Increasing Spectral Bandwidth for High Field Echo Planar Spectroscopic Imaging with a with a Two-Shot Approach

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Introduction: Echo Planar Spectroscopic Imaging (EPSI) is one of several established approaches to speeding up spectral acquisitions from multiple voxels (1-3). With bipolar multiple gradient echo readouts, combining positive and negative polarity echoes has always been problematic due to phase mismatches between the odd and even lines in k-space (4). Furthermore, as field strengths higher than 1.5 T become more widely available, spectral bandwidths must be increased and the requisite reductions in EPSI echo spacings become difficult to achieve. Here, we demonstrate, at 3 T, a two-shot approach in which the odd echoes and even echoes from the two scans are combined to provide two, artifact free spectra per voxel with twice the bandwidth available from either the odd or even echoes of a single EPSI scan alone.

Methods: Figure 1 shows the two-shot EPSI approach in which the EPSI readout of scan 2 is shifted forward by one echo so that for scans 1 and 2, odd echoes are collected under positive polarity conditions and even echoes are collected under negative polarity conditions, respectively. The method was applied to the calf of a healthy volunteer using 96 gradient echoes, 0.75 ms echo spacing, 96 x 96 spatial matrix, 5 mm thick slice, 1 s TR and a 3.2 minute scan time. Spectra from a ~ 1 ml voxel in bone marrow were analyzed.

Results and Discussion: The two spectra shown in Figure 2 were reconstructed from the odd and even echoes of scan 1, respectively, with the wraparound artifacts clearly showing the limitations of the 666 Hz bandwidth at 3 T. Figure 3 shows the two spectra obtained by combining the odd echoes of both scans and by combining the even echoes of both scans. The bandwidth of 1333 Hz yields typical fatty marrow spectra (5) with the small olefinic peak furthest to the left and the prominent methylene resonance some 450 Hz to the right of the small water peak which is situated around -150 Hz. The low signal-to-noise of EPSI acquisitions will generally require signal averaging. The approach suggested herein offers a simple and practical way to gain the advantages of signal averaging while also increasing spectral bandwidth and avoiding odd/even echo artifacts arising from bipolar EPSI readouts.

Figure 1

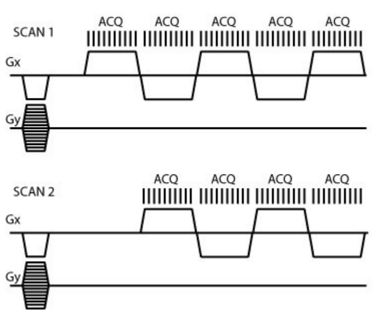


Figure 2

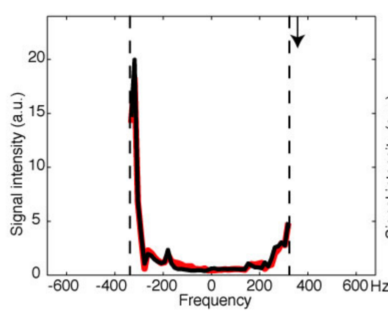
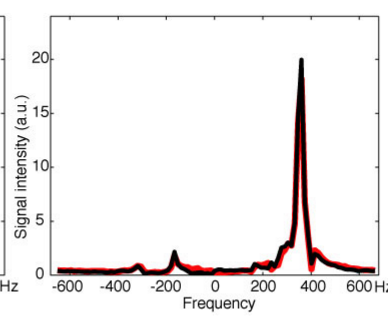


Figure 3



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