2019 SVT Calibration/Alignment

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Strategy

- Use elastically scattered beam electrons to calibrate the momentum scale of the SVT.
- Use bremsstrahlung events to extend the calibration to lower energies/momenta.
- Use field-off straight tracks to start the SVT alignment.
- Use GBL/millepede on FEEs to refine alignment.
- Performance metrics
  - No Mollers!
  - Position and width of FEE / WAB peak
- Currently working with Alessandra Filippi and Pierfrancesco Butti.
- Hope to attract others to this important task.

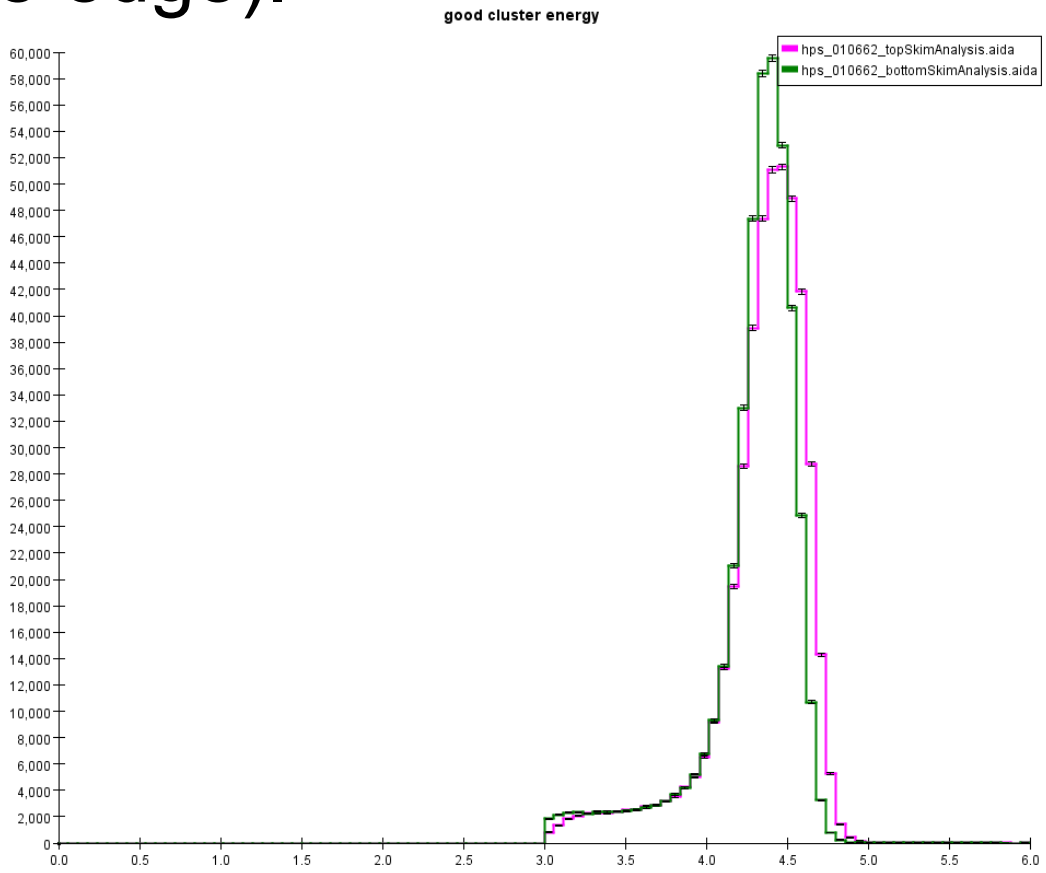
Calibration Data

- 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
  - 10097, 10104,10716, 10717, 10718
- Dedicated Field-Off Runs
  - 10101, 10103, 10104,10333,10662,10734
- Begin with 10101 & 10104
  - runs are close together and after SVT shift
  - Bottom layer 4 was still working.

FEE (Full Energy Electron) Selection

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

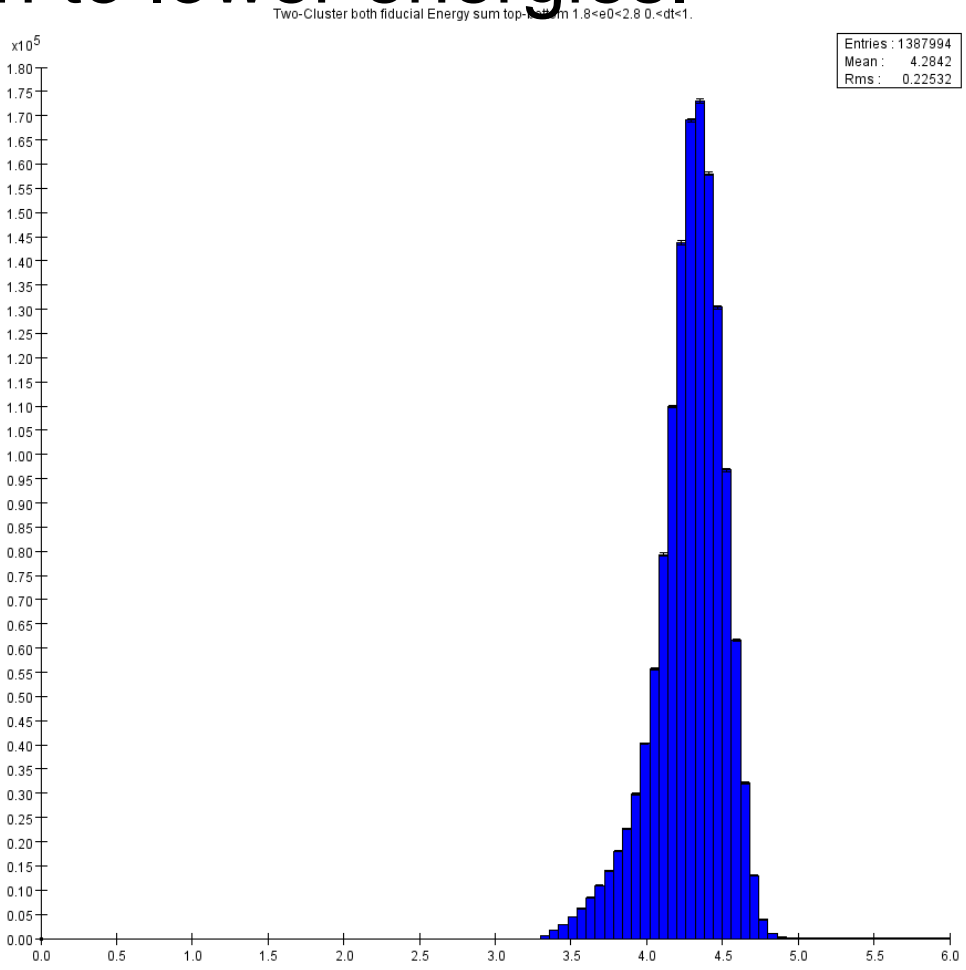
Looks pretty good right out of the box!
Slight differences in absolute scale and resolution between top and bottom.
Simple selection provides fairly clean sample of events.



Energy Scale (All Energies)

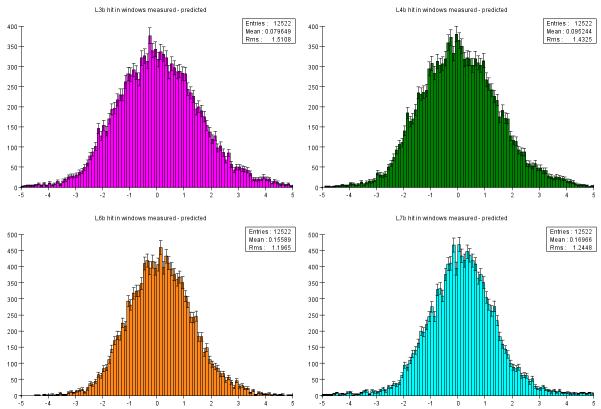
- Use bremsstrahlung events to transfer energy / momentum calibration to lower energies.

Select two and only two fiducial clusters in the event.
Plot energy sum.
Should equal beam energy if we have an inelastic electron and the radiated photon.
Looks pretty good right out of the box!
Provides sample of tracks with broad range of momenta to study scale/resolution/ tracking efficiency.

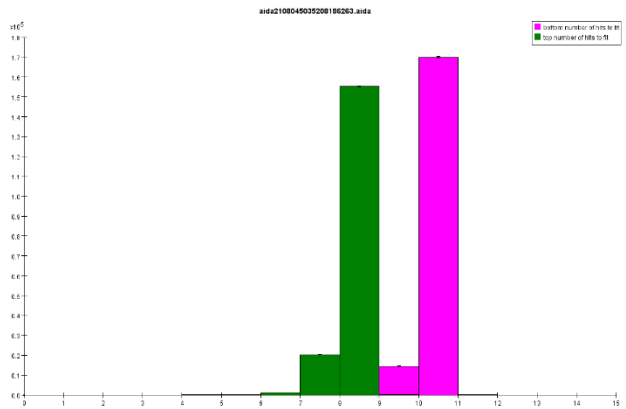


Straight Track Fits

- Have implemented code to perform straight-track fits to 1D strip cluster hits in the field-off data
- Pattern Recognition
  - Connect Ecal cluster position with 2H02 wire (~-2267)
  - Look for 1D hits in sensors in the road
  - Select “golden” events which have one and only one hit in the search window in each sensor.

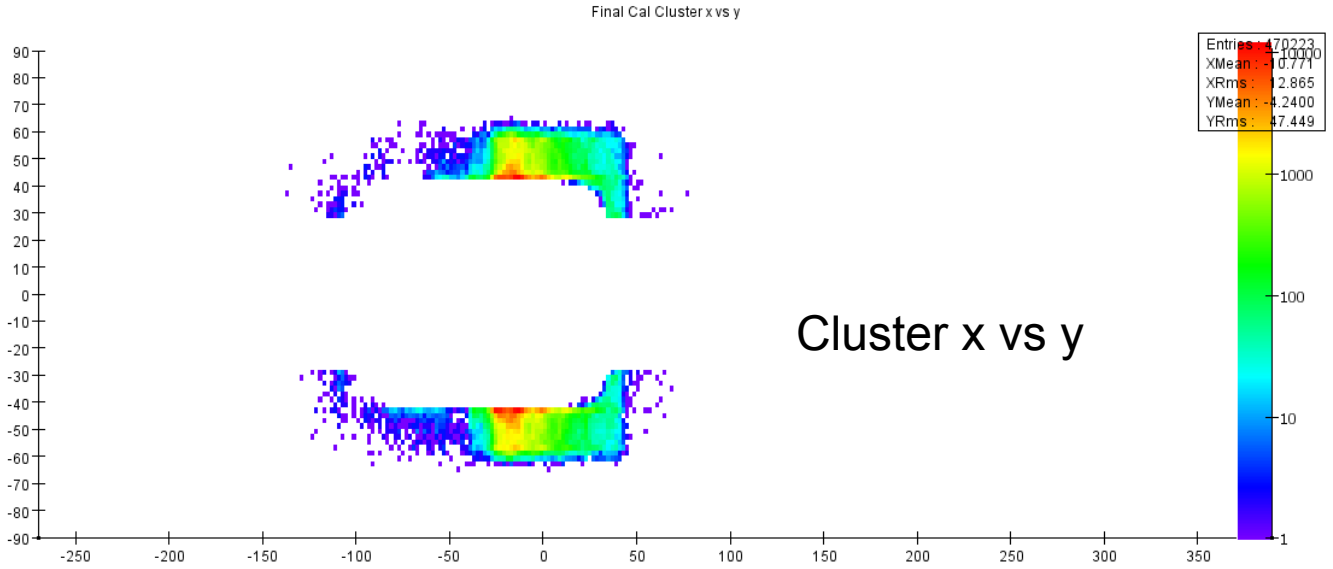


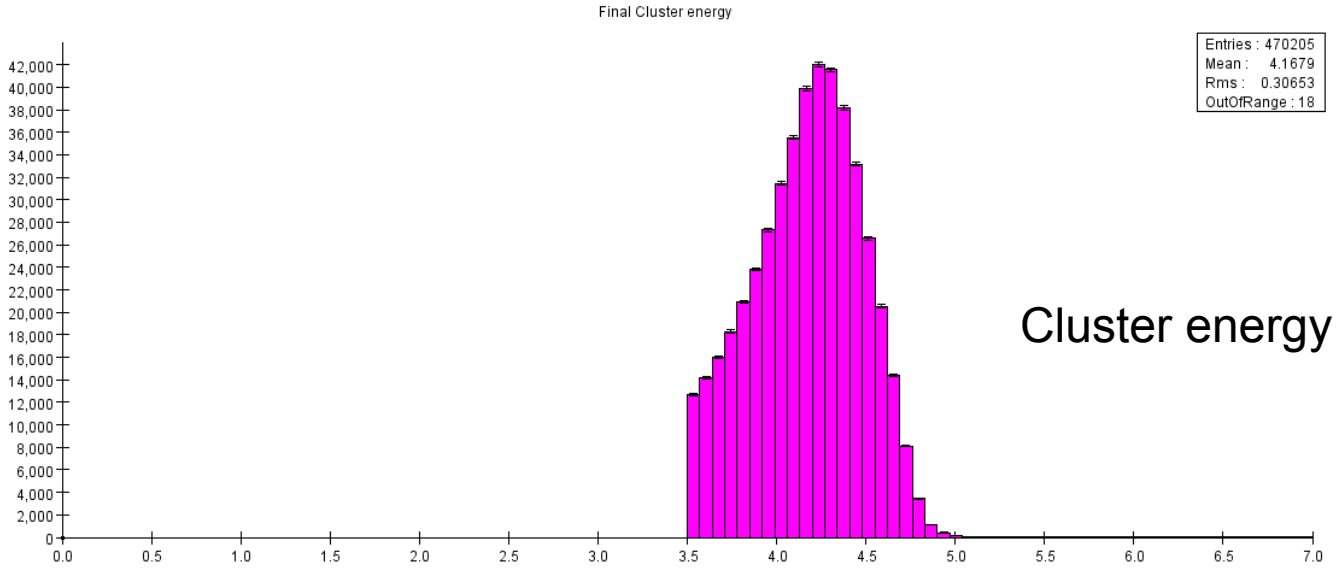
Residuals



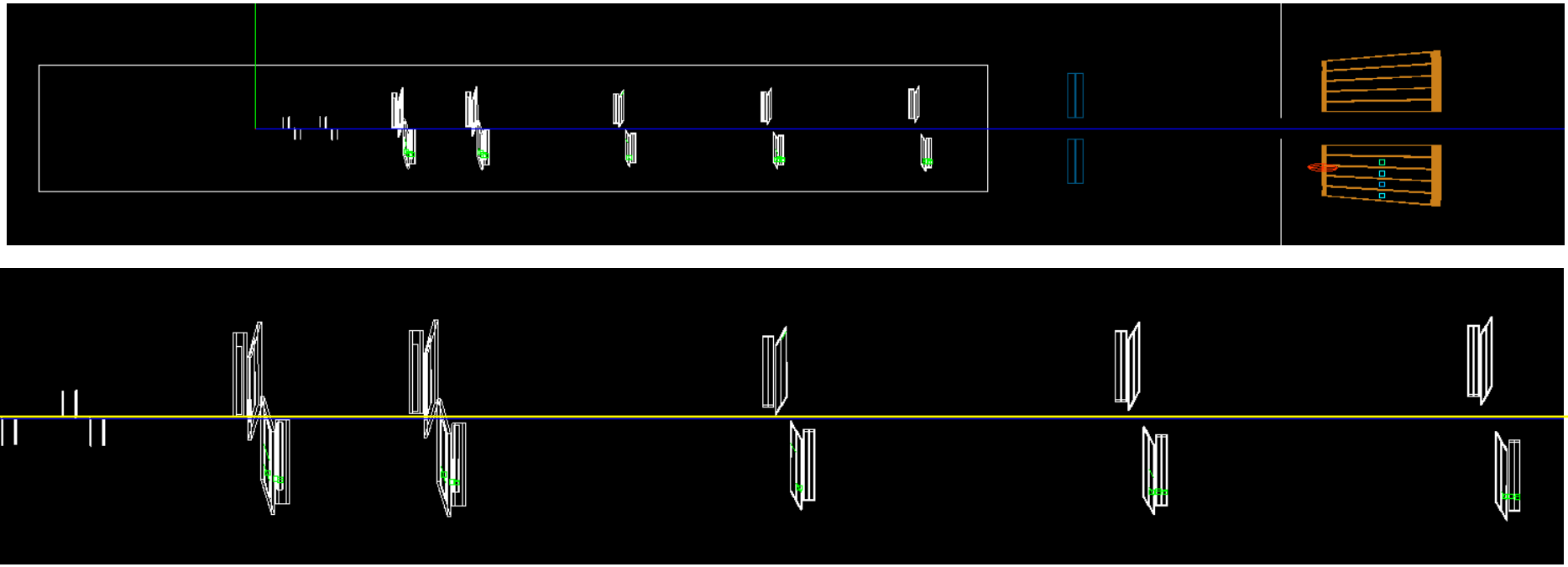
Number of Hits per Track

Field-Off Data



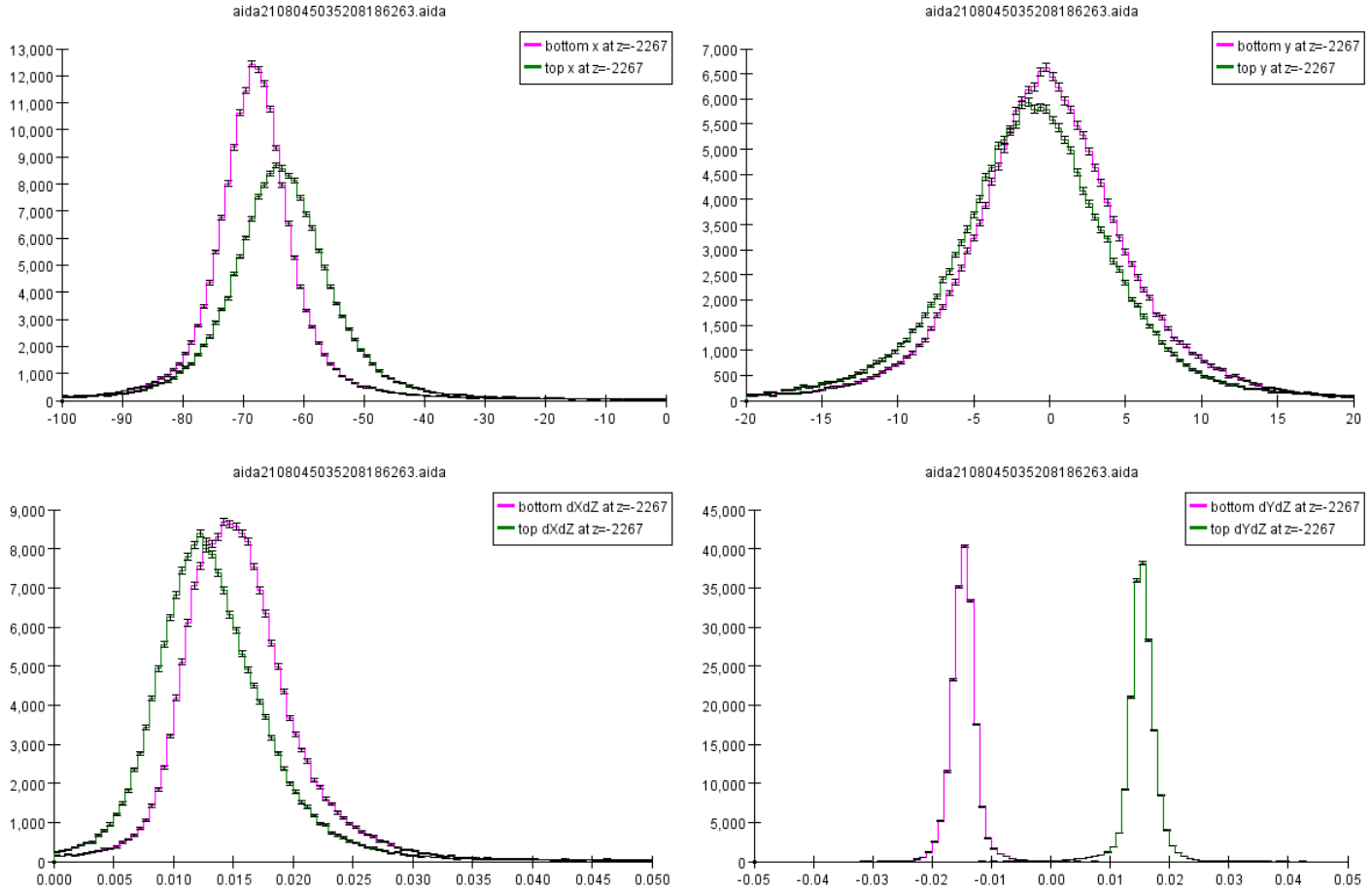


SVT Field-Off Alignment



Project Track fits 2H02 wire (-2267)

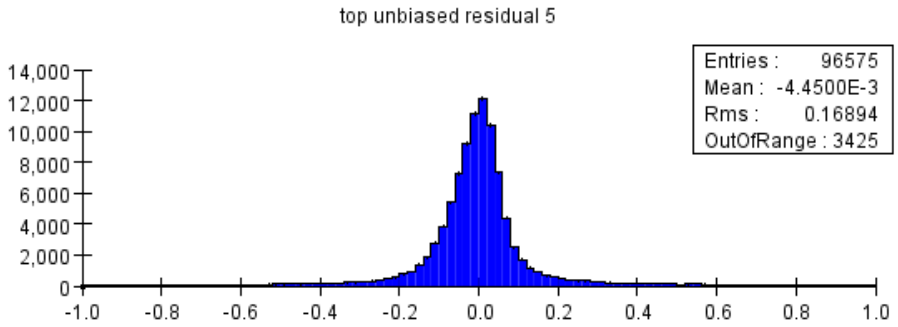
- Measure x,y,dx/dz, dy/dz for top and bottom

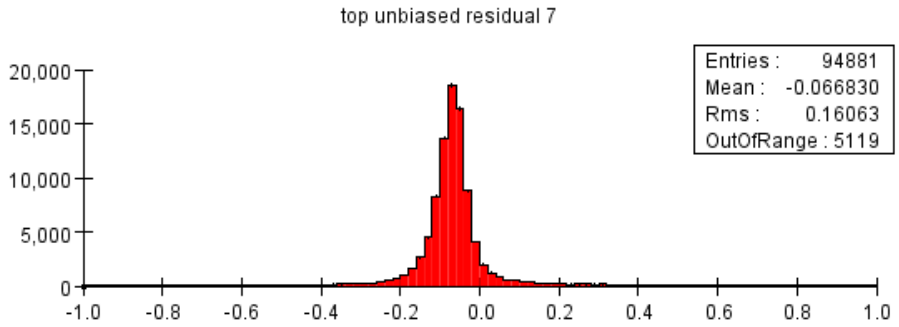


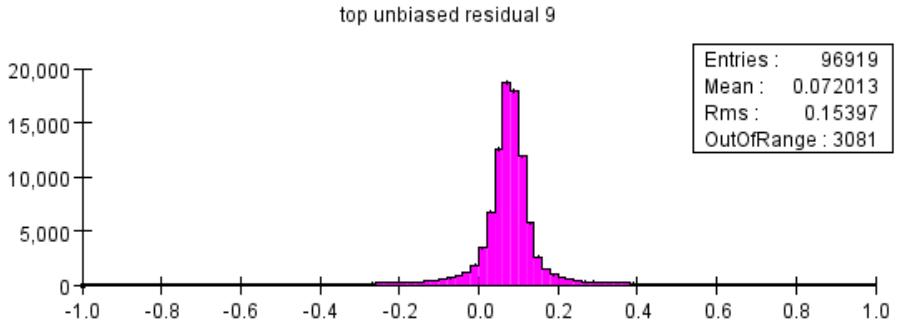
Unbiased Residuals

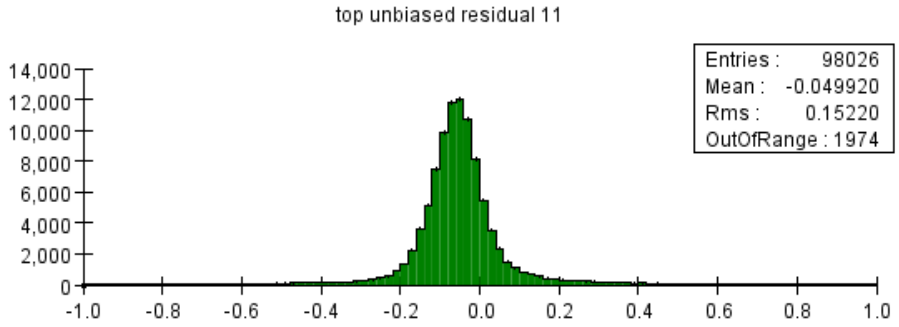
- Refit each track excluding one of the strip hits to get the unbiased residuals.
- Look for gross patterns which might indicate large-scale misalignments.

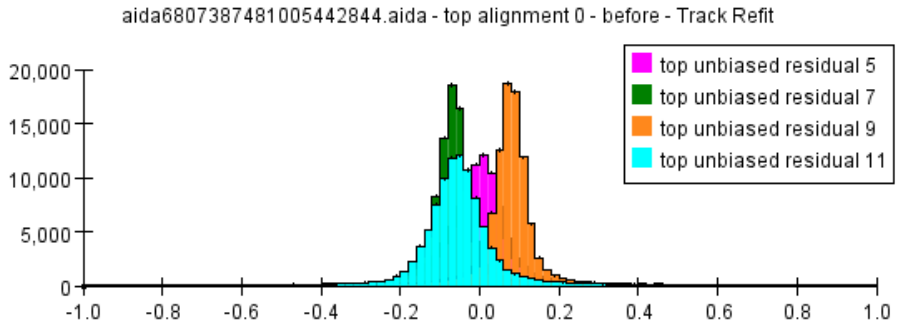
Top Axial Unbiased Residuals Before



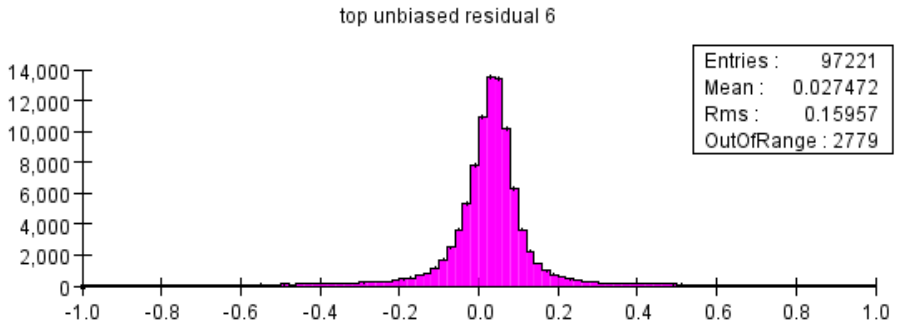


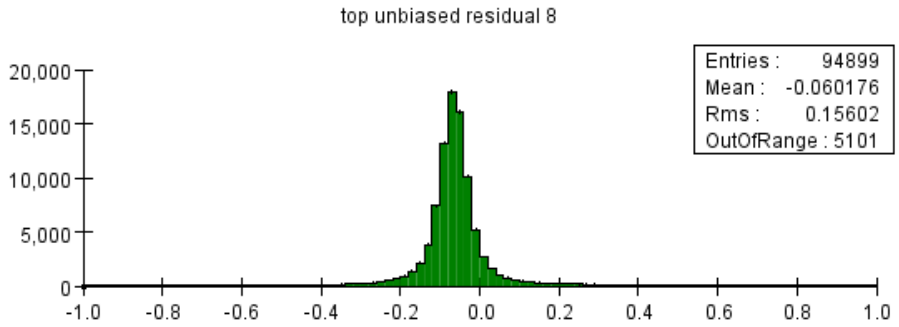


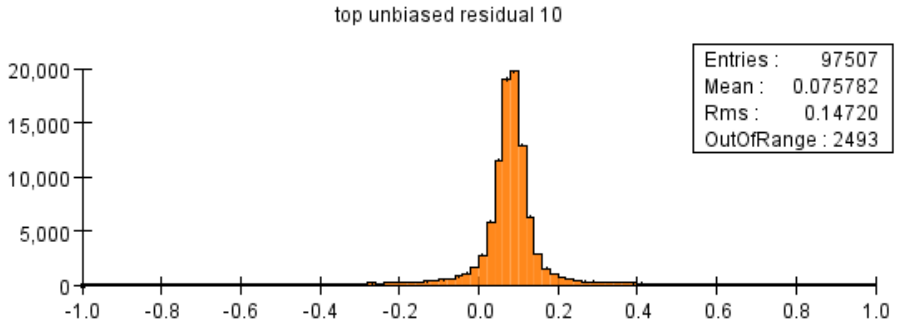


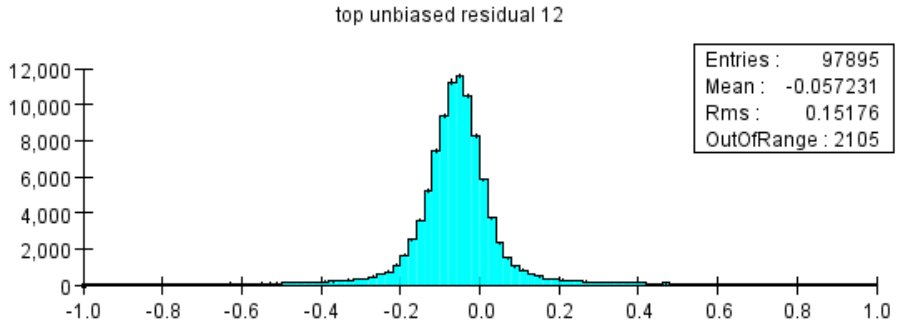


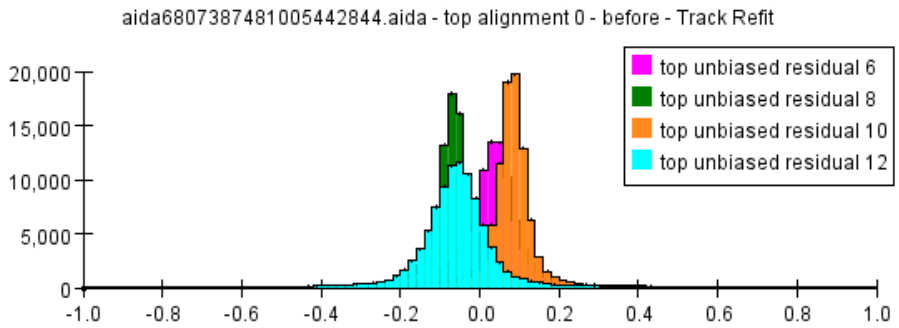
Top Stereo Unbiased Residuals Before



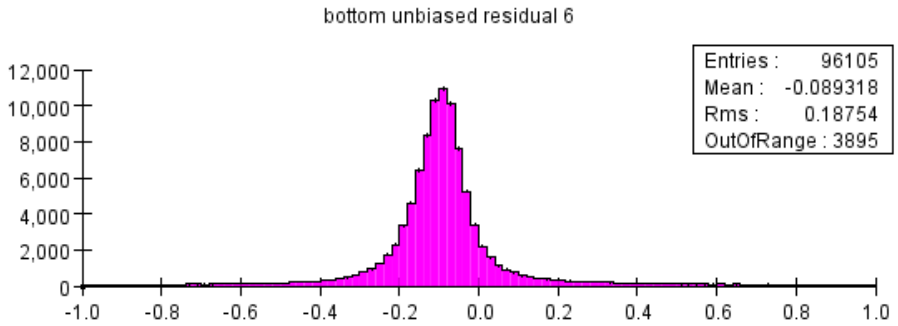


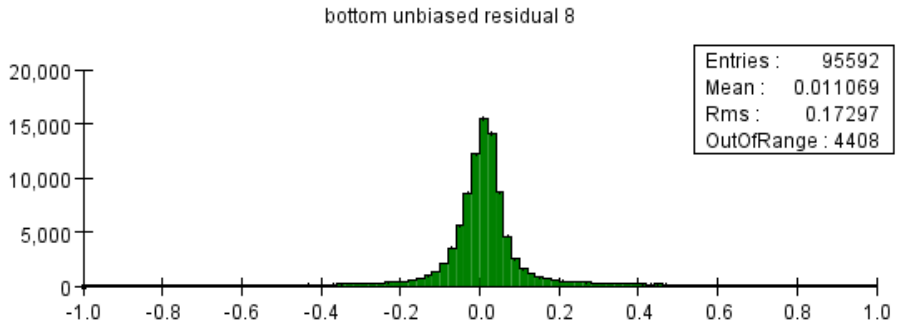


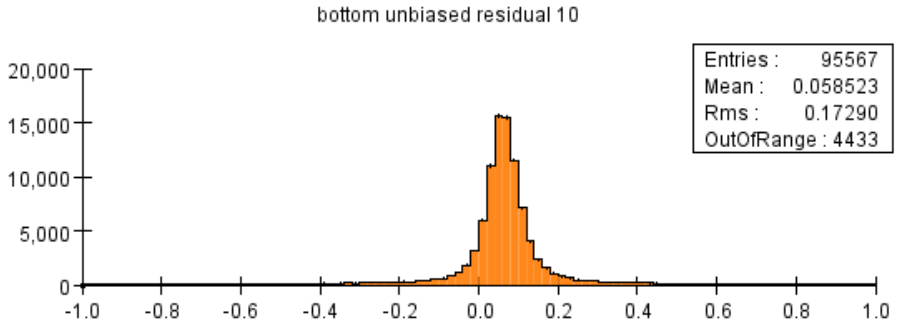


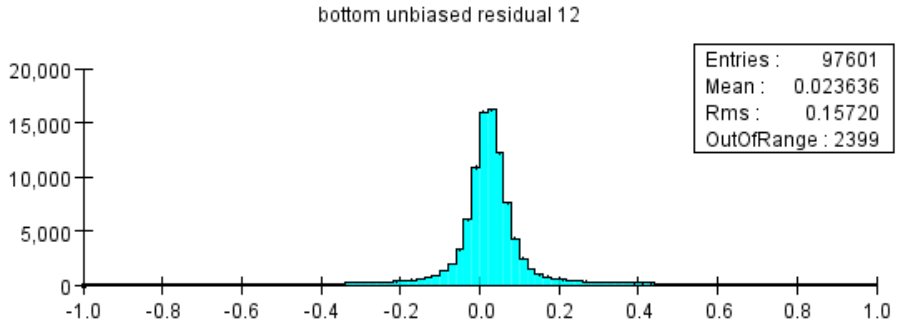


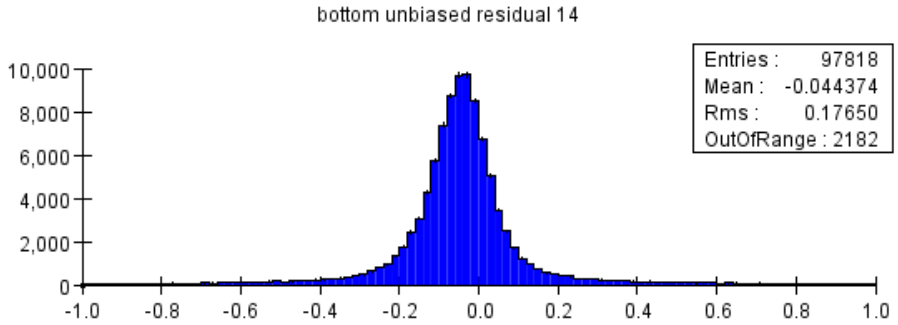
Bottom Axial Residuals Before

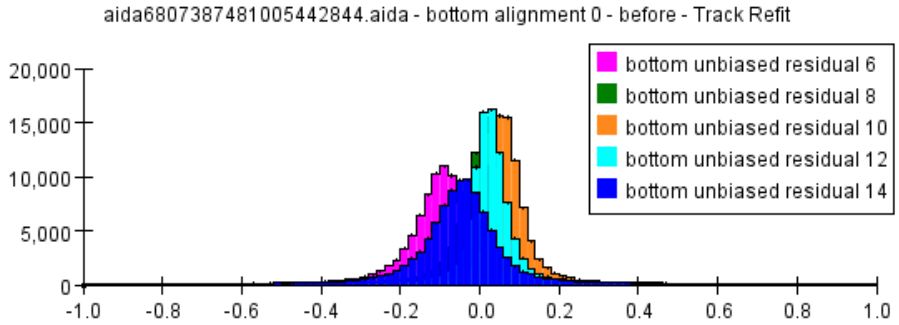




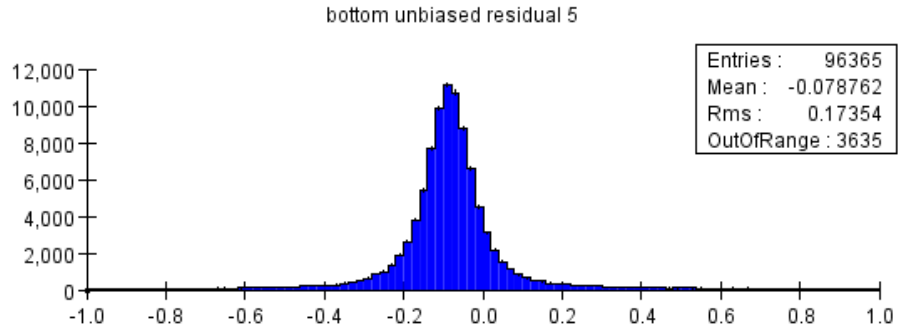


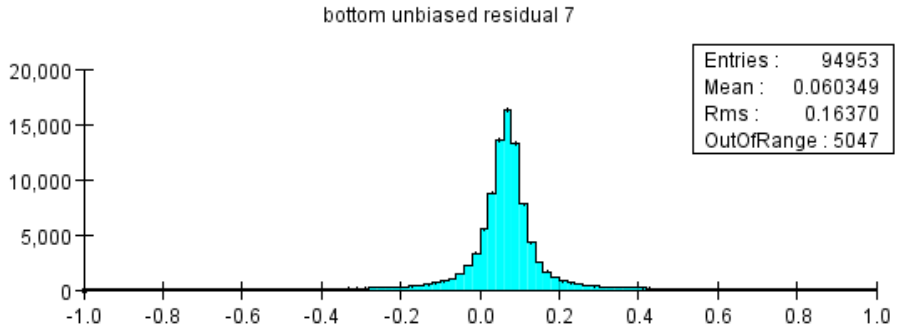


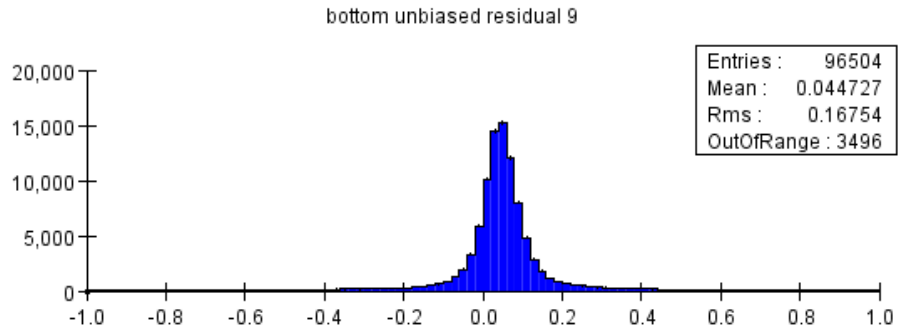


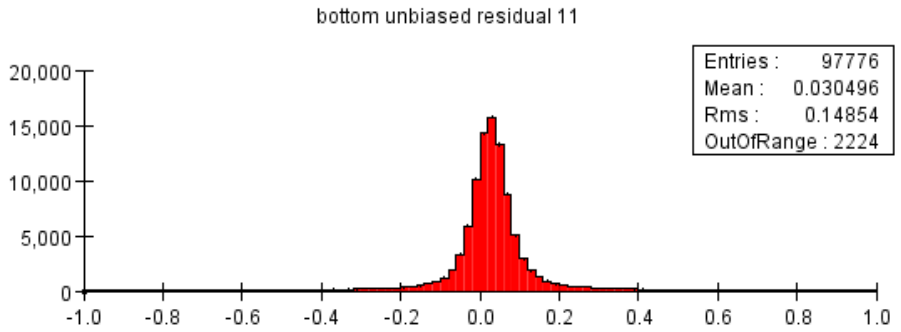


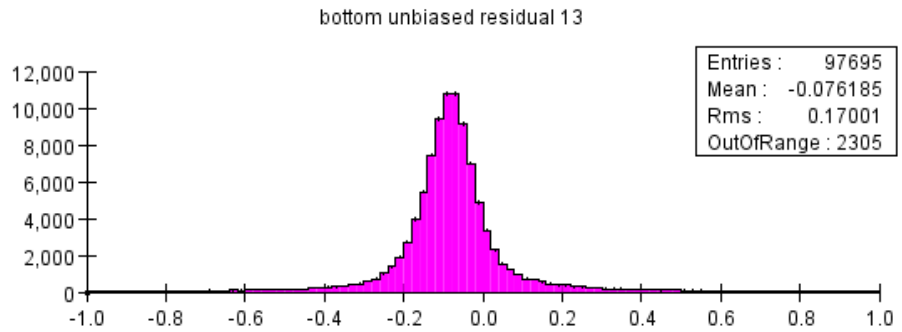
Bottom Stereo Residuals Before

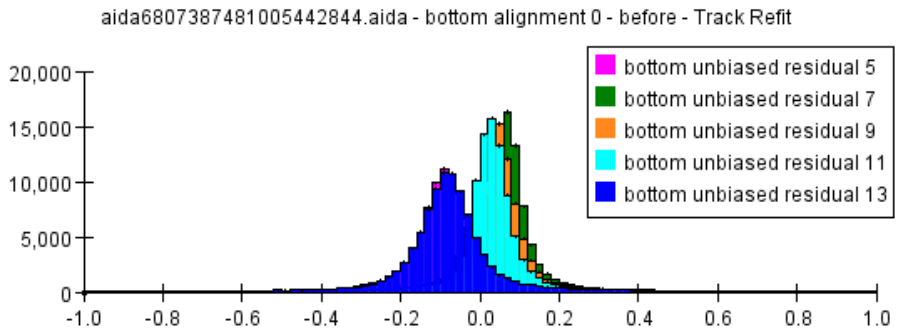












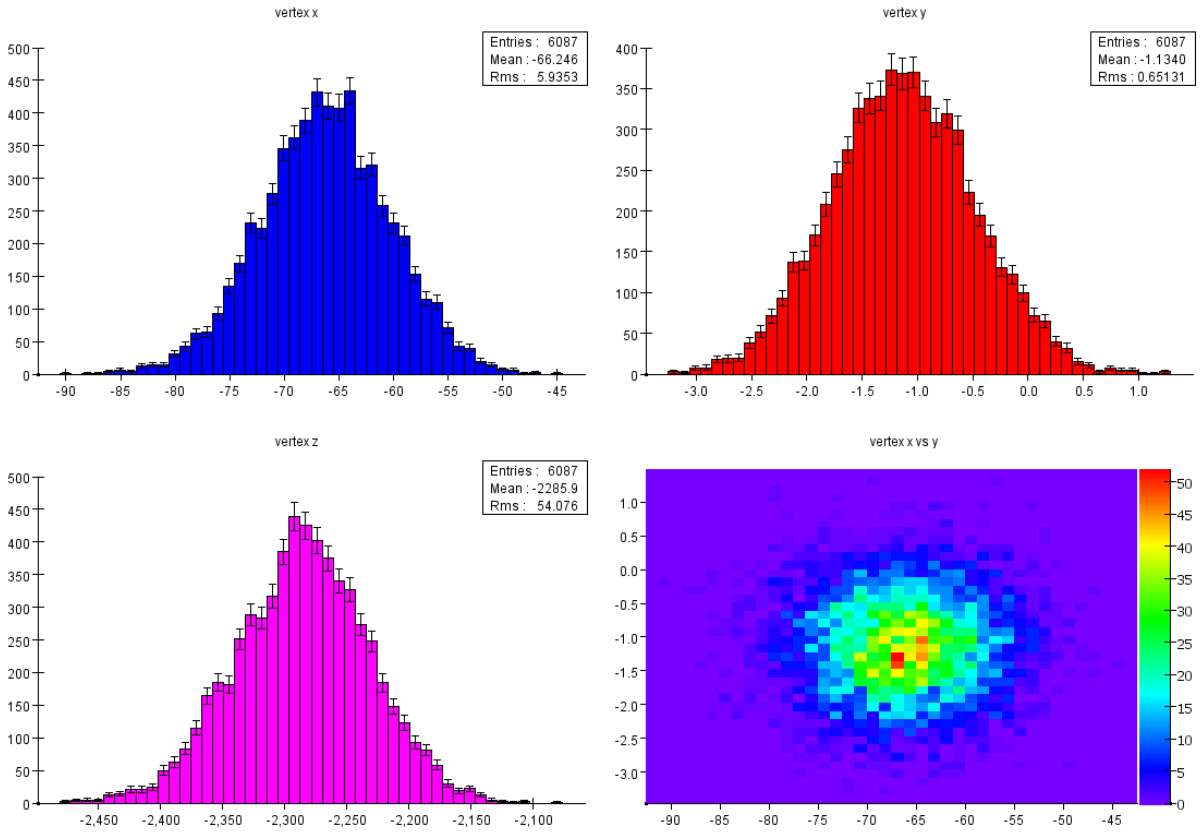
Vertexing

- Developed code to vertex collections of tracks from different events.
- Provides 3D target/beamspot positions.

X=-66.25

Y=-1.13

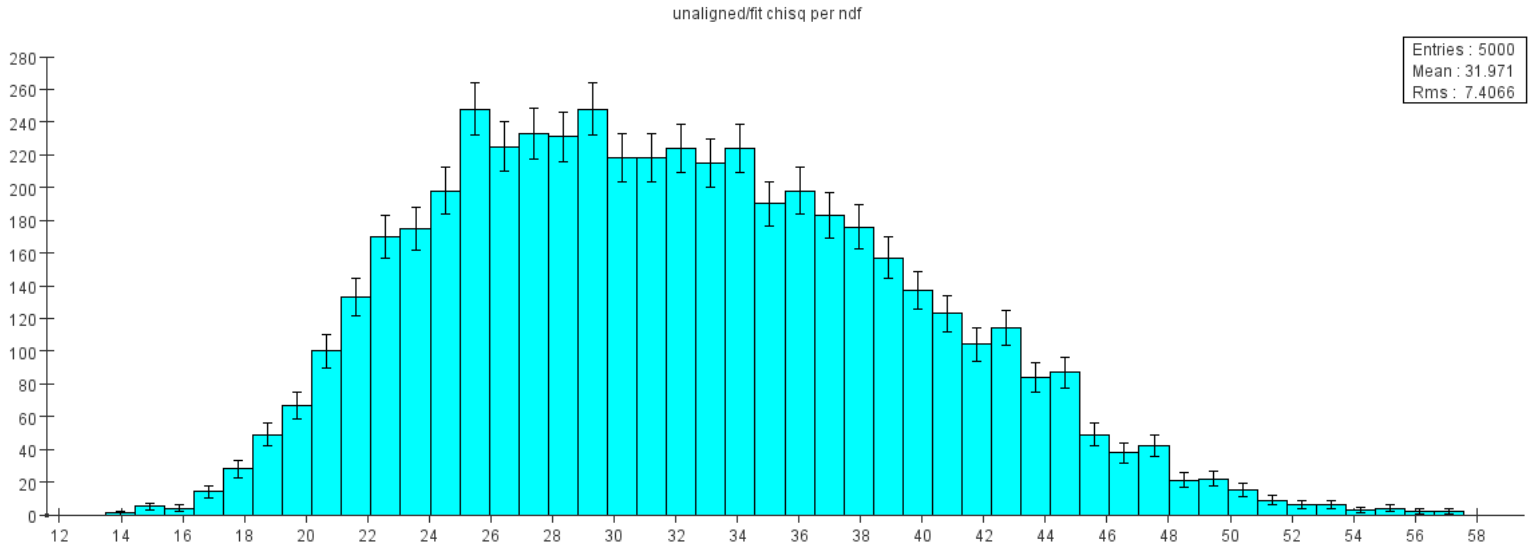
Z=-2286

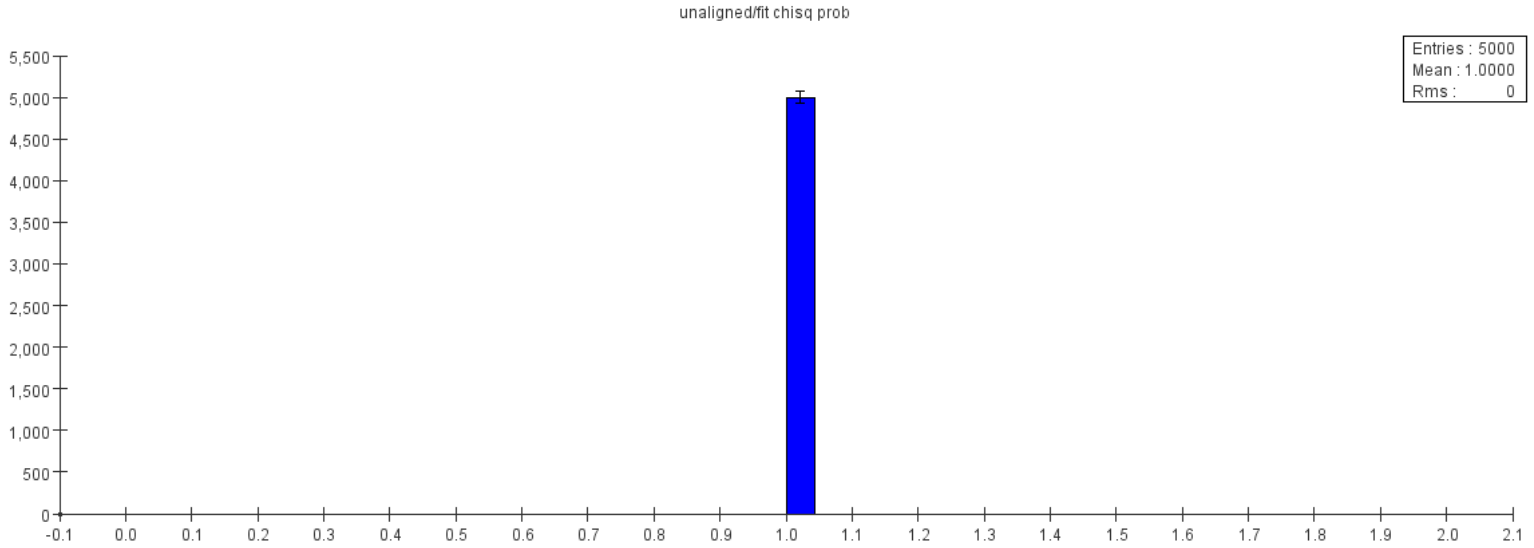


Field-Off Alignment Code

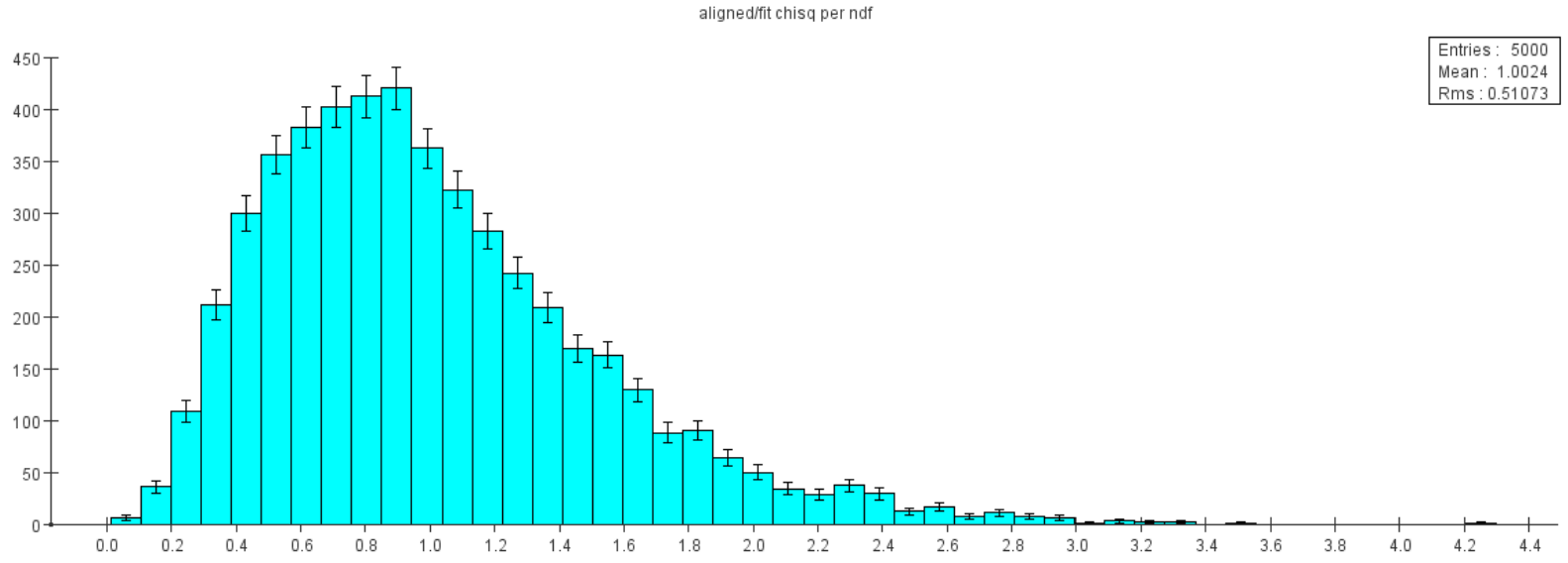
- I've developed code to perform a least-squares alignment independent of millepede.
- Code written to fit tracks to 1D strips in arbitrarily- oriented planes, propagate straight tracks to planes, introduce arbitrary 6-parameter misalignments and the least-squared code to derive the 6 position + orientation parameters.
- Currently works (with simplified MC) if I introduce misalignments and then align those mis-aligned planes.
- Run 5000 experiments randomly varying position and rotation of sensor to gauge precision.
- Moving from stand-alone sim to full MC
  - Need to handle misalignments better in both simulation and reconstruction (long story, ask me)
- Using this framework to develop strategies for not knowing which planes are misaligned.

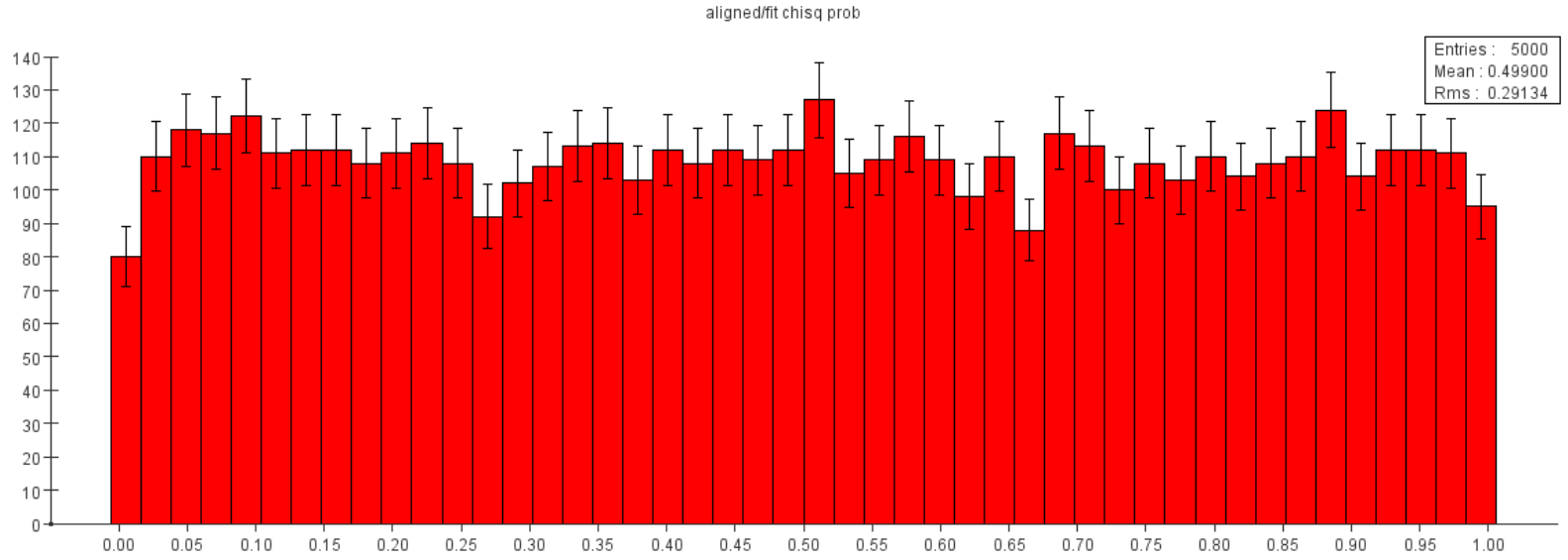
Misaligned track chi-squared



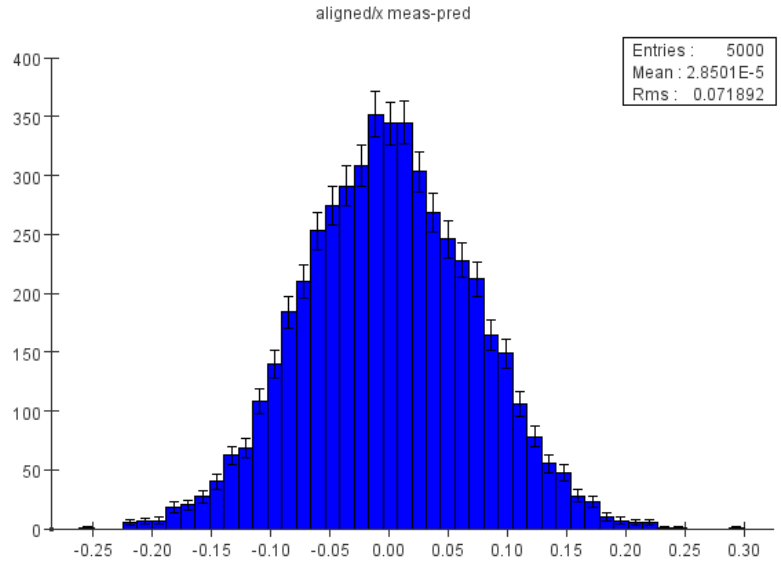


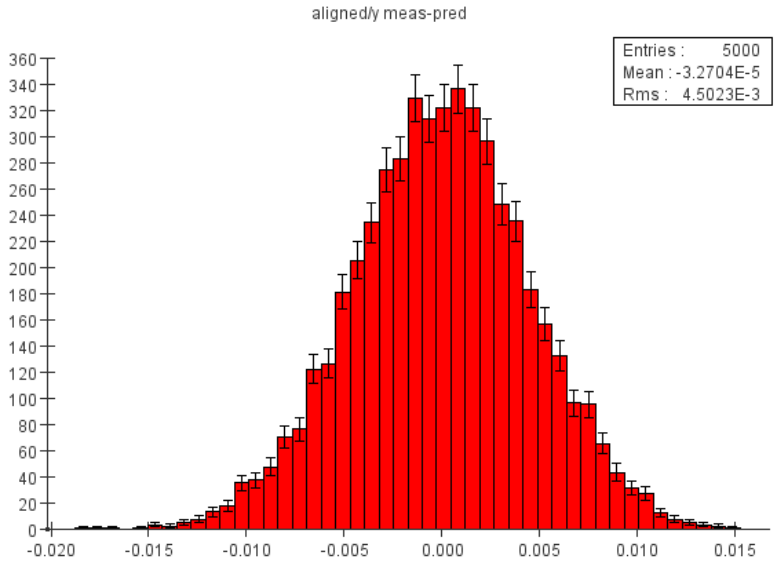
Aligned track chi-squared

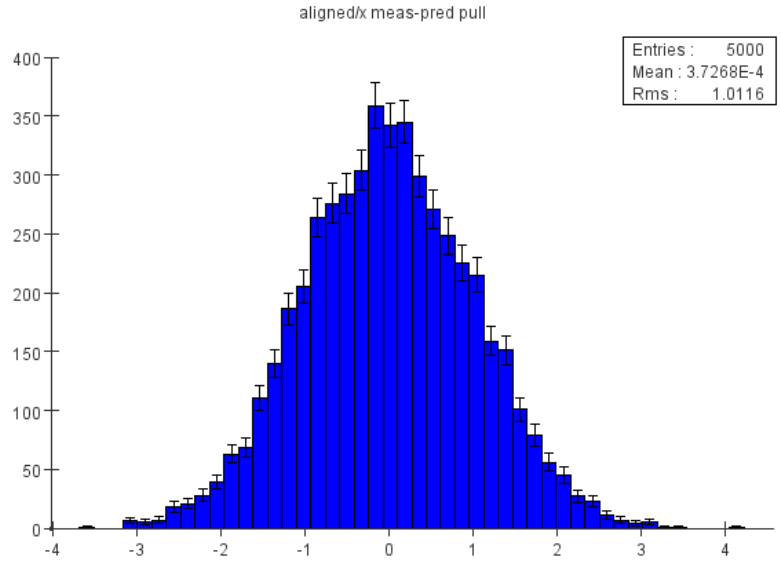


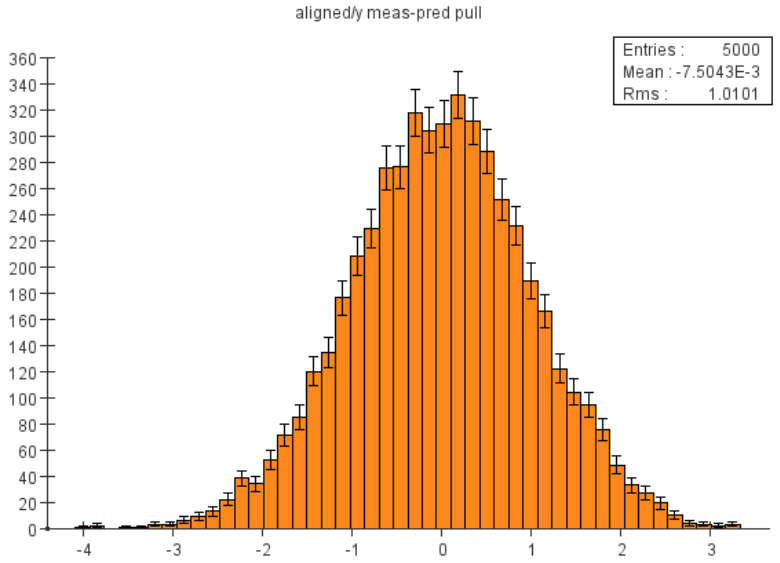


Position Alignment (res & pull)

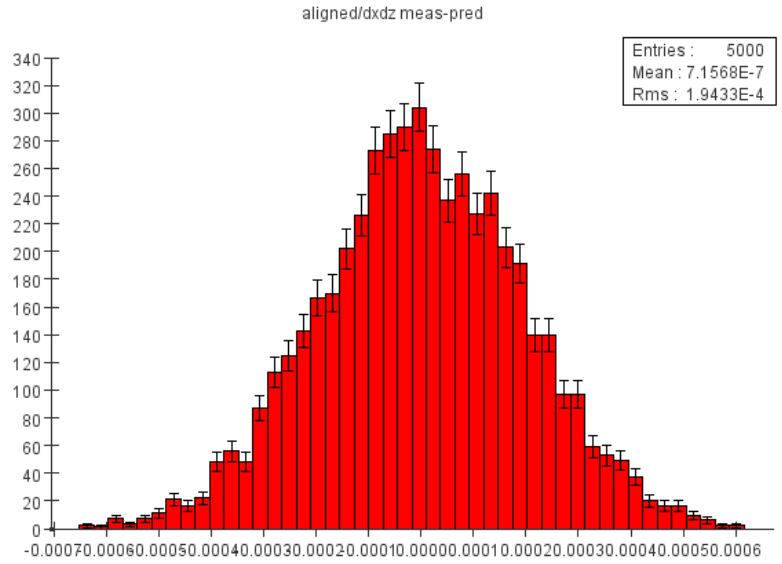


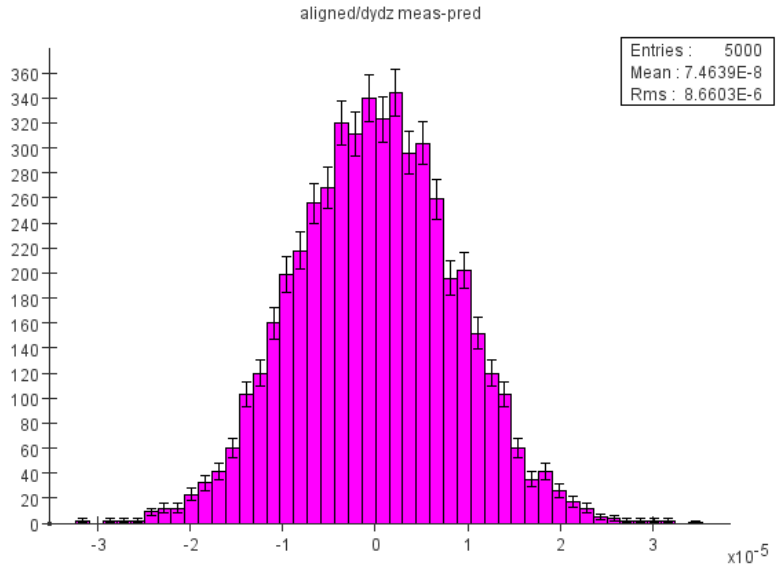


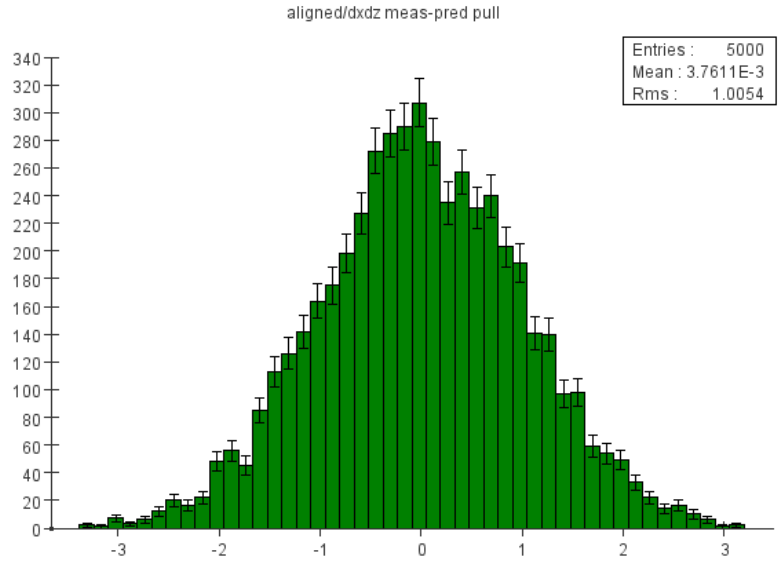


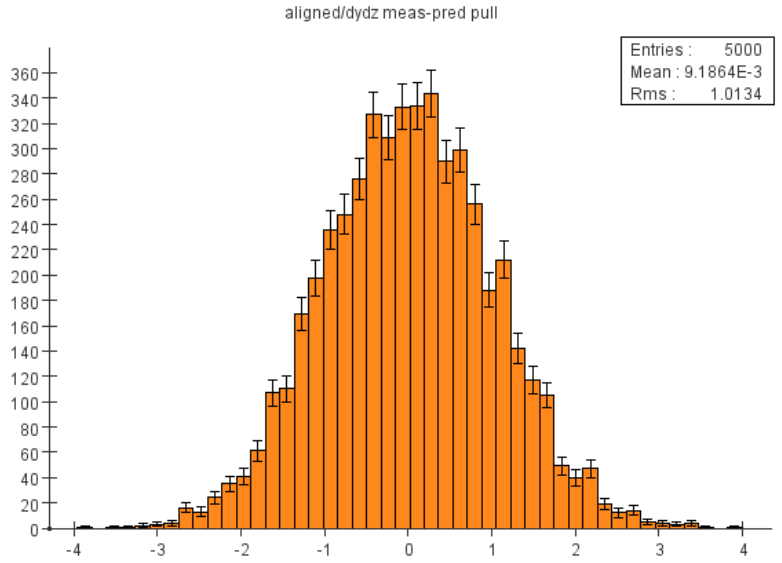


Rotation Alignment (res & pull)





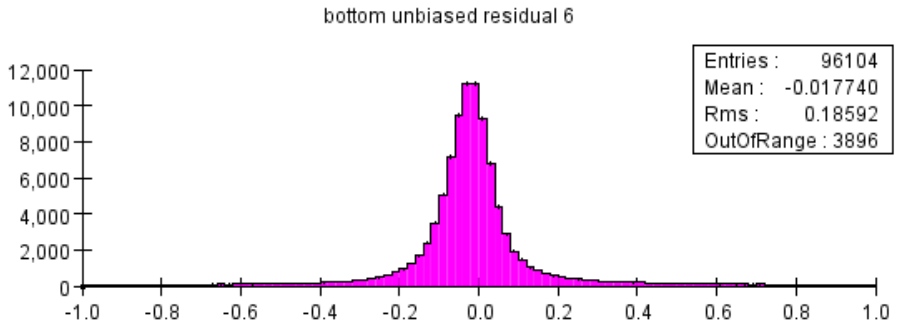


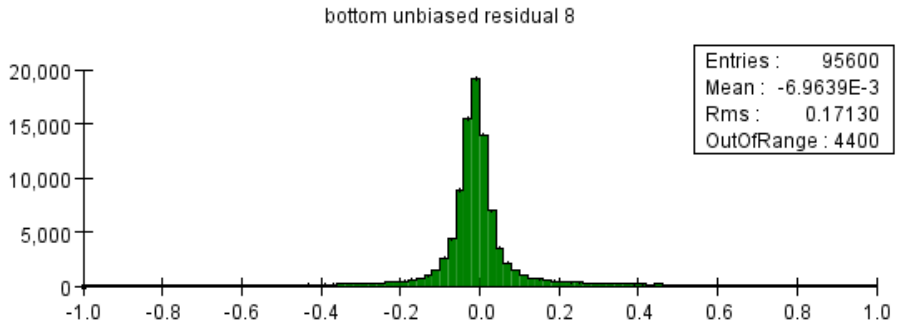


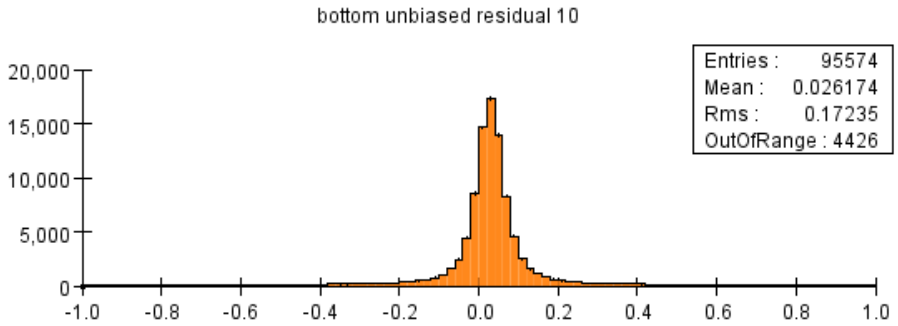
Alignment Constraints

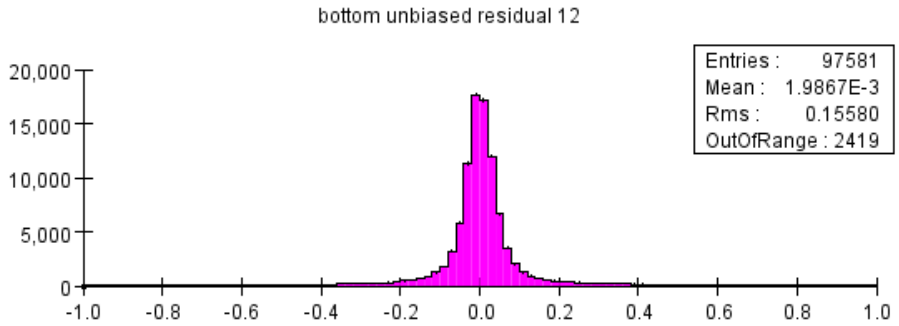
- Add beamspot/target position (as determined by vertex fit to multiple top/bottom tracks) as a constraint to the alignment fits.
- Pin Layer 5 Axial and Stereo sensors (common to both top and bottom).
- Float u coordinate for remaining sensors.
  - X distribution of the FEEs (in this run) does not provide sufficient lever arm to constrain rotations γ about the w axis

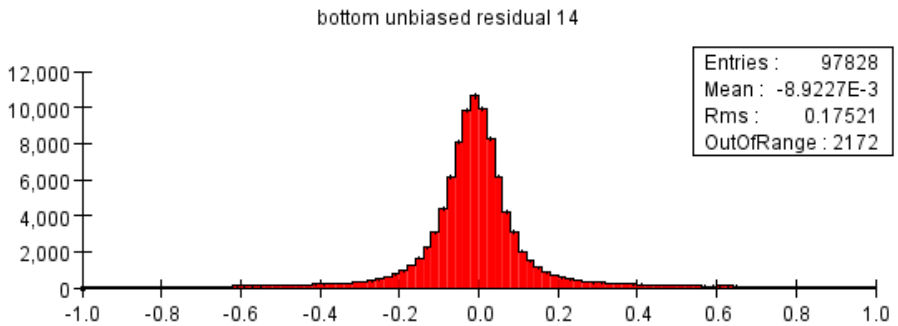
Bottom Axial Residuals After

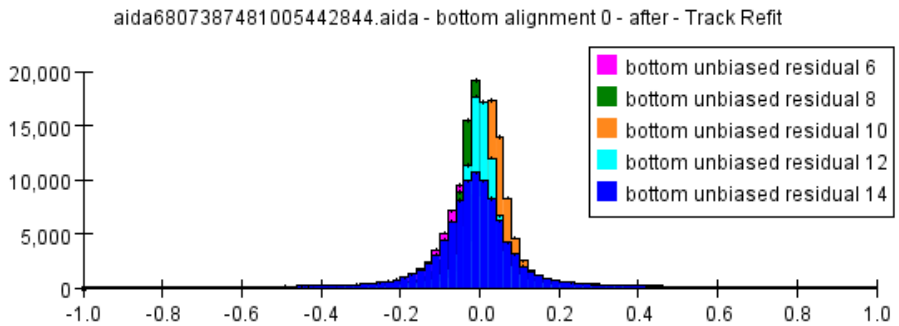




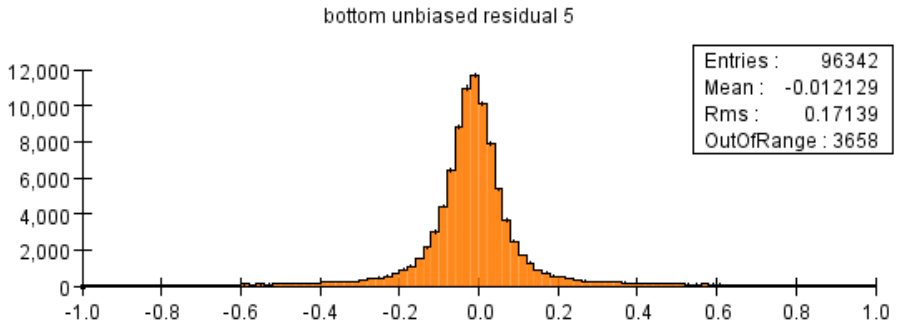


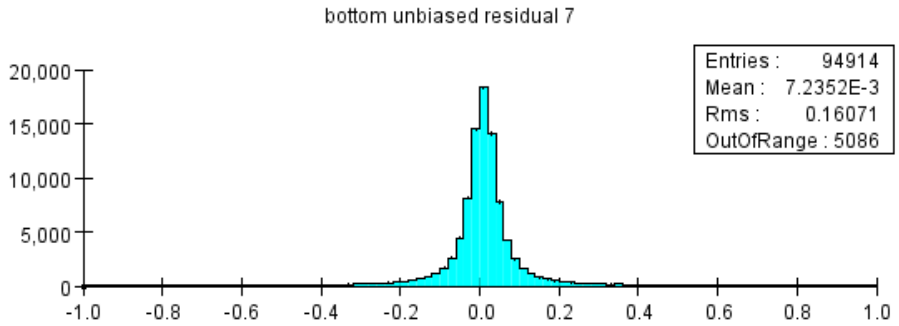


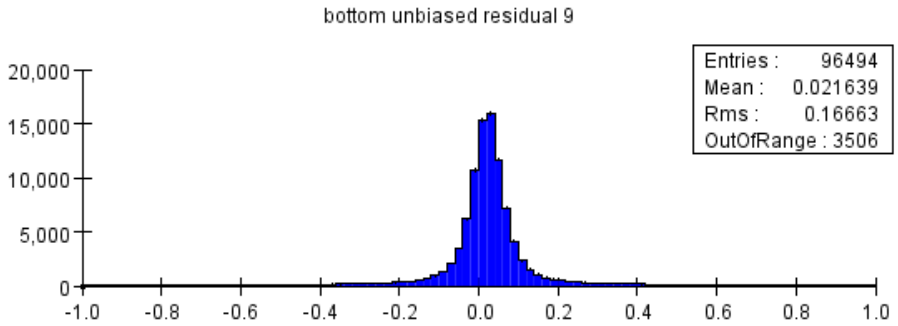


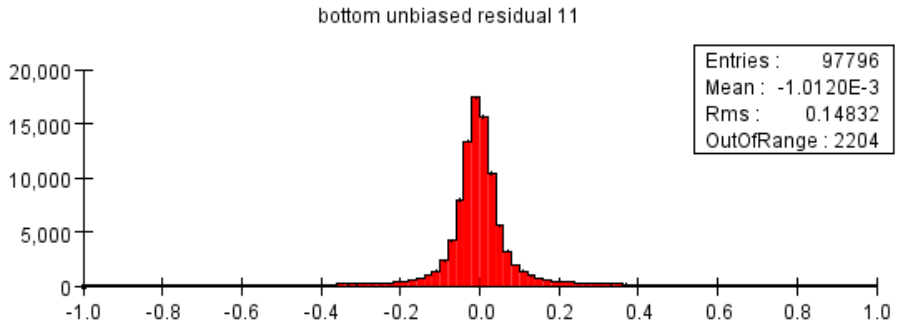


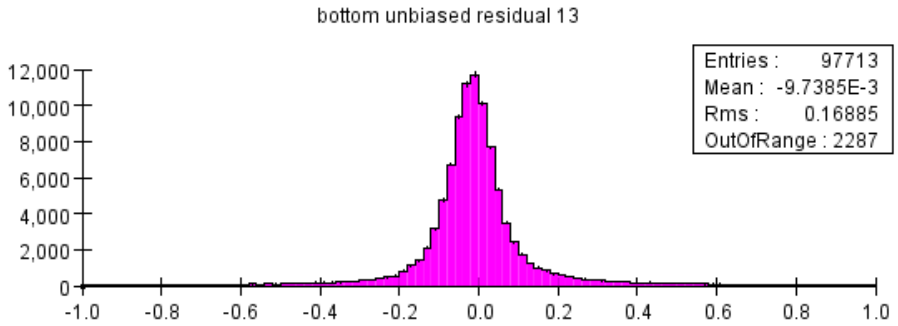
Bottom Stereo Residuals After

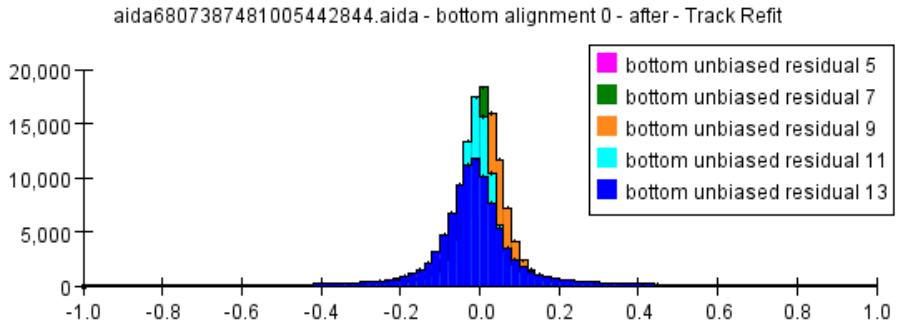




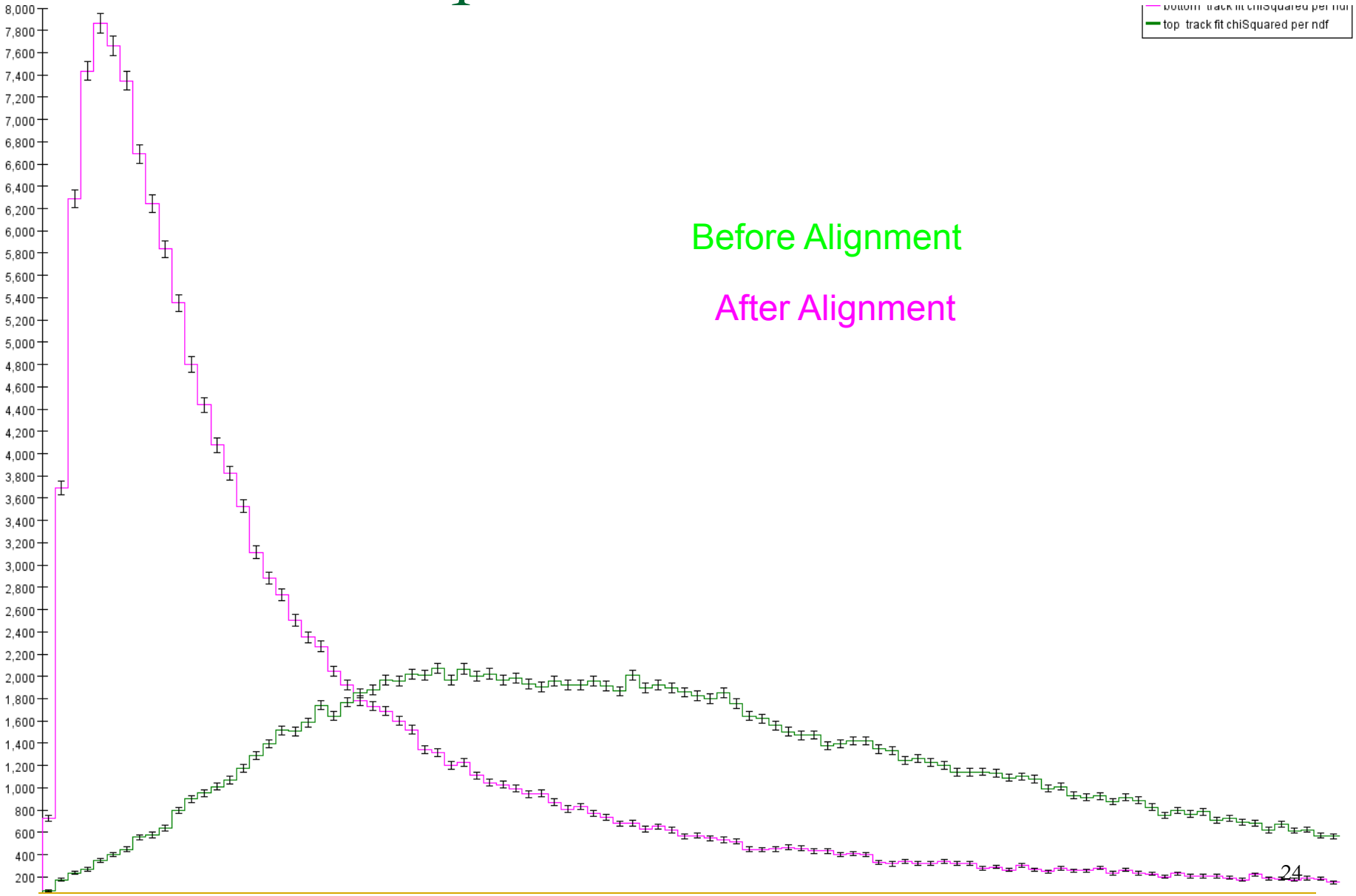








Track Chi-squared Before/After



Next Steps

- Generate MC samples in order to check validity of current fitting and alignment code & study systematic effects
- Reconstruct field-on FEE sample to check momentum scale and resolution
- Implement the millepede alignment procedures to work for 2019 geometry (include first 2 slim layers)
  - Need to be careful with directionality of split strips
- Refine alignments with full GBL / millepede framework
- Use momentum scale and resolution of FEEs as one metric for the internal alignment of SVT halves.
- Use vertexing of tracks from top vs vertexing of tracks from bottom to compare relative alignment of top/bottom.
- Mass scale without Mollers:
  - Trust MC
  - Search for phi / K signals in data