

2019 Calibration/Alignment

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2019 Data Analysis Workshop

April 7, 2020

Strategy

- Use elastically scattered beam electrons to calibrate the energy scale of the calorimeter and the momentum scale of the SVT.
- Use bremsstrahlung events to extend the calibration to lower energies/momenta and to study the track-finding efficiency.
- Use field-off straight tracks to start the SVT alignment.
- Follow up with GBL/millepede full alignment.

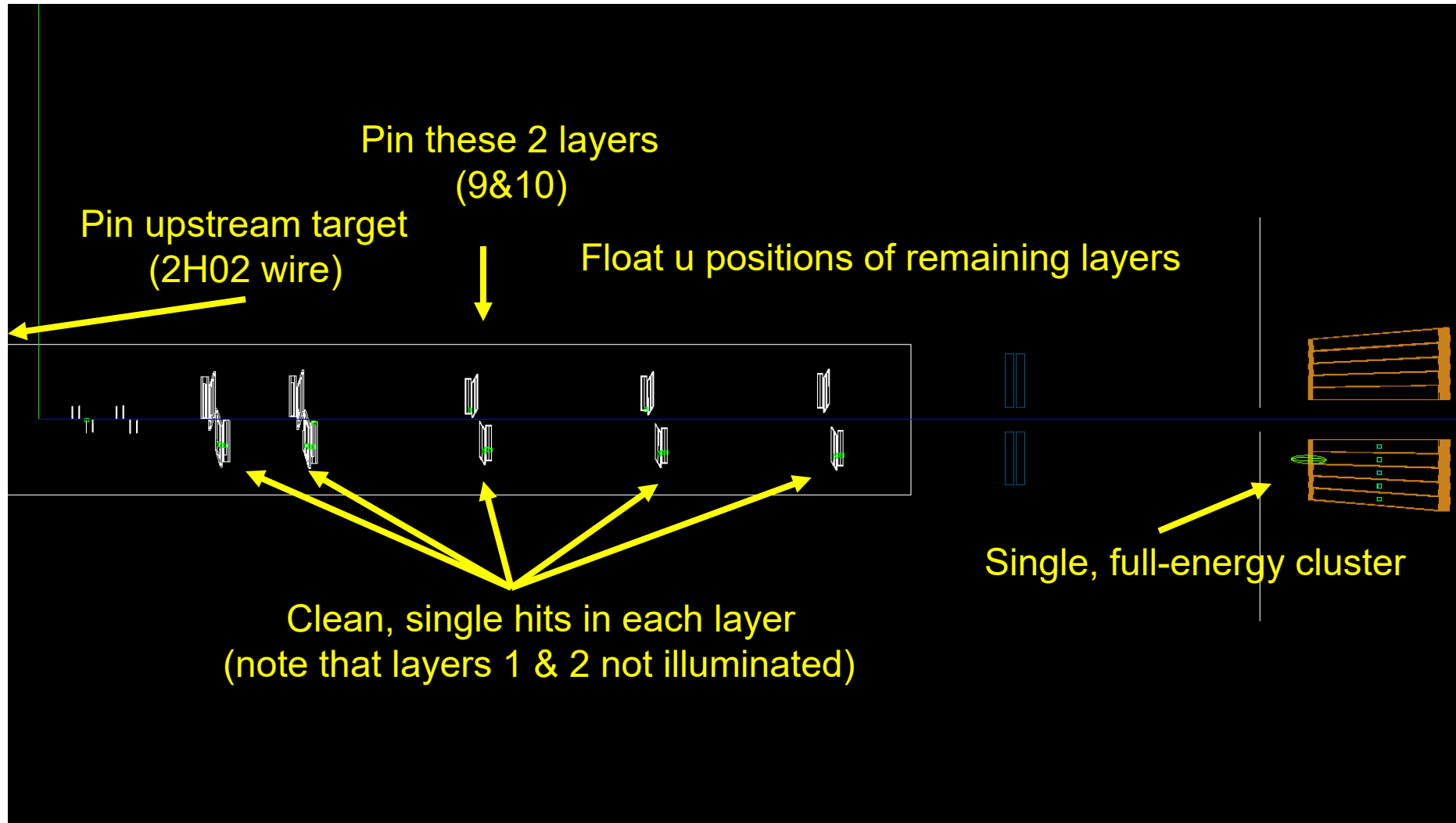
Calibration Data

- FEE triggers were taken throughout the run.
 - Maurik has written a nice evio file processor which can skim off events based on their trigger.
 - Can efficiently select events from any run.
- Dedicated FEE runs
 - 9371,9593,9898, 9899,9920, 9921,10097, **10103**, **10104**,10716, 10717, 10718
- Dedicated Field-Off Runs
 - **10101**,10333,10662,10734
- Two-gamma Trigger Skims for WAB analyses
- wab_beam MC for FEE and WAB

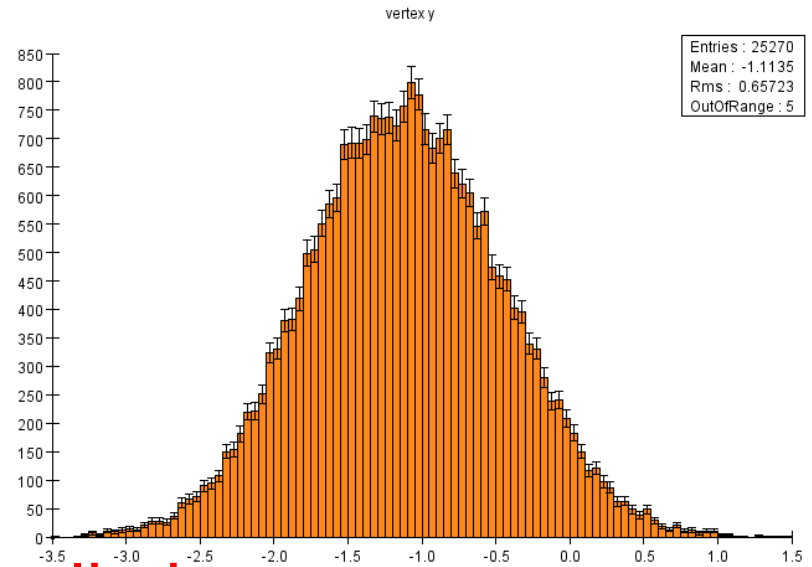
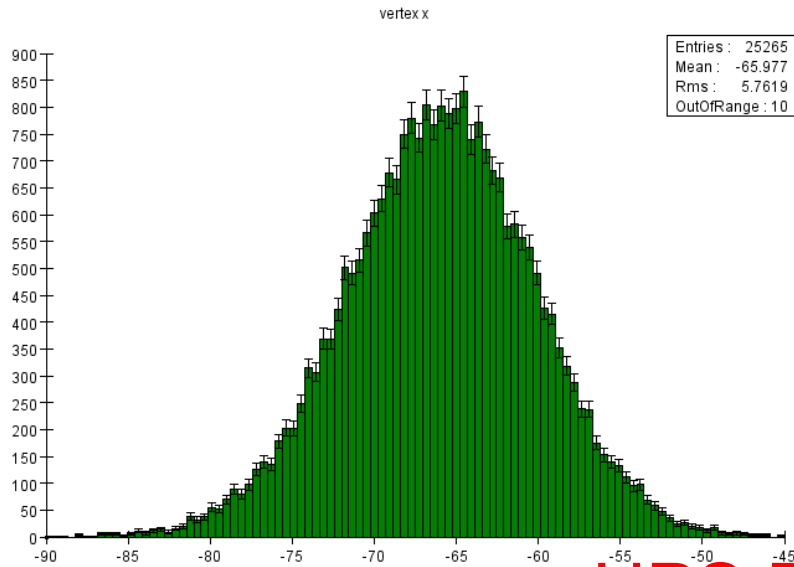
SVT Alignment

- Use straight tracks from the field-off runs.
- Select single cluster events with full energy.
- Used 2H02 wire as target (-2267mm upstream)
- Fit 1D strip hits in each hit sensor to straight line.
- Employ maximum likelihood alignment procedure to derive translation and rotation corrections.
- Work in progress to apply to field-on data, incorporating Layers 1&2 and using full GBL fit / millepede alignment.

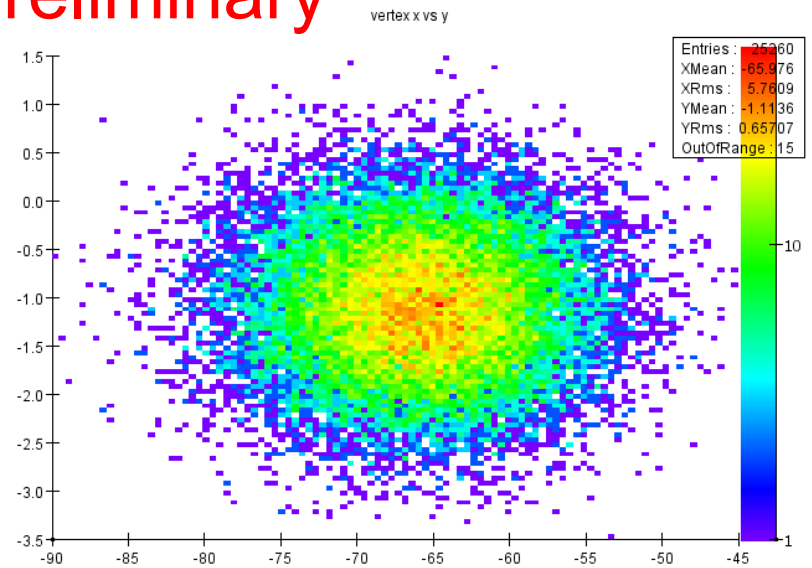
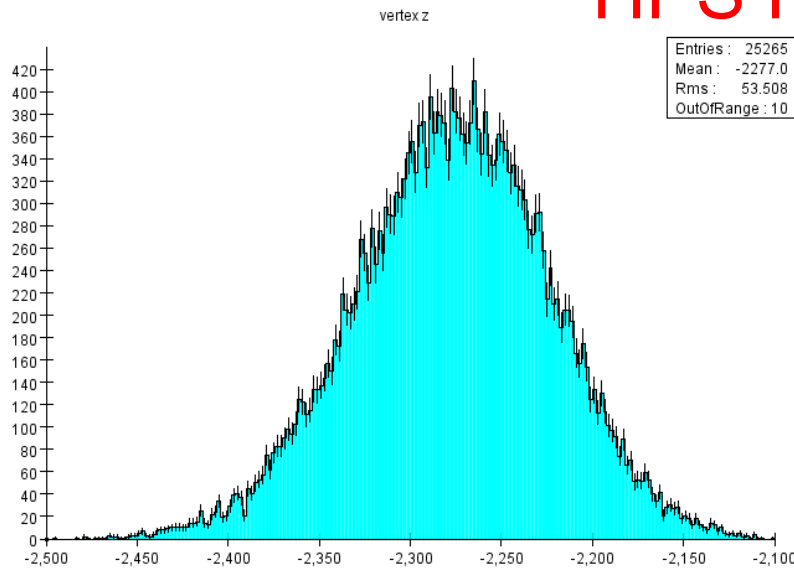
Field-Off Straight Track Alignment



Vertex Position (at 2H02 HARP wire)

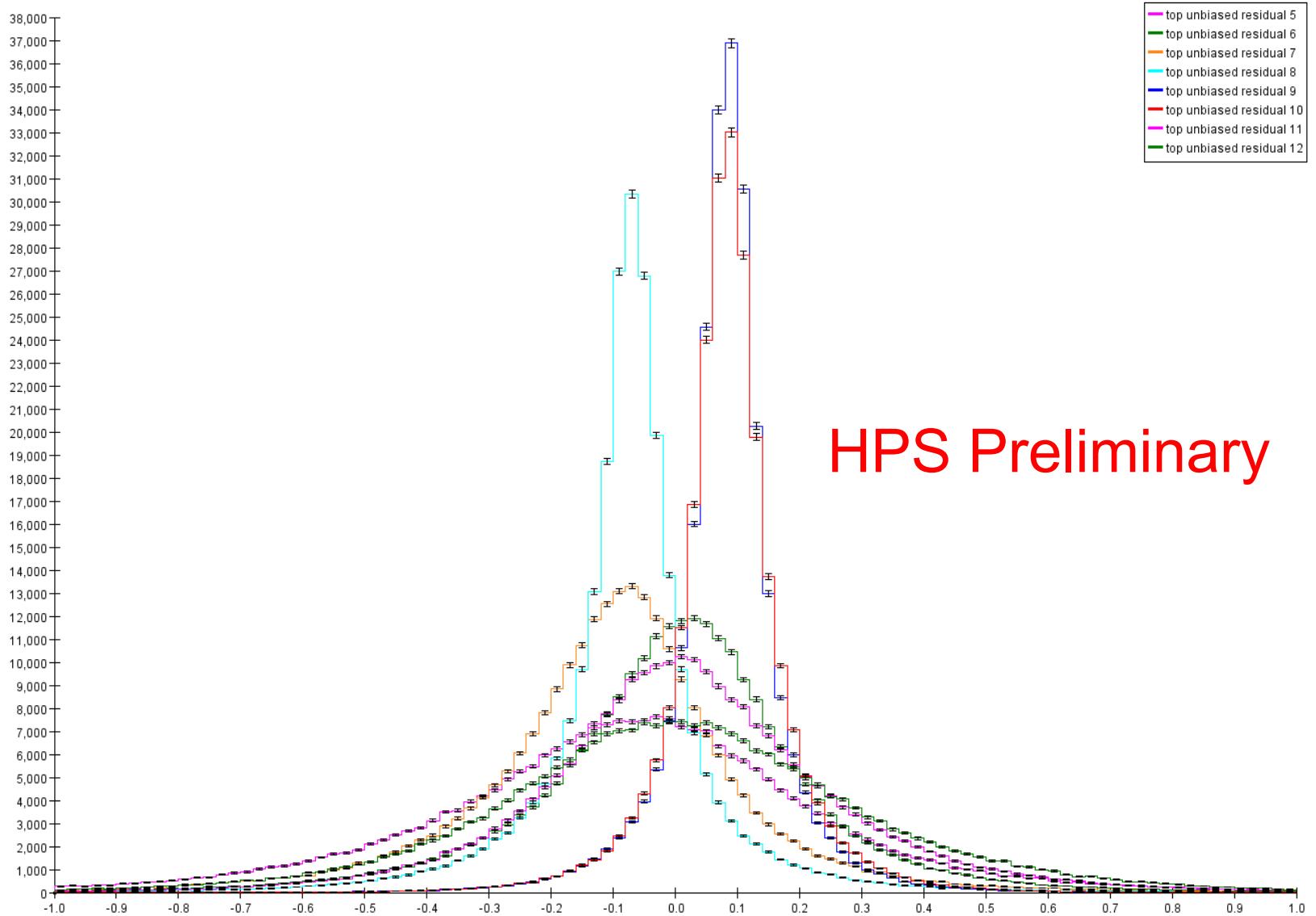


HPS Preliminary



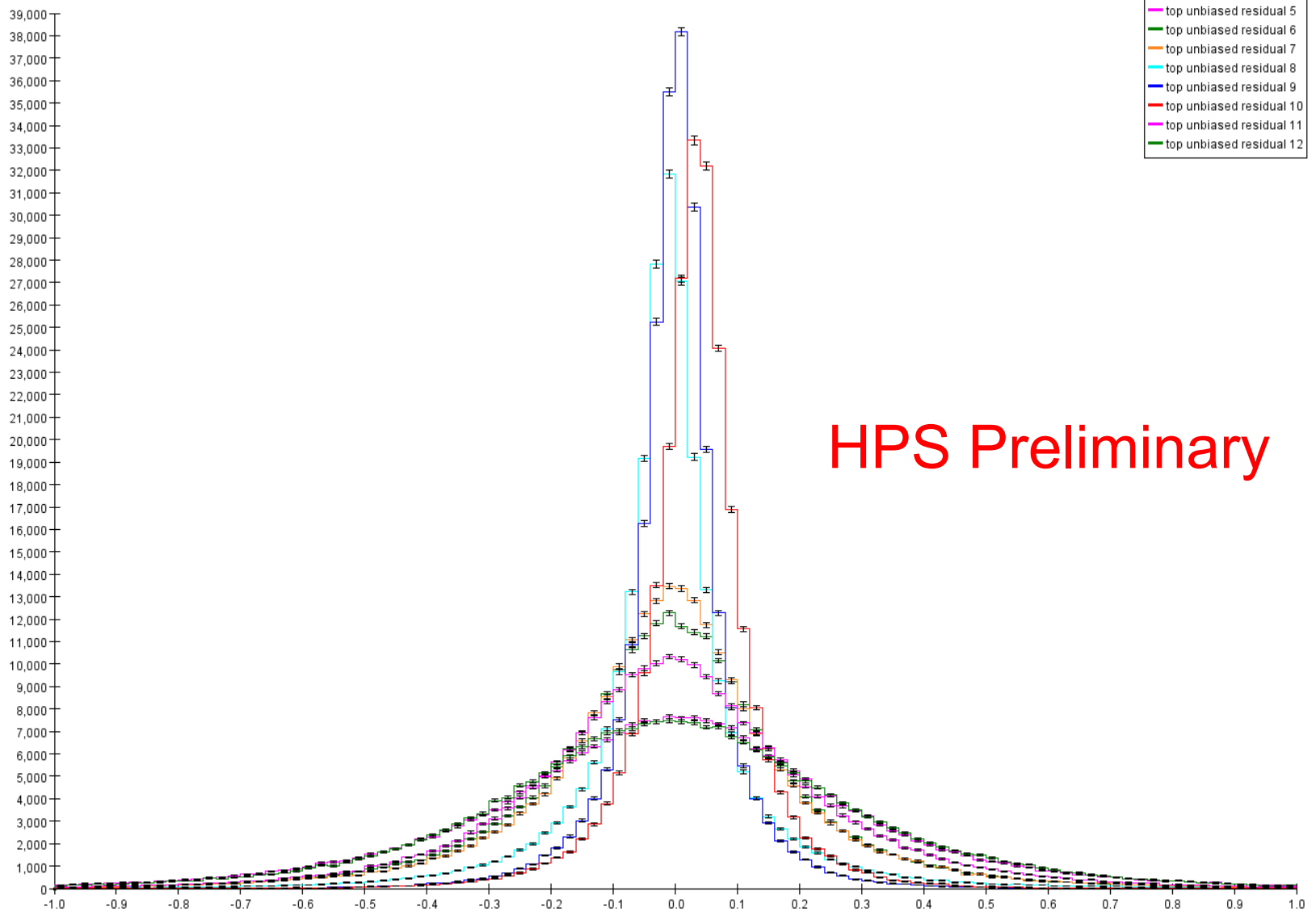
Top Residuals Before

20200121_10101_skim_alignment.aida - top alignment 1 - before - Track Refit



Top Residuals After

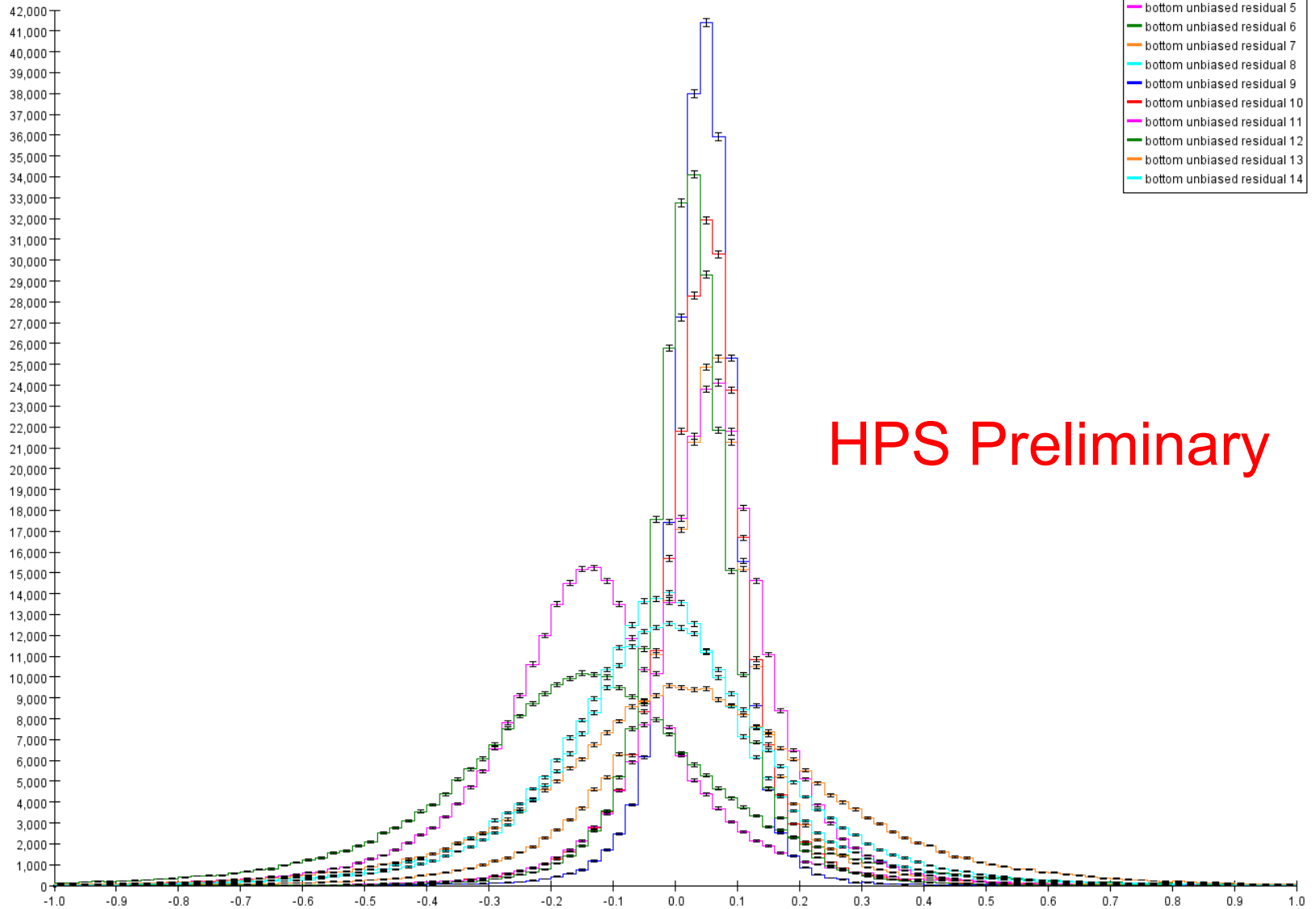
20200121_10101_skim_alignment.aida - top alignment 1 - after - Track Refit



HPS Preliminary

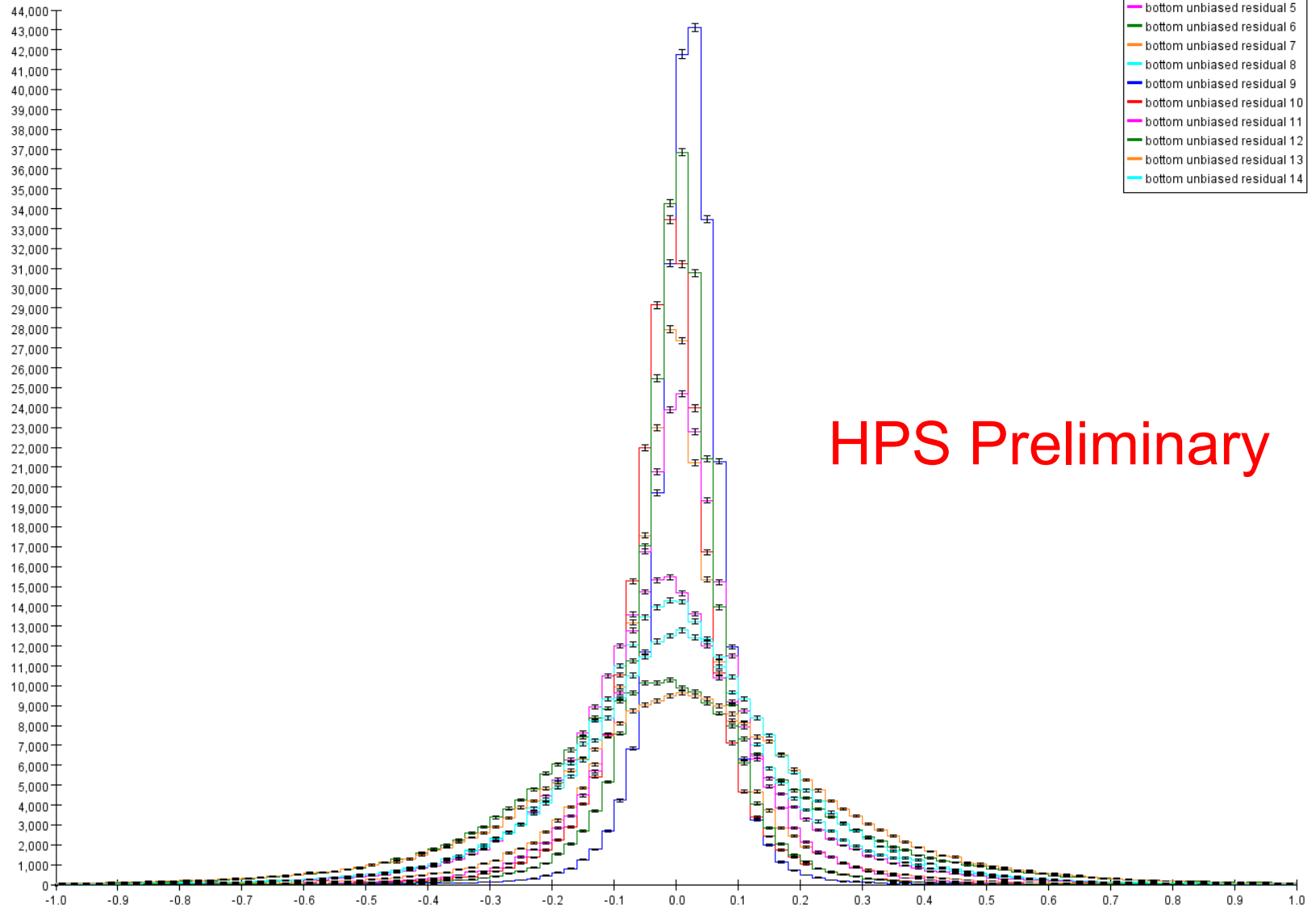
Bottom Residuals Before

20200121_10101_skim_alignment.aida - bottom alignment 1 - before - Track Refit



Bottom Residuals After

20200121_10101_skim_alignment.aida - bottom alignment 1 - after - Track Refit



HPS Preliminary

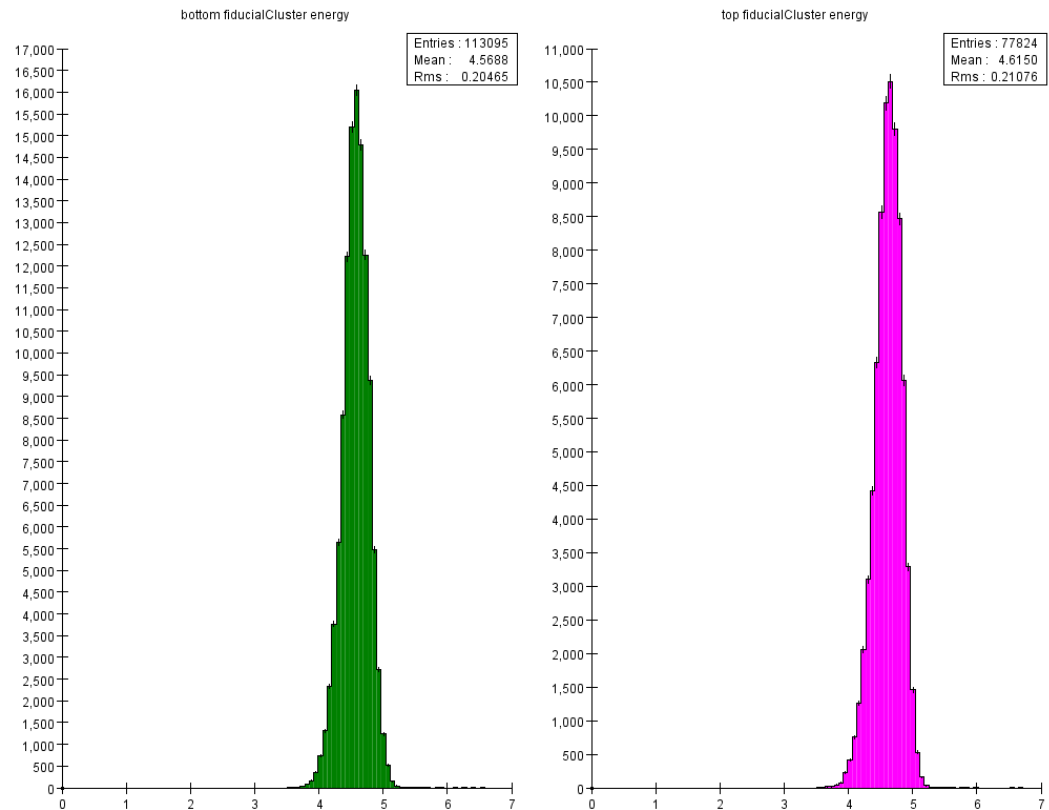
Ecal Energy Scale (Full Energy)

- Select events with one and only one cluster in the fiducial region of the calorimeter (viz. seed crystal is not on the edge).

Looks pretty good right out of the box!

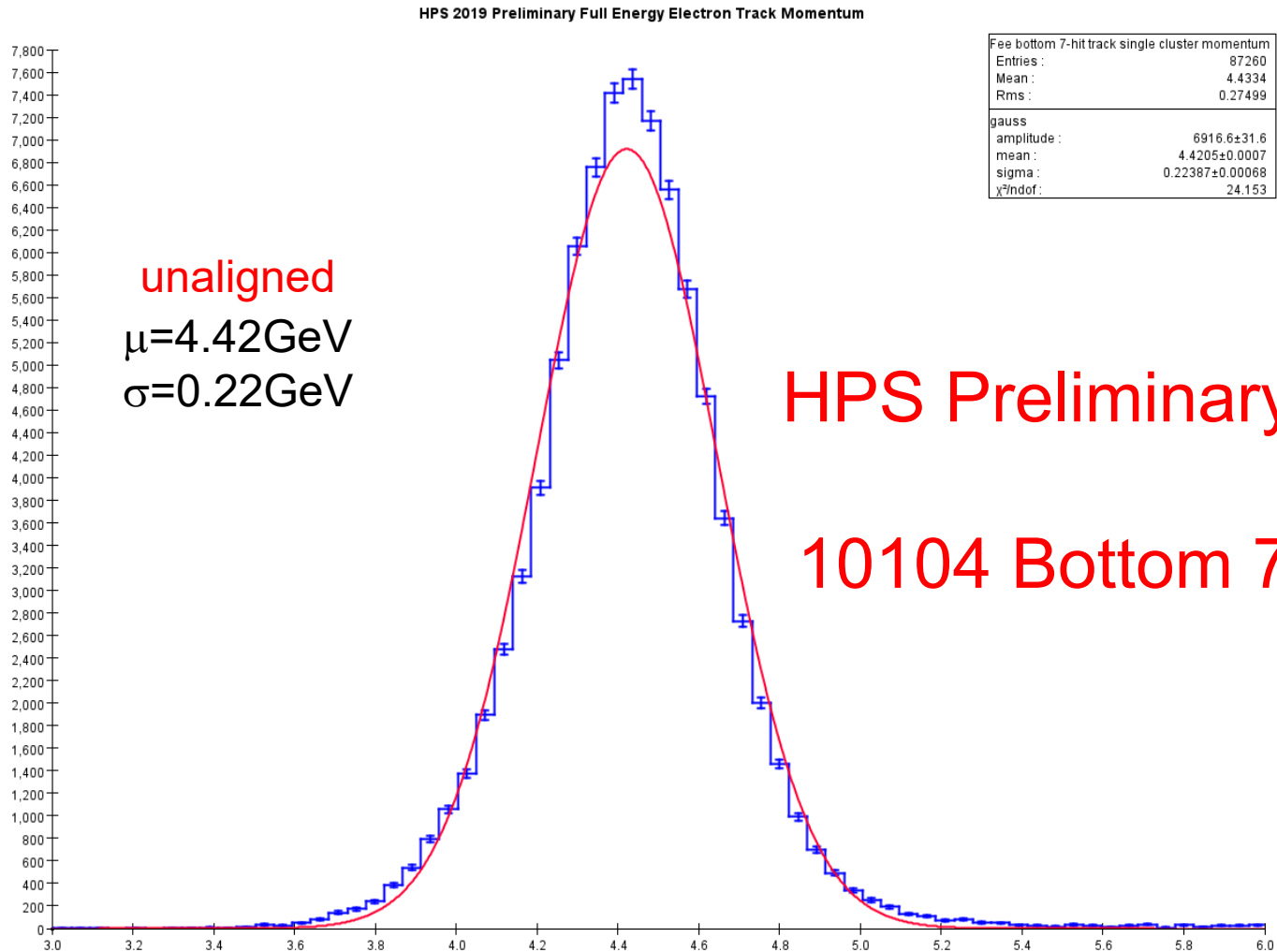
Slight differences in absolute scale and resolution between top and bottom.

Crystal-by-crystal calibration not yet applied.



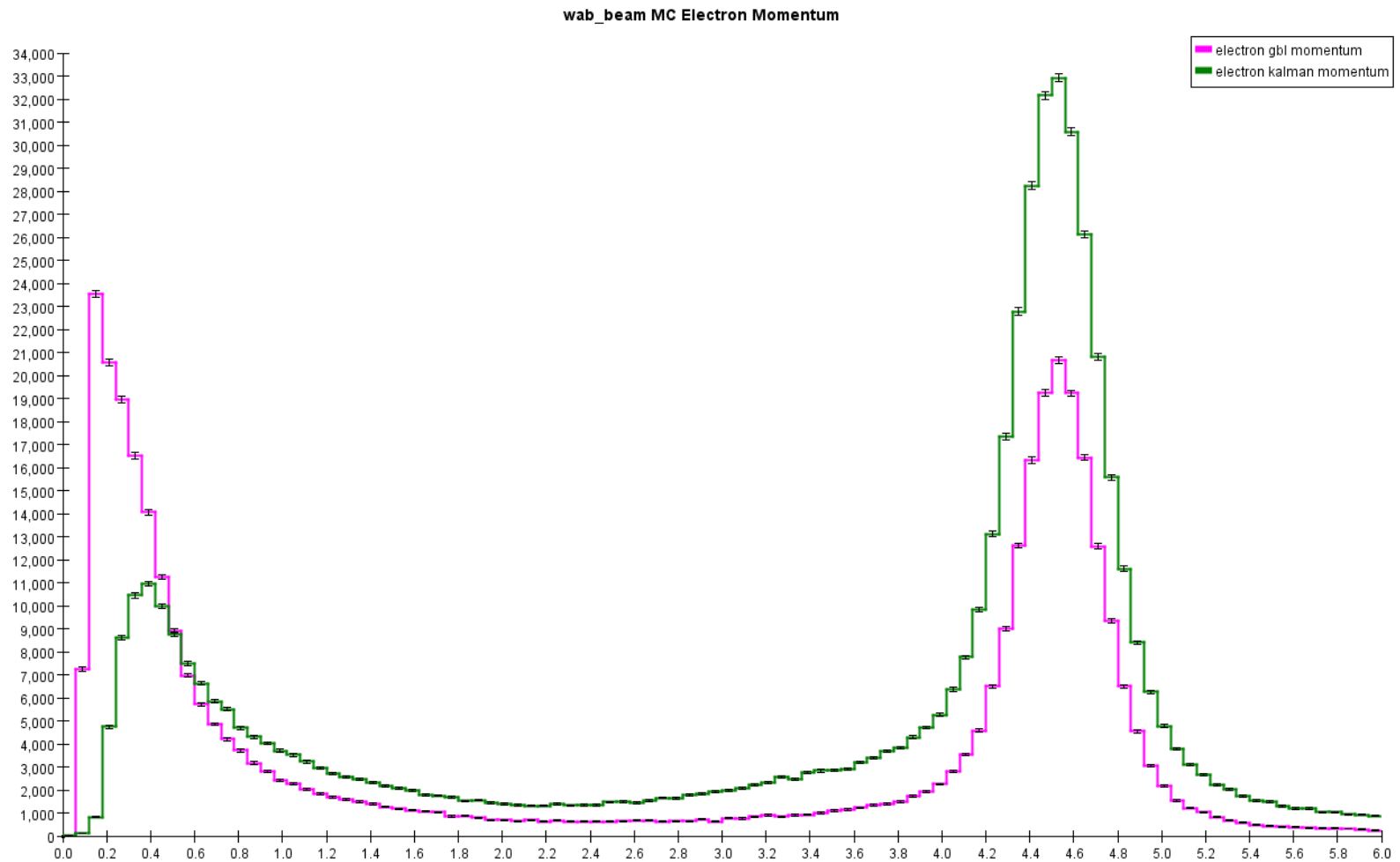
Field-On FEE Track Momentum

- Select single, high-energy cluster events



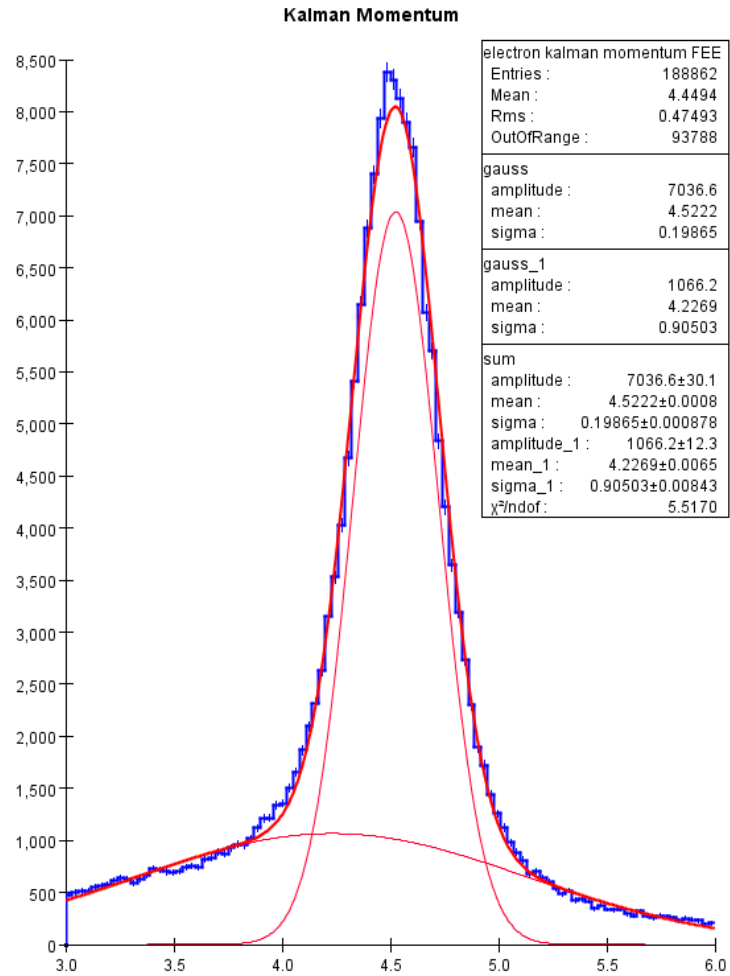
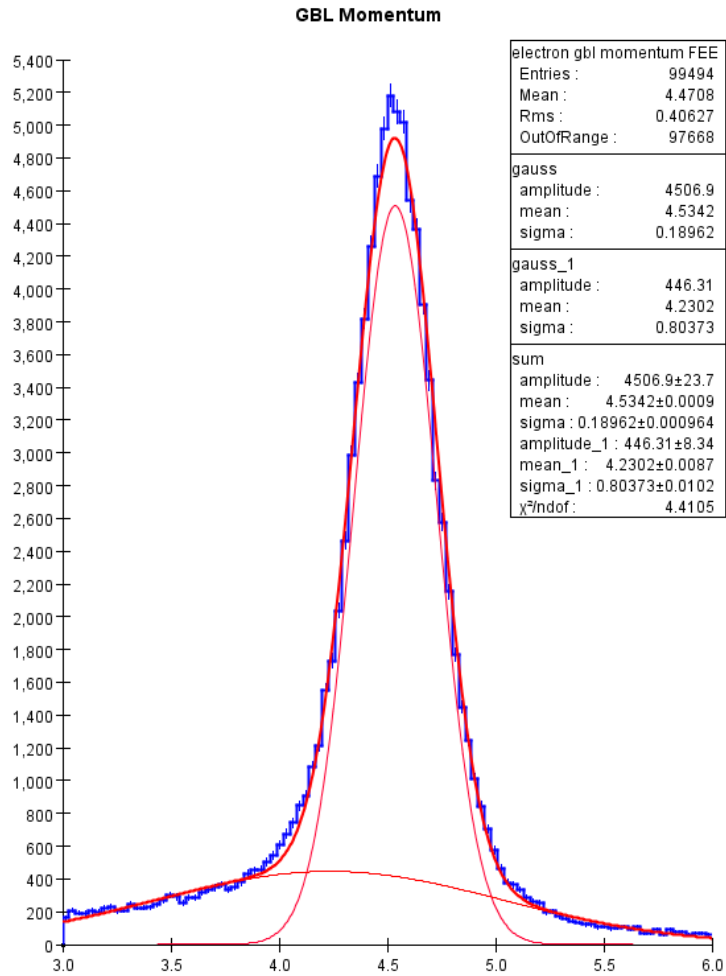
MC Electron Track Momentum

■ wab_beam MC



MC FEE Momentum Resolution

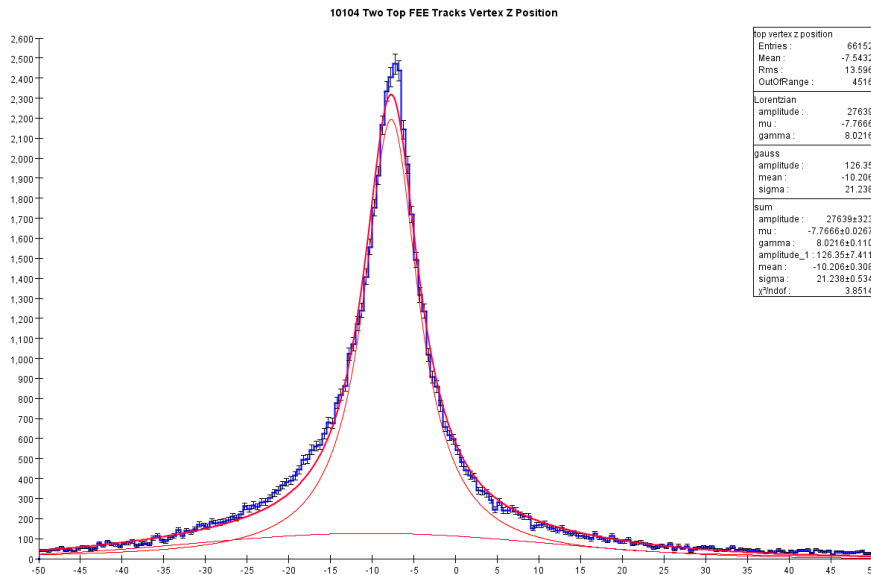
■ wab_beam MC



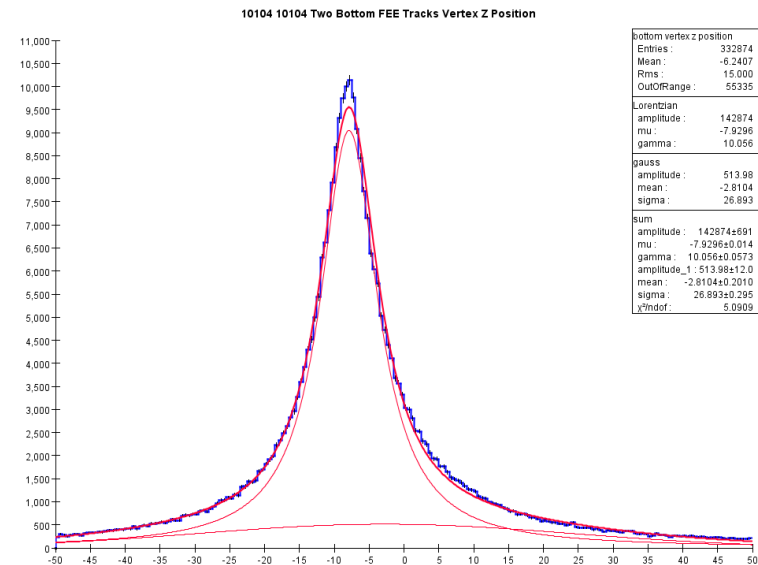
Target & Beam Location @ IP

- Vertex two top FEE tracks or two bottom FEE tracks to locate target in z.

HPS Preliminary



Top Z = -7.8mm



Bottom Z = -7.9mm

Ecal Energy Scale (All Energies)

- Use bremsstrahlung events to transfer calibration to lower energies.
- Plot $e^- \gamma$ energy sum

Select two and only two fiducial clusters in the event.

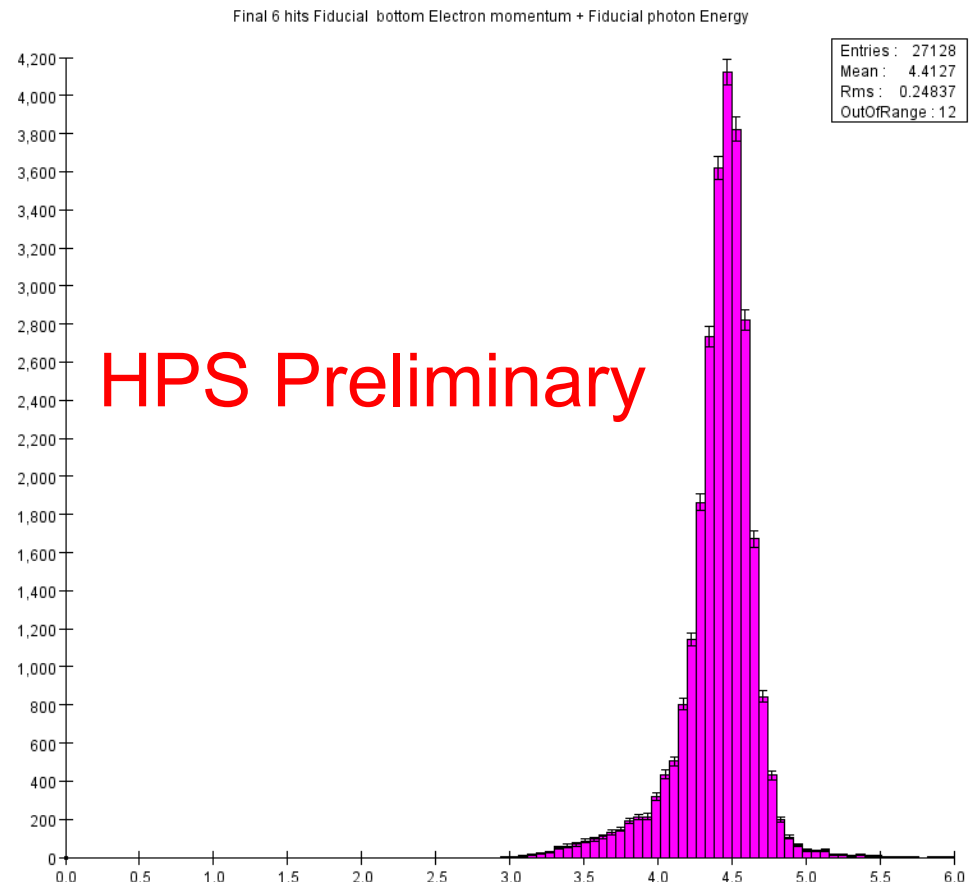
Plot sum of electron momentum and photon energy.

Should equal beam energy if we have an inelastic electron and the radiated photon.

Looks pretty good right out of the box!

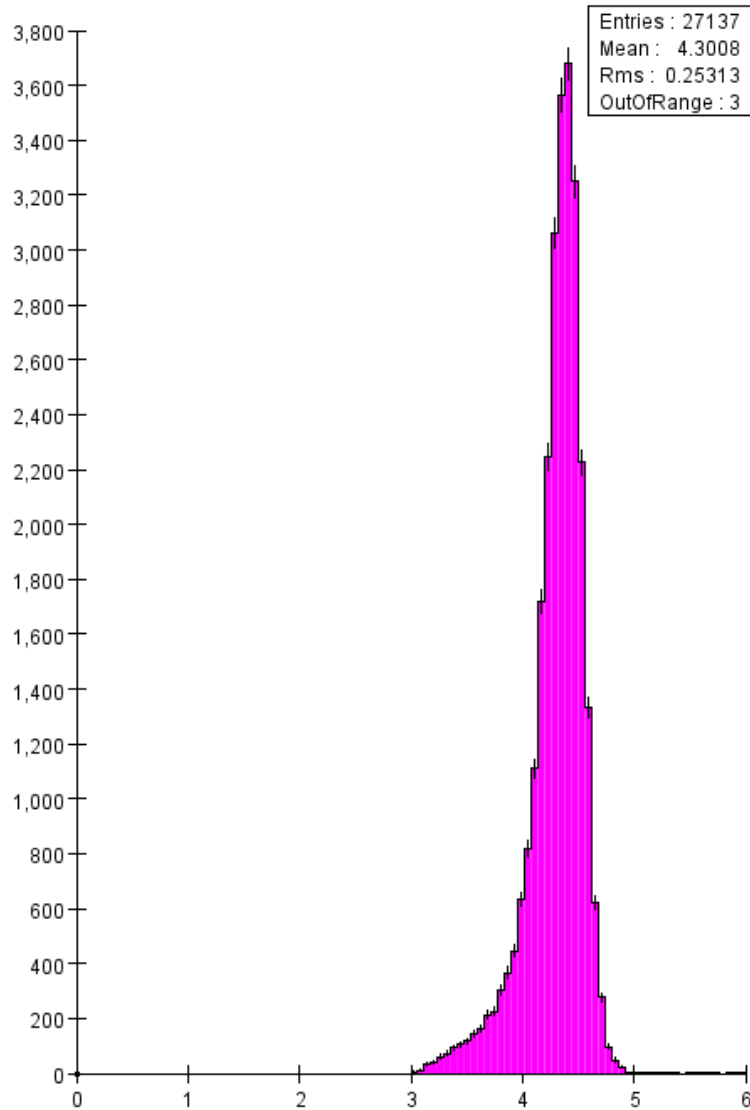
ECal NOT corrected.

Can select one fiducial cluster and correct edge clusters.

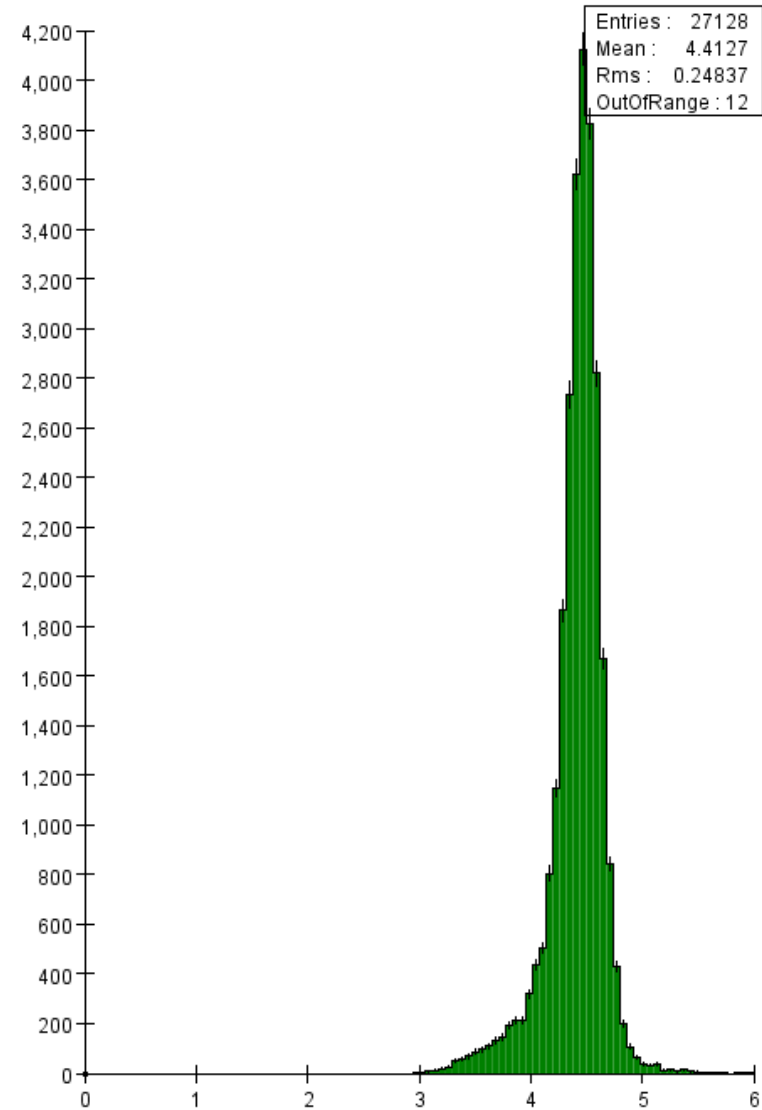


Bottom Electron + Top Photon

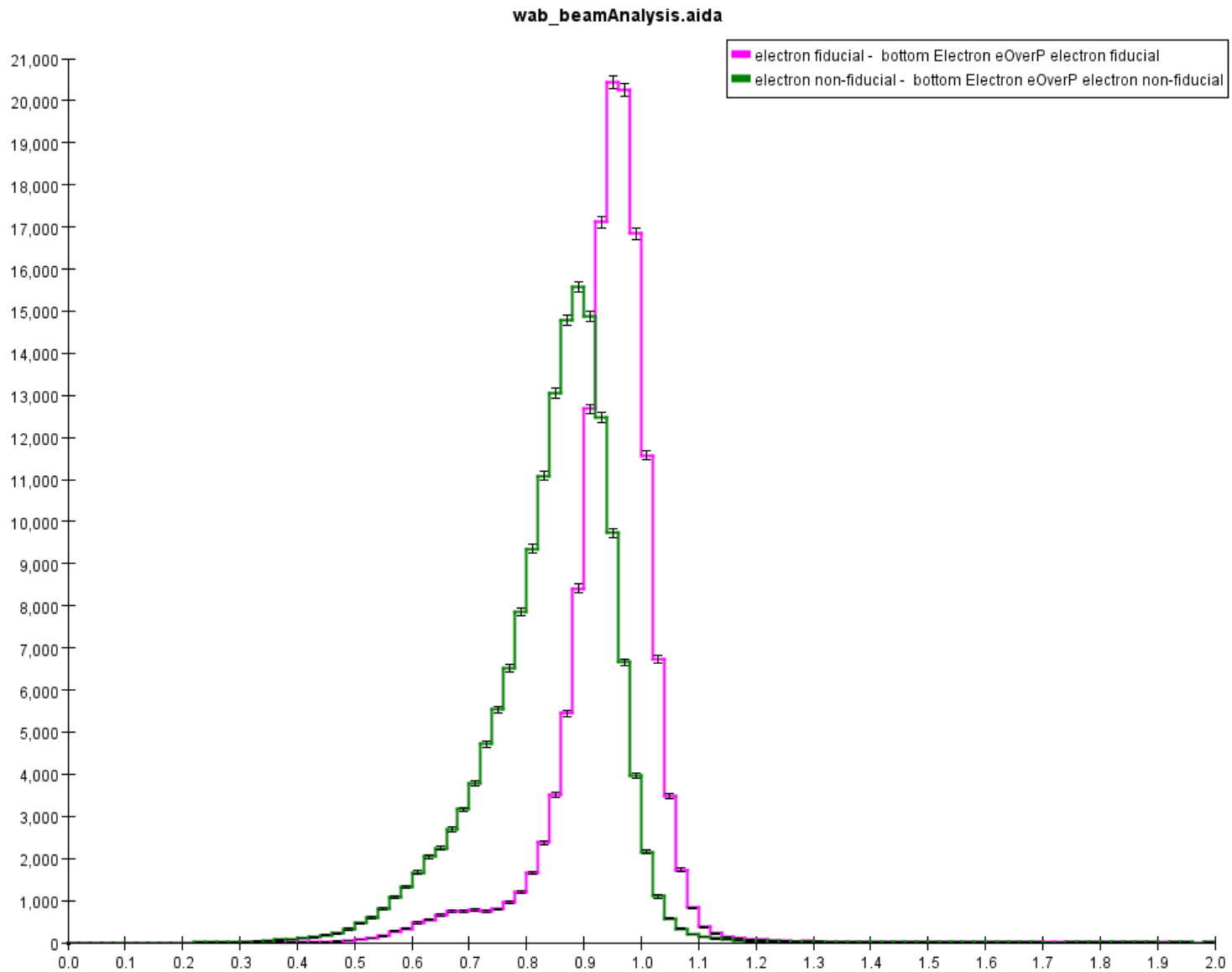
Final 6 hits Fiducial bottom Electron energy + Fiducial photon Energy



Final 6 hits Fiducial bottom Electron momentum + Fiducial photon Energy



Energy Calibration (E/P)



Good News

- We have LOTS of calibration data to analyze
 - Dedicated FEE runs
 - Dedicated Field-off runs
 - Trigger skims for WABs, etc.
- With judicious selection cuts
 - Clean calibration samples can be isolated
 - Good agreement between tracker and calorimeter results (in fiducial region)
 - Momentum scale and resolution are not too bad
 - Alignment proceeding (albeit slowly)

Real News

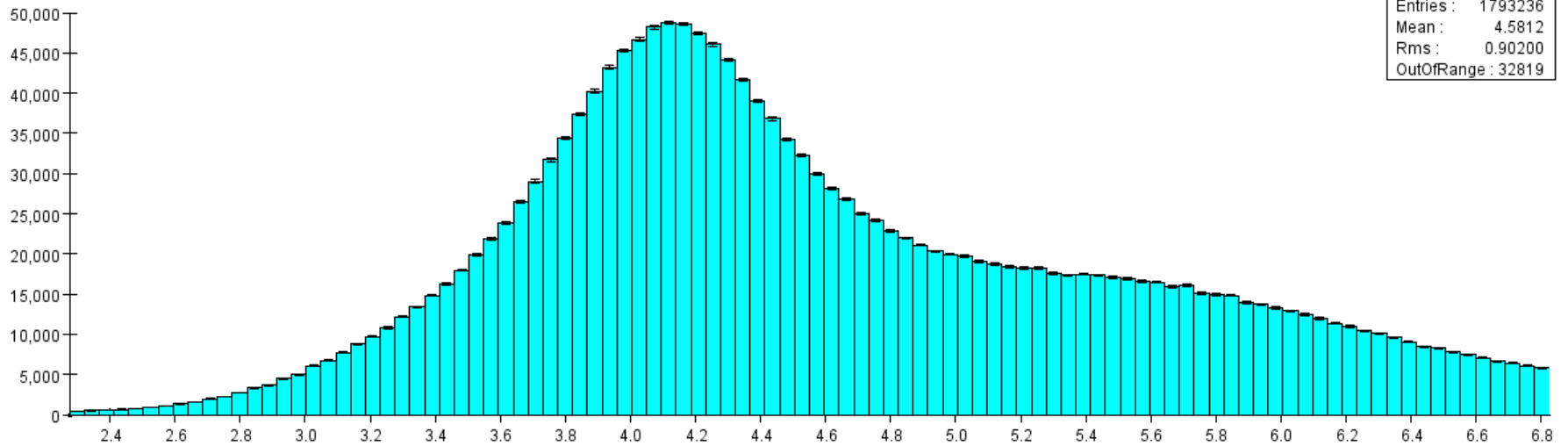
- We don't have the liberty of selecting just the "good" data
 - Missing SVT layers in both top and bottom for most of the "physics" data
 - Momentum scale and resolution for 5 & 6 hit tracks much worse.
 - Alignment still needs to be performed

hps_010104 FEE Run

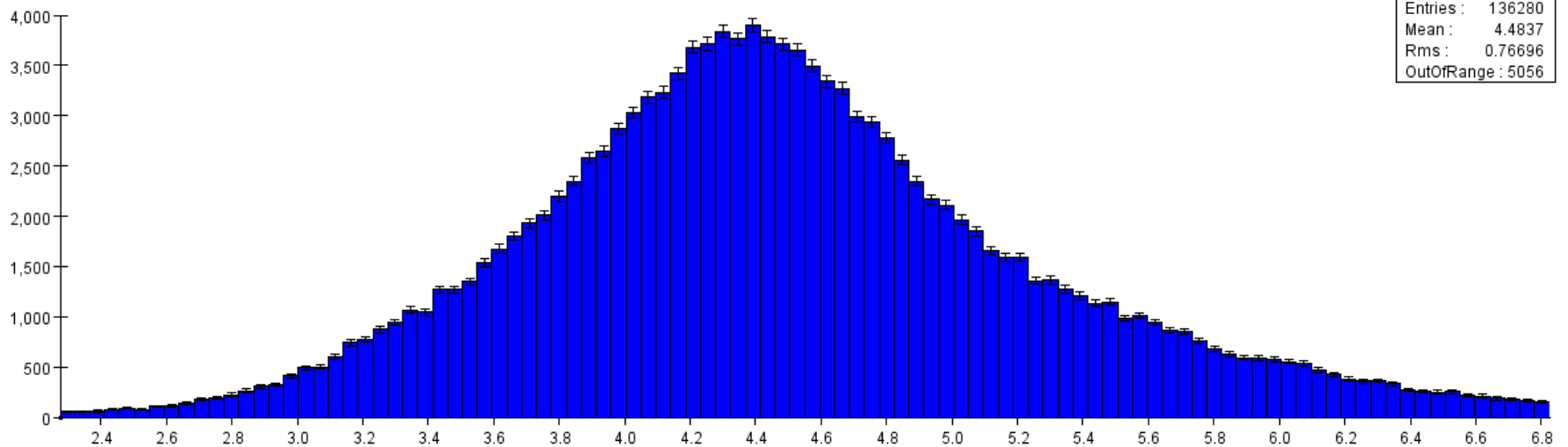
- Processed events from one of the early dedicated FEE runs.
 - All bottom layers were working → 14 hits tracks.
- Reconstructed using standard steering file
- Skimmed events separately from top and bottom.
- Selected events with one and only one cluster and track.

FEE 10104 Top Momenta

Fee top 5-hit track momentum

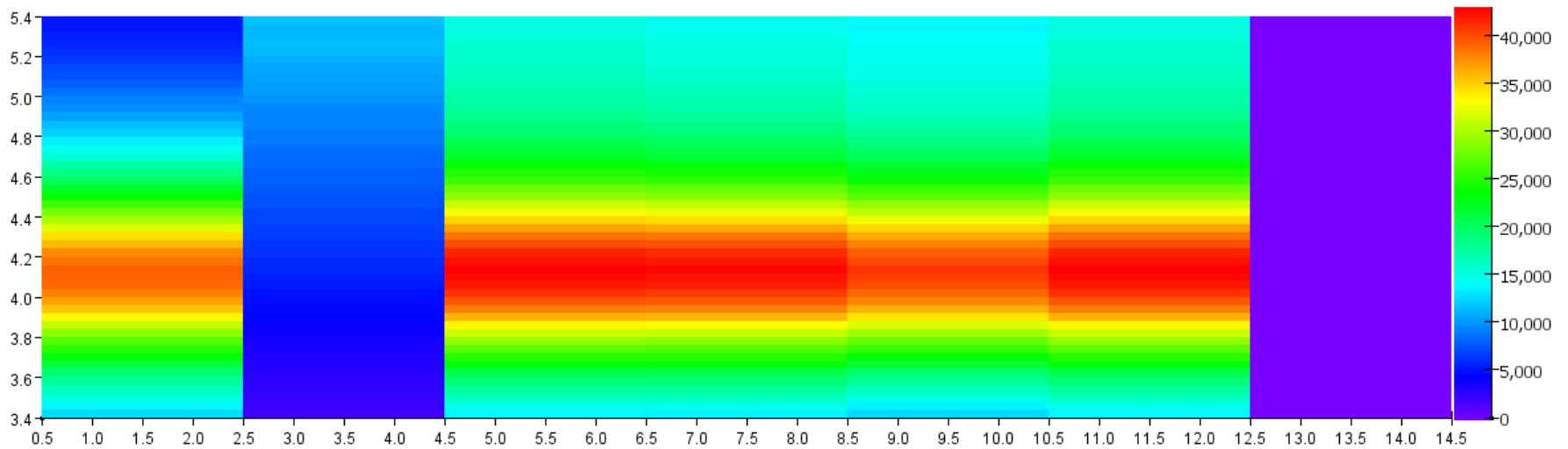


Fee top 6-hit track momentum

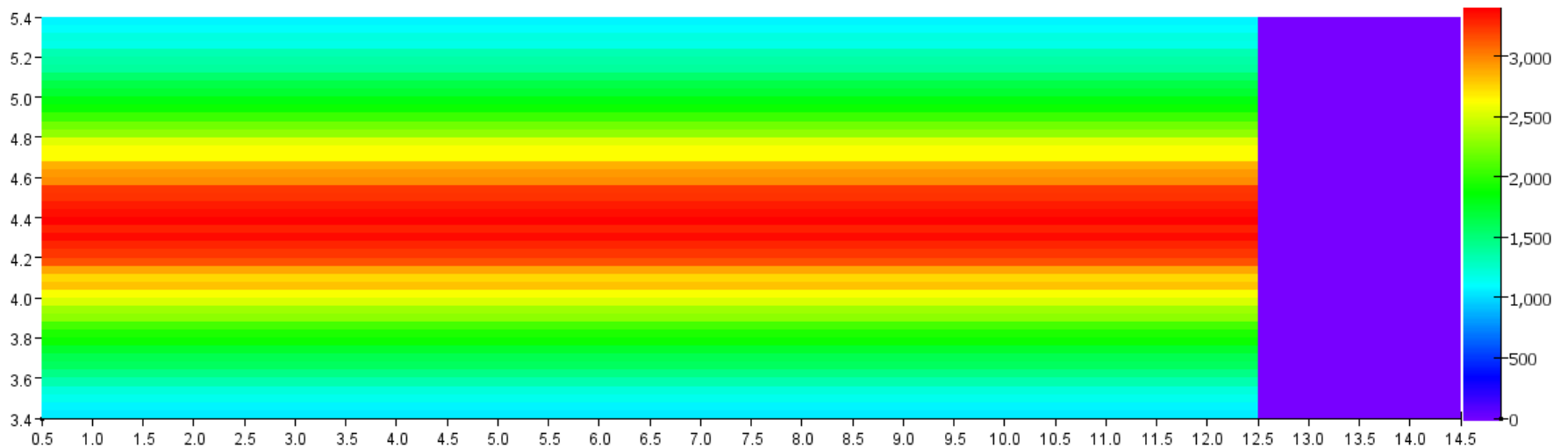


FEE 10104 Top Momenta vs Layer

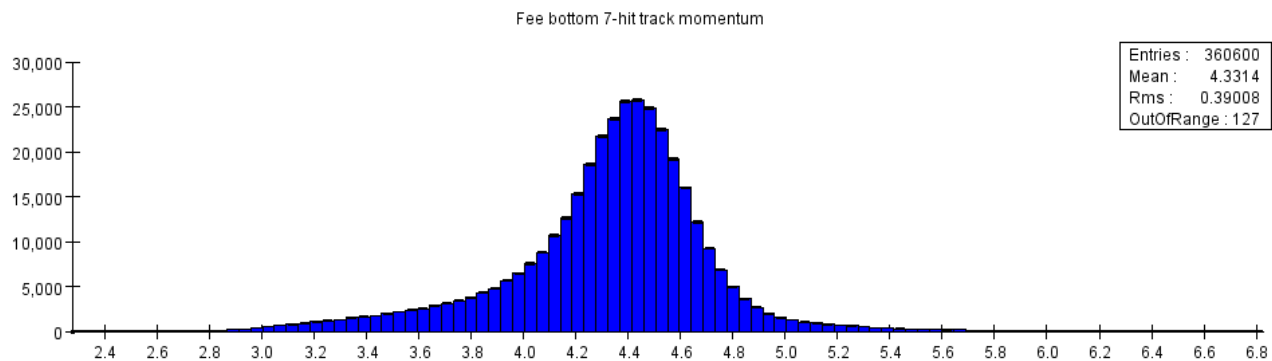
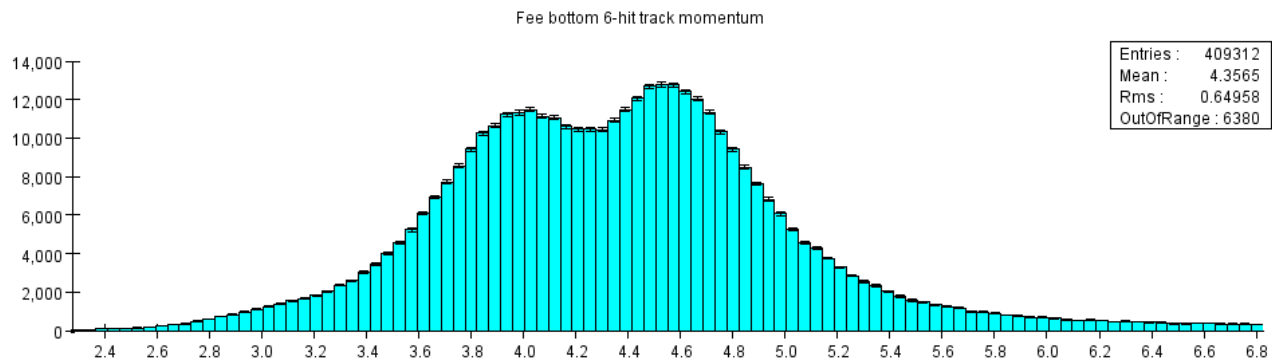
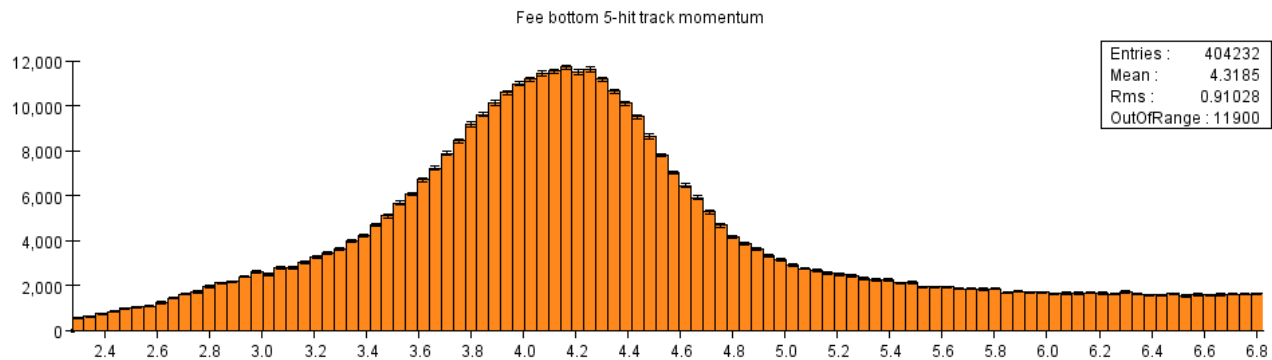
top 5-hit Track hit layer number vs track momentum



top 6-hit Track hit layer number vs track momentum

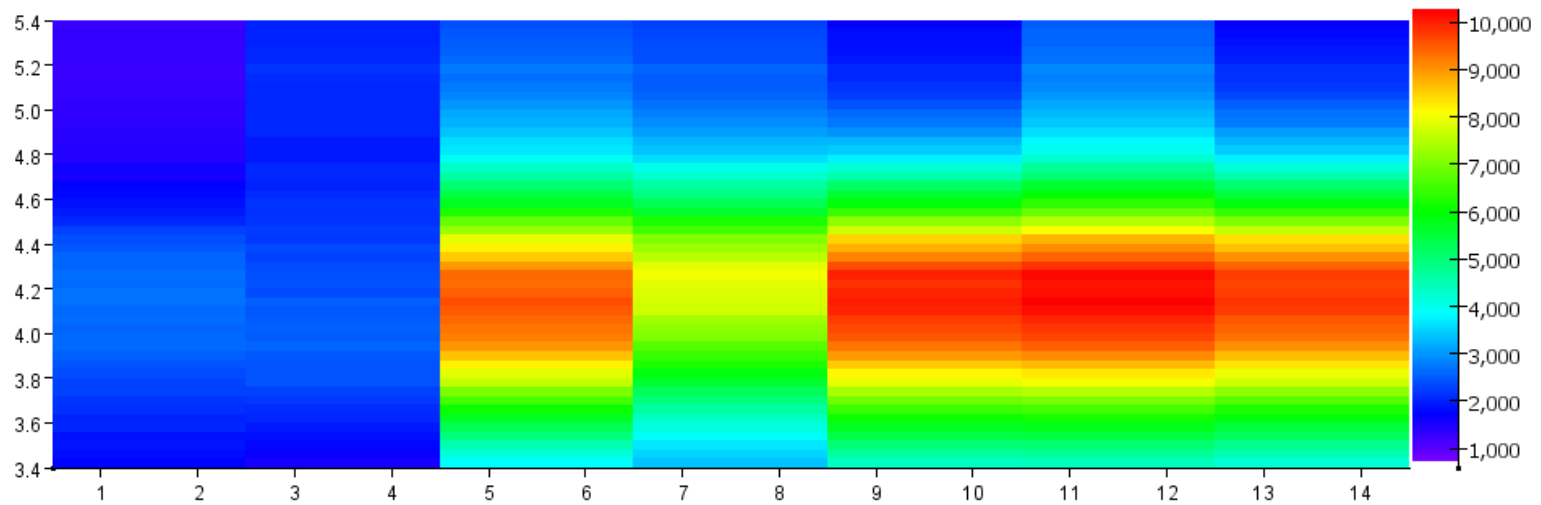


FEE 10104 Bottom Momenta

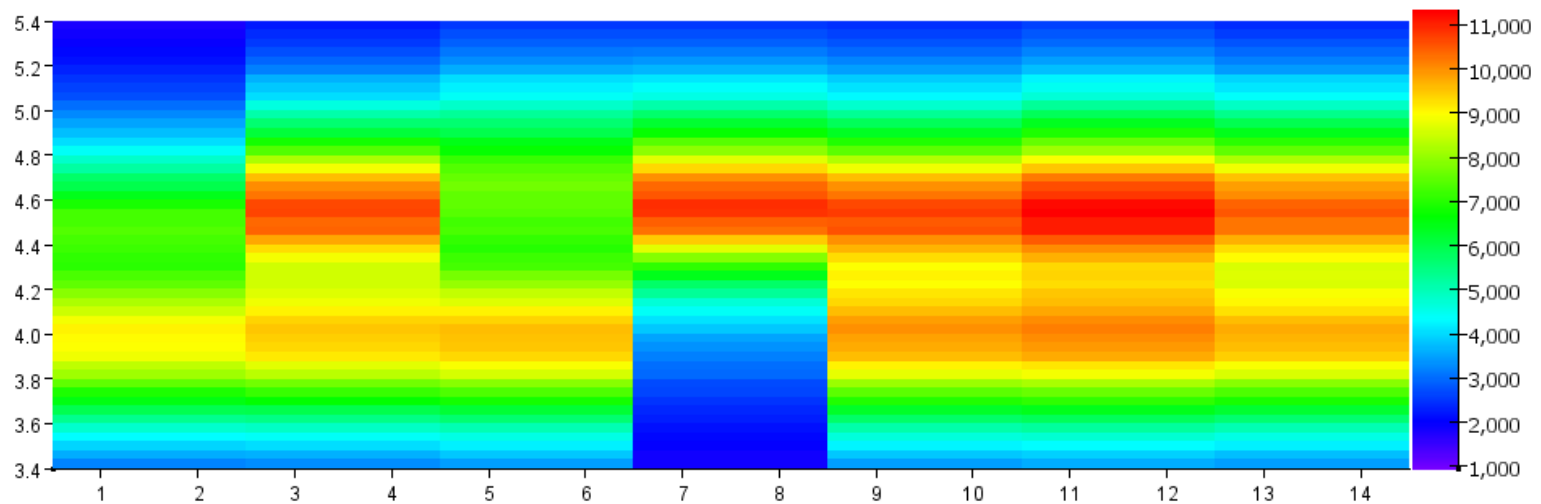


FEE 10104 Bottom Momenta vs Layer

bottom 5-hit Track hit layer number vs track momentum



bottom 6-hit Track hit layer number vs track momentum



Missing/Misaligned Layers

- Layers 1 & 2 are particularly influential
 - Alignment essential
- Use of Kalman Filter will allow us to pick up single sensor hits
 - Unbiased residuals from the fit can inform the alignment

Alignment

- ❑ Applying straight-track alignment to field-on data not as successful as hoped for.
 - Additional layers 1&2 may have added to confusion
- ❑ Deferred due to work on other more pressing needs
- ❑ Failure to modify/remove 2016 MOUSE cuts led to poor selection of GBL tracks for alignment procedures
 - e.g. essentially no 7-hit tracks survived.
- ❑ Have large samples of 4.5GeV electron tracks to use
 - Minimize multiple scattering contribution
 - Fast feedback on performance.
- ❑ GBLOutput root files produced
- ❑ Millepede binary files produced.

Moving Forward

- Pieces are in place to bring everything together
 - MC simulation now working
 - Thanks to Omar for fixing SVT digitization code
 - Thanks to Tongtong for timely generation of WAB & tritrig samples
 - Plan to generate samples with known misalignments to test alignment procedures.
 - Large samples of clean FEE and WAB events are available for use
 - GBL/Millepede chain is operational
 - GBLOutput root files available for analysis
 - GBLOutput millepede binary files available for analysis
 - Need to “turn the crank” and see what we get
- Stay tuned.