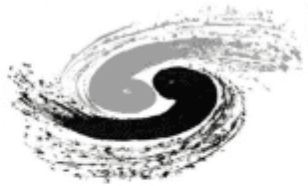

中国科学院高能物理研究所
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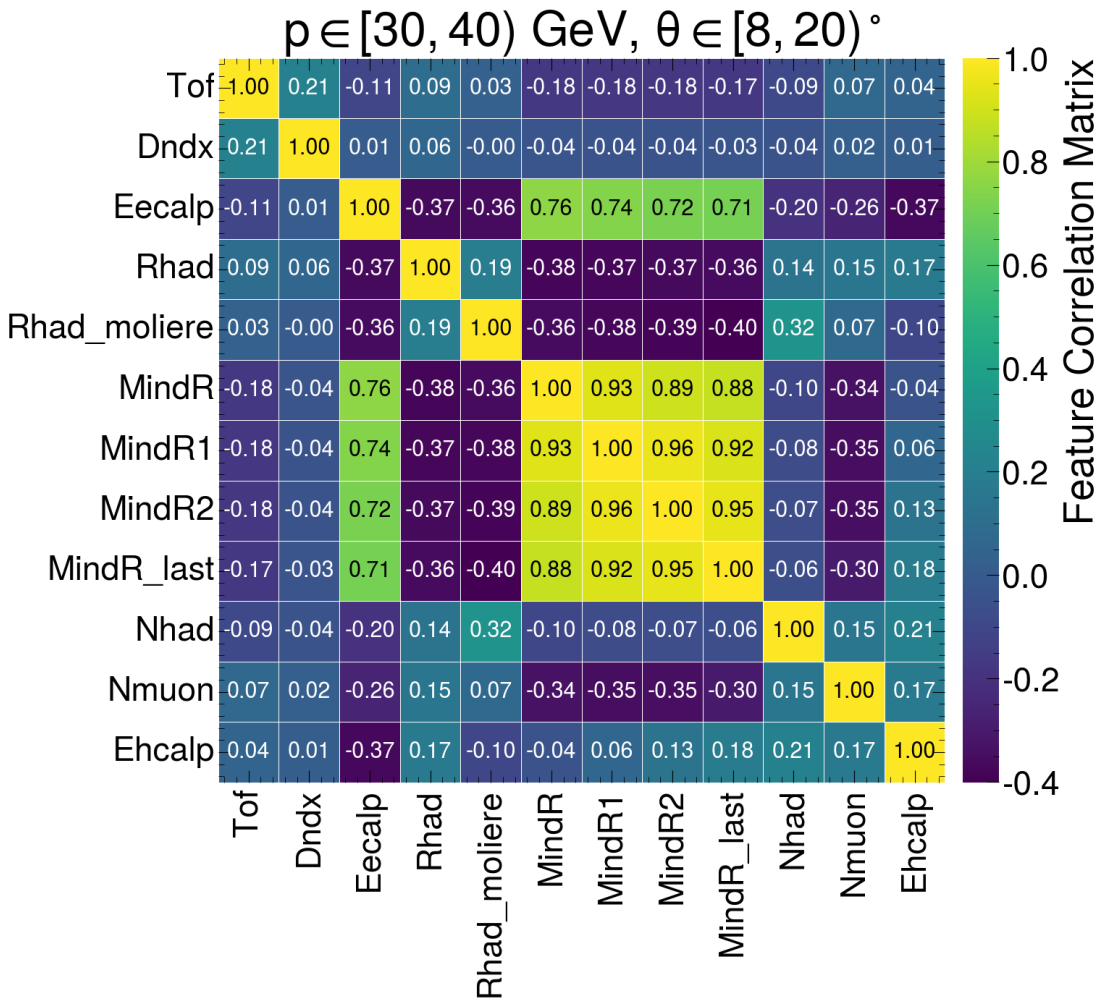
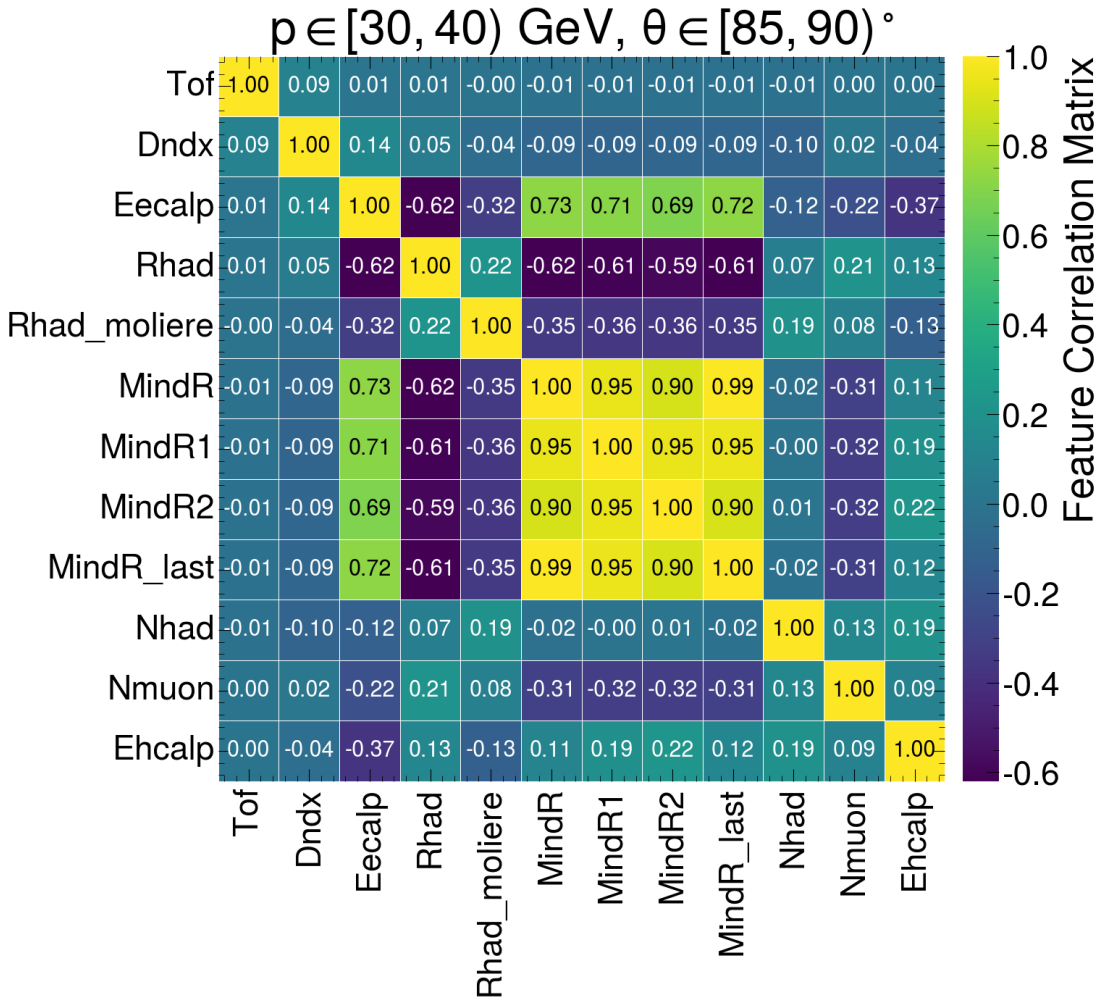
Updates on PID

Geliang Liu

Apr. 16th, 2025

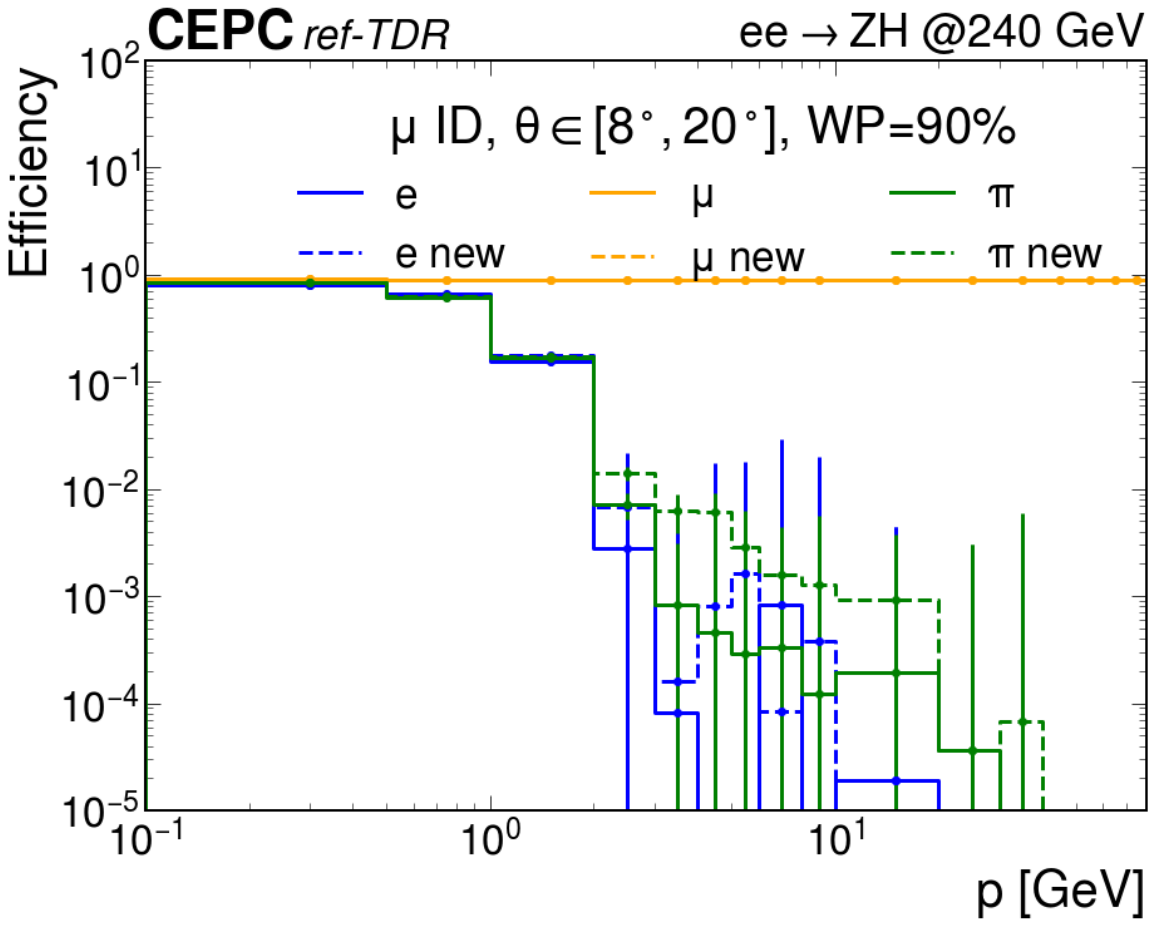
Lepton PID: correlation of ΔRs

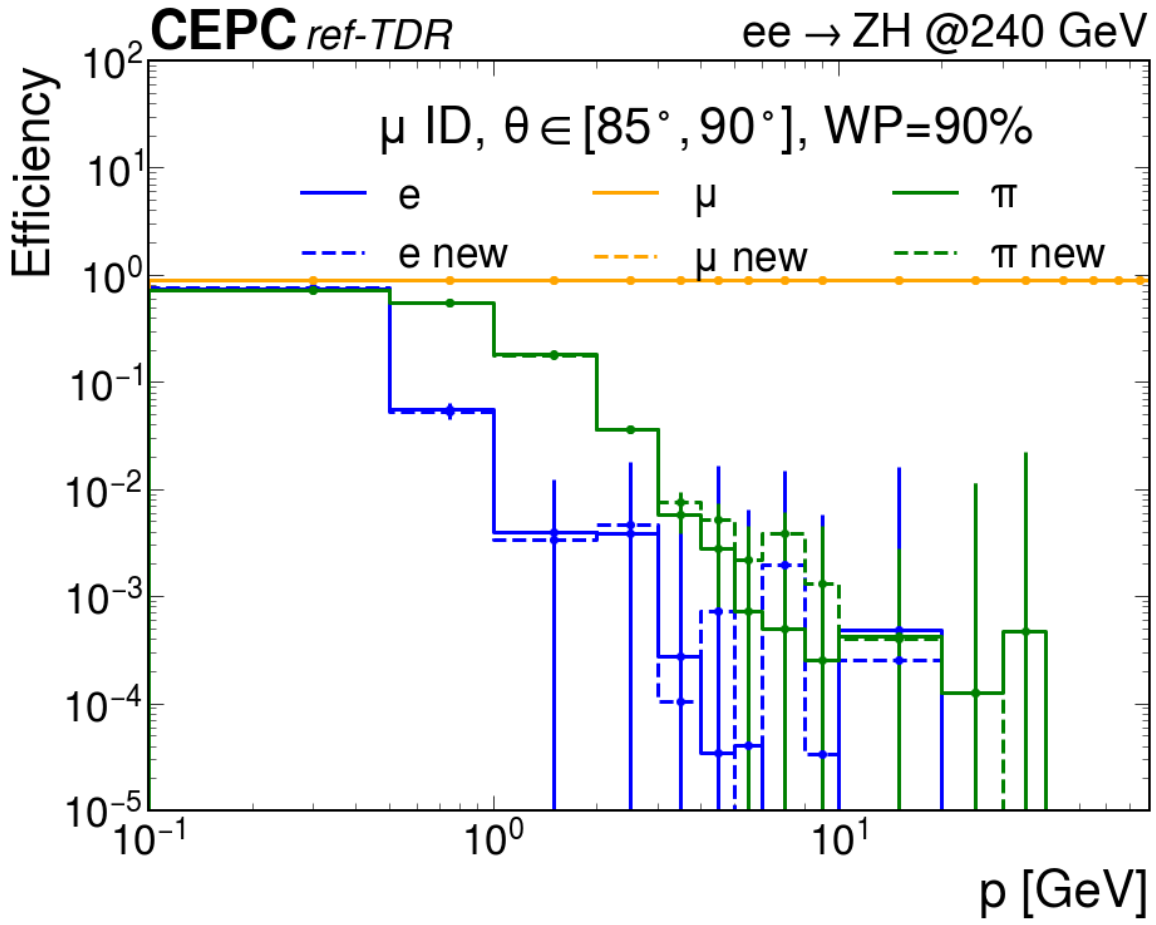




To examine the highly correlated features, the XGBoost model is trained with all four ΔRs or with only one ΔR

Lepton PID: correlation of ΔRs



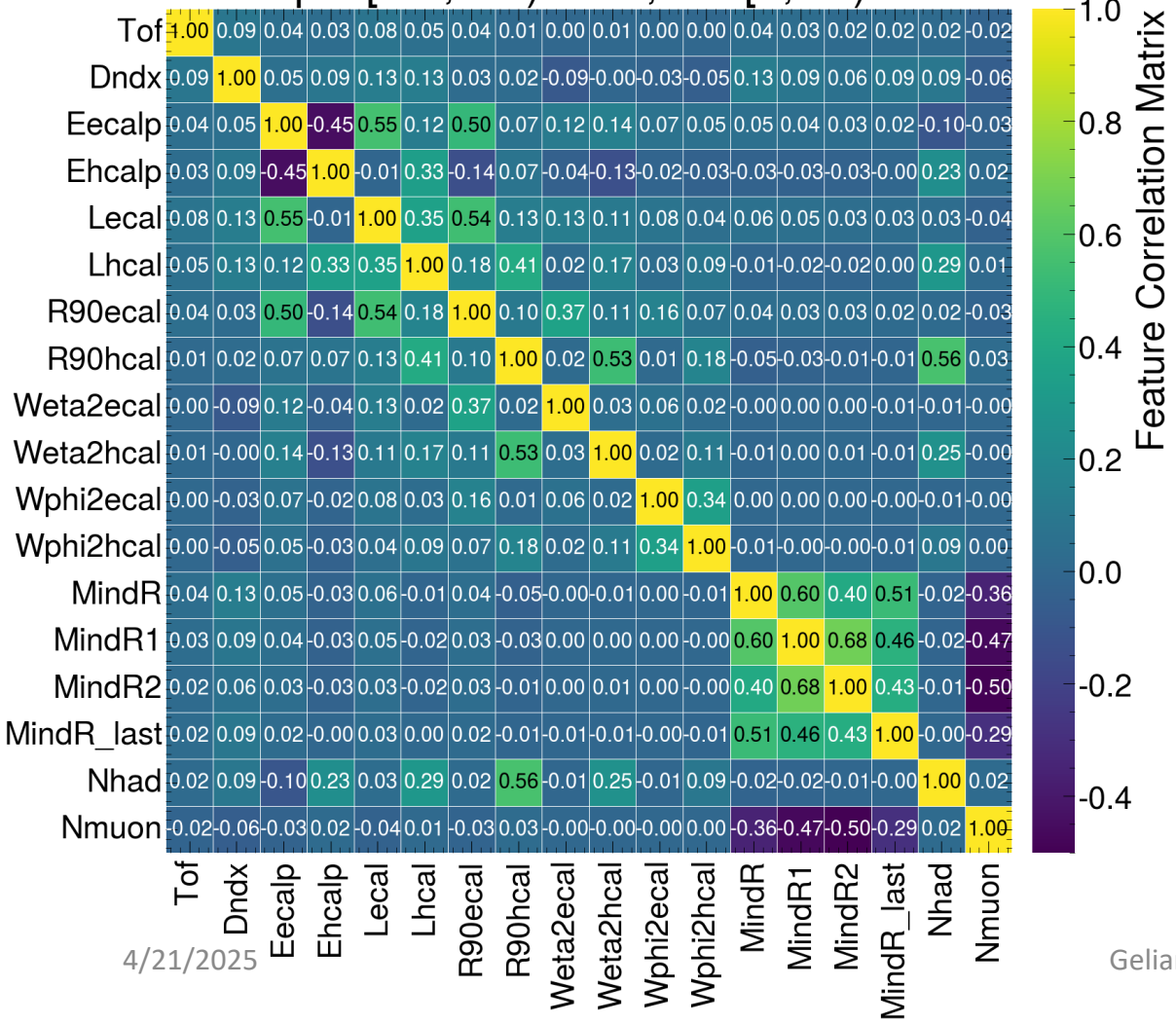


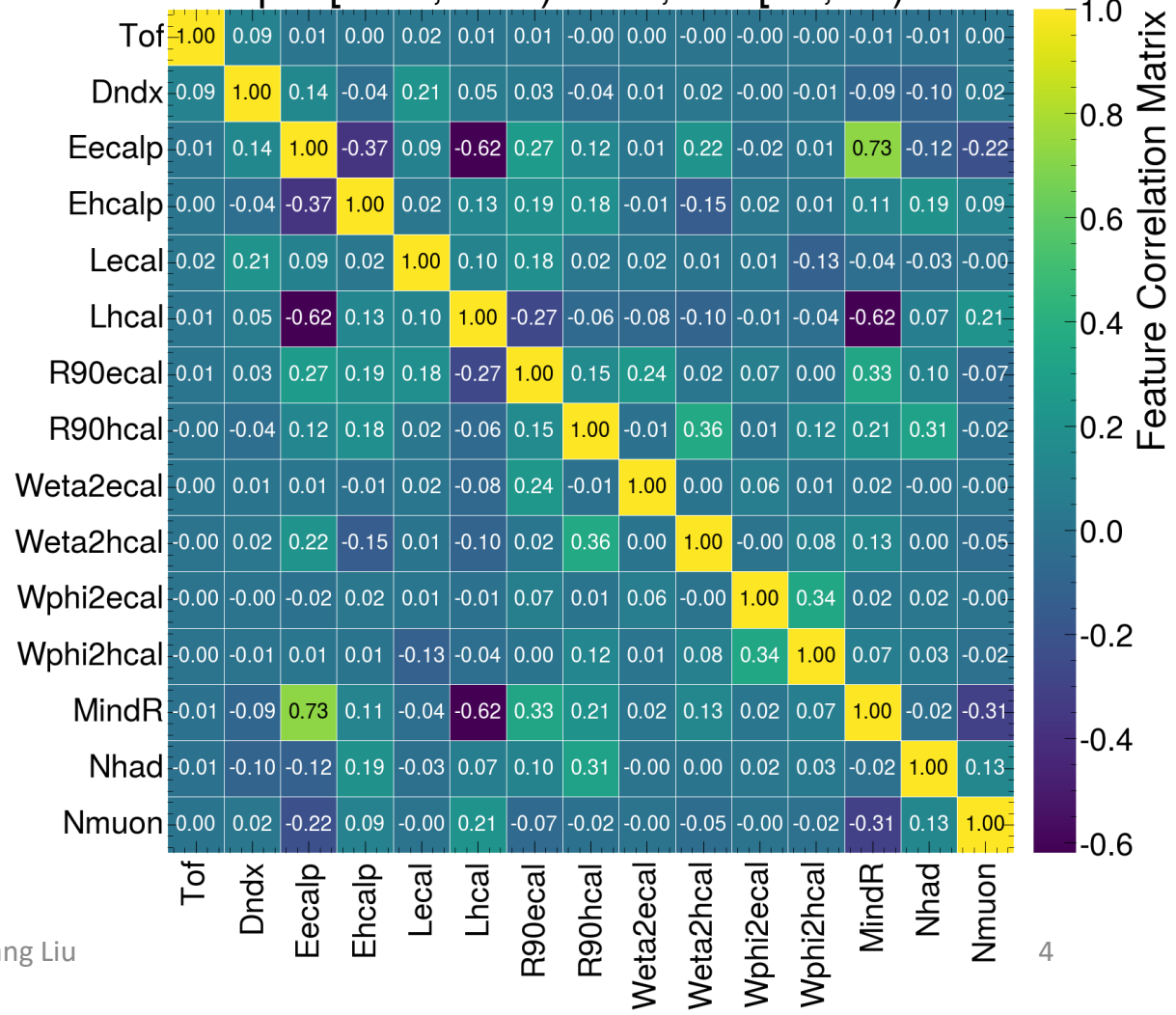
Results are in general worse in low p regions and in endcap regions.
Decide to use only one ΔR only when p >= 30 GeV in barrel regions.

Lepton PID: additional variables

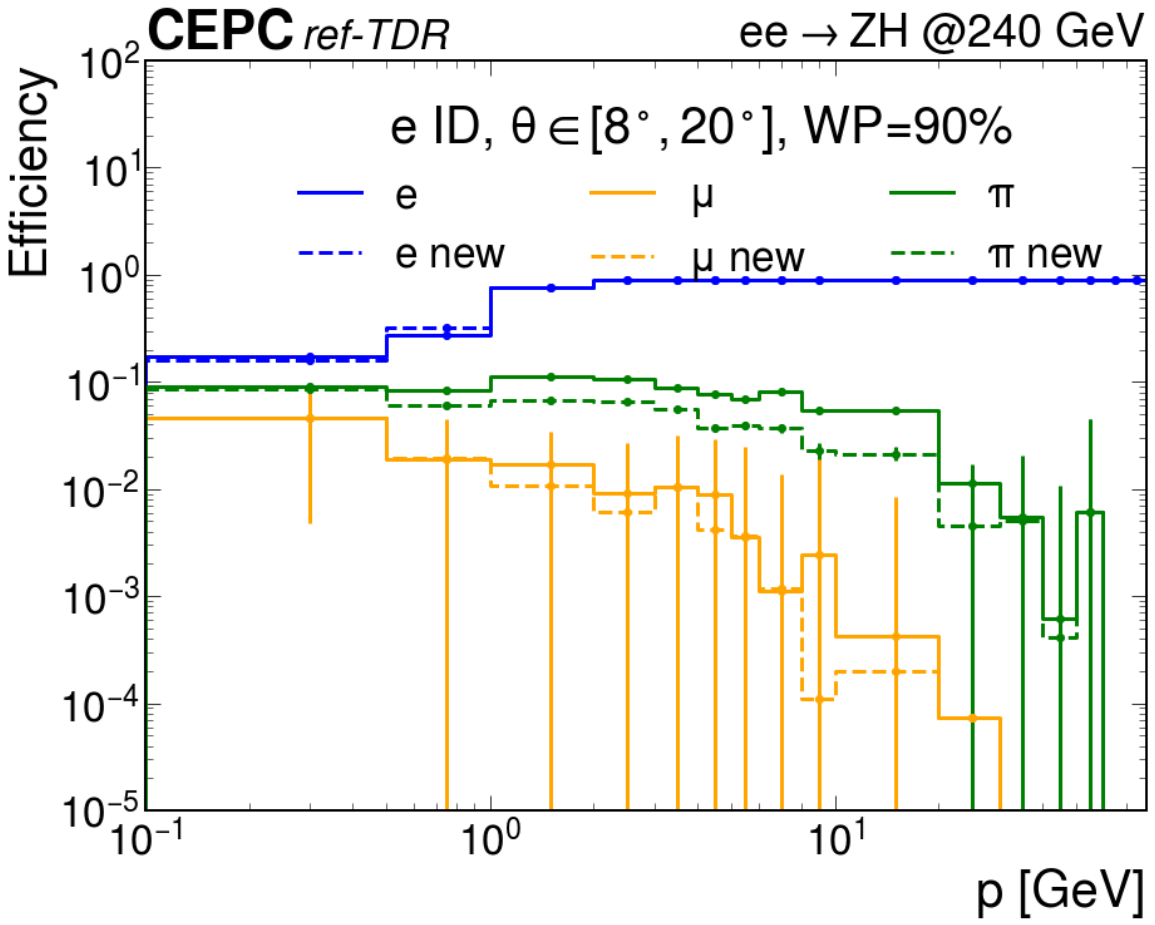
Variables related to shower shapes used for photon ID are also used for lepton ID:

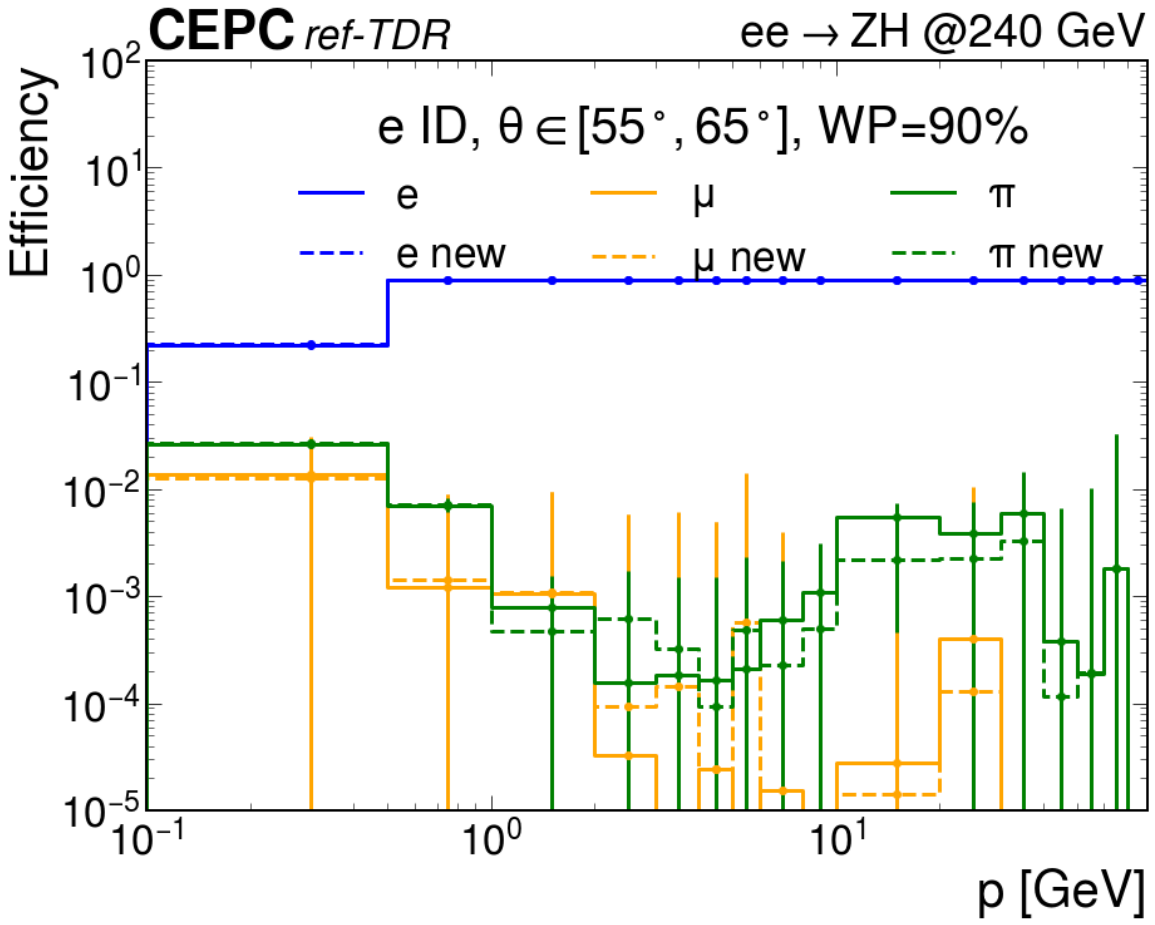
- l_{ECAL}, R^{90}_{ECAL}, Var^{η}_{ECAL}, Var^{ϕ}_{ECAL}, l_{HCAL}, R^{90}_{HCAL}, Var^{η}_{HCAL}, Var^{ϕ}_{HCAL}





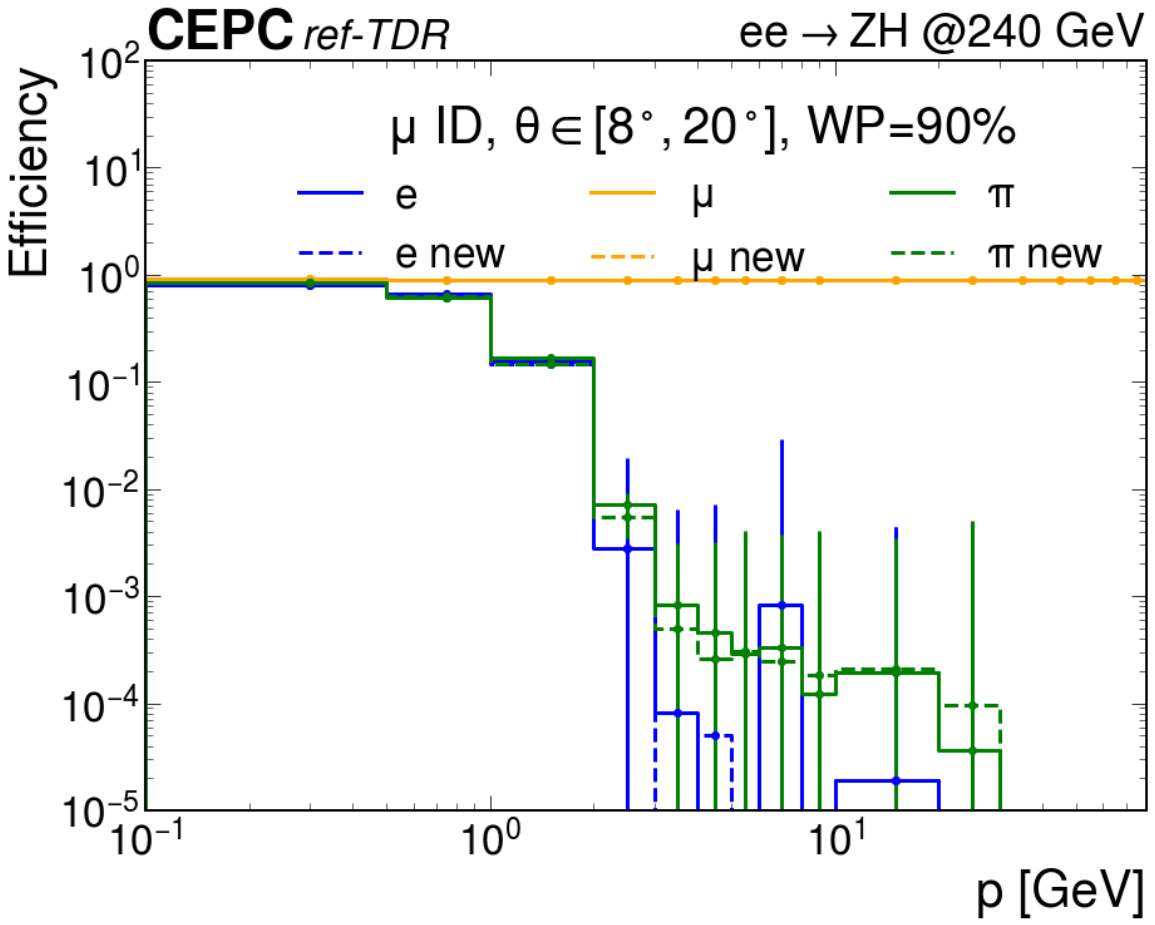
Lepton PID: additional variables

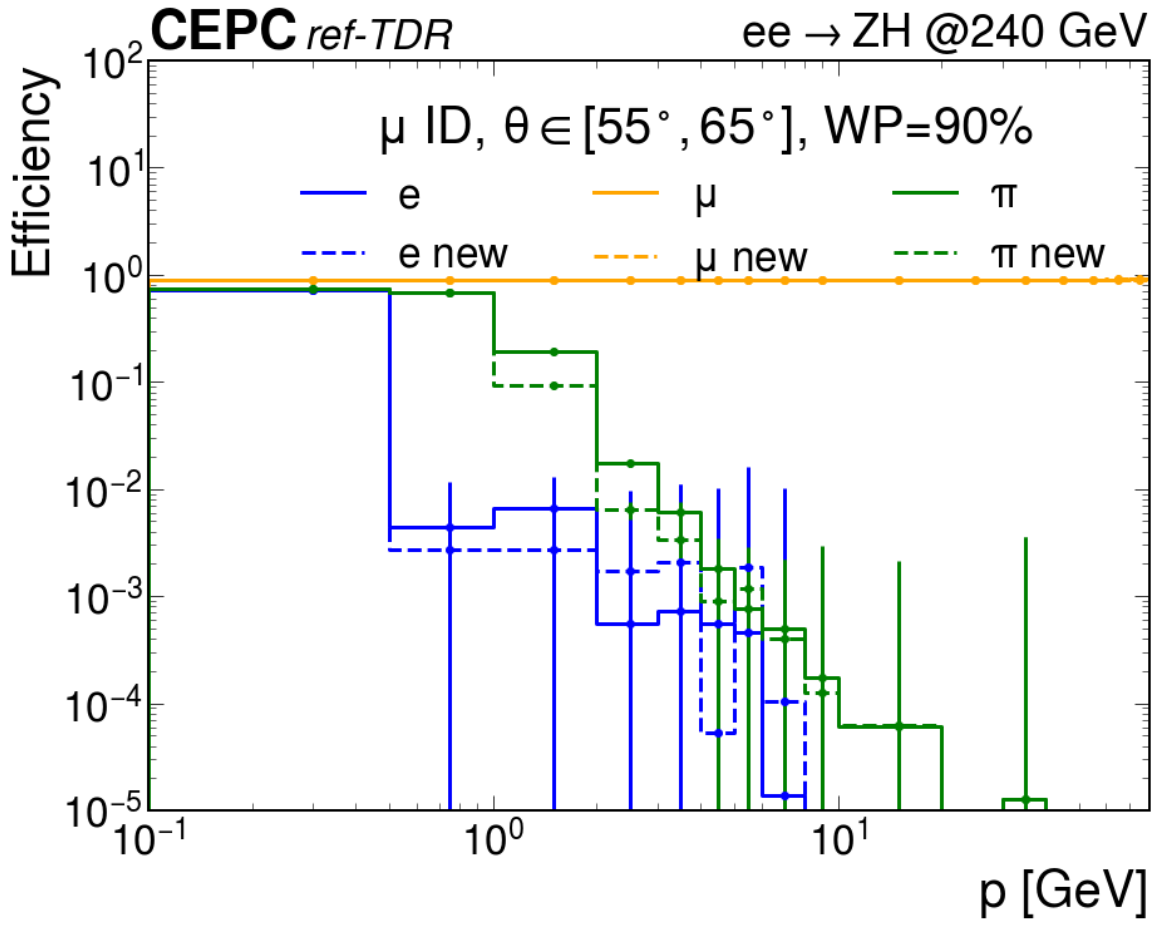




In general better performances with more variables, especially to distinguish between leptons and hadrons.

Lepton PID: additional variables





In general better performances with more variables, especially to distinguish between leptons and hadrons.

Hadron ID in Zqq environments

From Xiaotian:

- Kaon ID is checked in E91.2_Zqq environments, with a series of skimming processes to consider only "good" tracks.

Let's not apply all these criteria, but only necessary ones (gen-match and veto isDecayInTracker), and then compare the performances of the χ^2 method and XGBoost method.

Only charged hadrons are considered:

- Genuine leptons are not counted.
- For the χ^2 method: the old FinalPIDSvc with noLep WP.
- For the XGBoost method: most updated feature inputs; only identify as pi / K / p depending on their probs.

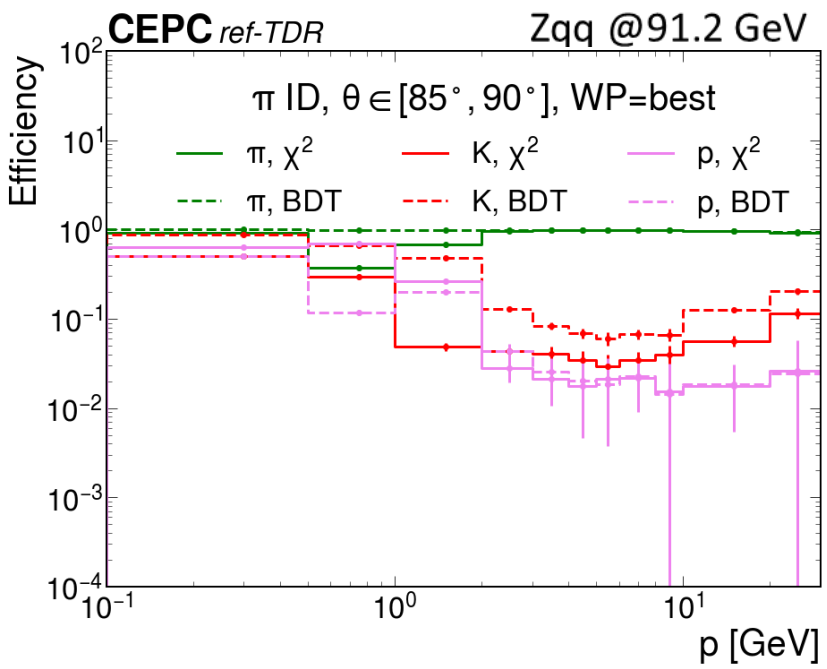
Kaon Track

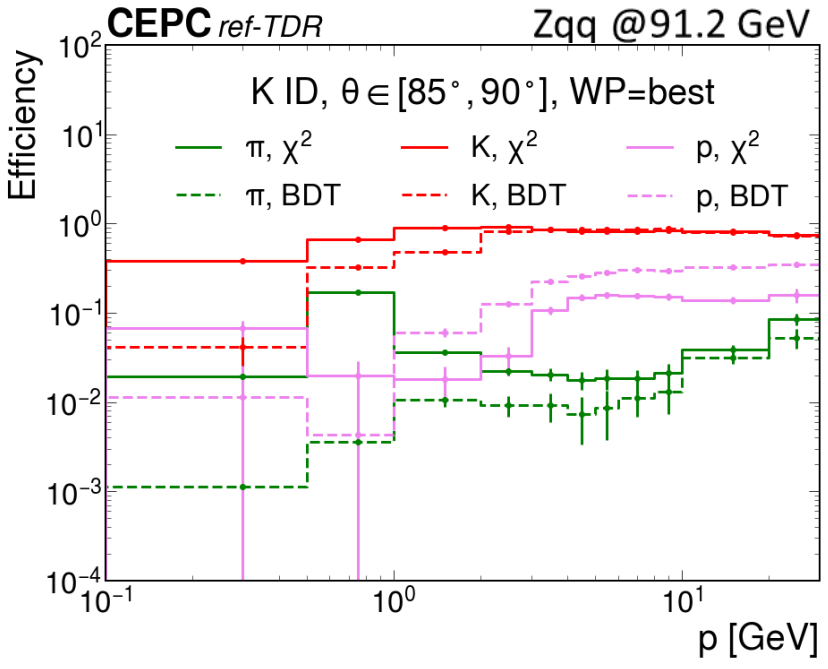
$Z \to q\bar{q}$ 100000 events (truth MCParticle charged stable e,μ,π,K,p: 2288676)				
Track selection criteria		Ntrack	Absolute Efficiency	Relative Efficiency
(a) CompleteTracks	…	2268408	100%	100%
(b) Track-MCP Match: CompleteTracks ParticleAssociation	Track hits match with stable MCParticle Choose MCParticle with max weight as truth particle	2268408	100%	100%
	Match with charged e,μ,π,K,p	2184944	96.32%	96.32%
	Match with charged K	230785	10.17%	10.56%
(c) No decays	Veto isdecayintrker	169639	7.48%	73.51%
(d) Hit TPC	matchedtpc	157234	6.93%	92.69%
(e) Hit TOF	matchedtof	141891	6.26%	90.24%
(f) No daughters	daughtersize==0	137638	6.07%	97.00%
(g) Track fitting	$\chi^2/ndof < 2$	136439	6.01%	99.13%
(h) Veto regions	Not in (p<0.5GeV && $\lvert\cos\theta\rvert < 0.55$) (p<1GeV && $\lvert\cos\theta\rvert > 0.55$) (p>4GeV && $\lvert\cos\theta\rvert > 0.9$)	128872	5.68%	94.45%

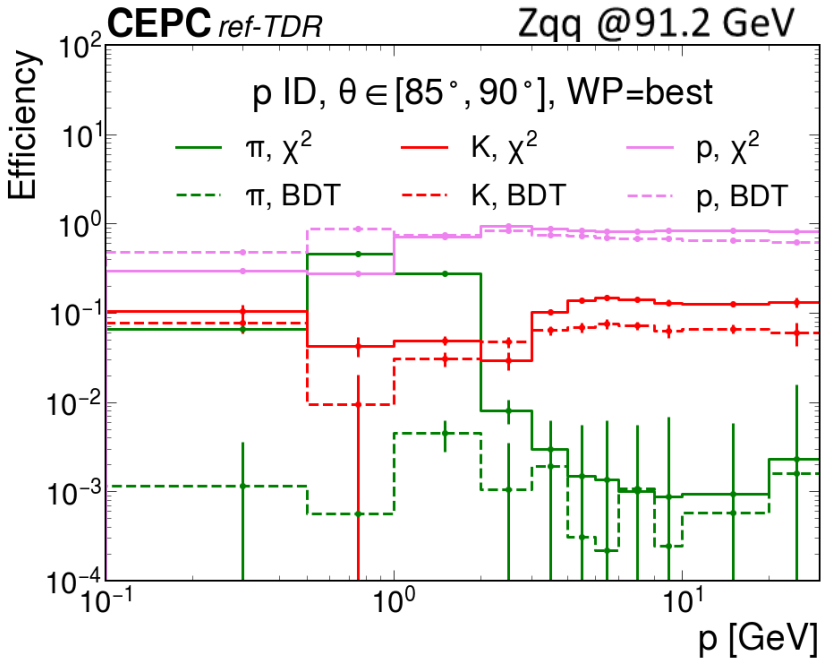
2

Hadron ID in Zqq environments

Efficiency and misID rates

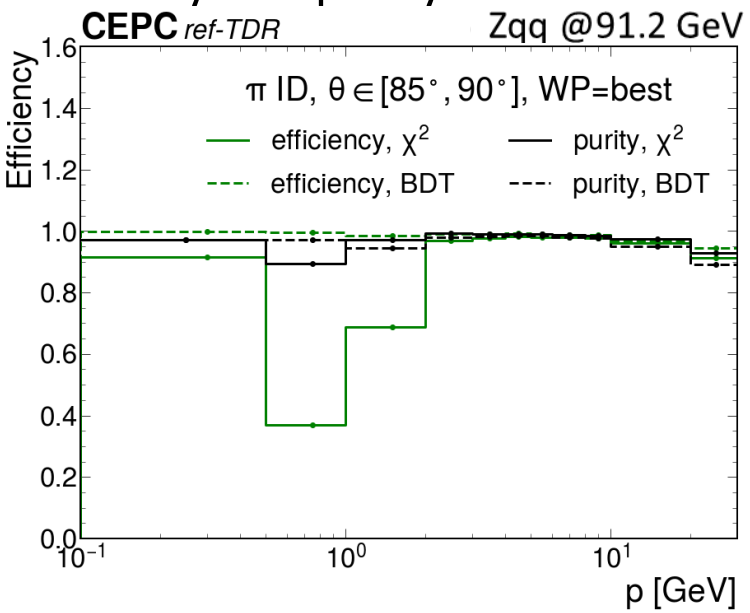


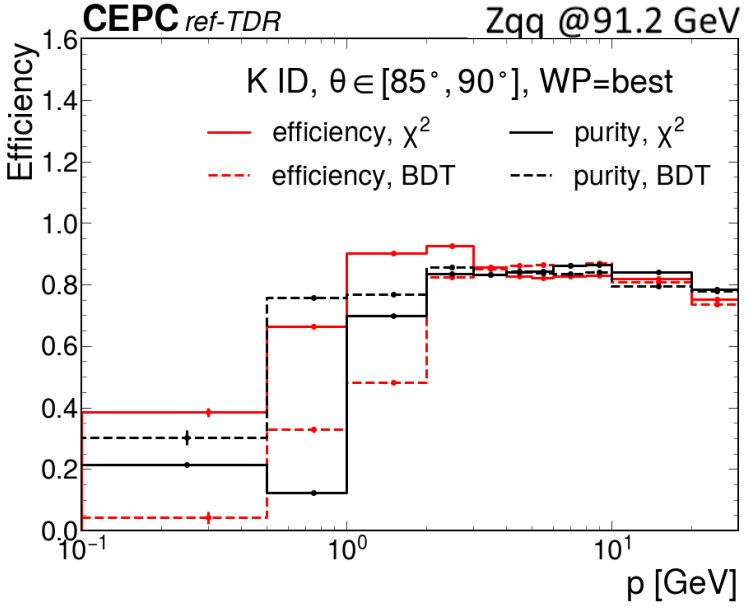


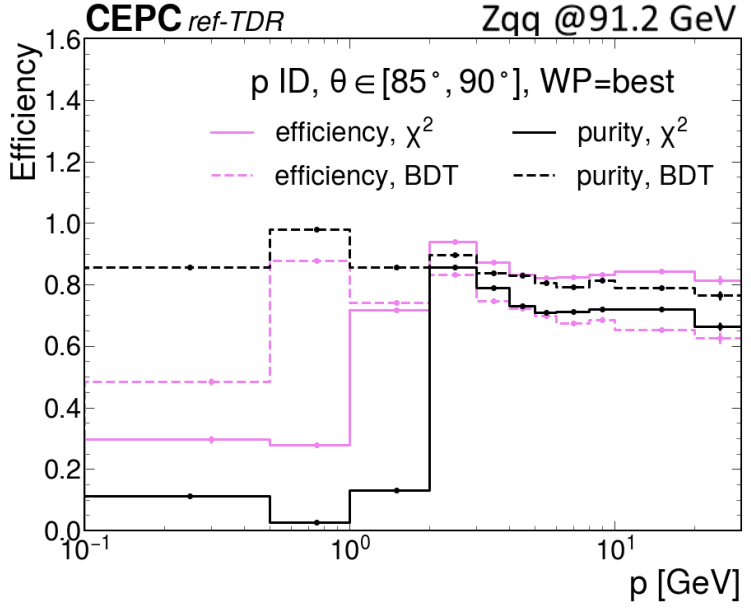


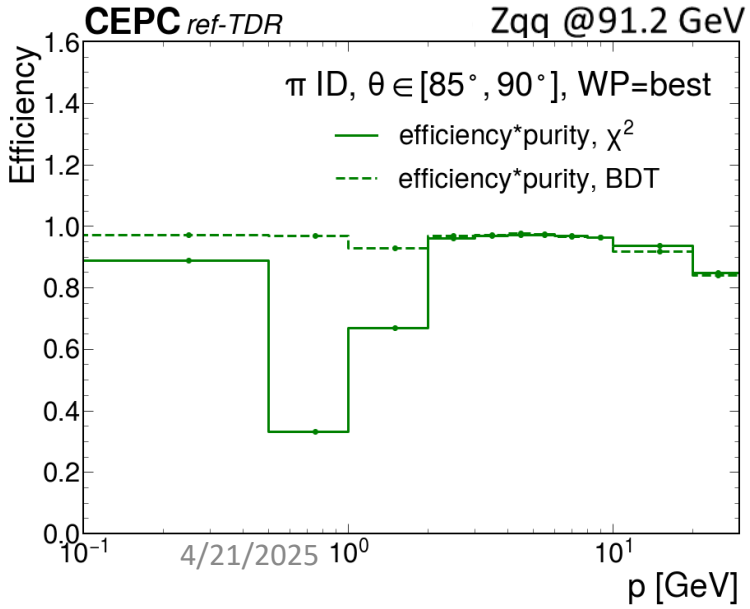
Hadron ID in Zqq environments

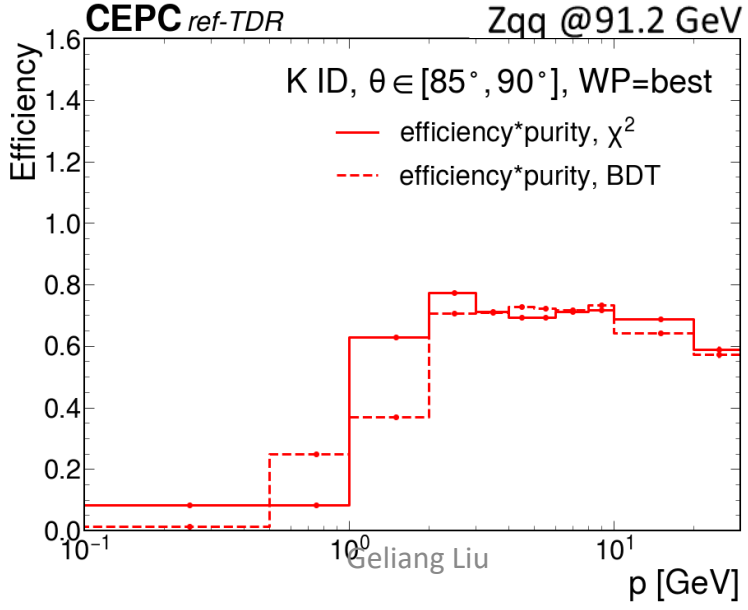
Efficiency and purity

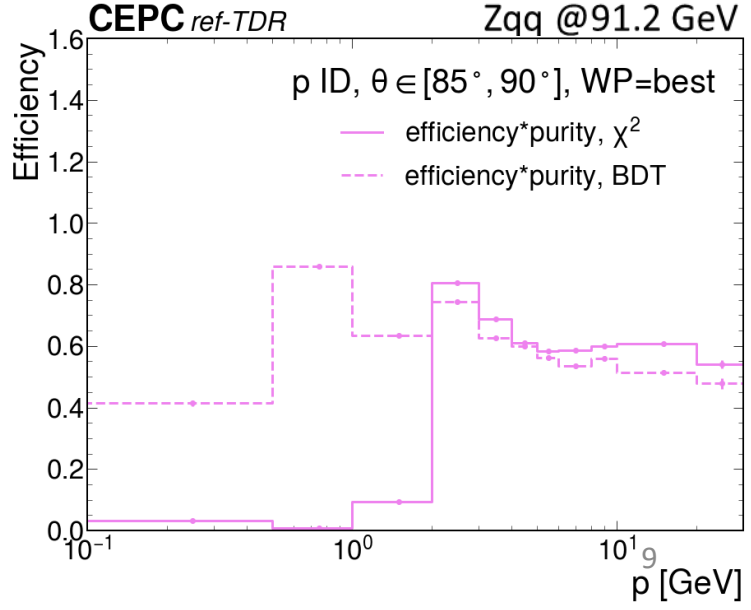












Hadron ID in Zqq environments

Overall efficiency and purity

- With skimming:

Not in (p<0.5GeV && $|\cos\theta| < 0.55$)
(p<1GeV && $|\cos\theta| > 0.55$)
(p>4GeV && $|\cos\theta| > 0.9$)

	χ^2 method			XGBoost		
	efficiency	purity	eff*pur	efficiency	purity	eff*pur
pion	74.7%	97.1%	72.5%	98.8%	95.6%	94.5%
kaon	83.3%	62.4%	52.0%	70.3%	80.1%	56.7%
proton	74.6%	21.4%	16.0%	65.7%	83.2%	54.7%

- From Xiaotian:
- Difference coming from other skimming procedures, especially **requiring both TOF and TPC to be fired**.
- Need further check if the computations are correct.

Kaon PID Efficiency just among charged π,K,p

Selections	K Ntrack	PID Strategy	K to K Ntrack	PID Eff.	π,K,p to K Ntrack	Purity	Eff*Purity
(a)-(e)	141891	Combined χ^2_K be the minimum	124627	87.83%	153255	81.32%	71.43%
		Maximize Kaon PID eff*purity Combined $\chi^2_K < 5.886$	119230	84.03%	152693	78.08%	65.61%
(a)-(h)	128872	Combined χ^2_K be the minimum	117213	90.95%	135181	86.71%	78.86%
		Maximize Kaon PID eff*purity Combined $\chi^2_K < 6.217$	112700	87.45%	137871	81.74%	71.49%