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Performance assessment of a small animal Fast Field Cycling MRI system used for the measurement of R_1-dispersion profiles over the range 1 to 2 T

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Fast Field Cycling (FFC) MRI[1] offers a new degree of freedom in contrast manipulation by switching rapidly the magnetic field B_0, enabling to access the NMRD profile for tissues. State-of-the-art systems generate, within milliseconds, offsets going up to ±500 mT for preclinical applications[2,3], and up to 200 mT for clinical ones[4]. Similarly to static field applications, inversion-recovery-prepared sequence could be performed to map T_1 at various fields around B_0. To do so, the inversion time comprises a time evolution during which relaxation occurs at a different field prior to imaging.

Here we present NMRD profiles around 1.5 T of dispersive and non-dispersive contrast agents[5,6], measured by inversion recovery. Multiple ΔB field shifts (46mT steps) were generated using a fast field cycling magnet (Stelar s.r.l., Mede, Italy) capable of providing ΔB = ±0.5T, inserted into a 1.5T MRI system (Philips Achieva). Multiple inversion times were applied (Fig1, T_Δ log-scaled from 0ms to 800ms) to obtain sufficient precision in a large range of T_1 values. Data were fitted all at once to a relaxation model including the inverted magnetization at TI=0, the equilibrium magnetization at 1.5T, and the relaxation rates R_1(ΔB) at the various applied ΔB.

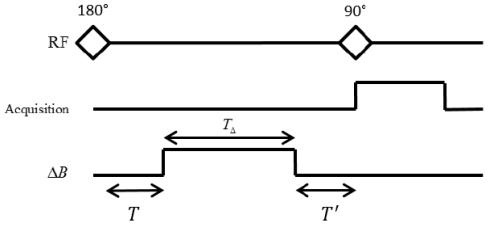

Fig.1 : Inversion recovery based sequence comprising an additional field offset during T_Δ with delays T=10ms and T′=13ms.

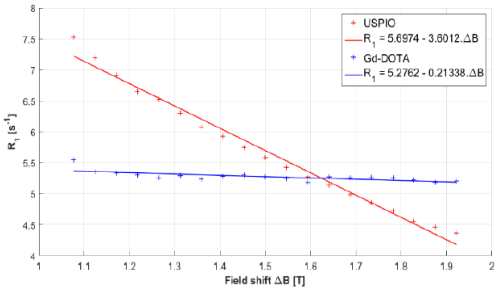

Fig.2 : NMRD profile of Gd-DOTA (1 mM) and Molday-ION CL-30Q02-02 (0.3 mM) with linear fit around 1.5T.

Fig.2 shows ΔB-resolved NMRD profiles, acquired in a few minutes in the range 1-2 T using a FFC-MRI system. As expected ION displays strong dispersion with a slope of -3.6 $s^{-1}.T^{-1}$ around 1.5T with a visible curvature, while Gd-DOTA dispersion is small but measurable[5,7]. Future work will focus on producing images at various ΔB field shifts for biological samples and in vivo tissue measurements.

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