ECalibration with muons

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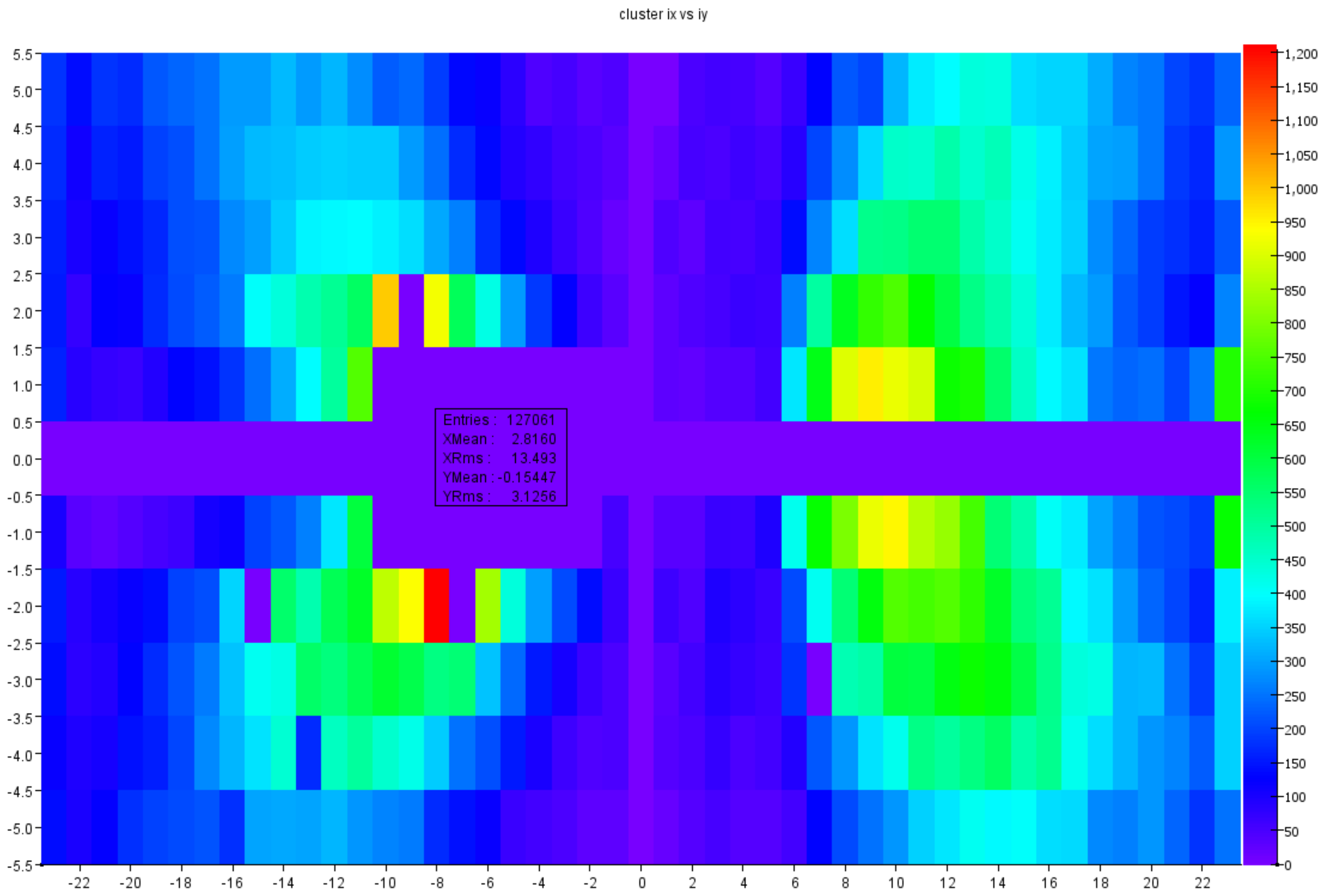
Last Day of Summer, 2020

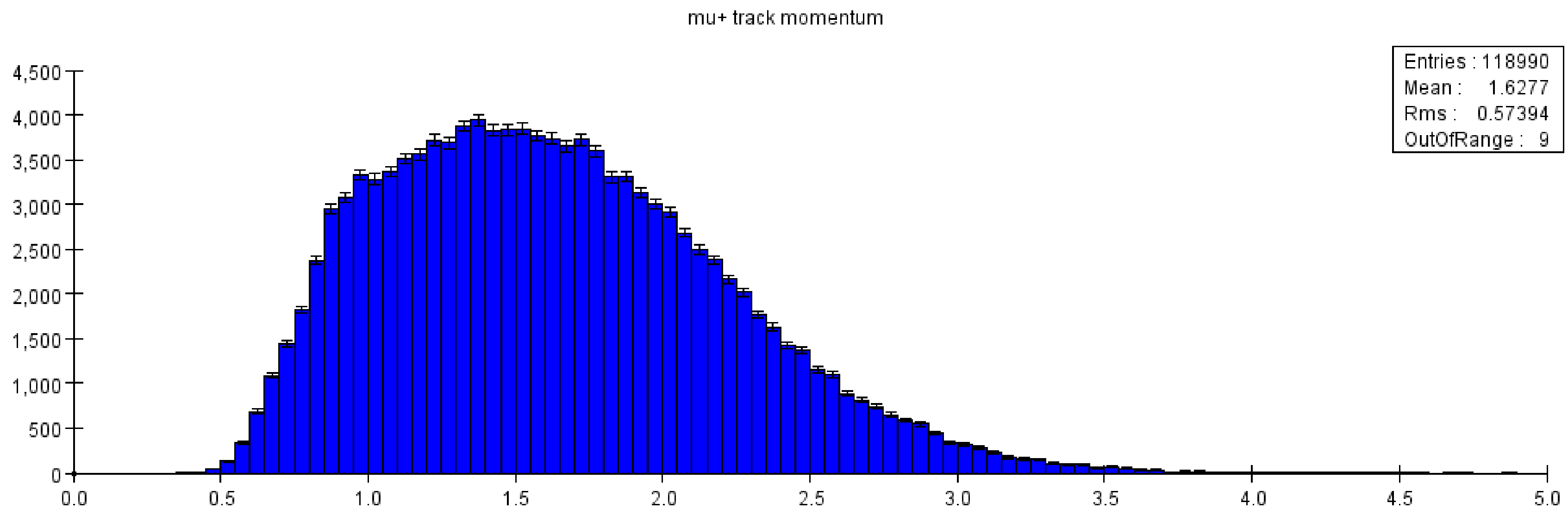
Event Samples

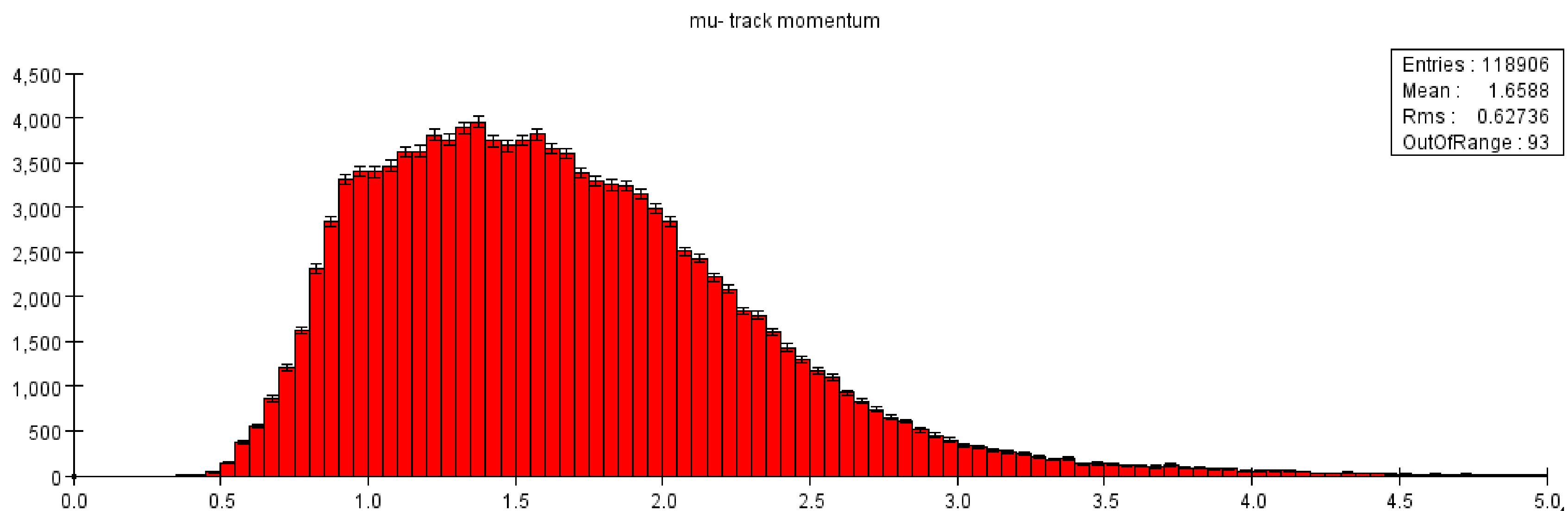
- Nathan has skimmed off events in evio format for events exclusively firing Pairs3 trigger
- Reconstructed these events using the latest git master snapshot.
- Select single-crystal clusters
  - Cluster energy should be “MIP” deposit
  - Use cluster energy to determine gains.
  - Using ADC sums with Gain=1 to determine *ab initio* gains
- This analysis is based on dimuon events from run 010261 (early in “golden” portion of the run).
- Generated and simulated single-muon (μ^+ and μ^-)
  - Used to determine muon-momentum dependent “MIP” depositions

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

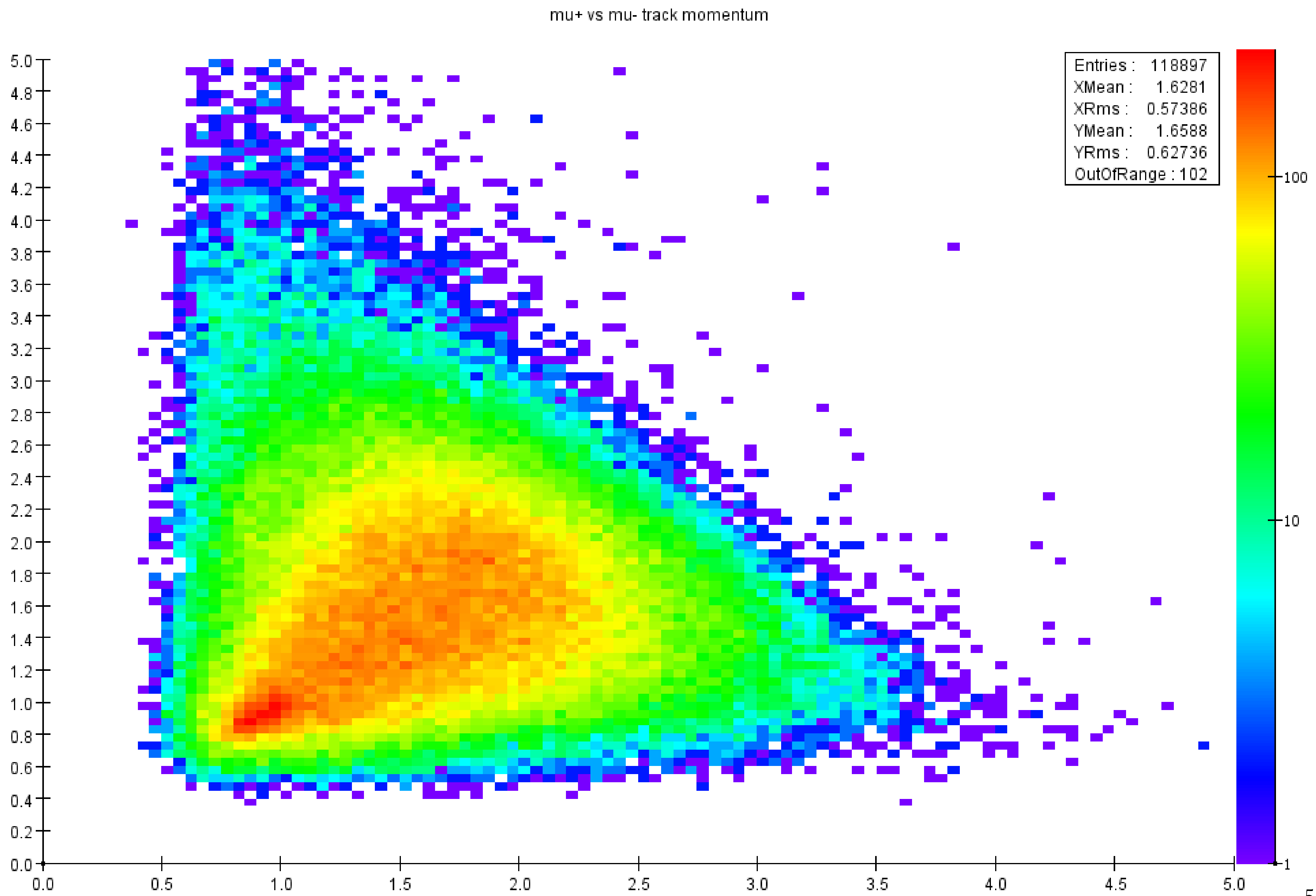


$\mu^+\mu^-$ Track Momenta

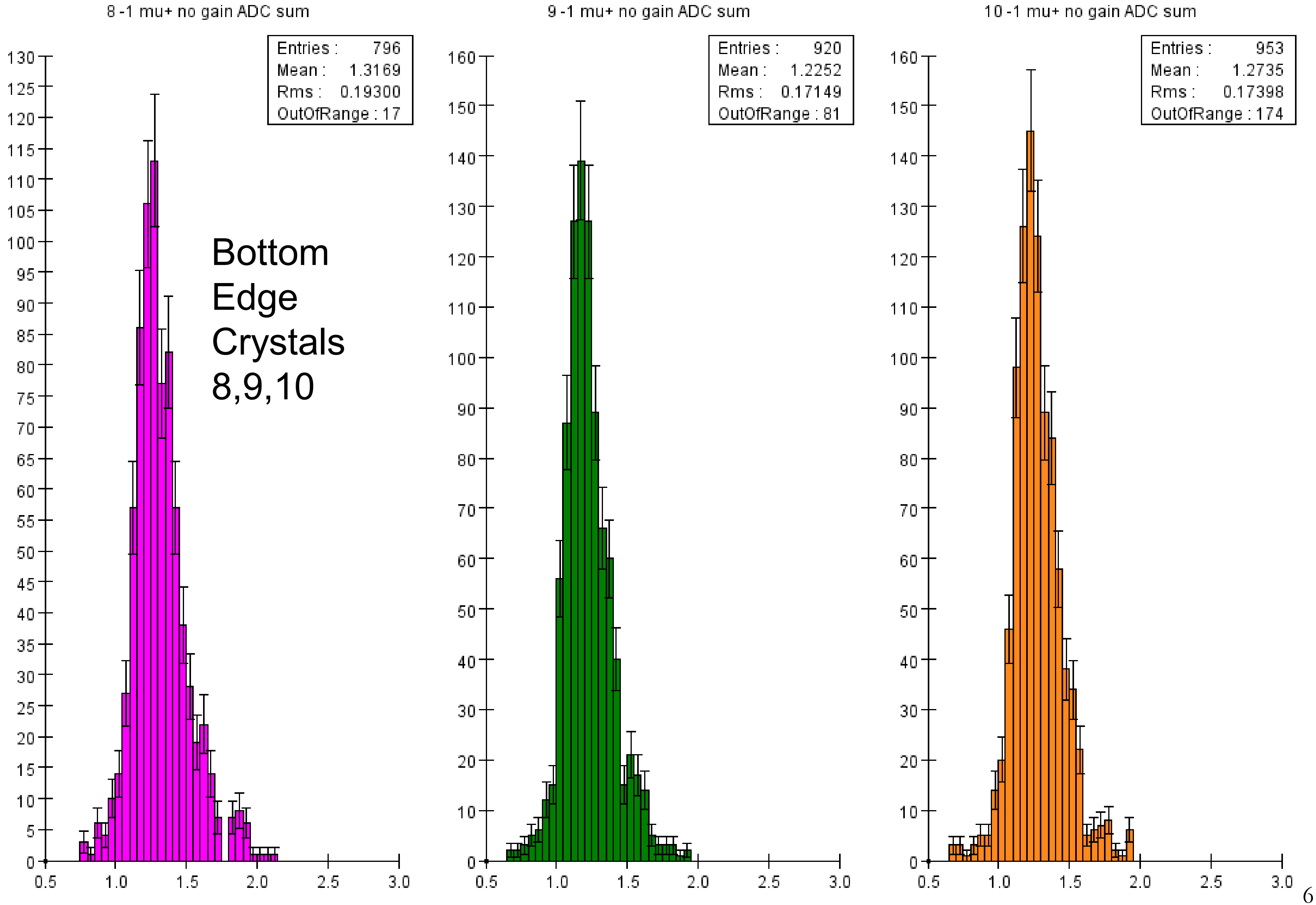




$\mu^+\mu^-$ Track Momenta

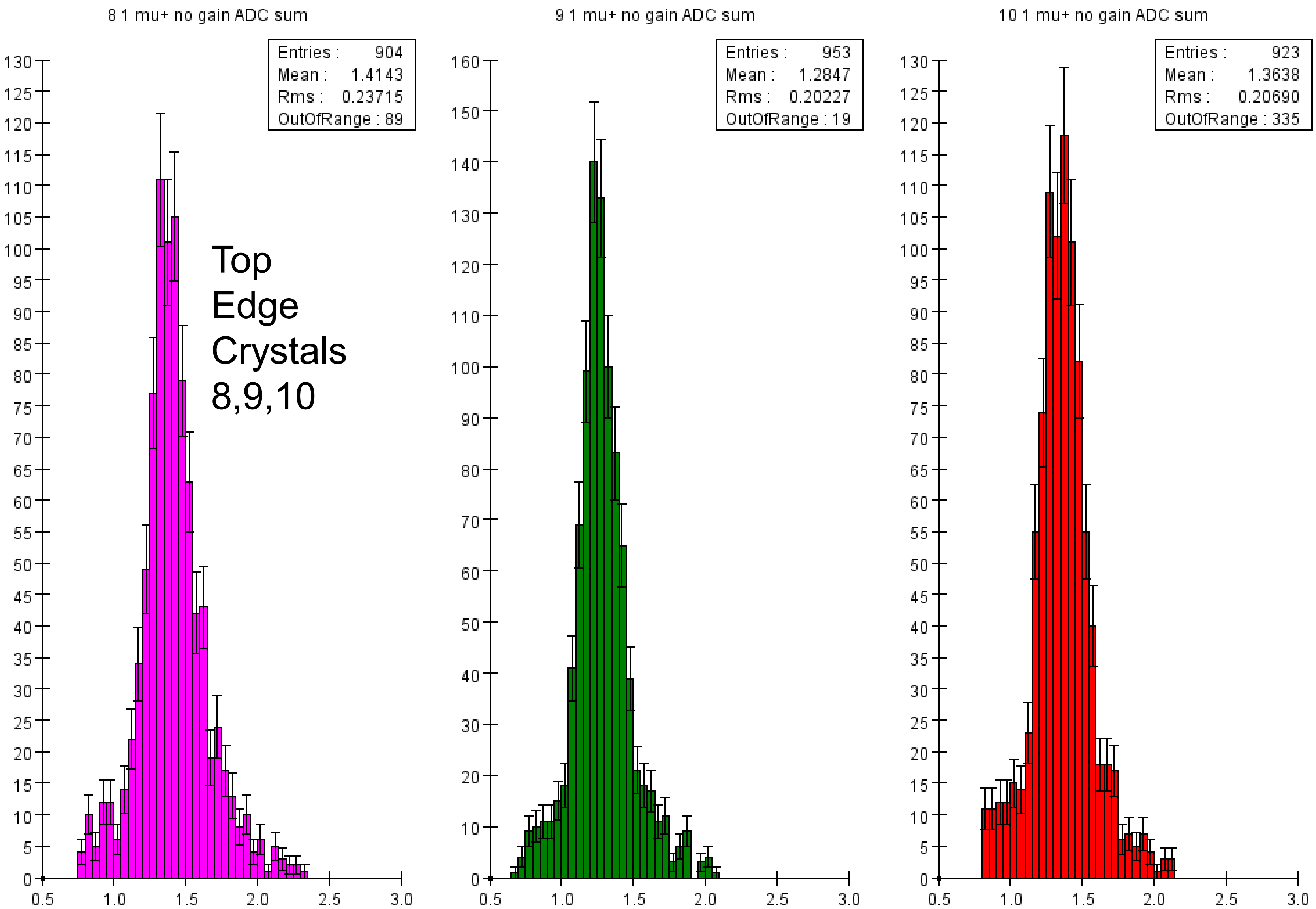


Individual Crystal Cluster ΣADCs

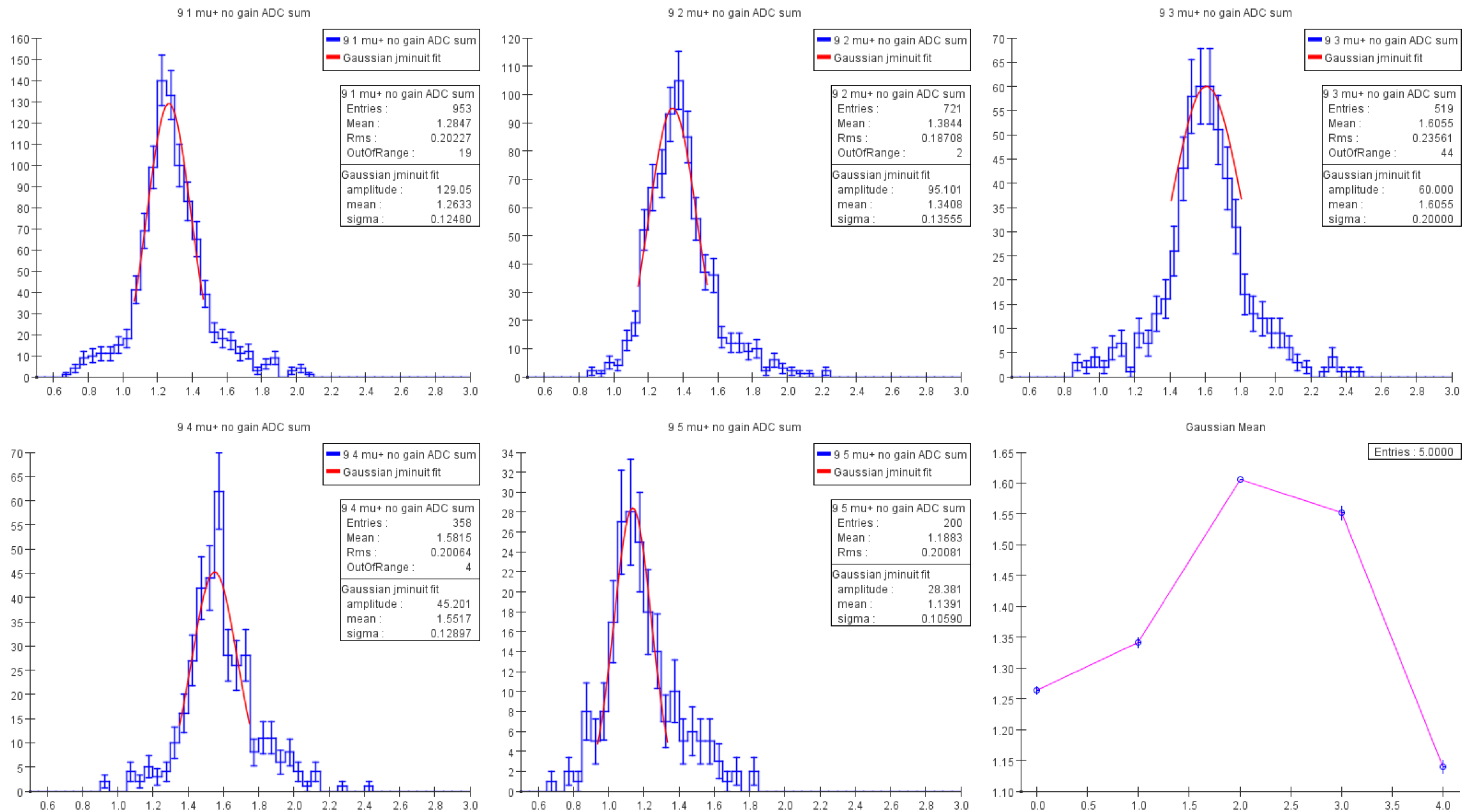


Bottom Edge Crystals 8,9,10

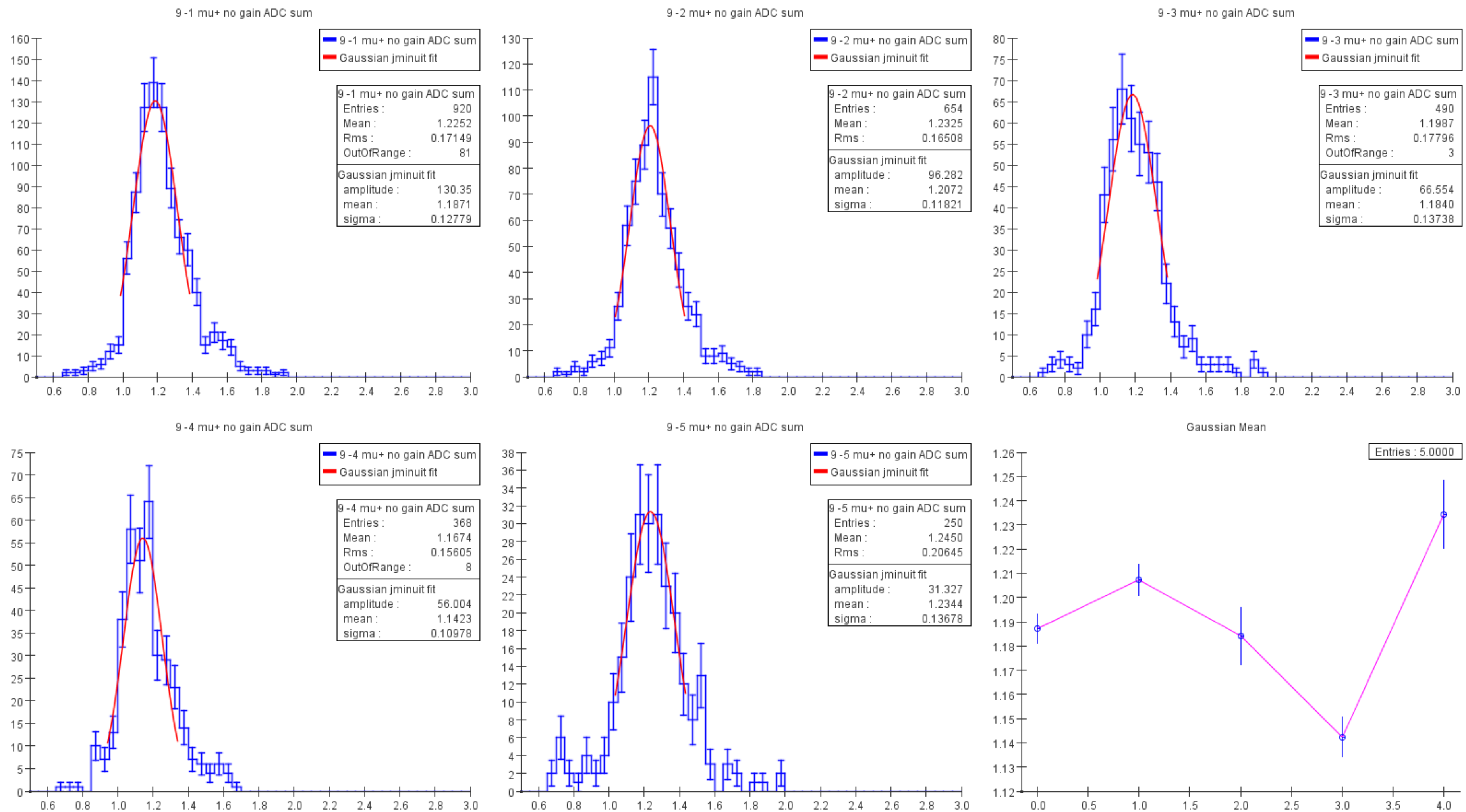
Individual Crystal Cluster ΣADCs



Individual Crystal Fits (top Column 9)



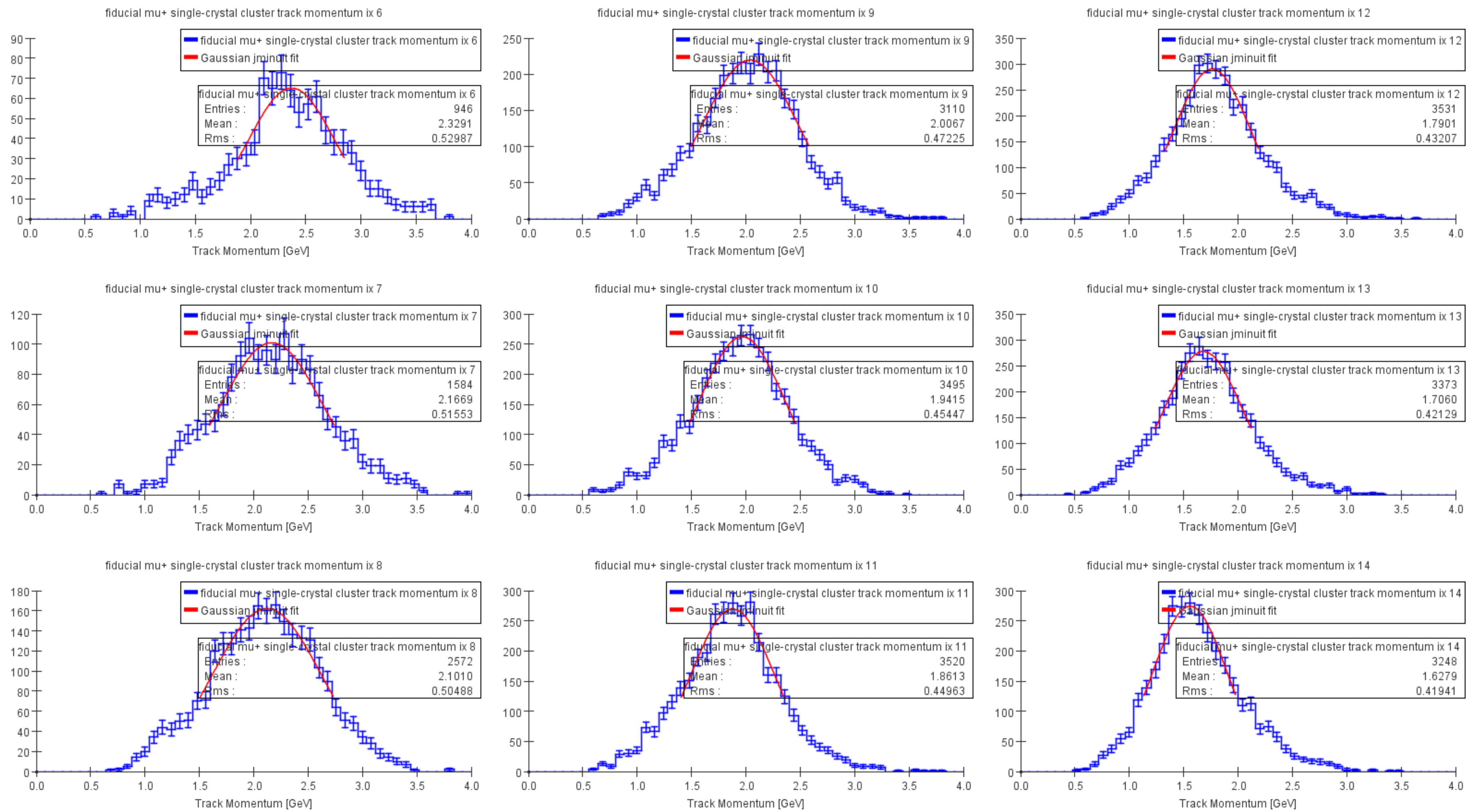
Individual Crystal Fits (bot Column 9)



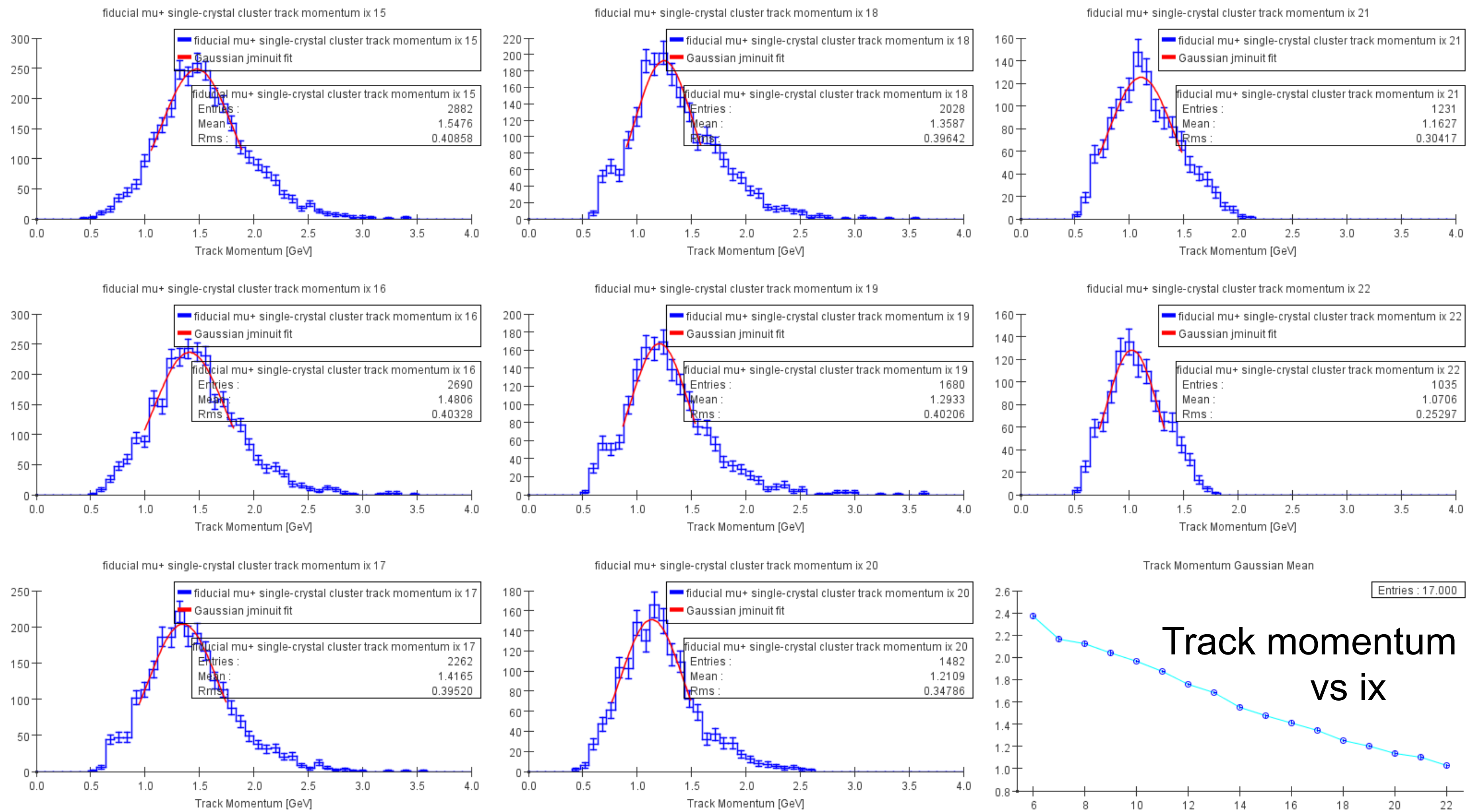
Muon Momentum Corrections

- Muons in our range of momenta are not strictly MIPS, and although the large aspect ratio of our crystals constrains the variation in path length, there are systematic differences in the amount of energy deposited in different crystal regions.
- Plot momentum of track associated with each single-crystal cluster.
- Fit momentum vs ix to extract mean momentum for each calorimeter column.

μ^+ Track Momenta



μ^+ Track Momenta

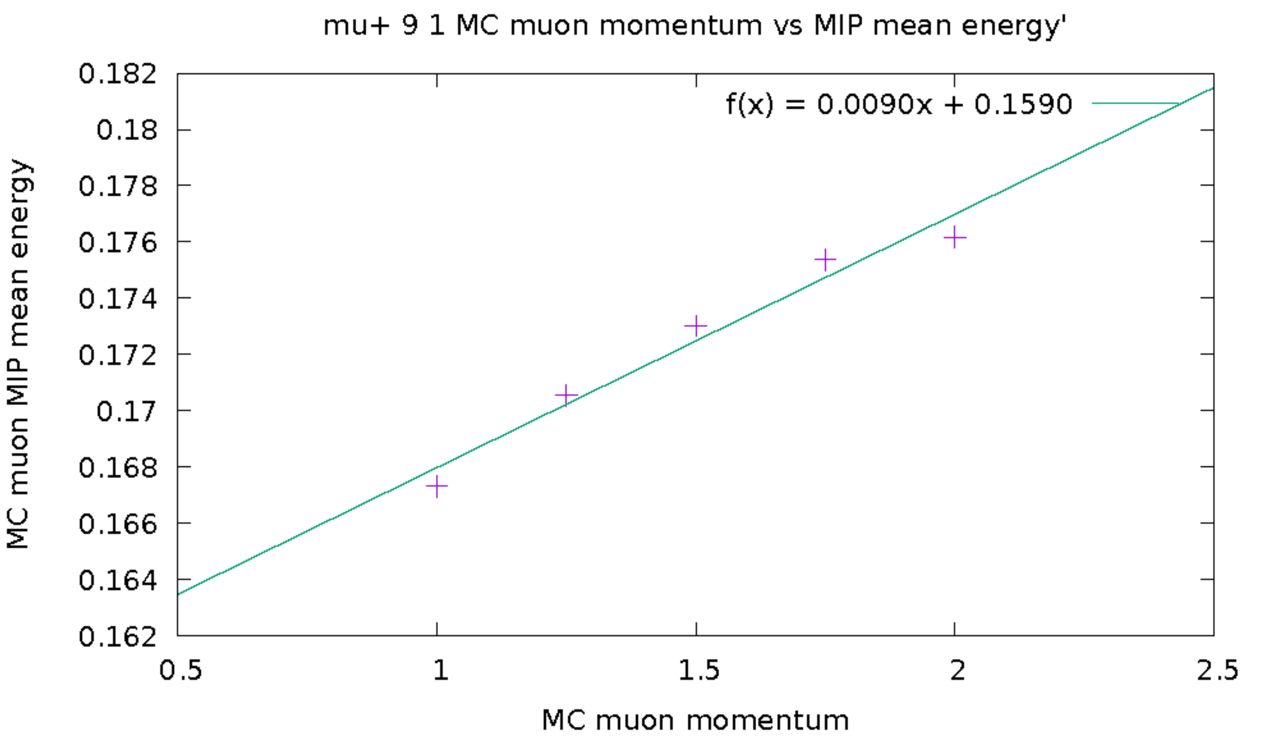


Muon Momentum Corrections: MC

- Generate single μ^+ and μ^- evenly covering the Ecal face with energies of
  - 1.00, 1.25, 1.50, 1.75, 2.00GeV
- Plot and fit single-crystal response as a function of MC momentum.
  - Should account for both dE/dx and geometric effects.

Monte Carol Single μ^+ Response

- Crystal ix = 9, iy = 1
- Single-crystal energy vs momentum



Putting it all together

- Select run (or runs to gather statistics) (261)
- Select dimuon events to reduce backgrounds.
  - Can also use single-muon events in fiducial regions to gather higher statistics.
- Select single-crystal clusters.
- For each crystal:
  - Fit ADC sum to extract mean of crystal energy deposition
  - Fit track momentum for all crystals in each column (ix).
  - Use MC events to determine expected single-crystal energy deposition based on momentum for each column.
  - Divide MC expected energy deposition by crystal ADC sum to determine crystal gain.
- Repeat for all runs (or run ranges).

Summary

- Muons produced in collisions at HPS provide a clean source of “MIP”s with sufficient statistics to calibrate individual crystals over most of the calorimeter.
- Currently very close to closing the loop and having first-pass gains for most of the crystals.
- Will compare to FEE-derived gains on electron side of the Ecal and cosmic ray-derived gains on the positron side of the Ecal.
- Will use WAB events to test.
- Could use some help to “turn the crank.”
- Stay tuned.