

中國科學院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

Updates on PID

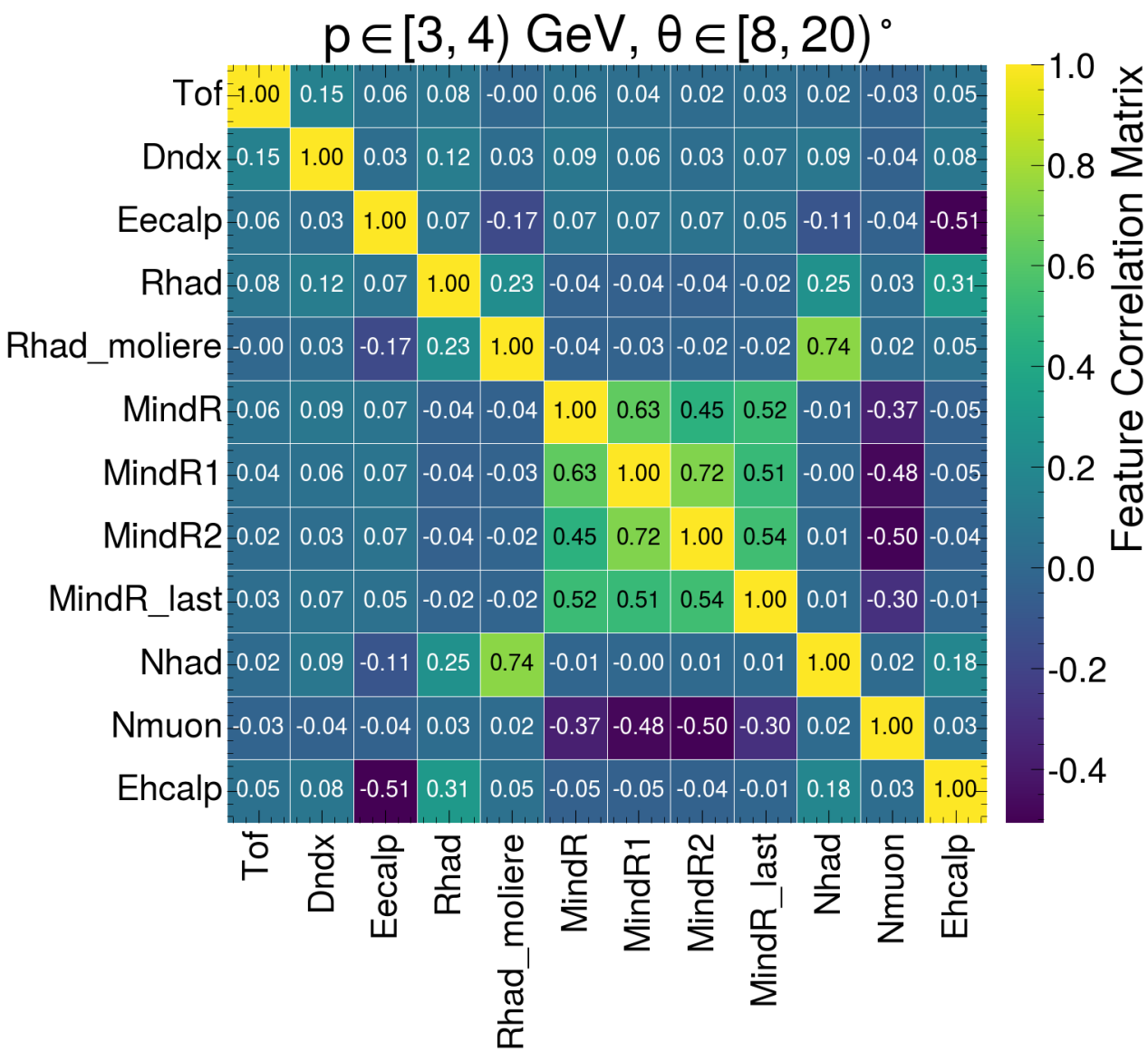
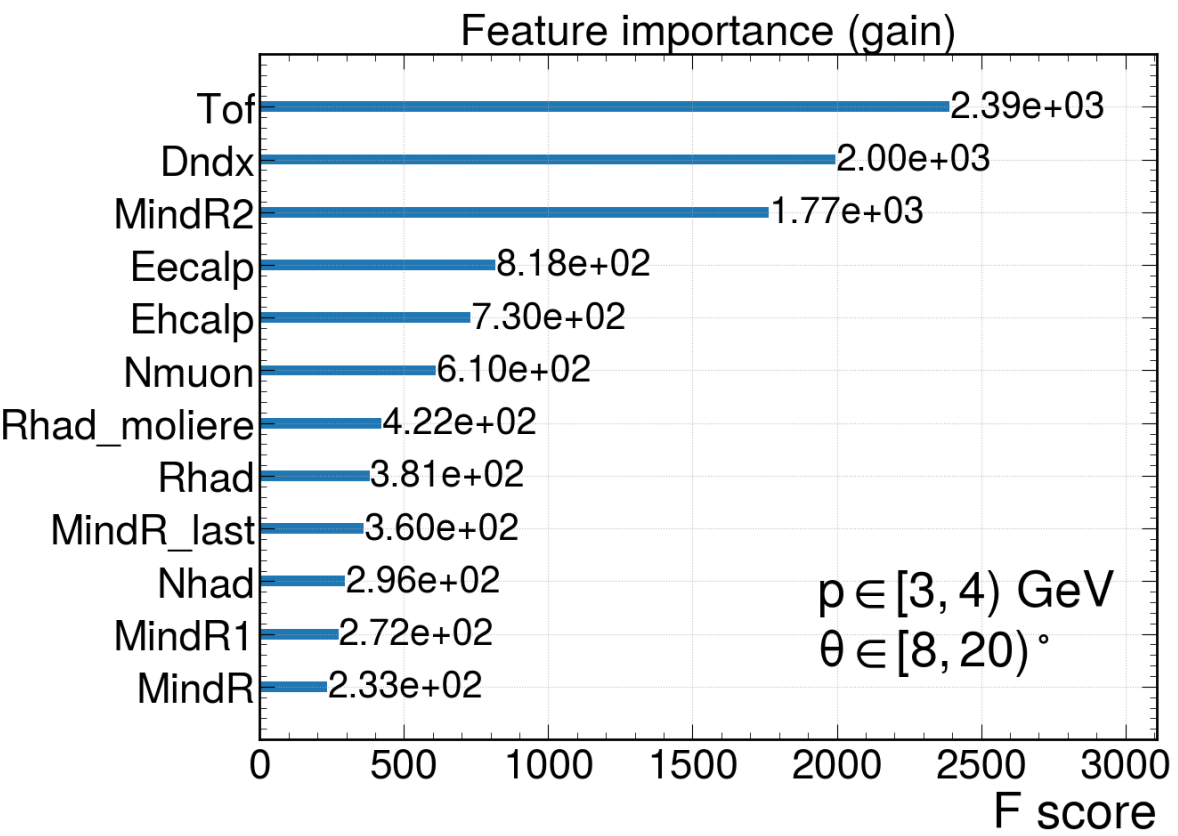
Geliang Liu

Apr. 16th, 2025

Charged PID: importance and correlation

$p = 3-4 \text{ GeV}, \theta = 8-20^\circ$

Features

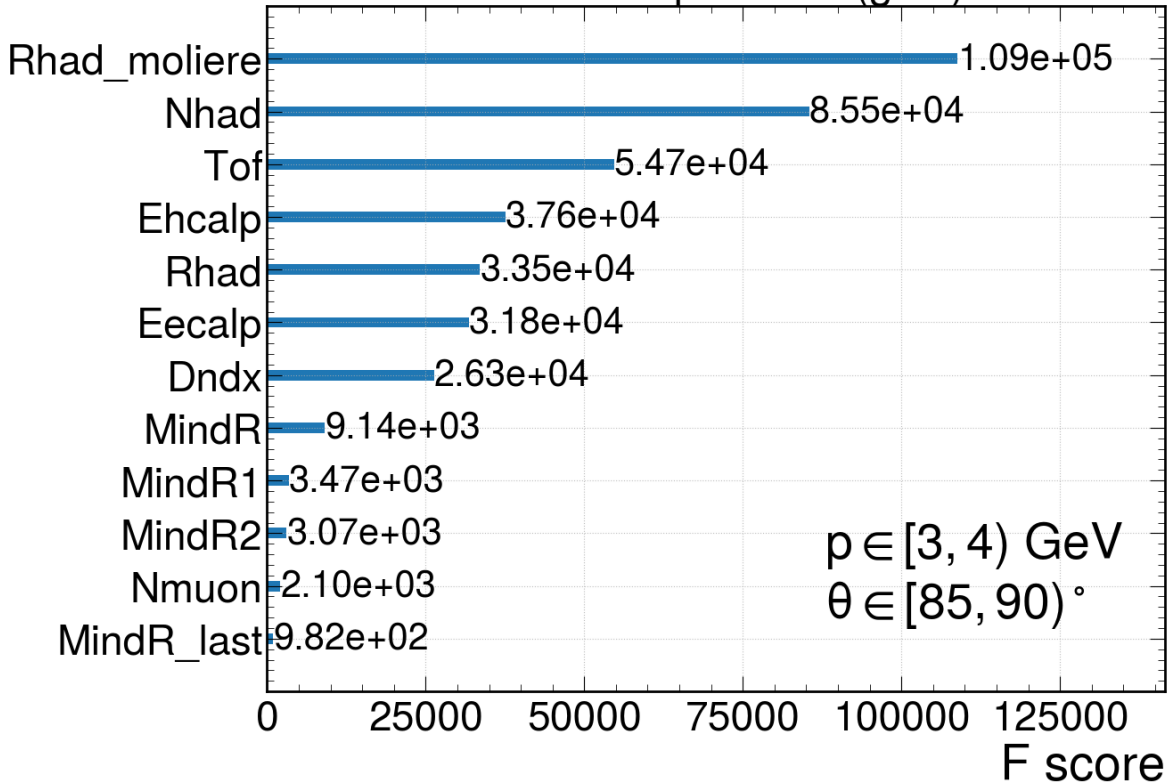


Charged PID: importance and correlation

$p = 3-4 \text{ GeV}, \theta = 85-90^\circ$

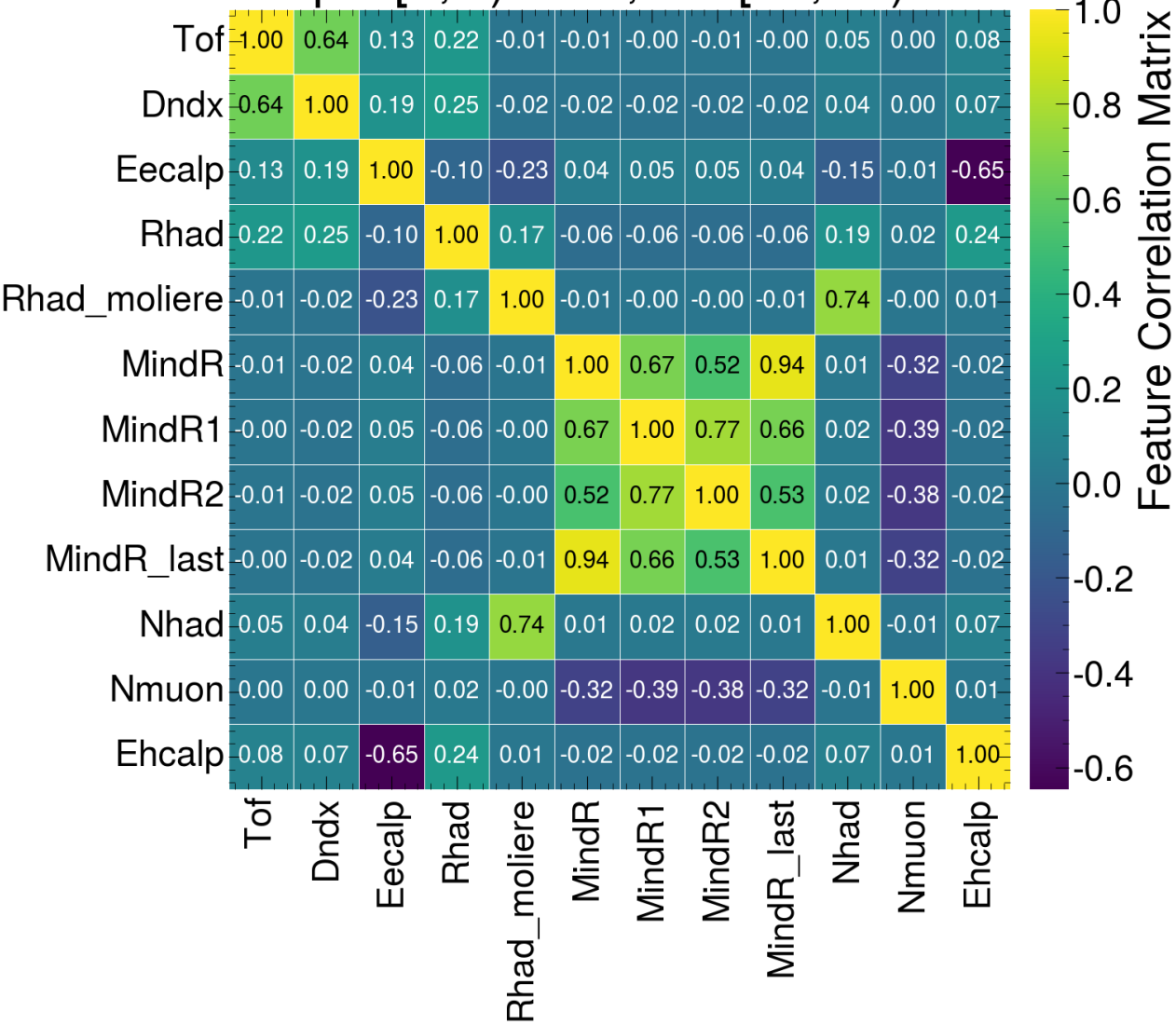
Features

Feature importance (gain)



$p \in [3, 4) \text{ GeV}$
 $\theta \in [85, 90)^\circ$

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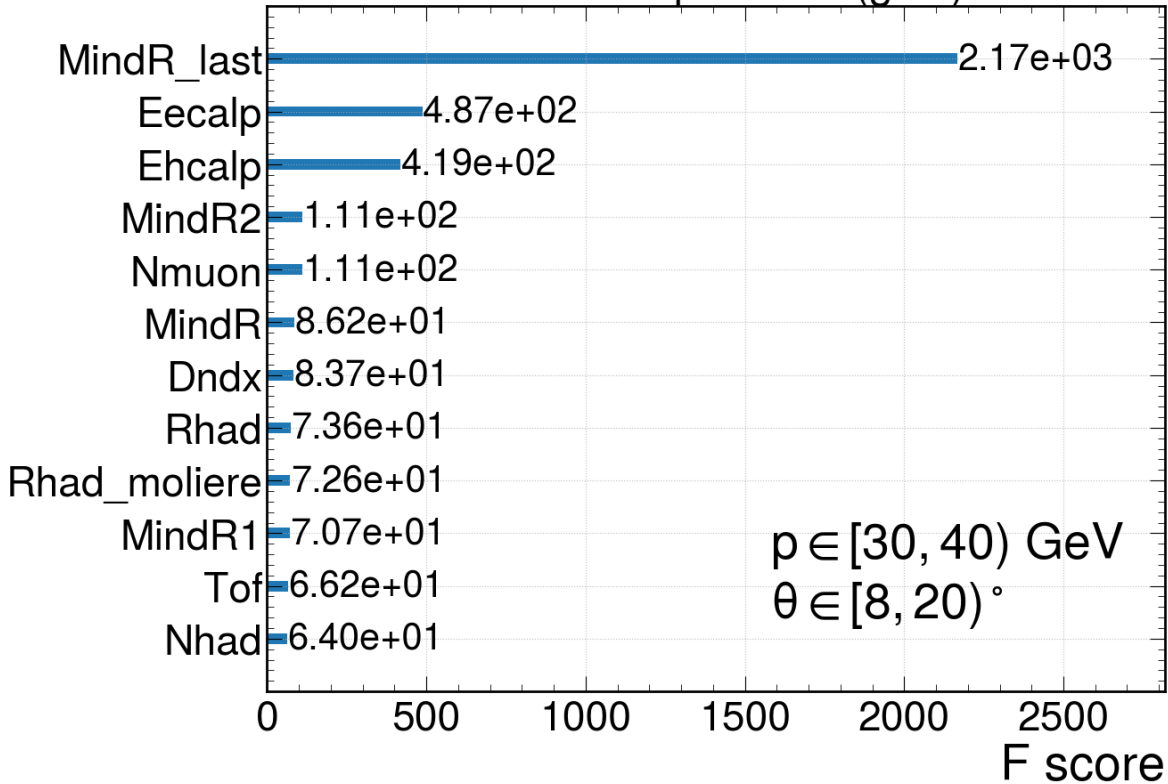


Charged PID: importance and correlation

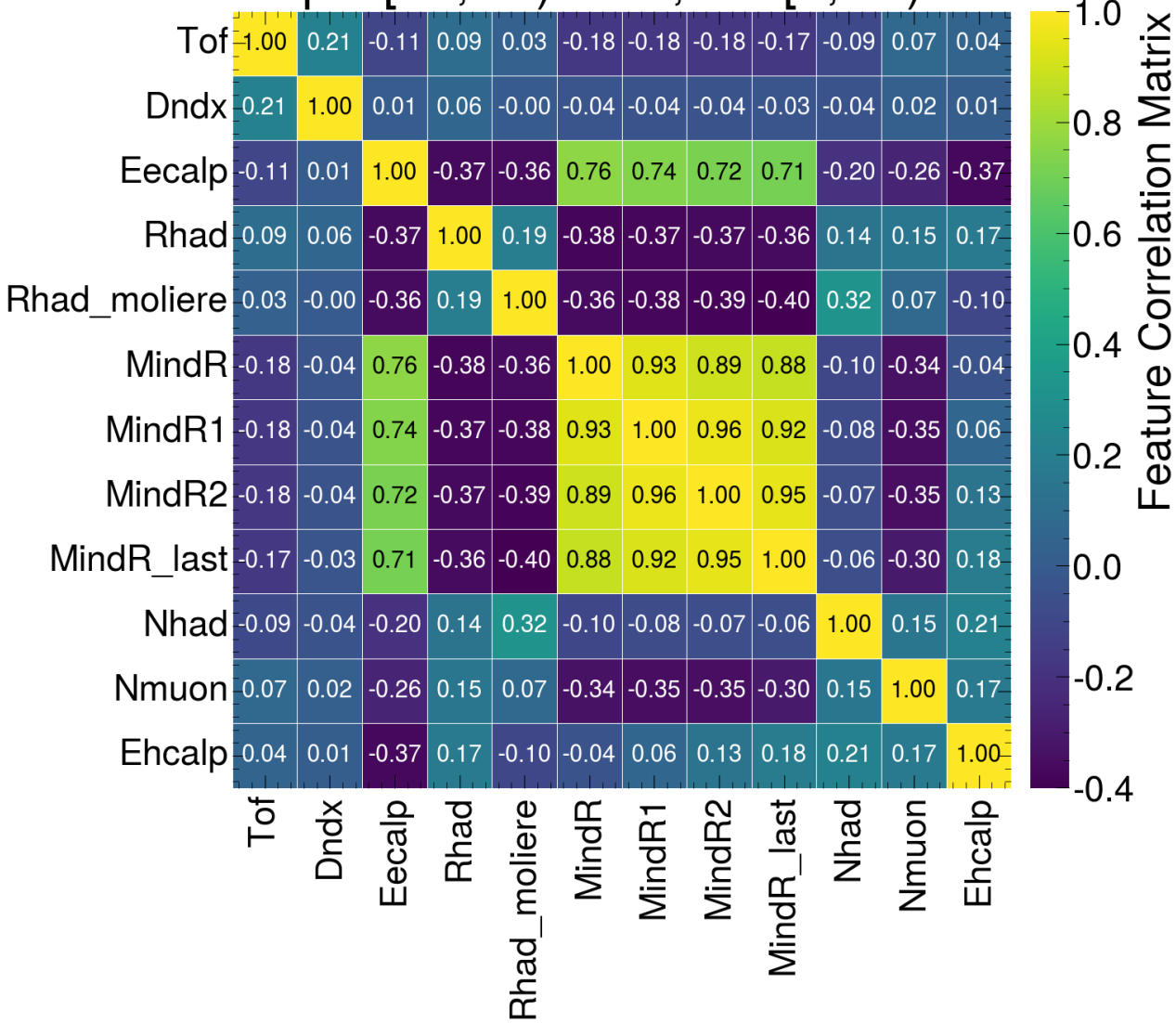
$p = 30\text{-}40\text{ GeV}, \theta = 8\text{-}20^\circ$

Features

Feature importance (gain)



$p \in [30, 40)\text{ GeV}, \theta \in [8, 20)^\circ$

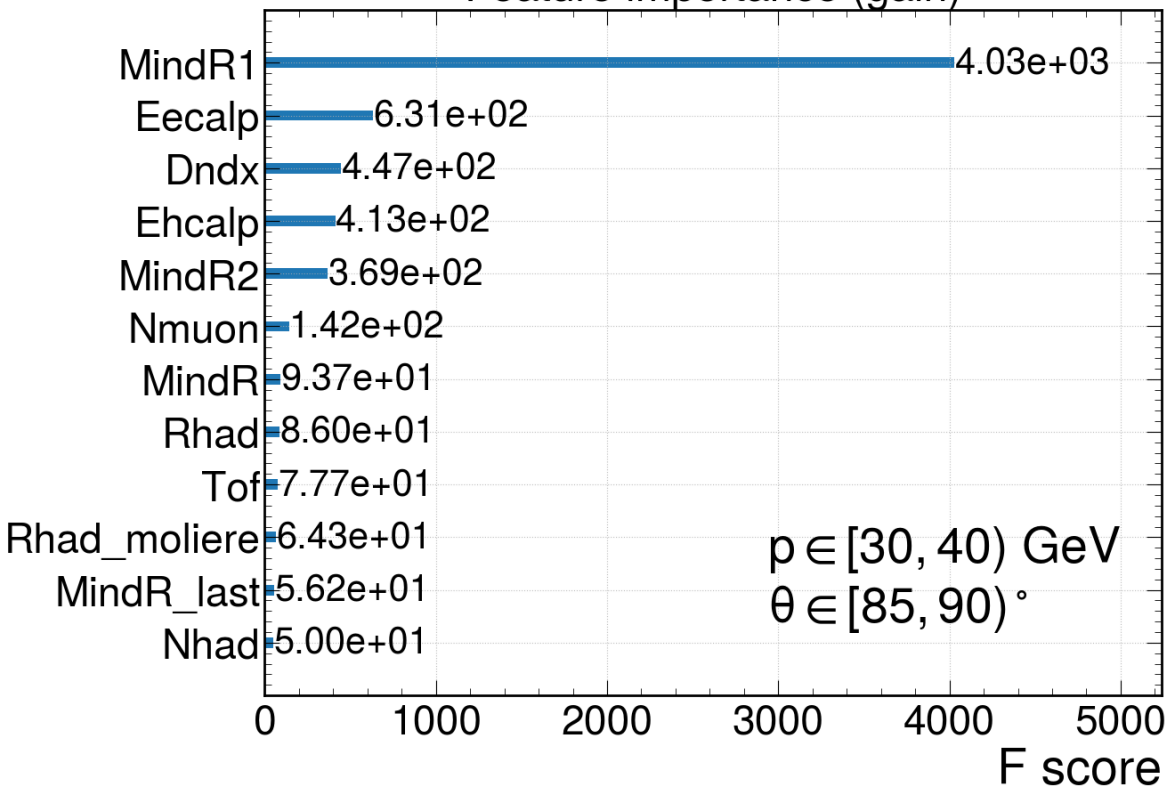


Charged PID: importance and correlation

$p = 30\text{-}40\text{ GeV}, \theta = 85\text{-}90^\circ$

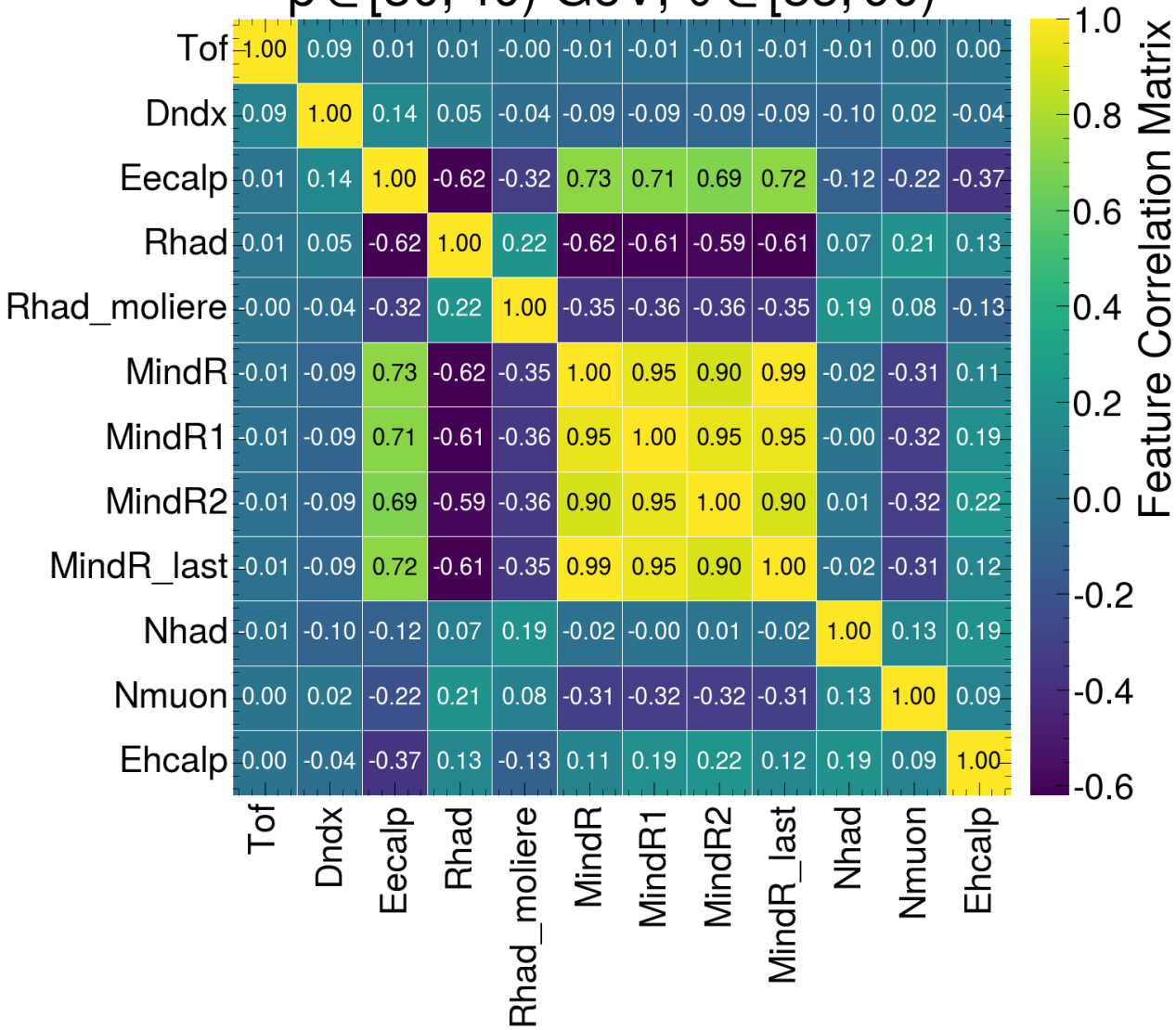
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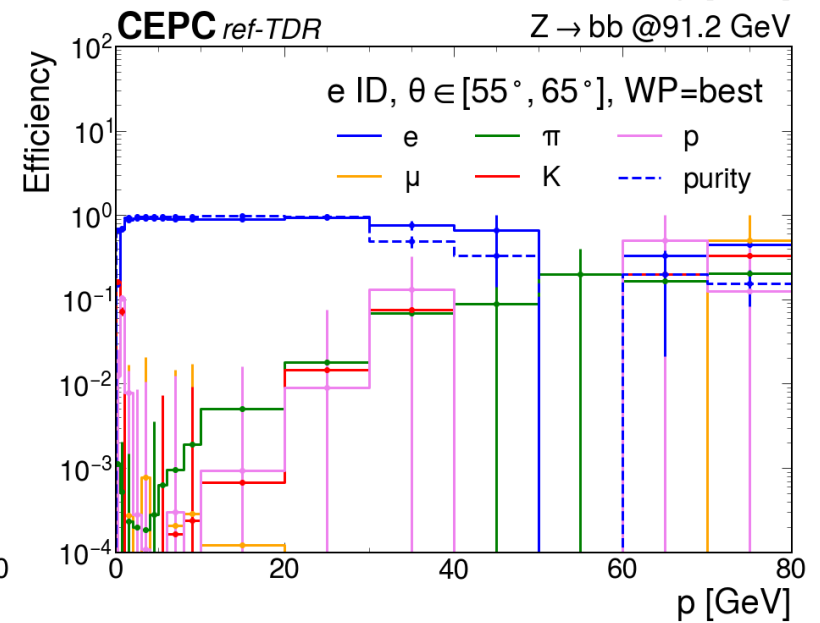
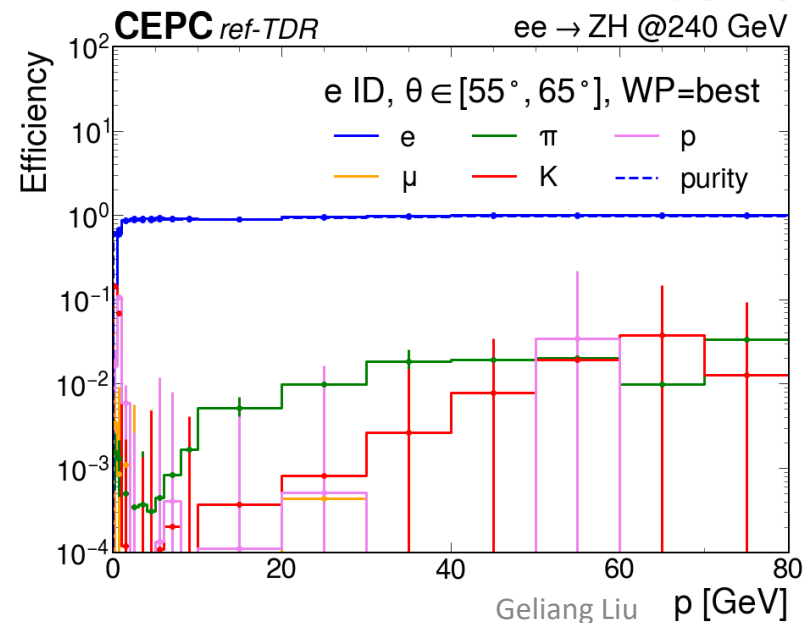
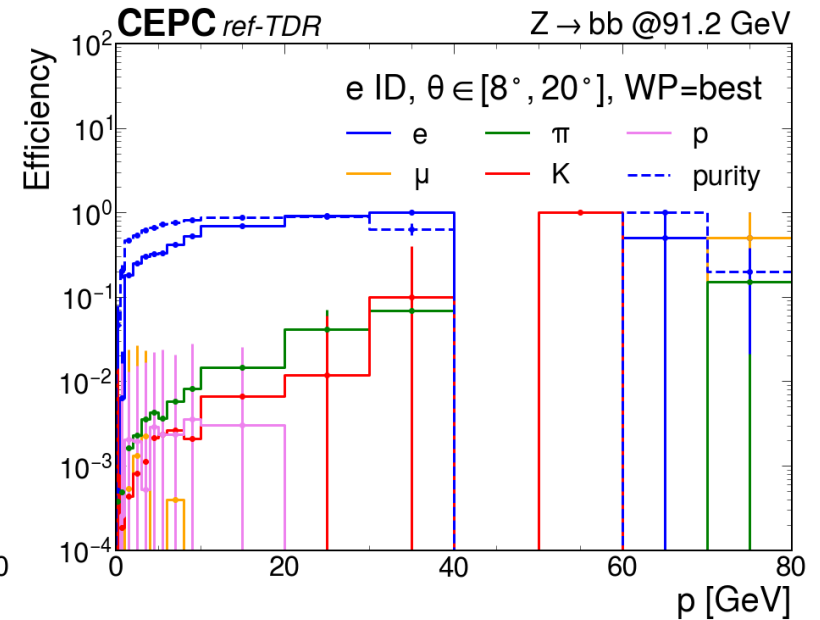
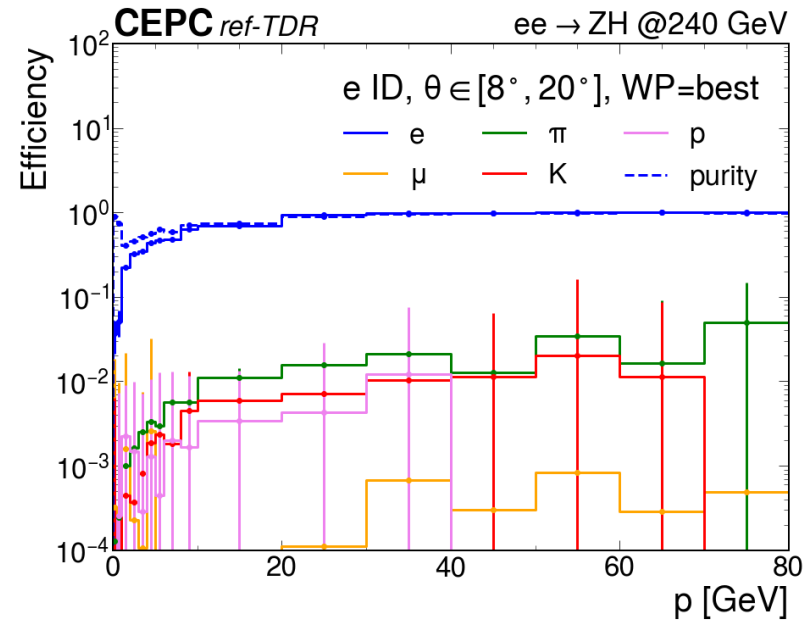
Charged PID: in Zqq environments

For now, only E91.2_Zbb is checked.

XGBoost models trained with E240_ZH and applied to E91.2_Zbb.

0-1 GeV also trained, but bad performance.

Electron ID comparison.

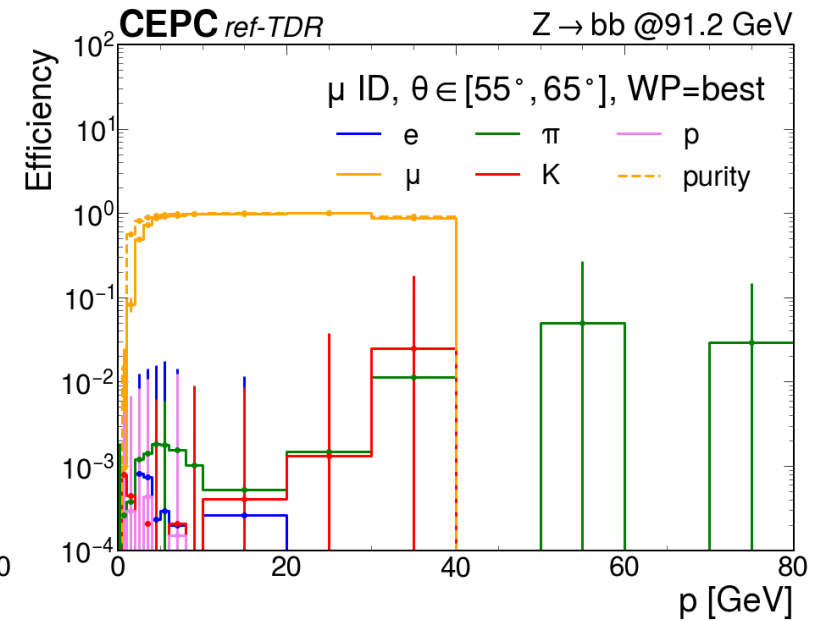
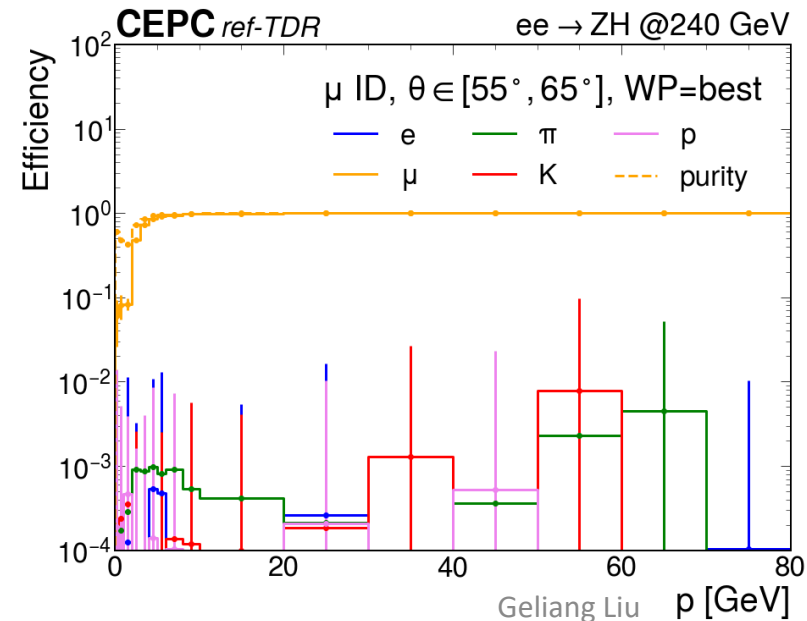
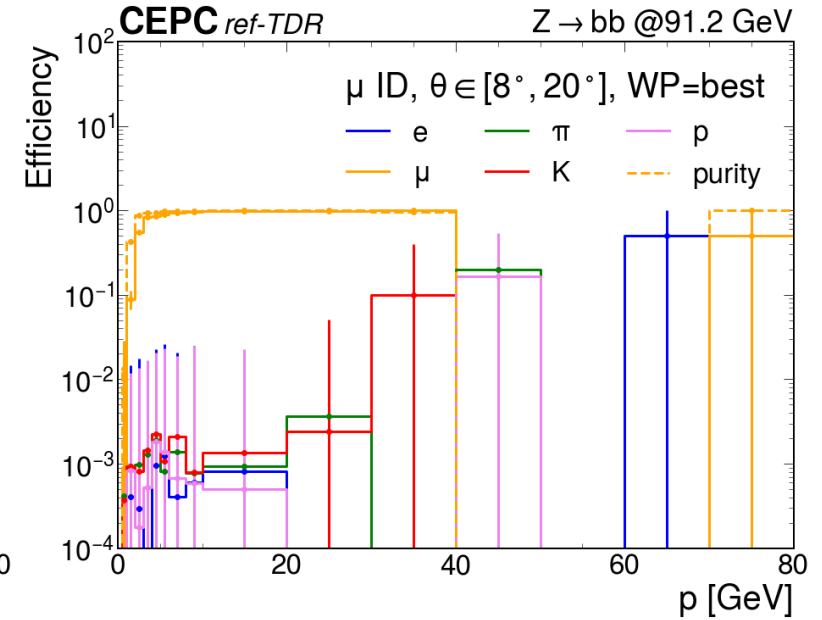
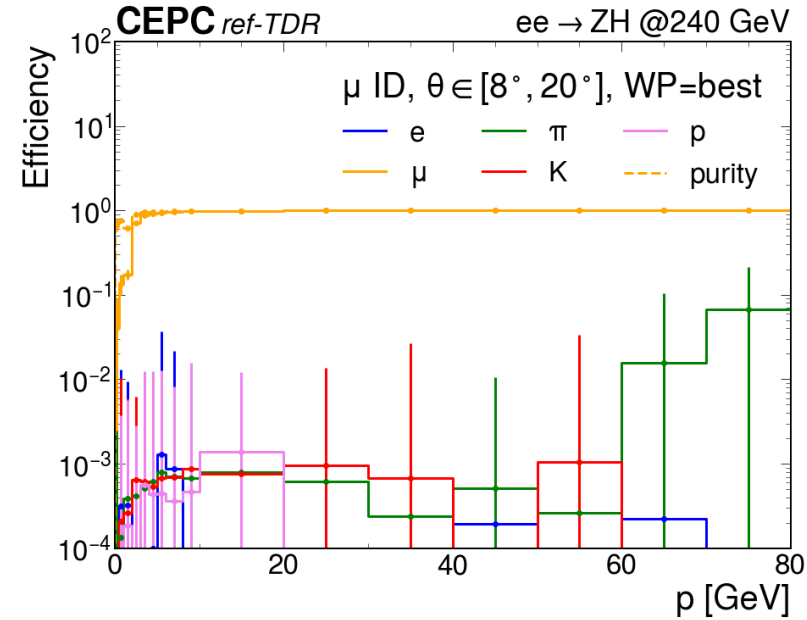


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Muon ID comparison.

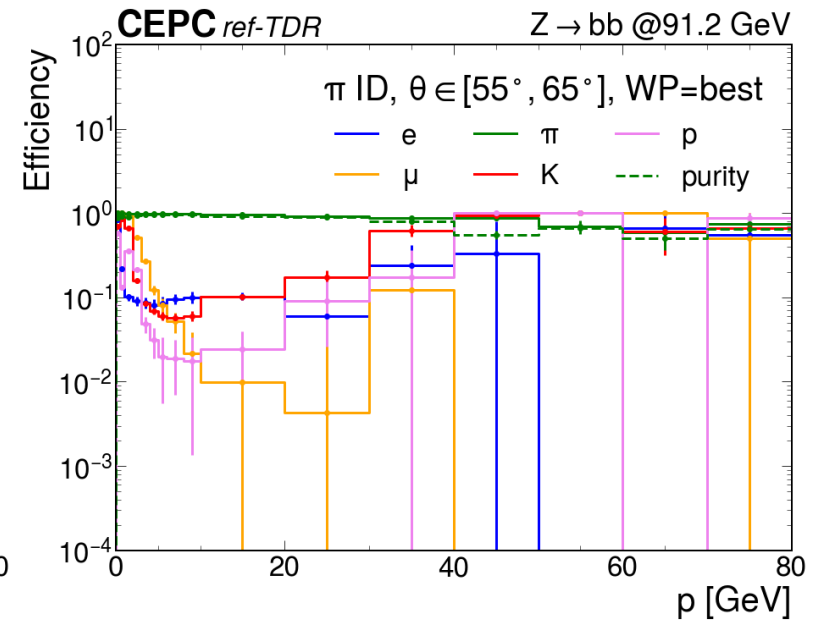
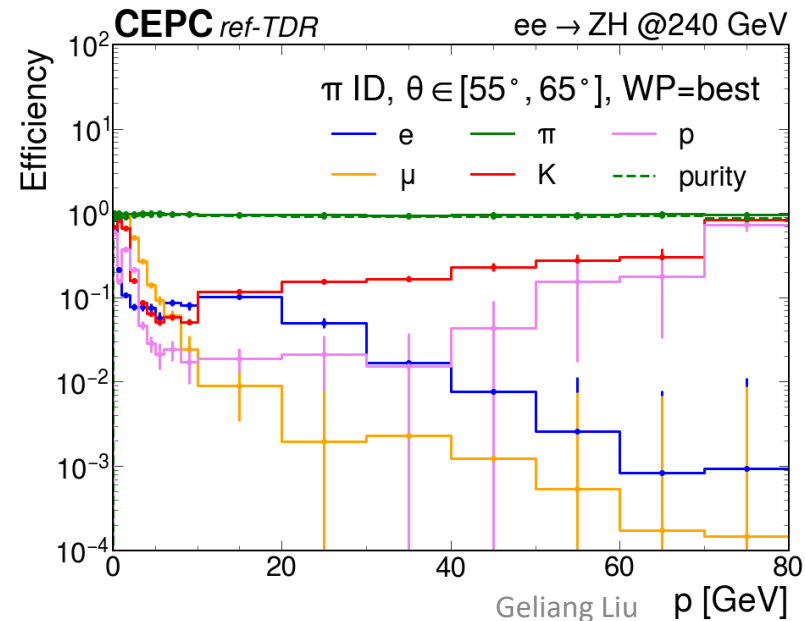
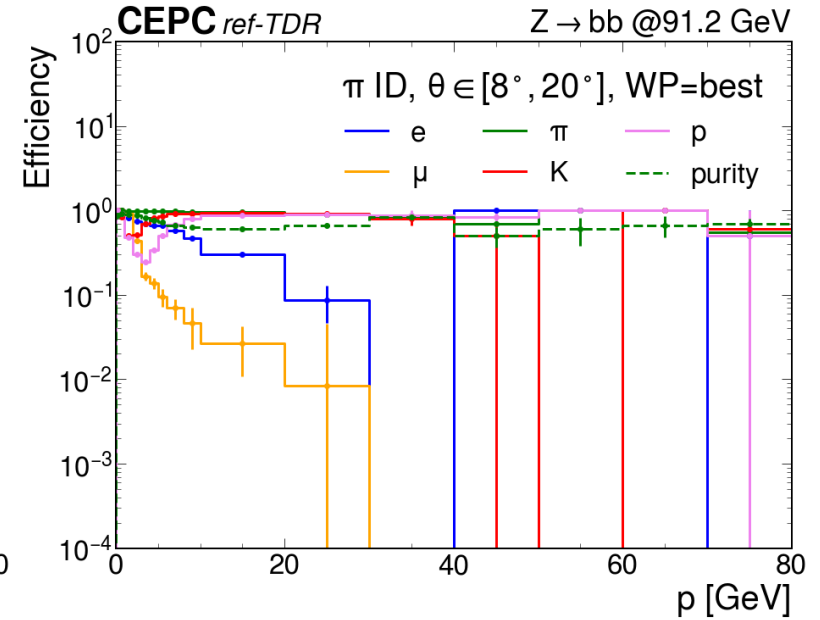
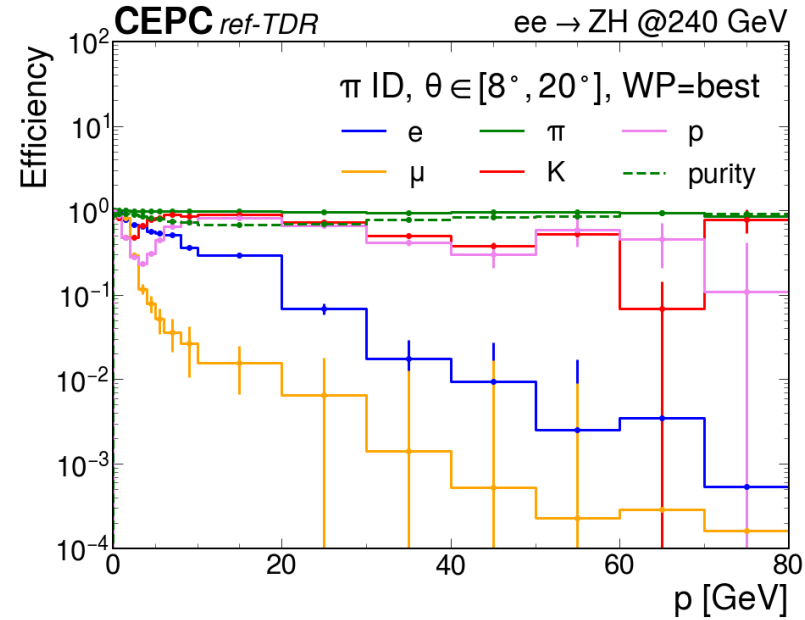


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Pion ID comparison.

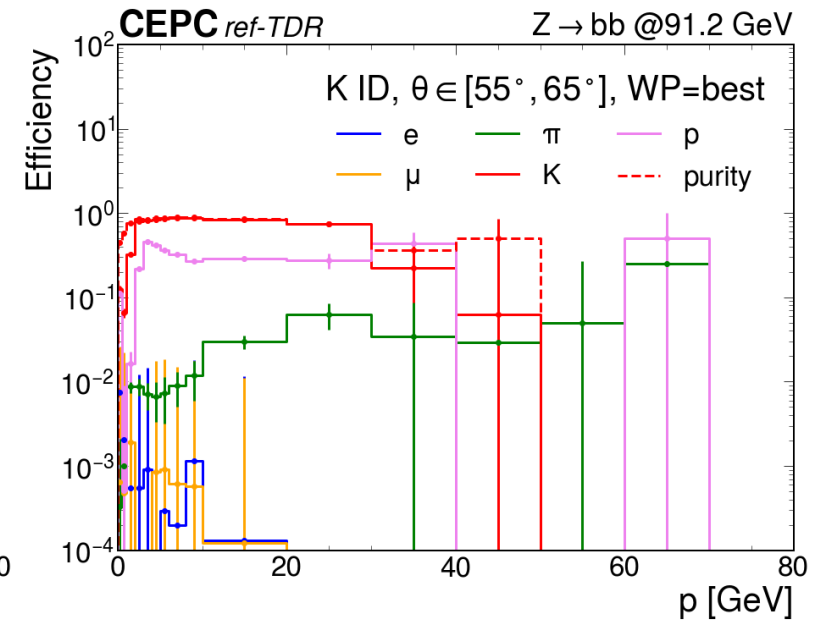
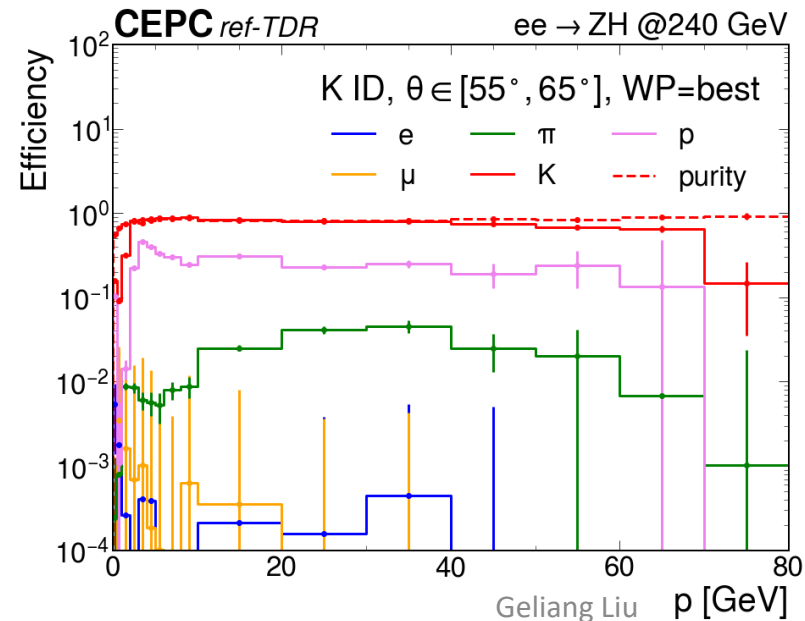
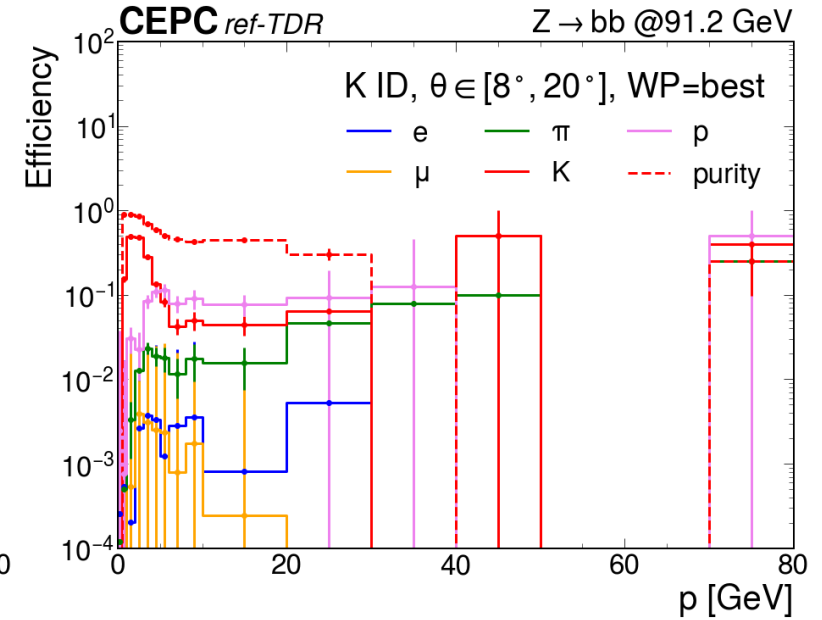
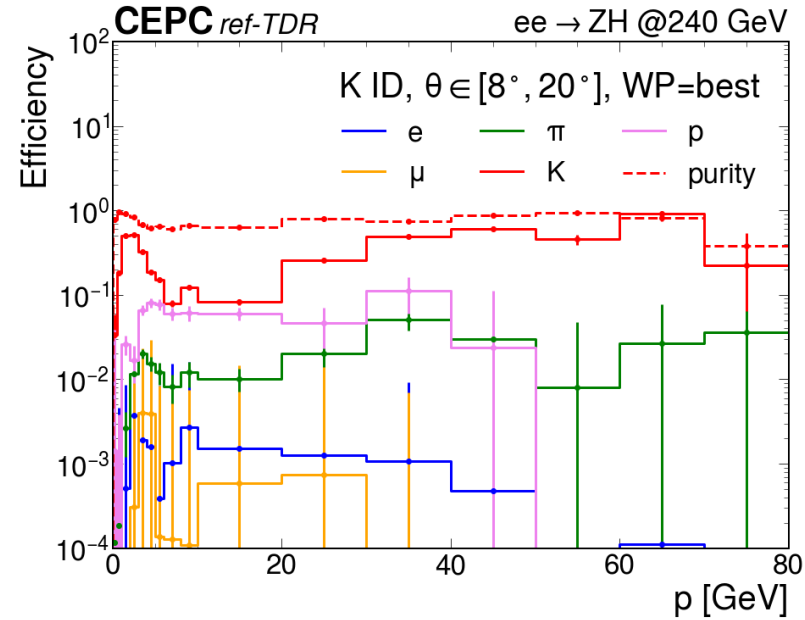


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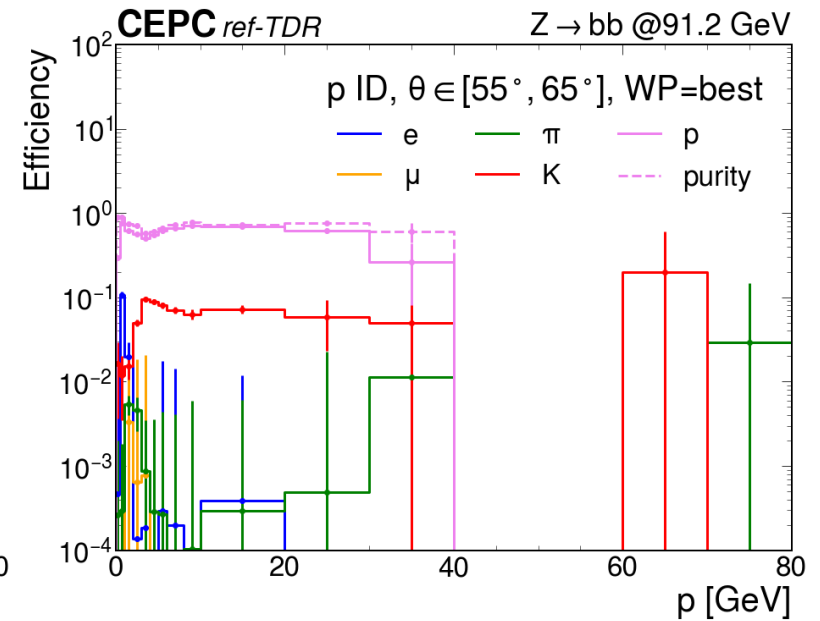
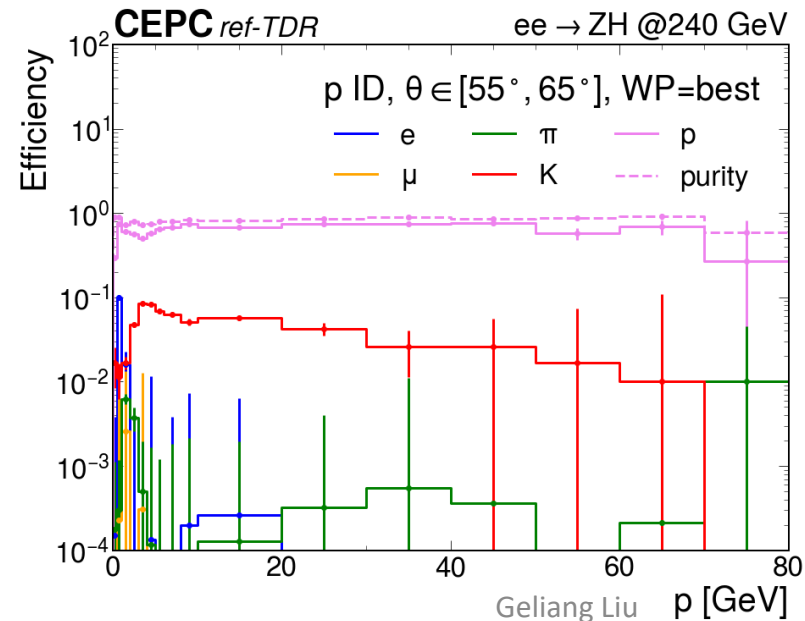
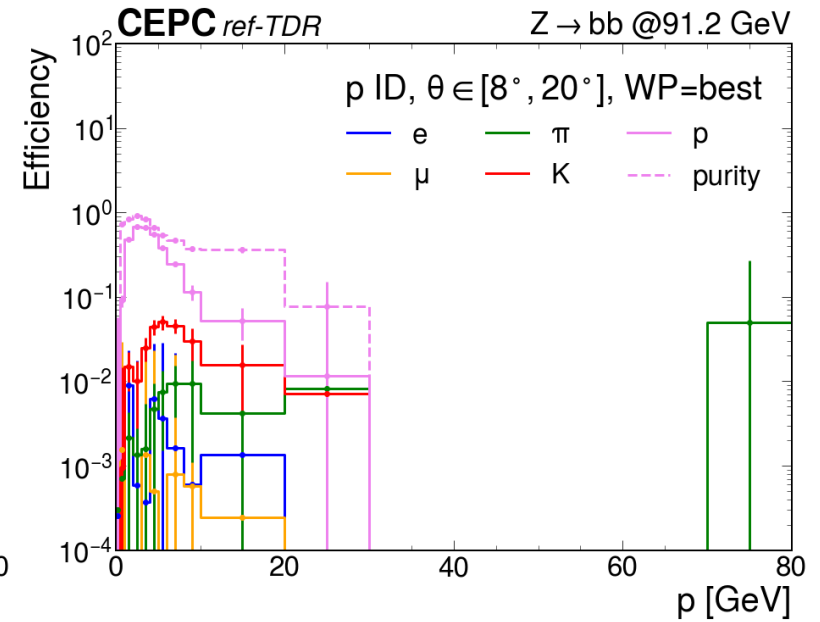
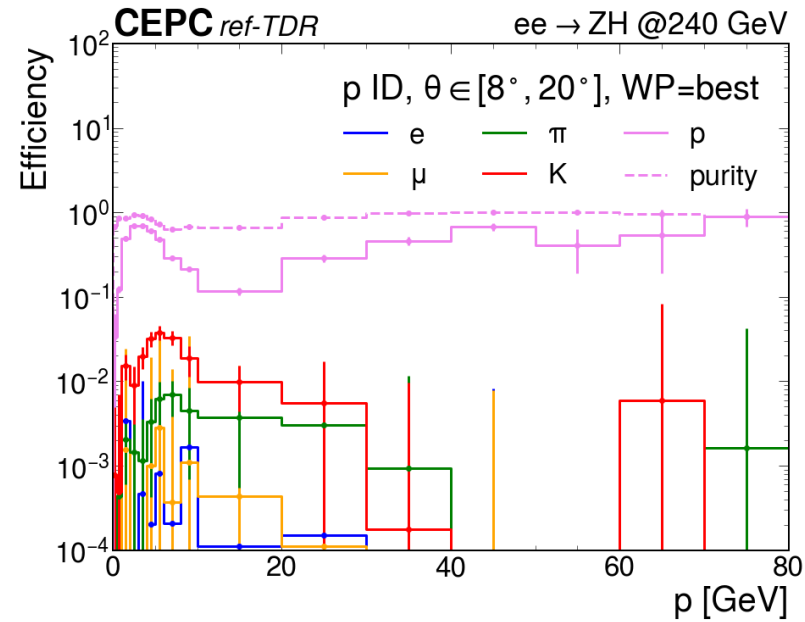


Charged PID: in Zqq environments

For now, only E91.2_Zbb is checked.

XGBoost models trained with E240_ZH and applied to E91.2_Zbb.

Proton ID comparison.



Photon ID with XGBoost

Input features

- $E_{\text{ECAL}}/p, l_{\text{ECAL}}, R_{\text{ECAL}}^{90}, W_{\text{ECAL}}^{\eta}, W_{\text{ECAL}}^{\phi}$
- $E_{\text{HCAL}}/p, l_{\text{HCAL}}, R_{\text{HCAL}}^{90}, W_{\text{HCAL}}^{\eta}, W_{\text{HCAL}}^{\phi}, N_{\text{hadClus}}$

Samples

- Single particle gun samples of γ and K_L^0 with $p \in [1, 80]$ GeV and $\theta \in [8, 172]^\circ$
- `/cms/user/liugeliang/CEPC/202503/Production/ParticleGun/gamma*`
- `/cms/user/liugeliang/CEPC/202503/Production/ParticleGun/K_L0_*`

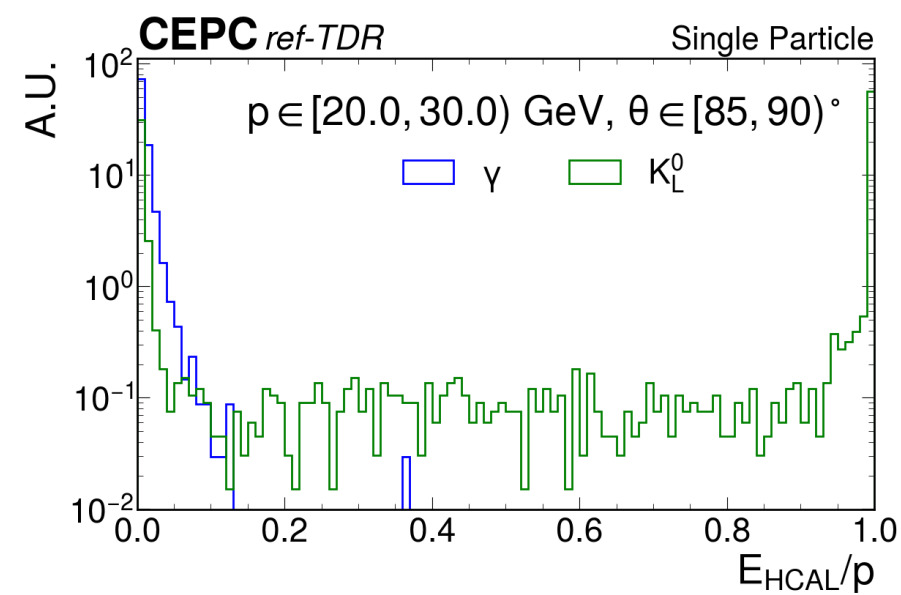
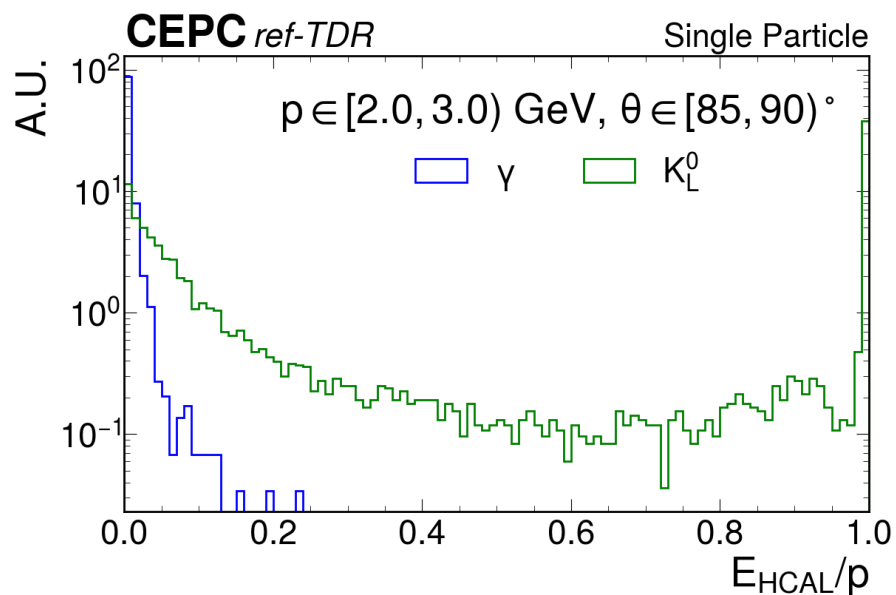
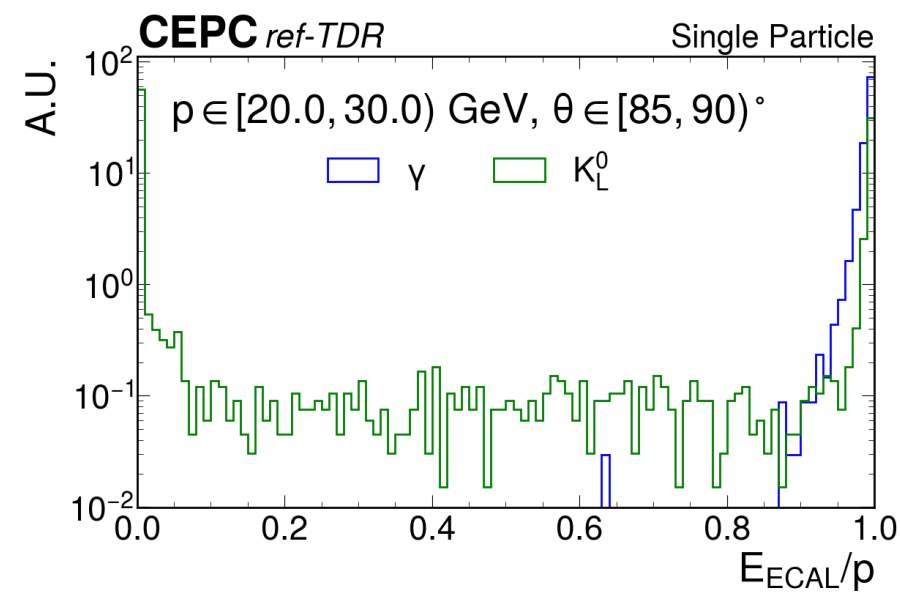
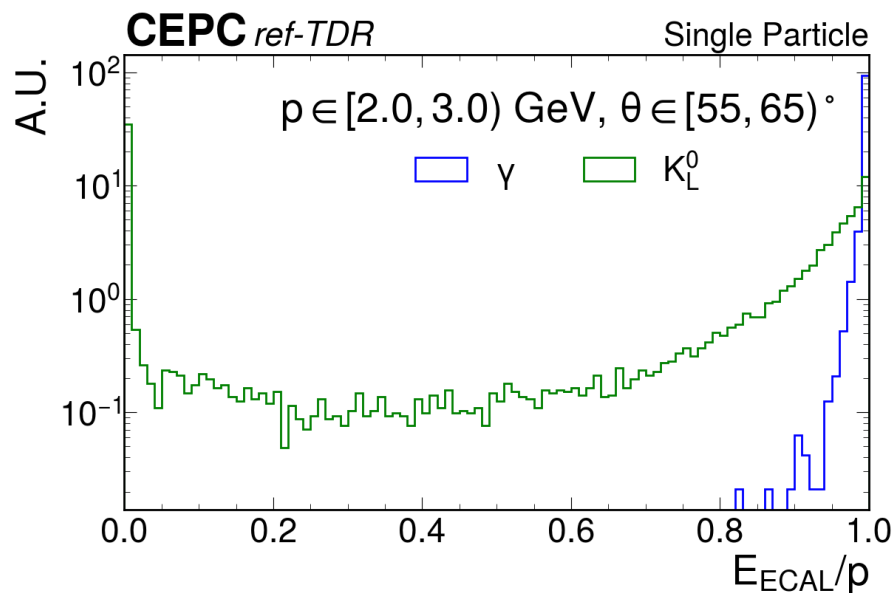
Input features

E_{ECAL}/p

E_{HCAL}/p

low p

high p

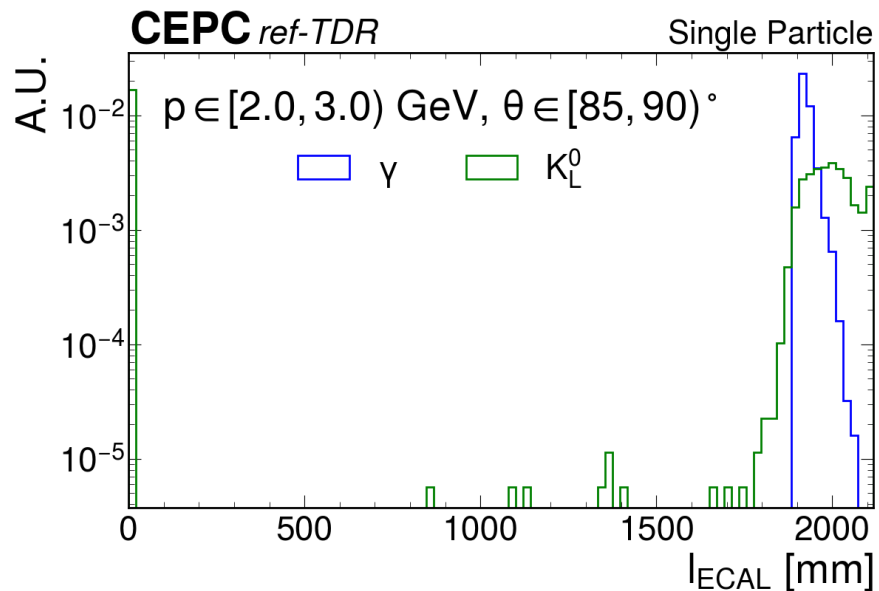


Input features

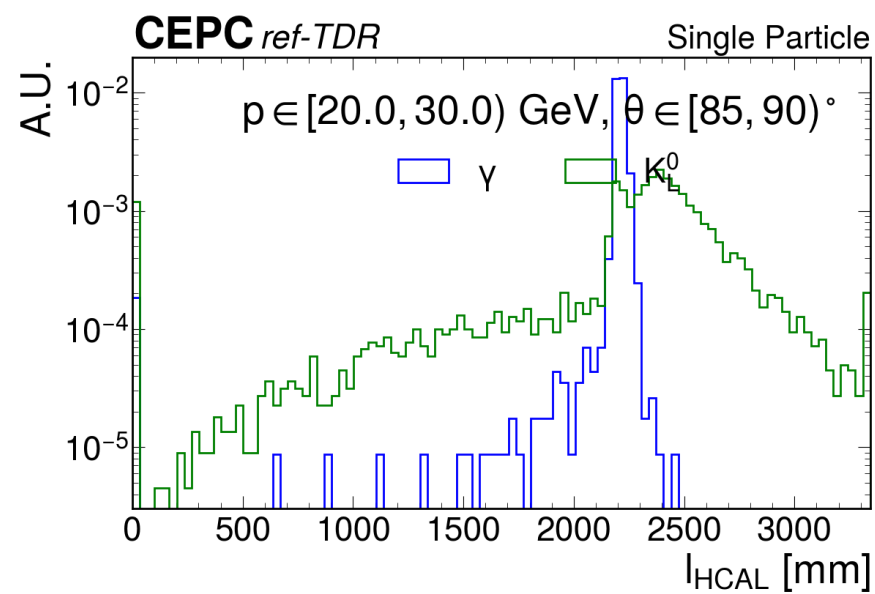
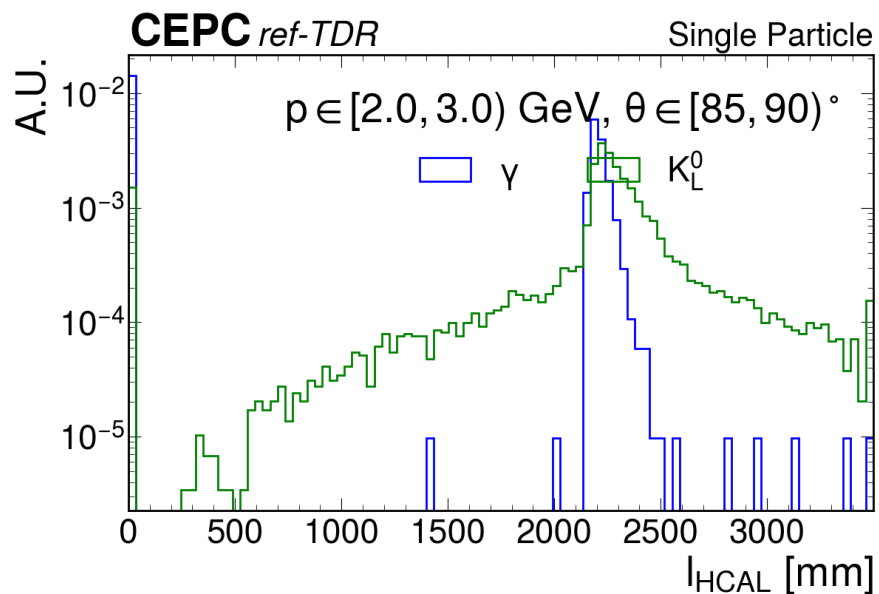
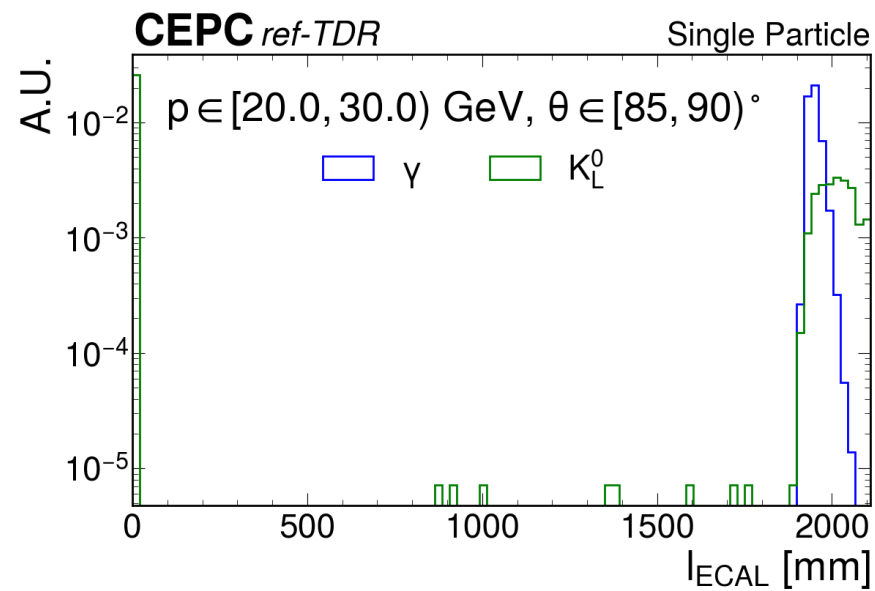
I_{ECAL}

I_{HCAL}

low p



high p

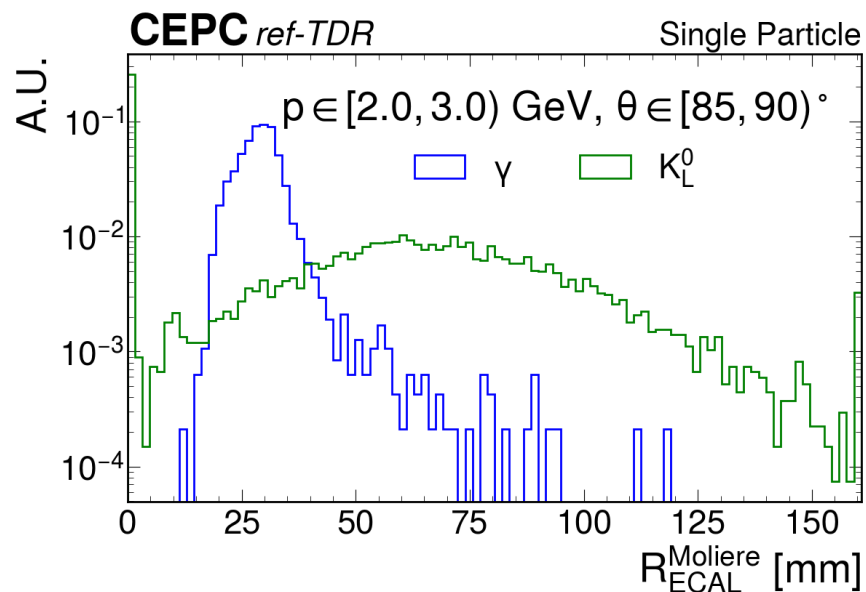


Input features

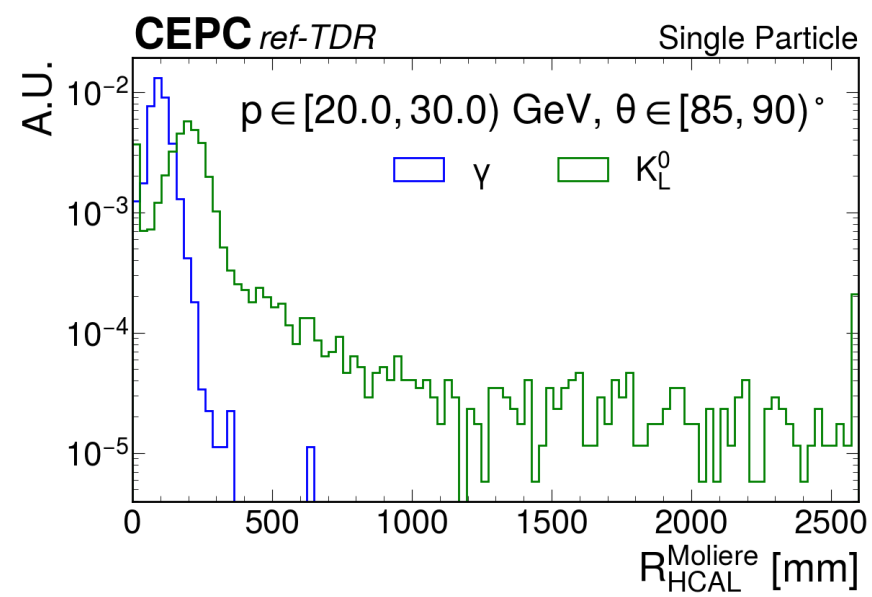
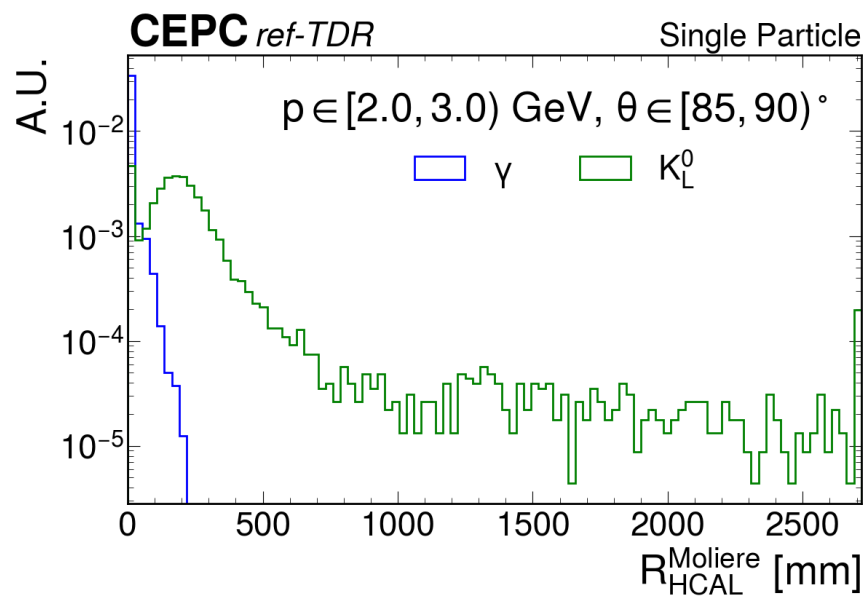
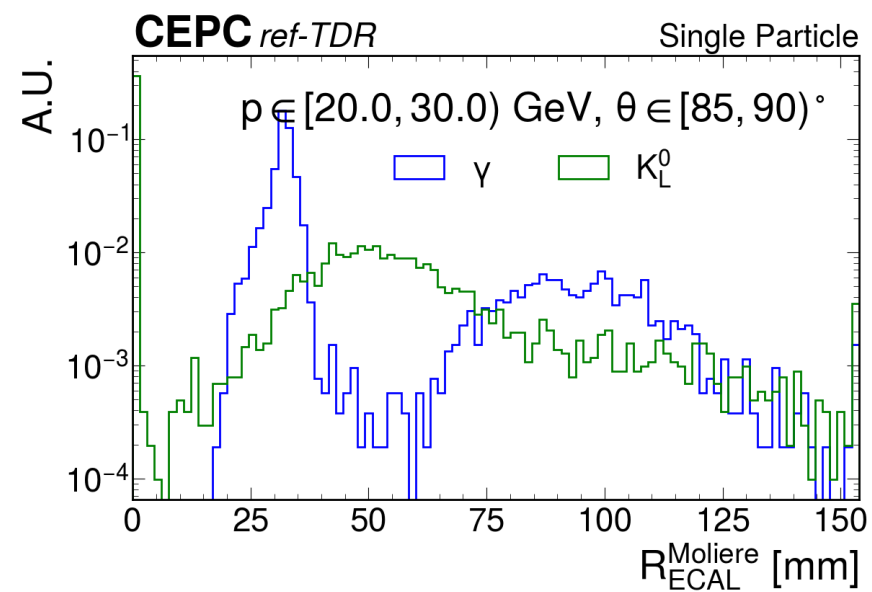
R_{ECAL}^{90}

R_{HCAL}^{90}

low p



high p

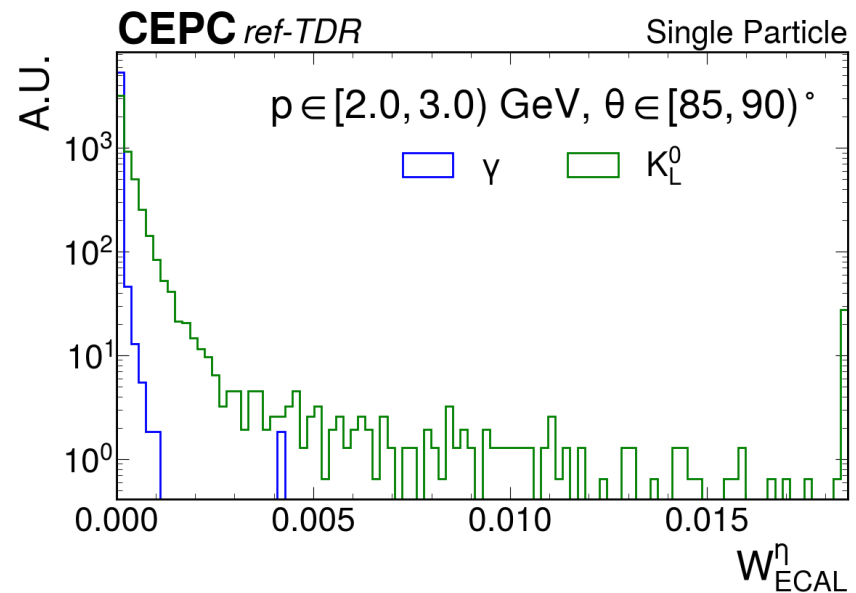


Input features

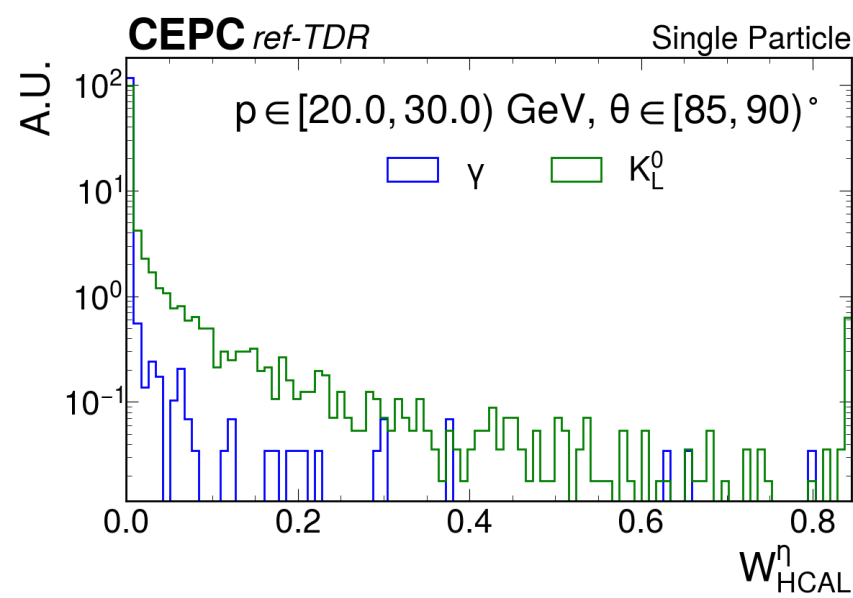
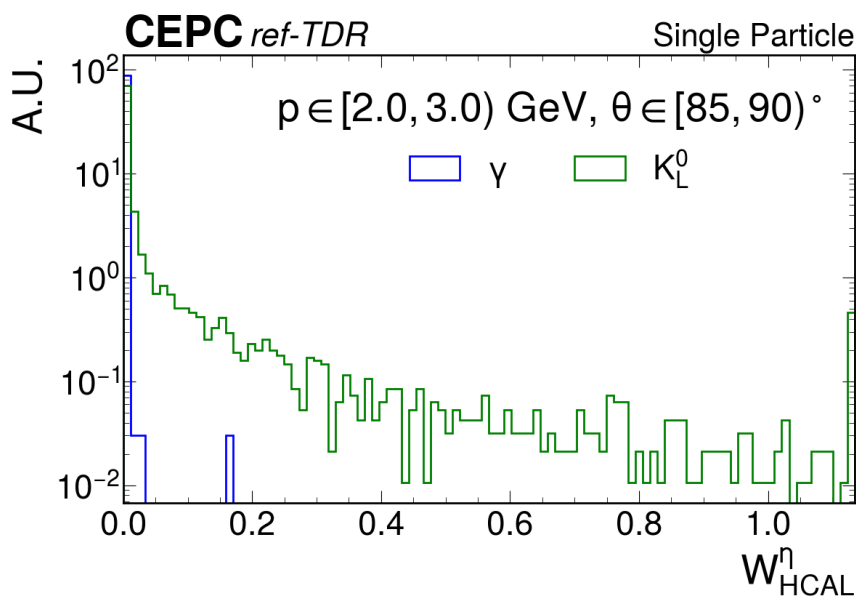
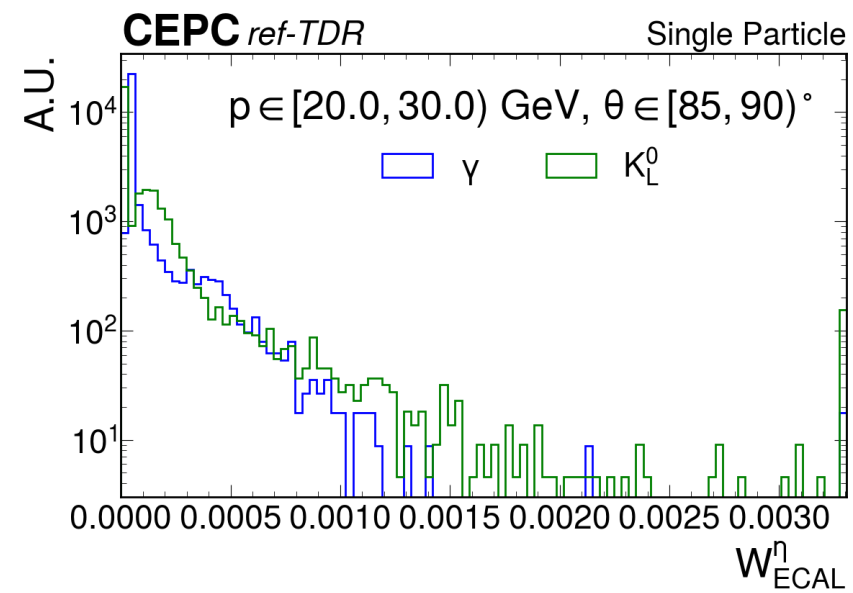
W_{ECAL}^η

W_{HCAL}^η

low p



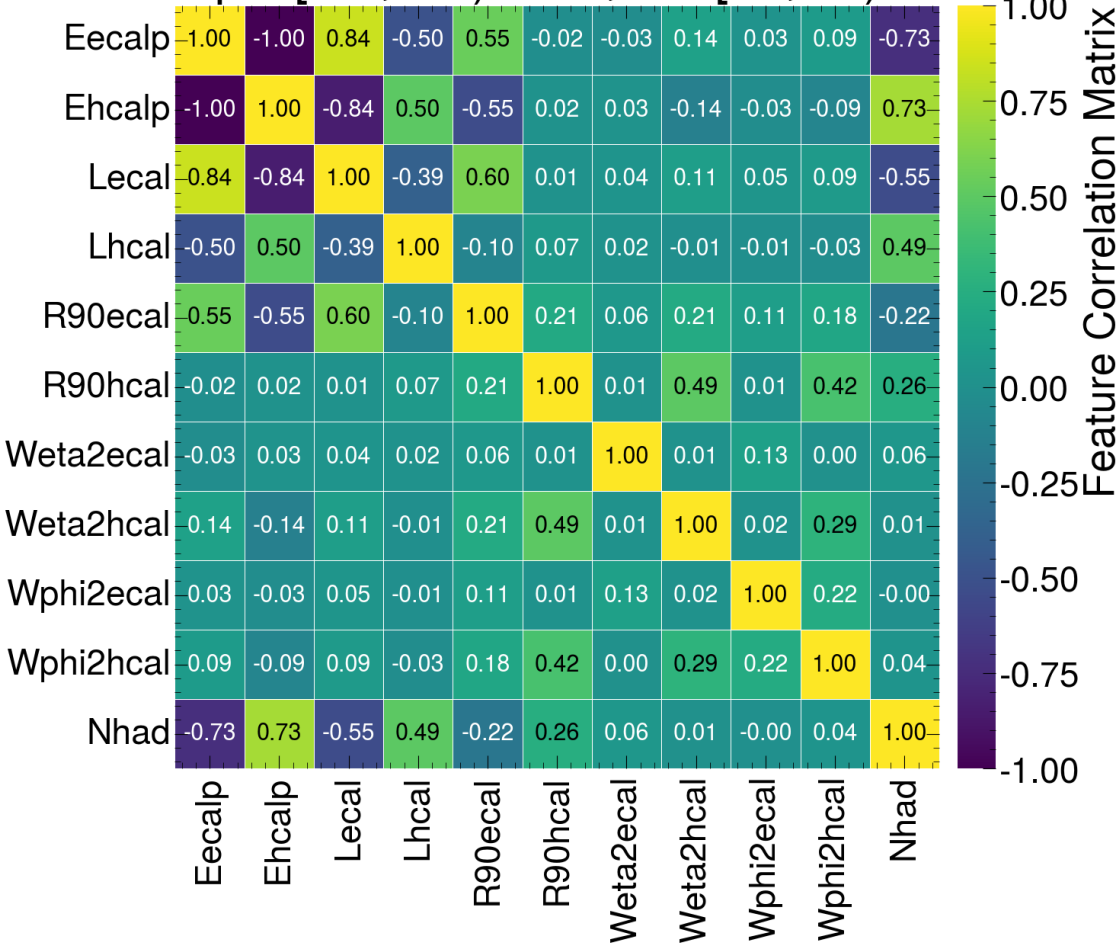
high p



Correlations

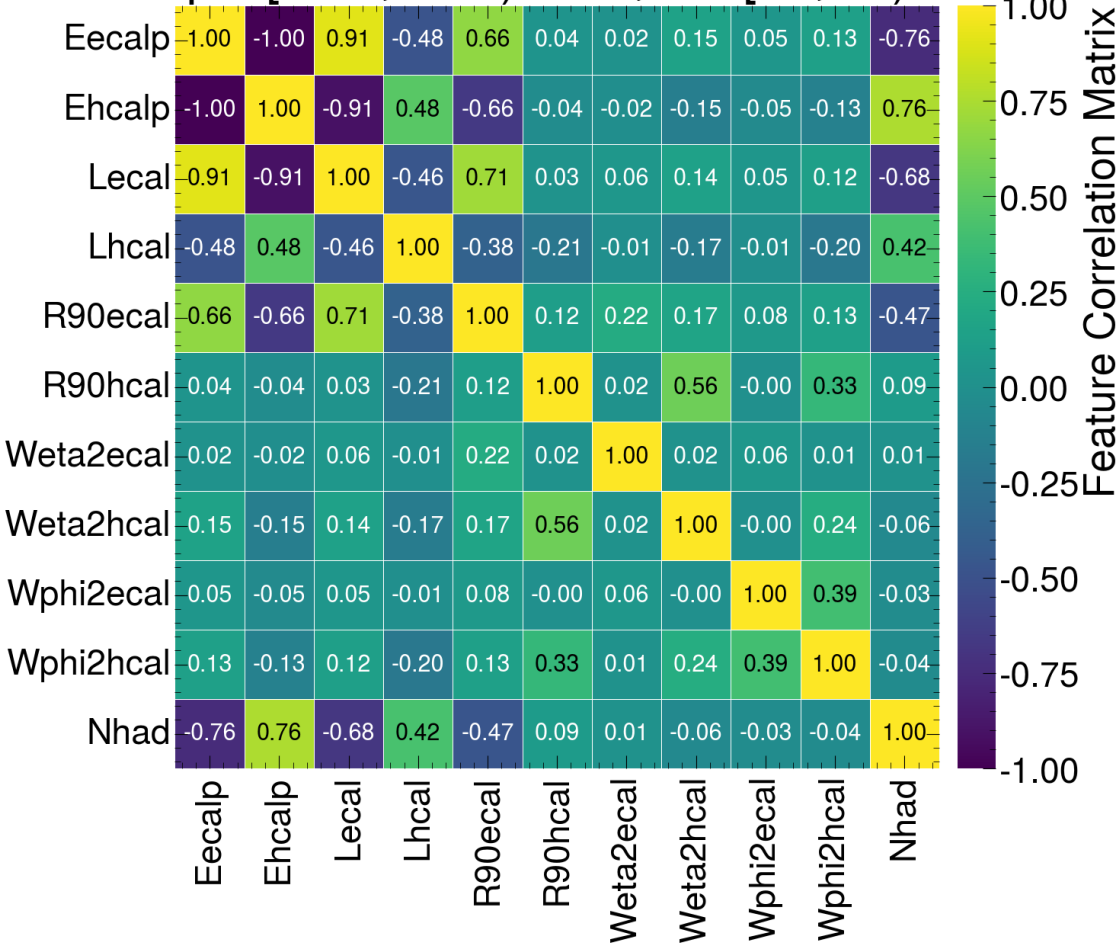
low p

$p \in [2.0, 3.0) \text{ GeV}, \theta \in [85, 90)^\circ$

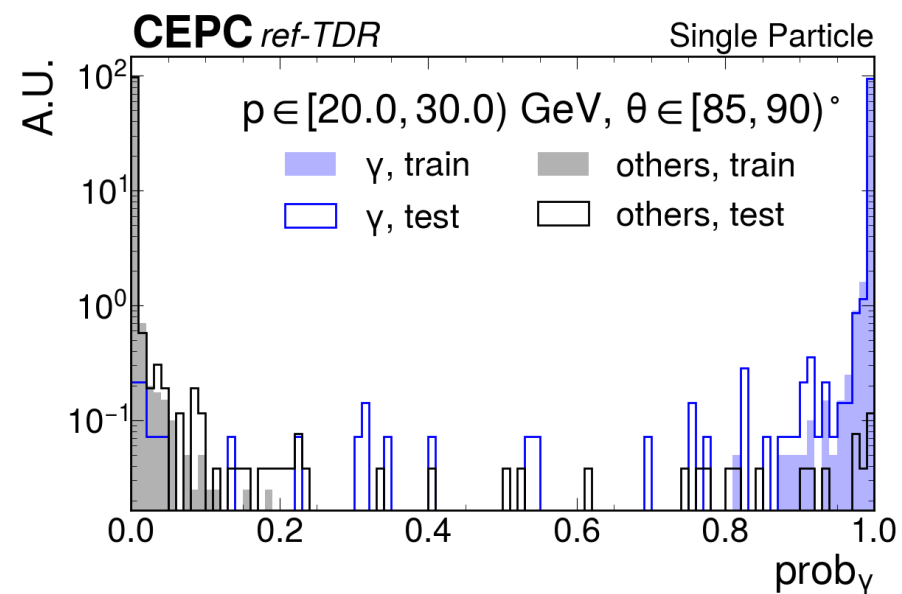
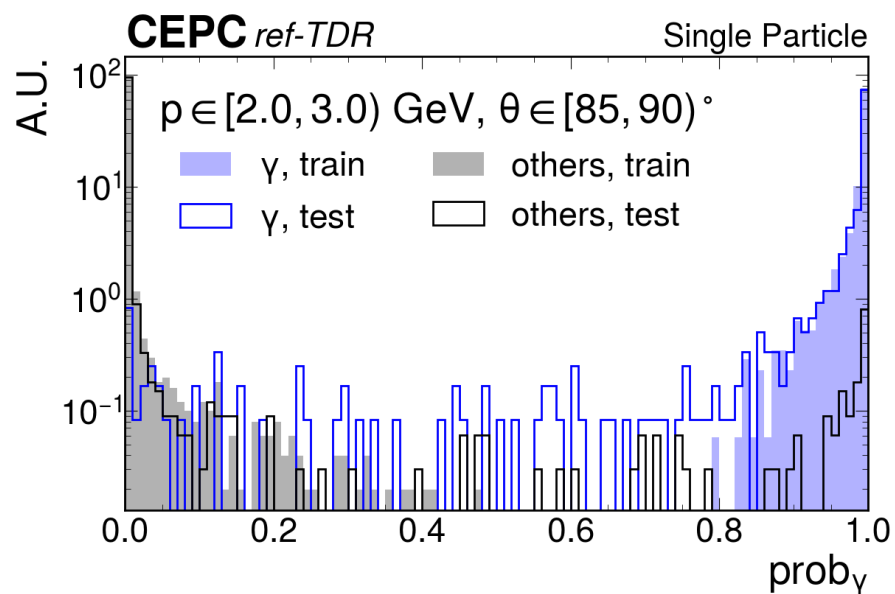
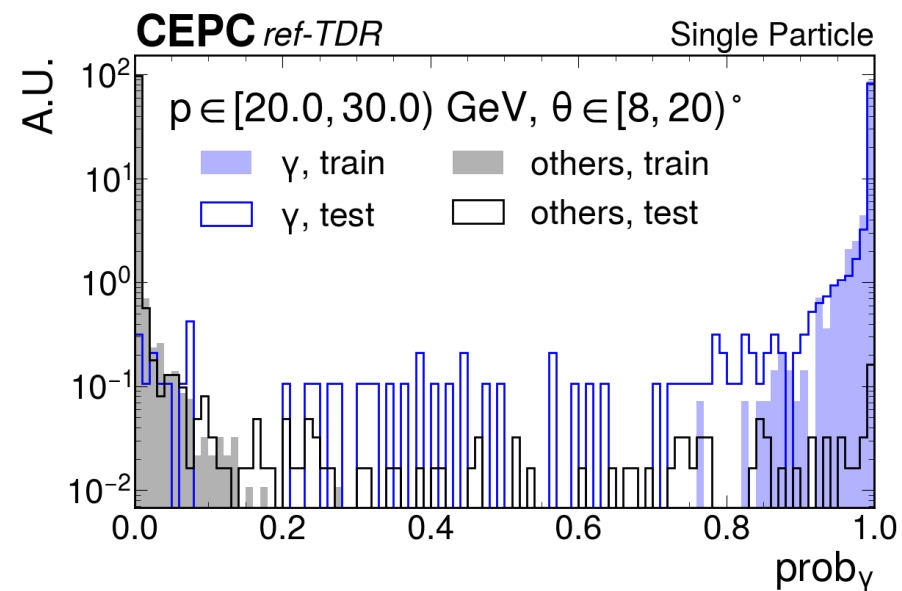
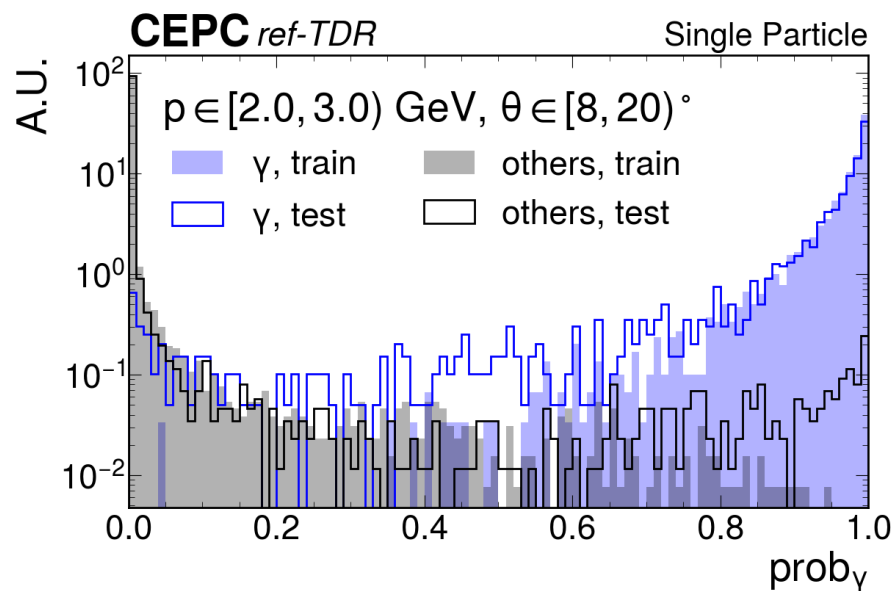


high p

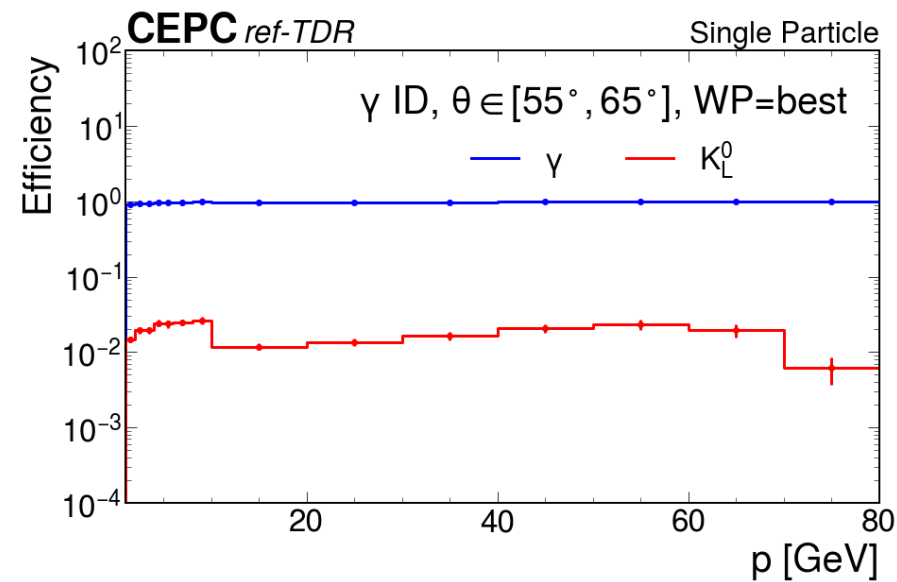
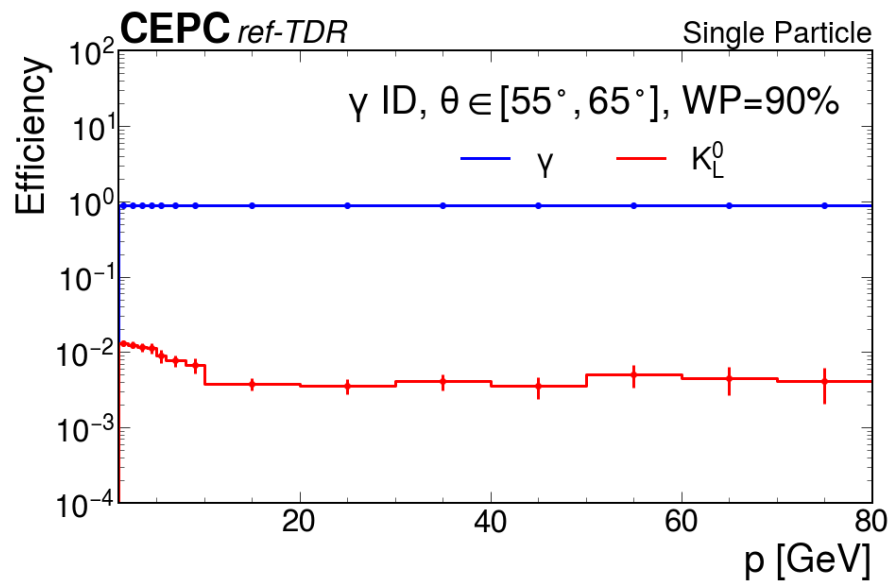
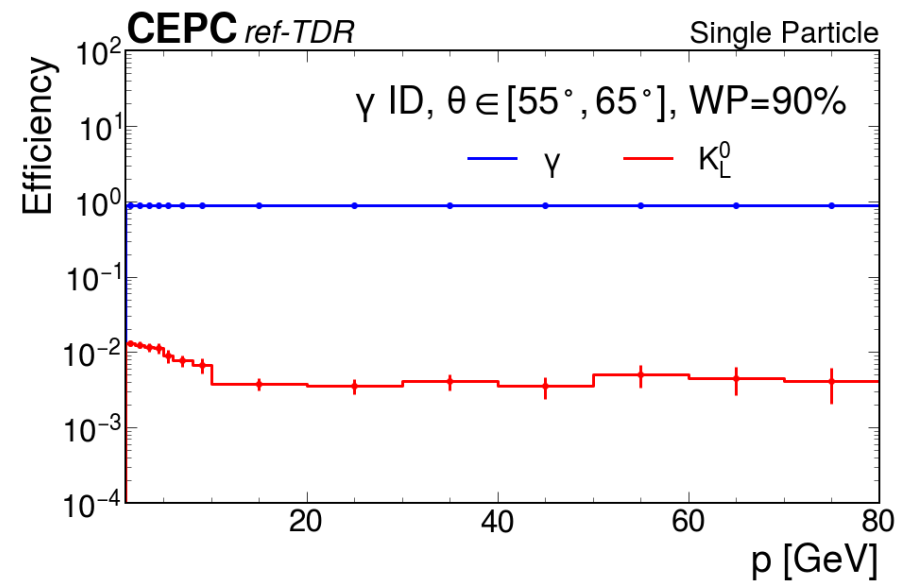
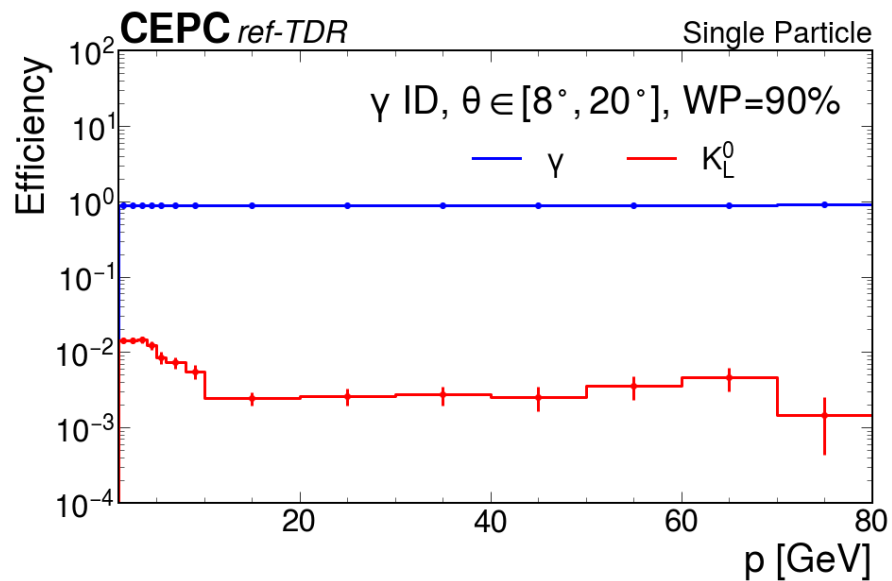
$p \in [20.0, 30.0) \text{ GeV}, \theta \in [85, 90)^\circ$



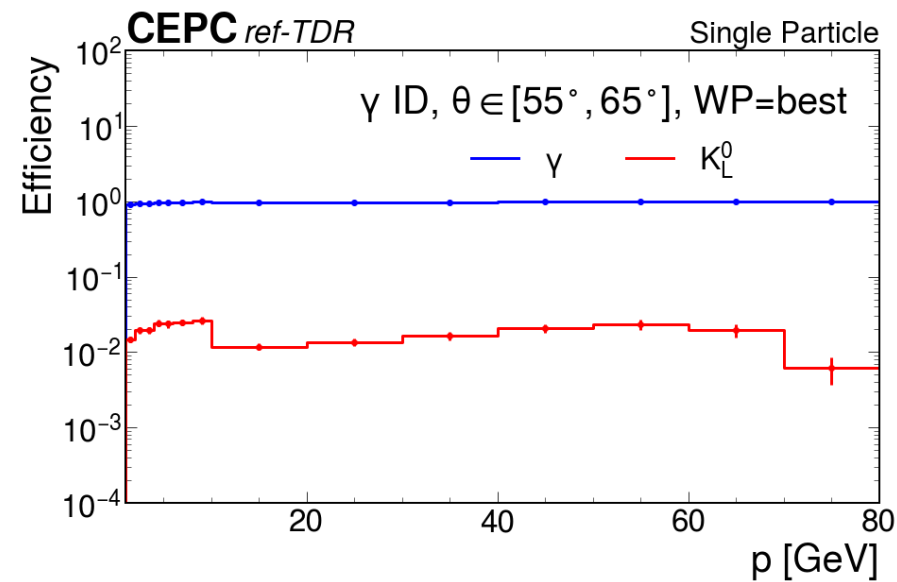
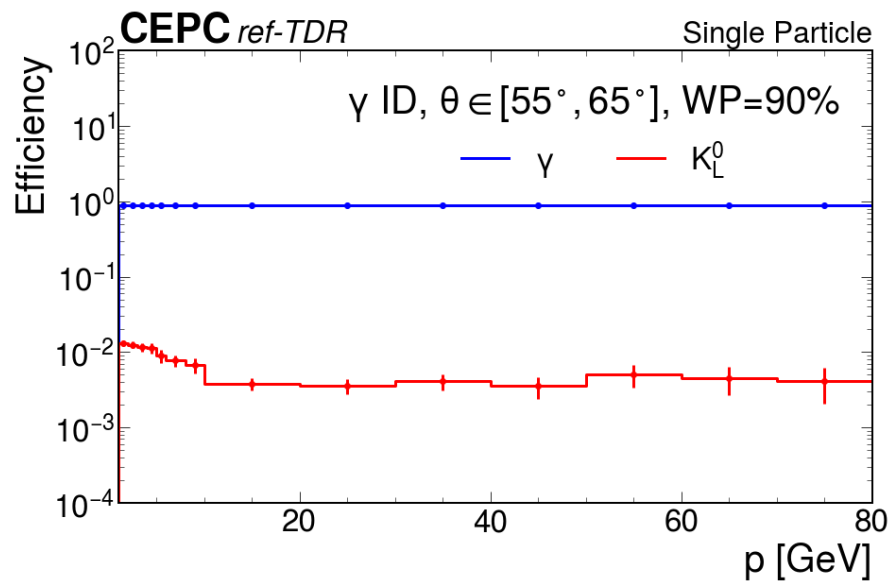
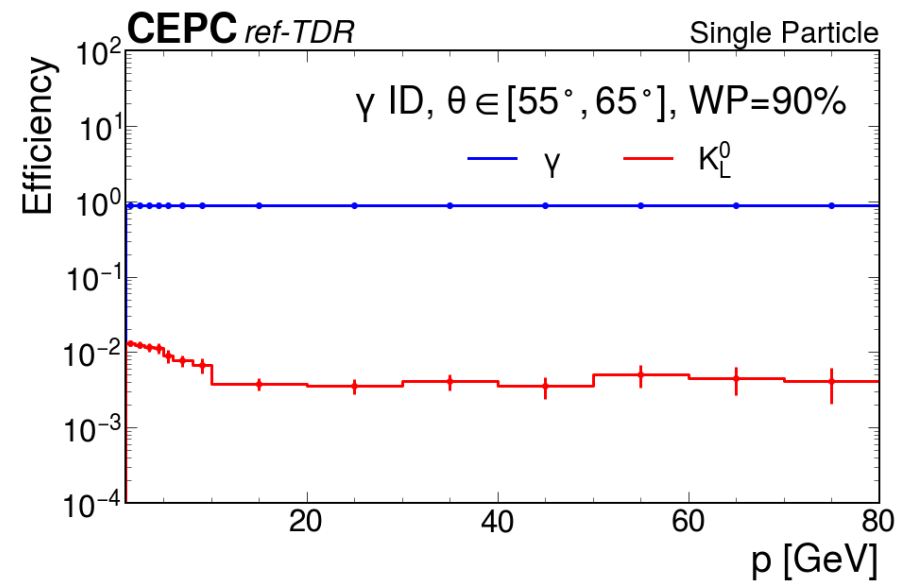
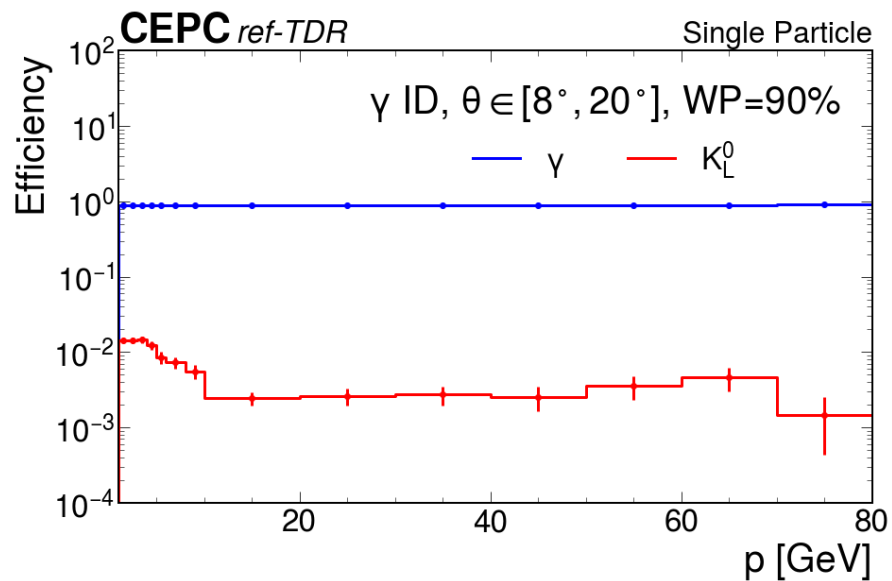
Train v.s. test



Efficiency



Efficiency



To be tested in ZH environments

Challenges

- Not only to distinguish photons from neutral hadrons, but also from clusters induced by charged hadrons
- A quick look shows that the large fraction of neutral PFOs are matched to charged hadrons.
- Even for those matched to neutral hadrons, the signatures are different from particle gun samples (still have large fraction of energy in ECAL).
- Need further checks.