select	Default
FoV phase	100.0 %	Auto Coil Select	
Slice thickness	5.0 mm	Shim mode	Tune up
TR	100 ms	Adjust with body coil	Off
TE 1	6.00 ms	Confirm freq. adjustment	Off
TE 2	10.00 ms	Assume Silicone	Off
TE 3	15.00 ms	Ref. amplitude 1H	337.166 V
TE 4	20.00 ms	Adjustment Tolerance	Auto
TE 5	30.00 ms	Adjust volume	
TE 6	50.00 ms	Position	Isocenter
TE 7	70.00 ms	Orientation	Transversal
TE 8	80.00 ms	Rotation	0.00 deg
Averages	1	R >> L	350 mm
Concatenations	1	A >> P	263 mm
Filter	Raw filter	F >> H	350 mm
Coil elements	HEA;HEP	Į.	550 mm
	, -	Physio	
Contrast		1st Signal/Mode	None
MTC	Off	Segments	1
Magn. preparation	None		O#
Flip angle	15 deg	Dark blood	Off
Fat suppr.	None	Resp. control	Off
Water suppr.	None	'	
Averaging mode	Long term	Inline	
Averaging mode Reconstruction	Long term	Subtract	Off
	Magnitude	Liver registration	Off
Measurements	1	Std-Dev-Sag	Off
Multiple series	Each measurement	Std-Dev-Cor	Off
esolution		Std-Dev-Tra	Off
Base resolution	128	Std-Dev-Time	Off
Phase resolution	100 %	MIP-Sag	Off
Phase partial Fourier	6/8	MIP-Cor	Off
Interpolation	Off	MIP-Tra	Off
·······································	OII	MIP-Time	Off
PAT mode	None	Save original images	On
Matrix Coil Mode	Auto (CP)		
		···· Wash - In	Off
L	O#		
Image Filter	Off	Wash - Out	Off
Image Filter Distortion Corr.	Off Off	Wash - Out TTP	Off Off

Sequence Introduction On Dimension 2D Phase stabilisation Off Asymmetric echo Off Contrasts 8 Bandwidth 1 300 Hz/Px Bandwidth 2 300 Hz/Px Bandwidth 3 300 Hz/Px Bandwidth 4 300 Hz/Px Bandwidth 5 300 Hz/Px Bandwidth 5 300 Hz/Px Bandwidth 6 300 Hz/Px Bandwidth 7 300 Hz/Px
Dimension 2D Phase stabilisation Off Asymmetric echo Off Contrasts 8 Bandwidth 1 300 Hz/Px Bandwidth 2 300 Hz/Px Bandwidth 3 300 Hz/Px Bandwidth 4 300 Hz/Px Bandwidth 5 300 Hz/Px Bandwidth 6 300 Hz/Px
Phase stabilisation Asymmetric echo Contrasts Bandwidth 1 Bandwidth 2 Bandwidth 3 Bandwidth 3 Bandwidth 4 Bandwidth 4 Bandwidth 5 Bandwidth 6 Off Off Off Off Off Off Off O
Asymmetric echo Contrasts Bandwidth 1 Bandwidth 2 Bandwidth 3 Bandwidth 3 Bandwidth 4 Bandwidth 5 Bandwidth 5 Bandwidth 6 Off S00 Hz/Px Bandwidth 5 S00 Hz/Px Bandwidth 6 Off S00 Hz/Px S00 Hz/Px S00 Hz/Px
Contrasts Bandwidth 1 Bandwidth 2 Bandwidth 3 Bandwidth 4 Bandwidth 4 Bandwidth 5 Bandwidth 6 Souther State of the
Bandwidth 1 300 Hz/Px Bandwidth 2 300 Hz/Px Bandwidth 3 300 Hz/Px Bandwidth 4 300 Hz/Px Bandwidth 5 300 Hz/Px Bandwidth 6 300 Hz/Px
Bandwidth 2 300 Hz/Px Bandwidth 3 300 Hz/Px Bandwidth 4 300 Hz/Px Bandwidth 5 300 Hz/Px Bandwidth 6 300 Hz/Px
Bandwidth 3 300 Hz/Px Bandwidth 4 300 Hz/Px Bandwidth 5 300 Hz/Px Bandwidth 6 300 Hz/Px
Bandwidth 4 300 Hz/Px Bandwidth 5 300 Hz/Px Bandwidth 6 300 Hz/Px
Bandwidth 5 300 Hz/Px Bandwidth 6 300 Hz/Px
Bandwidth 6 300 Hz/Px
Bandwidth 7 300 Hz/Px
Bandwidth 8 300 Hz/Px
Flow comp. 1 No
Flow comp. 2 No
Flow comp. 3 No
Flow comp. 4 No
Flow comp. 5 No
Flow comp. 6 No
Flow comp. 7 No
Flow comp. 8 No
Readout mode Bipolar
Allowed delay 0 s
RF pulse type Normal
Gradient mode Fast
Excitation Slice-sel.
RF spoiling On

\\USER\INVESTIGATORS\HST_583\Physics2\epi_esp730			
TA: 2.0 s PAT: Off	Voxel size: 3.1×3.1×3.1 mm	Rel. SNR: 1.00 USER:	ep2d_bold_MGH_pro_tb
Properties		System	
Prio Recon	Off	Body	Off
Before measurement	Oli	HEP	On
After measurement		HEA	On
Load to viewer	On		
Inline movie	Off	Positioning mode	FIX
Auto store images	On	Table position	Н
Load to stamp segments	Off	Table position	0 mm
Load images to graphic	Off	MSMA	S - C - T
segments	Oli	Sagittal	R >> L
Auto open inline display	Off	Coronal	A >> P
AutoAlign Spine	Off	Transversal	F >> H
Start measurement without	On	Coil Combine Mode	Sum of Squares
further preparation	Oli	Auto Coil Select	Default
Wait for user to start	Off	Shim mode	Standard
Start measurements	single		
	Sirigio	Adjust with body coil	Off Off
Routine		Confirm freq. adjustment Assume Silicone	Off
Slice group 1			_
Slices	9	Ref. amplitude 1H	337.166 V
Dist. factor	67 %	Adjustment Tolerance	Auto
Position	R0.3 A11.0 F2.1	Adjust volume	DO 2 A44 0 F2 4
Orientation	T > C-10.4	Position	R0.3 A11.0 F2.1
Phase enc. dir.	A >> P	Orientation	T > C-10.4
Rotation	0.34 deg	Rotation	0.34 deg
Phase oversampling	0 %	R >> L	200 mm
FoV read	200 mm	A >> P	200 mm
FoV phase	100.0 %	F >> H	45 mm
Slice thickness	3.10 mm	Physio	
TR	2000 ms	1st Signal/Mode	None
TE	30 ms	_	
Averages	1	BOLD	
Concatenations	1	GLM Statistics	Off
Filter	None	Dynamic t-maps	Off
Coil elements	HEA;HEP	Starting ignore meas	0
		Ignore after transition	0
Contrast		Model transition states	Off
MTC	Off	Temp. highpass filter	Off
Flip angle	90 deg	Threshold	4.00
Fat suppr.	Fat sat.	Paradigm size	1
Averaging mode	Long term	Meas	Baseline
Reconstruction	Magnitude	Motion correction	Off
Measurements	1	Spatial filter	Off
Delay in TR	0 ms	Sequence	
Multiple series	Off	Introduction	Off
	-	Bandwidth	1502 Hz/Px
Resolution		Free echo spacing	Off
Base resolution	64	Echo spacing	0.73 ms
Phase resolution	100 %		
Phase partial Fourier	Off	EPI factor	64
Interpolation	Off	RF pulse type	Normal
PAT mode	None	Gradient mode	Fast
Matrix Coil Mode	Auto (CP)	Dummy Scans	0
Distortion Corr	Off	*	
Distortion Corr.	Off		
Prescan Normalize Raw filter	Off		
	On Off		
Elliptical filter			
Hamming	Off		
Geometry			
Multi-slice mode	Interleaved		

Interleaved

None

Series

Special sat.

\\USER\INVESTIGATORS\HST_583\Physics2\epi_esp460 TA: 2.0 s PAT: Off Voxel size: 3.1x3.1x3.1 mm Rel. SNR: 1.00 USER: ep2d_bold_MGH_pro_tb **Properties** System Prio Recon Off Off Body HEP Before measurement On After measurement **HEA** On Load to viewer On Positioning mode FIX Off Inline movie Table position Н Auto store images On Table position 0 mm Load to stamp segments Off **MSMA** S - C - T Load images to graphic Off Sagittal R >> L segments Coronal A >> P Auto open inline display Off Transversal F >> H AutoAlign Spine Off Coil Combine Mode Sum of Squares Start measurement without On Auto Coil Select Default further preparation Off Wait for user to start Shim mode Standard Start measurements single Adjust with body coil Off Confirm freq. adjustment Off Routine Assume Silicone Off Slice group 1 Ref. amplitude 1H 337.166 V Slices 9 Adjustment Tolerance Auto Dist. factor 67 % Adjust volume Position R0.3 A11.0 F2.1 Position R0.3 A11.0 F2.1 Orientation T > C-12.5Orientation T > C-12.5Phase enc. dir. A >> P 0.34 deg Rotation 0.34 deg Rotation R >> L 200 mm 0 % Phase oversampling A >> P 200 mm FoV read 200 mm F >> H 45 mm FoV phase 100.0 % Slice thickness 3.10 mm Physio TR 2000 ms 1st Signal/Mode None ΤE 30 ms **BOLD Averages GLM Statistics** Off Concatenations Dynamic t-maps Off Filter None Starting ignore meas 0 Coil elements HEA;HEP Ignore after transition 0 Contrast Model transition states Off MTC Off Temp. highpass filter Off Flip angle 90 deg Threshold 4.00 Fat suppr. Fat sat. Paradigm size Meas Baseline Averaging mode Long term Motion correction Off Reconstruction Magnitude Spatial filter Off Measurements Delay in TR 0 ms Sequence Multiple series Off Introduction Off Bandwidth 2520 Hz/Px Resolution Free echo spacing Off Base resolution 64 Echo spacing 0.46 ms Phase resolution 100 % Phase partial Fourier Off EPI factor 64 Interpolation Off RF pulse type Normal Gradient mode Fast PAT mode None Matrix Coil Mode Auto (CP) **Dummy Scans** 0 Off Distortion Corr. Prescan Normalize Off Raw filter On Elliptical filter Off Hamming Off Geometry Multi-slice mode Interleaved

Interleaved

None

Series

Special sat.

\\USER\INVESTIGATORS\HST_583\Physics2\epi_esp480_grappa2 TA: 8.0 s PAT: 2 Voxel size: 3.1×3.1×3.1 mm Rel. SNR: 1.00 USER: ep2d_bold_MGH_pro_tb

Properties		Series	Interleaved
Prio Recon	Off	Special sat.	None
Before measurement			
After measurement		System	2"
Load to viewer	On	Body	Off
Inline movie	Off	HEP	On
Auto store images	On	HEA	On
Load to stamp segments	Off	Positioning mode	FIX
Load images to graphic	Off	Table position	Н
segments	.	Table position	0 mm
Auto open inline display	Off	MSMA	S - C - T
AutoAlign Spine	Off	Sagittal	R >> L
Start measurement without	On		A >> P
further preparation	On	Coronal Transversal	F >> H
Wait for user to start	Off		
Start measurements		Coil Combine Mode	Sum of Squares
Start measurements	single	Auto Coil Select	Default
Routine		Shim mode	Standard
Slice group 1		Adjust with body coil	Off
Slices	9	Confirm freq. adjustment	Off
Dist. factor	67 %	Assume Silicone	Off
Position	R0.3 A11.0 F2.1	Ref. amplitude 1H	337.166 V
Orientation	T > C-12.5	Adjustment Tolerance	Auto
Phase enc. dir.	A >> P	Adjust volume	, (010
Rotation	0.34 deg	Position	R0.3 A11.0 F2.1
Phase oversampling	0.9 4 deg	Orientation	T > C-12.5
FoV read	200 mm		
	100.0 %	Rotation	0.34 deg
FoV phase Slice thickness		R >> L	200 mm
	3.10 mm	A >> P	200 mm
TR	2000 ms	F >> H	45 mm
TE A	30 ms	Physio	
Averages	1	1st Signal/Mode	None
Concatenations	1	1	140110
Filter	None	BOLD	
Coil elements	HEA;HEP	GLM Statistics	Off
Contrast		Dynamic t-maps	Off
MTC	Off	Starting ignore meas	0
Flip angle	90 deg	Ignore after transition	0
Fat suppr.	Fat sat.	Model transition states	Off
		Temp. highpass filter	Off
Averaging mode	Long term	Threshold	4.00
Reconstruction	Magnitude	Paradigm size	1
Measurements	1	Meas	Baseline
Delay in TR	0 ms	Motion correction	Off
Multiple series	Off	Spatial filter	Off
Resolution		ļ '	
	64	Sequence	0#
Base resolution	100 %	Introduction	Off
Phase resolution		Bandwidth	2520 Hz/Px
Phase partial Fourier	Off Off	Free echo spacing	Off
Interpolation	Off	Echo spacing	0.48 ms
PAT mode	GRAPPA	EPI factor	64
Accel. factor PE	2	RF pulse type	Normal
Ref. lines PE	32	Gradient mode	Fast
Matrix Coil Mode	Auto (Triple)		
Reference scan mode	Separate	Dummy Scans	0
		·	
Distortion Corr.	Off		
Prescan Normalize	Off		
Raw filter	On		
Elliptical filter	Off		
Hamming	Off		
•			
Geometry Multiplica made	Interiory		
Multi-slice mode	Interleaved		
		9/-	