**MR Imaging Techniques and Pulse Sequences**
**Wednesday, August 12th 11:00-12:00**

The concept of using a static magnetic field, gradient magnetic fields and radio frequency (rf) magnetic fields to produce a tomographic MR image will be extended to describe production of spin echo and gradient echo images. These basic MR image types are produced using the spin-warp two-dimensional Fourier transform method.

The technical specifications of the MRI system constrain the pulse sequence timing parameters. Gradient slew rate and maximum gradient amplitude are typically the limiting factors, although signal-to-noise ratio (SNR) may be an important consideration at lower magnetic field strengths. Pulse sequence design considerations are focused on maintaining the maximum SNR while producing images with the prescribed soft tissue contrast, determined by the selection of the time-to-echo (TE) and the rf excitation repetition time (TR).

The strength and duration of the slice-selection gradient is determined by the characteristics of the crafted rf pulse, used to limit the excitation frequencies, and the minimum slice thickness required. A rephasing gradient is applied after termination of the rf pulse in order to compensate for dephasing of the excited spins, which occurs during application of the slice selection gradient. The minimum required field of view (FOV) and the bandwidth of the received signal determine the readout gradient strength. Dephasing gradient pulses of the readout gradient determine the precise time that the spin echo or gradient echo occurs. The increment in the amplitude of the phase encoding gradient, for successive rf excitations, determines the image size in this dimension. The relationship between the slice thickness, pixel size, receiver bandwidth and matrix size will be explored.

Variations on the standard imaging pulse sequences will also be addressed. These include asymmetric sampling of the echo, oblique imaging, three-dimensional FT methods, pre-saturation pulses, and multi-echo imaging. Fast MR imaging methods that acquire more than one image line per excitation pulse (fast spin echo and echo planar imaging) will be briefly discussed in this context.

Educational Objectives:

Upon completion of the course the participants will be prepared to:

1. Describe the basic principles of the spin-warp MRI pulse program.
2. Design a workable spin echo and gradient echo pulse sequence.
3. Describe the acquisition of a three-dimensional data set.
4. Site differences between fast MR imaging and standard spin-warp methods.