Hadron Energy Reconstruction with Barrel EMcal

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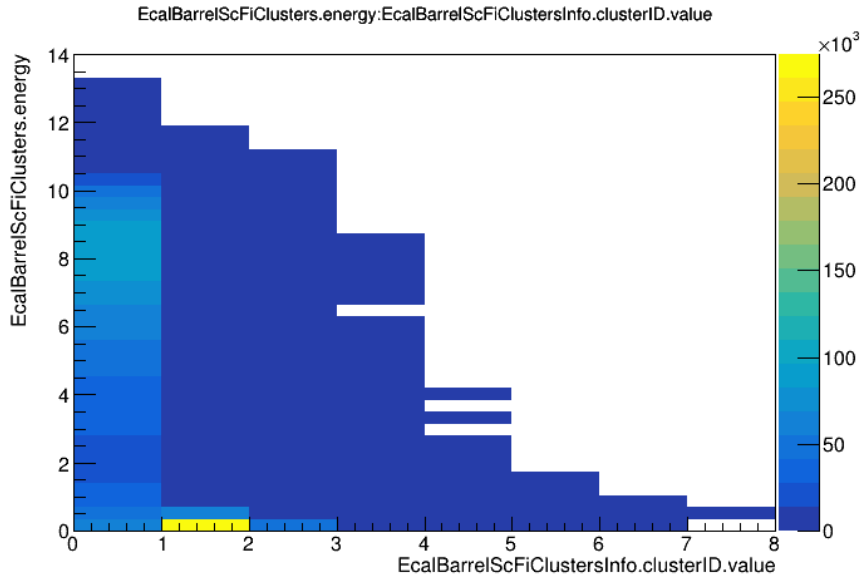
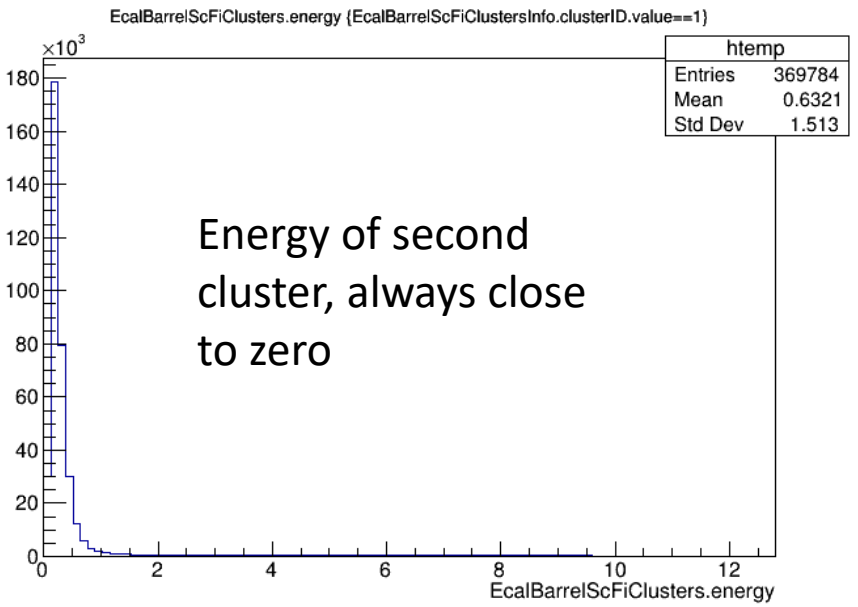
First Attempts at Energy Reconstruction

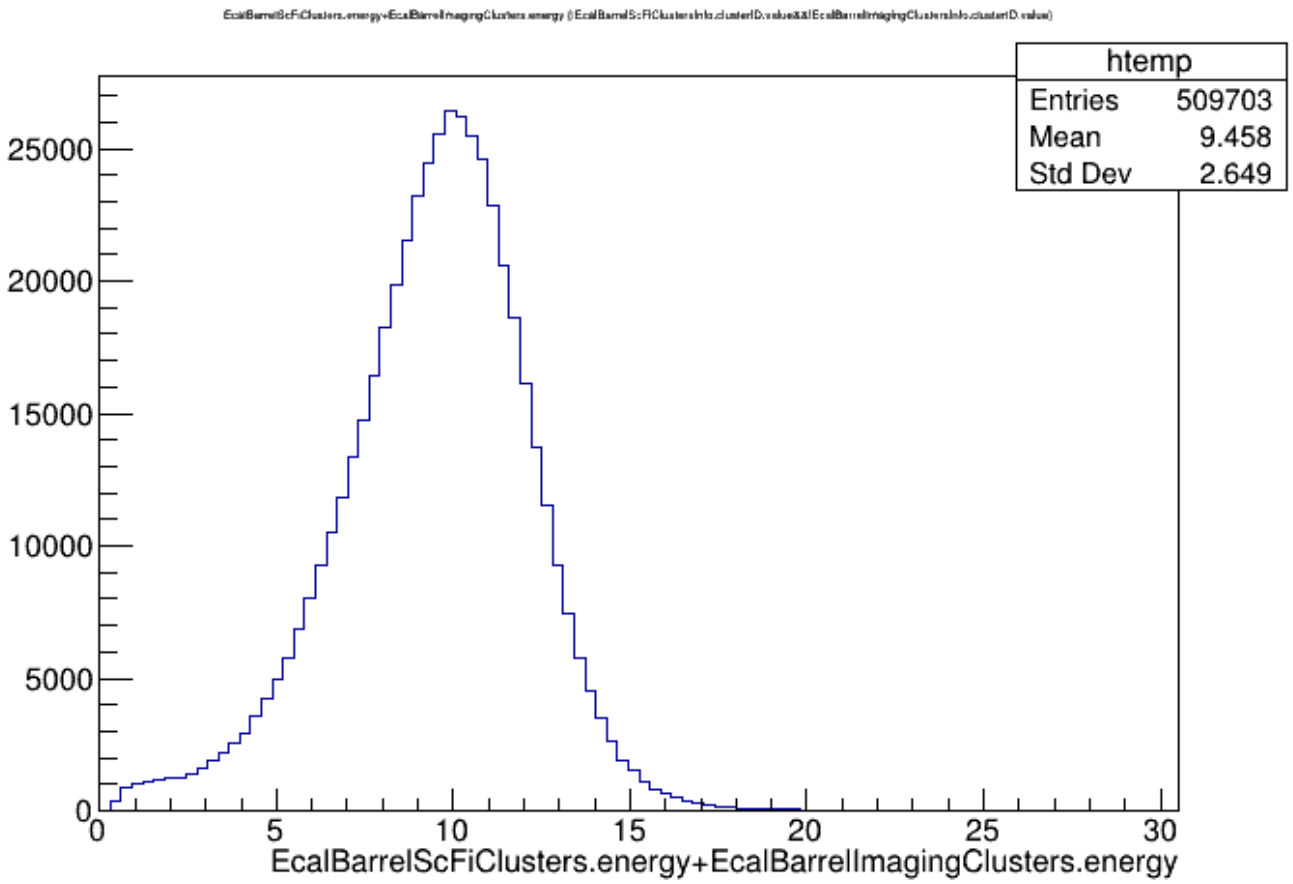
- 10 GeV neutrons
- Take most energetic cluster as the particle's reconstructed energy
  - For energetic neutral hadrons, not such a bad assumption
  - In 2M events: 1.6M have one cluster, 370k have two clusters, 74k have three+
- Will use first cluster as a proxy for reconstructed energy moving forward





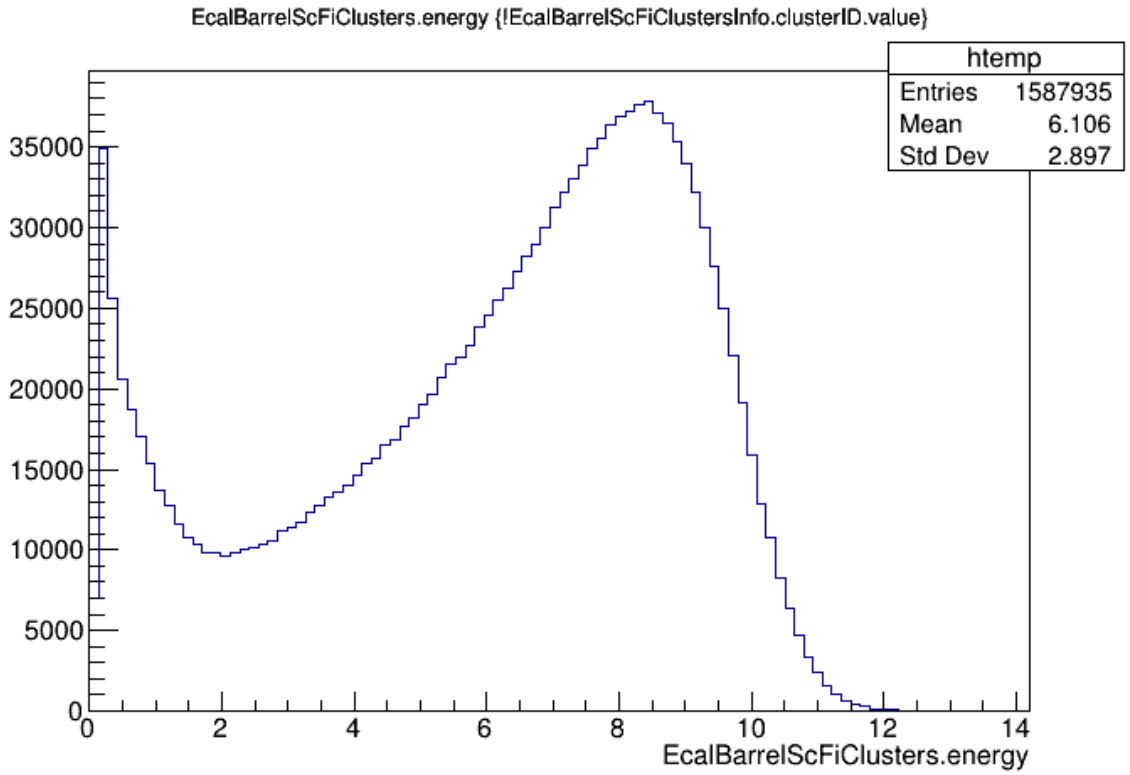
Resolution doesn’t tell the whole story

- 10 GeV neutrons
  - Requiring at least one cluster in both SciFi and imaging
    - Proxy for early shower, well contained
- Relatively gaussian, 28% sigma
  - ~Matches previous studies for Ecal hadronic resolution
- However, only ~25% of thrown particles pass this imaging+SciFi cluster criteria at 10 GeV
  - 0.07% at 1 GeV, 10% at 5 GeV



Resolution doesn’t tell the whole story

- 10 GeV n (pi+/- similar)
- Here only a cluster in the SciFi is required
  - Shower no longer constrained to be early
- Standard deviation is similar to previous case, but highly non-gaussian
- Large number of events where energy is missing
  - To be expected
- Still, ~20% of events leave no cluster in either Ecal section
  - 16% leave no cluster in any calorimeter
- Could also be an issue with the current clustering, but results are ~consistent with expectations

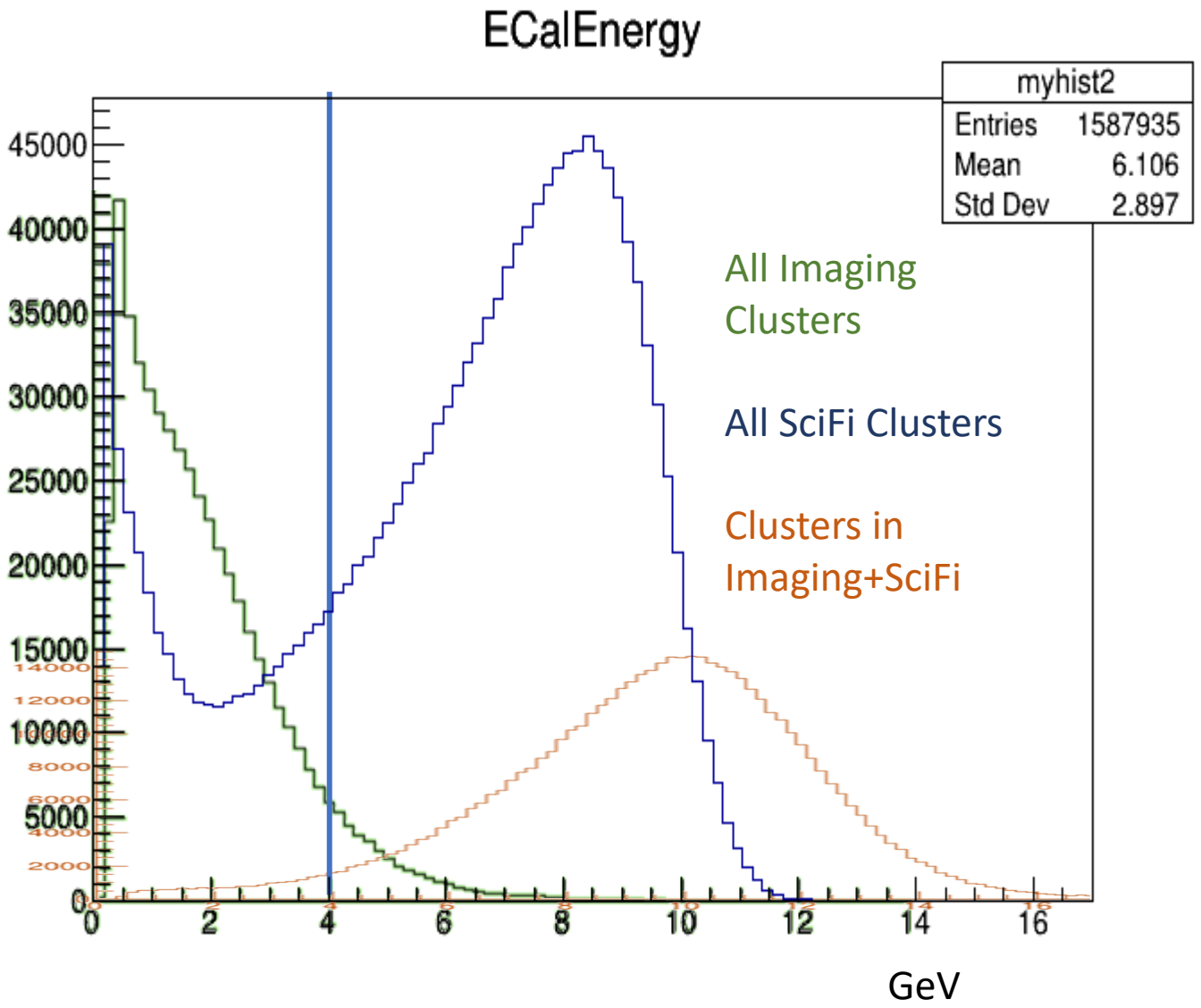


- Peak at 0 in SciFi isn't from energy lost to imaging
  - Imaging absorbs very little energy overall
- ~20% of SciFi clusters < 4 GeV
- ~11% < 2 GeV

- If orange condition is met, one can measure energy
  - Otherwise, energy response will be very non-linear

- Can maybe still provide neutral-ID with only one cluster
  - Will need in-depth study with DIS sample
  - Still only 80% efficient at max

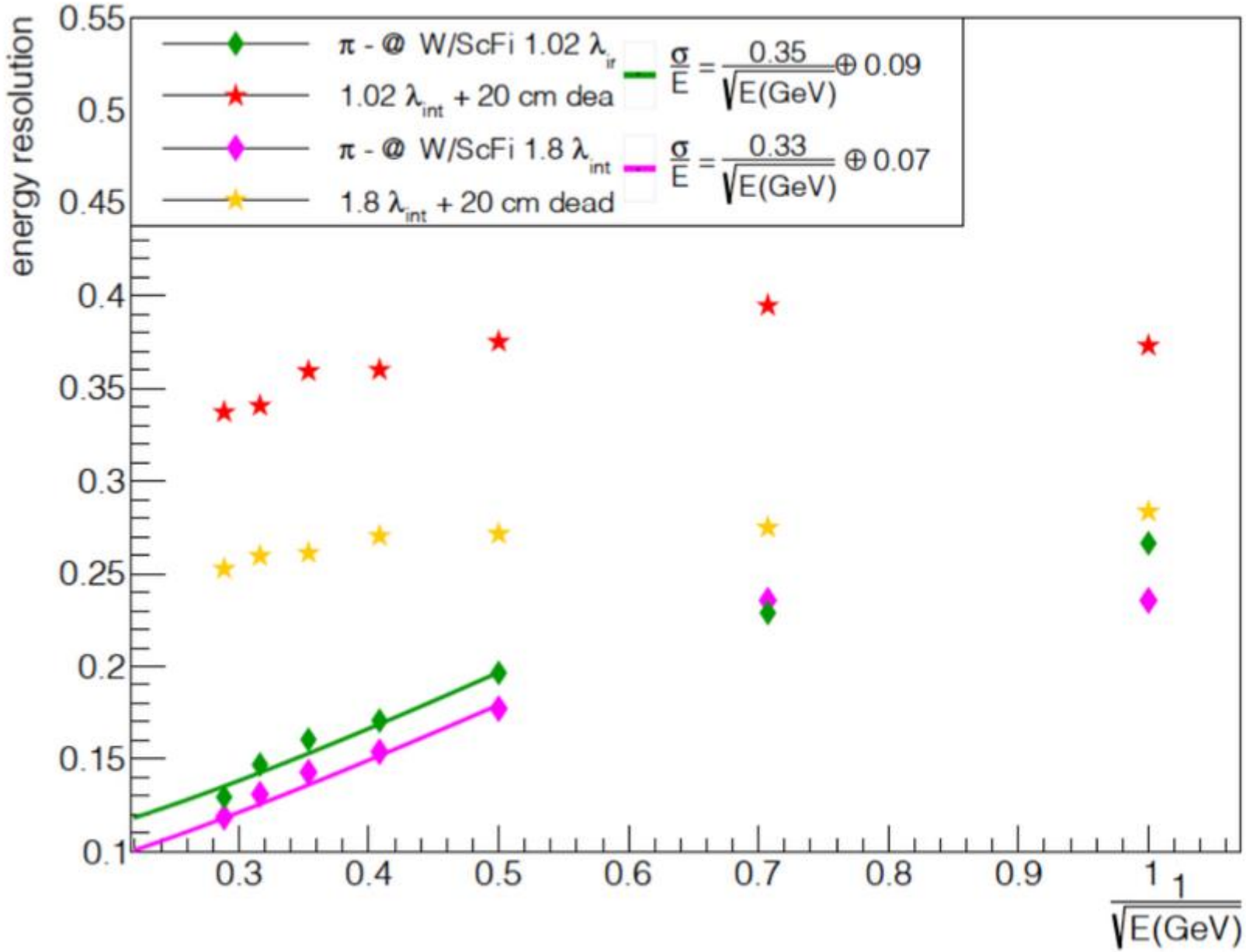
- Aside: EMcal cracks can be problematic, magnet will absorb channeled hadrons, electrons, photons before HCal



Conclusions

- Current ECal sees clusters from ~80% of high energy neutral hadrons
  - Can measure energy relatively well if shower is in imaging layers (~25% of the time)
  - Poor energy measurement if only SciFi has clusters
- Efficiency of ECal is significantly worse for low energy neutral hadrons (e.g 1 GeV neutrons)
  - Clustering issue? Threshold? Below Noise? Interaction Cross-section?
  - These hadrons are common and important and should be measured if at all possible
- Extending ECal should improve efficiency and gaussianity of energy response to hadrons

Backup


energy resolution
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
$\frac{1}{\sqrt{E(GeV)}}$
π - @ W/ScFi 1.02 λ_{int}
1.02 λ_{int} + 20 cm dea
π - @ W/ScFi 1.8 λ_{int}
1.8 λ_{int} + 20 cm dead
$\frac{\sigma}{E} = \frac{0.35}{\sqrt{E(GeV)}} \oplus 0.09$
$\frac{\sigma}{E} = \frac{0.33}{\sqrt{E(GeV)}} \oplus 0.07$