DESIGN AND CONSTRUCTION OF A 0.2 T SYSTEM FOR WHOLE-BODY FIELD-CYCLING MRI

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Introduction

Fast Field-Cycling (FFC) MRI is a developing technique which enables imaging with contrast based on relaxation dispersion over a range of magnetic field strengths[1]. The essential feature is that the field strength is changed during a pulse sequence, allowing evolution at any magnetic field of interest before returning to the fixed 'detection field' for data acquisition. Switching the field requires unconventional magnets, power supplies and ancillary devices. Here, we describe a new whole-body human-scale FFC apparatus.

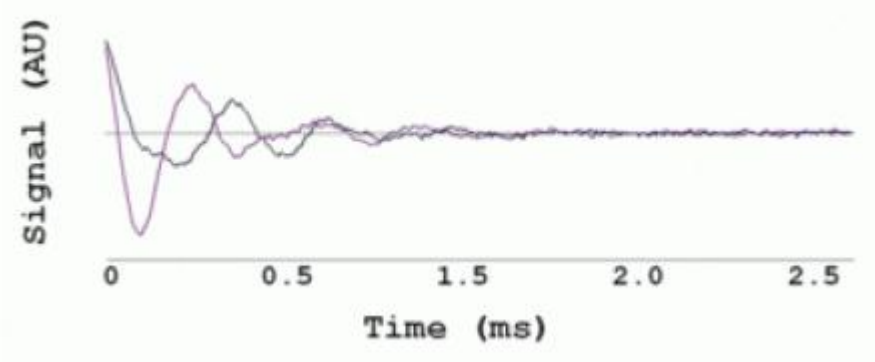
Methods

Several FFC apparatus have been described previously. Typically, they are dual-magnet designs in which a stable and homogeneous field from one magnet (superconducting or resistive) used for read-out is offset by a secondary electromagnet[2-6]. In this work, for increased flexibility, a single-magnet design was employed, with exacting requirements for field homogeneity and stability.

The magnet (Figure 1) consists of three co-wound copper coils on a cylindrical former, embedded in epoxy resin (Tesla Engineering Ltd, Storrington, UK). Its length is 2040 mm, and the bore has an inner diameter (net of the gradient assembly) of 500 mm suitable for human subjects. Per channel, its inductance is 55 mH and DC resistance 0.29 Ω, requiring a current of 650 A to generate its design field strength of 0.2 T. This current is provided by a specially-made bank of high-power gradient amplifiers (International Electric Co. Oy, Helsinki, Finland) with a custom control system.

Results

Initial commissioning and testing of the system has been carried out. First results are promising, with field stability and shot-to-shot reproducibility within acceptable limits. An un-shimmed FID NMR signal from a sample of distilled water doped with $CuSO_4$ is shown in Figure 2.



Conclusion

The single-magnet FFC-MRI system will have increased flexibility compared to our earlier dual-magnet system. Furthermore, benefits will accrue from the higher detection field (0.2 vs. 0.06 T) and faster field ramp time (20 vs. 40 ms). Work is continuing to implement B_0 shimming and then fully characterise the apparatus for imaging experiments. Once fully in operation, the system will be used to explore further the clinical benefits of field-cycling[7].

References

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