Fast Field-Cycling Magnetic Resonance Imaging

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Fast Field-Cycling Magnetic Resonance Imaging (FFC-MRI) is a relatively new variant of MRI, aimed at increasing its medical diagnostic potential by introducing a new dimension, namely the magnetic field strength [1]. FFC-MRI is able to obtain spatially-resolved T_1-dispersion data, by collecting images at a range of evolution field strengths [1,2,3]. The first use of FFC-MRI was in conjunction with Proton-Electron Double-Resonance Imaging (PEDRI) to image the distribution of free radicals in biological samples, making use of the Overhauser effect [4].

We have built two whole-body human sized scanners, operating at detection fields of 0.06 T [5] and 0.2 T. The 0.06 T scanner uses a double magnet, with field-cycling being accomplished by switching the current flowing in a resistive magnet within the bore of a permanent magnet; this has the benefit of inherently high field stability during the detection period. The 0.2 T system uses a single, resistive magnet, giving increased flexibility in pulse sequence design. The collection of T_1-dispersion images using FFC-MRI is inherently slow, due to the extra magnetic-field dimension. However, it is possible to accelerate data collection by an order of magnitude by incorporating rapid MRI scanning methods and improved pulse sequences and algorithms [6,7].

Our work has 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 [8]. We have also demonstrated that FFC-MRI can detect changes in human cartilage induced by osteoarthritis [9]. Recent work has demonstrated significant differences in T_1-dispersion curves obtained from cancerous and normal tissues.

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

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Project web sites: `www.ffc-mri.org` `www.identify-project.eu`

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