Negative Signal Tracking

Sean Jeffas
March 23, 2022

Negative Signal Tracking

- Implemented changes in the analyzer to handle negative strips on tracks.

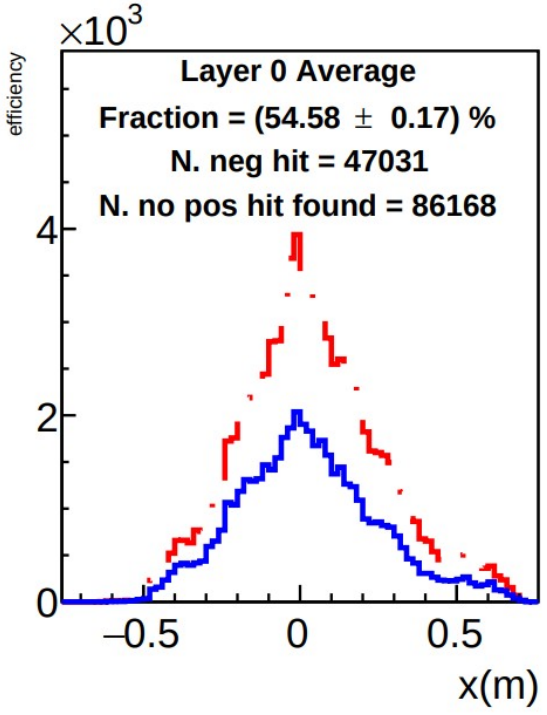
1) Goes through normal tracking procedure for positive strip signals.
2) Stores all negative strips passing “negative” zero suppression (< -5 sigma cut).
3) After tracking loop through all modules on tracks that do not have hits found.
4) Loops over all possible 2D combinations of negative matched with negative or negative matched with positive strips.
5) Check if the 2D position is withing 2 mm of the expected track hit.
6) Record this as negative strip on track or not on track.

- This analysis is done for any events with no zero suppression (1/100 full readout events).
- All raw negative strips passing zero suppression are used.
  - There is no correlation cuts or clustering.
- **This is extremely biased in favor of finding negative tracks.**
- Creating a more robust method would take a bit more work.

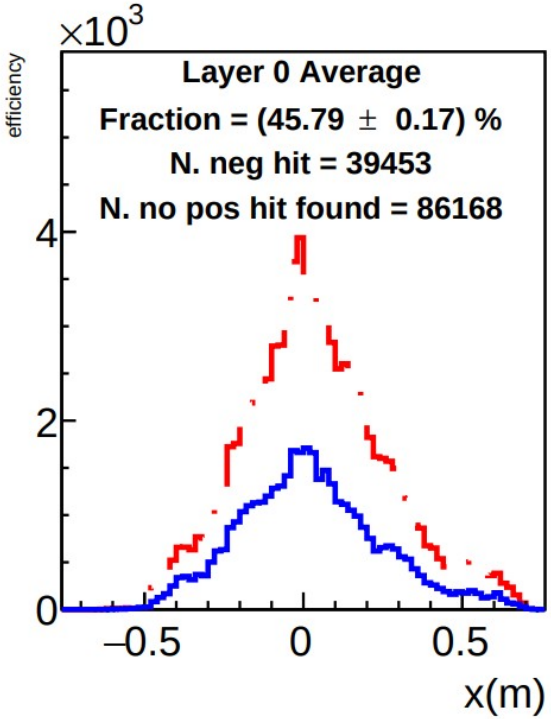
Negative Tracking Efficiency

- The red histograms are tracks where no positive hit is found.
- The blue histograms are the tracks where a negative hit is found instead of a positive hit.
- Not a true efficiency, but the fraction of how often we find a negative hit on the tracks when the positive hits are missing.
- 1D tracking simply checks if any negative hits on one axis are within 2 mm of the track.
  - ~40% numbers are expected for random noise.
- 2D tracking checks using all 2D combinations between negative and positive hits.

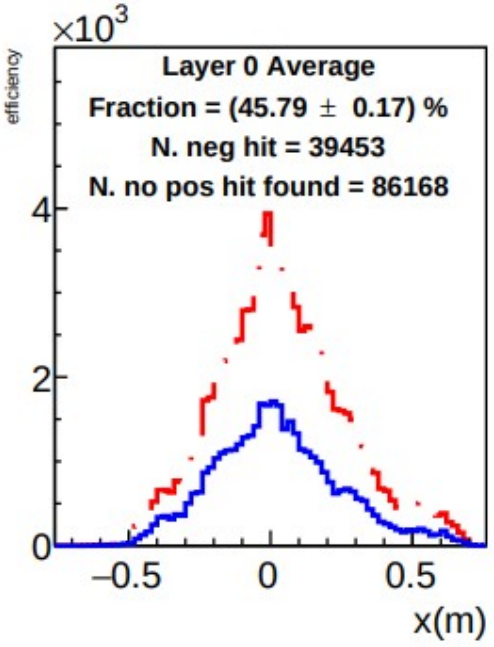
1D tracking

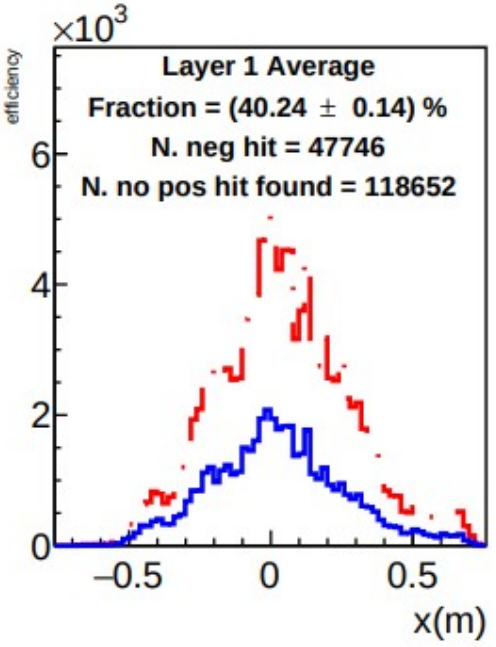


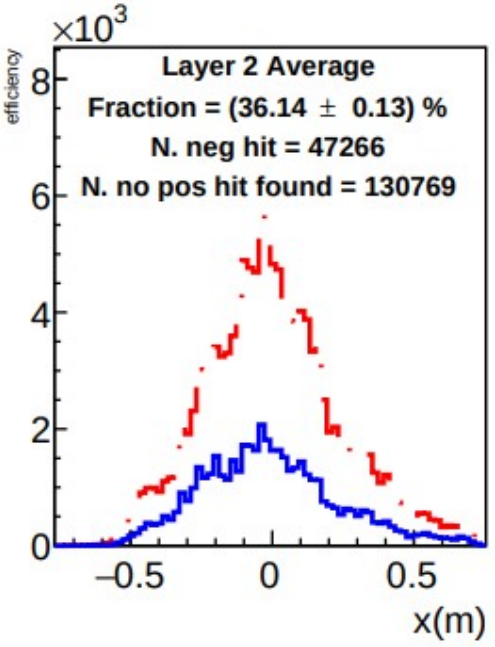
2D tracking

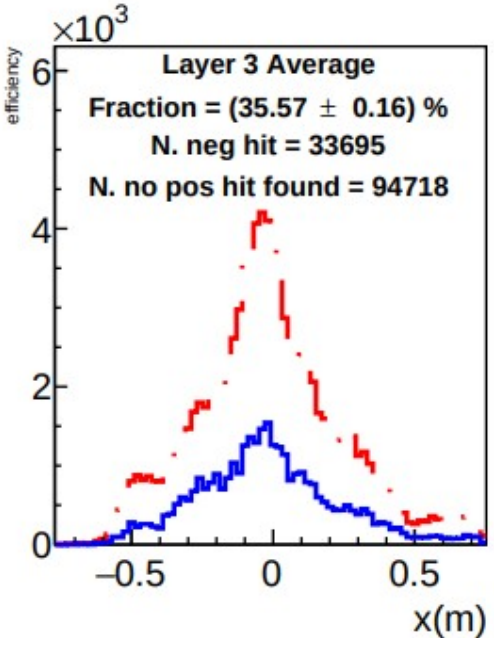


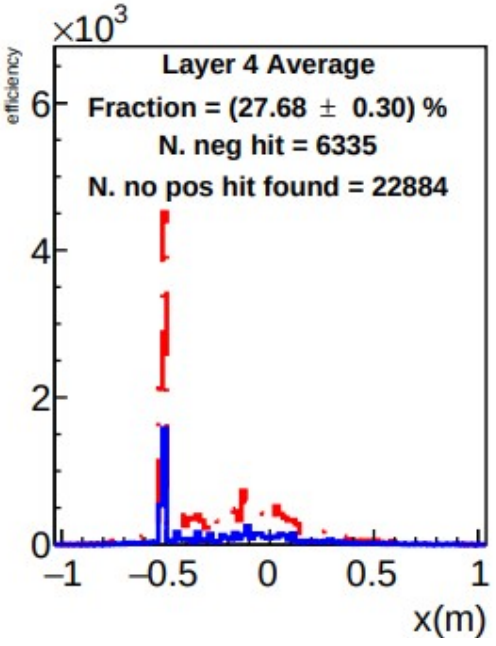
2D Tracking Efficiency









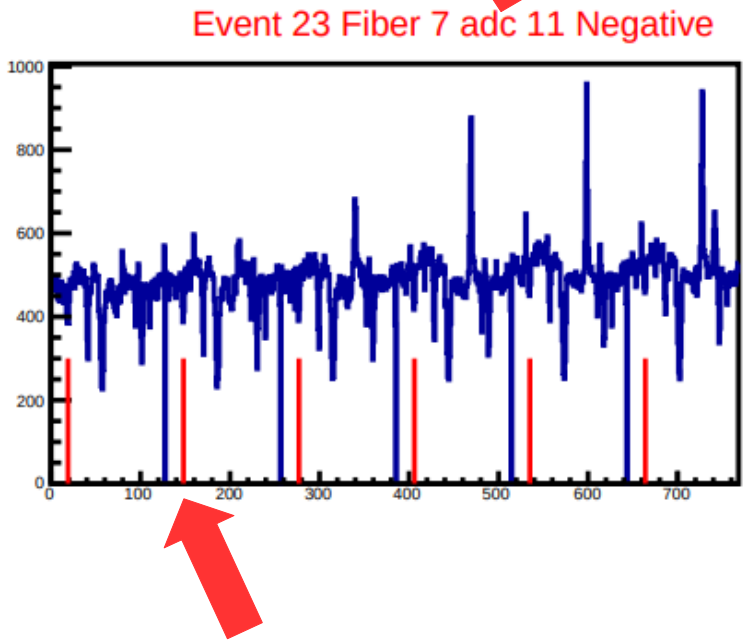


34.5 uA on LD2

Negative Tracking Displays

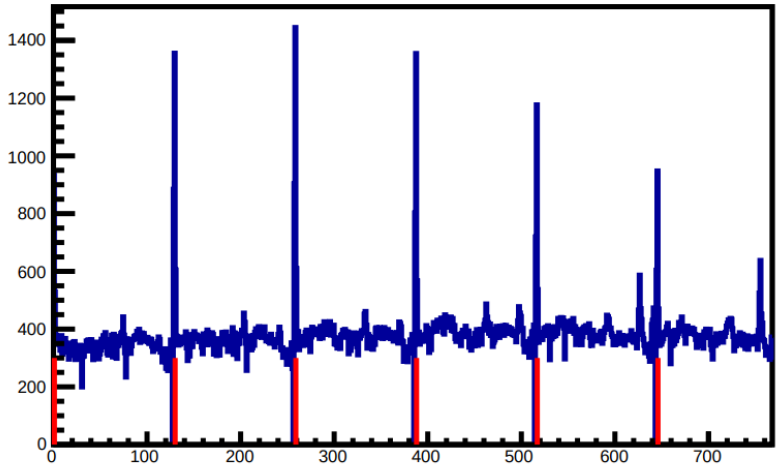
- On the HALOG I have posted 100 events with negative tracks found, and highlighted their position.
  - https://logbooks.jlab.org/entry/3989020

Large red title shows which APV had the negative hit on a track



Red line shows the hit strip location.

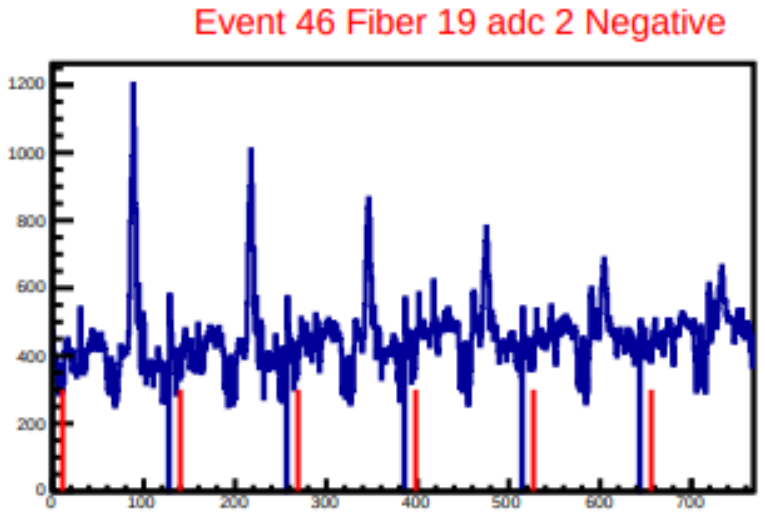
Large blue title shows which APV had the positive hit on a track



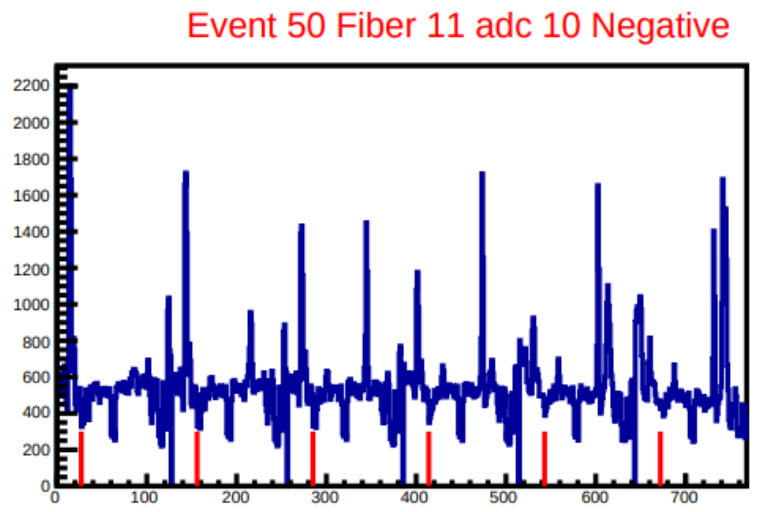
Negative Event Types

- 70 events from 34.5 uA have been investigated by eye.
- Majority of “negative hits on tracks” are either:
  - Random fluctuations near the track
  - Negative strips directly next to a large positive hit.
- More examples and some estimations coming later.

Random Fluctuation Example



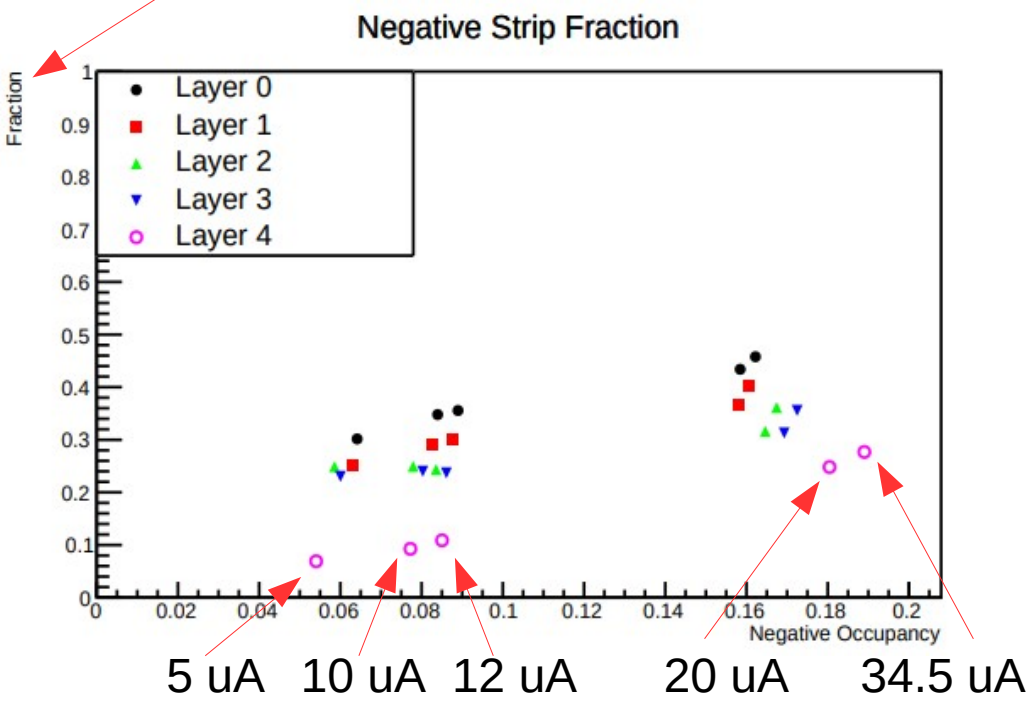
Negative strips next to positve hit example



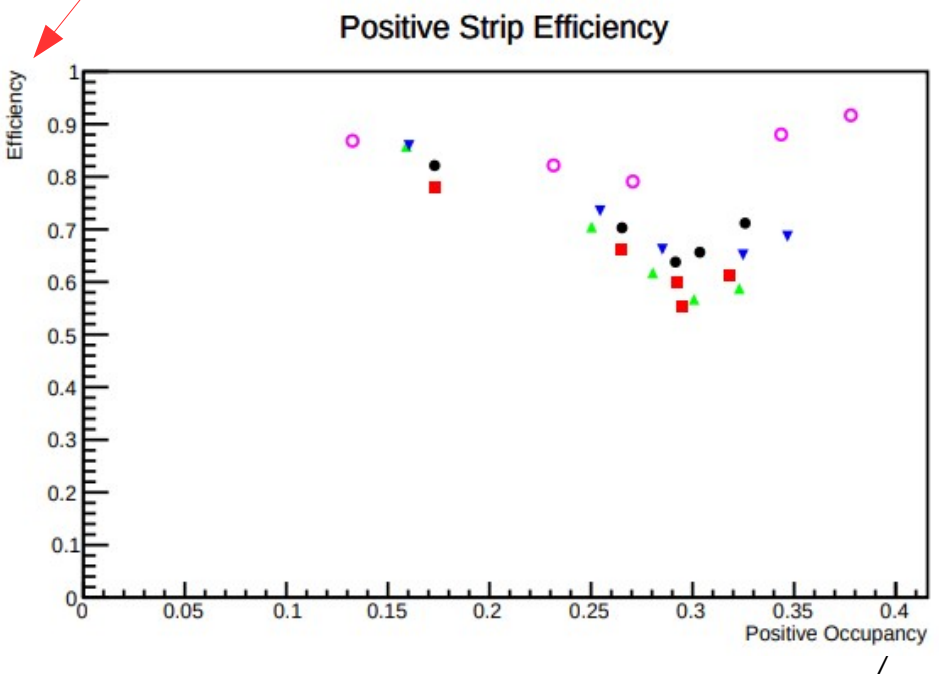
Tracking Efficiency Comparison

- Below is the tracking results for different beam currents, shown on the x-axis as different negative and positive occupancy
- Interestingly the efficiencies increase when the beam current goes to 20 and 34 uA.
  - Does this make any sense?
- The first 3 data points the efficiency drops about 20% for the front 4 layers, while the negative strip fraction only increases by about 2%.
  - Does not indicate that a large portion of the efficiency drop can be due to negative strips.

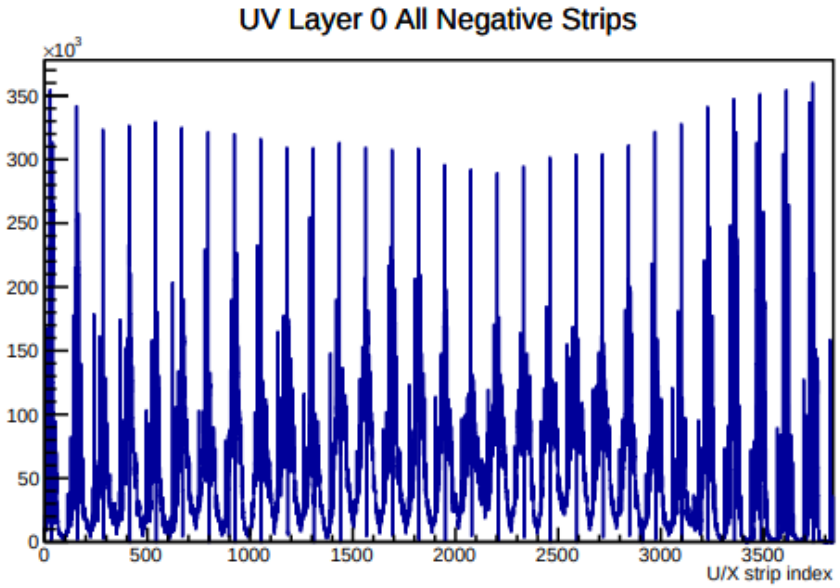
Fraction of missed hits with negative strips on tracks

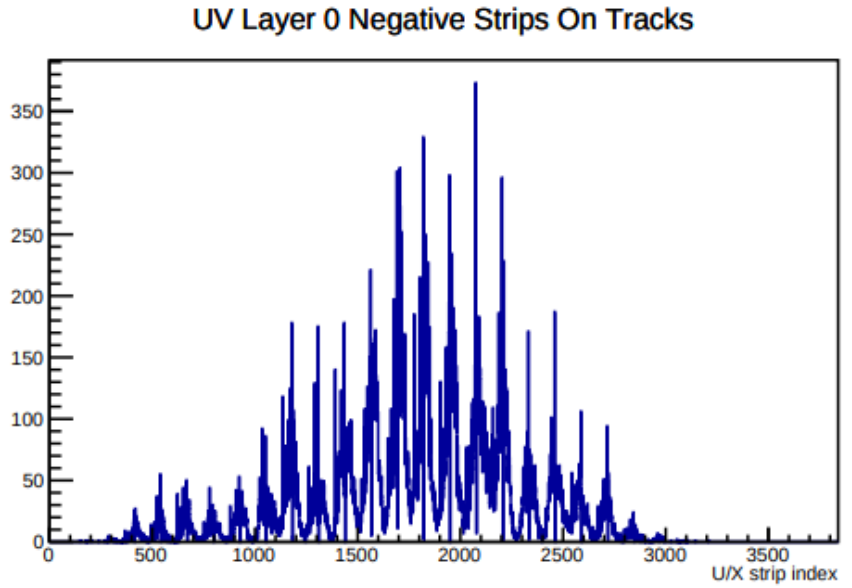


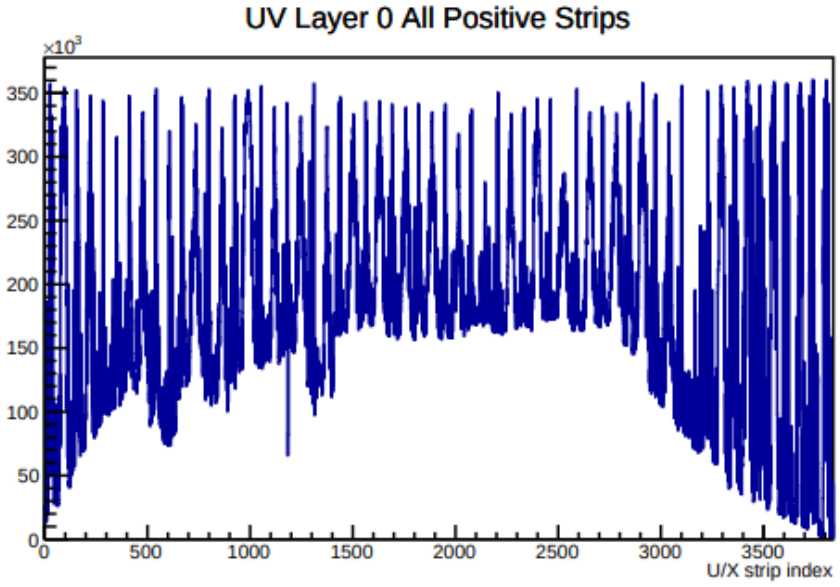
Usual Efficiency

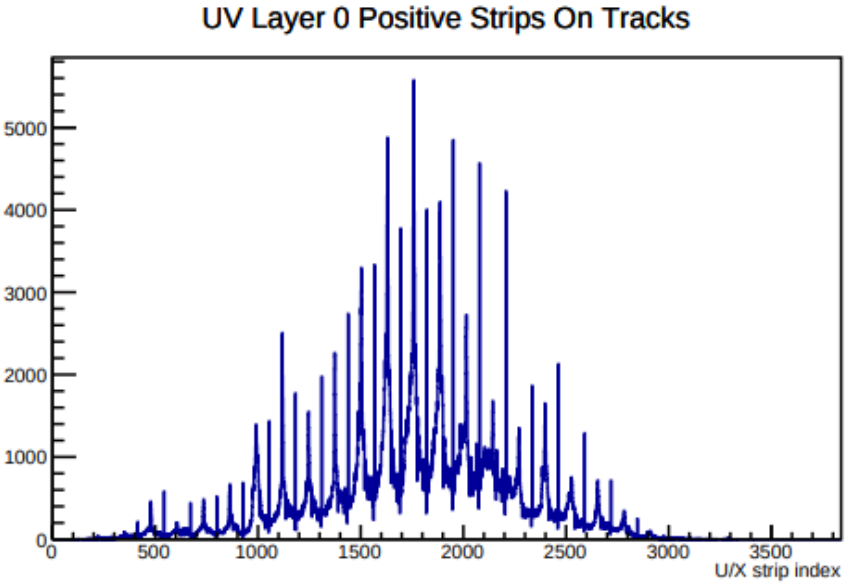


34 uA Run Investigation



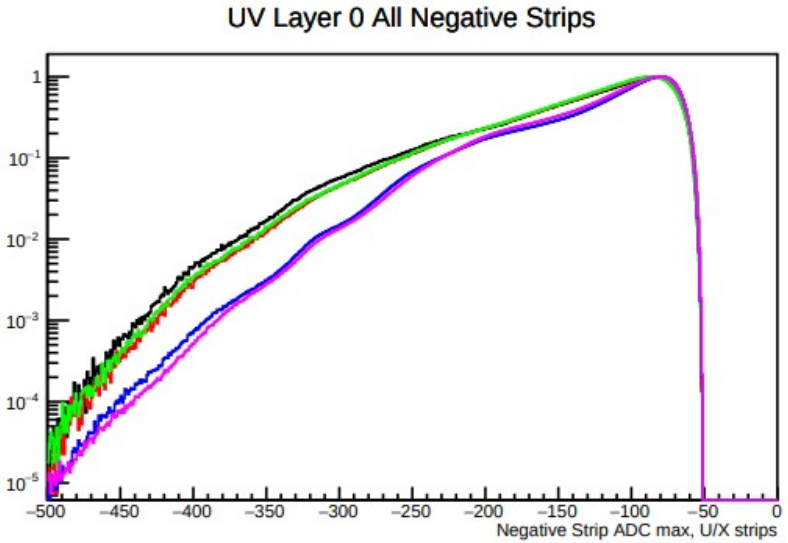


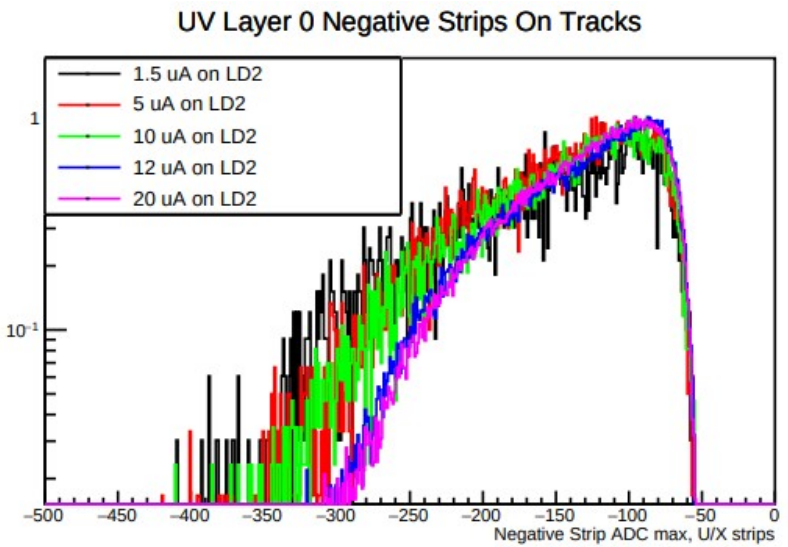


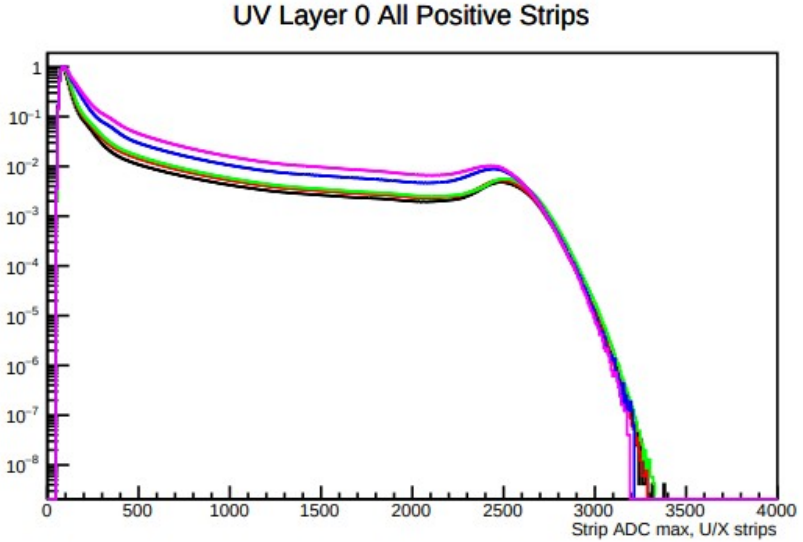


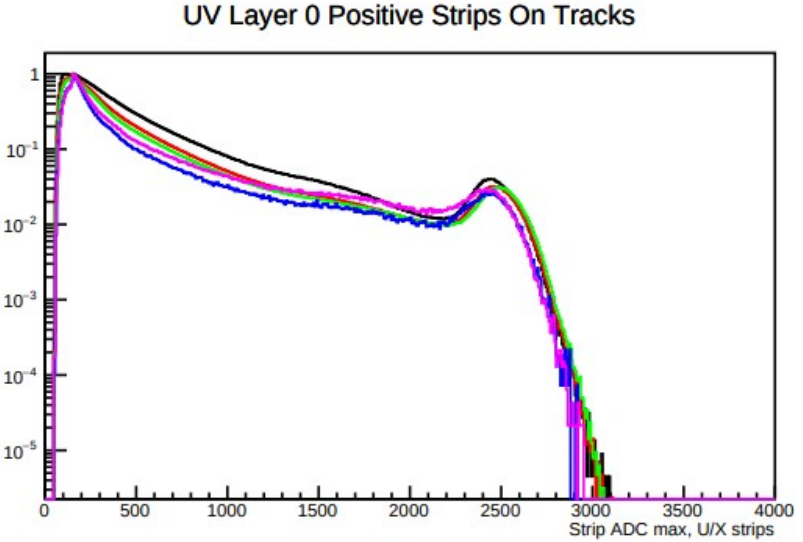
ADC Comparisons

- Unlike the positive ADC distributions, the average negative ADC is significantly reduced when cutting from all strips to just strips on tracks.
  - Another sign that the strips on tracks are mostly lower ADC noise.



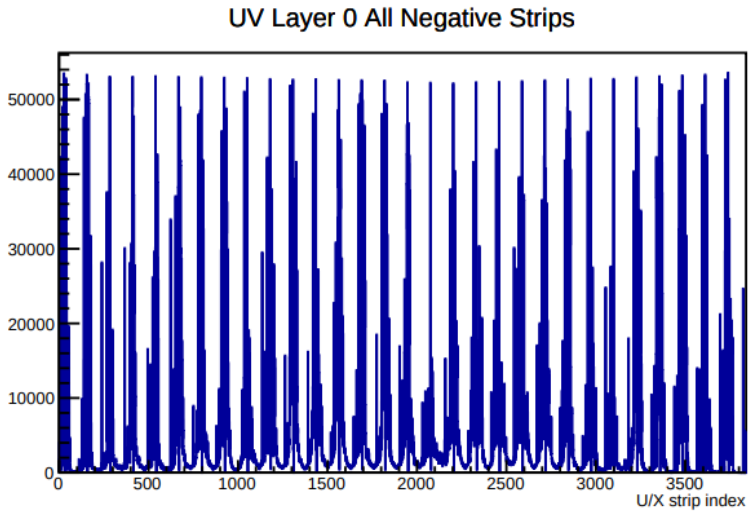


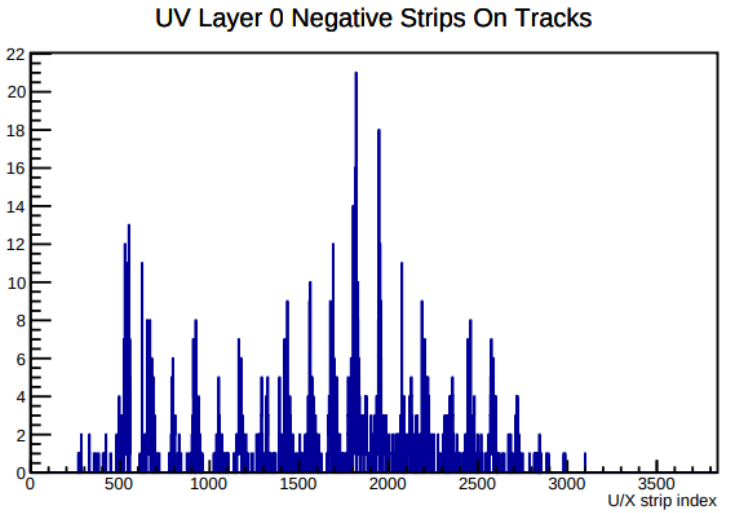


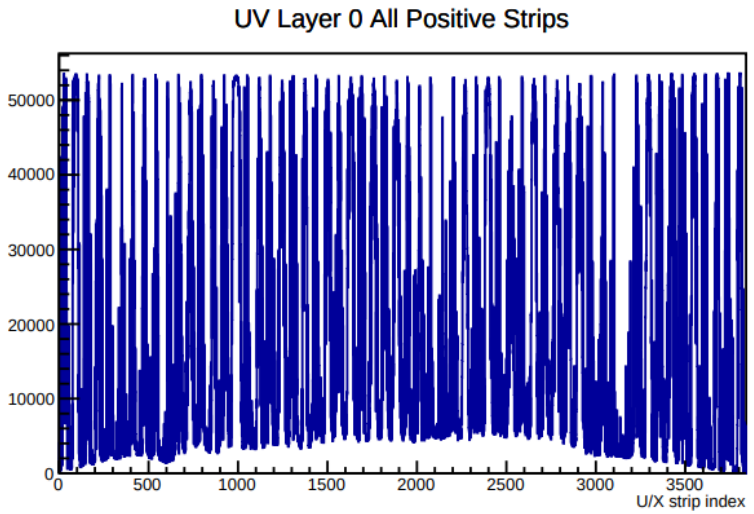


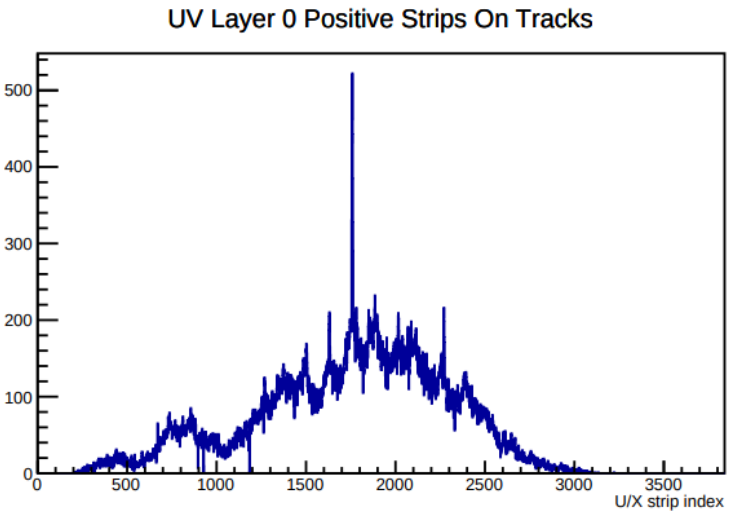
Strip Distributions

- The left plots show many noise effects for both positive and negative, which is usual.
- When tracking cuts are added we see the negative strips retain most of the noise effects.



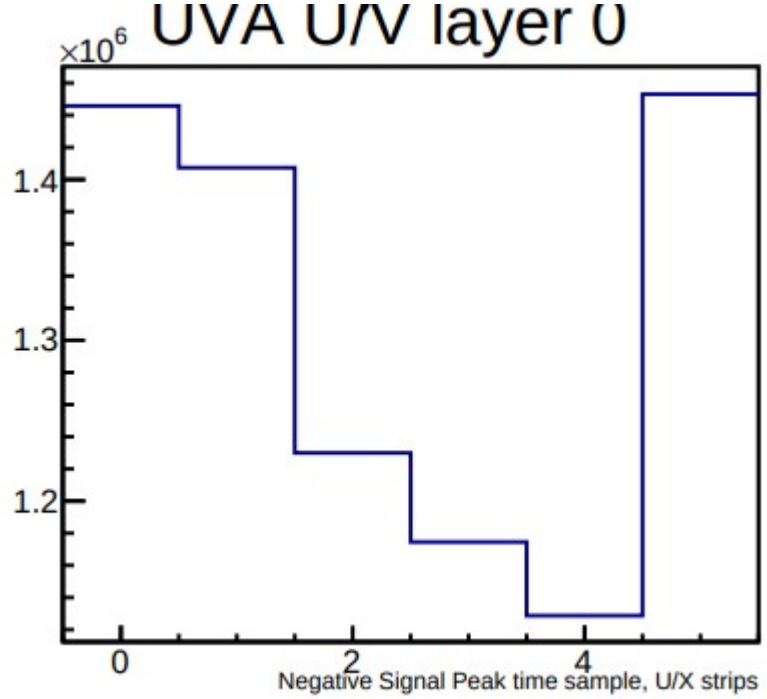


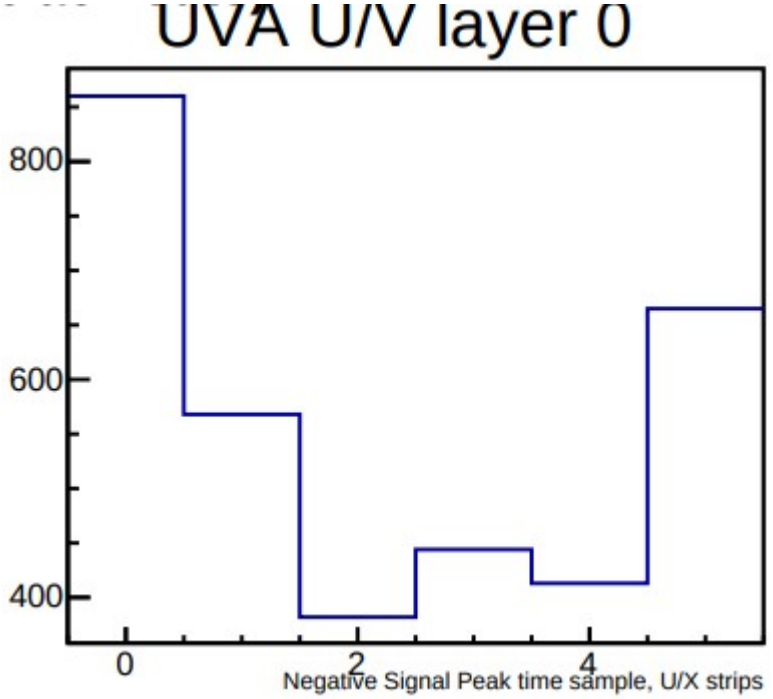




Negative Strip Timing

- Negative strips “on tracks” do no peak in the middles like we expect for good hits.
  - Should probably redo analysis with first and last time sample cut out.





Conclusions

- See all plots and event displays here, https://logbooks.jlab.org/entry/3989020
- Most results of negative hits on tracks point to random noise fluctuations and negative strips near positive strips.
  - Very basic tracking done with no clustering
  - Could be improved but would take time
- Still need to go through all results and get estimations