The Pion rejection study

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Pion rejection study

- particle identification of e- and pi- in the EM calorimeter:
  - **E/P**: pi- has smaller energy deposition
  - **M02, M20**: shower shape of the e- and pi-
  - **leakage energy in inner HCAL[barrel]**: if leakage happened in barrel EM calorimeter, pi- will deposit more energy in inner HCAL than e-
- study the pion rejection factor as function of momentum and pseudo-rapidity

Pion rejection study

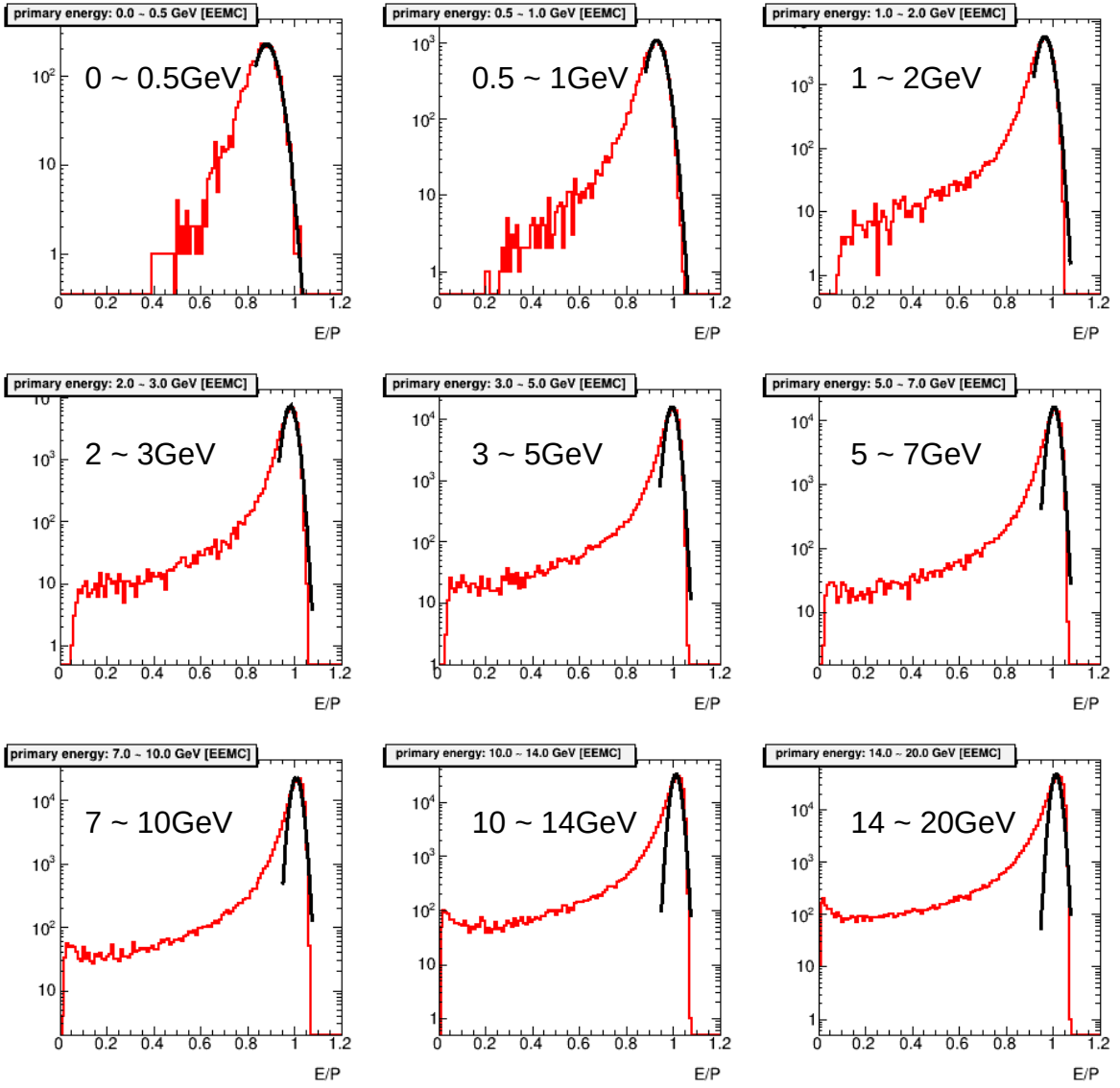
- Prop4 single pion evaluator: 5M events
- EM calorimeter: EEMC, BECAL, FEMC
- Selection:
  good eta region: -3.2<eta<-1.9(EEMC), -1.4<eta<1.1(BECAL) and 1.5<eta<3.2(FEMC)
  # cluster: 1
  # tower in the cluster: >1
  cluster matched to tracker: True
  # tracker matched: 1
  cluster_E / reco_P: <1.05
- Correct the pion cluster energy by electron E/P fitting
- E/P cut: 1 - 1.6 x σ_E/E

  M02 cut: >1

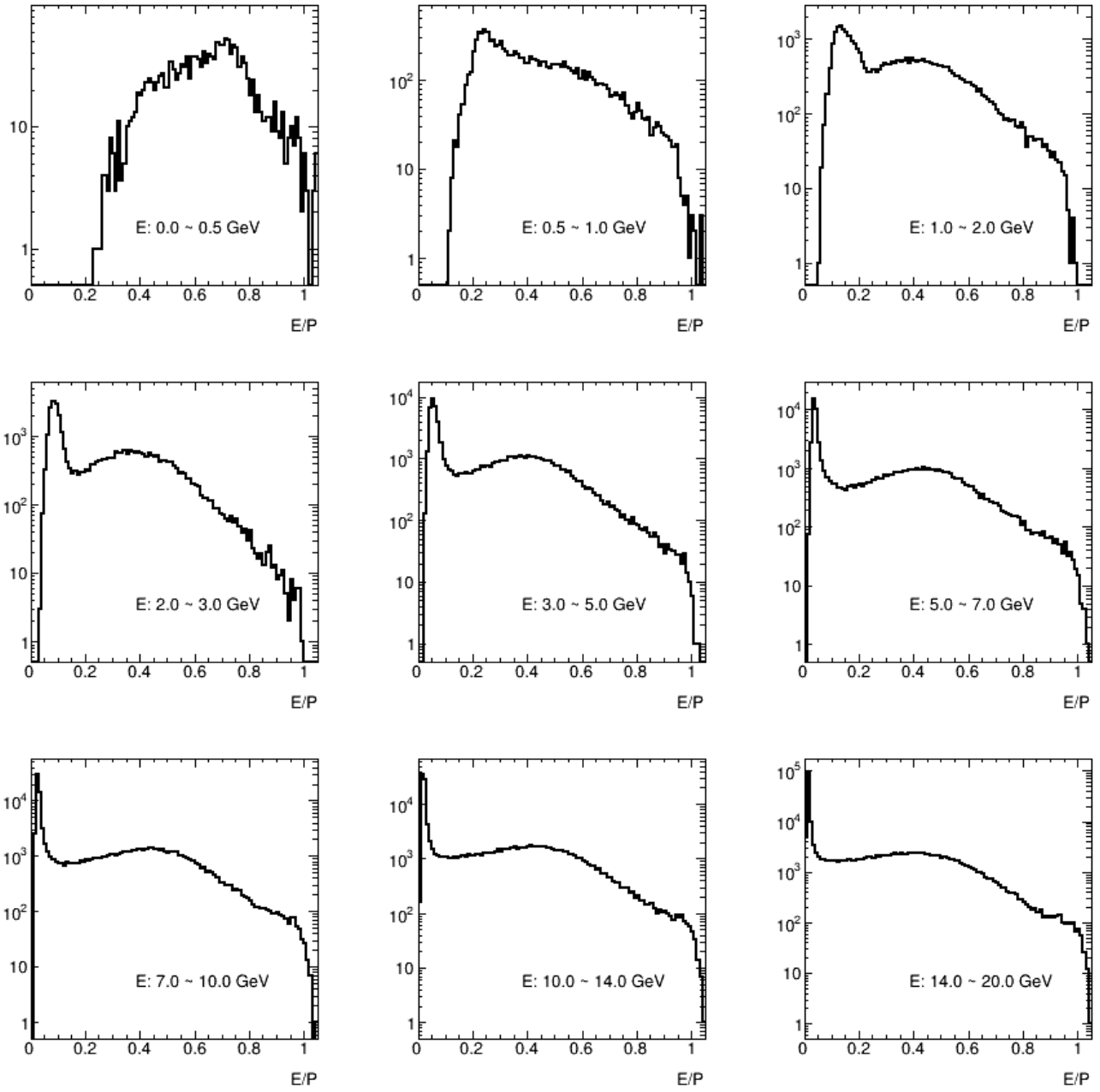
  inner HCAL nearest tower energy cut: >0.02GeV
- One step for getting the pion rejection plots:
  need to add the header pi_reject.cxx, and the functions, pi_reject(), pi_rejectSave() before running the command
  root -b -q -l 'treeProcessing.C("data_path_pion.txt", "geometry.root", "PI_REJECT")'

Pion rejection study

- The E/P peak of electron is not @ 1, do the Gaus fit to get the mean (correction factor)
- apply correction factor to the pion E/P.
- the correction factor are 0.8(low p) ~ 1(high p)



Pion rejection study



EEMC

E/P distribution of different bin

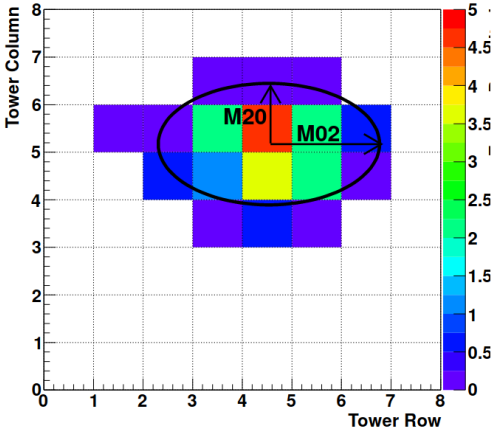
E: cluster energy
P: truth pion momentum

E/P cut: 1 - 1.6 x σ_E/E is calculated event by event.

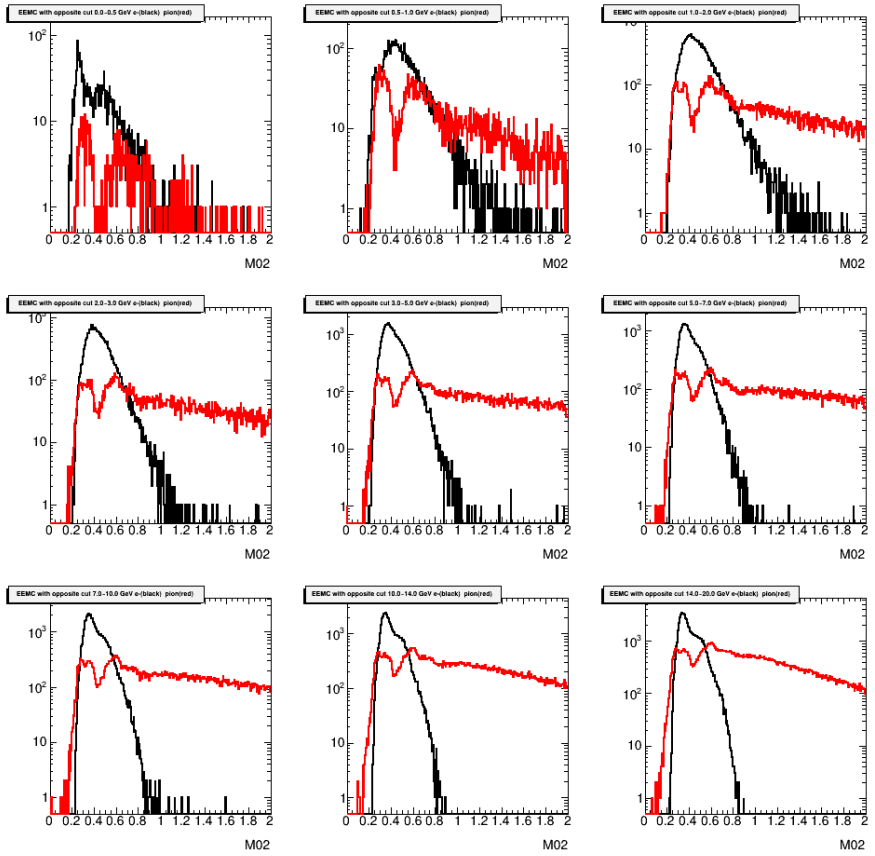
shower shape

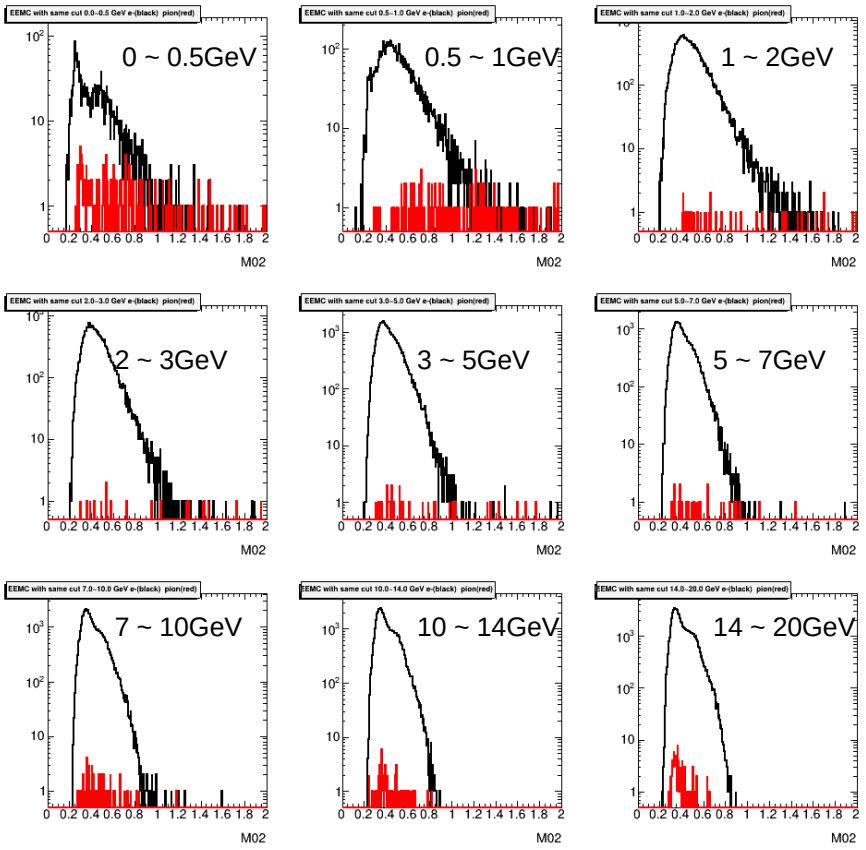
$$M_{02} = \frac{1}{2}\sum_i E_i(x_i^2+y_i^2) + \sqrt{\frac{1}{4}\left(\sum_i (x_i^2+y_i^2)^2\right) + \left(\sum_i E_i x_i y_i\right)^2}$$

$$M_{20} = \frac{1}{2}\sum_i E_i(x_i^2+y_i^2) - \sqrt{\frac{1}{4}\left(\sum_i (x_i^2+y_i^2)^2\right) + \left(\sum_i E_i x_i y_i\right)^2}$$



- M02 distribution of EEMC electron[black] and pion[red]
- M02 cut: < 1. can keep most e-



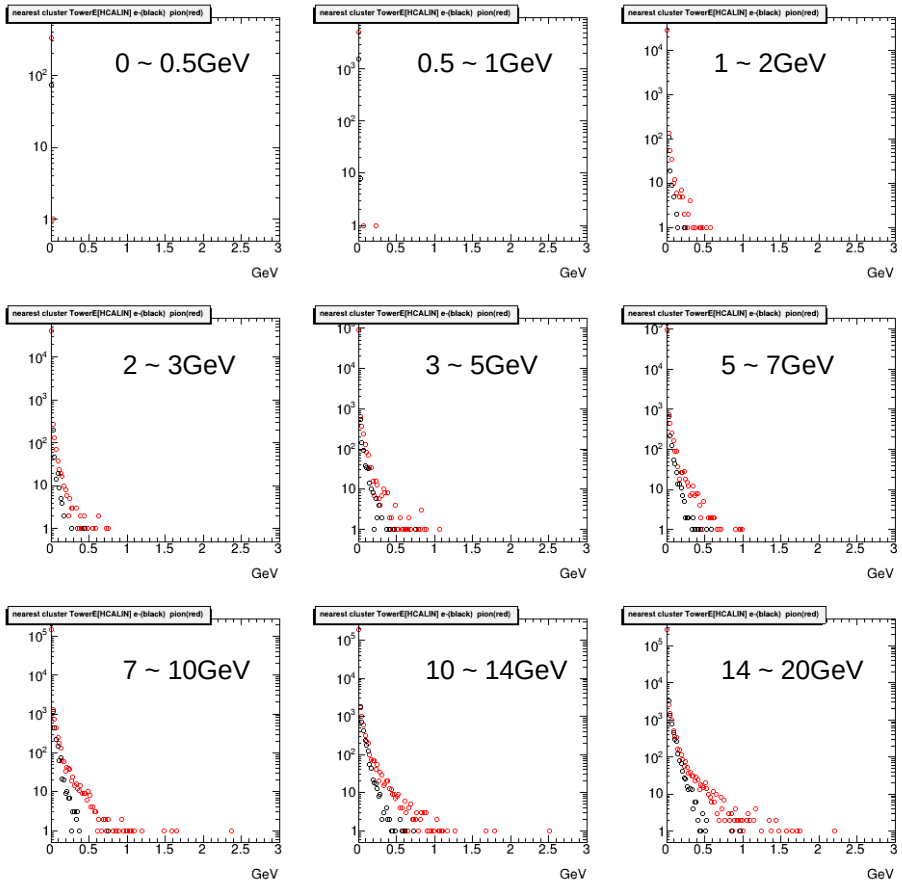


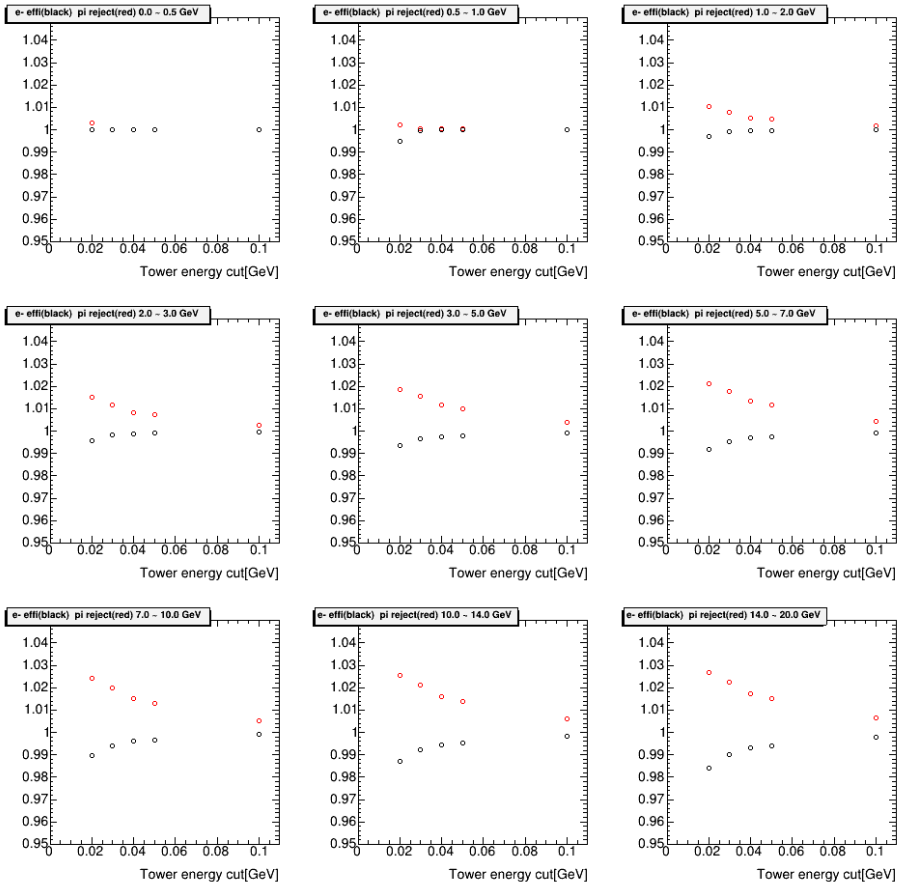
EP cut pion: < 1 - 1.6 x σE/E
EP cut electron: > 1 - 1.6 x σE/E

EP cut pion: > 1 - 1.6 x σE/E
EP cut electron: > 1 - 1.6 x σE/E

inner HCAL tower energy

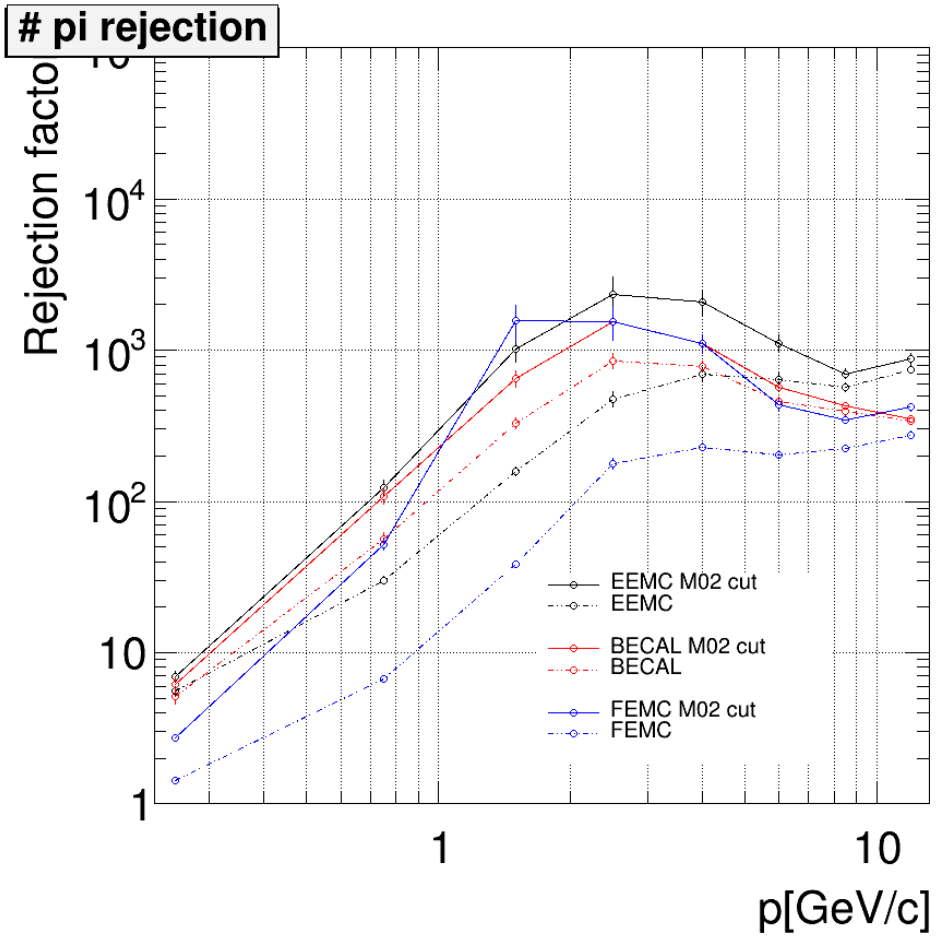
- The nearest tower energy[HCALIN] to the cluster of BECAL, pi-[red], e-[black]
- Apply different tower energy cut to calculate the pi- rejection[red] and e- efficiency[black]
- pion rejection can up to 1.02 ~ 1.03 and the corresponding e- efficiency ~99%



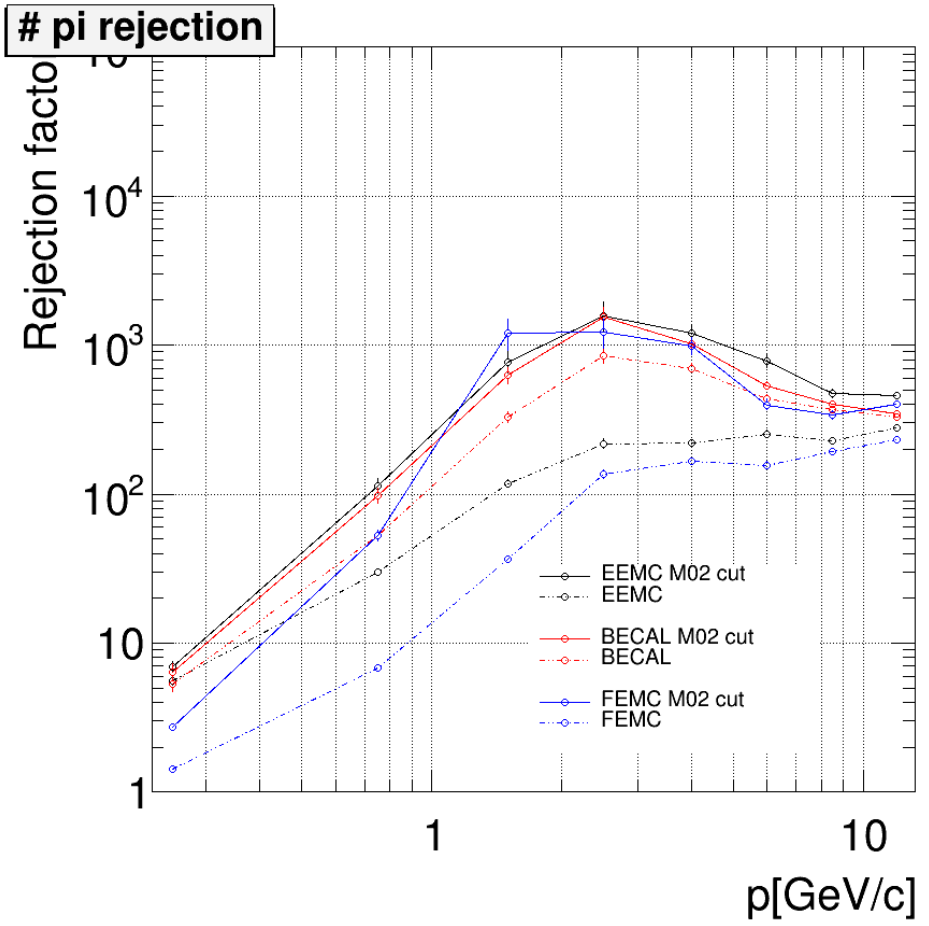


Pion rejection study

$E_{deposited} / P_{truth}$

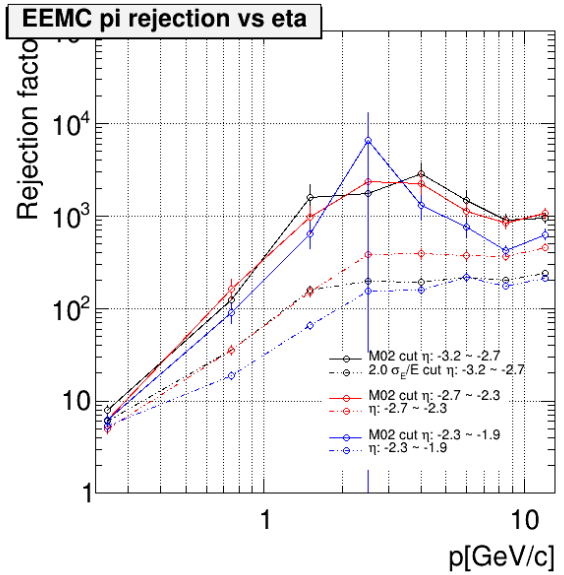


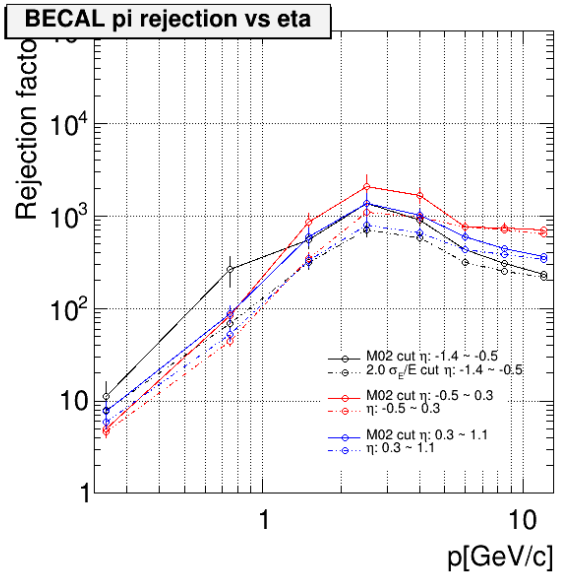
$E_{deposited} / P_{reconstructed}$

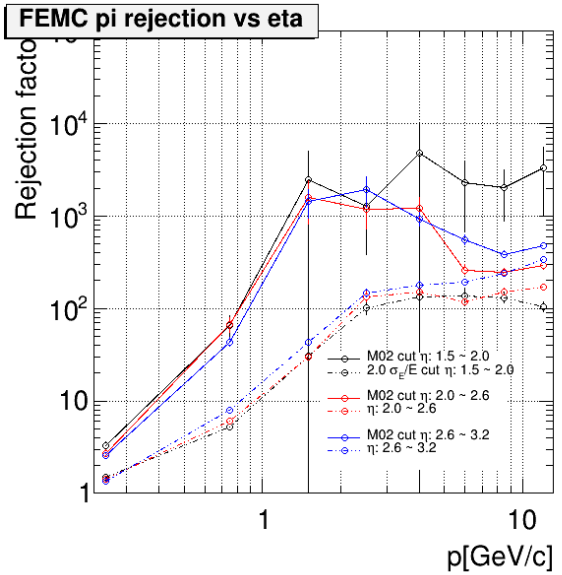


- Similar trend of truth P with the reconstructed P
- No real improvement after the HCALin tower E cut

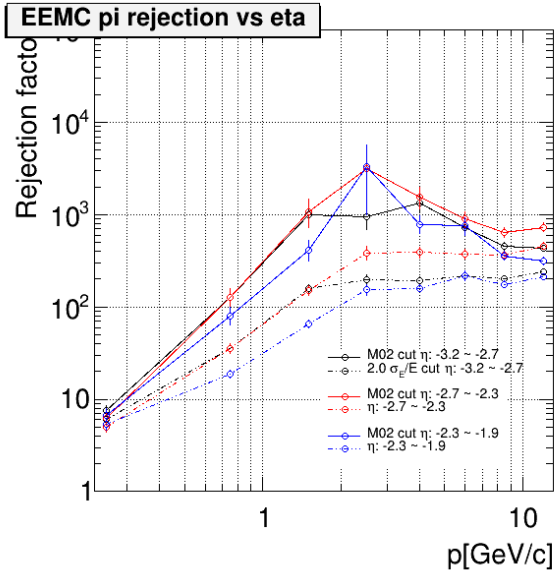
Pion rejection study

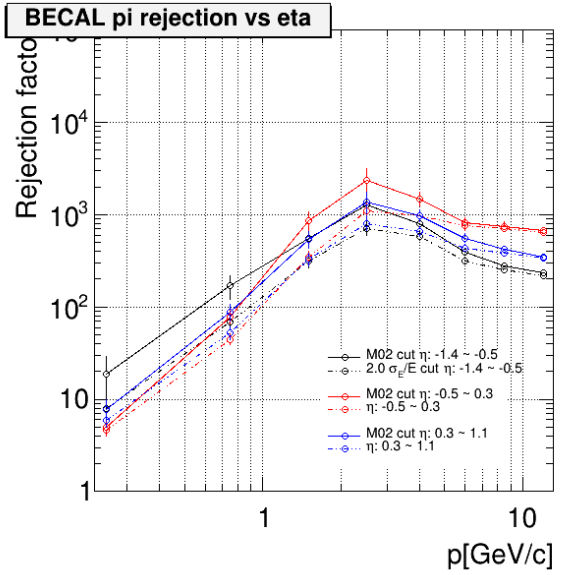


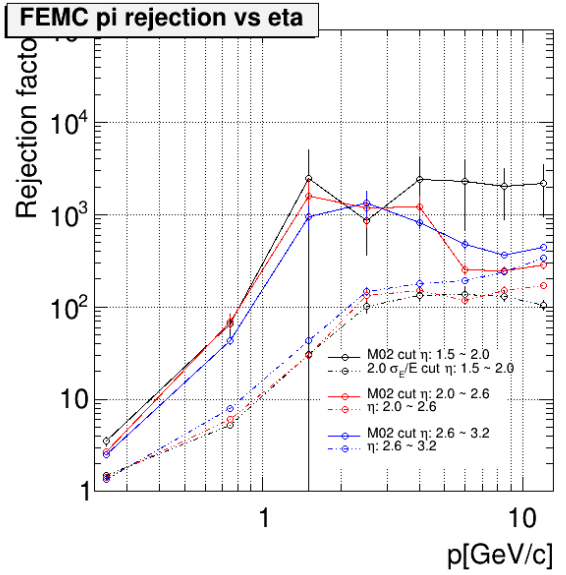




$E_{deposited} / P_{truth}$





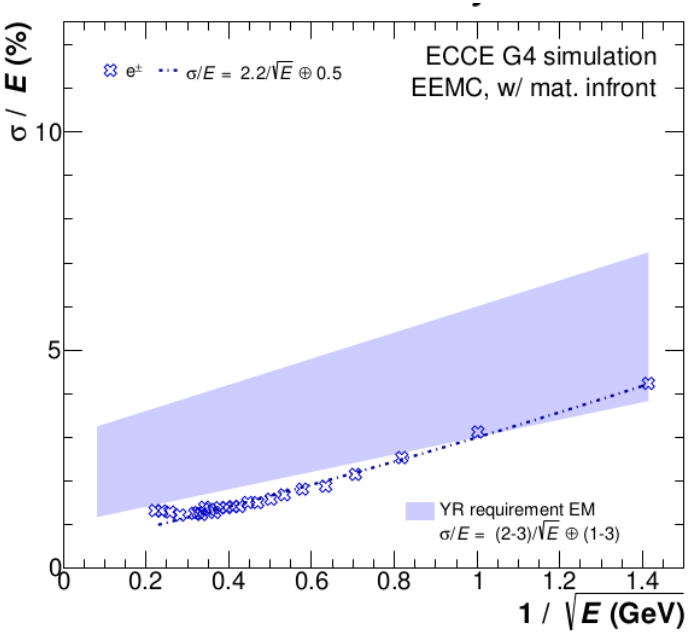


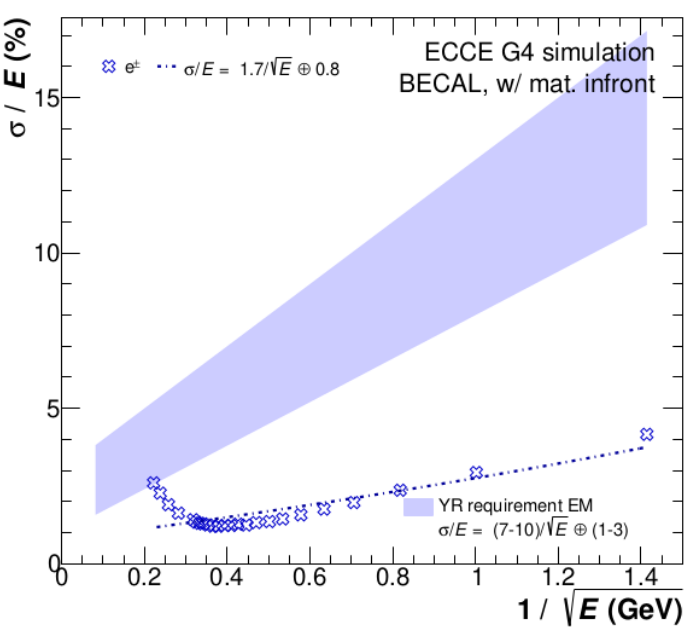
$E_{deposited} / P_{reconstructed}$

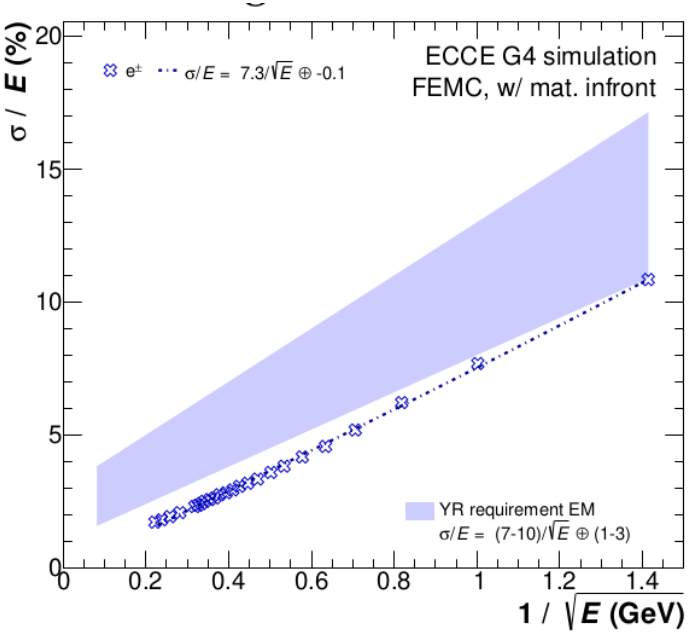
Summary

- The pion rejection < 1000, only with the E/P cut, 1 - 1.6 x σ_E/E, for the 95% electron efficiency
- The additional M02 cut can improve to >2000
- No real improvements with the HCALin nearest tower energy cut
- No significant difference as function of pseudo rapidity

Backup

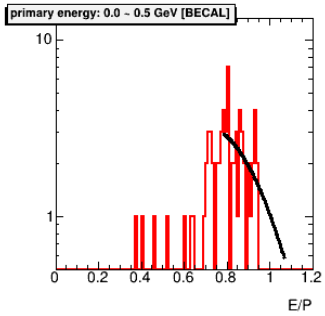

e±
σ/E = 2.2/√E ⊕ 0.5
ECCE G4 simulation
EEMC, w/ mat. infront
YR requirement EM
σ/E = (2-3)/√E ⊕ (1-3)
σ / E (%)
1 / √E (GeV)

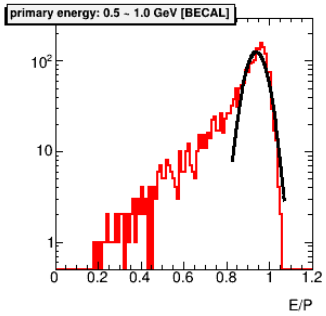

e±
σ/E = 1.7/√E ⊕ 0.8
ECCE G4 simulation
BECAL, w/ mat. infront
YR requirement EM
σ/E = (7-10)/√E ⊕ (1-3)
σ / E (%)
1 / √E (GeV)

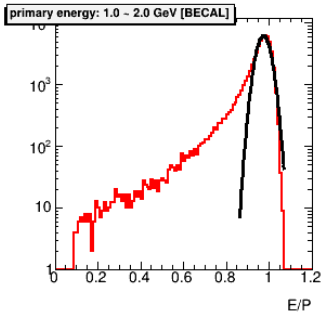

e±
σ/E = 7.3/√E ⊕ -0.1
ECCE G4 simulation
FEMC, w/ mat. infront
YR requirement EM
σ/E = (7-10)/√E ⊕ (1-3)
σ / E (%)
1 / √E (GeV)

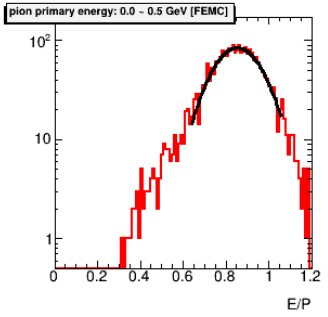
From note

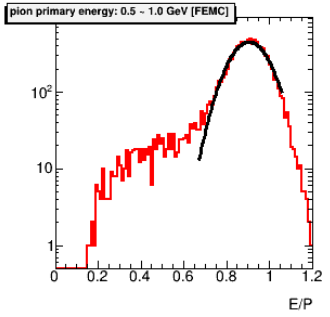
Pion rejection study

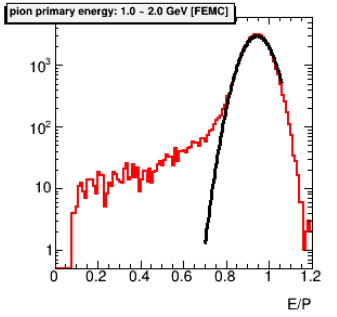


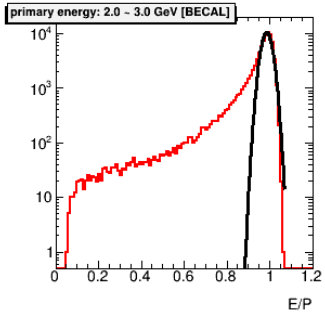


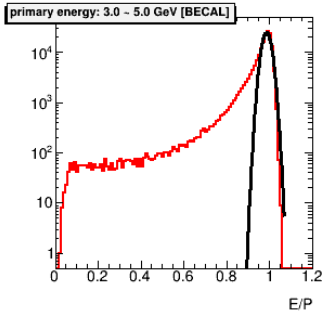


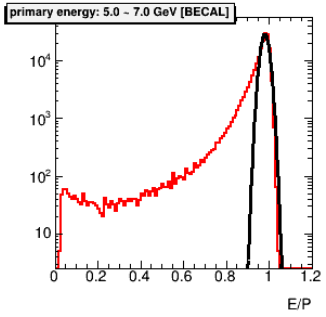


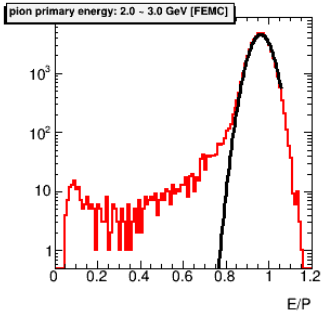


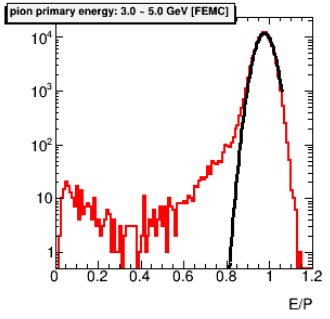


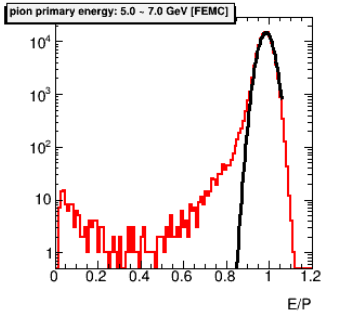


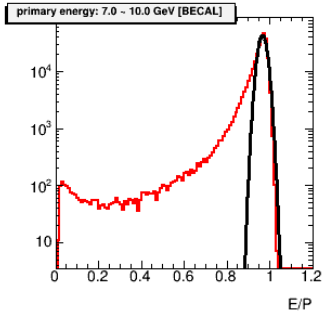


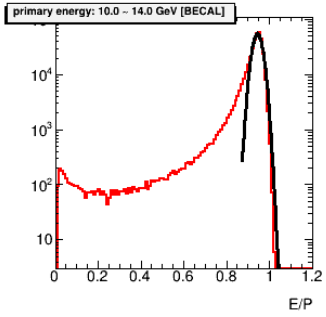


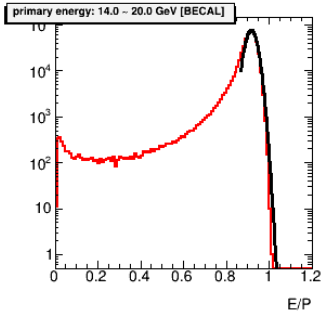


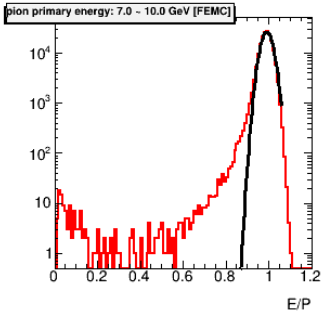


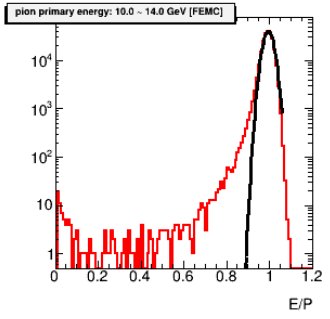


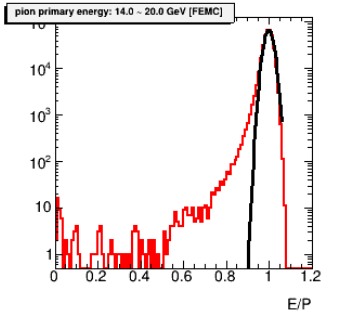








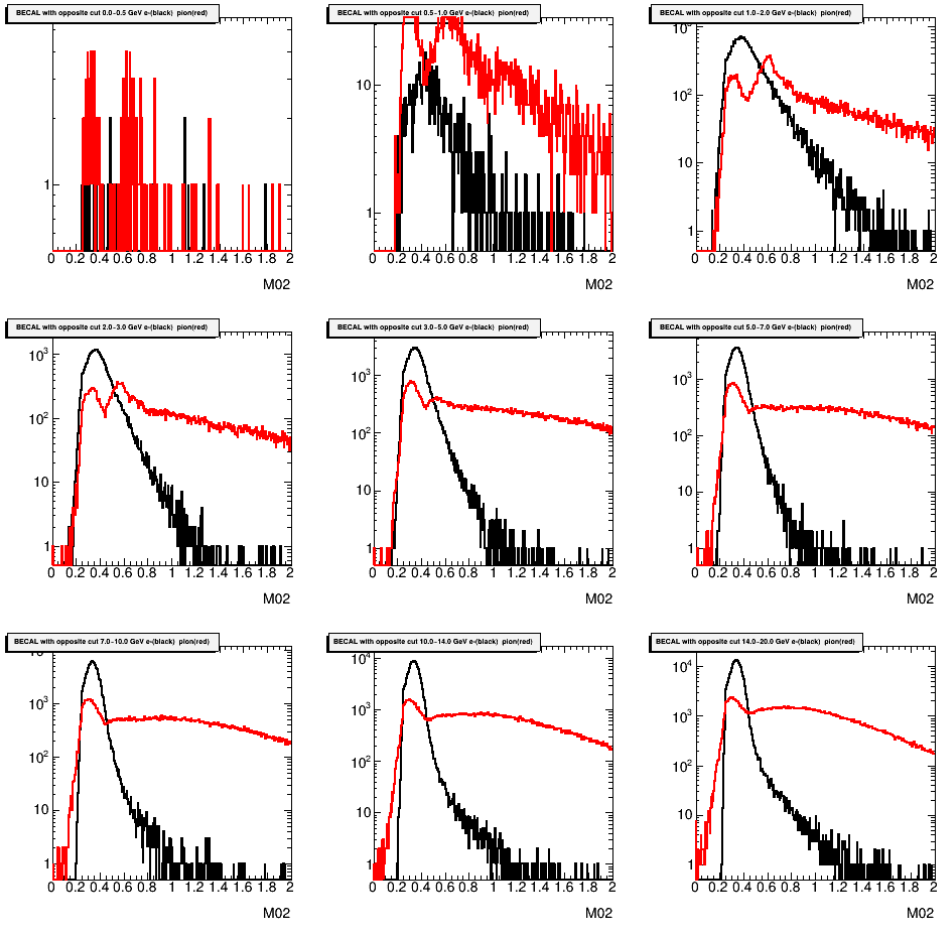


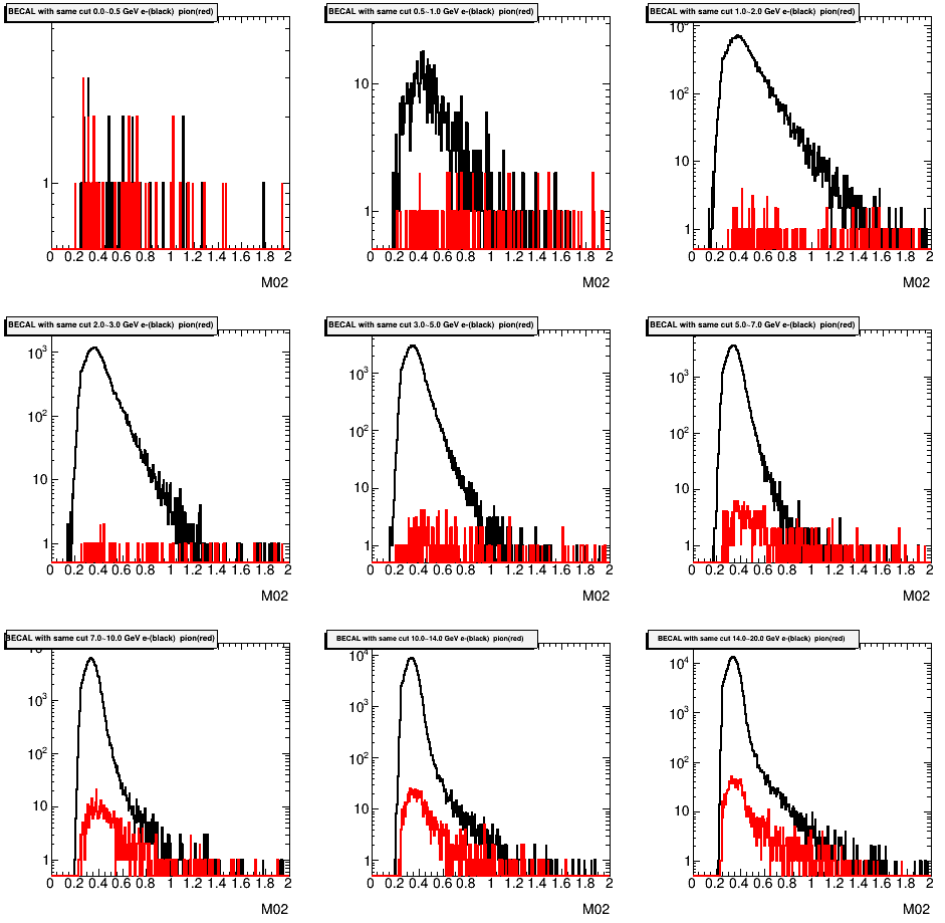


BECAL

FEMC

- M02 distribution of BECAL electron[black] and pion[red]





EP cut pion: < 1 - 1.6 x σE/E
EP cut electron: > 1 - 1.6 x σE/E

EP cut pion: > 1 - 1.6 x σE/E
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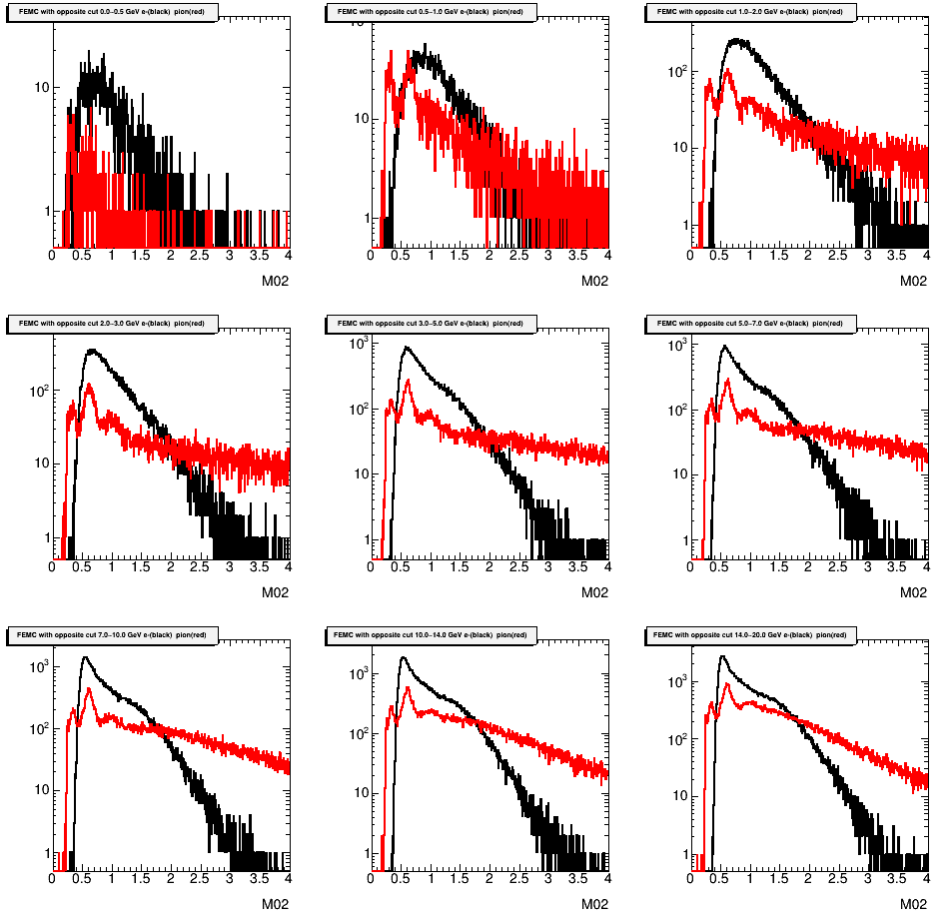
- M02 distribution of FEMC electron[black] and pion[red]



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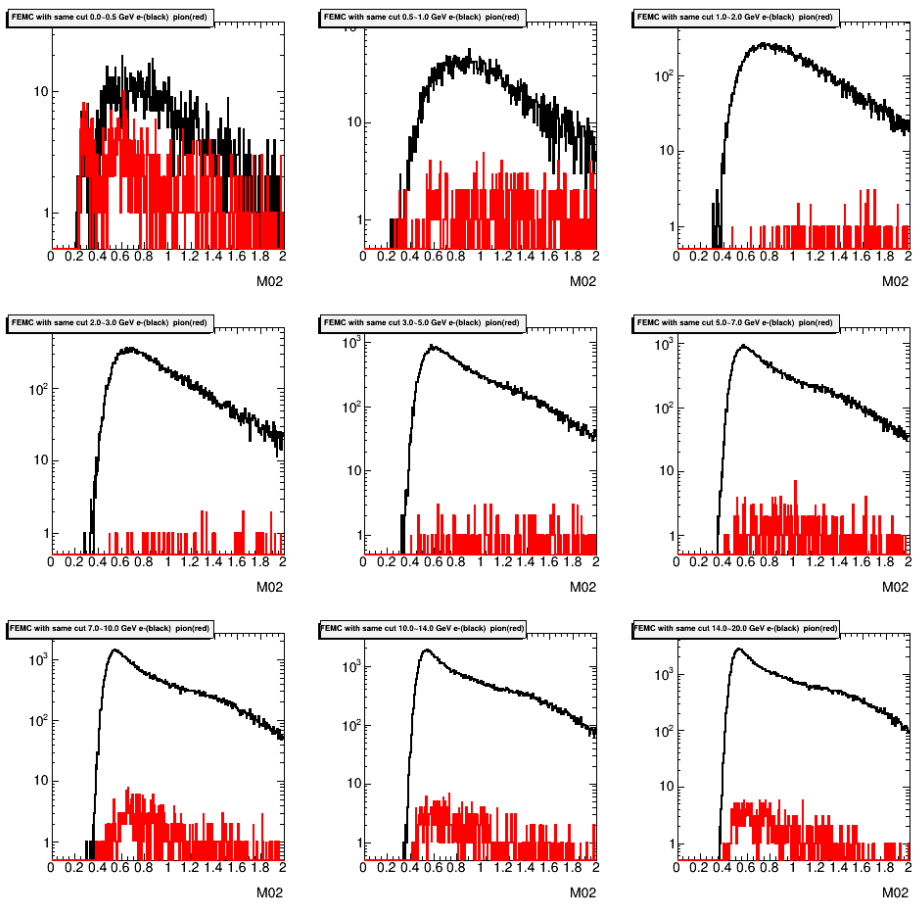

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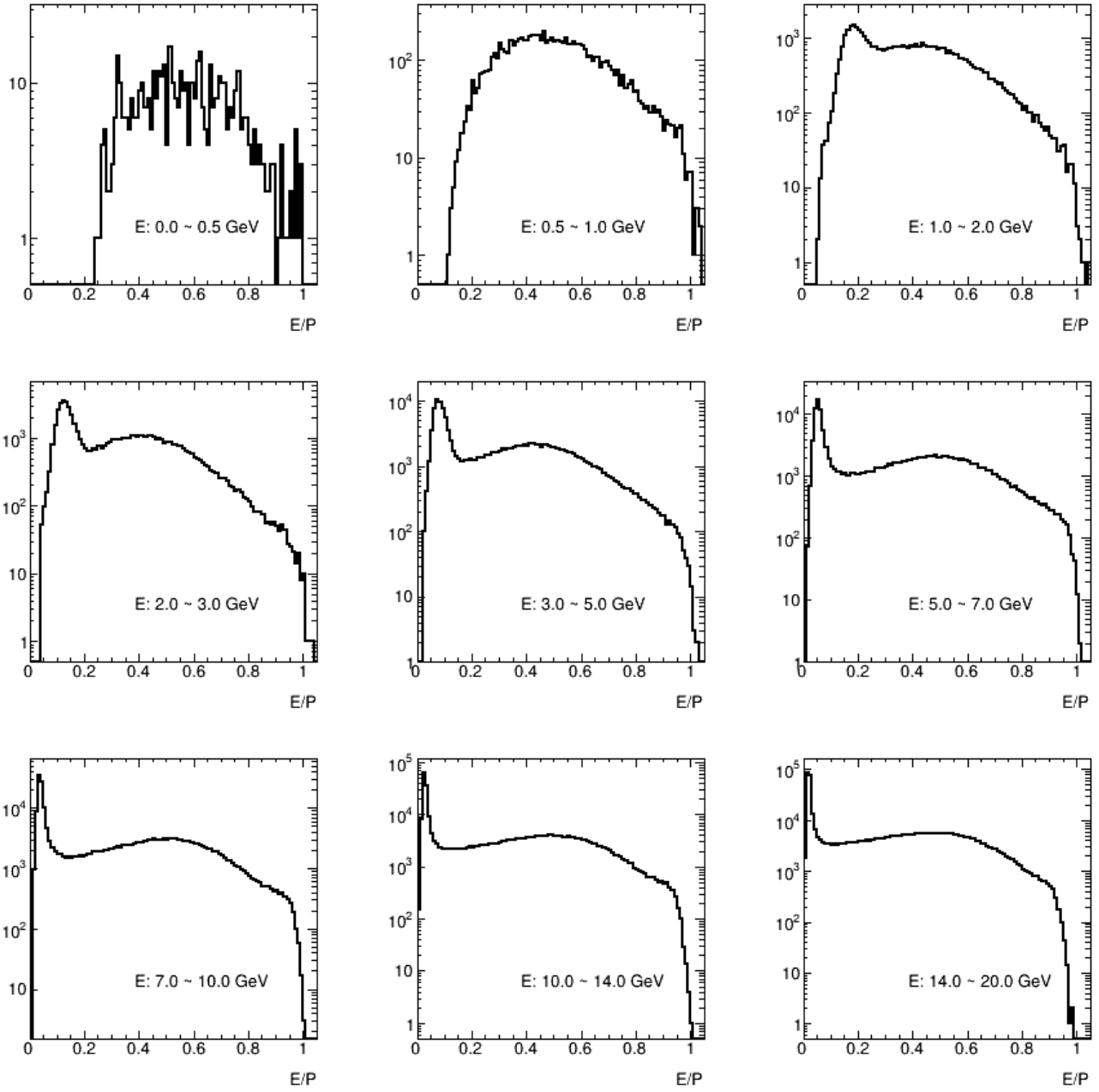
Pion rejection study

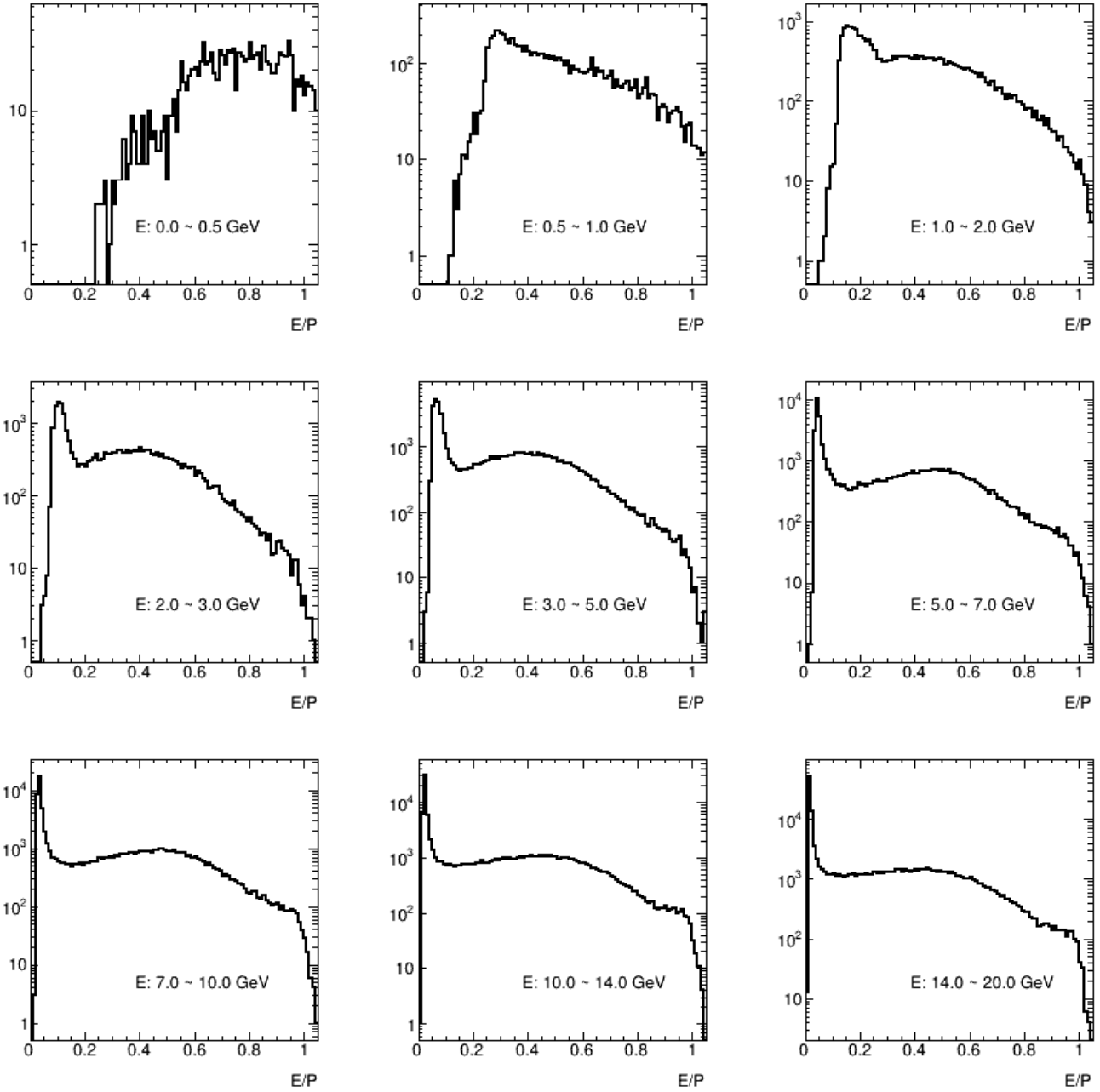


BECAL

E/P distribution of different bin

E: cluster energy
P: truth pion momentum

Pion rejection study



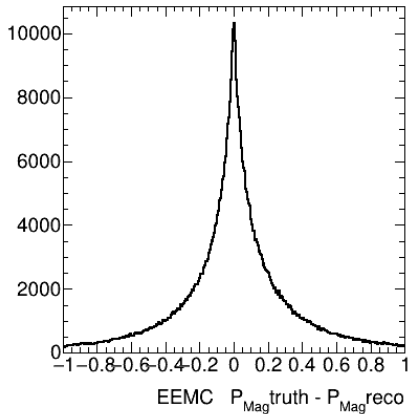
FEMC

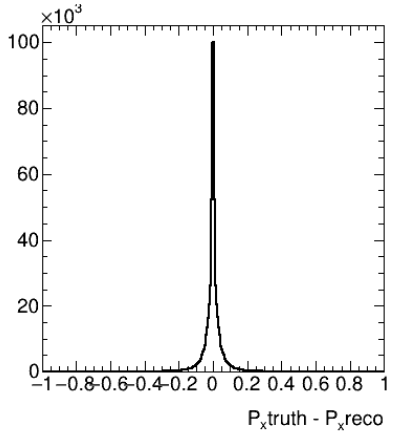
E/P distribution of different bin

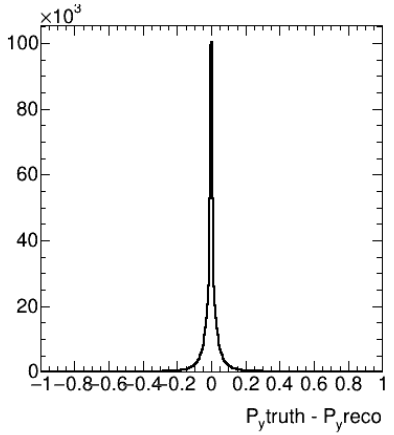
E: cluster energy
P: truth pion momentum

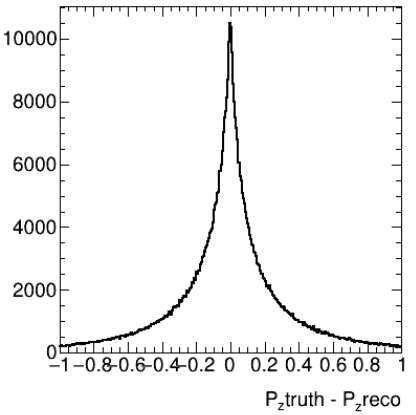
Pion rejection study

The difference of primary and reconstructed momentum of different detectors

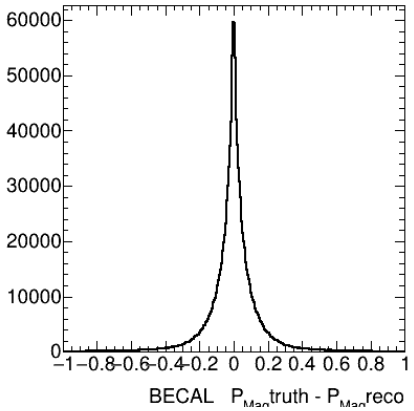


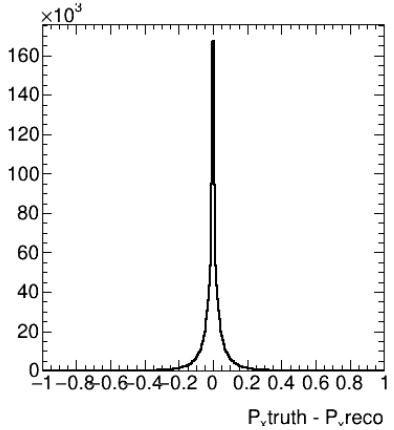


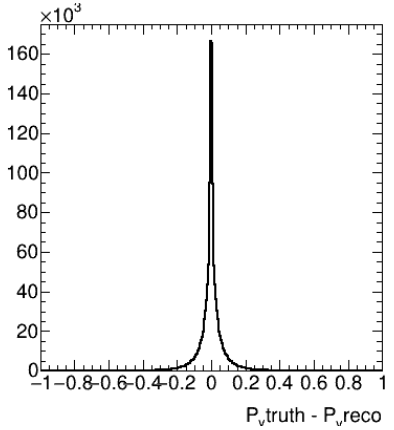


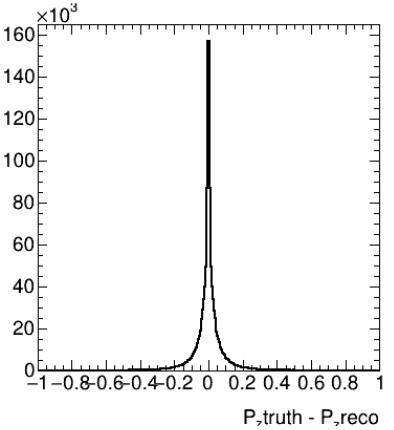


EEMC

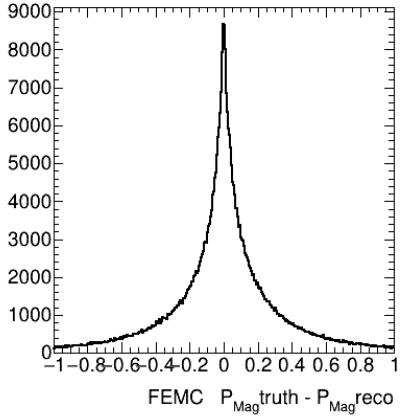


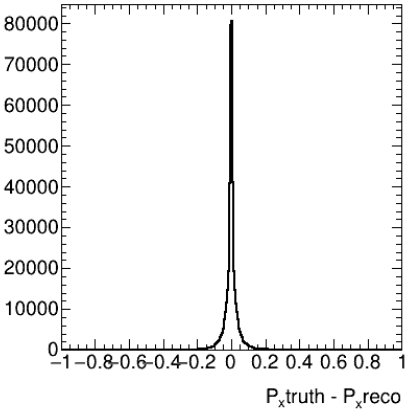


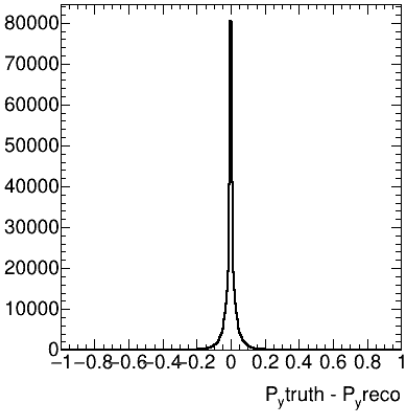


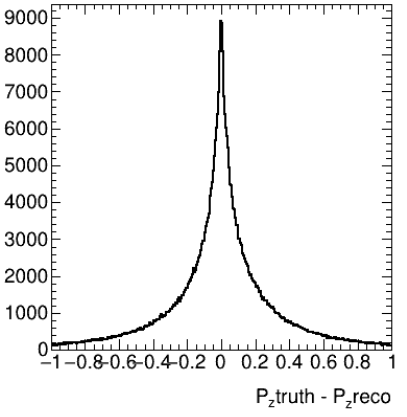


BECAL









FEMC