

# A 2021 FEE Alignment Iteration

Cameron Bravo (SLAC)

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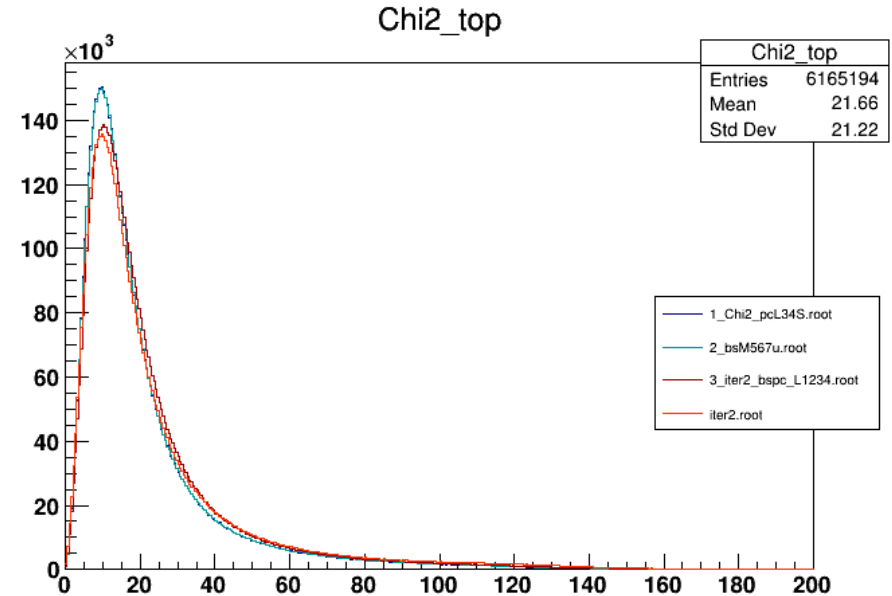
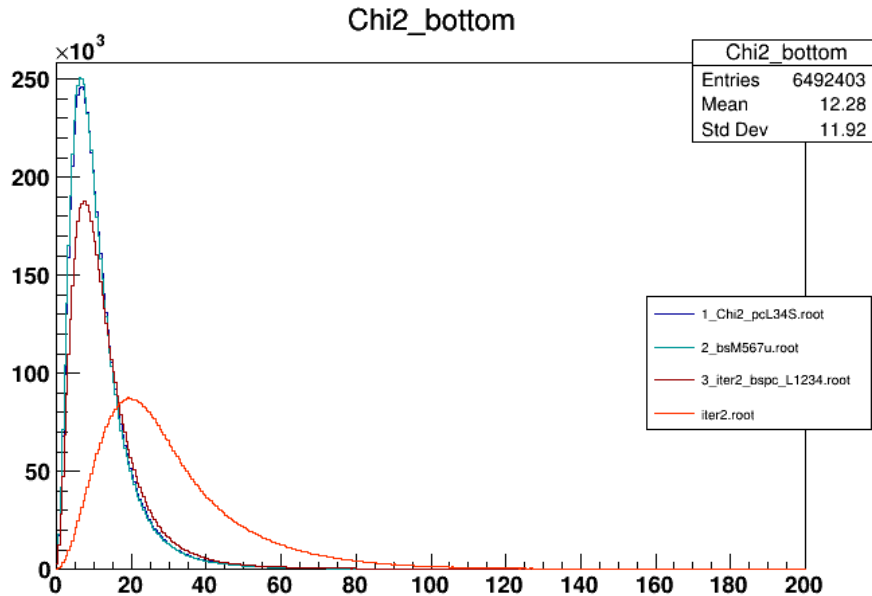


# Introduction

- Used FEE run 14168, also checking physics run 14552 with hpstr
- Software detailed by PF in his talk “[Alignment Overview and Recipes](#)”
- Started with HPS\_Run2021Pass1Top
- First step was to look at unbiased residuals and clean up small satellite peaks in ures
- Moved L7T stereo slot about 65 um and saw improvements to unbiased residuals
- Next I tried fixing the momentum scale via rotation of the uchannels
- Managed to get the momentum scale in a reasonable place
- Movement required was unphysically large (~12 mrad around global Y, back uchannel)
- Second step was to remove Tx of modules put in by PF for top layers 5, 6, & 7
- An iteration of beam spot constraint with Module u movements
- An iteration of momentum constraint with stereo sensor u movements
- Did same thing in bottom, which mostly fixed the big momentum scale issue

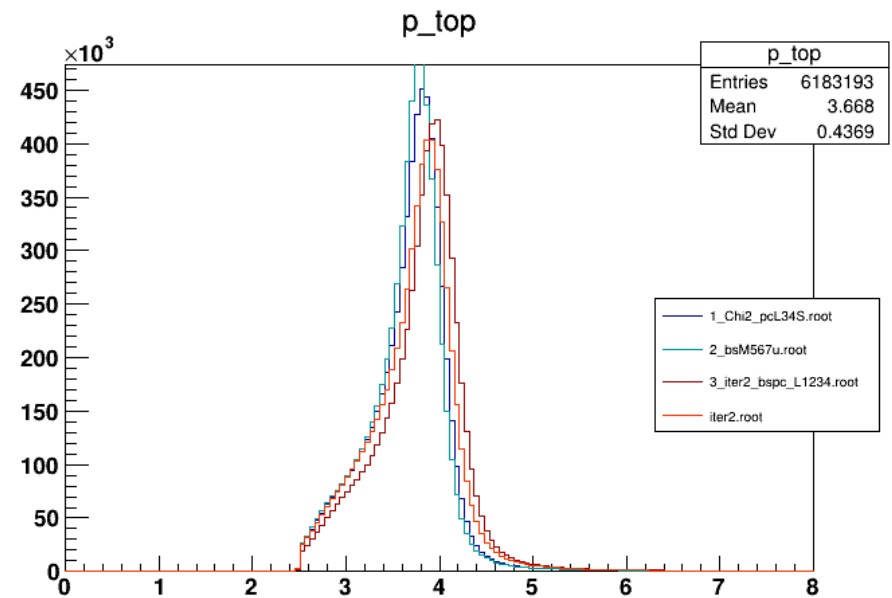
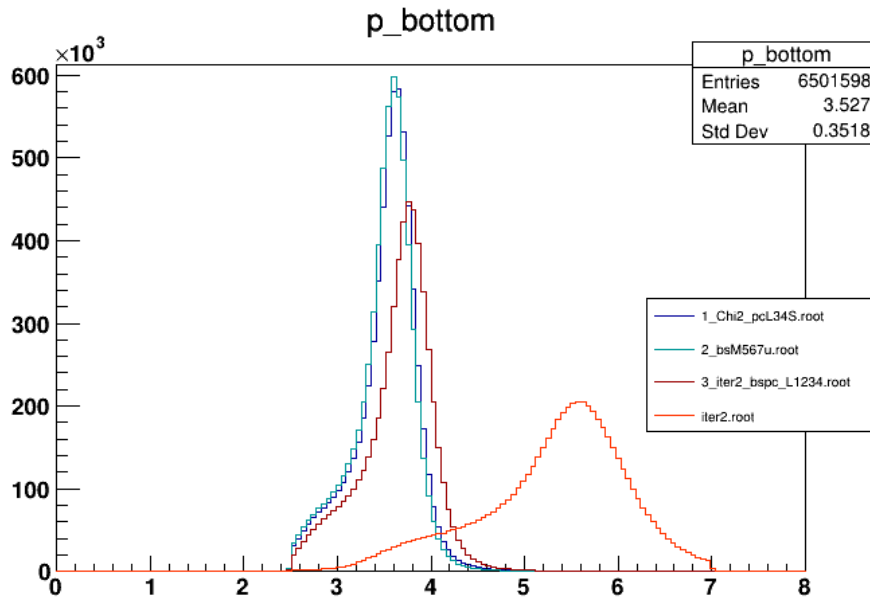
- Next step was starting to move front to move beam spot position to (0, 0, -1)
- Beam spot constraint and module u movements
- Momentum constraint and stereo sensor u movements
- During this the bottom track Chi2 distribution decreases significantly, is now roughly what is expected, width is still a little large but average Chi2 is close
- Roughly half-way through moving beamspot, back and front seemed to be in tension
- Iteration of same sort of constraints and movement of back layers removed tension
- Kept moving beamspot with beam spot constraint in front
- Beamspot ends up where I was trying to move it to, D0 and Z0 are centered on zero when track parameters are taken with respect to (0, 0, -1)
- Next do another iteration of back layers to get it more lined up with front again
- Finish with momentum constraint with movement of layers 3 and 4 stereo sensors in u

# Chi2 Distribution of FEE Run



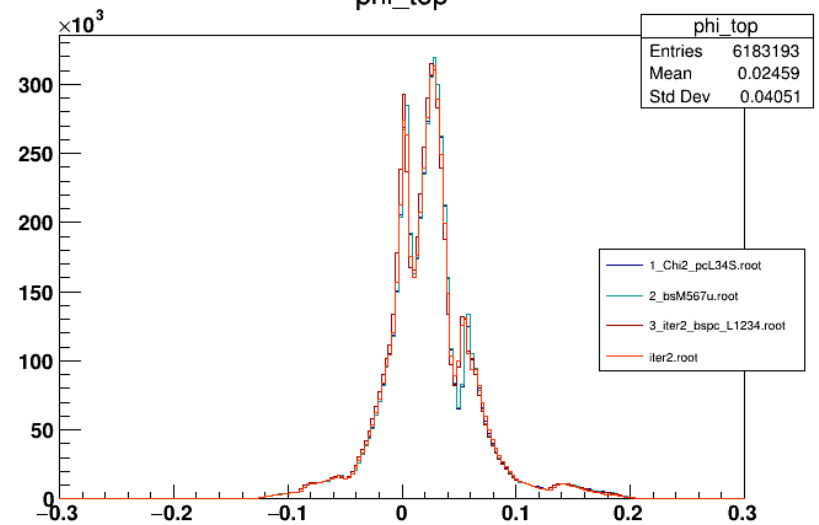
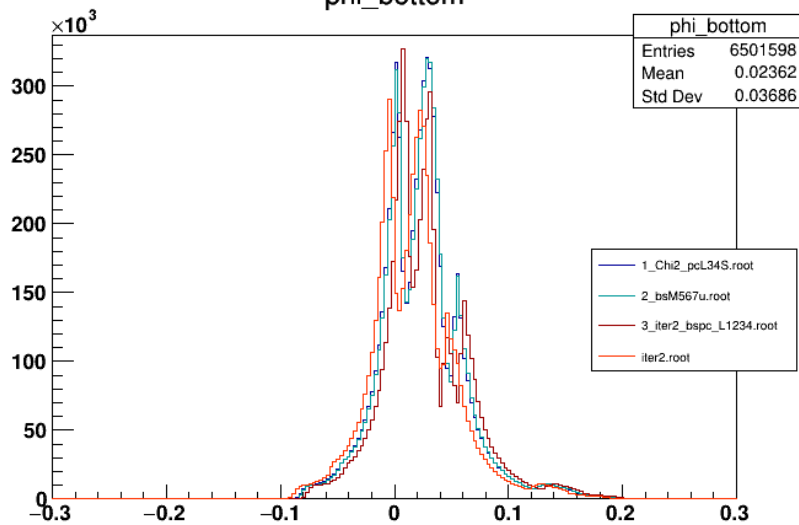
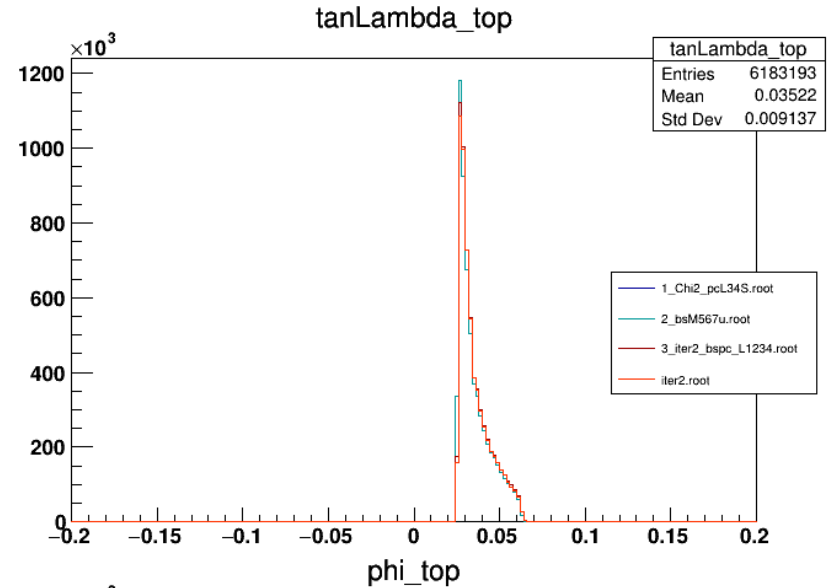
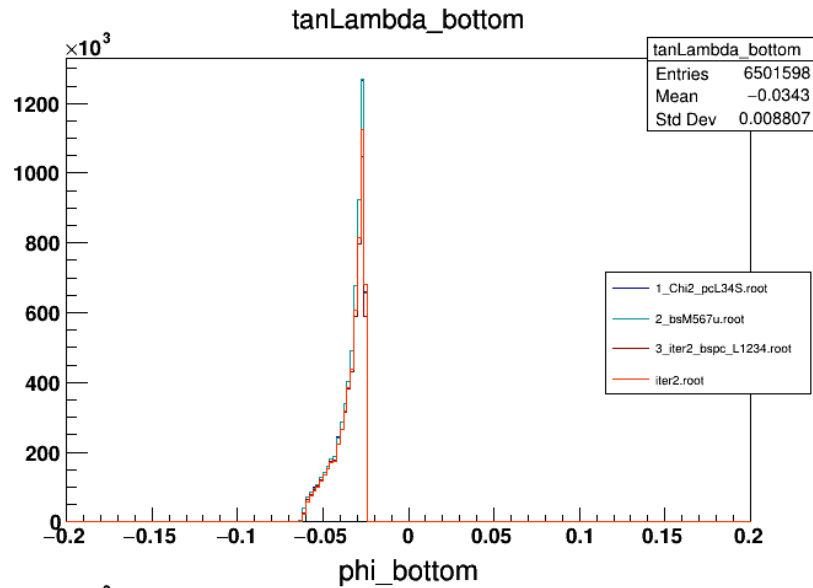
- Detectors are in order from most recent to oldest in my progress
- The oldest detector I am showing today is HPS\_Run2021Pass1Top plus the movements I summarized in [my first update on alignment](#)
- Next detector is after using a combination of the beam spot and momentum constraint on the back and then using a beam spot constraint on the front

# Momentum Distribution of FEE Run

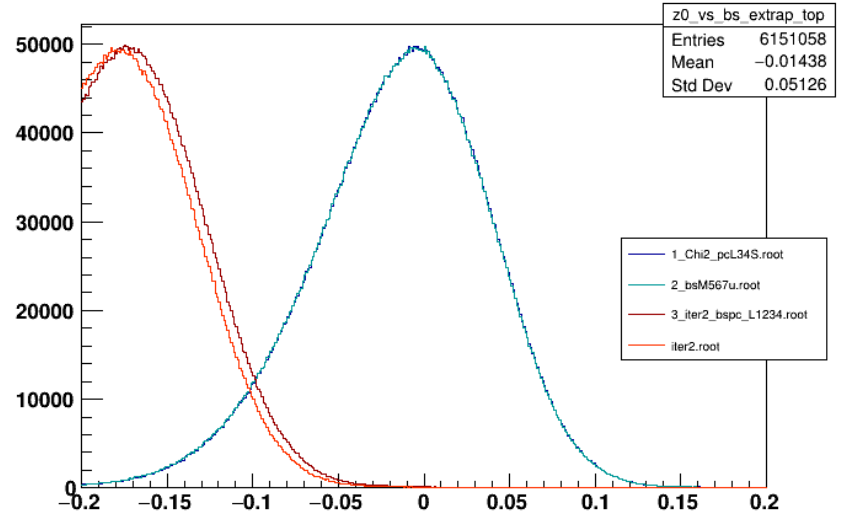
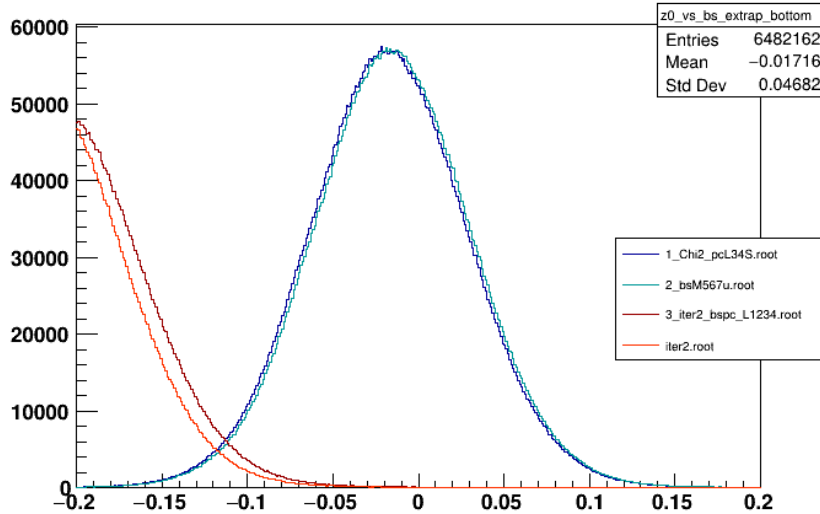
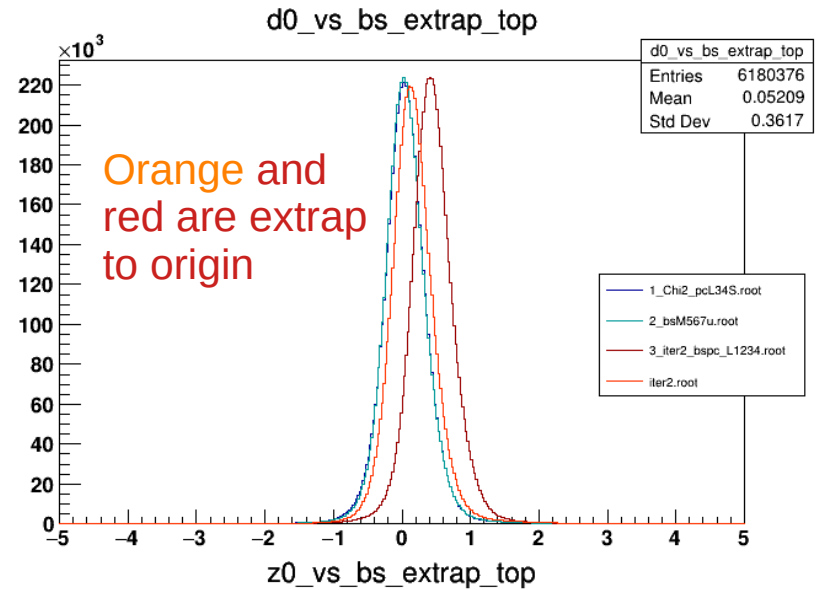
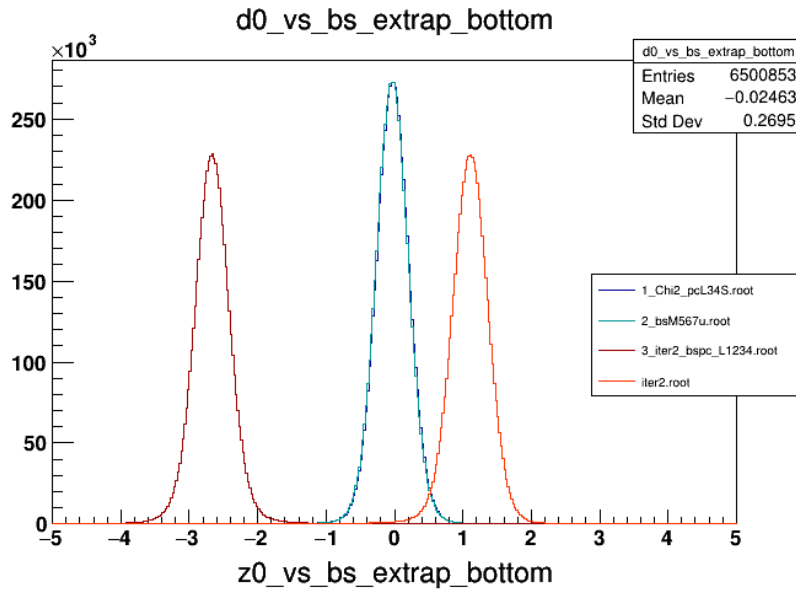


- The next detector is after using a beam spot constraint and moving the module u position of layers 5, 6, and 7
- The most recent detector then had an iteration track chi2 minimization with stereo sensor u movements and a momentum constraint with stereo sensor u movement of layers 3 and 4

# Track Angular Distributions of FEE Run

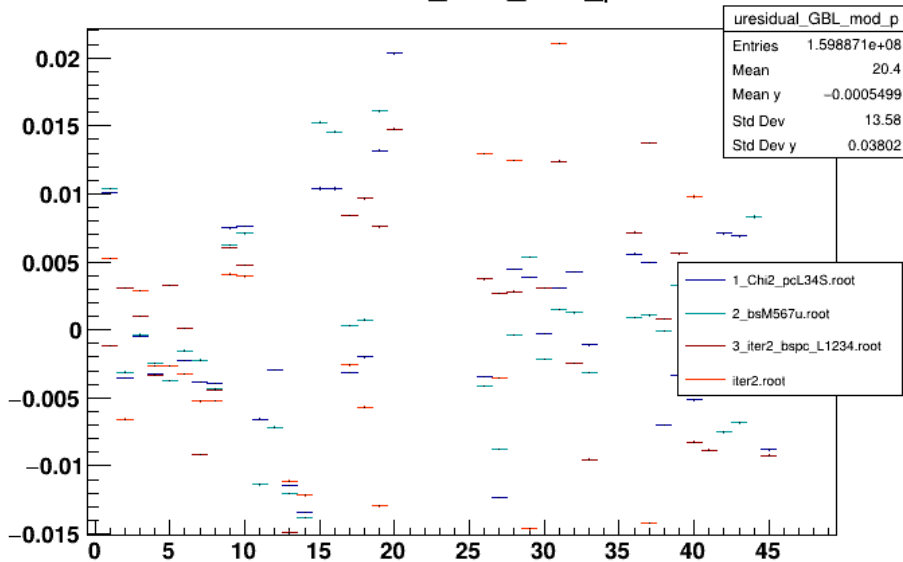


# $z_0$ and $d_0$ Distributions of FEE Run at (0, 0, -1)

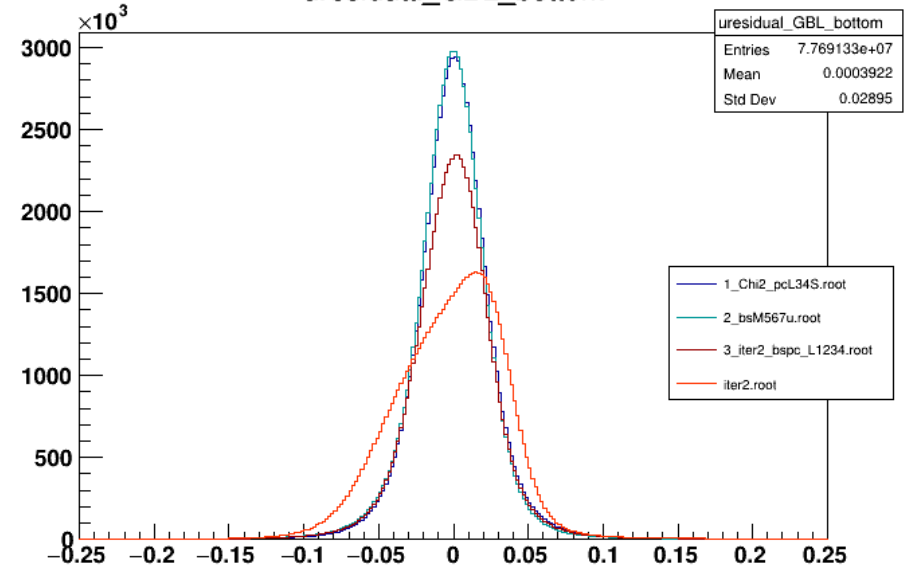


# Unbiased Residuals from FEE Run

uresidual\_GBL\_mod\_p



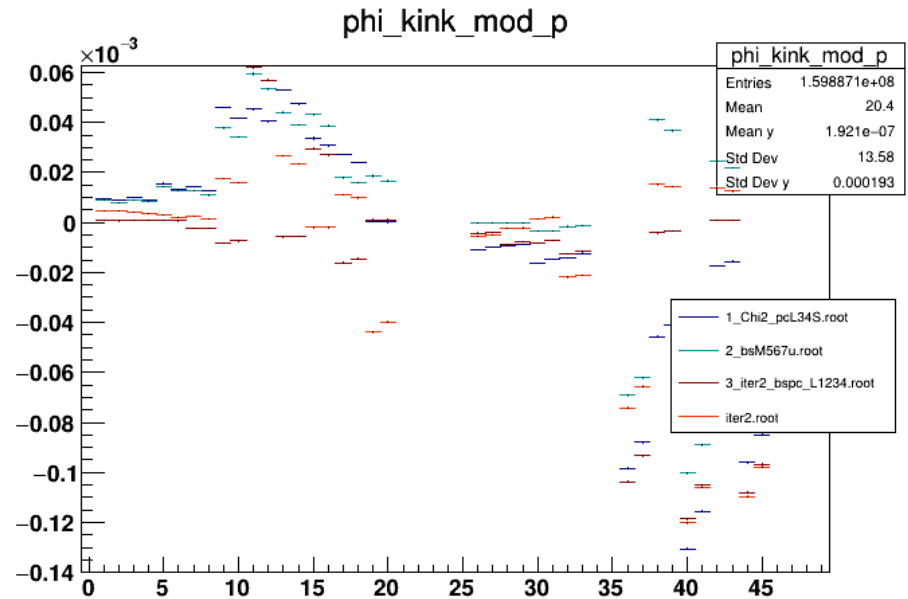
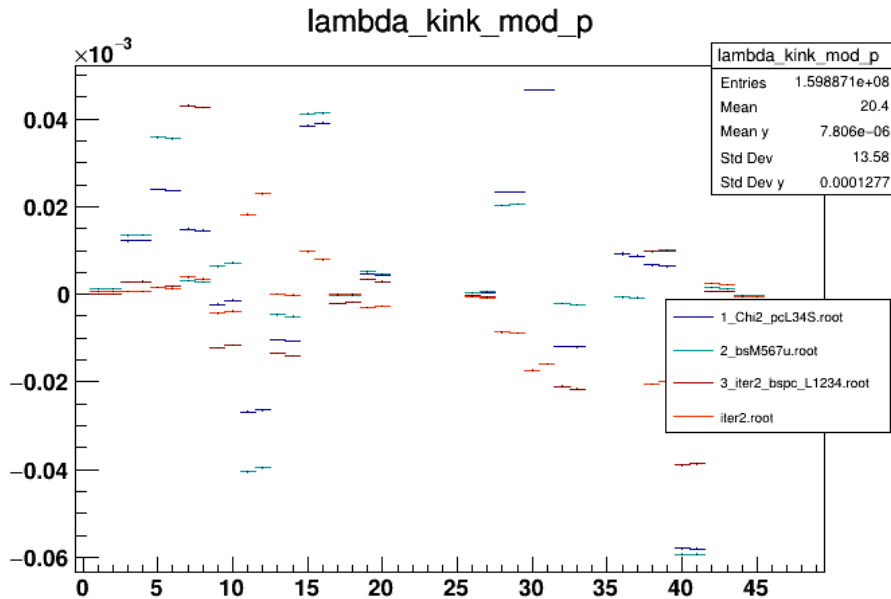
uresidual\_GBL\_bottom



- Overall the unbiased residuals are looking better
- Still some improvement to be made
  - The beam spot doesn't seem to be in the correct position currently
  - Unclear if top and bottom even agree on beamspot position
- Thinking about studying moving beamspot to more positions

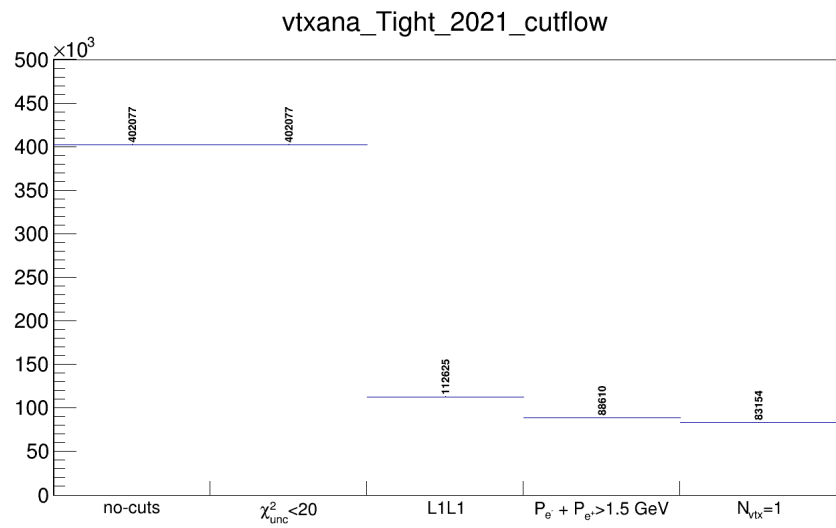
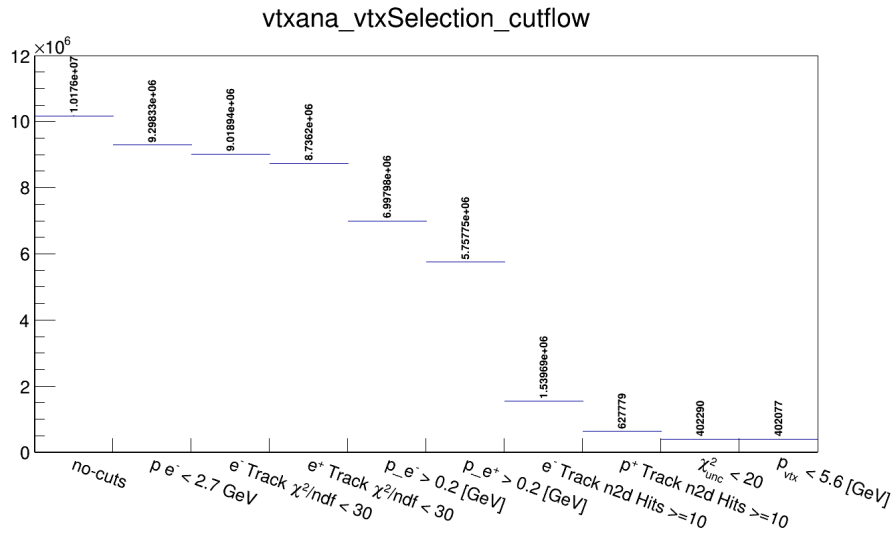


# Track Kinks from FEE Run



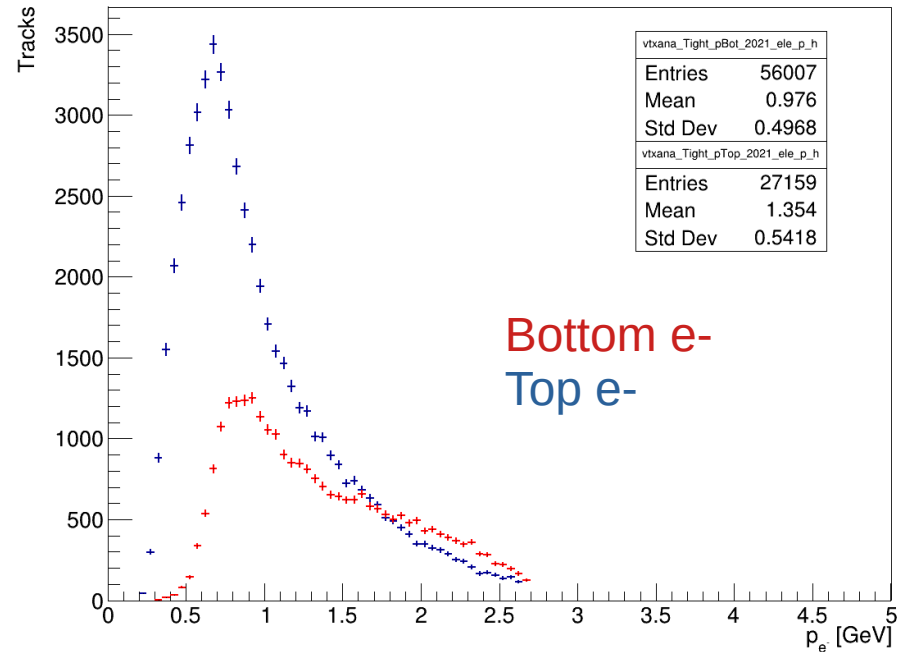
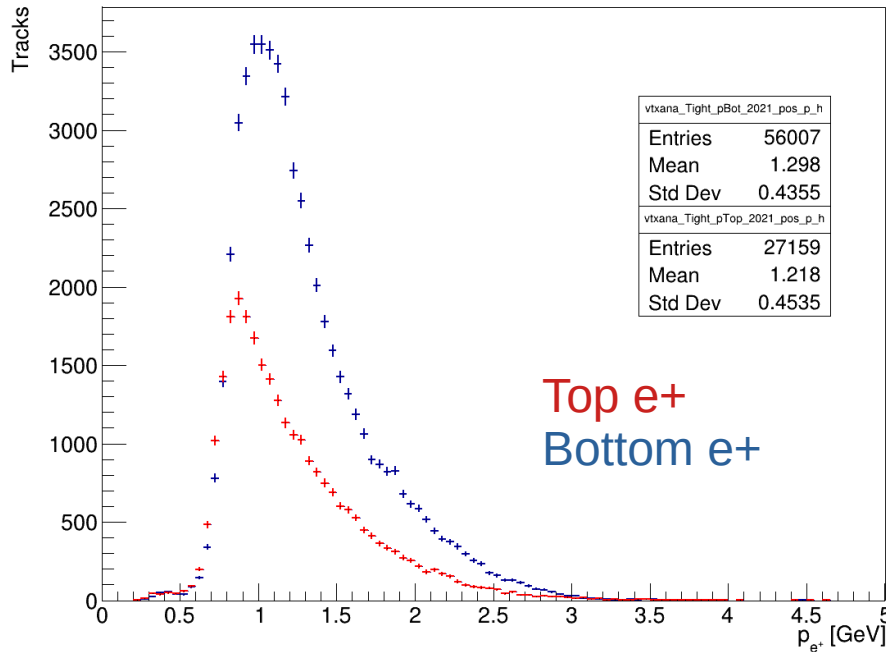
- Overall kinks are mostly on the scale of tens of microradians
  - Probably not big enough to complain too much about
  - Front is better overall than the back
- BS constraint and track Chi2 minimization movements tend to improve kinks

# Reco Vertex Cutflow



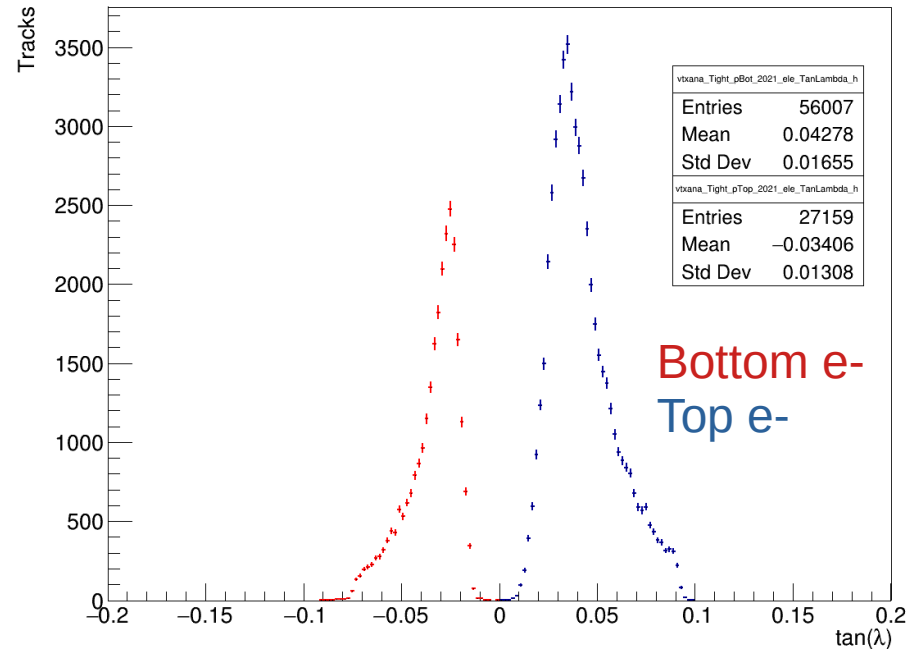
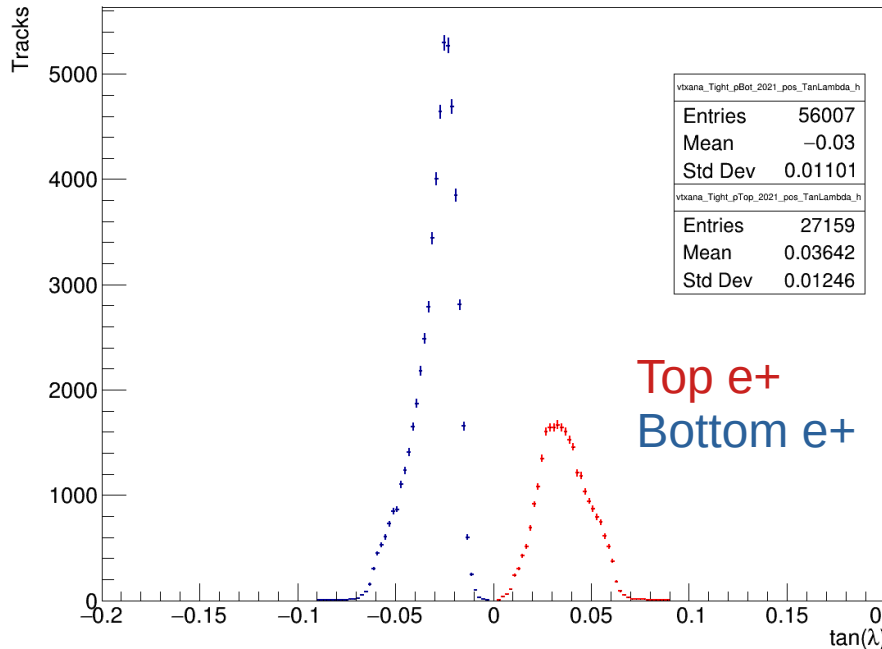
- Let's transition to looking at Kalman tracks in physics data
- Run 14552 with new alignment
  - 45 files, ~6.6 million events
- Selection is still loose overall
- Though I am including the L1L1 requirement for now

# Particle Momenta



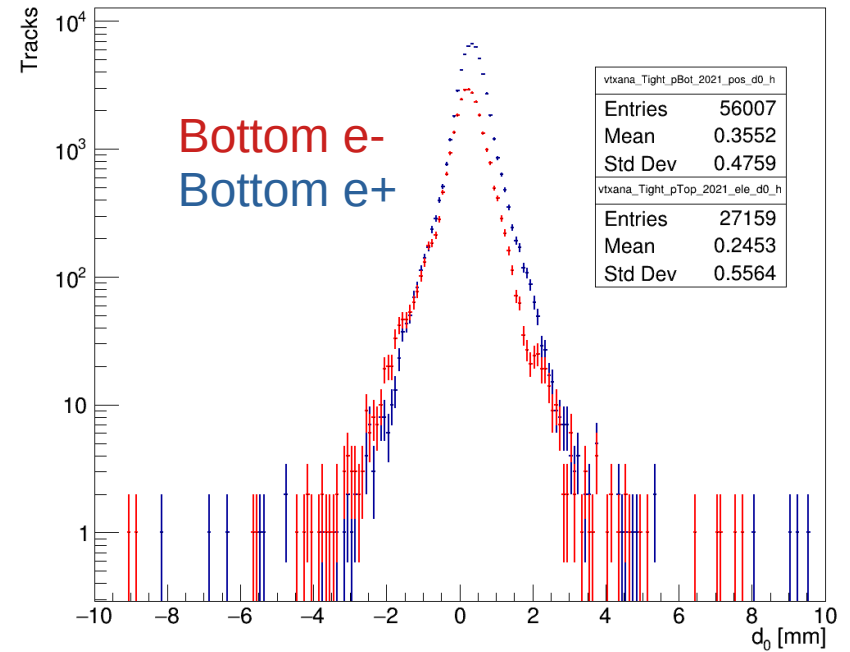
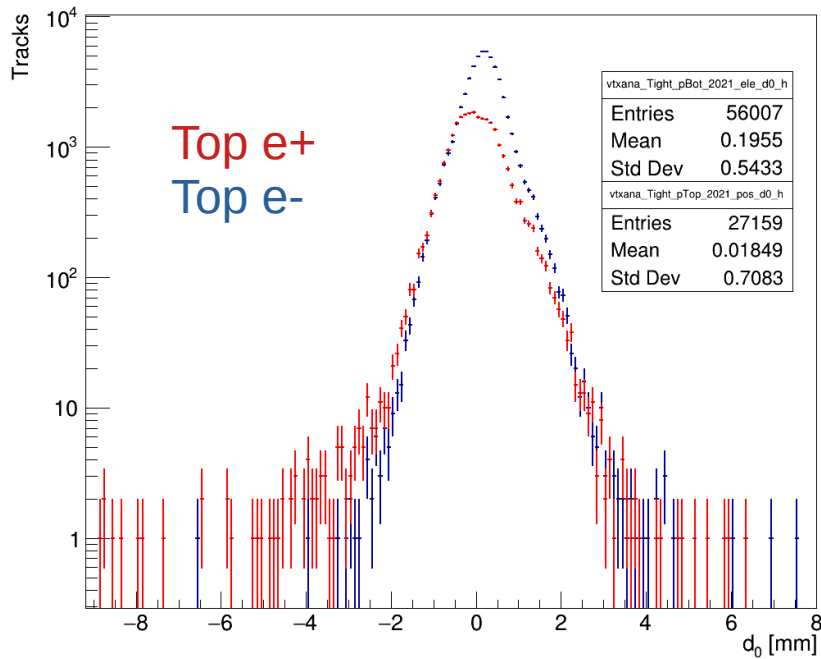
- Red are vtx with the positron in the top tracking volume
- Blue are vtx with the positron in the bottom tracking volume
- Something is way off for bottom e- and hurting the acceptance
- Something in the back would make the most sense for missing low  $p$

# Track Tan Lambda



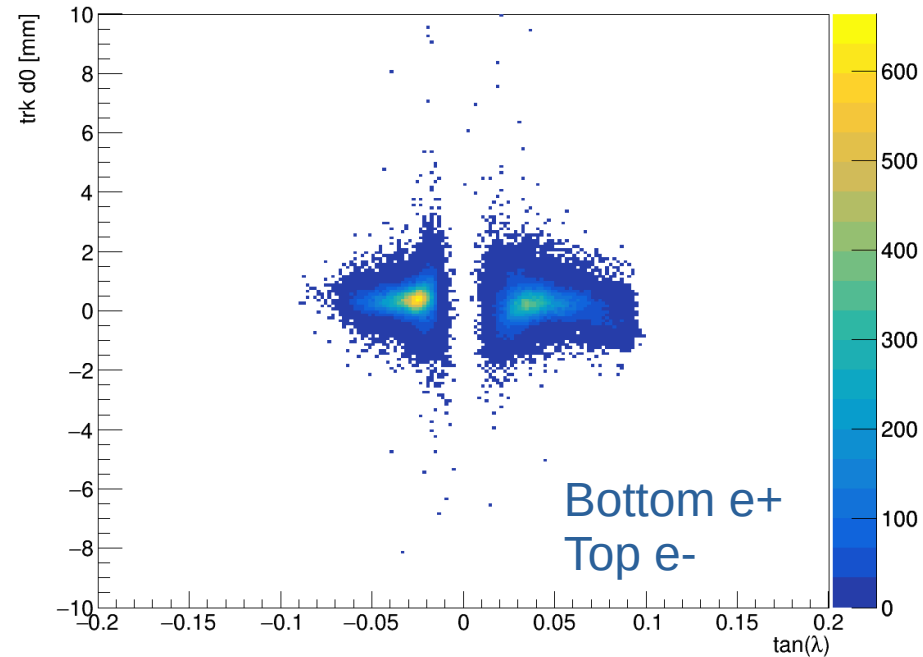
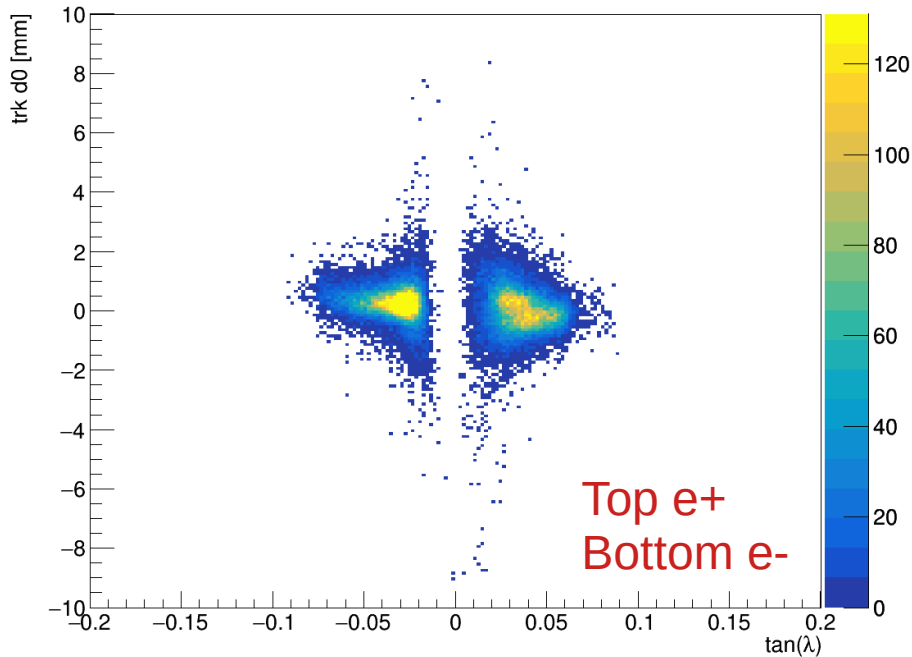
- Red are vtx with the **positron in the top** tracking volume
- Blue are vtx with the **positron in the bottom** tracking volume
- Looks like the vertex with the positron in the top are all kinds of messed up
- Less low tan lambda Top e+ on selected vtx
- Range of bottom e- tan lambda much smaller

# Track $d_0$



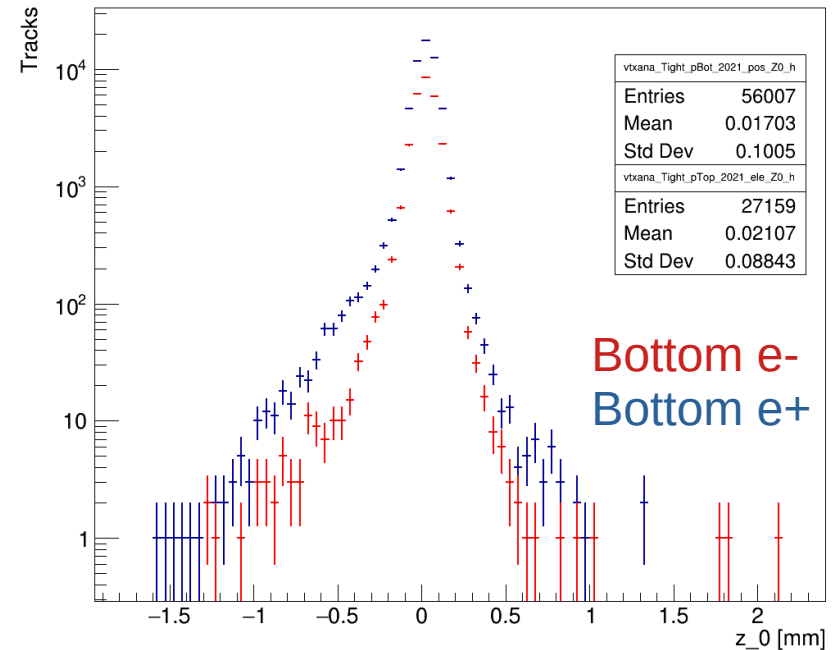
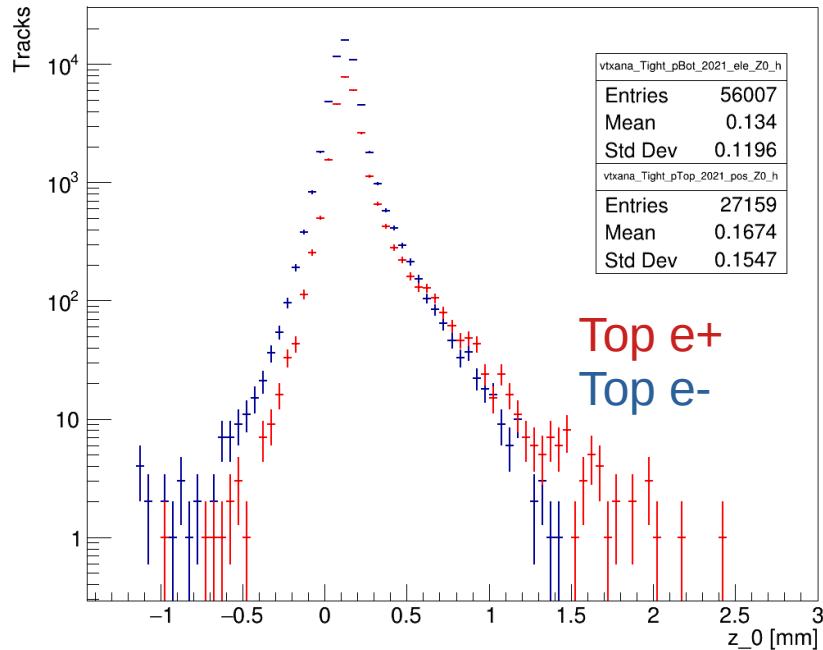
- The positron distribution looks more sick than the electron distribution for vtx with positron in top (where the issue is)

# Track $d_0$ vs Tan Lambda



- Something looks really off for top  $e^+$  here
  - Scale of z axis of left plot is a little funny, I will explain
  - So maybe this means the issue is really in the front of the top?

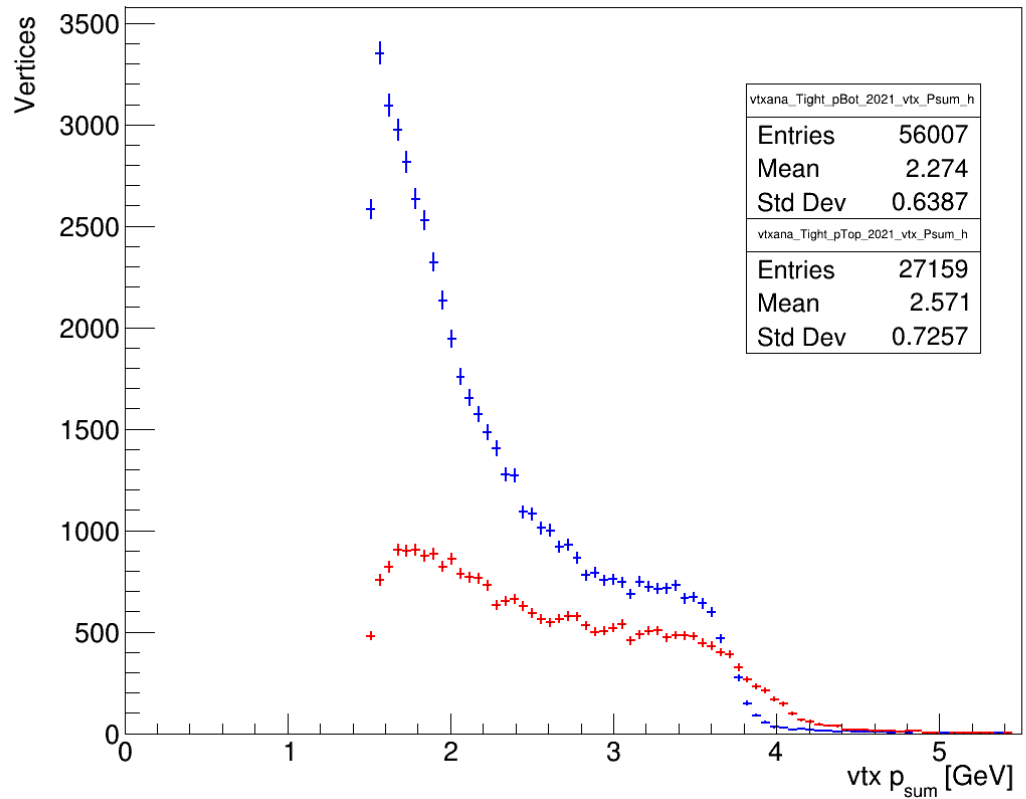
# Track $z_0$



- Top and bottom don't quite agree on where the vertex is in  $z$

# Vertex Momentum Sum

- This makes some sense because we were missing low momentum electrons in the bottom
- Vtx with a bottom positron are getting close to decent
  - Rad peak is there
  - The peak is a little low wrt 3.7





- Finished a coarse grain alignment for 2021
  - Only moved modules and stereo sensors in u
- Still have some major issues we need to figure out
- Overall, things are looking better
  - Momentum scale is much closer than it was before
  - $d_0$  and  $Z_0$  are close to being centered at zero
  - Track kinks are scale 10s of microradian
  - Unbiased residuals are all within  $\sim 20$   $\mu\text{m}$
- What's next?
  - Investigate sensor rotations around w (global z)
  - Run alignment using physics samples

# Discussion

