



**MGH/MIT/HMS Athinoula A. Martinos Center  
for Biomedical Imaging**

## **Policy & Procedures**

# **MRI Safety and Operations Training Manual**

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## Hazards of the MR Environment

"It is not possible to prove safety, one can only disprove it." --E. Kanal, 1996

Magnetic Resonance Imaging techniques (including spectroscopy, conventional, and fast imaging techniques) have been in use for over a decade, and are viewed as medical procedures associated with acceptable and well controlled risks. However, technological advances in MRI (higher static fields, faster gradients, stronger RF transmitters) have occurred rapidly and many questions regarding the safety of these developments remain unanswered. This document provides an introduction to some of the safety concerns associated with MR research. Other related pages address the practical implications of these safety issues.

- ✿ Static Magnetic Fields
- ✿ Projectiles
- ✿ Metal in the Body
- ✿ Gradient Magnetic Fields
- ✿ Nerve Stimulation
- ✿ Acoustic Noise
- ✿ Radiofrequency (RF) Electromagnetic Fields
- ✿ Tissue Heating
- ✿ Electrical Burns
- ✿ Other Concerns
- ✿ Pregnancy
- ✿ Additional Information
- ✿ Contact

### *Static Magnetic Fields*

**Projectiles** The most immediate danger associated with the magnet environment is the attraction between the magnet and ferromagnetic metal objects. Ferromagnetic metal objects can become airborne projectiles when placed in a strong magnetic field. The strength of the field increases superlinearly with distance from the magnet bore, and even hand-held objects can be jerked free very suddenly as the holder moves closer to the magnet. (Small objects, such as paper clips and hairpins, have a terminal velocity of 40 mph when pulled into a 1.5T magnet.) In addition to the possibility of severely injuring someone, it is not good for the

magnet to be bombarded with difficult to remove small metal missiles. Remember, even when you are not scanning, the magnet is not "off". NEVER bring any metal objects into the scanner rooms.

**Metal in the Body** Metallic objects in the body can also have dangerous effects when placed in a magnetic field, Ferromagnetic metal implants or fragments may twist or move causing internal injury. Even non-ferromagnetic metal (including metal on clothing) can heat up during scanning, causing burns or discomfort. Many of the Martinos Center's subject screening criteria are aimed at avoiding these hazards. In addition, metal in or near the body (such as dental implants) can produce artifacts, which adversely effect image quality.

### ***MRISafety Websites:***

If a subject or patient has any medical devices, you must get clearance from one of the NMR MRI Center Staff.

An excellent resource for checking the safety of medical devices is [www.mrisafety.com](http://www.mrisafety.com). Please note that some items that have been tested as "safe" at 1.5T are not necessarily safe at 3T or 7T. Unless it says specifically that something is safe at the higher field strengths, we assume that it isn't.

Also, most medical devices or implants can be looked up on the manufacturer's website. If you still are not sure, most companies have help lines you can contact

For other information regarding MRI safety- please go to:  
<http://www.radiology.upmc.edu/MRsafety>

### ***Gradient Magnetic Fields***

**Nerve Stimulation** Another concern in MR Imaging is related not to the strength of the static magnetic field, but to the transient

application of magnetic field gradients that can induce current in conductive materials, including biological tissue. The induced current is greater in peripheral tissue because the amplitude of the gradient is highest farther away from the magnet's isocenter. Mild skin sensations and involuntary muscle contractions, which are thought to be the result of direct neural stimulation, have been reported rarely during echoplanar imaging (EPI). Simply repositioning the subject in the scanner can usually alleviate this.

**Acoustic Noise** Another potentially hazardous effect related to gradient magnetic fields is the acoustic noise produced as current is passed through the gradient coils during image acquisition. For anatomical imaging, the noise is mostly of low frequency and has a "clunking" sound; for EPI, the noise can be of very high frequency (600-1400 Hz) and sounds like a loud "beep". Generally, the higher gradients used with higher magnetic fields and with EPI produce more intense noise. Prolonged exposure to this noise will damage the unprotected ear. (Even conventional scanning procedures, which are considered to produce noise within the recommended FDA safety guidelines, have been documented to cause reversible hearing loss in patients who did not wear ear protection). Therefore, all research subjects are to wear hearing protection in the form of earplugs or headphones during scanning (both are recommended on the 3T). Earplugs must be the right size and properly inserted into the ear canal to obtain their full effect. This requires instruction and practice. It is the responsibility of the researcher to see that the subject is aptly fitted with hearing protection. Additional packing of the head with foam cushions further dampens the noise and is recommended in the 3T environment. Additional noise in the magnet environment comes from the magnet coolant pump, air handling system and patient fan. While not dangerous, these other sources of noise can be annoying to subjects and can interfere with communication.

### **Radiofrequency (RF) Electromagnetic Fields**

**Tissue Heating** An RF pulse (a short burst of an electromagnetic wave originating from the RF coils) is used in MRI

to "excite" tissue protons by an exchange of energy. This absorption of RF energy can potentially cause heating of the tissue. Absorption of RF power by the tissue is described in terms of Specific Absorption Rate (SAR), which is expressed in Watts/kg. (In the US, the recommended SAR level for head imaging is 3.2 Watts/kg.) SAR in MRI is a function of many variables including pulse sequence and coil parameters and the weight of the region exposed. However, the actual increase in tissue temperature caused by exposure to RF radiation is dependent on the subjects thermoregulatory system (e.g. tissue perfusion, etc.). The risk of exposing subjects with compromised thermoregulatory function (e.g. elderly patients and patients taking medications that affect thermoregulation, such as calcium-blockers, beta-blockers, diuretics, or vasodilators) to MR procedures that require high SARs has not been assessed.

**Electrical Burns** RF fields can cause burns by producing electrical currents in conductive loops. When using equipment such as surface coils, ECG or EEG leads, the investigator must be extremely careful not to allow the wire or cable to form a conductive loop with itself or with the subject. Coupling of a transmitting coil to a receive coil may also cause severe burns.

**Other Concerns      Pregnancy** There are no known adverse effects of MRI on developing fetuses. Most early studies on pregnant animals were negative for teratogenic effects, and a recent survey found no association between working in the MR environment and a number of pregnancy outcome variables. However, given the scarcity of data on the subject and the high susceptibility of the developing fetus to damage in general, we believe it is not worth the risk for pregnant women to participate as subjects in MR research studies. Most clinical units allow pregnant employees to enter the scan room, but not to remain in the room while the RF and gradient fields are applied during image acquisition. Pregnant researchers at the Center will regulate their own exposure to the magnets. \*For references see Shellock and Kanal, 1996, Ch. 5 (see below).

**Contact** [Larry Wald](#), Director, NMR Core  
[Mary O'Hara](#), Operations Manager

## MR Suite Safety Rules

Any researcher who uses the research Bays is required to set up and clean up properly. If the area is untidy when you arrive, or if equipment has not been returned to its proper position or default state, notify [mri-time@nmr.mgh.harvard.edu](mailto:mri-time@nmr.mgh.harvard.edu). If you fail to notify, you could be held responsible.

### Set Up and Scanning

- ✿ Only qualified persons may operate the MR scanners. (Safety trained & CITI certified) Mary O'Hara runs the safety program and the CITI information can be found at <http://healthcare.partners.org/phsirb/aboutciti.htm>
- ✿ Two members of the research team must be present during scanning. During tech supported hours, the MR techs may be the second person. Off hours each group must have two investigators in the scanner bay.
- ✿ No one (including researchers and assistants) may enter the scanner room without signing a screening form initially.
- ✿ Subjects must sign the appropriate consent (given to the study rep. by the PI on a study by study basis) and screening forms before they are imaged. The consents must be closely reviewed by study rep to ensure that the subject meets the study's criteria (appropriate age, sex, physical health etc) and they are being scanned at the proper field strength.
- ✿ If there are any questions regarding a subject's compatibility with the magnetic field, one of the technical staff must be notified.
- ✿ Anyone entering the scanner room must first "de-metal" (empty pockets; remove jewelry, watches, wallets, beepers, hair clips; leave pens, clipboards etc. outside) and fill out the safety checklist located on the backs of the screening form. A copy of the signed consent, screening form and safety checklist must be left for each subject.
- ✿ Hearing protection (in the form of earplugs or headphones, or both) must be used when scanning all subjects.
- ✿ Double check wires on all equipment you use in the scanning room for loops that can cause serious electrical burns.
- ✿ The scanner bed will not support subjects weighing more than about 450 pounds.



- ⚙ Don't use paper clips or other small metal objects (staples, etc.) around scanner. They tend to land on the floor and find their way into the magnet room and into the magnet.

### *In Case of Emergency*

In the event that a subject becomes ill enough to require medical assistance please follow these instructions:

- ⚙ Step1: 1st scanner removes subject from magnet.
- ⚙ Step 2: While subject is being removed 2nd scanner calls 6-5400 and alerts MGH Police & Security who will initiate a call to Boston EMS.
- ⚙ Step3: Contact other support such as Nursing, Mary O'Hara R.T or Larry White R.T. Phone numbers are listed in each Bay by the wall phone.

### ***Clean Up***

- ⚙ Return all equipment to its labeled place on the shelves or in the drawers.
- ⚙ Place soiled linens in the laundry hamper in the magnet room.
- ⚙ Contaminated materials (excluding sharps) must be placed in the contaminated waste box in the magnet rooms.
- ⚙ All sharps are to be placed in the plastic sharps container located in the magnet room and on the wall outside the control room. Sharps are never to be placed in any wastebasket.

### ***Food and Drink***

- ⚙ No food or drinks are allowed in the magnet lab areas. The ONLY exception is that research subjects may have a drink of water prior to or immediately following an experiment.
- ⚙ Do not throw food wrappers of any kind in the wastebaskets.

### ***Proper Footwear and Dress Attire***

- ⚙ No open toed shoes, sandals or flip-flops are allowed in the scanning or prep areas
- ⚙ No short skirts/shorts/shirts allowed. Proper, professional dress is expected in the scanning and prep areas.

### ***Broken Equipment***

Report ALL broken equipment and equipment failures immediately to [mri-time@nmr.mgh.harvard.edu](mailto:mri-time@nmr.mgh.harvard.edu). It is understood that equipment in such constant use will occasionally break. You will not be held responsible (unless a pattern develops), but we cannot fix items unless we know they are broken.

### ***Assisting Subjects Onto The Scanner Bed***

The scanner bed can be lowered for elderly or sick patients. The Siemens scanner beds do not detach and thus cannot be brought outside the scanner room. Do not bring wheelchairs into the scanner room. If you will be scanning a wheelchair bound subject, ask the technical support for assistance. There is an MRI-compatible wheelchair in the Bay1 vicinity.

The scanner bed will not support patients weighing more than about 450 pounds.

**Contact** Mary O'Hara for more information.

## **Screening Subjects for MRI Compatibility**

Although MR research is safe for most volunteers, for certain subjects, MRI may pose unnecessary risk. Most contraindications that would rule out a subject involve metallic foreign bodies, however, there are several other concerns of which investigators should be aware. If any question exists regarding a subject's MR compatibility contact the technical staff or the subject must not be scanned.

### ***Screening and Consent Forms***

In addition to screening subjects thoroughly before scheduling them for MRI, everyone must fill out and sign all appropriate Consent and Screening Forms and safety checklists, prior to entering the magnet. Copies of all consents and screening forms are to be left for the Martinos Center. These copies will be checked for accuracy daily (proper subjects, magnet strength, expiration dates, etc) and checked on the PACs system to make sure there is consent for every subject and no identifiers were used.

### ***Conditions that Rule Out a Subject***

- ✿ Cardiac pacemaker
- ✿ Surgical aneurysm clips
- ✿ Neurostimulator
- ✿ Implanted pumps
- ✿ Metal fragments in body / eyes
- ✿ Pregnancy
- ✿ Nitroglycerin patch (rule out if subject cannot remove patch; foil may heat up)
- ✿ Colored contact lenses should not be worn in scanner
- ✿ Cochlear implants
- ✿ Weight >450 (also consider shoulder and chest size)

### ***Conditions that Might Rule Out a Subject\****

- ✿ Ear implants (tubes are fine/cochlear implants are not)
- ✿ Metal rods, plates or screws in body or mouth
- ✿ Injury to eyes involving metal (subject must have X-ray exam to rule out fragments)

- ✿ Previous surgery (if metal left in body\*)
- ✿ IUD (most are OK, check with [mrisafety.com](http://mrisafety.com))
- ✿ Hearing aid (should be removed before scanning)
- ✿ Dentures (should be removed before scanning)
- ✿ History of vestibular or inner ear abnormality such as Meniere's disease.

\*Check the list of magnet compatible and incompatible products published by Shellock and Kanal posted at each magnet bay and check with MR Technical staff.

- ✿ Prosthetic heart valve (get the name of the valve\*)
- ✿ Breast feeding (rule out if using Gadolinium)
- ✿ Braces (causes severe frontal artifact; rule out for EPI)
- ✿ Hair extensions (some are connected with wire, causes severe artifact)
- ✿ Tattoos or permanent eyeliner (if ink is metallic or tattoo is < 2 weeks old do not scan)
- ✿ All transdermal patches

### ***Other Screening Considerations***

- ✿ Claustrophobia
- ✿ Physical discomfort (body size, back or neck pain, etc.)
- ✿ Movement disorders (i.e. ticks, restless legs, etc., that may cause movement artifact)
- ✿ Vision / Hearing problems
- ✿ Problems using response devices

### ***Things Not to Bring or Wear in the Scanner***

- ✿ ANYTHING in your pockets
- ✿ Metal jewelry (face and body piercing items should be removed if possible)
- ✿ Watches
- ✿ Hair holders
- ✿ Eye glasses
- ✿ Metal on clothing (i.e. metal buttons, snaps or trimming, under wire bras, belt buckles)
- ✿ Eye shadow (many contain metallic specks that can heat up)

- ⚙ Colored contact lenses (remind subject to bring a case to store contacts in during scanning)

### ***Equipment Not provided by the Martinos Center***

The technical staff before use MUST approve any equipment that will go into the magnet room but is not provided by the center. The equipment will be checked for

- Safety (is it made of nonferrous materials)
- Cabling (will the electrical source cause rf artifacts in the images)

Once the equipment has been deemed usable in the MR environment, it will have a neon yellow label with black lettering saying it is so. Anyone caught using outside equipment in the MR environment that has not been properly tested will forfeit his or her scan time for 1 month. A second violation will lead to permanent loss of scanning privileges at the center.

### ***For More Information***

If you have any doubts whether a subject is magnet compatible, do not scan. Contact the technical staff @mri-time@nmr.mgh.harvard.edu

For additional MR safety information visit the [MR Safety Website](#)

## **MR SYSTEM OPERATION AND SAFETY TRAINING**

EVERYONE INVOLVED IN RUNNING AN EXPERIMENT ON OR AROUND THE LARGE AND SMALL BORE RESEARCH MAGNETS IS REQUIRED TO VIEW THE MAGNET ENVIRONMENT SAFETY VIDEO and ATTEND THE SAFETY AND TRAINING LECTURES.

Mary O'Hara will hold training sessions as needed. Notifications of these training sessions will be announced via email on the smsscan list.

If you have not done so already- please sign up for the SMS Scan list to get scanning updates. Go to:

<https://mail.nmr.mgh.harvard.edu/mailman/listinfo/smsscan> and fill in the info requested.

Our training system consists of three levels,

**1) White =Safety**

**2) Yellow = In Training (for all areas)**

**3a) Green = Certified Scanner for human scanning on Bays 2, 3, 4, 5**

**3b) Dark Blue = Certified Scanner for Animal scanning on the Small Bore scanners and Bays 2, 3, 3**

**3c) Light blue = Certified user of the surgical prep room**

The descriptions of each role are below. We have developed this system so we can better keep track of what level each person is at in his or her training, as well as to ensure that each person has received the proper training to work around a MRI scanner.

**\*\*\*If you do not have a badge, you should not be in the scanning bays or prep rooms\*\*\***

Badges usually take up to 3-4 business days to make. Larry White will send out an email to the smsscan list notifying you that your badge is ready. Badges may be picked up in Mary O'Hara's office, room 110D in the back and to the right of bay1.

The Technical staff reserves the right to refuse anyone permission to operate the magnets.

## ***I. Description of Training Levels***

## ***II. Training Program Contents***

## ***III. Evaluation and Certification Procedure***

## ***IV. Center Record Keeping***

### ***I. Descriptions of Training Levels***

White = Safety: This is a person who is present during the scan and is available to get help or to assist in the case of an emergency. This person does NOT assist with the set up of the subject or run the scanner or any of the equipment (this includes stimulus equipment). With this white SAFETY badge, the person is allowed to sit in the scanning area for emergency purposes ONLY under the supervision of a person at the Certified Level Status (See Manual for further details).

Training requirements to obtain a white SAFETY badge include:

Step 1: Watch the safety video (~40 minutes)

Step 2: Take and pass the Safety Training Video Test (passing score is an 7 out of 9 (~5-10 minutes)

Step 3: Attend the 1<sup>st</sup> half of Mary's Lecture (the safety portion) (~30 minutes).

*Altogether this training session takes approximately 1.5 hours*

Yellow = In Training: This is a person who is present during the scan session and is in training to learn the finer details of running the scanner. This yellow, "In Training" badge allows the person to assist with the setup of the subject in the magnet room, setup and run the stimulus and scanner equipment, and to assist in an emergency under the supervision of a person at the Certified Level status (See Manual for further details).

Training requirements to obtain a yellow IN TRAINING badge include:

Step 1: Watch the safety video (~40 minutes)

Step 2: Take and pass the Safety Training Video Test (passing score is an 7 out of 9 (~5-10 minutes)

Step 3: Attend the 1<sup>st</sup> half of Mary's Lecture (the safety portion) (~30 minutes).

Step 4: Attend the 2<sup>nd</sup> half of Mary's Lecture (the scanner/console training portion (~40 minutes)

*Altogether this training session takes approximately 2+ hours.*

- 3 a) Green = Certified Scanner for the regular bays
- b) Dark Blue = Small Bore Scanners\*\*
- c) Light blue = for the surgical prep room\*\*

This person has completed steps 1-4 of the initial training and has been scanning at the lab for 4 months, becoming proficient in scanning and MRI safety (see list on last page of packet for check off list of items each person should be able to do for either A, B or C above). For someone who is training for the regular scanning bays (Bays, 2,3, 4,5, 6), human or nonhuman and feel like he/she is proficient with everything on the check off list, then they are to email [nri-time@nmr.mg.harvard.edu](mailto:nri-time@nmr.mg.harvard.edu) to set up an appointment with Mary or Larry. One of them will then observe you during a scan session with a real subject to determine your qualification to become a "Certified Scanner".

\*\*If you are training to work the Small Bore Scanners or in the Surgical Prep Room- you need to speak with George Dai ([dai@nmr.mgh.harvard.edu](mailto:dai@nmr.mgh.harvard.edu)) or John Moore ([john@nmr.mgh.harvard.edu](mailto:john@nmr.mgh.harvard.edu)), respectively, to set up appointments to be signed off.

## **II. Training Program Contents**

### **Magnet Safety**

- ⚙ Safety video
- ⚙ Emergency Procedures
- ⚙ Stop scan buttons
- ⚙ Calling for help (when to call MGH Police & Security)
- ⚙ Getting the subject out of the magnet
- ⚙ Scanning after hours (check in with security)
- ⚙ Adverse event reporting
- ⚙ Scanner Bay Orientation
- ⚙ Rules for equipment use
- ⚙ Getting clearance for equipment not provided by the center
- ⚙ Reporting equipment problems
- ⚙ Where to find; coils, linens, supplies
- ⚙ How to use; coils, linens, supplies



- ⚙ Subject Preparation
- ⚙ Informed consent
- ⚙ MR screening
- ⚙ Demetaling
- ⚙ Hearing protection
- ⚙ Registration of subjects without identifiers
- ⚙ Positioning in magnet and landmarking
- ⚙ Bite bar and head restraint use
- ⚙ Squeeze ball

### ***Using the Testing Equipment***

- ⚙ Computers
- ⚙ Audio
- ⚙ Video
- ⚙ Response box
- ⚙ Physiological monitoring

### ***Operating the Magnet***

- ⚙ Login/Logout
- ⚙ Scanning
- ⚙ Archiving and Retrieving Data
- ⚙ Discovery of a potential physical abnormality

### ***Handouts***

- ⚙ Safety Rules for the Magnet Environment
- ⚙ Safety Hazards
- ⚙ Magnet Operation Standard Brain Mapping Protocols
- ⚙ Martinos Center Policies and Procedures for Human Subjects
- ⚙ MR Compatibility Screening
- ⚙ Investigator's Responsibilities reading list

### ***III. Evaluation and Certification Procedure***

- ⚙ View Safety Video
- ⚙ Complete Training
- ⚙ Scan a subject or phantom with technical staff member ("qualifying exam")

#### ***IV. Center Record Keeping***

The Martinos Center will keep records of all investigators certified to operate scanners including:

- ✿ Date safety video viewed
- ✿ Date training course completed, trainer
- ✿ Date of qualifying scan session
- ✿ Date of CITI renewal

## **EMERGENCY INFORMATION FOR MR SCANNERS**

### ***Emergency Phone Numbers***

\* In case of emergency call:

MGH CNY Security: **617-726-5400**

Tell them your emergency and exact location. They will activate the Boston EMS if needed.

BAY 1: 617-724-6189

BAY 2: 617-726-5713

BAY 3: 617-726-5818

BAY 4: 617-724-8844

Bay 5: 617-724-8840

Bay 6: 617-643-4884

Bay 8: 617-643-4892

Mary O'Hara, Operations Manager: 617-724-9539 (office)  
617-448-4013 (cell)

Larry White 617 -726-5716 (office)  
617-913-5207 (cell)

### ***Incident Reporting***

In the rare event that a subject reports any untoward or unexpected reaction to the scan (e.g. painful cutaneous sensation, nausea, etc.) the experiment is to be terminated and the incident reported to the Operations Manager, Mary O'Hara. Adverse events should also be reported to the Partners IRB using the Adverse Events reporting forms provided by the Human Research Committee. A copy of all Adverse Events reports should be submitted to Mary O'Hara.

**Contact** [Mary O'Hara](#)

### ***MRISafety Website:***

If a subject or patient has any medical devices, you must get clearance from one of the NMR MRI Center Staff. To see more info on medical devices and their MRI compatibility, please go to:

<http://www.mrisafety.com>

For other information regarding MRI safety- please go to:

<http://www.radiology.upmc.edu/MRafety>

## Running Protocols

### *Tips for Scanning on the Siemens Sonata & Trio Scanners*

- *Registration*
- *Scanning*
- *Printing The Slice Prescription*
- *Making A CD & Sending Data To The DICOM Server*
- *Trouble Shooting*
- *Resetting the Table*

#### **Registration:**

- 1) There are four tabs along the right hand side of the screen: EXAM, VIEW, FILMING, and 3D.
- 2) You want to select the EXAM card to start your study.
- 3) Next, in the patient pull down menu (top rt. hand corner) select registration. There is also a key in the right hand corner that has a small man and a keyboard on it. Hitting this will also bring up the registration. A form will appear and you need to fill in all the boxes that have bold writing. Remember, no identifiers (names, DOBs, hospital #s etc,) can be used in research studies. A study code must be used for the name and the MR system will give it a number. The system asks for a DOB so we use 1/1 and the true year of birth. This is so a radiologist can give an accurate assessment if asked to look at images for a possible abnormality. For the study, press the arrow and click on INVESTIGATORS, then select your name or the name of the PI. For the generic protocol select MGH the FMRI.
- 4) For patient position press the arrow and select the first option. Head first, supine.
- 5) Although they are not mandatory for scanning you need to enter the PIs name in the physician box and your name or initials in the operators box.

- 6) When info is correct hit the exam button. Another window will appear checking that you info is correct. If it is, hit confirm.

**Scanning:**

- 1) On the lower right half of the screen all of the sequences within the protocol will appear. To actually scan you must move them over to the lower left.
- 2) The first sequence is always a localizer, followed by the Auto Align (AA) localizer. Highlight these sequences and then click the double arrow (<<) to move it over to the left. You can see that these localizers do not have the small man icon beside them, as the others below it have. Once they are moved they will automatically run. All of the parameters have been pre-programmed. When scanning is complete a sagittal, axial, and coronal image will appear in the 3 upper segment of the screen.
- 3) If you use the AA scout, once you move the next sequence (3dflat) to the left hand side and open it by either double clicking on it or hitting the open button the sequence will open properly positioned to the brain. However, if you do not use the AA scout, bring over the 3d mprage sequence. Either double click on the sequence or hit open once you have move it to the left side of the screen. This sequence will not run until you position your volume. The yellow box represents the area to be scanned. This needs to be centered in all 3 planes. Also make sure all of the anatomy fall within the box. Anatomy cut off (such as the nose) can wrap and end up in the occipital lobe. Move the box via the circle in the center. Grabbing any of the sides can change the FOV (it has to be 256X100%) or the slice thickness. If you need to rotate the volume, move the cursor down over the centerline until you see a double arrow. Hold the right mouse down on this to rotate.
- 4) You can also adjust the shim. The icon of a head with pink lines is for the toolbox, Click the icon and select the second from the right on the bottom row. This will activate a green

box s you may tighten the shim around the brain. The center circle centers the box. The diamonds on the side make it smaller or larger and if you put the cursor over one of the sides a circular arrow appears and you can now angle the box. When every thing is set, double check to see that you are scanning with the head coil. On the bottom right of the screen it should show HA & HP, if it shows BC go to the system tab and change it. If there is no option but BC your head coil is not plugged in. Once you know your coils are correct hit apply and the scan will start.

- 5) To run a second (and possibly a third) 3d mprage when using AA simply bring another one over from the right open it and apply. If you are manually setting the scans, click on the flat that's running with the right mouse and a menu appears. Select append from that menu. It will copy everything from the scan that's running. However you will notice there is a small workman to the left of the sequence. A scan will not run with him there. You have to open the sequence (double click or hit open), an option of automatic or manual shim will appear. Choose manual so it will copy the adjusted shim from the scan that's running then hit apply. When the first scan ends the second will start automatically.
- 6) When the first mprage has completed reconstruction an icon of a head in profile will appear. Drag the icon with the left mouse into the window that has the sagittal scout. The center slice of this series will appear. Use the dog-ears in the right corner to go forward and back in the series until you find the best slice. Also, go through the entire series to check for motion or possible abnormalities. If you see an abnormality call Mary or Larry, if not continue on. If AA was used, all sequences can be brought over to the left hand side of the page, opened by double clicking on the sequence or hitting open (slices automatically are centered) then hitting apply. If manually setting up your slice prescriptions follow below.
- 7) Bring over the t1w epi sequence. Open the sequence and align the slices. Center dot moves the stack; double arrows

allow you to change the angle. Again, stay away from the edges so the FOV and slice thickness does not change. Hit apply when positioned properly.

- 8) Bring over the t2s and open them. With the right mouse highlight the t1w epi and select copy parameters from the menu. From the list of parameters you want the second option, slices & sat parameters. Now the t2s are in the same location as the t1s and you can hit apply. Do the same for the field map if you run that sequence.
  
- 9) Bring over the functionals. Before you open them, highlight with the right mouse and select properties (the last choice on the menu). Choose properties from the top menu. Click the wait for users to start box and the repeat measurement circle if you intend to do multiple runs with the same parameters. Close the window. (Mary can set this in the protocol for you, if you let her know when she is making it.) Now open the functionals and copy the t1s just as you did for the t2s and field map. Once you have the slices all set you need to set the # measurements. (Again, this can be built into the protocol). On the bold tab (the 2<sup>nd</sup> to last tab) you can enter the # of measurements needed to run your paradigm. Remember that the time reflects the 4 dummies scans so, deduct 4x the tr from the time of the scan to start the paradigm. We recommend that you use the trigger which sends a ttl pulse from the scanner to your laptop in the form of an equal sign that starts your paradigm. Because you have the wait for user to start on, a window will appear click continue when you have every thing ready to go. When the scan is complete this window will reappear (the repeat measurement you put on in the beginning), hit continue when you are ready to go again. Hit skip when you have completed the entire run.
  
- 10) If you want more runs with the same slice prescription but a different tr or # of measurements, highlight the functionals with the right mouse, append, open, make the changes and apply.

### ***Using the Squeeze-Ball to Signal an Emergency***

The squeeze ball is a small hand-held device that when squeezed by a subject in the magnet, produces a sound that can be heard by the magnet operator. While in the magnet, subjects should have the squeeze-ball in an easily accessible location. In case of an emergency during scanning (when scanner noise may prevent the operator from hearing the subject), the squeeze-ball can be used to signal the operator to stop scanning.

### ***Emergency STOP Scan***

Stop the Scanner - To stop a scan quickly, either click **Stop on the console** or hit the **red Stop Scan** button on the top of the speaker control box. Be sure you and your assistants know the location of these buttons.

(Note: There is an additional emergency button in front of the console by the projector window that shuts down the whole system. Use this only when absolutely necessary. With this shut-down method, scanning cannot resume for ~10 ten minutes.)

### ***Printing The Slice Prescription:***

- 1) Make the sagittal with the slice prescription the active window by clicking on it. A blue box will appear around it.
- 2) Hit the button in the lower right hand corner of the keyboard that look like a sheet of film. This will send the active image to the filming page.
- 3) Go to the filming page, a tab on the right of the screen. The image will be in the upper left hand corner of the page. Click the edge of the film border, (multiple blue boxes will appear) then click the layout tab on the lower right and choose the single image layout. It should now be large.
- 4) Go to the camera tab and make sure that the setting is for the laser printer and the normal setting (not inverted.).



- 5) Click the icon that looks like a printer with a sheet of film coming out of it; this is the printer. The image comes out of the paper printer. Film printing can only be done on bay2 and should only be done if a subject had an incidental finding.

### ***Making A CD & Sending Data To The DICOM Server:***

- 1) Label a CD and put it in the top draw of the burner. Make sure you do not hit the round silver button. This shuts off the computer, it does not open the cd-rom. There is a small black button below the draw that opens it.
- 2) Highlight your study from the browser. The browser can be activated through the patient pull down menu or by hitting the button in the lower right hand corner that has a folder tree file on it. Highlight your subject up to but not including any of the series. Go to transfer pull down menu select export to CD-R.
- 3) Next a window appears asking you to label the CD. There is also a check box that you can click if you want the viewing options from the system on the CD. A CD icon (a CD with a red ball on it) will appear on the bottom of the screen. When the icon is gone, the burning is complete.
- 4) Go back to the transfer menu, select send to Bourget. Your study will now go to the server. Go back to the transfer menu and select local job status to make sure the cd transfer is working or select network job status to make sure the dicom transfer is working.

### ***TROUBLE SHOOTING:***

- 1) Got to the system pull down menu from the top of the scanner page and select control. There are 4 tabs on the top. You need to look at the image recon and mr scanner

options. If all is well they will have green checks and/or an indication that component is running. If there any red x's select the reboot option and wait about 5 minutes.

- 2) If rebooting does not work from system/control menu, take the table all the way out and unplug any coils you are using. Now go to the system pull down menu, select system end session and then check the restart system box. This should take about 10 minutes for the system to go down then restart.
- 3) If system restart does not work as indicated by red x's still on the system/control tabs, you will need to power cycle the system. Hold the CPU power button in until the CPU shuts off. Wait 10-15 seconds and then press the power button in until the system starts again. This will take about 20 minutes for the RFPA to completely restart.
- 4) A message stating contact you service rep, finding occurred will appear; just click ok. You do not need to write this in the book or contact me. Gunjan (Siemens service rep) checks the logs regularly. If all goes well, you will hear 3 beeps in about 5-7minutes in the 1.5 scanner but, it takes 20 minutes for the 3T systems. The satellite consoles will also need to be re-started by going to system/end session and choosing the restart system option.
- 5) If the system is still not functional at this point, you will need to contact Mary or Larry.

### ***RESETTING THE TABLE:***

A common mistake people make is hitting the red button (located on top of the intercom box & on the bore of the magnet) while reaching for something. This not only stops whatever scan is running, it also releases the table and it will not scan. You will know you have done this if the lights on the bore of the magnet are flashing. To reset the table simply hit the table up button, the down button and then the up again. You will hear a click when the table

resets. Now, just relandmark your subject and continue to scan.

## **STANDARD BRAIN MAPPING IMAGE PARAMETERS 1.5T and 3T**

Go to:

<https://nmr.mgh.harvard.edu/martinos/userInfo/safety/parameters15T.php>

And:

<https://nmr.mgh.harvard.edu/martinos/userInfo/safety/parameters3T.php>

## **SUPPLIES PROVIDED AT LARGE BORE MAGNETS**

The Martinos Center supplies these items in the research magnet bays for use during scanning experiments. Individual research groups must provide additional study specific items. If you notice that supplies are running low, please email [Mary Foley](#)

- ✿ ALCOHOL PREPS
- ✿ BLEACH
- ✿ BLUE CAPS
- ✿ BUTTERFLY NEEDLES & ANGIO CATHS
- ✿ CD'S
- ✿ EAR PLUGS
- ✿ EKG LEADS
- ✿ GLOVES
- ✿ LINENS
- ✿ POWER INJECTOR SYRINGES
- ✿ SALINE
- ✿ SYRINGES
- ✿ TAPE
- ✿ VITAMINE E CAPSULES
- ✿ 4 X 4S

## **Using the physiological monitoring systems**

Investigators interested in using the physiological monitors, INVIVO or AD Instruments (in any bay) or the AVOTECH Headphones in Bay4 **must** submit their protocol to the CRC. For assistance or more information, contact [Randy Gollub](#), or go the CRC Biomedical Imaging Core office on the 2nd floor of Building 149 and talk with Kashawna Harley at the front desk.

### ***Best Practices for use of monitoring systems***

- 1) Scheduling for use will be exclusively by requesting use of the In Vivo system when signing up for scan time. A specific check box for this is on the web based request form. The Martinos Center staff will be responsible for ensuring that the 3150 system is not double booked in Bays 4 and 5.
- 2) Placement of the In Vivo 3150 unit in Bay 4 and Bay 5 will be restricted to behind the blue taped lines on the floor (away from the scanner) that indicate a safety zone for the equipment.
- 3) CRC staff (nurse practitioners) will be trained in the use of the equipment and for GCRC approved protocols they will be responsible for the patient set up, data recording and post-study clean up of the physiological monitoring systems. For studies conducted in Bay 4, they will also be responsible for copying the collected information from the acquisition computer to CDs and giving them to the investigators.
- 4) CRC will provide all disposable physiological monitoring supplies for CRC approved users.
- 5) All human studies that include physiological monitoring will be conducted with appropriate IRB approval for these practices.
- 6) All users must agree to follow the rules for use of the Martinos/CRC physiological monitoring systems for either animal or human studies as appropriate.
- 7) All animal studies (pig, monkey, etc) will be conducted with appropriate SRAC approvals that include screening of animals for contagious diseases, methods for sanitizing unit before and after use.

- 8) This policy statement will be posted on the CRC BIC website, the NMR Center website and a printed copy of it will be attached to each of the physiological monitoring systems.
- 9) In Service training sessions for the In Vivo system can be scheduled by any investigator wishing to use the unit independently by contacting Michael Orlandella (1-800-331-3220 x203).
- 10) The physiological monitoring system in Bays 4 & 5 allow digital acquisition of the recorded signals.

Current capabilities for physiological monitoring in all Bays include: ECG, EtCO<sub>2</sub>, SaO<sub>2</sub>. In Bays 4 and 5 the system can also record invasive blood pressure and anesthetic gases. In Bay 2 the system can record trigger pulses from the scanner, skin temperature, galvanic skin response, respiratory measures (e.g. tidal volume), and other investigator supplied analog or digital signals.

## **14T Spectrometer Users Information page**

Go to:

<http://www.nmr.mgh.harvard.edu/%7Ejerry/brukerinfo.htm>



**Certified to Scan Check-off List:**

Person Being Observed: \_\_\_\_\_

Person Observing: \_\_\_\_\_

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Number of times observed: \_\_\_\_\_

Person has yellow badge to turn in? Yes NO

	Satisfactory	Unsatisfactory
<b>Setting up the scanning room</b>		
Prepped table with Linens		
Provided covered pillow		
Tested Button Box		
Know how to turn on projector		
<b>Communication with/consenting the subject:</b>		
Subject signed consent form*		
Subject completed screening form		
*If subject has already been scanned, checked off "rescan" on screening form and filled in protocol inform.		
<b>Putting the subject in the Scanner:</b>		
Check that subject has gone to the bathroom		
Check subject for metal before entering room		
Provided earplugs		
Made sure the subject was comfortable (knee cushion, blanket, etc)		
Adjusted Mirror		
Mad sure they can see the screen		
Gave instructions on the squeeze ball		
<b>Work the headcoil and table properly:</b>		
Connect headcoil		
Padded subject		
Move table up and down		
Landmark in proper spot		
Send the subject in properly		
<b>In the console room:</b>		
Registered subject (includes knowing no identifiers are to be used)		
Spoke with the subject ASAP (esp. right before starting localizer)		
Know to wait for AA recon		
Started all the scans properly		
Know how to convert body coil back to head coil		
Know how to transfer data via Bourget		
Know how to burn cd		
Know how to print		
Know how to start stim. Program		
Know when to turn on trigger (after the first 'continue' screen appears)		
Spoke to subject consistently between scans		
Worked in a timely manner		
Knows who can and cannot be in the scanning room/console room during the session		

MRI Safety and Operations Training Manual

Knows which forms people need to fill out if they're going into the scanning room and are not being scanned		
<b>Safety:</b>		
Know what all the red buttons mean		
What to do if the subject squeezes the ball unexpectedly during the session		
Know you always need 2 people there to scan (esp. after hours and on the weekend)		
<b>Other:</b>		
Know when to log into the account system (i.e. when the group first gets there and starts occupying the room)		
Know what can and cannot go into the biohazard boxes		
Know what forms to copy for LTW		
Know where to put the forms		
Know when to hand in the forms		
<b>Troubleshooting:</b>		
Know where to look for error messages		
Know how to check and reboot the mr scanner or reconstruction system		
Know how to shutdown the entire system		
<b>Confidence Level:</b>		

Notes: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Certified to Scan?

Yes  No

\_\_\_\_\_  
Signature of Observed

\_\_\_\_/\_\_\_\_/\_\_\_\_  
Date

\_\_\_\_\_  
Signature of Observer

\_\_\_\_/\_\_\_\_/\_\_\_\_  
Date



## Acknowledgement of Reading and Understanding

Hand in this form at the time of your observation to become a certified MRI scanner for the MGH/MIT/HMS Athinoula A. Martinos Center for Biomedical Imaging.

I, \_\_\_\_\_ acknowledge that I have read this packet and understand the rules and safety and operational regulations of the scanning areas for the MGH/MIT/HMS Athinoula A. Martinos Center for Biomedical Imaging.

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Witness Signature

\_\_\_\_\_  
Date