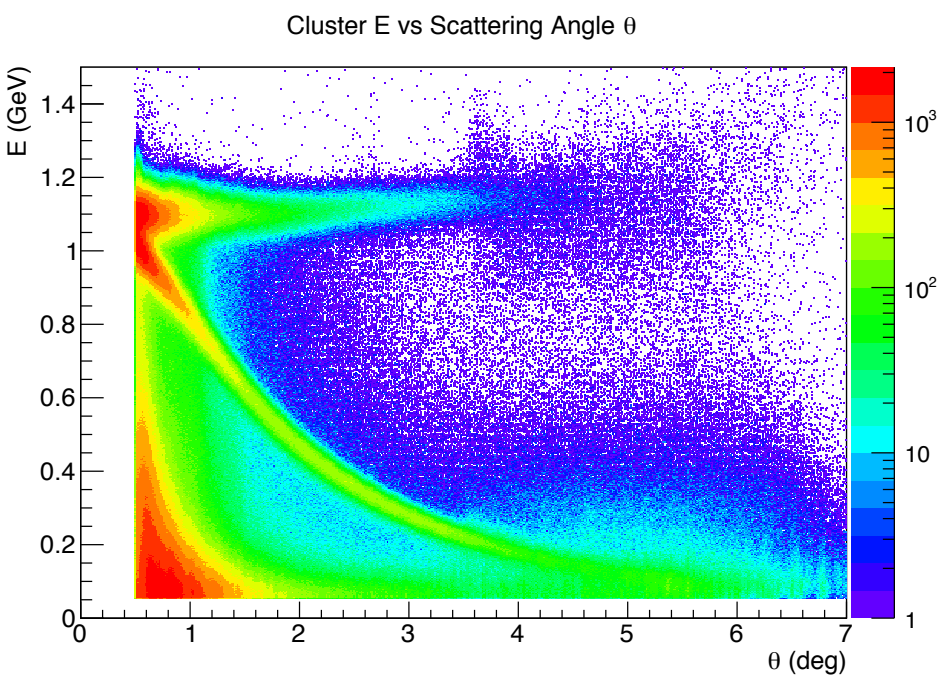
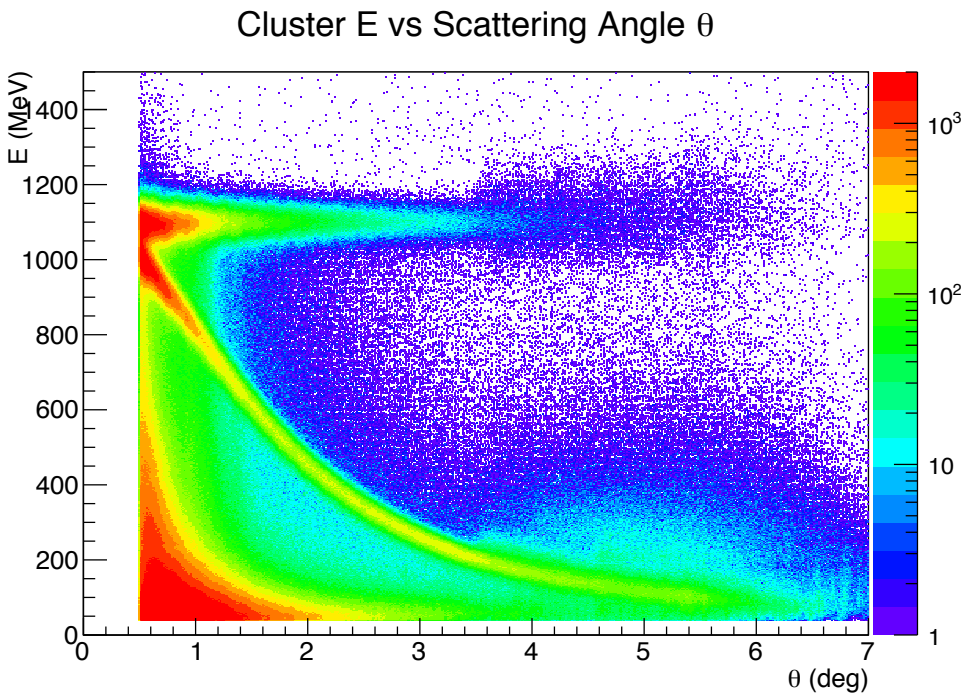
HyCal Physics Calibration



Old constants: obtain using Ilya's initial physics calibration constants, using PrimEx island algorithm



New constants: after second iteration, calibrate using ep elastic scattering events, using PrimEx island

HyCal Physics Calibration

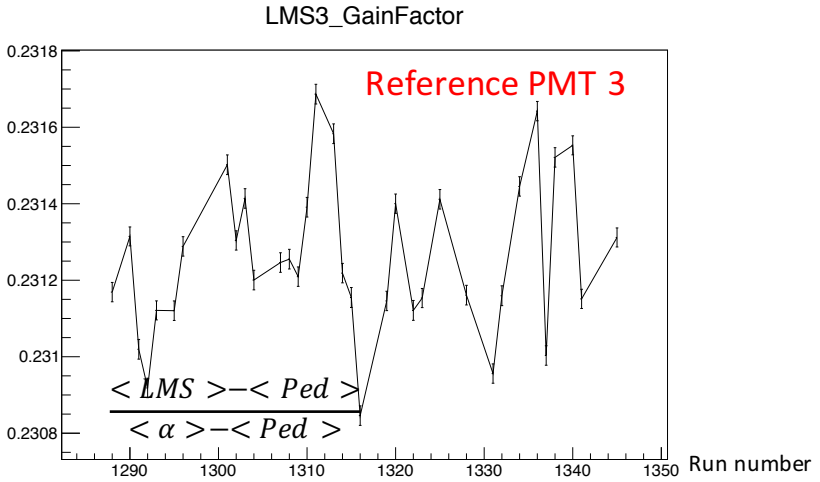
- Why we need physics calibration (Opinions from Ilya)
  - Lead Glass booster problem (Linearity constants one order of magnitude larger than PWO's)
  - Radiation damage on many PWO modules
  - Particles are now electrons not photons
  - Impact momenta are not perpendicular to HyCal anymore (important for edge hits)

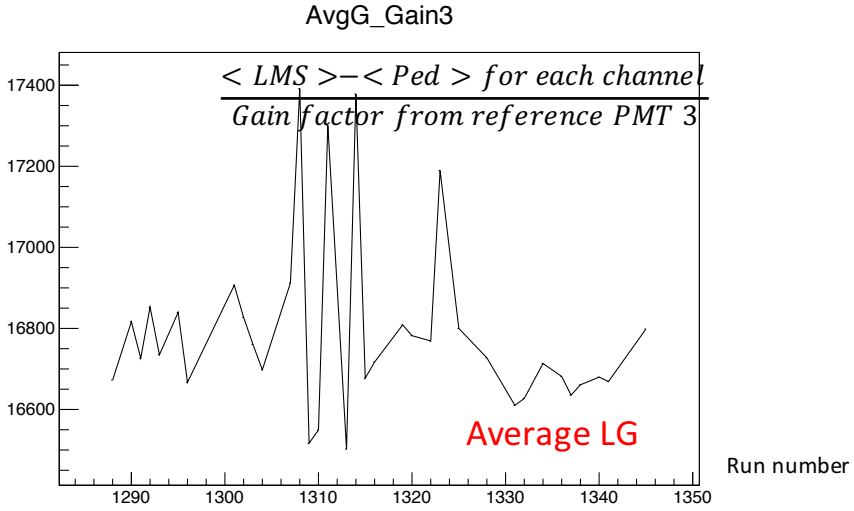
- What we expect to see from physics calibration compare to snake run calibration
  - Large discrepancy might appear for LG and inner modules that were radiation damaged, and edge
  - Reasonably good agreement for outer part of the PWO

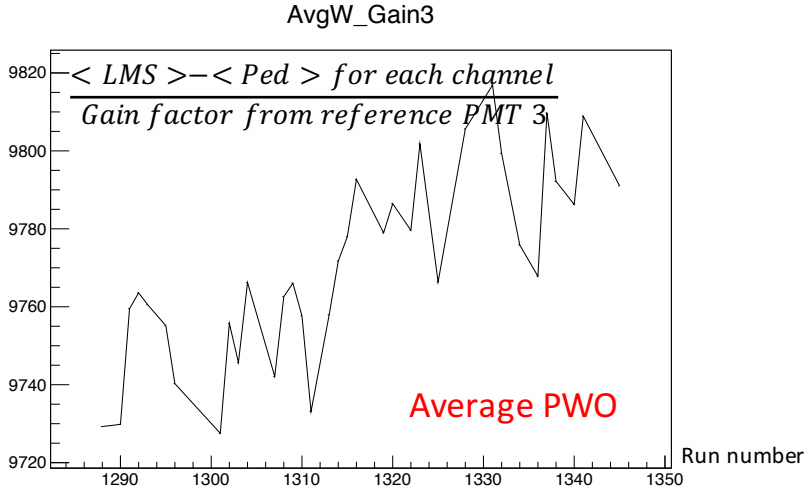
- Final result now depend on what we "believe" to be the expected energy, i.e. whether consider the energy loss in the expected energy. Need to be careful on this

HyCal Physics Calibration

- Starting with calibration period 1288 ~ 1345
  - The most stable period in 1.1 GeV
  - Large statistics: > 400 M events in total (including 24M carbon data)
  - Relatively stable LMS and pedestal
  - < 6hr to do one pass, reasonably fast





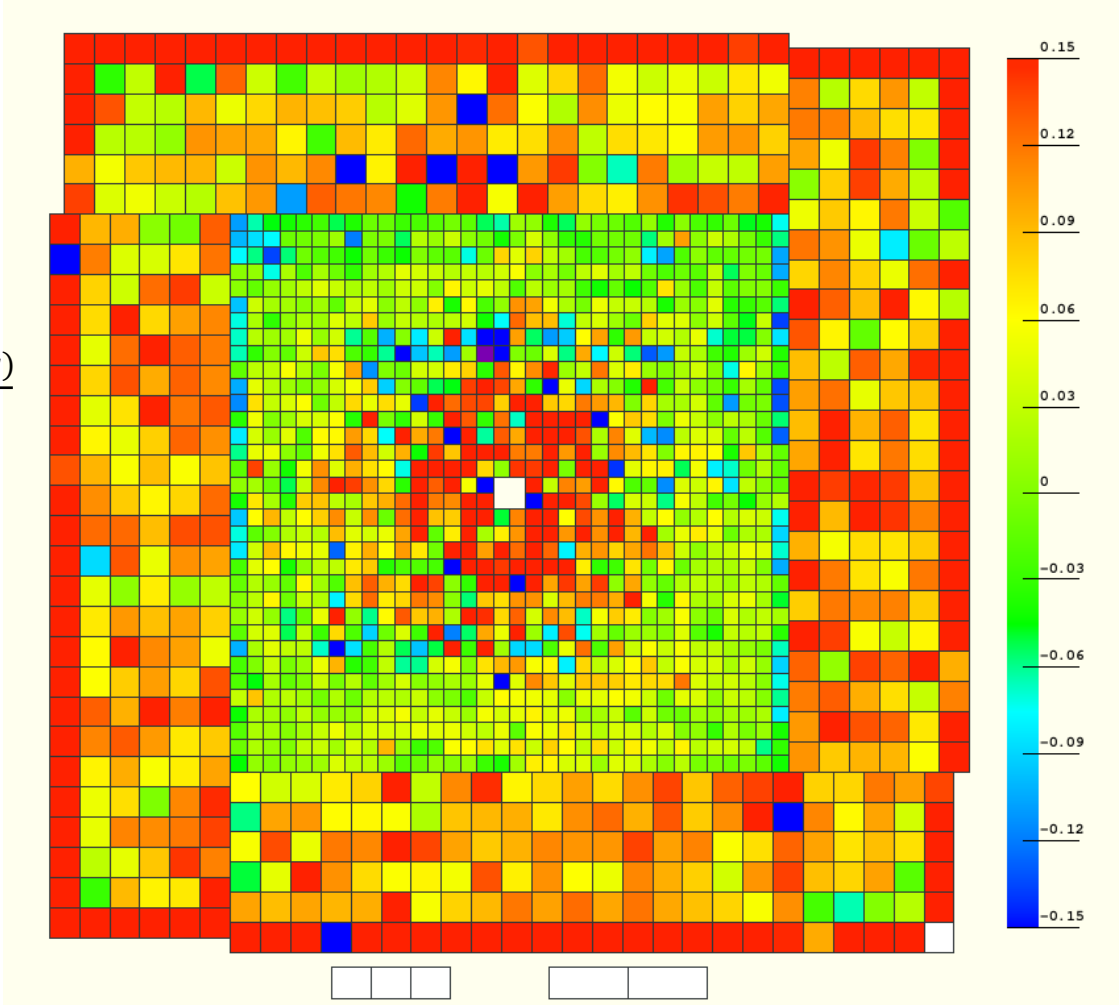


HyCal Physics Calibration

- Procedure:
  - Start with the initial calibration constants that Ilya provided (calibrated to Moller)
  - Reconstruct each event using Primex island algorithm
  - Preliminary event selection for ep elastic (elasticity and almost independent on angle) and double arm Moller (elasticity and co-plane)
  - Calculate expected energy for ep and Moller
  - Fill the ratios (E recon / E expect) to a histogram correspond to the central module of a cluster
  - Identify the ep/Moller peaks of each histogram, fit it with a Gaussian function
  - Using the mean value of the fit to correct for the old constants and obtain new ones, until things converges

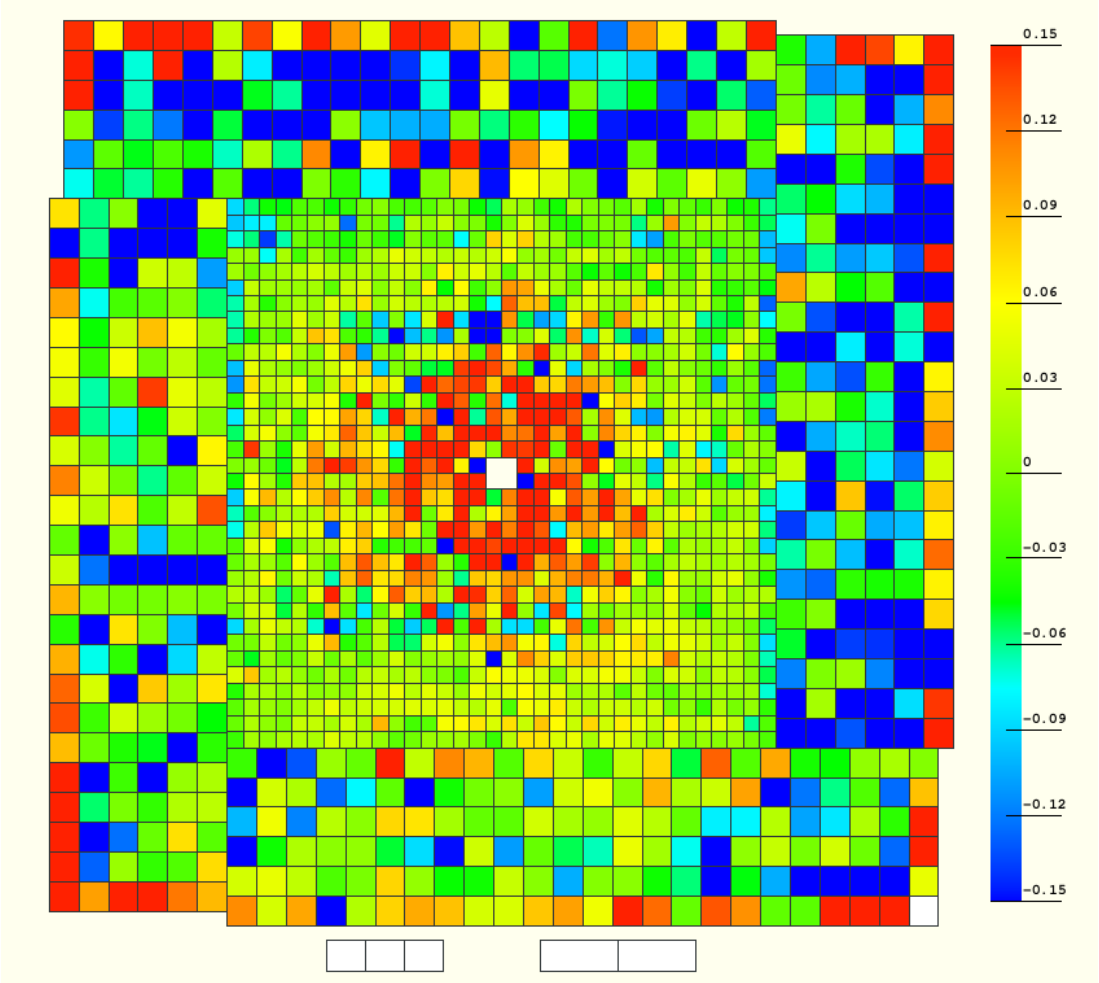
HyCal Physics Calibration -- Compare with Snake Run Constants

- Comparison between the calibration constants from snake run (Ilya's) and new constants
- Showing $\frac{(my\ constants - Ilya's\ constants)}{my\ constants}$
- My constants are calibrated to ep (1.1GeV)
- No linearity correction
- No LMS correction



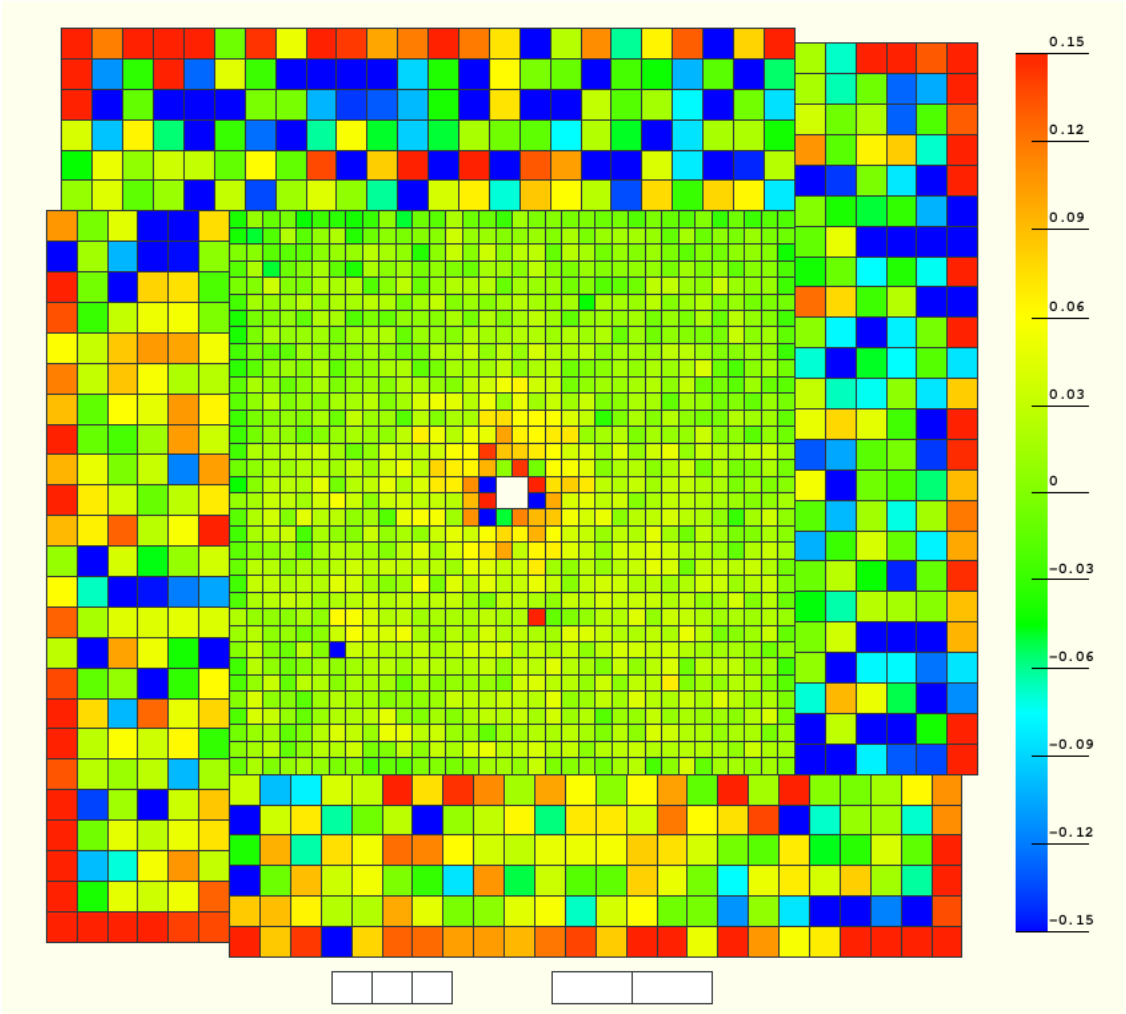
HyCal Physics Calibration -- Compare with Snake Run Constants

- Comparison between the calibration constants from snake run (Ilya's) and new constants
- Showing $\frac{(my\ constants - Ilya's\ constants)}{my\ constants}$
- My constants are calibrated to ep (1.1GeV)
- With Ilya's linearity correction from snake run
- No LMS correction

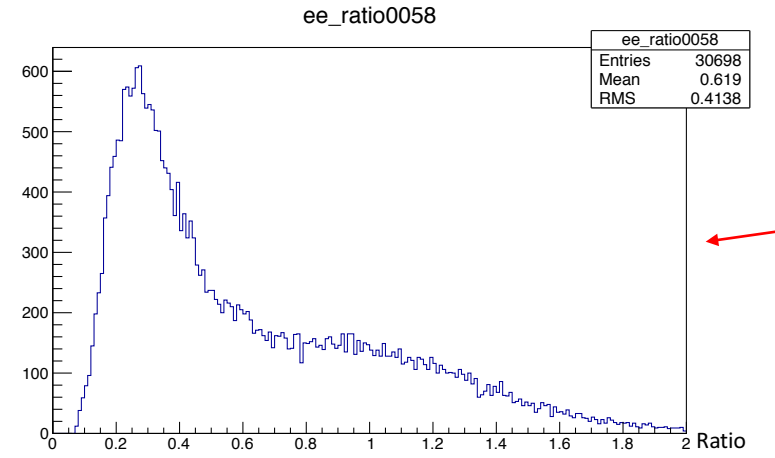


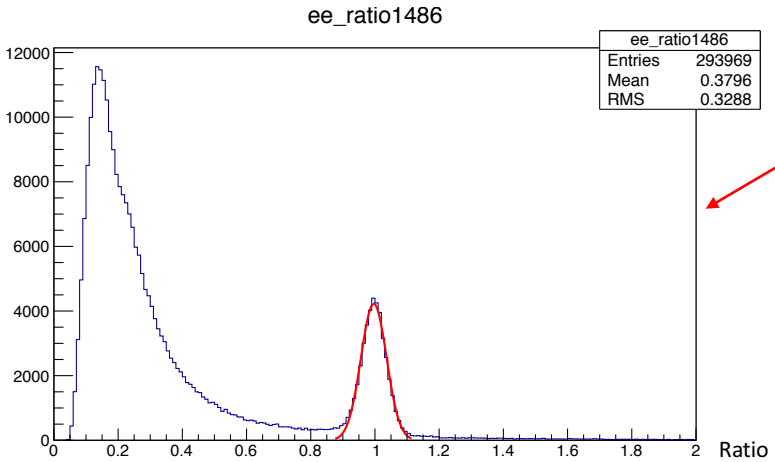
HyCal Physics Calibration -- Compare with Snake Run Constants

- Comparison between the calibration constants from snake run (Ilya's) and new constants
- Showing $\frac{(my\ constants - Ilya's\ constants)}{my\ constants}$
- My constants are calibrated to ep (1.1GeV)
- With Ilya's linearity correction from snake run
- With LMS correction
  - A bit sloppy here, use only LMS and pedestal from run 935 (before the gate shift problem occur)

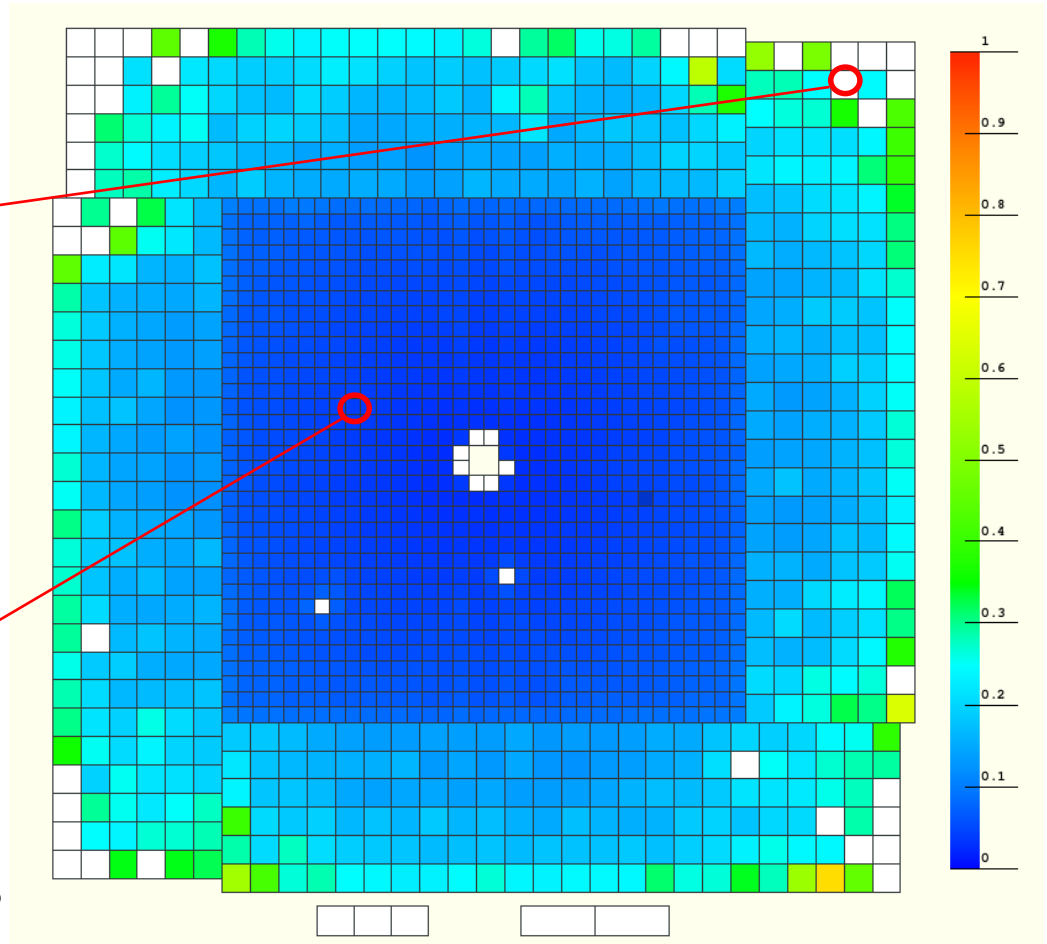


HyCal Physics Calibration -- Moller

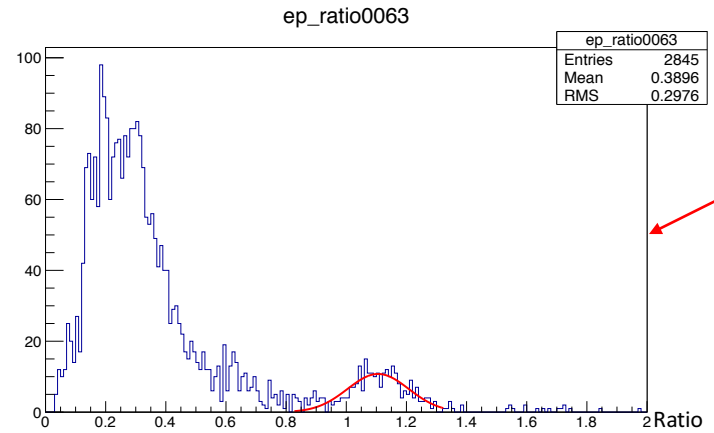


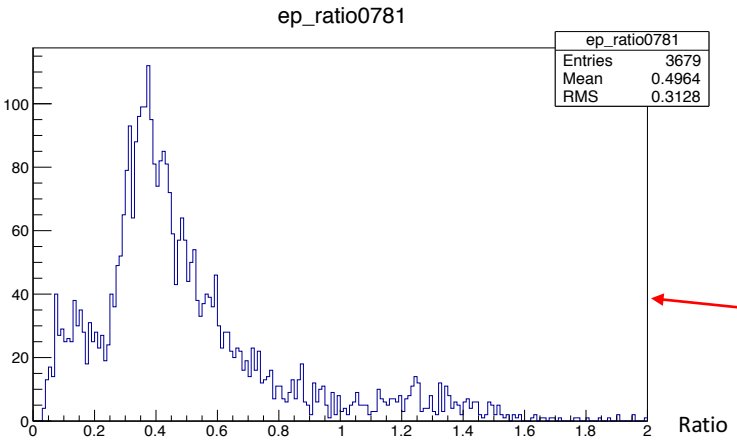


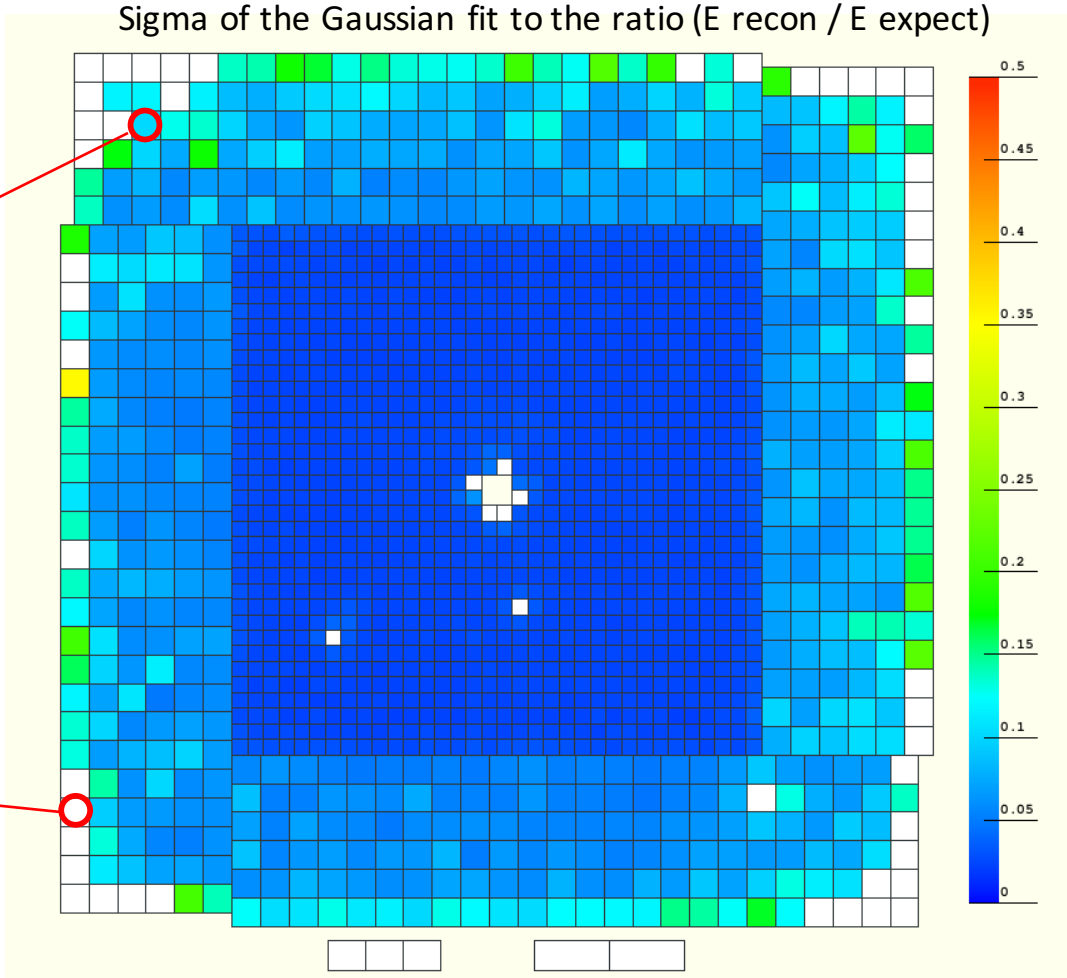
Sigma of the Gaussian fit to the ratio (E recon / E expect)



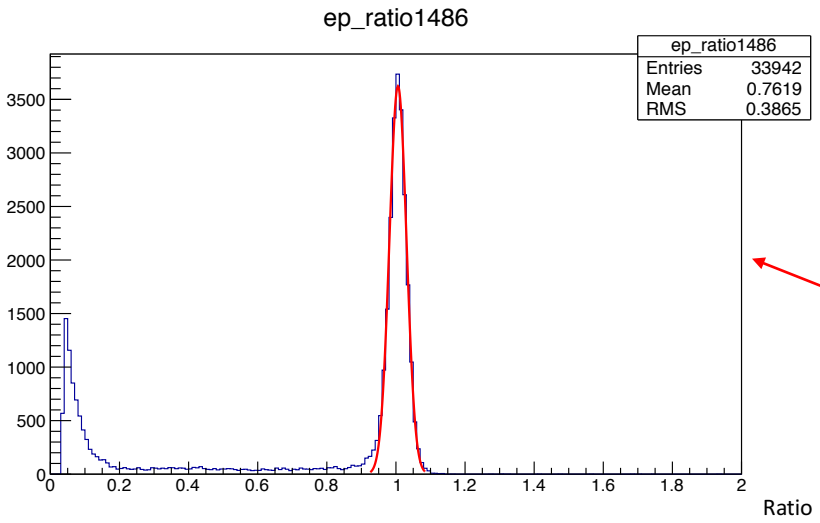
HyCal Physics Calibration -- ep

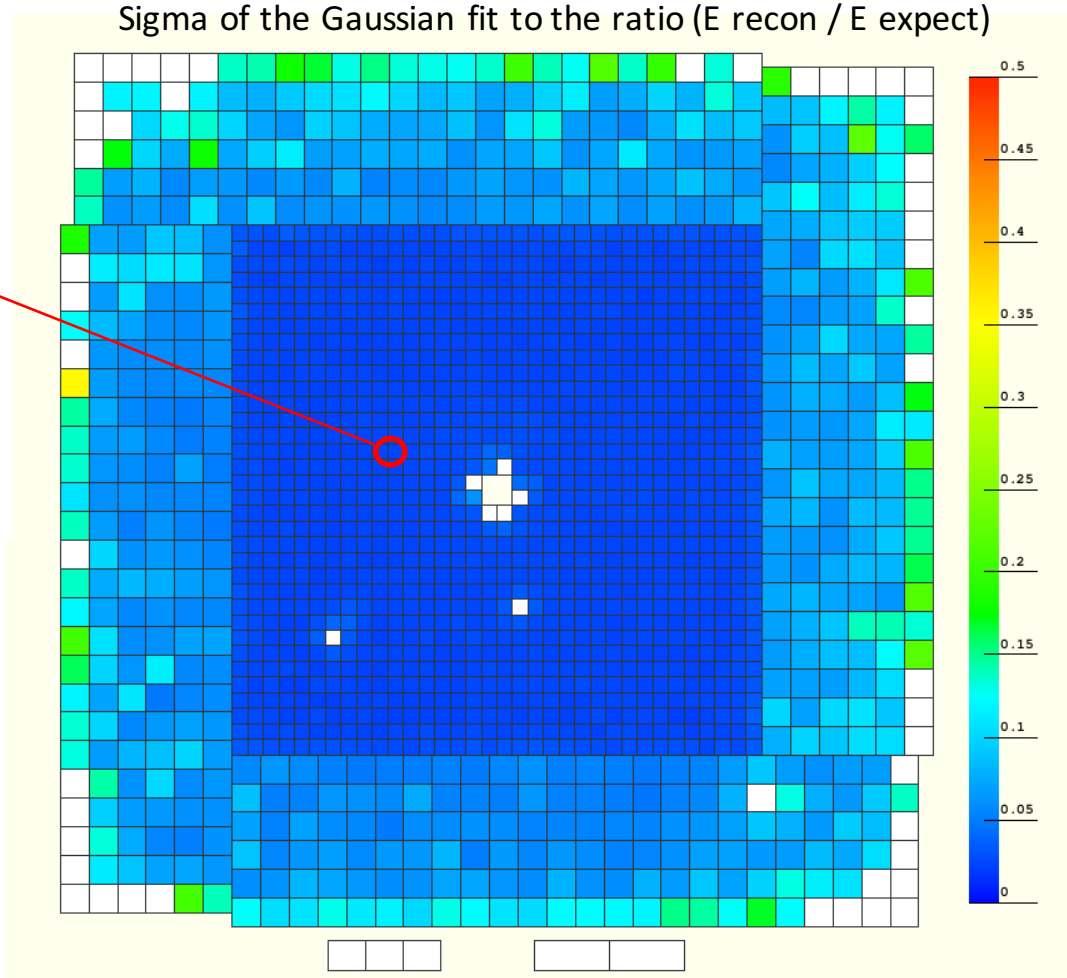




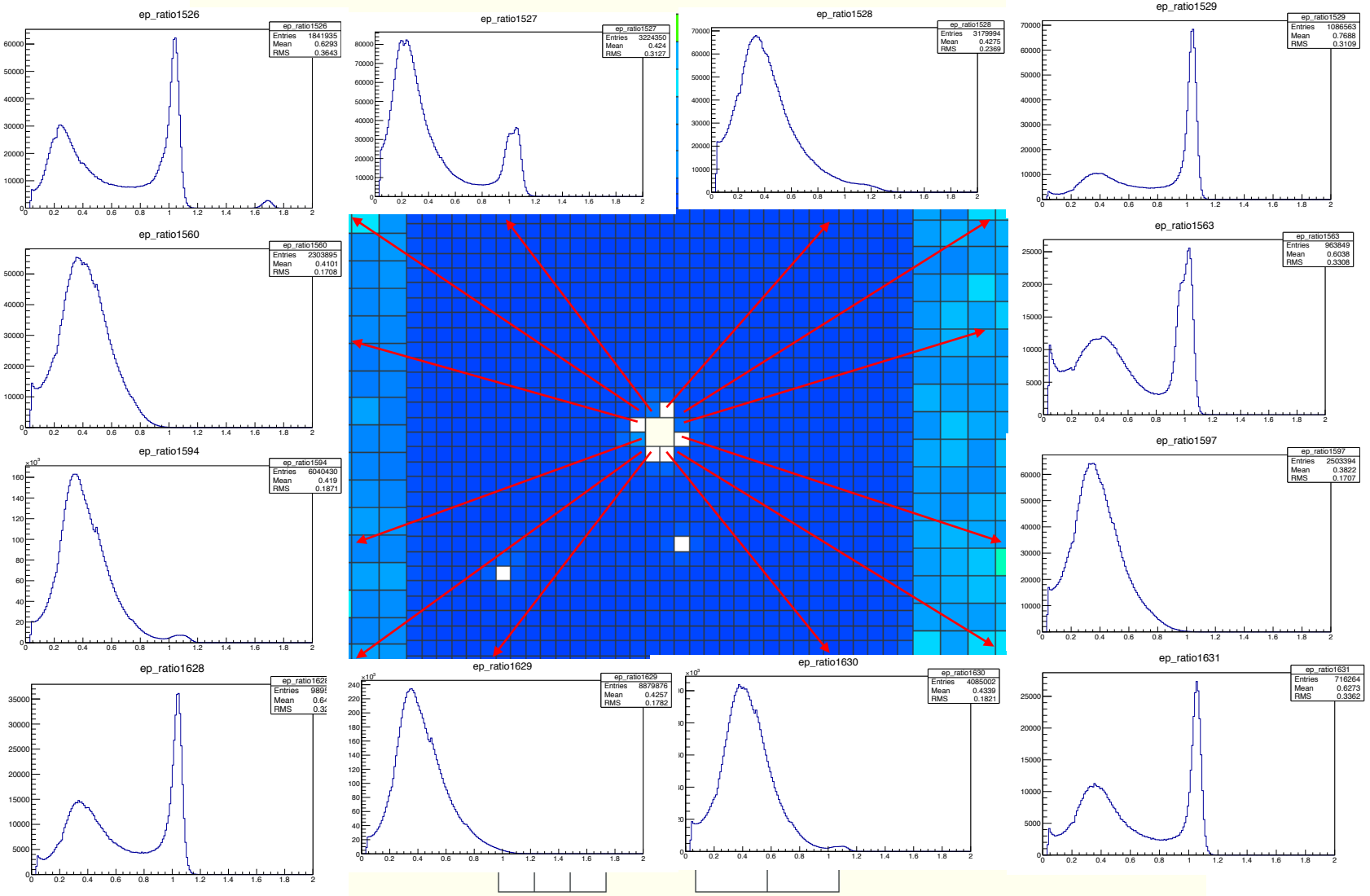


HyCal Physics Calibration -- ep



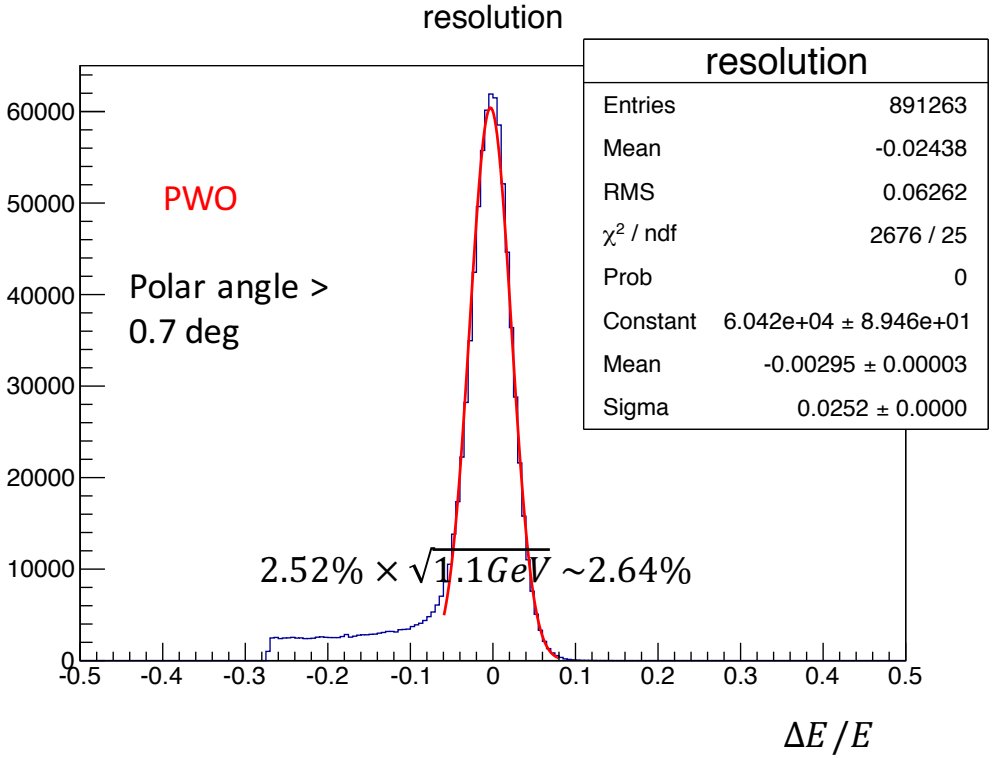


- Statistics enough for most part of HyCal for this calibration period, except for part of the edge and corner, but that could also due to leakage from the boundary
- There are 4 other calibration periods in 1.1GeV, they may not have enough statistics, may need to combine some of them

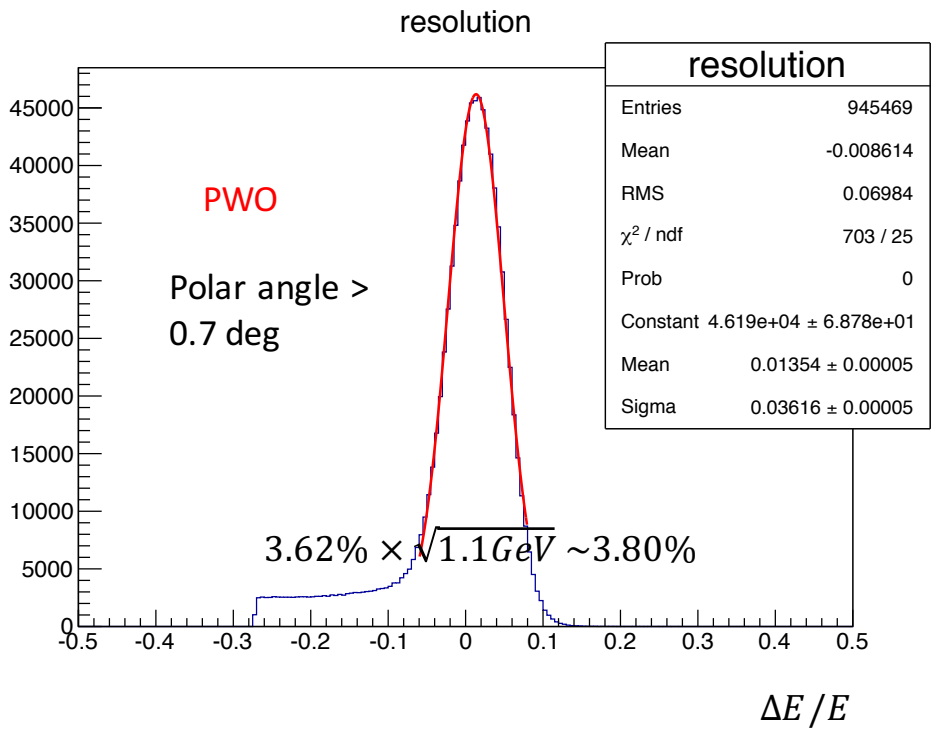

ep_ratio1526
ep_ratio1526
Entries 1841935
Mean 0.6293
RMS 0.3643
ep_ratio1527
ep_ratio1527
Entries 3224350
Mean 0.424
RMS 0.3127
ep_ratio1528
ep_ratio1528
Entries 3179994
Mean 0.4275
RMS 0.2369
ep_ratio1529
ep_ratio1529
Entries 1086563
Mean 0.7688
RMS 0.3109
ep_ratio1560
ep_ratio1560
Entries 2303895
Mean 0.4101
RMS 0.1708
ep_ratio1563
ep_ratio1563
Entries 963849
Mean 0.6038
RMS 0.3308
ep_ratio1594
ep_ratio1594
Entries 6040430
Mean 0.419
RMS 0.1871
ep_ratio1597
ep_ratio1597
Entries 2503394
Mean 0.3822
RMS 0.1707
ep_ratio1628
ep_ratio1629
ep_ratio1629
Entries 8879876
Mean 0.4257
RMS 0.1782
ep_ratio1630
ep_ratio1630
Entries 4085002
Mean 0.4339
RMS 0.1821
ep_ratio1631
ep_ratio1631
Entries 716264
Mean 0.6273
RMS 0.3362

HyCal Physics Calibration -- Resolution

New calibration constant after second iteration



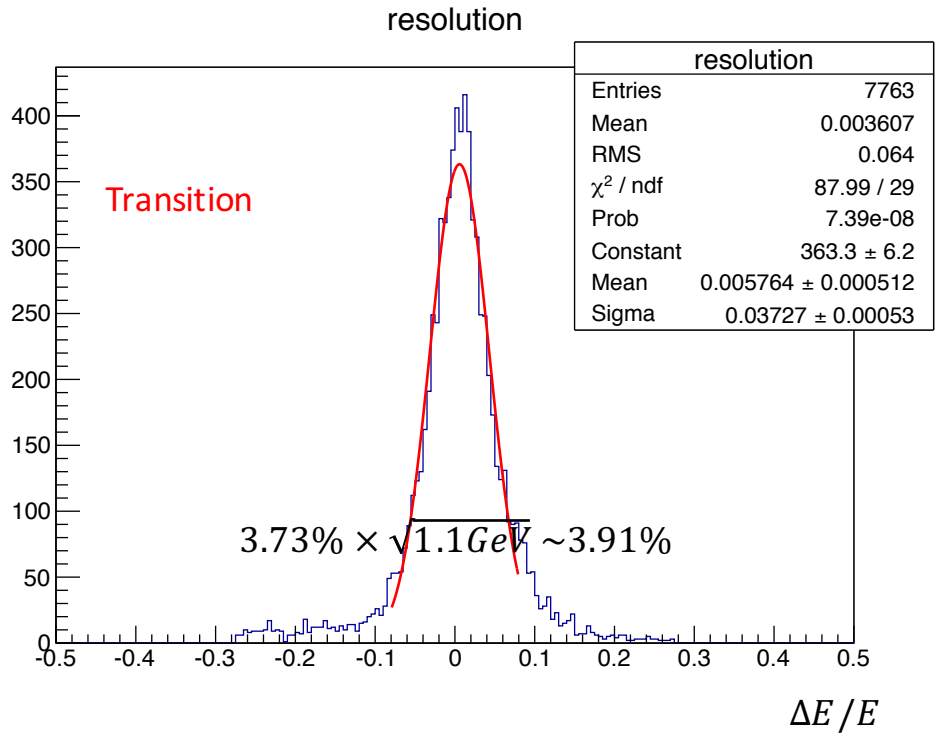
Old calibration constant before iteration



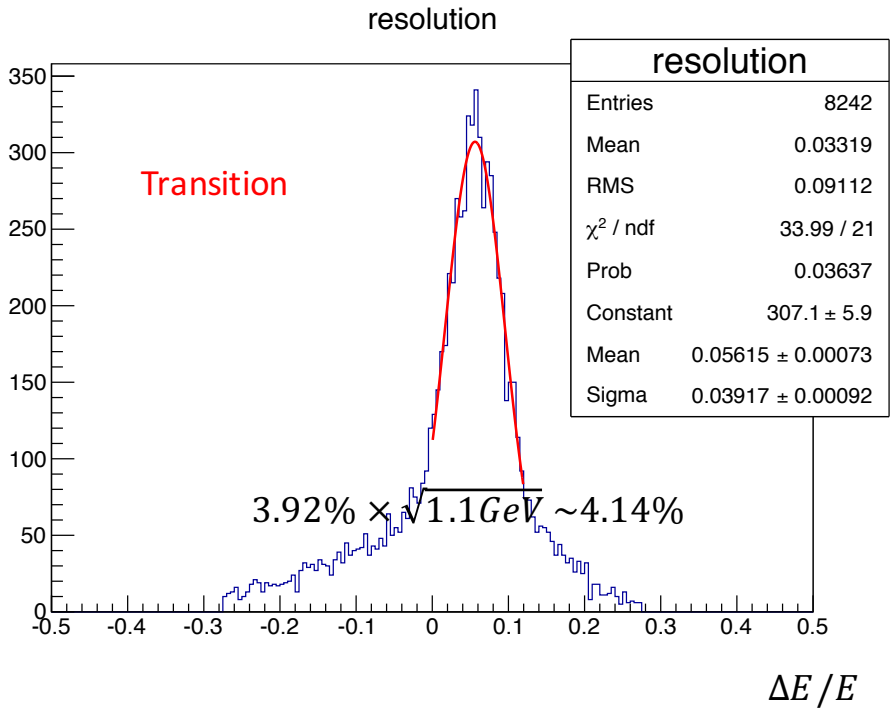
Still small improvement with third iteration

HyCal Physics Calibration -- Resolution

New calibration constant after second iteration

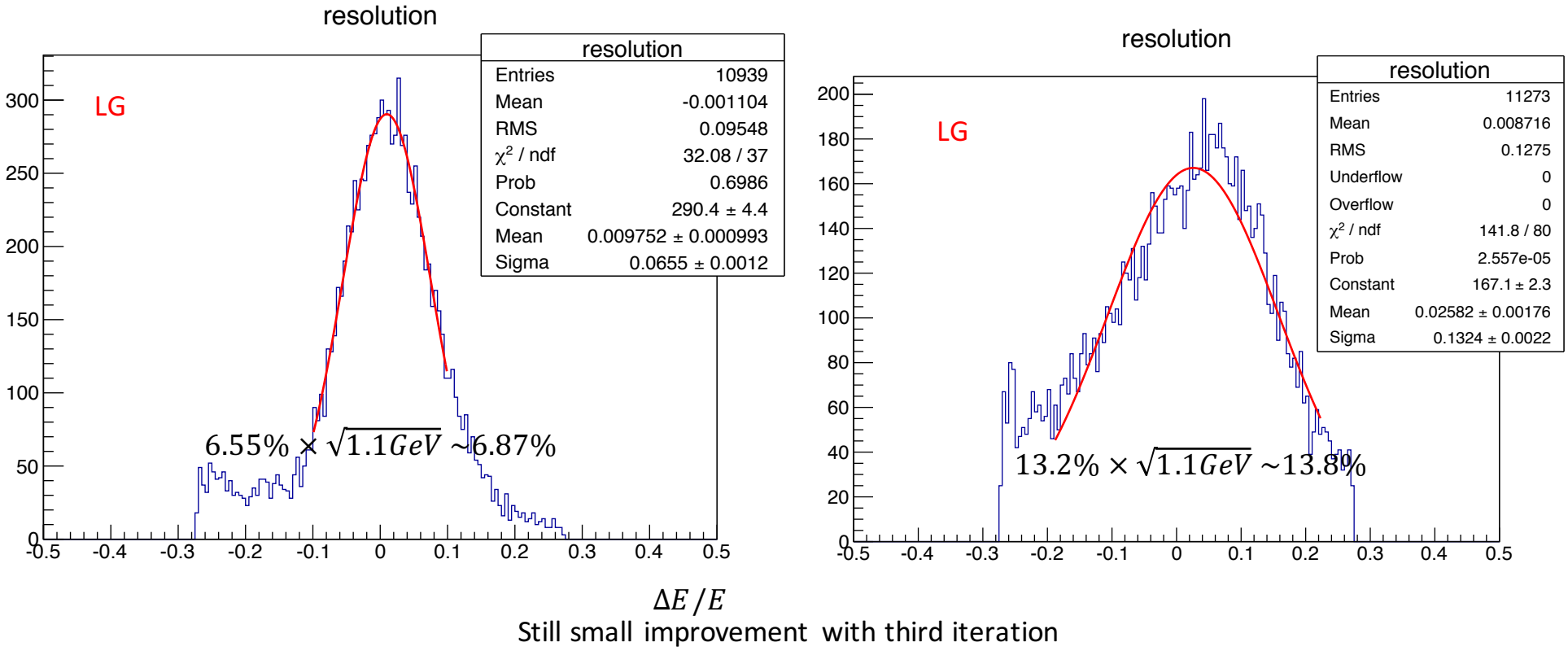


Old calibration constant before iteration



Still small improvement with third iteration

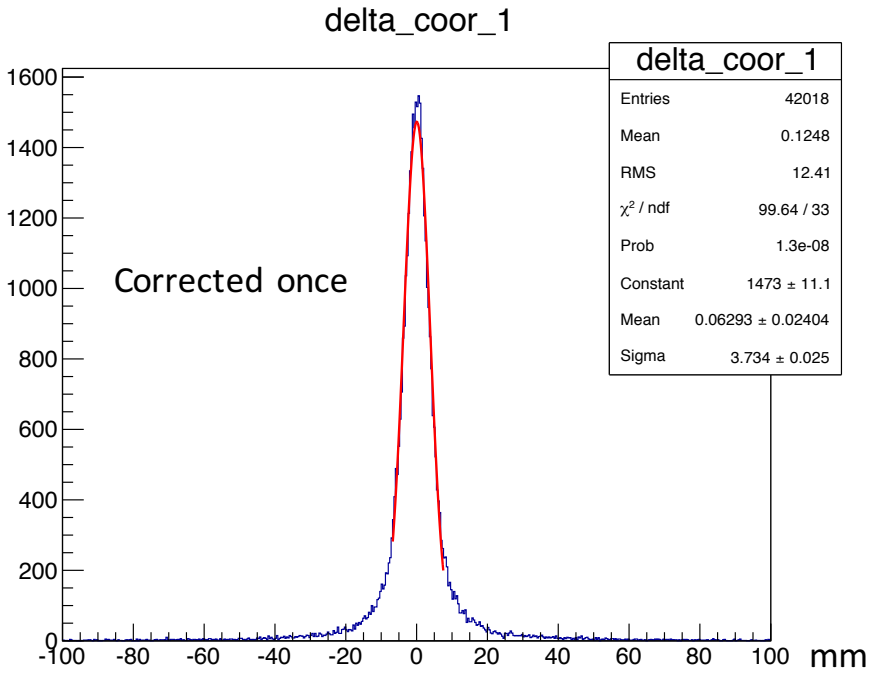
HyCal Physics Calibration -- Resolution

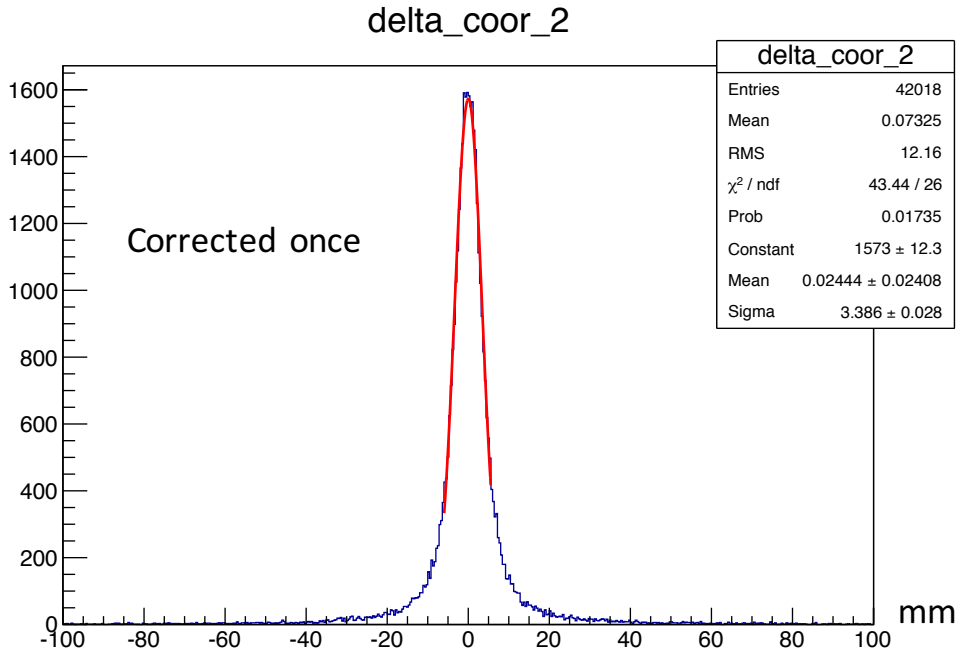


Still small improvement with third iteration

HyCal Physics Calibration -- Resolution

- Also calculate offset using ee events during calibration, continuously monitor changes with each iteration
- Using only ee events in PWO region, much better position resolution





To do

- Edge, central hole, dead modules deserve a bit more effort on studying
- Continue testing the reconstruction algorithm (with simulation hopefully)
- A few more iterations see if thing converge more
- Finalizing the threshold cut (threshold cut can make the calibration constant shift to one side)
- Linearity correction has not been studied yet
- Move on to another calibration period, probably one of the 2.2 GeV period.