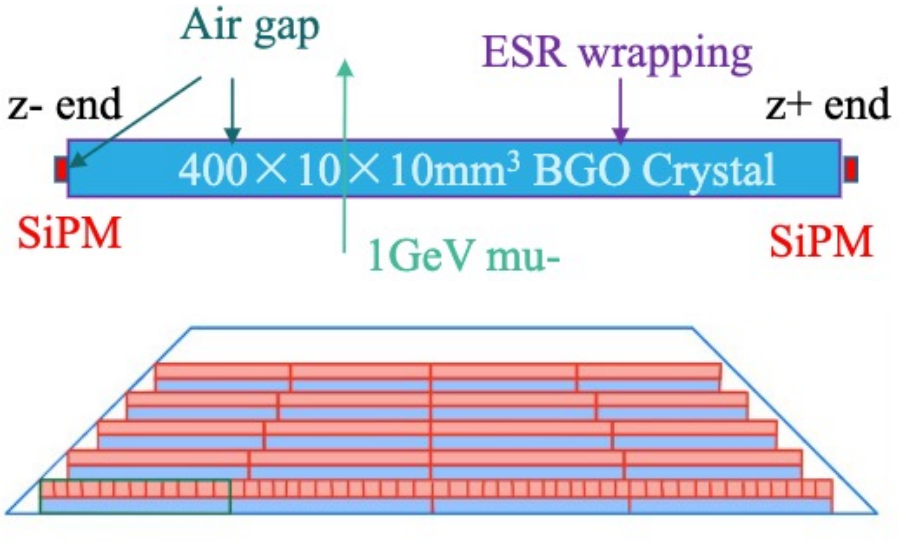
Ecal Reconstruction algorithm

Previous remind

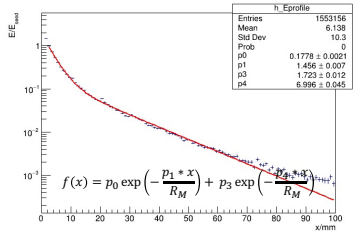
Input: Digitalized crystal bars.

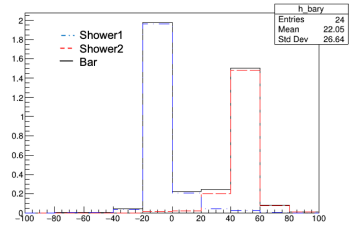
- Time resolution: 0.5 ns smearing (~0.3 ns in readout).
- Fired energy threshold: 100 keV.
- Attenuation length: ∞.
- Calibration: not considered.



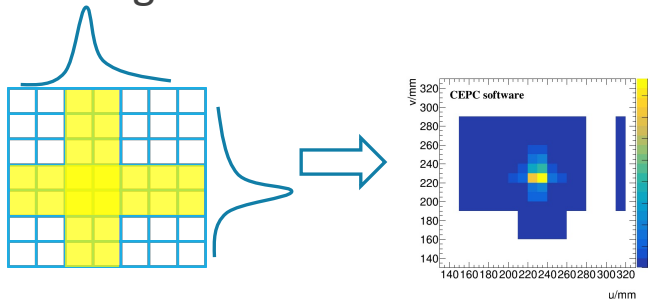
Reconstruction:

- 1D clustering & cluster splitting:
  - "Seed" in 1D cluster: local maximum && E>5MeV (~0.5MIP).
  - If ≥ 2 seeds in one cluster: split with transverse profile.

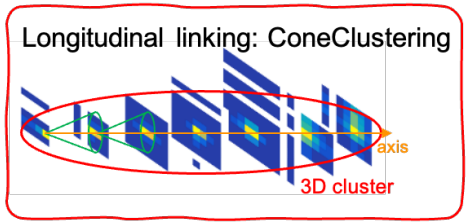




- 2D matching: match X-Y bars to showers in plane:



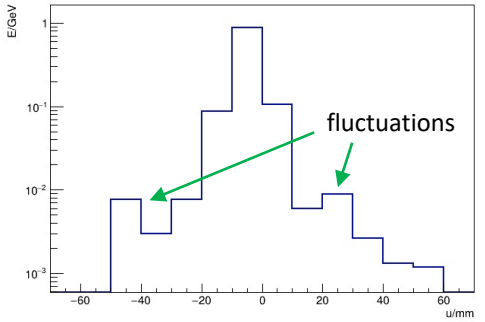
- 3D clustering:

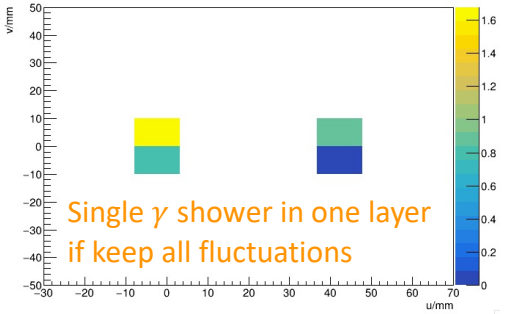


Issues in reconstruction

Issue 1: Fluctuation in 1D clustering.

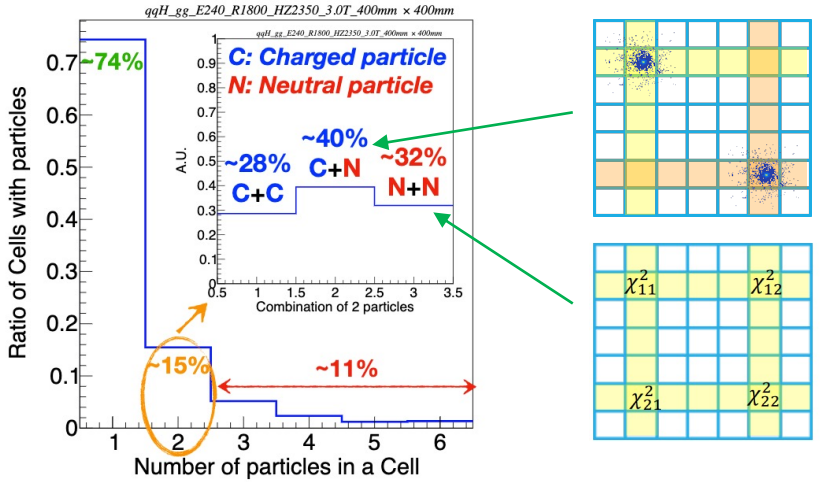
- Solution: longitudinal information: fluctuation would not appear in the same position in 2 layers.
- Sub-issue 1.1: little showers (e.g. MIP beside an EM shower) is easily to be regarded as fluctuations
  - Solution: use track information to confirm the little shower.





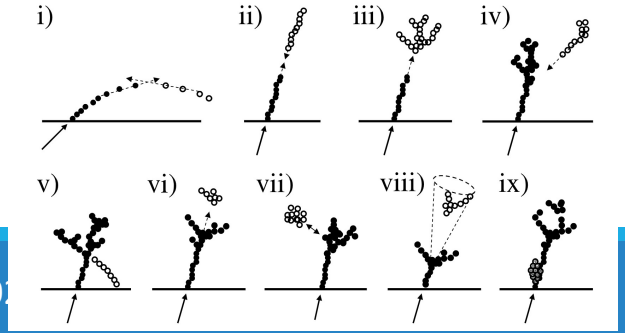
Issue 2: X-Y Matching in layer (ghost hit problem)

- Solutions: (ordered by priority)
  - Track information.
  - Longitudinal information.
  - Timing information: chi2 matching.

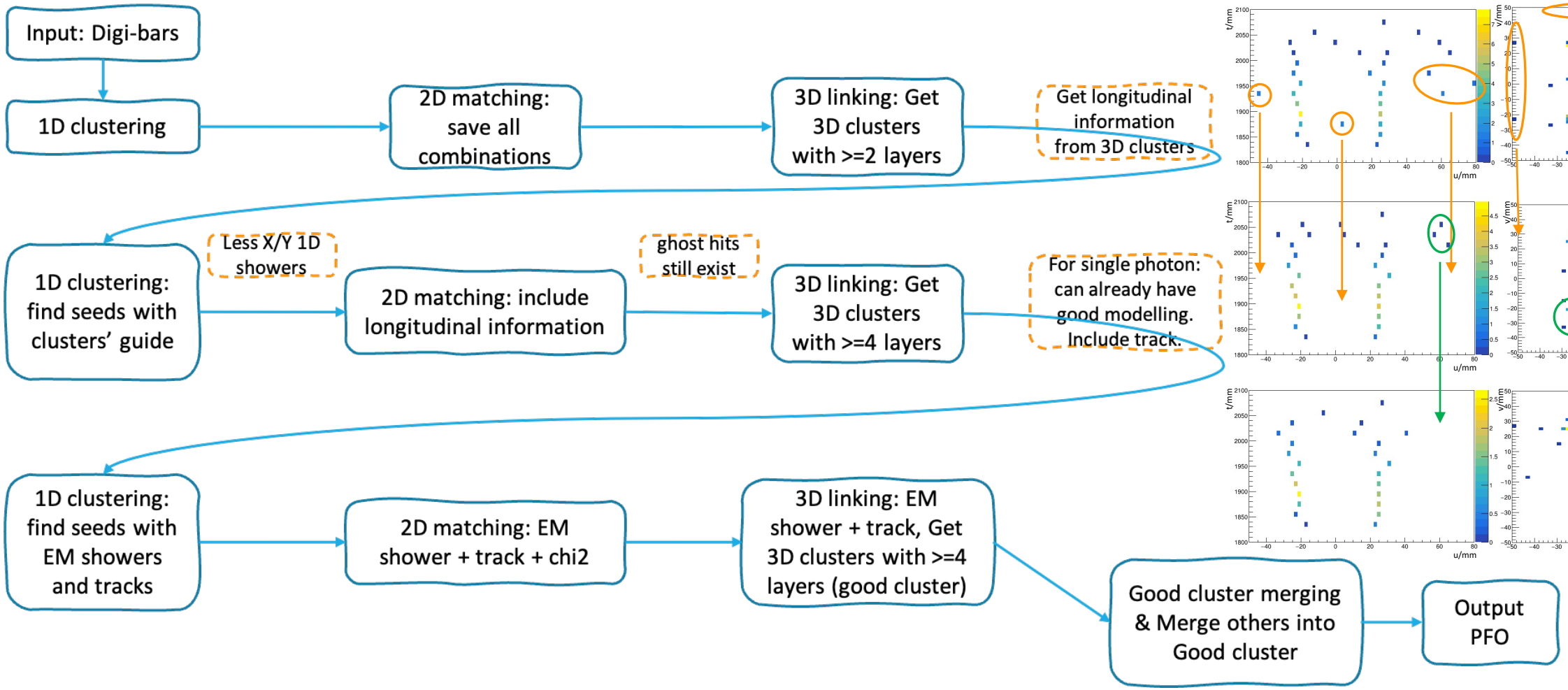


Issue 3: 3D cluster association

- Solution: Merge with topology one by one (undergoing).

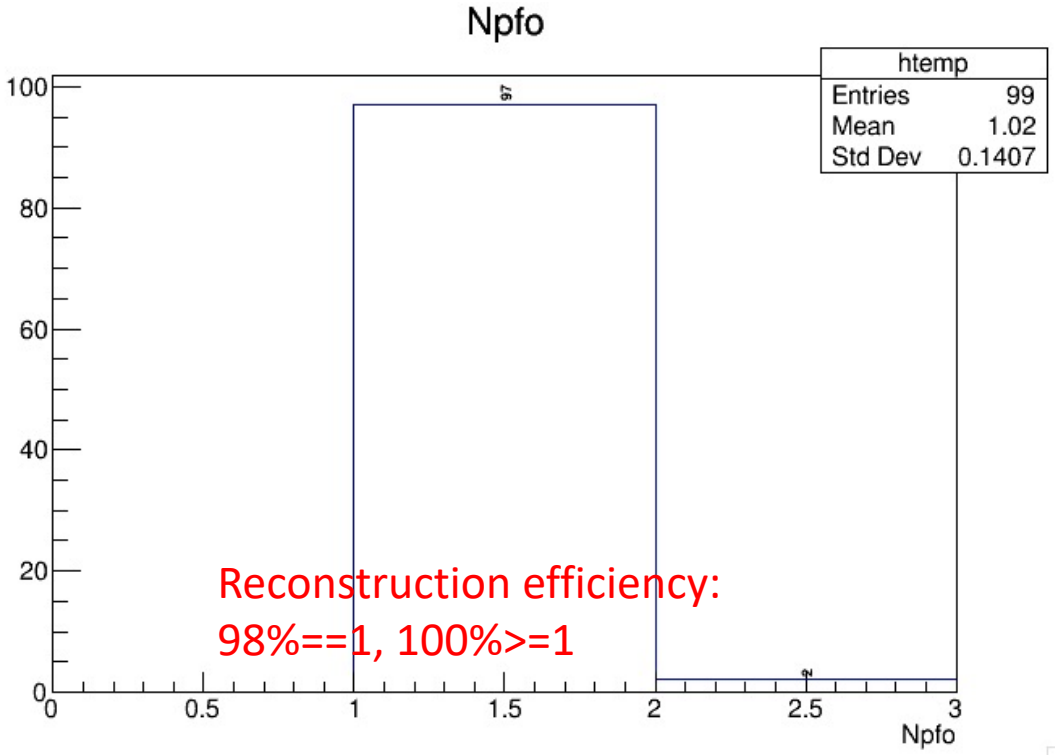


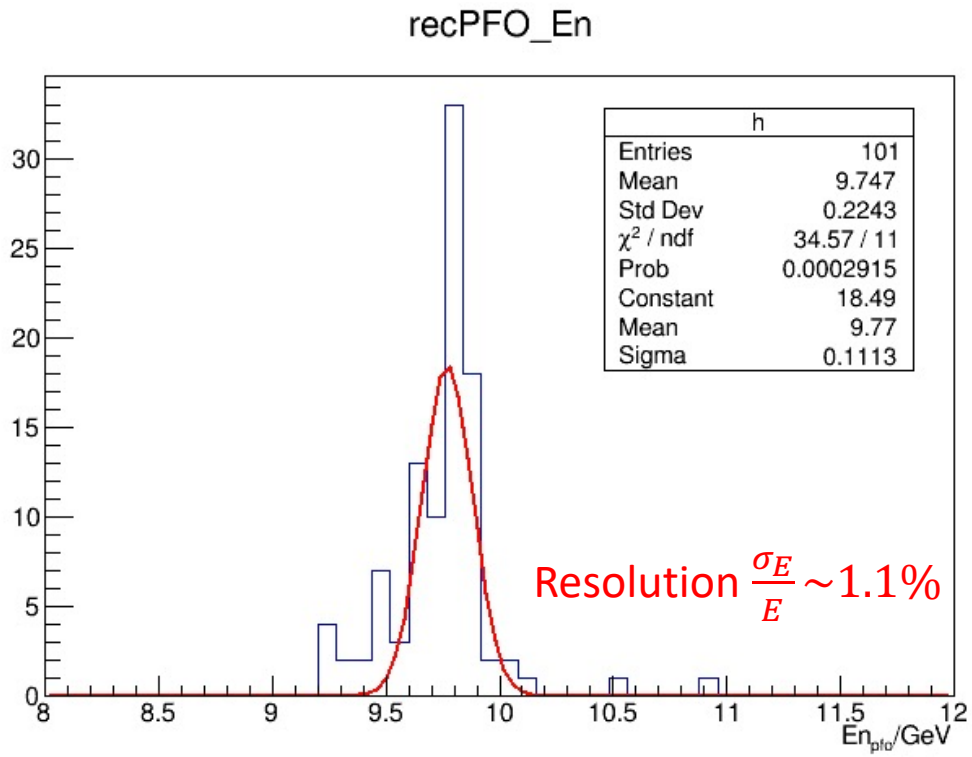
Final reconstruction flow



Reconstruction performance

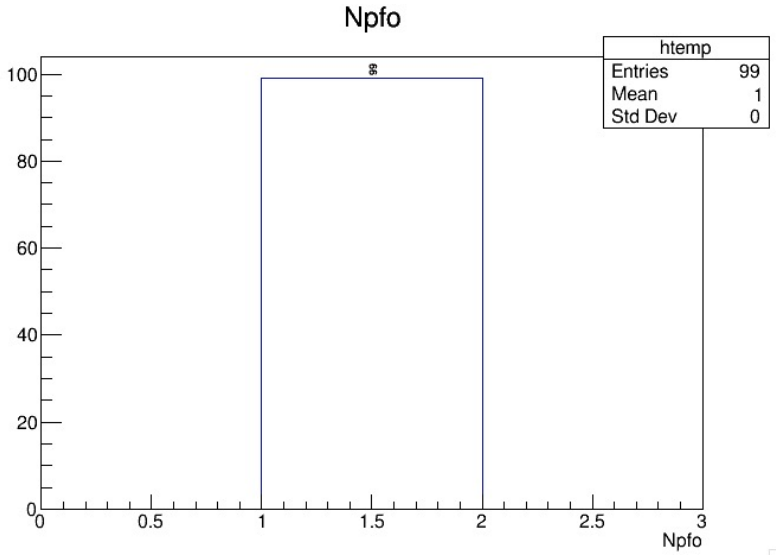
Single Photon, 10GeV



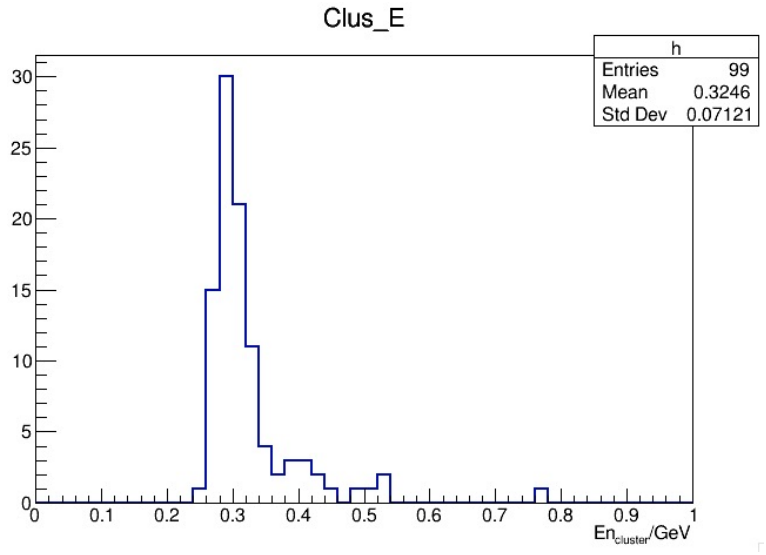


Reconstruction performance

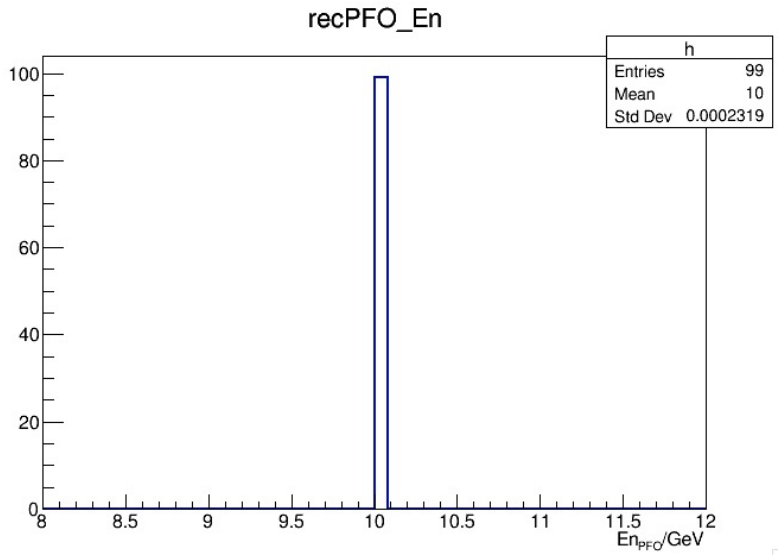
Single Muon, 10GeV, no magnetic field.



Reconstruction Efficiency: 100%



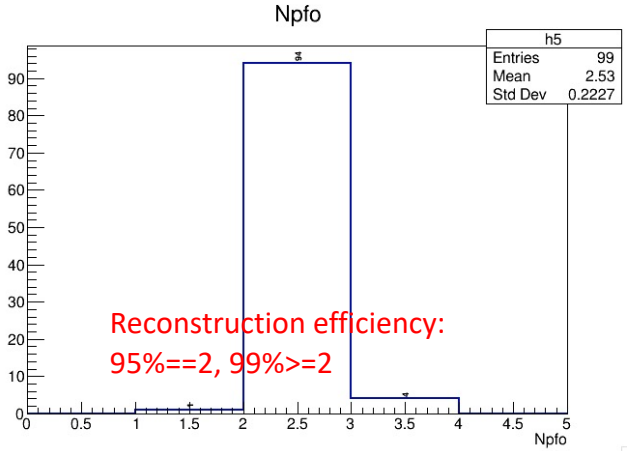
MIP cluster energy: ~0.3GeV



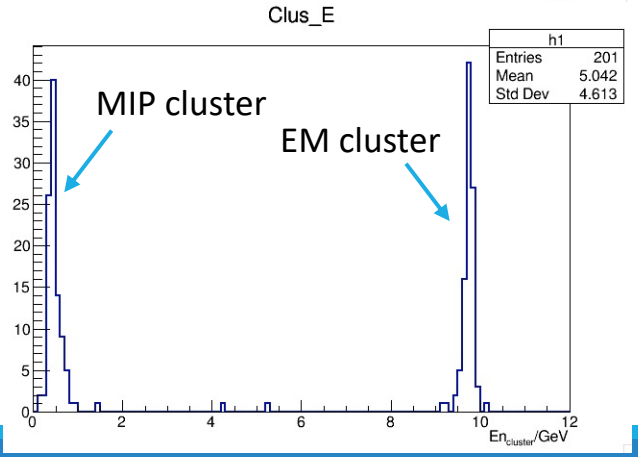
PFO energy: truth track P if cluster matches the track.
Match efficiency ~ 100%.

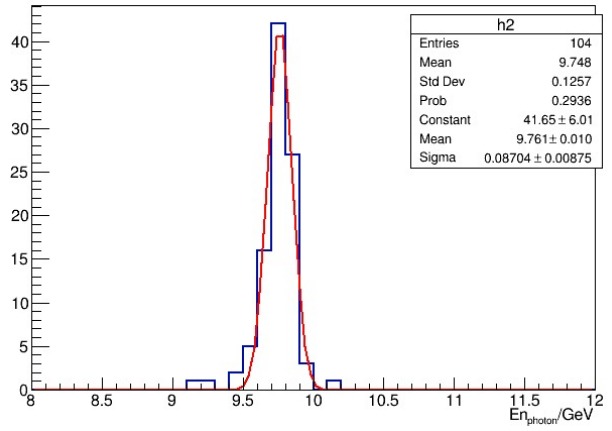
Reconstruction performance

10GeV photon + 10GeV muon, $\Delta x = 5cm$.

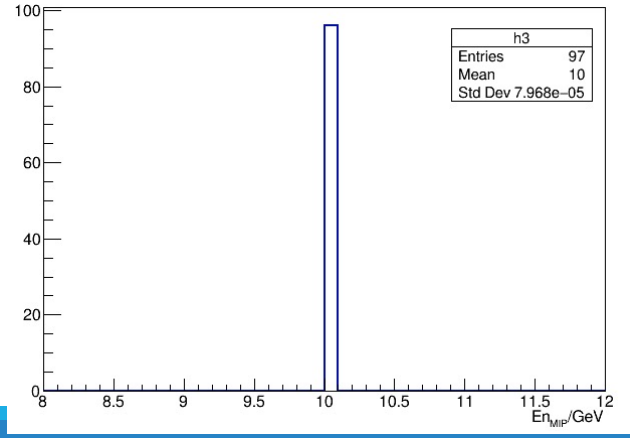


Reconstruction efficiency:
95%==2, 99%>=2





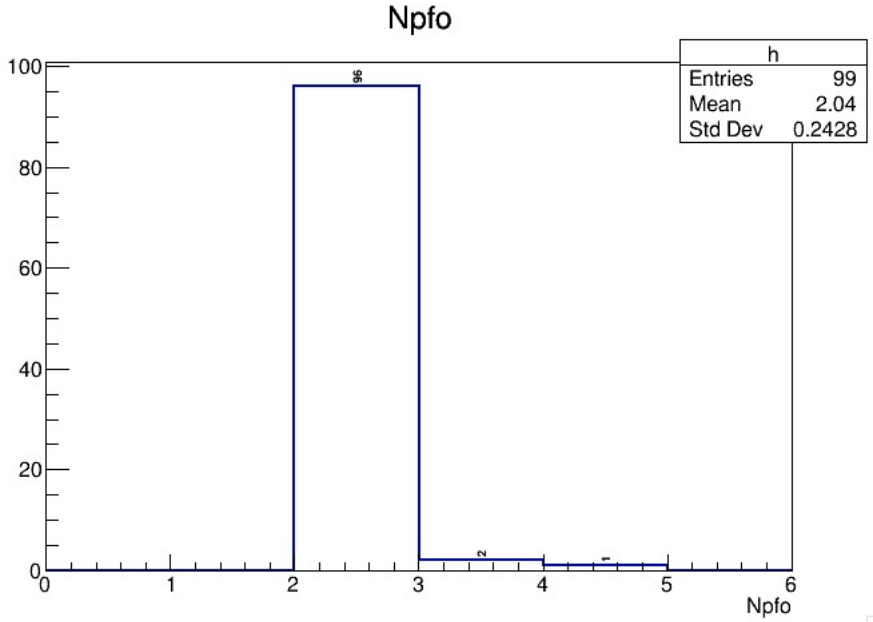
Neutral object energy: $\sigma_E/E \sim 0.9\%$



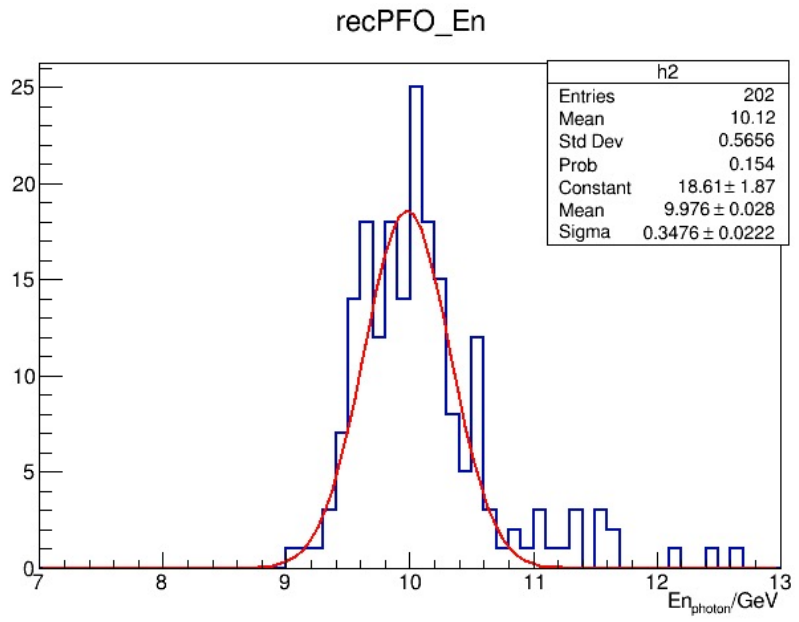
Charged object: E=P=10GeV

Reconstruction performance

10GeV photon + 10GeV photon, $\Delta x = \Delta y = 5cm$



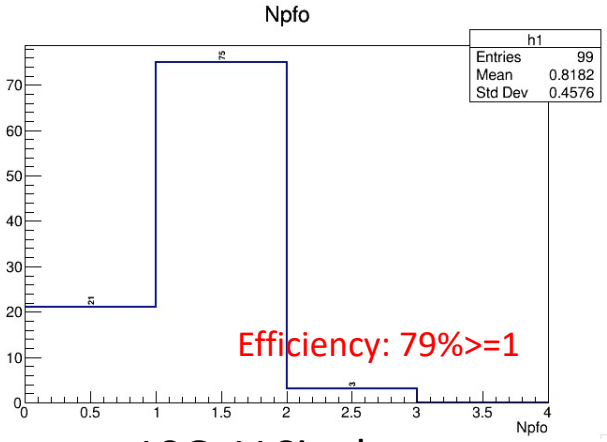
Reconstruction efficiency:
97%==2, 100%>=2



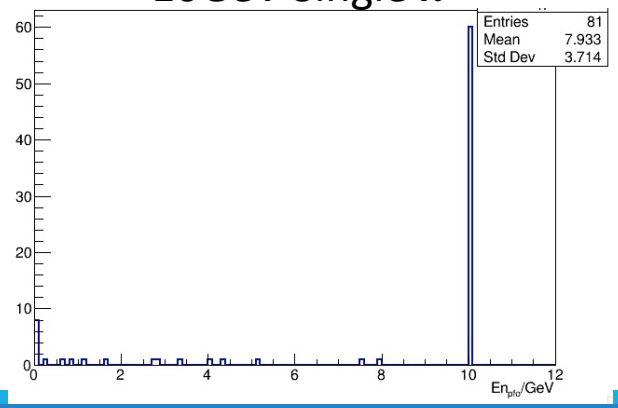
Di-photon energy resolution:
$\sigma_E/E \sim 3.5\%$(confusion between 2 gamma)

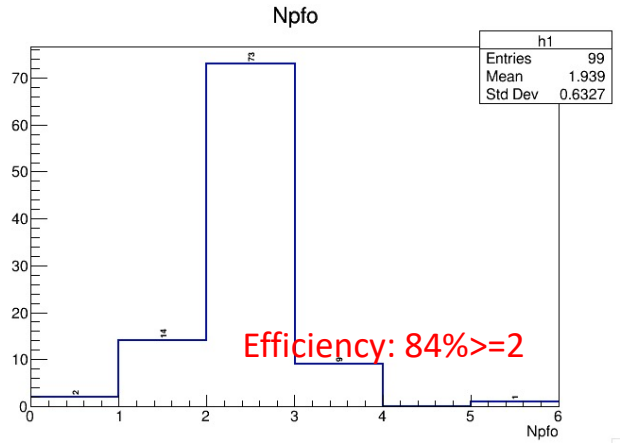
Reconstruction performance

Hadrons: Need further study

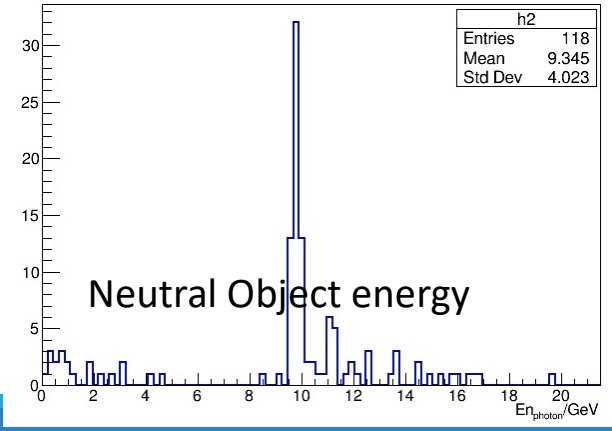


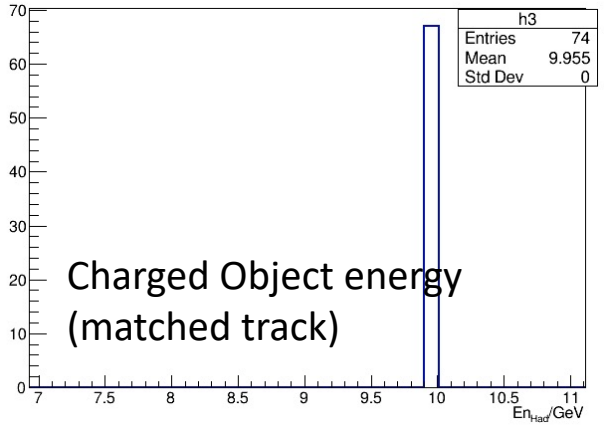
10GeV Single π^-





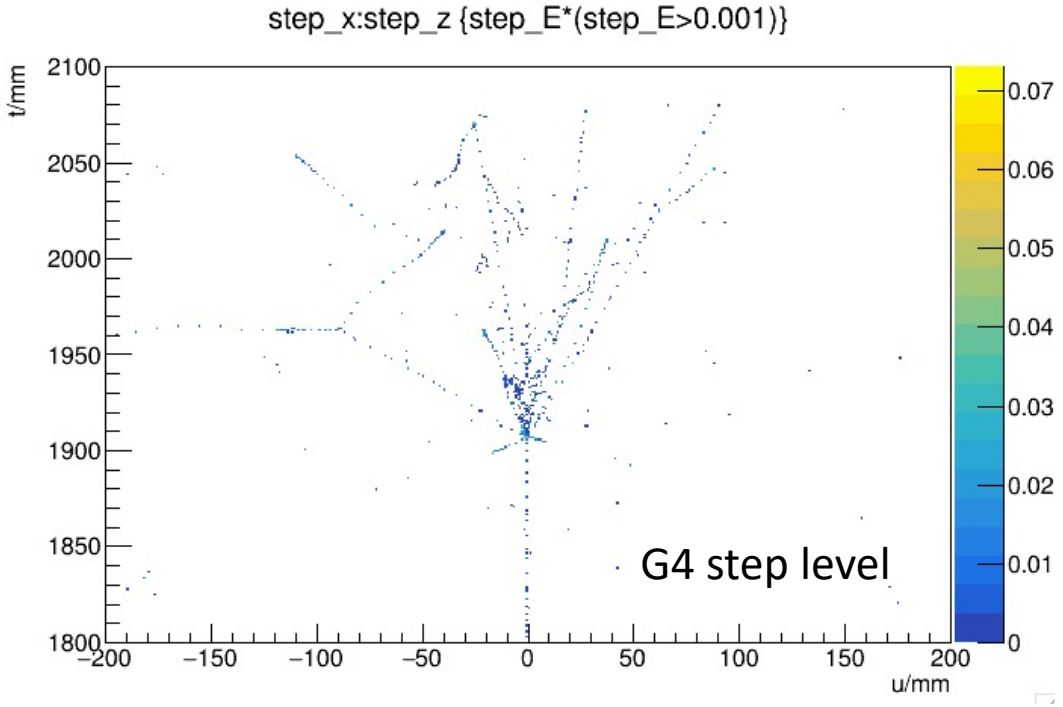
10GeV π^- + 10GeV γ, d=10cm

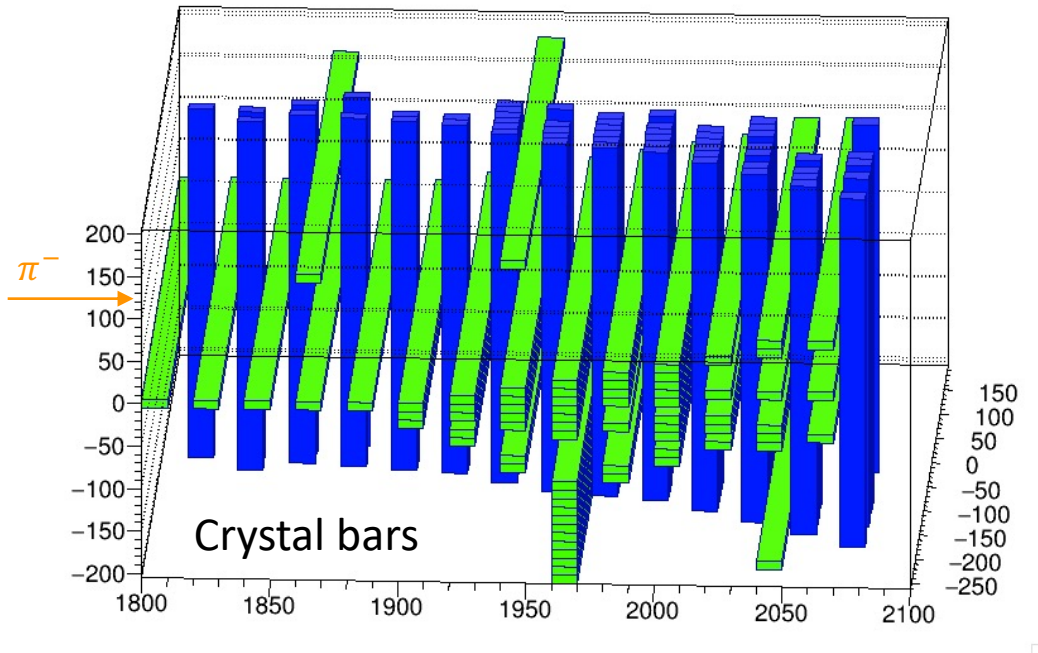




Performance check

Hadrons: event display of π^-





Summary

Level 1: single photon, single muon (MIP)

- ~100% efficiency, energy resolution ~1% for 10GeV (stochastic term ~3%).

Level 2: γ + muon, $\gamma + \gamma$ (ghost hit problem)

- >95% efficiency, σ_E/E~1% in γ + muon, σ_E/E~3.5% in $\gamma + \gamma$ (confusion term).
- No ghost hit appears.

Level 3: hadrons

- Single hadron: 20% lost the object.
- $\gamma + \pi^-$: 16% lost objects, 1% have multiple objects.
- Need to consider hadronic cluster identification and merging.

Next step

Hadronic shower:

- Shower modelling, merging, ghost hits with hadronic showers(complex case).

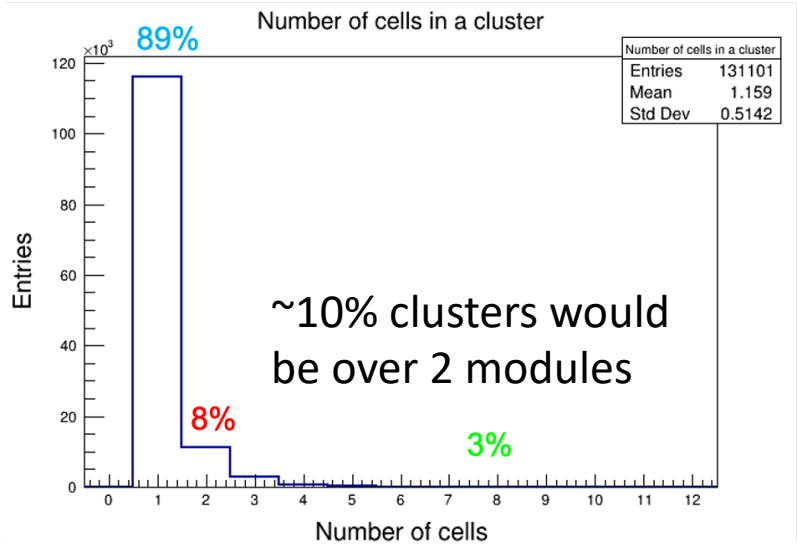
Jet reconstruction:

- Option1: depart clusters into fine granularity hits (1*1*2, e.g.), use Pandora/Arbor for jet reconstruction.
  - Pros: convenient, compatible for Hcal reconstruction.
  - Cons: lost precision from energy splitting with profile.
- Option2: finalize this new PFA
  - Need to deal with:

    Cluster merging algorithm.

    Cluster cover >=2 modules, gaps in detector.

    Hcal reconstruction: link with Arbor clusters.



Final reconstruction flow