Bioengineering 208: Magnetic Resonance Imaging Laboratory
Winter 2007
Lab 3- Week of 1/22 ***** MODIFIED *****

1. **Coherence Pathways.** Place the BIRN phantom in the birdcage coil Acquire 2-echo spin echo images from a single slice through the phantom under the conditions described in the Table to the right (RF2 refers to the refocusing RF pulse). Use the pulse sequence 'mempecw' and TE=20,40. Observe the pulse sequence on the oscilloscope and make sure you know what all the pulses are doing.

Run	RF2 Flip Angle CVs:ia_rf2, ia_rf22	RF2 Phase CV:rf2phase
1	180	90
2	180	0
3	90	90
4	90	0

   a. **Using the data from Run 1 as a reference, calculate the expected signal in echo 2 of Runs 2-4.** You can do this using the transformation matrix from the Hennig paper (also on slide 5 of the lecture). Solution for echo 1: For a 90° - A° sequence, you have $[F_1; F_1^*; Z_1; Z_1^*]=[1\ 0\ 0\ 0]$ prior to the A° pulse. After the A° you have $[\cos^2(A/2); \sin^2(A/2)\ \sin(A)/2\ -\sin(A)/2]$. The only component of this that will give an echo after the second 90° is F_1^*, so the echo amplitude will be $\sin^2(A/2)=\{1, 0.5\}$ for $A=\{180, 90\}$. For the second echo, there are two pathways that may be present: double spin echo and stimulated echo. Three things can happen:
      i. These two pathways add constructively (CPMG echo train).
      ii. These two pathways add destructively (non CPMG echo train).
      iii. The sequence is cleverly set up so that the stimulate echo cannot form.

      Calculate the expected echo 2 signal for these 3 cases, and compare with your data from Runs 2-4 (5 points)
   b. Look VERY carefully at the pulse sequence on the oscilloscope. What features of the sequence tell you whether Run 1 is a CPMG echo train or whether the stimulated echo pathway is destroyed. Explain. (5 points)
2. **Gradient echoes.** Place the BIRN phantom in the birdcage coil. You will be scanning the phantom using a single axial slice:
   a. **Understanding the pulse sequence diagram.** For each of the following pulse sequences, observe the RF and 3 gradient channels on the oscilloscope. Observe both the amplitude and phase of the RF pulses. Sketch all pulses within one TR interval and label each pulse. Describe as precisely as you can in words the function of each pulse in each sequence. Be sure to point out the key differences between the sequences. (5points)
      i. **SPGR (spoiled GRASS)**
      ii. **GRASS**
      iii. **FIESTA**
   b. **Resonance offset sensitivity in FIESTA (balanced SSFP, FISP).** Using the FIESTA sequence, determine the gain of the manual X shim adjustment (in G/cm per unit shim offset). (5 points)