

Update on the PDS in On-Going VD ColdBox Run

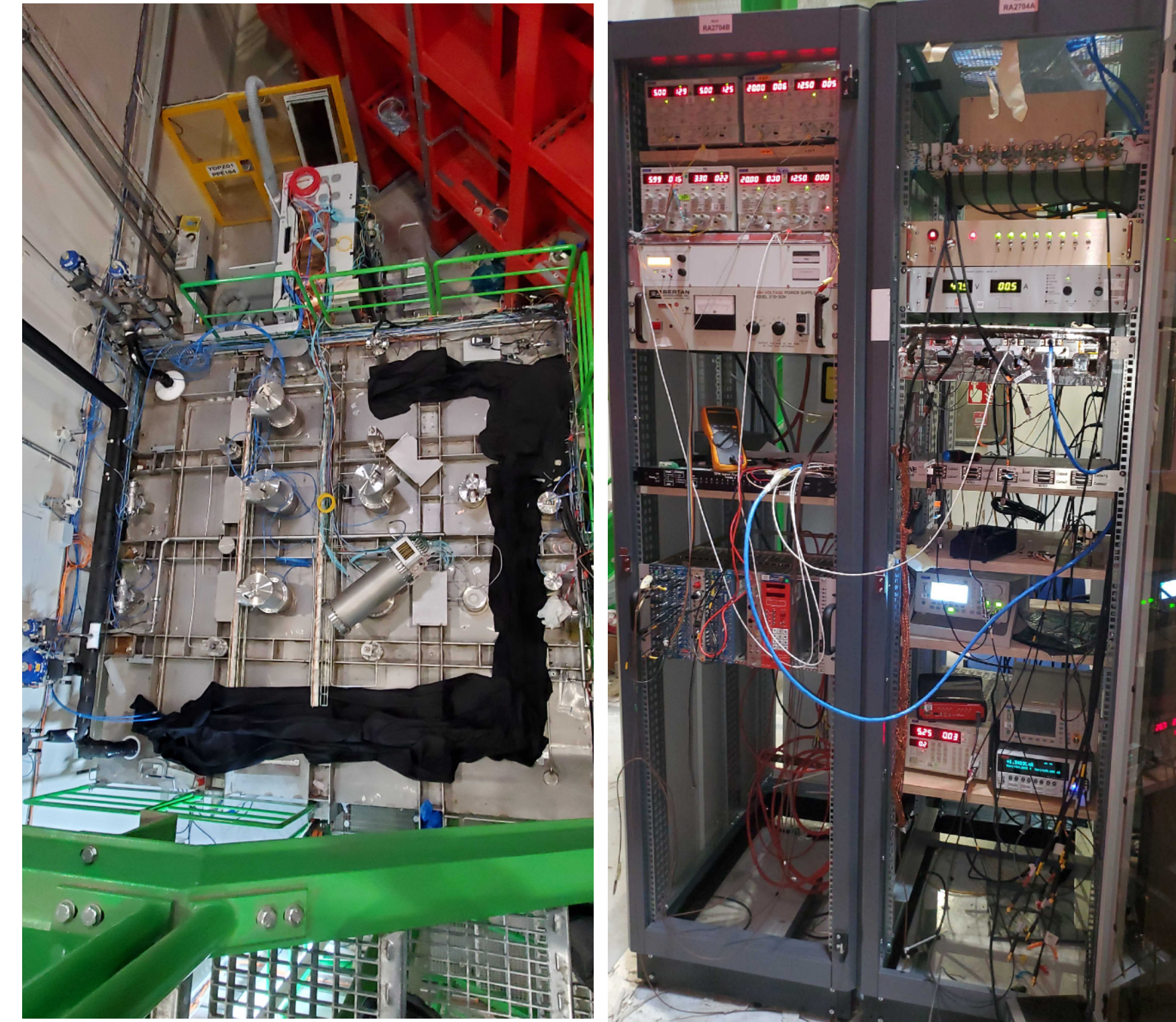
Sam Fogarty

(also Henrique Souza, Ajib Paudel, Eleonora Bertolini, Federico Galizzi, Manuel Arroyave at CERN)

April 12, 2024

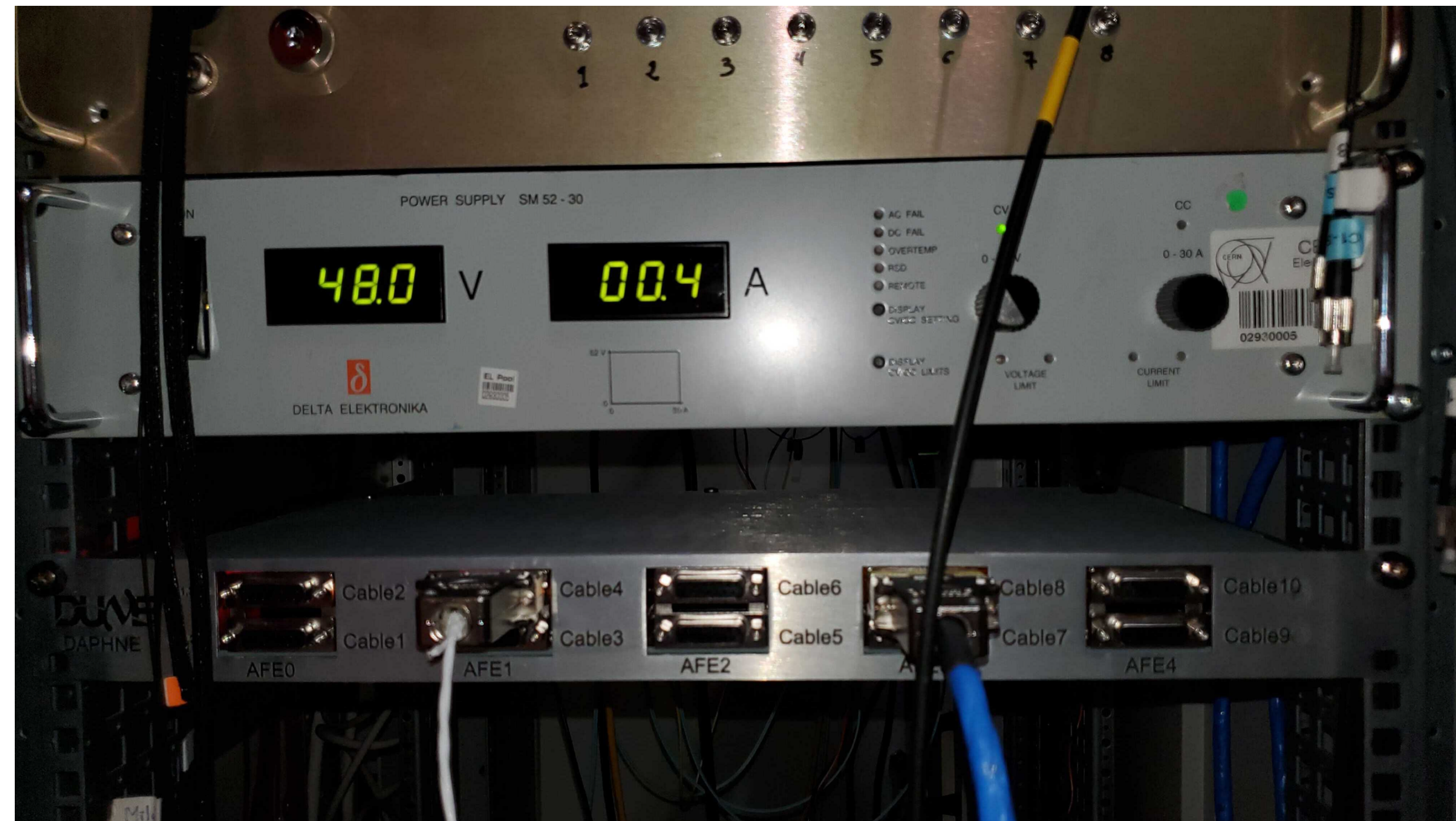
Coldbox PDS General Details

- The coldbox was filled Thursday April 4th
- The first week Ajib, Manuel, and I worked on installing the DAPHNE from CSU in the rack next to the coldbox
- This week Eleonora, Henrique, and Federico arrived to help. Eleonora, Federico, and Henrique helped us to install the DAPHNE from Milano and connect the cathode modules.
- Henrique has been working on the analysis of the calibration data from DAPHNE. He also took some CAEN digitizer data for the cathode modules for comparison to DAPHNE.



DAPHNE Installation at Coldbox

- DAPHNEv2 I brought from CSU was installed down by the coldbox at CERN.
- Only can readout membrane modules with this DAPHNE since it is not setup to readout cathode modules (DAPHNE from Milano is)
- We started looking at signals in the HD-style and VD-style membrane modules in the meantime. We were able confirm that we could see signals and make some general observations. The datataking with DAPHNE spy buffers was a work-in-progress at this point so we did not take a lot of good calibration data.
- Ajib and Henrique were working with Dante (remote) to make some changes to the VD membrane warm electronics.



DAPHNE Installation at Coldbox

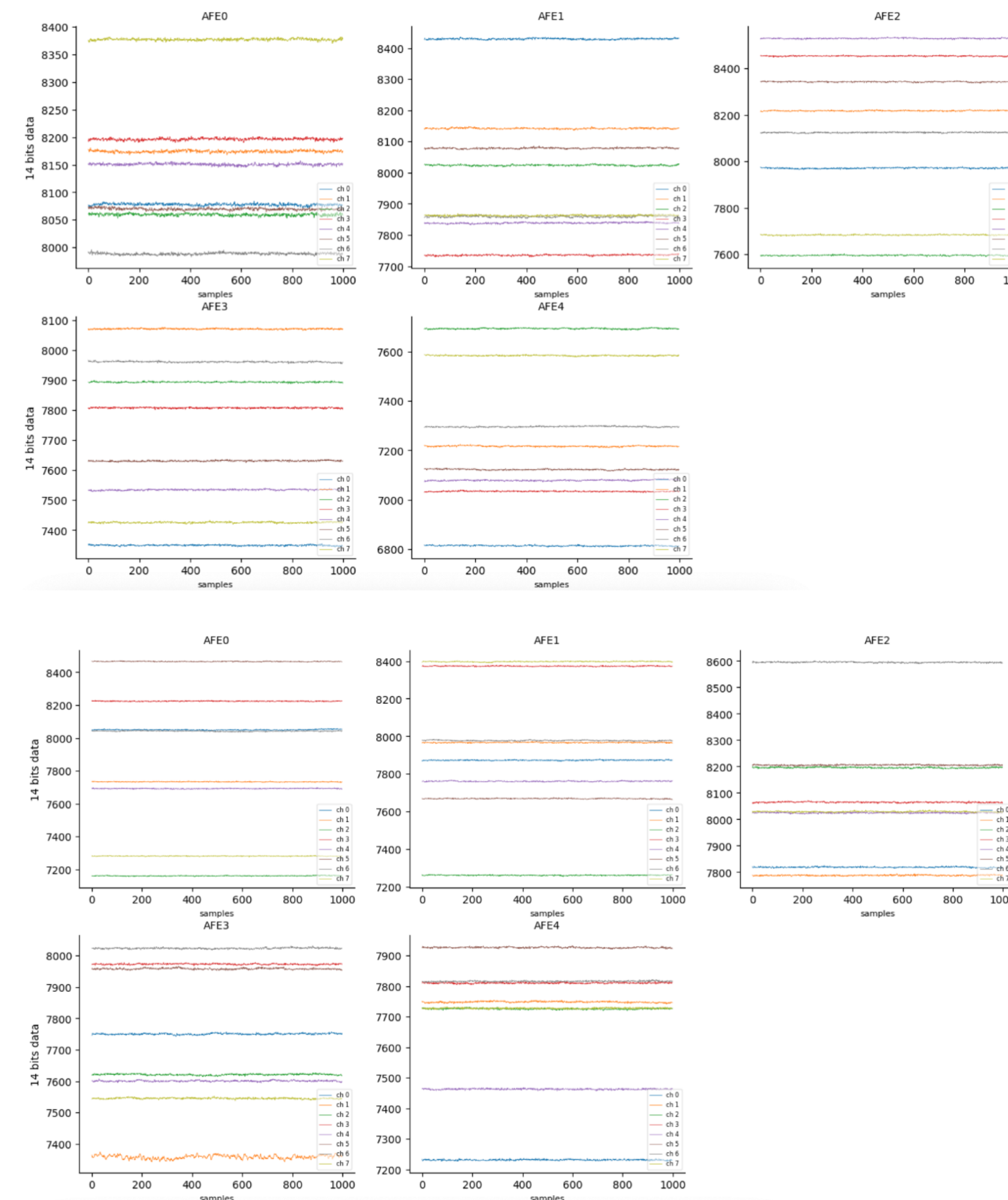
- On Tuesday this week we installed the DAPHNE from Milano at the rack with the other DAPHNE (Milano DAPHNE is hidden behind a make shift faraday cage for the fiber receivers)
- We were able to power them in parallel on the same 48V power supply (PS was reading about 900 mA total current draw).

Optical fiber transceivers for reading out the cathode modules with DAPHNE



Reading from DAPHNE

- Can access DAPHNE spy buffers over the network (on an np04 server) for both DAPHNEs (example random waveforms shown on the right, with VGAIN=1800, offset=1118)

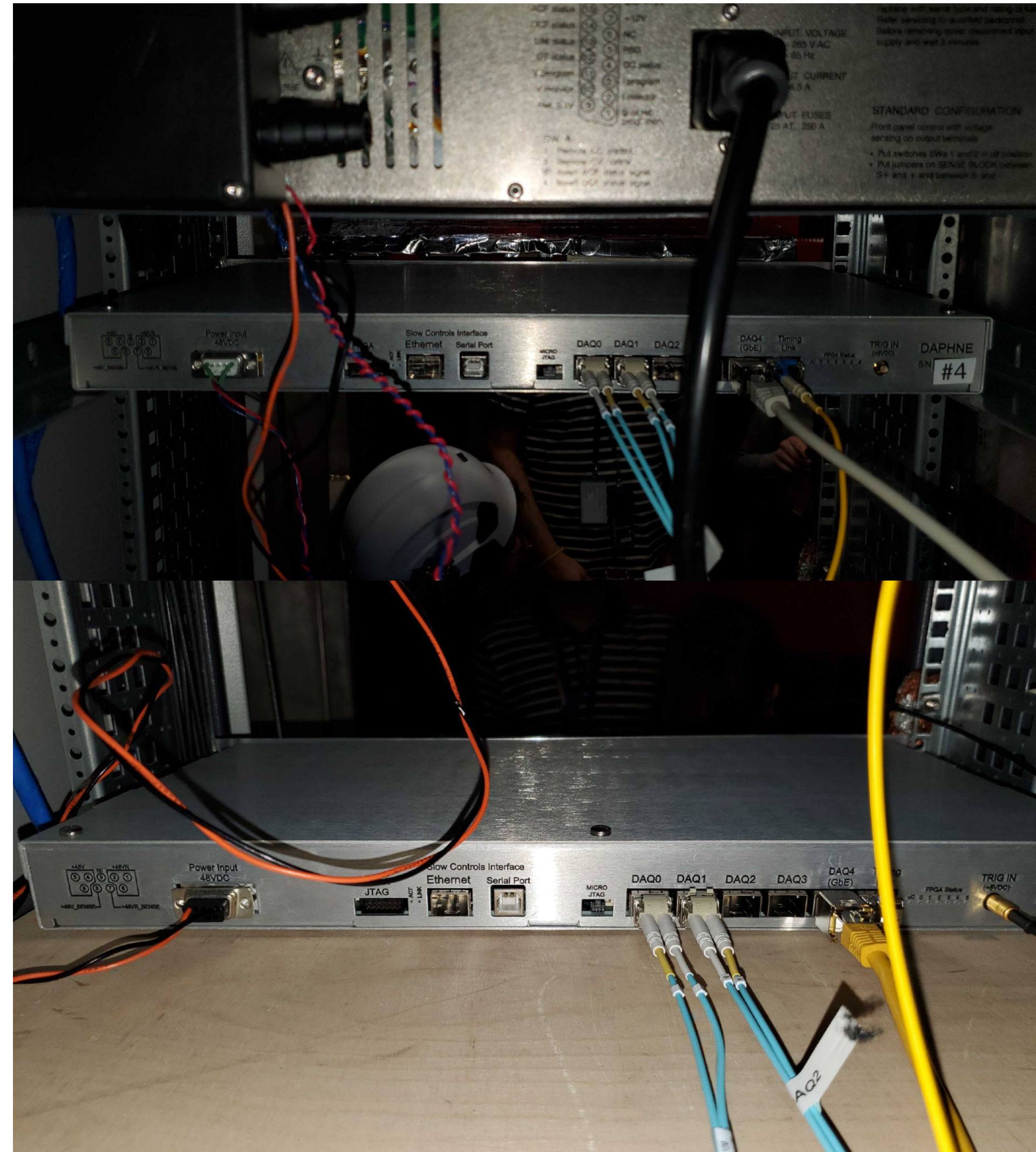


DAPHNE
Label: #4
EP 106

DAPHNE
Label: #3
EP 110

DAPHNE Installation at Coldbox

- Moved two data fibers to the second DAPHNE (would have moved three but one was stuck)
- The links are:
 - DAQ 1 fiber -> DAQ0 DAPHNE 3
 - DAQ 2 fiber -> DAQ1 DAPHNE 3
 - DAQ 3 fiber -> DAQ0 DAPHNE 4
 - DAQ 4 fiber -> DAQ1 DAPHNE 4
- I had to update the microcontroller firmware on the Milano DAPHNE to be able to communicate with it over ethernet. Will be soon updating the fpga firmware to make sure it is the latest version



DAPHNE
Label: #4
EP 106

DAPHNE
Label: #3
EP 110

Some Problems with the Two DAPHNE Setup

- We could get the timing interface setup for Milano DAPHNE but not CSU DAPHNE. This may be due to firmware differences, but we have not had too much time to further debug
 - A larger problem: Need two timing interface fibers so that both DAPHNEs can be connected to DAQ at once. Talking to the DAQ folks, we do not have one on hand. They ordered some that will come next week. So this presents a barrier to using two DAPHNEs
 - Another problem: Since yesterday we cannot run both DAPHNEs on the same power supply, the CSU DAPHNE was not working properly when powering the two at once. But powering it on its own it appears to work fine.
- We have been investigating the possibility of putting the membrane modules on the Milano DAPHNE along with the cathode modules, as this seems to be our best (and only) option right now (if we want to read all modules through the DAQ, which we obviously do)



Calibration Data With DAPHNE

- The calibration data we took can be found at this directory on Ixplus: [/eos/experiment/neutplatform/protodune/experiments/ColdBoxVD/April2024run/calibrationData](#)
- The data acquisition utilizes the DAPHNE spy buffers. This took some time to debug and to make more efficient. But today we were able to take data very quickly. (The slowest part is tuning the offsets on all the channels. Choosing a good starting offset is important otherwise it is slow. Certainly a more efficient algorithm could be devised)



Calibration Data With DAPHNE

- Care must be taken when using the spy buffers to take data. We operate the LED with some trigger rate and pass the trigger to the DAPHNE external trigger. The ext trigger triggers the spy buffers and writes ~65 usec samples from each channel to buffers that can be read over ethernet
 - Problem: If the trigger rate is too fast, the buffers may overwrite *while* we are reading them. This causes a lot of the waveforms we read to be unusable.

We fix this by reading the waveform timestamp (actually just the first timestamp of the waveforms) and then read the same timestamp after reading the data. If the timestamps are different before and after, we know another trigger happened during that time. So we discard this waveform.

The faster the trigger rate, the more waveforms we have to discard (which effectively harms the rate we read data). We found a nice balance at 500 Hz on the LED, where we could read waveforms ~500Hz.

Calibration Data With DAPHNE

- I encountered an issue where we would issue a command to DAPHNE of any kind, and sometimes the command would hang and not finish. This would cause of data taking script to freeze randomly, forcing us to rerun the script. These interruptions would sometimes happen a lot, so it was very disruptive to datataking.
- To fix this, I added some code to the catch whenever a command takes too long to execute (more than 1s) and retries the command until it works. This fixed the issue all together so we were able to take calibration data much more easily.



DAPHNE Calibration Data Procedure

- For the calibration data we followed the following procedure:
 - Set VGAIN
 - Tune offsets on all channels in AFE to close to 10000 for membrane (2000 for cathode because signals are inverted, and less over/undershoot) (optionally turn on offset integrators at this stage)
 - Take 10000 waveforms from each of the two channels in cathode (or for a membrane channel)
 - Save waveforms to csv file (data can be found here: `/eos/experiment/neutplatform/protodune/experiments/ColdBoxVD/April2024run/`)
 - Repeat process for various VGAIN values

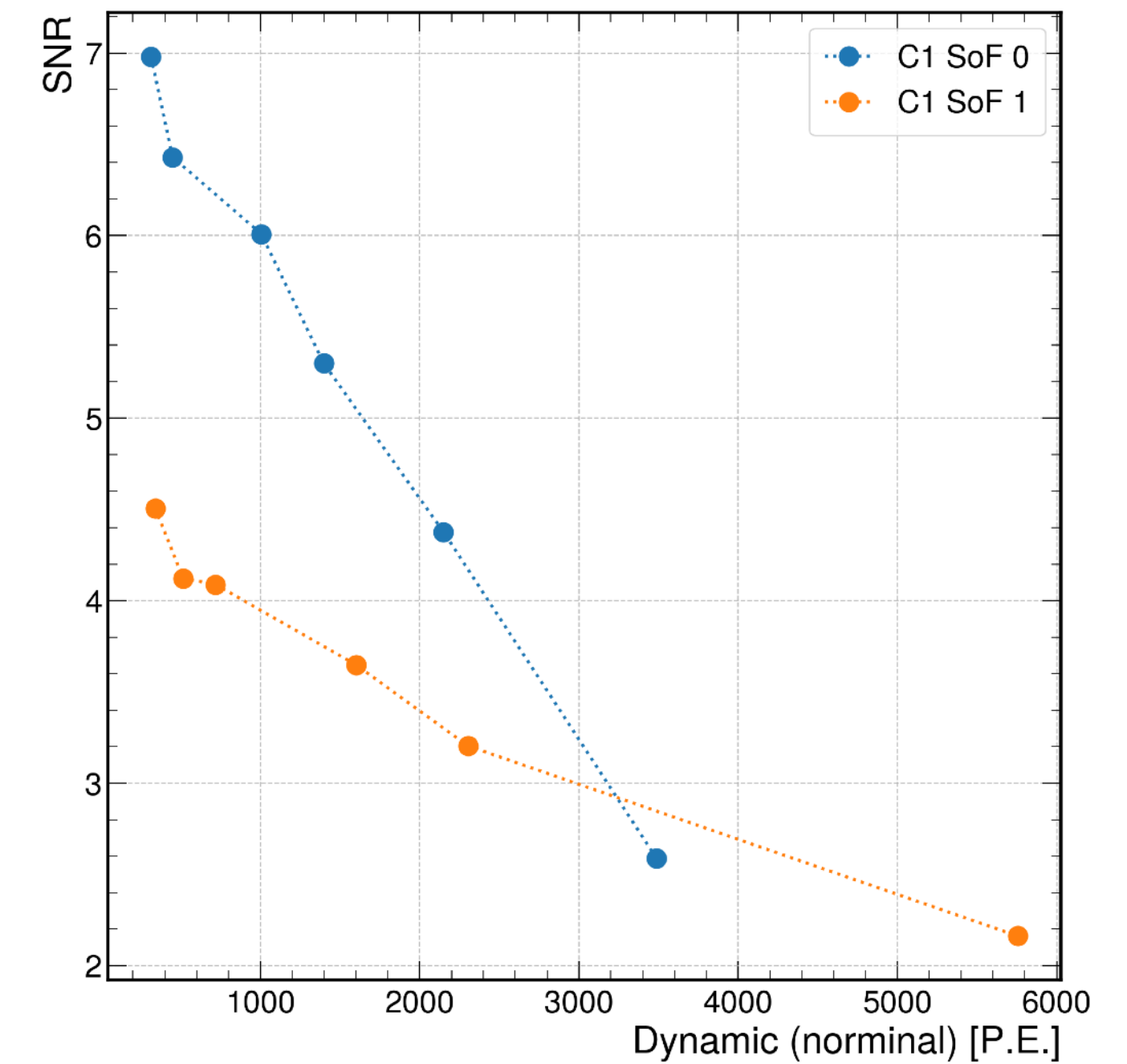
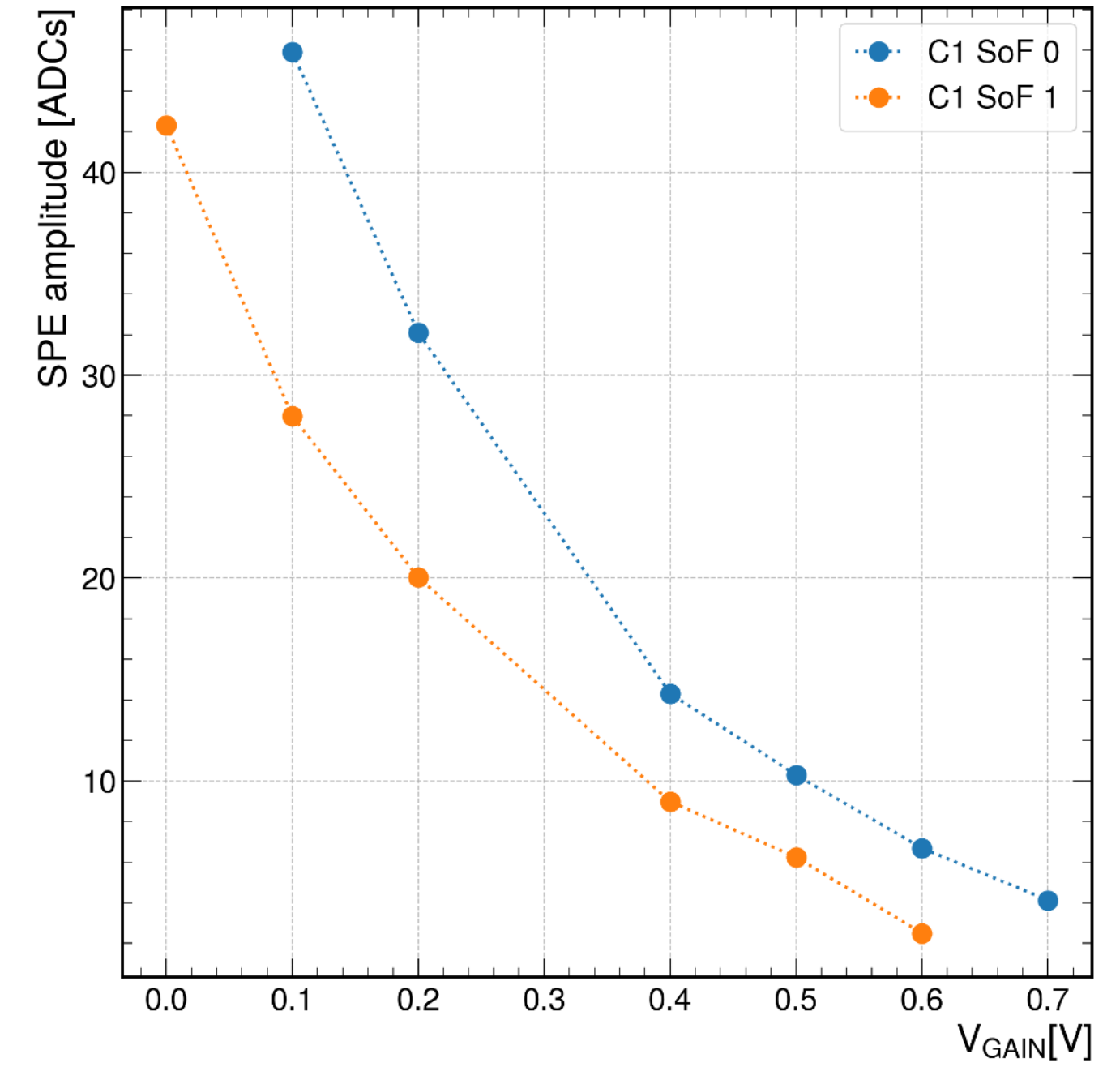
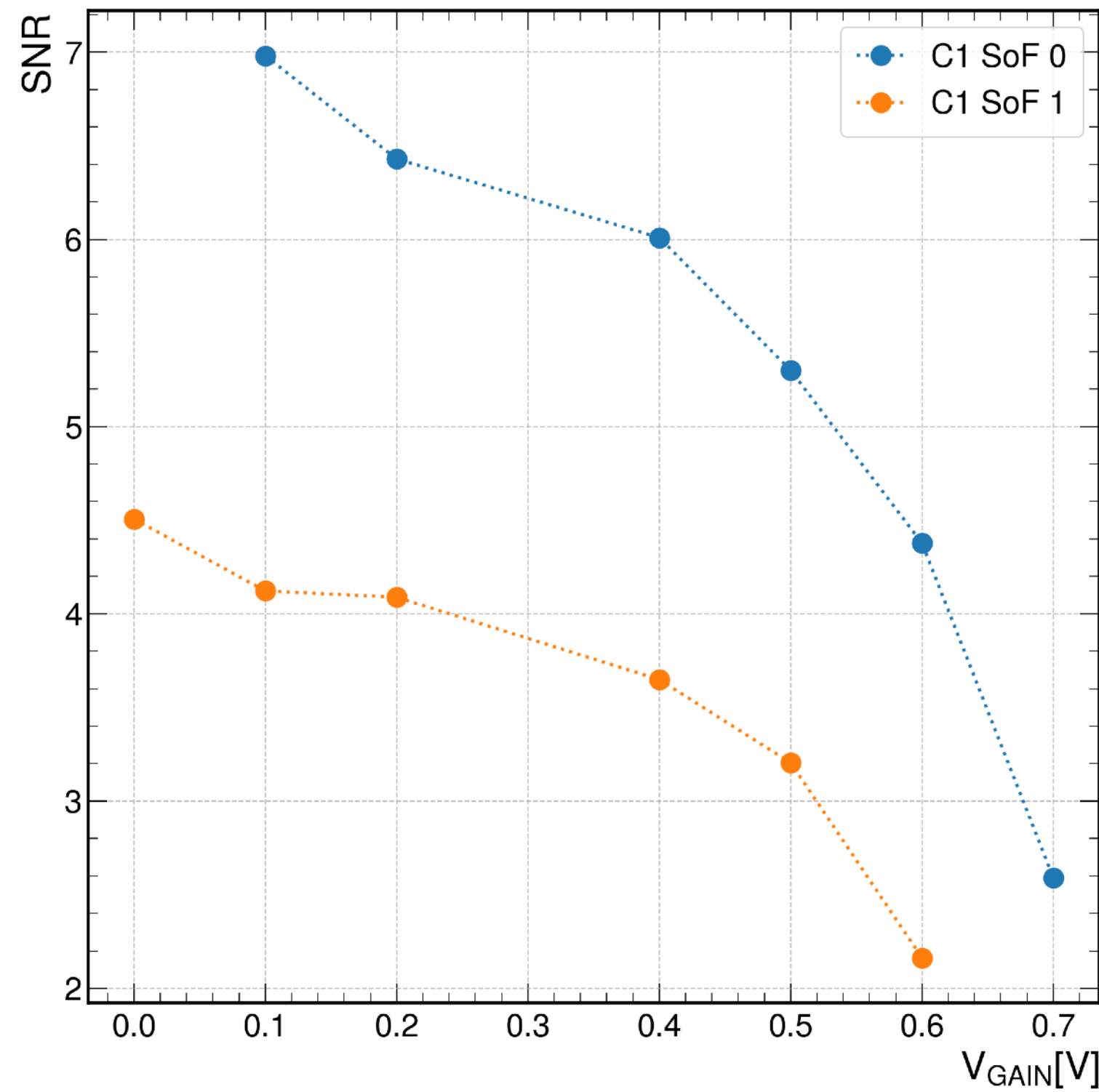
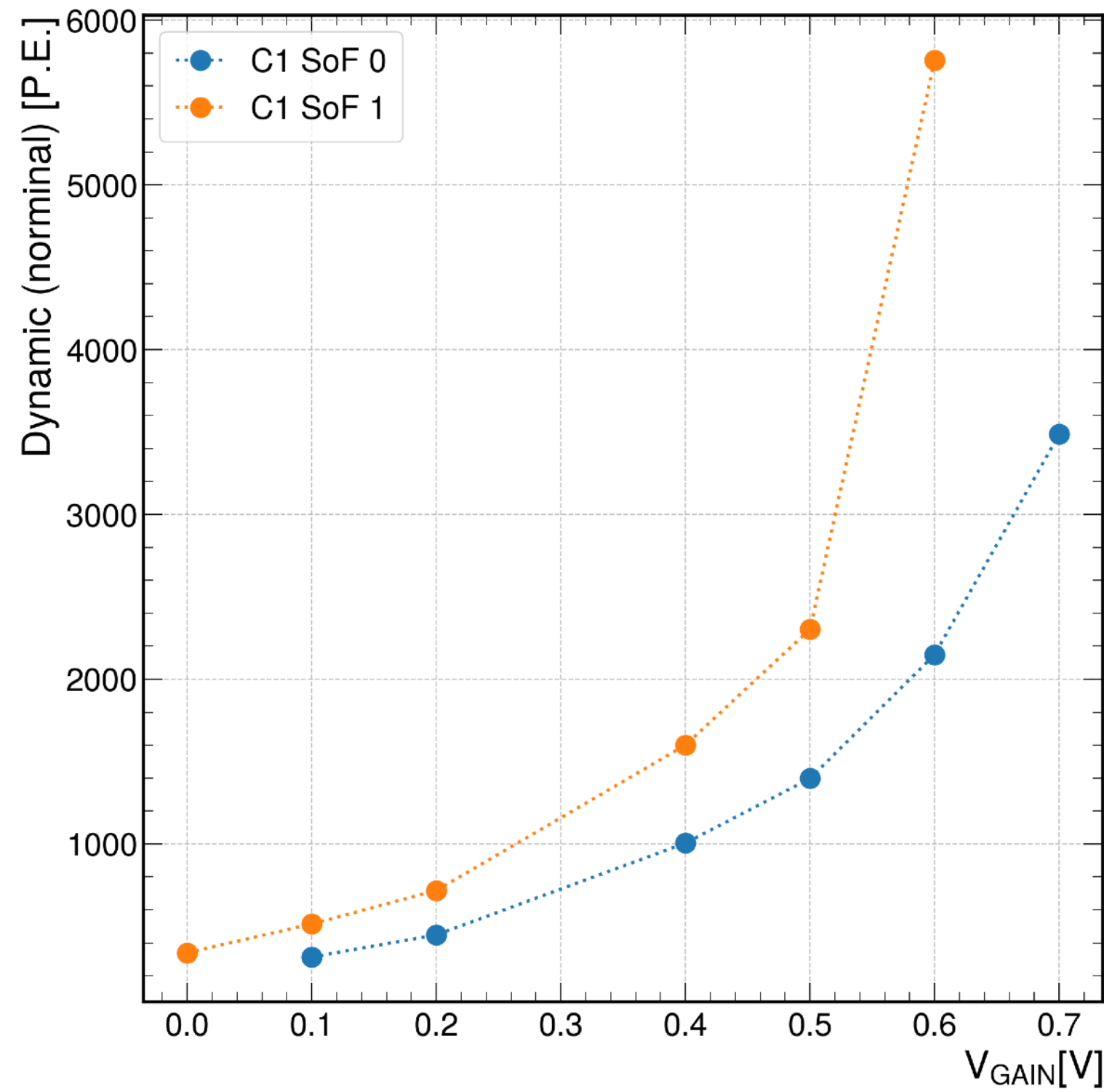


Calibration Results

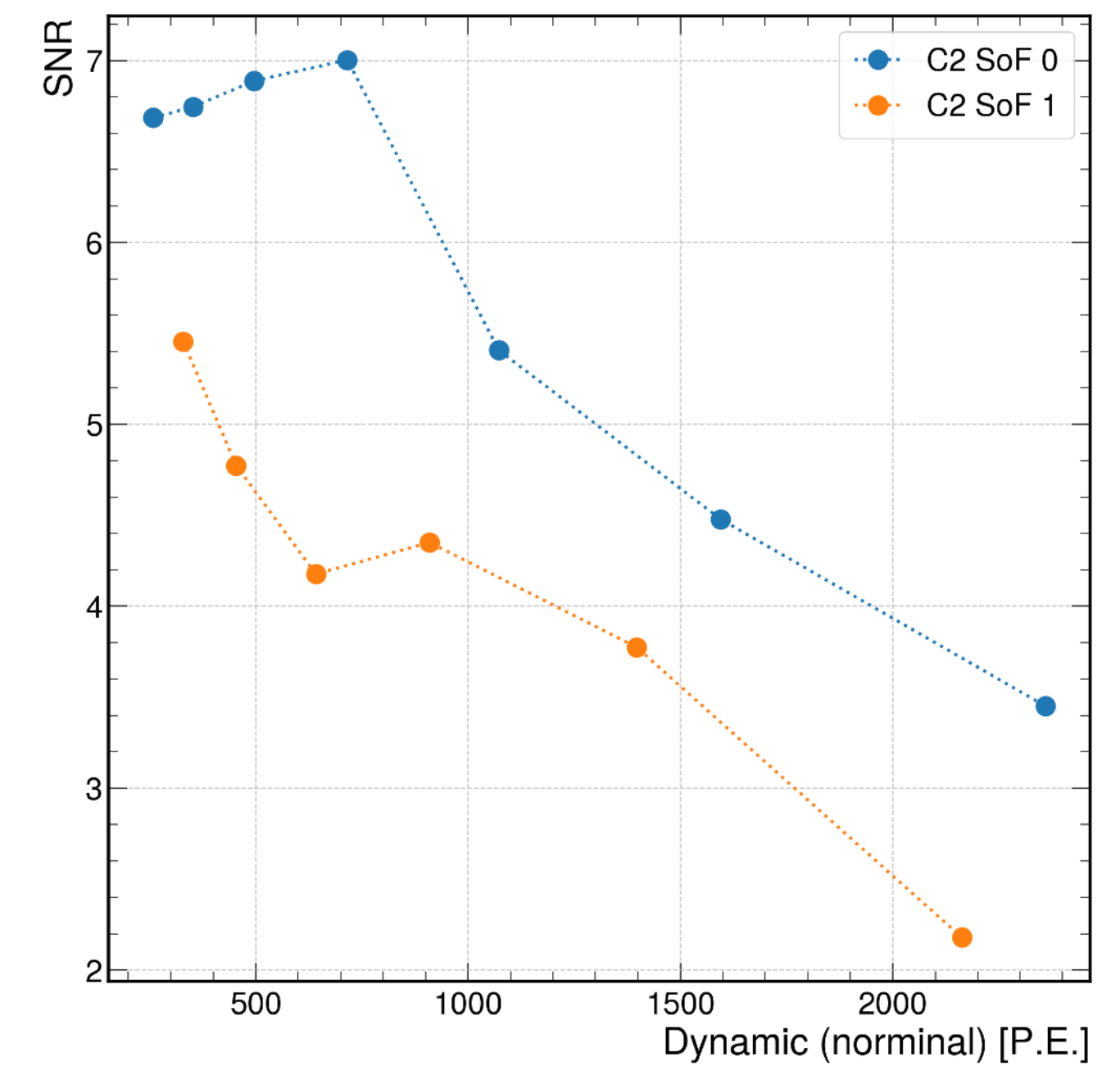
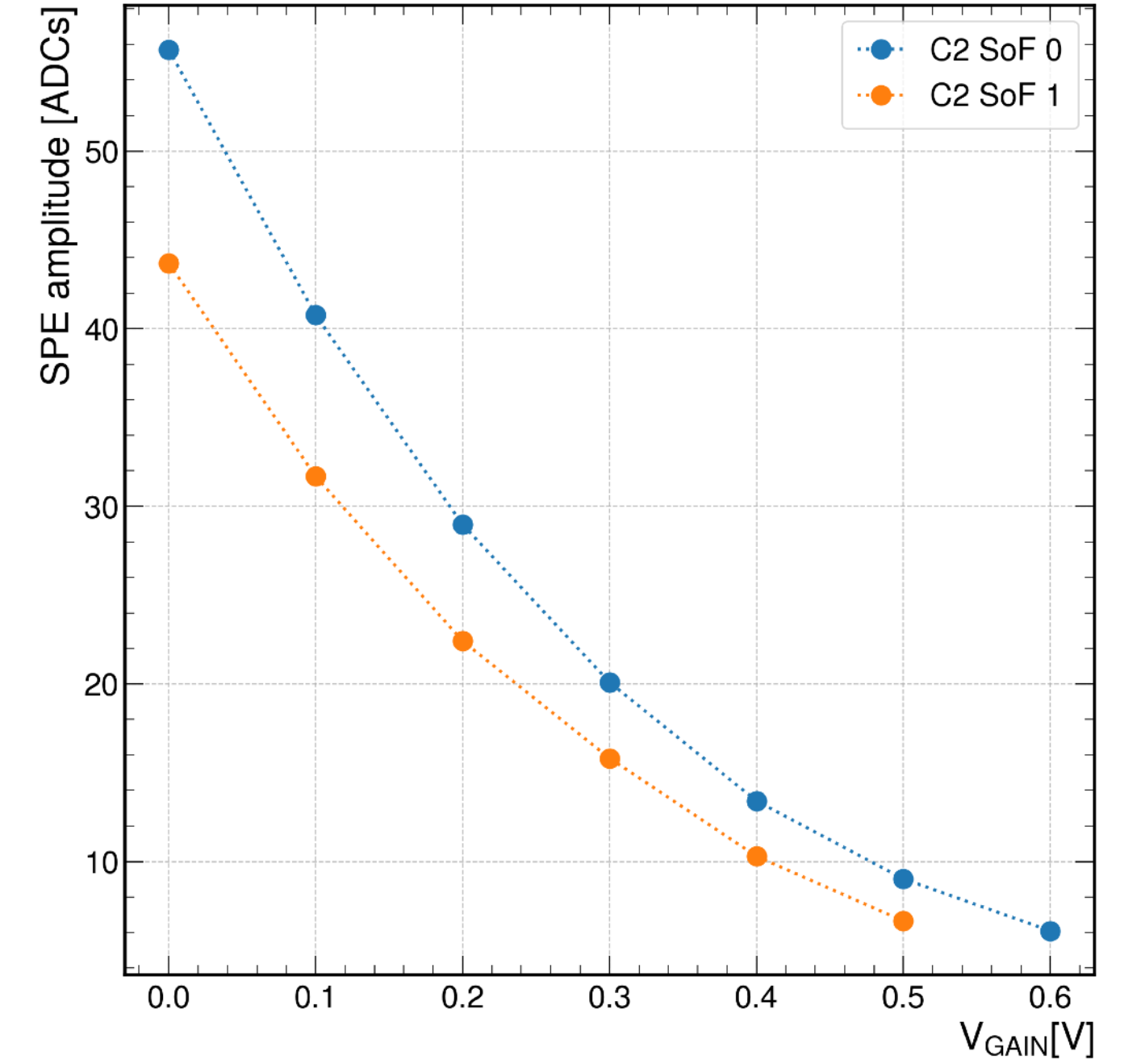
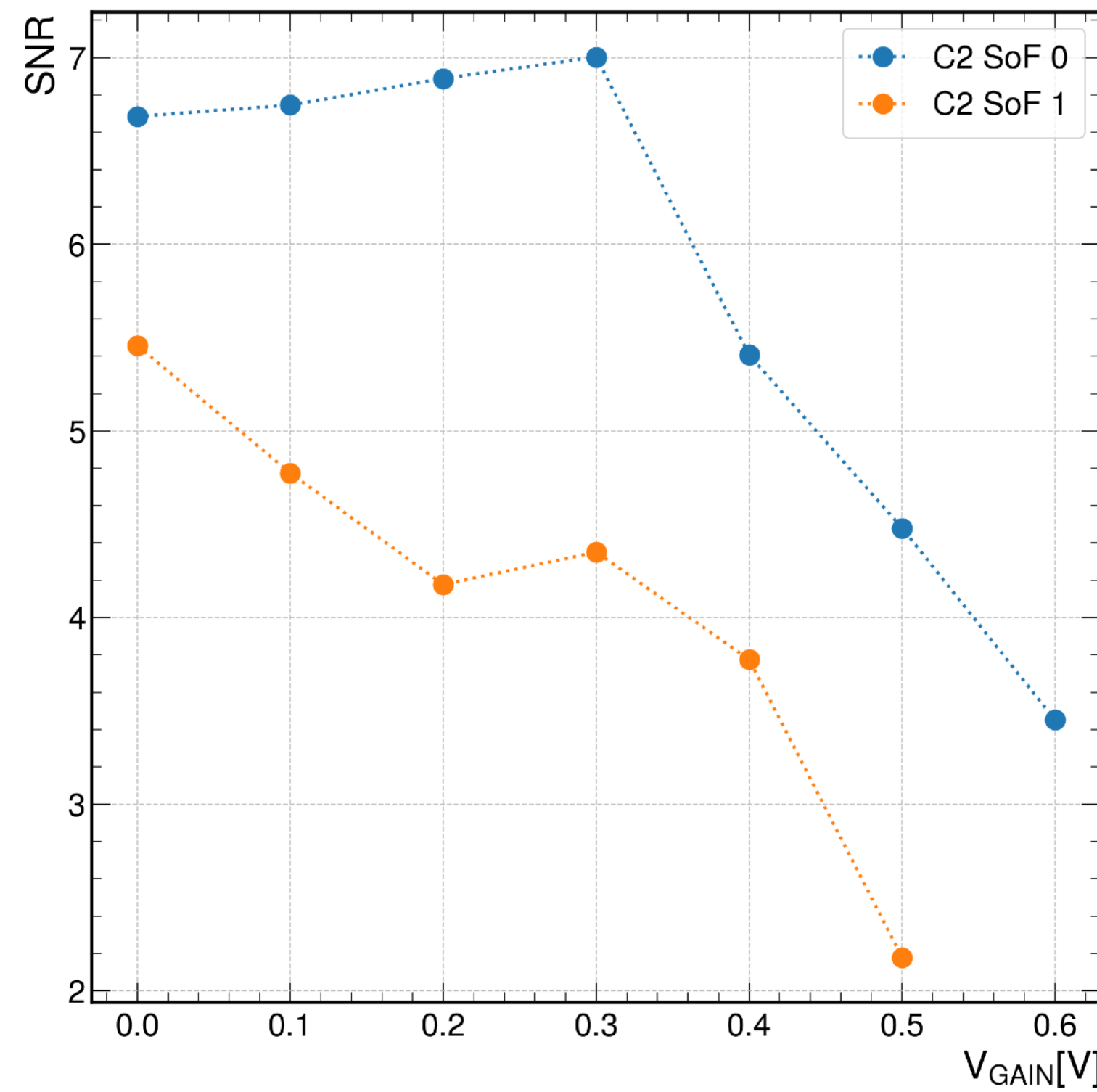
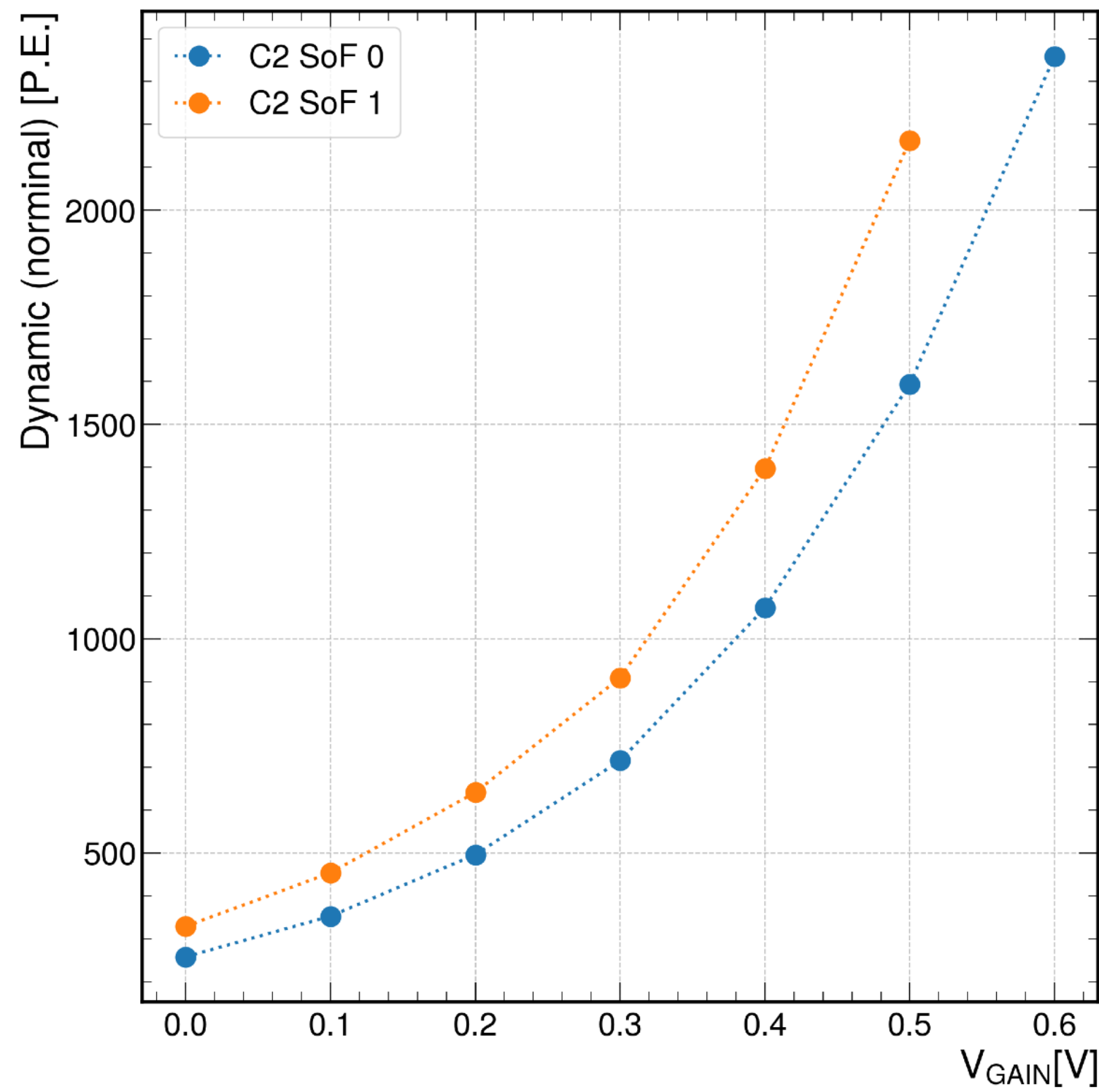
- In the following slides I will show results from Henrique, but know that **they are preliminary**, and we expect to show final results hopefully next week (and in the final configuration).



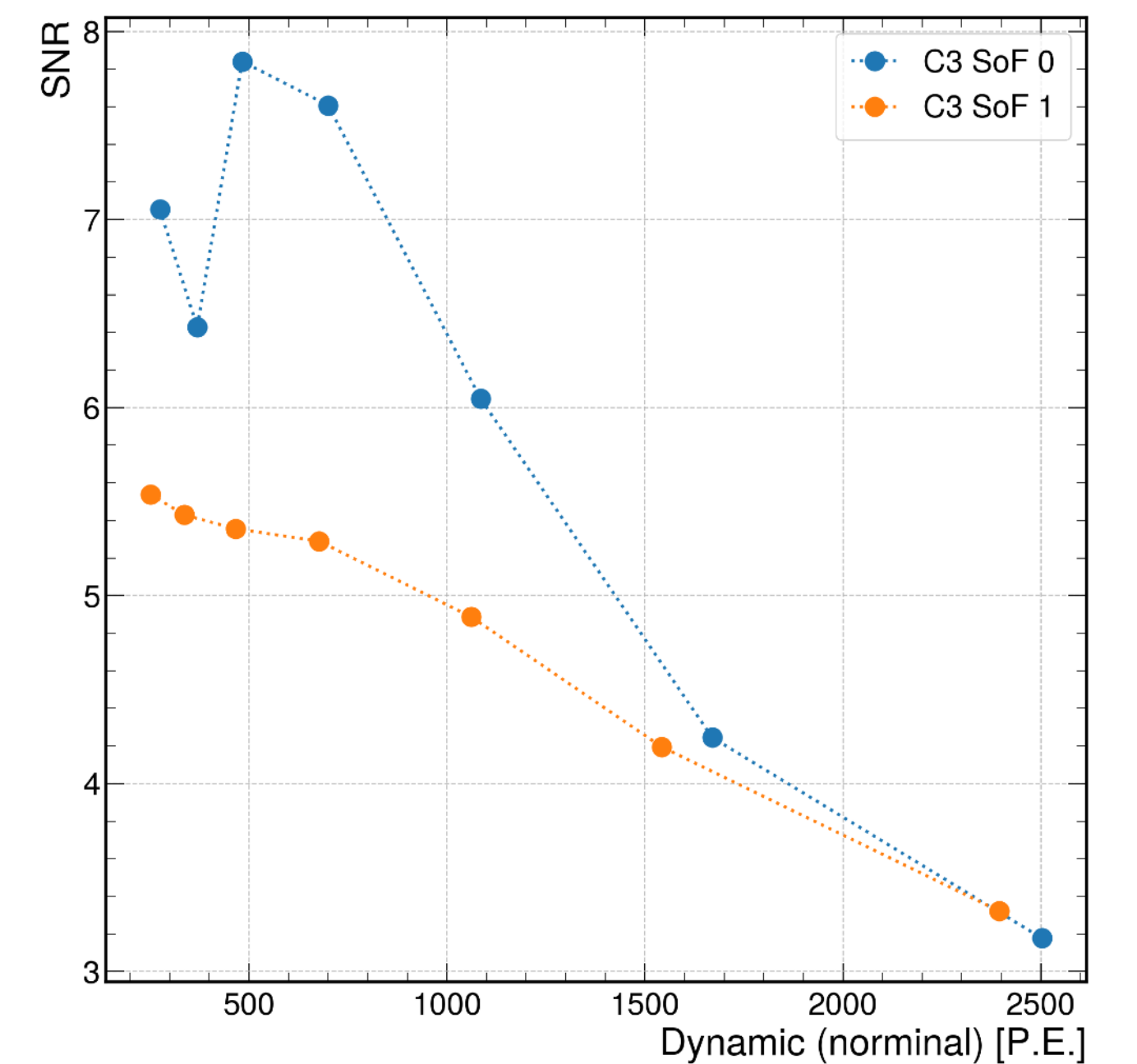
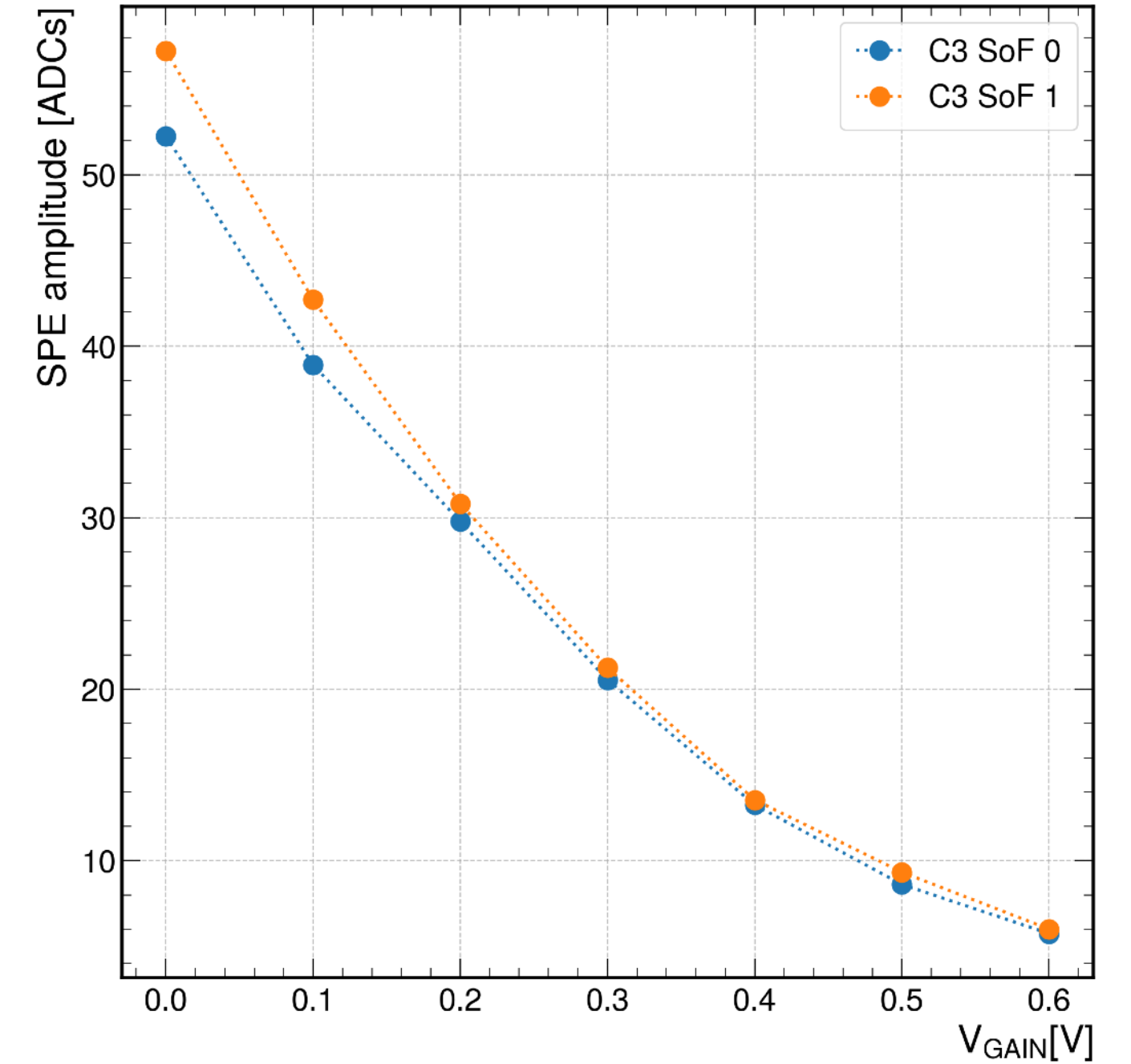
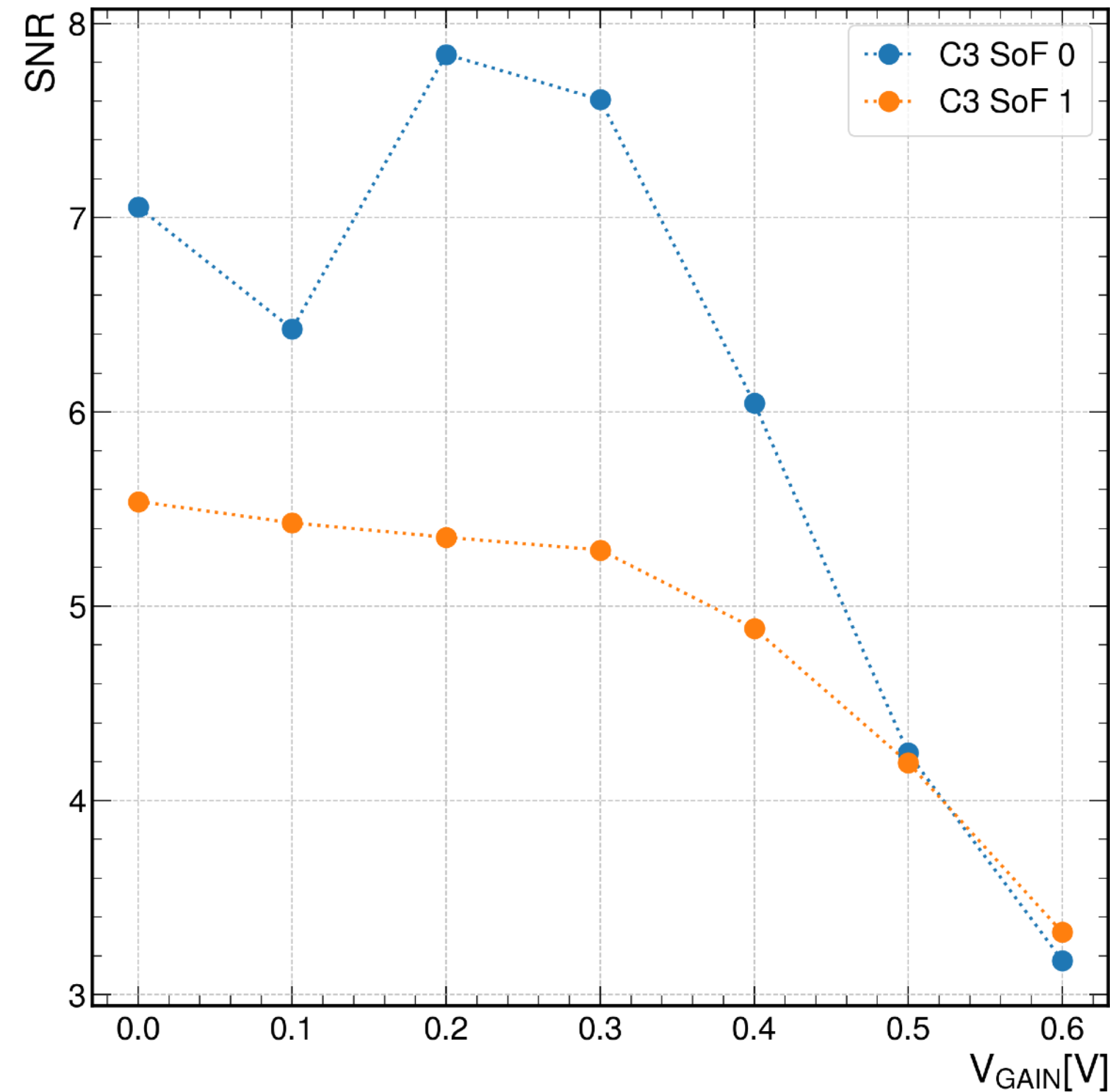
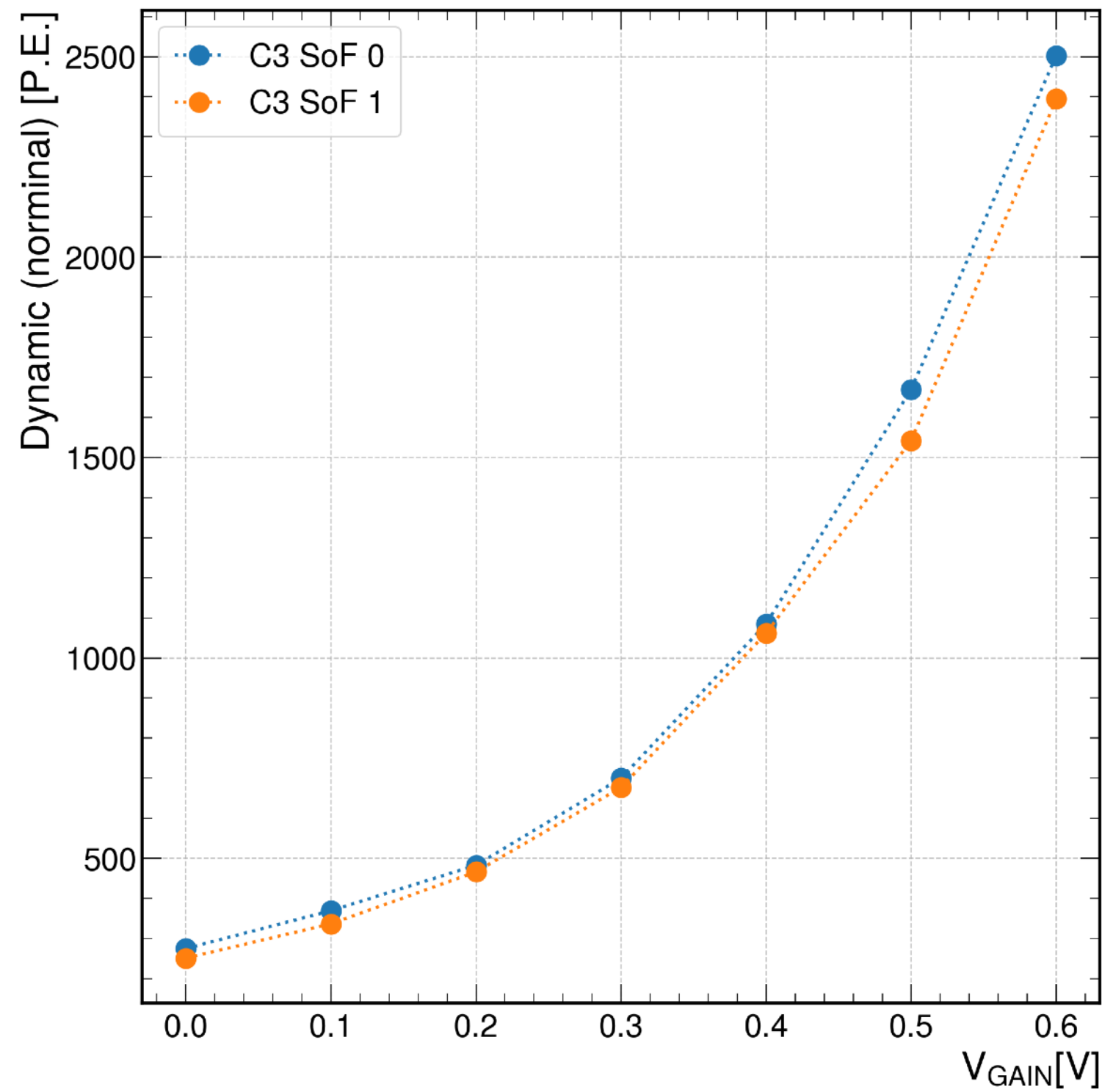
Calibration Results - C1



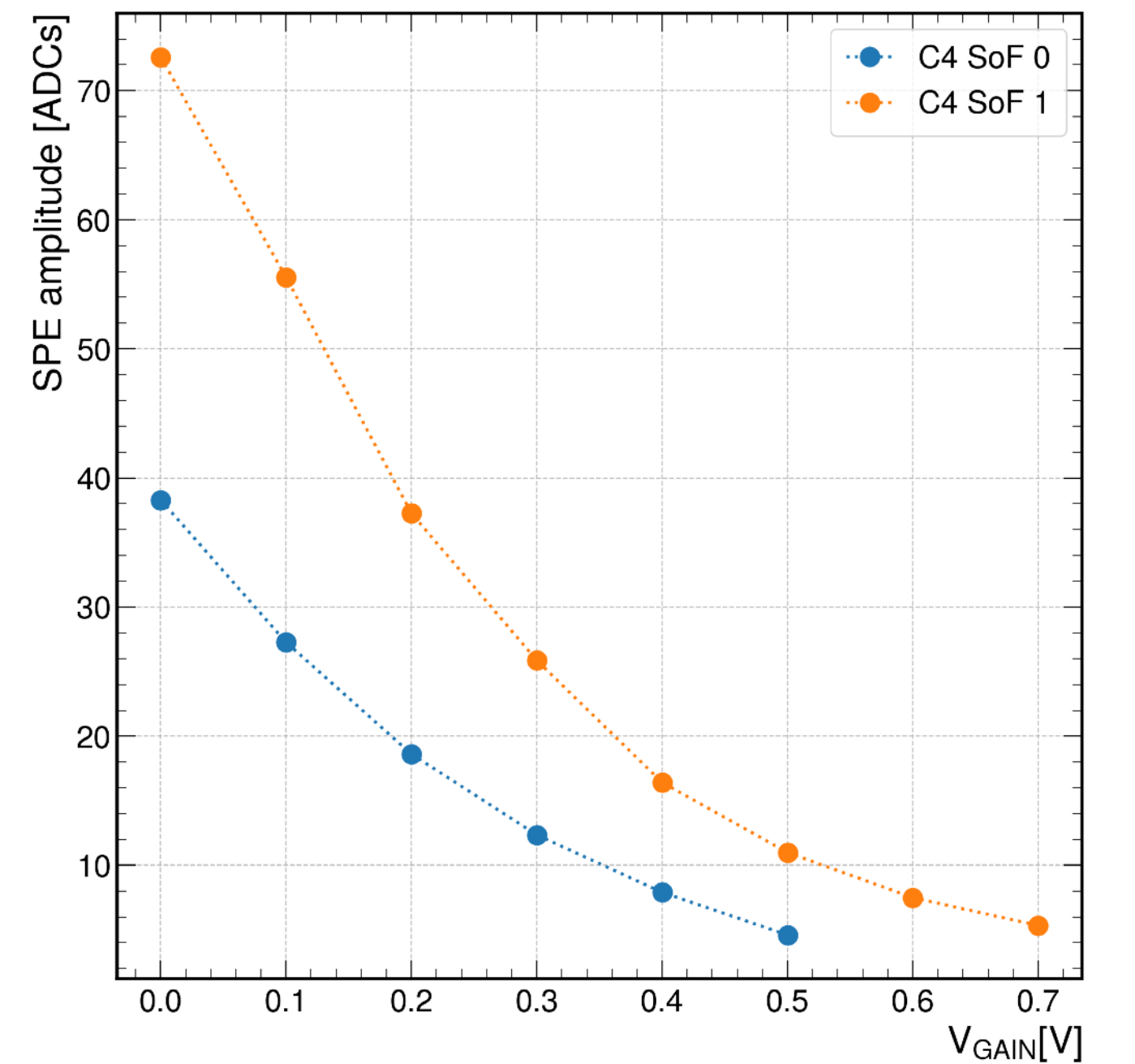
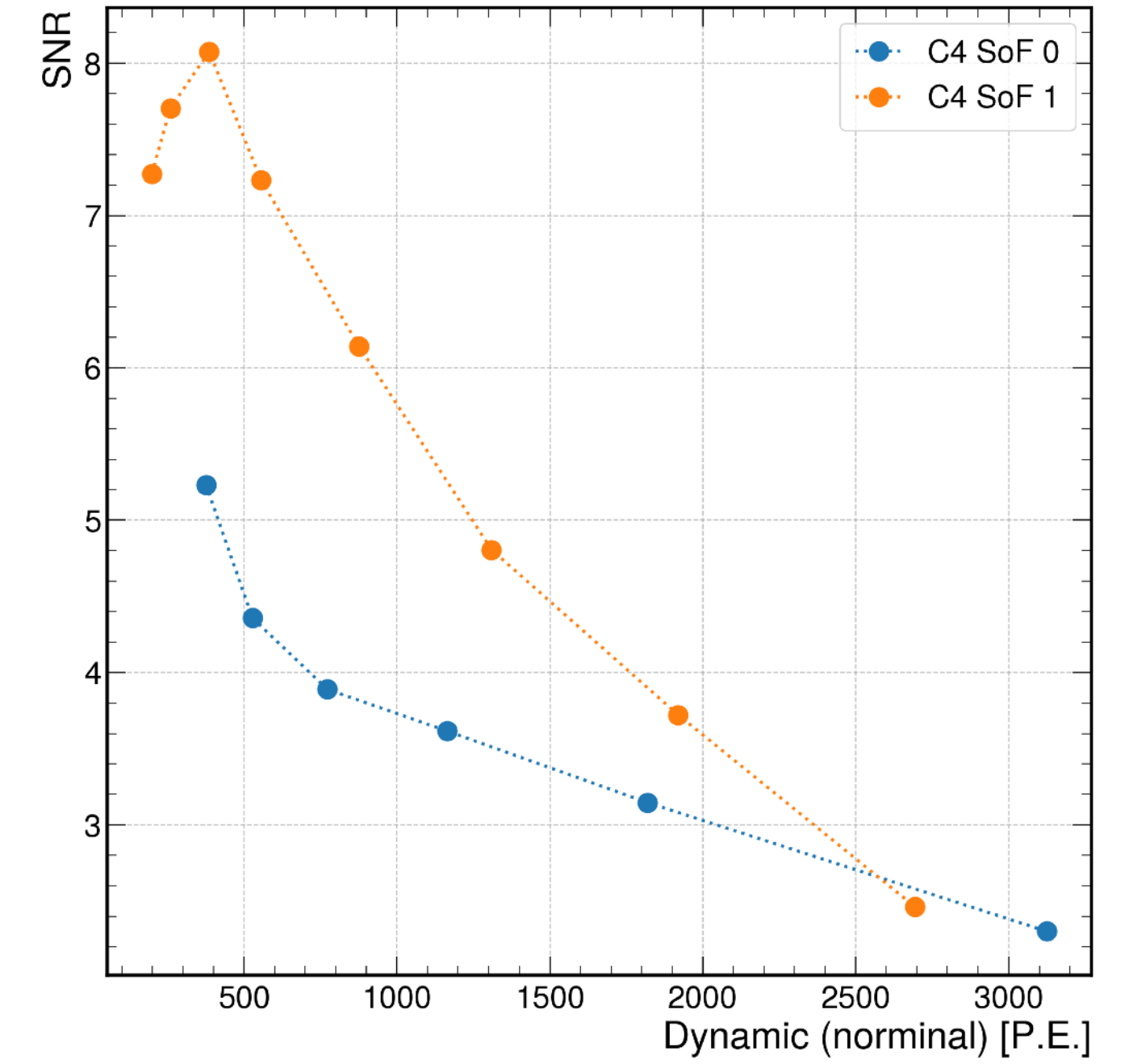
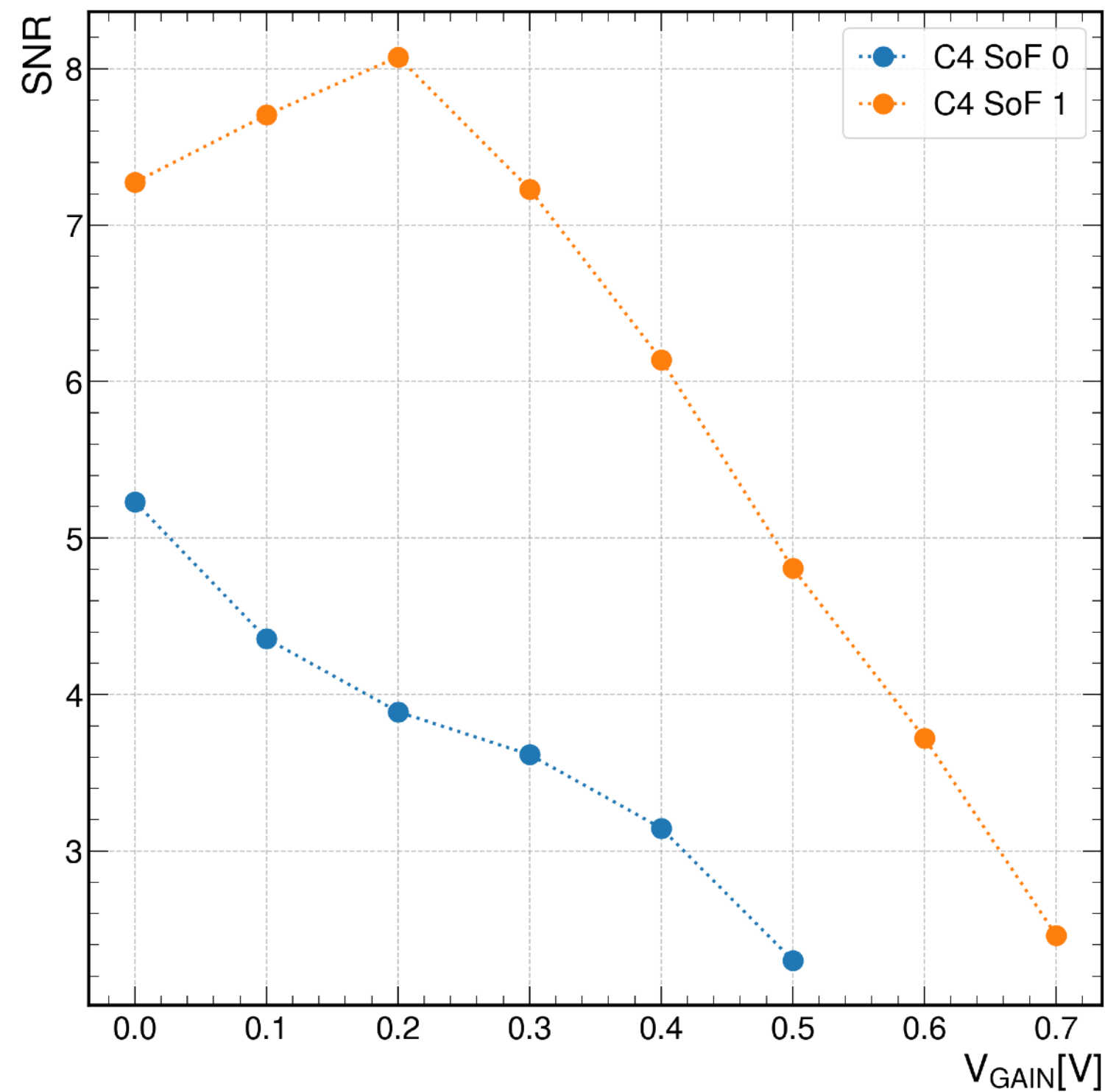
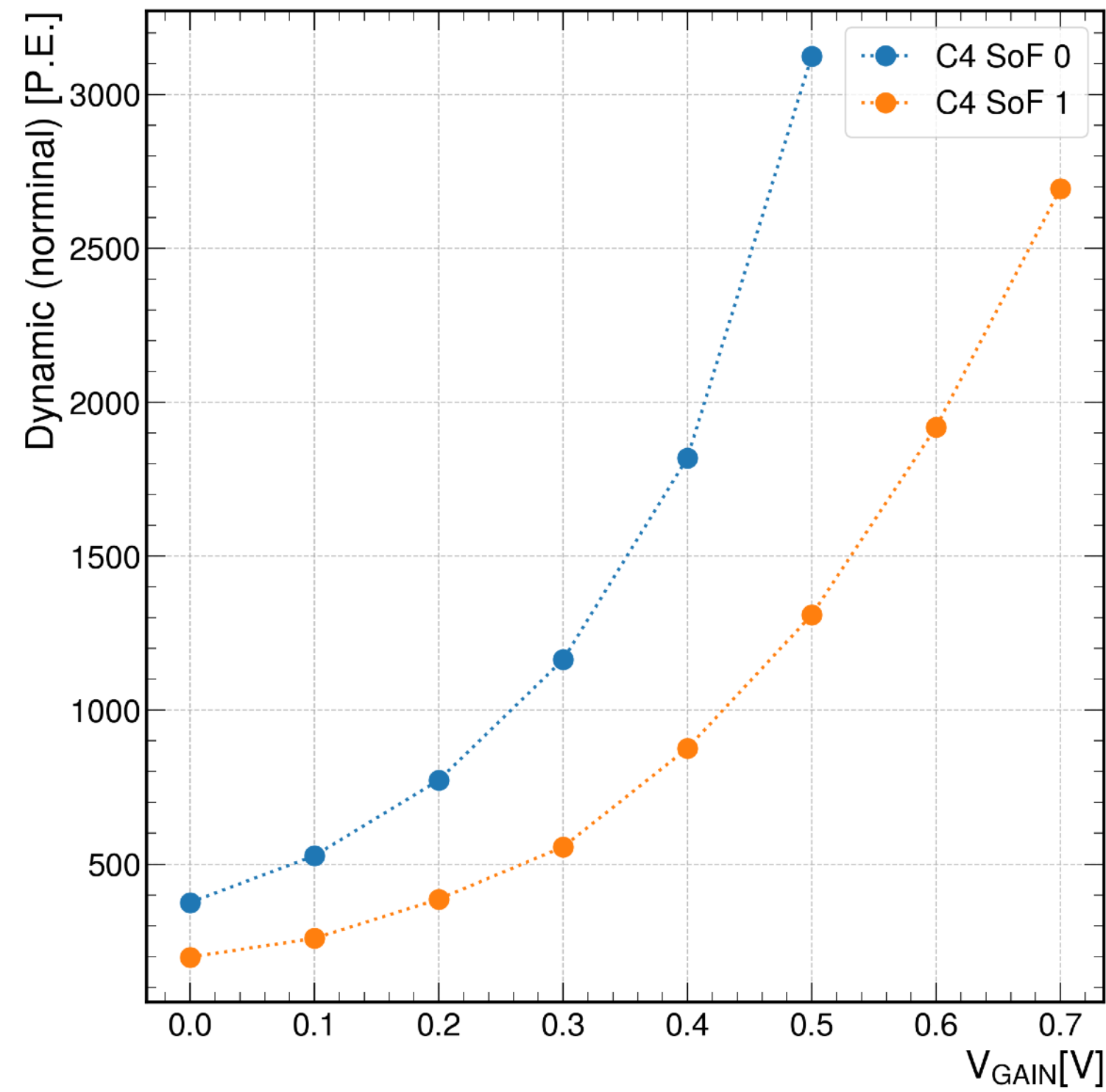
Calibration Results - C2



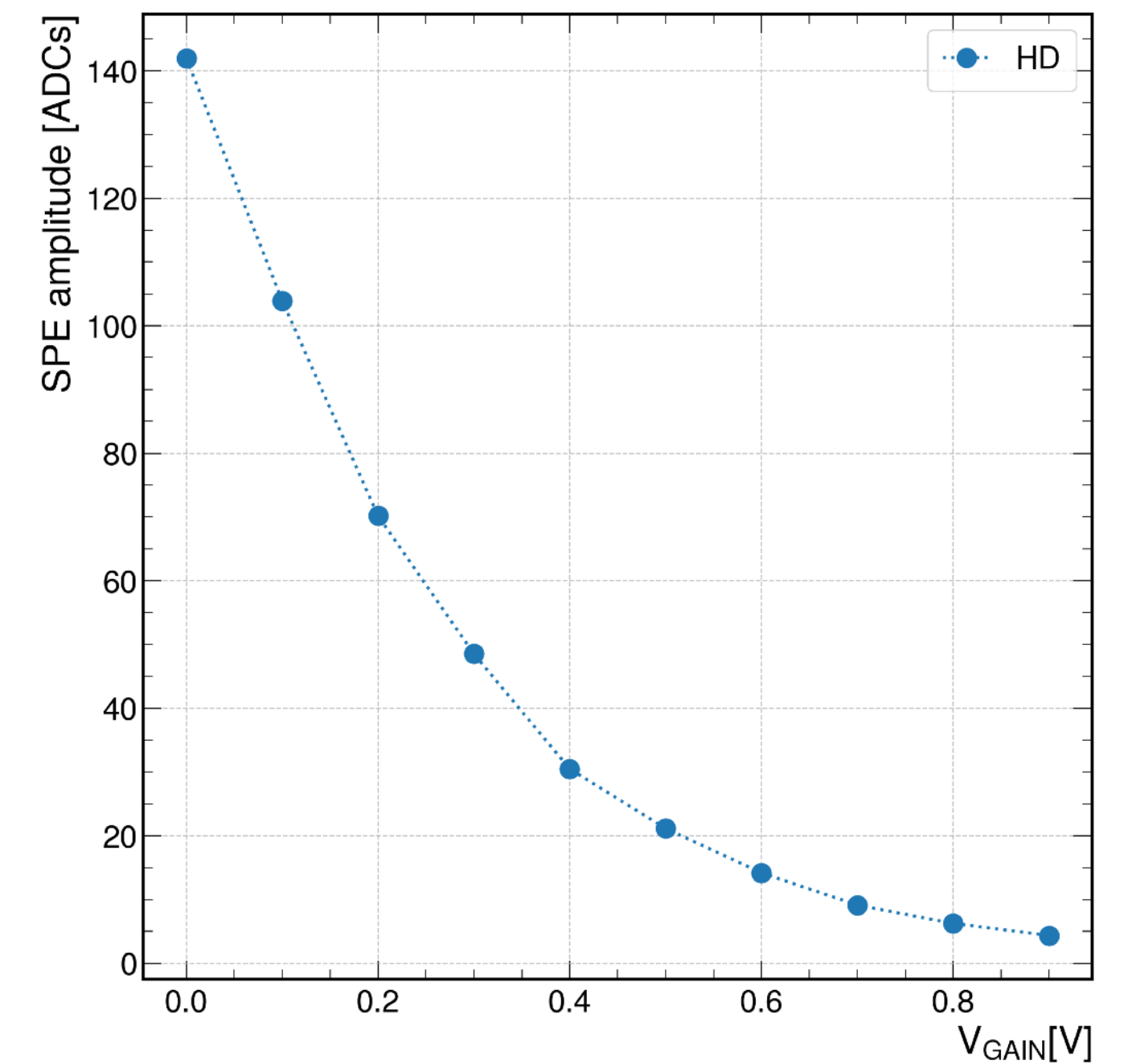
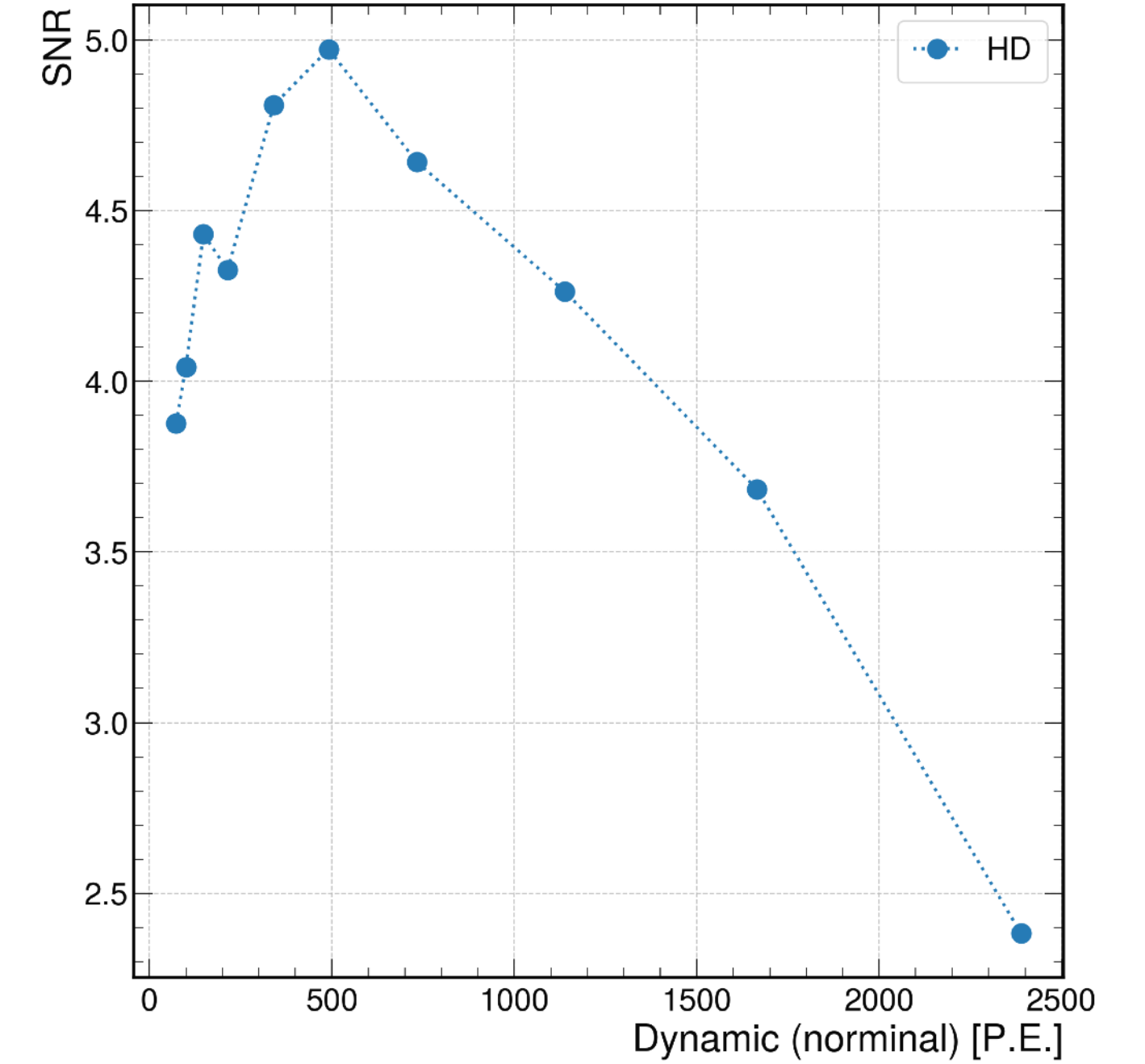
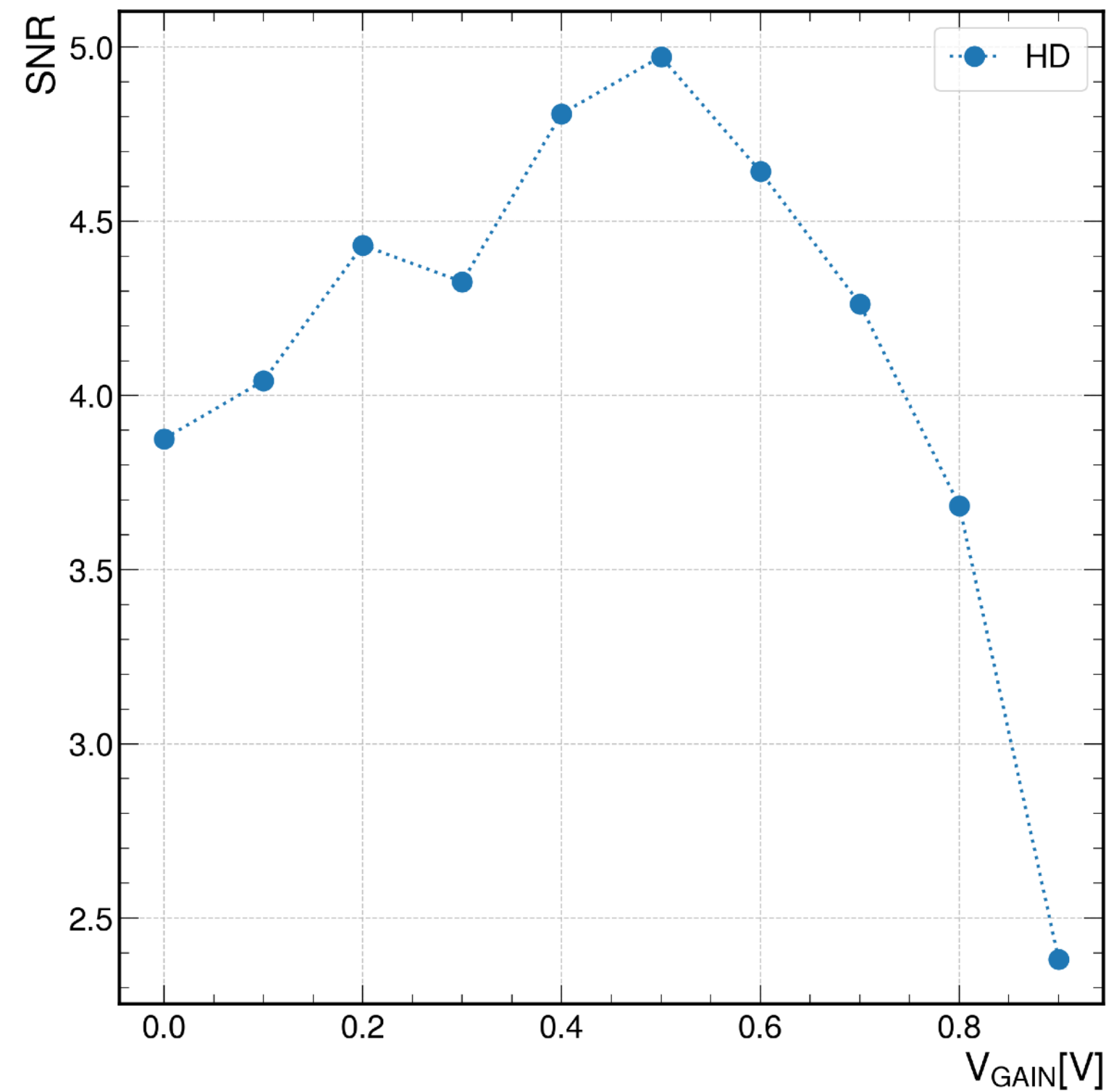
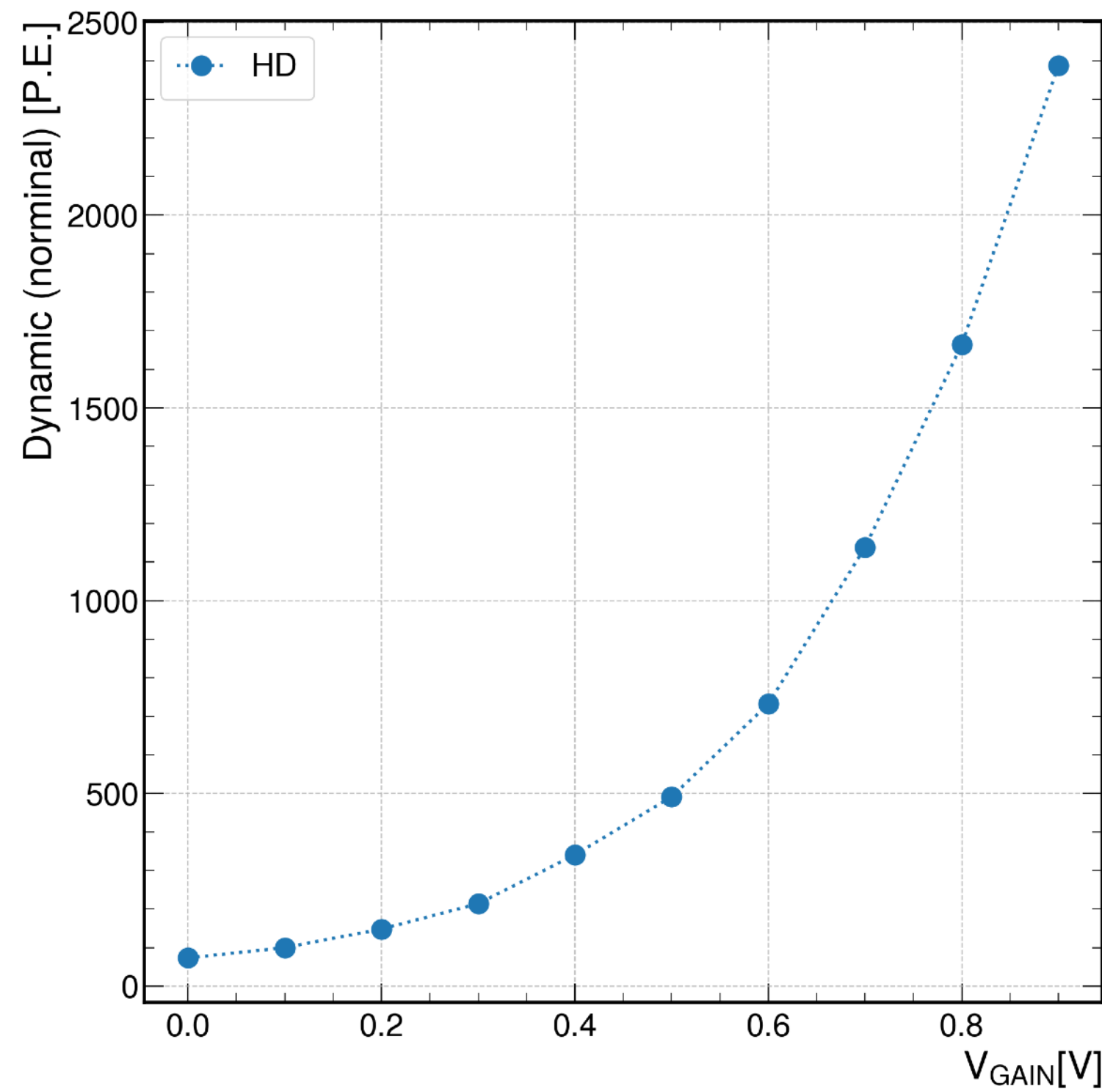
Calibration Results - C3



Calibration Results - C4



Calibration Results - HD



Note: Results from HD membrane connected to Milano DAPHNE

More Results to Come

- We are investigating the prospects of putting HD and VD membrane on the Milano DAPHNE with the cathode modules. Analysis in-progress.
 - Ended up putting HD membrane on AFE3 and VD membrane on AFE2. We confirmed for HD that we could bias to 32.5V in that AFE, and that the fiber receiver received no bias.
 - So far it seems plausible — but we need to do the analysis of SNR and compare to a previous configuration without membrane on the Milano DAPHNE to make sure the SNR does not get worse on any channels



Setting Up With the DAQ

- We were able to setup the Milano DAPHNE with the DAQ and took an initial ~5min run with cosmics (with only PDS and just cathode). We still need to look at the file to make sure it looks okay, but in principle it should.

You can find the file [here](#)

- We are targeting either today or Monday to try a cosmics run with CRP — from what I can tell it should be relatively straightforward to do this.
- Also we are preparing to be able to do the LED calibration with the DAQ — the TTL trigger is setup from the LED and the LED configuration needed is ready. Just need someone from the DAQ to help us find the right configuration to use in the daq
- Another step: With the PNS finishing installation soon, we will need to be able to run DAPHNE and CRP with the PNS, so as I understand it there is a particular trigger we will need to setup for that. So early next week we will need to set that up.



Additional Thoughts

- Given the things mentioned previously, I think our best option is to put all channels on one DAPHNE. Getting it to work with two DAPHNEs seems too much trouble, and we would have to wait anyway (and we really need something to work by next week).
- We should have results from the final configuration probably next week, I plan to take calibration data with all channels again with this configuration (one DAPHNE).
 - I'm considering also taking calibration data with offset integrators turned on, we have not had time to try this yet — since the pedestal would be fixed to ~8200, the dynamic range will suffer (more so for cathode modules since their pedestals are usually set to 2000, while for membrane 10000).