



Magnet Safety Training

Scannexus



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Magnet Safety Training

Privacy statement

<http://www.scannexus.nl/information> →





Magnet Safety Training

Siemens safety video

[present video clip](#)



Magnet Safety Training

MR system components

Superconductive magnet



- B_0 , static field
- **Always on!!**
- 3T:
 - 1200 liters of liquid helium
 - 60.000 * earth magnetic field

Gradient coil

- **dB/dt**, time varying magnetic field
- 600kg

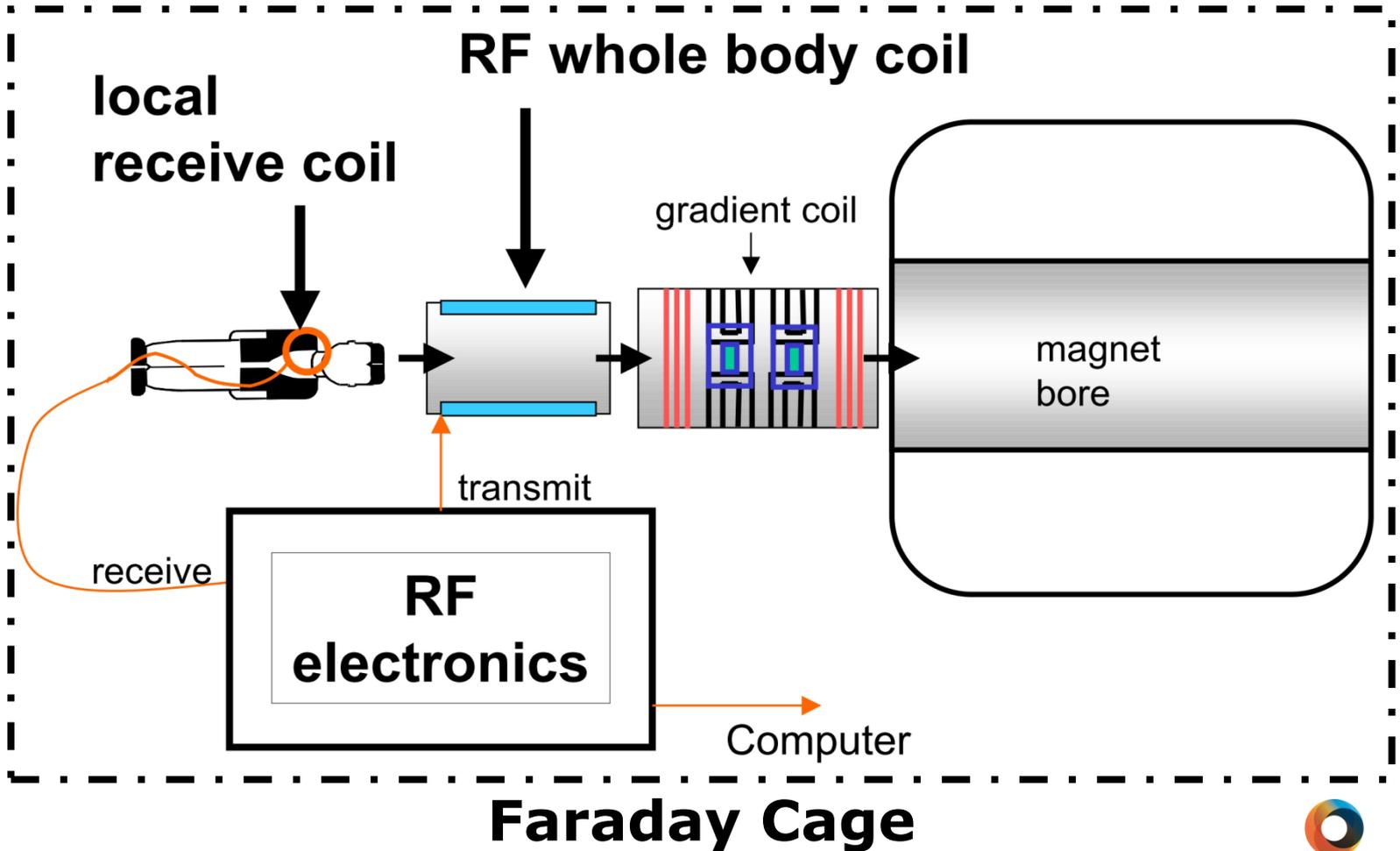


Radio Frequency transmit coil

- B_1 , radio frequency field
- 3T, whole body coil
- 7T/9.4T, local transmit coils

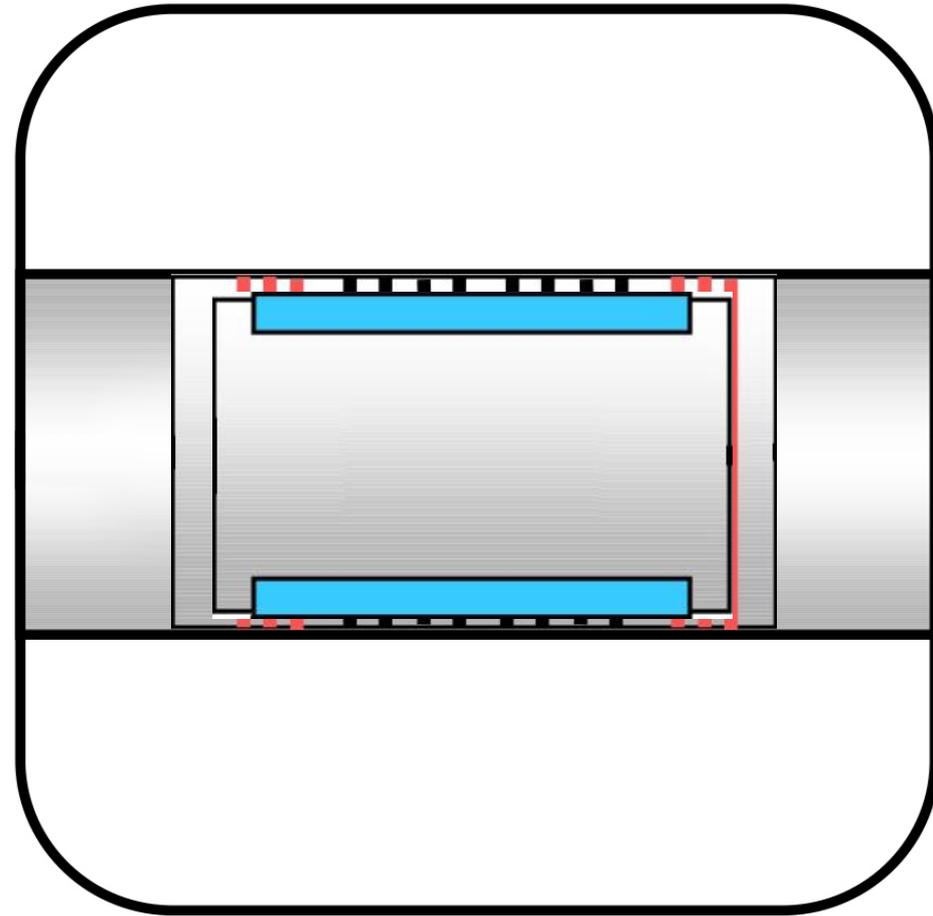
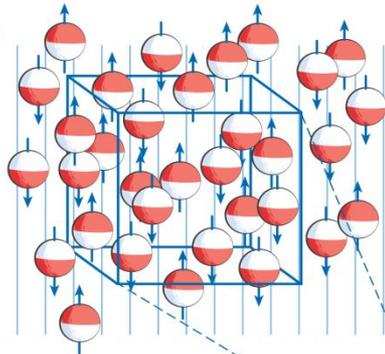


MR system



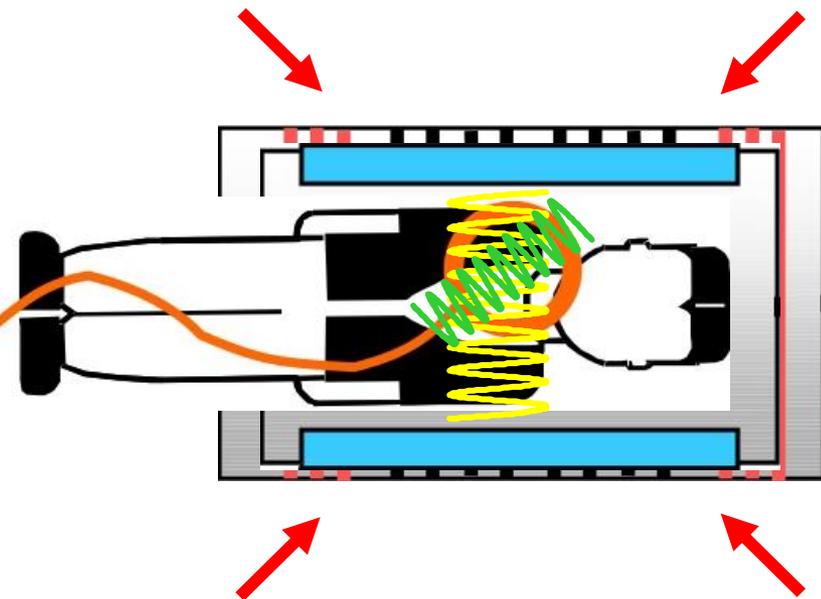
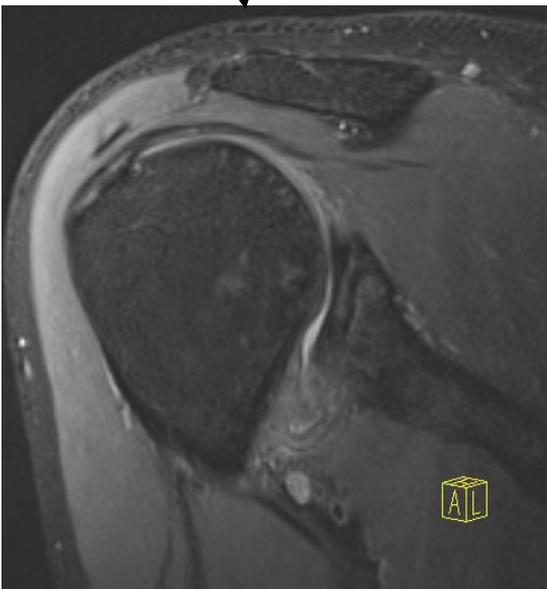
Signal

Hydrogen Nuclei



Signal

computer





Magnet Safety Training

Areas of concern magnetic fields

Areas of concern magnetic fields



B_0 , static field:

- 5 Gauss line
- Attractive force
- Vertigo/nausea
- Metallic taste



dB/dt



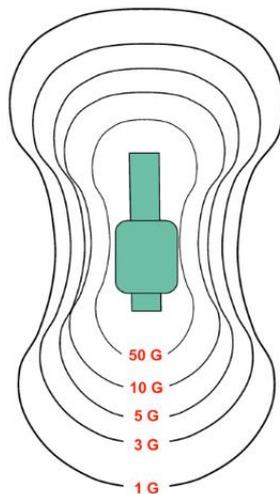
B_1



Attractive force

5 gauss (=0.5 mT) line

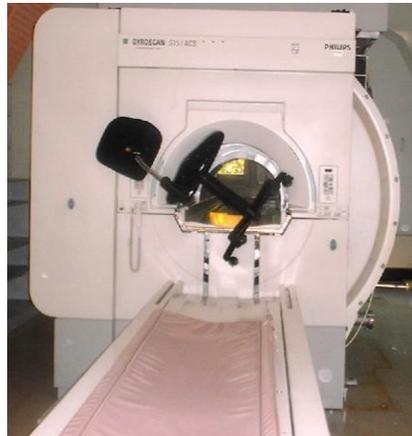
- The five Gauss line is the point at which the magnetic field begins to affect electromagnetic devices. The five Gauss line may not always be confined to the MRI-Scanner Room, but may extend outside the building. Or in the console room.
- Especially, exceeding the 5 Gauss line is life-threatening for people with pacemakers, insulin pumps and other electromagnetically impressionable implants!!!!
- **At Scannexus this 5 Gauss line is within the MR room!**



⚠ WARNING	
 5 GAUSS	Static magnetic fields located inside this enclosure. Pacemaker wearers should NOT enter this enclosure.
	ONLY authorized personnel may service this equipment. See manual for safety information.



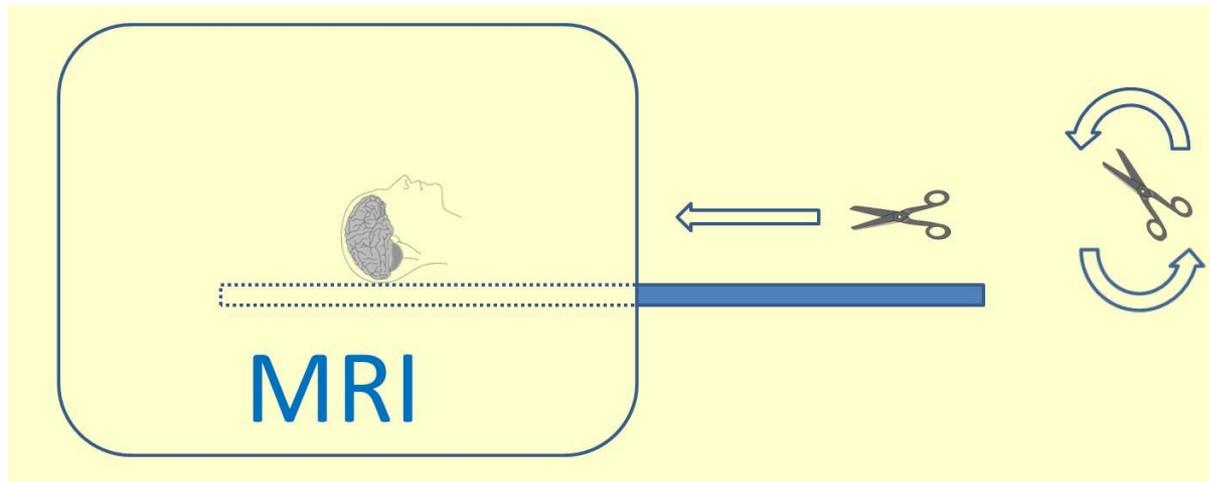
Attractive force



Attractive force

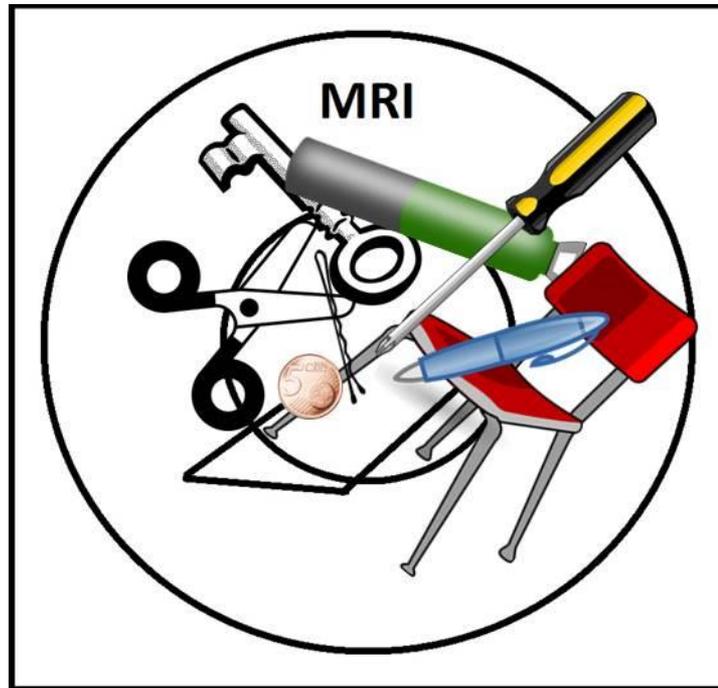
Each asymmetric ferromagnetic object will align with its longitudinal axis parallel to the magnetic field (torsion forces). So a scissor would fly in the scanner with the tip first.

Magnetisable and ferromagnetic implants and objects in the body are moving in a parallel position.



Attractive force

Size does not matter!!
(clip)



Six Year Old Killed During MRI

Outside of the X-ray, perhaps no other medical examination is as well known or as safe as the magnetic resonance imaging test, which is conducted eight million times a year in the United States on patients ranging from people with brain tumors to famous athletes with knee injuries.

But today, officials at the Westchester Medical Center announced that something went horribly wrong on Friday with an MRI test on a boy, 6, who had just undergone surgery.

Even though no metal objects are supposed to be in the testing area, because they will be pulled toward the 10-ton machine by its powerful electromagnet, a metal oxygen tank somehow made it into the examination room.

On Friday morning, the boy, sedated, was placed inside the MRI - a General Electric Signa machine - with his head in the center of the machine. At some point, the tank was "introduced into the exam room" and, magnetized, was drawn to the center of the room, striking the boy, according to a hospital news release.

The tank, about the size of a fire extinguisher, became magnetized, then flew through the air at 20 to 30 feet per second and fractured the boy's skull.

The boy died on Sunday. And today, an autopsy conducted by the Westchester County Medical Examiner's office confirmed that he had died of blunt force trauma, severe hemorrhaging and a contusion to the brain.

The hospital and the State Department of Health are investigating, and the Westchester District Attorney's office is also

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"MRI is safe, but if something goes wrong, it can go very wrong," said Dr. Gregory Chaljub, a radiologist at the University of Texas Medical Branch in Galveston and the study's primary researcher.

Indeed, the power of the MRI is so strong that in one case, a janitor who was buffing the floor of the examination floor suffered a wrist fracture because of the magnetic pull on the cleaning equipment, Dr. Chaljub said.

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scale within the last two decades, it has generally been considered very safe, according to Dr. Emanuel Kanal, a professor of radiology and neuroradiology at the University of Pittsburgh Medical Center.

Still, there have been several MRI accidents, some of them fatal, involving metal objects as small as paper clips, Dr. Kanal said. One woman who underwent an MRI died because of an implanted aneurysm clip in her brain.

Another who forgot to pull a hairpin out of her hair required a procedure to extract the hairpin after the pin traveled up her nose and lodged in her pharynx. And in Rochester last year, an MRI magnet pulled a .45-caliber gun out of the hand of a police officer and the gun shot a round that lodged in a wall.

The accident in Westchester also comes on the heels of a recent article in The American Journal of Roentgenology about the potential dangers of oxygen tanks being brought into MRI testing areas.

In that study, researchers found that there had been five such accidents in 15 years, including four in the last three years, mostly involving patients on life support who have been wheeled into an examination room with an oxygen tank nearby.

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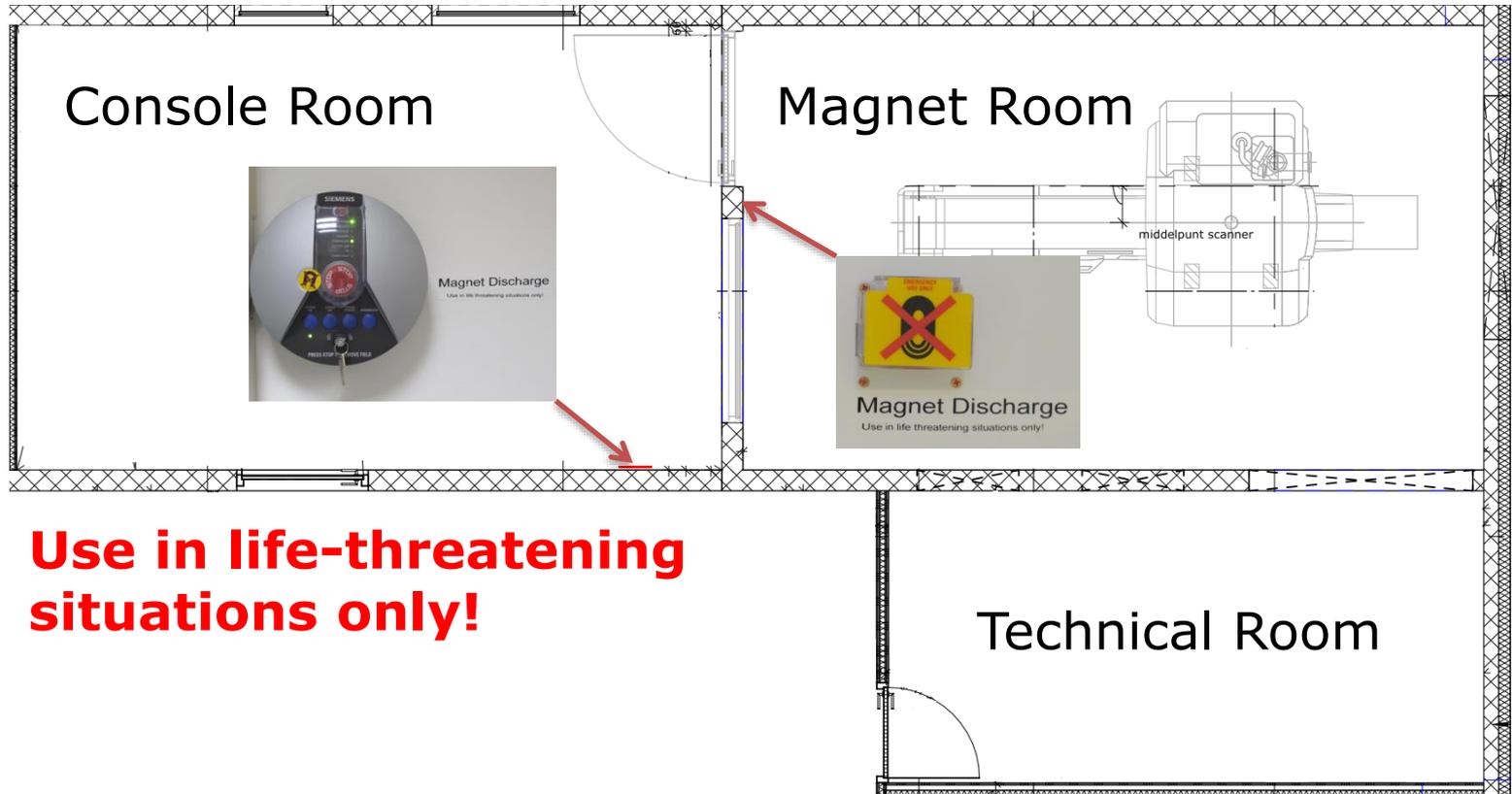
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Magnet discharge button



Use in life-threatening situations only!



Quench

Liquid helium is used to keep the superconductive magnet at a temperature near absolute zero.

At this temperature the superconductive magnet will always keep its magnetic potential.



Quench

Quench refers to sudden loss of superconductivity due to temperature raise and the liquid helium will boil off as a gas.

- A quench will effectively demagnetize the system.
- Quenching:
 - activation of the MAGNET DISCHARGE BUTTON.
 - spontaneously, caused by a fault in the magnet itself.
- The helium gas will rapidly escape through a vent tube to the roof top.
- A quench will in general be accompanied by a loud bang or thundering or hissing or rushing sound with the cold gas expulsion.
- Quenching may cause severe and irreparable damage to the superconducting coils and so a decision to quench should only be made in life threatening cases.



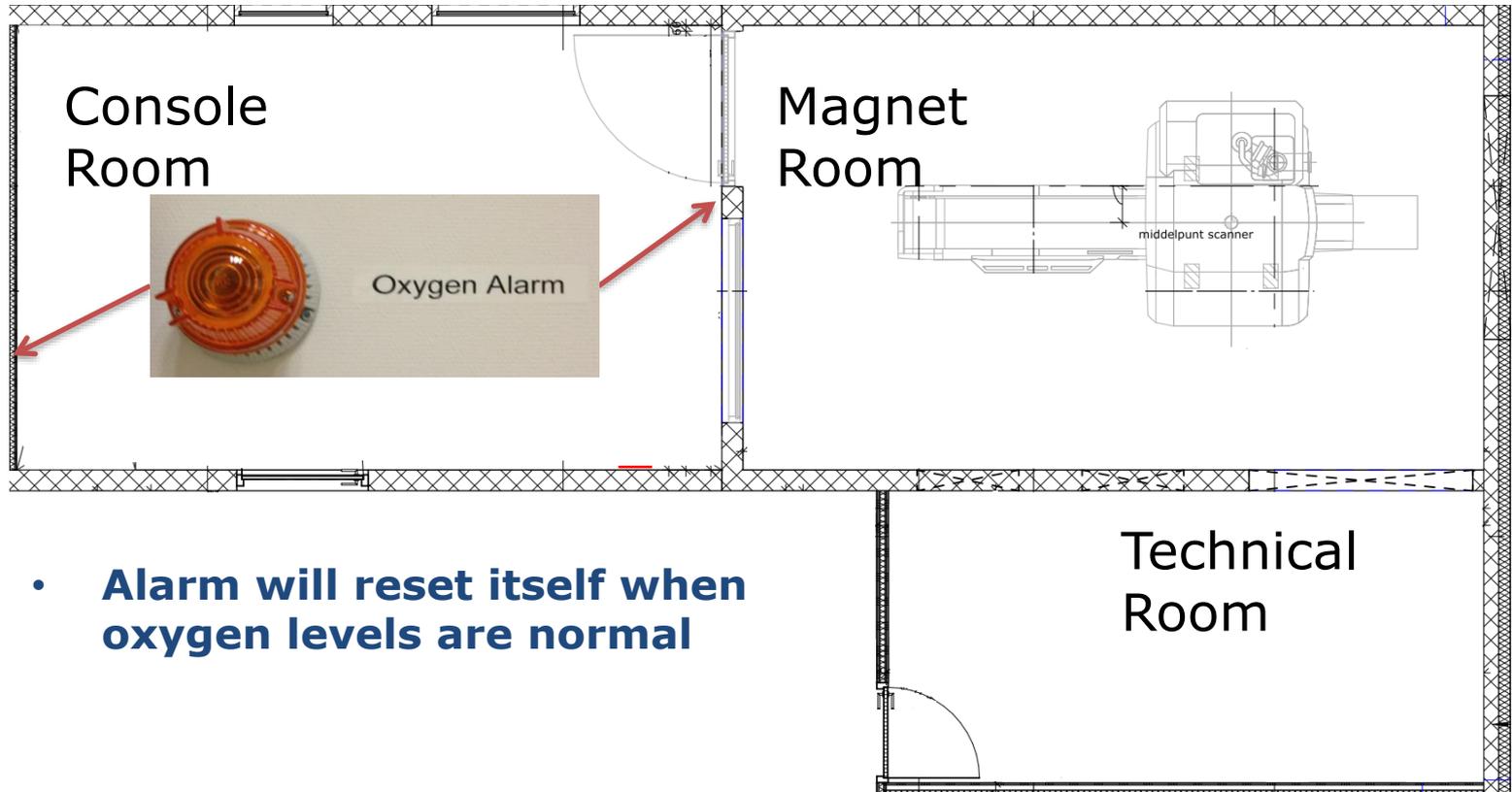
Quench (Oxygen alarm)

If venting system fails the Helium gas will escape into the scanner room.

Consequence:

- Helium is lighter than air
- Oxygen level drops, **OXYGEN ALARM!**
- Very cold gas
- Pressure in the room up to 700 times bigger

Oxygen alarm



- **Alarm will reset itself when oxygen levels are normal**

Areas of concern magnetic fields



B_0



dB/dt , time varying magnetic field

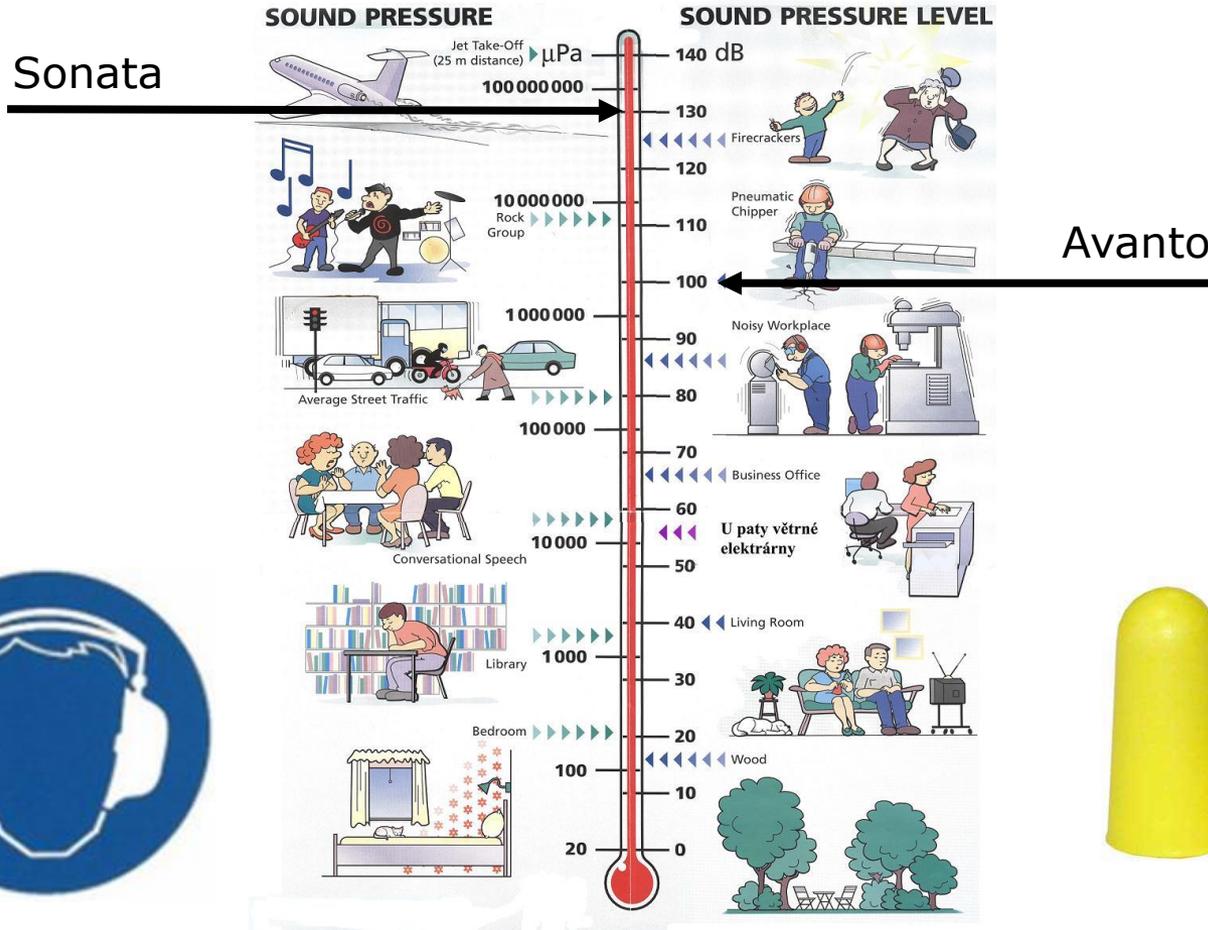
- Sound pressure
- Peripheral nerve stimulation
- Eddy Currents



B_1

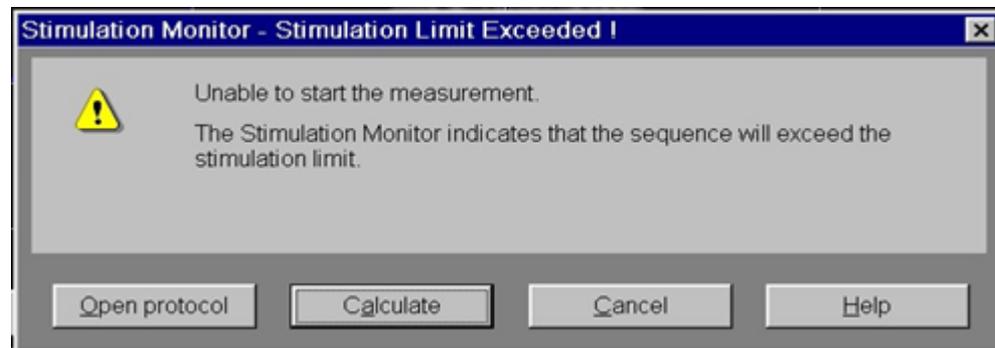
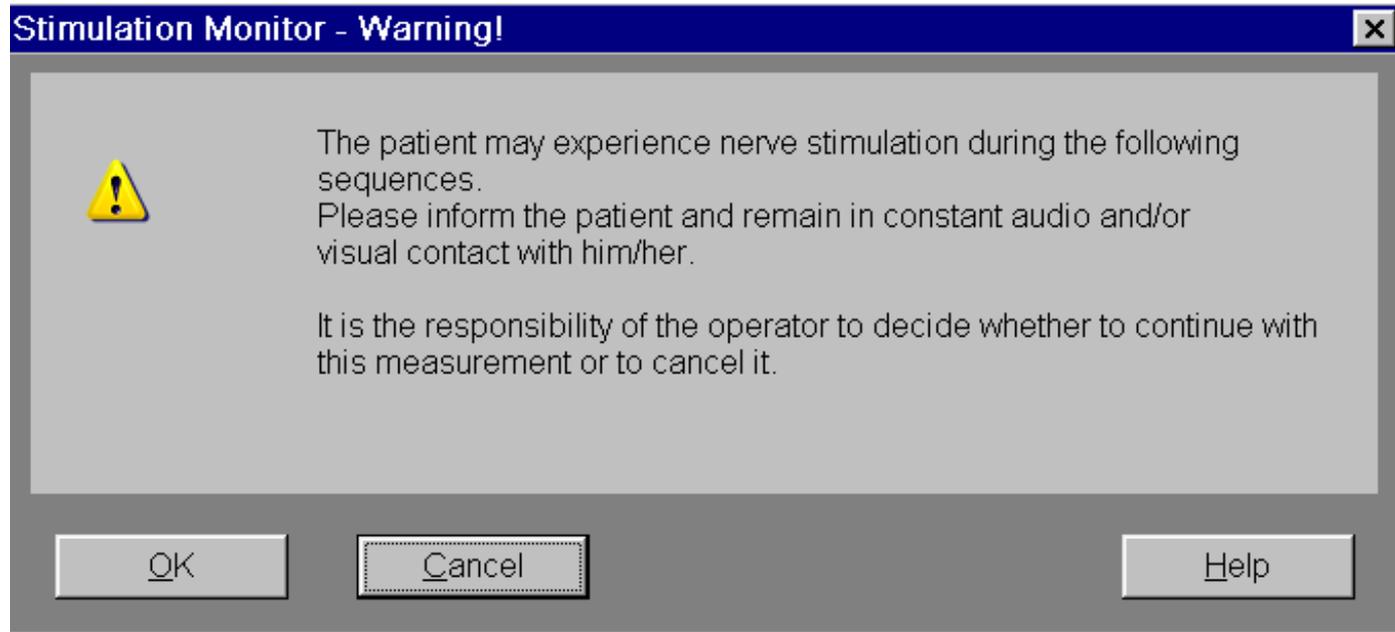


Sound pressure



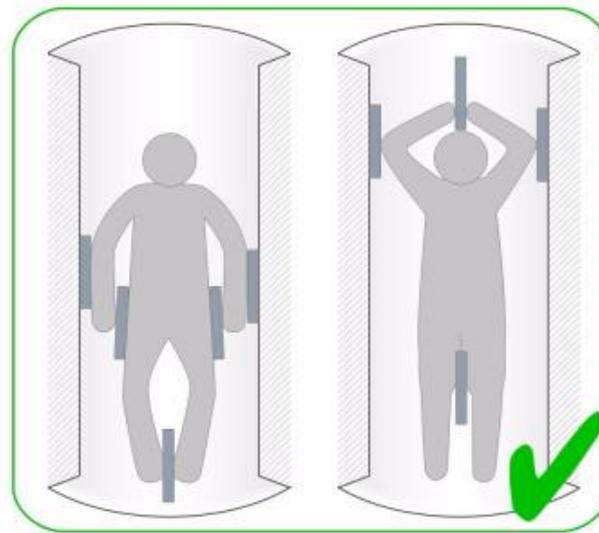
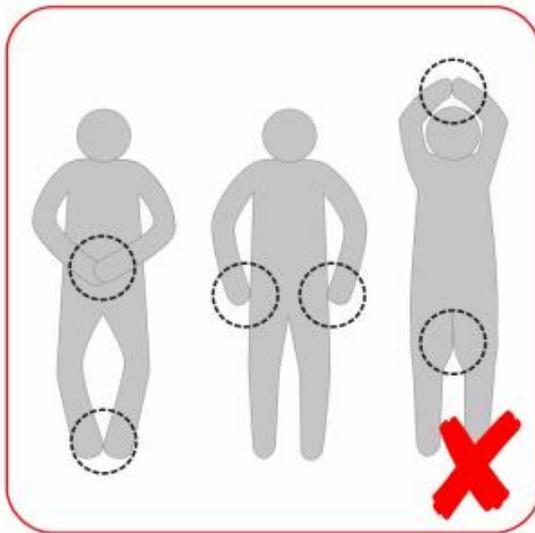
Always wear earplugs!

Peripheral nerve stimulation



Eddy Currents

- Electric currents are induced by a changing magnetic field, like time varying gradients or RF coils. **Can cause burns.**
- Avoid creating loops.
- Avoid contact with bare skin.
 - Skin – Skin
 - Skin – Cables
 - Skin – Bore



Areas of concern magnetic fields



B_0



dB/dt



B_1 (Radio Frequency)

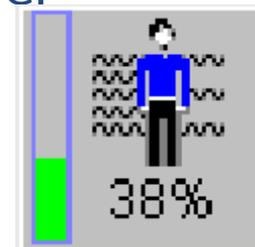
- SAR
- Eddy Currents
- Electrical conduction



SAR

Specific Absorption Rate

- The Specific Absorption Rate (SAR) describes the potential for heating of the subjects tissue due to the application of the RF energy
- The SAR is defined as the RF power absorbed per unit of mass of an object, and is measured in watts per kilogram (W/kg).
- Maximum temperature rise of 1°C.
 - At the end of the sequence you are at 38% of 1°C.
 - This varies per sequence.
 - Sum of sequences and delay time in between.



Click for
info

SAR

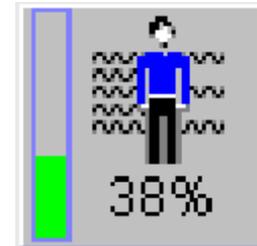
Specific Absorption Rate



Microwave
2.5 GHz



3 Tesla
126 MHz



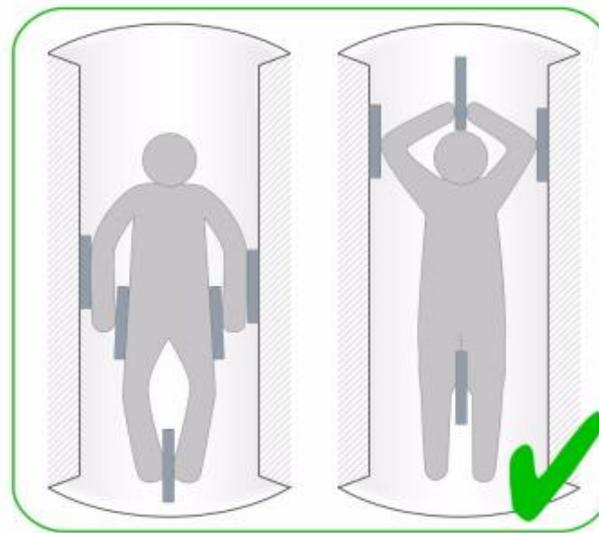
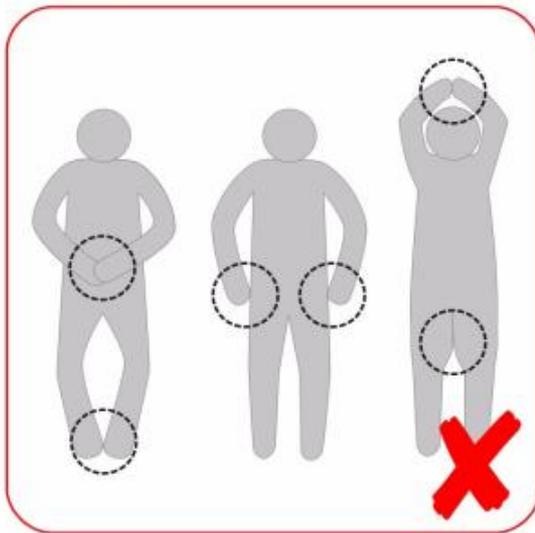
[Click for info](#)

Level 1 operation mode

- Normal operation mode
 - Can be used for all volunteers
 - Nerve stimulation (~1%)
 - SAR
 - 80% IEC norm
- Level 1 operation mode
 - Not to be used with subjects with reduced thermoregulation
 - Nerve stimulation (~50%)
 - SAR ↑
 - 100% IEC norm

Eddy Currents

- Electric currents induced by a changing magnetic field, like time varying gradients or RF coils. **Can cause burns.**
- Avoid creating loops.
- Avoid contact with bare skin.
 - Skin – Skin
 - Skin – Cables
 - Skin – Bore





Electrical conduction

Heating in electrical conductive wires, implants or devices during MRI can be caused by:

- direct electromagnetic induction in a conductive loop.
- electric field resonant coupling with a wire (the antenna effect).

NOTE:

Higher RF needed at **ultra high field MR** leads to altered conditions for electromagnetic resonance of conductive material.

Due to **shorter wavelengths** at higher field, even smaller extensions of wires/metallic parts tend to show resonance effects, especially when surrounded by aqueous media.



Magnet Safety Training

Implants and devices

Implants and devices



MR SAFE

- Non-magnetic
- Non-electrically conductive
- Non-RF reactive



MR Conditional

- Observe the manufactures manual!
- MRI-safety.com



MR UNSAFE

- Induces hazards in all MR environments

MR Safe or MR Compatible



MR SAFE

- The implant or device will present **no additional risk** to the subject but may affect the quality of the diagnostic information.



MR COMPATIBLE

- The implant or device is MR safe and will **not significantly affect the quality of the diagnostic information**, nor will its operation be significantly affected being in the MR environment.



MR objects clearance

It is prohibited to introduce and use in the magnet rooms any device or instrument that has not been tested and approved by the Safety Review Board/Safety Officer.

New devices/questions of MR safety:

safety@scannexus.nl

Add information of the device/ safety checks of other institutions/manufacturer if possible



Magnet Safety Training

Screening

Screening forms

- **Safety Screening Form Scannexus**
 - Mandatory!
 - Fill in just before entering the magnet room.
 - Has to be signed by the CU and the subject.
 - If questions arise, **DO NOT SCAN**, always contact Support Staff!
 - Every time (day) a new form.
- Completed Safety Screening Forms should be put into the reception mail box and will be archived by Scannexus.
- Blank forms are available at the console rooms and at www.scannexus.nl/documentation



Before entering the magnet room

- **Always screen before entering the magnet room!**
- Do not bring any unscreened subjects/persons into the magnet room!
- Top-down screening, check for magnetic objects
 - Hair tie/pins
 - Jewelry
 - All pockets
 - Belt/shoes
- Do not take any objects, (medical) devices which are not cleared to be MR safe into the magnet room.
- Do not take students/ uncertified people with you into the magnet room if it is not absolutely necessary.



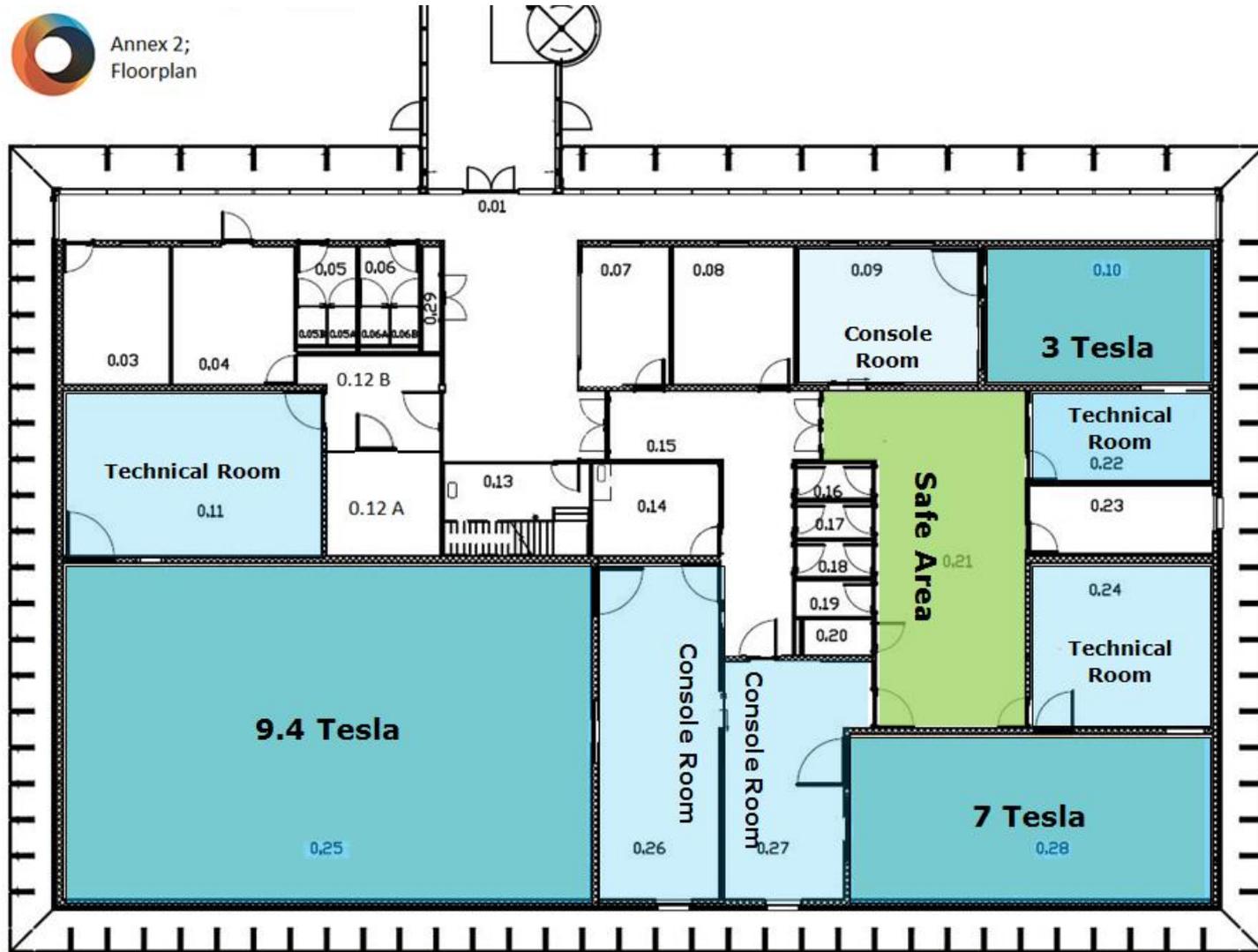
Magnet safety training

Emergency

Floor plan



Annex 2;
Floorplan





Gurney/stretchers

You can use the gurney to quickly evacuate an unconscious subject out of the MR room to the safe area.

[**Video Clip**](#)

Fire alarm/extinguisher, first aid



Emergency phone numbers

- UM Emergency Number: **1333**
 - Injuries
 - Fire
 - BHV
- You are responsible for the safety of emergency workers if they have to enter the magnet room!
- Support team: 85668
- Siemens Hotline: 088 210 0510
 - Quench

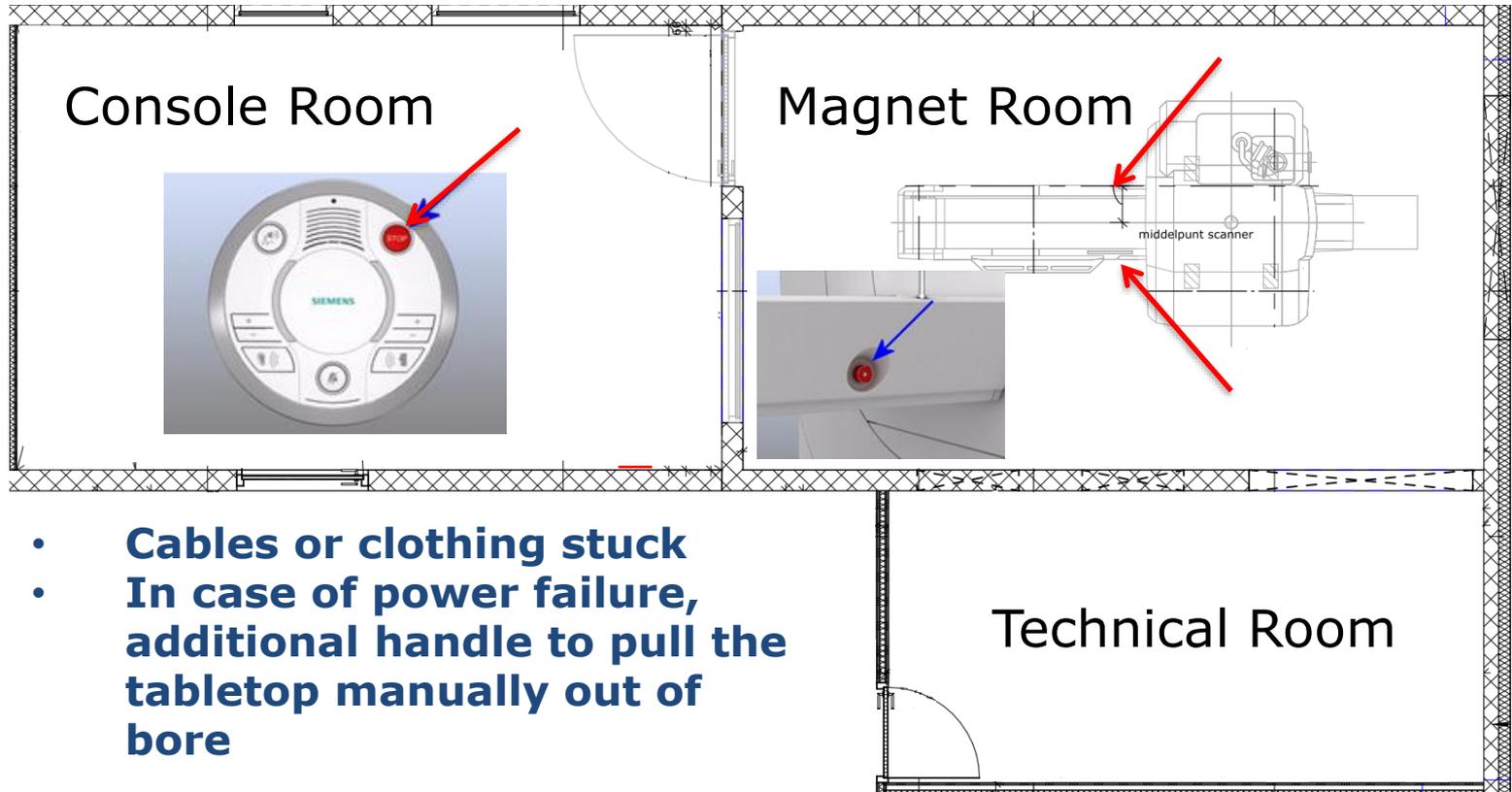




Magnet Safety Training

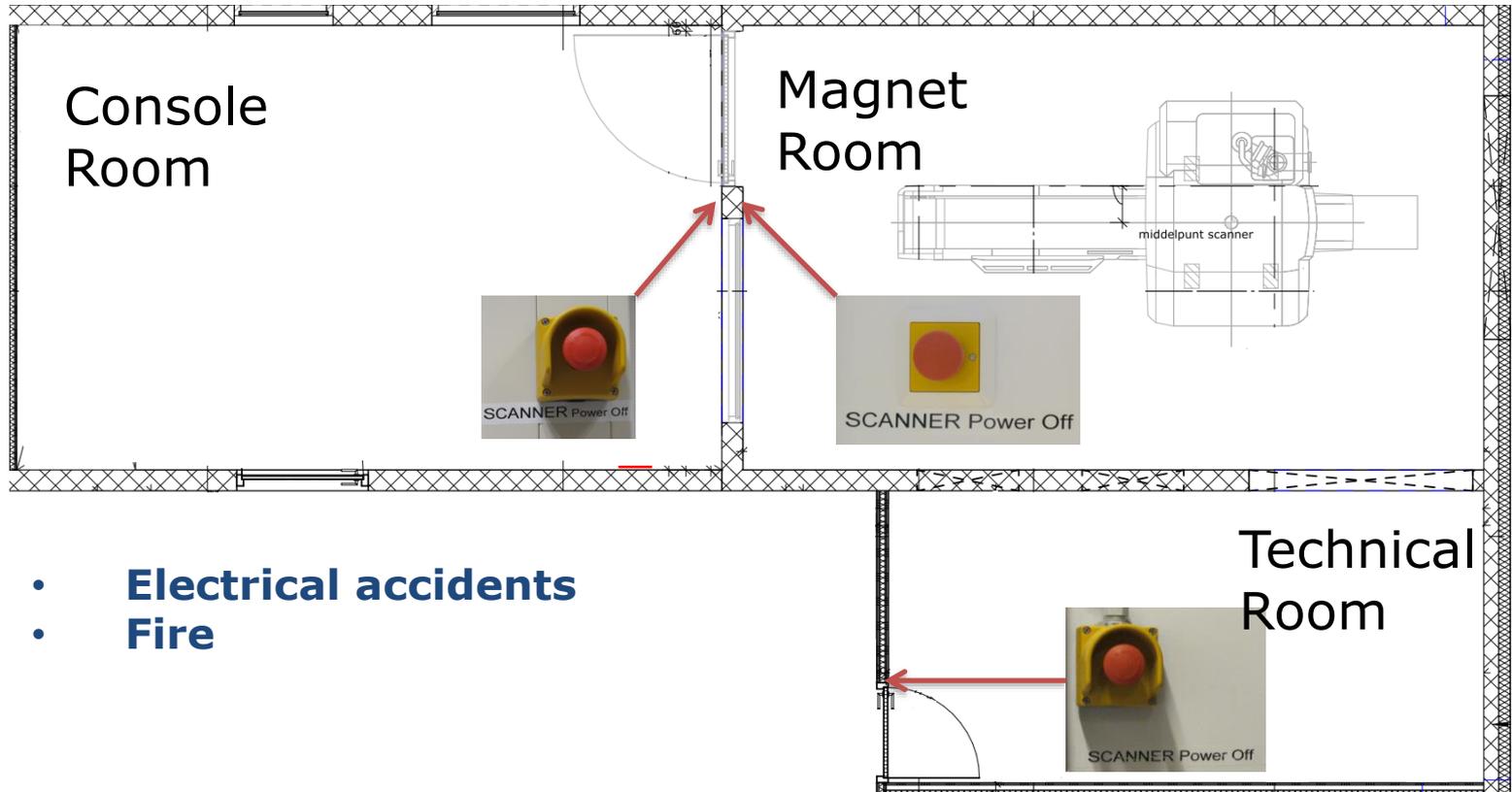
Emergency buttons
Prisma

Table stop



- **Cables or clothing stuck**
- **In case of power failure, additional handle to pull the tabletop manually out of bore**

Electrical shutdown



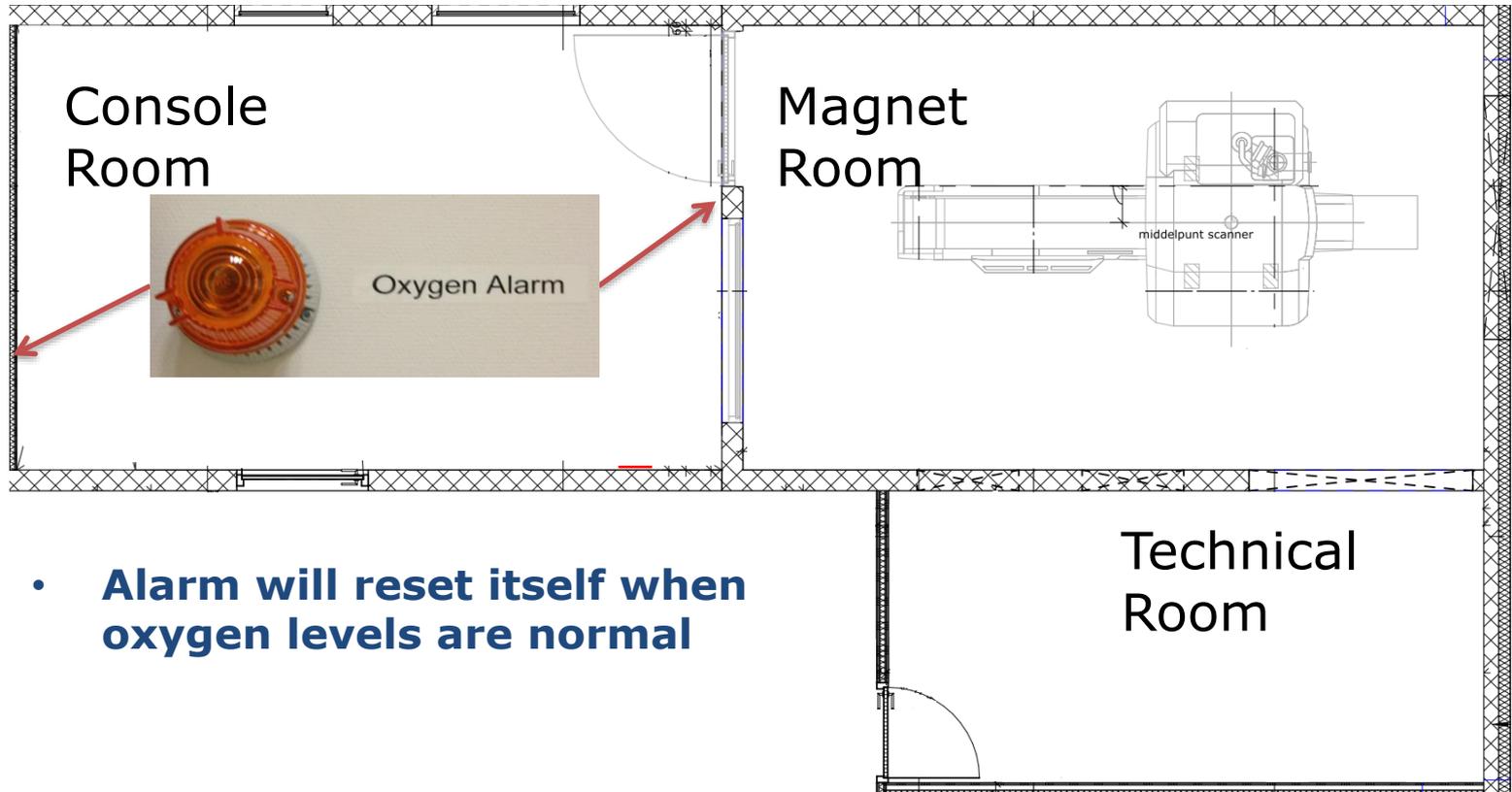
- **Electrical accidents**
- **Fire**

Magnet discharge



- **Use in life-threatening situations only!**
- **Big fire**

Oxygen alarm



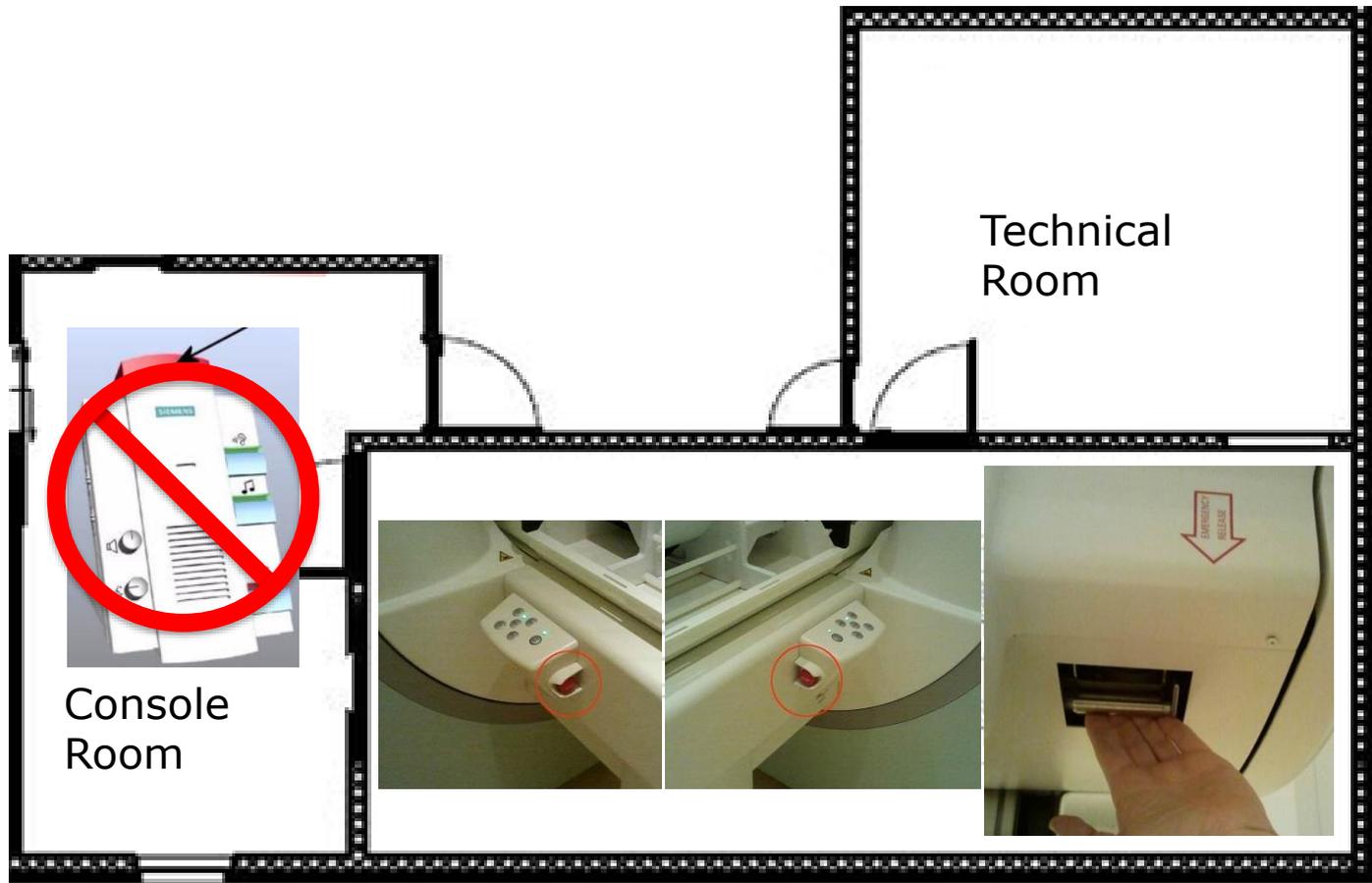
- **Alarm will reset itself when oxygen levels are normal**



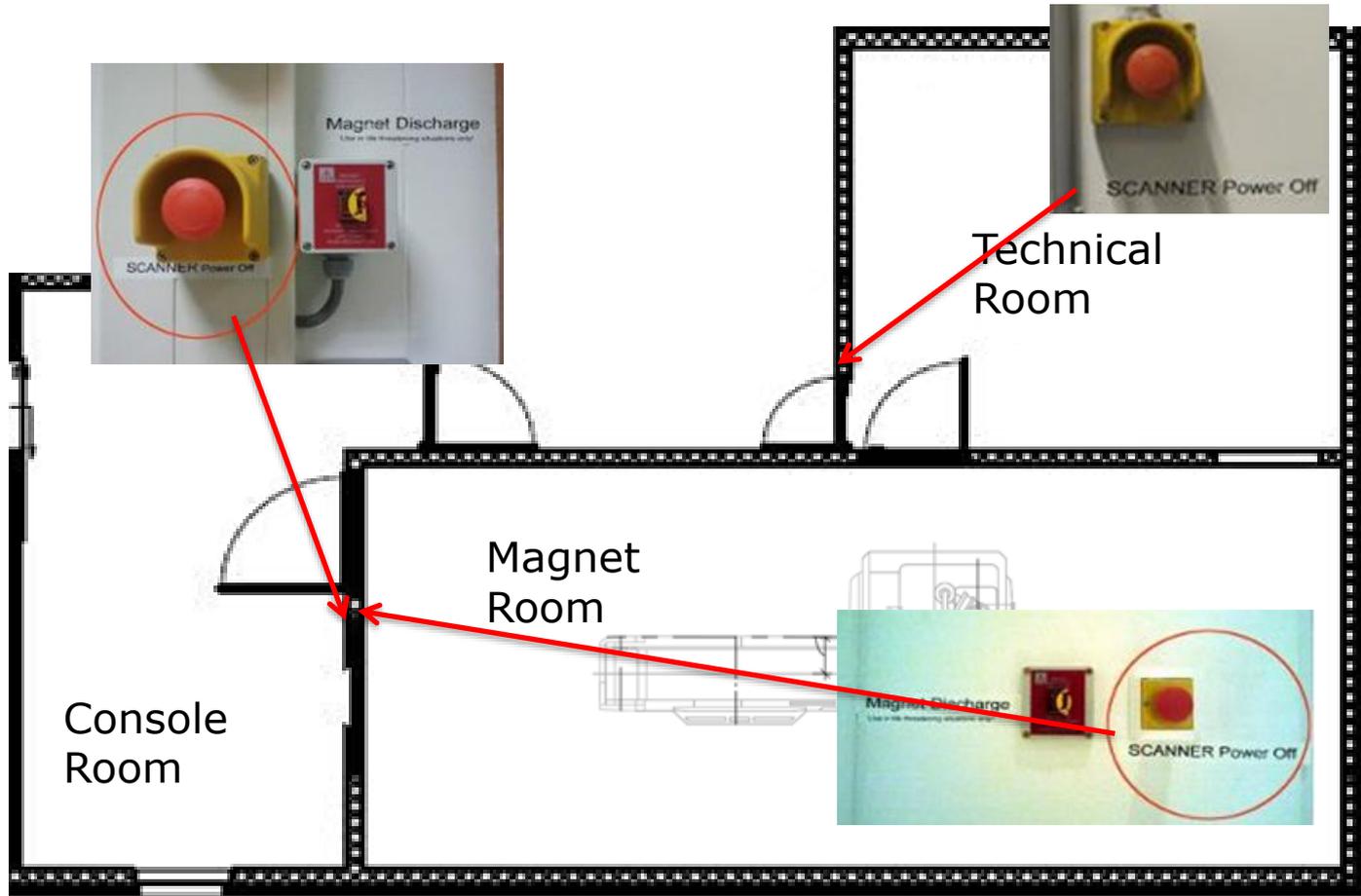
Magnet Safety Training

Emergency buttons
7T

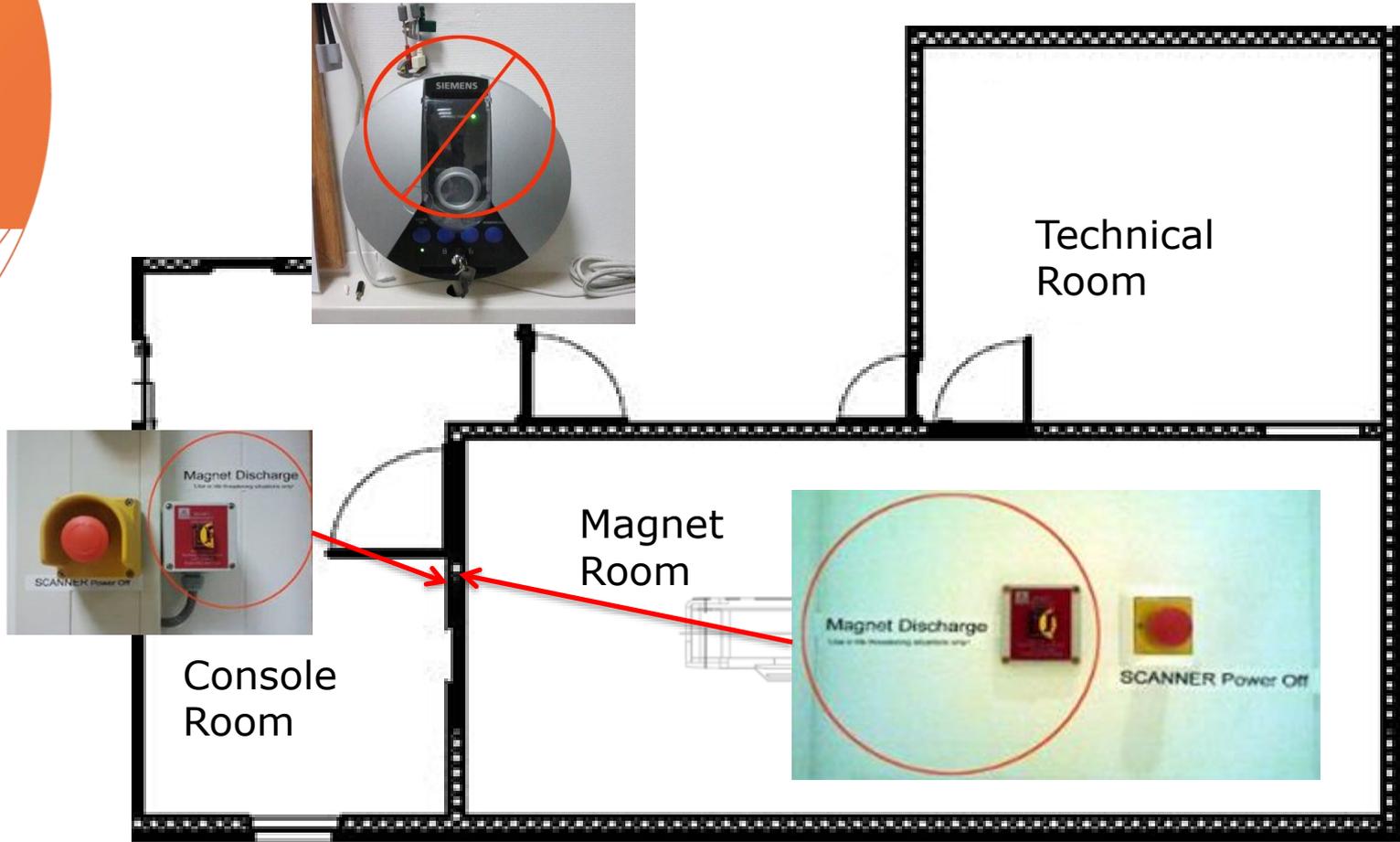
Table stop



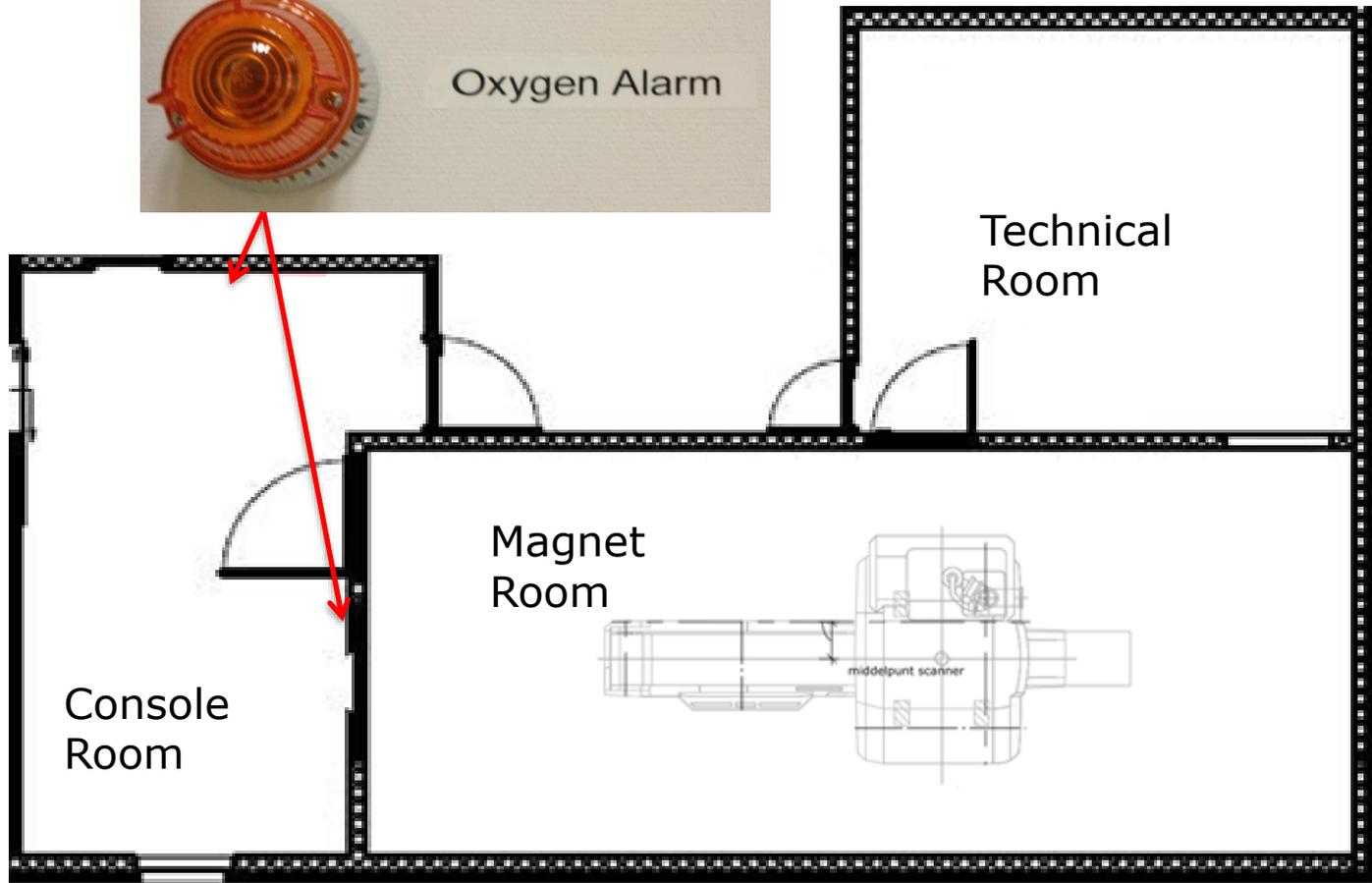
Electrical shutdown



Magnet discharge



Oxygen alarm

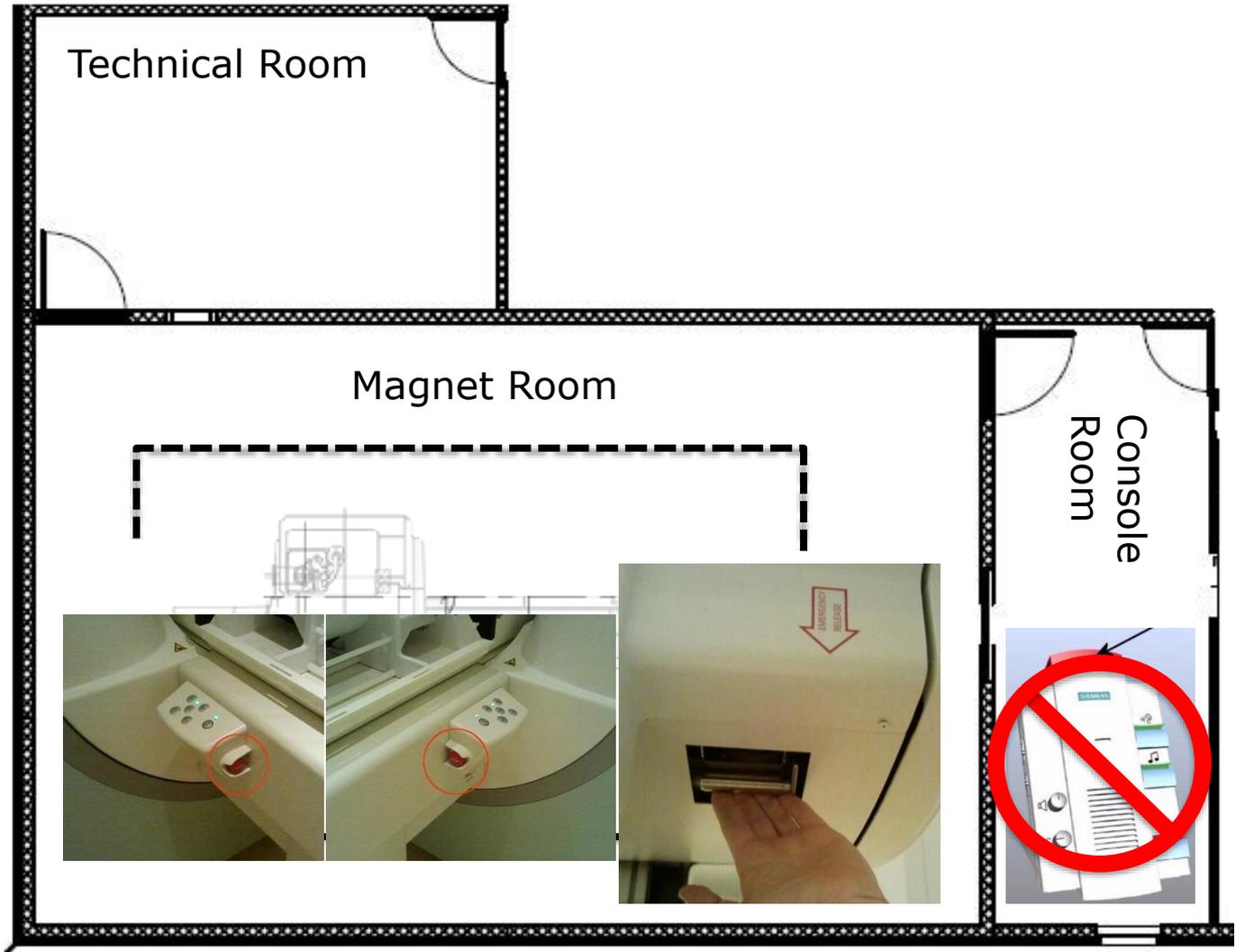




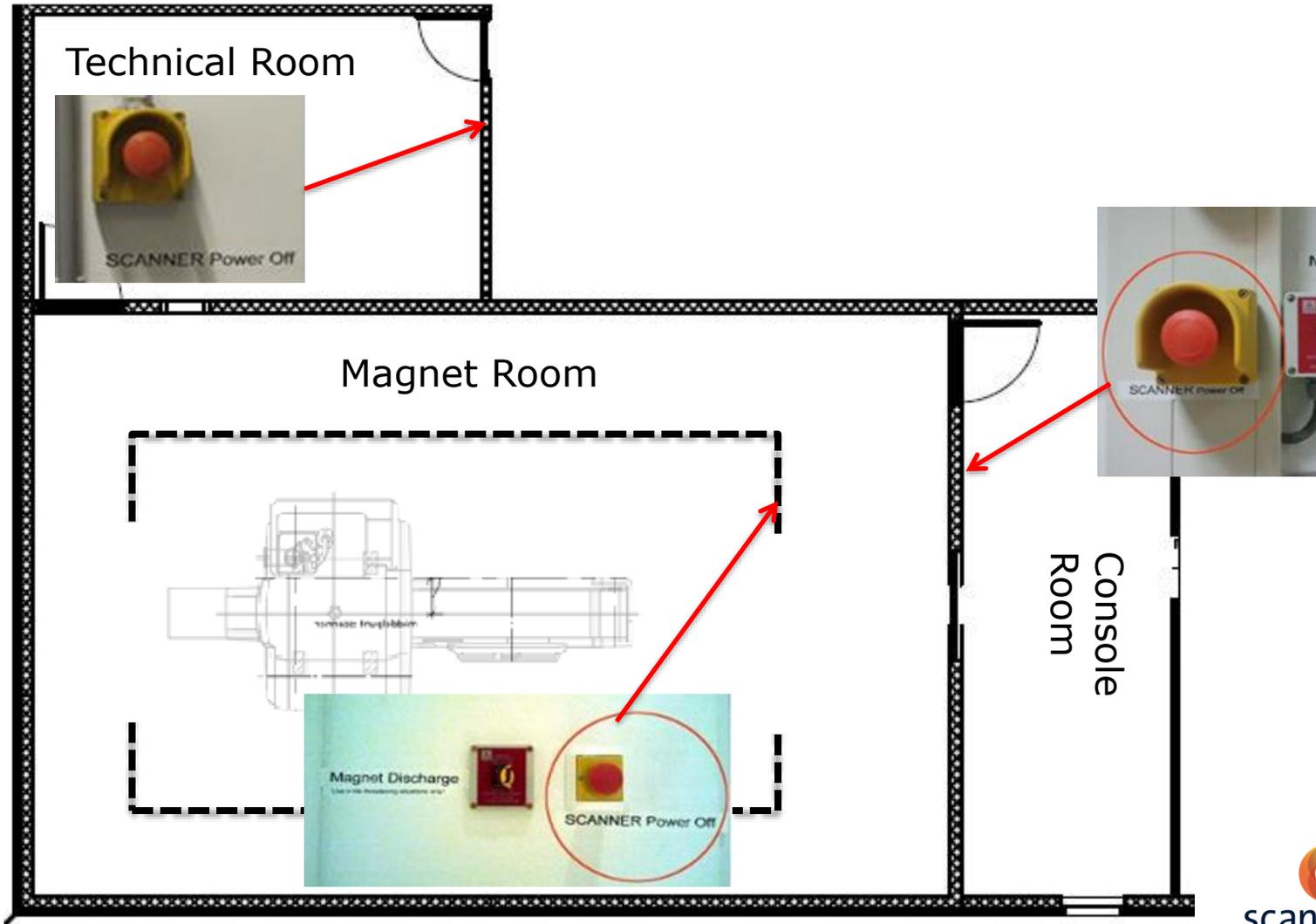
Magnet Safety Training

Emergency buttons
9.4T

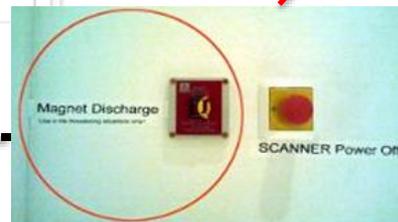
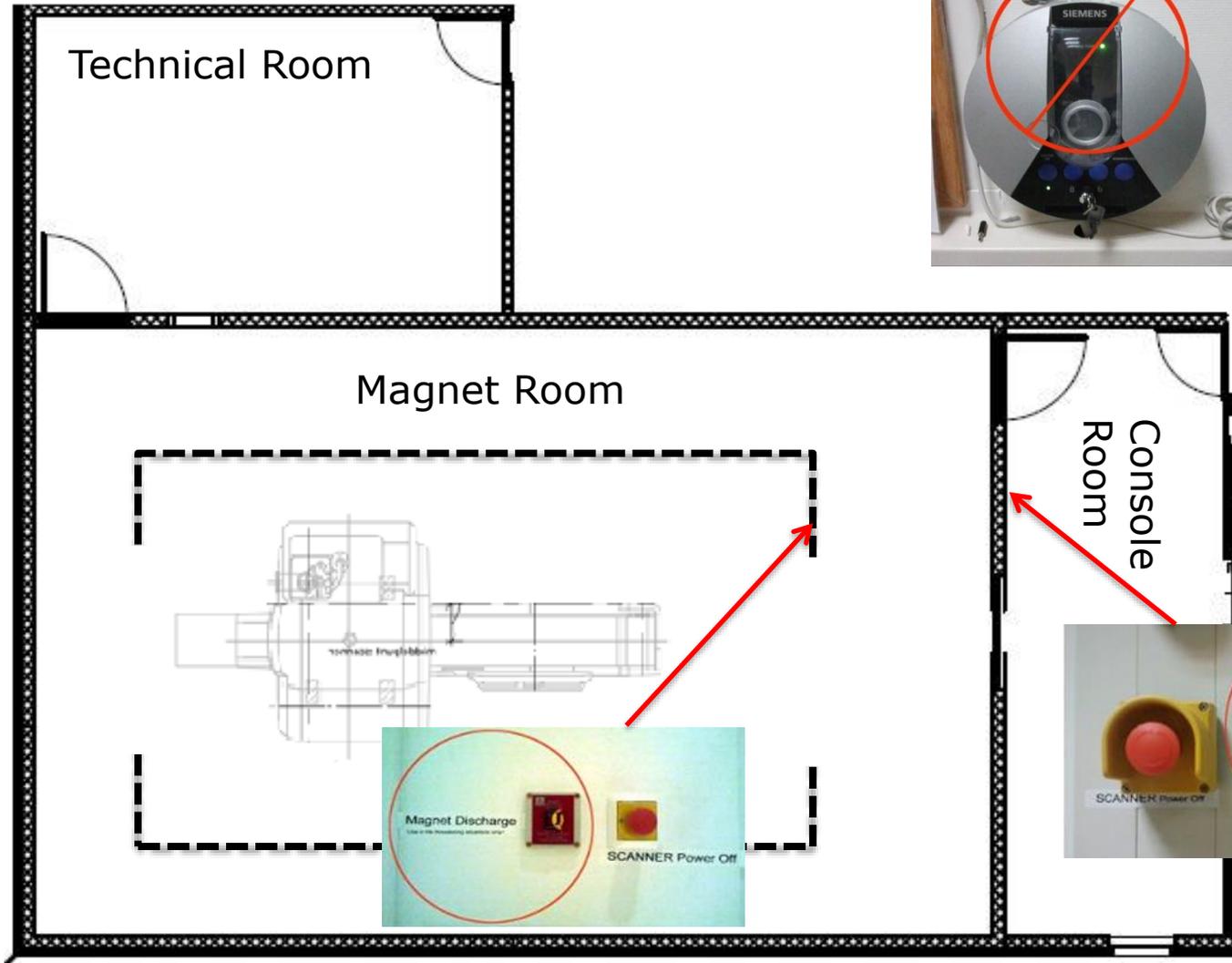
Table stop



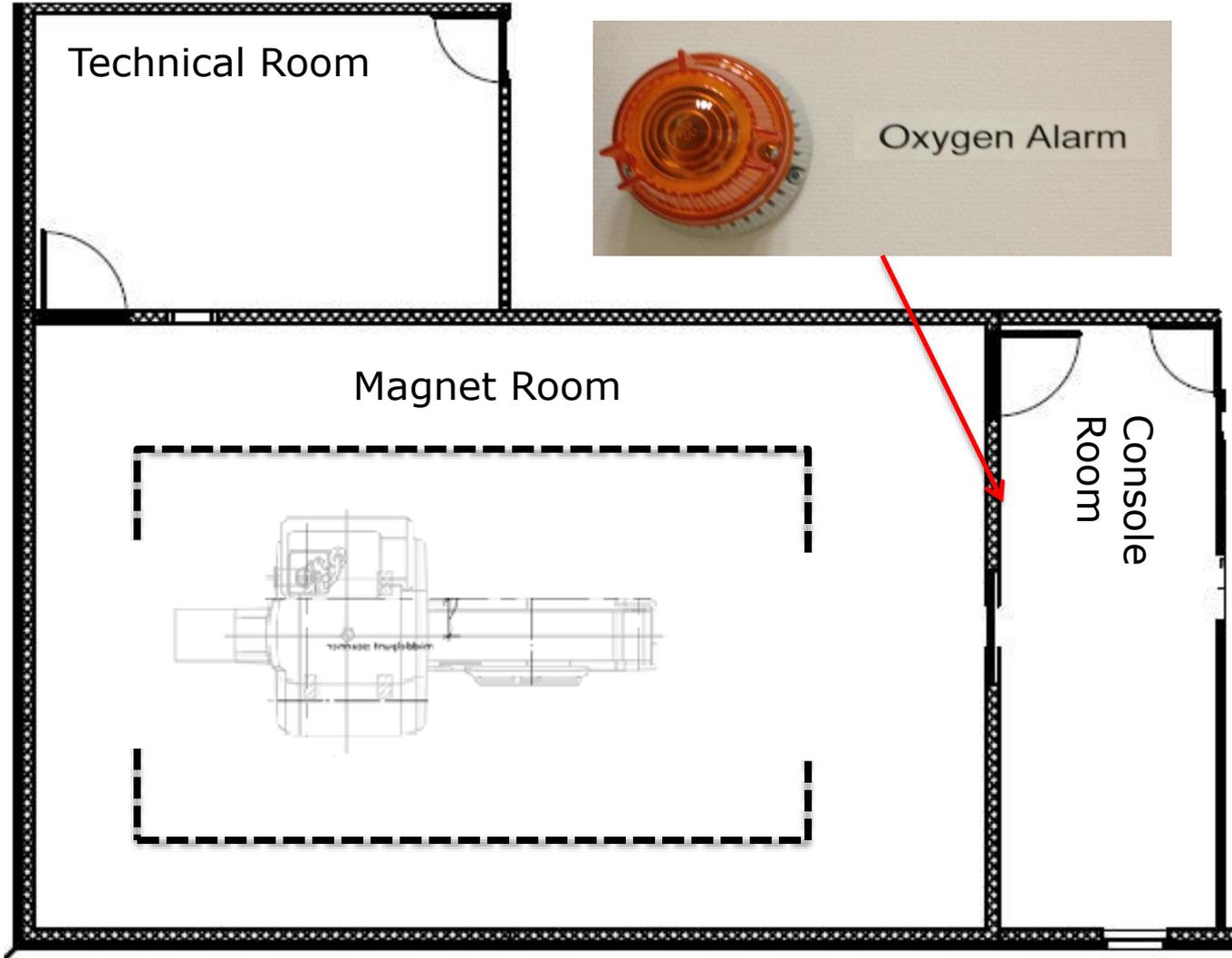
Electrical shutdown



Magnet discharge



Oxygen Alarm





Magnet Safety Training

Access rules



MTP access profile

MTP (Magnet Trained Personnel) access profile:

- After completion MST, 24/7 access to the Scannexus Scannerlab via UM (guest)card.
- No access to key cabinet, MR rooms.

Do not hand over your access card to others to provide them access to the labs!

Yearly Online Refresher MST

confluence.scannexus.nl/quiz/course/view.action?qs=rL42Rj87NbM3mNwtoWgLw1yELDvqU5px%2F%2FwEowgz6WJeF2fE%2BfbOLAsT6EP9U09uKwOp8b%2FrPIqt...

Apps Scannexus Calpendo Log In - Confluence Log In - Scannexus... Service Request Global LifeNet | Sie... System Dashboard... SURFfilesender Other bookmarks

scannexus Spaces People Learning Create

Scanner lab Safety training 2021 CU

- Introduction
 - Introduction
- Emergencies
 - Introduction - Emergencies
 - Medical Emergencies
 - Quench
 - Quench in case of life-threatening si...
 - Quench - buttons
 - Oxygen Alarm
 - Oxygen Alarm - How to act
 - Fire
 - Fire - floorplan

Introduction

Welcome to the magnet safety refresher.

We aim to keep your knowledge up-to-date in a time-efficient way. The refresher discusses frequently asked questions as well as topics that are not fully discussed in the class magnet safety training.

The exam at the end of the refresher consists of question about those topics, but also about assumed basic knowledge.

If you failed after three attempts, you will be invited for the class magnet safety training.

This refresher consists of 3 parts:

1. Theory about emergencies situations (updated, since the last online safety training the guidelines were updated with more details about how to act in emergencies situations (see chapter 5.2 of the guidelines)).
2. Theory about subject safety
3. Exam

Completed



Rules

The Scannexus Staff have the authority to ask anyone present within the MR scanner rooms to immediately leave these areas. Such a request must be immediately obeyed by said person.

Do not leave uncertified people (for example interns/ students) without you in the rooms (including the room with the mock scanner!).

Tours

- When a visitor or group wants to see the labs:
 - Approval of Scannexus is required.
 - You must be accompanied by a member of the Scannexus staff.
 - Submit the request at least 24 hours in advance.
 - A timeslot will be booked in Calpendo.
 - Do not enter the magnet rooms.
 - Do not enter the console rooms during a scan session or maintenance.
 - **Remember you are responsible for their safety!**



Magnet Safety Training

European and
GUFU guidelines



European and GUFi guidelines

European guide for minimum of safety requirements to risks regarding workers being exposed to Electro Magnetic Fields is available. It contains specific guidelines for MRI.

- <http://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=7845&type=2&furtherPubs=yes>
- <http://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=7846&type=2&furtherPubs=yes>

GUFi (German ultrahighfield) guidelines

- https://mr-gufi.de/images/documents/Approval_of_subjects_for_measurements_at_UHF.pdf



Magnet Safety Training

Cases



Cases

Suddenly you hear a loud bang and a rushing sound. What might be going on and how should you act?



Cases

What do you do when your subject forgot to take off his/her belt and he/she is already in the MR room?



Cases

What do you do if a pen flew into the bore while your subject is inside and the pen sticks to the magnet bore?



Cases

What if this pen got stuck in his/her arm?



Cases

You are scanning and see an artefact (signal drop) in your image which might be caused by some metallic implant. You were not aware of any implant. What should you do?