5 June
1:00pm

Fast Field-Cycling Magnetic Resonance Imaging

David J. Lurie , Lionel M. Broche, Gareth R. Davies, Nicholas R. Payne, P. James Ross and Vasileios Zampetoulas

Aberdeen Biomedical Imaging Centre, University of Aberdeen, AB25 2ZD, Scotland, UK

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 T1-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.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 668119 (project "IDentIFY").
Project web sites: **www.** ffc-mri. org **www.** identify-project. eu

References:

[1] Lurie D.J., Aime S., et al., *Comptes Rendus Physique* **11,** 136-148 (2010).
[2] Carlson J.W., Goldhaber D.M., et al., *Radiology* **184,** 635-639 (1992).
[3] Lurie D.J., 1st Symposium on Field-Cycling NMR Relaxometry, Berlin, p5, (1998).
[4] Lurie D.J., Hutchison J.M.S, et al., J. *Magn. Reson.* **84,** 431-437 (1989).
[5] Lurie D.J., Foster M.A., et al., *Phys.Med.Biol.* **43**, 1877-1886 (1998).
[6] Ross, P.J., Broche, L.M., and Lurie, D.J., *Magn. Reson. Med.* **73,** 1120-1124 (2015).
[7] Broche, L.M., Ross, P.J., Pine, K.J. and Lurie, D.J., J. *Magn. Reson.,* **238,** 44-51 (2014).
[8] Broche L.M., Ismail S.R., et al., *Magn.Reson.Med.* **67,** 1453-1457 (2012).
[9] Broche L.M., Ashcroft G.P and Lurie D.J., *Magn.Reson.Med.* **68,** 358-362 (2012).