

APA Crossing Muons!

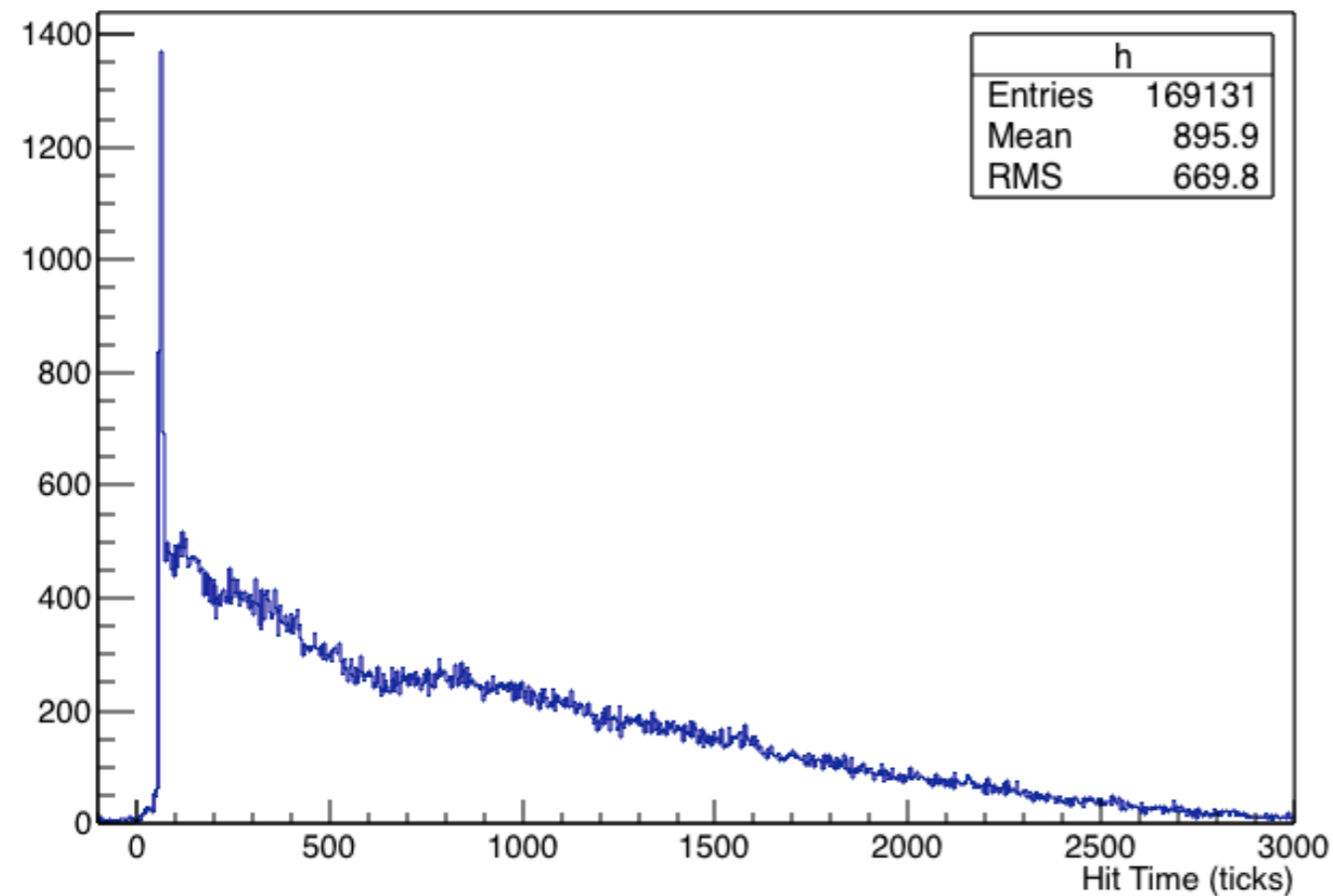
Mike Wallbank

11/1/2017

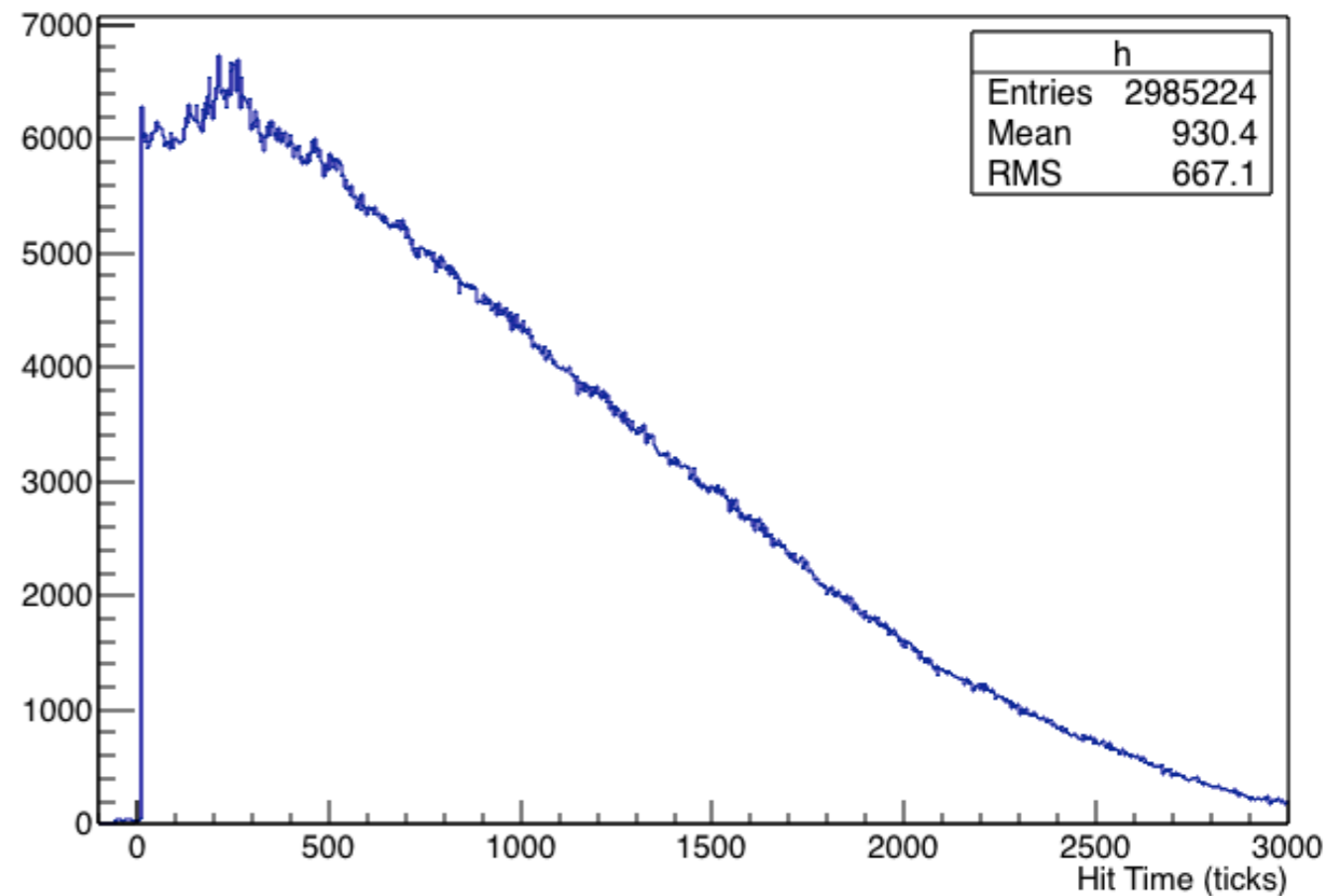
Updates

- Coming to the very end of the APA crossing muon study!
 - Looked at interaction time by lining up tracks on either side of the APAs and by looking at the hit time distributions for all track hits.
 - Looked at event displays and noted the little hook-like marks.
- Mark indicated it'd be interesting to try to measure the gap in between the collection planes by aligning tracks, rather than the interaction time (T_0 can be estimated from the hit time distribution).
- I've been looking at this — as always, interesting and unexpected things appear...

Hit Time Distributions



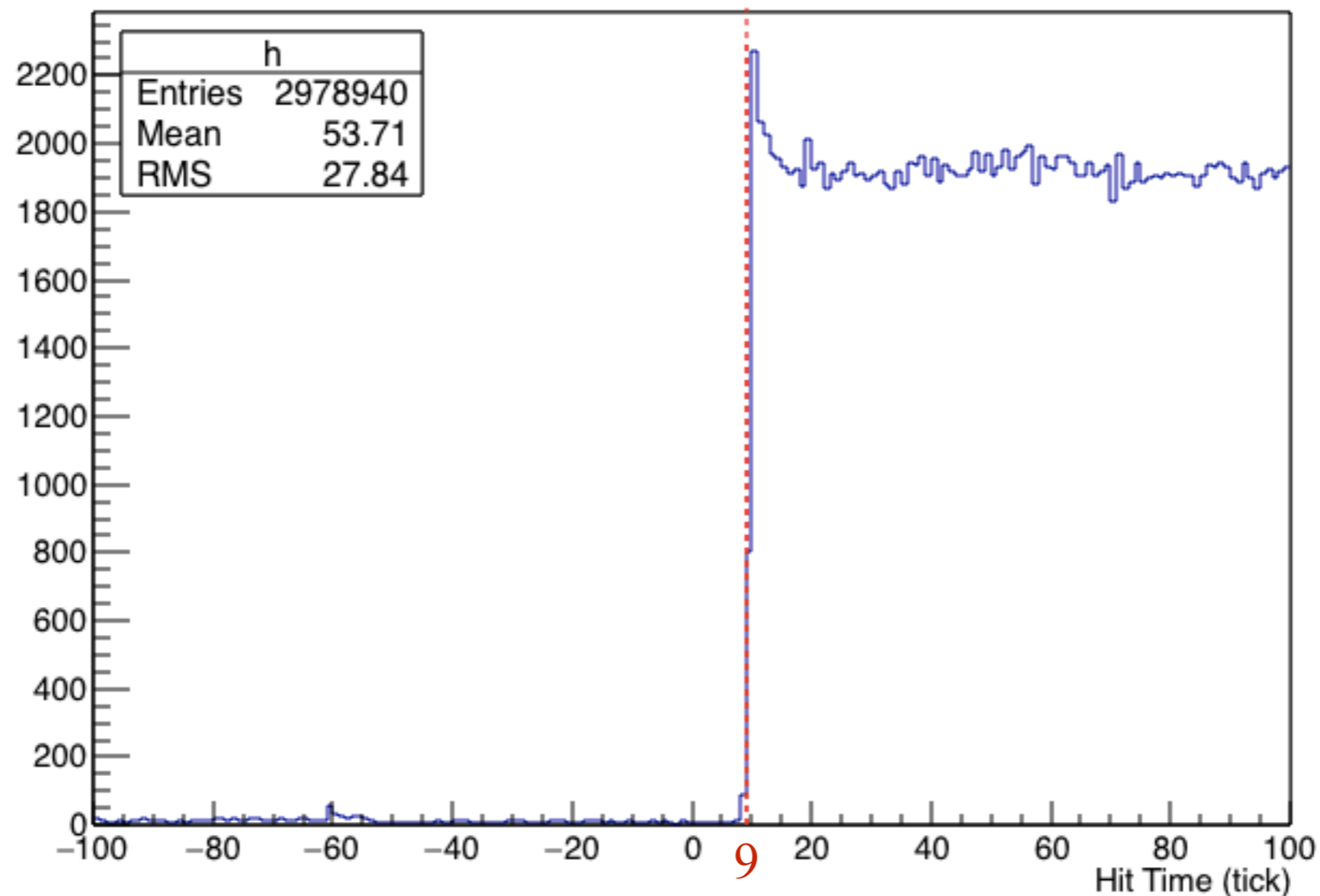
Data



Simulation

- As we now know, there is a sharp peak of hits which arrive at the interaction time when considering APA crossing tracks.
- These hits appear to come from ionised charge produced after the particle has passed through the collection planes (so drift 'backwards').

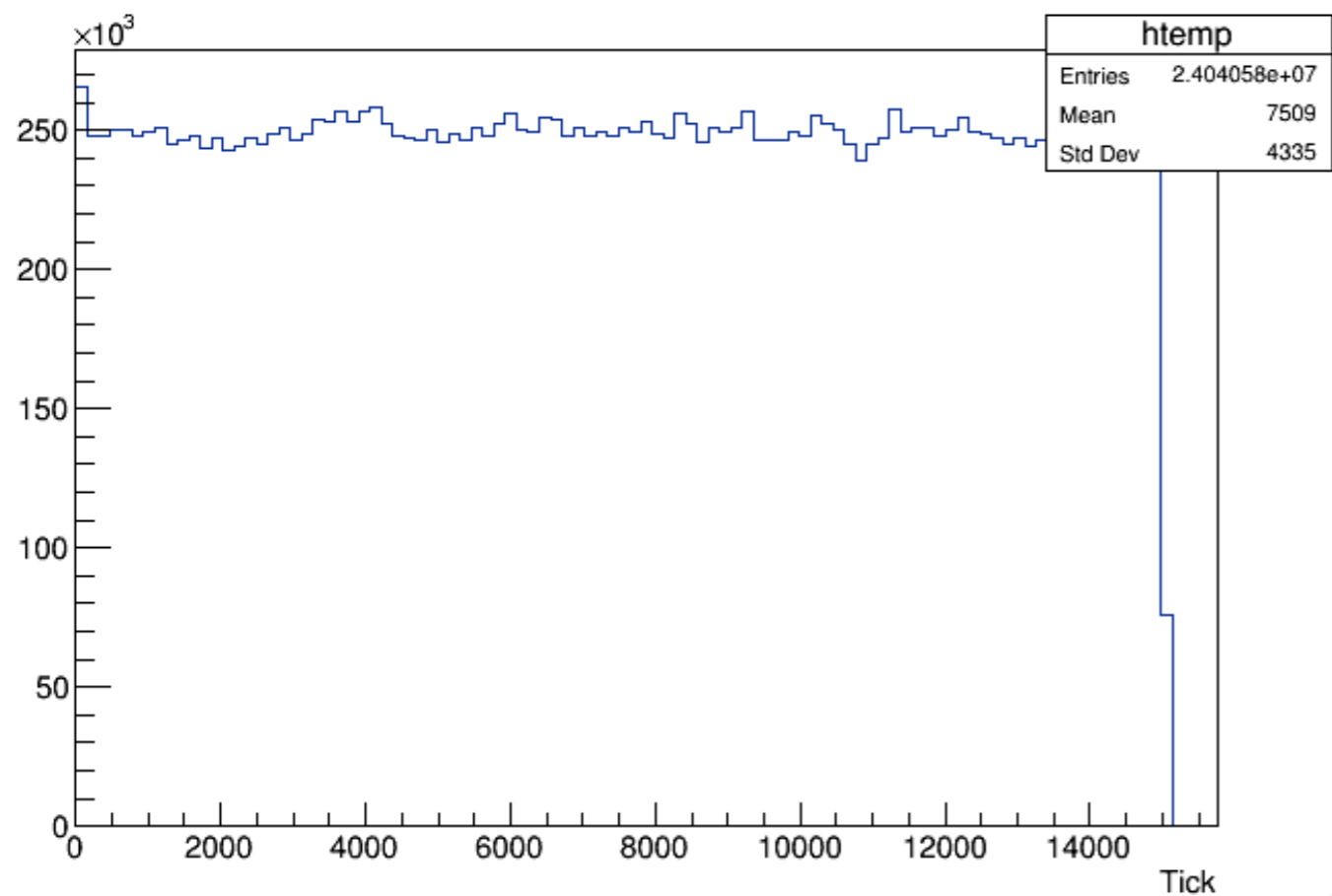
MC Distribution



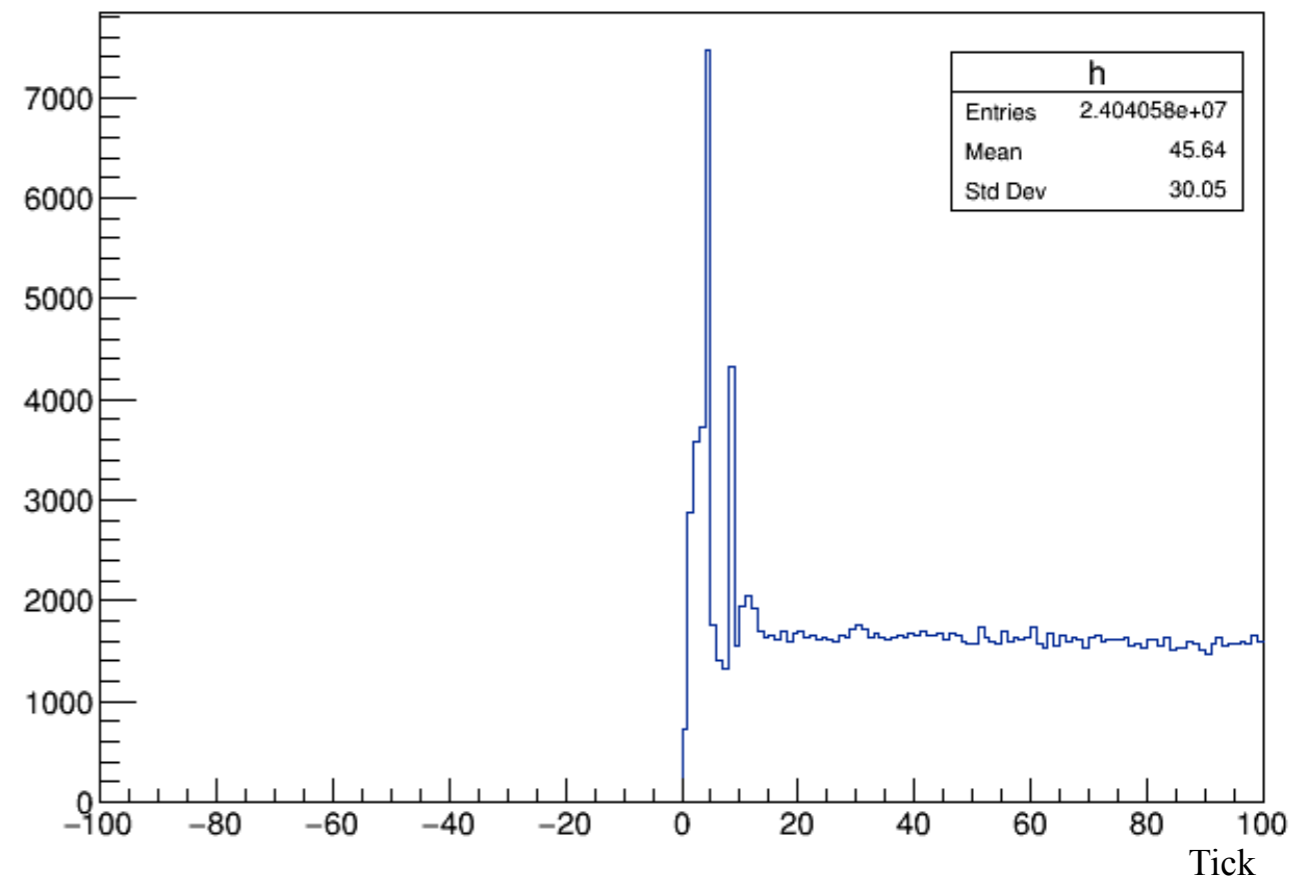
- Haven't actually zoomed in before — it looks like this doesn't peak at 0!
- Interestingly, 9 ticks == 4.5 us (0.5us/tick) ≈ 4.9 mm (109cm/ms). In LArSoft, spacing between the planes is 4.88 mm. Could be coincidence... or maybe not...

MC Distribution

- Decided to look into this further!
- Distribution of hit times when not correcting for T0:



Full range of ticks

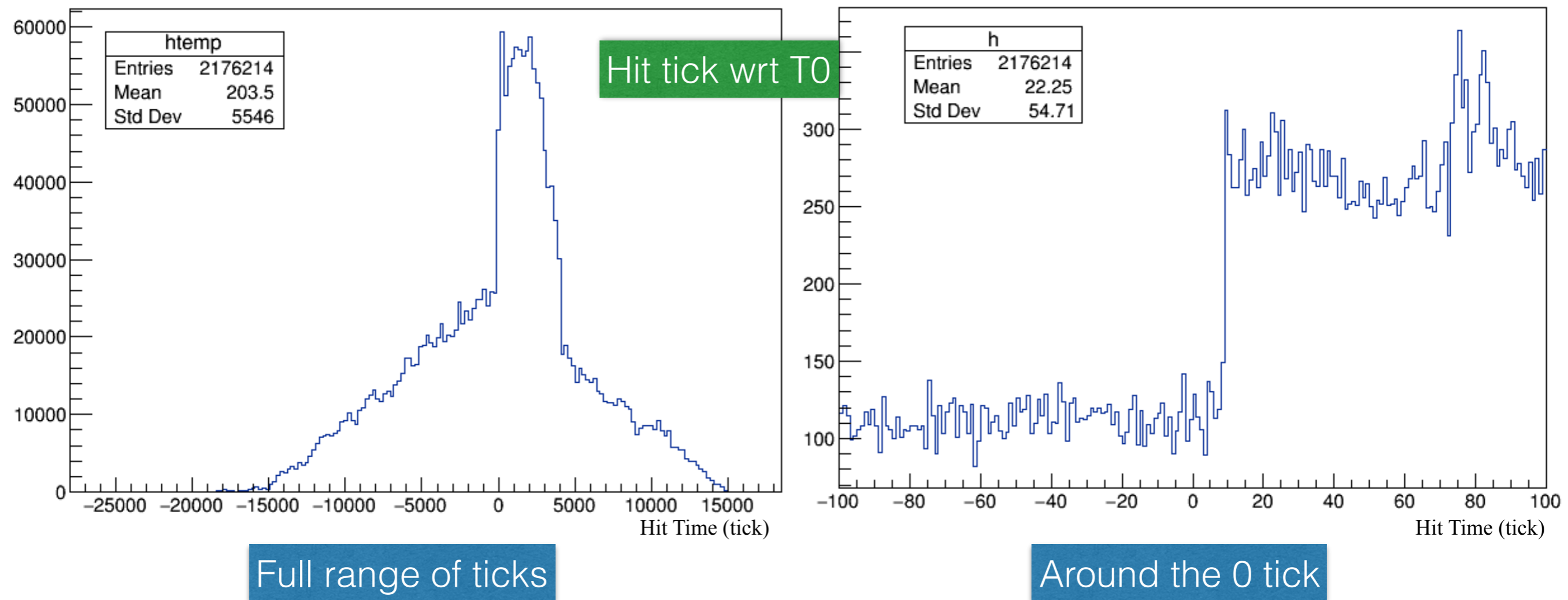


Around the 0 tick

- So, before correcting for T0, there is (obviously) a big edge at 0.

MC Distribution

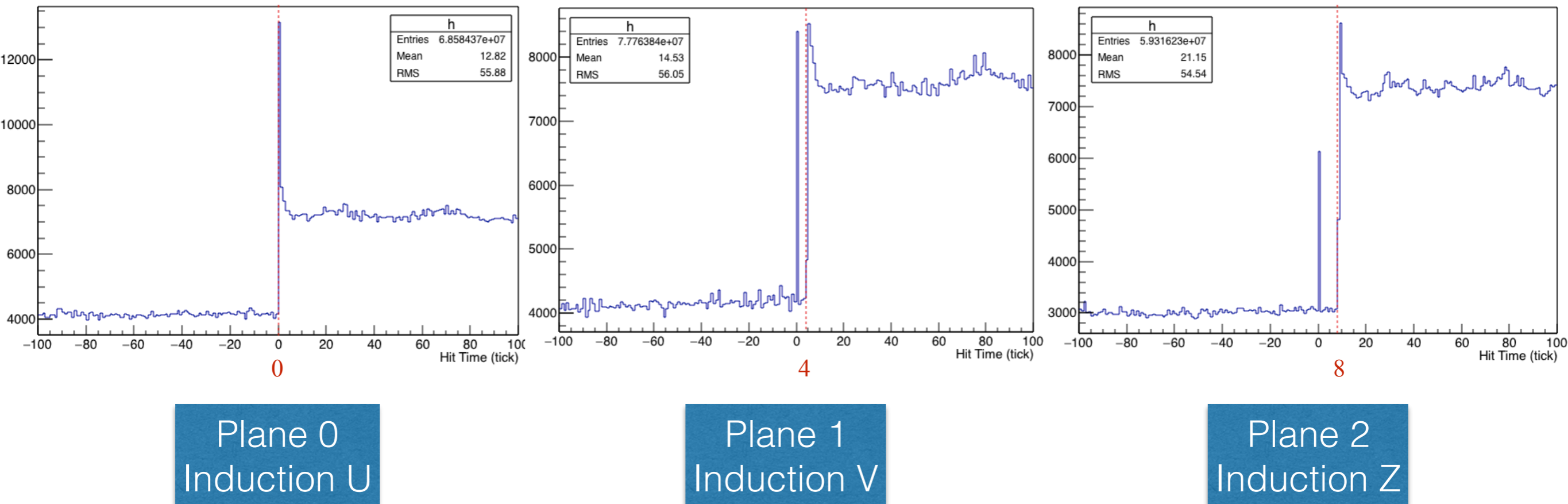
- Now, correct for T0...



- Interesting! Now there's a lot of negative ticks (hits which came before the interaction time), but the leading edge now shifts up to ~9 ticks again.

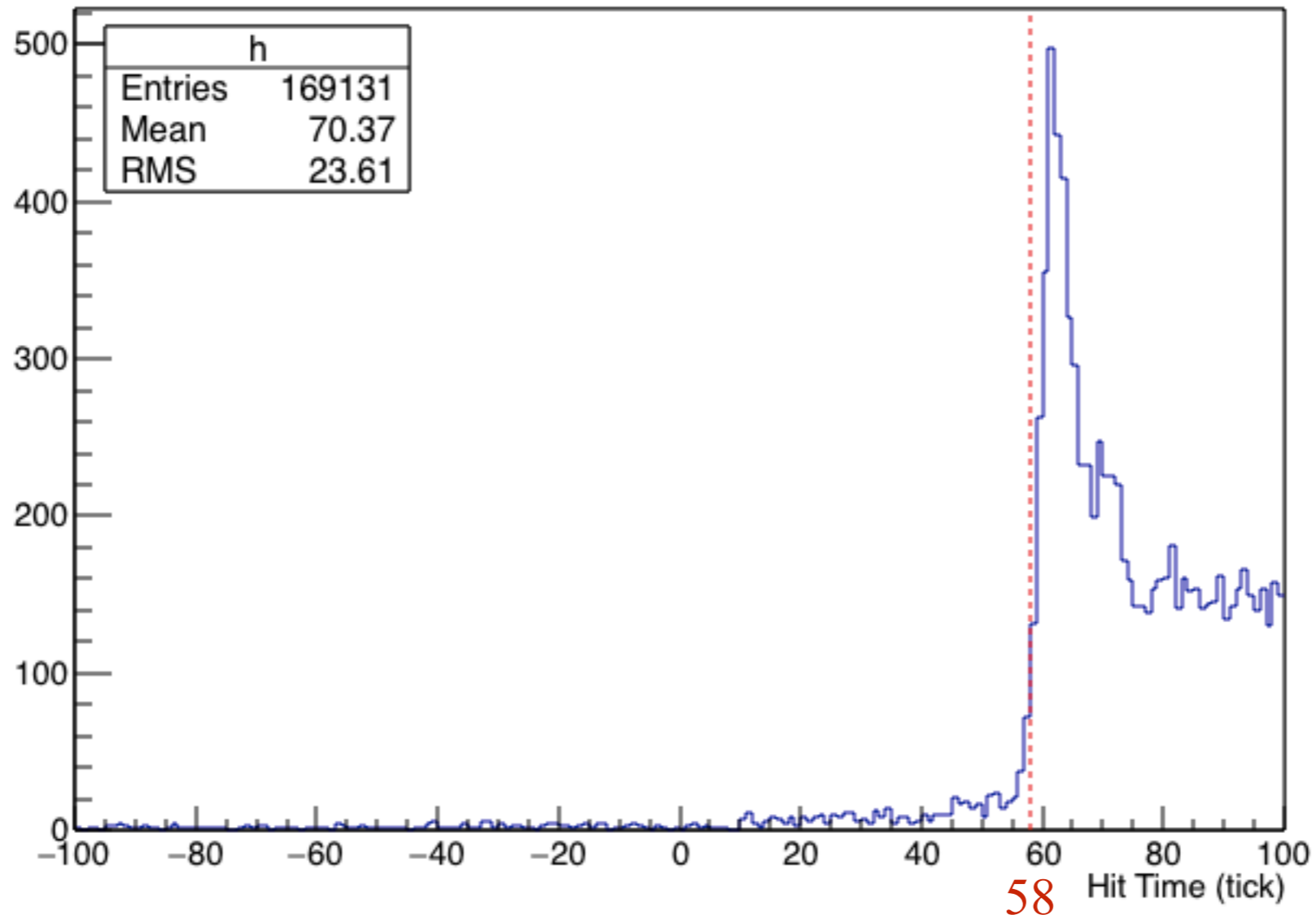
MC Distribution

- T0 corrected hit time for all hits on all planes (not just collection):



- What's going on here?!
- Looks like all times are defined wrt the U plane? Or something similar? Is this what we expect from the simulation? It's not at all what I expected!

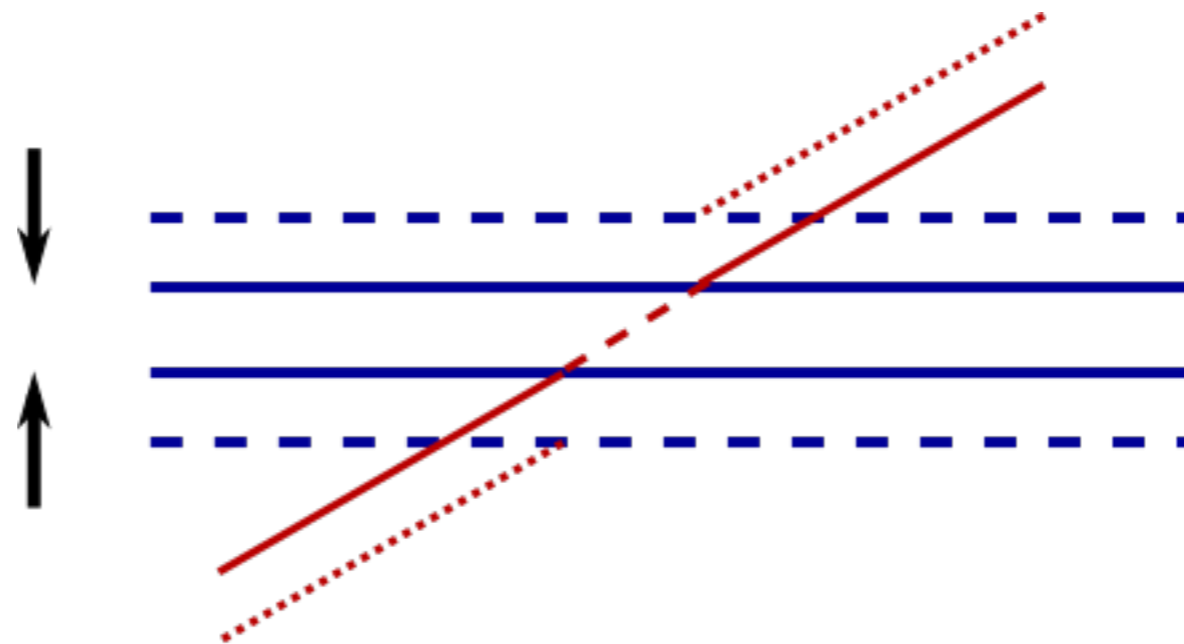
Data Distribution



- Tried to estimate a leading edge from data — a lot less clear than simulation!
- Chose 58 — comments?! NB/ When aligning tracks, determined an offset of 64 ticks.

Measuring APA Width

- Previously, have geometrically aligned track either side of the APA to measure a timing offset. Since we have another way of doing this (~58 ticks, hit time distribution), we can instead align the tracks by varying the APA width in order to measure this.

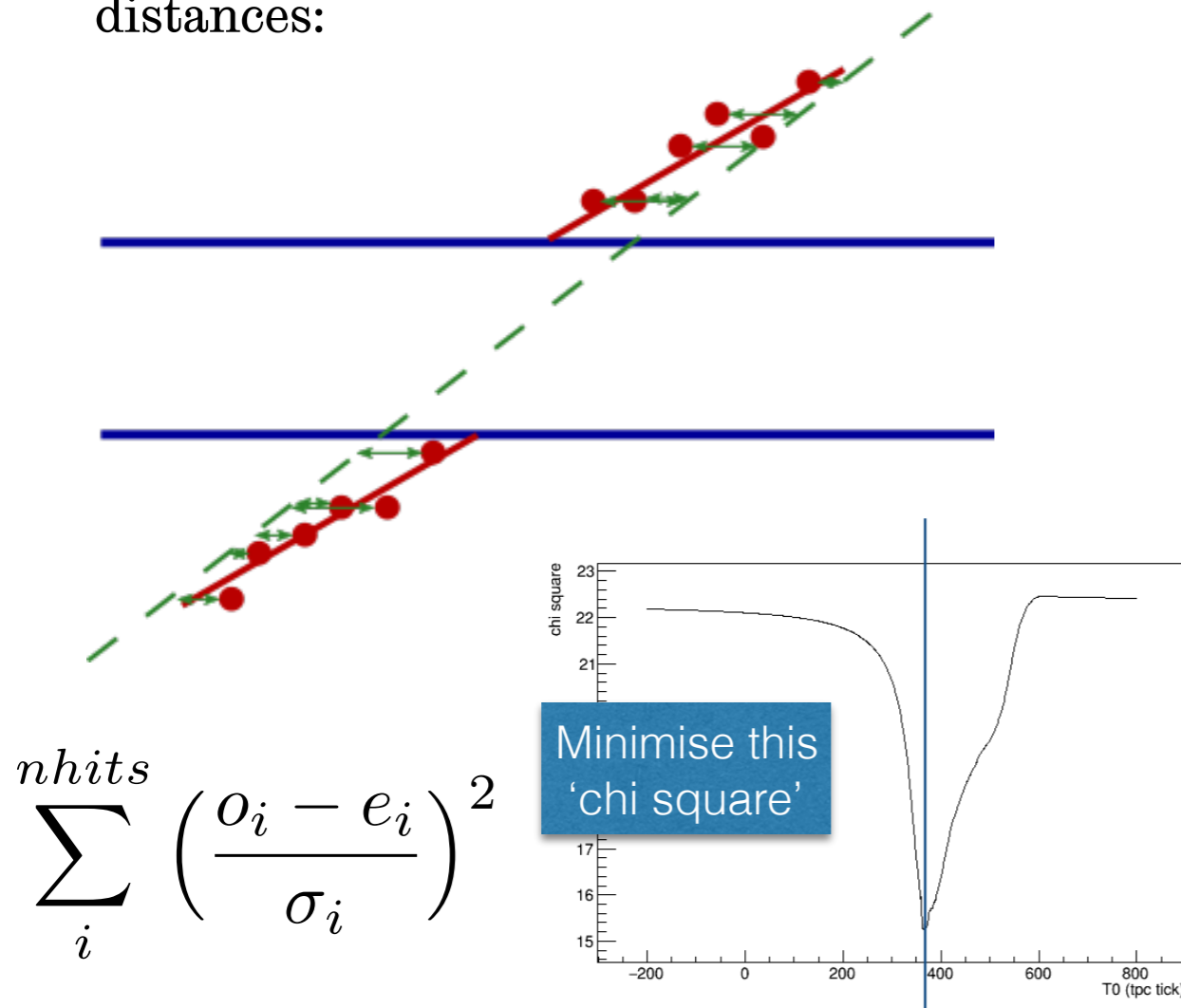


- In LArSoft, the gap between collection planes is 6.031 cm.
- Assume any issues present with the timing in the simulation aren't present in the data!

Reminder: Methods for Aligning Tracks

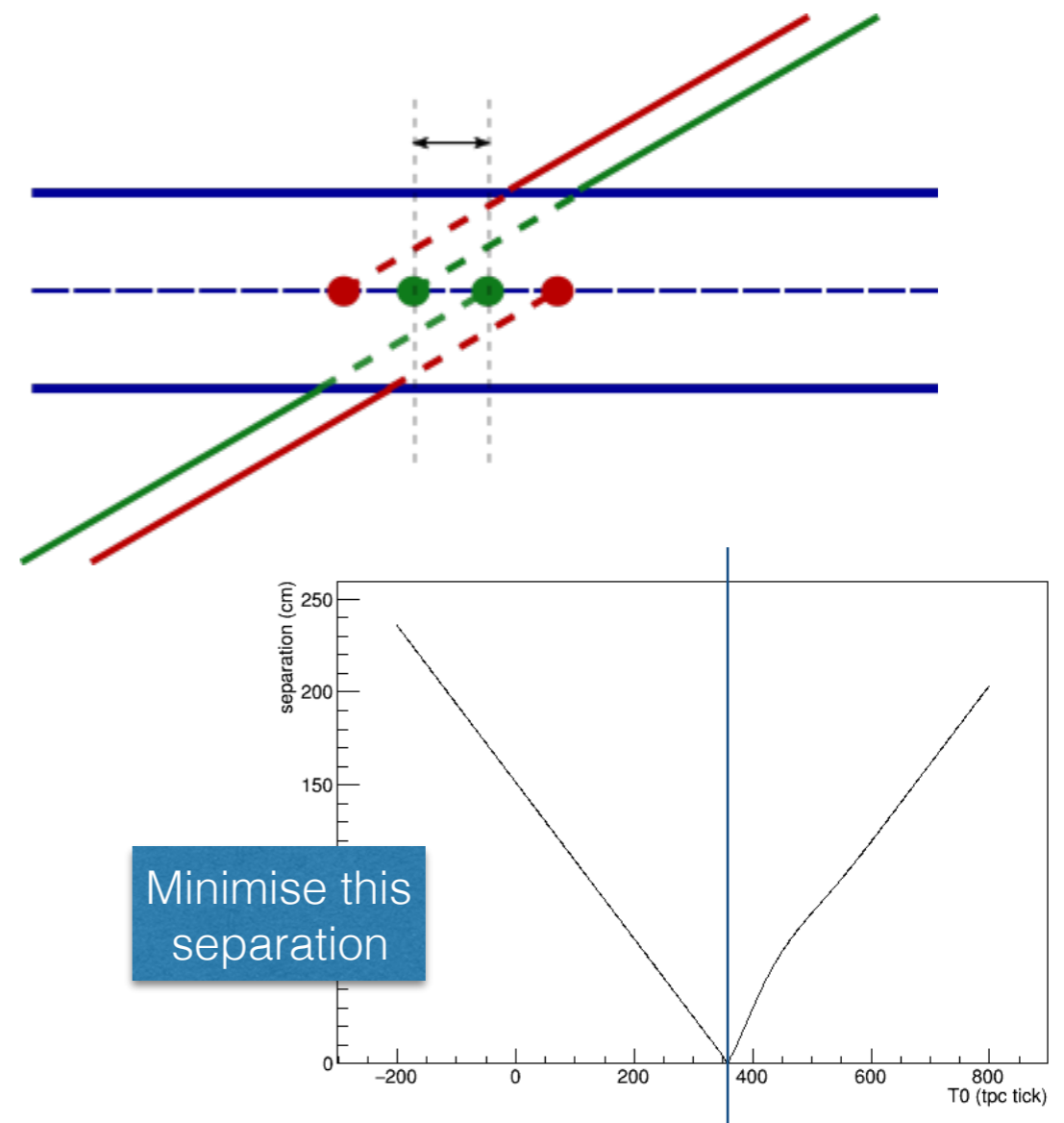
- Fitting residuals:

- Fit straight line through all points;
- Find a 'chi-squared' using distance from line to each hit and the rms of all hit-line distances:

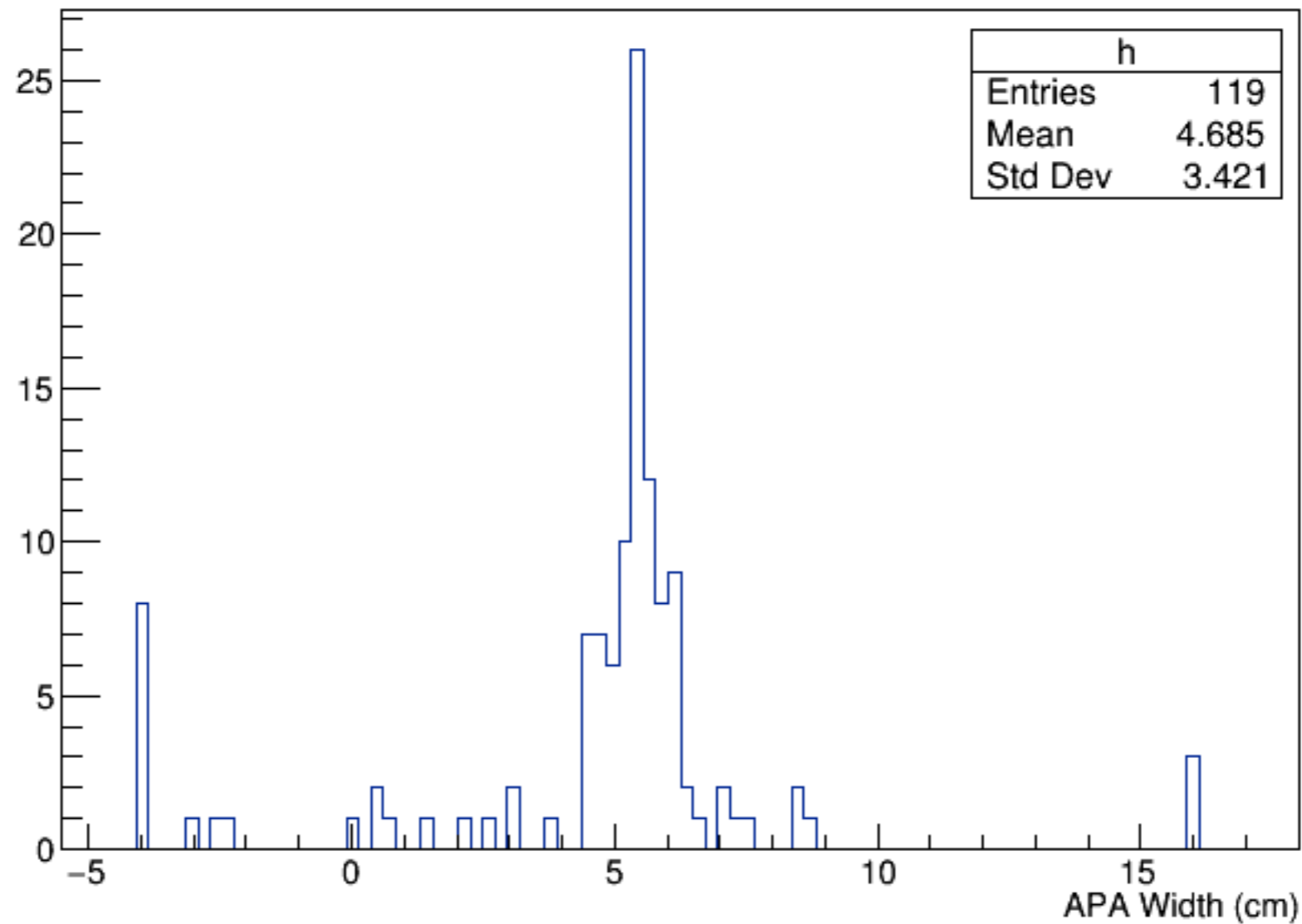


- Minimise separation:

- Fit a line to each segment individually and determine where they intersect at the APA midpoint.



Measuring APA Width



- Peak of distribution = 5.4 cm (c.f. 6.013 cm in LArSoft).

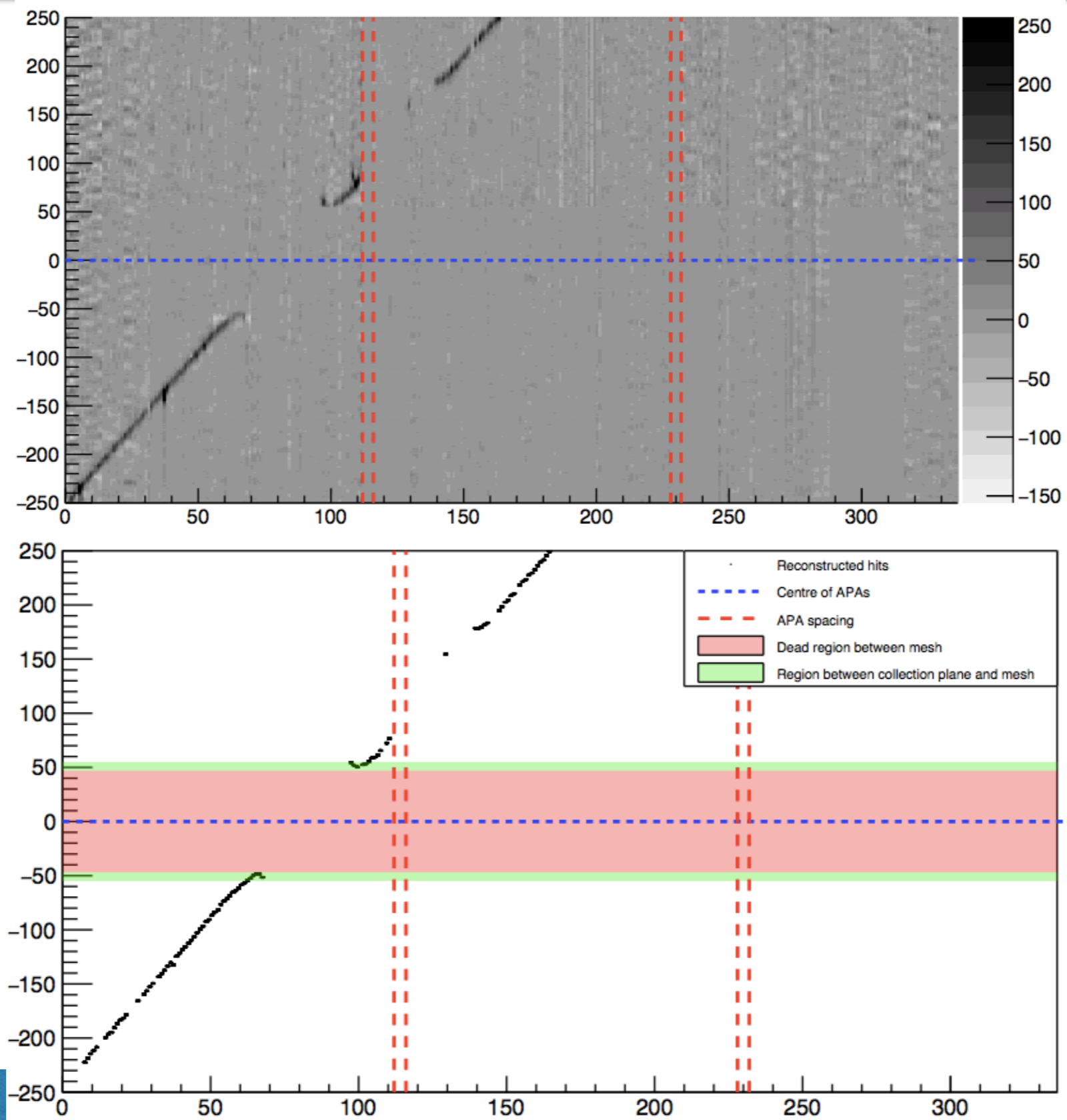
Some Quick Thoughts

- Assuming we believe my estimation of the interaction time as measured from the hit time distributions for data, this is significantly different to that measured by just aligning tracks
 - 64 ticks c.f. 58 ticks (~3 us).
- It's possible this is due to two competing effects: a timing offset and a slight offset (<1cm) in the geometry.
- With an offset of only 58 ticks, the two collection planes would need to be separated by 5.4 cm rather than 6.0 cm for the tracks to align.
- Recall the issue I found with the timestamps being saved in the raw DAQ data? There was an offset of ~26.6 us between the trigger as recorded by the PTB and the RCEs... This is ~54 ticks. I could be convinced the lower edge of the data hit time distribution is as low as 54 ticks (c.f. 58 which I picked); see slide 8.
 - Then everything would be 'explained'! At least to the accuracy of all these methods :)

Some EVDs

- Many people probably saw these before Christmas but I had to leave the meeting early so didn't get much feedback.
- Anything else anyone would be interested in seeing?
- Mark has suggested remaking them with units of mm rather than wire/tick. I can certainly do this if this is desirable.

Some EVDs



Some EVDs

