

MR Systems Engineering: Siting the System

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Highlights

- Think of all the activities you will be performing in and around the system
- Where will the 5 Gauss line fall - is it practical to keep the general public out this region
- Large, moving, metal objects close to the scanner will affect your images
- Electrical items introduce noise into your images so think about shielding and filtering

Planning is the key

There are many details to be considered when siting the system, but in all the detail it can be easy to miss something critical to the day-to-day use. It is therefore essential to start the siting process by thinking about how the system will actually be used. Questions to ask include:

- What kind of scanning is happening - high throughput clinical; research studies; fMRI?
- Does your patient group have specific needs - clinical environment for critically ill; non-clinical environment for research studies; hoists; trolley access?
- How many patients or subjects will be waiting at one time? How many staff will be around and what will they be doing?
- Will subjects need to get changed? Where will they lock their valuables or ferromagnetic items?
- What might you want to do in the future?
- Can the system be replaced or upgraded in the future? Is there room for helium dewars to enter or gradient coils to be replaced?

Keeping everyone safe

Most regulators require keeping the public outside the 5 Gauss (0.5 mT) fringe field of the magnet. This is usually done by arranging the room layout to create a 'controlled area', secured in some way.

If it is not possible to contain the 5 Gauss field within the layout then it is possible to incorporate steel shielding in the walls of the magnet room to contain the field. It is important to remember that the fringe field will also extend above and below the magnet, so consideration needs to be given to what the impact will be on other floors.

Magnet siting arrangements

Other things that need to be considered in the magnet siting include:

- Large, moving, metal items will affect the homogeneity of the field - how close is the scanner to car parks, lifts, hoists or other scanners?
- What other equipment needs to function in the fringe field - will it work?
- Is the building construction able to carry the weight of the scanner? Will the stability of the images be affected by building vibrations?
- Will the acoustic noise generated by the scanner affect those working nearby?
- What will happen if the magnet quenches and several thousand litres of helium boil off? Is there appropriate provision of ducting, extraction fans and oxygen monitoring?

RF Shielding

Any environmental RF radiation may be detected by the scanner and appear as artefact in the images. To avoid this the scan room should have a continuous RF shield.

- What construction will the RF shield be? Copper is versatile; Aluminium is easier to construct?
- Will you test the shielding yourself or rely on installer's tests?

- Will you have any electrically conductive cables going into the room? They will need to be filtered.
- Will you have non-conductive cables going into the room (e.g. fibre optics). They can go through waveguides.

fMRI Stimulus Presentation

Some facilities will want to present visual stimuli to subjects. There are three main options:

- Projectors placed inside or outside the magnet room. Can be a cheap solution.
- LCD screens. These will need to be magnet safe and RF filtered.
- Close fitting goggles or screens. These offer very good quality, but are expensive.

More general siting questions to ask

Modern scanners have quite high electrical power and chilled water requirements. If you are replacing an old system it is possible that the existing facilities are not sufficient. Other questions you might want to ask include:

- How is access to controlled areas managed? - RFID cards or key locks are preferable to magnetic swipe cards.
- Are there enough electrical and network sockets? Is there space to store coils, phantoms and other equipment?
- Is the magnet room lighting MR compatible?

Summary

- Think about all the activities you will be performing in and around the system before you start.
- Where will the 0.5 mT line fall? Is it practical to keep the general public or staff out of this region?
- What is nearby that could affect or be affected by the system?
- Is the room suitably RF shielded?

Useful documents

- Vendor site planning guides
- ACR Guidance Document on MR Safe Practices. *JMRI* **37**(3), 501-530 (2013)
- Medical electrical equipment - Particular requirements for the basic safety and essential performance of magnetic resonance equipment for medical diagnosis. IEC 60601-2-33