Arbor status and update

MA Binsong

2016/03/27

Outline

- Introduction of reconstruction with Arbor
- Arbor_v3_KD version update
- Sample validation
- Neutral particle energy estimator
- Conclusions and outlook

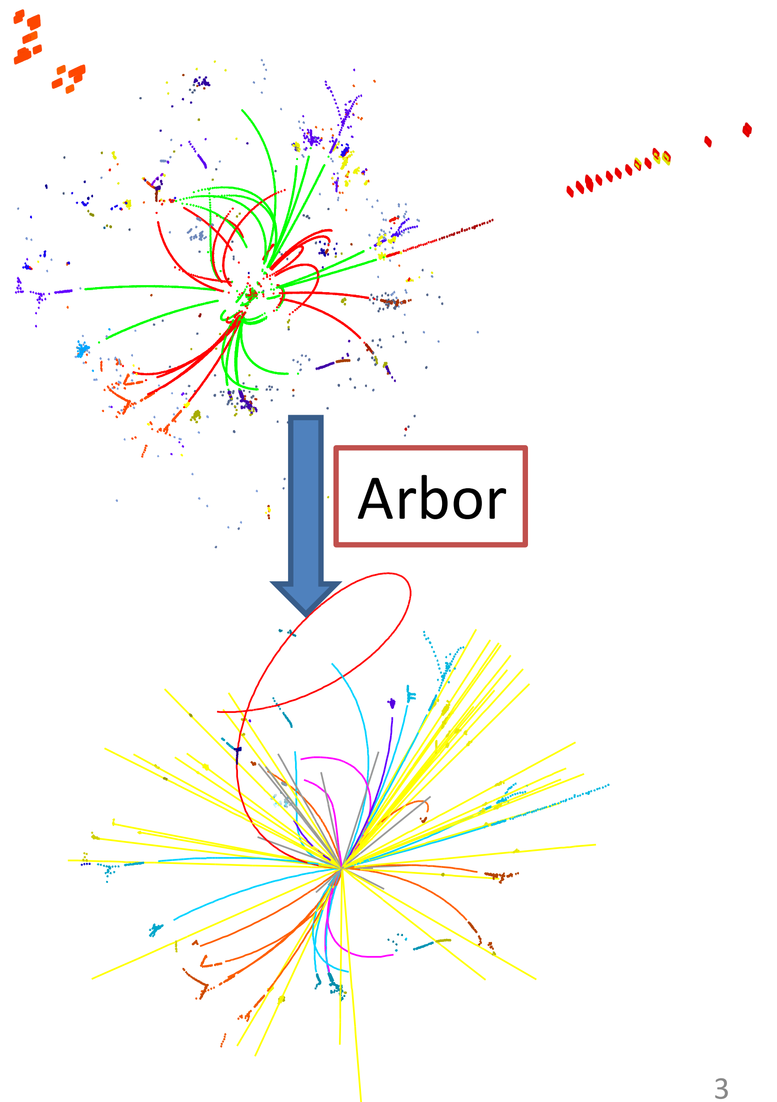
Introduction of Arbor

- Goal: reconstruct all the visible final state particle and give a precise momentum and particle identification

- Input: calorimeter hits, tracks

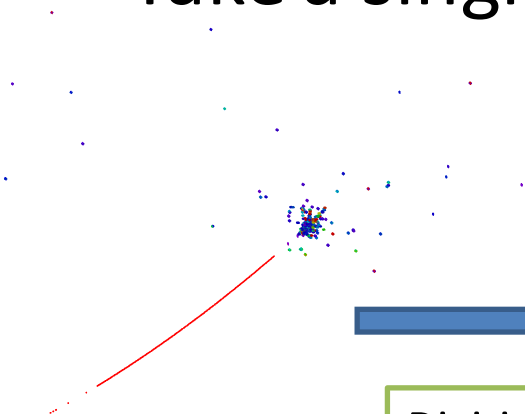
- Output: Arbor PFOs, including the cluster and the track information and its ID

- Example: an ep→vvH H →gg event



The chain of Arbor reconstruction

- Take a single Pion plus at 10GeV for example



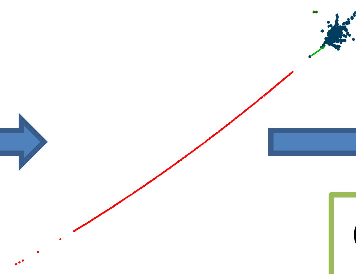
Simu calo hits

Tracks from central tracking system

Digitization

Hit selection

Form the selected hit to do the clustering



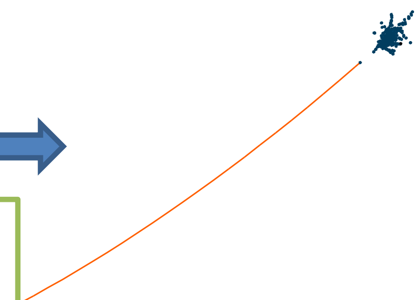
clusters

Tracks

Cluster and cluster matching

Cluster and track matching

Particle ID



Arbor PFOs

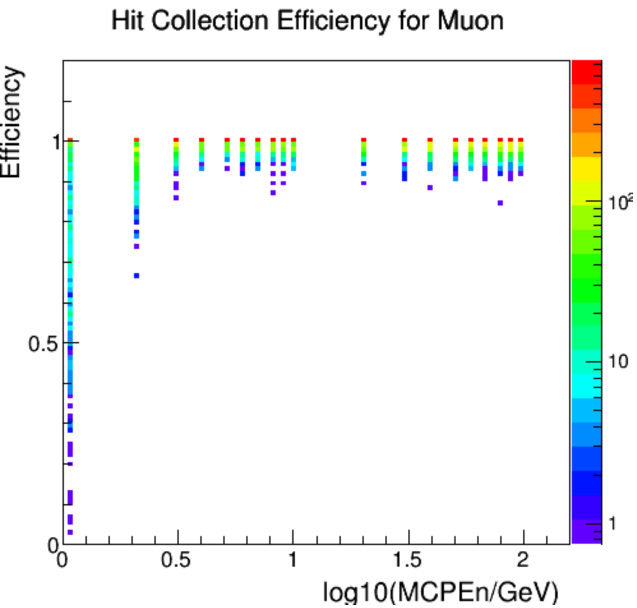
Arbor_v3_KD version update

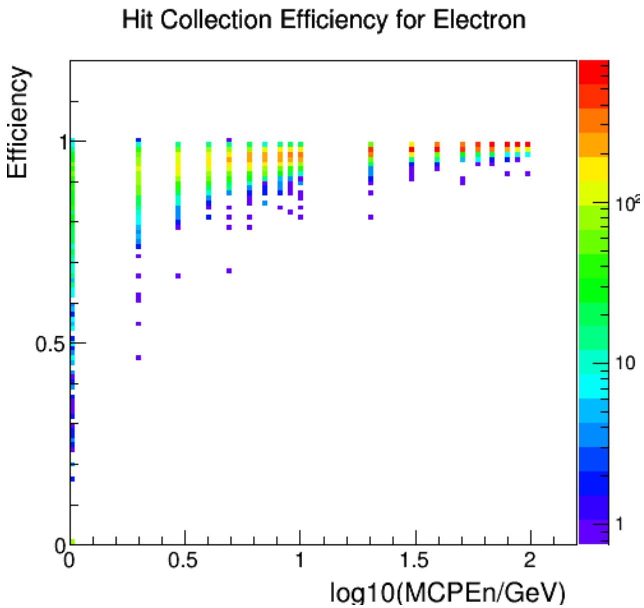
- Using K-Dimensional tree methods to reduce the calculation time of the Arbor core code.
- Add a cluster self-merge process to reduce the reconstructed neutral object, especially the photon split.
- Fix some existing bugs.
  - At the closest cluster finding level: add a cut for Ncircles to make sure the matched cluster is close to the first circle of the helix.
  - Fix some cluster protection bugs.

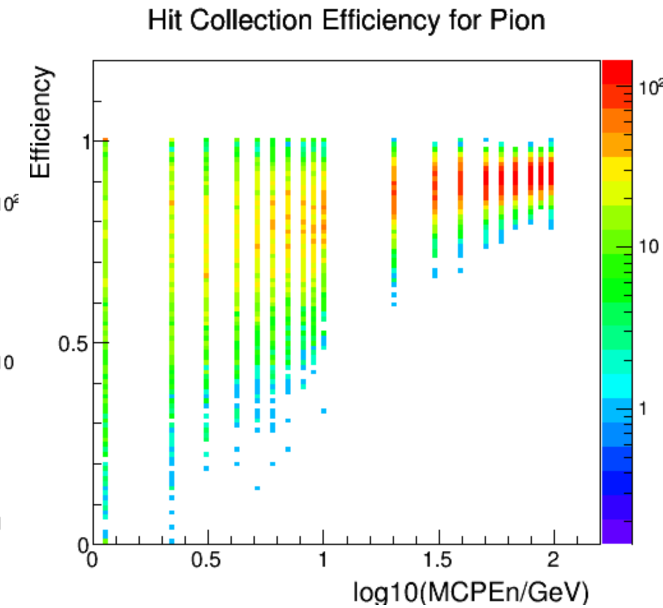
Sample Validation

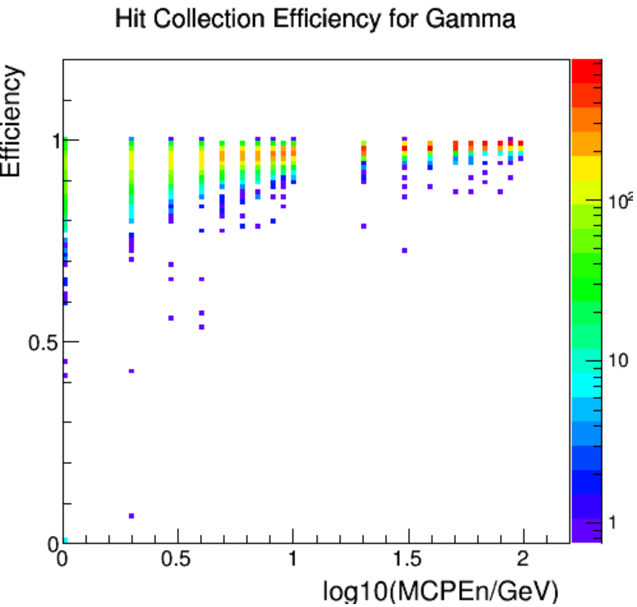
- Single Particle(e, μ, π, γ, n)
  - Hit collection efficiency
  - E, Theta, Phi, D0, Z0 residuals
  - PID Efficiency
- Overlay sample(π and γ)
  - Total reconstructed energy
  - Efficiency
    - One charged and one neutral
    - Correct energy
    - Correct position
- nnH sample
  - Numbers of reconstructed objects
  - Total invariant mass
  - MC and reco Particle energy comparison

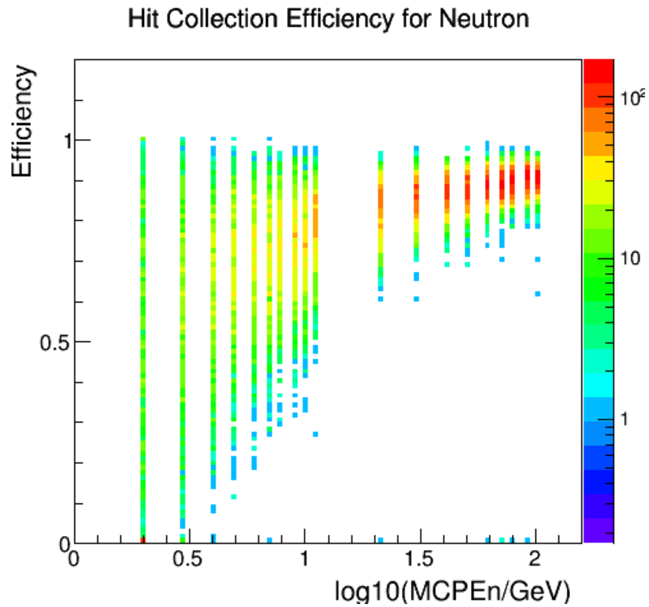
Single particle hit collection efficiency:





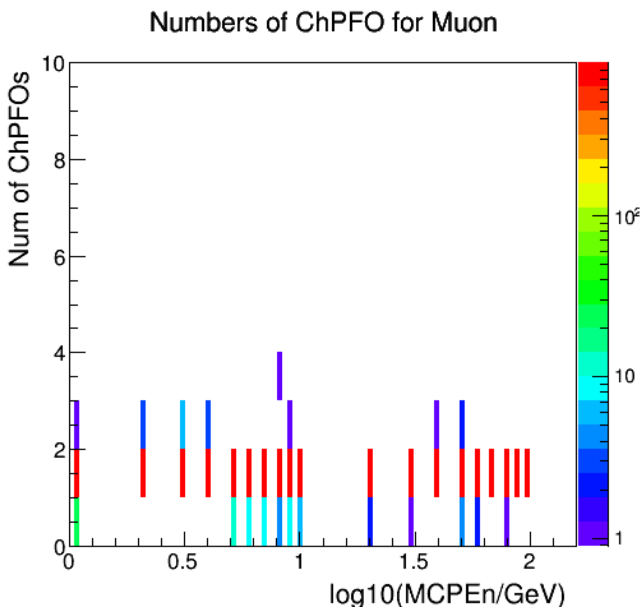


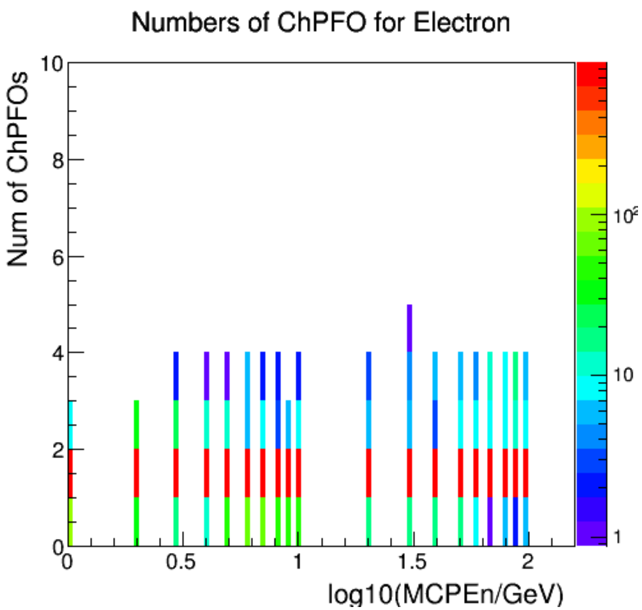


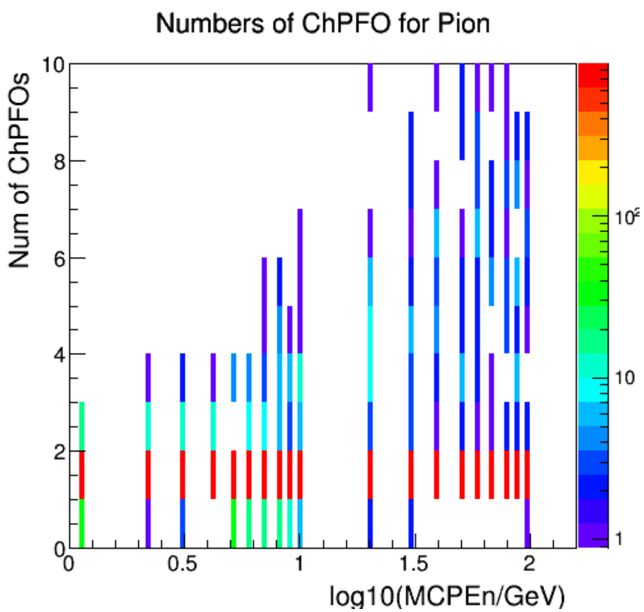


Efficiency = Tot Cluster Energy/Tot Hit Energy

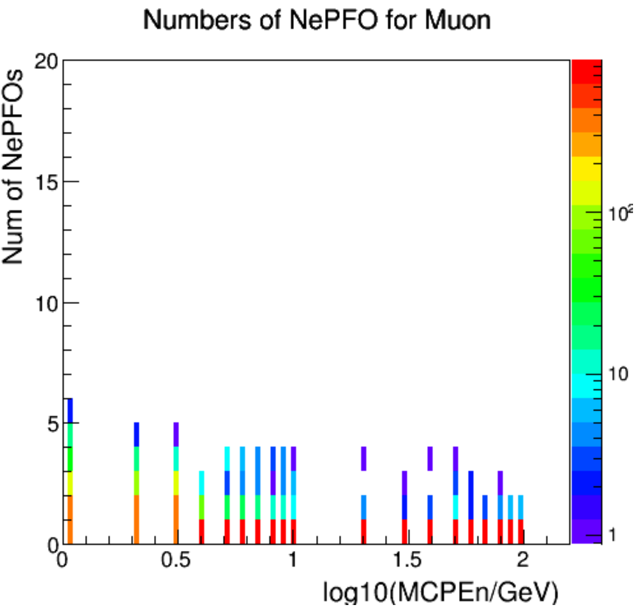
Single particle numbers of reconstructed charge object:

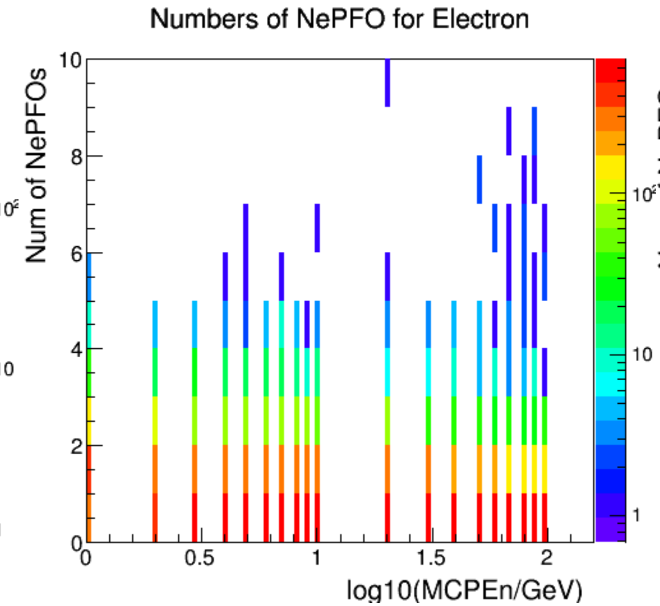


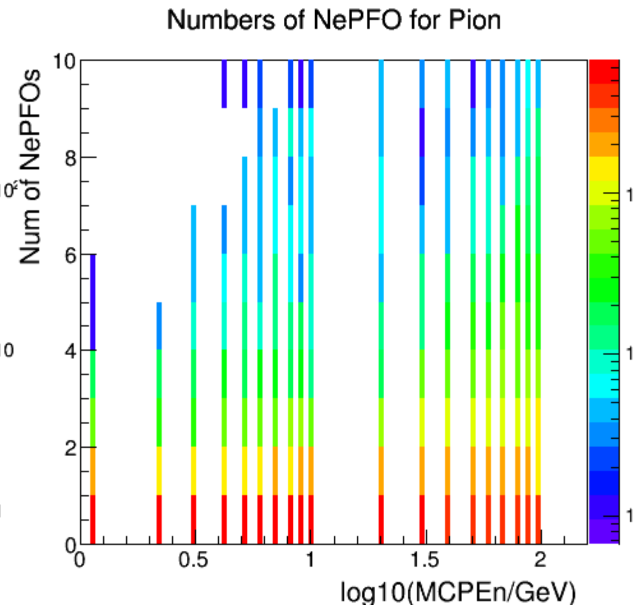


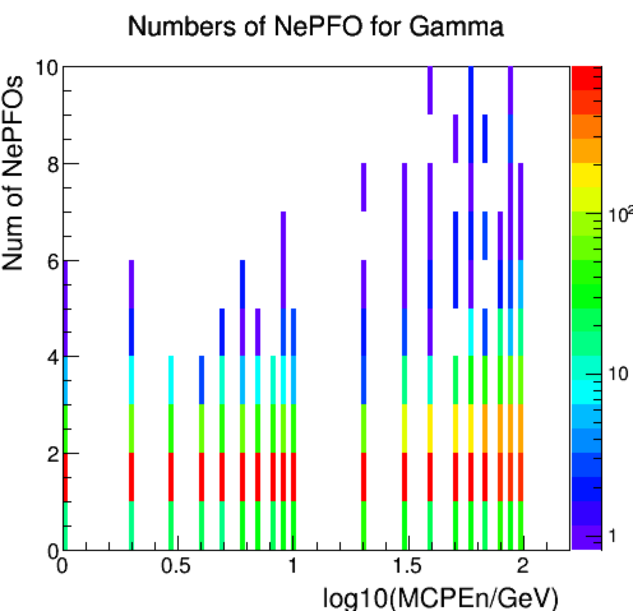


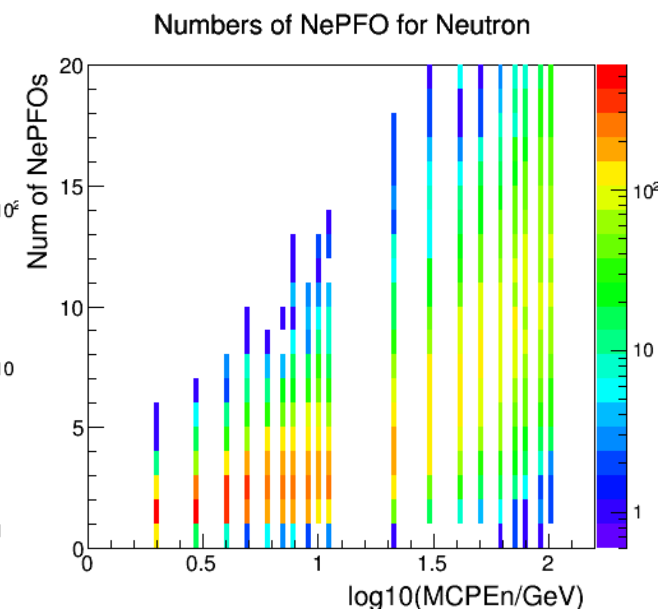
Single particle numbers of reconstructed neutral object:





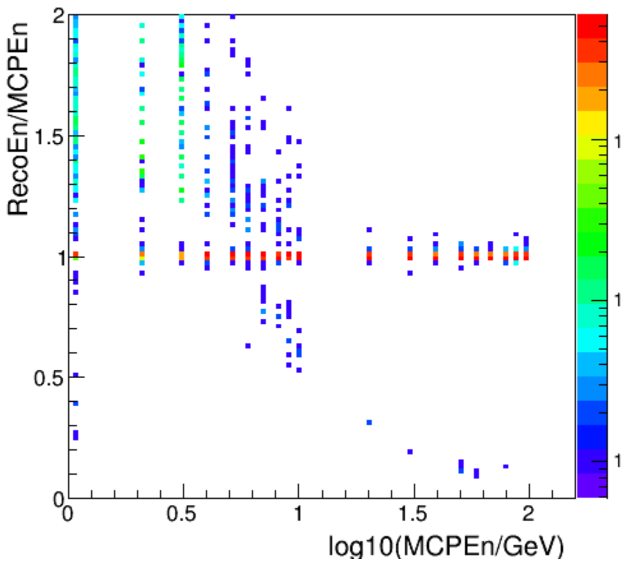




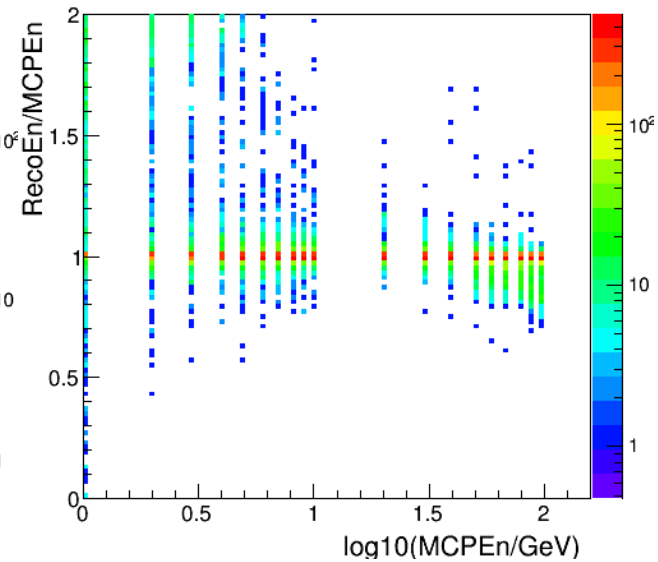


Single particle linearity of total reconstructed energy:

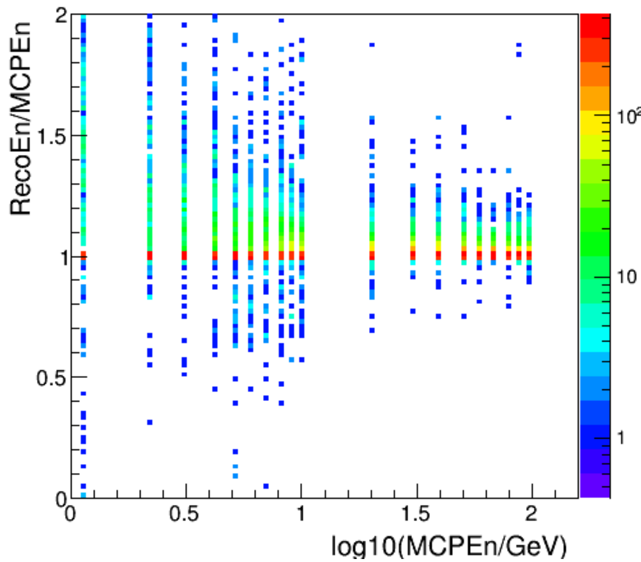
Energy linarity for Muon



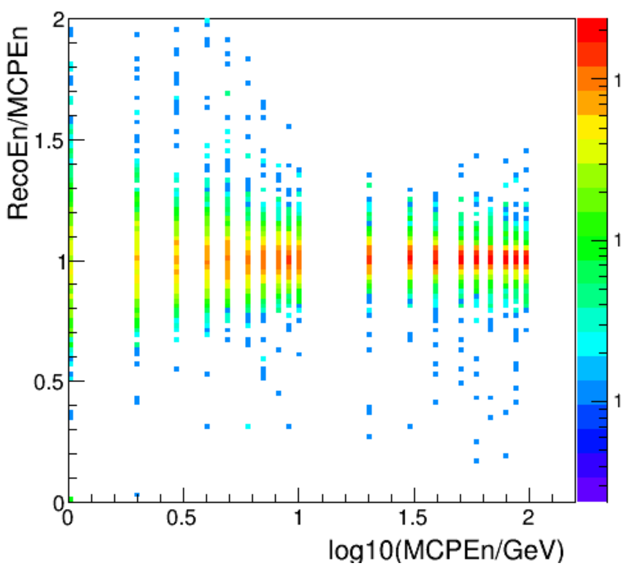
Energy linarity for Electron



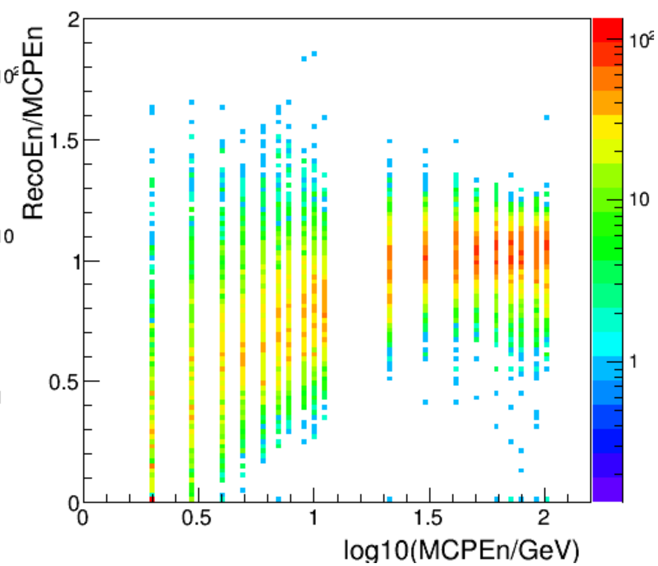
Energy linarity for Pion



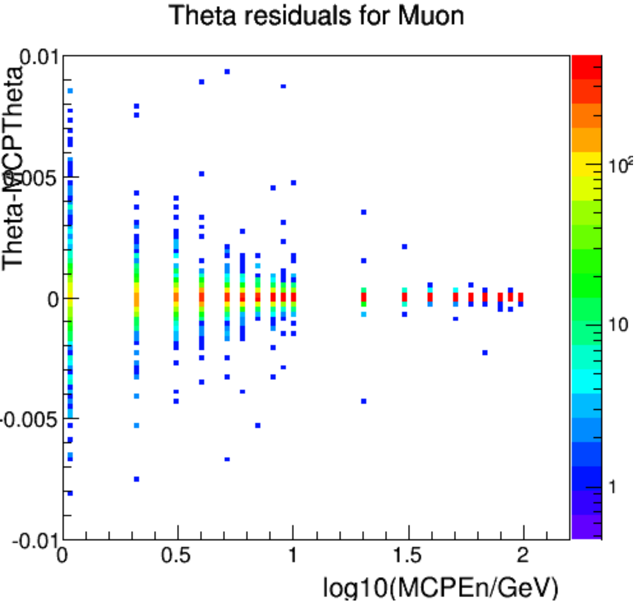
Energy linarity for Gamma

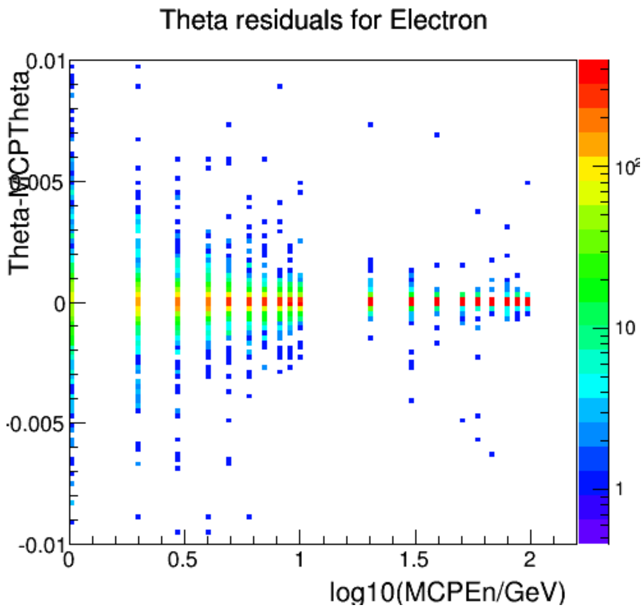


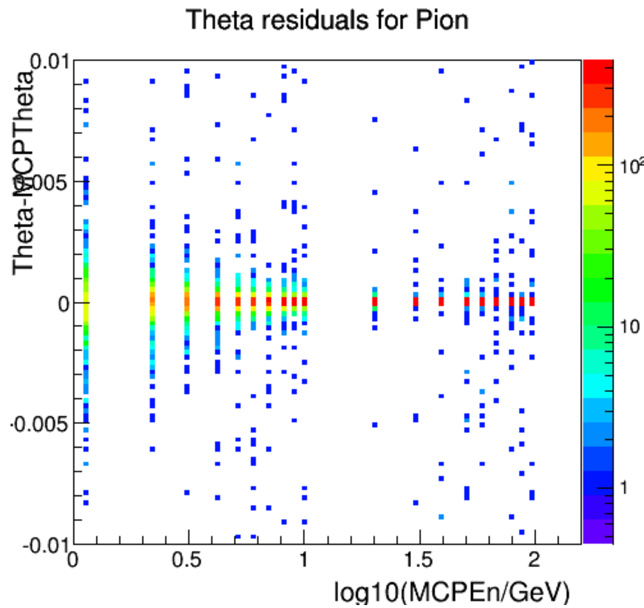
Energy linarity for Neutron

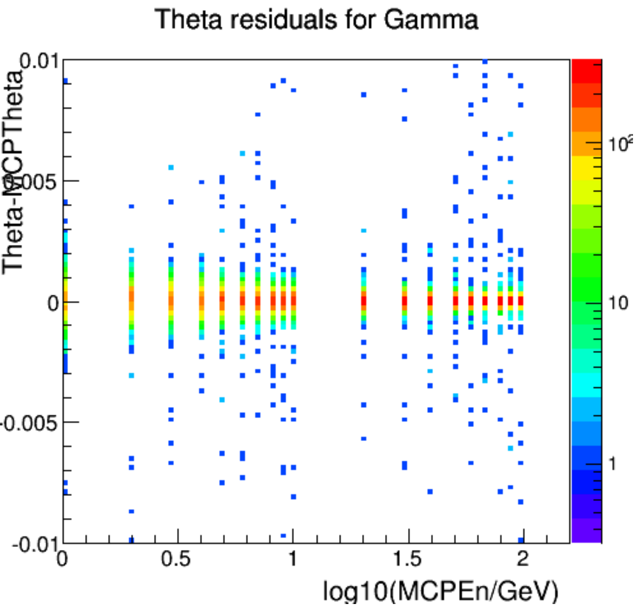


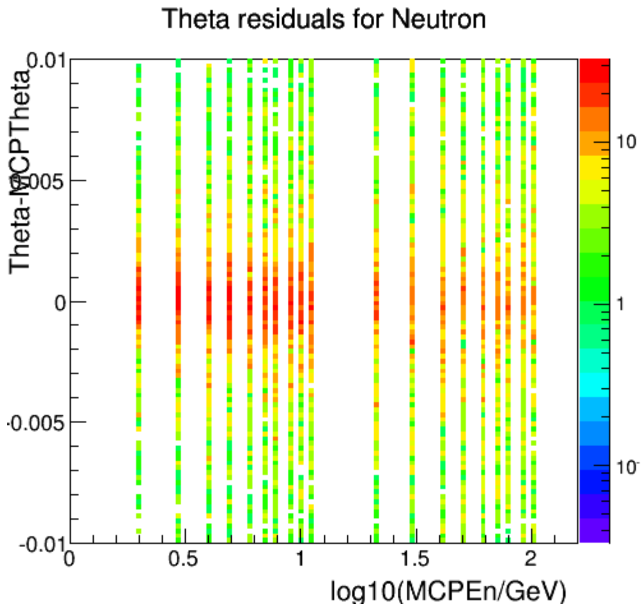
Single particle reconstructed Theta residuals:



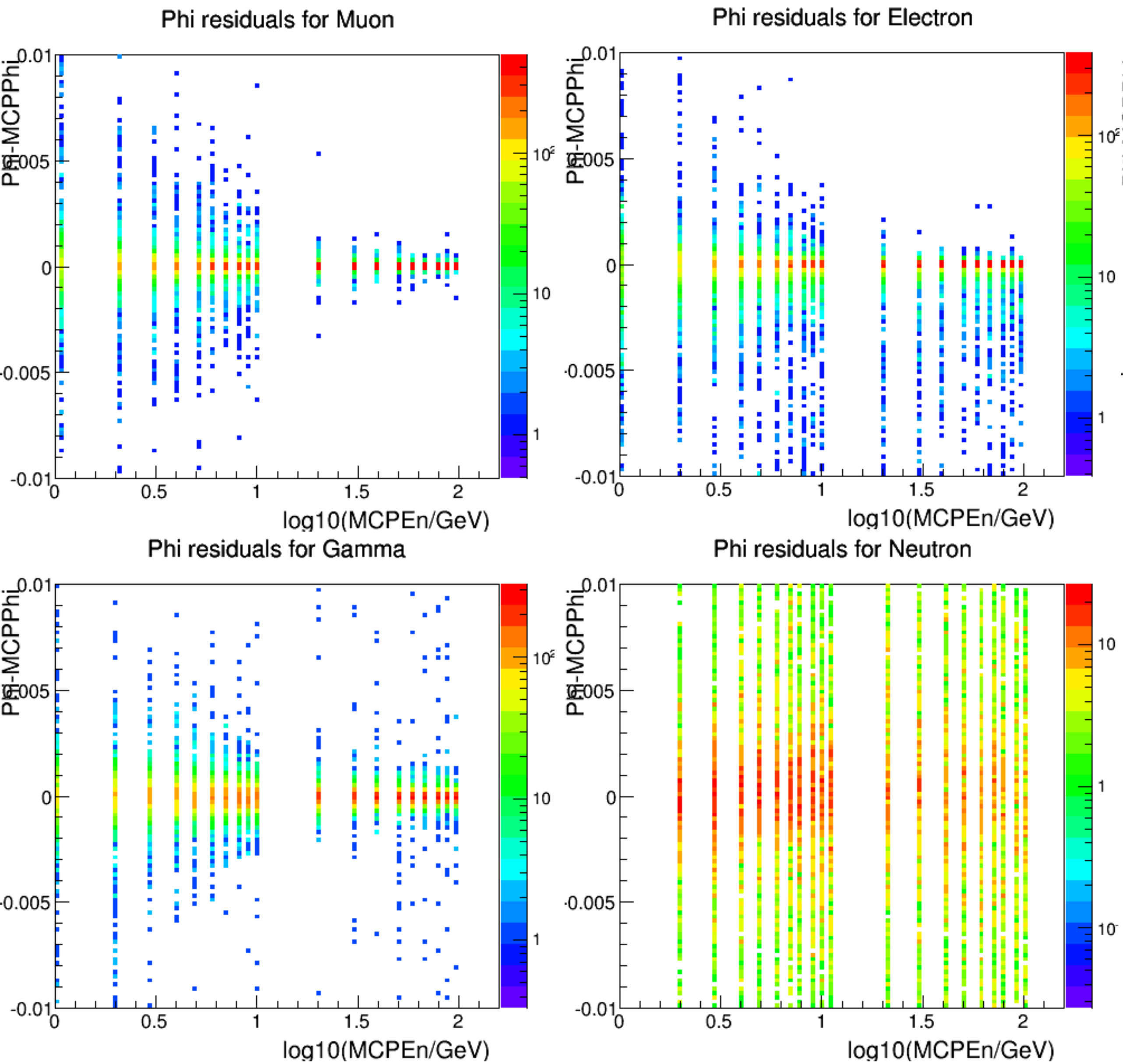




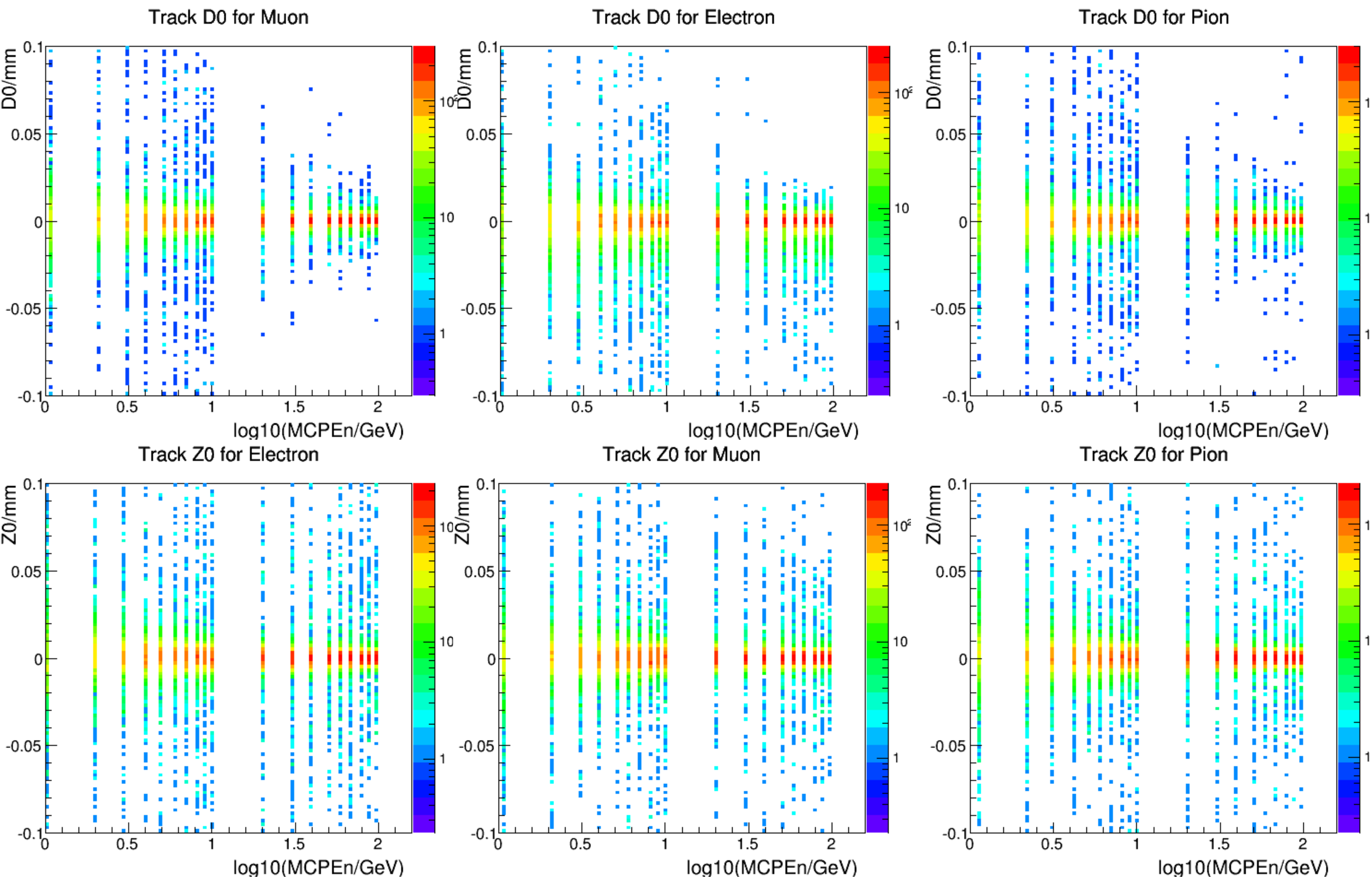




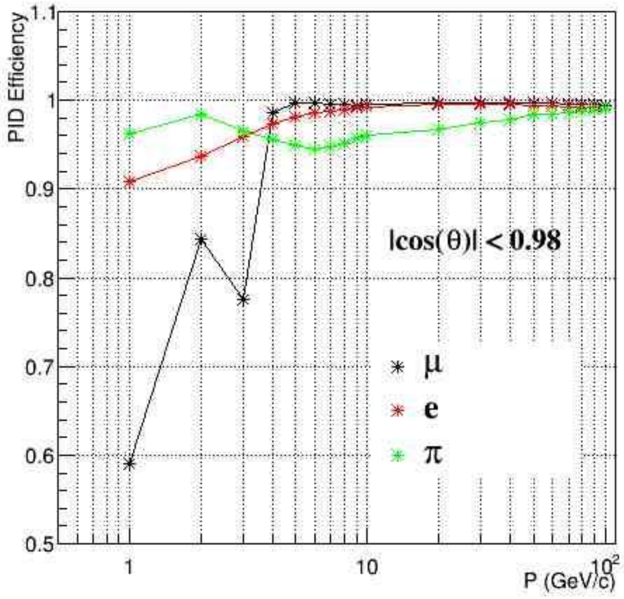
Single particle reconstructed Phi residuals:

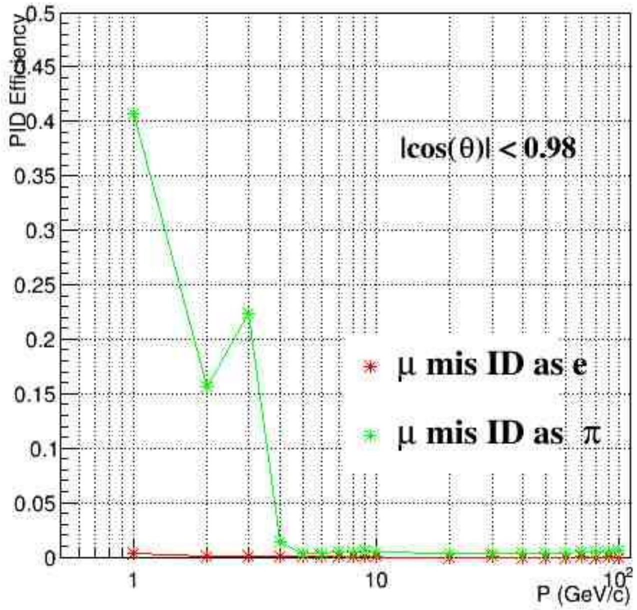


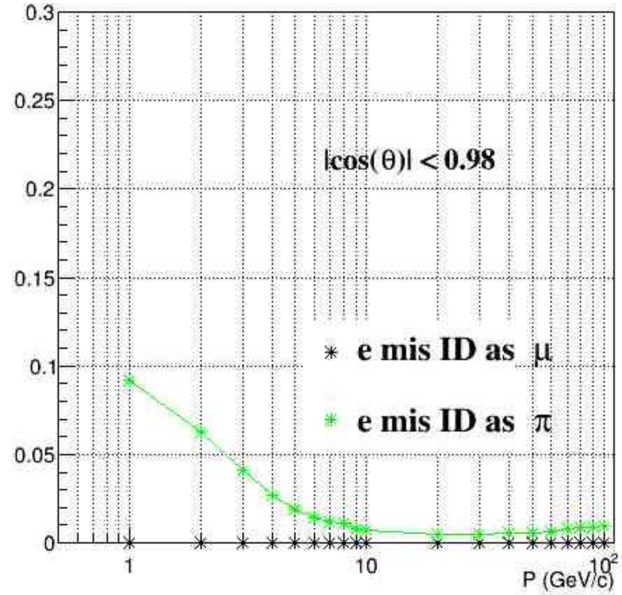
Single particle D0 and Z0 of the Track:

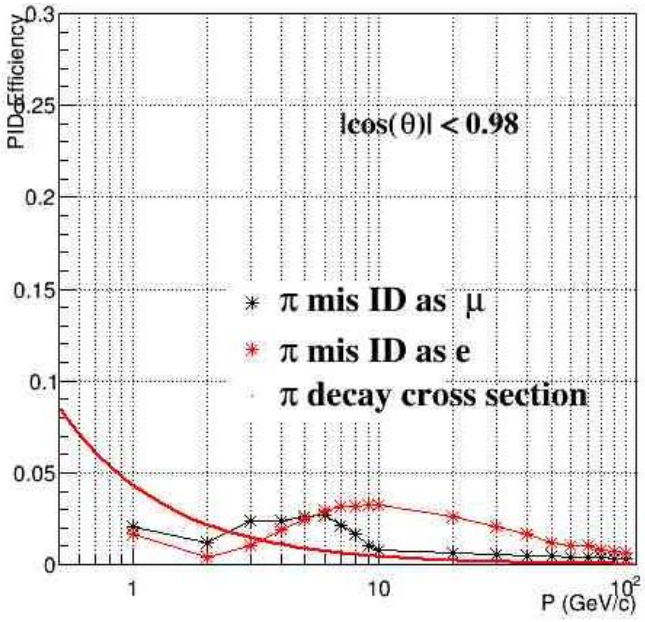


Single particle cut based PID performance:



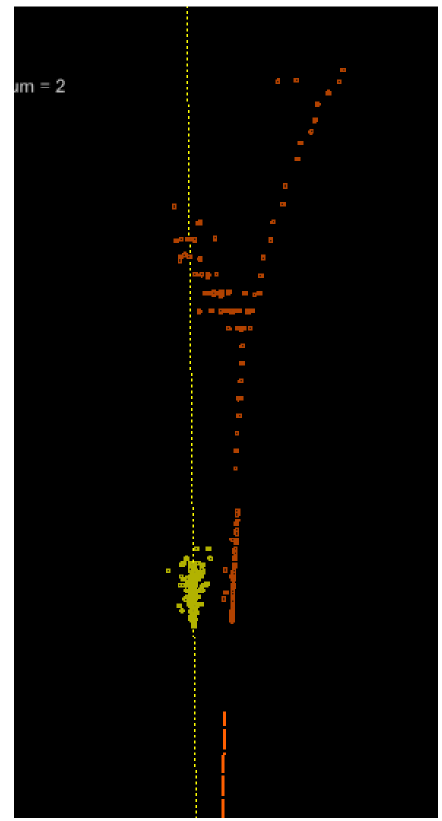




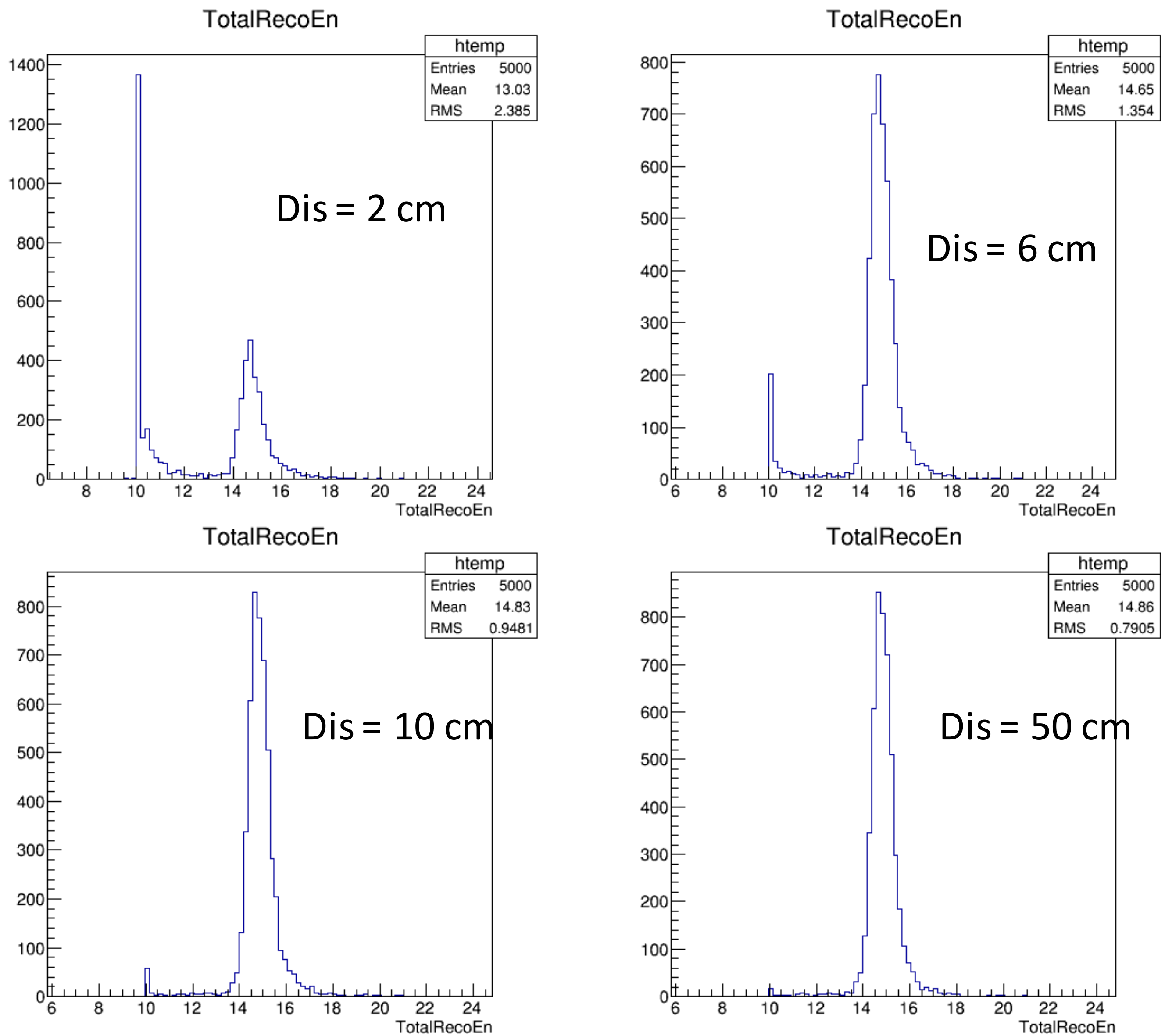


Overlay sample validation

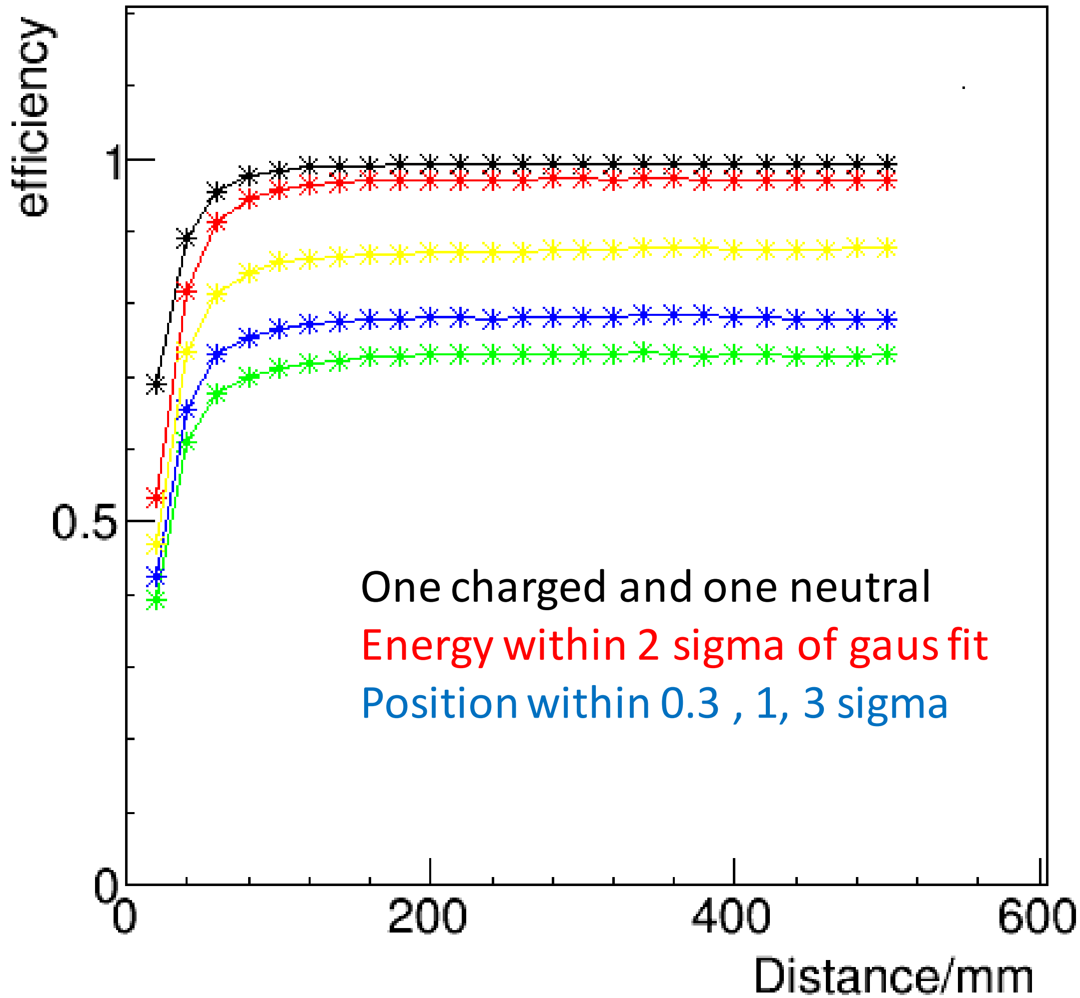
- Verify the track cluster matching performance
- Using a 10GeV single Pion overlay a 5GeV single photon sample
- Distance of Photon and Pion from 2 cm to 50 cm
- Defined three efficiencies:
  - One charged and one neutral
  - Energy within 2 sigma of gaus fit
  - Position within 0.3 , 1, 3 sigma



Overlay sample total reconstructed energy:



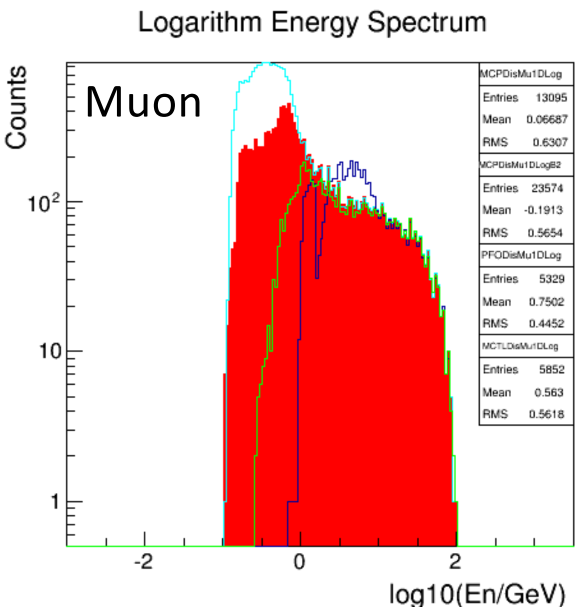
Three efficiencies:

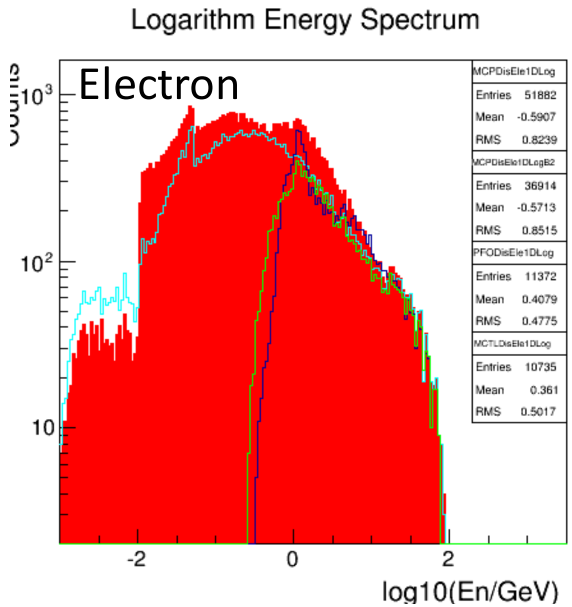


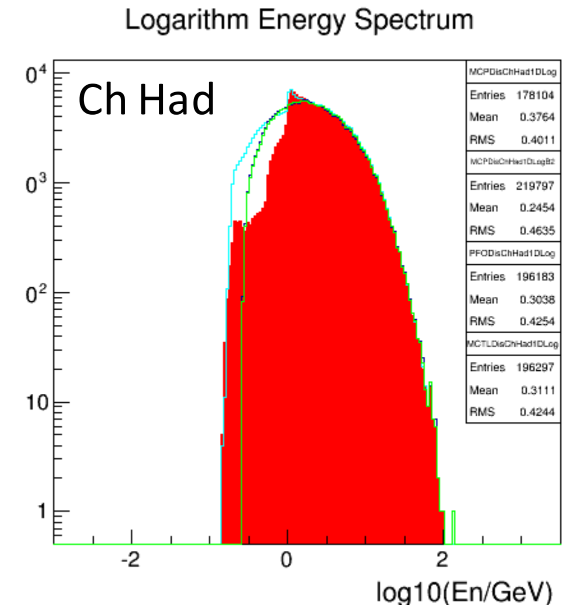
nnH sample validation

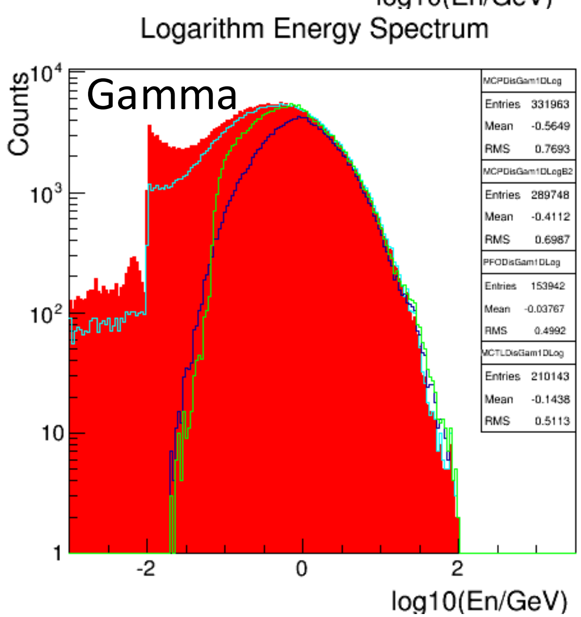
- Energy spectrum of different particles
- Numbers of reconstructed object
- Total invariant mass of different higgs decay channels

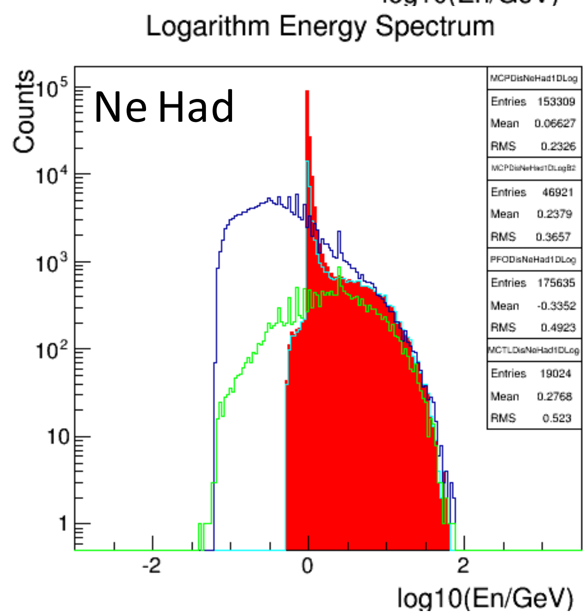
Energy spectrum





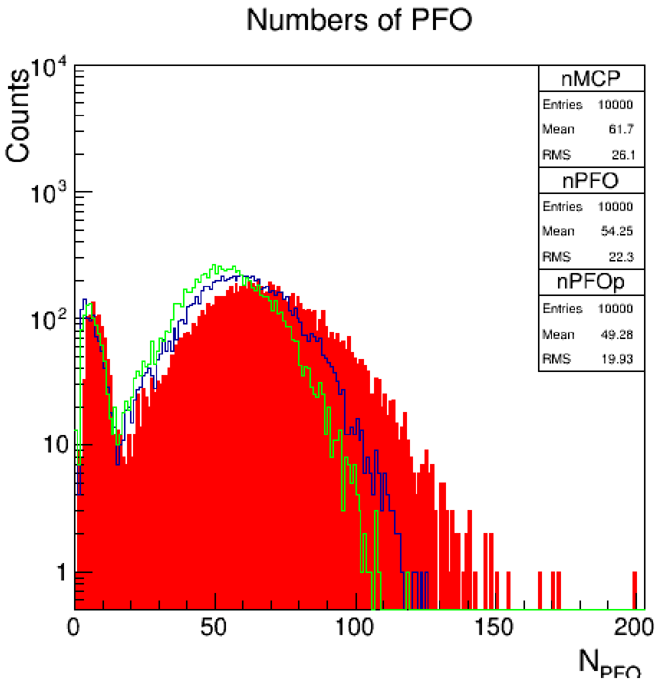






Red: all MCP
Light blue: selected MCP
Green: Reco PFO with truth link
Blue: Reco PFO with Truth PID

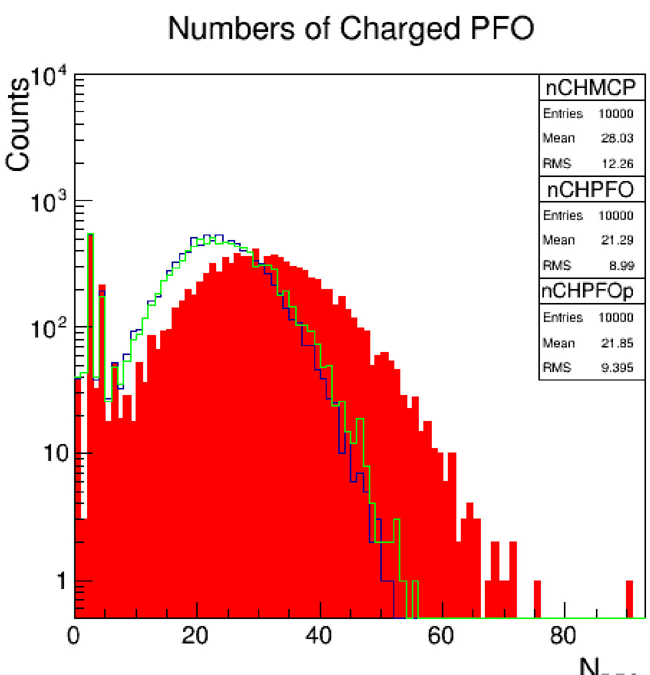
Numbers of reconstructed object

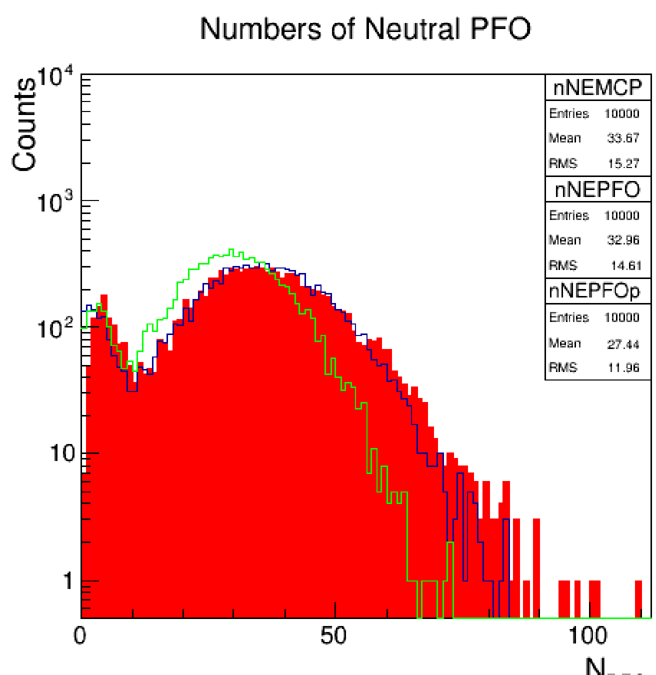


Red for MCParticle

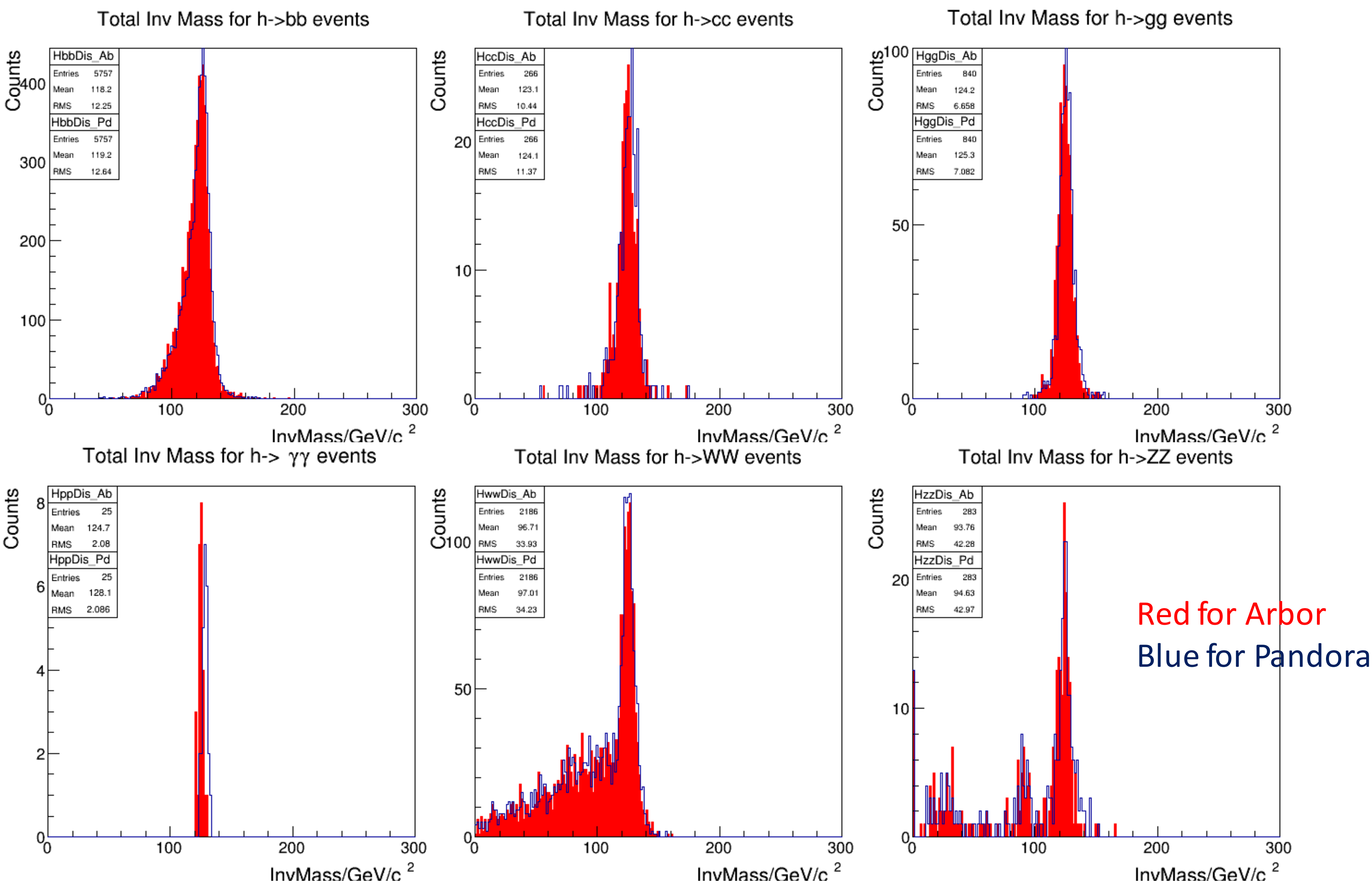
Blue for Arbor

Green for Pandora





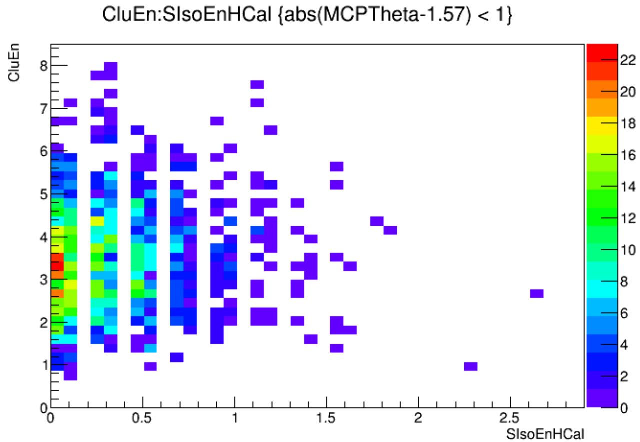
Total invariant mass

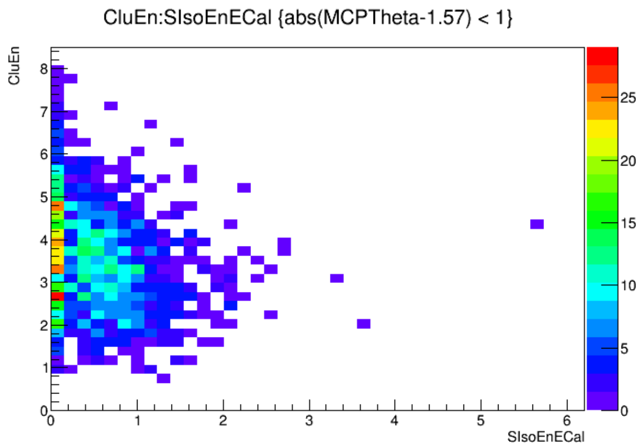


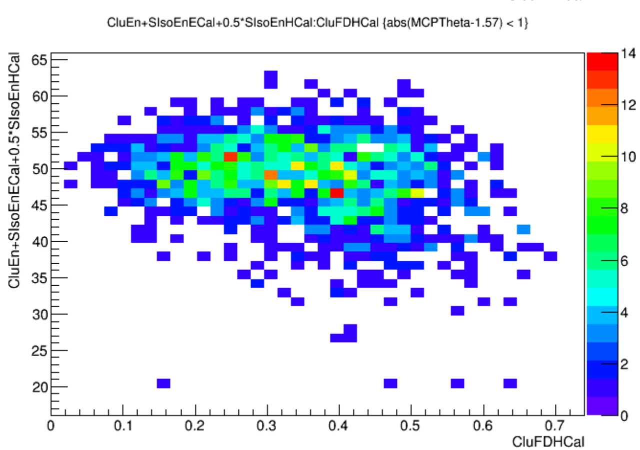
Neutral particle energy estimator

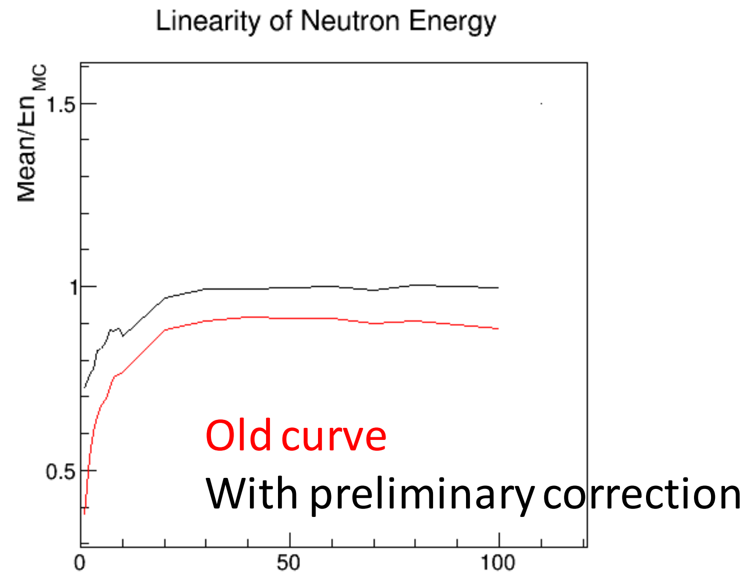
- Photon energy estimator: see Wang Feng's talk
- Neutron energy estimator: using the information of isolated hit.

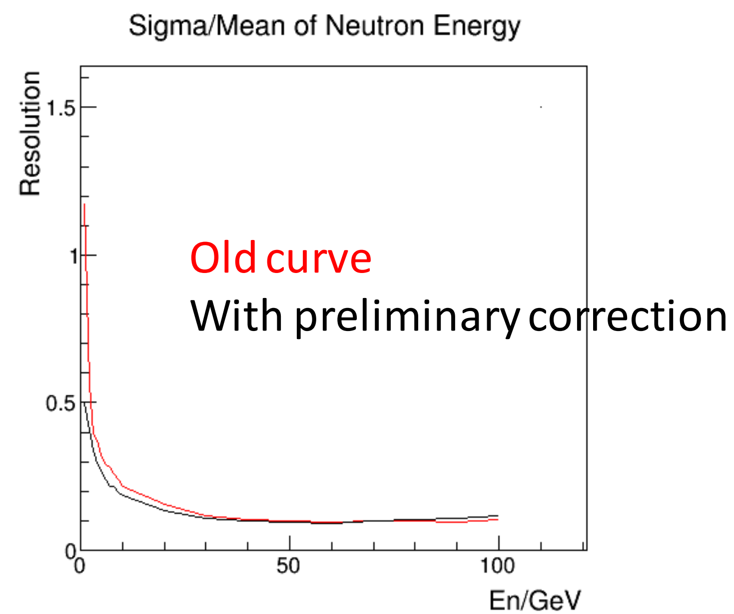
Neutron energy estimator:











Conclusions

- Arbor_v3_KD version with the K-dimensional tree algorithm is much faster than the old arbor version.
- The sample validations show good performance in energy and position measurement and a comparable jet energy resolution to the Pandora PFA.

Outlook

- Neutron energy estimator
- Validation of the Arbor_KD version to CEPC_o_v2 geometry (see Li Qiuyang's talk)
- Now the test of the nnh sample for the v2 geometry is not so optimized.