Hitachi Site
Yearly Performance Evaluation
Hitachi Airis II
2-Dec-07

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MRI Equipment Evaluation Summary & Signature Page

Site Name: Hitachi Site **MRAP #** 3235

Address: **Survey Date:** 12/2/07

City, State, Zip **Report Date:** 12/10/07

MRI Mfg: Hitachi **Model:** Airis II **Field:** 0.3

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

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

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

*See comments page for description of any failures.

Specific Comments and Recommendations

1. The shim of the magnet is typical to poor for this type of magnet. Definitely worse than Florissant.
2. Positioning Laser is slightly out of calibration. Reproducibility is good.
3. All three body flex coils have SNR values 10-30% lower than Florissant. All other coils are comparable.
4. The display console is adequate, the film printer is very good.
5. The slice thickness look good but slice crosstalk starts when the slice gap drops below 40% of the slice thickness.
6.
7.
8.
9.

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

MRI Equipment Performance Evaluation Data Form

Site Name: Hitachi Site

Contact	Title	Phone	eMail
	Chief Tech		

Equipment Information

MRI Manufacturer: Hitachi Model: Airis II SN: C416 Software: V5.0R-3

Camera Manufacturer: Model: SN: Software:

PACS Manufacturer: Model: SN: Software:

ACR Phantom Number used: 6998

1. Table Positioning Reproducibility: **Pass**

Table motion out/in:	IsoCenter	Out/In	Out/In
Measured Phantom Center	-4.6	-4.5	-5.2

Comment:

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

Last Year CF: **N/A** This Year CF: **12.65546** CF Change: **NA**

GRE TR/TE: 500/10 & 500/18 FOV: 300, BW 10 & 40 KHz

10 mm skip 10 mm, Flip Angle 45°, 256x256, 2nex

	22 cm
Axial plane - Frequency L/R:	**20-22**
Axial plane - Frequency A/P:	**22-26**
Sagittal plane - Frequency H/F:	**14-27**

Comments: This shim is typical to poor.

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	5.48	5	9.6%
SE (Site T1)	500	18	90	1	5.49	5	9.8%
SE (20/80)	2000	20	90	1	5.59	5	11.8%
SE (20/80)	2000	80	90	2	5.02	5	0.4%
FSE(8)	4000	100	90	4	5.08	5	1.6%

Comments:

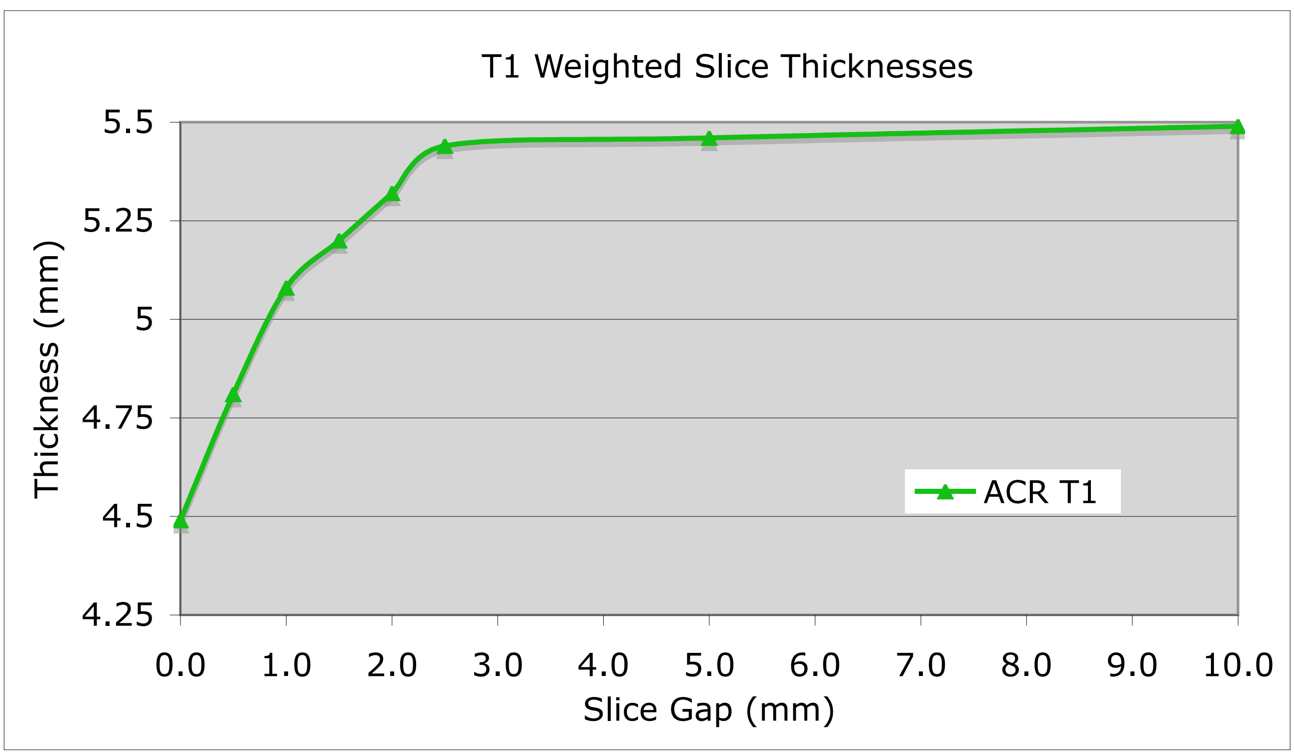
4. Slice Crosstalk (RF interference)

The following data were obtained using the ACR phantom slice thickness wedges to measure the slice profile of a typical 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. Once the slice gap drops below 40% of the slice thickness, the measured slice profile begins to drop. From this data it is clear that slice gaps should be at least 20% of the slice thickness and ideally should be greater than 40%.

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
Site T1	SE	400	18	25	256x256	2	5	11	6

Skip	ACR T1
0.0	4.49
0.5	4.81
1.0	5.08
1.5	5.2
2.0	5.32
2.5	5.44
5.0	5.46
10.0	5.49



5. Soft & Hard Copy Displays

Luminance Meter Make/Model: Tektronix J16 Digital Photometer   Cal Expires: 4/6/07

Monitor Description: LCD display

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	32.4	29.8	27.8	30.8	29.3

Uniformity		
MAX	MIN	Percent Delta
32.4	27.8	15%

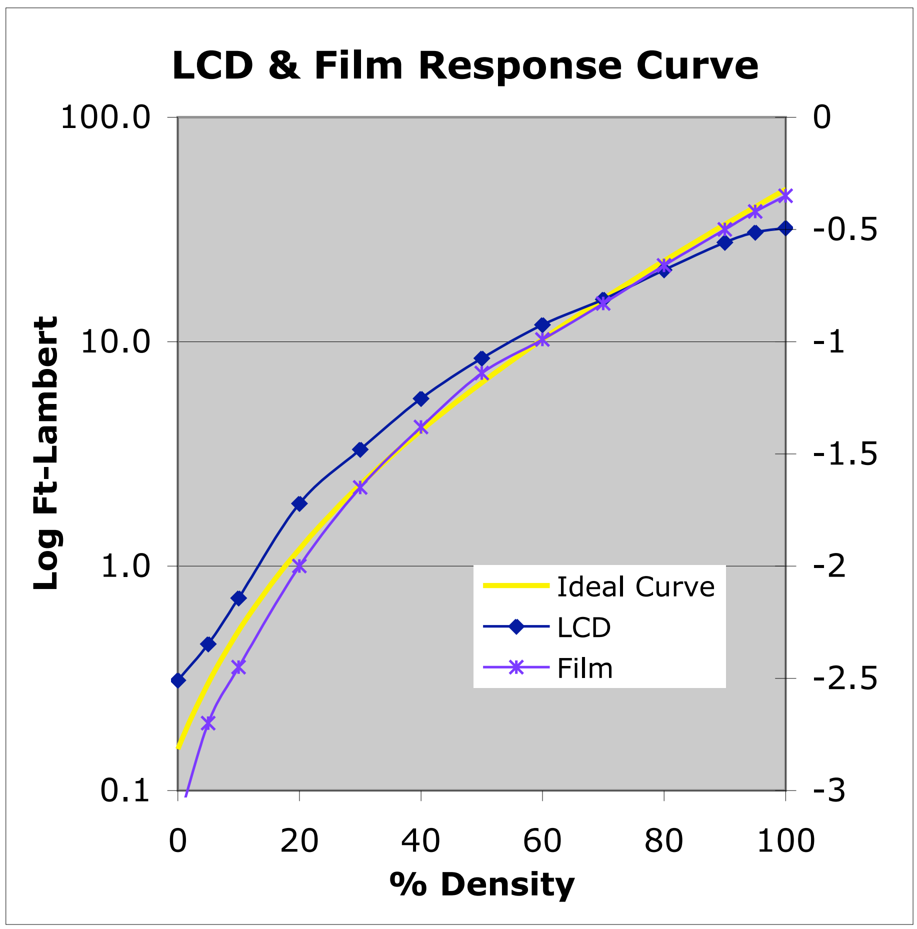
SMPTE
OK?
Y

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

Minimum Brightness must be > 26.24 Ft. Lamberts

The display is adequate, the film printer is very good.

Density	Ft-Lambert	Film Density
0	0.31	-3.15
5	0.45	-2.7
10	0.72	-2.45
20	1.90	-2
30	3.31	-1.65
40	5.58	-1.38
50	8.44	-1.14
60	11.90	-0.99
70	15.5	-0.83
80	20.9	-0.66
90	27.7	-0.5
95	30.7	-0.42
100	32.1	-0.35



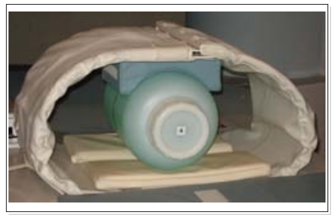
Coil and Other Hardware Inventory List

Site Name Hitachi Site

ACR Magnet # ____ Nickname Airis II

Active	Coil Description	Manufacturer	Model	Rev.	Mfg. Date	SN	Channels
☐	Body Flex Large	Hitachi	MR-QFC-53AN		Aug, 2003	KR19457304	1
☐	Body Flex Medium	Hitachi	MR-QFC-52AN	A	Aug, 2003	KR19456305	1
☐	Body Flex X-Large	Hitachi	MR-QFC-55		Aug, 2003	KR10036301	1
☐	C-Spine Quad	Hitachi	MR-QCS-52	1	Mar, 2004	527	1
☐	CTL Coil	USA Instruments	MR-CTL-51	A	Jun, 2002	435	4
☐	Head	Hitachi	MR-QHC-52		Apr, 2003	KR10031306	1
☐	Knee	Hitachi	MR-QKC-51		Sep, 2003	KR100	1
☐	Latch/Joint	Hitachi	MR-JCL-53		Feb, 2003	KR10039305	1
☐	Neck/Joint	Hitachi	MR-JC-53		Oct, 2003	KR1032303	1
☐	Shoulder	Hitachi	MR-PSC-51		Mar, 2004	527	1
☐	Wrist	Hitachi	MR-QWC-51	1	Sep, 2004	KR1044407	1
☐							

RF Coil Performance Evaluation



Test Date: 12/2/2007

Coil: Body Flex Large

Model: MRQFC 53AN

Mfg.: Hitachi

Revision:

Mfg. Date: 3/3/1998 Coil ID: 1366

SN: KR18951804

Phantom: Hitachi Bottle #4

# of Channels 1

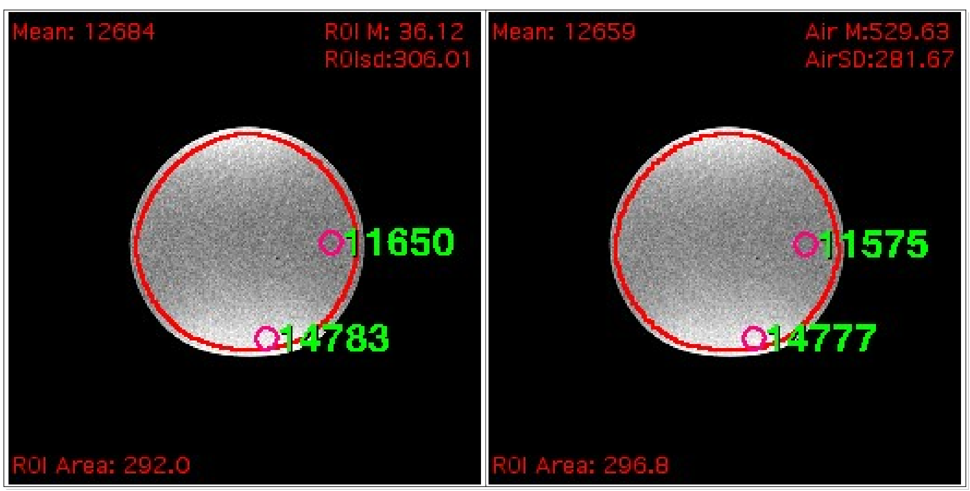
Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	42	256	256	24	1	5	-

Coil Mode: Body Flex L

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	12,684	14,783	11,650	36.1	306.01	NEMA	29.3	11.1	34.2	88.1%
A	12,659	14,777	11,575	529.6	281.67	Air	29.5	11.2	34.4	87.8%

The SNR of this coil is 12.5% lower than Florissant's



Test Images

RF Coil Performance Evaluation

Coil:	Body Flex Medium	Test Date:	12/2/2007
Mfg.:	Hitachi	Model:	MRQFC 52AN
Mfg. Date:	6/14/2001 (Coil ID: 1365)	Revision:	
Phantom:	Hitachi Bottle #4	SN:	KR15159102
		# of Channels	1

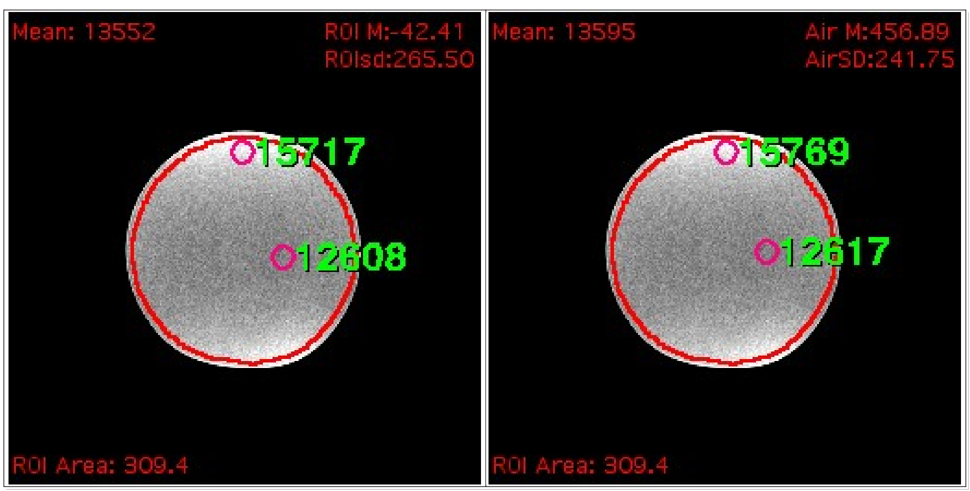
Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	42	256	256	24	1	5	-

Coil Mode: Body Flex M

Analysis of Test Image

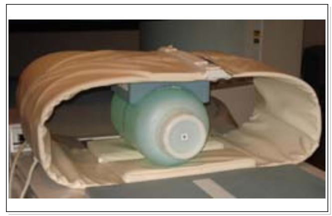
Measured Data							Calculated Results			
Label	Mean	Max	Min	Back ground	Noise SD	Noise Type	Mean SNR	Normal-ized	Max SNR	Uni-formity
N	13,552	15,717	12,608	-42.4	265.50	NEMA	36.1	13.7	41.9	89.0%
A	13,595	15,769	12,617	456.9	241.75	Air	36.9	14.0	42.7	88.9%

The SNR of this coil is 9% lower than Florissant's



Test Images

RF Coil Performance Evaluation



Coil: Body Flex X-Large

Mfg.: Hitachi

Mfg. Date:

Coil ID: 1368

Phantom: Hitachi Bottle #4

Test Date: 12/2/2007

Model: MR-QFC-55

Revision:

SN:

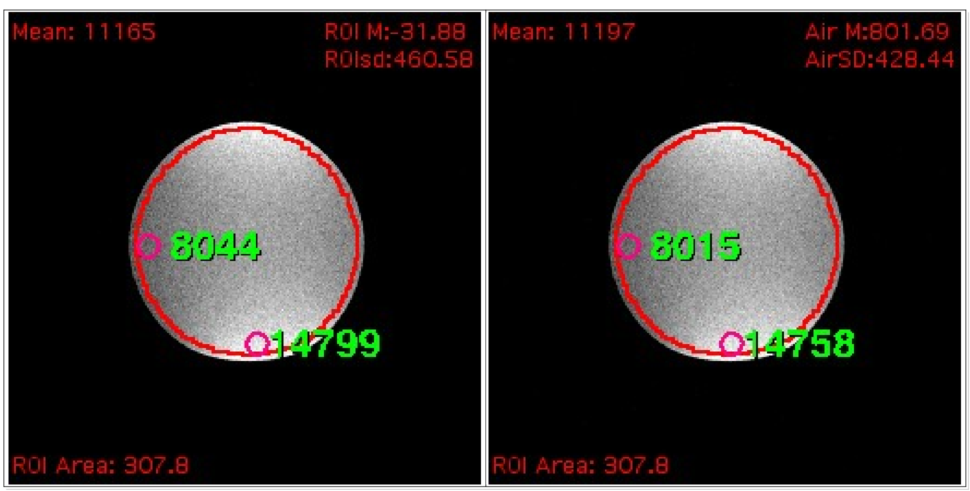
# of Channels 1

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	42	256	256	24	1	5	-

Coil Mode: Body Flex XL

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	11,165	14,799	8,044	-32.0	461.00	NEMA	17.1	6.5	22.7	70.4%
A	11,197	14,758	8,015	802.0	428.00	Air	17.1	6.5	22.6	70.4%



Test Images

RF Coil Performance Evaluation

Coil: C-Spine Quad

Mfg.: Hitachi

Mfg. Date: 6/14/2001 Coil ID: 1364

Phantom: Hitachi Bottle #3

Test Date: 12/2/2007

Model: 52AN

Revision:

SN: 938

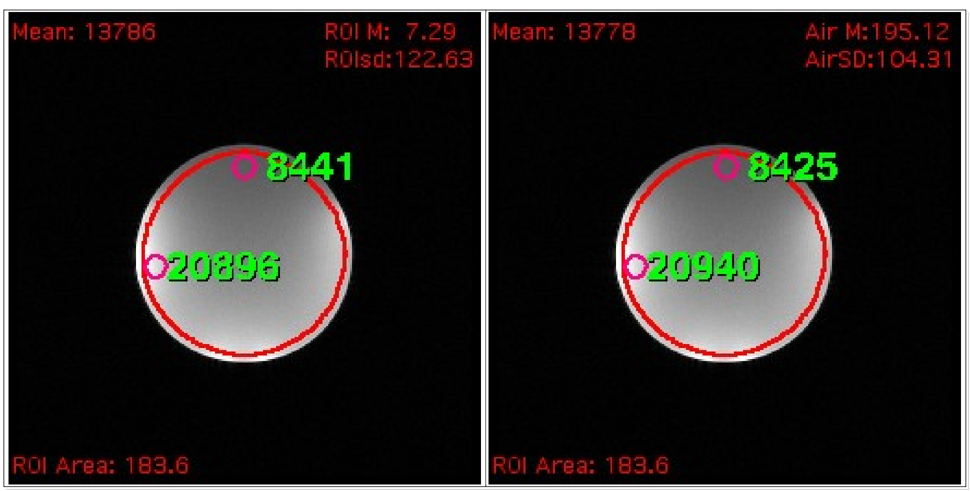
# of Channels 1

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	36	256	256	24	1	5	-

Coil Mode: Quad Cspine

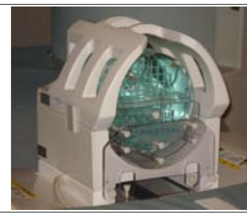
Analysis of Test Image

Measured Data							Calculated Results			
Label	Mean	Max	Min	Back ground	Noise SD	Noise Type	Mean SNR	Normal-ized	Max SNR	Uni-formity
N	13,786	20,896	8,441	7.3	122.63	NEMA	79.5	41.1	120.5	57.5%
A	13,778	20,940	8,425	195.0	104.30	Air	86.6	44.7	131.6	57.4%



Test Images

RF Coil Performance Evaluation



Coil: Head Coil

Mfg.: Hitachi

Mfg. Date:

Coil ID: 1363

Test Date: 12/2/2007

Model:

Revision:

SN:

Phantom: ACR Phantom

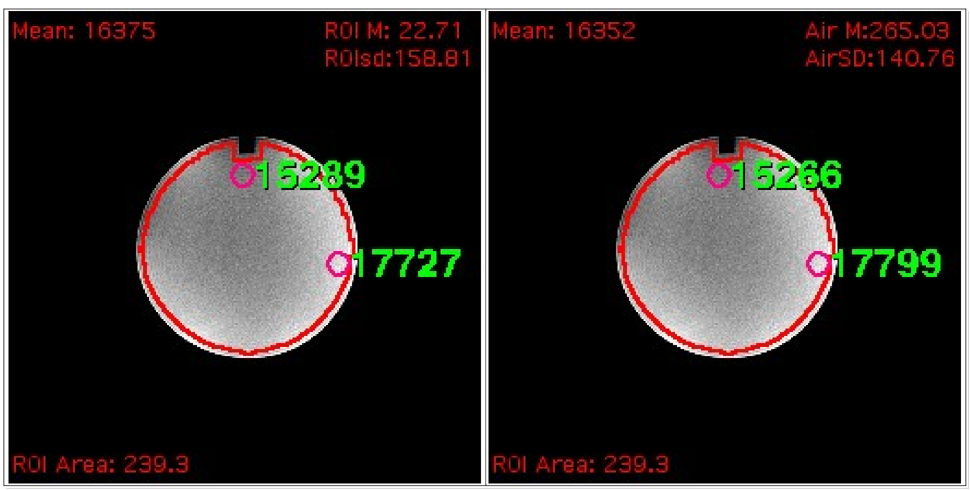
# of Channels 1

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	40	256	256	24	1	5	-

Coil Mode: Head

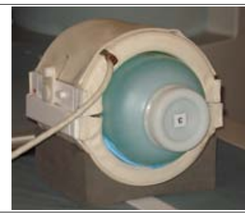
Analysis of Test Image

Measured Data							Calculated Results			
Label	Mean	Max	Min	Back ground	Noise SD	Noise Type	Mean SNR	Normal-ized	Max SNR	Uni-formity
N	16,375	17,727	15,289	22.7	158.81	NEMA	72.9	30.5	78.9	92.6%
A	16,352	17,799	15,266	265.0	140.76	Air	76.1	31.9	82.9	92.3%



Test Images

RF Coil Performance Evaluation



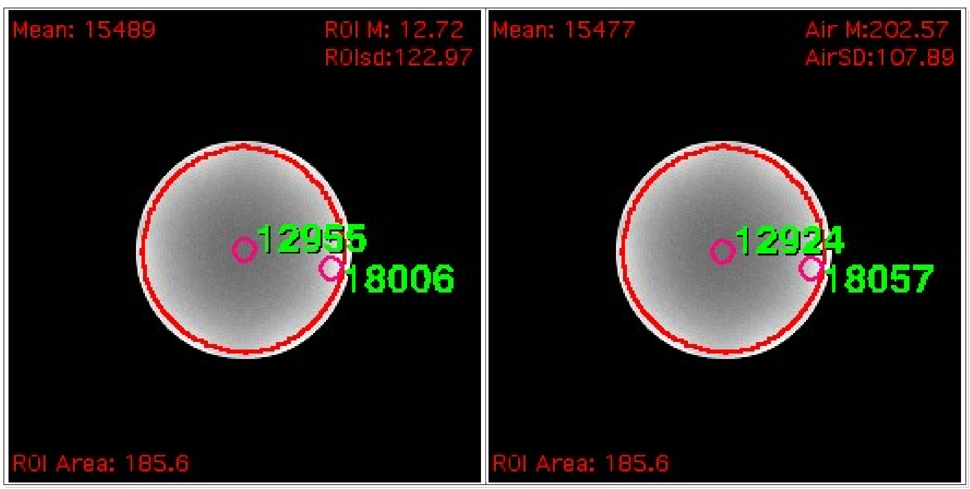
Coil:	Knee	Test Date:	12/2/2007
Mfg.:	Hitachi	Model:	MR-QKE 51
		Revision:	
Mfg. Date:	5/28/2001 Coil ID: 1367	SN:	KR12403962
Phantom:	Hitachi Bottle #3	# of Channels	1

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	36	256	256	24	1	5	-

Coil Mode: Knee

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	15,489	18,006	12,955	12.7	122.97	NEMA	89.1	46.0	103.6	83.7%
A	15,477	18,057	12,924	202.6	107.89	Air	94.0	48.6	109.7	83.4%



Test Images

RF Coil Performance Evaluation

Coil: Latch/Joint(Oval)

Mfg.: Hitachi

Mfg. Date: 6/26/2001   Coil ID: 1370

Phantom: Hitachi Bottle #3

Test Date: 12/2/2007

Model: MR-JCL 52

Revision:

SN: KR15176102

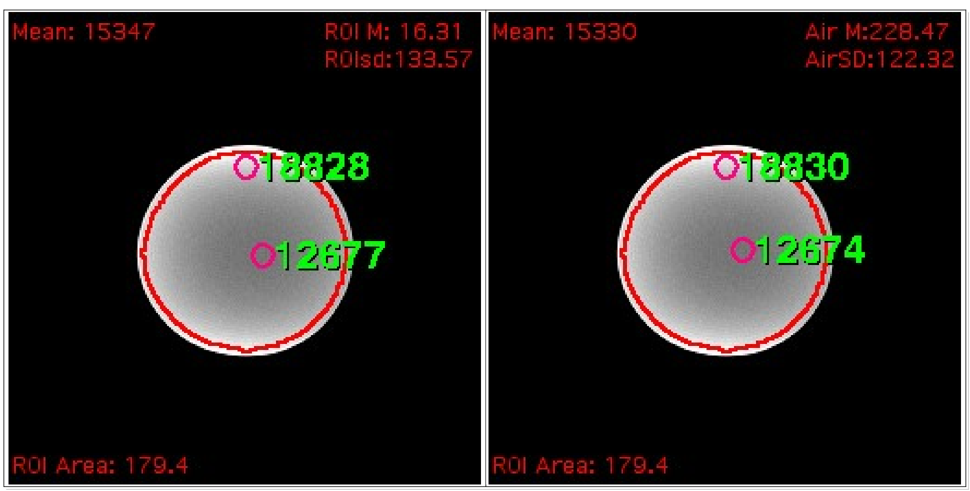
# of Channels 1

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	36	256	256	24	1	5	-

Coil Mode: Latch/Joint

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	15,347	18,828	12,677	16.3	133.57	NEMA	81.3	42.0	99.7	80.5%
A	15,330	18,830	12,674	228.5	122.32	Air	82.1	42.4	100.9	80.5%



Test Images

RF Coil Performance Evaluation

Coil: Neck/Joint (round)

Mfg.: Hitachi

Mfg. Date: 6-21-2001   Coil ID: 1369

Phantom: Hitachi Bottle #3

Test Date: 12/2/2007

Model: MR-JC 53

Revision:

SN: KR15157101

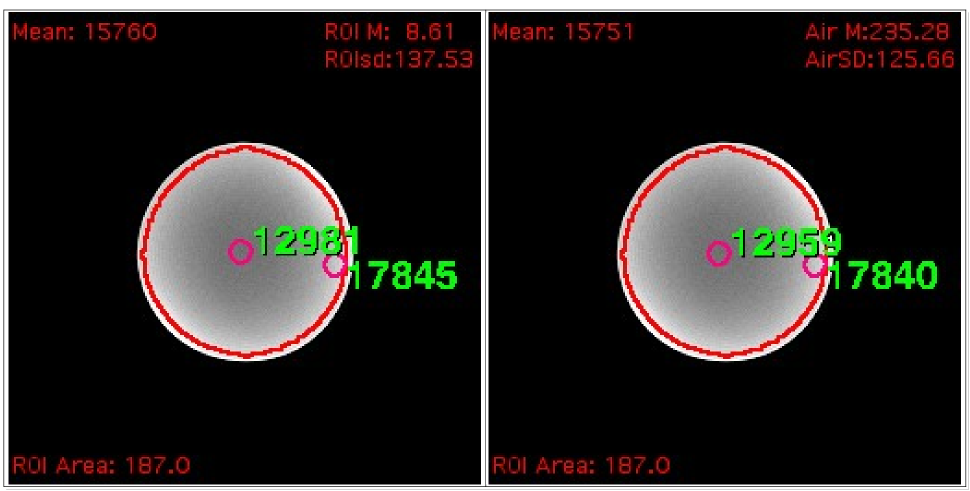
# of Channels 1

Sequence	TR	TE	Plane	FOV	Nx	Ny	BW	NSA	Thickness	Gap
SE	300	20	T	36	256	256	24	1	5	-

Coil Mode: Neck/Joint

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	15,760	17,845	12,981	8.6	137.53	NEMA	81.0	41.9	91.8	84.2%
A	15,751	17,840	12,959	235.3	125.66	Air	82.1	42.5	93.0	84.2%



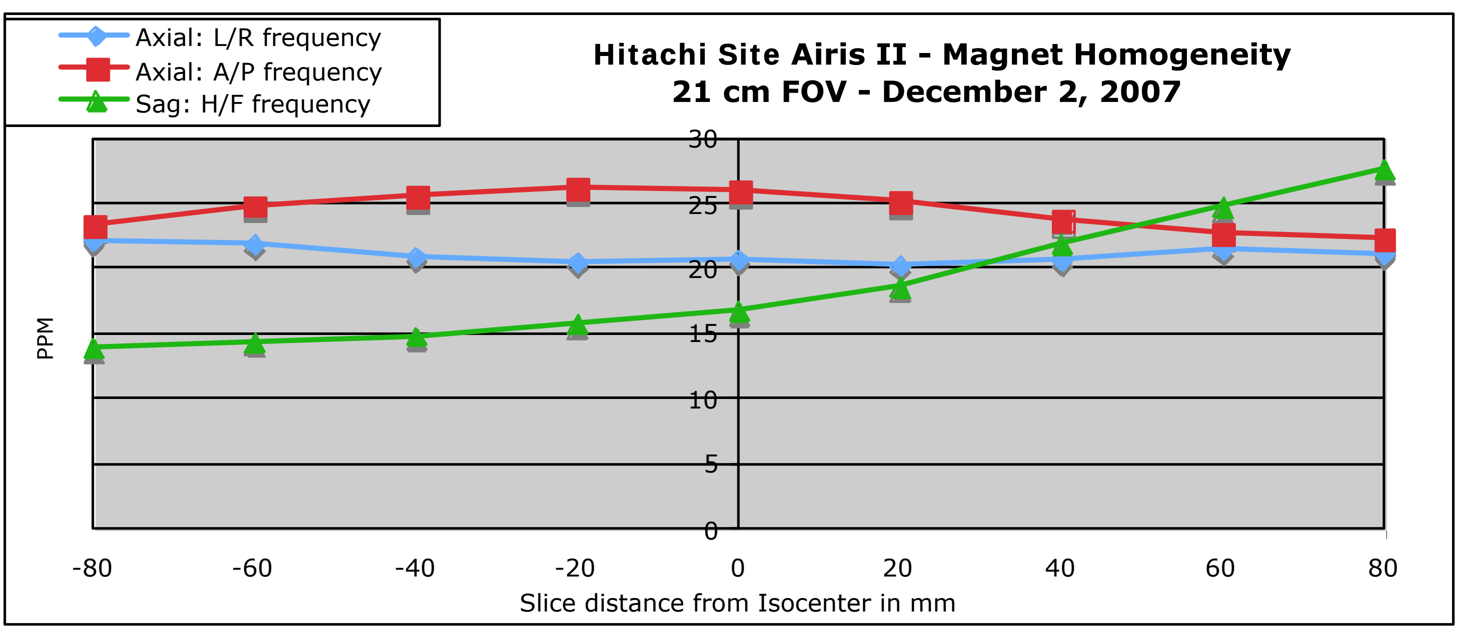
Test Images

Appendix A:
Estimating Homogeneity by Measuring Geometric Distortion

The preferred method of measuring magnet homogeneity is to use gradient echo imaging sequence to obtain phase images also known as phase maps. Ideally, if a magnet is absolutely perfectly uniform then all of the protons will be perfectly in-phase with each other at the echo time. Any variations in the magnetic field will cause variations in the resonance frequencies across the field of view (FOV) which, in turn, will cause variations in the signal phase that are directly proportional to the variations in the magnet homogeneity. In order to obtain these phase map images, it is necessary to be able to reconstruct phase images instead of the usual magnitude images. Unfortunately, Hitachi does not provide that option on their scanners except to the service engineers and I was unable to obtain the assistance of the site engineer to make this measurement.

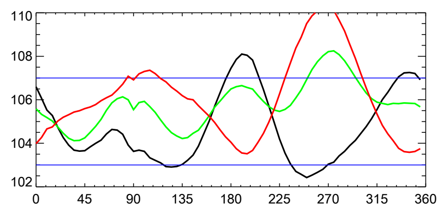
Fortunately, there is an alternative, although not a good one. When acquiring images, one encodes the spatial location of signal by applying a readout gradient of known strength, for example 1000 Hz/cm. When the images are reconstructed, the signal is analyzed for the strength of the signal at different frequencies and they are then mapped to the different pixels in the image. The assumption is that the ONLY thing that affects the signal frequency is the imaging or readout gradient. If there are inhomogeneities in the magnetic field, this will cause spatially varying frequencies unrelated to the readout gradient which will, in turn, cause errors in mapping the signal to different pixels which will be visible as geometric distortion. By imaging a phantom using two different receiver bandwidths (BW) is is possible to estimate the variations in the magnetic field at the edges of the phantom by measuring the differences in the distortion of the two sets of images.

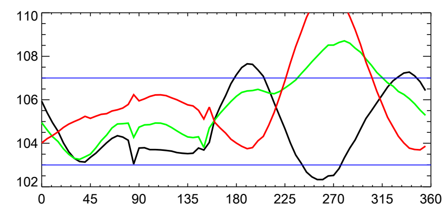
The following pages depict the results of imaging the largest Hitachi bottle phantom (#4) which has an approximate diameter just over 21 cm, using a 39 Hz/pixel and a 156 Hz/pixel gradient. This was done in the axial plane with the readout gradient in both the L/R and A/P directions and in the sagittal plane with H/F readout gradient. Nine slices were acquired with each set using a 10 mm thick slice with a 10 mm gap. The phantom edges were detected and a set of radial lines were drawn with radial lengths measured as a function of rotational angle. The difference in radial diameters for the two sets of gradients were calculated and then converted to differences in frequencies (in Hz.) These values were then divided by the magnets operating frequency, 12.7MHz to provide a value in Parts per Million (PPM). Below is a graph of the measured PPM for the three different gradient directions. Although I have very little experience with these type of results on a low field magnet, I believe these data are somewhere between typical and poor. The values in the graph below are about 50-75% higher than Florissant

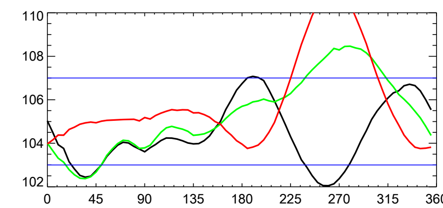


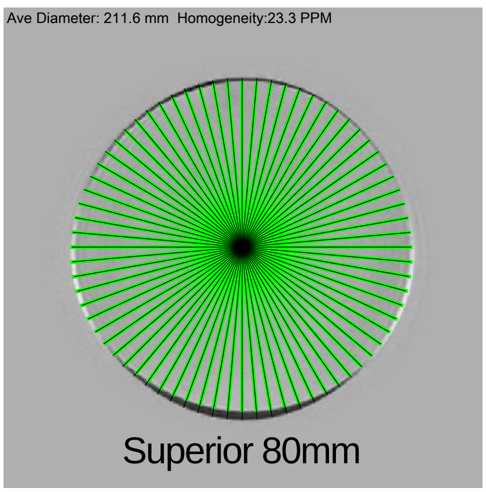
Appendix A:
Estimating Homogeneity by Measuring Geometric Distortion
Axial Plane - Frequency Direction: Anterior to Posterior
Measured December 2, 2007

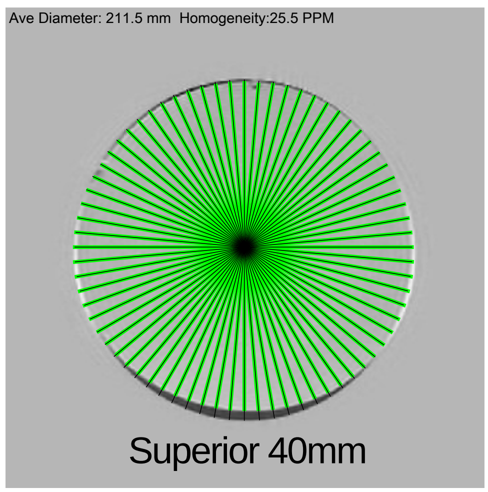
The green lines are radii acquired with 156 Hz/pixel (least distortion)
The black lines are radii acquired with 39 Hz/pixel (most distortion)
The red plots are the differences in the radii.
The images are the subtraction of the images using the two BW values

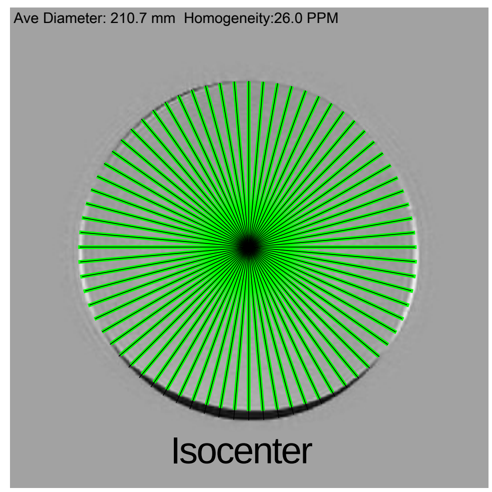


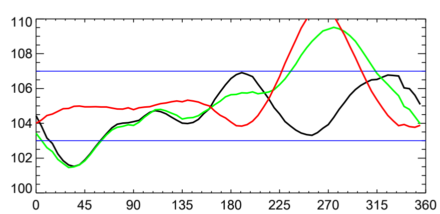


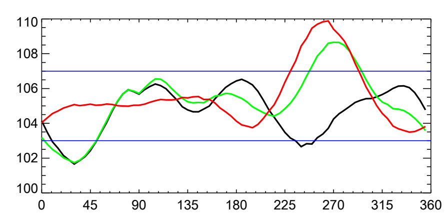


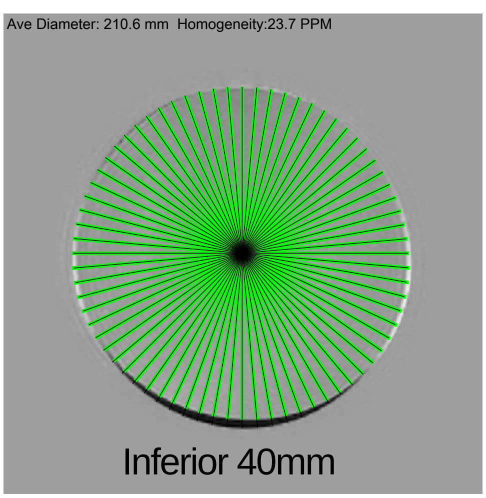


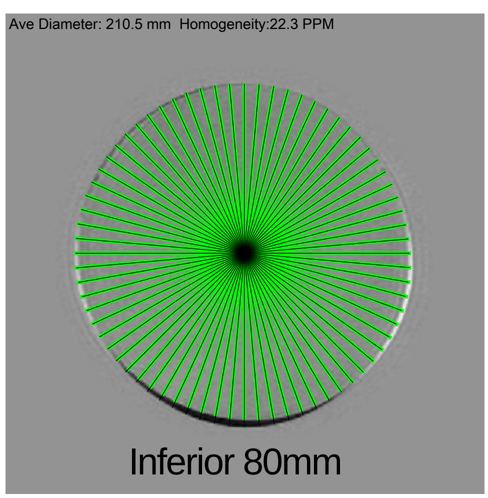






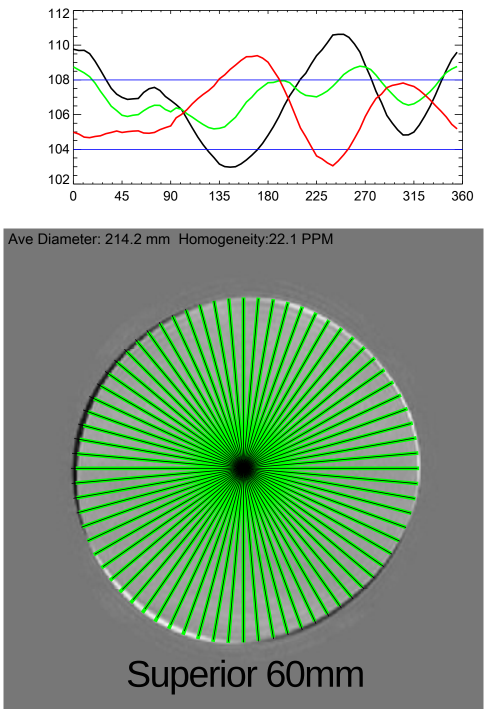


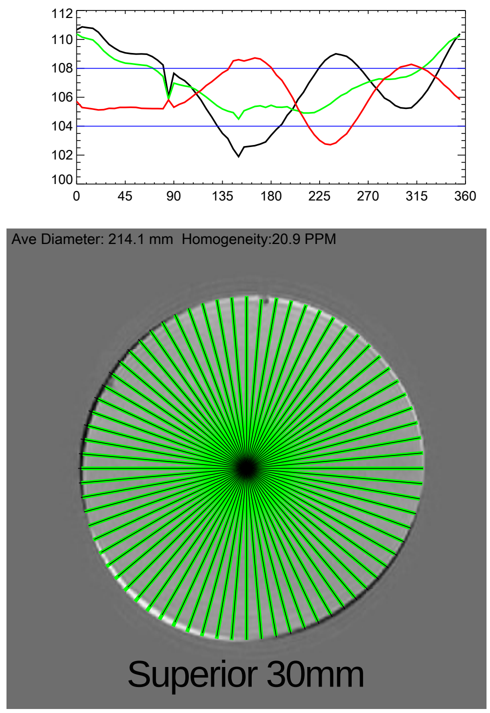


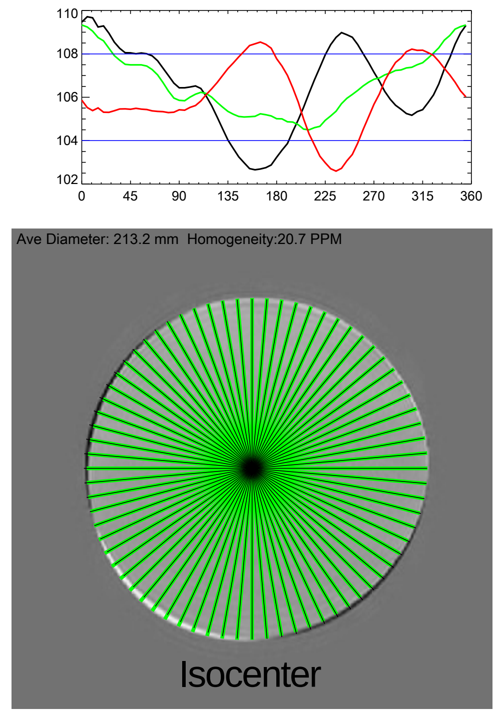


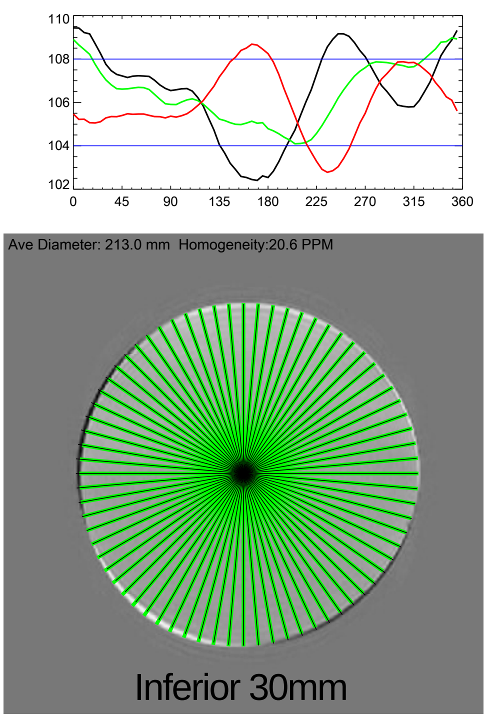
Appendix A:
Estimating Homogeneity by Measuring Geometric Distortion
Axial Plane - Frequency Direction: Left to Right
Measured December 2, 2007

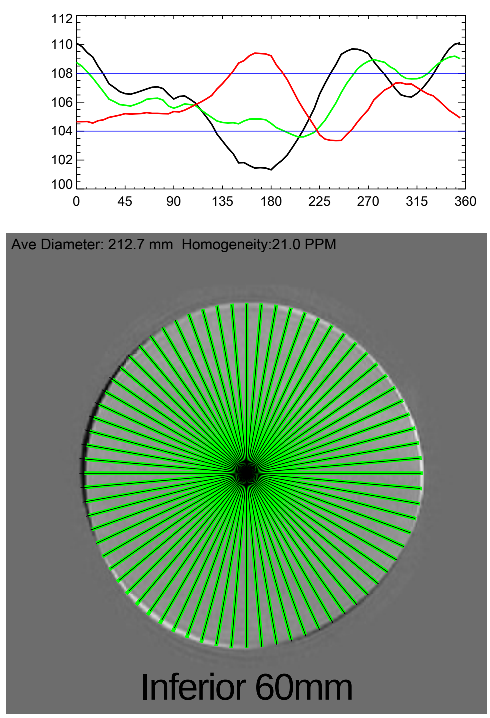
The green lines are radii acquired with 156 Hz/pixel (least distortion)
The black lines are radii acquired with 39 Hz/pixel (most distortion)
The red plots are the differences in the radii.
The images are the subtraction of the images using the two BW values





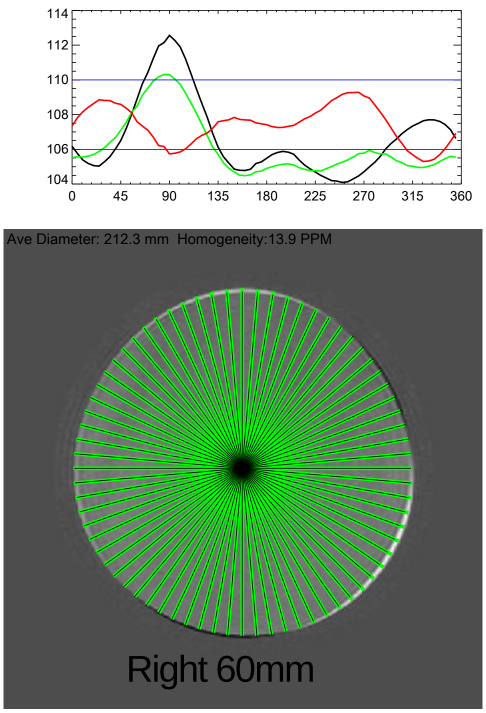


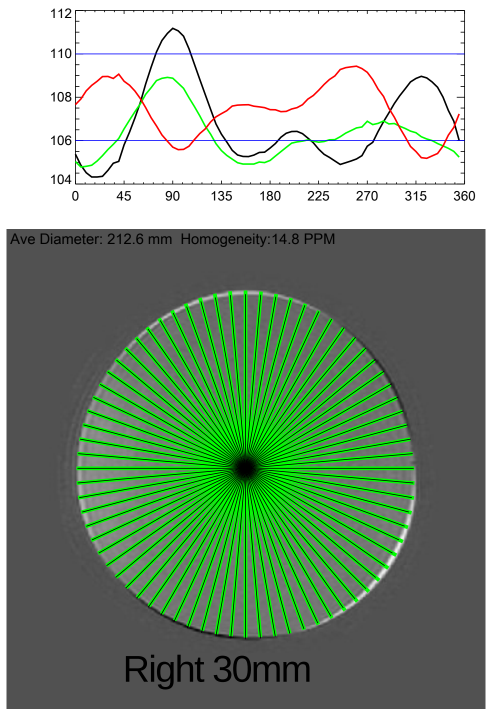


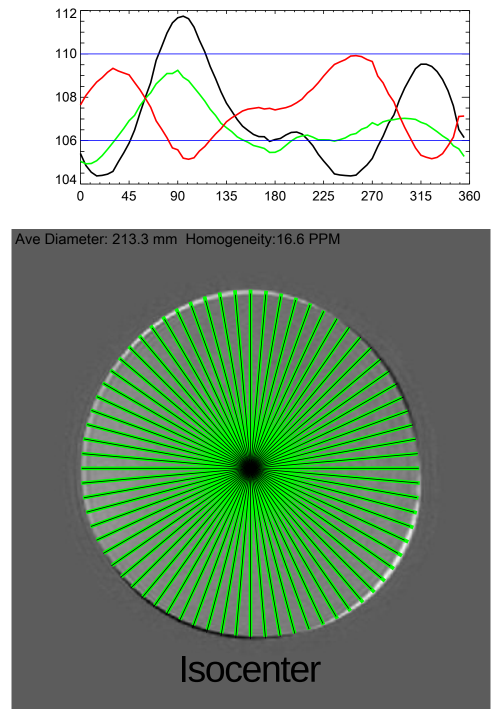


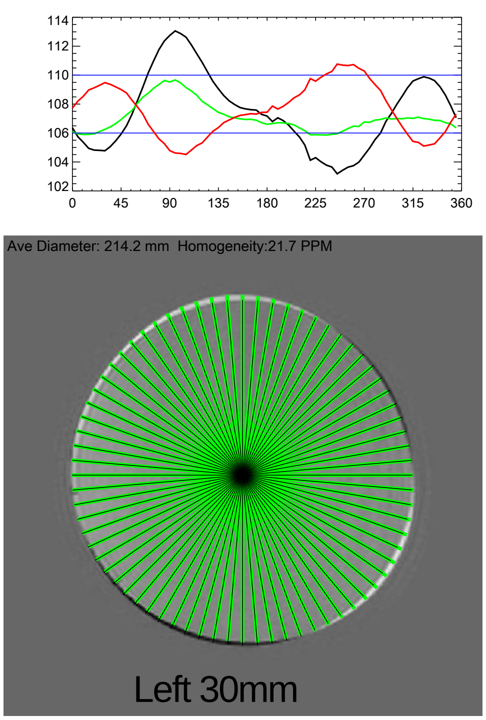
Appendix A:
Estimating Homogeneity by Measuring Geometric Distortion
Sagittal Plane - Frequency Direction: Head to Foot
Measured December 2, 2007

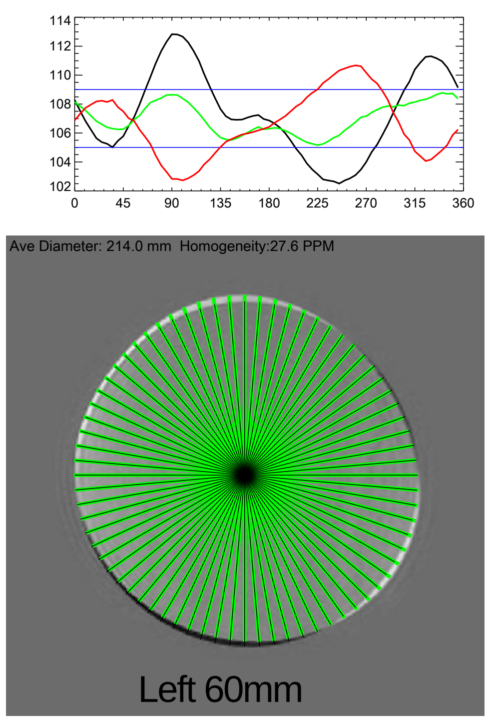
The green lines are radii acquired with 156 Hz/pixel (least distortion)
The black lines are radii acquired with 39 Hz/pixel (most distortion)
The red plots are the differences in the radii.
The images are the subtraction of the images using the two BW values





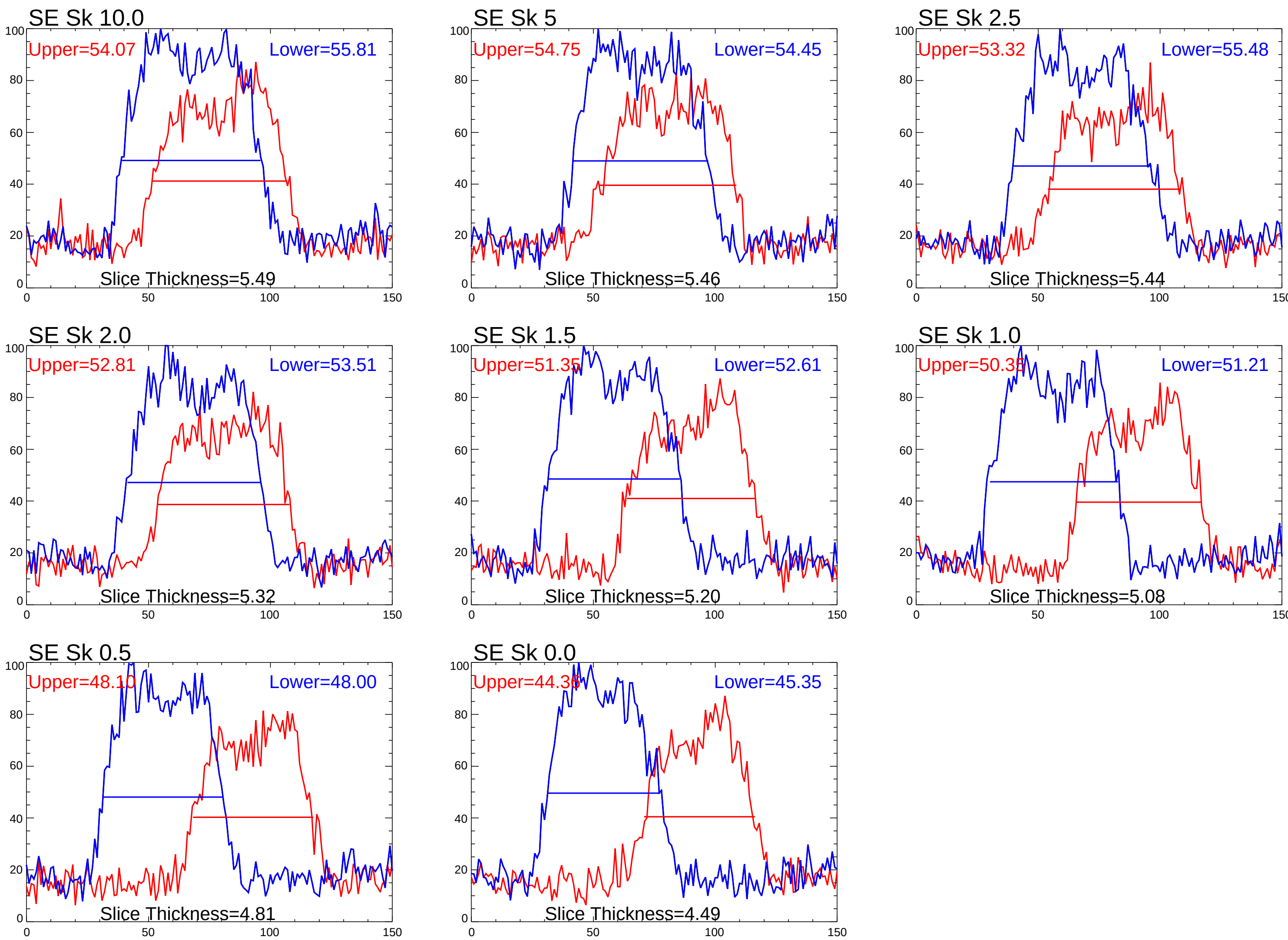


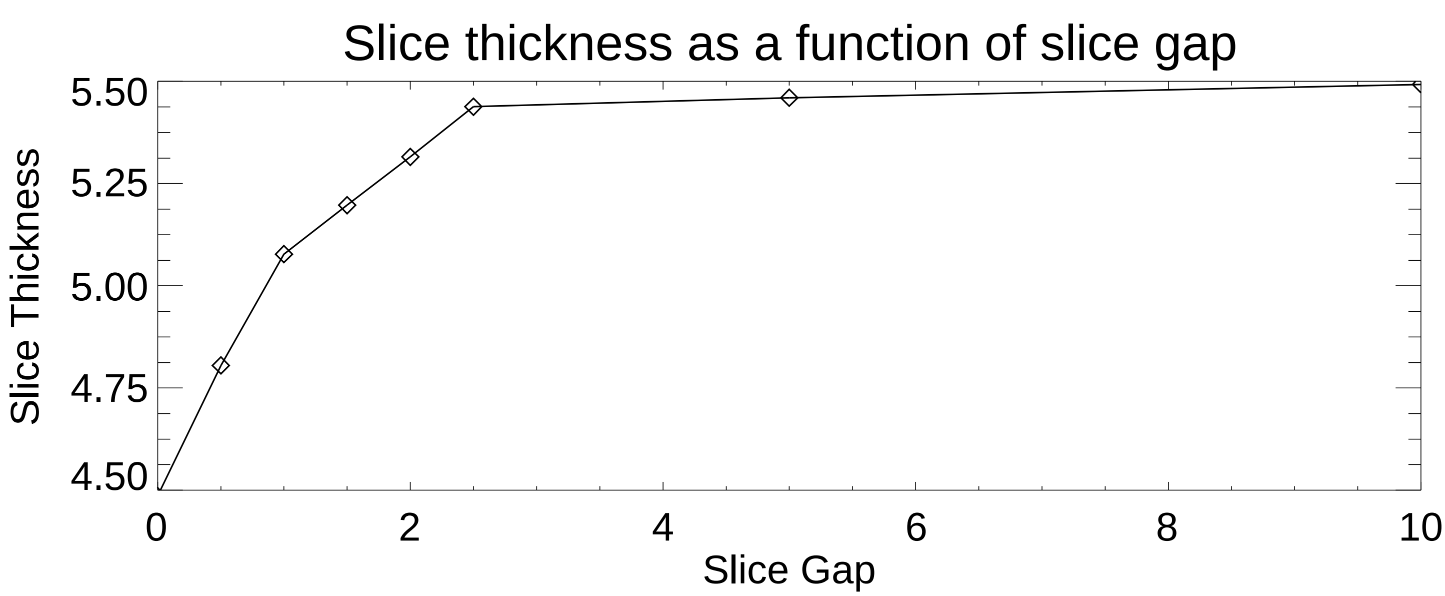




Appendix B: RF Slice Profiles and Crosstalk

Spin Echo : ACR T1
TR/TE = 400/18
BW = 20 KHz
nex = 2
Scan time: 3:25





Hitachi Site **Airis II**

Coil Used: **Head Coil** Test Date: 12/2/2007

	Sagittal Locator	
1	Length of phantom, end to end (mn 148± 2)	145.8

(yellow) = 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	0.9	0.9	0.9	1.0	1.0
3	(1.10, 1.00, 0.90 mm)	1.0	1.0	0.9	1.0	1.0
4	Slice Thickness Top	56.3	57.2	49.9	55.3	50.1
5	(fwhm in mm) Bottom	53.4	54.6	50.5	54.5	51.5
6	Calculated value 5.0±0.7	5.48	5.59	5.02	5.49	5.08
7	Wedge (mm) = + = -	-1.1	-3.4	-3.7	-1.2	-1.7
8	Diameter (mm) (190±2) ⦶	191.2	190.6	191.8	190.6	190.2
9	⊖	189.1	189.2	189.0	189.1	189.3
	Slice Location #5					
10	Diameter (mm) (190±2) ⦶	191.5	190.7	192.7	190.6	190.2
11	⊖	189.0	189.1	188.8	189.0	189.0
12	⊘	189.2	189.1	190.2	189.0	188.9
13	⃠	188.1	187.8	188.2	189.0	187.5
	Slice Location #7					
14	Signal Big ROI	11167	11929	6840	22766	21642
15	(mean only) High	12398	13051	7829	24804	24227
16	Low	10112	10826	6026	20868	17978
17	Uniformity (>87.5%)	89.8%	90.7%	87.0%	91.4%	85.2%
18	Background Noise Top	296.2 ±161.8	338.2 ±179.13	217.7 ± 117.1	479.2 ± 258.5	591.1 ±292.78
19	Bottom	312.6 ±165.6	340.4 ±181.35	231.9 ±125.38	487.6 ±264.88	591.1 ±308.19
20	(mean ±std dev) Left	314.2 ±167.7	347 ±183.85	264.8 ±135.98	527.4 ±287.47	789.9 ±424.56
21	Right	313.5 ±166.4	404.1 ±203.54	271.4 ±135.52	528.2 ±273.90	912.1 ±429.41
22	Ghosting Ratio (<2.5%)	0.1%	0.3%	0.6%	0.2%	1.2%
23	SNR (no spec)	68	66	56	87	72
	Low Con Detectability					
24	Slice Location #8 1.4%	0	0	0	1	0
25	Slice Location #9 2.5%	2	0	0	2	1
26	Slice Location #10 3.6%	5	2	1	7	3
27	Slice Location #11 5.1%	6	7	8	8	8
28	Total # of Spokes (>=9)	13	9	9	18	12
	Slice Location #11					
29	Wedge (mm) = + = -	-1.5	-3.2	-3.2	-1.3	-1.9
30	Slice Position Error	-0.4	0.1	0.4	-0.1	-0.2

Hitachi Site — Airis II

Sequence parameters

Test Date: 12/2/2007

Coil Used: **Head Coil**

Test ID 228

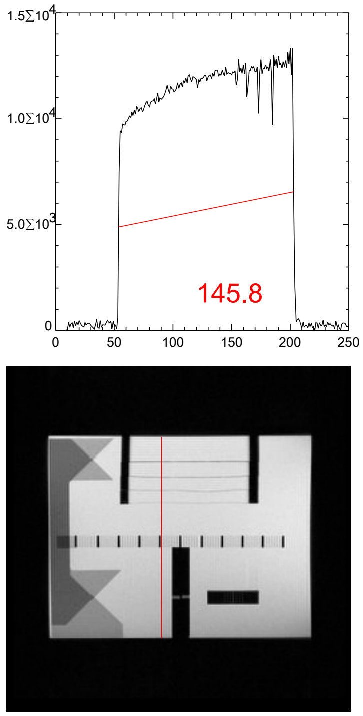
Study Description	Pulse Sequence (ETL)	TR (ms)	TE (ms)	FOV (cm)	Phase Sample Ratio	Number of Slices	Thickness (mm)	Slice Gap	NSA (Nex)	Freq Matrix	Phase Matrix	Band Width (kHz)	Scan Time (min:sec)
ACR T1	SE	500	20	25	1	11	5	5	1	256	256	16	2:09
ACR PD	Dual Echo SE	2000	20	25	1	11	5	5	1	256	256	18	8:32
ACR T2	Dual Echo SE	2000	80	25	1	11	5	5	1	256	256	8	8:32
Site T1	SE	500	18	25	1	11	5	5	2	256	256	20	3:44
Site T2	FSE(8)	4000	100	25	1	11	5	5	4	256	256	22.7	7:28

Magnet ID: 180 **Coil ID:** 1363 **TestID:** 228

Appendix C: ACR Phantom Analysis

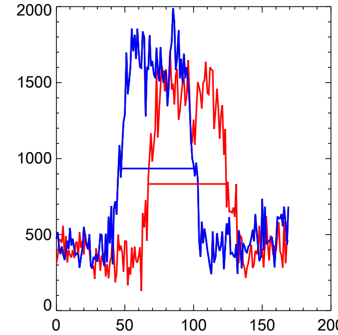
ACR T1

Sagital Length



High Contrast Resolution

Slice Thickness

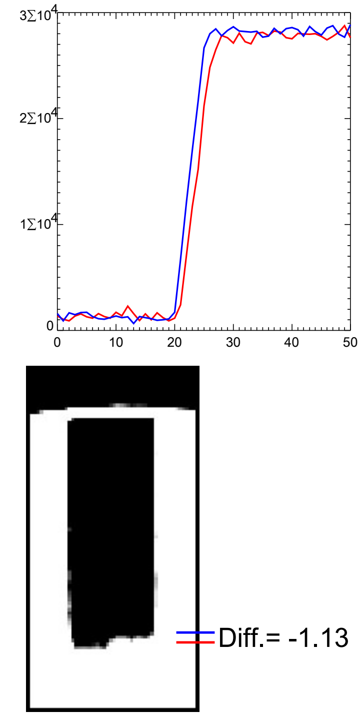


Upper=56.34

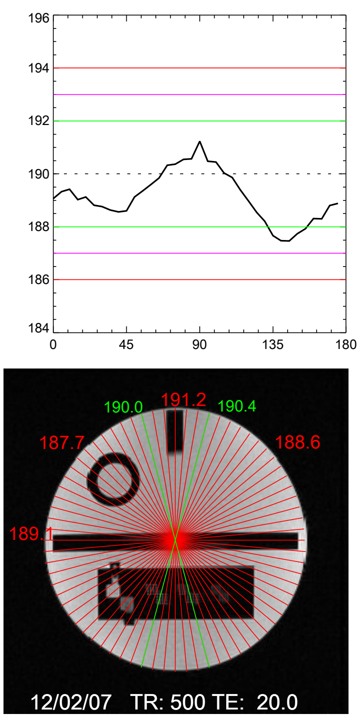
Lower=53.42

Slice Thickness=5.48

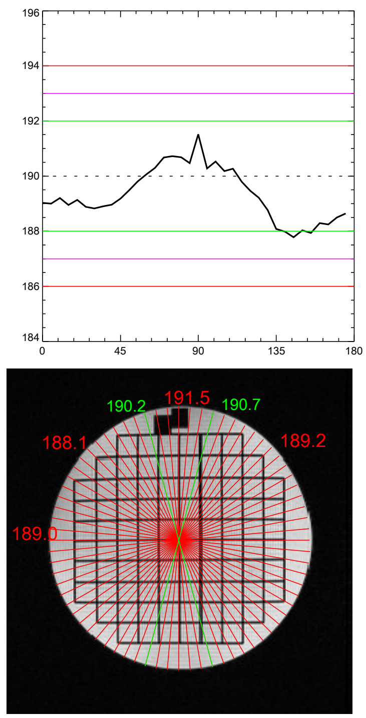
Slice Position - Inferior



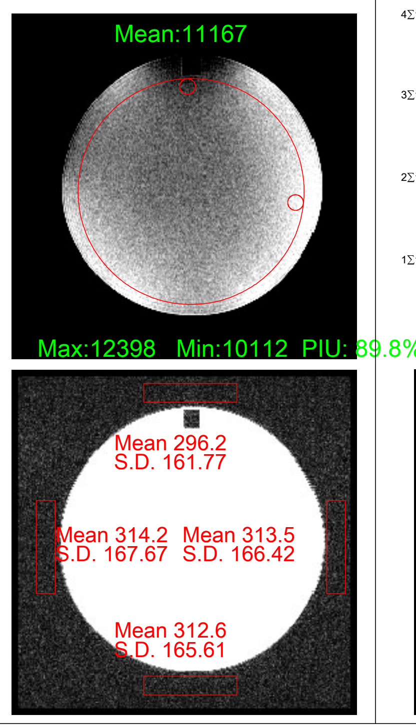
Axial Diameters - #1



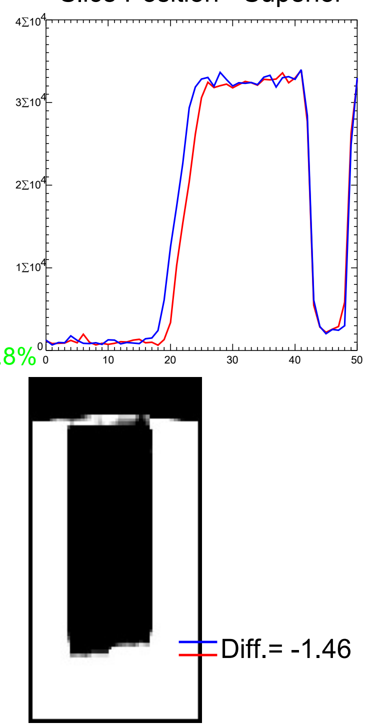
Axial Diameters - #5



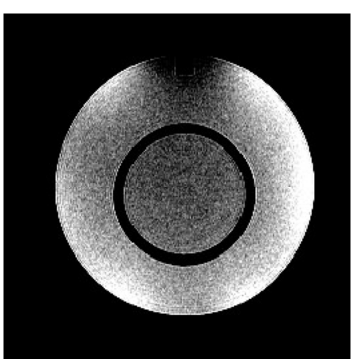
Uniformity & Ghosting - #7



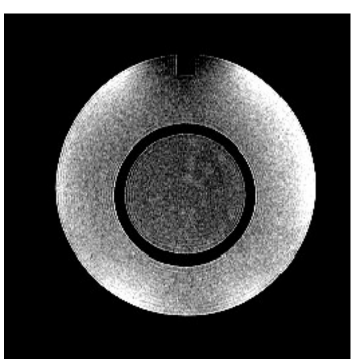
Slice Position - Superior



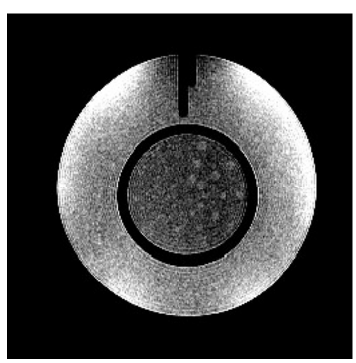
Low Contrast - #8



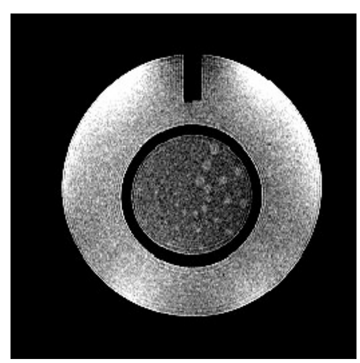
Low Contrast - #9



Low Contrast - #10



Low Contrast - #11

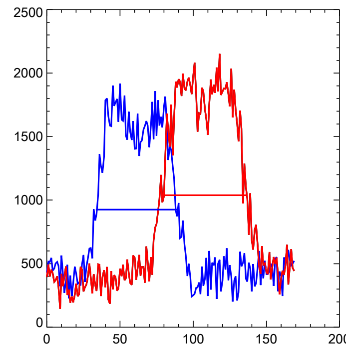


Appendix C: ACR Phantom Analysis

ACR PD

High Contrast Resolution

Slice Thickness

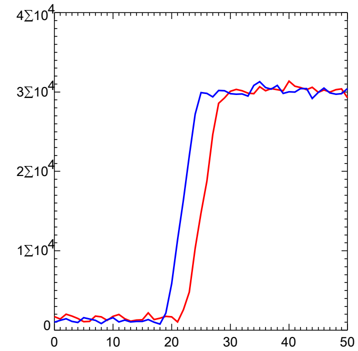


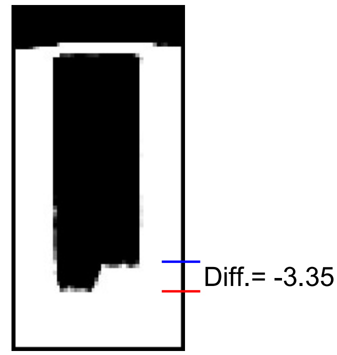
Upper=57.17

Lower=54.62

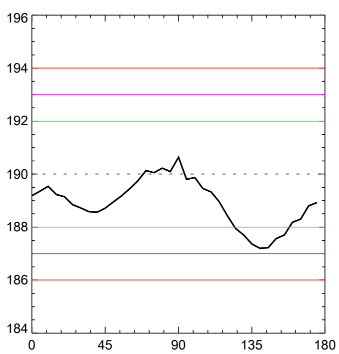
Slice Thickness=5.59

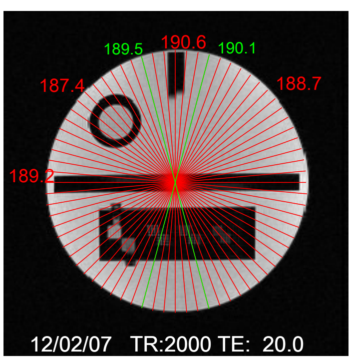
Slice Position - Inferior



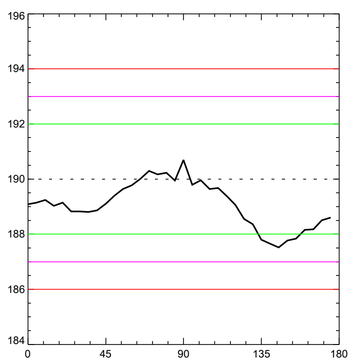


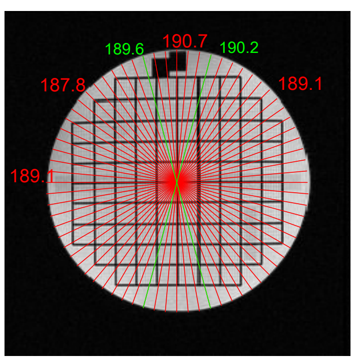
Axial Diameters - #1



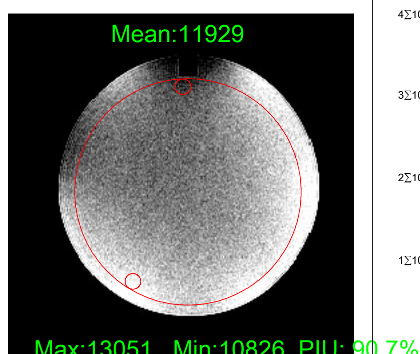


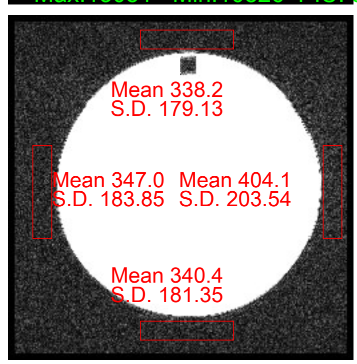
Axial Diameters - #5



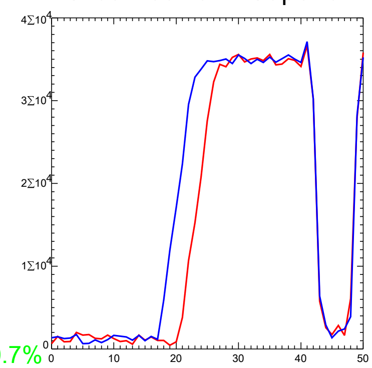


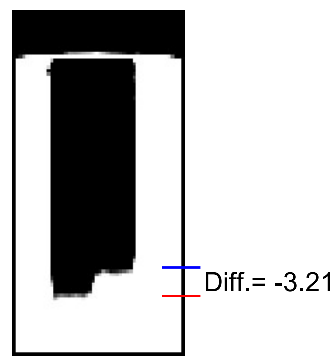
Uniformity & Ghosting - #7



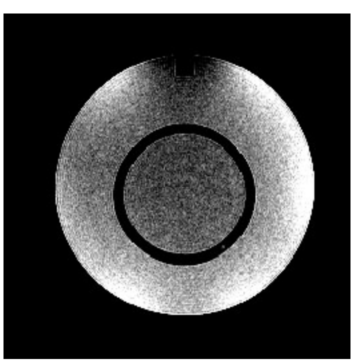


Slice Position - Superior

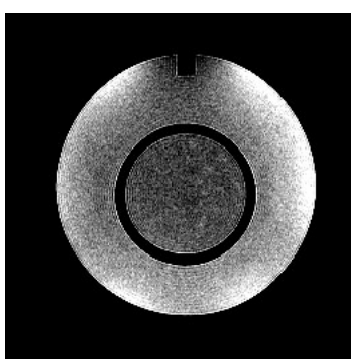




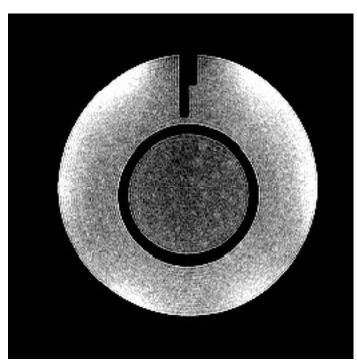
Low Contrast - #8



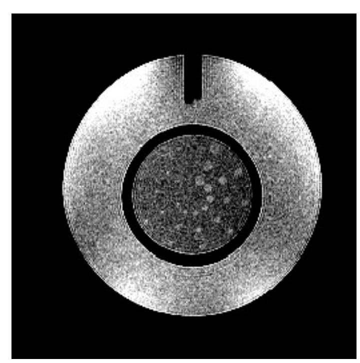
Low Contrast - #9



Low Contrast - #10



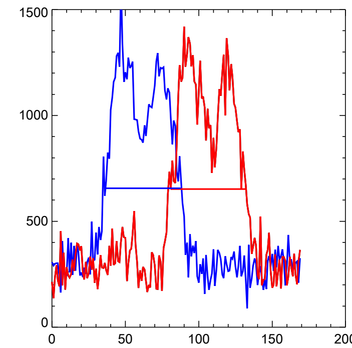
Low Contrast - #11



Appendix C: ACR Phantom Analysis

High Contrast Resolution

Slice Thickness

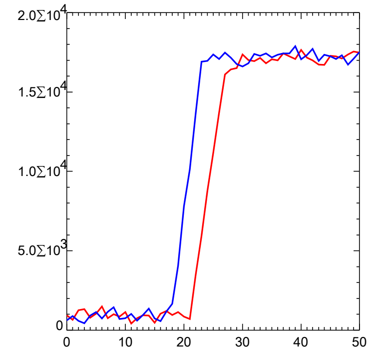


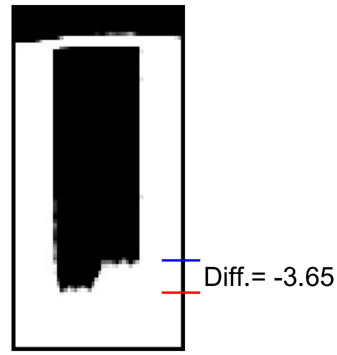
Upper=49.91

Lower=50.46

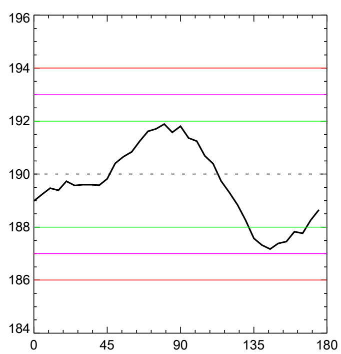
Slice Thickness=5.02

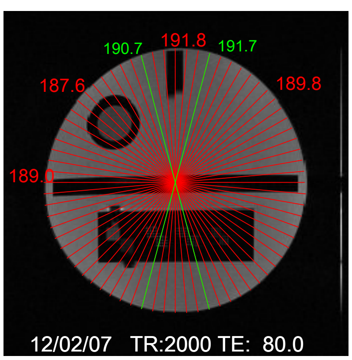
Slice Position - Inferior



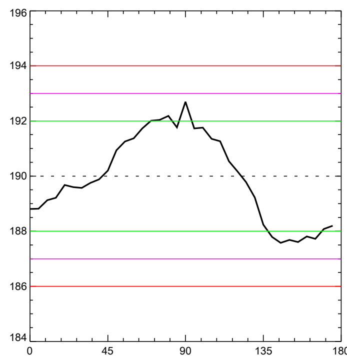


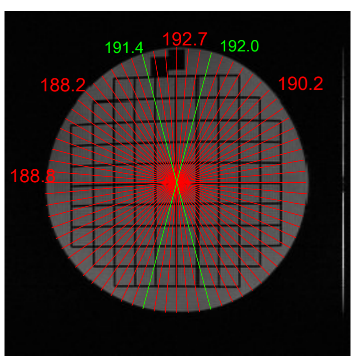
Axial Diameters - #1



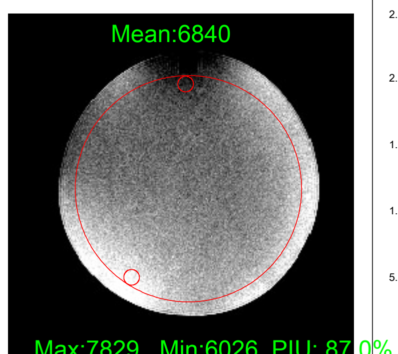


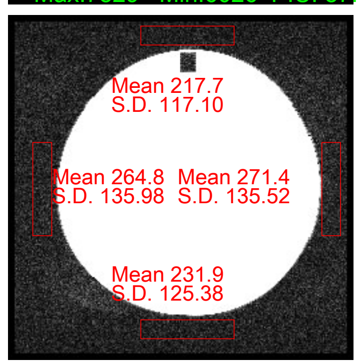
Axial Diameters - #5



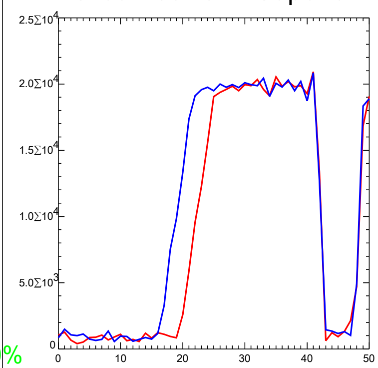


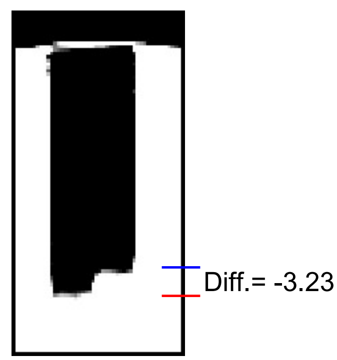
Uniformity & Ghosting - #7



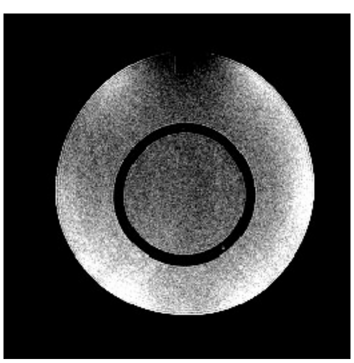


Slice Position - Superior

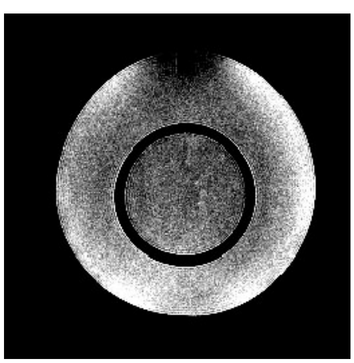




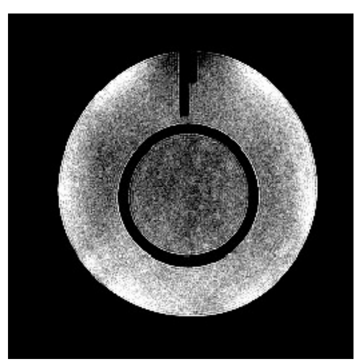
Low Contrast - #8



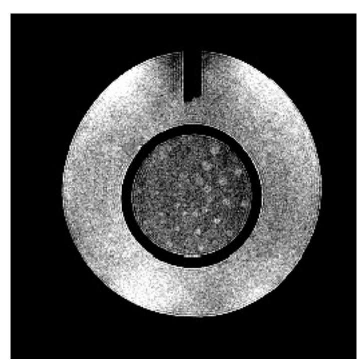
Low Contrast - #9



Low Contrast - #10



Low Contrast - #11

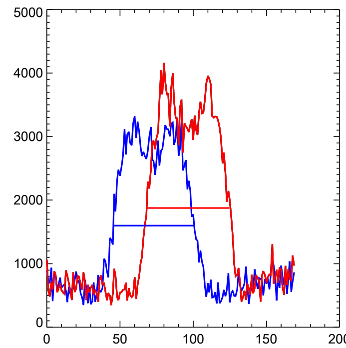


Appendix C: ACR Phantom Analysis

Site T1

High Contrast Resolution

Slice Thickness

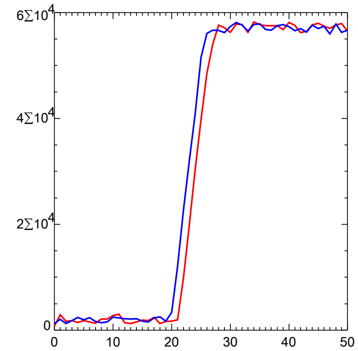


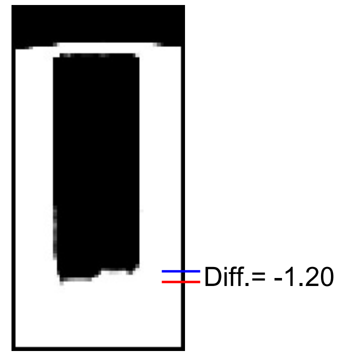
Upper=55.26

Lower=54.48

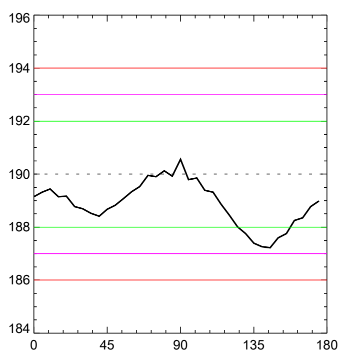
Slice Thickness=5.49

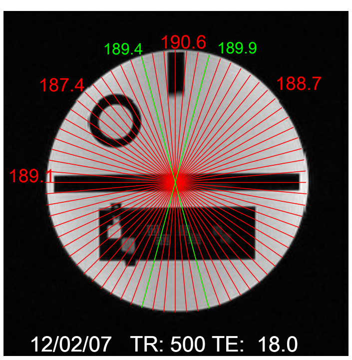
Slice Position - Inferior



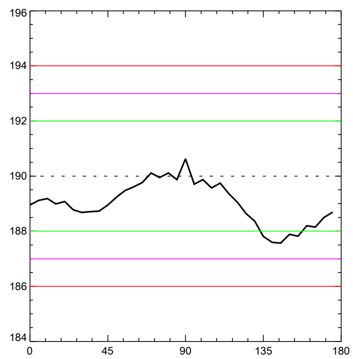


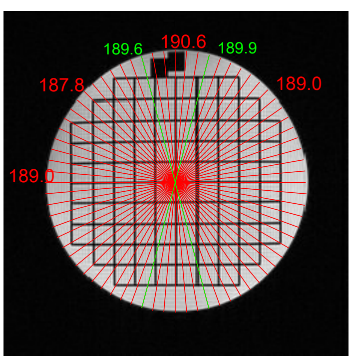
Axial Diameters - #1



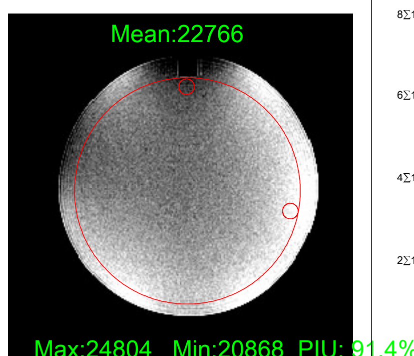


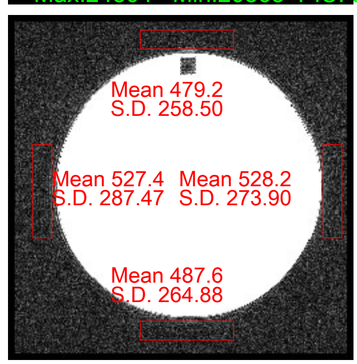
Axial Diameters - #5



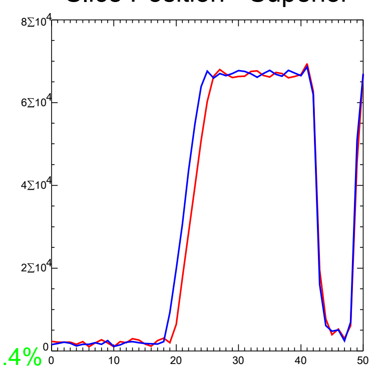


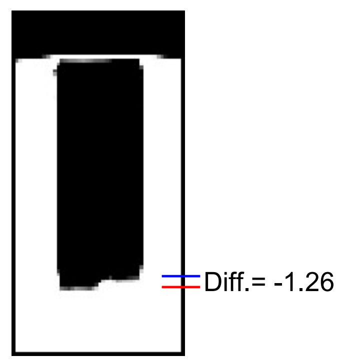
Uniformity & Ghosting - #7



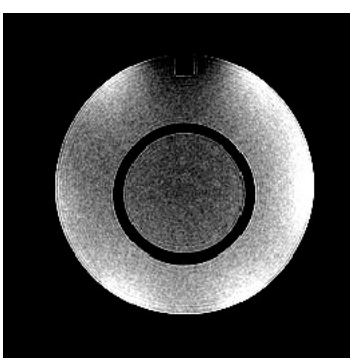


Slice Position - Superior

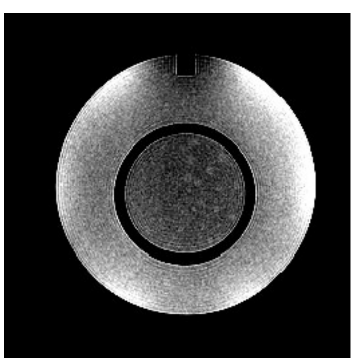




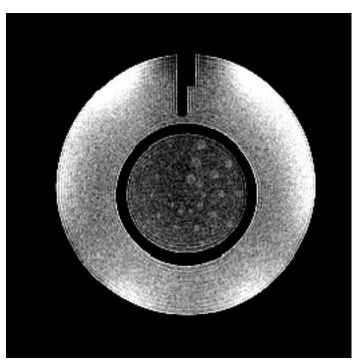
Low Contrast - #8



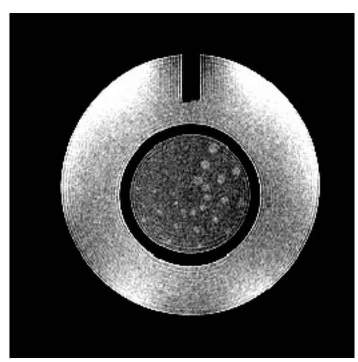
Low Contrast - #9



Low Contrast - #10



Low Contrast - #11

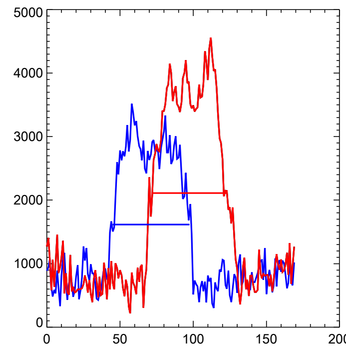


Appendix C: ACR Phantom Analysis

Site T2

High Contrast Resolution

Slice Thickness

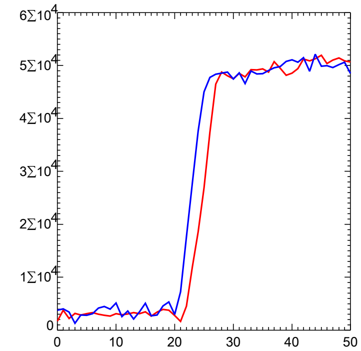


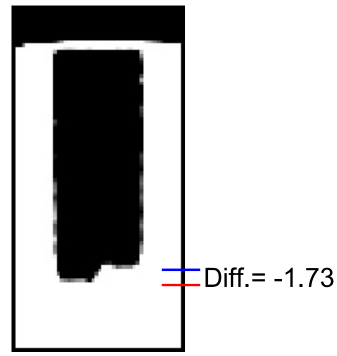
Upper=50.11

Lower=51.49

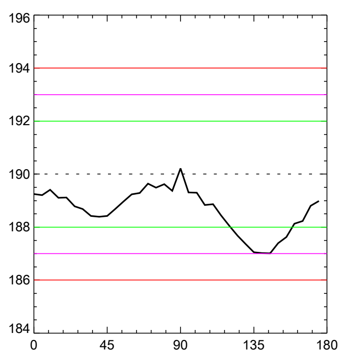
Slice Thickness=5.08

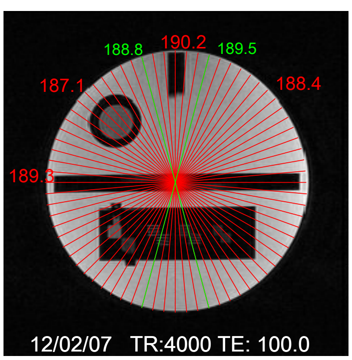
Slice Position - Inferior



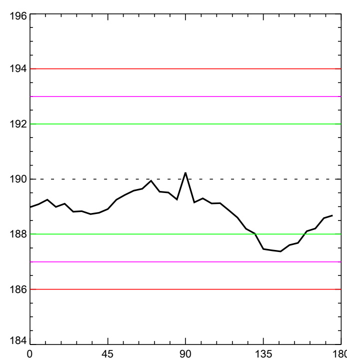


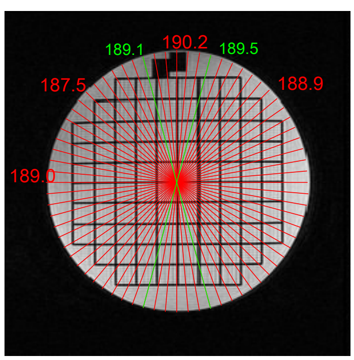
Axial Diameters - #1



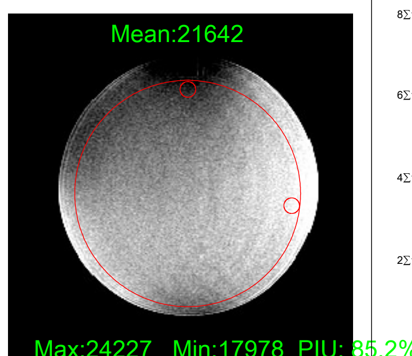


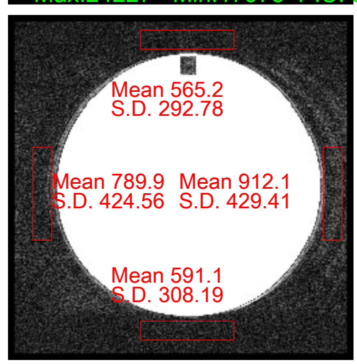
Axial Diameters - #5



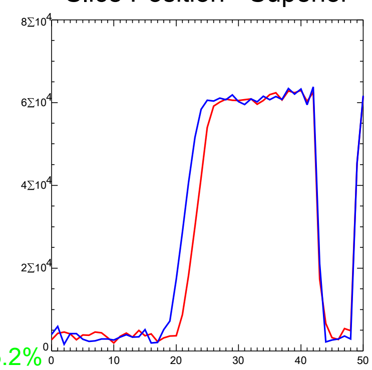


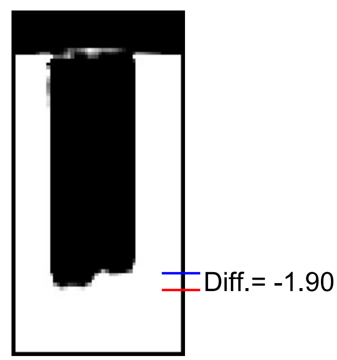
Uniformity & Ghosting - #7



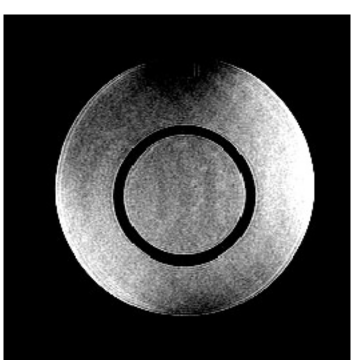


Slice Position - Superior

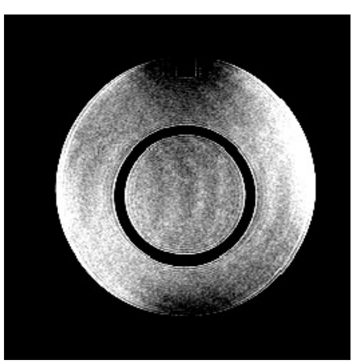




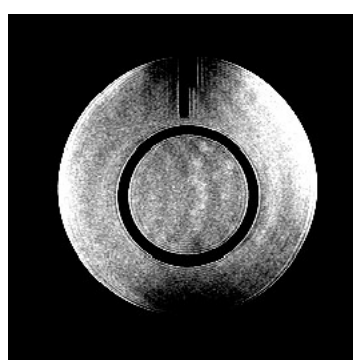
Low Contrast - #8



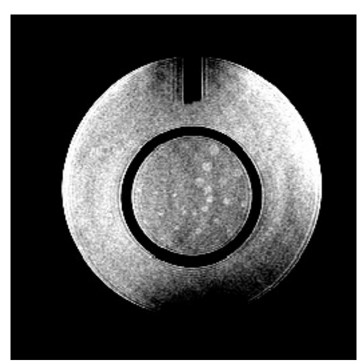
Low Contrast - #9



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.