# Pass1b Reconstruction Analysis

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HPS Analysis Meeting
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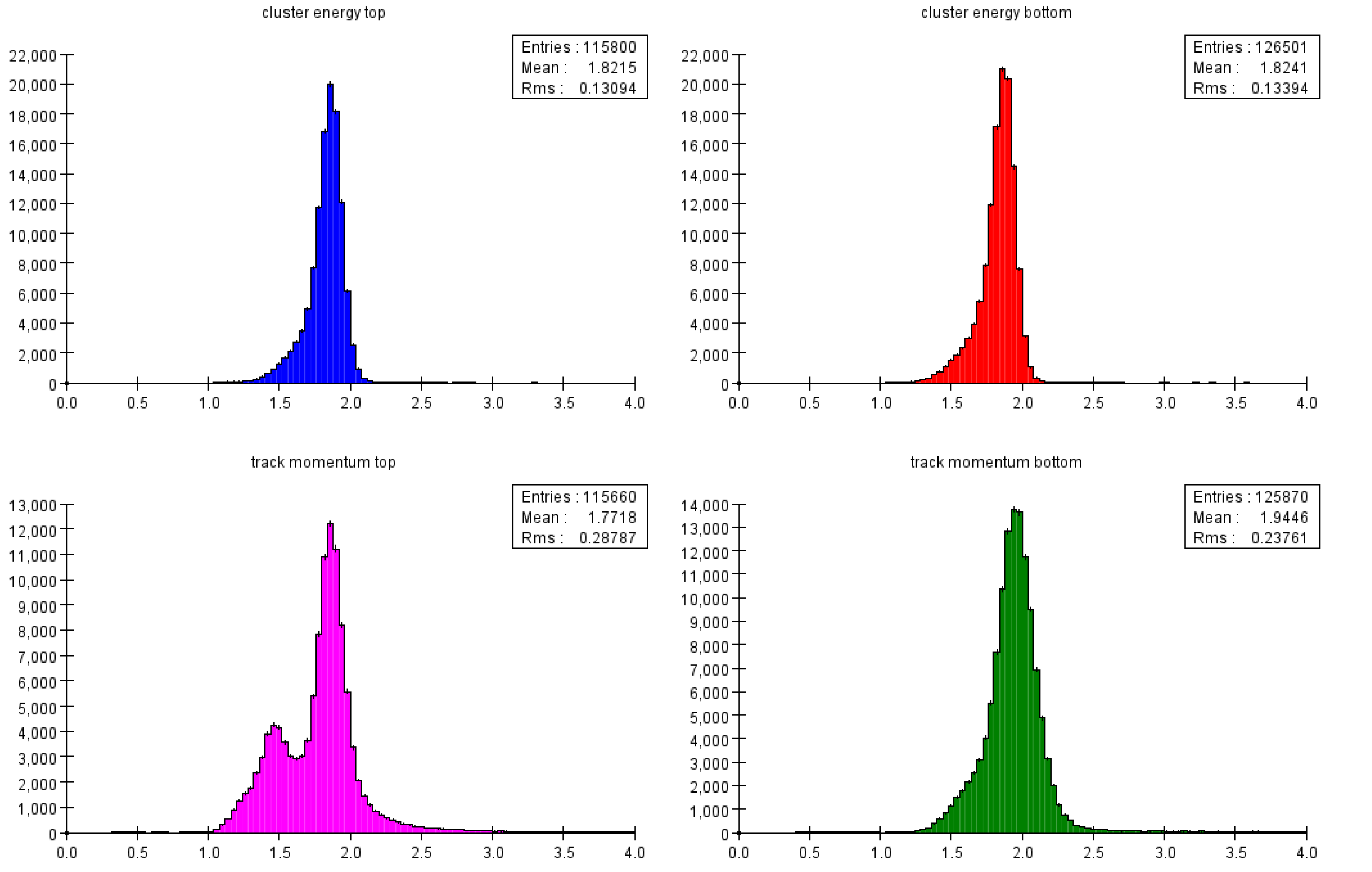
# Data Quality Assurance

- Primary goal is to assure the quality of the reconstruction of the 2019 and 2021 data sets
- Analyzing 2021 data pass1b reconstruction output
  - HPS_Run2021Pass1_v3
  - HPS_Run2021Pass1_v3_1pt92GeV
  - ~280 runs with a few tens of file partitions per run
- Focus is on the characterization of detector performance
- Comparing tracking and calorimeter performance
- Analyzing single-track performance with an emphasis on momentum scale and pointing resolution to Ecal and IP
- Studying track-finding efficiencies for electrons and positrons using low-background three-prong Trident event samples
- Providing data samples for use by the wider collaboration

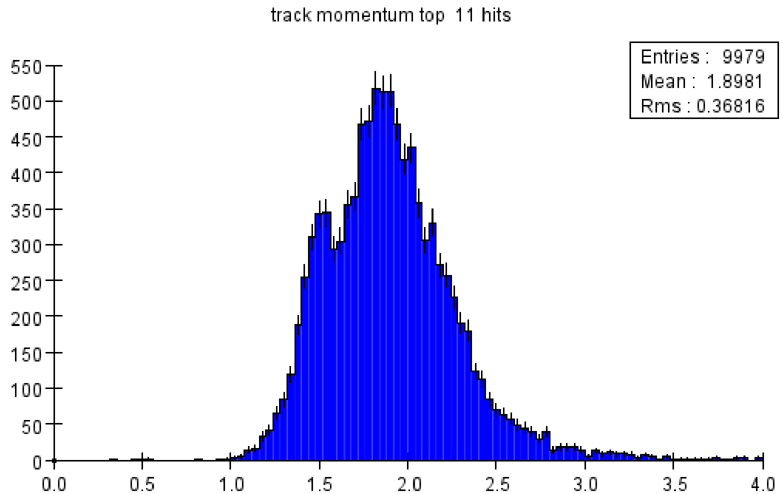
# Momentum & Energy

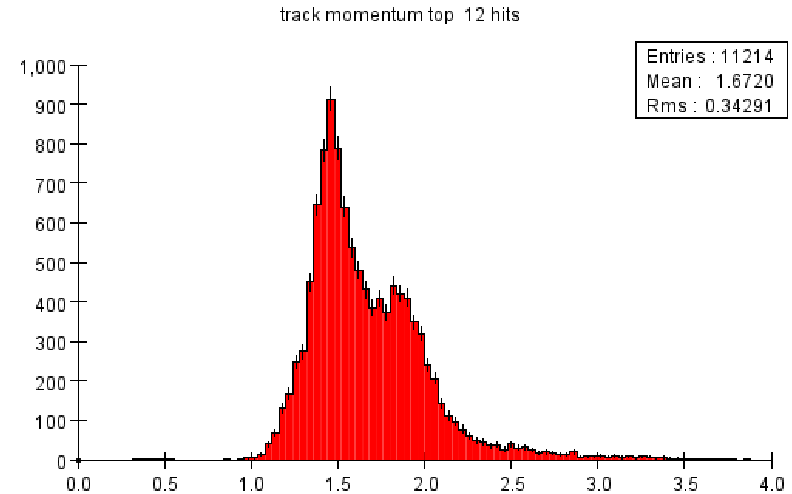
- Use a series of simple cuts to provide samples of events which can be used for energy and momentum calibration, tracking efficiency studies and beam position/direction determination
- Full Energy Electrons (FEEs)
  - Single monochromatic particles at beam energy
- Three-prong Tridents
  - Three-particle system whose sum equals beam energy and direction
  - Lower-energy and wider angular coverage
  - Checks electron and positron cluster corrections
  - Vertexing positron+same-side electron and positron+opposite-side electron checks global alignment of top/bottom in same event.
  - Low-background sample for electron, positron and recoil track-finding efficiency studies

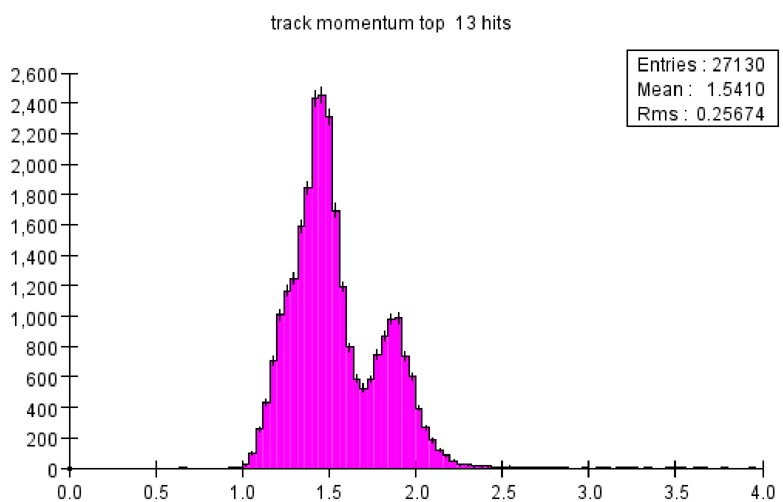
# 2021 1.92GeV FEE Analysis

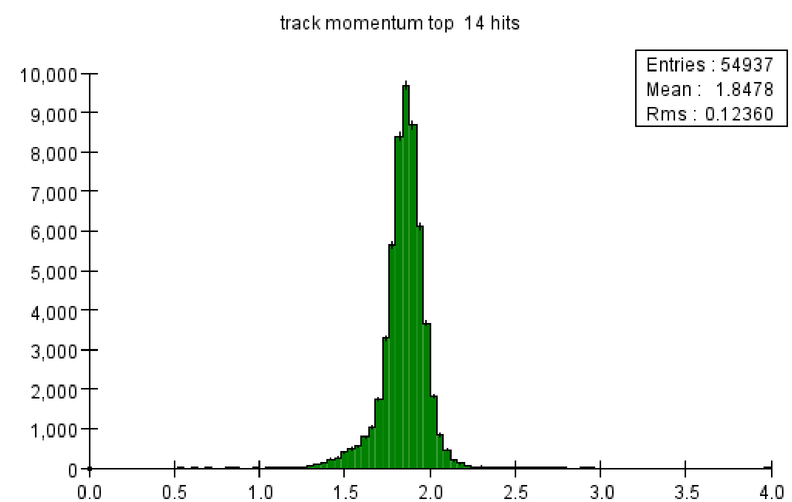


# 2021 1.92GeV Top Momentum

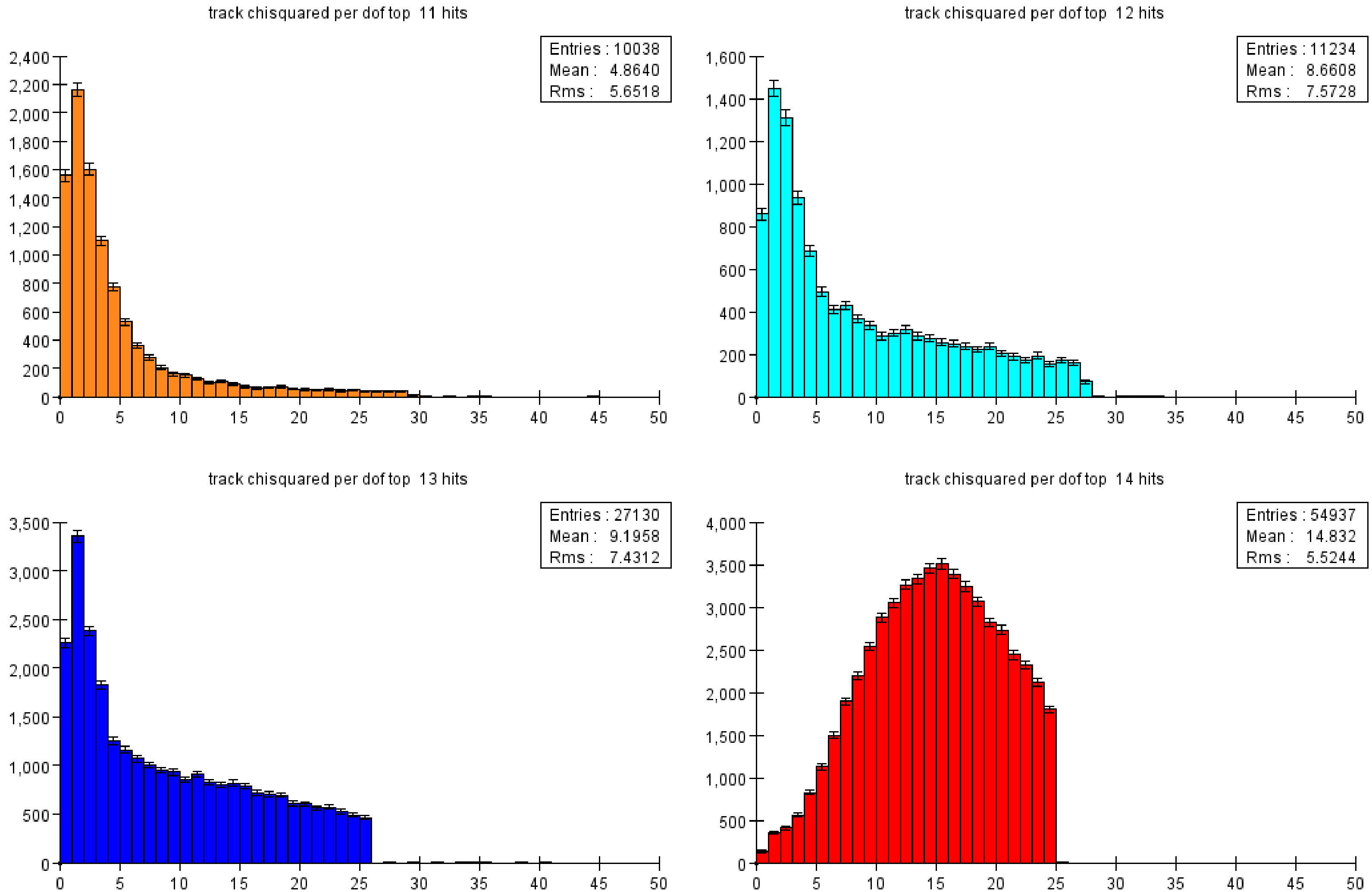


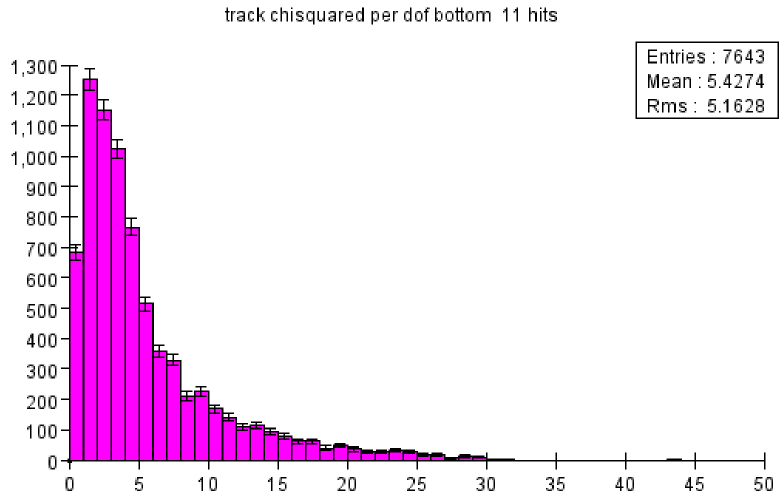



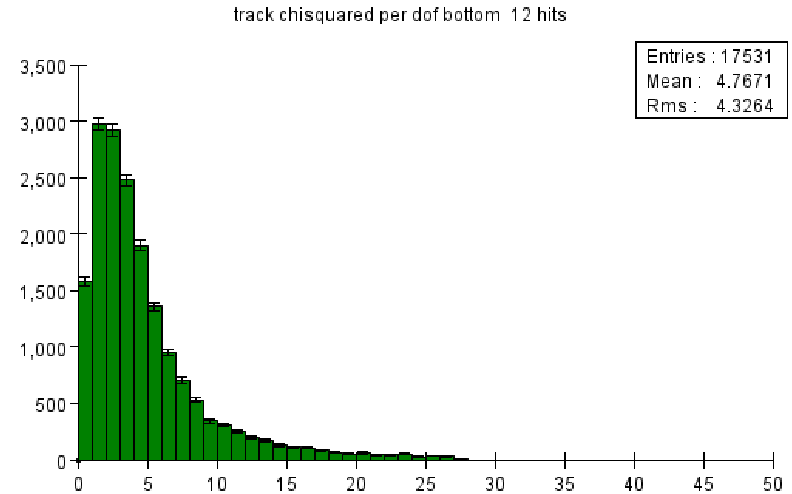



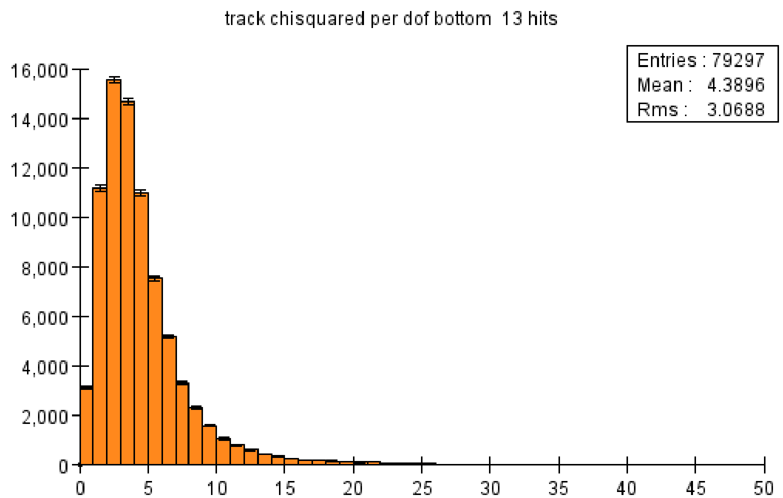
# 2021 1.92GeV Track Chi-squared

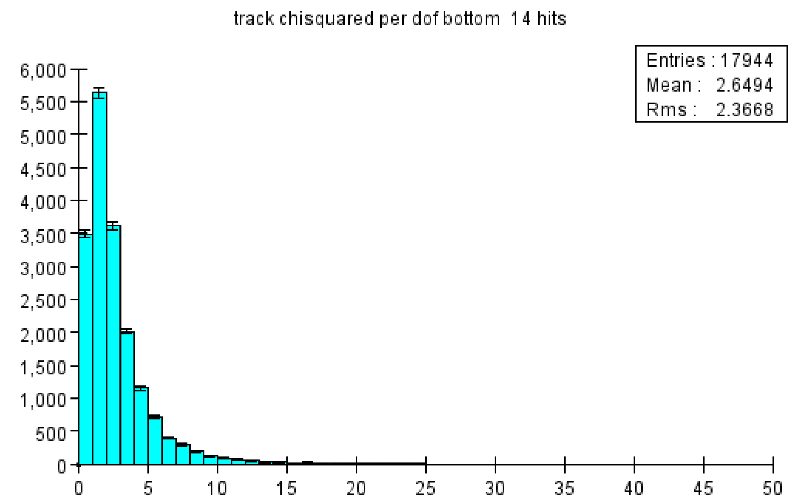


# 2021 1.92GeV Track Chi-squared



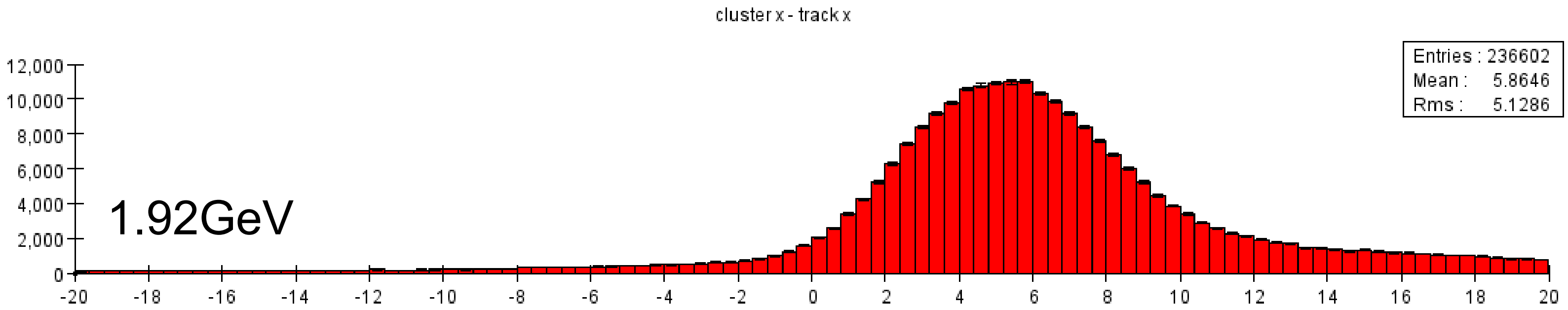
# Track Momentum and Chi-squared

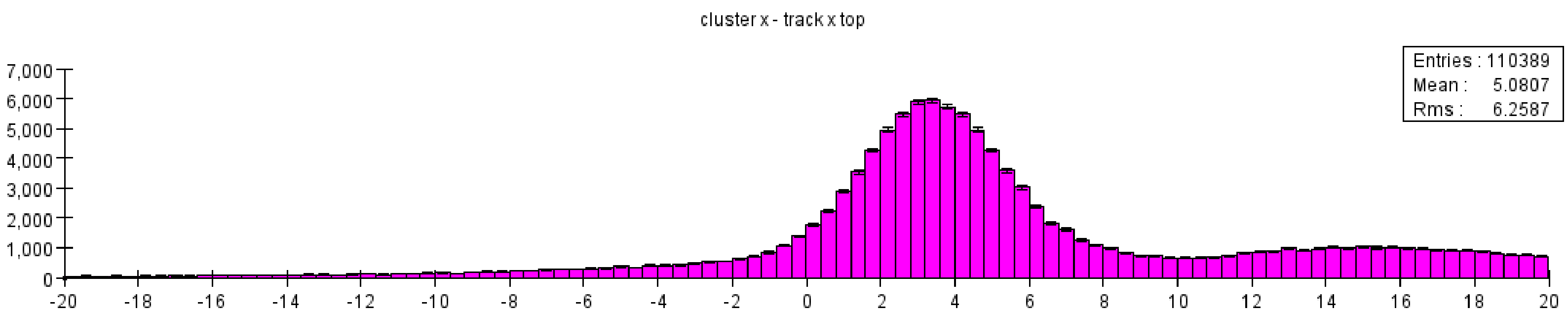
- pass1b data uses essentially the same detector that was qualified four months ago.
- So no surprise that track momenta and chi-square distributions show similar behavior
  - Bottom reasonably well-behaved
  - Top shows momentum bifurcation for less than 14 hits
  - However, chi-squared for 14-hit tracks shows huge tension in the alignment

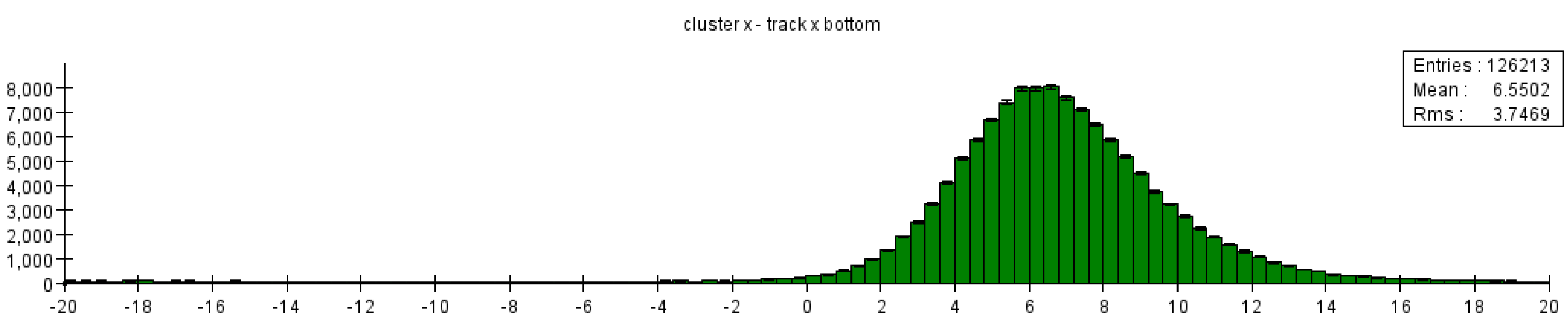
# Track-Calorimeter Matching

- Although the SVT defines the HPS coordinate system, it is important to realize that the Ecal also provides important position information.
  - It has been surveyed before and after both the 2019 and 2021 runs
  - Provides cluster positions with a resolution of a few mm
- Severe discrepancies have been shown between the position of tracks projected to the calorimeter face and the position of the associated cluster

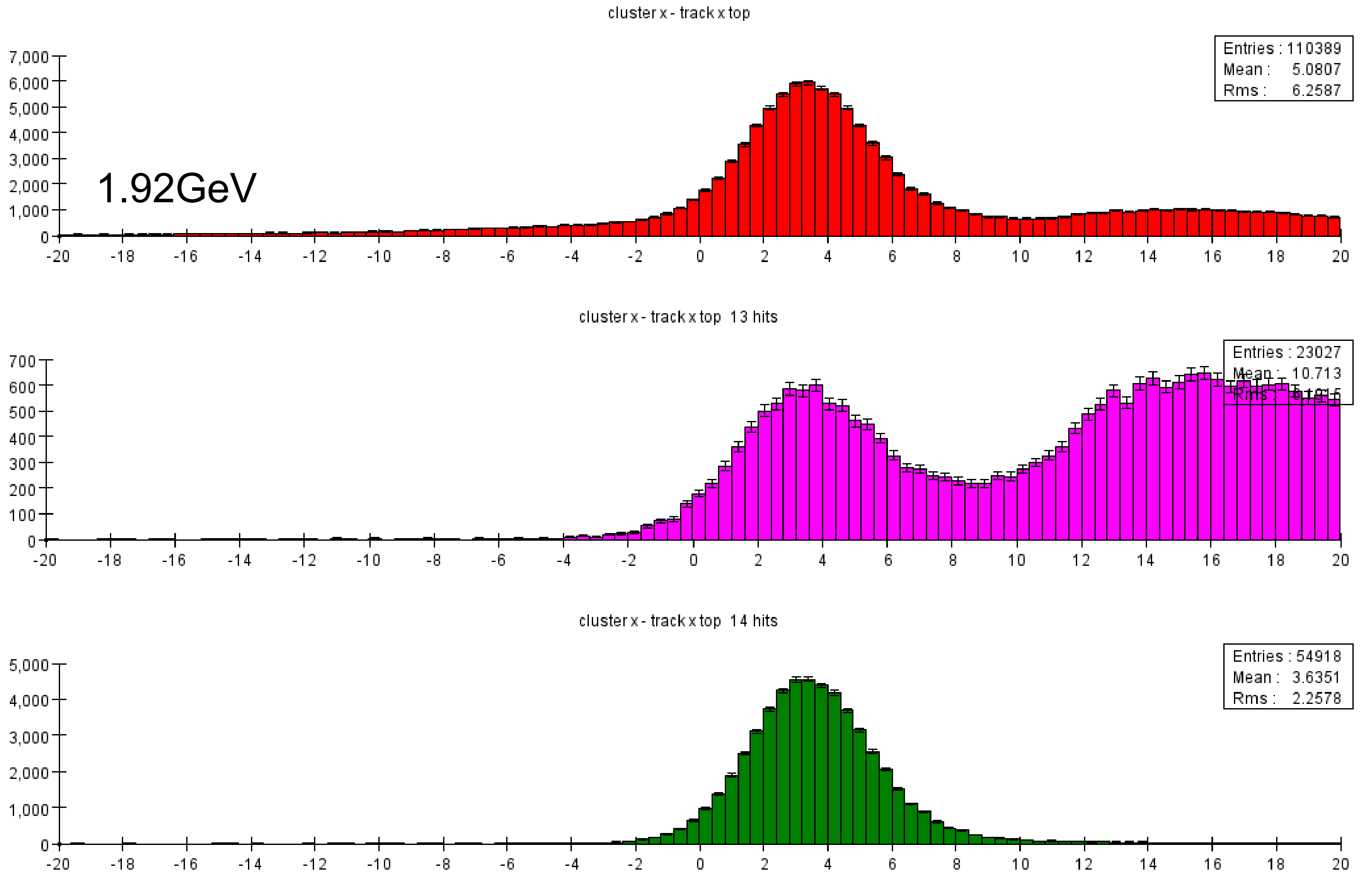
# 2021 FEE Cluster X – Track X



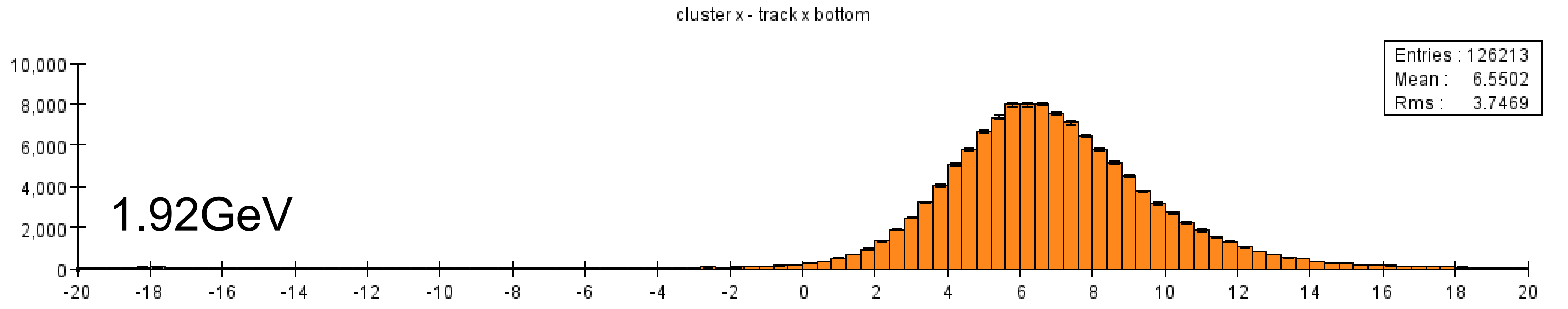



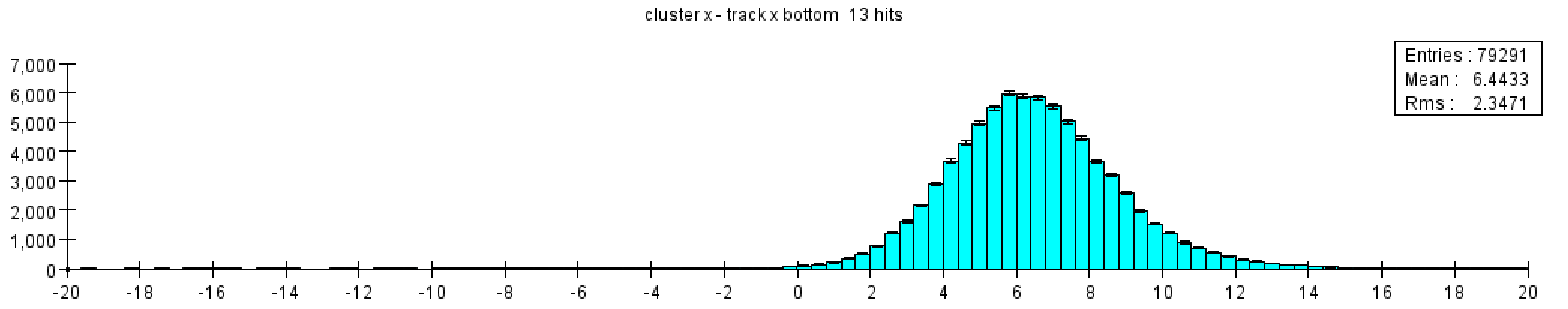



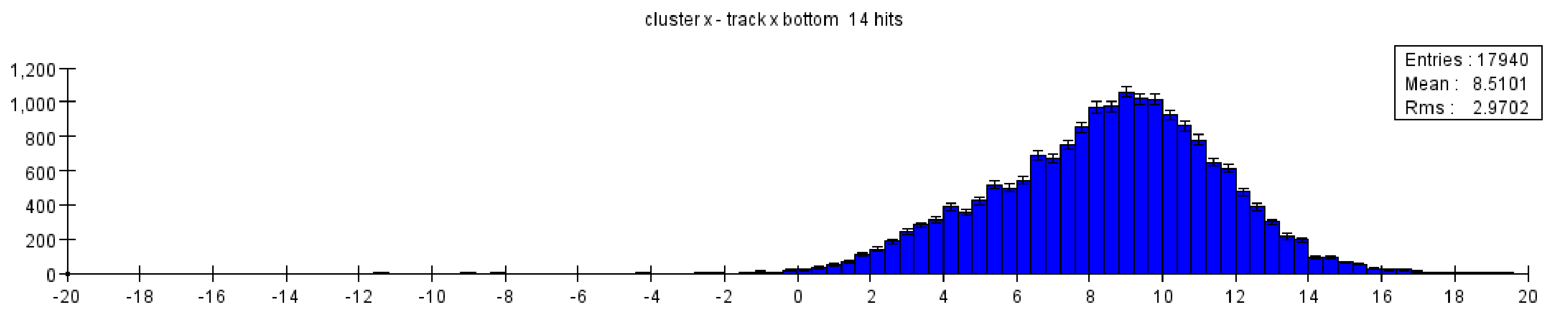
# 2021 FEE Cluster X – Track X top



# 2021 FEE Cluster X – Track X bottom

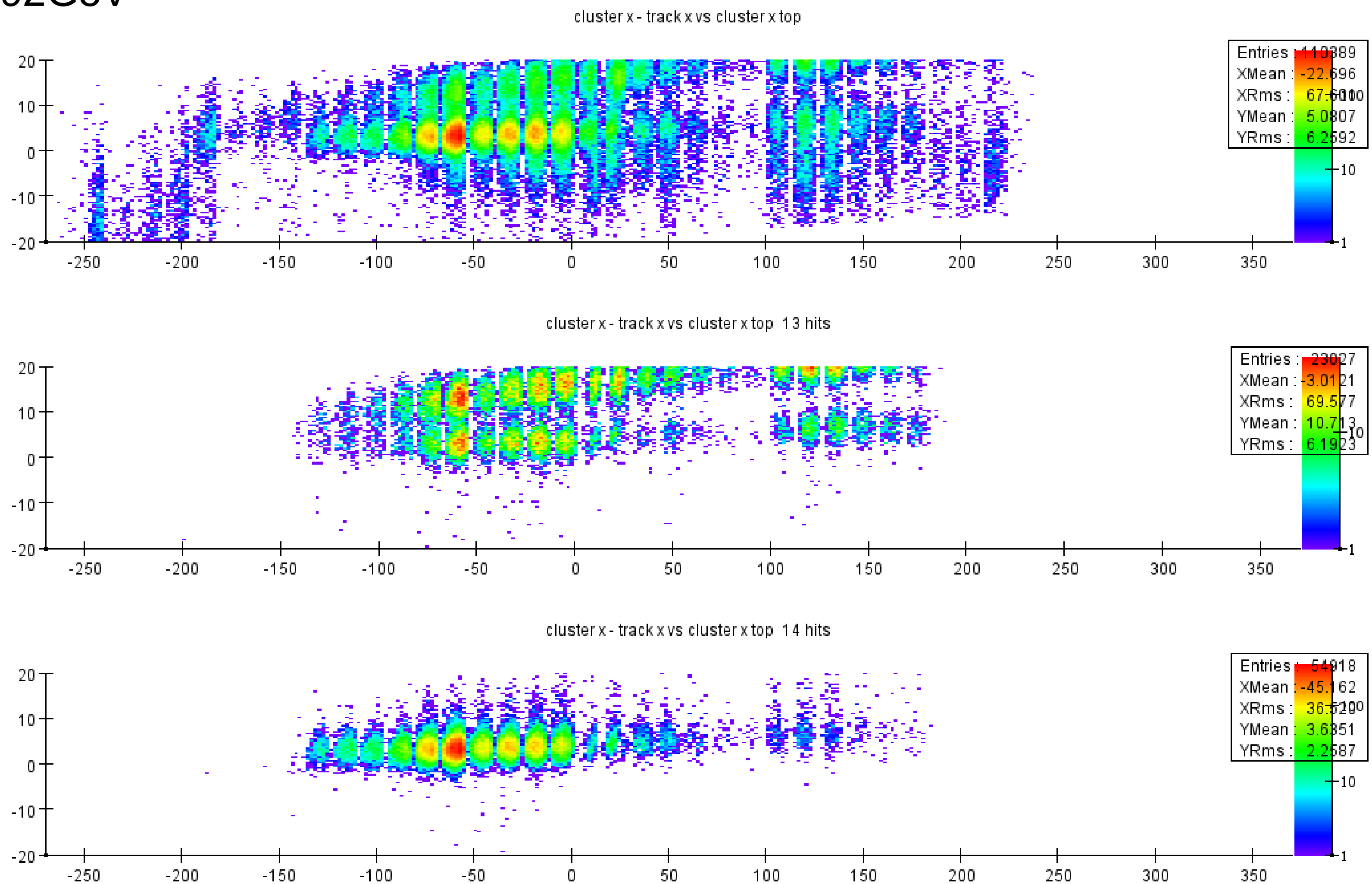


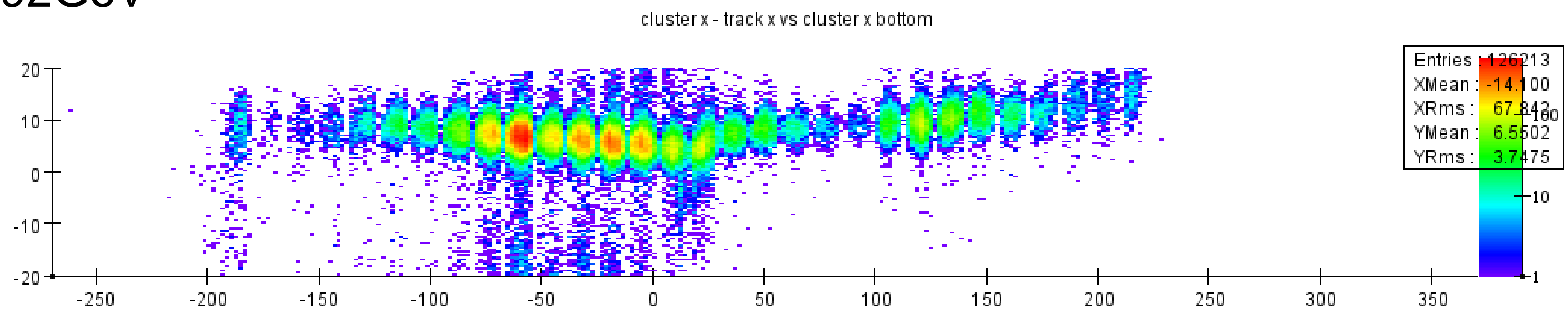
# 2021 FEE Cluster X – Track X vs X

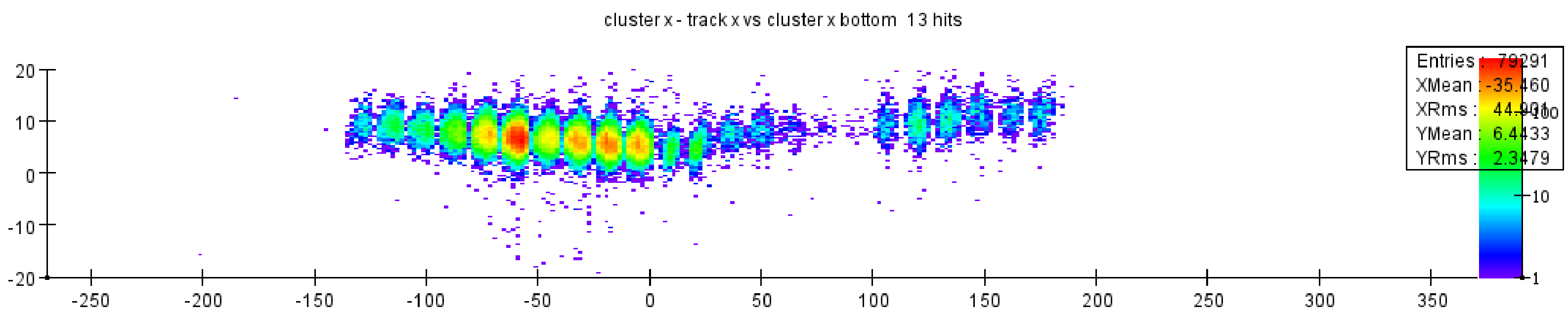
1.92GeV

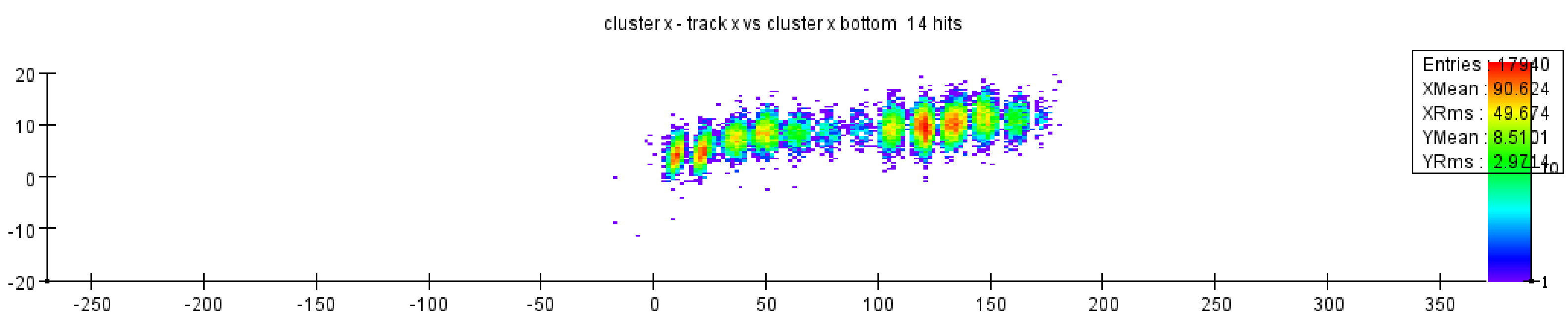


# 2021 FEE Cluster X – Track X vs X

1.92GeV

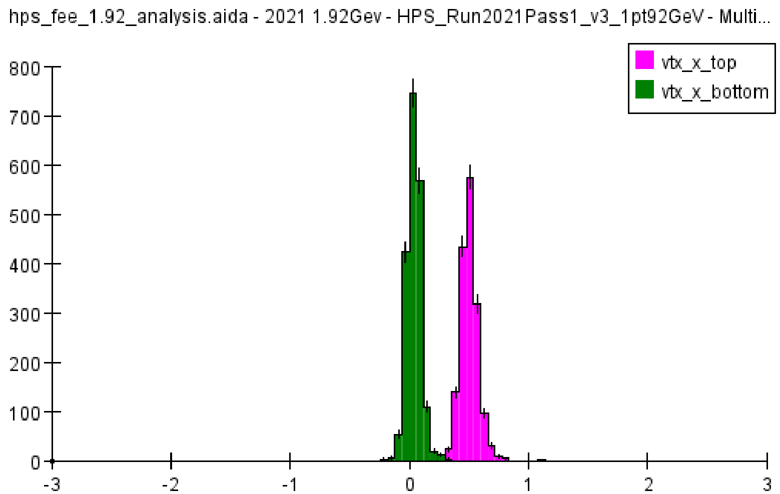


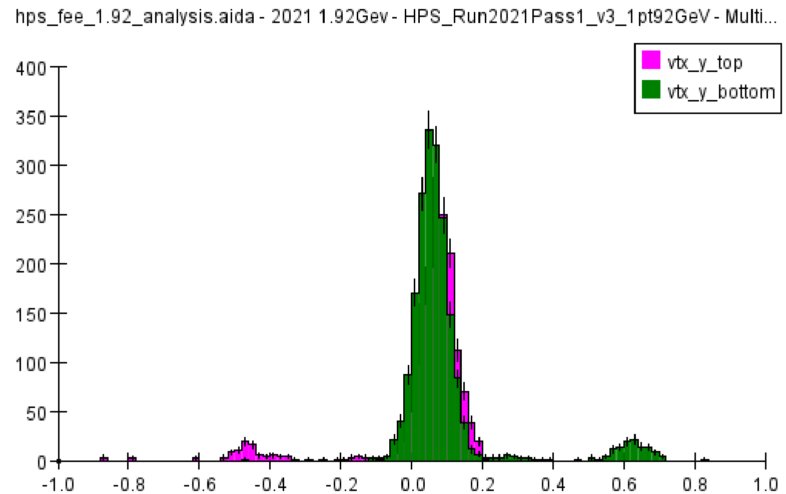



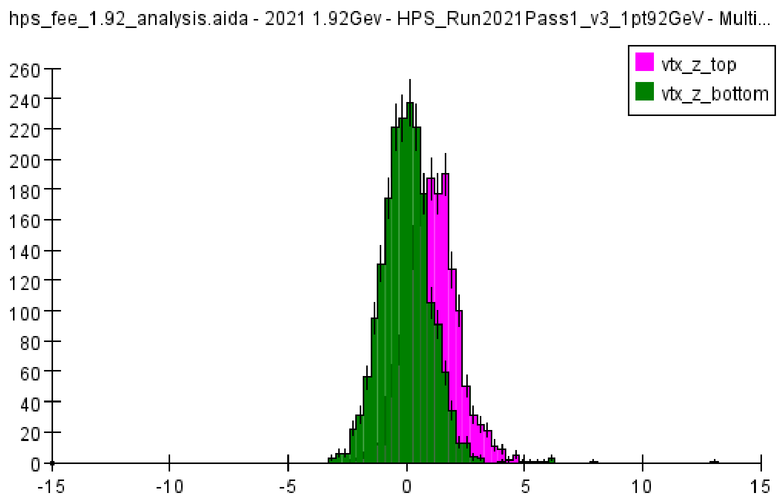



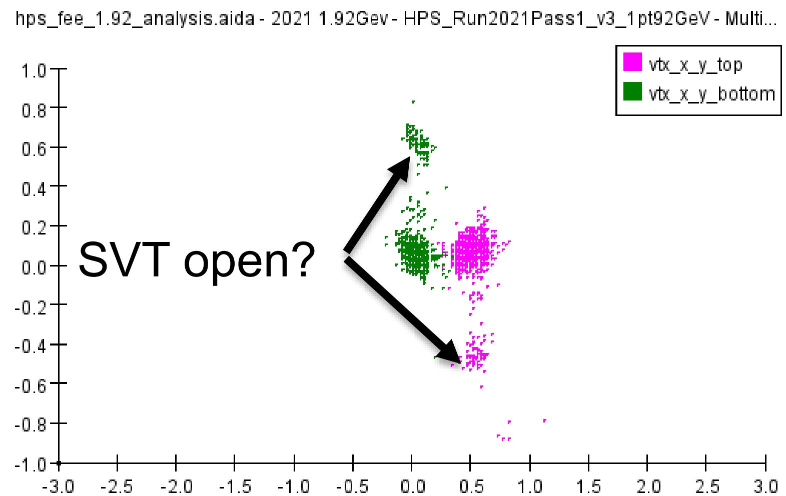
# 2021 FEE MultiVertex

1.92GeV



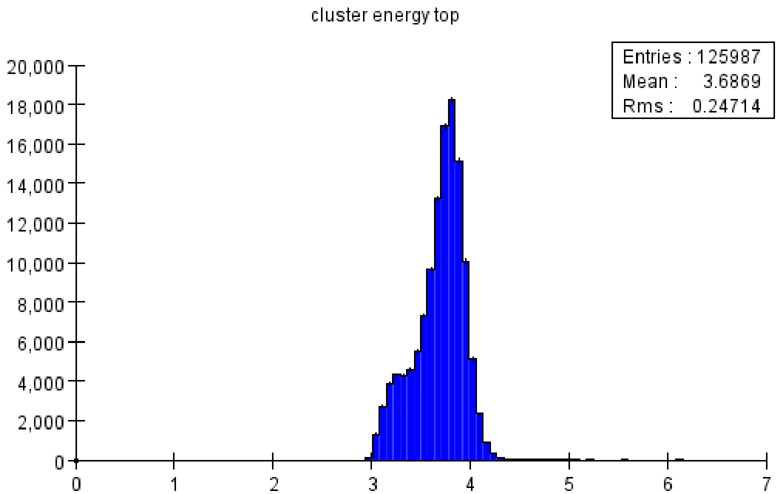



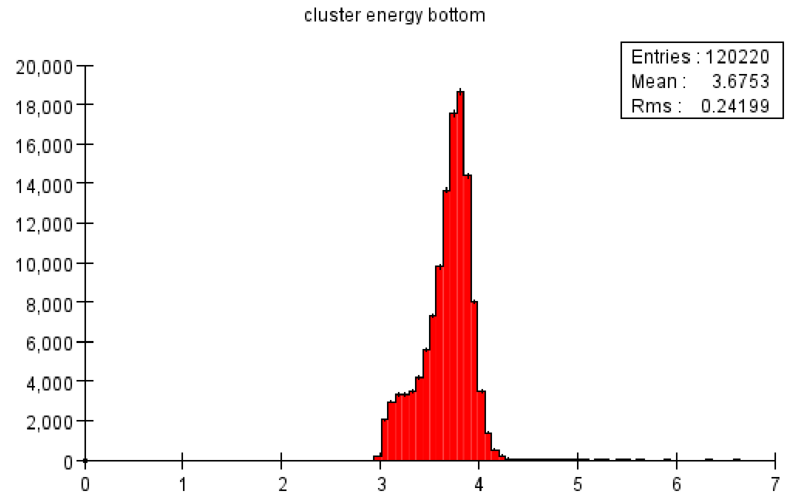



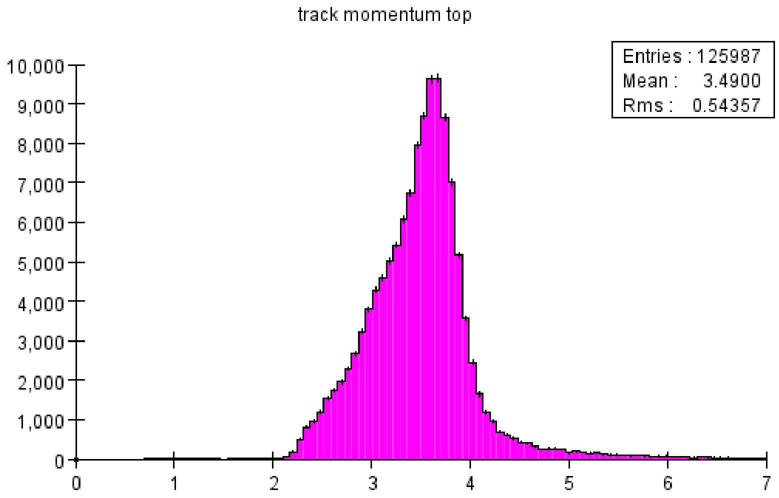
# Track-Calorimeter & IP Matching

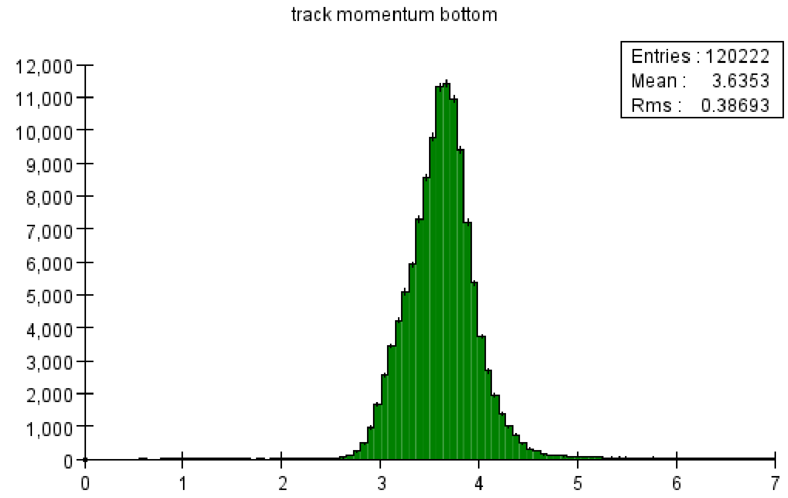
- Both top and bottom halves of the SVT exhibit rather severe misalignment with respect to the calorimeter, both as a function of the number of hits on the track but also whether the tracks are in the slot or hole side of the SVT.
- Vertexing only top or only bottom tracks shows relatively good agreement in y and z vertex position, but a fairly substantial yaw in x.
- Future alignments should keep these distributions in mind.

# 2021 3.74GeV early FEE Analysis

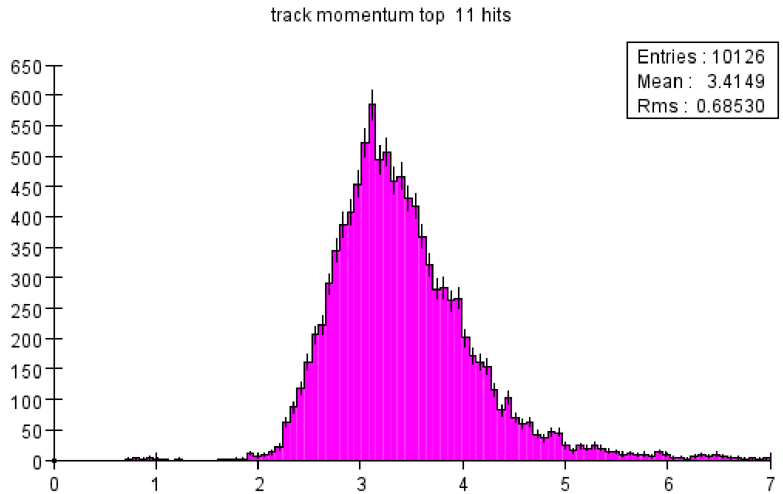


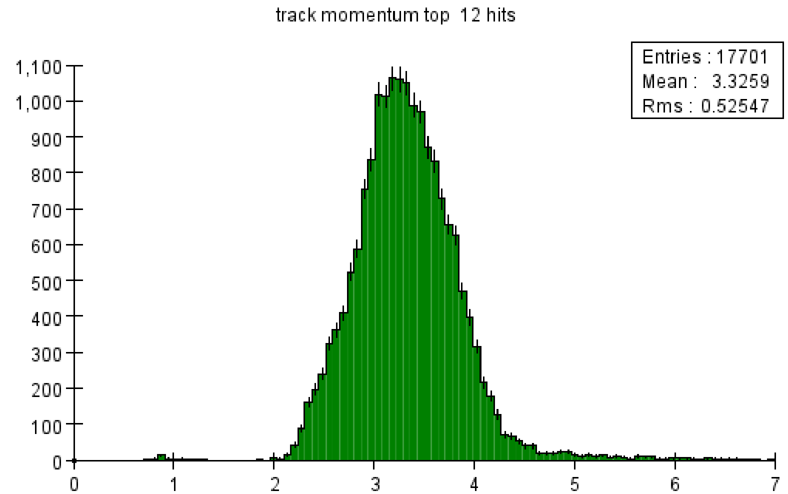



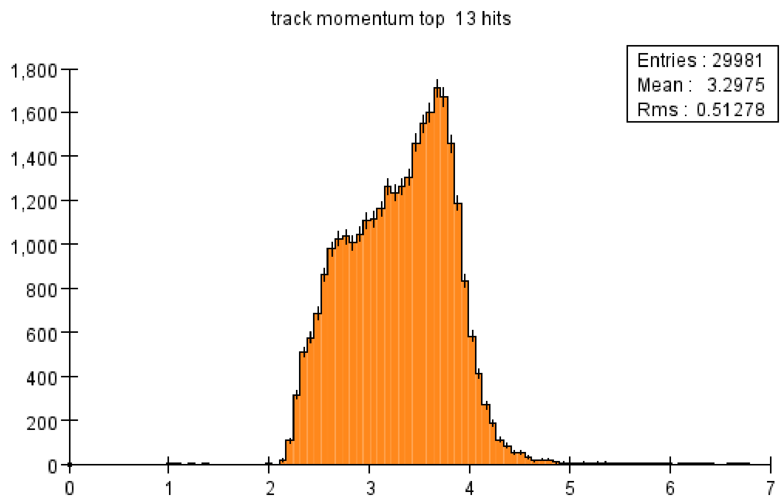



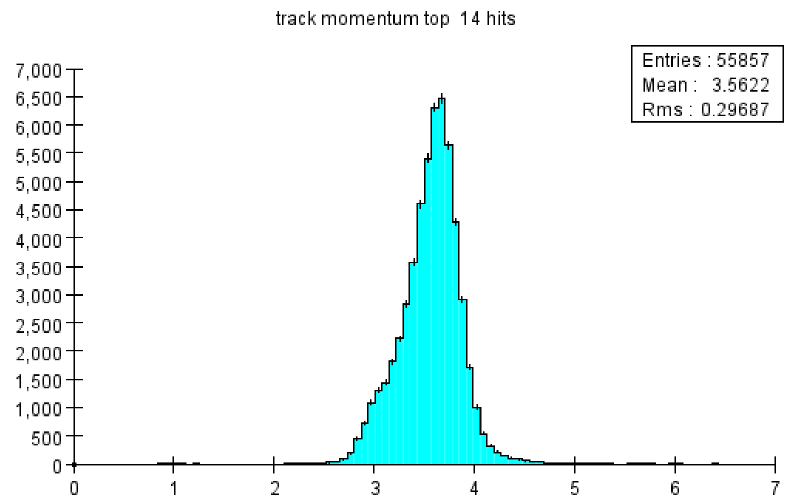



# 2021 3.74GeV early Top Momentum

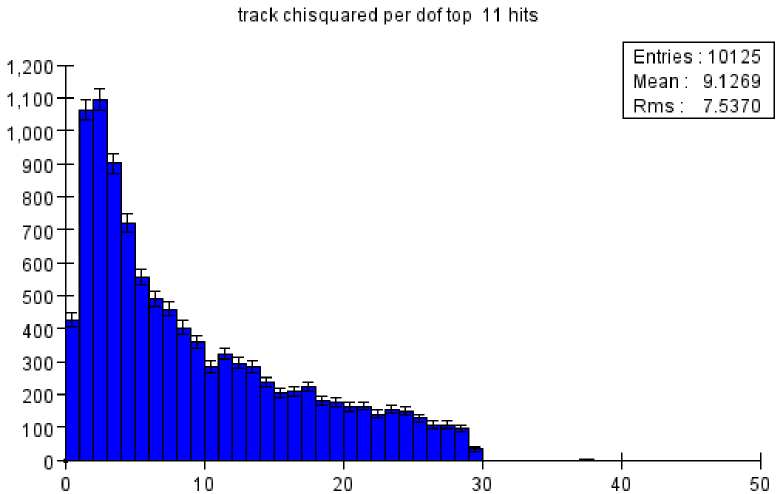


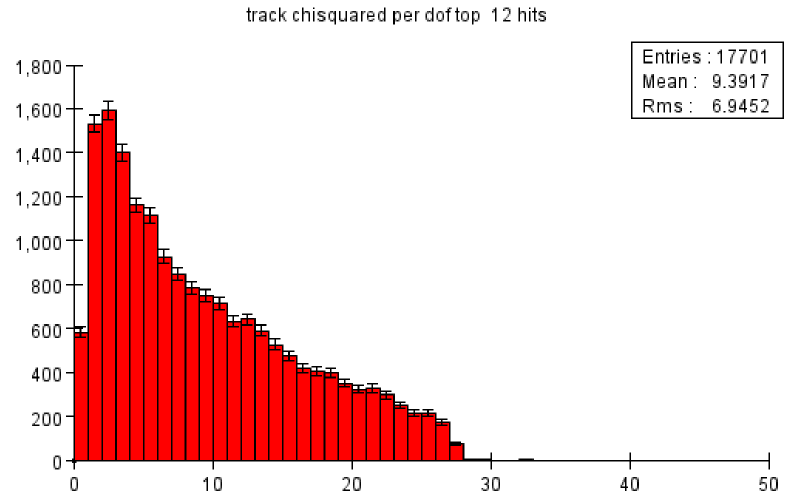



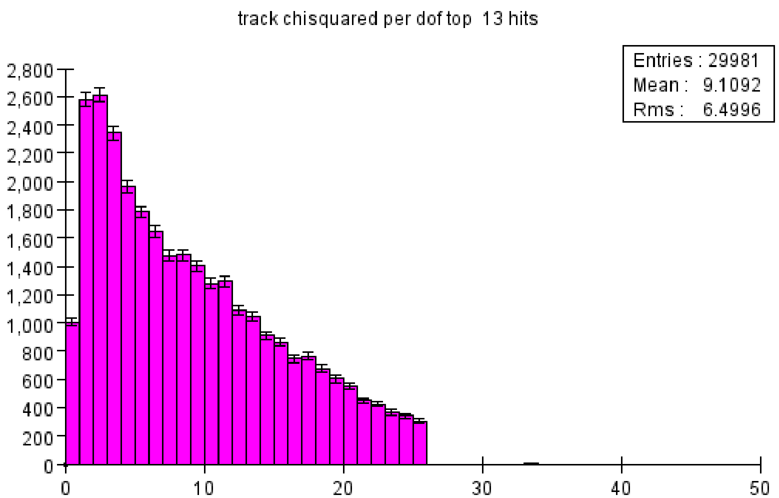



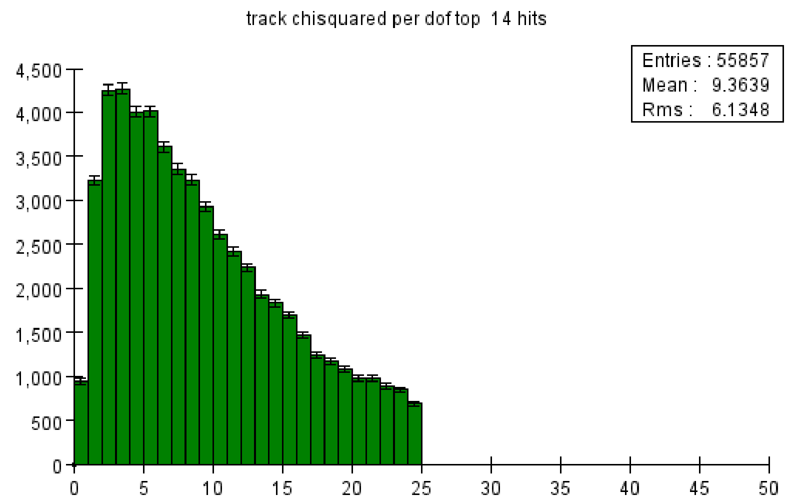



# 2021 3.74 early GeV Track Chi-squared



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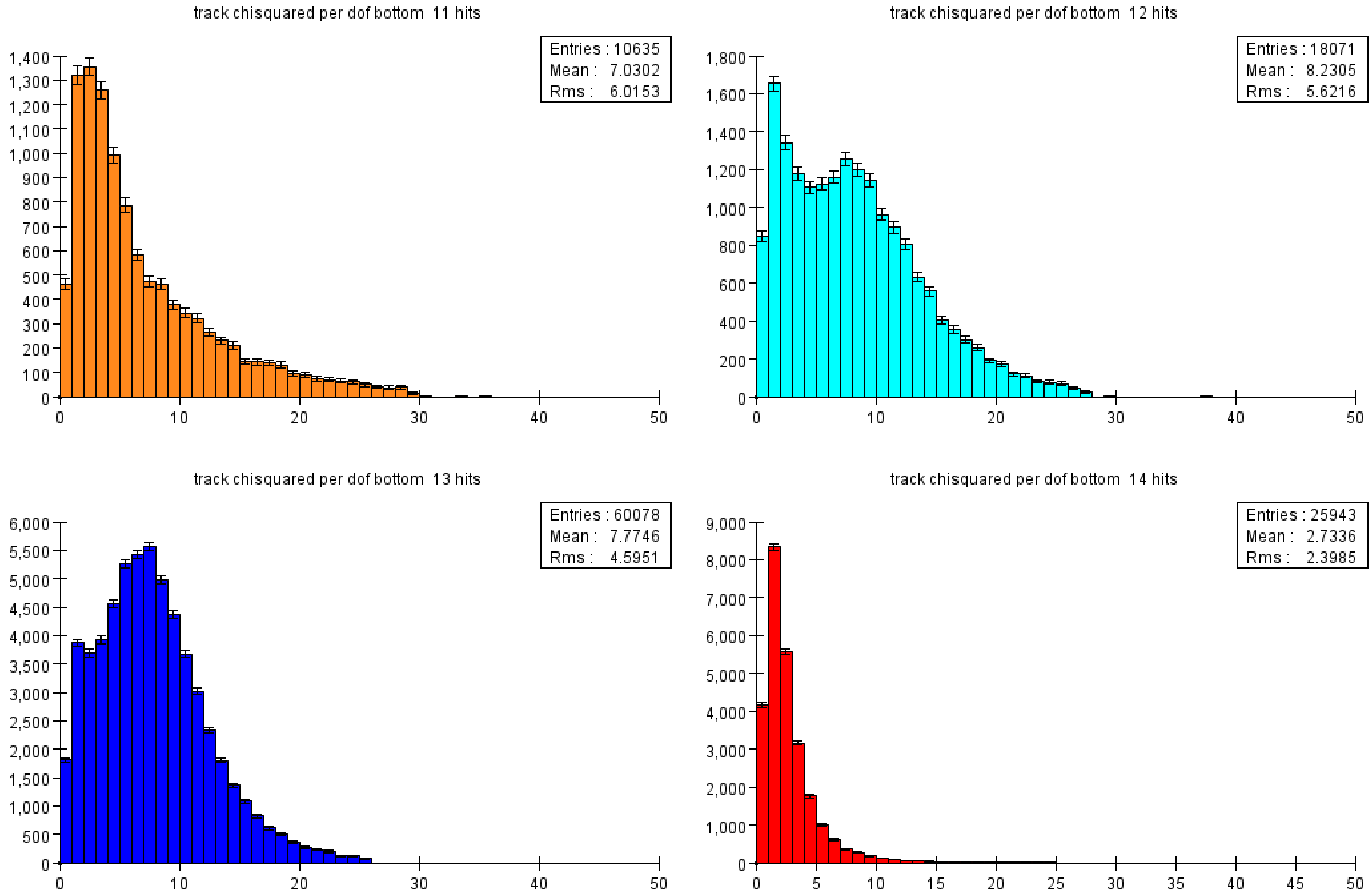
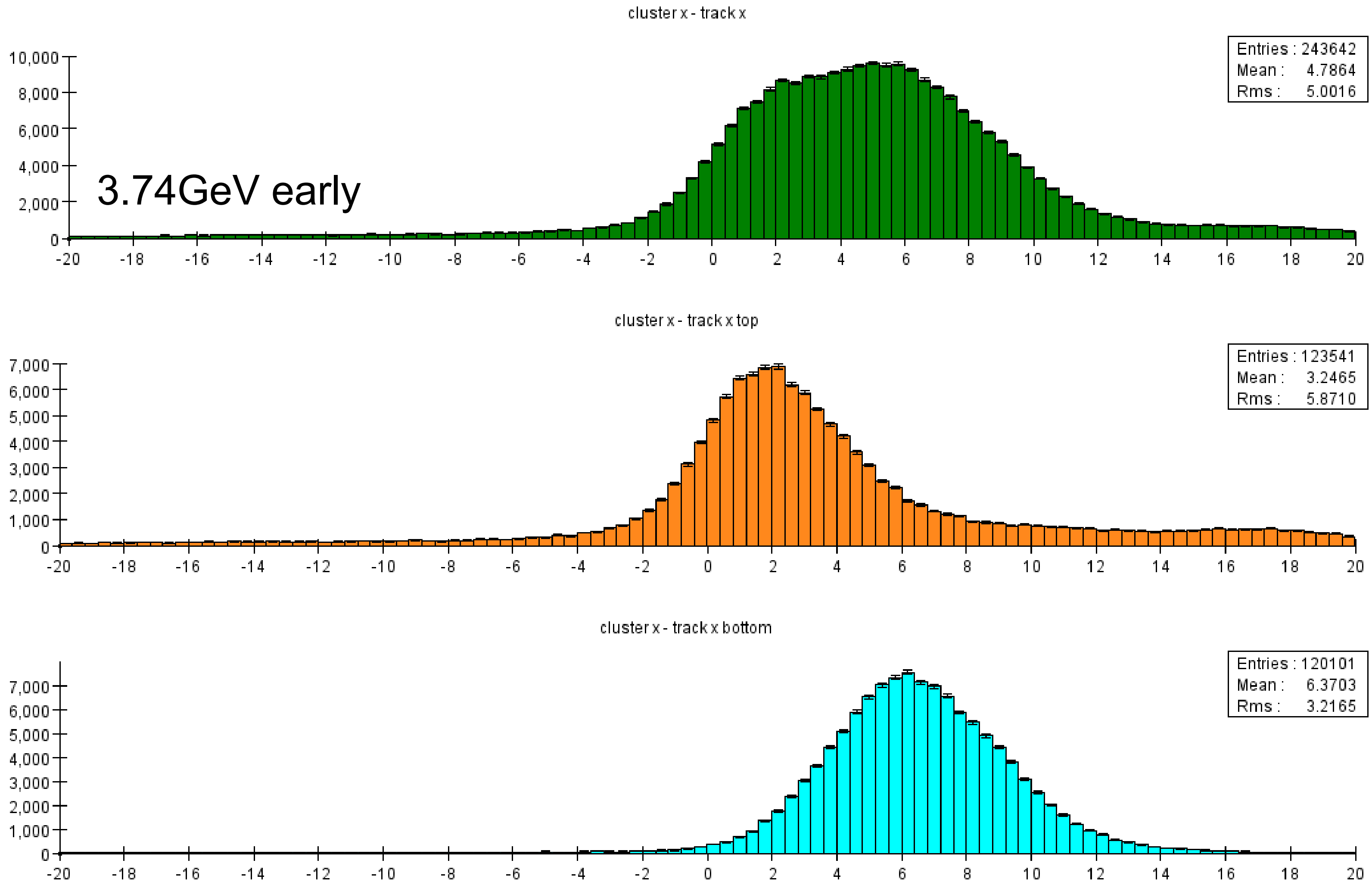
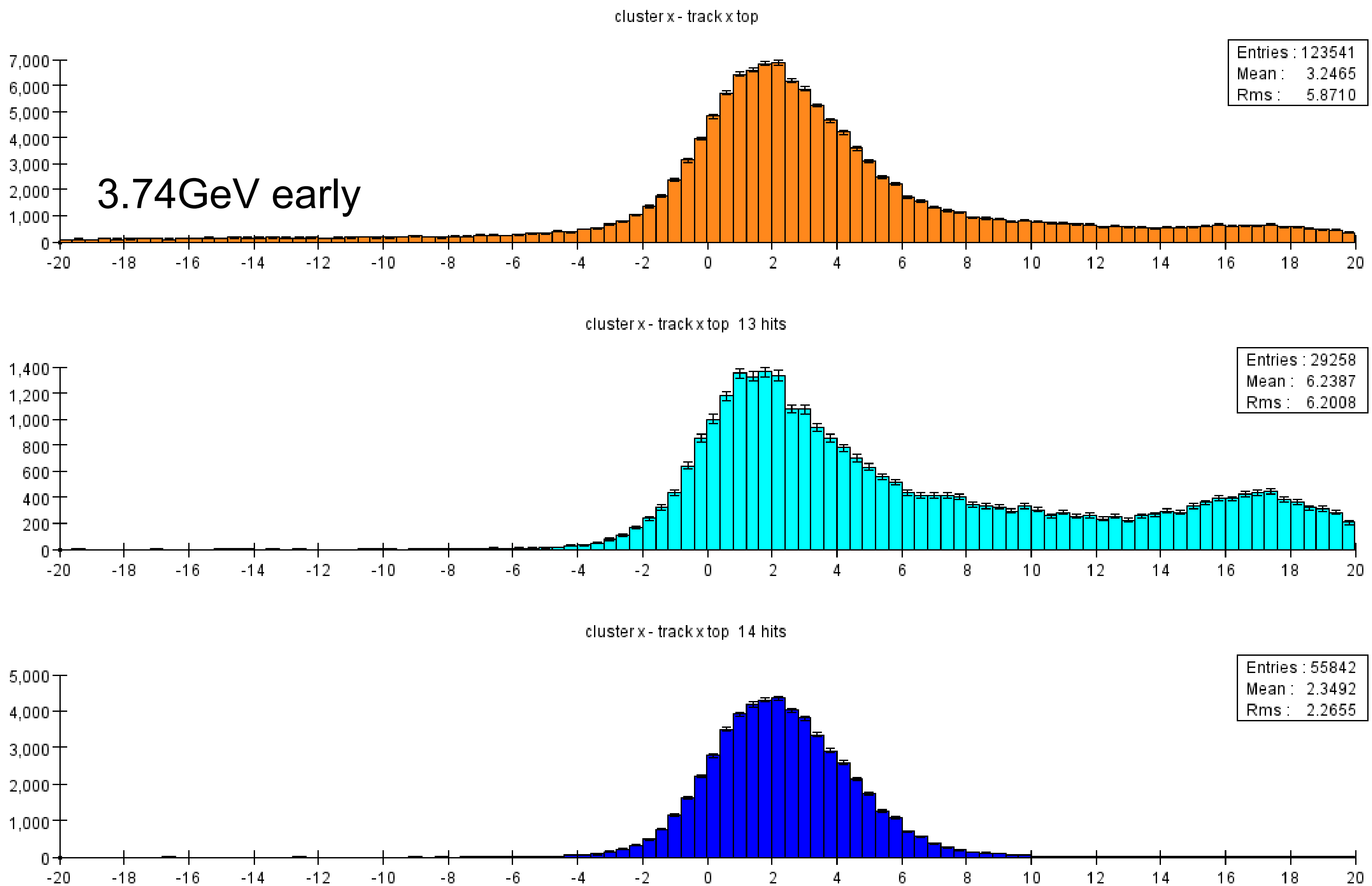


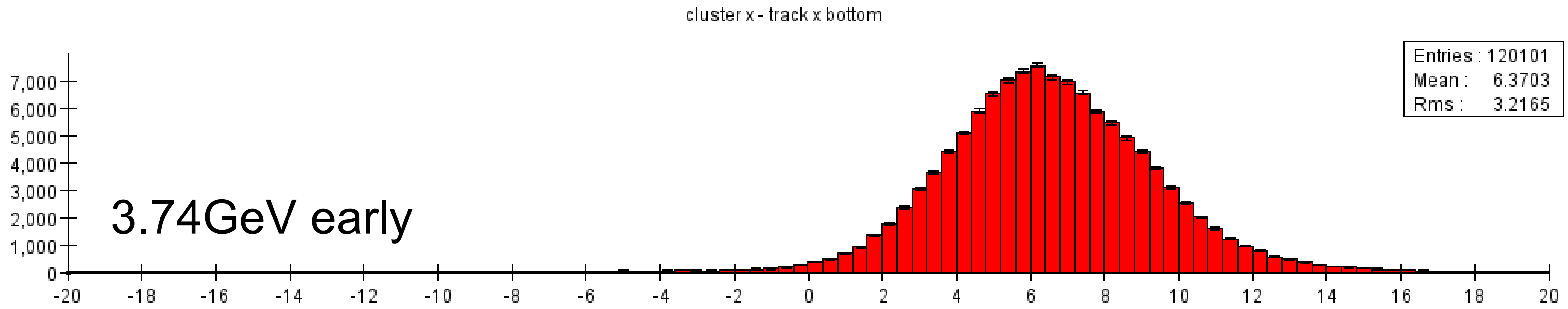
# 2021 FEE Cluster X – Track X

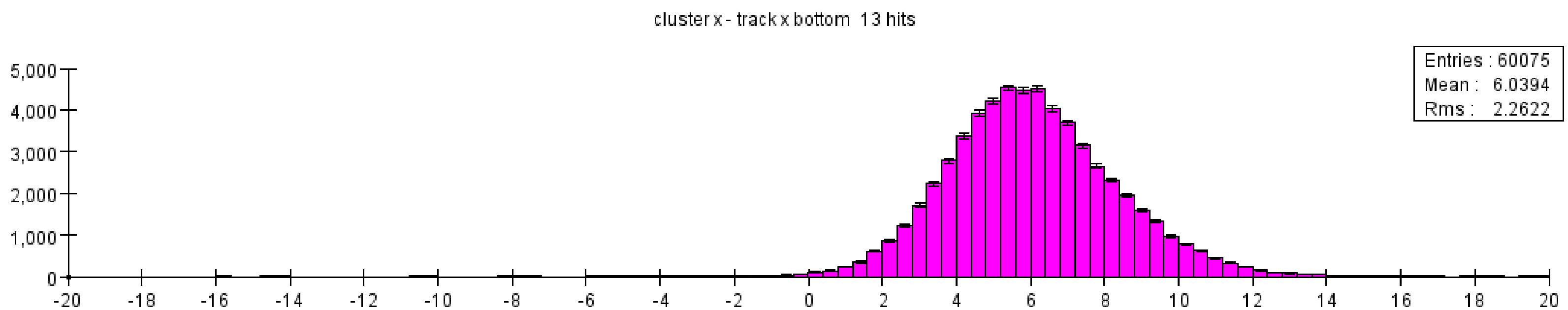


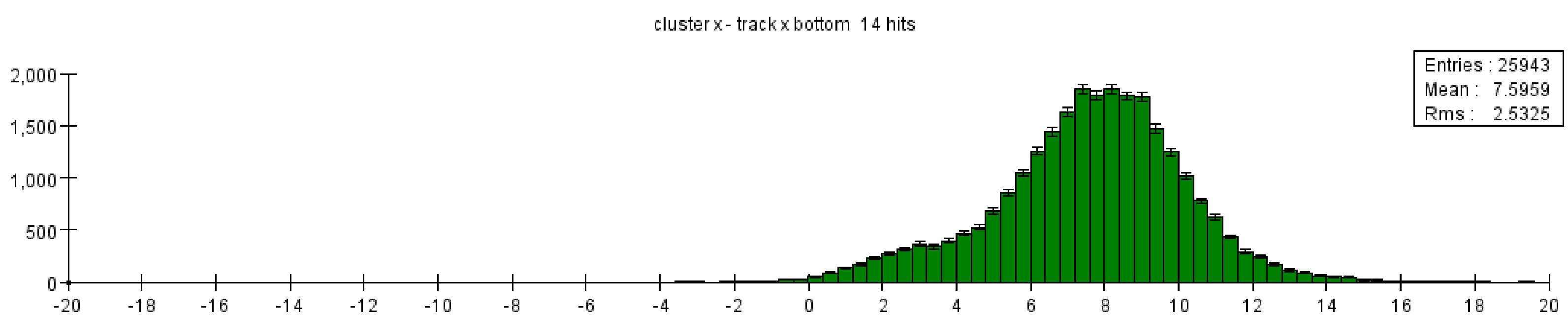
# 2021 FEE Cluster X – Track X top



# 2021 FEE Cluster X – Track X bottom

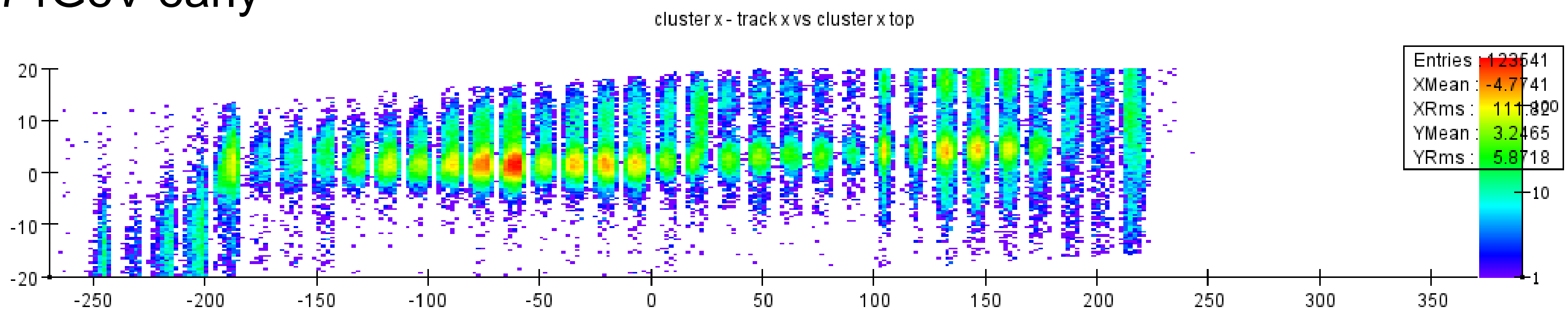


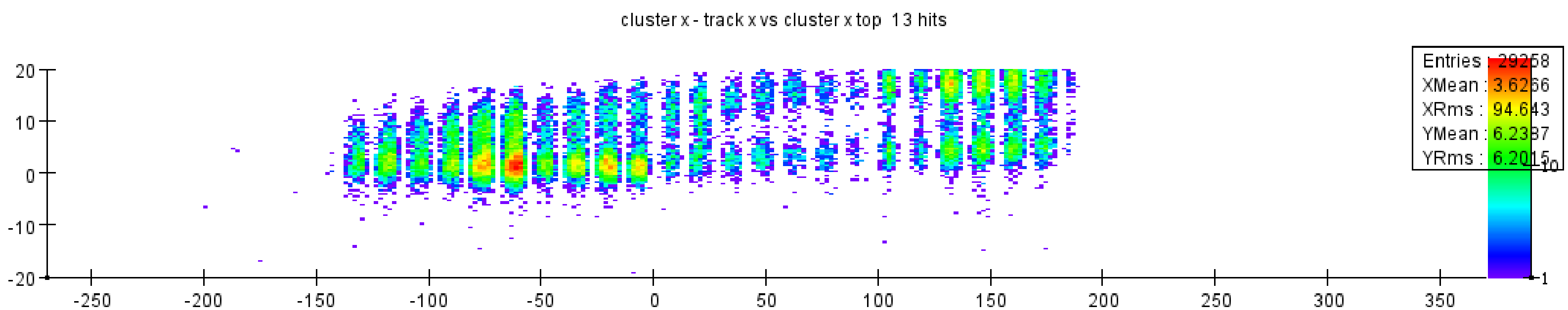



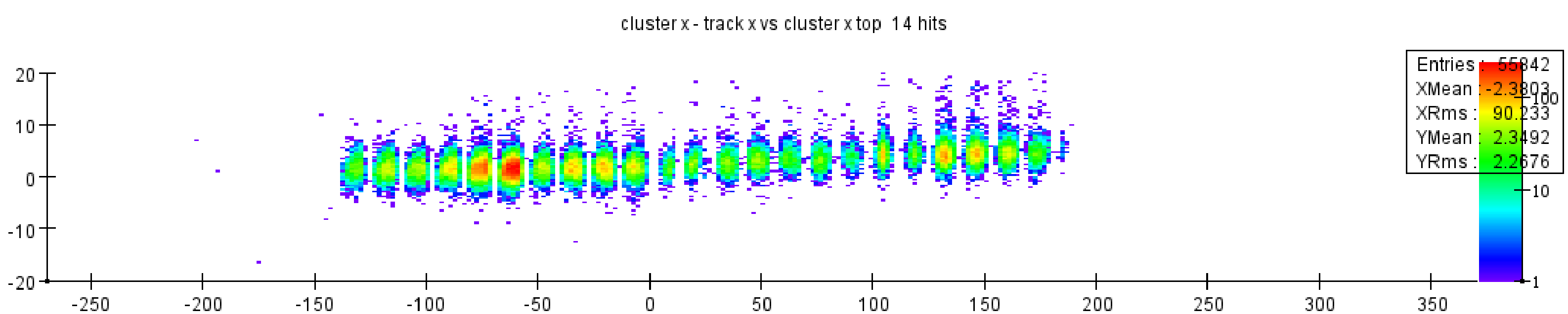



# 2021 FEE Cluster X – Track X vs X

3.74GeV early

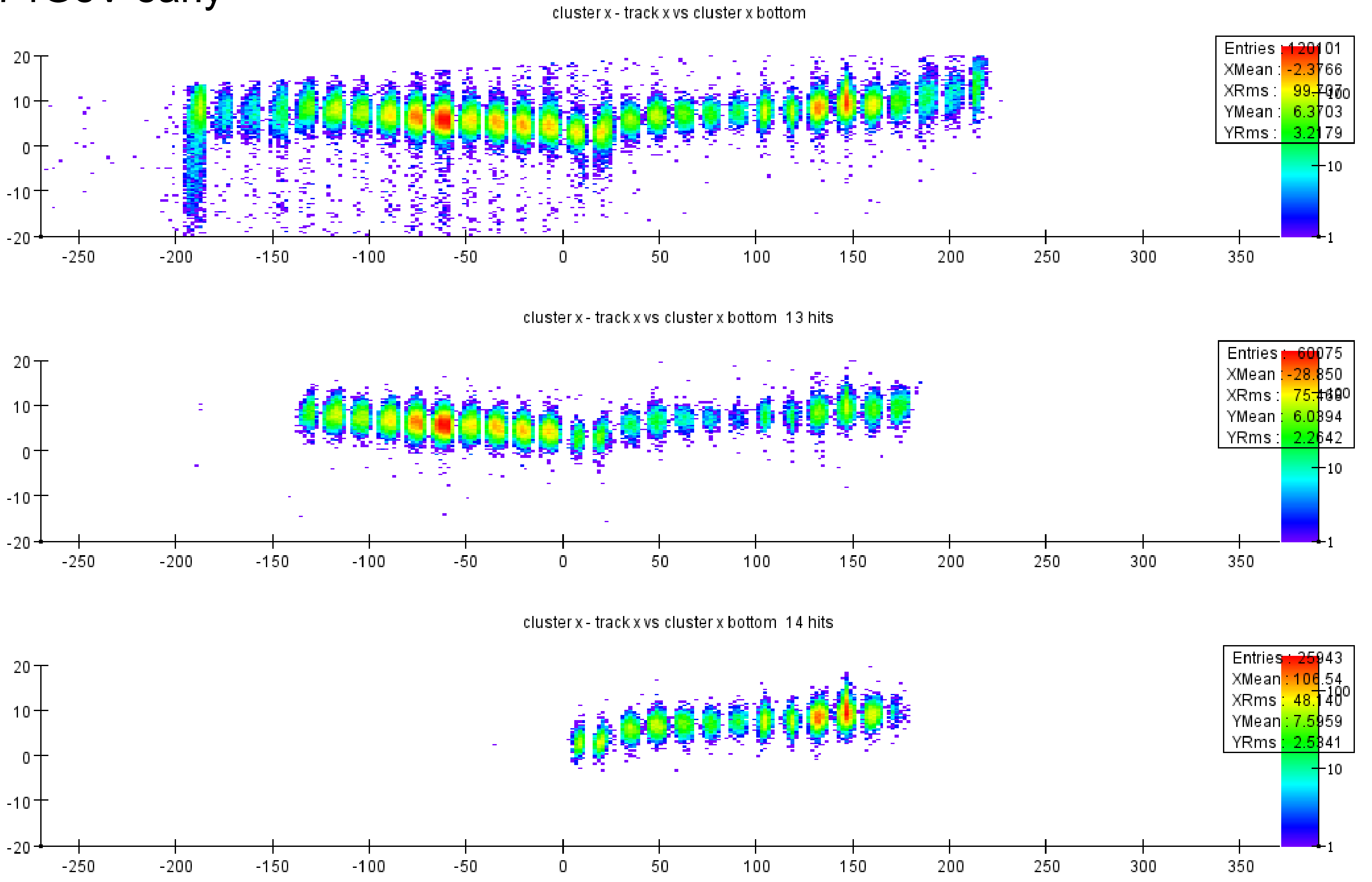


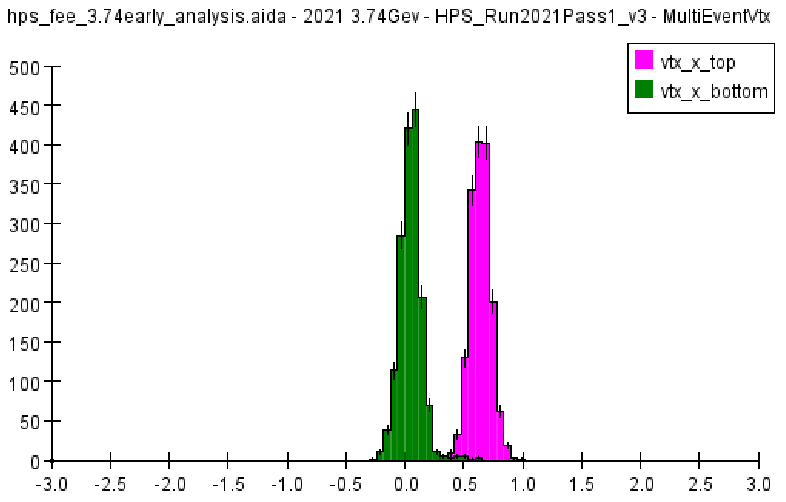
# 2021 FEE Cluster X – Track X vs X

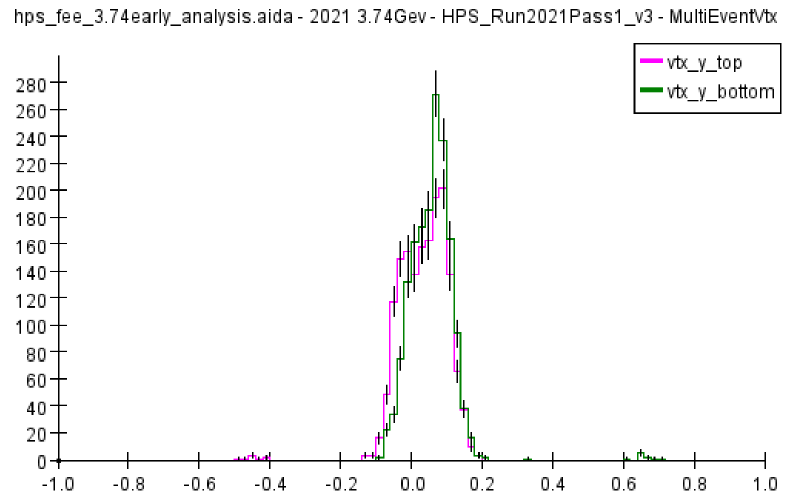
3.74GeV early

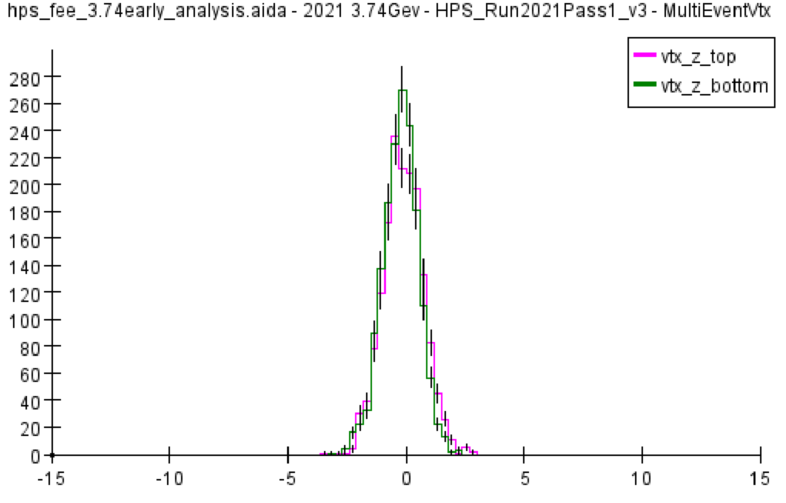


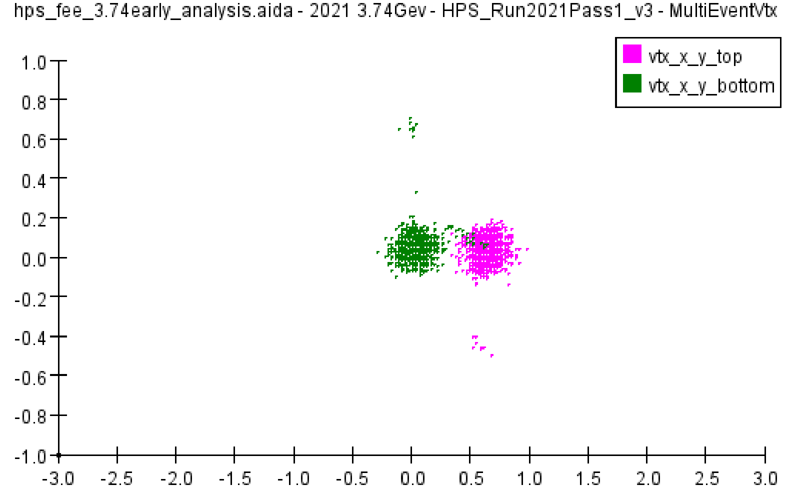
# 2021 FEE MultiVertex

3.74GeV early

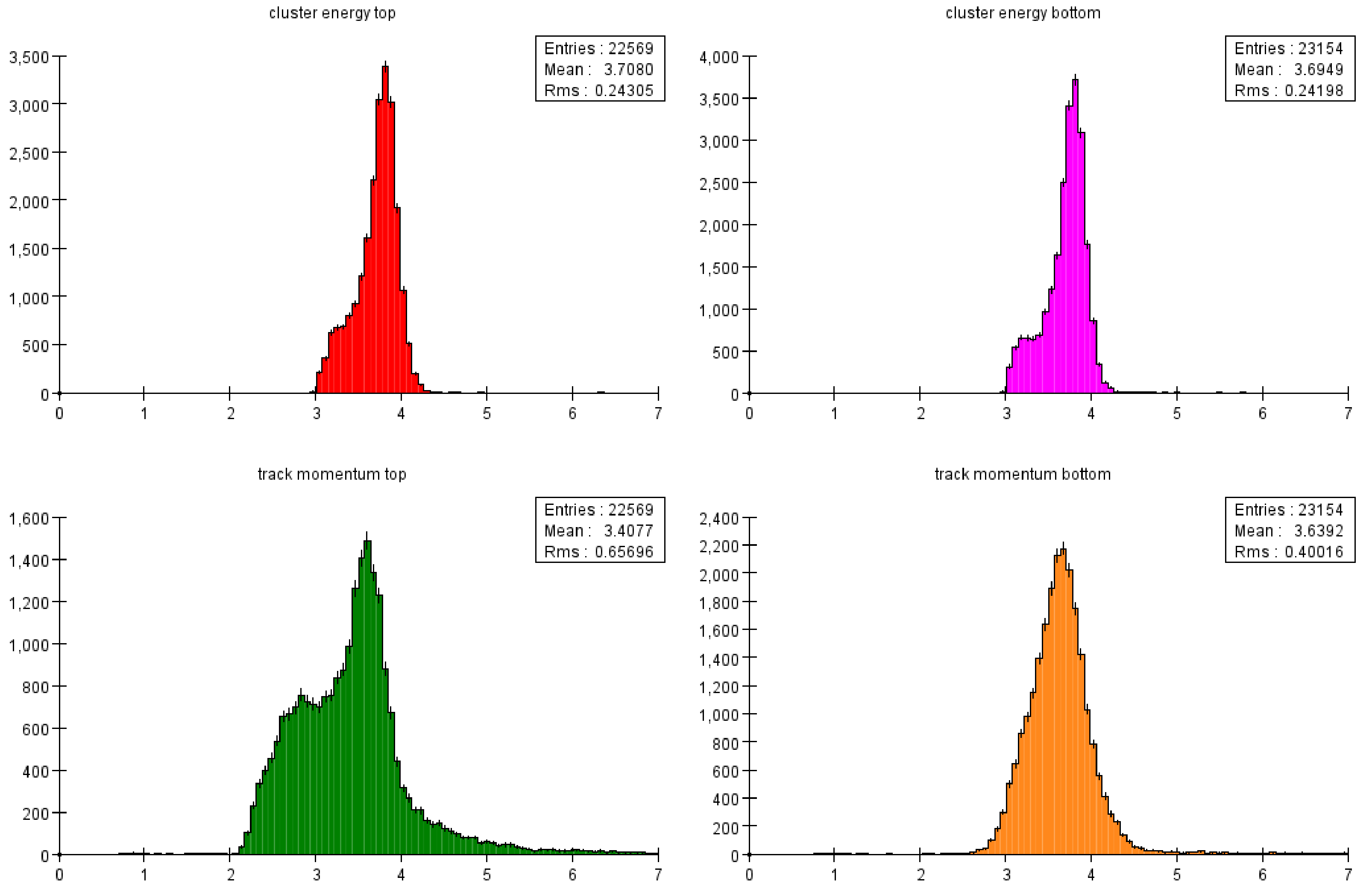


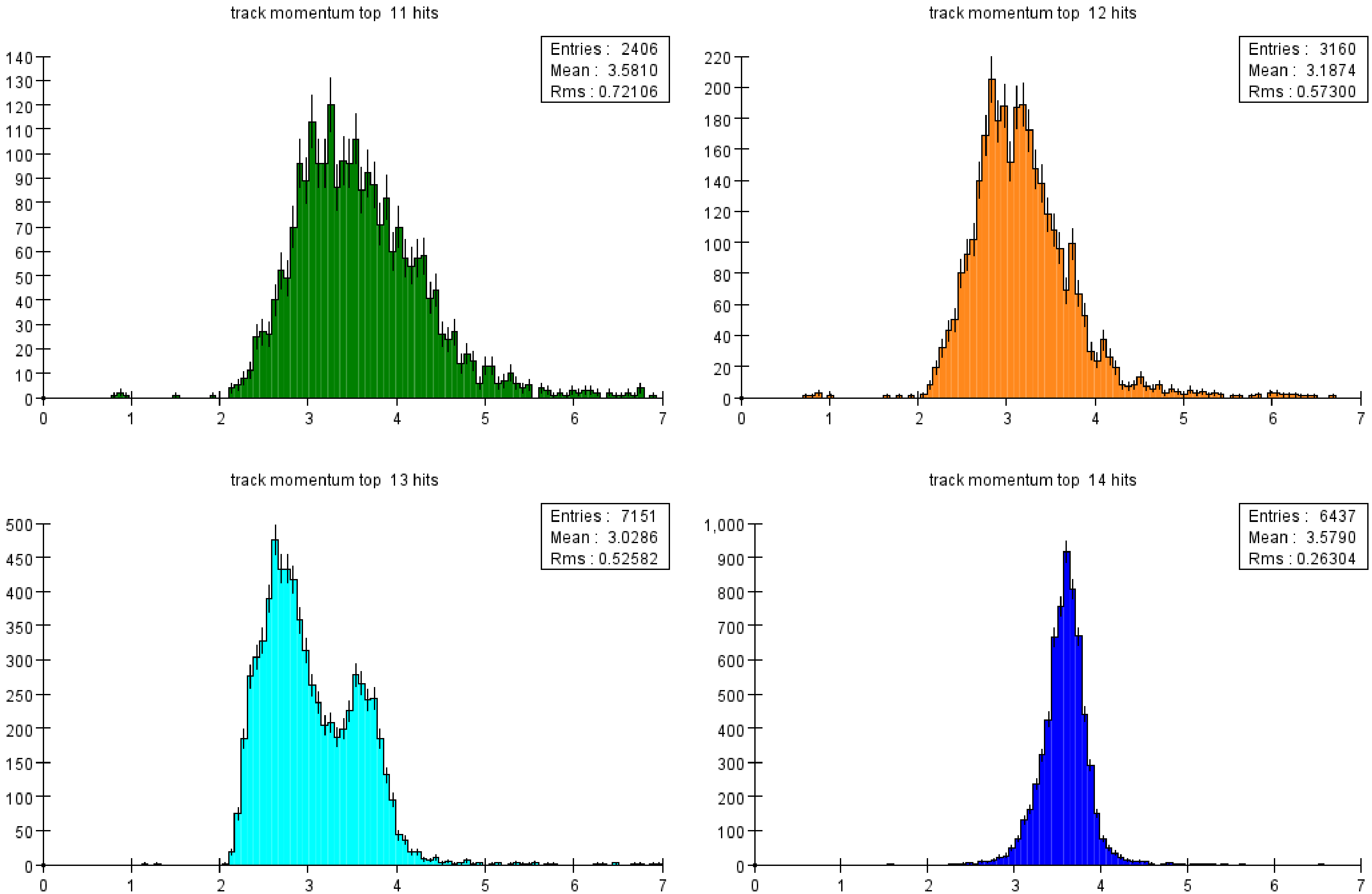



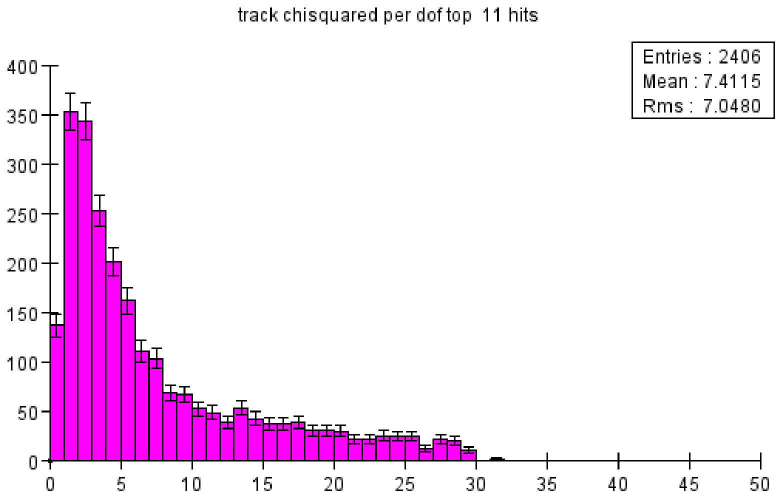
# 2021 3.74GeV late FEE Analysis

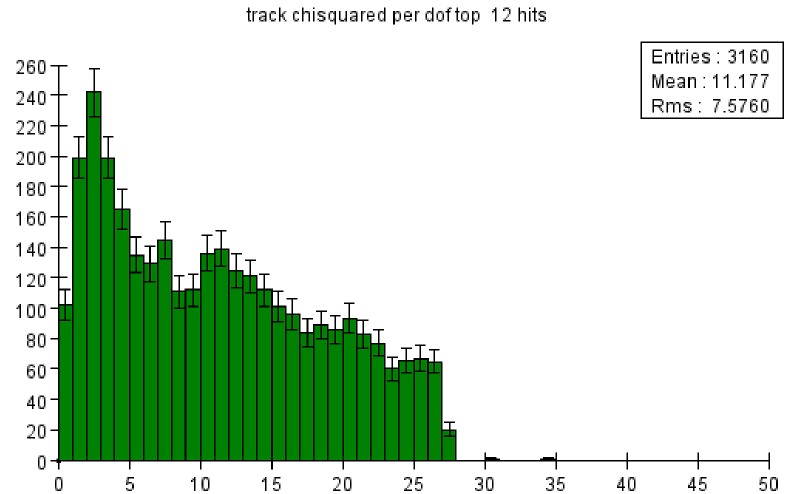


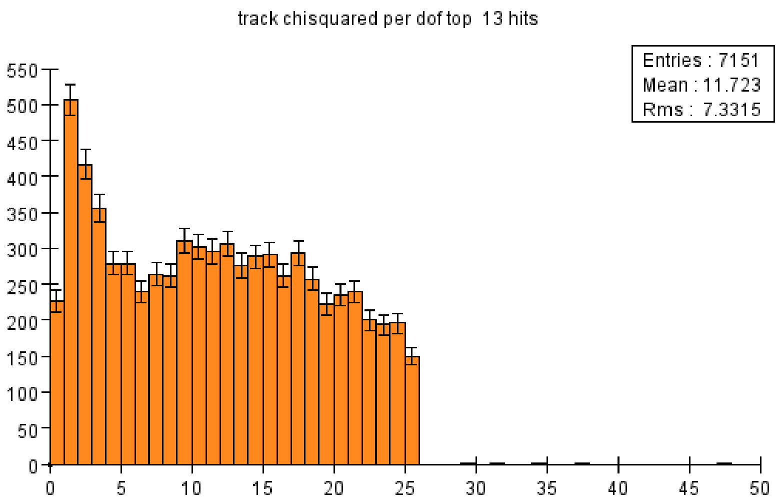
# 2021 3.74GeV late Top Momentum

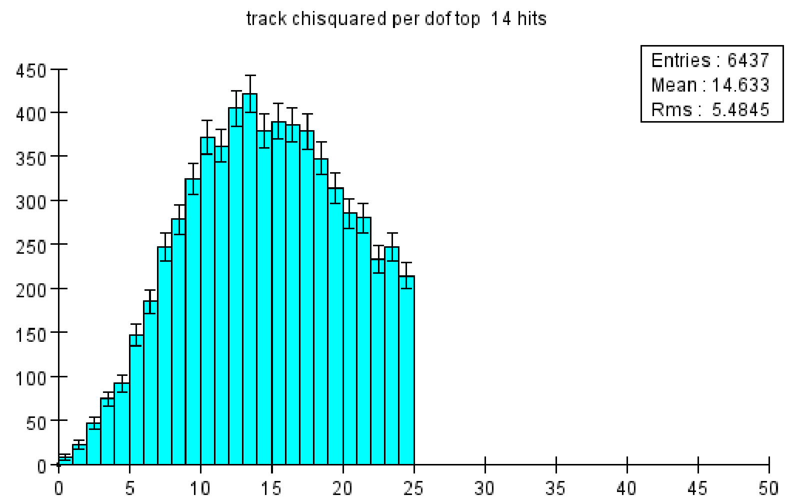


# 2021 3.74 late GeV Track Chi-squared



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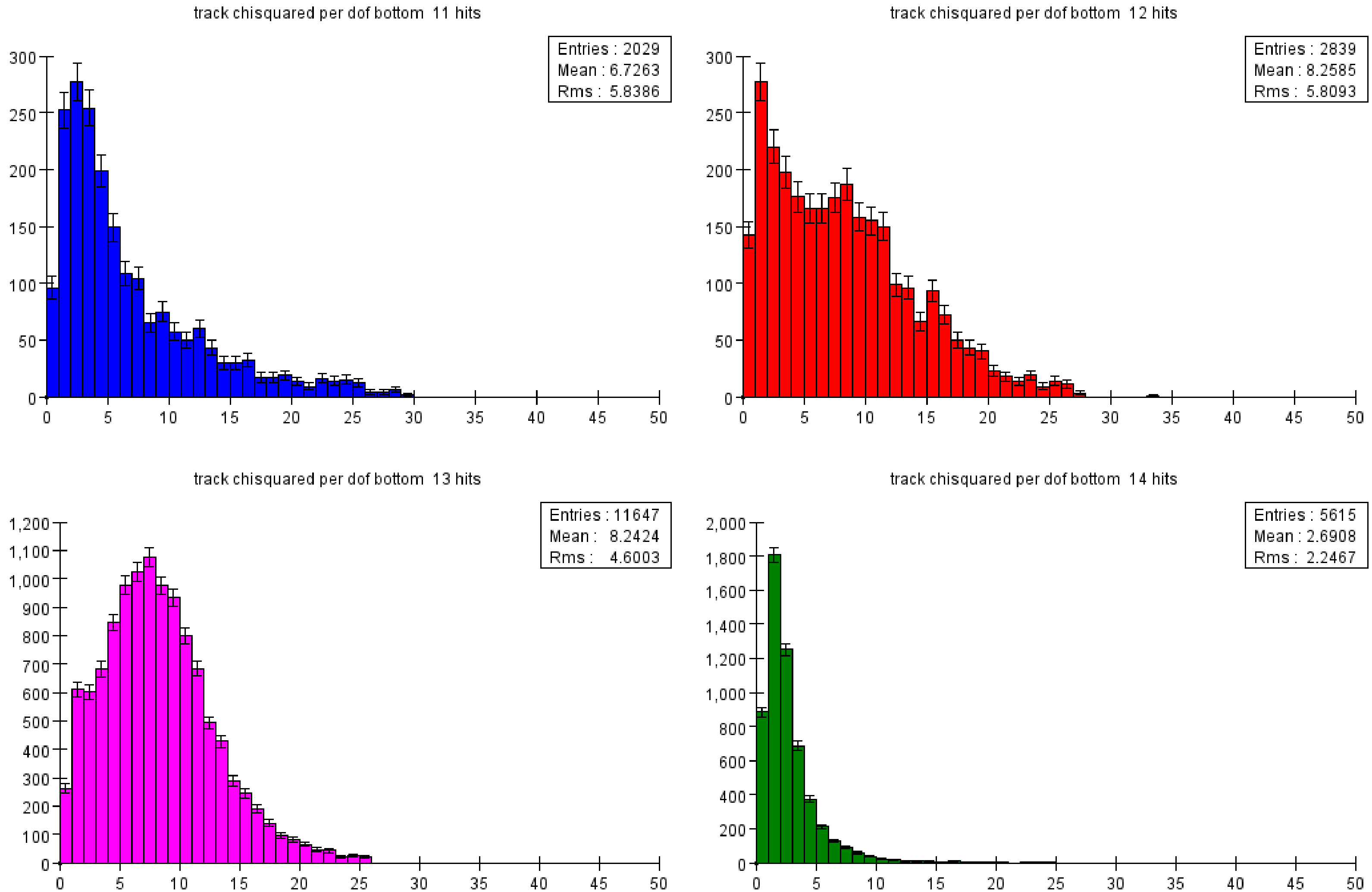
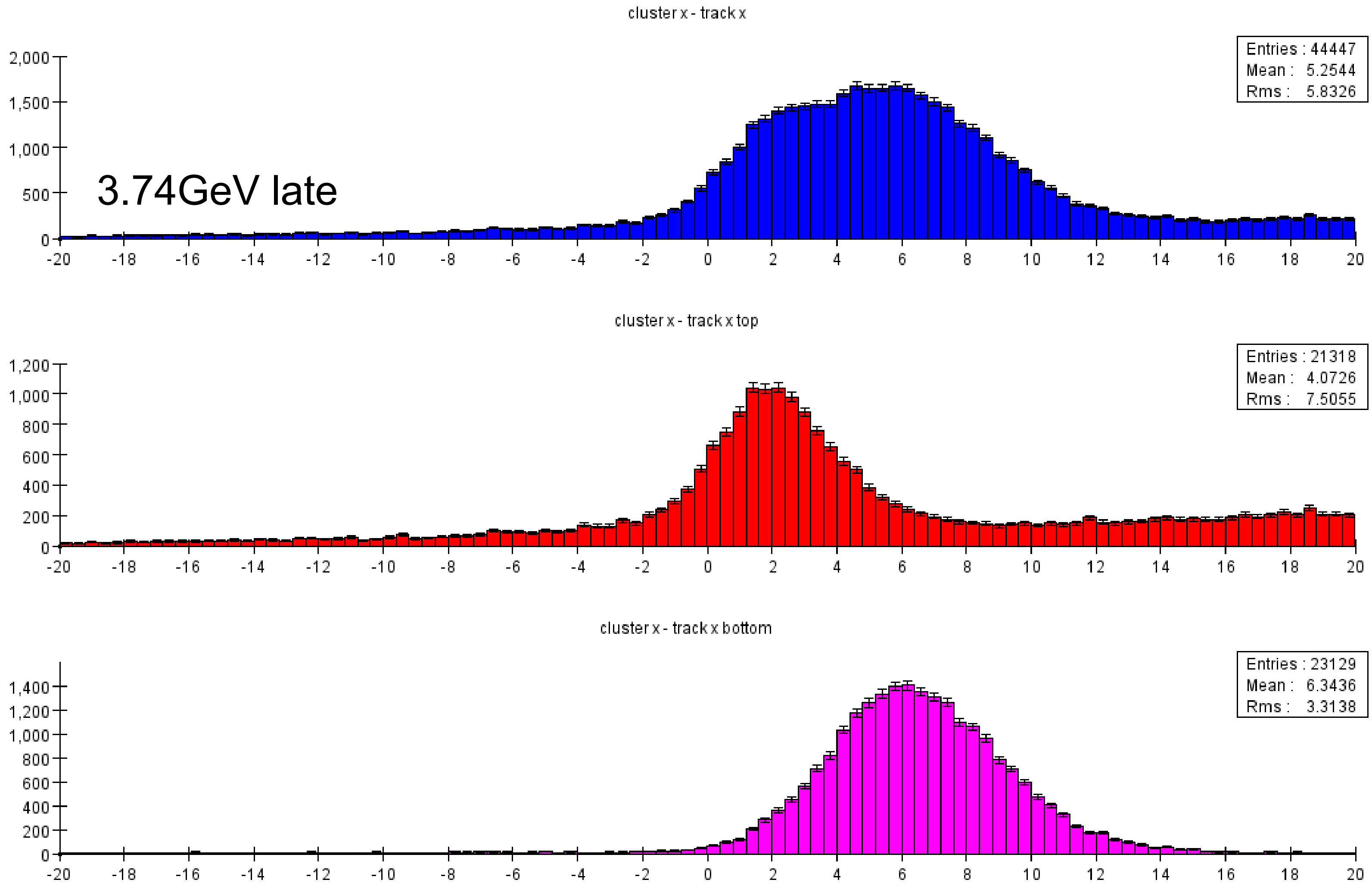
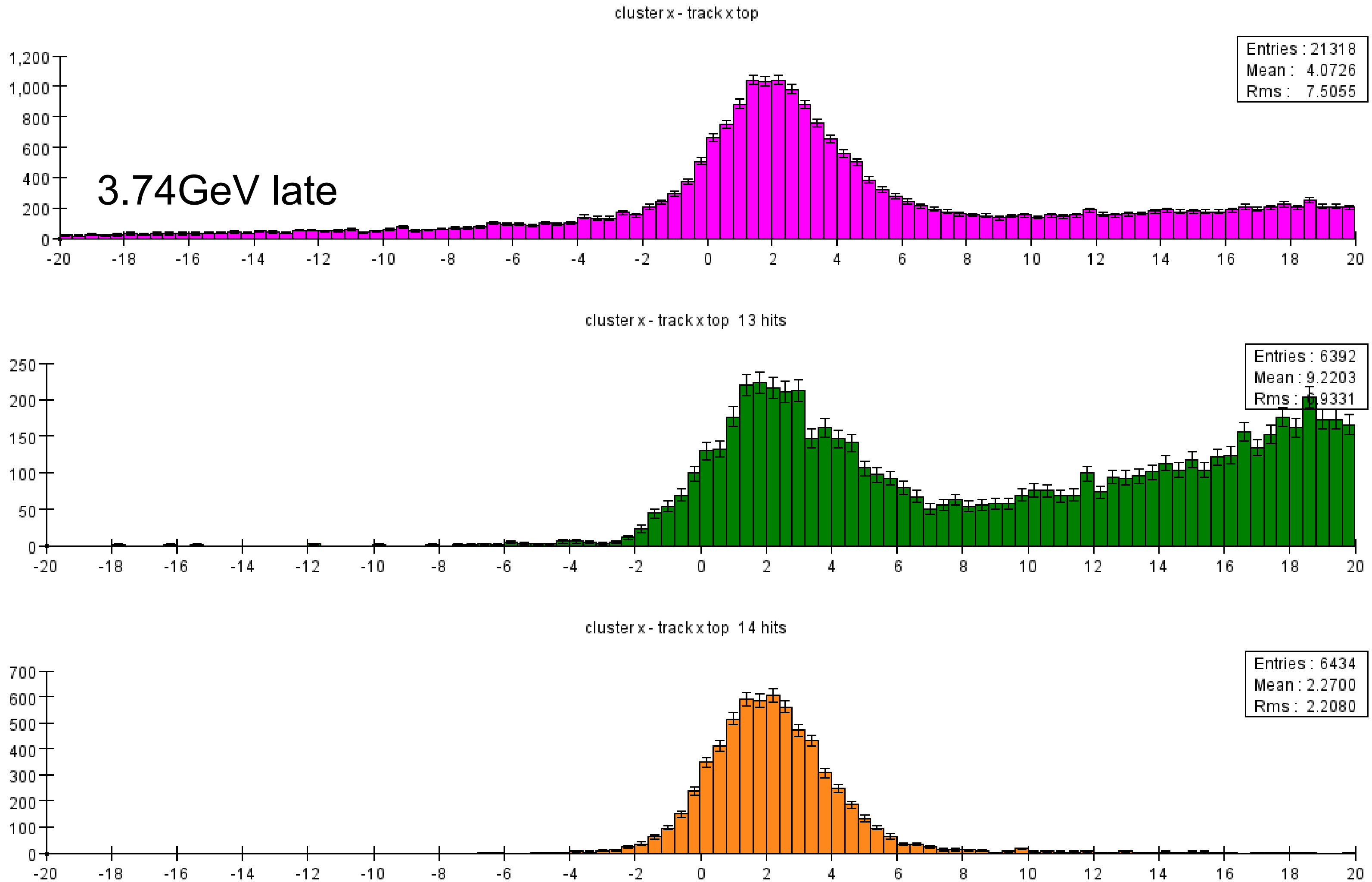


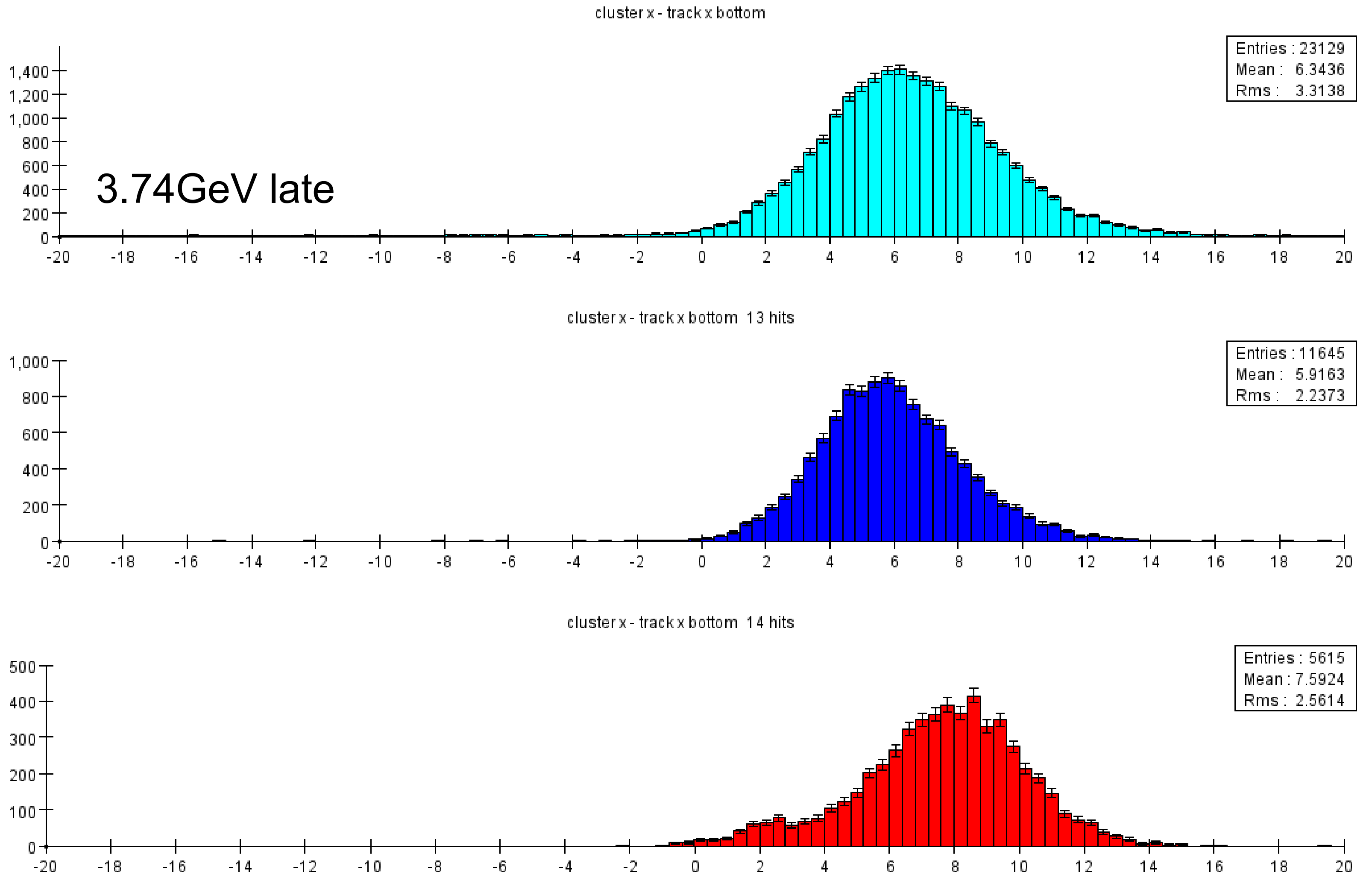
# 2021 FEE Cluster X – Track X



# 2021 FEE Cluster X – Track X top

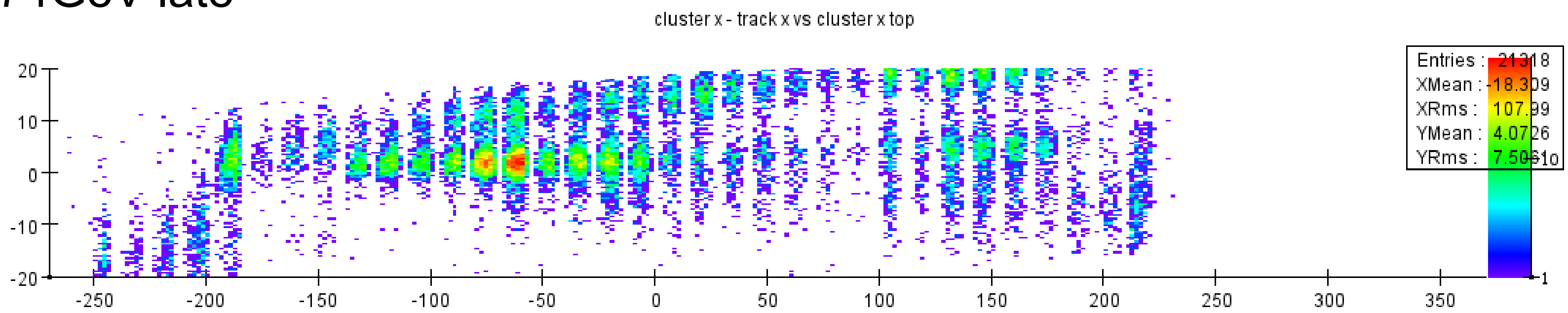


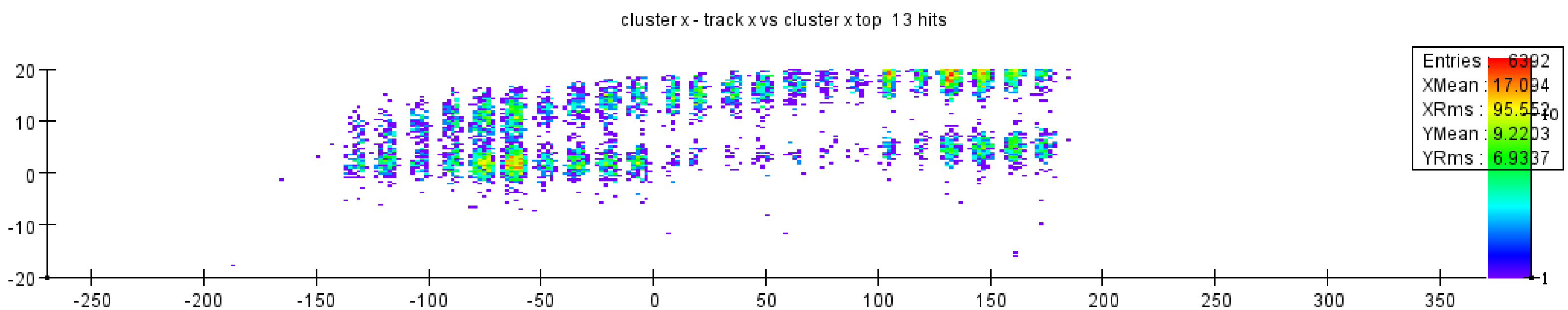
# 2021 FEE Cluster X – Track X bottom

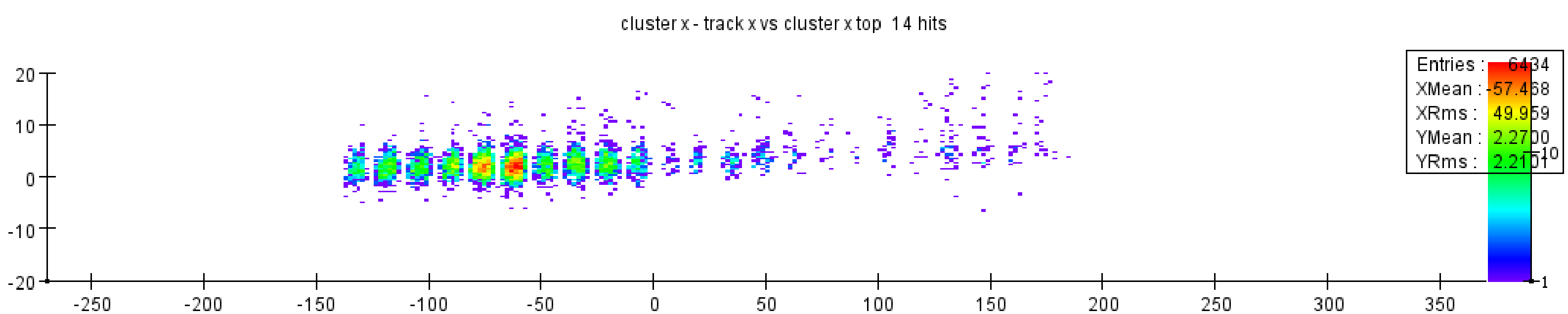


# 2021 FEE Cluster X – Track X vs X

3.74GeV late

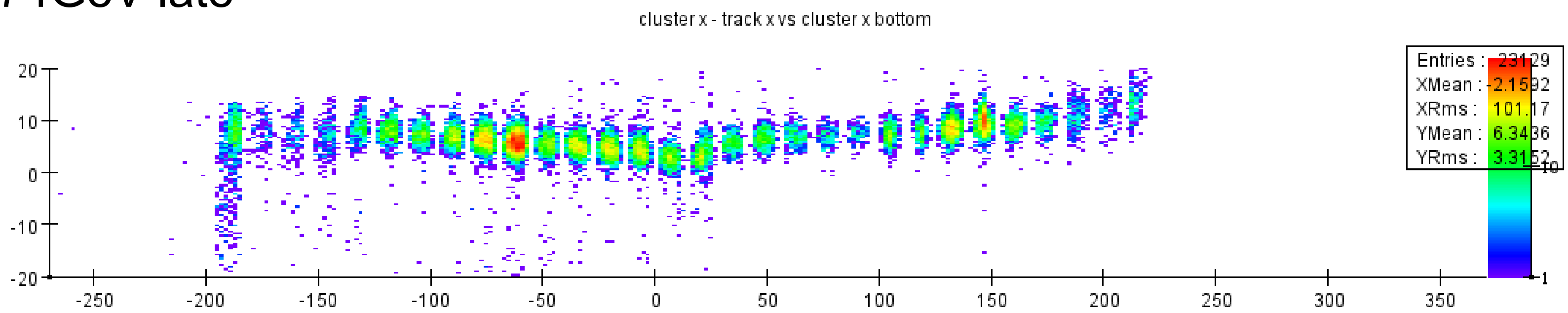


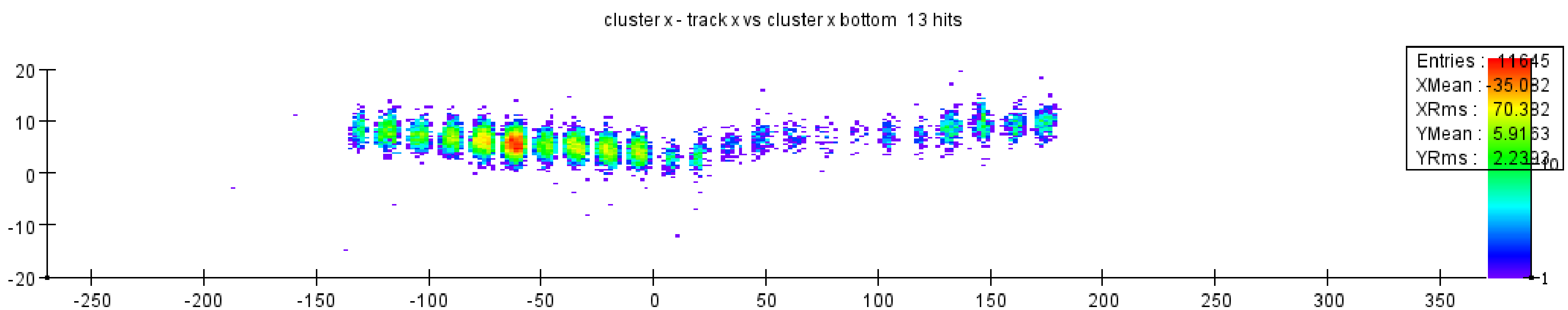



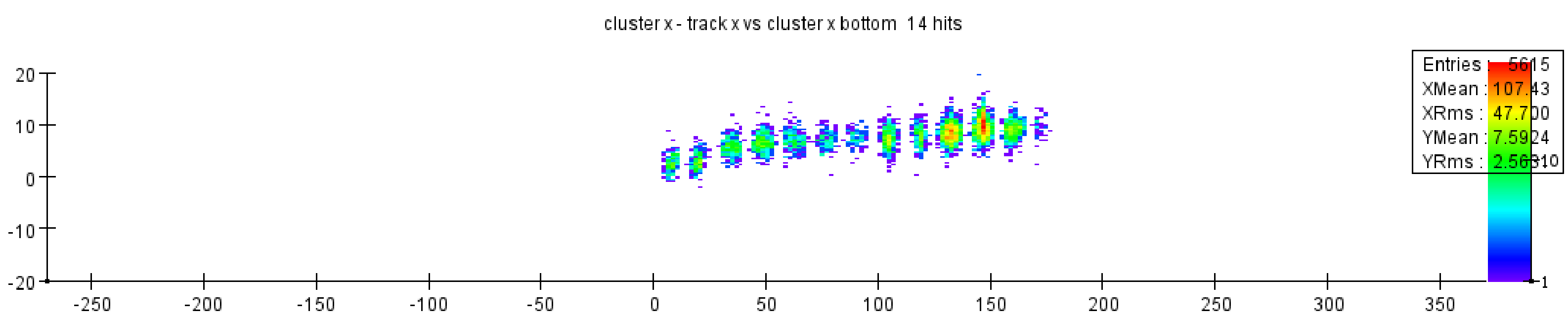



# 2021 FEE Cluster X – Track X vs X

3.74GeV late

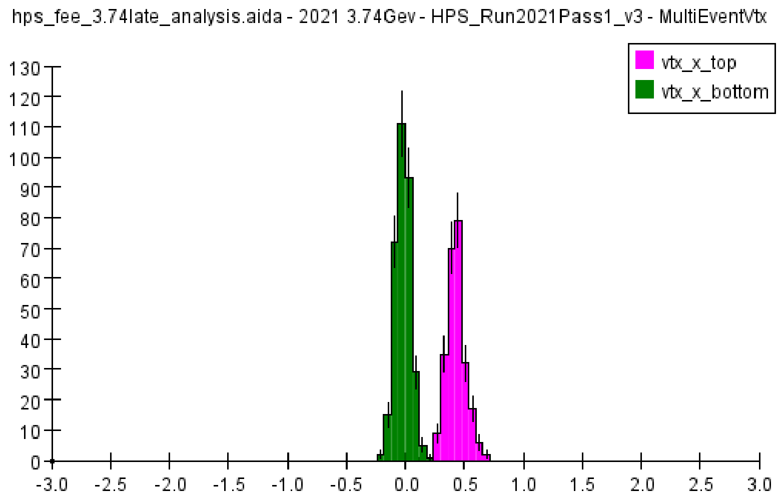


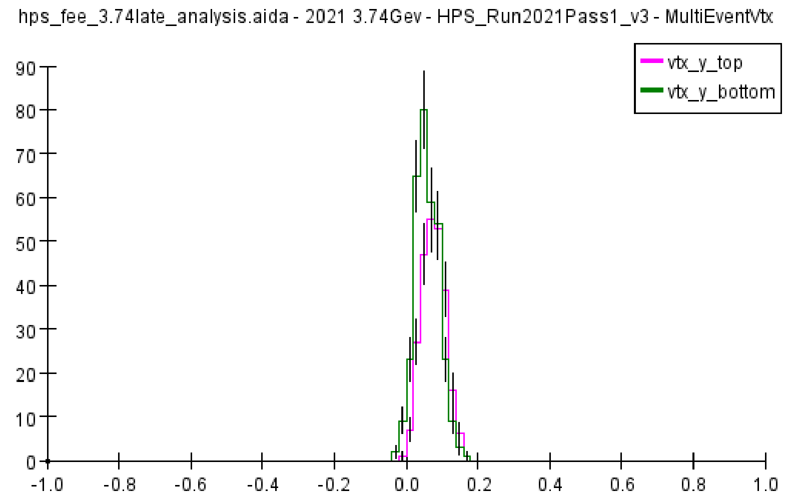



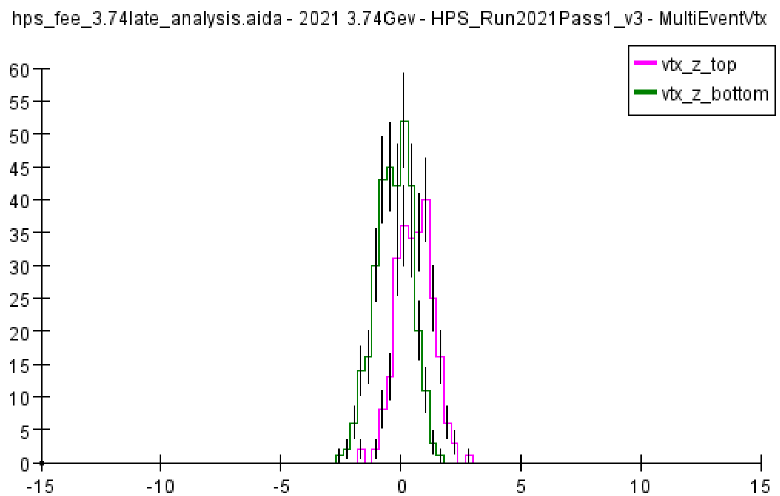



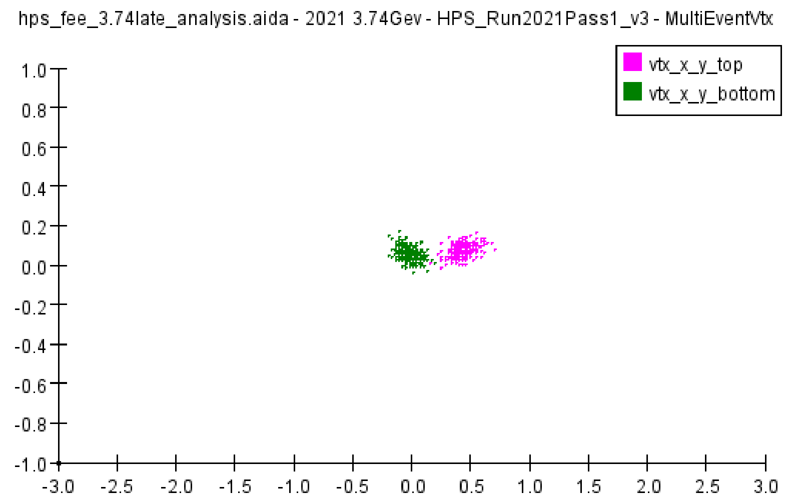
# 2021 FEE MultiVertex

3.74GeV late



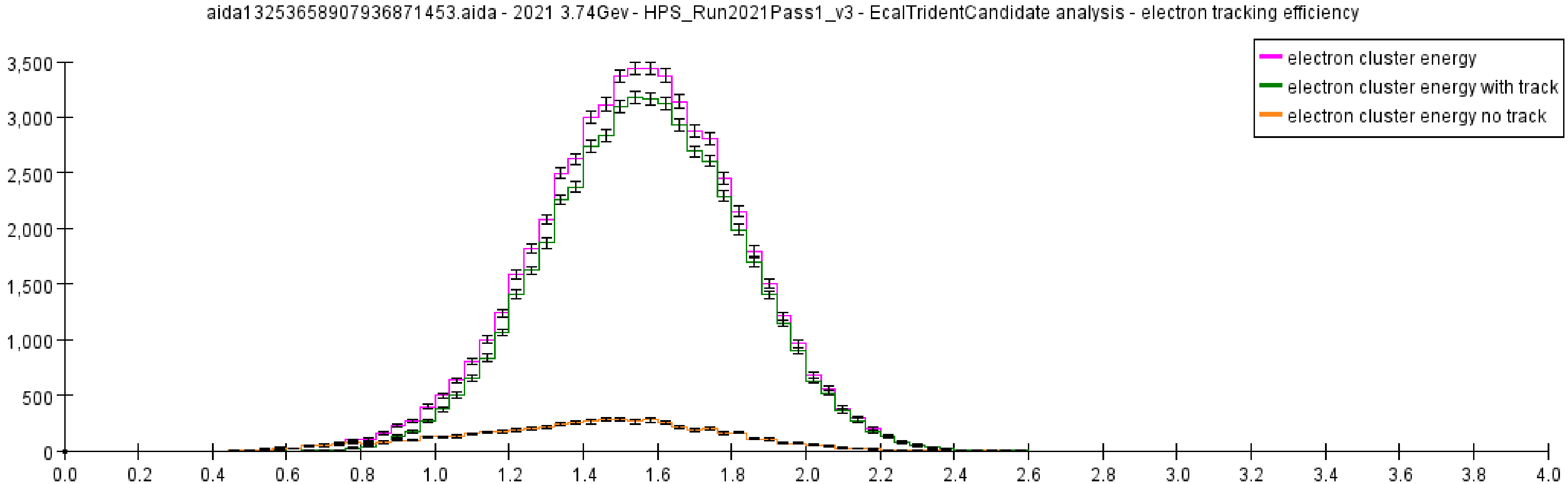



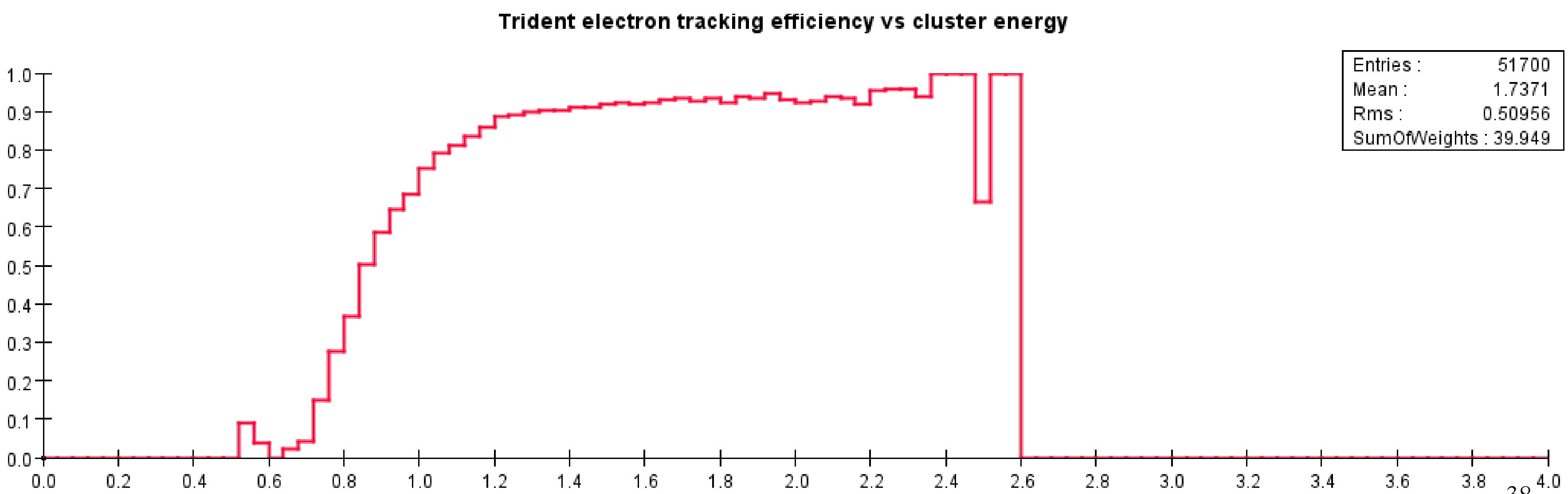



# Trident Tracking Efficiency

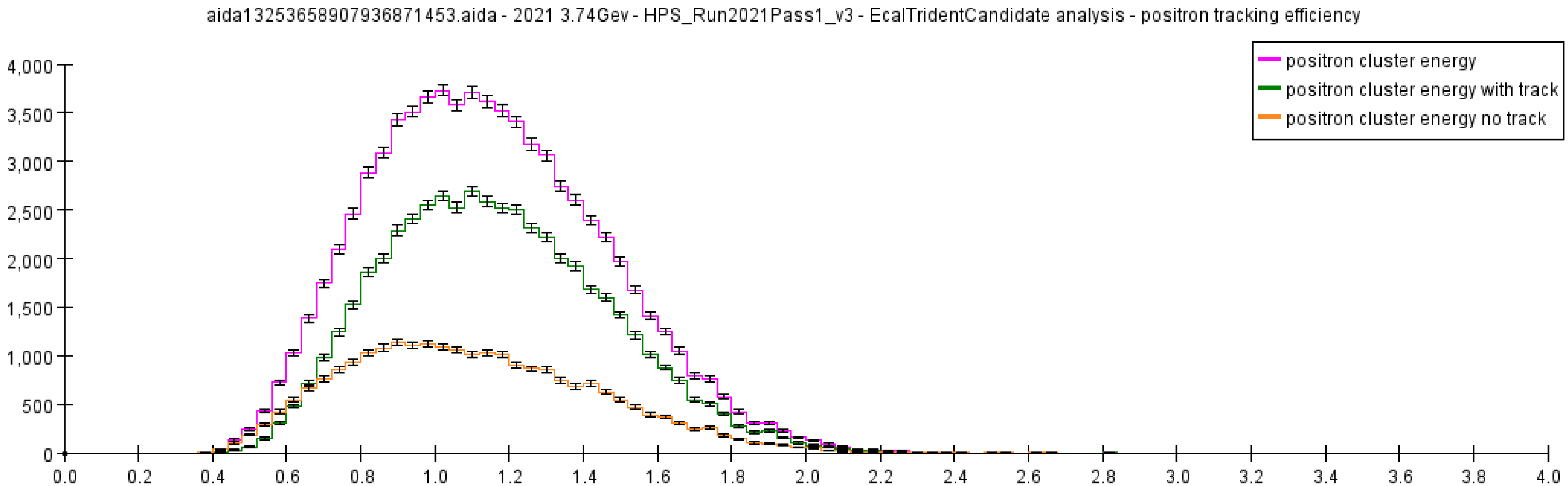
- Standard trident calorimeter-only event selection
- “positron” is cluster x > 100
- “electron” is cluster x <0
- Require one “positron”, one “electron” in opposite half, and one other “electron” called here “recoil”
  - If both “electrons” in the same half, higher energy cluster is called “electron,” lower one is “recoil”
- Require two clusters to have correct sign tracks associated to them, then probe the third cluster to check whether or not a track was found.
- Essentially no quality requirements on the track
- Mixed both top and bottom

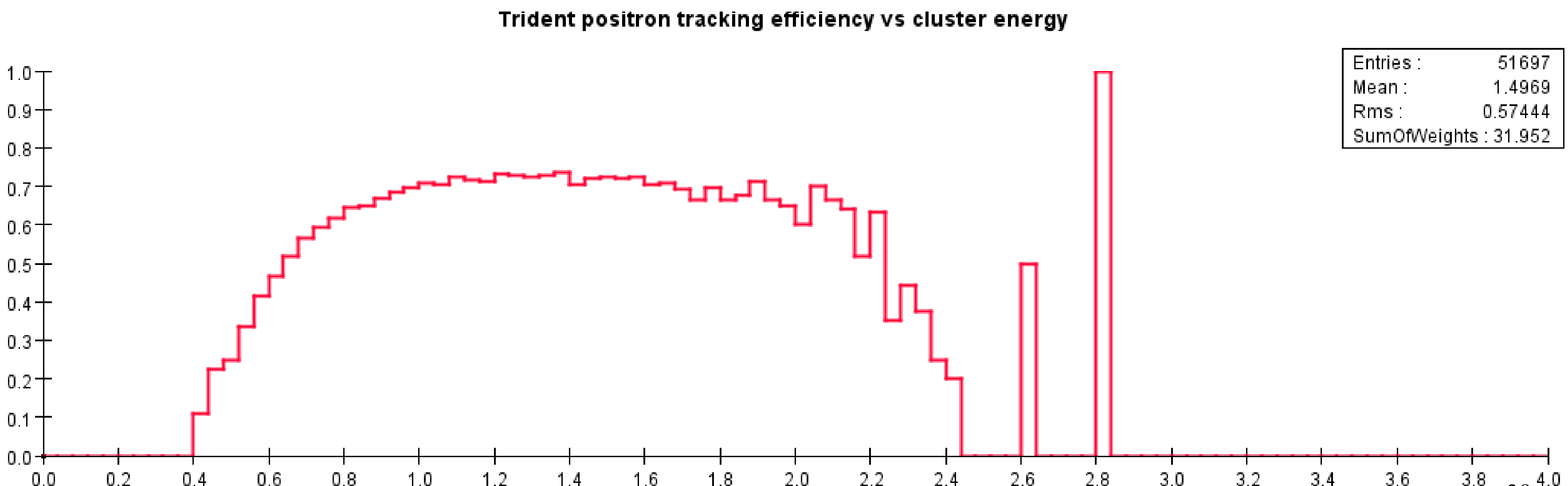
# Trident Electron Efficiency by Energy



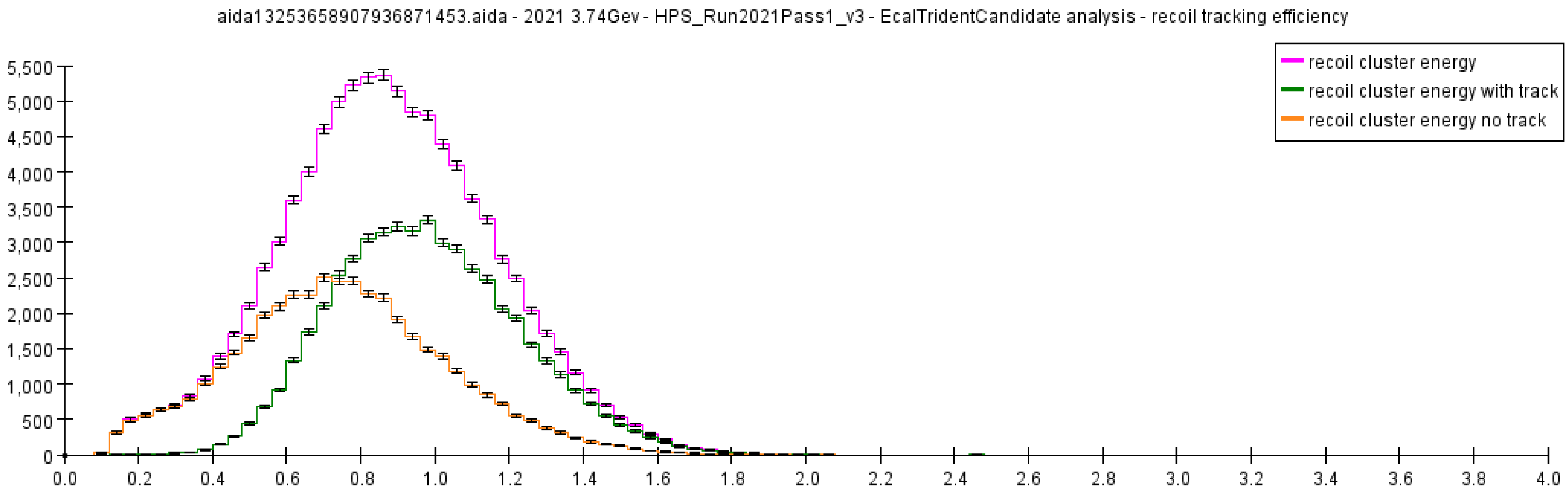



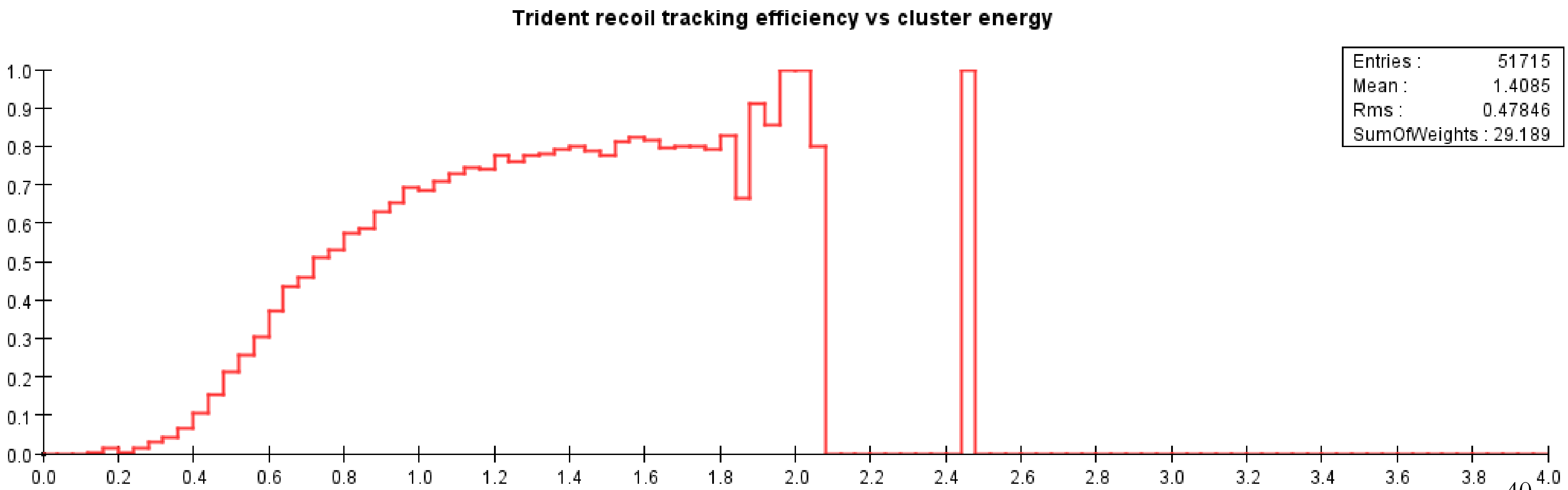
# Trident Positron Efficiency by Energy



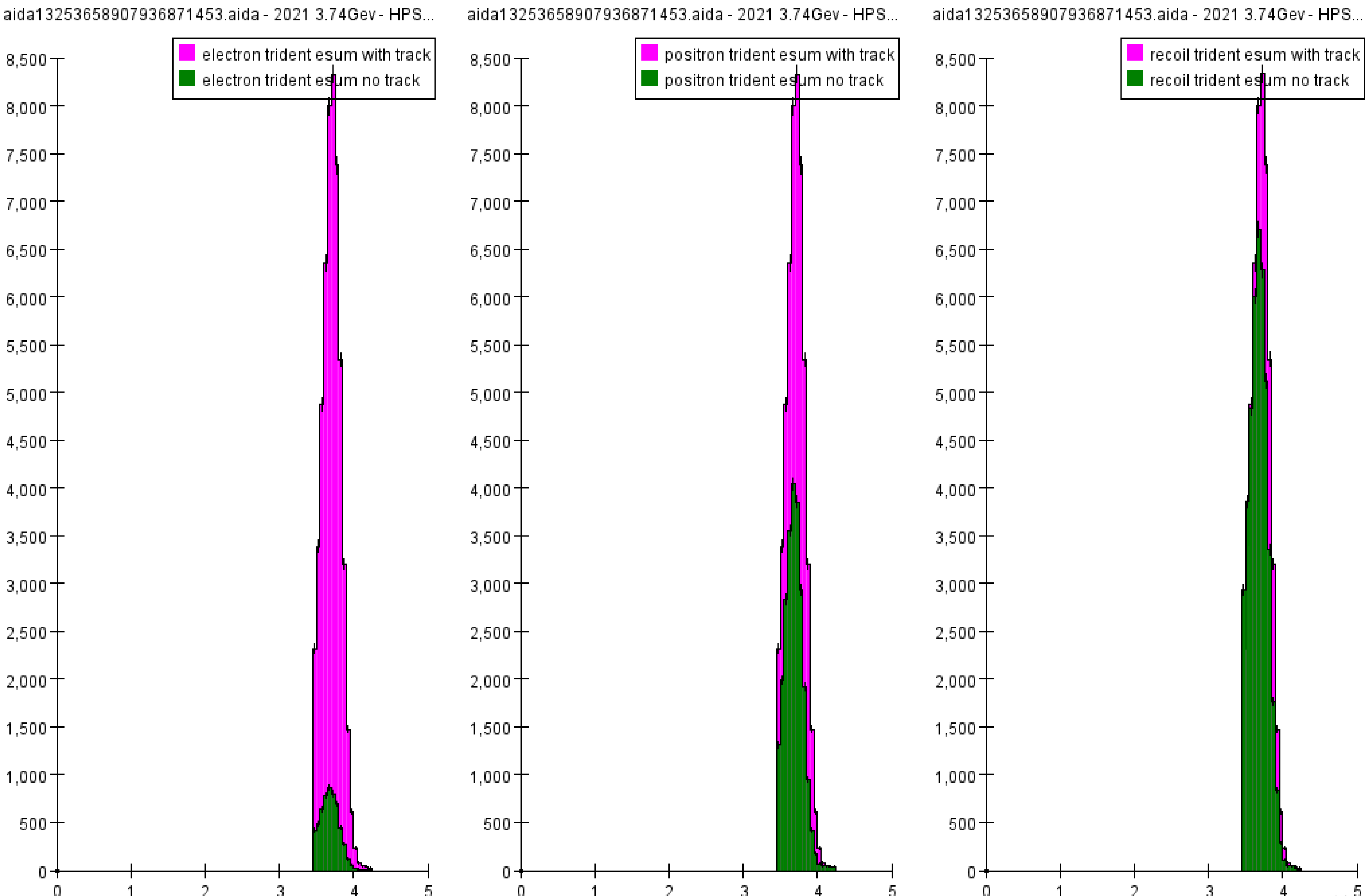



# Trident Recoil Efficiency by Energy



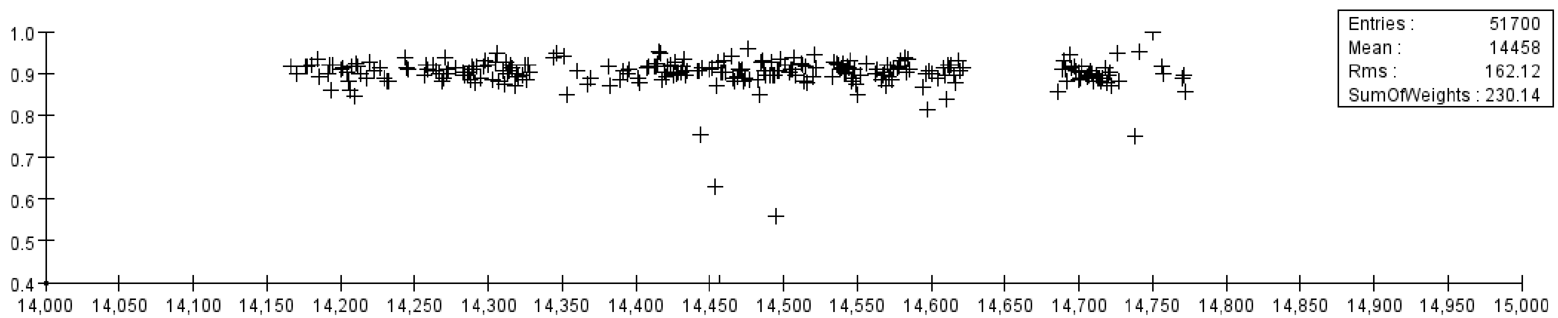



# Trident Esum with & without track

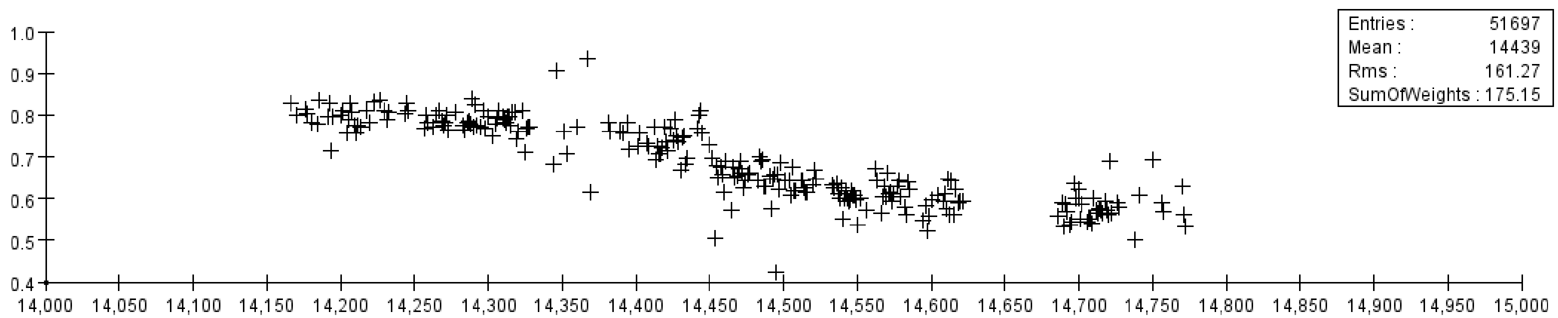


# Trident Tracking Efficiency by Run

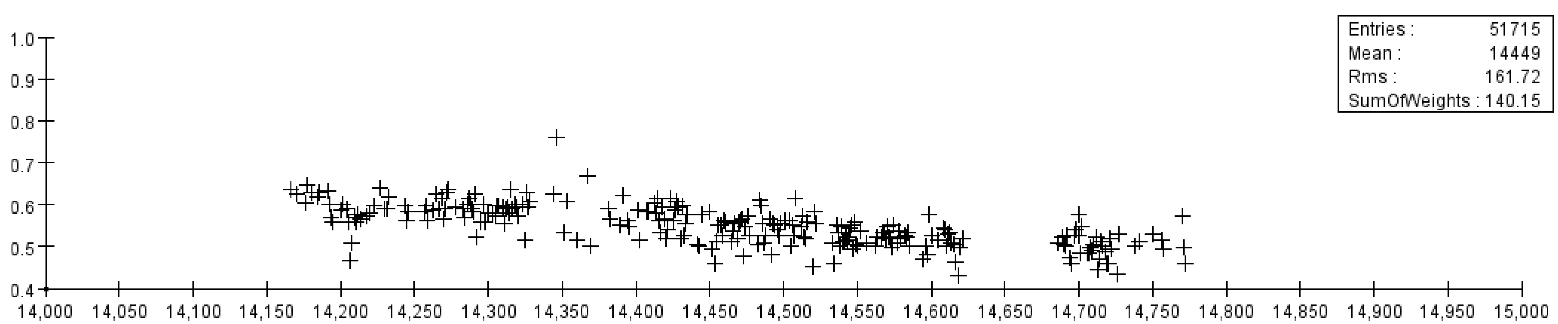
Trident electron track efficiency vs run number




Trident positron track efficiency vs run number




Trident recoil track efficiency vs run number



# Trident Tracking Efficiency by Run

- Electron efficiency is uniformly high (~90%) during the whole of the 2021 run
- Positron efficiency is roughly stable at ~80% at the beginning (<1435) of the run, falls to roughly ~60% by 14700, then remains ~stable
- Recoil electron efficiency follows a similar pattern, but starts at roughly ~60% and ends at roughly ~50% during the run

# Track-Finding Efficiencies

- Machinery exists to determine track-finding efficiencies from the data.
- These plots are the most basic ones I could put together
- We have a long way to go to improve the overall efficiencies before worrying about details of the inefficiencies.
- The recent work by Rory on baselines appears to have led to a slight increase in the overall tracking efficiency.
- Poor track chi-squares and large dependence on number of hits indicate internal tensions in the alignment
- Bringing the track-finding efficiencies and track chi-squares to acceptable levels will require future improvements to the tracker alignment and hit-finding.
- Skims of events missing tracks can be made available to anyone wishing to investigate this in more detail