APA Gap Crossers

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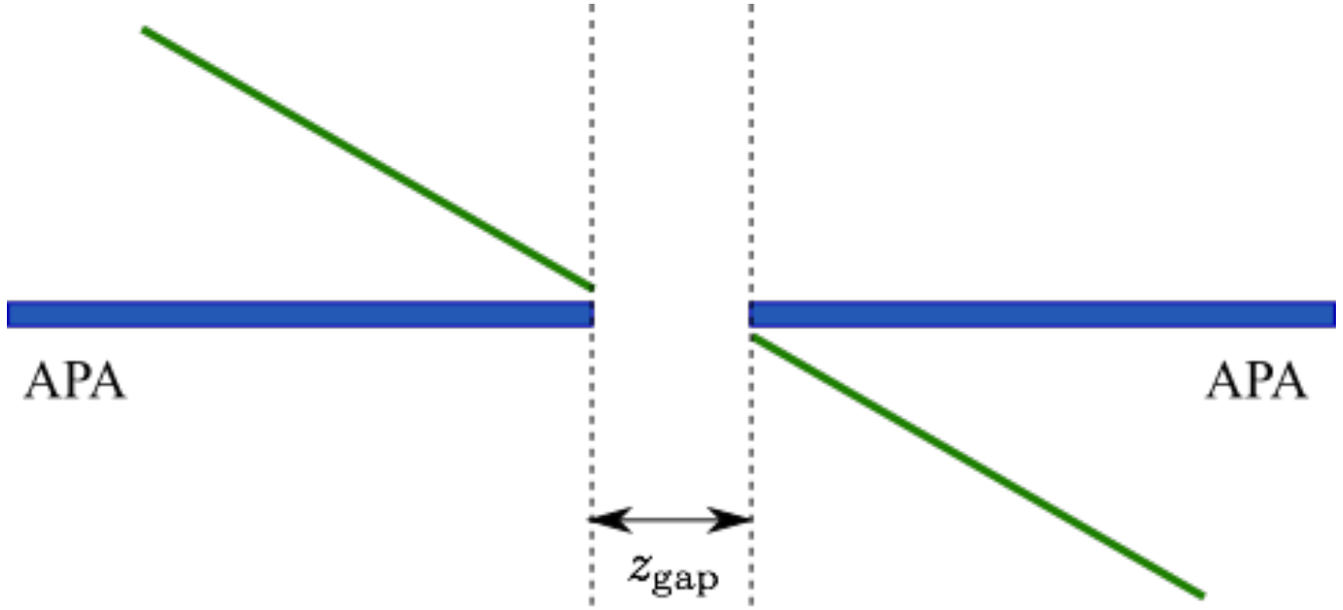
Intro

- Continuing the work I did with the APA crossers and considering APA gap crossers.
- Verifying Animesh's measurements of the gaps from data.
- Since last week:
  - Tidied up my track selection — looks much better now!
  - Attempted to measure all gaps and resolve ambiguities related to the track angle.
    - Found some 'interesting' things out…
  - Had a look to see what we can find out by looking at charge deposited near the gaps.

Measuring APA Gaps

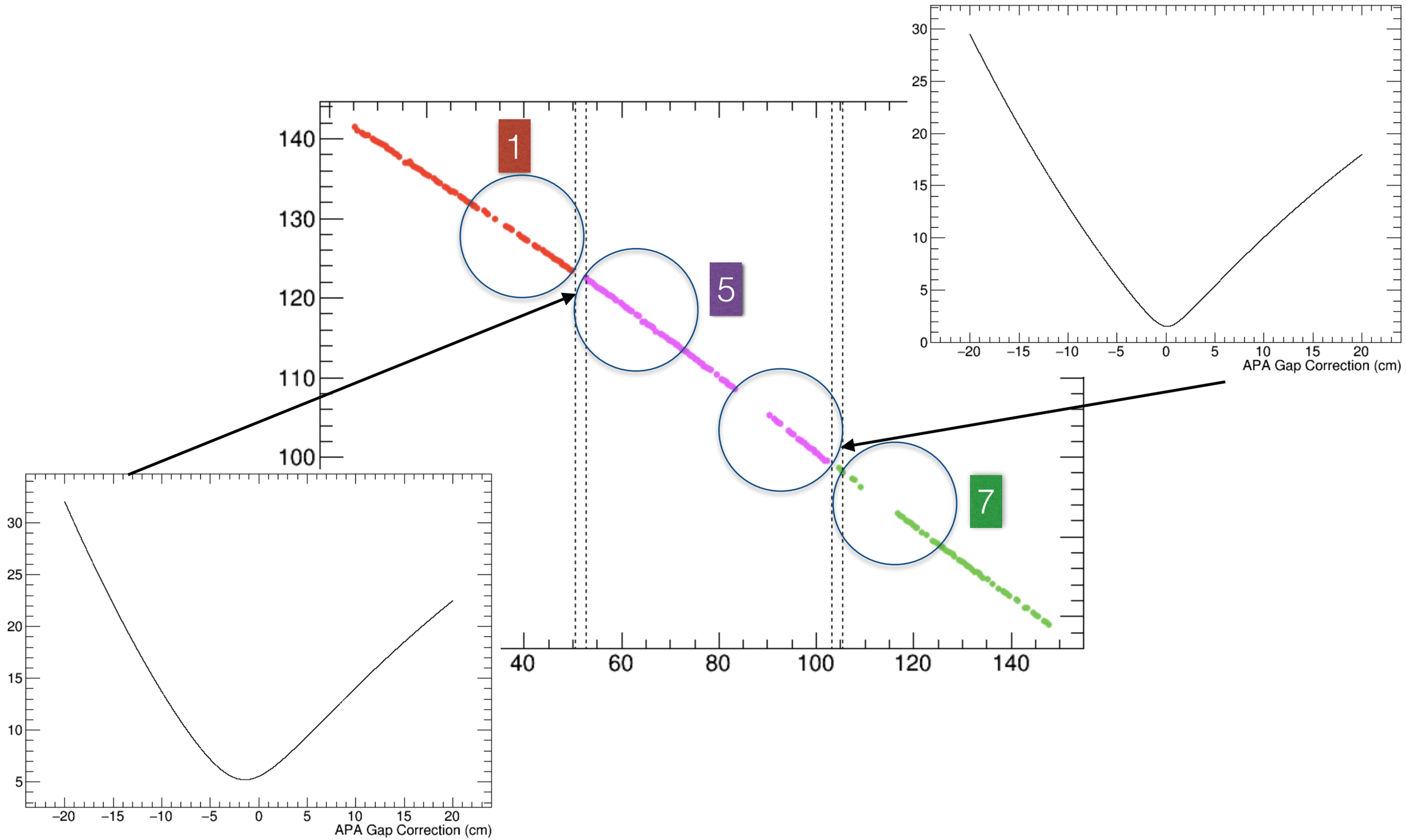
- Same code I used as APA crossers; fit linear regression, vary gap, minimise the residuals.
- Use only hits <15cm from the gap.



$$\sum_{i}^{nhits} \left(\frac{o_i - e_i}{\sigma_i} \right)^2$$

Minimise this ‘chi-square’

Measuring APA Gaps

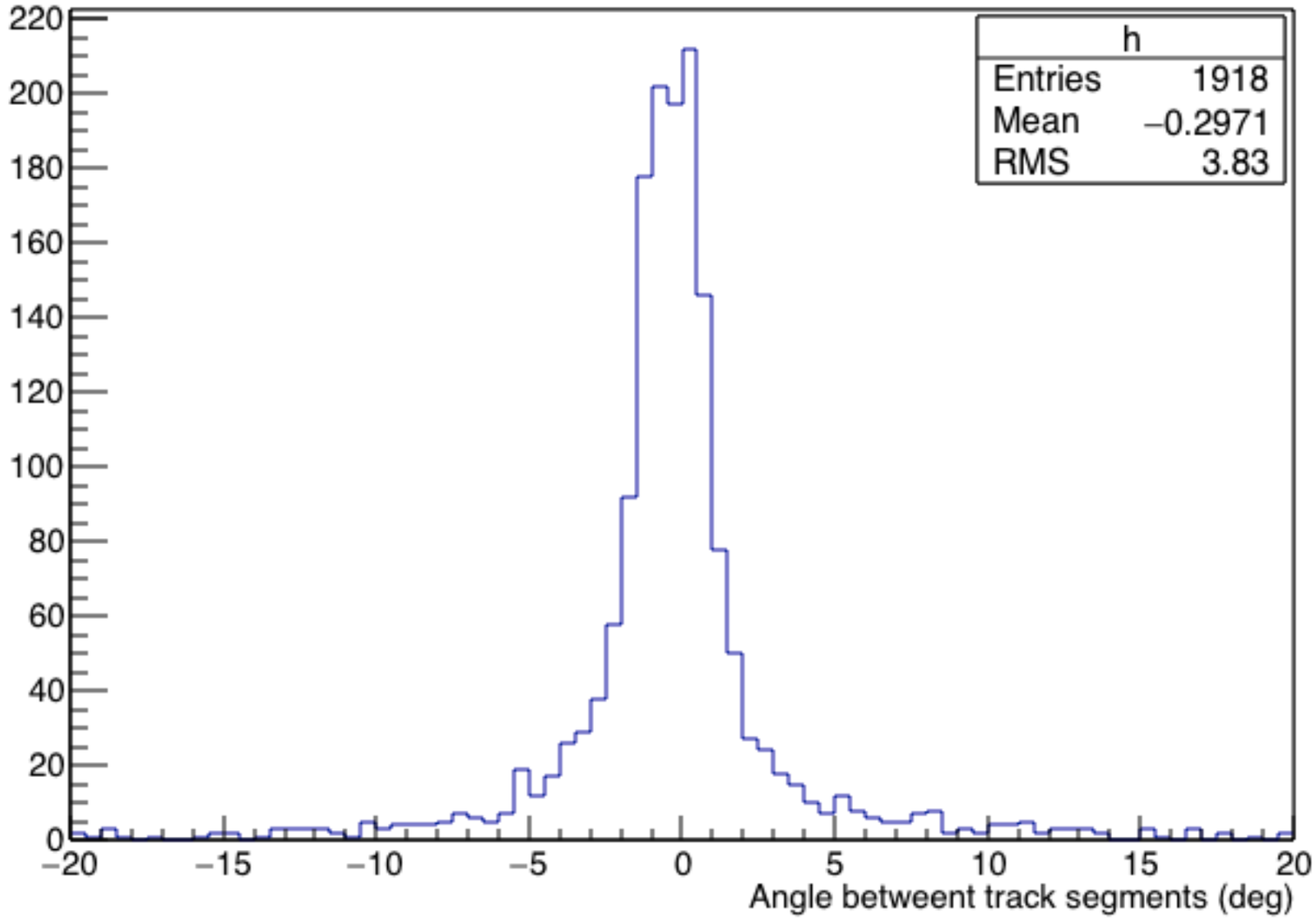


Track Selection

- Take only hits close to the gap.
- Angle between segments < 0.5 degs.
- Number of hits in each segment >= 5.
- Counter gradient >= 3.
- Non-APA crosser.

Angle Resolution

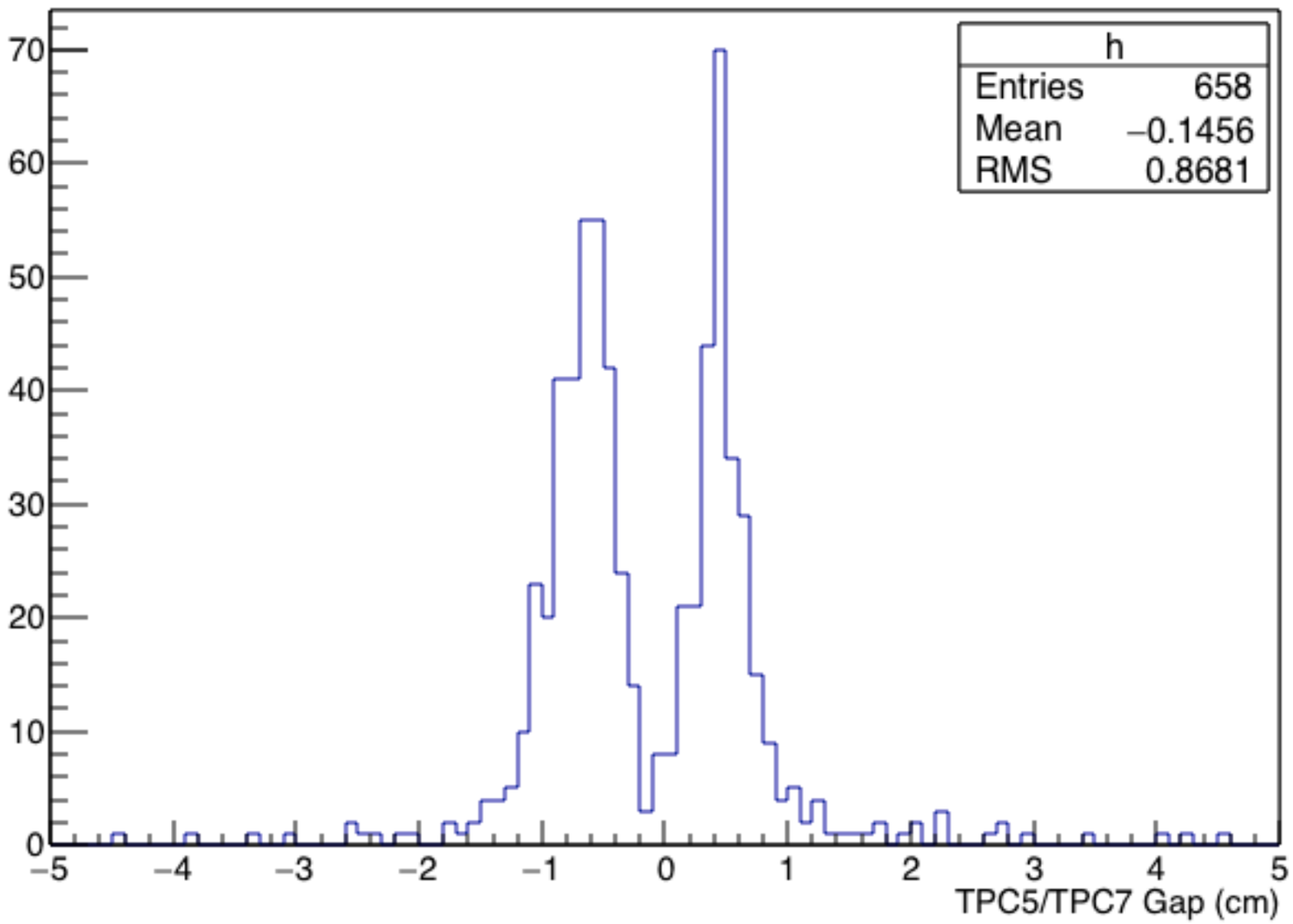
- TPC5/TPC7



- Interesting distribution — could be due to issues discussed later…

TPC5/TPC7 Gap

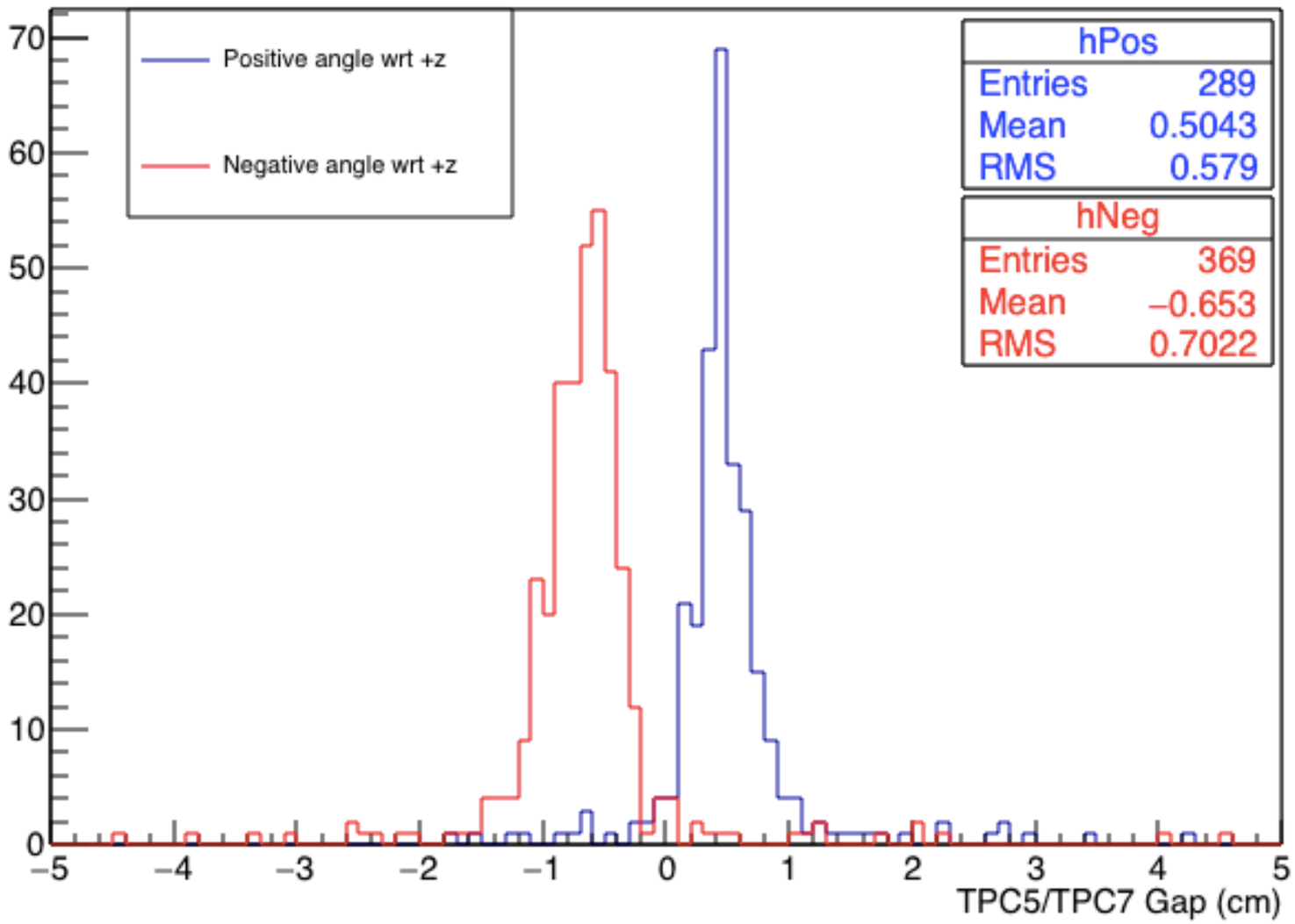
- Very obvious issue related to two peaks:



- Noticed this last week but it's conclusive now!

TPC5/TPC7 Gap

- This can be explained by separating this out by track angle (wrt to the z-direction):



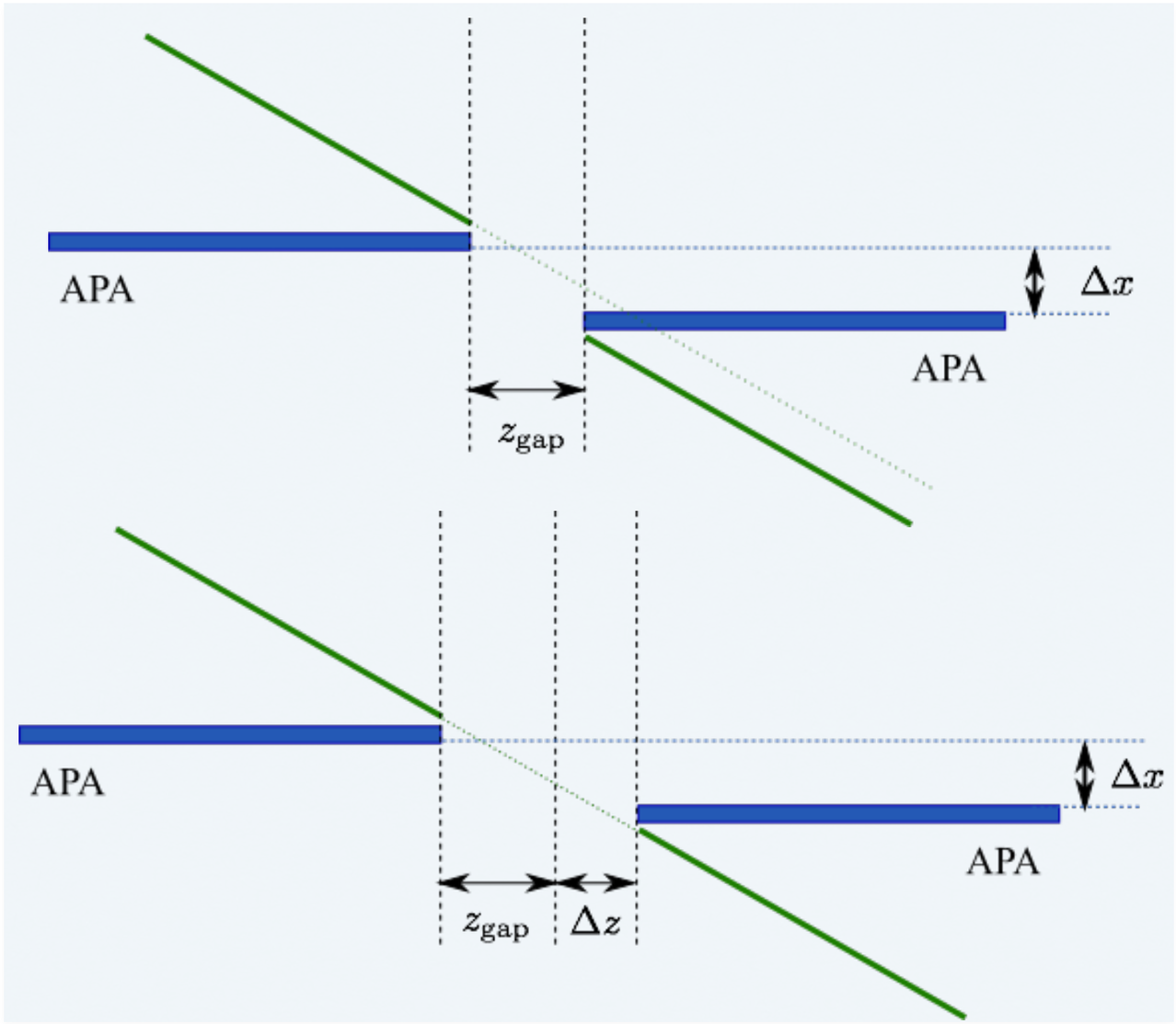
Double Peak

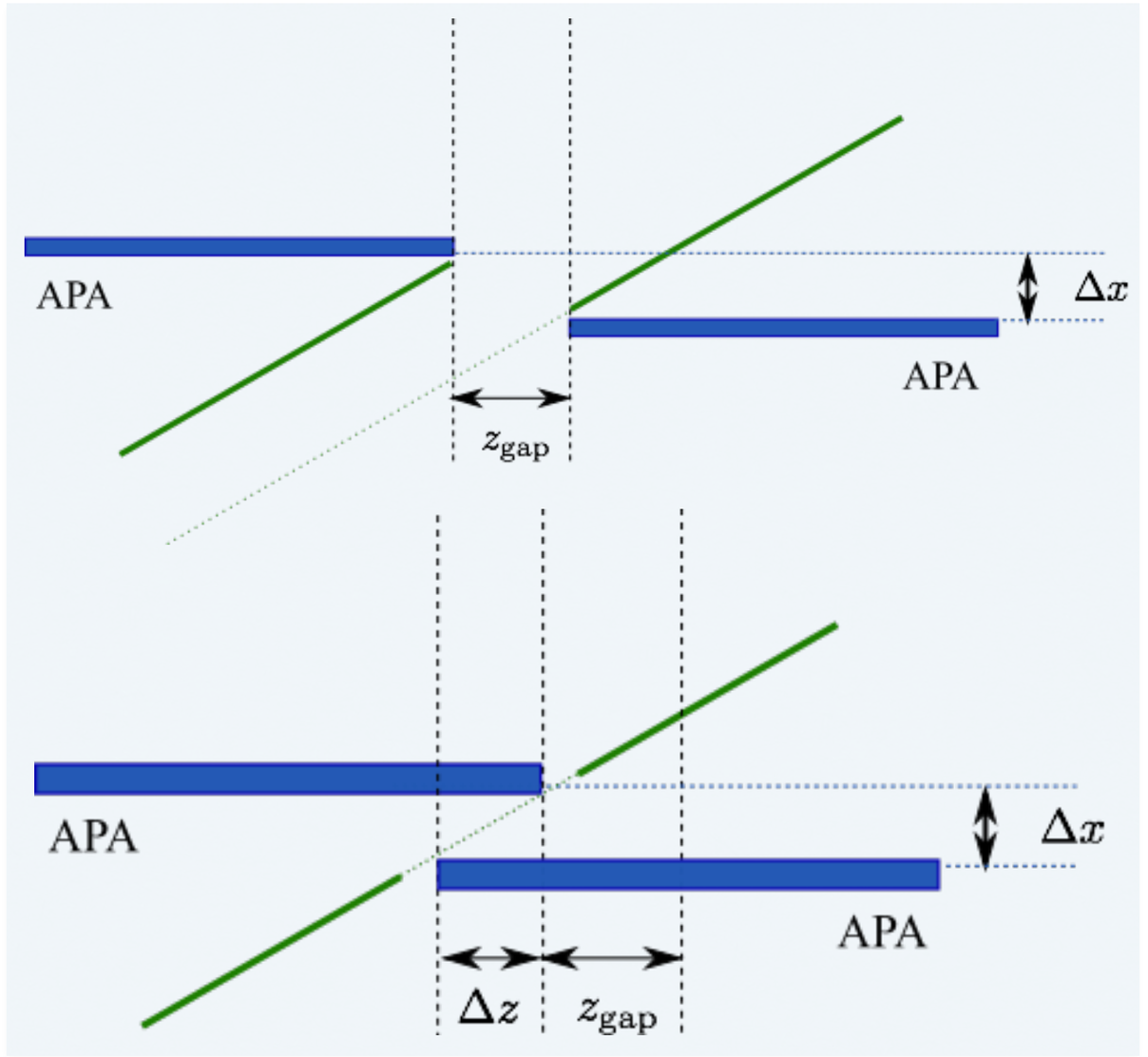
- It looks like there's a bias here — the sign of the gap is affected by the angle the track makes with the APAs.

- Two possibilities:
  - problem with my method;
  - problem with the geometry (my favourite kind of problem…).

Double Peak

- This is could be due to a misalignment in x:

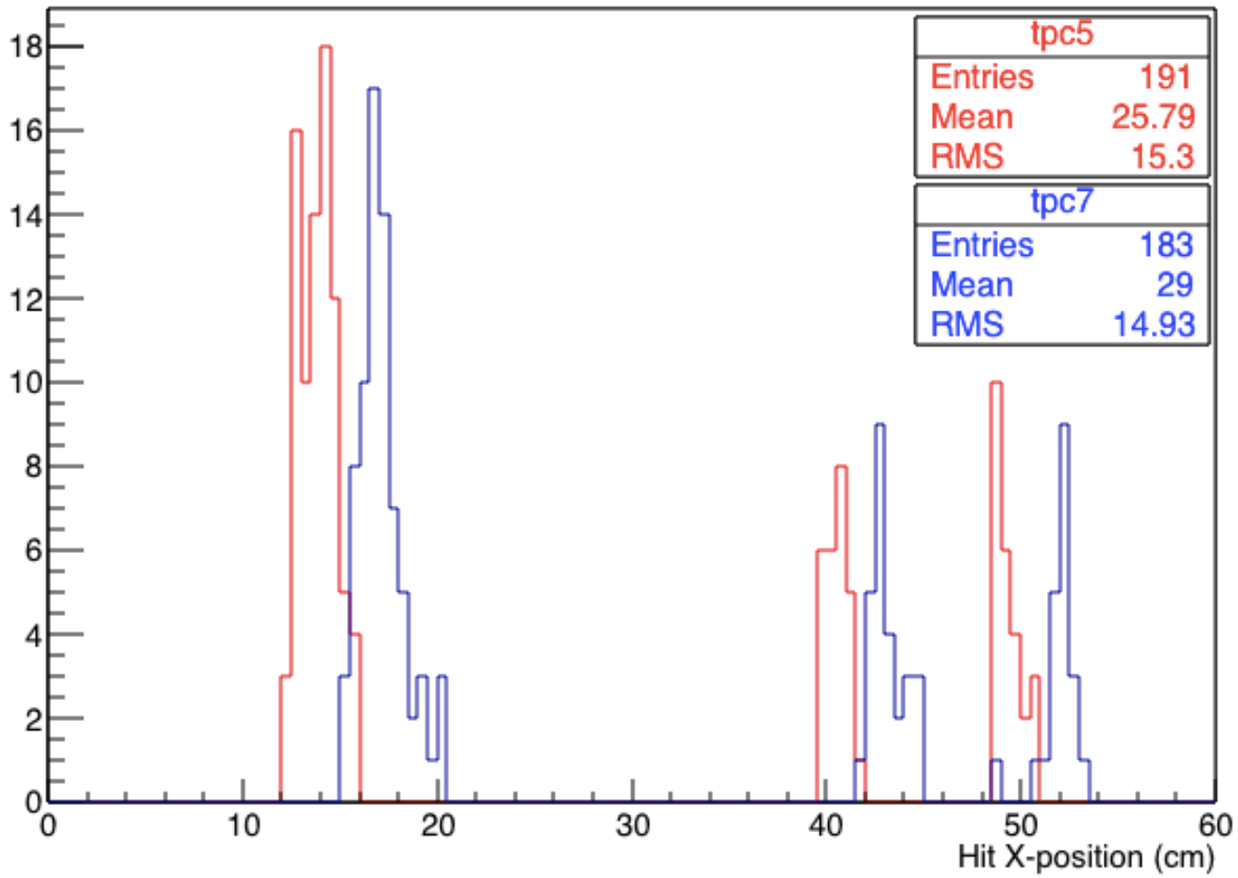


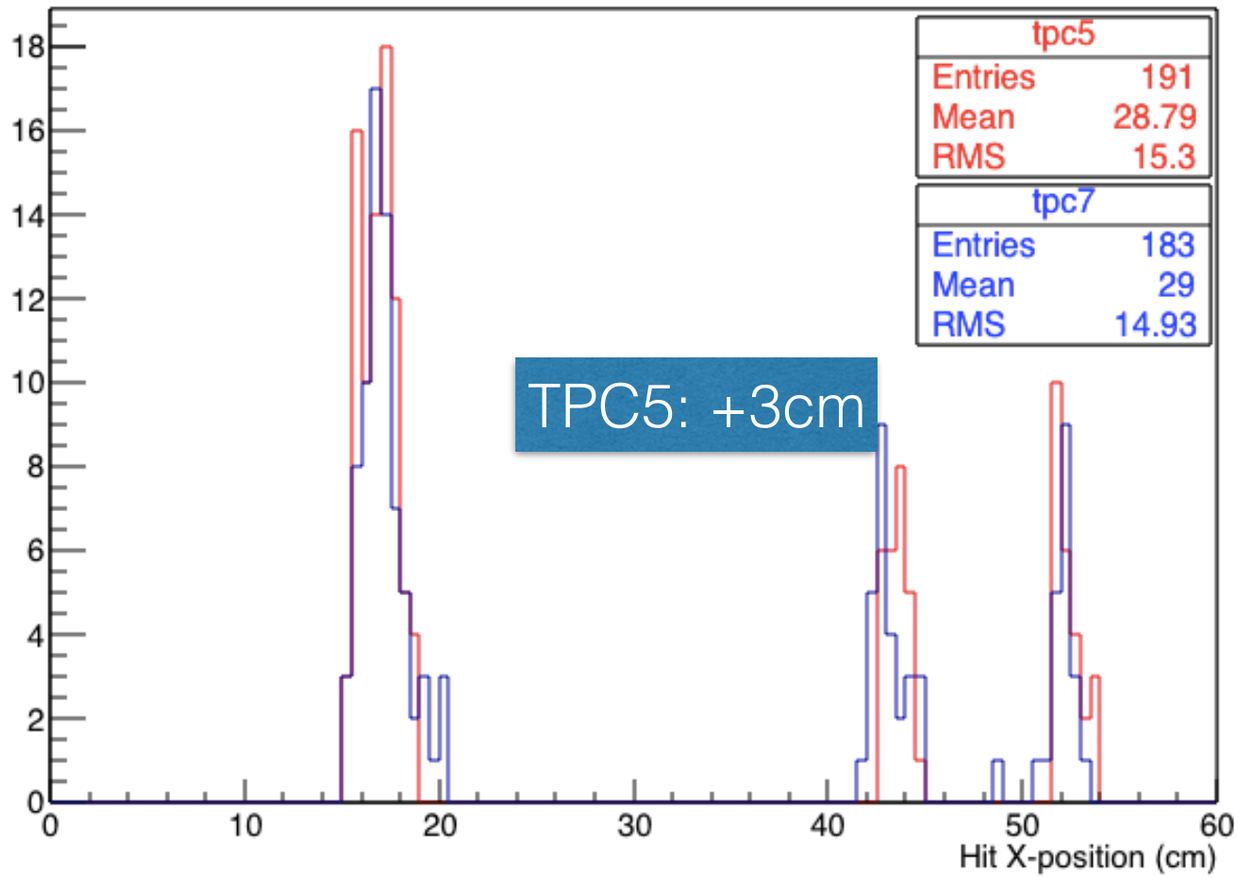


Double Peak

- Distribution of measured x-position of hits coming from opposite counter pairs for TPC5 and TPC7.

- Systematic offset? 3 cm seems very large!

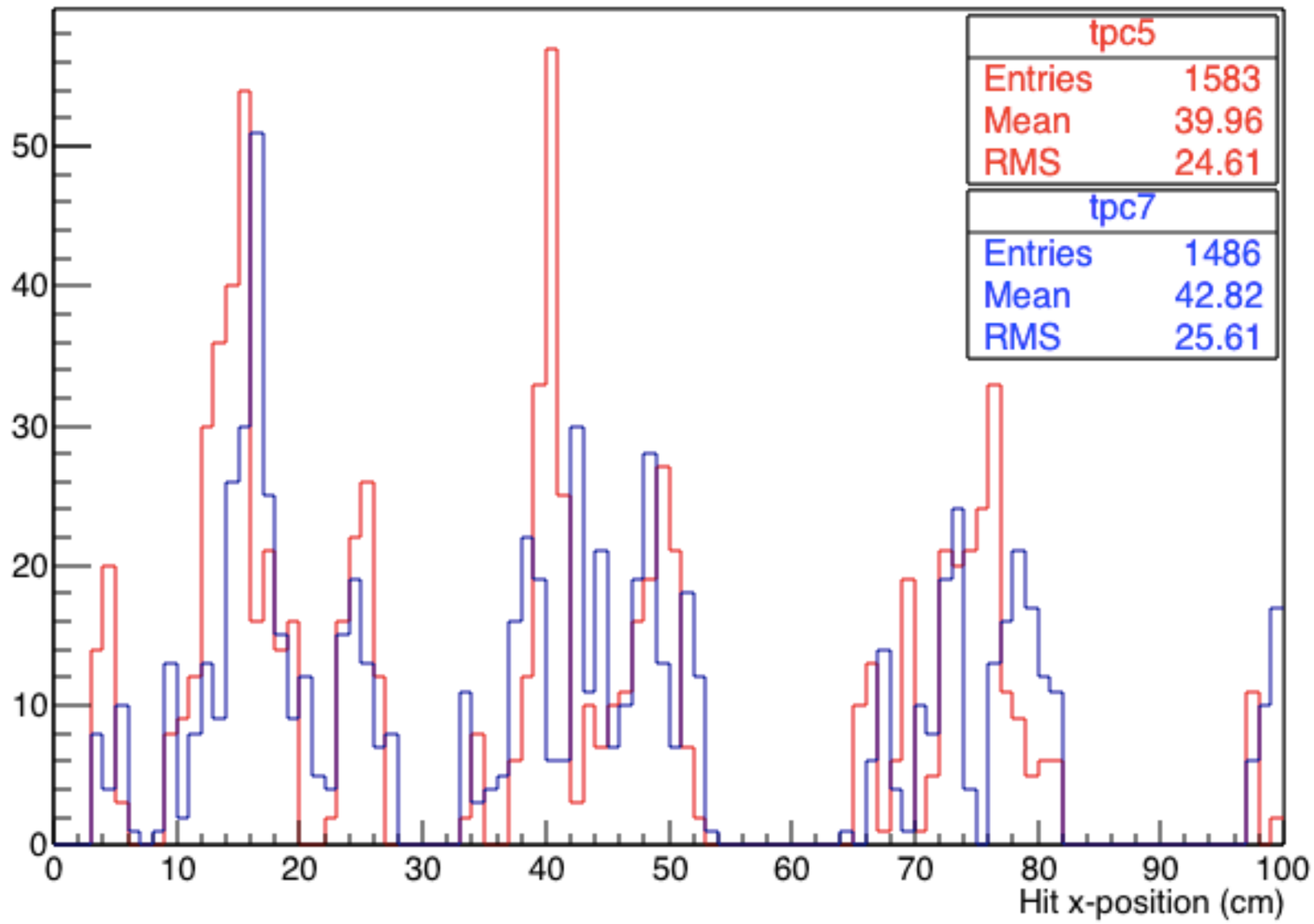




- I applied this offset and recalculated the gaps… got wholly nonsensical results though!

Double Peak

- Looks less obvious with more stats…



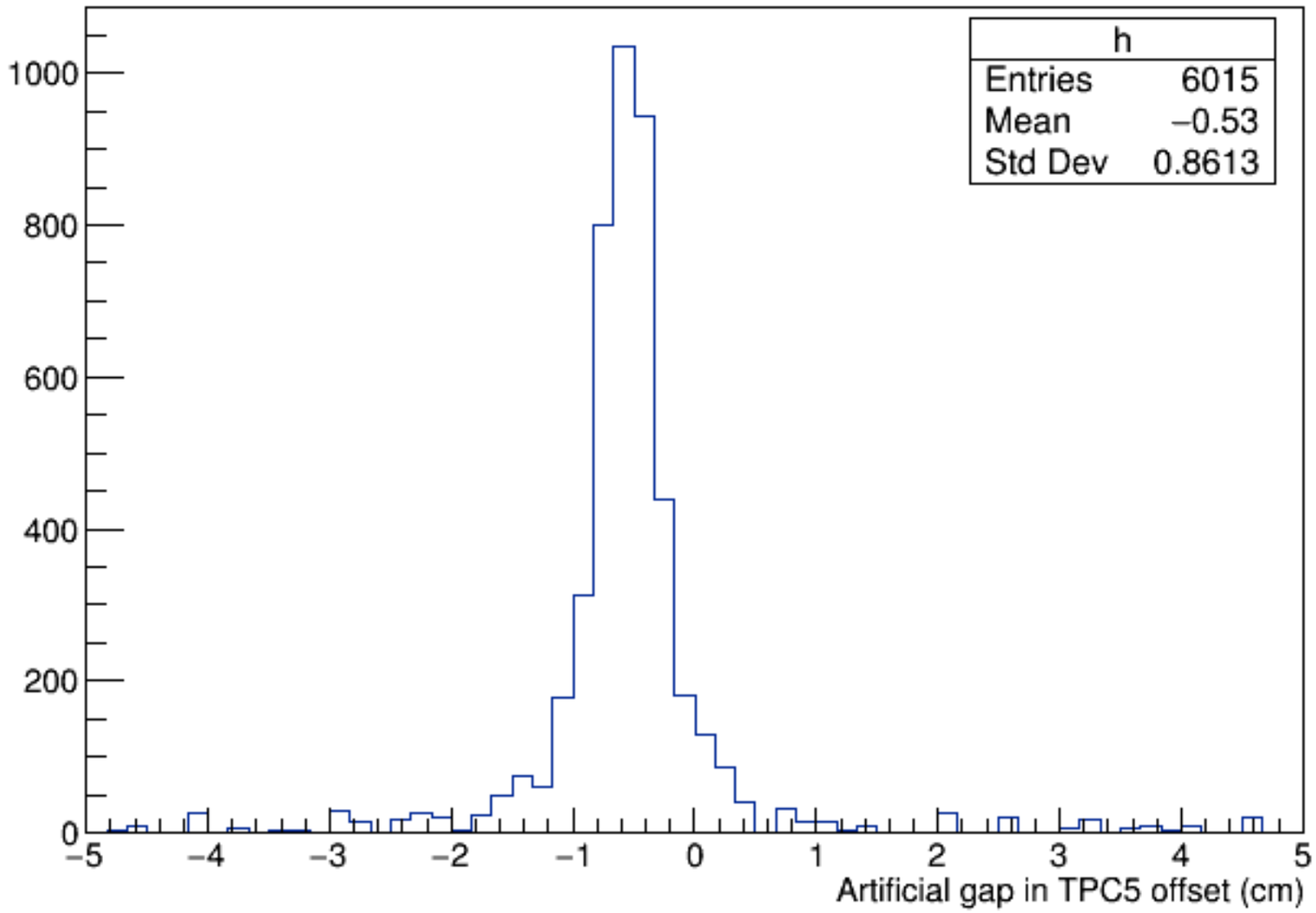
Investigating the Double Peak

- Validated the method in 3 ways:
  - using simulation;
  - artificially considering a few wires in a TPC as a gap (David's suggestion from last week);
  - drawing hits directly!
- The method seems fine…
  - I'm calculating delta z directly, not calculating delta x or anything else first.
  - I'm as certain as I can be that my method is not biased wrt track angle!

Data Validation

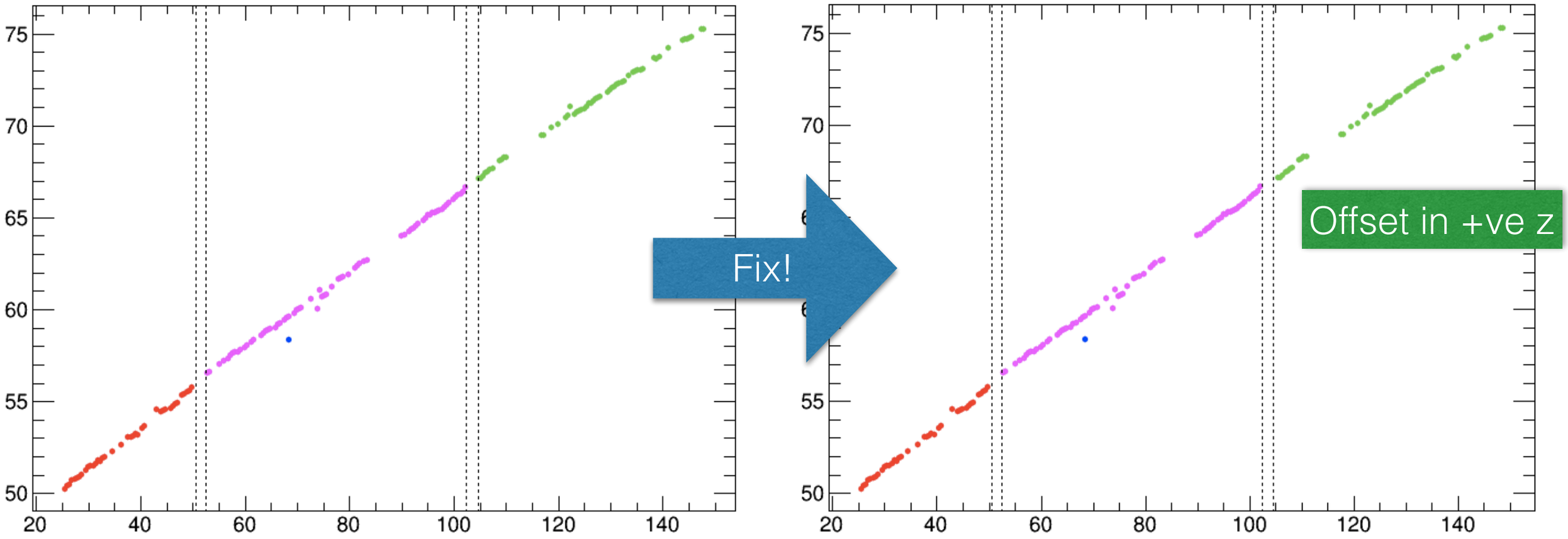
- Artificially created a gap in the one single TPC by removing hits from 3 cm worth of wires in the centre.

- Peaked nicely at 0. The introduced a 0.5 cm offset and measured that:



Observing Hits Directly

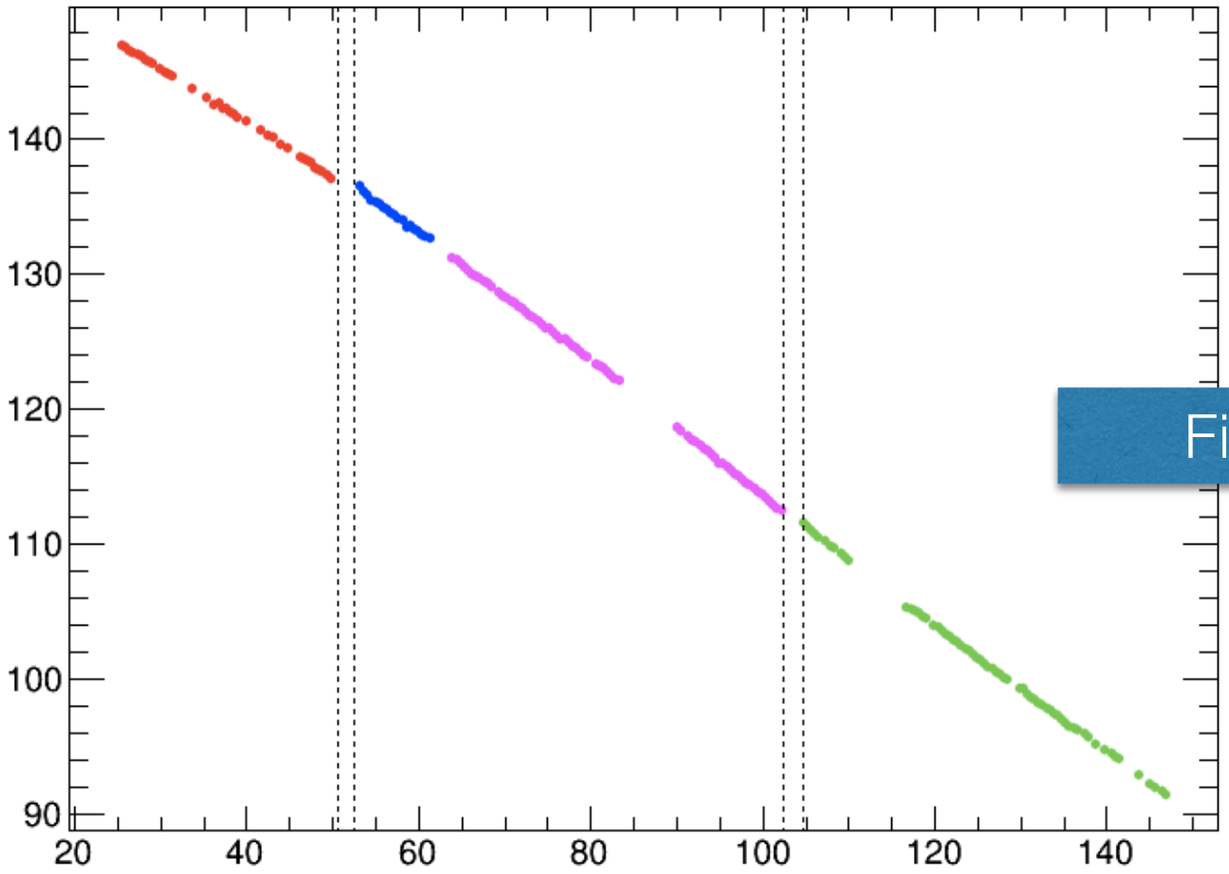
- Positive gradient track:



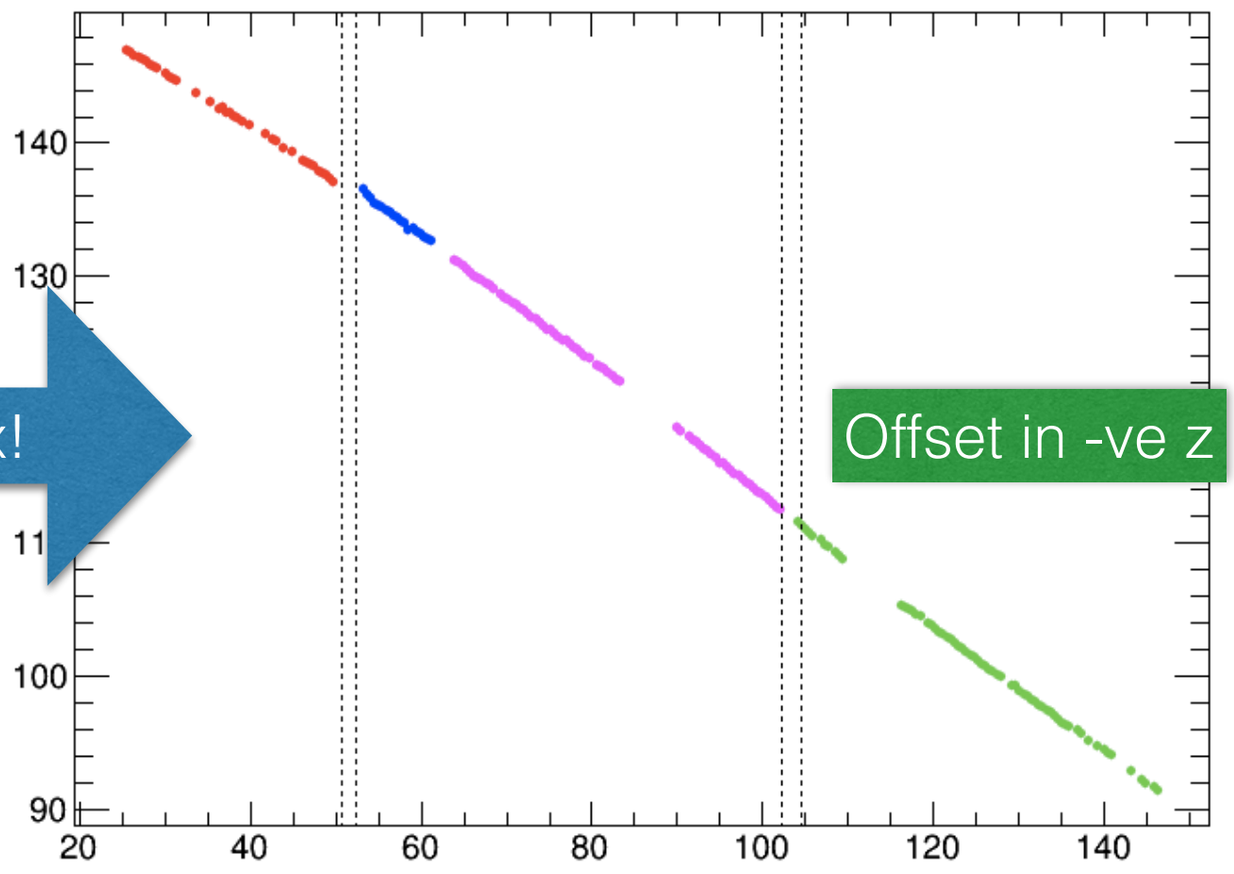
- Seems fine, I've zoomed in on the region with my ruler and it certainly appears to fix things!

Observing Hits Directly

- Negative gradient track:



Fix!



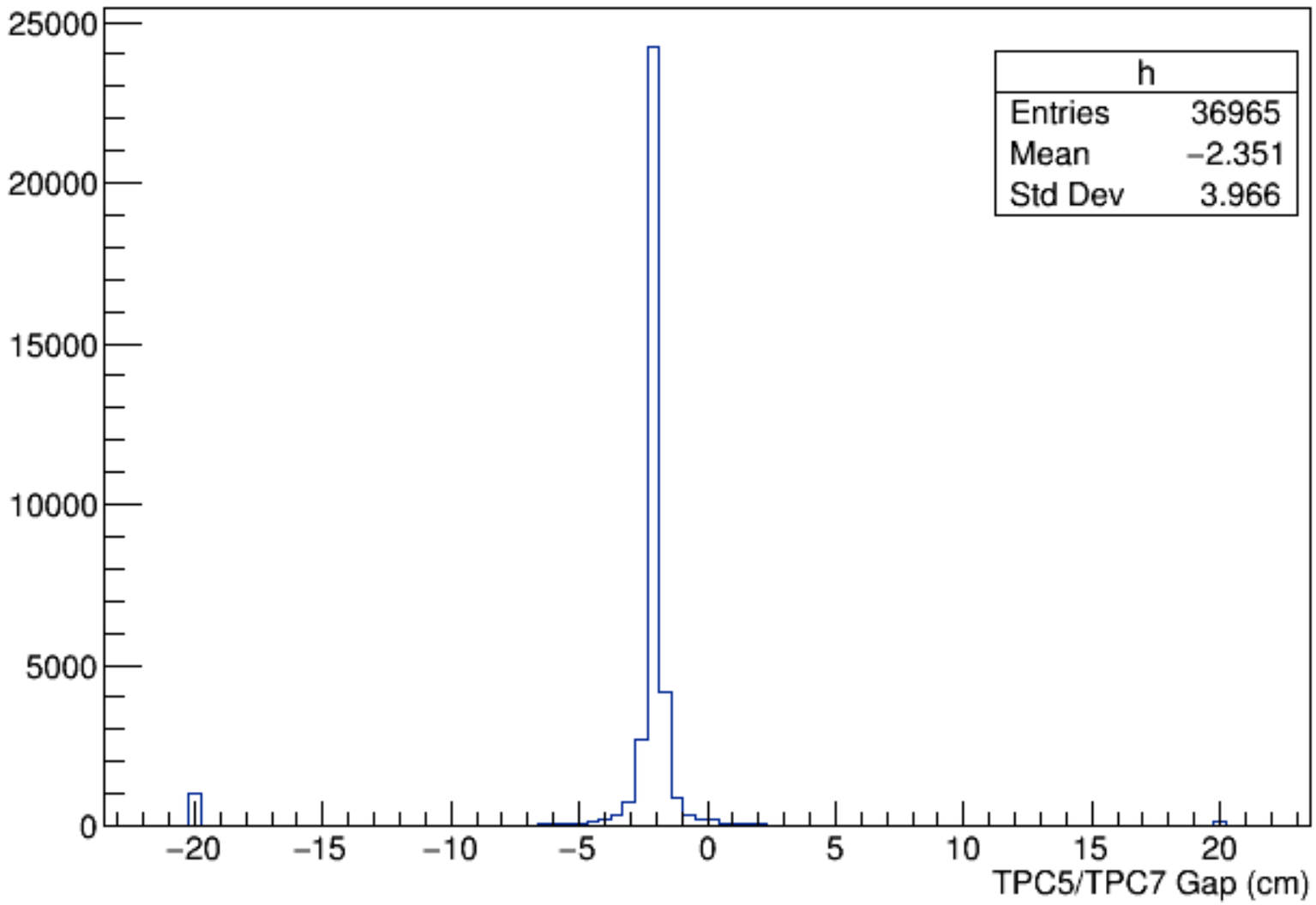
Offset in -ve z

- Again, the fix appears to improve things.

Simulation Validation

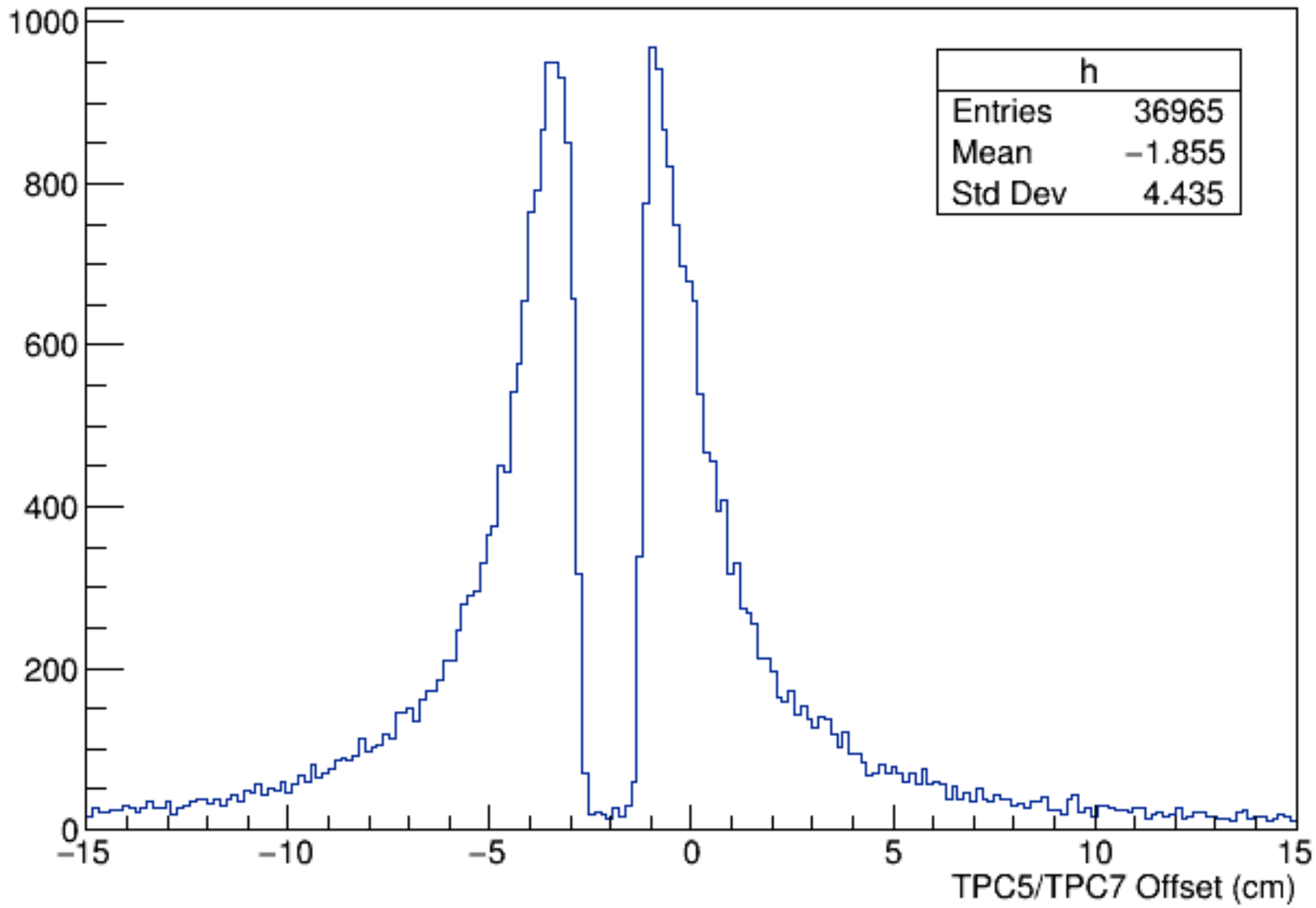
- Only one peak — at 0, as expected.

- I tried introducing a z-offset (2 cm); this is measured very accurately:



Simulation Validation

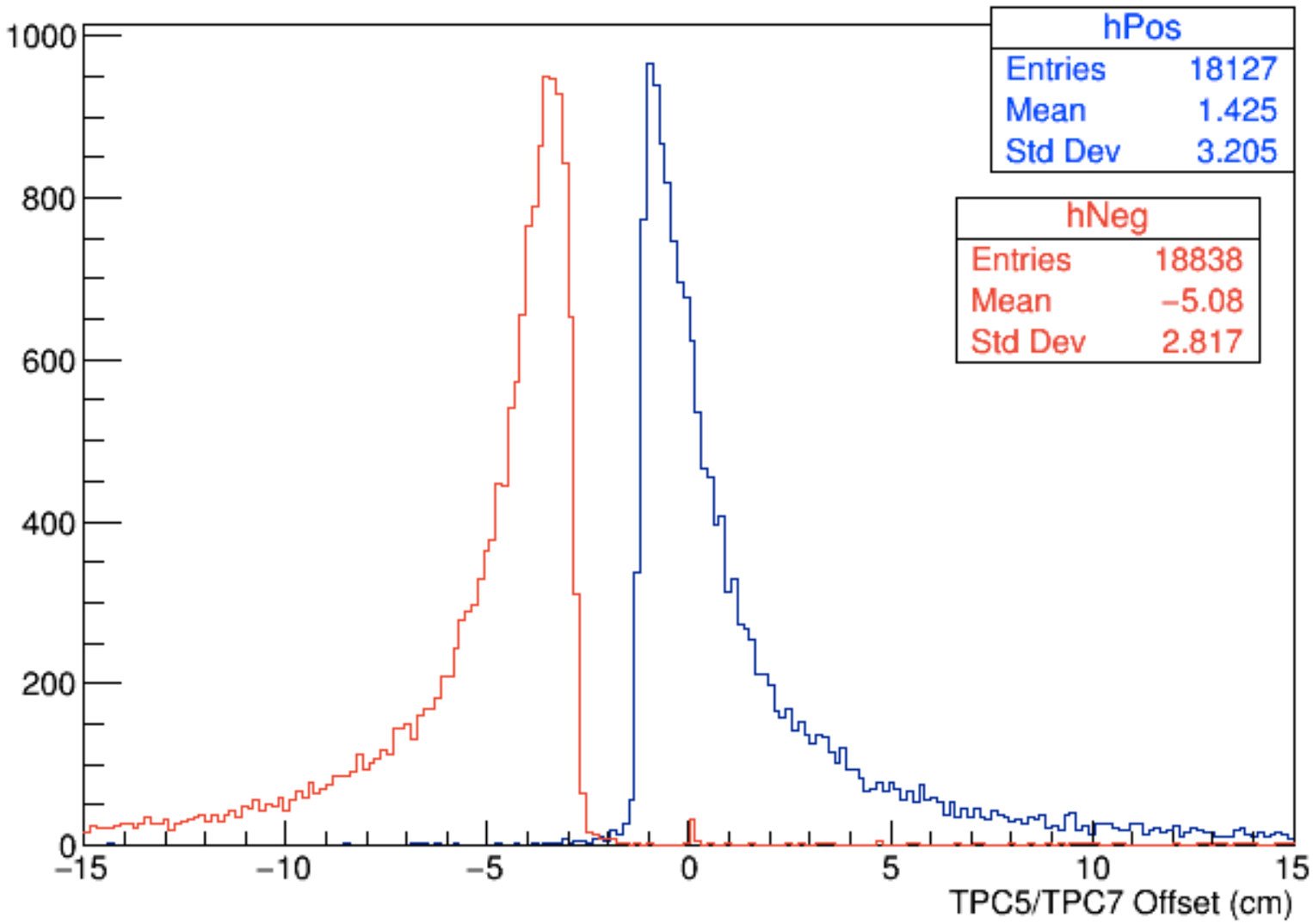
- Now tried introducing an x-offset (0.5 cm).



- This is the exact effect I'm seeing in the data! And the z-offset is where the distribution is minimised.

Simulation Validation

- Now separate out wrt track angle:

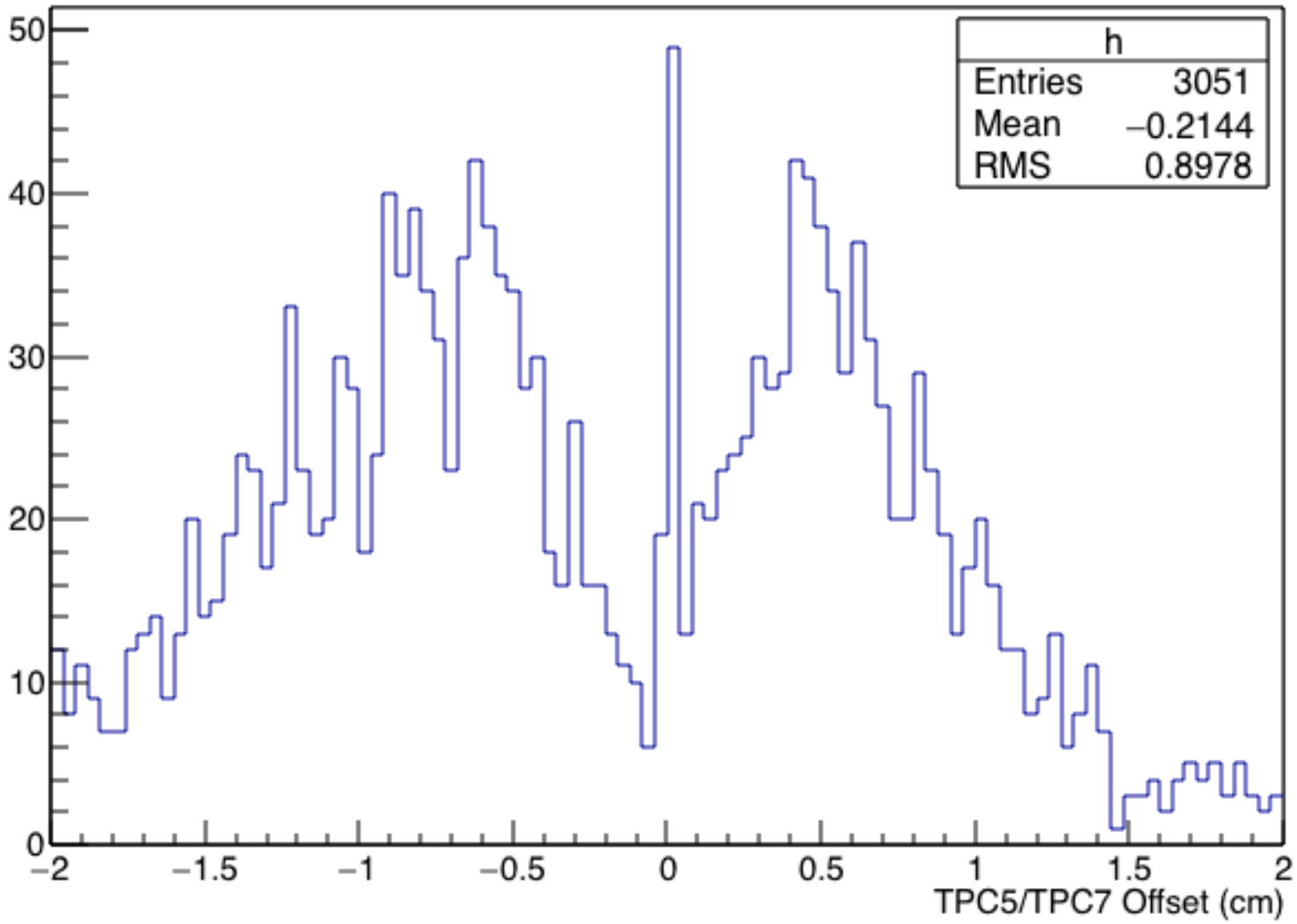


- ‘True offset’ is the maximum of the negative angle distribution and the minimum of the positive angle distribution.

Observations

- I'm convinced that the issue here is an offset in x between the APAs.
- A shift in -ve x for TPC7 would fix the offsets on both slides 18 and 19.
- Problem: Animesh hasn't seen the same thing. However, it looks like there may be hints…
  - e.g. Slides 11&12 from last week: link.
  - The binning in most of these plots wouldn't show this.
- Next problem: it is impossible to separate out the effects of z offset and x offset (using these tracks only).

Back to TPC5/TPC7 Gap

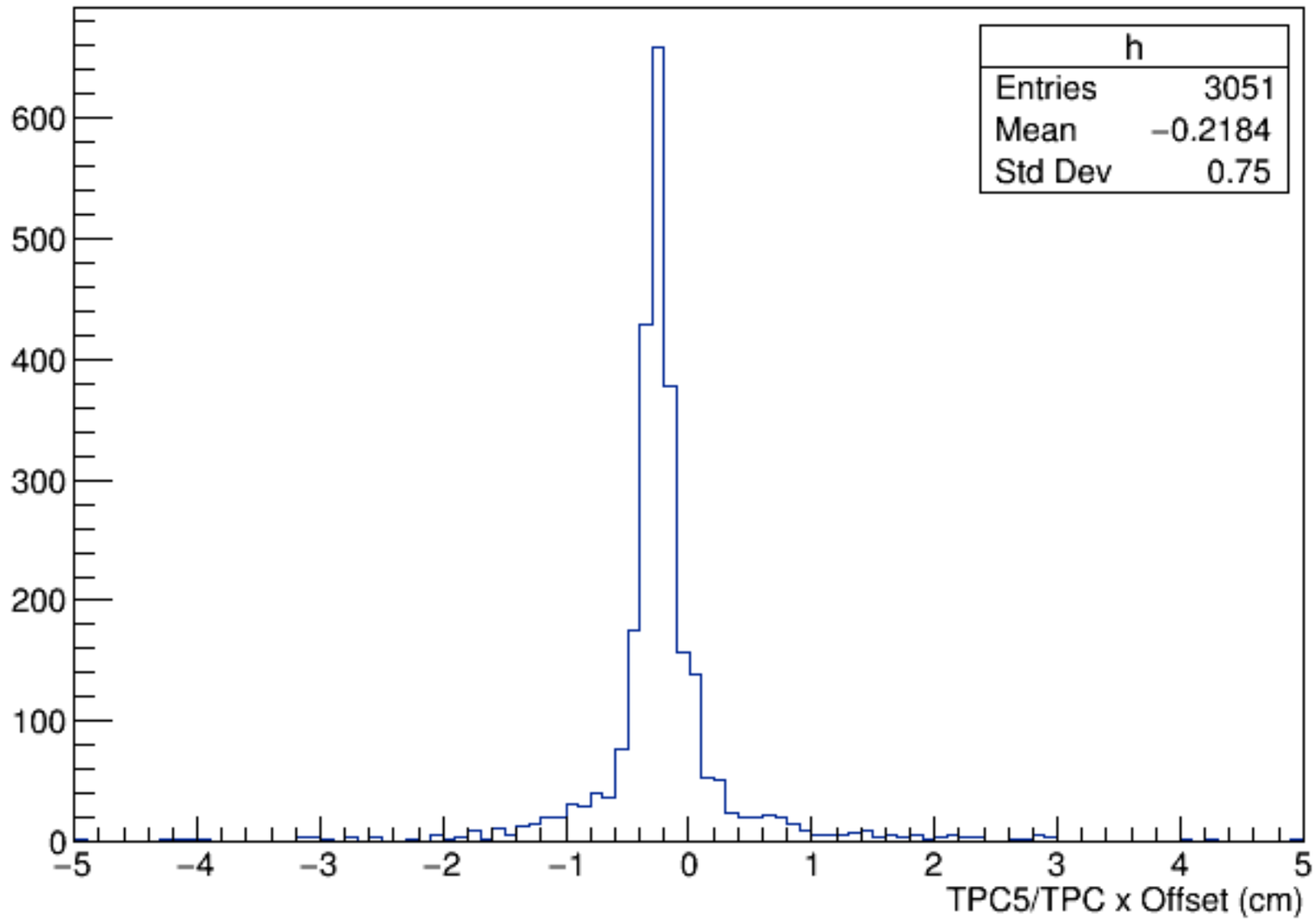


- Using what is implied from the simulation, assuming the model of both x-offset and z-offset, measure the z-offset by minimising the distribution.

- -0.1 cm.

Back to TPC5/TPC7 Gap

- Instead of measuring z-gap, instead use these tracks to measure x-gap (with z-offset set to -1 mm):

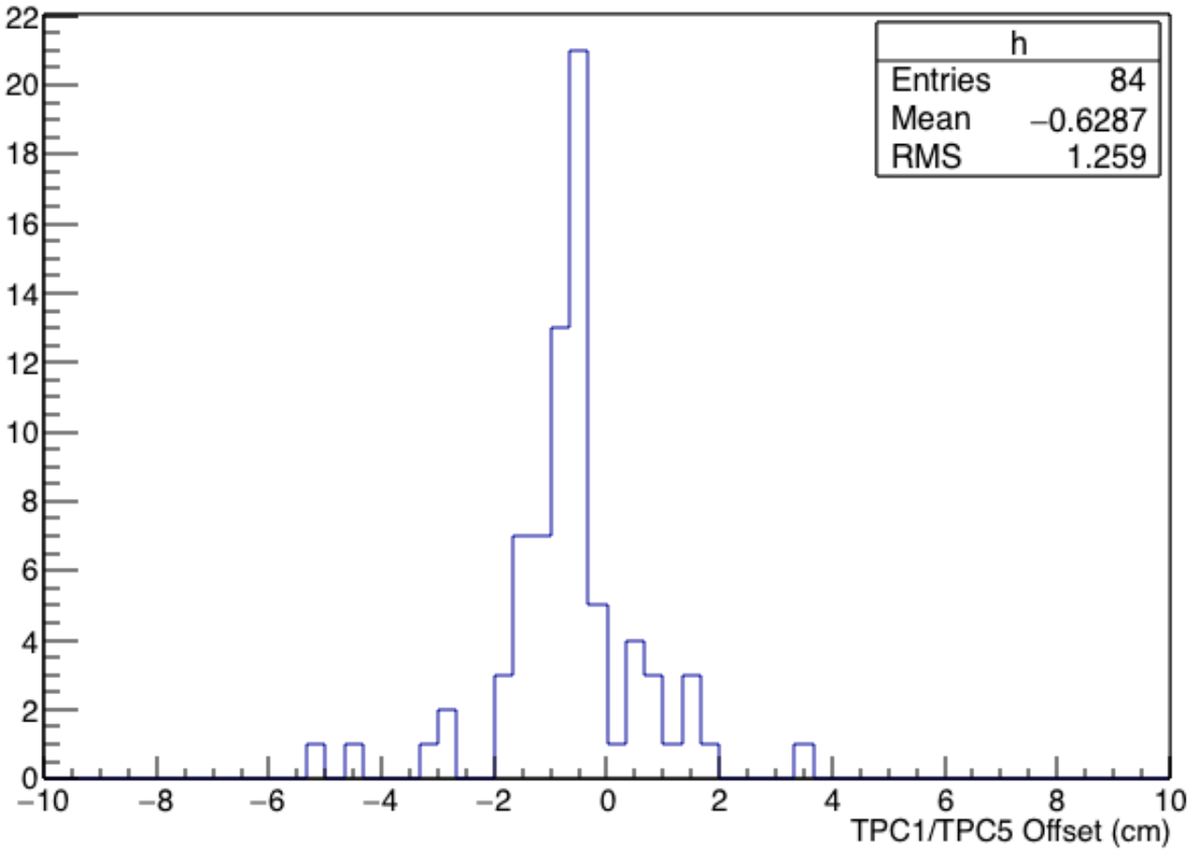


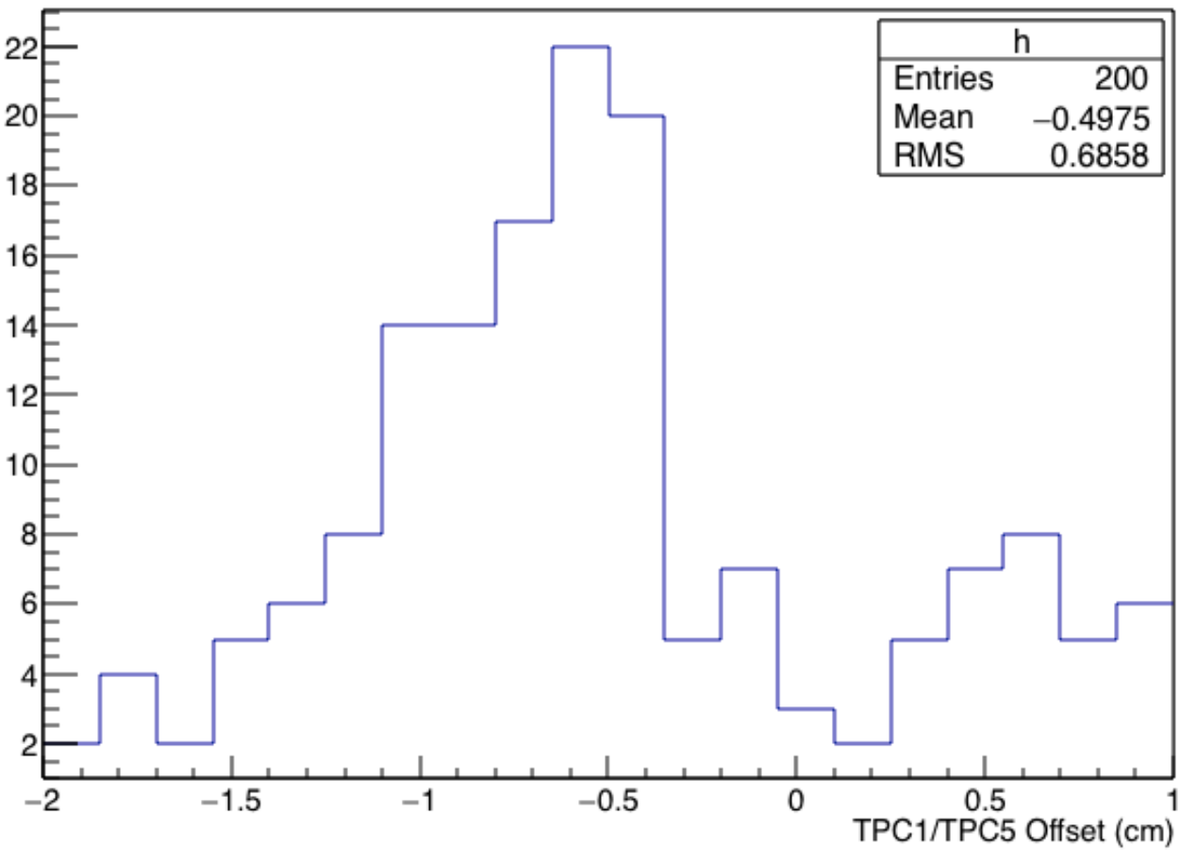
- Looks consistent (and very convincing!) with a ~ -2 mm x-offset.

Back to TPC5/TPC7 Gap

- Assuming the model which contains offsets in both x and z, with the z offset given by minimising the distributions for positive and negative track angle simultaneously, the x-offset can be measured very accurately.
  - Seems to be believable too — but still relatively large…
- If this method appears to look ok, I will write a script to find the minima of both distributions simultaneously, rather than estimating by eye.
  - Can then get z-offset from this and use the track to measure x-offset directly.

TPC1/TPC5 Gap

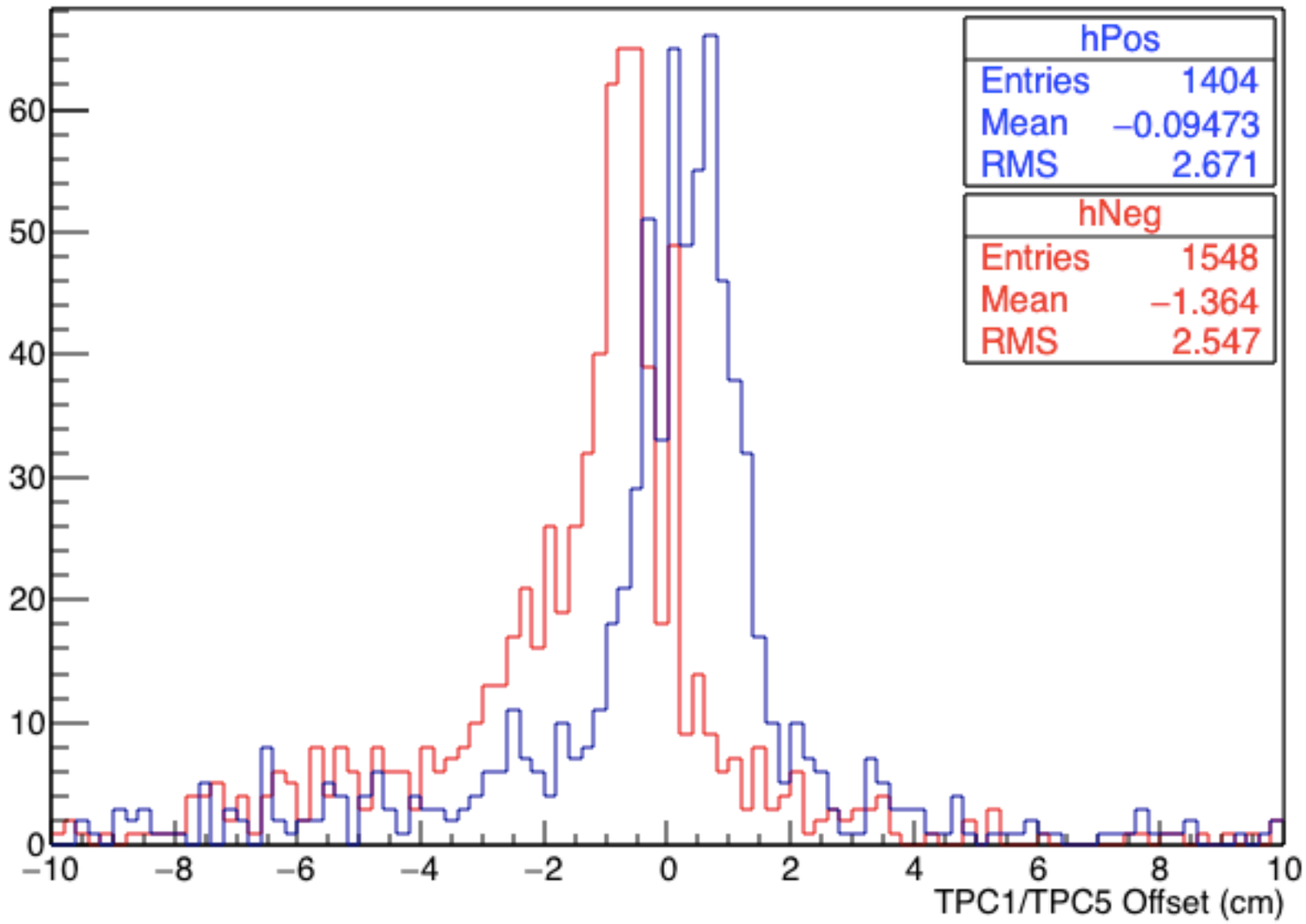




- Nice peak, low stats though. (Single peak — no (or very small) x-offset?)
- Offset -0.6 cm.
- (Plot on right — relaxed selection, zoomed in on peak. Seems to confirm -0.6.)

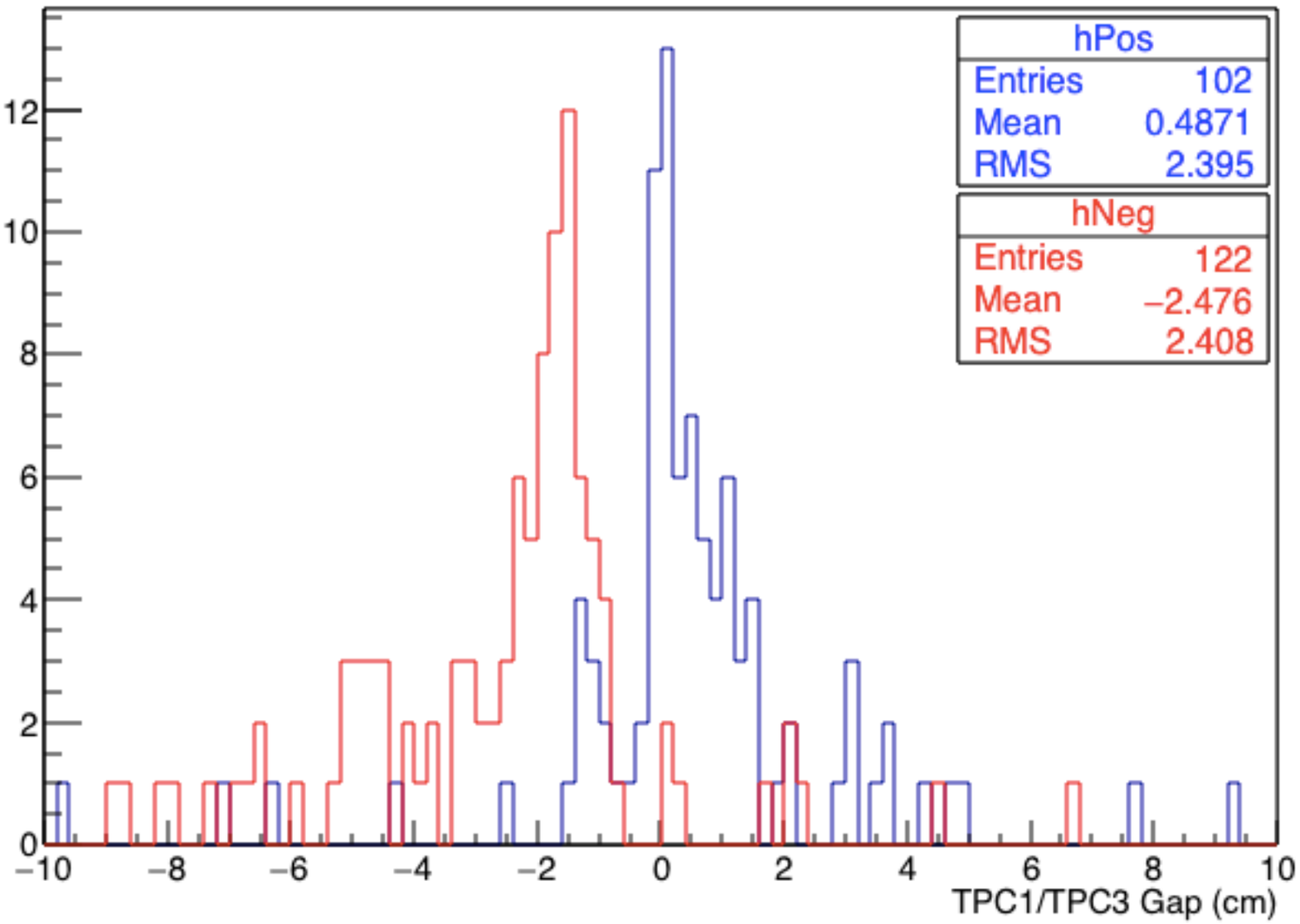
TPC1/TPC5 Gap

- Although, splitting this up does imply a small x-offset…
- Still looks consistent with z-offset of -0.6 cm.



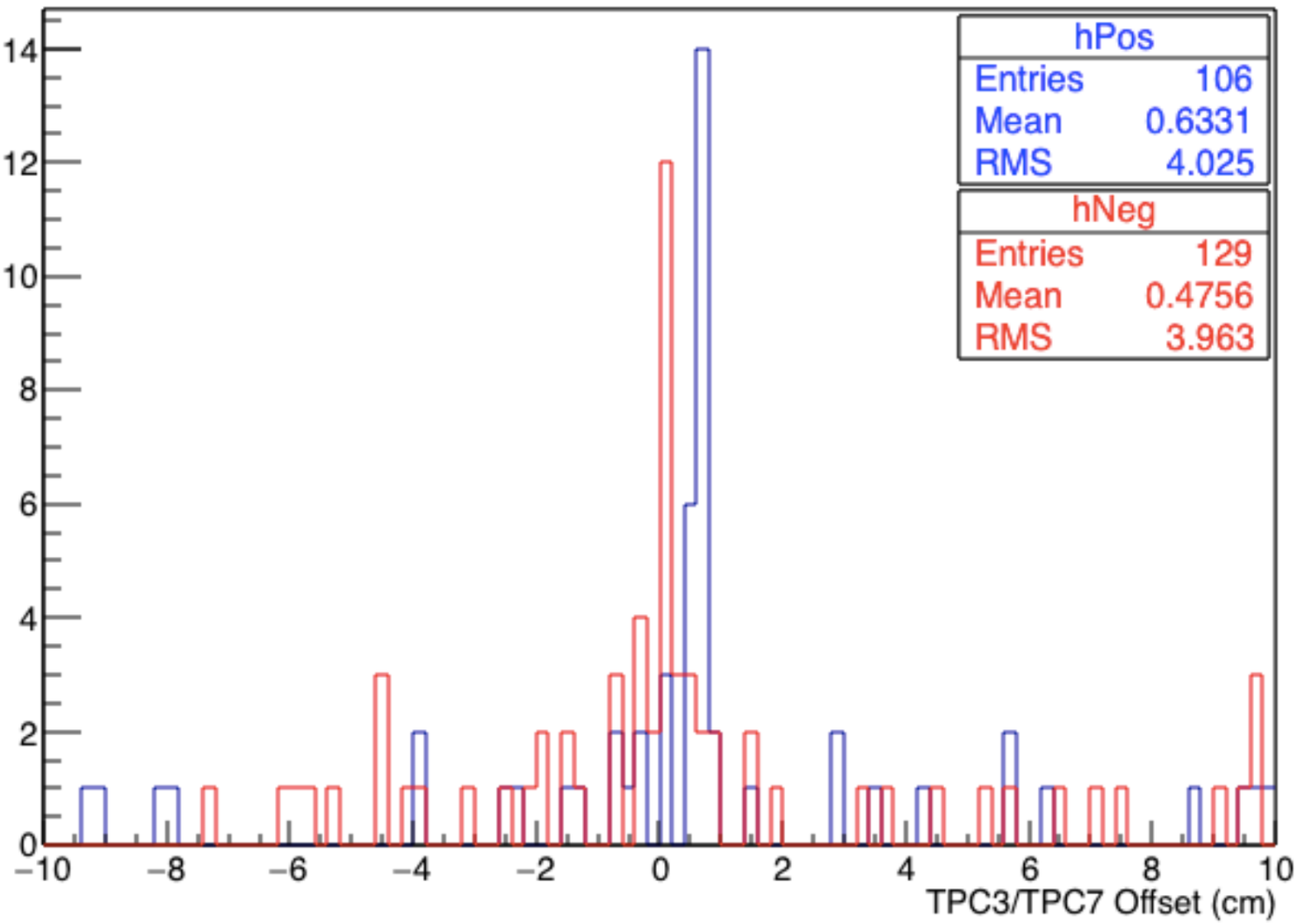
TPC1/TPC3 Gap

- Low stats, but looks like there's a x-offset here too.



TPC3/TPC7 Gap

- Again, very low stats, looks like there's a (small) x-offset…



Summary

- Measured the gaps, and also the x-offsets between the APAs.
  - Does this seem reasonable?
  - If so I'll do it again but more robustly!
- I've started looking at the location of charge deposited by APA-gap crossing tracks, but got sidetracked with the x-offset stuff;
  - Update on this next week,
  - Including some EVDs!