Studying the “confusion term”

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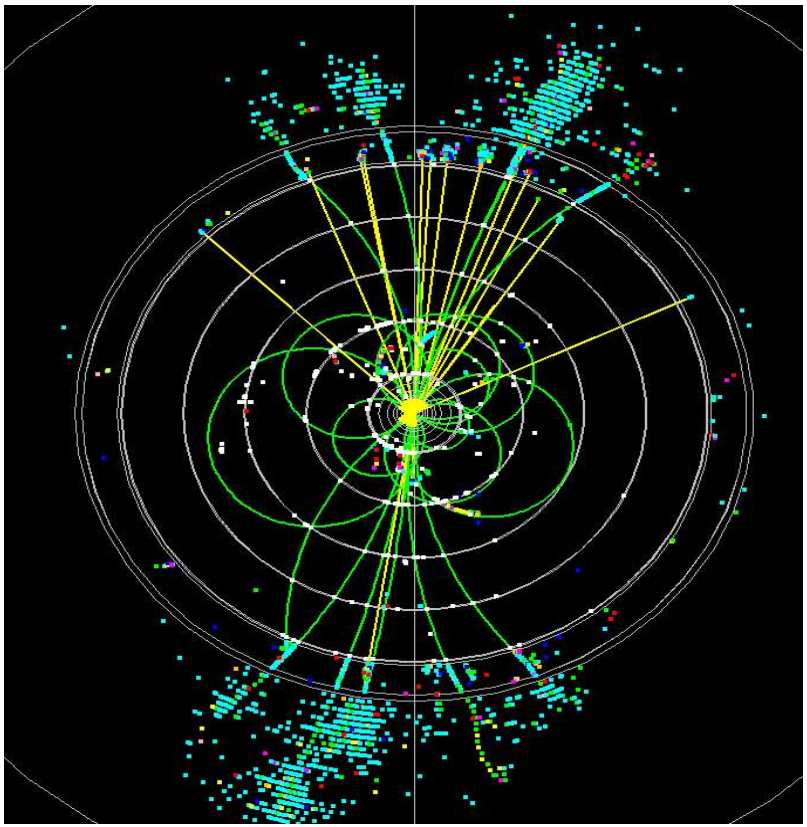
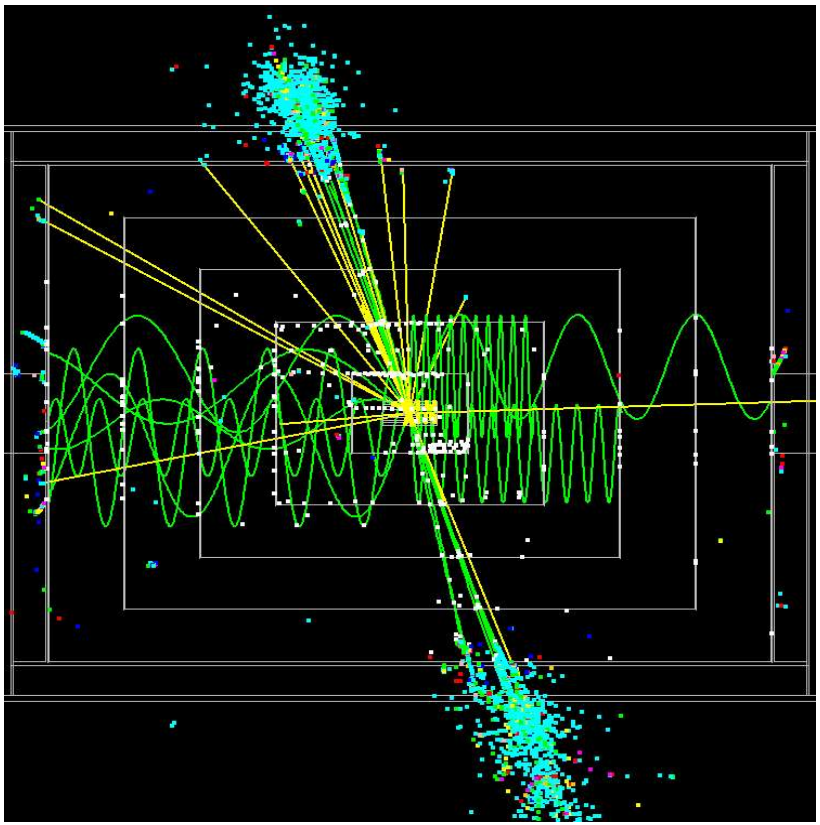
What's the “confusion term”?

- Some hits are due to more than one particle depositing energy in a single calorimeter cell

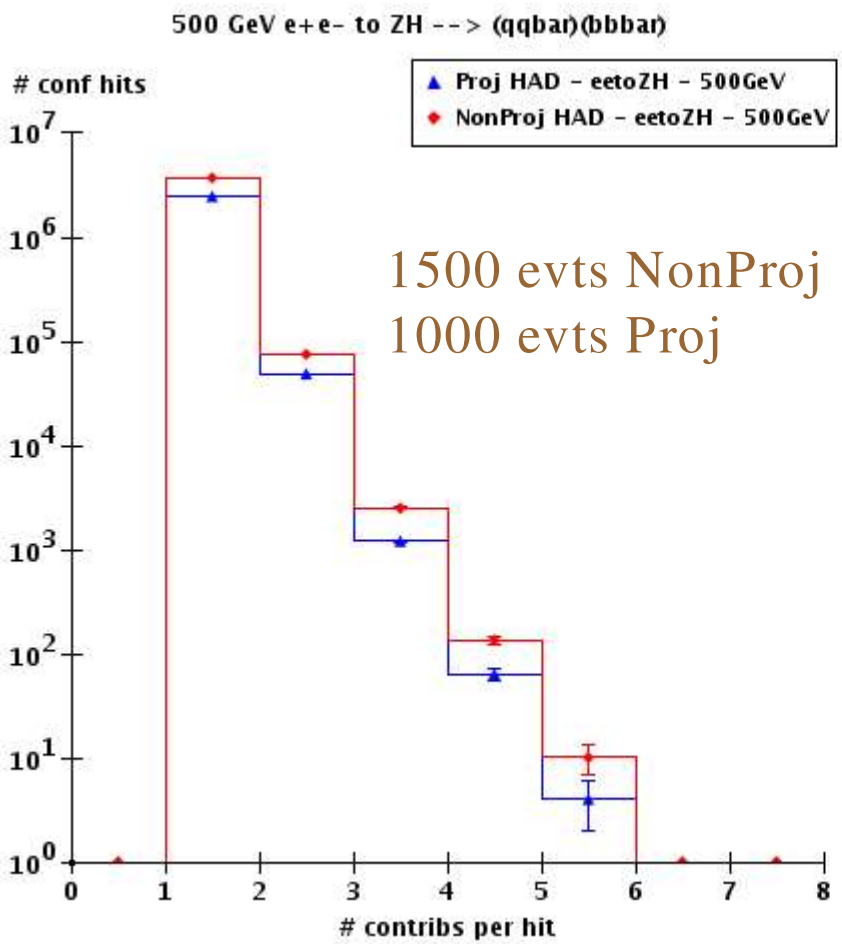


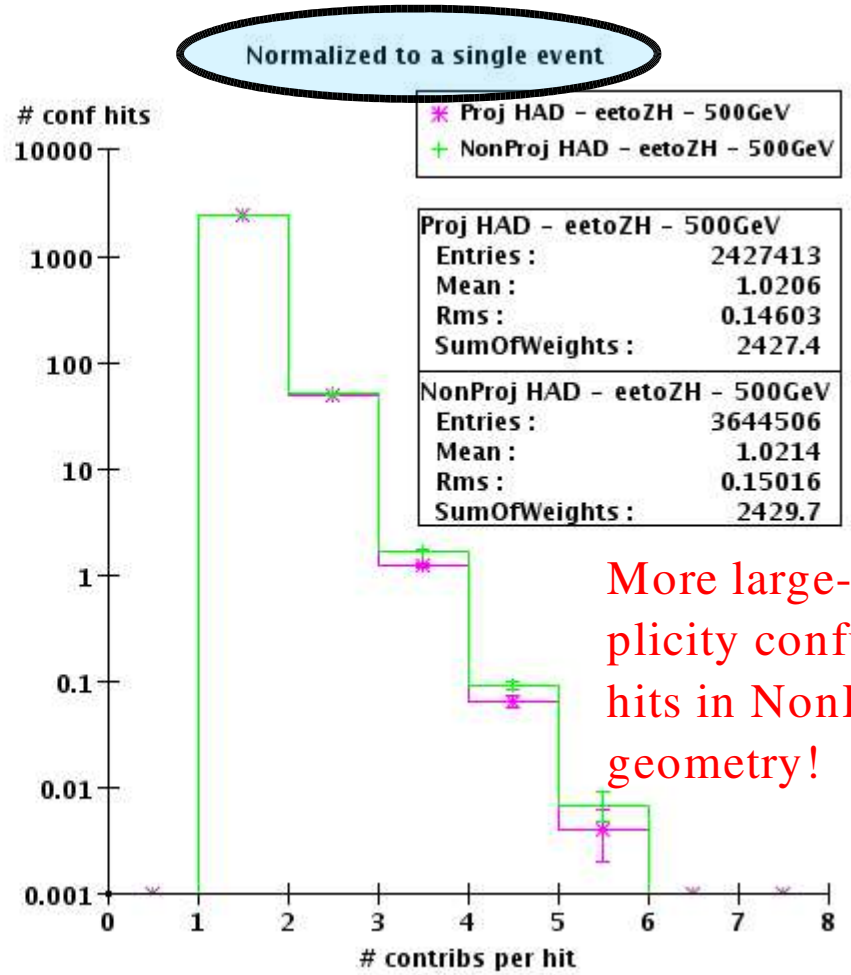


Studying the confusion term

- more than 2 contribs? How frequent?
- total Elive/event, total Econf/event, #ConfHits/event, Efrac = Econf / Elive
- Econf distributions (linear, log)
- Longitudinal distribution of confusion hits
- largest relative contribution in confusion hits
- Isolation parameter: (clean-conf)/(clean+conf)
  neighbor hits within: +/-1 layer; +/- 2 in theta, phi
- Two weeks ago: Em vs. had components, charged vs. neutral components, energy evolution (500 and 1000 GeV e+e- --> ZH --> (qqbar)(bbbar))
- Today: projective HCal (SDJan03, 1000 events)
  Vs. non-projective HCal (SDNPHJun04, 1500 events)
  Based on 500 GeV samples, M_H = 120 GeV

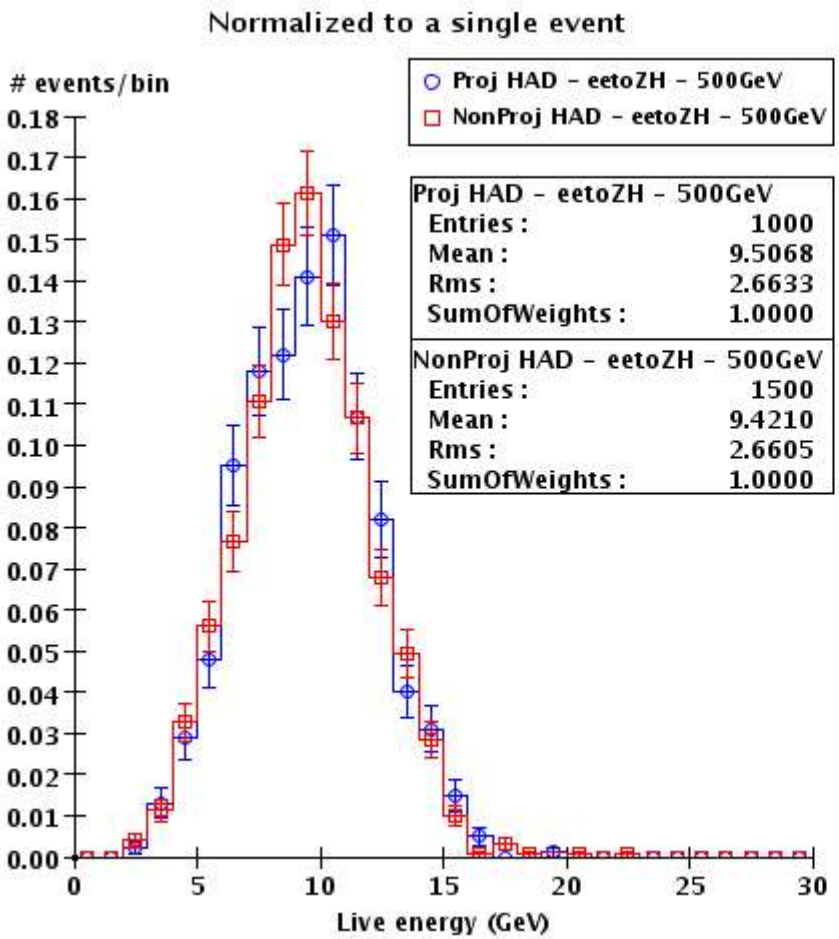
Frequency of confusion hits

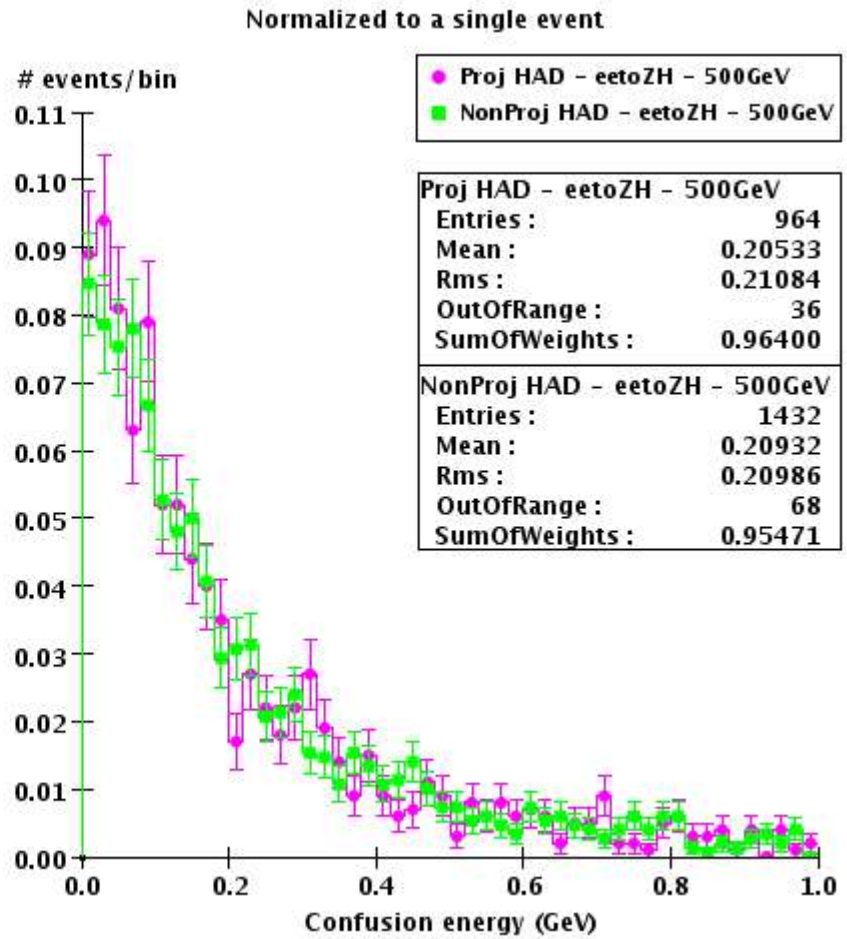




More large-multi-plicity confusion hits in NonProj geometry!

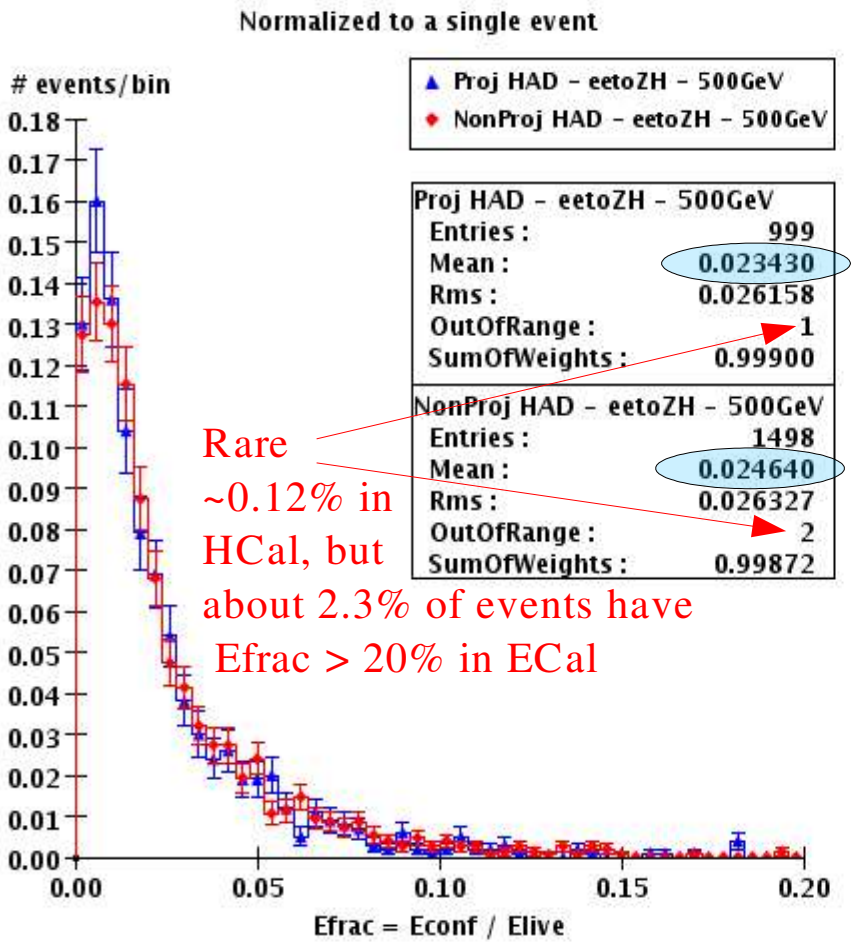
Total Elive and Econf per event



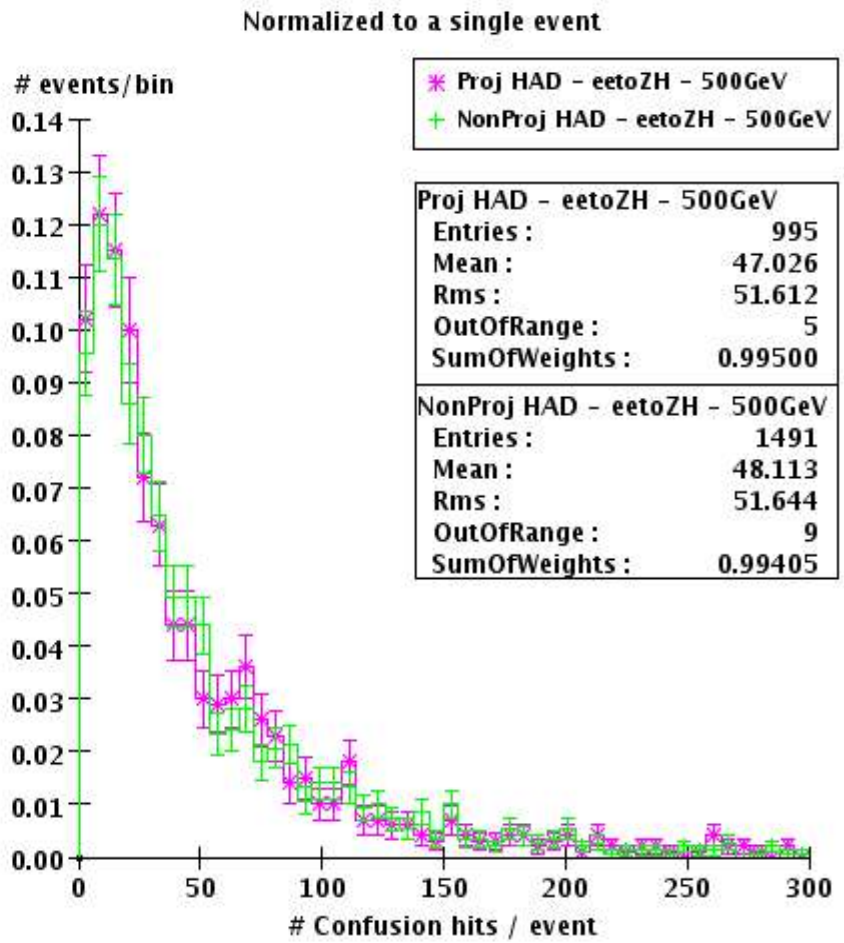


Distributions are quite similar.

Econf/Elive and # confusion hits

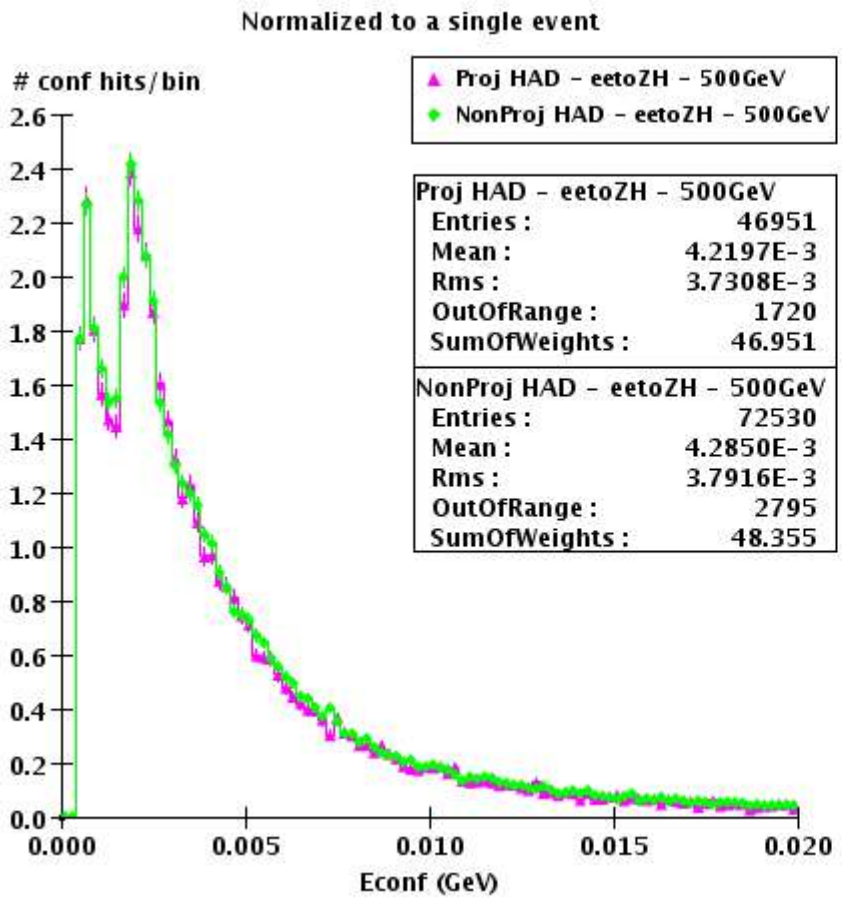


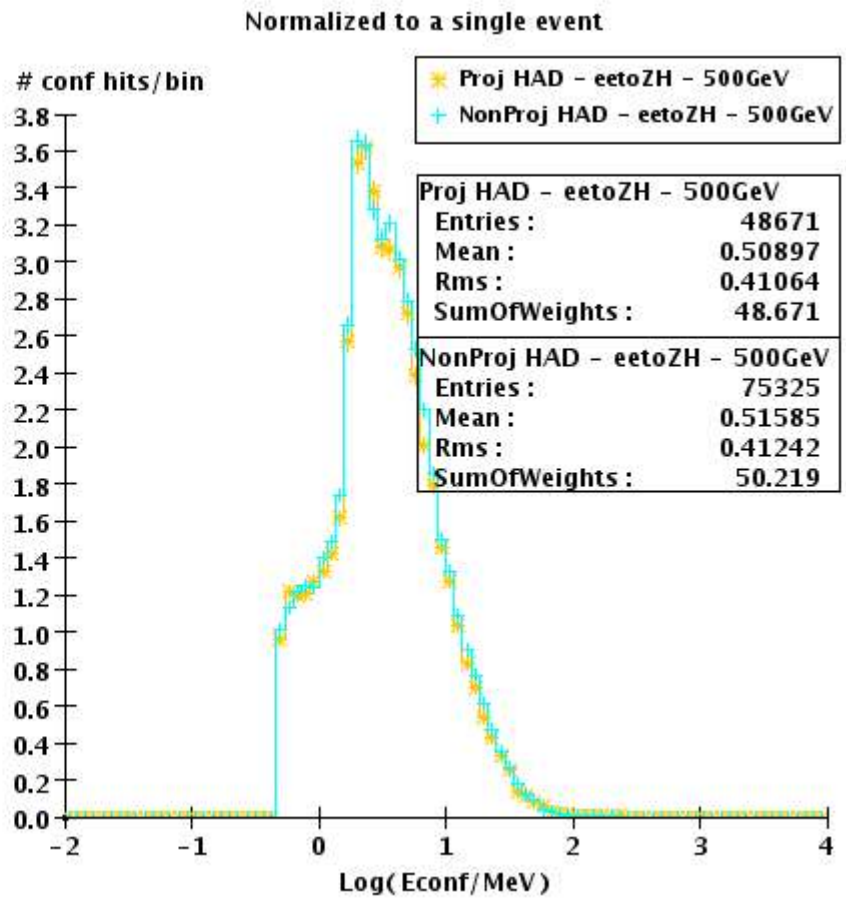
Rare ~0.12% in HCal, but about 2.3% of events have Efrac > 20% in ECal



Efrac and NconfHits are also quite similar.

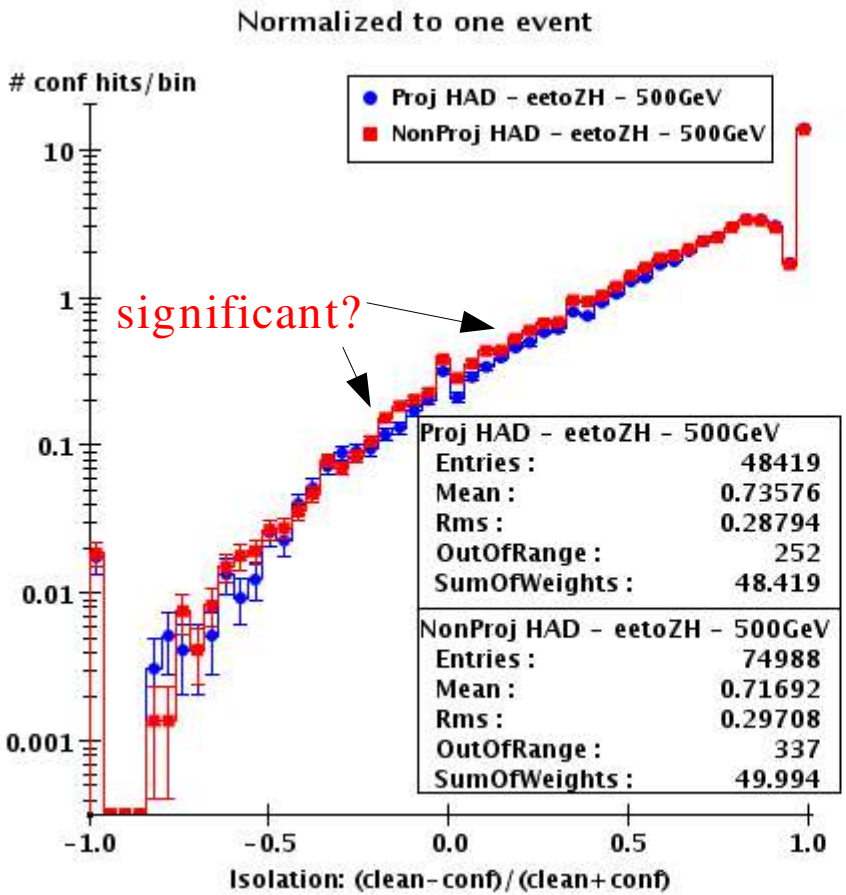
Econf / hit distribution

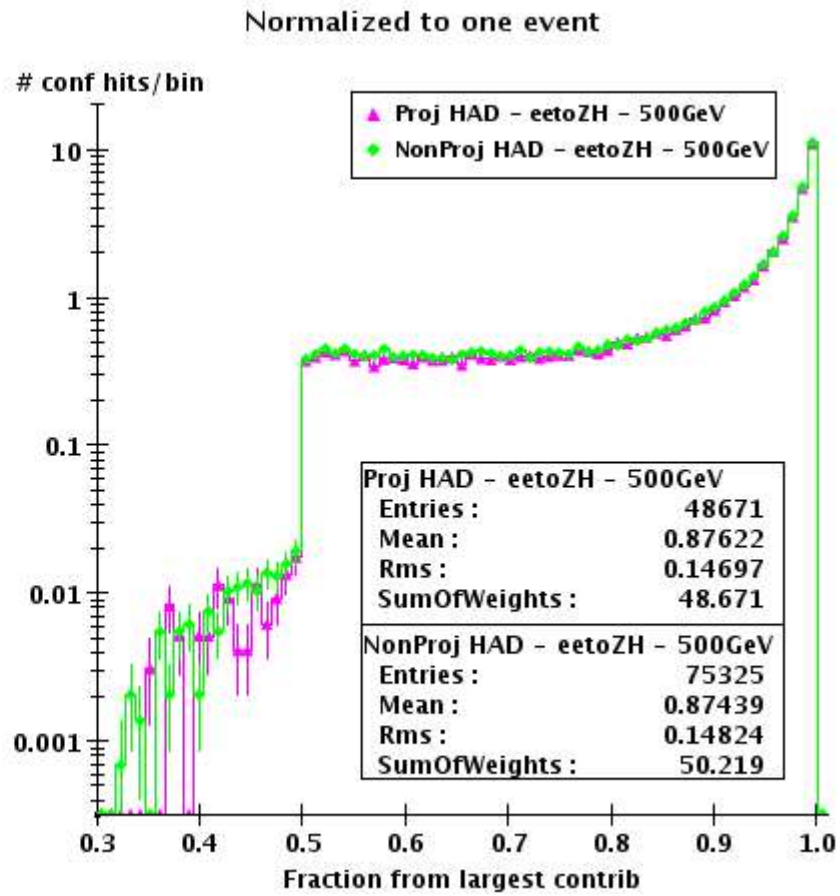




Econf/hit distributions are also similar.

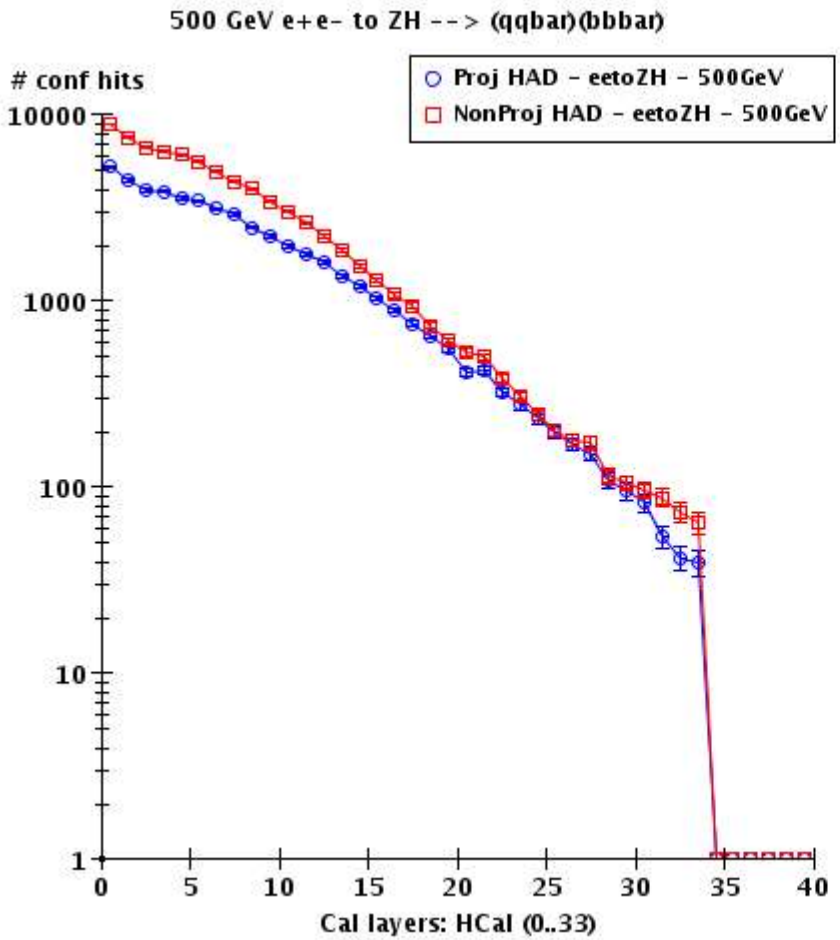
Isolation and largest contribution

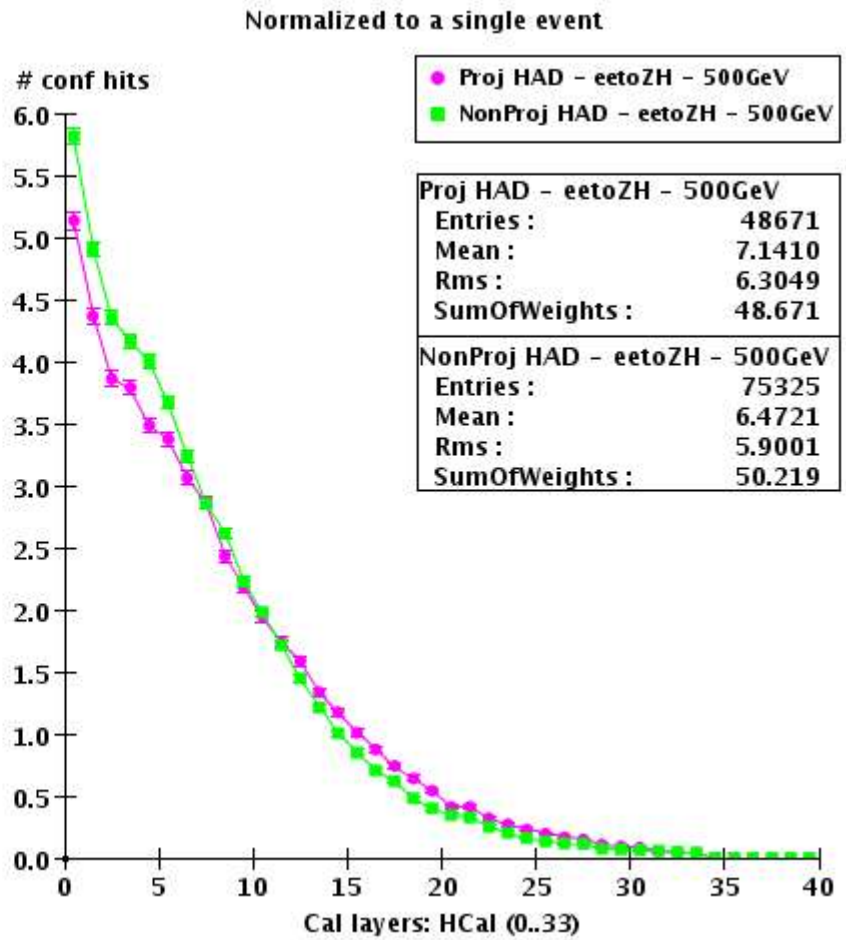




Distributions are quite similar.

Longitudinal distribution

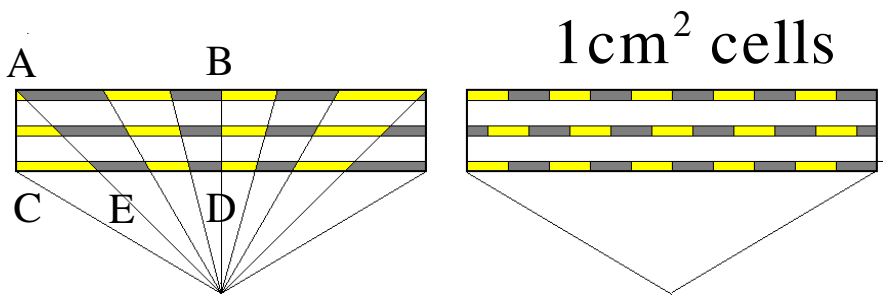




Most significant difference between proj and NonProj geometries!

Understanding the longitudinal distributions

- Can we reasonably explain these facts?
  - More high-multiplicity confusion hits in NonProj geometry
  - NonProj has more confusion hits in first few layers, and less confusion hits after layer 12

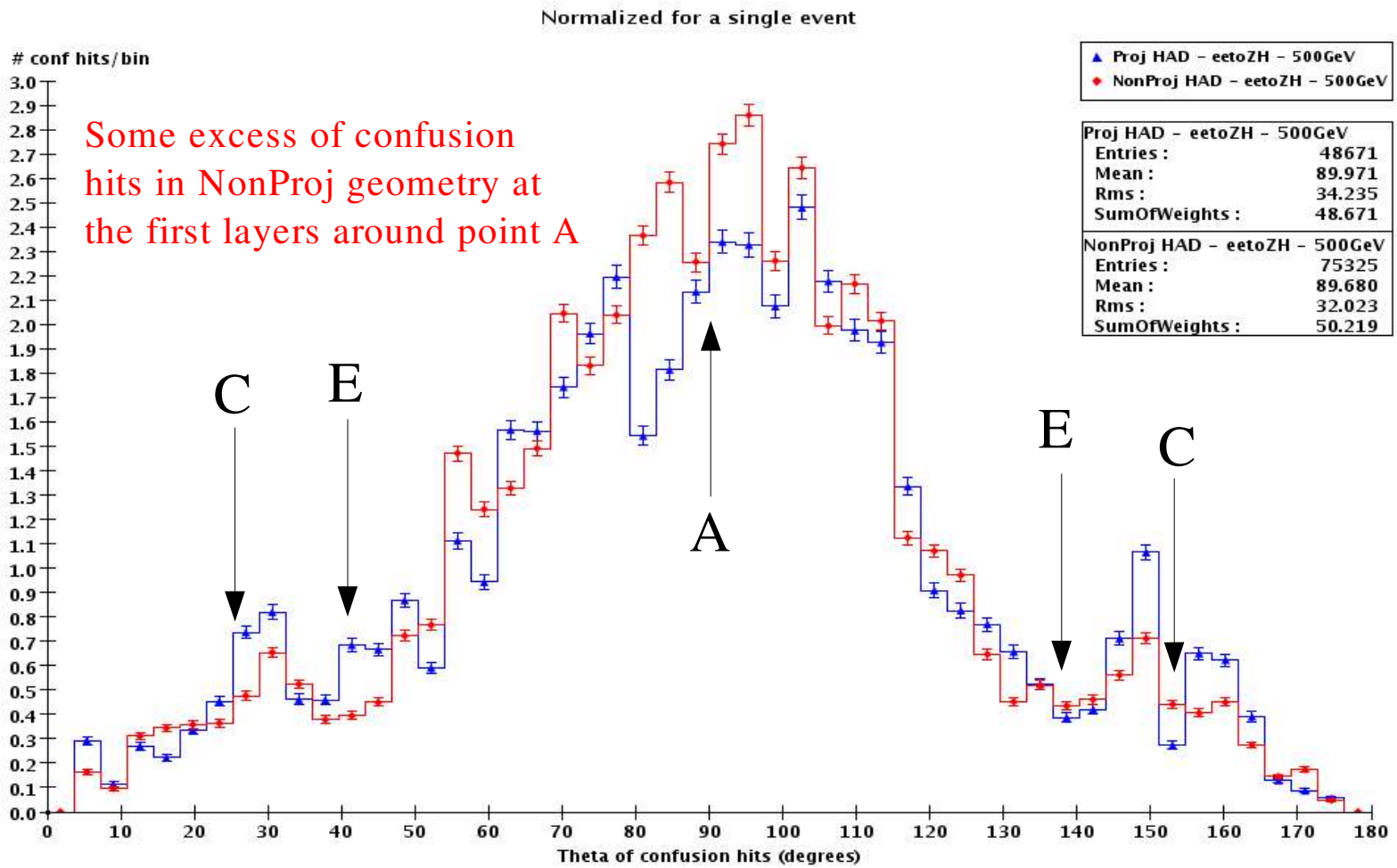


Cell sizes at points:
A: 1.975cm
B: 1.288cm
C: 1.677cm
D: 0.754cm
E: 1.000cm at $\theta = 41.1°$

Things to consider

- Inner layers are busier than outer layers (low-E EM spray? Check em-had in HiContr plot)
- In busy regions, smaller cells may produce larger number of non-isolated confusion hits (check theta)
- In quieter regions, larger cells may see isolated confusion hits where smaller cells can better resolve the clusters and not see any confusion at all
- HCal endcaps are always projective!

Theta distribution of confusion hits



Next steps

- Understand some issues:
  - Cross-checks mentioned earlier
  - Some PDGIDs are set to zero
  - Conf hits w/undefined isolation (0/0)
- Look again at 1000 GeV events (more conf)
- Varying geometries and B-fields

That's all, folks!

Motivations for a PFA

- Linear Collider ⇒ precision studies of new physics at the TeV scale
- Goal: Significant improvement on Z- and W-mass resolution using multijet final states (~30%/√E)
  Typical energy resolution: 20%/√E (ECal), 80%/√E (HCal)
- Typical jet composition:
  - charged hadrons (~64% with $\sigma_p/p < 2\%$)
  - Photons (~25% with $\sigma_E/E < 15\%/\sqrt{E(\mathrm{GeV})}$)
  - neutral hadrons (~11% with $\sigma_E/E < 60\%/\sqrt{E(\mathrm{GeV})}$)

Particle Flow Algorithm

- A significant improvement on mass resolution can be reached if we can associate CAL energy depositions to each photons and to charged or neutral hadrons
- The association can be done using the so-called *Particle Flow Algorithms (PFA)*
- *PFA* requires high calorimeter granularity, to a point we can do particle tracking in the calorimeters