Calibration of 2019 Data

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HPS Weekly Meeting

US Tax Day, 2020

Selected Efforts

- SVT/Tracking Meetings

https://indico.slac.stanford.edu/category/41/

  - SVT Alignment (PF)

- ECal / Hodoscope Meetings

https://confluence.slac.stanford.edu/pages/viewpage.action?pageId=263756689

  - ECalibration with FEEs (Andrea / Nathan)
  - ECalibration with muons (Norman / Nathan)

- Data Production, QA
- https://confluence.slac.stanford.edu/display/hpsg/2019+Reconstruction+Passes
  - (Norman)

SVT Alignment (PF)

- Lot of infrastructure work being done to incorporate full geometry hierarchy into the GBL/millepede framework.
- Nice presentation at this Monday's tracking meeting.
- The current alignment software:
  - Transfers the geometry hierarchy information from the detector builders to tracking framework
  - Computes the C-matrices for all UChannels, Modules and SvtBox.
  - Computes the millepede (MPII) constraints file
  - Dumps the sensor + composite derivatives to the MPII binary file for solution
  - Can provide **momentum** (and in general, all track parameters) **constrained** local derivatives

Current SVT Alignment Status (PF)

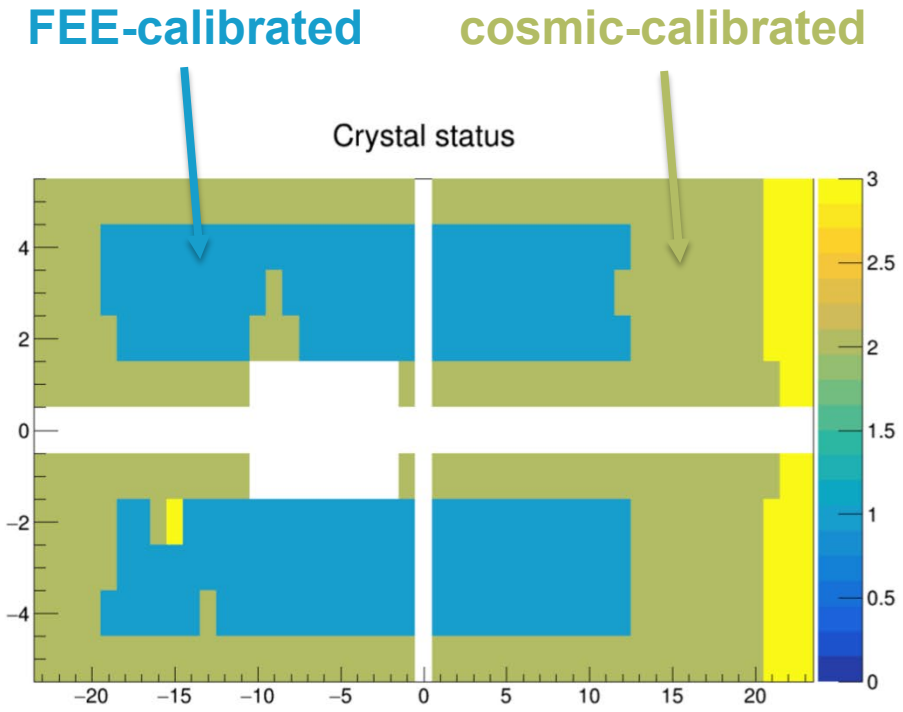
- Global alignment of UChannel for pitch, yaw and roll rotations has been tested.
  - **Encouraging results as they show that the new hierarchical alignment is able to correct for such misalignment** (That part of C-matrices seem correct).
- Tested 4 iterations to check the recovery of ru, rv and rw of the front UChannel keeping the back UChannel and all the other degrees of freedom fixed.
- The alignment solution converges quickly.
- Also checked Ty, which seems to correct the misalignment and convergence.
- For Tx and Tz we need additional constraints such as E/p, soft terms cuts, beamspot, IPs …
- Next steps: align strong modes for UChannels in Data
  - First round gives “opening angle” and offsets comparable to that found with field-off, straight-track FEEs.

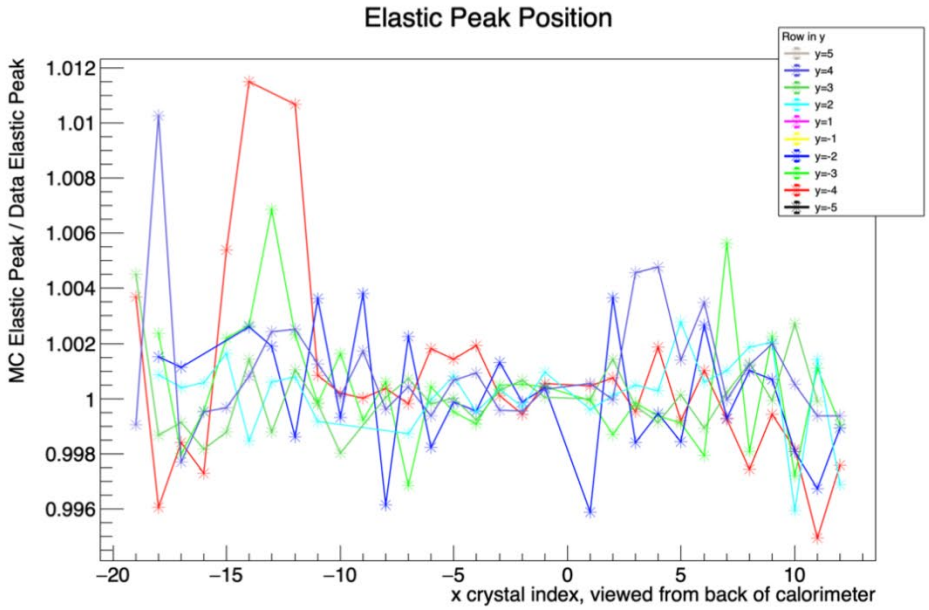
ECal Gain Calibration (Andrea/Nathan)

- Preliminary results presented at Collaboration Meeting.
- Initial gains came from cosmic runs before and after run, ~4% resolution on 4.5 GeV e^-.
- Next round derived from dedicated FEE runs
  - Run dependence correlated well with temperature variations.
- Have since skimmed all of the FEE triggers from the "good" runs and are using these to derive and test the gains.
  - Linear drop in gains with time/run# through the golden period, presumably beam-induced
  - Up to a ~2% effect from beginning to end of golden period

FEE Gain Calibration Coverage

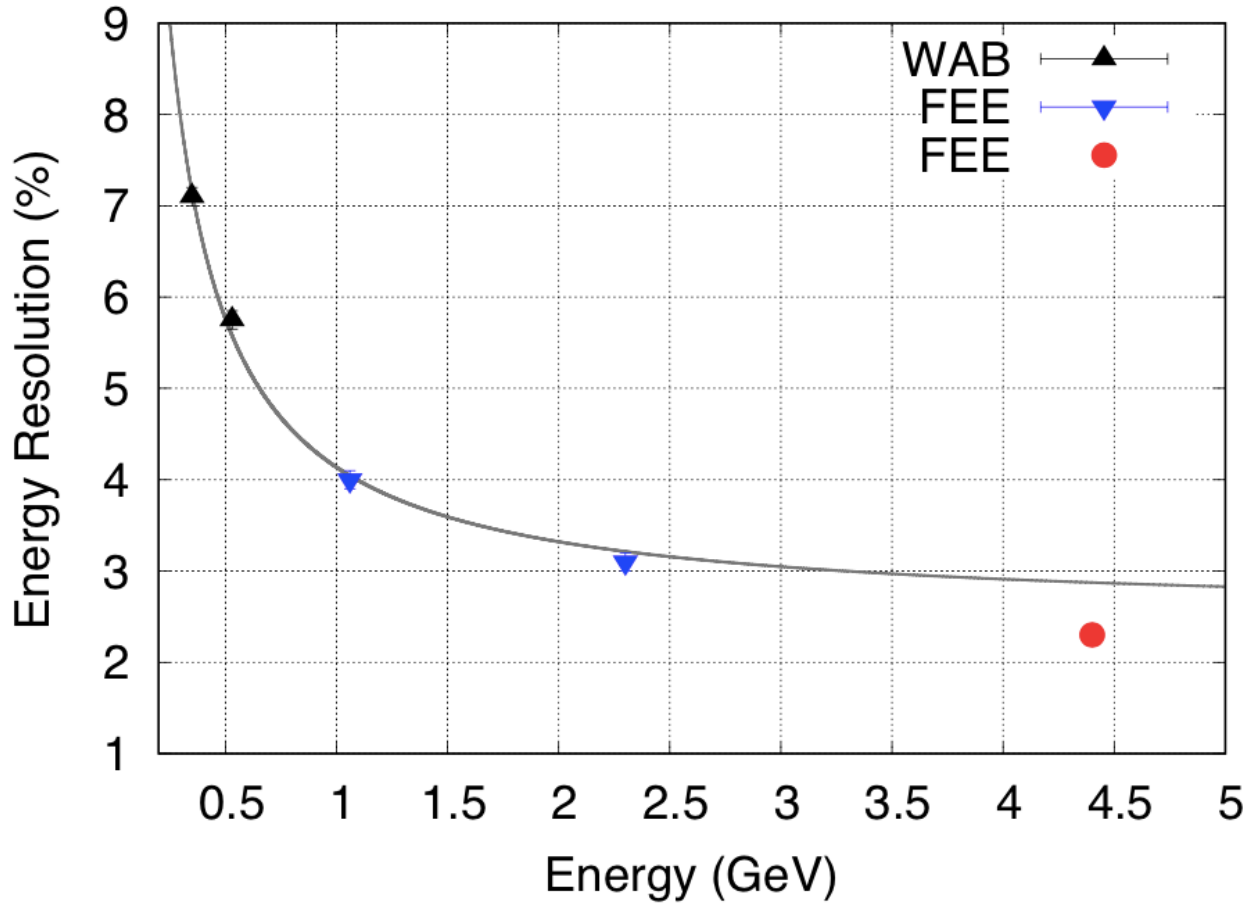
- Fiducial region FEE peak constant to <1%
- Region covered by FEEs is smaller than in previous runs.





Resolution so far

- After FEE calibration, preliminary resolution at 4.5 GeV is ~2%



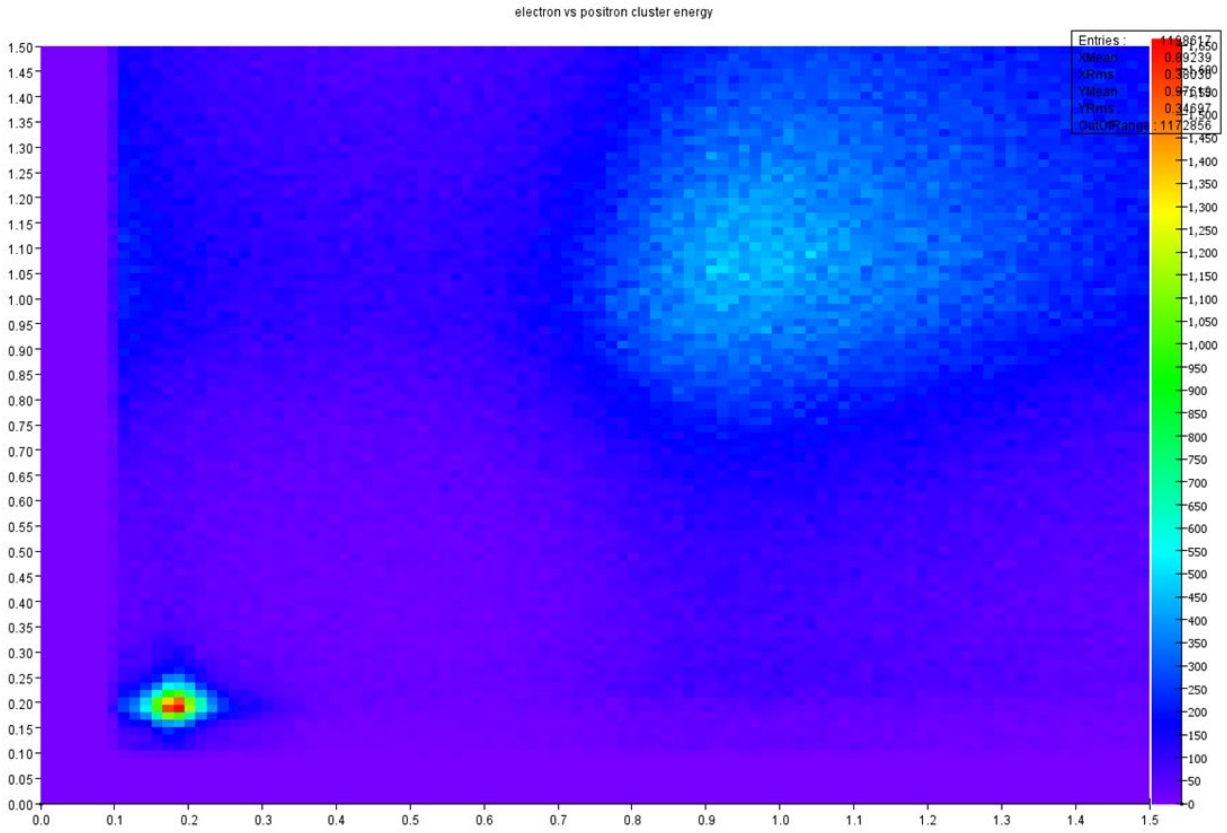
Extending the Gain Calibration Region

- Have considered using wide-angle bremsstrahlung (WAB) events to extend the angular and energy coverage, but techniques would need to be developed and systematic effects understood.
- I decided to investigate using continuum production of muon pairs to calibrate the ECal.

Events Consistent with $\mu^+\mu^-$ production

- Selected V0s in 2019 data to search for $\phi \rightarrow K^+K^-$
- Didn't find any, but did find $\mu^+\mu^-$
- Plot cluster E1 vs E2.

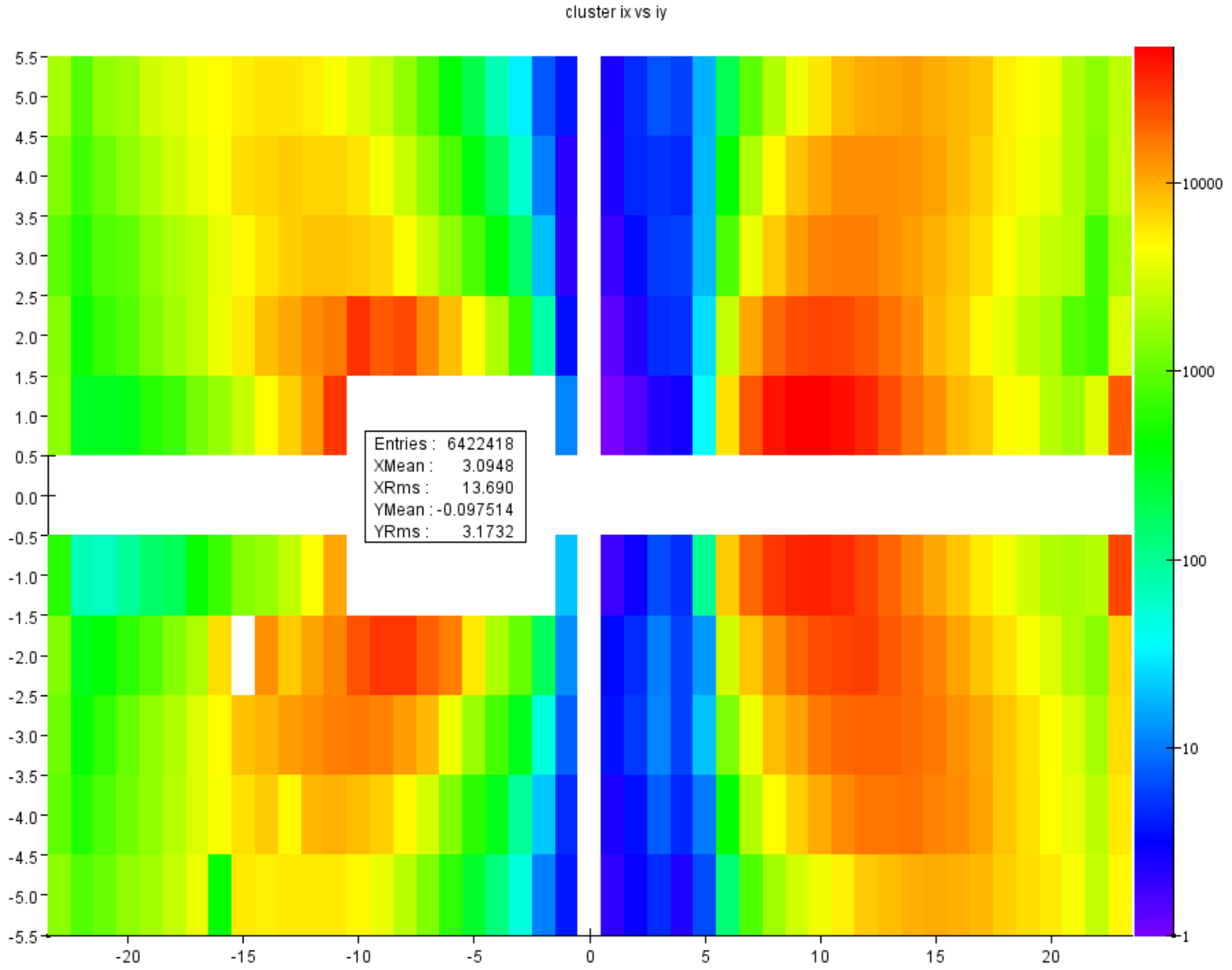
Two clusters consistent with MIP deposition



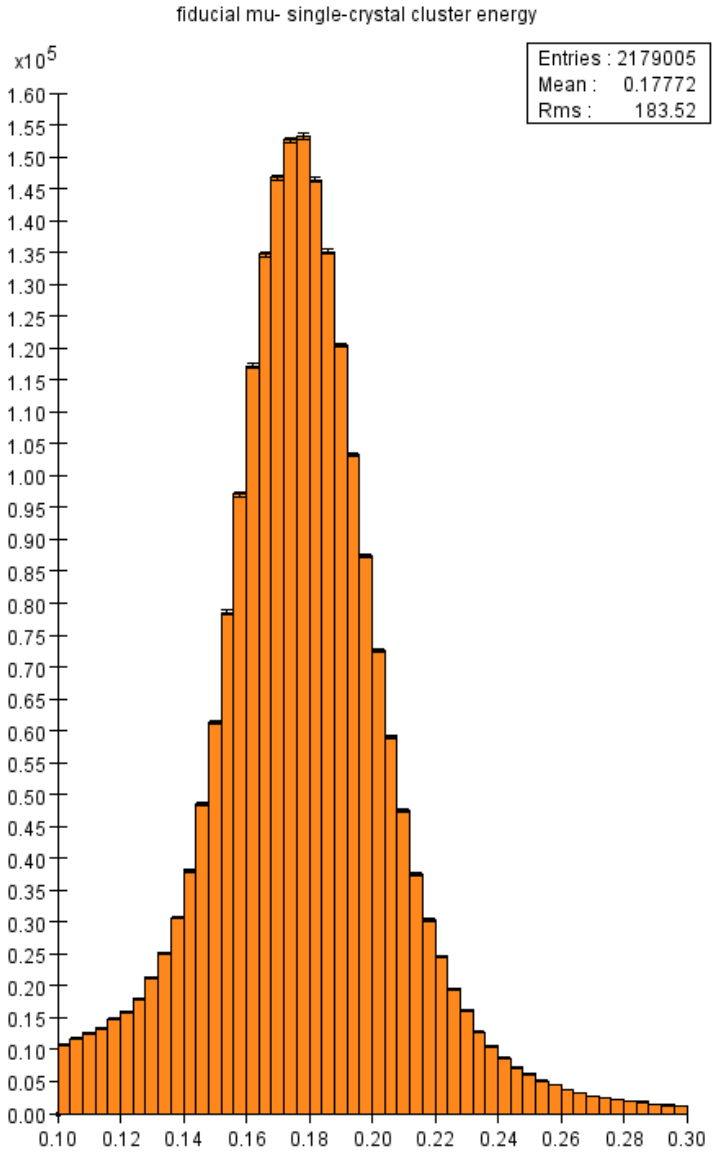
Data Selection

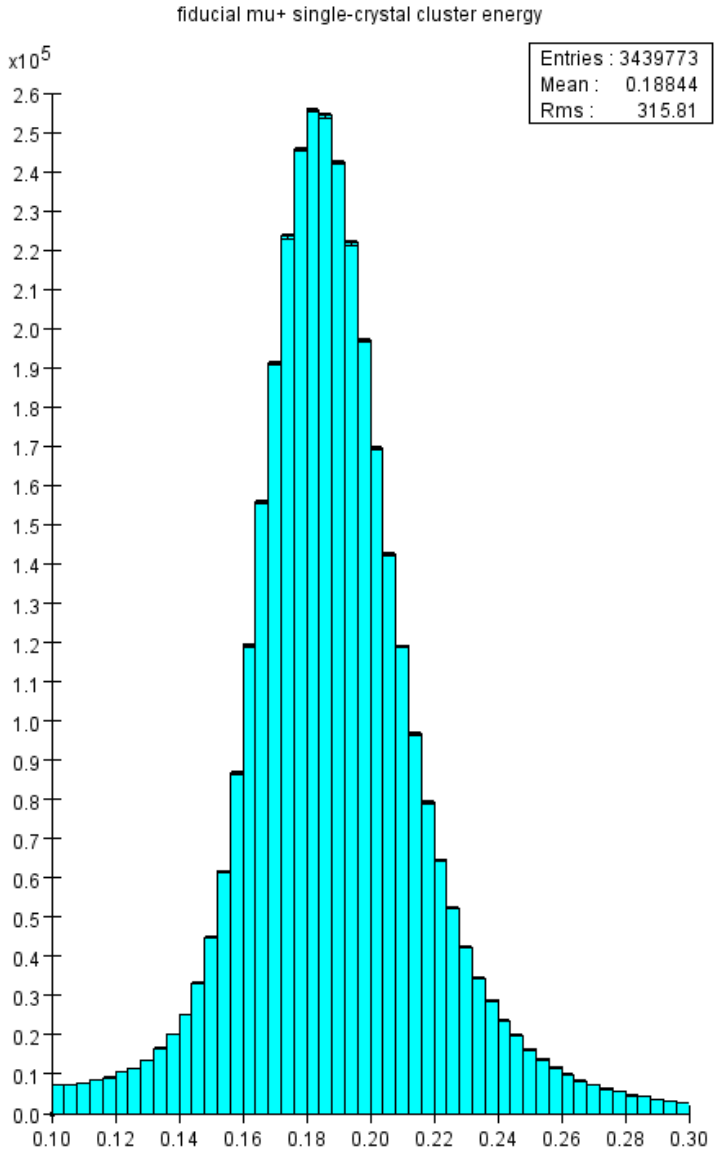
- Skim events firing the dimuon trigger exclusively
- Reconstruct with latest hps-java snapshot
- Select ReconstructedParticles with track associated with a single-crystal cluster.
- 10-to-1 aspect ratio of ECal crystals restricts range of muon path-lengths, giving monochromatic MIP peak.
- Adjusting measured MIP peak to that predicted by MC gives gain.

Single-Crystal $\mu^+\mu^-$ Coverage

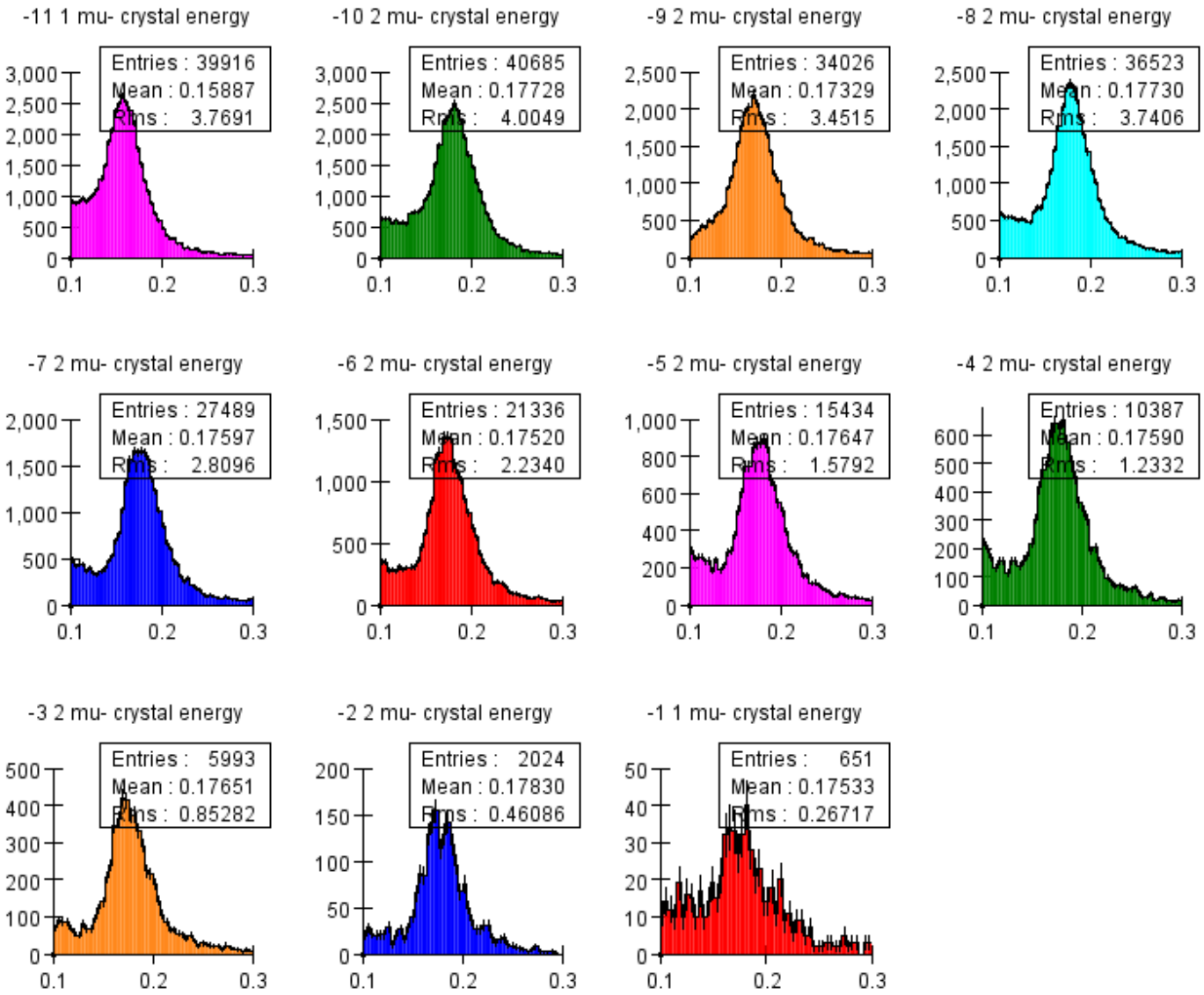


Single-Crystal Cluster Energies





Top Ecal Edge Crystals



Sampling Fractions

- The amount of energy which is lost in the interstitial region between crystals is a function of particle type, energy and impact position.
- We are in the process of deriving these corrections via Monte Carlo simulations
- One million events per particle type (e+, e-, gamma) per energy (0.5, 0.75, 0.8, 0.9, 1.0, 1.1, 1.2, 1.25, 1.3, 1.5, 1.75, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5 GeV) have been generated, simulated and reconstructed.
- Response functions are being fit and will be used to correct clusters in the reconstruction stage after particle ID has been done (e.g. track-cluster matching).

ECalibration Summary

- Muons produced in collisions at HPS provide a clean source of MIPs with sufficient statistics to calibrate individual crystals over most of the calorimeter, excepting roughly -2 to +5, and +/-23.
- The full set of exclusive Pairs3 events has been processed and fits to the MIP peaks have been performed.
- Comparison to MC is underway to extract the crystal-by-crystal gains.
- Gains will be compared with FEE gains in the fiducial region where these are available.
- Performance will be checked with WAB events with the inelastic electron in the e- fiducial region and the photon on the positron side. The width and position of the e- & photon energy sum should improve if we are doing things correctly (both gains and sampling fractions enter here).
- The two-photon triggered events have been skimmed and we will soon begin to reconstruct them.

Data Reconstruction Monitoring

- A set of “sample partitions” is available from each of the 2019 “good” runs.
  - 1054 partitions, ~3‰ of the run
- I have been processing these partitions at irregular intervals, whenever the software, calibration or alignment has changed (improved?) sufficiently to warrant a high-statistics data set for further analysis.
- Documentation at
- https://confluence.slac.stanford.edu/display/hpsg/2019+Reconstruction+Passes