Lab 6

Medical Imaging

IST 2022-2023

Consider the study of a homogenous sample with T_1/T_2 = 800/80 ms, using a saturation-recovery NMR pulse sequence, with an excitation flip angle of 60°, *TE/TR* = 1/1000 ms and a total number of excitations / repetitions *NEX* = 10.

1. Draw the pulse sequence diagram (including indication of the RF pulses, signal acquisition times, *TE* and *TR*). Compute the total study duration.

In the following simulations, use the rotating reference frame and a time step of 1 ms. Consider on-resonance spins and the equilibrium magnetization vector M_0 = [0; 0; 1]

2. Simulate the evolution of the longitudinal and transverse magnetization during the sequence. Indicate which component of the magnetization is measured and plot its amplitude at each acquisition time.

3. Calculate the steady-state magnetization, M_{ss}, and determine this from the data.

4. Repeat 2 and 3, if *TR* is reduced to 100 ms and *NEX* is increased to 100 (yielding the same total study duration).

5. Compute the Ernst angle, the flip angle that maximizes the value of M_{ss}, for each *TR* value considered. Verify that the given value of 60° is close to optimal for *TR* = 1 s but not *TR* = 100 ms.

6. Repeat 4 using the Ernst angle for *TR* = 100 ms.

7. Indicate how the SNR varies with *NEX*, and compare the overall SNR per unit time of M_{ss} in 4 vs. 3 and 6 vs. 3.