SVT Alignment Update for 2021

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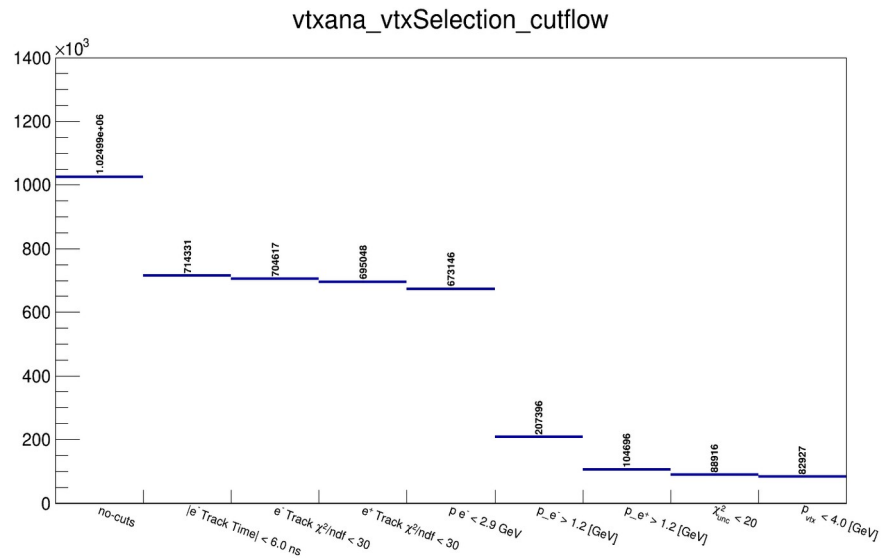
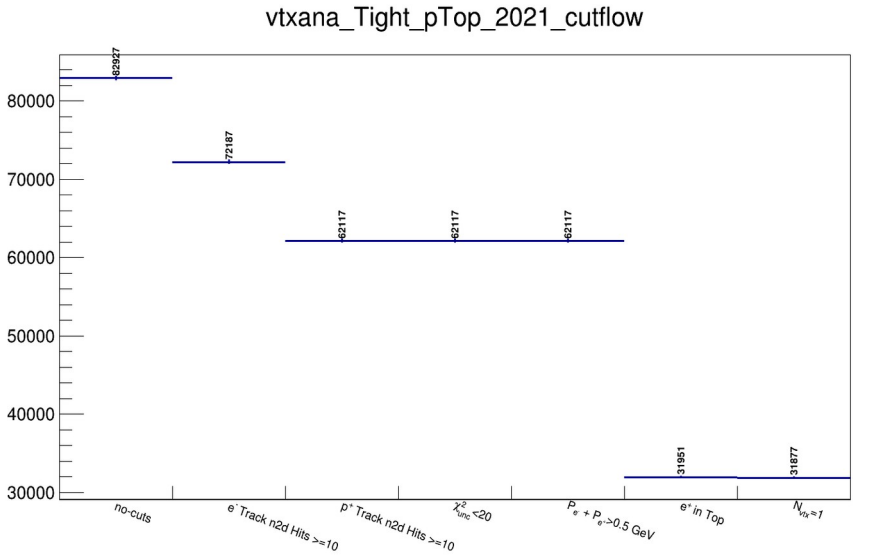
U.S. DEPARTMENT OF ENERGY
Office of Science

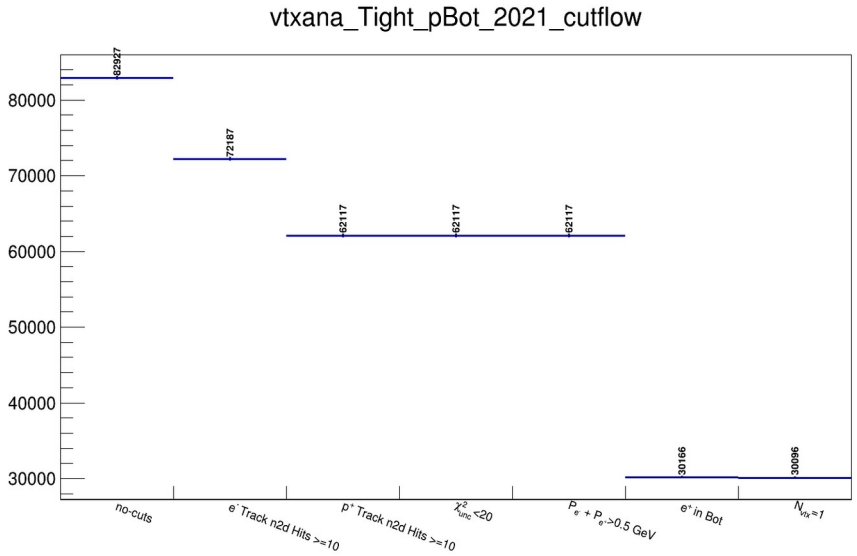
SLAC NATIONAL ACCELERATOR LABORATORY

Selection

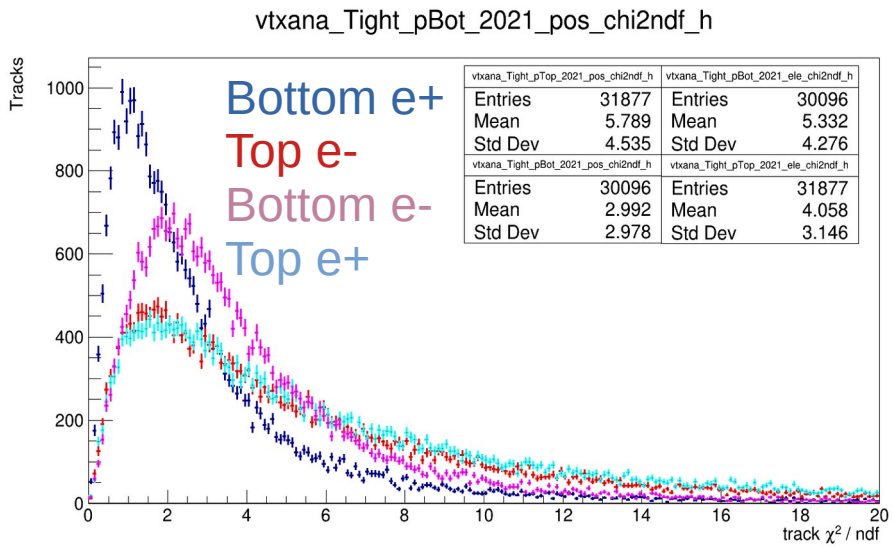


- Looking at early run first
- Not including L1L1 at first
- Low track momentum cut
- Require at least 10 hits on track
  - Some acceptance missing 6&7 at low momentum

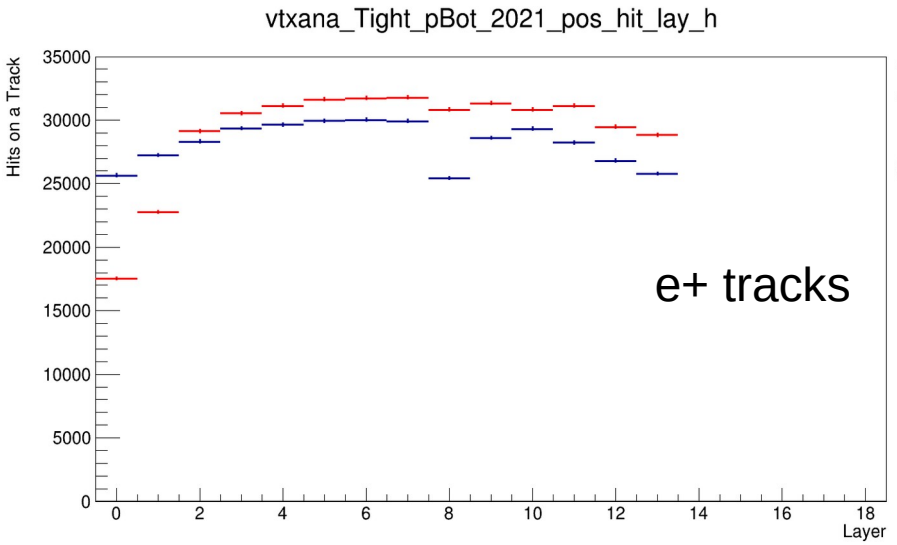


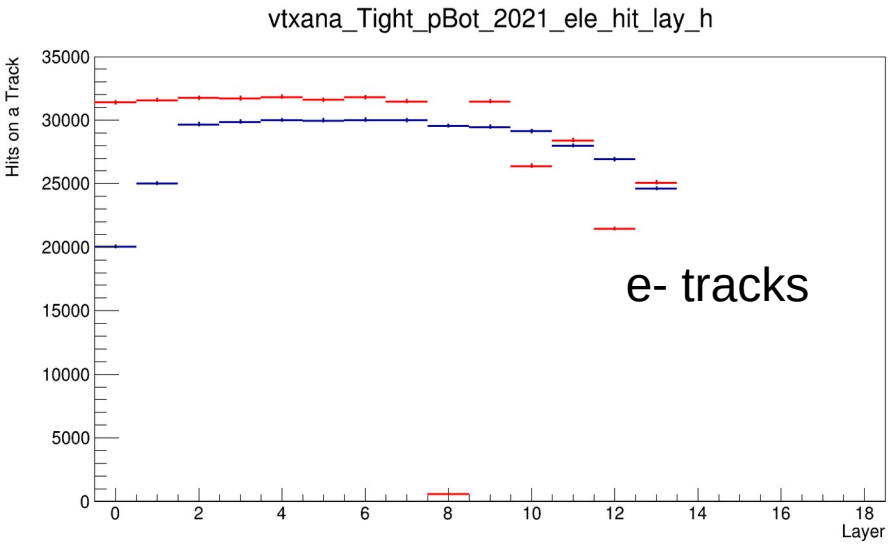


Chi2/ndf and Layers Hit

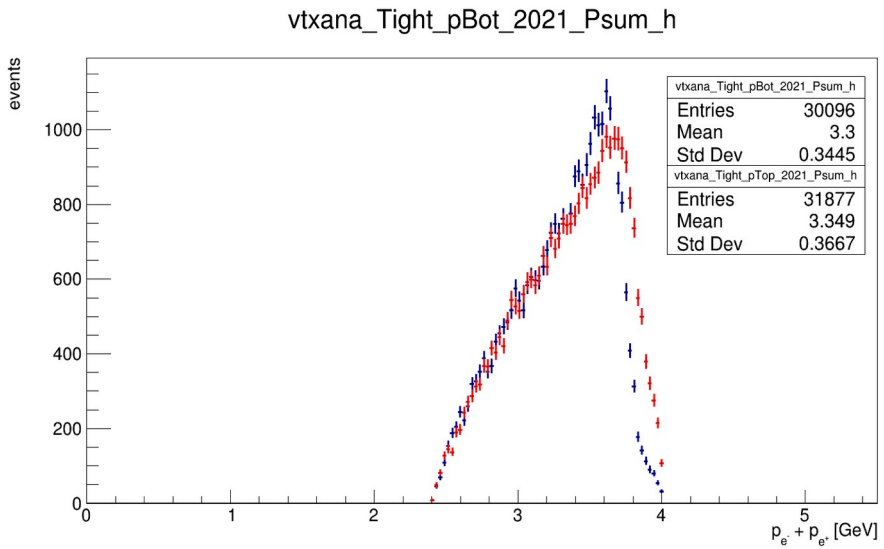


- Blue is vtx with positron in bottom
- Red is vtx with positron in top
- Requiring 10 hits on track is gonna make the acceptance of bottom electrons different since there is already a missing hit

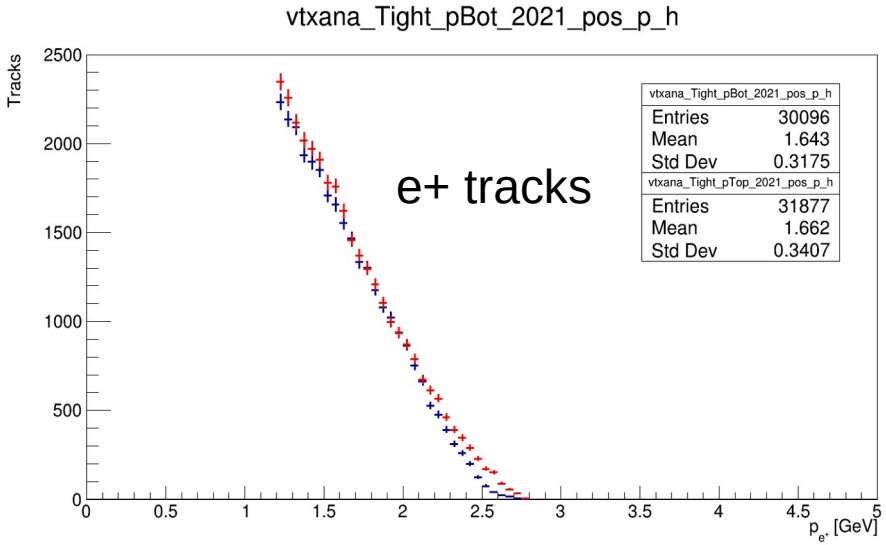


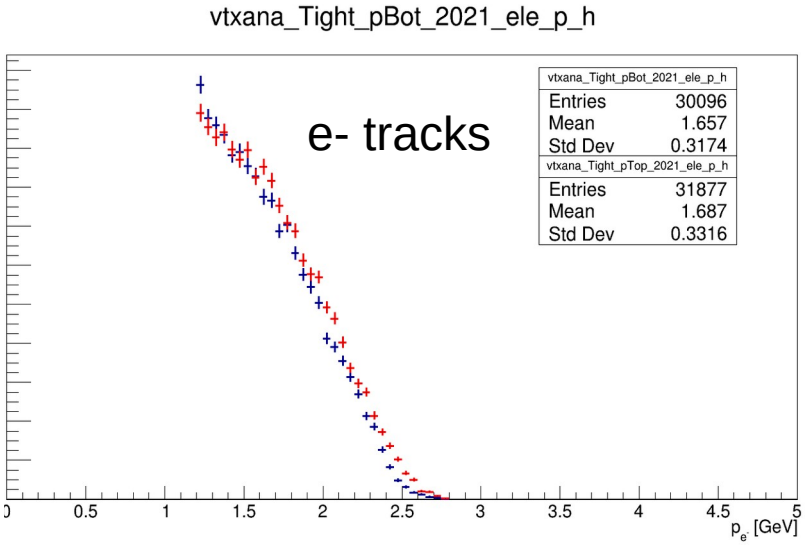


Momenta

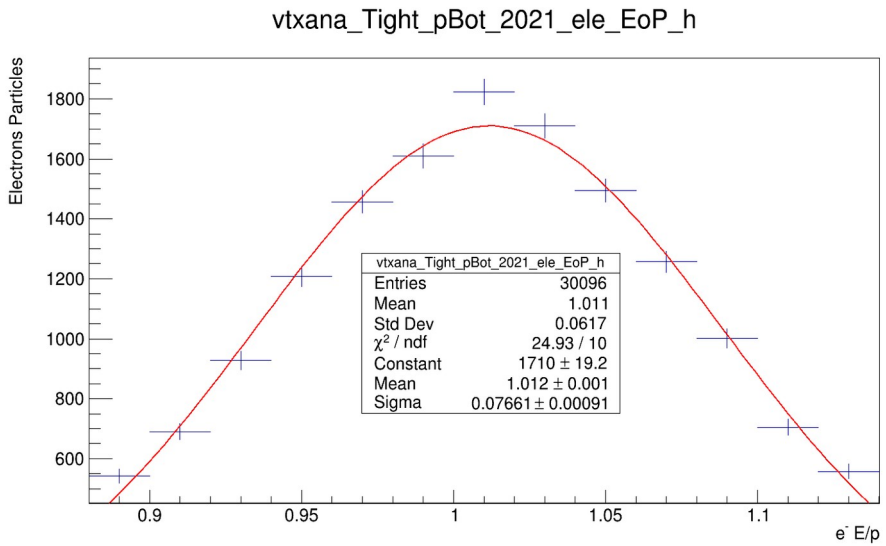


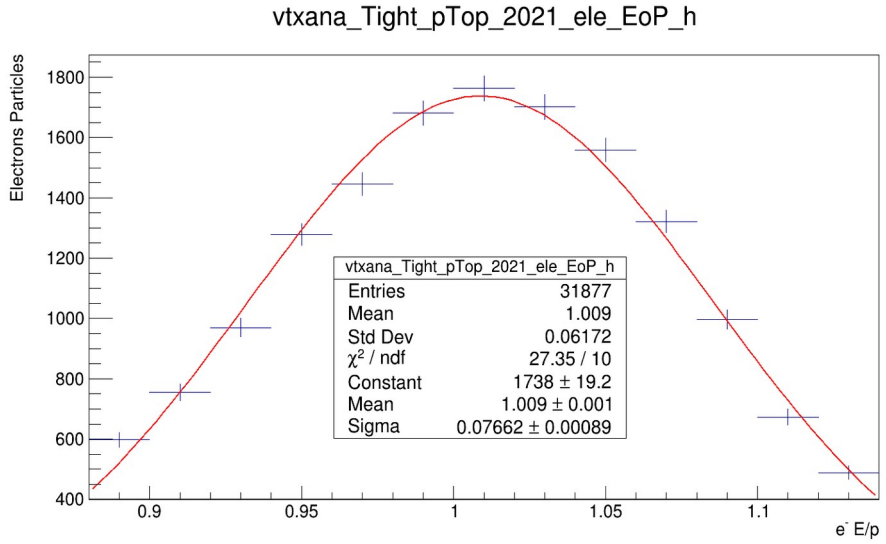
- Blue is vtx with positron in bottom
- Red is vtx with positron in top
- Missing L5 bottom stereo, so 10 hit requirement forces us to have a hit in layer 6 or 7, which means our acceptance starts at a higher momentum for electrons in the bottom





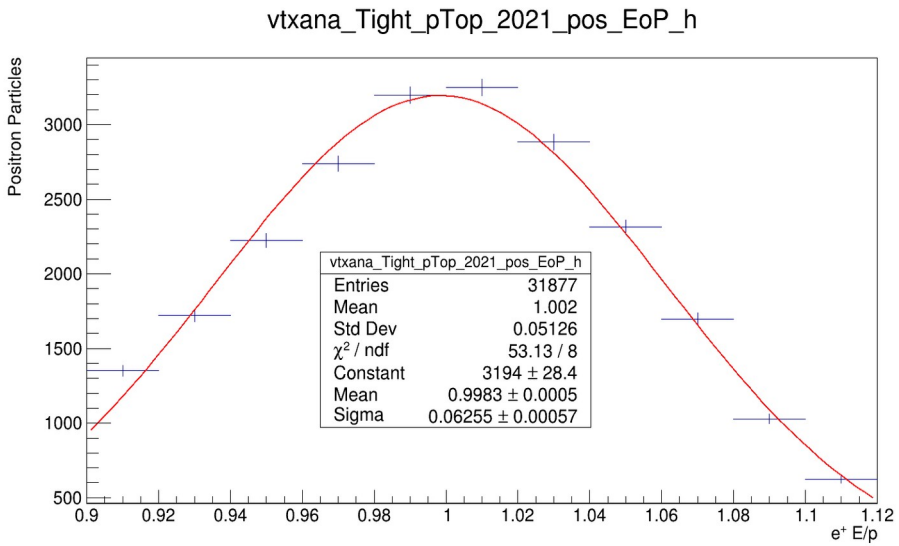
Electron Momentum Resolution

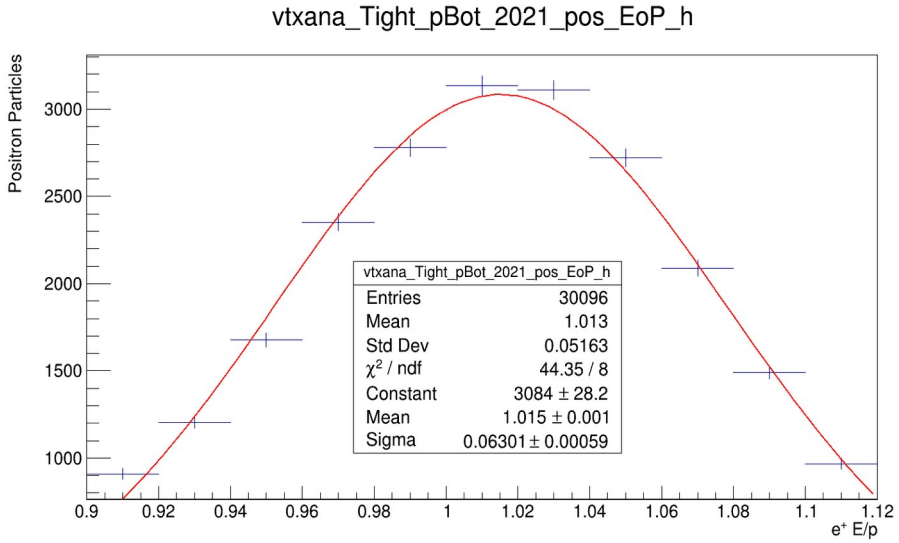




- Momentum scale of electrons is better than 1% in top and bottom
- Momentum resolution better than 8% in both top and bottom
  - MC has a resolution of ~5%
- Electrons looks pretty solid if we trust the Ecal cluster energies

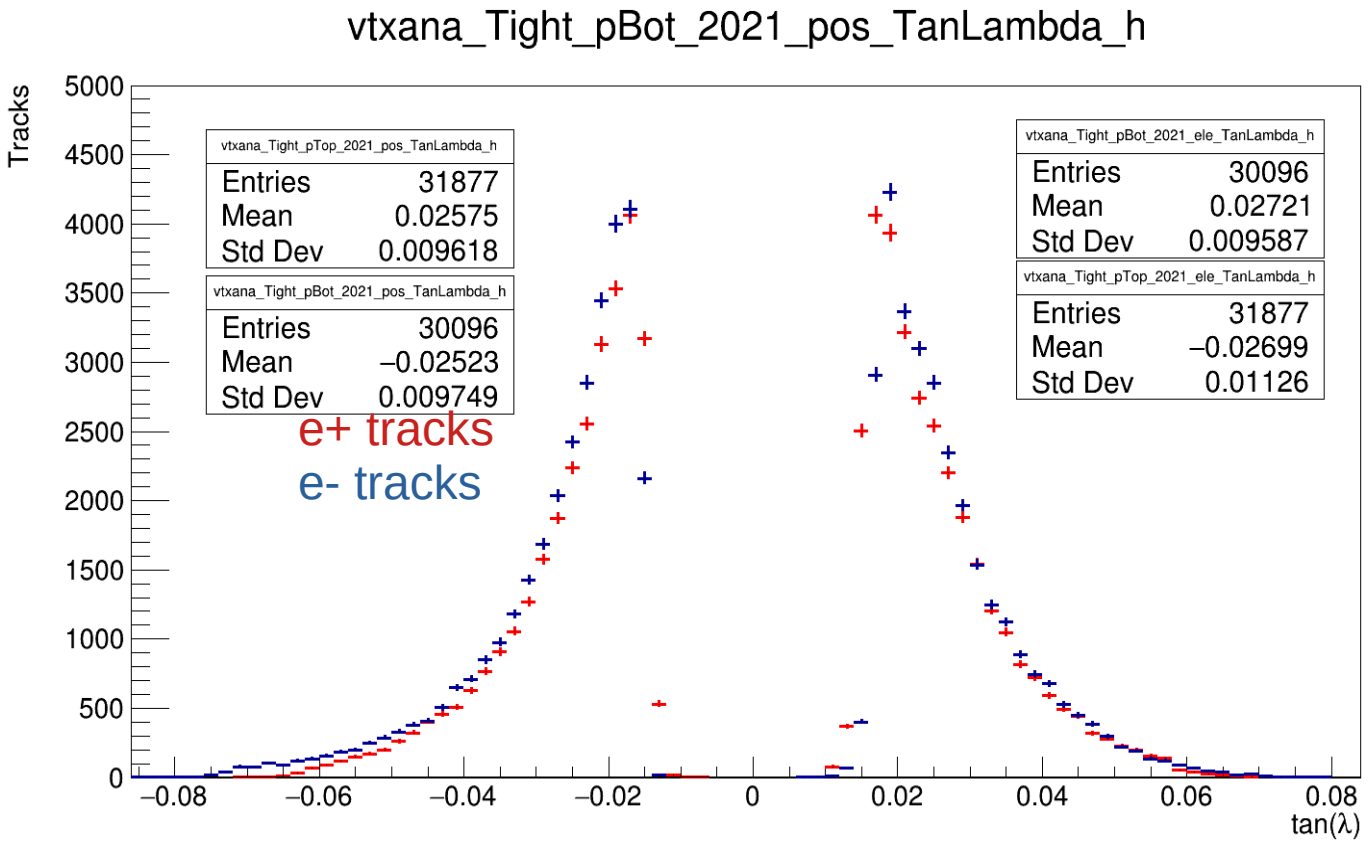
Electron Momentum Resolution





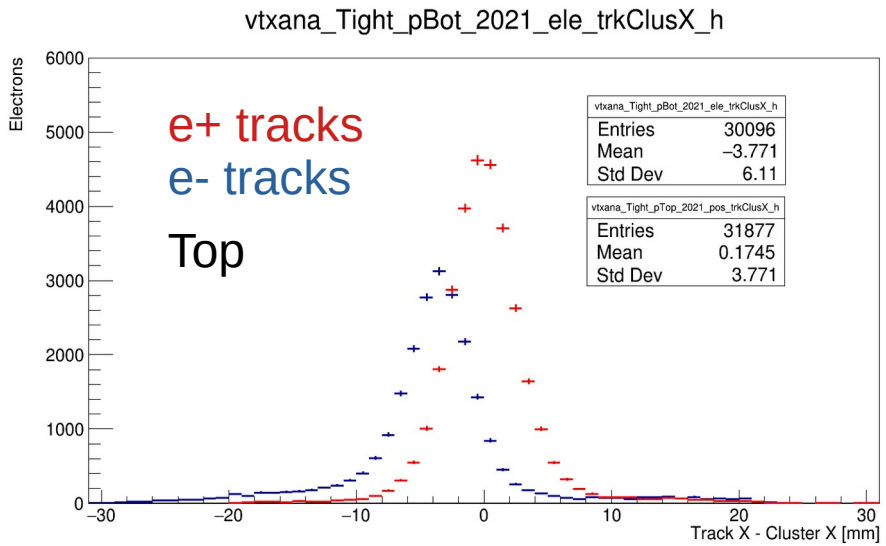
- Positron momentum scale better than 2% in both the top and bottom
- Momentum resolution ~7% in both top and bottom volumes
  - This is about ~5% in MC
- Momentum scale and resolution look pretty solid for positrons if we trust the Ecal cluster energy

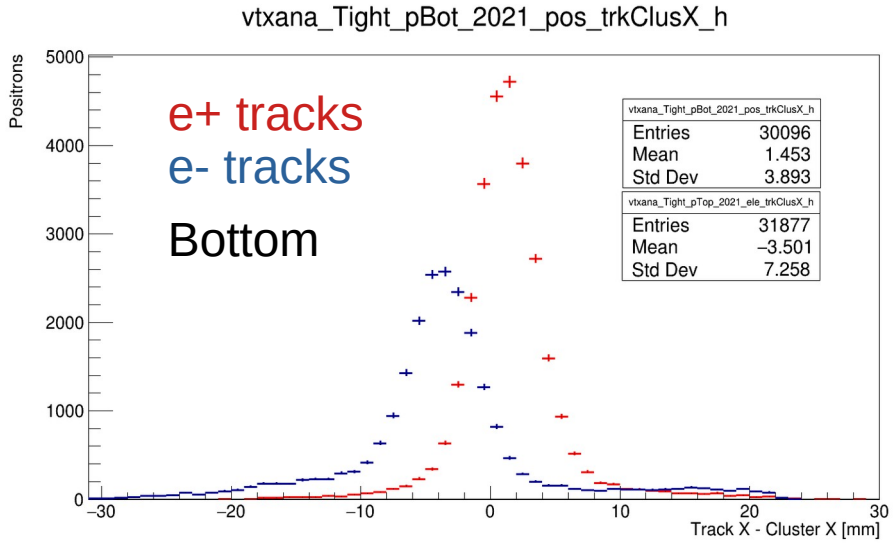
Tan(λ) Acceptance



- Acceptance starts at about 15 mrad as expected
- Similar shapes all around

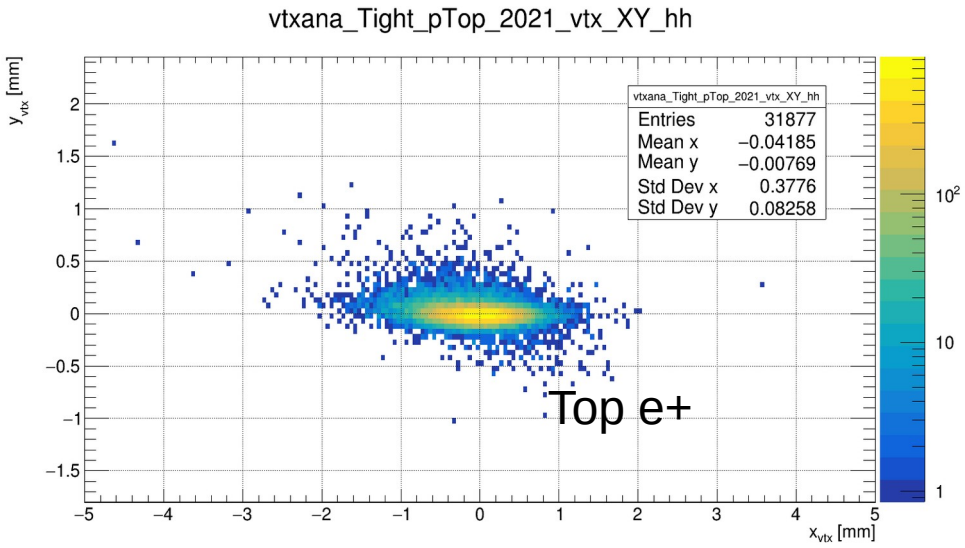
Track X at Ecal minus Ecal Cluster X

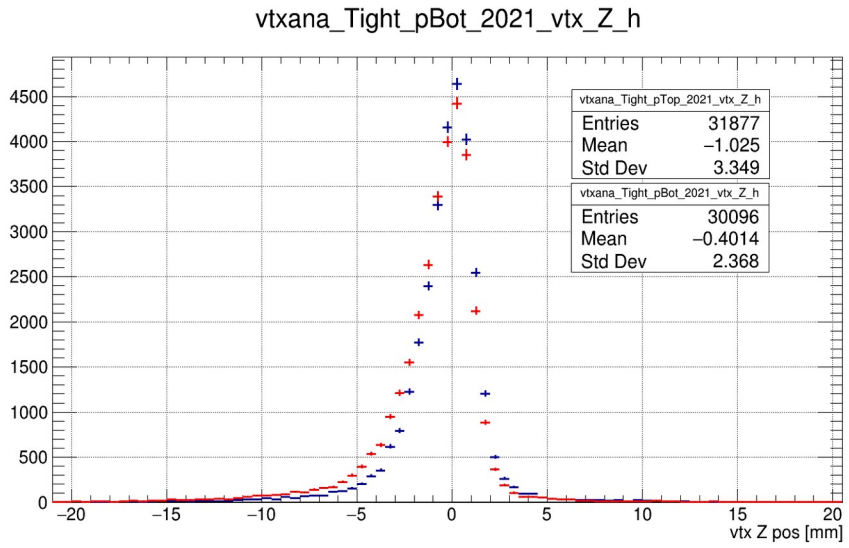


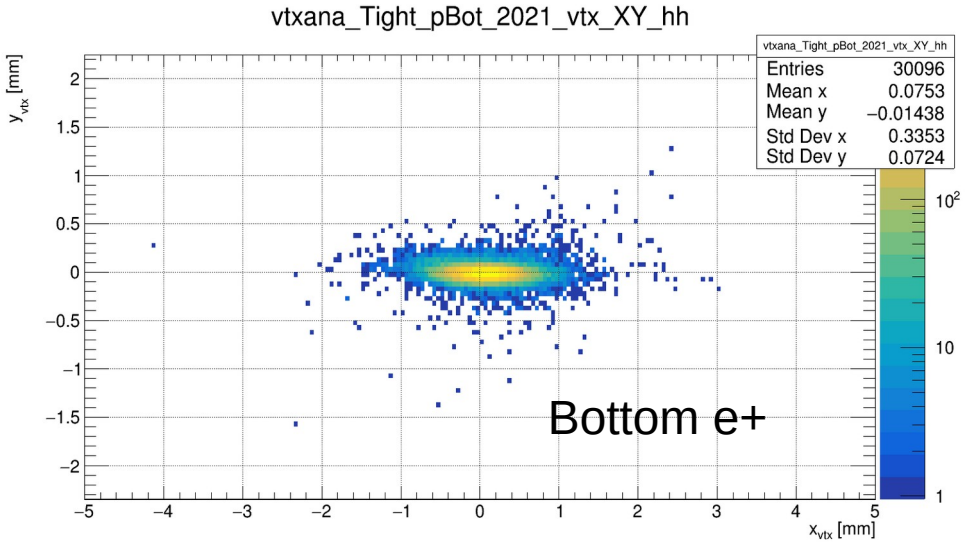


- Overall, looks pretty good
  - Top and bottom now have very similar situation, as advertised on first slide
- Funny tail in direction of track reconstructing at a higher X than where the Ecal cluster is
  - This is there for positron and electrons, in the same direction on the Ecal face
  - Showed 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 still the same in top and bottom
  - Plan to shift via stereo Tu's worked!

Vertex X-Y Position

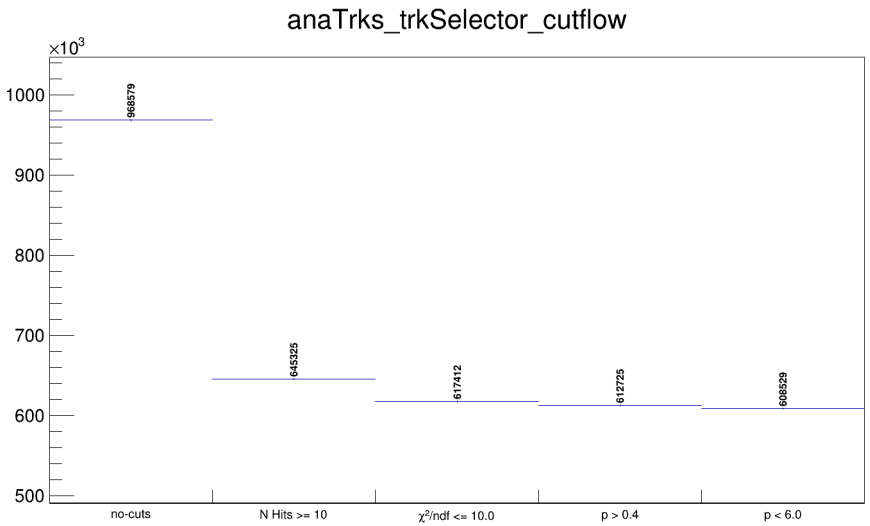


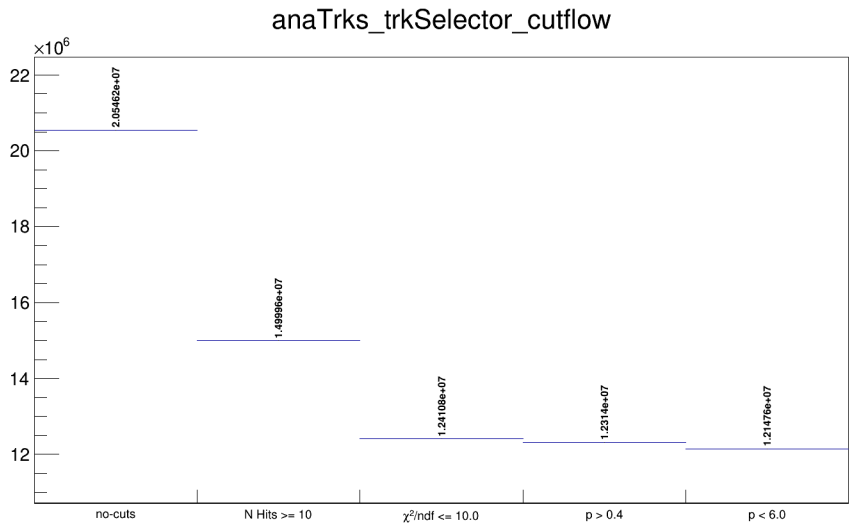




- Vertex position looks great!
- Shifting at tracks at Ecal didn't move vertex

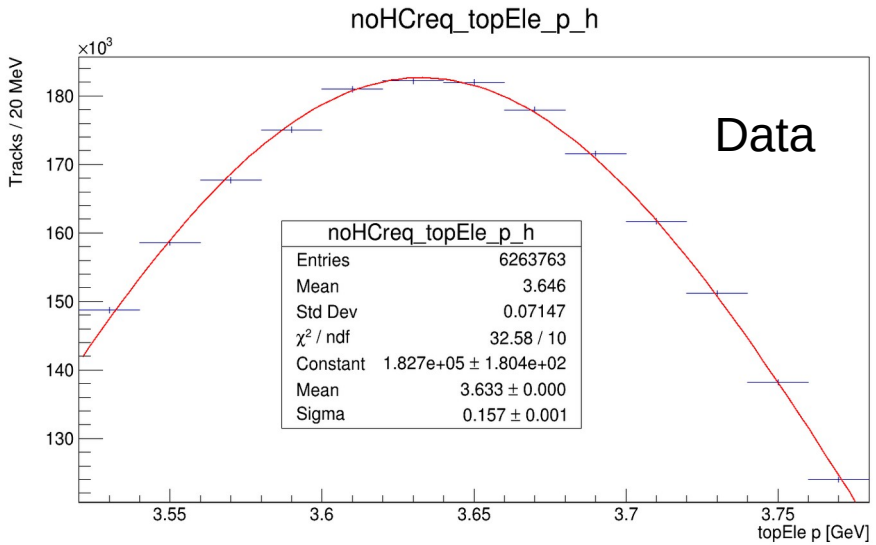
Switching Focus to FEEs

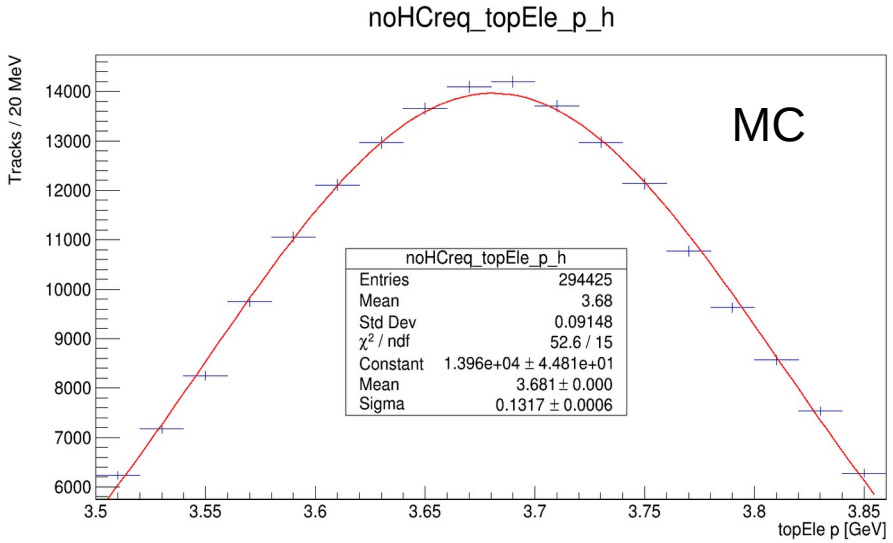




- Ran reconstruction using this detector on run 14168, a low lumi FEE run
- Made 100 files of FEE MC using this detector
- Using really simple selection, most important cut is requiring at least 10 hits on track

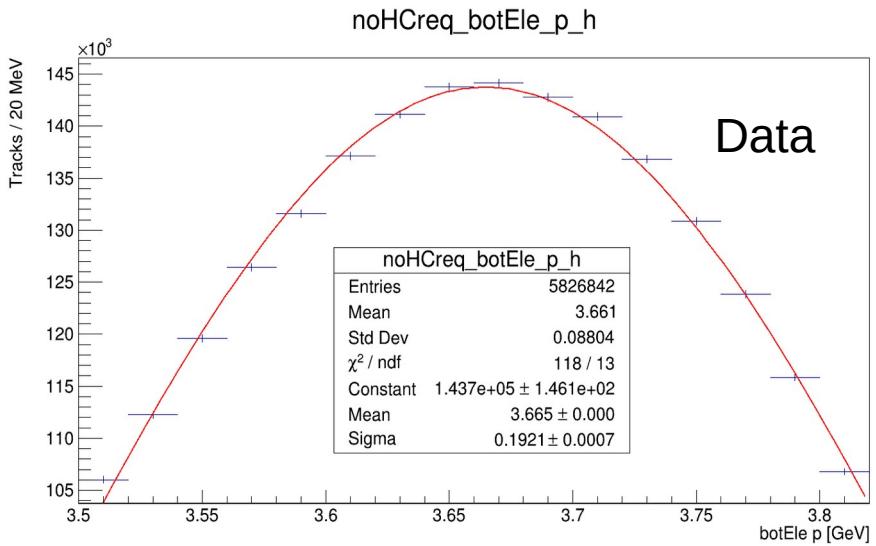
Top FEE Momentum Resolution and Scale

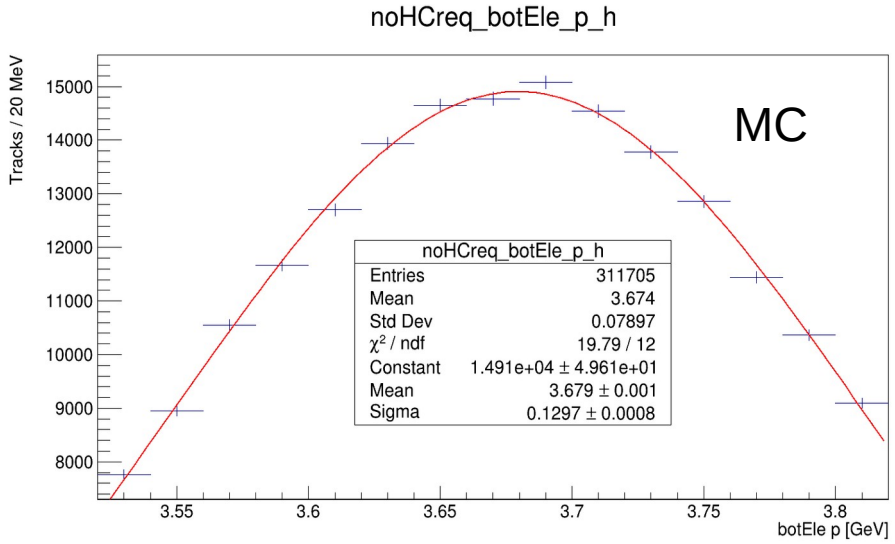




- Momentum scale and resolution are similar in data and MC, in the top
  - MC resolution is about 3.6%
  - Data resolution is about 4.3%
- Momentum scale is super close, a hair lower in data

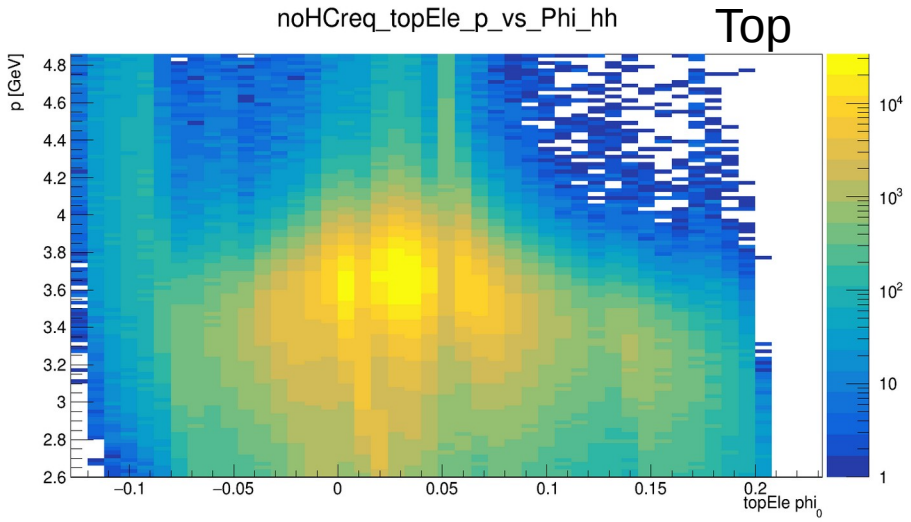
Bottom FEE Momentum Resolution and Scale

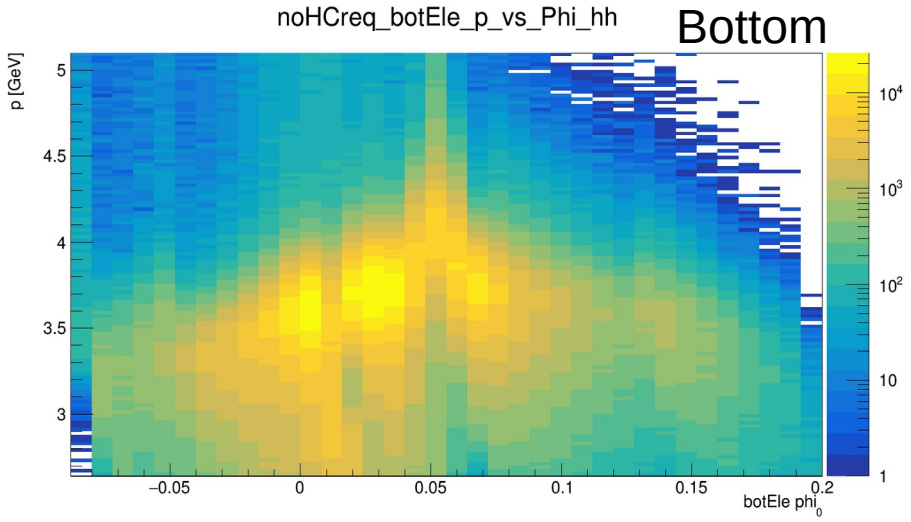




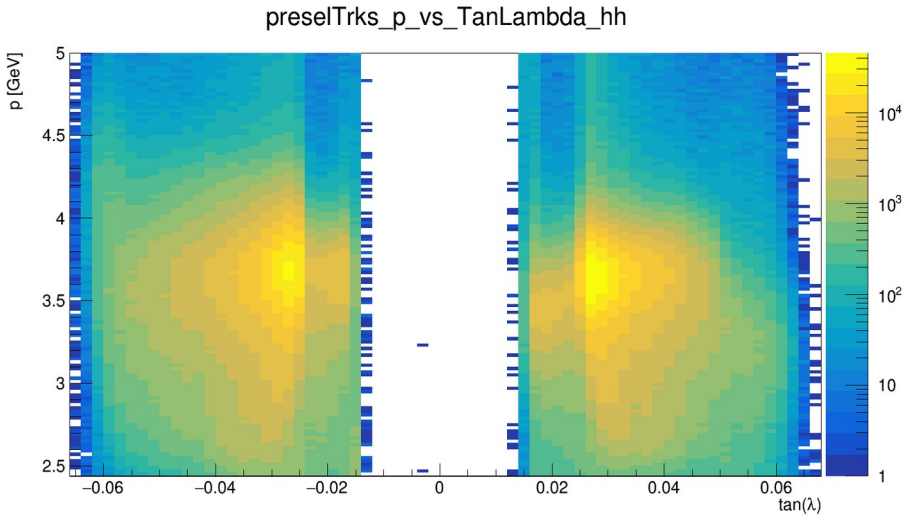
- Momentum scale and resolution are similar in data and MC, in the bottom
  - MC resolution is about 3.6%
  - Data resolution is about 5.2%
- Momentum scale is super close, a hair lower in data

FEE Momentum vs Track Direction





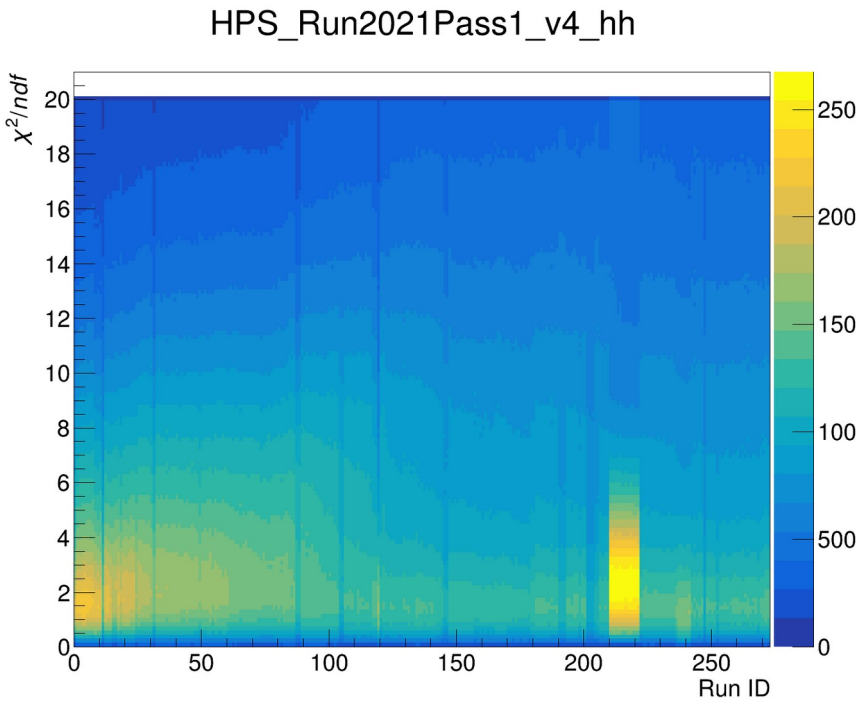
- Still see some evidence of a bit of Rw in the top and bottom
  - Pretty flat overall in phi0
  - ~10% at highest phi0
- Looks mostly flat vs Tan λ
  - Change in scale is less than 6%

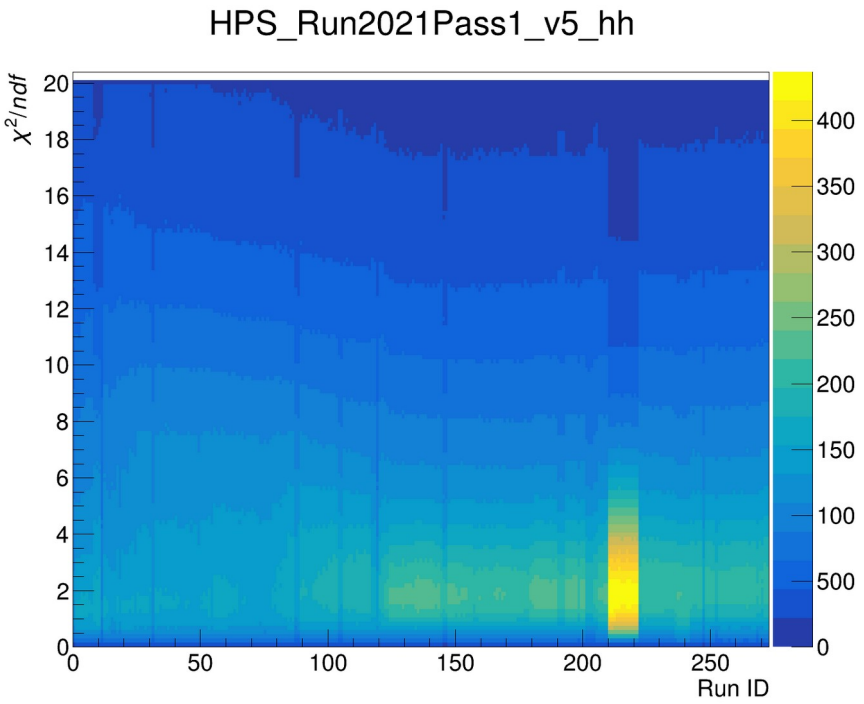


Now let’s look at later runs

- Part of SVT is moving throughout run so we are going to need a time dependent alignment (v4)
- Made an alignment that looks pretty reasonable for the end of the run also (v5)
- Ran reco on 1% of data on files sprinkled fairly evenly throughout run
- Wrote new analysis processor based on FinalStateParticles
- Now have new tools to study 1D distributions run-by-run
- First thing this was used for is to find runs where we have less than ideal run conditions (missing sensors in DAQ)

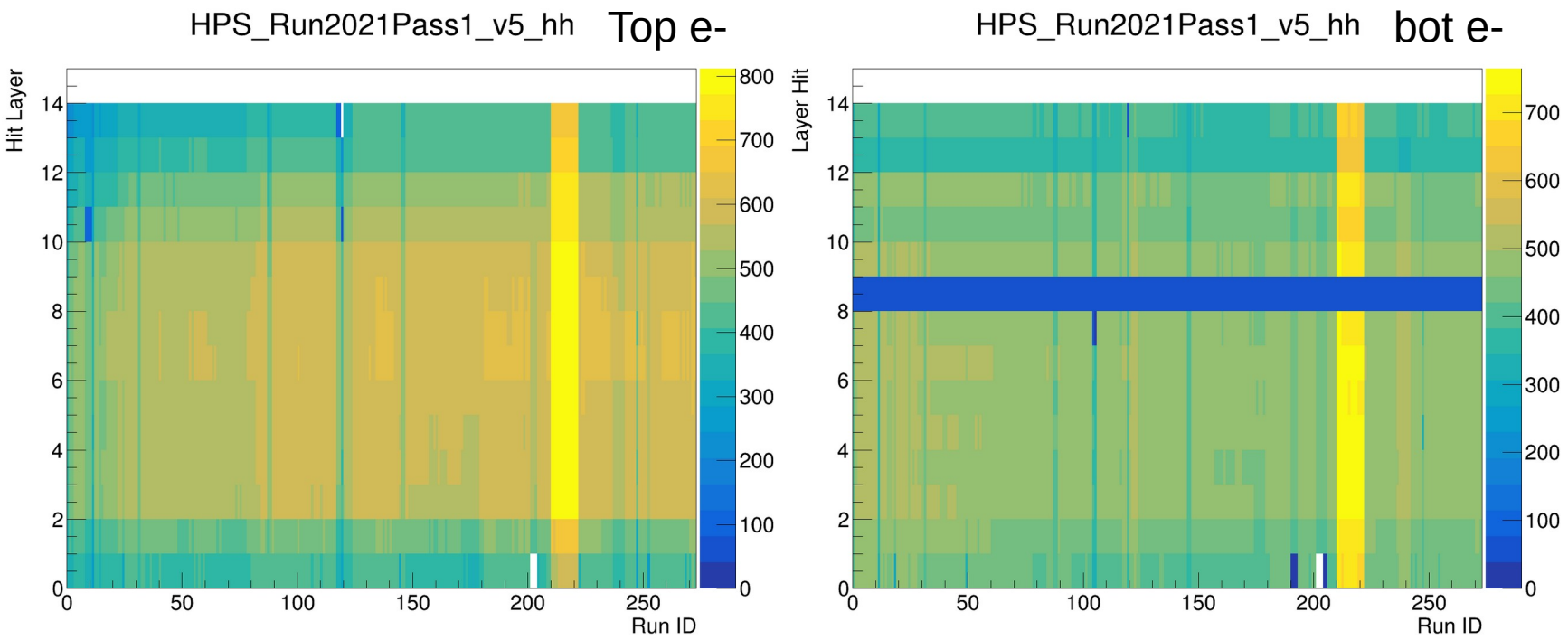
Track Chi2/ndf





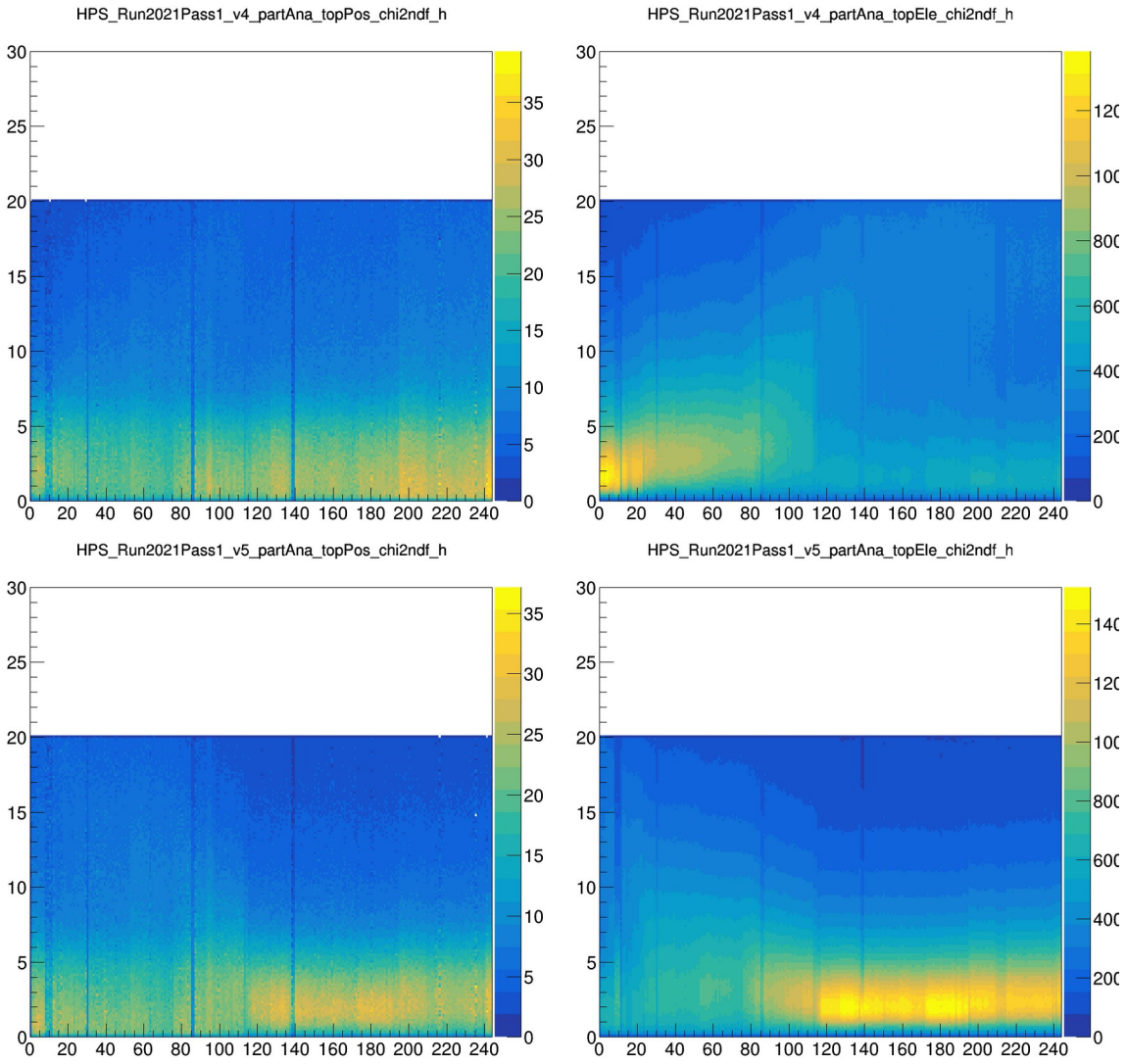
- Run ID is number starting from zero which orders the runs in time that are used in this analysis
- v4 is the run aligned using early data and v5 uses later data
- First let’s

Simple Track Selection



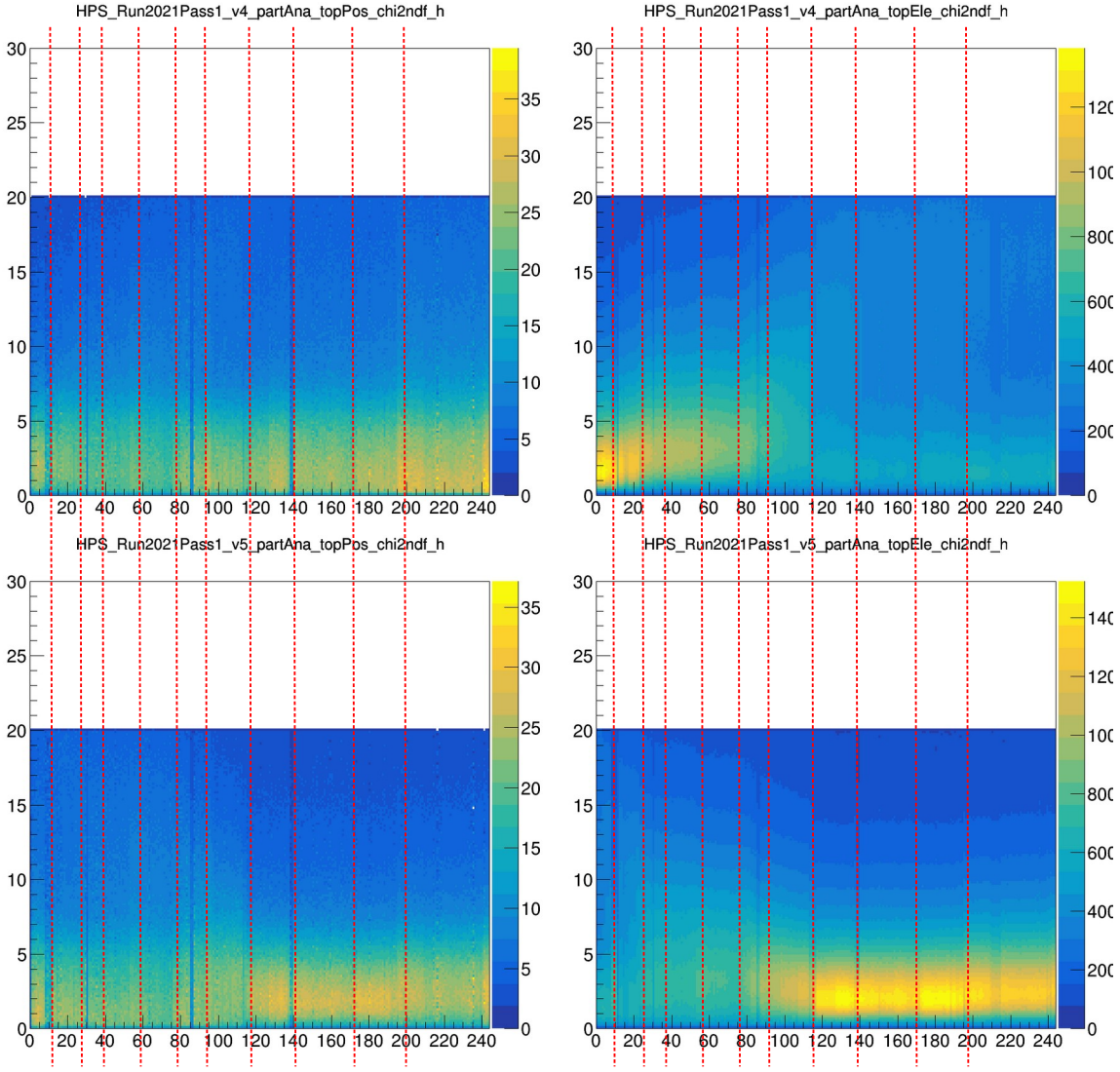
- This gives a more clear picture of the state of the SVT run-by-run
- Have some clear Run ID targets to remove for having poor SVT condition
  - Run IDs: 18, 49, 104, 105, 117,118, 119, 190, 191, 192, 201, 202, 203, 247, 252
  - 14226, 14312, 14416, 14417, 14441, 14442, 14443, 14577, 14578, 14579, 14608, 14609, 14610, 14727, 14732

Top Track chi2/ndf



- X-axis is run id which is a count of the golden run numbers starting at zero
  - Removed the 1-pass runs that were at 1.92 GeV
- These are normalized to equal number of FEE triggers per run
- v4 detector clearly better for early runs, very inefficient for later runs
- v5 detector clearly better for later runs
- Where do we want to draw the boundaries in run ID to delineate the alignment states?

Top Track chi2/ndf



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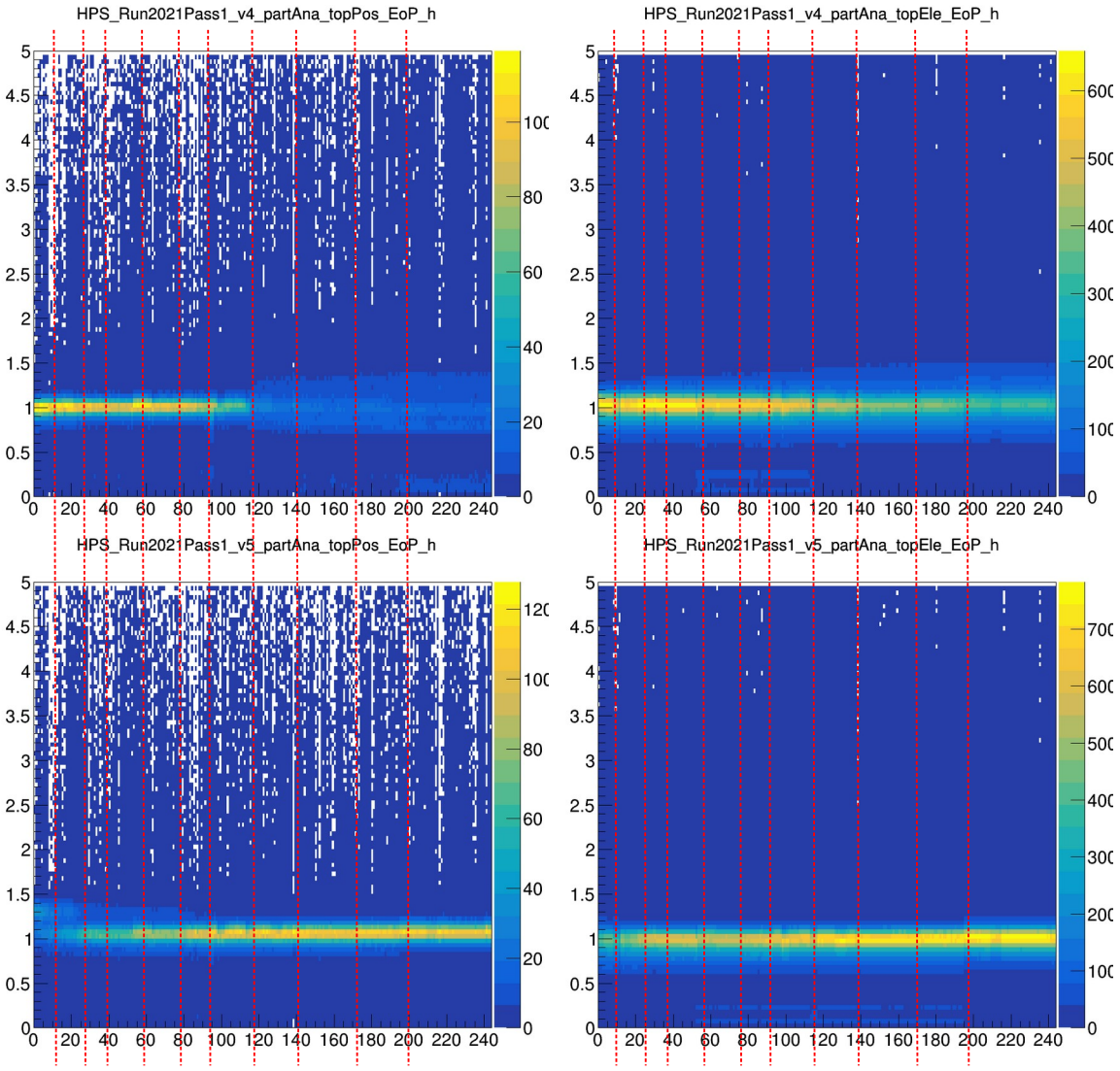
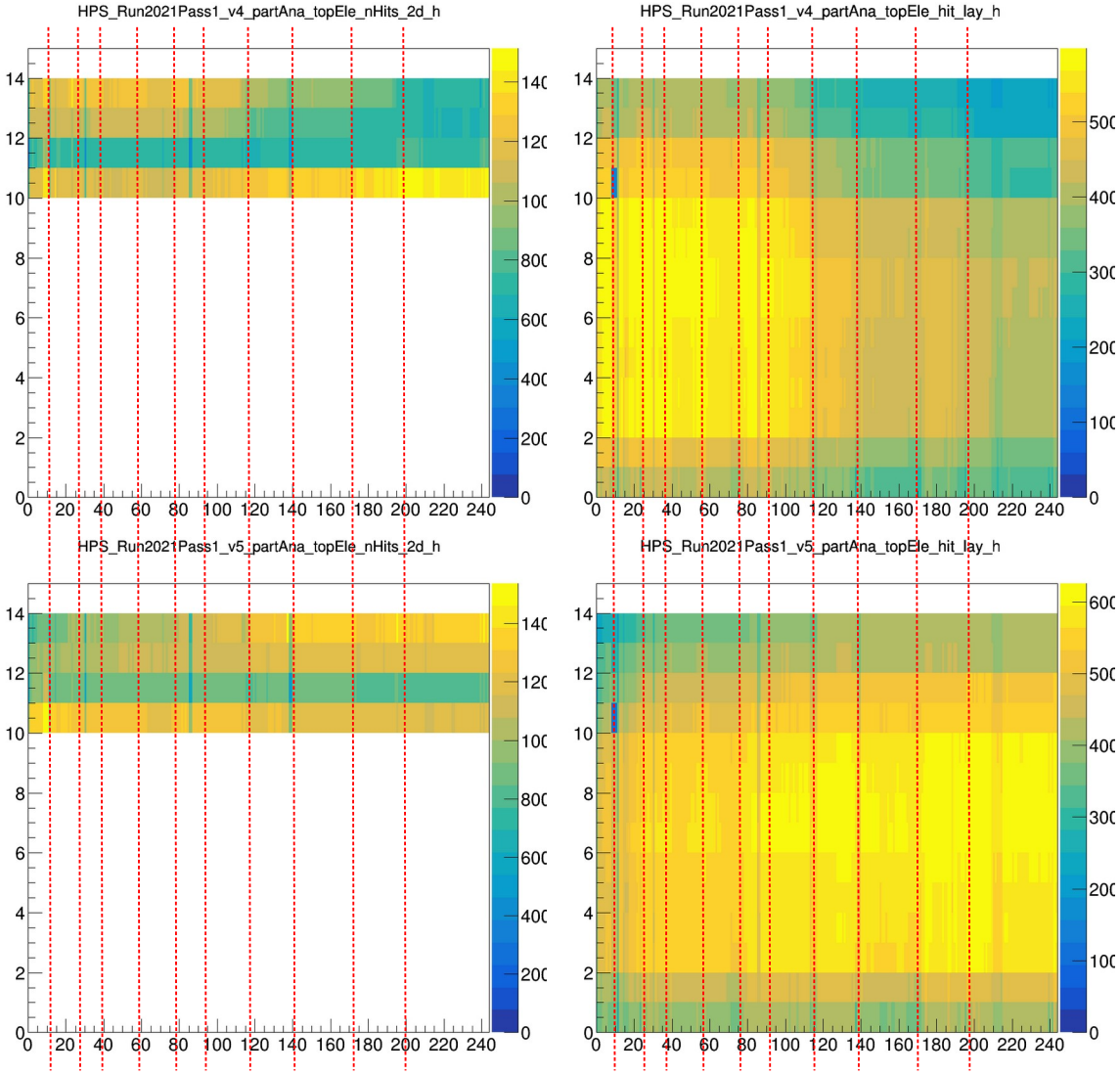
Top Track E/p



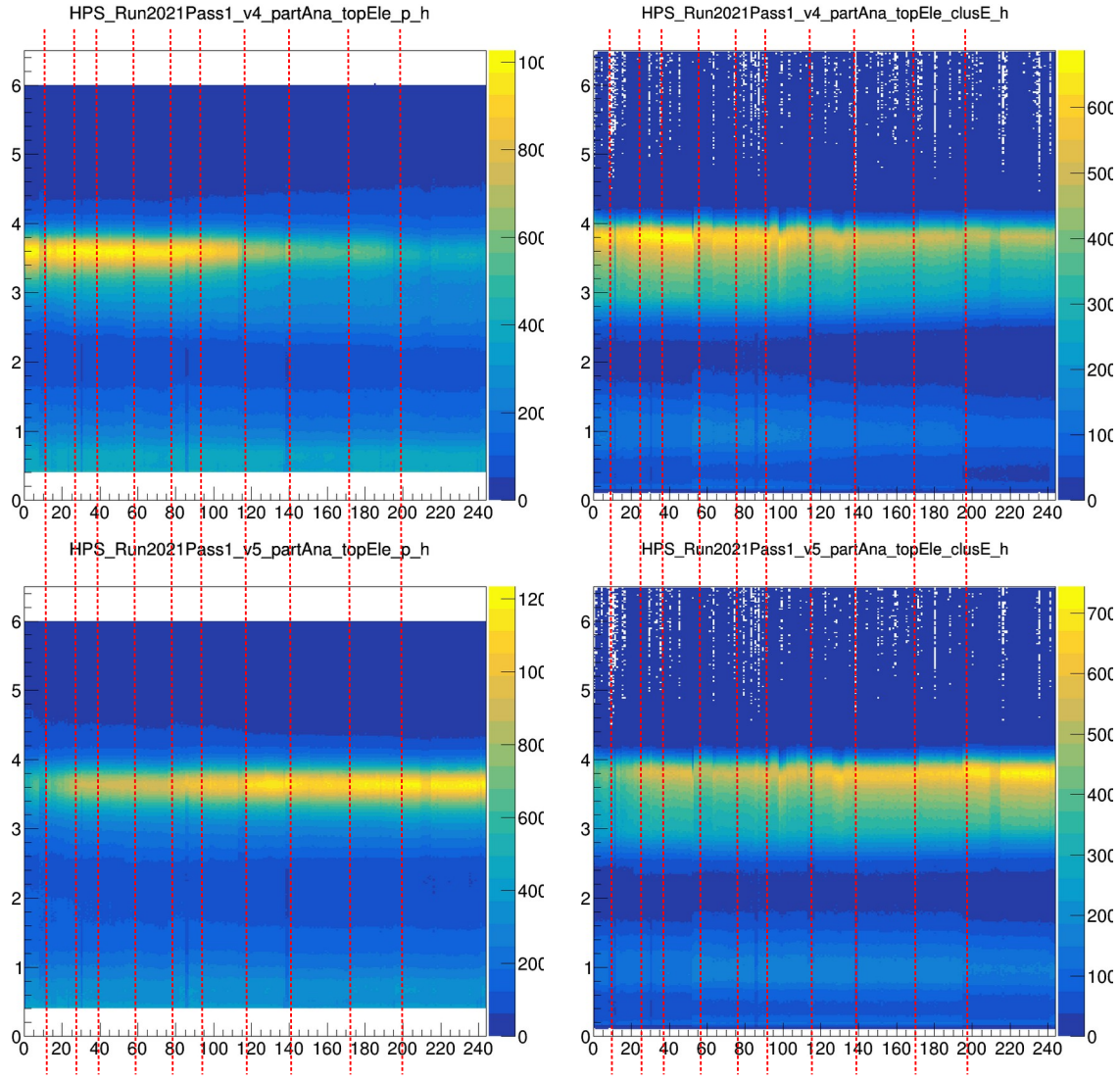
- Positron E/p bifurcates for early runs using the detector aligned using a later run
- The lines line up with features we see in E/p as a function of run ID

Hits on Top Tracks



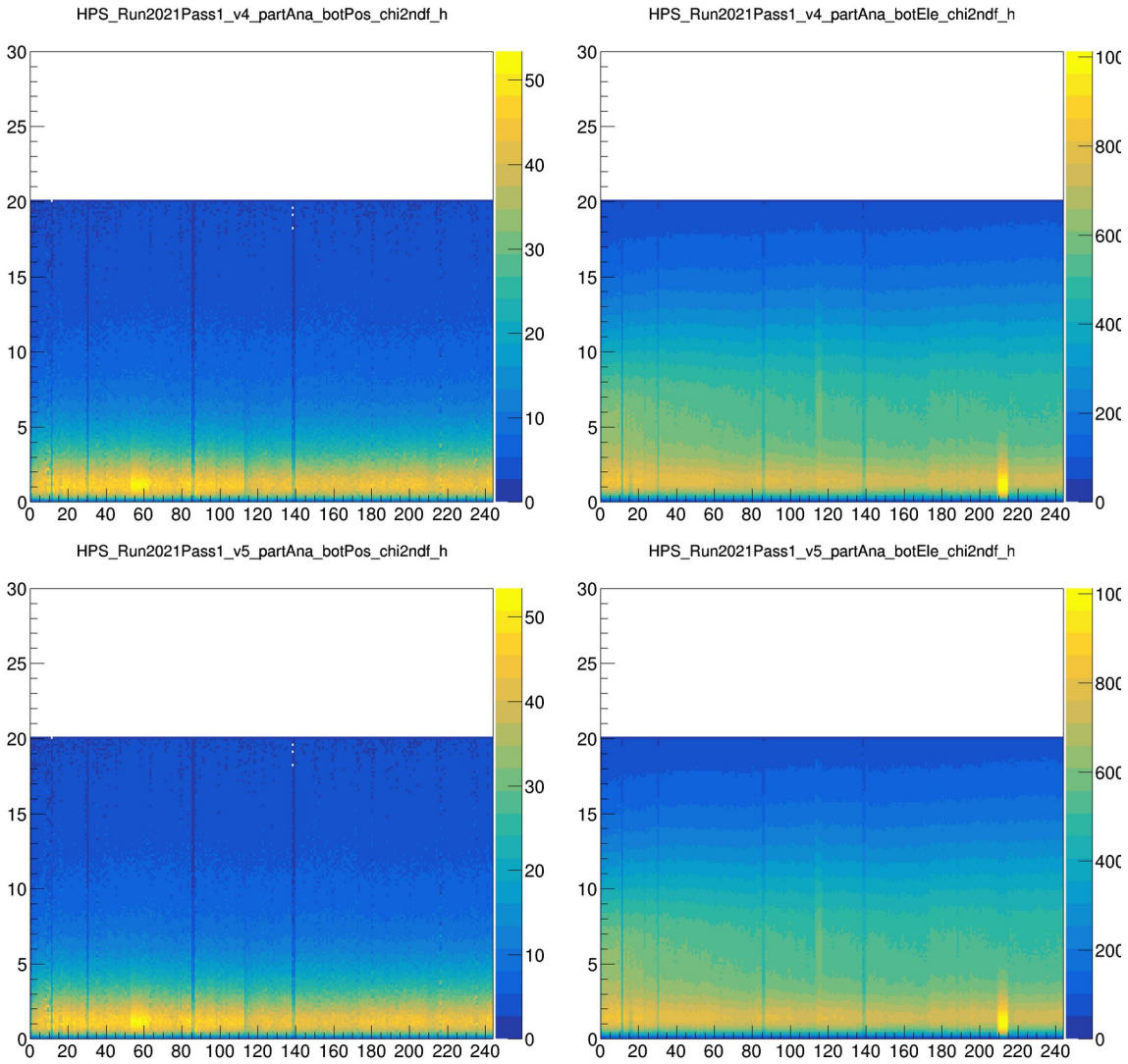
- We can also see the movements in the track hit multiplicity lays of the hits

Top Track P and Cluster E



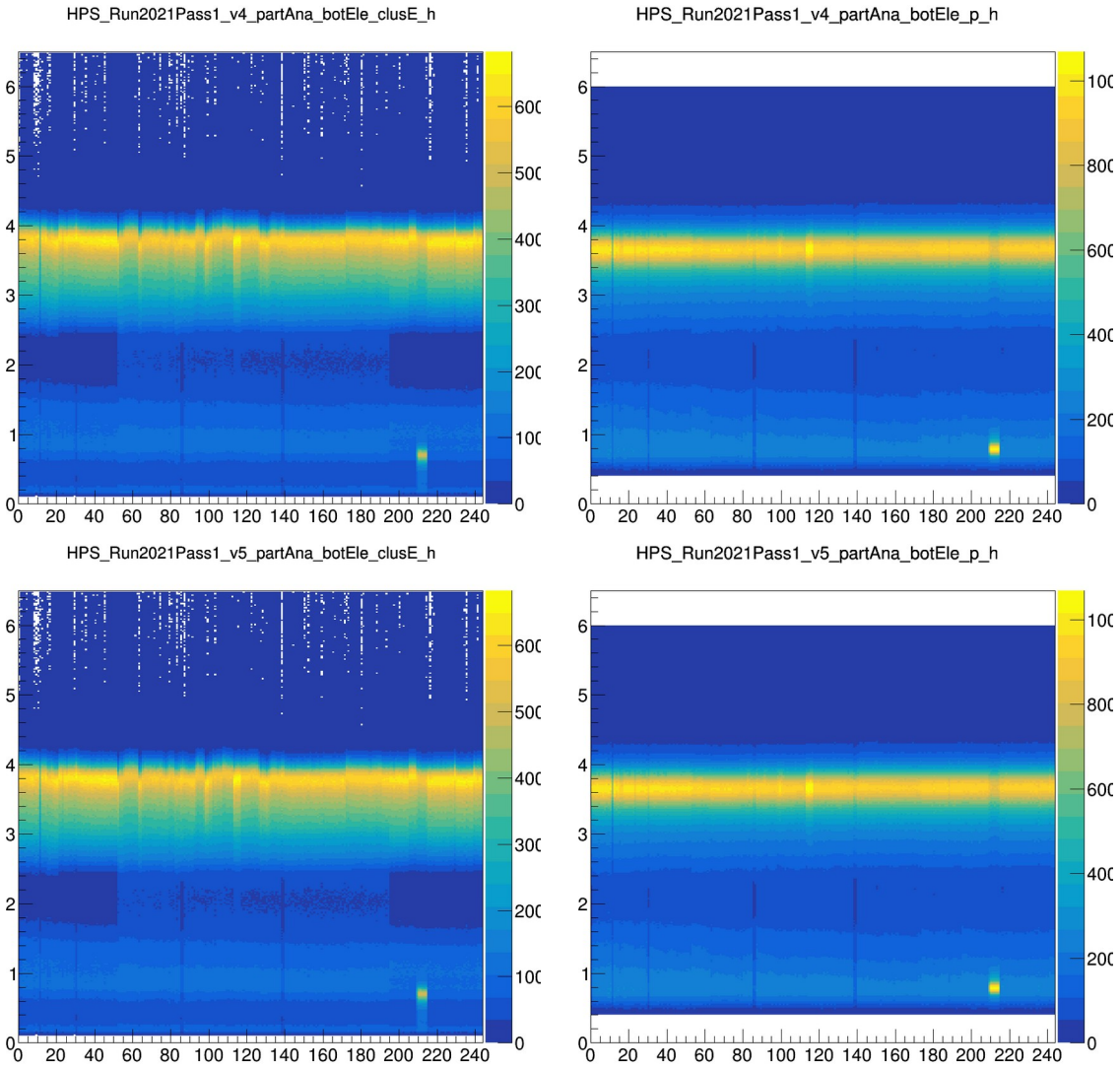
- Cluster energy peak seems to be less stable than track momentum
  - Reminder that these are from FEE trigger skims

Track chi2/ndf in the Bottom



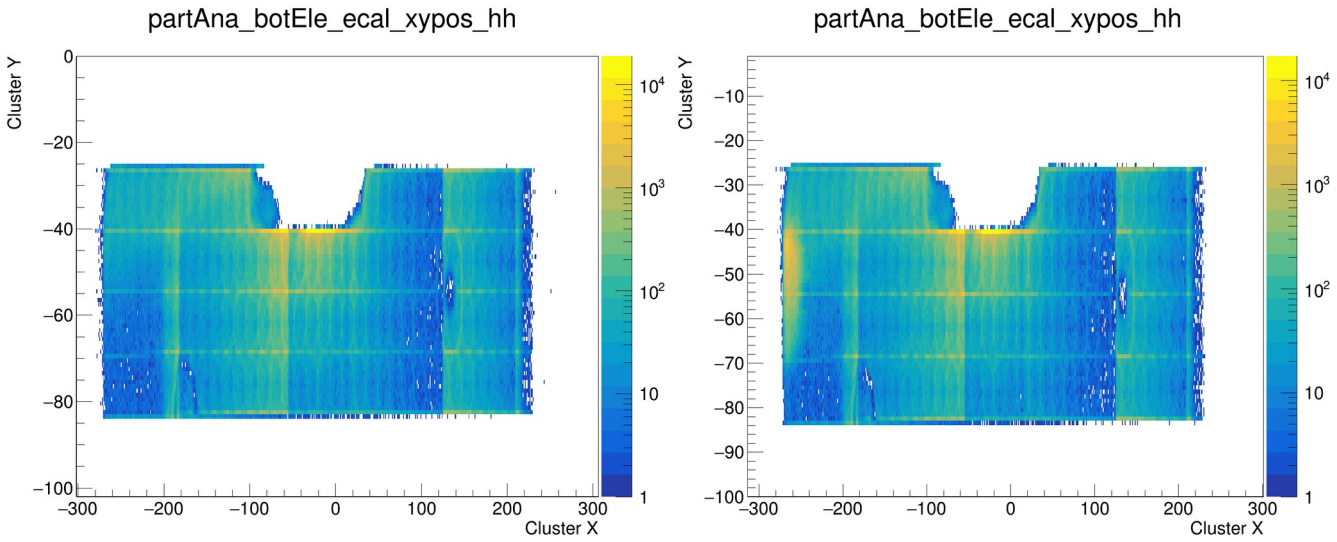
- Looks pretty stable, but why do we have so many more low chi2/ndf tracks in run IDs ~210-215?
  - There is potentially some room to have a few different alignment states for the bottom

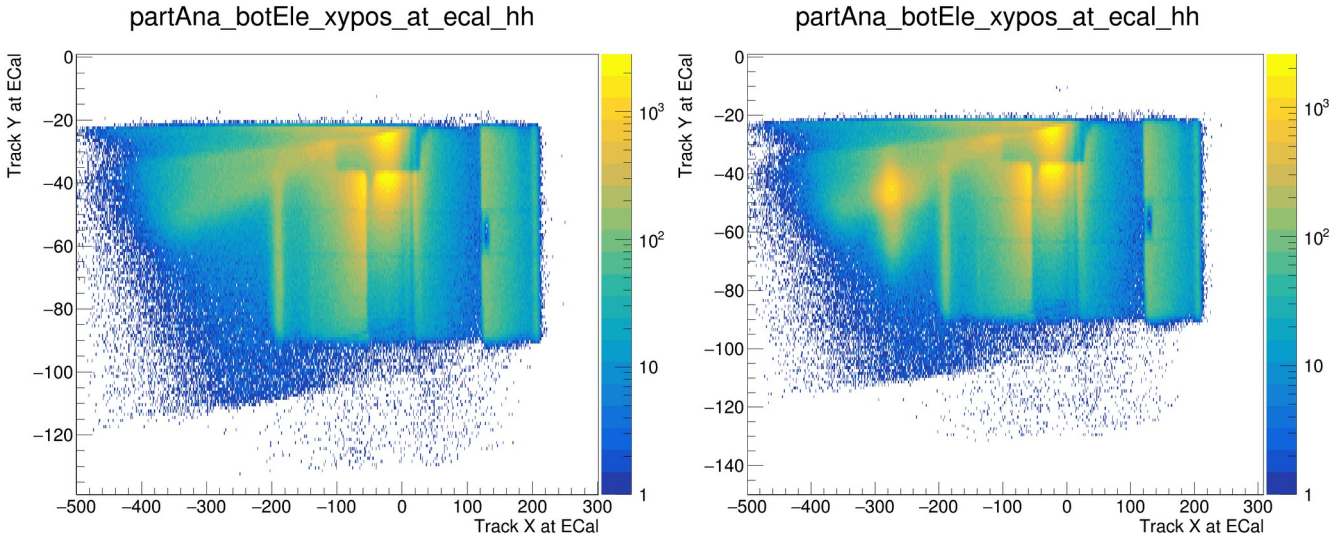
Track P and Cluster E for Bottom Electrons



- We see some low momentum electrons in the bottom around run IDs 210-215
- FEE cluster energy peak in bottom seems less stable than track momentum peak
- Where are these low momentum clusters and energies in the FEE triggers coming from?

Bottom Track and Ecal Cluster Positions





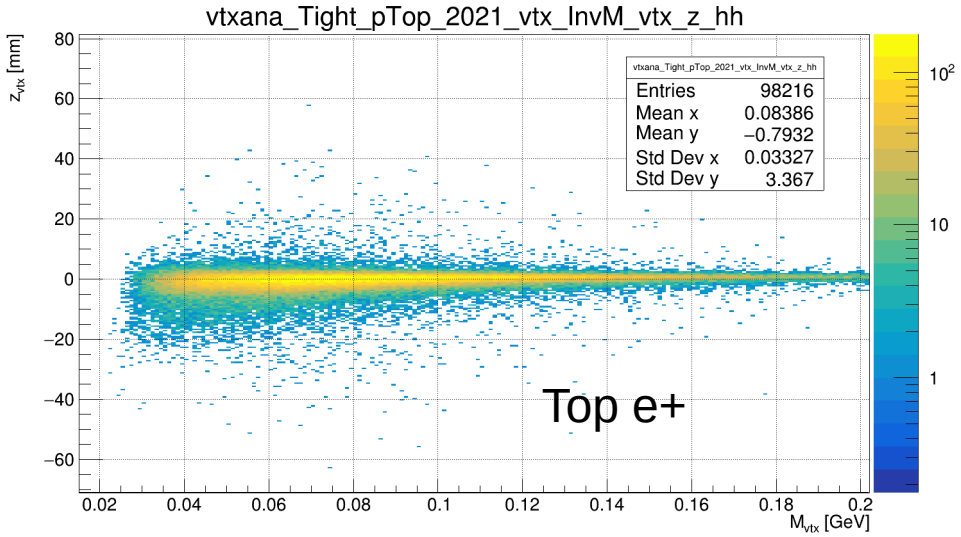
- Left is not in 210-215, and right is
- Looks like Ecal has some fake FEE triggers on low momentum electrons that point to a specific crystal on the low x edge
  - Note that Ecal and track projection plots have slightly different ranges in x

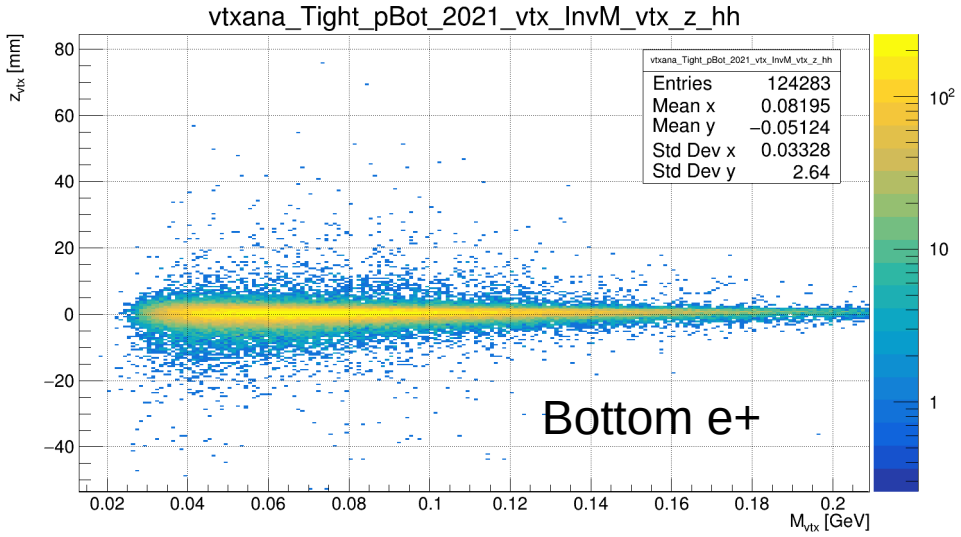
Discussion

- Early run in 2021 appears to have an acceptable alignment with a minor change to the pass1 detector
  - The late runs also have an acceptable alignment after an O(1 mrad) Rw of L6 top stereo
- Matt has been making some improvements to the bottom that will be done soon
- Momentum scale and resolution look pretty good for these tracks comparing to Ecal cluster energy
- There will always be places where we could certainly still improve
  - What is good enough? We need a paper ASAP

Backup

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