TECHNIQUES AND BIOMEDICAL APPLICATIONS OF FIELD-CYCLING MRI

David J. Lurie, Lionel M. Broche, Gareth R. Davies and Kerrin J. Pine

Biomedical Physics, School of Medicine & Dentistry, University of Aberdeen, Foresterhill, Aberdeen AB25 2ZD, United Kingdom
E-mail: d.lurie@abdn.ac.uk www.ffc-mri.org

In fast field-cycling (FFC) NMR, the magnetic field is switched between levels during the pulse sequence; the "fast" in the name implies that the field is switched in a time short compared with the sample's T_1 relaxation time. FFC has been used for several decades for relaxometry measurements (T_1 as a function of field strength) of small samples. In our laboratory we have combined FFC with MRI using a number of techniques [1].

An important application of FFC is imaging free radicals using Field-Cycled Proton-Electron Double-Resonance Imaging (FC-PEDRI). Irradiation of the free radical's ESR causes a transfer of polarisation from electron spins to coupled nuclear spins (the Overhauser effect), resulting in a difference in image intensity. FFC allows the ESR irradiation to be applied at low field (so relatively low frequency, and low non-resonant absorption), while NMR signal detection and imaging is carried out at higher field, to preserve SNR. We have previously constructed two FC-PEDRI scanners [2,3].

Relaxometric MRI can also be achieved using FFC. The aim is to obtain spatially-resolved T_1 versus magnetic field data, by collecting images at a range of evolution field strengths. We have recently demonstrated methods for implementing relaxometry on localised regions defined on a pilot image [4]. 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 [5]. This relies on ^{14}N-^{1}H cross-relaxation phenomena, also known as "quadrupole dips" in the T_1-dispersion plot [6].

We have recently built a single-magnet FFC-MRI system with signal detection at 0.5 T, and we are nearing completion of a whole-body human FFC-MRI scanner with detection at 0.2 T.

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