Field-Cycling MRI: a New Imaging Modality?

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Much of the contrast in conventional MRI arises from differences in the NMR relaxation times, especially the spin-lattice relaxation time, T_1. It is also well known, from *in vitro* measurements on small tissue samples, that the variation of T_1 with the strength of the applied magnetic field B_0 (known as T_1-dispersion) is tissue-dependent, and that the shape of a tissue's T_1-dispersion curve is altered in disease. However, T_1-dispersion is invisible to conventional MRI scanners, because each scanner can only operate at its own native magnetic field (e.g. 1.5 T, 3.0 T). The aim of our work is to exploit T_1-dispersion as a new MRI contrast mechanism, by building new types of MRI scanner which make use of Fast Field-Cycling (FFC) [1].

In FFC, the applied magnetic field is switched rapidly, while the sample (or patient) is inside the scanner. Thus, the nuclear magnetisation can be made to evolve at a range of magnetic field strengths, allowing the measurement of T_1-dispersion. The magnetic field is always switched to the same value prior to measurement of the NMR signals, so that the instrument's radiofrequency system does not require retuning during the procedure.

In our laboratory we have built two whole-body human sized FFC-MRI scanners, one of which makes use of a dual magnet in order to achieve field switching [1,2]. The detection field of 59 mT is provided by a vertical-field, permanent magnet. Inside its bore is located a resistive magnet which generates an opposing magnetic field; field-cycling is achieved by switching the current in the resistive magnet coil.

We have begun to explore bio-medical applications of FFC-MRI, and early results have shown promise in the areas of thrombosis [3] and in osteoarthritis [4], where the technique seems to be an indicator of early disease-related changes. FFC-MRI is showing significant potential as a new variant of MRI. Please consult our web site (www.ffc-mri.org) for further information.

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8th European Conference on Medical Physics, Athens, Greece, September 2014.
Published as *Physica Medica* **30(S1)**, 8-9 (2014).