# Picker Site
# Yearly Performance Evaluation
# Picker Outlook .23
# 23-Jul-08

## Table of Contents

## MRI Equipment Evaluation Summary & Signature Page

**Site Name:** Picker Site **MRAP #** 6040-01

**Address:** **Survey Date:** 7/23/07

**City, State, Zip** **Report Date:** 8/1/07

**MRI Mfg:** Picker **Model:** Outlook **Field:** 0.23

**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. Overall.. The system looks better than last year, probably because of the improvement in the RF transmit coil.
2. The SNR of the Extermity coil is up 39%. The coil with serial number ending in 87 is roughly 9% higher than the coil ending in 44.
3. The ACR phantom SNR is up by 9%.
4. TheSNR of the mult-purpose medium is up by 50% and the uniformity is up by 12%
5. I tested two neck coils, one with serial number ending in 69 and the other ending in 70. The #69 is the one I tested last year. This coil's SNR dropped by 9% (measured in the axial plane.) It also had 18% lower SNR than #70. Because the SNR is very dependent on slice positioning in the axial plane I also tested it in the sagittal plane. In the sagittal plane, coil #70 has 13% higher SNR than #69.
6. The gradients calibration is fair. The Sagittal (H/F) direction is right on. The L/R should be increased by 0.8% and the A/P should be decreased by 0.8%
7. I was able to obtain phase map images for the first time during this trip. Unfotunately, the two sequences used to obtain different echo times also have different bandwidths which causes errors due to geometric distortion. Also… different BW sequences can have slightly different sampling patterns which can cause linear phase ramps in the imges The initial pass in the processing shows a substantial linear ramp in the A/P direction. If I remove this ramp via processing, the overall magnet homgeneity looks fine. Next year, if the sphere is available, I can do a more thorough job of evaluating homogeneity. Based upon the ACR phantom images, I judge the homogeneity is adequate.

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:** Picker Site

| Contact | Title | Phone | Fax | eMail |
|---|---|---|---|---|
| | | | | |
| | | | | |

**Equipment Information**

MRI Manufacturer: Picker Model: Outlook SN: 2094 Software: G4.5

Camera Manufacturer: Imation Dryview Model: SN: Software:

ACR Phantom Number used: J6789

**1. Table Positioning Reproducibility:** **Pass**

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

Comment: The H/F laser is out of calibration by roughtly 4.5 mm. Because all of the table motion is done manually, I did not test reproducibility.

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

Last Year CF: **9,800,000** This Year CF: **9,800,000** CF Change: **0**

| | 10 cm | 15 cm | 18 cm |
|---|---|---|---|
| Axial: | **9.8** | **14.7** | **17.9** |
| Coronal: | **2.23** | **3.24** | **4.25** |
| Sagittal: | **4.62** | **7.53** | **9.48** |

| | 10 cm | 15 cm | 18 cm |
|---|---|---|---|
| Axial: | **1.1** | **2.59** | **4.07** |
| Coronal: | **0.83** | **1.48** | **2.22** |
| Sagittal: | **1.17** | **2.82** | **4.1** |

**GRE TR: 600, TE: 10, 12 & 15 Flip Angle: 45, FOV: 30**

**5 mm skip 5 mm, BW: 16.64KHz, 256x128, 2nex**

Comments: I was able to obtain phase map images for the first time during this trip. Unfotunately, the two sequences used to obtain different echo times also have different bandwidths which causes errors due to geometric distortion. Also… different BW sequences can have slightly different sampling patterns which can cause linear phase ramps in the imges. The initial pass in the processing shows a substantial linear ramp in the A/P direction. If I remove this ramp via processing, the overall magnet homgeneity looks fine. Next year, if the sphere is available, I can do a more thorough check.

**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 | 4.98 | 5 | -0.4% |
| SE (Site T1) | 450 | 20 | 90 | 1 | 4.85 | 5 | -3.0% |
| SE (20/80) | 2000 | 20 | 90 | 1 | 5.52 | 5 | 10.4% |
| SE (20/80) | 2000 | 80 | 90 | 1 | 4.86 | 5 | -2.8% |
| SE (20/80) | 2000 | 22 | 90 | 1 | 5.62 | 5 | 12.4% |
| SE (20/80) | 2000 | 100 | 90 | 1 | 5.87 | 5 | 17.4% |
| FSE(8) | 3000 | 90 | 90 | 4 | 4.87 | 5 | -2.6% |

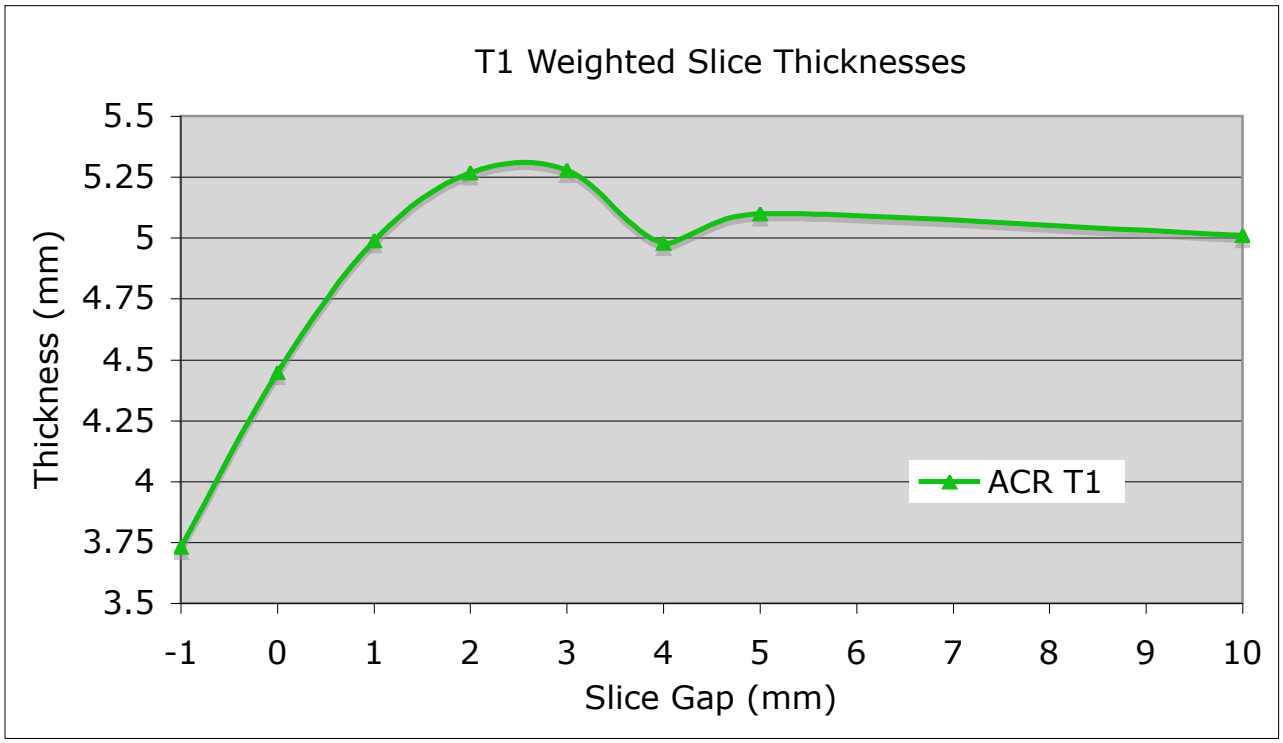
Comments:

## 4. Slice Crosstalk (RF interference)

The following data were obtained using the ACR phantom slice thickness wedges to measure the slice profile of a common SE sequence when the slice gap varies from 200% down to -20% (overlapping). 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 below shows an unexpected rise in slice thickness between 2 and 4 mm slice gap but below 2 mm (40%) the measured slice profile begins to drop. --- All of the slice profiles can be seen in Appendix C

| Sequence Type | TR | TE | FOV ($cm^2$) | Matrix | NSA | Thickness | # of slices | Slice Measured |
|---|---|---|---|---|---|---|---|---|
| SE | 375 | 20 | 25 | 256x256 | 2 | 5 | 9 | 5 |

| Skip | ACR T1 |
|---|---|
| -1 | 3.73 |
| 0 | 4.45 |
| 1 | 4.99 |
| 2 | 5.27 |
| 3 | 5.28 |
| 4 | 4.98 |
| 5 | 5.1 |
| 10 | 5.01 |



## 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 | | | | | |
| | | | | | |

| Uniformity | | |
|---|---|---|
| MAX | MIN | Percent Delta |
| | | |
| | | |

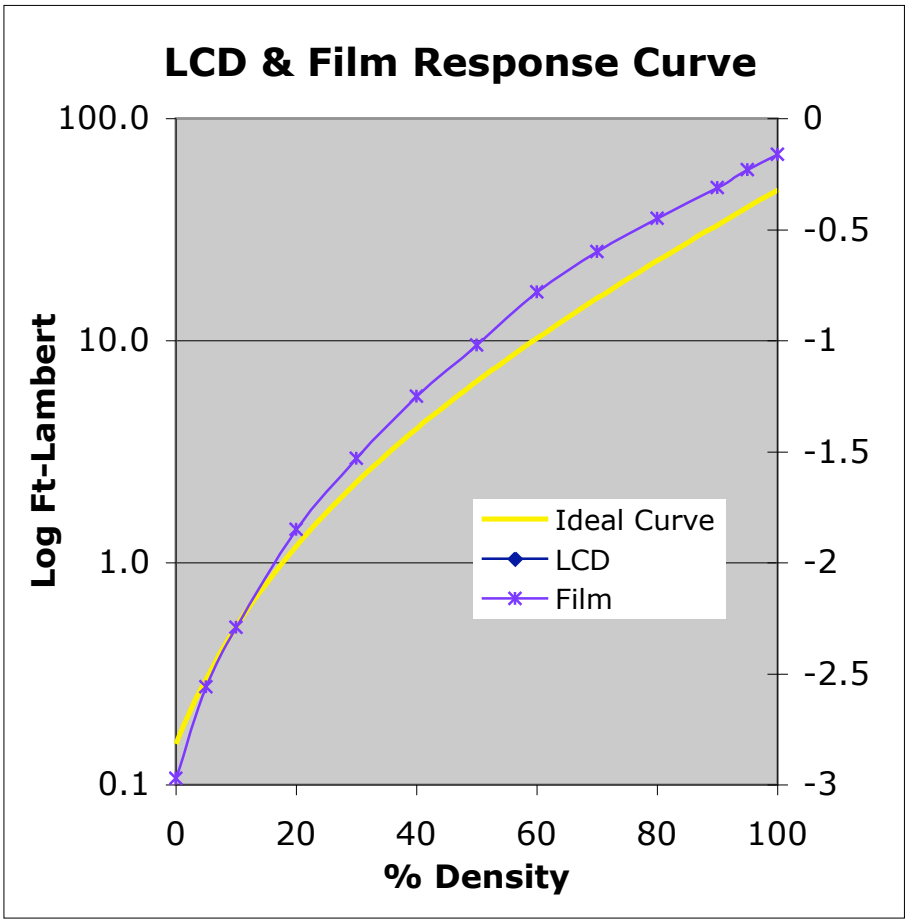
| SMPTE |
|---|
| OK? |
| \ |
| |

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

Minimum Brightness must be > 26.24 Ft. Lamberts

I was unable to test the soft copy display due to the lack of a SMPTE pattern on the system. In retrospect, I should have at least tested uniformity and max brightness. Next year. The film's response curve is 'OK' but not ideal.

| Density | Ft-Lamber | Film Density |
|---|---|---|
| 0 | | -2.97 |
| 5 | | -2.56 |
| 10 | | -2.29 |
| 20 | | -1.85 |
| 30 | | -1.53 |
| 40 | | -1.25 |
| 50 | | -1.02 |
| 60 | | -0.78 |
| 70 | | -0.6 |
| 80 | | -0.45 |
| 90 | | -0.31 |
| 95 | | -0.23 |
| 100 | | -0.16 |



# Coil and Other Hardware Inventory List

Site Name Picker Site

ACR Magnet # 01 Nickname Outlook

| Active | Coil Description | Manufacturer | Model | Rev. | Mfg. Date | SN | Channels |
|---|---|---|---|---|---|---|---|
| ☐ | Body Flex - Large | Picker | 100005 | C | Jun, 1998 | 304 | 1 |
| ☐ | Body Flex - Medium | Picker | 100006 | | Feb, 1998 | 407 | 1 |
| ☐ | Extremity | Picker | | | | NOC-100-4-44 | |
| ☐ | Head Coil (not tuned) | Picker | 956344A | | Nov, 1999 | 45 | |
| ☐ | MPL | Picker | | | | NOC-100-9-17 | |
| ☐ | MPM | Picker | | | | NOC-100-5-89 | |
| ☒ | | | | | | | |
| ☒ | Body Flex - Large | Picker | 100005 | C | Jun, 1996 | 420 | 1 |
| ☒ | Body Flex - Medium | Picker | 100006 | C | Oct, 1997 | 392 | 1 |
| ☒ | Extremity | Picker | | | | NOC-100-4-87 | 1 |
| ☒ | Extremity | Picker | | | | NOC-100-4-44 | 1 |
| ☒ | Head Coil | Picker | 956344-A | | Sep, 1999 | 21 | 1 |
| ☒ | Multi Purpose - Large | Picker | | | | NOC-100-5-116 | 1 |
| ☒ | Multi Purpose - Medium | Picker | | | | NOC-100-921 | 1 |
| ☒ | Neck | Picker | | | | NOC-100-12-69 | 1 |
| ☒ | Neck | Picker | | | | NOC-100-12-70 | 1 |
| ☐ | | | | | | | |

# RF Coil Performance Evaluation

Coil: Body Flex - Large
Mfg.: Picker
Mfg. Date: 6-28-1996 Coil ID: 1215
Phantom: Phantom F11

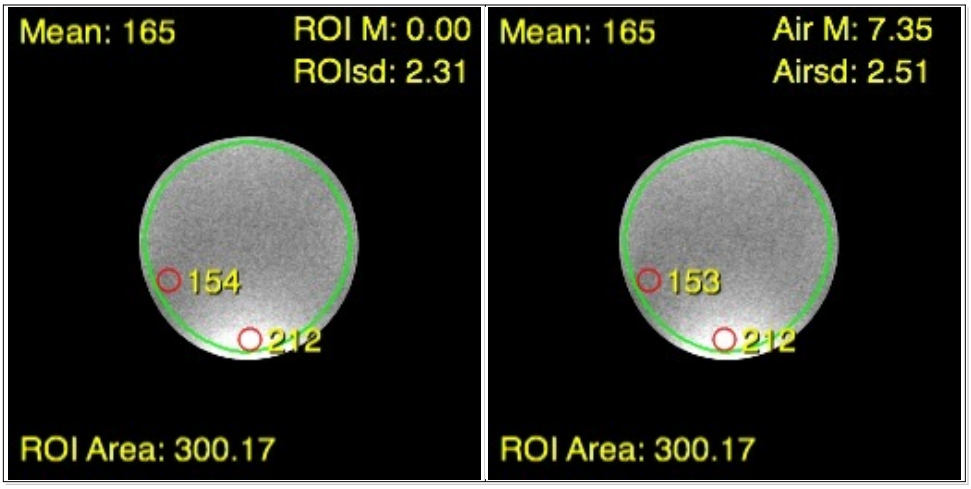
Test Date: 7/23/2008
Model: 100005
Revision: C
SN: 420
# of Channels 1

| Sequence | TR | TE | Plane | FOV | Nx | Ny | BW | NSA | Thickness | Gap |
|---|---|---|---|---|---|---|---|---|---|---|
| SE | 300 | 20 | T | 45 | 256 | 256 | 9.9 | 1 | 5 | - |

Coil Mode: Spine_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 | 165 | 212 | 154 | 0.0 | 2.31 | NEMA | 50.5 | 10.7 | 64.9 | 84.2% |
| A | 165 | 212 | 153 | 7.4 | 2.51 | Air | 43.1 | 9.2 | 55.3 | 83.8% |




Test Images

# RF Coil Performance Evaluation

Coil: Body Flex - Medium
Mfg.: Picker
Mfg. Date: 10/30/1997 Coil ID: 1222
Phantom: Phantom F11

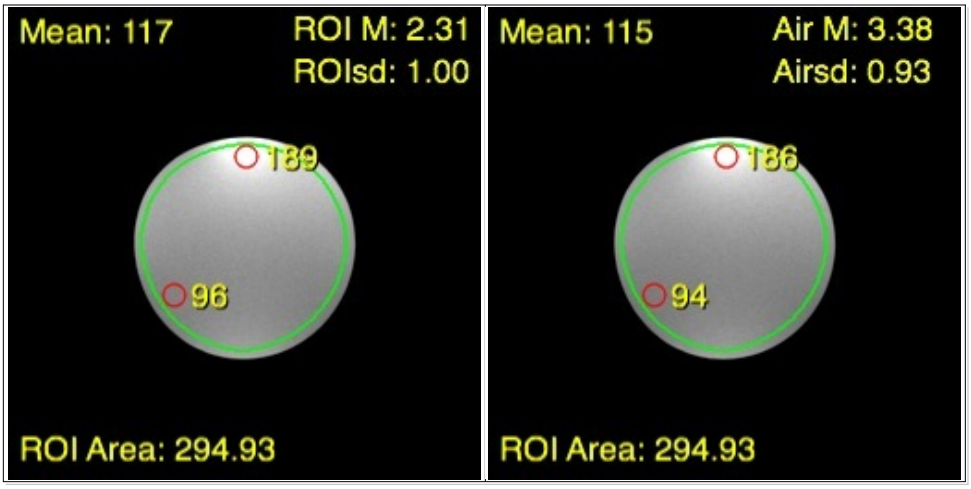
Test Date: 7/23/2008
Model: 100006
Revision: C
SN: 392
# of Channels 1

| Sequence | TR | TE | Plane | FOV | Nx | Ny | BW | NSA | Thickness | Gap |
|---|---|---|---|---|---|---|---|---|---|---|
| SE | 300 | 20 | T | 45 | 256 | 256 | 9.9 | 1 | 5 | - |

Coil Mode: Spine_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 | 117 | 189 | 96 | 2.3 | 1.00 | NEMA | 82.7 | 17.6 | 133.7 | 67.4% |
| A | 115 | 186 | 94 | 3.4 | 0.93 | Air | 81.0 | 17.2 | 131.1 | 67.1% |




Test Images

# RF Coil Performance Evaluation

Coil: Extremity
Mfg.: Picker
Mfg. Date: _____ Coil ID: 1210
Phantom: F2 phantom in T34 holder

Test Date: 7/23/2008
Model: _____
Revision: _____
SN: NOC-100-4-87
# of Channels 1

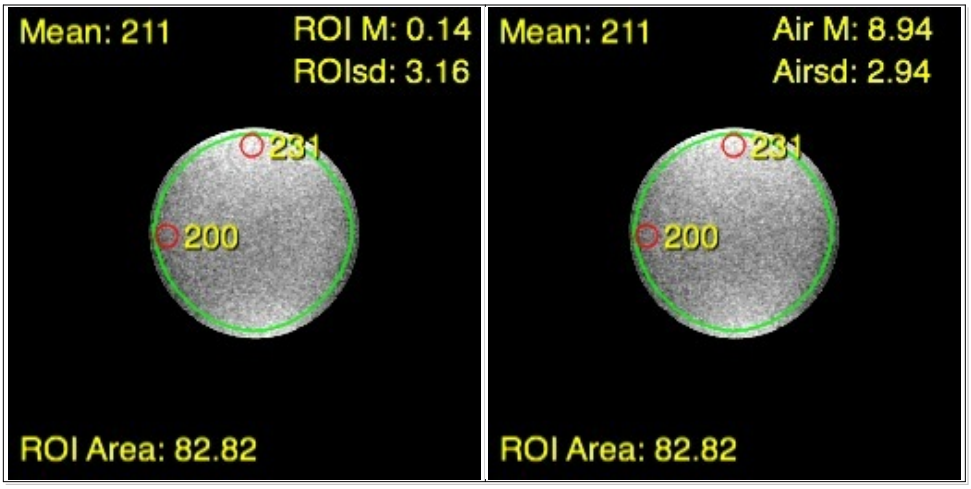
| Sequence | TR | TE | Plane | FOV | Nx | Ny | BW | NSA | Thickness | Gap |
|---|---|---|---|---|---|---|---|---|---|---|
| SE | 300 | 20 | T | 25 | 256 | 256 | 9.9 | 1 | 5 | - |

Coil Mode: Extremity

## 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 | 211 | 231 | 200 | 0.1 | 3.16 | NEMA | 47.2 | 32.5 | 51.7 | 92.8% |
| A | 211 | 231 | 200 | 8.9 | 2.94 | Air | 47.0 | 32.4 | 51.5 | 92.8% |

The SNR is up 39% over last year. This coil has roughly 9% higher SNR than serial # NOC-100-4-44




Test Images

# RF Coil Performance Evaluation

Coil: Extremity
Mfg.: Picker
Mfg. Date: _____ Coil ID: 1736
Phantom: F2 phantom in T34 holder

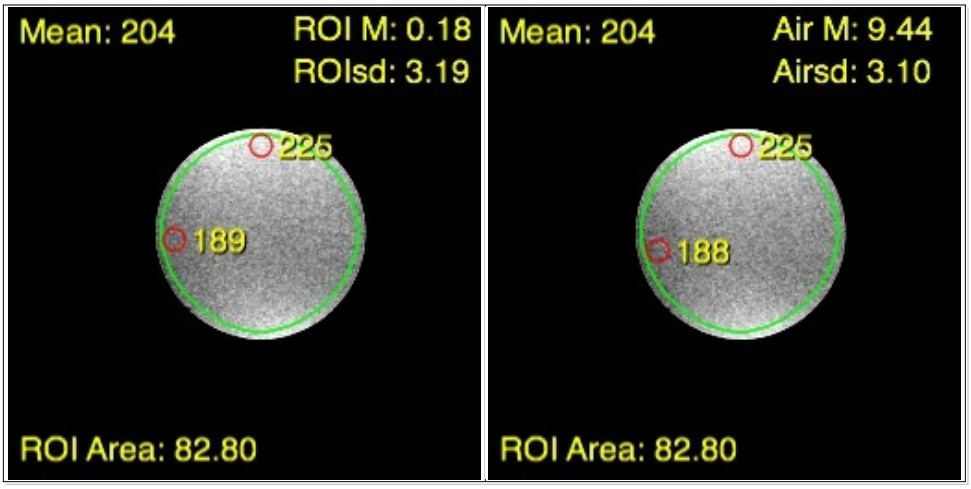
Test Date: 7/23/2008
Model: _____
Revision: _____
SN: NOC-100-4-44
# of Channels 1

| Sequence | TR | TE | Plane | FOV | Nx | Ny | BW | NSA | Thickness | Gap |
|---|---|---|---|---|---|---|---|---|---|---|
| SE | 300 | 20 | T | 25 | 256 | 256 | 9.9 | 1 | 5 | - |

Coil Mode: Extremity

## 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 | 204 | 225 | 189 | 0.2 | 3.19 | NEMA | 45.2 | 31.1 | 49.9 | 91.3% |
| A | 204 | 225 | 188 | 9.4 | 3.10 | Air | 43.1 | 29.7 | 47.6 | 91.0% |




Test Images

# RF Coil Performance Evaluation

Coil: Head Coil
Mfg.: Picker
Mfg. Date: 9/1/1999 Coil ID: 1209
Phantom: ACR Phantom

Test Date: 7/23/2008
Model: 956344-A
Revision:
SN: 21
# of Channels 1

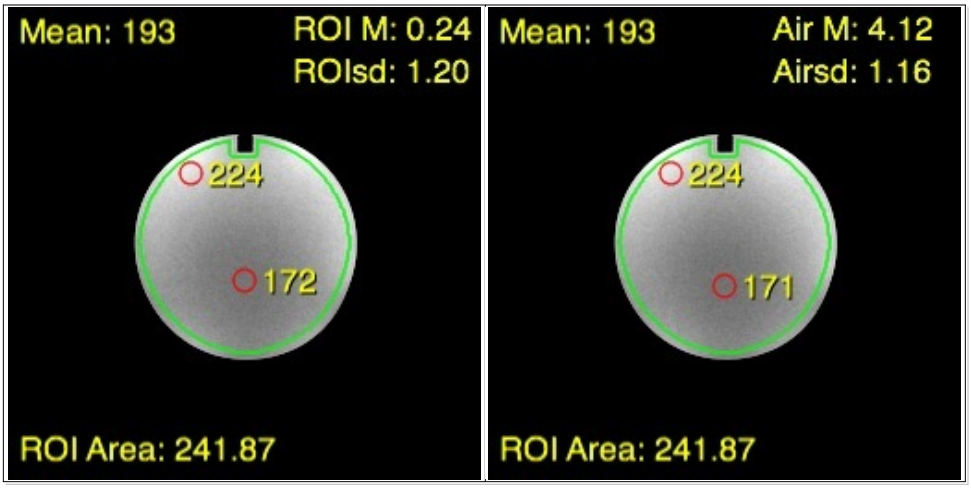
| Sequence | TR | TE | Plane | FOV | Nx | Ny | BW | NSA | Thickness | Gap |
|---|---|---|---|---|---|---|---|---|---|---|
| SE | 300 | 20 | T | 40 | 256 | 256 | 9.9 | 1 | 5 | - |

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 | 193 | 224 | 172 | 0.2 | 1.20 | NEMA | 113.7 | 30.6 | 132.0 | 86.9% |
| A | 193 | 224 | 171 | 4.1 | 1.16 | Air | 109.0 | 29.3 | 126.5 | 86.6% |

Please look at Appendix C for complete ACR Phantom analysis. SNR is up by about 9% over last year




Test Images

# RF Coil Performance Evaluation

Coil: Multi Purpose - Large

Mfg.: Picker

Mfg. Date: _____ Coil ID: 1212

Phantom: Phantom F2 in holder T39

Test Date: 7/23/2008

Model: _____

Revision: _____

SN: NOC-100-5-116

# of Channels 1

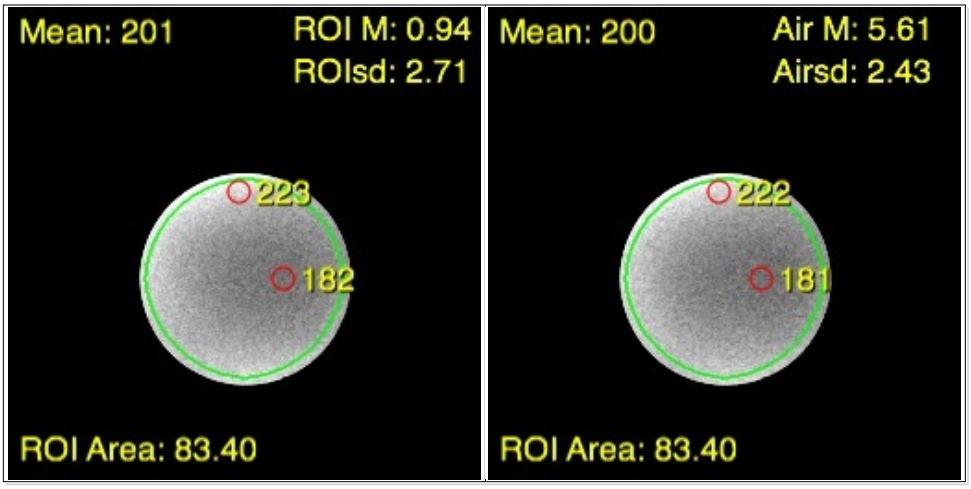
| Sequence | TR | TE | Plane | FOV | Nx | Ny | BW | NSA | Thickness | Gap |
|---|---|---|---|---|---|---|---|---|---|---|
| SE | 300 | 20 | T | 25 | 256 | 256 | 9.9 | 1 | 5 | - |

Coil Mode: MPL

## 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 | 201 | 223 | 182 | 0.9 | 2.71 | NEMA | 52.5 | 36.1 | 58.2 | 89.9% |
| A | 200 | 222 | 181 | 5.6 | 2.43 | Air | 53.9 | 37.1 | 59.9 | 89.8% |

The SNR is virtually unchanged since last year (but signal uniformity is up by 9%)




Test Images

# RF Coil Performance Evaluation

Coil: Multi Purpose - Medium

Mfg.: Picker

Mfg. Date: _____ Coil ID: 1213

Phantom: Phantom F2 in holder T34

Test Date: 7/23/2008

Model: _____

Revision: _____

SN: NOC-100-921

# of Channels 1

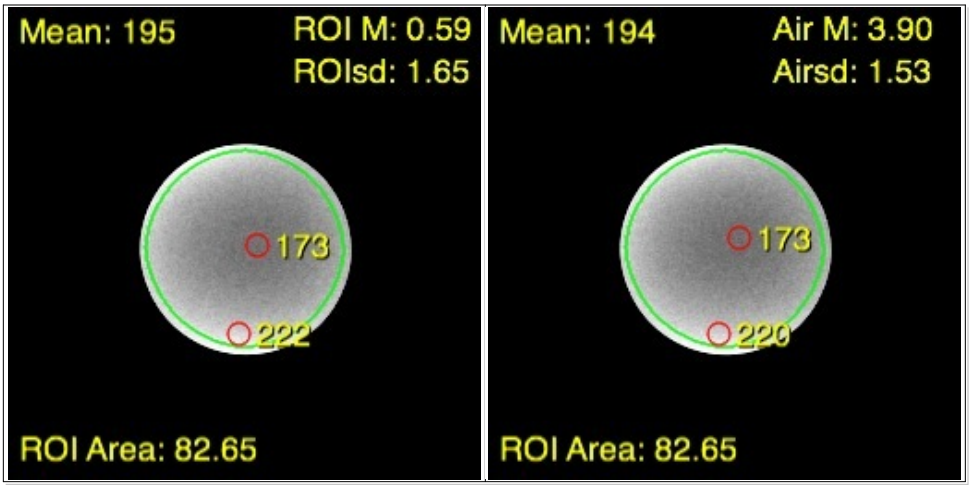
| Sequence | TR | TE | Plane | FOV | Nx | Ny | BW | NSA | Thickness | Gap |
|---|---|---|---|---|---|---|---|---|---|---|
| SE | 300 | 20 | T | 25 | 256 | 256 | 9.9 | 1 | 5 | - |

Coil Mode: MPM

## 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 | 195 | 222 | 173 | 0.6 | 1.65 | NEMA | 83.6 | 57.5 | 95.2 | 87.6% |
| A | 194 | 220 | 173 | 3.9 | 1.53 | Air | 83.1 | 57.2 | 94.2 | 88.0% |

There is a 53% increase in SNR over last year as well as an increase in uniformity of 12%.




Test Images

# RF Coil Performance Evaluation

Coil: Neck
Mfg.: Picker
Mfg. Date: _____ Coil ID: 1211
Phantom: Phantom F2 in holder T41

Test Date: 7/23/2008
Model: _____
Revision: _____
SN: NOC-100-12-69
# of Channels 1

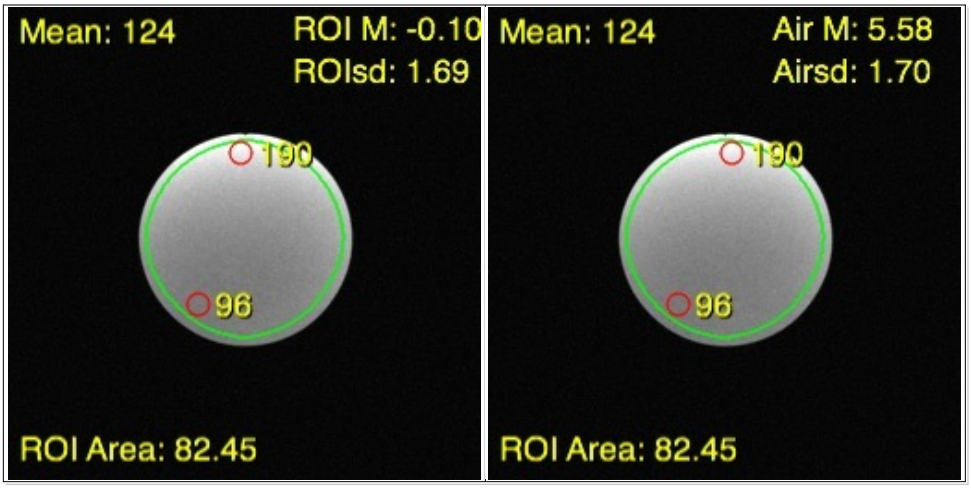
| Sequence | TR | TE | Plane | FOV | Nx | Ny | BW | NSA | Thickness | Gap |
|---|---|---|---|---|---|---|---|---|---|---|
| SE | 300 | 20 | T | 25 | 256 | 256 | 9.9 | 1 | 5 | - |

Coil Mode: Neck

## 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 | 124 | 190 | 96 | -0.1 | 1.69 | NEMA | 51.9 | 35.7 | 79.5 | 67.1% |
| A | 124 | 190 | 96 | 5.6 | 1.70 | Air | 47.8 | 32.9 | 73.2 | 67.1% |

There is a 6% drop in the SNR of this coil over last year and is 18% lower than the coil serial # ending in -70




Test Images

# RF Coil Performance Evaluation

Coil: Neck
Mfg.: Picker
Mfg. Date: _____ Coil ID: 1211
Phantom: Phantom F2 in holder T41

Test Date: 7/23/2008
Model: _____
Revision: _____
SN: NOC-100-12-69
# of Channels 1

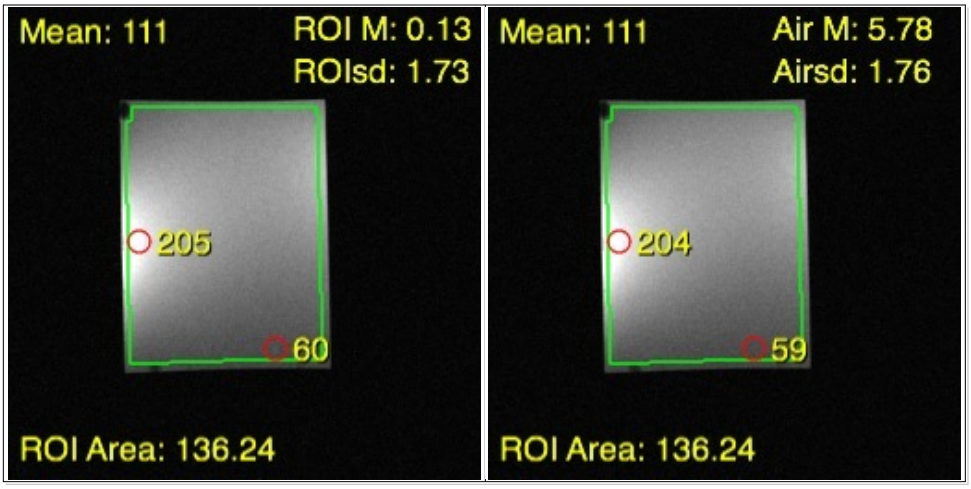
| Sequence | TR | TE | Plane | FOV | Nx | Ny | BW | NSA | Thickness | Gap |
|---|---|---|---|---|---|---|---|---|---|---|
| SE | 300 | 20 | S | 25 | 256 | 256 | 9.9 | 1 | 5 | - |

Coil Mode: Neck

## 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 | 111 | 205 | 60 | 0.1 | 1.73 | NEMA | 45.4 | 31.2 | 83.8 | 45.3% |
| A | 111 | 204 | 59 | 5.8 | 1.76 | Air | 41.3 | 28.4 | 76.0 | 44.9% |

This coil has 12% lower SNR than serial # NOC-100-12-70




Test Images

# RF Coil Performance Evaluation

Coil: Neck
Mfg.: Picker
Mfg. Date: _____ Coil ID: 1219
Phantom: Phantom F2 in holder T41

Test Date: 7/23/2008
Model: _____
Revision: _____
SN: NOC-100-12-70
# of Channels 1

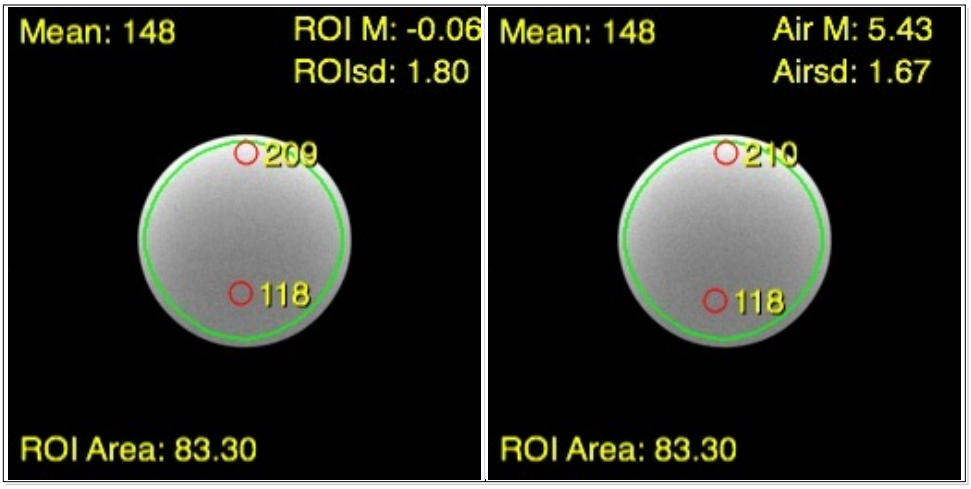
| Sequence | TR | TE | Plane | FOV | Nx | Ny | BW | NSA | Thickness | Gap |
|---|---|---|---|---|---|---|---|---|---|---|
| SE | 300 | 20 | T | 25 | 256 | 256 | 9.9 | 1 | 5 | - |

Coil Mode: Neck

## Analysis of Test Image

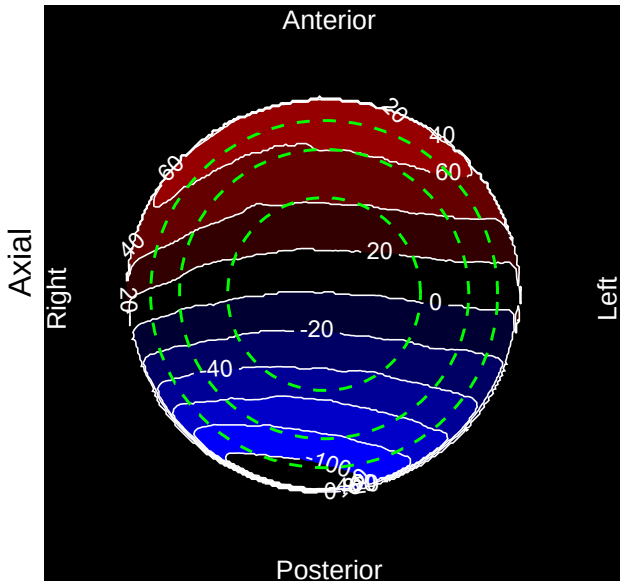
| Measured Data | | | | | | | Calculated Results | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Label | Mean | Max | Min | Back ground | Noise SD | Noise Type | Mean SNR | Normal-ized | Max SNR | Uni-formity |
| N | 148 | 209 | 118 | -0.1 | 1.80 | NEMA | 58.1 | 40.0 | 82.1 | 72.2% |
| A | 148 | 210 | 118 | 5.4 | 1.67 | Air | 58.1 | 40.0 | 82.4 | 72.0% |

This coil has 21% higher SNR than serial # NOC-100-12-69 but the SNR in this plane is very dependent on slice position (which is why I also tested it in the sagittal plane.)



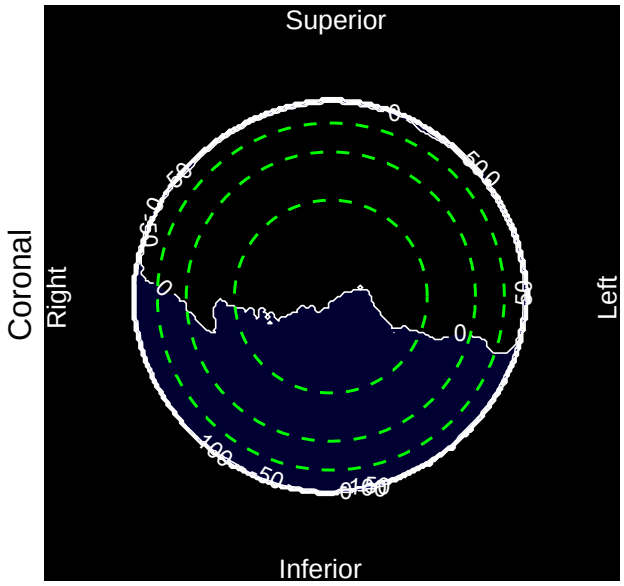

Test Images

# Appendix A: Magnet Homogeneity Field Maps Picker Site
## Picker Outlook 0.23T - 3 central planes
## Measured July 23, 2008



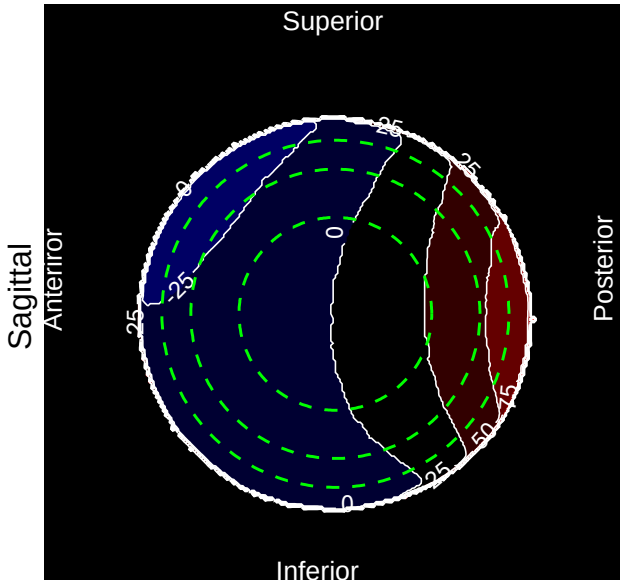

### Axial

| DIAMETER | MIN | MAX | RANGE | PPM | MEAN | STDEV |
|---|---|---|---|---|---|---|
| 10 | -54.0 | 42.1 | 96.0 | 9.80 | -0.78 | 23.8 |
| 15 | -84.1 | 60.3 | 144.5 | 14.74 | -1.03 | 36.1 |
| 18 | -104.0 | 71.4 | 175.4 | 17.90 | -1.10 | 43.5 |




### Coronal

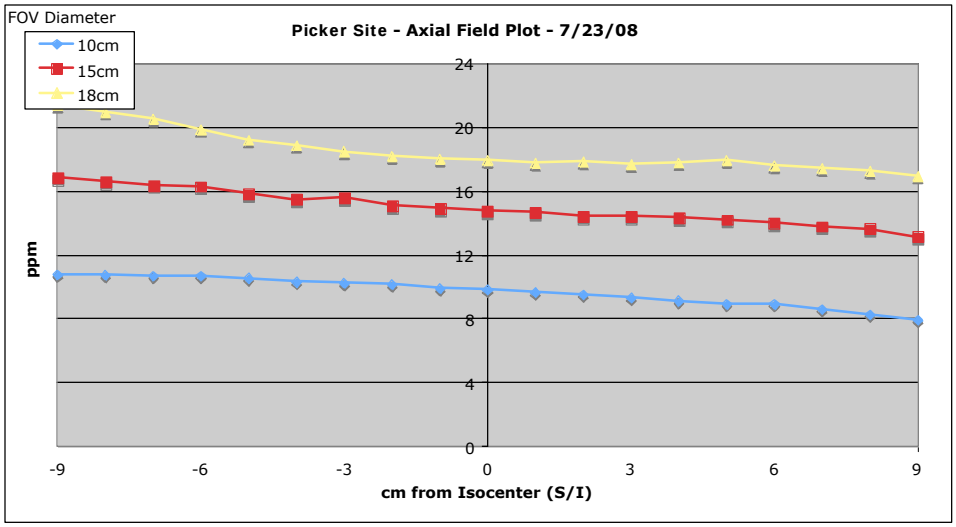
| DIAMETER | MIN | MAX | RANGE | PPM | MEAN | STDEV |
|---|---|---|---|---|---|---|
| 10 | -11.9 | 9.9 | 21.8 | 2.23 | 0.57 | 5.1 |
| 15 | -17.9 | 13.9 | 31.7 | 3.24 | 0.33 | 7.3 |
| 18 | -23.8 | 17.9 | 41.7 | 4.25 | 0.01 | 8.7 |

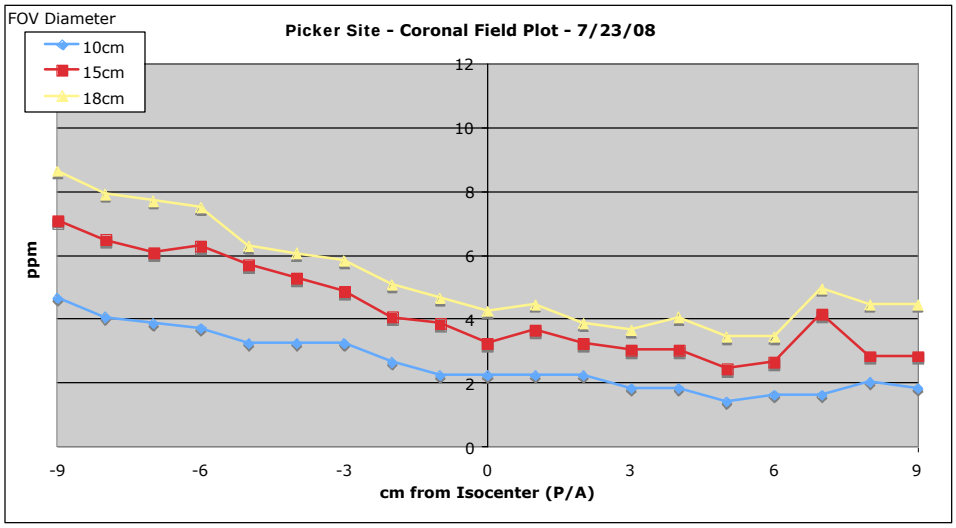


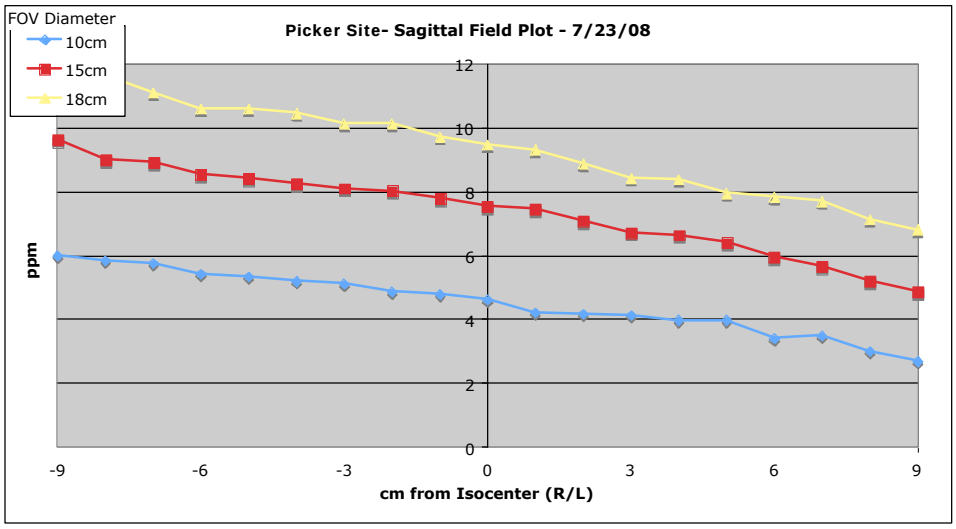

### Sagittal

| DIAMETER | MIN | MAX | RANGE | PPM | MEAN | STDEV |
|---|---|---|---|---|---|---|
| 10 | -17.5 | 27.8 | 45.2 | 4.62 | 0.87 | 10.8 |
| 15 | -26.2 | 47.6 | 73.8 | 7.53 | 1.00 | 16.9 |
| 18 | -32.5 | 60.3 | 92.9 | 9.48 | 1.22 | 20.8 |

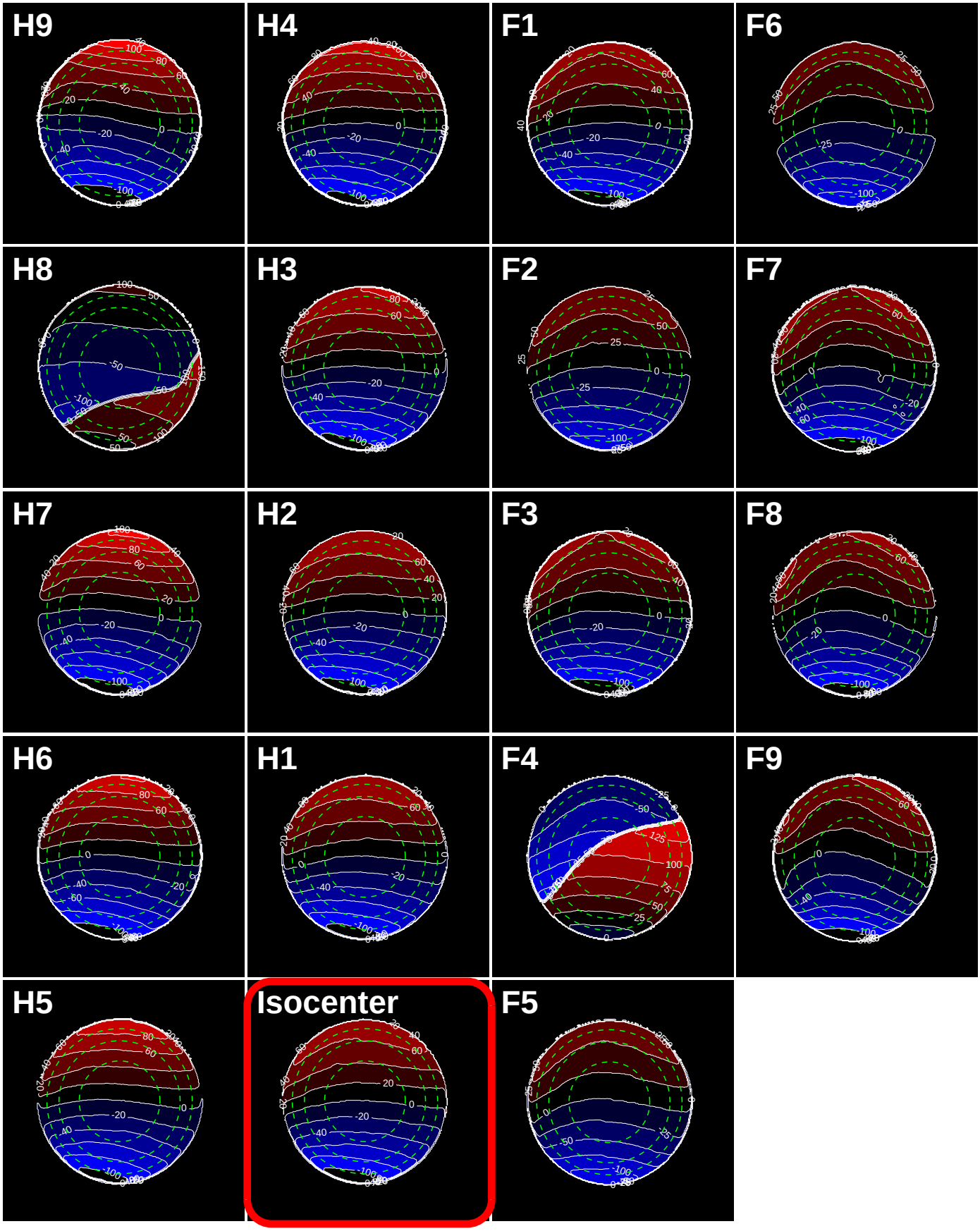
# Appendix A: Magnet Homogeneity Field Maps Picker Site
## Picker Outlook 0.23T
## Measured July 23, 2008



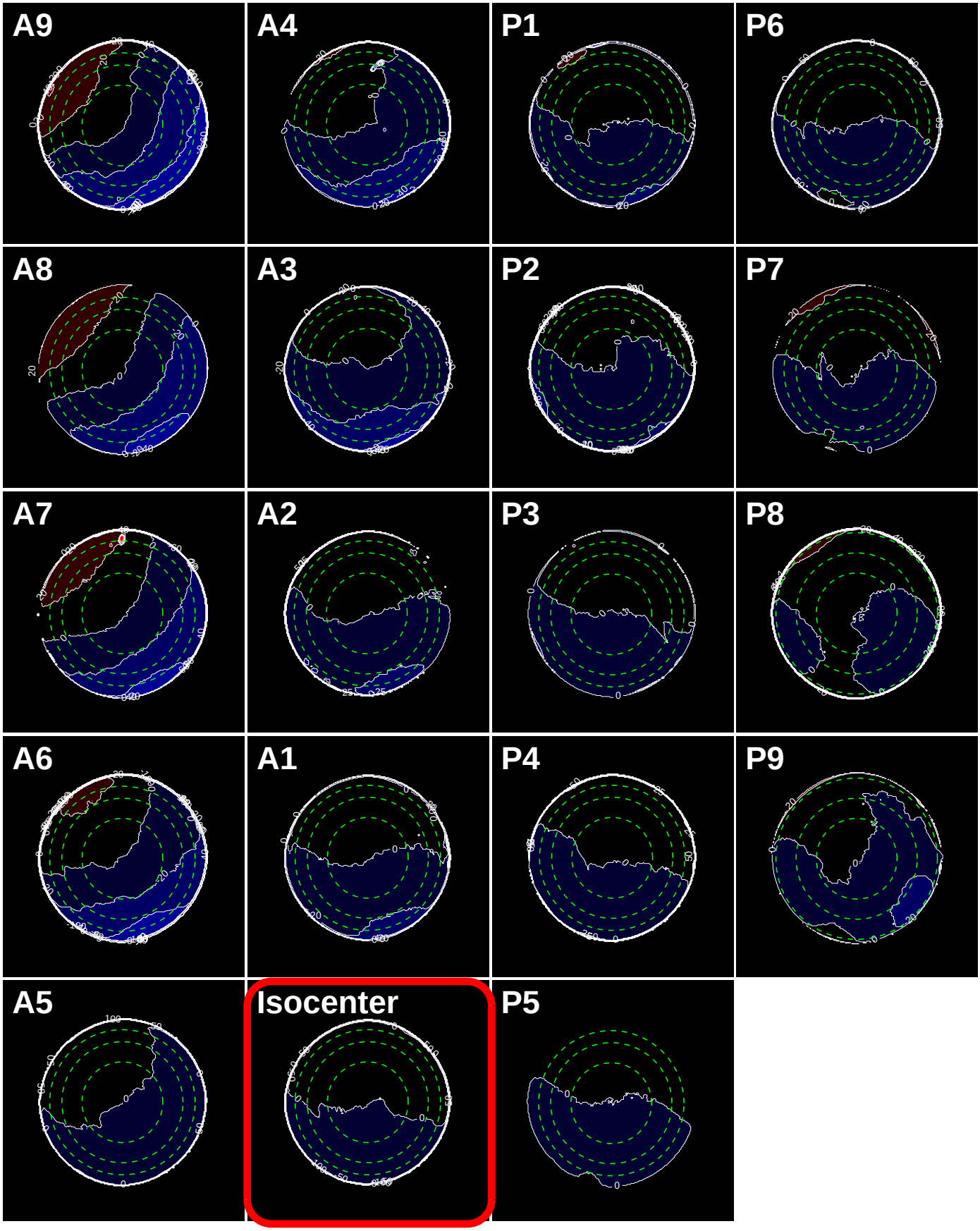



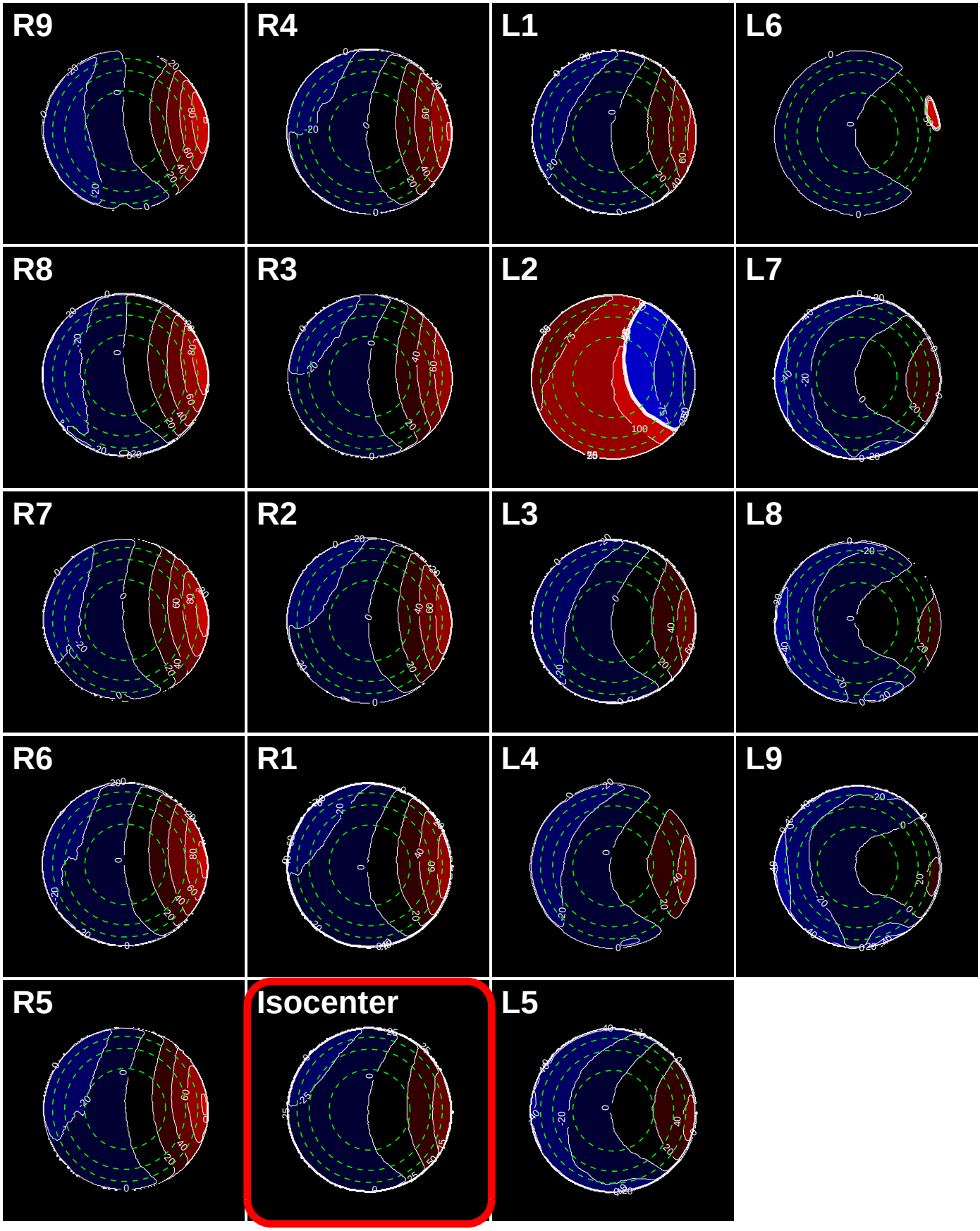
# Axial Field Plots



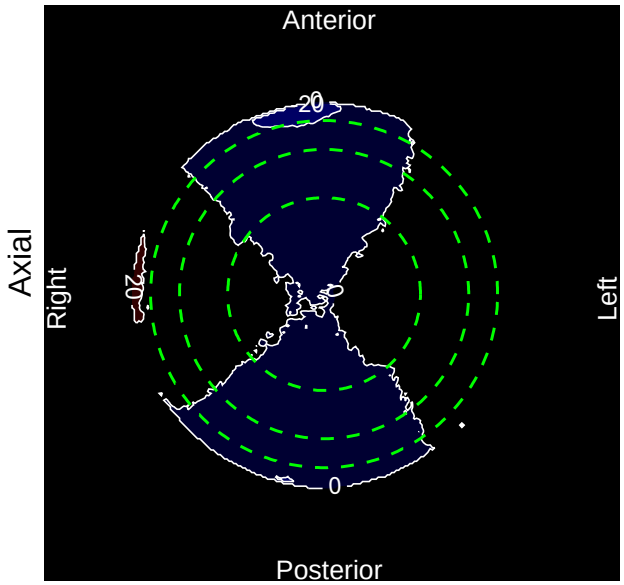
# Coronal Field Plots



# Sagittal Field Plots

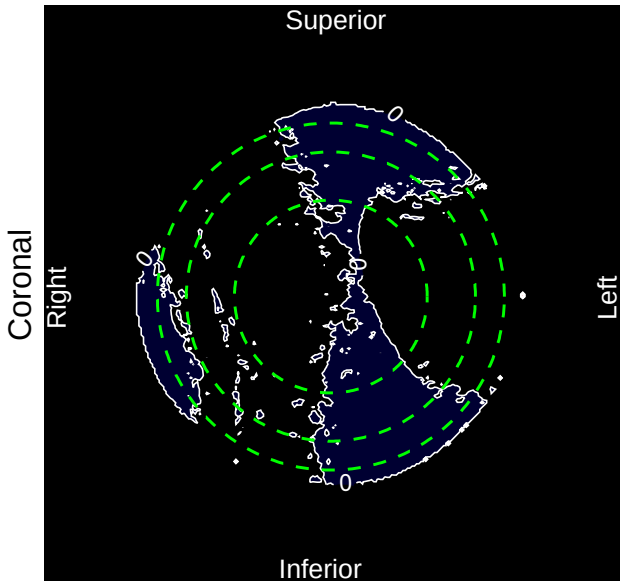


# Appendix A: Magnet Homogeneity Field Maps Picker Site
## Picker Outlook 0.23T - 3 central planes
## Measured July 23, 2008 with Linear Corrections applied



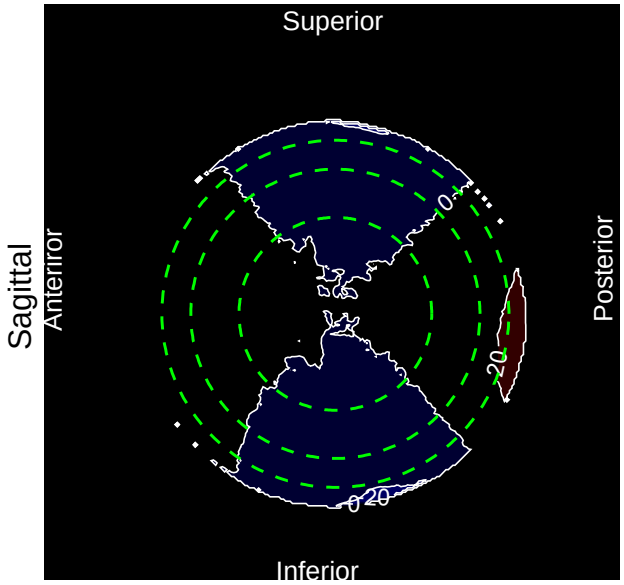

### Axial

| DIAMETER | MIN | MAX | RANGE | PPM | MEAN | STDEV |
|---|---|---|---|---|---|---|
| 10 | -5.9 | 4.9 | 10.8 | 1.10 | -0.07 | 2.0 |
| 15 | -13.1 | 12.3 | 25.3 | 2.59 | -0.32 | 4.4 |
| 18 | -21.1 | 18.8 | 39.9 | 4.07 | -0.38 | 6.4 |




### Coronal

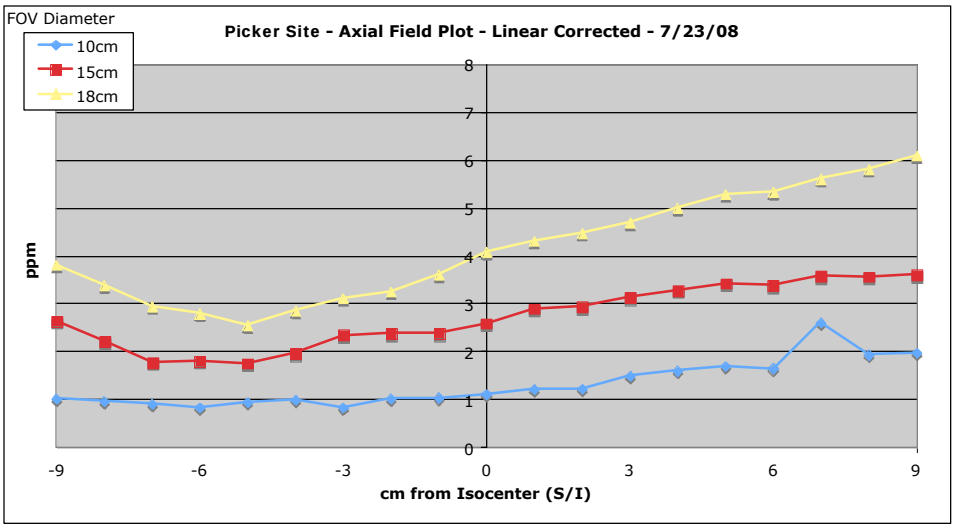
| DIAMETER | MIN | MAX | RANGE | PPM | MEAN | STDEV |
|---|---|---|---|---|---|---|
| 10 | -3.7 | 4.4 | 8.2 | 0.83 | 1.20 | 1.5 |
| 15 | -8.0 | 6.5 | 14.5 | 1.48 | 0.96 | 2.1 |
| 18 | -13.1 | 8.6 | 21.7 | 2.22 | 0.65 | 2.9 |

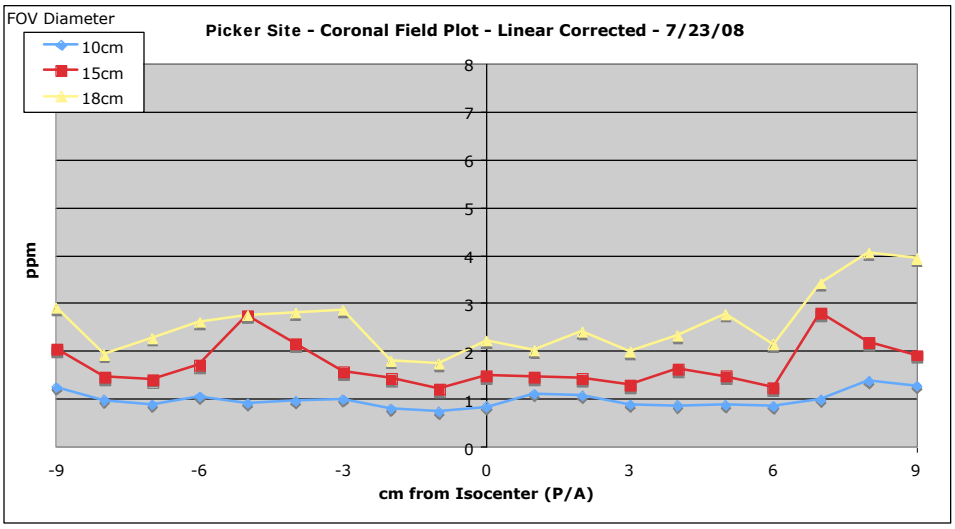


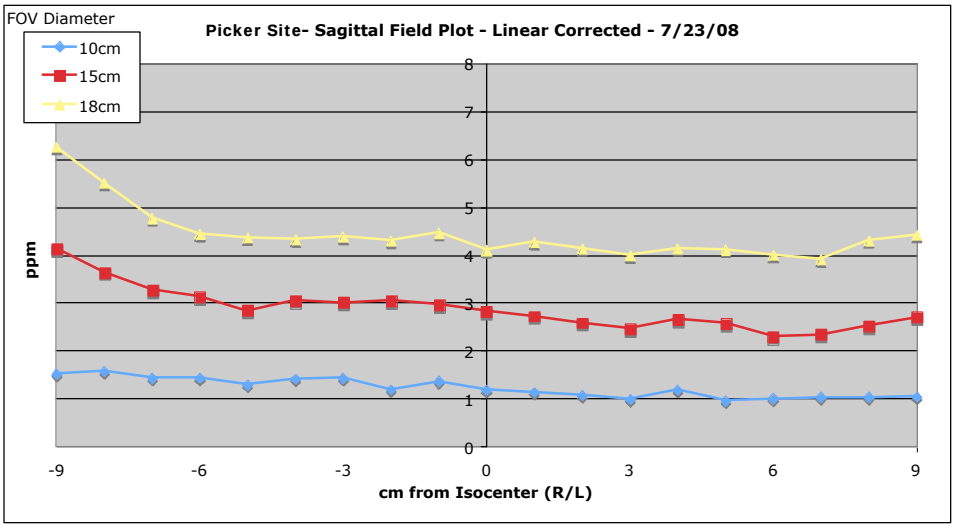

### Sagittal

| DIAMETER | MIN | MAX | RANGE | PPM | MEAN | STDEV |
|---|---|---|---|---|---|---|
| 10 | -5.5 | 6.0 | 11.5 | 1.17 | 0.45 | 2.0 |
| 15 | -12.6 | 15.1 | 27.6 | 2.82 | 0.59 | 4.7 |
| 18 | -17.3 | 22.8 | 40.2 | 4.10 | 0.81 | 6.9 |

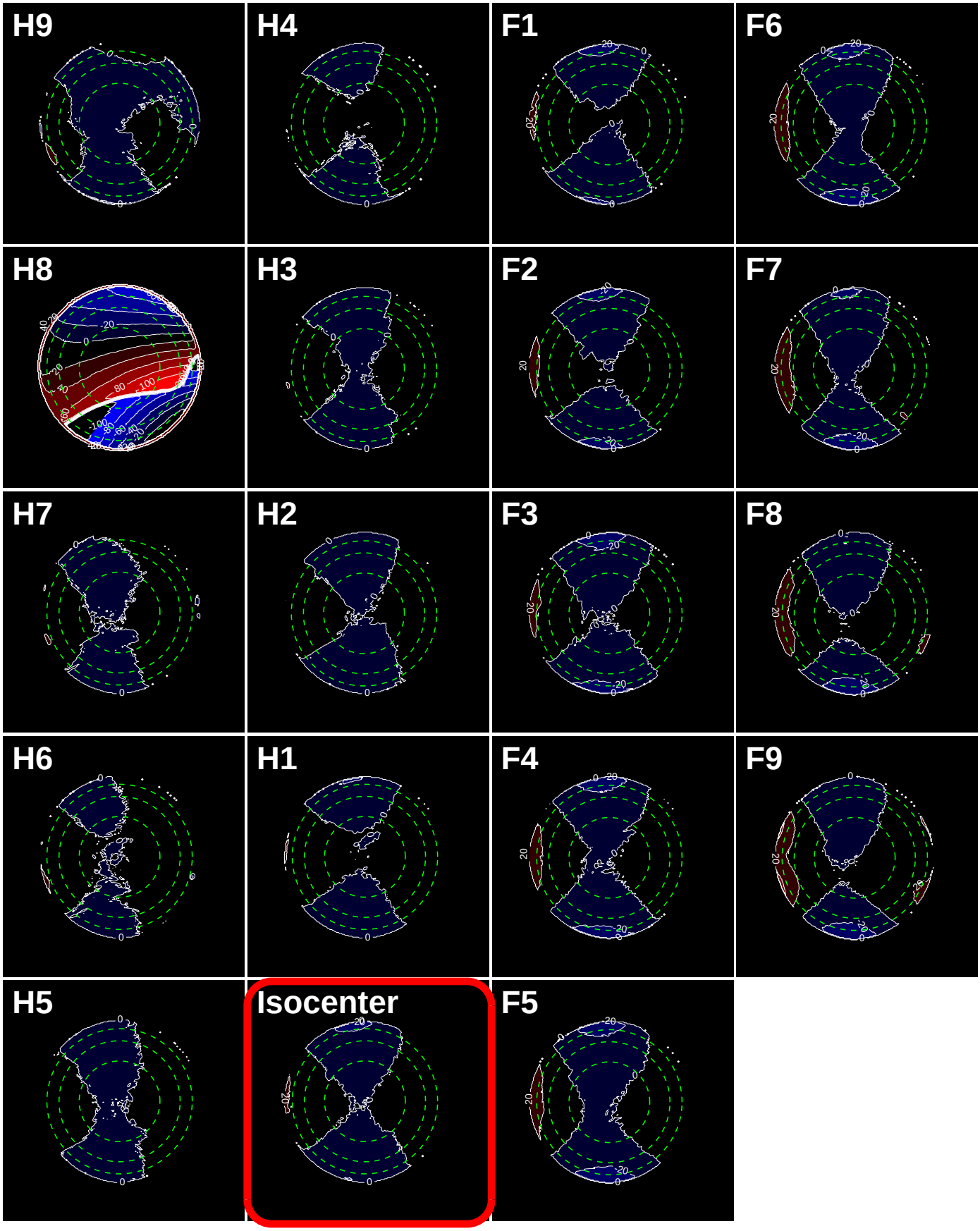
# Appendix A: Magnet Homogeneity Field Maps Picker Site
# Picker Outlook 0.23T
# Measured July 23, 2008 with Linear Corrections applied



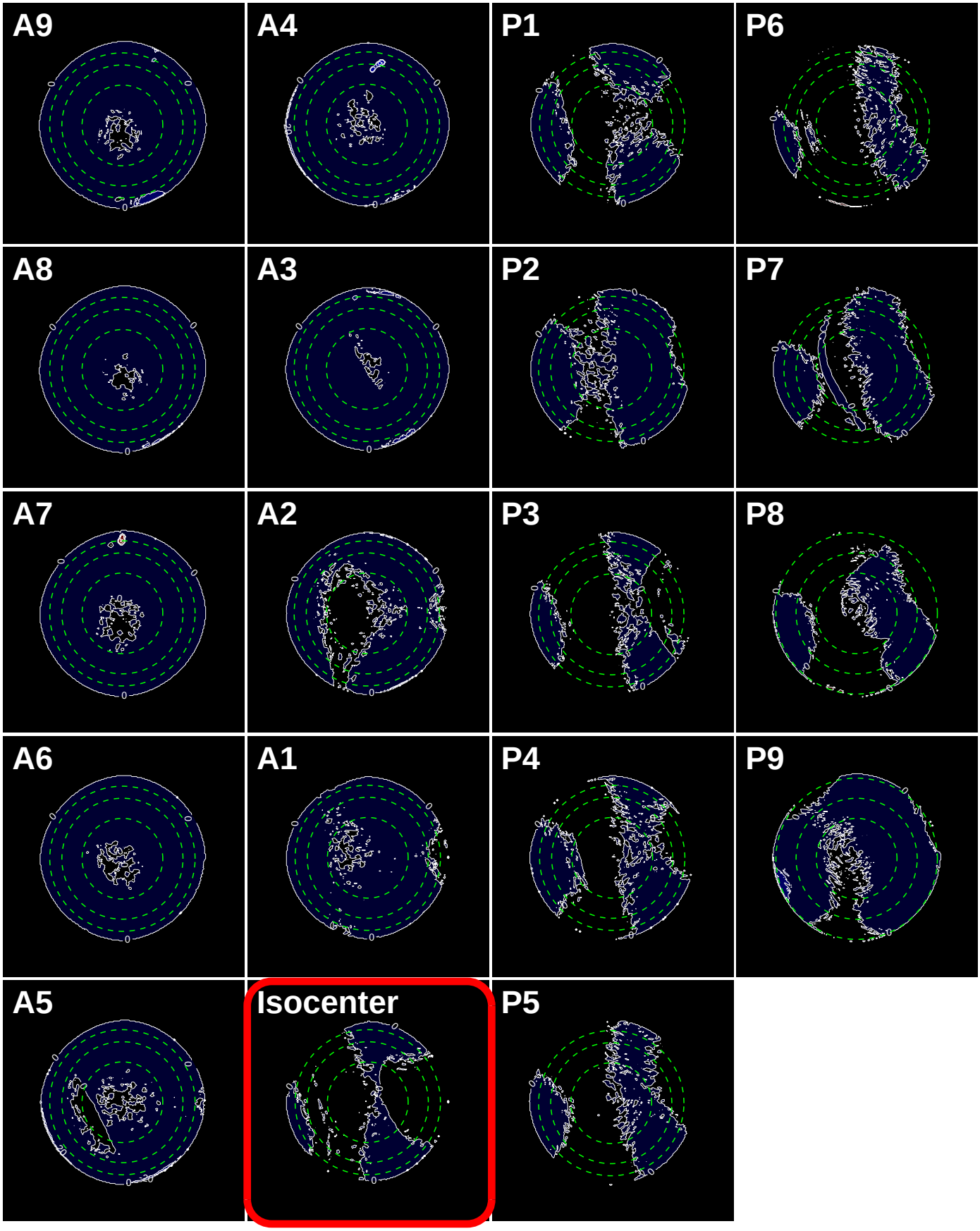



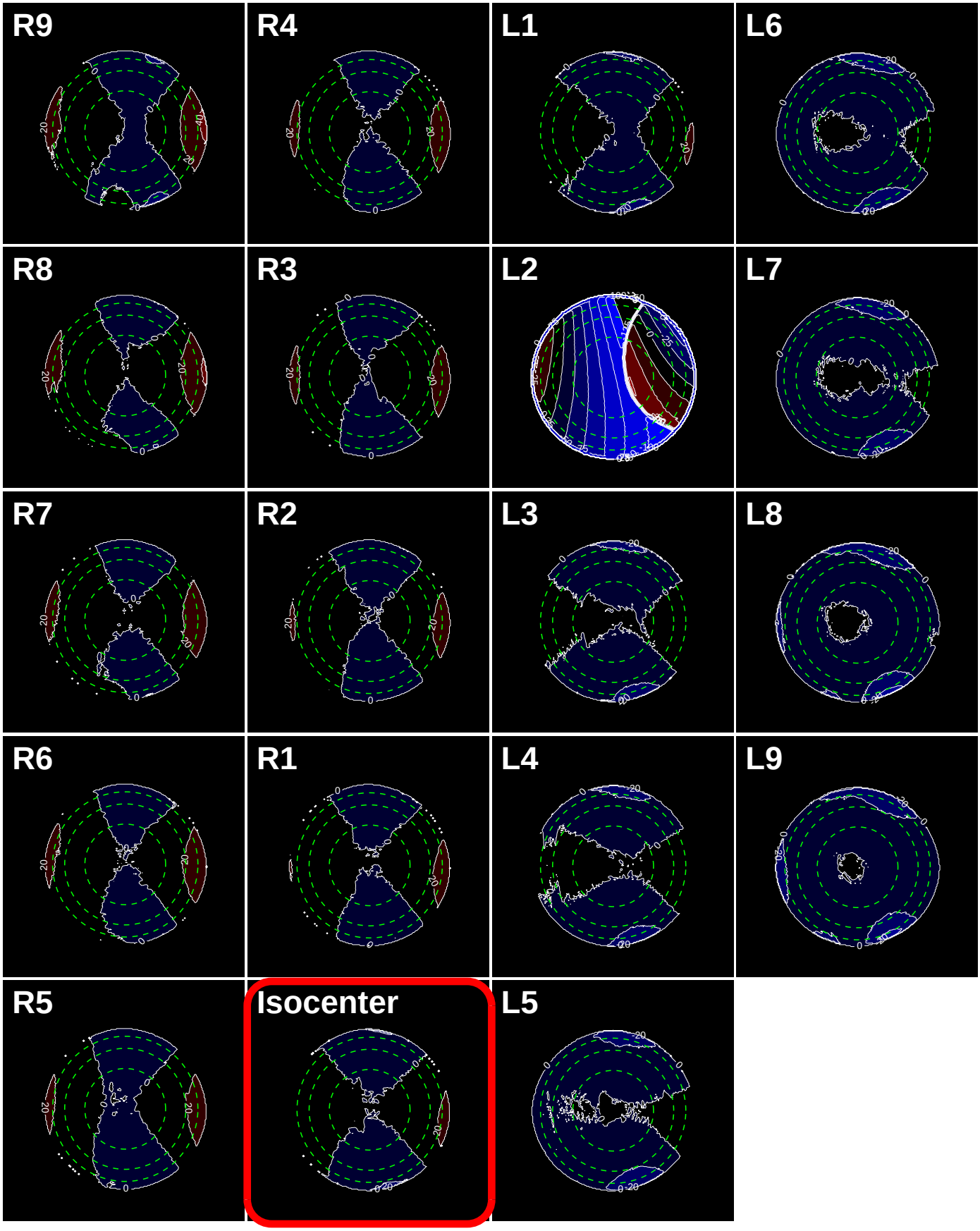
# Axial Field Plots



# Coronal Field Plots



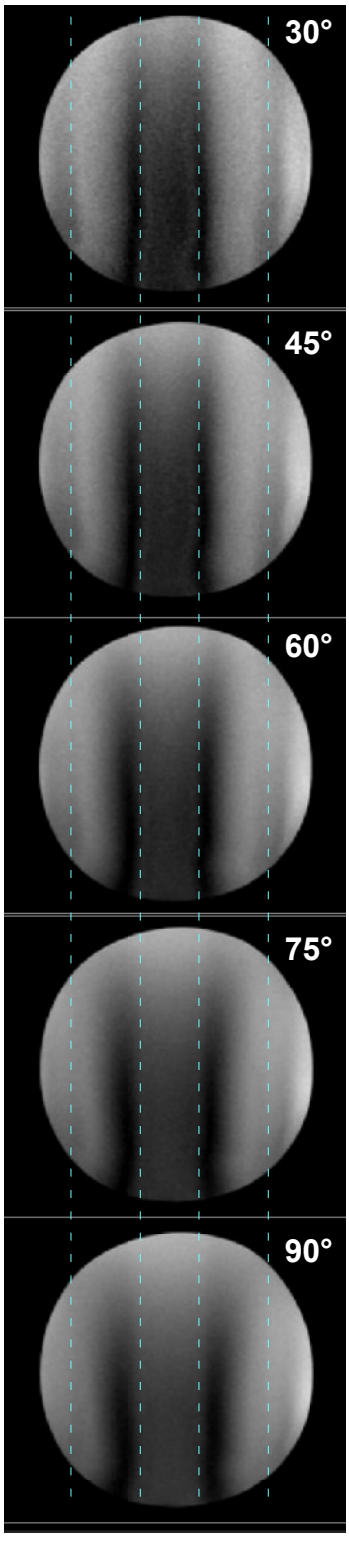
# Sagittal Field Plots



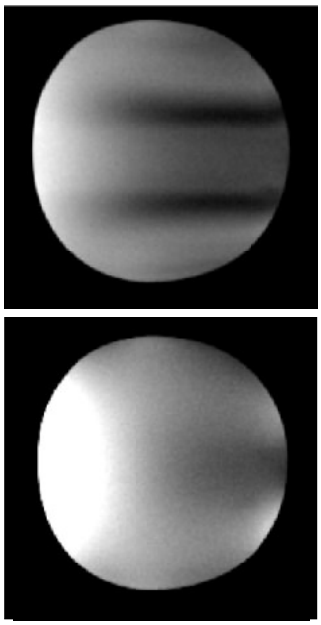
## Appendix B: RF Homogeneity Problems

# Body Flex Medium
# 28 cm sphere

Axial Localizer
Varying Flip Angles
1 average (NSA)



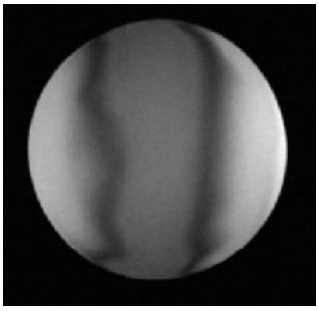

Sagittal 90° - 1 NSA



Sagittal 90° - 1 NSA



Coronal 90° - 1 NSA



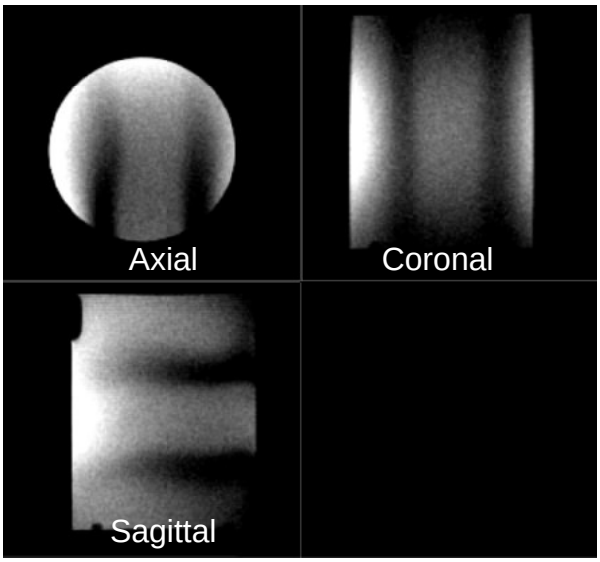
OBSERVATIONS:

1. Periodic bands of low signal
2. Central pair have lowest signal.
3. Effect is most prominent posteriorly.
4. When using 2 averages, the low signal becomes high signal.
5. The spacing of the  bands depends on the flip angle.

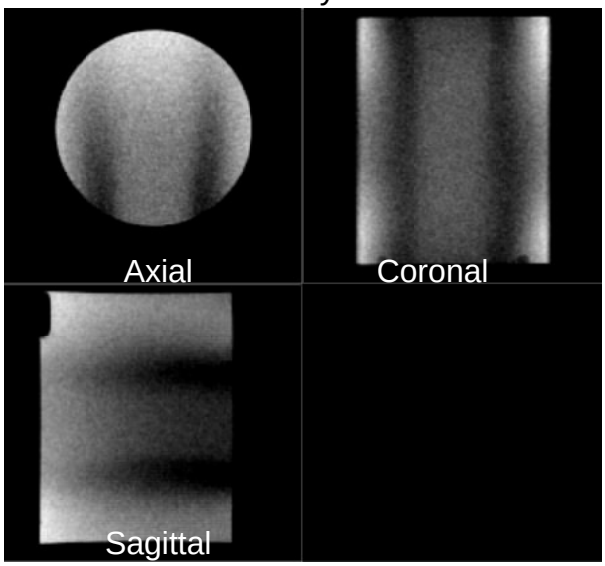
## Appendix B: RF Homogeneity Problems

# Problem present with every coil tested
# F2 phantom

Multipurpose Large Coil

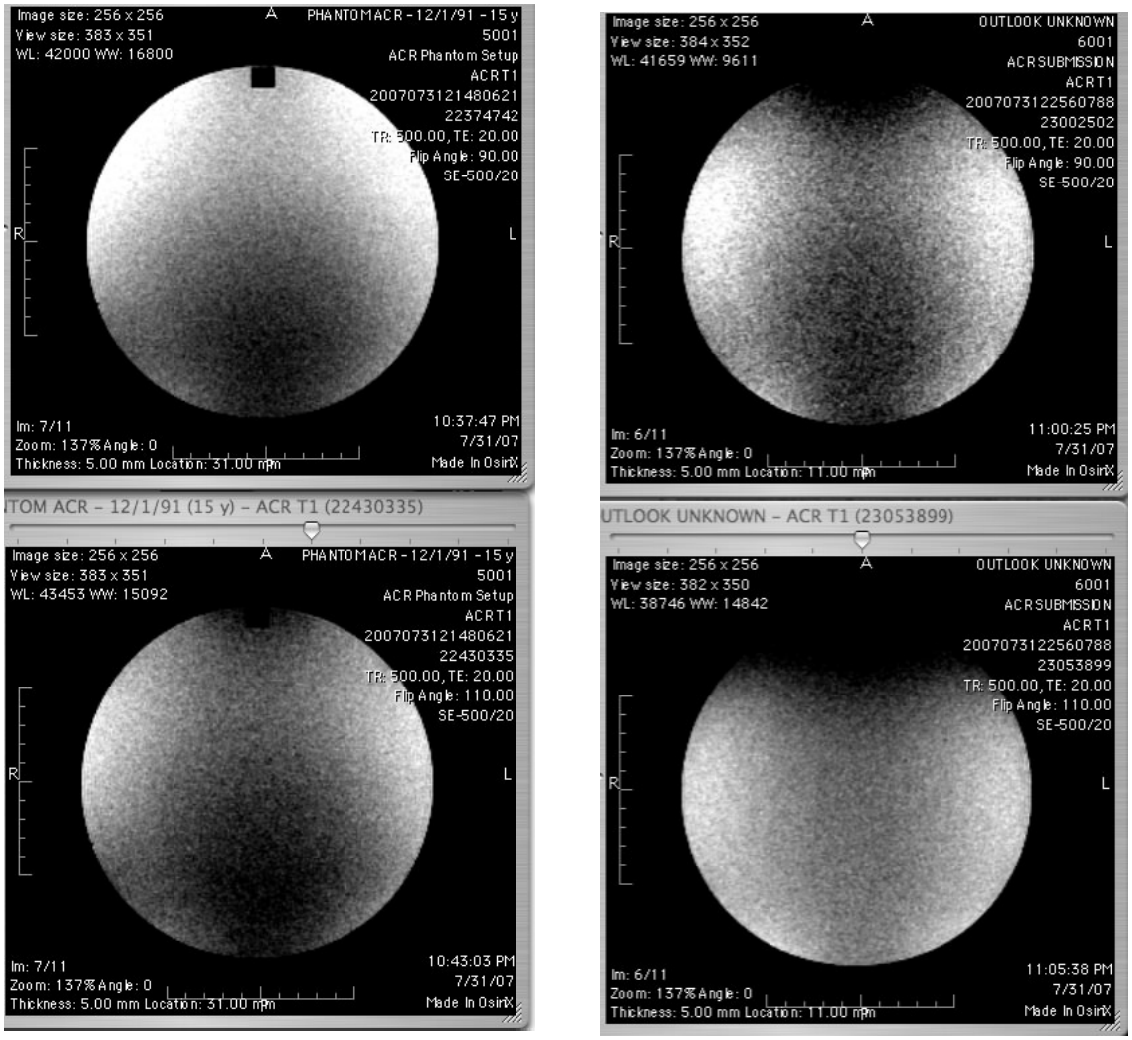



Extremity Coil



## Appendix B: RF Homogeneity Problems

| | System Default RF Calibration | After I re-ran RF Calibration |
|---|---|---|
| 90° | 81.5% Homogeneity<br>SNR: 65.2 | 87.6% Homogeneity<br>SNR: 69.1 |
| 110° | 85.8% Homogeneity<br>SNR: 63.1 | 77.1% Homogeneity<br>SNR 64.3 |



**Picker Site** **Outlook**

Coil Used: **Head Coil** Test Date: **7/23/2008**

| | Sagittal Locator | |
|---|---|---|
| 1 | Length of phantom, end to end (mn 148± 2) | 147.8 |

= 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 | 0.9 | 1.0 |
| 3 | (1.10, 1.00, 0.90 mm) | 0.9 | 0.9 | 0.9 | 1.0 | 1.0 |
| 4 | Slice Thickness Top | 49.3 | 55.6 | 49.3 | 50.1 | 50.1 |
| 5 | (fwhm in mm) Bottom | 50.4 | 54.9 | 48.0 | 47.0 | 47.4 |
| 6 | Calculated value 5.0±0.7 | 4.98 | 5.52 | 4.86 | 4.85 | 4.87 |
| 7 | Wedge (mm) = + = - | 0.4 | 0.3 | 0.3 | 2.3 | 1.9 |
| 8 | Diameter (mm) (190±2) ⊕ | 191.9 | 190.1 | 192.3 | 192.0 | 190.7 |
| 9 | ⊖ | 188.7 | 188.2 | 188.2 | 188.9 | 188.6 |
| | **Slice Location #5** | | | | | |
| 10 | Diameter (mm) (190±2) ⊕ | 191.8 | 189.8 | 192.4 | 191.9 | 190.5 |
| 11 | ⊖ | 188.8 | 188.4 | 188.6 | 189.1 | 188.6 |
| 12 | ⊘ | 191.3 | 189.9 | 191.2 | 191.1 | 190.0 |
| 13 | ⊘ | 191.6 | 190.2 | 191.9 | 191.7 | 190.6 |
| | **Slice Location #7** | | | | | |
| 14 | Signal Big ROI | 163 | 152 | 149 | 153 | 147 |
| 15 | (mean only) High | 186 | 171 | 168 | 173 | 174 |
| 16 | Low | 150 | 138 | 139 | 142 | 113 |
| 17 | Uniformity (>87.5%) | 89.3% | 89.3% | 90.6% | 90.2% | 78.7% |
| 18 | Background Noise Top | 6.8 ± 2.08 | 8.1 ± 2.65 | 9.9 ± 3.2 | 4.9 ± 1.29 | 10.6 ± 2.34 |
| 19 | Bottom | 7.1 ± 2.30 | 8.5 ± 2.75 | 9.9 ± 3.28 | 5.0 ± 1.47 | 10.3 ± 2.52 |
| 20 | (mean ±std dev) Left | 7.0 ± 2.19 | 8.7 ± 2.86 | 9.9 ± 3.37 | 5.1 ± 1.37 | 12.9 ± 2.93 |
| 21 | Right | 7.2 ± 2.22 | 9.0 ± 9.0 | 9.8 ± 3.32 | 5.0 ± 1.30 | 12.2 ± 4.19 |
| 22 | Ghosting Ratio (<2.5%) | 0.1% | 0.4% | 0.0% | 0.1% | 1.4% |
| 23 | SNR (no spec) | 74 | 56 | 46 | 115 | 60 |
| | **Low Con Detectability** | | | | | |
| 24 | Slice Location #8 1.4% | 0 | 0 | 0 | 1 | 0 |
| 25 | Slice Location #9 2.5% | 1 | 0 | 1 | 5 | 1 |
| 26 | Slice Location #10 3.6% | 1 | 0 | 1 | 6 | 1 |
| 27 | Slice Location #11 5.1% | 4 | 6 | 5 | 7 | 5 |
| 28 | Total # of Spokes (>=9) | 6 | 6 | 7 | 19 | 7 |
| | **Slice Location #11** | | | | | |
| 29 | Wedge (mm) = + = - | -4.2 | -3.9 | -4.2 | -2.1 | -2.5 |
| 30 | Slice Position Error | -4.7 | -4.3 | -4.5 | -4.5 | -4.4 |

The FSE(8) T2 has poor ghosting and signal uniformity. I also ran a Dual Echo T2 with and TE 100. This sequence has better uniformity and no ghosting but has excessive geometric distortion. The distortion could be reduced by recalibrating the gradients. The H/F gradient is fine. The L/R gradient should be scaled **up** by 0.8%. The A/P gradient should be scaled **down** by 0.7-0.8%

**Sequence parameters** Test Date: **7/23/2008**

Coil Used:**Head Coil** **Test ID** **319**

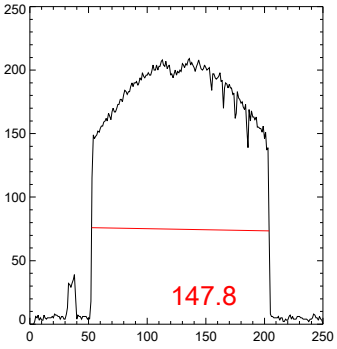
| Study Description | Pulse Sequence (ETL) | TR (ms) | TE (ms) | FOV (cm) | Phase Sample Ratio | Number of Slices | Thick-ness (mm) | Slice Gap | NSA (Nex) | Freq Matrix | Phase Matrix | Band Width (kHz) | Scan Time (min:sec) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACR T1 | SE | 500 | 20 | 25 | 1 | 11 | 5 | 5 | 1 | 256 | 256 | 9.9 | 2:09 |
| ACR PD | Dual Echo SE | 2000 | 20 | 25 | 1 | 11 | 5 | 5 | 1 | 256 | 256 | 9.9 | 8:32 |
| ACR T2 | Dual Echo SE | 2000 | 80 | 25 | 1 | 11 | 5 | 5 | 1 | 256 | 256 | 4.0 | 8:32 |
| Site T1 | SE | 470 | 20 | 25 | 1.5 | 11 | 5 | 5 | 3 | 240 | 240 | 11.9 | 8:00 |
| Site T2 | FSE(8) | 2300 | 90 | 25 | 1.5 | 11 | 5 | 5 | 4 | 240 | 240 | 15.6 | |

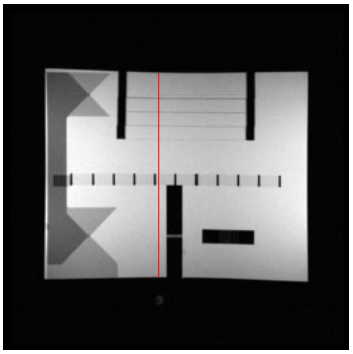
**Magnet ID:** **148** **Coil ID:** **1209** **TestID:** **319**

# Appendix C: ACR Phantom Analysis

ACR T1

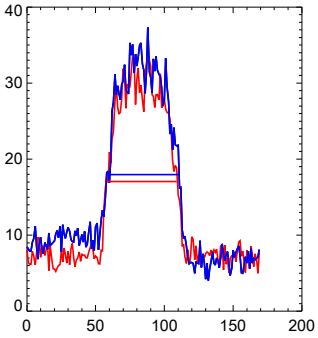
## Sagital Length



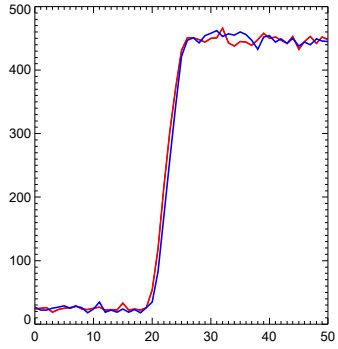
## High Contrast Resolution

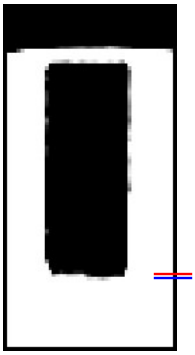
## Slice Thickness



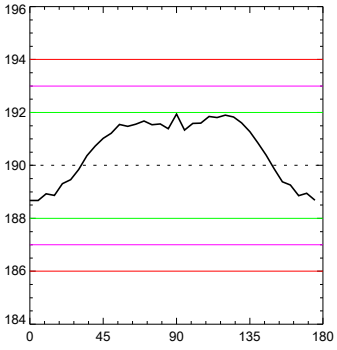
Upper=49.31
Lower=50.38
Slice Thickness=4.98

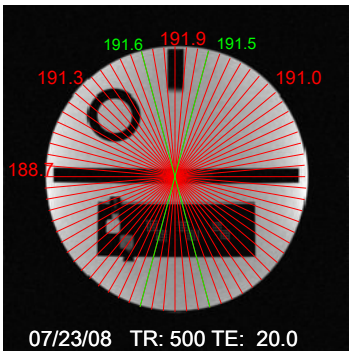
## Slice Position - Inferior



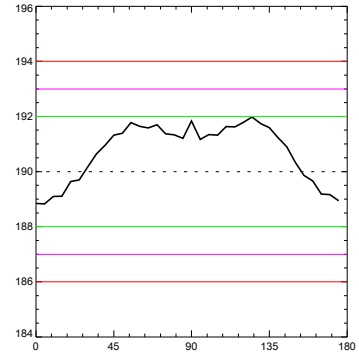


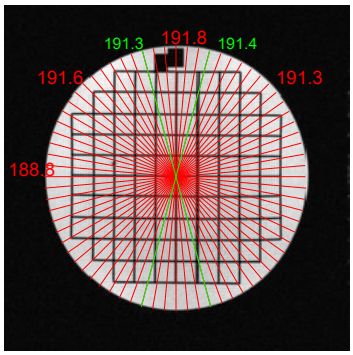

## Axial Diameters - #1



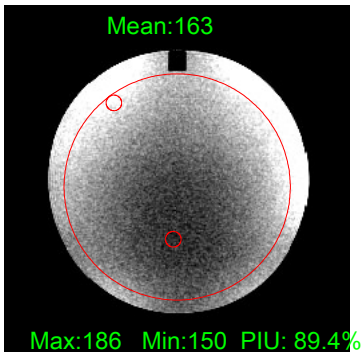


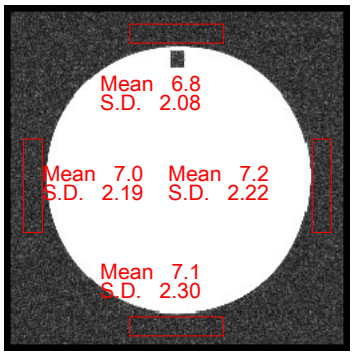

## Axial Diameters - #5



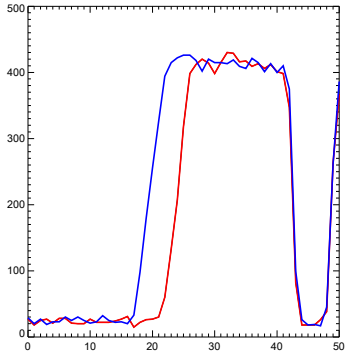


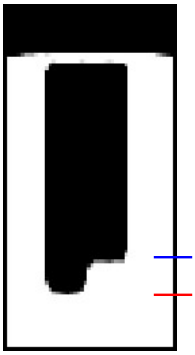

## Uniformity & Ghosting - #7



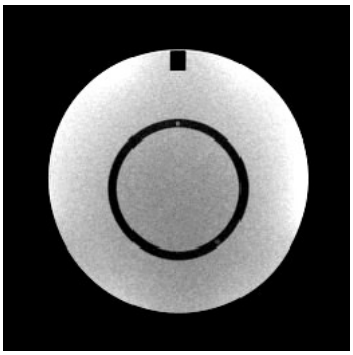




## Slice Position - Superior

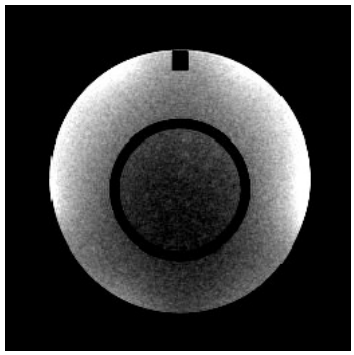




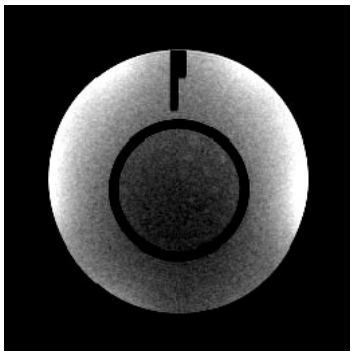

## Low Contrast - #8



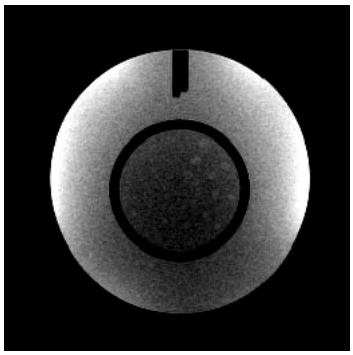
## Low Contrast - #9



## Low Contrast - #10



## Low Contrast - #11

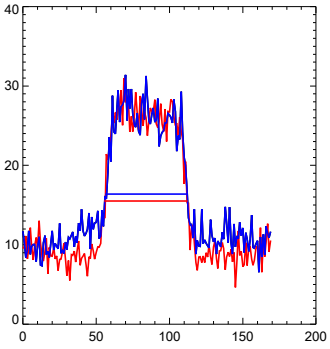


# Appendix C: ACR Phantom Analysis

ACR PD

High Contrast Resolution

Slice Thickness

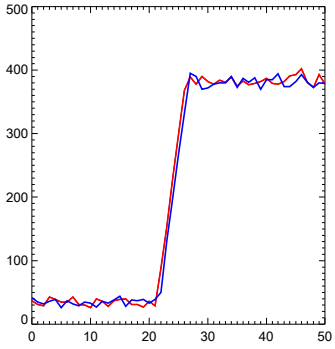


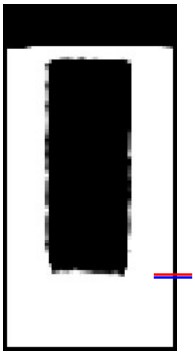

Upper=55.56

Lower=54.85

Slice Thickness=5.52

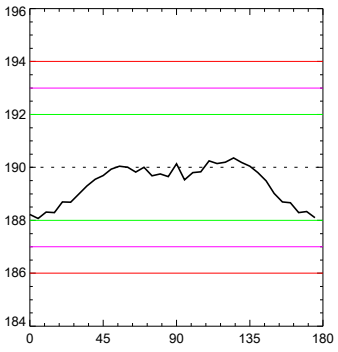
Slice Position - Inferior

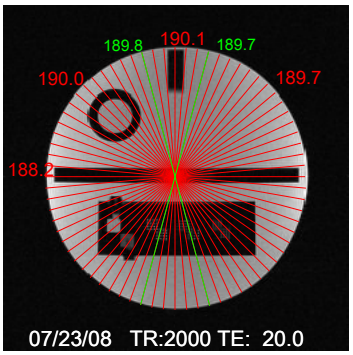


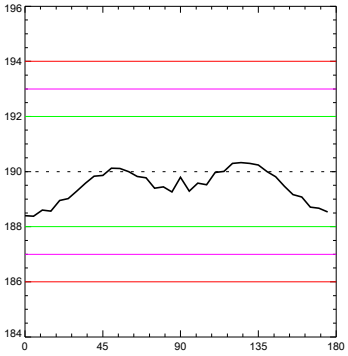
Diff.= 0.33

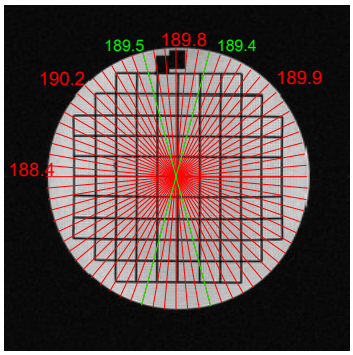
Axial Diameters - #1



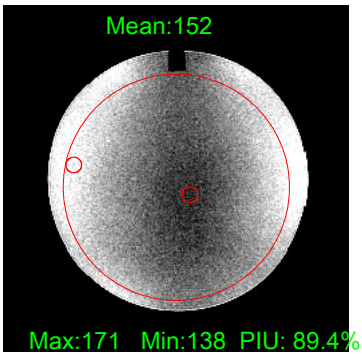



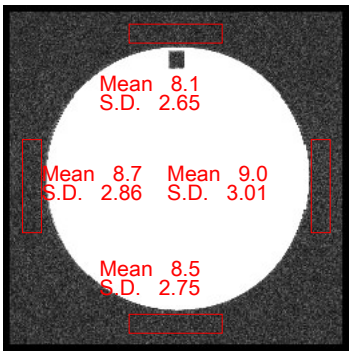

Axial Diameters - #5



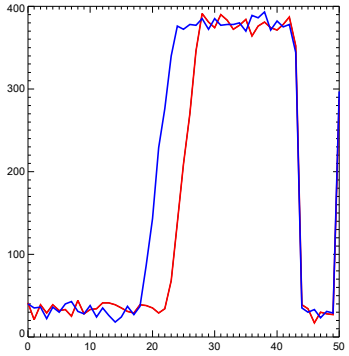



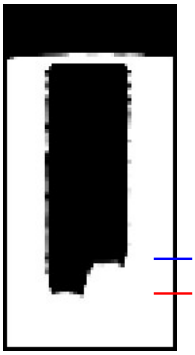

Uniformity & Ghosting - #7



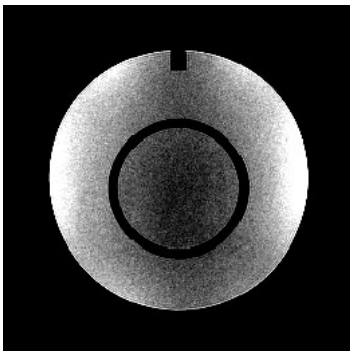

Slice Position - Superior



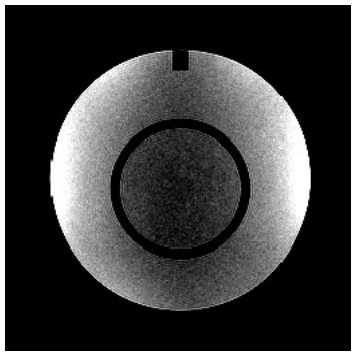



Diff.= -3.93

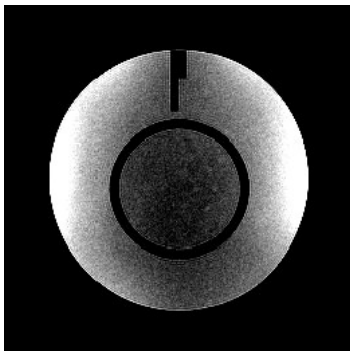
Low Contrast - #8



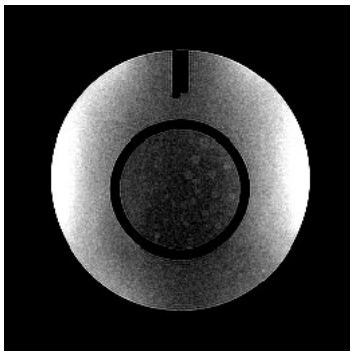
Low Contrast - #9



Low Contrast - #10



Low Contrast - #11

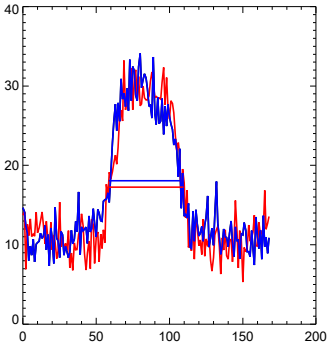


# Appendix C: ACR Phantom Analysis

ACR T2

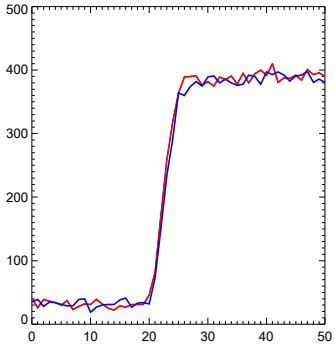
High Contrast Resolution

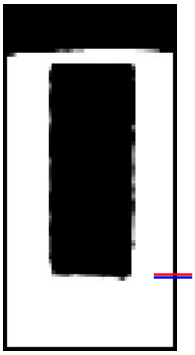
Slice Thickness




Upper=49.26
Lower=47.97
Slice Thickness=4.86

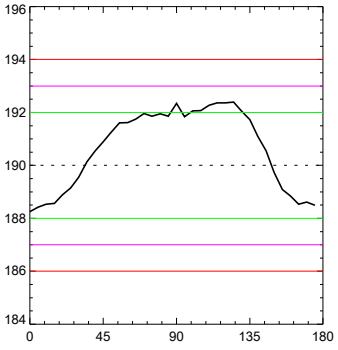
Slice Position - Inferior

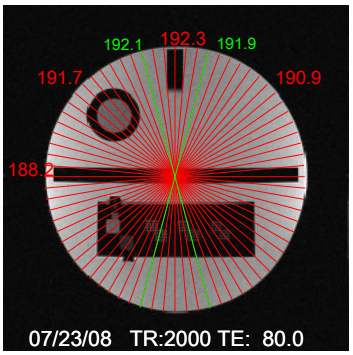


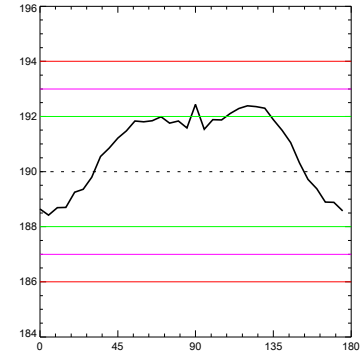
Diff.= 0.31

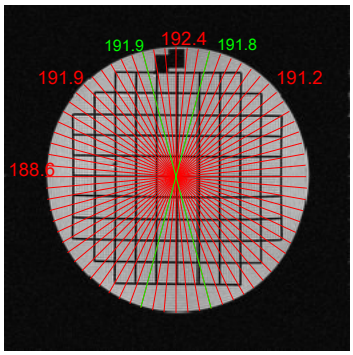
Axial Diameters - #1



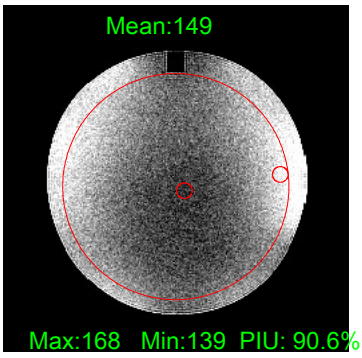



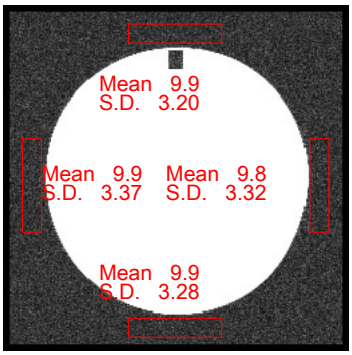

Axial Diameters - #5



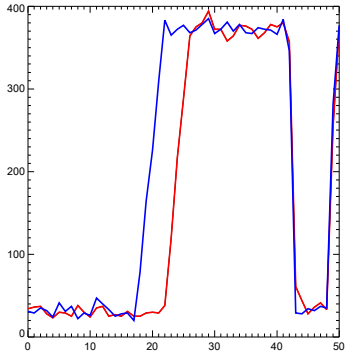



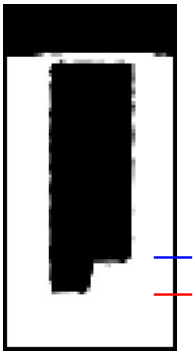

Uniformity & Ghosting - #7



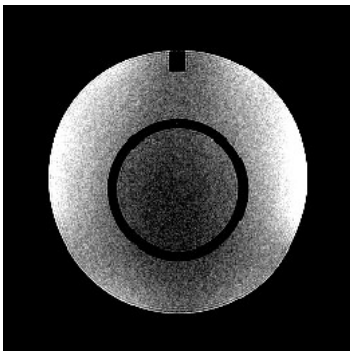

Slice Position - Superior



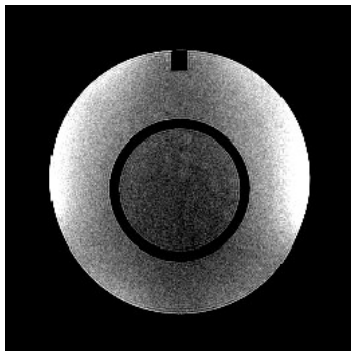



Diff.= -4.18

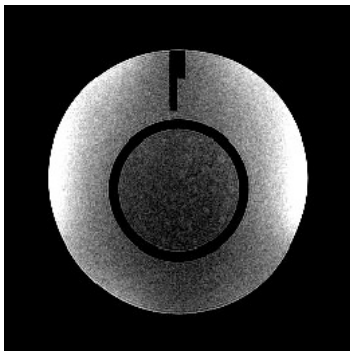
Low Contrast - #8



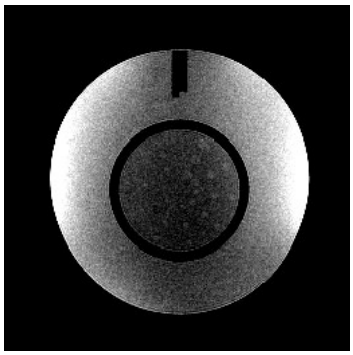
Low Contrast - #9



Low Contrast - #10



Low Contrast - #11

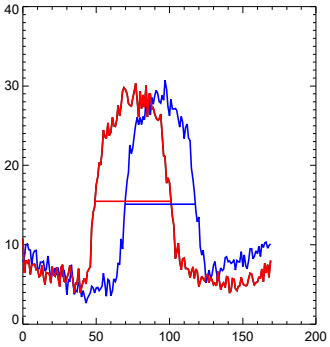


# Appendix C: ACR Phantom Analysis

Site T1

## High Contrast Resolution

## Slice Thickness

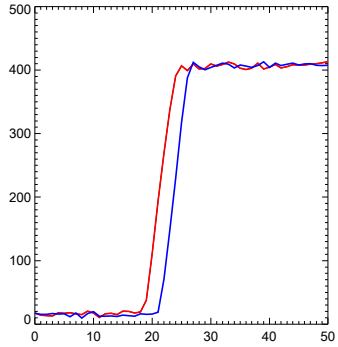


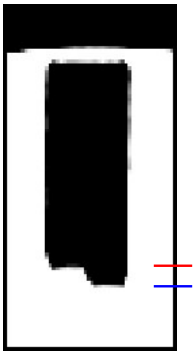

Upper=50.14

Lower=46.98

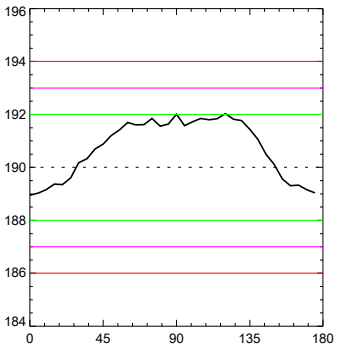
Slice Thickness=4.85

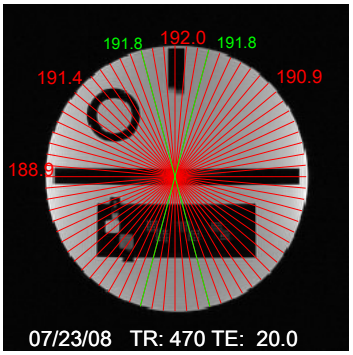
## Slice Position - Inferior



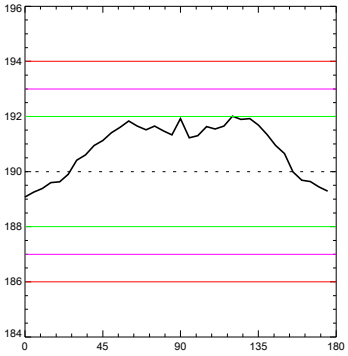



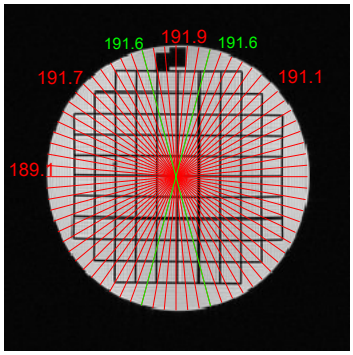

## Axial Diameters - #1



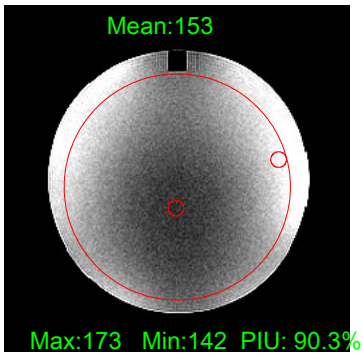



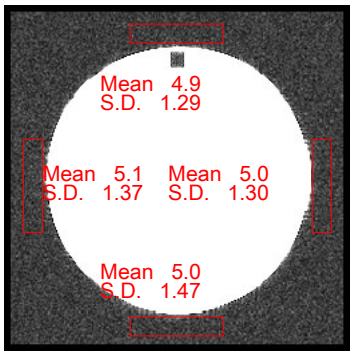

## Axial Diameters - #5



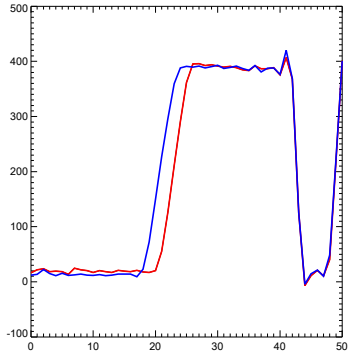



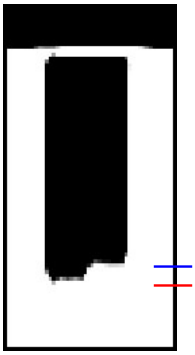

## Uniformity & Ghosting - #7



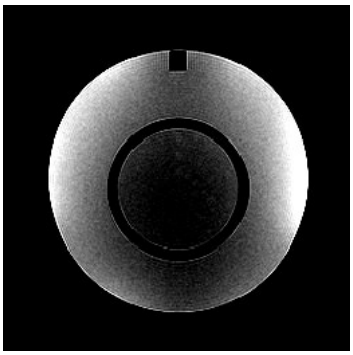




## Slice Position - Superior

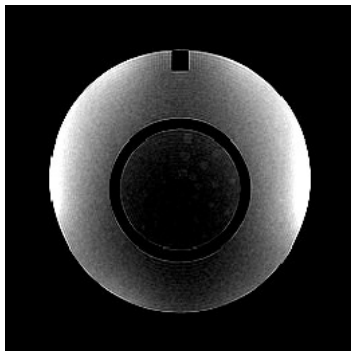


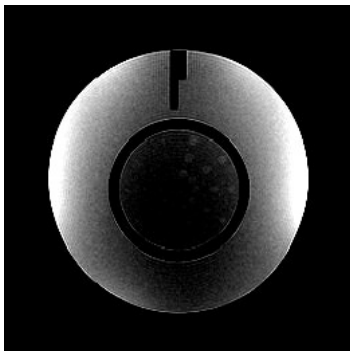

## Low Contrast - #8



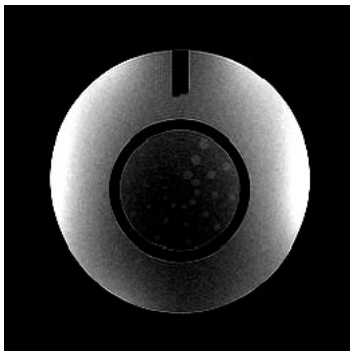
## Low Contrast - #9



## Low Contrast - #10



## Low Contrast - #11

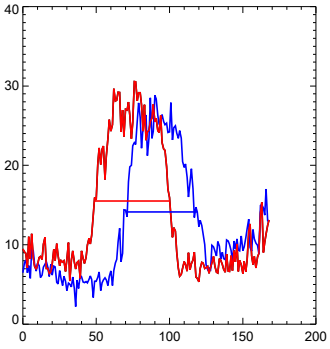


# Appendix C: ACR Phantom Analysis

Site T2

## High Contrast Resolution

## Slice Thickness

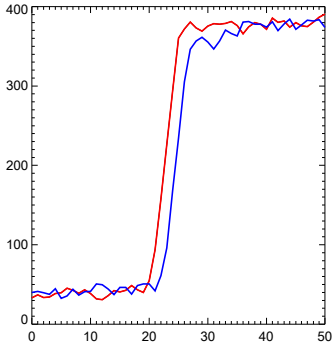



Upper=50.09

Lower=47.41

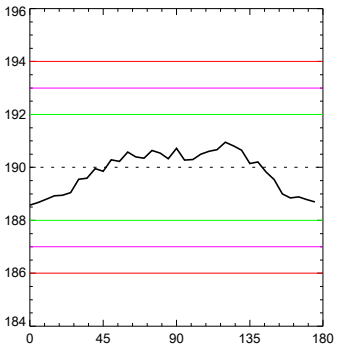
Slice Thickness=4.87

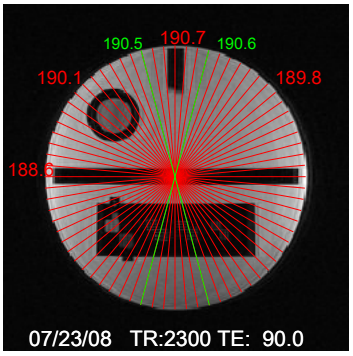
## Slice Position - Inferior



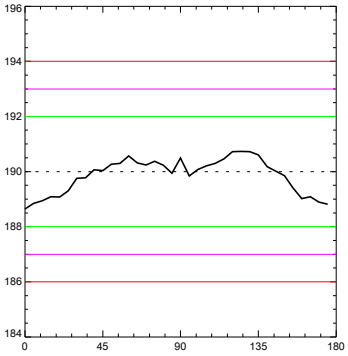

Diff.= 1.89

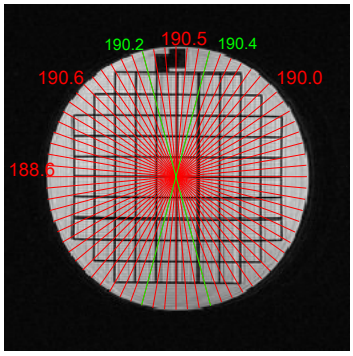
## Axial Diameters - #1



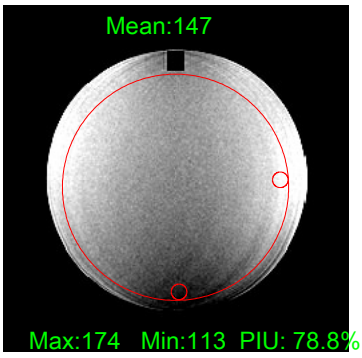



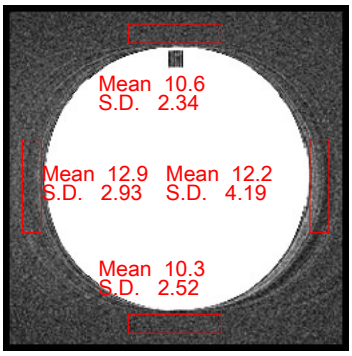

## Axial Diameters - #5



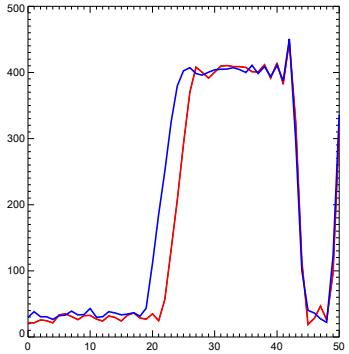



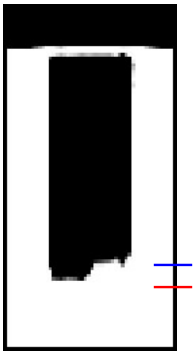

## Uniformity & Ghosting - #7



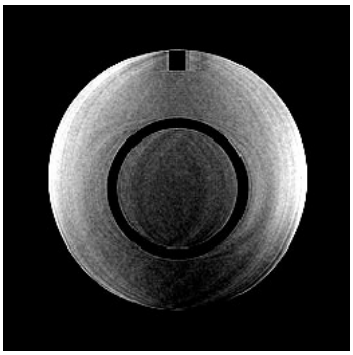

## Slice Position - Superior



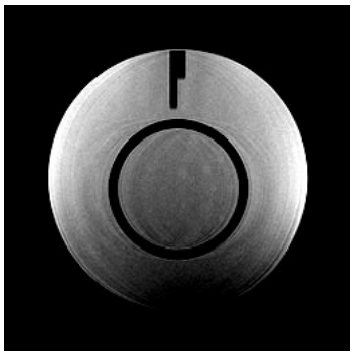
Diff.= -2.48

## Low Contrast - #8

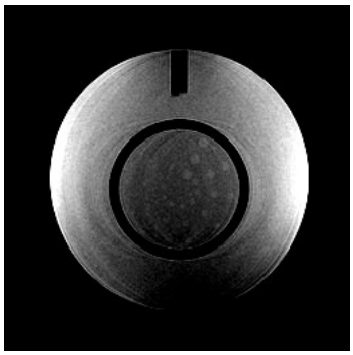


## Low Contrast - #9

## Low Contrast - #10



## Low Contrast - #11

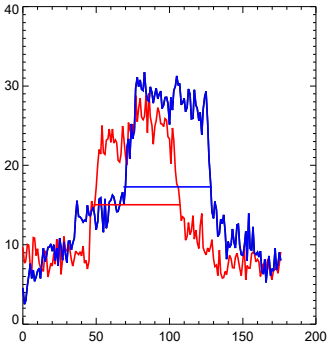


# Appendix C: ACR Phantom Analysis

Site PD

## High Contrast Resolution

## Slice Thickness

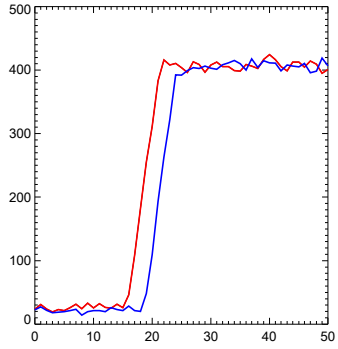


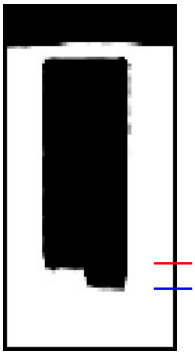

Upper=55.68

Lower=56.77

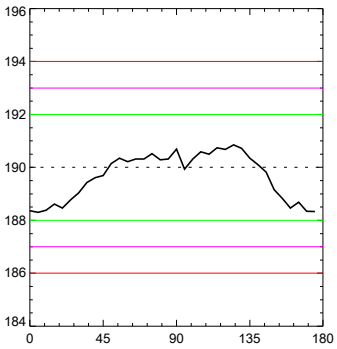
Slice Thickness=5.62

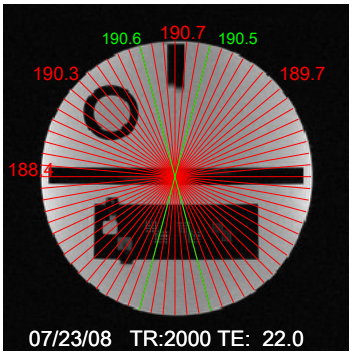
## Slice Position - Inferior



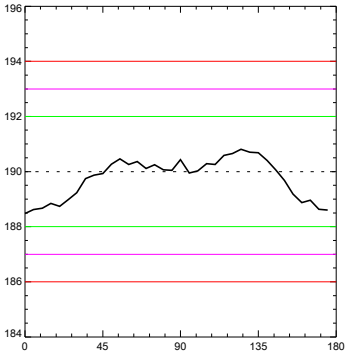



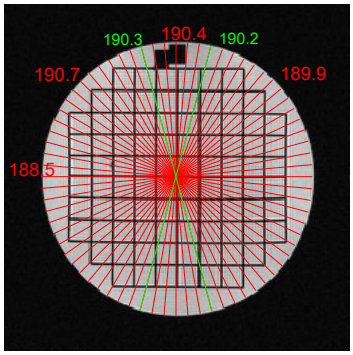

## Axial Diameters - #1



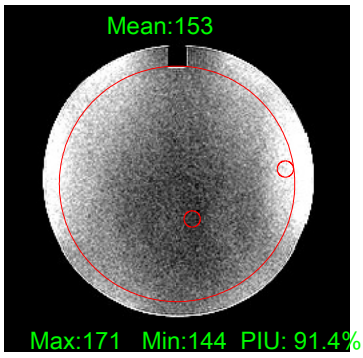



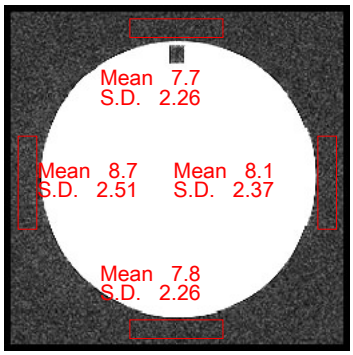

## Axial Diameters - #5



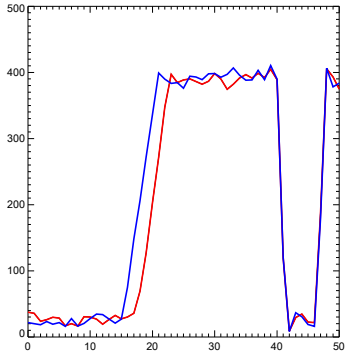



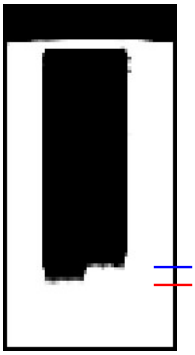

## Uniformity & Ghosting - #7



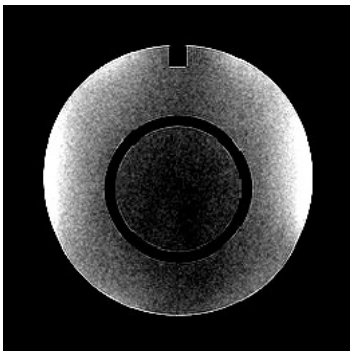




## Slice Position - Superior

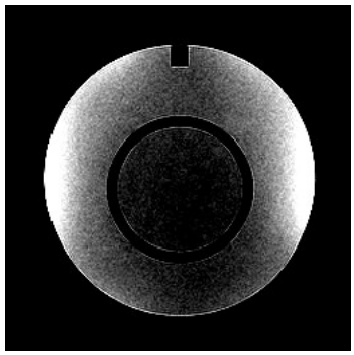


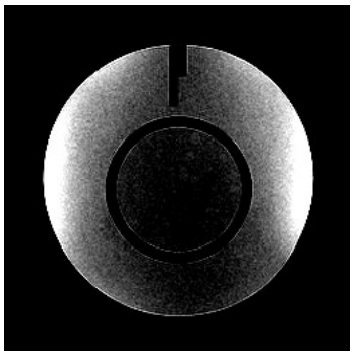

## Low Contrast - #8



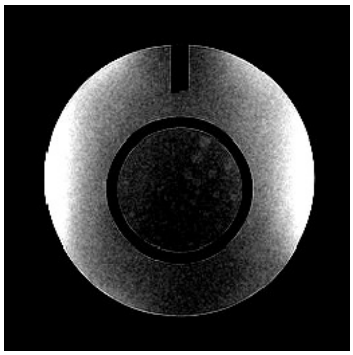
## Low Contrast - #9



## Low Contrast - #10



## Low Contrast - #11

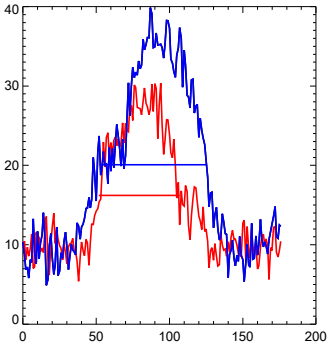


# Appendix C: ACR Phantom Analysis

Site PD/T2

## High Contrast Resolution

## Slice Thickness

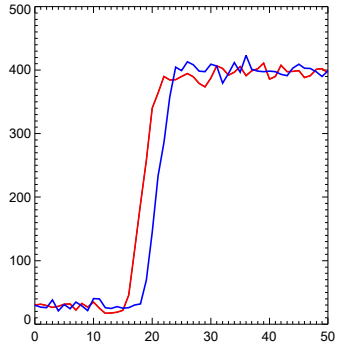


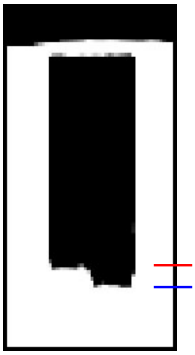

Upper=51.67

Lower=68.08

Slice Thickness=5.87

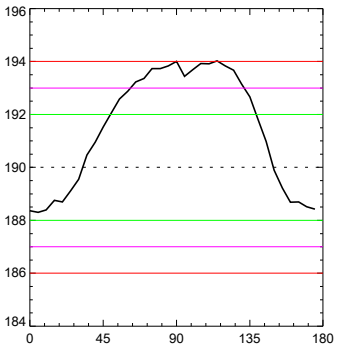
## Slice Position - Inferior

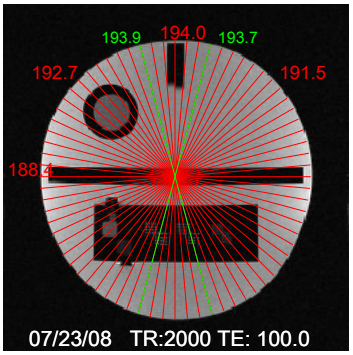


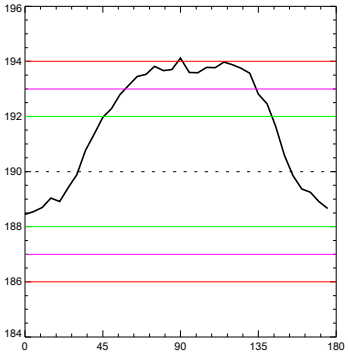
Diff.= 2.37

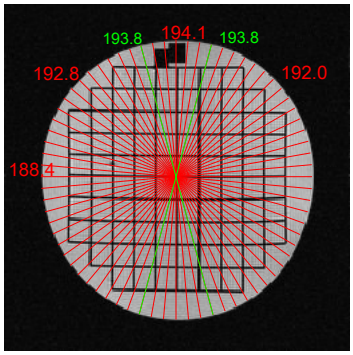
## Axial Diameters - #1



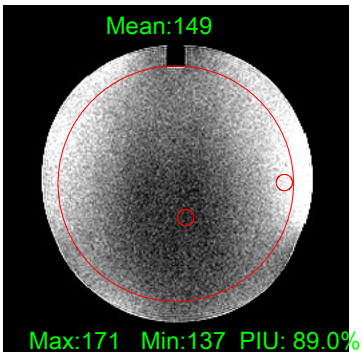



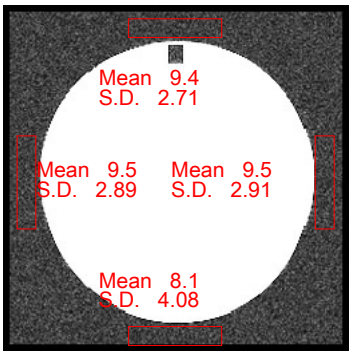

## Axial Diameters - #5



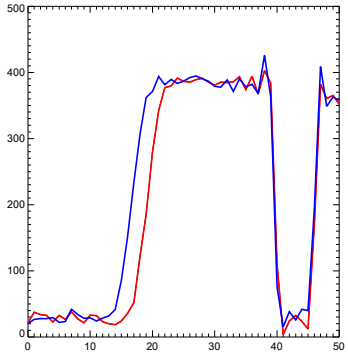



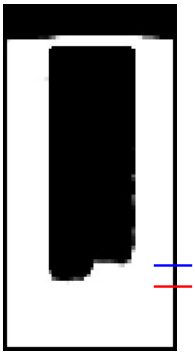

## Uniformity & Ghosting - #7



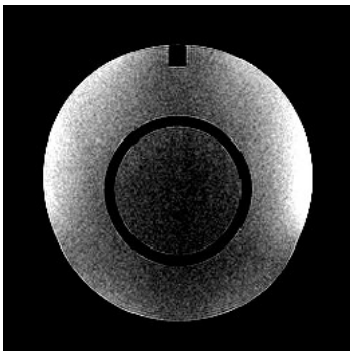

## Slice Position - Superior



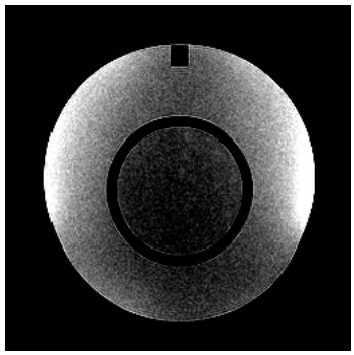



Diff.= -2.29

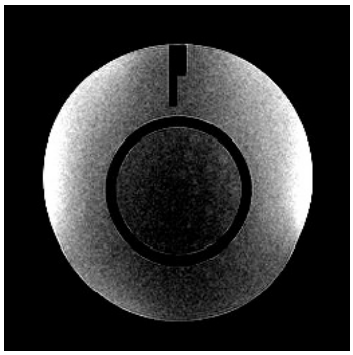
## Low Contrast - #8



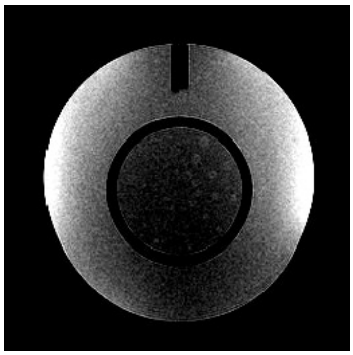
## Low Contrast - #9



## 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.