AA 2023/2024
Introduction to Quantum Hardware
Recommended structure for the pulsed NMR laboratory report

Give an estimate, with the related error, of the net magnetic moment of the sample.
Remember that glycerin $C_3H_8O_3$ has a molar mass of $92.09382\,\mathrm{g/mol}$ and its density is $1.26\,\mathrm{g/cm^3}$.

Report the experimental parameters used in your experiment:
$\rightarrow$ measured B field, current flowing in the electromagnet
$\rightarrow$ drive generator and local oscillator generator frequencies (ν_{RF} and ν_{LO} respectively)
$\rightarrow$ the Larmor frequency of the precessing spins for the measured B.
Remember that for protons the gyromagnetic ratio is $\gamma_p = 42.5756\,\mathrm{MHz/T}$

Show in a plot the free induction decay signal recorded after a $\pi/2$-pulse, and report the $T_2^\star$ obtained by the fit. Display in the same plot the fit curve. Make a plot of the residuals and briefly describe your error analysis.

Explain the pulses sequence used to measure the spin-spin relaxation time T_2. What is the effect of the second pulse on each precessing spin and in turn on the magnetization vector?
A pictorial representation can be also used here.

Report in a table the maximum amplitude of the pulse echo signal as a function of the delay between $\pi/2$- and π-pulses. How do you obtain the spin-spin coherence time T_2? Give the values obtained by the fits and discuss related errors.

In general the decay constant $T_2^\star$ in the free induction decay contains the effects of the spin-spin interaction, spin-lattice relaxation, and the magnetic field inhomogeneity:

$$\frac{1}{T_2^\star} = \frac{1}{T_2} + \frac{1}{T_1} + \gamma_p \Delta B_0 \tag{1}$$

Can you give an estimate of the field inhomogeneity across the sample?