

Drift Correction Updates

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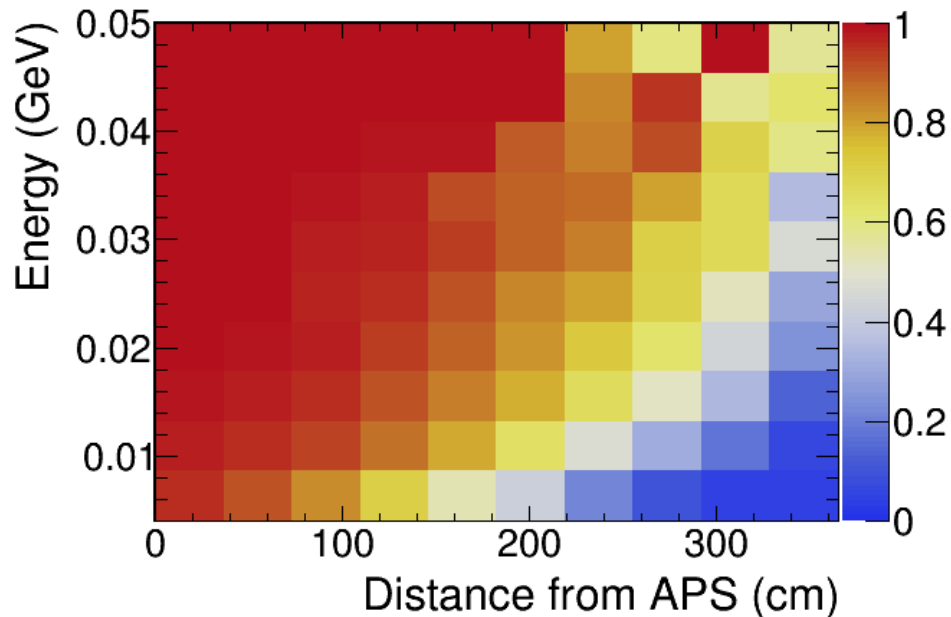
August 8, 2019

SNB Working Group Meeting

Introduction

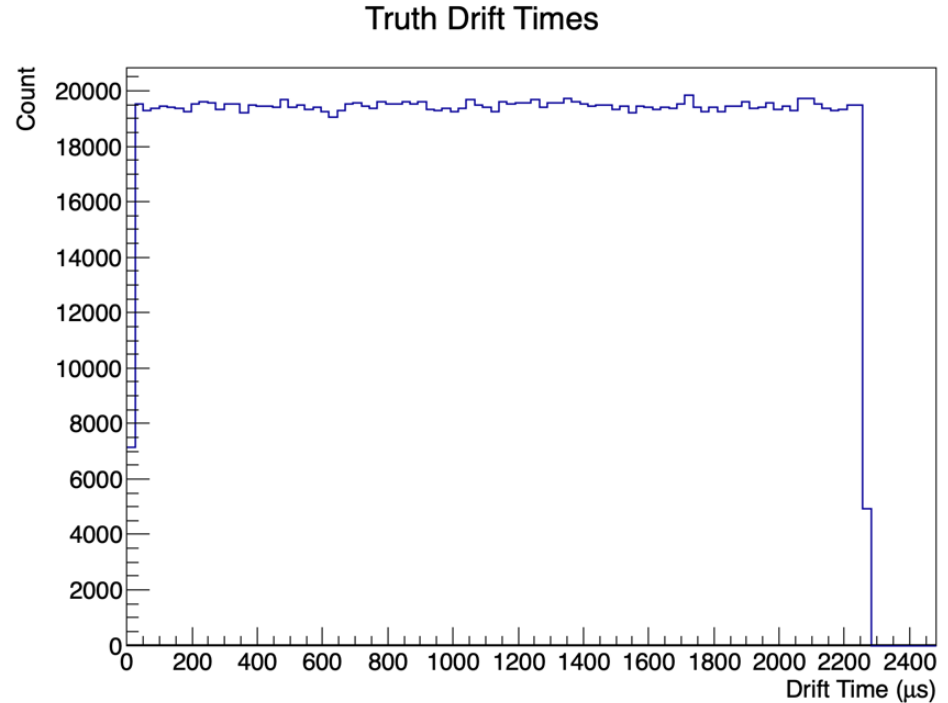
- During Hack Days 2018, produced smearing matrices using efficiency matrices corresponding to different PD performances
 - Probability of successful flash matching as a function of energy and distance from APS
 - Toy drift correction scheme
- See [this talk](#) from September 2018 Collaboration Meeting for more information

2018 efficiency matrix for ARAPUCA design



Toy drift correction

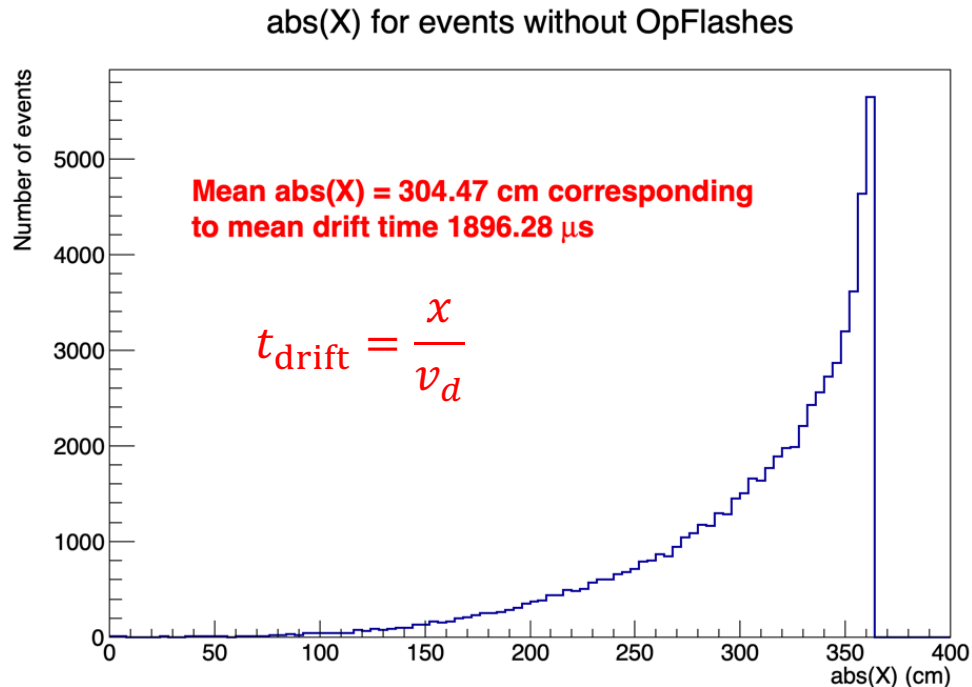
- Study different PD performances:
 - For given MARLEY neutrino energy and distance from APA, find probability in efficiency matrix (different PD performances)
 - Throw a random number $[0.0, 1.0]$; if less than efficiency, drift correct with MC truth T0. If greater than efficiency, correct with a random T0



Distribution used for random correction

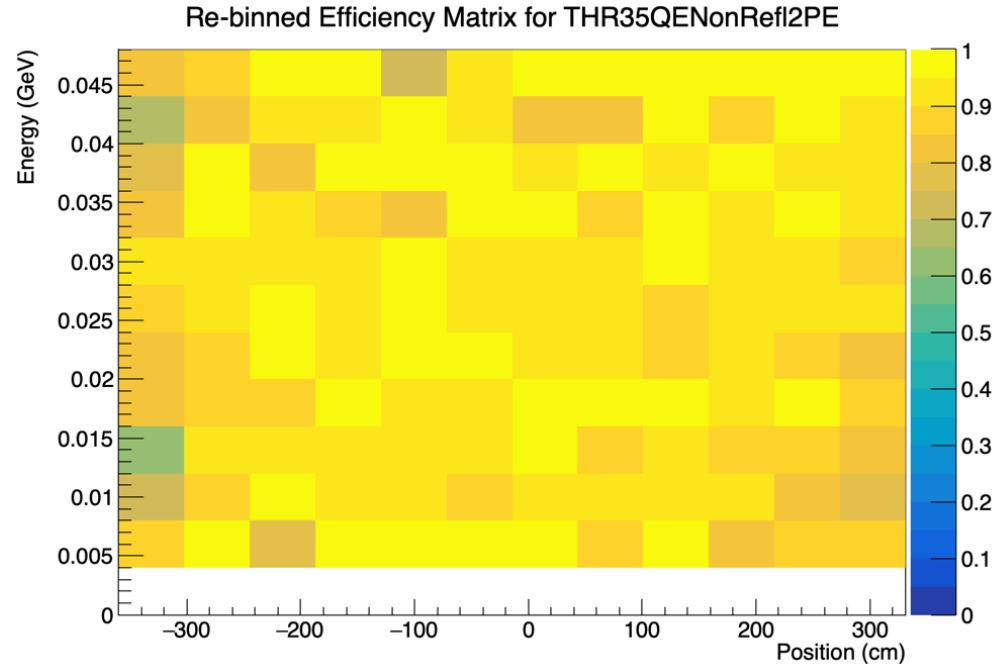
Update to toy drift corr. method

- Update: If random number [0.0, 1.0] greater than efficiency, drift correct with specific MC truth T0
 - Corresponding to mean of abs(X) from the distribution of positions of events without matching flashes
 - Essentially making the assumption that we can identify bad flash matches



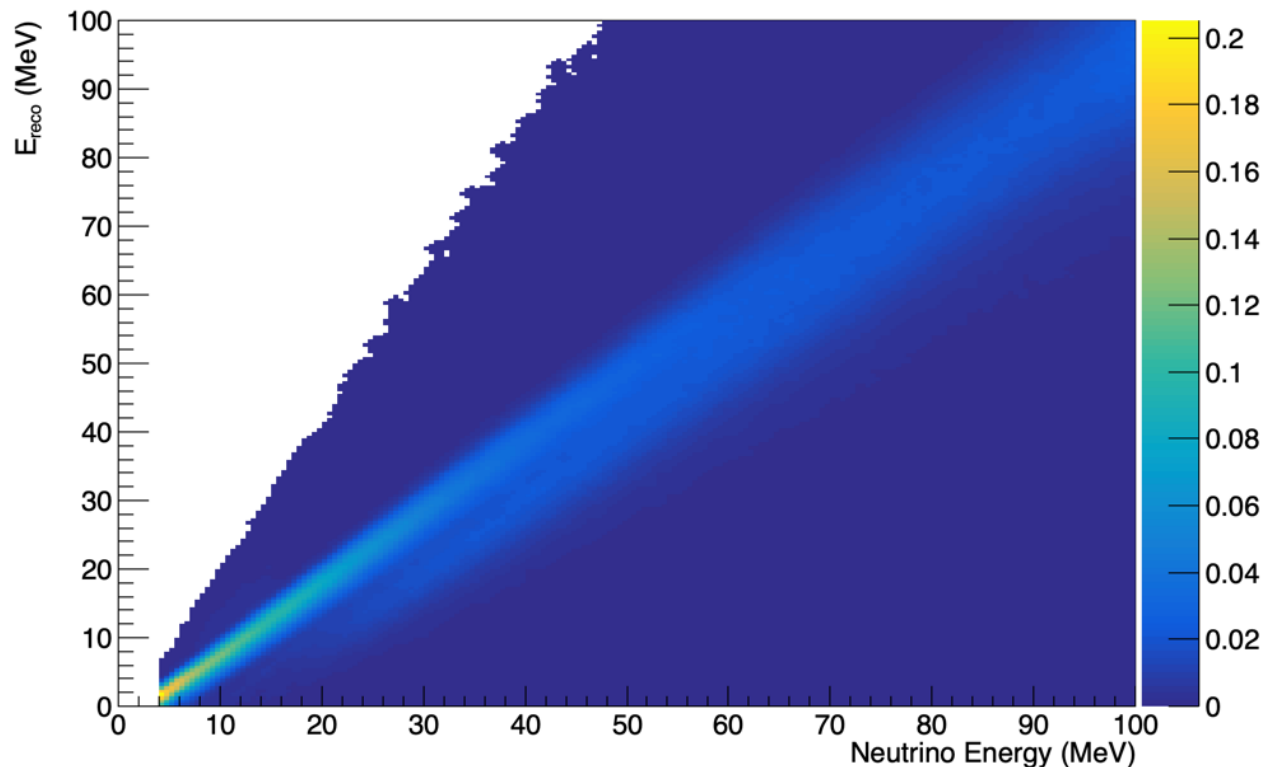
Efficiency Matrix

- From A. Himmel, B. Behera:
 - 35 QE = 3.5% efficiency
 - 45 cm² effective area
 - 2 PE threshold
- Re-binned due to limited statistics
- Why so uniform? Detector efficiency maxes out at certain threshold; light yield is non-uniform



Smearing matrix with updated drift corr.

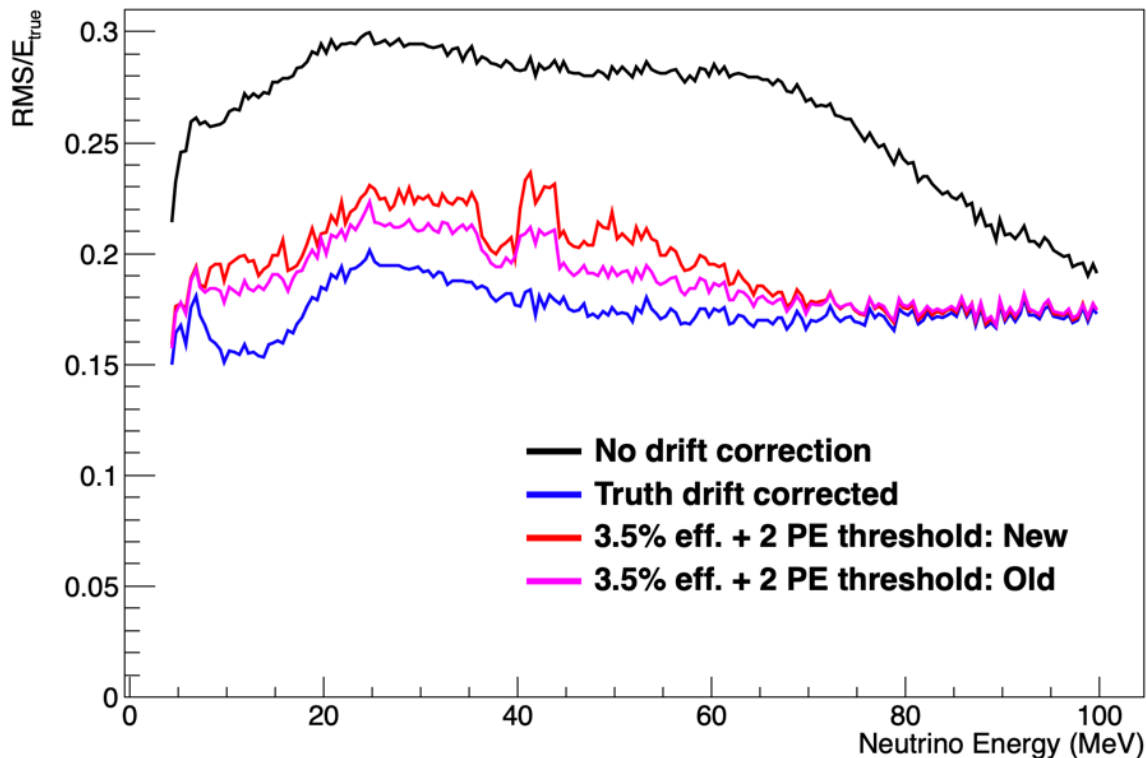
Smearing matrix for 3.5% eff. + 2PE thresh.



Columns were
normalized to
1.0; smoothing
applied

Studying Resolution vs Energy

σ vs Neutrino Energy



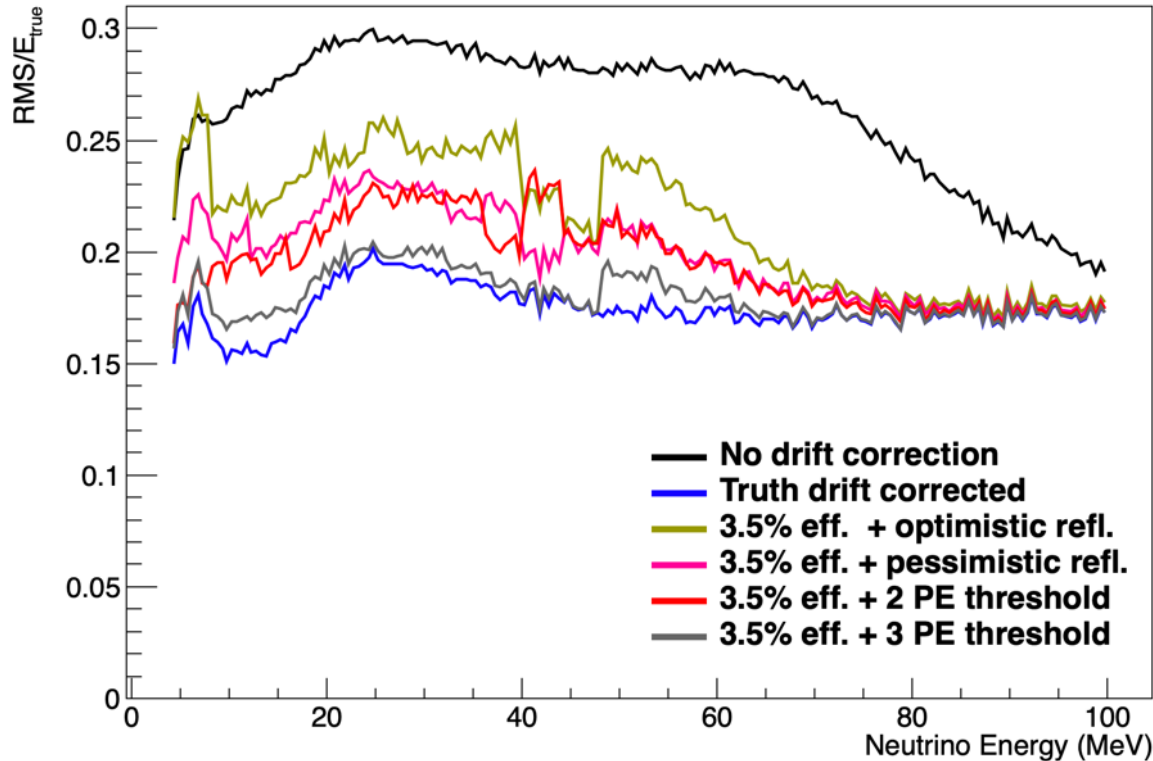
Using fractional energy values, calculate standard deviation:

$$\sigma_{\text{frac}} = \sqrt{\frac{\sum_{i=1}^N (E_{\text{frac},i} - \bar{E}_{\text{frac}})^2}{N - 1}}$$

“Old” refers to previous method of toy drift correction while “new” is the updated method

Comparing to other PD systems

σ vs Neutrino Energy for new DC method

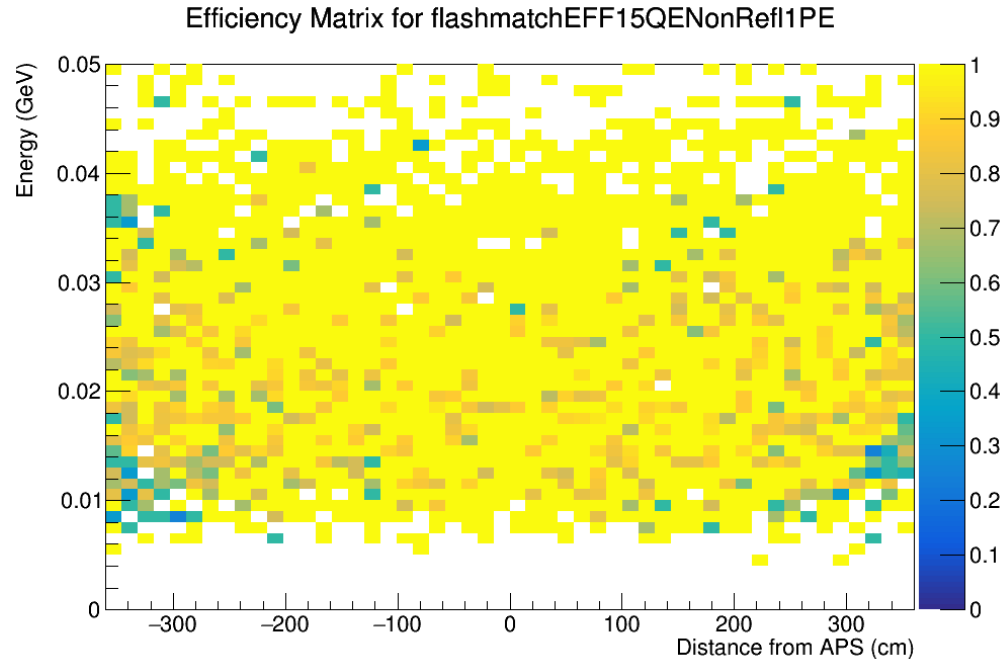


We can approach truth drift correction – current baseline can achieve excellent performance

Backup Slides

Efficiency Matrices

- Efficiency matrix:
Probability of successful flash matching given true neutrino energy, distance from APA
- Less statistics compared to previous efficiency matrices; re-binned to reduce number of “holes”
 - Merged 4 bins into 1 for both axes

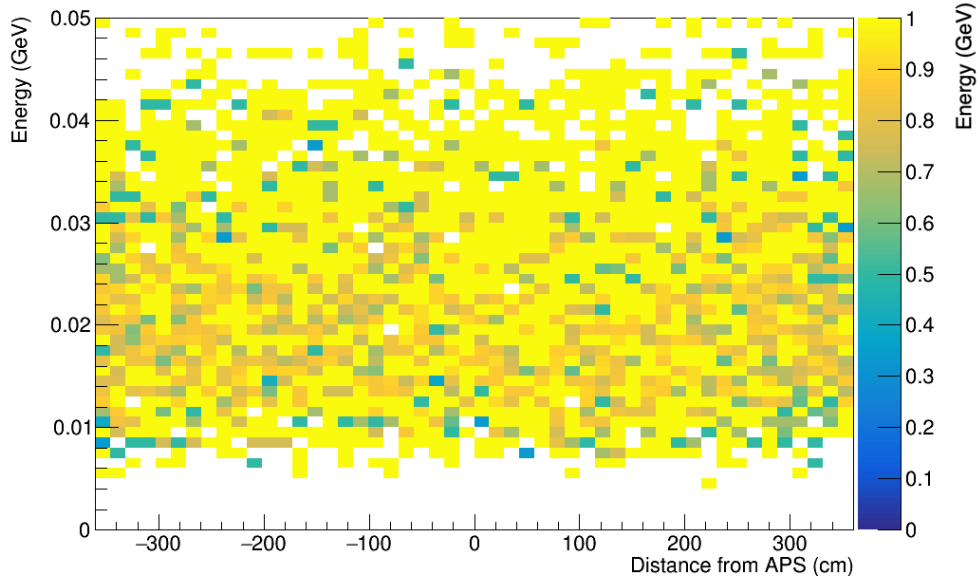


15 cm² effective area (before re-binning)

Efficiency Matrix: 3.5% efficiency

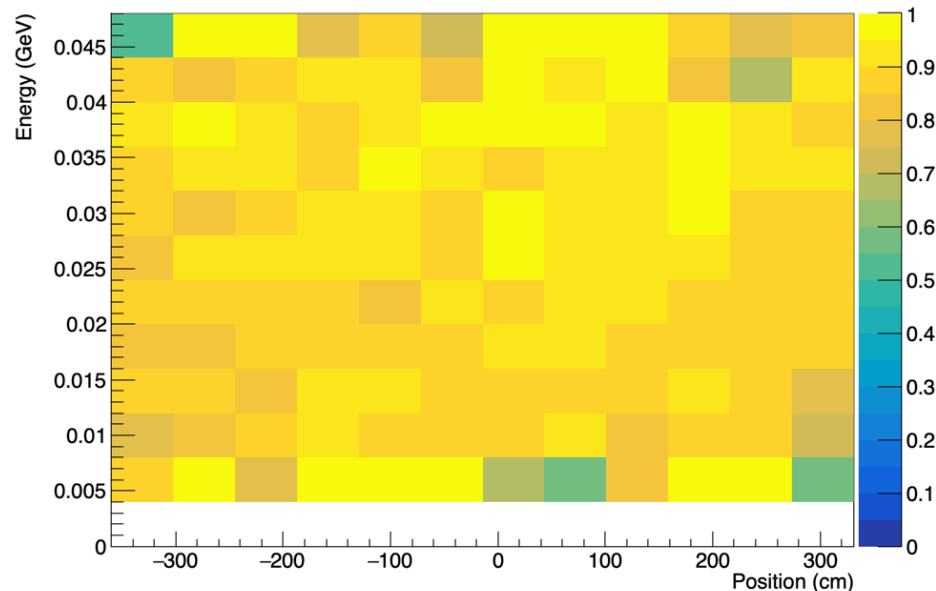
Before re-binning

Efficiency Matrix for flashmatchDEF35QENonRef1PE



After re-binning

Re-binned Efficiency Matrix for DEF35QENonRef1PE



Fractional Energy from Truth

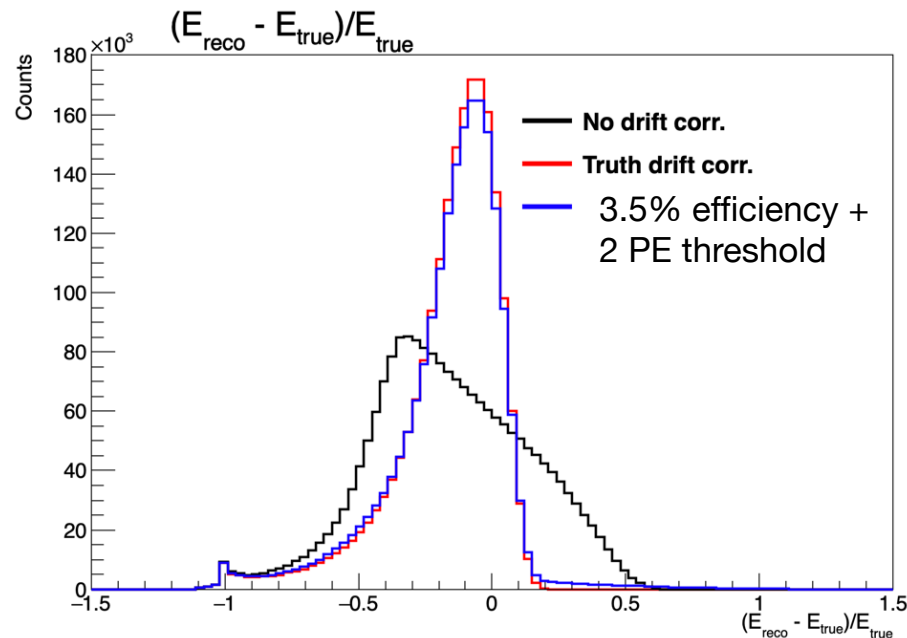
- Another way to see effects of toy drift correction is to look at fractional energy from truth:

$$(E_{\text{reco}} - E_{\text{true}})/E_{\text{true}}$$

- Truth drift correction:

$Q = Q_0 \exp\left(\frac{x}{v_d \tau_e}\right)$, where x is the MC truth distance from electron vertex to APA (cm)

- Right: fractional energy distributions for all MARLEY MCC11 clean events



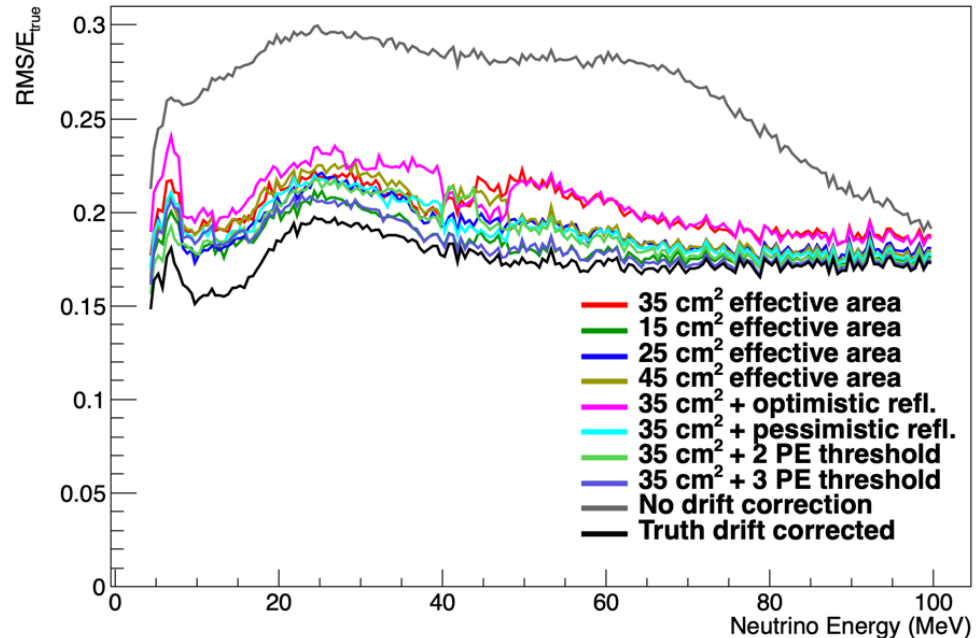
Resolution Plots: Old DC Method

- Using fractional energy values, calculate standard deviation:

$$\sigma_{\text{frac}} = \sqrt{\frac{\sum_{i=1}^N (E_{\text{frac},i} - \bar{E}_{\text{frac}})^2}{N - 1}}$$

- Comparable to truth drift correction!
- Configuration with “optimistic reflection” performs the worst...
- Legend is incorrect...“effective areas” are actually “0.1*(collection efficiencies)”

σ vs Neutrino Energy: Charge Reco Energy



Comparing to other PD systems

σ vs Neutrino Energy for new DC method

