

# Negative Signal Study

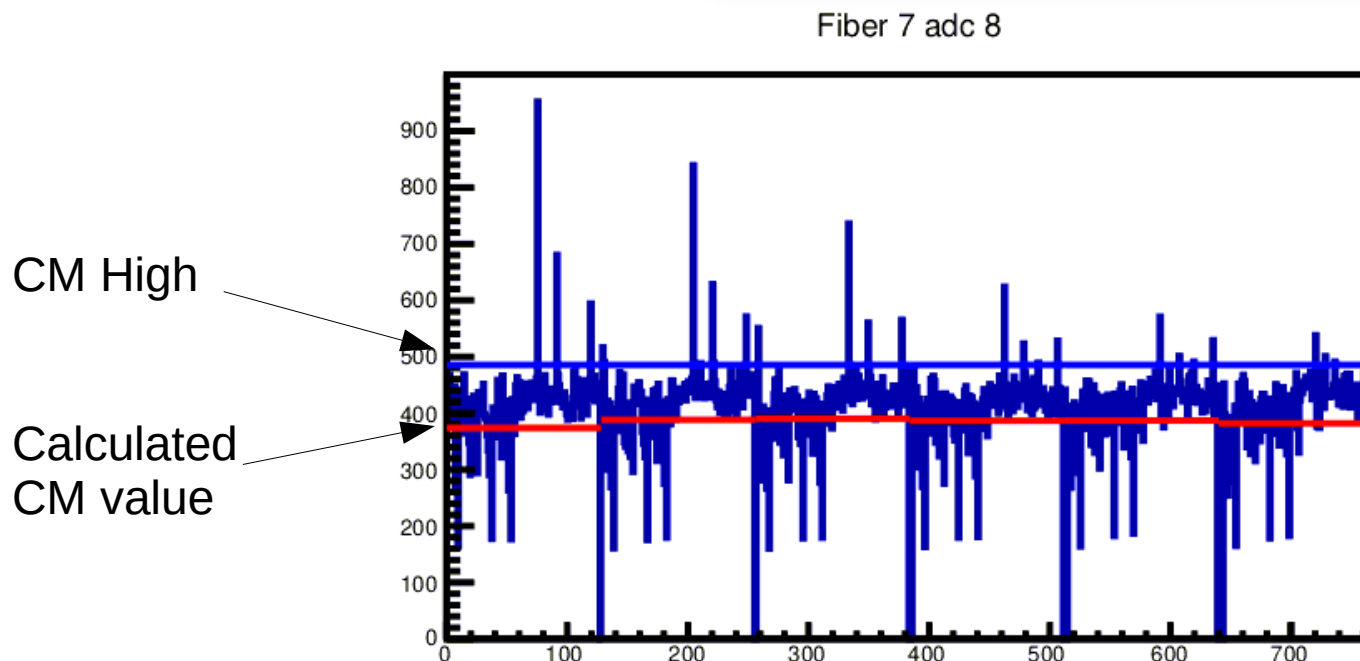
Sean Jeffas  
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# Negative Pulse Study

- Several runs with beam and full readout to study this effect.
  - 13598 - 1  $\mu\text{A}$ , LD2, GEMs at operational HV
  - 13599 - 3  $\mu\text{A}$ , LD2, GEMs at operational HV
  - 13600 - 3  $\mu\text{A}$  LD2, GEMs at 1500 V
  - 13601 - 5  $\mu\text{A}$ , LD2, GEMs at operational HV
  - 13602 - 7  $\mu\text{A}$ , LD2, GEMs at operational HV
  - 13603 - 7  $\mu\text{A}$ , LD2, GEMs at 1500 V
  - 13604 - 7  $\mu\text{A}$ , LD2, GEMs at 0 V
- All the data I will show will be from one MPD on UV layer 0, to study the simplest case.
- Only 35000 events have been analyzed from each run.

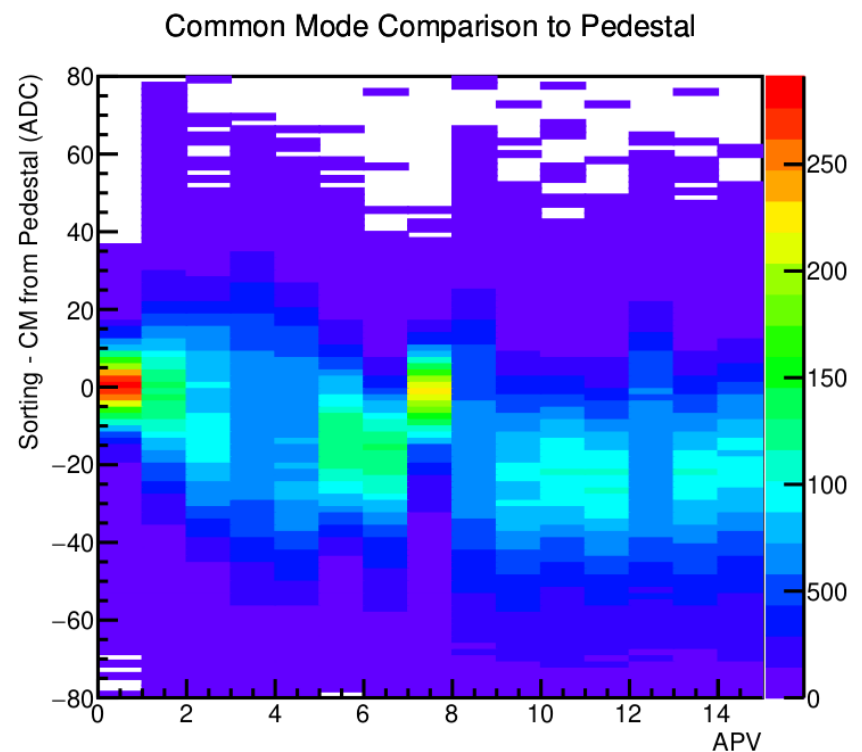
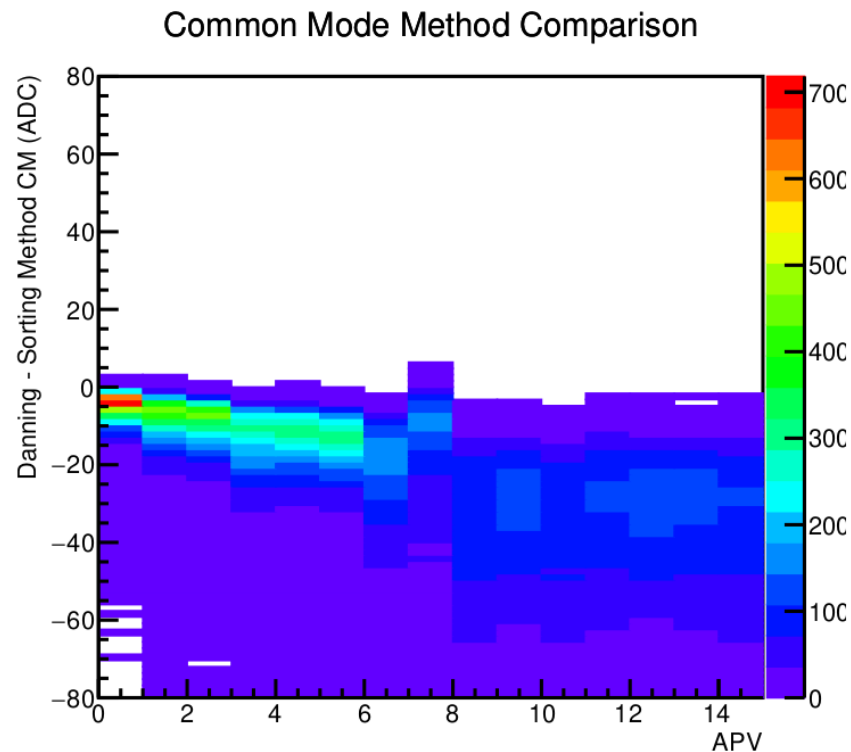
# Common Mode Calculation

- The DAQ reads in a “high” CM and removes any strips above this number.
- The mean is then calculated and then calculated again with strips  $< \text{new mean} + 3 * \text{ped rms}$ .
- Therefore our current setup uses all strips below these numbers, and are greatly affected by the negative pulses.



# Full Readout Events

- Clearly the current Danning calculation is significantly affected by negative signals.
- The sorting method uses only the “middle 20 strips” (in order of ADC) and is resistant to this.
- Due to the APV circuit, we believe the voltage is shifted downward in high occupancy events.
  - Ben suggested that we can use the occupancy to calculate the expected shift.
- On top of this affect the Danning method is also shifted lower from the negative signals.

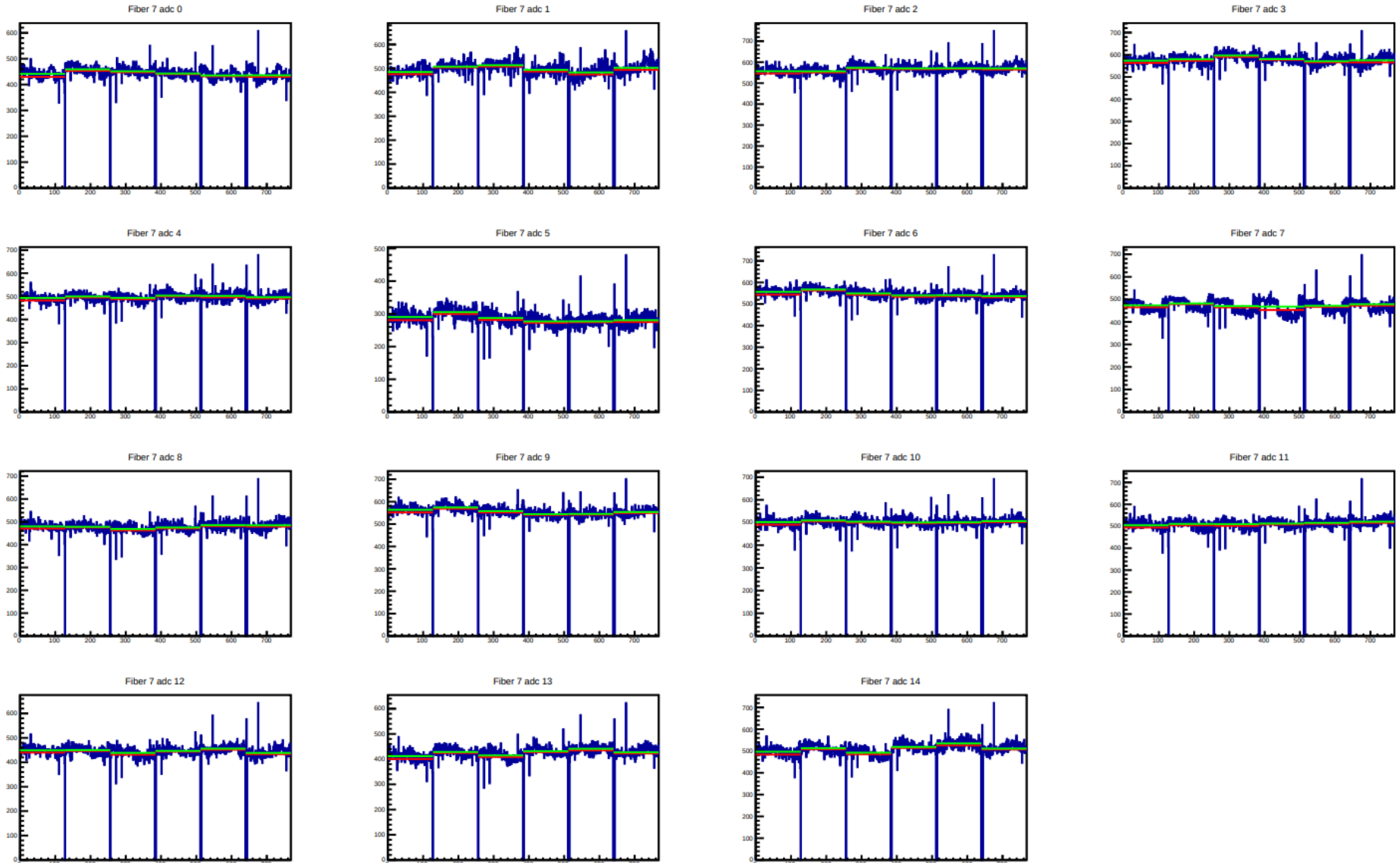


# Full Event Displays

- Event displays from all runs can be found here: <https://logbooks.jlab.org/entry/3984280>
  - **NOTE:** The strips are now in the correct physical ordering.
- Two “types” of negative signals
  - One or two strips with large negative ADC, in all APVs on an MPD in the same location
    - Found in runs with GEMs at 0 V or 1500 V regardless of beam current
    - Similar to positive noise found in APVs
  - Cluster of negative ADC strips, in one or more APVs in the same location
    - Found whenever GEMs are at operational voltage and beam is on
- Negative signals always stay constant in all time samples.
- Examples on the following pages

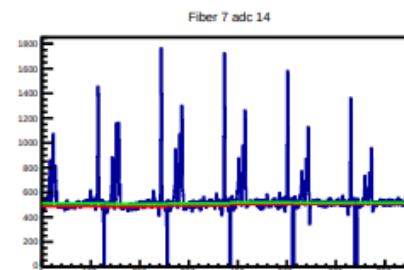
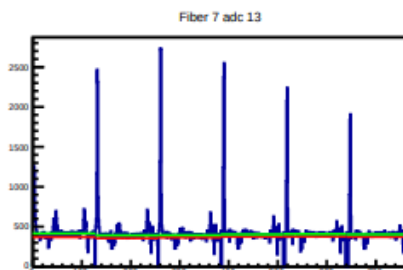
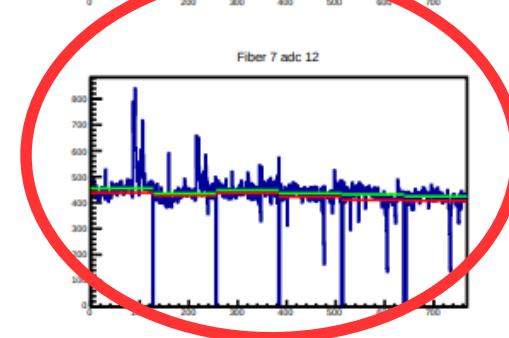
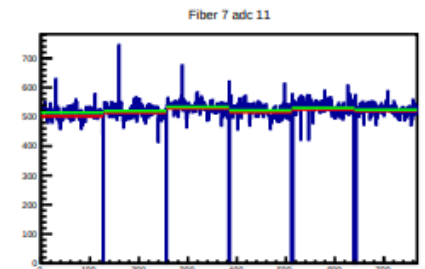
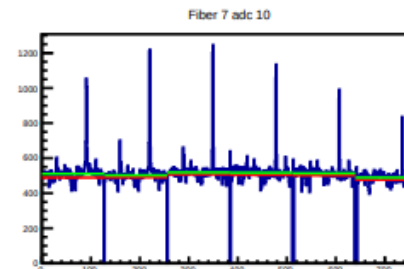
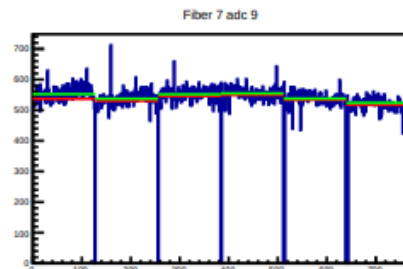
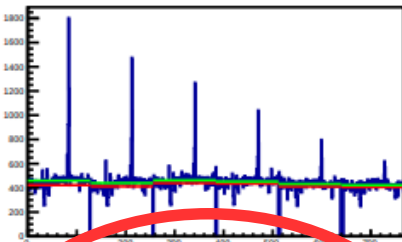
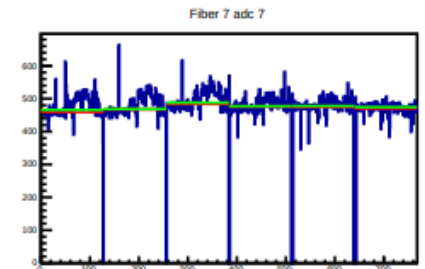
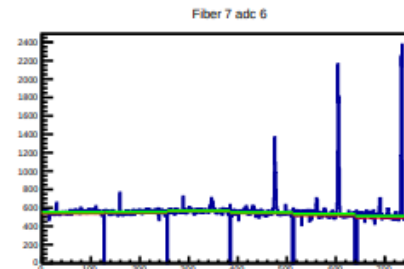
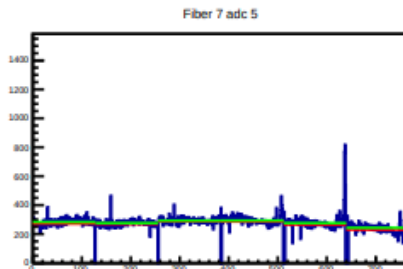
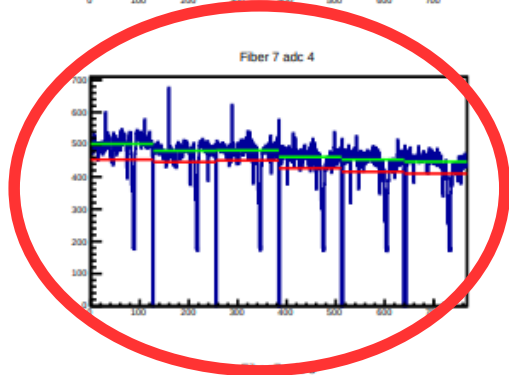
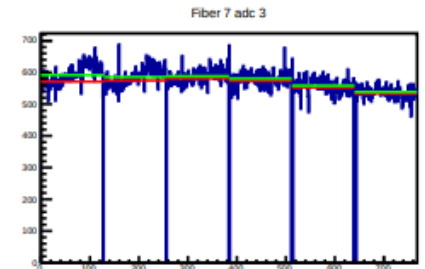
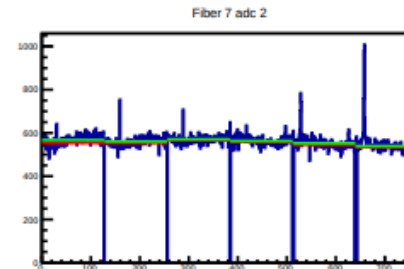
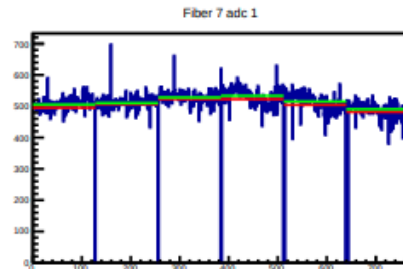
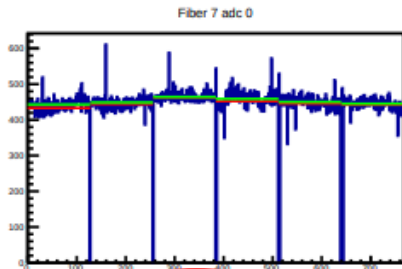
# Event Examples

- Pedestal event shows random pedestal noise in negative and positive directions.
- All APVs show the same strips in this type of event.



# Event Examples

- 1  $\mu\text{A}$  with GEMs on.
- Negative pulse found in handful of APVs.

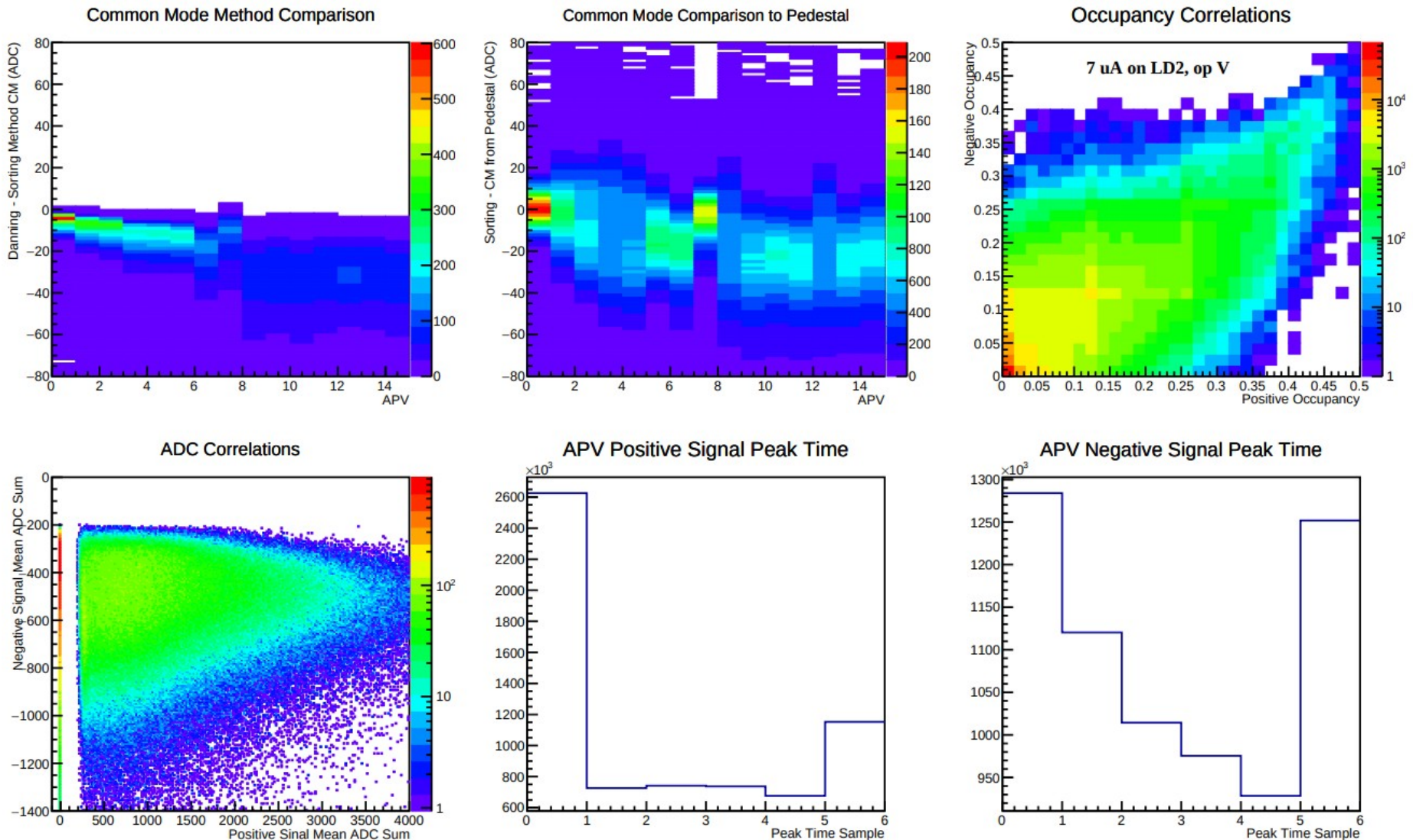






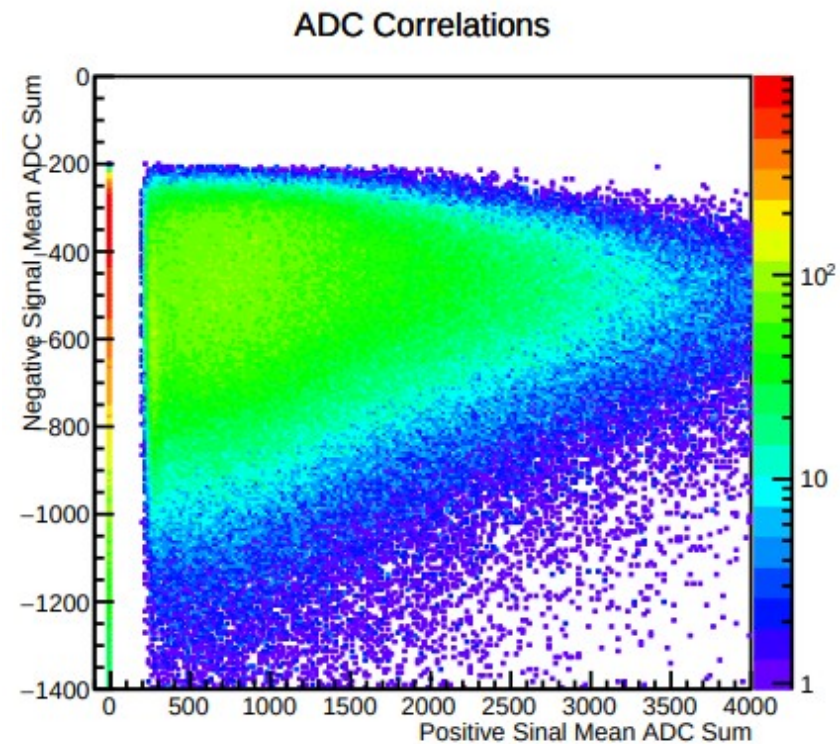
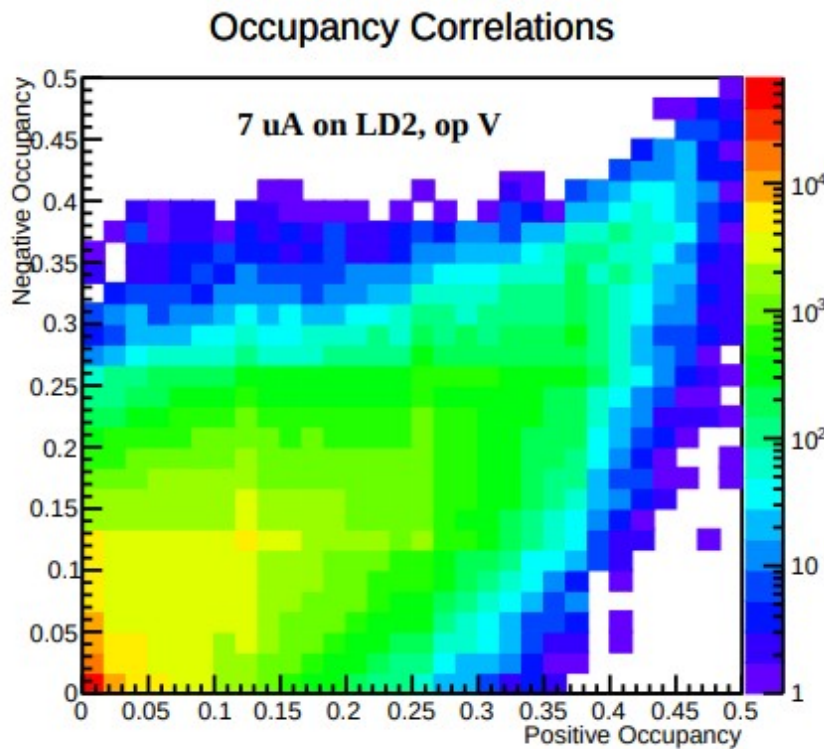
# Negative Pulse Analysis

- Using the sorting method to calculate the “correct” ADC value.
- Positive signal when a strip ADC sum has  $> 6 \times \text{pedestal rms}$  and negative signal when a strip has  $< 6 \times \text{pedestal rms}$ .
- See all the data here: <https://logbooks.jlab.org/entry/3984417>



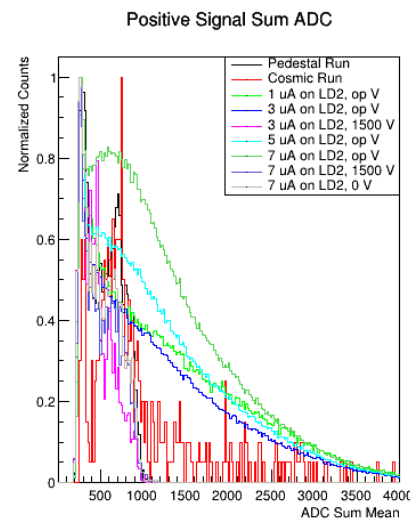
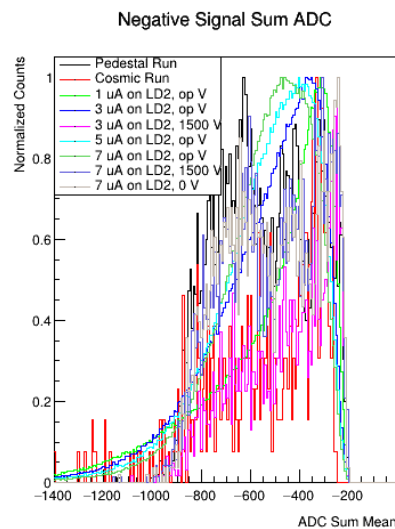
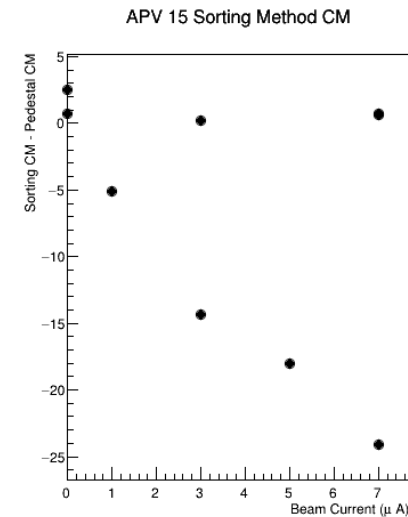
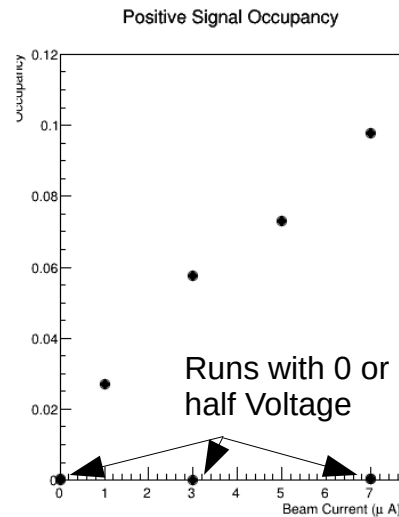
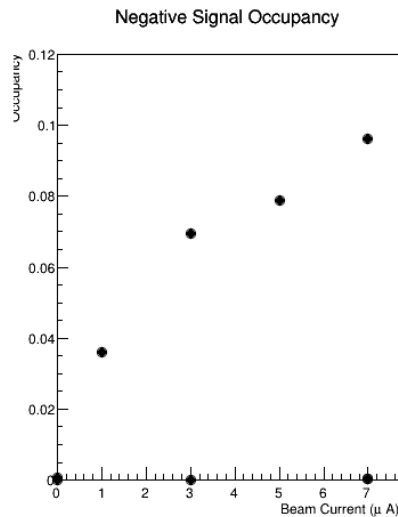
# Correlations

- Occupancy plots there is a slight positive correlation.
- Slight correlation between higher positive signals and higher negative signals.



# All Runs Analysis

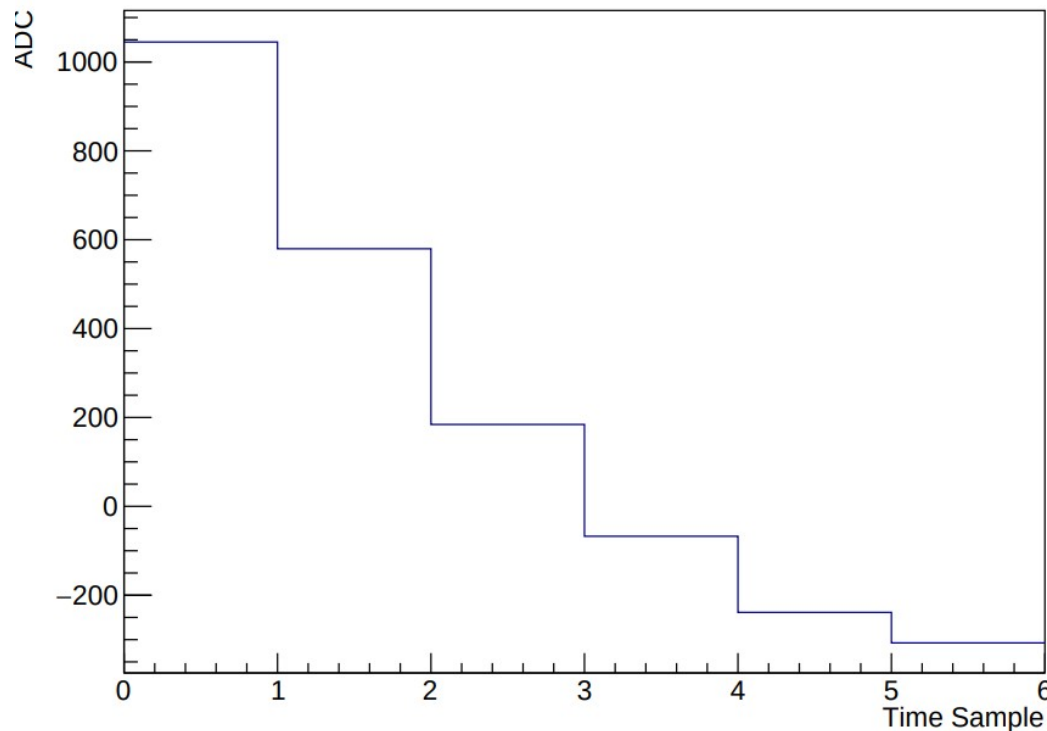
- Negative occupancy increases with beam current, just like regular occupancy.
- When GEMs are off the negative ADC distribution is more uniform.
  - May need to replay more statistics to fill out graphs
- For runs with GEMs on the negative signal increases slightly with beam current.



# Signal Flip

- Checked if a signal ever “flipped” between positive and negative in the 6 time samples.
- Use extreme cut for these results,  $|\text{signal}| > 7 \cdot \text{sigma}$ , to make results more obvious.
- The plots shows the ADC for one strip over the 6 time samples.
- The signal gradually decreased over time, so it did not abruptly “flip” and signal was not lost.
- 300 events can be found in the HALOG and all of them are like this example:
  - [https://logbooks.jlab.org/files/2022/02/3984417/Signal\\_flip\\_event\\_display\\_run13602\\_1.pdf](https://logbooks.jlab.org/files/2022/02/3984417/Signal_flip_event_display_run13602_1.pdf)
- Therefore the negative signals is not causing us to lose positive signals.

Strips with Flipped Signal



# Work In Progress

- Calculate the expected CM shift from the APV circuit.
- Use tracking to see if negative strips are often in the area that we expect a hit.
- Understand the source of the negative pulses.