

2019 Calibration/Alignment

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HPS Analysis Meeting, September 10, 2019

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.

Calibration Data

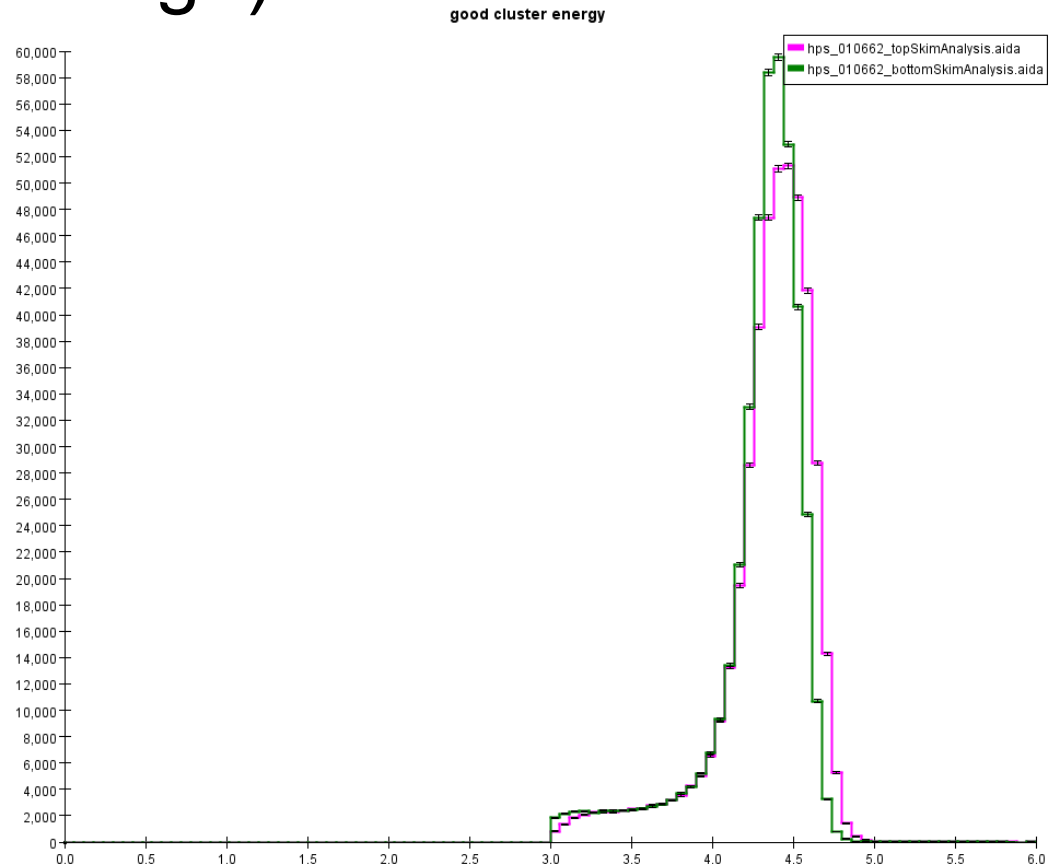
- FEE triggers were taken throughout the run.
 - Maurik has written a nice evio file processor which can skim off events based on their trigger.
 - Can efficiently select events from any run.
- Dedicated FEE runs
 - 9371,9593,9898, 9899,9920, 9921,10716, 10717, 10718
- Dedicated Field-Off Runs
 - 10101,10333,10662,10734

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!

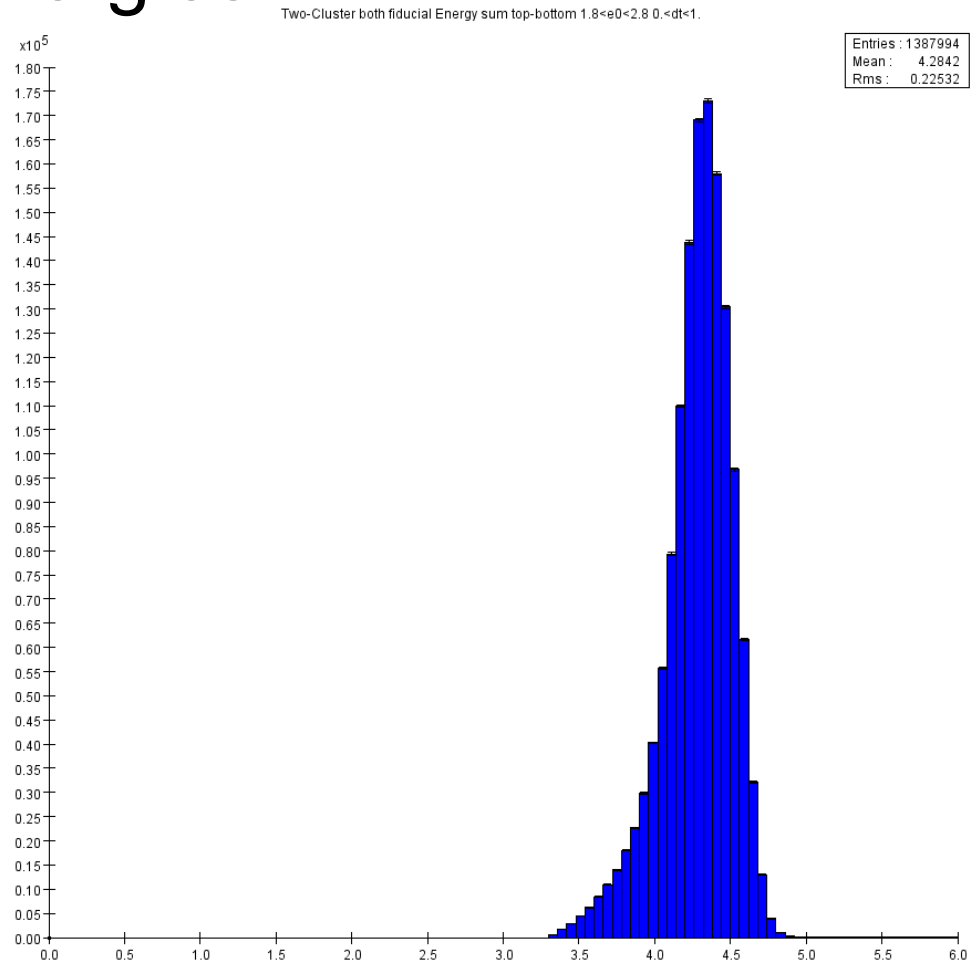
Slight differences in absolute scale and resolution between top and bottom.



Ecal Energy Scale (All Energies)

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

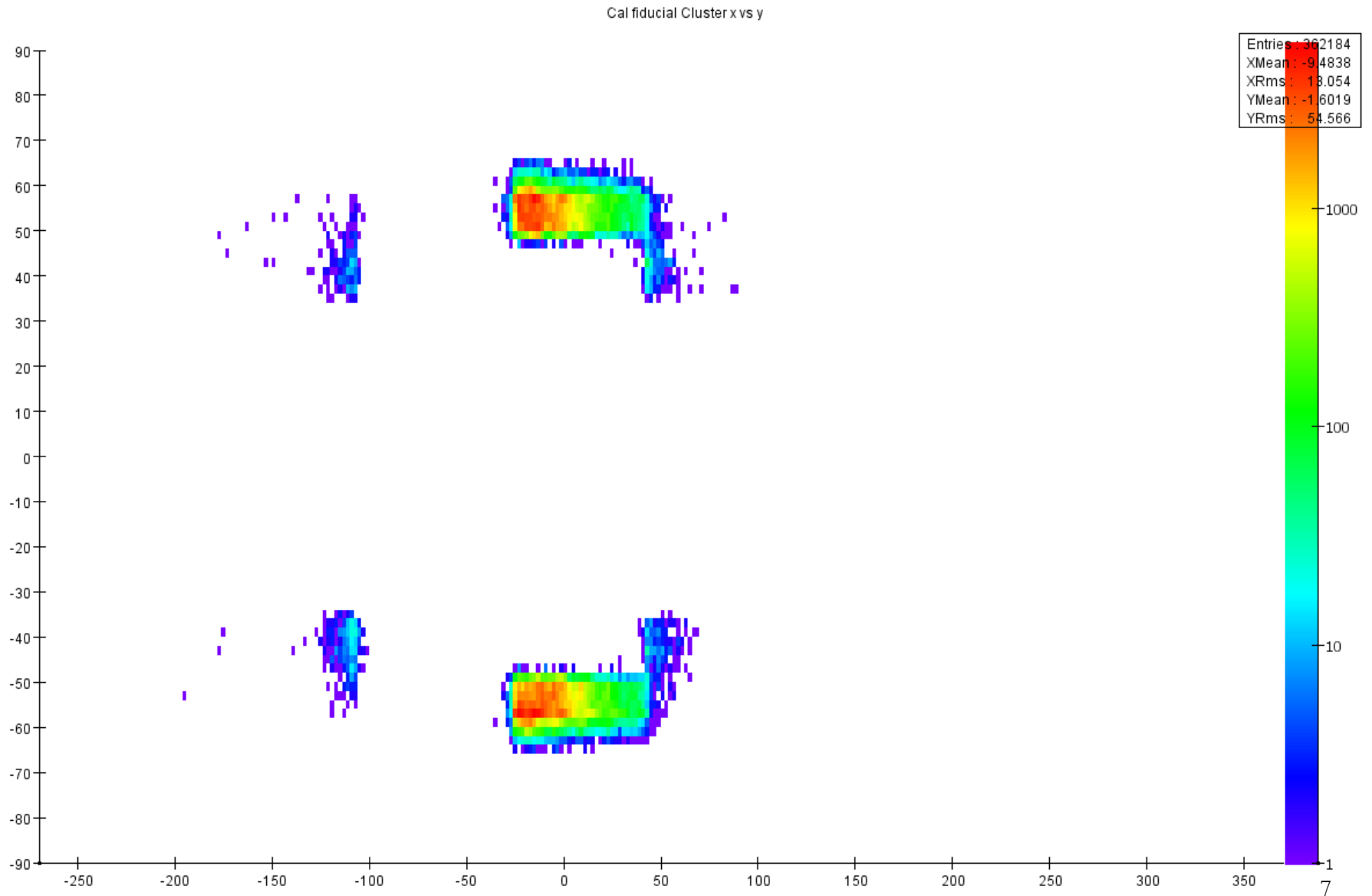
Select two and only two fiducial clusters in the event.
Plot energy sum.
Should equal beam energy if we have an inelastic electron and the radiated photon.
Looks pretty good right out of the box!
Can select one fiducial cluster and correct edge clusters.



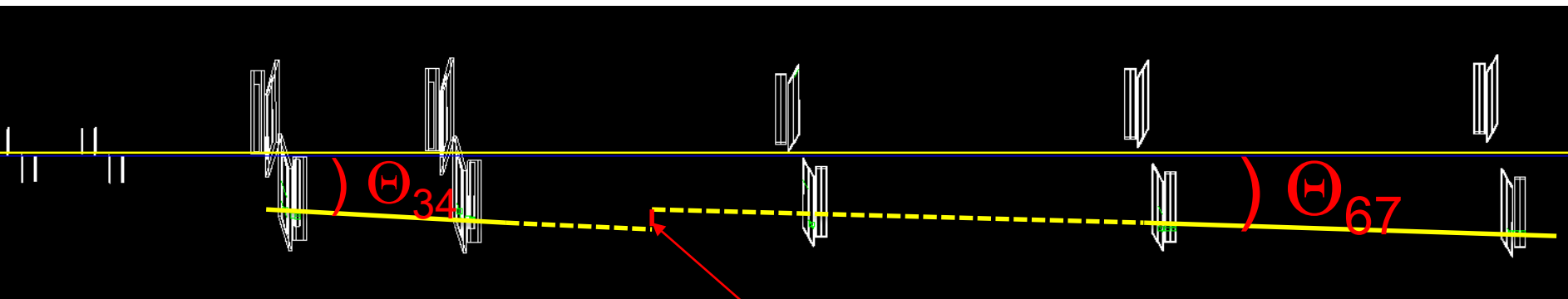
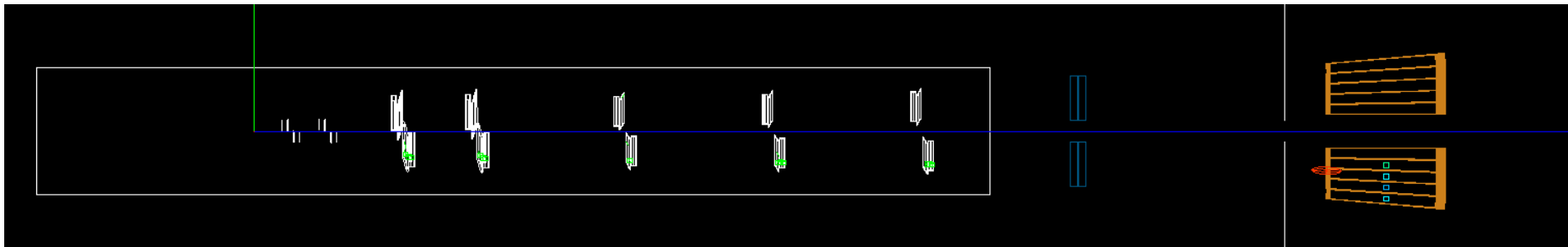
SVT Alignment

- Use straight tracks from the field-off runs.
- Used 2H02 wire as target (-2267mm upstream)
- Start with analysis of axial sensor hits to investigate SVT opening angle.
- Form “track” segments from layers 3-4 & 5-6 (top) or 3-4 & 6-7(bottom) and compare θ_y slopes.
- Once angles are matched, project “tracks” to an intermediate z position and compare offsets.

Ecal Cluster Positions

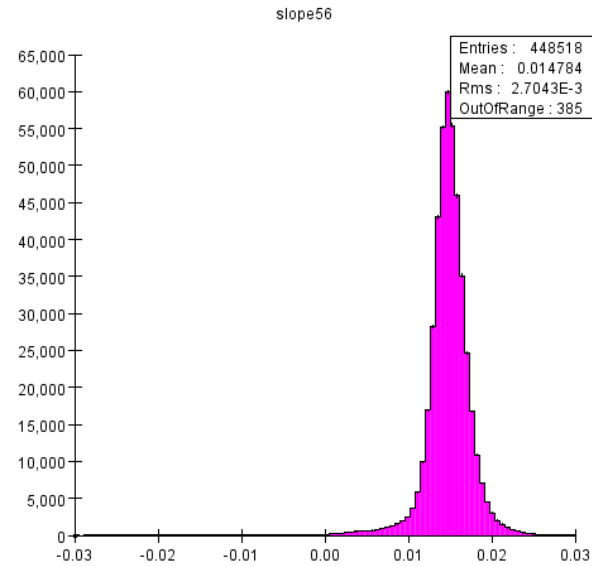
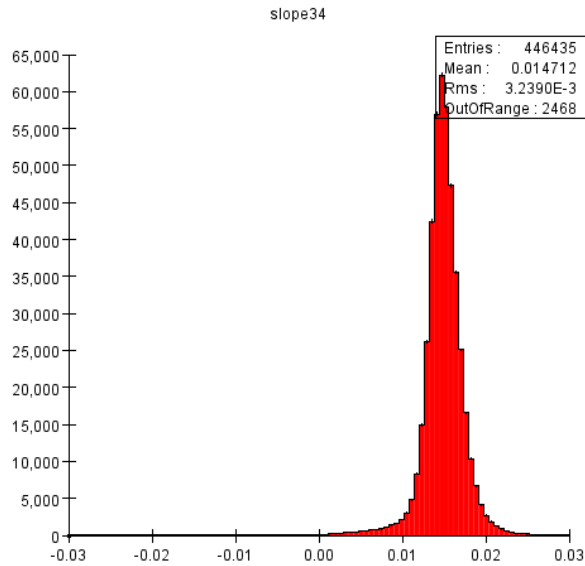


SVT Field-Off Alignment



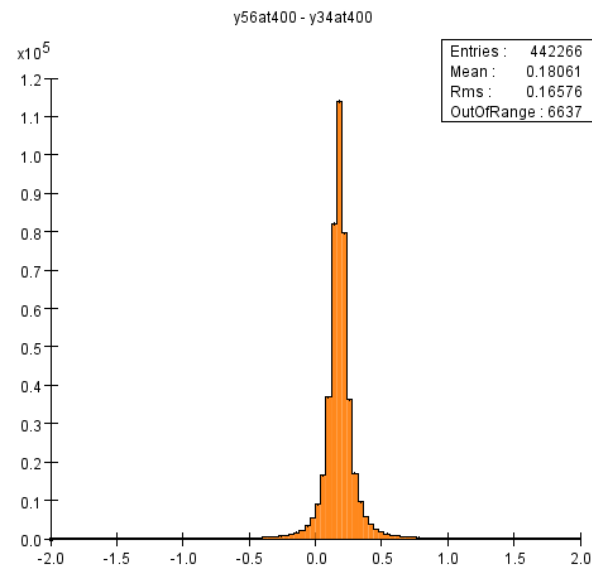
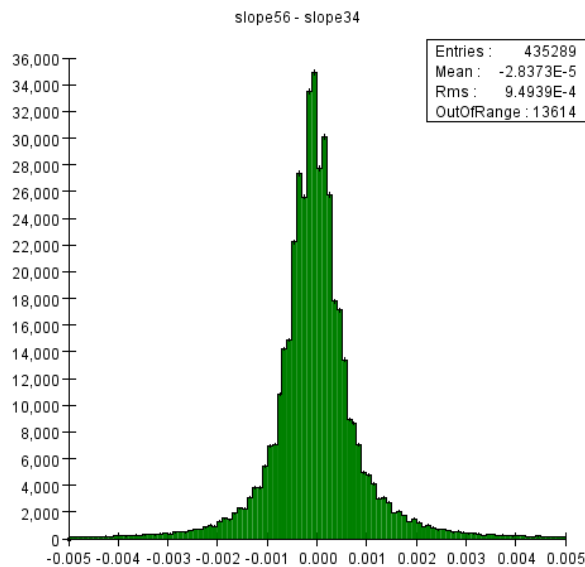
$\Delta Y @ z = 400$

SVT opening angle top



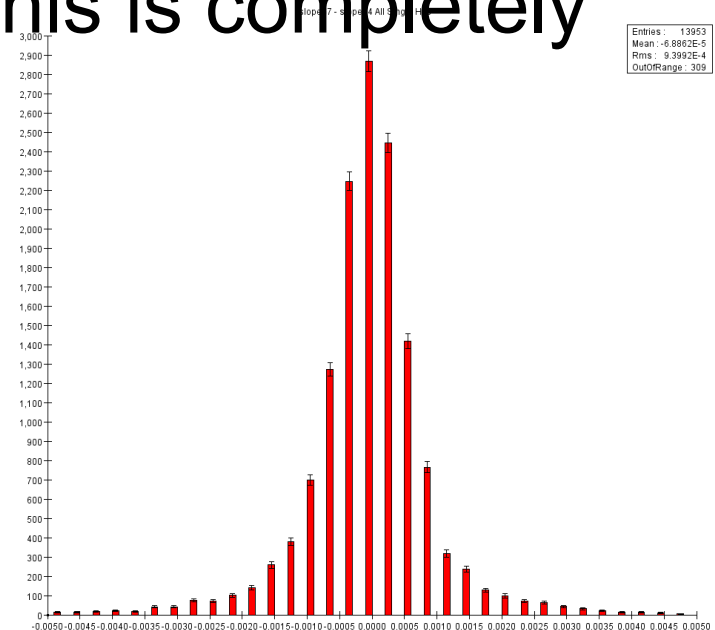
$$\Delta\Theta = -2.8E-5$$

$$\Delta Y = 0.180$$

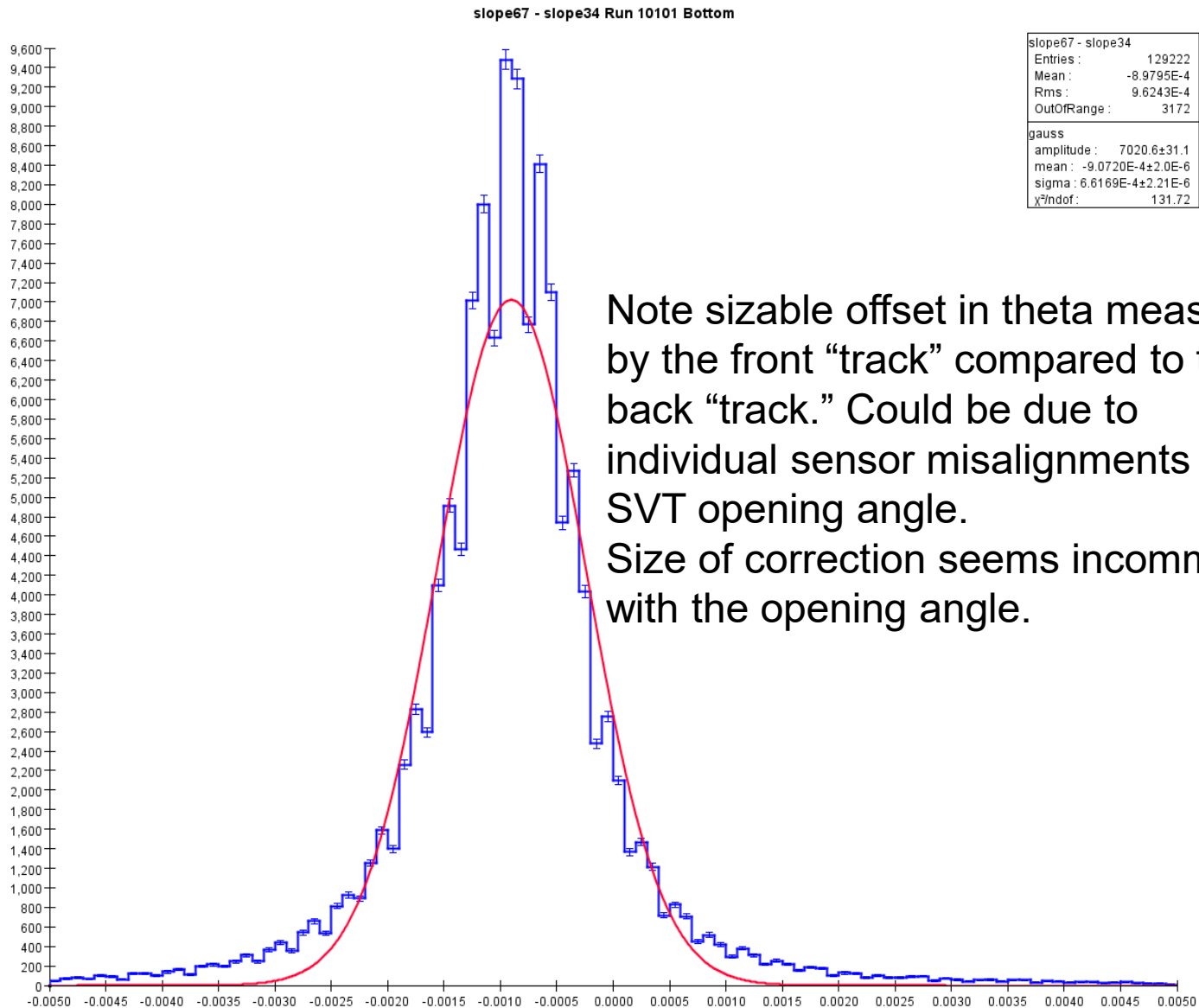


Track Segment Angles

- Single-strip axial clusters have y positions which are quantized by the strip pitch, leading to fixed angles. This is the cause of the structure in the delta theta plots.
- Note that for two “track” segments composed of four single-strip clusters this is completely quantized.

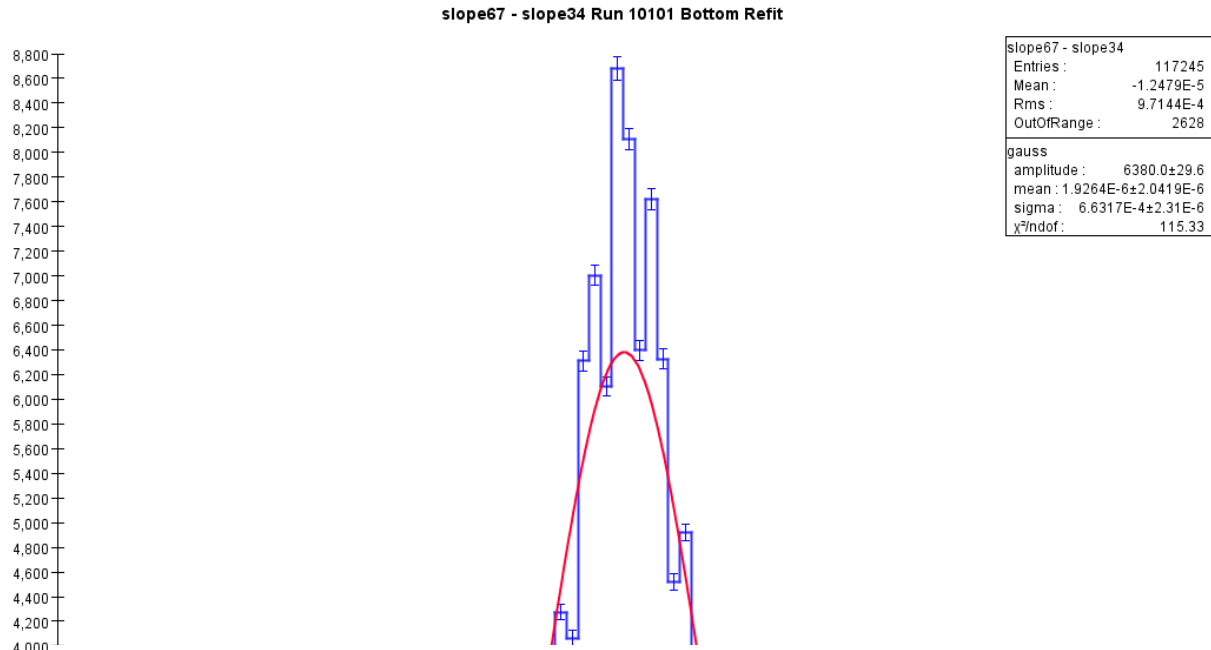


SVT opening angle bottom

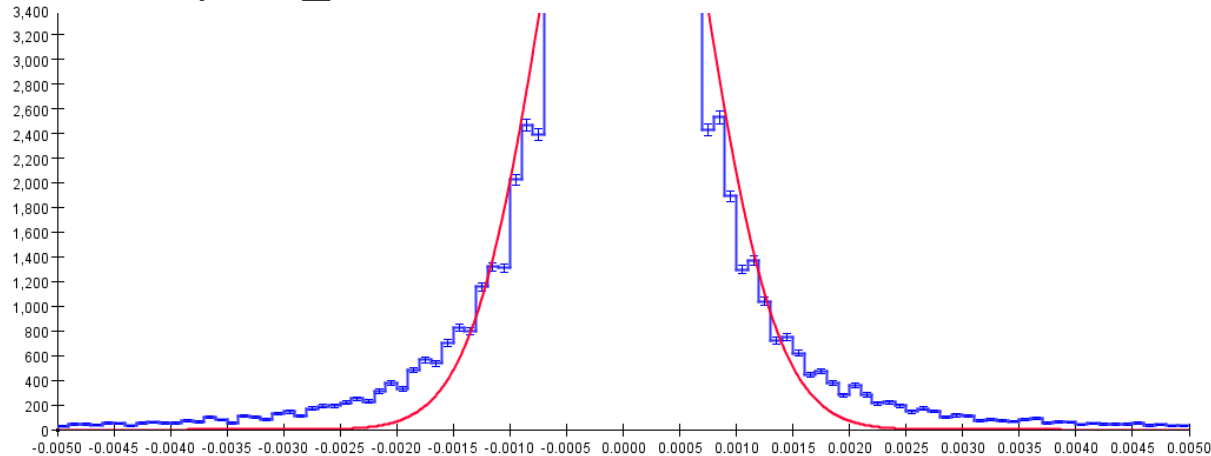


Note sizable offset in theta measured by the front “track” compared to the back “track.” Could be due to individual sensor misalignments or to SVT opening angle. Size of correction seems incommensurate with the opening angle.

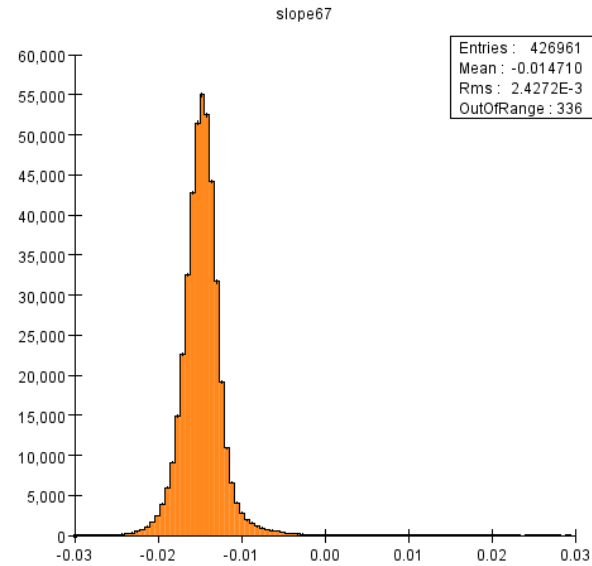
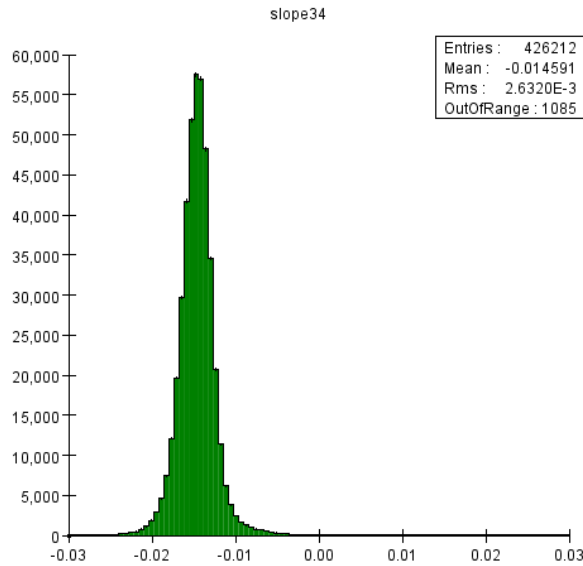
SVT opening angle bottom (fixed)



`<millepede_constant name="23100" value="0.0001+0.000911"/>`

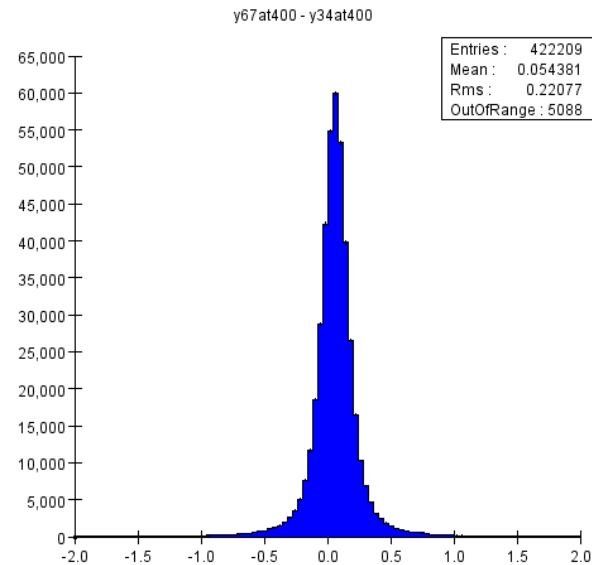
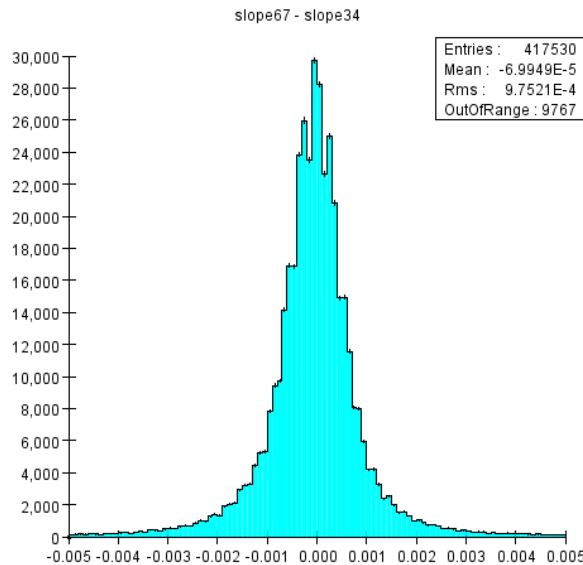


SVT opening angle bottom (fixed)



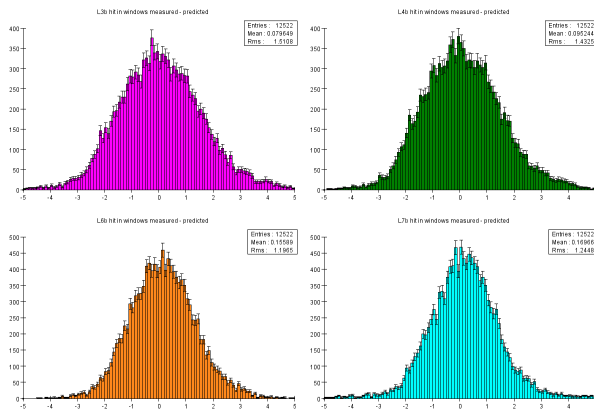
$$\Delta\Theta = -7.0E-5$$

$$\Delta Y = 0.054$$

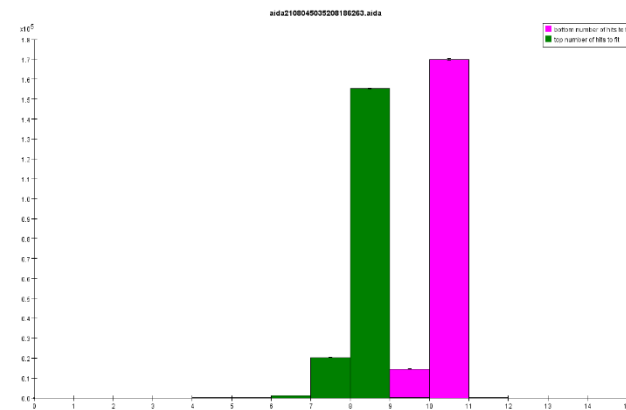


Straight Track Fits

- Have implemented code to perform straight-track fits to 1D strip cluster hits in the field-off data
- Pattern Recognition
 - Connect Ecal cluster position to the 2H02 wire
 - 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.



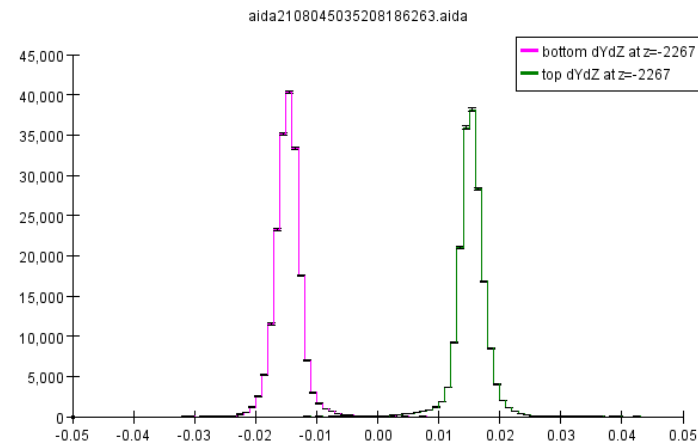
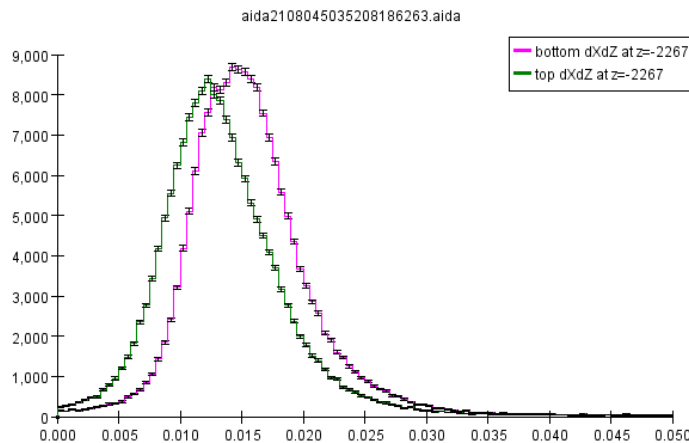
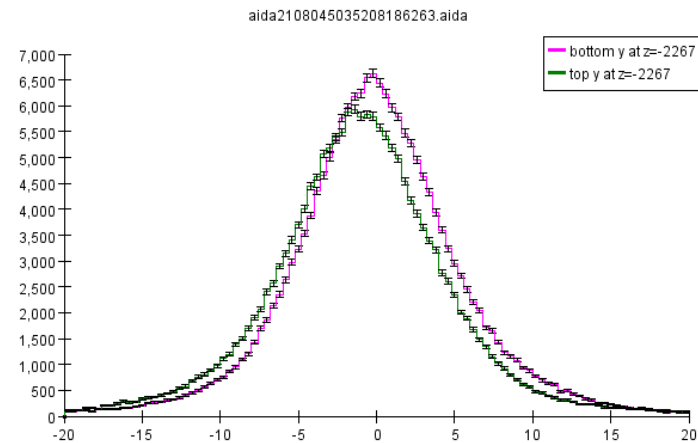
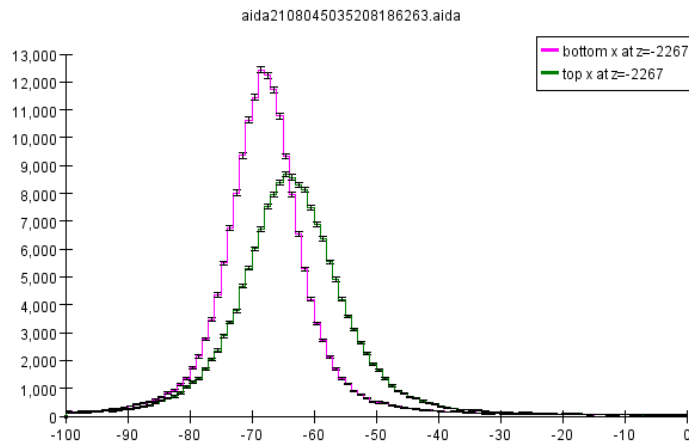
Residuals



Number of Hits per Track

Project Track fits 2H02 wire (-2267)

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



Constraints

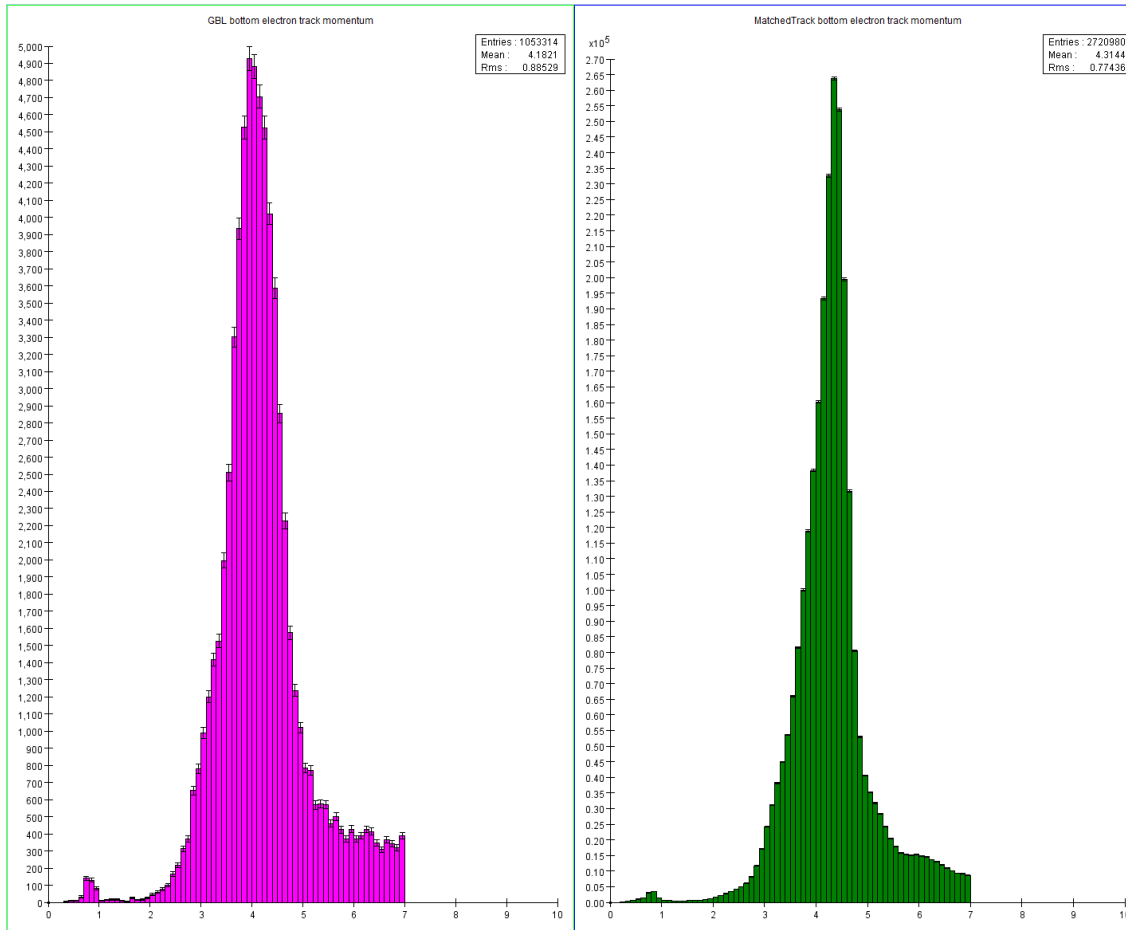
- Find reasonable agreement between top and bottom with expected position of beam in (x,y) at $z=-2267$.
- Will fix position of beam on wire and use it as one constraint in the alignment procedure.
- Will compare track-fit projection to the ECal to the measured ECal position to investigate position resolution and any systematic biases.
- Implementing code for maximum-likelihood alignment of individual sensors with constraints.
- Will begin formal alignment process.

SVT Alignment & Calibration

- Will check that FEE tracks from top and bottom point to same target position after field-off alignment.
 - Will help disambiguate effects of the SVT opening angles from the effects of simply shifting stations 3 & 4.
 - Will allow alignment of “slim sensors” in stations 1 & 2 (old 0 & 1), which are not hit by straight-tracks in the field-off running.
- Will use momentum scale and resolution of FEEs as one metric for the alignment.

SVT Momentum Scale

- Compare GBL and Matched Tracks (helical fit)
- Clearly work to be done.



Summary

- A number of calibration and alignment efforts are ongoing, not all of which were touched on here.
- Have identified and in many cases staged and reconstructed event samples (field-off & FEE).
- Will have full reports on all calibration projects at upcoming meetings.
- Stay tuned to the Ecal, SVT, software and DAWG meetings.