

# MRI homogeneity: Introduction and vendor-specific evaluation

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# Learning objectives

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- Understand what  $B_0$  homogeneity is, why it matters, and the challenges of this measurement
- Understand methods for measuring  $B_0$  homogeneity
  - General and specific
- Identify resources for background and step-by-step instructions on homogeneity testing



# What we'll cover

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- Homogeneity **OVERVIEW**
- An introduction to the main **METHODS** of measuring  $B_0$  homogeneity
- Step-by-step **PROCEDURES** for  $B_0$  homogeneity measurement on different vendor platforms
- **RESOURCES** for more information about theory and implementation of different  $B_0$  homogeneity testing methods



# Contributors

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TG325 MRI Resources website accessible to AAPM members:  
<https://w3.aapm.org/pubs/MRIResources/>



# $B_0$ inhomogeneity ( $\Delta B_0$ )

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- Measure of static magnetic field strength uniformity
- Influenced by
  - › Magnet design & manufacturing
  - › External ferromagnetic structures
  - › Shim compensation
  - › Phantom or patient in magnet
- Influences
  - › Chemical shift techniques: fat suppression (SPIR, SPAIR)
  - › Spectroscopy techniques
  - › Geometric distortion
  - › Signal uniformity
  - › Banding artifacts

# For diagnostic physicists...

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- Annual evaluation of  $B_0$  homogeneity required by **The Joint Commission** and for **American College of Radiology (ACR)** accreditation.
- Challenge:
  - Vendor phantoms, software tools, access level
  - Vendor accepted methods and tolerance levels
  - Quick on-site evaluation

## For therapy physicists...

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- Contributes to geometric distortion, especially near edges of FOV
  - Extensive and frequent QA procedures
- need quick, easy, meaningful  $B_0$  homogeneity evaluation approach

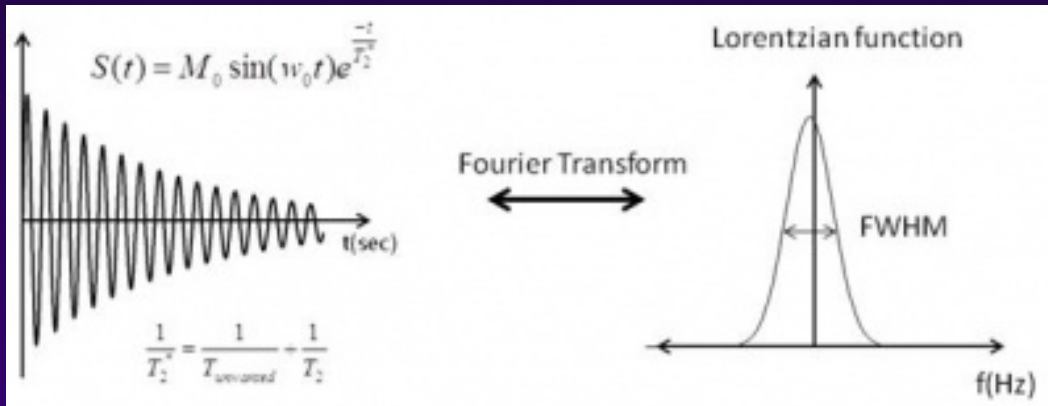
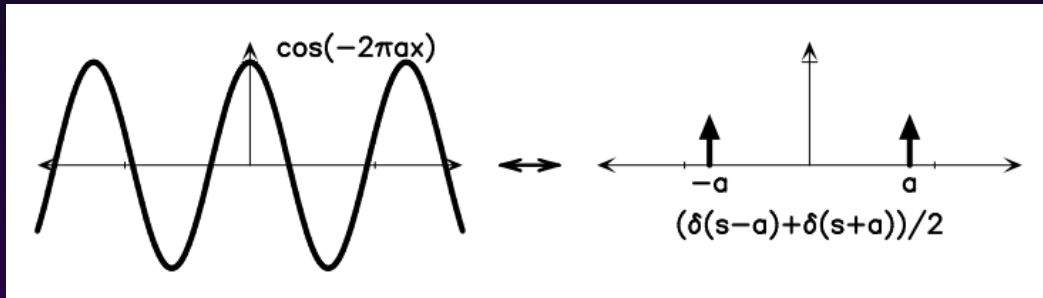
# Further considerations

- How to choose a method
  - Accessibility
  - Compatibility with vendor action limits
  - Output characteristics: 1D vs. 2D vs. 3D
  - Quick results at workstation
- How to establish tolerances

GE	Availability and accessibility	Immediately actionable by vendor	Provides spatial information	Quick results at workstation
<i>Spectral peak</i>	+	-	-	+
<i>Phase difference</i>	-	-	+	+
<i>Field mapping</i>	+	+	~ (multiple DSVs)	+
<i>Bandwidth difference</i>	+	-	-	+

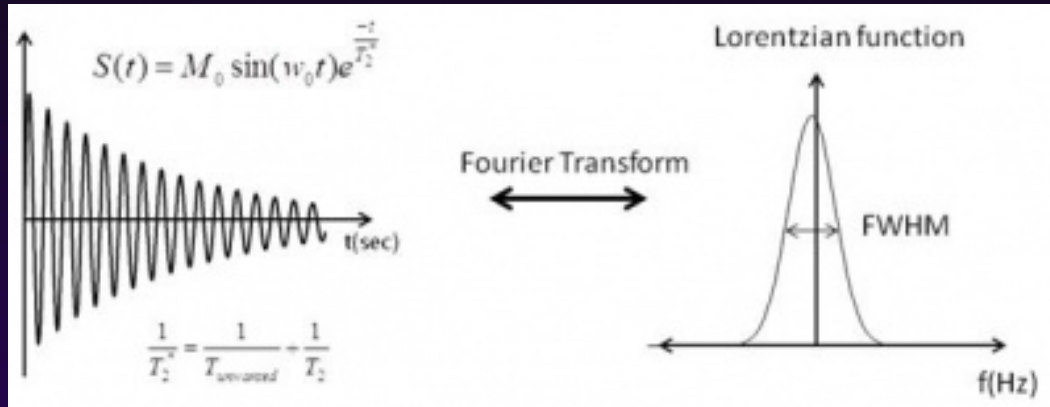


# $B_0$ inhomogeneity ( $\Delta B_0$ )



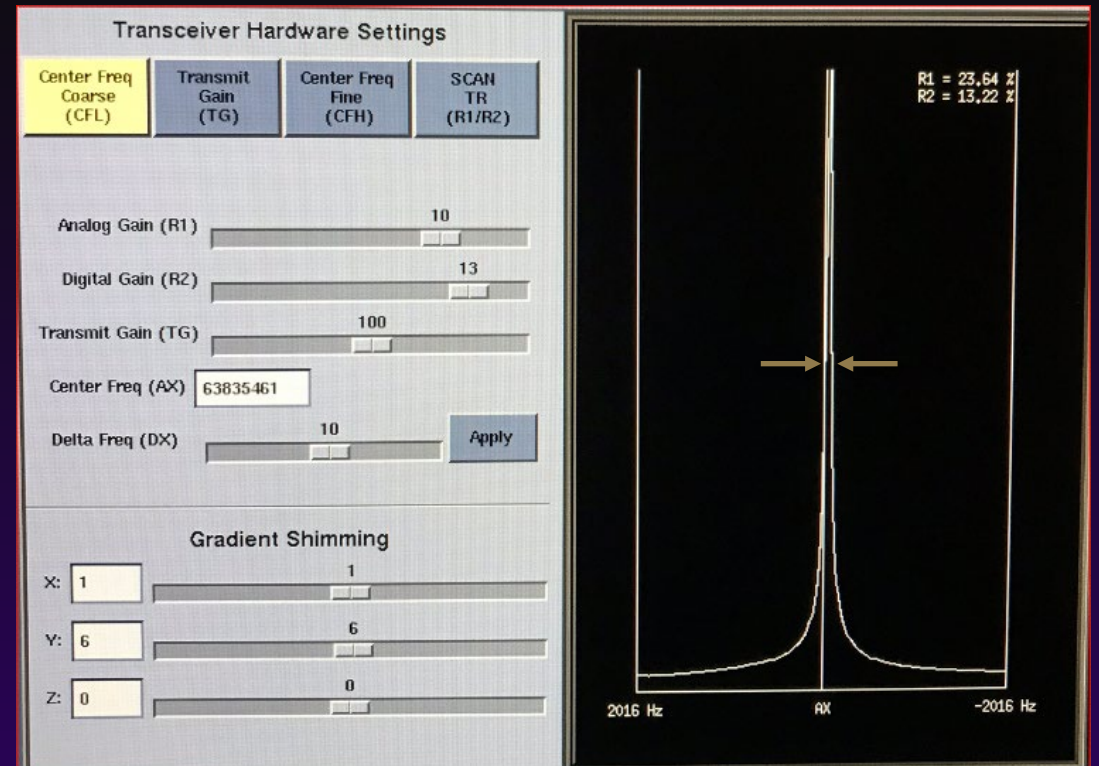
- Measure of static magnetic field strength uniformity
  - › Variation over a specified volume (DSV)
  - › Expressed in ppm or Hz
  - › **RMS** measurement of  $B_0$  inhomogeneity is volume-averaged
  - › **Peak-to-peak** requires a spatial measurement of variations

# Spectral peak



## Notes

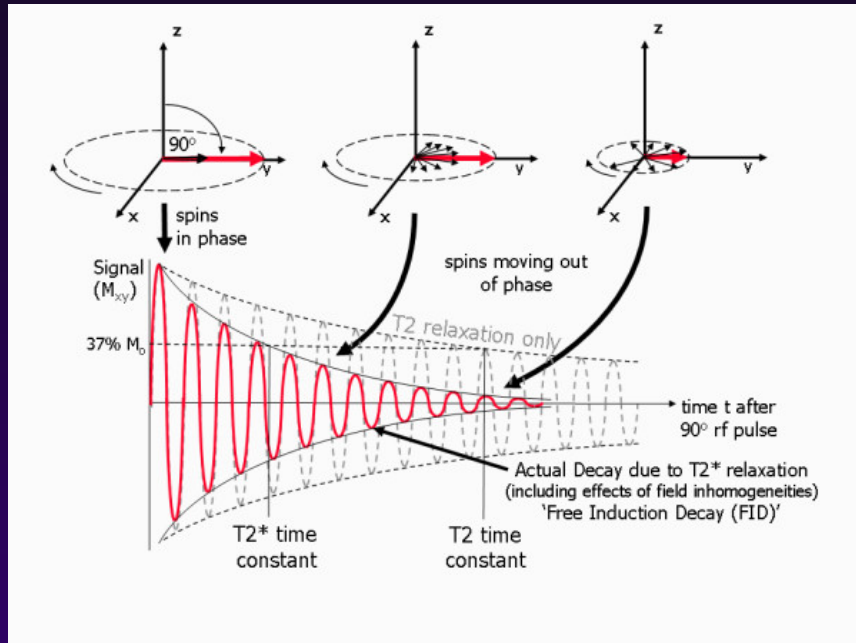
- + quick and simple
- no spatial information
- Global measure:  $B_{0,rms}$  only, not  $B_{0,pp}$
- DSV determined by phantom



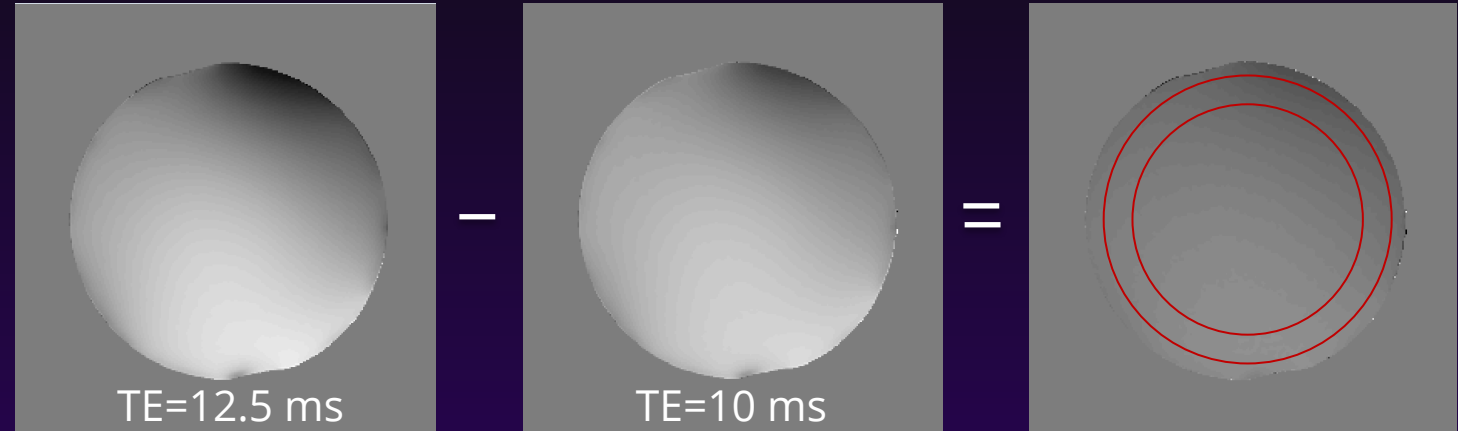
$$\Delta B_{0,rms} (ppm) = \frac{FWHM (Hz)}{\gamma \left( \frac{MHz}{T} \right) \times B_0 (T)}$$

$$\gamma = 42.56 \text{ MHz/T}$$

# Phase difference & phase map



Ridgway JP. *J Cardivasc Magn Reson* 2010. 12(1):71.



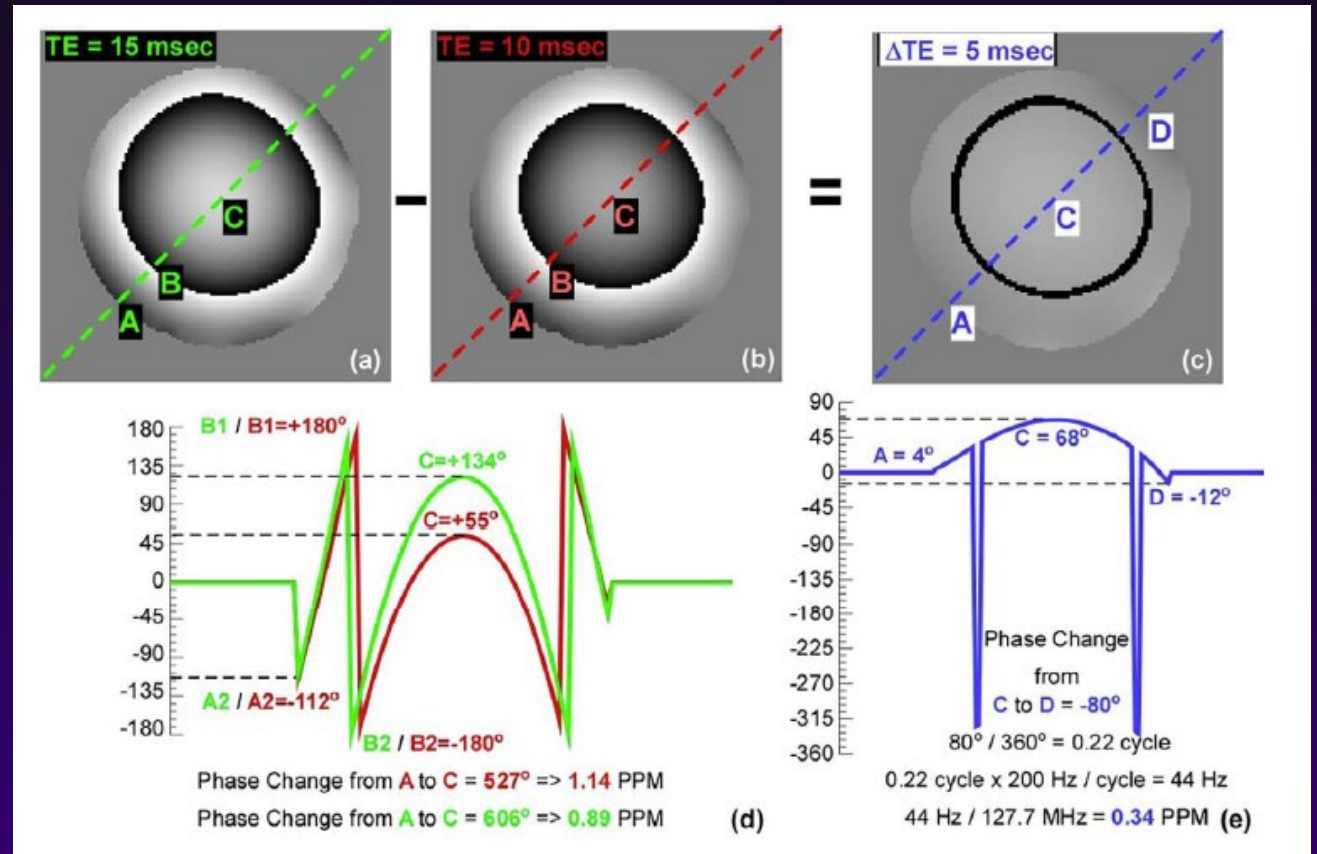
$$\Delta\phi_{pp} = \frac{ROI_{max} - ROI_{min}}{DR_{ADC}} \quad \Delta\phi_{rms} = \frac{\sqrt{ROI_{mean}^2 + ROI_{stdev}^2}}{DR_{ADC}}$$

$$\Delta B_0 \text{ (ppm)} = \frac{\Delta\phi}{\gamma B_0 \times \Delta TE}$$

# Phase difference & phase map

## Notes

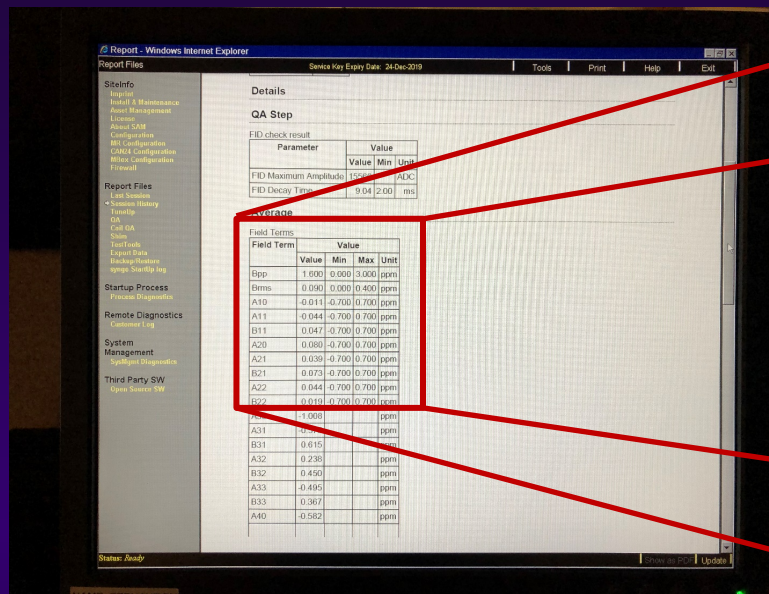
- + can perform in 3D (or 3 orthogonal planes)
  - + includes spatial information
  - phase image accessibility
  - phase wraps
  - analysis on scanner can be difficult
- $B_{0,rms}$  or  $B_{0,pp}$
  - DSV determined by ROI (user-selectable within phantom)
  - A single phase map can also be used to estimate upper bound of  $\Delta B_0$



ACR 2015 MRI Quality Control Manual

# Field map

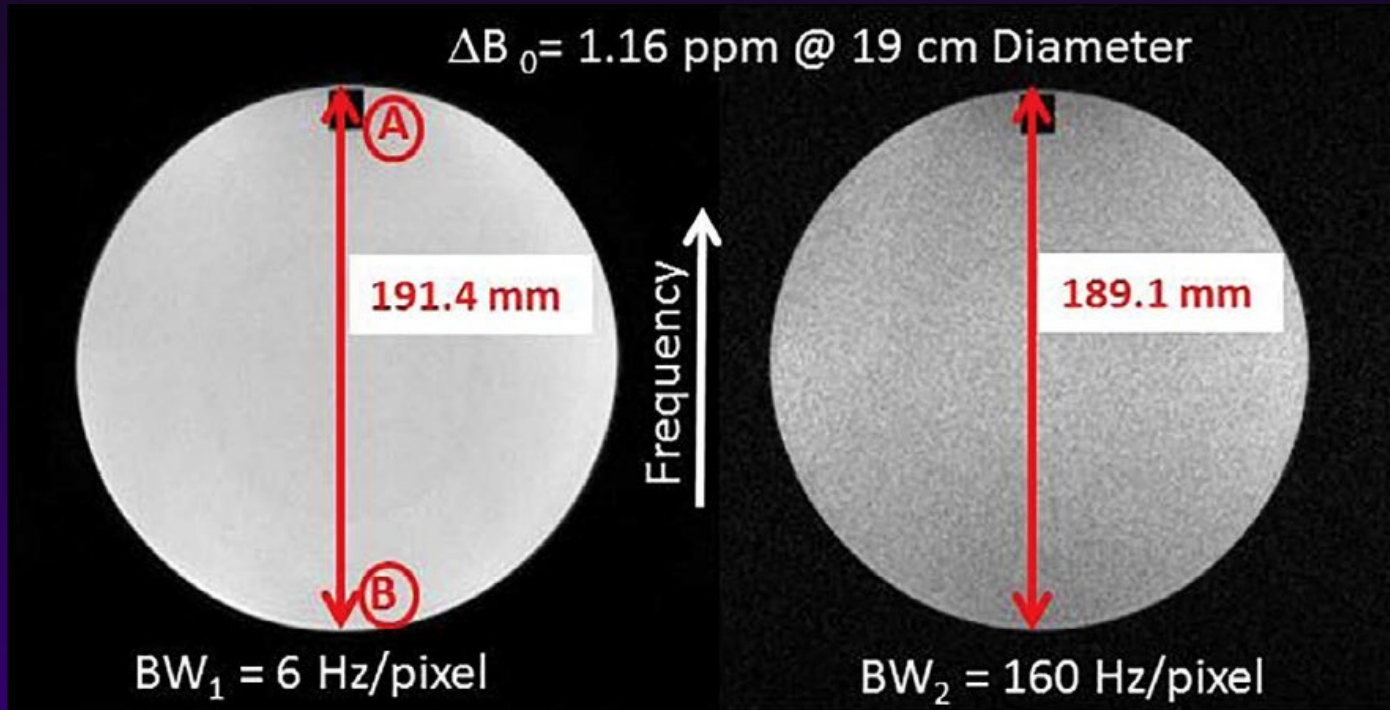
- If available, this is a straightforward vendor-provided capability
- 3D map acquired or created from 2D maps
- Comparable results to phase difference mapping



Field Term	Value			
	Value	Min	Max	Unit
Bpp	1.600	0.000	3.000	ppm
Brms	0.090	0.000	0.400	ppm
A10	-0.011	-0.700	0.700	ppm
A11	-0.044	-0.700	0.700	ppm
B11	0.047	-0.700	0.700	ppm
A20	0.080	-0.700	0.700	ppm
A21	0.039	-0.700	0.700	ppm
B21	0.073	-0.700	0.700	ppm
A22	0.044	-0.700	0.700	ppm
B22	0.019	-0.700	0.700	ppm



# Bandwidth difference



ACR 2015 MRI Quality Control Manual

$$\Delta B_0 \text{ (ppm)} = \frac{BW_1 \times BW_2 \times (x_1 - x_2)}{\gamma B_0 \times FOV \times (BW_2 - BW_1)}$$

(BW in Hz)

## Notes

- + accessible on all platforms
- many acquisitions & measurements for 3D evaluation
- assumes proper gradient calibration
- DSV determined by phantom or internal markers

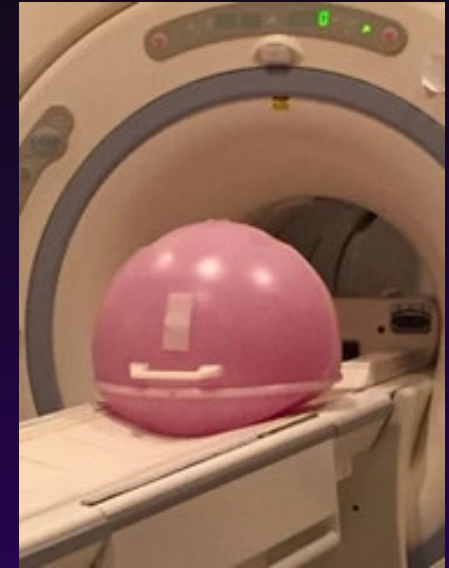
# Procedures by vendor

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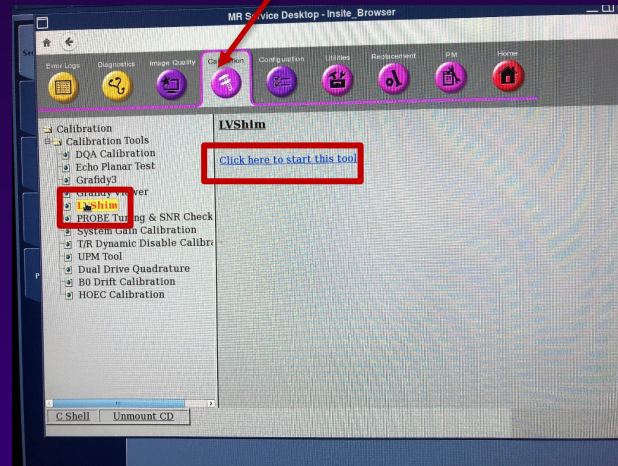
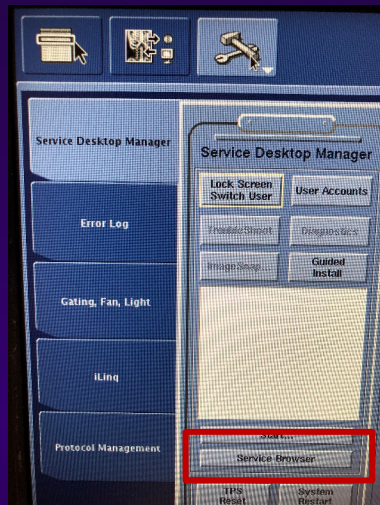
- Step-by-step instructions/button-ology
- Variation by software version, but this should provide a solid starting point
- Talk to vendor field engineer if you need guidance on your specific system

# GE: LV shim procedure

- Accessible field map function: Large Volume (LV) shim
- Phantom: 45 cm diameter LV shim phantom\*
- Coil: body coil



Calibration → Calibration tools → LV shim



→ "Click here to start this tool"  
→ Test  
→ Scan

\*no matter the phantom or procedure, let it rest a few minutes so fluid can settle



# GE: LV shim results

Shim Type for 3.0T Wide Bore  
Gradient Shim  
Text

Auto/Manual Mode  
Auto Mode Max Hz's:  
Manual Mode

Current E/S/I  
Exam: P0644  
Series: 1  
Image:

Initial Current	Scan 1	
0)/Z1	-0.30	[ NA]
0)/Z2	39.05	[ NA]
0)/Z3	21.58	[ NA]
0)/Z4	-44.97	[ NA]
0)/Z5	-52.74	[ NA]
0)/Z6	-58.51	[ NA]
1)/X	-0.96	[ NA]
-1)/X	-1.46	[ NA]
1)/ZY	-8.10	[ NA]
-1)/ZY	-2.83	[ NA]
-2)/YZ-YZ	-25.17	[ NA]
-2)/XY	12.05	[ NA]
1)/ZX	-5.34	[ NA]
-1)/ZX	36.89	[ NA]
-2)/YZ-ZY	10.88	[ NA]
-2)/XY	-6.57	[ NA]
-2)/XZ	-19.16	[ NA]
-2)/YZ	-6.34	[ NA]
x48 p2p (ppm)	24.417	[ NA]
x45 p2p (ppm)	12.013	[ 15.00]
x40 p2p (ppm)	4.049	[ 6.00]
x30 p2p (ppm)	0.795	[ 2.00]
x20 p2p (ppm)	0.294	[ 1.00]
x48 rms (ppm)	1.116	[ NA]
x45 rms (ppm)	0.585	[ 1.25]
x40 rms (ppm)	0.231	[ 1.00]
x30 rms (ppm)	0.091	[ 0.50]
x20 rms (ppm)	0.040	[ 0.10]

id shim: X/Y/Z 5 -11 -1

width: 45  
a Type: 400  
Test

pp  
or  
DSV rms

result spec

-3)/Y3		-6.34 [ NA]	
x48 p2p (ppm)	←	24.417 [ NA]	←
x45 p2p (ppm)		12.013 [ 15.00]	
x40 p2p (ppm)		4.049 [ 6.00]	
x30 p2p (ppm)		0.795 [ 2.00]	
x20 p2p (ppm)		0.294 [ 1.00]	
x48 rms (ppm)		1.116 [ NA]	
x45 rms (ppm)		0.585 [ 1.25]	
x40 rms (ppm)		0.231 [ 1.00]	
x30 rms (ppm)		0.091 [ 0.50]	
x20 rms (ppm)		0.040 [ 0.10]	

id shim: X/Y/Z 5 -11 -1

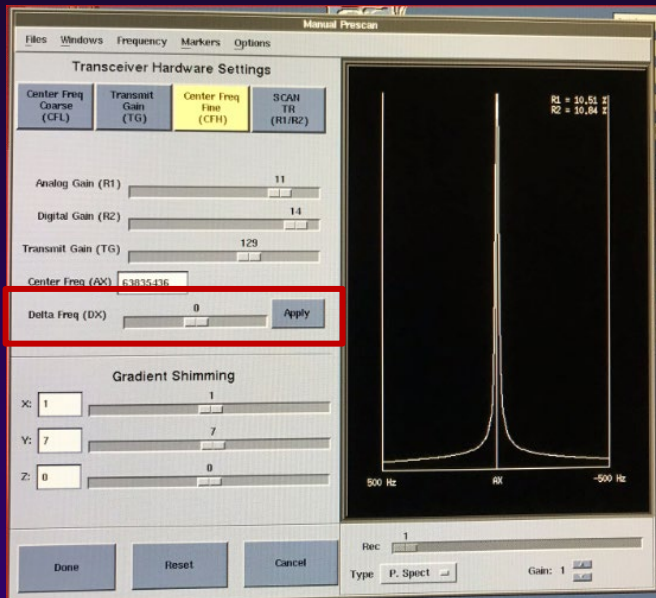
		-0.53 [ NA]	
		23.443 [ NA]	
		11.604 [ 15.00]	
		4.886 [ 6.00]	
		1.321 [ 2.00]	
		0.580 [ 1.00]	
		0.973 [ NA]	
		0.604 [ 1.25]	
		0.340 [ 1.00]	
		0.195 [ 0.50]	
		0.114 [ 0.10]	

-1

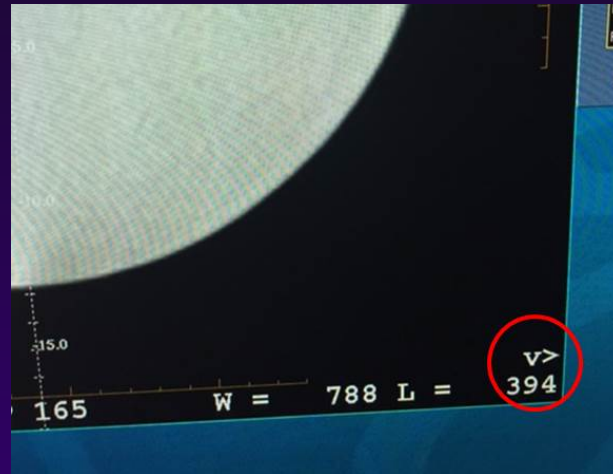
50645/1/1  
45  
400  
Test

# GE: Other options

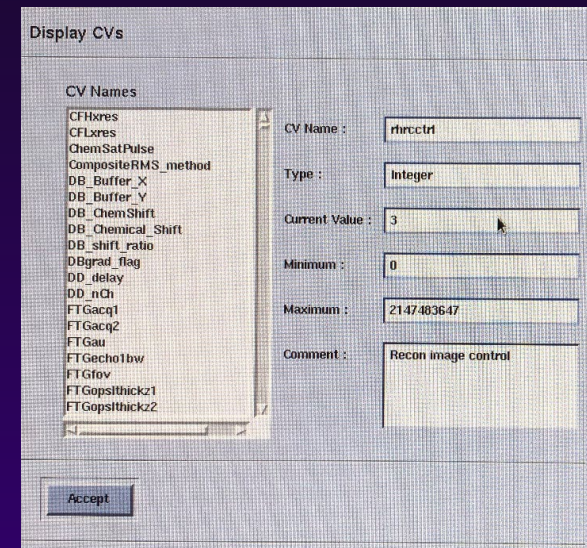
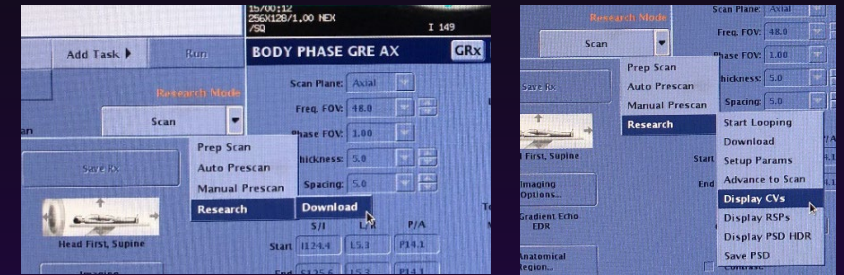
## Spectral peak in manual pre-scan



## Bandwidth difference



## Phase difference



CV rhrctrl = 3 for magnitude and phase (31 for magnitude, phase, real, imaginary)



# GE: Comparing methods

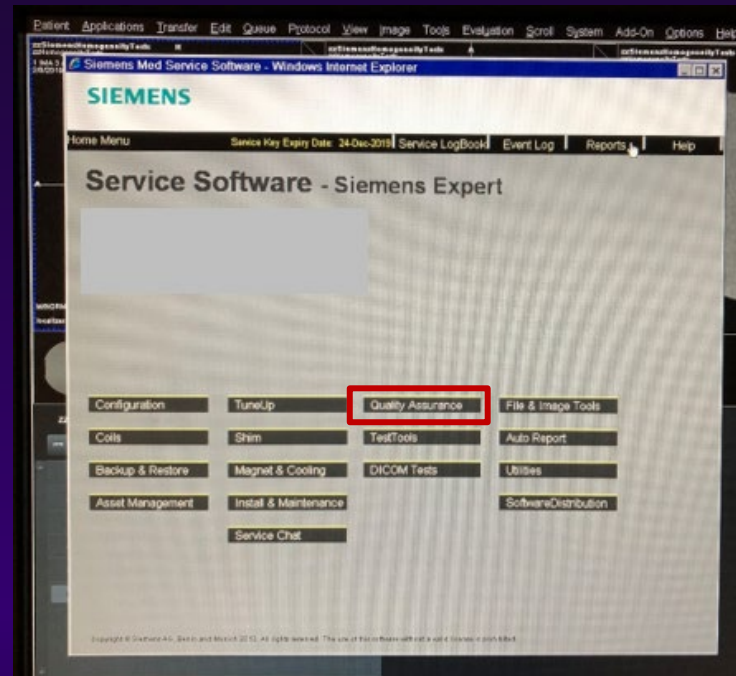
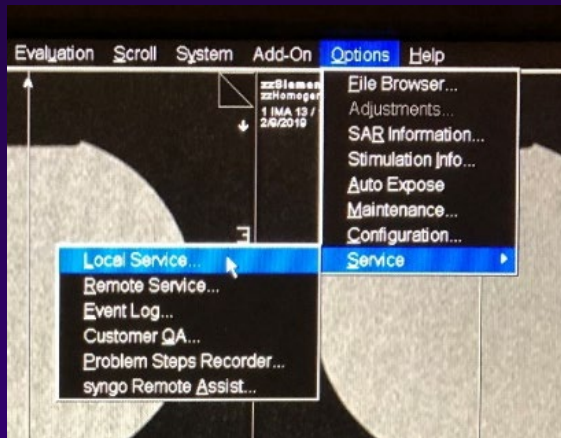
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GE	Availability and accessibility	Immediately actionable by vendor	Provides spatial information	Quick results at workstation
<i>Spectral peak</i>	+	-	-	+
<i>Phase difference</i>	-	-	+	+
<i>Field mapping</i>	+	+	~ (multiple DSVs)	+
<i>Bandwidth difference</i>	+	-	-	+



# Siemens: Phantom shim check procedure

- Accessible field map function: Phantom shim check
  - Requires a service password which is typically easily obtained
- Phantom: 24 cm homogenous sphere
- Coil: Body

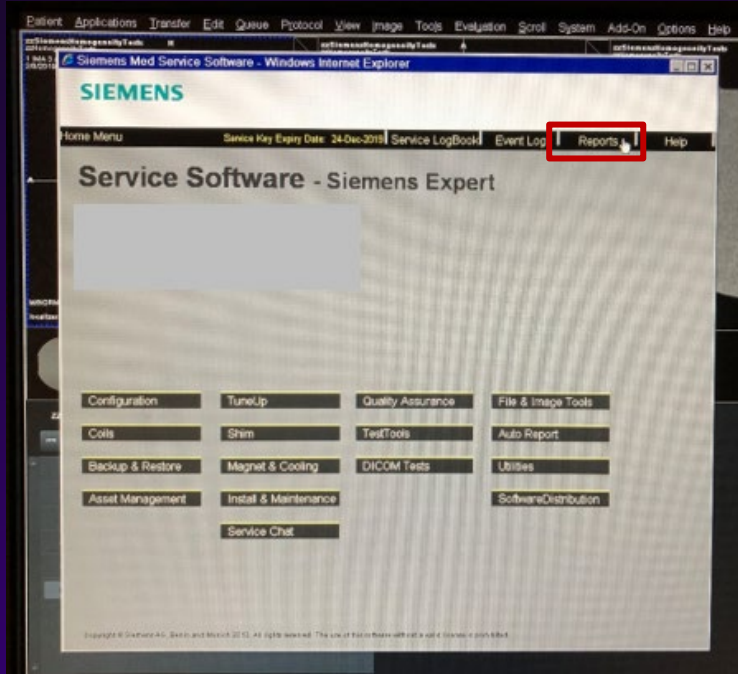


Quality Assurance → Phantom Shim Check



→ Hit "Go"

# Siemens: Phantom shim check results



Report - Windows Internet Explorer

Service Key Expiry Date: 24-Dec-2019

Report Files

SiteInfo

Function: Quality Assurance

Workflow	Function	Start	Status
Quality Assurance	Coil Check Body_18	18-Jan-2019, 21:03:46	Success
Quality Assurance	Coil Check Body_18	14-Jan-2019, 22:51:17	Out of Spec
Quality Assurance	Coil Check HeadNeck_20	12-Jan-2019, 12:39:23	Success
Quality Assurance	Coil Check Prostate_2_F_Sen	12-Jan-2019, 12:36:44	Success
Quality Assurance	Coil Check Prostate_2_F_Sen	12-Jan-2019, 12:31:26	Success
Quality Assurance	Coil Check Prostate_2_F_Sen	12-Jan-2019, 12:18:40	Out of Spec
Quality Assurance	Coil Check Prostate_2_F_Sen	12-Jan-2019, 12:14:06	Aborted
Quality Assurance	Coil Check 15Ch_A_Breast_F	12-Jan-2019, 12:06:52	Success
Quality Assurance	Coil Check Endorectal	12-Jan-2019, 12:02:54	Success
Quality Assurance	Coil Check TxRx_15Ch_knee	12-Jan-2019, 11:56:45	Success
Quality Assurance	Coil Check FlexSmall_4	12-Jan-2019, 11:52:35	Success
Quality Assurance	Coil Check FlexSmall_4	12-Jan-2019, 11:48:00	Success
Quality Assurance	Coil Check FlexLarge_4	12-Jan-2019, 11:44:12	Success
Quality Assurance	Coil Check FlexLarge_4	12-Jan-2019, 11:39:22	Success
Quality Assurance	Coil Check HandWrist_16	12-Jan-2019, 11:33:52	Success
Quality Assurance	Coil Check FootAnkle_16	12-Jan-2019, 11:25:03	Success
Quality Assurance	Coil Check ShoulderSmall_16	12-Jan-2019, 11:19:59	Success
Quality Assurance	Coil Check ShoulderLarge_16	12-Jan-2019, 11:14:31	Success
Quality Assurance	Coil Check Body_18	12-Jan-2019, 11:00:57	Success
Quality Assurance	Coil Check Body_18	12-Jan-2019, 10:46:24	Out of Spec
Quality Assurance	Coil Check Body_18	12-Jan-2019, 10:26:43	Out of Spec
Quality Assurance	Coil Check Body_18	12-Jan-2019, 10:04:53	Success
Quality Assurance	Coil Check PA_35_F	12-Jan-2019, 09:34:48	Success
Quality Assurance	Coil Check Spine_32	24-Dec-2018, 09:41:05	Success
Quality Assurance	Coil Check Spine_32	24-Dec-2018, 09:40:35	Success
Quality Assurance	Coil Check Spine_32	24-Dec-2018, 09:36:55	Out of Spec
Quality Assurance	Coil Check Spine_32	24-Dec-2018, 09:34:31	Out of Spec
Quality Assurance	Gradient Sensitivity Check	24-Dec-2018, 09:07:31	Success
Quality Assurance	Gradient Sensitivity Check	24-Dec-2018, 09:07:31	Success
Quality Assurance	Long Term Stability Check	24-Dec-2018, 09:05:23	Success
Quality Assurance	Synthesizer Check	24-Dec-2018, 08:56:22	Success
Quality Assurance	Stability Check	24-Dec-2018, 08:50:15	Success
Quality Assurance	RF Noise Check	24-Dec-2018, 08:50:15	Success
Quality Assurance	Spike Check	24-Dec-2018, 08:50:03	Success
Quality Assurance	Gradient Rise Time Check	24-Dec-2018, 08:45:58	Success
Quality Assurance	Gradient Rise Time Check	24-Dec-2018, 08:45:58	Success

Phantom Shim Check

Service Key Expiry Date: 24-Dec-2019

Details

QA Step

FID check result

Parameter	Value		
	Value	Min	Unit
FID Maximum Amplitude	15566		ADC
FID Decay Time	9.04	2.00	ms

Average

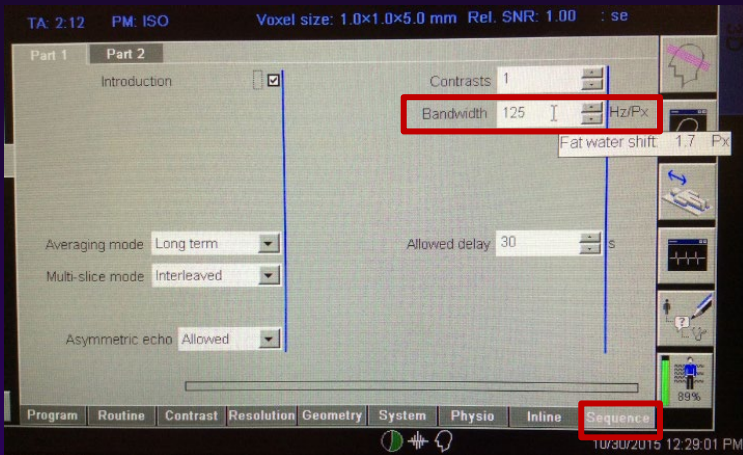
Field Terms

Field Term	Value			
	Value	Min	Max	Unit
Bpp	1.600	0.000	3.000	ppm
Brms	0.090	0.000	0.400	ppm
A10	-0.011	-0.700	0.700	ppm
A11	-0.044	-0.700	0.700	ppm
B11	0.047	-0.700	0.700	ppm
A20	0.080	-0.700	0.700	ppm
A21	0.039	-0.700	0.700	ppm
B21	0.073	-0.700	0.700	ppm
A22	0.044	-0.700	0.700	ppm
B22	0.019	-0.700	0.700	ppm
A30	-1.008			ppm
A31	-0.575			ppm
B31	0.615			ppm
A32	0.238			ppm
B32	0.450			ppm
A33	-0.495			ppm
B33	0.367			ppm
A40	-0.582			ppm



# Siemens: Other options

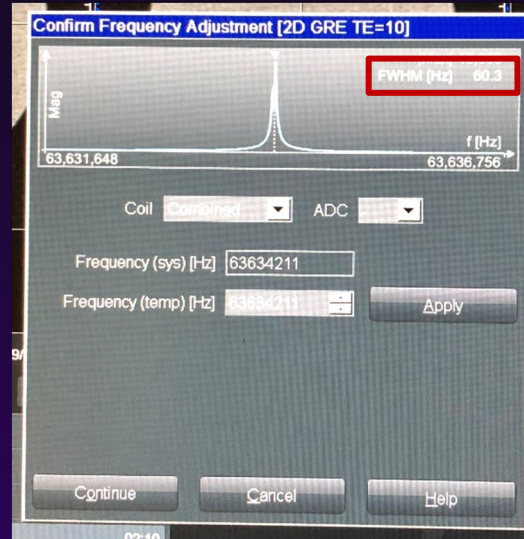
BW difference is generally accessible



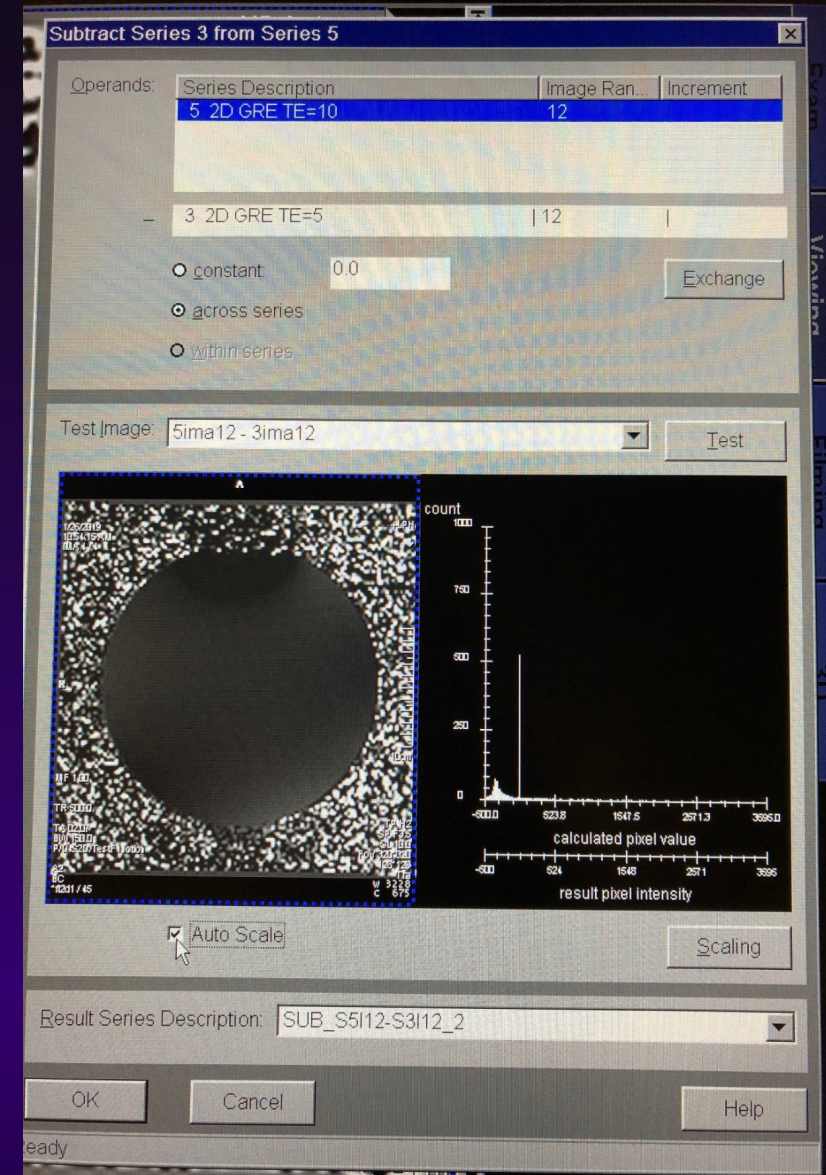
$$\Delta B_o \text{ (ppm)} = \frac{BW_1 \times BW_2 \times (x_1 - x_2)}{\gamma \times B_0 \times FOV \times (BW_2 - BW_1)}$$

BW in Hz – multiply Hz/pixel by number of pixels in FE direction

Spectral peak (newer systems)



- After localizer, while setting up another protocol, System → Adjustments → Confirm frequency adjustment
- After pre-scan begins, spectrum displayed
- FWHM displayed or estimate by moving vertical line



# Siemens: Comparing methods

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Siemens	Availability and accessibility	Immediately actionable by vendor	Provides spatial information	Quick results at workstation
<i>Spectral peak</i>	+	-	-	+
<i>Phase difference</i>	+	-	+	+
<i>Phantom shim check</i>	+	+	-	+
<i>Bandwidth difference</i>	+	-	-	+

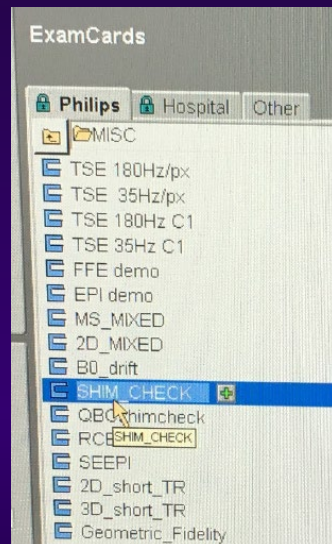


# Philips: Shim check procedure

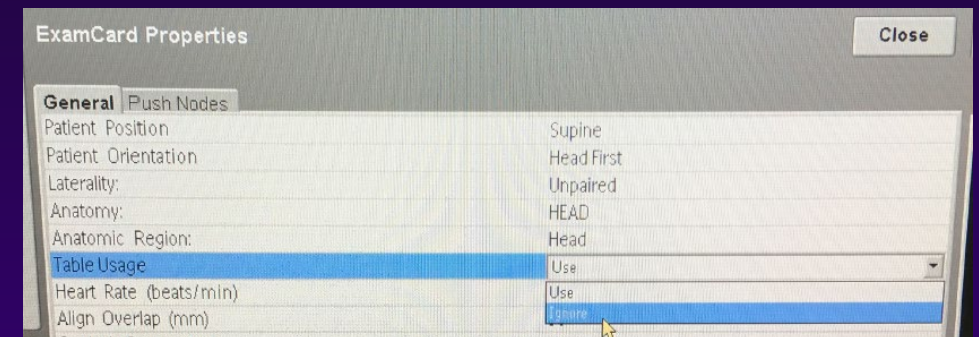
- Accessible field map function: Shim check
- Phantom: 40 cm disk
- Coil: Body



Phantom studies → MISC

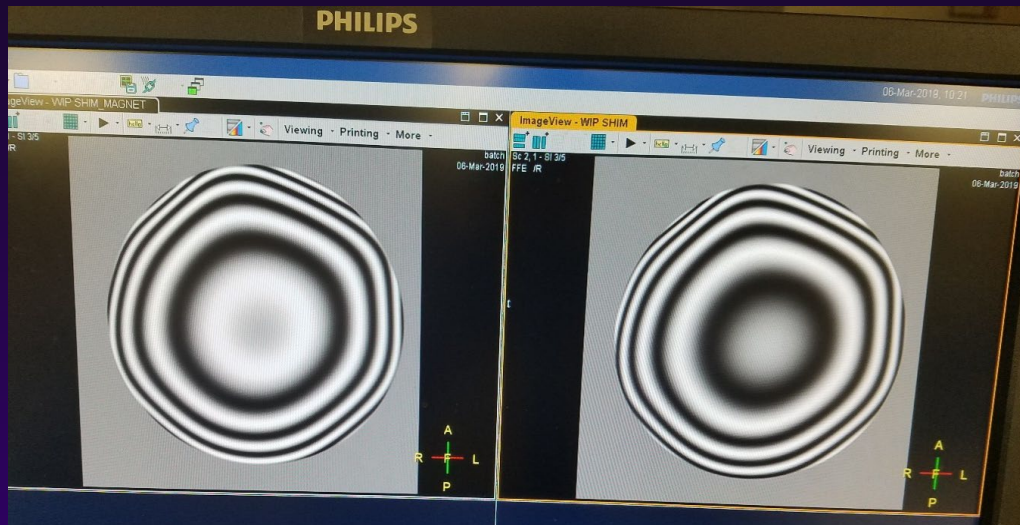


Run as is. Example 1.5T parameters below	
Sequence	FFE
TR	400 ms
TE	16 ms
FA	30°
FOV	45 cm





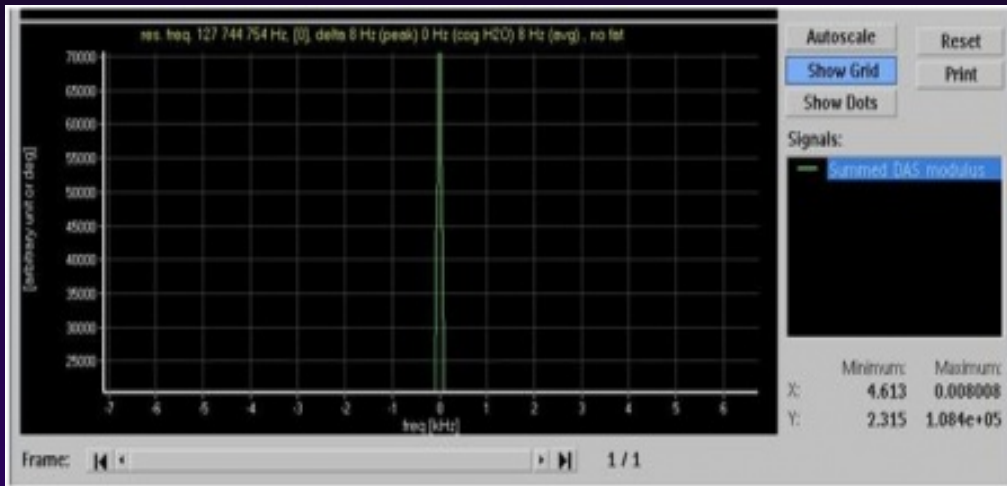
# Philips: Shim check results



- Each B→W transition is 1.0ppm. (1 full cycle is 1.0 ppm)
- Count number N of B→W transitions,  $\Delta B_{0,pp} = N \times 1.0ppm$
- Re-position phantom and run in 3 planes

# Philips: Other options

## Spectral peak



After running non-survey scan  
Examination → Data Monitoring →  
F0 → Show Latest  
Zoom in on half of Y Maximum to estimate FWHM

## BW difference

- Older systems display fat-water shift in pixels instead of bandwidth/pixel
- Calculate Hz/pixel:

$$\frac{\text{Hz}}{\text{pixel}} = \frac{3.5\text{ppm} \times \gamma \left( \frac{\text{MHz}}{T} \right) \times B_0(T)}{\text{fat} - \text{water shift (pix)}}$$

## Phase difference map

- Phase images can be reconstructed also by selecting M (magnitude) and P (phase) on Postproc → Images on the exam card.
- Use image algebra in viewing environment to subtract
- If necessary, reduce TE difference to reduce phase wraps

## Field mapping

- SPT tools can be used with a service dongle

# Philips: Comparing methods

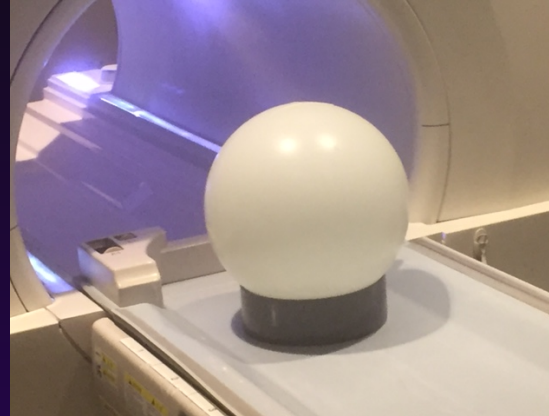
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<b>Siemens</b>	<b>Availability and accessibility</b>	<b>Immediately actionable by vendor</b>	<b>Provides spatial information</b>	<b>Quick results at workstation</b>
<i>Spectral peak</i>	+	-	-	+
<i>Phase difference</i>	+	-	+	+
<i>Shim check</i>	+	+	-	+
<i>Field mapping</i>	-	+	+	+
<i>Bandwidth difference</i>	+	-	-	+



# Toshiba/Canon: Phase difference procedure

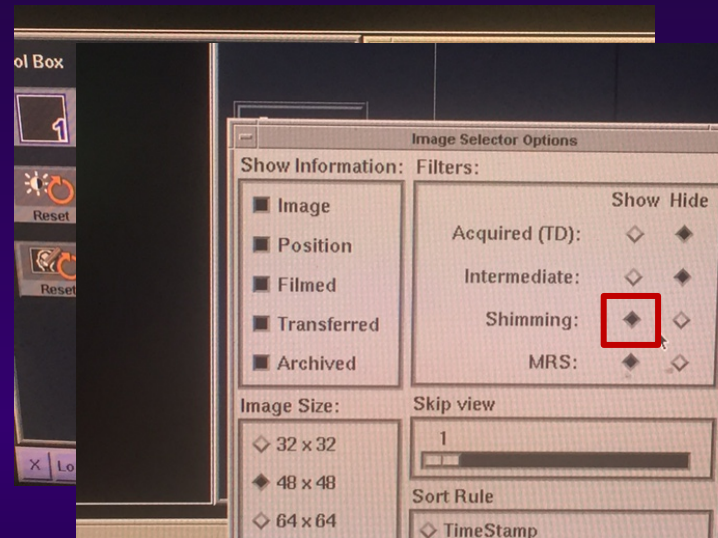
- Phantom: 30 cm spherical
- Coil: Body
- Protocol: FE\_AAS



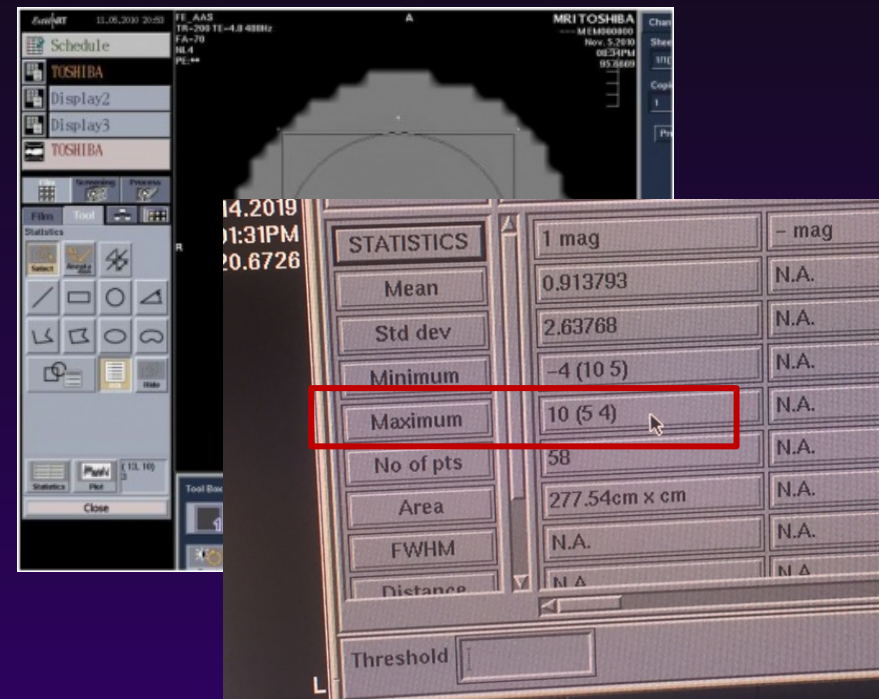
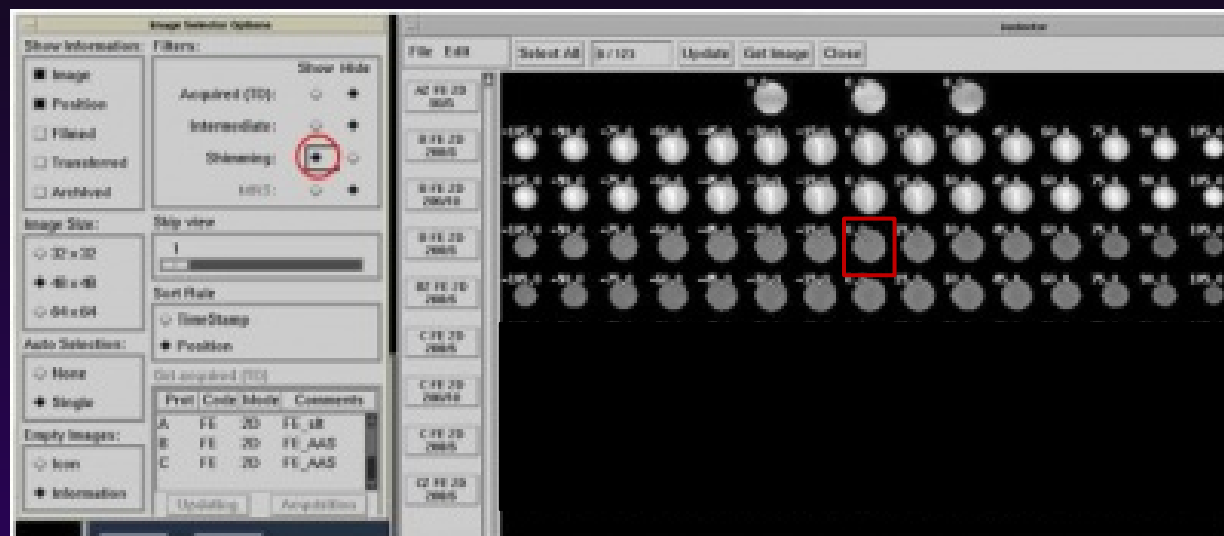
	Scan ID	Time	Mode	Plane	In. Tech	TR	TE
TP:SE	FE_AAS	00:04	----	RX:RL	FE 2D	200	4.5/2.5
TP:FE	FE_slt	00:13	----	RX:RL	FE 2D	50	9
TP:FE3D	FE_fc	00:13	----	RX:RL	FE 2D	50	5.5
TP:IR	FE_fc_skip	00:13	----	RX:RL	FE 2D	50	9
TP:FSE	FE_loc	00:02	----	RX:RL	FE 2D	10	1.5
TP:FSE3D	FE_map	00:11	----	RX:RL	FE 2D	180	4
TP:FFE	FE_skip	00:13	----	RX:RL	FE 2D	50	1.7
TP:FFE3D	FE_spc	00:27	----	RX:RL	FE 2D	102	45
TP:FASE							
TP:FASE3D							
TP:HVEPI							
TP:SEPI+							

Run in axial plane

Image selector window



# Toshiba/Canon: Phase difference results



- Repeat in sagittal and coronal planes
- Field homogeneity (within DSV = ROI diameter) is the absolute max pixel value found in the ROI in any plane
- Absolute pixel value of 100 corresponds to 1 ppm

# Hitachi: Fine magnetic field analysis set-up

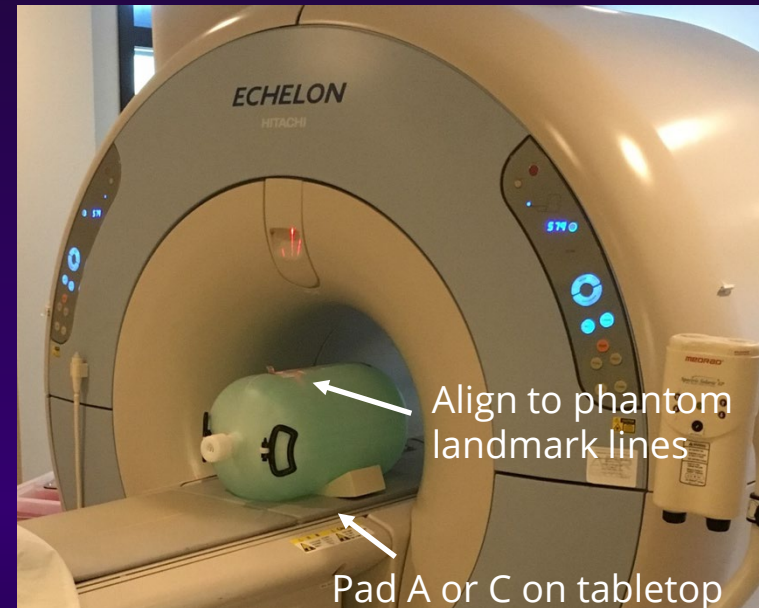
- Oasis & Echelon
- Phantom: Bottle 11
- Coil: RAPID body (Oasis) or T/R Body (Echelon)
- Protocol: Fine magnetic field analysis tool



Oasis

RAPID body coil, laterally centered, no pads (required for valid results)

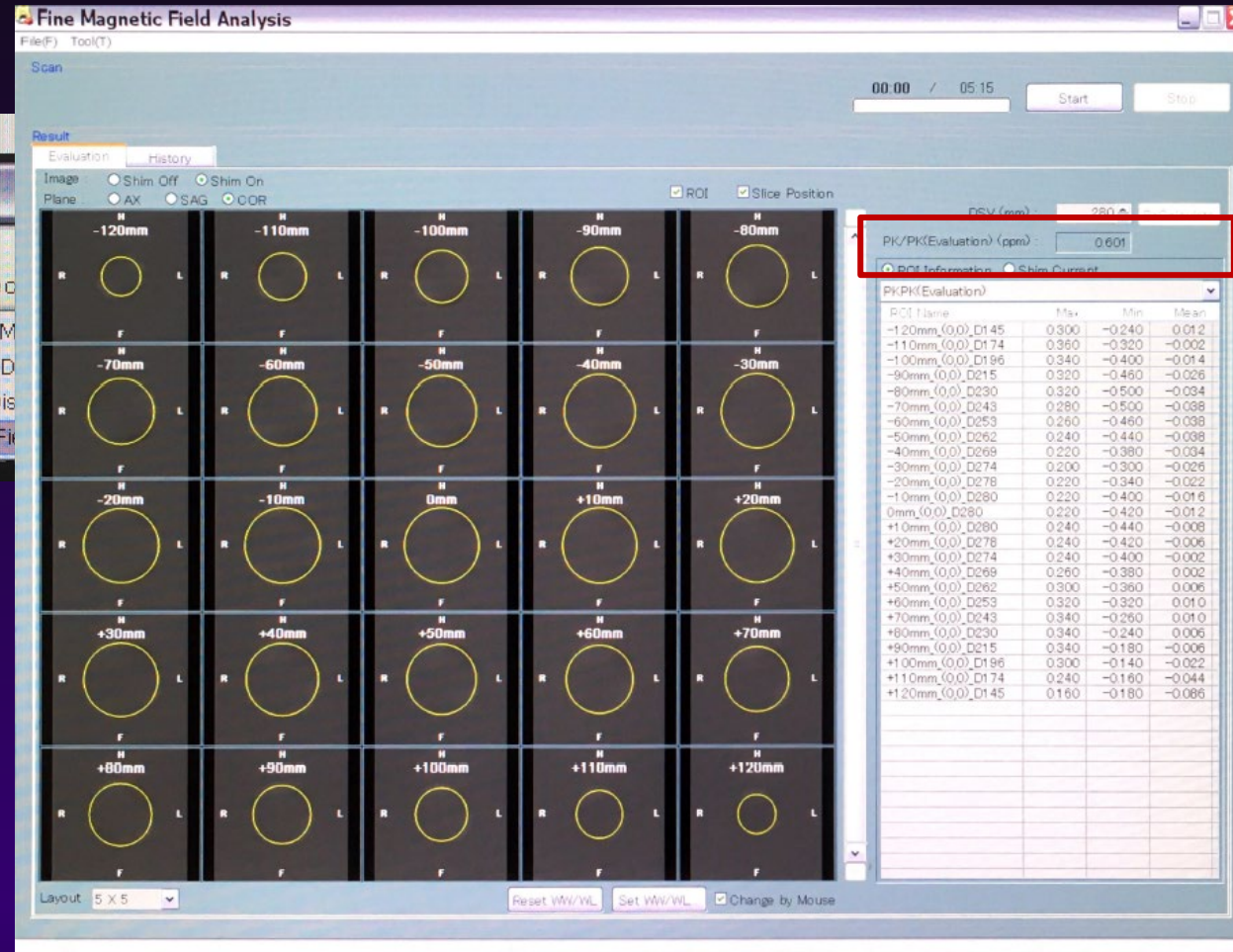
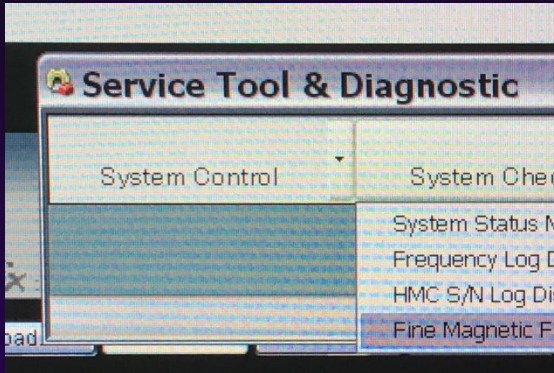
Align laser with phantom landmarks, not coil



Align to phantom landmark lines

Pad A or C on tabletop

# Hitachi: Fine magnetic field analysis results



- Hitachi recommends service call if >1.0ppm for Shim On and >5.0 ppm for Shim Off
- ROI placement is automatic – very sensitive to lateral positioning!

# Hitachi: SHIM procedure

- AIRIS, Altaire
- Phantom: #4 bottle (AIRIS) or D bottle (Altaire)
- Coil: Head

Axial: TR= 1850, Multi Slice=15, Presat=0, W=11, L=500, Prescan=ON  
 Sagittal: TR= 2430, Multi Slice=15, Presat=4, W=11, L=500, Prescan=ON  
 Coronal: TR= 2430, Multi Slice=15, Presat=4, W=11, L=500, Prescan=ON

SNR analysis card – place measurement ROIs and record Max and Min for each slice

Slice Number	Slice position (mm)	ROI diameter (mm)
1	-70	110
2	-60	134
3	-50	150
4	-40	160
5	-30	170
6	-20	175
7	-10	178
8	0	180
9	10	178
10	20	175
11	30	170
12	40	160
13	50	150
14	60	134
15	70	110

Calculate  $\Delta B_{0,pp}$  for each slice:

Airis 2:  $\Delta B_0 = 0.114 \text{ ppm} * \text{Max(Rel.)} - \text{Min(Rel.)}$   
 Airis Elite:  $\Delta B_0 = 0.104 \text{ ppm} * \text{Max(Rel.)} - \text{Min(Rel.)}$   
 Altaire:  $\Delta B_0 = 0.068 \text{ ppm} * \text{Max(Rel.)} - \text{Min(Rel.)}$

Determine largest  $\Delta B_{0,pp}$  value among all slices from each of three planes and compare to specifications:

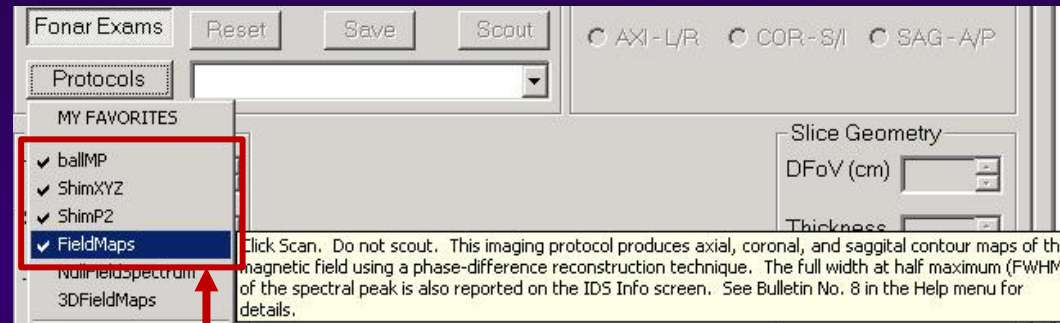
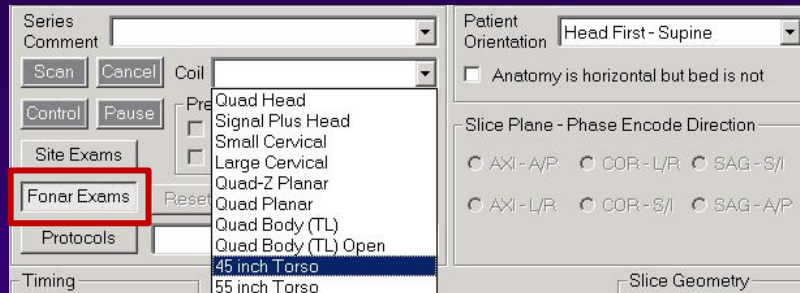
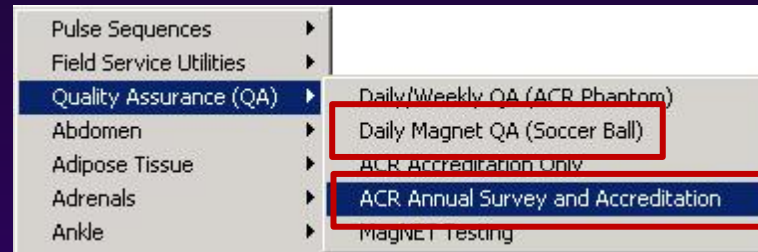
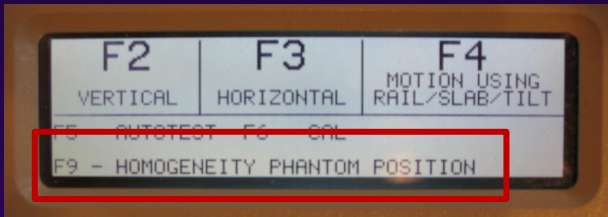
Airis 2:  $\Delta B_0 \leq 1.5 \text{ ppm}$   
 Airis Elite:  $\Delta B_0 \leq 1.5 \text{ ppm}$   
 Altaire:  $\Delta B_0 \leq 1.75 \text{ ppm}$





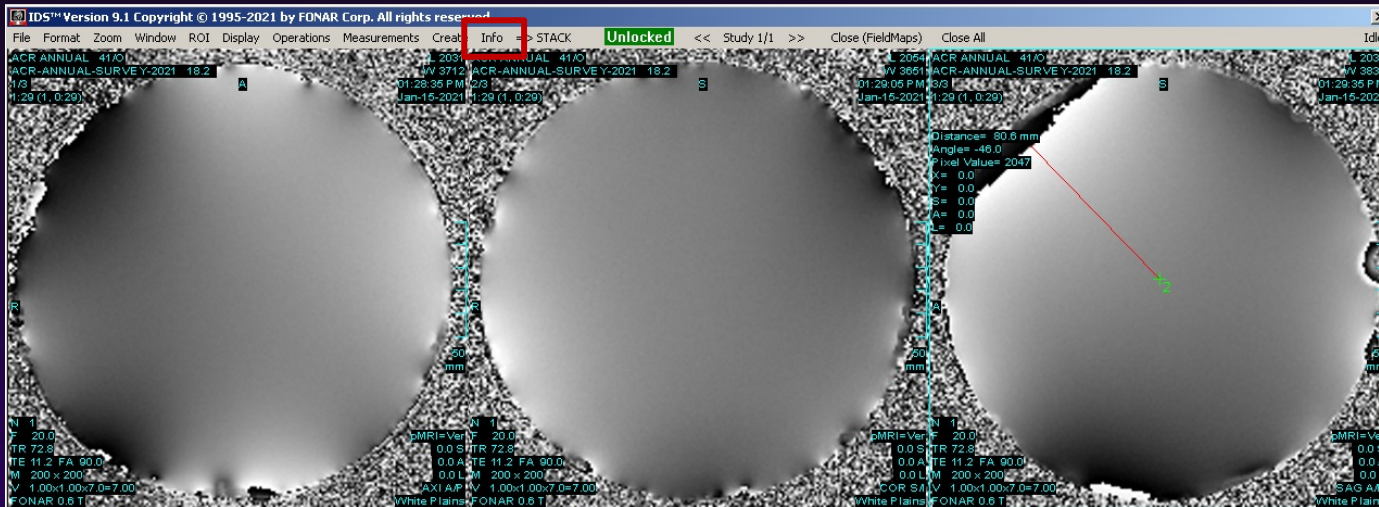
# Fonar: Field map procedure

- Accessible field map function
- Phantom: 19 cm soccer ball!
- Coil: 45 inch torso belt coil



Run these in order

# Fonar: Field map results



- Echo spacing such that phase wraps are 1.0ppm apart
- Center of volume always scaled to middle of greyscale range

SEQUENCE: PROTOCOL	ge5 0RF3.7PE: FonarFieldMaps
DESCRIPTOR	SSFP-FID GRE: Hz/pix=50.03, B0 Sensitivity 1.0 ppm, EF=67% ; FWHM=14 Hz
OPERATING MODE	Normal
RECEIVER COIL	45 inch Torso
PRE-SCAN CALIBRATIONS	C-G
TUNING VARIATORS (V)	1.05
TRANSMITTER GAIN	Power Amp=30 (default=30)
RECEIVER GAIN	Coarse=(575, -) Fine=(575, -)
CENTER FREQUENCY (Hz)	25474000
PHASE OVERSAMPLING RATIO (RFoV)	1.000
ACQUISITION MATRIX (f x a)	1024 x 200 (For ACR: Nf = 200, Np = 200)
RECONSTRUCTION MATRIX (f x a)	1024 x 200
DISPLAY & STORAGE MATRIX (f x a)	200 x 200

# Toshiba, Hitachi, Fonar

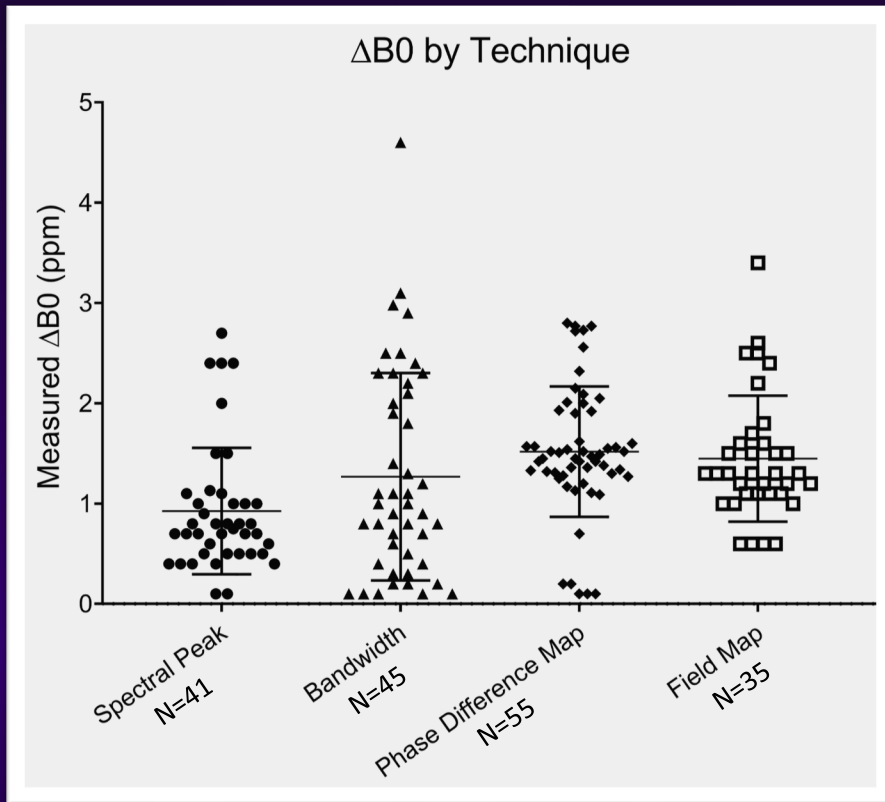
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Vendor	Method	Availability and accessibility	Immediately actionable by vendor	Provides spatial information	Quick results at workstation
<i>Toshiba</i>	<i>Phase difference</i>	+	+	~	+
<i>Hitachi (Oasis, Echelon)</i>	<i>Fine magnetic field analysis</i>	+	+	~	+
<i>Hitachi (AIRIS, Altaire)</i>	<i>SHIM</i>	+	+	-	+
<i>Fonar</i>	<i>Field map</i>	+	+	+	+



# Typical values

- Gathered from past annual & acceptance tests from TG325 members



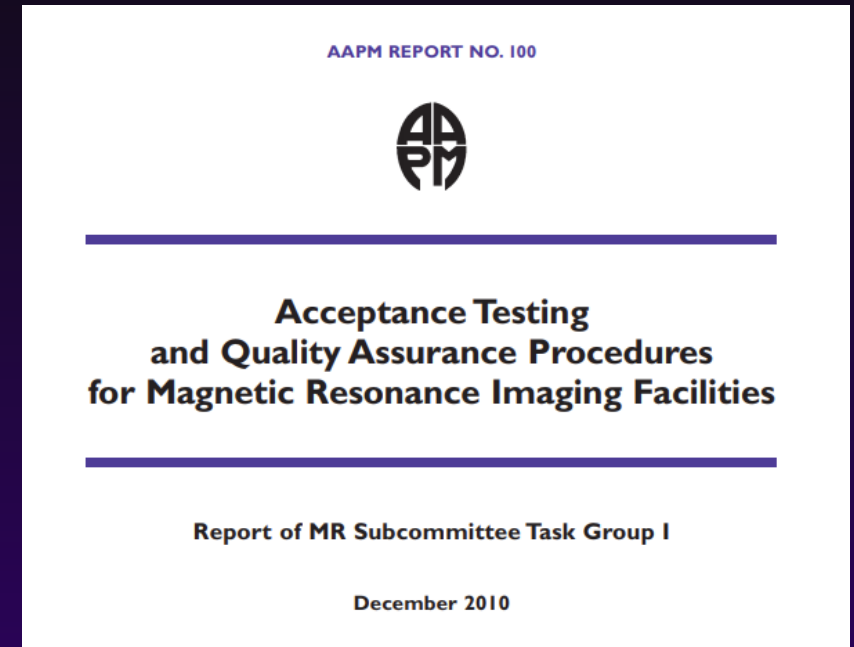
Test method and phantom size	Mean of archived data (ppm)	SD of archived data (ppm)
<i>Spectral peak (&lt;30cm)</i>	0.62 (RMS)	0.36
<i>Spectral peak (≥30cm)</i>	1.07 (RMS)	0.69
<i>Phase difference</i>	1.53 (PP)	0.65
<i>Field map</i>	1.45 (PP)	0.63
<i>Bandwidth difference</i>	1.26 (PP)	1.01



# More Resources: AAPM Report 100

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- Details sources and impacts of poor homogeneity
- Overview of 3 measurement methods
- Advantages and disadvantages of each
- Suggested acceptance criteria for routine and ultrafast imaging

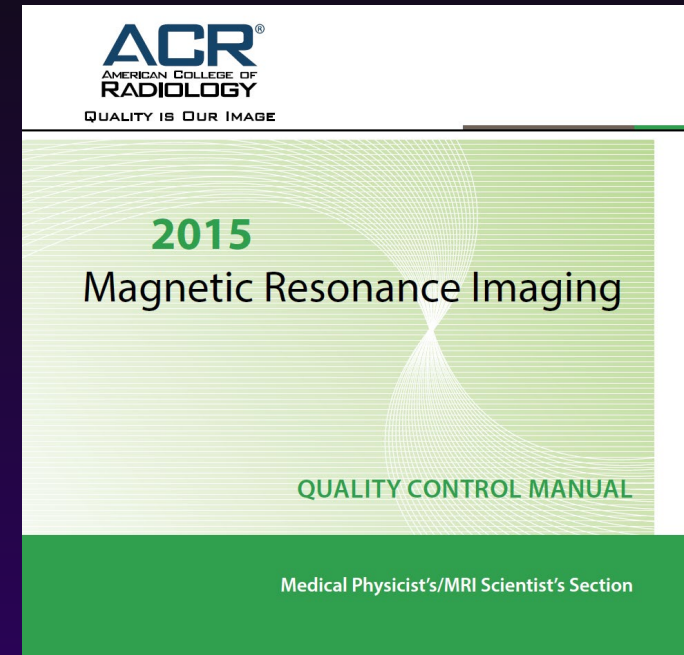


[https://www.aapm.org/pubs/reports/RPT\\_100.pdf](https://www.aapm.org/pubs/reports/RPT_100.pdf)

# More Resources: ACR MRI QC Manual

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- ACR-specific requirements for  $B_0$  testing
- General theory behind homogeneity testing
- Detailed vendor agnostic descriptions of 4 measurement methods
- Suggested corrective action



[https://www.acr.org/-/media/ACR/NOINDEX/QC-Manuals/MR\\_QCManual.pdf](https://www.acr.org/-/media/ACR/NOINDEX/QC-Manuals/MR_QCManual.pdf)

# More Resources

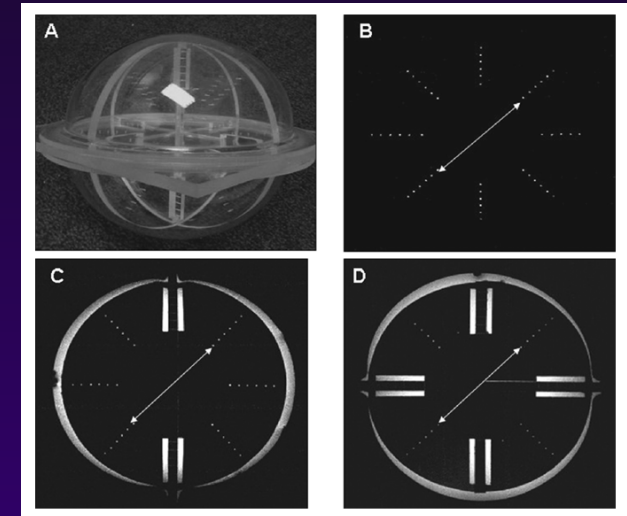
- **Bandwidth difference method:** Chen HH, Boykin RD, Clarke GD, Gao JHT, Roby JW. Routine testing of magnetic field homogeneity on clinical MRI systems. *Med Phys* 2006 33(11)

## Routine testing of magnetic field homogeneity on clinical MRI systems

Hua-Hsuan Chen, Rex D. Boykin, and Geoffrey D. Clarke<sup>a)</sup>  
*Department of Radiology, The University of Texas Health Science Center at San Antonio,  
San Antonio, Texas 78284*

Jia-Hong T. Gao<sup>b)</sup> and John W. Roby III  
*Research Imaging Center, University of Texas Health Science Center, San Antonio, Texas 78284*

(Received 28 March 2006; revised 21 July 2006; accepted for publication 11 September 2006;  
published 23 October 2006)



# More Resources

MRI Resources website accessible to AAPM members:  
<https://w3.aapm.org/pubs/MRIResources/>

Part 1: Motivation & introduction to B0 homogeneity measurement methods

Part 2: Step-by-step homogeneity measurement methods – multiple methods on multiple vendors

Part 3: Typical homogeneity values based on historical results from TG325 members (community contribution encouraged)

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## Vendor Specific Testing

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[Jump to Section 1 \(background information\)](#)  
[Jump to Section 3 \(typical homogeneity values\)](#)

### Foreword

This section contains detailed descriptions for performing homogeneity tests on a variety of platforms. It is possible that a particular unit may have a software variation or other difference to which the detailed instructions cannot be applied. We have tried to include enough information to facilitate discussion with the service engineer to explore workarounds or updates.

For each vendor, of the various approaches to testing homogeneity, there may be an obvious choice due to ease of running the test and/or quality of the results. In some cases, instructions for a particular test on a particular vendor's platform are not provided because the choice of that test is not logical in that setting. These cases are noted in the individual vendor-specific section.

Some of the tests use methodology supplied by the vendor. In these cases, it is expected that the results obtained will be in close agreement with those which would be obtained by the service engineer. For the other tests, the vendor may dispute the validity of the results. For example, no vendor has a prescribed test for measuring homogeneity using the bandwidth difference method. In these disputes, it is probably best to discuss your concerns with the service engineer and encourage them to test homogeneity with their own methods to compare results. For all tests, a large-diameter spherical or cylindrical phantom is recommended. After positioning, the phantom should be allowed to rest for a few minutes to allow the fluid to settle prior to measuring homogeneity.

FONAR ▾	GE ▾	HITACHI ▾	PHILIPS ▾	SIEMENS ▾	TOSHIBA ▾
				SHIM CHECK	
				SPECTRAL PEAK	
				PHASE DIFFERENCE	
				BANDWIDTH DIFFERENCE	
				PHASE MAP	

