

# Troubleshooting Guide

Prep, Scan Errors, and Artifacts

# Preparing for the Study

Participant Compliance with MRI Scans

# Participant Prep

Having your participant prepped will allow you to run your study with minimal interruptions.

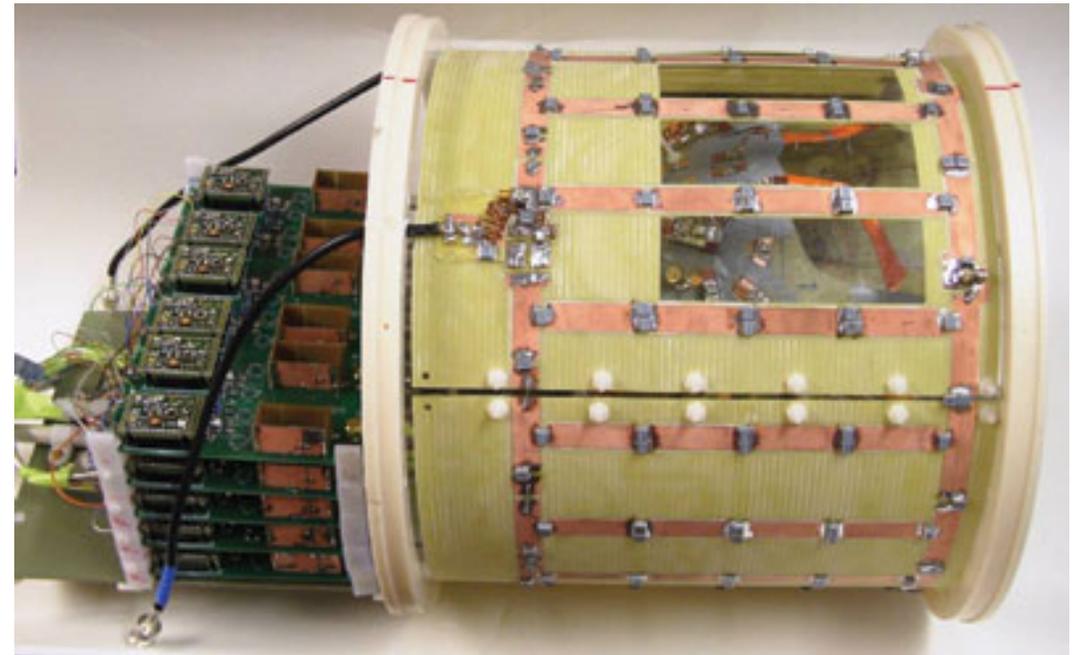
- Let your participant know to wear cotton or cotton blend clothing and not spandex type of clothing.
- Ask them not to bring any metallic items that can be left at home or in the car.
- Explain to them what they can expect being in the scanner, the sounds, and importance of being still.
- Check for signs of anxiety such as claustrophobia. Will the participant tolerate the time to complete the study?
- If the participant wears glasses, use the MRI compatible goggles to see the screen.
- Let them know you are able to see and hear them. Give the participant the call button.
- Remind them to use the bathroom before you start your MRI scan.



# Checking Equipment

Checking equipment before bringing your participant into the scan room will reduce confusion and confirms equipment is ready.

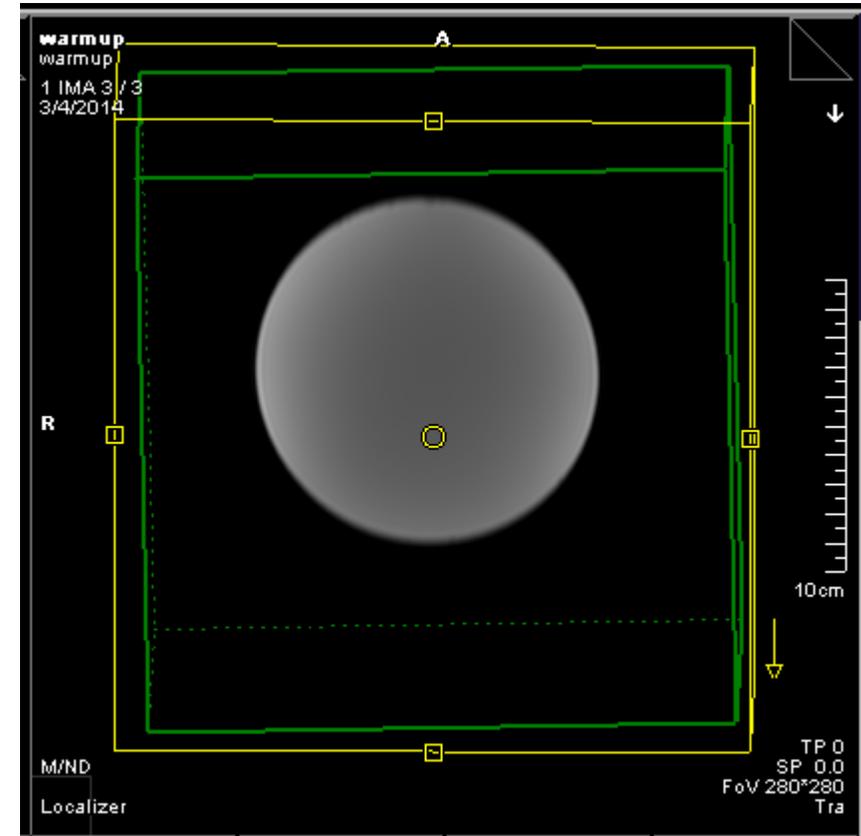
- Turn on the projector, boot the stim computer or have your laptop ready, check that the sound is working.
- If you are using other equipment make sure they are functioning.
- Place a clean sheet on the scanner bed, have necessary positioning sponges, and clean the head coil with the anti-bacterial towellets.
- Test the button boxes to make sure they function properly.
- Check that your stimulus is on the stim computer and is ready to go.



# Scanner Warm-up

Warm-up the scanner if it has not been used within four hours to minimize any initial signal variations and to confirm the scanner is functioning normally.

- Does the scanner need to be warmed up? If so give yourself at least an additional 15 minutes.
- Register and select the proper warm up protocol for the head coil you will be using.
- Make sure the head coil plugs are securely connected.
- Always use a phantom when you warm up the scanner.



# MRI Screening

MRI Screening is mandatory on all participants

- Complete the MRI screening form before the day of your study to avoid potential screening issues such as implant contraindications.
- If there are questions that may compromise the safety of your participant, check with the MRI safety officer before proceeding.
- Be absolutely sure that all loose metal has been removed before you or your participant enters the scan room.
- Remember to ask your participant verbally if there is anything in their body that they were not born with.

**UC DAVIS IMAGING RESEARCH CENTER PRE-MRI SCREENING FORM**

Date: 1/11/09 | Principal Investigator: \_\_\_\_\_  
 Name: Last name: \_\_\_\_\_ First name: \_\_\_\_\_ MI: \_\_\_\_\_ Height: \_\_\_\_\_ Weight: \_\_\_\_\_  
 Birth Date: \_\_\_\_\_

2. Have you ever had surgery or similar invasive procedure in which medical devices may have been implanted?  
 If yes, please list: \_\_\_\_\_ No  Yes   
 Type: \_\_\_\_\_ Date: \_\_\_\_\_

2. Have you had any previous MRI imaging studies?  
 If yes, please list: \_\_\_\_\_ No  Yes   
 Body part: \_\_\_\_\_ Date: \_\_\_\_\_ Facility Location: \_\_\_\_\_

3. Have you ever worked with metal (grinding, fabricating, etc.) or ever had an injury to the eye involving a metallic object (e.g., metallic shavings, shavings, shrapnel, foreign body)?  
 If yes, please describe: \_\_\_\_\_ No  Yes

**For female subjects only:**

4. Are you pregnant, or is there a possibility that you are pregnant?  
 (If unsure, please notify MRI operator or Principal Investigator) No  Yes

5. Are you breast feeding? No  Yes  6. Date of last menstrual period: 1/11/09

7. Are you taking any type of fertility medication or having fertility treatments? No  Yes

8. Are you taking oral contraceptives or receiving hormone treatment? No  Yes

9. Are you currently taking or have you recently taken any medication?  
 If yes, please list: \_\_\_\_\_ No  Yes

10. Do you have anemia or any diseases that affect your blood, or a history of renal disease?  
 If yes, please list: \_\_\_\_\_ No  Yes

11. Do you have a history of seizure disorder or epilepsy? No  Yes

12. Do you have any drug allergies?  
 If yes, please list: \_\_\_\_\_ No  Yes

13. Have you ever had asthma, allergic reaction, respiratory disease, or any type of reaction to a contrast medium or dye used for an MRI or CT examination? No  Yes

UC Davis Research Imaging Center  
 Version 1.1, February 23, 2004.

Some of the following items may be hazardous to your safety and some can interfere with the MRI examination. Please check the correct answer for each of the following. Do you have any of the following:

Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Cardiac pacemaker
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Implanted cardiac defibrillator
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Aneurysm clips
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Cerebral artery vascular clamp
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Neurostimulator
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Insulin or infusion pump
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Implanted drug infusion device
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Bone growth/union stimulator
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Cochlear, otologic, or implant
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Any type of prosthesis (eye, penis, etc.)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Heart valve prosthesis
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Artificial limb or joint
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Electrodes (on body, head, or brain)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Intravascular stents, filters, or coils
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Stents (spinal or intravascular)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Vascular access port and/or catheter
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Swan-Ganz catheter
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Any implant held in place by a magnet (Remove before MRI)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Transdermal Patch Delivery System (e.g. Nicotine)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	IUD or diaphragm
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Tattooed makeup (eyeliner, lips, etc.)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Body piercings (Remove before MRI)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Any metal fragments (including bullets, shrapnel)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Internal pacing wires
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Aortic clip
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Metal or wire mesh implants
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Wire sutures or surgical staples
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Harrington rods (spine)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Metal rods in bones
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Joint replacement
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Base/joint in, screw, nail, wire, plate
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Hearing aid (Remove before MRI)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Dentures (Remove before MRI)
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Bruxing disorder
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Movement disorder
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Chlasmophobia
Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Anxiety

Please mark on the figure below, the location of any implant or metal inside of or on your body.

Before your MRI, please remove all metallic objects, including keys, hair pins, barrettes, jewelry, watch, safety pins, paperclips, money clip, credit cards, coins, pens, ball, metal buttons, pocket knife, & clothing with metal in the material.

**NOTE: YOU ARE REQUIRED TO WEAR EARPLUGS OR EARPHONES DURING THE MRI EXAMINATION.**

Signature/Printed name of Person Completing Form: \_\_\_\_\_ Date: 1/11/09

Form completed by:  Patient/Subject  Relative: \_\_\_\_\_ Name & relationship to patient

Physician or other: \_\_\_\_\_ Name & relationship to patient

Signature/Printed name of Person Reviewing Form: \_\_\_\_\_ Date: \_\_\_\_\_

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# Proper Earplug Insertion

Verifying that your participant has inserted the earplugs correctly will avoid interruption of your study and more importantly prevent hearing injury.

- Instruct your participant with the proper method to insert the earplugs. It is best to roll the earplugs rather than twisting them.
- Once the participant has inserted the earplugs, make sure that the earplugs do not fall out by asking the participant to pull on their ears.
- Make one final check that the earplugs are still in place after positioning their head before moving them into the scanner.



# Positioning and Immobilization

Taking the time to position the head correctly and using the sponges to minimize movement will improve data quality.

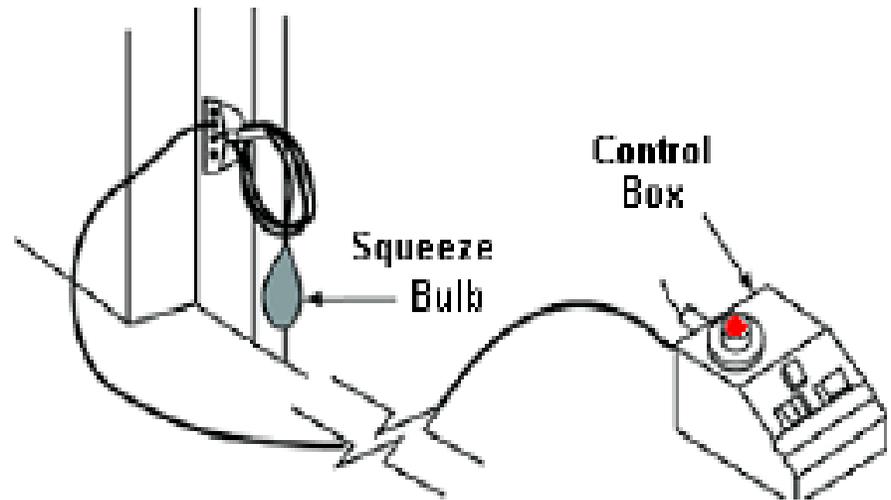
- Before you lay your participant on the scanning bed check that they understand to hold still during the time they are in the scanner. Sometimes if a scan is not in progress the participant thinks it is OK to move.
- When positioning, if at all possible align the head with the laser light to check for head tilt and rotation.
- Position the head so that it is not rotated, skewed, or overly flexed. This will give you better image quality.
- The head should be orthogonal in all three planes. Look down at the foot end to verify the head is not rotated right or left. Look at the face to verify the head is not tilted. Having the head in a neutral position is best.



# Checking Intercom and Call button

While the participant is in the scanner, you should always be in communication by the intercom and/or the call button. This provides safe scanning and the participant will have a better sense of trusting you.

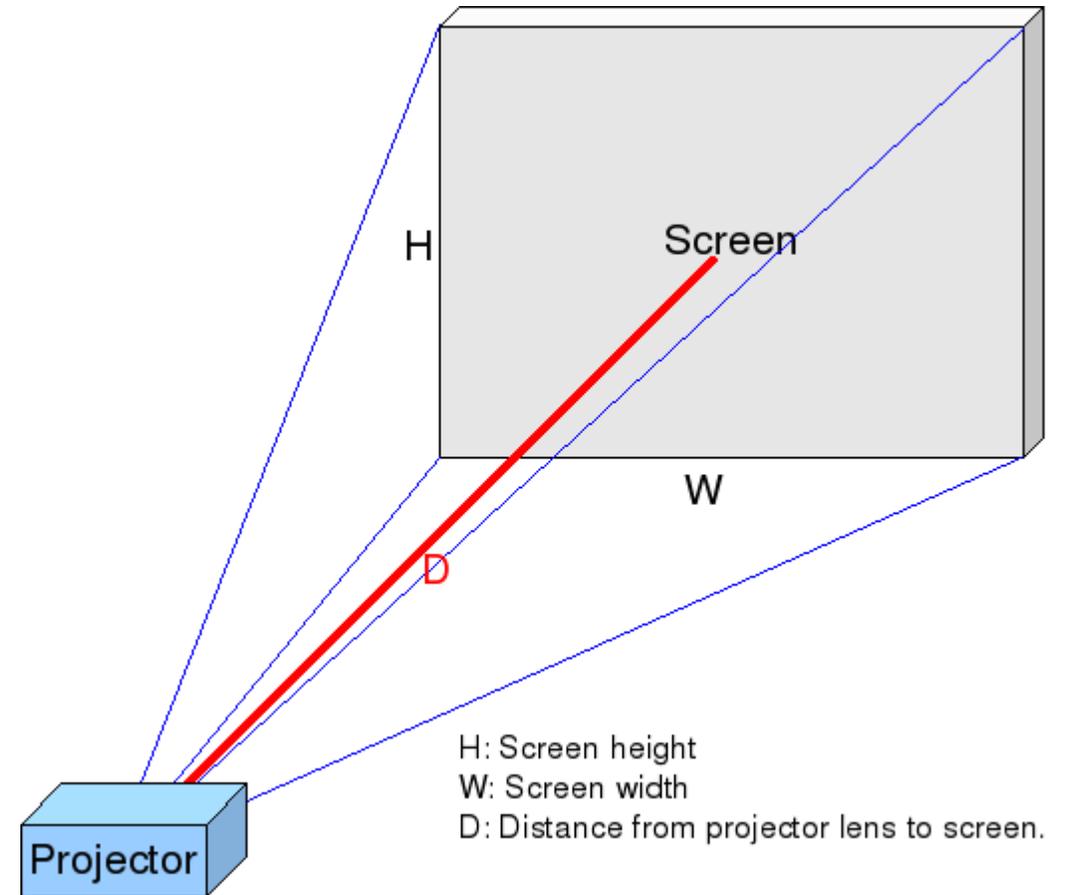
- Before you start your scan ask the participant if they are able to hear you. If not check the volume control and increase it and ask your participant again if they are able to hear you.
- Verify that you are able to hear them as well, and adjust the volume as needed.
- Check the call button by asking the participant to squeeze it. If you are not able to hear the alarm on the intercom, check the location of the tubing for proper connection. If it is correctly connected and still does not work, please notify the IRC tech support.



# Checking Visual field

Your participant must be able to see the projected stimulus to respond appropriately.

- If your participant wears glasses, select the proper goggles that allows your participant to see the screen.
- Confirm when using the projector that the screen side (shiny side) is correctly facing the participant.
- With the projector on, check that your participant can see the upper and lower borders of the image on the screen. If they cannot see parts of the image adjust the magnification, focus, and position of the image on the screen.
- It is best to have the lights off in the bore because the refraction can obscure the projected image.
- With the screen in front, it blocks the participant and is difficult to see them. Verify that you can see them on the camera monitor.



# Claustrophobia

Claustrophobia is a main cause of failure to complete the MRI scan.

- Prepare and educate the participant concerning specific aspects of the MRI scan (e.g. the dimensions of the scanner, noise, intercom, call button, and that you are always present).
- Maintain verbal, visual and/or physical contact if appropriate.
- Make sure air is circulating in the bore of the scanner.
- If your participant is not comfortable with being in the scanner, you will need to terminate your study.



“OK, Mrs. Dunn. We’ll slide you in there, scan your brain, and see if we can find out why you’ve been having these spells of claustrophobia.”

# Common Scanning Errors

Causes and Corrections

# Participant Registration

Registration must be completed first before landmarking to avoid isocenter failures.

- Complete all bold fields.
- Never use participants name, DOB, or other identifiable demographics.
- Participants weight must be accurate to avoid RF heating or shimming failures.
- Participant orientation should always be head first/supine.
- Verify that the correct study has been selected
- If preregistration was accidentally selected go to search, find participant and select it.
- Click on Exam.
- If wrong study was select it is not necessary to re-register. You can select the down arrow under study and select the correct study.

**Patient Registration**

**PATIENT**

Last name

First name

Title

Patient ID

Date of birth  [M/d/yyyy]

Sex  Male  Female  Other

Age  Years

Height  [ft'in']

Weight  [lb]

Additional info

Details...

**PROCEDURE**

Accession No

Request ID

Requested procedure(s)

Study

Study comment

Patient position

**INSTITUTION**

Institution name  IRC

1. Performing physician

1. Operator

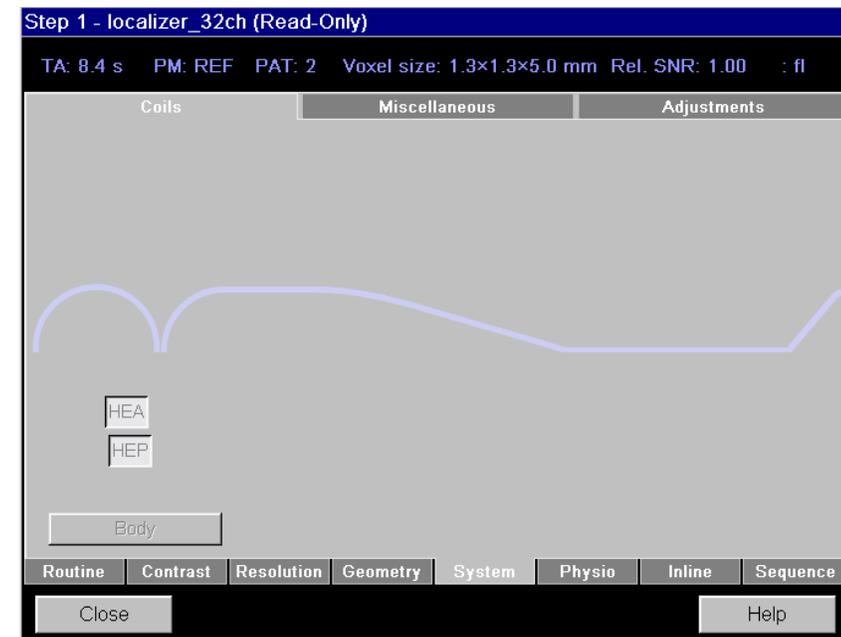
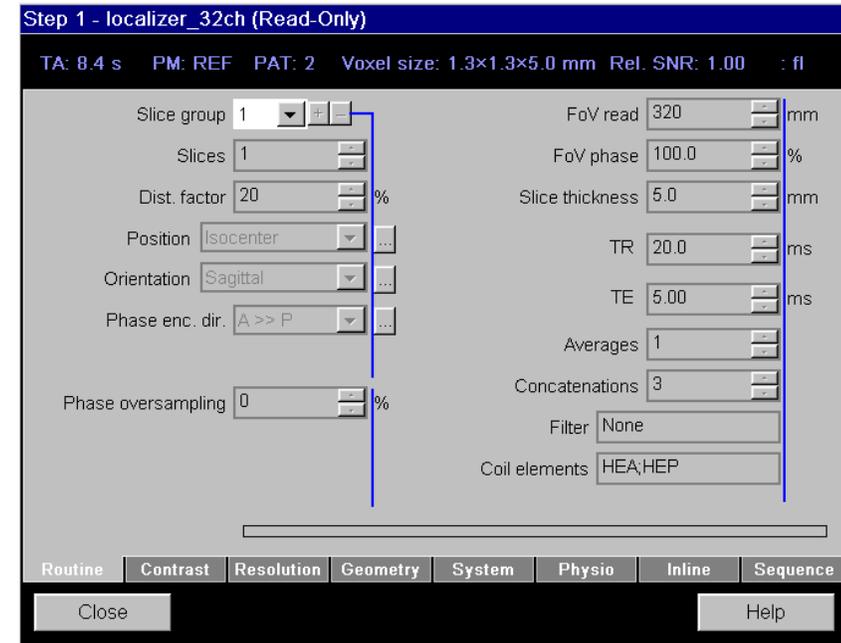
Preregister Exam Search Cancel Help

Patient Registration ISO\_IR 100

# Coil Selection (plugs)

A common cause of scan failures are coil plugs are not correctly seated.

- Confirm that all plugs are seated correctly by pushing down on the plugs individually.
- If the plugs are loose the images will be degraded.
- Also, verify on the console that both HEA and HEP coil elements are selected. If they are not go to the system tab and select them.



# Landmarking

- Move participant as close as possible to window of laser light before turning on laser.
- Turn on laser and center on eyebrows. Note: Eyebrows should be at the line on the head coil. This will center the brain in the coil.
- Check the LCD window to verify that the landmark was accept.
- If the laser light timed out, turn the laser light on and landmark. If you are not sure if the laser light timed out, it is best to re-landmark to avoid scanning in the wrong anatomical location.

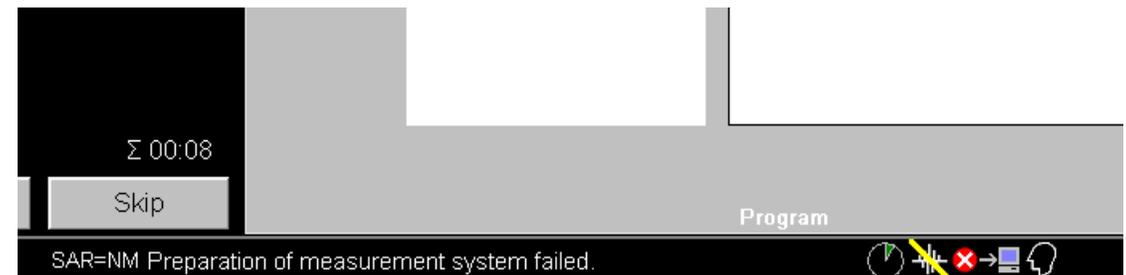
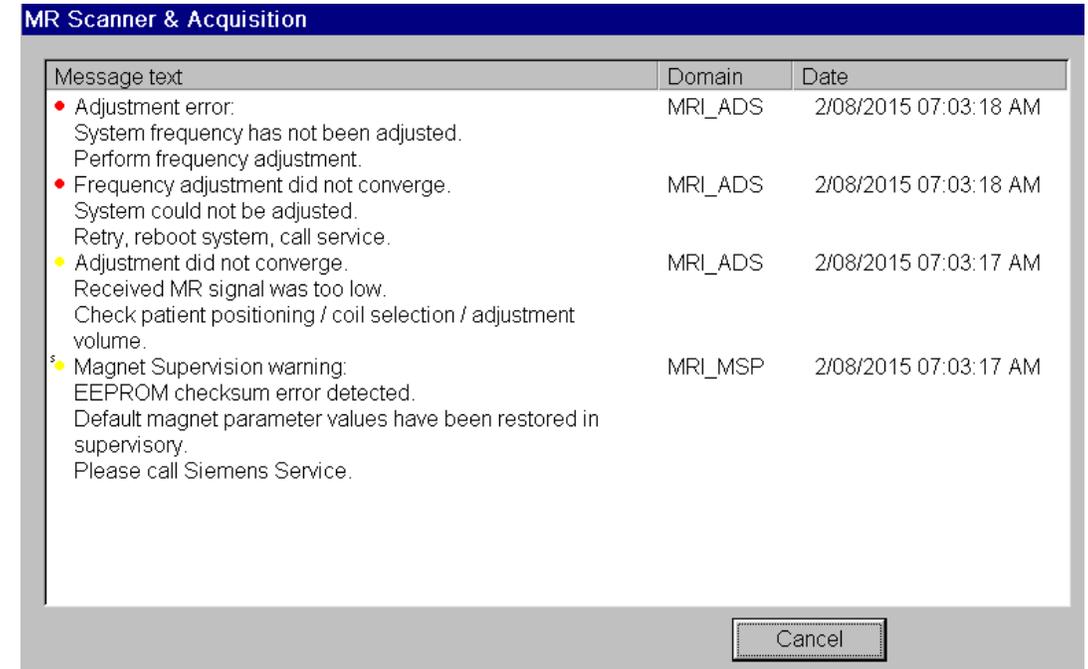


# Measurement failures

If the scanner fails to scan check the following:

- Is the table at isocenter.
- Is the coil securely clamped down.
- Is the head positioned in the center of the coil.
- Is the correct coil selected.
- Is the correct protocol selected

If all of the above is fine. Then the last option would be to reboot the scanner.



# Earphone sound troubleshooting

## Pneumatic headphones

- Is the tubing plug in the port?
- Is there sound from the computer? If not check the volume.
- Is the switch on scanner or earbuds? Should be on scanner.
- Is the middle button on the intercom on?

## Earbud earphones

- Is earbuds selected on switch?
- Are the cables plugged in correctly?
- Is the volume set correctly?



# Participant Positioning and Immobilization

Positioning of the head in the 32 channel head coil:

- Position the head so that it is not rotated, skewed, or overly flexed. This will give you better image quality.
- The head should be orthogonal in all three planes. Look down at the foot end to verify the head is not rotated right or left. Look at the face to verify the head is not tilted. If possible avoid the head flexing forward or backwards. A neutral position is best.



# Hardware and Software errors

If you have checked that the participants head is in isocenter and the scanner will not scan, check the following:

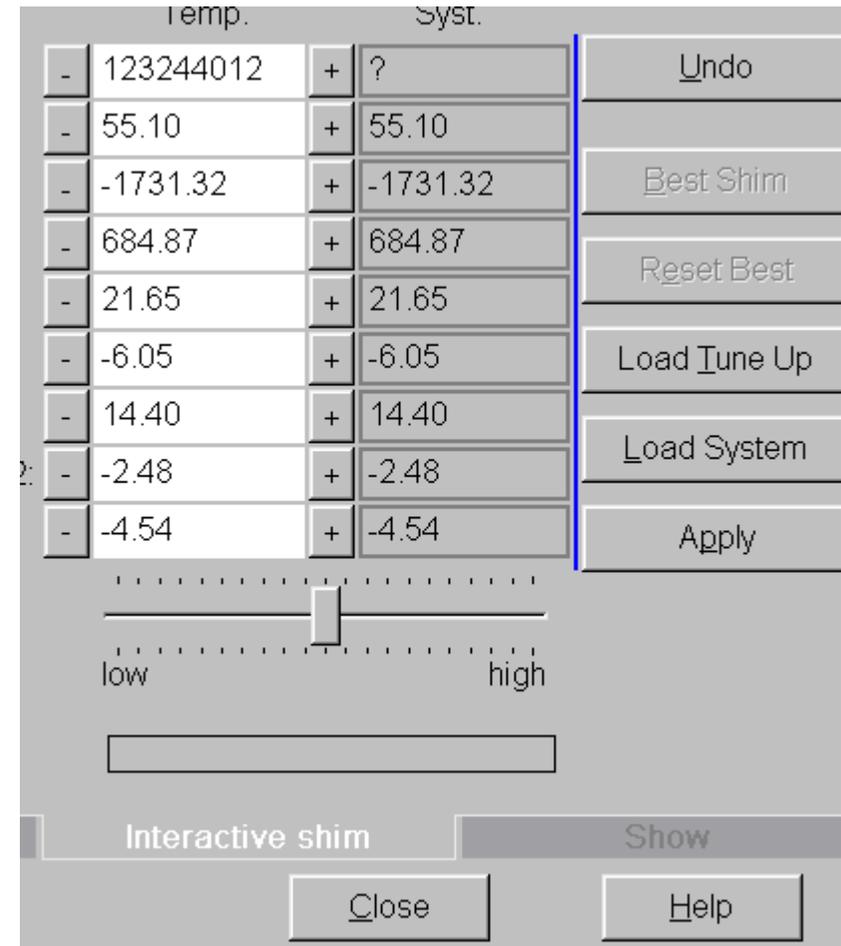
- Check that all the plugs to the head coil are seated in the outlets securely.
- The top half of the 32 channel coil is seated and secure on the bottom half with nothing, i.e. the sheet is pinched between the coil halves.
- Verify that HEA and HEP is selected on the scanner console.
- Verify the series you want to scan is in the queue correctly.
- If all fails reboot the scanner to reset operating software.
- Contact UCD IRC tech support.



# Preserving the Shim

Preserving the shim allows you to use the current shim values if you do not want to create new shim values.

- Select the next series and click “Open”. Go to “Options”, “Adjustments”, and select “Interactive shim”.
- Click on “Apply”. The current value will be applied.
- Click on “Close”.
- Click on “Apply”.
- Verify that 3D shim does not appear in the lower left hand corner.
- The shim will be preserved.

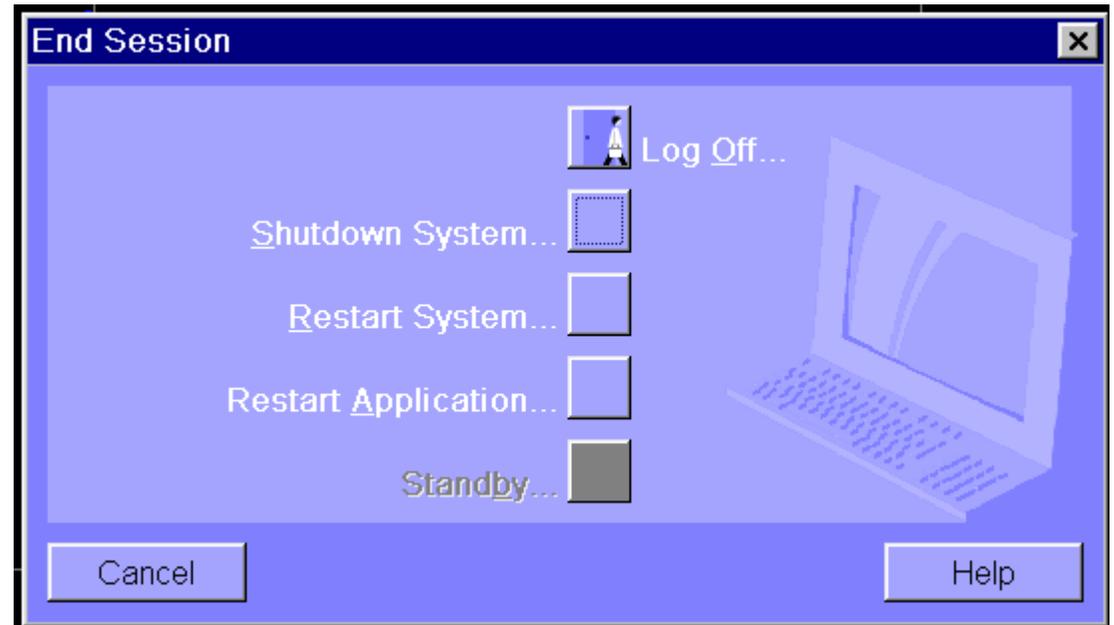


# Rebooting the scanner

Rebooting the scanner is the last resort to restore the normal functions of the scanner. Always check with one of the IRC tech support group before perform a reboot.

Normal rebooting (takes up to 20 minutes):

- Make sure the table is completely out.
- Go to “Options”, “Shutdown”. Click on the appropriate choices.
- Reboot procedure are found on the IRC web site under quicknotes.



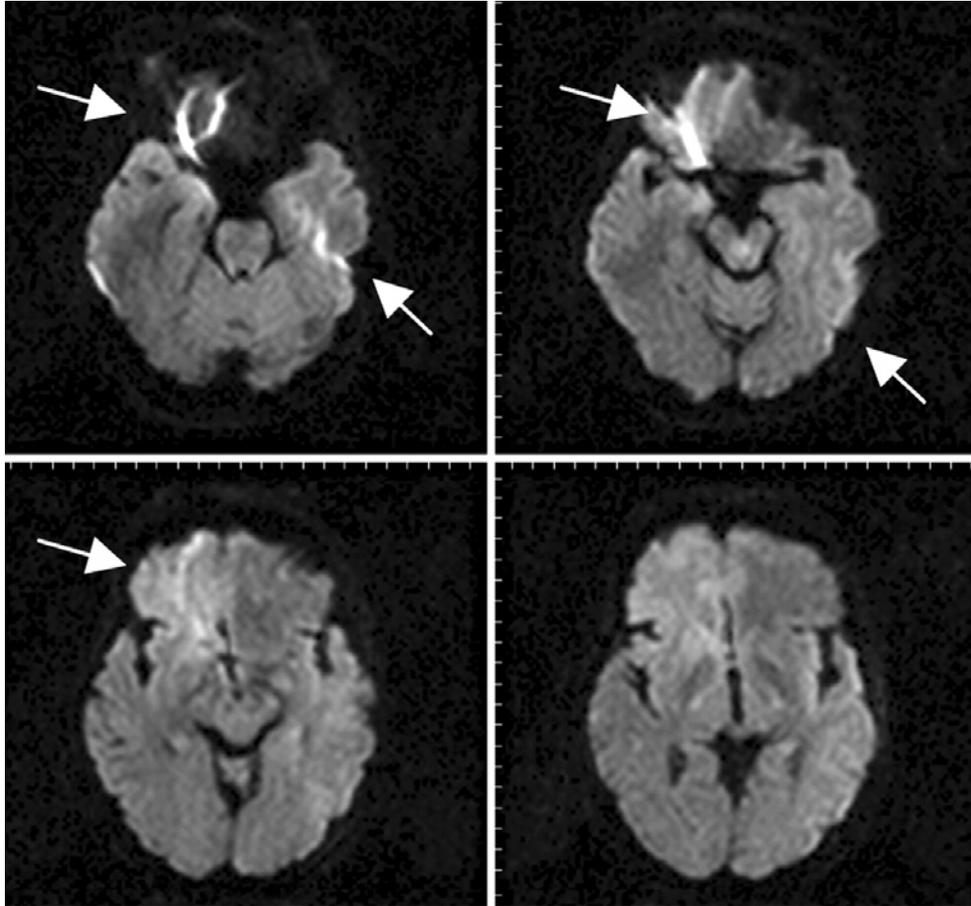
# Common MRI Artifacts

Causes and Corrections

# Introduction to MRI artifacts

MR imaging artifacts can be grouped into two general categories. First, there are artifacts that are hardware related. These artifacts are relatively uncommon—fortunately, because they are often difficult to diagnose and usually require service personnel to correct. The second category consists of artifacts related to the participant or under operator control. This category is encountered much more commonly and may often be easily prevented or corrected once they are recognized.

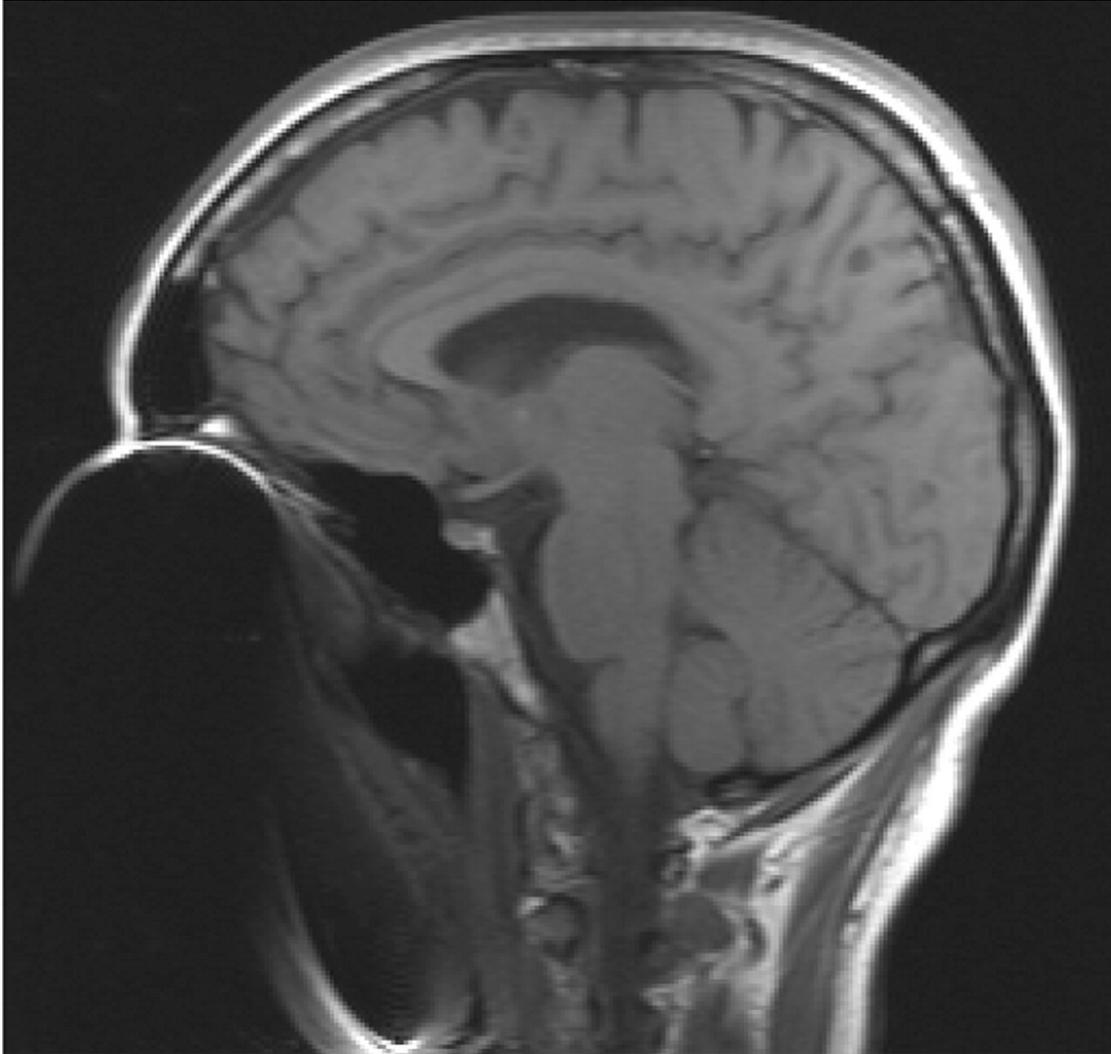
# Magnetic Susceptibility Artifact



Functional or BOLD images show magnetic susceptibility artifacts. Left-right phase encoding causes severe distortion of the signal (refer to arrows).

Correction: check phase encode direction, must be AP or PA for functional, DTI, or ASL sequences. This will minimize distortion.

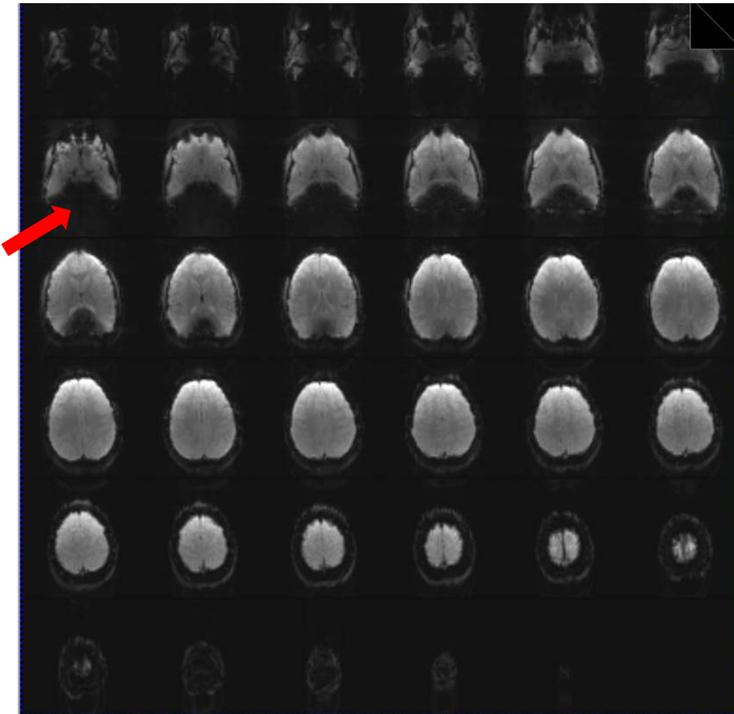
# Magnetic Susceptibility Artifact



Magnetic susceptibility artifact caused by braces, dental partials, or permanent retainers.

It is very difficult to compensate for this type of severe artifact. It is best to exclude participants with these types of dental hardware. The results have a high risk of unusable data.

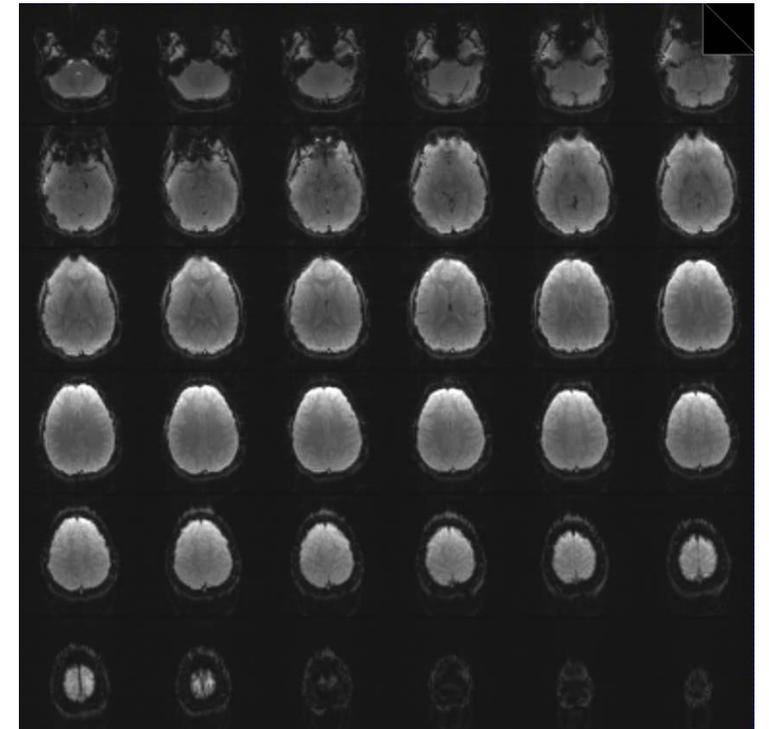
# Metal Artifacts



Safety pin in sweater.

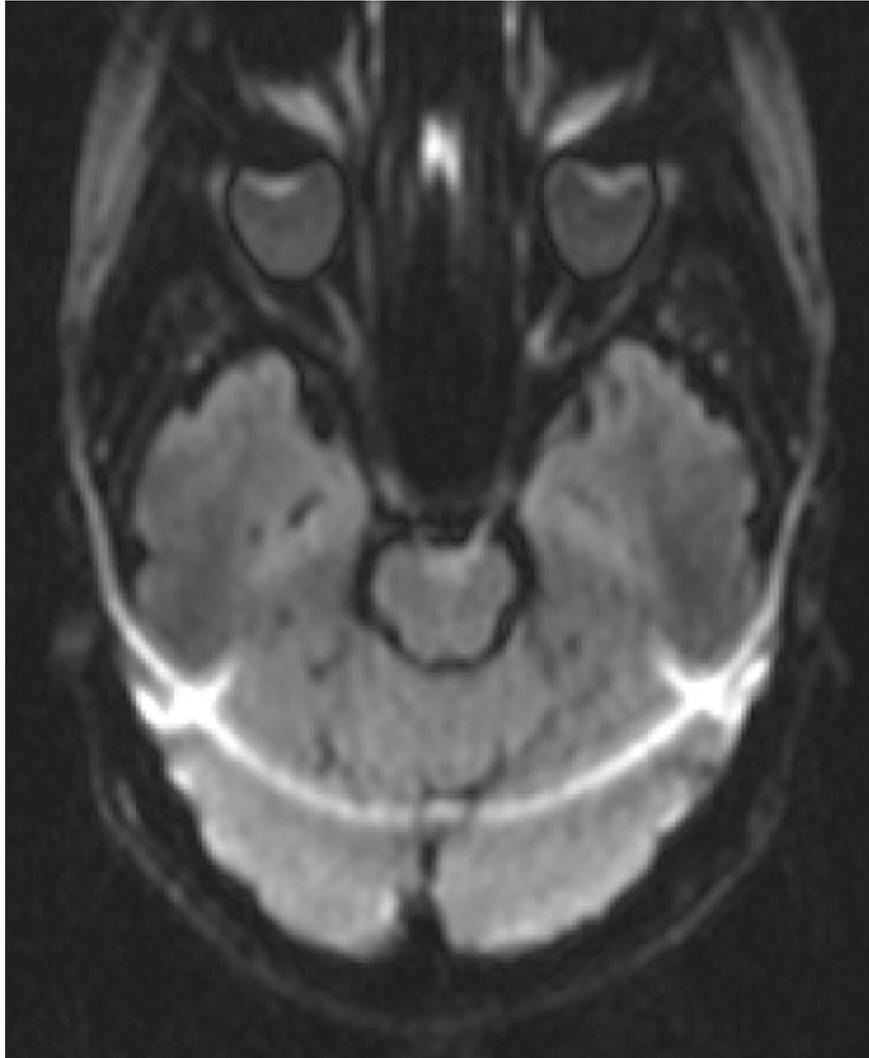
Participant thought they removed all their metal. The artifact was not obvious on the localizer and the MPRAGE. On the functional scan a loss of signal was noticed on the base of the brain but was OK toward the top of the brain.

Correction was made by removing a safety pin attached to the back of the sweater



Safety pin removed from sweater.

# Poor Suppression of Fat on Bold scans



Poor suppression of fat can cause severe chemical shift artifact. This may look like severe ghosting. This may be caused by a bad calibration, also known as “shimming”.

To correct the chemical shift artifact, invalidate the shim and start a new shim. Verify in the lower left corner during the shimming process that “3D shim” is posted. Remember to “invalidate the shim” before clicking apply if you reshim.

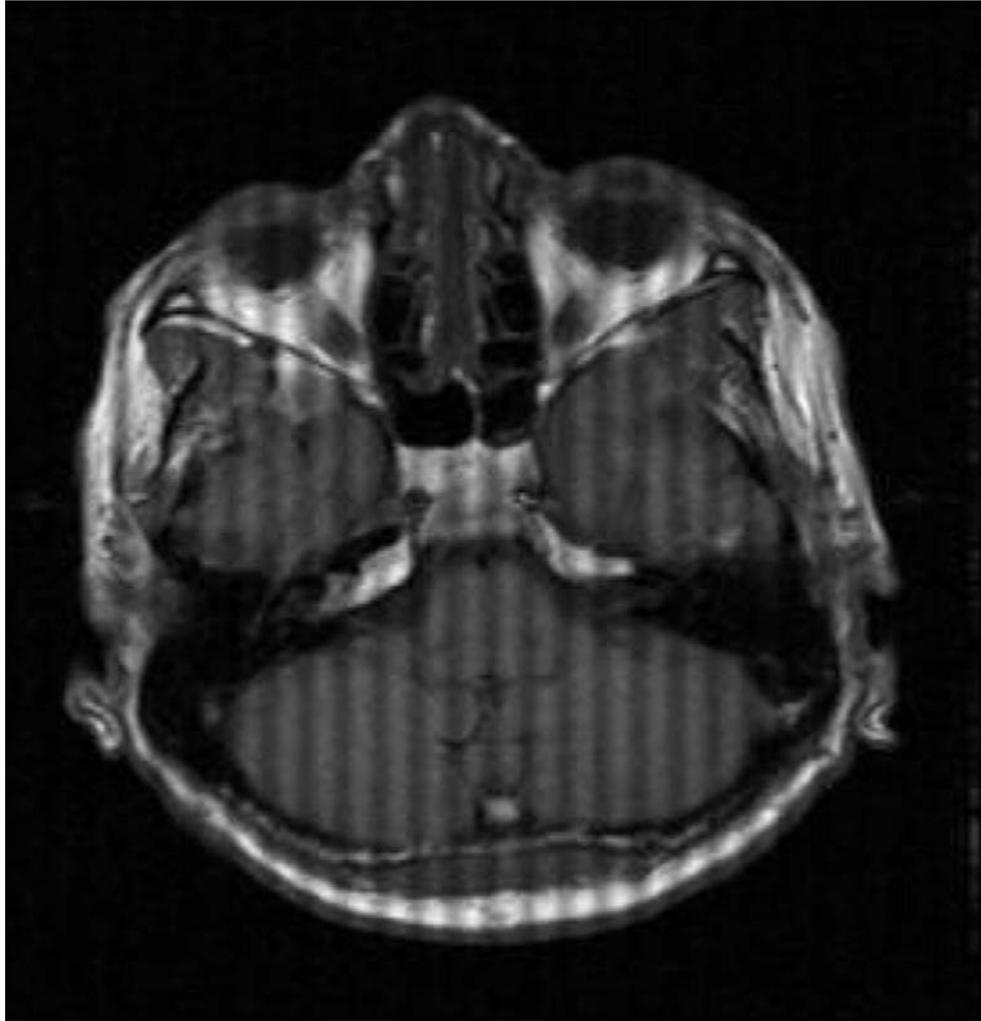
# Aliasing artifact



Aliasing artifact, also known as wrap-around, is a common MRI artifact that occurs when the field of view (FOV) is smaller than the body-part being imaged. The part of the head, in this image, lies beyond the edge of the FOV and is projected on the other side of the image. This commonly occurs in the phase encode direction.

This can be corrected by using a larger FOV. Please note that you should never change your FOV once you have finalized your protocol to avoid variations of signal to noise ratio across participants. If you have this type of artifact, consult with the IRC tech support personnel.

# Signal Spike Artifact



Bad data points in K-space result in band artifacts on the MRI image. The location of the bad data points, and their distance from the center of k-space, determine the angulation of the bands and the distance between them. The intensity of the spike determines the severity of the artifact.

This is a difficult artifact to resolve because it can be caused randomly. The electronic spike occurs during the gathering of K-space and may only occur on one image. This is commonly caused by hardware faults or electrical arcs in the MRI scan room. This type of artifact requires service from the manufacture.

If this artifact occur during you study, contact the IRC tech support.

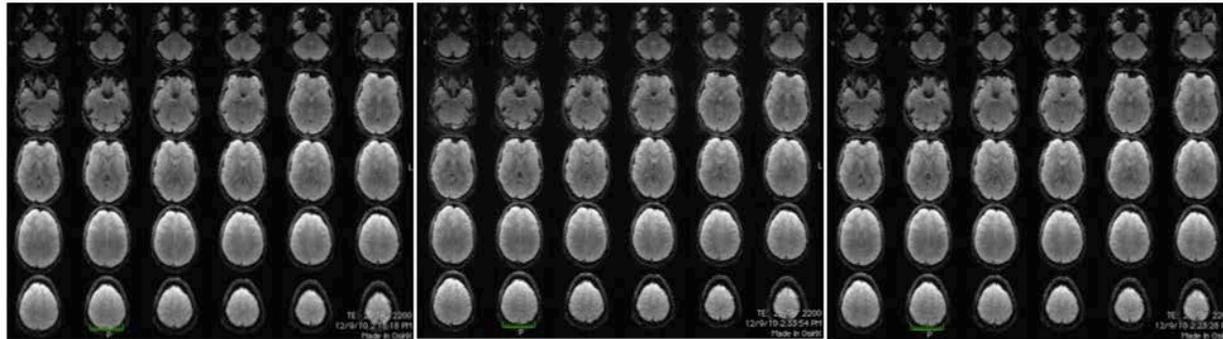
# RF Artifacts



RF artifacts are caused by external RF entering the scanner room from an unknown source, due to defects in the faraday shield. Also, this could be caused by equipment brought into the scan room that transmits an RF frequency received by the head coil.

To correct this type of artifact, first eliminate any equipment brought into the scan room. Then rescan and determine if this has resolved the artifact. If this does not resolve, contact the IRC tech support.

# Motion Artifacts with GRAPPA

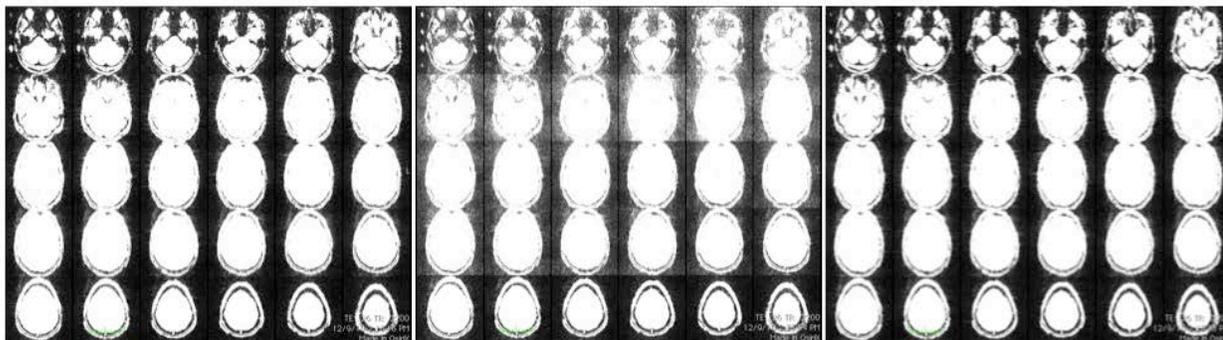


Low Motion

Motion during shimming

Motion after shimming

Background does not show significant changes in normal image brightness and contrast.



Low Motion

Motion during shimming

Motion after shimming

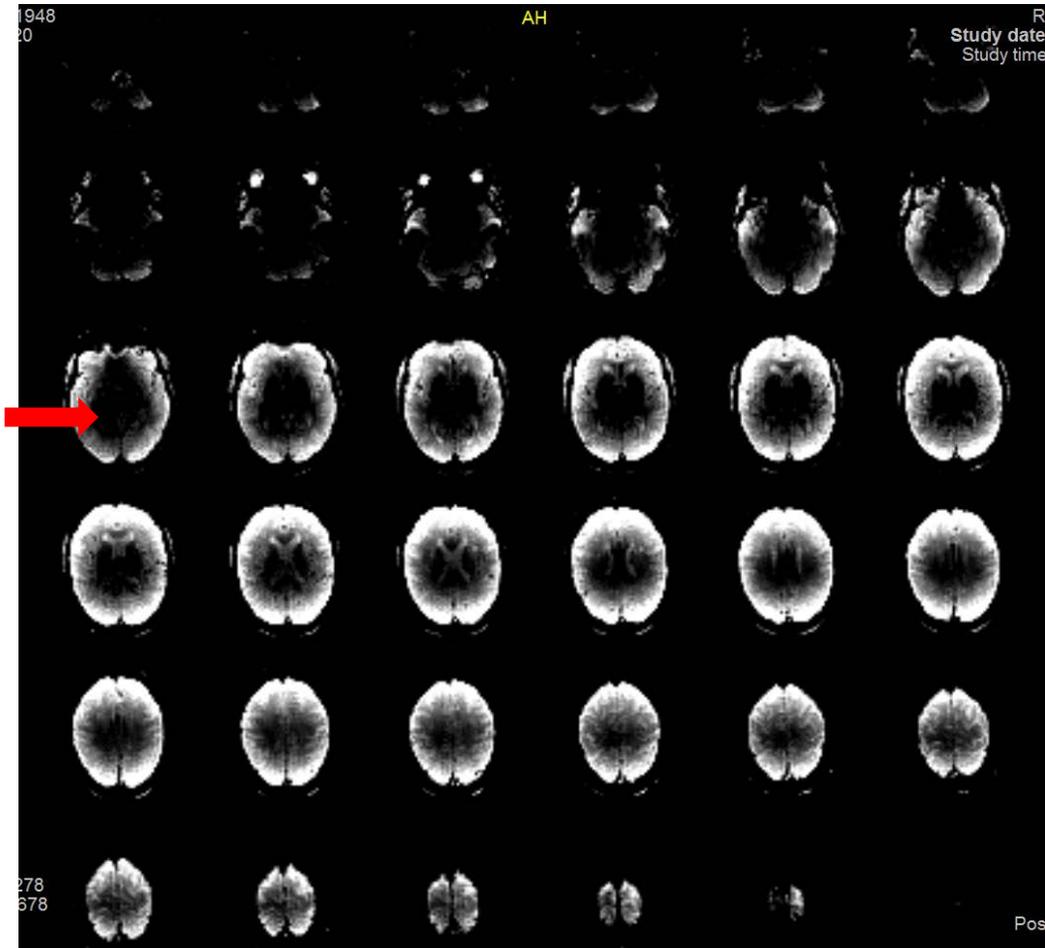
Background shows significant changes with high image contrast (same scan).

There are two parts to GRAPPA's motion sensitivity. The first is the effect of motion during the shimming of the scans. Movement during the shimming is a particularly bad thing because it corrupts the spatial information that isn't being encoded directly in k-space, thereby causing spatial artifacts that will carry through the entire time series. The second is motion during the actual data collection of the scans.

With the first case all functional scans will be bad because the shim is not accurate due to motion, even if the participant is still for the scan. The second case, as long as the participant does not move during the shimming, only the current series will be effective with motion artifacts.

The general consensus at UCD IRC is not to use GRAPPA on functional scan.

# Artifacts caused by Volume Shim

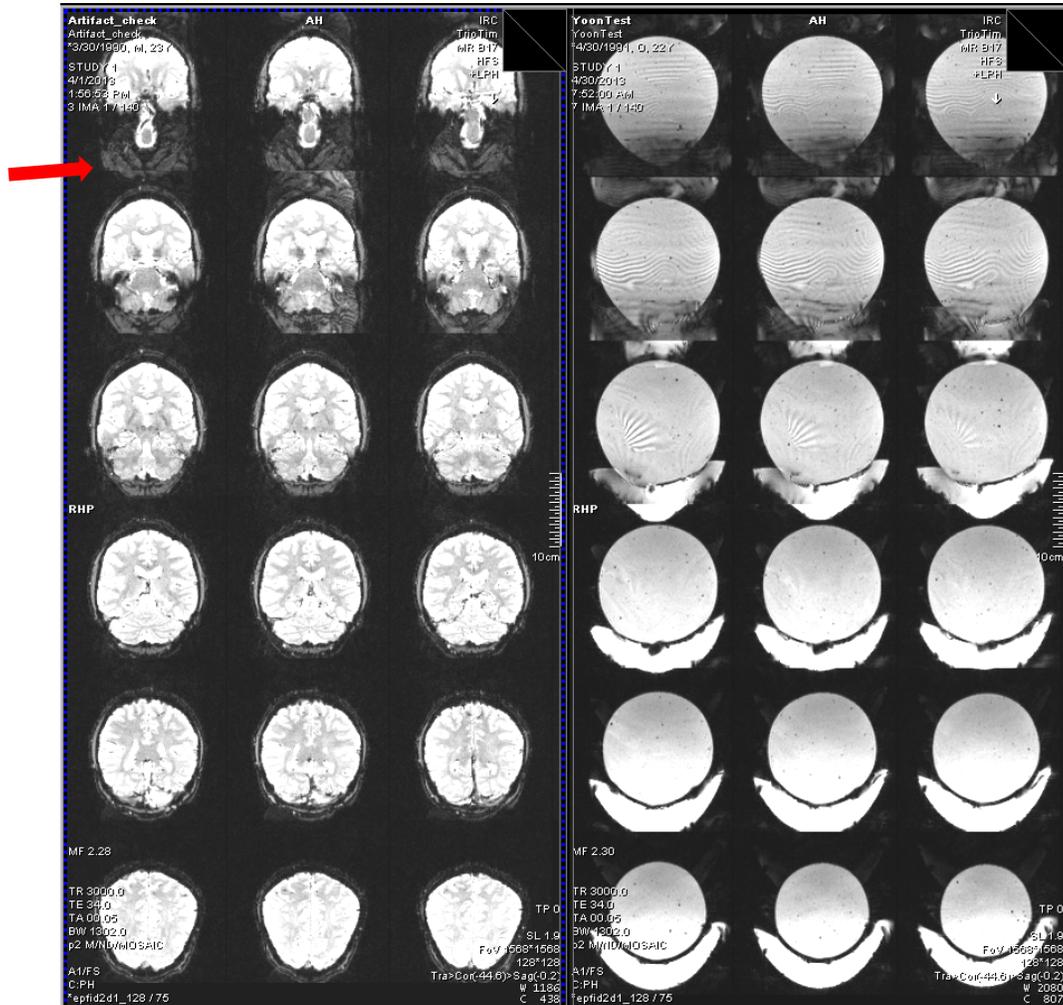


Volume shim artifact randomly appears when the volume shim (green box) is used. Signal quality is bad on some functional runs and on others it is fine within the same study.

The correction for this type of artifact is to invalidate current shim and reshim not using the volume shim. This seems to eliminate the signal loss.

If the problem persists, contact the UCD IRC tech support group.

# Ghosting Artifact due to slice position



Ghosting artifacts occurs only on a few images and the remainder looks good. This is caused by a few slice locations being excited outside the FOV creating only some slices having artifacts as seen on the right. This is duplicated on the phantom on the left.

To correct this artifact place the anatomy so all slice locations are within the FOV.