ProtoDUNE-HD Time Resolution Studies

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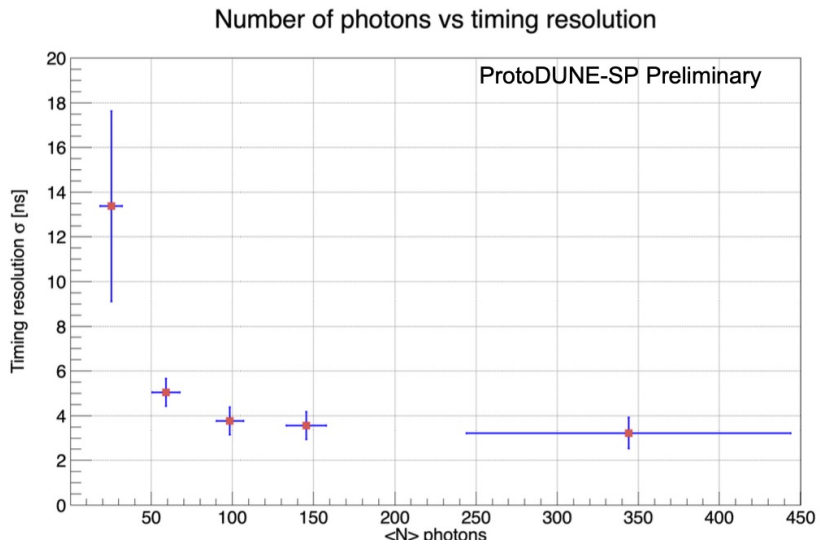
Motivations

- The PDS time resolution is a TDR requirement we must fulfill
- Include this into the NP04-PDS paper
- Input for light-charge match algorithms
- Channel-by-channel time allignment (remove possible hardware-induced delay)
- Trigger algorithms
- Replicate ProtoDUNE-SP and DP studies
- …

… Sorry for the low quality of these slides…

Dependence of timing resolution on photon numbers (<N>):



@credit Ajib

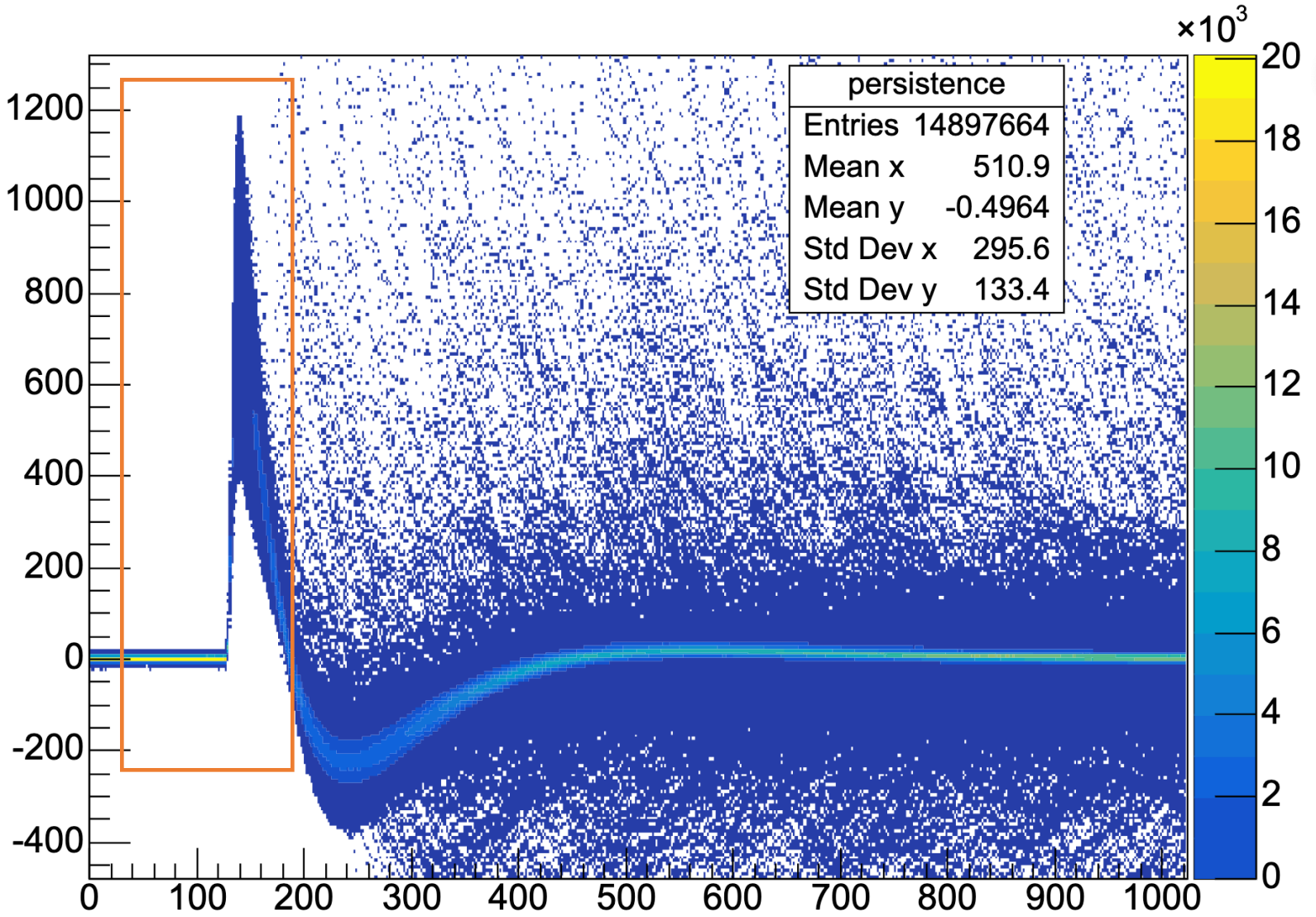
Waveform Selection

Need to isolate LED pulses

- Cuts in the pre-pulse region
- Cuts around the peak
- Range in amplitude

Take t0 as the time where the pulse surpasses half of its height

- Find the last tick below ampl/2
- Find the first tick above ampl/2
- Linear interpolation

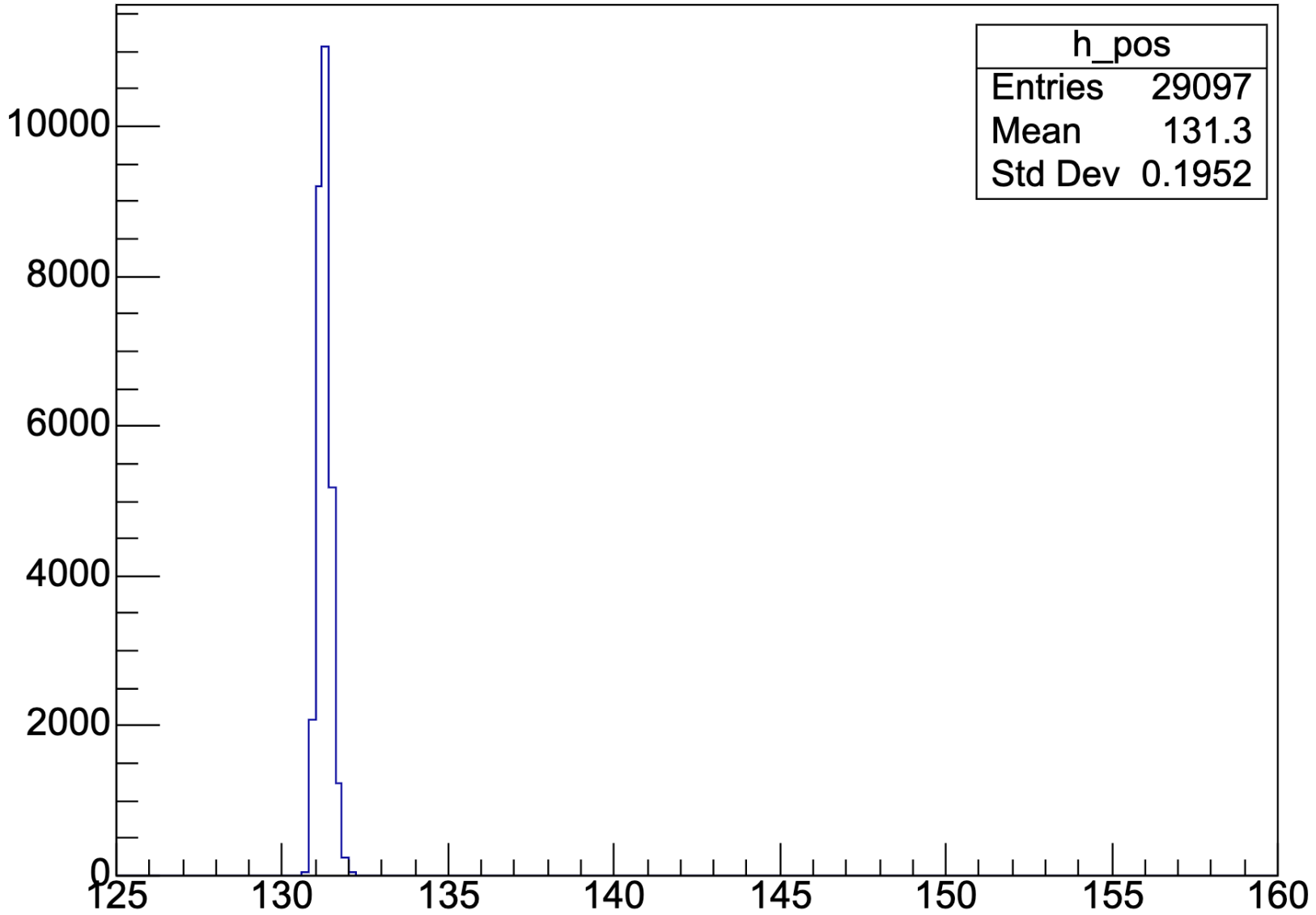


T0 time distribution

The linear interpolation gives us a sub-tick resolution

(at least for large pulses)

1 tick = 16 ns



t0 difference between adjacent channels

Channel: 112-25, 112-27 (APA 3)

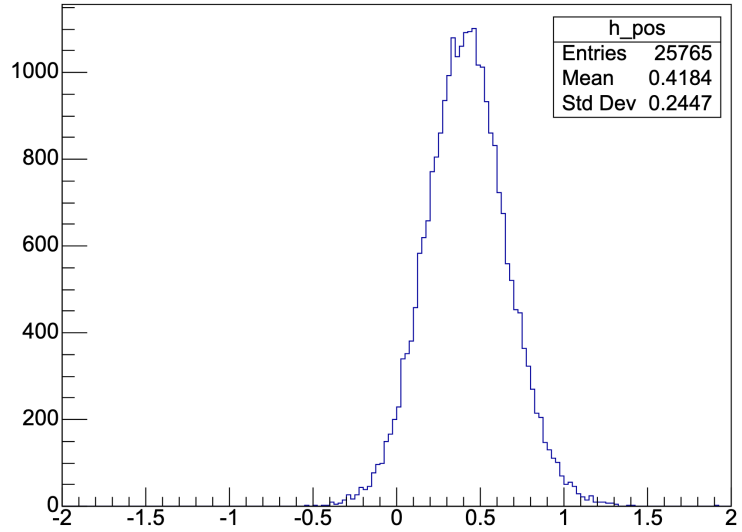
Require that the waveforms have the same timestamp (same LED flash)

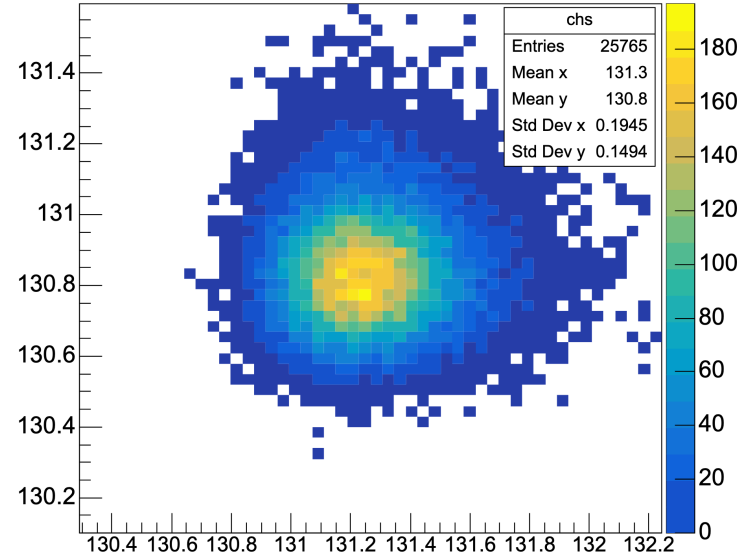
Look for hardware-induced delay

- To do: demonstrate that the non-zero offset doesn't not come from the analysis method

No evident correlation

- The PDS resolution gives the main contribution to the distribution width



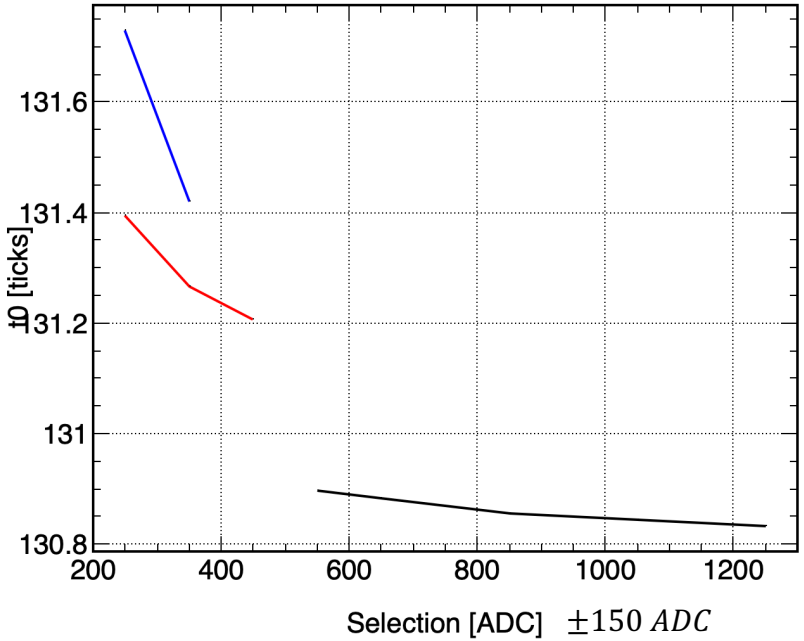


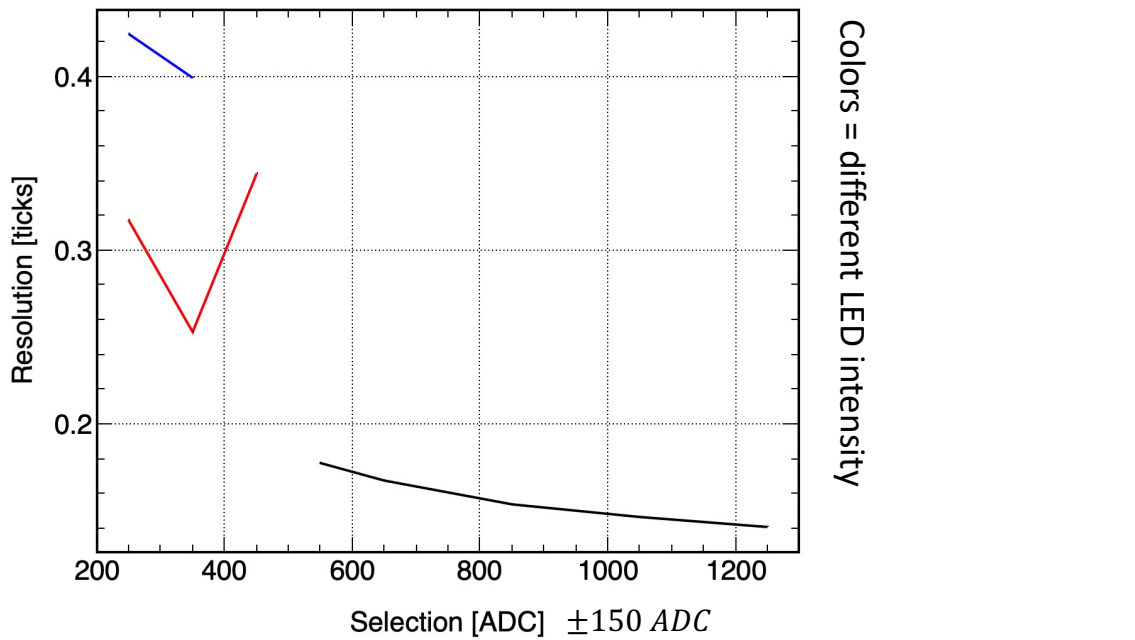
t0 – LED intensisty and selection

The t0, apparently, drifts with the amplitude cut and the LED intensity

- Cuts: not expected
  - The relative amplitude approach should limit the jitter
- LED intensity: reasonable
  - The more intense the LED light, the larger the probability to detect “early-emitted photons”
  - … Or it can be an analysis artefact

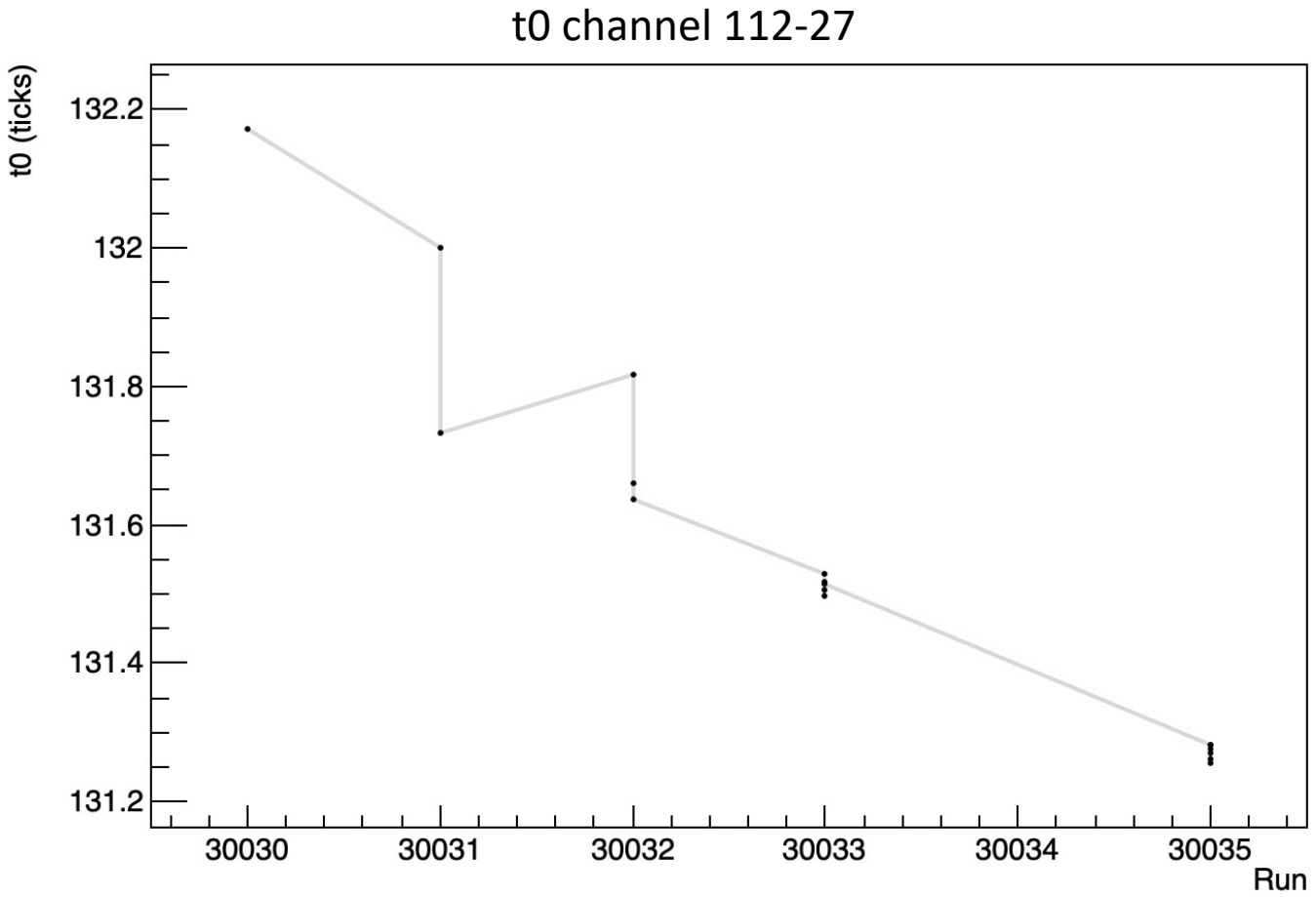
Runs 30032-30033-30035





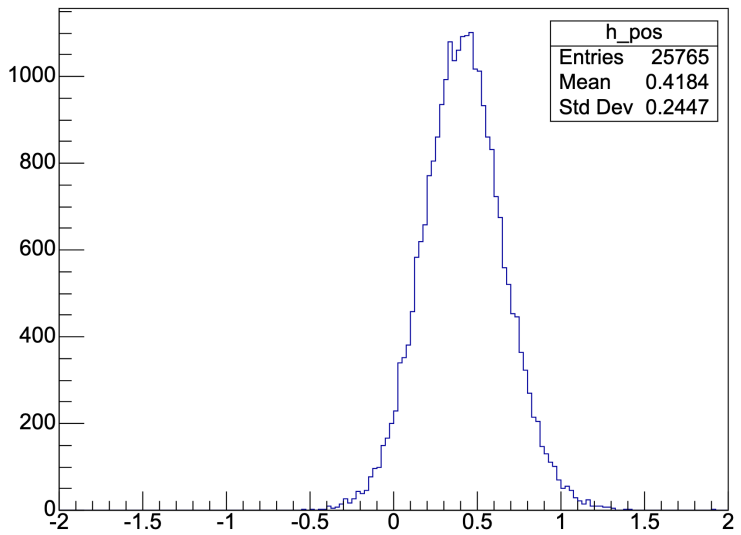
t0 drift

Can this explain the non-zero offset
of the difference bewtween channels?

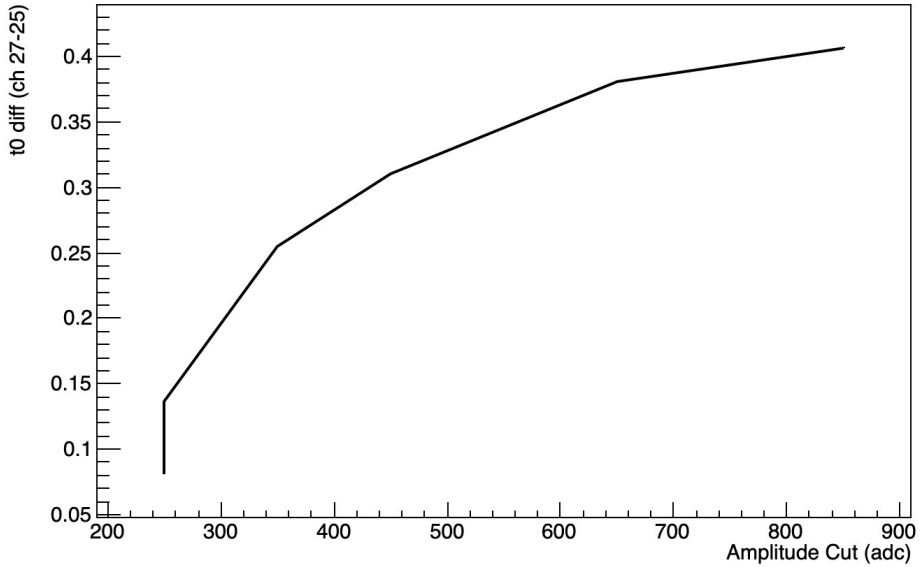


More points for a run <-> different cuts

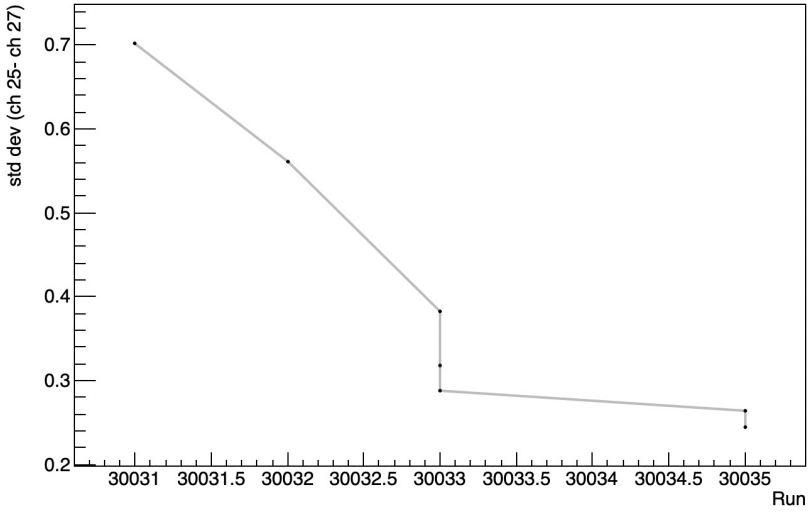
t0 difference



Ch 11225 – 11227 t0 difference



Standard deviation of ch 11225 – 11227 difference



To dos

To dos:

- Investigate different methods
- “Low energy studies”
- ADC -> p.e. conversion
- Do all the channels
- ...