In vivo human brain imaging at 0.2 T using a whole-body fast field-cycling MRI system

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Purpose: Fast Field-Cycling (FFC) instruments change the main magnetic field strength $B_0$ during the pulse sequence. With FFC it is possible to obtain image contrast from the dispersion of $T_1$ over a range of field strengths1. In a typical pulse sequence the field strength is switched from a polarising field, $B_{0p}$, to an evolution field $B_{0e}$, at which relaxation processes of interest occur, before switching to a detection field $B_{0d}$. FFC requires bespoke magnets, power supplies and ancillary equipment.

Methods: A number of FFC instruments are presented in the literature2-6. Most are dual magnet designs in which $B_{0d}$ is supplied by one magnet, the second magnet providing offset for $B_{0e}$. Our magnet (Fig.1) consists of three copper coils, co-wound on a cylindrical former, and potted in epoxy resin (Tesla Engineering Ltd, Storrington, UK). At 2040 mm long, 500 mm bore, it is suitable for human subjects. The magnet has a bare inductance of 5 mH and resistance of 85 mΩ per channel, each requiring 650 A to attain the 0.2 T field specified. The current is supplied by a purpose-built bank of high-power gradient amplifiers (International Electric Co. Oy, Helsinki, Finland).

Results: Fig. 2 shows a transaxial spin-echo FFC image of the brain of a healthy volunteer. Acquisition parameters were: 64x64, field-of-view 300 mm , slice thickness 10 mm, TE 10 ms, TR 1500 ms, field ramp time 20 ms, polarization time 500 ms, $B_{0p} = B_{0e} = B_{0d} = 196$ mT (8.34 MHz proton frequency).

Discussion and conclusion: Our next step is to employ $B_{0e}$ control to obtain images with $T_1$-dispersion contrast. We are also working on methods of compensating for environmental magnetic fields, including use of the external correction coils visible in Fig. 1.

References