Update on Lepton ID

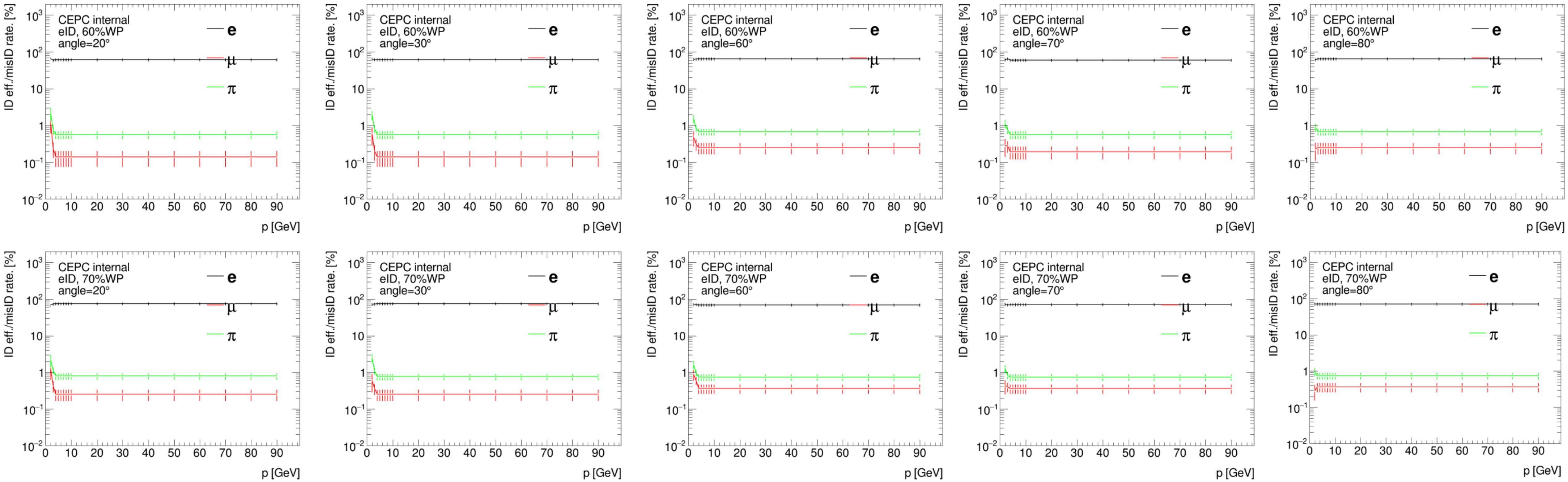
Changhua Hao, Ligang Xia

Nanjing University

Updates

- 1) More angles: 10, 20, 30, 45, 60, 70, 80, 90 degrees
- 2) Use the distance of the cluster in HCAL from the collision point for the mu ID to suppress pion faking
- 3) High-energy electrons have strange behavior at 90 degrees

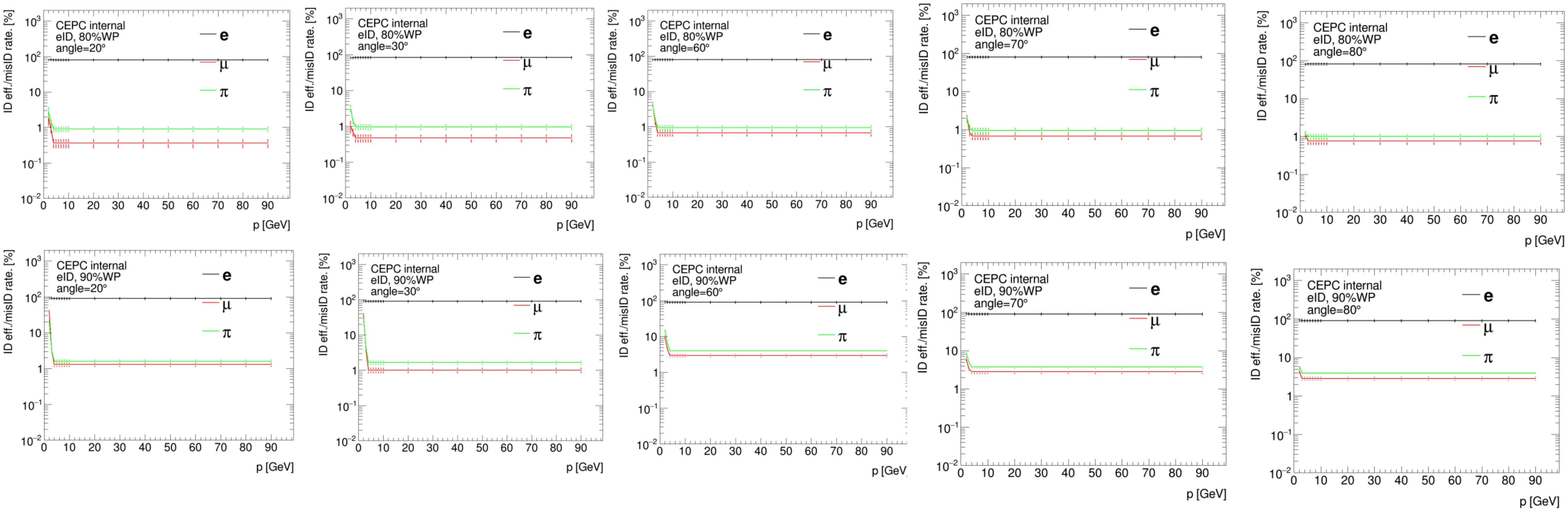
Electron ID Efficiency and background rejection power



WP=60： eID efficiency~60%； muon faking rate=0.14~0.23%； pion faking rate=0.57~0.76%

WP=70： eID efficiency~70%； muon faking rate=0.25~0.43%； pion faking rate=0.80~1.1%

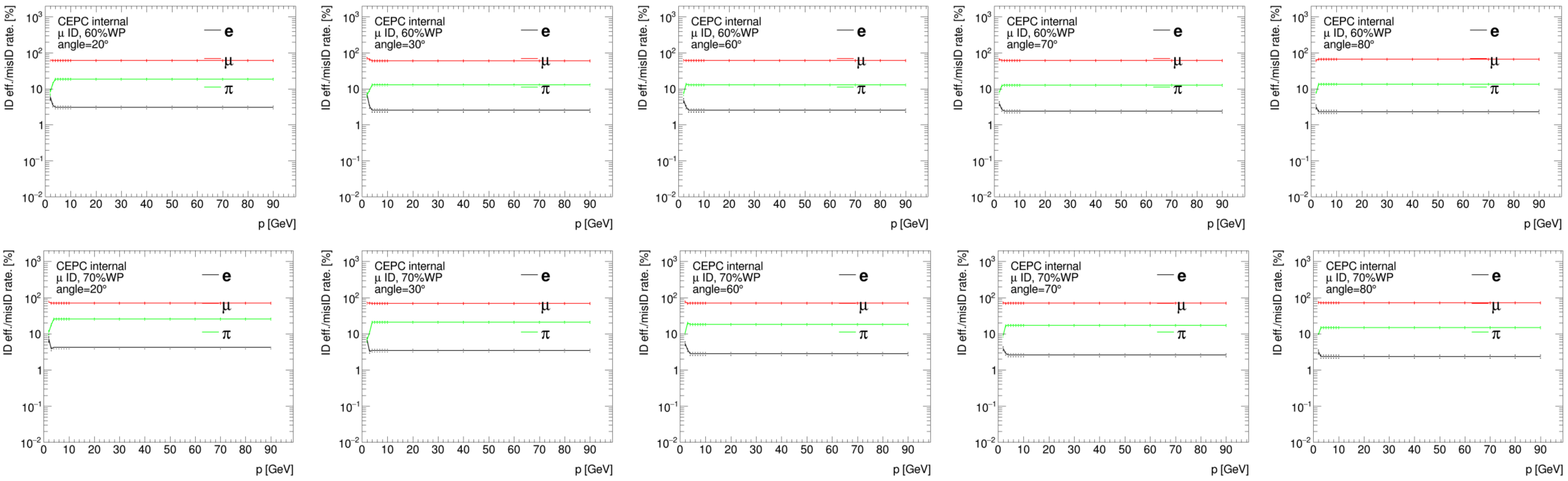
Electron ID Efficiency and background rejection power



WP=80：eID efficiency~80%；muon faking rate=0.36~0.91%；pion faking rate=0.91~1.4%
WP=90：eID efficiency~90%；muon faking rate=1.3~3.2%；pion faking rate=1.5~3.1%

- In the following 2 slides, the HCAL cluster position information is **not used**. So pi → mu faking rate is high.

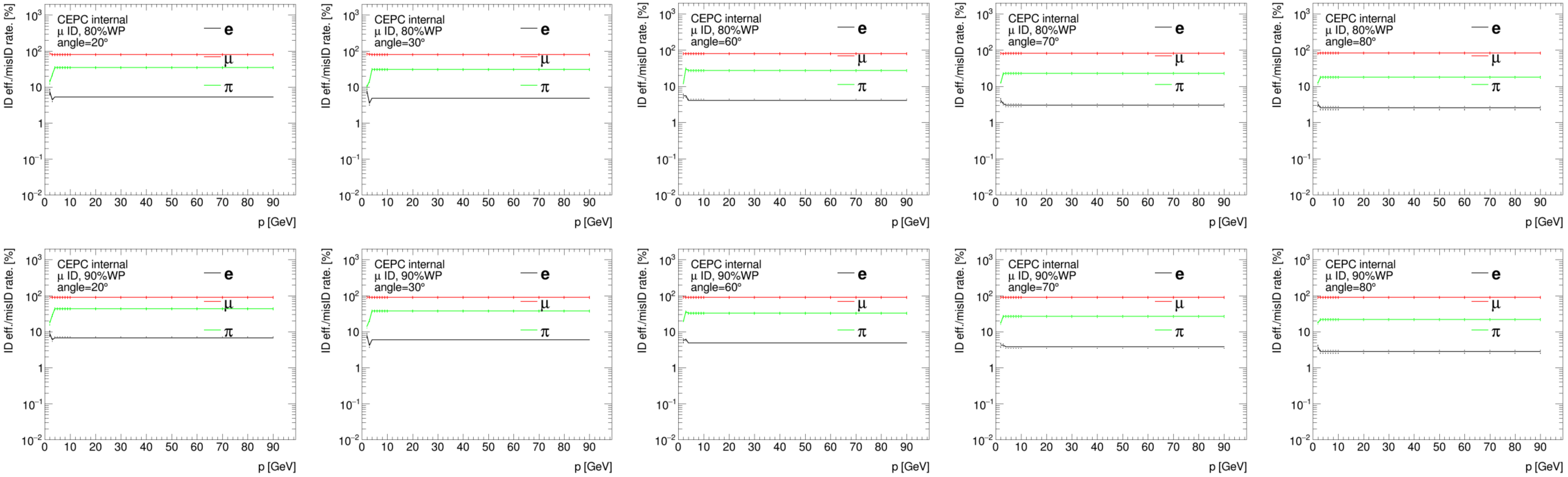
Muon ID Efficiency and background rejection power



WP=60：muID efficiency~60%；electron faking rate=3.0~3.5%；pion faking rate=14~18%

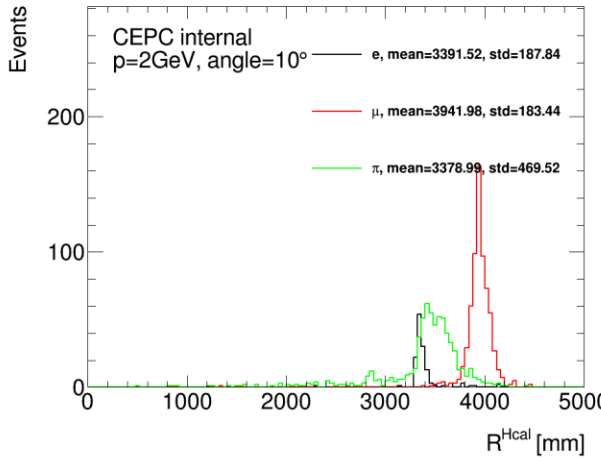
WP=70：muID efficiency~70%；electron faking rate=3.8~4.2%；pion faking rate=14~20%

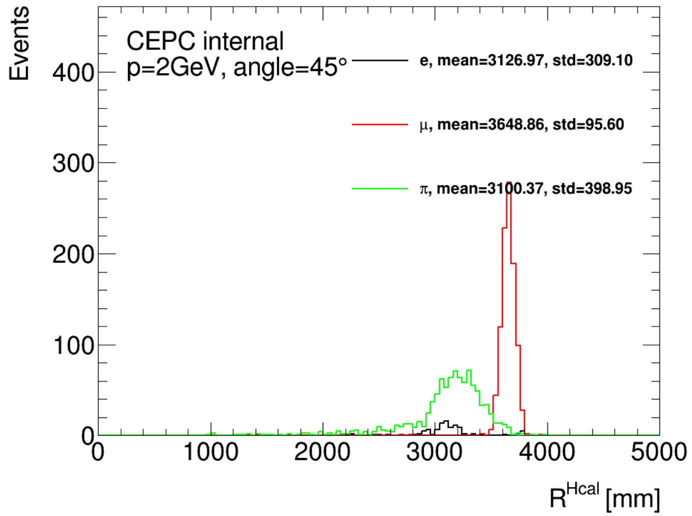
Muon ID Efficiency and background rejection power

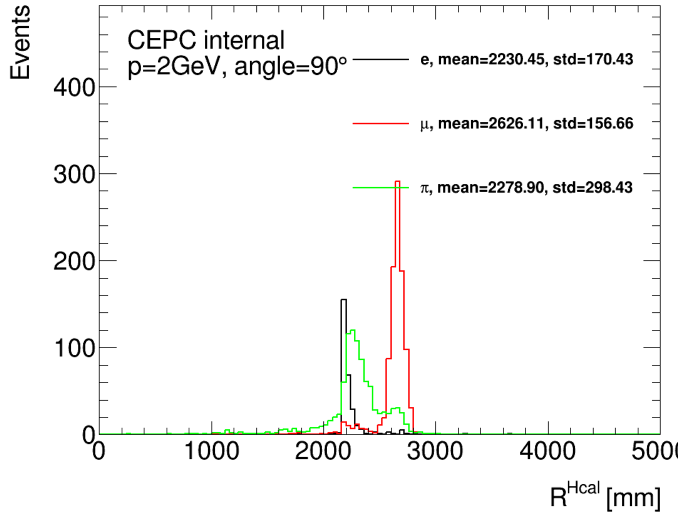


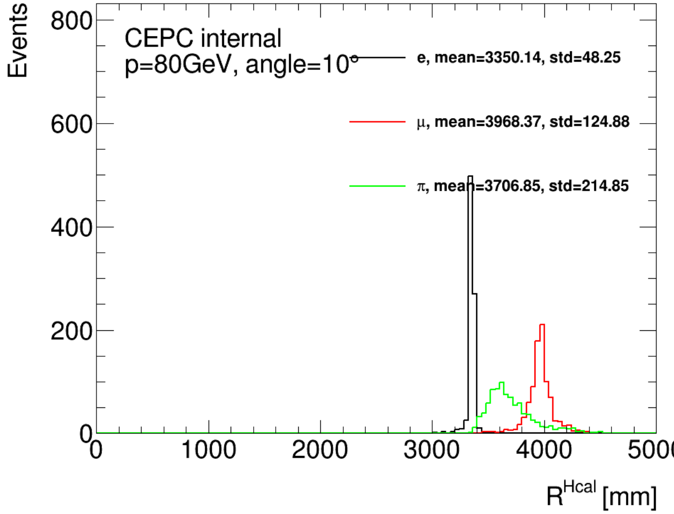
WP=80： muID efficiency~80%； electron faking rate=4.4~5.2%； pion faking rate=22~34%
WP=90： muID efficiency~90%； electron faking rate=6.0~6.7%； pion faking rate=28~43%

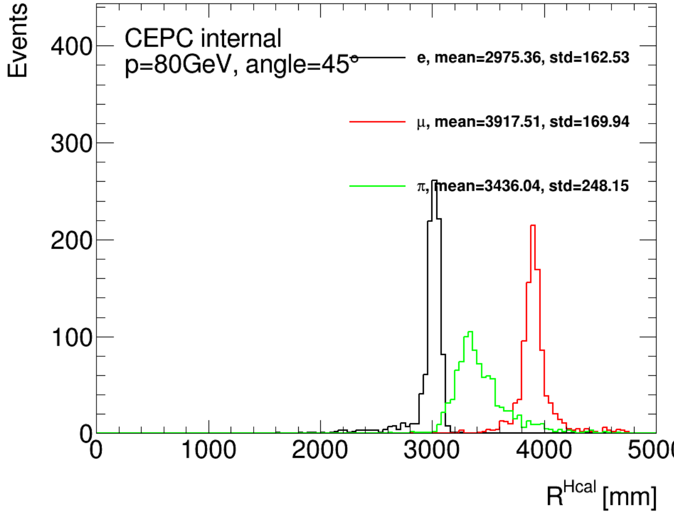
R=sqrt(x^2+y^2+z^2) is defined to suppress pi→mu faking rate

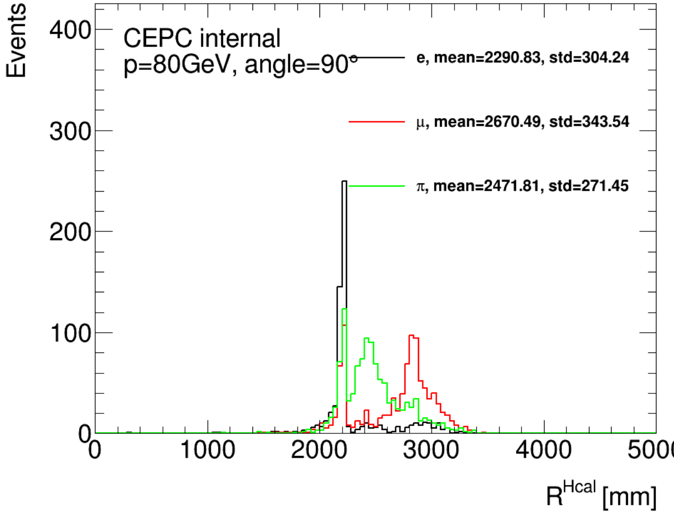






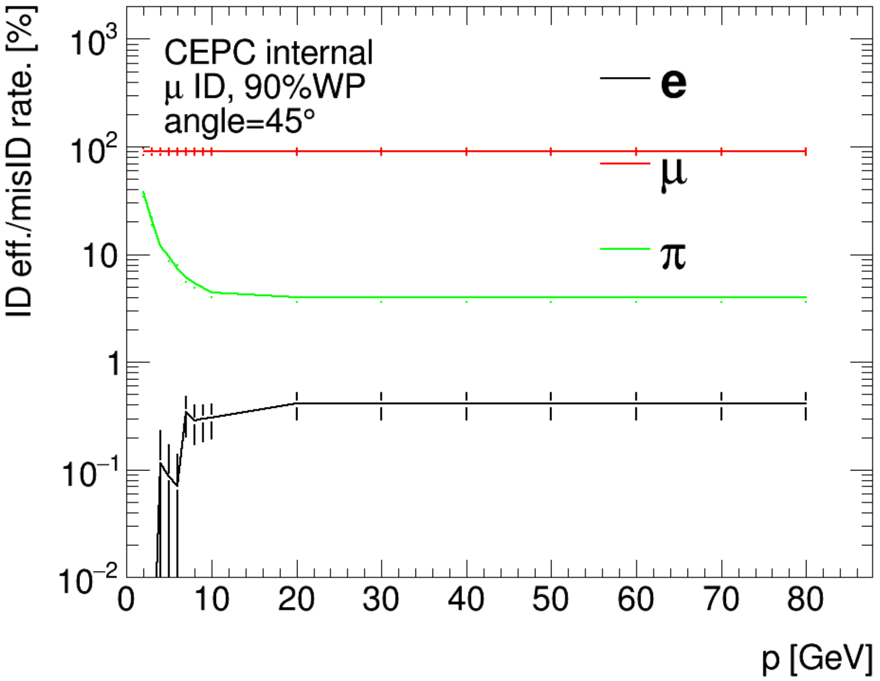


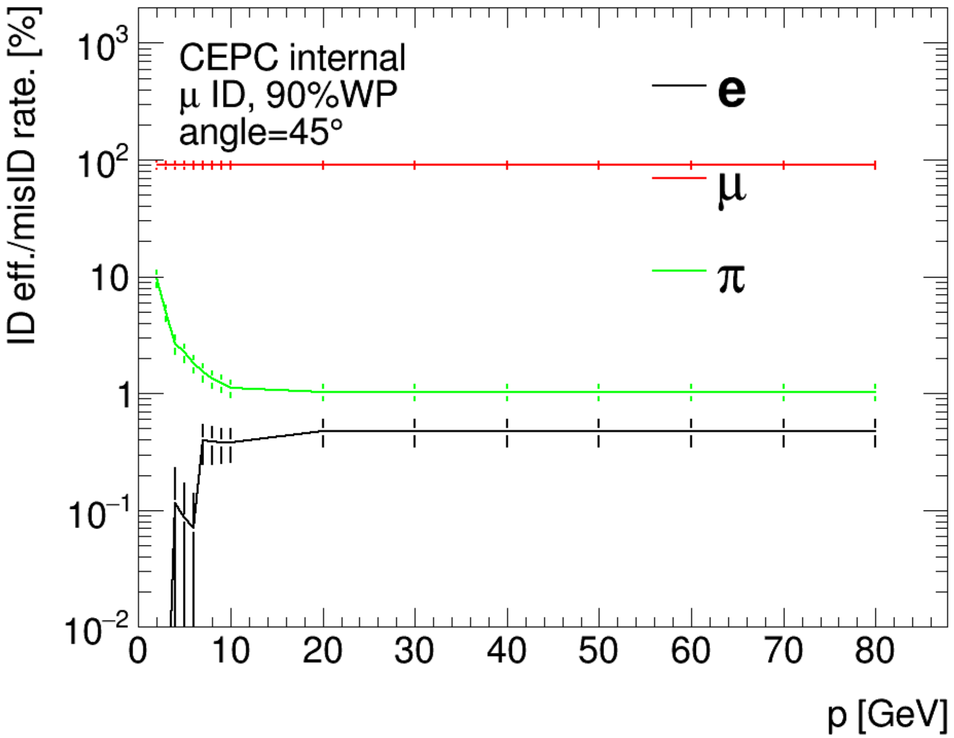




Use HCAL cluster position information: R

So it improves the muon ID!
Now it is compatible with the belle2 performance.

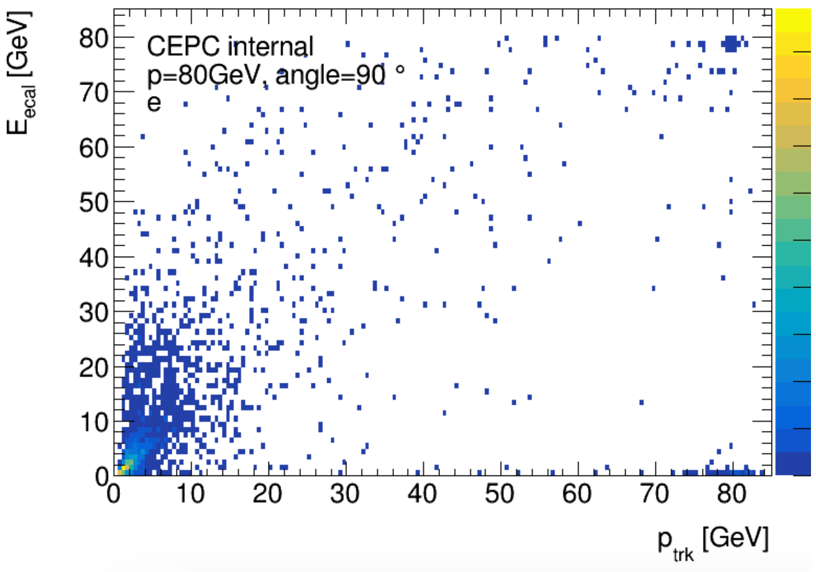


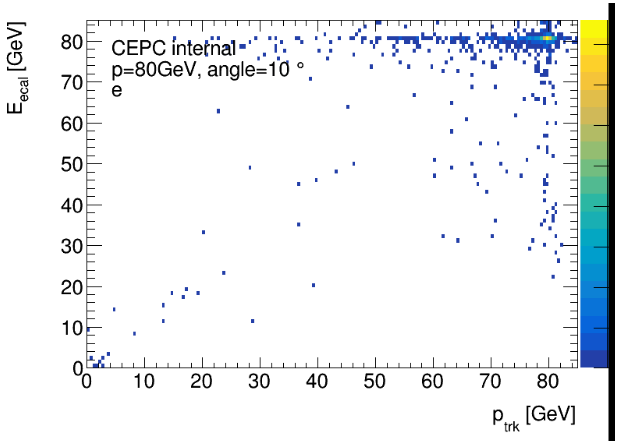


High-energy electrons have strange behavior at 90 degrees

```
root [3] RecClusters -> Scan("EcalClus_Escale: EcalClus_ptrk")
**********************************************
*    Row   * Instance * EcalClus_ *  EcalClus *
**********************************************
*        0 *        0 * 44.633419 *       -99 *
*        0 *        1 * 11.853218 *       -99 *
*        0 *        2 * 1.4521493 *       -99 *
*        0 *        3 * 1.9581376 *       -99 *
*        0 *        4 * 2.0132775 *       -99 *
*        0 *        5 * 5.5196671 * 4.6200199 *
*        0 *        6 * 0.3351255 * 82.548378 *
*        0 *        7 * 4.6821360 * 80.383293 *
*        1 *        0 * 14.571101 *       -99 *
*        1 *        1 * 0.7703134 *       -99 *
*        1 *        2 * 2.4197115 * 2.6498141 *
*        1 *        3 * 2.4097900 *       -99 *
*        1 *        4 * 0.7135742 *       -99 *
*        1 *        5 * 0.7872552 *       -99 *
*        1 *        6 * 0.5370724 *       -99 *
*        1 *        7 * 22.041257 * 4.7981500 *
*        1 *        8 * 2.4374325 *       -99 *
*        1 *        9 * 21.323782 *       -99 *
*        1 *       10 * 6.8366298 *       -99 *
*        1 *       11 * 13.277712 * 8.9585189 *
*        1 *       12 * 8.2117967 *       -99 *
*        1 *       13 * 8.1258878 * 1.9261008 *
*        1 *       14 * 1.0107168 *       -99 *
*        1 *       15 * 0.7958690 *       -99 *
*        1 *       16 * 0.2996896 *       -99 *
```

Ecal Energy,   Track momentum





this is 10 degrees
for comparison purpose.

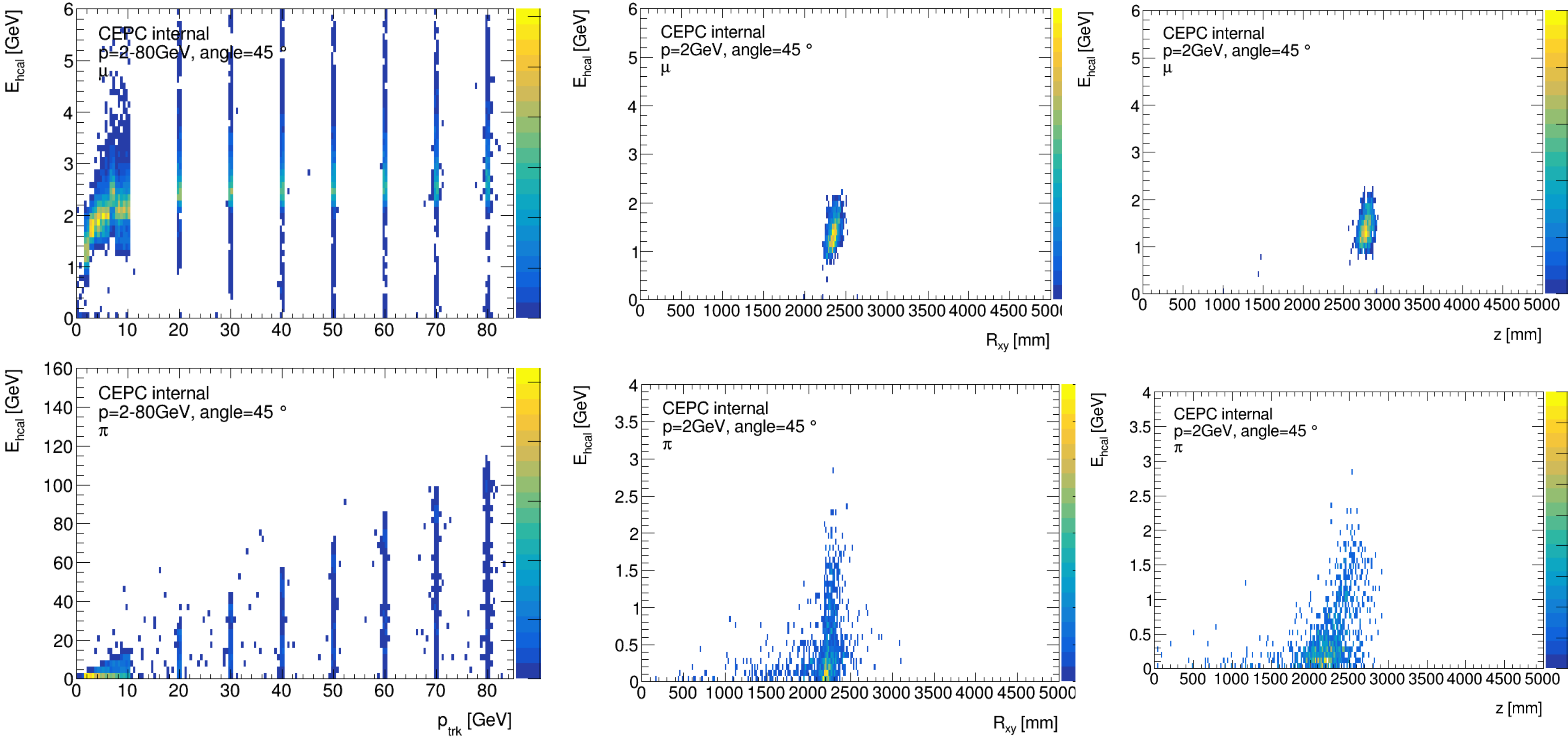
My first thoughts:

1) It seems high-energy electrons moving in 90 degrees (purcendicular to the beam direction) would likely break down into small pieces (EM shower?) Also also it is difficult to find an associated track (see many -99 on the screenshot).
2) I assume electrons moving in 90 degrees would meet more materials than in 10 degrees
3) Apparently it needs a more careful reconstruction of a high-energy electron track to collection EM shower (gamma-conversion) and also Ecal energy.
4) Moreover, high-energy electrons will likely arrive on HCAL as ECAL is not able to stop them completely (because ECAL is the thinnest at 90 degrees).

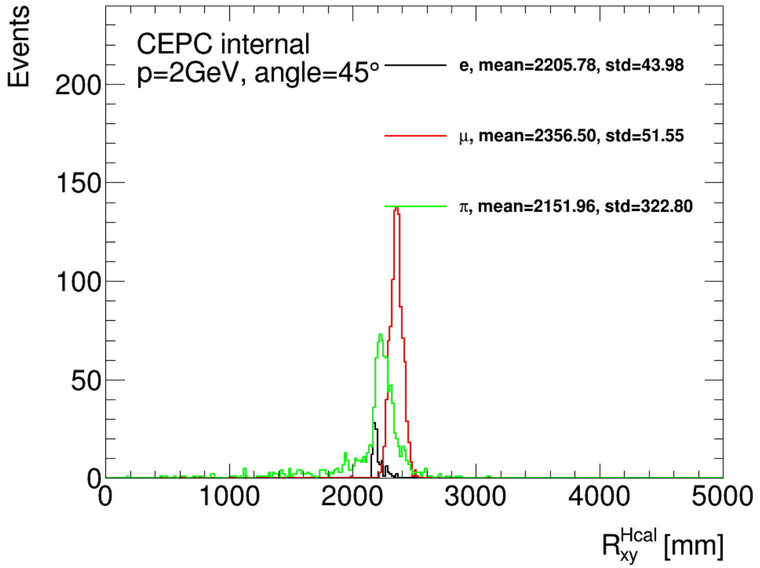
- BACK UP

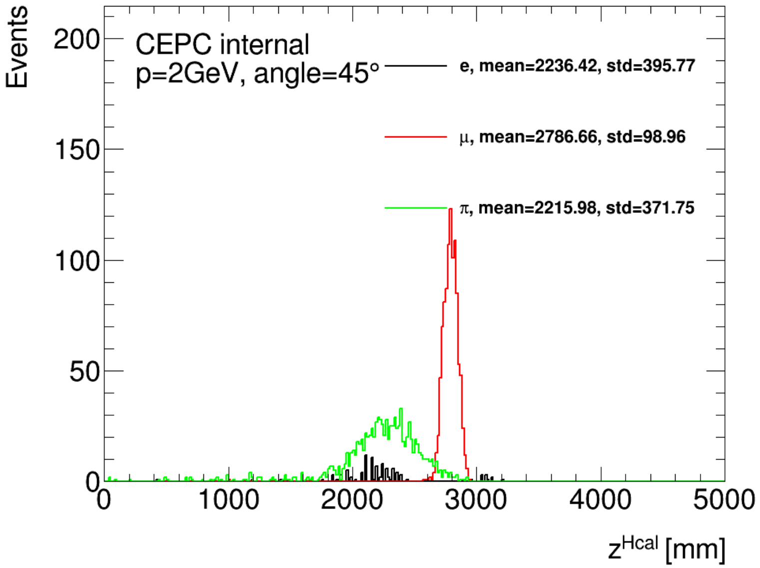
Hcal energy X 4

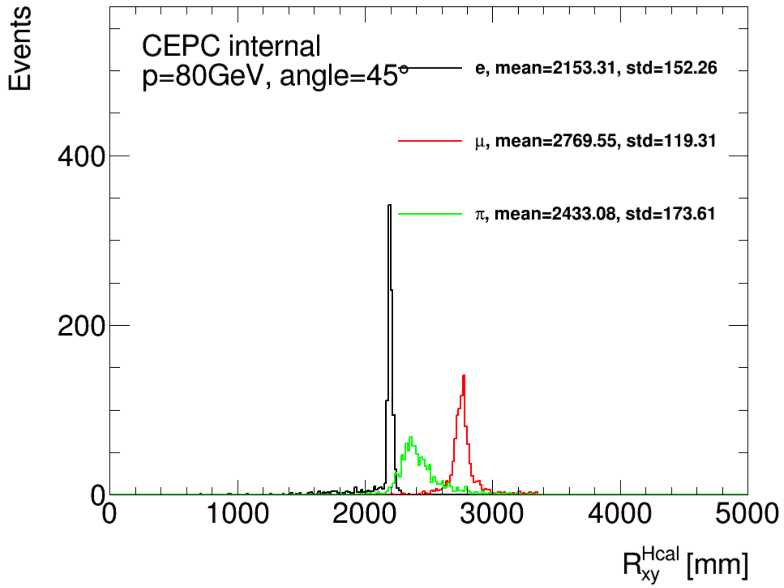
Hcal cluster position is a good discriminant for mu/pi separation.

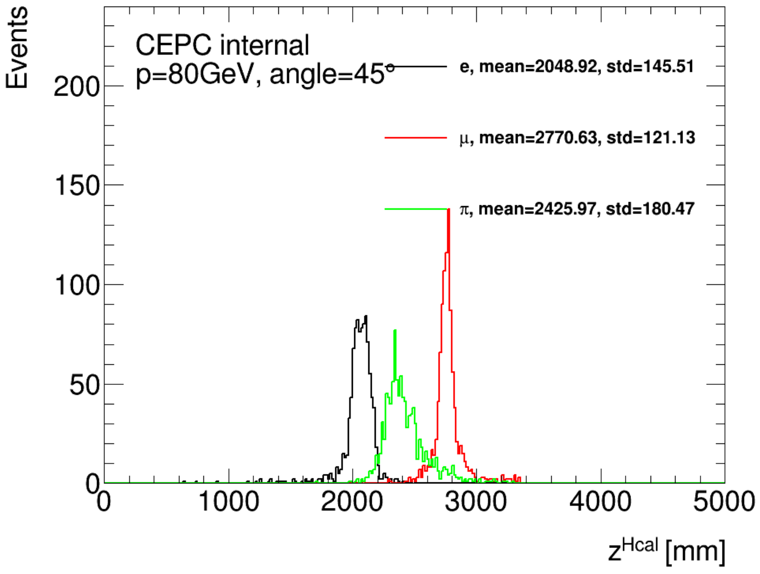


mu/pi separation









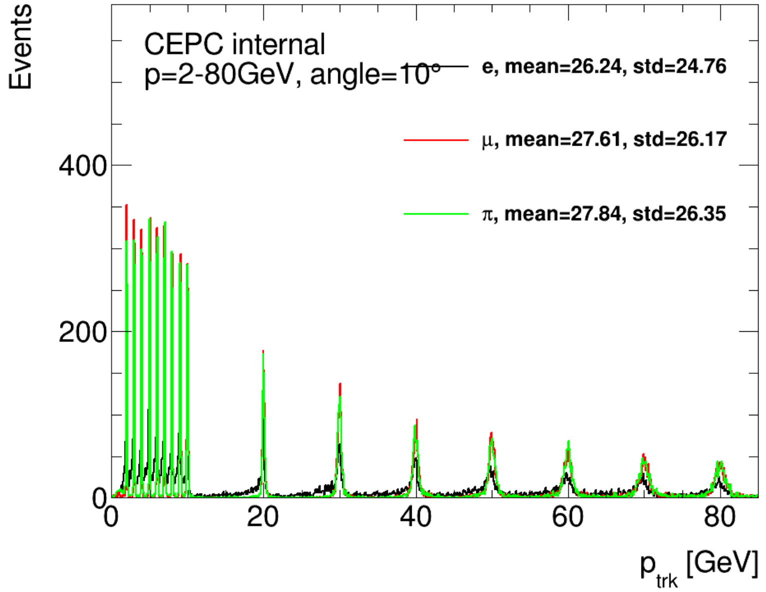
- Hcal cluster position should be very powerful to separate mu from pi.
- Fangyi is concerned that the good separation is due to bad calibration/misalignment in Hcal.
- Use energy only for mu ID for the moment.
- High-energy electrons will also go to Hcal.
- These should be studied further in the future.

Angle=10 degrees

- Particles are moving closer to the beams
- It’s more likely to fail reconstructing dN/dx and TOF. Expected?

```
...................working on 0
tpc_chi2s = []
tof_chi2s = [0.009367692666300597, 0.12117647970013272, 0.28633111954138984, 30.327683594966462, 359.28525058422343]
tpc_chi2s = []
tof_chi2s = []
tpc_chi2s = []
tof_chi2s = [1.5390786963127456, 2.2342075604832177, 2.8352238877863645, 45.03210915465941, 412.0889504680022]
tpc_chi2s = []
tof_chi2s = [0.04416259631882931, 0.2171790620363473, 0.4308707247522208, 32.68619476199803, 376.13482679761927]
tpc_chi2s = []
tof_chi2s = [0.8708062872284047, 0.45742399356464825, 0.23545100764064153, 21.107632102013397, 335.61223299598294]
tpc_chi2s = []
tof_chi2s = []
tpc_chi2s = []
tof_chi2s = [0.18179986248883093, 0.4686415365117571, 0.7685674413310041, 35.792905950239486, 391.1418385379478]
tpc_chi2s = []
tof_chi2s = [18872.337293939323, 18853.602311454684, 18839.670026540025, 18471.604204638177, 17498.398389509668]
tpc_chi2s = []
tof_chi2s = [1.8984920788050923, 1.2659084347636917, 0.8781183079562397, 16.503488630607535, 309.10699592955825]
tpc_chi2s = [0.6674849390983582, 0.20279456675052643, 0.6112053990364075, 1.2885851860046387, 1.5267596244812012]
tof_chi2s = [1390.9604940204672, 1345.2363929058235, 1311.7662084235208, 587.2851781177436, 41.320849332509525]
```

p(trk)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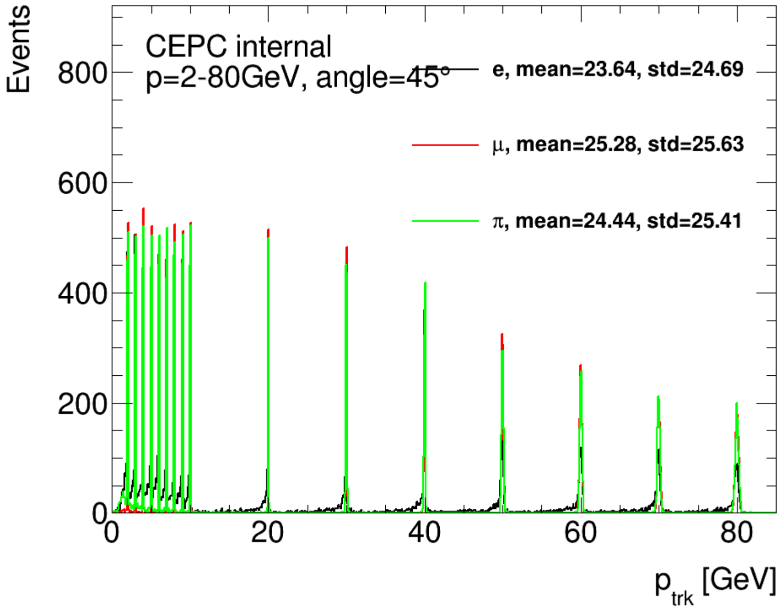
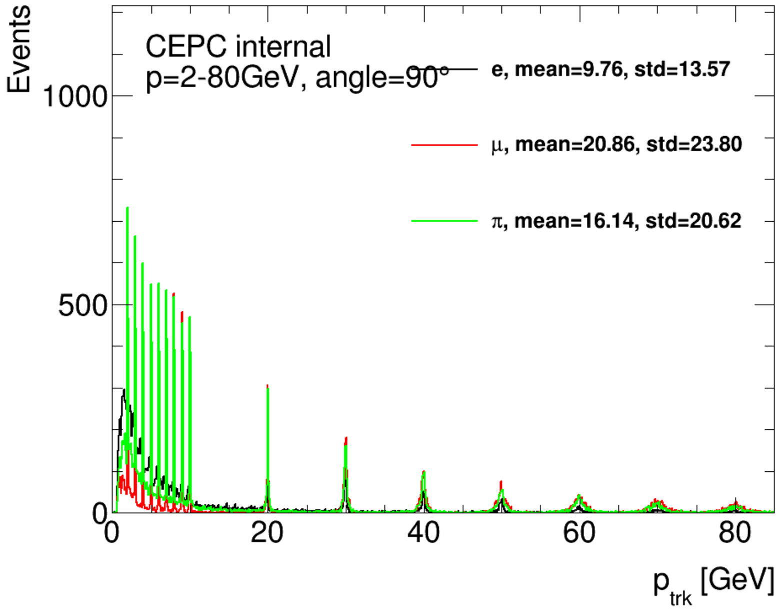
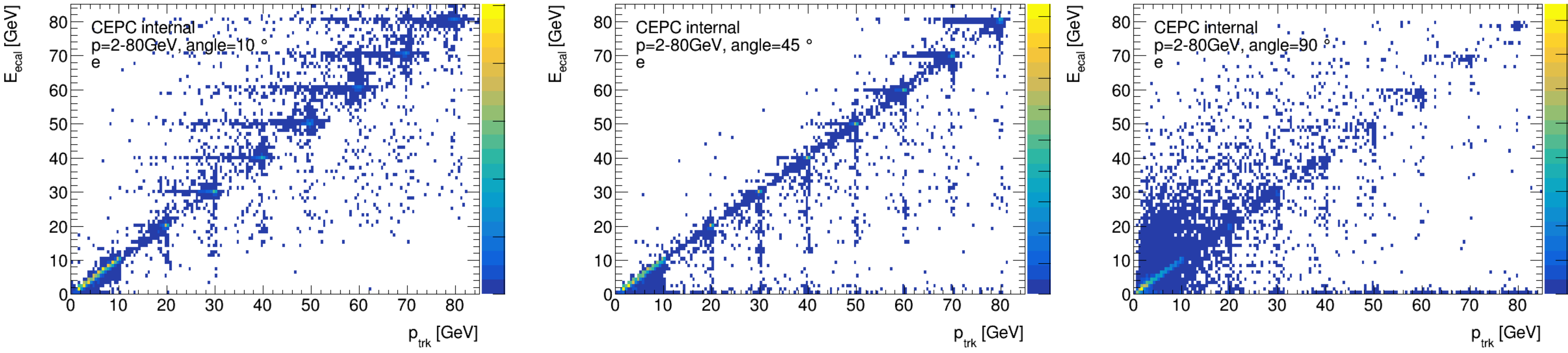
CEPC internal
p=2-80GeV, angle=10°
e, mean=26.24, std=24.76
μ, mean=27.61, std=26.17
π, mean=27.84, std=26.35
0
200
400
0
20
40
60
80
p_trk [GeV]

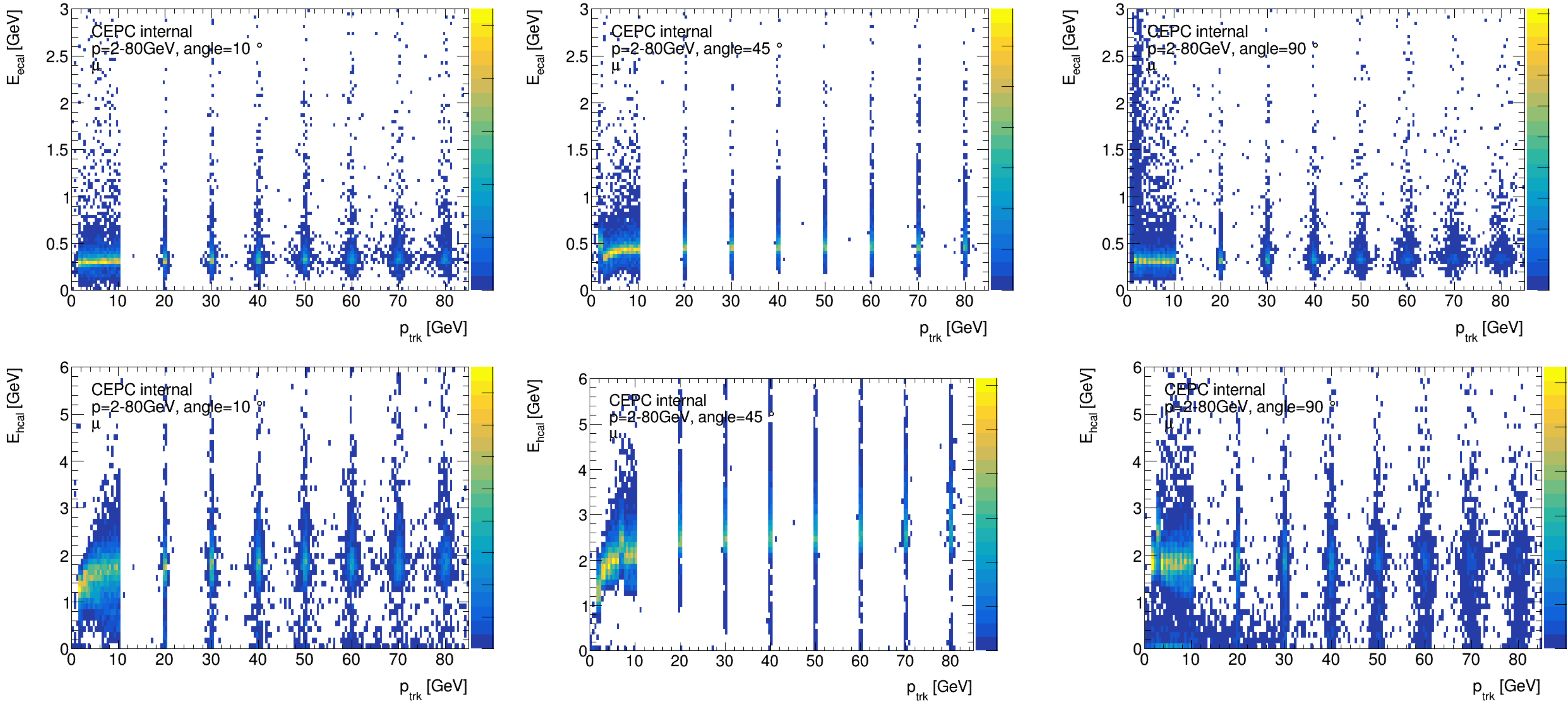

Events
CEPC internal
p=2-80GeV, angle=45°
e, mean=23.64, std=24.69
μ, mean=25.28, std=25.63
π, mean=24.44, std=25.41
0
200
400
600
800
0
20
40
60
80
p_trk [GeV]


Events
CEPC internal
p=2-80GeV, angle=90°
e, mean=9.76, std=13.57
μ, mean=20.86, std=23.80
π, mean=16.14, std=20.62
0
500
1000
0
20
40
60
80
p_trk [GeV]

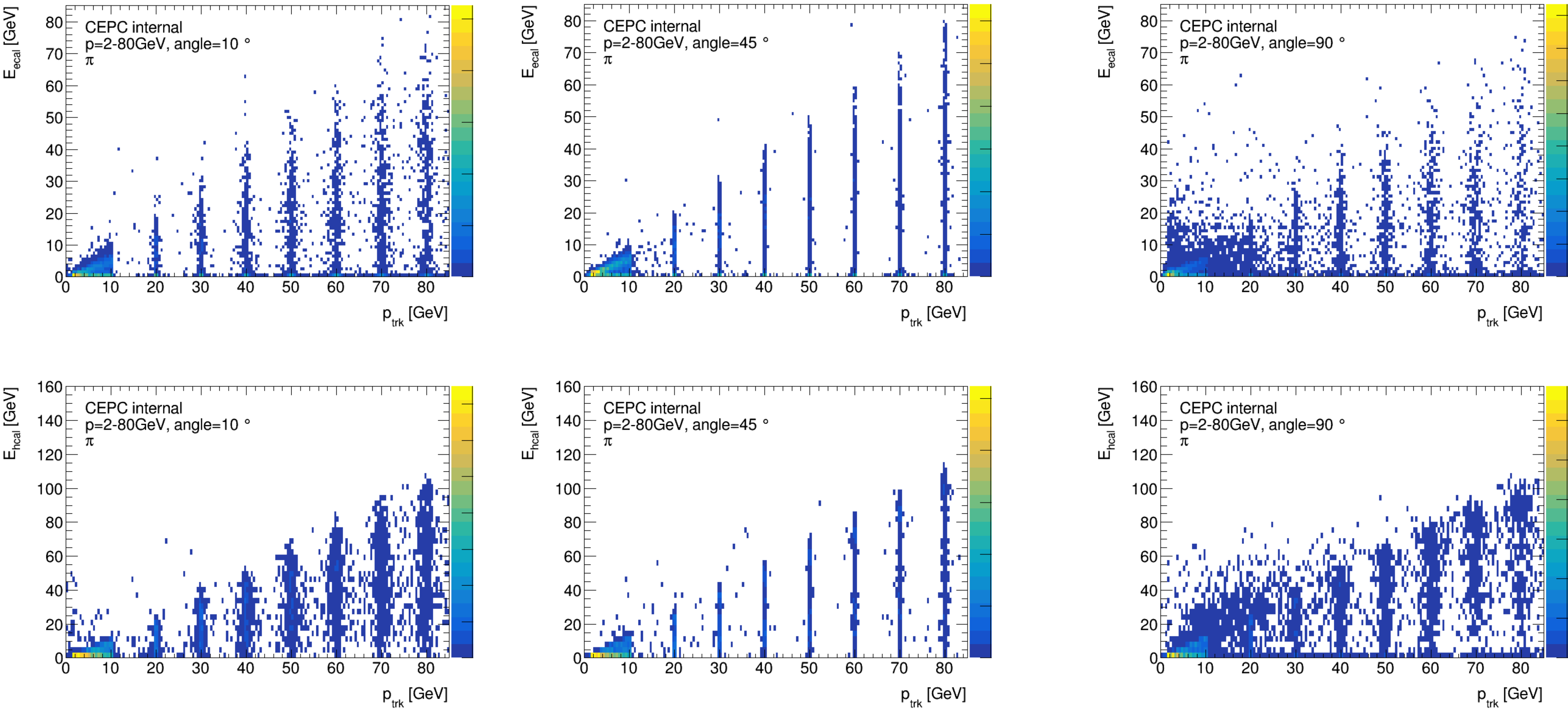
electron: E(ecal) v.s. p(trk)



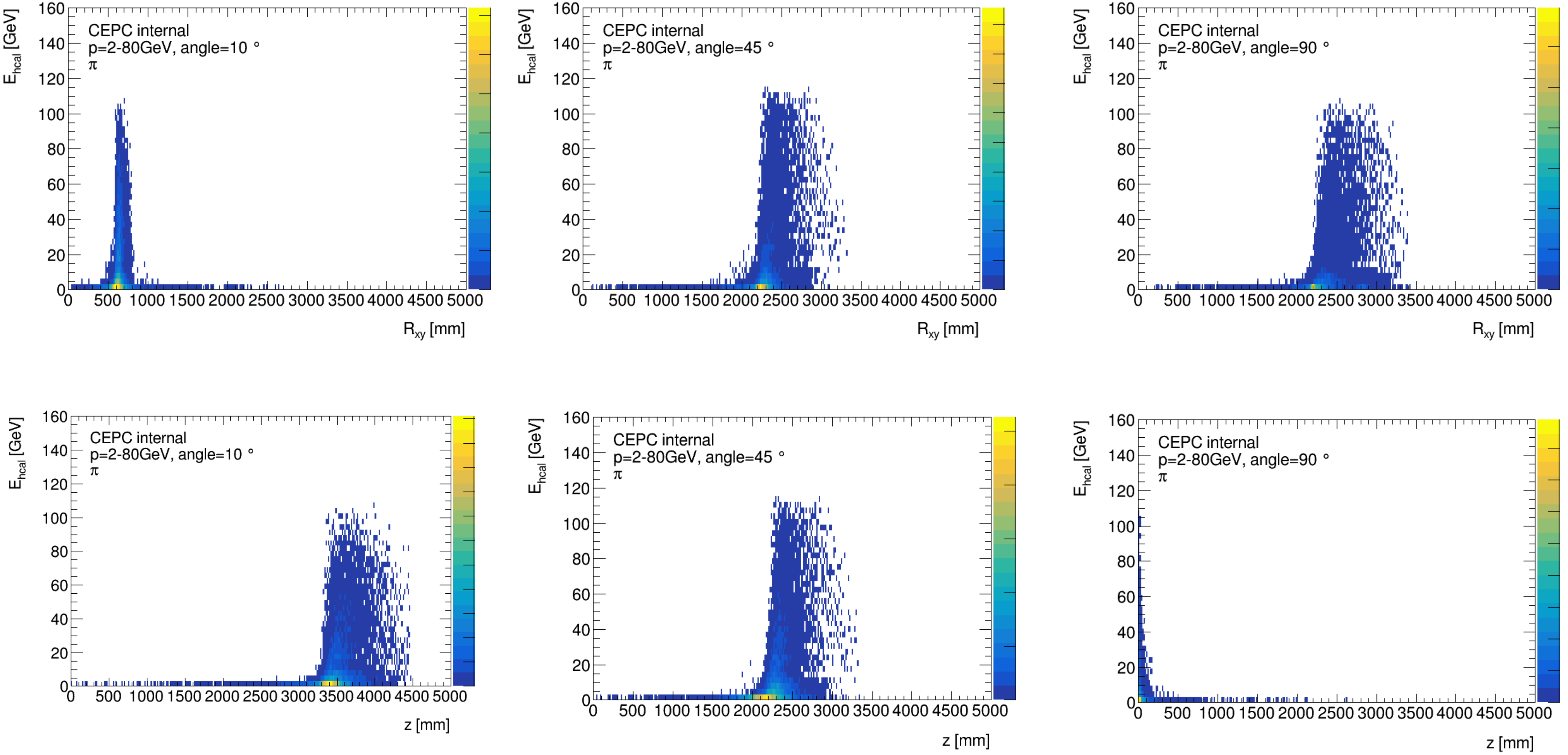
muon: E(ecal/hcal) v.s. p(trk)



pion: E(ecal/hcal) v.s. p(trk)



pion Hcal cluster position: Rxy and z



Summary

- First look at lepton ID at angle=10 and 90 degrees.
- They would be available soon this afternoon.