Bioengineering 278: Magnetic Resonance Imaging Laboratory
Winter 2009
Lab 2- Week of 1/12

1. **Understanding the basic spin echo imaging sequence.**
    a. Place a large phantom in a birdcage coil and position in scanner. Scan the phantom using a spin echo pulse sequence with xres=256, yres=128, rhexecctrl=11 to save raw data. Record the values of the CV area_gz1, the area of the slice rephaser in G/cm-us. Calculate and set the required reduction in area_gz1 in order to generate a phase shift of π across the width of your slice. Scan again. Verify the reduction in the area of gz1 using the oscilloscope. Further reduce area_gz1 to generate a phase shift of 2π across your slice. Scan again.
        i. From the first image, calculate what the intensity of your second image would be if the slice profile was a perfect rect function. Generate an image of the difference between this ideal calculated second image and your actual second image. Repeat for the third image. (5 points)
    b. Return area_gz1 to it's default value. Record the value of CVs: a_gx1, pw_gx1, pw_gx1a, and pw_gx1d. These are the amplitude and pulse widths of the readout dephaser gradient, with the a and d suffixes denoting the attack and decay of the trapezoidal gradient. Repeat the scan with the value of a_gx1 reduced by a factor of 2. Generate images of the magnitude of the raw data before FT for both data sets. Generate images of both the magnitude and phase of the images after FT.
        i. Why is the echo located where it is in the two scans. Write a mathematical expression for the location of the echo as a function of a_gx1. (3 points)
        ii. Why are the phases of the images different? Write a mathematical expression that describes the relative phases of the two images as a function of the position x along the frequency encode direction and the changes in the area of gx1. (3 points)

2. **Calculate proton density, T_1, and T_2 maps from spin echo data.** Place a large phantom with some structure (ie not a simple sphere or cylinder) in a volume coil. Collect spin echo images at 5 values of TE for a fixed TR, and 5 values of TR for a fixed TE. From the images:
    a. **C**alculate a map of the relative proton density (times RF sensitivity) of the phantom. (3 points)
    b. Calculate a map of the T_1 of the phantom. (3 points)
    c. Calculate a map of the T_2 of the phantom. (3 points)