Time-varying Magnetic Field Gradients

What is it?

MRI scanners contain additional coils of wire inside the magnet bore. These coils create linear changes (gradients) in the magnetic field with respect to position inside the bore of the magnet and are used to form the MR image. The gradients are switched on and off very rapidly during imaging resulting in the loud knocking noise that can be heard.

What are the units?

Gradient performance is often described in terms of maximum amplitude in millitesla per metre, e.g. 50mT/m, and the slew rate (how fast the gradient amplitude can be changed), e.g. 200 T/m/s. The change in magnetic field (dB) with time (dt) in the bore can be described by dB/dt, however this value will be specific for a given location in the bore of the scanner , consult your scanner technical documentation for details.

Why is it important?

Switched field gradients can interact with implants and may cause device heating or vibration / movement.

Are there different limits for implants?

Implants that are MR conditional may specify maximum slew rate or maximum dB/dt as one of the conditions.

If the maximum slew rate is specified as an MR Condition then this is typically stated as the maximum slew rate achievable by the machine. This value can be found in the technical documentation of the scanner.

Maximum dB/dt is less often stated as an MR Condition. The technical documentation of the scanner will specify the maximum dB/dt that is achievable. The scanner may also calculate and display the maximum dB/dt for each sequence and this may allow scanning of implants that have lower limits.

Further Reading:

Scanner technical documentation

MHRA 2016: Safety Guidelines for Magnetic Resonance Equipment in Clinical Use, https://www.gov.uk/government/publications/safety-guidelines-for-magnetic-resonance-imaging-equipment-in-clinical-use

https://www.sor.org/learning/document-library/safety-magnetic-resonance-imaging/6-timevarying-gradient-magnetic-fields-dbdt