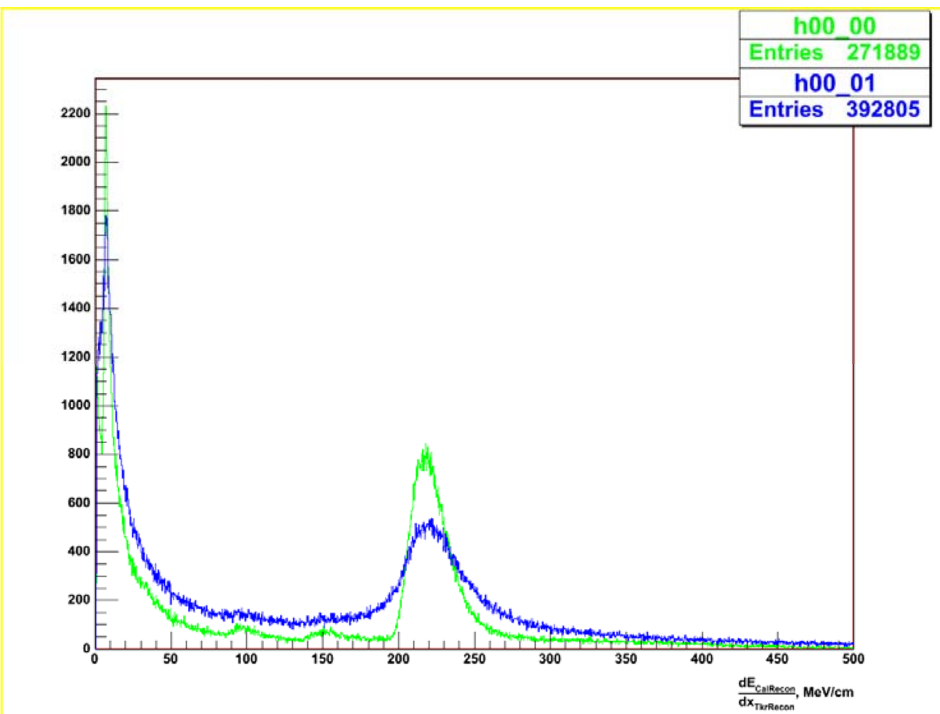
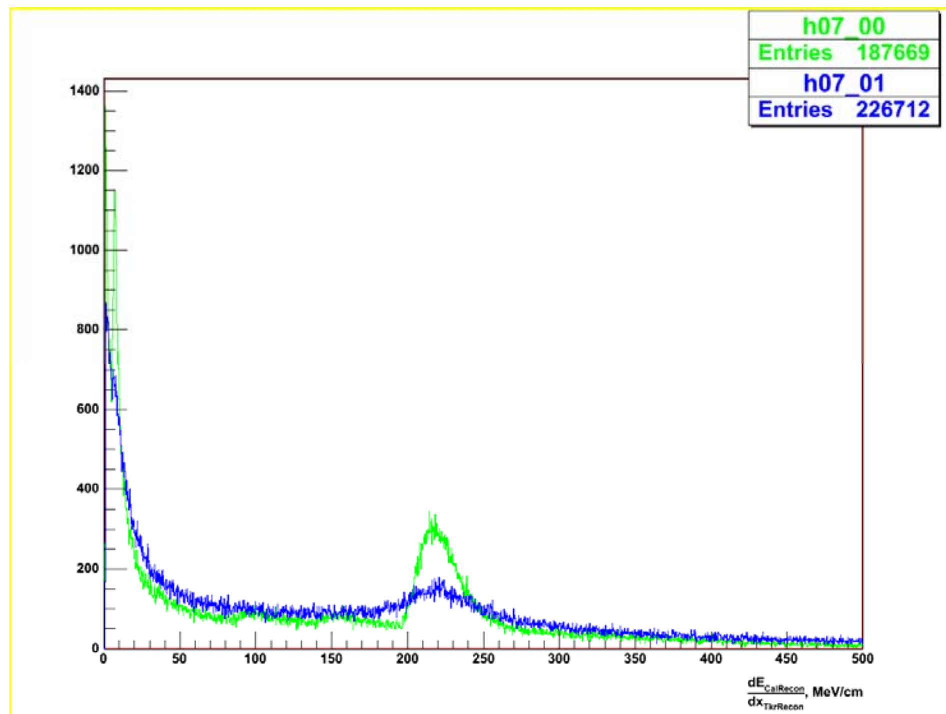
Simulation of the CAL energy calibration using GCR carbon ions

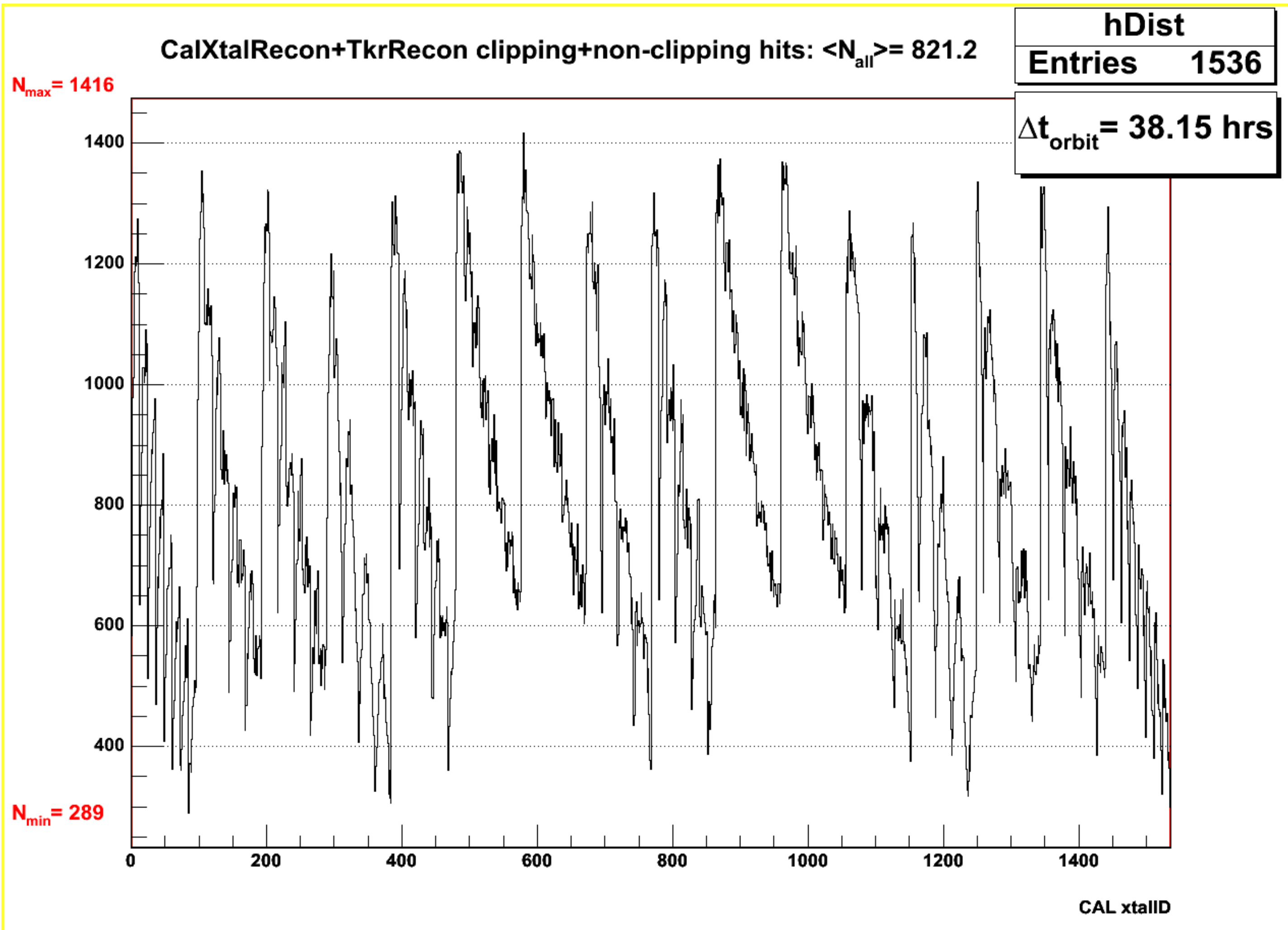
- **Goal:** using TkrRecon and CalRecon perform the energy calibration of the calorimeter. Estimate the rate of useful events.
- **Procedure:** run simulation with CrHeavyIonPrimary source and record dE/dx for carbon ions passing through CAL CsI crystals.
- **Details:** use TkrTrack information (primary particle's initial position and it's initial direction) to extrapolate the track into the CAL and calculate the pathlength in a given crystal. Use CalRecon to get the energy deposit in a given crystal. A hit is considered "good" if in a given CAL crystal there is a CalRecon hit and non-zero pathlength as it is predicted by TrkTrack.
- **Tracks selection:** tracks that passed within 30 mm or less from the crystal's ends were disregarded, in order to avoid the non-uniformity effects near the photodiodes. Good tracks are classified in non-clipping and clipping tracks. If the track happens to pass through both horizontal surfaces of a crystal – it is a non-clipping track, and a clipping one otherwise.
- **JobOptions:** Trigger mask was set to 0 to accept all events. On-board filter (OBF) was not simulated.
- 250 (100,000 events each) batch jobs were ran at SLAC, giving a total orbit time of ~ 38 hrs, or ~ 24 GLAST orbits. GlastRelease v9r9 has been used for simulation.

- dE/dx histograms summed over crystals in CAL's top and bottom layers are shown
- The green histogram corresponds to non-clipping tracks.
- The width of the dE/dx peak is due mostly to errors in track reconstruction. The carbon dE/dx peak is narrower for non-clipping tracks since in this case determination of a pathlength depends only on the angle of the track, while for clipping tracks the determination of a pathlength is also strongly dependent on track's x-y position.
- The heavy-ion experiences multiple scattering as it propagates through the CAL, making a "real" track diverging from extrapolated one (causes the difference in resolution of the peak between CAL layers).
- Smaller dE/dx peaks are from B(Z= 5) and Be(Z= 4) that occur from charge changing interactions. There is also a large peak from protons. Protons come from CC interactions as well.
- There are ~ 1.2 - 1.5 times more clipping tracks than non-clipping ones.



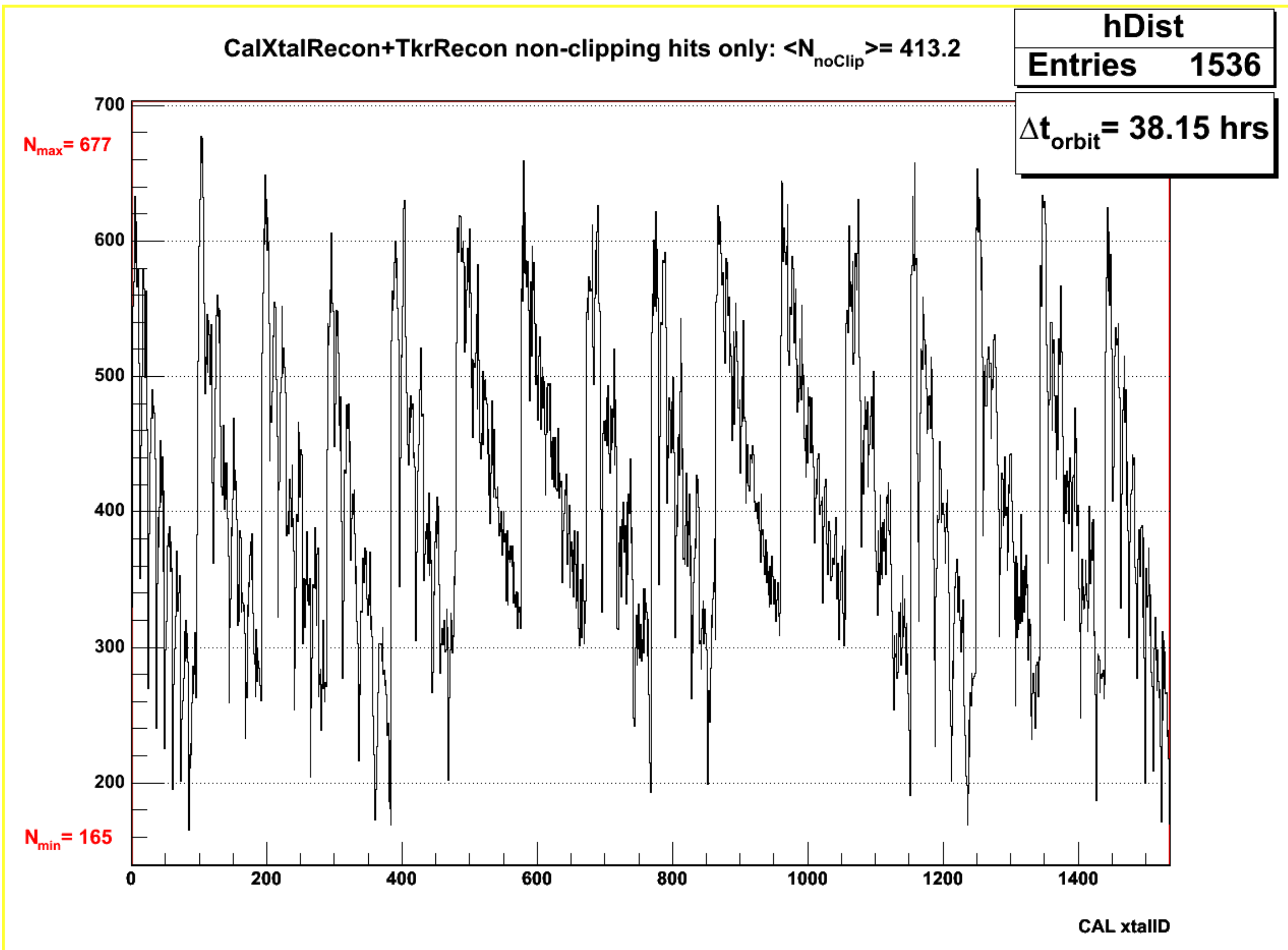


The plot below shows the CAL crystals population distribution. Only hits which contribute to the carbon dE/dx peak determination (170 – 280 MeV/cm) are considered. There is ~ a factor of 5 difference between the most and the least populated crystals.



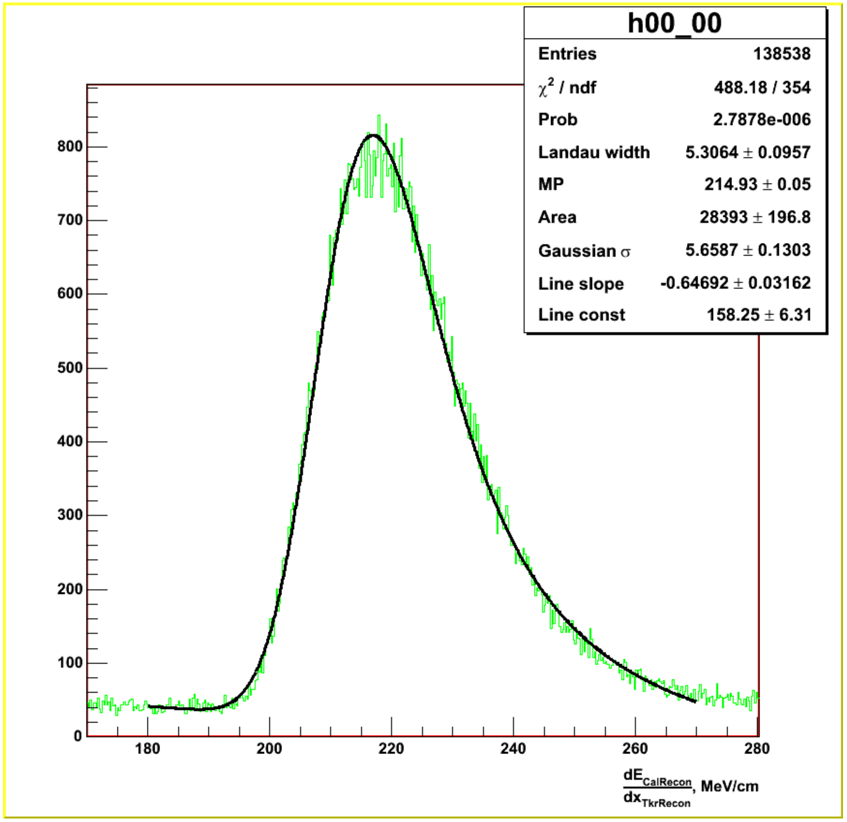
If use non-clipping hits only, it would cut the average rate approximately by half

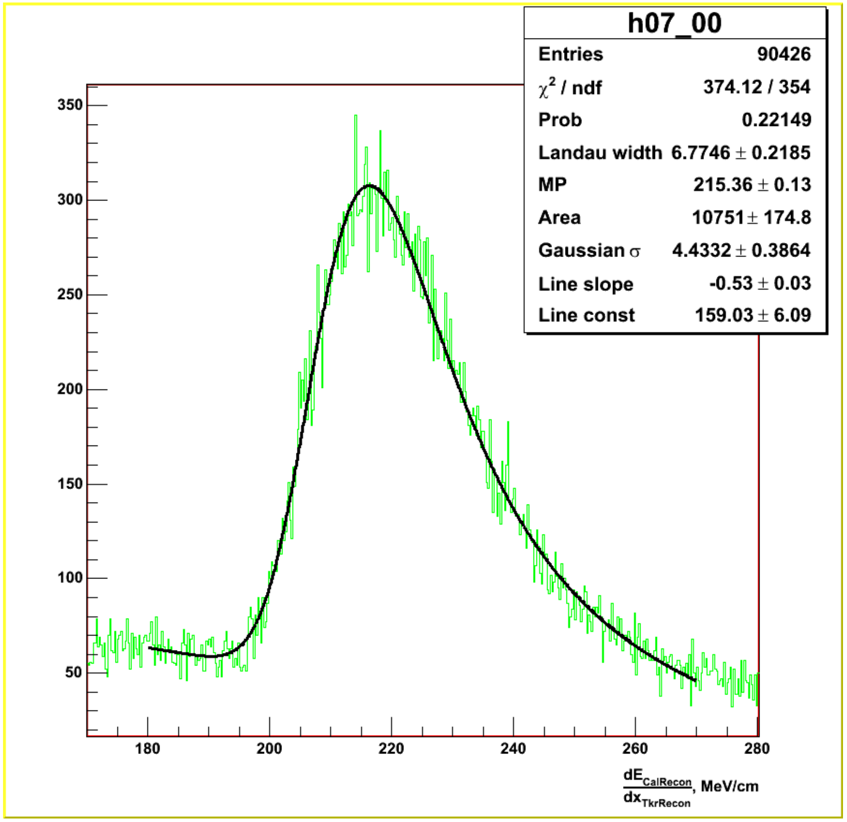
In order to collect a **min** of **1000** non-clipping hits/crystal we would need ~ 231.2 hrs (**10 days – without OBF; ~25 days with OBF**)



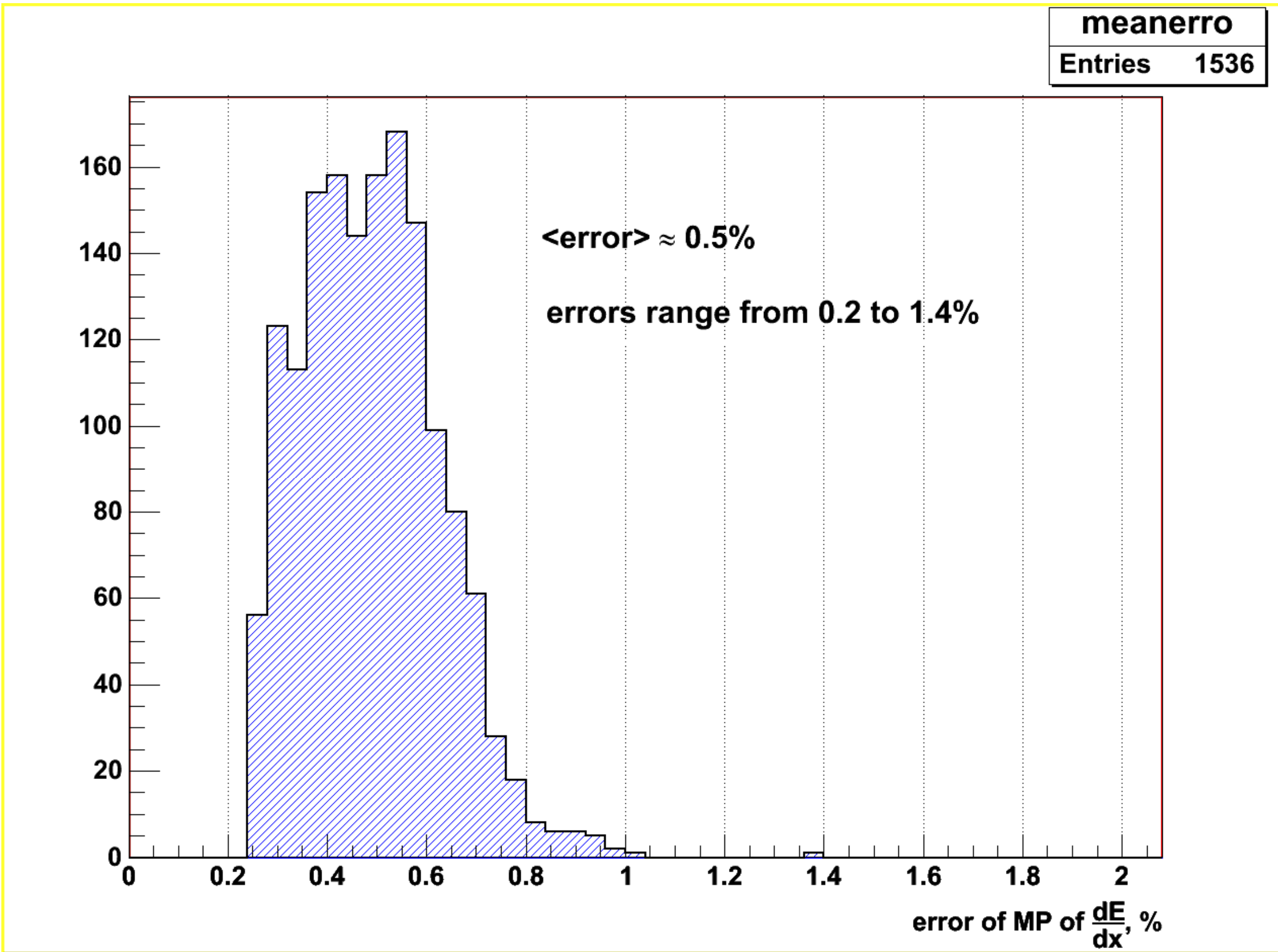
- Determine Peak Shape Fixed Parameters
  - Create dE/dx histograms for each CAL layer (12x16=192 crystals/layer) for better statistics
  - Fit each with the Landau-Gaussian convolved function with added linear background. The parameters are: **[1]** Landau width, **[2]** Most probable value **[3]** Area, **[4]** Gaussian sigma, **[5]** Line's slope, **[6]** Line's constant.
  - Fix the shape of the function – Landau width and Gaussian sigma
- Calibrate Individual Crystals
  - Release other params and fit it to dE/dx distributions for individual crystals.
  - The mean error on MP dE/dx in individual crystals determines the calibration error for a given exposure time period.

Summed over CAL's top and bottom layers dE/dx histograms used for the shape determination of the fitting function.





Distribution of the error for the [MP of dE/dx] for all CAL crystals



Distribution of dE/dx for all CAL crystals
(216 MeV/cm predicted)