

ProtoDUNE Photon Detector Reconstruction

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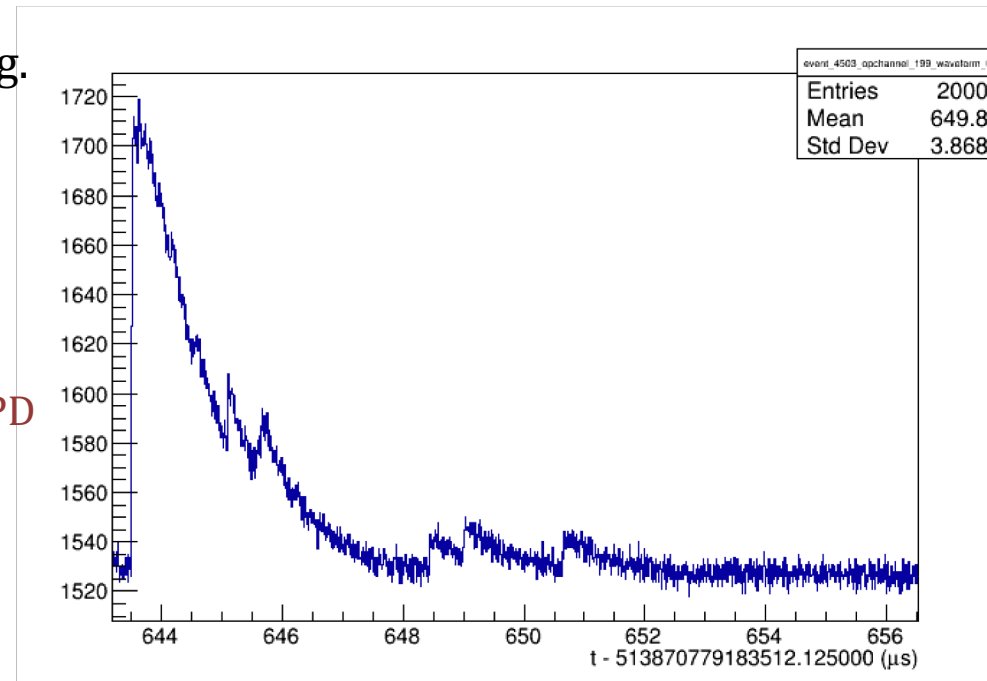
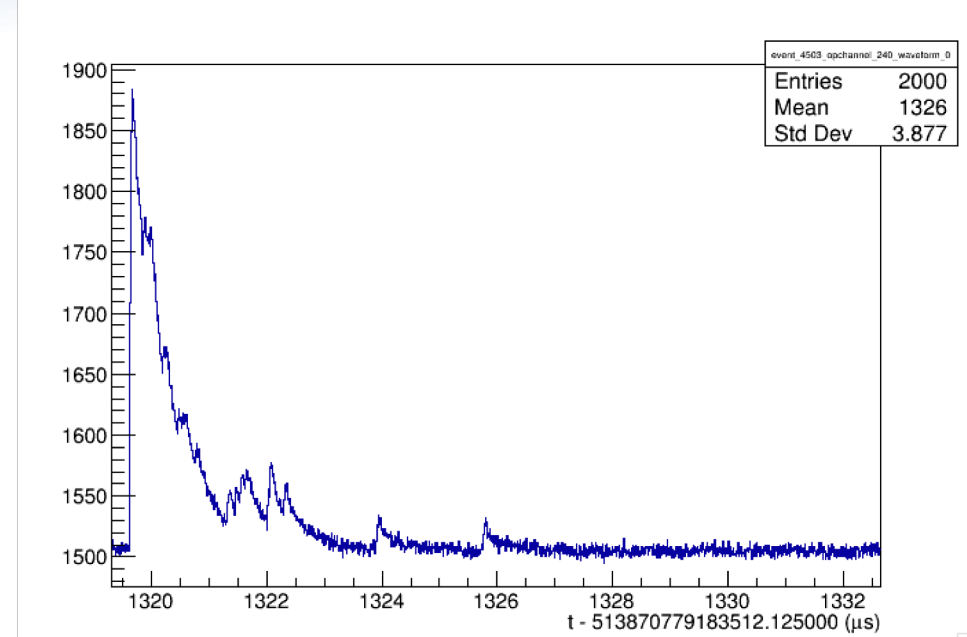
ProtoDUNE PDS Meeting
April 11th, 2019

Introduction

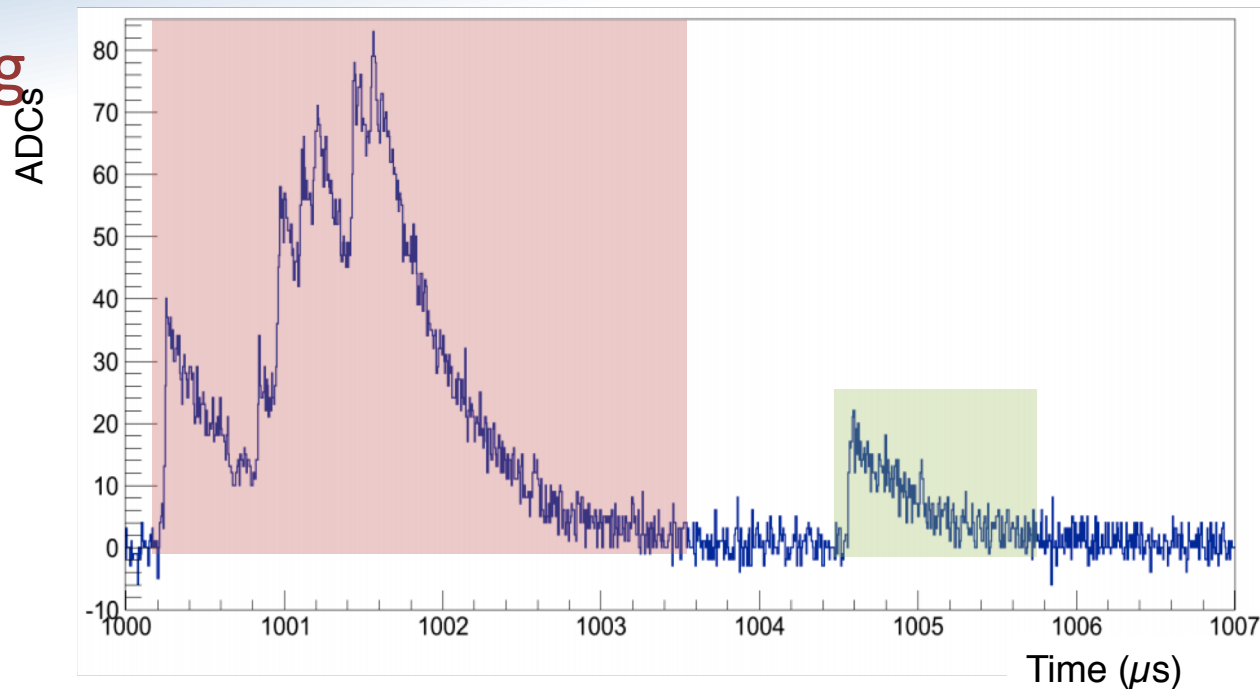
- Going to run through the various stages of the reconstruction which gets run in production.
- Also try to lay out any known issues or things to be wary of.
- The stages:
 - Raw Decoding (`daq::fragment` → `raw::OpDetWaveform`)
 - Hit Finding (`raw::OpDetWaveform` → `recob::OpHit`)
 - Flash Finding (`recob::OpHit` → `recob::OpFlash`)

Raw Decoding

- Module: ssprawdecoder
- Creates:
 - 2x vector<raw::OpDetWaveform>
 - labels Internal, External
 - 2x vector<recob::OpHit>
 - labels Internal, External
- The OpHit contains the SSP header information.
 - Meaningless for external triggers.
- “External” means an external trigger (e.g. beam or CRT)
- “Internal” means self-triggered on cosmics
- Caveats:
 - The timestamps may still be wrong because of the conversion between the PD clock (150 MHz) and the experiment clock (50 MHz)
 - If you use the “external” data products, you know it was at the trigger time whatever the timestamp says.

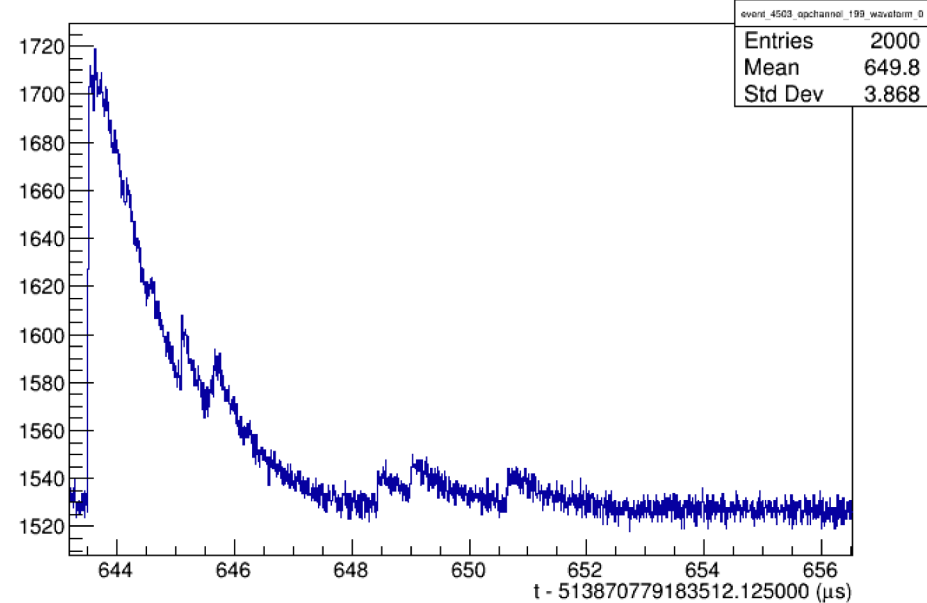
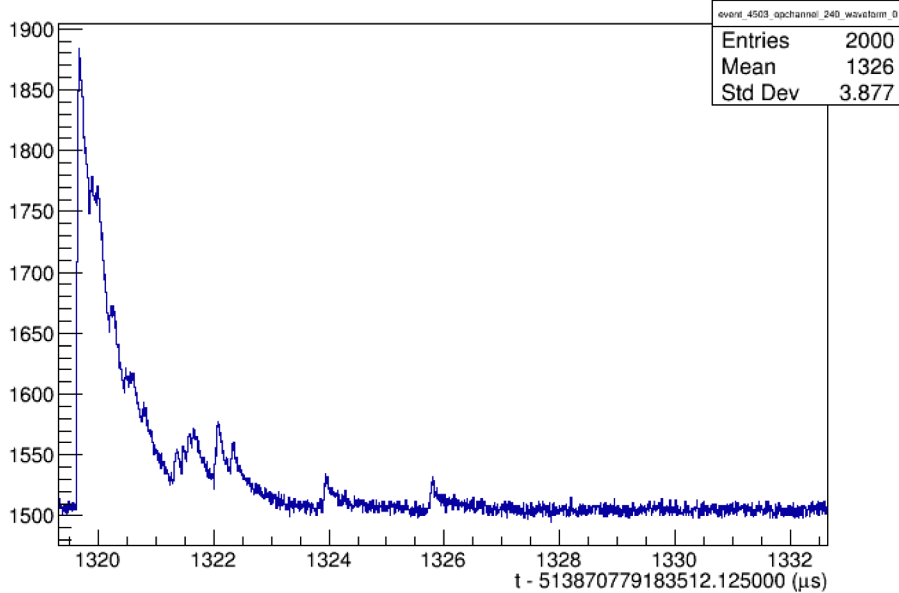


Hit Finding



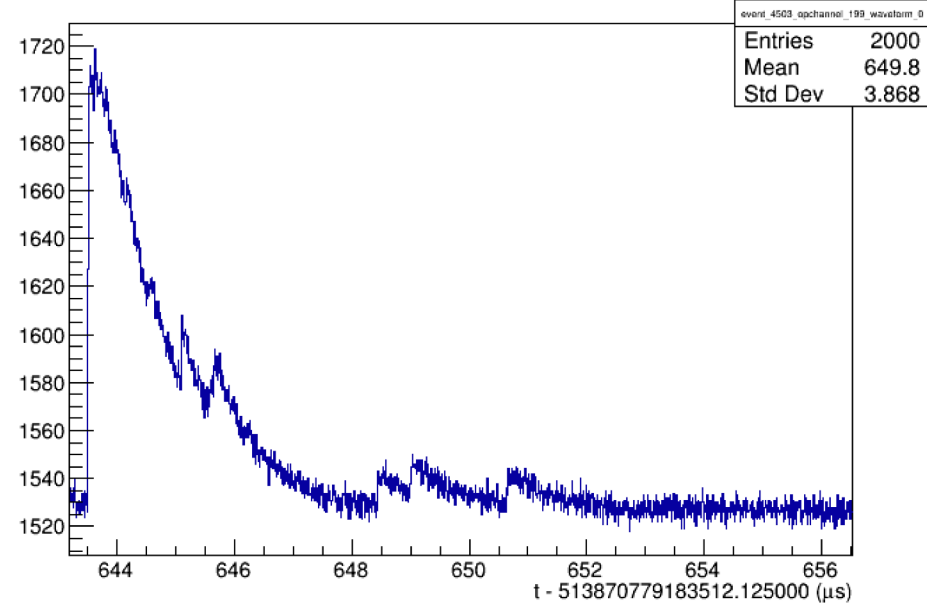
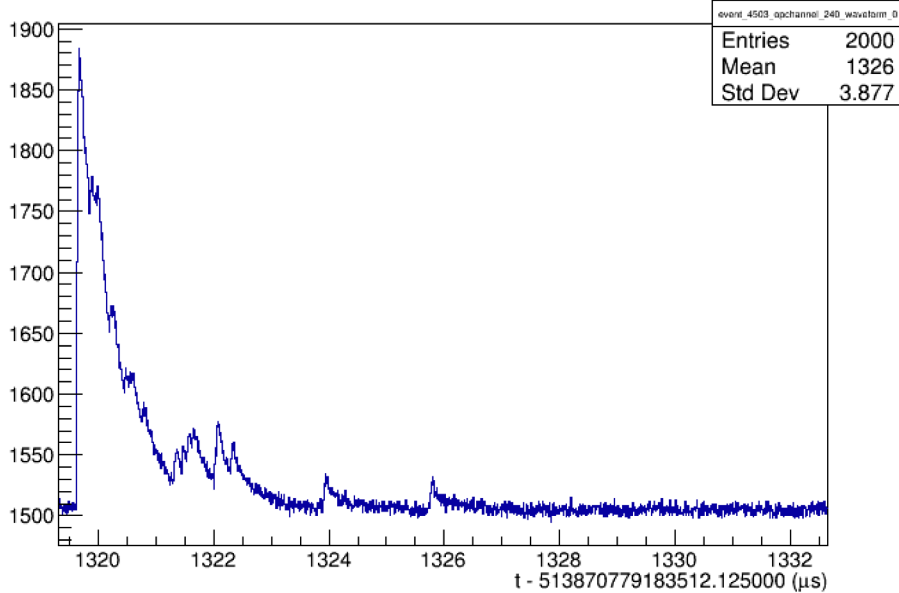
- Modules: opHitInternal & opHitExternal
- Each create: `vector<recob::OpHit>`
- How it Should Work:
 - Hit finding identifies signals on individual channels by looking for contiguous sets of samples above a threshold.
 - The time is assigned to the *first* peak, not the highest.
 - Because of the many overlapping peaks staggered in time, we use integral (rather than height) to convert back to Photoelectrons (PE).
- Gain calibrations are applied at this stage, too.
- Have discussed running with a noise filter first in the past, but this isn't in current reconstruction.

Hit Finding in Practice



- It appears the hit finding is pretty broken.
 - More broken than I realized, TBH.
- Hit finding is assuming a fixed 1500 ADC pedestal
 - A pedestal finder is run, but its results are being ignored.
 - An assumption made for the simulation which is clearly wrong.
- Creates 2 different sets of symptoms, which I'll demonstrate.

Hit Finding in Practice



- Should have:
 - 1 hit $\sim 4 \mu\text{s}$ wide with amplitude ~ 350 ADC and 2 smaller hits
- What we get:
 - We do see 1 hit $4 \mu\text{s}$ wide with amplitude 14 and 2 smaller hits
 - Also have 22 *other* hits with tiny widths and fractional PE integrals.

- Should have:
 - 1 hit $\sim 4 \mu\text{s}$ wide with amplitude ~ 350 ADC and integral $\sim 65\text{k}$ ADC
- What we get:
 - 1 hit $13 \mu\text{s}$ wide with amplitude 32 and integral $\sim 100\text{k}$ ADC
- It also looks like every hit in the event gets exactly the same time?
 - I think this is an analyzer issue.

I think fixing this is quite urgent if we want to use reconstructed quantities.

Flash Finding

- Modules: opFlashInternal, opFlashExternal
- Each create: vector<recob::OpFlash>
- Looks for coincidences of hits in time.
 - Some discussion recently about making flashes in the two drift regions separately.
 - This is a good idea, but it needs someone to work on it.
- The flash reports a total PE, position, and widths in Y, Z, T.
 - All of these elements are PE-weighted, so the channels with higher collection efficiency will have more pull in the sum.
 - Basically, flashes will all be biased to appear closer to the ARAPUCAs.
- At right: PE-weighted channels in 2 flashes from the same event.
 - Both flashes report the same time, which should be impossible, hence my guess that the times are an analyzer issue.

