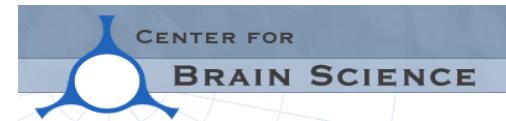
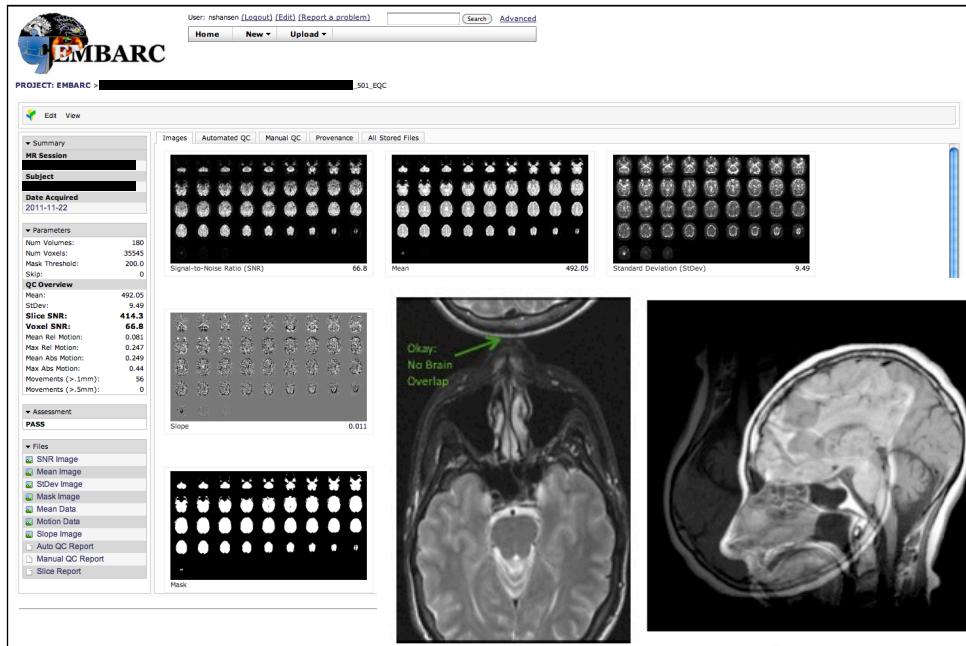
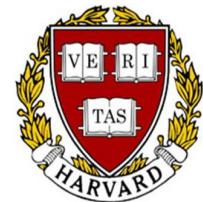
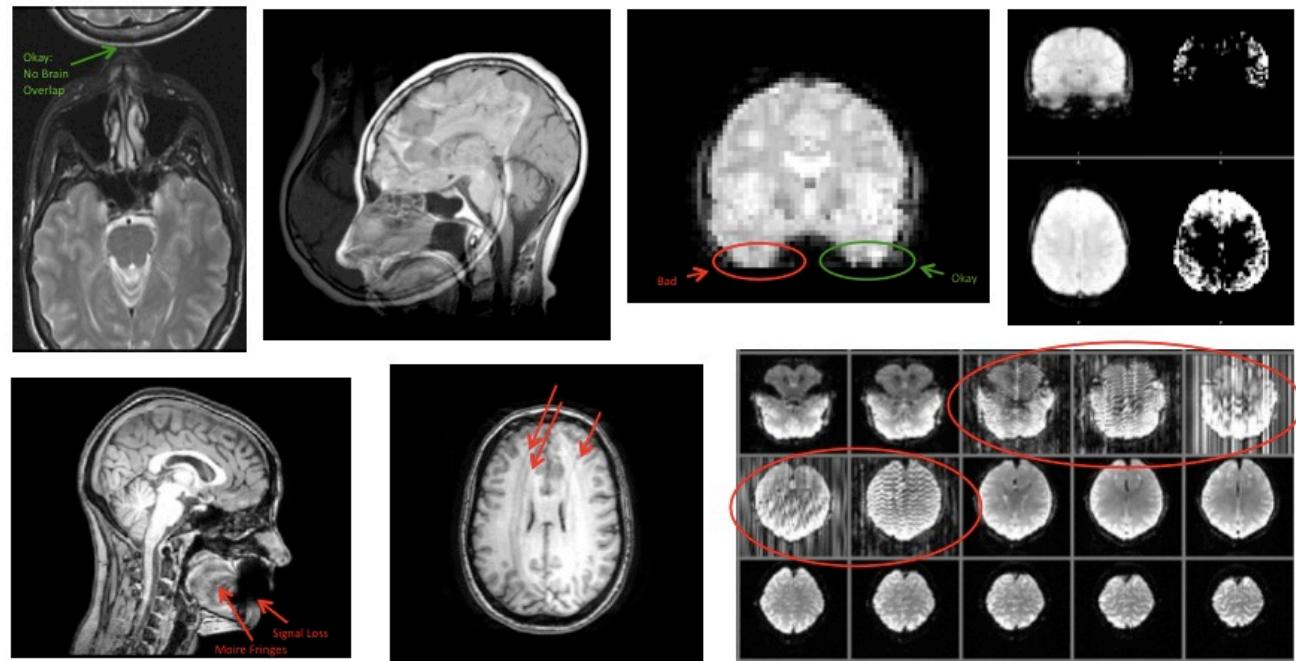




MRI Quality Control



Presented by
Natasha S. Hansen
February 20, 2013



Workshop Road Map

Where we're headed....

- Why is Quality Control (QC) Important?
- Two Kinds of QC
- Quantitative QC
 - Quantitative QC in action: EMBARC Central XNAT
- Qualitative QC
 - MRI artifacts
 - Qualitative QC in action: EMBARC scans in FSL
- Acknowledgements
- Questions & Discussion



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Why is Quality Control Important?

1. Quality data are essential for good science
2. Flawed data are surprisingly common
3. Even serious flaws in data can sometimes be very difficult to detect without carefully looking for them



© Copyright Massachusetts General Hospital &



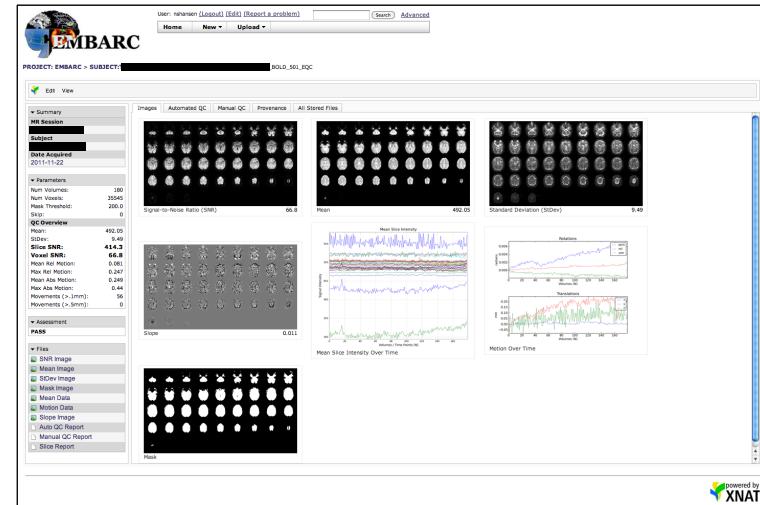
Harvard University; all rights reserved.

Two Kinds of QC

1. Quantitative:

By the numbers.....

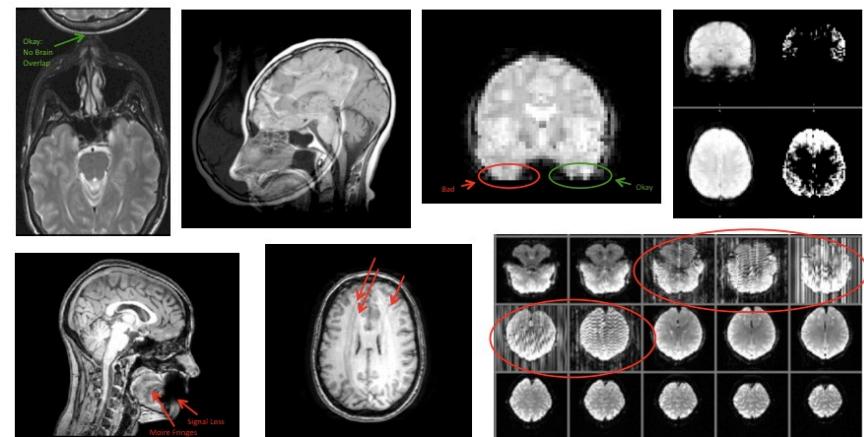
Evaluating automated system-calculated numerical values



2. Qualitative:

By the trained eye....

Manually scrolling through each slice of RAW data to look for artifacts



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

What is XNAT?

XNAT can calculate values used for Quantitative QC

- 3rd party neuroimaging database developed and maintained by Washington University in St. Louis
- Designed to help researchers capture, organize, and process neuroimaging data
- First developed by Dan Marcus under Randy Buckner at WUSTL (Marcus 2006)*
- Has large user community
- Visit: <http://xnat.org/>

The screenshot shows the XNAT website homepage. At the top, there's a navigation bar with links for About XNAT, Download, Documentation, Support, XNAT Marketplace, and Contact Us. Below the navigation is a main content area with a large graphic illustrating the integration of Imaging Data and Clinical Data. A central text box defines XNAT as an open-source imaging informatics platform. To the right, there's a "XNAT News" sidebar with sections for XNAT 1.6 is Here!, XNAT Marketplace Launches, XNAT 1.6 Beta RC1 Released, and XNAT Documentation Updates. At the bottom, there's a section titled "What does XNAT provide?" with six icons and descriptions: Full DICOM Integration and Anonymization, Secure Access & Permission Control, Integrated Search & Reporting, Pipeline Processing, Modular Extensibility, and Developer Community.

*Marcus, D. S., Olsen, T., Ramaratnam, M., & Buckner, R. L. (2006). XNAT: a software framework for managing neuroimaging laboratory data. In *Proceedings of the 12th Annual Meeting of the Organization for Human Brain Mapping Held in Florence* (pp. 11-15).



Quantitative QC

QC by the numbers.....

Examples of Quantitative QC values calculated in XNAT:

- Mean Signal Intensity
- Signal Intensity Standard Deviation
- Voxel-Based Signal to Noise Ratio (vSNR)
- Slice-based Signal to Noise Ratio (sSNR)
- Subject Motion:
 - Relative Motion & Absolute Motion
 - Mean Motion & Maximum Motion
 - # Movements >.1mm & # Movements >.5mm



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Quantitative QC in XNAT

User: nhansen ([Logout](#)) ([Edit](#)) ([Report a problem](#)) Search Advanced

[Home](#) [New ▾](#) [Upload ▾](#)

PROJECT: EMBARC > SUBJECT: [REDACTED] BOLD_501_EQC

[Edit](#) [View](#)

MR Session

Subject

Date Acquired
2011-11-22

Parameters

Num Volumes:	180
Num Voxels:	35545
Mask Threshold:	200.0
Skip:	0

QC Overview

Mean:	492.05
StDev:	9.49
Slice SNR:	414.3
Voxel SNR:	66.8
Mean Rel Motion:	0.081
Max Rel Motion:	0.247
Mean Abs Motion:	0.249
Max Abs Motion:	0.44
Movements (>.1mm):	56
Movements (>.5mm):	0

Assessment
PASS

Files

- SNR Image
- Mean Image
- StDev Image
- Mask Image
- Mean Data
- Motion Data
- Slope Image
- Auto QC Report
- Manual QC Report
- Slice Report

Images [Automated QC](#) [Manual QC](#) [Provenance](#) [All Stored Files](#)

Signal-to-Noise Ratio (SNR) 66.8

Mean 492.05

Standard Deviation (StDev) 9.49

Slope 0.011

Mean Slice Intensity Over Time

Rotations

Translations

Mask

powered by  XNAT



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Quantitative QC in XNAT

For EMBARC* Quantitative QC, we focus on:

1. Slice-Based SNR
2. Maximum Absolute Motion
3. Movements $\geq 0.5\text{mm}$

Parameter Evaluations:

Slice-Based SNR: Good = ≥ 150 , Bad = < 99

Maximum Absolute Motion: Good = < 1.49 , Bad = $> 2\text{mm}$

Movements $\geq .5\text{mm}$: Good < 5 , Bad = ≥ 5

NOTE: Remember these parameters are examples only. Consider your scanner (e.g. Siemens vs. Phillips) and head coil (e.g. 12 vs. 32 channel) to determine the right Quantitative QC parameters for your study.

▼ Parameters	
Num Volumes:	397
Num Voxels:	36772
Mask Threshold:	200.0
Skip:	0
QC Overview	
Mean:	548.13
StDev:	11.36
Slice SNR:	341.8
Voxel SNR:	67.3
Mean Rel Motion:	0.049
Max Rel Motion:	0.154
Mean Abs Motion:	0.411
Max Abs Motion:	0.79
Movements ($>.1\text{mm}$):	19
Movements ($>.5\text{mm}$):	0

* Establishing Moderators/Biosignatures of Antidepressant Response in Clinical Care (EMBARC) is a multi-site NIMH-funded study used in the creation of these QC standards



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Why these Parameters?

The Quantitative QC parameters used for EMBARC are based on research done at Massachusetts General Hospital and Harvard Medical School

Learn more about:

- How subject motion affects MRI data
- How motion values are calculated
- The relationship between Quantitative QC measures (e.g. mean vs. max motion values)
- How temporal SNR is calculated

Van Dijk KRA, Sabuncu MR, and Buckner RL. (2012) The Influence of Head Motion on Intrinsic Functional Connectivity MRI. *NeuroImage*. 59(1):431-8.



© Copyright Massachusetts General Hospital &

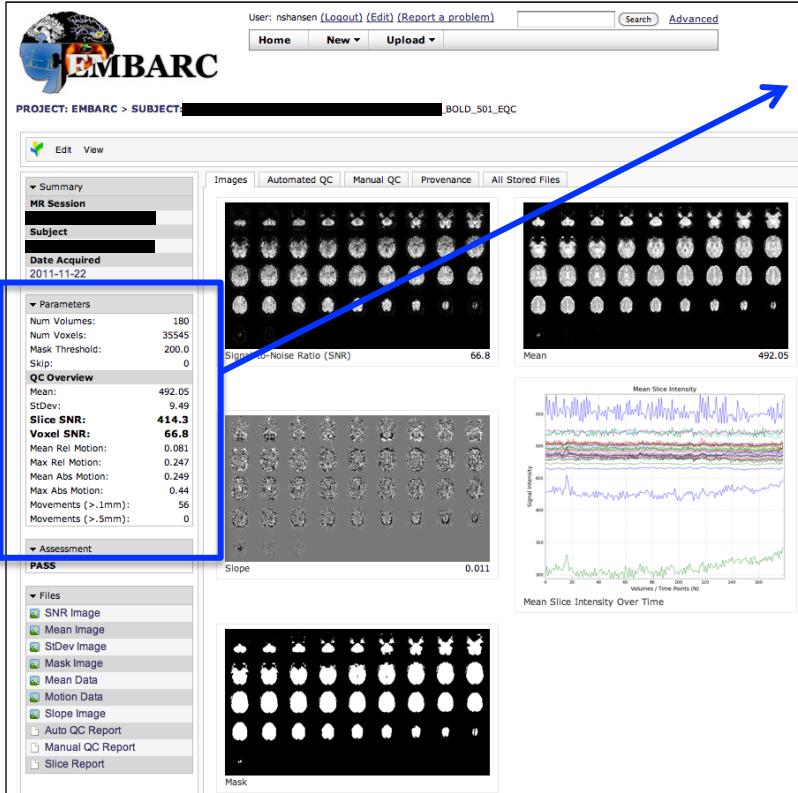


Harvard University; all rights reserved.

Quantitative QC in Action

For EMBARC Quantitative QC, we focus on:

1. Slice-Based SNR. Good = >150 Bad = <99
2. Maximum Absolute Motion. Good = <1.49 Bad = $>2\text{mm}$
3. Movements $>.5\text{mm}$. Good <5 Bad = >5



Parameters	
Num Volumes:	180
Num Voxels:	35545
Mask Threshold:	200.0
Skip:	0
QC Overview	
Mean:	492.05
StDev:	9.49
Slice SNR:	414.3
Voxel SNR:	66.8
Mean Rel Motion:	0.081
Max Rel Motion:	0.247
Mean Abs Motion:	0.249
Max Abs Motion:	0.44
Movements (>.1mm):	56
Movements (>.5mm):	0

414.3 > 150 = Good

.44 < 1.49 = Good

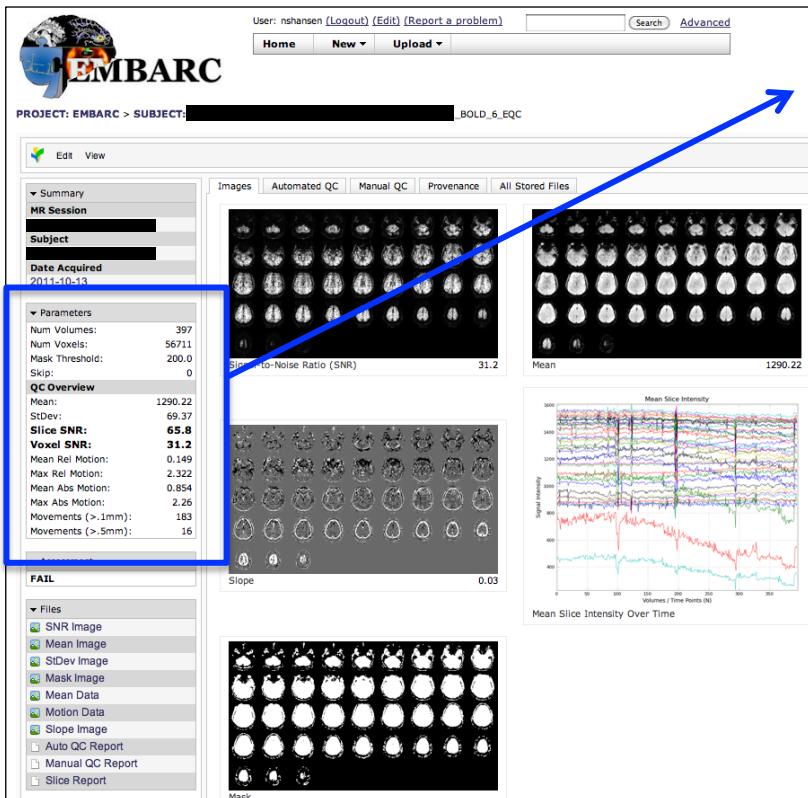
0 < 5 = Good



Quantitative QC in Action

For EMBARC Quantitative QC, we focus on:

1. Slice-Based SNR: Good = >150 , Bad = <99
2. Maximum Absolute Motion: Good = <1.49 , Bad = $>2\text{mm}$
3. Movements $>.5\text{mm}$: Good <5 , Bad = >5



Parameters	
Num Volumes:	397
Num Voxels:	56711
Mask Threshold:	200.0
Skip:	0
QC Overview	
Mean:	1290.22
StDev:	69.37
Slice SNR:	65.8
Voxel SNR:	31.2
Mean Rel Motion:	0.149
Max Rel Motion:	2.322
Mean Abs Motion:	0.854
Max Abs Motion:	2.26
Movements (>.1mm):	183
Movements (>.5mm):	16

65.8 < 150 = Bad

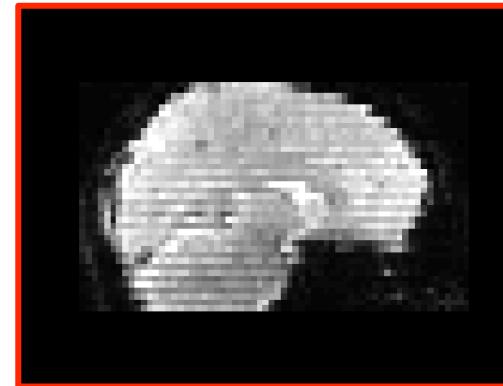
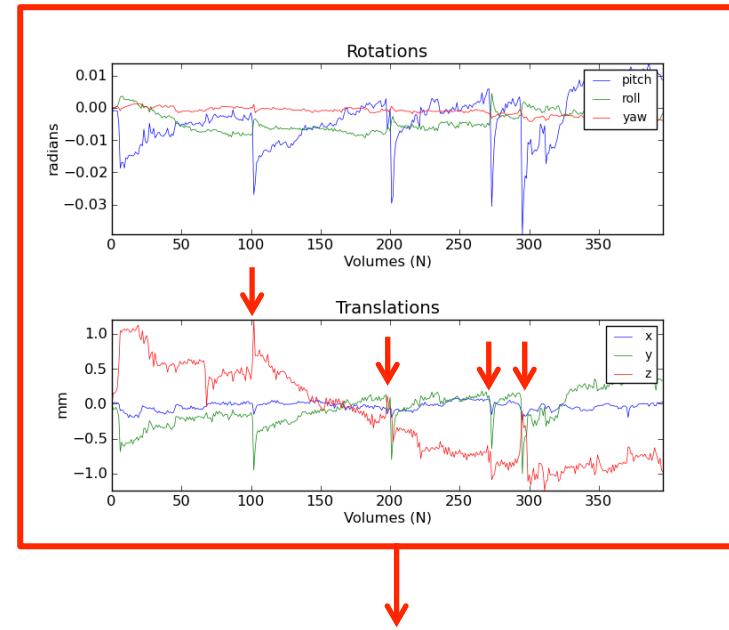
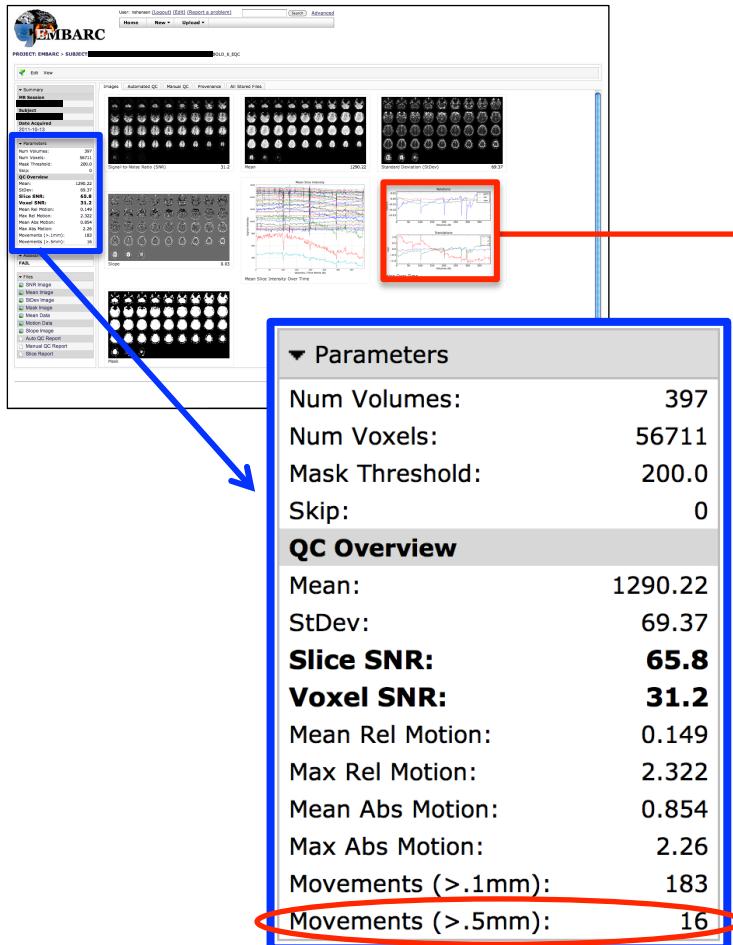
2.26 > 2 = Bad

16 > 5 = Bad



Quantitative QC meets Qualitative QC

A scan's numerical values are often reflected in its visible artifacts...



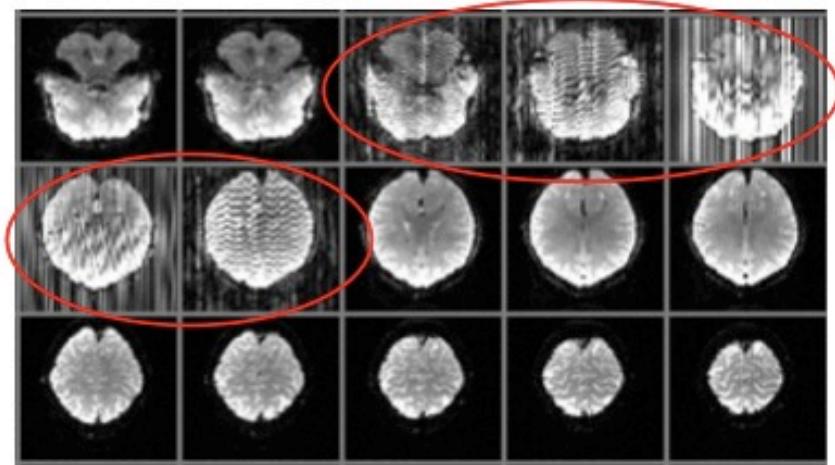
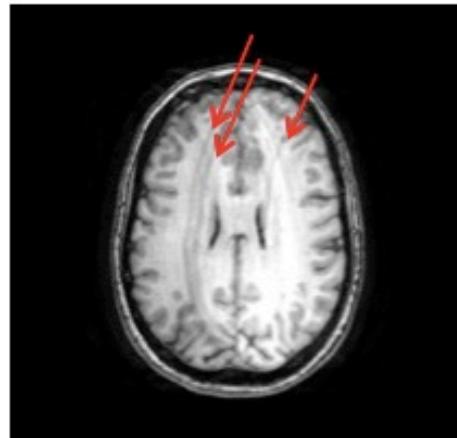
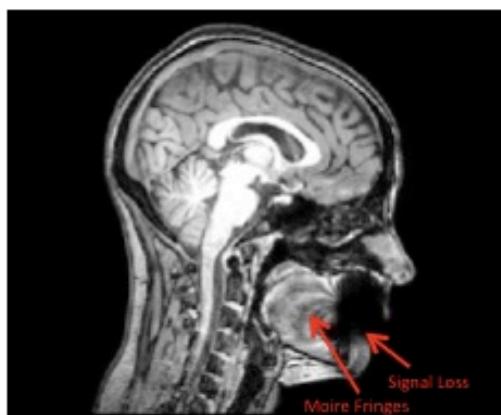
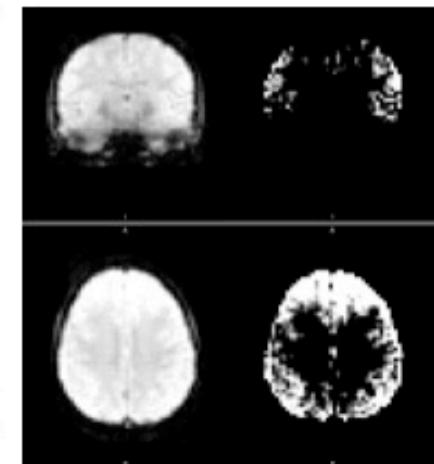
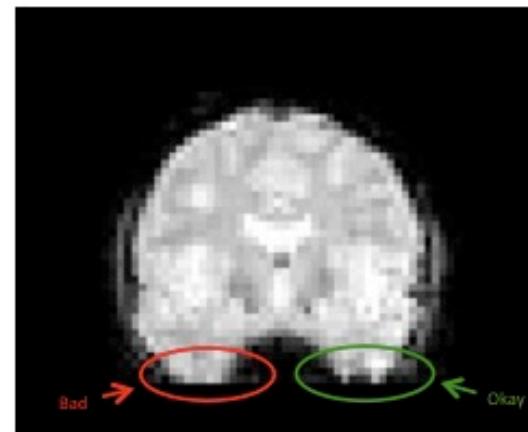
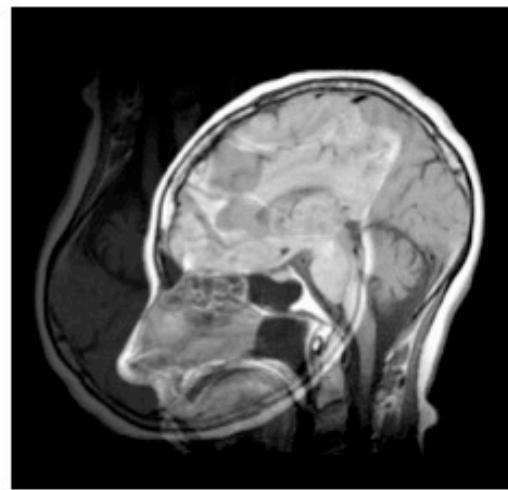
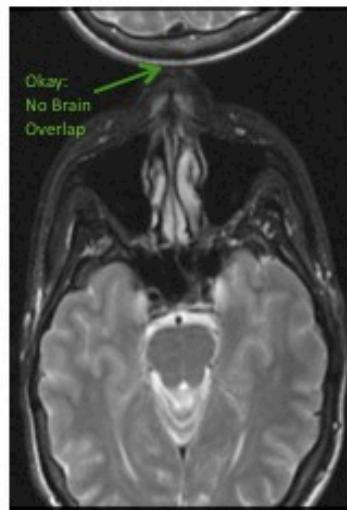
© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Qualitative Quality Control

Artifacts in Structural and Functional MRI



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

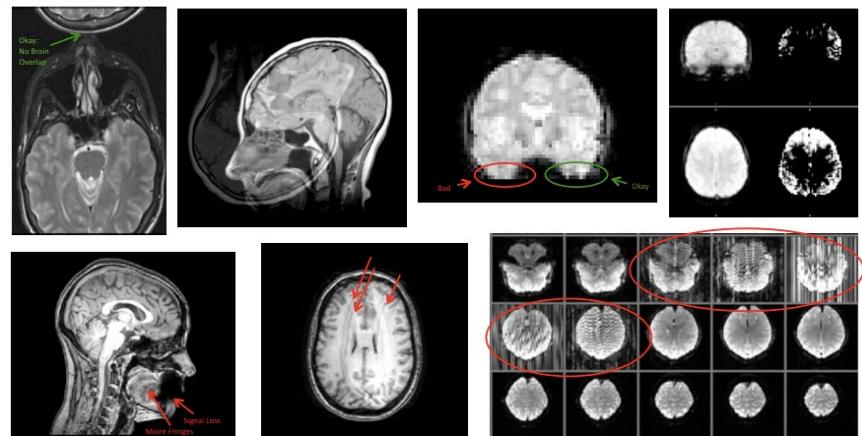
Qualitative QC

QC by the trained eye....

Some factors that can compromise data quality are so far only detectable by manually scrolling through each slice of RAW data to look for visible distortions called “**artifacts**”.

Examples of MRI artifacts:

- Field of View (FOV) clipping anatomy
- Wrapping
- Signal Loss/Susceptibility Artifact
- Ringing, Striping, or Blurring (in ANAT)
- Ghosting
- Radio Frequency Noise/Spiking
- Signal Inhomogeneity
- Motion Slice Artifact (in BOLD)



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

What causes MRI artifacts?

Experimenter Error:

- Field of View (FOV) positioned wrong -> brain image clipped -> “Wrapping”
- Neglected to remove all ferromagnetic metal -> signal loss -> “Susceptibility Artifact”

Subject Motion:

- Ringing, Striping, or Blurring (in structural scans)
- “Motion Slice Artifact” (in functional scans)

Problems with the Scanner/Head Coil:

- Radio Frequency Noise/Spiking
- Signal Inhomogeneity

Artifacts from Image Reconstruction:

- Consistent low-level “Ghosting”
- Some types of “Ringing” (e.g. “Shadowed Arc Artifact” in structural scans)

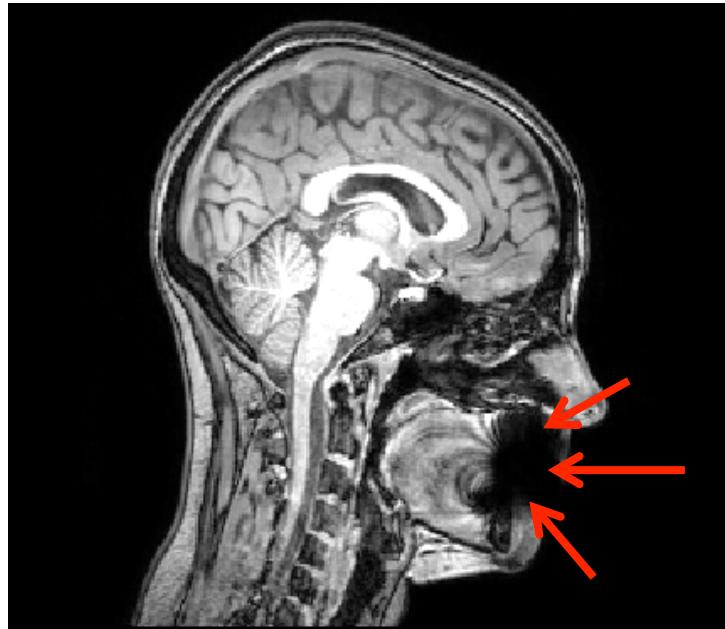


© Copyright Massachusetts General Hospital &

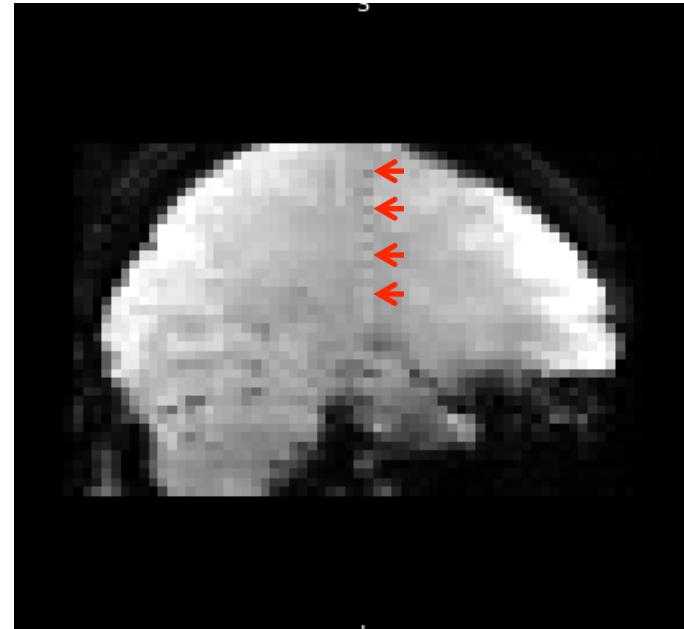


Harvard University; all rights reserved.

How do you detect artifacts?



Some artifacts are hard to miss



Others are incredibly subtle

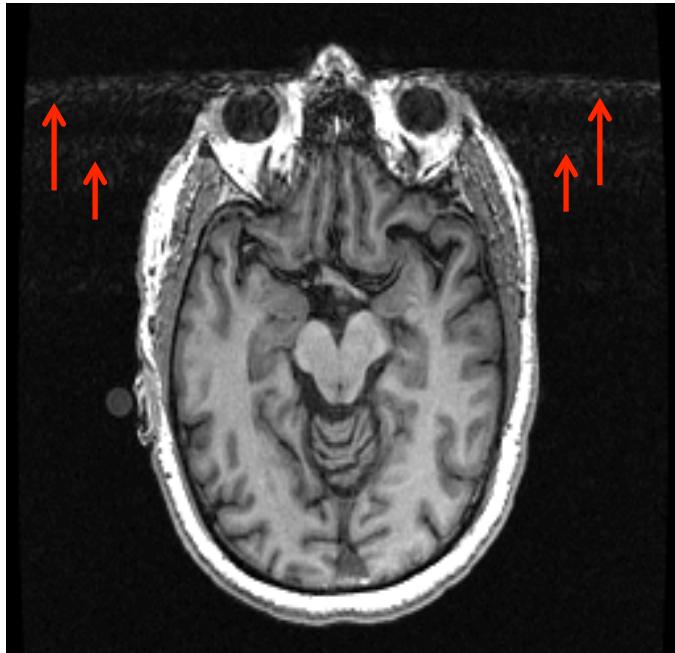


© Copyright Massachusetts General Hospital &

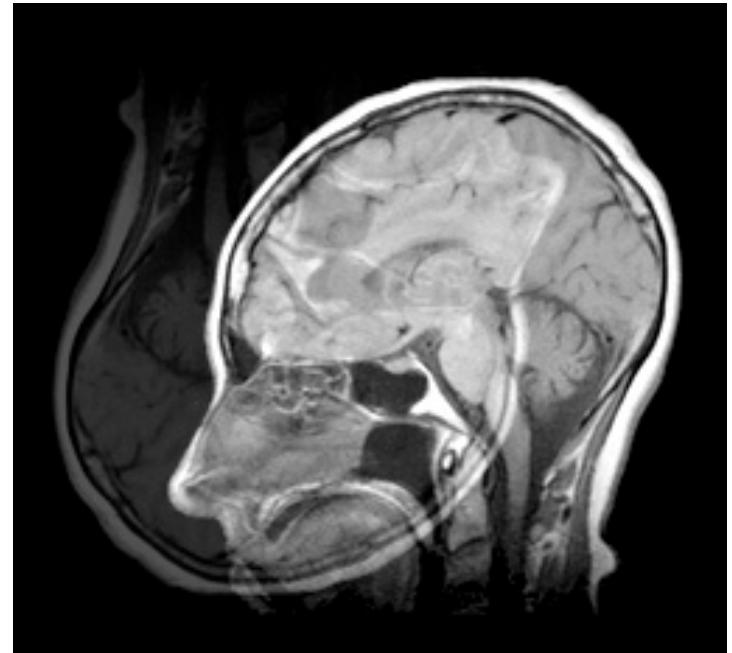


Harvard University; all rights reserved.

When are artifacts a problem?



Some artifacts don't affect data quality



Others render it unusable



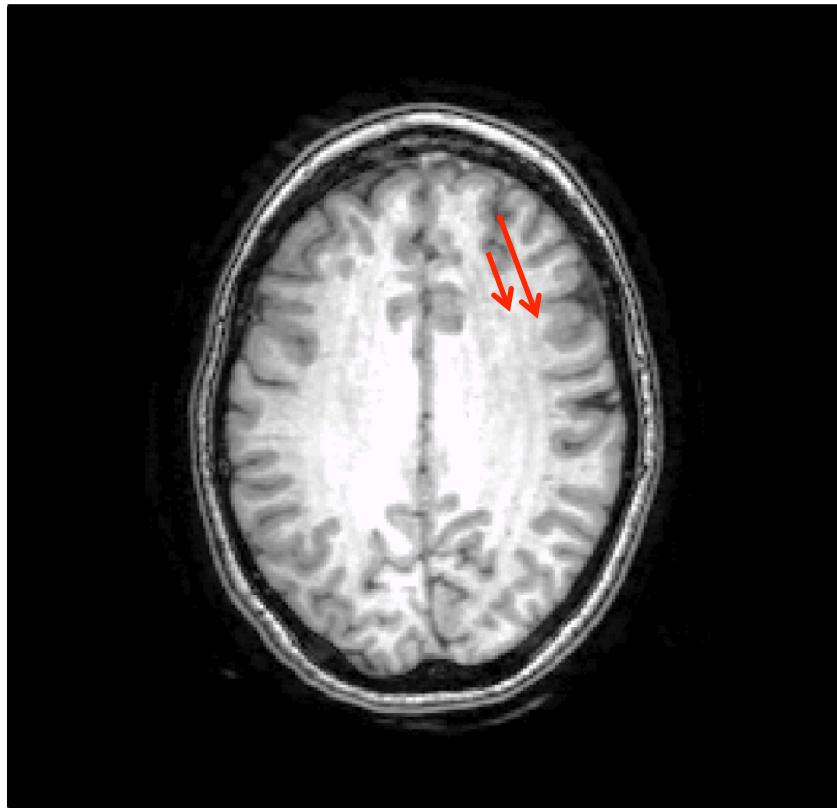
© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Training the Eye...

The intention is to familiarize you with the various types of artifacts and their levels of severity so you will be able to recognize them in your own data and make an informed decision for yourself about whether or not they affect your data quality.



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

MRI Qualitative Quality Control Manual

What to look for and How to look for it!

ANAT : Susceptibility Artifact



None: Susceptibility Artifact not present

What to look for: A black area, like a hole of bright and dark ripples (called "Moiré pattern") in the brain?

How to look for it: Scroll through all the slices in the brain. Do any of the distortions appear?

What causes it: A common cause is metal. Different substances (e.g. metal vs. bone) next to each other in the scanner will interact (too dark (signal loss) and/or too bright (bright signal transmitted by the scanner), meaning



Mild: Ghosting faintly detected

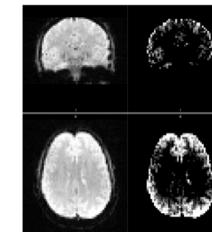
What to look for: A fainter displaced copy of a structure can appear anywhere. Displaced "ghost(s)" can appear anywhere.

How to look for it: Ghosting is easier to detect by looking for a maximum brightness value while leaving others. Check in the brain slices and time points in motion, or around eyes). Signal intensity varies notably at the front and back of the brain. Signal

What causes it: Ghosting comes in several forms (imagine fainter copies of an image or a mismatch in the signal channels that occur)



ANAT : Ghosting



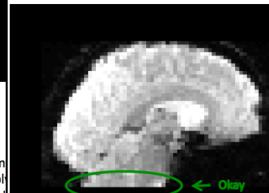
None: signal intensity uniform throughout image

What to look for: An inconsistency/asymmetry between the slices. Signal homogeneity varies notably at the front and back of the brain. Signal

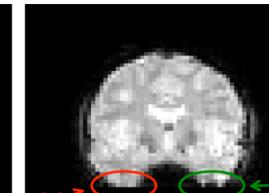
How to look for it: Signal inhomogeneity is detected by looking for a minimum brightness value while leaving the maximum, each time scrolling through all slices. Signal intensity varies notably at the front and back of the brain, but this pattern should be symmetric.

What causes it: MRI's use a receiver coil incorrectly reads the signal as stronger in systems use receiver coils made up of array coils. The scanner will always read the signal with the strongest signal. If the array coil has failed, some part of the receiver coil array (small coils the array have failed) in this

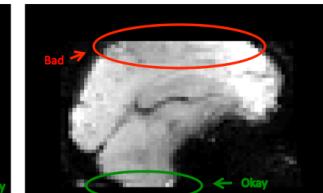
BOLD : Signal Inhomogeneity



Good: EMBARC brain target area fully covered in FOV.



Questionable: FOV clips slice(s) of EMBARC brain target area.



Bad: FOV clips significant portion of EMBARC target area

BOLD : Head Coverage

What to look for: Perfect head coverage means the entire brain target area (the part of the brain you care about in your study) is clearly visible in the scan's field of view (FOV), ideally with at least one slice of black background buffer on each side. For EMBARC, the brain target area runs from the top of the brain to the bottom of the temporal lobes, and does not include the cerebellum. Note: if a subject's brain is just too large to fit in the scan's FOV, the FOV frame should be centered over the brain target area and should clip the extra slice from the top of the brain (not the temporal lobes) if the number of slices that must be clipped is odd.

How to look for it: Scroll through all the slices in each view of the brain. Is there any place where the brain's natural curve becomes suddenly flat as if clipped off by the black background? Is the clipped piece part of your brain target area? How much of the brain target area is clipped, only a few slices or a much larger section? Remember you will need to scroll through all the slices in the coronal (front/back) view of the brain to check if the full temporal lobe is covered since the bottom tips are not visible in all slices.

What causes it: The person operating the scanner positions the frame of MRI FOV by hand. Poor head coverage is usually caused by the scanner operator failing to reposition the FOV if a part of the brain target area is being cut off. Occasionally, the subject will cause the head coverage loss by moving out of the FOV.



© Copyright Massachusetts General Hospital 2012; all rights reserved.



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Want to Reference the Manual?

The full MRI Qualitative Quality Control Manual is available online!

Go to the Harvard Center for Brain Science Website: <http://cbs.fas.harvard.edu/>
Center for Brain Science > Neuroimaging > Information for Investigators > FAQ

MRI Quality Control Manual

What to look for and How to look for it!

ANAT : Susceptibility Artifact

None: Susceptibility Artifact not present

Mild: Susceptibility Artifact present

What to look for: A black area, like a hole or bright and dark ripples (called "Moire") in the brain! Do any of the distortions affect each other? If yes, then there is a susceptibility artifact.

How to look for it: Scroll through all the slices in the brain. Do any of the distortions affect each other? If yes, then there is a susceptibility artifact.

What causes it: A common cause is metal next to each other in the scanner (e.g. metal vs. bone). Different substances (e.g. metal vs. bone) next to each other in the scanner will interact with the magnetic field and the signal transmitted by the scanner, causing distortion.

ANAT : Ghosting

Mild: Ghosting faintly detected

Moderate: Ghosting clearly visible

What to look for: A faint signal displaced or displaced ("ghosts") from the original signal will form a streak, like cartoon motion blur. Check at the front and back of the brain.

How to look for it: Ghosting is easier to see in the coronal and sagittal planes than in the axial plane. Check at the front and back of the brain.

What causes it: Ghosting comes in several forms: fainter copies of an image or a mismatch in the signal channels that create the image.

BOLD : Signal Inhomogeneity

Normal: Signal intensity uniform throughout image

Grey: Signal intensity not uniform throughout image

Bad: Signal intensity not uniform throughout image

What to look for: An inconsistency between the signal intensity in different areas of the brain. Check at the front and back of the brain.

How to look for it: Signal inhomogeneity means minimum brightness value while leaving maximum. Each time scrolling through all the slices in the brain, check if the image is darker in one part of the brain than the back or the left brighter than the right.

What causes it: MRI uses a receiver coil incorrectly reads the signal as stronger in some areas than others. This is because receiver coils made up of many small coils in the array. If one or more of these small coils in the array have failed, in the wrong place, then the signal will be incorrect.

BOLD : Head Coverage

Good: EMBARC brain target area fully covered in FOV.

Questionable: FOV clips significant portion of EMBARC brain target area

Bad: FOV clips significant portion of EMBARC target area

What to look for: Perfect head coverage means the entire brain target area (the part of the brain you care about in your study) is clearly visible in the scanner's field of view (FOV), ideally with at least one slice of black background buffer space. For EMBARC, the brain target runs from the top of the brain to the bottom of the brain. If the FOV is too large, it will not include the entire brain. Note: If the FOV is just too large, then the scan's FOV, the FOV frame should be centered over the brain target area and should clip the extra slice from the top of the brain (not the temporal lobes) if the number of slices that must be clipped is odd.

How to look for it: Scroll through all the slices in each view of the brain. Is there any place where the brain's natural curve becomes suddenly flat as if clipped off by the black background? Is the clipped piece part of your brain target area? How much of the brain target area is clipped, only a few slices or a majority of the slices? If you are not sure, scroll through the slices in the coronal (front/back) view of the brain to check if the full temporal lobe is covered since the bottom tips are not visible in all slices.

What causes it: The person operating the scanner positions the frame of MRI FOV by hand. Poor head coverage is usually caused by the scanner operator failing to reposition the FOV if a part of the brain target area is being cut off. Occasionally, the subject will cause the head coverage loss by moving out of the FOV.



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

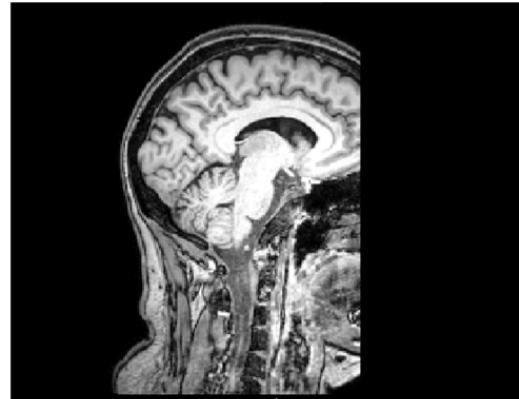
Manual Sample Page

Includes: *What to look for*, *How to look for it*, and *What causes it*

ANAT : Head Coverage



Good: brain fully covered in FOV.



Bad: FOV clips brain

What to look for: Perfect head coverage means the entire brain target area (the part of the brain you care about in your study) is clearly visible in the scan's field of view (FOV), ideally with at least one slice of black background buffer on each side. For EMBARC, the brain target area runs from the top of the brain to the bottom of the temporal lobes, and does not include the cerebellum. Note: imperfect head coverage with no wrapping is almost never seen in anatomical scans.

How to look for it: Scroll through all the slices in each view of the brain. Is there any place where the head's natural curve becomes suddenly flat as if clipped off by the black background? Does the clipping cut off any portion of the brain?

What causes it: The person operating the scanner positions the frame of MRI FOV by hand. Poor head coverage is usually caused by the scanner operator failing to reposition the FOV if a part of the brain target area is being cut off. Occasionally, the subject will cause the head coverage loss by moving out of the FOV.



© Copyright Massachusetts General Hospital &

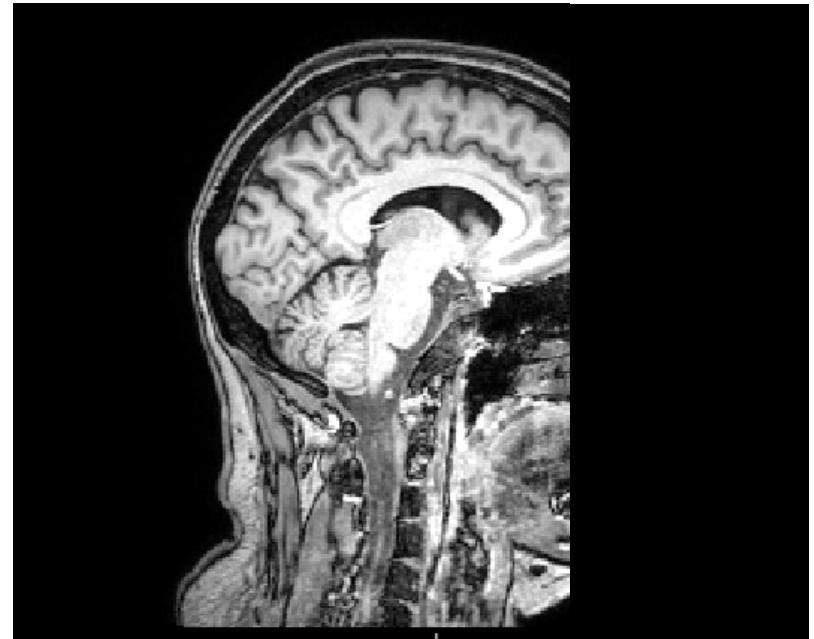


Harvard University; all rights reserved.

ANAT : Head Coverage*



Good: brain fully covered in FOV



Bad: FOV clips brain

*Reference the MRI Qualitative Quality Control Manual for full text on each artifact

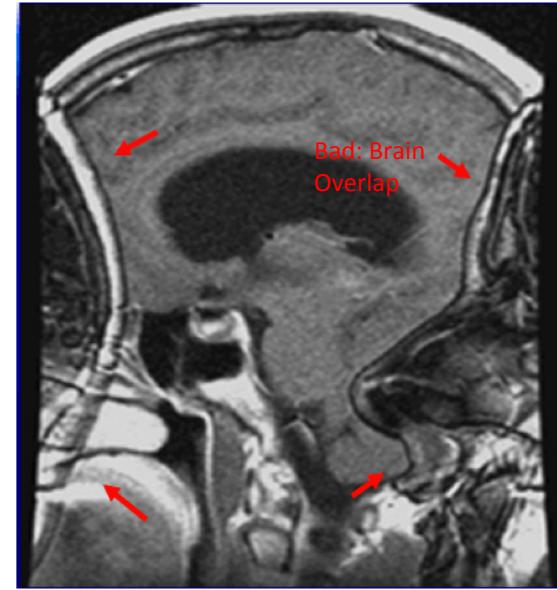
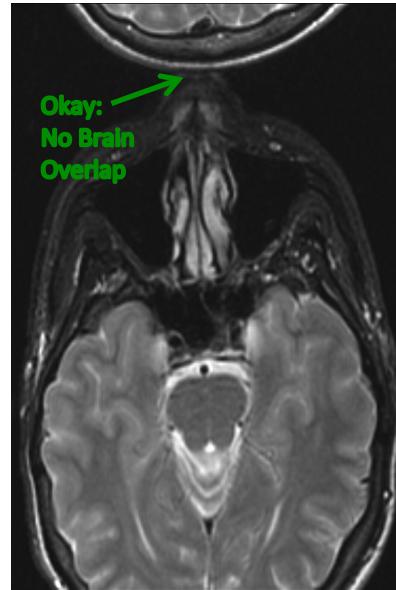


© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

ANAT : Wrapping



Mild: head wrapping, but does not affect brain

Moderate: brain wrapping but not overlapped by other anatomy

Severe: brain wrapping and overlapped by other anatomy

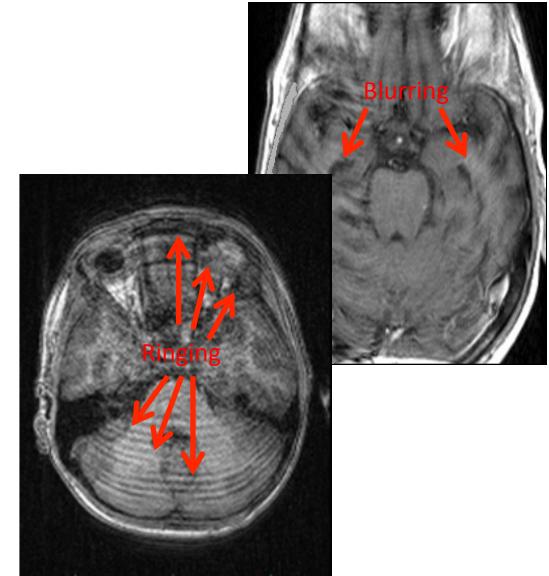
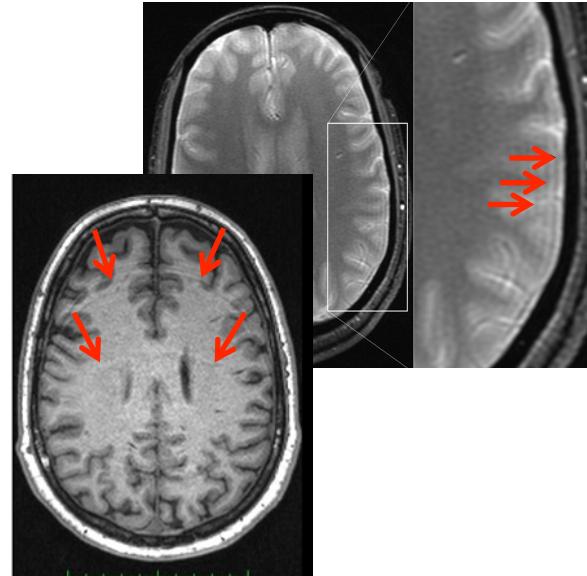
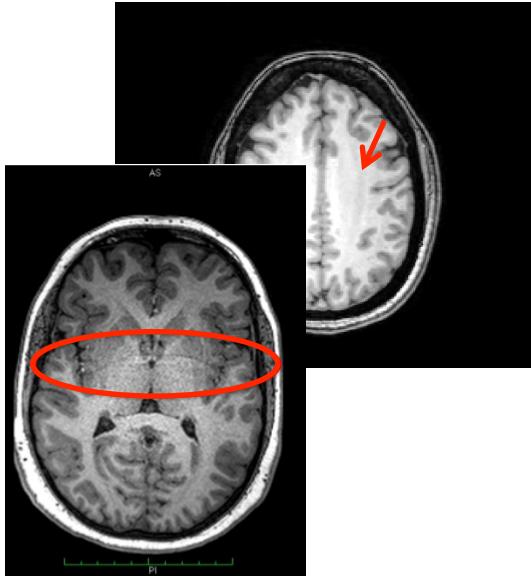


© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

ANAT : Ringing, Striping, Blurring



Mild: Ringing, Striping, Blurring faintly detectable

Moderate: Ringing, Striping, Blurring pronounced

Severe: Ringing, Striping, Blurring extreme

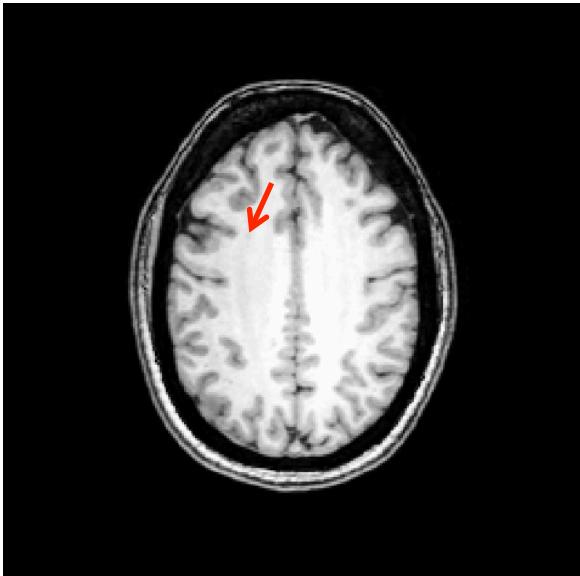


© Copyright Massachusetts General Hospital &

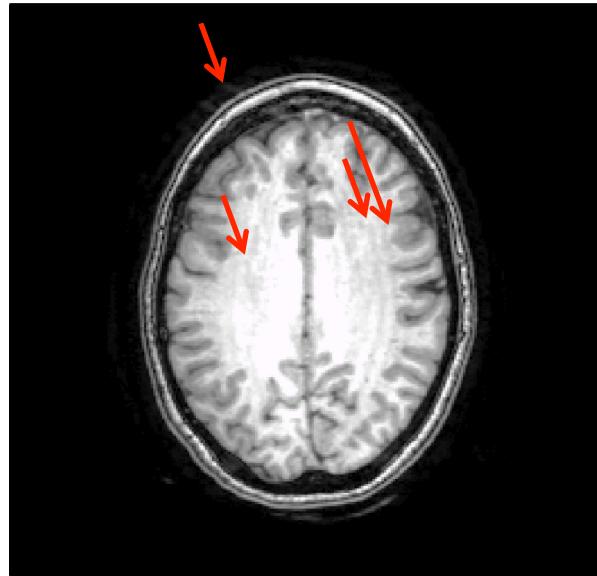


Harvard University; all rights reserved.

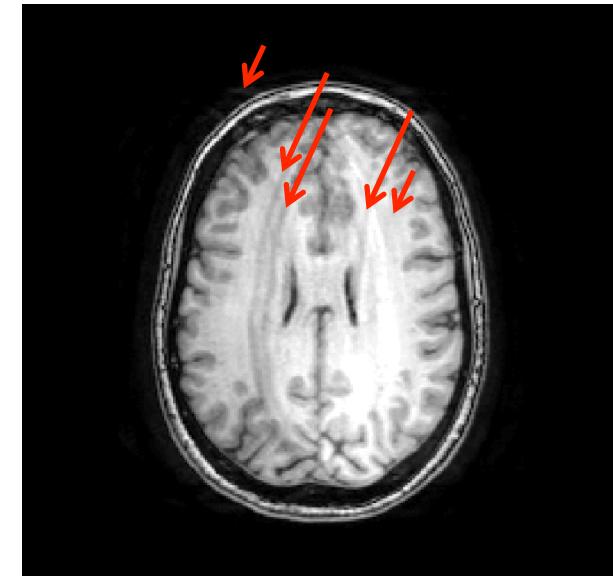
ANAT : Shadowed Arc Artifact



Mild: Shadowed Arc Artifact
faintly detectable



Moderate: Shadowed Arc
Artifact pronounced



Severe: Shadowed Arc
Artifact extreme

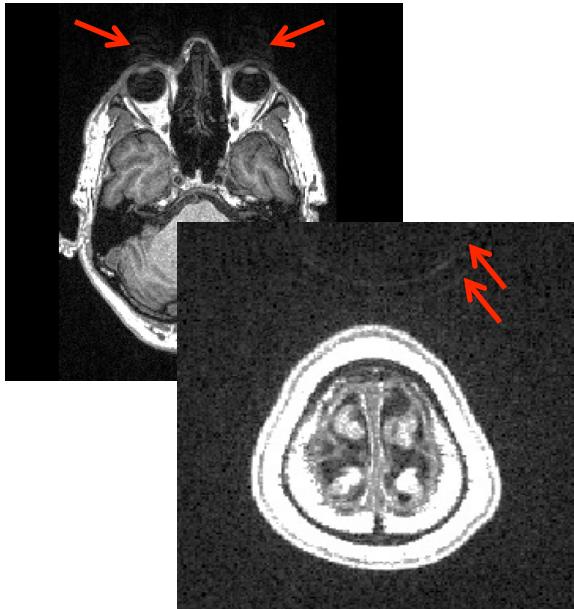


© Copyright Massachusetts General Hospital &

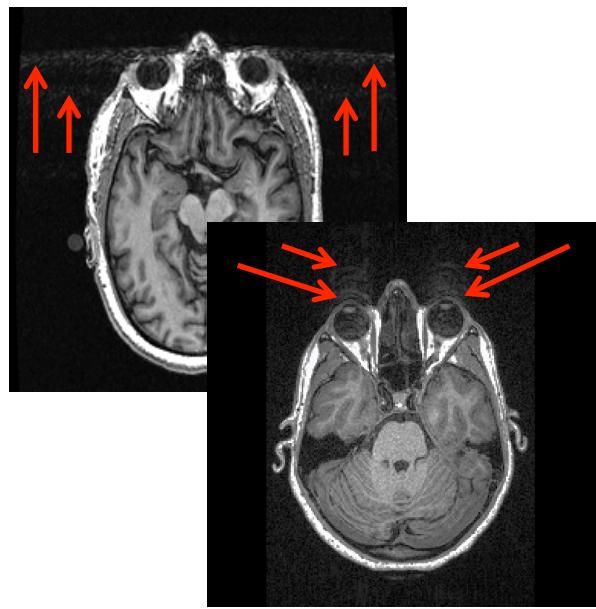


Harvard University; all rights reserved.

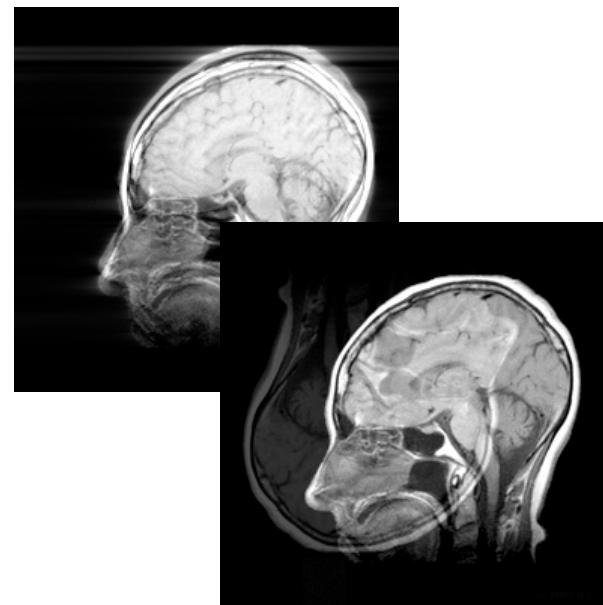
ANAT : Ghosting



Mild: Ghosting faintly
detectable



Moderate: Ghosting
pronounced



Severe: Ghosting extreme

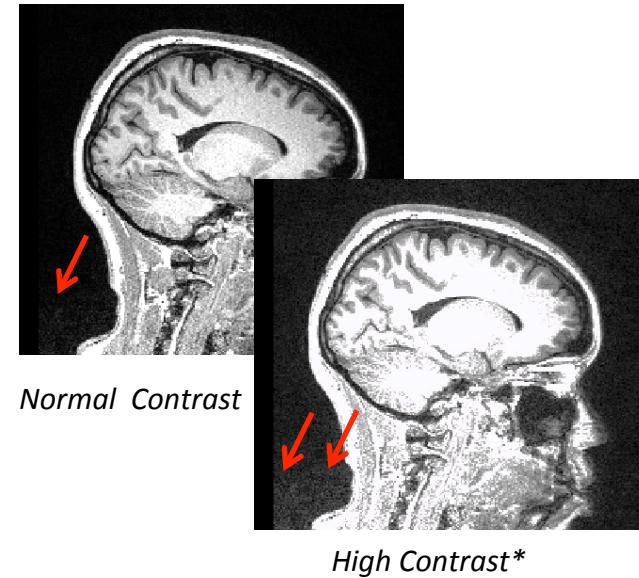


© Copyright Massachusetts General Hospital &

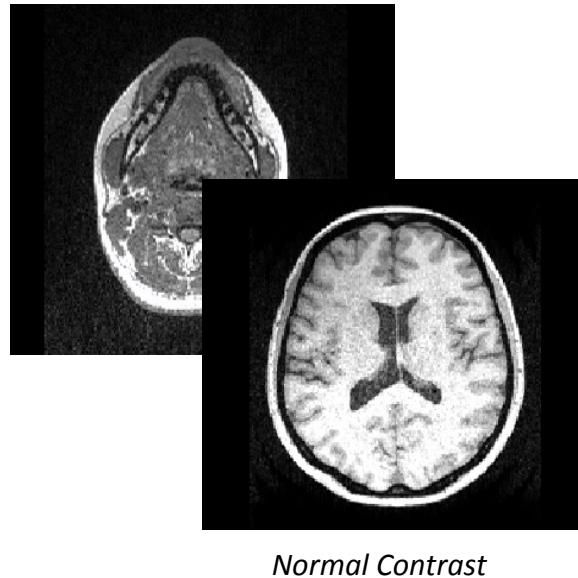


Harvard University; all rights reserved.

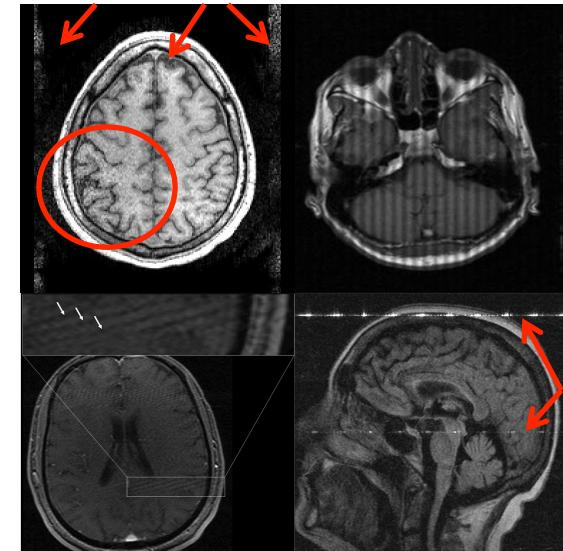
ANAT : Radio Frequency (RF) Noise (Severe = Spiking)



Mild: Low-level RF noise visible only after adjusting contrast



Moderate: RF noise prominently visible without adjusting contrast



Severe: Spiking is present

*RF Noise is most clearly visible at high contrast, adjusted by lowering the Maximum Brightness.

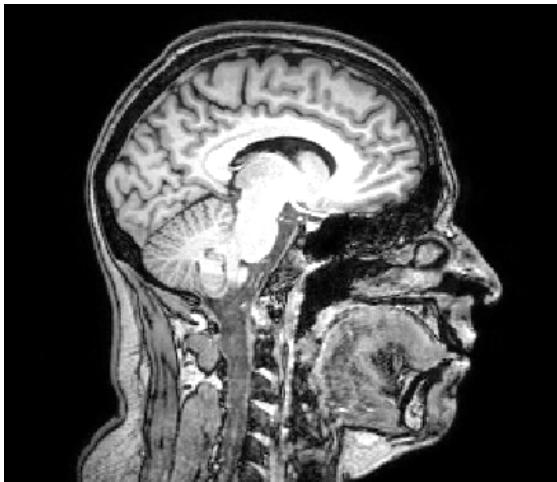


© Copyright Massachusetts General Hospital &

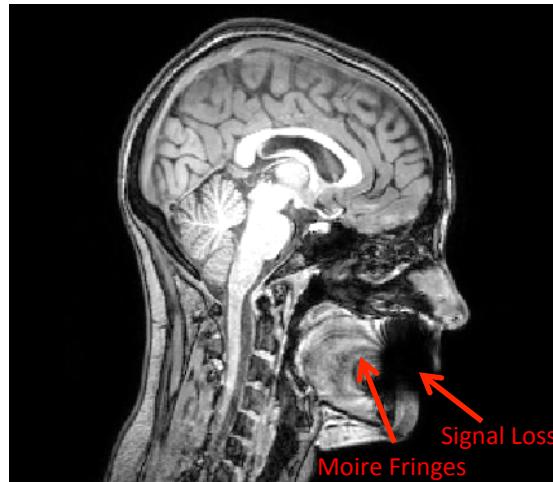


Harvard University; all rights reserved.

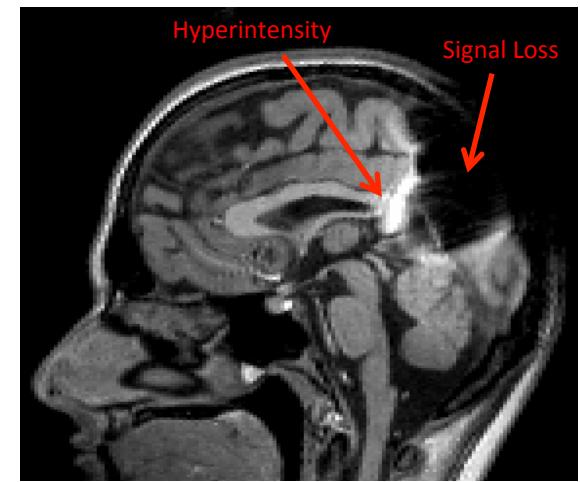
ANAT : Susceptibility Artifact



None: Susceptibility Artifact
not present



Outside Brain: Susceptibility
Artifact present, but does not
affect brain



Affecting Brain: Susceptibility
Artifact present and affects
brain

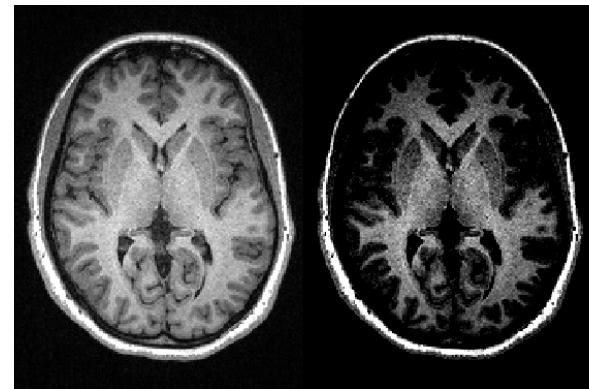


© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

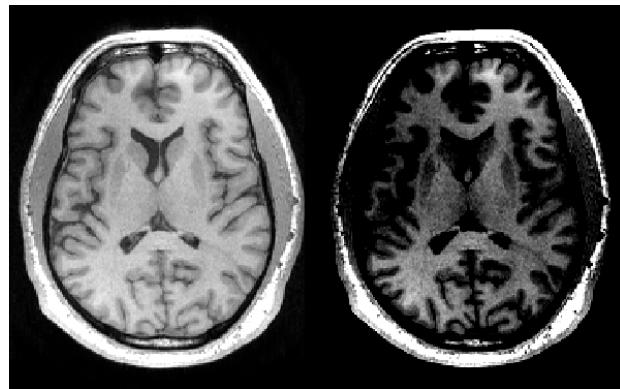
ANAT : Unexpected Inhomogeneity



Normal Contrast

*High Contrast**

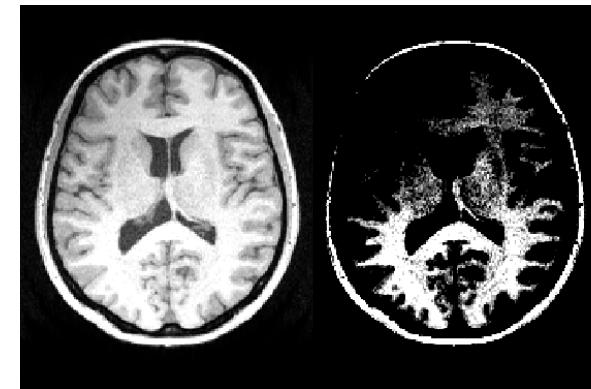
None: signal intensity uniform throughout image



Normal Contrast

*High Contrast**

Expected: inconsistent signal intensity fits coil profile



Normal Contrast

*High Contrast**

Unexpected: inconsistent signal intensity does not fit coil profile

*Signal inhomogeneity is most clearly visible at high contrast, adjusted by raising the Minimum Brightness.

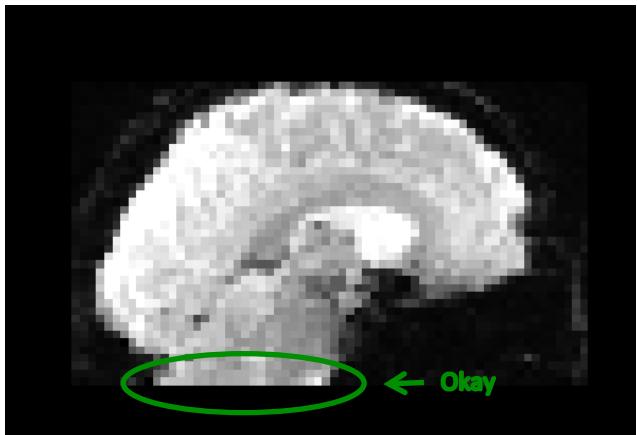


© Copyright Massachusetts General Hospital &

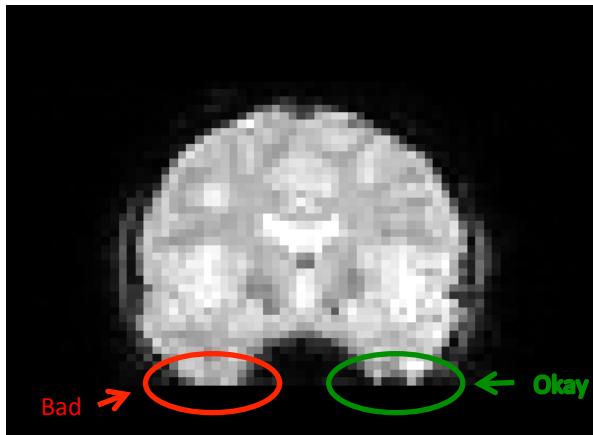


Harvard University; all rights reserved.

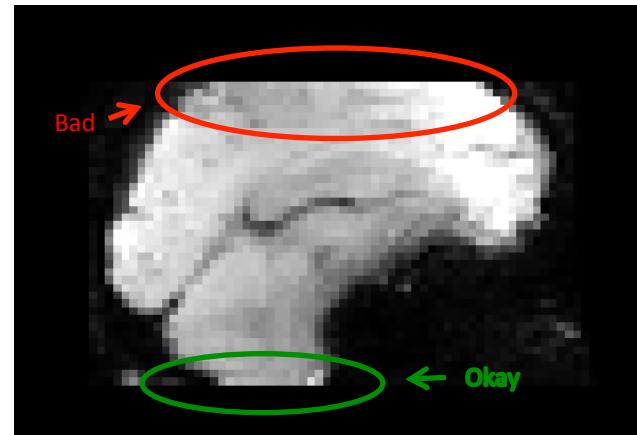
BOLD : Head Coverage



Good: EMBARC brain target area fully covered in FOV.



Questionable: FOV clips slice(s) of EMBARC brain target area.



Bad: FOV clips significant portion of EMBARC target area

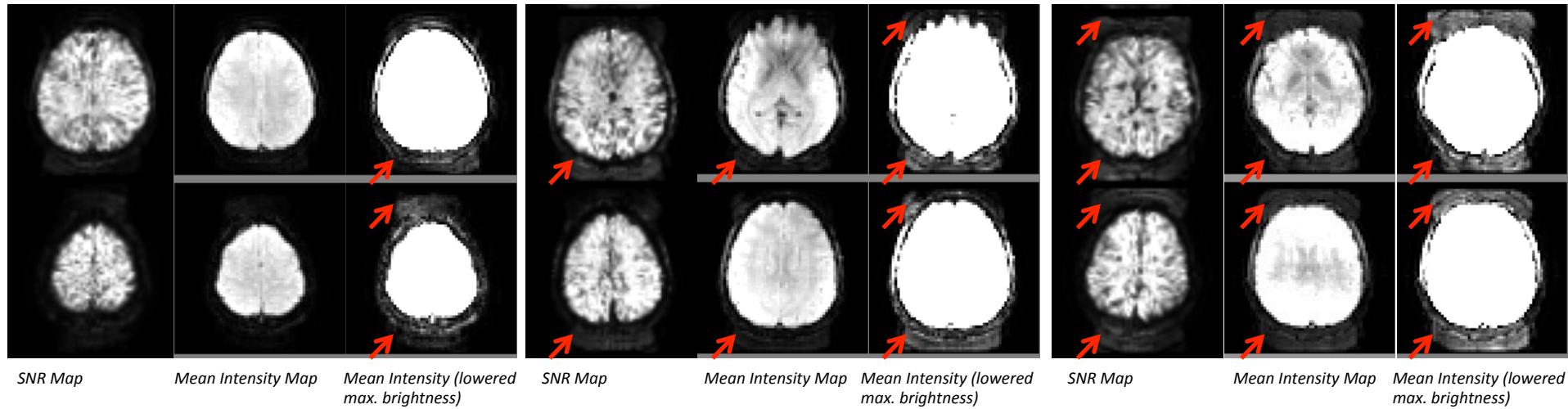


© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

BOLD : Ghosting



Mild: Ghosting faintly detectable only after adjusting contrast (decrease Maximum Brightness)

Moderate: Ghosting notably visible without adjusting contrast and prominently visible after adjusting contrast

Severe: Ghosting prominently visible without adjusting contrast

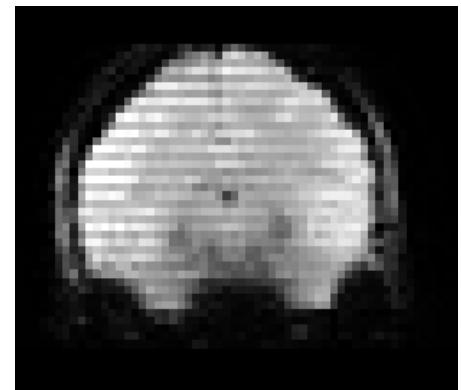
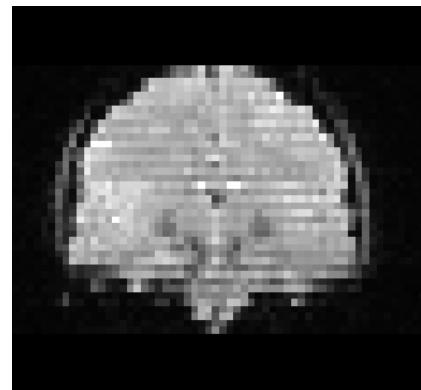


© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

BOLD : Motion Slice Artifact

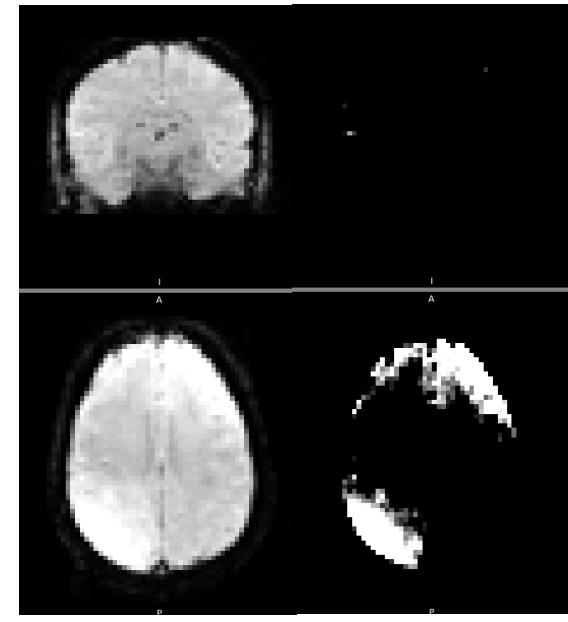
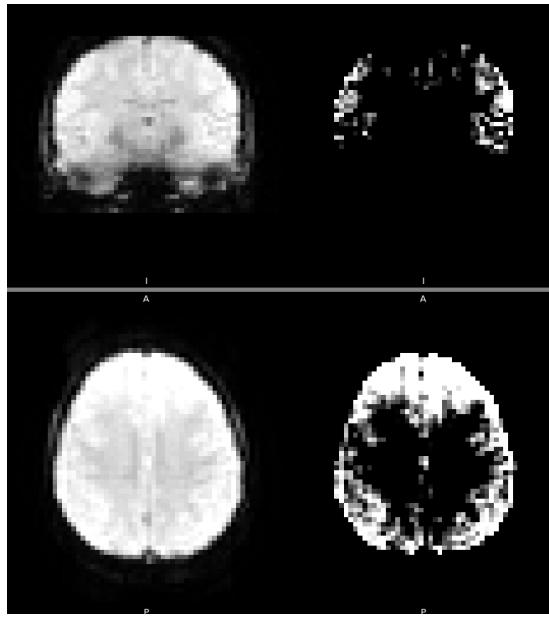
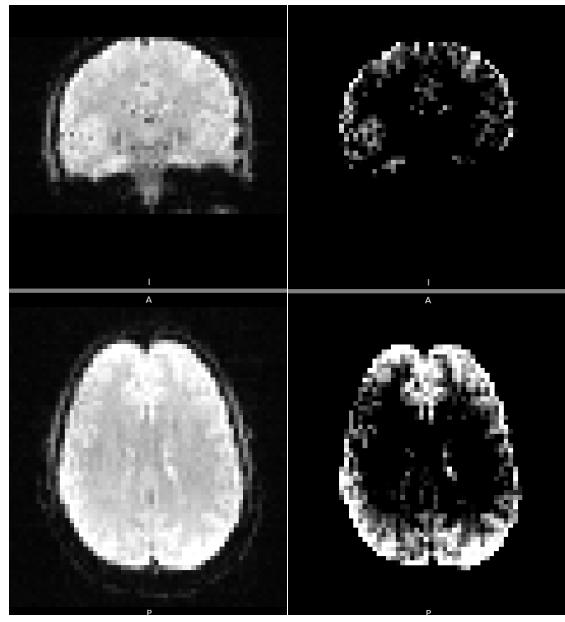


© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

BOLD : Signal Inhomogeneity



None: signal intensity uniform throughout image.

Expected: inconsistent signal intensity fits scanner/coil profile

Unexpected: inconsistent signal intensity does not fit scanner/coil profile

*Signal inhomogeneity is most clearly visible at high contrast, adjusted by raising the Minimum Brightness.

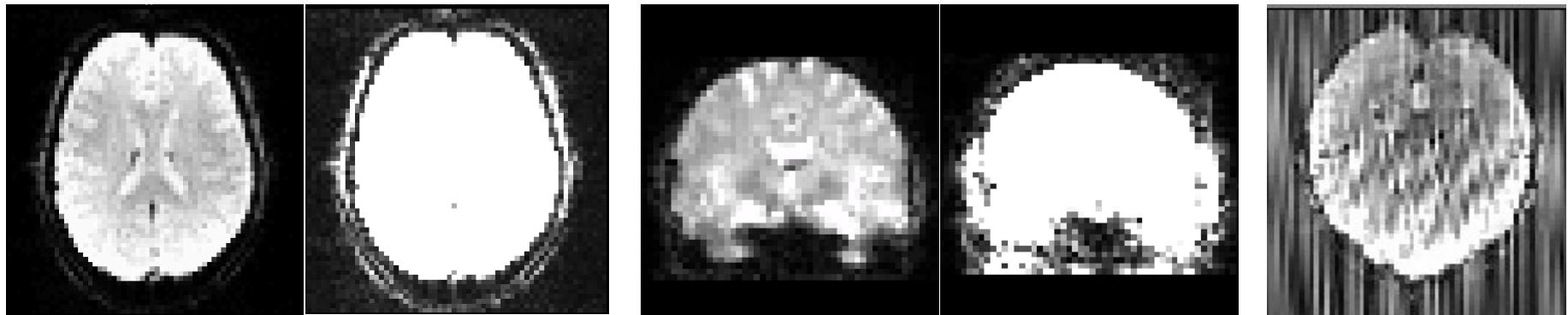


© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

BOLD : Radio Frequency (RF) Noise (Severe = Spiking)



Normal Contrast

*High Contrast**

Normal Contrast

*High Contrast**

Normal Contrast

Mild: Low-level RF noise visible only after adjusting contrast

Moderate: RF noise prominently visible without adjusting contrast

Severe: Spiking is present

*RF Noise is most clearly visible at high contrast, adjusted by lowering the Maximum Brightness.



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Make a Record

User: nshansen (Logout) (Edit) (Report a problem) Search Advanced

Home New Upload

PROJECT: EMBARC > SUBJECT: [REDACTED] BOLD_13_EQC

Manual QC tab in EMBARC Central XNAT

Provenance

Motion

Mean Absolute Motion: 0.258
Maximum Absolute Motion: 0.532
Movements (>0.1mm): 28
Movements (>0.5mm): 0

Affects Brain Outside of Brain

None None
 Mild Mild
 Moderate Moderate
 Severe Severe

Overall QC Assessment

PASS - Data passed quality control
 WARN - Data have significant quality issues
 FAIL - Data failed quality control

Save changes ▾ Do not save changes ▾

Ghosting

RF Noise/Spiking

Head Coverage

Good - full brain coverage with \geq 1 slice buffer
Questionable - slight clipping or necessary clipping
Bad - brain clipped unnecessarily or severely

Inhomogeneity

Comments

WARN: FOV clips top
AI: Wrapping; moderate inhomogeneity; motion slice artifact @ TP's 17-23, L149, 202-207

Note any information necessary to clarify broad ratings (e.g. Head Coverage -> Note: "FOV clips top")

SNR Image
Mean Image
StDev Image
Mask Image
Mean Data
Motion Data
Slope Image
Auto QC Report
Manual QC Report
Slice Report

powered by 



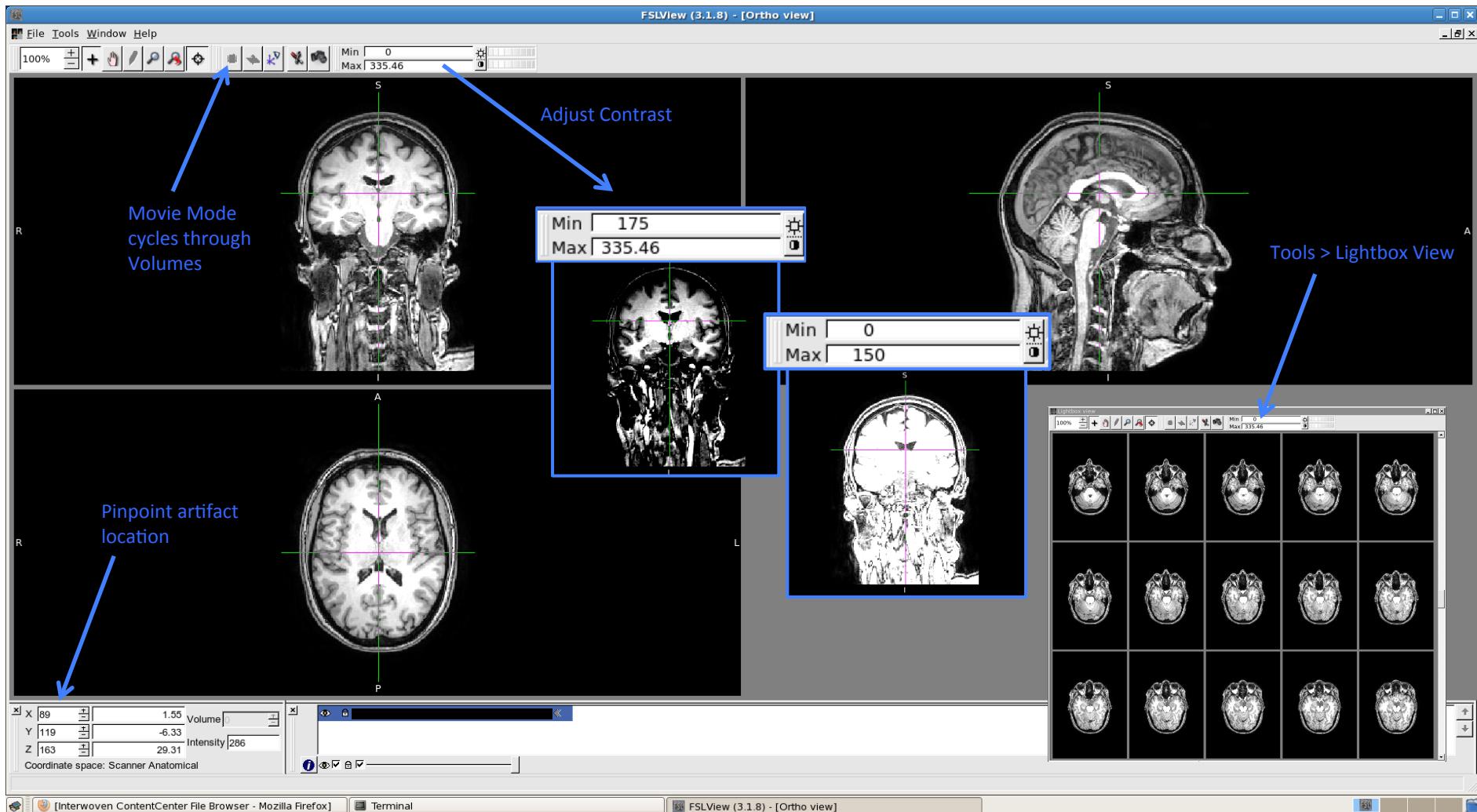
© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Qualitative QC in Action

Examples from EMBARC scans in FSL



© Copyright Massachusetts General Hospital &



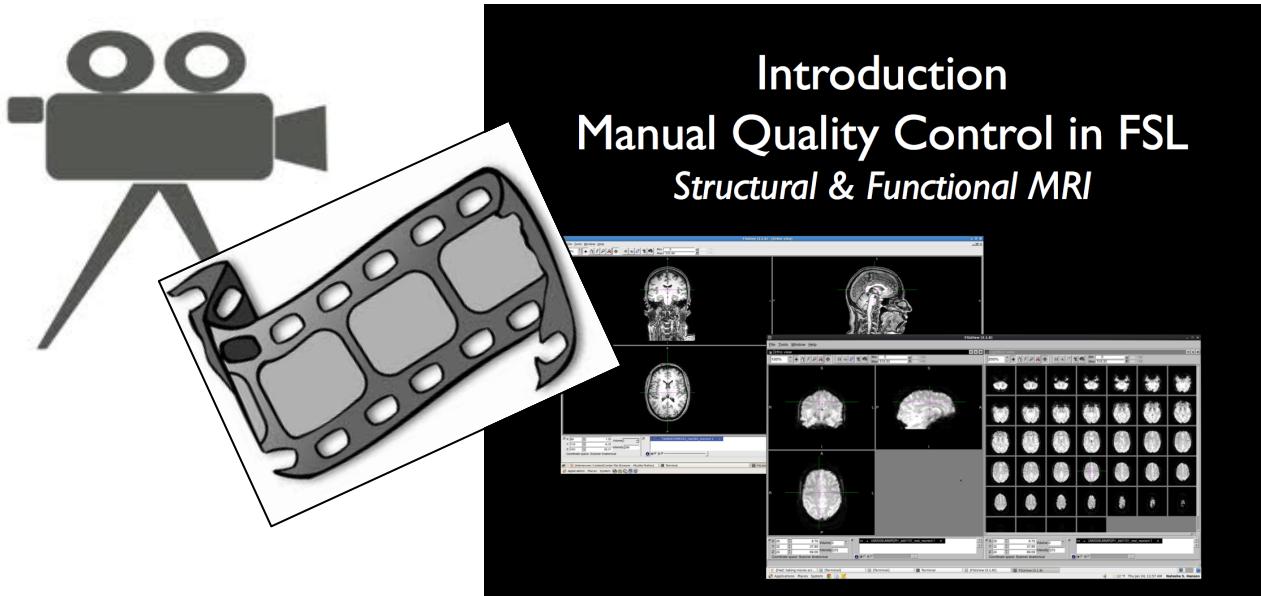
Harvard University; all rights reserved.

Video Tutorial

“Introduction to Quality Control Tools in FSL”

MRI quality control tutorial videos are available online!

Go to the Harvard Center for Brain Science website: <http://cbs.fas.harvard.edu/>
Center for Brain Science > Neuroimaging > Information for Investigators > FAQ



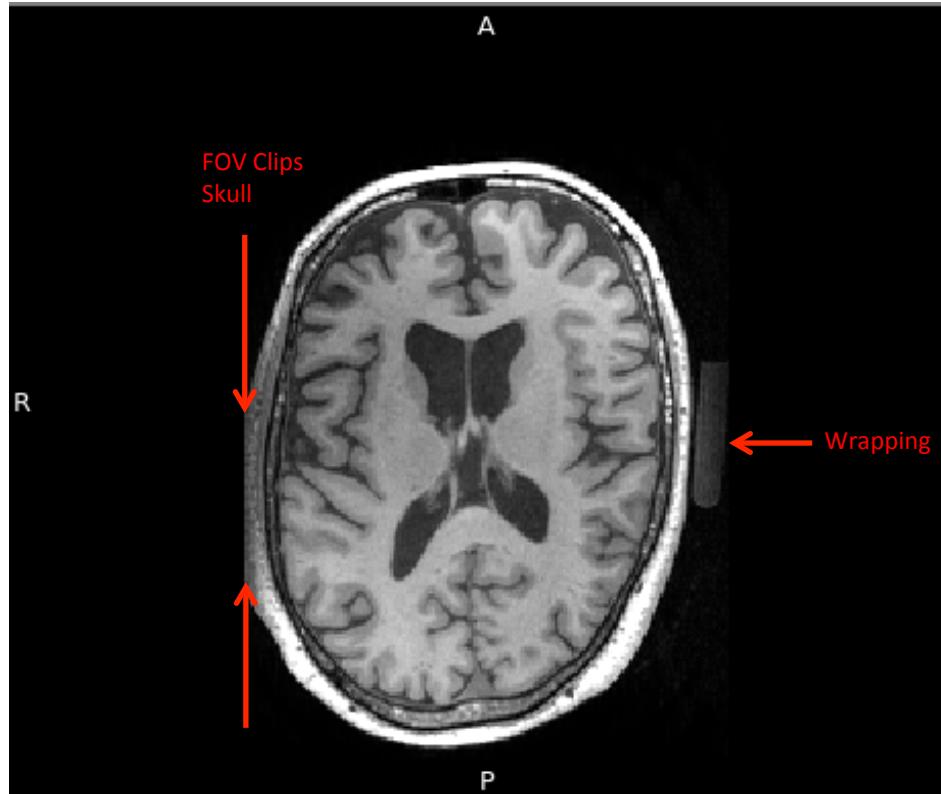
© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Head Coverage & Wrapping

FOV clips skull causing Wrapping



Normal Contrast



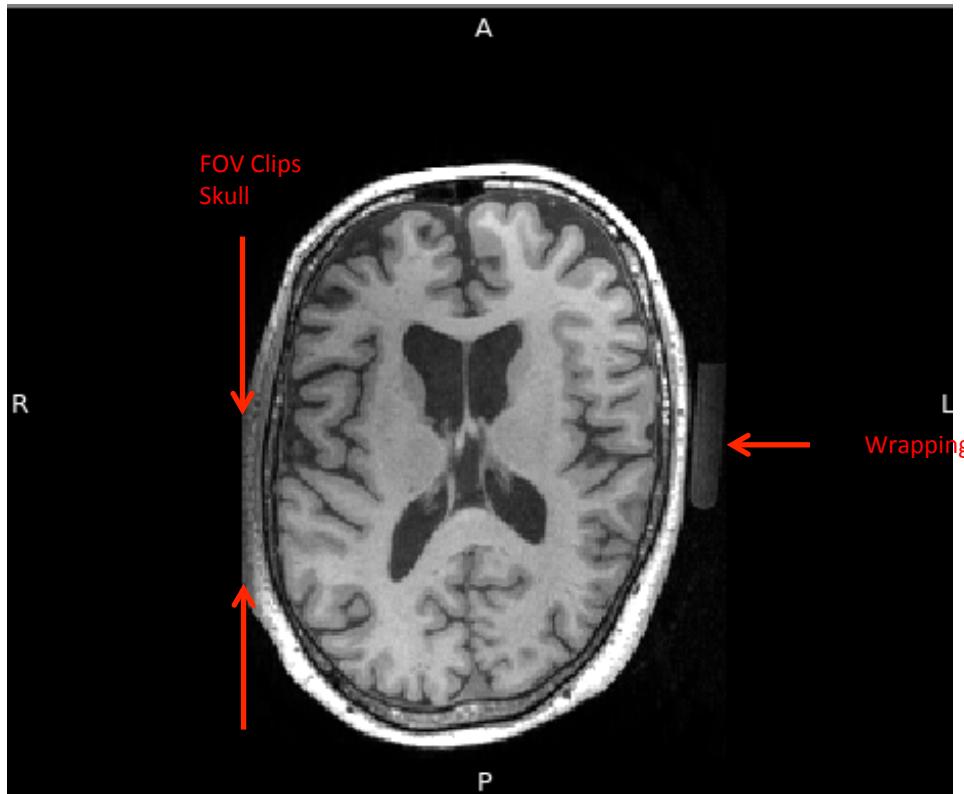
© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

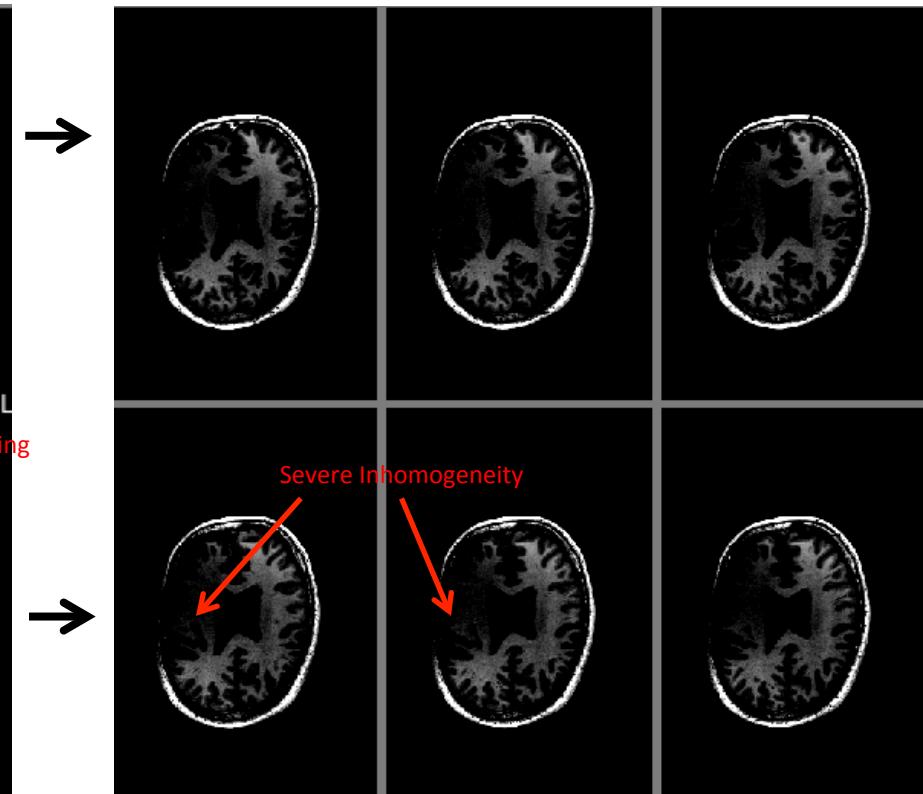
Head Coverage & Wrapping

FOV clips skull causing Wrapping



Normal Contrast

Inhomogeneity revealed at point of skull clip



Adjusted Contrast



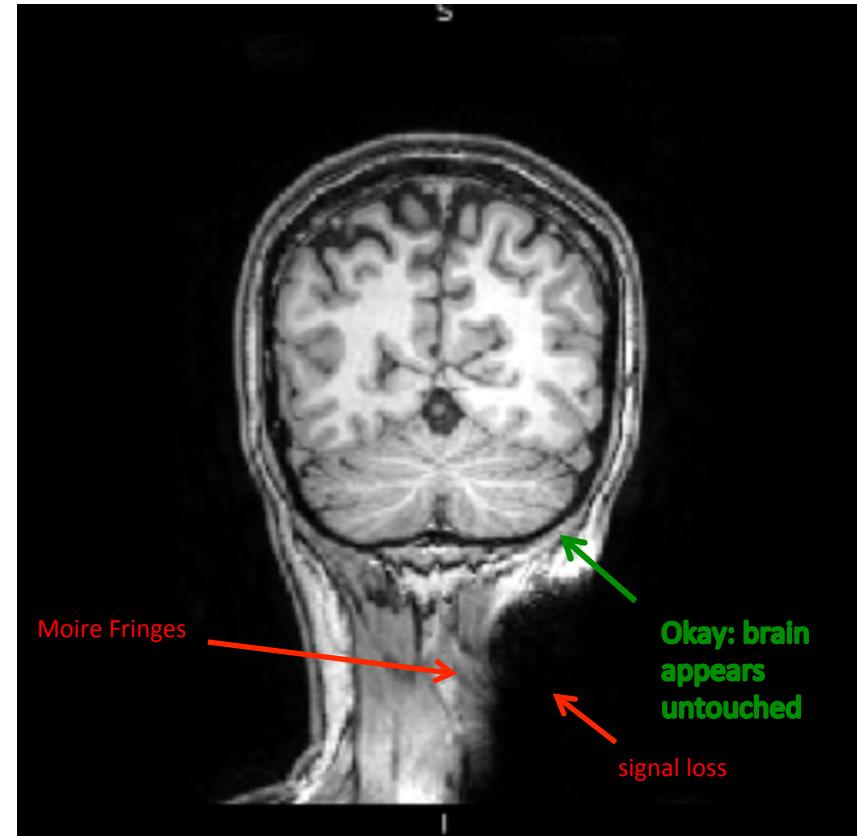
© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Susceptibility Artifact

Massive signal loss accompanied by “Moire Fringes” – brain appears unaffected



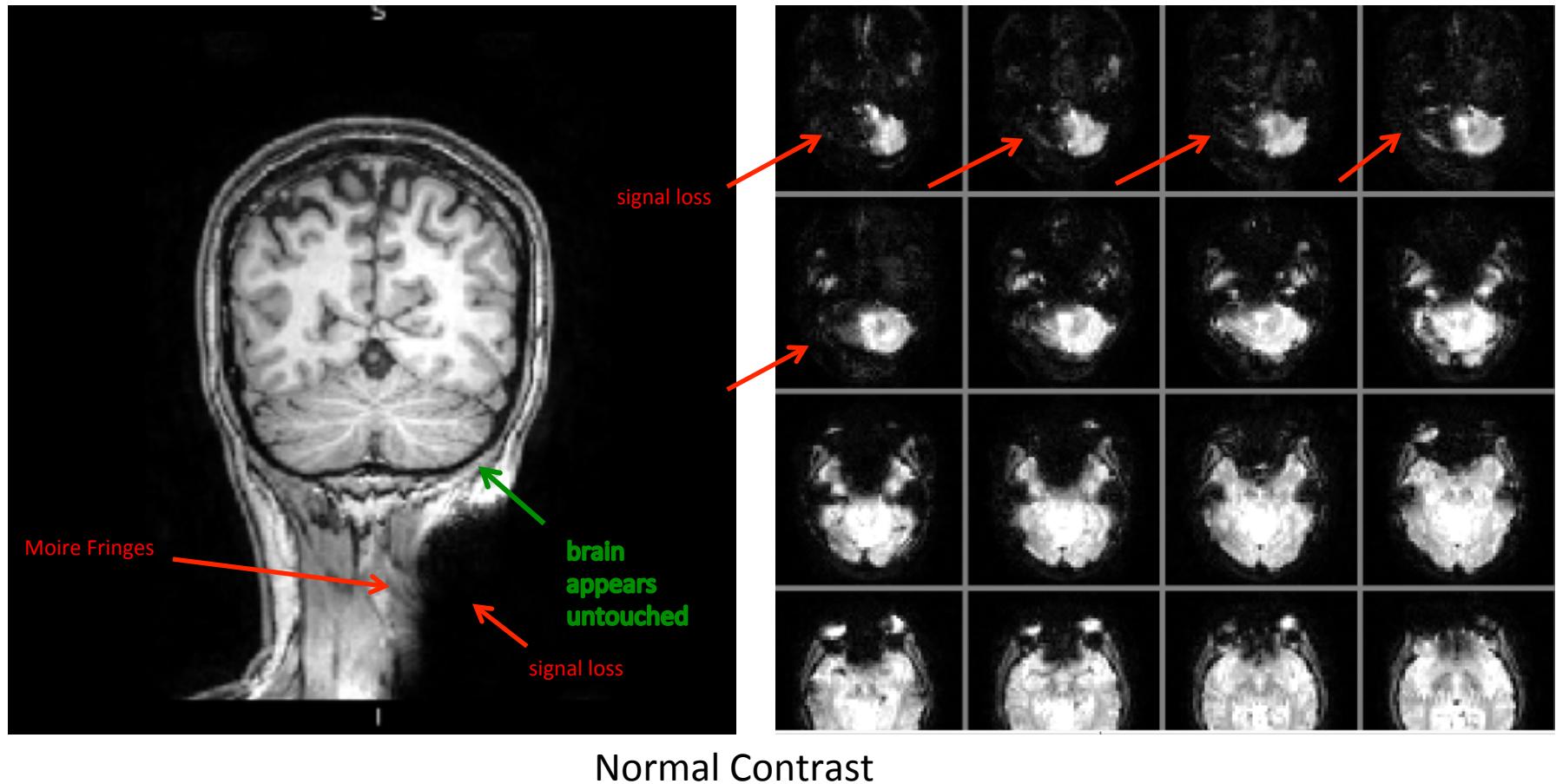
© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Susceptibility Artifact

Brain appears unaffected in by Susceptibility Artifact in structural scans,
but signal drop out is visible in BOLD scans



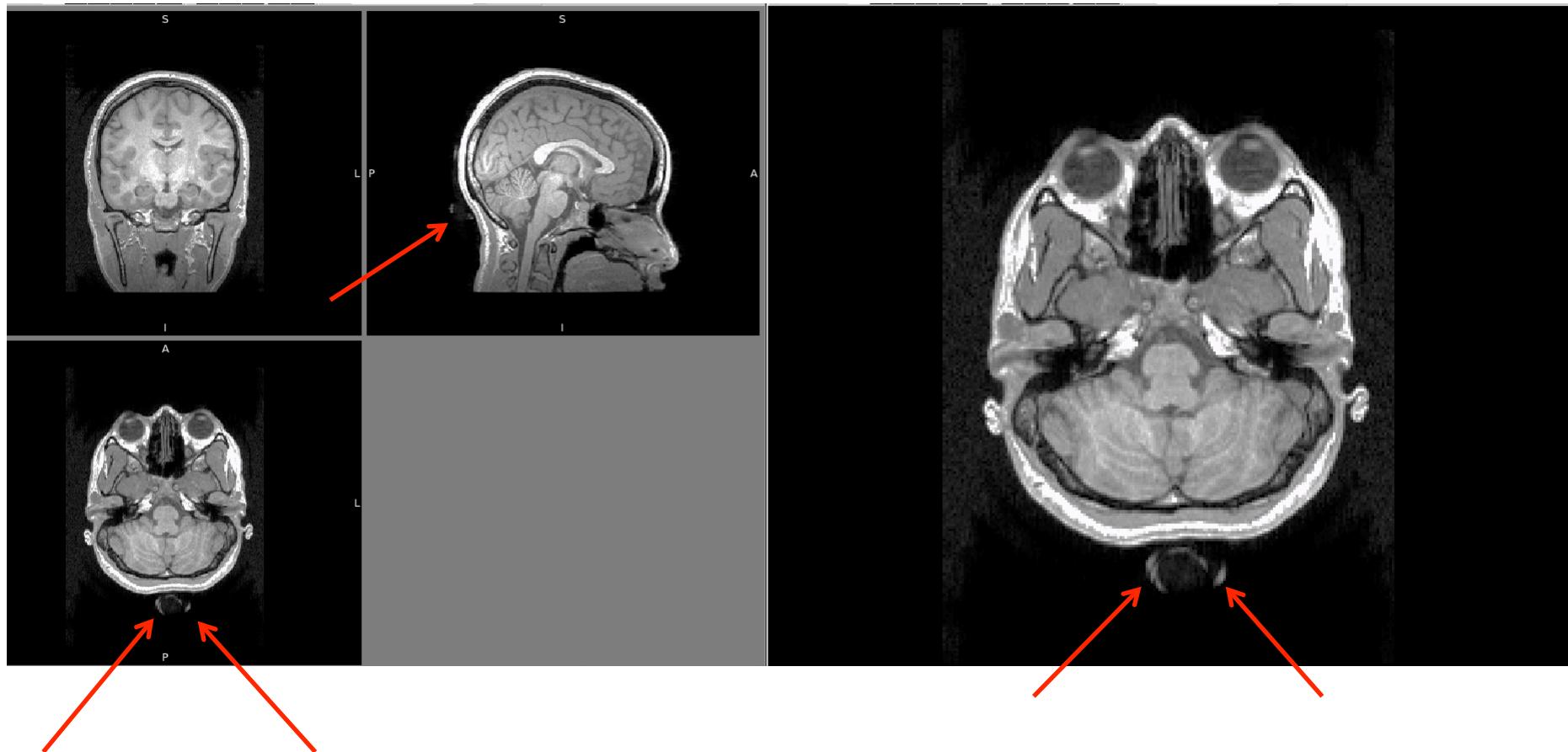
© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

“Swirling Galaxy Artifact”!

This artifact is caused by the subject's hair tie or greasy bun – perspective and humor are key!



© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Want to Learn More?

The Harvard Center for Brain Science Website has more useful information for you!

Go to: <http://cbs.fas.harvard.edu/>

Center for Brain Science > Neuroimaging > Information for Investigators > FAQ

The Qualitative QC Manual

Detailed practical QC Tutorial Videos

How to create your own measures of goodness

Preventive QC: at the scanner

What to do when you discover artifacts

MRI Quality Control Manual

What to look for and How to look for it!

ANAT : Susceptibility Artifact

What causes it: A susceptibility artifact is a result of magnetic field inhomogeneities. It appears as dark areas in the image.

How to look for it: Scan through all the slices in the axial plane. Look for dark areas that are not anatomical structures.

What to do if it occurs: If the dark areas are small, they can be removed by using a mask or segmentation.

ANAT : Ghosting

What causes it: A common cause is motion during the scan. It appears as horizontal streaks.

How to look for it: Look for horizontal streaks in the image.

What to do if it occurs: If the motion is significant, the scan should be repeated.

BOLD : Signal Inhomogeneity

What causes it: A common cause is motion during the scan. It appears as bright areas in the image.

How to look for it: Look for bright areas in the image.

What to do if it occurs: If the motion is significant, the scan should be repeated.

BOLD : Head Coverage

What causes it: Signal inhomogeneity and motion during the scan.

How to look for it: Look for bright areas in the image.

What to do if it occurs: If the motion is significant, the scan should be repeated.

© Copyright Massachusetts General Hospital 2012; all rights reserved.

What to do if you find something.

There are several basic steps you can do to try and improve the quality of your data at the scanner.

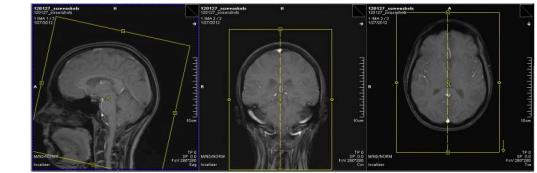
1. Movement: Provide feedback to your subject about their movement. If your paradigm permits, it can be useful to provide gentle reminders that they need to stay still, or you can specifically tell them that you checked their movement and you noticed that they moved at a particular time (such as, the beginning, middle, or end of scan). This can help the subject to realize what kind of movements aren't allowed. However, if you are using a task, or would like to provide feedback to the subject about their movement, you may want to do this feedback, then you may want to consider saying nothing or providing very general, generic feedback.
2. Ghosting: There is generally not a great solution for this. However, if you see severe ghosting or a change in ghosting patterns, you should inform the [Ross Lyman](mailto:ross.lyman@cbs.fas.harvard.edu) who is holding the box down by their side and not up in the scanner. You should also inform the radiographer that the subject is stationary. This is something that should be reported to [Ross Lyman](mailto:ross.lyman@cbs.fas.harvard.edu) with the date, subject number, and fan scanner where observed.
3. RF/Spiking: One common source of RF Interference is the beam box. Make sure the beam box is holding the box down by their side and not up in the scanner. You should also inform the radiographer that the subject is stationary, and run scans where something was observed.

How to check for correct coverage.

It is important to make sure that every part of the brain you want to collect information about is inside the field of view (yellow box).

Structural

For structural scans, make sure the top, bottom, and sides of the brain are in the yellow box, and that the noise isn't being cut off. Anatomical structures outside of the yellow FOV will wrap around to the other side. For example, the noise would show up in the occipital lobe. If you use autotrig, then this will usually come up correctly for you, but it is always wise to look closely.



FAQ

NCF Questions

Getting Started

- How do I get help?
- What is the NCF?
- Who may use the NCF?
- How do I use the NCF?
- How do I get an NCF User Account?
- How do I set up my user environment/access software?
- How do I set my permissions so that everything is read group?
- How do I access the NCF from a different computer (VPN)?
- How do I access the NCF from a designated workstation?
- How and where do I login remotely to the NCF?
- How do I connect to the NCF from a PC?
- How do I get files back and forth between the NCF and my local computer?
- How do I look at and/or edit files from a workstation?

Advanced Topics

- How do I submit jobs to the compute cluster?
- Useful commands to work with submitted scripts (bsub tools).
- Using VNC, which allows GUI intensive programs from my computer?
- How do I change my password?
- What if I want to VPN to the NCF from a different computer than usual?
- What software is available on the ncf?
- Which spm version do I have to use to process and store my data?
- How do I use the internet from the workstations?
- How do I change the version of my FreeSurfer, Afni, FSL, or other brain analysis packages?
- How do I set or change my SPM version?

Funding Resources

- Human Subjects
- Policies
- Scanner Fees
- Scheduling

Information for Students

- Electrophysiology
- Connectome Project

Education

- Swartz Program



© Copyright Massachusetts General Hospital & Harvard University; all rights reserved.



Harvard University; all rights reserved.

Acknowledgements

MRI Qualitative Quality Control Manual written and created by:

Natasha Hansen, Garth Coombs, Thilo Deckersbach, & Randy Buckner

Special Thanks to:

Primary Investigator

Randy Buckner, PhD

EMBARC Quality Control Team

Thilo Deckersbach, PhD

Kristen Ellard, PhD

Sharmin Ghaznavi, MD, PhD

Natasha Hansen, BA

Garth Coombs, BA

Neuroinformatics Team

Gabriele Fariello, MA

Victor Petrov, BA

Timothy O'Keefe, BA

MR Physics Consultant

Ross Mair, PhD

Neuroimaging Consultants

Stephanie McMains, PhD

Erik Kastman, BS

Sophia Mueller, MD

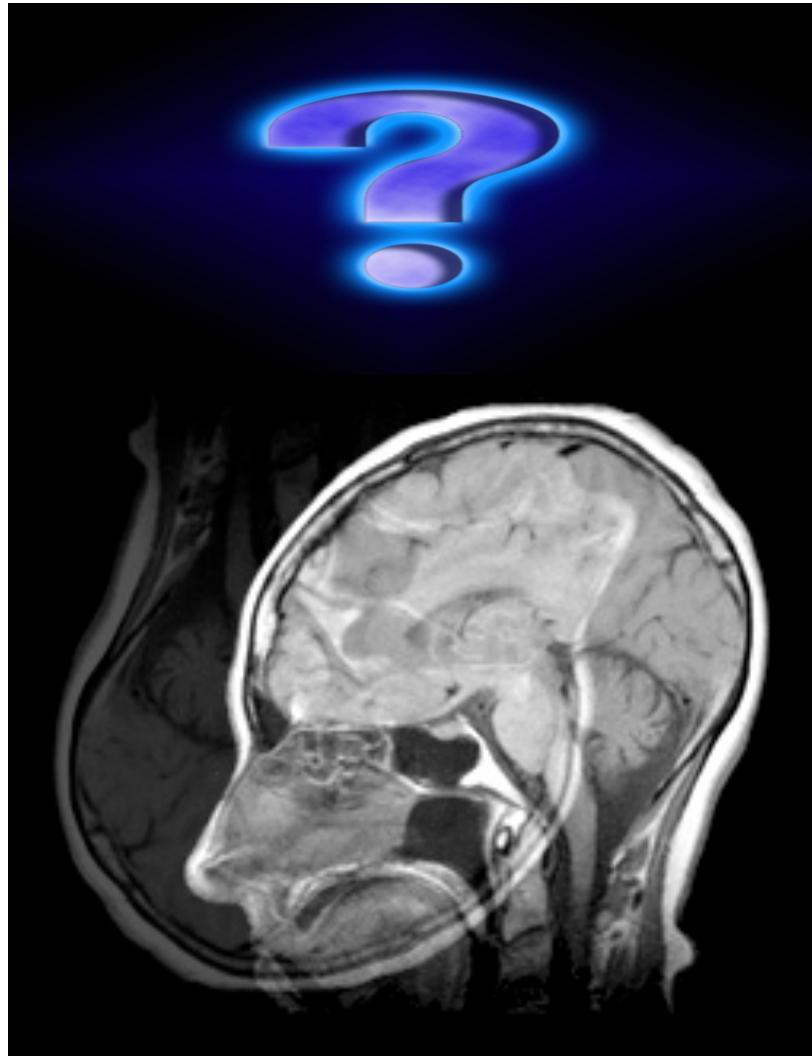


© Copyright Massachusetts General Hospital &



Harvard University; all rights reserved.

Questions and Discussion...



© Copyright Massachusetts General Hospital & Harvard University; all rights reserved.

