Update on PFA @ NIU

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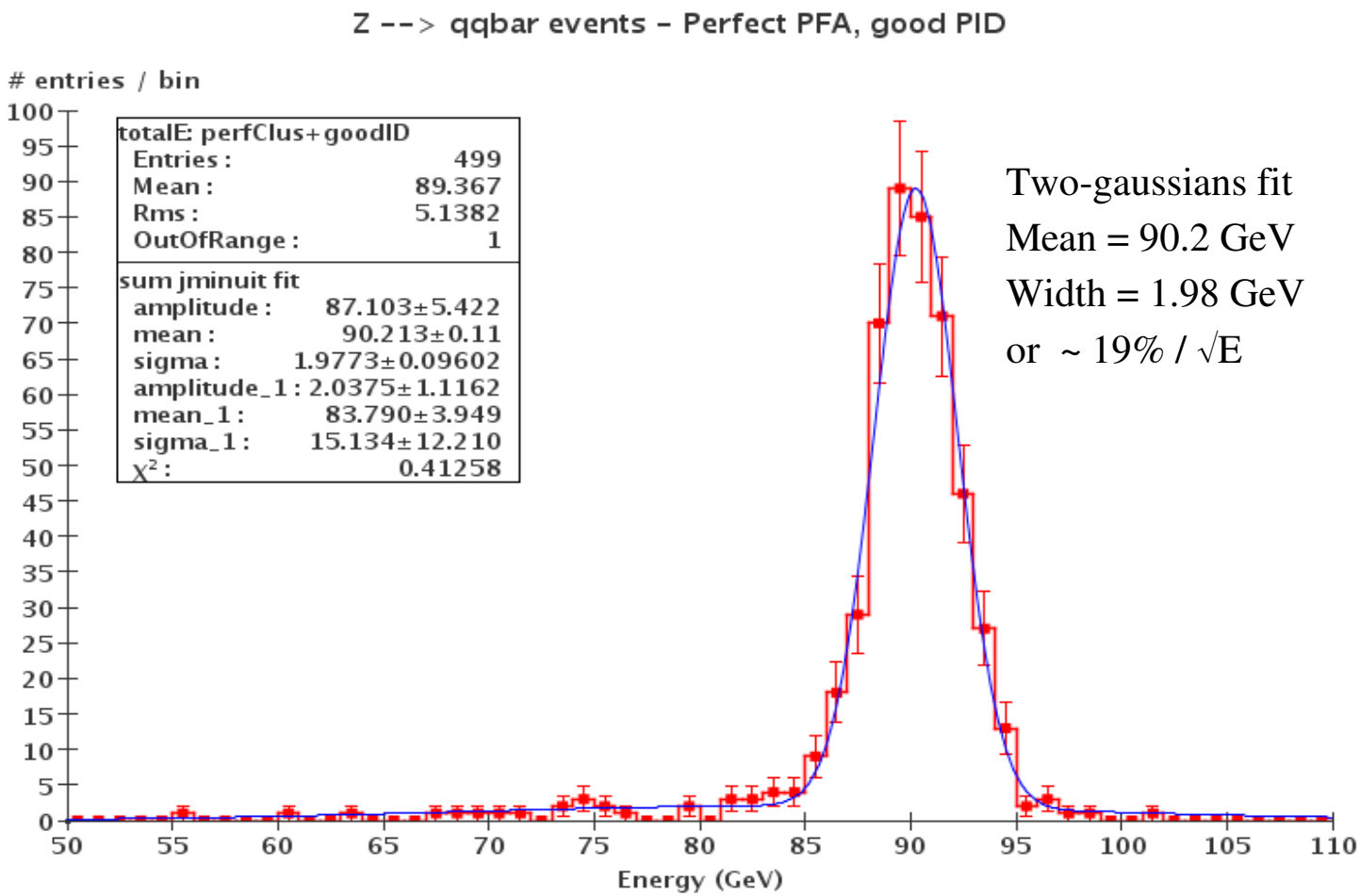
ALCPG Calorimetry Meeting
June 26, 2006

Updates since talk on Calor 2006

- Clear up some bug suspicions
- Remove some “LCIO non-standardness”
- Increased statistics
- Investigation on how to improve cluster ID

Perfect PFA: the ultimate, unattainable goal

- Perfect clusters: all hits coming from each generated Final State particle
- Good PID: use pion masses for all charged hadrons (incomplete Particle-ID)
- Calibrated by global particle type contributions
- Low-E tail is partially due to energy lost through beam pipe
- Further improvements are likely by using a more sophisticated calibration (angular and longitudinal corrections)

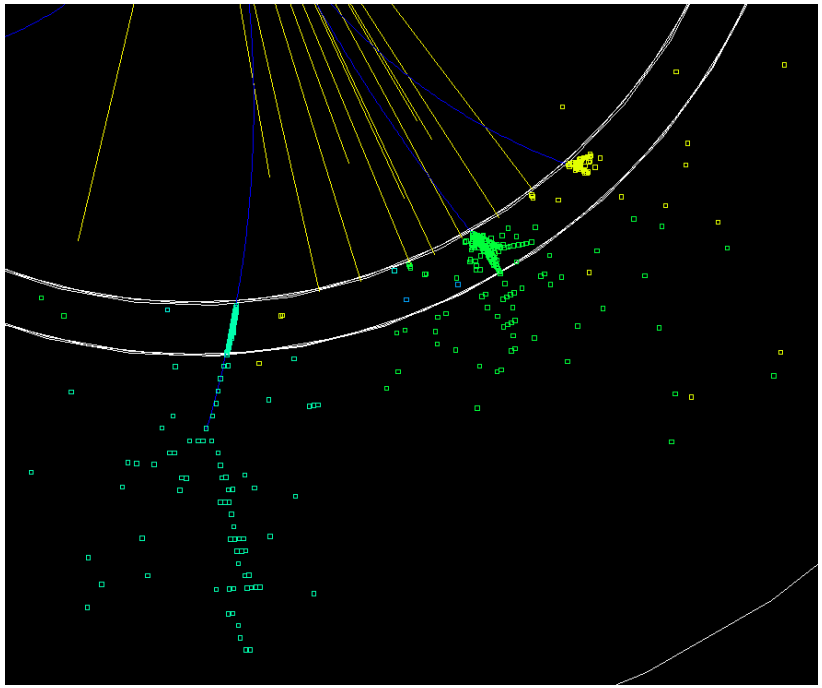


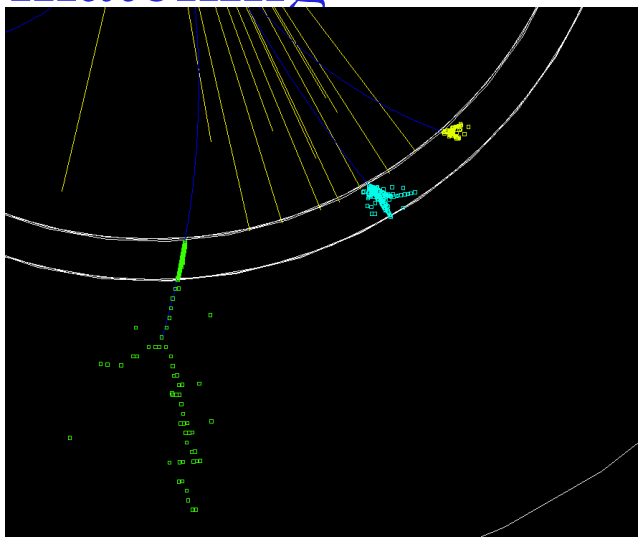
Developing a realistic Particle Flow Algorithm

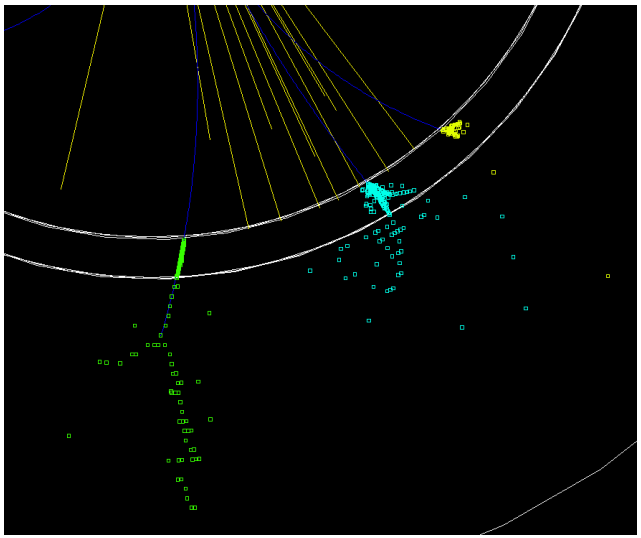
- Development based on:
  - Data: Z --> q $\bar{q}$ (light quarks) on sidaug05_tcmt geometry: SLIC v1.13 + Geant4 v8.0.p1
  - Java-based framework (org.lcsim) and the directed tree clustering algorithm

- Algorithm description:
  - Inputs: Directed tree clusters in ECal and HCal, reconstructed tracks
  - Track extrapolations --> track-cluster associations --> seeds for charged clusters
  - Photon-ID: use an Hmatrix (longitudinal cluster profile) --> seeds for photon clusters
  - Shower pattern recognition: algorithms to merge clusters based on cluster shapes and distances
  - Remaining clusters: sorted by size/energy --> seeds for neutral hadron clusters
  - Low multiplicity fragments are discarded (reduce confusion, but degrades final resolution)

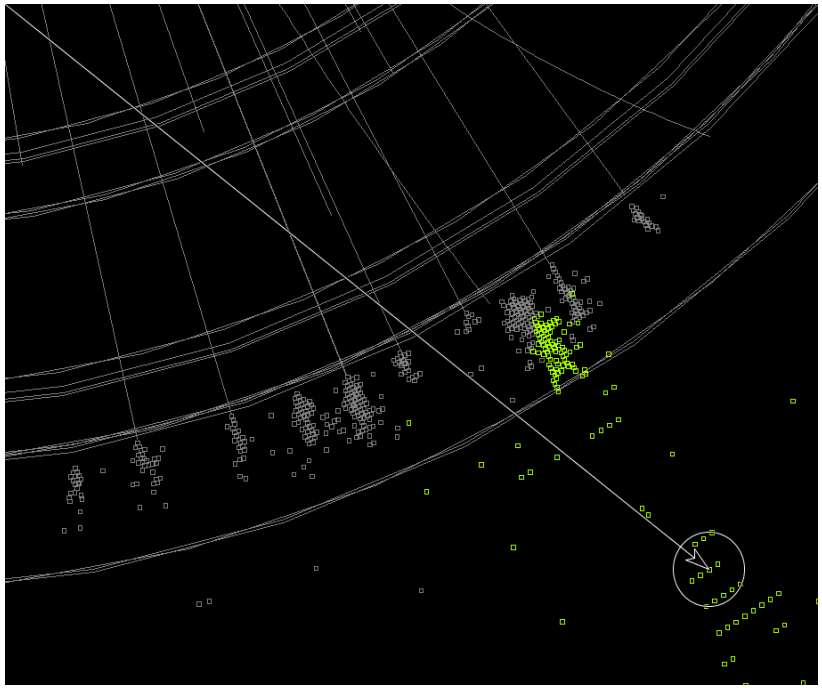
Cluster ID: Track matching

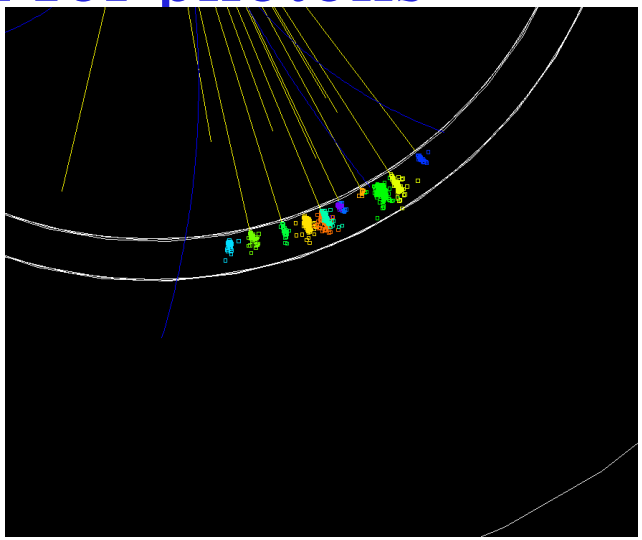


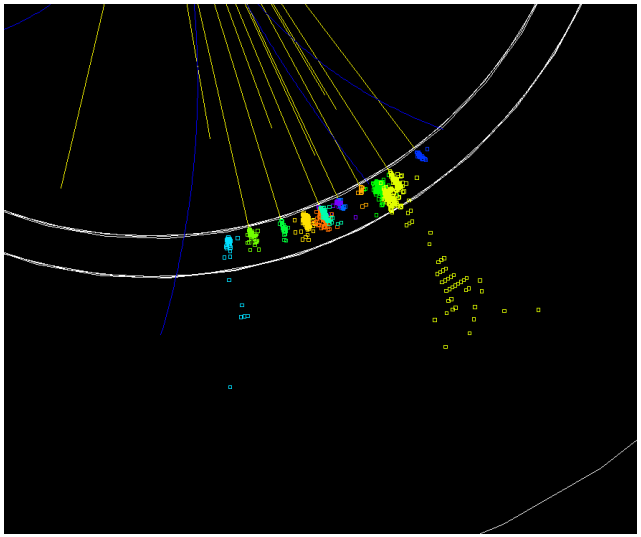




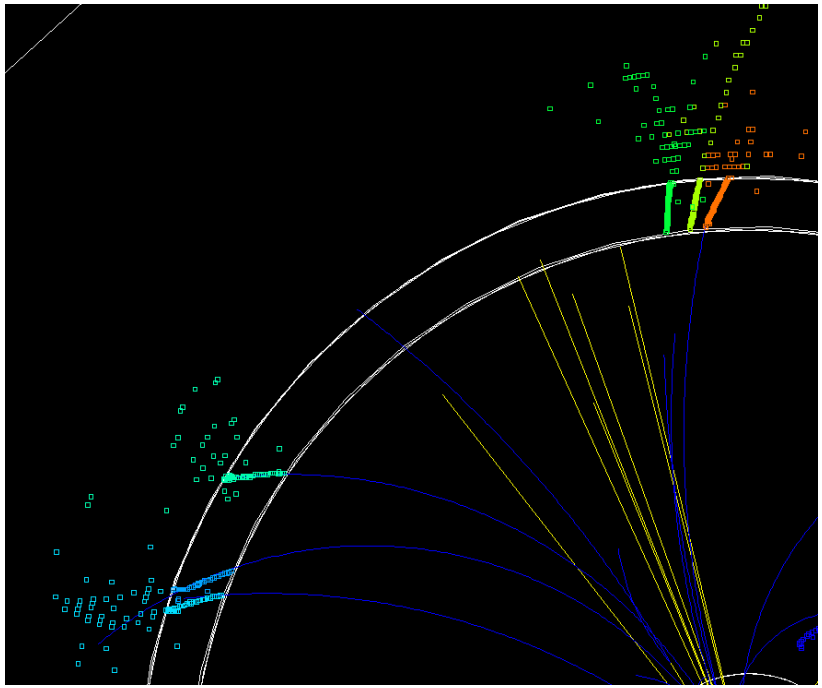
Cluster ID: H-Matrix for photons

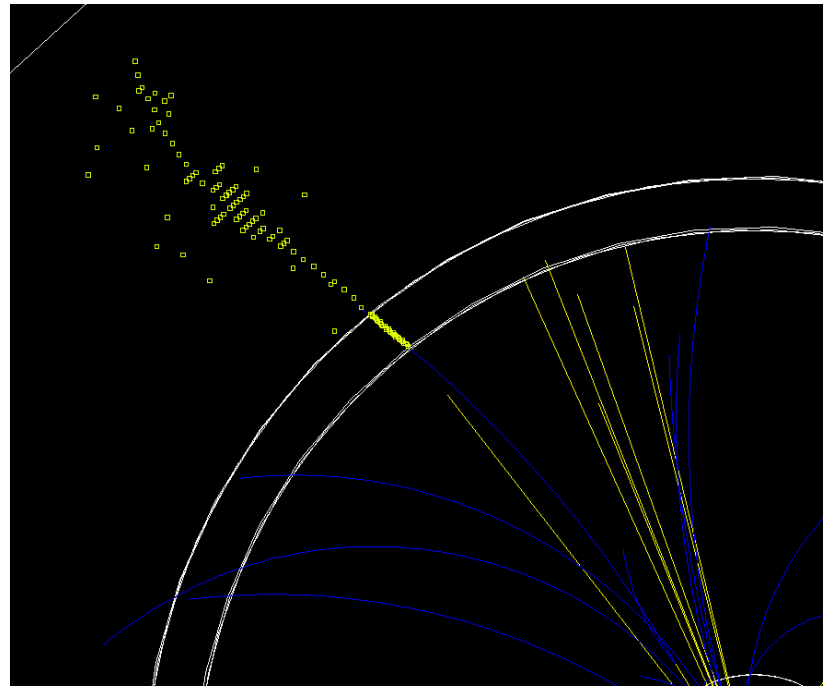




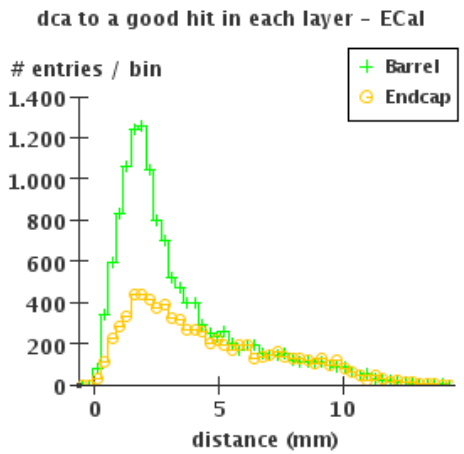


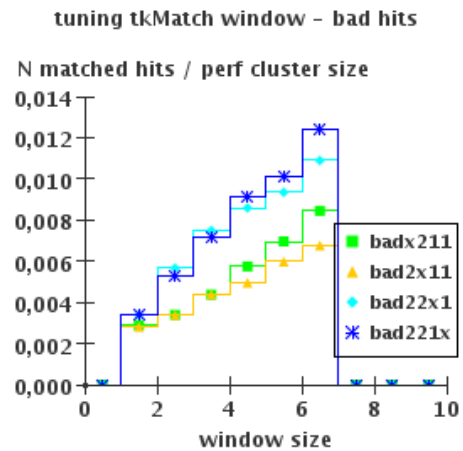
Cluster ID problem: a badly missed charged cluster

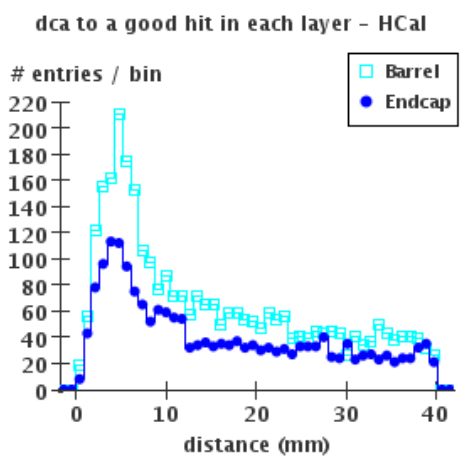


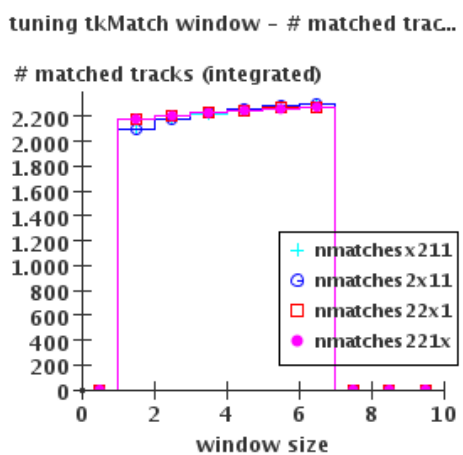


Optimizing the track matching window





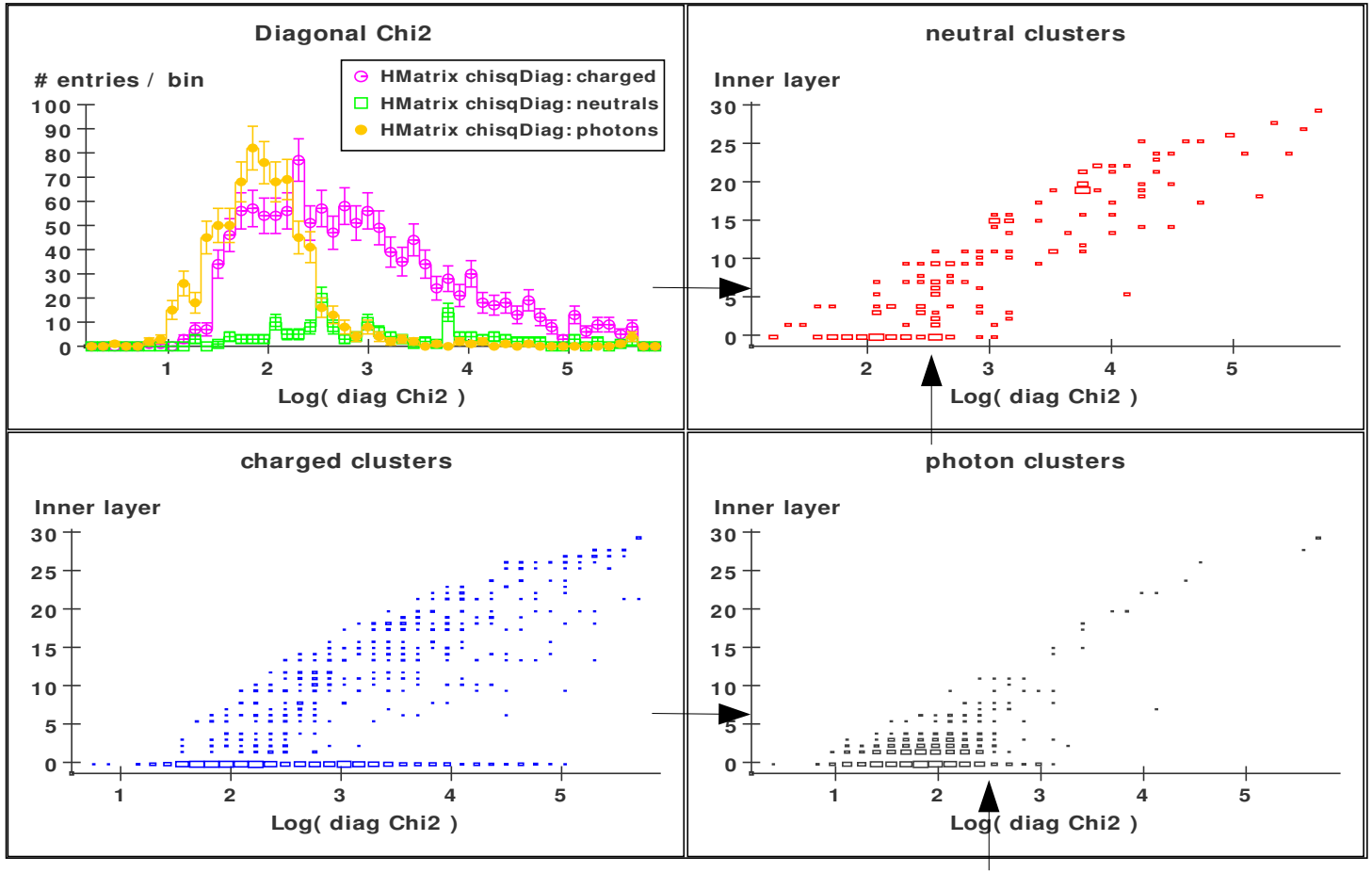




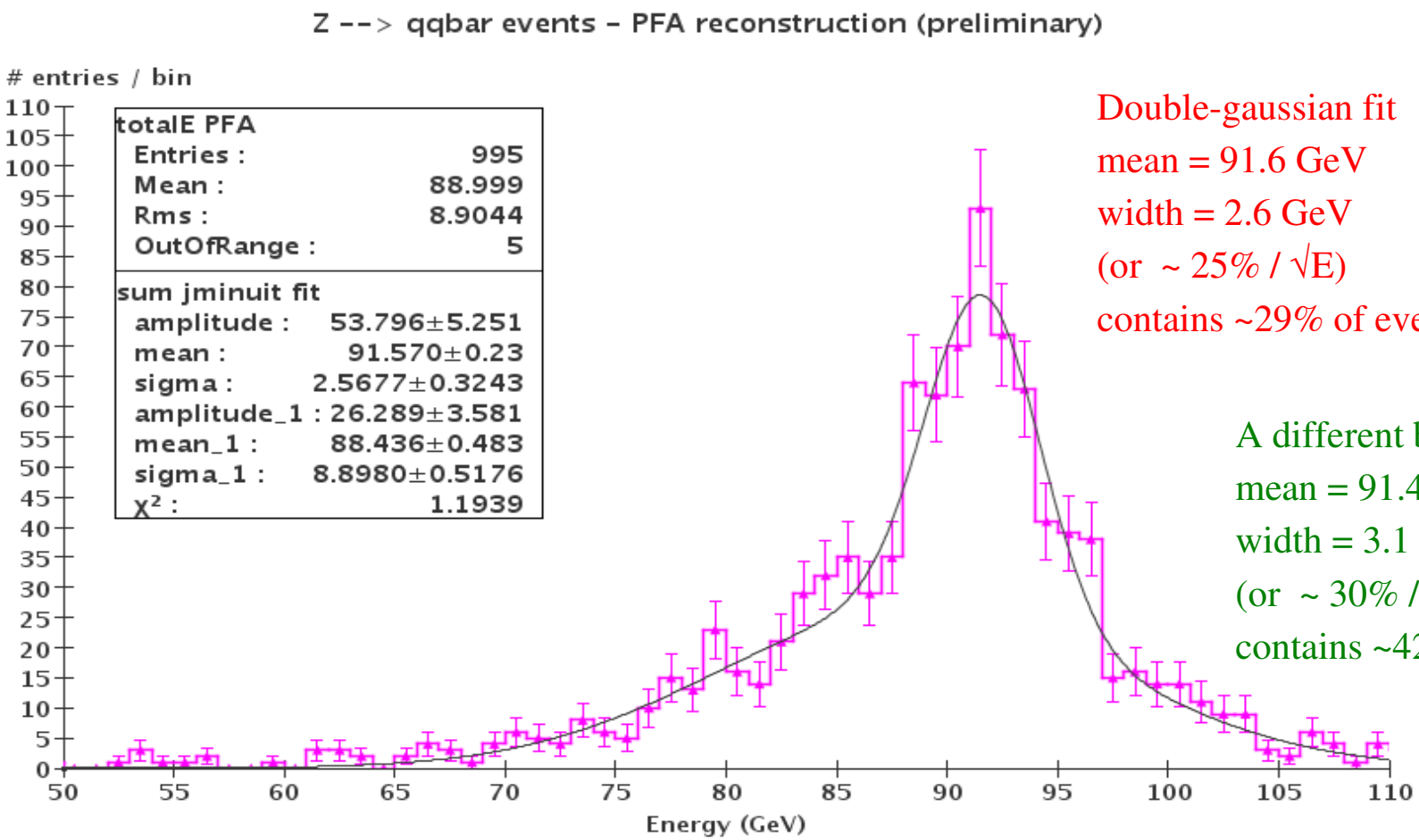
- A +/-1 window seems to be enough for good track matching in Ecal, but going to +/-2 still gets more good than bad hits
- Track matching window selected:
  +/-2 in ECal (each unit --> 5mm)
  +/-1 in HCal (each unit --> 10mm)

Photon-ID: longitudinal H-Matrix

- H-Matrix is not yet fully optimized, so there is room for improvements
- Lowest layer hit in clusters provides further γ - h^0 discrimination
- Photon selection:
  $\log(\chi^2_{diag}) < 2.5$
  lowLayer <= 6



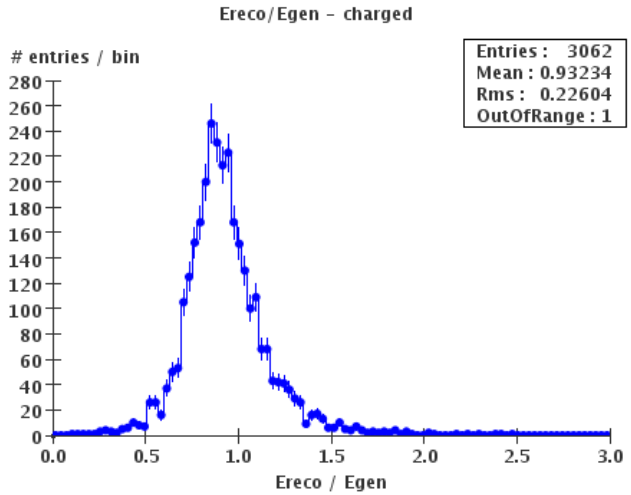
Current PFA status

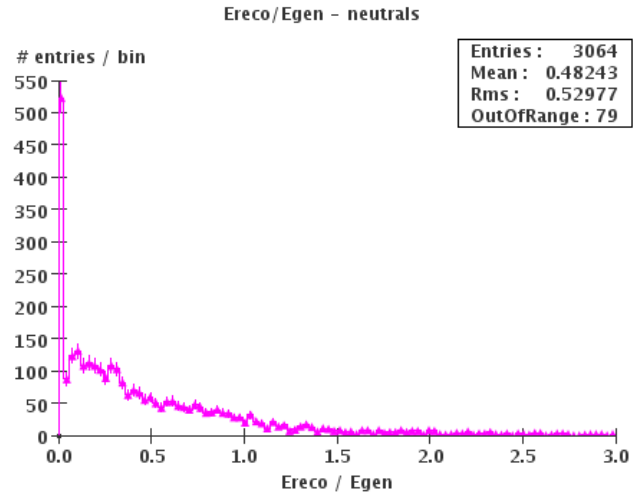


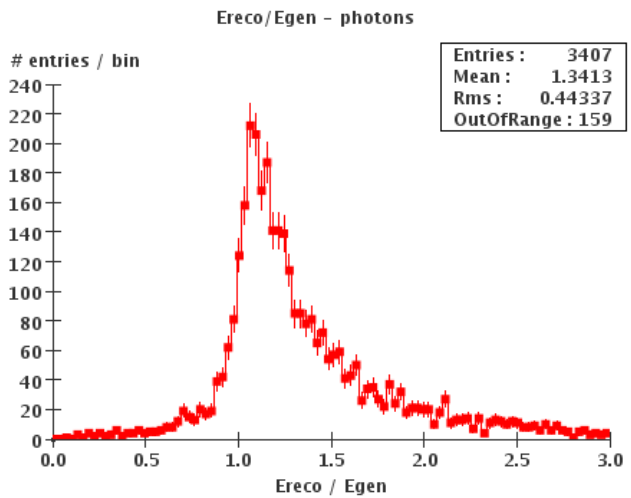
Double-gaussian fit
mean = 91.6 GeV
width = 2.6 GeV
(or ~ 25% / √E)
contains ~29% of events

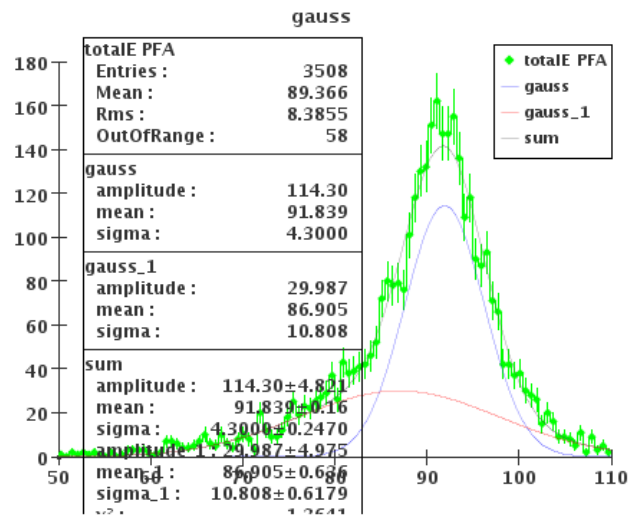
A different binning:
mean = 91.4 GeV
width = 3.1 GeV
(or ~ 30% / √E)
contains ~42% of events

More statistics









Summary and outlook

- All the basic tools needed for a full PFA are in place (ALCPG Java-based framework)
- Big effort to develop code which is independent of geometry
- Preliminary results are encouraging (in the PFA-sense), but a lot of optimization still needed
- Things to do:
  - Investigate origin of misidentified clusters and how to improve cluster identification
  - Use tail catcher information to improve jet energy resolution (important for jetE > 75 GeV)
  - Further calibration corrections (dependency on energy, particle type, incidence angle and interaction layer)
  - Comparisons to other people's results (standard geometries)
  - Investigate PFA at higher energies and more complex physics processes (WW, ZH, etc)
  - Comparisons for different geometries, B-fields and technologies