

SCANNING MANUAL



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In Case of Emergency

Emergency Medical Telephone contacts:

If there is an emergency during VA hours: Dial 33333

If there is an emergency during off VA hours: Dial 911

Troubleshooting

All potential issues should be first reported to Imaging Center administration at vajpscan@yahoo.com to determine the appropriate course of action. In the event that help within the Center is not available in a timely manner, then various supporting contacts can be found in the following section.

If there is an issue with the scanner that you are unable to solve during VA hours, contact Clinical Engineering at extension 45395. Margaret Byrne is the head of Clinical Engineering and can be reached at Margaret.Byrne@va.gov only when necessary.

If there is an issue with the scanner that you are unable to solve after hours, call Clinical Engineering ON-CALL pager at: 617-705-5740. They will handle the problem and determine whether Siemens needs to be contacted.

The Siemens service engineer Yucel Ergin may be contacted at ergin.yucel@siemens.com for any questions related to the scanner malfunction that can not be addressed through Center staff or through Clinical Engineering. The Siemens Service Engineer should only be contacted with prior approval from the Center director or in the case of an emergency.

The last number to call is Siemens Uptime Center at 800-888-7436. Use site id 203048.

Reminder: we are only borrowing the scanner room from the clinical department so please put everything back where it was before.

Routine Access to Facilities

The scanner area is divided into three zones: A, B and C as seen in Figure 1 below. Access to area A will be restricted to the individuals certified to scan or currently in training. No other individual should enter area A during research scans.

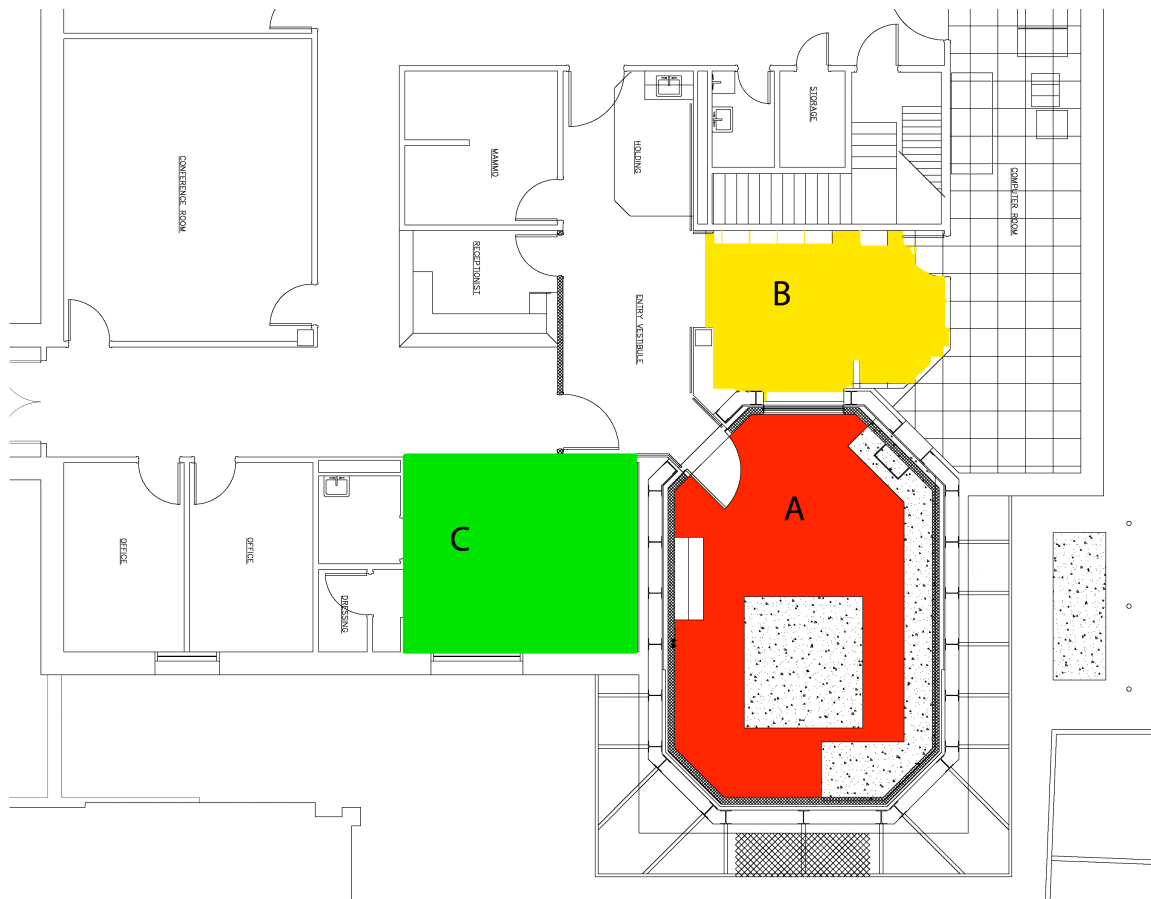


Figure 1. Floor plan of the VA Boston scanning facilities specifying magnet room as area A shown in red, control room and MR equipment room as area B in yellow, and waiting and scanner prep room as area C colored green.

Area A. Metallic items, wallets/purses, hearing aids and other items that could become projectiles and/or be damaged by the static magnetic field need to be secured in the personal lockers before entering the control room. The certified user on duty has the responsibility to restrict access to Area A only to individuals who have been properly screened, and to ask individuals acting in an unsafe manner to leave the room. The certified user must be in the magnet or control room when the magnet room is occupied by a non-certified user. Casual staff will not be allowed in the magnet room unless screened and supervised by the certified user in charge. During use of the magnet room, its door is to be kept closed as much as

possible to reduce the possibility of inadvertent entry. While the subject is in the magnet, the certified user in charge shall not be left alone for more than five minutes at a time.

Area B. Access to area B is limited to the individuals certified to scan or currently in training and also senior staff members briefed on the MR safety rules. Users in training may occupy the control room alone with the explicit permission of a certified user on the premises. In this case, the allowing certified user assumes full responsibility as s/he would if actually in the room. Under no circumstances will non-certified users (subjects, visitors, etc.) occupy the control room without a certified user physically in the control or magnet room. Only those users who understand the use and operation of the equipment in that room should touch anything.

Area C. Since there are minimal risks associated with these areas, there are no special requirements for those that enter. However, the person granting access should make sure that those that are granted access understand that that they may only occupy Areas C.

General Preparation

All users must watch the safety video and read through the entire scanning manual.

Wear closed shoes and minimize metal on scan days.

Only trained investigators or individuals being trained should be allowed into the console and scanner rooms.

The participant needs to be in the waiting area downstairs 15 minutes prior to the scan time with all screening forms completed. The participant also needs to be briefed and trained on the scanning procedure. This includes procedures (such as experiments) that will be used for fMRI scanning. The scan time will not be extended for late participants.

Under no circumstances should the participant be in the console room. All discussion, screening, consenting, and clearing of metal should occur in the waiting room. The only areas open to the participants are the waiting room and the scanner room.

No one should be scheduled for scanning until it is confirmed that they have no exclusion factors. Any questions about potential exclusions can be directed to Center staff. In the case of a medical device, the investigator should consult online

safety documentation (mrisafety.com) and in the event that this information is not available, the investigator should consult the manufacturer and should provide documentation from the manufacturer that the device in question is safe for 3T MRI.

Check the scan calendar in advance to see if the desired time slot has already been claimed.

Arrange for someone (on the protocol) with scanning privileges (right now, only people that have gone through training at the MGH Martinos center), to be available to scan with Dr. Salat (or the technologist when available).

Investigators are responsible for making sure that anyone else in the area is also aware of the rules (e.g. it is possible that a VA employee may come in that is not familiar with the dangers of the scanner).

The scanner door should be closed at all times, and never locked when a participant is in the scanner.

It is important to take note if the participant had any history of anxiety or claustrophobia in a confined space. Participants who had these issues in the past, are likely to experience some discomfort in the MR scanner, and should not be scanned. If a participant shows some anxiety during scanning, but would like to continue, then they should be provided with extra attention and communication during scanning. In case the participant experiences more than mild anxiety or claustrophobia while in the scanner or demonstrates a physiological response, such as profuse sweating or blushing, the scanning session should be stopped.

IRB Forms

The Boston VA Neuro-Imaging Center wiki website (<http://imaging.local/groups/vabostonneuroimagingcenter/wiki/4dc82/Internal.html>) lists several sample IRB related documents/forms which may be required for scanning.

Subject Screening

Screening form can be found on the Boston VA Neuro-Imaging Center wiki website (http://imaging.local/groups/vabostonneuroimagingcenter/wiki/95b7f/Scanning_Info.html). Participants should be screened prior to the day of scanning to assure that there are no doubts about whether the person can be scanned. If you have any questions about whether a participant can be scanned, check available resources (e.g. www.mrisafety.com and/or other investigators). During the initial MRI phone

screen collect relevant information concerning any metal in participant's body (type of implant, part number and etc.) and pass this information along to the research assistant in charge of subject recruitment. The RA would then do any necessary research that would either confirm that the research MRI can be performed or exclude the participant. In some cases it may help to access the VA clinical records to see the exact procedure performed or contact the doctor who performed the procedure for further clarification. If none of these approaches result in a conclusive answer and the participant is unsure of whether he/she may have any metal in the body, the participant should be excluded from the study. In case there are still doubts the RA should contact Dr. Salat with further questions.

The metal checklist must be completed by the subject for every scan and a response indicated for every item. If there is a yes checked off for anything, a brief explanation should be included to the right and initialed by the person doing the screening so we know that the item was noticed. Also any additional follow-up questions must be asked at this point. The page must be signed by both the subject and the person who actually did the screening.

The participant should be told to wear comfortable clothing, preferably with no pockets and no metal (e.g. sweatpants), on the day of scanning. Participants should also be reminded not to wear any jewelry on the day of scanning.

Recent MRI Safety Issues

- *ParaGard Intrauterine Device.* We have just excluded a participant from MRI due to the ParaGard Intrauterine Device. While this device has limited support for use with 1.5 Tesla MRI, there is no support for use with 3 Tesla MRI. <http://www.drugs.com/pro/paragard.html> Limited data suggest that MRI at the level of 1.5 Tesla is acceptable in women using ParaGard®. One study examined the effect of MRI on the CU-7® Intrauterine Copper Contraceptive and Lippes Loop™ intrauterine devices. Neither device moved under the influence of the magnetic field or heated during the spin-echo sequences usually employed for pelvic imaging.¹⁰ An in vitro study did not detect movement or temperature change when ParaGard® was subjected to MRI.¹¹ Mark AS, Hricak H. Intrauterine devices. MR imaging. Radiology. 1987;162:311-314.
- *Work with Metal.* In cases where subject has worked with metal and had to get eyes washed out due to the metal, he/she needs to get to get an orbital x-ray and have it cleared by a radiologist. Unless this is performed and we have a formal letter from the radiologist no scans will be scheduled.
- *Meniere's Disease.* People with Meniere's Disease may experience some nausea when being put into the magnet and they should be entered in slowly.

Also, let them know about this potential and for them to be extra careful to squeeze the ball in the case that they experience discomfort.

Subject Consent

All participants must be consented and screened using the MR screening form. During the consenting procedure, be sure that the participant is aware of exactly what will happen during the scan session. Make sure they know how long the session will be and how many scans will be done, It is also important to let them know about the noises and vibrations that the scanner makes during particular scans. It is also important to talk to the participant about keeping their head still, etc.

What if the Participant Needs Glasses?

The VA Boston Neuro-Imaging Center has lenses for the VisuaStim goggles to compensate for the imperfect vision. These lenses are available upon request. With a planned acquisition of the projector non-goggle lenses will be considered for purchase. Possible options are <http://www.pstnet.com/hardware.cfm?ID=93> and <http://www.newmaticsound.com/ccp0-prodshow/LENS.html>. Comfort and size will need to be carefully considered especially with a future use of a 32-channel coil.

Safety

Caution: any metal allowed in the scanner room may result in a serious bodily injury or death.

The investigators are responsible for making sure that the participant and all research staff have removed all metal prior to entering the scanner room. It is best to double check that all items have been removed from pockets and any other potential accessory (belt, etc.). It is also important to double check that certain items that people would wear in their hair (bobby pins, clips) are also removed. Always double check with participants by asking such questions as: are you sure you have no metal in the body? Are you sure there is no metal in your pockets?

Once all checking is complete, all participants must be checked with the metal detector. This wand should be scanned along the outline of the person's body (i.e., starting at ankles and moving up to armpits, around arms, over head, and down the other side). Then, scan the wand across the front and back of the subject. Make sure all parts of the body have been scanned by the wand. This scanning should occur at

in the waiting area outside of the control room because other locations have metal in the floor and cause the detector to go off even though there is no metal on the participant. Scanning with the metal detector should be comprehensive.

Immediately Before Scanning

All scanner room setup should occur while participant is in the waiting room.

Checklist:

- Remove excess clothing and any metals
- Place a new sheet on the scanner bed
- Place the earplugs squeeze-ball, head clamps, and leg pillow on the bed
- Check with the participant about using the restroom

- Have participant sit on the scanner bed
- Explain the procedure to the participant and remind them to keep their head still
- Instruct on how to use the squeeze-ball
- Insure earplugs are used properly
- Position the head clamps
- Attach and position the head coil

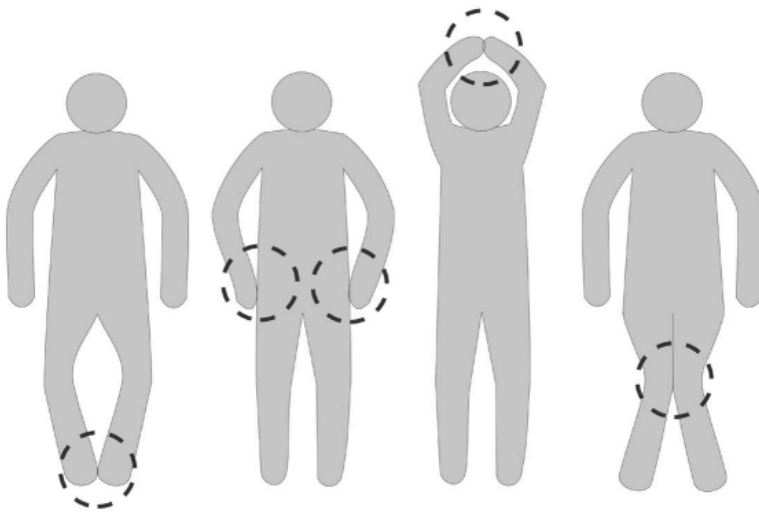
To turn on the lights in the scanner room use the two knobs located to the left of the computer terminal, behind the stimulus presentation hardware.

Explain the entire procedure to the participant *before* you begin to prepare them for the scanner and before entering the imaging room. You must make sure that they have a clear understanding of the procedure and how you will communicate with them before they are laying on the bed, and before the earplugs have been placed. Also, explain to them that the scanner is loud and that the table may vibrate, and that this is normal. Check with the participant about using the rest room and anything else that they may need to do prior to scanning. Have them remove any excess clothing (jackets/sweatshirts/fleece/shoes/sneakers/things with pockets, etc.). The less they are wearing, the less you will have to worry about metal in their pockets. Use a lockable shelf at the main reception desk to temporarily store participant's personal belongings. Put a sheet down on the scanner bed prior to

scanning. This sheet should be placed in the linen basket when scanning is complete, and a new folded sheet should be placed on the bed.

The earplugs can be found in the top shelf of the cabinet to the right of the scanner inside the scanner room. Make sure that the participant uses the earplugs, and that they are put in correctly. It is important that they compress them and get them well into their ear so that they will expand and maximally block noise. Speak loudly to the participant when earplugs are in. Explain the use of the squeeze ball before the earplugs are in, and make sure that the participant has comfortable access to the squeeze ball in their hand. Attach the head coil gently while the table is in the lowered position, and try to position the participant so that the line in the head coil is just above the eyebrows of the participant. Never force the head coil plug. Use the padded guides to help the participant to keep their head still during the session. These should not be too tight.

Participants should be properly positioned to lower the risk of stimulation and RF burns caused by electric current loops forming in the body. When positioning patients, ensure that the arms and legs are not touching. Maintain a distance of at least 5 cm between the extremities. Picture below shows several examples of skin contact that may lead to large-surface current loops.



Position the head clamps to stabilize the participant during scanning. The head clamps can be found on the shelf to the right of the scanner. Avoid placing the head clamps too tightly as it may discomfort the participant. Instruct the participant to try not to move during scanning.

Make sure that the participant closes his/her eyes for positioning with the laser. The laser should be positioned so that the red horizontal line is aligned with the raised line on the head coil. Once positioning is done, put the participant in the scanner.

When operating the scanner bed watch the blanket and the squeeze ball to ensure they don't get caught while the bed is moving into the scanner. Explain the procedure to the participant: We will be scanning you for about an hour, we will do about 7 scans, each scan will be 5-10 minutes, please keep your head still, etc. During scanning communicate with the participant in a loud and clear voice. Explain to the participant that the table may vibrate during some of the scans, especially during the diffusion scan.

During Scanning

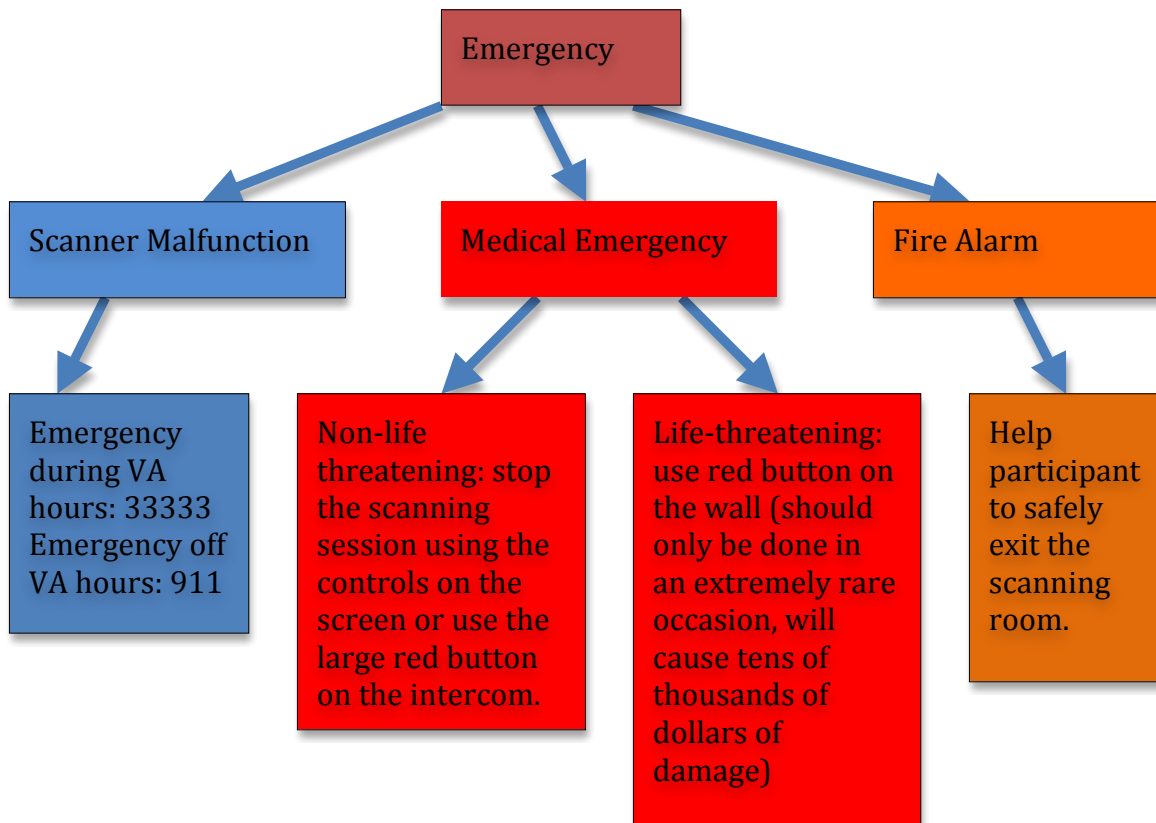
All scan session must have two trained imagers present at all times, and at least one of those two should be monitoring the scanner and participant at all times.

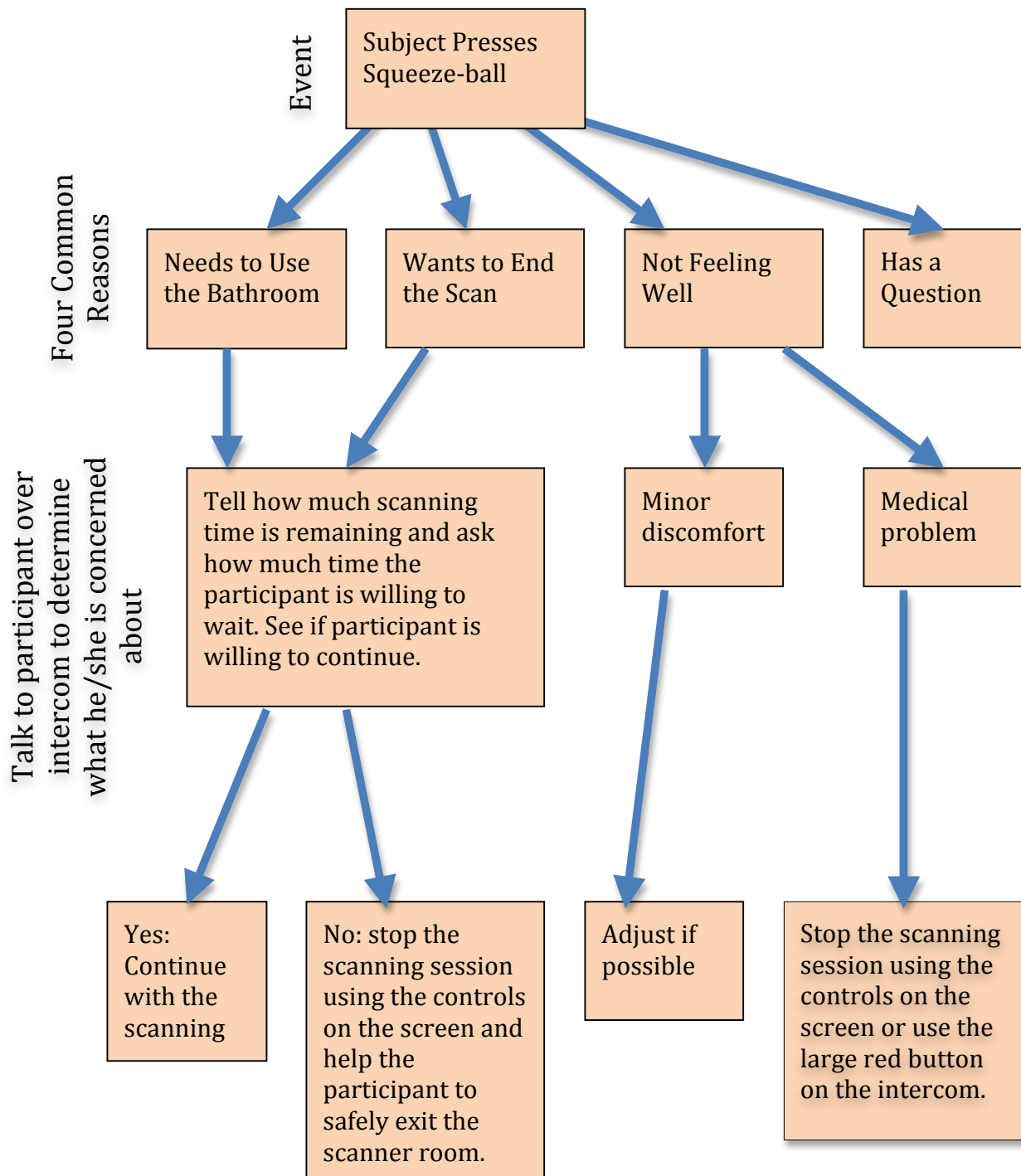
No other people should be at the scanner other than investigators on the protocol of the study, and people that are on the protocol but not trained should not go into the scanner room. Any visitors should be approved prior to the scan session by Center administration.

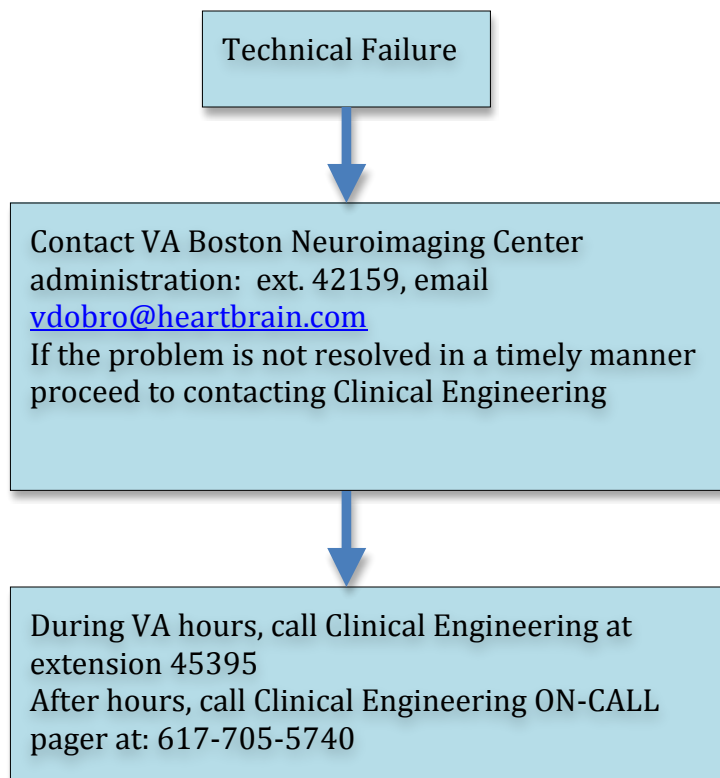
The key to the scanner room is on the bottom shelf in the back left cabinet in the console room (facing away from the scanner). This key should be left in the door, turned so that it is locked in and cannot be pulled out. **The door needs to stay unlocked during the scan session.** When the scan is complete, make sure that the door is tightly shut and locked (check to see that you can not still push the door open), and put the key back in the cabinet.

Always inform the participant about the progress of the scanning session. It is usually good to let them know when they are halfway through the scan session, when there is about 15 minutes remaining, and when it is the last scan.

Quick Guide: What to do if something goes wrong

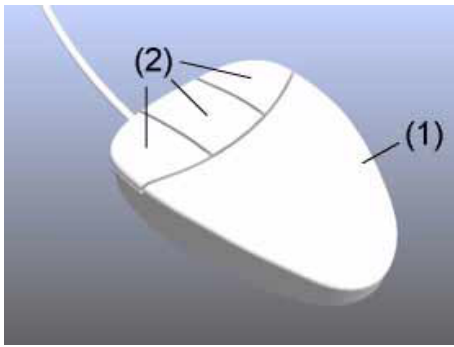






Handling the Scanner

Most of the scanner functions are accessed with the mouse. Below is the short overview of the mouse functionality.



(1) Hand rest

(2) Mouse buttons

The mouse provides the following functions:

❑ Left mouse button:

- Selecting or moving objects.
- Selecting syngo MR functions from the menus.

❑ Center mouse button:

- Medical windowing of patient images by setting contrast and brightness.

❑ Right mouse button:

- Displaying a context-sensitive menu (depending on the position of the mouse pointer).

The keyboard has some important keys to simplify scanner operation. Below is the short list of some useful Siemens keys:



Decrease/Increase image brightness (set window position)



Decrease/Increase contrast (decrease/increase window width)

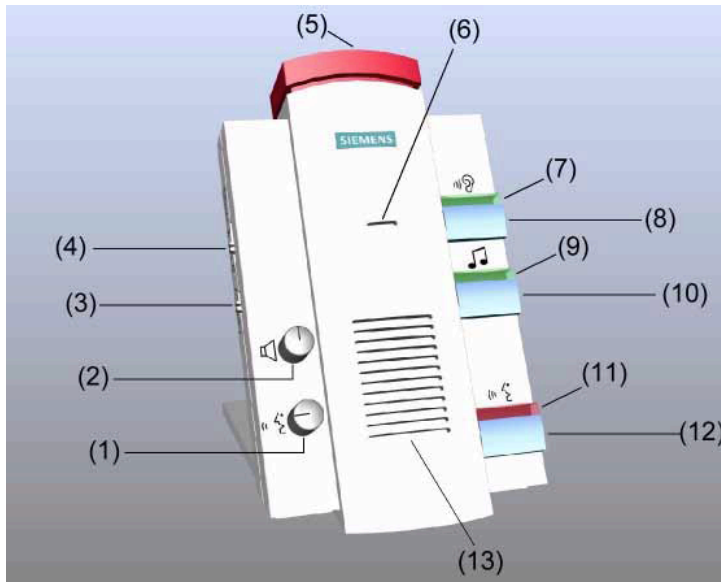


Automatically set contrast and brightness



Previous/Next image

Communication during scanning between a participant and the imager occurs via an intercom. Picture below shows the intercom currently used. Red button on top of the intercom (5) can be used to unlock the table in case of emergency so that it can be manually moved.



- (1) Volume control for examination room (voice volume only)
- (2) Volume control for MR console
- (3) Toggle switch (to be assigned)
- (4) Volume control for trigger pulses
- (5) **Table Stop** button
- (6) Microphone
- (7) **Listen** LED
- (8) **Listen** button
- (9) **Music On** LED
- (10) **Play Music** button
- (11) **Squeeze Bulb Active** LED
- (12) **Speak** button
- (13) Speaker

To register a new patient go to **Patient -> Register** on the console. Register the participant's subject number and weight. It is important to enter the correct subject weight, please double check that it is entered properly. Subject number can be put in Last Name (a required entry) and Patient ID (for example B20). Make sure that the position setting is in the '**Head First- Supine**' position. Then click '**Exam**'. No other information should be put into the scanner. **Birth date** is a required entry but DO NOT put the subject's real birthday. Instead, put a random date (such as **1/1/1985**). For **sex**, choose "**other**". NO IDENTIFYING INFORMATION SHOULD BE PUT INTO THE SCANNER.

WE NEED TO FIX THE ORDERING PHYSICIAN PART

The image sequences that we currently use can be found in the RESEARCH folder on the scanner. Click on the research folder to see the various pulse sequences. Below is a list of the standard scans usually collected for our participants; this will vary for individual investigators.

1. Localizer
2. MPRAGE/T1
3. MPRAGE/T1
4. DTI – 30 directions, 2 averages, 2 mm³
5. T2/BD dual echo
6. fMRI
7. fMRI
8. T2 Space 1mm³
9. FLAIR

Additional sequences and protocols can be found on the lab wiki.

Tell the participant that you are going to begin scanning, and to squeeze the ball if everything is ok. If there is no response, ask again. If there is still no response, go in the room to check on the participant (make sure you didn't pick up any metal in the meantime). (SEE FLOW CHART ABOVE) UPDATE CHART WITH THESE ACTIONS.

Each scan begins with a 'brain localizer'. This is a very short scan that collects a single sagittal, coronal, and axial slice that are used for setting up/positioning subsequent scans. To run the localizer, click on it in the scan window and click the arrow to bring it into the scan queue.

Before the scanning proceeds a message appears on the console screen warning that the subject may experience nerve stimulation. This is ok, and you can click *Ok* to proceed with the scan.

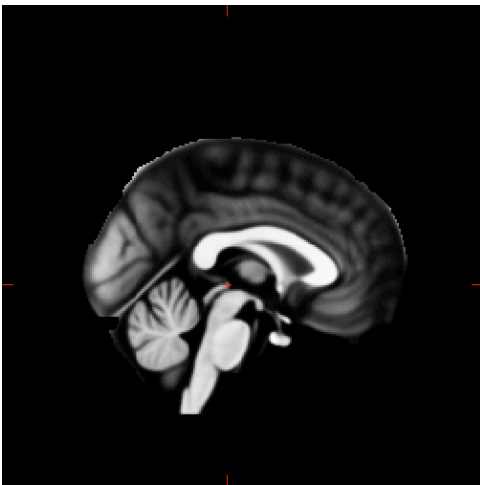
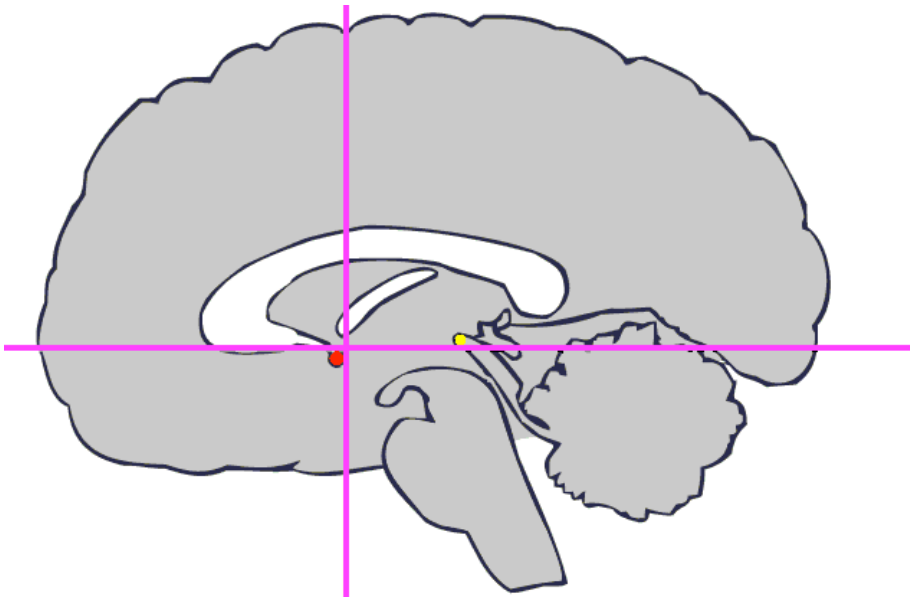
When finished, three views will automatically appear in the Exam viewing window. This localizer should show the brain optimally positioned within the hashmarks.

Autoalign

Most scans will be automatically aligned using the 'autoalign' procedure. If the autoalign is functioning properly, each scan should have a slice orientation that approximates the anterior-posterior commissure line (see below). Autoalign may fail in the case of brains with highly abnormal anatomy. In these cases, the AC-PC line must be identified manually for slice prescription.

Identifying Anterior and Posterior Commissures

The scanner uses an anterior commissure (AC) and a posterior commissure (PC) as landmarks for image alignment. You will need to manually locate these landmarks using a cursor on the computer screen. Image below shows the position of the AC (red dot) and the PC (yellow dot) in a sagittal view of the brain.



The typical morphometry scan (for calculating brain volumes and creating cortical surface/thickness models) is 'MPRAGE'. Run this scan next.

Check the MPRAGE in the 3D viewer tab.

Check all scans immediately. The 3D scans can be checked in the 3D tab, and the 2D scans in the Viewing tab.

MPRAGE REPEAT

Drag the MPRAGE into the sagittal box for better viewing of the anatomy.

The next scan is the diffusion scan (ep2d_diff_mddw_20_p2-MOD). This sequence should be positioned using the AC-PC that can be found by scrolling through the

MPRAGE image. The DTI scan is louder and has more vibration than the MPRAGE, so it is good to tell the participant this in advance.

The next scan is a dual echo T2/PD. This scan should be set up by copying the positioning parameters from the diffusion scan above it. Copy the parameters by double clicking on the T2/PD scan and then right clicking on the DTI scan above it and selecting 'copy parameters'.

The next scan is the resting functional 'ep2d_bold'. This is a resting functional scan. There are a variety of ways that a scan like this can be run. For now, we are simply asking the participant to keep his/her eyes open and to focus on the mirror. This scan is run twice.

FLAIR

The phantom should be in the head coil and sent it into the magnet (with all connectors plugged in) at the end of the last scanning session of the day for morning stability checks.

DVD copying

After each scanning session the imaging data should be transferred to the DVD disc. DVD's as well as DVD cases can be found on the top shelf in the right part of the cabinet in the control room. To transfer images on the DVD it is very important to first take out the clinical DVD. Make sure to NOT copy research data onto the clinical DVD, or to write over clinical data with research data. The clinical DVD will ALWAYS be in the DVD. To ensure proper copying of research image data the following procedure should be used:

1. Click "Eject from DVD-R" from the *Transfer* menu located at the top part of the screen.
2. Remove Clinical DVD (it will always have a number written in black on it) and set aside in a safe place.
3. Insert blank DVD-R.
4. Select the entire research scan folder, to ensure that all scans are copied.
5. Select *Archive to DVD-R* from the *Transfer* menu.
6. The progress of the data transfer can be monitored by clicking on *Local job status* from the *Transfer* menu.
7. Once the DVD is complete, select *Eject from DVD* on then PLACE THE CLINICAL DVD BACK INTO THE DVD.

Hardware

All hardware is extremely fragile and uses fiber optic cables, which have limited flexibility to bend and manipulate. Broken cables are very expensive to replace, and reinstall, and will result in lost time on the scanner. Please be careful when setting up your studies.

Audio-Visual Stimulation.

VisuaStim Digital (Resonance Technology) is an all-digital audio-visual stimulation technology designed for functional MRI (fMRI) applications. It can be used to broadcast high quality audio and video signal from the computer in the control room to the subject in the scanner. Dual-display stereoscopic video yields 3D images, which deliver visual paradigms that appear to emerge from the screen. Head mounted display operates inside the magnet bore. The display features eye-relief optics for subject's comfort. Display resolution of 500,000 pixels per 0.25 square inch makes it possible to clearly see small text delivered from a PC. The unit has a refresh rate of up to 85 Hz. Contrast ratio benefits from each pixel being illuminated independently without the need for backlighting. The high contrast ratio is maintained in magnetic fields greater than 4.7T. Digital audio system features a 30 dB noise-attenuating headset with 40Hz.-40 kHz. frequency response.

<http://www.mrvideo.com/product/fmri/vsd.htm>

Stimulus Presentation

The Avotec Silent Scan 3000 (Avotec) consists of several major components for high quality auditory stimulus presentation: communication console with gooseneck microphone, full coverage and stethoscopic headsets, stereo system with AM/FM and CD and a patient alarm system. Hearing protection provides patient/participant comfort and safety by minimizing noise from the MRI scanner. The headsets also include a built-in microphone to ensure communication between the subject in the scanner and the researcher.

<http://www.avotecinc.com/audio3000.htm>

Physiological Monitoring

The MP150 Data Acquisition System (BIOPAC) allows for the measurement of several physiological parameters. It runs on Macintosh computers and can be used with BIOPAC's amplifiers and accessories and with other equipment. BIOPAC offers a series of magnetic resonance imaging compatible electrodes, electrode leads, transducers, and stimulus options for safe data acquisition of physiological signals in the MRI environment. Physiological signals such as Electrocardiogram (ECG), Electromyogram (EMG), Electroculogram (EOG), Temperature, Respiration, Pulse, Hand Grip Strength (Dynamometry), Finger Twitch can be recorded during an MRI

scan. Specialized cable systems provide isolated and RF filtered interfacing between the subject/chamber panel and the control room. Proprietary AcqKnowledge program offers an interactive and intuitive way to instantly view, measure, analyze, and transform data. Online analysis settings, filters, and transformations provide real-time feedback. Wide variety of off-line analysis tools is also available. The MP 150 offers:

- Ethernet-ready data acquisition and analysis
- Recording multiple channels with differing sample rates
- Recording at speeds up to 400 kHz (aggregate)

<http://www.biopac.com/data-acquisition-analysis-system-mp150-system-mac>

Eye tracking

The VisuaStim system and View Point Software (Arrington Research) feature eye-tracking and recording capabilities. VisuaStim Digital controller provides interface for paradigm delivery, connecting to the eye-tracker module.

<http://www.arringtonresearch.com/viewpoint.html>