# LANL NMR System

## Operating Instructions

by
**Nisal Vismith, Forhad Hossain, Ishara Fernando, Kun Liu**
**For the**
**SpinQuest Collaboration**

Version 2 (03/20/2025)

If anyone makes any modification to this system, then it's that person's responsibility to update this document and update the confluence page and FNAL docdb.

# Version History

| Version # | Update by | What's updated |
|---|---|---|
| 1 | Nisal Vismith, Forhad Hossain, Ishara Fernando, Kun Liu | Initial document |
| 2 | Devin Seay | IP Configuration Troubleshooting |
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# Outline

A. Turning ON the system
B. Setting-up/Tuning for “warm NMR” measurements
C. Setting-up/Tuning for “cold NMR” measurements

# (A) Turning ON the system

# (A) Turning ON the system

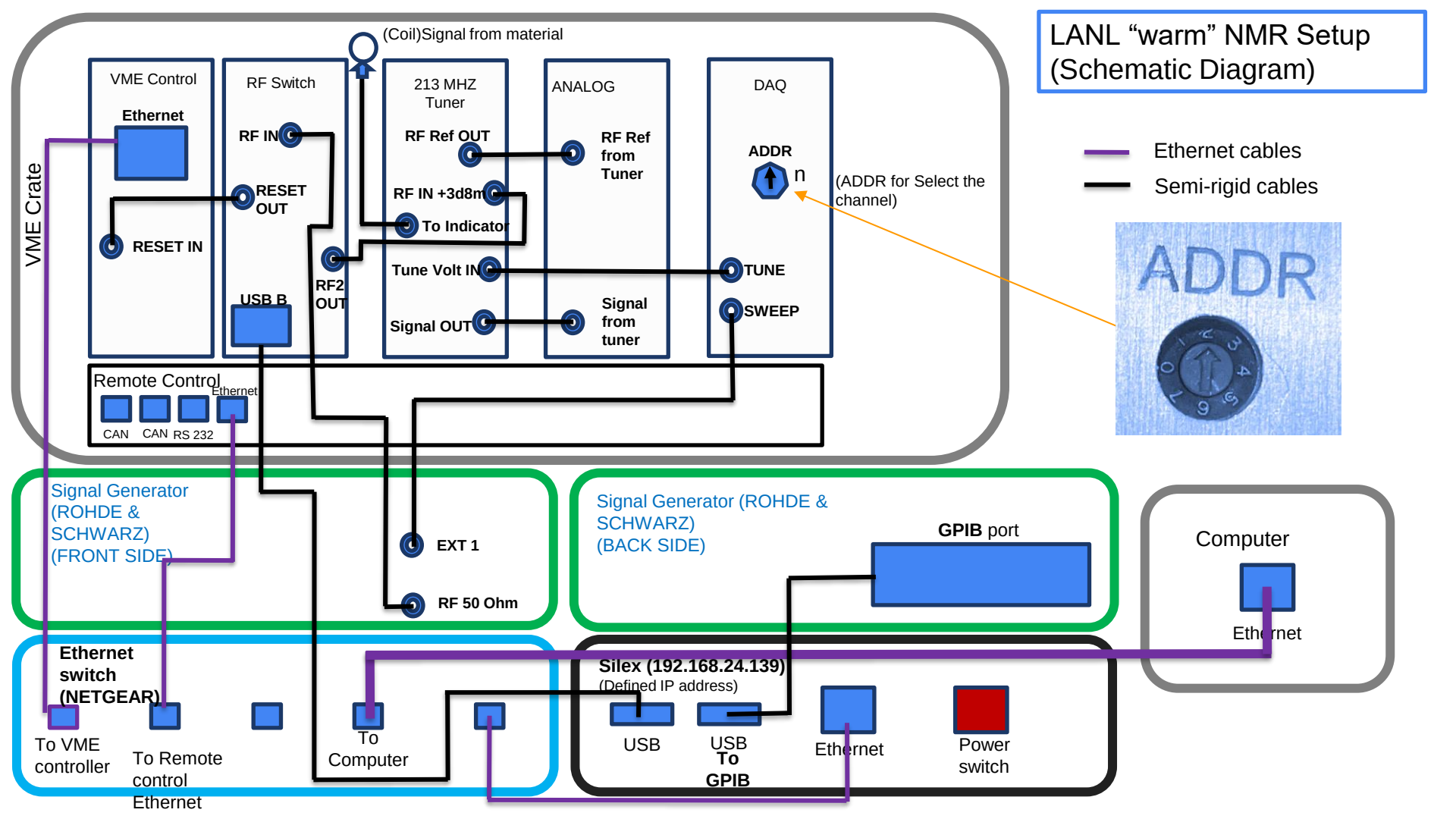
NOTE:
If the computer is far away from the crate, then you will need the Silex device to have both GPIB and RFswitch communicating to the computer via Ethernet. If the computer is close enough so you can simply connect the GPIB & RFswitch via USB directly (without needing the Silex device)

* straightforward steps are in these steps inside the “blue” frame

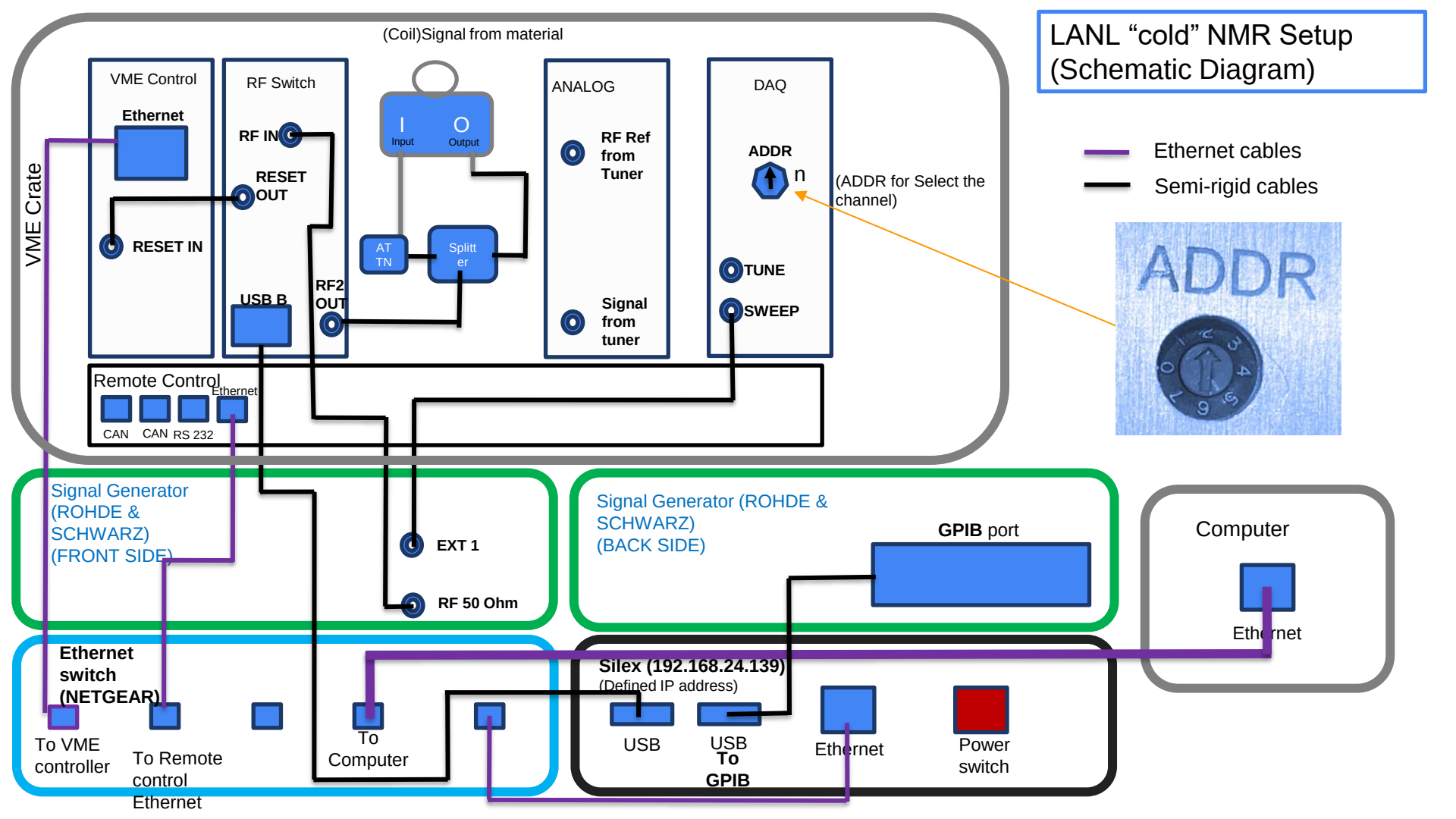
1. Ensure to complete the cable connections (either for “warm” or “cold” NMR measurement) following the schematic diagram. The schematic diagrams are given in the preceding slides. Also, ensure to select the channel number on “**ADDR**” of DAQ board using a small flathead screwdriver.
2. Turn ON the VME crate.
3. Turn ON the Rhodes & Schwartz (R&S) signal generator.
4. Ensure the Silex-Device and Ethernet-Switch are powered.
   Turn ON the computer and login.
5. Open Silex application (SX Virtual Link) and connect the devices.
   [See the following slides for each of the following steps]
6. Open “NBEclipse” software, click “search” □ select the identified IP □ connect
7. Open “RFswitch3.vi” □ Select Channel □ Run the VI □ confirm “green indicator” (If you don’t see the greenlight, then check the GPIB to USB connection and try again).
8. Open “NMRFMswitch.vi” □ Select Channel □ Set the IP address correctly □ Run VI
9. Stop “NMRFMswitch.vi” using the “stop” button.


* follow the next slides for each of these steps inside the “red” framed

# LANL “warm” NMR Setup (Schematic Diagram)



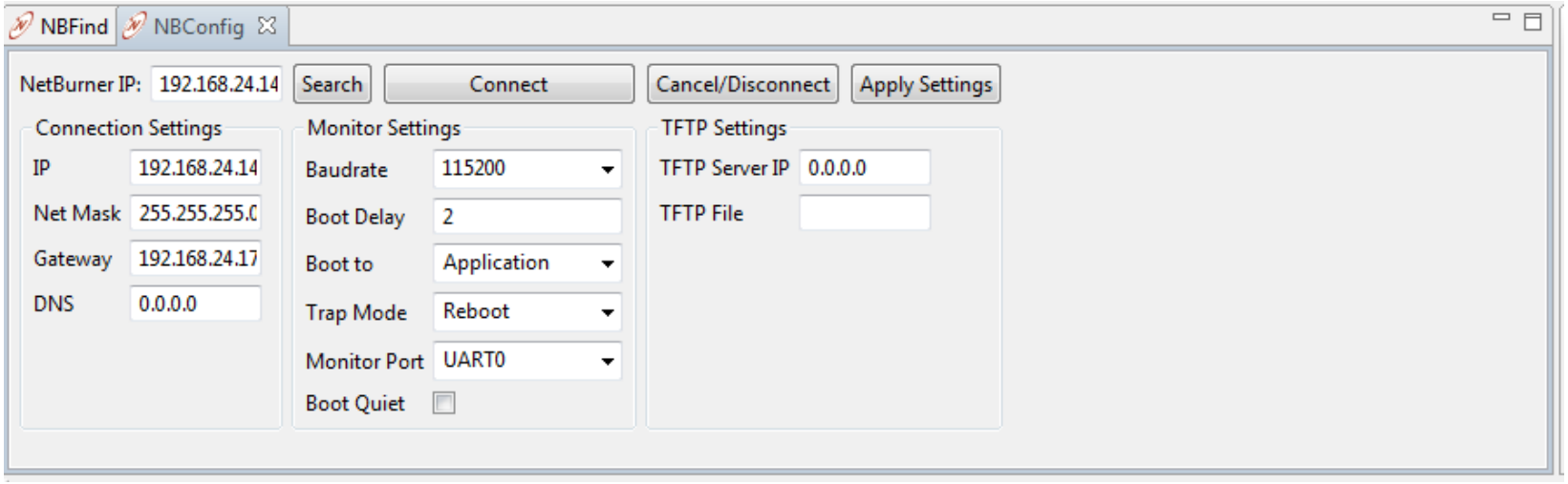
# LANL “cold” NMR Setup (Schematic Diagram)



## (A) Turning ON the system

The steps 1-6 are relatively straightforward

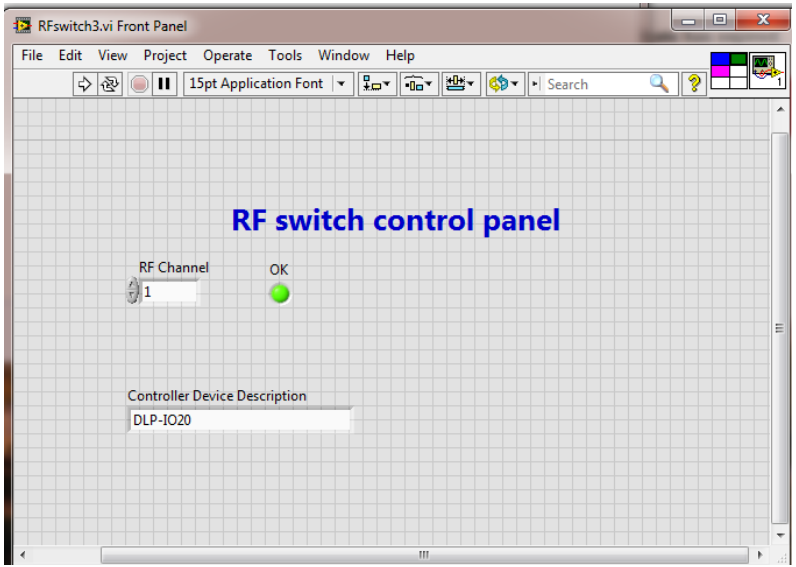
Step 6: Open “NBEclipse” software, click “search” □ select the identified IP □ connect



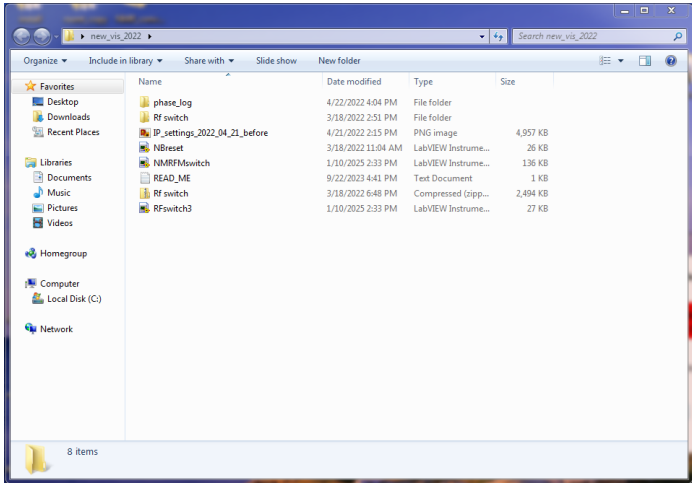

Note: You may need to wait a few seconds after click “connect”. You will notice that the “Connection Settings”, “Monitor Settings”, “TFTP Settings” are automatically populated when the ”connect” is successful. If it takes too long, try click “connect” again. You can also use the “NBFind” tab as well. Don’t close the window. Just minimize it.

# (A) Turning ON the system

Step 7: Open “RFswitch3.vi” □ Select Channel □ Run the VI □ confirm “green indicator”



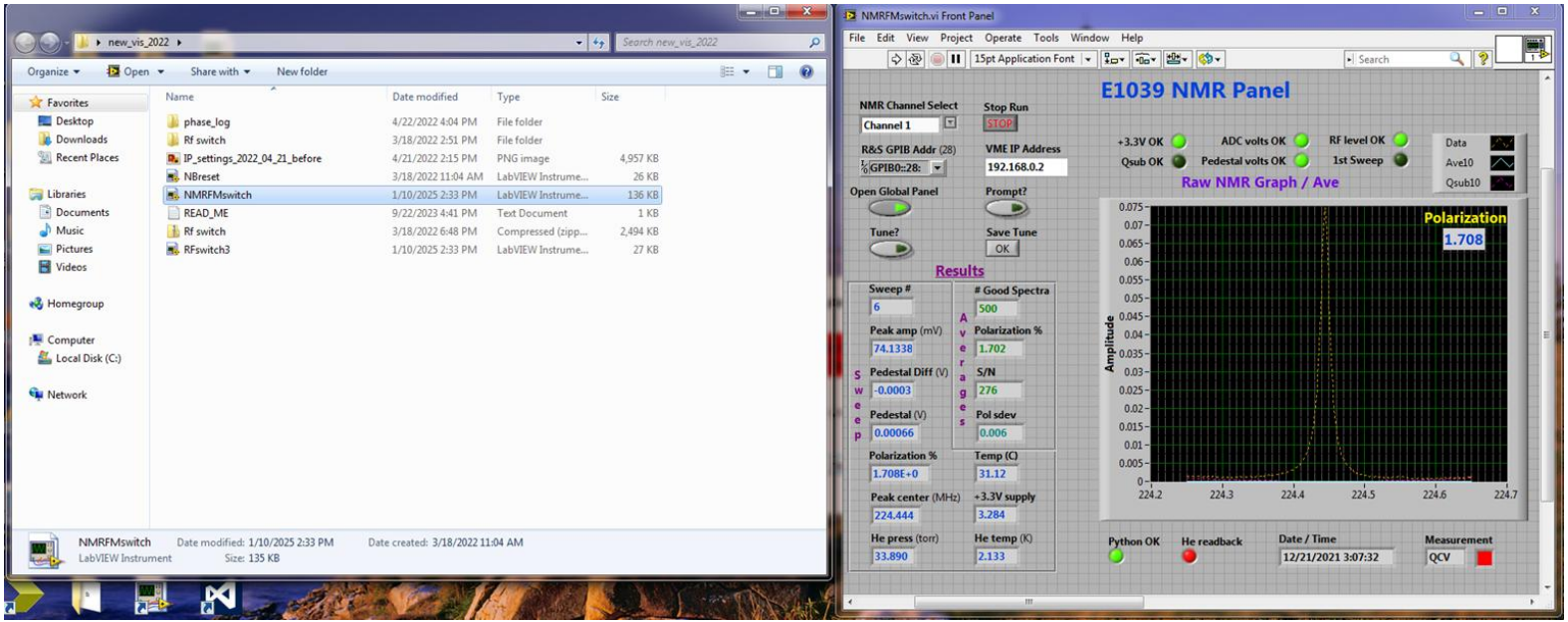

These VI’s can be found in the “new_vis_2022” folder




Note: If you don’t see the greenlight, then check the GPIB to USB connection and try again.

# (A) Turning ON the system

Step 8: Open “NMRFMswitch.vi” □ Select Channel □ Set the IP address correctly □ Run VI



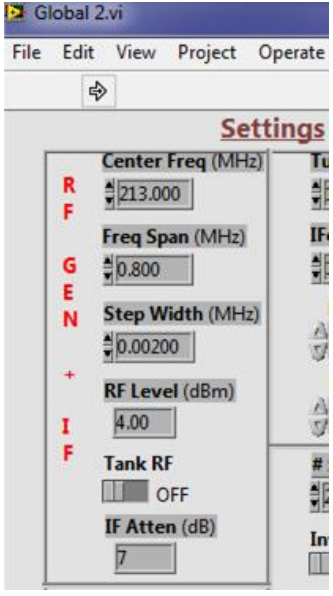

Note: Currently we use the IP address 192.168.24.144. Ones you press the “Run” button of the Vi, a new Vi window (called “Global2.vi) will be opened with the default settings, which you may need to change.

Step 9: Stop “NMRFMswitch.vi” using the “stop” button, in order to change the configuration on the Global2.vi

# (B) Setting-up/Tuning for “Warm NMR” measurements

# (B) Setting-up/Tuning for “Warm NMR” measurements

1. Confirm the cable connections are completed for the “warm” NMR measurement. Cross-check the connection with the schematic diagram provided in Section (A).
2. There are 3 types of tuning should be completed before taking any measurements.
   i. Diode Tune
   ii. Phase Tune
   iii. Operating Tune
3. Ensure the parameters on the Global2.vi as shown in the image, before you press the “Run” button after the “Step 10” of Section (A): Turning ON the system.
   Note: Frequency Span and Step Width were set to have 400 bins.




**Possible LabView Project:**
**Increase the bins to 500**

(B) Setting-up/Tuning for “Warm NMR” measurements

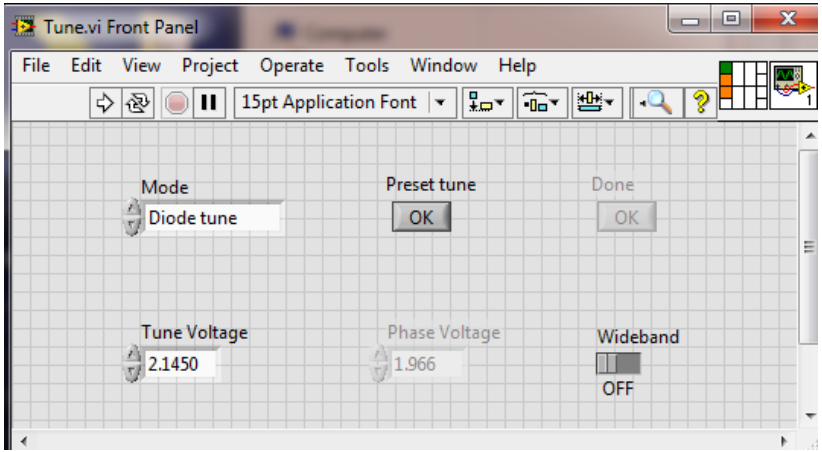
# Diode Tune (Important Facts)

1. Calculated inductance for a single loop coil **80 nH**, which will be in resonance around **213 MHz** and this can be calculate the tune voltage from the data sheet of the varactor diode.
2. In ideal case, the tune voltage should be around **3.3 (+/- 1) V** for nominal values of the entire LCR circuit.
   Note: There are some additional cable lengths that will contribute to the tune voltage, so the uncertainty of the voltage corresponding to the capacitance is higher as 1 V based on the characteristic curve of Voltage vs Capacitance.
3. You will need to be patience with this Diode Tune step, because you may need to increase/decrease the cable length to the ”loop” with the steps of 1 cm at a time to ensure the Tune Voltage is between 2V– 4V (ideally close to 3.3 V), and the “Pedestal Offset” should be below 4V.
4. During the tuning, ensure the “ADC volts ok” shows “**green**” light. If it is “red” then you will need to reduce the RF power or increase the attenuation

(B) Setting-up/Tuning for “Warm NMR” measurements

# Diode Tune

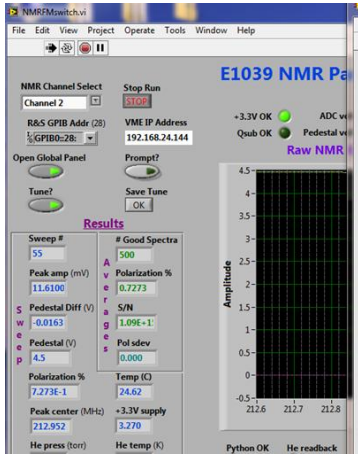
3. You will need to adjust the “Tune Voltage” using the up/down button to obtain the Q-curve. Note: you must increase/decrease the length using SMA connector at a time. So, let’s start with untuned setup. The following image shows how it looks like when nothing is connected.



(B) Setting-up/Tuning for “Warm NMR” measurements

# Diode Tune

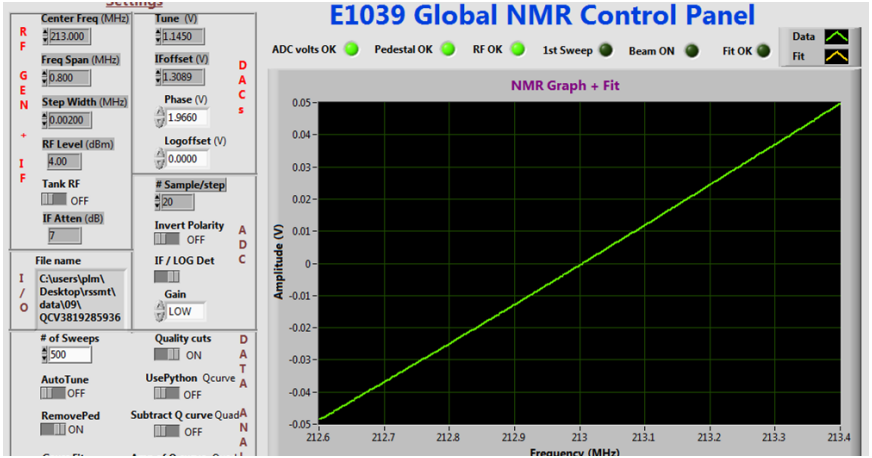
4. Now, connect the coil + long cable to the connector called “To Inductor” on the “Tuner”. This is how it looks like if you are still out of tune (still need to add more cable + adjust the tune voltage). Keep in mind that you need to have the tune voltage around 3.3 V such that adjust the cable length accordingly. Otherwise you may tune the system in a non-linear region which would impact the polarization.

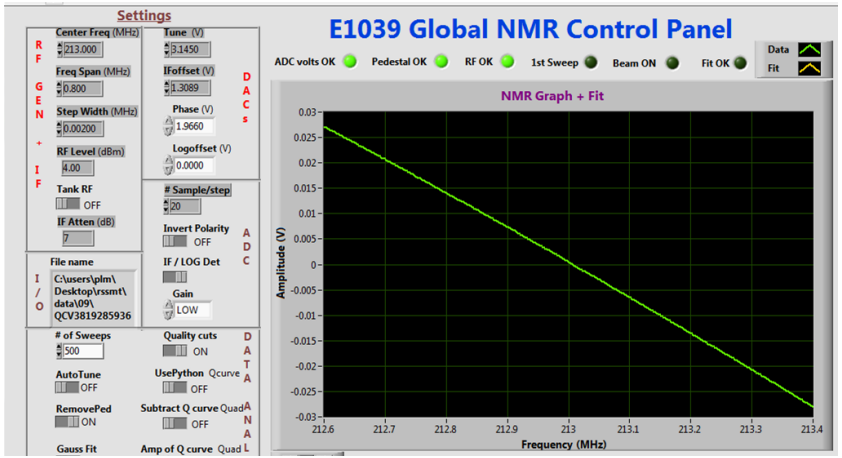



(B) Setting-up/Tuning for “Warm NMR” measurements

# Diode Tune

5. Keep adding small lengths (SMA connectors) and adjust the tune voltage. You may notice the change in the slope when you add/remove cables + voltage-adjustments, which indicate that you are closer to a tune of an integer multiple of lambda/2.

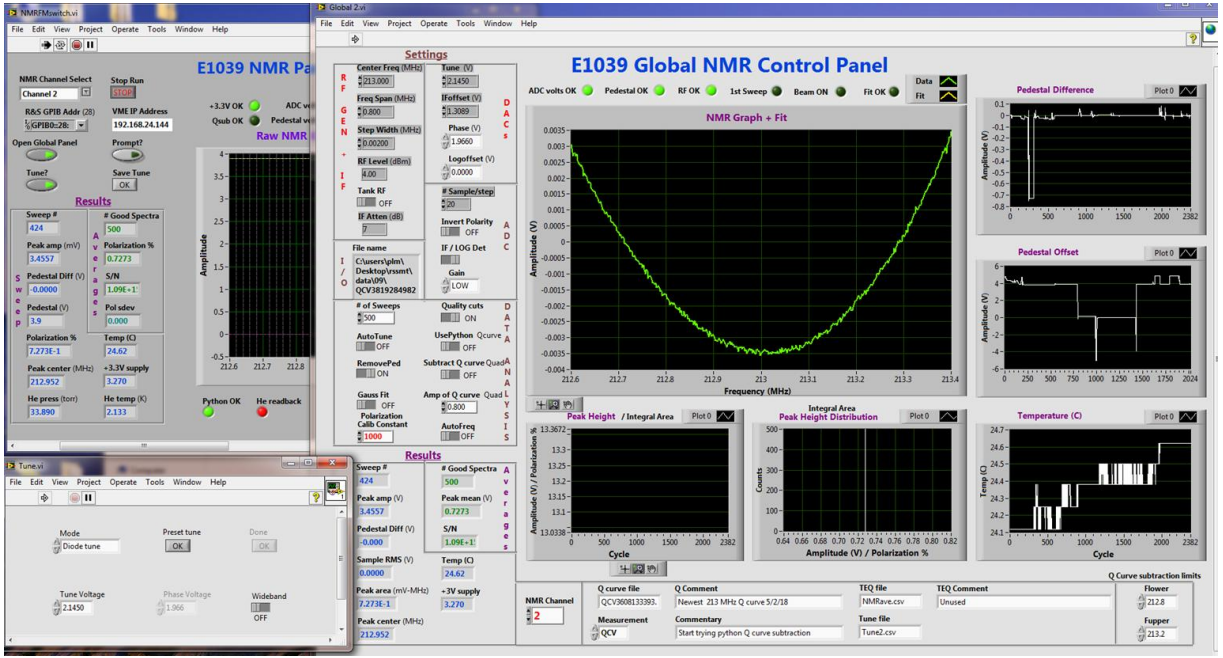


(B) Setting-up/Tuning for “Warm NMR” measurements

# Diode Tune

6. Keep adding small lengths (SMA connectors) and adjust the tune voltage until the Q-curve is obtained

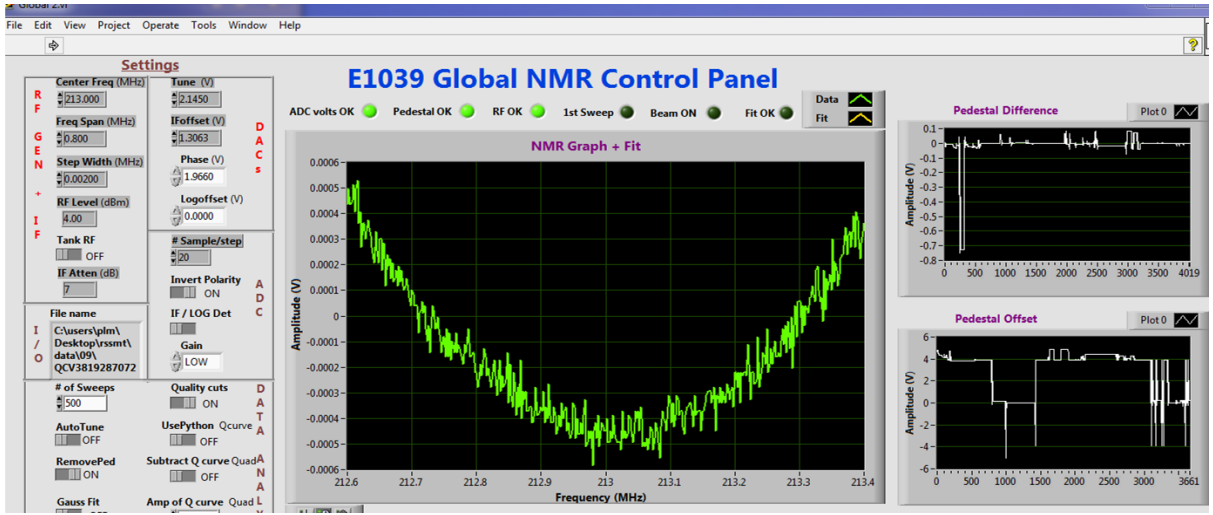



- Pedestal voltage should be below 4V Once everything is “tuned”.
- The tune voltage should be around 3.3 V for nominal values of the entire circuit.
- An example tune length would be “**95 inches (241.3 cm)**”+ loop

(B) Setting-up/Tuning for “Warm NMR” measurements

# Phase Tune

1. Switch the “Mode” to the “Phase Tune” on “Tune.vi”, and adjust the “Phase Voltage until you obtain the graph similar to the Q-curve.
   Note: The phase voltage should be in the range 2V - 8 V in order to be in the Linear operation.

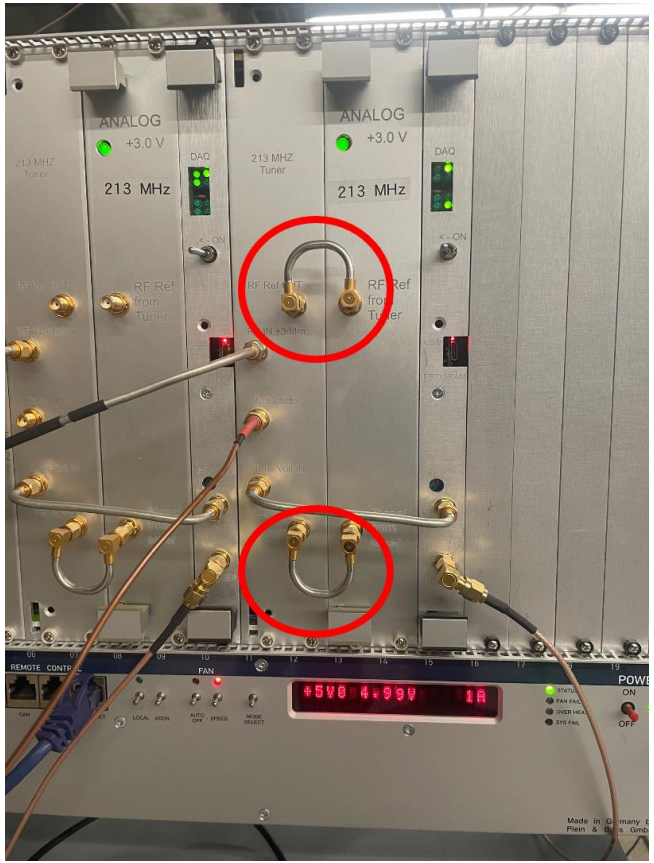


(B) Setting-up/Tuning for “Warm NMR” measurements

# Phase Tune

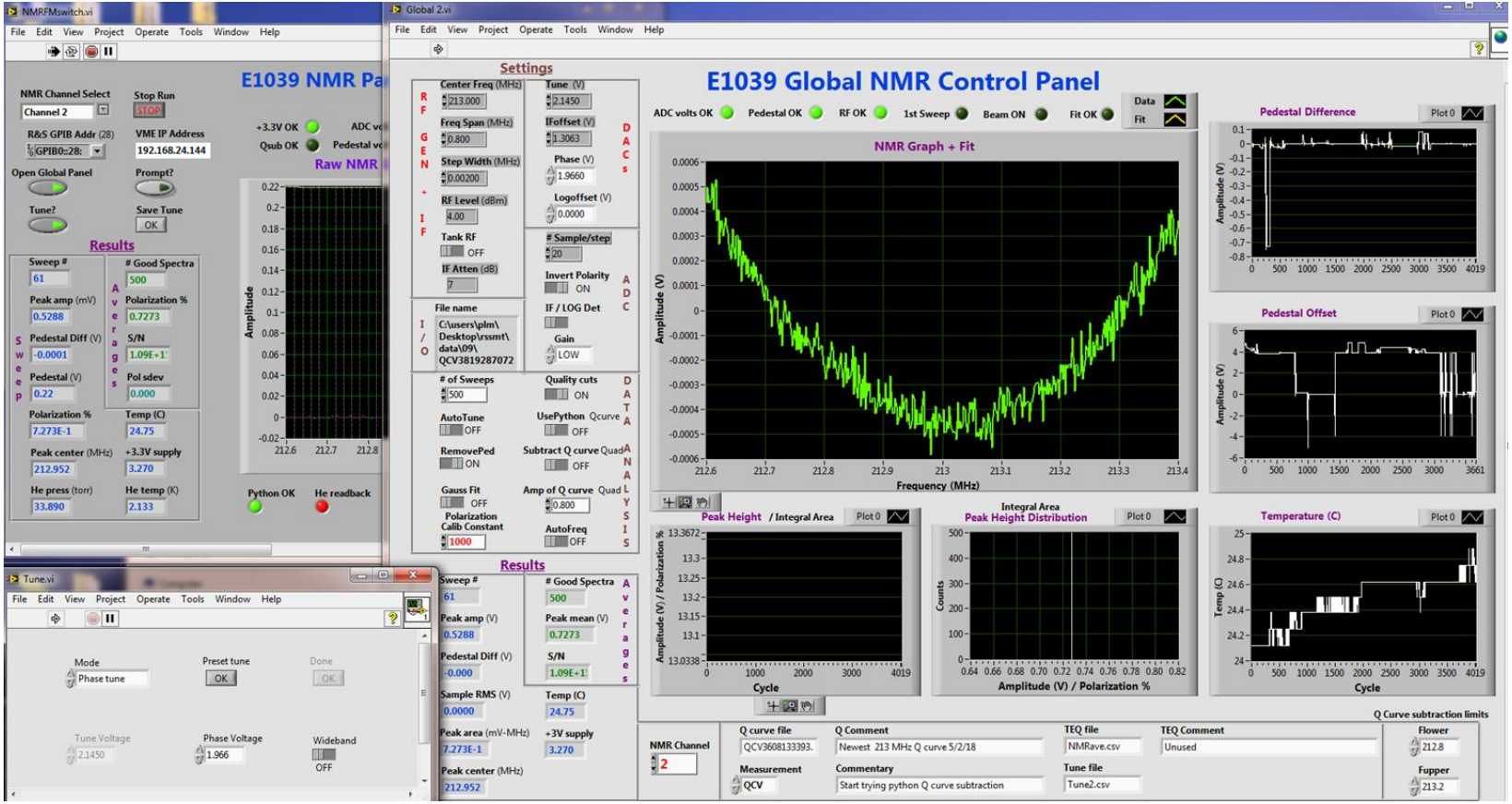
2. If the “Phase Voltage” happens to be giving you the Q-curve shape for a very small value (less than 0.5 V) of the Phase Voltage, then that means you will need to adjust one of the following physically.
[Note:]
a) Cable length between “RF Out” and “RF Ref from Tuner”
b) Cable length between “Signal Out” and “Signal from Tuner”

3. After that, start adjust the Phase Voltage until you obtain a symmetric Q-curve.



(B) Setting-up/Tuning for “Warm NMR” measurements

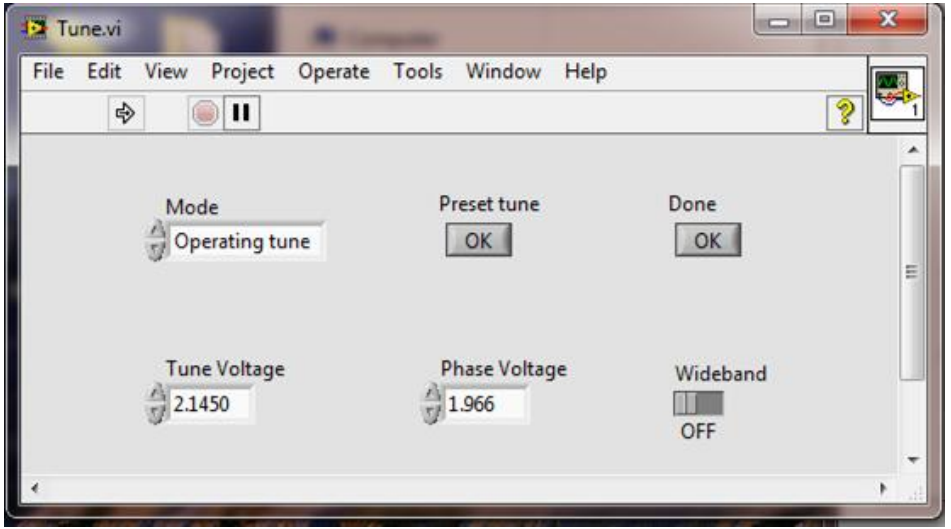
# Phase Tune



(B) Setting-up/Tuning for “Warm NMR” measurements

# Operating Tune

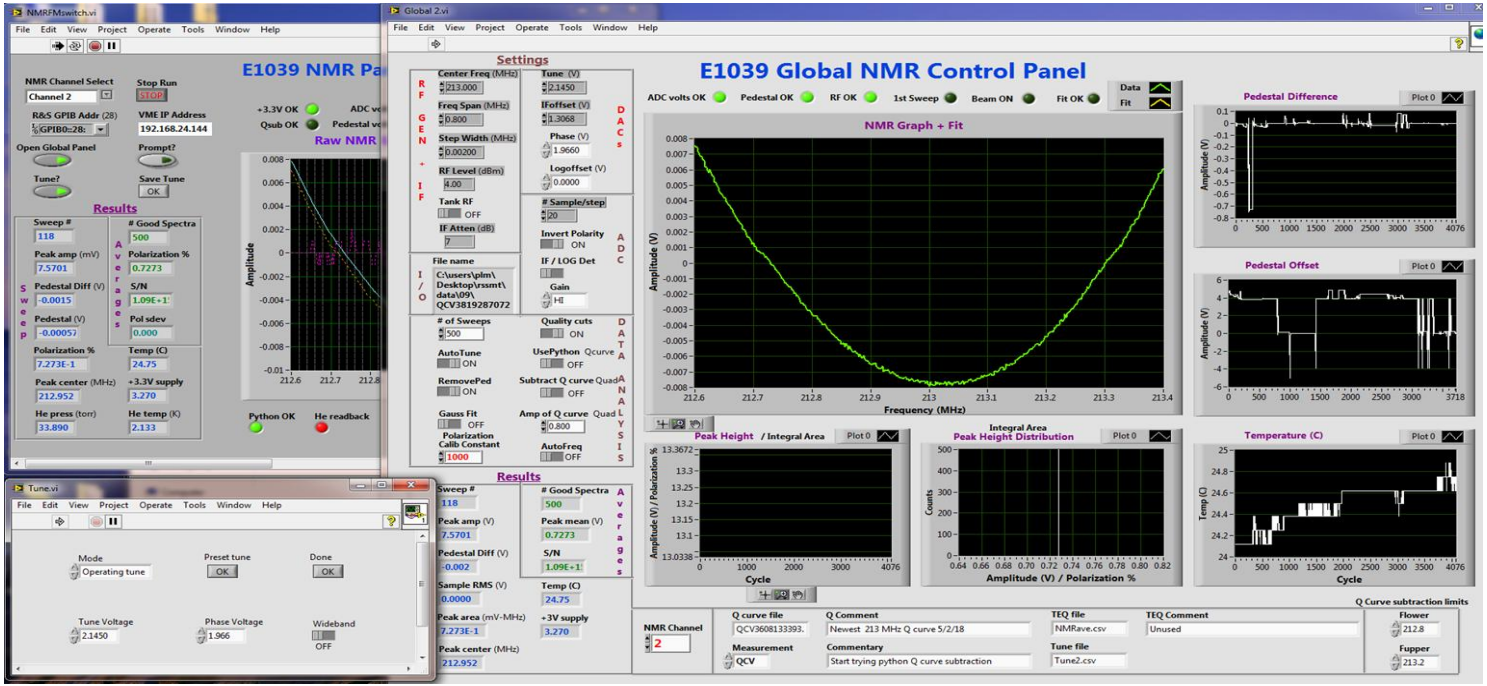
1. Once the Diode Tune and Phase Tune looks reasonable (as symmetric Q-curve as possible), then switch to the “Operating Tune” Mode using the drop-down list on the “Tune.vi”.
   The purpose of this mode is to perform ”crystal check” ( and do fine adjustments if needed)



(B) Setting-up/Tuning for “Warm NMR” measurements

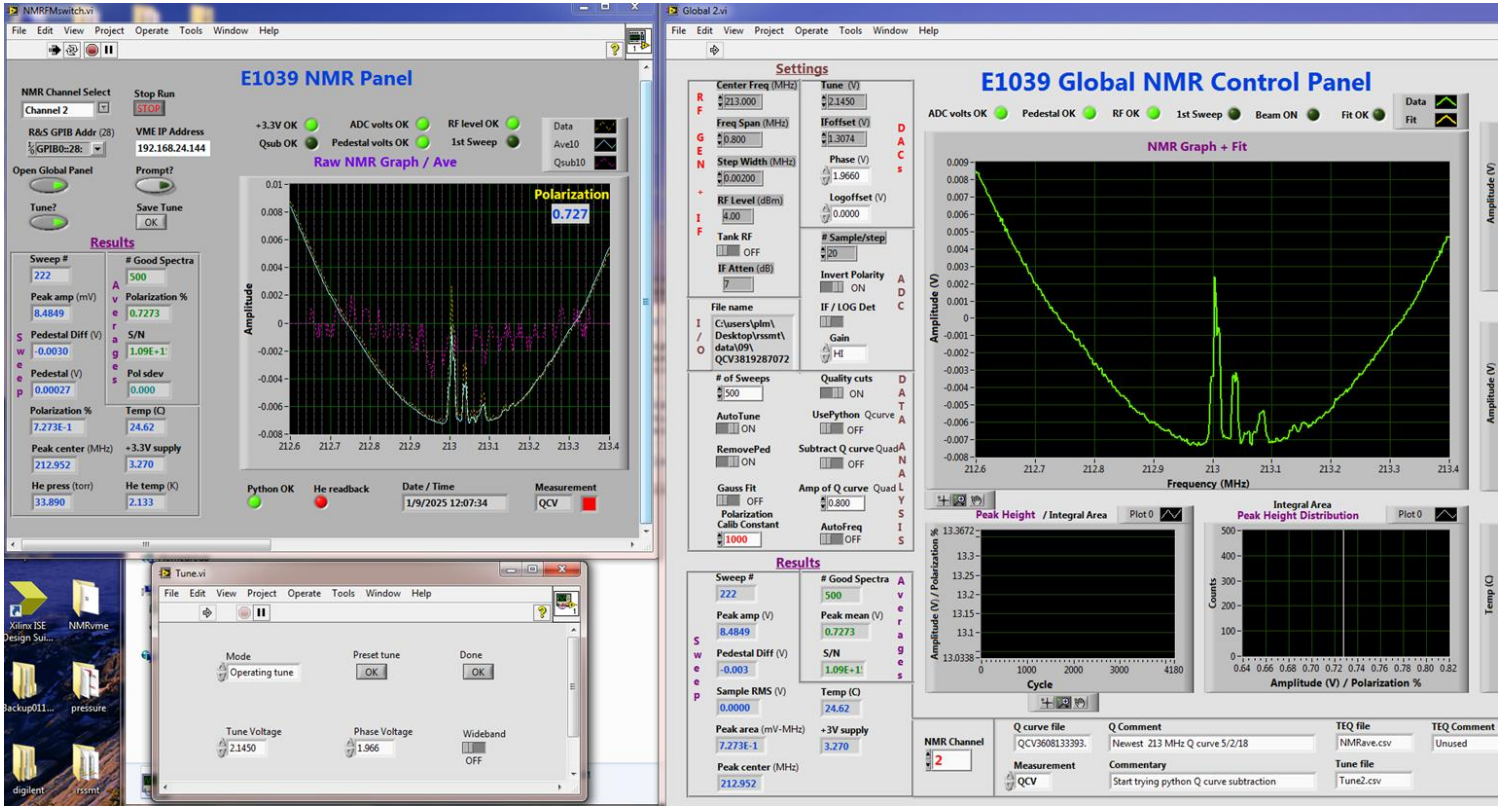
# Operating Tune

2. Then the tuned system would looks like the following.



(B) Setting-up/Tuning for “Warm NMR” measurements

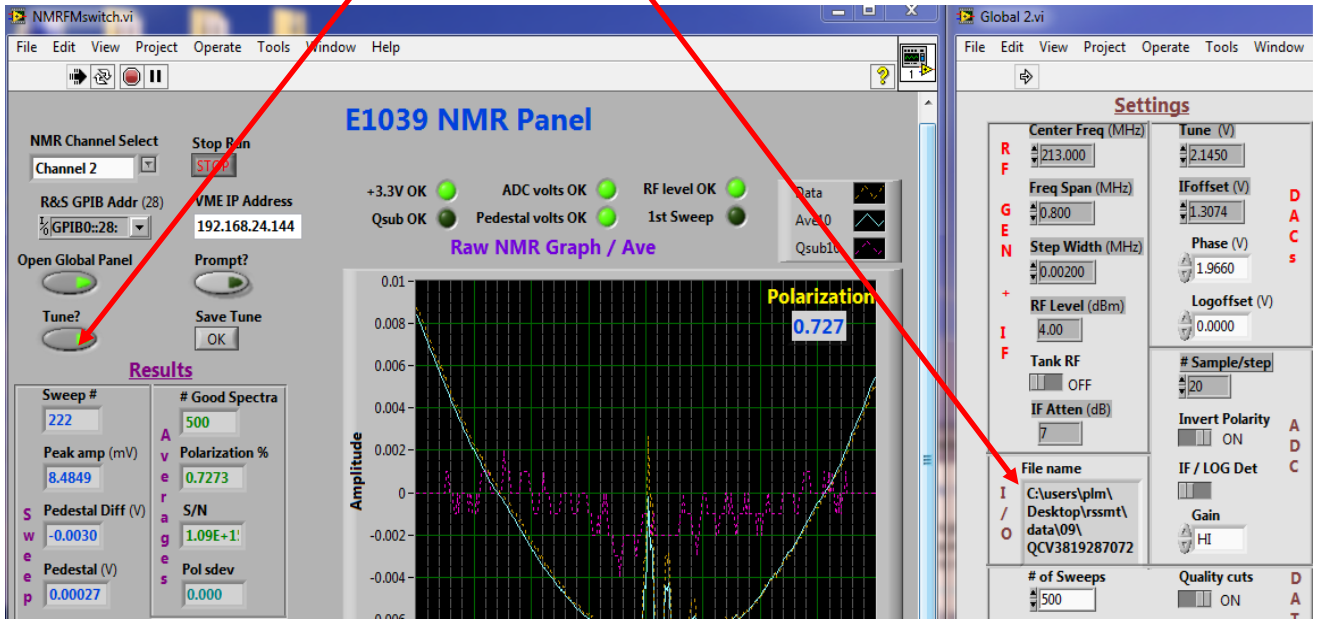
# Fully Tuned System with Crystal Check




(B) Setting-up/Tuning for “Warm NMR” measurements

# Data Taking Mode

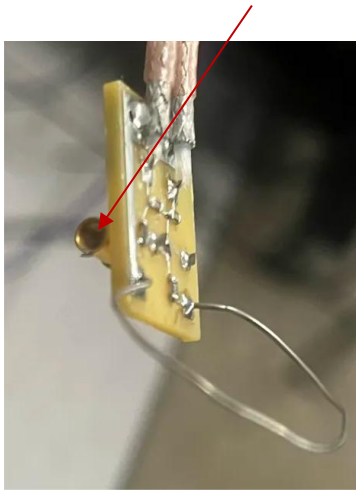
Once the Operating Tune is done,
i) Stop the NMRFMswitch.vi using the “Stop Run” button
ii) Toggle “OFF” the “Tune” button
iii) You may modify the “Number of Sweeps” on Global2.vi
iv) Run the NMRFMswitch.vi (this time you won’t see the ”Tune.vi” screen
v) Data file will be saved in this location

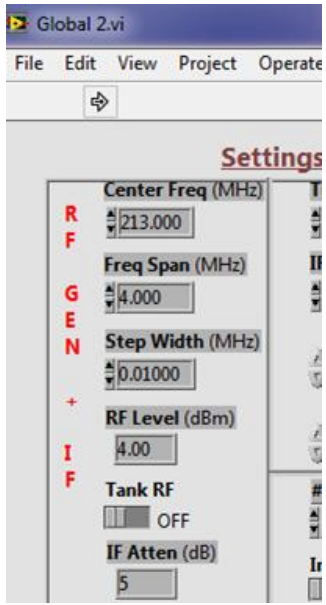


# (C) Setting up for “cold NMR” measurements

# (C) Setting-up/Tune for “Cold NMR” measurements

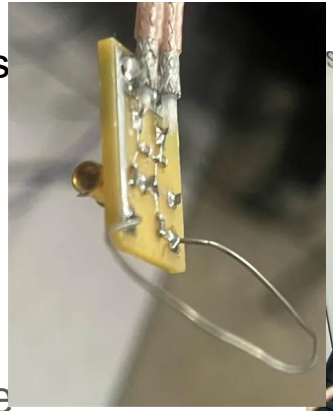
1. Confirm the cable connections are completed for the “cold” NMR measurement. Cross-check the connection with the schematic diagram provided in Section (A).
2. There are 3 types of tuning should be completed before taking any measurements.
   i. Diode Tune (This will be done by adjusting the capacitance using a screwdriver)
   ii. Phase Tune
   iii. Operating Tune
3. Ensure the parameters on the Global2.vi as shown in the image, before you press the “Run” button after the “Step 10” of Section (A): Turning ON the system.
   Note: A wider Frequency Span (4MHz) and Step Width (0.01) were set to have 400 bins.
4. Using a wider frequency span because the cable length is minimal such that the Q-curve’s curvature may not be visible within a 0.2 MHz span, so we need to increase it for the Diode and Phase tuning.





(C) Setting-up/Tune for “Cold NMR” measurements

# Diode Tune



1. You will need to adjust the “Capacitance” of the variable capacitor using a screwdriver to obtain the Q-curve.

Note:

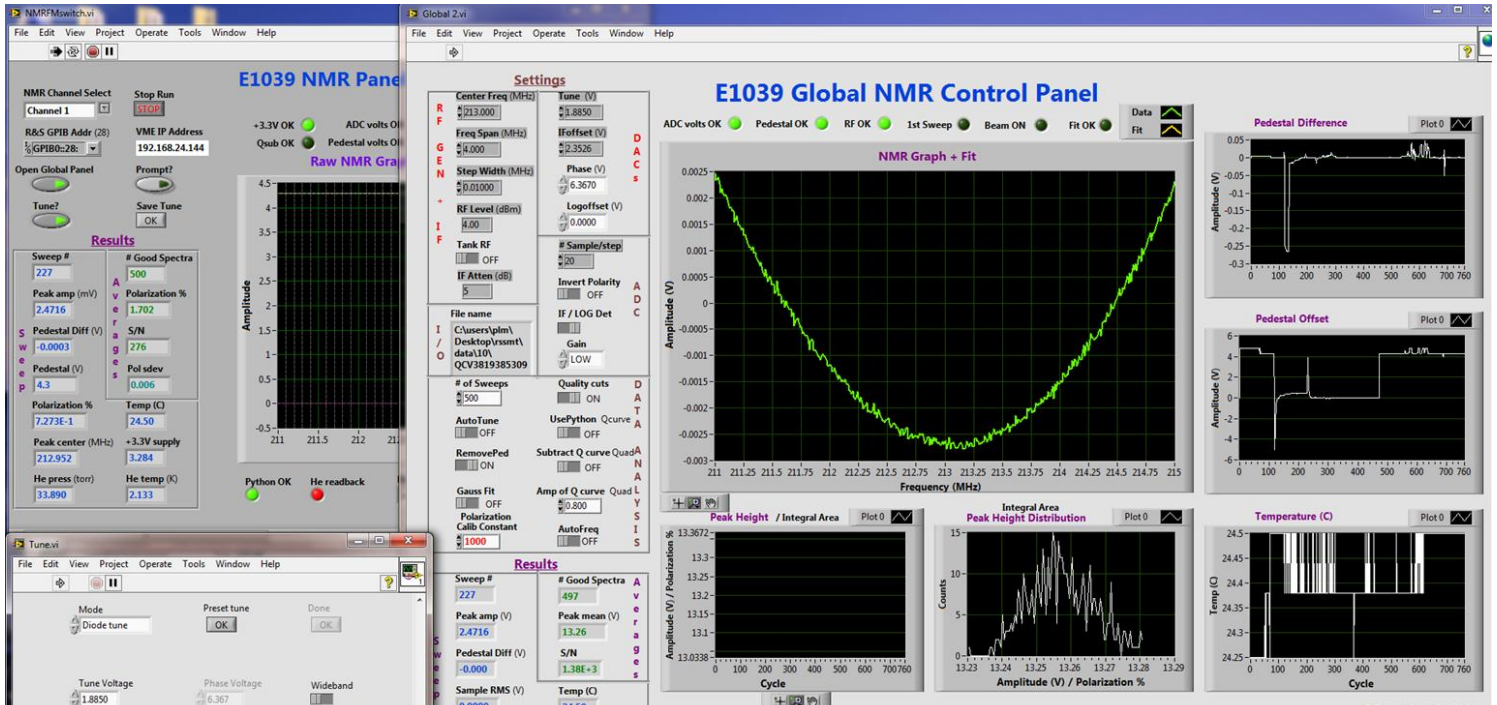
* Please be patience to make very small adjustment at a time and check the graph on Global 2.vi
* Ensure not to break the capacitor by going beyond its range.
* If you

a) can’t reach the Q-curve with the capacitor adjustments,

b) Phase Voltage is not in the range of 2V - 8V then that indicates that you will need to increase/decrease either of these cables.

# (C) Setting-up/Tune for “Cold NMR” measurements (Diode Tune)

1. Make sure you press Tune before running the VI at NMRFMswitch.vi.
2. Rotate the capacitor clockwise to move the minimum point of the Q-curve to left (low frequency), and anticlockwise ←→ higher frequency

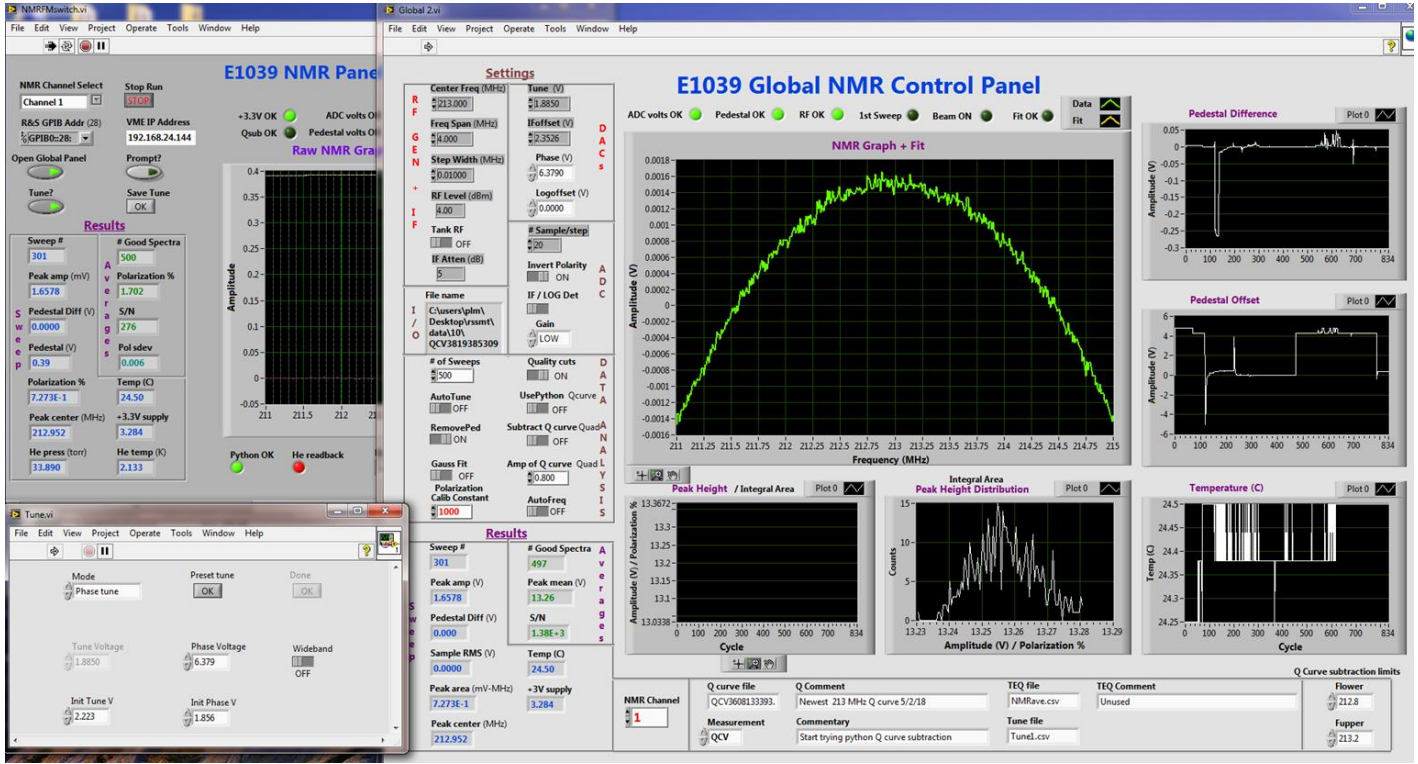


(C) Setting-up/Tune for “Cold NMR” measurements

If the, Phase Voltage is not in the range of 2V - 8V then that indicates that you will need to increase/decrease the reference cable length or the return cable length (see slide #27)

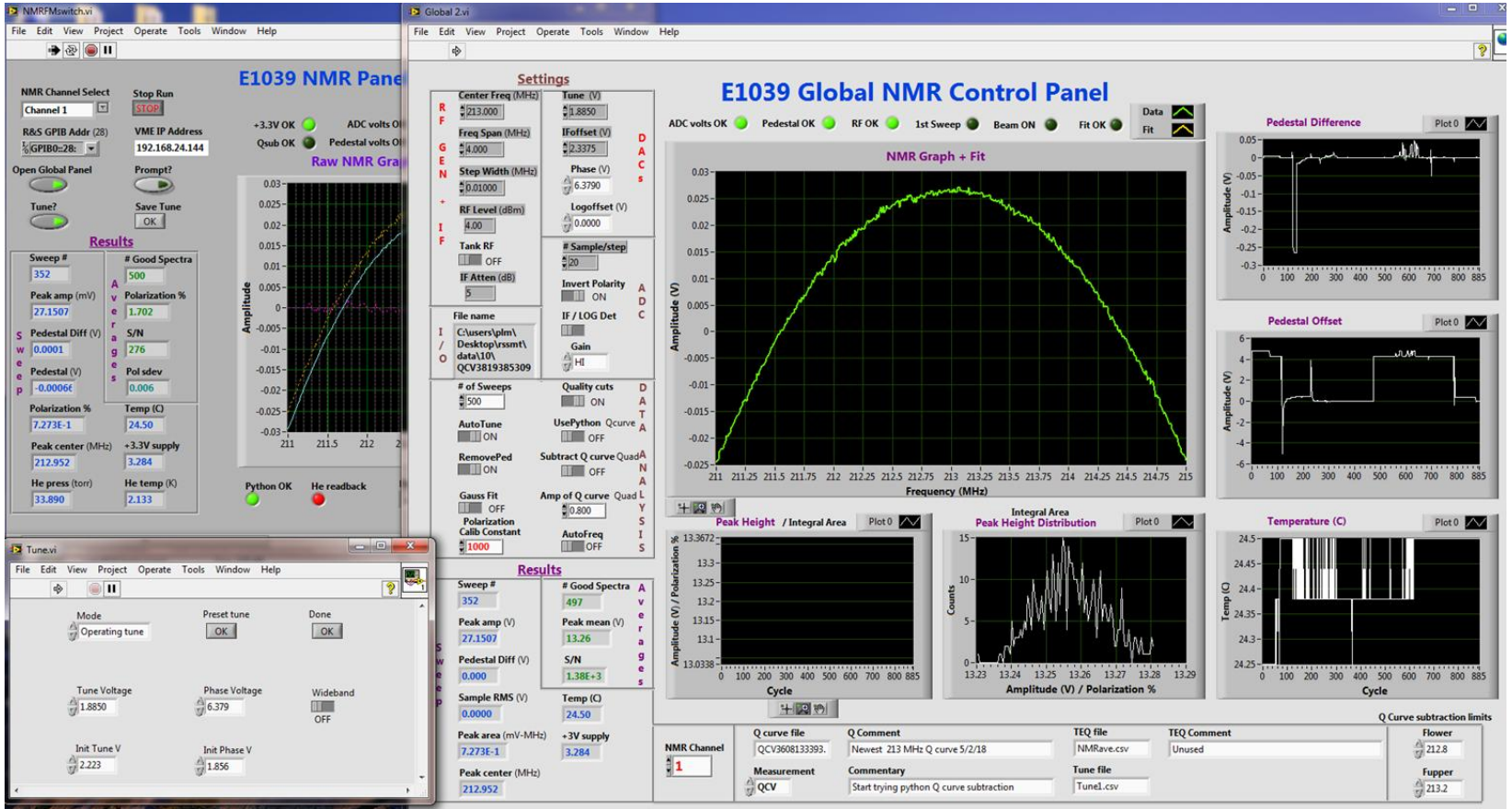
# Phase Tune

1. Switch to the “Phase Tune” mode using Tune.vi
2. Adjust the phase voltage until you get a symmetric curve (inverted Q-curve for cold NMR).



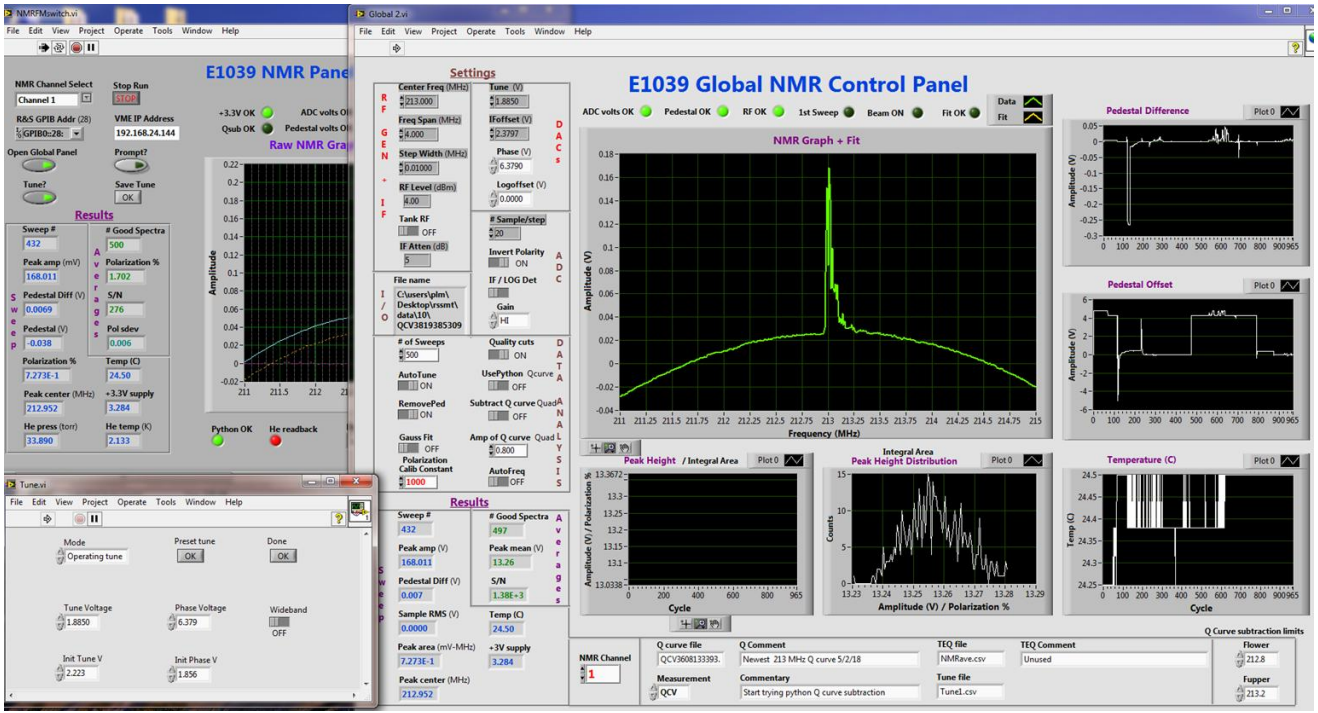
(C) Setting-up/Tune for “Cold NMR” measurements

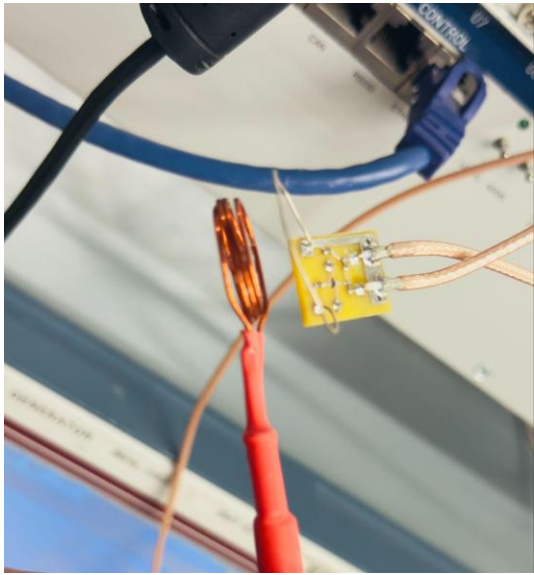
# Operating Tune



(C) Setting-up/Tune for “Cold NMR” measurements

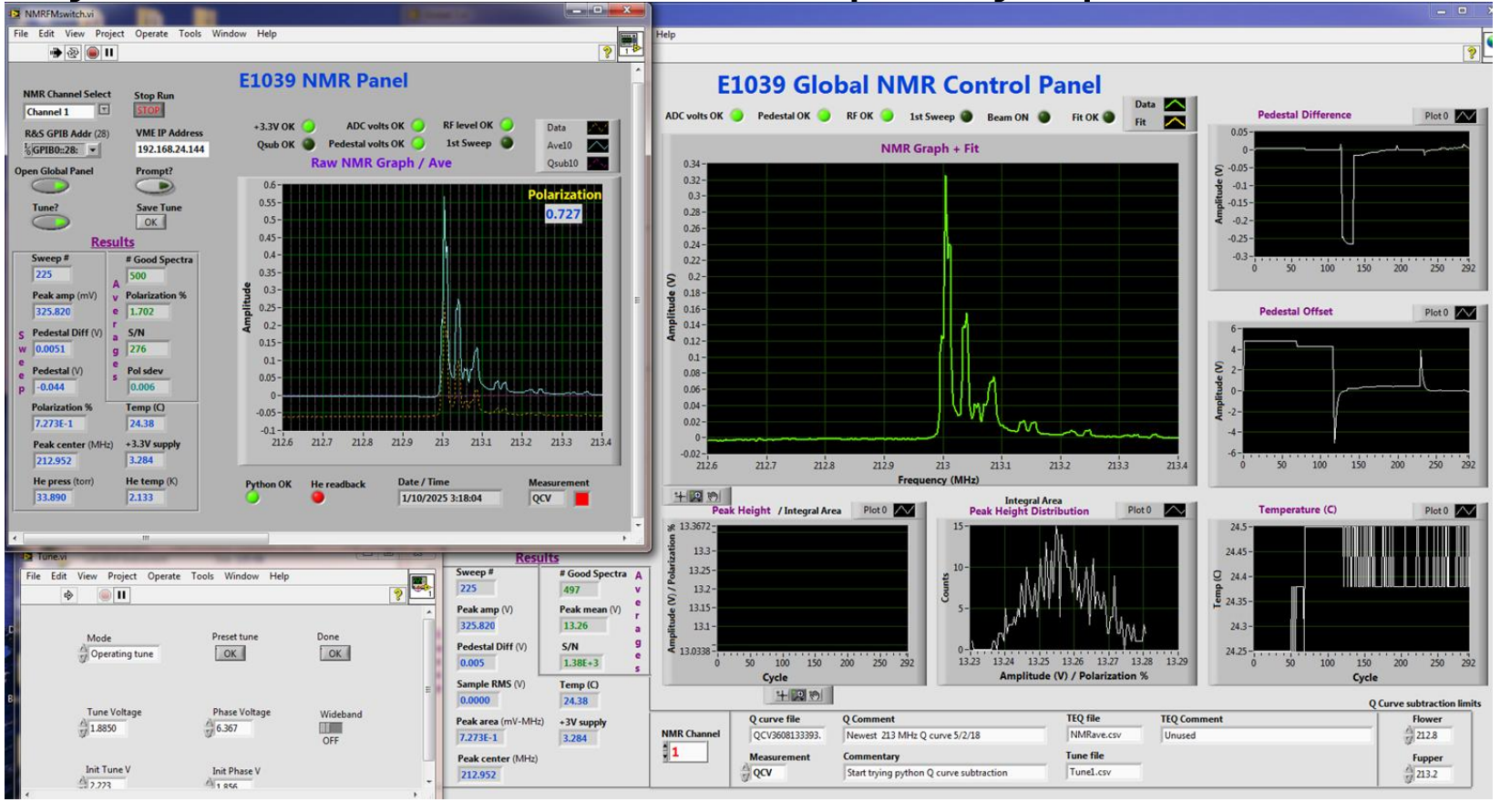
# Operating Tune with Crystal Check



(C) Setting-up/Tune for “Cold NMR” measurements

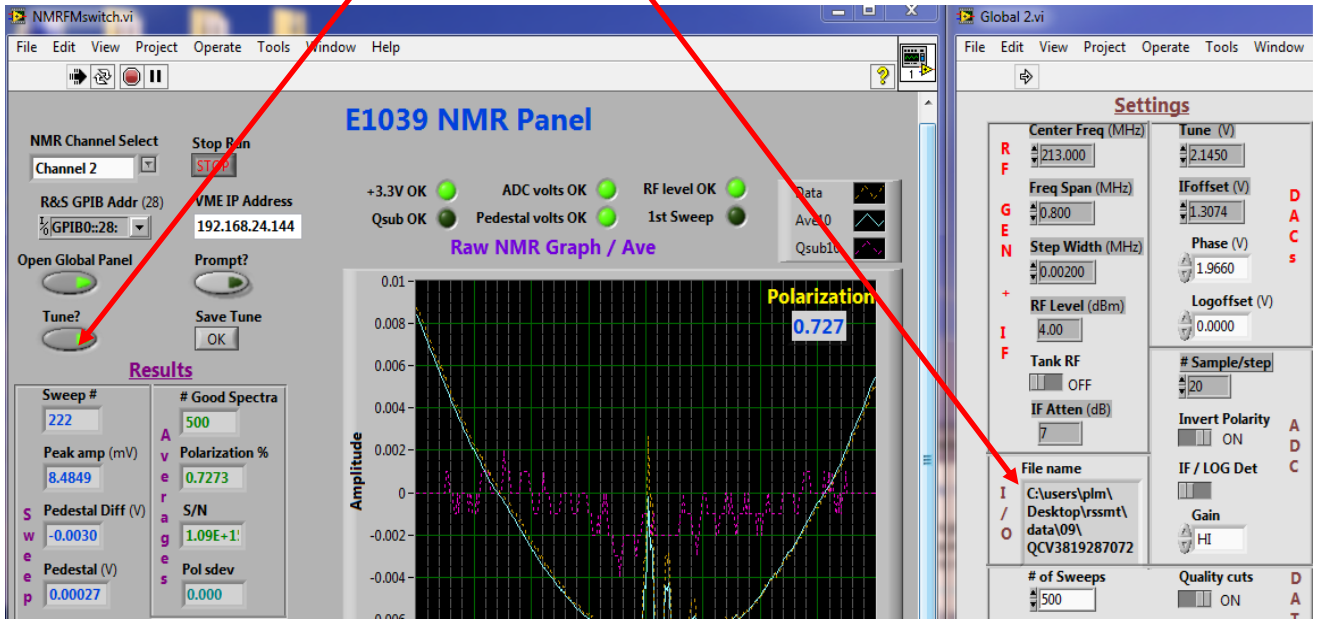
# Crystal Check with smaller Frequency Span



(C) Setting-up/Tune for “Cold NMR” measurements

# Data Taking Mode

Once the Operating Tune is done,
i) Stop the NMRFMswitch.vi using the “Stop Run” button
ii) Toggle “OFF” the “Tune” button
iii) You may modify the “Number of Sweeps” on Global2.vi
iv) Run the NMRFMswitch.vi (this time you won’t see the ”Tune.vi” screen
v) Data file will be saved in this location

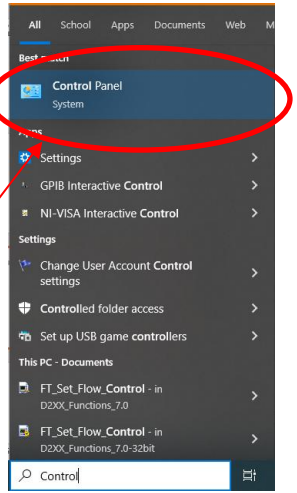


# Troubleshooting

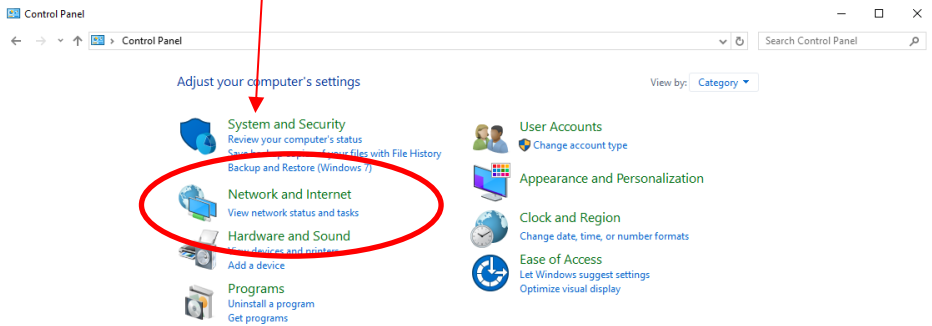
# IP Configuration

- If the IP Address on the NUC computer gets reset, follow these instructions

1. Press the Windows key and type in *“Control Panel”* and select *Control Panel*

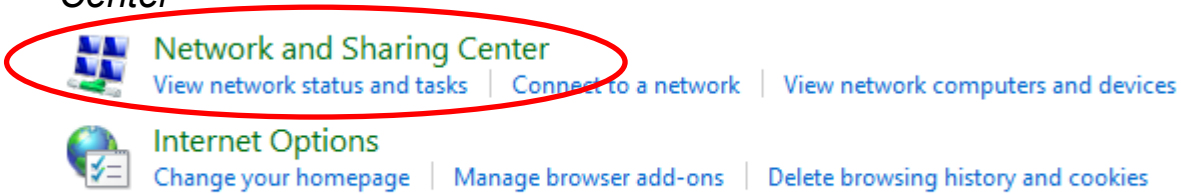



2. Select *“Network and Internet”*

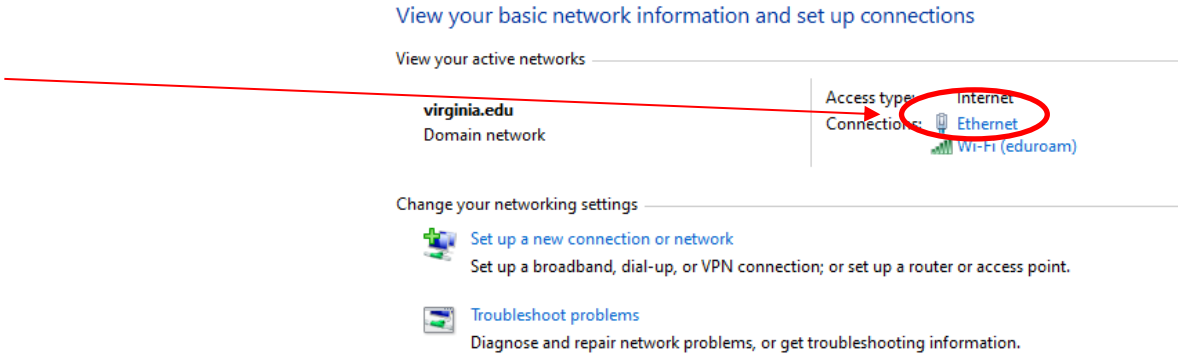


# IP Configuration

3. Then navigate to *“Network and Sharing Center”*

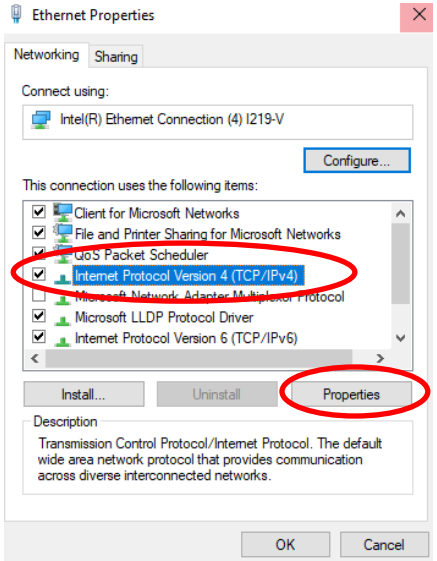



4. Select *“Ethernet”*

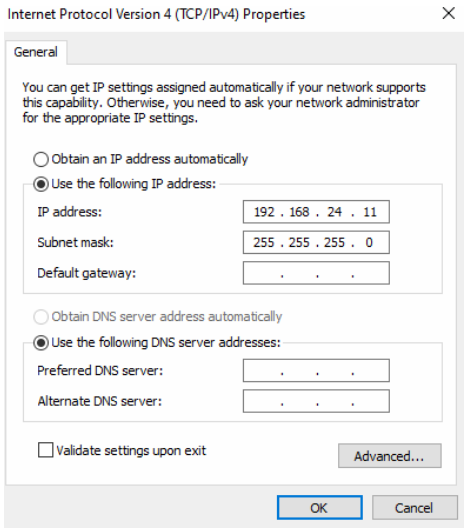


# IP Configuration

5. Select *“Internet Protocol Version 4 (TCP/IPv4)”* and select *“Properties”*




6. Fill out according to the picture below and press *“Ok”.*



Thank you …