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Updates on PID

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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

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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_{ECAL}^{90} , Var_{ECAL}^{η} , Var_{ECAL}^{ϕ} , l_{HCAL} , R_{HCAL}^{90} , Var_{HCAL}^{η} , Var_{HCAL}^{ϕ} $p \in [2.0, 3.0) \text{ GeV}, \theta \in [8, 20)^{\circ}$

Tof 1.00 0.09 0.04 0.03 0.08 0.05 0.04 0.01 0.00 0.01 0.00 0.04 0.03 0.02 0.02 0.02 -0.02 Dndx 0.09 1.00 0.05 0.09 0.13 0.13 0.03 0.02 0.09 0.00 0.03 0.05 0.13 0.09 0.06 0.09 0.09 0.06 Eecalp 0.04 0.05 1.00 -0.45 0.55 0.12 0.50 0.07 0.12 0.14 0.07 0.05 0.05 0.04 0.03 0.02 -0.10 -0.03 Ehcalp 0.03 0.09 -0.45 1.00 -0.01 0.33 -0.14 0.07 -0.04 -0.13 -0.02 -0.03 -0.03 -0.03 -0.03 -0.00 0.23 0.02 hcal 0.05 0.13 0.12 0.33 0.35 1.00 0.18 0.41 0.02 0.17 0.03 0.09 0.01 0.02 0.02 0.00 0.29 0.01 R90ecal 0.04 0.03 0.50 0.14 0.54 0.18 1.00 0.10 0.37 0.11 0.16 0.07 0.04 0.03 0.03 0.02 0.02 0.03 **B90hcal** 0.01 0.02 0.07 0.07 0.13 0.41 0.10 1.00 0.02 0.53 0.01 0.18 -0.05 -0.03 -0.01 0.01 0.56 0.03 Weta2ecal 0.00 0.09 0.12 0.04 0.13 0.02 0.37 0.02 1.00 0.03 0.06 0.02 0.00 0.00 0.00 0.01 0.01 0.01 0.00 Weta2hcal 0.01 -0.00 0.14 -0.13 0.11 0.17 0.11 0.53 0.03 1.00 0.02 0.11 -0.01 0.00 0.01 -0.01 0.25 -0.00 Wphj2ecal 0.00-0.030.07-0.020.08 0.03 0.16 0.01 0.06 0.02 1.00 0.34 0.00 0.00 0.00-0.00-0.01-0.00 Wphi2hcal 0.00-0.05 0.05 0.03 0.04 0.09 0.07 0.18 0.02 0.11 0.34 1.00 0.01 0.00 0.00 0.01 0.09 0.00 MindR 0.04 0.13 0.05-0.03 0.06-0.01 0.04 -0.05-0.00-0.01 0.00 -0.01 1.00 0.60 0.40 0.51 -0.02-0.36 MindR2 0.02 0.06 0.03 -0.03 0.03 -0.02 0.03 -0.01 0.00 0.01 0.00 -0.00 0.40 0.68 1.00 0.43 -0.01 -0.50 MindR last 0.02 0.09 0.02 0.00 0.03 0.00 0.02 0.01 0.01 0.01 0.00 0.01 0.51 0.46 0.43 1.00 0.00 0.29 Nhad 0.02 0.09 0.10 0.23 0.03 0.29 0.02 0.56 0.01 0.25 0.01 0.09 0.02 0.02 0.01 0.00 1.00 0.02 Nmuon -0.02-0.06-0.03 0.02 -0.04 0.01 -0.03 0.03 -0.00-0.00 -0.00 0.00 -0.36-0.47-0.50 -0.29 0.02 Nmuon Lecal Lhcal **R90hcal** Dndx R90ecal eta2eca Wphi2hca MindR2 Ehcalp **Veta2hca** MindF ສິ Wphi2ed MindF MindR

 $p \in [30.0, 40.0) \text{ GeV}, \theta \in [85, 90)^{\circ}$



Lepton PID: additional variables



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

Lepton PID: additional variables



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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

$Z o q ar q$ 100000 events (truth MCParticle charged stable e, μ, π, K, p : 2288676)							
Т	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 && cosθ < 0.55) (p<1GeV && cosθ > 0.55) (p>4GeV && cosθ > 0.9)	128872	5.68%	94.45%			

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Efficiency and misID rates





0.90

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⊆^{0.60}

uoey

0.3

0.4

ă

Overall efficiency and purity

With skimming:

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

From Xiaotian: ullet

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

	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%	

Kaon PID Efficiency just among charged π, K, p								
Selections	<i>K</i> Ntrack	PID Strategy		<i>K</i> to <i>K</i> Ntrack	PID Eff.	π, <i>K</i> , <i>p</i> to <i>K</i> Ntrack	Purity	Eff*Purity
(a)-(e) 1418		Combined χ^2_K be t	he minimum	124627	87.83%	153255	81.32%	71.43%
	141891	Maximize Kaon F Combined χ^2_K	ID eff*purity < 5.886	119230	84.03%	152693	78.08%	65.61%
<mark>(a)-(h)</mark> 128		Combined χ^2_K be t	he minimum	117213	90.95%	135181	86.71%	78.86%
	128872	Maximize Kaon F Combined χ^2_K	ID eff*purity < 6.217	112700	87.45%	137871	81.74%	71.49%

