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 strengths[1]. 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 literature[2-6]. 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. Acquistion 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).

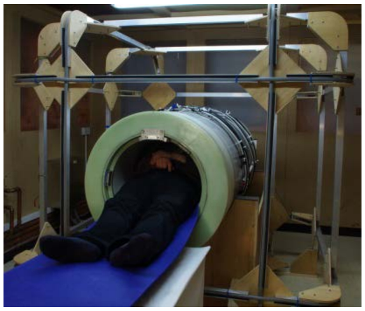

Fig. 1: 0.2 T whole-body FFC imager.

Fig.2: Transaxial image through volunteer's brain.

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

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