Wirecell Group Update

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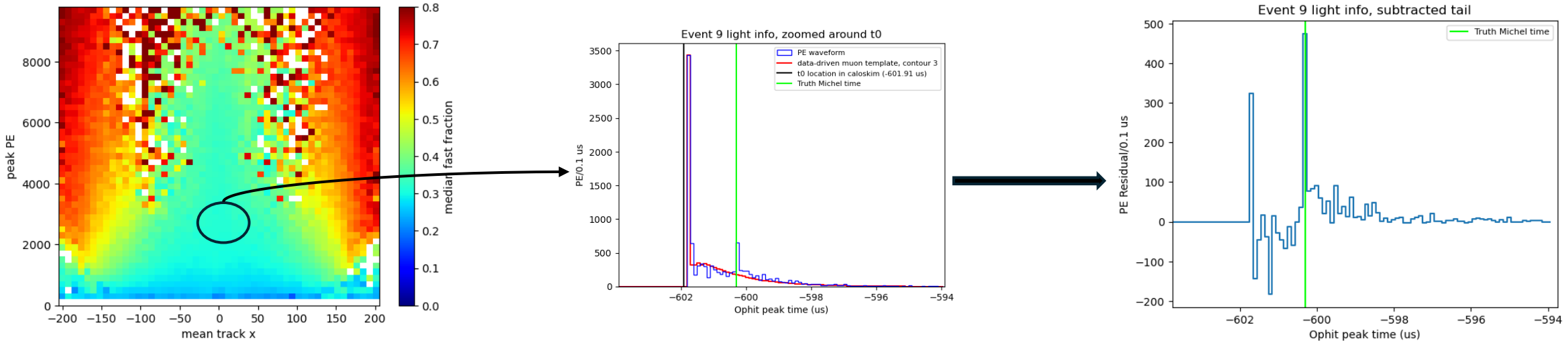
Refresher

- I’ve implemented a lookup table to use for a given input candidate pulse
  - Since the behavior of the muon pulse seems to change wrt peak PE and track mean x position, a lookup table gives a more “refined” template to subtract
  - The next step is to determine how well we can extract a Michel pulse *after* subtraction

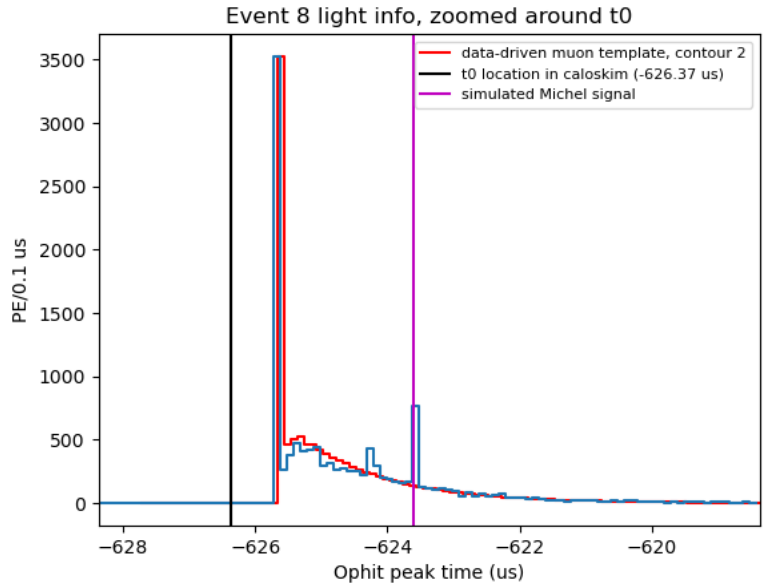


Toy model (from Calibration WG meeting slides)

- I'm using the same sample of stopped muon pulses from template building
- Question: What is the impact of different variables (energy deposited/Michel PE, track x-position, Michel pulse start time, etc.) in this uncertainty estimation?
- With true energies and light yield used, any deviations from truth is expected only from residual PEs in template extraction

$$LY_{measured} = \frac{PE_{measured}}{E_{measured}} = \frac{PE_{truth}}{E_{truth}} + \frac{\delta PE}{E_{truth}}$$

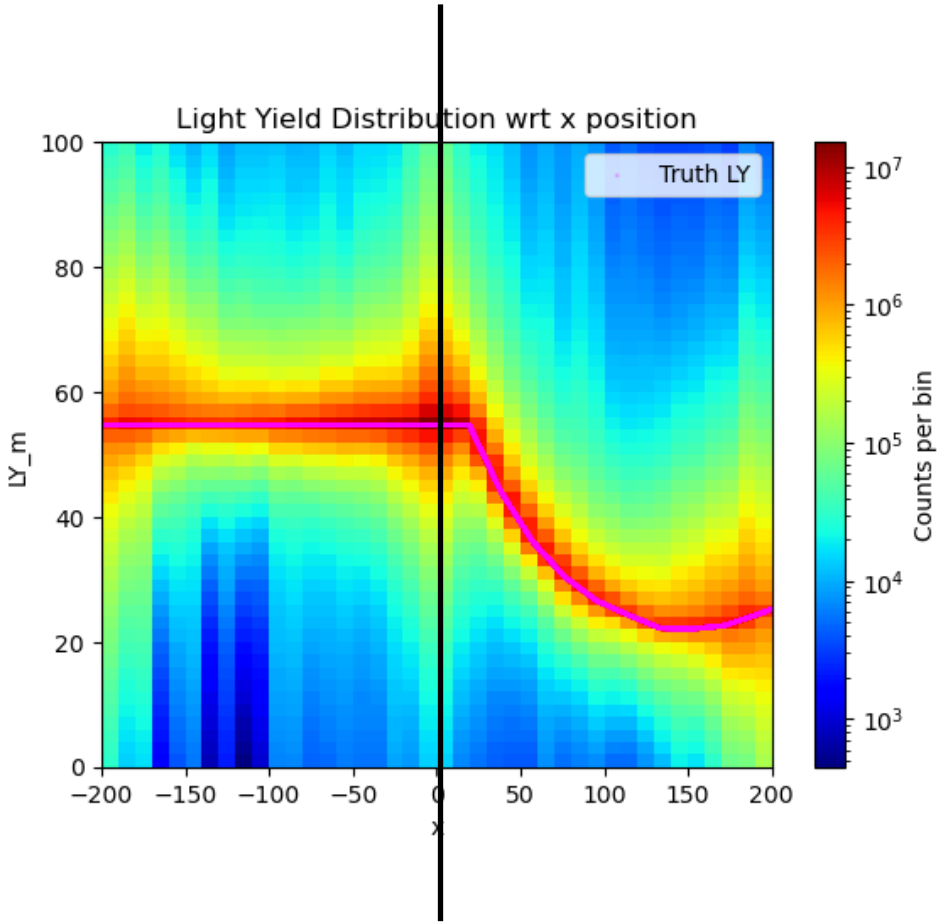
$$\rightarrow PE_{measured} = (LY_{truth} * E_{truth}) + \delta PE$$



X-regions

Since truth light yield is dependent on mean track x-position, and is mostly symmetric about x, I made two regimes for comparison

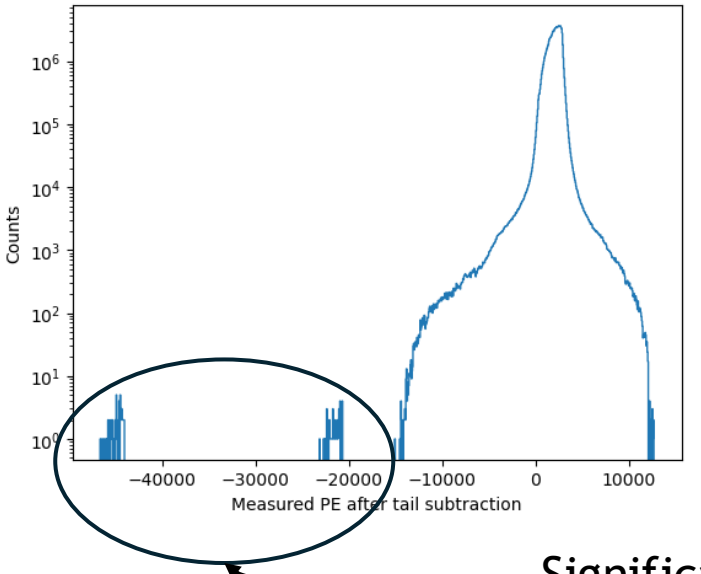
- For “fixed” truth light yield (x < 0), can examine how this reconstruction performs for different E, regions, and Michel pulse start times
- For “variable” light yield (x > 0), can study if reconstruction smearing depends on light yield itself (in progress)



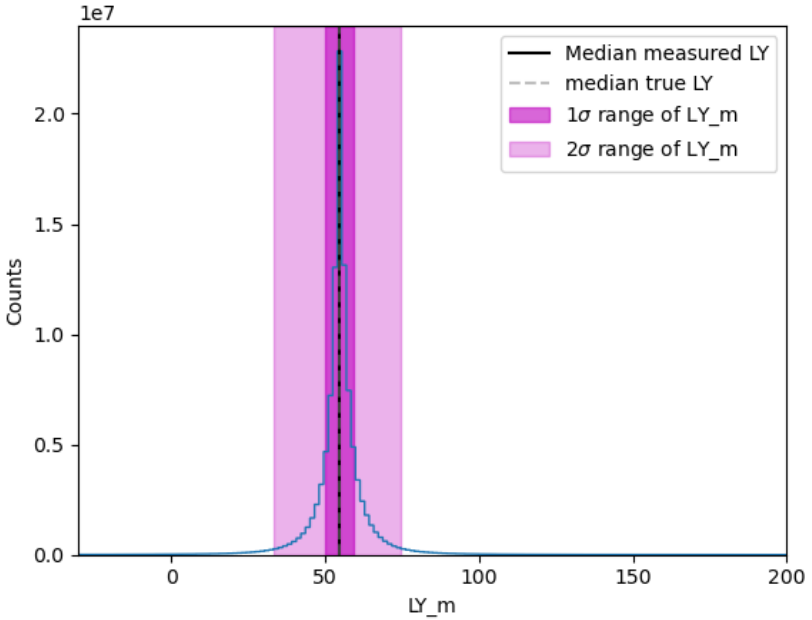
Toy Model Results (fixed LY regime)

- Simulated 10k “Michels” for every stopped muon used (20994 muons)

  → ~108 M events in fixed LY regime



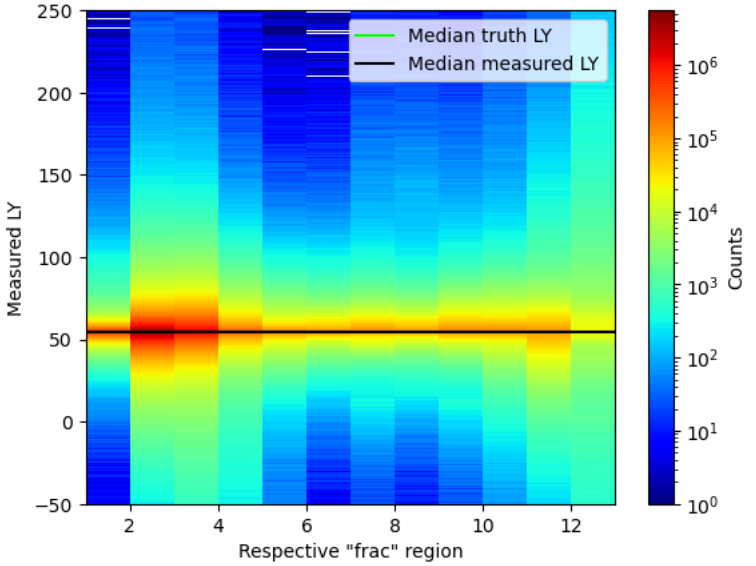
Significant underestimation, but # of occurrences is small

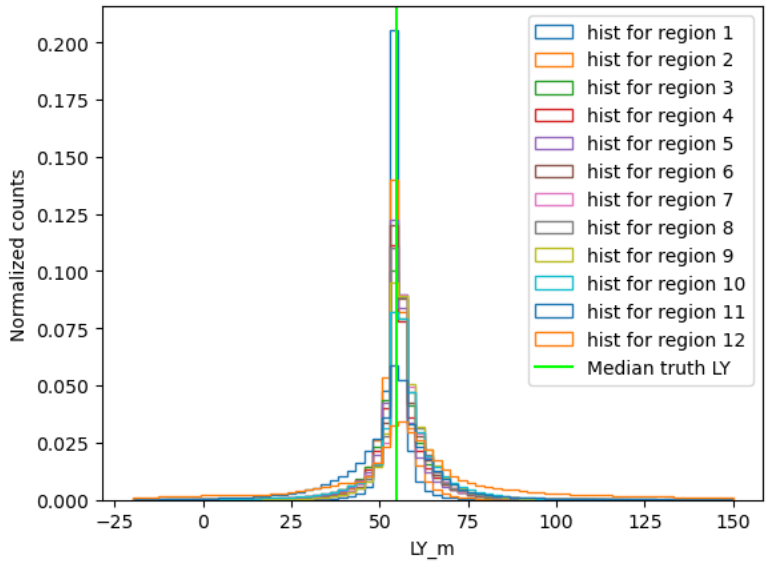


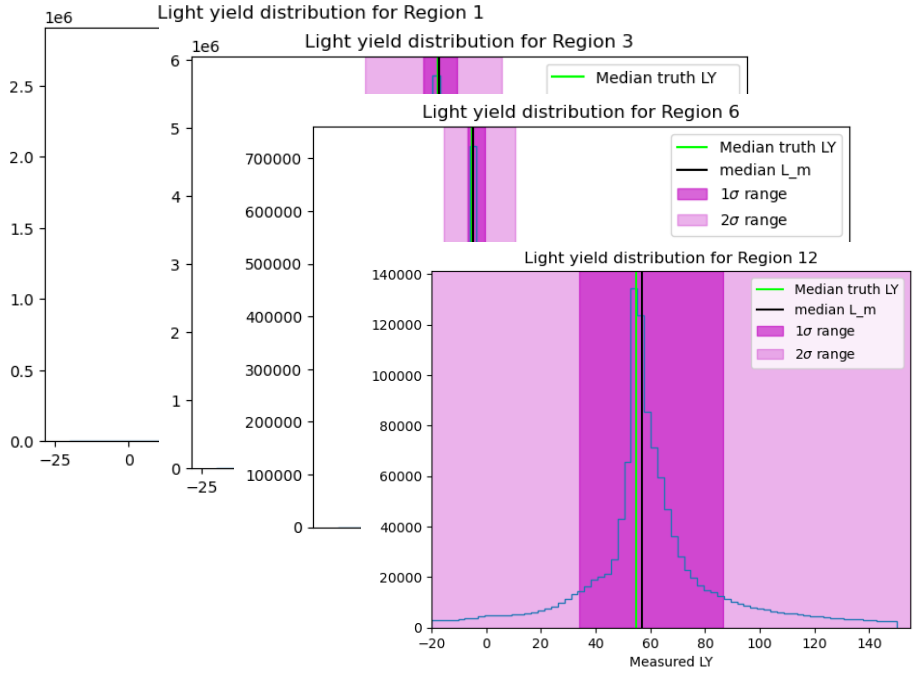
Good agreement between true and median measured LY, $54.79^{+4.75}_{-4.50}\frac{PE}{MeV}$ up to 2σ

Toy Model Results (fixed LY regime, contd.)

- For each respective fraction region, all seem to align with truth well, however smearing effects are prevalent in some regions more than others

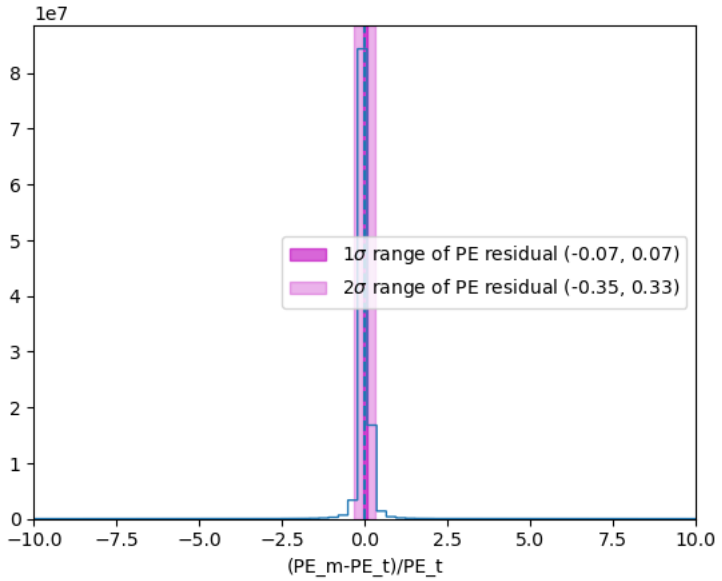


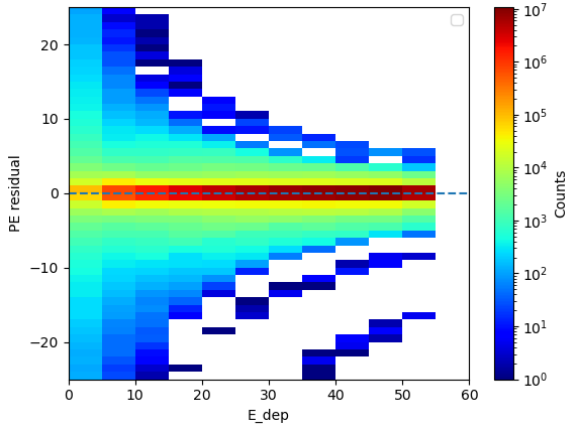


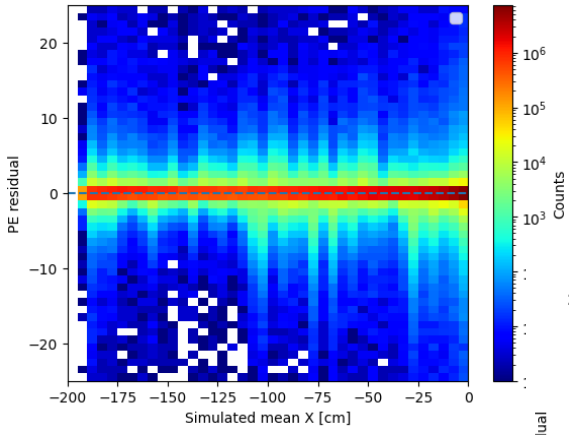


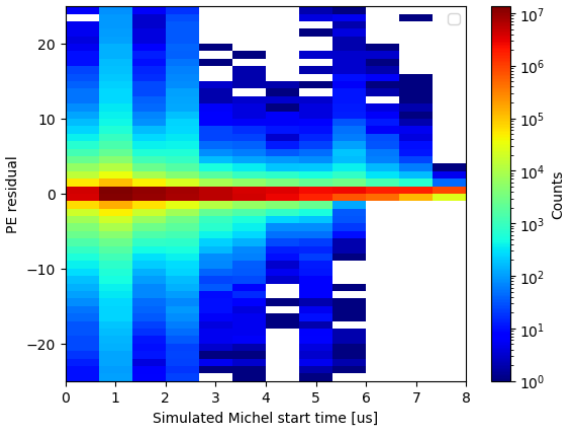
Toy Model Results (fixed LY regime, contd.)

PE residual looks reasonable! (still need to quantify how much “spread” each variable contributes to PE reconstruction)





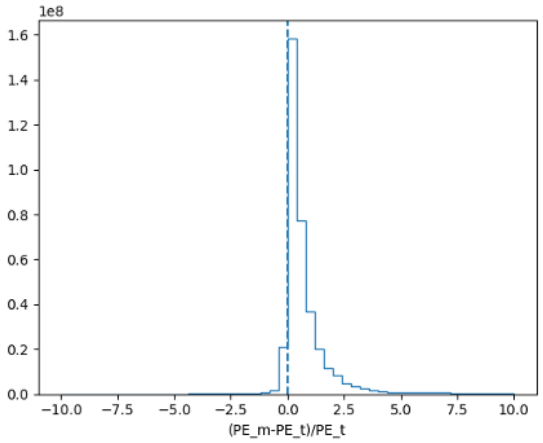




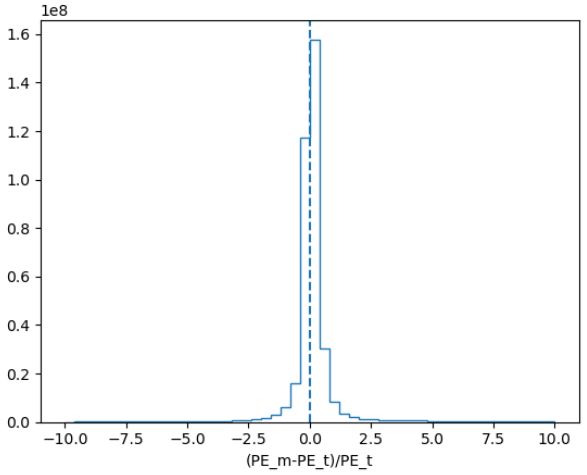
Further Sanity Checks

- Can perform 3 additional tests to isolate variables (fixed integration time, fixed input/truth deposited energy, fixed time + deposited energy)
  - Some overestimation in fixed Edep regime (likely due to Michels starting near muon tail), but we deemed that this isn't significant worry (at least for now)

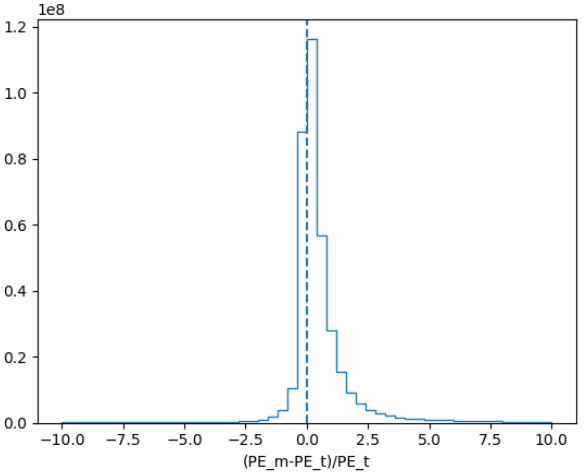
Fixed Edep only



Integration directly after muon pulse

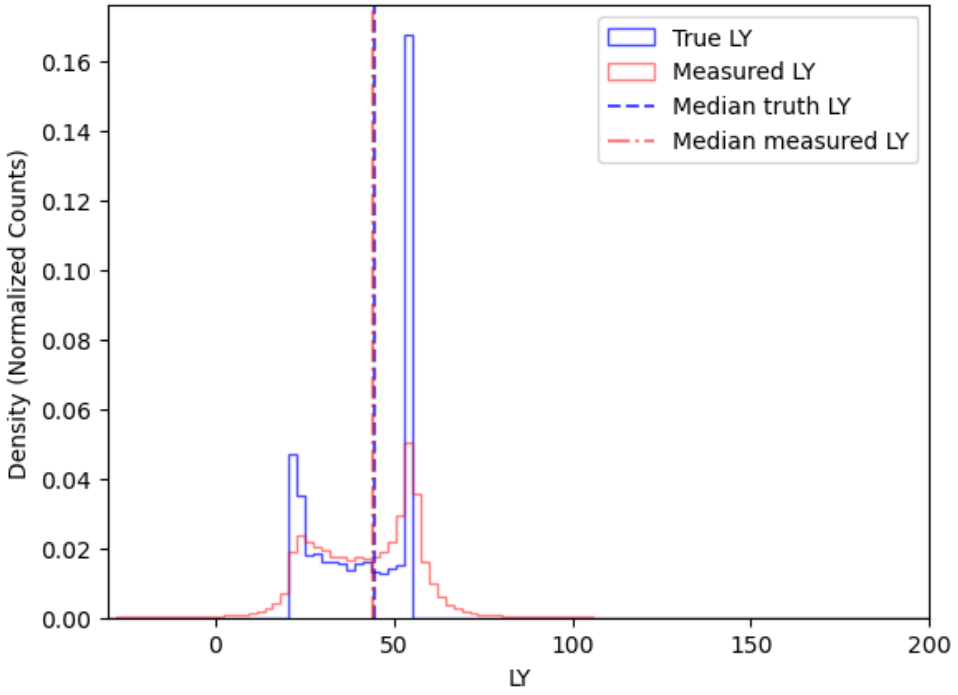


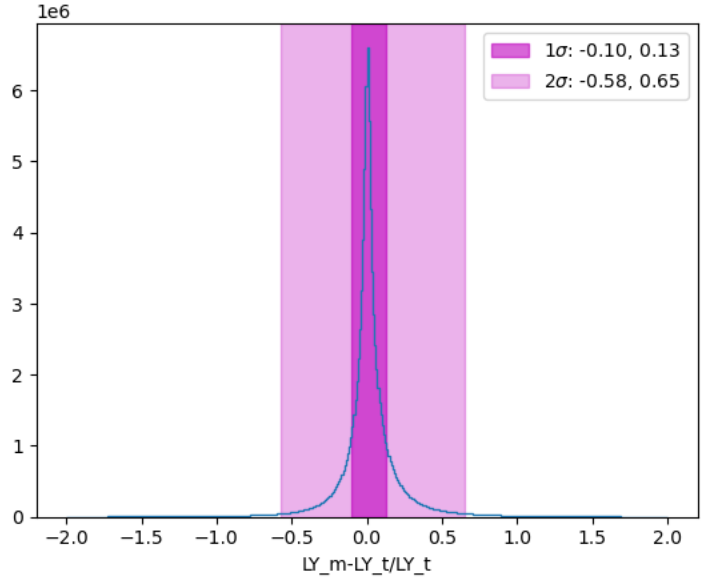
Both fixed



Toy Model Results (variable LY regime)

- Looking instead at how well the “variable” region gets reconstructed can tell us if there’s smearing/bias in light yield itself

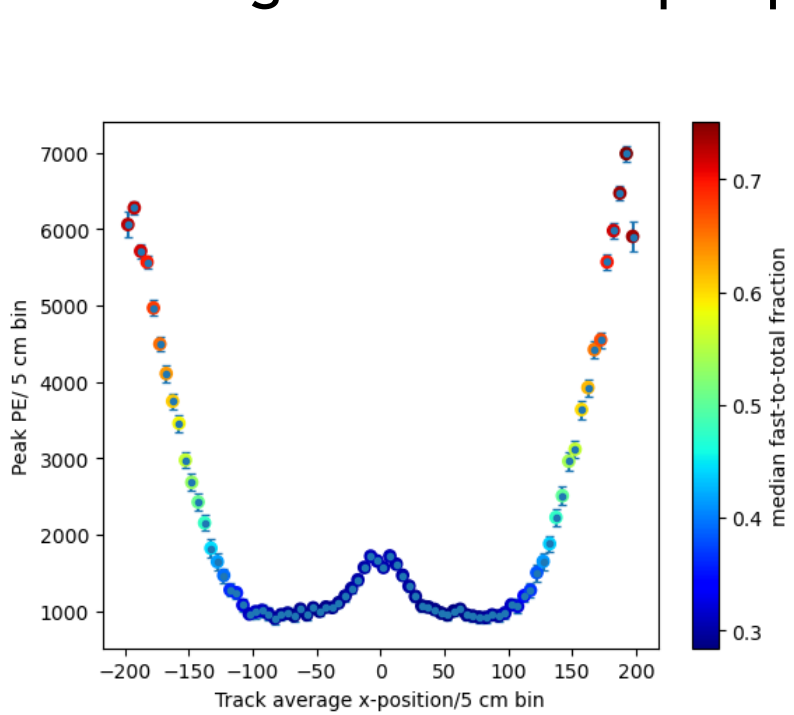


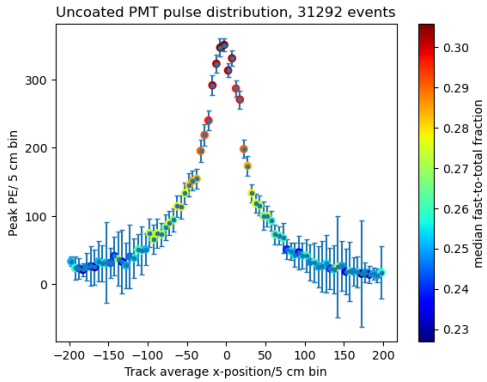


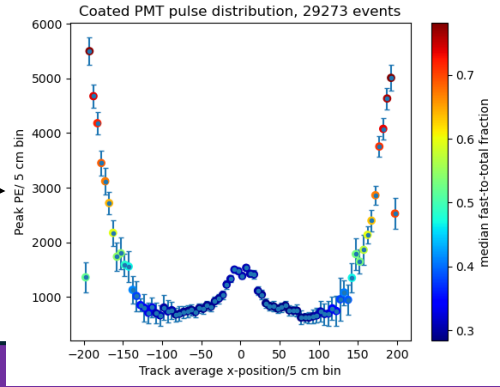
Additional notes regarding coated vs uncoated PMTs

One comment/question that got brought up was regarding how muon pulses differ between coated/uncoated PMTs

- Would be good to decouple pulses between VUV vs visible light







Extra

Distributions per region

My theory is that ”problem regions” are due to limited stats in template-building stage