Current Practice and Future Directions (MR Testing and Quality Control)

By
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Prepared for
Spring Clinical AAPM Meeting 2015

Validating Me

- I began my career at Baylor Medical Center in Dallas, Texas and quickly dove into consulting
- I own a consulting group based in Florida
- I performed approximately 1200 annual evaluations in 9 years with over 200 magnets in one year (now 130 scanners/year)
- I have given CAMPEP accredited lectures to individual consulting groups & MTMI and performed hands on training with these groups as well
- I am now a serial AAPM presenter
- I am the self proclaimed Low Field Magnet Whisperer!
- I have no affiliation with any particular vendor, nor the ACR – aside from membership

Accrediting Organizations

- Intersocietal Accreditation Commission
  - As of 7/15/2014 –
  - "The Quality Improvement (QI) Program **must** consist of MRI system installation acceptance testing and acceptance testing following a major upgrade."
  - "The manufacturer's representative, service engineer, or the MRI site-appointed medical physicist, or qualified expert **must** perform the acceptance testing."
  - Medical Physicist not explicitly defined

Accrediting Organizations

- Intersocietal Accreditation Commission
  - Required Tests:
    - Magnetic Field Homogeneity
    - Gradient and RF Calibration
    - Resonance Frequency
    - Slice Thickness
    - Slice Accuracy
    - Image Quality
      - signal-to-noise ratio (SNR) evaluation for all coils
      - spatial resolution
      - artifact assessment
    - Image Uniformity
    - Image Linearity (Geometric Distortion)
    - Monitor/Processor QC

Accrediting Organizations

- The Joint Commission
  - As of 7/1/2015
  - "At least annually, a diagnostic medical physicist or magnetic resonance imaging (MRI) scientist conducts a performance evaluation of all MRI imaging equipment."
  - "Note: Medical physicists or MRI scientists are accountable for these activities. **They may be assisted** with the testing and evaluation of equipment performance by individuals who have the required training and skills, as determined by the medical physicist or MRI scientist."

Accrediting Organizations

- The Joint Commission
  - Required Tests:
    - Image uniformity for all radiofrequency (RF) coils used clinically
    - Signal-to-noise ratio (SNR) for all coils used clinically
    - Slice thickness accuracy
    - Slice position accuracy
    - **Alignment light accuracy**
    - High-contrast resolution
    - Low-contrast resolution (or contrast-to-noise ratio)
    - Geometric or distance accuracy
    - Magnetic field homogeneity
    - Artifact evaluation

Accrediting Organizations

- The American College of Radiology
  - "The Annual System Performance Evaluation or Acceptance test **must** be performed by a medical physicist/MR scientist and the full report (including all data pages and evaluation of site's technologist QC program) must be submitted for review."
  - Very specific about what constitutes a QMP or MRI Scientist

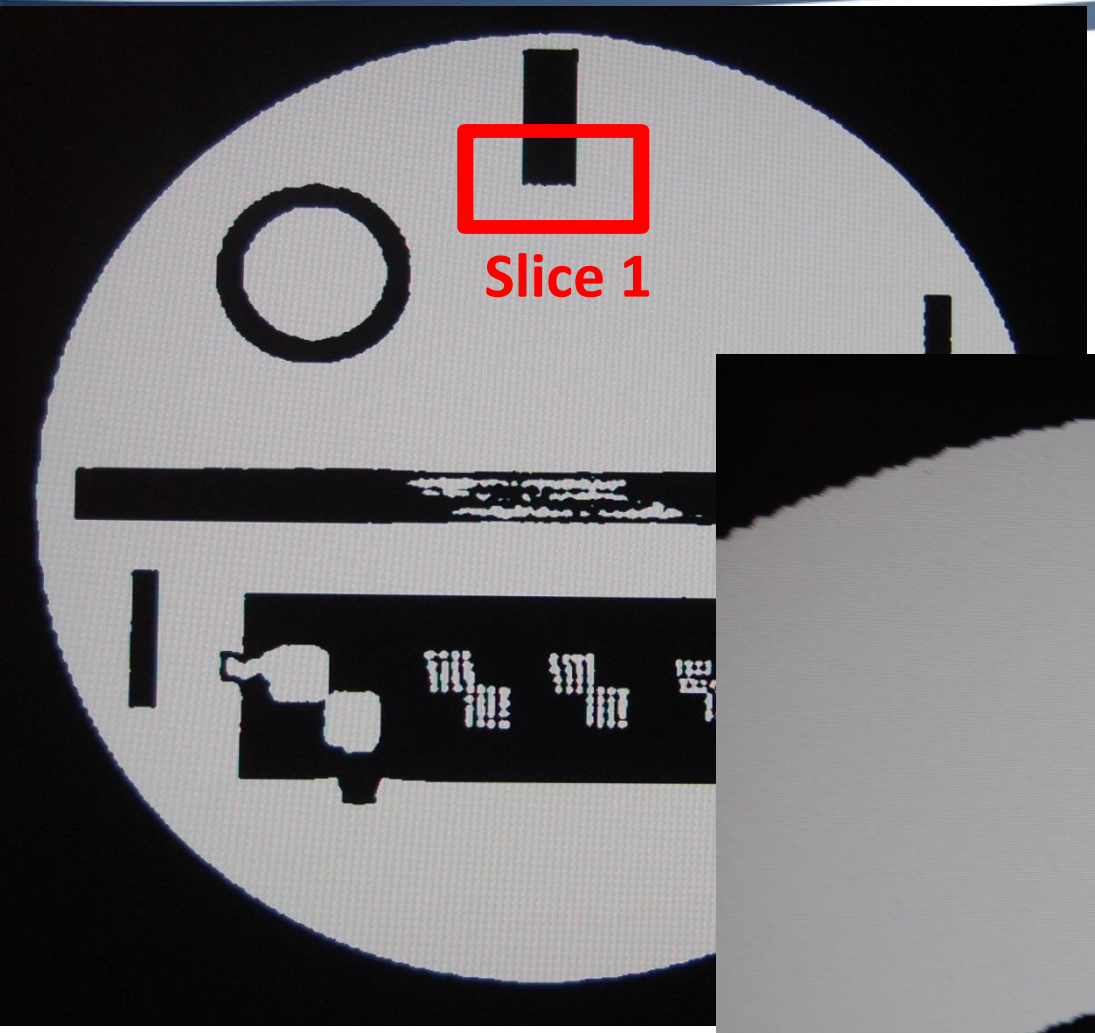
Accrediting Organizations

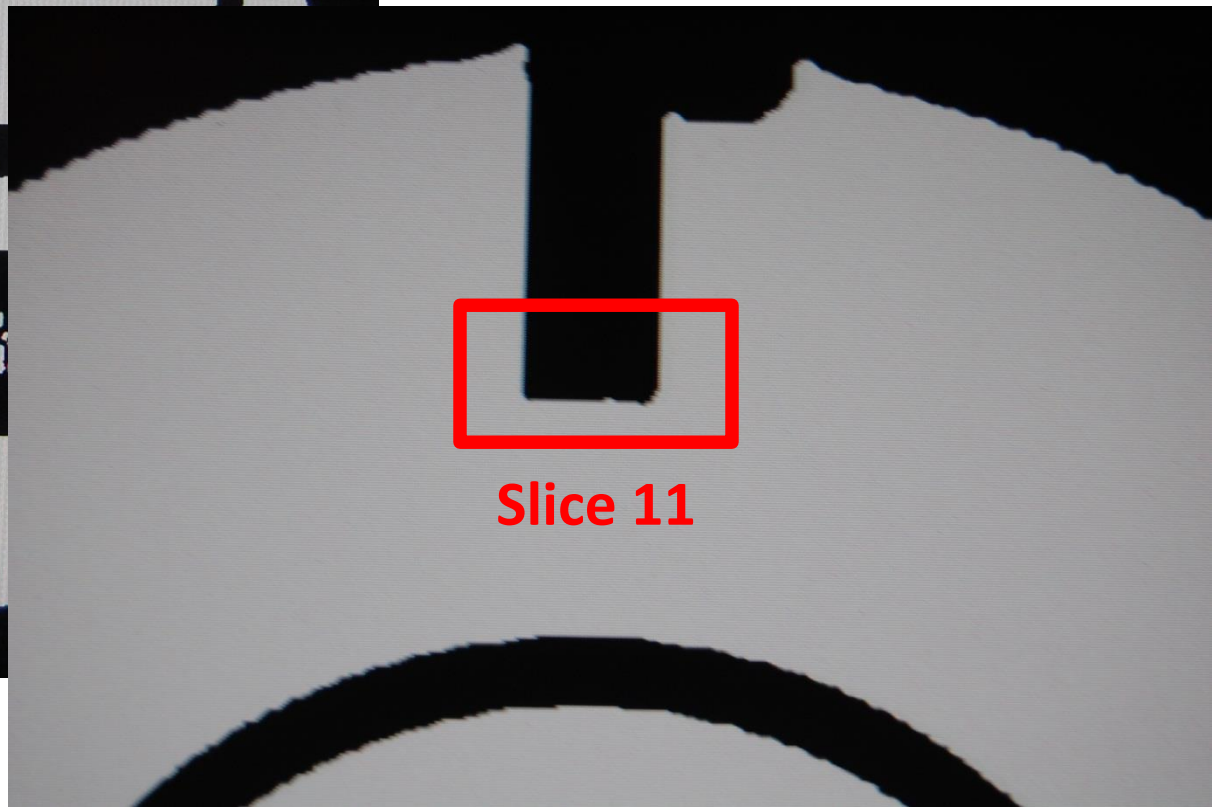
- The American College of Radiology
  - Required Tests:
    - **Magnetic Field Homogeneity – I discussed in depth at the Spring Clinical in 2013 and Summer Meeting 2013. If you would like a copy of my presentation and supporting documents, please email me**
    - Slice Position Accuracy
    - Slice Thickness Accuracy
    - Radiofrequency Coil Checks
    - Soft-Copy Displays (Monitors)

Annual System Performance Evaluation

- Physicist's Annual QC Tests
  - Magnetic Field Homogeneity – I discussed in depth at the Summer Meeting 2013
  - **Slice Position Accuracy – Will briefly discuss failures**
  - Slice Thickness Accuracy
  - Radiofrequency Coil Checks
  - Soft-Copy Displays (Monitors)

Slice Position Accuracy



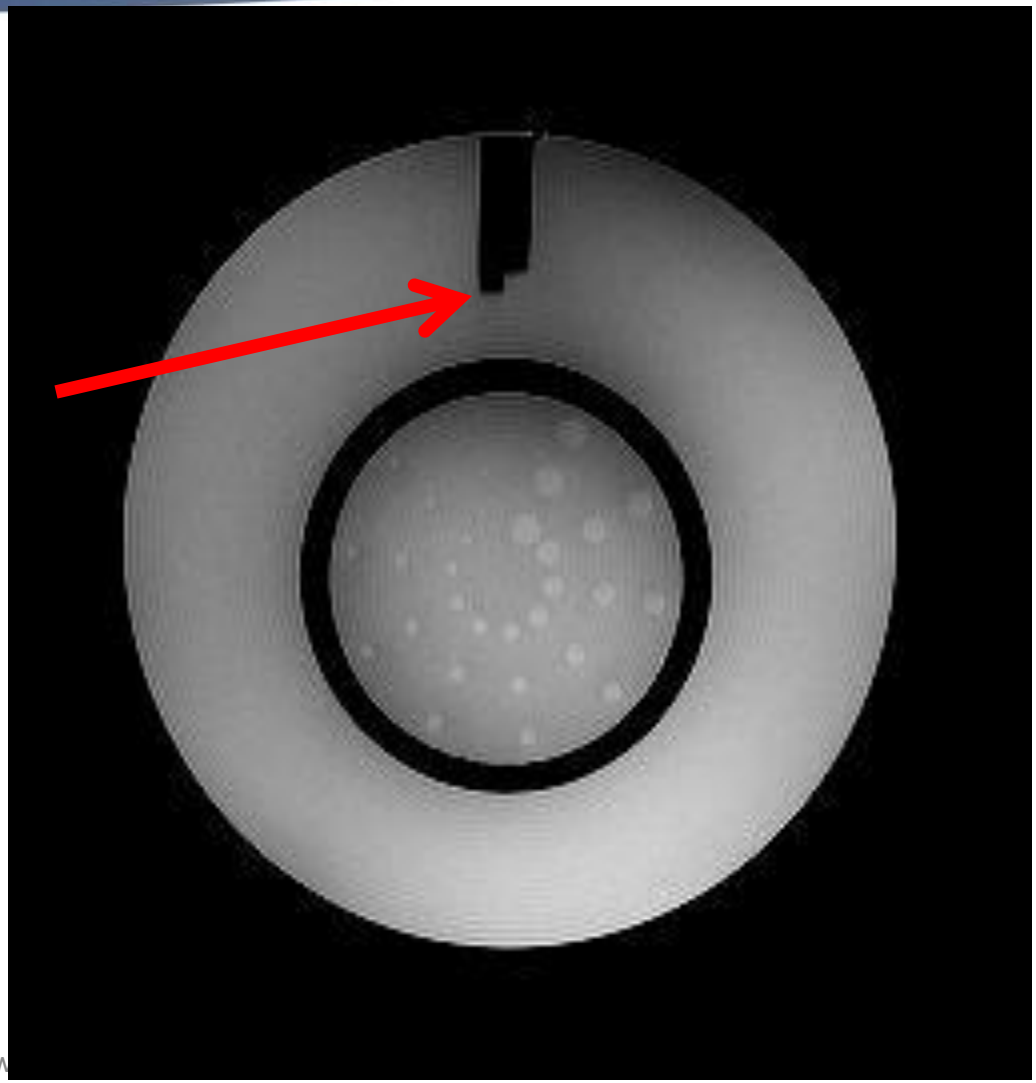


Slice Position Accuracy

- If wedge is long on same side: positioning error

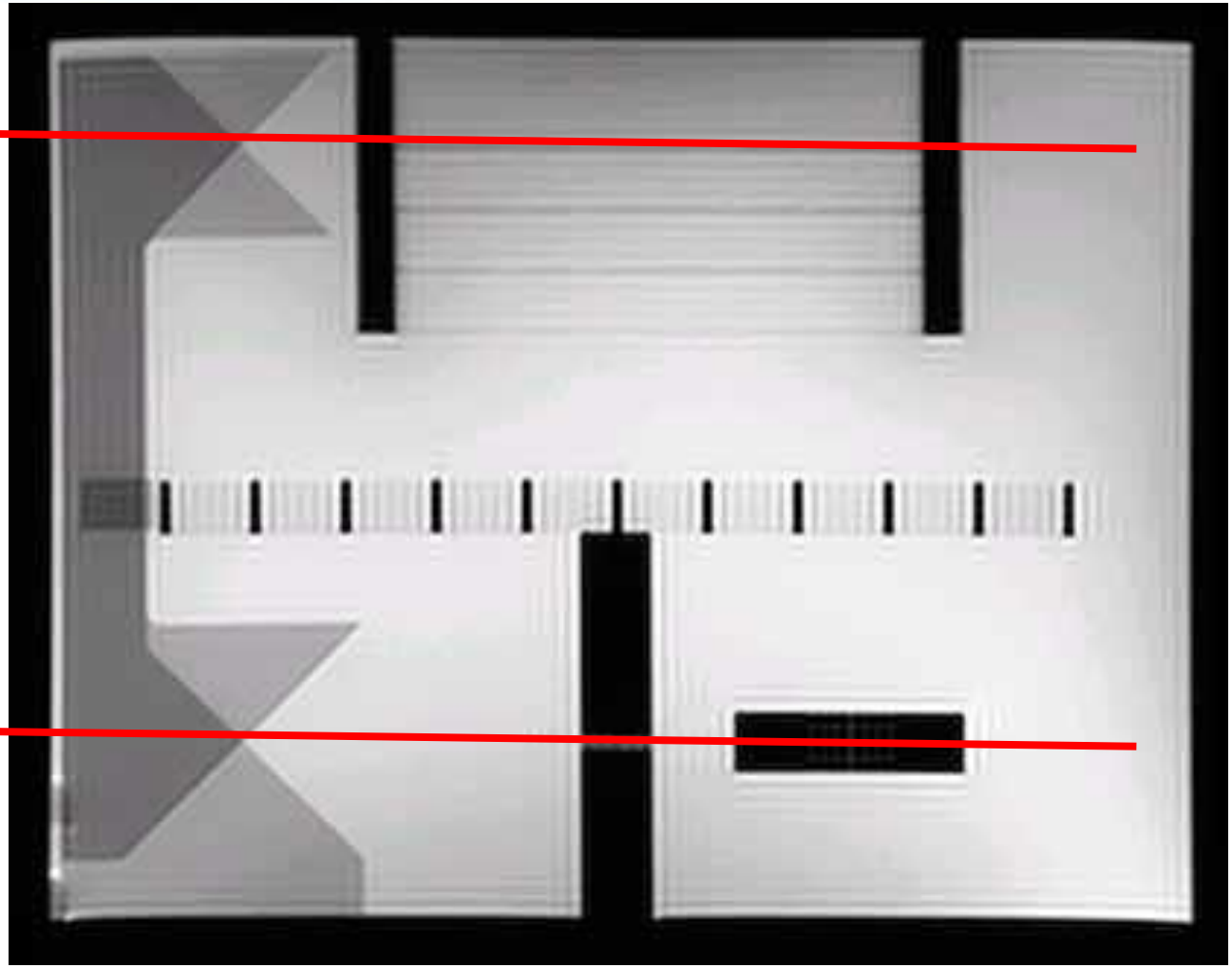
Slice Position Accuracy

- If longer bar on LEFT, move slice prescription UP
- If longer bar on RIGHT, move slice prescription DOWN
- **Note:** If > 4mm off on slice 11, LCD test is completely invalid



Perfecting Slice Position Accuracy

Move these prescription lines up or down depending on which side is long



Slice Position Accuracy

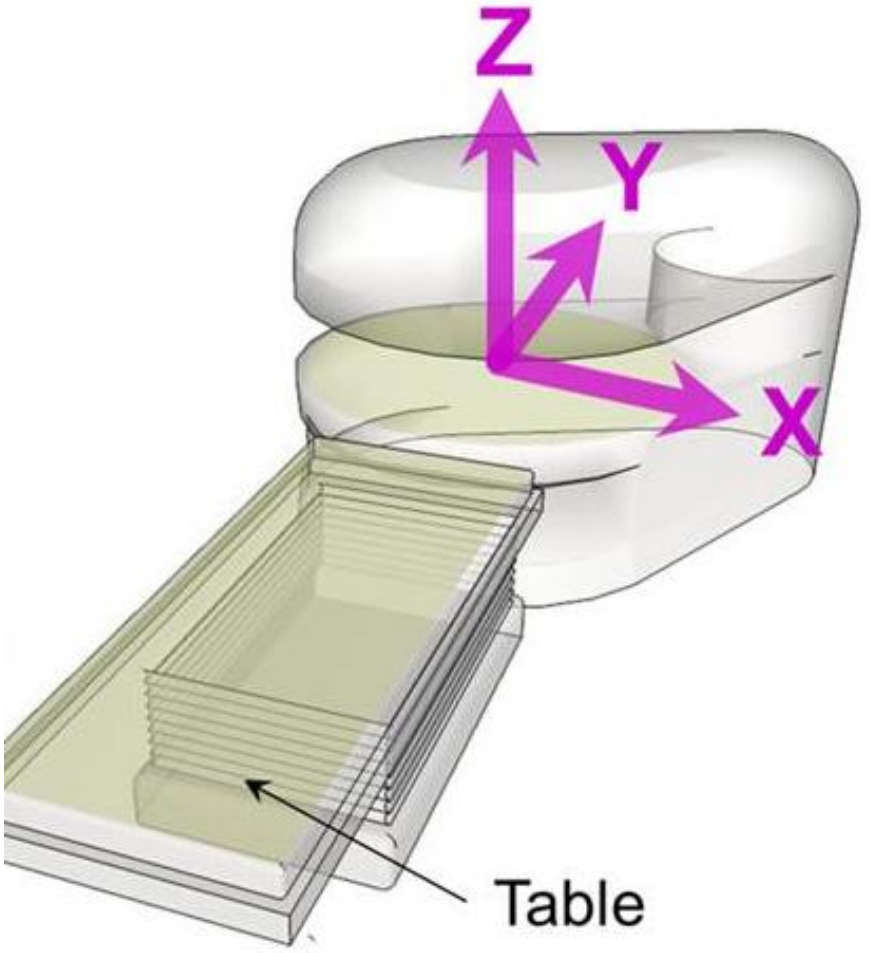
- If wedges are long on opposite sides: gap error - service must be called to correct

Annual System Performance Evaluation

- Physicist's Annual QC Tests
  - Slice Position Accuracy – Typically this test fails by exceeding the allowable 5.0 mm (again LCD test is invalid if more than 4.0 mm off)
  - This is typical of GE, open scanners
  - Historically: Adjusted position of phantom, slices, etc., to no avail
  - Current Practice: ask service to adjust the table axis gradient (Y) by 2.0 mm (normally, prior to arrival on site)
    - Works like a charm but no more than 2.0 mm

Gradient Direction

Open Magnet
Note:
Y Gradient is along the table axis



Annual System Performance Evaluation

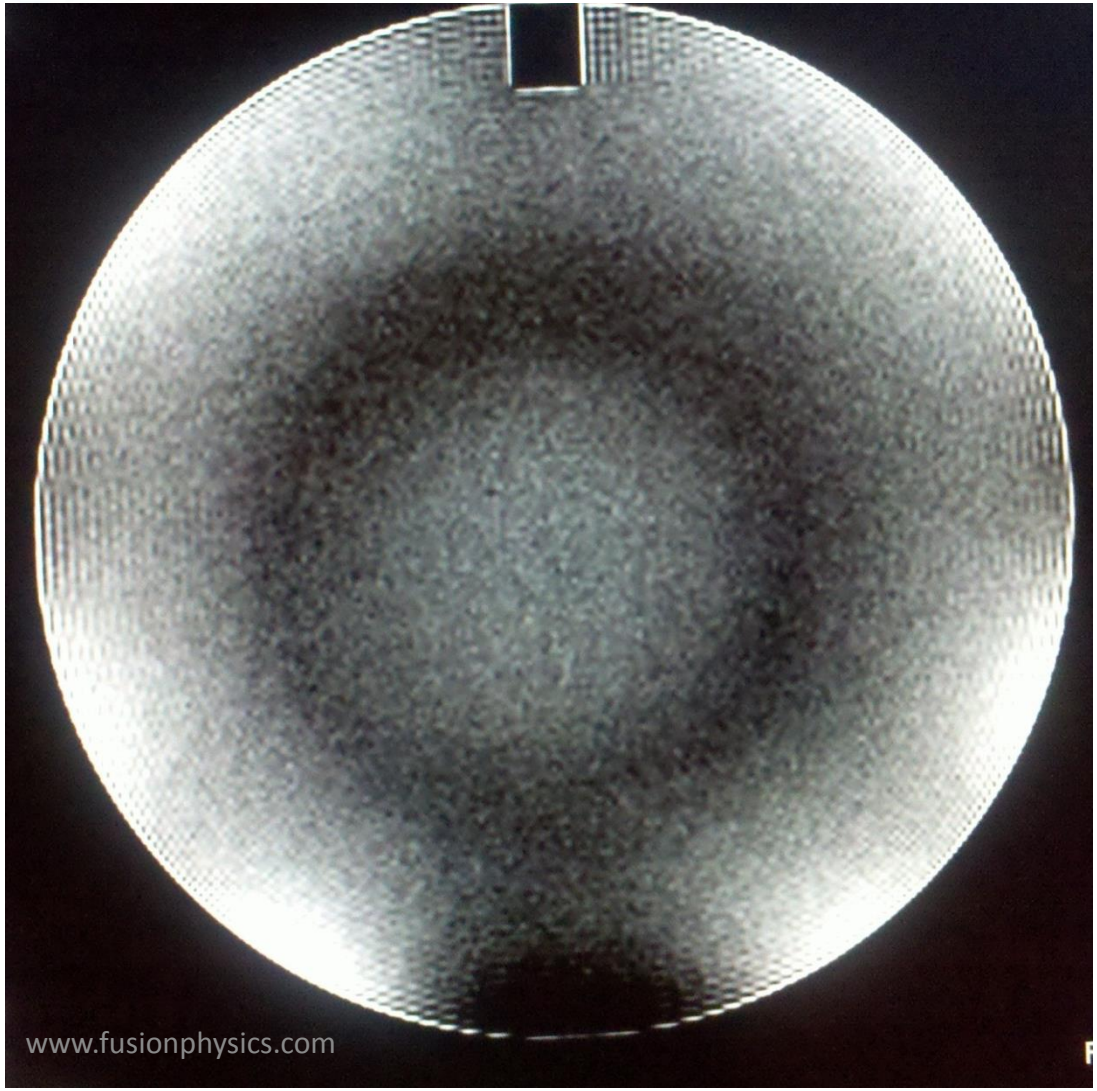
- Physicist's Annual QC Tests
  - Magnetic Field Homogeneity – I discussed in depth at the Summer Meeting 2013
  - Slice Position Accuracy
  - **Slice Thickness Accuracy – Will briefly discuss failures**
  - Radiofrequency Coil Checks
  - Soft-Copy Displays (Monitors)

Annual System Performance Evaluation

- Physicist's Annual QC Tests
  - Slice Thickness Accuracy – Typically this test fails by exceeding the allowable 5 mm +/- 0.7 mm
  - This is typical of Siemens, all models
  - Historically: filters, bandwidth, gradient strength and mode were adjusted, to no avail
  - Current Practice: ask service to adjust the Z gradient by 0.5 mm
    - Works like a charm but no more than 0.5 mm

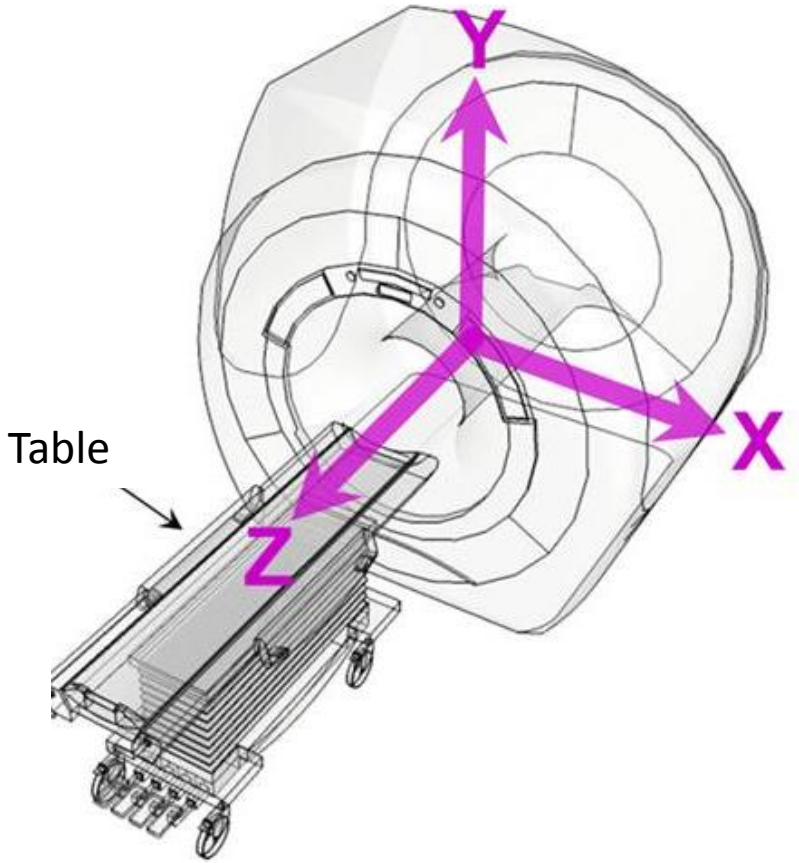
Artifact on a Siemens?

- Slice 7 on a Siemens scanner
  - doesn't appear uniform
  - there appears to be cross talk from slice 8
  - slice thickness is too large!



Gradient Coils

Closed Bore Gradient Direction Note:
Z Gradient is table axis



Annual System Performance Evaluation

- Physicist's Annual QC Tests
  - Magnetic Field Homogeneity
  - Slice Position Accuracy
  - Slice Thickness Accuracy
  - **Radiofrequency Coil Checks – 2004 ACR Manual says on ALL RF coils! Be sure to include serial number and gain of every coil, so that you know you are actually tracking coil performance**
  - Soft-Copy Displays (Monitors)

Annual Coil Test

- Decide on your methodology and be consistent
  - Some vendors provide step by step coil testing manuals (Siemens & Fonar)
    - Foam pads for proper positioning of phantoms
    - Analysis of results (Hitachi analyzes ACR Phantom)
  - The ACR manual shows a method for independent testing
    - Useful for vendors who don't provide manuals
    - As a consultant who tests every vendor, this is my preference

Annual Coil Test

- My thoughts:
  - As a hired consultant, I believe the physicist should be a third party, independent verification that the system is working properly
    - For this reason, I test MFH and coils differently than service
    - I remove all pads – because pads change over time, get lost or disposed of and replaced
    - I track coil performance for 3 years via SNR

Nuances per Vendor

- Fonar is the only exception to my rule
- Fonar – has a built in PDF in the help menu that shows coil positioning for annual testing. Keep the PDF open while scanning, it will change your life.
- Fonar – only supplies 1 bottle phantom with their coils and a soccer ball for MFH testing on the 55 inch torso array coil

Current Debate on Coil Testing

- Some physicists say that every element must be tested individually (Conservative)
- Others state there is no need for annual testing of the coils by a medical physicist – that this should be left up to the MRI Experts, the service engineer (Liberal)
- I lean toward conservatism – I test the maximum SNR of every coil and visually inspect all coil elements

Choosing the Phantom

- The phantom of choice should mimic the geometry of the body part that the coil is used to scan
- Many vendors provide lots of phantoms specific for each coil
  - These phantoms have become quite elaborate
  - Many phantoms require a holder to properly position the phantom within the coil

Choosing the Phantom

- The substance in the phantom should have a T1 value within the range of those similar to the tissues which is dependent on field strength
- The phantom should also fill a good portion of the coil but also allow for some noise measurement to be made
- It is best to use phantoms that are stored on site
- But you should always keep phantoms with you, just in case!

Nuances per Vendor

- Toshiba – Some scanners only have a QA cube for testing coils. Believe it or not, this produces excellent SNR
  - You may need to bring your own phantoms for testing larger coils
- DO NOT use a Zephyrhills water bottle – ask the site first if they only have the cube phantom, if not bring your own phantoms.

Scan Parameters for Coil Testing

- The ACR specifically details the parameters that are required for collection of the ACR phantom images within the head coil (SE with a TR=500 ms, TE=20 ms and typically a FA=90 degrees – leading to a scan time = 2+ min)
- You can adjust the TR (I drop it to 300 ms) and scan time plummets to a mere 1 min 16 sec!
- The ACR manuals suggests adjusting the matrix to clinically relevant limits in an effort to save time as well.

Scan Parameters for Coil Testing

- FOV must be appropriate for the Coil – i.e. a lumbar coil requires a 35 cm FOV clinically, be sure to test it that way, whereas a wrist coil may use only 12 cm FOV clinically
- Be sure that FOV is large enough to include background noise measurement
- Slice Thickness should also be clinically relevant
- All parameters should be included in the report for reproducibility from year to year

Defining a Volume Coil

- Volume coils have been designed to image body parts placed within their volumes (head coils, body coils, knee coils, wrist coils)
- Volume coils produce uniform images where MR signal should minimize at the center of the image
- My rule of thumb is if the coil in question can be turned on end and liquid poured into it, does it constitute a volume?

Volume Coil???

The Original Volume Coil

- Don’t forget to test the internal body coil!!!
- It is used for LARGE patients and long leg studies

Volume Coils

- Wrist Array Coil

8 Channel Knee Coil

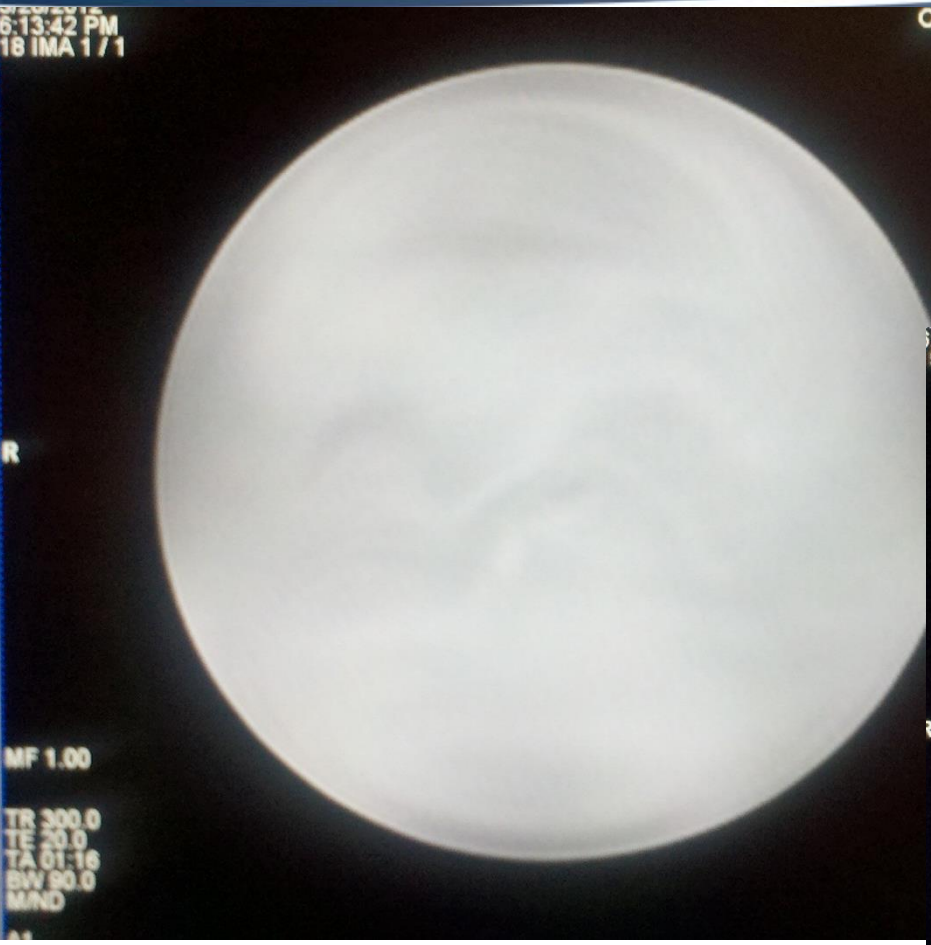
Volume Coils

- Ideally the phantom should be placed at isocenter within the coil AND isocenter within the magnet to determine the best uniformity and to ensure reproducibility from year to year AND phantom should fill at least 75% of the area on the display FOV
- Tests that are run include 3 measurements:
  - Image uniformity
  - SNR
  - Percent signal ghosting

Volume Coils

- How I test volume coils:
  - I set up the phantom and coil at isocenter (as much as possible)
  - I run a 3 plane loc
  - I plot the modified ACR T1 (modifications include drop in TR to 300, drop # of slices to 1 and use a clinically relevant FOV) off of the axial plane loc
  - I run the T1 in the axial plane to ensure uniformity measurement would be correct. Time should be 1 min approx. 16 sec per coil

Wait for it….



Wait for fluid in the phantom to settle before scanning!

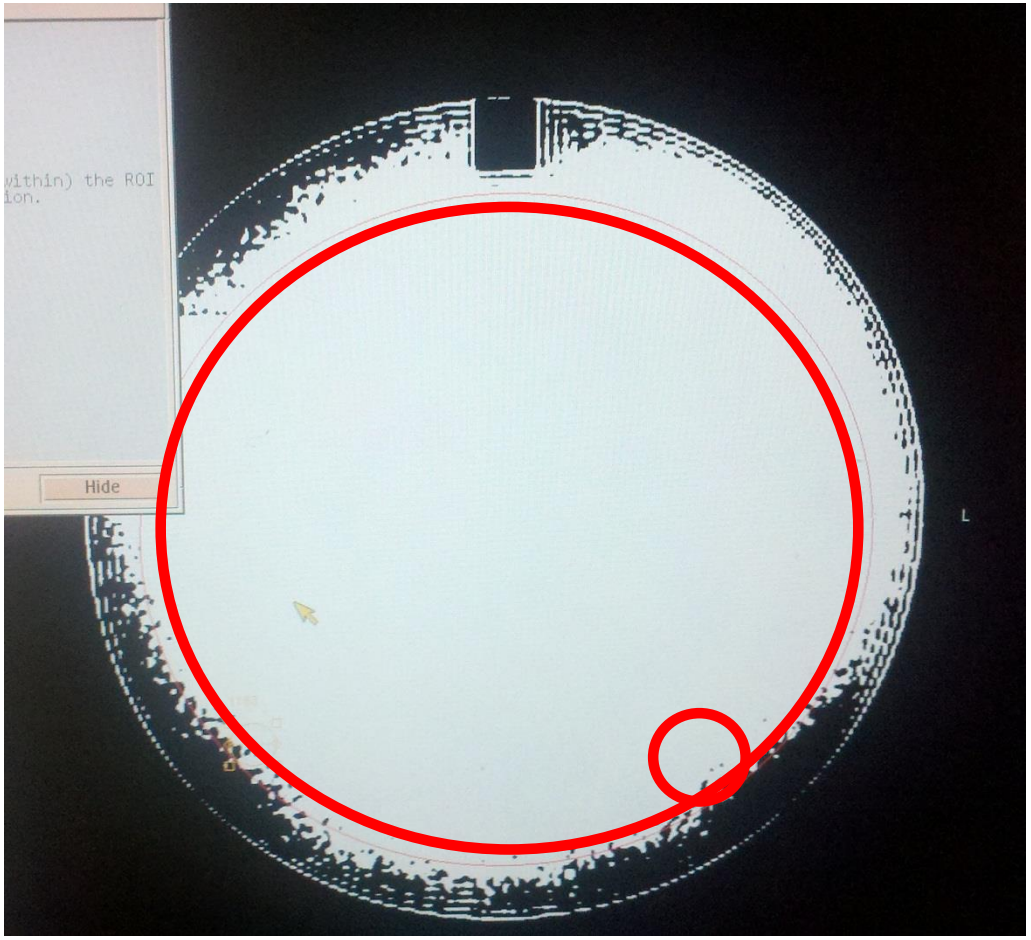
After a minute, fluid stills

Image Uniformity

- Lack of uniformity suggests a deficiency in the scanner, with the coil itself or in the RF subsystem
- 8 Channel Brain Coil requires Surface Coil Intensity Correction (GE- SCIC, Siemens – Normalize, Philips – Clear) to pass ACR's uniformity criteria
- Run with SCIC on to pass Uniformity AND THEN run with SCIC off to test individual coil element performance

Uniformity Measurement

- Measure Mean with an ROI that is 80% of area, Maximum & Minimum both measured with an ROI that is 0.15% of the area of the FOV
- Max & Min should be truly the first and last signal visualized when leveling



Uniformity Measurement

$$\text{Percent Image Uniformity (PIU)} = 100 \times \left[1 - \right.$$

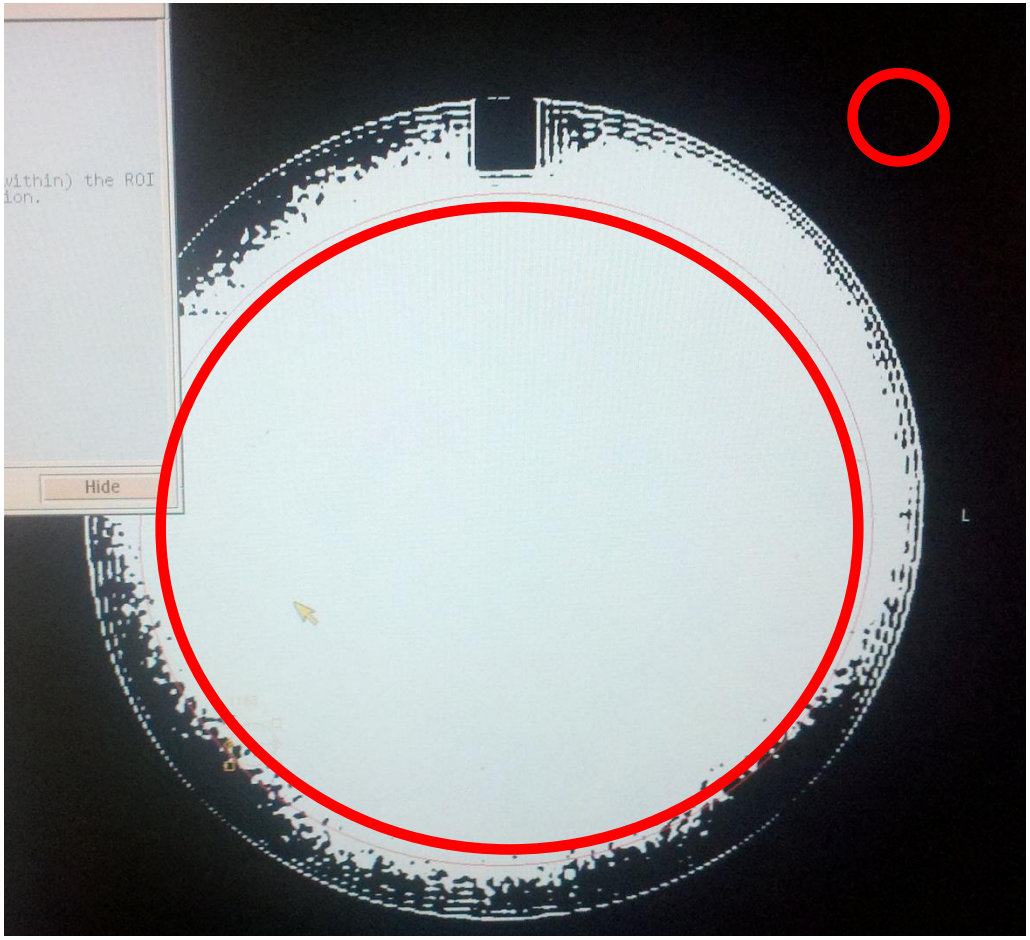
Action criteria: PIU should be 87.5% on all units less than 3T and 82% on 3T magnets

Uniformity Measurement

- Causes of Uniformity Failure
  - 1st - Check that SCIC, PURE, Normalize or CLEAR are on
  - 2nd - Check that the top of the head coil is securely fastened to the bottom of the head coil
  - 3rd - Check that the phantom is centered within the coil and is NOT touching the coil (this can cause signal blow up)

SNR Measurement

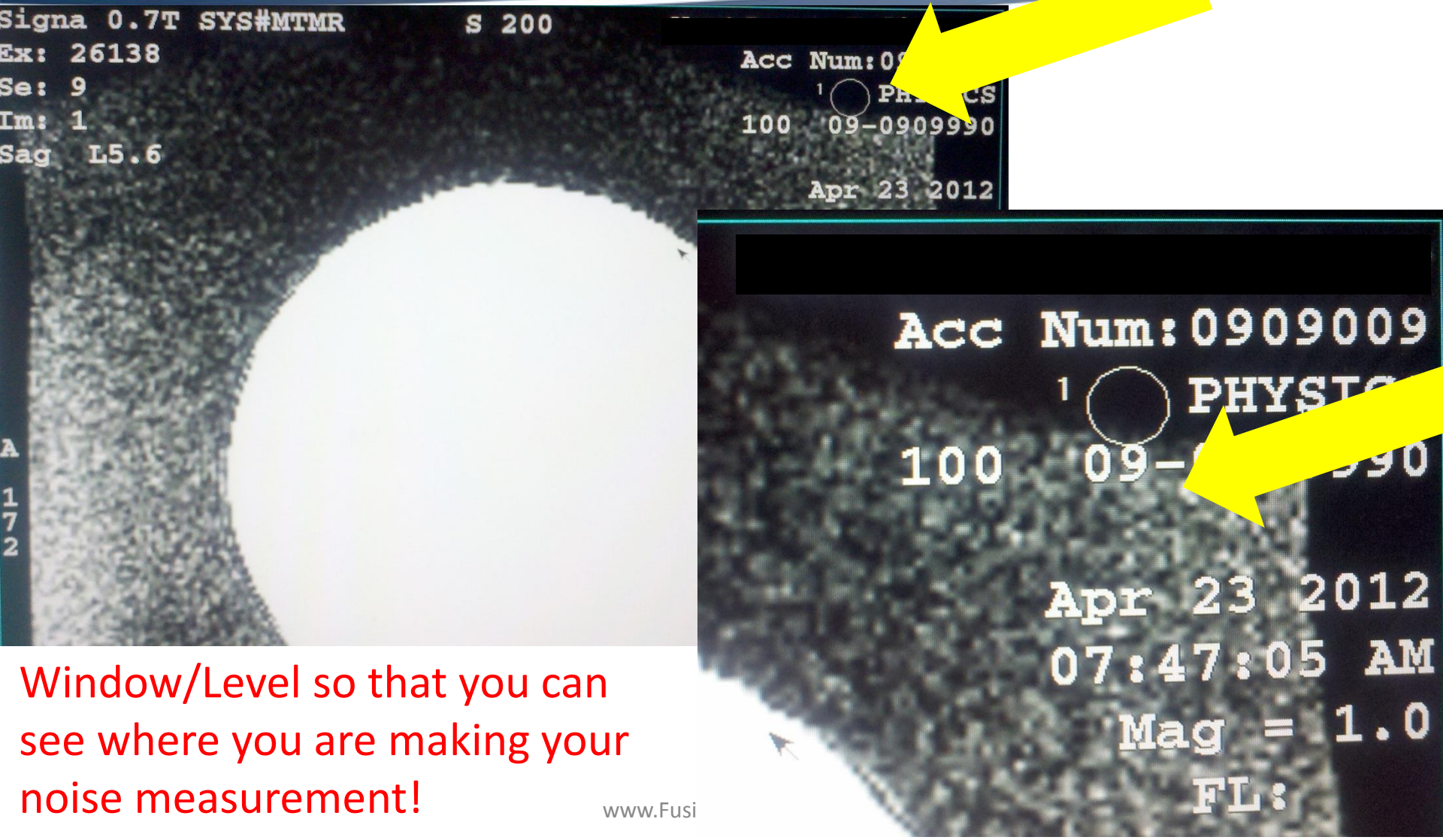
- Record the Mean of large ROI
- Move the small ROI to determine the **minimum** STD of the noise ROI and record this value



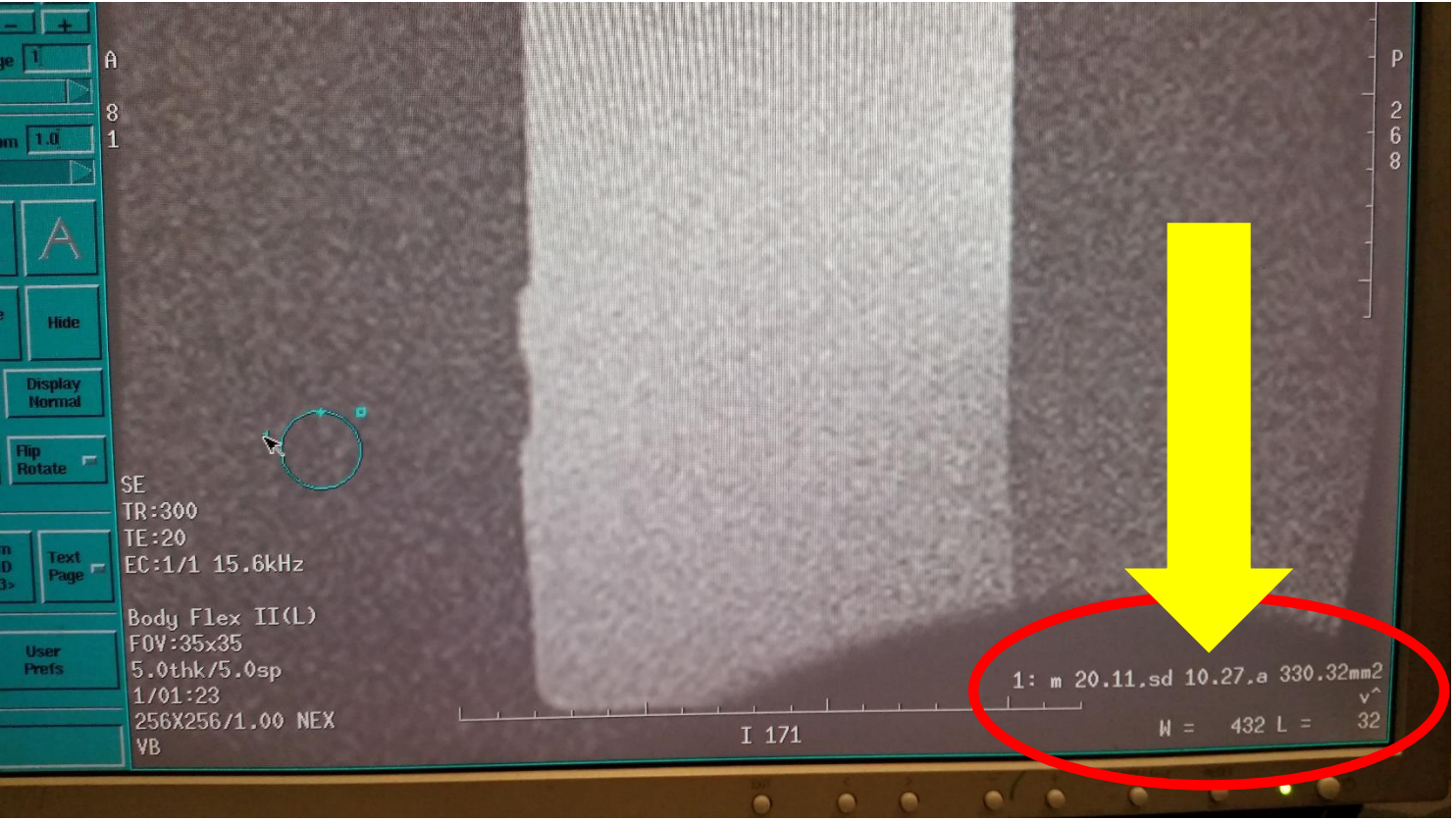
Measuring Noise

- Do NOT measure in regions of non-uniformities due to bandwidth limiting filtering, truncation of background signal and RF filtering of signal at the edges of the frequency encode range
- Be sure that the ROI that is used to measure the noise standard deviation is free of artifacts and is within the image

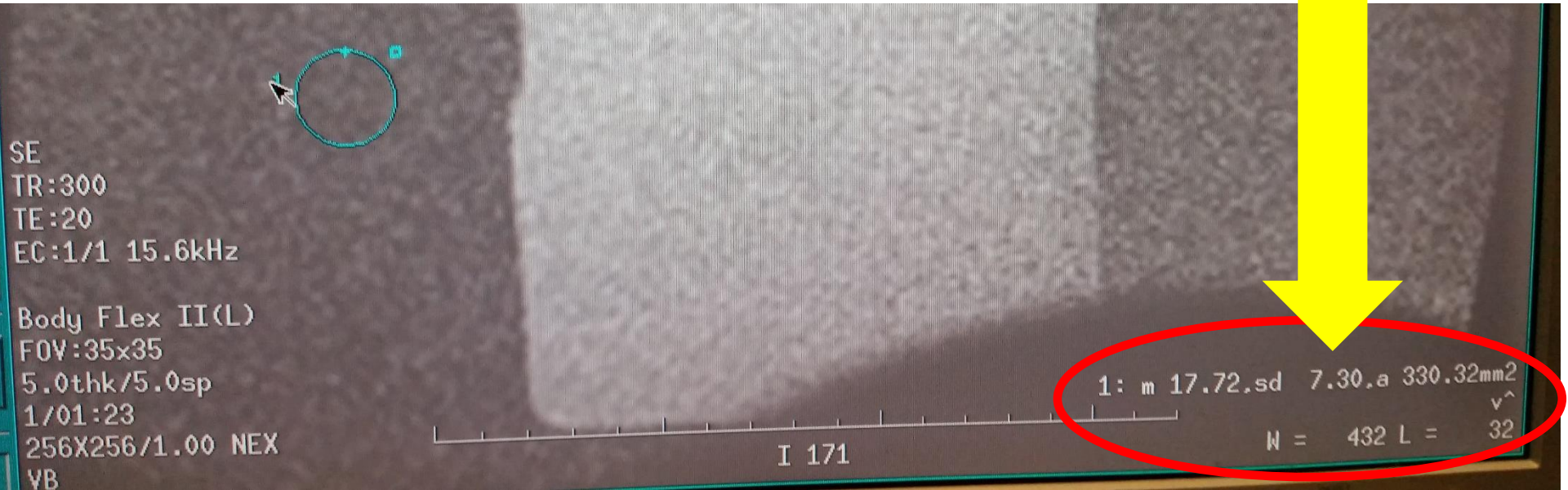
Measuring noise



Window/Level so that you can see where you are making your noise measurement!



All things equal except noise value… This shows nearly 30% difference! So always look for minimum noise!



SNR Measurement

$$SNR = \frac{Mean\ Signal}{Noise\ Standard\ Deviation}$$

Action criteria: Values are all over the board!
Action limits should be set at 20% from previous measurement

-only if consistent testing methodology is used
-if you are not consistent this value will not be meaningful

Percent Signal Ghosting Measurement

- Record the ghosting signal, whichever is higher
- Most frequently this is in the phase encode direction, but not always!

Ghosting Measurement

$$\text{Percent Signal Ghosting} = 100 \times \left[\left(\frac{Ghost\ Signal - Background\ Signal}{2 \times Mean\ Signal}\right)\right]$$

Action criteria: Should be less than 0.25%

Defining a Surface Coil

- Enhances SNR by sacrificing uniformity
- Increases SNR by placing the coil as close to the area of interest as possible
- Excludes both signal and noise from regions not under investigation
- Maximizes the sensitive region of the coil AT the area of interest
- These coils yield very non-uniform images

Surface Coils

Siemens Flex Body Coil

- Shoulder Coils – Large&Small

Philips CTL Coil

Phased Array & Parallel Coils

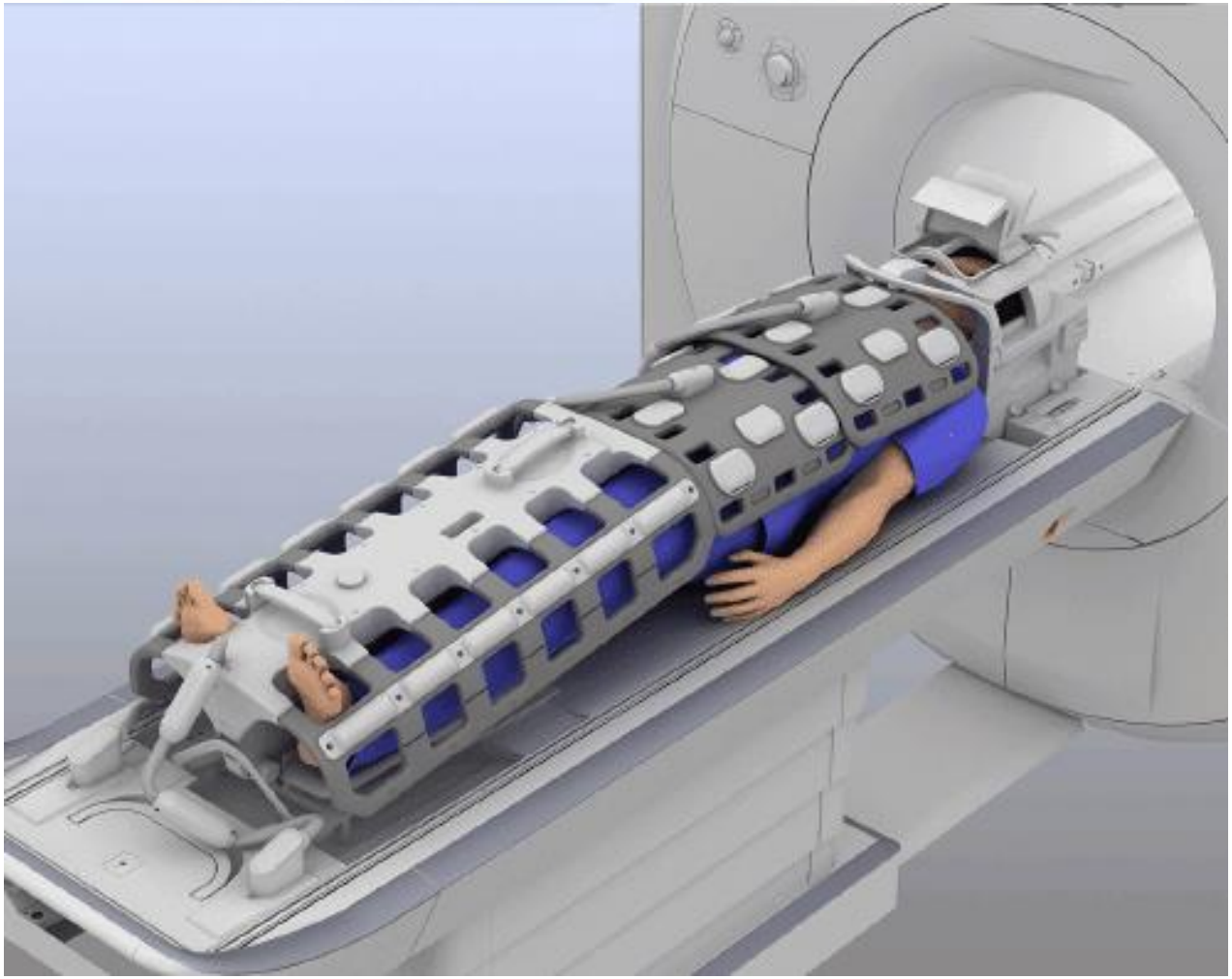


Image Courtesy of Siemens

Surface Coils

- How I test surface coils:
  - I set up the phantom(s) and coil so that there are no pads
  - I run a 3 plane loc – keep in mind the coronal loc may show nothing because we are not at isocenter of the bore!
  - I plot the modified ACR T1 (modifications include drop in TR to 300, drop # of slices to 1 and use a clinically relevant FOV) off of the sagittal plane loc
  - I run the T1 in the sagittal plane. Time should be 1 min approx. 16 sec per coil

Surface Coils

- Window to zero, raise level to last signal
- Create an ROI that is 0.15% of the area of the FOV
- Move ROI to the location of maximum signal
- Move the ROI to the Noise region (again, typically in the corner of the image) and record the smallest standard deviation visualized

Maximum SNR Measurement

$$Maximum\ SNR = \frac{Maximum\ Signal}{Noise\ Standard\ Deviation}$$

Action criteria: I personally track this measurement as a percent change from the previous year's measurement. 20% is flagged by my spreadsheet

Annual System Performance Evaluation

- Tracking SNR from year to year indicates a problem with the coil, multi year evaluation is even better
- If SNR drops 20% across all coils check the lightbulbs, check the lightbulbs!!!
- if CFLs were used to replace the old lightbulbs, that will cause a 20% drop in signal
  - These CFLs cause an RF leak

Combination Volume & Surface Coils

NV Coil

Invivo Chimney Coil

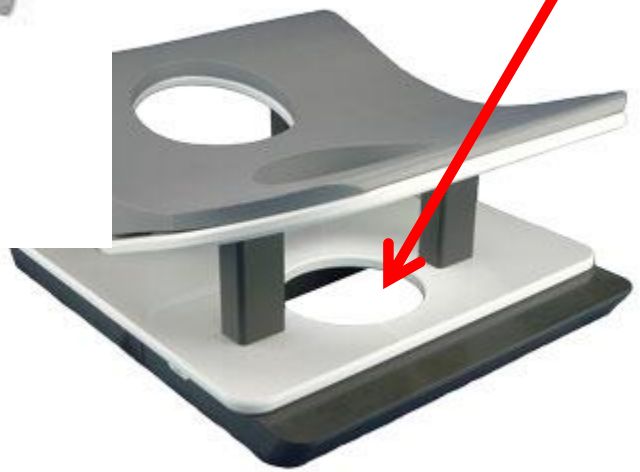
Foot/Ankle Coil

Chimney Coil Chronic Issue

Testing the Breast Coil

Biopsy Breast Coil

This coil comes with 2 plastic discs that set inside the coil with 2 small sphere phantoms



Testing the Breast Coil

- Test both sides of the coil simultaneously
- Maximum SNR
- Look for artifacts
- Be sure to compare the breast coil performance **bilaterally**!
  - Maximum Signal should be roughly equal on both
  - Noise should be equally minimal on both

Breast Accreditation

- If the site is breast accredited, you, the QMP are responsible for establishing the breast coil QC program
- Minimally, the site should track
  - artifacts
  - Bilateral signal intensity (via visual inspection only)
  - Bilateral noise (via visual inspection only)
  - Gain on the coil

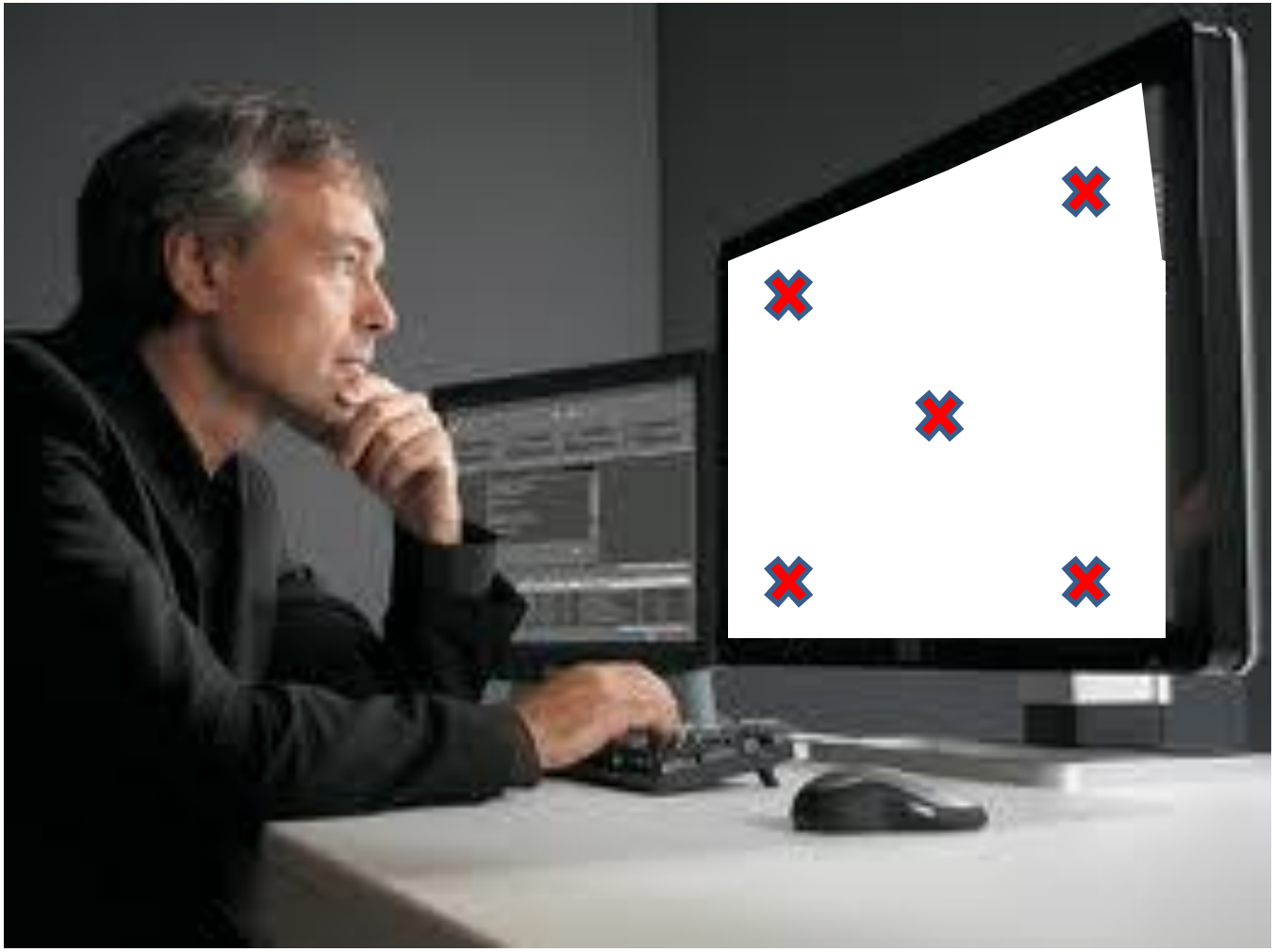
Annual System Performance Evaluation

- Physicist's Annual QC Tests
  - Magnetic Field Homogeneity – I discussed in depth at the Summer Meeting 2013
  - Slice Position Accuracy
  - Slice Thickness Accuracy
  - Radiofrequency Coil Checks
  - **Soft-Copy Displays (Monitors)**

Monitor Evaluation

- MRI is OBVIOUSLY a contrast based modality so it is important for us to verify that any and all contrast comes from the image itself NOT from variations within the monitor
- For this reason, we must test the uniformity of the monitor

Luminance Uniformity



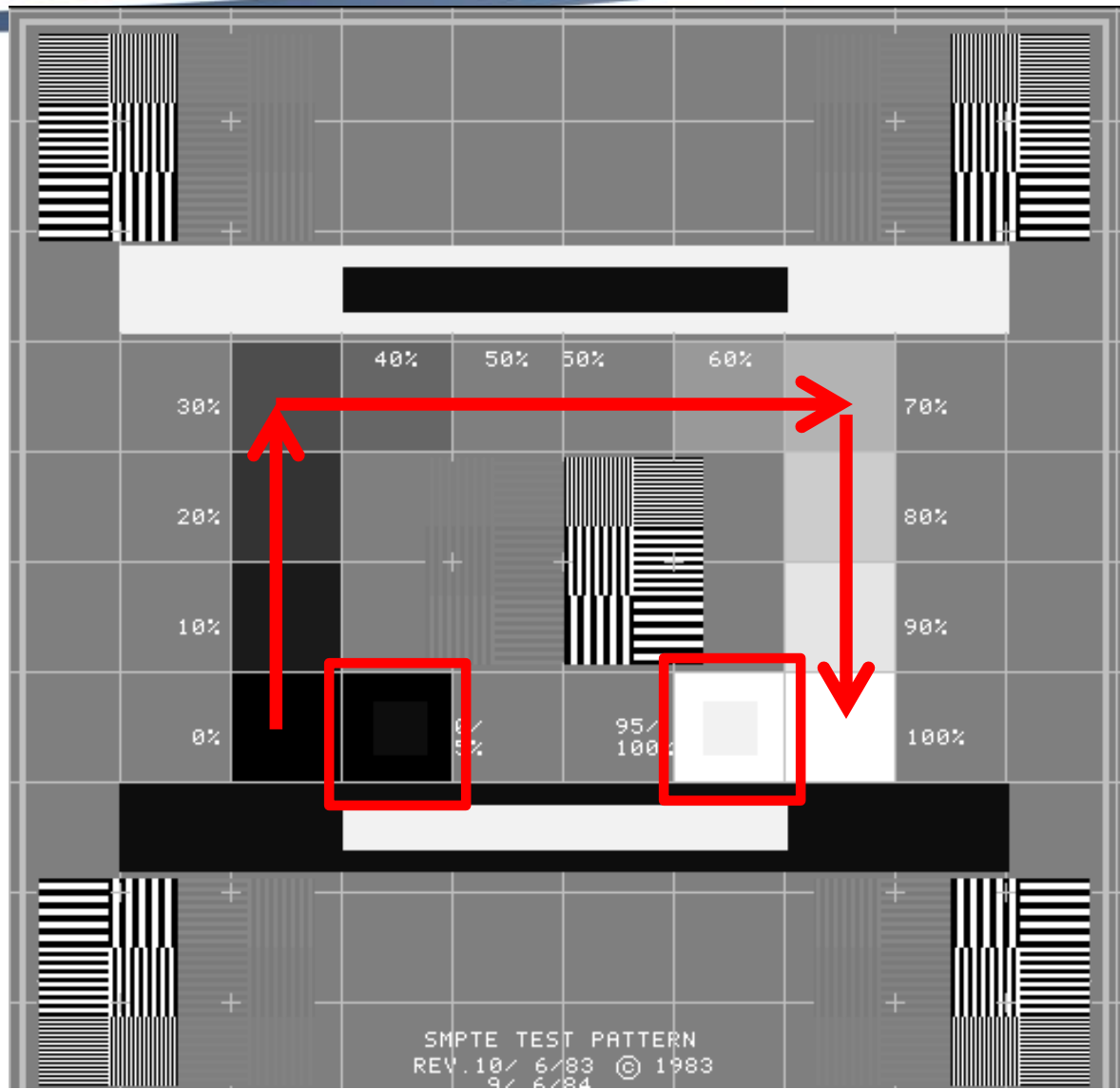
Monitor Evaluation

$$\%\, Difference = 200 \times \frac{Lmax - Lmin}{Lmax + Lmin}$$

- Luminance Uniformity – All four corner measurements should be within 30% of the maximum brightness at the center of the monitor
- The maximum brightness should **exceed 90 Cd/m^2**
- The minimum brightness should **be less 1.2 Cd/m^2**
- Resolution: 100% Contrast
- Spatial Accuracy: + 5 mm

SMPTE Pattern Evaluation

- We need to see a 10% gradation change
- You should clearly and equally visualize the 5% and 95% blocks.



Scanning the Phantom for Submission

- You have done all your coil testing and now need to collect phantom images for submission
- What you MUST submit are a ACR Sag Loc, ACR T1, ACR T2, Site T1 and Site T2
- The ACR series are specific parameters that have little flexibility

Alphabet Soup

- The ACR Sag loc and the ACR T1 are both spin echo sequences, which are the bread and butter of MRI
- The ACR T2 is a double echo, which is completely irrelevant in clinical imaging anymore (no one uses it). Mostly due to the extremely long scan times.
- You MUST scan the phantom according to the site protocols and this can get a little tricky

TSE/FSE

- Choosing the Site T1 & T2 – the TSE or FSE is best for scanning the phantom, but again you MUST use what the site is using
- The TSE is very susceptible to motion due to the speed with which the image is made, be careful to pad the phantom to minimize motion artifact. You will see some artifact but you should do what you can to reduce it.

FLAIR

- Many sites are going away from the SE for their site T1 (which accents fat) and using a FLAIR sequence for Axial Brain Imaging
- T2s show fluid brightly, but in T1 imaging, we want to suppress fluid
  - a FLAIR sequence is Fluid Attenuation Inversion Recovery which suppresses fluid is utilized (keep in mind FLAIRs can also be used as T2s by suppressing free water and accenting fluid from edema)
- FLAIRs are great for suppressing CSF (cerebrospinal fluid) and accentuating MS lesions, for example

Motion Cancelling

- What you need to know:
- Standard line by line filling of k-space is replaced by radial k-space filling with the use of a multishot radial acquisition technique
- Siemens – “BLADE”, GE – “PROPELLER”
- Great for patients with Parkinson’s
- Bad look on phantoms

Motion Cancelling

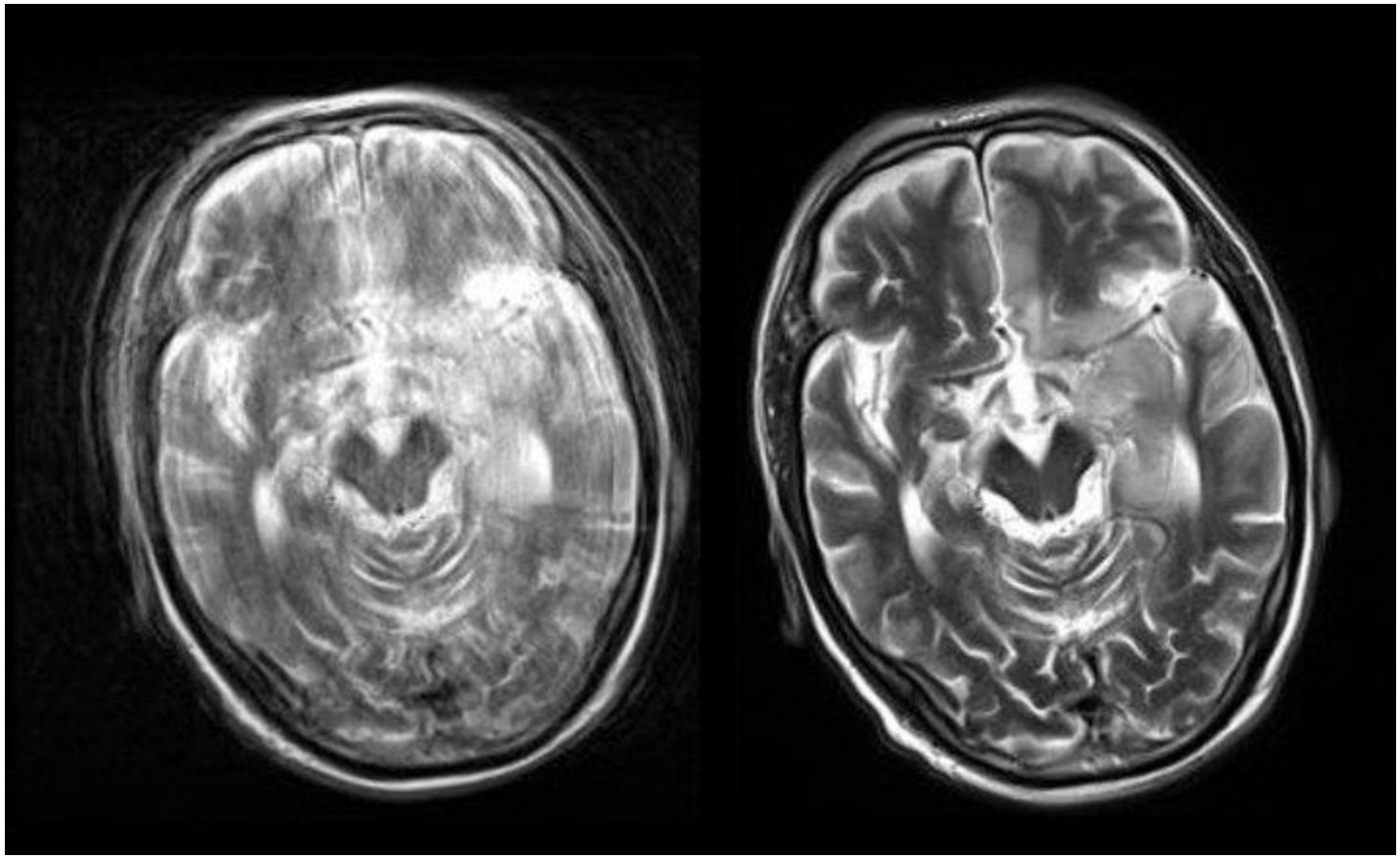


Image Courtesy of GE

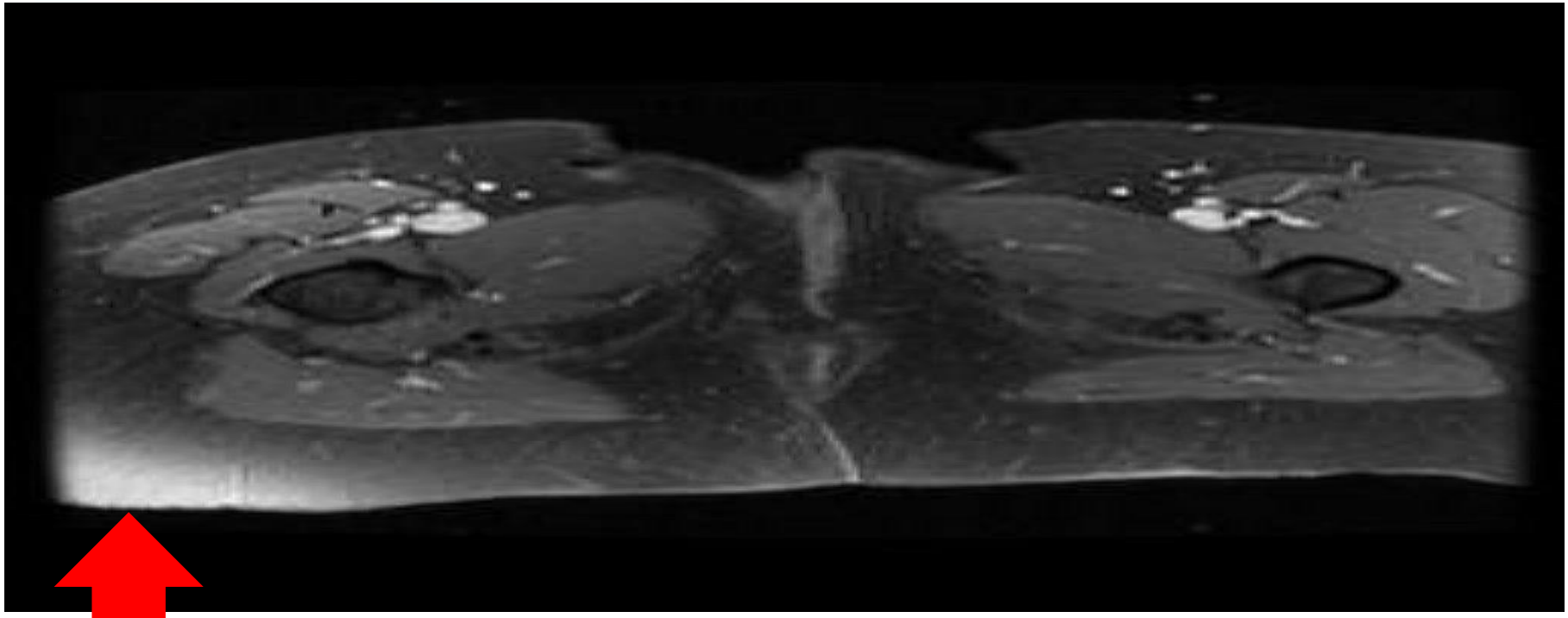
STIR

- Also in your bowl of alphabet soup, you should be familiar with the STIR sequence
- This is used as a poor man's fat sat
- All the advanced scans that the ACR is requiring clinically now require some sort of fat saturation. Current scanners with newer technology do not struggle with this, but older scans that do not have fat sat must compensate by running STIRs (short tau inversion recovery)
- STIRs are very important where we want to eliminate fat (i.e. abdominal imaging & breast)

When Fat Sat Fails

- A special, RF pulse having a narrow band of frequencies centered on the resonant frequency of fat can be applied before executing the MR pulse sequence
- This will “saturate” the fat molecules so that they generate no signal when you excite tissue with the ordinary excitation RF pulse with a wider band of frequencies
- The special RF pulse is known as a Fat Saturation pulse, sometimes referred to as “fat sat”. If the resonant frequency of fat does not match the special RF pulse, fat sat will fail, and some of the fat will be bright on the image. Failures can result from poor uniformity of the magnetic field of the scanner.

Fat Sat Failure



Bright Fat

Current Artifacts

- We'll take a brief look at a few artifacts I've helped troubleshoot or that my clients have come across recently
- If you see these in your practice, by all means, try these solutions
- If you see any new artifacts, please send them my way!

Siemens High Field Artifact

Shoulder

Knee

Siemens High Field Artifact

- These artifacts appear on shoulders and knees if you've had a recent upgrade to your software
- This maybe classified as a Spike in k-space artifact
- Solution: Contact Siemens immediately, alert them you have a corrupt file and they will reload the software

Dielectric Effect

- Commonly seen with single shot sequences with long echo trains and large number of refocusing RF pulses
- Increase in Larmor Frequency correlates with increase in the magnetic field strength
- Wavelength shortens as frequency increases
- Wavelength on 3T is 26 cm which is similar to the dimensions of an adult abdomen, resulting in a greater chance of negative interference

Dielectric Effect

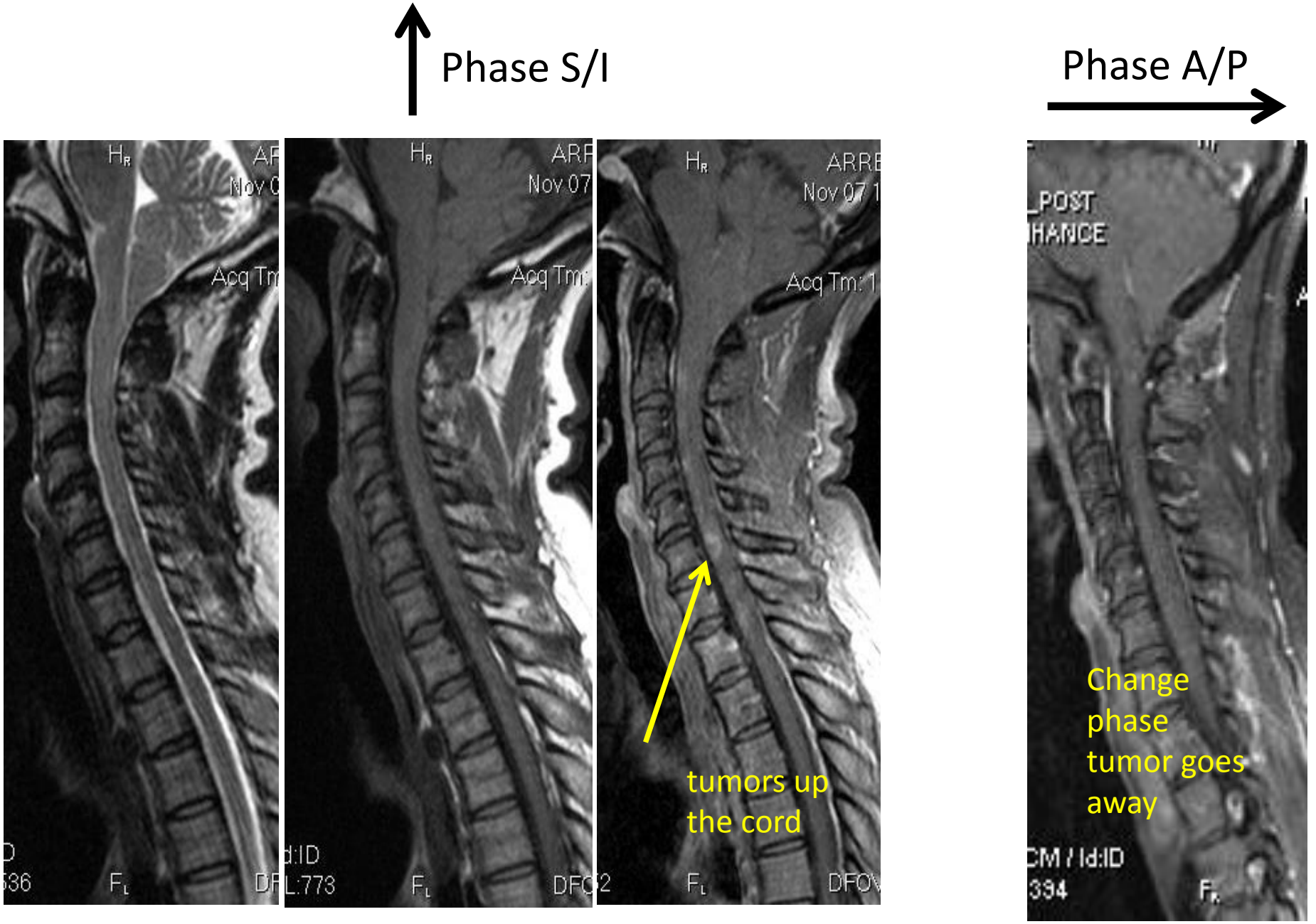
3 Tesla 1.5 Tesla

Dielectric Effect

- **Appearance:**
  - Large-scale signal non-uniformity
  - Shading often near center of field of view
- **Causes:**
  - Variation in tissue conductivity
  - More prominent with higher field strength scanners(e.g., 3T)
- **Common Occurrences:**
  - Abdominal imaging
  - Spinal imaging
  - Imaging of large water volume (e.g., pregnancy or obese patients)

Phase Encode Motion

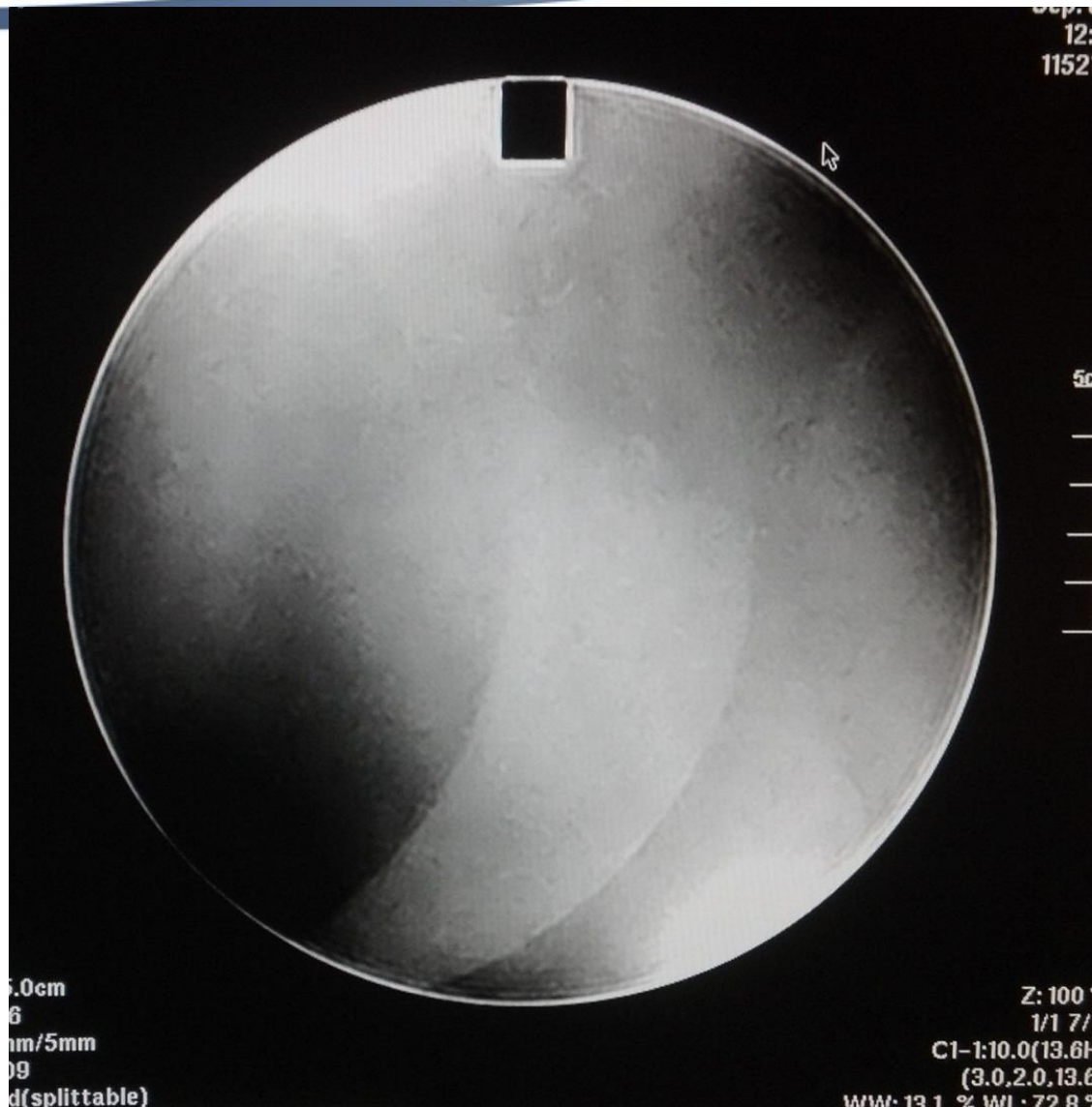
- This is a phase encoding motion artifact. Image three, at the level of C6, looks as there is an enhancing neoplasm within the cord
- **Change the phase encode direction (this is the trick of the pros)**
- Was determined to be a pulsatile artifact from the heart.


Phase S/I
Phase A/P
tumors up the cord
Change phase tumor goes away

Toshiba Artifact

Toshiba Service wrestled with this artifact for some time

Applied a filter to eliminate the pock mark artifact



FusionPHYSICS LLC

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Center Frequency and Gain on all Vendors

By

Kathryn (Kat) W. Huff, M.S., DABR

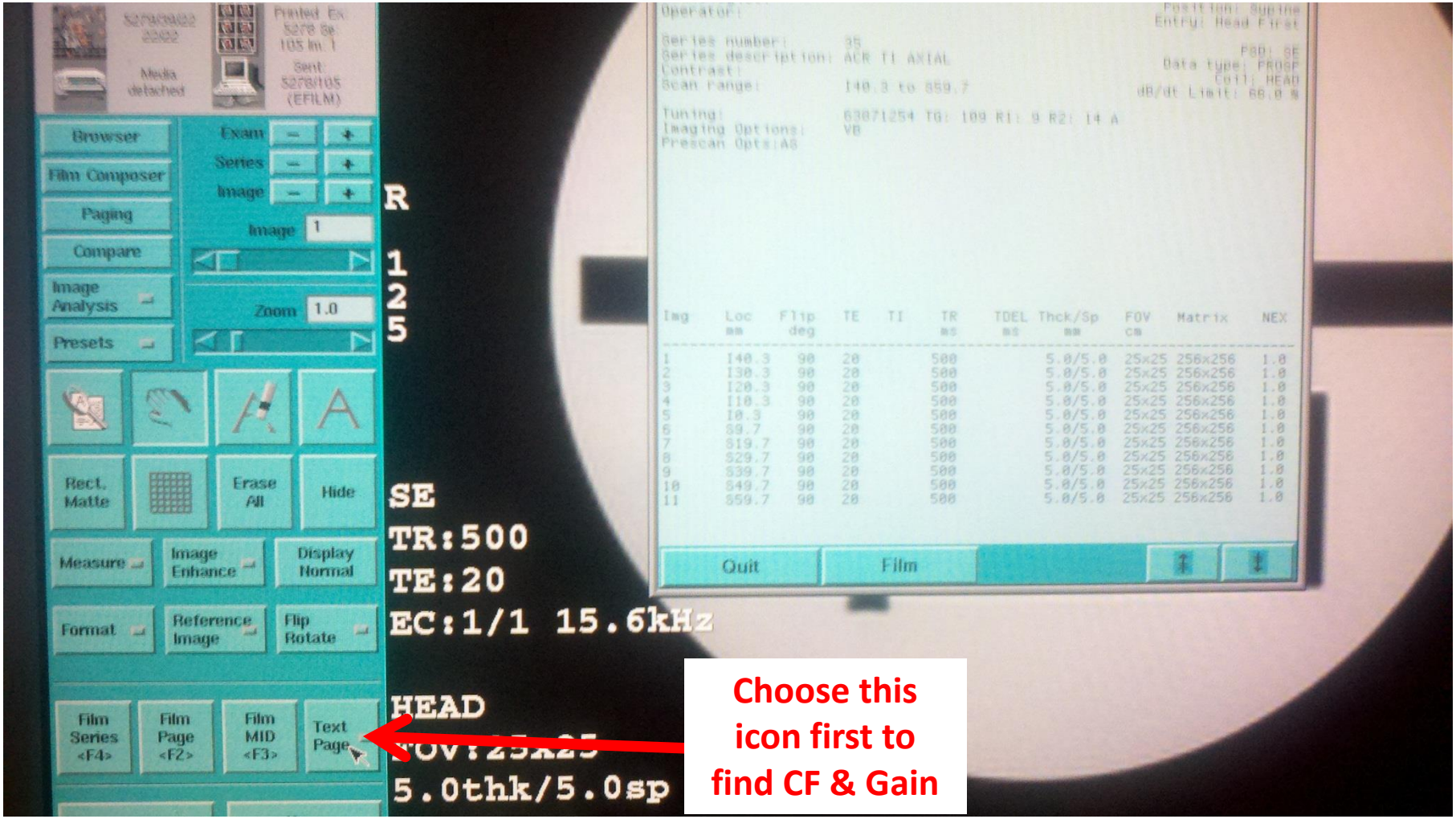
Tracking Center Frequency and Gain

- You must know where to find CF in order to calculate MFH via the bandwidth methodology
- And to establish the technologist's QC program, you must be able to show the tech where to find CF and Gain on their system
- The next slides show how to do that on every vendor and software package that I have encountered

GE

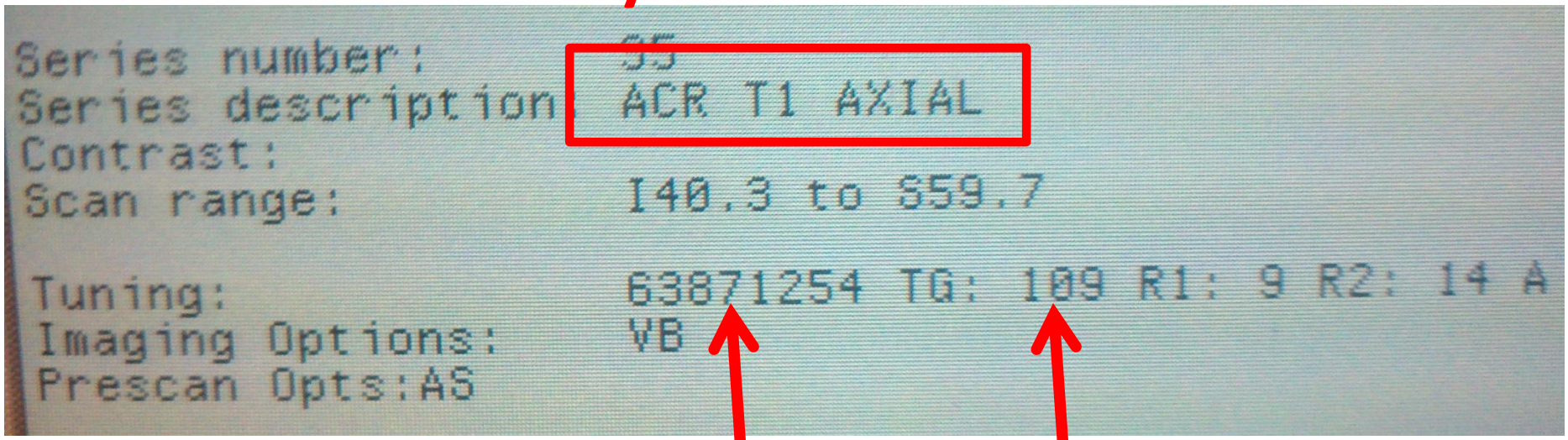
- This could not be easier on the GE scanner select the idle button then while the T1 is scanning, in the upper left hand corner AX is displayed, as is TG.
- AX is center frequency and TG is transmitter gain
- Or you can use the text page button below if the scan is already complete – see next slides

GE


Browser
Film Composer
Paging
Compare
Image Analysis
Presets
Exam
Series
Image
Zoom
Rect. Matte
Erase All
Hide
Measure
Image Enhance
Display Normal
Format
Reference Image
Flip Rotate
Film Series <F4>
Film Page <F2>
Film MID <F3>
Text Page
R
125
SE
TR:500
TE:20
EC:1/1 15.6kHz
HEAD
5.0thk/5.0sp
Quit
Film
Choose this icon first to find CF & Gain

GE

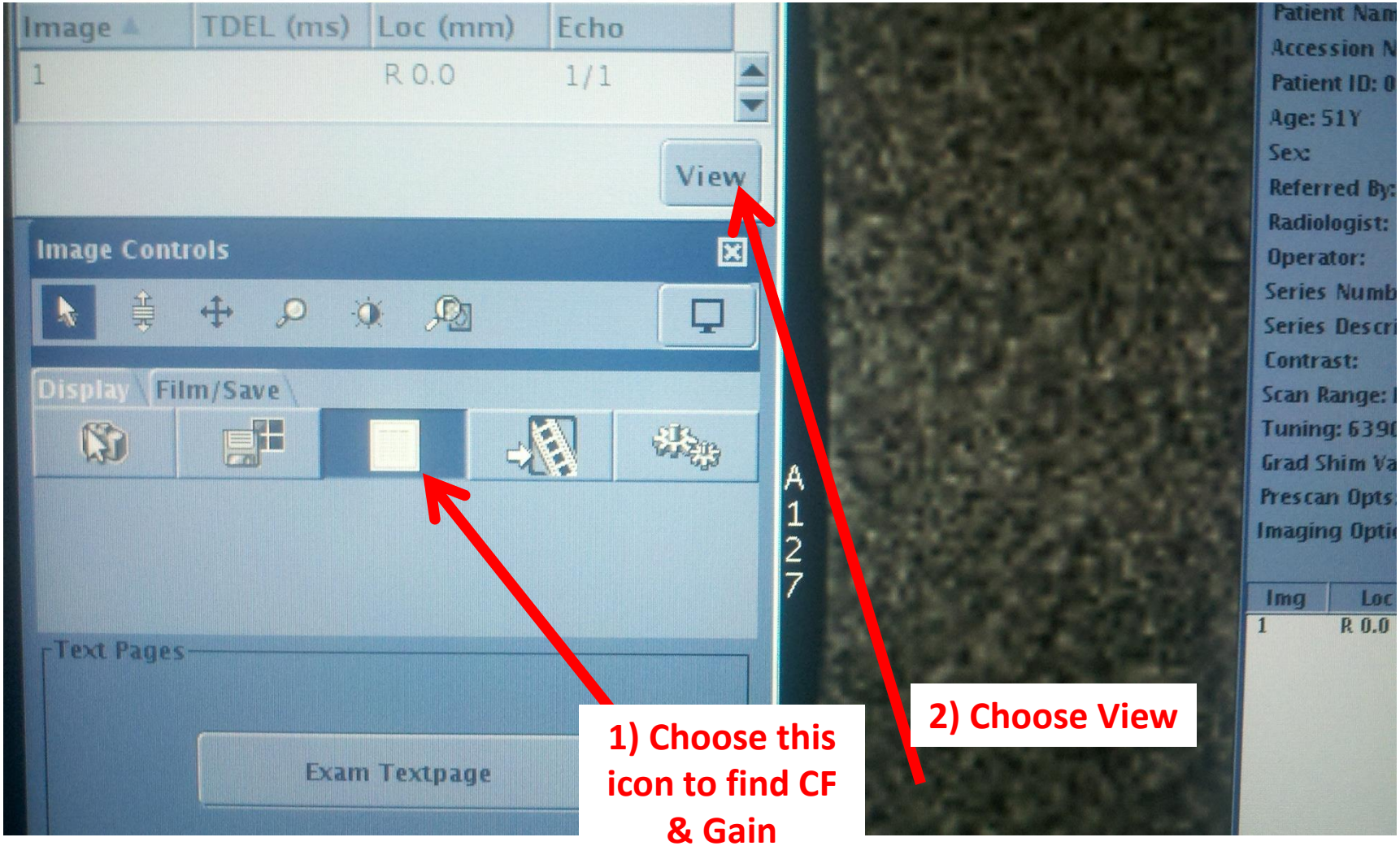
Always choose ACR T1



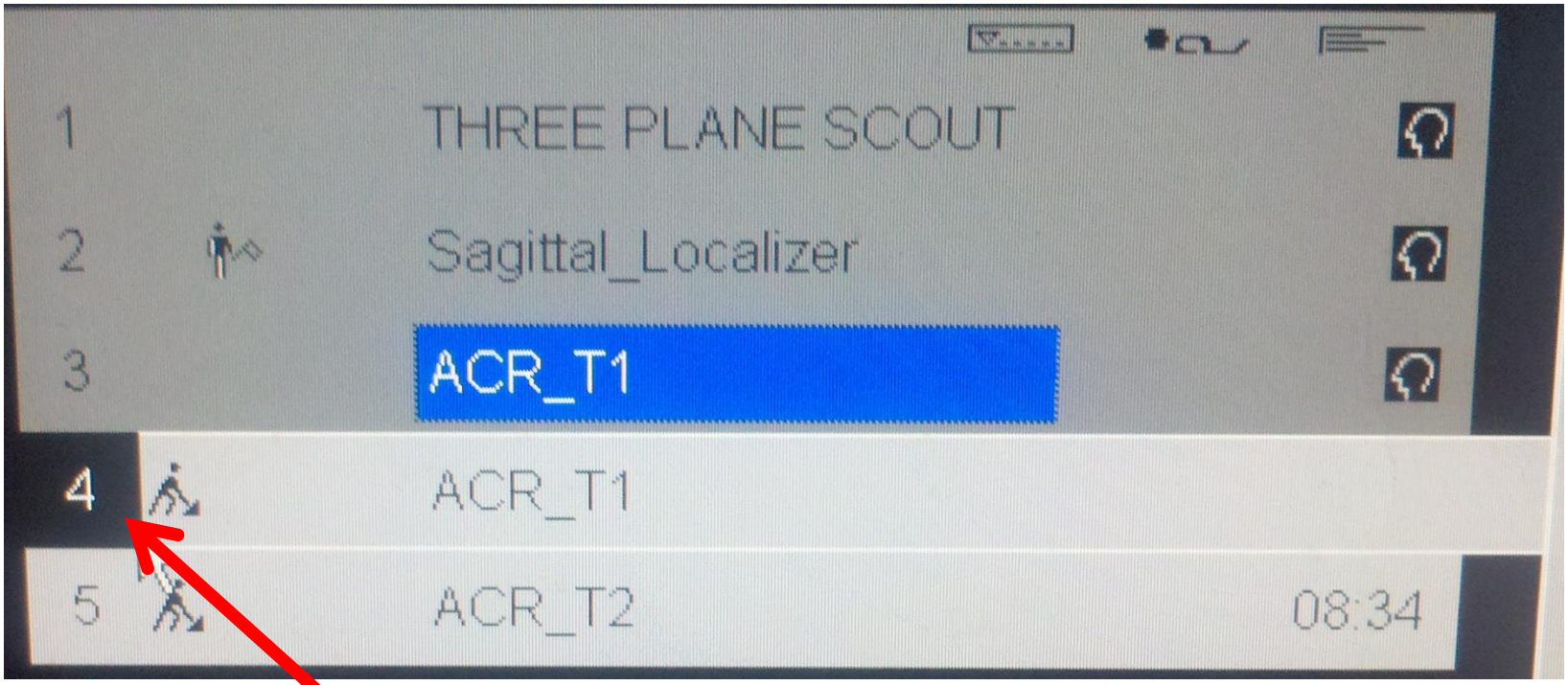
Center Frequency

Transmitter Gain

New GE Software

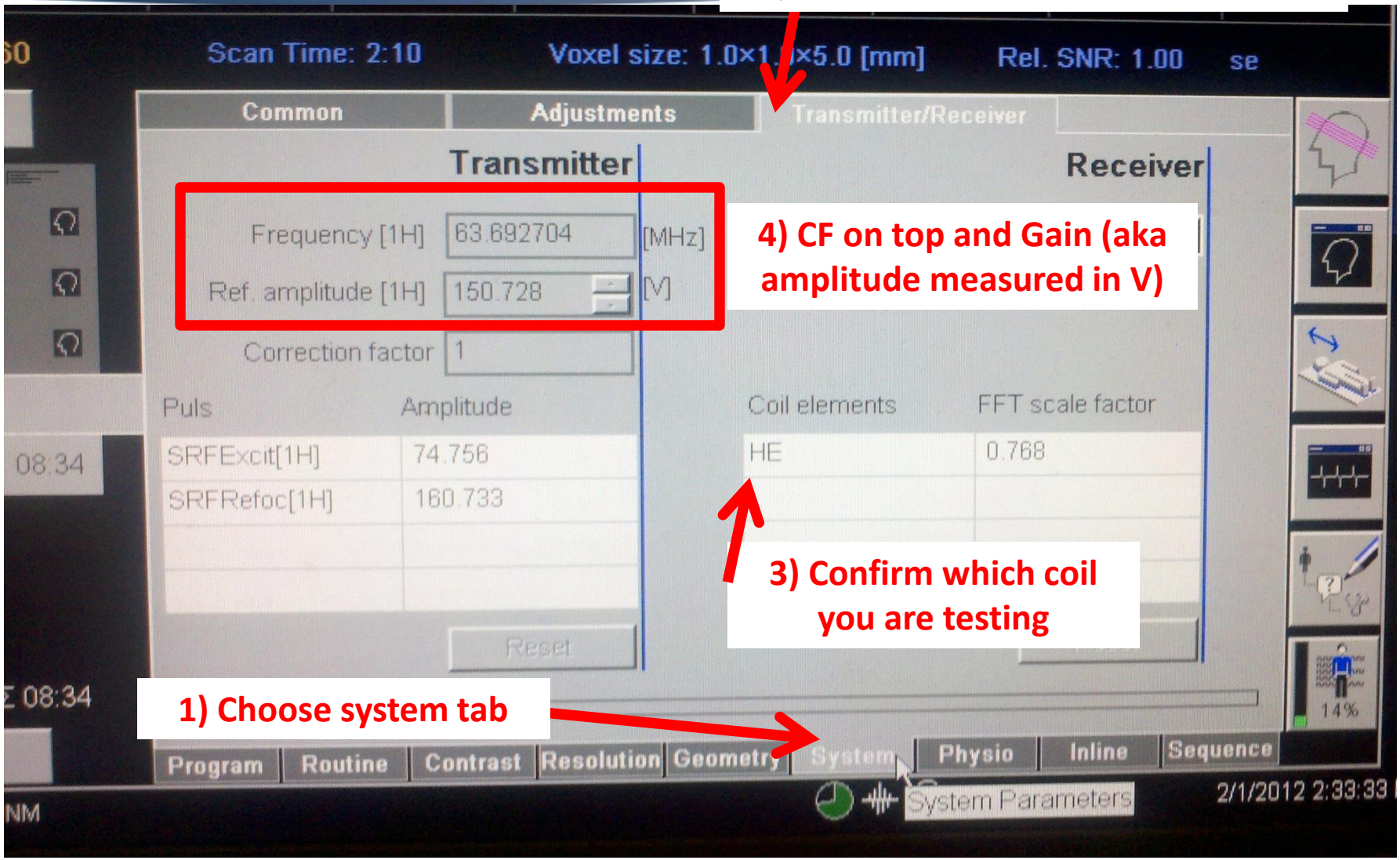


Siemens

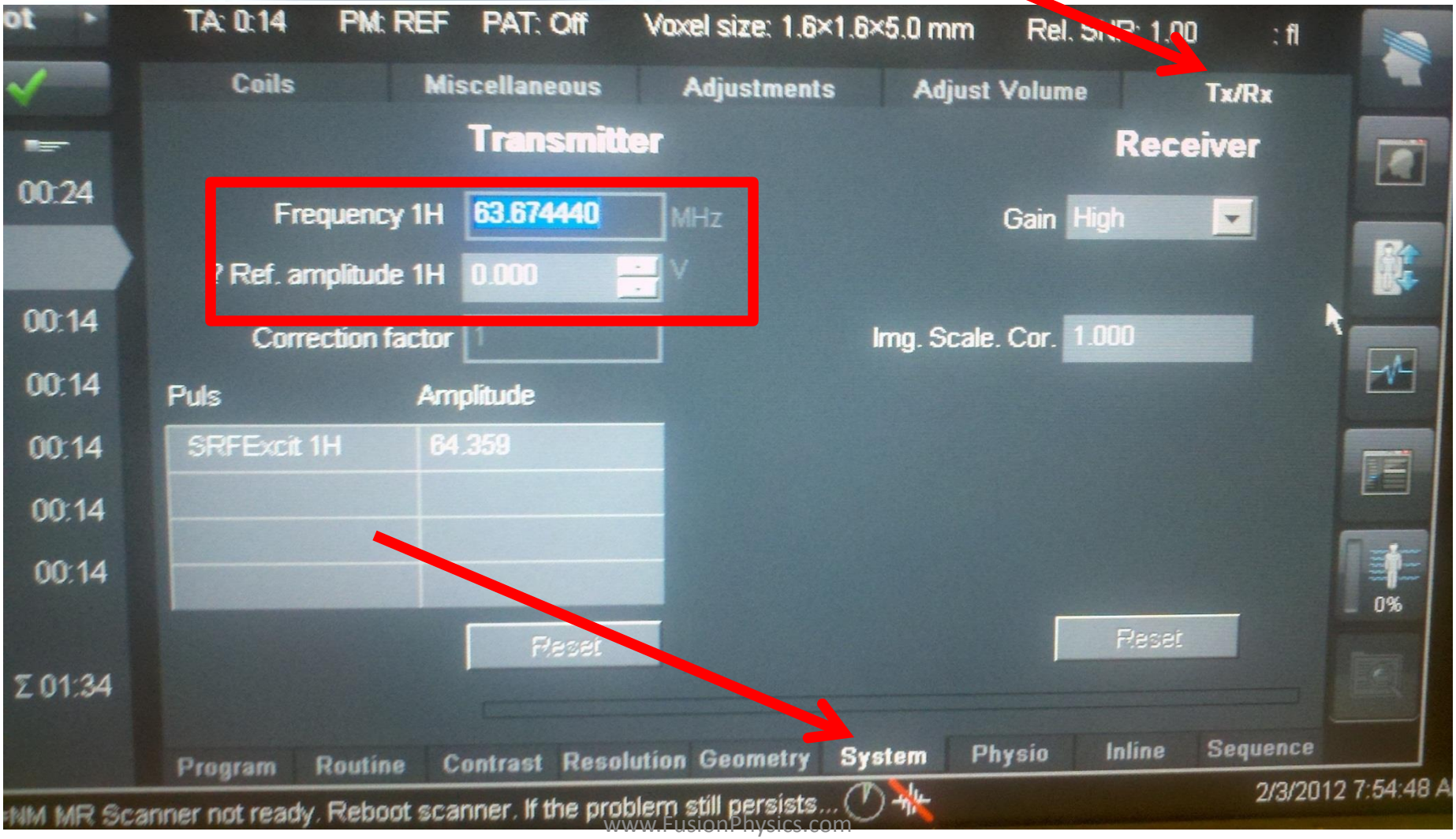


1) Make sure the ACR T1 is indented with the black box selecting the scan. This is best collected after the scan has been run, BEFORE the coil is changed!

Siemens

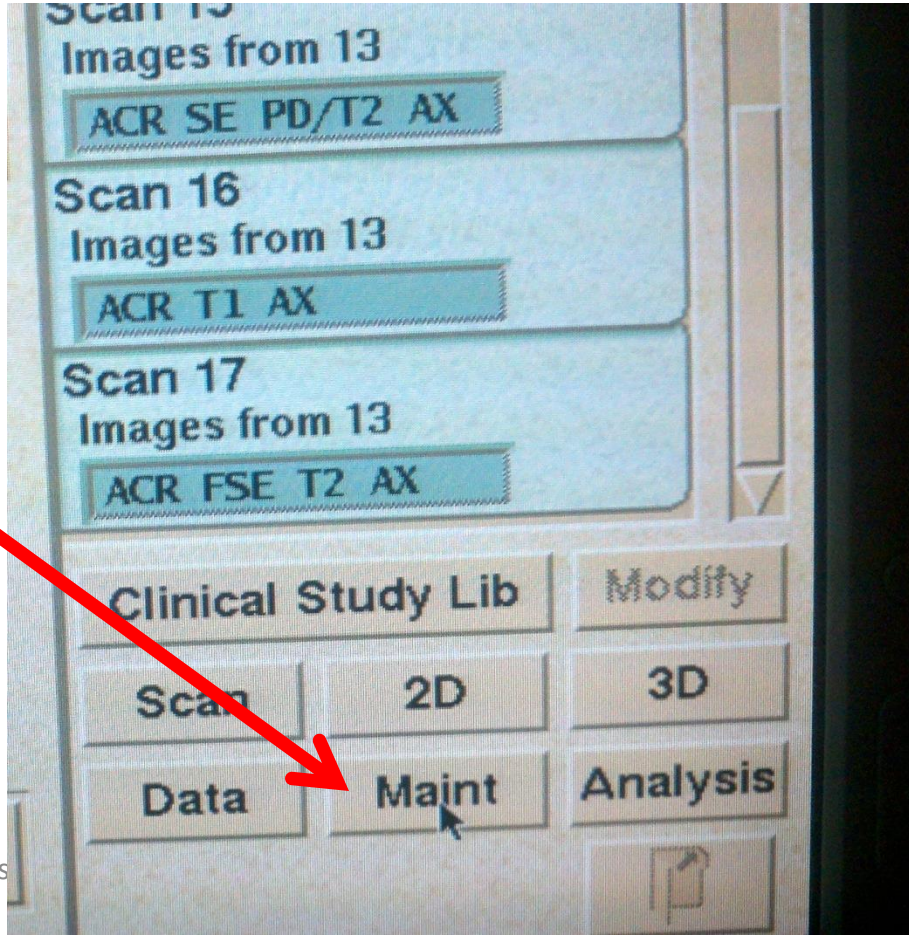

2) Choose Transmitter/Receiver tab
Scan Time: 2:10
Rel. SNR: 1.00
Common
Adjustments
Transmitter/Receiver
Transmitter
Receiver
Frequency [1H]
63.692704
[MHz]
Ref. amplitude [1H]
150.728
[V]
4) CF on top and Gain (aka amplitude measured in V)
Correction factor
1
Puls
Amplitude
SRFExcit[1H]
74.756
SRFRefoc[1H]
160.733
Coil elements
FFT scale factor
HE
0.768
3) Confirm which coil you are testing
Reset
1) Choose system tab
Program
Routine
Contrast
Resolution
Geometry
System
Physio
Inline
Sequence
System Parameters
2/1/2012 2:33:33
14%

Siemens New Software



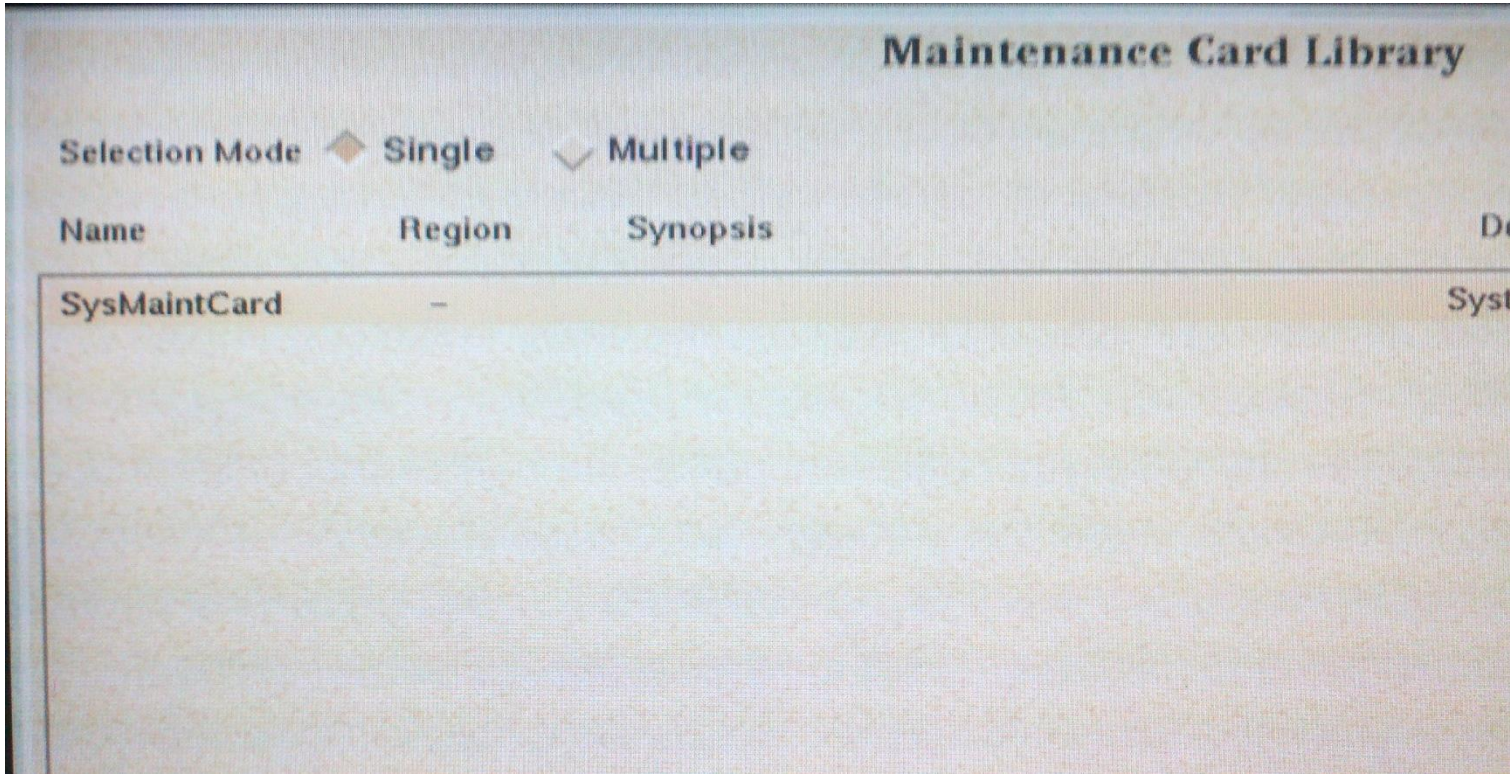
Hitachi

- If Maintenance card is not at the bottom of your list, put it there!
- Hit Maint button in the center

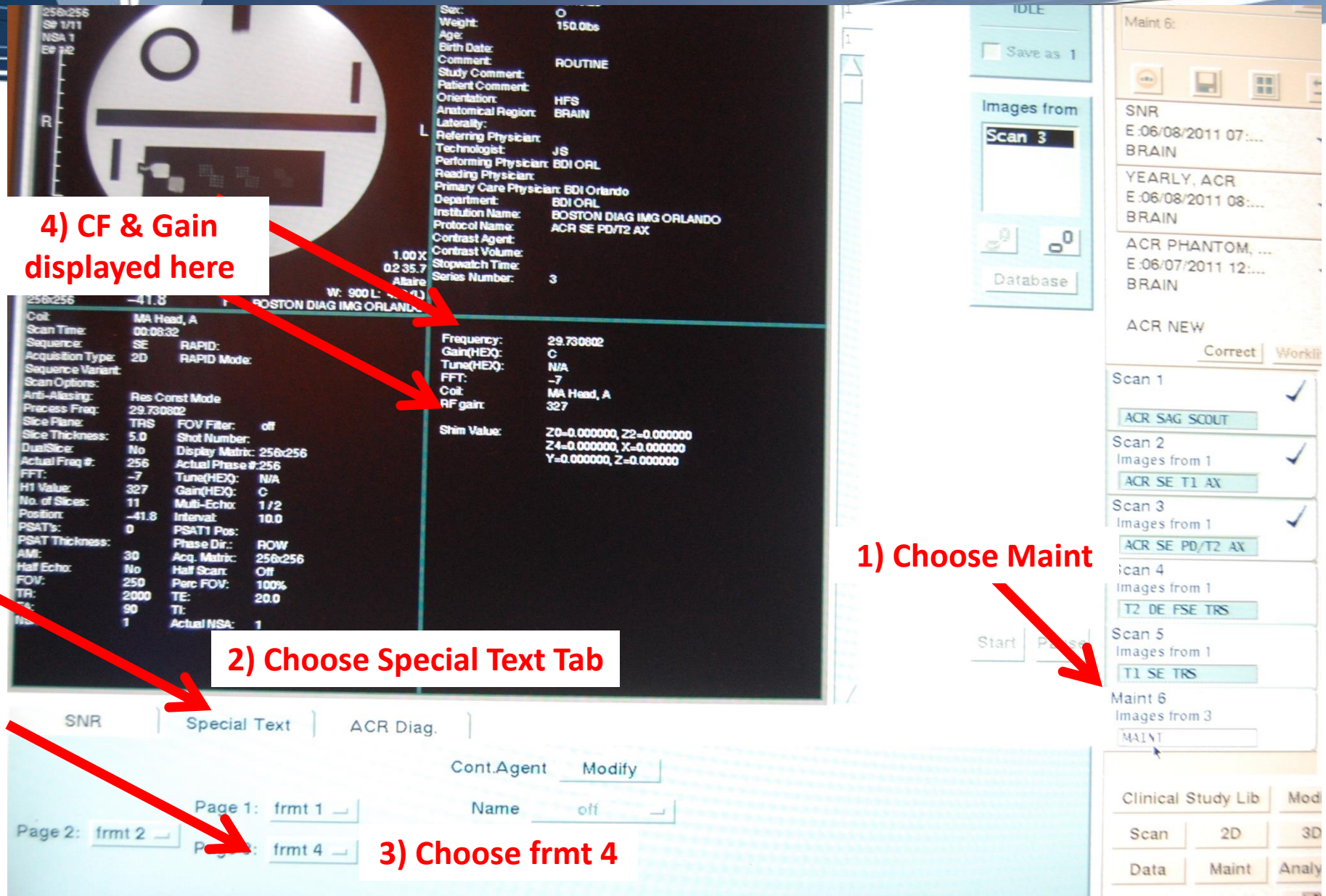


Adding System Maintenance Card

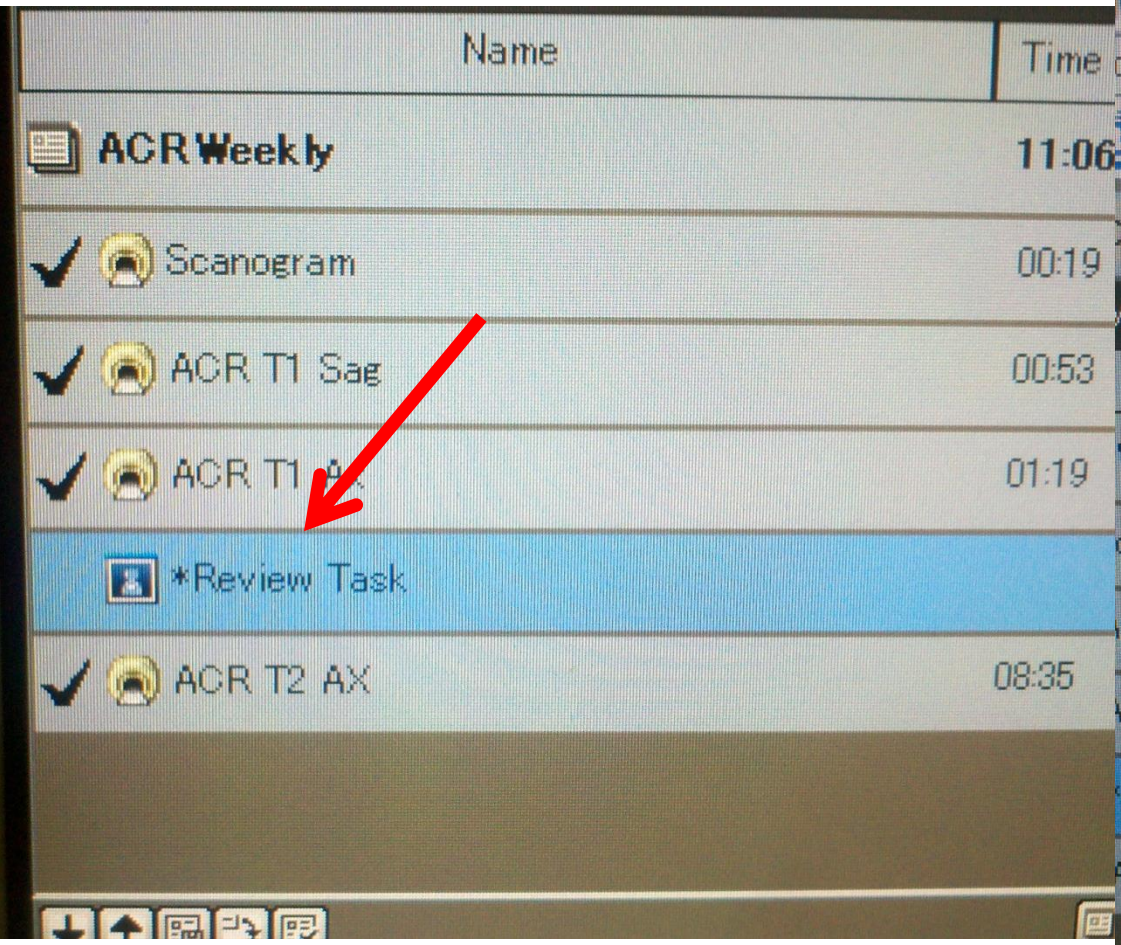
- Choose SysMaintCard then hit done
- Under ACR protocols there will be a Maint tab – see next slide

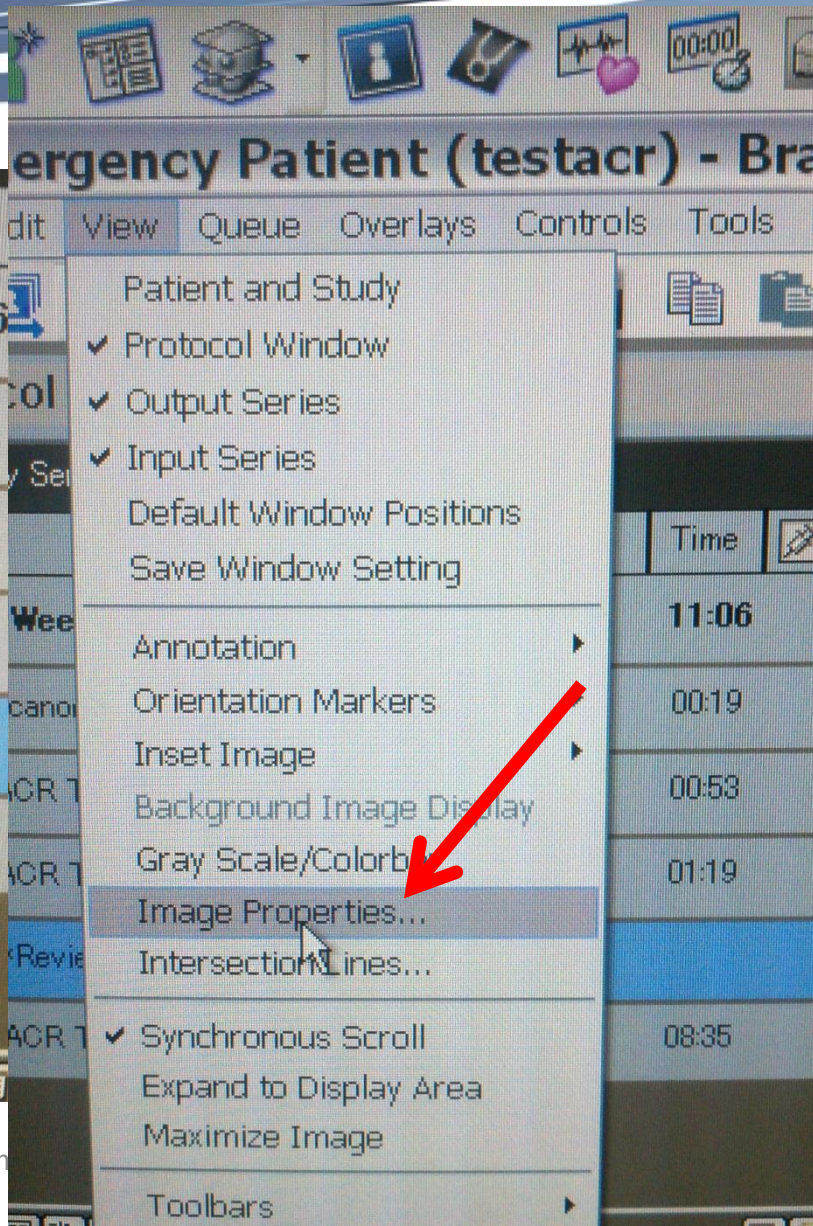


Hitachi

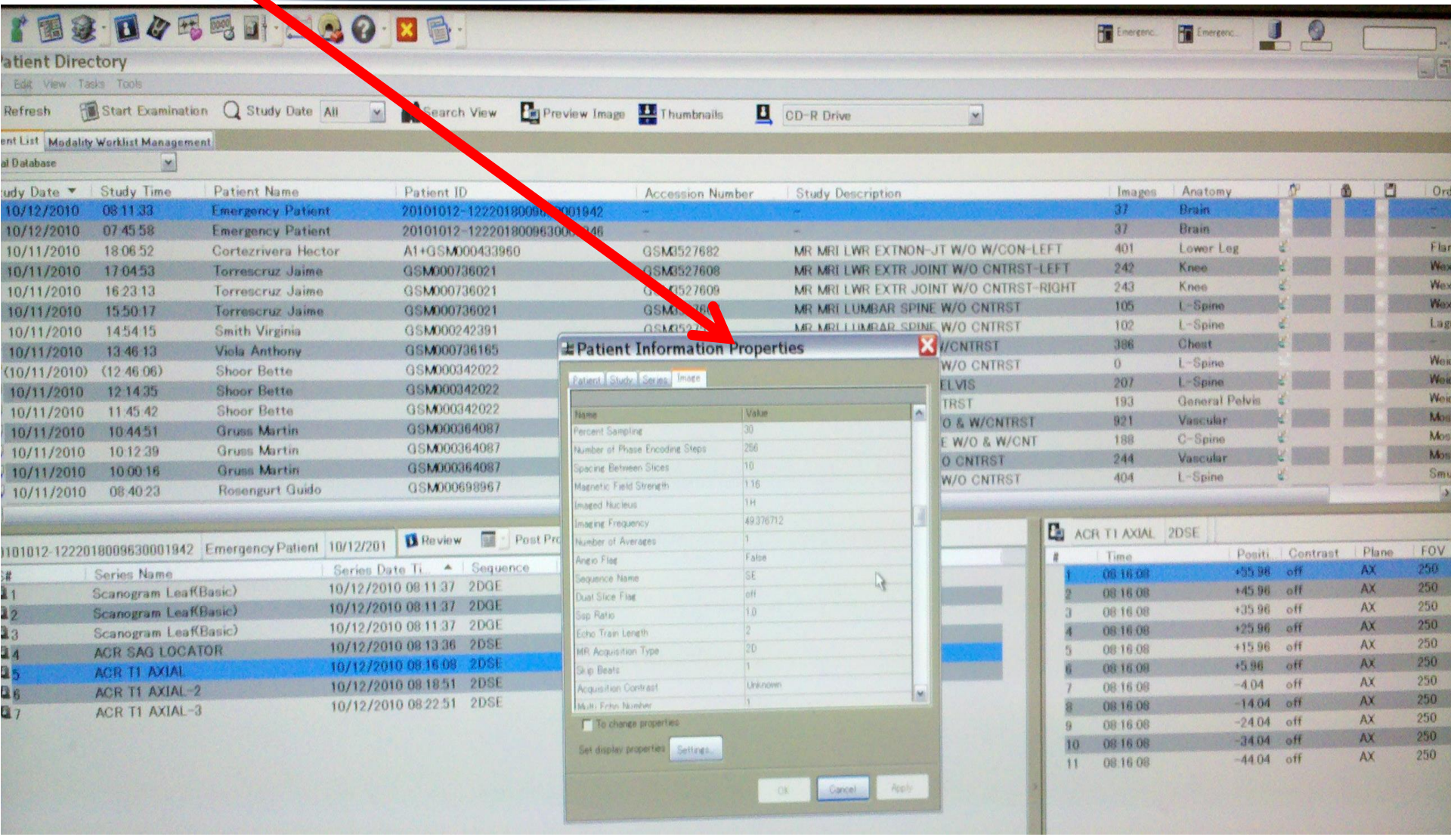

4) CF & Gain displayed here
2) Choose Special Text Tab
3) Choose frmt 4
1) Choose Maint
SNR
Special Text
ACR Diag.
Cont.Agent
Modify
Page 1:
frmt 1
Name
off
Page 2:
frmt 2
frmt 4
Images from
Scan 3
Database
Save as 1
Maint 6:
SNR
E:06/08/2011 07:...
BRAIN
YEARLY, ACR
E:06/08/2011 08:...
BRAIN
ACR PHANTOM, ...
E:06/07/2011 12:...
BRAIN
ACR NEW
Correct
Scan 1
ACR SAG SCOUT
Scan 2
Images from 1
ACR SE T1 AX
Scan 3
Images from 1
ACR SE PD/T2 AX
Scan 4
Images from 1
T2 DE FSE TRS
Scan 5
Images from 1
T1 SE TRS
Maint 6
Images from 3
MAINT
Clinical Study Lib
Scan
2D
Data
Maint
Start
Sex:
Weight:
150.0lbs
Age:
Birth Date:
Comment:
ROUTINE
Study Comment:
Patient Comment:
Orientation:
HFS
Anatomical Region:
BRAIN
Laterality:
Referring Physician:
Technologist:
JS
Performing Physician:
BDI ORL
Reading Physician:
Primary Care Physician:
BDI Orlando
Department:
BDI ORL
Institution Name:
BOSTON DIAG IMG ORLANDO
Protocol Name:
ACR SE PD/T2 AX
Contrast Agent:
Contrast Volume:
Stopwatch Time:
Series Number:
3
Coil:
MA Head, A
Scan Time:
00:08:32
Sequence:
SE
RAPID:
Acquisition Type:
2D
RAPID Mode:
Sequence Variant:
Scan Options:
Anti-Aliasing:
Res Const Mode
Precess Freq:
29.730802
Slice Plane:
TRS
FOV Filter:
off
Slice Thickness:
5.0
Shot Number:
DualSlice:
No
Display Matrix:
256x256
Actual Freq #:
256
Actual Phase #:256
FFT:
-7
Tune(HEX):
N/A
H1 Value:
327
Gain(HEX):
C
No. of Slices:
11
Multi-Echo:
1 / 2
Position:
-41.8
Interval:
10.0
PSAT's:
0
PSAT1 Pos:
PSAT Thickness:
Phase Dir.:
ROW
AIM:
30
Acq. Matrix:
256x256
Half Echo:
No
Half Scan:
Off
FOV:
250
Perc FOV:
100%
TR:
2000
TE:
20.0
90
TI:
1
Actual NSA:
1
Frequency:
29.730802
Gain(HEX):
C
Tune(HEX):
N/A
FFT:
-7
Coil:
MA Head, A
RF gain:
327
Shim Value:
Z0=0.000000, Z2=0.000000
Z4=0.000000, X=0.000000
Y=0.000000, Z=0.000000

Hitachi New Software

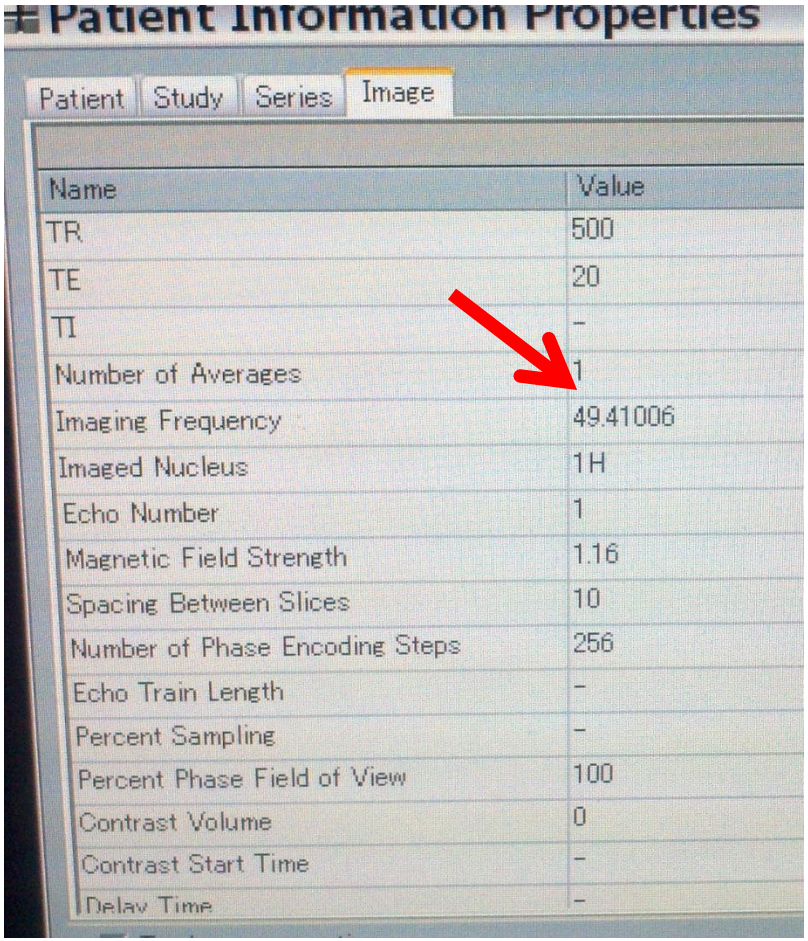


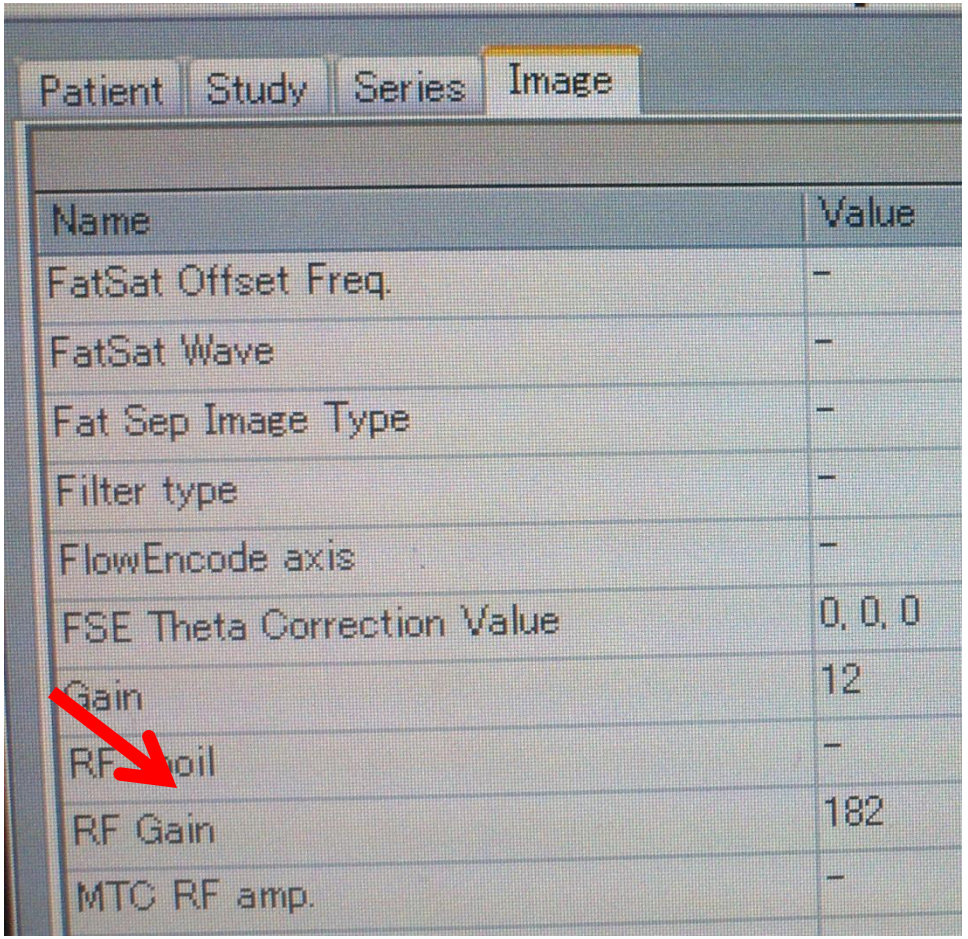


Hitachi New Software

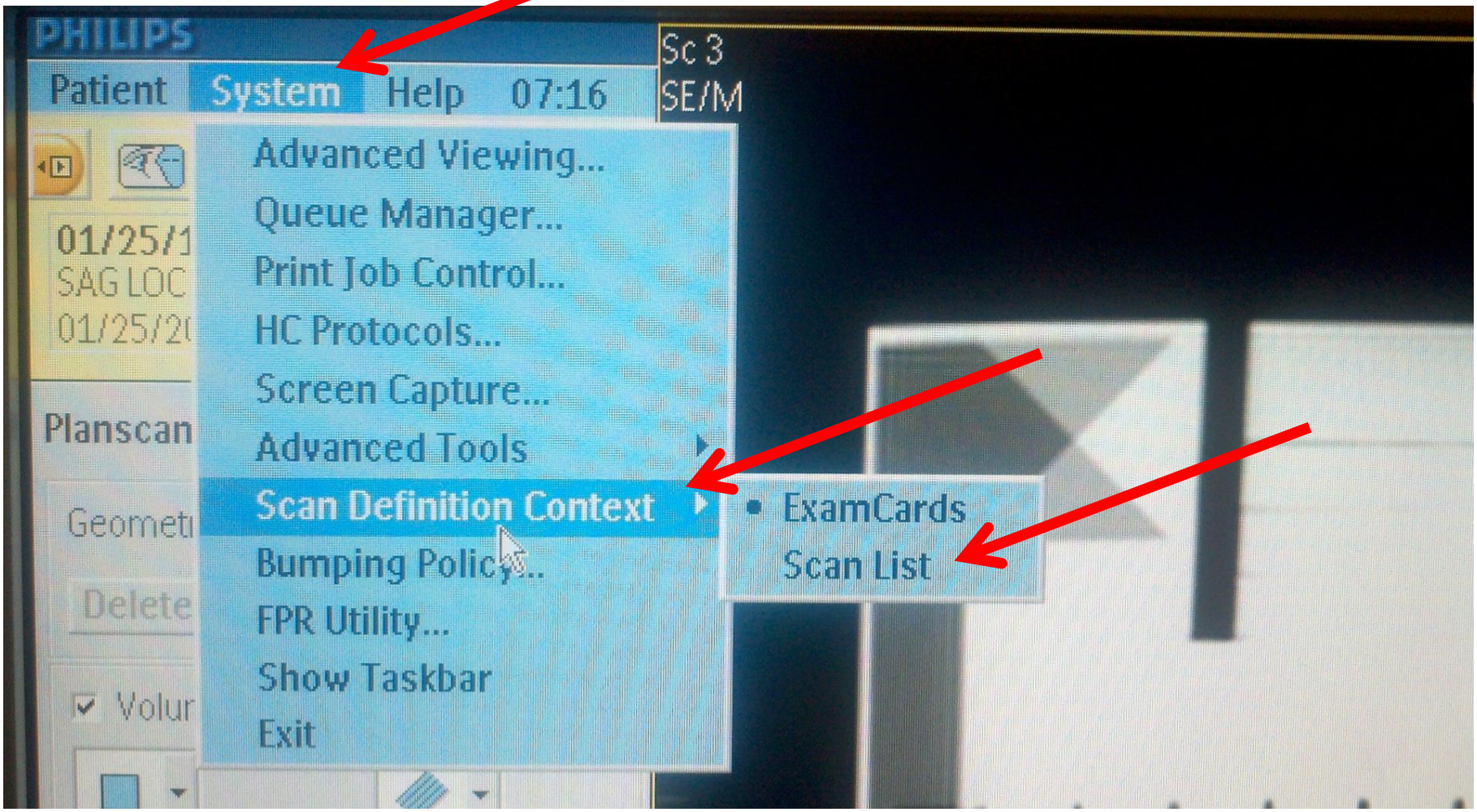


Hitachi New Software

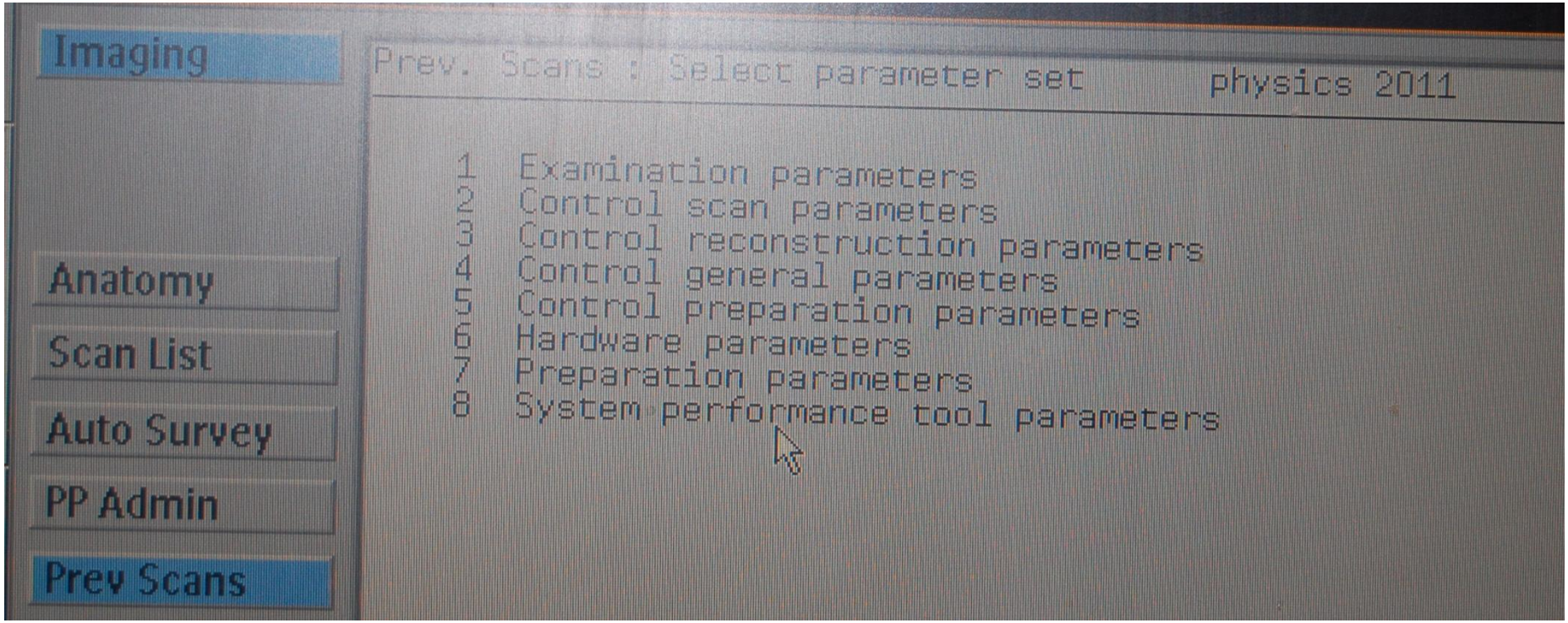




Philips

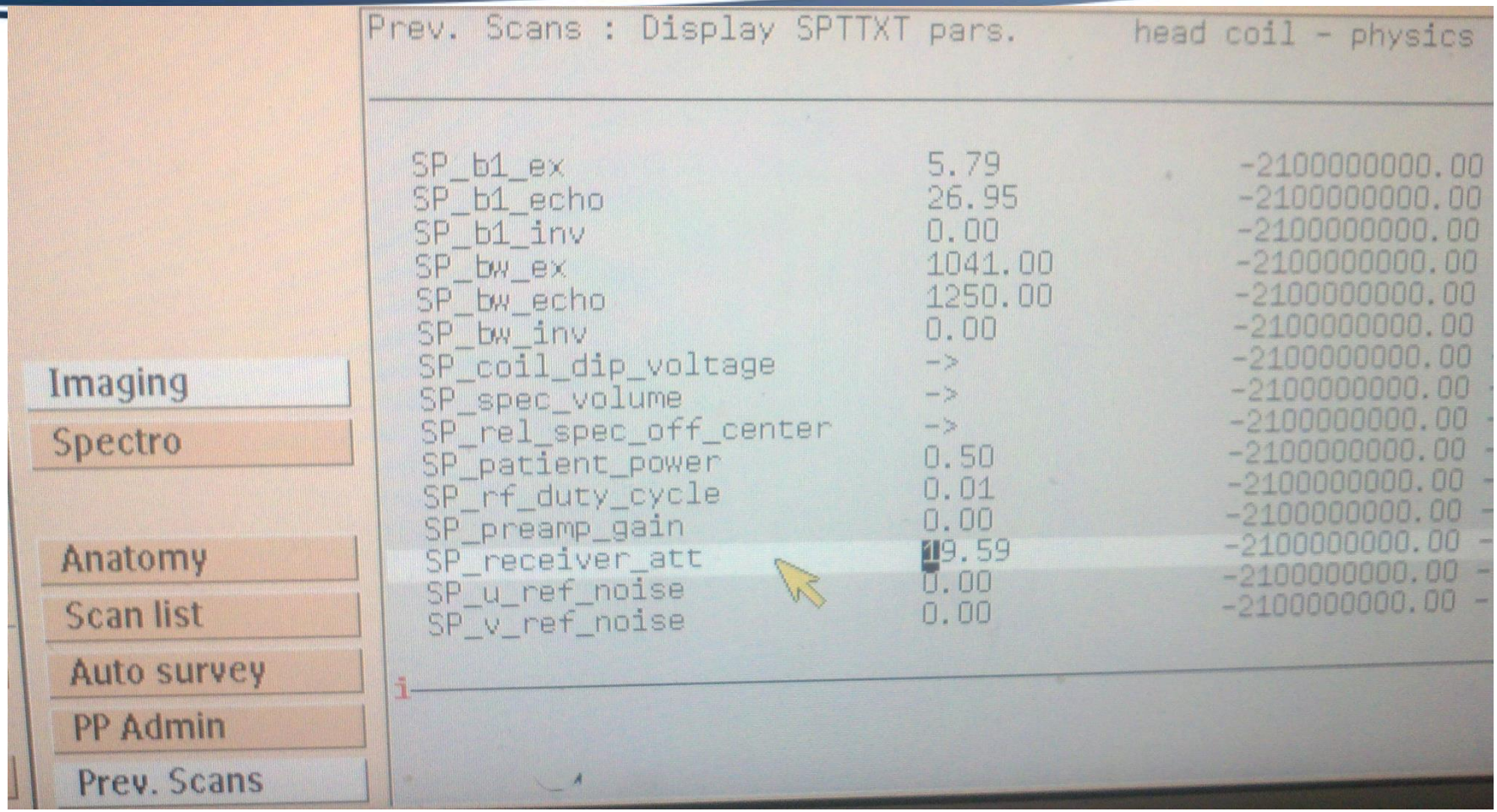

PHILIPS
Patient
System
Help
07:16
Sc 3
SE/M
Advanced Viewing...
Queue Manager...
Print Job Control...
HC Protocols...
Screen Capture...
Advanced Tools
Scan Definition Context
Bumping Policy...
FPR Utility...
Show Taskbar
Exit
ExamCards
Scan List
Planscan
Delete

Philips



- Under previous scan choose #8, then click on double arrows until you see sp_proton_freq and SP_receiver_att

Philips



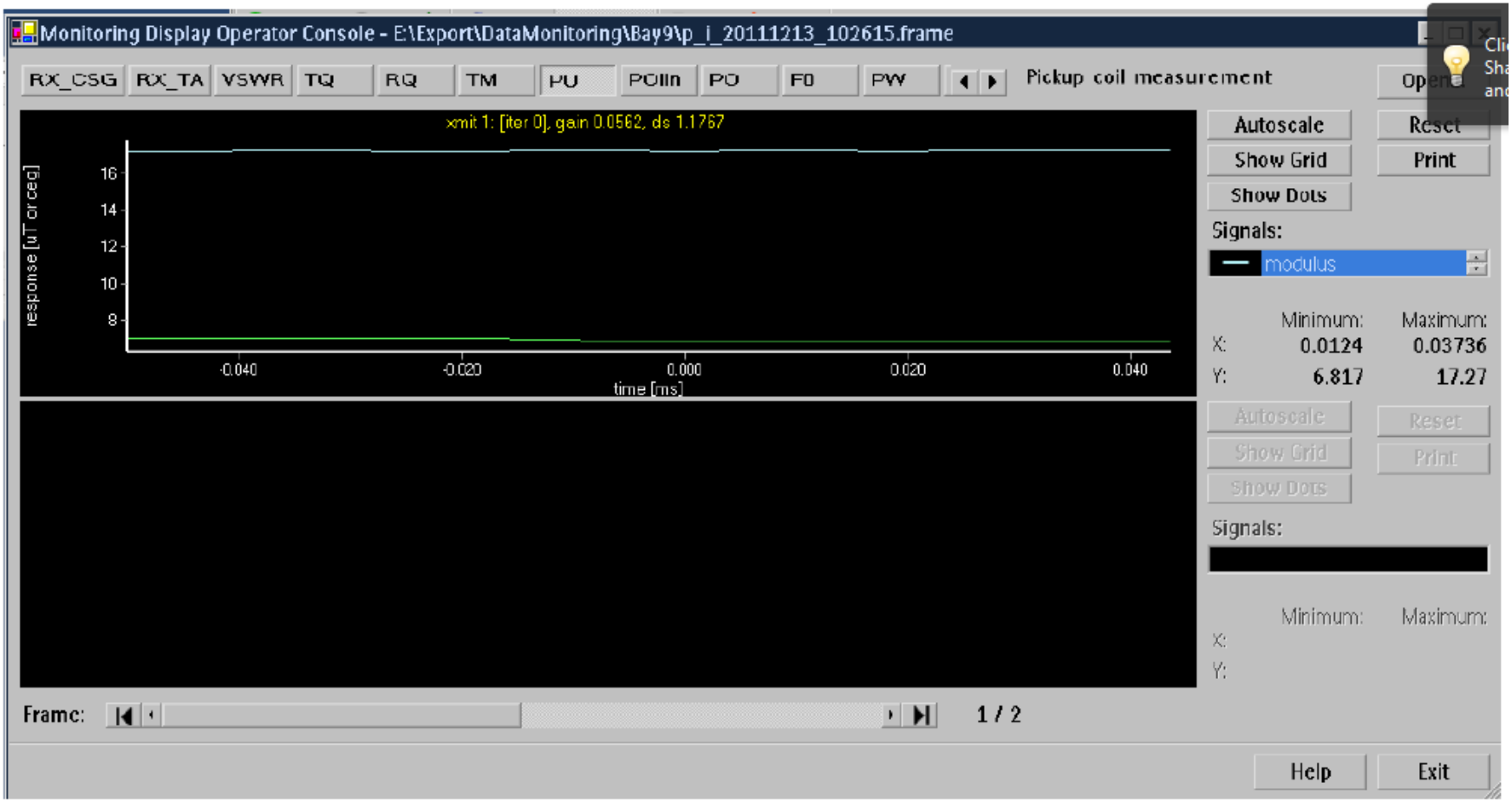
click on double arrows until you see SP_receiver_att

Philips New Software

Ingenia:

- While the sequence is running, on the Main Menu (Upper Left) choose **System**, and **DataMonitoring**
- This will bring up a window showing the preparation phases for the **currently running sequence**. You must review this page prior to the next sequence beginning, or use a different method to bring up the data.

Philips New Software



Click on the **PU** tab at the top to find **Transmit Gain**

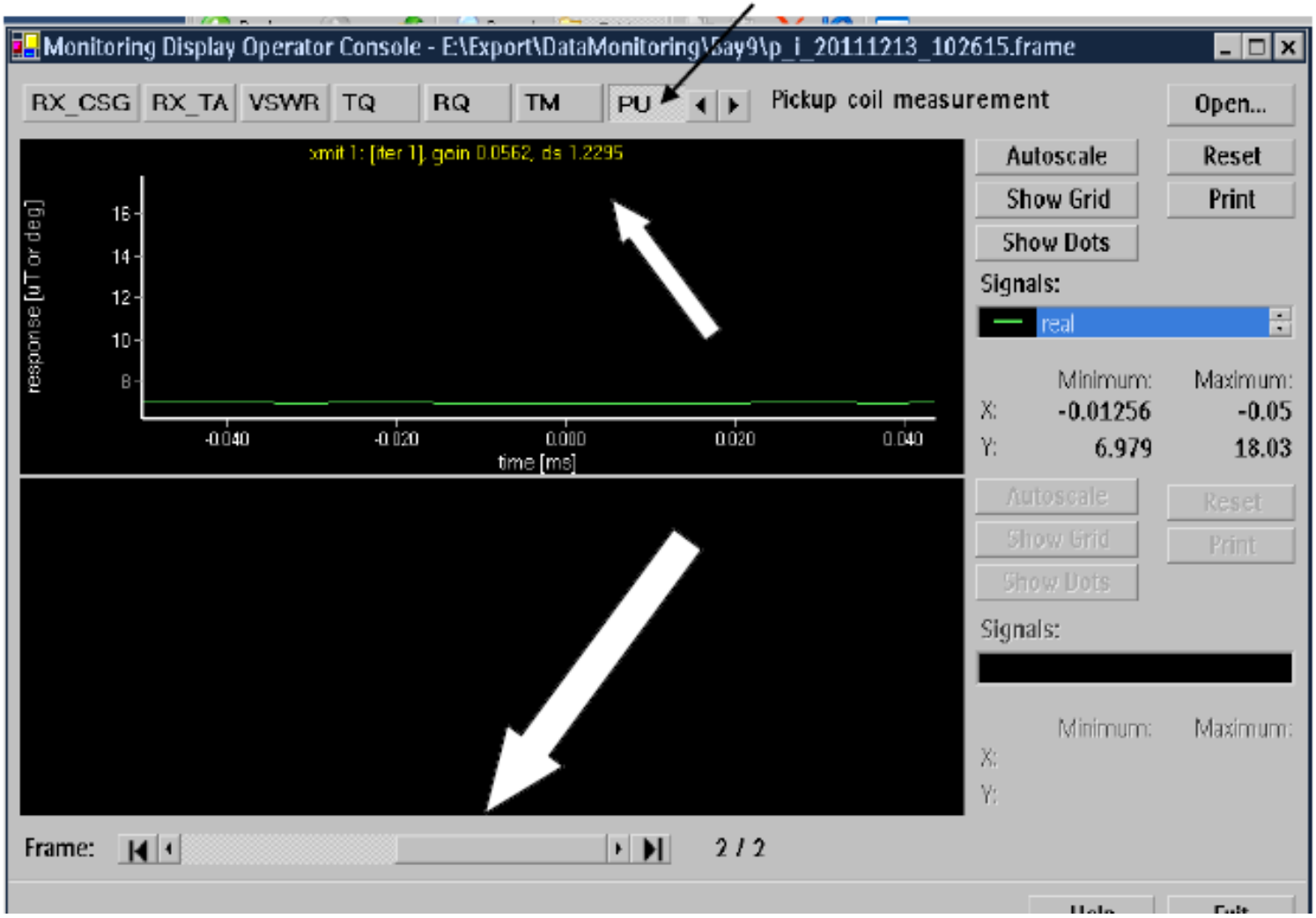
Click on the **F0** tab at the top to find **Center Frequency** (you may have to use the right arrowhead to

Move the Frame: slider to 2/2 (large white arrow)

Note that in the top window you will see

xmit 1: (iter 1),gain 0.xxxx, **ds x.xxxx** (in yellow)

ds is the abbreviation for **d**rive **s**cale, and is the number for you to use as transmit gain on the ACR document (small white arrow)



Center Frequency (f0):

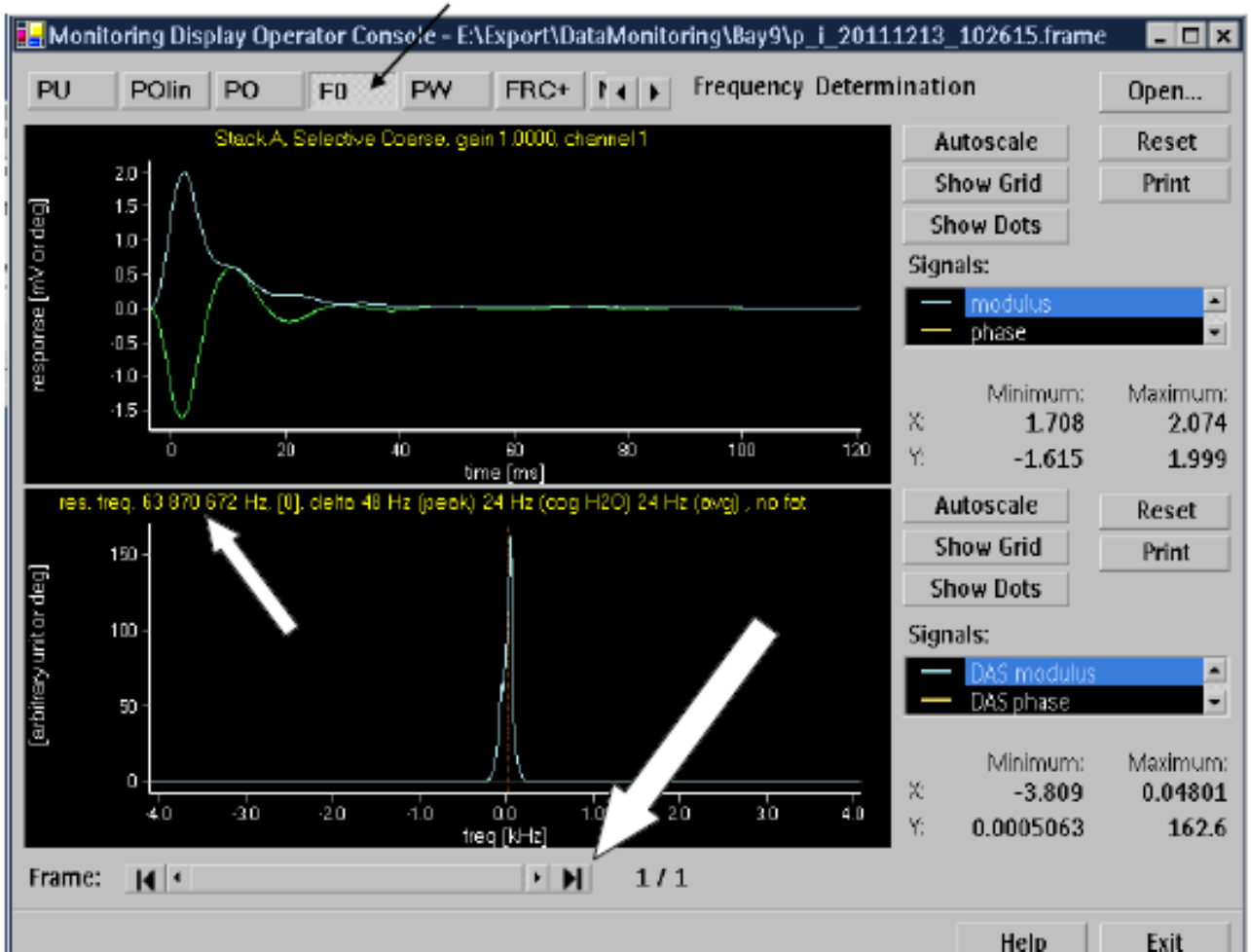
Click the F0 button at the top (black arrow)

Move the Frame: slider to last iteration 1/1, 2/2, 6/6, etc. (large white arrow)

Note that in the bottom window you will see

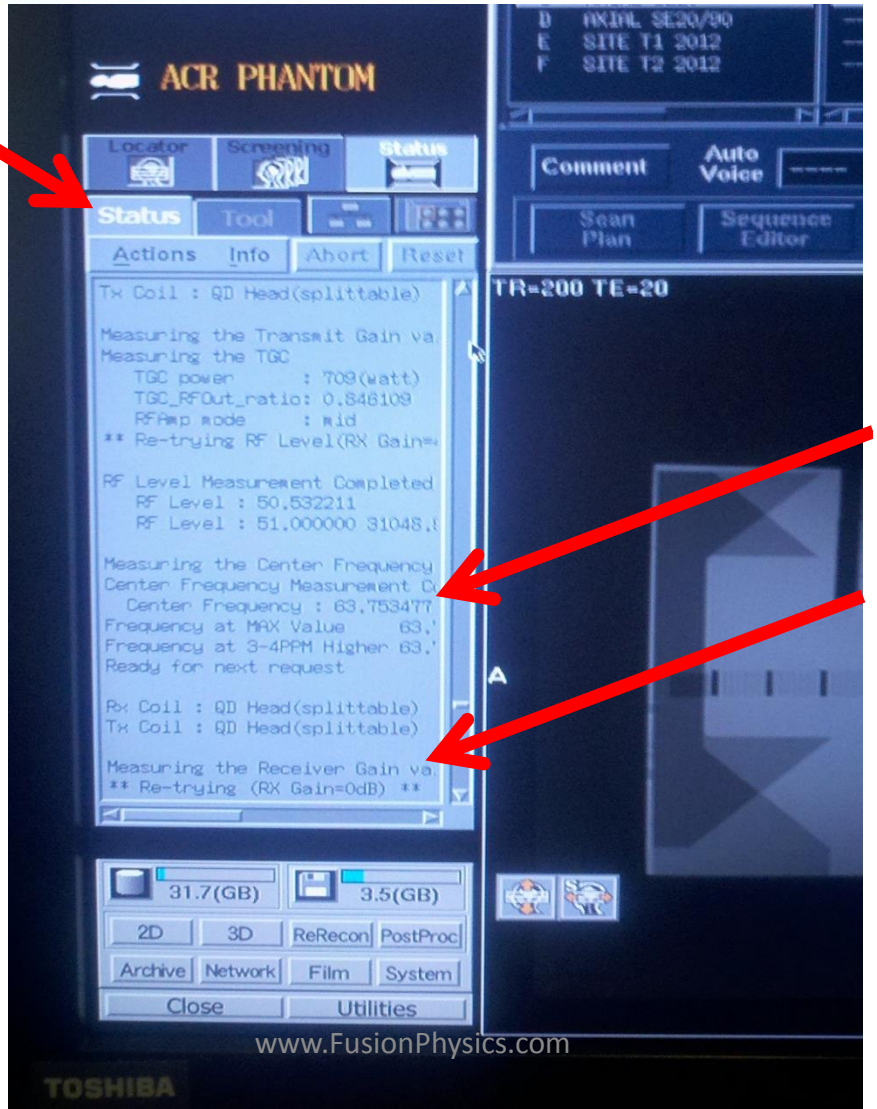
res. freq. **63 870 xxx Hz ...etc.** (in yellow) **(128 xxx xxx Hz for 3.0T)**

res. freq. is the resonant frequency for this sequence, and is the number for you to use as Center frequency on the ACR document (small white arrow)



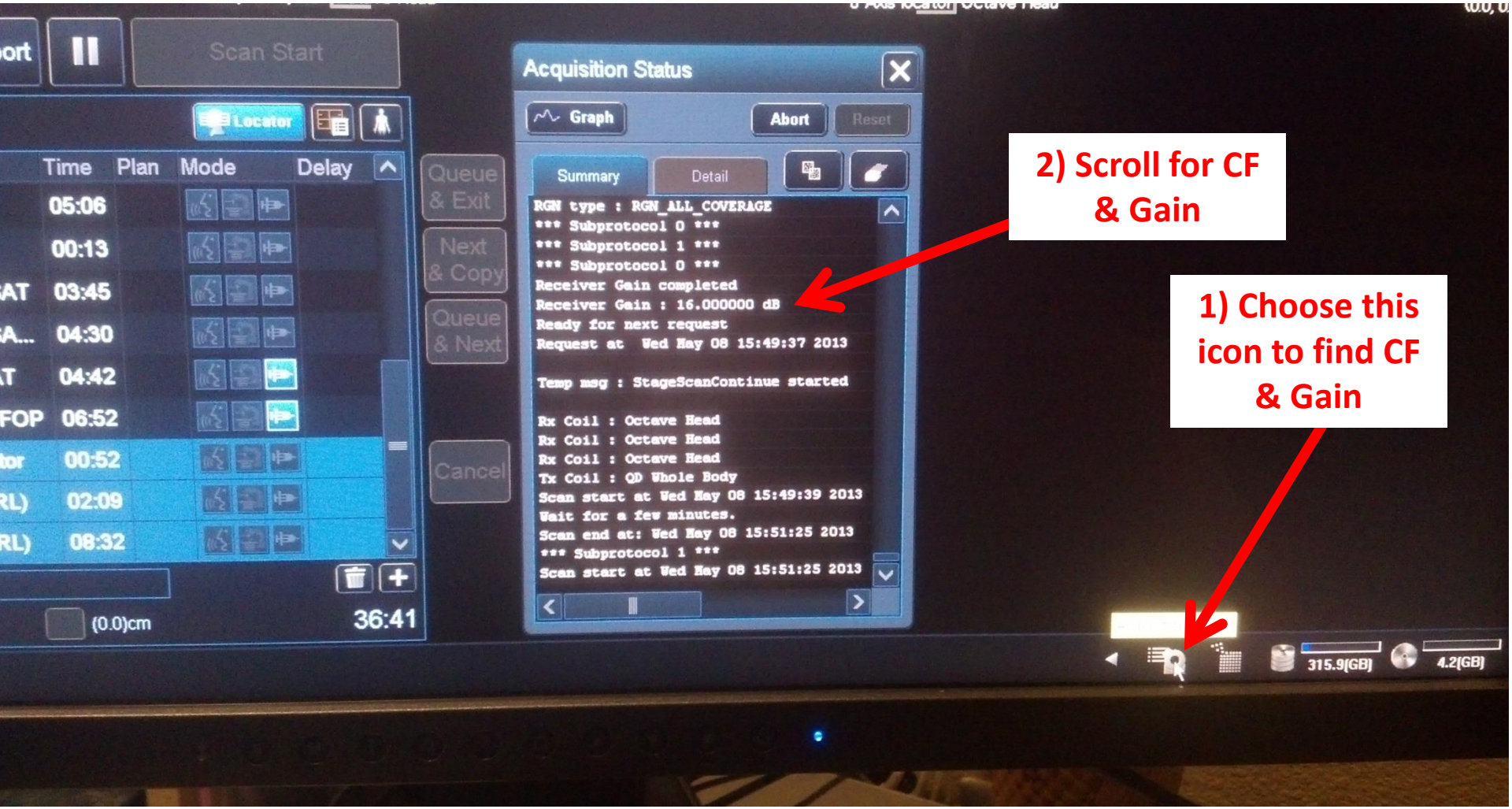
Toshiba

1) Choose this tab to find CF & Gain



2) Scroll for CF & Gain on each coil

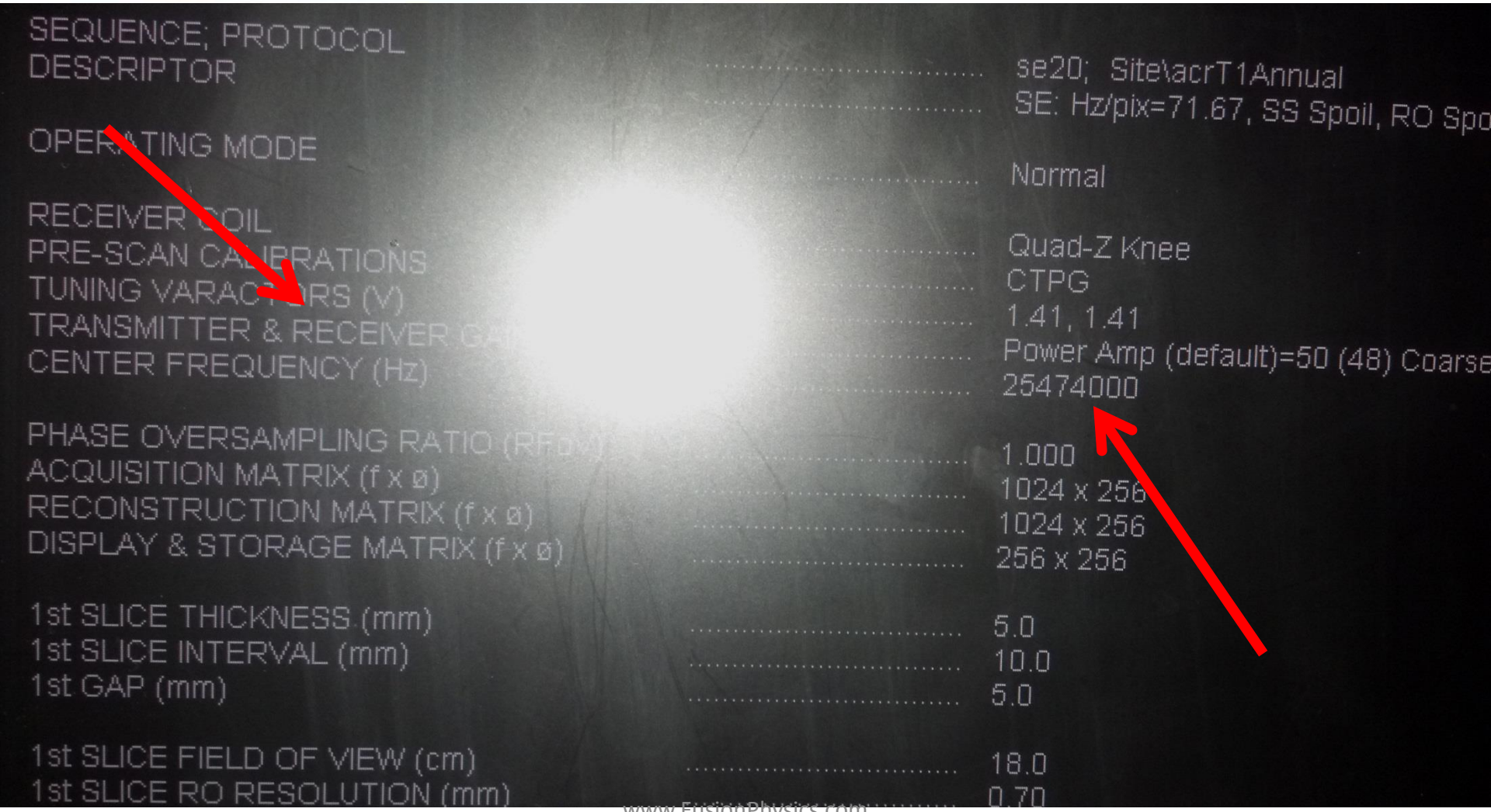
Toshiba's New Software



FONAR

- Open info tab while in viewing mode:
- Then follow the next slide

FONAR


SEQUENCE; PROTOCOL DESCRIPTOR ..... se20; Site\acrT1Annual
..... SE: Hz/pix=71.67, SS Spoil, RO Spo
OPERATING MODE ..... Normal
RECEIVER COIL ..... Quad-Z Knee
PRE-SCAN CALIBRATIONS ..... CTPG
TUNING VARACTORS (V) 1.41, 1.41
TRANSMITTER & RECEIVER GA ..... Power Amp (default)=50 (48) Coarse
CENTER FREQUENCY (Hz) 25474000
PHASE OVERSAMPLING RATIO (RFOV) 1.000
ACQUISITION MATRIX (f x ø) ..... 1024 x 256
RECONSTRUCTION MATRIX (f x ø) ..... 1024 x 256
DISPLAY & STORAGE MATRIX (f x ø) ..... 256 x 256
1st SLICE THICKNESS (mm) 5.0
1st SLICE INTERVAL (mm) 10.0
1st GAP (mm) 5.0
1st SLICE FIELD OF VIEW (cm) 18.0
1st SLICE RO RESOLUTION (mm) 0.70