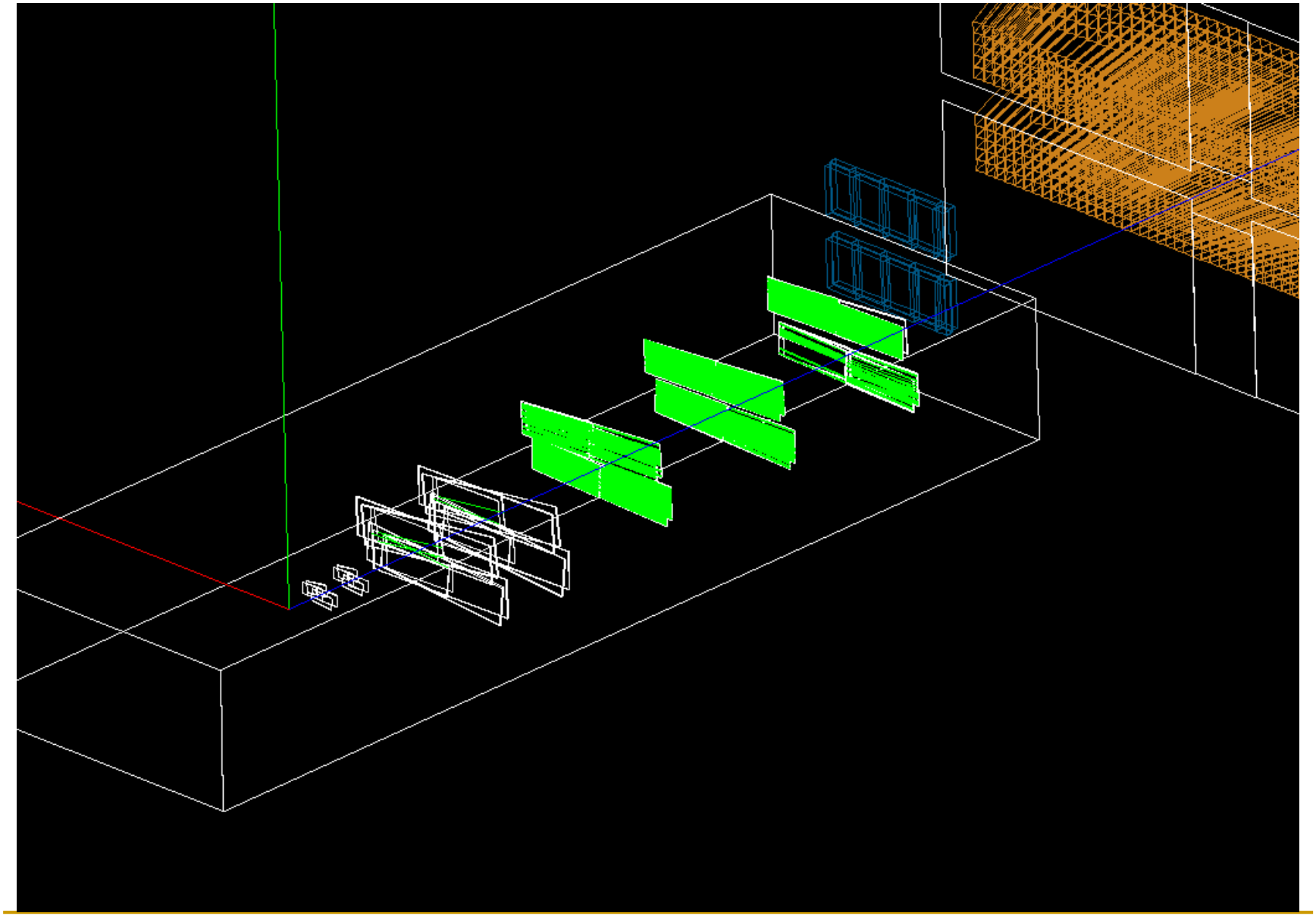
SVT Hit Timing

Norman Graf (SLAC)

Reconstruction / Calibration Meeting

May 25, 2021

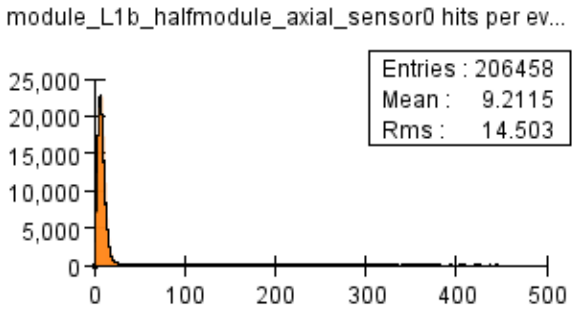
SVT “Monster” Event

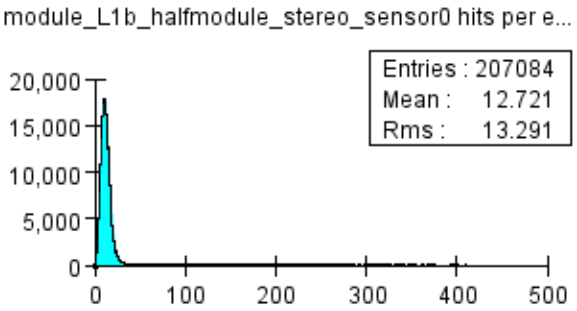


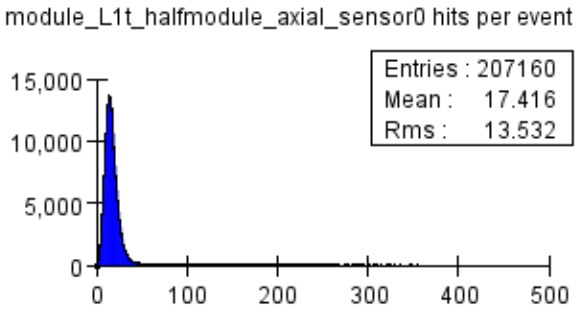
SVT Hits

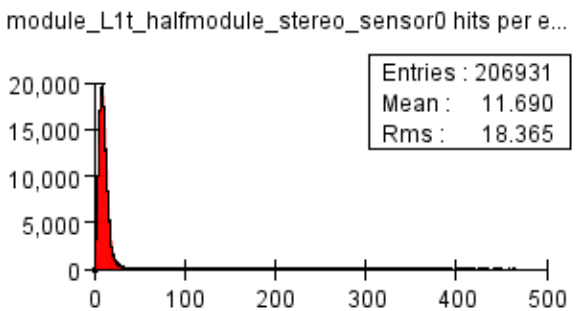
- A number of events and runs from 2019 have large numbers of SVT hits.
  - Some appear to be pathological whereas others appear to be simply increased occupancy.
- Fitting the APV25 waveforms for these hits consumes large amounts of CPU time.
- Handling such large numbers of hits also drastically slows the track-finding pattern recognition.
  - Particularly acute for the SeedTracker which combines axial and stereo hits to make 3D spacepoints, resulting in many more “ghost” hits.
- Need a strategy / strategies to handle these runs/events.
- We currently spend the time to fit all of these hits, cluster them, then zero out the StripClusterer_SiTrackerHit1D collection if it has more than 200 hits.
- This saves “tracking” time, but wastes all the APV25 fitting time!
- I’ve shown how to analyze the raw APV25 waveform before fitting to identify “bad” channels. (Not the topic of this talk.)

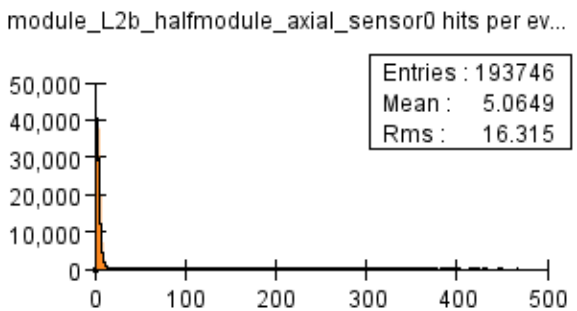
hps_010022 Hits per event by sensor

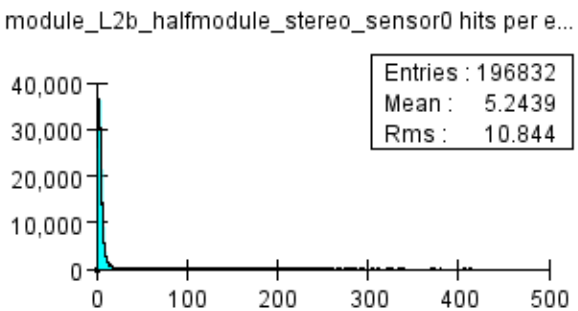


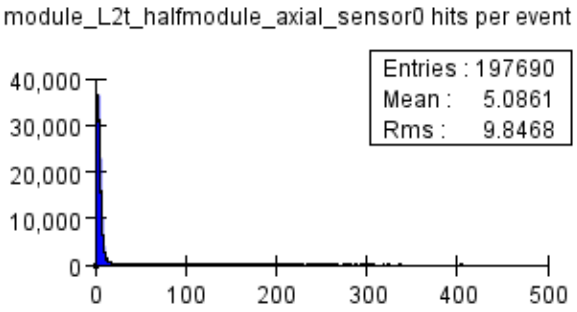


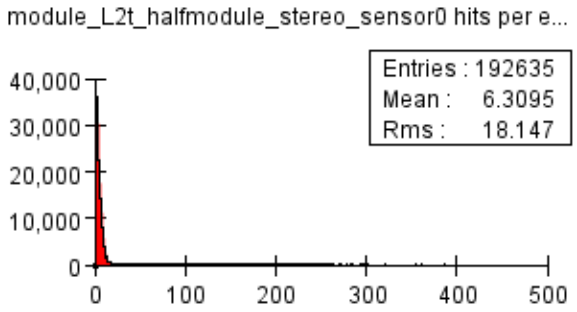


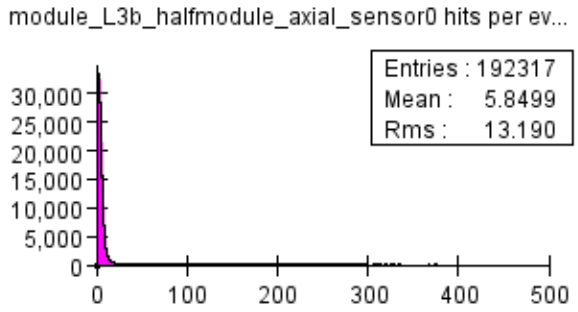




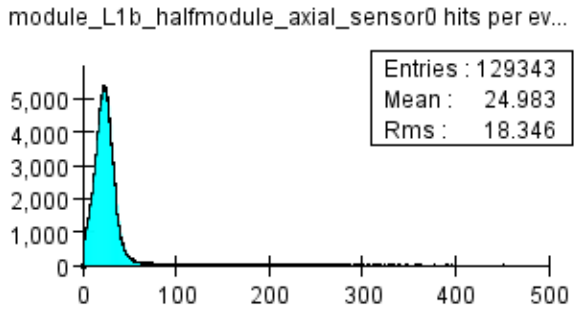


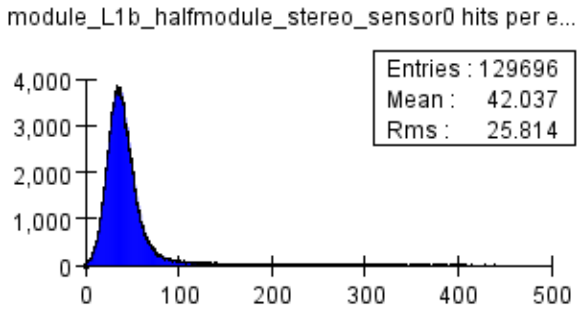


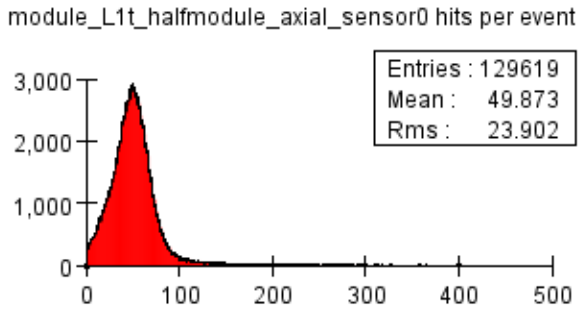


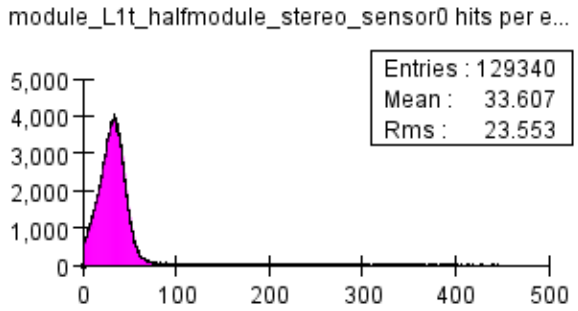


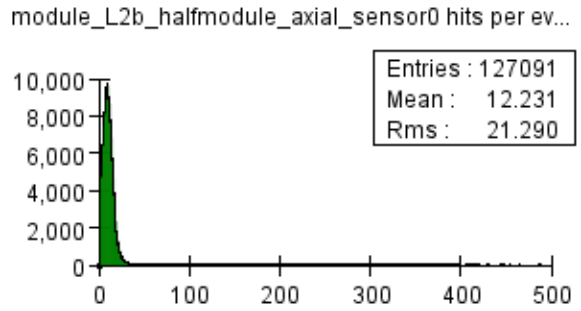
hps_010515 Hits per event by sensor

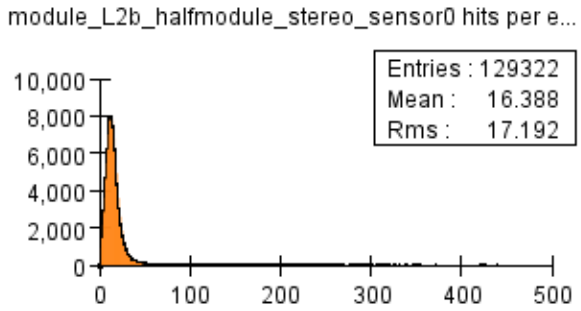


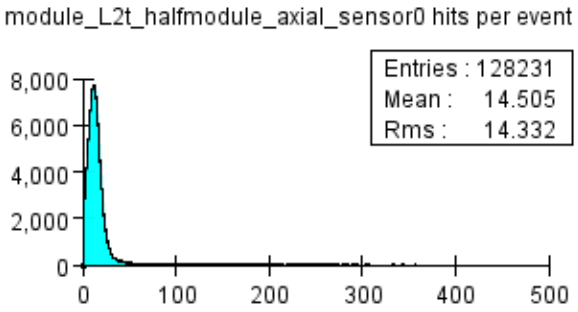


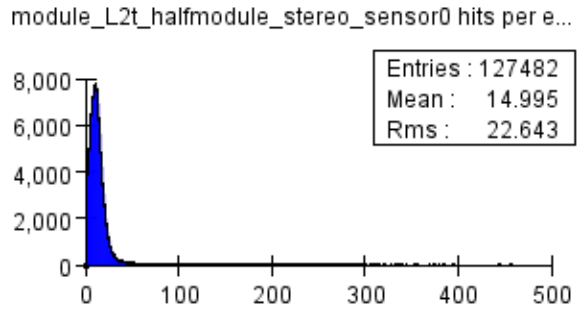


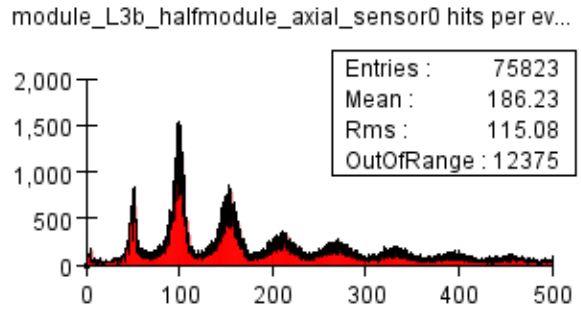




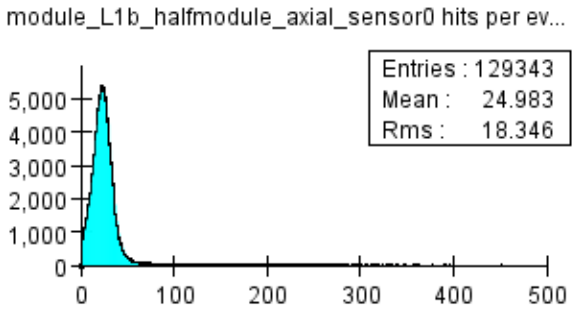


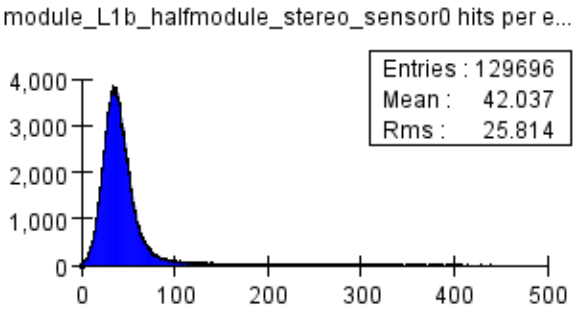


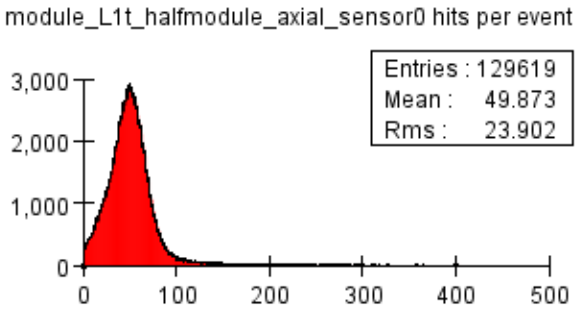




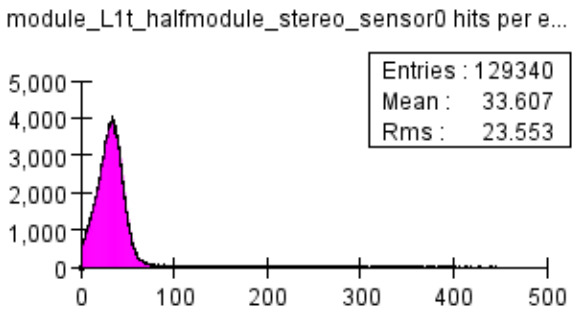
hps_010515 Hits per event by sensor

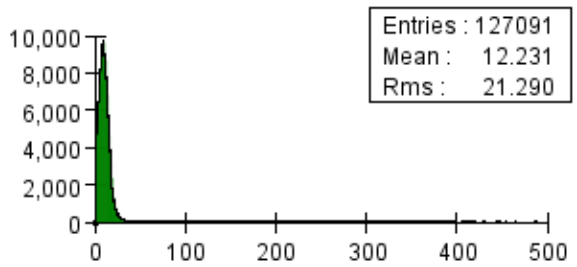


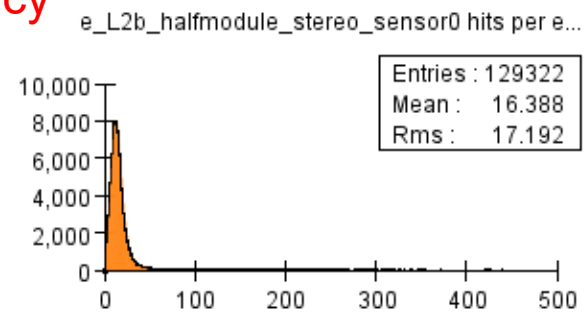


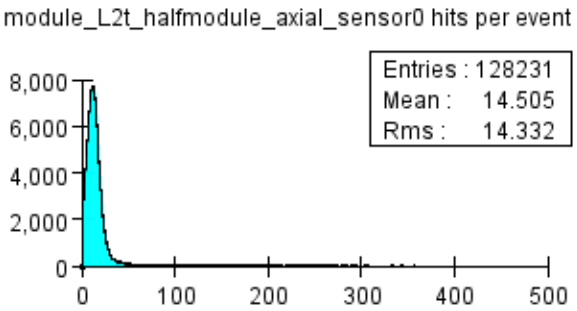


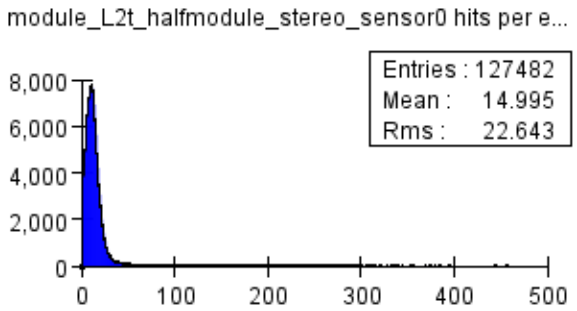
Overall increase in occupancy

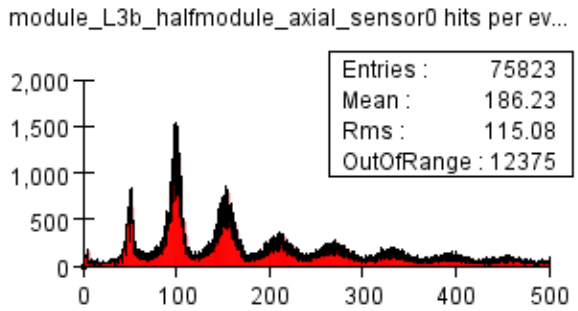










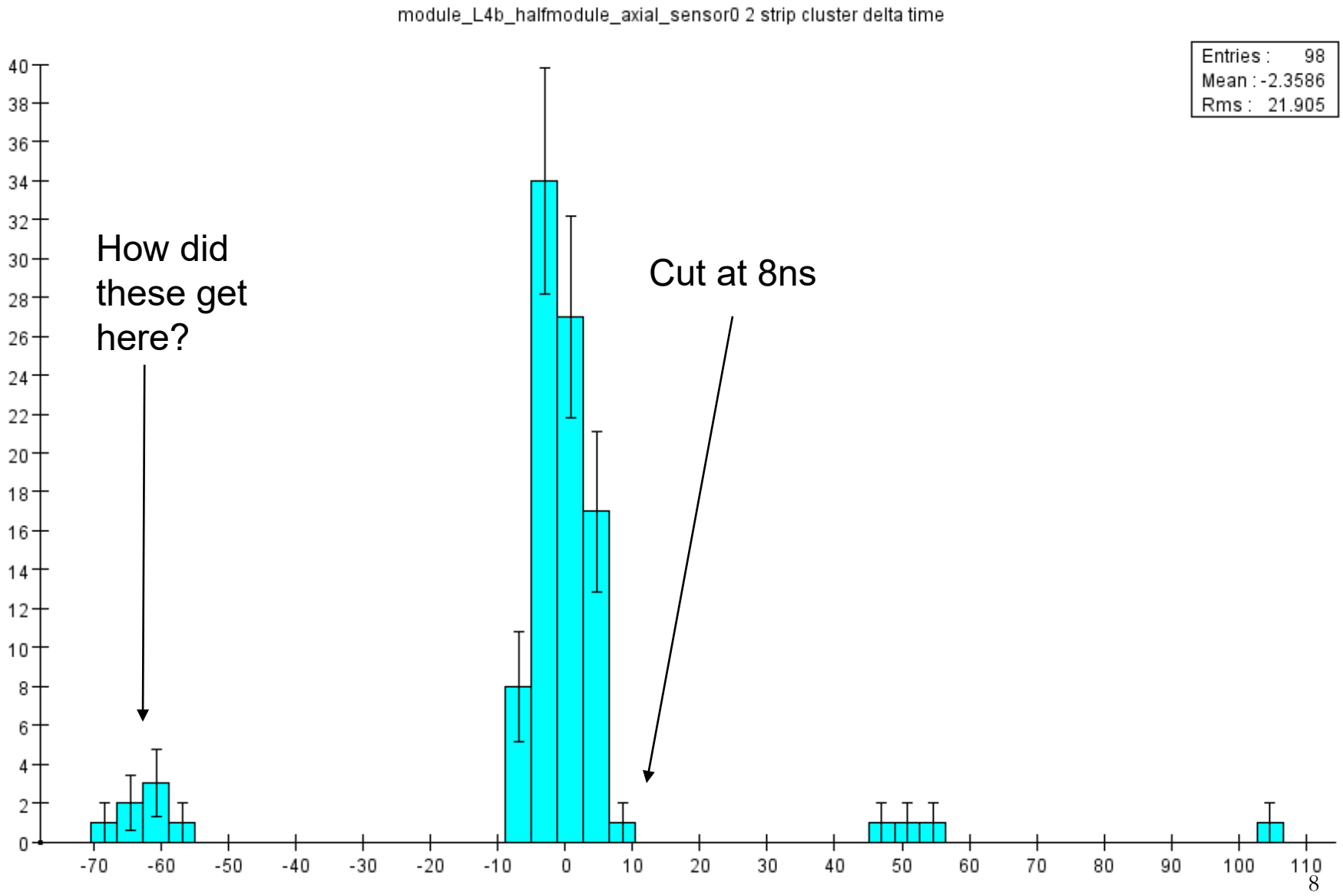


some pathologies

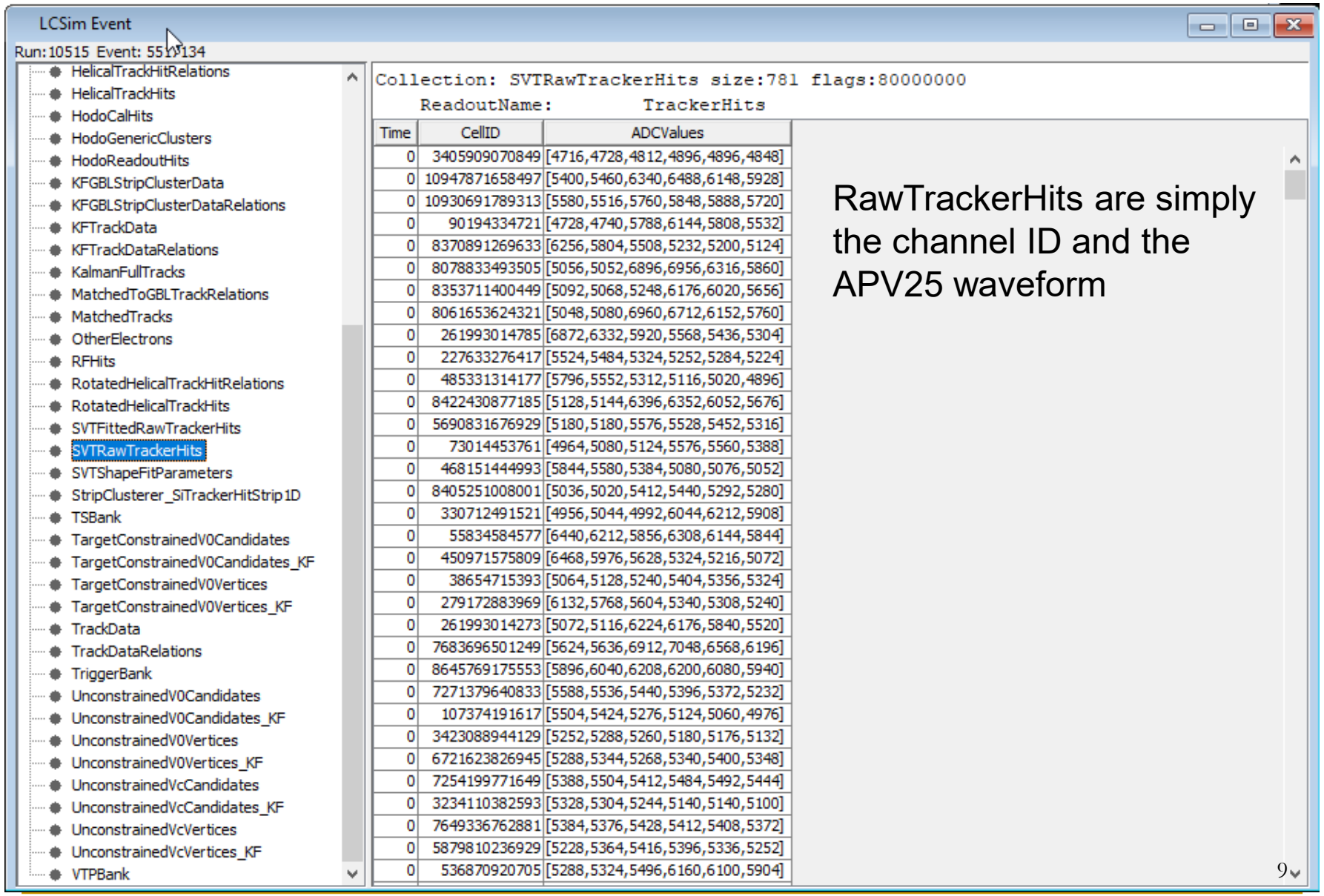
SVT Hit times

- We use hit times to:
  - associate neighboring strips into 1D hits
  - associate axial and stereo hits into 3D hits
  - compare track time to cluster time
  - compare track time to other tracks/clusters
- I wanted to check this…
- Start at the bottom, looking at strip clustering
  - Currently associate neighboring strip hits if they are within 8ns of each other.

Two-Strip Clusters delta time

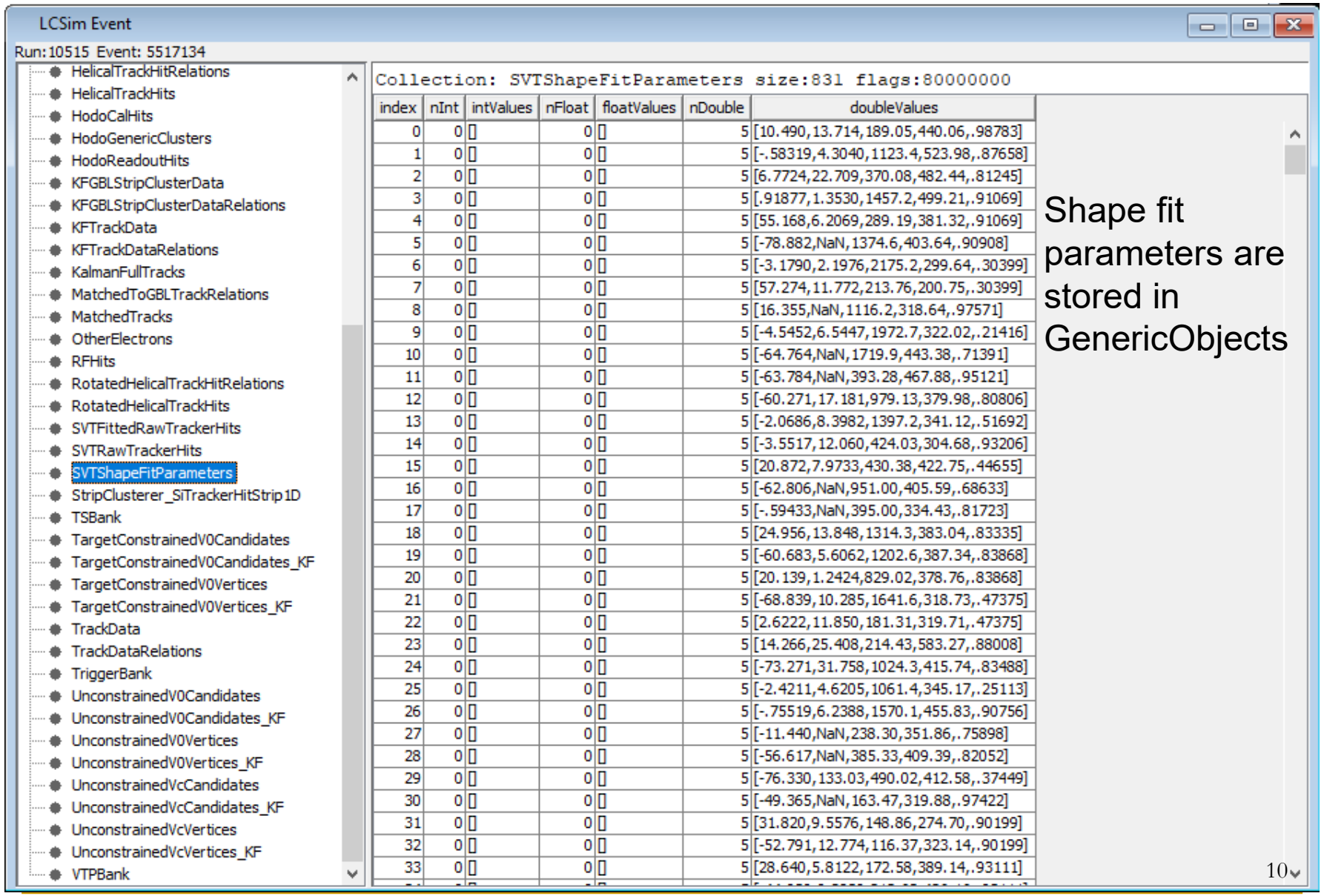


Raw Tracker Hits



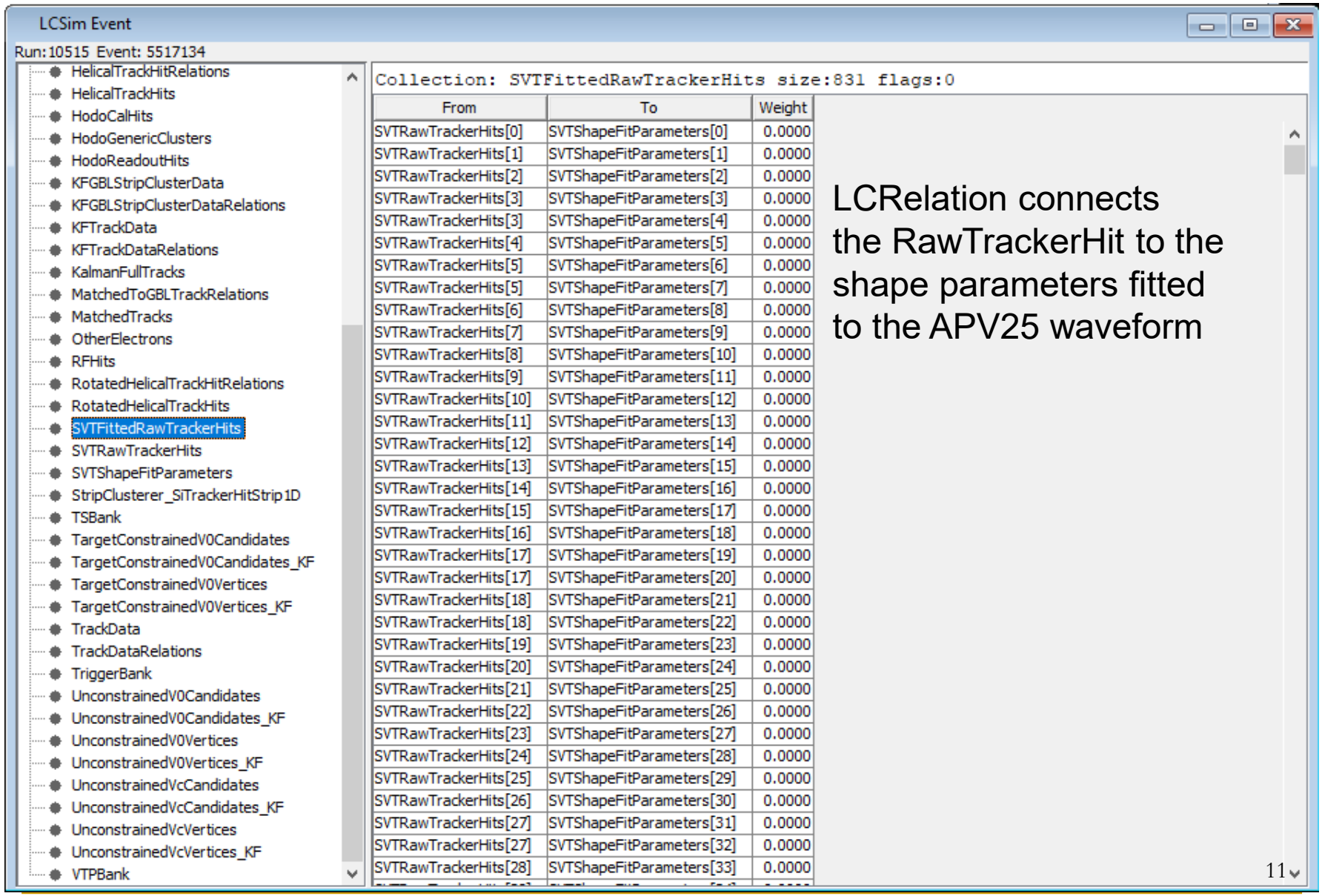
RawTrackerHits are simply the channel ID and the APV25 waveform

Shape Fit Parameters



Shape fit parameters are stored in GenericObjects

FittedRawTrackerHits



From	To	Weight
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SVTRawTrackerHits[1]	SVTShapeFitParameters[1]	0.0000
SVTRawTrackerHits[2]	SVTShapeFitParameters[2]	0.0000
SVTRawTrackerHits[3]	SVTShapeFitParameters[3]	0.0000
SVTRawTrackerHits[3]	SVTShapeFitParameters[4]	0.0000
SVTRawTrackerHits[4]	SVTShapeFitParameters[5]	0.0000
SVTRawTrackerHits[5]	SVTShapeFitParameters[6]	0.0000
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SVTRawTrackerHits[6]	SVTShapeFitParameters[8]	0.0000
SVTRawTrackerHits[7]	SVTShapeFitParameters[9]	0.0000
SVTRawTrackerHits[8]	SVTShapeFitParameters[10]	0.0000
SVTRawTrackerHits[9]	SVTShapeFitParameters[11]	0.0000
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SVTRawTrackerHits[11]	SVTShapeFitParameters[13]	0.0000
SVTRawTrackerHits[12]	SVTShapeFitParameters[14]	0.0000
SVTRawTrackerHits[13]	SVTShapeFitParameters[15]	0.0000
SVTRawTrackerHits[14]	SVTShapeFitParameters[16]	0.0000
SVTRawTrackerHits[15]	SVTShapeFitParameters[17]	0.0000
SVTRawTrackerHits[16]	SVTShapeFitParameters[18]	0.0000
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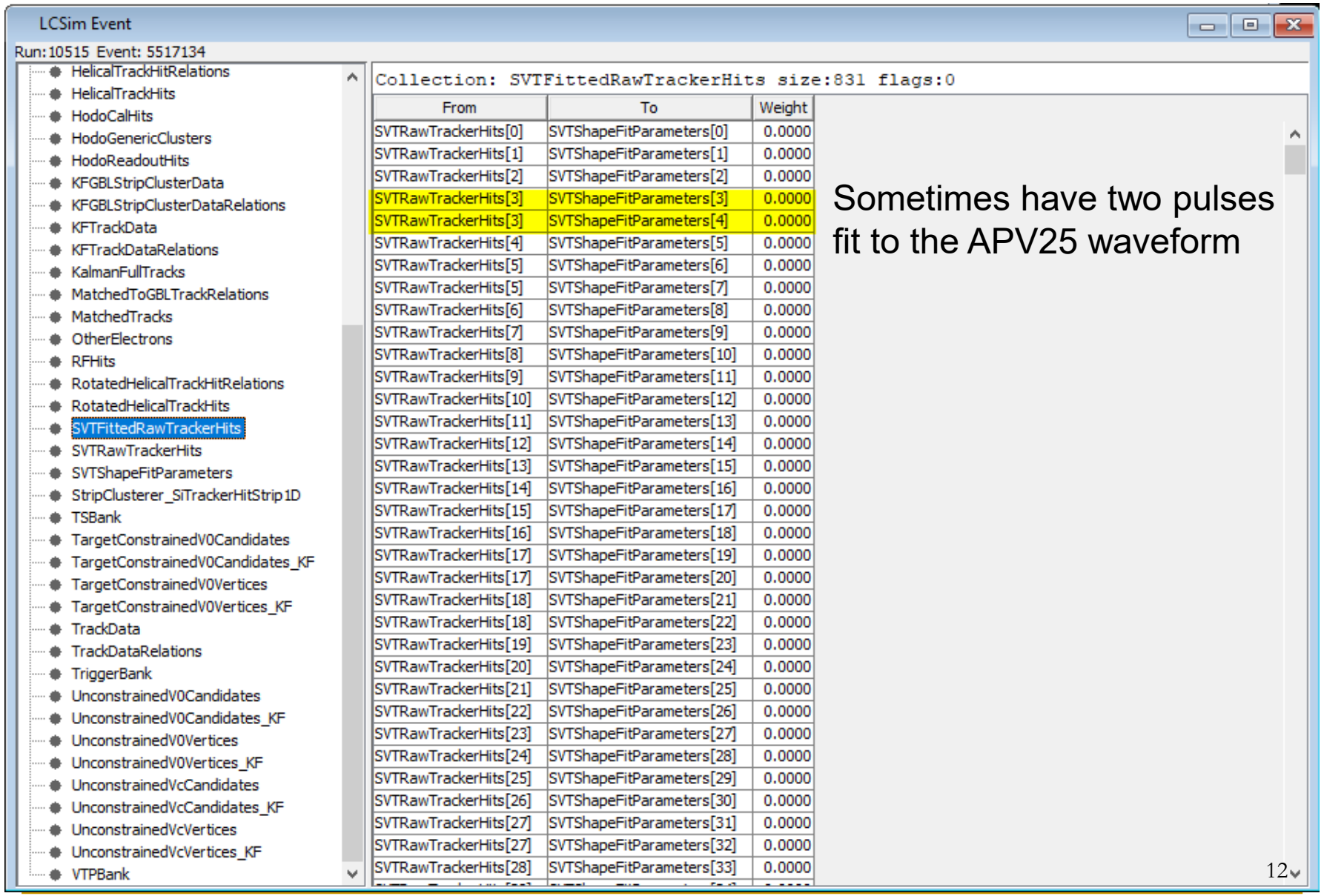
SVTRawTrackerHits[28]	SVTShapeFitParameters[33]	0.0000

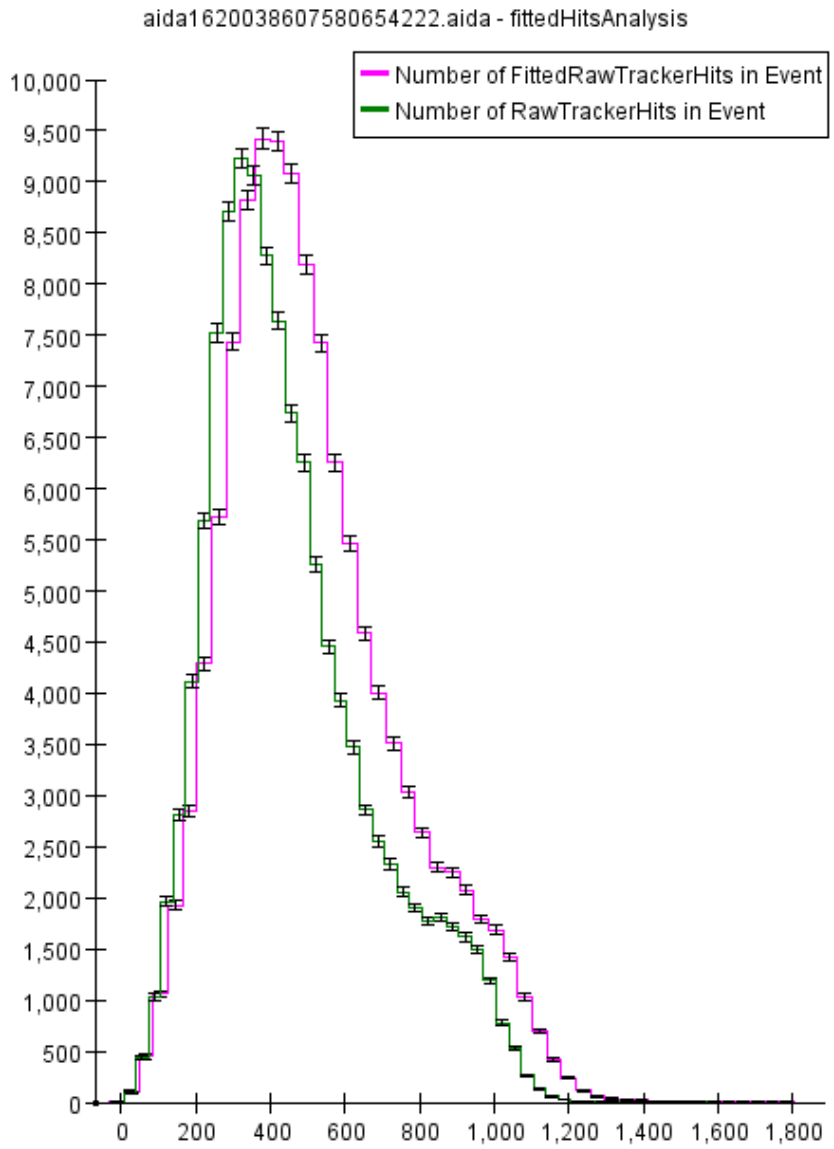
LCRelation connects the RawTrackerHit to the shape parameters fitted to the APV25 waveform

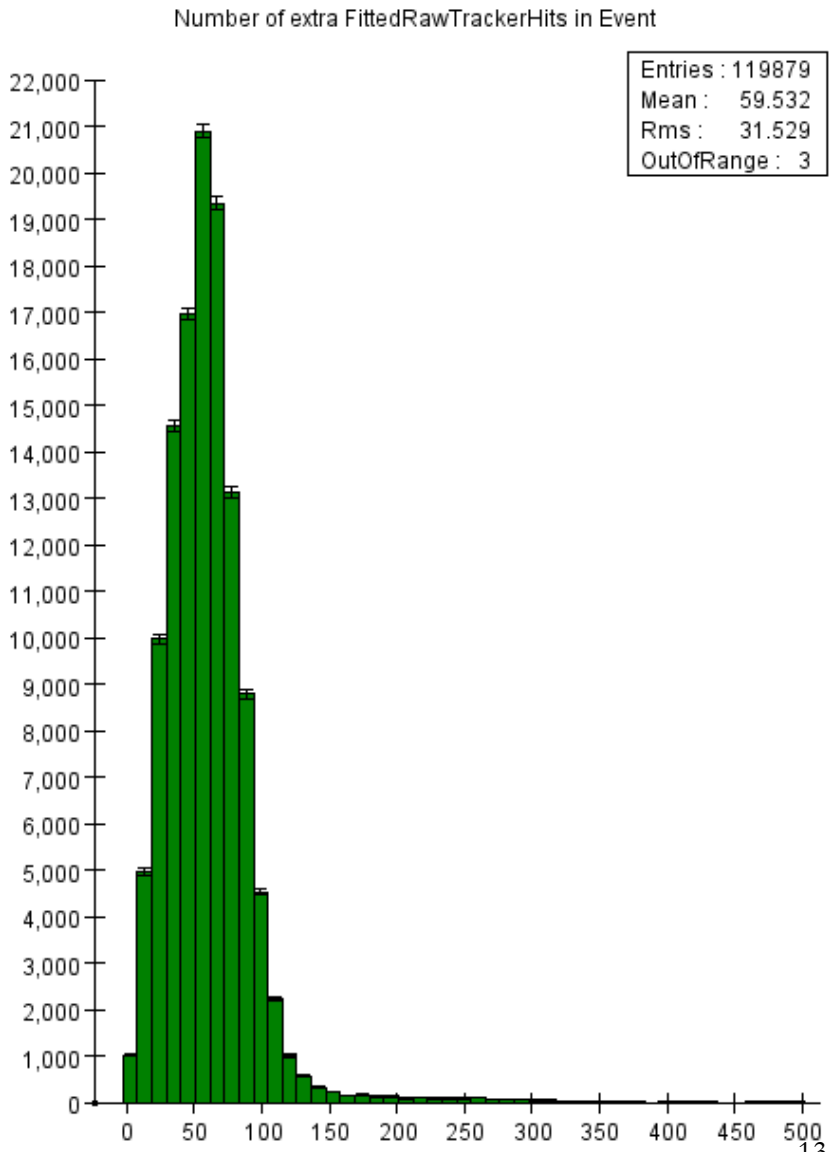
FittedRawTrackerHits



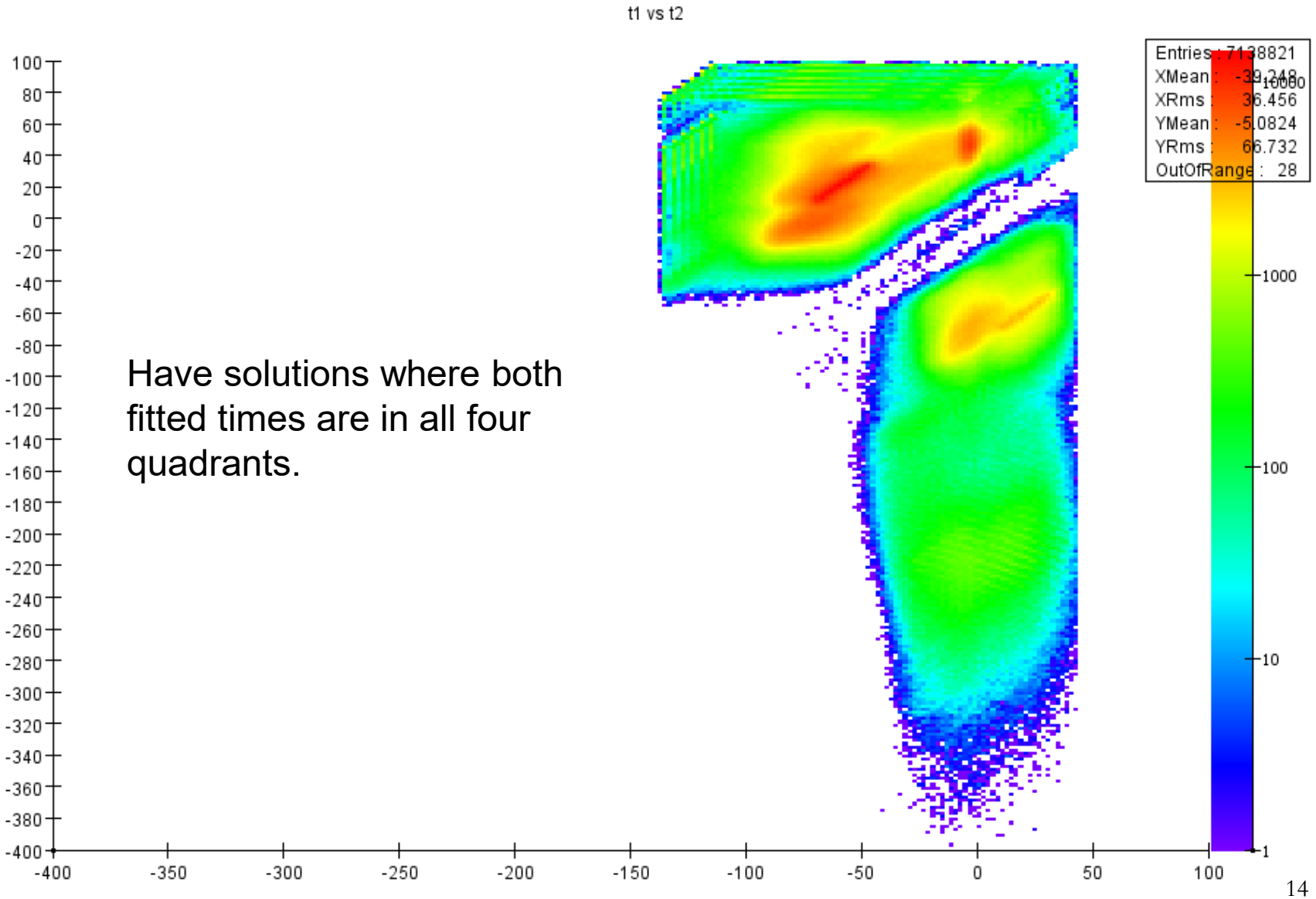
Sometimes have two pulses fit to the APV25 waveform

Multiple Fits APV25 Waveform



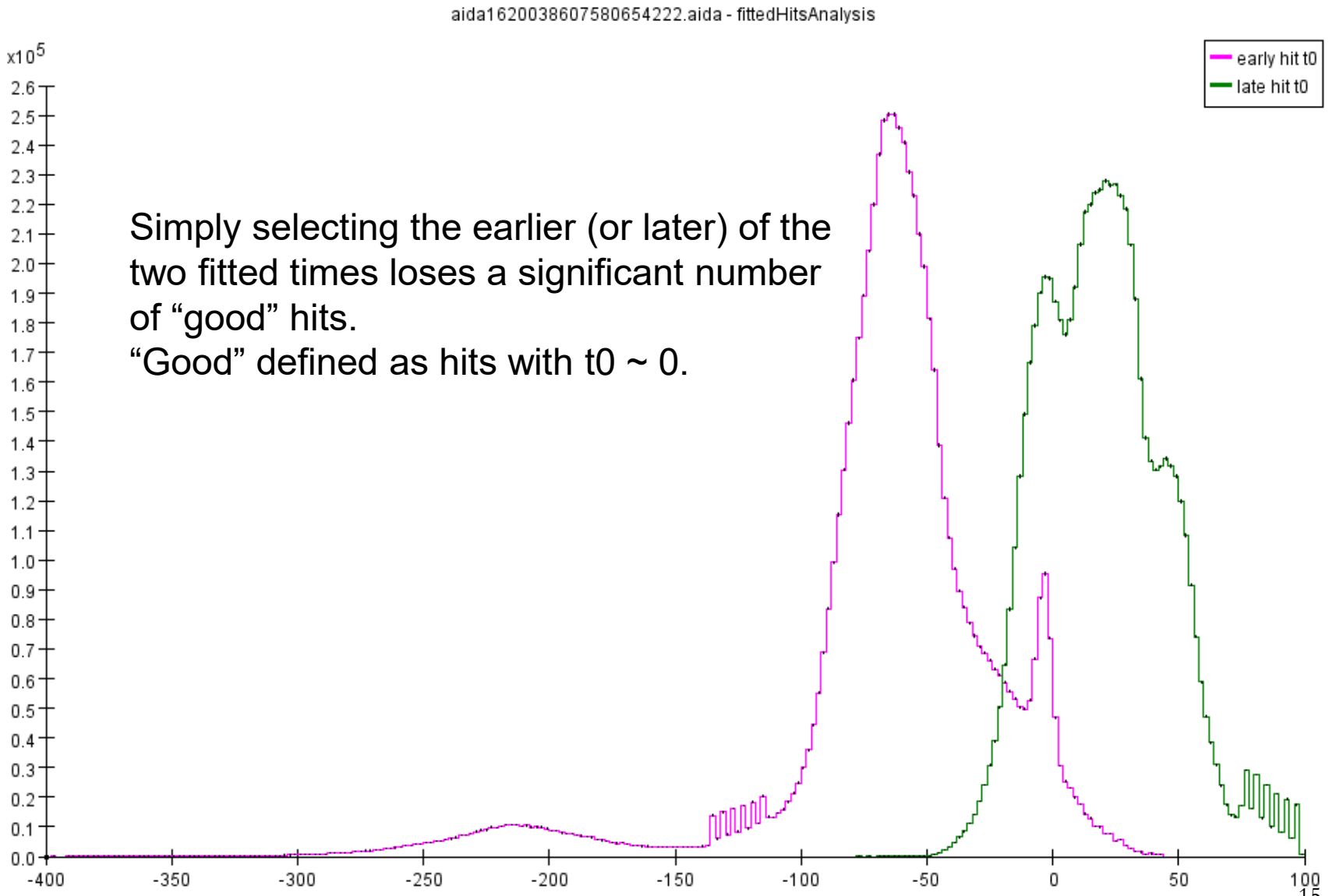


Multiple Fits APV25 Waveform



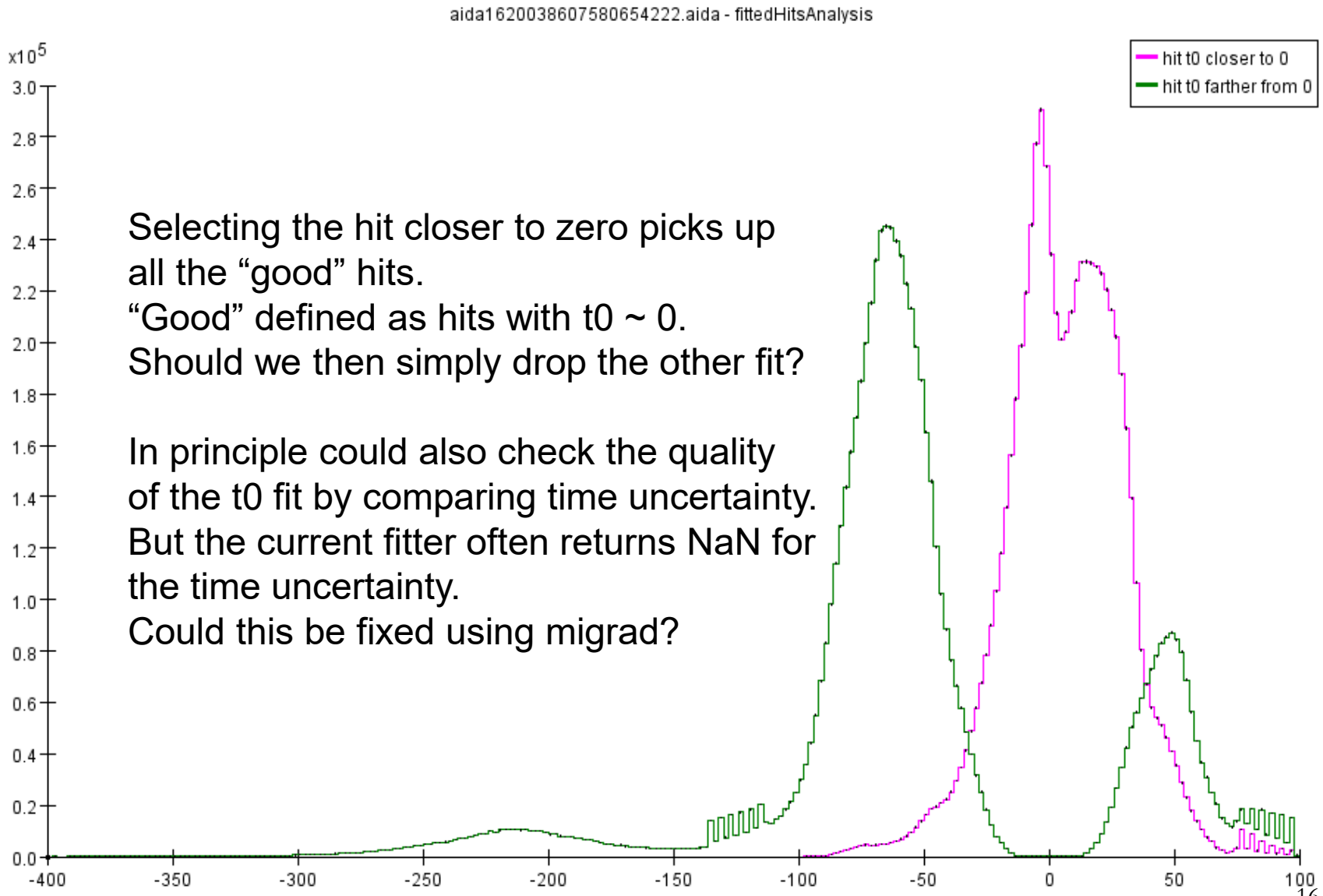
Have solutions where both fitted times are in all four quadrants.

Multiple Fits APV25 Waveform



Simply selecting the earlier (or later) of the two fitted times loses a significant number of “good” hits.
“Good” defined as hits with t0 ~ 0.

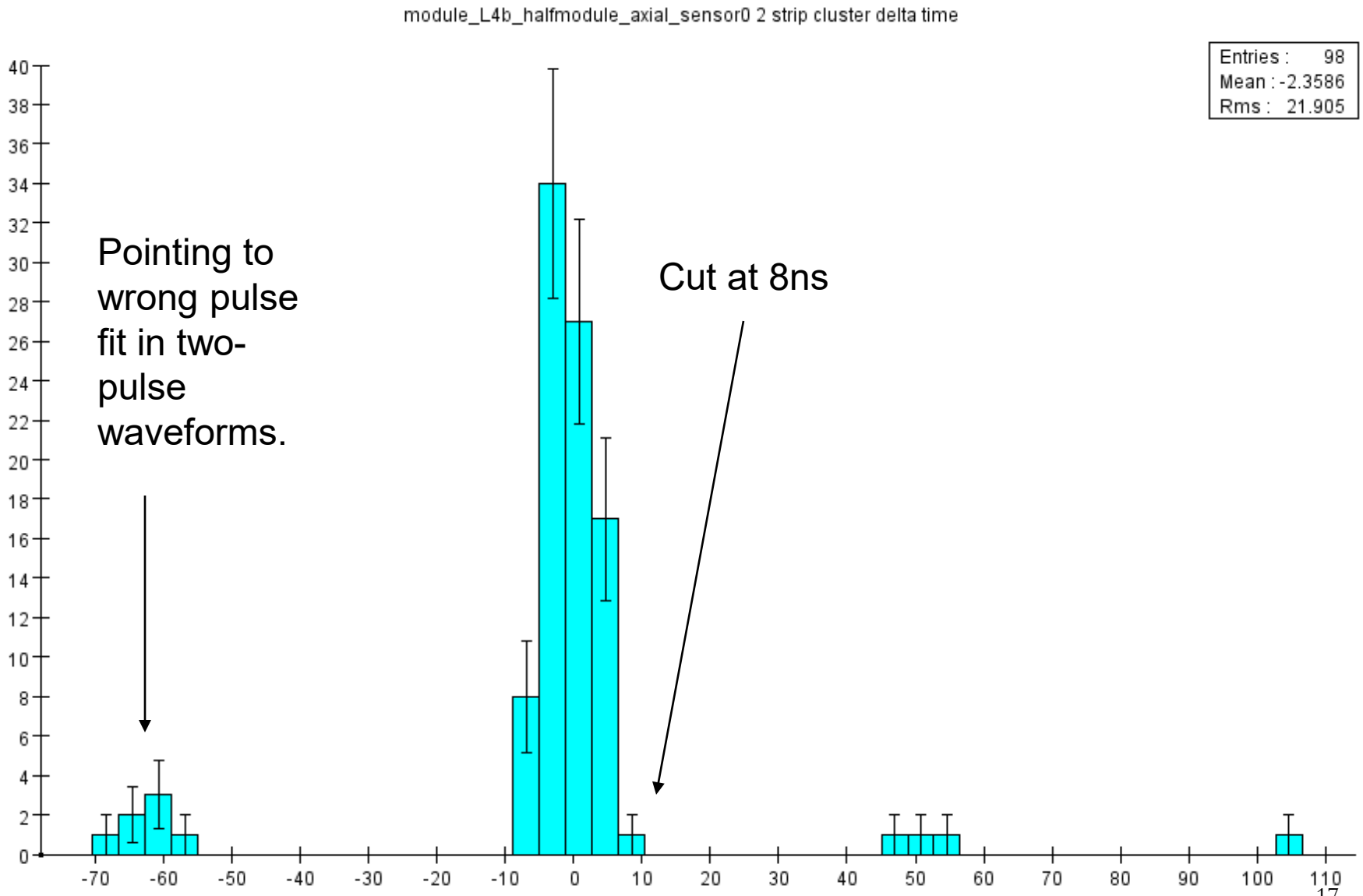
Multiple Fits APV25 Waveform



Selecting the hit closer to zero picks up all the “good” hits.
“Good” defined as hits with t0 ~ 0.
Should we then simply drop the other fit?

In principle could also check the quality of the t0 fit by comparing time uncertainty.
But the current fitter often returns NaN for the time uncertainty.
Could this be fixed using migrad?

Two-Strip Clusters delta time



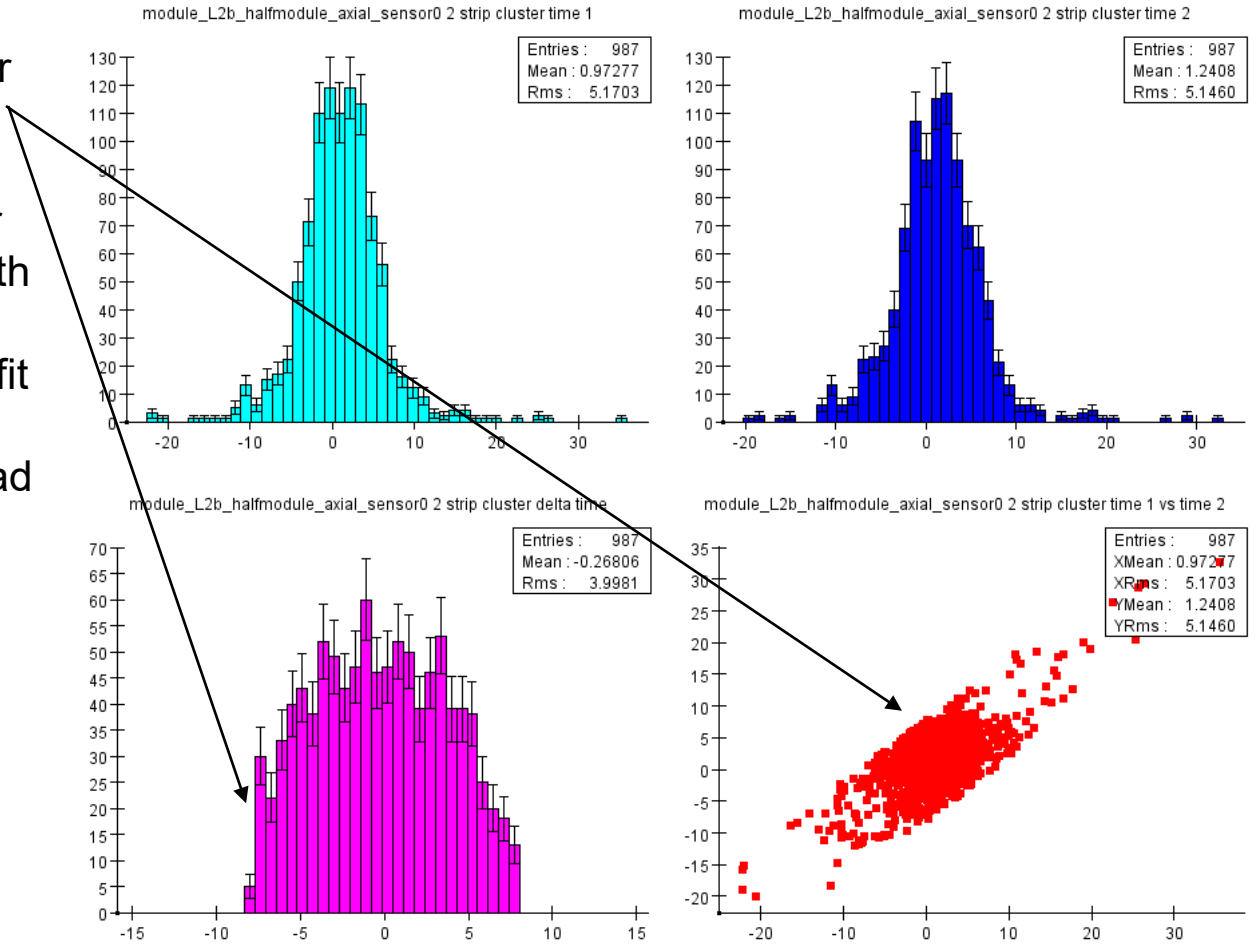
SVT Hit Times

- Selecting strip clusters with two strips, analyze times on these two adjacent strips.

Clear evidence for clipping.

Can we get better time resolution with better fits?
Can we use time fit uncertainty?
Could using migrad help?
Are there amplitude-dependent time-walk effects?

Should we simply open up the window?



Proposals

- Only accept a single valid fit per APV25 waveform
  - If two fits are found, select the one with t0 closer to zero.
  - Resolves issues with LCRelations pointing to wrong fit
  - Eliminates hits that won't be used anyway.
  - Only selecting the "good" hits by defining the hits to be "good" is a tautology. Need to be careful.

- Open up the time window for clustering adjacent strips
  - Would reduce the number of strip clusters used in track finding
    - Two adjacent strips outside the current time window would give us two single-strip hits instead of one two-strip hit.
  - Would (perhaps) improve the track quality
    - The two-strip hit would have a better-measured position and amplitude.
  - Might increase the backgrounds caused by out-of-time hits or noise.
  - Needs some more study.