# noise studies in ICEBERG

ICEBERG PD meeting

June 17, 2019

overview

- The Keithley that was supplying bias for the sipms induces noise in the system.

- We switched to the Wiener PL506 on the rack temporarily, which significantly reduced baseline power-supply related noise.

- Additional environmental noise is now observed by both the TPC and the PD.

- Last week we studied the effect of PD on TPC noise and TPC on PD noise.

- *All PD noise plots will be shown using arapuca data, for simplicity. The x-arapuca readout is comparable.*

Keithley-induced noise

average FFT
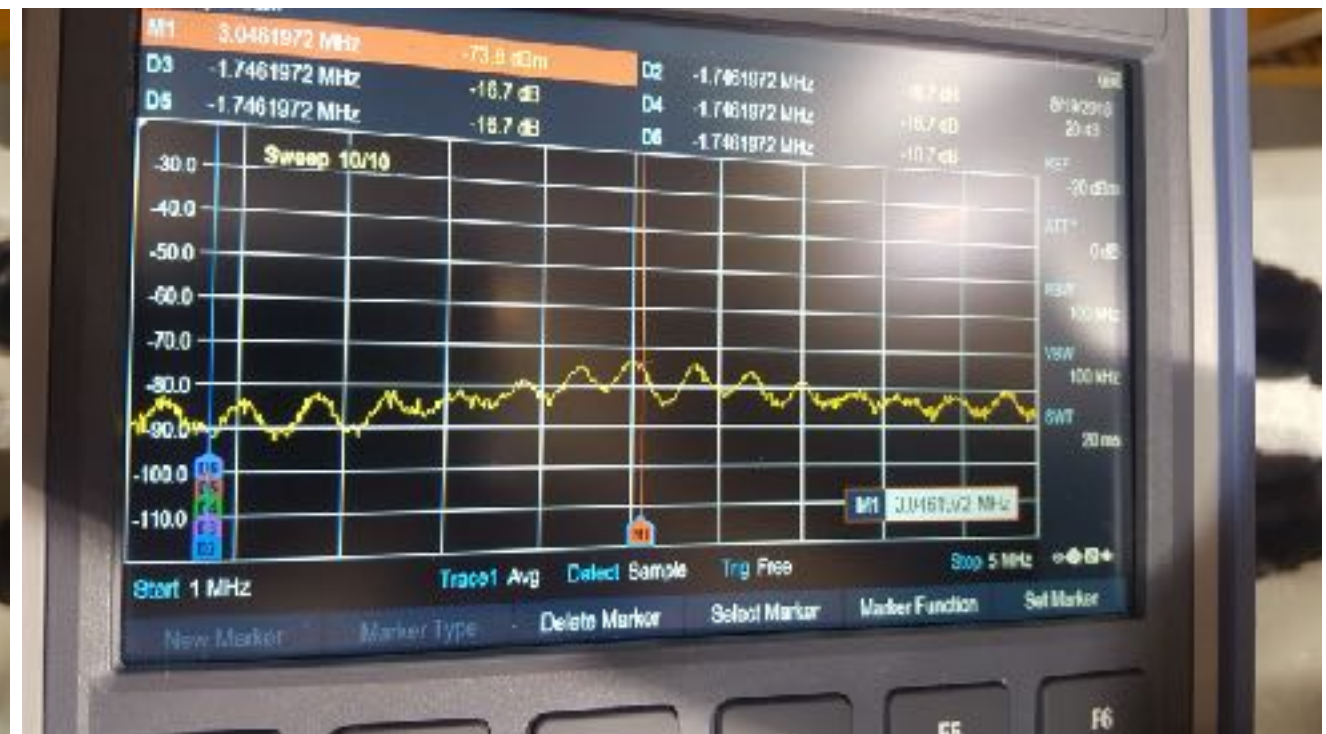
example readout

Keithley-induced noise
(~3 MHz)
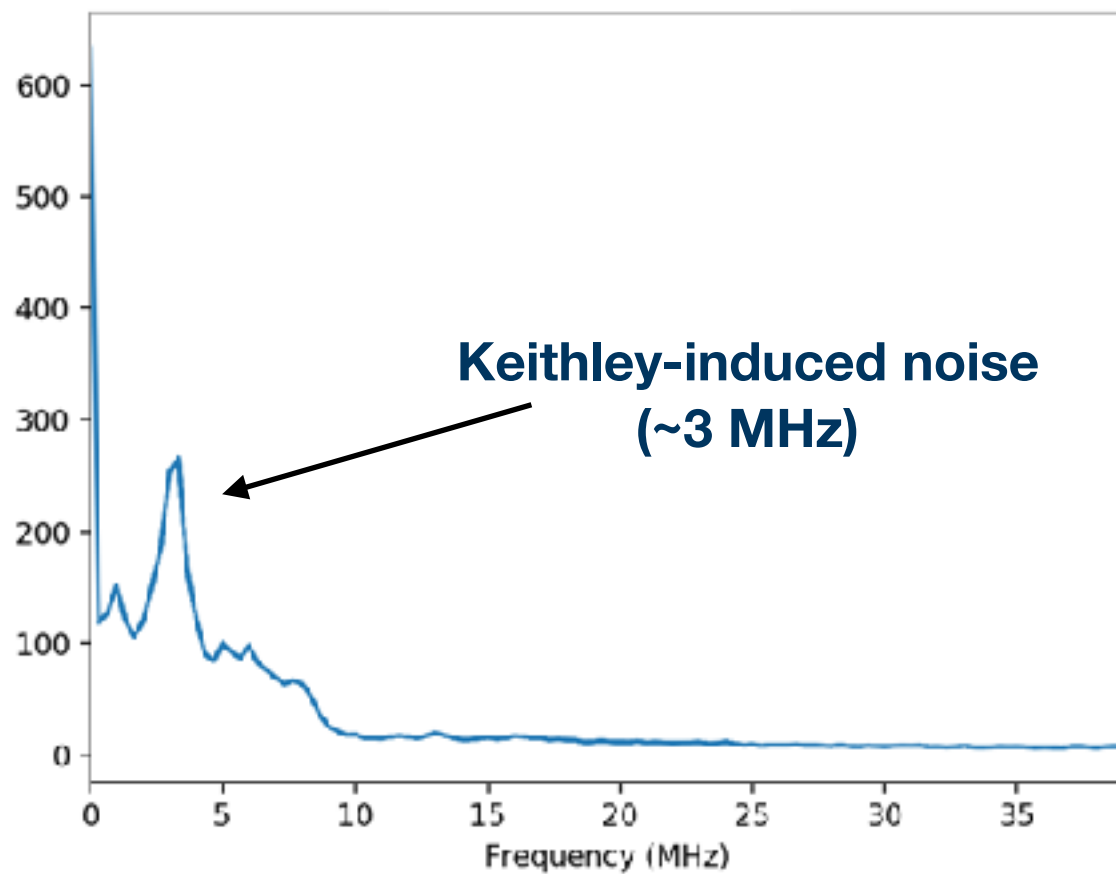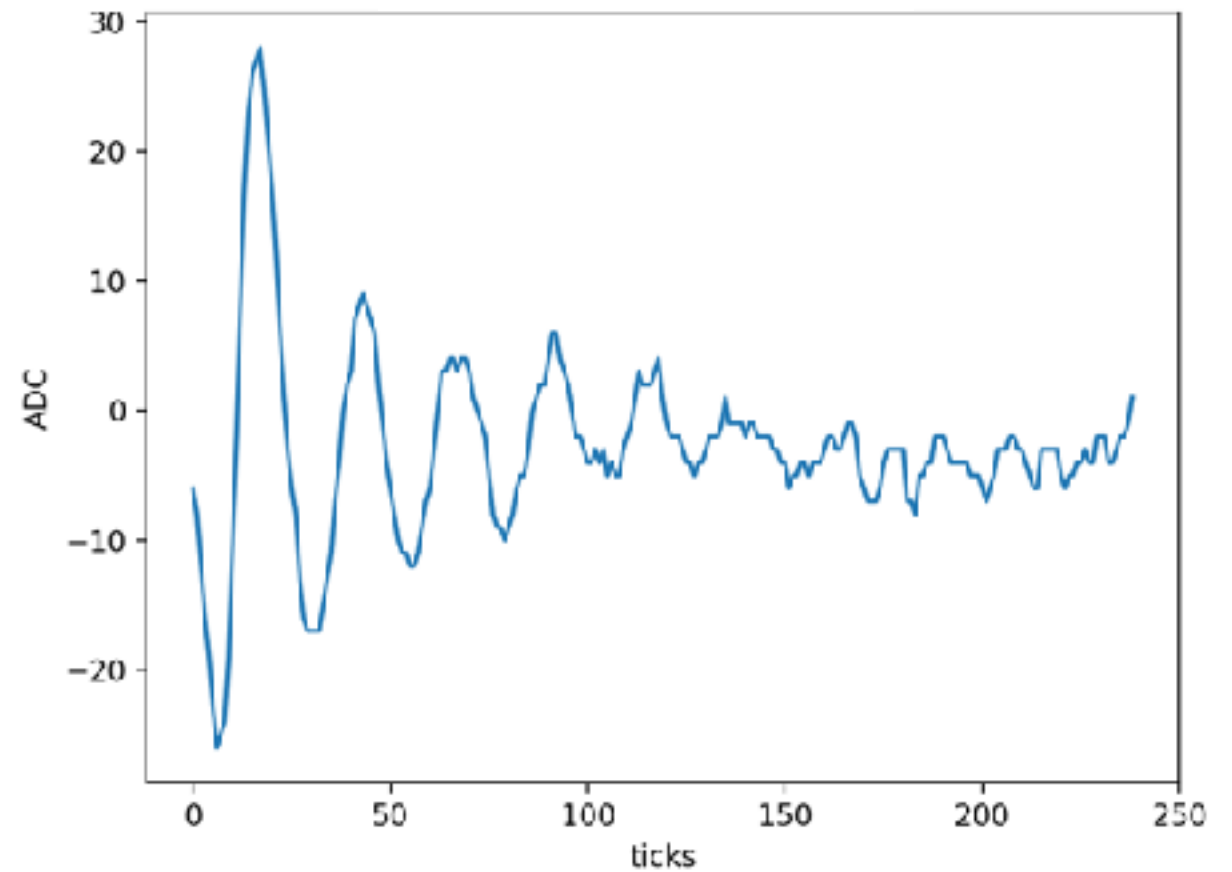
This noise is observed when the Keithley is powered on, independent
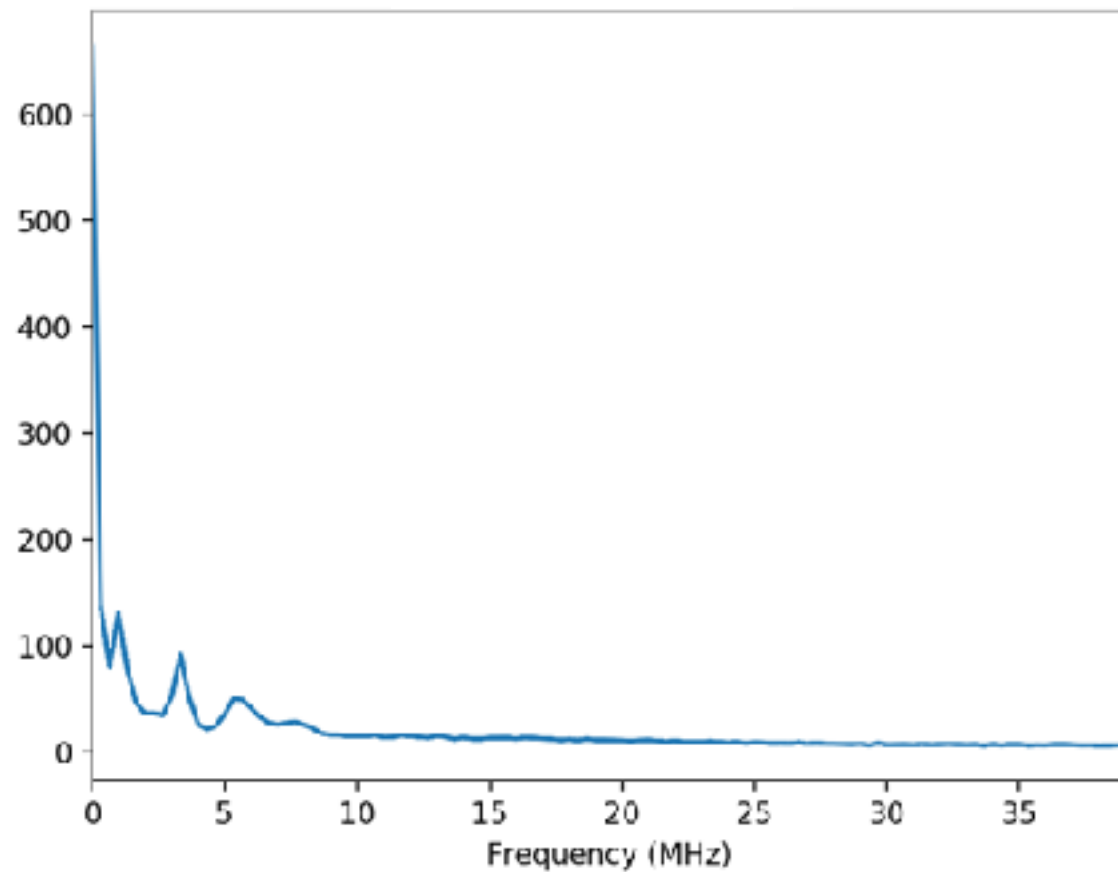of whether or not it is outputting bias voltage for the sipms.

spectrum analyzer

Keithley off

Keithley on

(red marker is at 3 MHz)

switch to Wiener PL506

average FFT

Significant improvement in noise spectrum after switch to new power supply.

additional changes

- The PD ground was moved to being referenced from the cat6 cable shields to an unused wire.

- This meant the cable shields were now floating (more on this to come).

- We did a bench test to verify that both an SSP and DAPHNE saw LED signals after the changes, and confirmed all connectivity using the "dummy module."

- No change was observed in the noise.

~800 kHz noise

PD average FFT

TPC FEMB 703 WIB 1 FFT
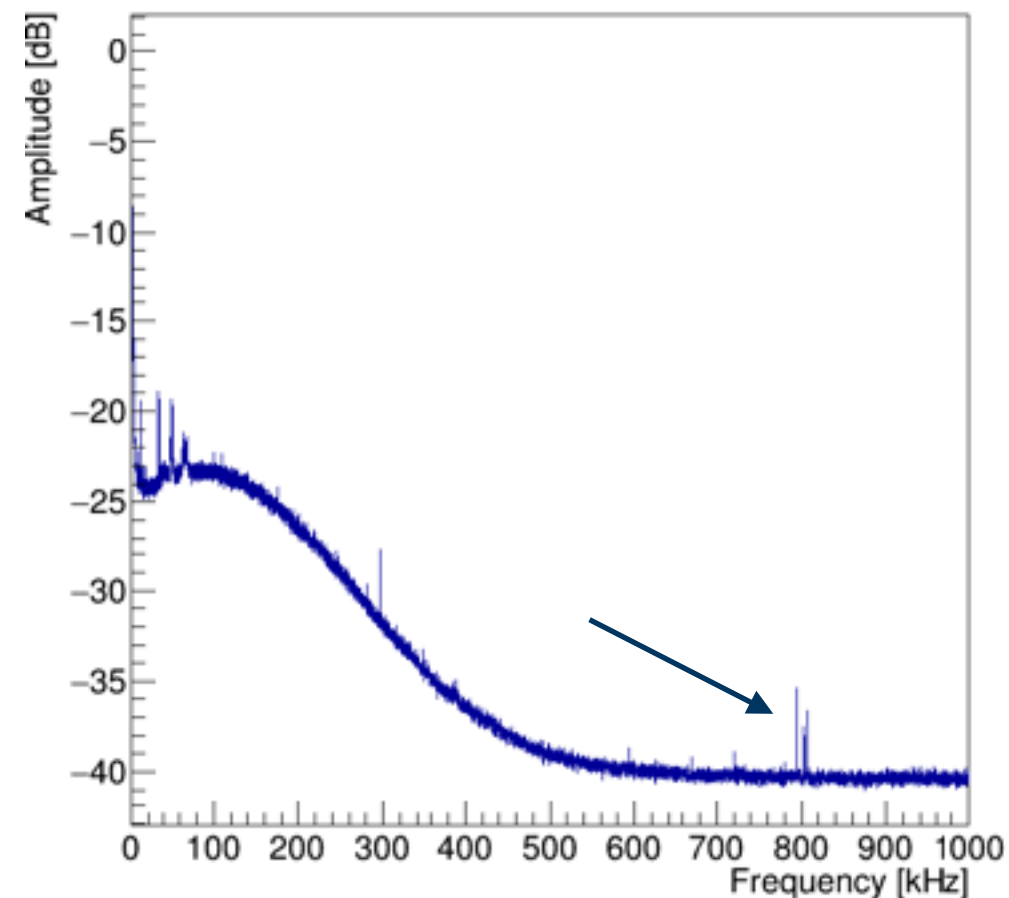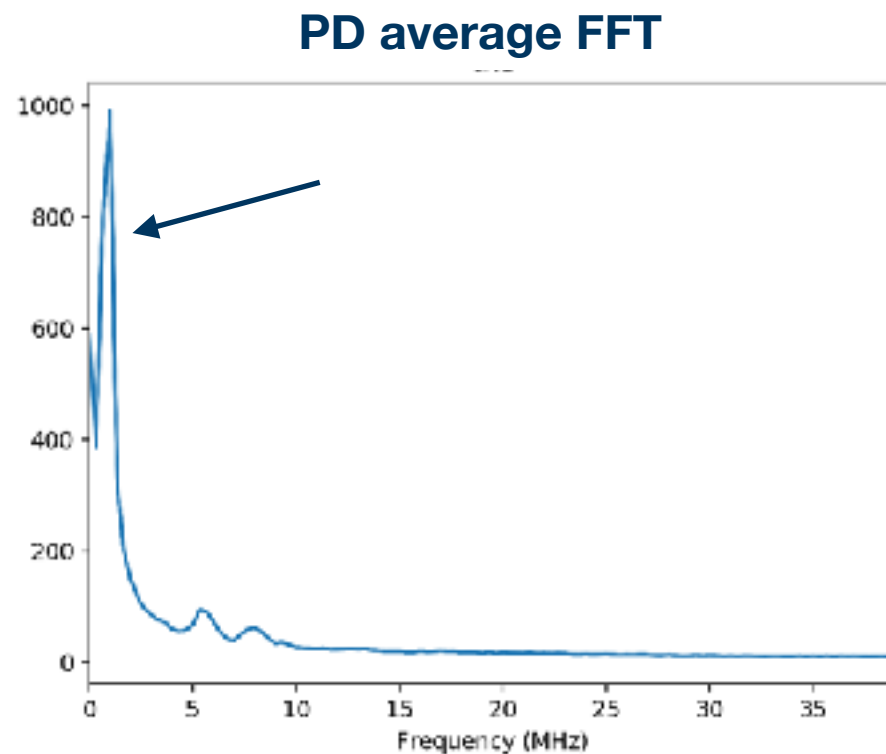
New environmental noise observed in both PD and TPC.

In addition the TPC sees an increase of low-frequency noise — there's some evidence of this in the PD, but our readout window is not long enough (3us) to see it in the FFT.

environmental noise

- The ~800 kHz noise that is observed in both the TPC and PD was seen throughout PAB when we used Linda's spectrum analyzer.

- It comes and goes, but is around more often than not.

- First evidence seen in the TPC as early as 5/15.

  - The arapucas were not reinstalled in the TPC until 5/21.

- The TPC was moved into the cryostat on Thursday (6/14) to study the effects of the PD and TPC on one another systematically.
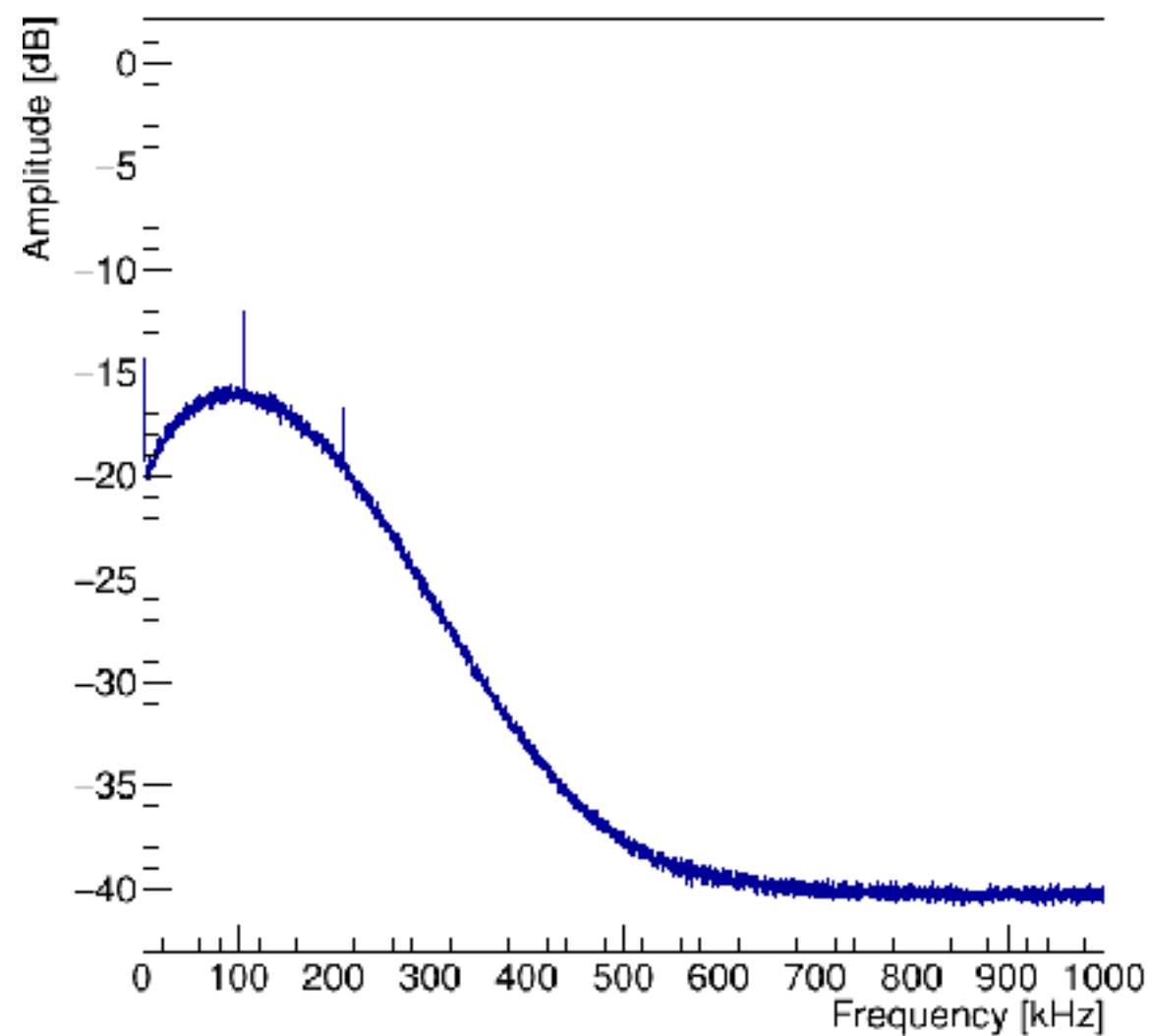
noise tests (6/13)

1. The TPC was moved into the cryostat.

2. TPC took data with PD cables disconnected.

3. PD cables were connected, both systems took data.

4. PD cables were wrapped in aluminum foil, referenced from the top of the cryostat.

5. PD was powered on, both systems took data.

6. TPC 48 V (WIB power, channel adjacent to PD on PL506) was turned off, PD took data.
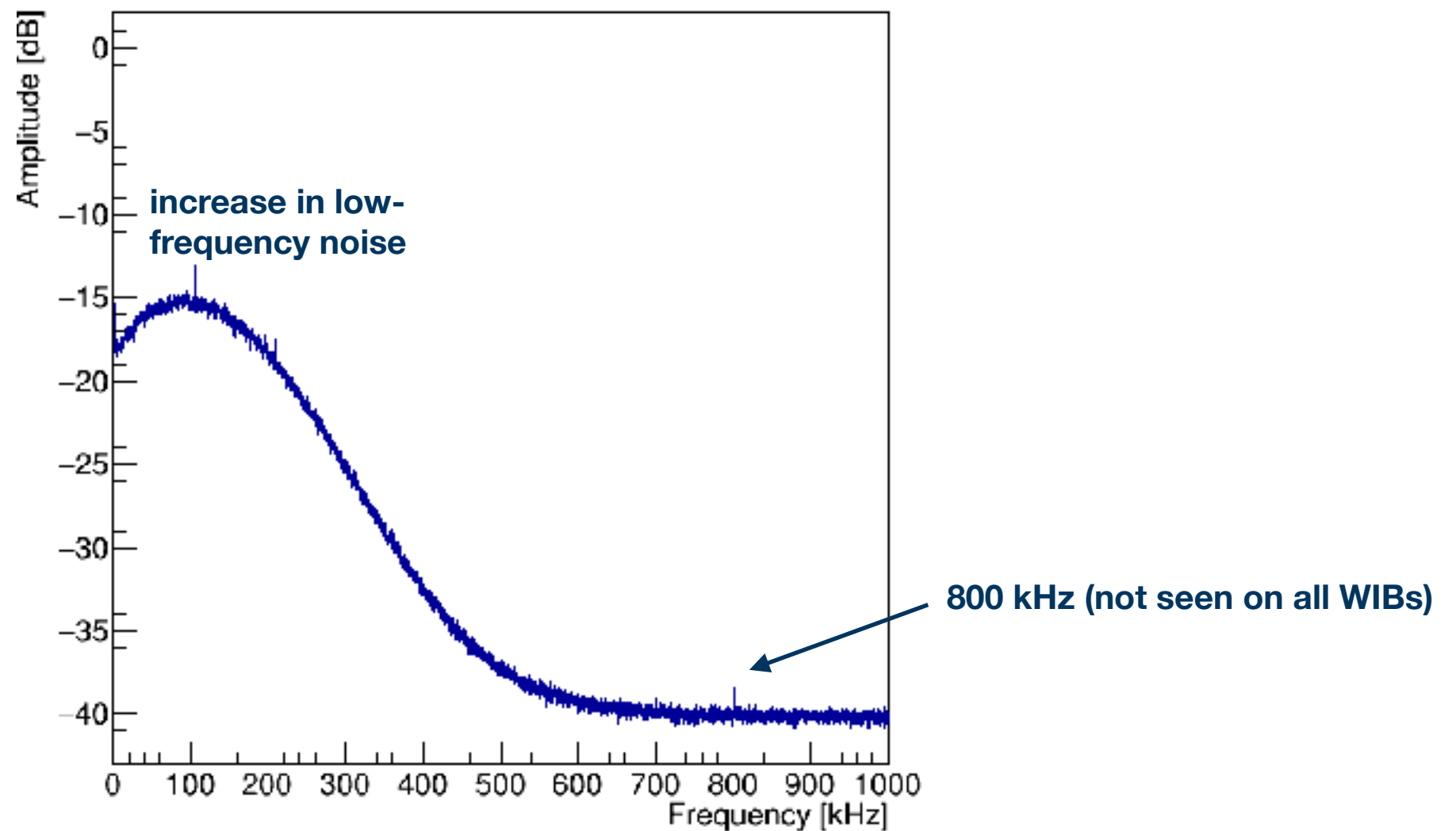
TPC noise, no PD

Profiled FFT FEMB_706 WIB2

TPC noise, PD Vb = 52 V

Profiled FFT FEMB_706 WIB2

increase in low-frequency noise

800 kHz (not seen on all WIBs)

https://internal.dunescience.org/iceberg/localincludes/Plots/Tscript/iceberg_r001477/index.html

connecting PD cables to cryostat

average FFT
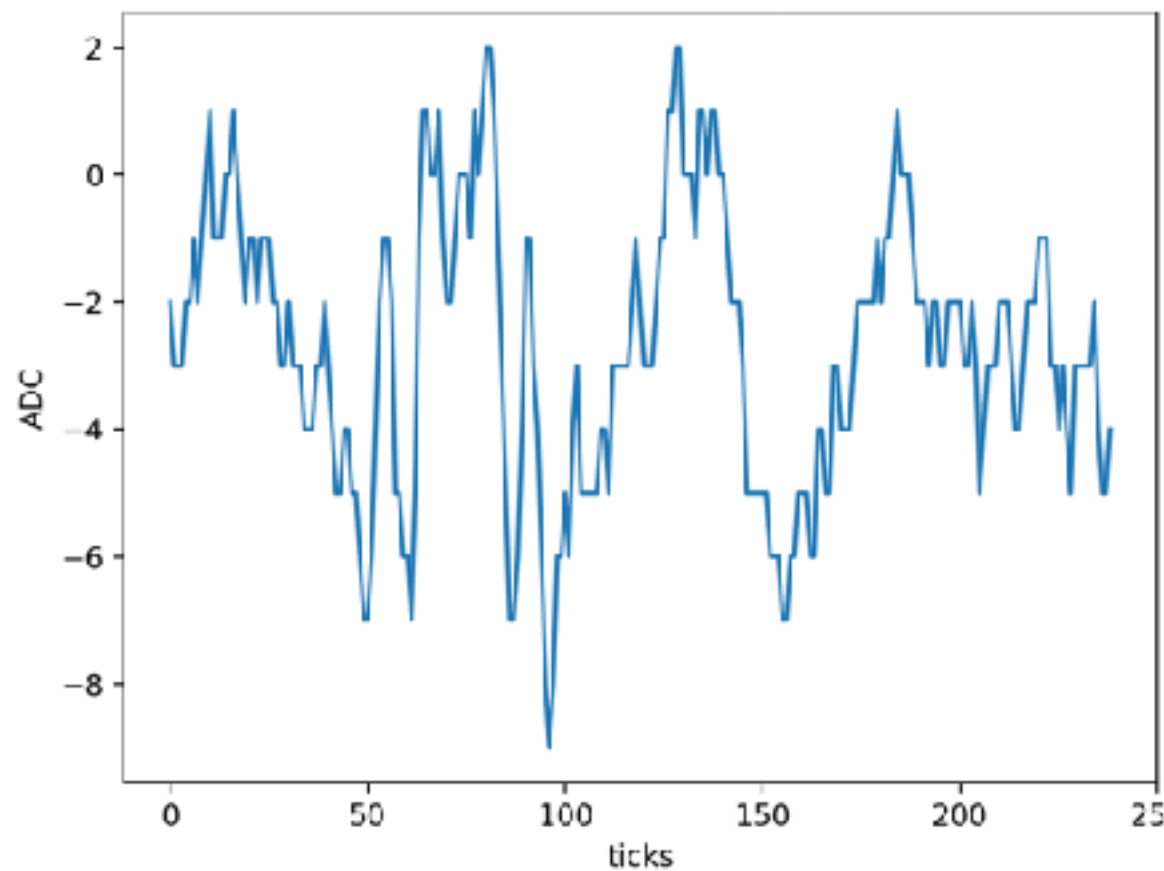
average FFT

PD cables disconnected

PD cables connected
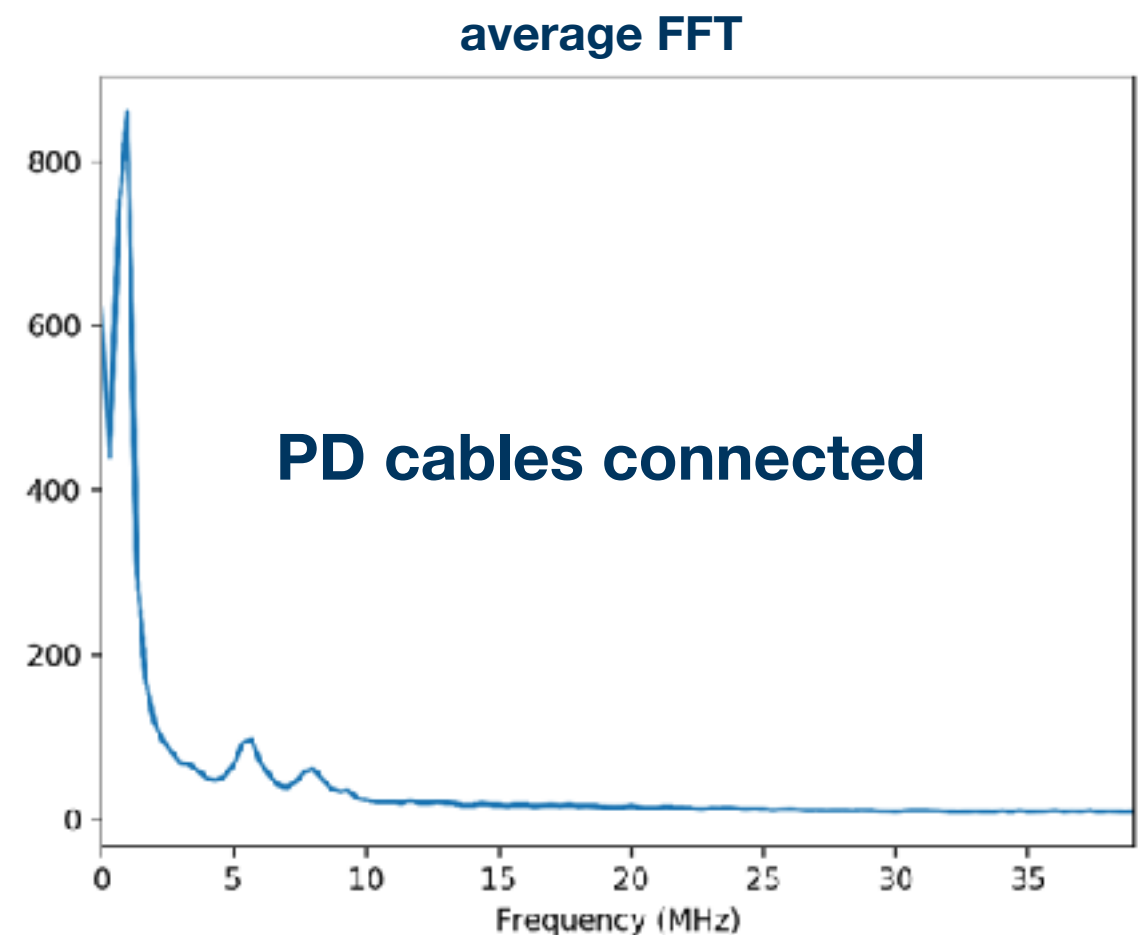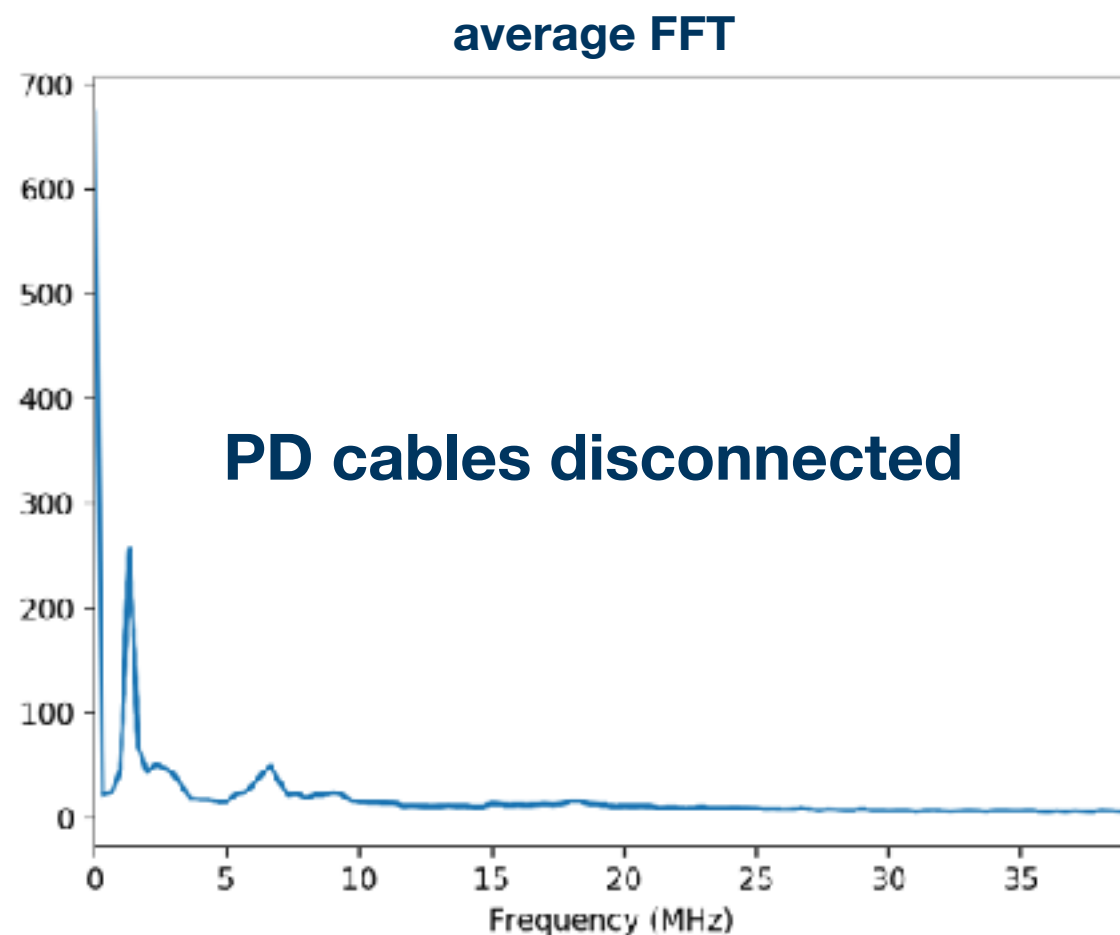
DAPHNE is the only PD system powered at this point

DAPHNE readout

1 tick = 12.55 ns

3 us readout (left) — PD cables disconnected

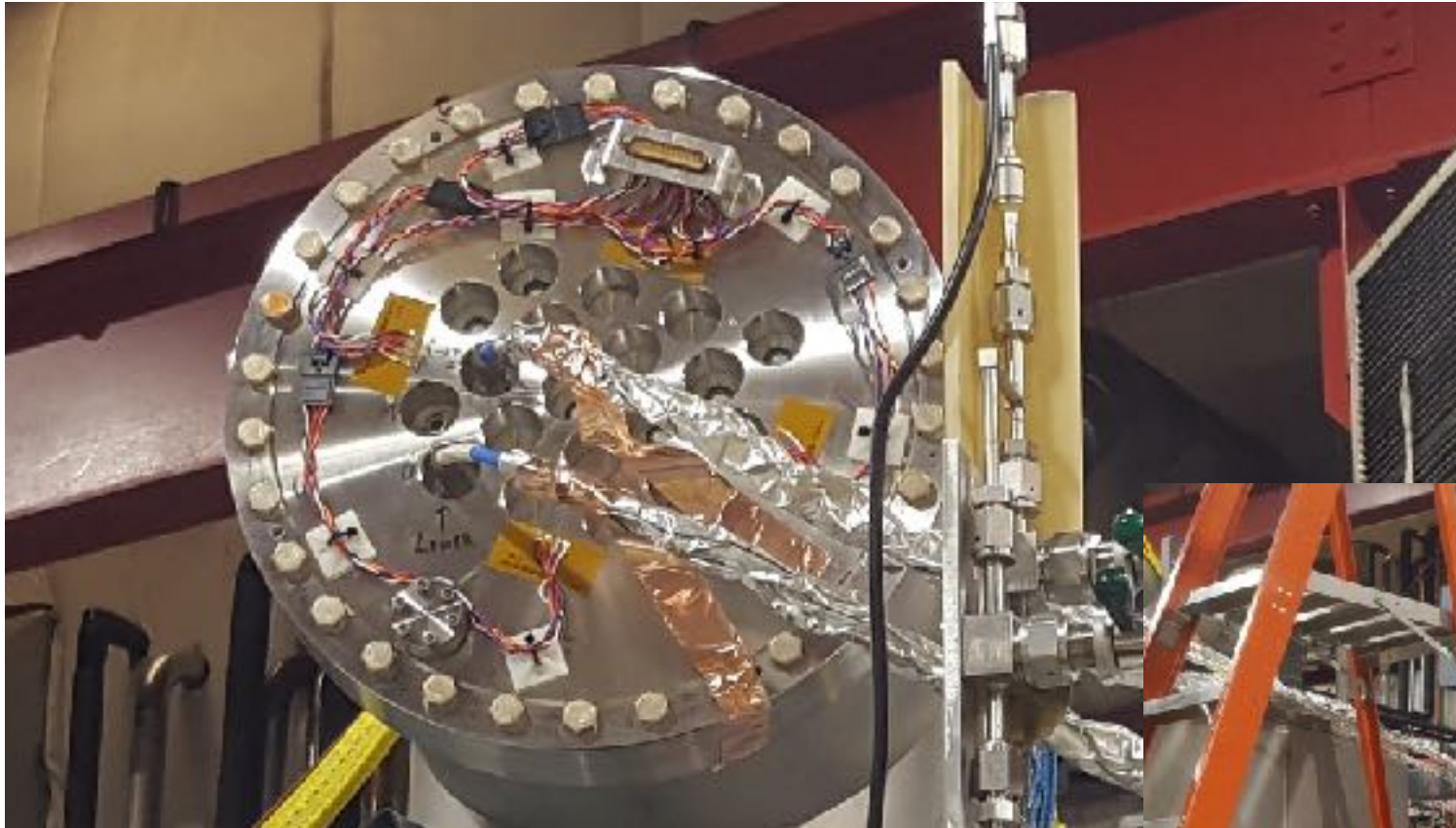**3 us readout** (right) — PD cables connected

PD cables disconnected
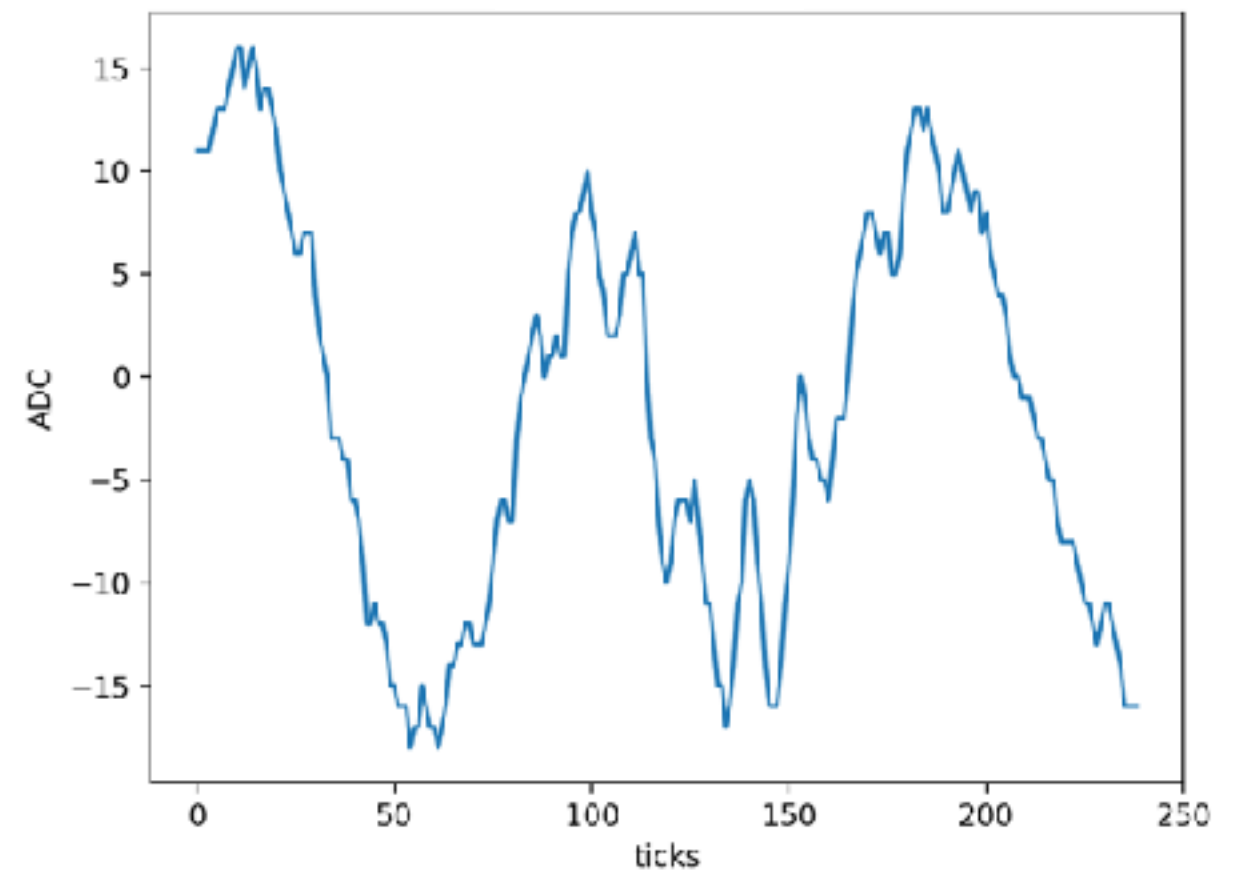
PD cables connected

Absolute 0 on y-axis is arbitrary — I'm showing these to give a sense of the amplitude of the noise.
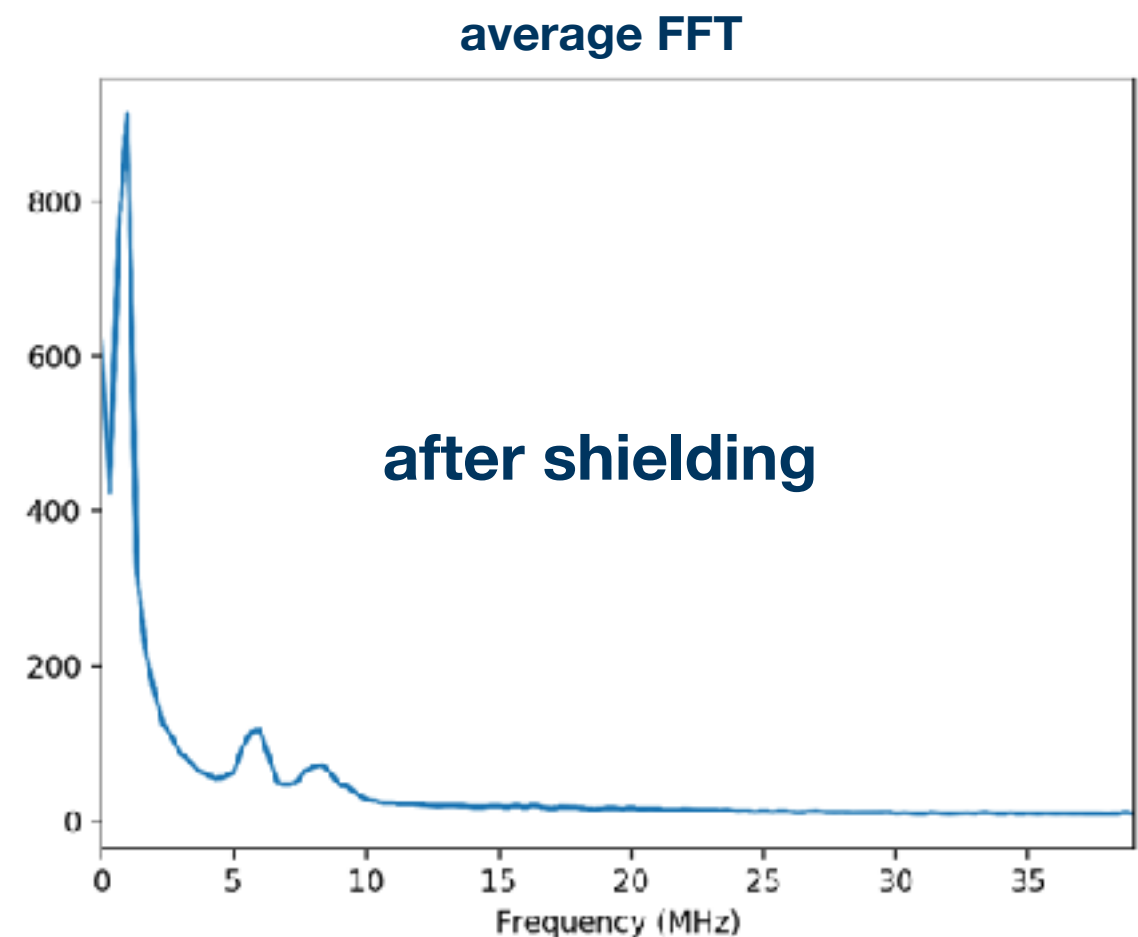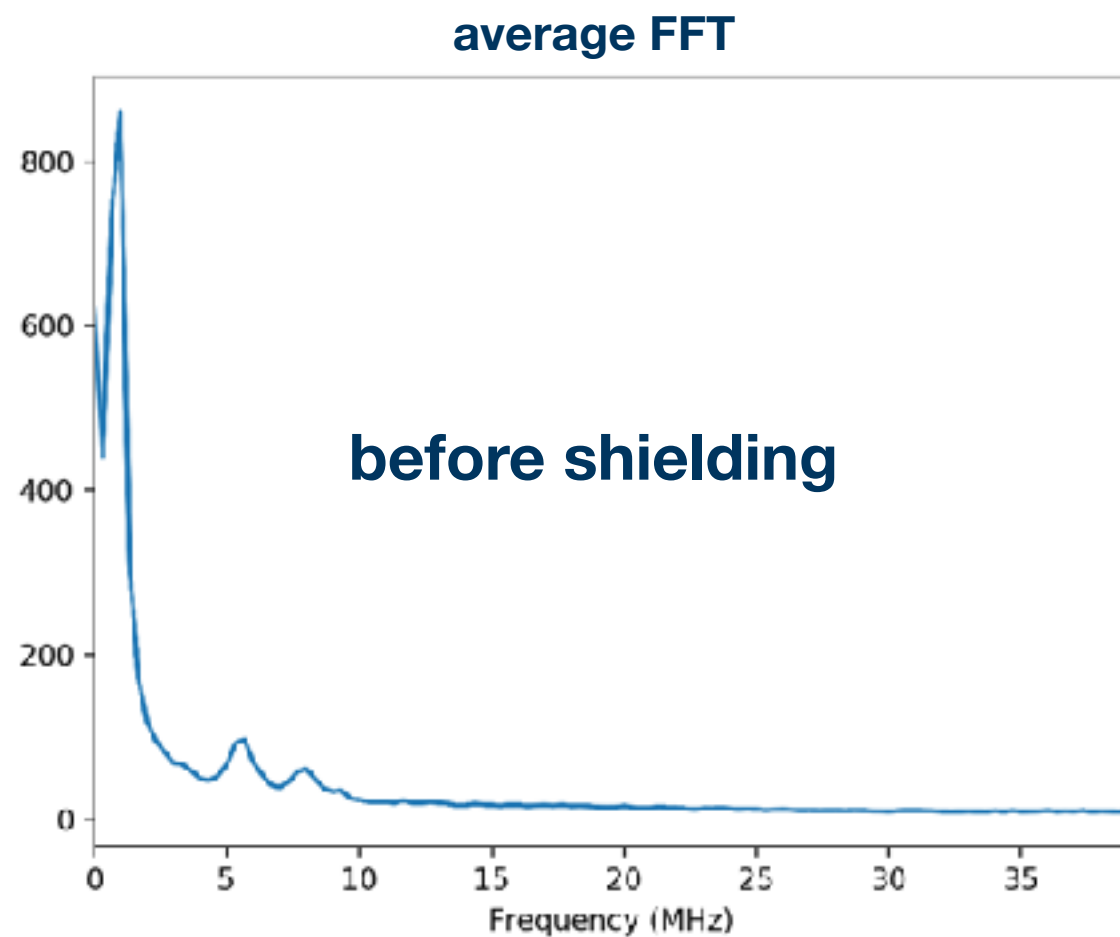
shielding PD cables

Cat6 cables covered in aluminum foil and referenced from the cryostat.
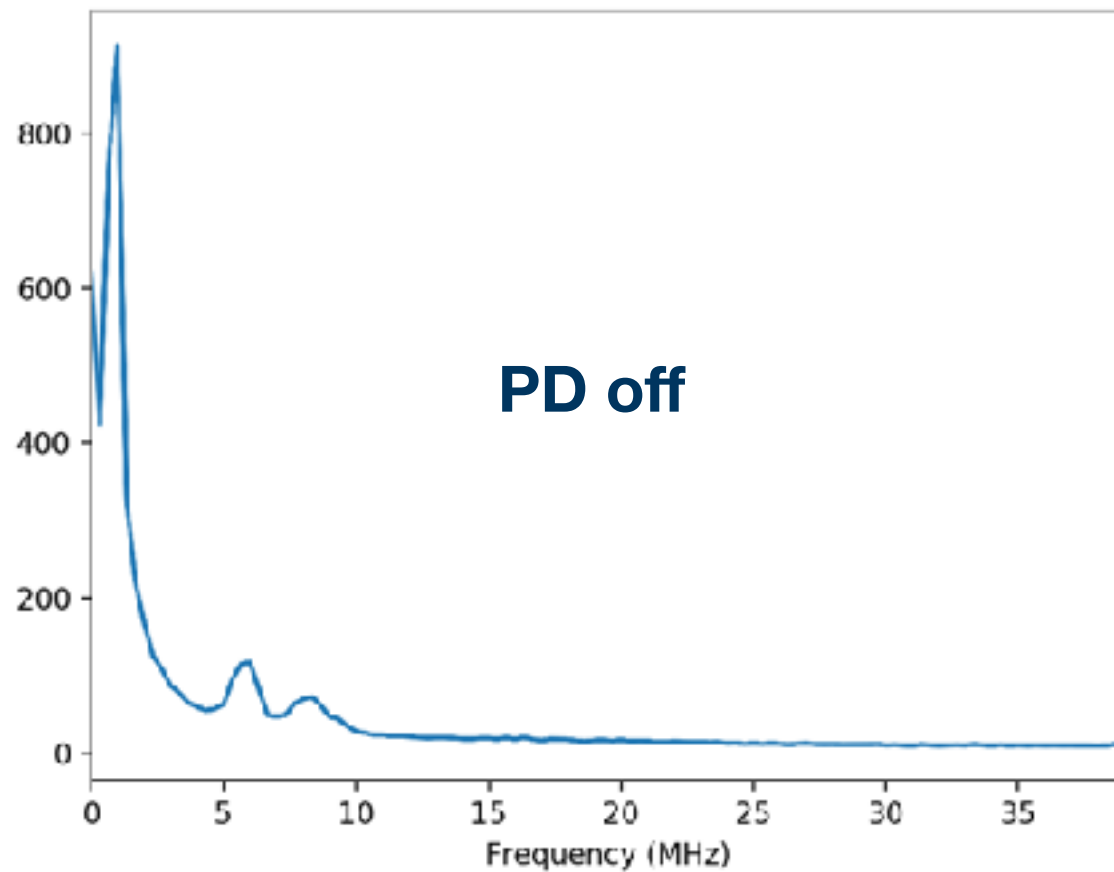
connecting PD cables to cryostat

average FFT

before shielding

average FFT

after shielding

no improvement observed

powering PD

average FFT

average FFT

PD off
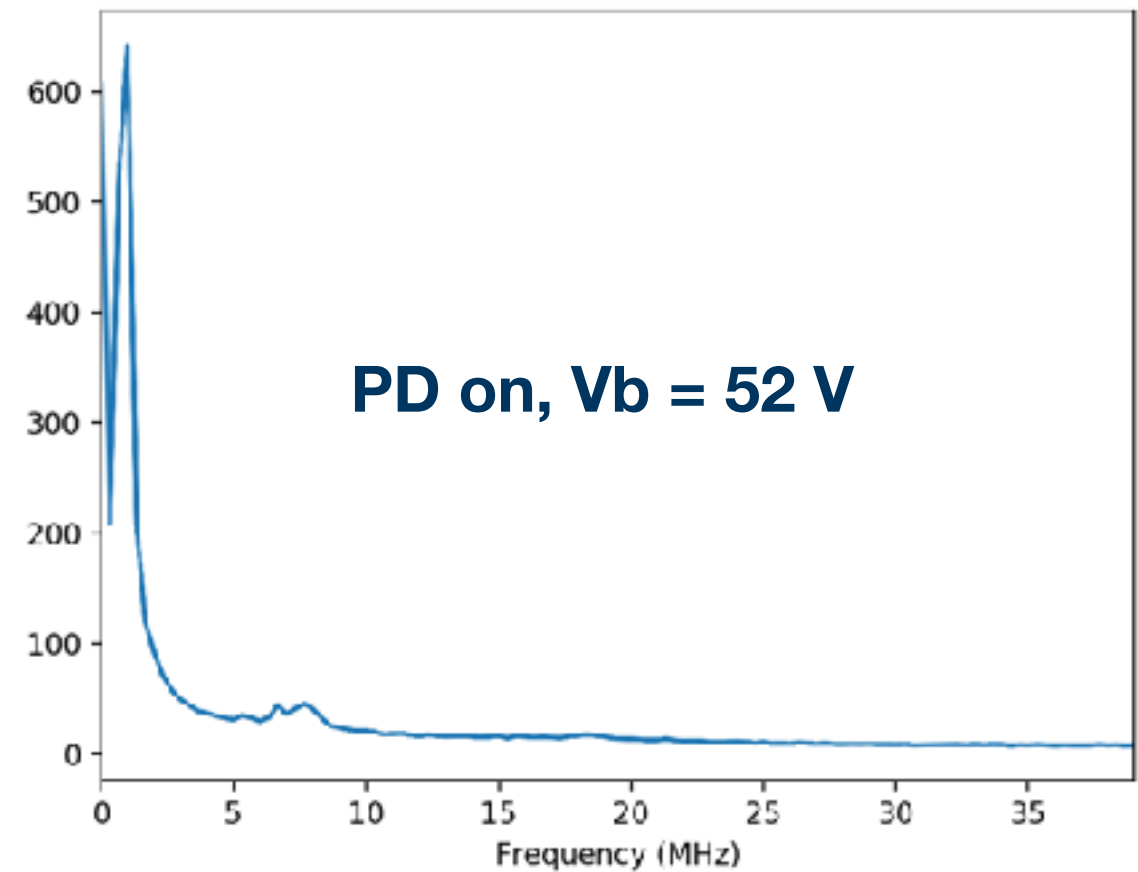
PD on, Vb = 52 V

some improvement, but not surprising

turning off TPC

average FFT

average FFT

**PD on, Vb = 52 V
TPC 48 V on**

**PD on, Vb = 52 V
*TPC 48 V off***

Frequency (MHz)
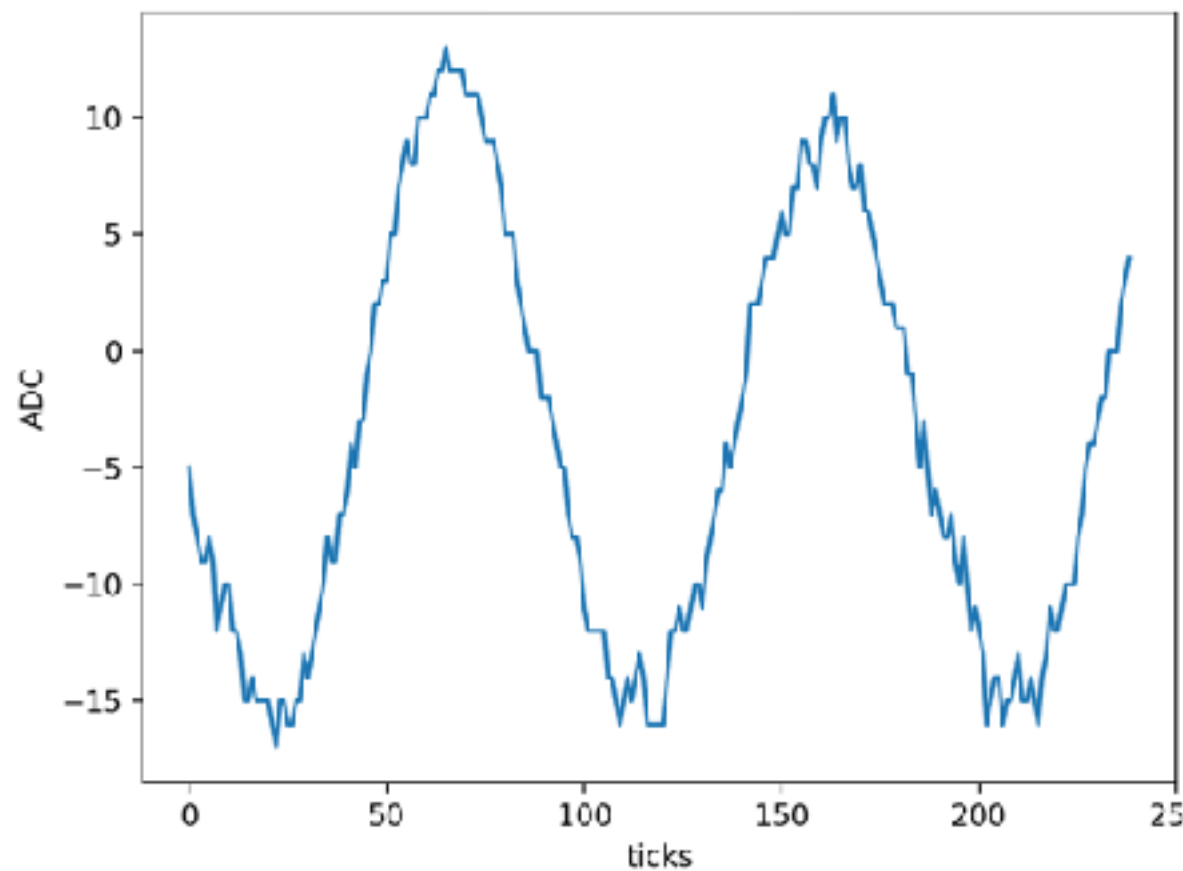
Frequency (MHz)
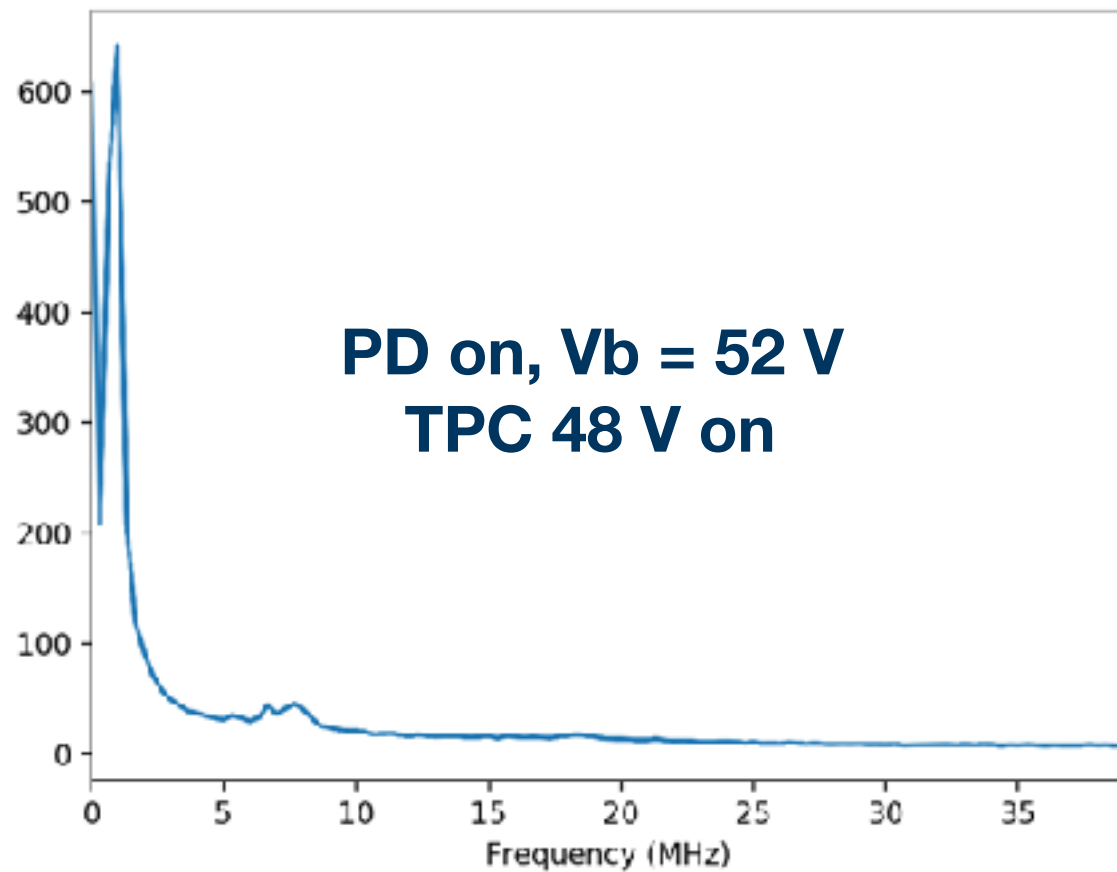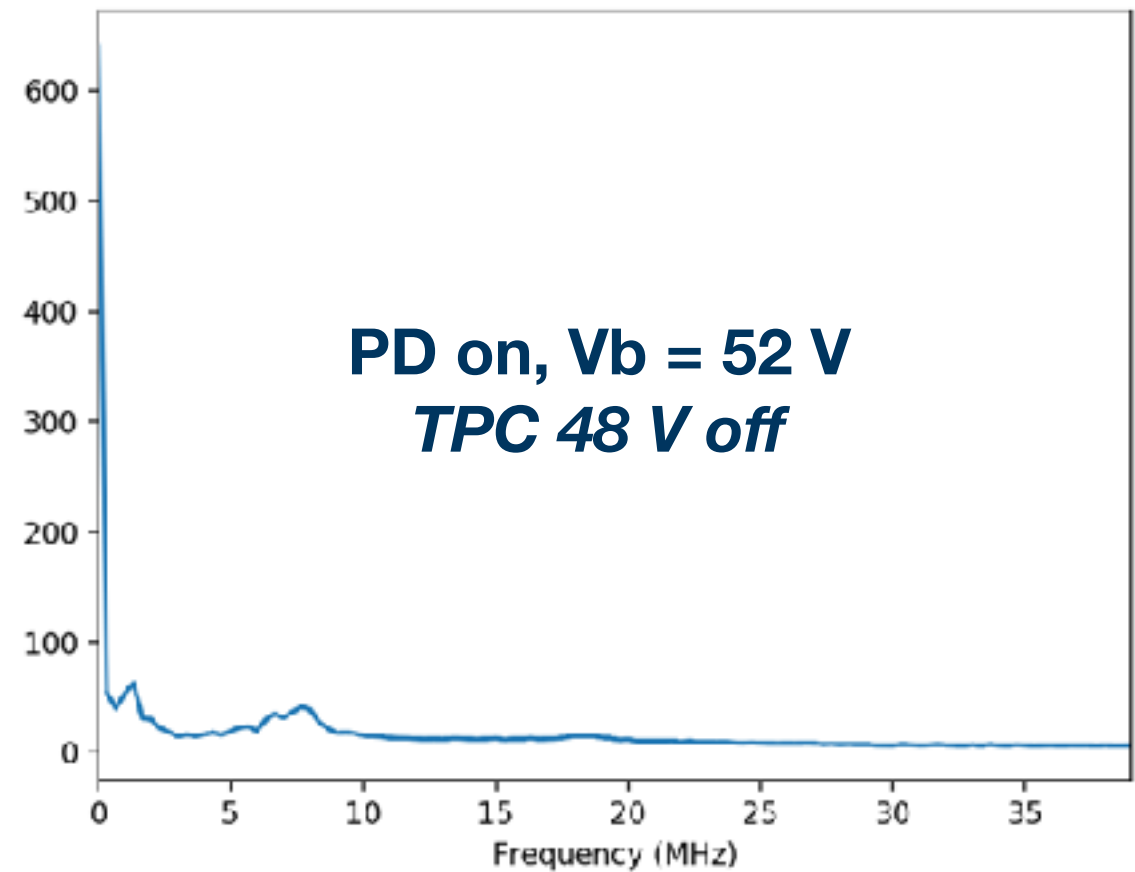
PD noise reduced to manageable levels

DAPHNE readout

1 tick = 12.55 ns

3 us readout

3 us readout

**PD on, Vb = 52 V
TPC 48 V on**
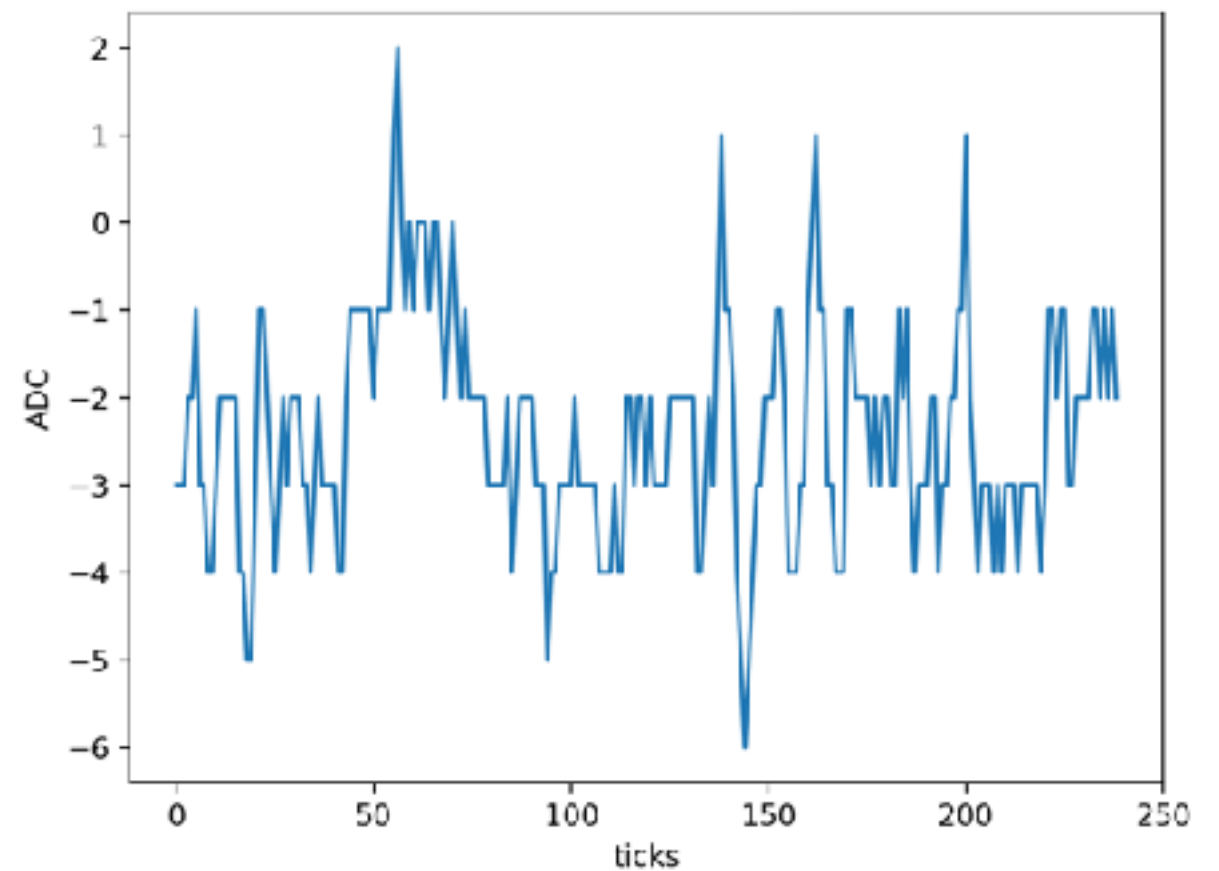
**PD on, Vb = 52 V
*TPC 48 V off***

**Absolute 0 on y-axis is arbitrary — I'm showing these
to give a sense of the amplitude of the noise.**

summary

- **Switching from the Keithley to the PL506 improved baseline PD noise.** ~3 MHz ringing noise disappears. This implies that we need a cleaner power source.

- **PD detector power system induces noise in CE.** This is visible by increase in the low frequency noise in CE, change in the shape of the noise (FFT) and overall rise of the noise level by up to 5 dB.

- **CE detector power system induces noise in PD.** Visible and significant increase in 800 kHz noise observed in PD when TPC is powered.

how to proceed? some possibilities

- The PL506 demonstrated that with less-noisy power supply, we have manageable noise levels in our readout, but it's not a sustainable solution as CE wants to be isolated from other powered systems.

- Return to using the Keithley and work towards filtering noise emitted at the source of the power?

    - We saw improvement by adding a simple low-pass filter to the output of the Keithley.

    - Carlos has suggested getting a different Keithley model, based on recommendations.

- Probably a combination of short-term and long-term solutions to make Run II data as useful as possible.

- Linda has suggested we get two LV Wiener modules to put in the crate on the rack. There is one 16V/5A supply available at PAB that may work, but we'd need to borrow/order a 60V supply.

- Other ideas?