Recent Progress in Fast Field-Cycling MRI

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Field cycled techniques in NMR provide information on molecular dynamics at the scales that are difficult to study by other techniques, especially for non-invasive applications. This particularity makes it an interesting tool for medical research as important tissue remodelling can be observed in the extra-cellular space in many diseases, though relatively little is known on their molecular dynamics due to the lack of non-invasive techniques.

Our team has been developing FFC MRI scanners for medical purposes during the last two decades, the most recent device being the fourth generation of FFC MRI scanners. Our efforts during the last years have been focusing on the development of a stable resistive scanner reaching sub-microtesla fields with improved acquisitions techniques. That scanner can reach up to 0.2 T with ramps of 10 T/s and has produced several proof-of-concept *in vivo* images of volunteers in minutes, thanks to the developments of improved pulse sequences adapted for field-cycling.

In addition to this we are also exploring the potential applications of FFC NMR/MRI in medicine, thanks to partnerships with clinicians from Aberdeen Royal Infirmary. We have investigated several diseases of particular relevance such as cancer, osteoarthritis or liver fibrosis, by measuring the T_1 dispersion curves of thrombus, fibrotic liver, tumours and cartilage. Several sources of contrast appear across various diseases, such as the quadrupolar peaks and the presence of multiple dispersion regimes in the background, though their physical interpretation remains difficult to determine so far.

Finally, our team is also developing new strategies to measure ^{14}N-^{1}H cross-relaxation effects faster and more accurately, as this interaction provides useful information in various diseases such as cancer or osteoarthritis.

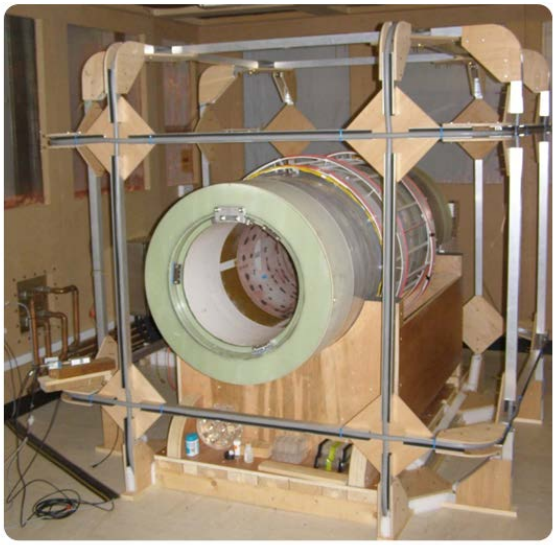

Figure 2: 0.2 T FFC MRI scanner currently developed at Aberdeen. The main field is generated by the cylindrical magnet, which is surrounded by square coils designed for earth field compensation.

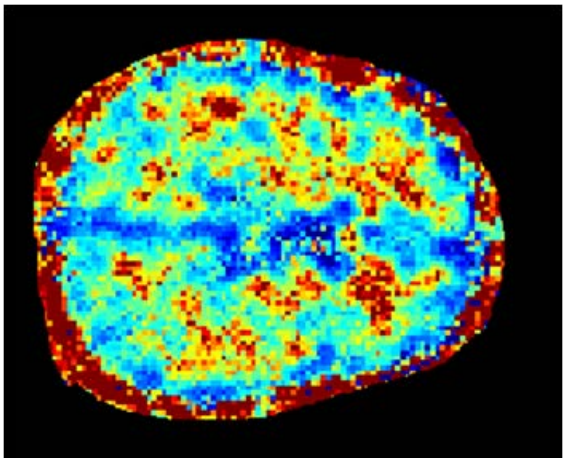

Figure 1: FFC MRI image of a volunteer's brain processed to show quadrupolar peak contrast. The original images were obtained by FFC spin echo.