Bioengineering 208: Magnetic Resonance Imaging Laboratory
Winter 2007
Lab 5- Week of 2/5

1. **Chemical Shift in MRI**. Place a phantom with both water and fat/oil in the birdcage coil.
   - **a. Magnitude of Chemical Shift.** Acquire a 256x256 full echo spin echo image at the lowest bandwidth available. Save the raw data. Repeat with the frequency/phase directions swapped. From the image data, measure the chemical shift of the fat relative to the water (σ). Check the data acquisition window (the duration of the readout gradient) on the scope to make sure the bandwidth means what you think it means. Hint: a bandwidth of X on a GE scanner means that the Larmour frequency ranges from –X to X across the FOV during readout.
   - **b. Dependence on FOV.** Repeat the scan with a different FOV. Does the chemical shift in cm, or the chemical shift in pixels stay constant? Why?
   - c. **Dependence on the Matrix size.** Repeat the scan with the original FOV at 512 resolution in the readout direction. What happens to the chemical shift?
   - d. **Phase shifts from chemical shift.** Reconstruct a phase image from the data from part 1a. What is the relative phase of the fat compared to the water? Collect an SPGR gradient echo image at the same FOV and matrix size, also full echo, at a TE of ($2/\sigma$). The bandwidth may need to be high to do this. Save the raw data. Repeat with TE=($2.5/\sigma$). Reconstruct phase images from these data and describe the phase relationship between water and fat at these two values of TE.
2. **Signal to Noise Ratio.** Place any phantom with signal in the birdcage coil. A simple measure of SNR in a magnitude image is the mean value of the signal in a ROI of the phantom divided by the mean value of a patch of background outside the phantom. The noise outside of the phantom in a complex image should have zero mean, but in a magnitude reconstructed image, the background has a funny distribution (Rayleigh) because of the magnitude operation, and the mean value is non-zero and proportional to the standard deviation of the complex noise.
   - a. **Dependence on bandwidth.** Collect 256x256 spin echo images at two bandwidths, for all other parameters constant. Predict the relative SNR and compare with your measurement.
   - **b. Dependence on FOV.** Increase the FOV by about 20%, predict the relative SNR, and compare with your measurement.
   - **c. Dependence on matrix size.** At the original FOV, reduce the resolution in the phase encode direction to 128 and rescan. Leaving the phase encode resolution at 128, increase the frequency encode resolution to 512 and rescan. Predict the relative SNR and compare with your measurements**.**
   - d. **Effect of 'no phase wrap' on SNR.** At the original 256x256 resolution, collect an image with NEX(averages)=2. Change NEX back to 1 and switch on the 'no phase wrap' option. Note the relative scan times, and predict and measure the relative SNR. If there is nothing to wrap, how do you choose between NEX=2 and 'no phase wrap'? Hint: Where does motion artifact energy go in the two scans?