GE Site
Yearly Performance Evaluation
GE Ovation 0.35
24-Oct-07

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MRI Equipment Evaluation Summary & Signature Page

Site Name: GE Site **MRAP #** 03292-01

Address: **Survey Date:** 10/24/07

City, State, Zip **Report Date:** 11/20/07

MRI Mfg: GE **Model:** Ovation **Field:** 0.35

MRI Scientist: Moriel NessAiver, Ph.D. **Signature:** Moriel NessAiver, Ph.D.

Equipment Evaluation Tests	Pass	Fail *	N/A
1. Magnetic field homogeneity:	☒	☐	☐
2. Slice position accuracy:	☒	☐	☐
3. Table positioning reproducibility:	☒	☐	☐
4. Slice thickness accuracy:	☒	☐	☐
5. RF coils' performance:			
a. Volume QD Coils	☒	☐	☐
b. Phase Array Coils	☒	☐	☐
c. Surface Coils	☒	☐	☐
6. Inter-slice RF interference (Crosstalk):	☒	☐	☐
7. Soft Copy Display	☒	☐	☐

Evaluation of Site's Technologist QC Program	Pass	Fail *	N/A
1. Set up and positioning accuracy: (daily)	☒	☐	☐
2. Center frequency: (daily)	☒	☐	☐
3. Transmitter attenuation or gain: (daily)	☒	☐	☐
4. Geometric accuracy measurments: (daily)	☒	☐	☐
5. Spatial resolution measurements: (daily)	☒	☐	☐
6. Low contrast detectability: (daily)	☒	☐	☐
7. Head Coil SNR (daily)	☒	☐	☐
8. Body Coil SNR (weekly)	☒	☐	☐
9. Fast Spin Echo (FSE/TSE) ghosting levels: (daily)	☒	☐	☐
10. Film quality control: (weekly)	☒	☐	☐
11. Visual checklist: (weekly)	☒	☐	☐

*See comments page for description of any failures.

Specific Comments and Recommendations

1. The Tx gain for all of the coils has gone up by roughly 10%. This could represent a gradual decay of the RF system.
2. All of the RF coils are within ±10% of last year's data.
3. The Soft and Hard Copy displays are performing well and are well matched.
4. Magnet homogeneity has deteriorated by about 30-40% in the axial and sagittal planes. I feel the problem is located in the posterior portion of the field. See the second page of appendix A. It is not so bad as to require immediate remediation but I recommend you show my results to your service engineer.
5. The fire extinguisher is magnetic. You need to replace it with an non-magnetic one.
6. The net slice position error fails ACR spec (barely) We will have to address this prior to your next submission.
7.
8.
9.
10.
11.
12.
13.

NOTE: Please be sure to read appendix D for an explanation of the new format of this document.

MRI Equipment Performance Evaluation Data Form

Site Name: GE Site

Contact	Title	Phone	Fax	eMail
	Chief Tech			

Equipment Information

MRI Manufacturer: GE Model: Ovation SN: Software: MFO.2_M.4.0220

Camera Manufacturer: AGFA Model: Drystar 3000 SN: Software:

PACS Manufacturer: Model: SN: Software:

ACR Phantom Number used: J2664

1. Table Positioning Reproducibility: **Pass**

Table motion out/in:	IsoCenter	Out/In	Out/In	Out/In
Measured Phantom Center	-2.5	-2.3	-2.3	-2.3

Comment:

2. Magnetic Field Homogeneity See appendix A for field plots. **PASS**

Last Year CF: **14855078** This Year CF: **14850733** CF Change: **-4345**

GRE TR: 500, TE: 10 & 30 Flip Angle: 45, FOV: 40

10 mm skip 10 mm, BW: 10.4KHz, 256x128, 2nex

	15 cm	20 cm	25 cm
Axial:	9.5	14.3	19.9
Coronal:	3.4	4.9	7.1
Sagittal:	10.1	14.8	20.0

Comments: The shim in the coronal direction is very good. The axial and sagittal shims suffer from inhomogeneity in the posterior portion of the field.

3. Slice Thickness Accuracy

FOV: 250mm Matrix: 256x256 (Slice #1 from ACR Phantom) All values in mm

Sequence	TR	TE	Flip	NSA	Calc	Target	% Error
SE (ACR)	500	20	90	1	5.49	5	9.8%
SE (20/80)	2000	20	90	1	5.50	5	10.0%
SE (20/80)	2000	80	90	1	5.00	5	0.0%
SE (Site T1)	500	14	90	1	5.55	5	11.0%
FSE(16)	3000	80	90	1	5.47	5	9.4%

Comments:

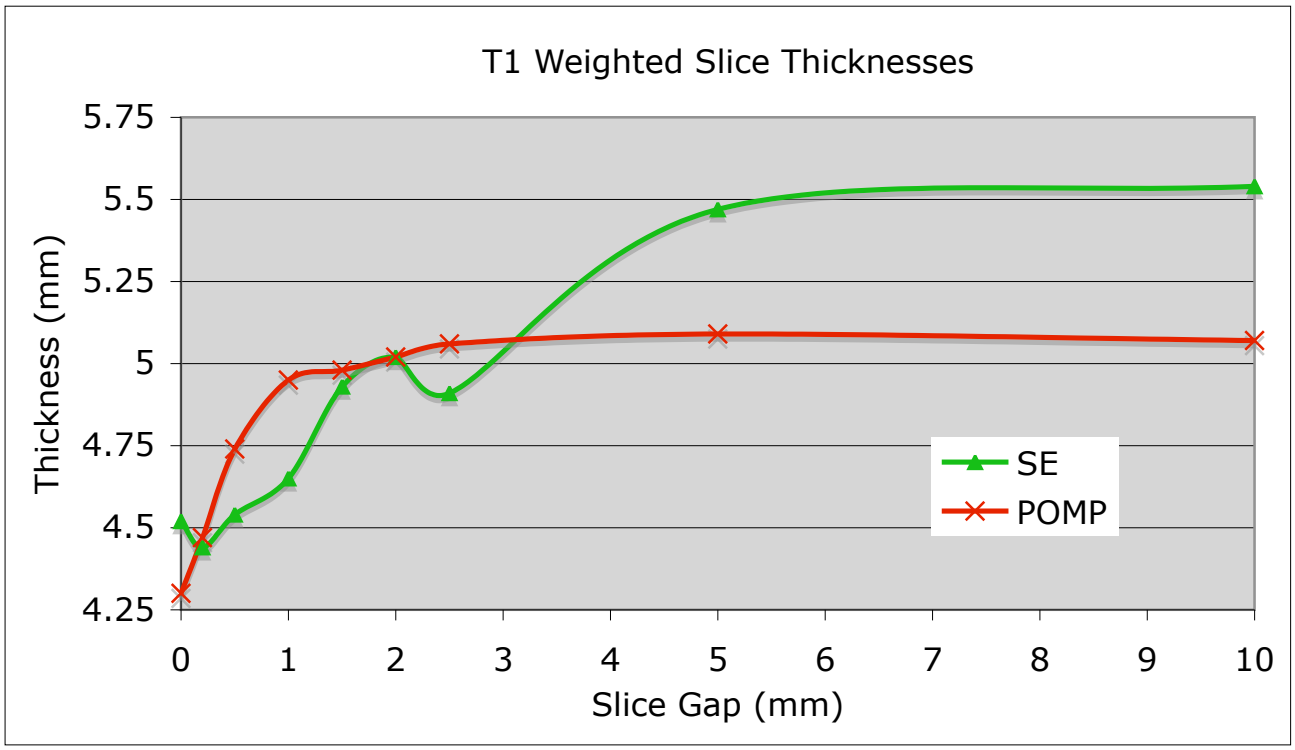
4. Slice Crosstalk (RF interference)

The following data were obtained using the ACR phantom slice thickness wedges to measure the slice profile of a two T1 weighted sequences when the slice gap varies from 200% down to 0% (contiguous) As the slices get closer together it is expected that the edges of the slices will overlap causing a deterioration of the slice profile. The data shown below clearly demonstrates this effect. The POMP sequence shows a stable slice thickness until the slice gap drops below 20%. The normal SE sequence has a rather strange curve. I'm not sure what is happening with the slice gaps above 35% but there is no question that there is crosstalk at 35% and lower.

All of the slice profiles can be seen in Appendix B.

Sequence Type	TR	TE	FOV (cm^2)	Matrix	NSA	Thickness	# of slices	Slice Measured
SE	400	18	25	256x256	2	5	11	6
POMP	400	19	25	256x256	2	5	12	6

Skip	SE	POMP
0	4.52	4.3
0.2	4.44	4.47
0.5	4.54	4.74
1	4.65	4.95
1.5	4.93	4.98
2	5.02	5.02
2.5	4.91	5.06
5	5.47	5.09
10	5.54	5.07



5. Soft & Hard Copy Displays

Luminance Meter Make/Model: Tektronix J16 Digital Photometer Cal Expires: 4/6/06

Monitor Description: LCD

Luminance Measured: Ft. lamberts

Measured Data					
Which Monitor	Center of Image Display	Top Left Corner	Top Right Corner	Bottom Left Corner	Bottom Right Corner
Console	49	40.8	44.2	45.8	46.2

Uniformity		
MAX	MIN	Percent Delta
49	40.8	18%

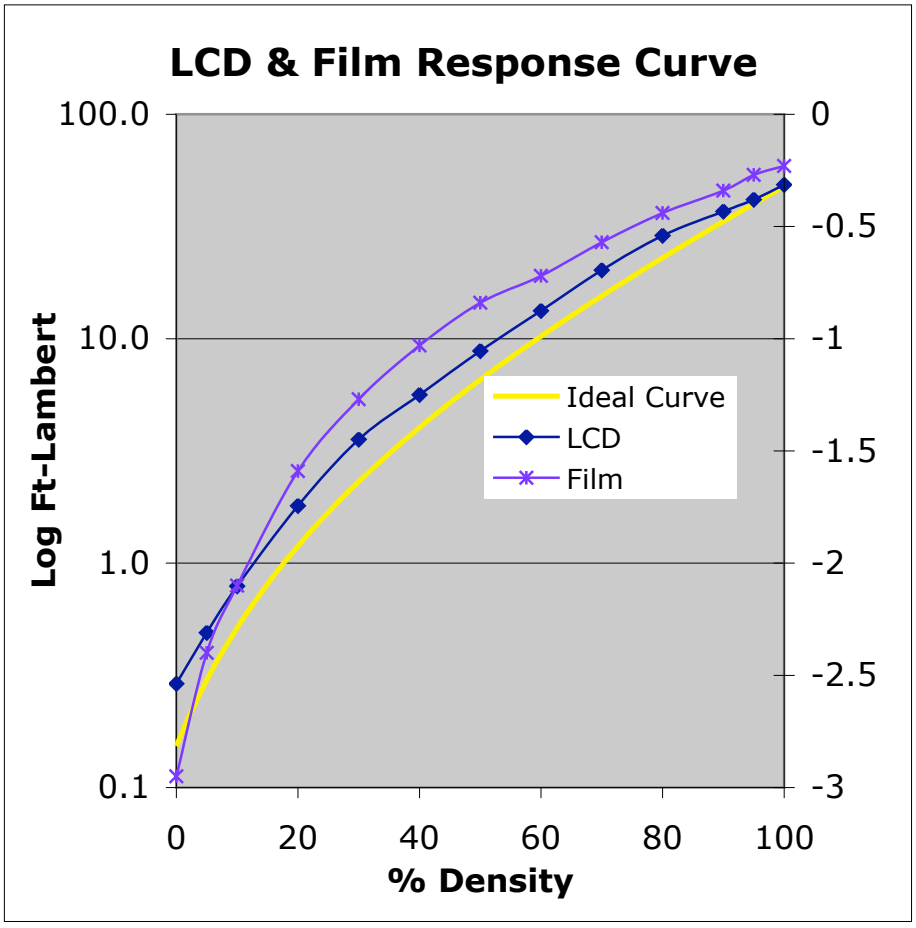
SMPTE
OK?
Y

% delta =200% x (max-min)/(max+center) (>30% is action limit)

Minimum Brightness must be > 26.24 Ft. Lamberts

Monitor and film - both look good.

Density	Ft-Lambert	Film Density
0	0.29	-2.95
5	0.49	-2.4
10	0.79	-2.1
20	1.80	-1.59
30	3.56	-1.27
40	5.63	-1.03
50	8.82	-0.84
60	13.31	-0.72
70	20.2	-0.57
80	28.8	-0.44
90	36.9	-0.34
95	41.7	-0.27
100	48.6	-0.23



Coil and Other Hardware Inventory List

Site Name GE Site

ACR Magnet # 1 Nickname Ovation

Active	Coil Description	Manufacturer	Model	Rev.	Mfg. Date	SN	Channels
☐	CTL Phased Array	USA Inst.	2282860	1	Apr, 2004	459	
☒	Body - Access Open	USA Inst.	10221	A	Apr, 2002	348	1
☒	Body - Integrated	GE					1
☒	CTL Phased Array	USA Inst.	100216	A	Jul, 2007	365	6
☒	Foot	USA Inst.	100187	B	Jan, 2002	386	3
☒	Head	USA Inst.	2280062		Feb, 2003	905034YM5	1
☒	Knee - Large	USA Inst.	100214	B	Mar, 2002	322	2
☒	Knee & Foot (small)	USA Inst.	100213	B	Jun, 2005	464	2
☒	Shoulder Phased Array	USA Inst.	100217	B	Aug, 2002	?352	2
☐							

RF Coil Performance Evaluation

Coil: Body - Access Open
Mfg.: USA Inst.
Mfg. Date: 4/1/2002 Coil ID: 239
Phantom: Body sphere

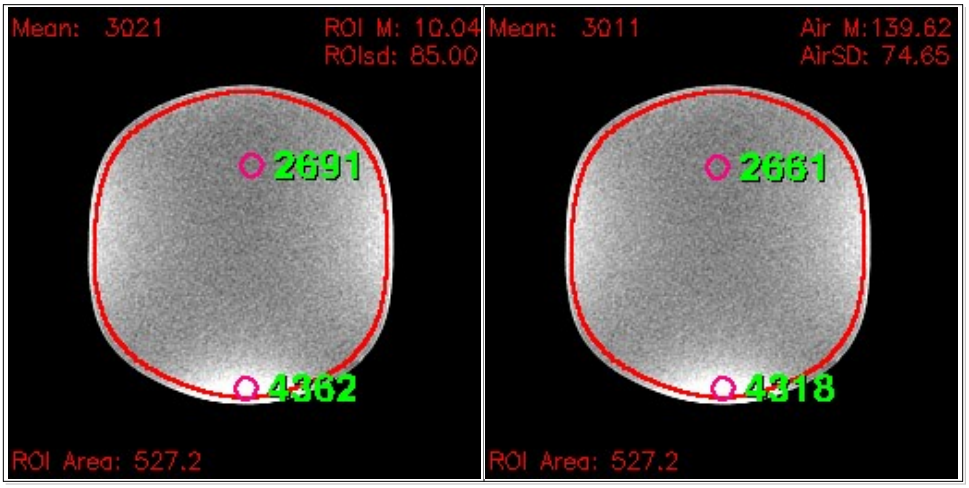
Test Date: 10/24/2007
Model: 10221
Revision: A
SN: 348
# of Channels 1

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	40	256	256	10.4	1	5	-

Coil Mode: Access Body TX gain: 185 R1: 11 R2: 30

Analysis of Test Image

Measured Data							Calculated Results			
Label	Mean	Max	Min	Back ground	Noise SD	Noise Type	Mean SNR	Normal-ized	Max SNR	Uni-formity
N	3,021	4,362	2,691	10.0	85.00	NEMA	25.1	6.9	36.3	76.3%
A	3,011	4,318	2,661	139.6	74.65	Air	26.4	7.3	37.9	76.3%



RF Coil Performance Evaluation

Coil: Body - Access Open

Mfg.: USA Inst.

Mfg. Date: 4/1/2002 Coil ID: 239

Phantom:

Test Date: 10/24/2007

Model: 10221

Revision: A

SN: 348

# of Channels 1

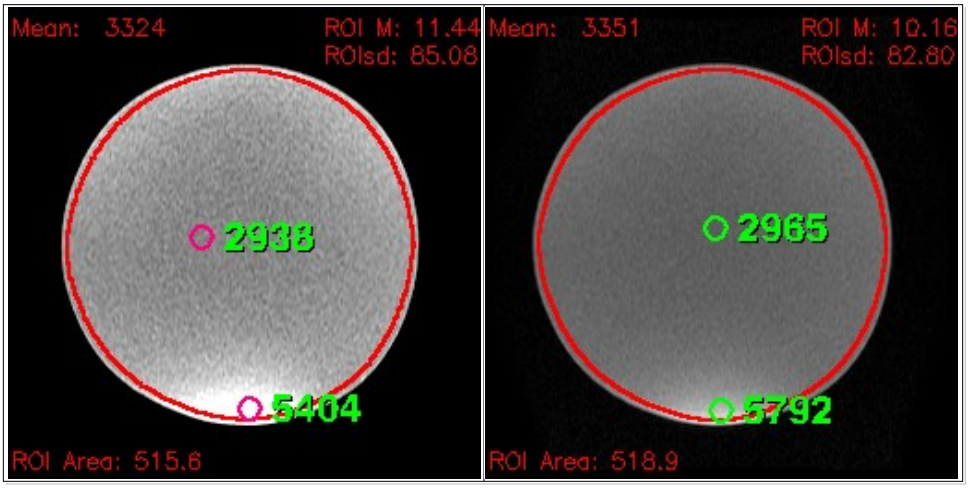
Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	500	25	T	35	256	128	10.4	1	5	-

Coil Mode: Access Body TX gain: 186 R1: 11 R2: 30

Analysis of Test Image

Measured Data							Calculated Results			
Label	Mean	Max	Min	Back ground	Noise SD	Noise Type	Mean SNR	Normal-ized	Max SNR	Uni-formity
2007	3,324	5,404	2,938	11.4	85.08	NEMA	27.6	5.0	44.9	70.4%
2006	3,351	5,792	2,965	10.2	82.80	NEMA	28.6	5.2	49.5	67.7%

This is the USA Test protocol. When using my NEMA method of calculating the SNR, the spec should be greater than 66. In 2005 it passed. In 2006 it failed. Current images are virtually identical to 2006. The images are noticeably noisier than 2005. (The images on the left below is from 2007, on the right is from 2006)



RF Coil Performance Evaluation

Coil: Body - Integrated

Mfg.: GE

Mfg. Date: _____ Coil ID: 242

Phantom: 27 cm sphere in loading ring.

Test Date: 10/24/2007

Model: _____

Revision: _____

SN: _____

# of Channels 1

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	40	256	128	10.4	4	5	-

Coil Mode: Body

TX gain: 189 R1: 11 R2: 29

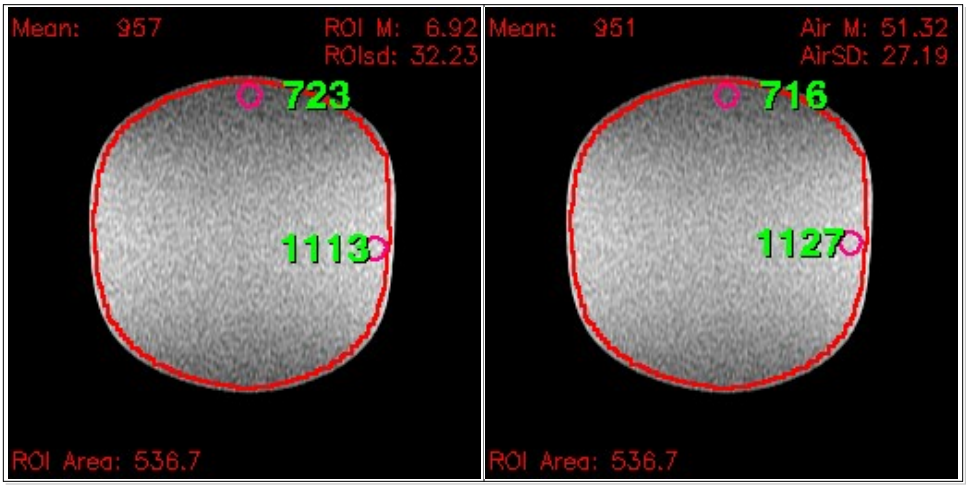
Analysis of Test Image

Measured Data

Label	Mean	Max	Min	Background	Noise SD	Noise Type
N	957	1,113	723	6.9	32.23	NEMA
A	951	1,127	716	51.3	27.19	Air

Calculated Results

Mean SNR	Normal-ized	Max SNR	Uni-formity
21.0	1.4	24.4	78.8%
22.9	1.6	27.2	77.7%



RF Coil Performance Evaluation

Coil: CTL Phased Array
Mfg.: USA Inst.
Mfg. Date: 7/10/2007 Coil ID: 795
Phantom: CTL Phantoms (no pad)

Test Date: 10/24/2007
Model: 100216
Revision: A
SN: 365
# of Channels 6

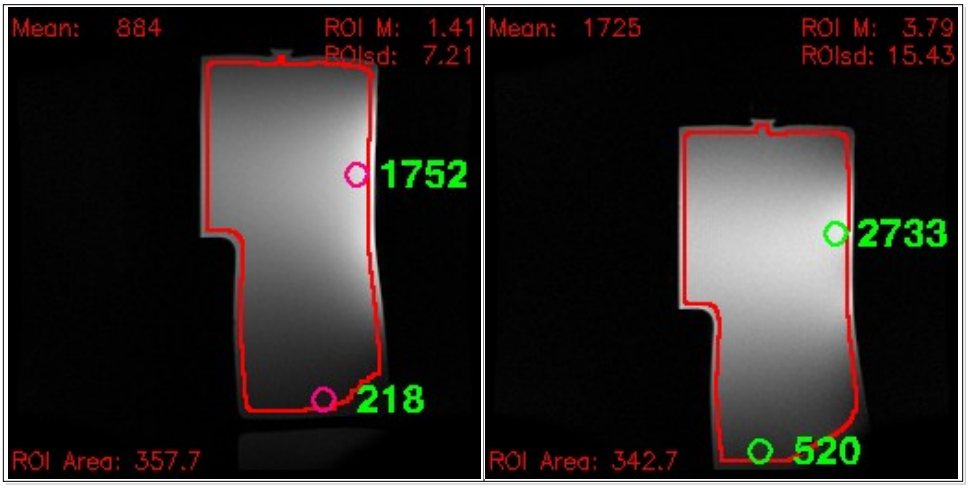
Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	500	25	S	40	256	256	10.4	1	5	-

Coil Mode: a Cervical - Postioned @ i0 mark
TX gain: 189 R1: 7 R2: 29

Analysis of Test Image

Measured Data							Calculated Results			
Label	Mean	Max	Min	Back ground	Noise SD	Noise Type	Mean SNR	Normal-ized	Max SNR	Uni-formity
2007	884	1,752	218	1.4	7.21	NEMA	86.7	23.9	171.8	22.1%
2006	1,725	2,733	520	3.8	15.43	NEMA	79.1	21.8	125.3	32.0%

Uses gradient distortion correction



RF Coil Performance Evaluation

Coil: CTL Phased Array
Mfg.: USA Inst.
Mfg. Date: 7/10/2007 Coil ID: 795
Phantom: CTL phantoms

Test Date: 10/24/2007
Model: 100216
Revision: A
SN: 365
# of Channels 6

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	S	40	256	256	10.4	1	5	-

Coil Mode: b Cervical - Location @ i65 TX gain: 188 R1: 7 R2: 29

Analysis of Composite Image

Measured Data

Label	Mean	Max	Min	Background	Noise SD	Noise Type
N	825	1,522	135	0.2	6.72	NEMA
A	825	1,522	135	16.8	6.41	Air

Calculated Results

Mean SNR	Normal-ized	Max SNR	Uni-formity
86.8	23.9	160.2	16.3%
84.3	23.2	155.6	16.3%

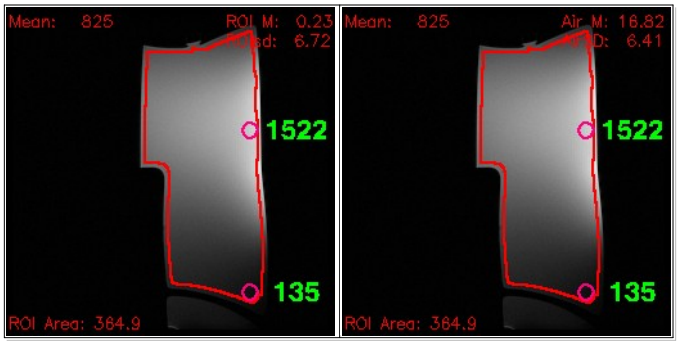
Analysis of Uncombined Images

Measured Data

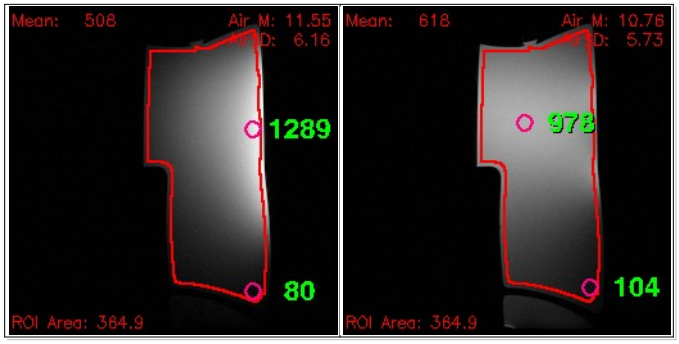
Ch	Mean	Max	Noise SD	Noise Type
1	508	1,289	6.16	Air
2	618	978	5.73	Air

Calculated Results

Mean SNR	% of Mean	Max SNR	% of Max
54.0	76%	137.1	100%
70.7	100%	111.8	82%



Composites



Channel 1 Channel 2

RF Coil Performance Evaluation

Coil: CTL Phased Array
Mfg.: USA Inst.
Mfg. Date: 7/10/2007 Coil ID: 795
Phantom: CTL phantoms

Test Date: 10/24/2007
Model: 100216
Revision: A
SN: 365
# of Channels 6

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	500	25	S	40	256	256	10.4	1	5	-

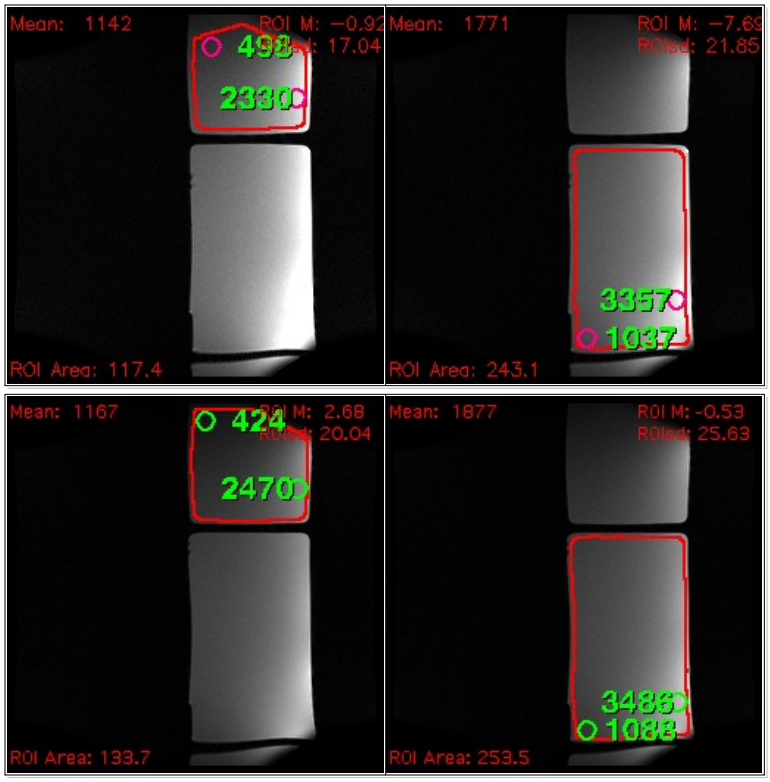
Coil Mode: c Thoracic
TX gain: 185 R1: 12 R2: 28

Analysis of Test Image

Measured Data							Calculated Results			
Label	Mean	Max	Min	Back ground	Noise SD	Noise Type	Mean SNR	Normal-ized	Max SNR	Uni-formity
2007s	1,142	2,330	498	-0.9	17.04	NEMA	47.4	13.1	96.7	35.2%
2007i	1,771	3,357	1,037	-7.7	21.85	NEMA	57.3	15.8	108.7	47.2%
2006s	1,167	2,470	424	20.0	19.00	NEMA	43.4	12.0	91.9	29.3%
2006i	1,877	3,486	1,088	-0.5	25.63	NEMA	51.8	14.3	96.2	47.6%

USAI Protocol

Test Images



RF Coil Performance Evaluation

Coil: CTL Phased Array
Mfg.: USA Inst.
Mfg. Date: 7/10/2007 Coil ID: 795
Phantom: CTL phantoms

Test Date: 10/24/2007
Model: 100216
Revision: A
SN: 365
# of Channels 6

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	S	40	256	128	6.91	1	5	-

Coil Mode: d Thoracic TX gain: 185 R1: 10 R2: 28

Analysis of Composite Image

Measured Data

Label	Mean	Max	Min	Back ground	Noise SD	Noise Type
N	1,136	1,947	612	-0.1	18.23	NEMA
N	1,645	2,639	1,001	-0.9	19.39	NEMA
A	1,136	1,942	611	58.8	18.64	Air
A	1,646	2,648	999	58.8	18.64	Air

Calculated Results

Mean SNR	Normal-ized	Max SNR	Uni-formity
44.1	4.9	75.5	47.8%
60.0	6.7	96.3	55.0%
39.9	4.5	68.3	47.9%
57.9	6.5	93.1	54.8%

Analysis of Uncombined Images

Measured Data

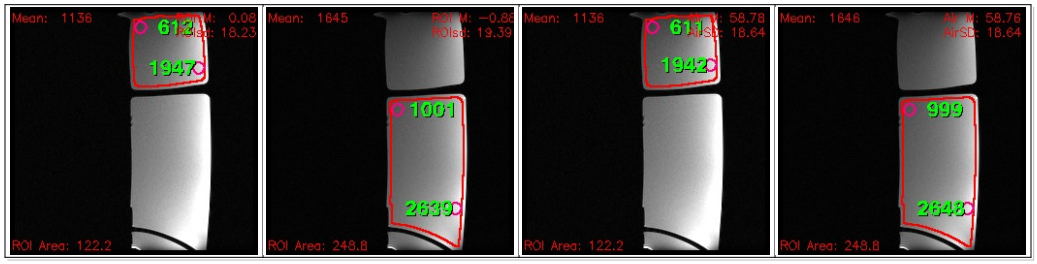
Ch	Mean	Max	Noise SD	Noise Type
1	935	1,857	17.09	Air
2	829	1,094	17.55	Air
3	722	2,208	15.11	Air

Calculated Results

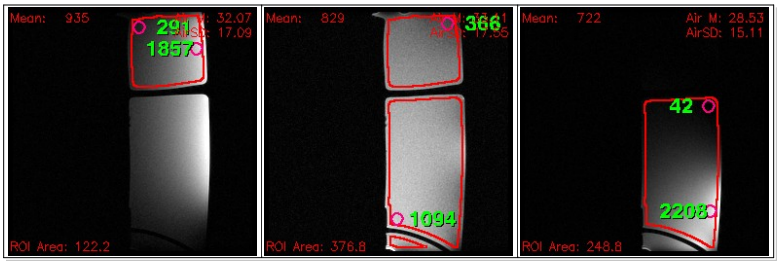
Mean SNR	% of Mean	Max SNR	% of Max
35.9	100%	71.2	74%
31.0	86%	40.8	43%
31.3	87%	95.8	100%

Simply Physics protocol

Composites



Channels



Channel 1 Channel 2 Channel 3

RF Coil Performance Evaluation

Coil: CTL Phased Array
Mfg.: USA Inst.
Mfg. Date: 7/10/2007 Coil ID: 795
Phantom: CTL phantoms

Test Date: 10/24/2007
Model: 100216
Revision: A
SN: 365
# of Channels 6

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	500	25	S	40	256	256	10.4	1	5	-

Coil Mode: e Lumbar
TX gain: 187 R1: 10 R2: 28

Analysis of Test Image

Measured Data

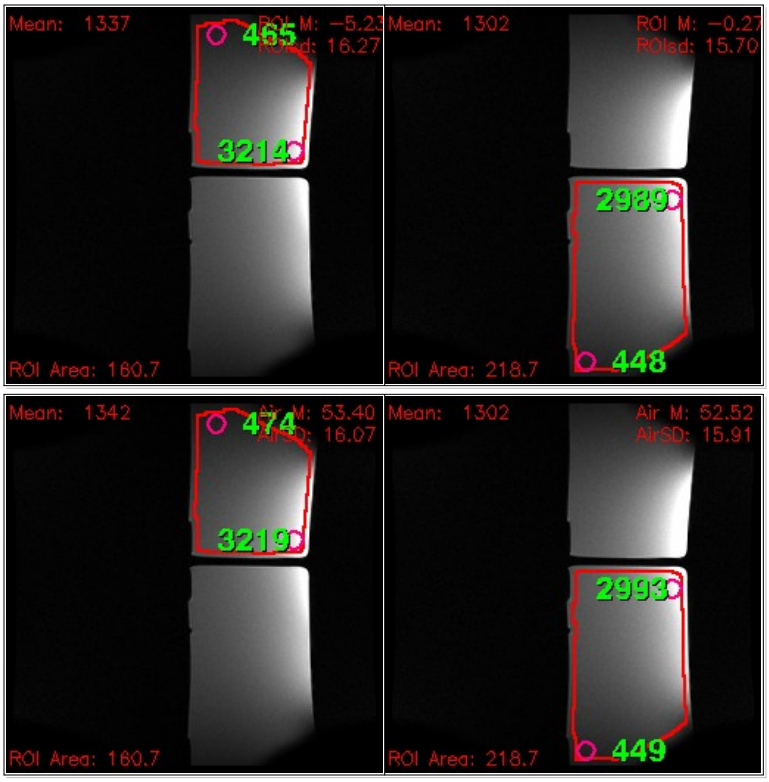
Label	Mean	Max	Min	Back ground	Noise SD	Noise Type
Ns	1,337	3,214	465	-5.2	16.27	NEMA
Ni	1,302	2,989	448	-0.3	15.70	NEMA
As	1,342	3,219	474	53.4	16.07	Air
Ai	1,302	2,993	449	52.5	15.91	Air

Calculated Results

Mean SNR	Normal-ized	Max SNR	Uni-formity
58.1	16.0	139.7	25.3%
58.6	16.2	134.6	26.1%
54.7	15.1	131.3	25.7%
53.6	14.8	123.3	26.1%

USAI Protocol
Ther is little difference between last year and this year. (Maybe a little higher this year.)

Test Images



RF Coil Performance Evaluation

Coil: CTL Phased Array
Mfg.: USA Inst.
Mfg. Date: 7/10/2007 Coil ID: 795
Phantom: CTL phantoms

Test Date: 10/24/2007
Model: 100216
Revision: A
SN: 365
# of Channels 6

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	S	40	256	128	6.91	1	5	-

Coil Mode: f Lumbar TX gain: 188 R1: 10 R2: 28

Analysis of Composite Image

Measured Data

Label	Mean	Max	Min	Back ground	Noise SD	Noise Type
N	1,242	2,549	564	-5.2	16.90	NEMA
N	1,243	2,466	591	-0.1	15.53	NEMA
A	1,247	2,545	565	50.5	15.74	Air
A	1,244	2,462	599	50.5	15.73	Air

Calculated Results

Mean SNR	Normal-ized	Max SNR	Uni-formity
52.0	5.8	106.7	36.2%
56.6	6.4	112.3	38.7%
51.9	5.8	106.0	36.3%
51.8	5.8	102.6	39.1%

Analysis of Uncombined Images

Measured Data

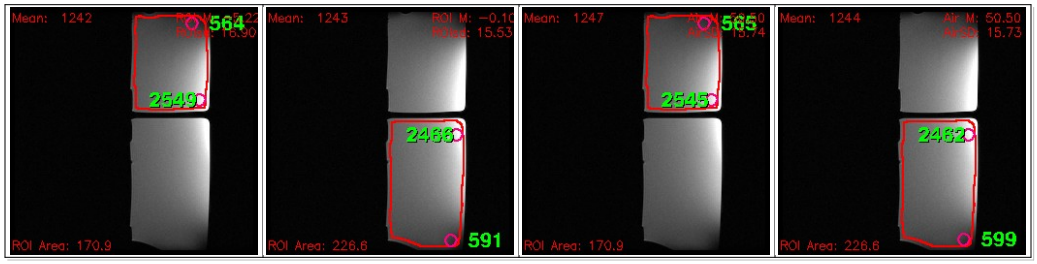
Ch	Mean	Max	Noise SD	Noise Type
1	892	2,200	13.64	Air
2	729	898	14.40	Air
3	849	1,992	14.49	Air

Calculated Results

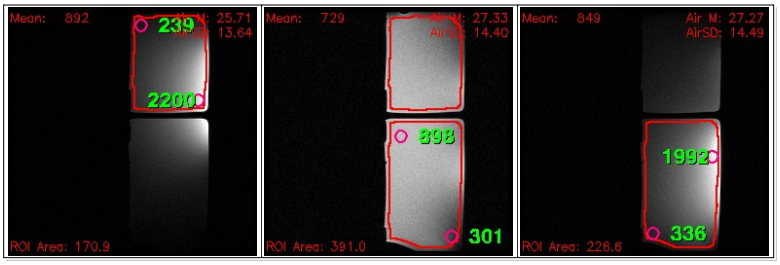
Mean SNR	% of Mean	Max SNR	% of Max
42.9	100%	105.7	100%
33.2	77%	40.9	39%
38.4	90%	90.1	85%

Just a little lower than last year

Composites



Channels



Channel 1 Channel 2 Channel 3

RF Coil Performance Evaluation

Coil: Foot

Mfg.: USA Inst.

Mfg. Date: 1/1/2002 Coil ID: 447

Phantom: Foot

Test Date: 10/24/2007

Model: 100187

Revision: B

SN: 386

# of Channels 3

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	40	256	256	10.4	1	5	-

Coil Mode: Foot @ S30 A20 TX gain: 189 R1: 7 R2: 29

Analysis of Composite Image

Measured Data

Label	Mean	Max	Min	Back ground	Noise SD	Noise Type
N	938	1,362	399	1.3	3.76	NEMA
A	937	1,359	403	11.1	3.49	Air

Calculated Results

Mean SNR	Normal-ized	Max SNR	Uni-formity
176.4	48.6	256.2	45.3%
175.9	48.5	255.2	45.7%

Analysis of Uncombined Images

Measured Data

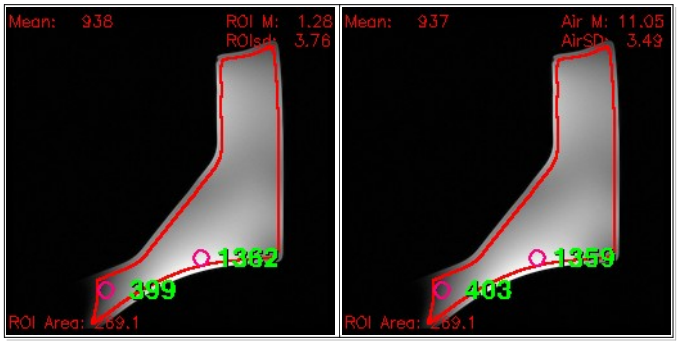
Ch	Mean	Max	Noise SD	Noise Type
1	384	923	2.80	Air
2	530	1,390	3.54	Air
3	444	803	2.97	Air

Calculated Results

Mean SNR	% of Mean	Max SNR	% of Max
89.9	92%	216.0	84%
98.1	100%	257.3	100%
98.0	100%	177.2	69%

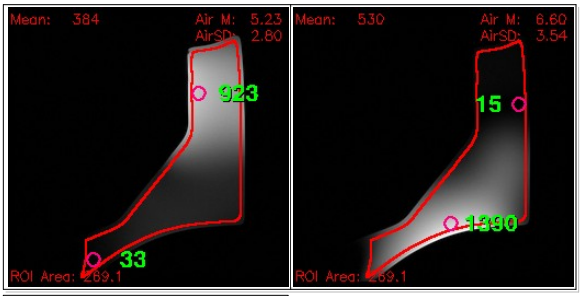
Simply Physics Protocol

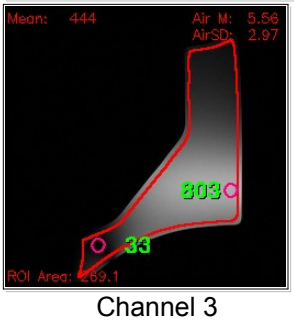
Little better than last year



Composites

Channel 1 Channel 2





Channel 3

RF Coil Performance Evaluation

Coil: Head

Mfg.: USA Inst.

Mfg. Date: 2/1/2003 Coil ID: 241

Phantom: ACR Phantom

Test Date: 10/24/2007

Model: 2280062

Revision:

SN: 905034YM5

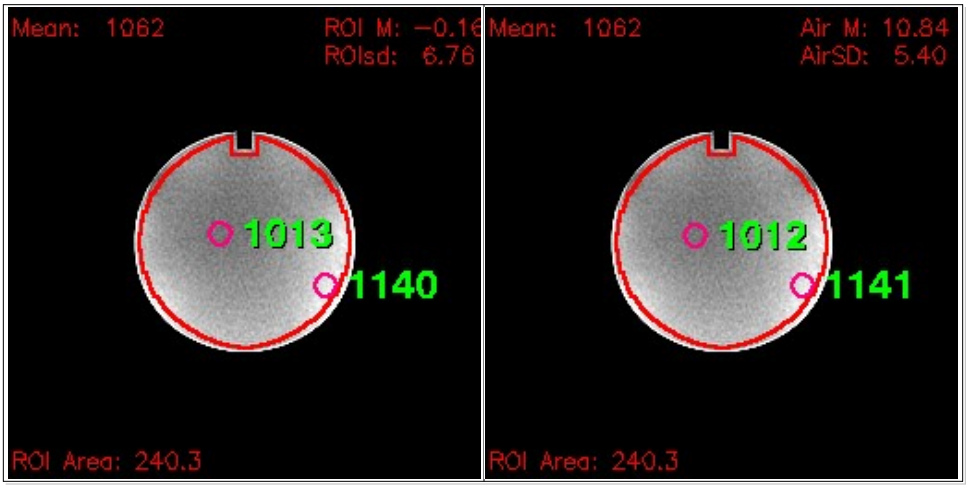
# of Channels 1

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	40	256	256	10.4	1	5	-

Coil Mode: Head TX gain: 127 R1: 8 R2: 28

Analysis of Test Image

Measured Data							Calculated Results			
Label	Mean	Max	Min	Back ground	Noise SD	Noise Type	Mean SNR	Normal-ized	Max SNR	Uni-formity
N	1,062	1,140	1,013	-0.2	6.76	NEMA	111.1	30.6	119.3	94.1%
A	1,062	1,141	1,012	10.8	5.40	Air	128.9	35.5	138.5	94.0%



RF Coil Performance Evaluation

Coil: Knee - Large
Mfg.: USA Inst.
Mfg. Date: 3/1/2002 Coil ID: 243
Phantom: Knee bottle

Test Date: 10/24/2007
Model: 100214
Revision: B
SN: 322
# of Channels 2

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	25	256	256	10.4	1	5	-

Coil Mode: Knee Large TX gain: 188 R1: 10 R2: 28

Analysis of Composite Image

Measured Data

Label	Mean	Max	Min	Background	Noise SD	Noise Type
N	2,576	2,813	2,381	3.0	18.72	NEMA
A	2,573	2,811	2,375	47.3	17.92	Air

Calculated Results

Mean SNR	Normal-ized	Max SNR	Uni-formity
97.3	68.7	106.3	91.7%
94.1	66.4	102.8	91.6%

Analysis of Uncombined Images

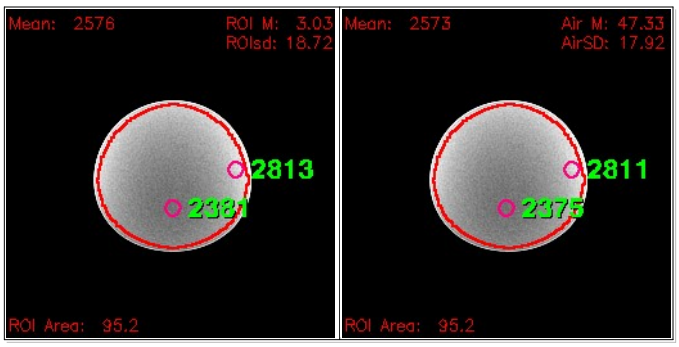
Measured Data

Ch	Mean	Max	Noise SD	Noise Type
1	1,897	2,112	14.96	Air
2	1,570	1,756	18.43	Air

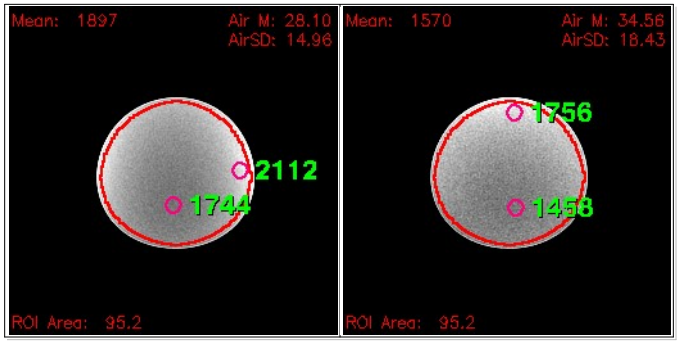
Calculated Results

Mean SNR	% of Mean	Max SNR	% of Max
83.1	100%	92.5	100%
55.8	67%	62.4	67%

Simply Physics protocol - no gradwarp



Composites



Channel 1 Channel 2

RF Coil Performance Evaluation

Coil: Knee - Large
Mfg.: USA Inst.
Mfg. Date: 3/1/2002 Coil ID: 243
Phantom: Knee bottle

Test Date: 10/24/2007
Model: 100214
Revision: B
SN: 322
# of Channels 2

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	S	30	256	256	10.4	1	5	-

Coil Mode: Knee Large TX gain: 188 R1: 8 R2: 29

Analysis of Composite Image

Measured Data

Label	Mean	Max	Min	Background	Noise SD	Noise Type
N	1,885	2,740	963	-0.2	13.00	NEMA
A	1,885	2,737	963	33.0	12.57	Air

Calculated Results

Mean SNR	Normal-ized	Max SNR	Uni-formity
102.5	50.2	149.1	52.0%
98.3	48.1	142.7	52.1%

Analysis of Uncombined Images

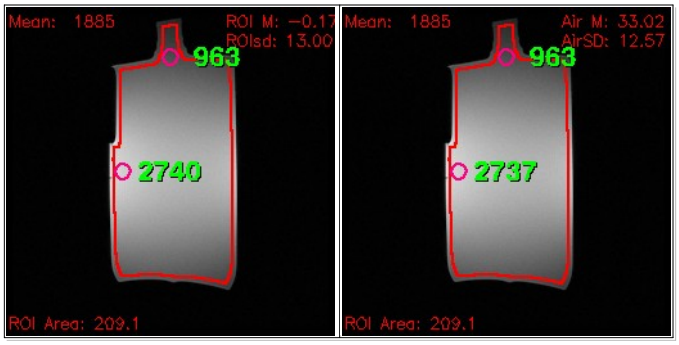
Measured Data

Ch	Mean	Max	Noise SD	Noise Type
1	1,406	2,010	10.53	Air
2	1,210	1,807	12.88	Air

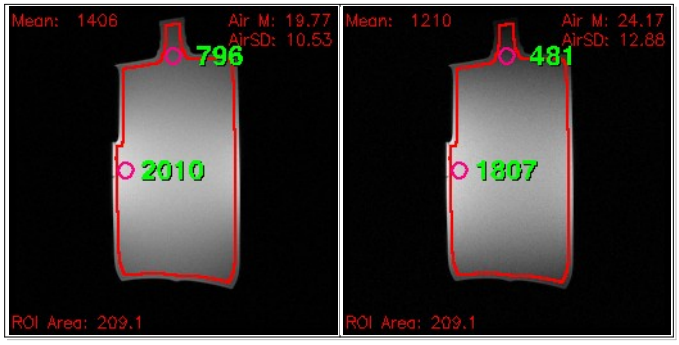
Calculated Results

Mean SNR	% of Mean	Max SNR	% of Max
87.5	100%	125.1	100%
61.6	70%	91.9	73%

Simply Physics protocol - no gradwarp

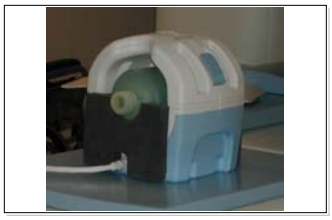


Composites



Channel 1 Channel 2

RF Coil Performance Evaluation



Coil: Knee & Foot (small)

Mfg.: USA Inst.

Mfg. Date: 6/1/2005 Coil ID: 244

Phantom: Knee phantom

Test Date: 10/24/2007

Model: 100213

Revision: B

SN: 464

# of Channels 2

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	25	256	256	10.4	1	5	-

Coil Mode: Small Knee TX gain: 188 R1: 8 R2: 28

Analysis of Composite Image

Measured Data

Label	Mean	Max	Min	Background	Noise SD	Noise Type
N	1,130	1,265	1,007	0.1	6.67	NEMA
A	1,130	1,264	1,008	16.2	6.15	Air

Calculated Results

Mean SNR	Normalized	Max SNR	Uniformity
119.8	84.5	134.1	88.6%
120.4	84.9	134.7	88.7%

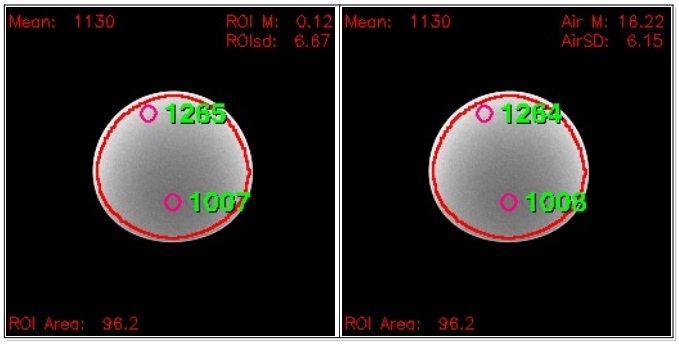
Analysis of Uncombined Images

Measured Data

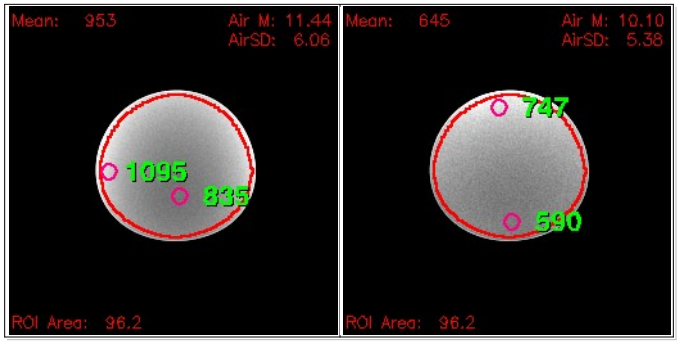
Ch	Mean	Max	Noise SD	Noise Type
1	953	1,095	6.06	Air
2	645	747	5.38	Air

Calculated Results

Mean SNR	% of Mean	Max SNR	% of Max
103.1	100%	118.4	100%
78.6	76%	91.0	77%

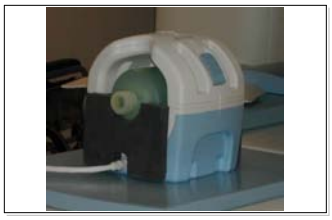


Composites



Channel 1 Channel 2

RF Coil Performance Evaluation



Coil: Knee & Foot (small)

Mfg.: USA Inst.

Mfg. Date: 6/1/2005 Coil ID: 244

Phantom: Knee phantom

Test Date: 10/24/2007

Model: 100213

Revision: B

SN: 464

# of Channels 2

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	S	30	256	256	10.4	1	5	-

Coil Mode: Small Knee TX gain: 187 R1: 7 R2: 29

Analysis of Composite Image

Measured Data

Label	Mean	Max	Min	Background	Noise SD	Noise Type
N	764	1,241	320	-0.0	4.67	NEMA
A	764	1,240	322	11.3	4.32	Air

Calculated Results

Mean SNR	Normal-ized	Max SNR	Uni-formity
115.7	56.7	187.9	41.0%
115.9	56.8	188.1	41.2%

Analysis of Uncombined Images

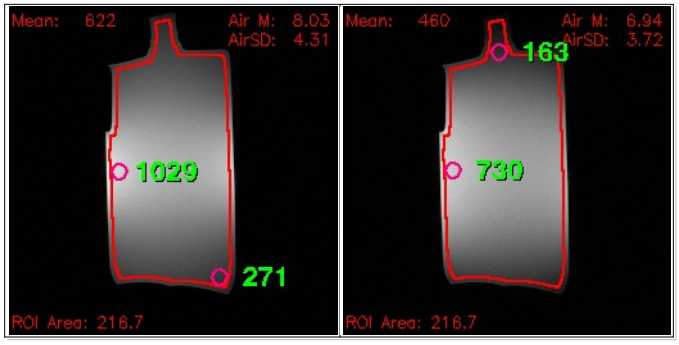
Measured Data

Ch	Mean	Max	Noise SD	Noise Type
1	622	1,029	4.31	Air
2	460	730	3.72	Air

Calculated Results

Mean SNR	% of Mean	Max SNR	% of Max
94.6	100%	156.5	100%
81.0	86%	128.6	82%

Composites



Channel 1 Channel 2

RF Coil Performance Evaluation

Coil: Shoulder Phased Array
Mfg.: USA Inst.
Mfg. Date: 8/28/2002 Coil ID: 245
Phantom: Head TLT sphere

Test Date: 10/24/2007
Model: 100217
Revision: B
SN: ?352
# of Channels 2

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	C	36	256	256	10.4	1	5	-

Coil Mode: Shoulder TX gain: 195 R1: 9 R2: 28

Analysis of Composite Image

Measured Data

Label	Mean	Max	Min	Background	Noise SD	Noise Type
N	830	1,485	467	-0.9	3.44	NEMA
A	831	1,485	468	8.7	3.30	Air

Calculated Results

Mean SNR	Normal-ized	Max SNR	Uni-formity
170.6	58.1	305.3	47.8%
165.0	56.1	294.9	47.9%

Analysis of Uncombined Images

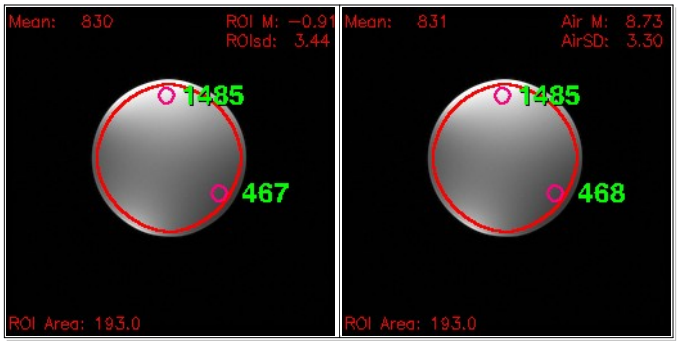
Measured Data

Ch	Mean	Max	Noise SD	Noise Type
1	650	1,081	3.16	Air
2	470	1,146	3.00	Air

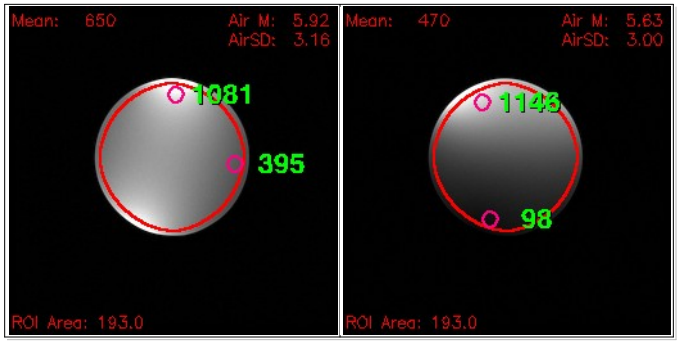
Calculated Results

Mean SNR	% of Mean	Max SNR	% of Max
134.8	100%	224.2	90%
102.7	76%	250.3	100%

Simply Physics Protocol

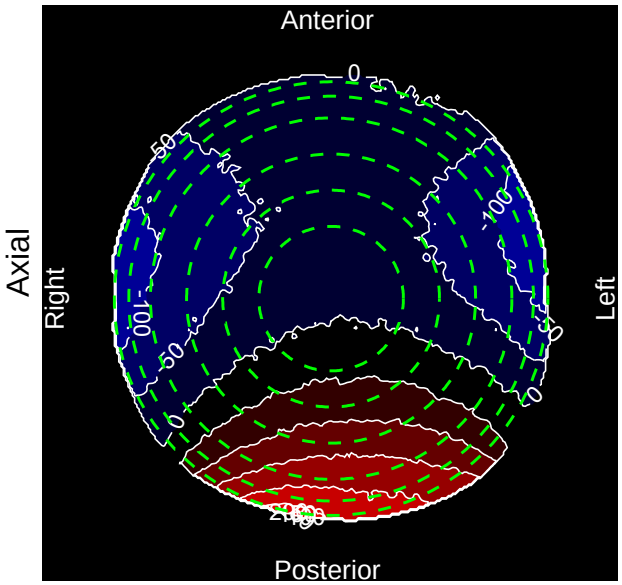


Composites



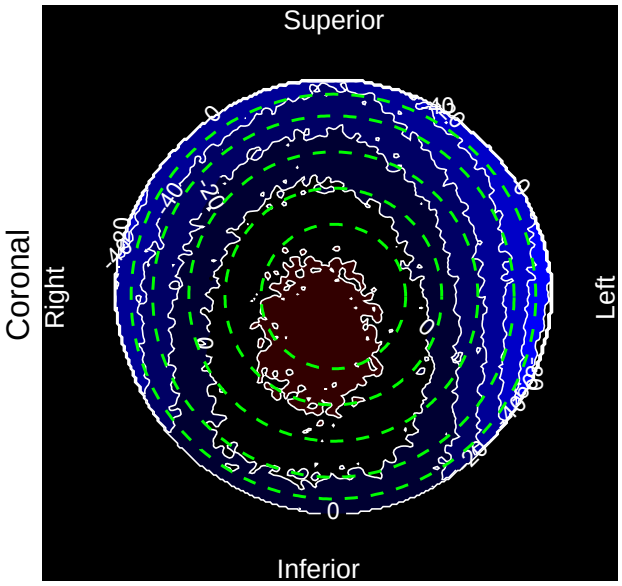
Channel 1 Channel 2

Appendix A: Magnet Homogeneity Field Maps
GE Ovation 0.35T - 3 central planes
Measured October 24, 2007



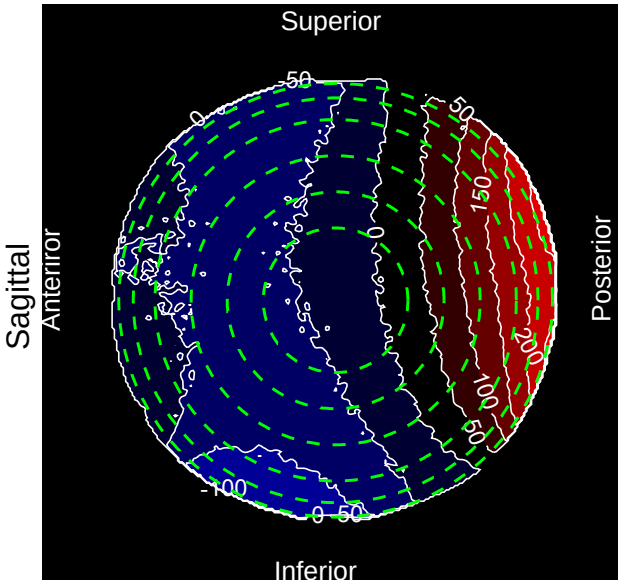
Axial

DIAMETER	MIN	MAX	RANGE	PPM	MEAN	STDEV
10	-43	41	85	5.7	-12.9	19.9
15	-59	80	140	9.5	-11.6	31.4
20	-80	131	211	14.3	-9.6	44.7
25	-105	189	294	19.9	-7.2	60.0
28	-128	234	362	24.5	-5.7	70.3
30	-148	276	424	28.6	-4.6	77.3



Coronal

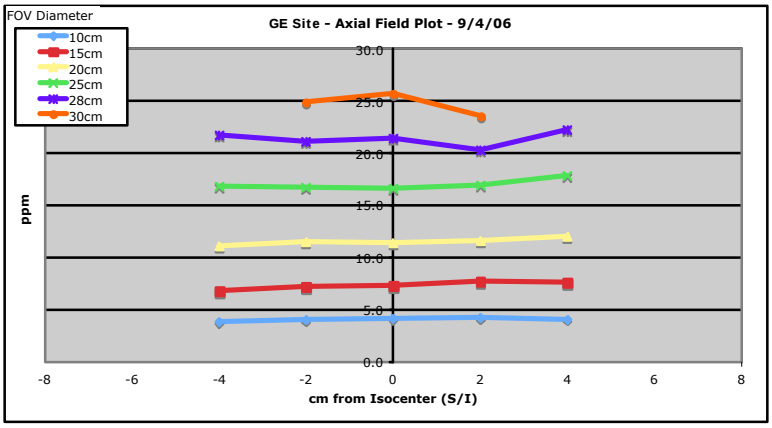
DIAMETER	MIN	MAX	RANGE	PPM	MEAN	STDEV
10	1	33	32	2.2	20.3	5.6
15	-16	33	50	3.4	14.6	9.5
20	-39	33	73	4.9	6.8	14.5
25	-71	33	104	7.1	-3.1	20.9
28	-94	33	128	8.7	-10.1	25.4

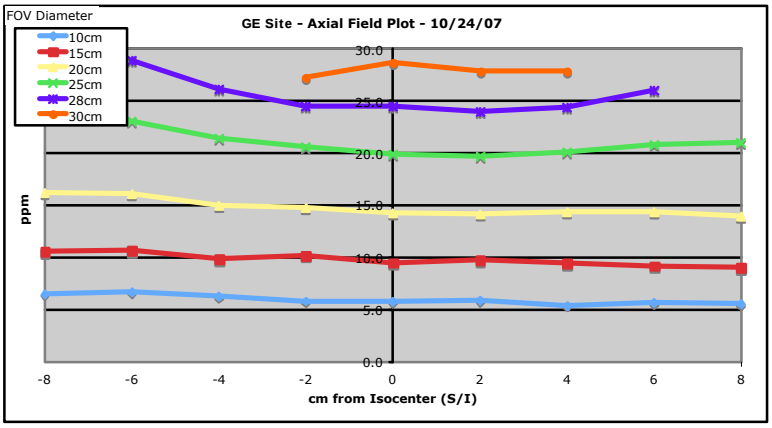


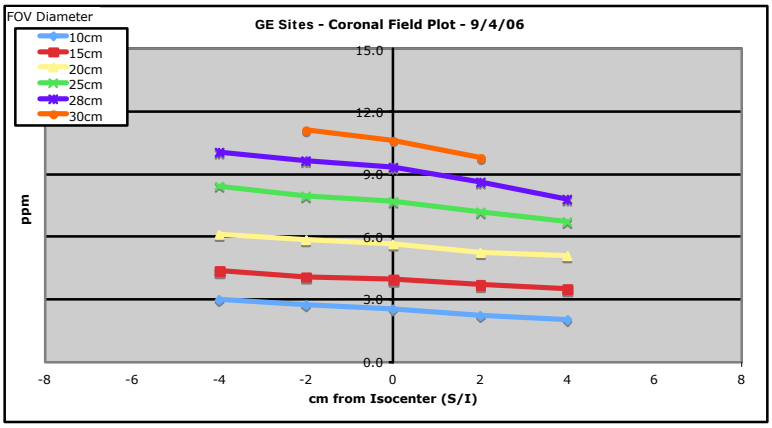
Sagittal

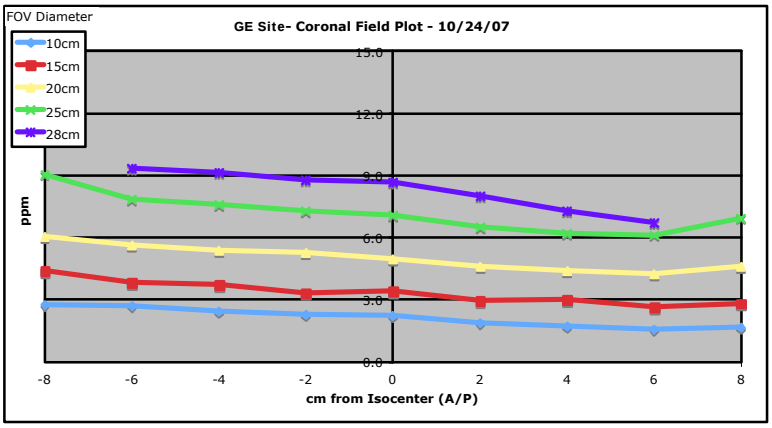
DIAMETER	MIN	MAX	RANGE	PPM	MEAN	STDEV
10	-67	25	93	6.3	-30.1	22.3
15	-75	73	149	10.1	-26.5	34.4
20	-90	128	218	14.8	-21.6	48.3
25	-110	186	297	20.0	-15.4	64.0
28	-122	225	347	23.4	-11.0	74.7
30	-137	258	395	26.6	-7.9	82.2

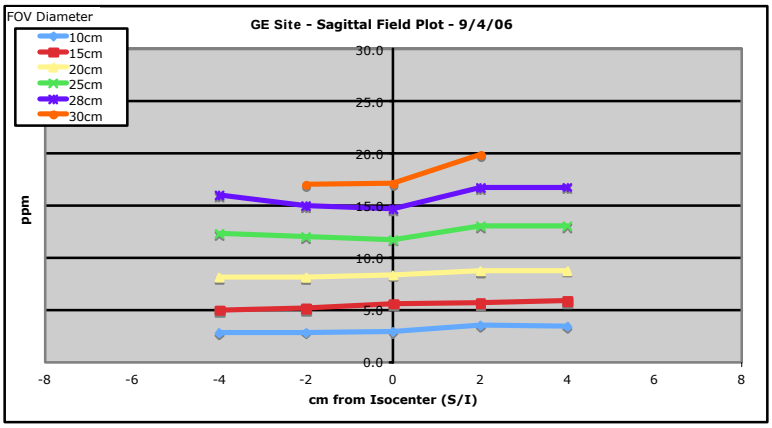
Appendix A: Magnet Homogeneity Field Maps
GE Ovation 0.35T
Measured October 24, 2007

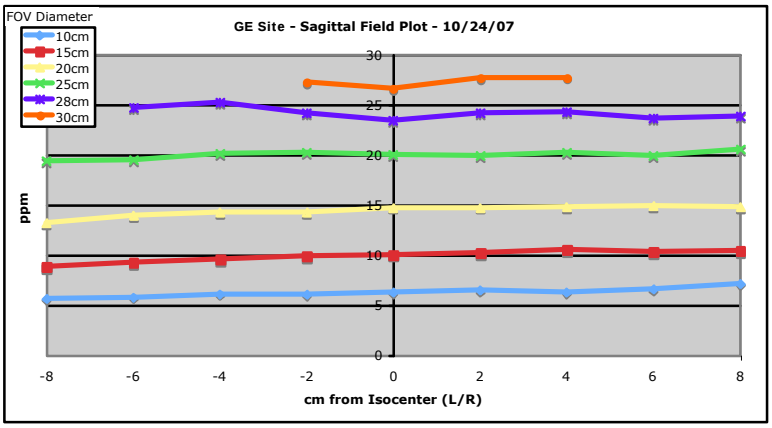




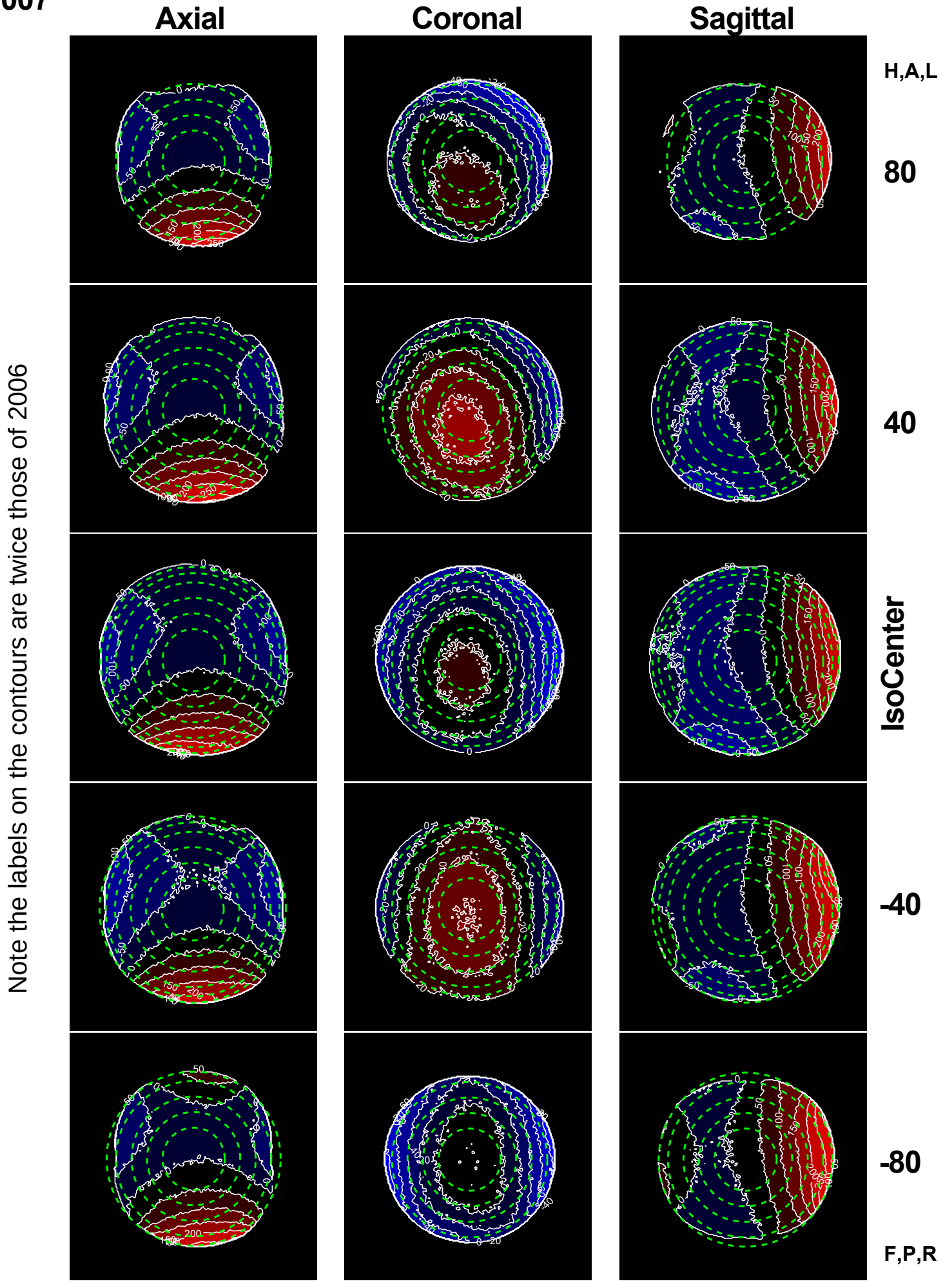






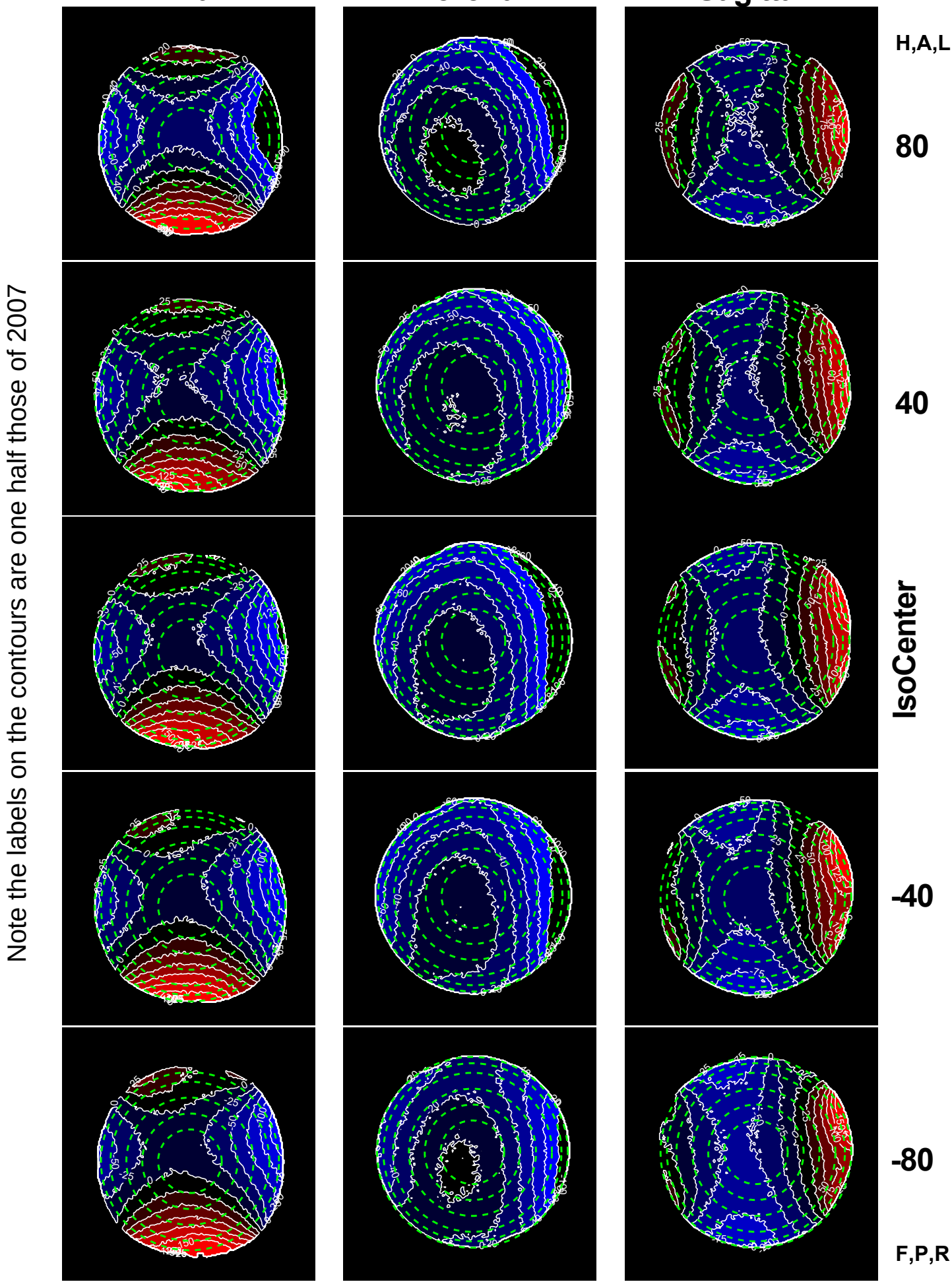


2007



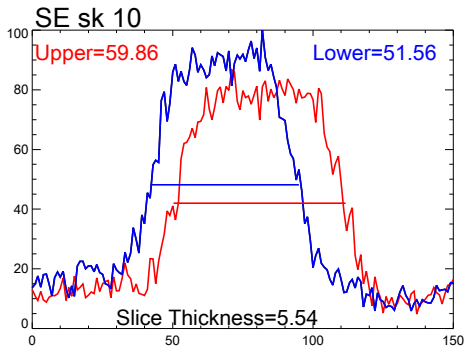
Note the labels on the contours are twice those of 2006

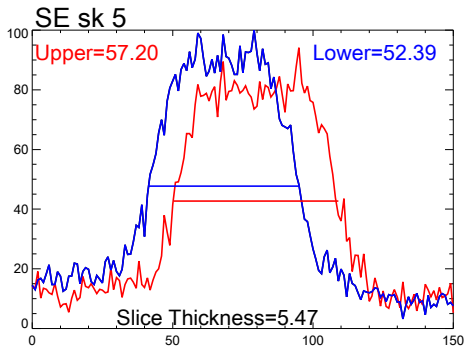
2006

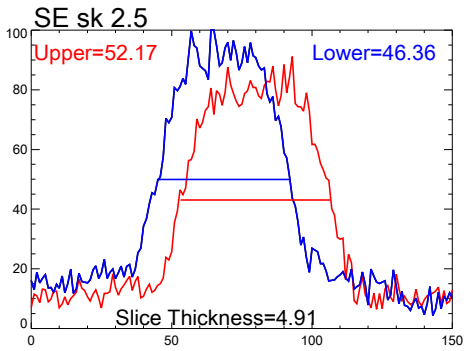

Axial
Coronal
Sagittal
H,A,L
80
40
IsoCenter
-40
-80
F,P,R
Note the labels on the contours are one half those of 2007

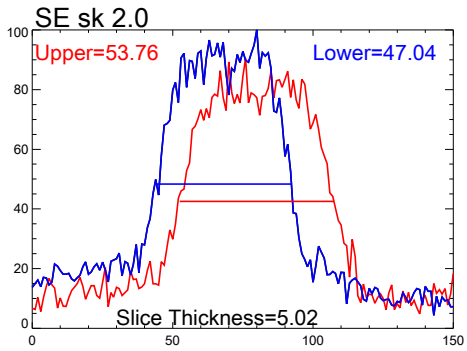
Appendix B: RF Slice Profiles and Crosstalk

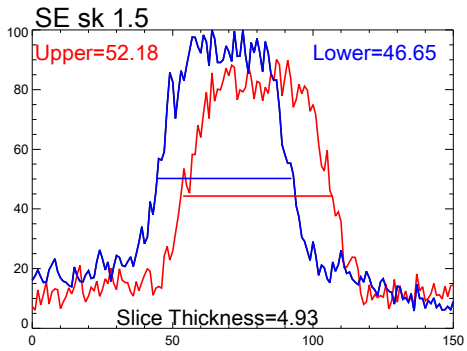
Spin Echo
TR/TE = 400/18
nex = 2
BW = 10.4 KHz
Scan time: 3:25

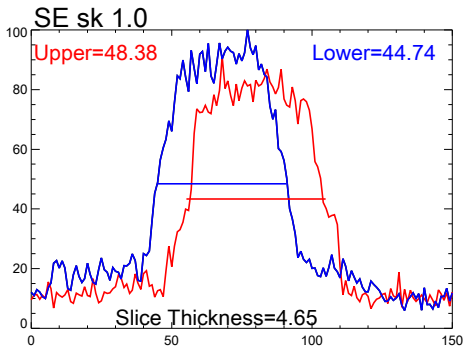


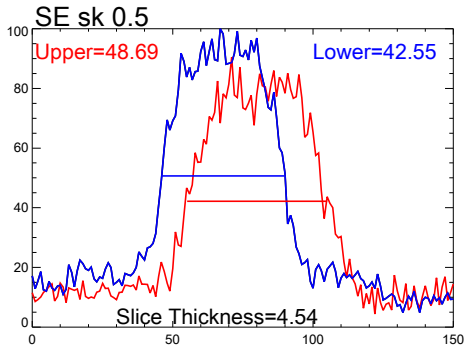


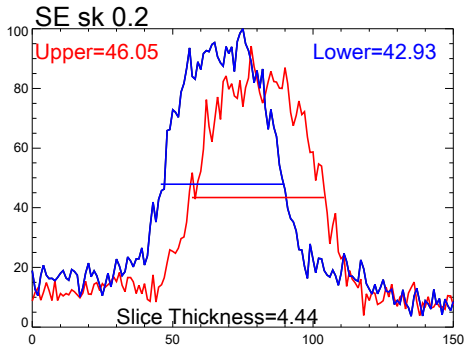


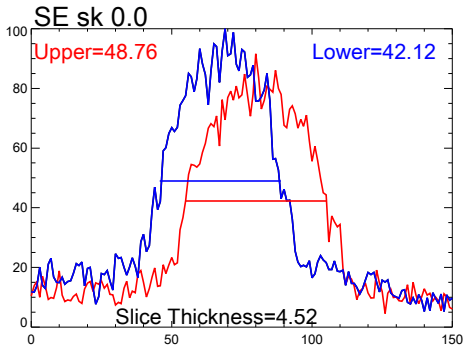


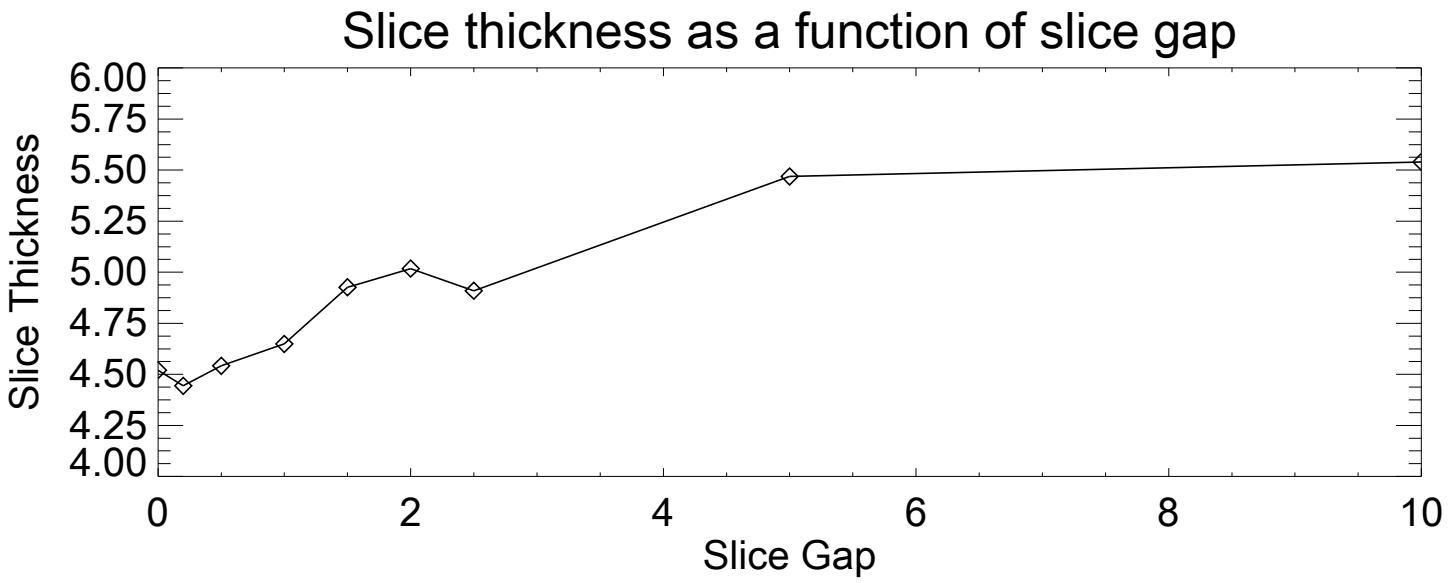






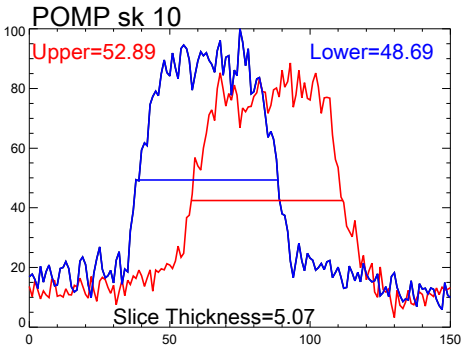


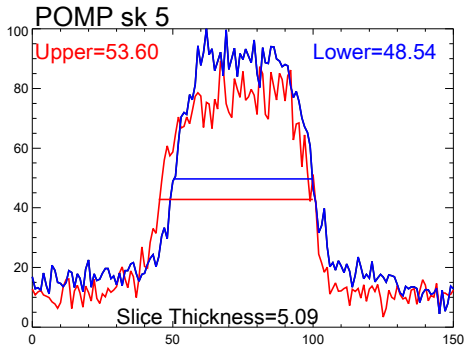


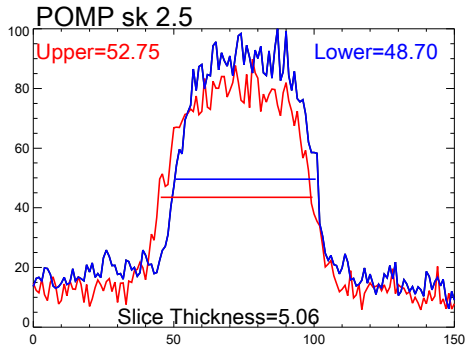


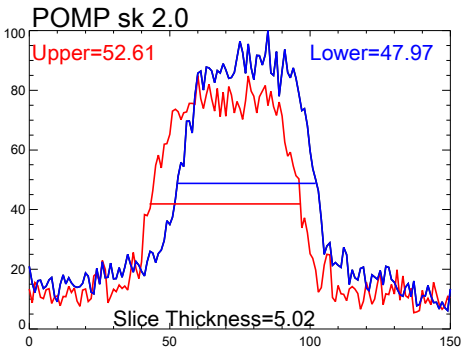
Appendix B: RF Slice Profiles and Crosstalk

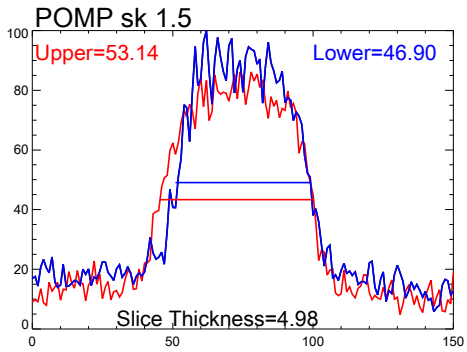
Spin Echo - POMP
TR/TE = 400/19
BW = 12.5 KHz
nex = 2
Scan time: 3:25

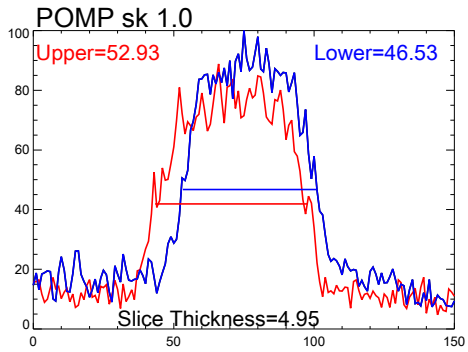


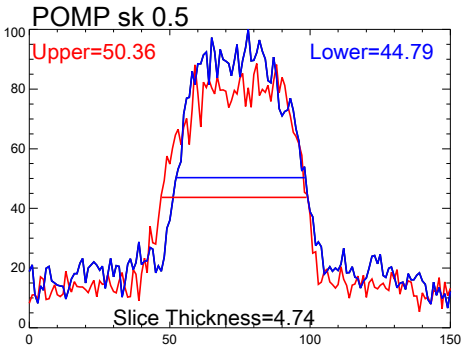


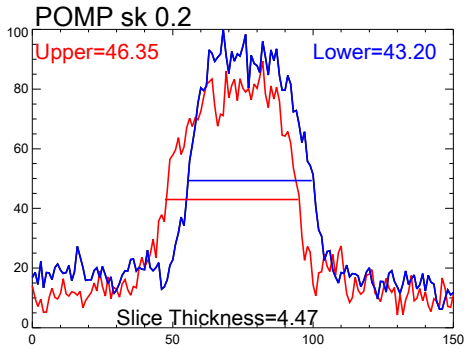


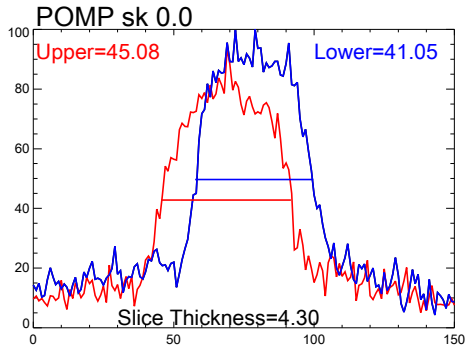


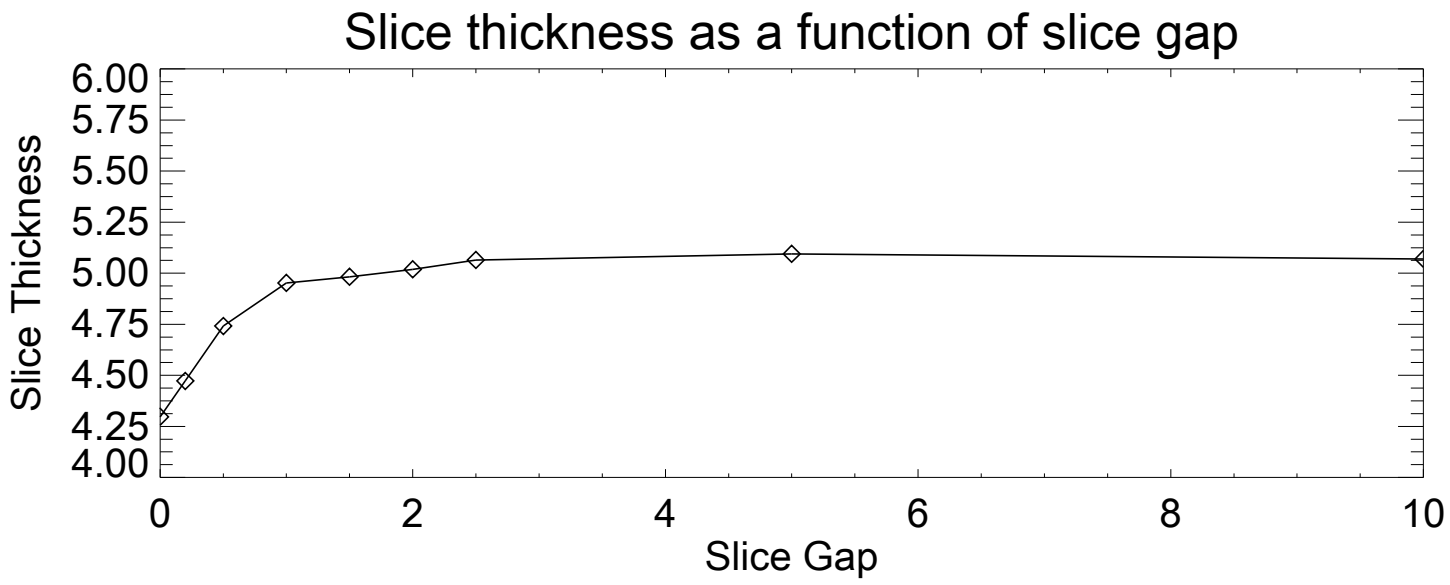












GE Site **Ovation**

Coil Used: **Head** Test Date: **10/24/2007**

	Sagittal Locator	
1	Length of phantom, end to end (mn 148± 2)	146.3

= calculated field

		(SE 500/20)	(SE 2000/20)	(SE 2000/80)	(Site T1)	(Site T2)
	Slice Location #1	ACR T1	ACR PD	ACR T2	Site T1	Site T2
2	Resolution (1.10, 1.00, 0.90 mm)	0.9	0.9	0.9	1.0	1.0
3		1.0	1.0	1.0	1.0	1.0
4	Slice Thickness (fwhm in mm) Top	52.1	51.3	47.1	52.3	52.8
5	Bottom	58.1	59.3	53.4	59.2	56.8
6	Calculated value 5.0±0.7	5.49	5.50	5.00	5.55	5.47
7	Wedge (mm) = + = -	2.4	2.8	2.6	2.5	2.4
8	Diameter (mm) (190±2) ⊕	190.5	190.2	190.0	190.3	190.4
9	⊖	188.7	188.7	188.6	188.6	188.3
	Slice Location #5					
10	Diameter (mm) (190±2) ⊕	190.2	189.9	189.7	190.1	190.2
11	⊖	188.8	188.8	188.7	188.7	188.5
12	⊘	189.9	189.9	189.7	190.1	190.0
13	⊘	190.5	190.5	190.3	190.5	190.4
	Slice Location #7					
14	Signal (mean only) Big ROI	1258	1316	849	1270	713
15	High	1342	1393	918	1346	771
16	Low	1216	1275	819	1227	689
17	Uniformity (>87.5%)	95.1%	95.6%	94.3%	95.4%	94.4%
18	Background Noise Top	33.2 ±17.36	44.9 ±21.94	33.2 ±16.26	19.7 ± 9.88	21.1 ±11.33
19	Bottom	33.3 ±16.49	43.3 ±21.24	33.3 ±16.10	19.6 ± 9.52	20.2 ±10.61
20	(mean ±std dev) Left	27.4 ±12.83	34.5 ±16.71	31.5 ±15.26	18.2 ± 9.38	16.9 ± 8.28
21	Right	27.8 ±13.75	34.0 ±16.75	30.5 ±14.10	17.0 ± 8.96	15.7 ± 7.82
22	Ghosting Ratio (<2.5%)	0.4%	0.7%	0.3%	0.2%	0.6%
23	SNR (no spec)	95	79	58	138	89
	Low Con Detectability					
24	Slice Location #8 1.4%	0	0	0	1	0
25	Slice Location #9 2.5%	2	1	0	7	2
26	Slice Location #10 3.6%	5	1	0	9	4
27	Slice Location #11 5.1%	7	4	5	9	7
28	Total # of Spokes (>=9)	14	6	5	26	13
	Slice Location #11					
29	Wedge (mm) = + = -	-4.4	-4.7	-4.3	-4.4	-3.8
30	Slice Position Error	-6.8	-7.4	-6.9	-6.9	-6.2

The net Slice position error fails ACR spec

GE Site **Ovation**

Sequence parameters Test Date: **10/24/2007**

Coil Used:**Head** **Test ID** **218**

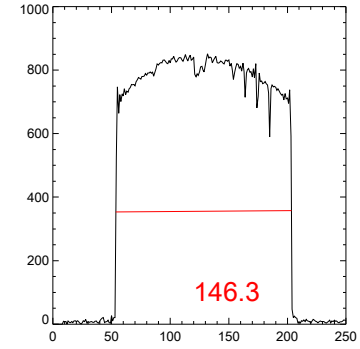
Study Description	Pulse Sequence (ETL)	TR (ms)	TE (ms)	FOV (cm)	Phase Sample Ratio	Number of Slices	Thick-ness (mm)	Slice Gap	NSA (Nex)	Freq Matrix	Phase Matrix	Band Width (kHz)	Scan Time (min:sec)
ACR T1	SE	500	20	25	1	11	5	5	1	256	256	8.93	2:09
ACR PD	Dual Echo SE	2000	20	25	1	11	5	5	1	256	256	15.6	8:32
ACR T2	Dual Echo SE	2000	80	25	1	11	5	5	1	256	256	8.93	8:32
Site T1	SE	500	16	24	1	11	5	5	4	256	256	12.5	8:32
Site T2	FSE(12)	4400	12	24	1	11	5	5	5	256	224	12.5	6:51

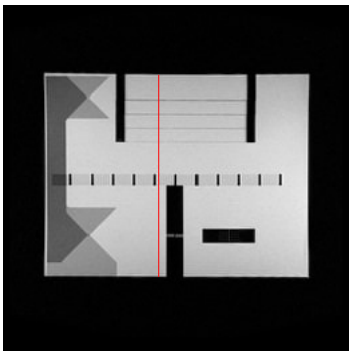
Magnet ID: **20** **Coil ID:** **241** **TestID:** **218**

Appendix C: ACR Phantom Analysis

ACR T1

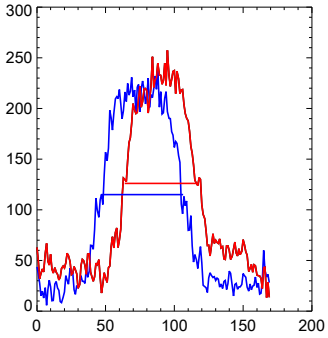
Sagital Length





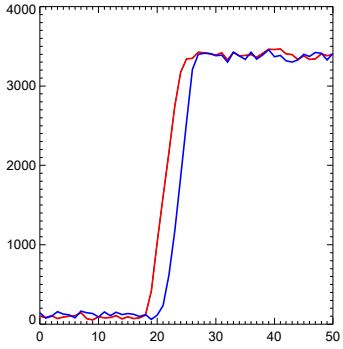
High Contrast Resolution

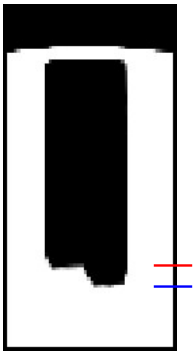
Slice Thickness



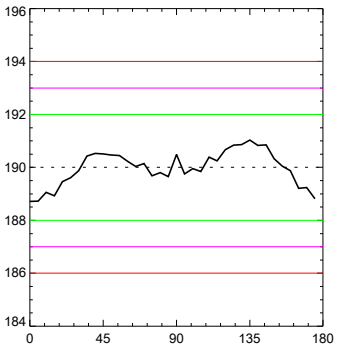
Upper=52.08
Lower=58.12
Slice Thickness=5.49

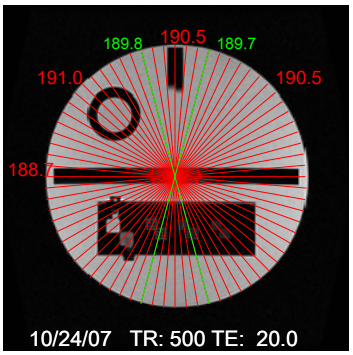
Slice Position - Inferior



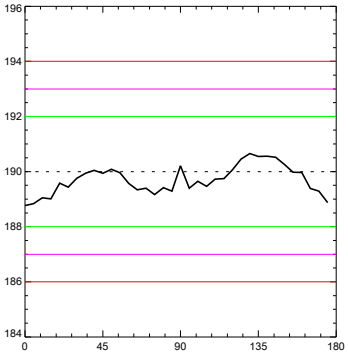


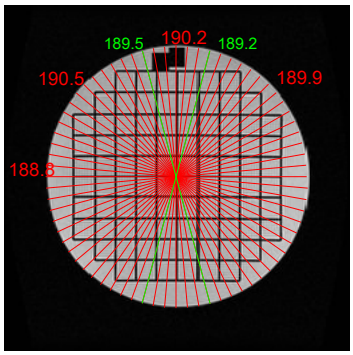
Axial Diameters - #1



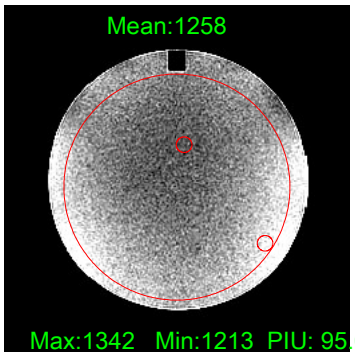


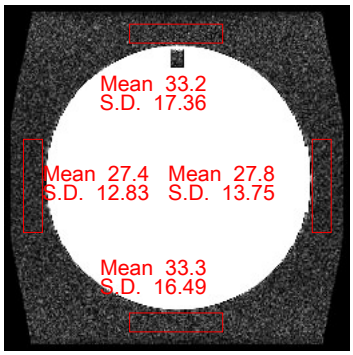
Axial Diameters - #5



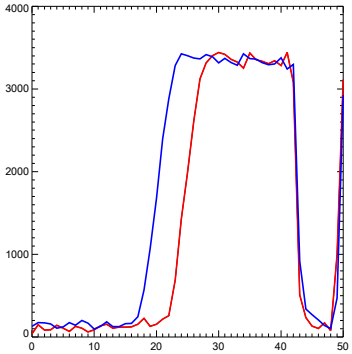


Uniformity & Ghosting - #7

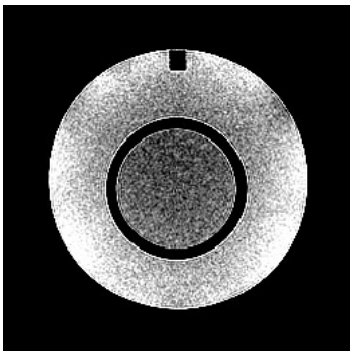




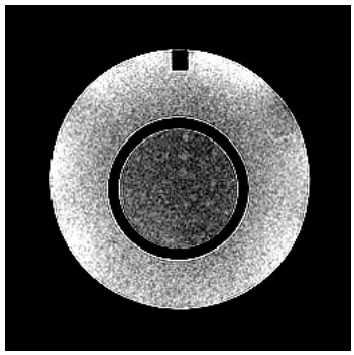
Slice Position - Superior



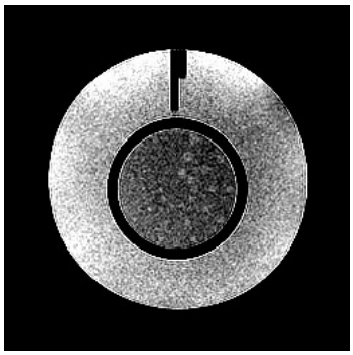
Low Contrast - #8



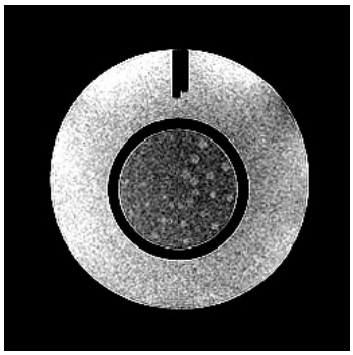
Low Contrast - #9



Low Contrast - #10



Low Contrast - #11

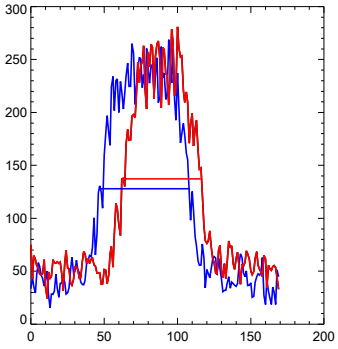


Appendix C: ACR Phantom Analysis

ACR PD

High Contrast Resolution

Slice Thickness

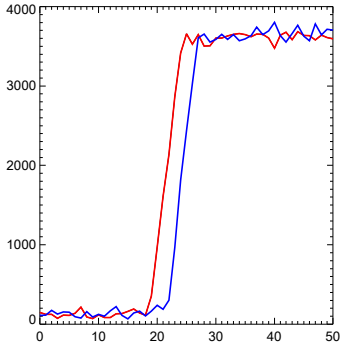


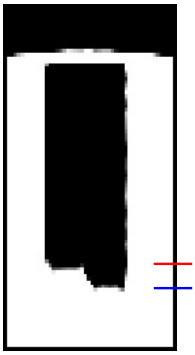
Upper=51.33

Lower=59.30

Slice Thickness=5.50

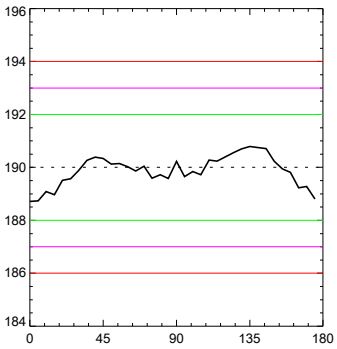
Slice Position - Inferior

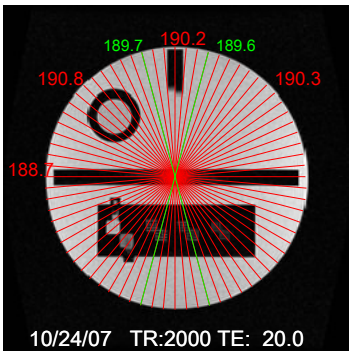




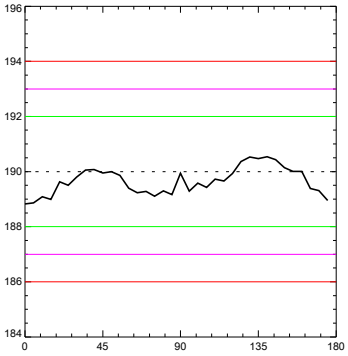
Diff.= 2.77

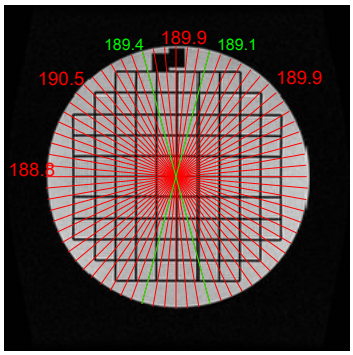
Axial Diameters - #1



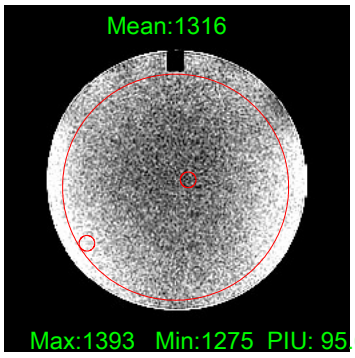


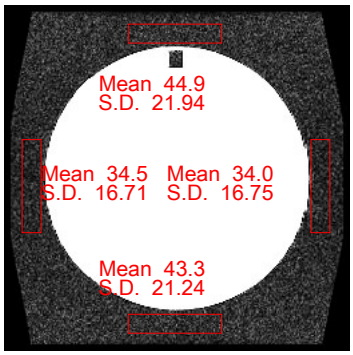
Axial Diameters - #5



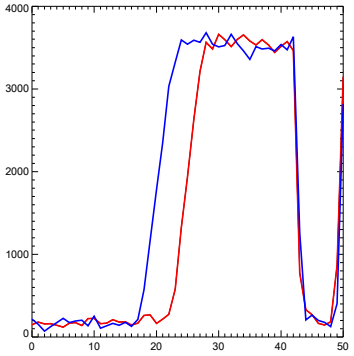


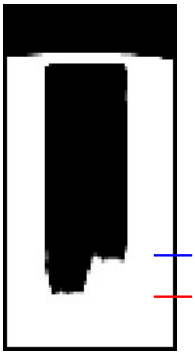
Uniformity & Ghosting - #7





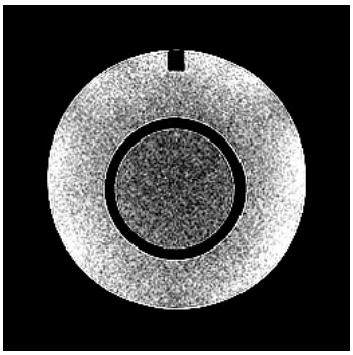
Slice Position - Superior



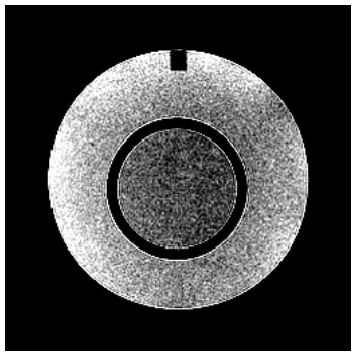


Diff.= -4.65

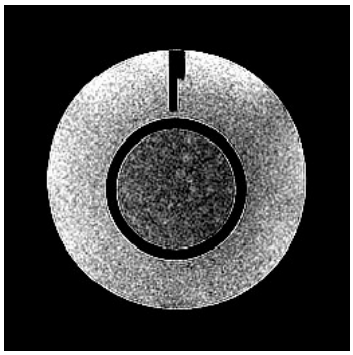
Low Contrast - #8



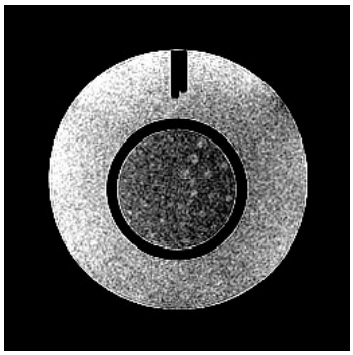
Low Contrast - #9



Low Contrast - #10



Low Contrast - #11

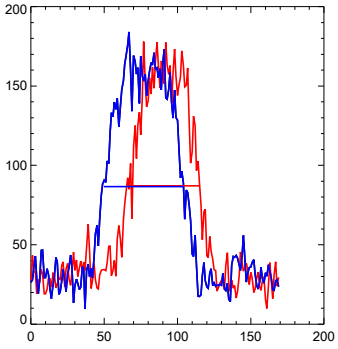


Appendix C: ACR Phantom Analysis

ACR T2

High Contrast Resolution

Slice Thickness

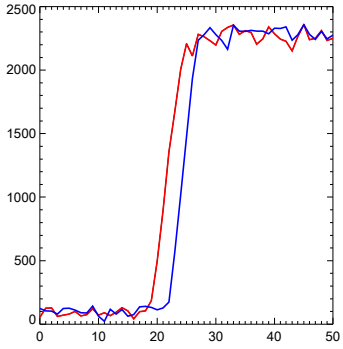


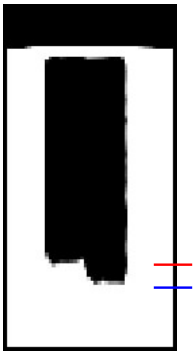
Upper=47.06

Lower=53.41

Slice Thickness=5.00

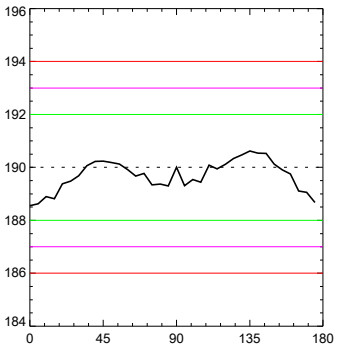
Slice Position - Inferior

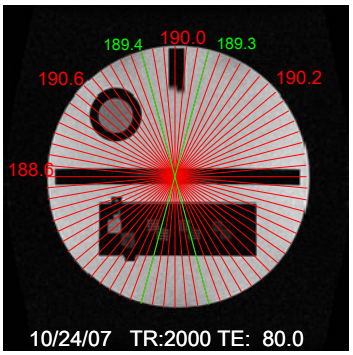




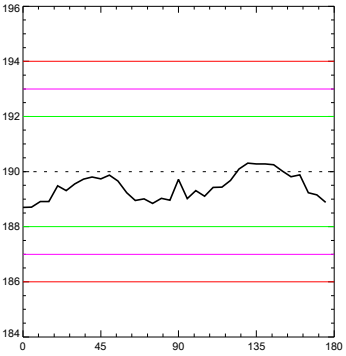
Diff.= 2.58

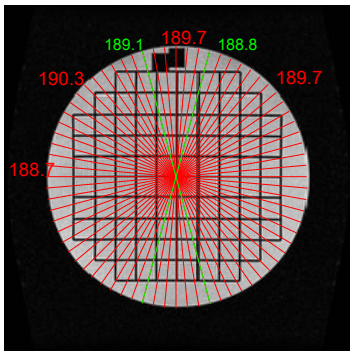
Axial Diameters - #1



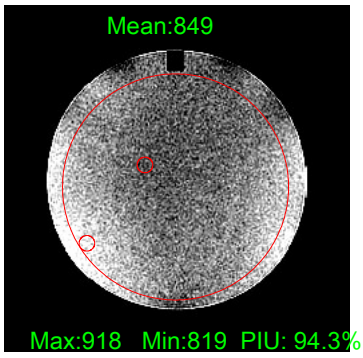


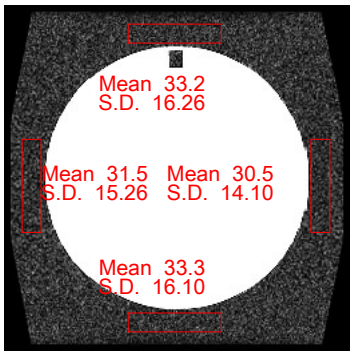
Axial Diameters - #5



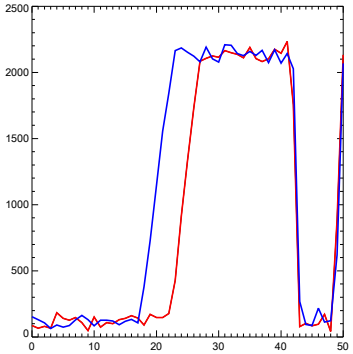


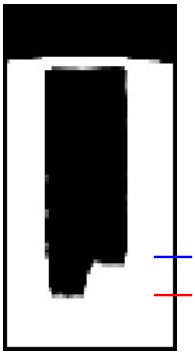
Uniformity & Ghosting - #7





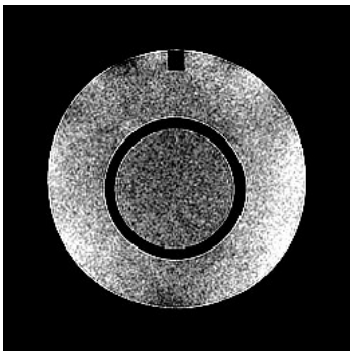
Slice Position - Superior



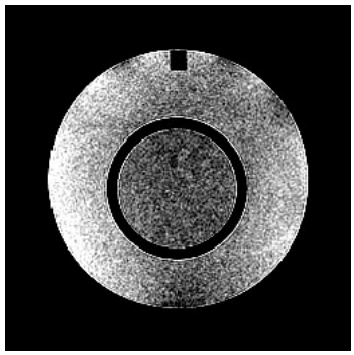


Diff.= -4.33

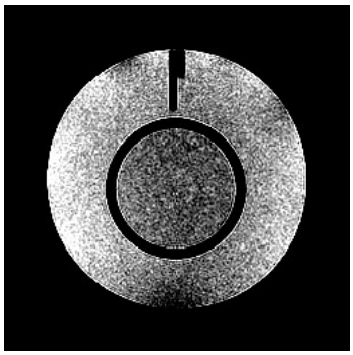
Low Contrast - #8



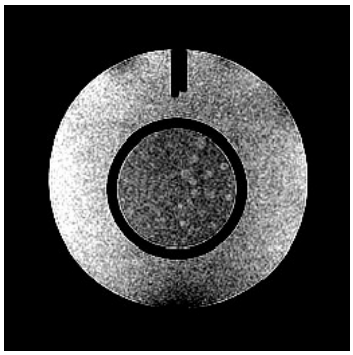
Low Contrast - #9



Low Contrast - #10



Low Contrast - #11

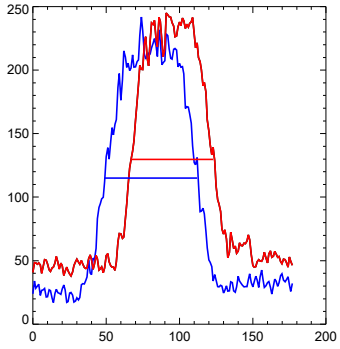


Appendix C: ACR Phantom Analysis

Site T1

High Contrast Resolution

Slice Thickness

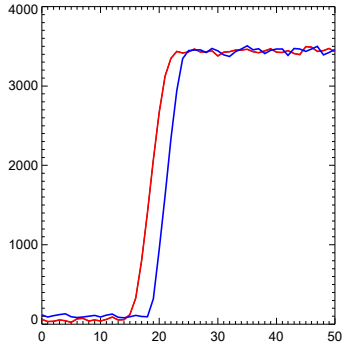


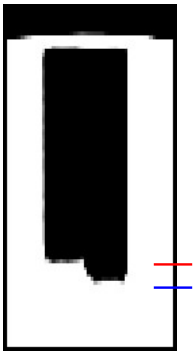
Upper=52.28

Lower=59.21

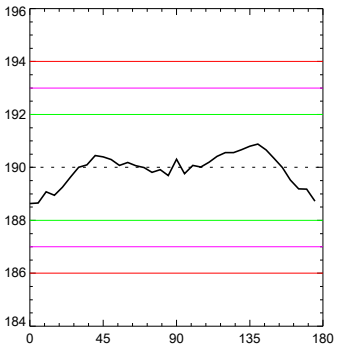
Slice Thickness=5.55

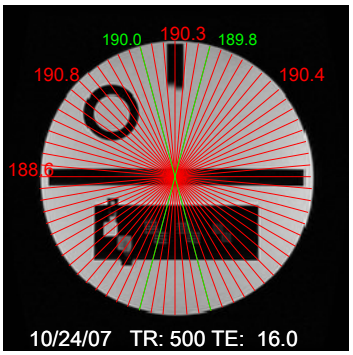
Slice Position - Inferior



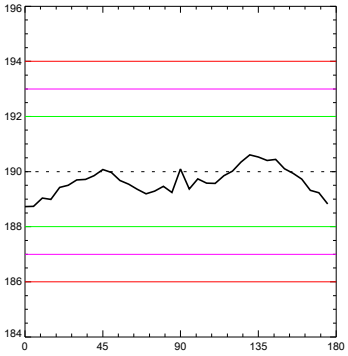


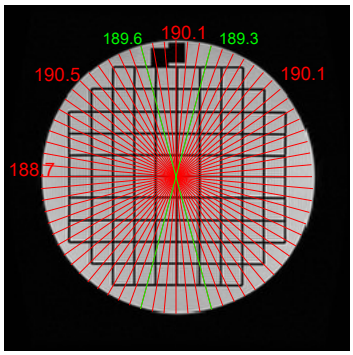
Axial Diameters - #1



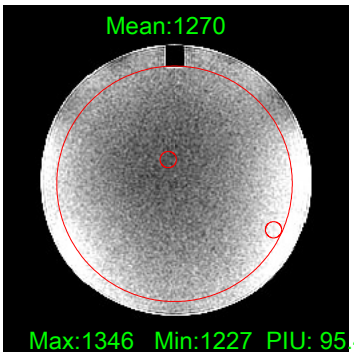


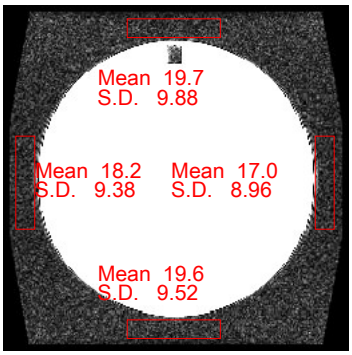
Axial Diameters - #5



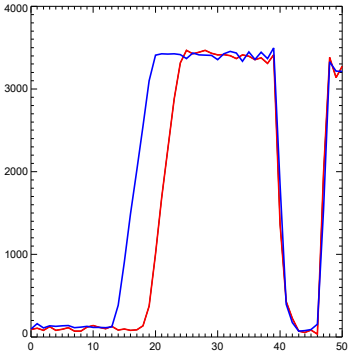


Uniformity & Ghosting - #7

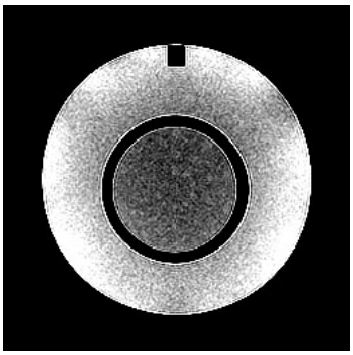




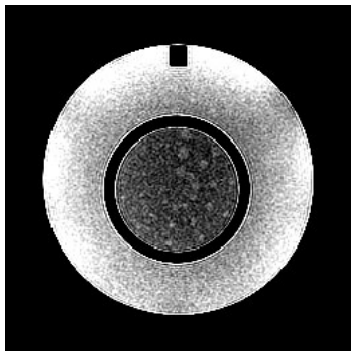
Slice Position - Superior



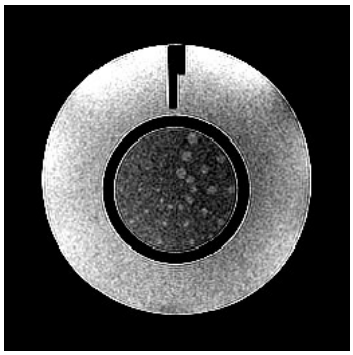
Low Contrast - #8



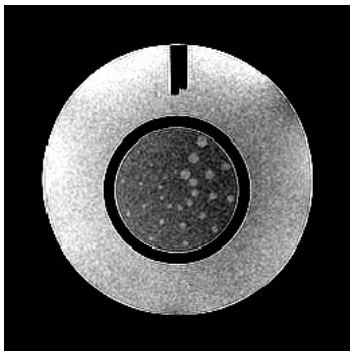
Low Contrast - #9



Low Contrast - #10



Low Contrast - #11

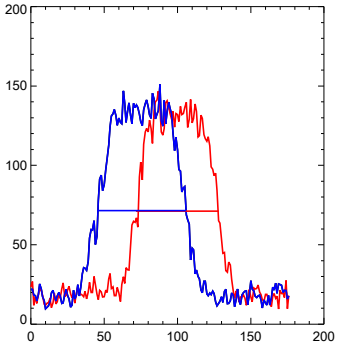


Appendix C: ACR Phantom Analysis

Site T2

High Contrast Resolution

Slice Thickness

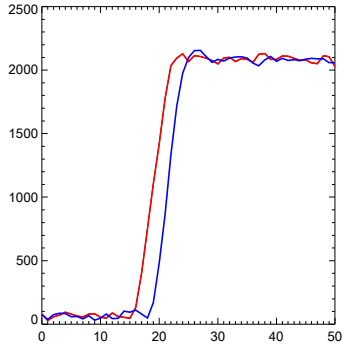


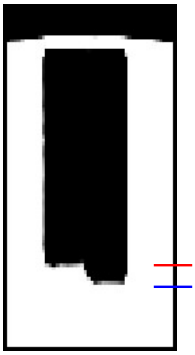
Upper=52.83

Lower=56.77

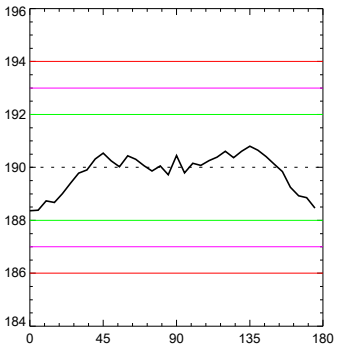
Slice Thickness=5.47

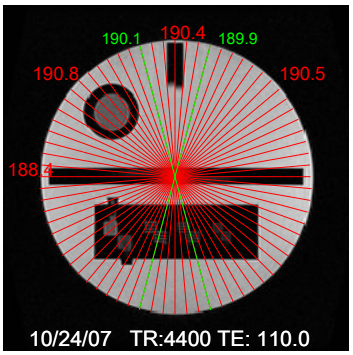
Slice Position - Inferior



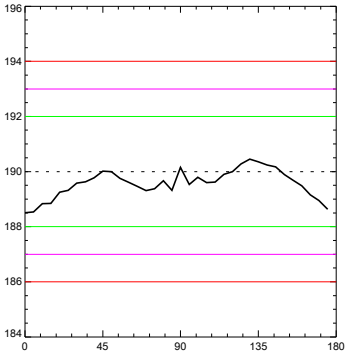


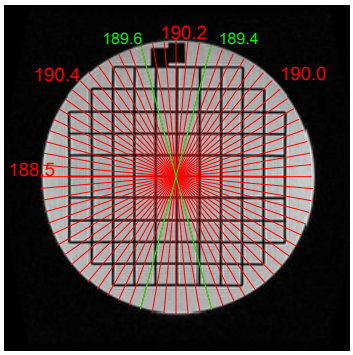
Axial Diameters - #1



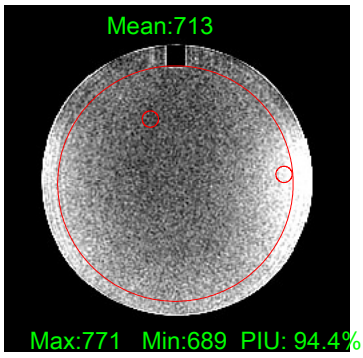


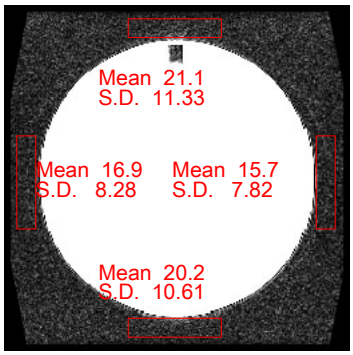
Axial Diameters - #5



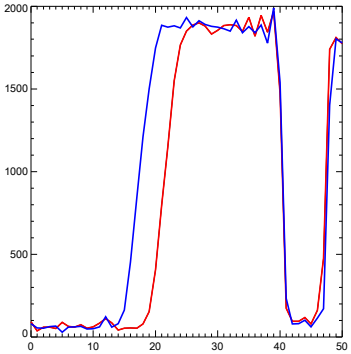


Uniformity & Ghosting - #7

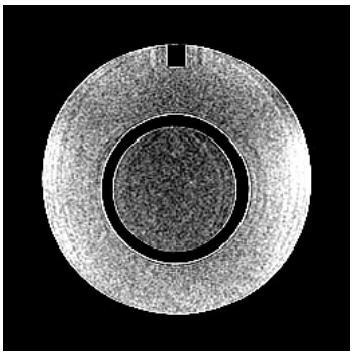




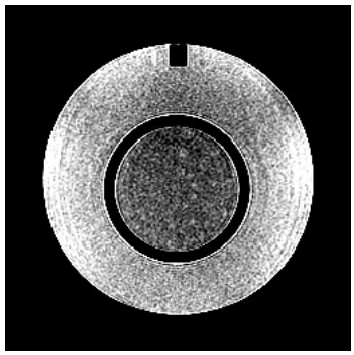
Slice Position - Superior



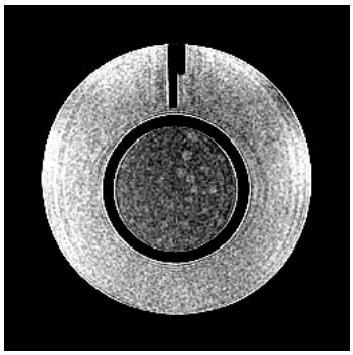
Low Contrast - #8



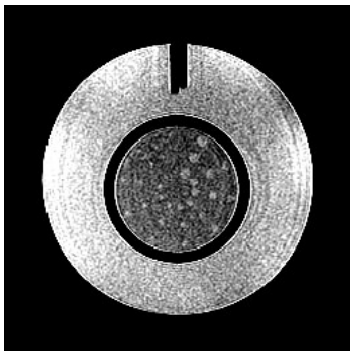
Low Contrast - #9



Low Contrast - #10



Low Contrast - #11



Appendix D:
Explanation of RF Coil Testing Report

Introduction

The primary goal of RF coil testing is to establish some sort of base line for tracking coil performance over time. The most common measure is the Signal to Noise Ratio or SNR. In addition, we can look at overall signal uniformity, ghosting level (or better - lack of ghosting) and in the case of phased array coils we look at the SNR of each and every channel and at symmetry between channels. Unfortunately, there is no single best method for measuring SNR. Below I explain the different methods used and the rationale for each.

SNR

One needs to measure the signal in the phantom (either mean or peak or both) and then divide that by the background noise. Measuring the signal is fairly straightforward, the noise can be more problematic. The simplest method is to measure the standard deviation (SD) in the background 'air'. However, MRI images are the magnitude of complex data. The noise in the underlying complex data is Gaussian but it follows a Rician distribution when the magnitude is used. The true noise can be estimated by multiplying the measured SD by 1.526.

During the reconstruction process, most manufacturers perform various additional operations on the images, This could include geometric distortion correction, low pass filtering of the k-space data resulting in low signal at the edge of the images, RF coil intensity correction (PURE, CLEAR, SCIC, etc), and other processing during the combination of phased array data and parallel imaging techniques. All of these methods distort the background noise making it impossible to obtain an accurate (and reproducible) estimate of the image noise in the air region. The alternative is to use a method which I shall refer to as the NEMA (National Electrical Manufacturers Association) method. The signal in the phantom area is a sum of the proton signal and noise. Once the signal to noise ratio exceeds 5:1, the noise in the magnitude image is effectively Gaussian. To eliminate the proton signal, you acquire an image twice and subtract them. The measured SD in the phantom region should now be the true SD times the square root of 2. When determining the SNR using the NEMA method, calculate the mean signal of the average of the two source images then divide by .7071 x the SD measured in the same area as the mean signal.

Unfortunately, this doesn't always work. It is absolutely imperative that the RF channel scalings, both transmit and receive, be identical with both scans. Any ghosting in the system is not likely to repeat exactly for both scans and will cause a much higher SD. Finally, the phantom needs to be resting in place prior to the scan long enough for motion of the fluid to have died down. Depending on the size and shape of the phantom, this could take any where from 5 to 20 minutes.

One of the most common causes of ghosting is vibration from the helium cold-head. The best way to eliminate this artifact is to turn off the cold head, which will increase helium consumption. Because this vibration is periodic, the ghosting is usually of an N over 2 (N/2) nature. The affect inside the signal region of the phantom can be minimized by using a FOV that is twice the diameter of the phantom (measured in the PE direction.) If the noise is to be measured in the air, then be sure to NOT make measurements to either side of the phantom in the PE direction.

Scan parameters also significantly affect measured SNR. For most of the testing performed in this document I used a simple Spin Echo with a TR of 300, a TE of 20 and a slice thickness of 3mm and a receiver BW of 15.6 KHz. The FOV was varied depending on the size of the coil and the phantom used. All of the parameters used for each test can be found on each page immediately below the coil description.

Report Layout

Each page of this report lists the data from a single test. The top third of the page describes the coil and phantom information, followed by the scan parameters used. The middle third contains the numbers measured and calculated results. This section will contain one table if the coil being tested is a single channel coil (i.e. quadrature or surface coils) and two tables if it is a multi-channel phased array coil. The entries in the table will be described further below. The bottom section contains a few lines of comments (if necessary), a picture of the coil with the phantom as used for the testing and one or more of the images that were used for the measurements.

There is usually one image for each composite image measurement and one image for each separate channel measurement. Each image shows the ROI (red line) where the mean signal was measured and two smaller ROIs (green lines) where the signal minimum and maximum was found. In the top left corner of each image is the mean signal in the large ROI. The bottom left corner contains the large ROI's area (in mm^2). The top right corner contains two numbers a mean and a standard deviation. If the NEMA method was used, then the top right corner will list the mean and SD of the large ROI (labeled ROI M and ROIsd) applied to the subtraction image. If the noise was measured in the background air the the numbers are labeled Air M and AirSD.

Data Tables

The meaning of most of the entries in the data table are should be self evident with a few exceptions. The first column in each table is labeled "Label". In the composite analysis, this field may be empty or contain some sort of abbreviation to identify some aspect of the testing. Some possibilities are the letter N for NEMA, A for Air, L for Left, R for Right, C for CLEAR, NoC for No CLEAR. In the Uncombined Image table, the label usually contains the channel number or similar descriptor. The column labeled "Noise Type" will be either Air or SubSig which stands for Subtracted Signal, *i.e*. the NEMA method. Both tables contain a column for Mean SNR and Max SNR which are the Mean or Max signal divided by the SD of the noise scaled by either 1.526 (Air) or 0.7071 (NEMA).

Composite Image Table: The final two columns in this table are "Normalized" and "Uniformity". It can be rather difficult to compare the performance of different coils particularly if different scan parameters are used. (Of course, it's even more difficult from one scanner to another.) I have standardized most of my testing to use a spin echo with a TR/TE of 300/20msec and a thickness of 3 mm. The FOV changes to depending on the size of the phantom used although I try to use a FOV that is at least twice the diameter of the phantom as measured in the PE direction. For one reason or another, a change may be made in the scan parameters (either accidentally or intentionally such as turning on No Phase Wrap to eliminate aliasing, etc.). In order to make it easier to compare SNR values I calculate a "Normalized" SNR value. This value is theoretically what the SNR would be if a FOV of 30cm, 256x256 matrix, 1 average, receiver BW of 15.6 KHz and slice thickness of 3mm had been used. Obviously, the final number is affected by the T1/T2 values of the phantoms used as well as details of the coil and magnet field strength but it can be useful in certain situations.

The "Uniformity" value is defined by the ACR as 1 - (max-min)/(max+min). This is most important when looking at volume coils or for evaluating the effectiveness of surface coil intensity correction algorithms (such as PURE, CLEAR or SCIC).

Uncombined Image Table: This table has two columns labeled "% of Mean" and "% of Max". When analyzing multi-channel coils it is important to understand the relationship between the different channels, the inherent symmetry that usually exists between channels. In a 8 channel head or 4 channel torso phased array coil, all of the channels are usually have about the same SNR. These two columns list how the SNR (either Mean or Max) of each channel compares to the SNR of the channel with the maximum value.