FIELD-CYCLING MAGNETIC RESONANCE IMAGING – A CURIOSITY OR THE NEXT BIG THING?

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The use of Fast Field-Cycling Magnetic Resonance Imaging (FFC-MRI) is a relatively new variant of MRI, aimed at increasing its medical diagnostic potential [1].

FFC-MRI was first demonstrated in conjunction with Proton-Electron Double-Resonance Imaging (PEDRI) to image the distribution of free radicals in biological samples using the Overhauser Effect (combined NMR and Electron Spin Resonance (ESR). Field-cycling allows the ESR irradiation to be applied at low field (hence relatively low frequency, and low non-resonant absorption), while NMR signal detection and imaging is carried out at higher field, to preserve SNR [2].

NMR relaxometry is usually accomplished using FFC, by switching the magnetic field rapidly between levels during the pulse sequence. In this way, a single instrument can be used to measure T_1 over a wide range of magnetic field strengths. FFC-MRI aims to obtain spatially-resolved T_1-dispersion data, by collecting images at a range of evolution field strengths [1,3,4]. We have demonstrated methods for implementing relaxometry on localised regions defined on a pilot image [5]. We have also shown that FFC relaxometry can detect the formation of cross-linked fibrin protein from fibrinogen *in vitro*, in a model of the blood clotting process, via the measurement of ^{14}N-^{1}H cross-relaxation phenomena [6], and we have shown that FFC-MRI can detect changes in human cartilage induced by osteoarthritis [7]. Recent work has focussed on speeding up the collection of FFC-MRI images by incorporating rapid MRI scanning methods and improved pulse sequences and algorithms [8,9].

In our lab we have built a range of FFC-MRI equipment, including two whole-body human sized scanners, operating at detection fields of 0.06 T [10] and 0.2 T. The 0.06 T scanner uses a double magnet, with field-cycling being accomplished by switching on and off a resistive magnet inside the bore of a permanent magnet; this has the benefit of inherently high field stability during the detection period. We have also demonstrated technology for localised field switching within a clinical MRI system [11].

This presentation will cover the main techniques used in FFC-MRI and will summarise current and potential bio-medical applications of the methods.

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*These references are available at *http://www.ffc-mri.org/publications*