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Simulation of Fast Field-Cycling MRI inversion-recovery pulse sequences to inform experimental parameters.

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Fast Field-Cycling MRI (FFC-MRI) has the ability to access contrast invisible to conventional scanners – that resulting from the dependence of T1 on magnetic field strength. FFC-MRI inversion-recovery experiments which use multiple inversion times at multiple magnetic field strengths take a long time to conduct thus the two-point method, requiring a single inversion time at each field, is often used. The accuracy of either method is dependent on the inversion time(s) chosen. It is therefore useful to attempt to optimise this parameter prior to conducting potentially lengthy scans.

Simulation of a FFC-MRI inversion-recovery sequence mapped a-priori T1-dispersion data onto the known variation in the magnetic field during each experimental cycle, giving the sample's T1 as a function of time throughout the sequence. The Bloch equations were used to track the longitudinal magnetisation of the sample throughout the experiment in 100 µs time-steps; this was denoted as the 'signal' at the point of the 90°-pulse.

After scaling, the simulation was found to match the original data from a sample of cross-linked BSA with an R2 value of >0.995 at a number of inversion times and field strengths (Fig. 1).

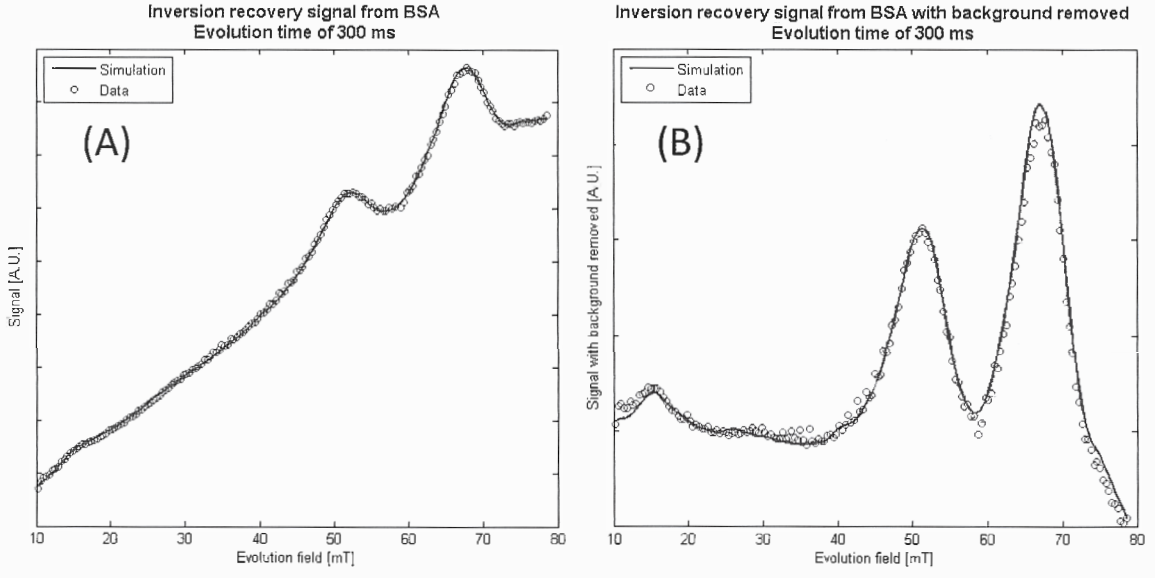

Figure 1 – ***(A)*** *Signal from a sample of BSA from a FFC IR sequence with a fixed evolution time of 300 ms as predicted by the simulation (red line) and overlaid with real data from an FFC-MRI scanner (blue circles) [R-squared = 0.9998]. The peaks in the signal are caused by a reduction in T1 when the NMR frequency of the protons in the sample is resonant with a NQR frequency of immobilised Nitrogen nuclei.* ***(B)*** *When the background signal is removed the effects from cross-relaxation with the Nitrogen nuclei are isolated.*