Ideas for real data TP quality checks

Klaudia Wawrowska
K.Wawrowska@sussex.ac.uk

University of Sussex | Rutherford Appleton Laboratory

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Overview

- **Performance metrics relevant to real data**
  - Global waveform properties
    - A way to validate individual HF algorithm steps.
  - Threshold scans as a measure of HF efficiency
  - Validating computed TP properties & angular HF performance

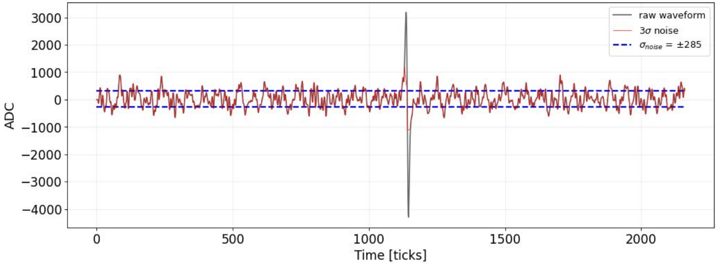
Validating the individual components of TP algs.

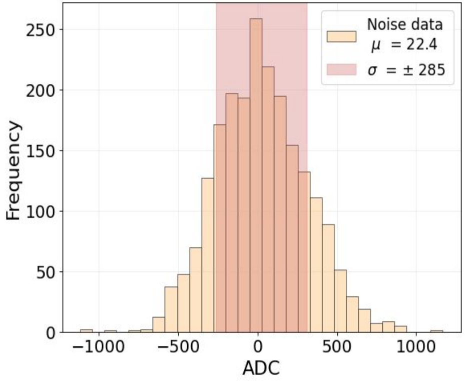
Plotting ADCs as a 1D histogram plot gives ~Gaussian distribution:

μ = waveform baseline, σ = waveform noise

- Plot such Gaussian for channels at each HF step to validate performance.
    - After pedestal subtraction the mean of the resulting Gaussian should be 0.
        - In high noise scenario pedestal may lag, throwing off the rest of the hit finding
    - After filtering, the value of sigma should be lower (exactly how noise transforms depends on filter nature).
        - How good is the mean IQR estimation for the waveform?
        - How suitable were the chosen thresholds, based on noise levels?

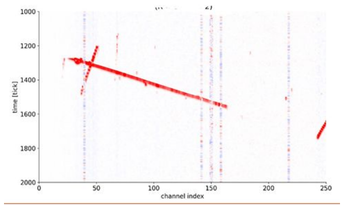
These are very basic quality checks, but make for an intuitive & easy way to monitor waveform properties without inspecting each individually.

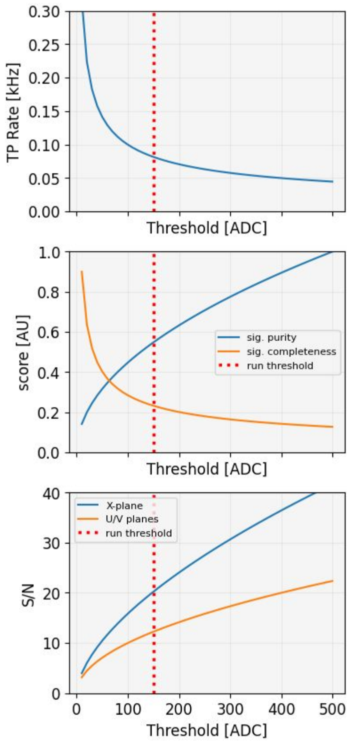




Threshold scans

- *Use emulator to estimate TP rates as a function of threshold (simple or IQR)*
- *Compare against habitual thresholds used during runs*
  - Compute the purity, completeness, and S/N for the found hits as a function of threshold.
    - These parameters could inform us about the noise levels (fake TP rate), signal sensitivity, and how resilient the HF is to the run configuration (e.g. does completeness fall rapidly with small changes in threshold? This would point at S/N which is too low (bad filter or faint signal) and we could risk losing sensitivity if thresholds aren't chosen carefully.)
  - How could we tell what's a true hit?
    - For clean, cosmic tracks, can use simple clustering packages in python (like DBSCAN) to loosely tag true cosmic hits to estimate the purity and completeness.
    - For HMA trigger, can use detector geometry and track length to predict how many hits should've been seen.
    - Missing signal might be especially a problem for showering particles, but not sure how true hits would be easily defined in this case (maybe basic cone reconstruction?).





Example plots with dummy data

Track orientation & response anisotropy

Pulse shapes change with track orientation due to spatial interferences between ionization charges.

→Leads to anisotropies detector response & charge sensitivity

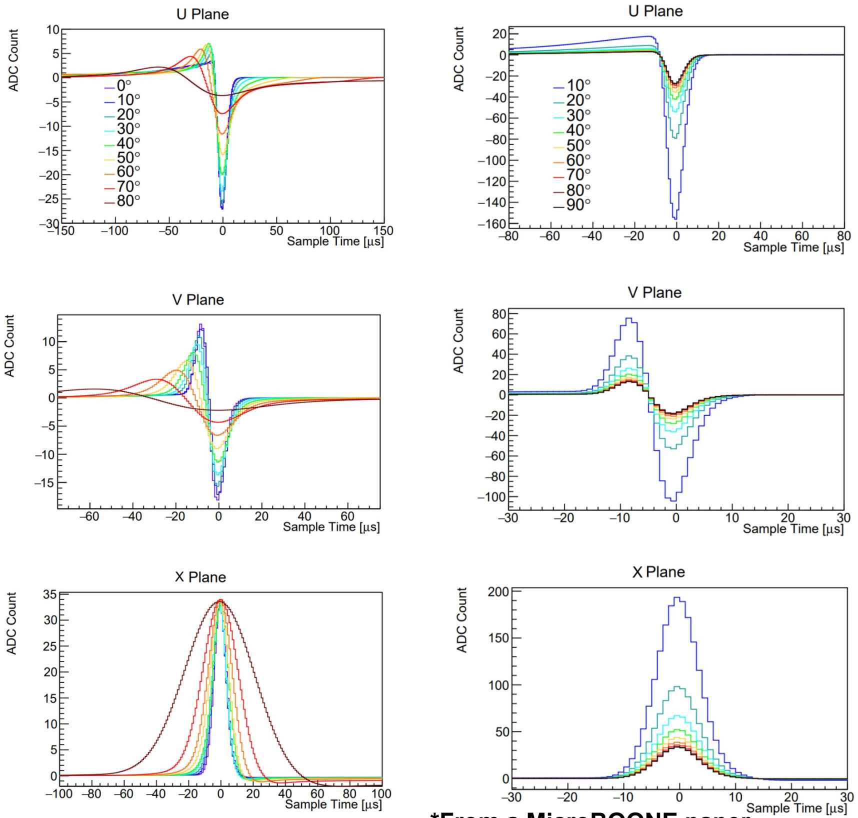
Cosmics form clean tracks with well-defined orientation. Could give us some potentially useful plots:

- **S/N vs track orientation**: good for identifying if we're losing sensitivity & how angle-dependent response is

- **Number of hits found for a given track length & orientation**: since there's good correlation between energy & range for muons, this could again tell us if we're missing hits.

- **Global hit parameters vs track orientation:** Are the calculated hit parameters what we expect for a given pulse shape? Might be useful to compare against spectra from simulated data (comprising Gaussian-fitted LarSoft hits for muons).

  → Such plots might be beneficial for people planning to use TP Stream for exotic physics searches, or for future, more sophisticated trigger which could potentially exploit directional information.



*From a MicroBOONE paper.