Status and Plans for 2021

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Office of Science

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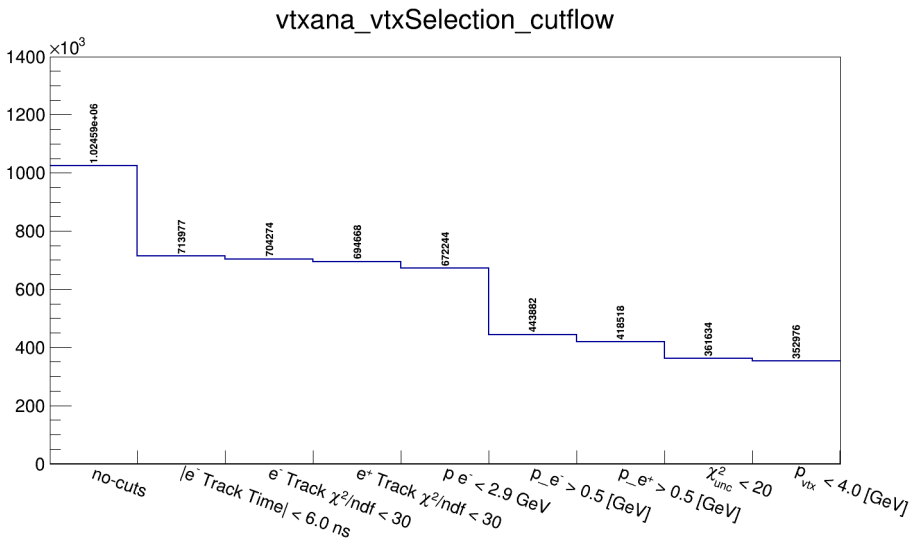
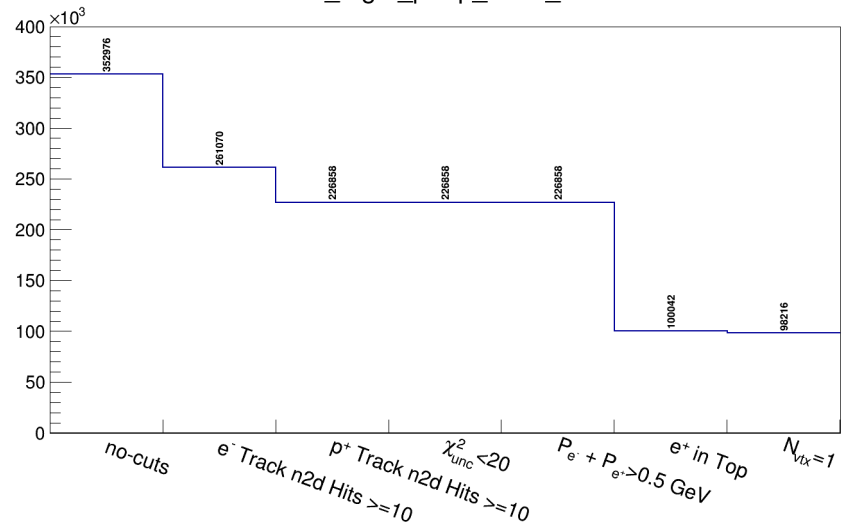
Introduction

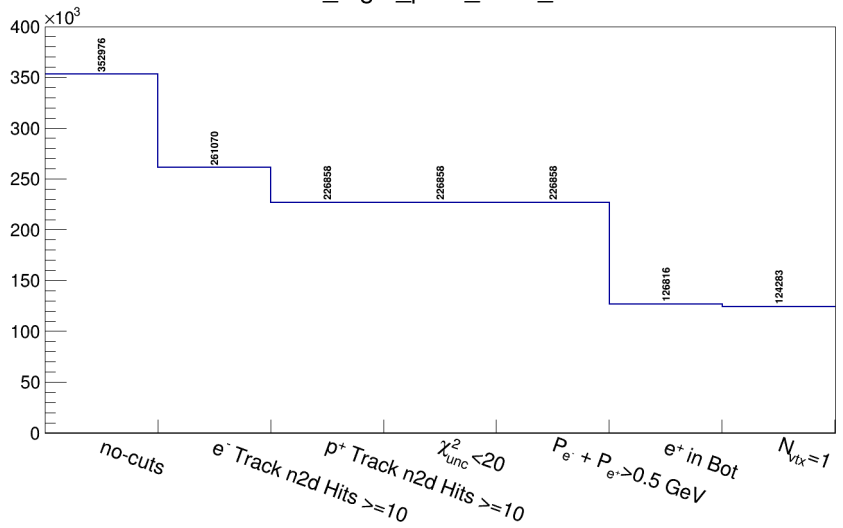
- Trying to determine any extra little polishing of alignment is needed before moving on to adjusting alignment for later runs
  - Track cluster matching
  - Tan(λ) acceptance
- Start by inspecting events with looser cuts and separating vertices by volume of positron track, move on to Tight L1L1 cuts closer to full analysis selection
- Looking at 20 partitions of run 14166
  - 8 um W 50 nA beam physics run
  - Alignment seems to change as run number increases, so lets start by understanding an early run first
  - Track variable use track state at target which is configured at z = 1 mm

Selection

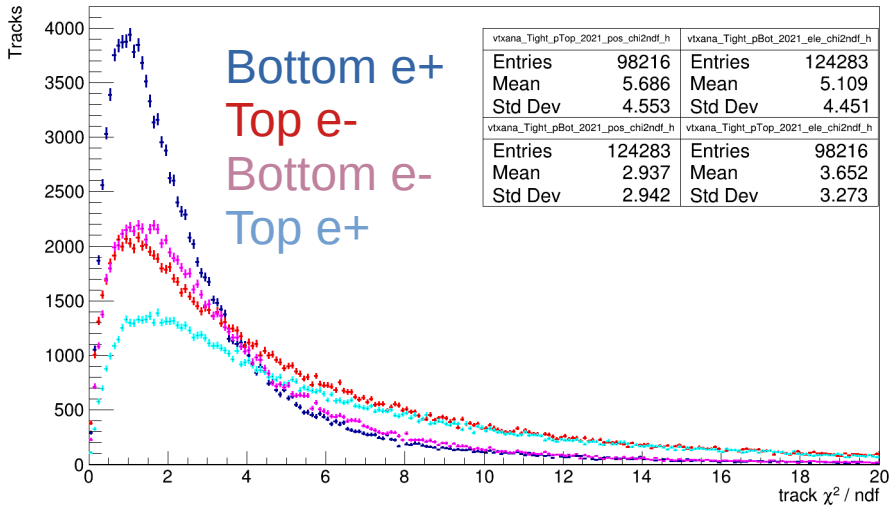


- Not including L1L1 at first
- Low track momentum cut
- Require at least 10 hits on track
  - Some acceptance missing 6&7 at low momentum



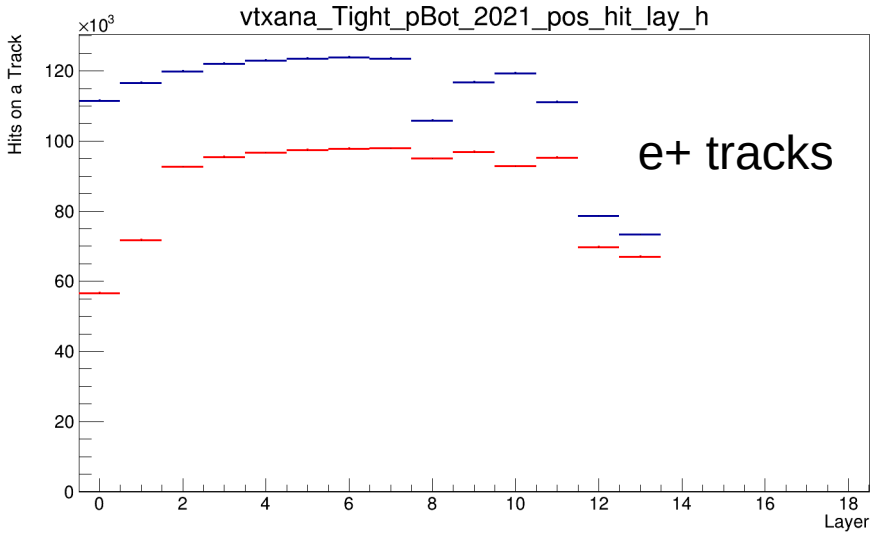


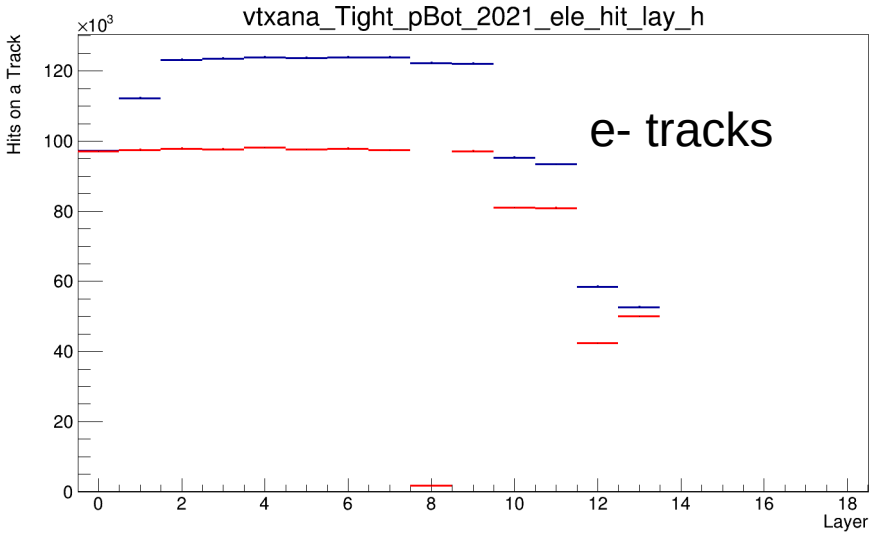
Chi2/ndf and Layers Hit



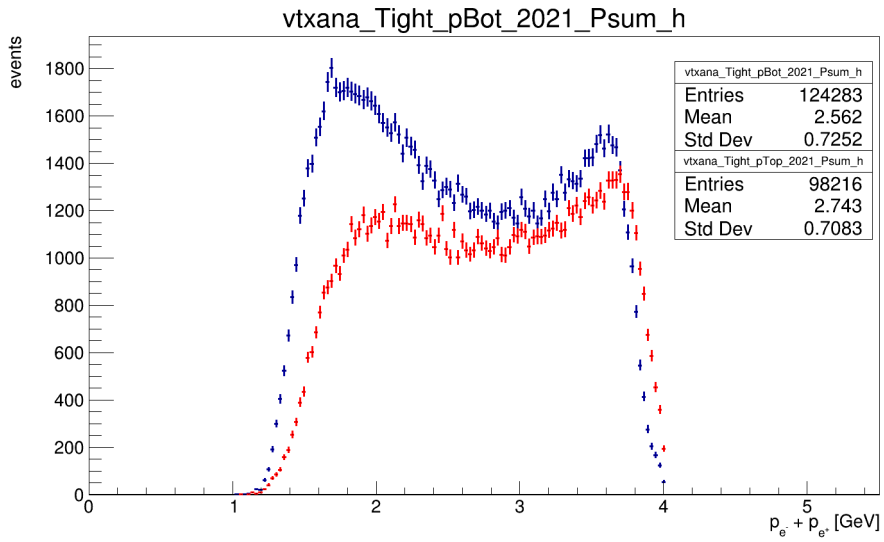
vtxana_Tight_pTop_2021_pos_chi2ndf_h		vtxana_Tight_pBot_2021_ele_chi2ndf_h	
Entries	98216	Entries	124283
Mean	5.686	Mean	5.109
Std Dev	4.553	Std Dev	4.451
vtxana_Tight_pBot_2021_pos_chi2ndf_h		**vtxana_Tight_pTop_2021_ele_chi2ndf_h**	
Entries	124283	Entries	98216
Mean	2.937	Mean	3.652
Std Dev	2.942	Std Dev	3.273

- Blue is vtx with positron in bottom
- Red is vtx with positron in top
- Requiring 10 hits on track is gonna make the acceptance of bottom electrons different since there is already a missing hit

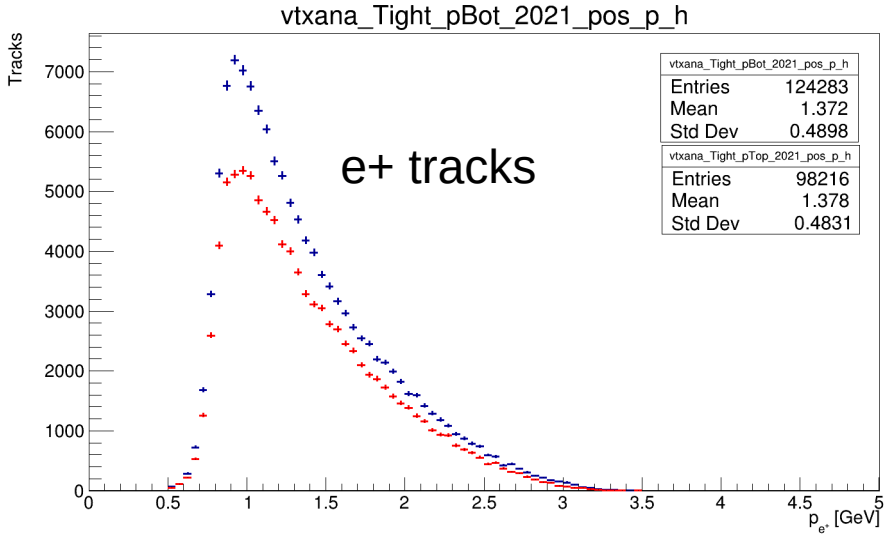


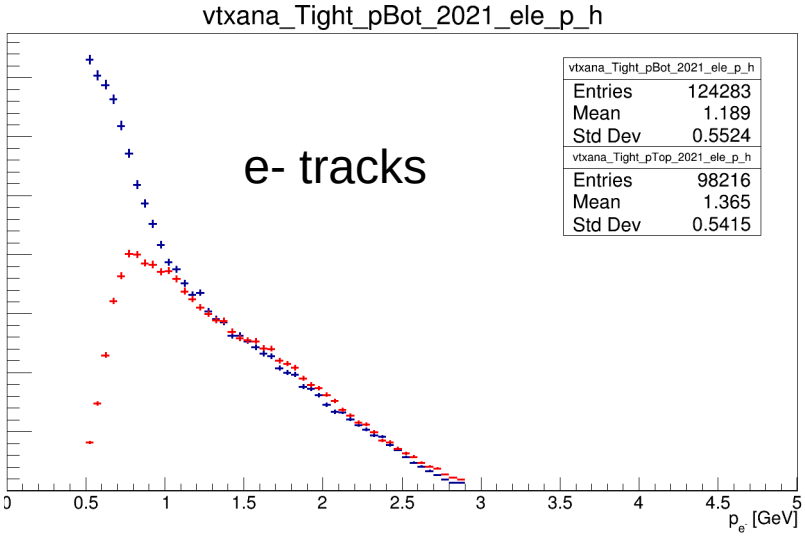


Momenta

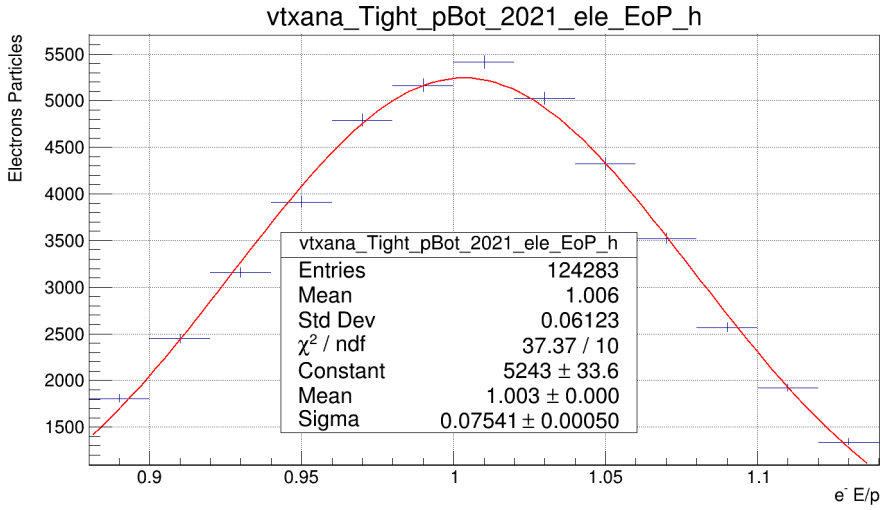


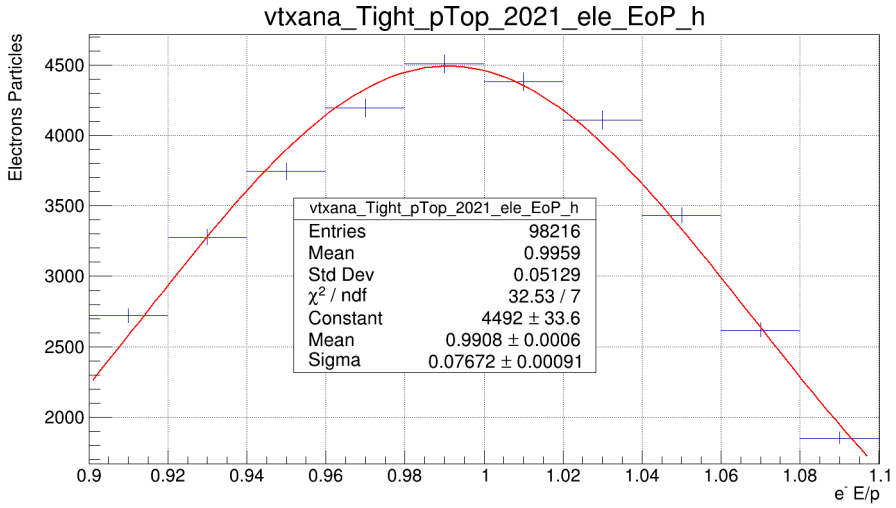
- Blue is vtx with positron in bottom
- Red is vtx with positron in top
- Missing L5 bottom stereo, so 10 hit requirement forces us to have a hit in layer 6 or 7, which means our acceptance starts at a higher momentum for electrons in the bottom





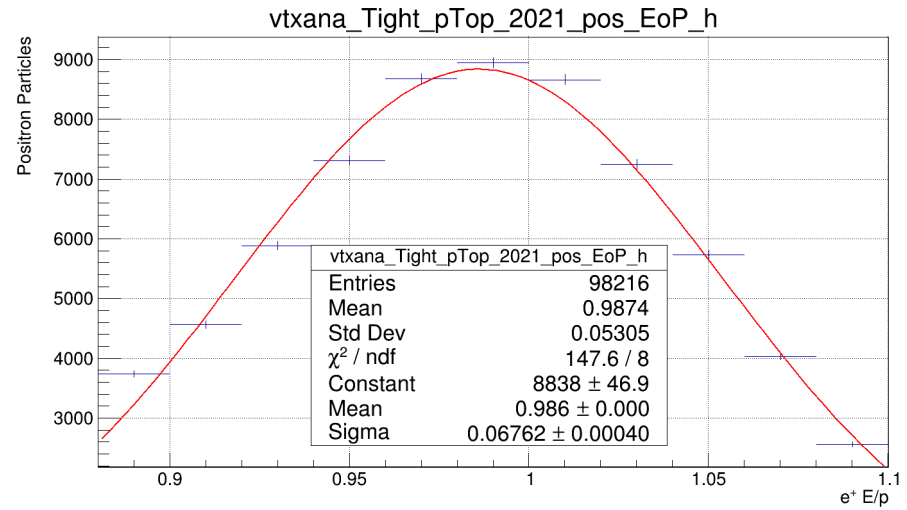
Electron Momentum Resolution

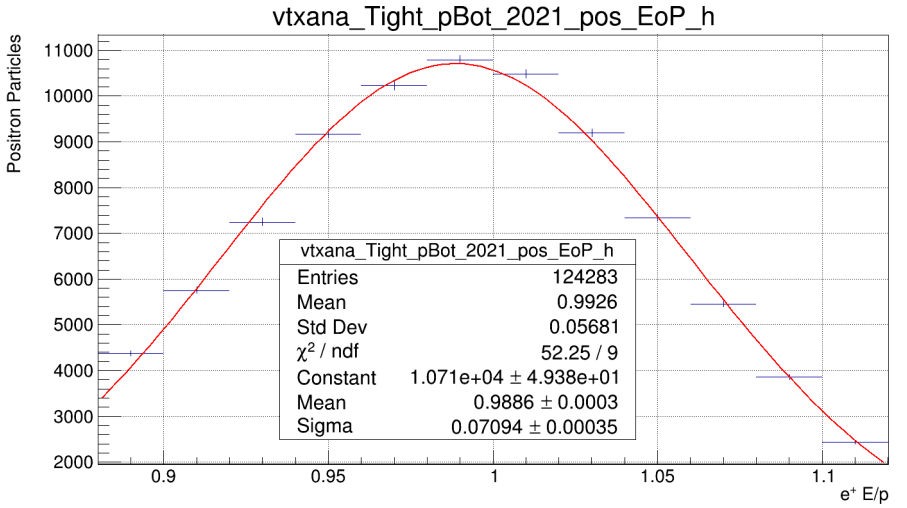




- Momentum scale of electrons is better than 1% in top and bottom
- Momentum resolution better than 8% in both top and bottom
  - MC has a resolution of 5-6%
- Electrons looks pretty solid if we trust the Ecal cluster energies

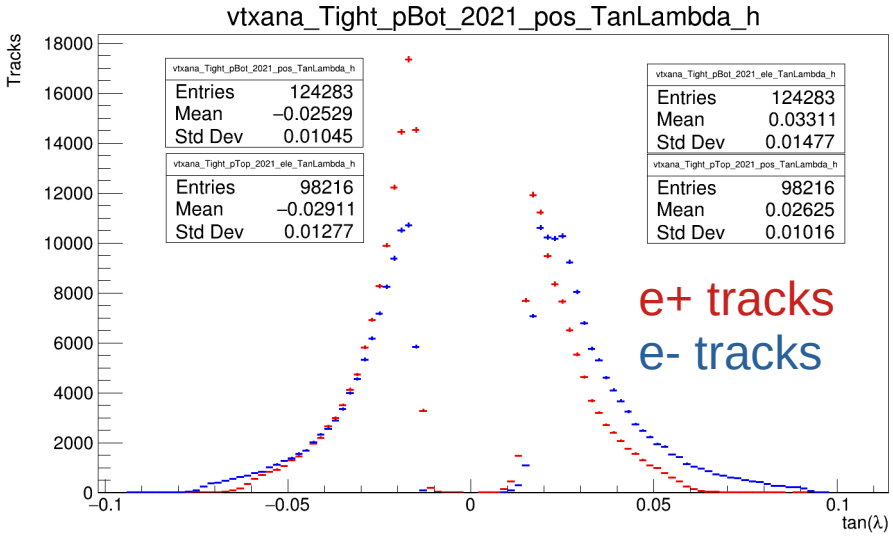
Electron Momentum Resolution



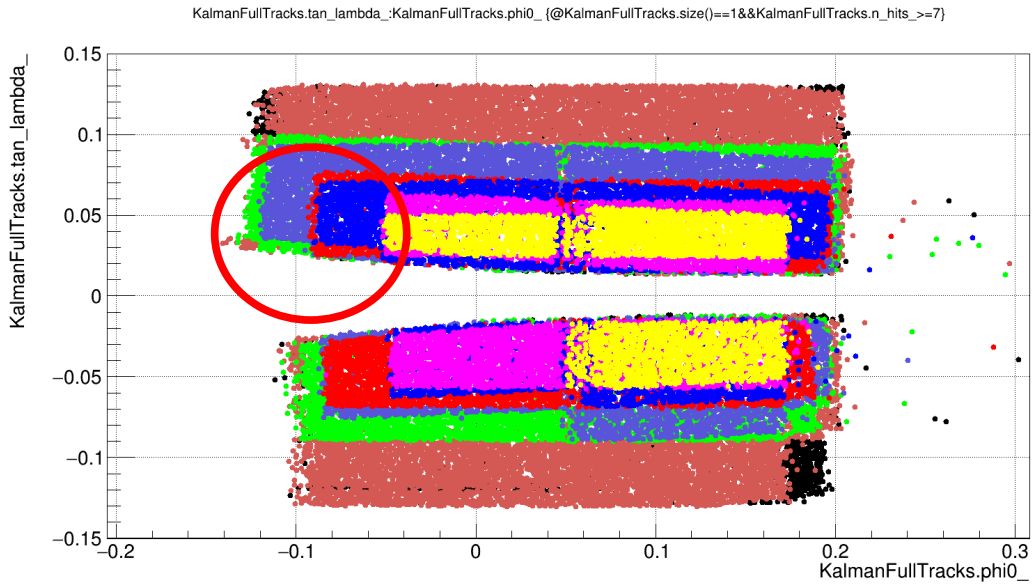


- Positron momentum scale better than 2% in both the top and bottom
  - A hair low overall for both volumes
- Momentum resolution ~7% in both top and bottom volumes
  - This is about 5-6% in MC
- Momentum scale and resolution look pretty solid for positrons if we trust the Ecal cluster energy

Tan(λ) Acceptance



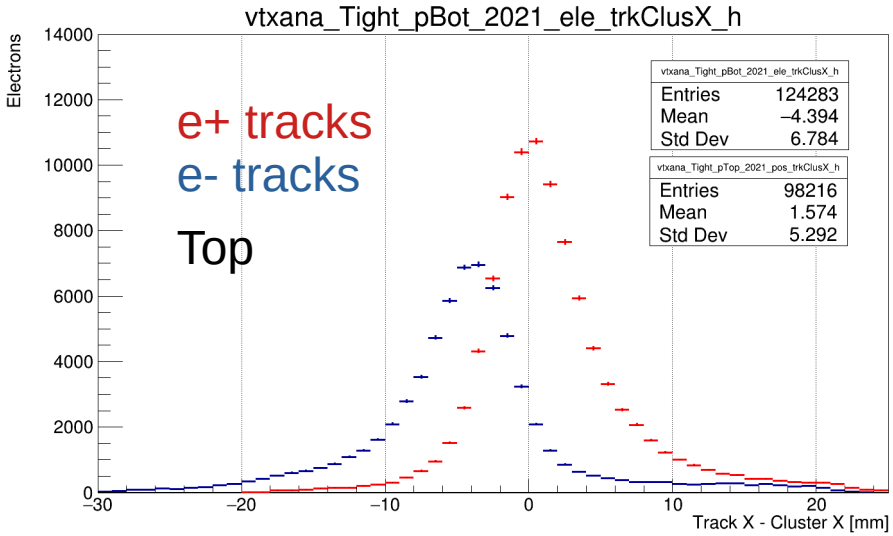
- Shape of top electrons is due to acceptance at low momentum having a chunk taken out at low tan(λ)
- Plot below is from acceptance study I showed before using realistic SVT conditions for 2021
  - Beam energy electrons

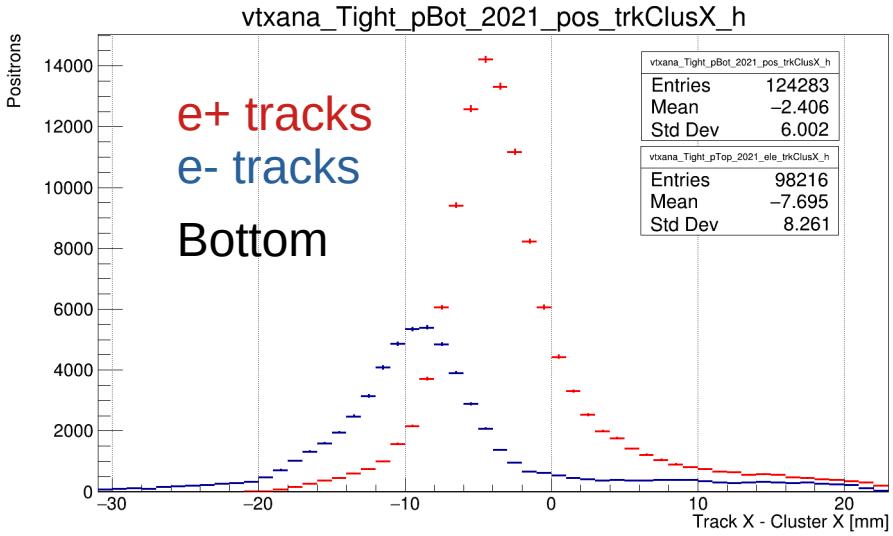


Min Hits on Track

14
13
12
11
10
9
8
7

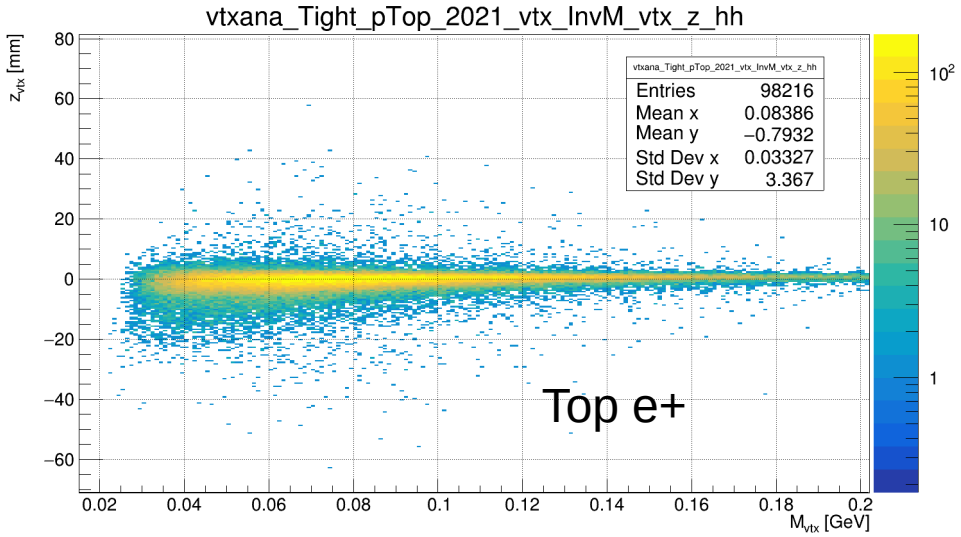
Track X at Ecal minus Ecal Cluster X

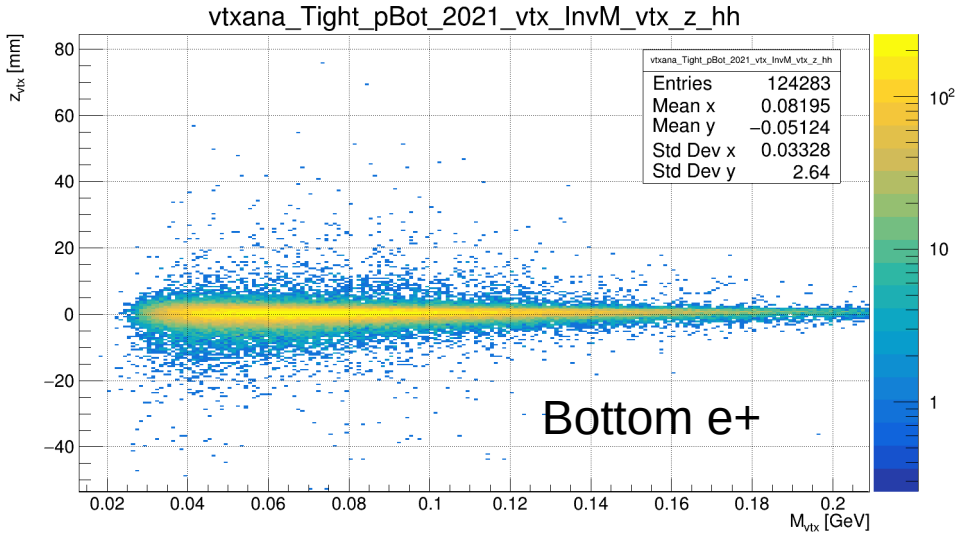




- Overall, looks pretty good
  - Top positron mean close to zero
- Funny tail in direction of track reconstructing at a higher X than where the Ecal cluster is
  - This is there for positron and electrons, in the same direction on the Ecal face
  - Showed last time this is coming from tracks with last hit in first Si sensor of last module
- Difference of peak positions of positrons and electrons is the same in top and bottom
  - Planning to shift via stereo Tu's

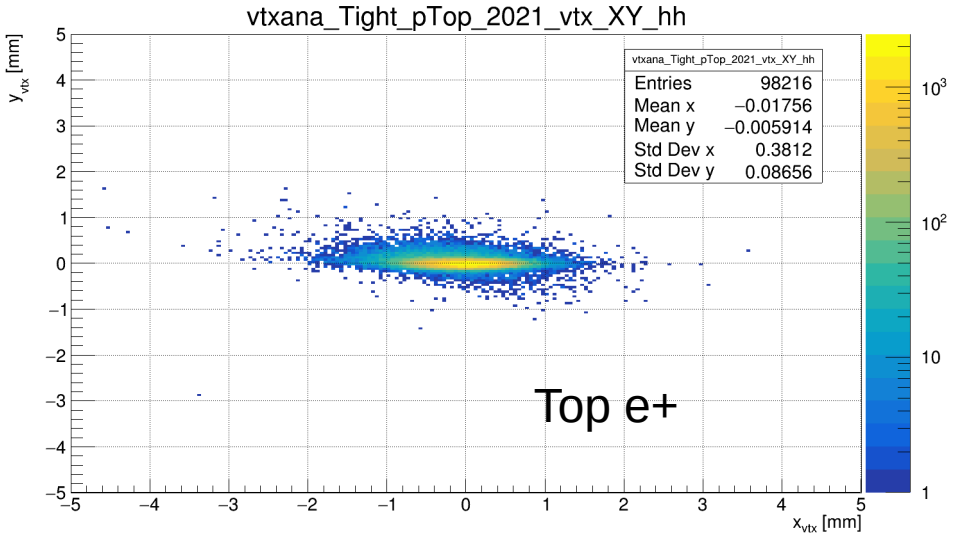
Vertex Mass vs Z Position

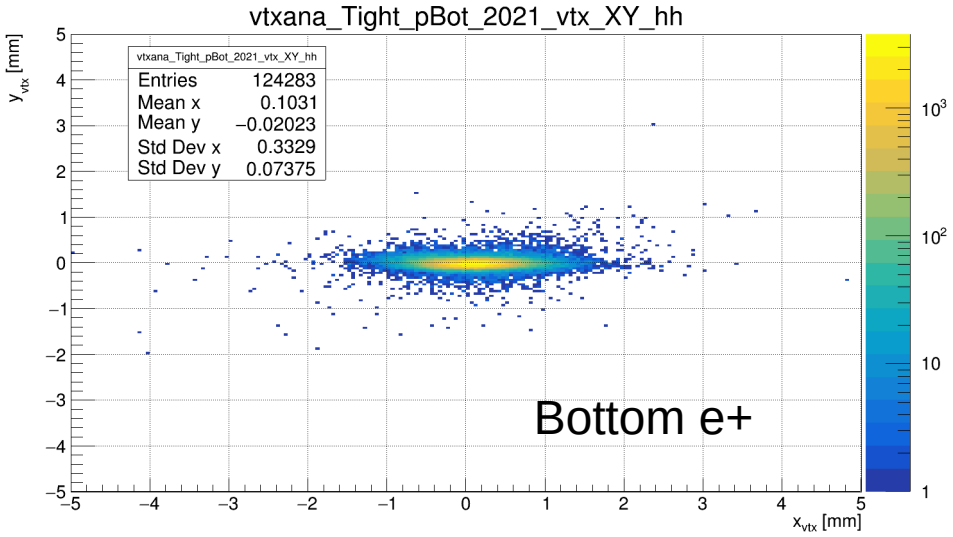




- Vertex z position flat as a function of mass
- Some high z tail we need to take care of
- Bottom e+ vertices have a bit lower mass acceptance, expected since top electrons have momentum acceptance that goes lower

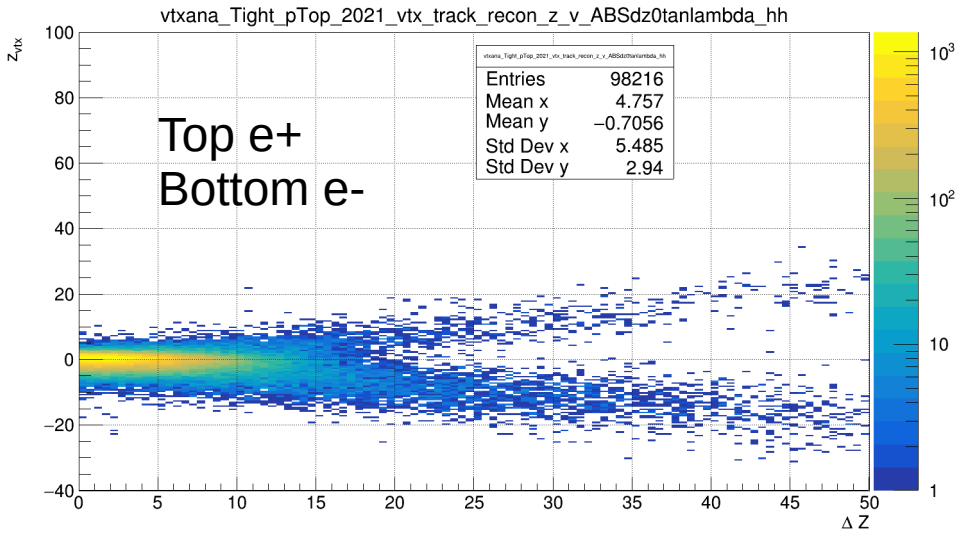
Vertex X-Y Position

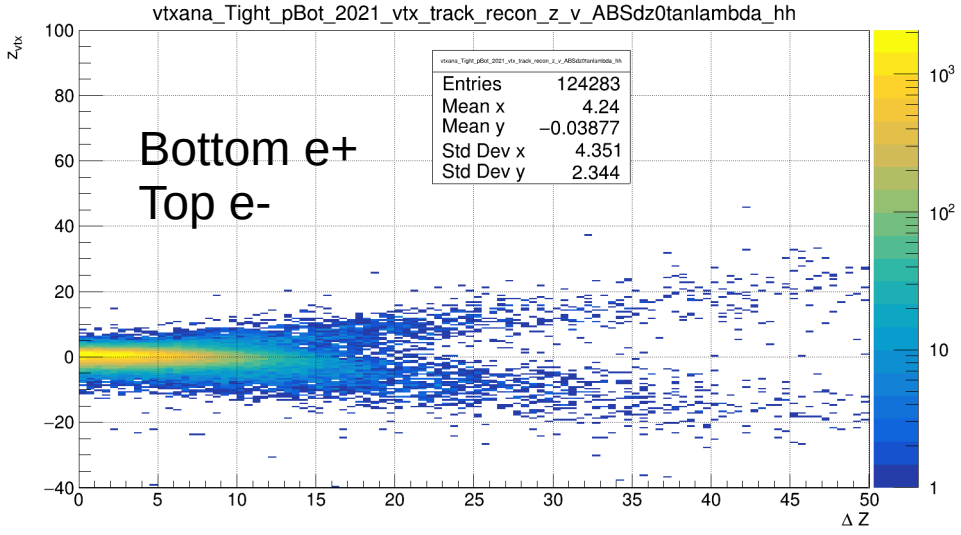




- Vertex x-y position agrees pretty well between vtx with e+ in top and in the bottom
- Apply a first order vertex projection cut by cutting on vertex x-y position
  - |x| < 1 mm
  - |y| < 150 um

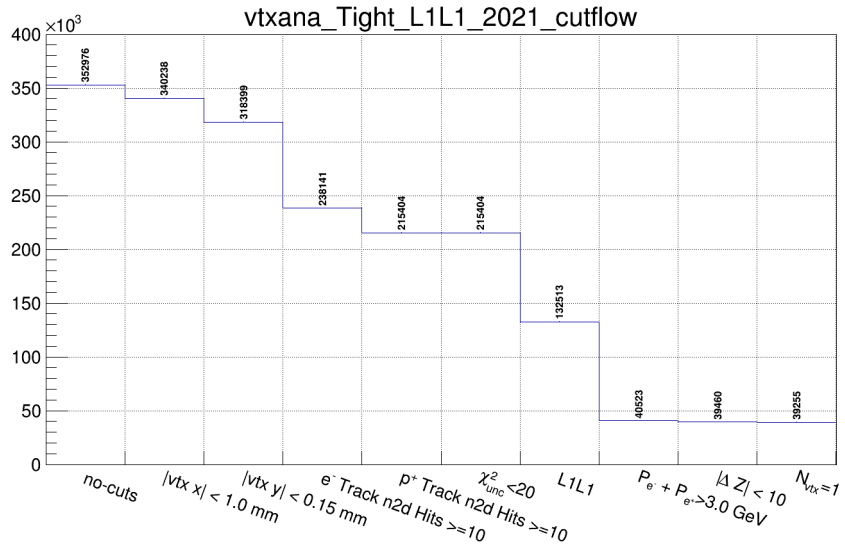
Δz Cut

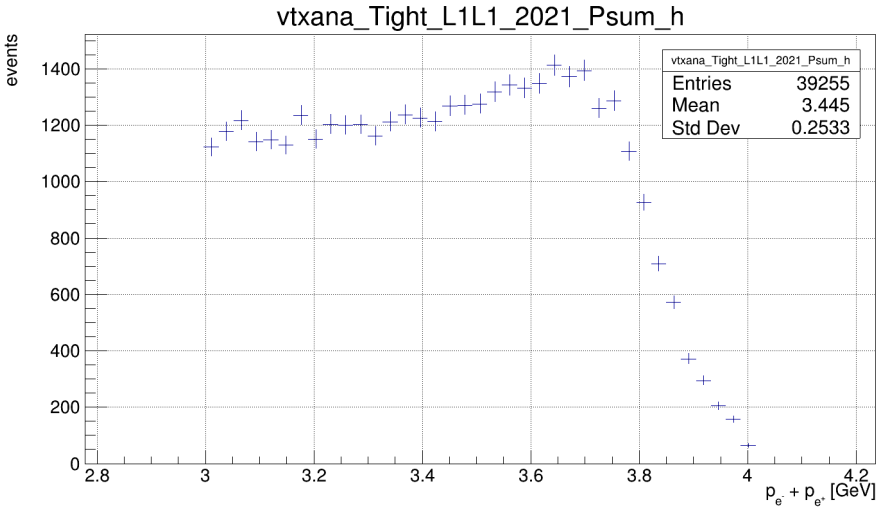




- Interested in looking into Δz cut developed by Alic and I for 2016 SIMP analysis
  - Appears to be a strong variable to use to remove high z background
- Apply cut at Δz < 10 to remove high z background

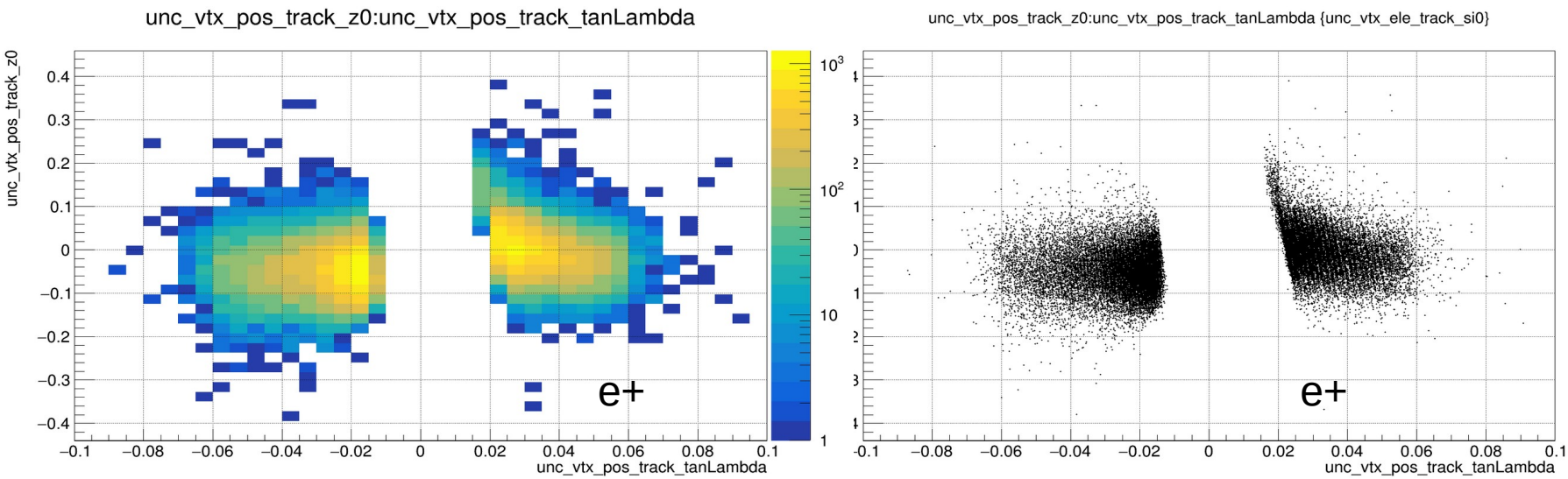
Tight L1L1 Analysis with some High Z Cuts

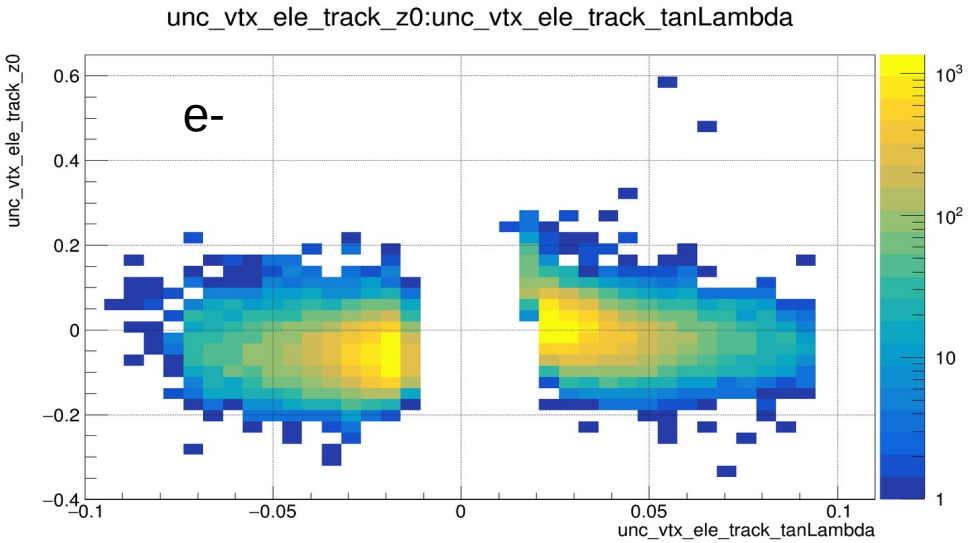




- Same preselection still
- Now including Psum cut at 3.0 GeV which should be close to what we will use for A' analysis
- Require L1L1, so first 4 layers of Si have hits on track
- Include cuts discussed on previous two slides to further remove high z backgrounds
- Psum peak appears to be pretty close to the correct momentum

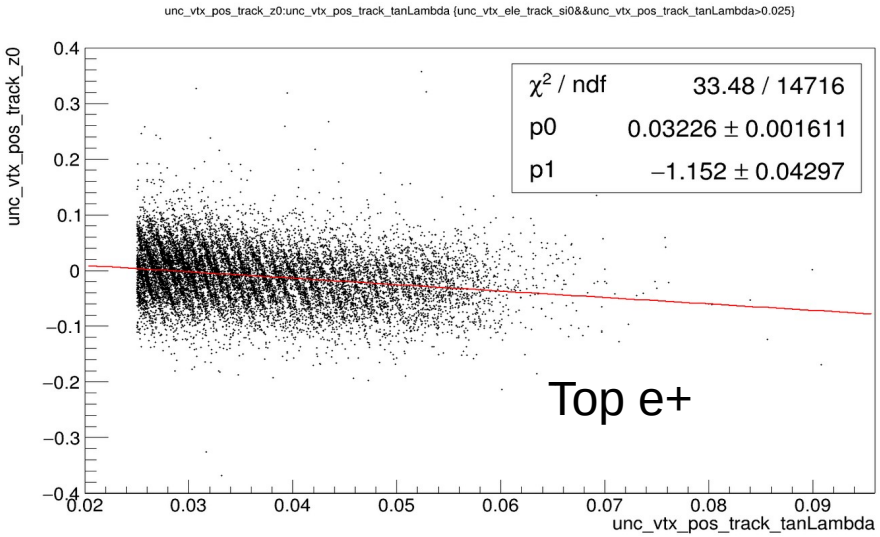
Z0 vs tan(λ)

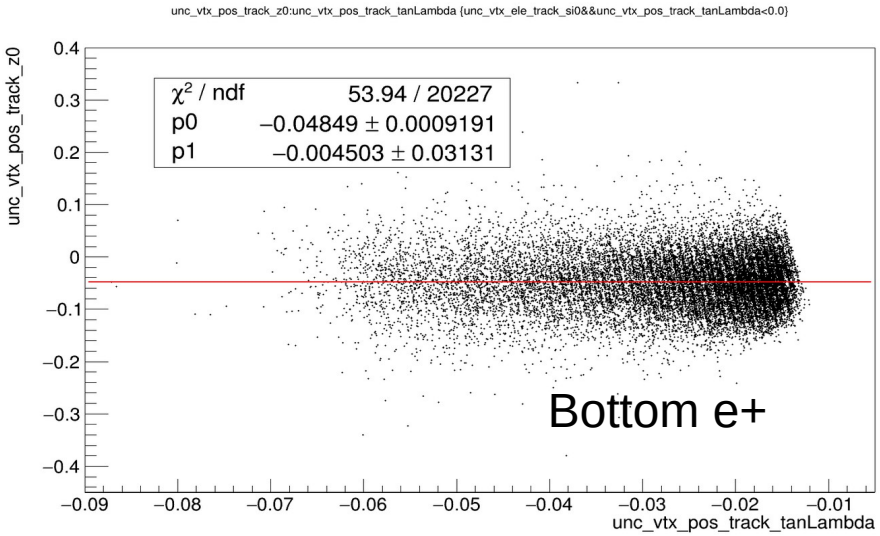




- Right plot is a scatter plot instead of a 2D histogram
- There is a shift in z0 in the top wrt the bottom
  - ~same for e+ and e-
- Let's see where this tells us the target is

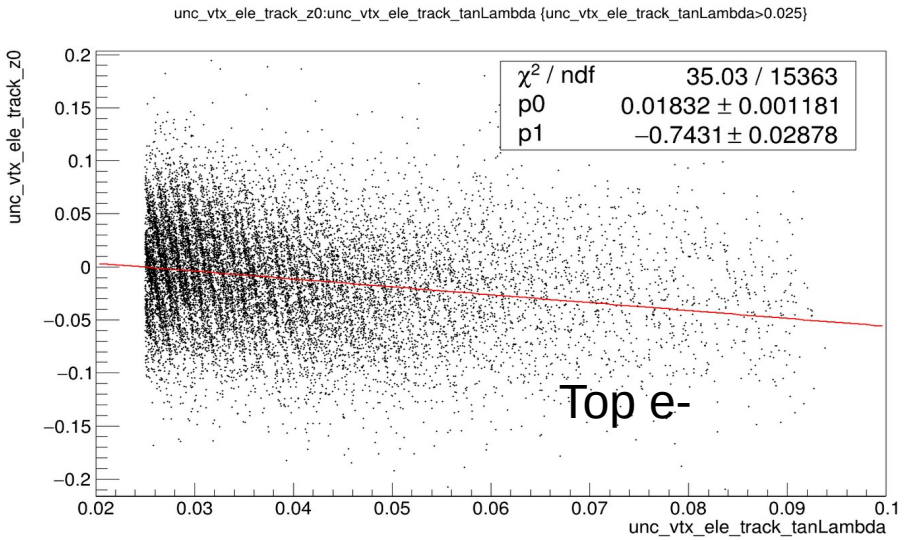
Positron Z0 vs tan(λ) Fits

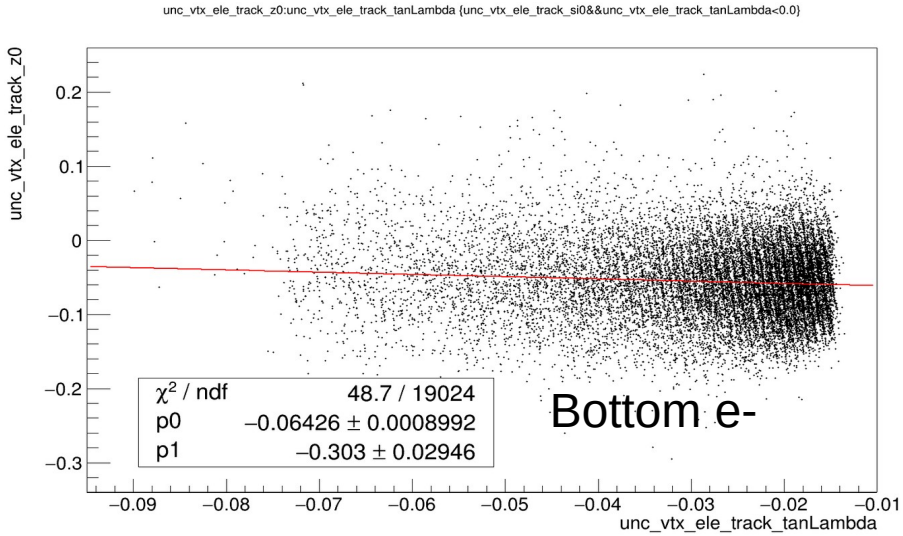




- Keep in mind track parameters are coming from the track state at the target
- Z0 average is shifted by roughly 80 um higer in the top wrt bottom

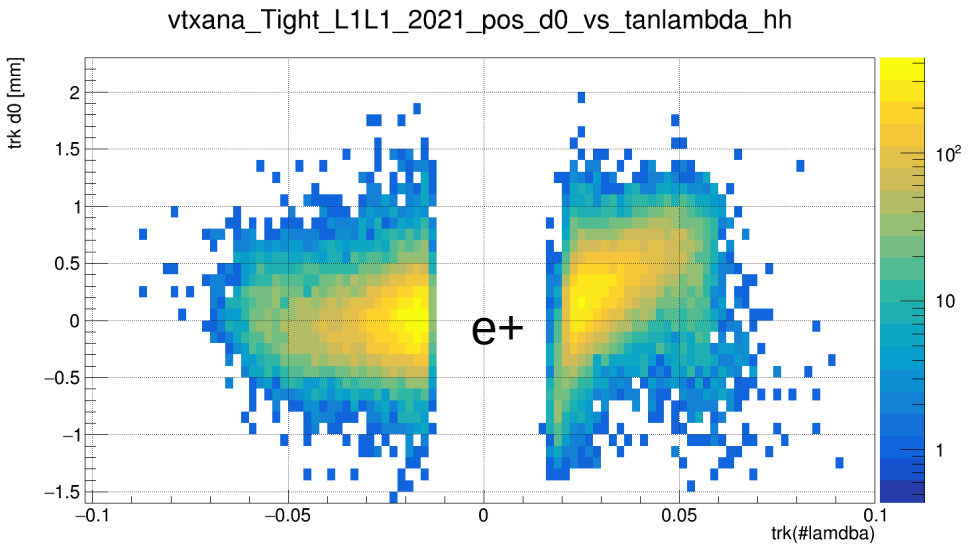
Electron Z0 vs tan(λ) Fits

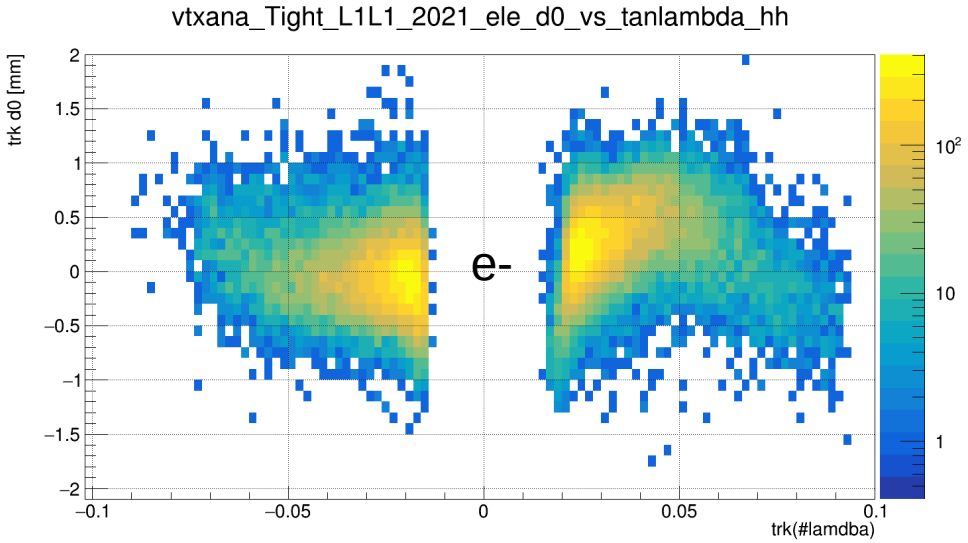




- Z0 vs tan(λ) slopes all agree on vtx position within about 1 mm
- Shift of about 80 um of z0 is also seen with electrons

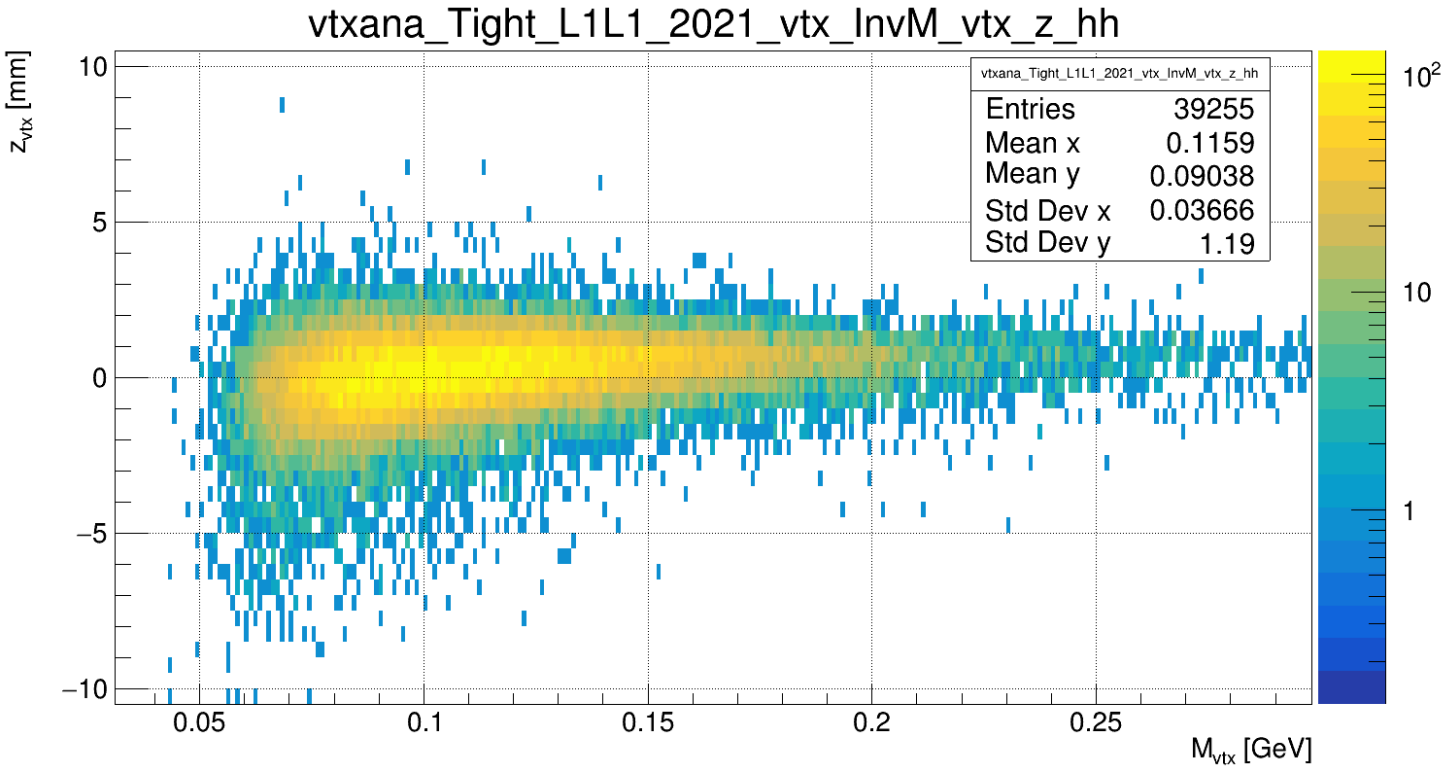
Electron Z0 vs tan(λ) Fits





- Change in direction at 0.05-0.06 which is where tan(λ) is too high to have a layer 7 hit
  - Shift is not large but is clear
  - Almost looks like two different slopes in top, w/ and w/o layer 7
  - Possibly see similar thing in bottom but smaller change in d0

Tight L1L1 Vtx Mass vs Z Position



- Vtx z position agrees pretty well with z0 vs tan(λ) slope
- High z background reduced significantly already
- This is only a small amount of data, so will be interesting to see how region beyond 5 mm fills in as we increase the luminosity we are using

Discussion

- Early run in 2021 appears to have a potentially acceptable alignment in pass1 despite what has been said about it in the past
- Would like to shift where track project to Ecal with simple coherent shift of stereo sensor Tu alignment
  - Geometrically shift hits over in x by appropriate amount to keep vtx position at target constant and move projection to Ecal by desired amount
  - Need to decide exactly how much to move each volume, unclear if we really want average of peak positions of positrons and electrons to be zero in each volume but we do want to get the top and bottom to agree
- Momentum scale and resolution look pretty good for these tracks comparing to Ecal cluster energy
- Quick first pass of a couple high z cuts already has tails looking manageable
  - Δz cut we developed for SIMP analysis also looks strong at high Psum
  - Quick version of vertex projection cut also used