Supporting information:



**Figure S1:** Pulse sequence used for the measurement of low-field longitudinal relaxation of water protons on the sample shuttle apparatus. Narrow filled and wide open rectangles represent 90° and 180° pulses respectively. The recycle delay was 5 s, up and down were between 60 and 200 ms, depending on the low-field position. The stabilization delay st was 250 ms. The phase cycle is 1 = {x, y}; 2 = {x, x, -x, -x, y, y, -y, -y}; and acq = {x, -x, -x, x, y, -y, -y, y}. The inversion of proton polarization every other scan leads to a decay of measured intensities (or integrals) towards zero. The delays Trel were adapted to the relaxation rates at each low field. Ten different delays were chosen and two were repeated. The difference between the minimum and the maximum delays Trel varied between 250 ms and 3.5 s for the USPIO solution and between 0.8 and 1 s for the GadospinTM solution.