Hadronic Calibration of Topological Clusters in the sPHENIX Experiment

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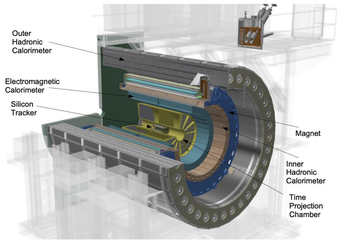
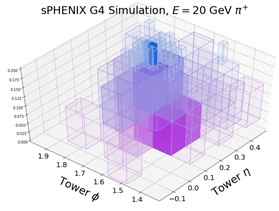
Background

Particle collisions are a large part of high energy physics. When particles collide at high energy density they create a quark-gluon plasma. By analyzing jets, an energetic spray of particles, we can learn about the collision and the quark-gluon plasma. Topological clustering is a method which is used to reconstruct jets. In the sPHENIX detector, jets will move through a tracker, an electromagnetic calorimeter, a hadronic calorimeter, a magnet, and then another hadronic calorimeter. By tracking the position and gathering the momentum of the particles that are contained within jets, reconstruction can be done. Topological clustering is an algorithm that groups together electromagnetic and hadronic calorimeter towers. In principle, a single topological cluster corresponds to a single particle, but that is not necessary. In this poster, we explore hadronic calibration using reconstructed topological clusters.



The sPHENIX Detector with each separate calorimeter layer, tracking layer, and the magnet.



Pictured right: 3-D image of a topological cluster. Smaller boxes are electromagnetic towers and larger boxes are hadronic towers.

Acknowledgements

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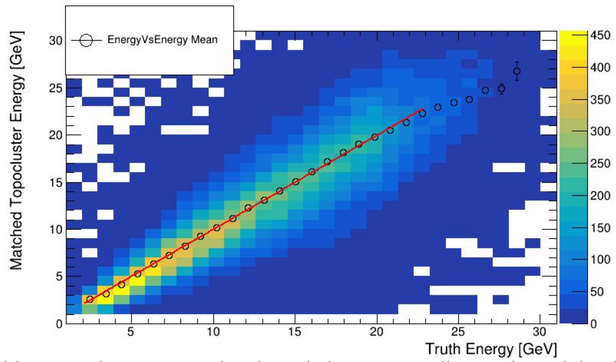
References

Adare, A. *et al.* sPHENIX Proposal arXiv:1501.06197

Aidala, C. *et al.* IEEE Transactions on Nuclear Science, Volume 65, Issue 12, pp. 2901-2919, December 2018

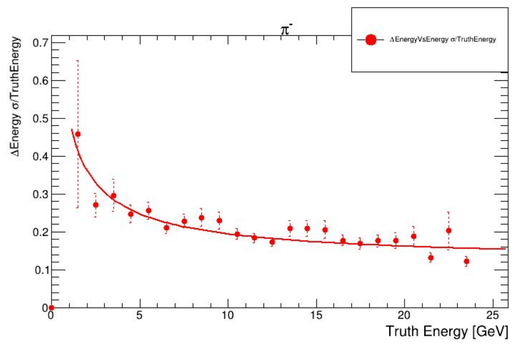
Energy Resolution

Single Particle Energy Matching



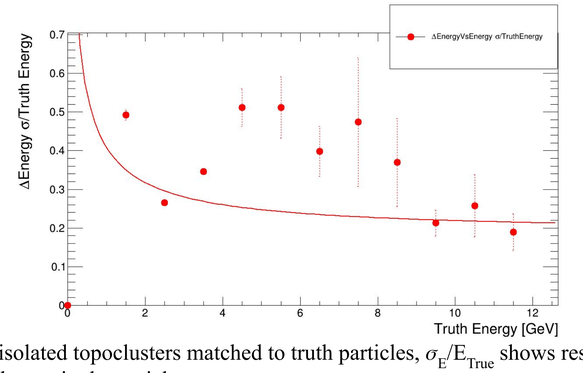
π^- matching topocluster energy levels to their corresponding truth particle after calibrating the slope to approximately 1. The slope is 0.996 +/- 0.0026.

Single Particle Energy Resolution



For matched topoclusters to generated π^-, σ_E/E_{True} shows better than 20% energy resolution above 10 GeV and consistent with sPHENIX test beam data.

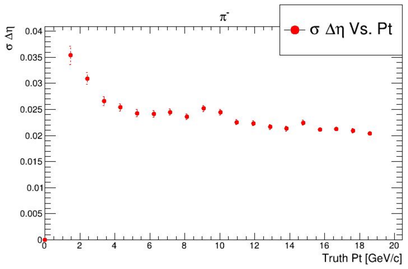
p+p Energy Resolution



For isolated topoclusters matched to truth particles, σ_E/E_{True} shows resolution similar to single particles.

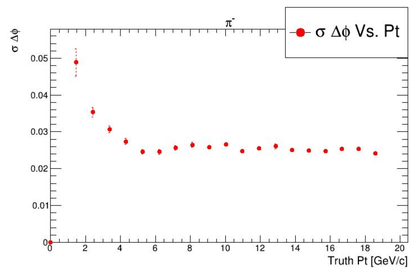
Single Particles

- 1 million π^- events with 5 π^- particles per event
- Match a topological cluster with a truth particle with $\Delta R<0.1$.
- Found the probability to match for charged and uncharged pions to be greater than 90%
- Position resolutions confirmed topological clusters matched well
- For matched topological clusters, the energy resolution leveled out around 20-30% for our hadronic particles.
- Made an H/E cut to accrue particles that would decay in hadronic calorimeter.



The η resolution of the pseudorapidity as a function of the truth particle's p_T.

The ϕ resolution as a function of the truth particle's p_T.



PYTHIA p+p

- Proton collisions closer represent heavy ion collisions
- Accurate sample of data came in the form of isolated particles
  - Isolated particles have $\Delta R>0.5$ from other particles
  - Topocluster data will not be corrupted with data from surrounding particles
- With an H/E cut on single particles
  - 97.8% were hadronic, only eliminated photons because particles such as electrons were nearly zero to begin with
- Used the same calibration from the single particle simulation to calibrate topoclusters
- Plotted energy resolution for hadronic particles in p+p events