Bioengineering 208: Magnetic Resonance Imaging Laboratory
Winter 2007
Lab 4- Week of 1/29

1. **Off resonance distortion in EPI.** In this exercise, you will estimate the resonance offset in a phantom using two different methods, and compare your results. Place the pink cylindrical GE phantom with structure in the birdcage coil. You will be using our in-house EPI sequence, called spep_product, and doing offline reconstruction of EPI images using a c program called gr, which outputs raw 16 bit images. First, scan the phantom using a conventional GRASS scan with 15 cm FOV, 5mm slice skip 5 from I60-S60. Somewhere around I30 and/or S30 will be a slice that is a circle with a clean black bar across the center. This is the slice you will be using.
    a. **In the first method, you will be using the off resonance dependent distortion to estimate the resonance offset of a point in the image.** Find a portion of the image that is visibly distorted. You can do this by comparing EPI images with conventional images. Acquire two gradient recalled EPI image of the phantom, one using the default phase encoding gradients, and a second using inverted phase encode gradients. The inversion is accomplished by inverting the sign of the CVs a_gyep1 and a_gy. The second image will reconstruct upside down relative to the first, because the gradients were inverted without the recon software's knowledge. These two images will have off resonance related spatial distortion that are opposite in direction, and should allow you to estimate the shift in pixels. Using the oscilloscope, measure the period and/or total duration of the EPI readout, and use this, combined with the pixel shifts to calculate the resonance offset at your chosen point. (How much phase shift across the readout train gives one pixel of spatial shift?)
    b. **In the second method, you will be measuring the resonance offset using the phase of the signal at two different gradient echo TEs.** Acquire a third image of the phantom at a TE that is 4ms longer than in part a. Reconstruct phase images at the two values of TE using the "-imgtyp" option in gr, and calculate from the phase difference the resonance offset at your chosen point. Compare with part a.

   c.

2. **T2* blurring in EPI.** In this exercise, you will be estimating the T2* of a point in your phantom using two different methods. In order for this to work, you must choose a point in the phantom that has a sharp edge, such as the edge of the bar running across the slice in part 1 above.
    a. **In the first method, you will be using the blurring of the edge to estimate T2*.** Measure the image profile across the nominally sharp edge. Convince yourself that the derivative of this profile is the local PSF. In principle, you could FT this PSF into a T2* decay curve, but this would require a very accurate measurement of the complex PSF and is not likely to work with our data, given the additional resonance offset related distortion. A simple but crude way is to simulate various T2* decay curves across the EPI readout, and FT them to find estimated PSFs. Adjust the T2* until the calculate PSF has the same width as the measured local PSF. The T2* that generates the best fit for the PSF is your estimate of T2*.
    b. **In the second method, you will measure T2* more directly, using the magnitude data from images acquired at 2 different values of TE.** Experiment with different echo times until you generate a significant signal drop in the longer TE and can calculate T2*. You data for part 1b may or may not suffice for this. Calculate T2* in your region of interest, and compare with your estimate from part 2a.