# Lab Notebook for
# **PHY 445**

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Lab notebook for PHY 445 Spring 2026

# Contents

# 1   Feb 5, 2026

**Link to the lab website:** https://you.stonybrook.edu/phy445/experiment-overview/

**Note:** We are allowed to have 1–2 extra days for this experiment as there was no lab manual given.

## 1.1   Experiment: Nuclear Magnetic Resonance

Experiments that we will run:

- We will test $T_1$, $T_2$, $T_2^*$, and $T_2'$ for three samples: distilled water, tap water, and water with metal in it (or honey if we do not have that);

**Sub-experiment one: distilled water**

We got the distilled water from the HEP-ex water room; poured it into the little pipe without a pipette because the only one we found was super dirty and probably full of AIDS.

**Distilled water: $T_1$**   Experimental set-up and tuning for measuring $T_1$ for distilled water:

- RF frequency matching: Tuned it until there was a minimal sine curve. Measured frequency is 21.01291 MHz.

- $\pi/2$ pulse: $1.12 \pm 0.005\,\mu\text{s}$

- $\pi$ pulse: $7.32 \pm 0.005\,\mu\text{s}$

Now we tried to measure $T_1$ for distilled water, but this was very hard:

- We didn't know how to export the osc. data to fit it.

- We didn't know if the pulse was just one peak of the sine curve or if it was the entire curve.

- Corliss came over and helped us kind of. We didn't know how to do anything. He pointed out that we were syncing on $A$ when we probably should have been syncing on $B$.

- TA came over and helped us more; got back to my original question which I'm just going to email Prof. Liu.

- After class, emailed Prof. Liu the following:

  Hi Professor Liu,

  My partner and I are trying to measure the $T_1$ timescale for the NMR experiment in PHY 445. We know that we have to fit a damped sine curve to the response of the nucleus to the A pulse to determine $T_1$. After asking both the TA and Professor Corliss for advice on how to do this, we are still not sure how to take the oscilloscope data and translate it into a form that we can fit a curve to. Do you have any advice on how to do this?

Also, you previously said that some sort of iron solution is commonly used in this experiment to test different responsivities to the external magnetic field and RF pulses. Will this be made available to us next Tuesday?

Thanks,
Will Lancer

## 2   Feb 10, 2026

- Prof. Liu responded:

  Hi Will,

  Prof. Xu Du is taking care of the NMR measurement this semester. You probably confused me as Prof. Du?

  Regarding the data, usually you can take the oscilloscope data from a USB drive and import it into the computer. Then you can fit it from there. (Depending on which oscilloscope you are using this semester.)

  Everything should be in the test kit – usually I will suggest you use the mineral oil first, and then the rubber.

- Whoops! Literally everyone in the lab thought that Prof. Du was Prof. Liu, so that's a bit funny.

- Anyway, time to continue with this experiment.

  Ok, we're going to switch our experiemnt to mineral oil on Prof. Liu's recommendation.

### 2.1   Sub-experiment: mineral oil

We're using the light mineral oil. Time to re-measure all of our stuff!

- RF frequency matching: $21.11319 \pm 0.00001$ MHz.

- $\pi/2$ pulse: $4.48 \pm 0.005\,\mu$s.

- $\pi$ pulse: $9.12 \pm 0.005\,\mu$s.

We think that we want an $A$ pulse and then a $B$ pulse. The former being a $\pi$ pulse and the latter being a $\pi/2$ pulse. But we don't really see that on the oscilloscope. We varied tons of numbers, and then figured out that we can put just one $B$ pulse. We did that, but when we vary $\tau$, we don't see the amplitude of $B$ change; this isn't what we expected, as we'd expect the curve to follow the equation $\sim 1 - e^{-\tau/T_1}$.

### 2.2   Enter Professor Du

We called Prof. Du over and he determined after some debugging that we were way off our resonance frequency. We were using the previous value, but he determined that it should be

$21.00854 \pm 0.00001$ MHz. The $A$ pulse and $B$ pulses were wrong because we were off resonance: the new ones are $A = 6.72 \pm 0.005\,\mu$s and $B = 2.60 \pm 0.005\,\mu$s.

### NOTE: ALL OF THESE VALUES ARE FOR BEESWAX, NOT MINERAL OIL.

The lesson from this is that the vertical scale of the blue line was *super* zoomed out; because of this, I tuned it to what seeemd tiniest but it was wayyyy off. So, make your vertical and horizontal scales fit the scales at hand or else you will get cooked.