Pass0 Analysis: SVT Wire Target Analysis IV

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Reconstruction / Analysis Meeting

June 20, 2023

SVT Wire Target Data

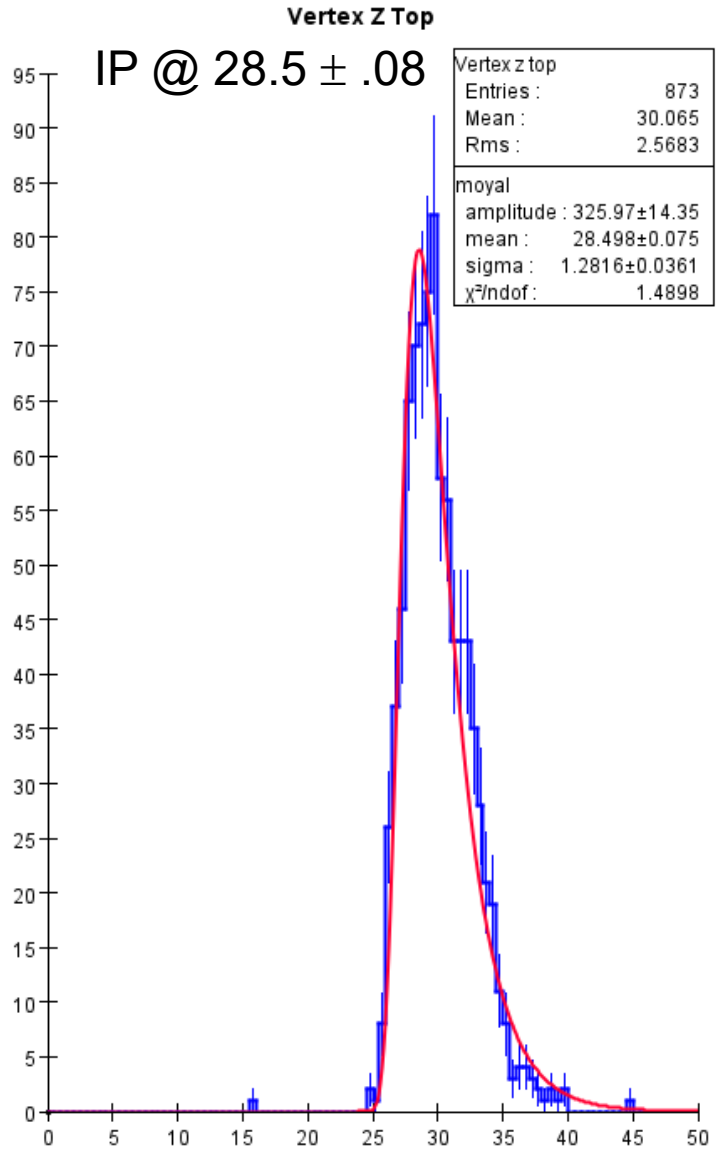
- Have reconstructed the two runs which used the SVT positioning wires as targets
  - 014753 SVT bottom wire
    - gives events in the top
  - 014754 SVT top wire
    - gives events in the bottom
- HPS_Run2021Pass0_v1
- Require charged particles with tracks containing 12 or more hits with an associated Ecal cluster.
- Updates my previous analysis.

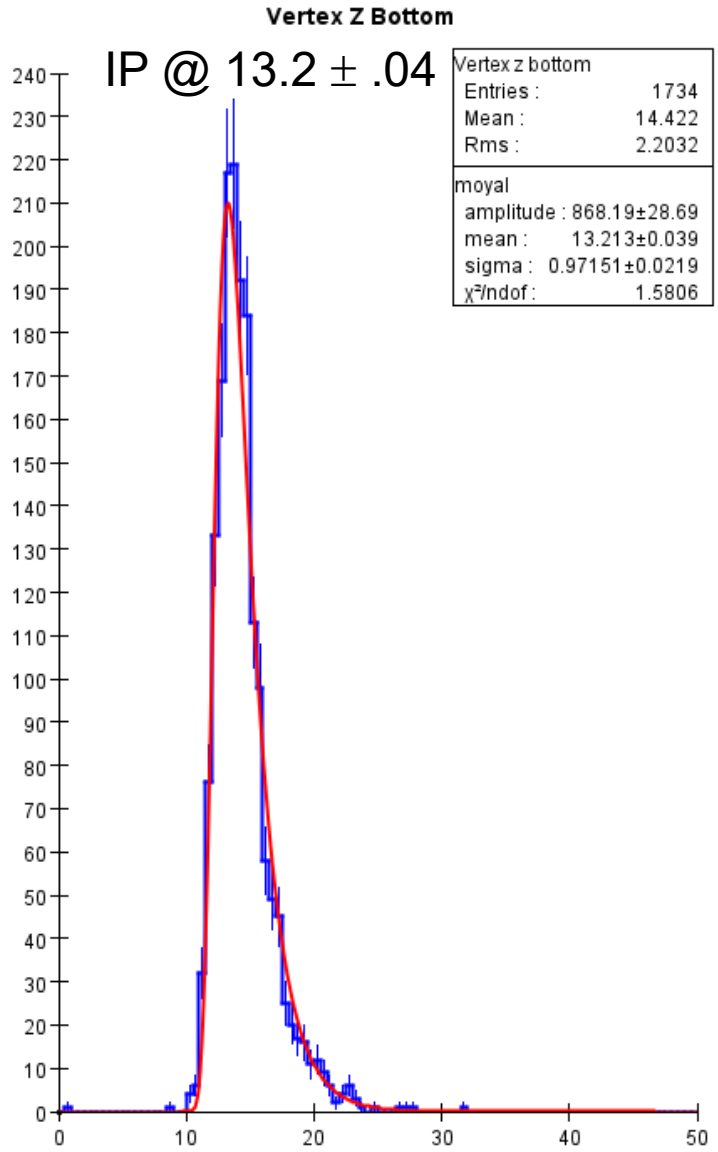
Previous Analysis Summary

- According to Tim, the SVT positioning wires are at:
  - Bottom wire: z=34.544 mm
  - Top wire : z=20.600 mm

- Data Top Tracks (bottom wire)
  - Fitting tanLambda vs z0
    - electron 25.7 ± 0.5
    - positron 26.7± 0.7
  - MultiVertex
    - 28.5 ± .08
  - Design - MultiVertex = 6.05mm
- Bottom Tracks (top wire)
  - Fitting tanLambda vs z0
    - electron 11.3 ± 0.8
    - positron 10.4 ± 1.1
  - MultiVertex
    - 13.2 ± .04
  - Design - MultiVertex = 7.4mm

Previous Analysis MultiVertex



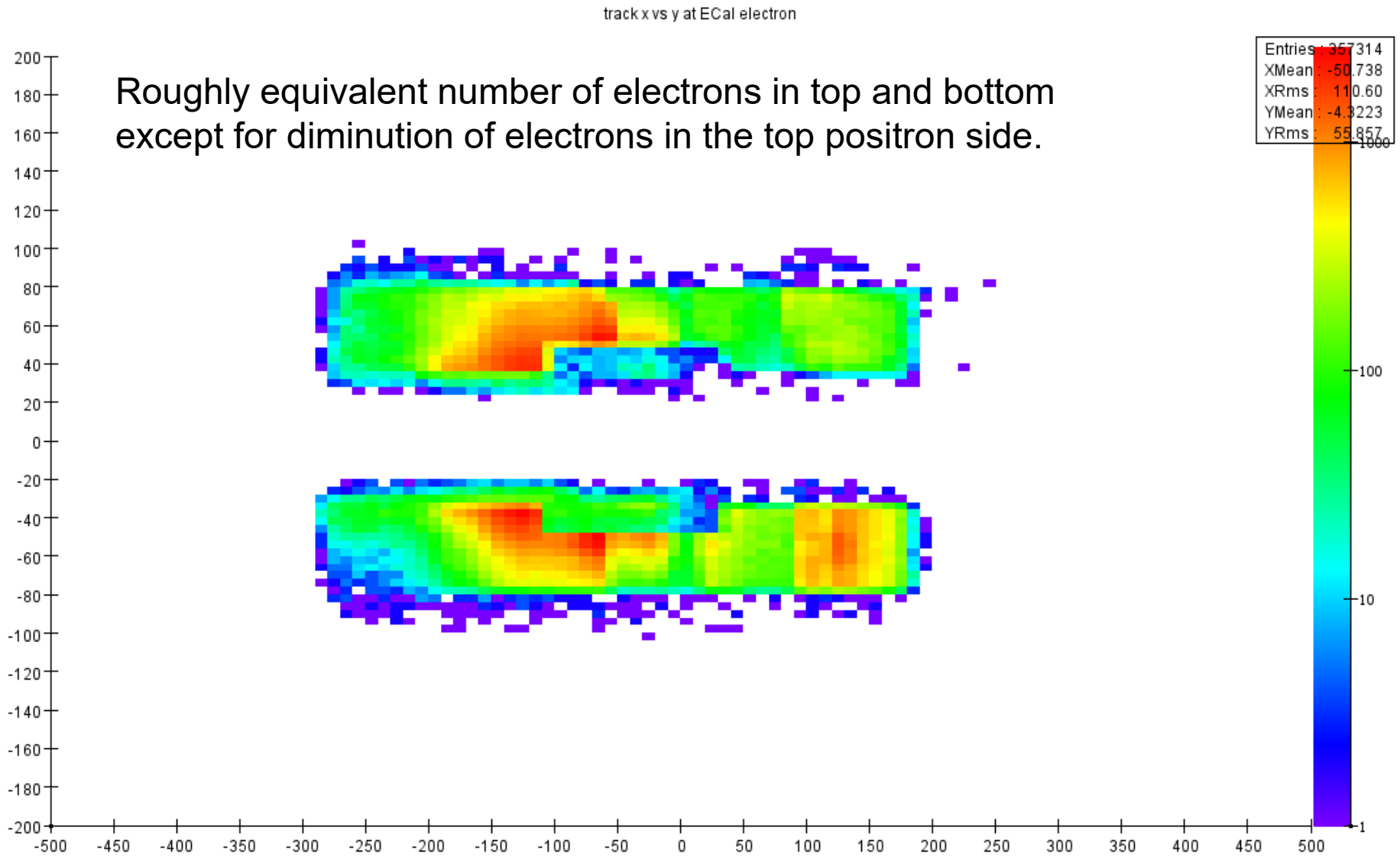


Latest Analysis

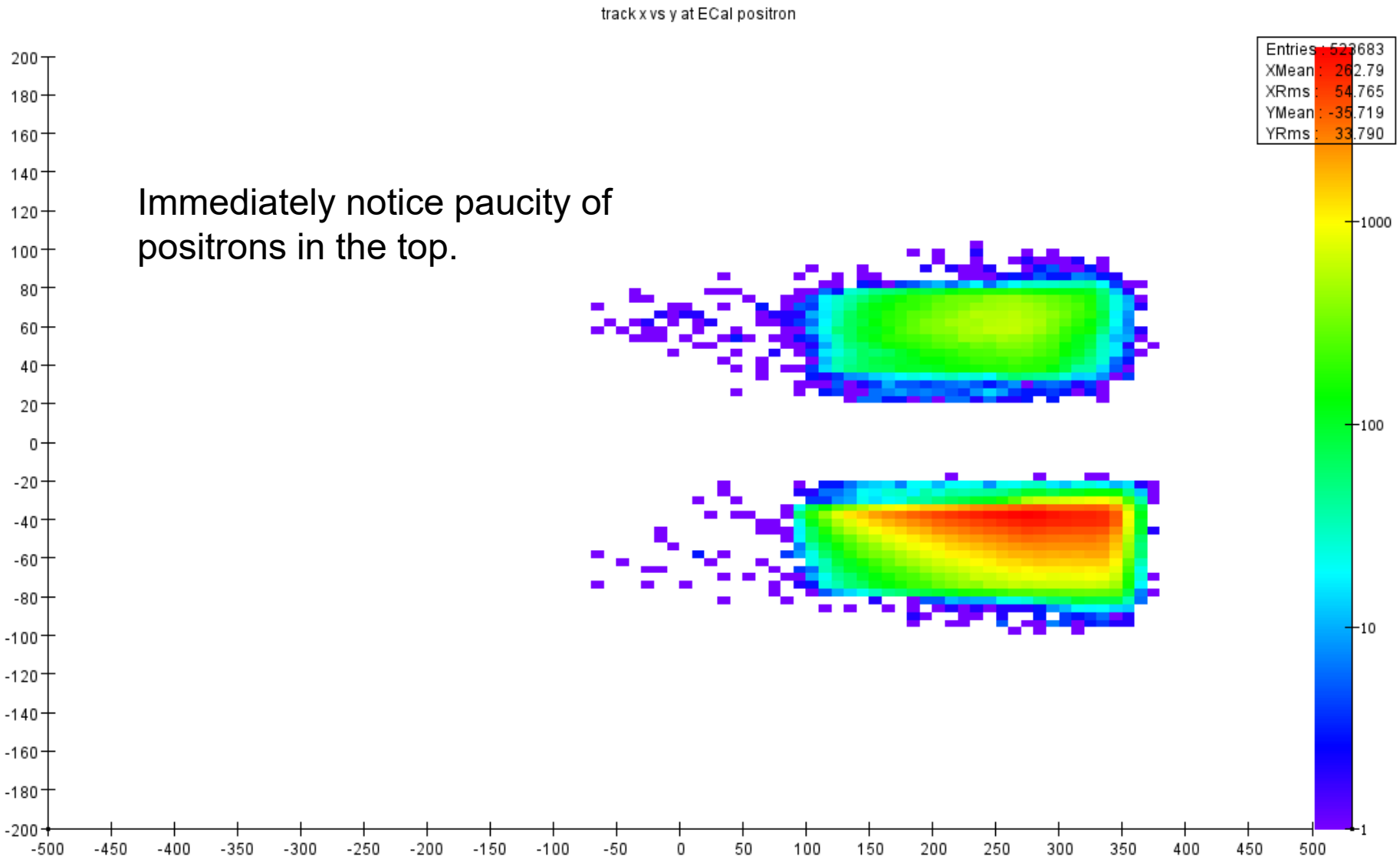
- Analyze all partitions from the two runs 14753 and 14754
- Require at least 12 hits on a track associated with an Ecal cluster
- Can slice and dice the data in many different ways, with quantitative differences, but qualitatively mostly the same
  - Will show one comparison at the end
-

Electron Track Coverage

Roughly equivalent number of electrons in top and bottom except for diminution of electrons in the top positron side.

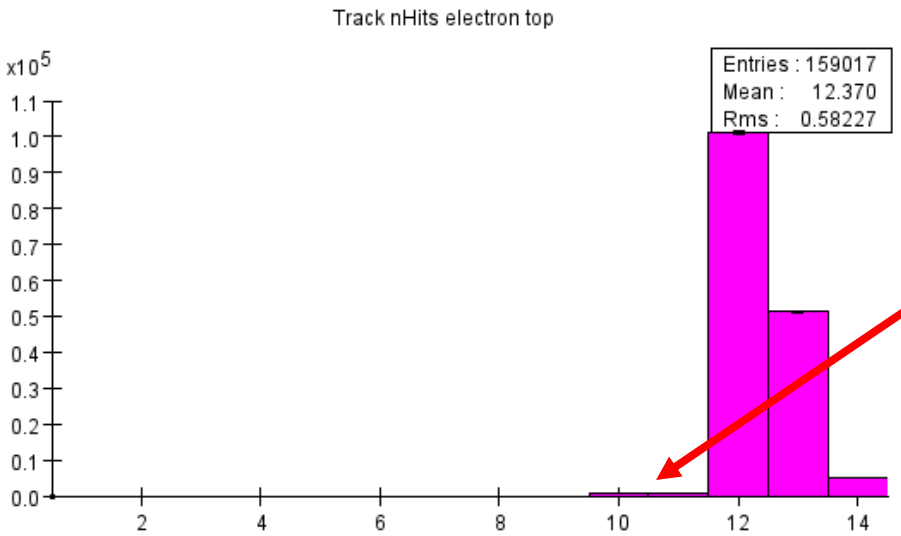


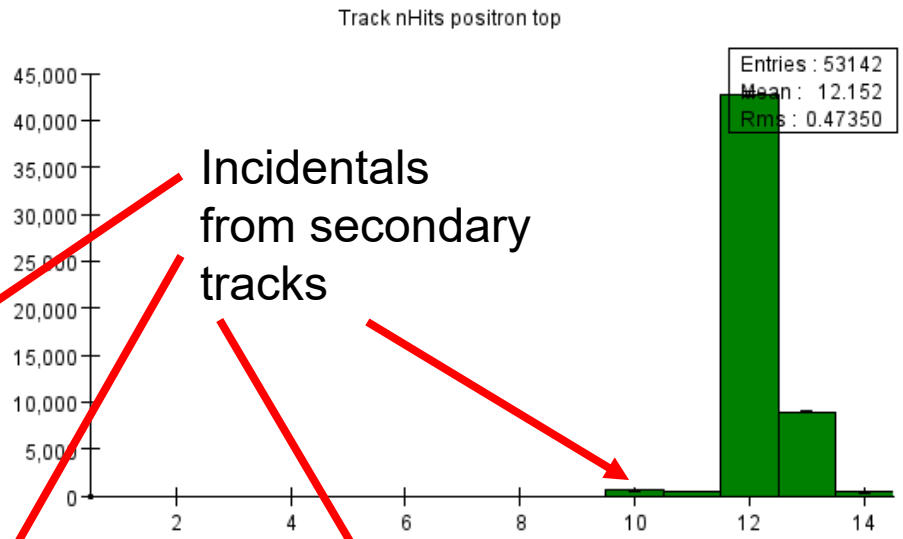
Positron Track Coverage



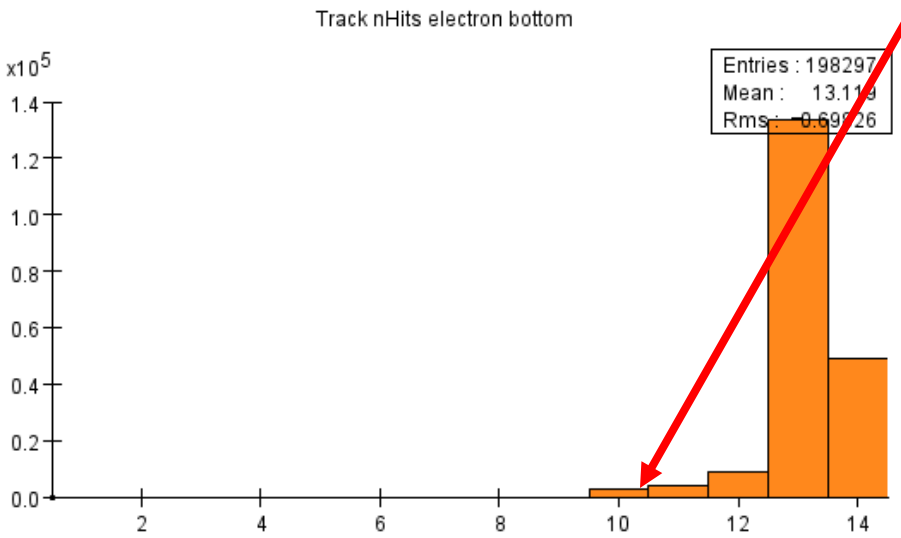
Immediately notice paucity of positrons in the top.

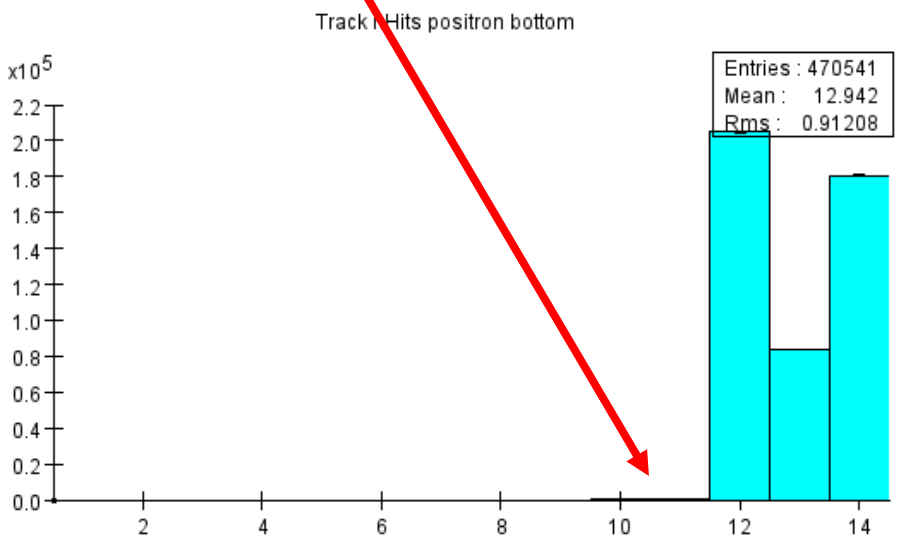
Number of Hits On Tracks





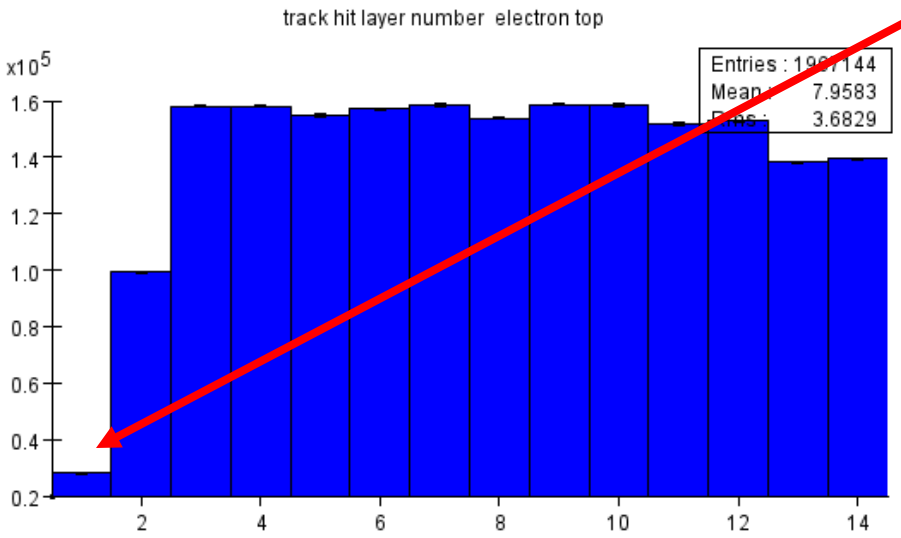
Incidentals from secondary tracks

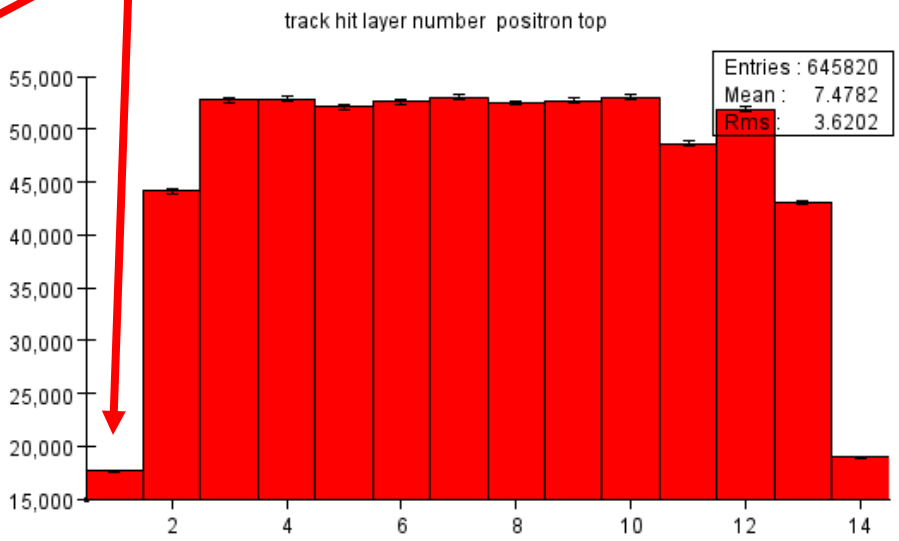


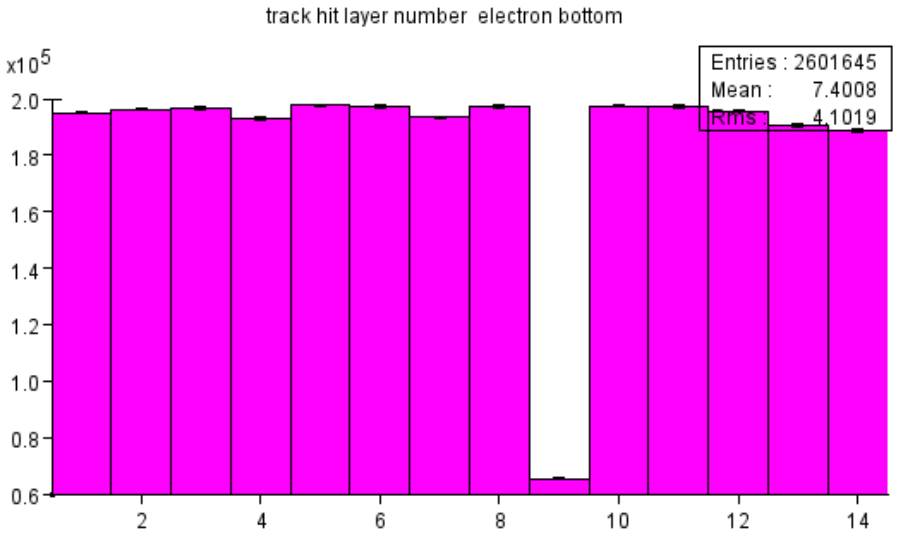


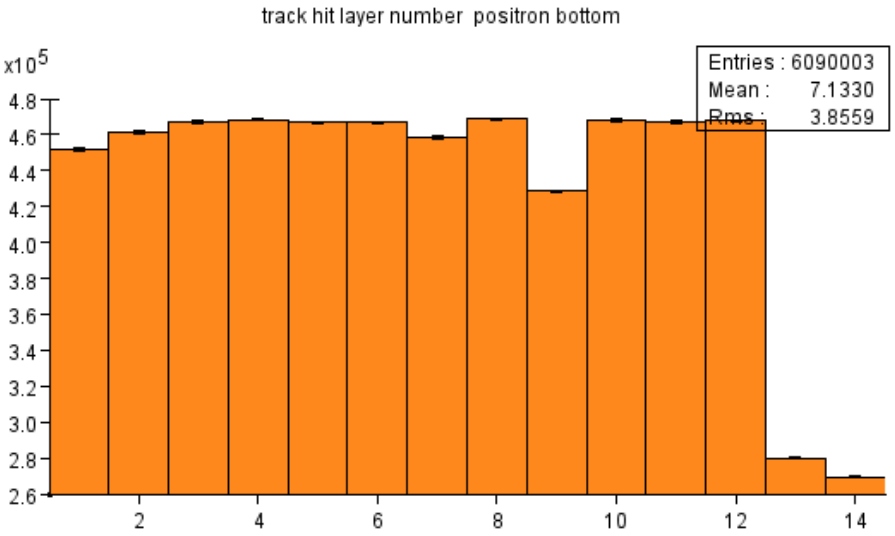
Layers Hit on Tracks

Missing Layer1 hits due to acceptance from downstream wire

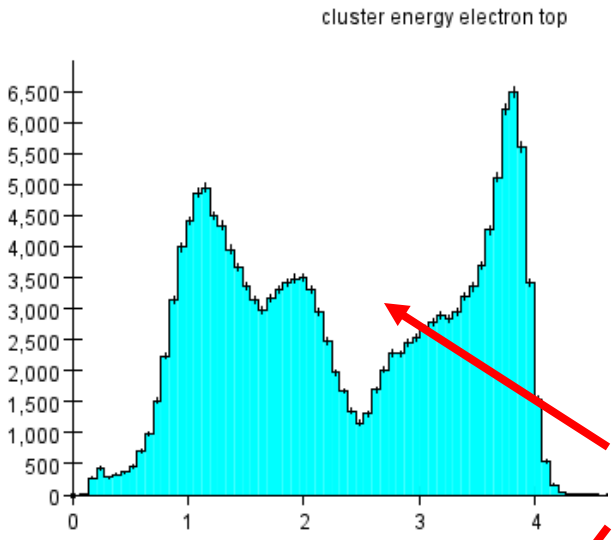


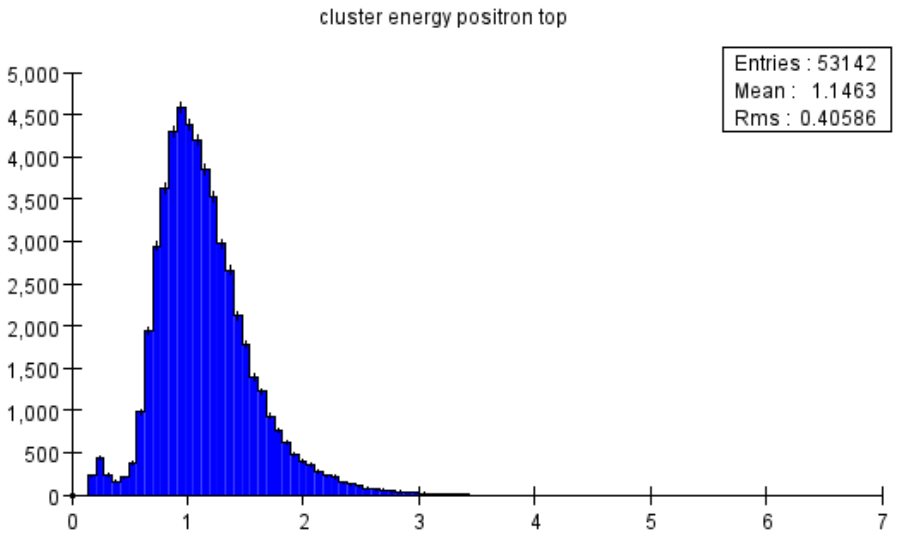




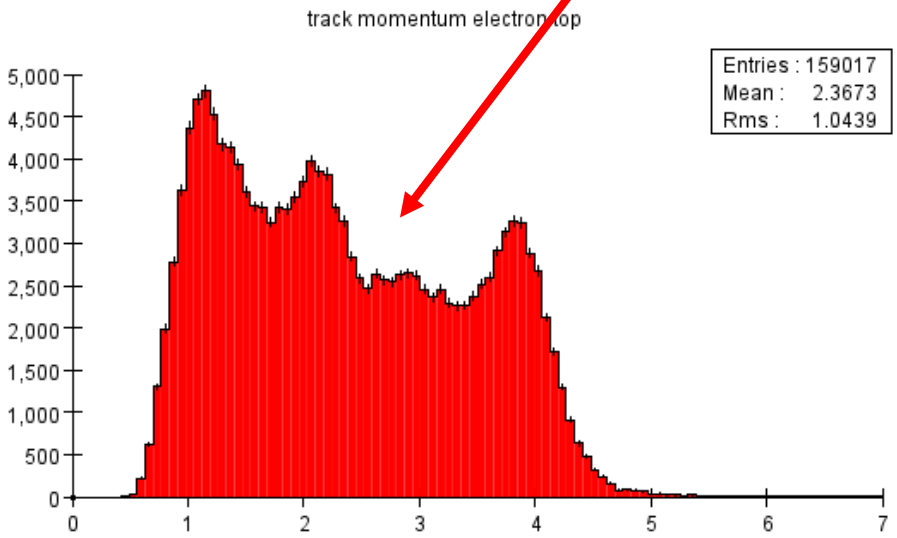


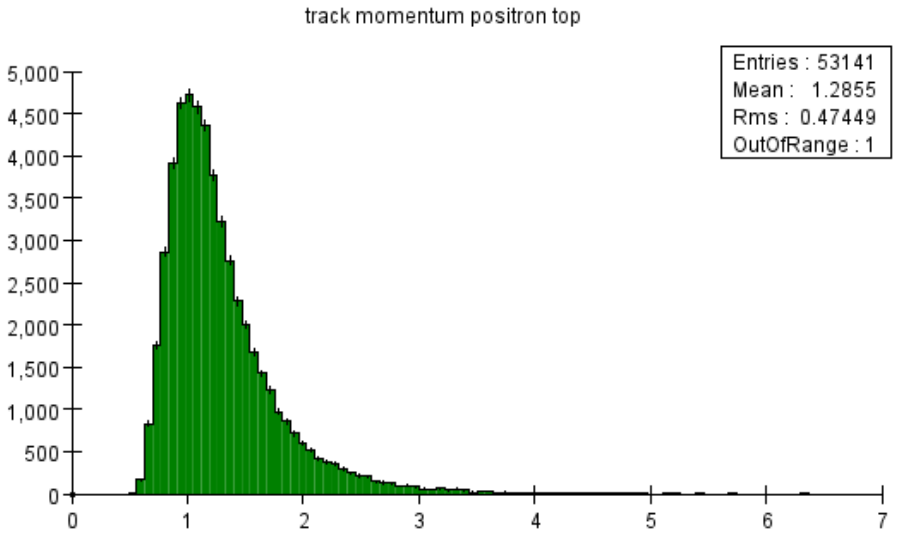
Energy & Momentum Top



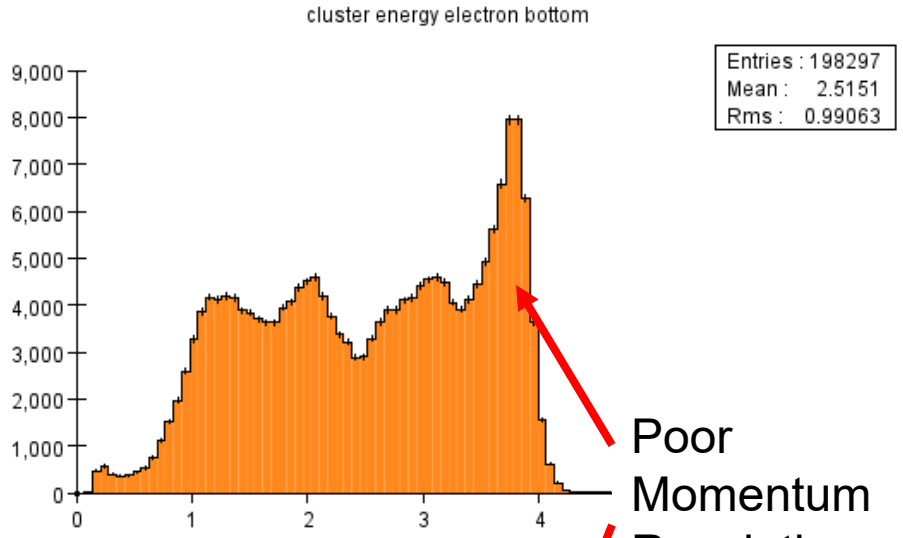


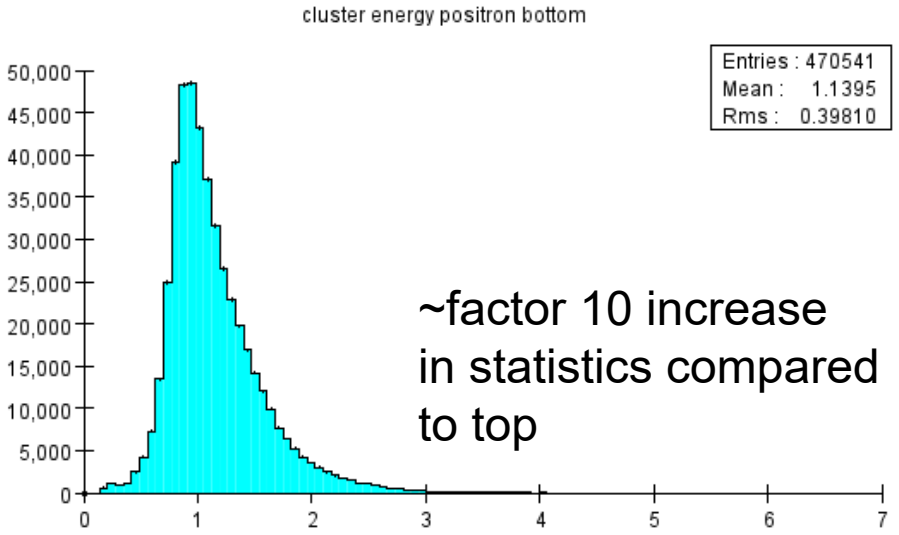
Momentum bifurcation filling in gap?





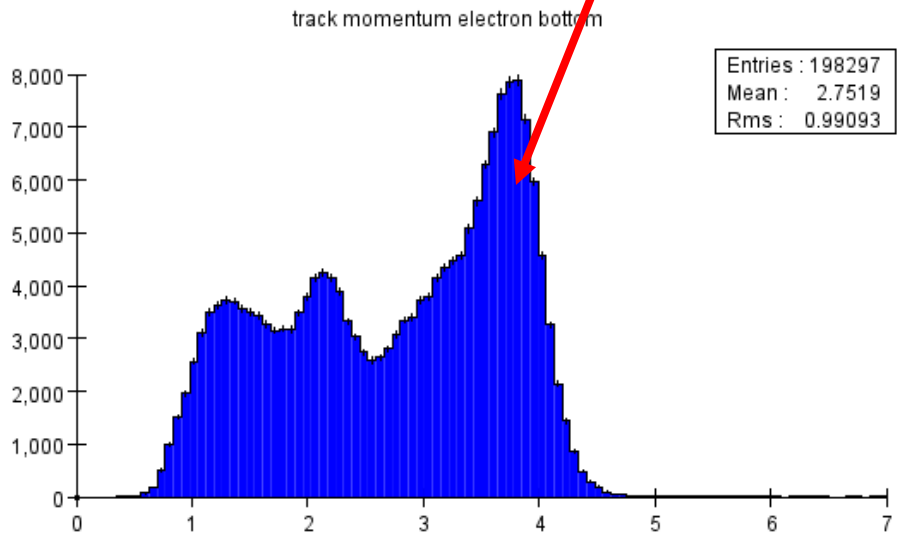
Energy & Momentum Bottom

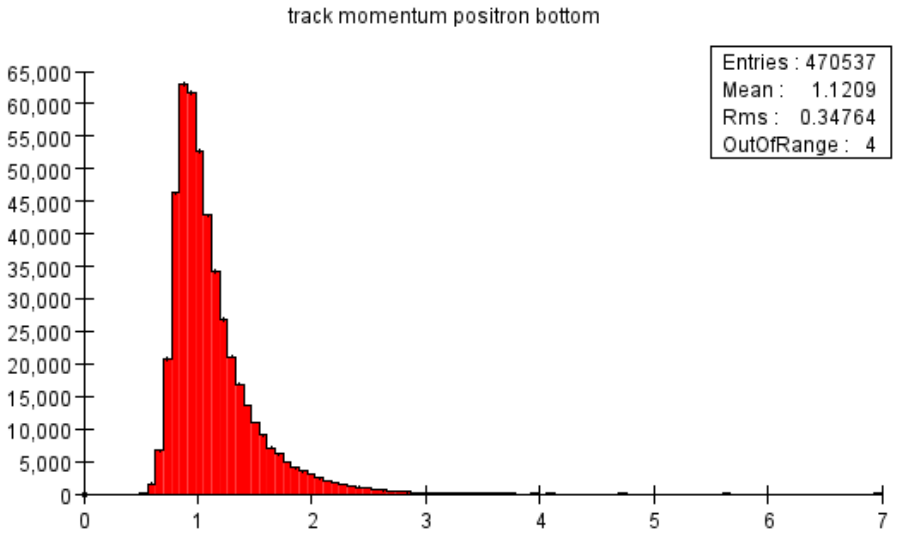




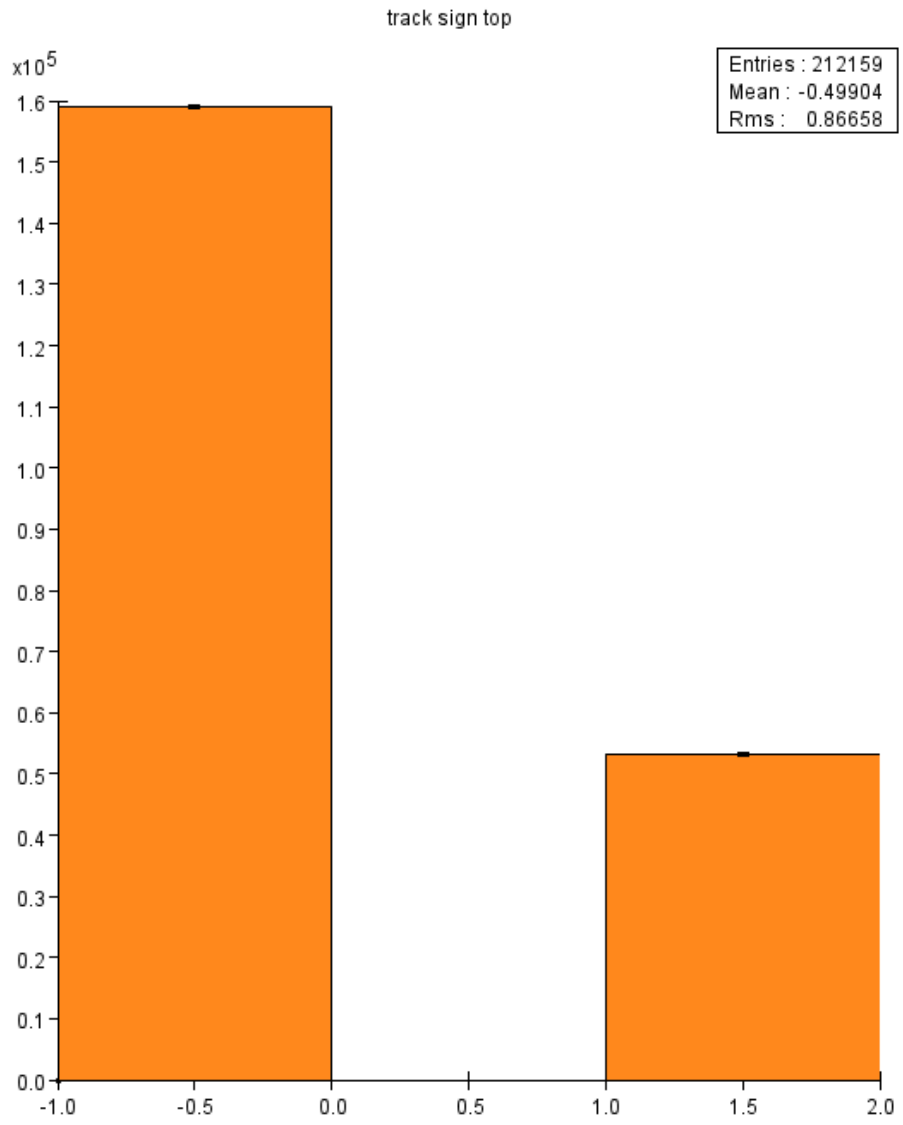
~factor 10 increase in statistics compared to top

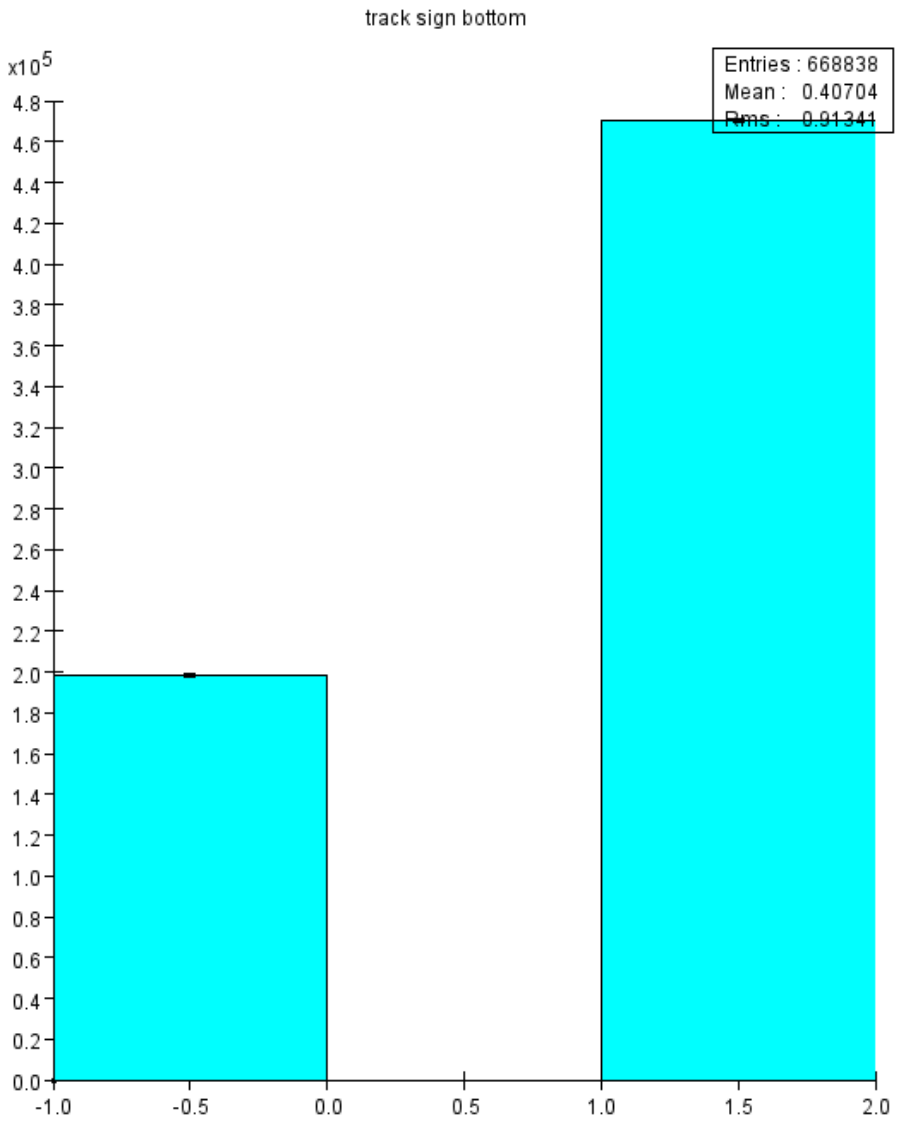
Poor Momentum Resolution



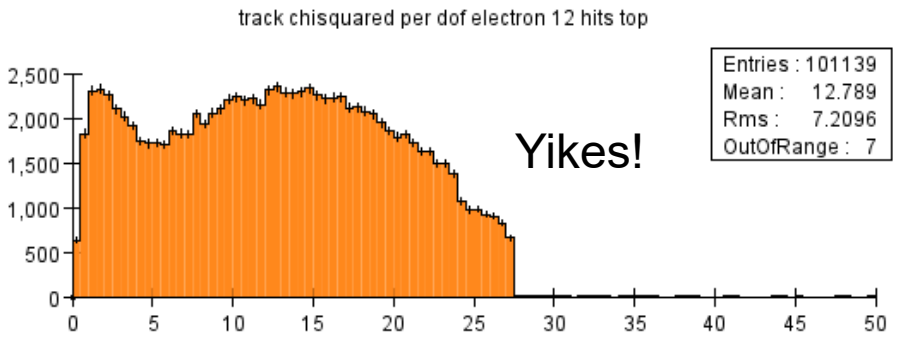


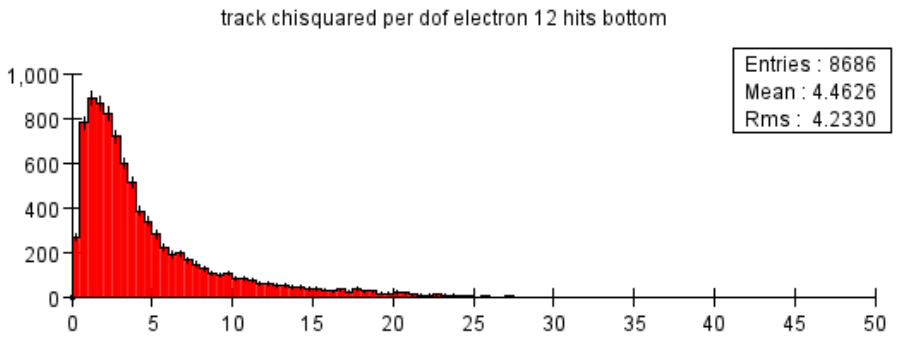
Track Sign (e^+ e^- Composition)

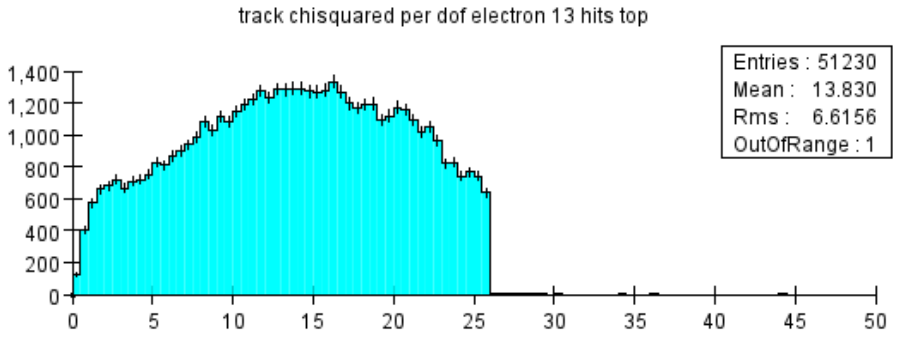


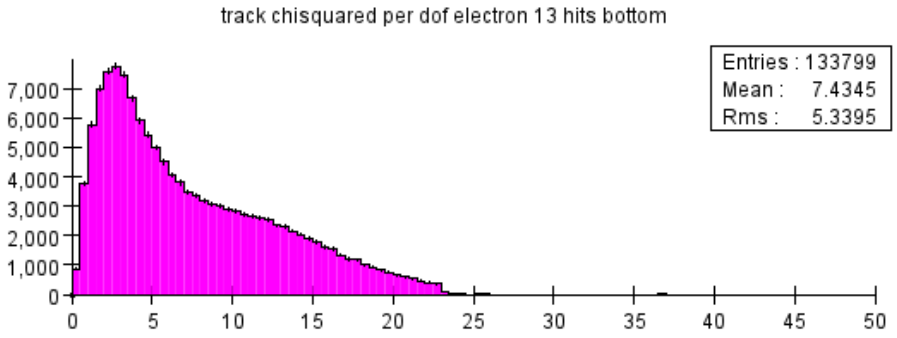


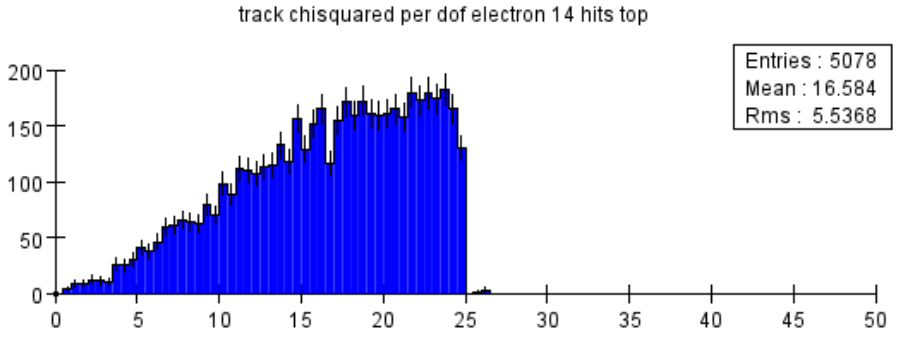
Track Chi-squared electron

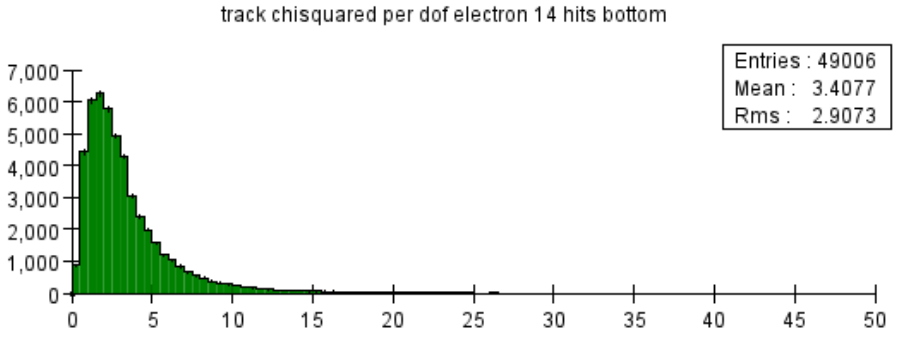




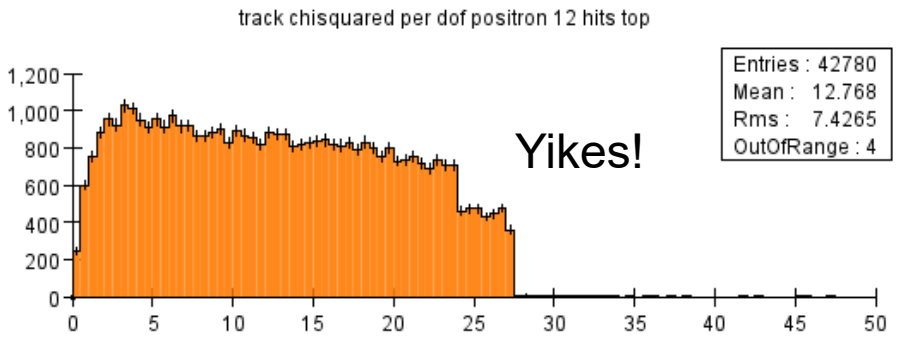


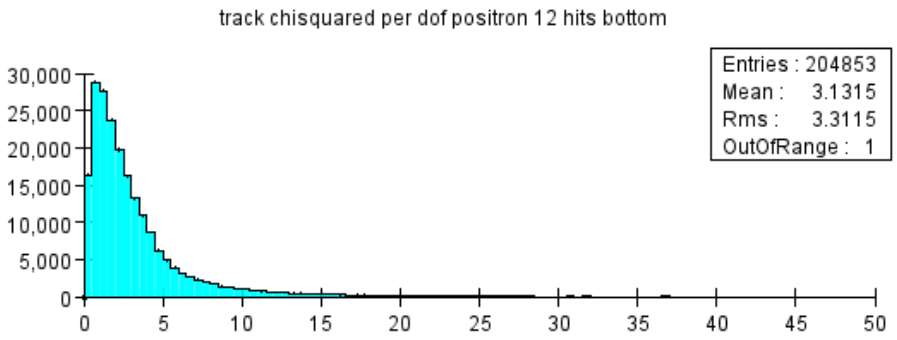


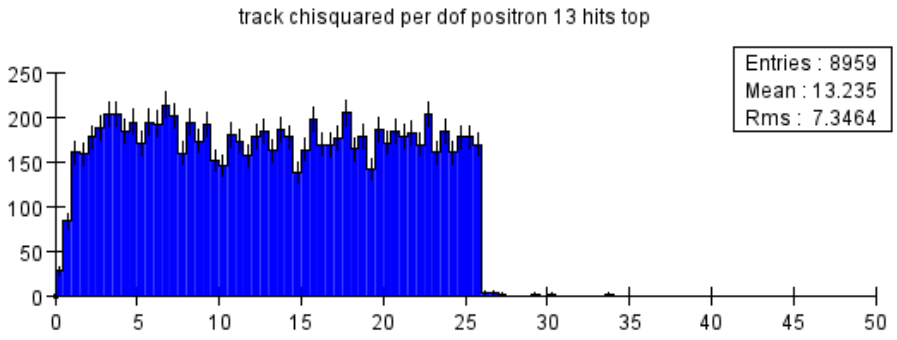


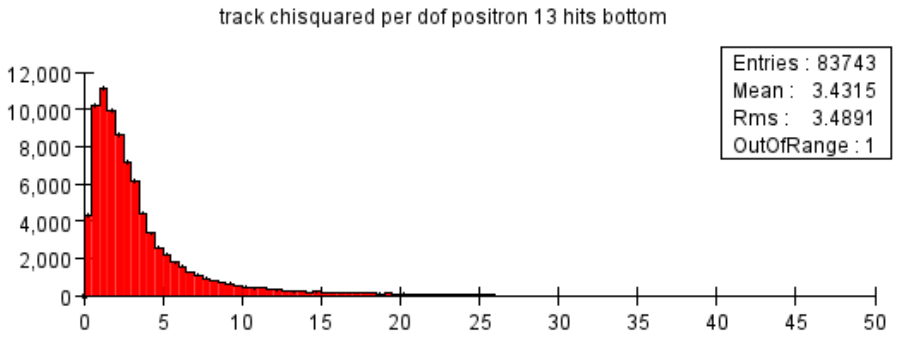


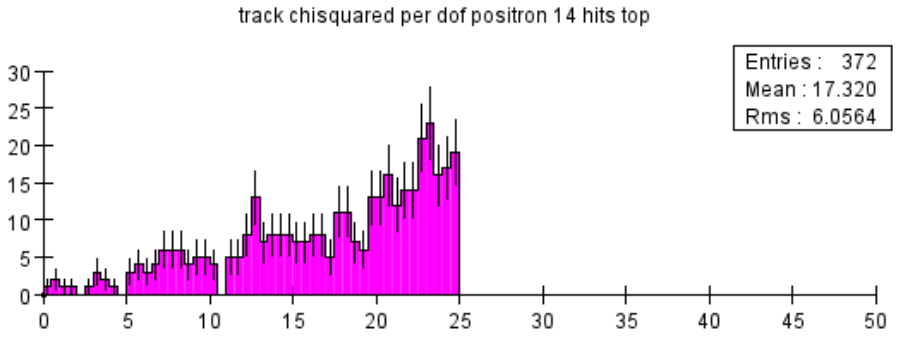
Track Chi-squared positron

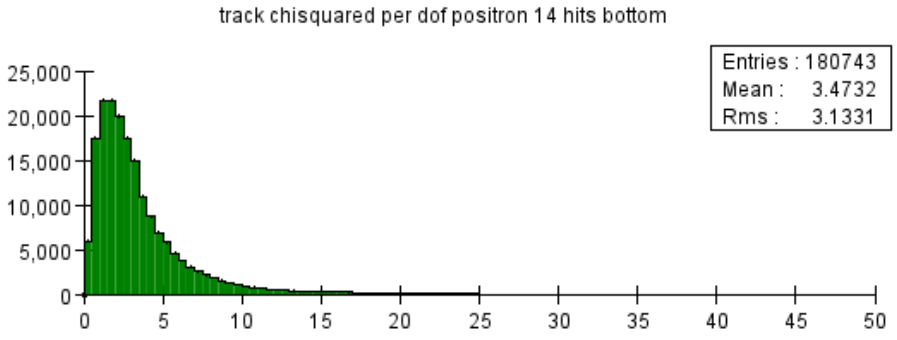








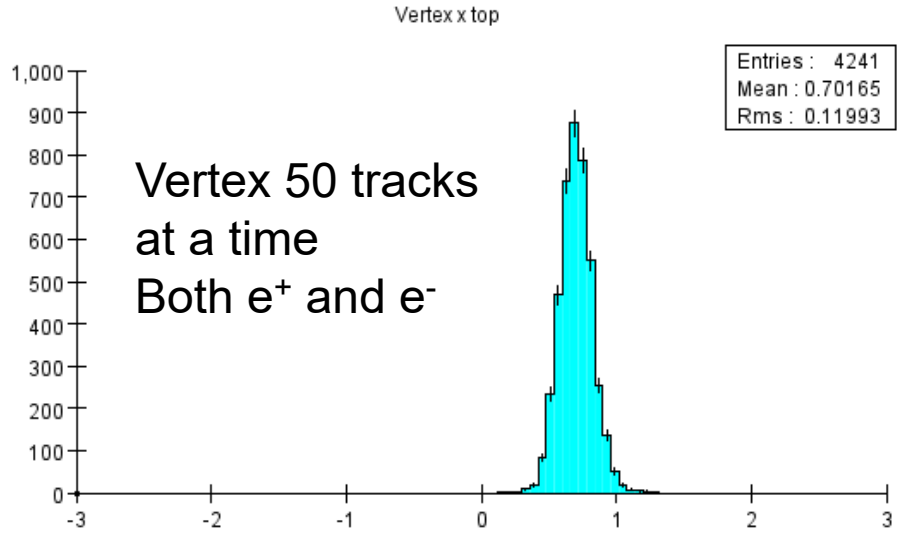




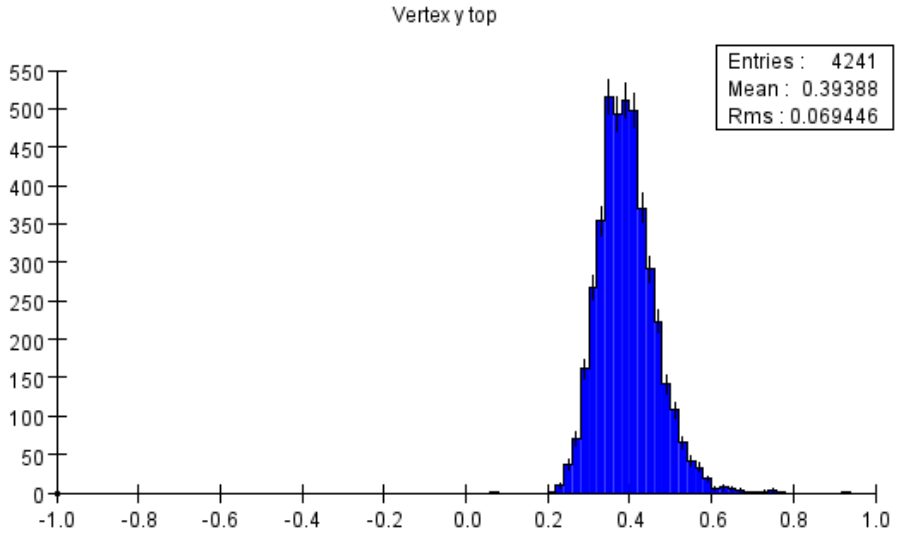
Track Chi-Squared

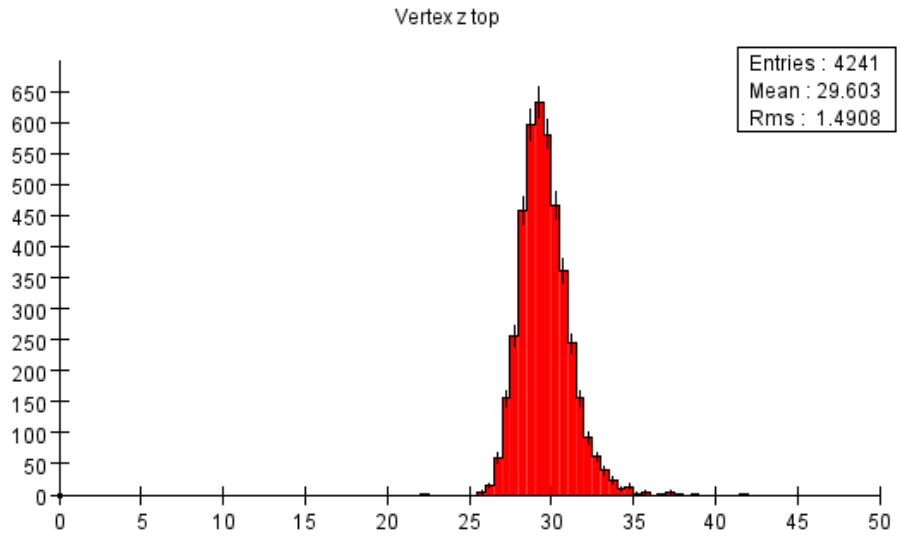
- Clearly something is really wrong in the top
  - Note that these are plots of chi-squared/dof
- Increase of chi-squared/dof as one adds hits is clear sign of internal tension, further indicating that top is poorly aligned.
- Clearly losing tracks with cut on chi-squared.
- Bottom reasonably well behaved.
  - Electron bottom tracks with 13 hits needs some attention.

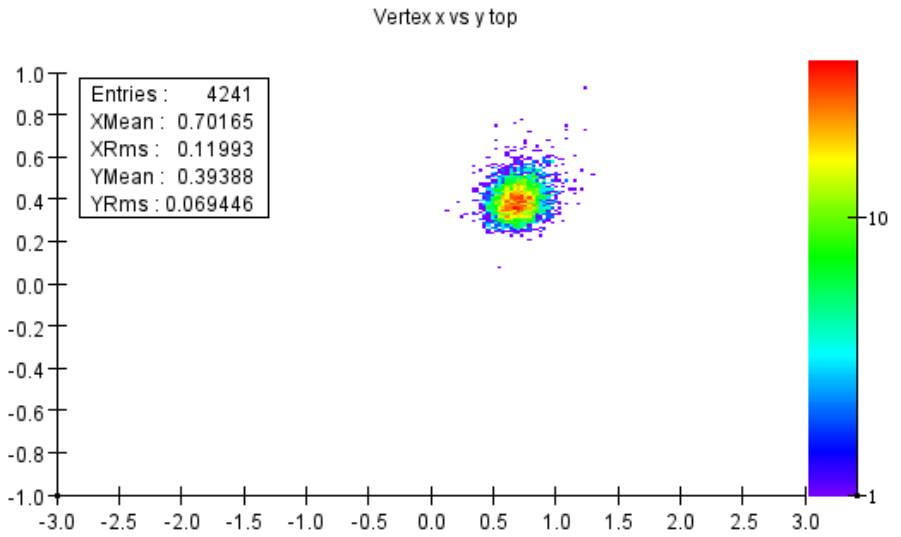
MultiVertex Positions Top



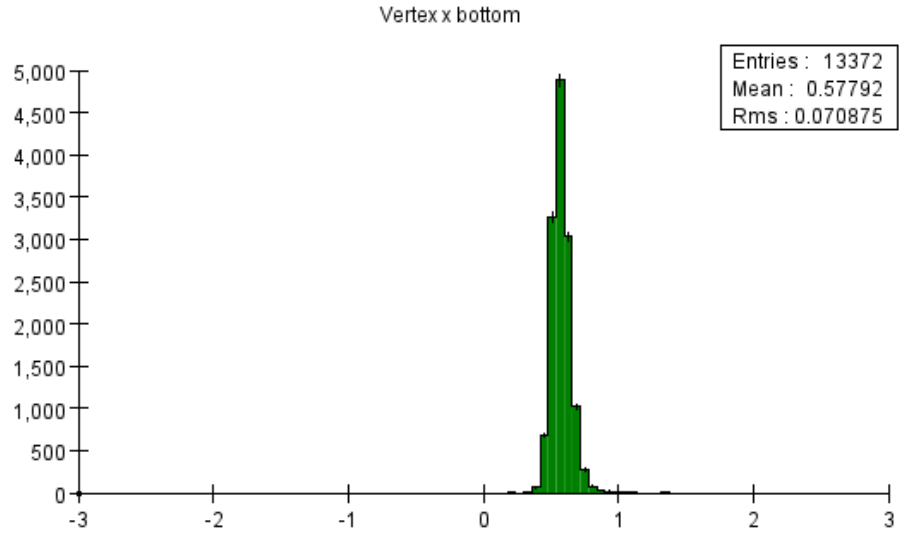
Vertex 50 tracks
at a time
Both e^+ and e^-

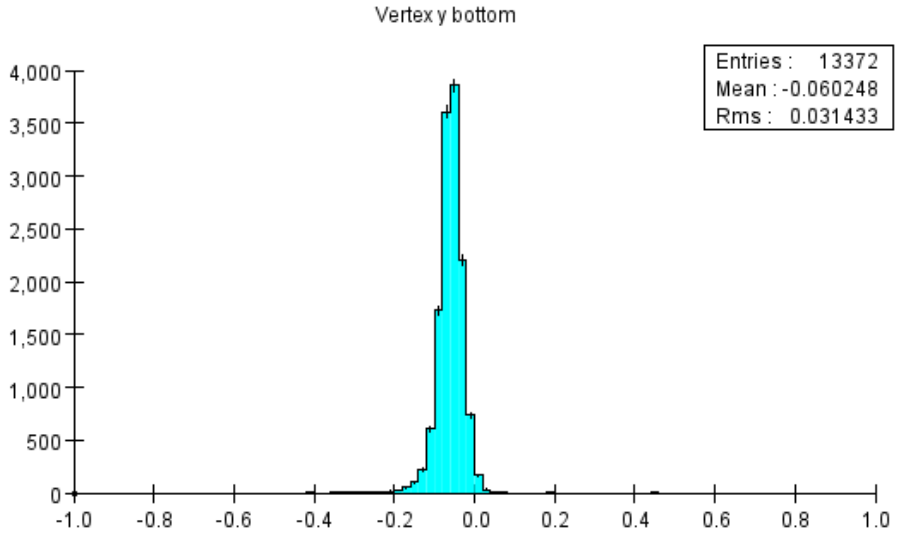


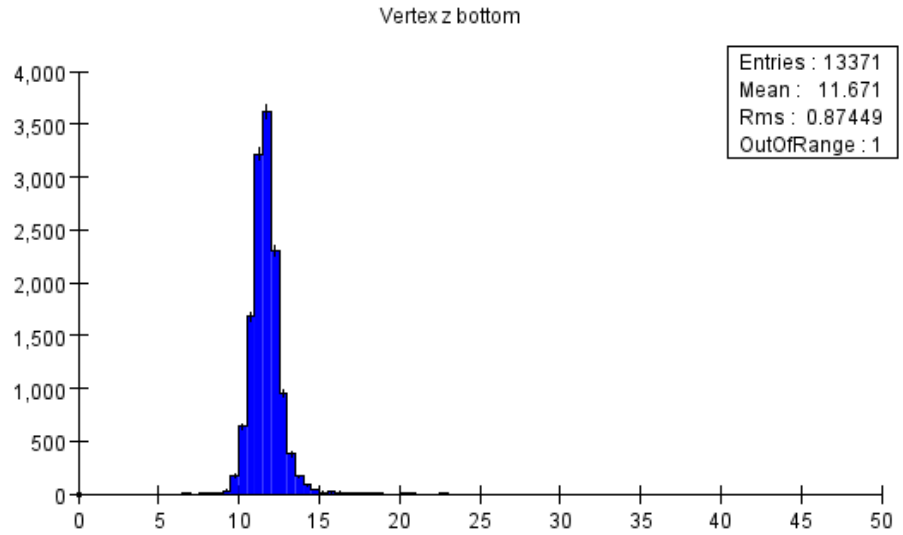


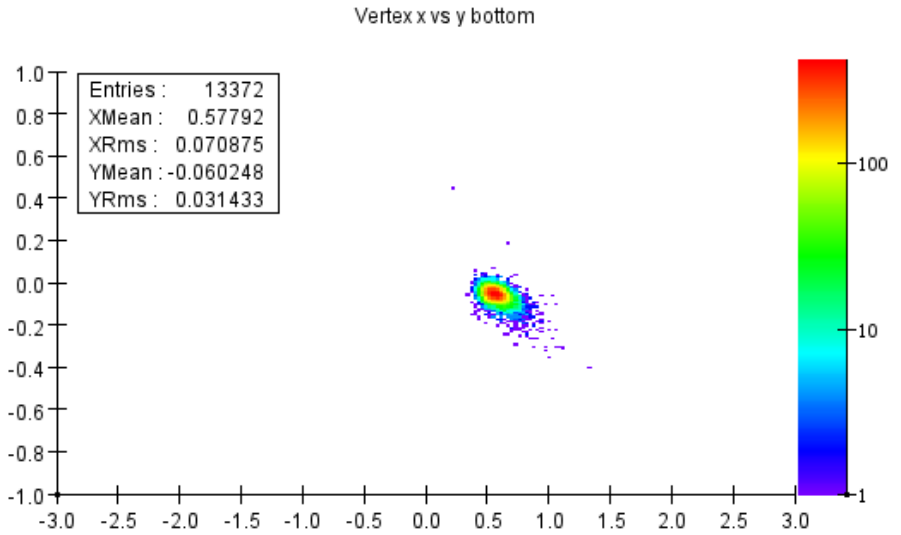


MultiVertex Positions Bottom

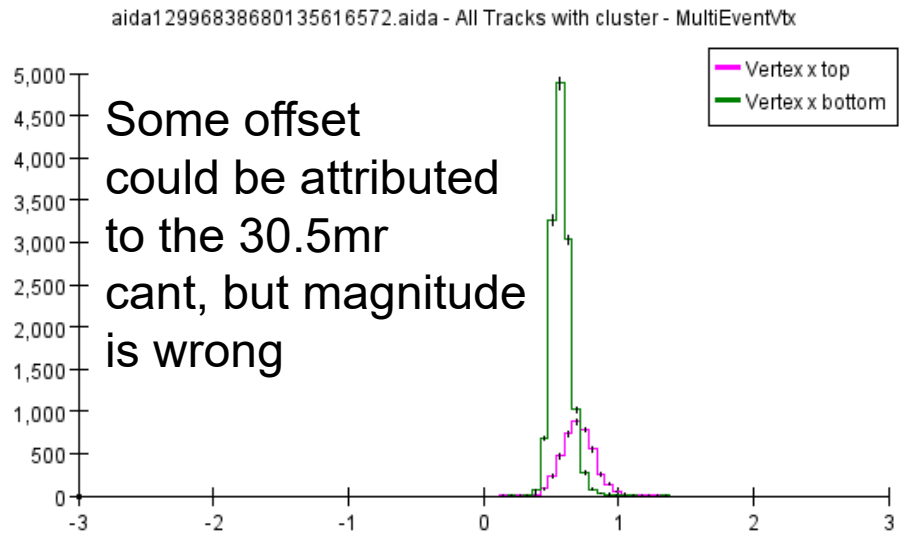


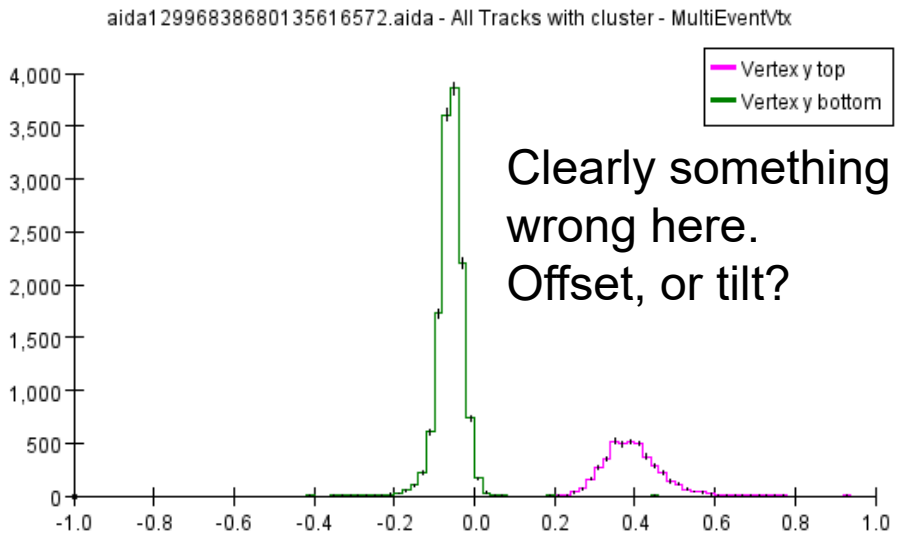


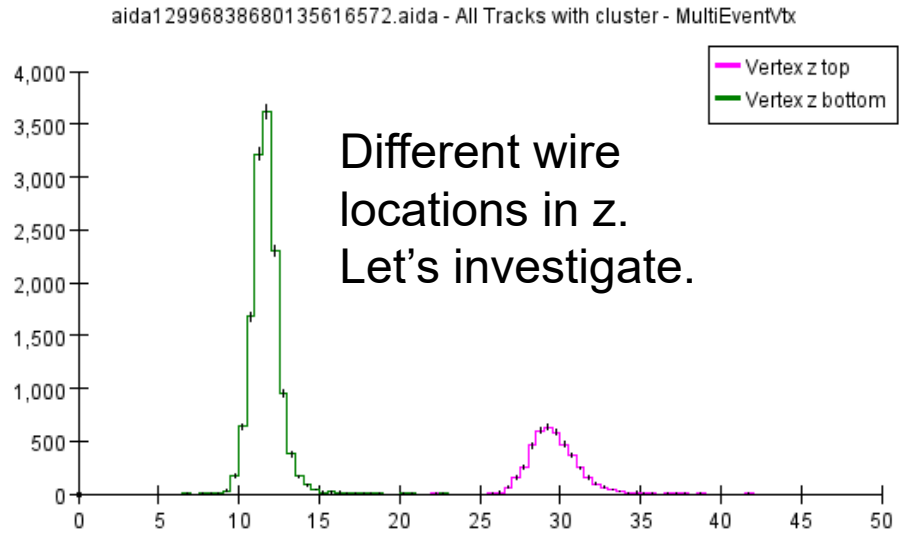


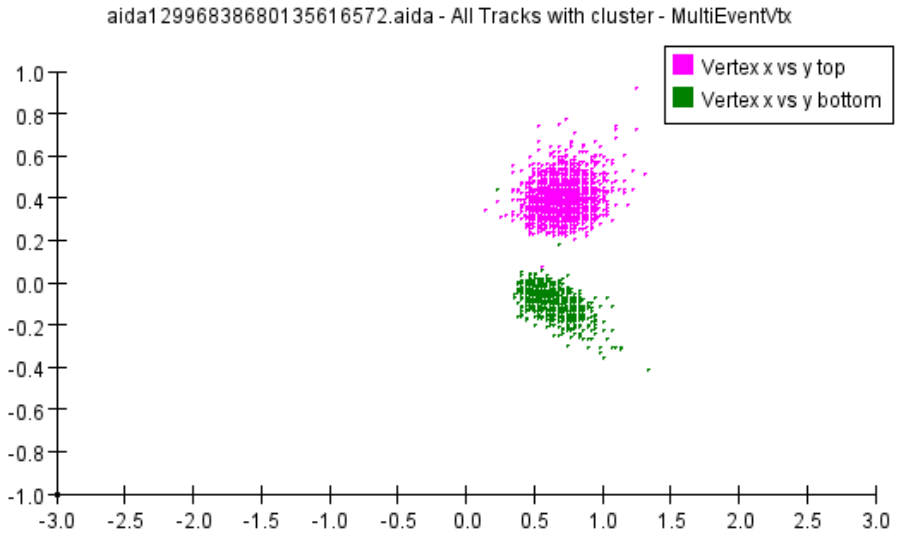


MultiVertex Positions Top / Bottom

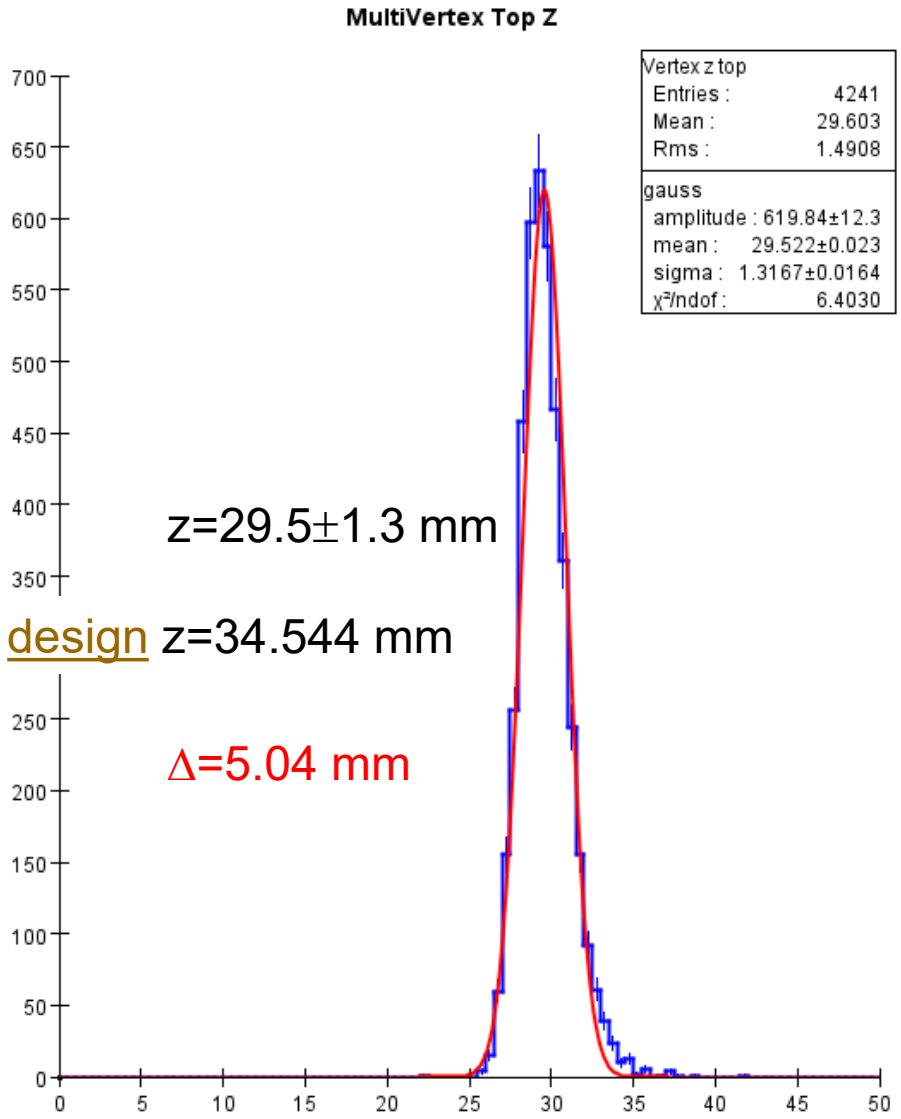


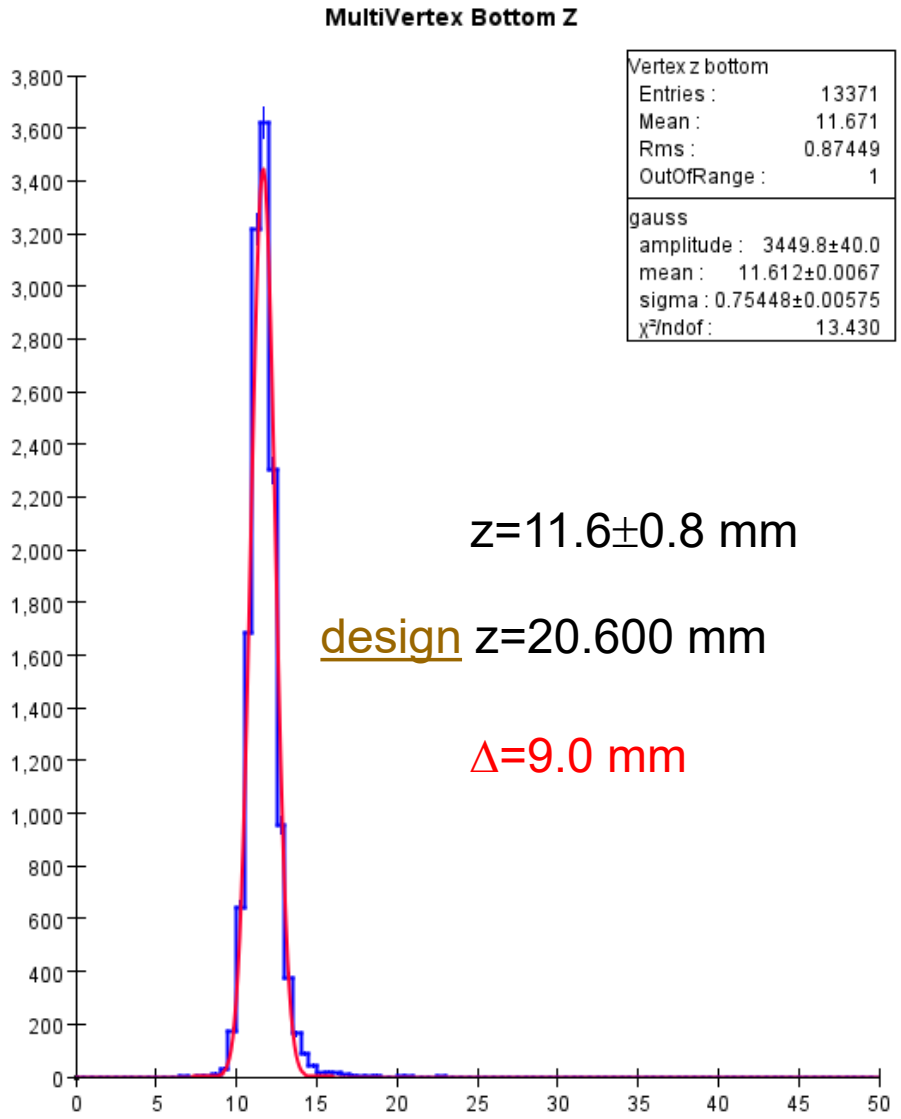






MultiVertex Z Positions





SVT Wire positions

- Hard to believe that the wire positions, or the target positions as measured in the data, could be off by 5mm, let alone almost a centimeter.
- Investigate this myself by looking at the survey data gathered by Matt Solt.
- Survey Data located at

https://github.com/mrsolt/HPS/blob/master/OGP/Measurements/results.txt

SVT Survey Top

From the survey measurements:

L0 Top Axial sensor in uchannel frame
Origin: [-54.09130816 -28.4573564 0.57462736]

L0 Top Axial sensor in JLab frame
Origin: [1.67903102 7.84837264 38.79269184]

I can derive:

Top uchannel -> JLab z = -54.09 -> 38.79 == +92.88

From the wire measurement:

Horizontal Wire Top in uchannel frame uchannel measurement
Position [-7.993253e+01 -1.431121e+01 1.587547e+01 9.021338e+01 1.390000e-03]

I then translate to get:
-79.93 + 92.88 = 12.95

SVT Survey Bottom

Repeat for the bottom:

L0 Bot Stereo sensor in uchannel frame
Origin: [-53.97045143 28.92468524   0.60123394]

L0 Bot Stereo sensor in JLab frame
Origin: [2.14239387 -7.82176606 54.77954857]

Bottom uchannel -> JLab z = -53.97 -> 54.78 == 108.75

Horizontal Wire Bot in uchannel frame uchannel measurement
Position [-8.149162e+01 1.713384e+01 1.583889e+01 -8.987309e+01 8.760000e-03]

so -81.49 + 108.75 = 27.26

SVT Survey Wire Positions

Bottom line:

Top wire Survey at: 12.95
Bottom wire Survey at: 27.26

These are to be compared with my measurements with the data:

Top wire Data at: z=11.6 ± 0.8
Bottom wire Data at: z=29.5 ± 1.3

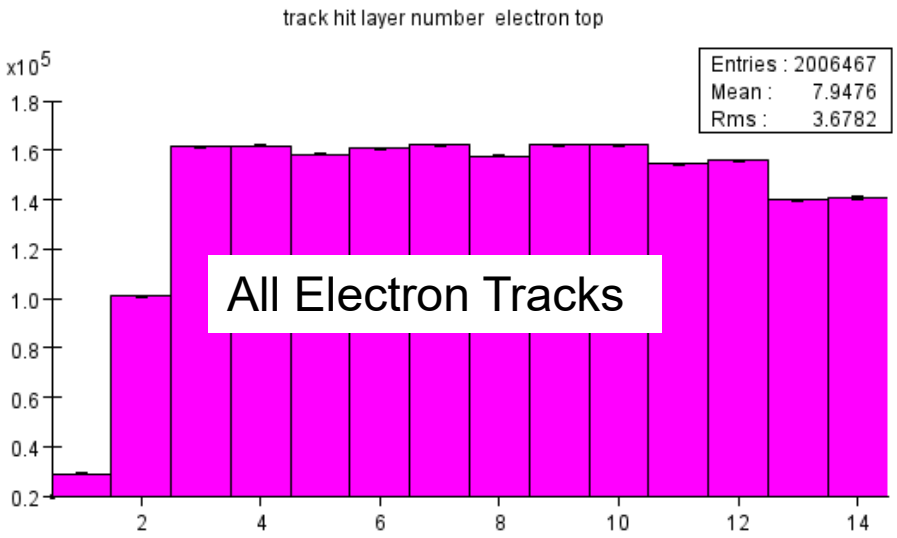
Top Wire Δ= +1.35 ± 0.8 mm
Bottom Wire Δ= -2.24 ± 1.3 mm

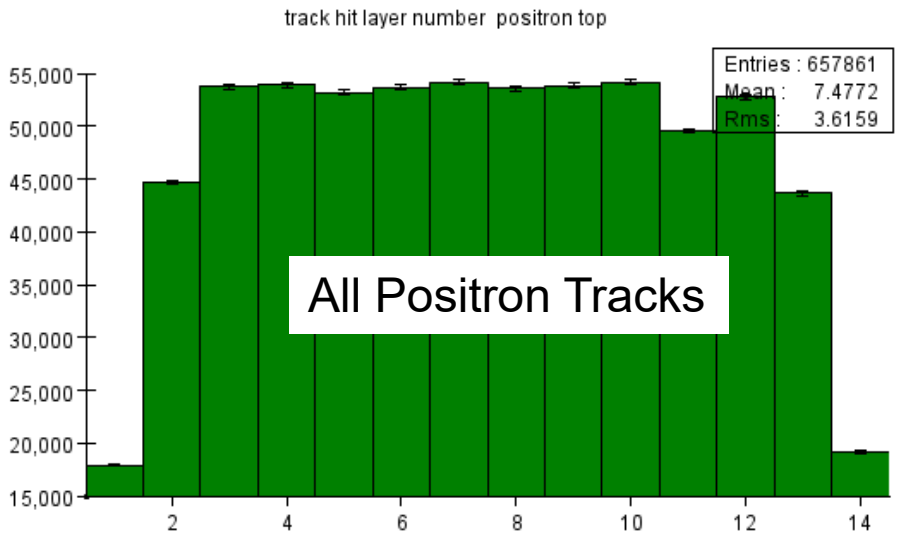
Still a work in progress, but I think progress has been made using the survey information. I'd really like to see a detector model that incorporates the survey information for the sensors.

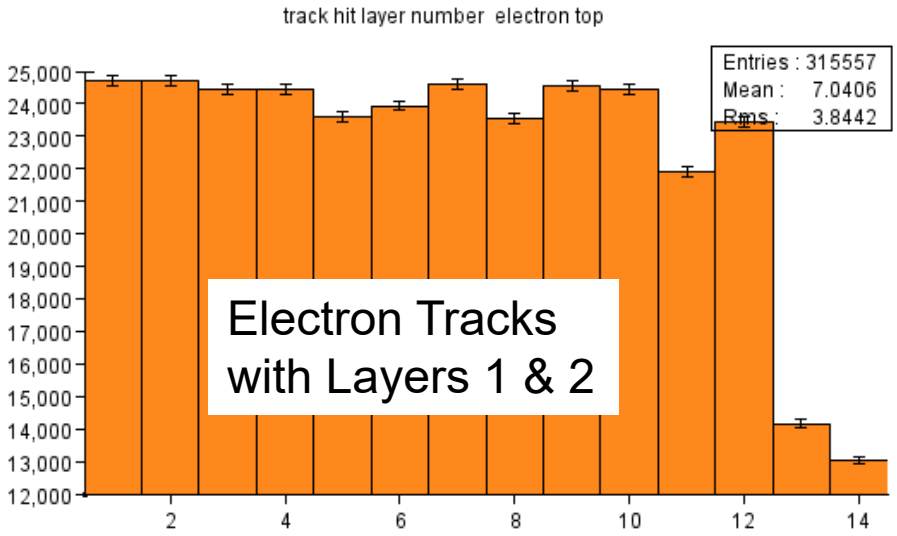
Some Additional Information

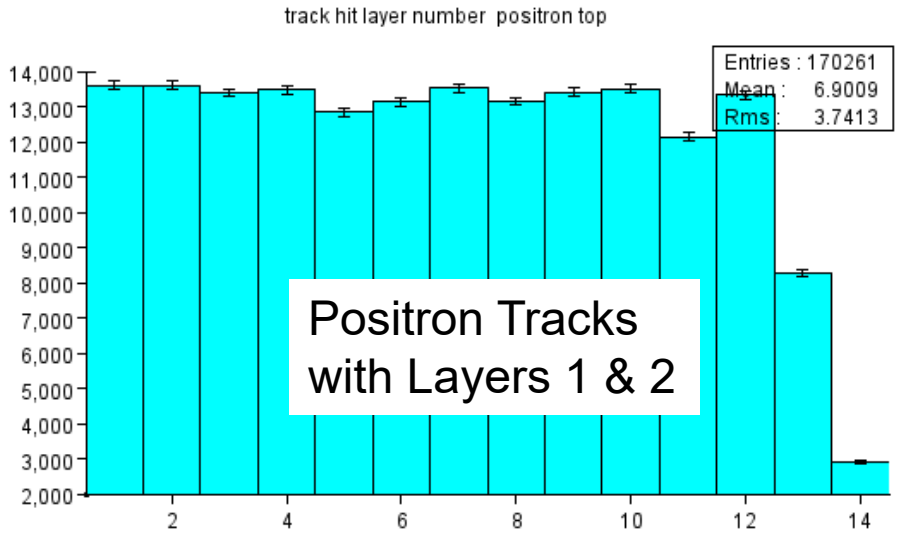
- There is some evidence for believing that the slim sensors in Layer 1 (and maybe 2) are incorrectly placed.
- Compare z location of multivertex vertices with and mostly without layers 1 (and 2).
- Position of z vertex moves substantially when including hits in layer 1 (and 2) indicating that the sensors are misplaced in the detector geometry.

Layers Hit on Top Tracks w & w/0 1&2

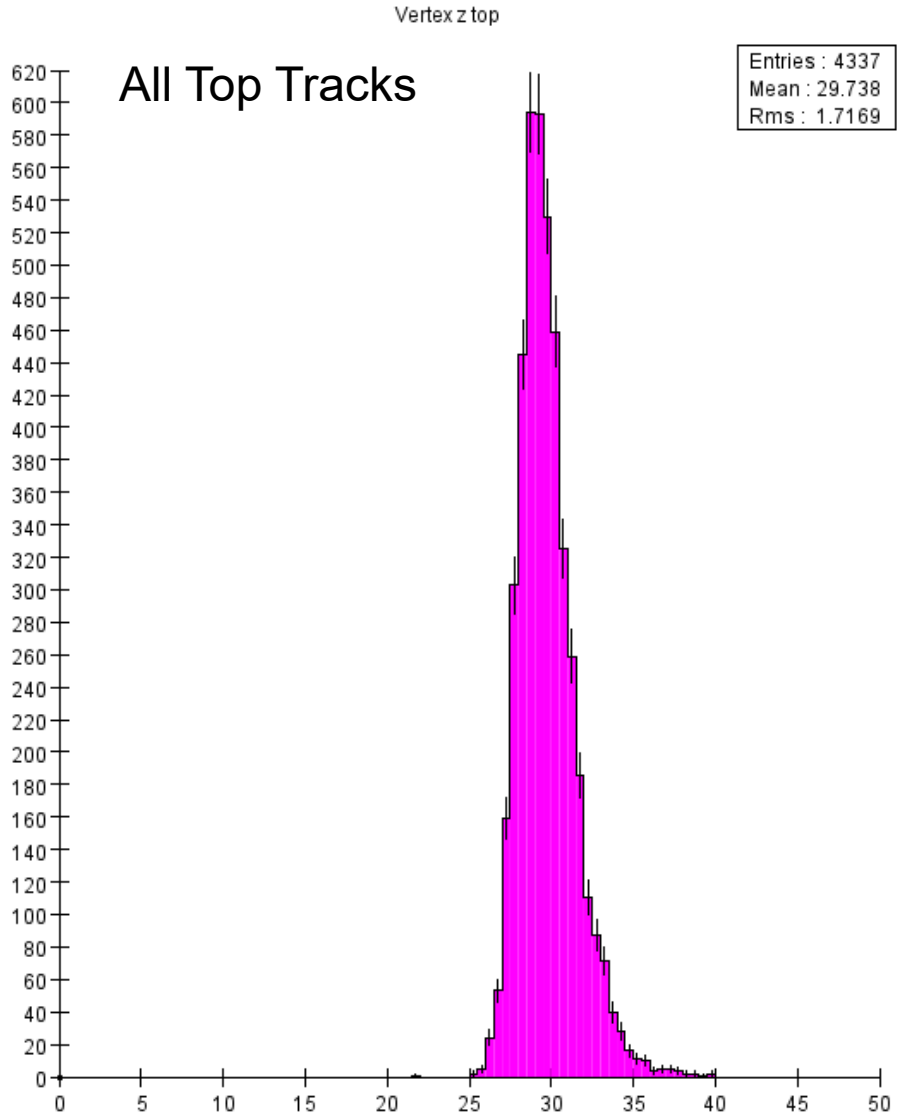


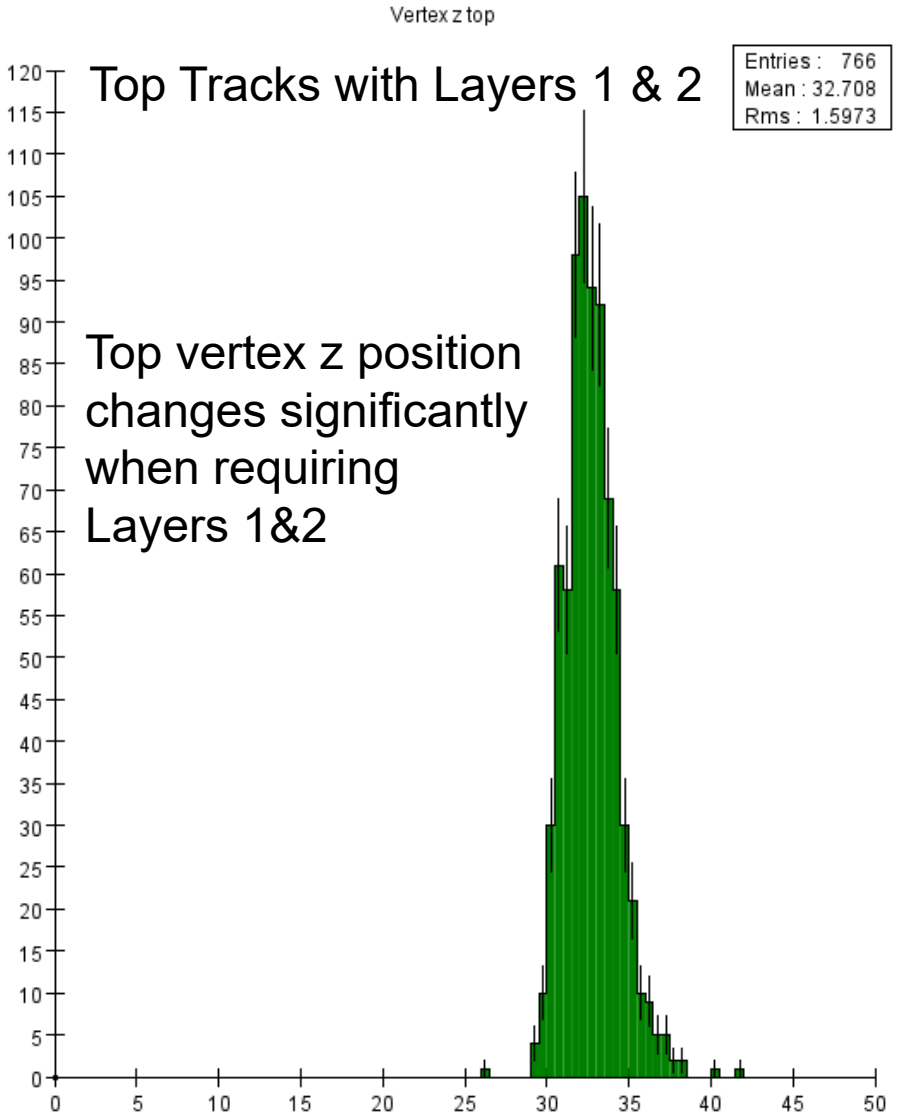






MultiVertex Z Position w & w/0 1&2





Top vertex z position changes significantly when requiring Layers 1&2