Negative Signal Tracking

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Negative Signal Tracking

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

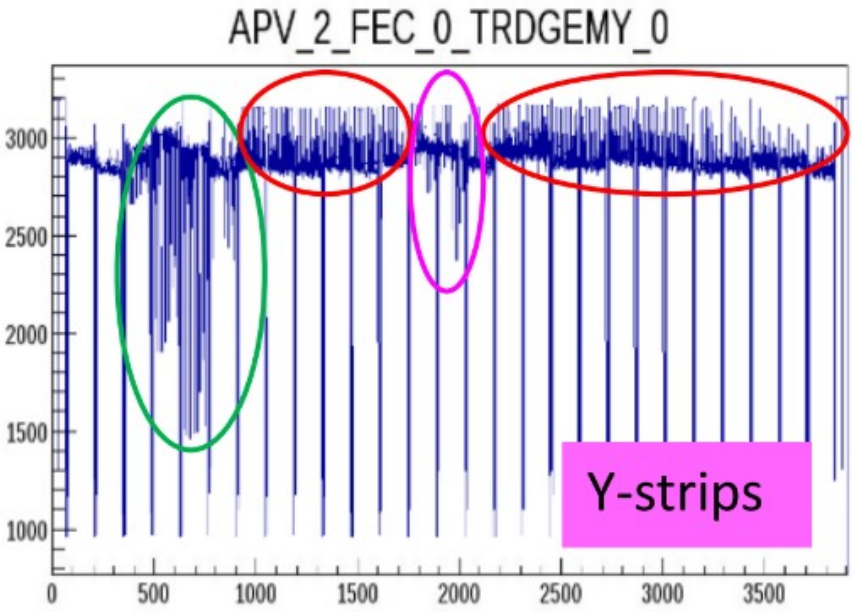
1) Goes through normal tracking procedure for positive strip signals.
2) Stores all negative strips passing “negative” zero suppression (< -5 sigma cut).
3) Clustering separately on positive and negative strips.
4) After tracking loop through all modules on tracks that do not have hits found.
5) Loops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

- This analysis is done for any events with no zero suppression (1/100 full readout events).
- ~60M events analyzed for each beam current to acquire enough statistics.

Signal “Flipping”

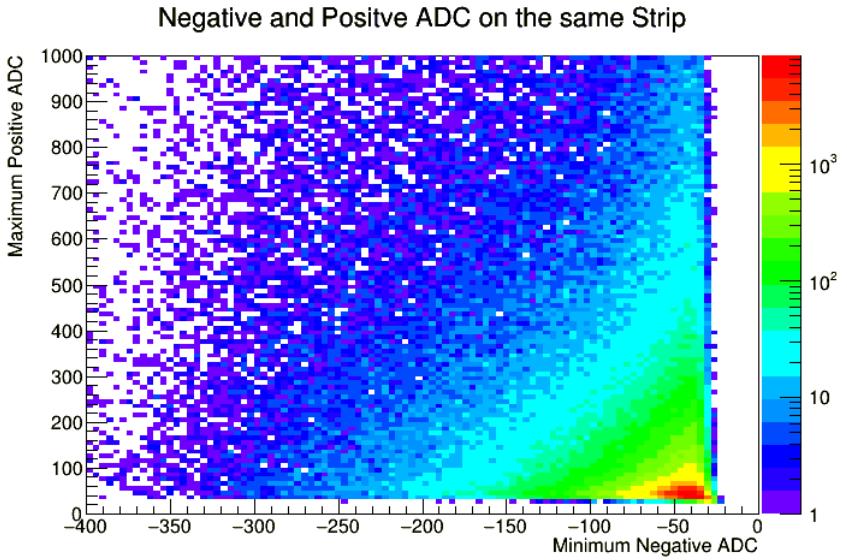
- One possibility is that the negative signal is some positive signal that flips between positive and negative
- Checked if a strip ever passes negative and positive zero suppression in the 6 APV time samples.
- Compare the minimum and maximum ADC values in a single strip.
  - Check if large positive ADC swings to large negative ADC
- Compare the ADC values between the two time samples where the ADC changes polarity.
  - Check if the transition is large negative to large positive.

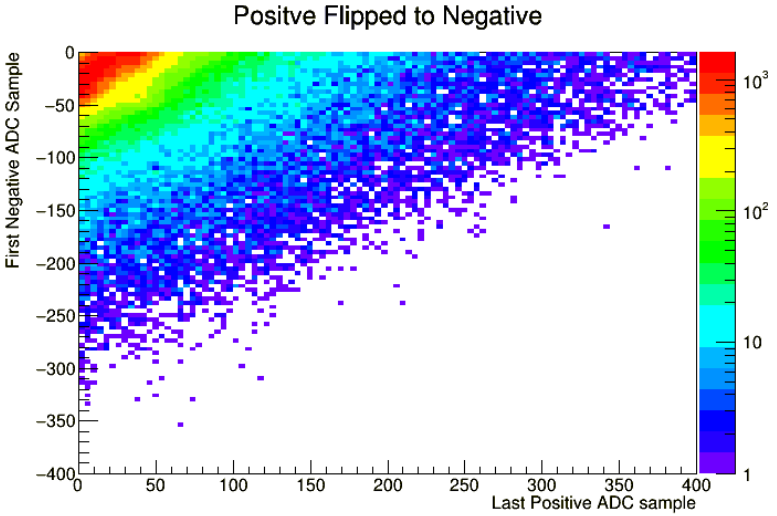
Plot from Kondo, SRS system

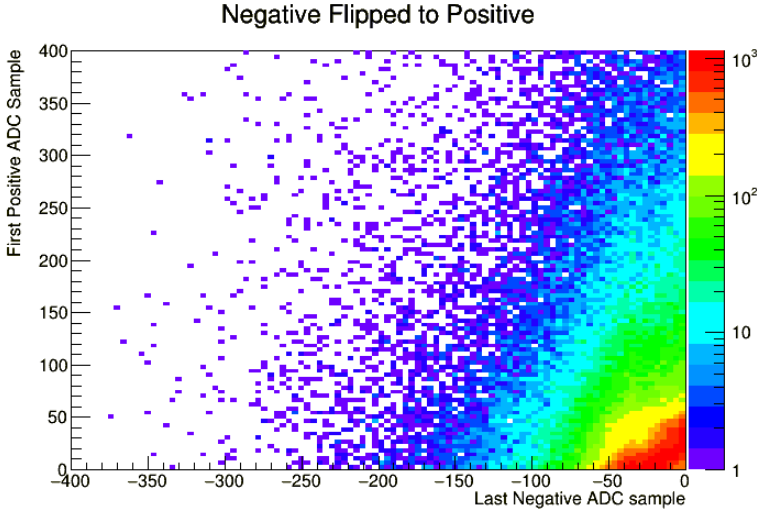


Signal “Flipping”

- Generally if the positive ADC is large, then the negative ADC is small, and vice versa.
- At the two time samples where the “flip” happens the ADCs are likely to be small.
- Implies that usually the ADCs gradually transition between polarities instead of abruptly changing.



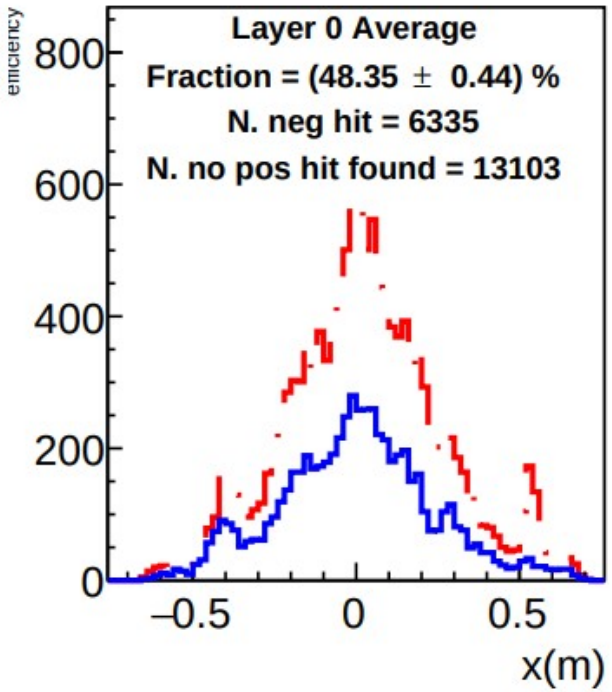




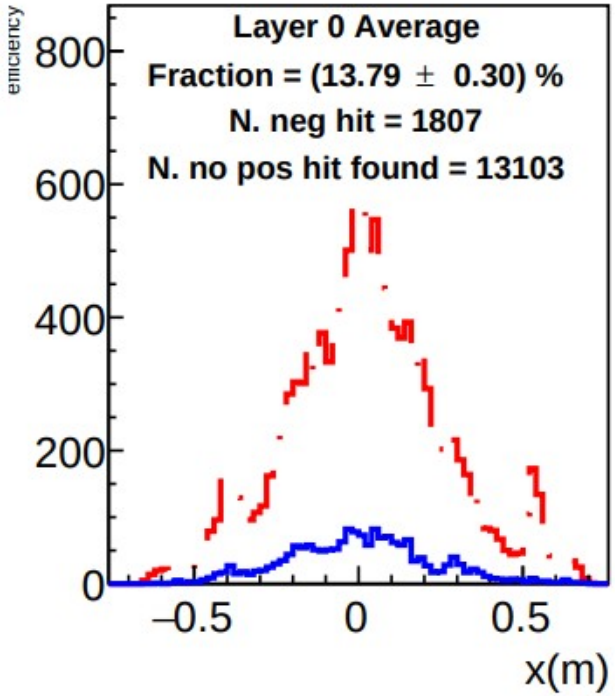
Negative Tracking Efficiency

- 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.
- 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 can be expected from random noise.
- 2D tracking checks using all 2D combinations between negative and positive hits.
- 2D tracking significantly reduced the number of negative hits on tracks to ~15%

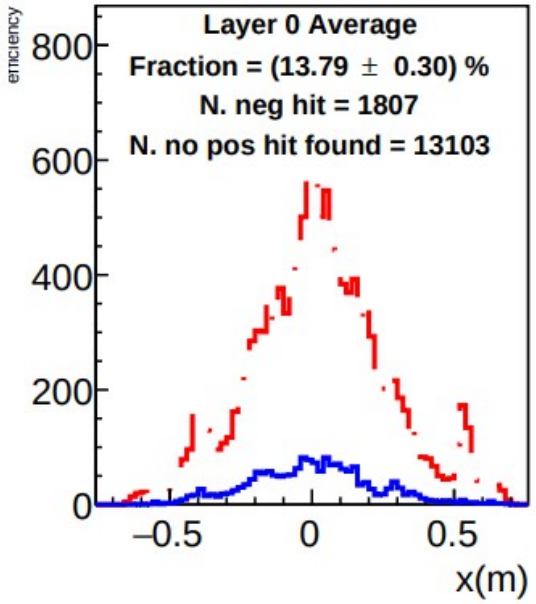
1D tracking

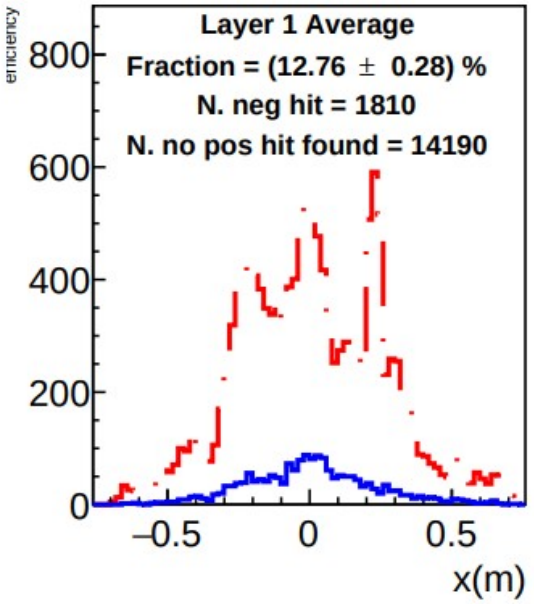


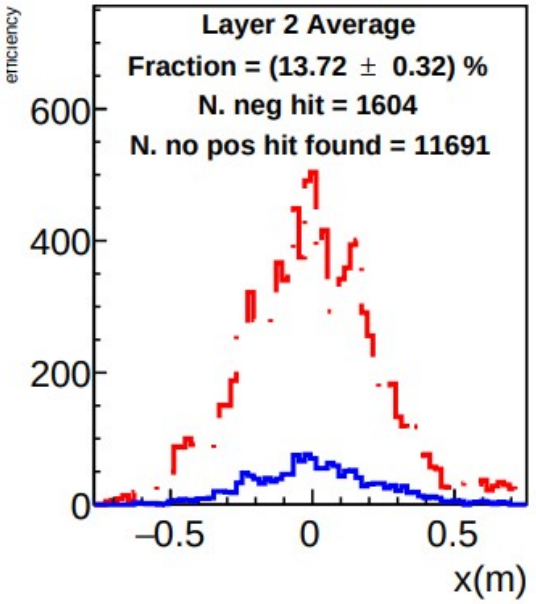
2D tracking

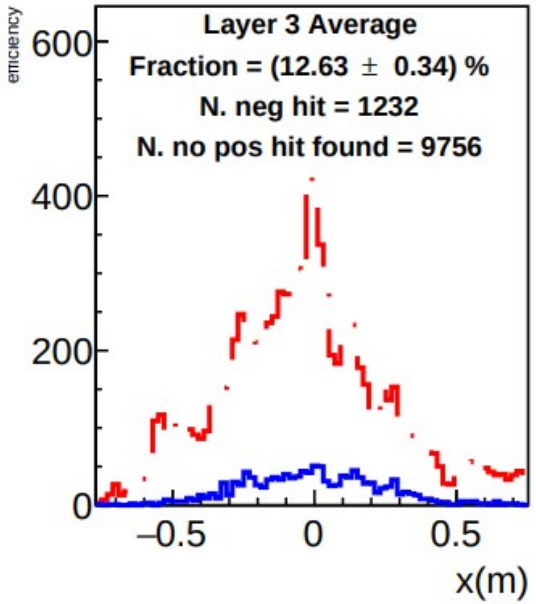


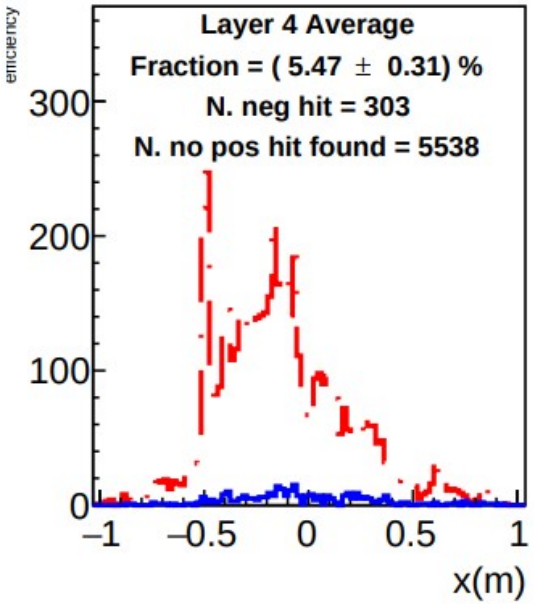
2D Tracking Efficiency









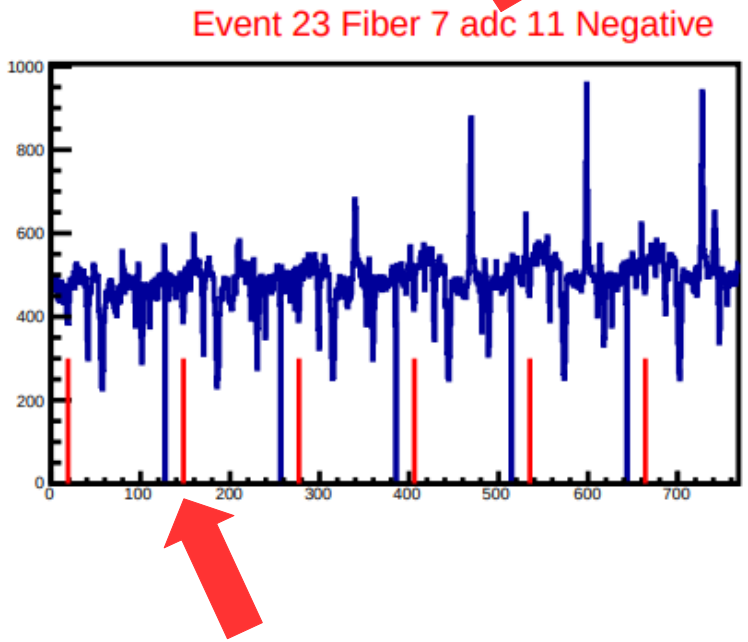


12 uA on LD2

Negative Tracking Displays

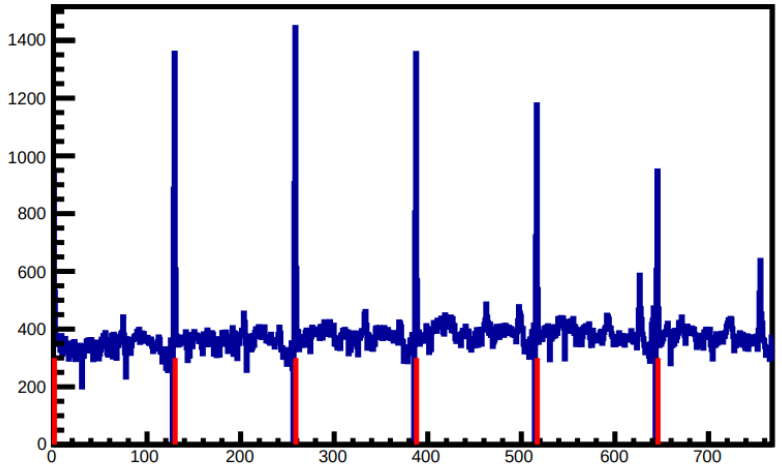
- On the HALOG I have posted 100 events with negative tracks found, and highlighted their position.
  - https://logbooks.jlab.org/entry/3989020

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

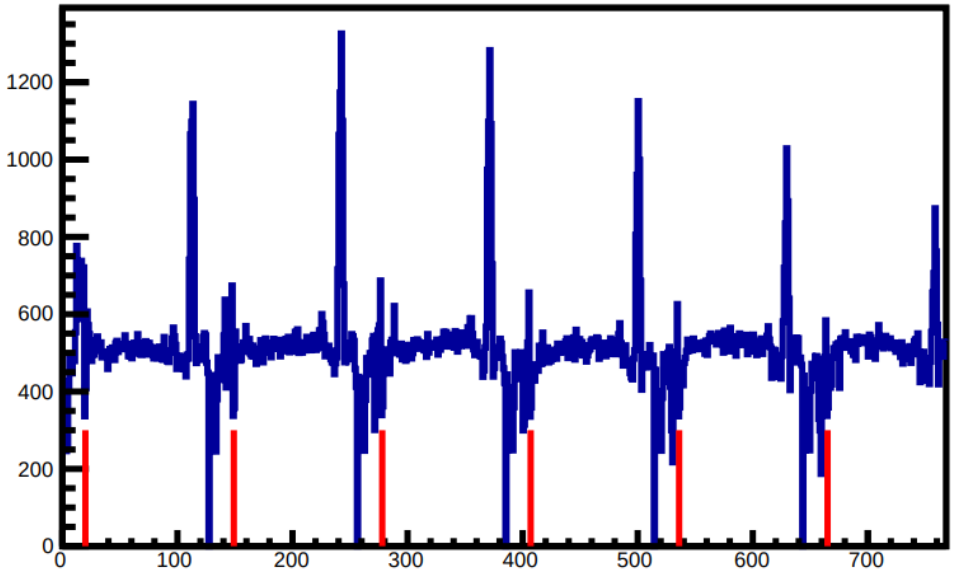


Negative Event Types

- Many events investigated by eye.
- Majority of “negative clusters on tracks” are directly next to a large positive cluster.
- Very few examples look like real negative clusters on tracks.

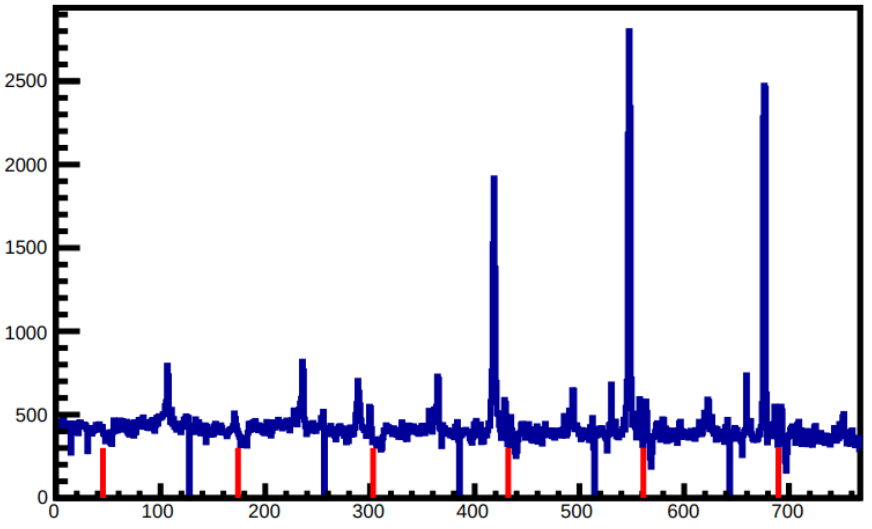
Possible cluster on track

Event 527 Fiber 12 adc 3 Negative



Negative strips next to positve hit example

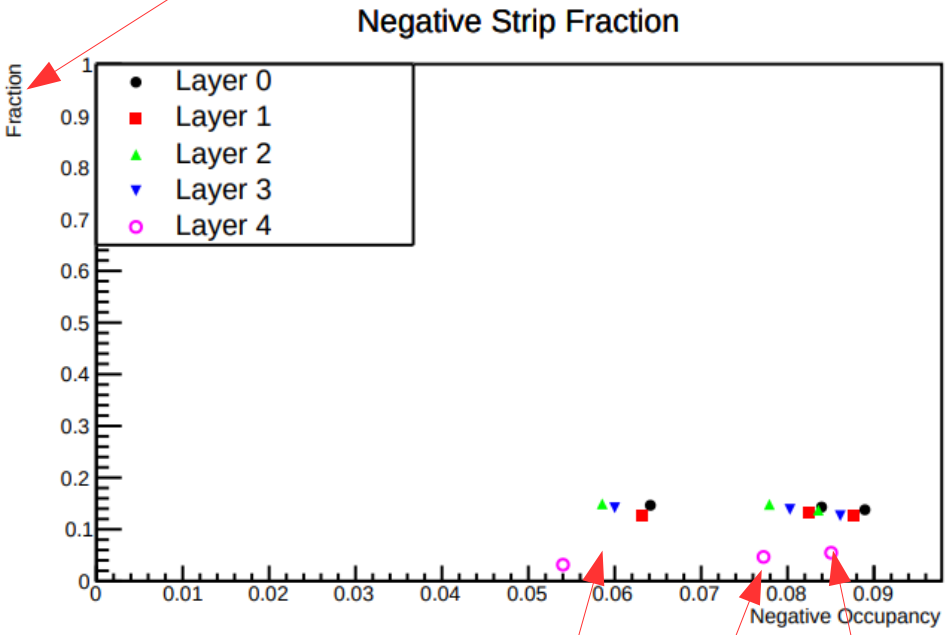
Event 174 Fiber 7 adc 12 Negative



Tracking Efficiency Comparison

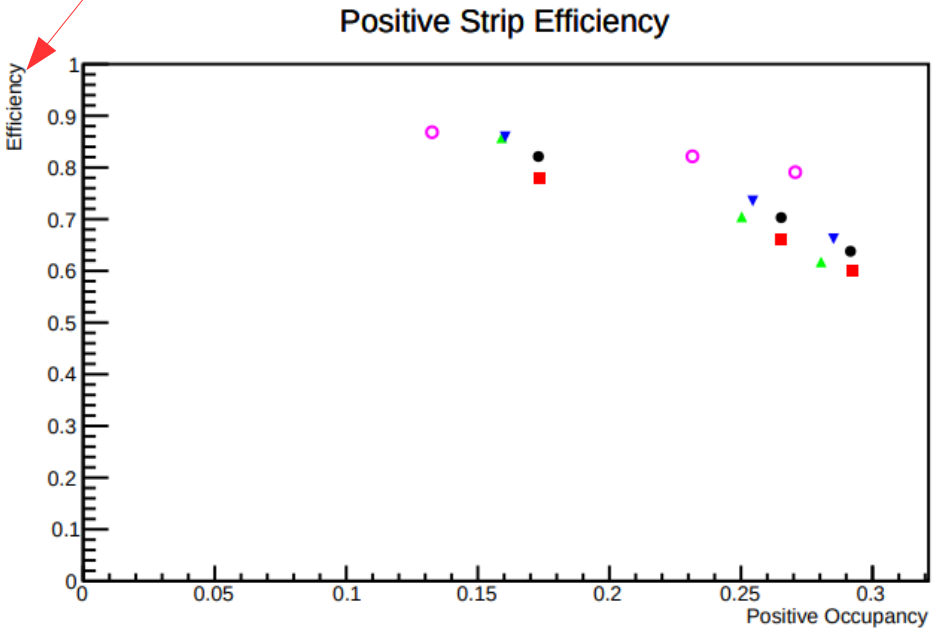
- Below is the tracking results for different beam currents, shown on the x-axis as different negative and positive occupancy
- Efficiency drops about 20% for the front 4 layers, while the negative strip fraction is steadily ~15%.
  - If the negative strips caused a significant part of this drop the fraction should be increasing.
  - Constant negative fraction implies that they are likely random coincidences.

Fraction of missed hits with negative strips on tracks



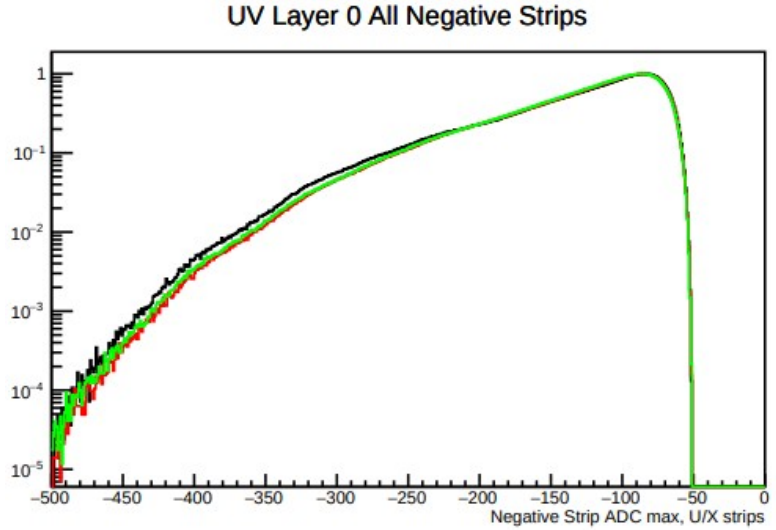
5 uA 10 uA 12 uA

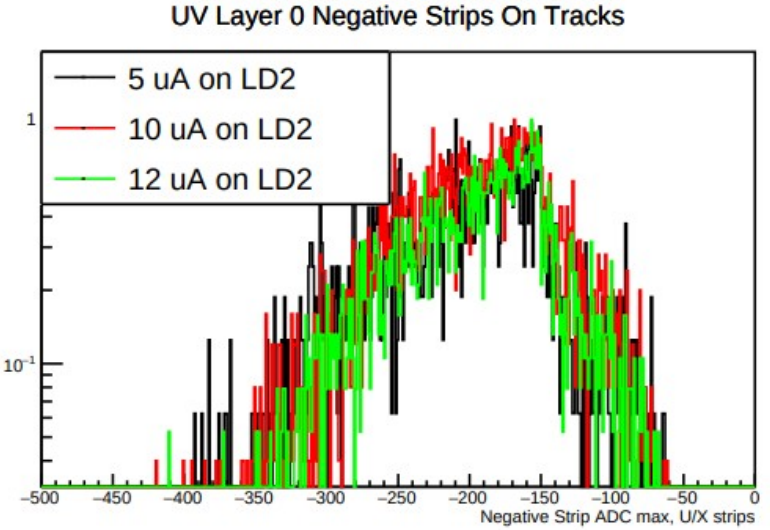
Usual Efficiency

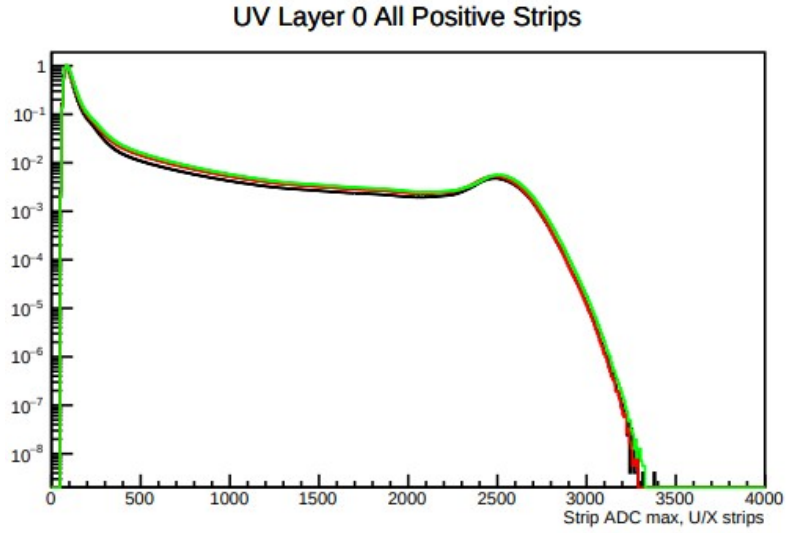


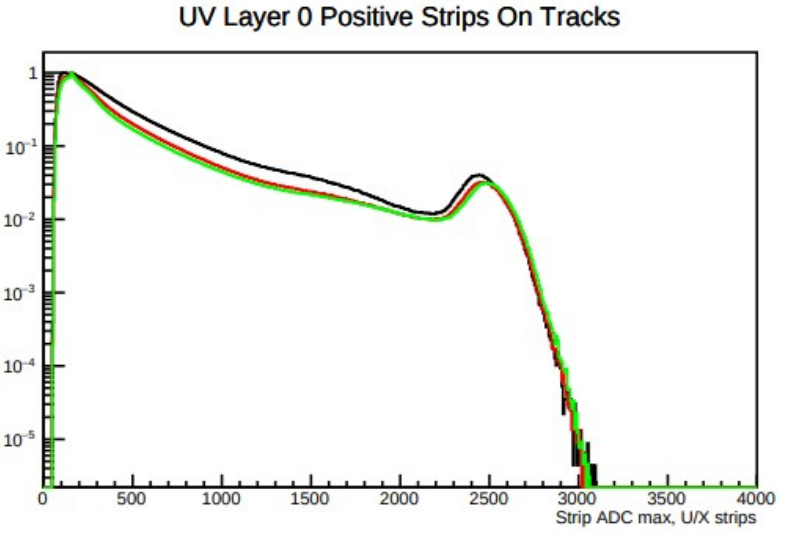
ADC Comparisons

- 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.



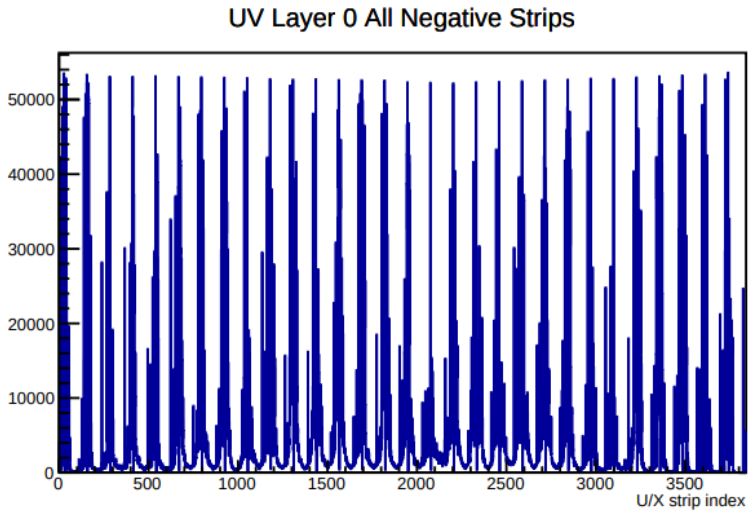


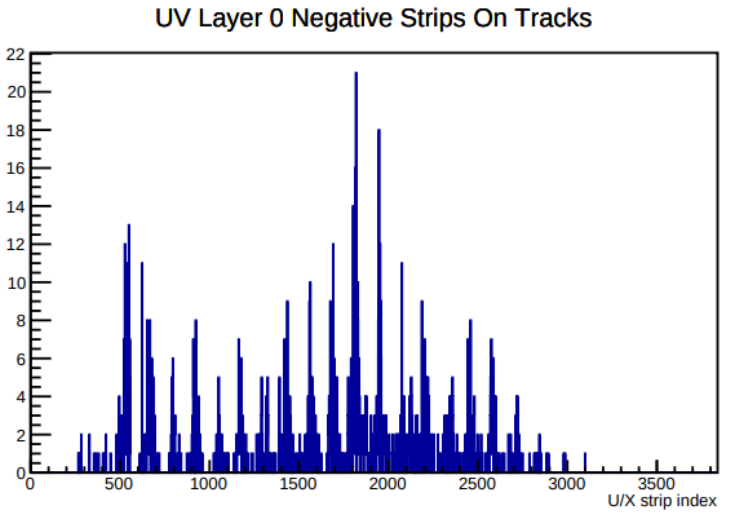


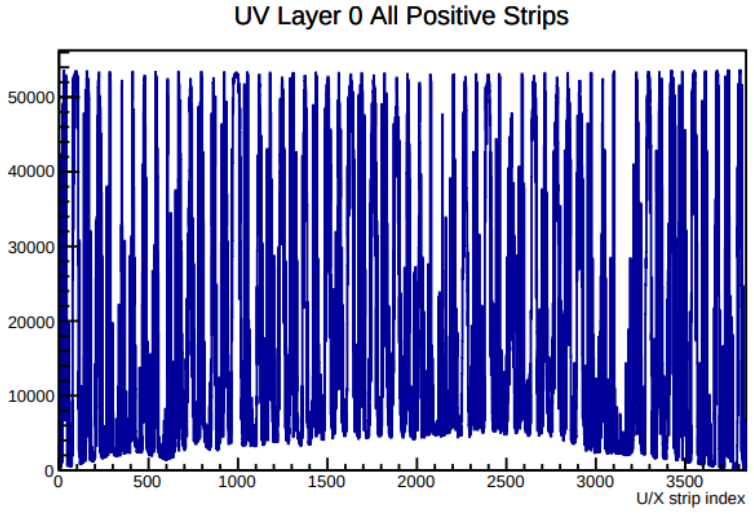


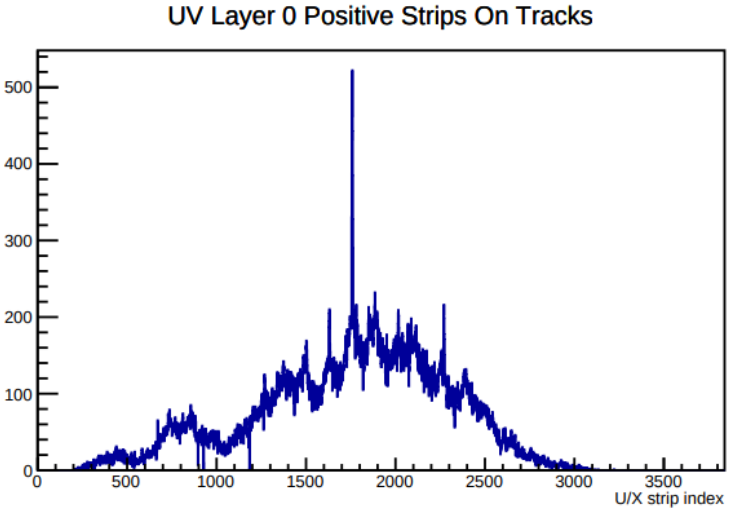
Strip Distributions

- 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.





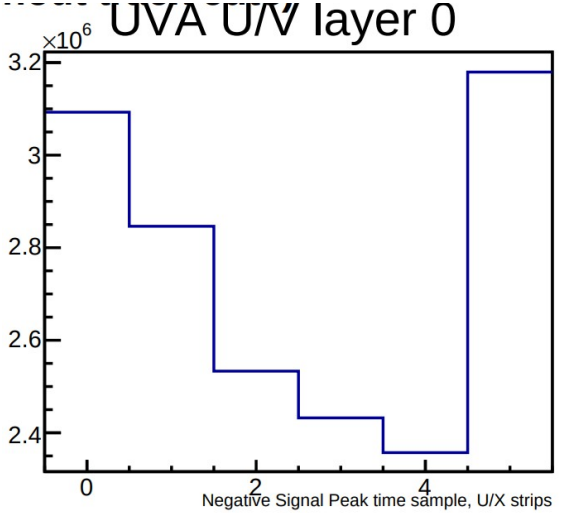


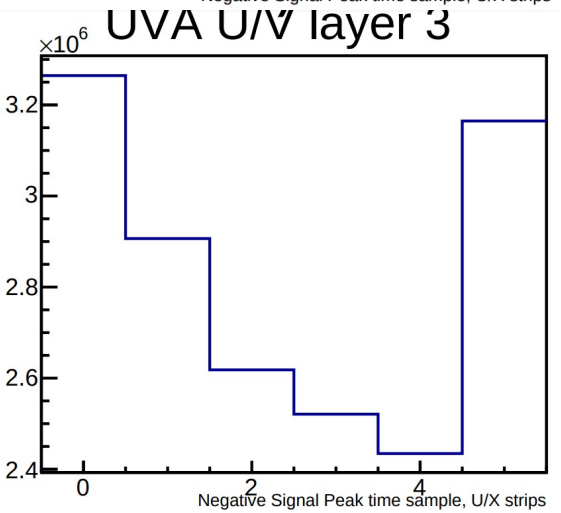


Negative Strip Timing

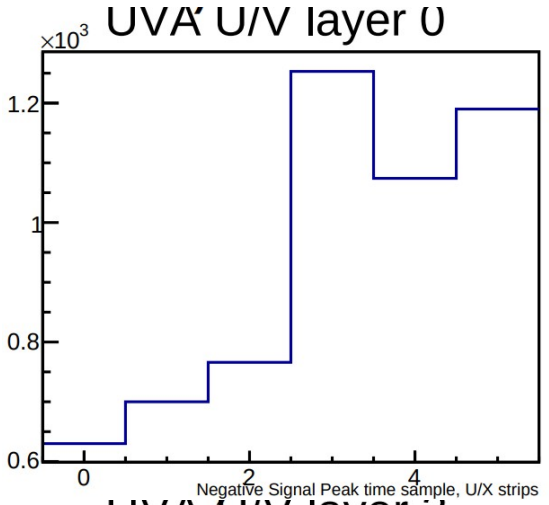
- Some negative strips “on tracks” do peak similarly to positive clusters but not similar for all layers.
  - Maybe this is because they are next to positive strips?

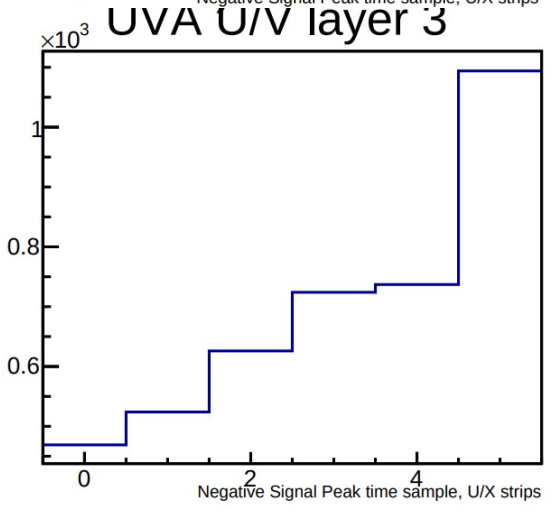
Before Track Cuts





After Track Cuts





Conclusions

- See all plots and event displays here, https://logbooks.jlab.org/entry/3989020
- ~15% of missed hits have a negative clusters on track (for front layers)
  - ~80% of these events are negative clusters directly next to positive clusters
- ~3% efficiency loss can possibly be attributed to negative signals.
  - Still refining this official number