New Detector Qualification: 2019

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HPS Analysis Workshop
April 12, 2023

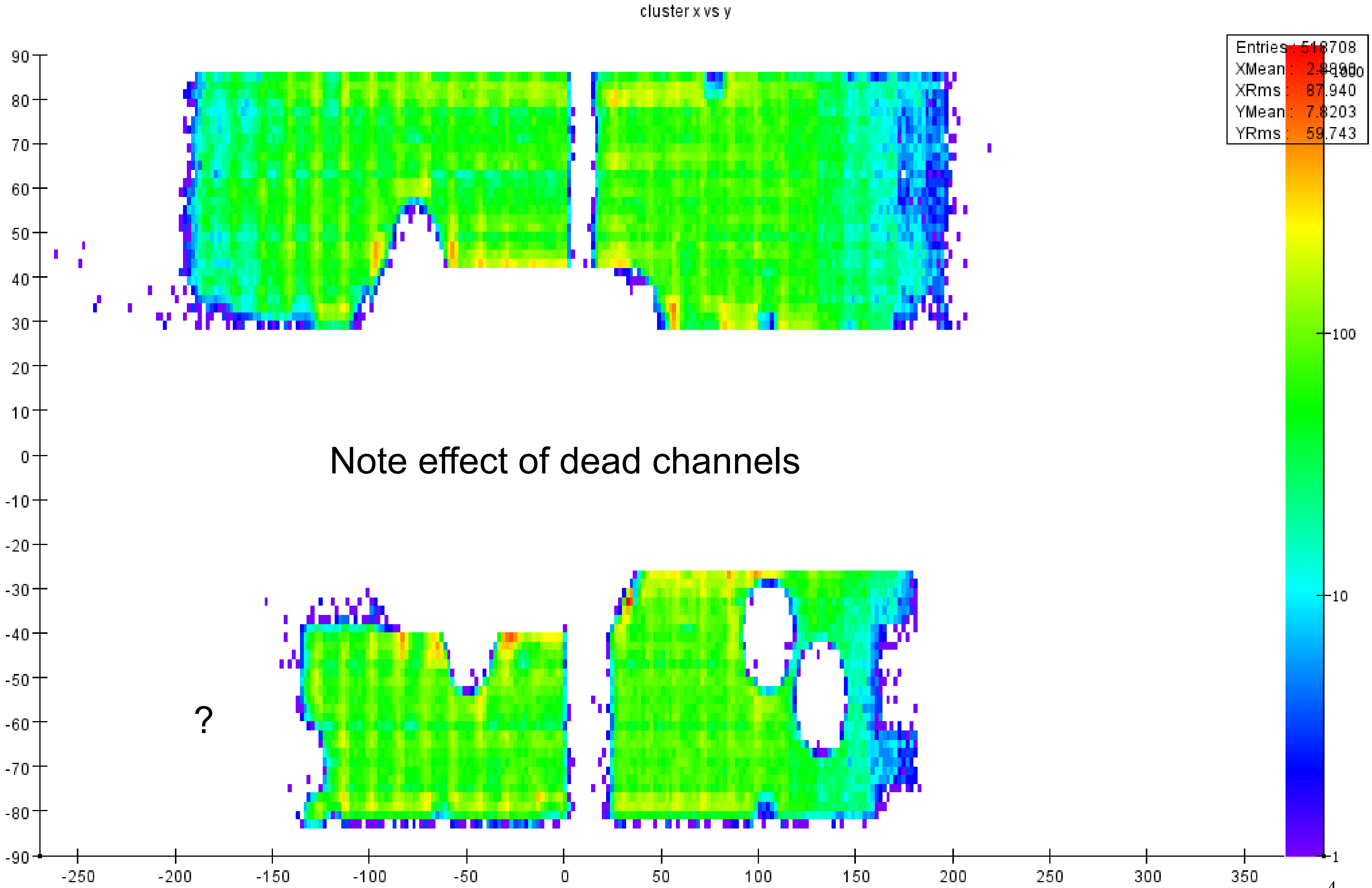
Characterizing A New Detector

- Characterize the detector performance for a new iteration of the 2019 detector
  - HPS_TimDesign_iter6
- Use dedicated FEE runs 10103, 10104

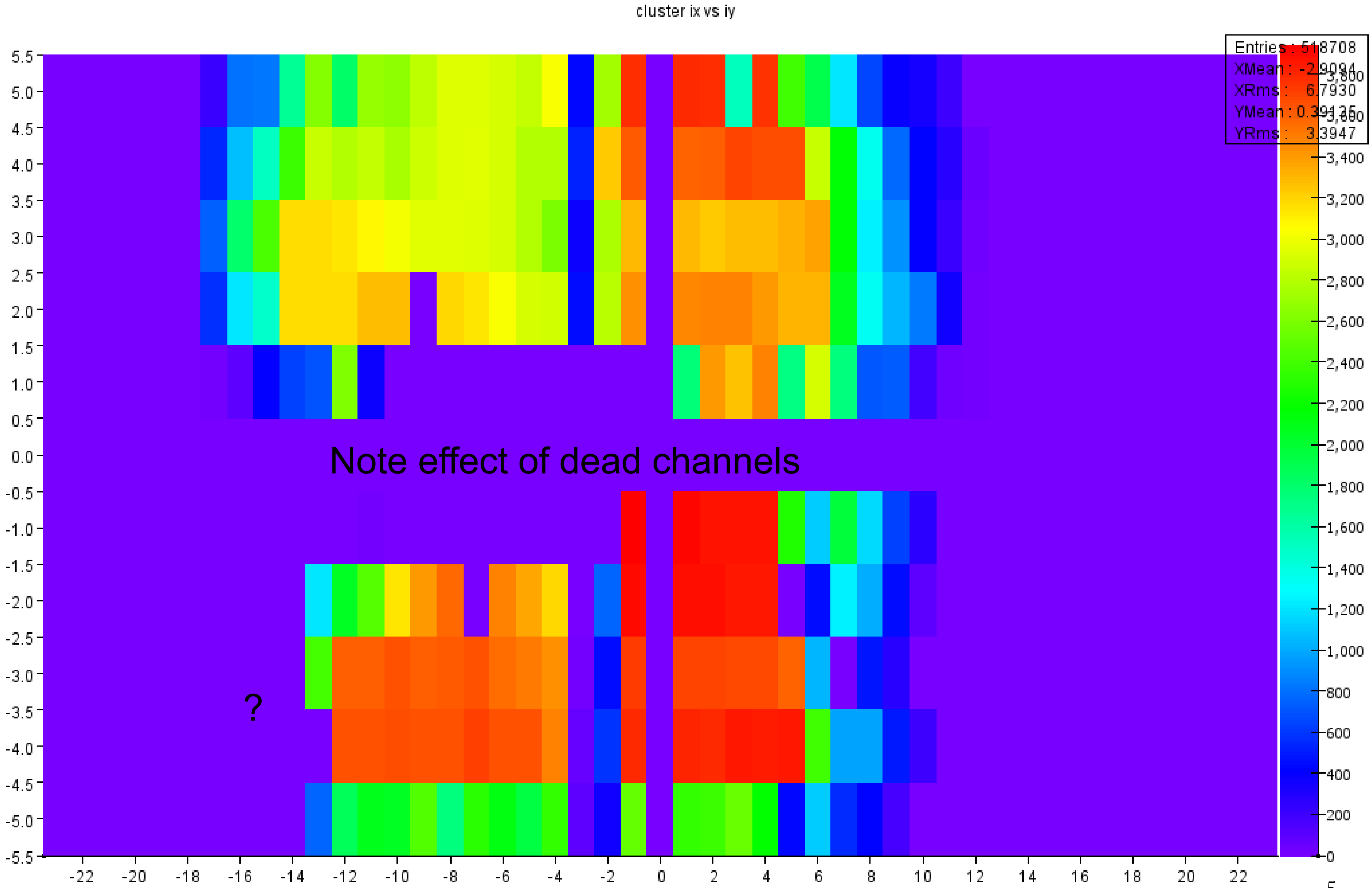
FEE Analysis

- Reconstruct FEE runs 10103 using
  - HPS_TimDesign_iter6
  - Correct z of Ecal face for track propagation
  - iss963 work in progress on Ecal cluster position improvements
- Skim FEE candidates to ~evenly populate as much of the Ecal as possible
  - 1 and only 1 Ecal cluster
  - negative-sign track associated with cluster
  - cluster energy > 4.3 GeV
  - maximize #hits on track
    - top hole & slot 12 hits
    - bottom hole 14 hits
    - bottom slot 12 or 13 (missing sensor and APV25 on another)
    - all hits on track on either slot or hole, no overlap
    - limit number of clusters per crystal channel to <4k

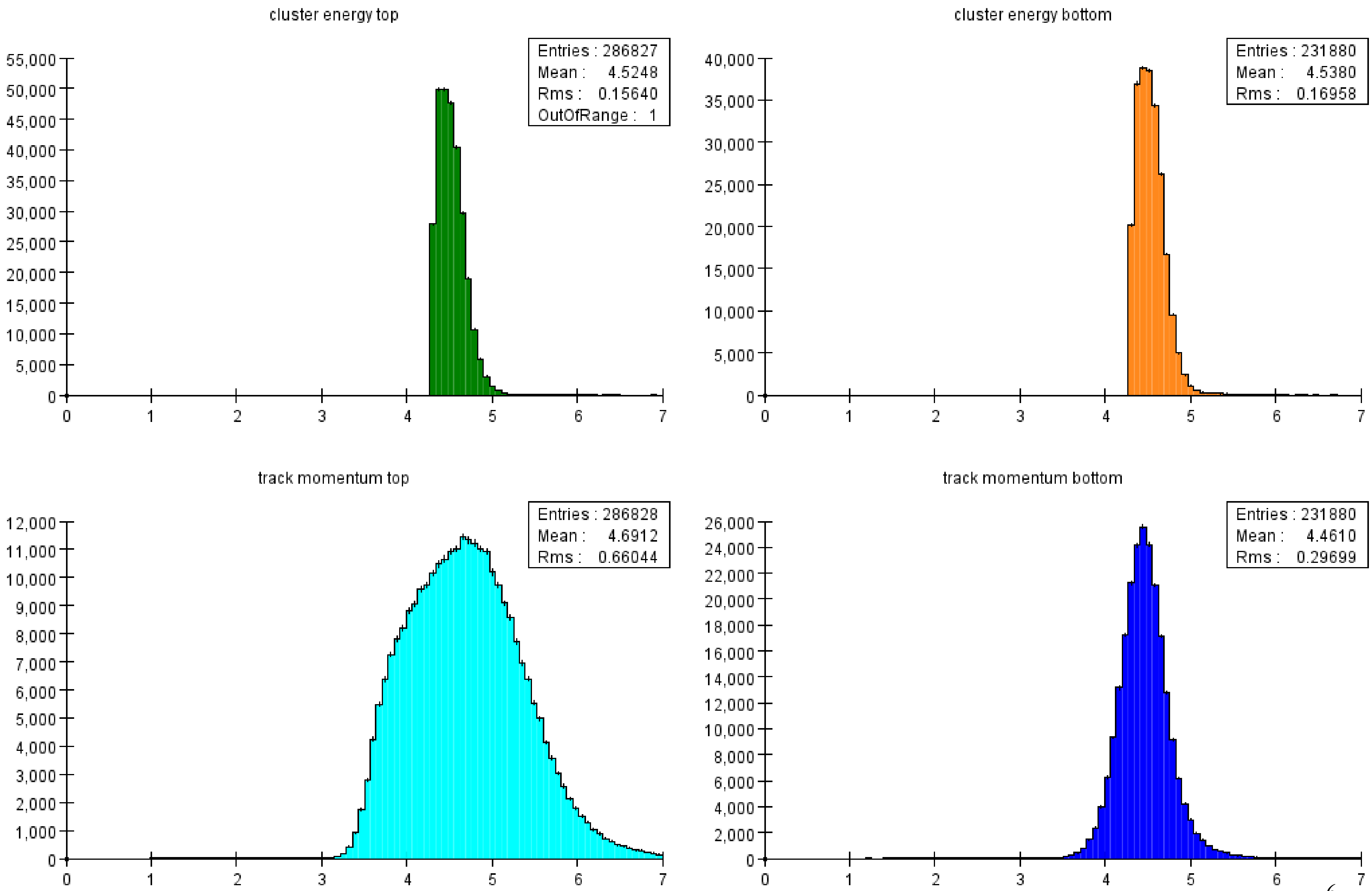
FEE Cluster (x,y) Positions



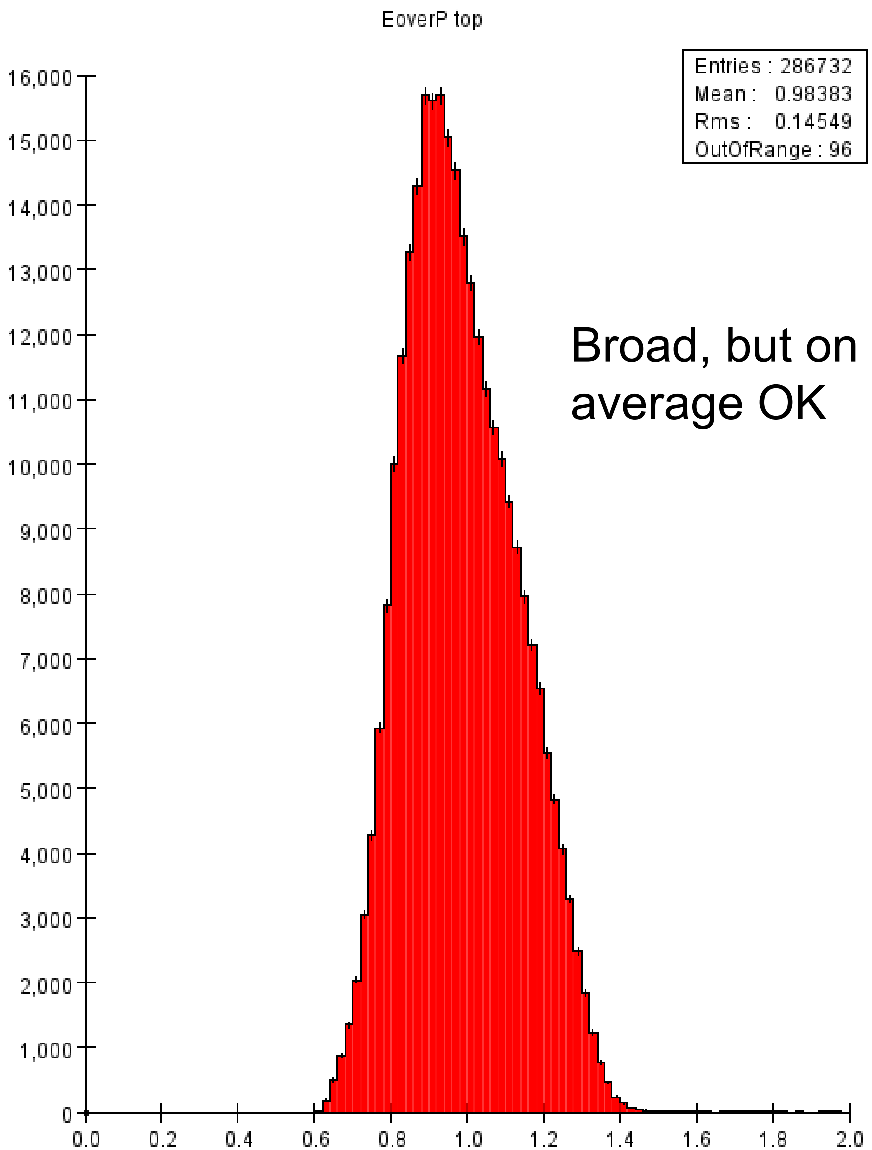
FEE Cluster Channel (ix,iy) Occupancy



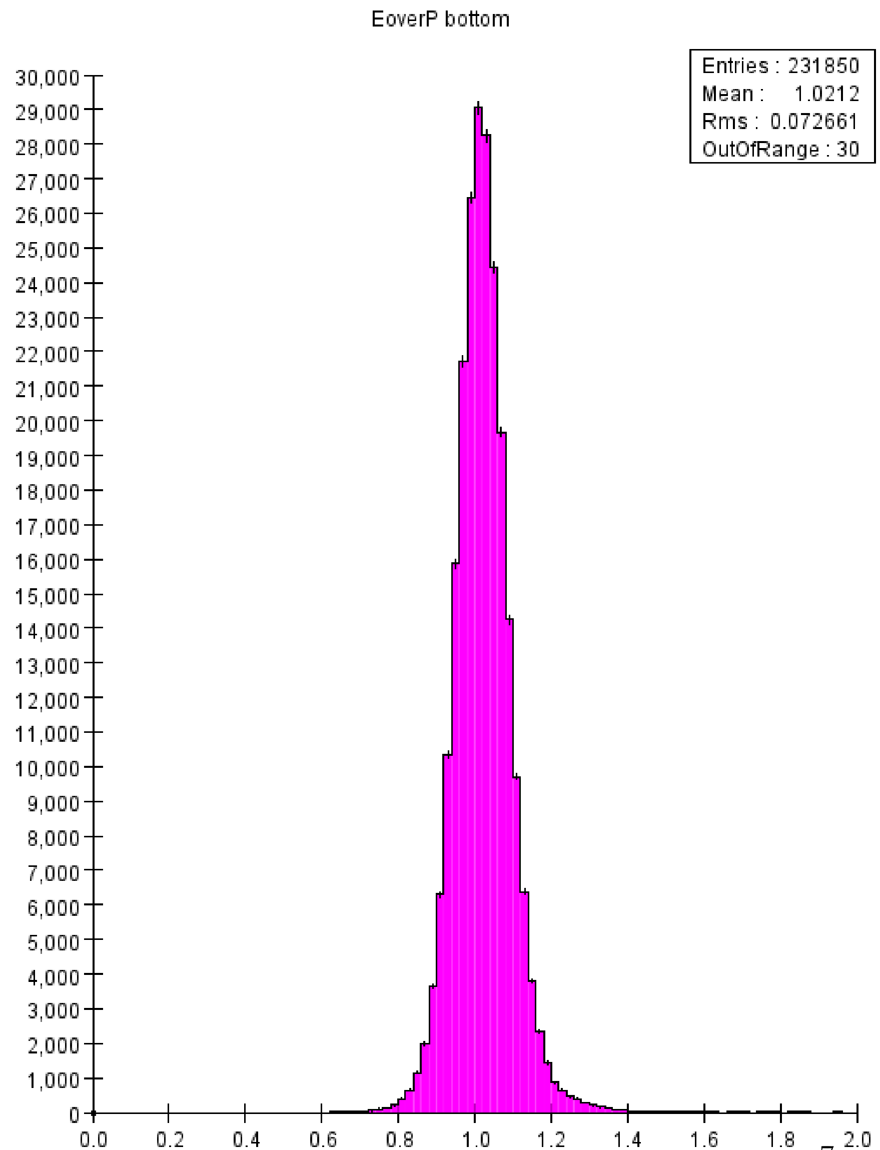
FEE Cluster Energy Track Momentum



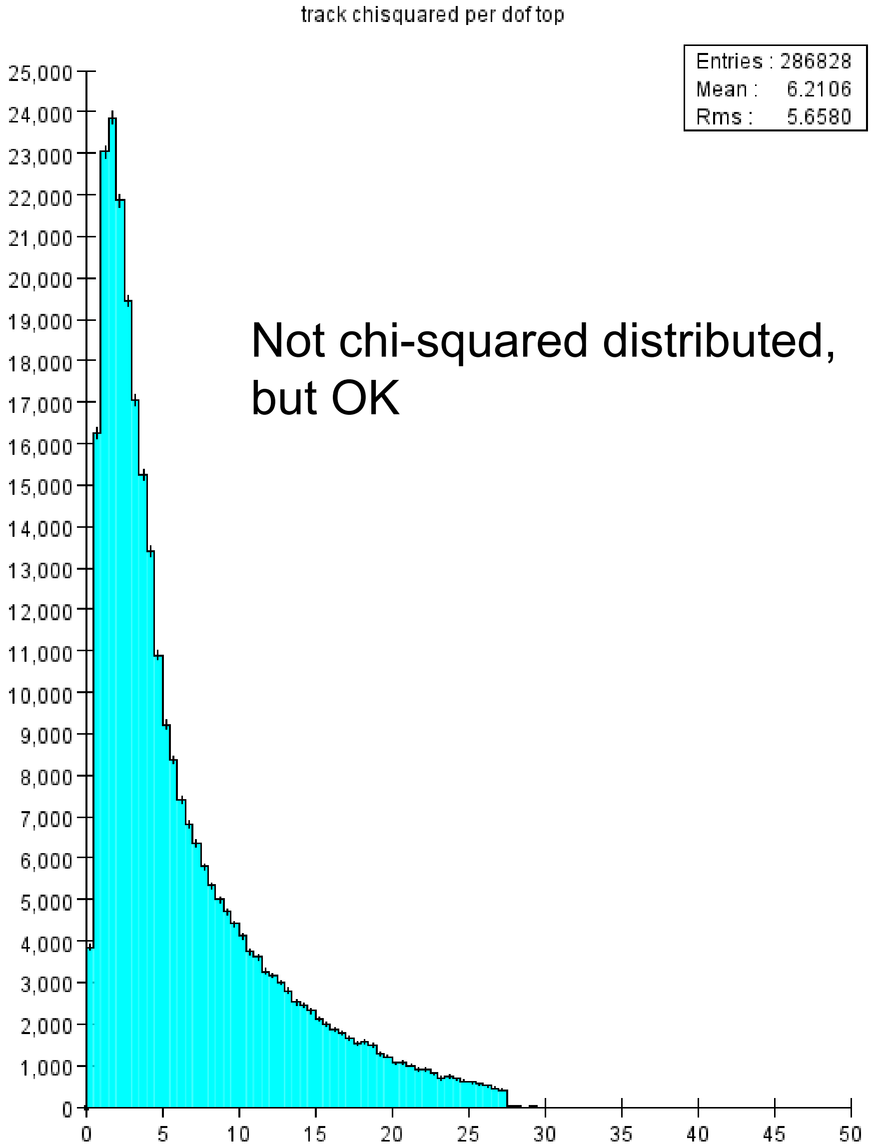
Track E/p



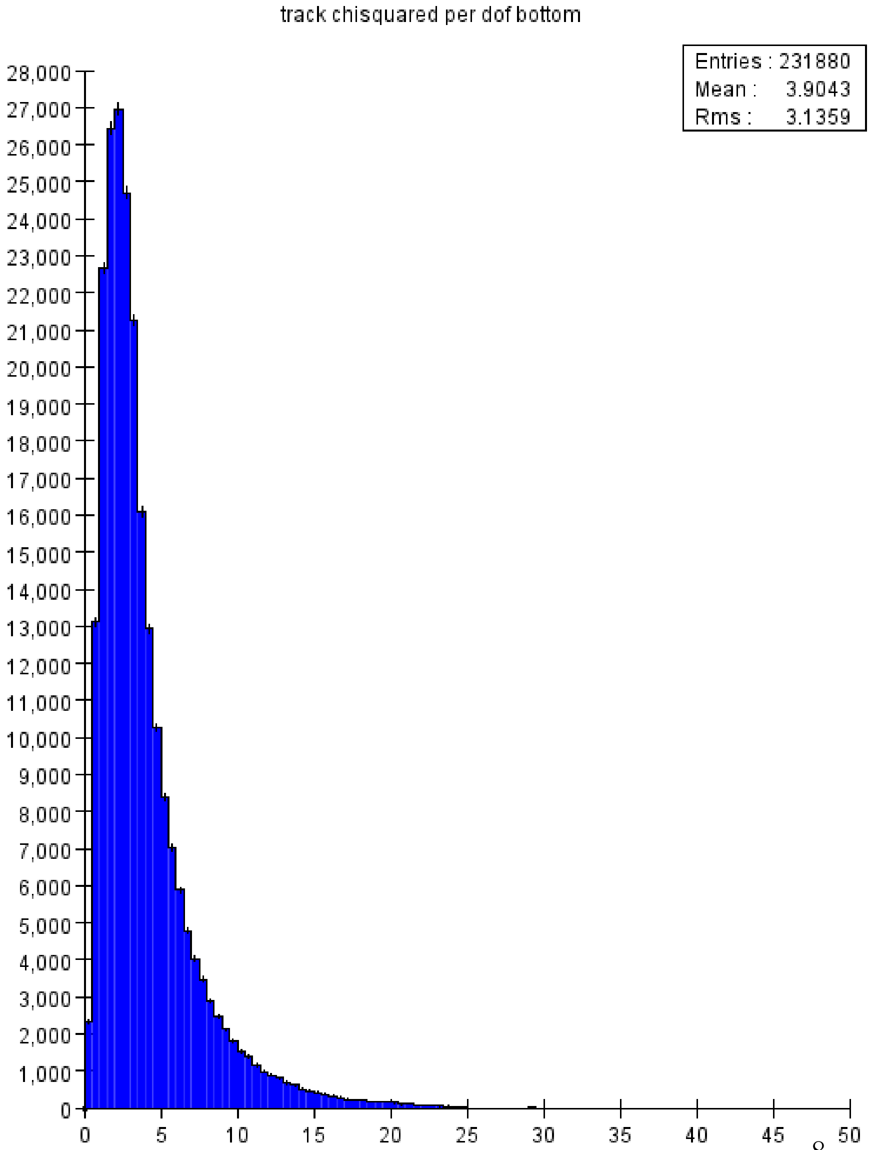
Broad, but on average OK



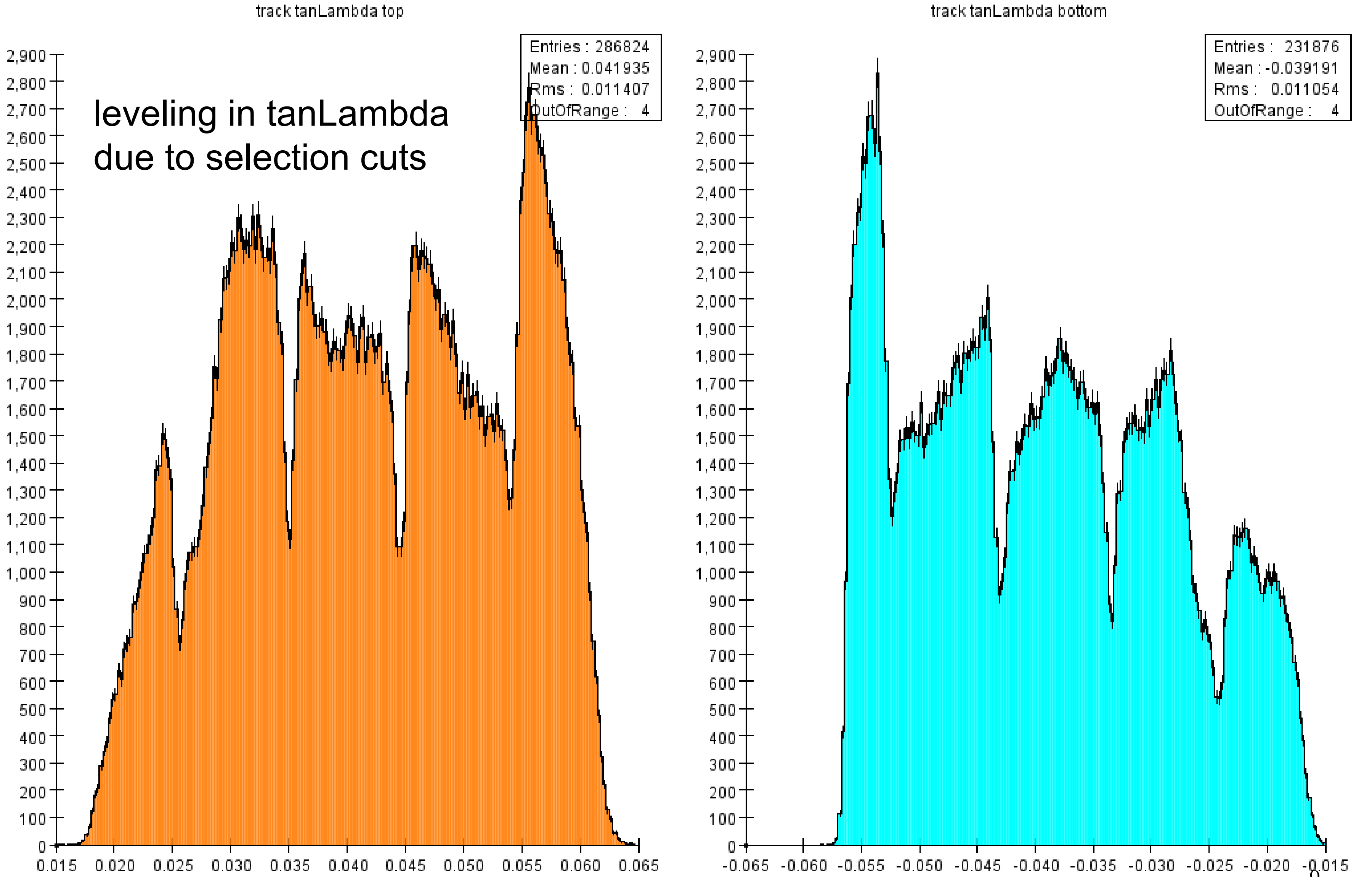
Track Chi-Squared



Not chi-squared distributed, but OK

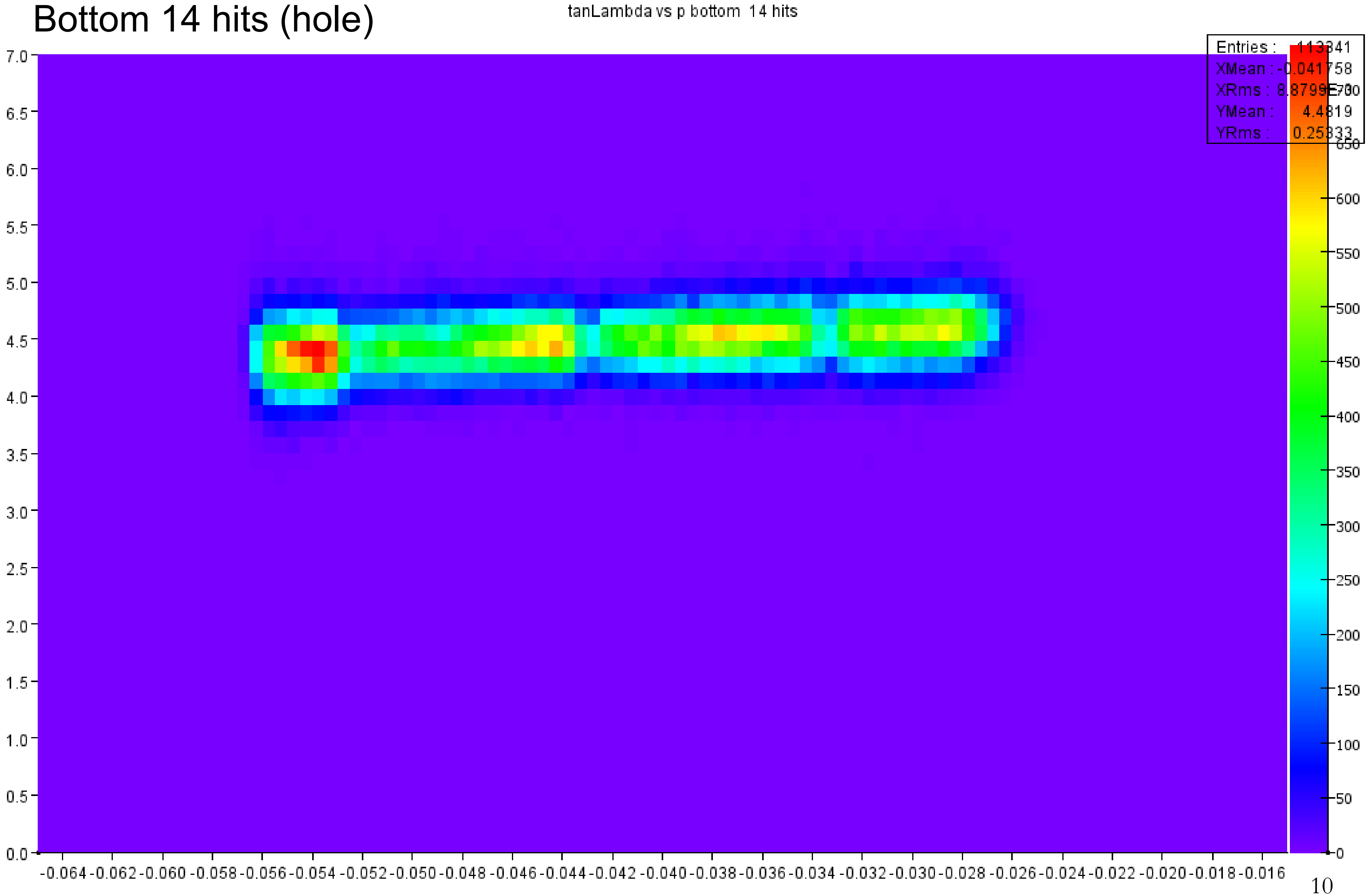


Track TanLambda (ThetaY)



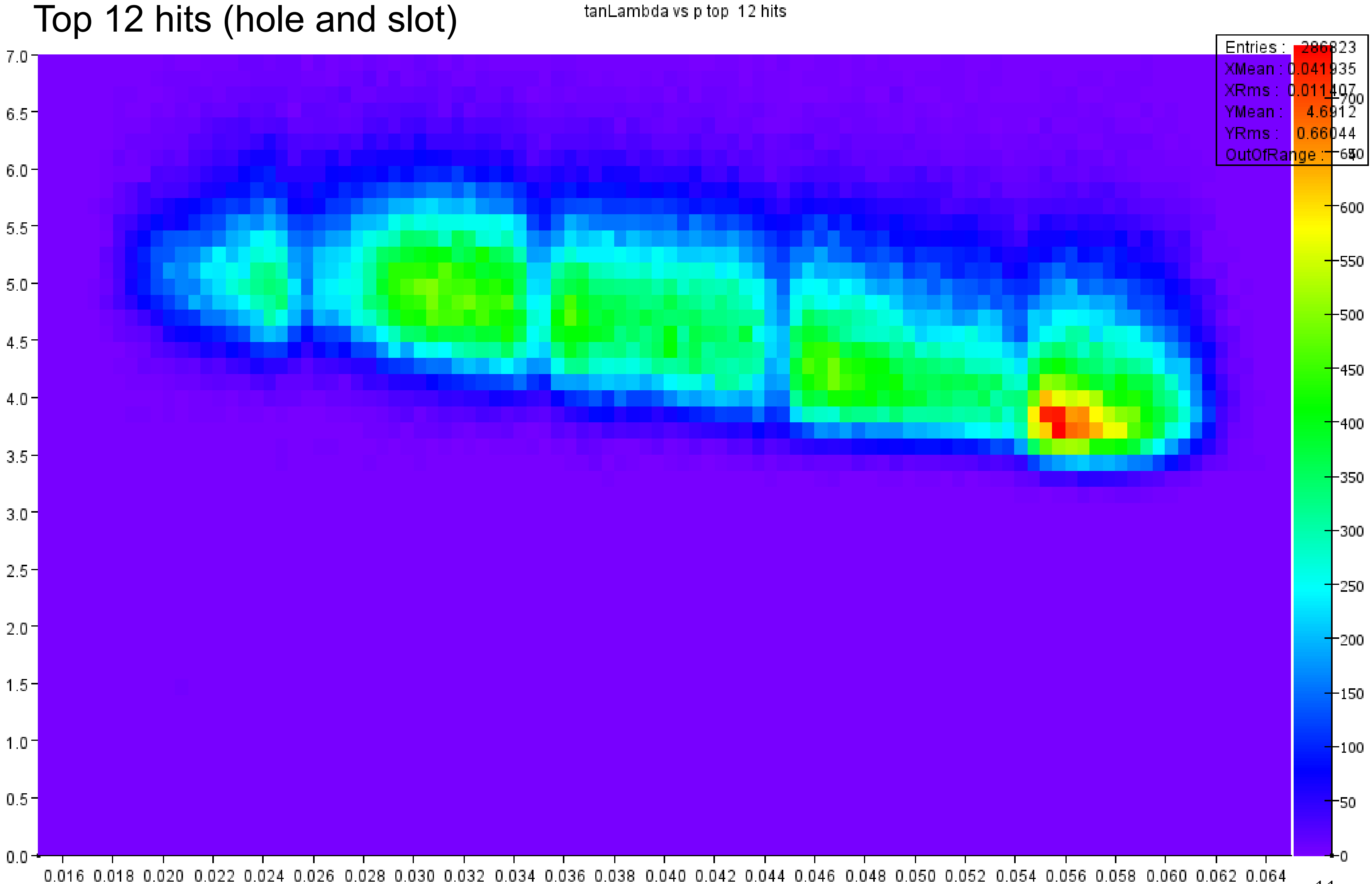
Track tanLambda vs Momentum

Bottom 14 hits (hole)



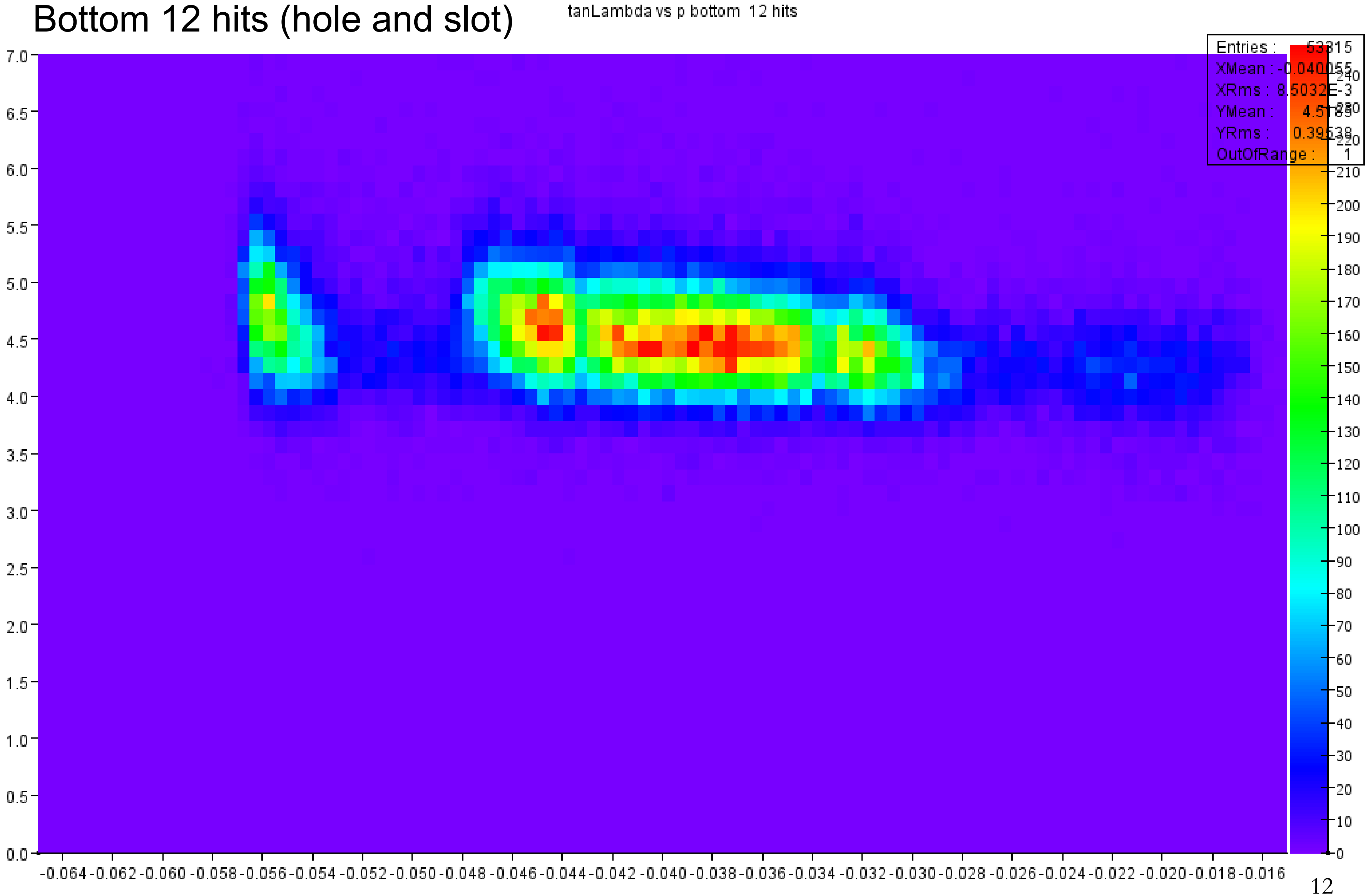
Track tanLambda vs Momentum

Top 12 hits (hole and slot)



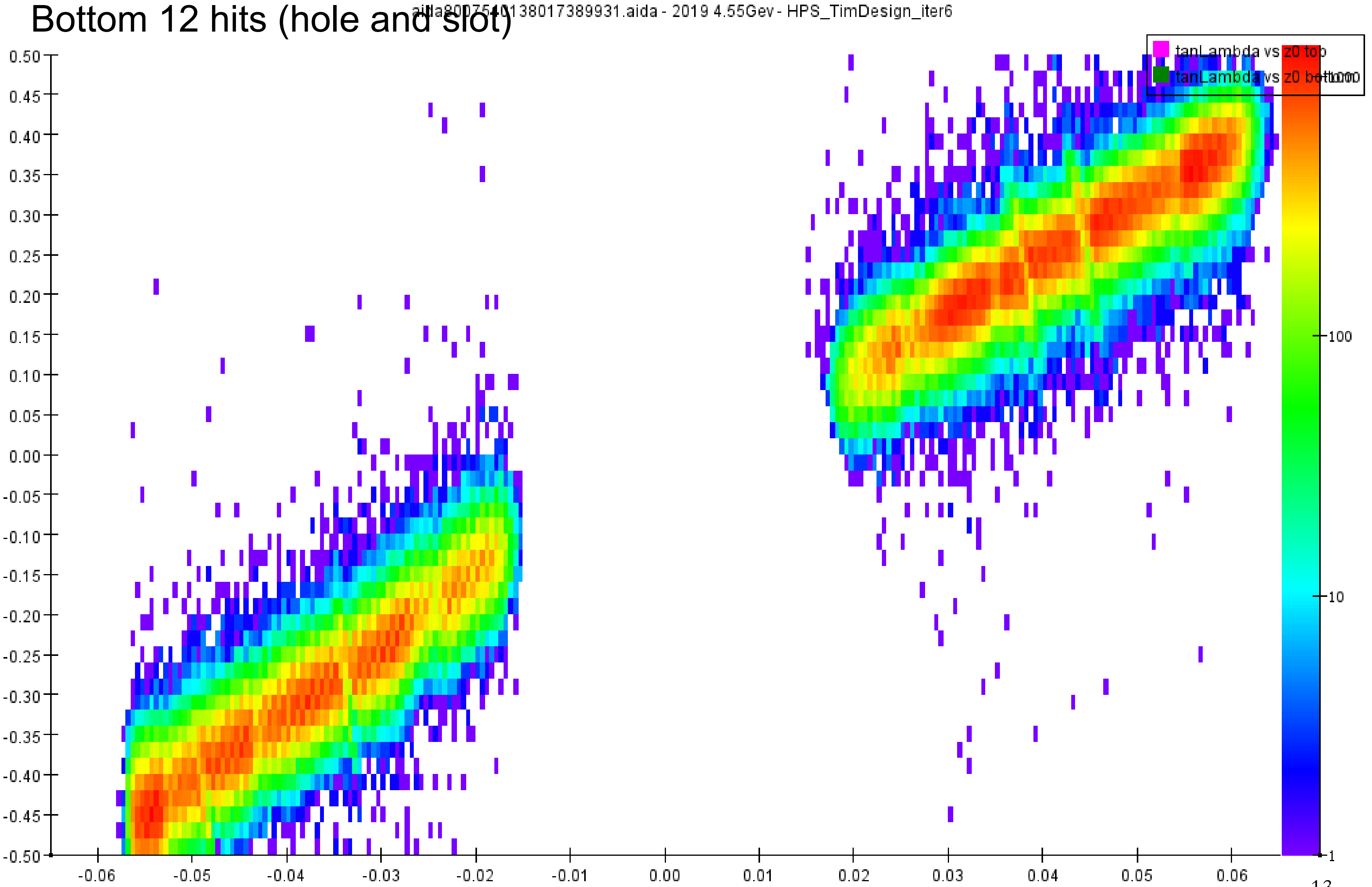
Track tanLambda vs Momentum

Bottom 12 hits (hole and slot)

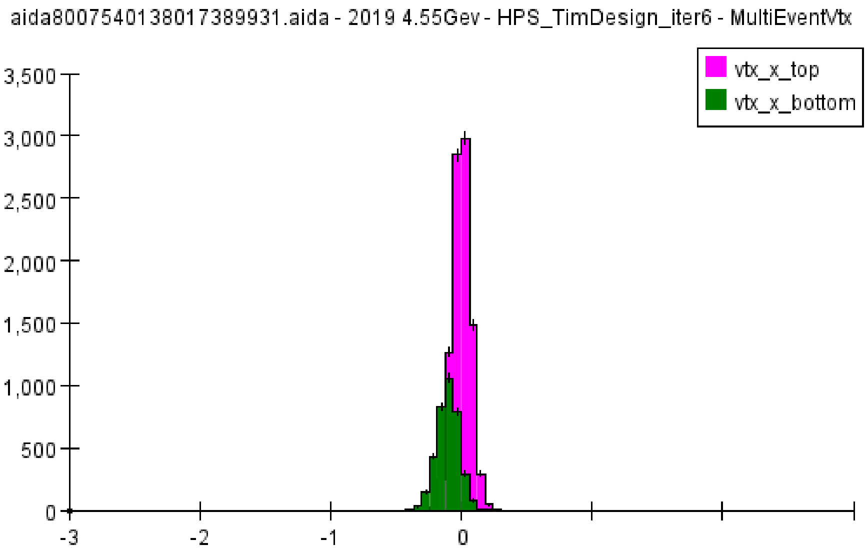


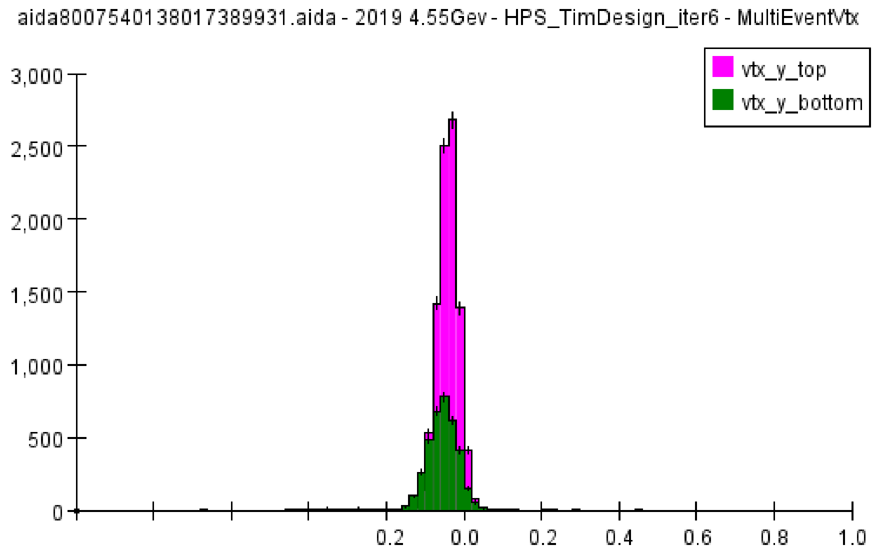
Track tanLambda vs Z0

Bottom 12 hits (hole and slot)

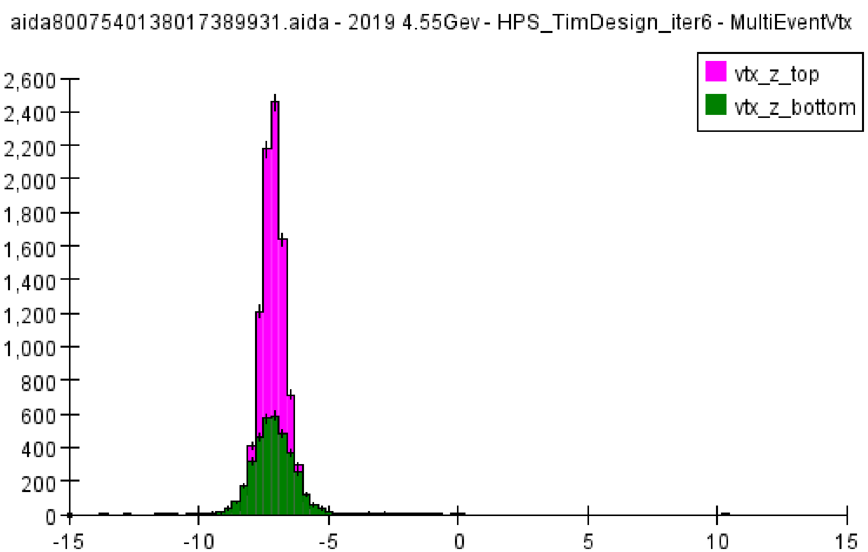


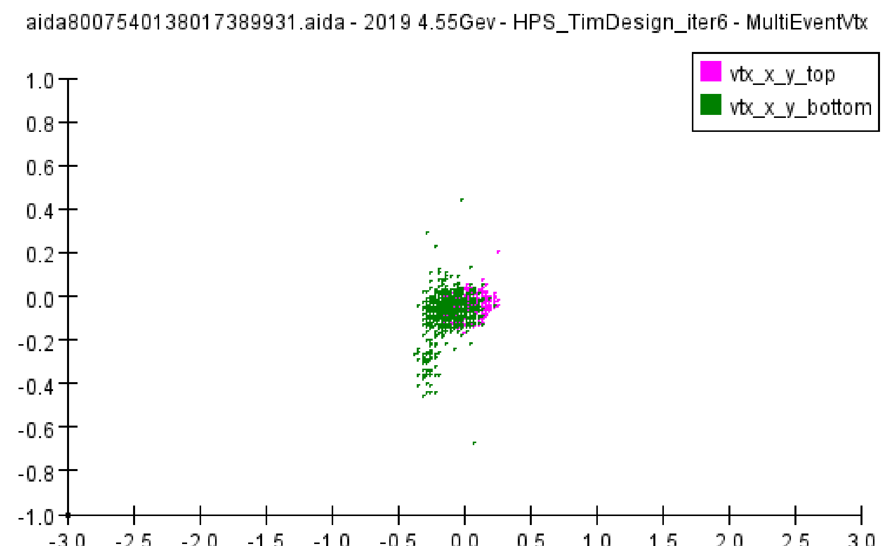
IP Position (multi-event vertex)



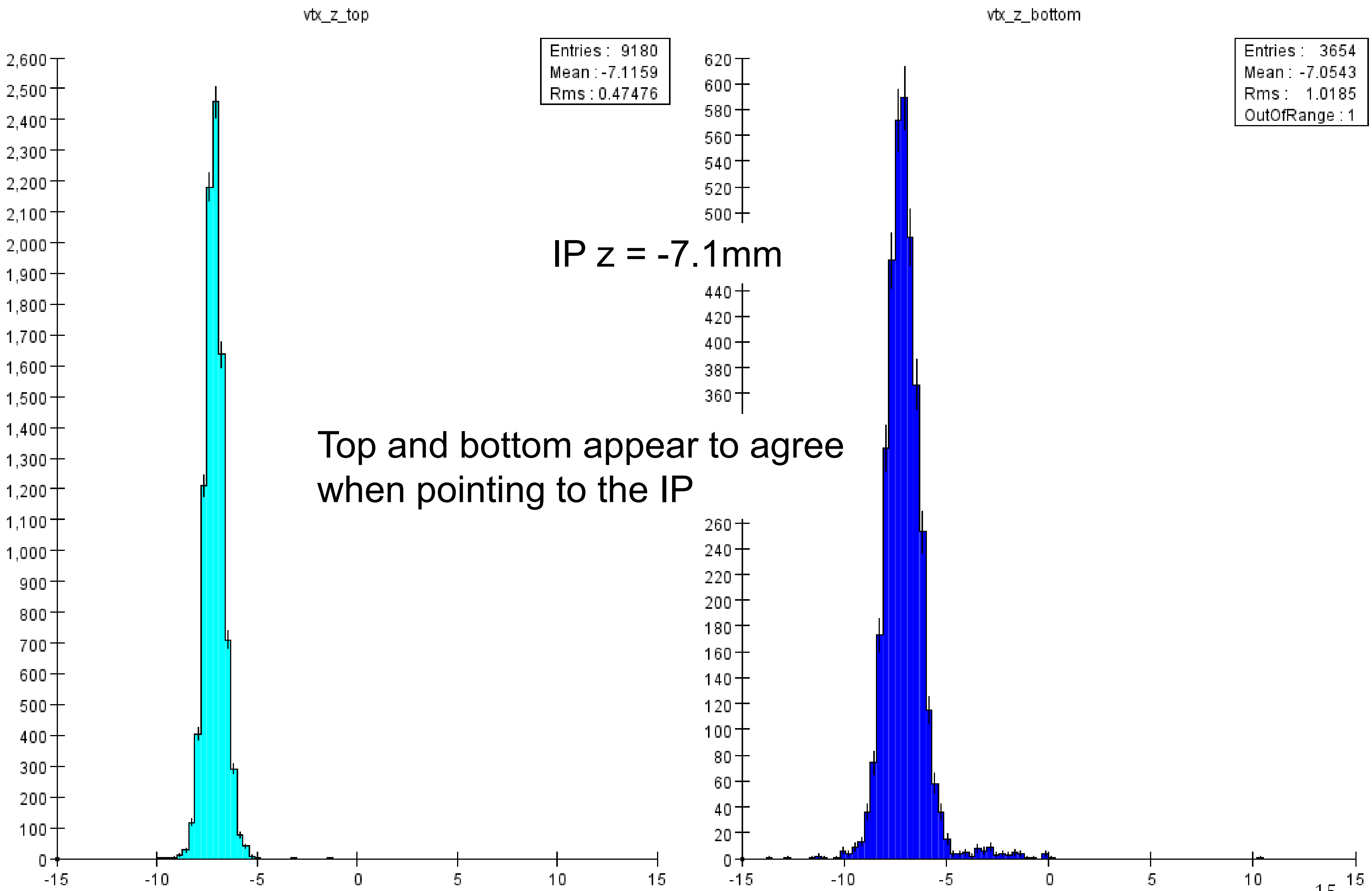


Good agreement in all coordinates





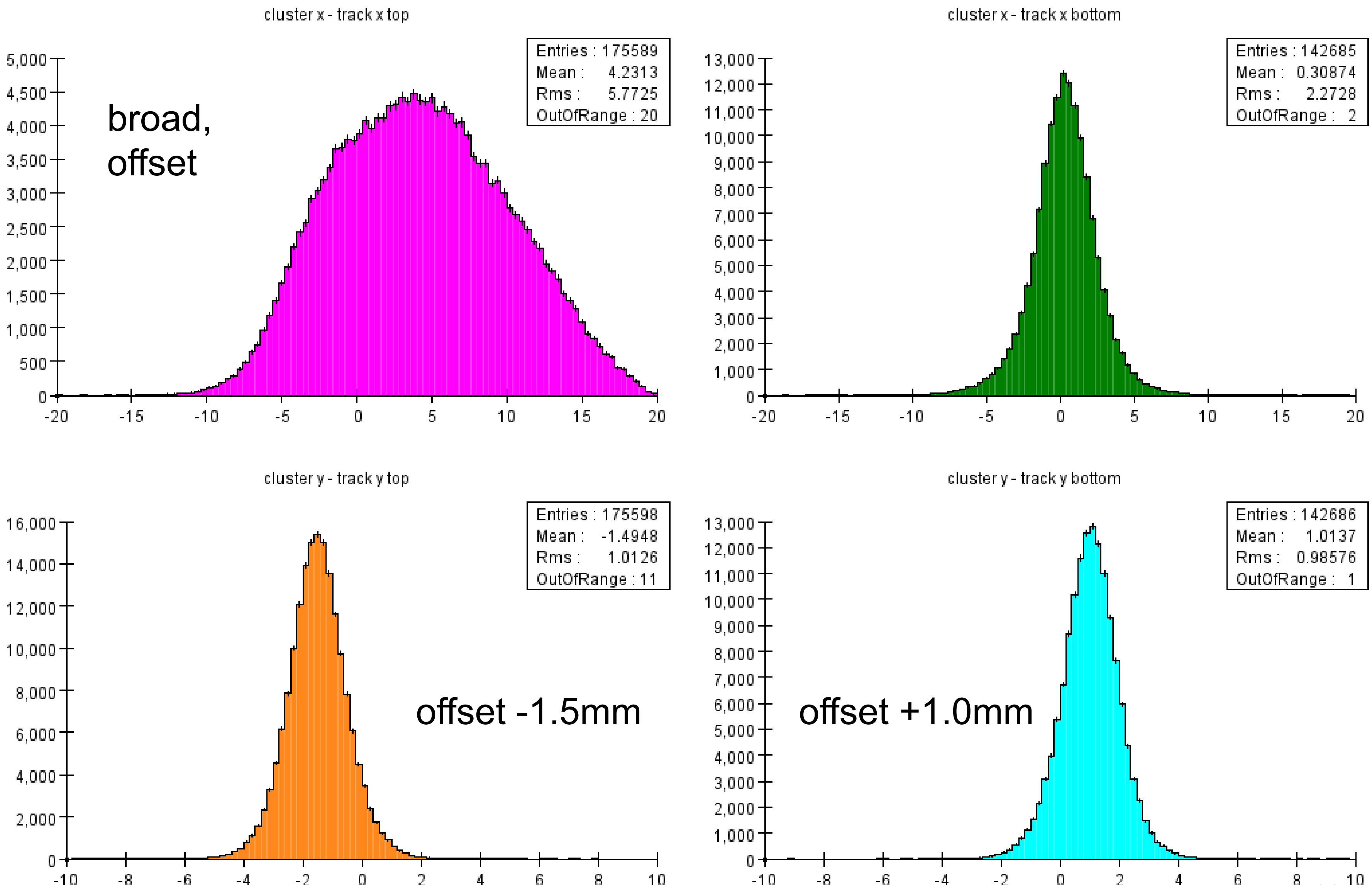
IP Z Position (multi-event vertex)



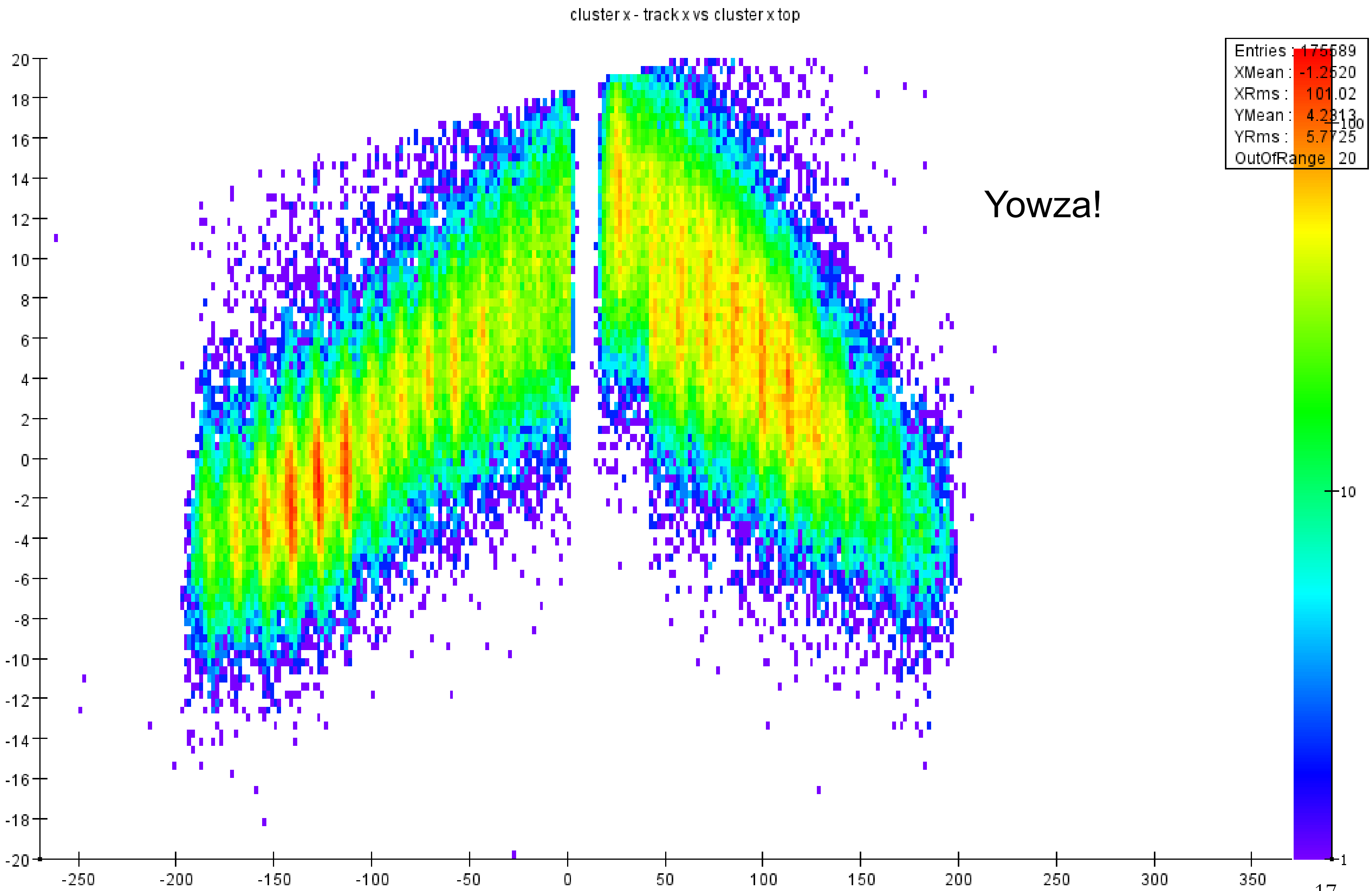
IP z = -7.1mm

Top and bottom appear to agree when pointing to the IP

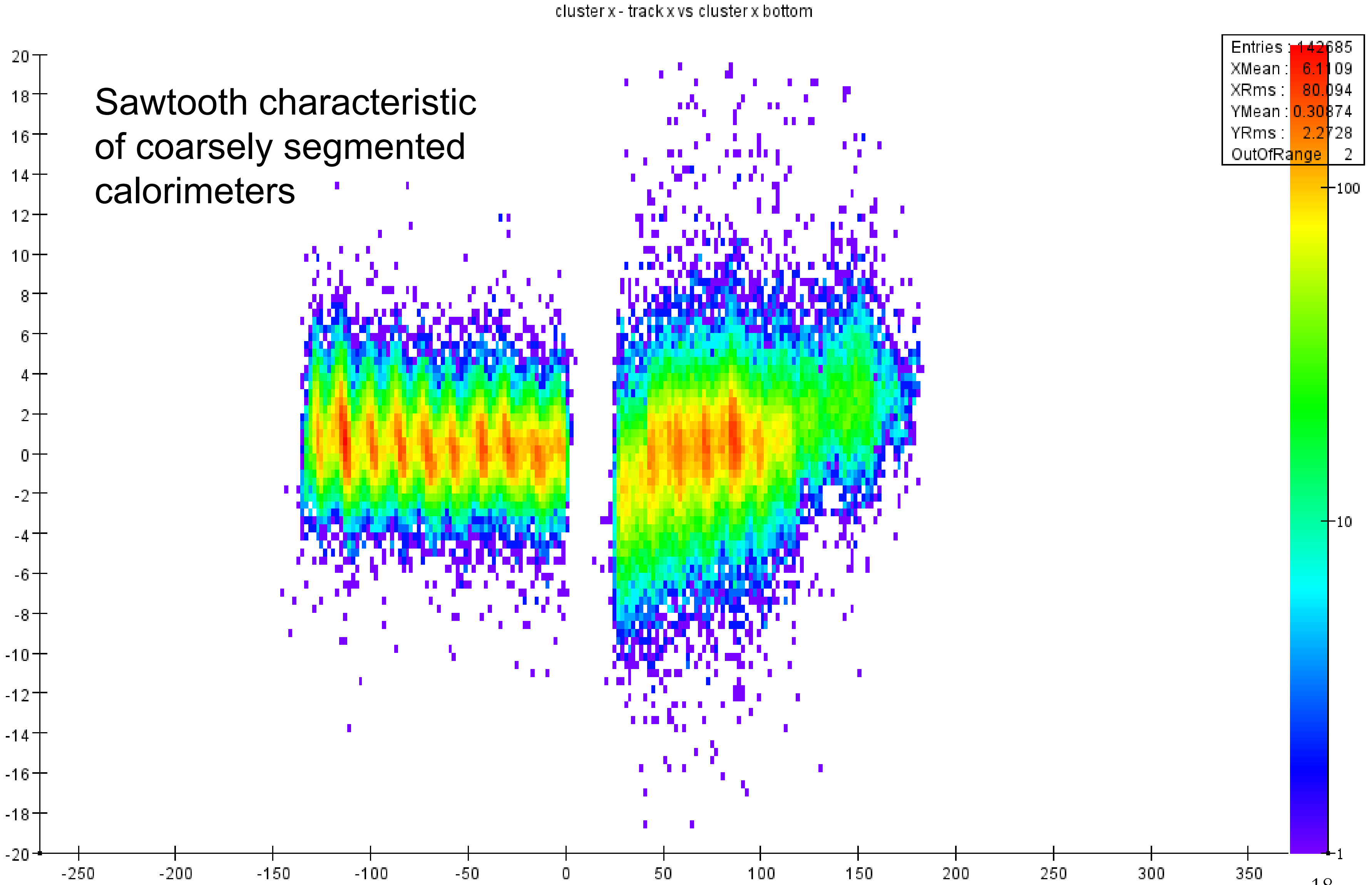
Check other end of track (fiducial)



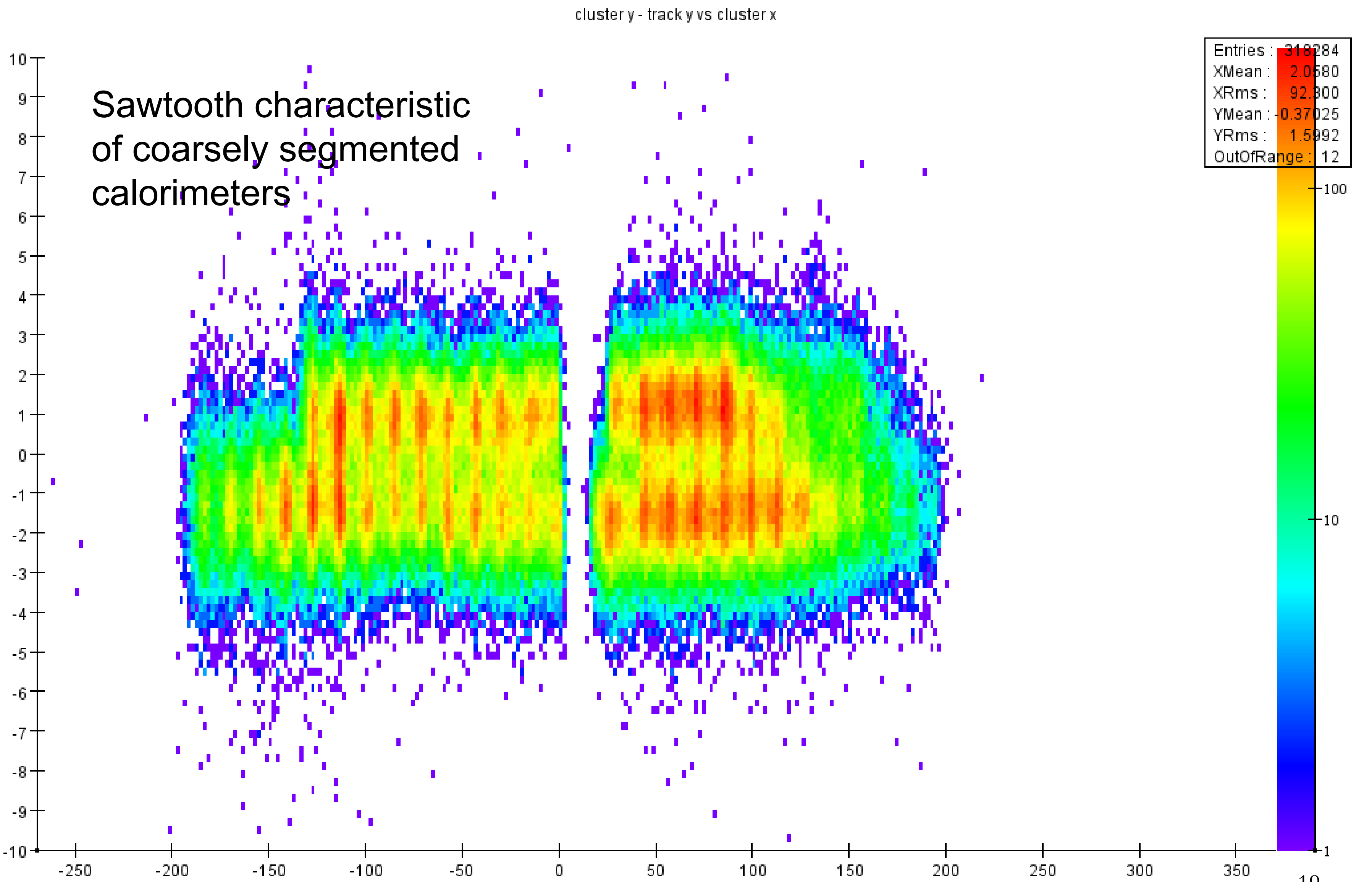
Track X – Cluster X vs X top (fiducial)



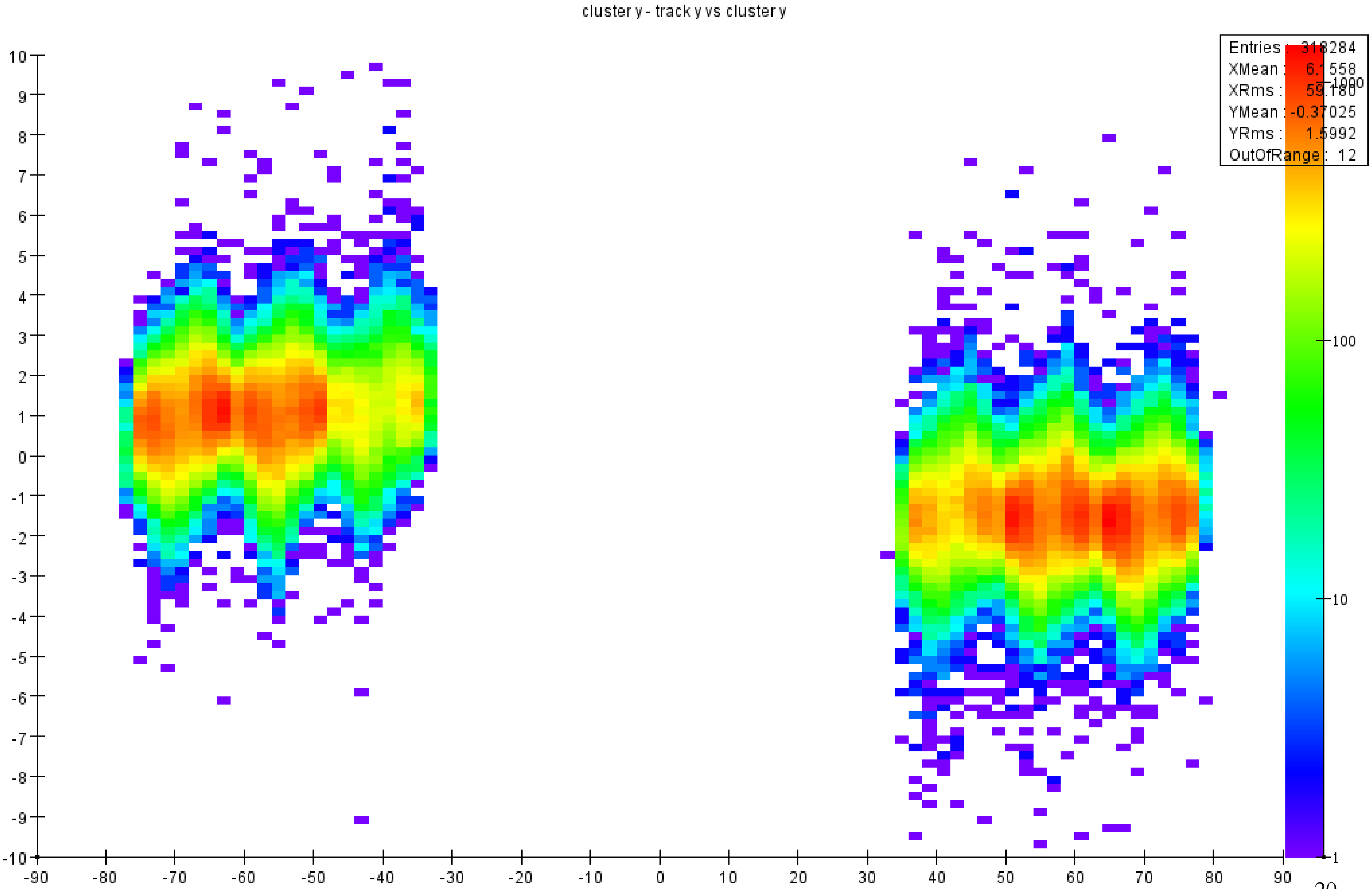
Track X – Cluster X vs X bottom (fid)



Track Y – Cluster Y vs X (fid)



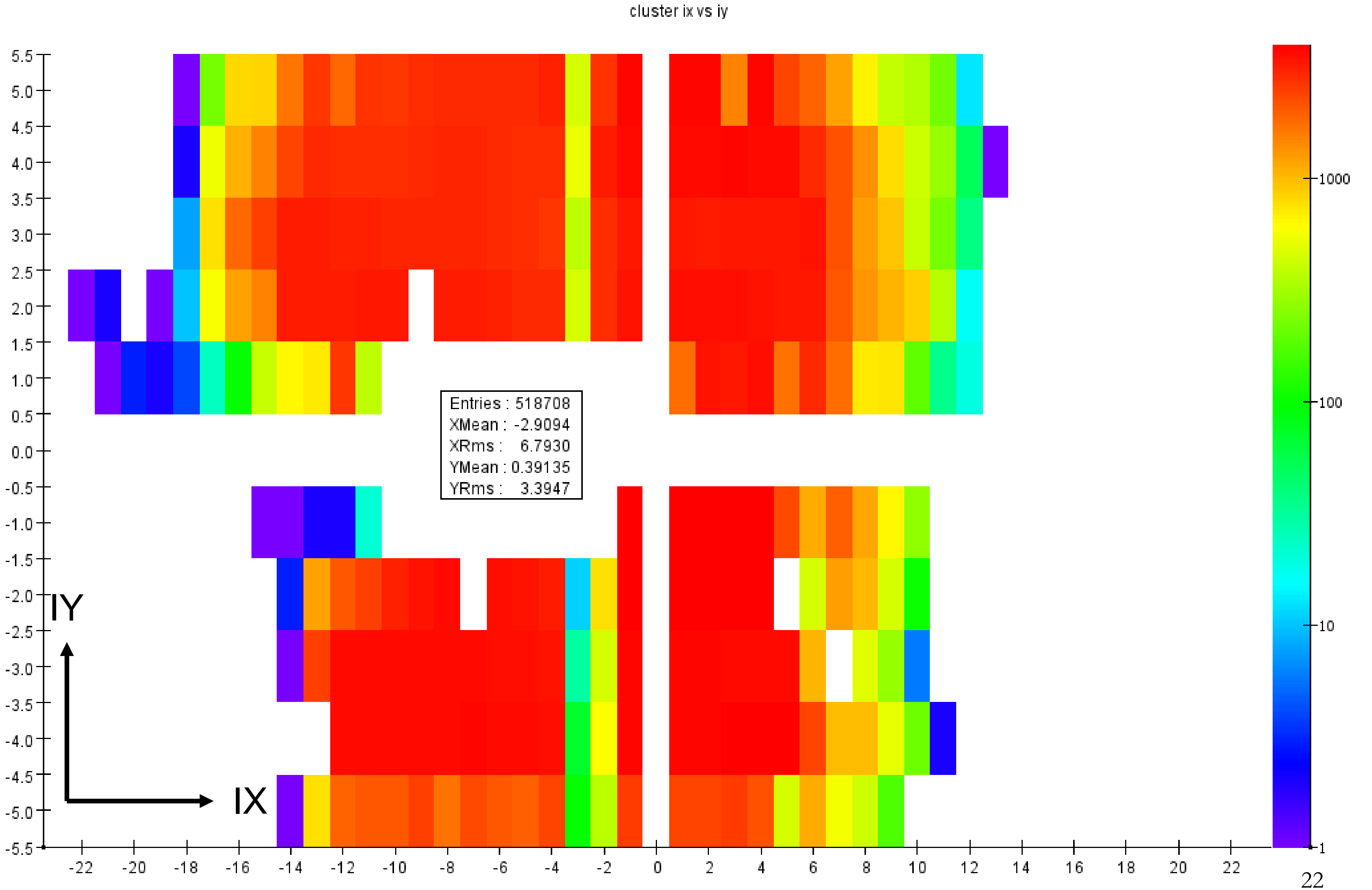
Track Y – Cluster Y vs Y (fid)



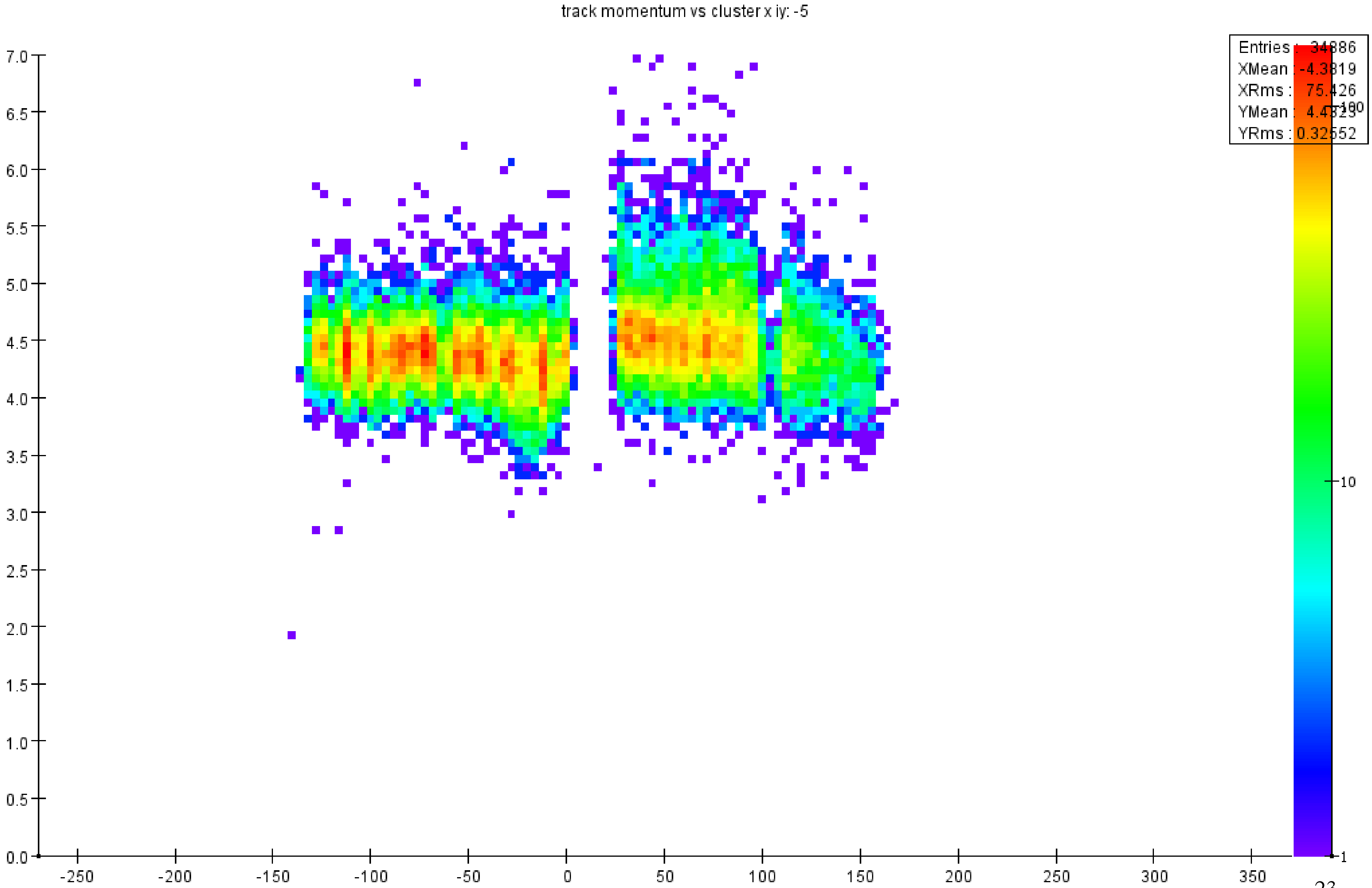
Track-Cluster Matching

- Severe systematics observed when matching tracks to fiducial calorimeter clusters
  - only one quadrant in deltaX looks OK
  - matching in Y is more precise, but mismatch between top and bottom matching on order of 1mm
- Check momentum as function of (x,y) at Ecal
  - have already seen dependence on tanLambda in top
- Analyze track momentum by cluster IX, IY
  - Plot Momentum as function of x for fixed IY

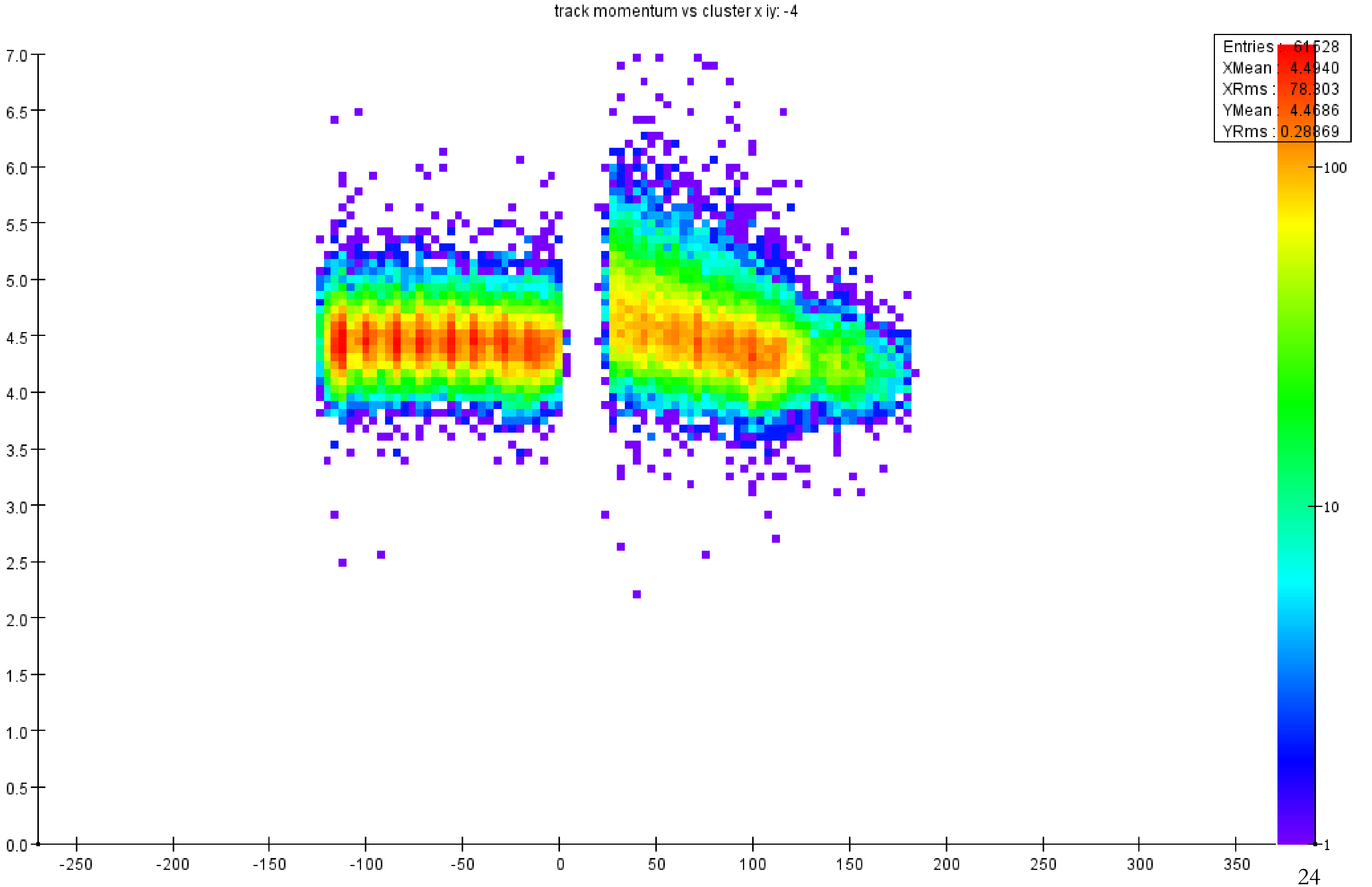
Cluster Index IX, IY



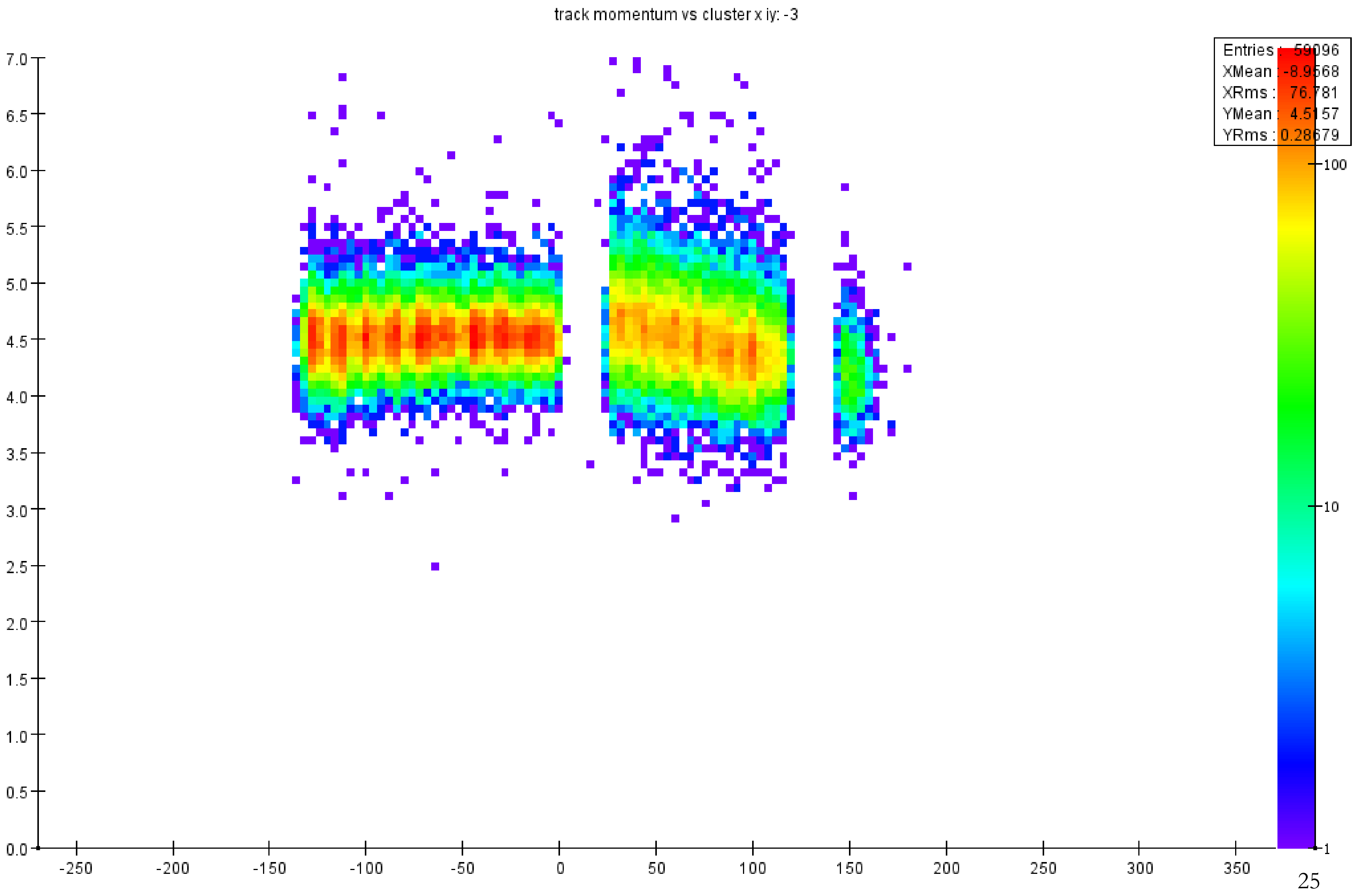
Track Momentum vs X, IY = -5



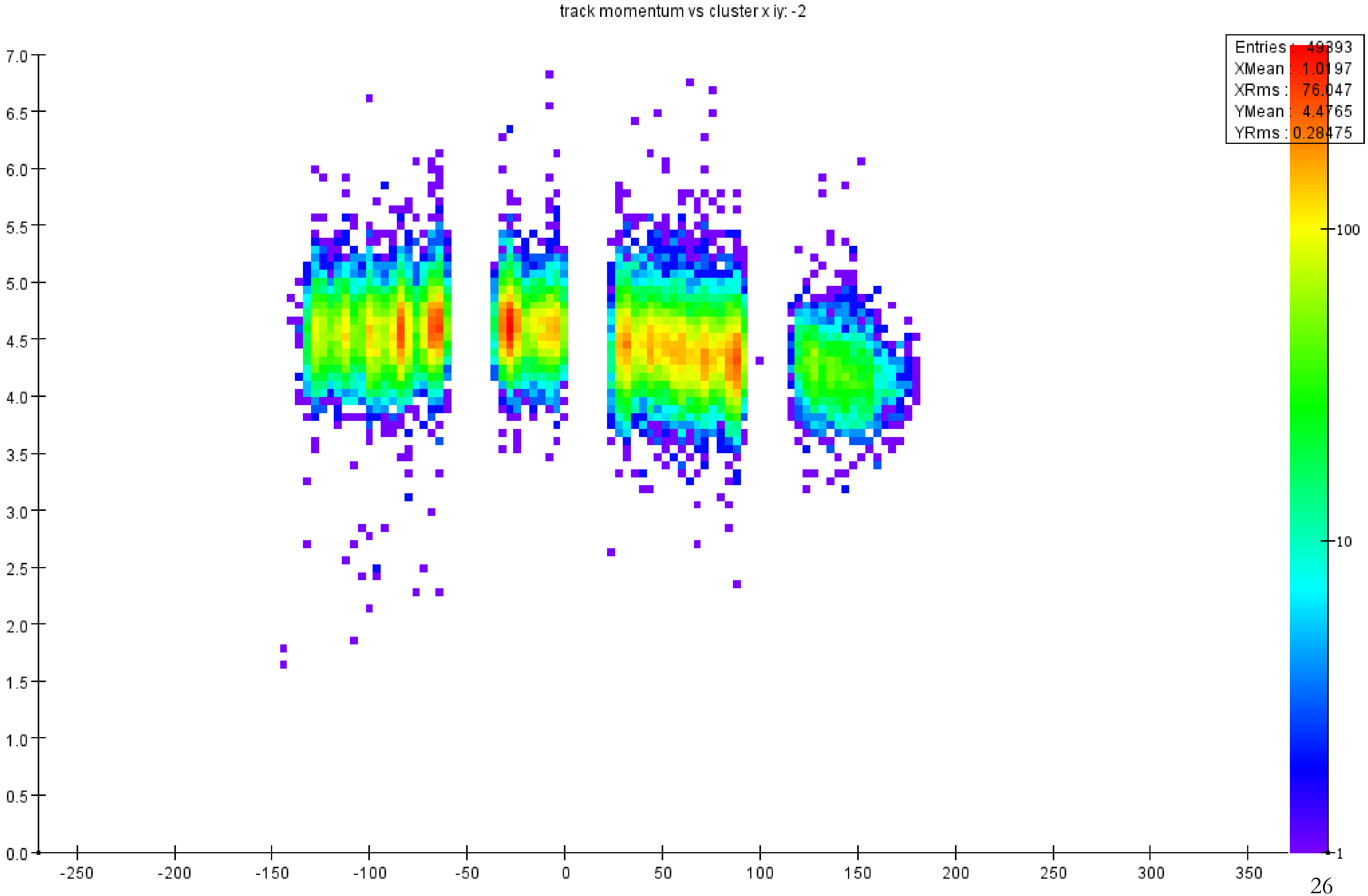
Track Momentum vs X, IY = -4



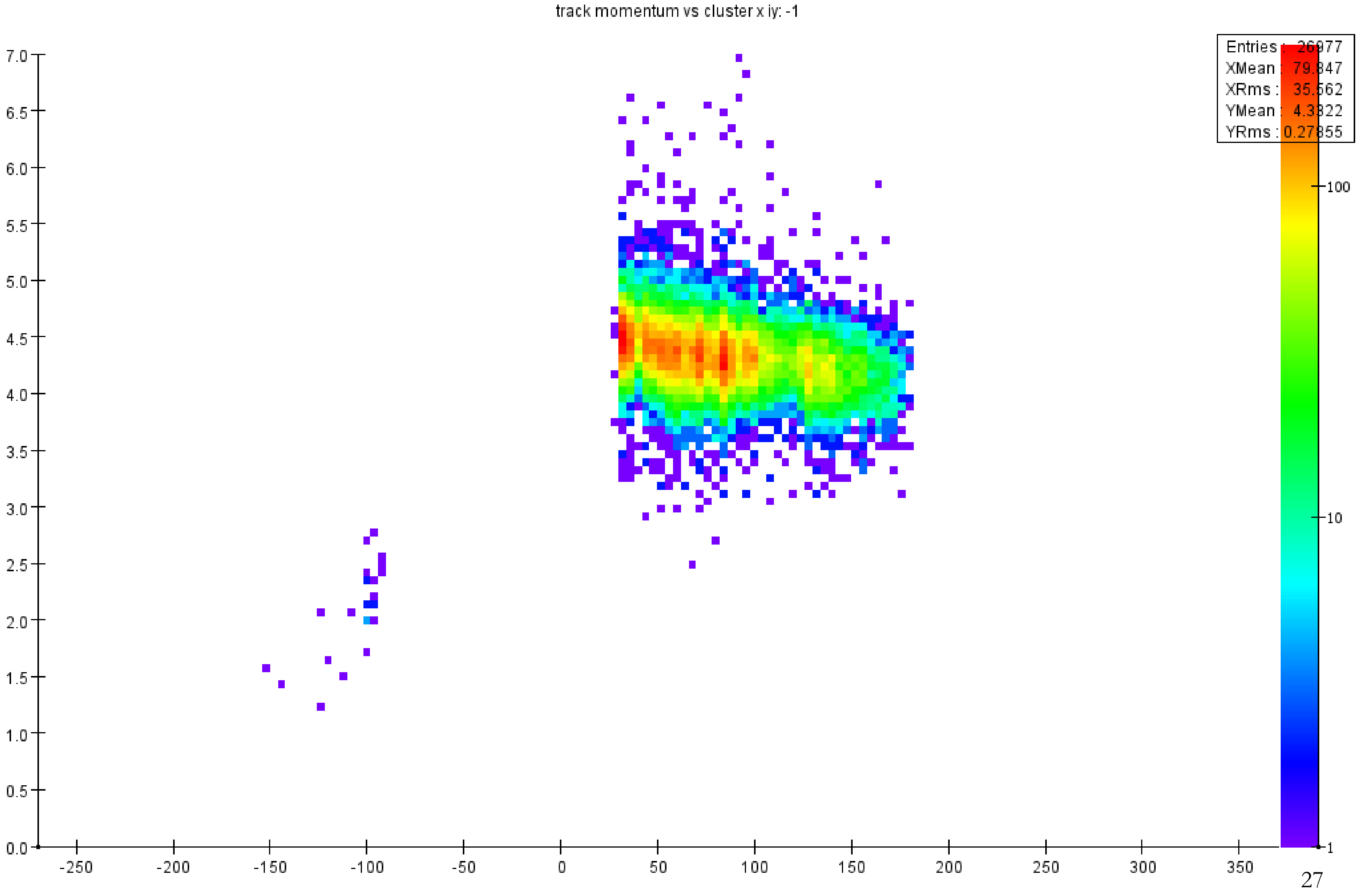
Track Momentum vs X, IY = -3



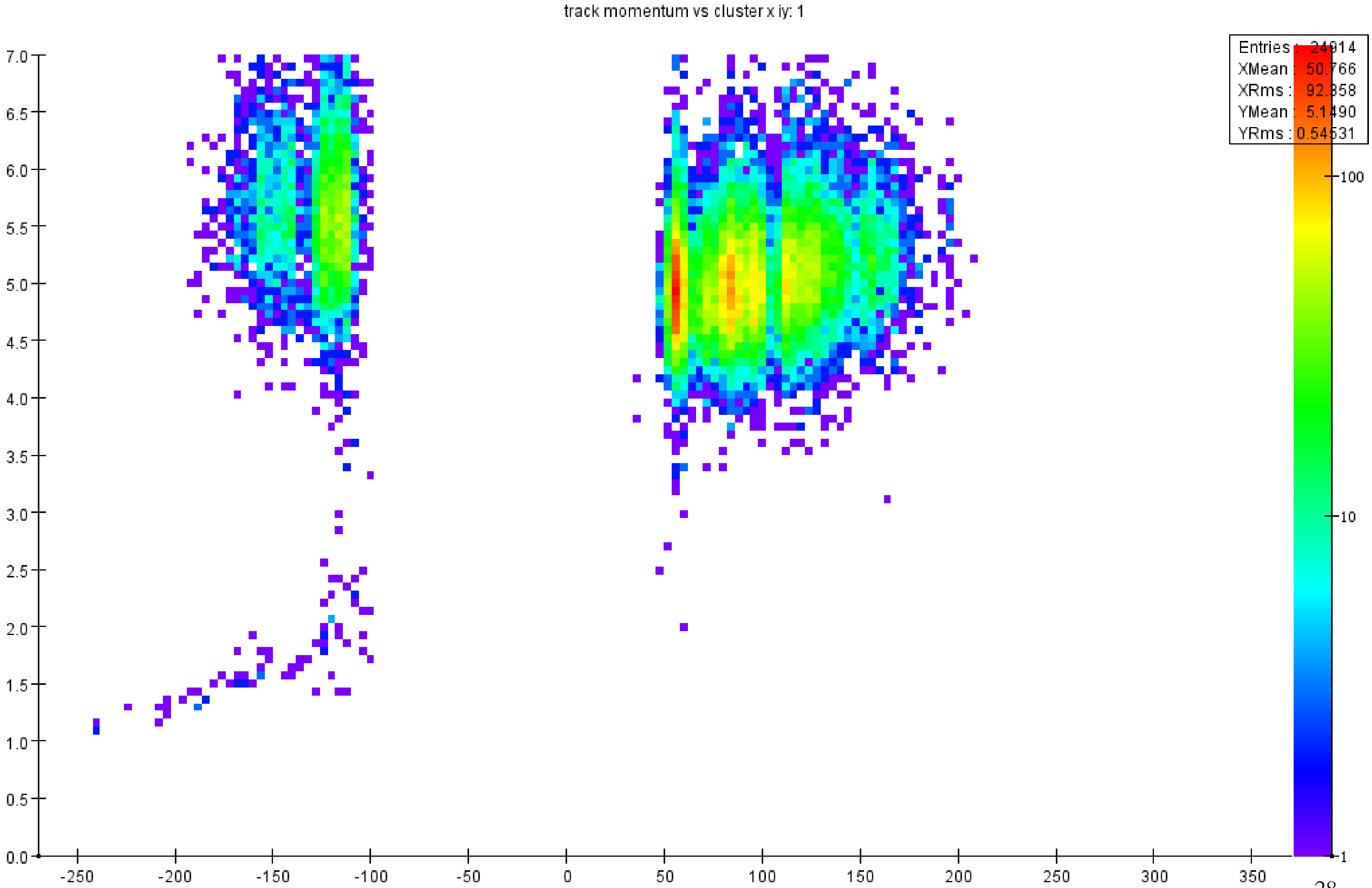
Track Momentum vs X, IY = -2



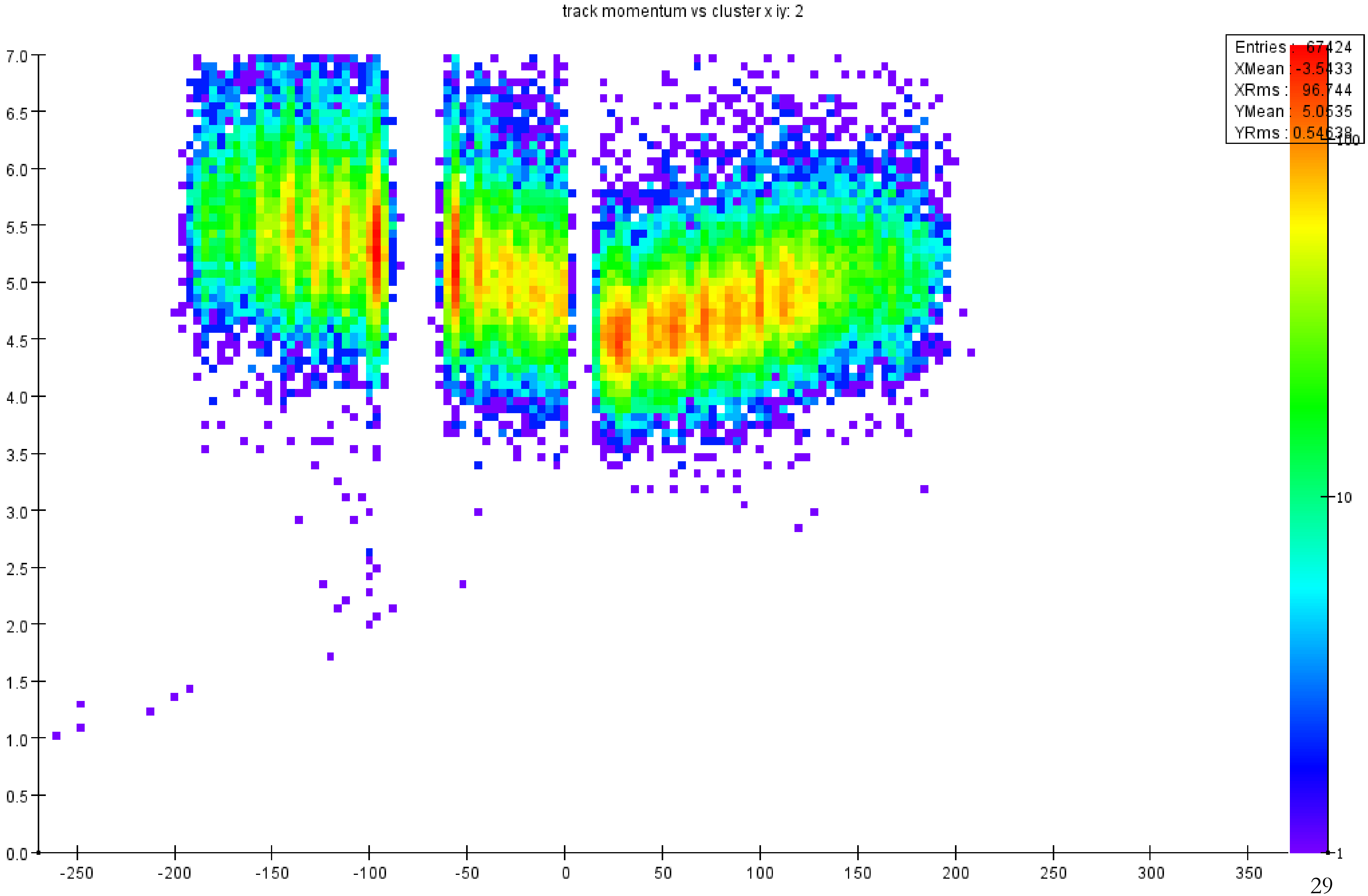
Track Momentum vs X, IY = -1



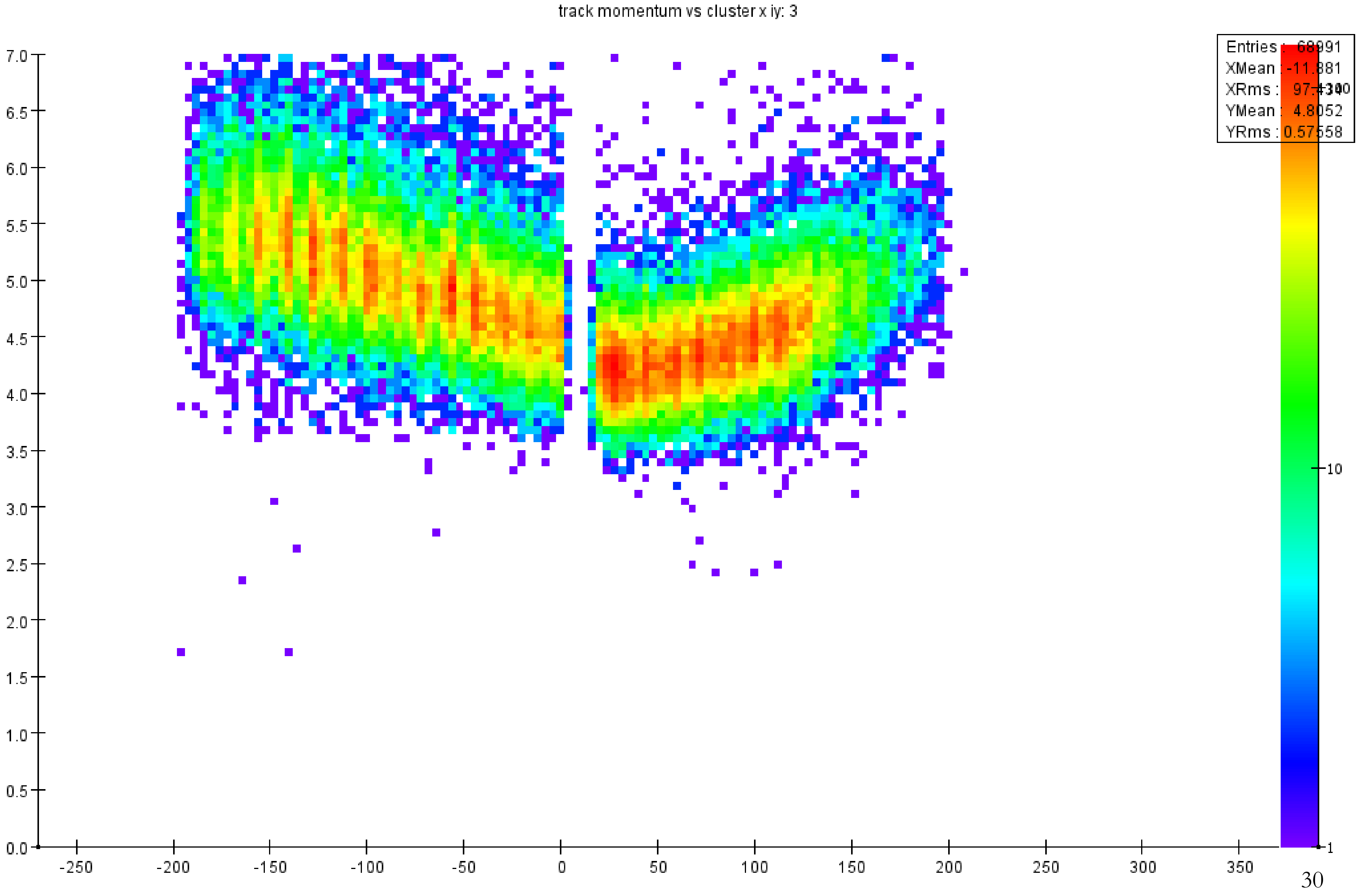
Track Momentum vs X, IY = +1



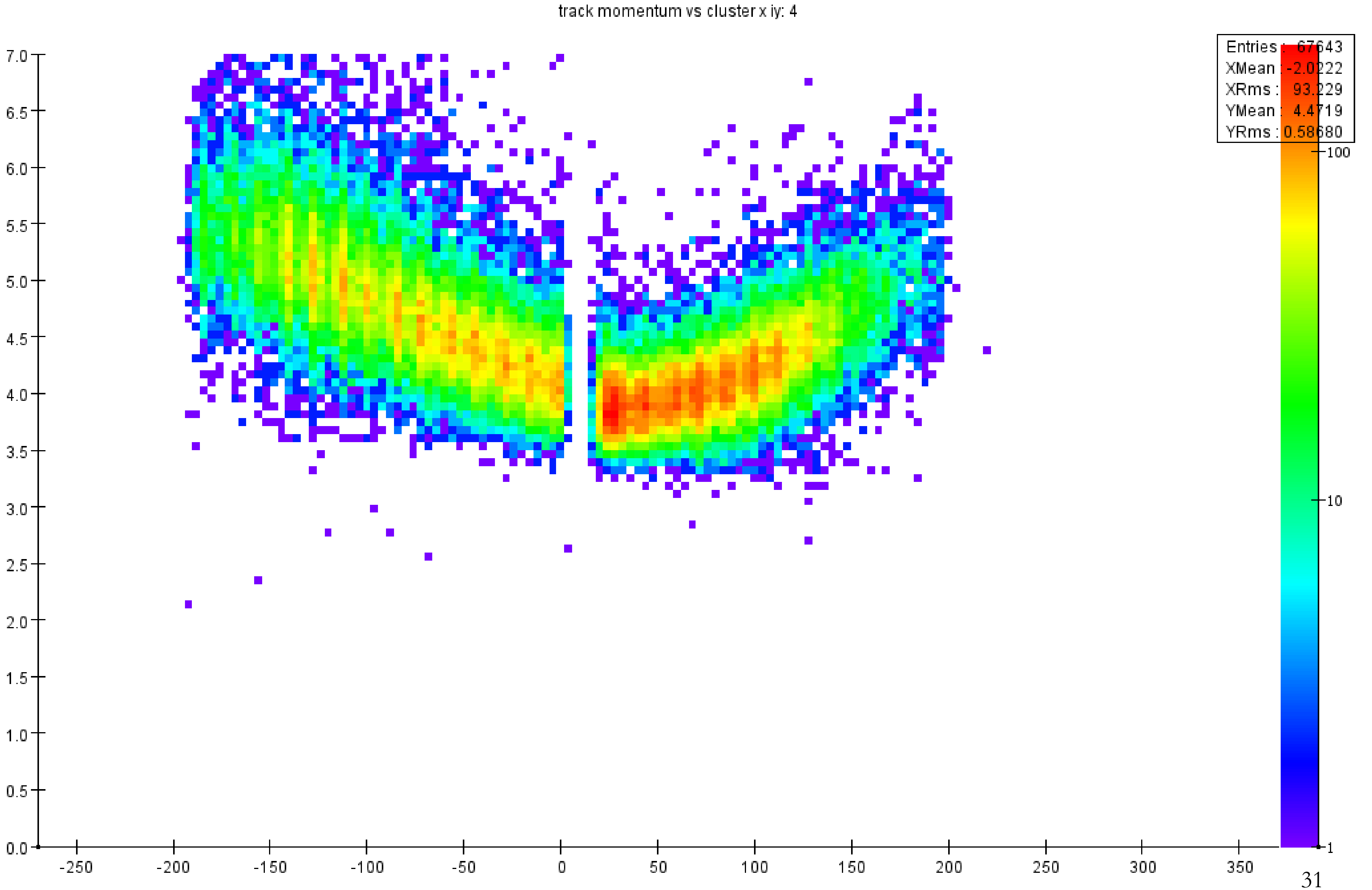
Track Momentum vs X, IY = +2



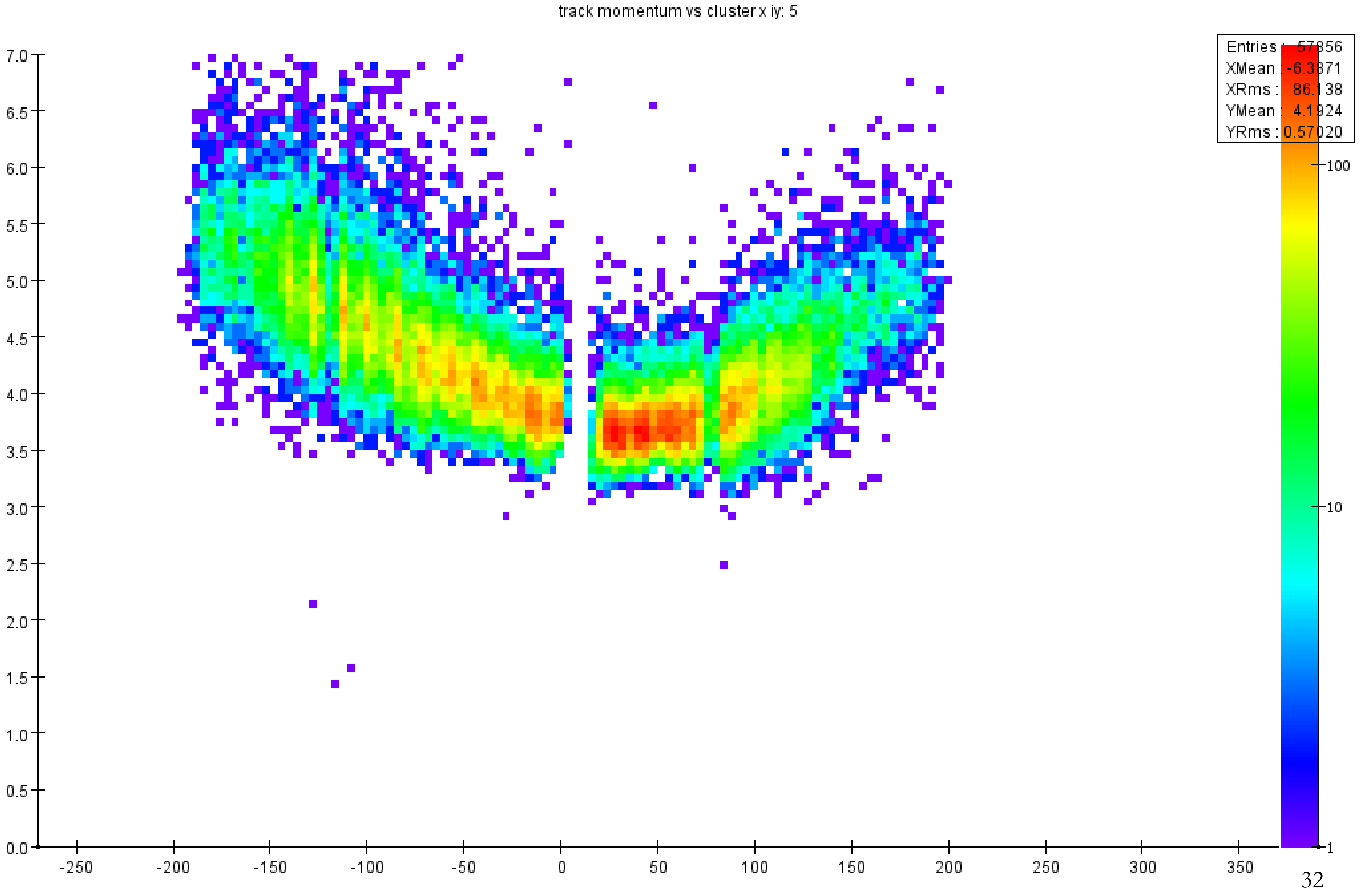
Track Momentum vs X, IY = +3



Track Momentum vs X, IY = +4



Track Momentum vs X, IY = +5



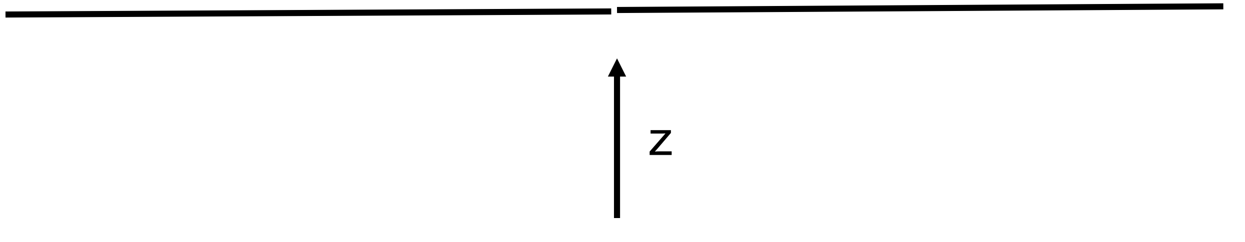
Momentum Systematics

- Bottom electron (hole) side is reasonbably well-behaved
- Bottom positron (slot) side shows shallow dependence on x
- Both electron and positron sides in the top show very strong dependence on x, increasing with y.
- This goes a long way towards explaining the differences we have seen when aligning with FEEs, which tend to populate the small |x| region, and with "physics" e+ and e- tracks, which tend to populate large |x|
- This behavior is consistent with suggestions of

out-of-plane bowing of the double-sensor stations.

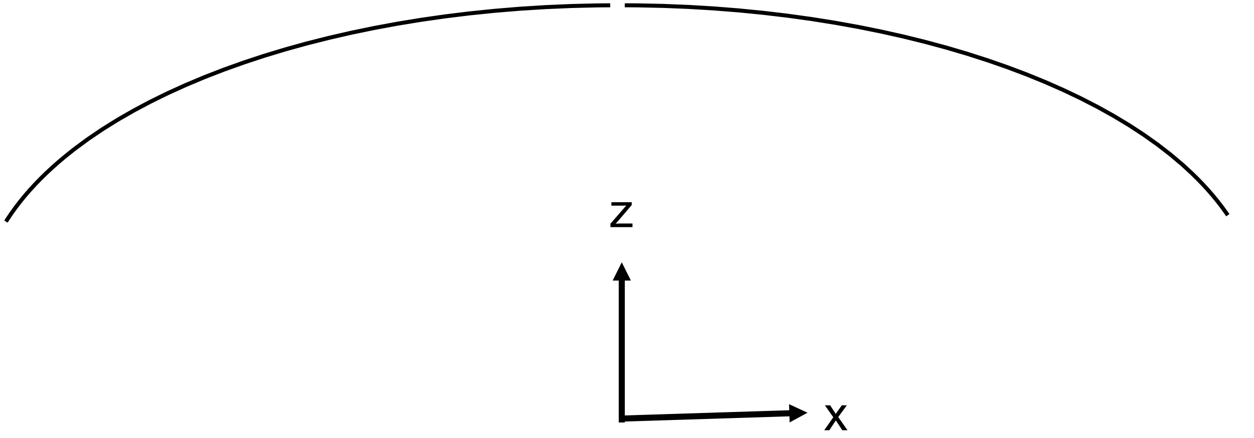
Out-of-plane bowing

- Evidence has been presented by PF for z translations of the sensors, but difficult to reconcile with locations of the aluminum mounts
- Bowing of the carbon fiber sensor mounts has recently been forwarded as a possible explanation of this behavior
- Ideal, flat, support for hole and slot sensors



Out-of-plane bowing

- Exaggerated bowing of support
- Telescoping of the detector in z would lower the curvature, and the momentum, with a dependence on x, lower in the middle, higher at the extrema

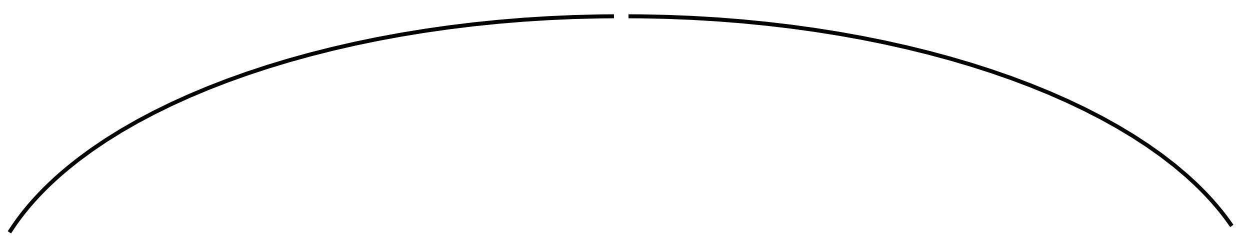


Out-of-plane bowing

- Need for MC studies to investigate both qualitative and quantitative behavior

Out-of-plane bowing

- Need for MC studies to investigate both qualitative and quantitative behavior
- Difficult to introduce non-planar sensors into our geometry and reconstruction software



Out-of-plane bowing

- Need for MC studies to investigate both qualitative and quantitative behavior
- Approximate non-planar detector with combination of Tz and Ry to place planar sensors on chords of the arc.