Bioengineering 208: Magnetic Resonance Imaging Laboratory
Winter 2008
Lab 7- Week of 2/18

1. **Phase Contrast MRA**. In this exercise you will be using a phantom for the first part, and a human for the second part. You can use the higher SNR 8 channel coil because we will let the scanner do the recon this week.
   a. **Flow compensation and flow weighting gradients.** In this part, you will be calculating the relative flow moment of a generic SPGR sequence, a flow compensated version of the sequence, and a flow weighted version of the sequence. Place a phantom in the scanner. Prescribe a 2D spoiled gradient echo sequence, and observe and sketch the pulse sequence using the oscilloscope. Measure the timing and amplitude of the slice select and refocusing gradients. The voltage can be converted to G/cm using the (volts/amps) scale labeled on the gradient amp test point, and a scaling of 4G/cm at 250A. Turn on the 'flow comp' option and note which gradient lobes change. Measure the timing and amplitude of the flow compensated slice select gradients. Prescribe a 2D phase contrast MRA with Z encoding and a VENC of 50cm/s, and measure the timing and amplitude of the flow encoding gradients. Calculate the flow moment of the slice select gradients with and without flow comp, and the flow weighting gradients. Approximate the gradients as rectangular lobes (neglect the ramps). Calculate the VENC from the flow moment.
   b. **Phase contrast MRA in the neck.** Place a human in the scanner. Collect axial localizer scans below the brain and look for a slice where all the major vessels going in and out of the head are clear and appear to be flowing straight north/south. Collect a 2D phase contrast image in this plane at 5mm slice thickness, 256x256 matrix, minimal FOV to encompass the anatomy, Z only encoding with VENC=50cm/s, and NEX=1. Check the image for wraparound in the velocity (ie |V|>VENC). Increase VENC if necessary, and recollect with more NEX if the image looks noisy. Calculate from the image the total blood flow into the head (in ml/s), and the total blood flow out of the head. Compare the inflow and outflow to each other, and to a rough literature value for total brain blood flow. Are you in the right ballpark?

2. **Time of Flight MRA.** In this exercise, you will compare flow velocities calculated directly using phase contrast MRA, and indirectly using TOF MRA. Place a human in the scanner. Choose any vessel of interest you like, preferably one with a nice straight section. Aorta, carotids, and vena cava are all good choices.
    - **a.** Acquire a 2D phase contrast image of the vessel with a VENC that does not wrap, and with enough resolution to measure the flow velocity well.
    - **b.** Acquire a 3D TOF image of the vessel, with the location of the 2D PC image at the proximal edge of the 3D slab. Use 64 partitions (slices), 256x256 matrix, and a slice thickness of 1mm for the carotids, or 2mm for the aorta or vena cava. Use a TR of 30ms and adjust the flip angle so that the vessel of interest fades from bright to dark across the thickness of the slab. Measure the decay of the vessel signal as a function of distance into the slab, and from this decay curve estimate the velocity of flow. You might get some clues from the matlab code that was used to generate the TOF signal curves from the lecture: http://cfmriweb.ucsd.edu/ecwong/tof.m. Also, you will notice that the signal in the vessels increases as they enter the slab before starting to decay. This is due to the imperfect profile of the excitation pulse. You can improve your fit to the data by including a simple model for the slab profile, such as a linear ramp to the nominal flip angle. Compare your estimated velocity to that from your phase contrast image.