Measurements of HD PDS electronics with DAPHNE at CSU, Progress Update

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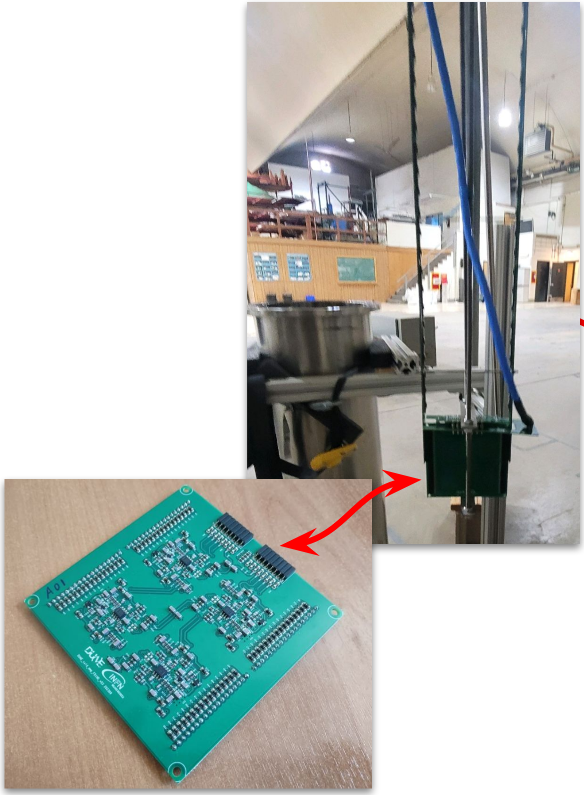
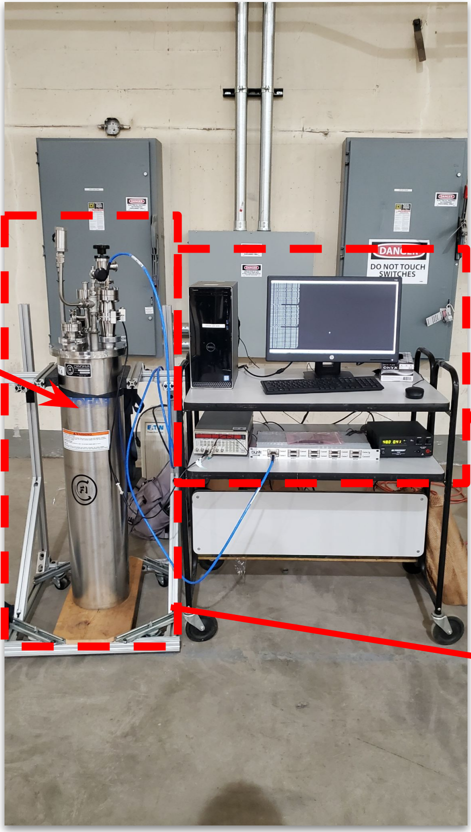
Background

- To prepare for testing DUNE FD PDS modules at CSU, we have been working on developing:
  a. **The datataking and analysis capabilities with DAPHNE**
  b. The facility to where we will test the modules
- Today I will talk about **(a)**, specifically:
  a. Progress with taking data from an HD supercell using DAPHNE
  b. Analysis progress:
     - Rise time / signal shape
     - Signal to noise ratio (SNR)
     - Dynamic range
     - Dark count rate

Experimental Setup





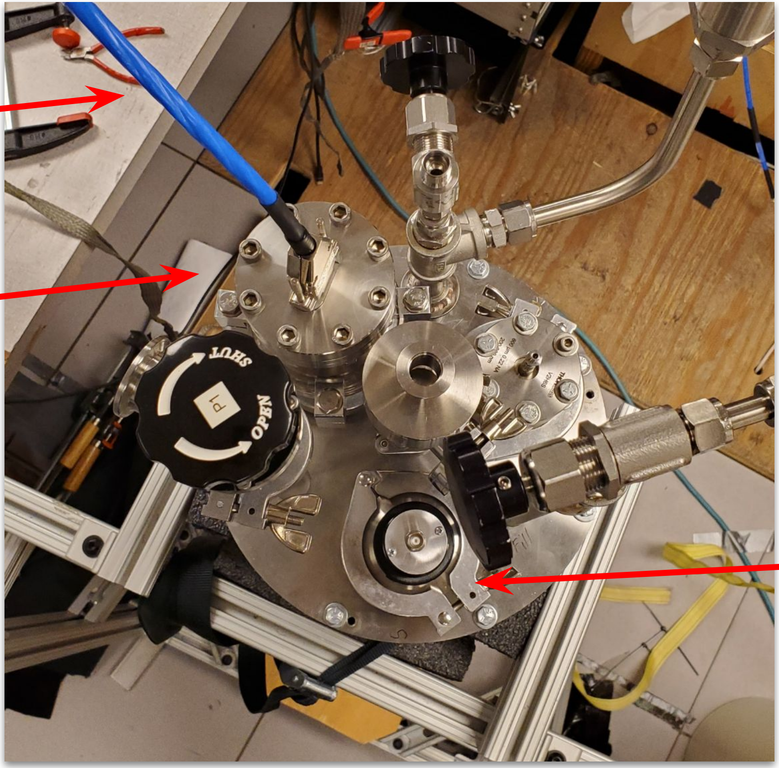
Warm electronics:
- PC for acquiring data/analysis
- DAPHNEv2 for DAQ
- 48V power supply for DAPHNE
- SRS pulse generator for LED

40 liter dewar containing one supercell with an HD cold amplifier board, filled with LN2

Experimental Setup

Warm DB15 (DAPHNE) to DB15 (flange) cable.

DB15 feedthrough for bias/signals to/from DAPHNE



Shielded enclosure with LED and view port for LED tests

DAPHNE Configuration

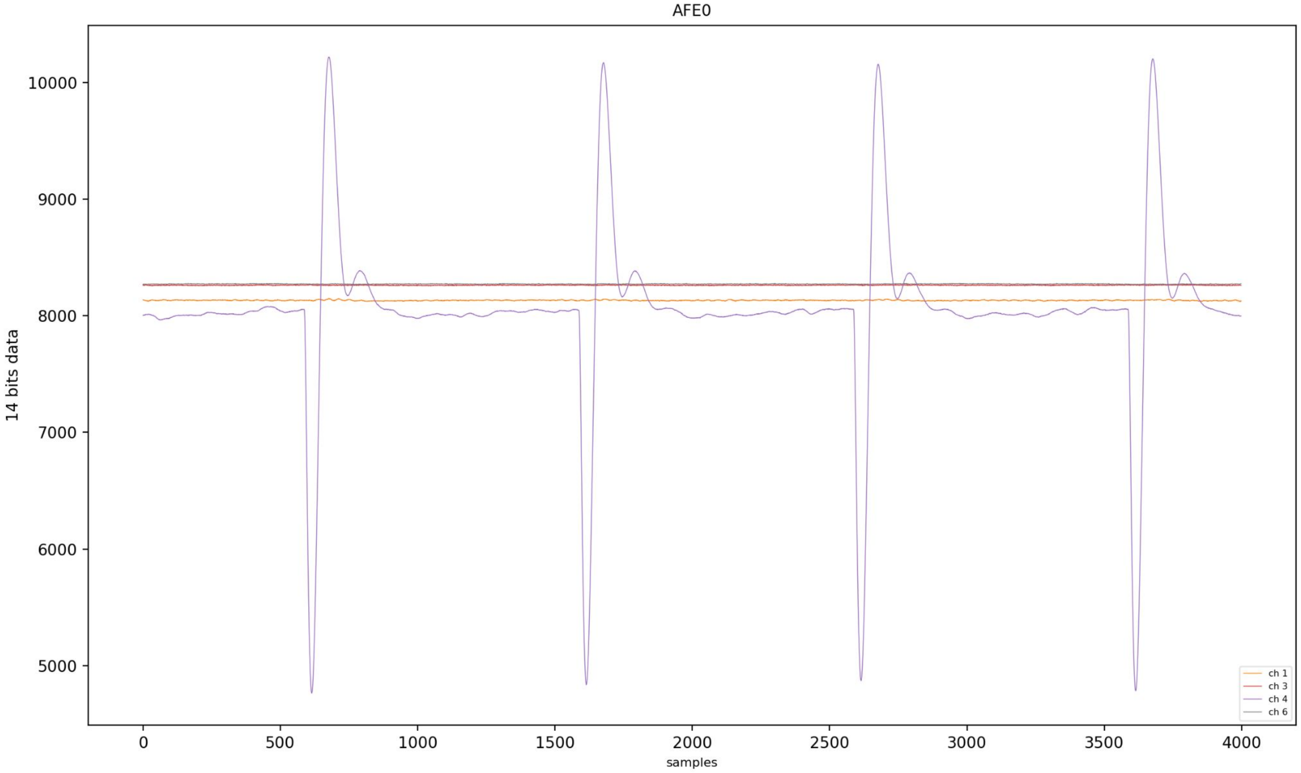
- DAPHNE is setup in the following way:
    - Initialization to set registers to configure channel offsets and AFEs. Default VGAIN set to max (2666).
    - Configure DAPHNE to use internal clocks (script found here)
    - Trims for all channels tuned to bias measured at 0V
        - use linear fits of bias DAC vs bias voltage – makes it easy to set precise voltages with a script

DAPHNE Datataking

- DAPHNE is connected to the PC via ethernet, data acquired from the SPI buffers.
  - We use a C++ script to acquire data from the SPI buffers (faster than python), data saved to hdf5

- Two primary datataking modes:
  - LED
    - Pulser triggers DAPHNE SPI buffers and (a few microseconds later) pulses the LED (~10ns width)
    - 10k waveforms acquired for SNR measurements
  - DCR
    - C++ script triggers DAPHNE, read 10k waveforms – enough to get good precision on DCR measurements

Warm signals using LED



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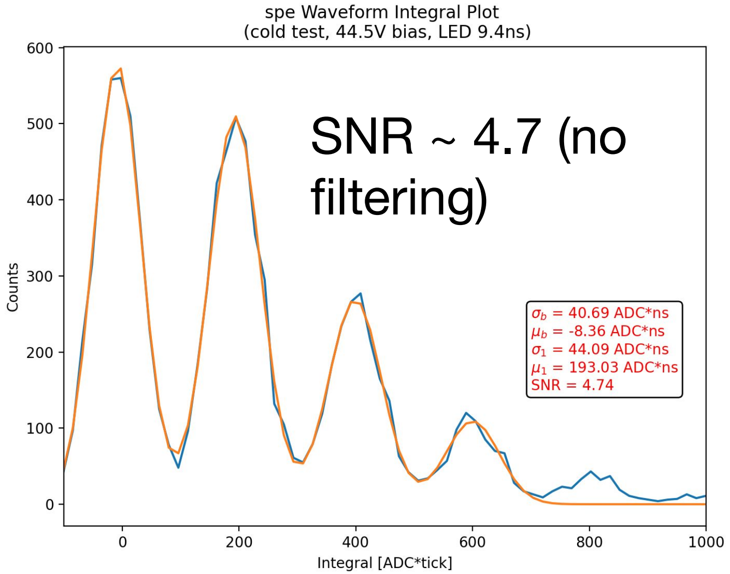
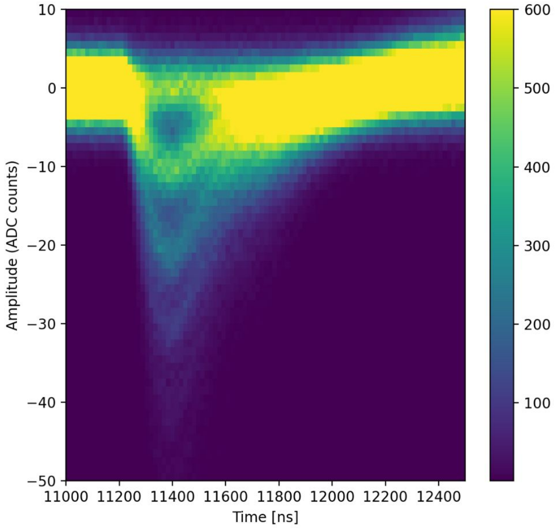
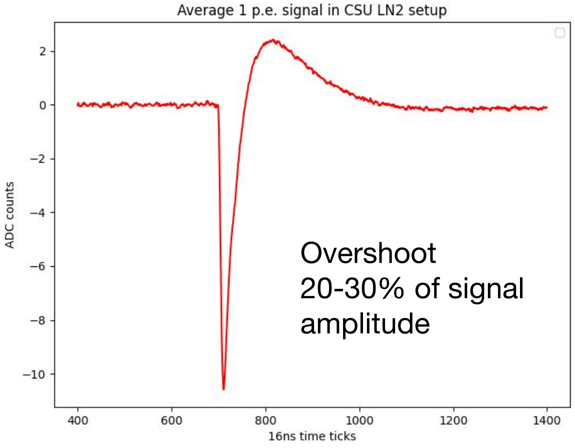
Cold Test Results

SNR and persistence plot for 44.5V (2.5 OV, assuming breakdown at 42V)

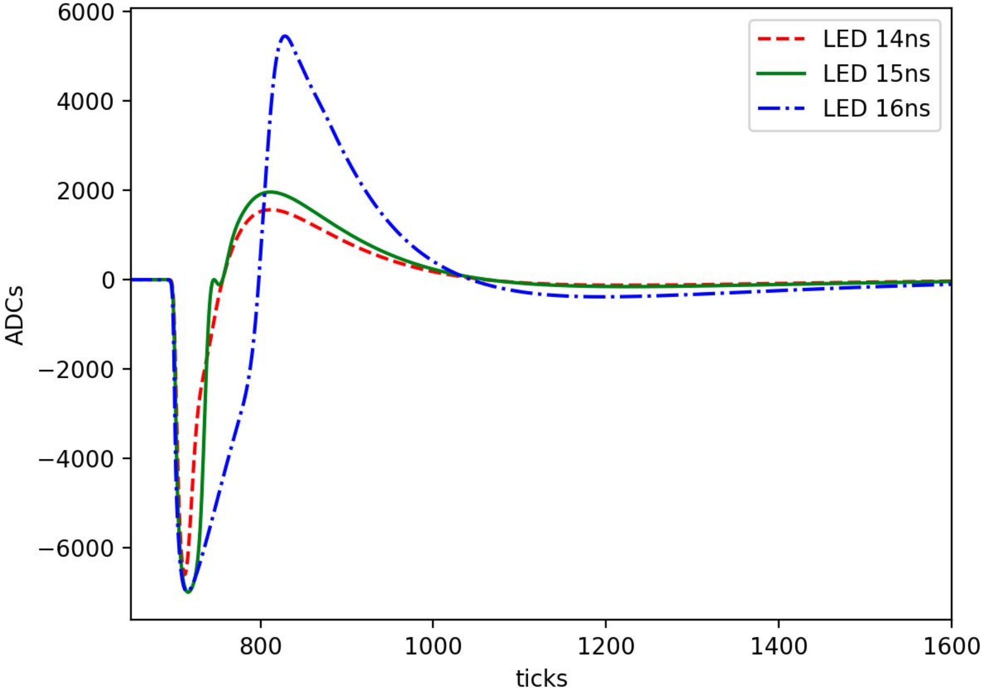






Dynamic range ~1200 p.e.

Signal Saturation



We observe saturation effects at 7000 ADC in DAPHNE (max VGAIN) (probably the cold amplifier board saturating).

To increase dynamic range (DR), we need to lower the SiPM overvoltage.

We can achieve ~1500 p.e. DR with 44V (2 OV). SNR however is closer to 4.

2000 p.e. would be very difficult (if possible at all) in this setup

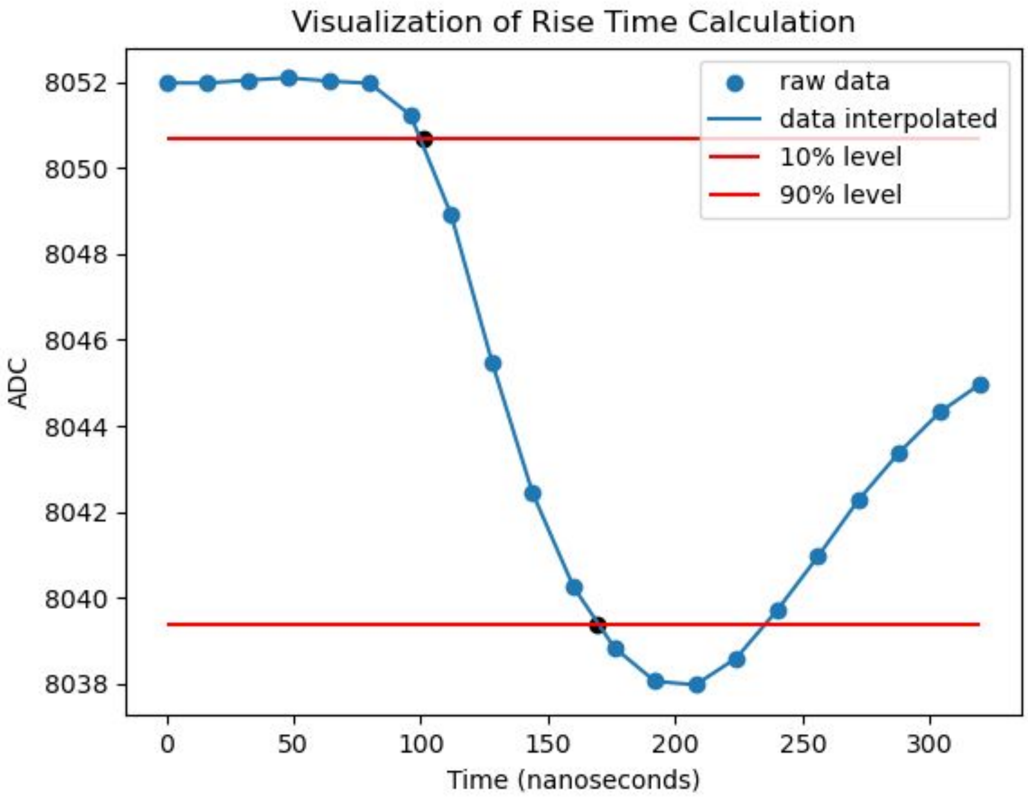
Rise Time

Noah Vardy

We have looked at measuring rise time of the single p.e. signals.

We use interpolation of the DAPHNE waveforms, then calculate the 10% to 90% rise time.

In this case, rise time ~68 ns.



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Dark Count Rate (DCR)

- Measuring DCR was expected to be challenging due to the environmental noise; multiple potentially noisy labs around us
    - Experimenting with cross correlation (e.g. scipy.signal.correlate) to look for high correlations between waveforms and a single p.e. template
- The takeaways so far are:
    - The measured DCR is sometimes constant over time (~0.2 Hz/mm^2) despite some noise fluctuations
    - Large enough noise fluctuations cause the measured DCR to rise (correlated with a rise in waveform RMS).
- We will continue working to improve the DCR measurement and will give an update at a future meeting. Suggestions are welcome on how to improve this measurement.

Conclusions

- We have developed an effective data taking setup with DAPHNE which will be essential for testing full PDS modules in the near future

- In our setup we are able to assess SNR, signal rise time, signal shape, and dynamic range pretty well

- We are working to improve the DCR measurement, as this will be an important measurement to make. If we cannot get around the environment noise, we will consider potential power/ground isolation

- Also another to-do item: Measuring SiPM breakdown voltage