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A Fast Field-Cycling MRI system for clinical applications

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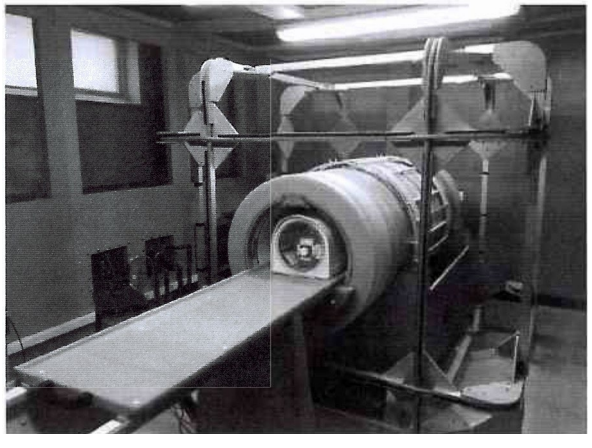
Fast Field-Cycling MRI[1] (FFC-MRI) is a novel MRI technique in which the external magnetic field is switched during the imaging experiment. By doing this, FFC-MRI grants access to information, which is invisible to conventional MRI scanners, including the variation of T1 with magnetic field.

The construction of an MR imaging system capable of rapidly switching magnetic fields, and reaching ultra-low fields requires novel magnets, power supplies and control electronics.
Here we describe progress on a new whole-body human sized FFC imaging system.
The magnet (Tesla Engineering Ltd, Storrington, UK) is of a resistive design with a length of 2 m and an inner bore diameter of 500 mm. The main magnet is comprised of three identical coils embedded in epoxy resin.

Each of the BO coils is driven by a rack of 6 current amplifiers (IECO, Helsinki, Finland). The maximum total current supplied to the magnet is 1800 A, corresponding to a maximum field strength of 0.2 T (8.52 MHz proton Larmor frequency) with a maximum slew rate of 10 T/s. The scanner is also equipped with a set of three orthogonal 2-metre-wide square Helmholtz coils (Figure 1) centred on the isocentre of the magnet to provide earth's field cancellation, allowing a minimum BO of less than 1 μT (42 Hz) to be achieved over a 30 cm DSV.



The gradients and RF system are controlled by a commercial MRI console (MR Solutions Ltd, Guildford, UK) while the main magnet coil, shim coils and earth-field cancellation coils are controlled by a dedicated computer running in-house software written in Labview (National Instruments, Austin, US). The main magnetic field is controlled by a 16-bit DAC which provides a field resolution of 3 μT.

1. Lurie, D. J. et al. Fast field-cycling magnetic resonance imaging. Comptes Rendus Phys. 11, 136, 148 (2010).

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