Bioengineering 278: Magnetic Resonance Imaging Laboratory
Winter 2011
Lab 4

EPI. In this lab, you will observe and correct the effects of time shifts and resonance offset in EPI. Place a phantom in the birdcage head coil and insert into scanner. Use the UCSD generated pulse sequence called spepgj, which supports both EPI and spiral image acquisition. Prescribe a single axial slice with 64x64 resolution, spin echo, set the frequency encode direction to R/L, and set CVs: gtype=1 (EPI); ia_gyep1=0 (turn off Y dephaser); ia_gy=0 (turn off blip gradients); skipline=0; reps=1; dda=0. Record the value of the CVs: skip; pw_xcyc, tsp (the sampling time in μs). Autoprescan and then scan. In manual prescan, misset the X shim by 10 units and rescan. Return the X shim to the original value, and set CVs: ia_gyep1=u; ia_gy=u. Check that both CVs are reset to non-zero values. Scan, set the X shim off by 10 units and rescan. In this pulse sequence, EPI data is collected using a single readout that covers all 64 echoes. The data appears in raw time order. In order to reconstruct the data, you will need to extract the individual echoes from the echo train, discarding the (skip/2) data points before the first echo, and the (skip) points between echoes that are collected on the gradient ramps. Even numbered echoes should be reversed in time, and 2D FT performed. The resulting image will likely have significant Nyquist Ghosts that are dominated by time shifts between even and odd echoes.

1) **Correction of Nyquist Ghosts.** The Fourier shift theorem states that a shift in K-space can be simulated (or corrected) by applying a phase ramp in image space (after row FT). From the first data set, measure and report the time shift for each echo, using the center echo as a reference (this can be done using complex division of each echo by the reference echo after 1D FT of each echo) (**6 points**). Use these measured time shifts to correct the third data set by multiplying your data after row FT by exp(j(A*x)) where x is the x location in pixels (centered at pixel 33), and A is the phase slope measured above. Reconstruct the image from the third data set with and without this correction. The correction should remove Nyquist ghosts (**6 points**).
2) **Off resonance effects in EPI.** Repeat the above process using the data with misset X shim (the second and fourth data sets). Use the measured time shifts to calculate the gain of the shim system (gradient per unit shim offset) and compare with Lab 3. (**8 points**)