Update on Ecal Code and Calibrations

Holly Szumila-Vance
HPS Collaboration Meeting
25 Oct 2015, Jefferson Lab

OLD DOMINION UNIVERSITY

Outline:

- Ecal Code
  - Cosmic calibration
  - Full energy electron (FEE) calibration

- Calibration Overview
  - Energy
  - Timing

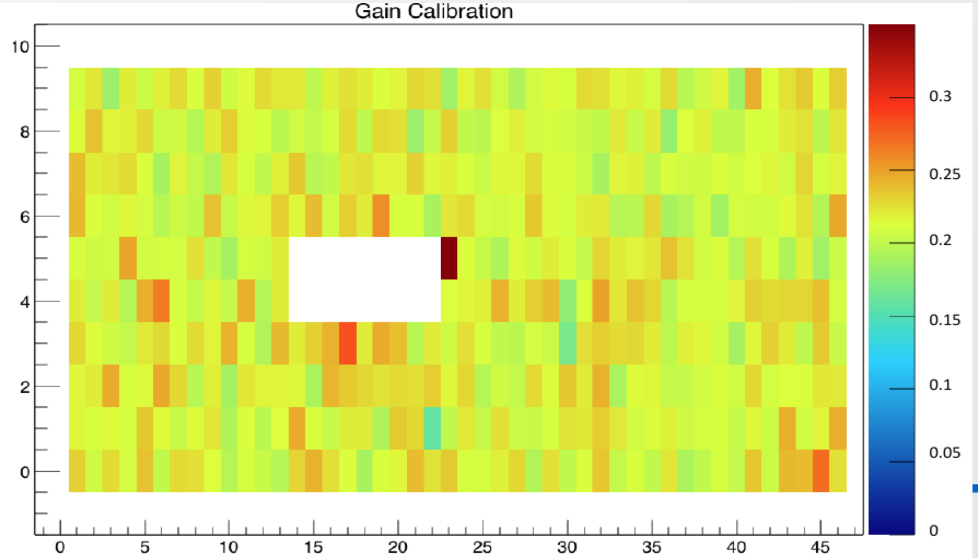
- Energy Resolution and Edge Effects
  - FEE data from Pass 2
  - Simulation for edge corrections

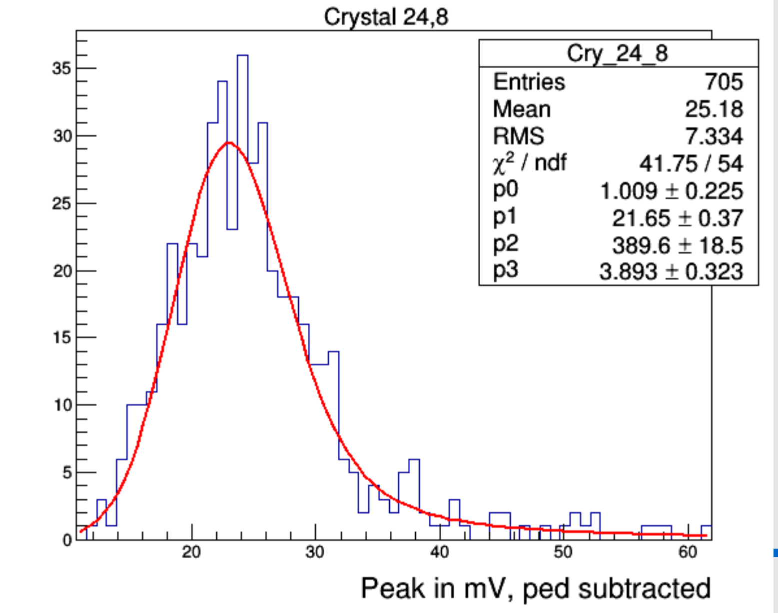
Cosmic code

https://github.com/hszumila/HPS_Calibration

- 40 hours min. for gains
- Geometric cuts based on surrounding crystals
- Threshold in raw ADC spectra, integrated signal
- Sufficient for the trigger and first beam

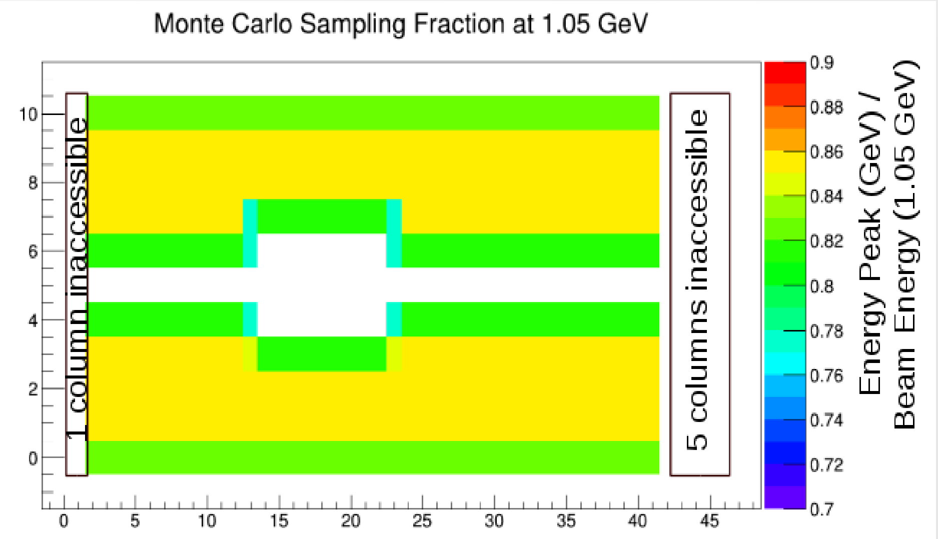
- Future work:
  - Pulse fitting (reduce data-taking?)
  - Implement in hps-java (add PMTs)
  - Track fitting





FEE code

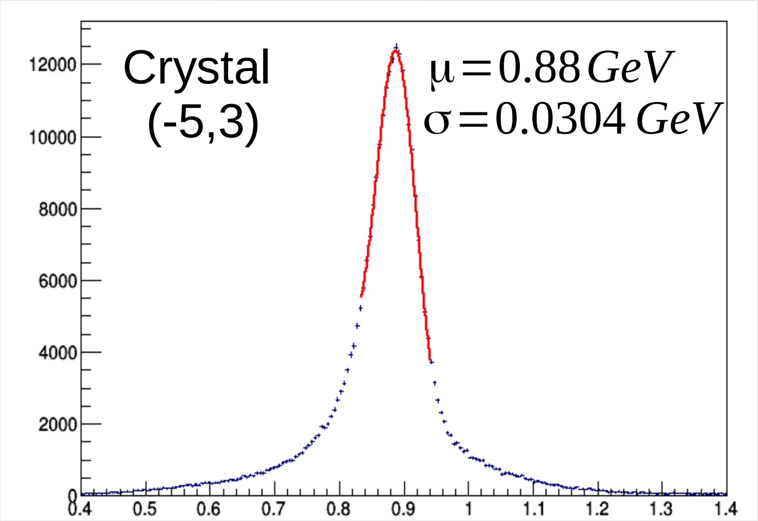
- Simulation first!
- FEE skim data
- Fit peaks offline: $c_i = \frac{MC_E\, peak}{data_E\, peak}$



- Run reconstruction on skim:
  - IterateGainFactorDriver reads in coefficients and multiplies hit energy

$$hit_{new} = c \times hit_{old}$$

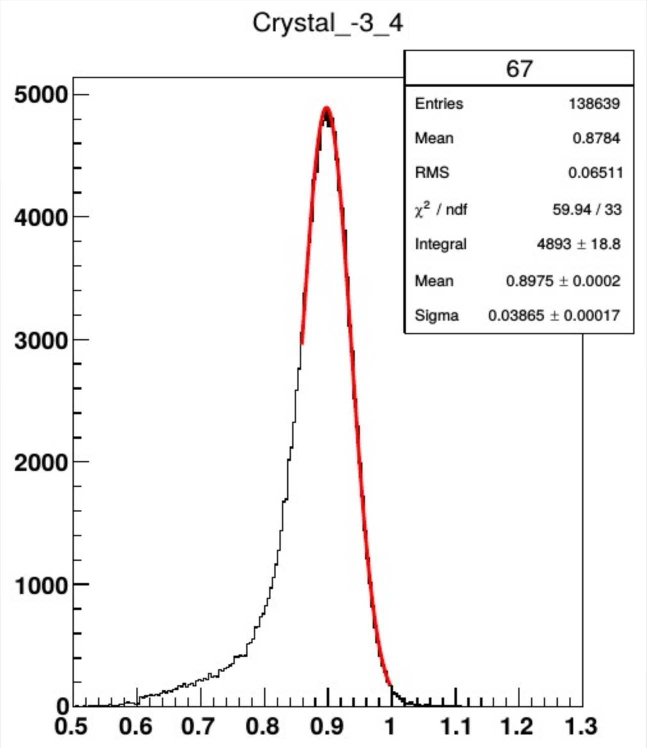
  - Cluster new hit energies
  - FEEClusterPlotter plots FEE peak per crystal
  - Fitting is done offline in ROOT

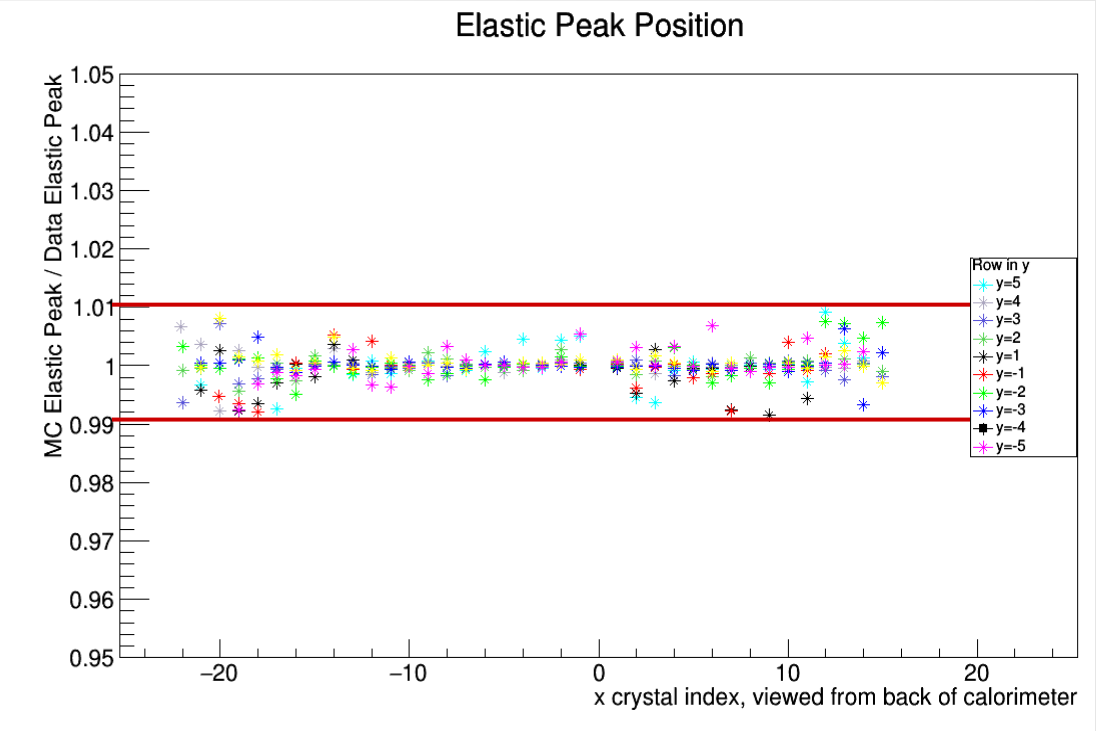


MC Cluster Energy (GeV)

FEE code

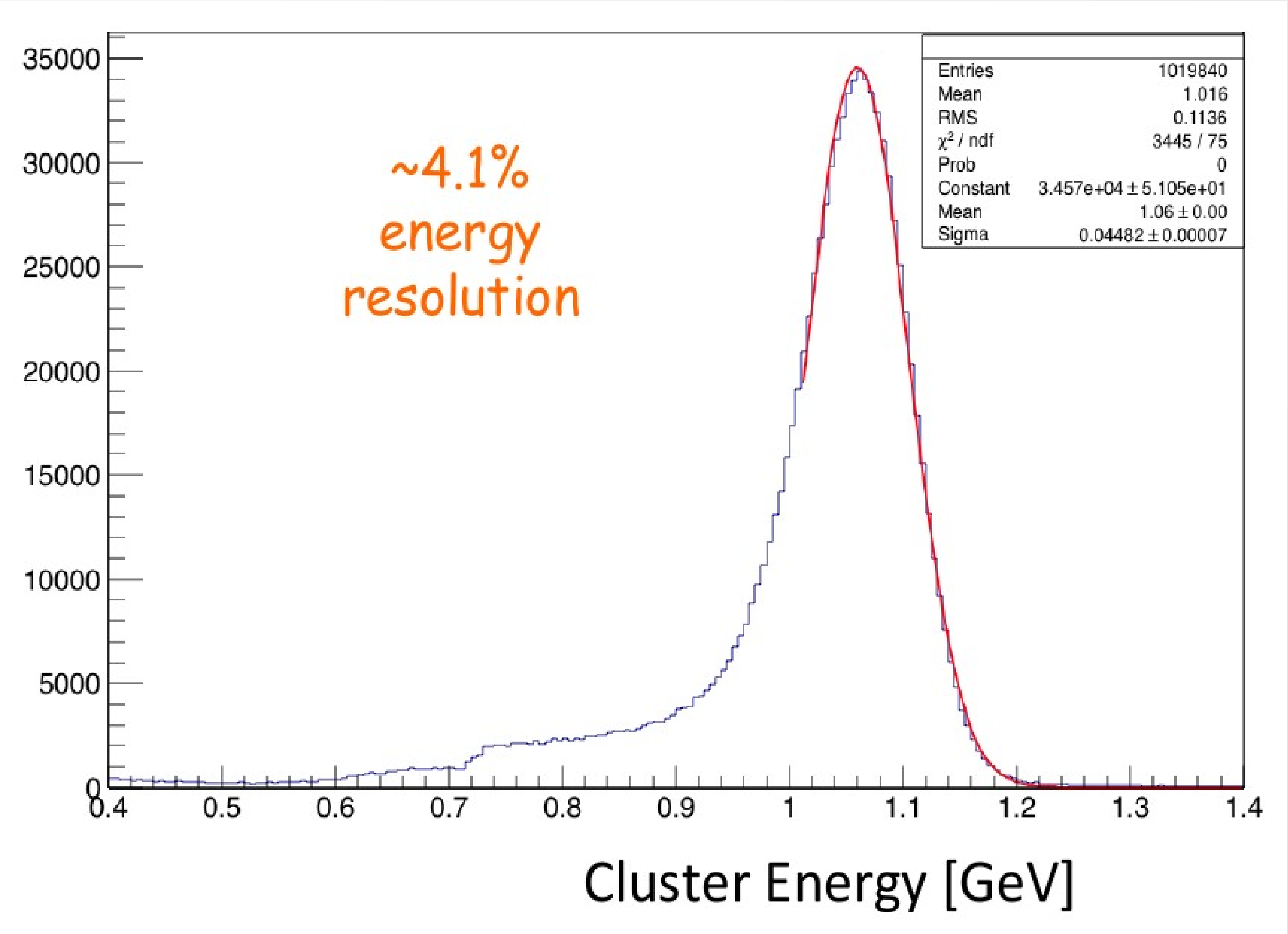
- Each iteration, improve gain coefficient: $c = c_1 \times c_2 \times c_3$
- Re-run reconstruction until $c_i = 1 \pm 0.01$



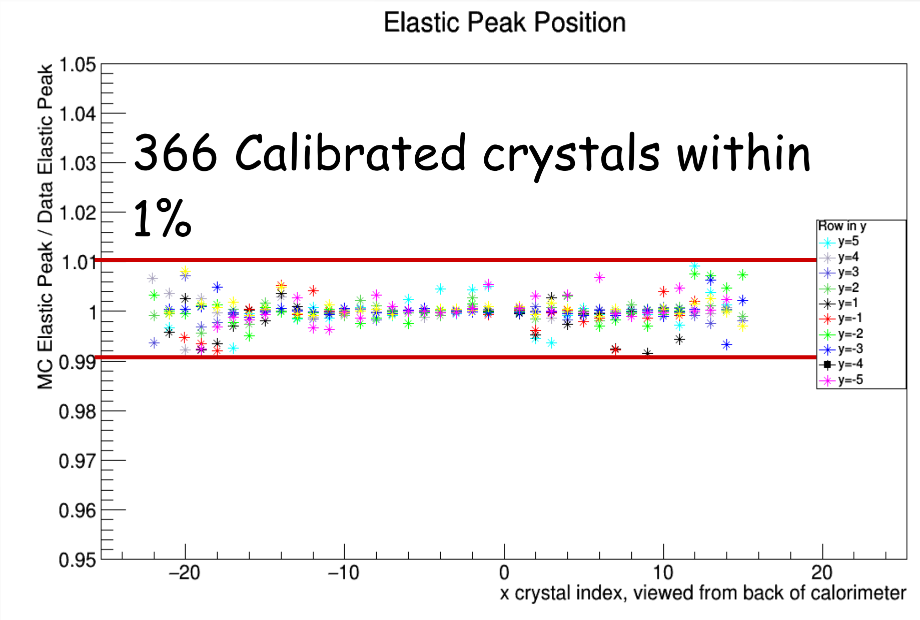


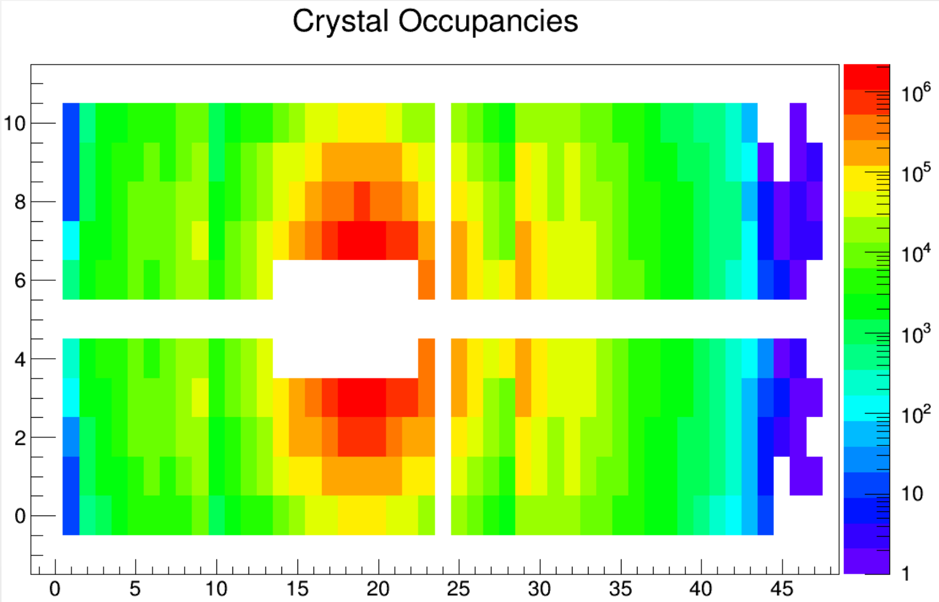
Energy calibration (more details later in this talk)

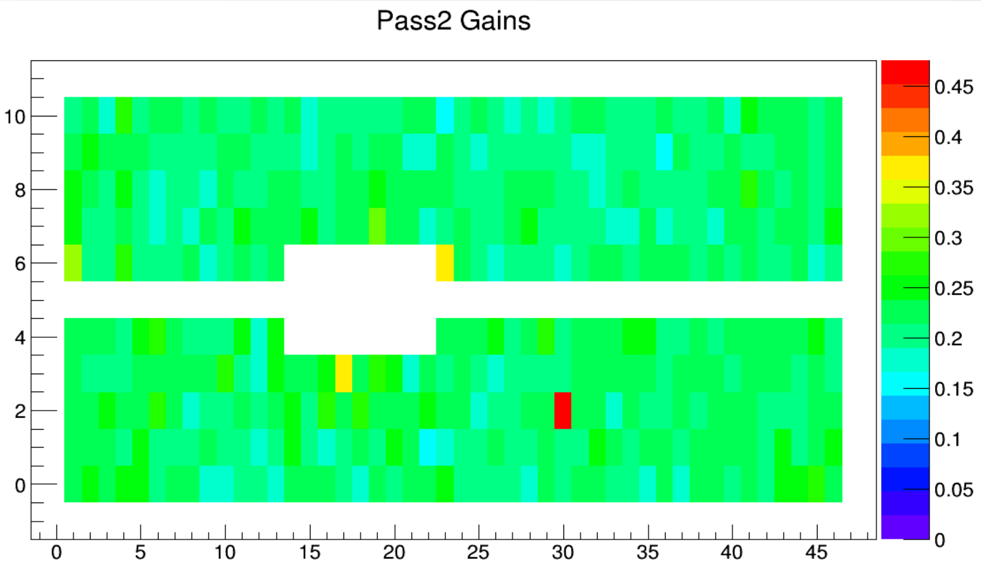
HPS Analysis note coming soon!



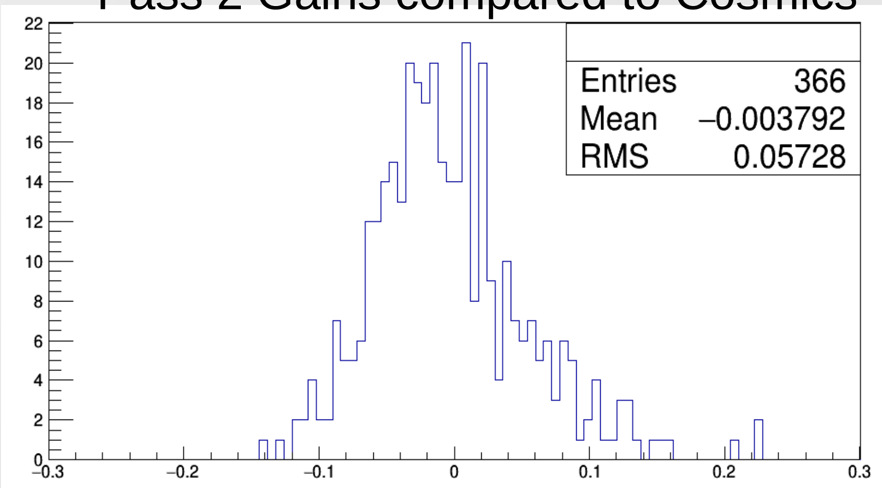
Energy calibration







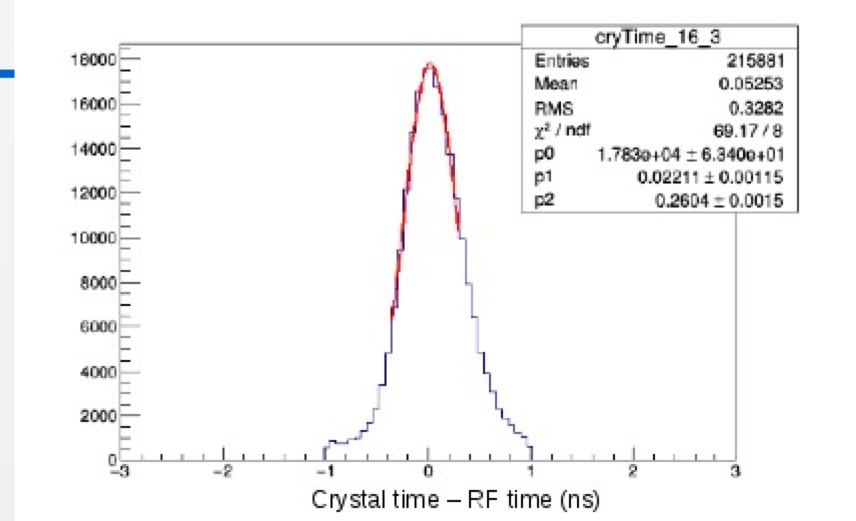
Pass 2 Gains compared to Cosmics

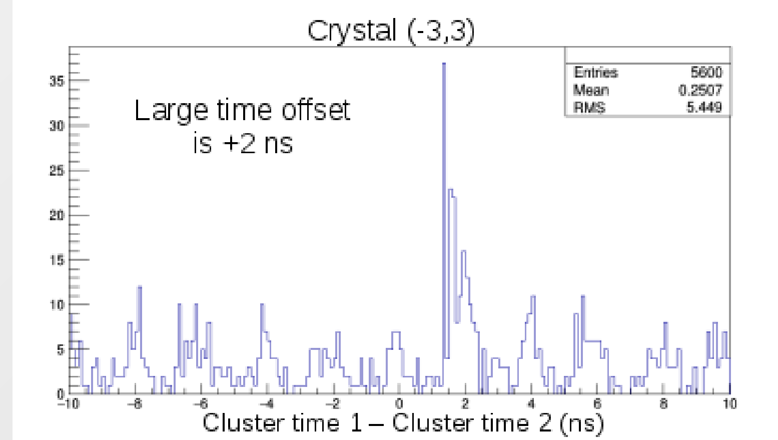


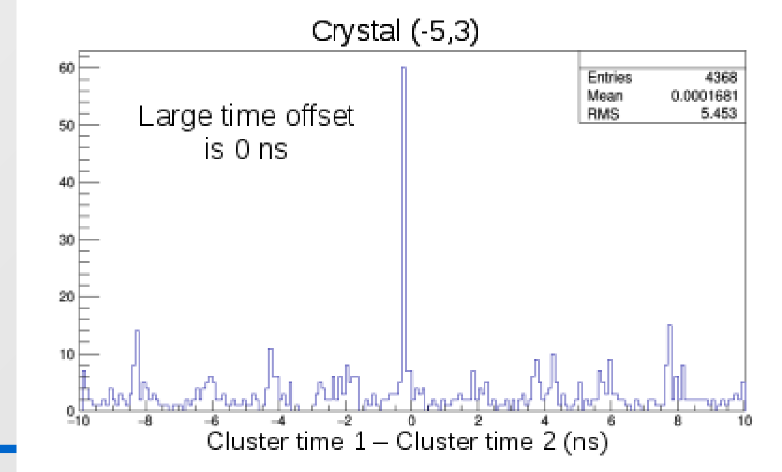
Diff rel to cosmic gains

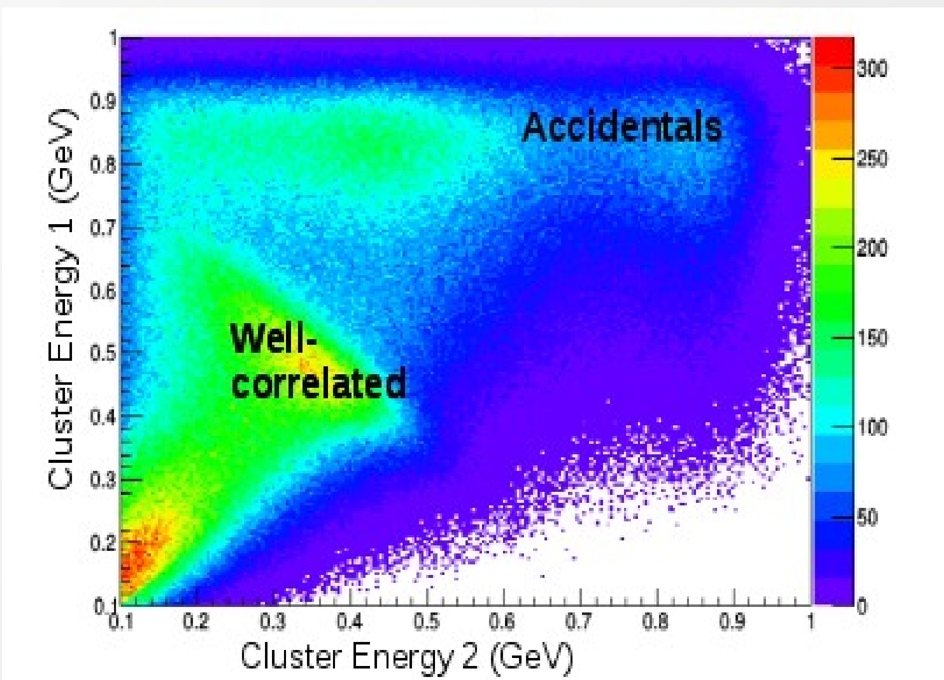
Timing calibration

- HPS Note 2015-011
- Fit RF signal
- Hit time and RF time
- Time between two clusters
- Timing within a cluster









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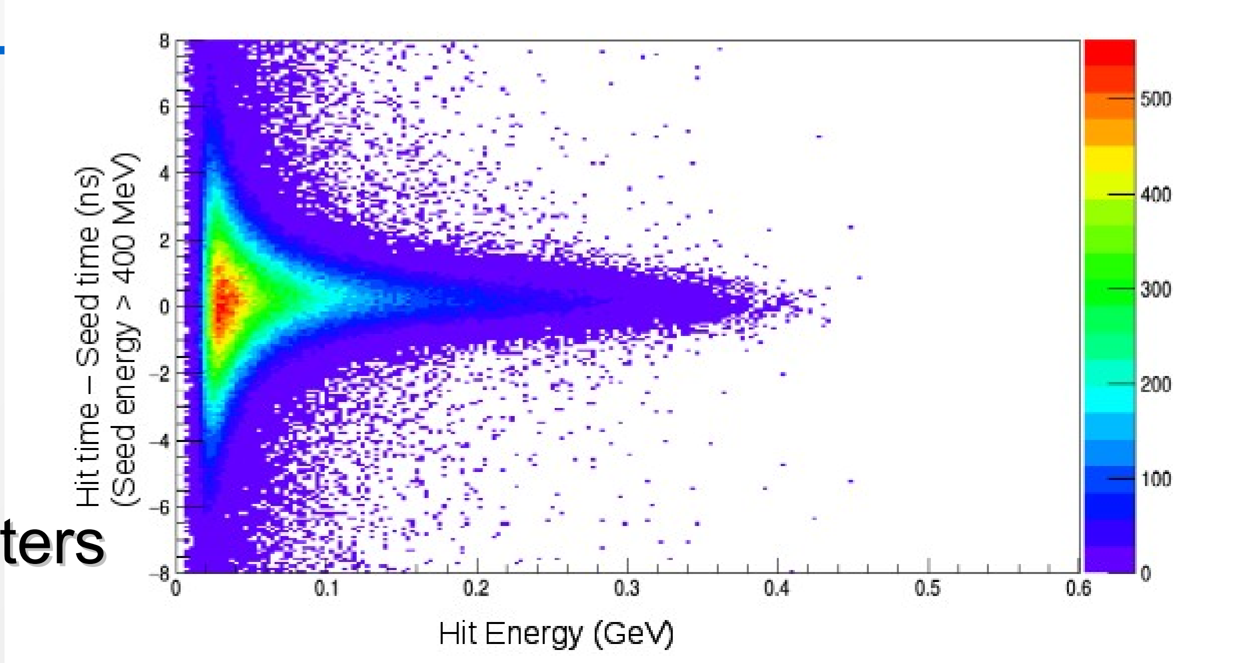
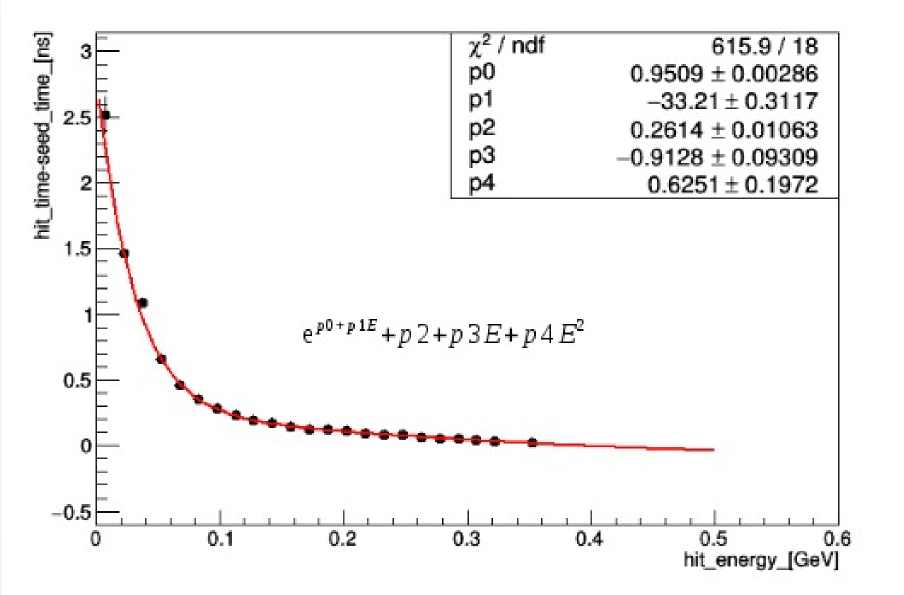
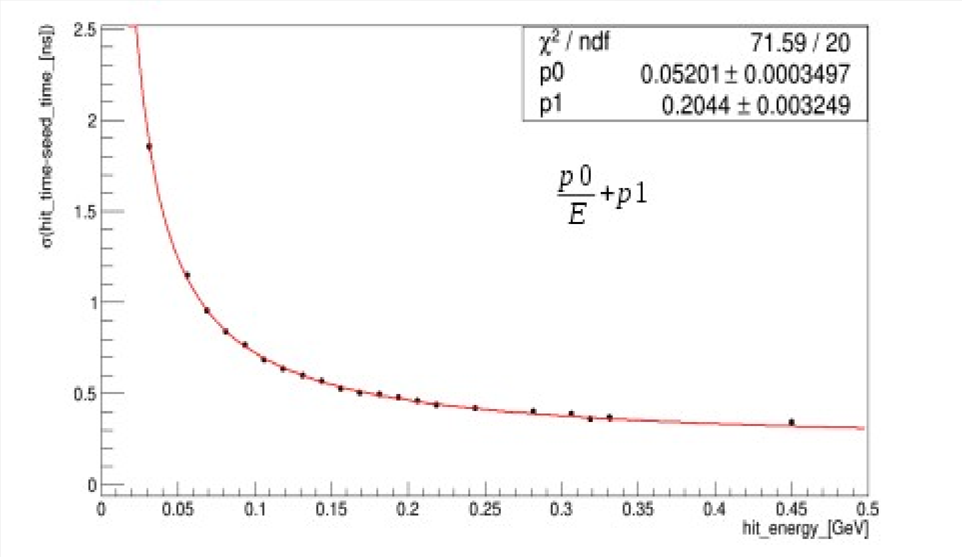


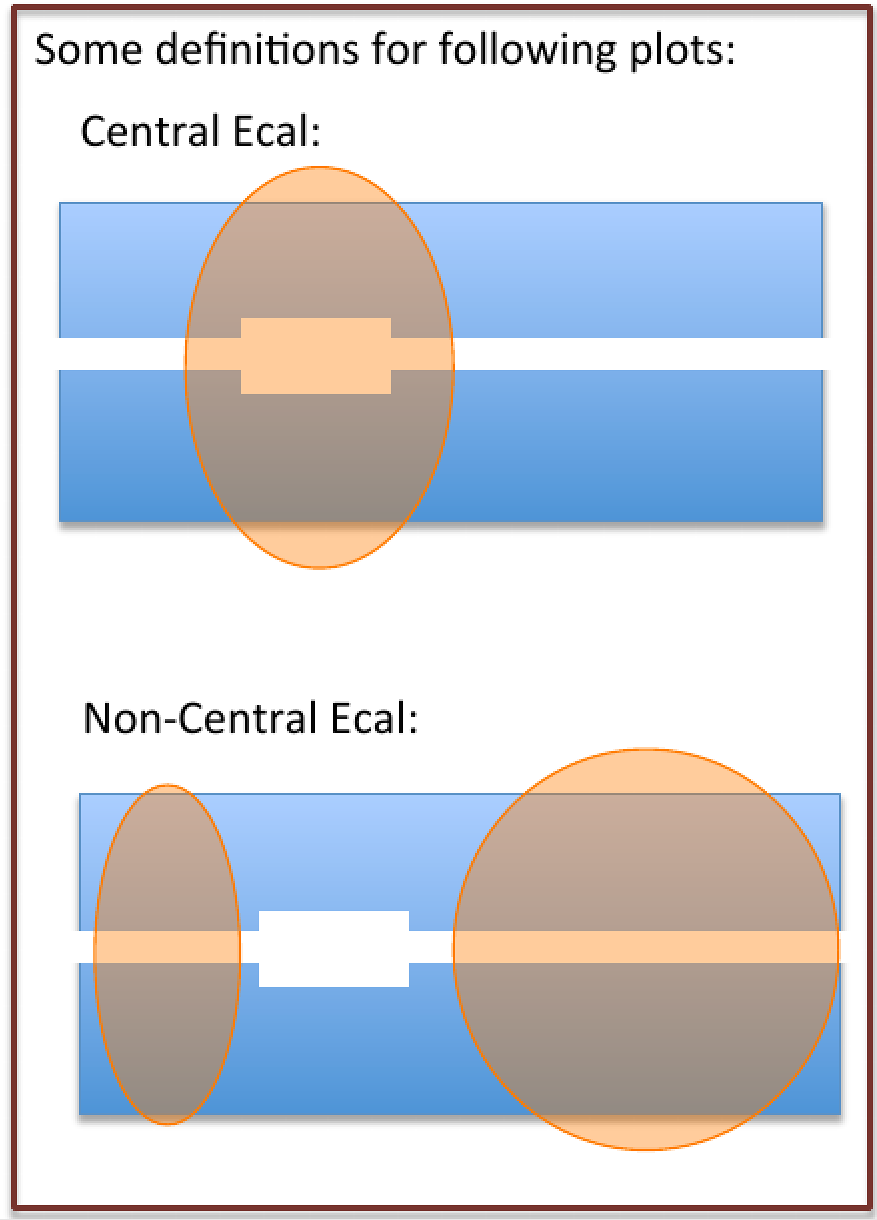
Two cluster time resolution ~ 550 ps





FEE Track-Matched Clusters

- Pass 2 FEE skim
- FSParticles Collection
- e- tracks
- GBL Tracks



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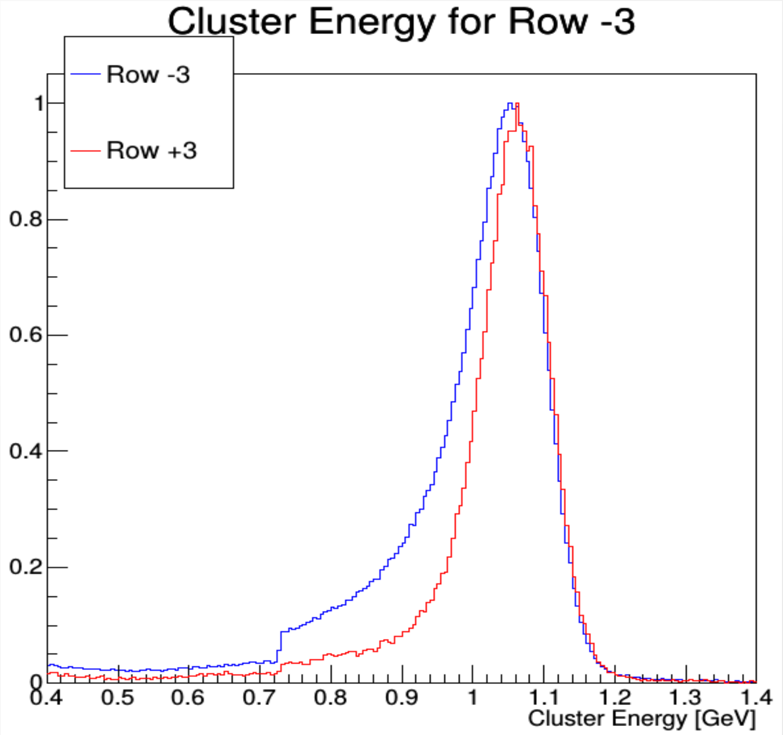

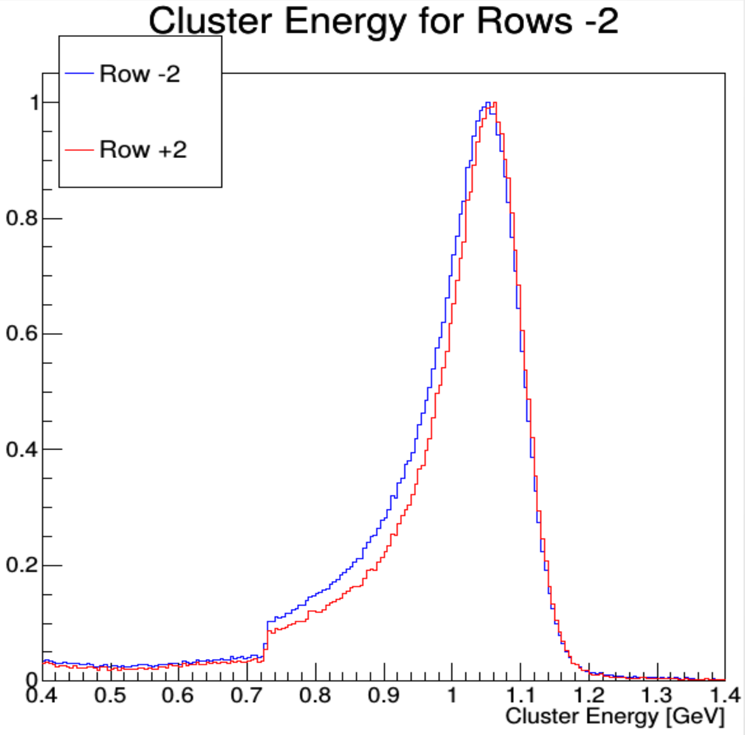

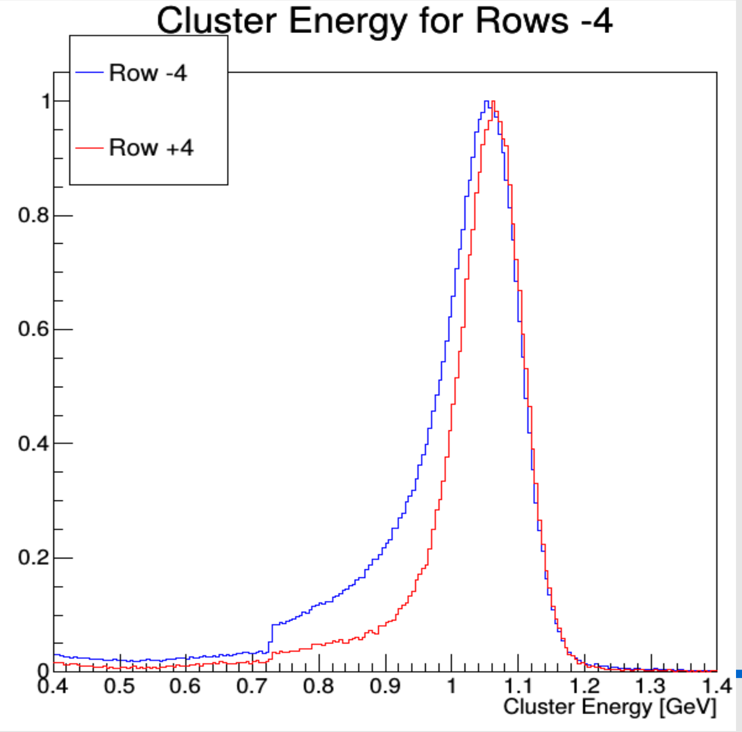

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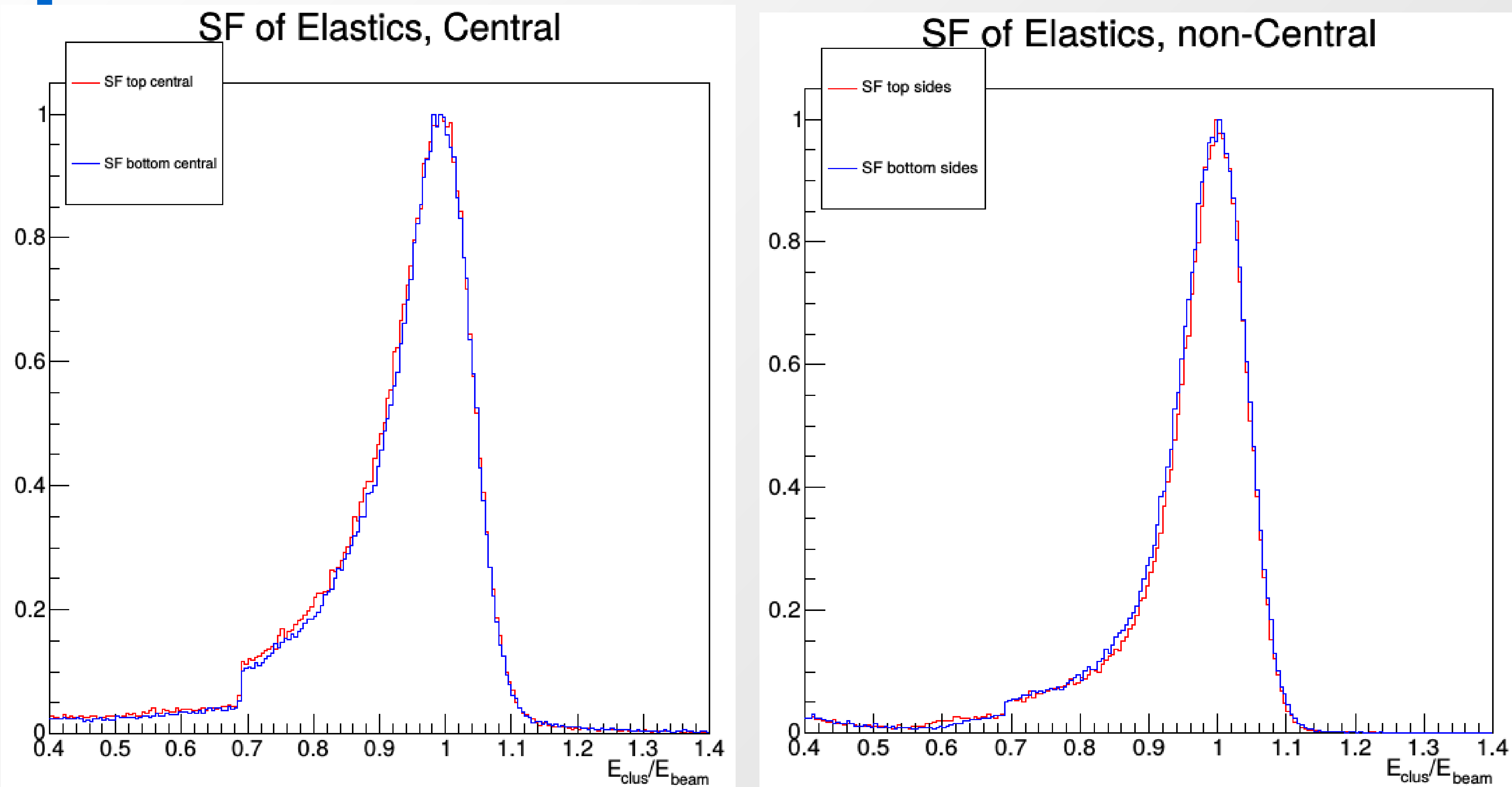
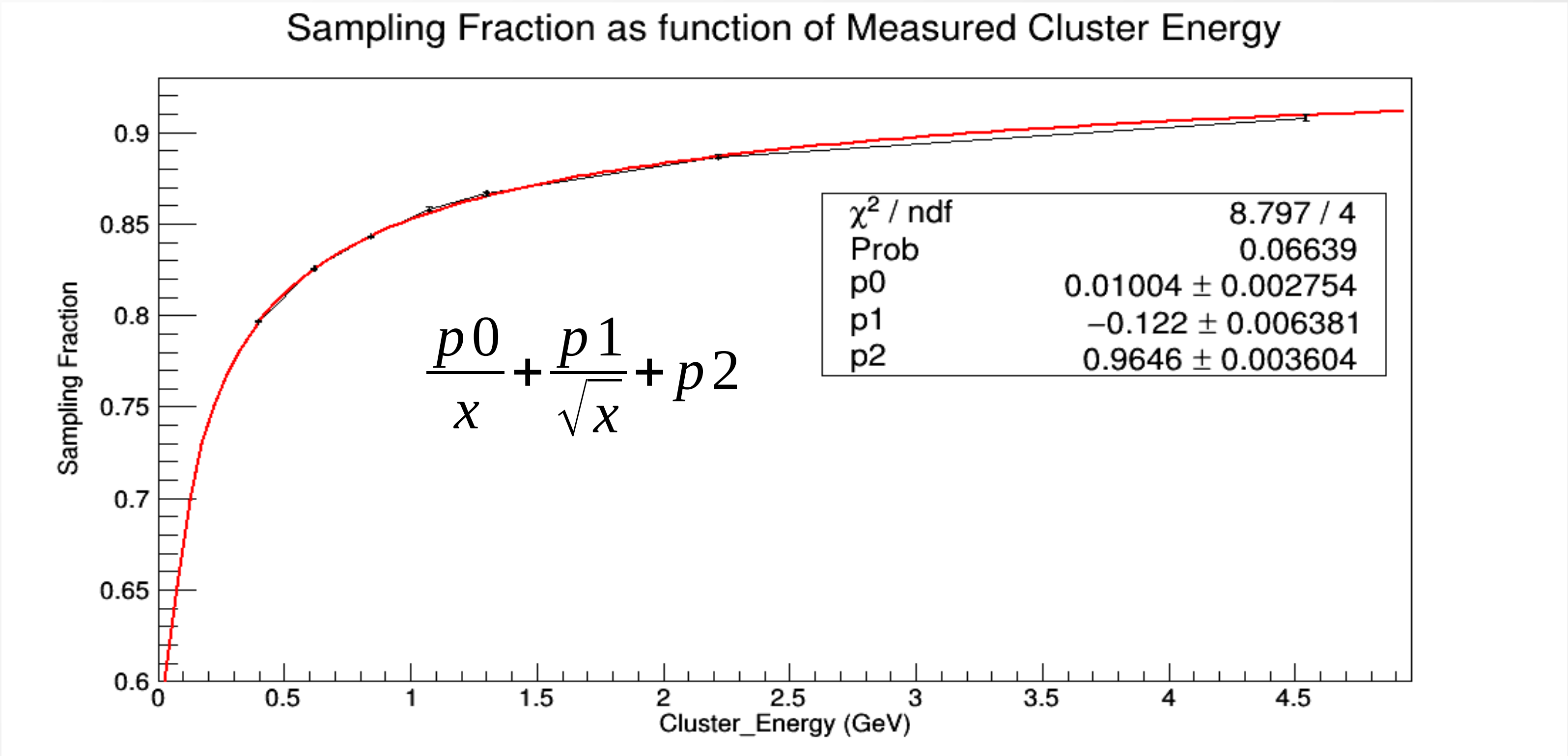


Fiducial Sampling Fraction from Simulation

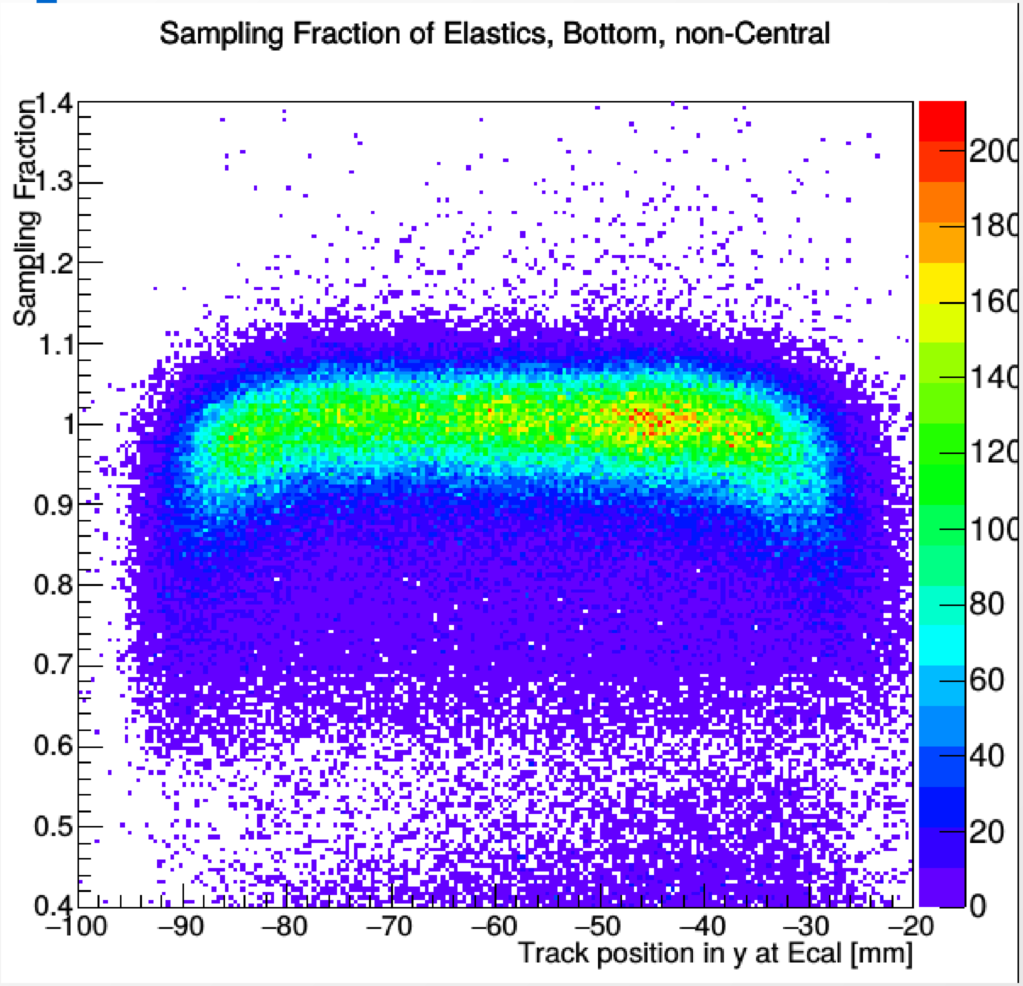


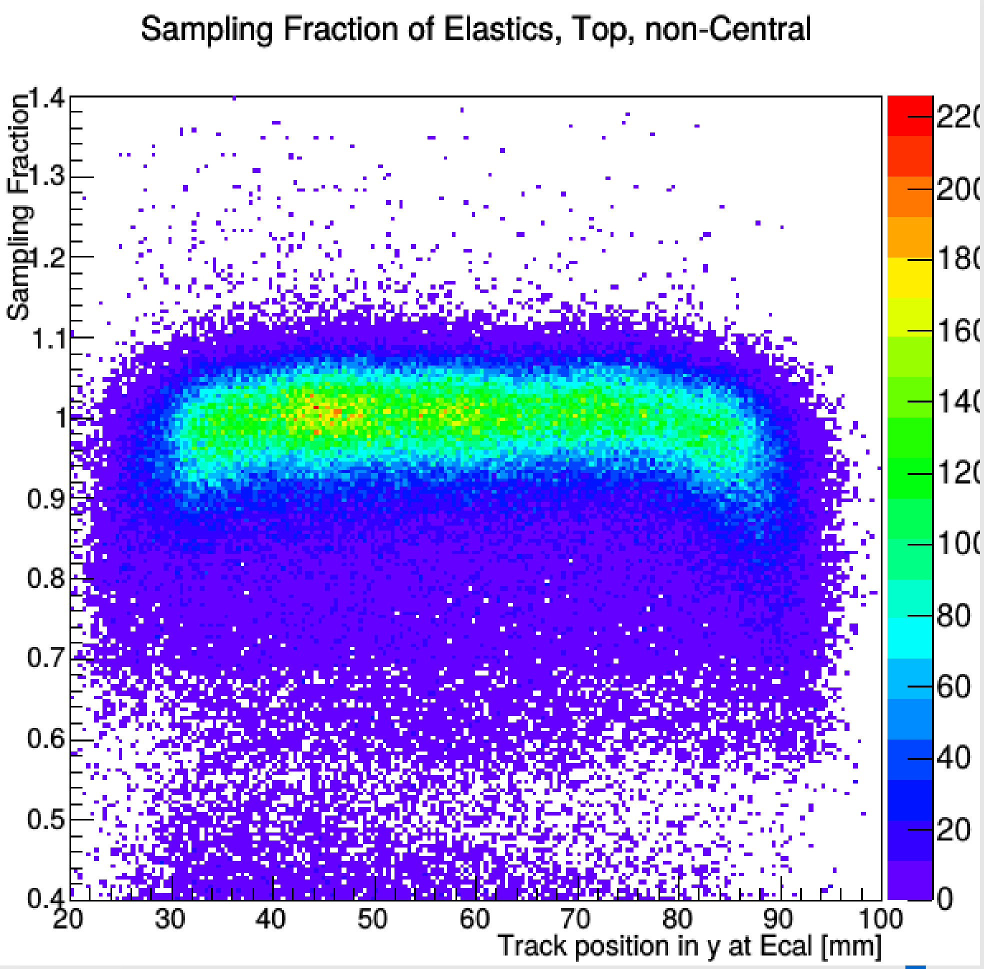
We know the Sampling Fraction is energy dependent.

What happens at the edges?

FEE Track-Matched Clusters

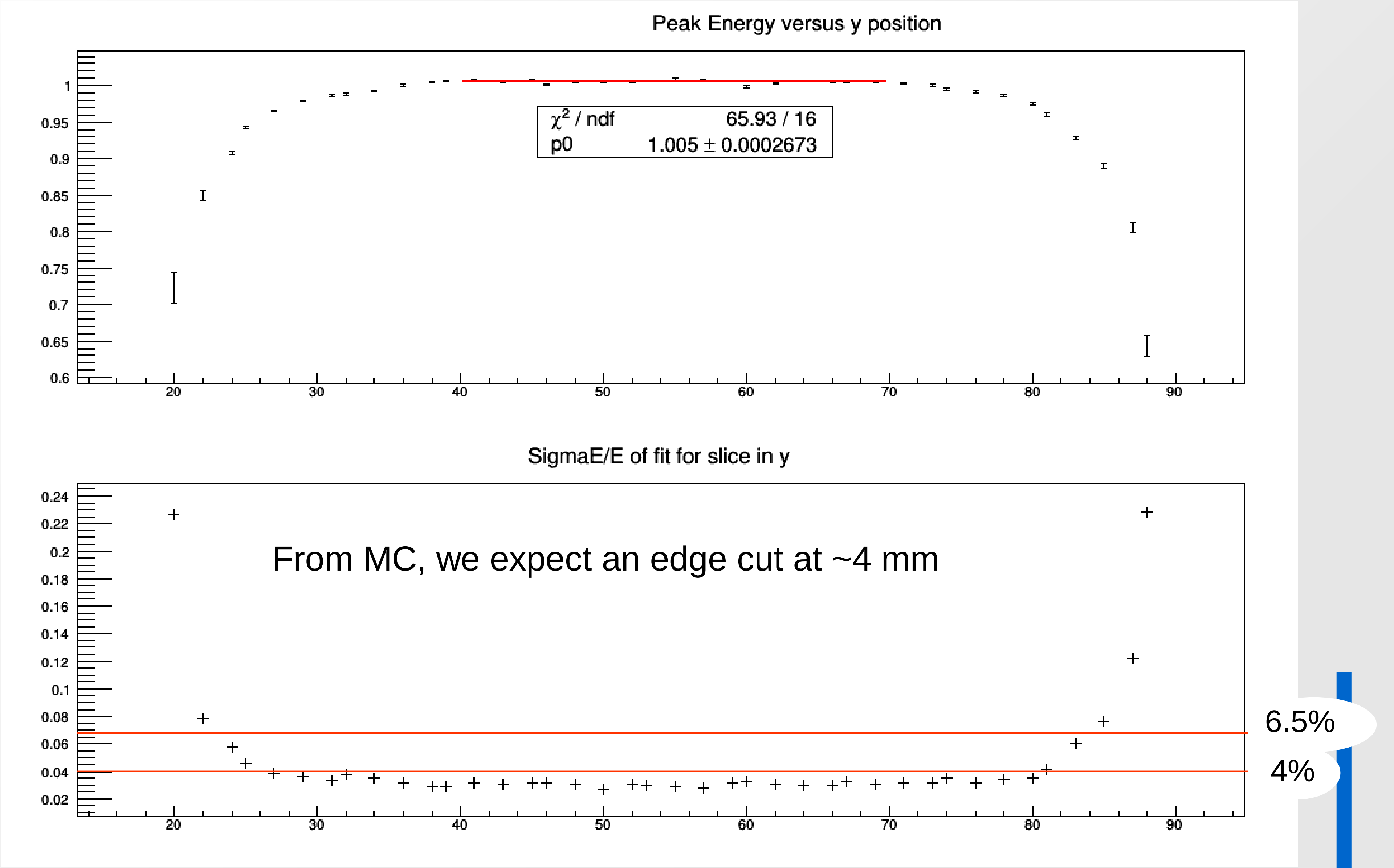
Look at sampling fraction for regions of x as a function of y position:



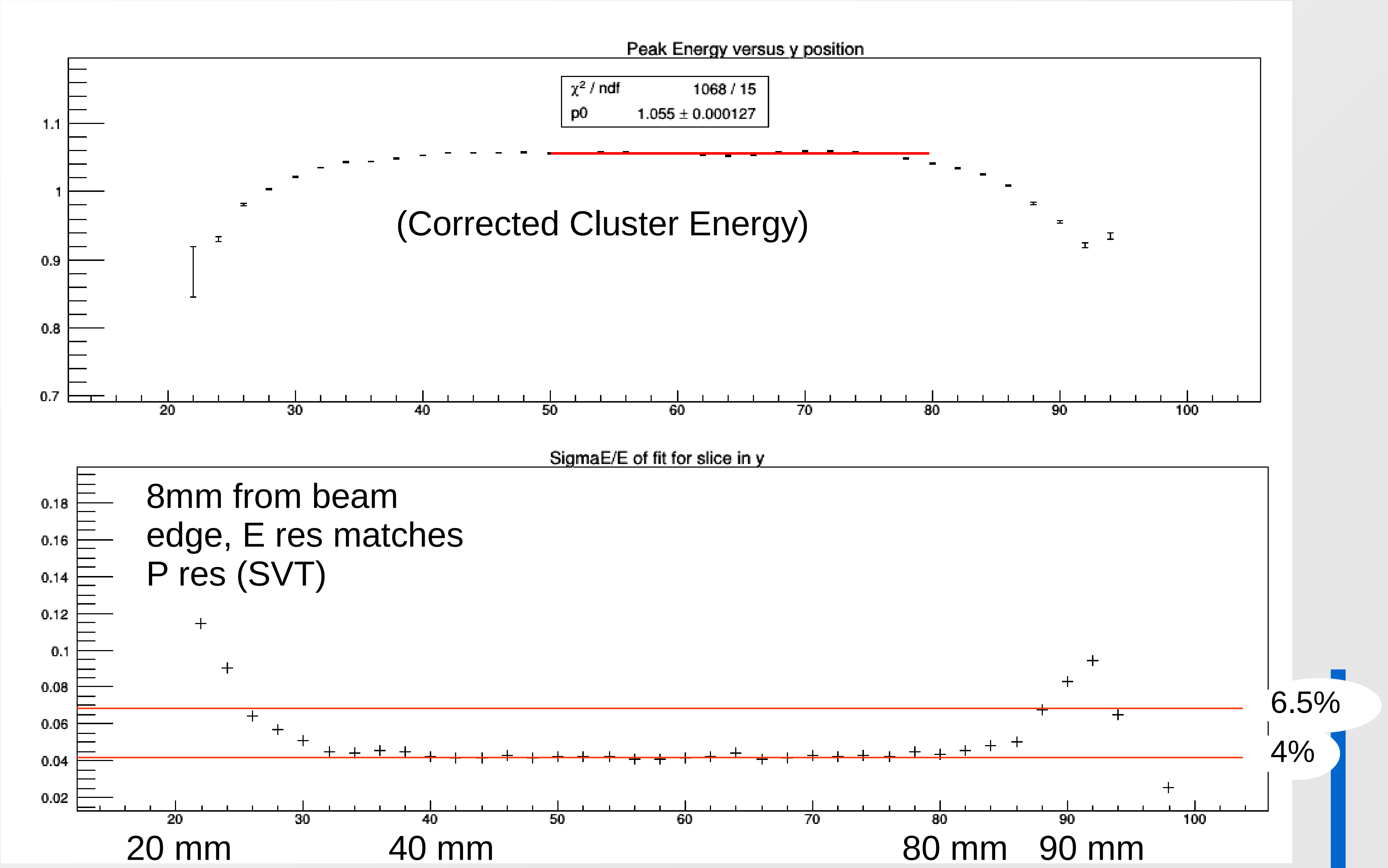


(For 1 GeV electrons)

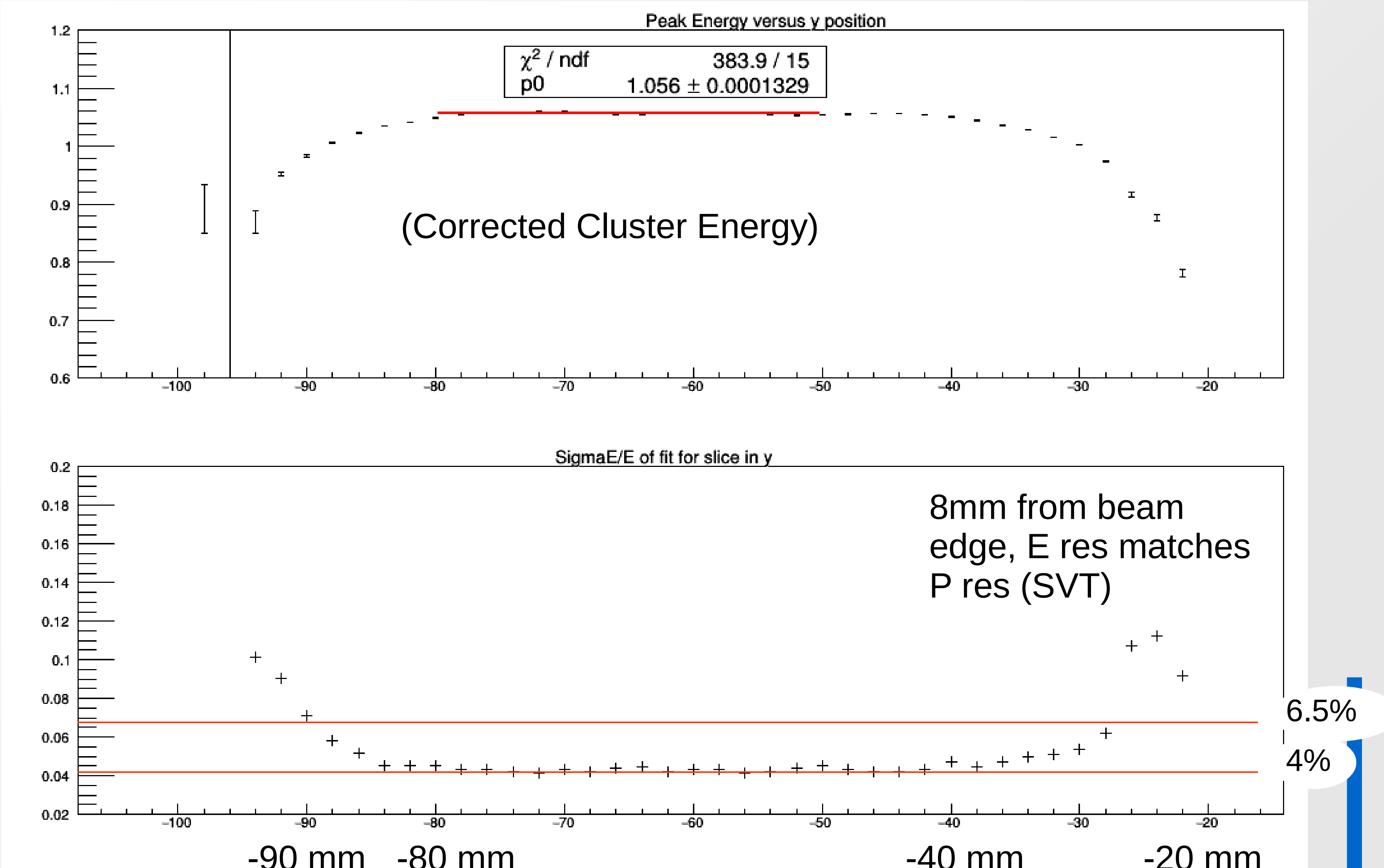
MC Sampling Fraction (excludes region above e- hole)



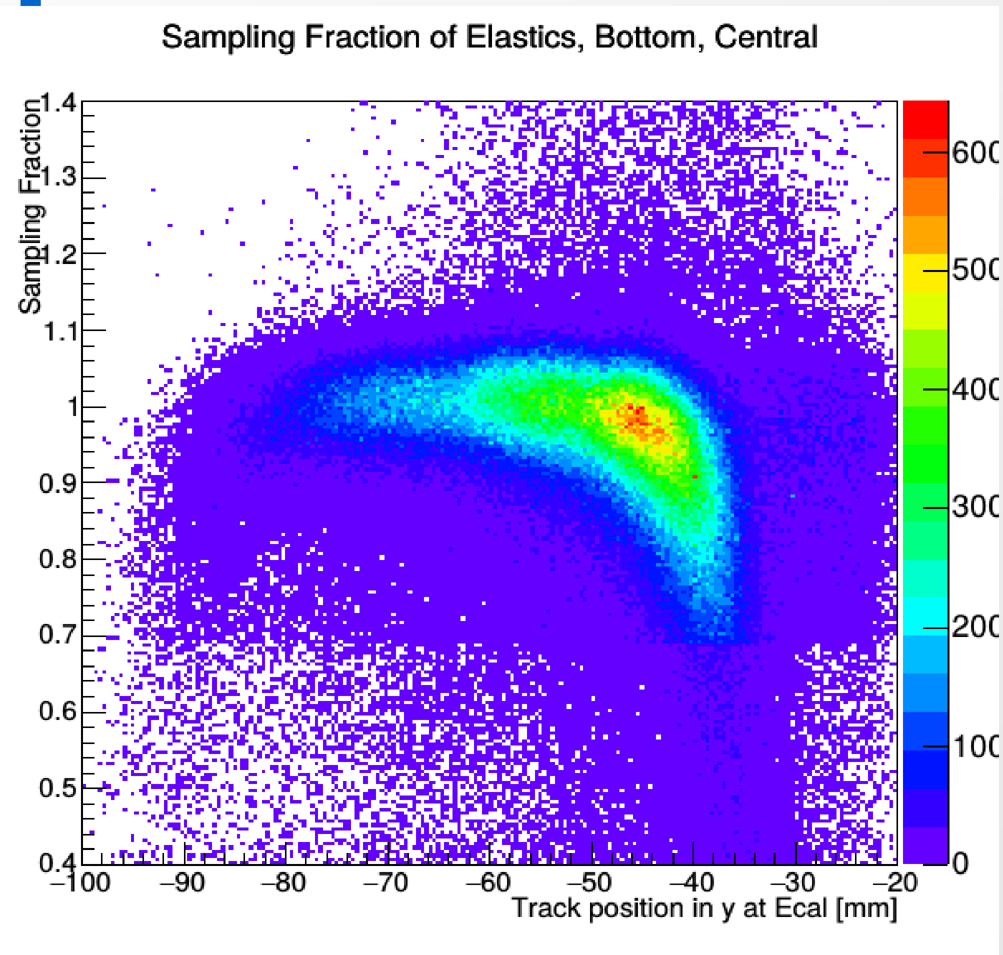
Data Sampling Fraction (excludes region above e- hole)-Top

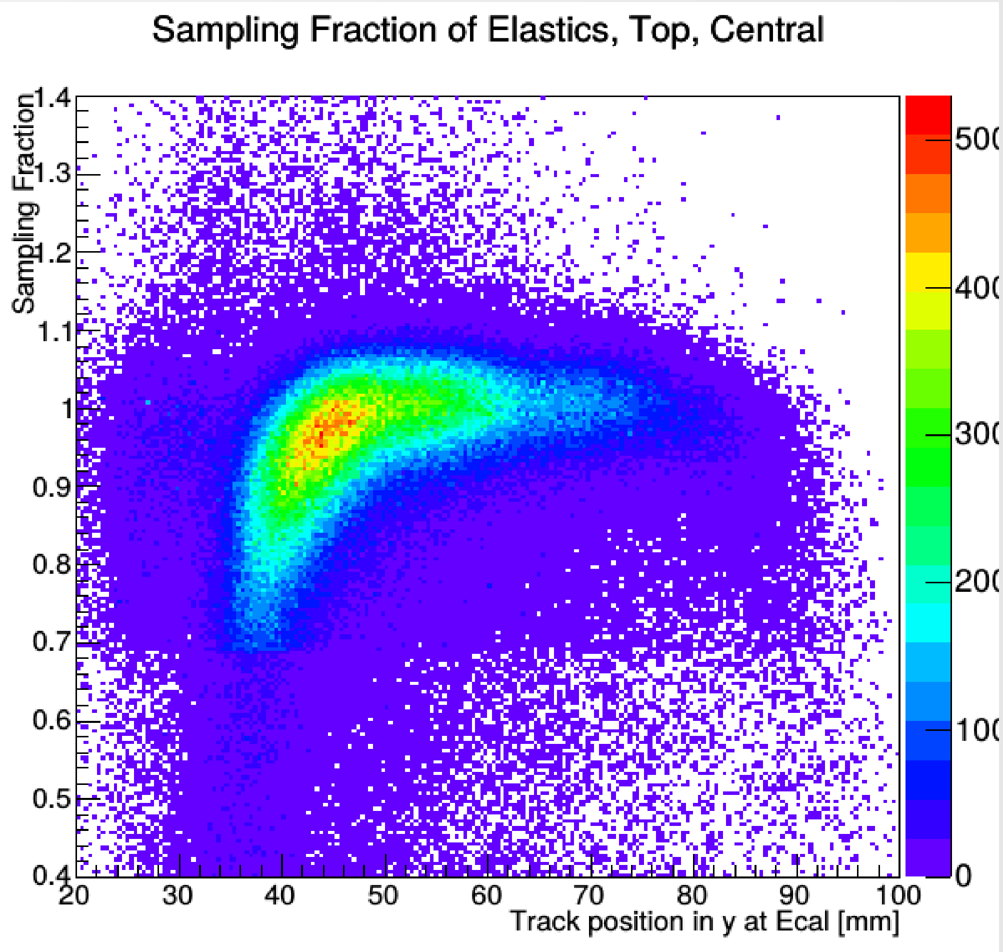


Data Sampling Fraction (excludes region above e- hole)-Bot

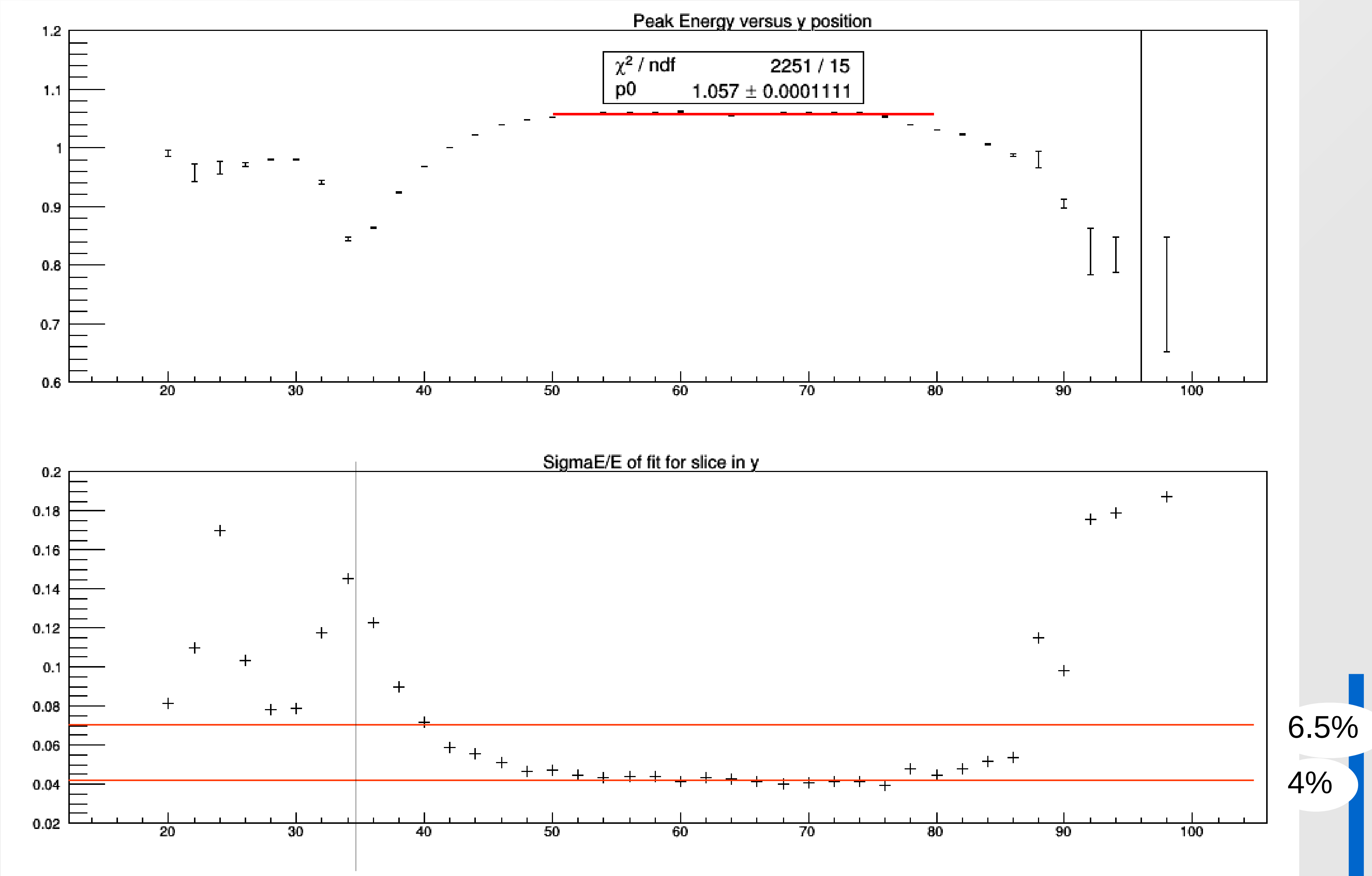


FEE Track-Matched Clusters



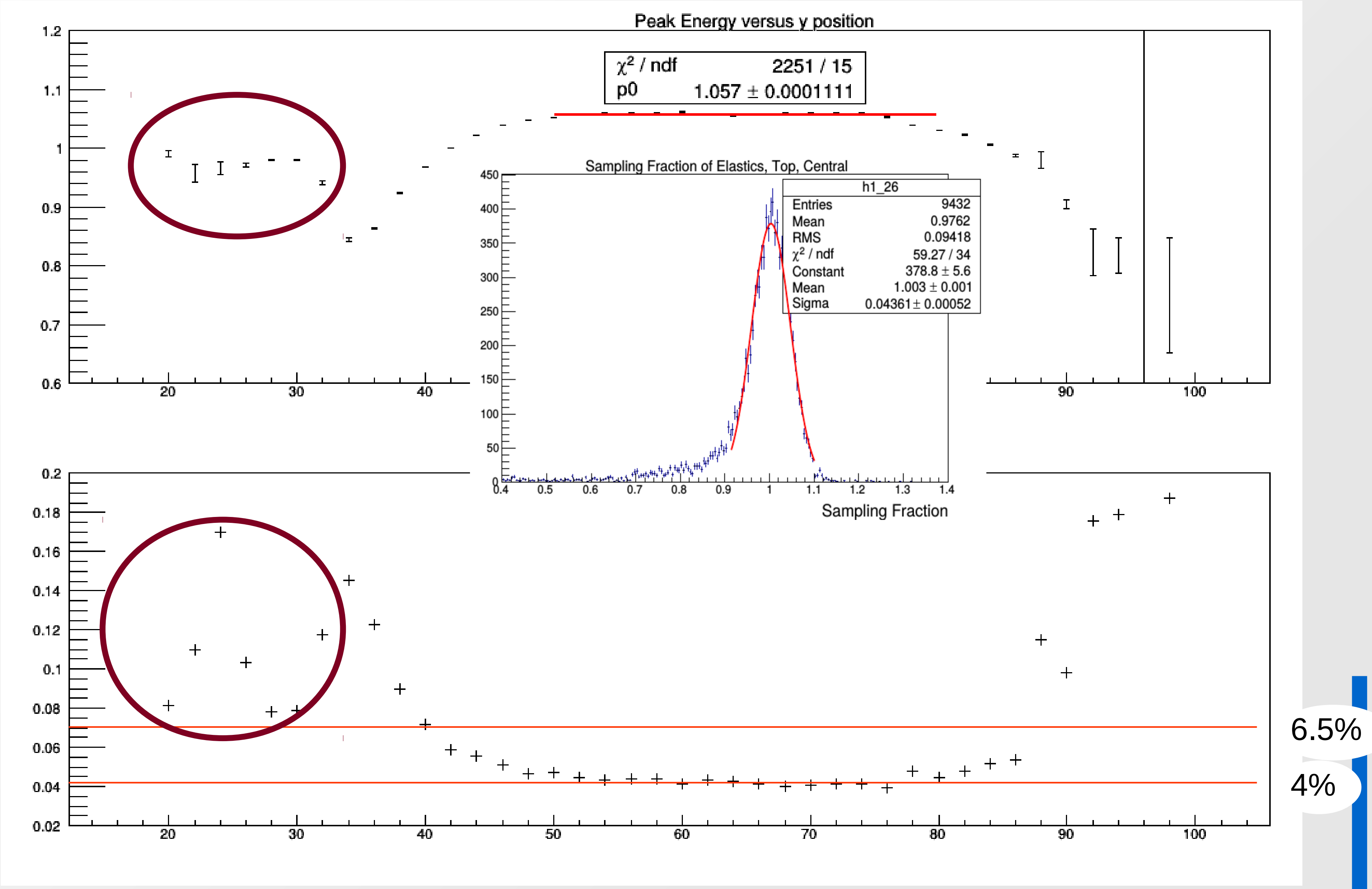


Sampling Fraction (region above e- hole)-Top



Bottom of Layer 2 top crystal

Sampling Fraction (region above e- hole)-Top



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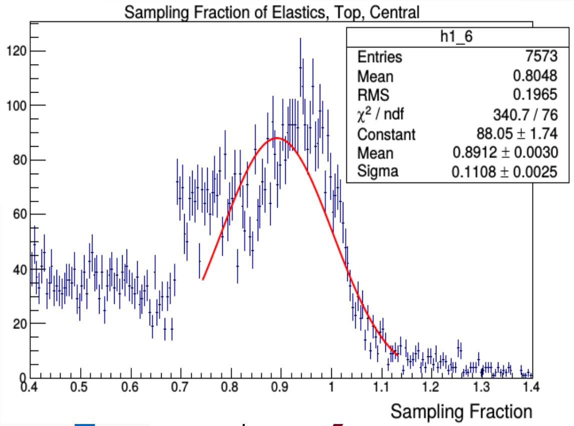
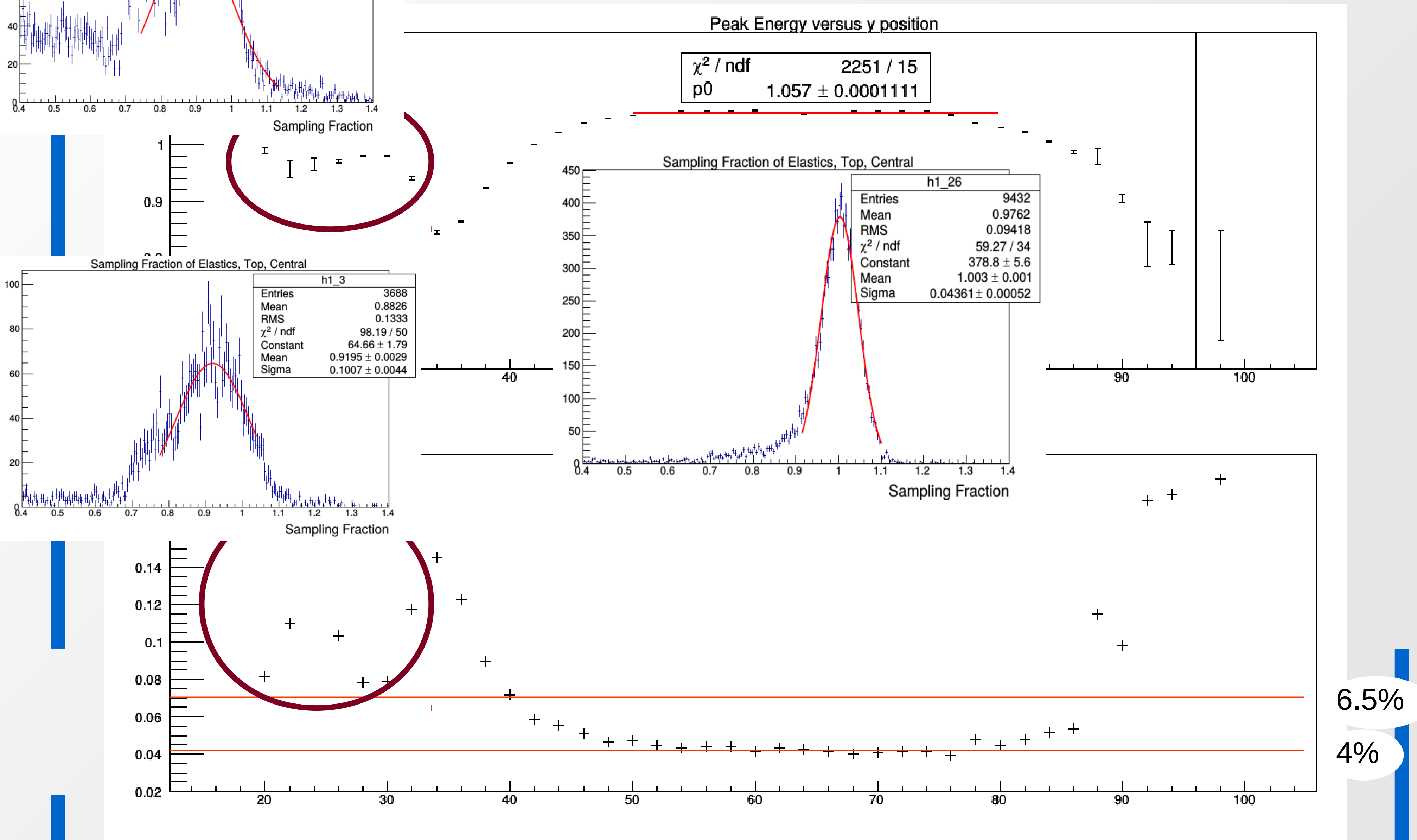
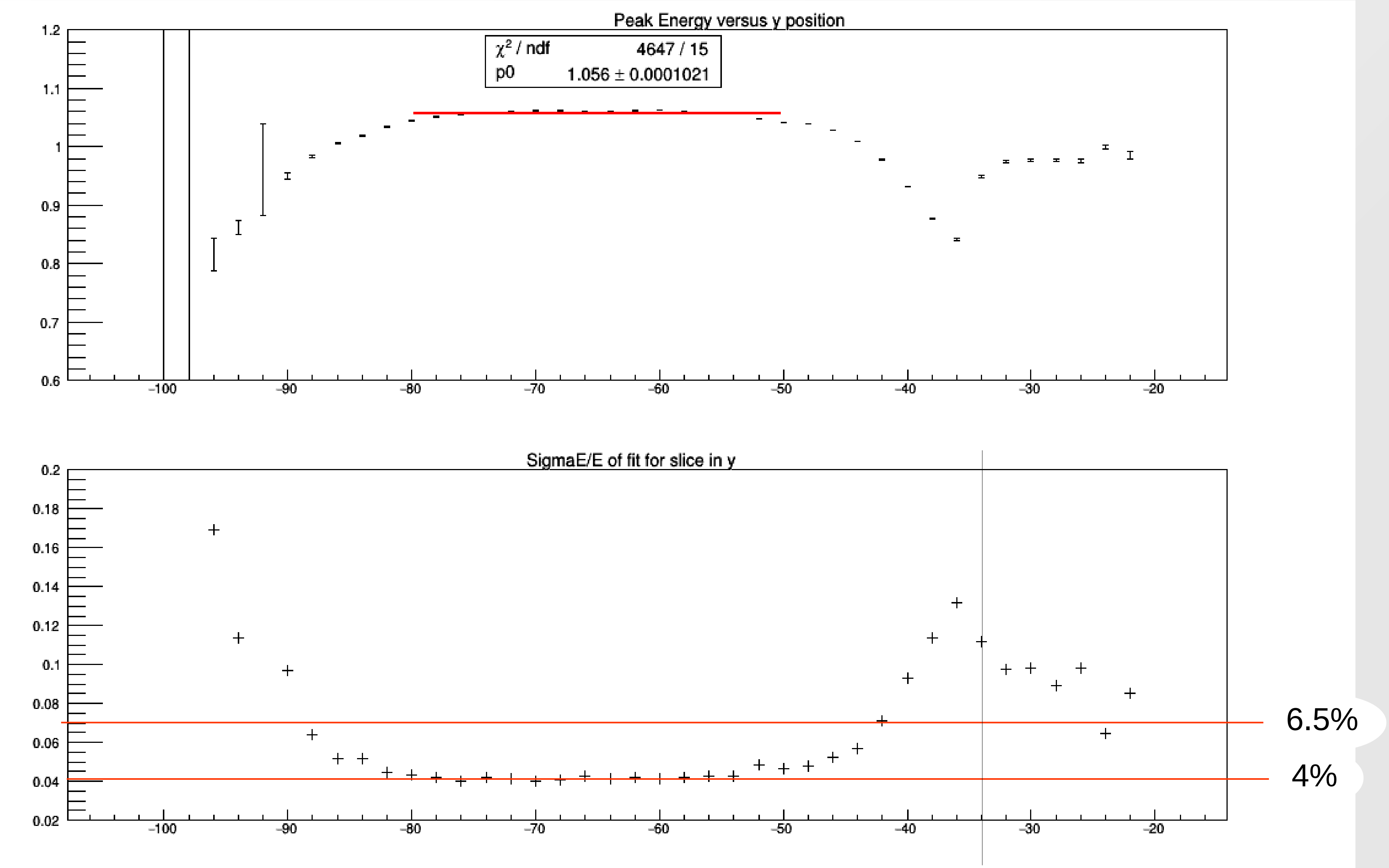




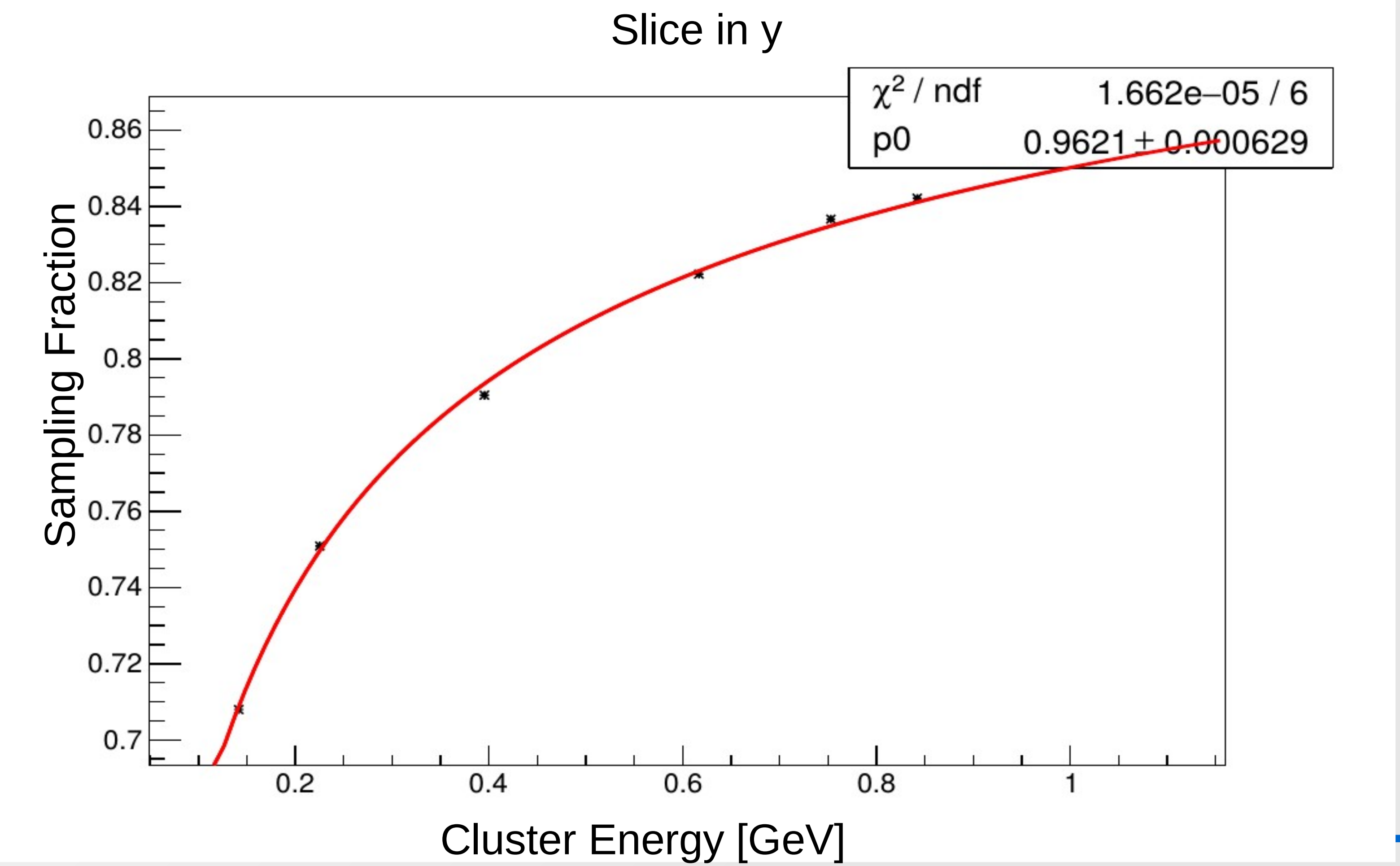
Sampling Fraction (region above e- hole)-Bottom



Top of Layer -2 crystal

Edge Sampling Fraction Corrections

- Energy dependence $$\frac{E_c}{E_{truth}} = \frac{P0}{E_c} + \frac{P1}{\sqrt{E_c}} + P2(y)$$
- P0 and P1 parameters change very little with respect to y
- Fit p2 parameter as a function of y



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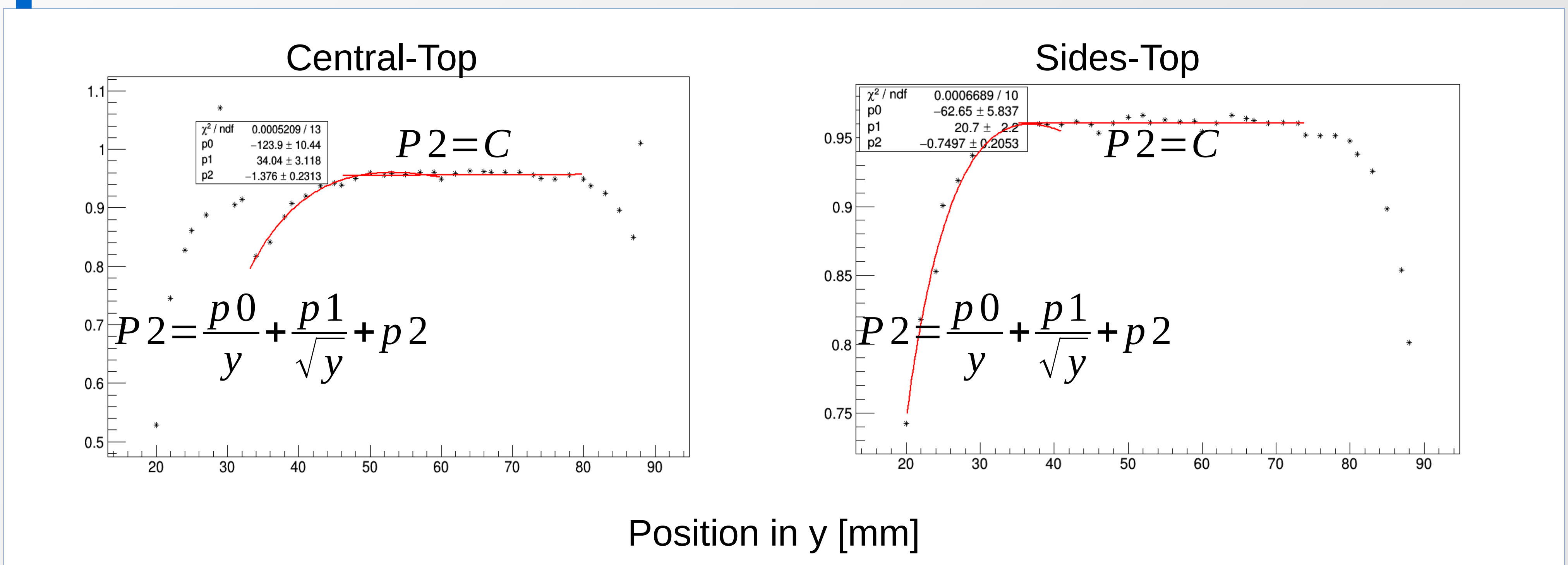
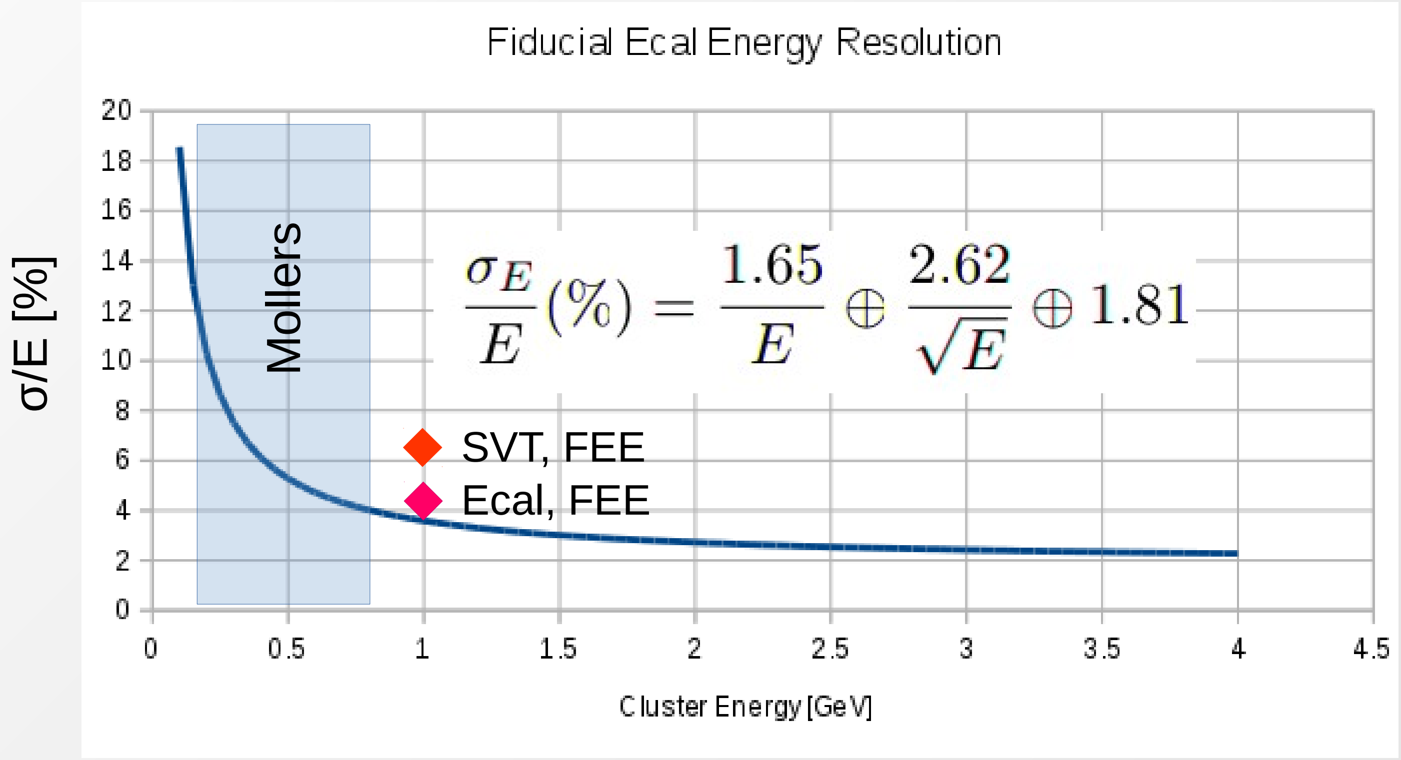
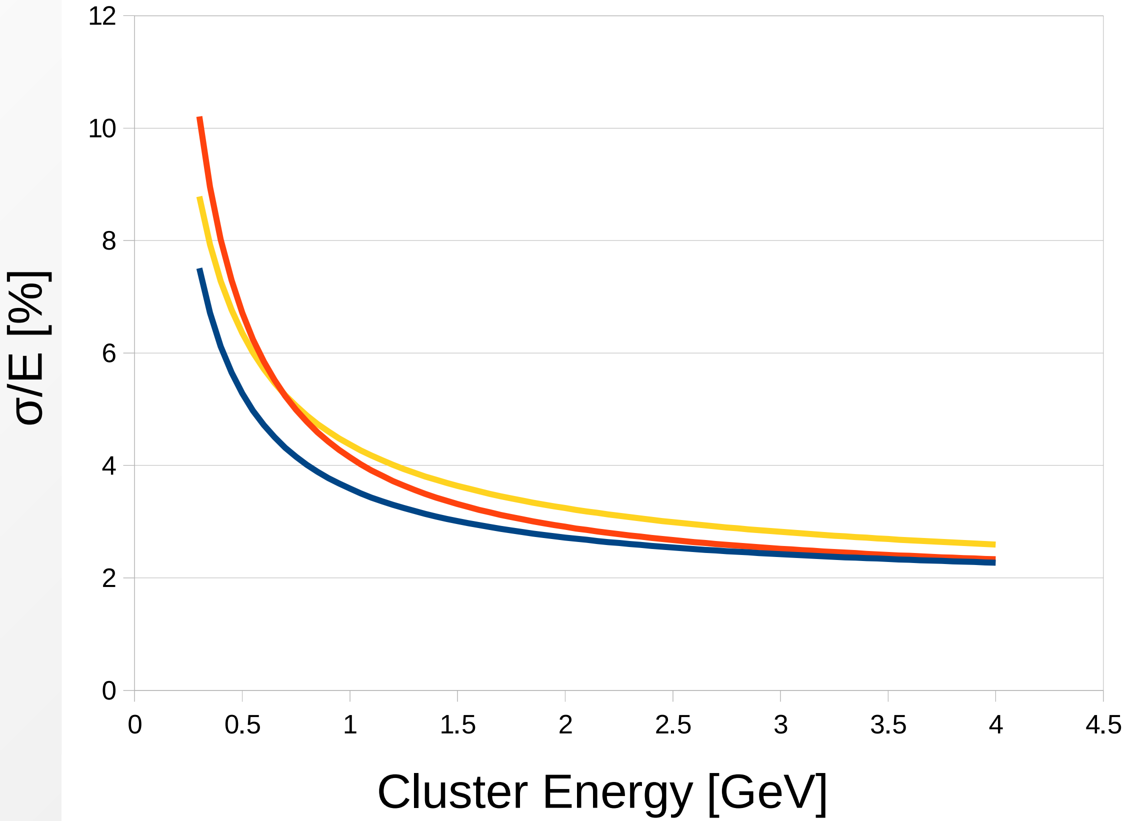


Energy Resolution in Ecal



For FEE electrons, we expected 3.6%, but we measure 4.1%
How does this scale with energy?
How does the SVT scale with energy (MC scattering effects)?

Possible Resolution Effects



$$\frac{\sigma_E}{E}(\%) = \frac{1.65}{E} \oplus \frac{2.62}{\sqrt{E}} \oplus 1.81$$

Simulated
Pre-amp noise higher than sim
Crystal spacing higher than sim

Conclusions and Future Work

- Sampling fraction corrections from simulation
  - Re-do with surveyed Ecal geometry
  - Check resolution with crystal gaps

- Ecal energy can supplement SVT momentum