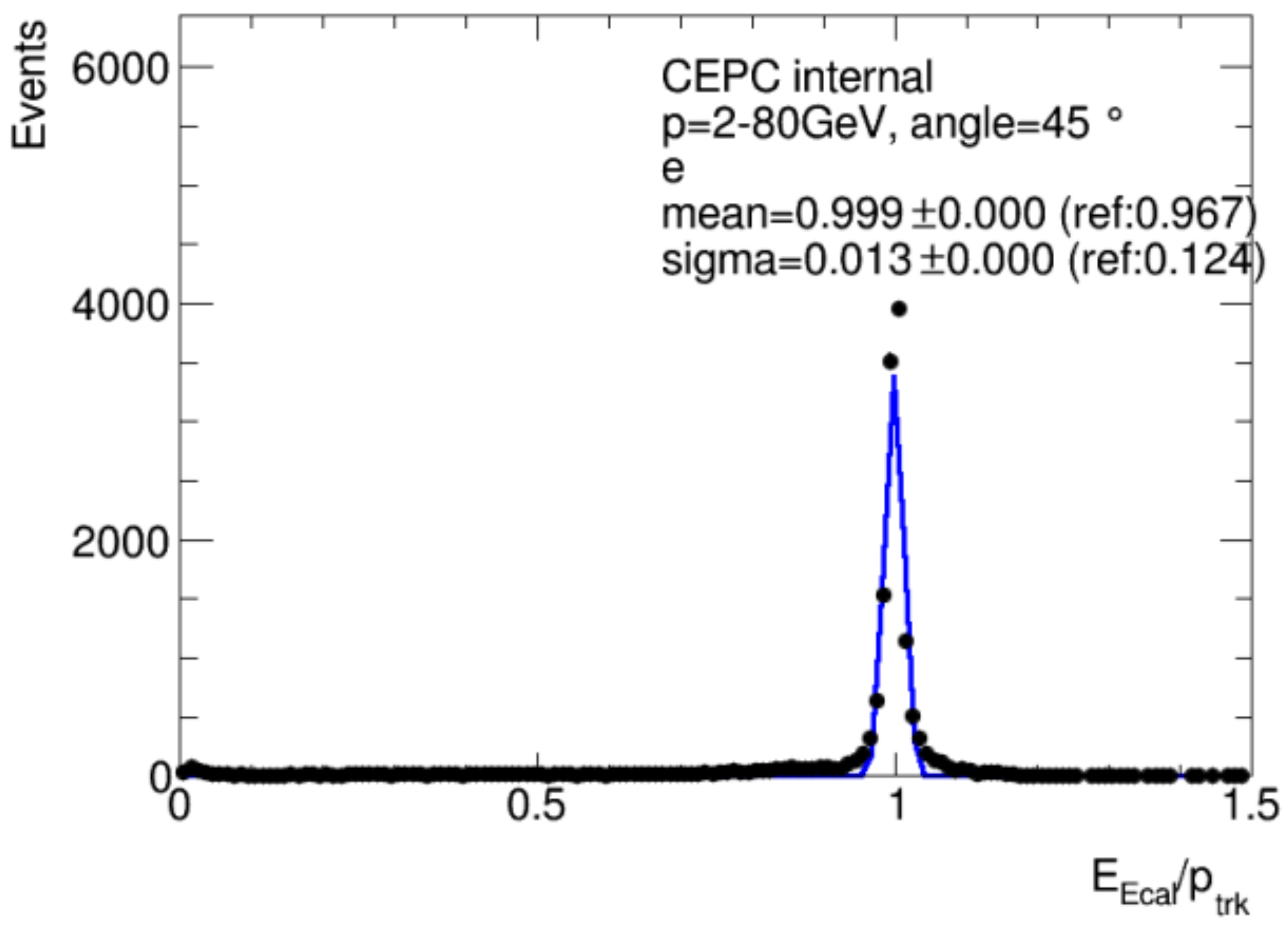
Performance: PID & Vtx
Analysis: Recoil-mass

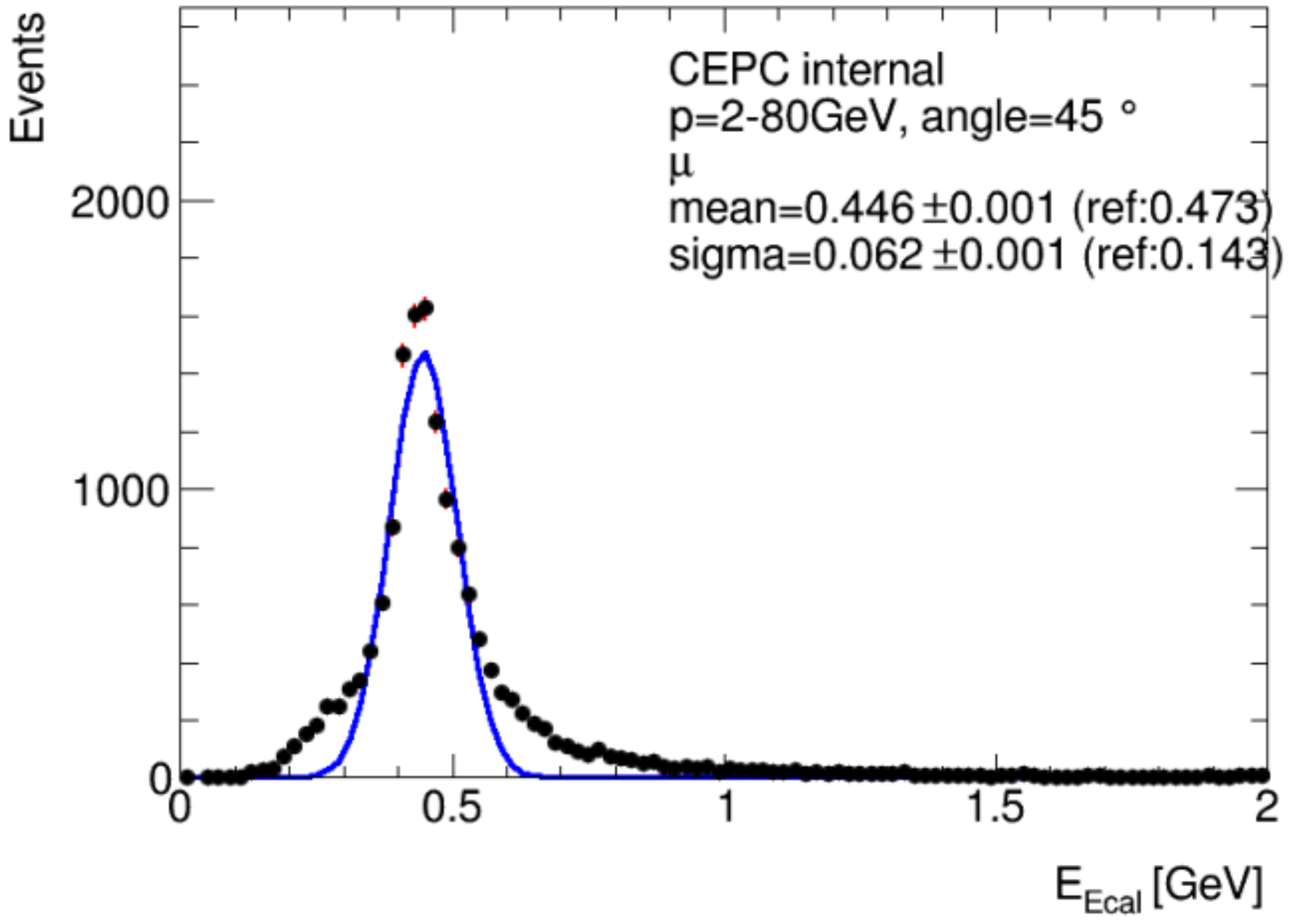
C.Zhang/17Feb2025

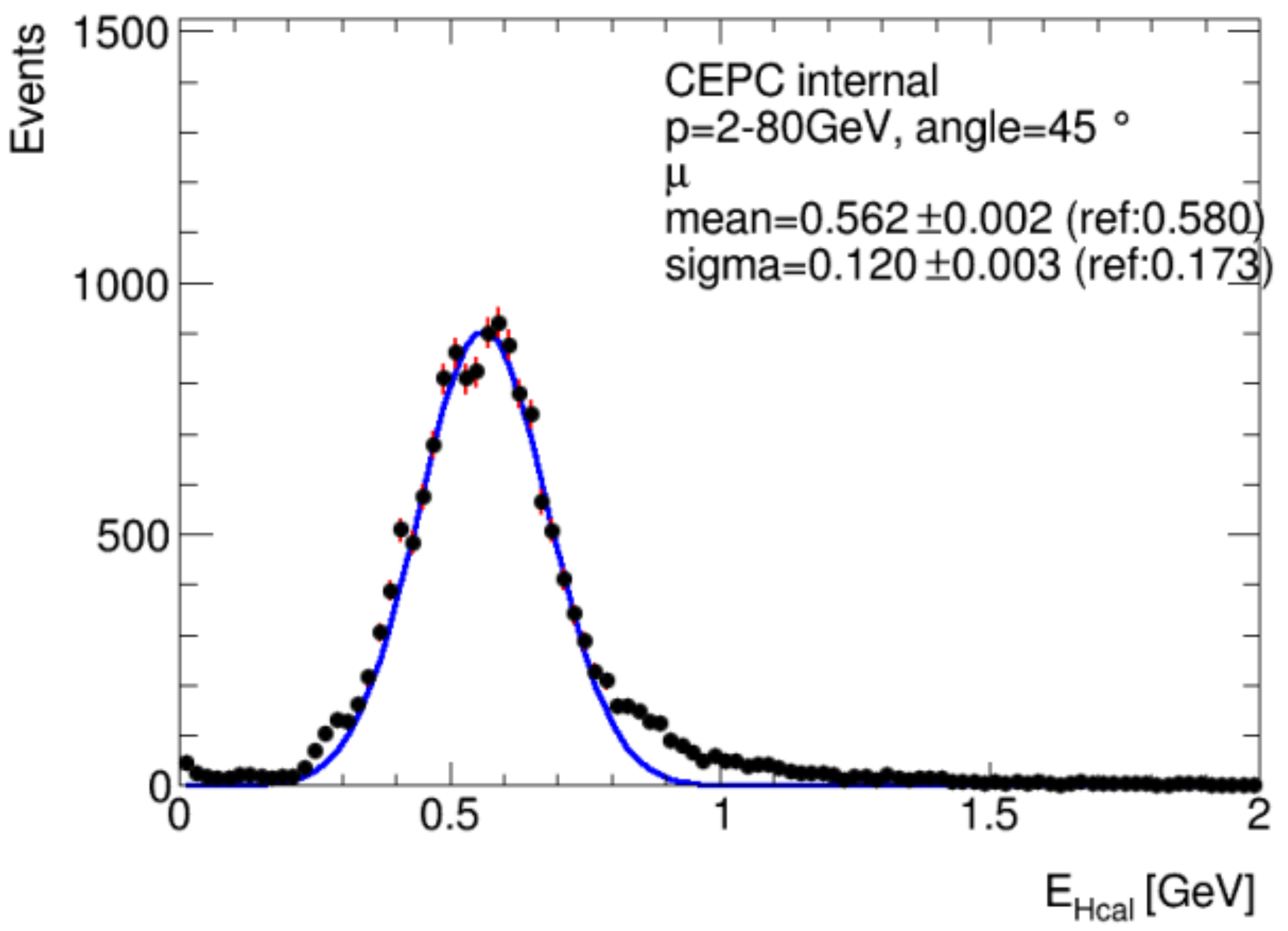
Lepton ID

A brief summary from Ligang Xia

- E/p for electron
  - chi2 =chi2(TPC) + chi2(TOF) + chi2(E/p)
- Ecal and Hcal for muon, chi2 = chi2(TPC)+chi2(TOF)+chi2(Ecal) +chi2(Hcal)







Features in PID:
- E_{Ecal}/Ptrk ~ 1 for electrons
- construct a chi2: chi2=(x-mean)^2/sigma^2
- mean, sigma: momentum/angle dependent

Features in PID:
- Energy deposit in Ecal: roughly single energy for muon
- Energy deposit in Hcal: roughly single energy for muon
- construct a chi2 for each energy: chi2=(x-mean)^2/sigma^2
- mean, sigma: momentum/angle dependent

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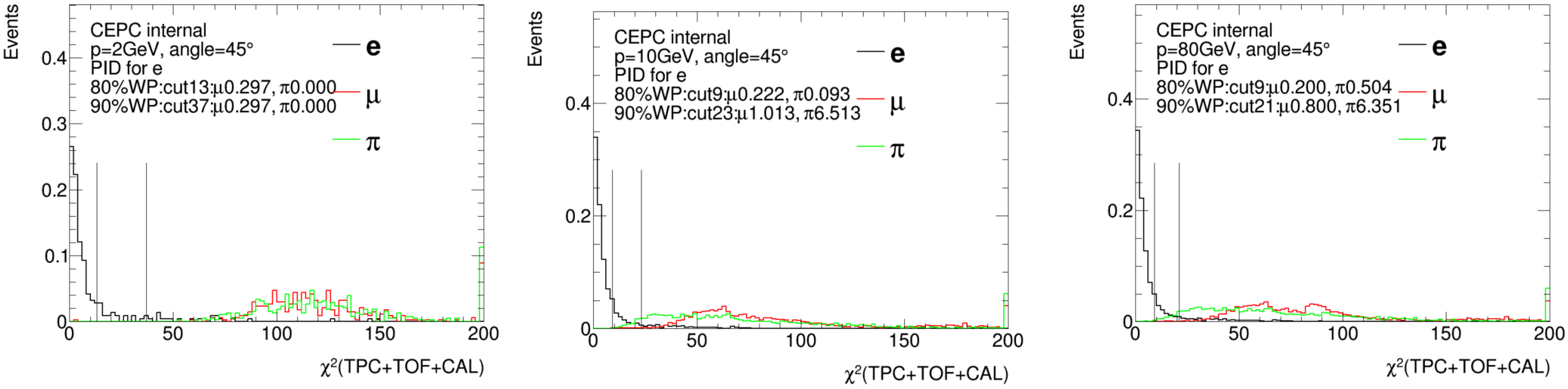
Electron ID performance



- 80% WP:
  - definition: chi2<13(2GeV), chi2<9(10GeV), chi2<9(80GeV)
  - misID(mu->e) = 0.2% - 0.3%, misID(pi->e)=0-0.5%
- 90% WP:
  - definition: chi2<37(2GeV), chi2<23(10GeV), chi2<21(80GeV)
  - misID(mu->e) = 0.2%-1.0%, misID(pi->e)=0-6.5%

Similar performance to Belle2

Belle2 90%WP

$$\mathrm{mis-ID}(\pi^\pm \to e^\pm) = \left(4.11^{+0.20}_{-0.20}\ (\mathrm{stat.})^{+<0.01}_{-<0.01}\ (\mathrm{syst.})\right) \times 10^{-3}$$
$$\mathrm{mis-ID}(\pi^\pm \to \mu^\pm) = \left(7.33^{+0.02}_{-0.01}\ (\mathrm{stat.})^{+0.01}_{-0.01}\ (\mathrm{syst.})\right) \times 10^{-2}.$$

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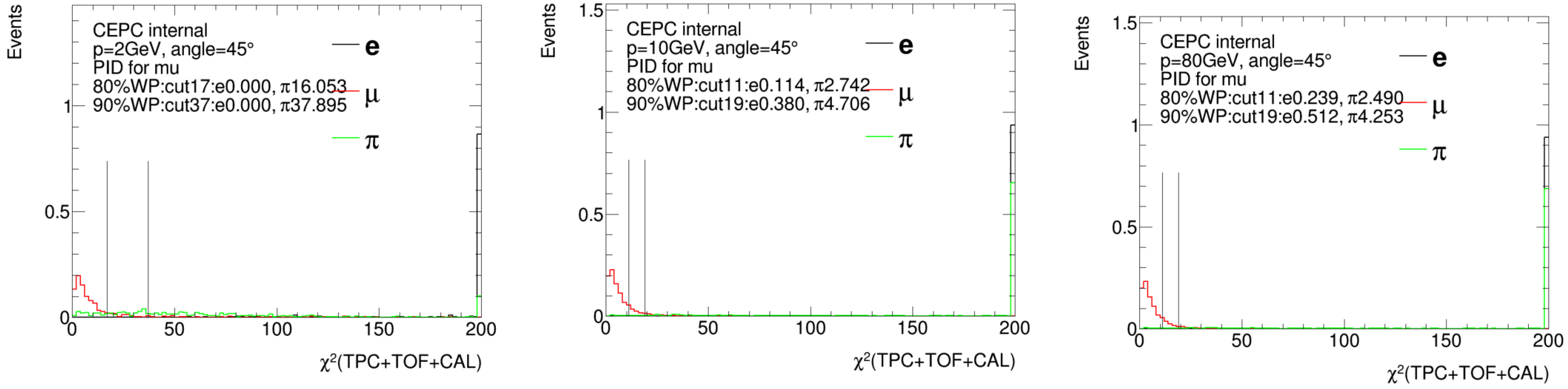
A brief summary from Ligang Xia

Muon ID performance



- 80% WP:
  - definition: chi2<17(2GeV), chi2<11(10GeV), chi2<11(80GeV)
  - misID(e->mu) = 0.% - 0.2%, misID(pi->mu)=2-16%
- 90% WP:
  - definition: chi2<37(2GeV), chi2<19(10GeV), chi2<19(80GeV)
  - misID(e->mu) = 0.%-0.2%, misID(pi->e)=4-37%

Similar performance than Belle2

Belle2 90%WP

$$\text{mis} - \text{ID}(\pi^\pm \to e^\pm) = \left(4.11^{+0.20}_{-0.20}\ (\text{stat.})^{+<0.01}_{-<0.01}\ (\text{syst.})\right) \times 10^{-3}$$
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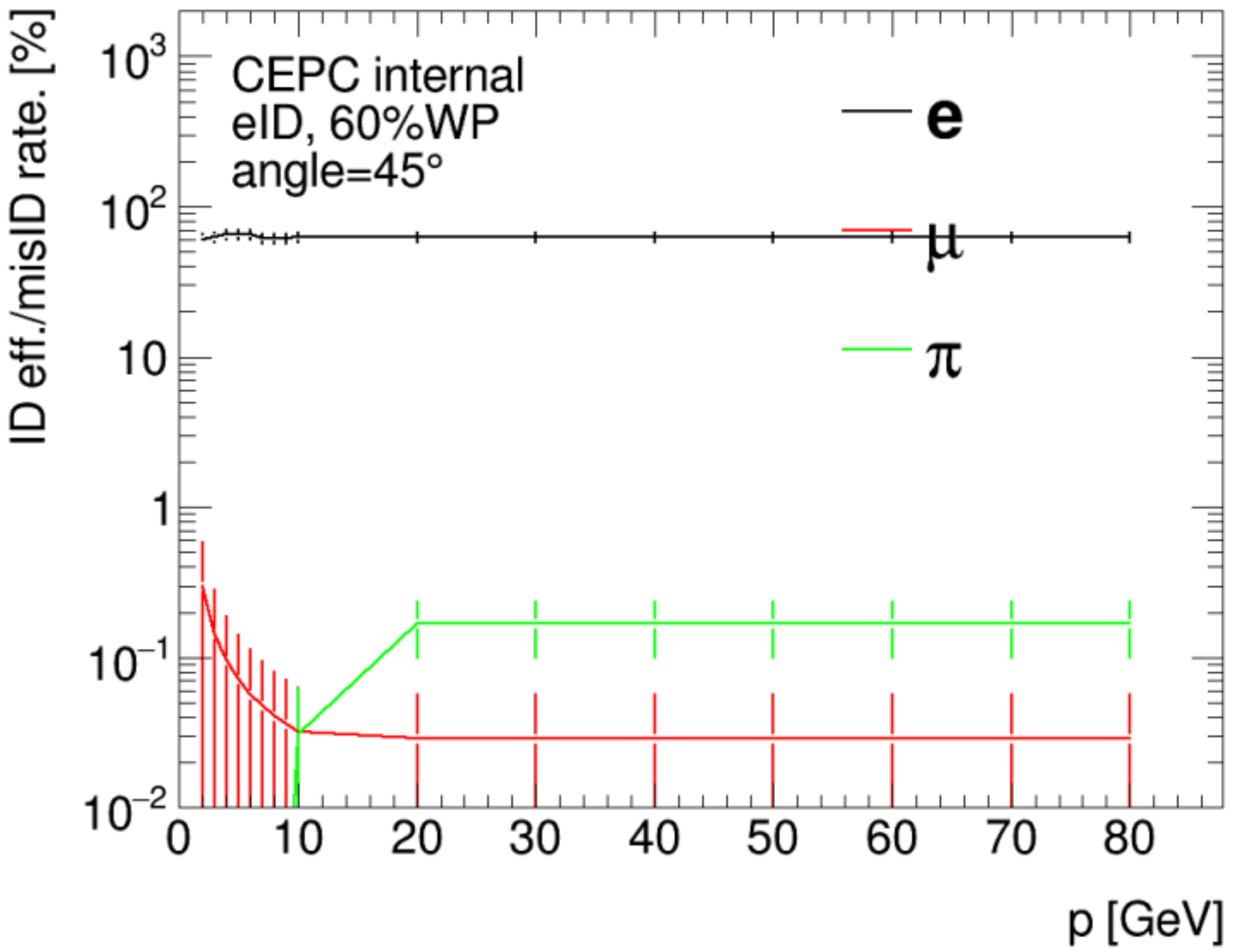
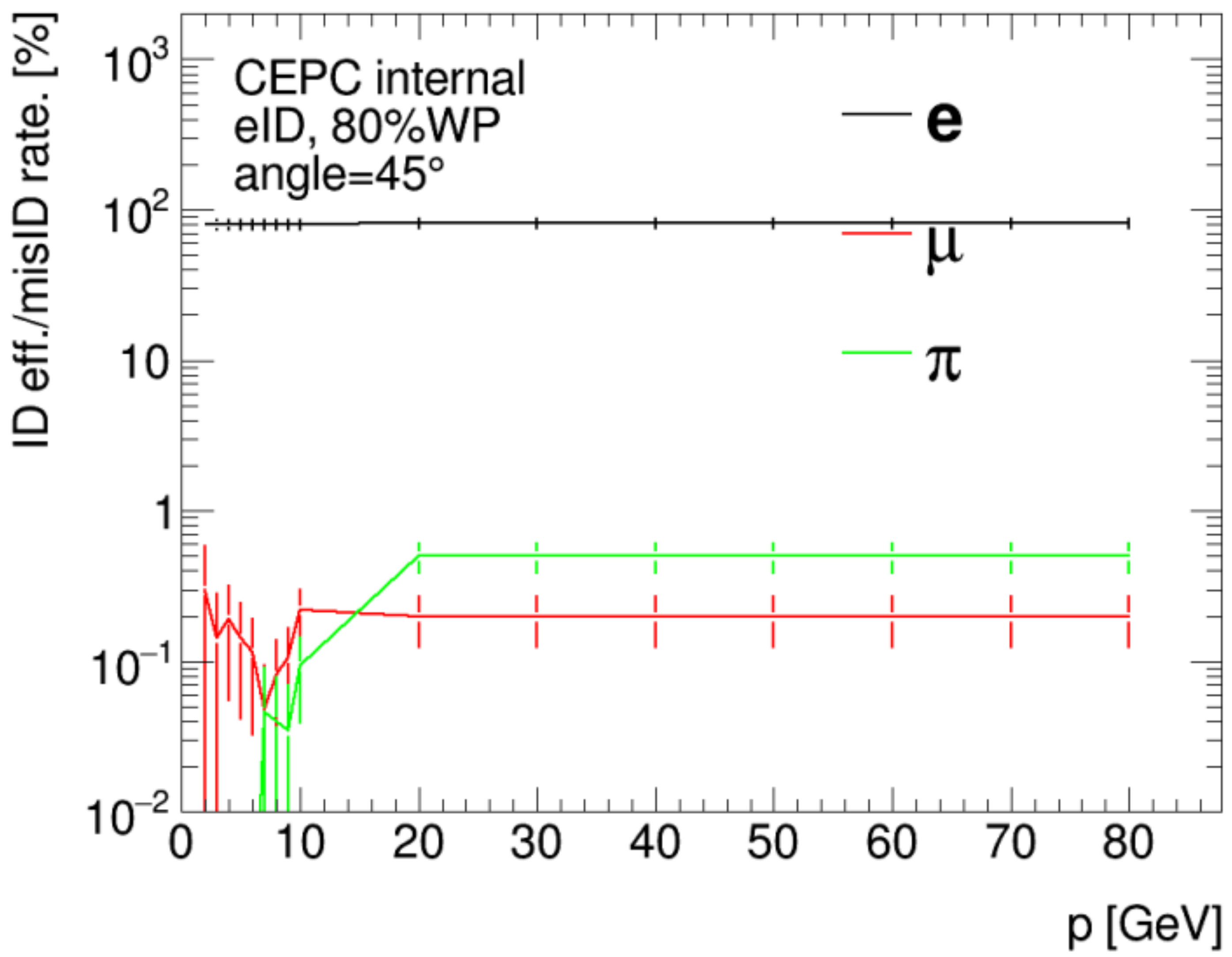
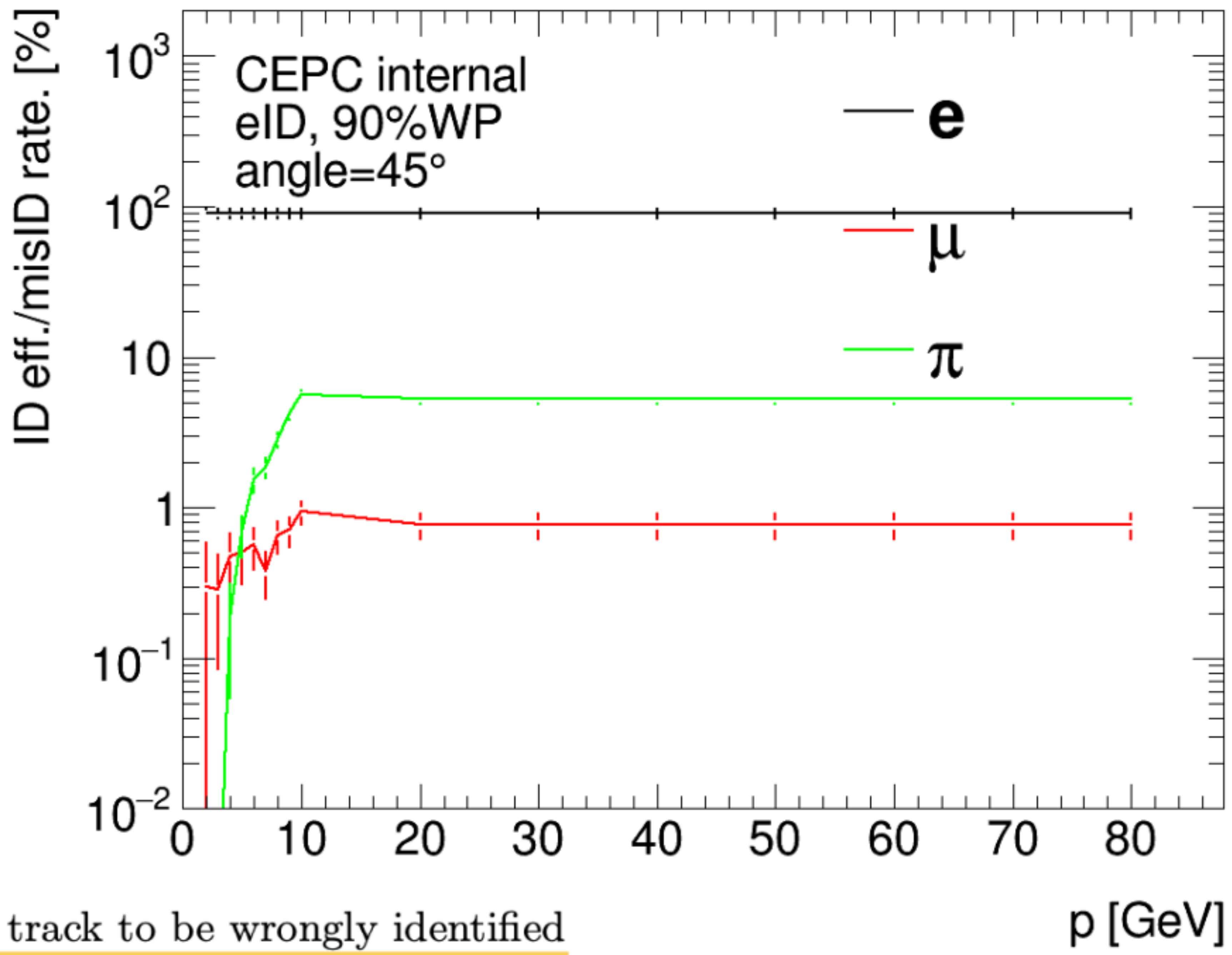
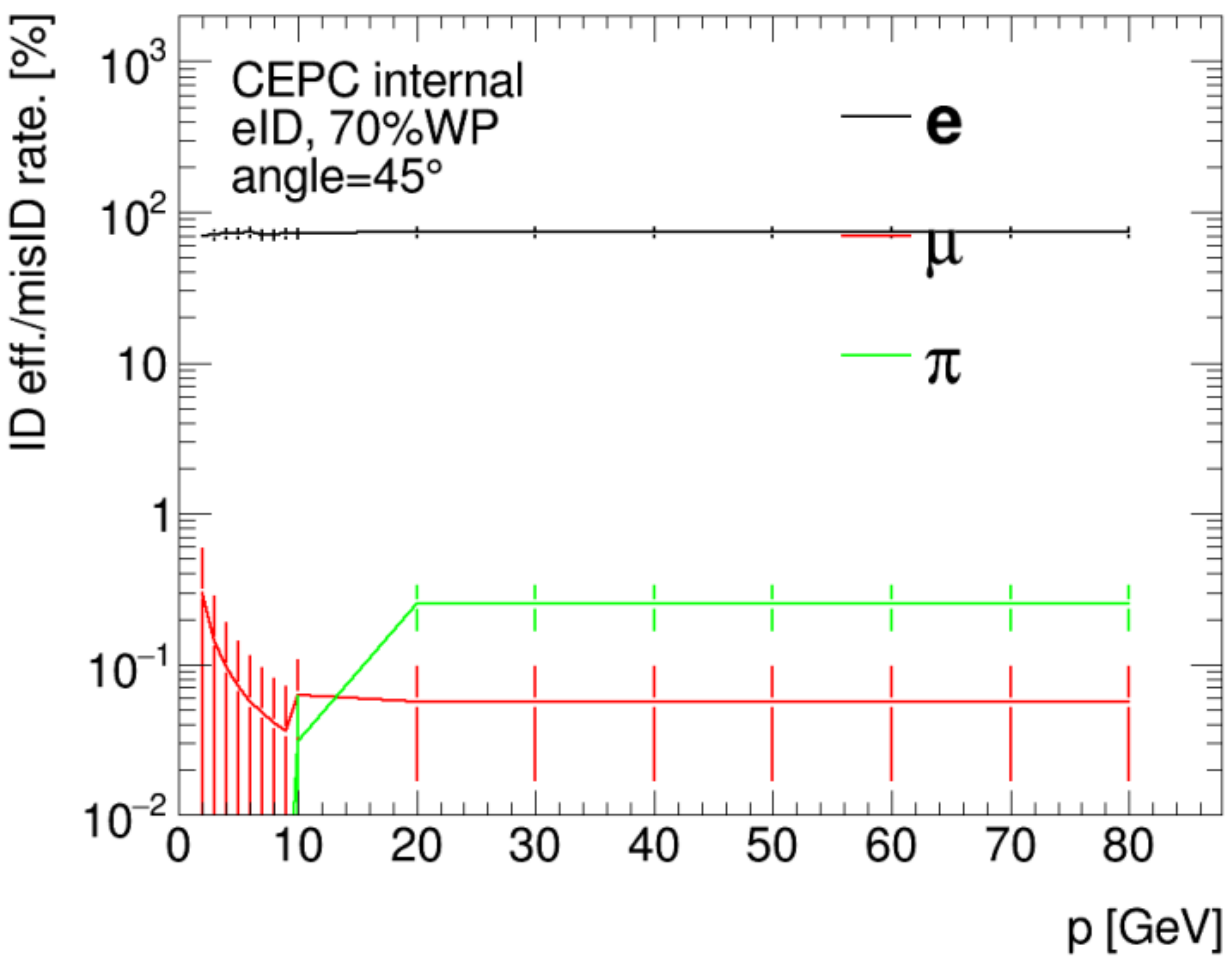
electron ID performance









correctly identified as such, and the probability for a hadron track to be wrongly identified as a lepton track. Electron and muon identification efficiencies are studied using $e^+e^- \to \ell^+\ell^-(\gamma)$, $e^+e^- \to e^+e^-\ell^+\ell^-$, and $J/\psi \to \ell^+\ell^-$, while pion mis-identification rates are studied using $K^0_S \to \pi^+\pi^-$ and $e^+e^- \to \tau^\pm(1P)\tau^\mp(3P)$. The $D^{*+} \to D^0(\to K^-\pi^+)\pi^+$ channel is used to determine kaon mis-identification rates.

Performance is evaluated in the polar angle acceptance regions corresponding to the electromagnetic calorimeter (ECL) for electrons (0.22 to 2.71 rad), and to the K^0_L-muon detector (KLM) for muons (0.40 to 2.60 rad). Combined, the set of probe channels covers a lab-frame momentum range of 0.4 GeV/c to 7.0 GeV/c for electrons and of 0.4 GeV/c to 6.5 GeV/c for muons. Results are also binned with respect to the track lab-frame polar

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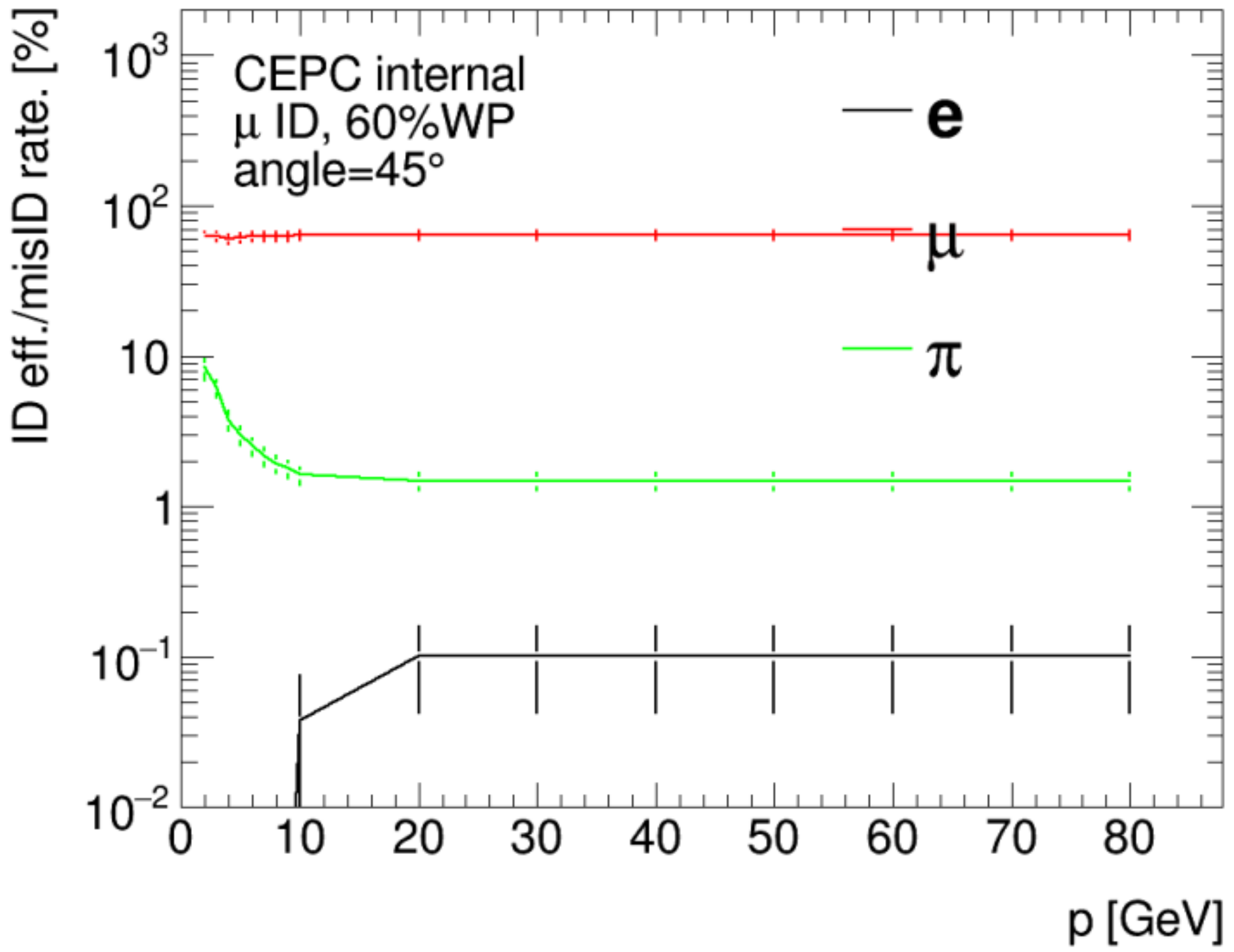
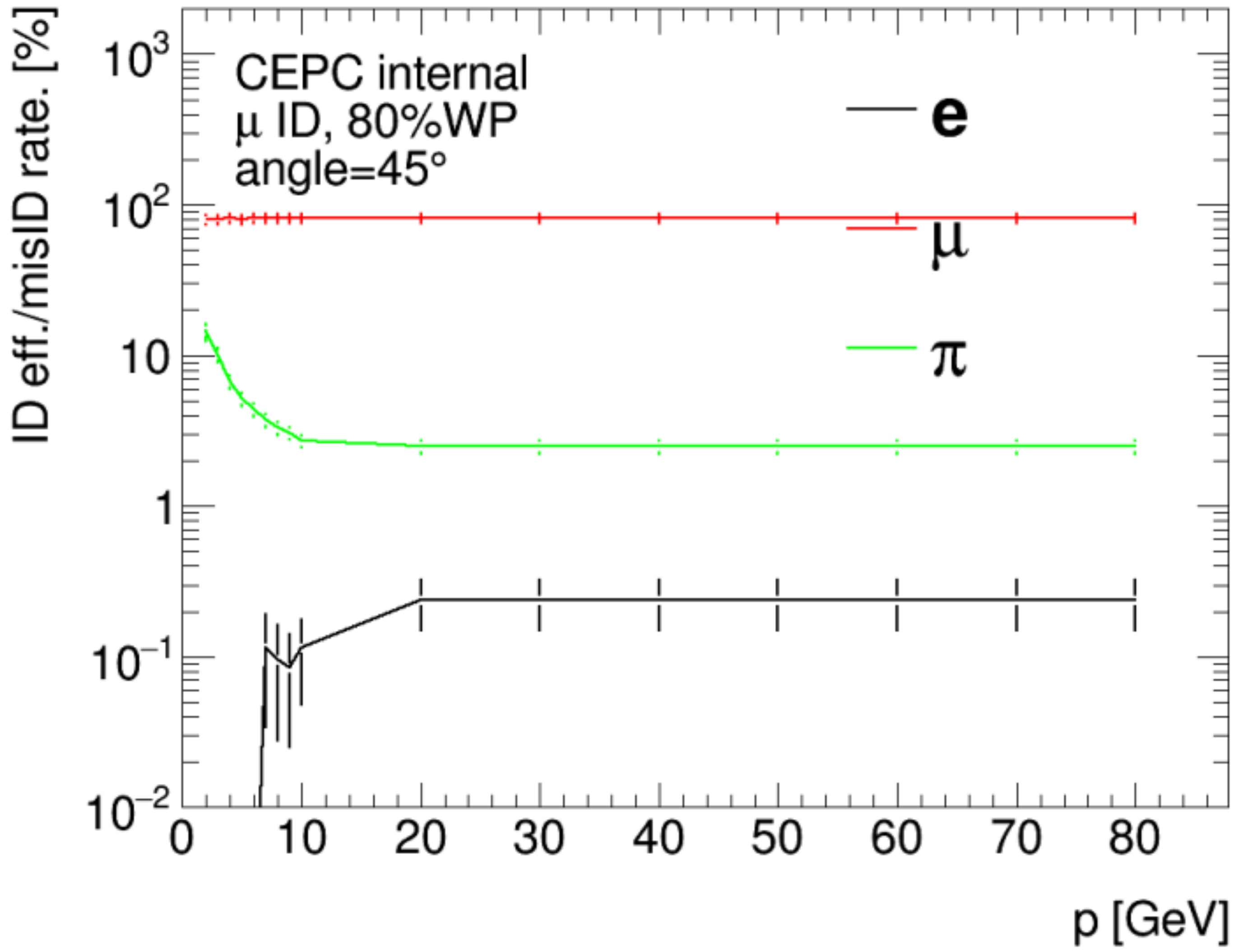
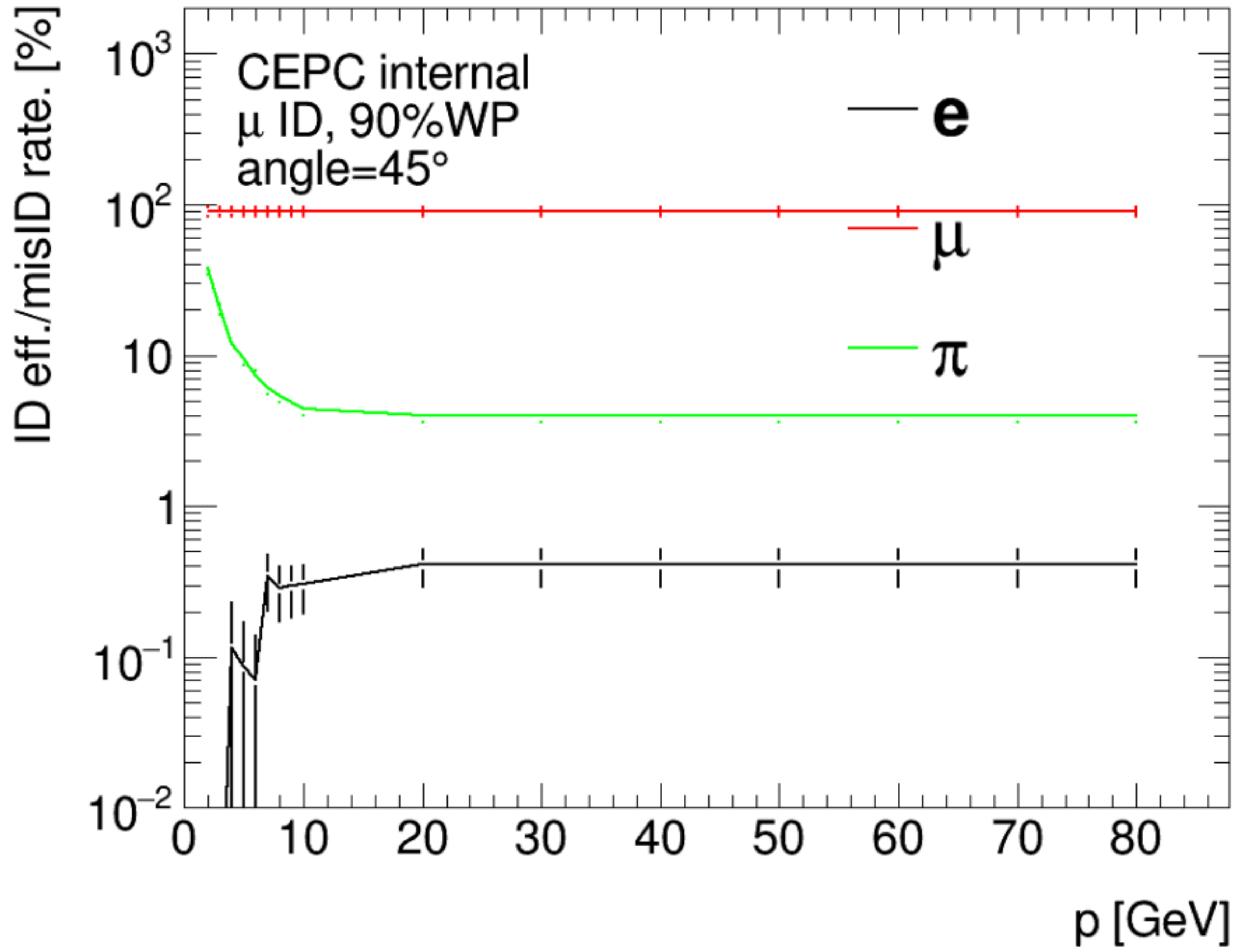
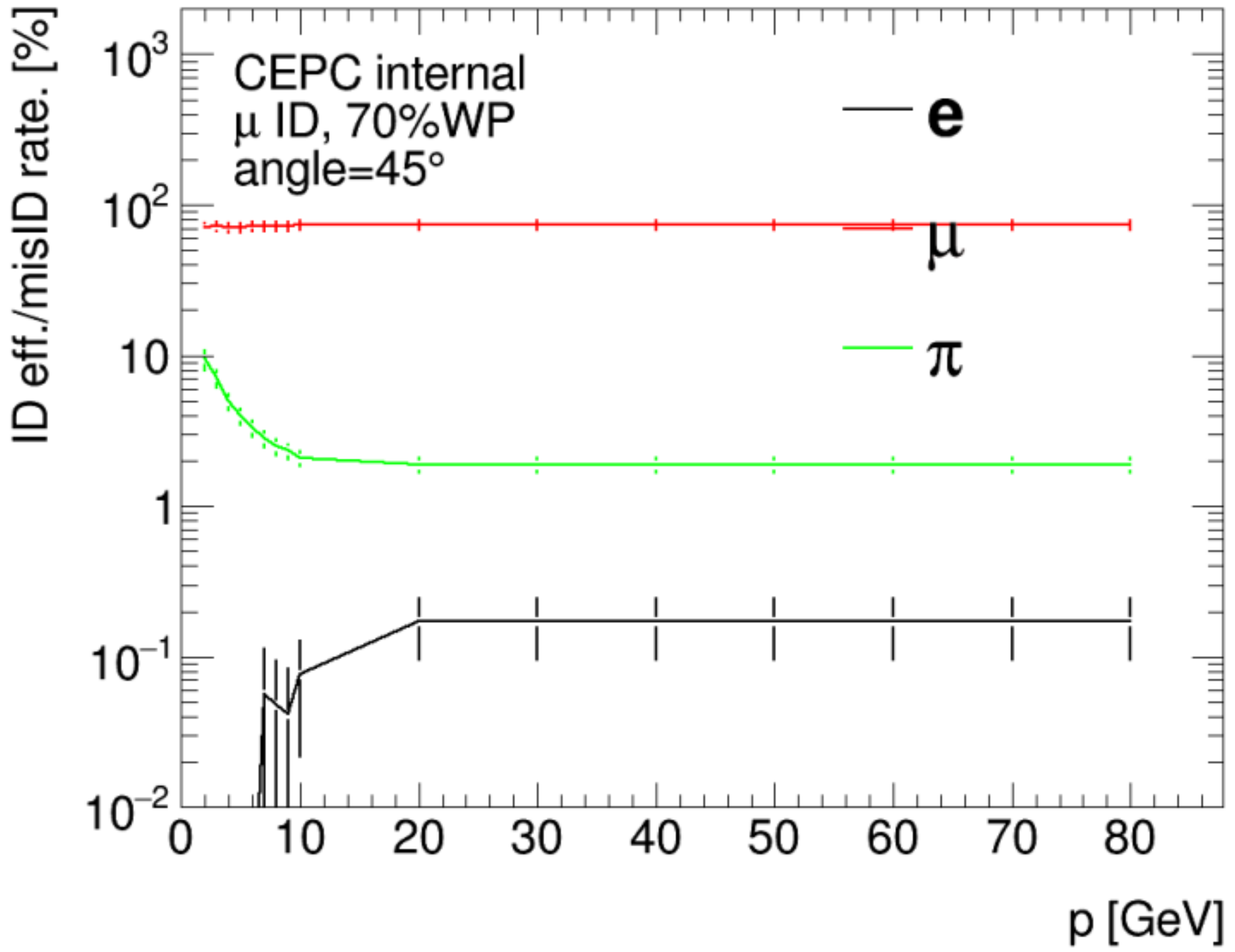
muon ID performance









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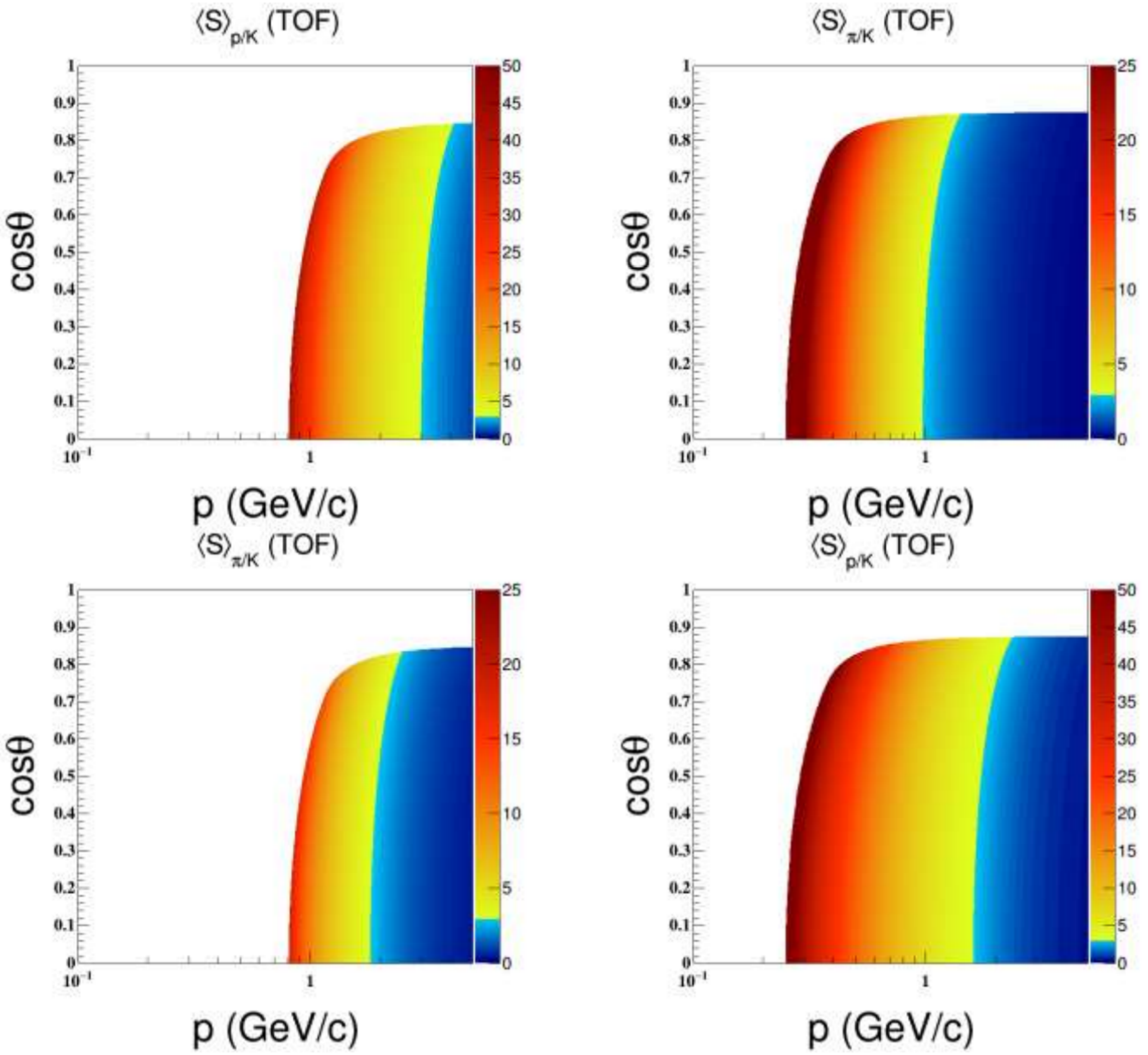
Hadron PID with ITK

A brief summary from Houqian Ding

Effect of different radius(length) of TOF(only barrel) on the PID



L=2900mm;R=1800mm

L=1000mm;R=555mm

Separation power:

$S_{AB} = \frac{|T_A - T_B|}{\sigma}$, T is TOF of particle, σ is the TOF resolution.

X axis is momentum of particle

Y axis is the angle from Z direction

❖ **Conclusion :**

L=2900mm , R=1800mm : p>800MeV , cosθ<0.8;

L=1000mm , R=555mm : p>250MeV , cosθ<0.8;

ITK can improve the PID on 0~1GeV with ac-lgad.

$D_0 \rightarrow K\pi\pi^0$ (E91_eebb events)

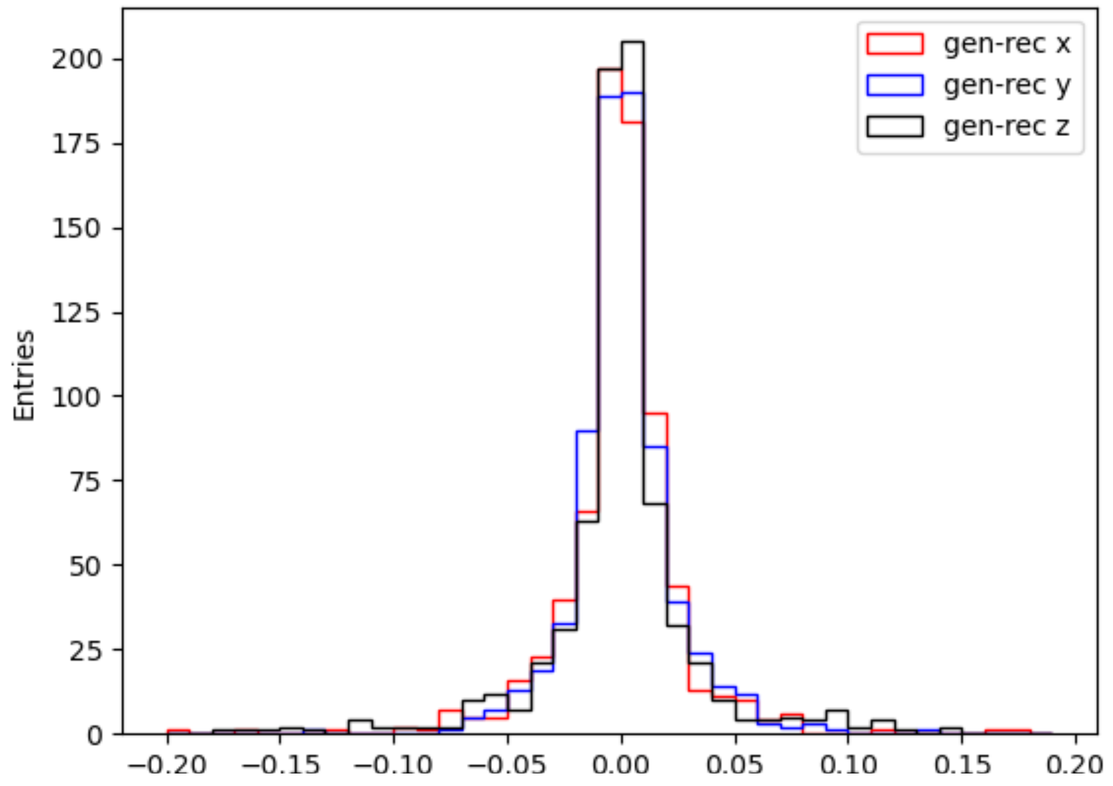
- Together with other relevant processes, $D_0 \rightarrow KK, \pi\pi, \pi\pi\pi^0$

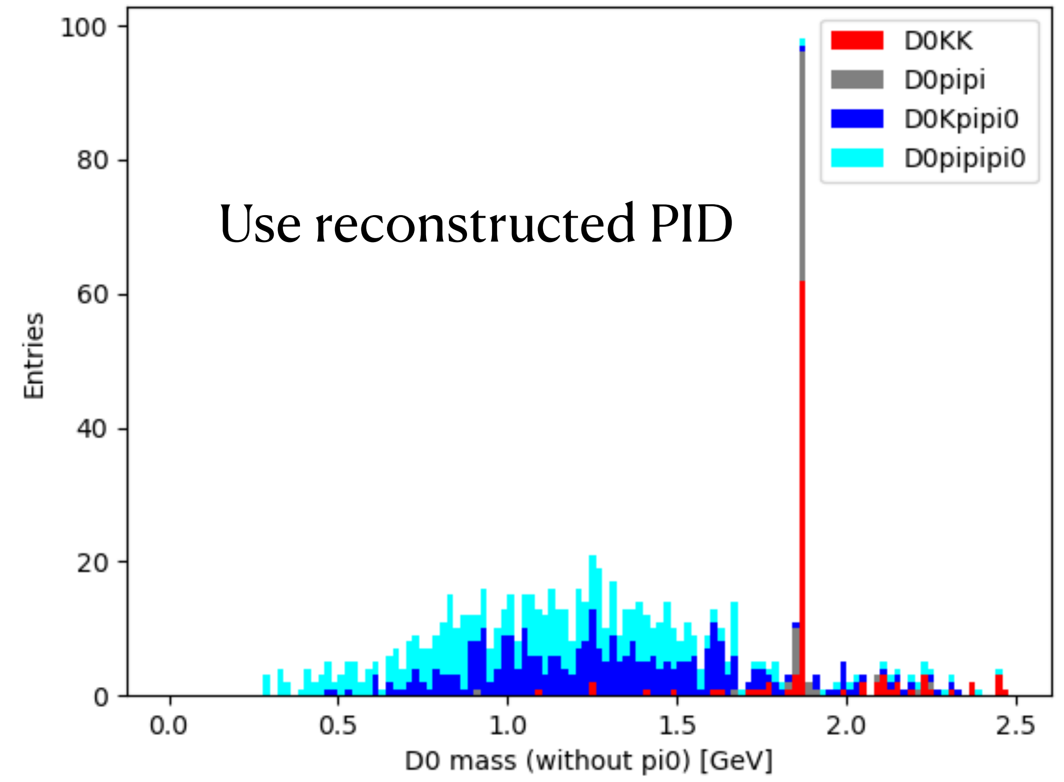
	Global efficiency	SV algorithm efficiency	
Events with two tracks reconstructed	94 %		
Vertex reconstructed	87 %	93 %	7% tracks used by prim vtx
Geometry-cut	83 %	88 %	R(firsthit1 & 2) > R(vtx)
Kinematic-cut	82 %	87 %	(p1+p2) dot vtx > 0
Prefit-cut	75 %	80 %	Before fitting, chi2<100
Postfit-cut	74 %	79 %	After fitting, Chi2<10 (dof=1)

update

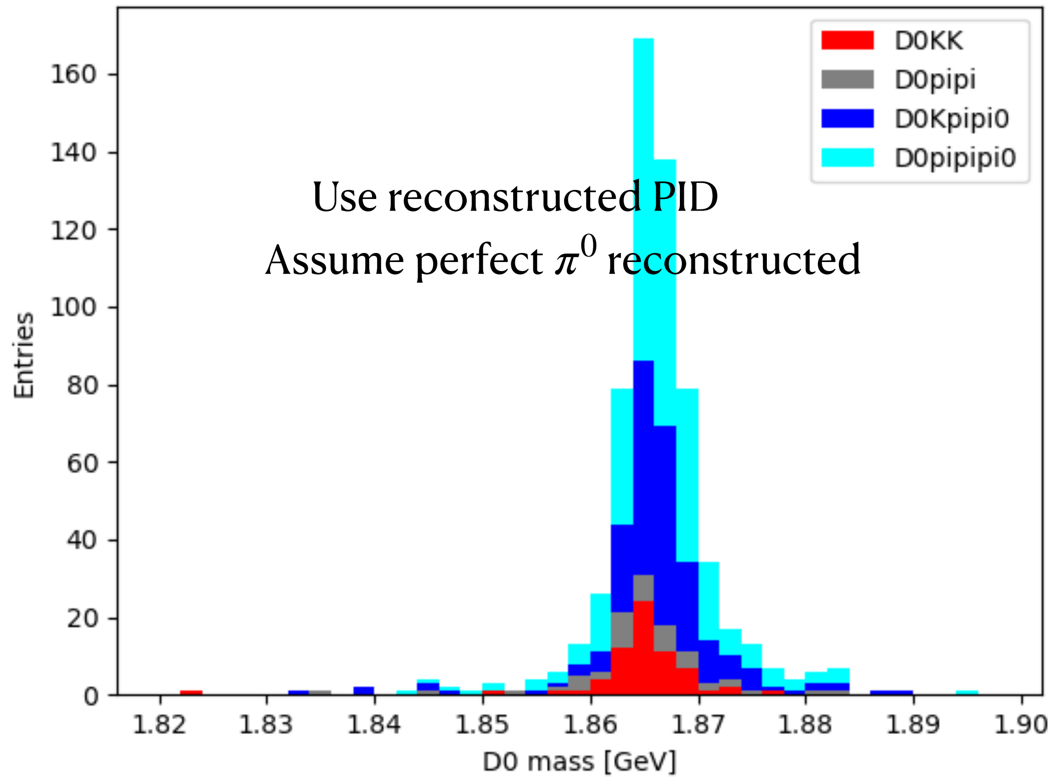
	Global efficiency	SV algorithm efficiency	
Events with two tracks reconstructed	94 %		
Vertex reconstructed	87 %	93 %	7% tracks used by prim vtx
Geometry-cut	82 %	87 %	R(firsthit1 & 2) > R(vtx)
Kinematic-cut	81 %	86 %	(p1+p2) dot vtx > 0
Prefit-cut	**Cancelled**, the fit doesn't get segmentaiton while returns status-code 0		
Postfit-cut	78 %	83 %	After fitting, Chi2<10 (dof=1)

- Todo
  - Look into purity/background, go forward to the analysis





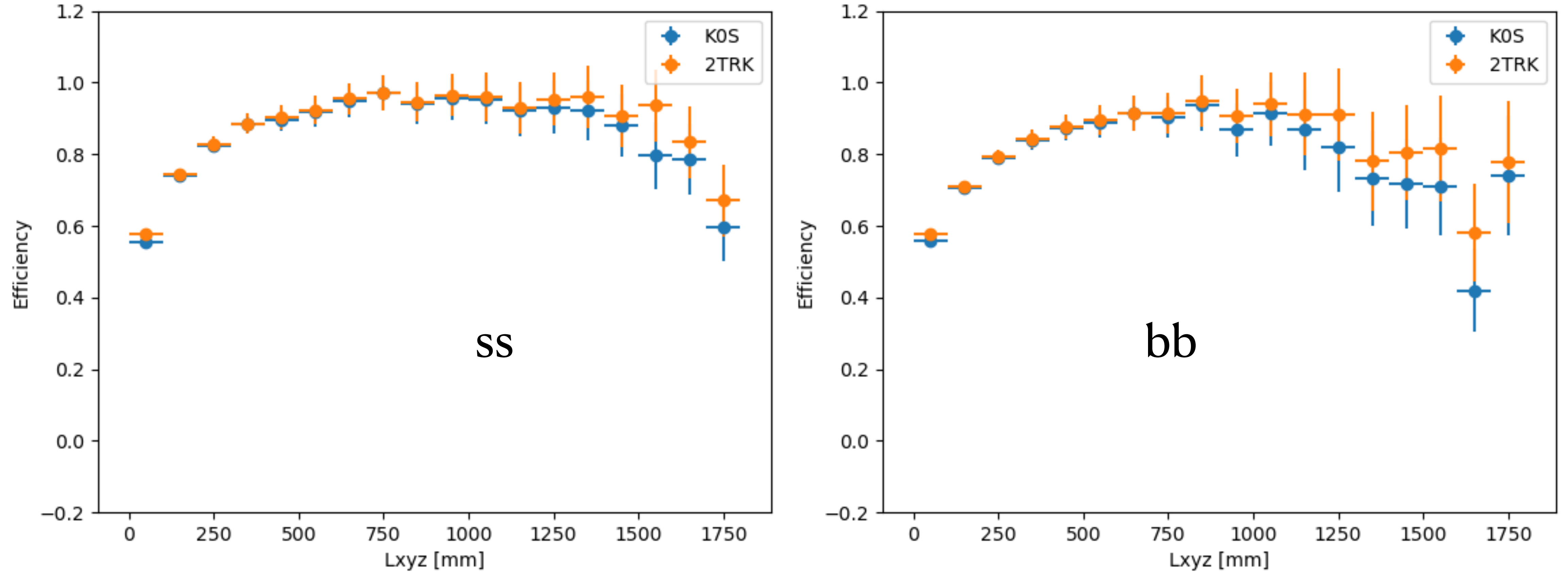
No Cuts Applied



$K_S^0 \rightarrow \pi^-\pi^+$ (E91_eeqq events)

	Global efficiency (uu)	SV algo. eff. (uu)	Global (dd)	SV (dd)	Global (cc)	SV (cc)	Global efficiency (ss)	SV algorithm efficiency (ss)	Global efficiency (bb)	SV algorithm efficiency (bb)	
Events with two tracks reconstructed	63 %		64 %		70 %		71 %		68 %		Compare to CDR, 74% (Zqq events)
Vertex reconstructed	61 %	98 %	63 %	97 %	68 %	98 %	69 %	98 %	66 %	98 %	(in CDR, after several cuts, 80%)
Geometry-cut	56 %	89 %	57 %	89 %	63 %	90 %	64 %	91 %	61 %	89 %	R(first-hit 1 & 2) > R(vtx)
Kinematic-cut	55 %	87 %	56 %	85 %	61 %	88 %	62 %	88 %	59 %	87 %	(p1+p2) dot vtx > 0
Postfit-cut	50 %	80 %	51 %	79 %	56 %	81 %	57 %	81 %	55 %	81 %	After fitting, Chi2<10 (dof=1),

No Cuts Applied



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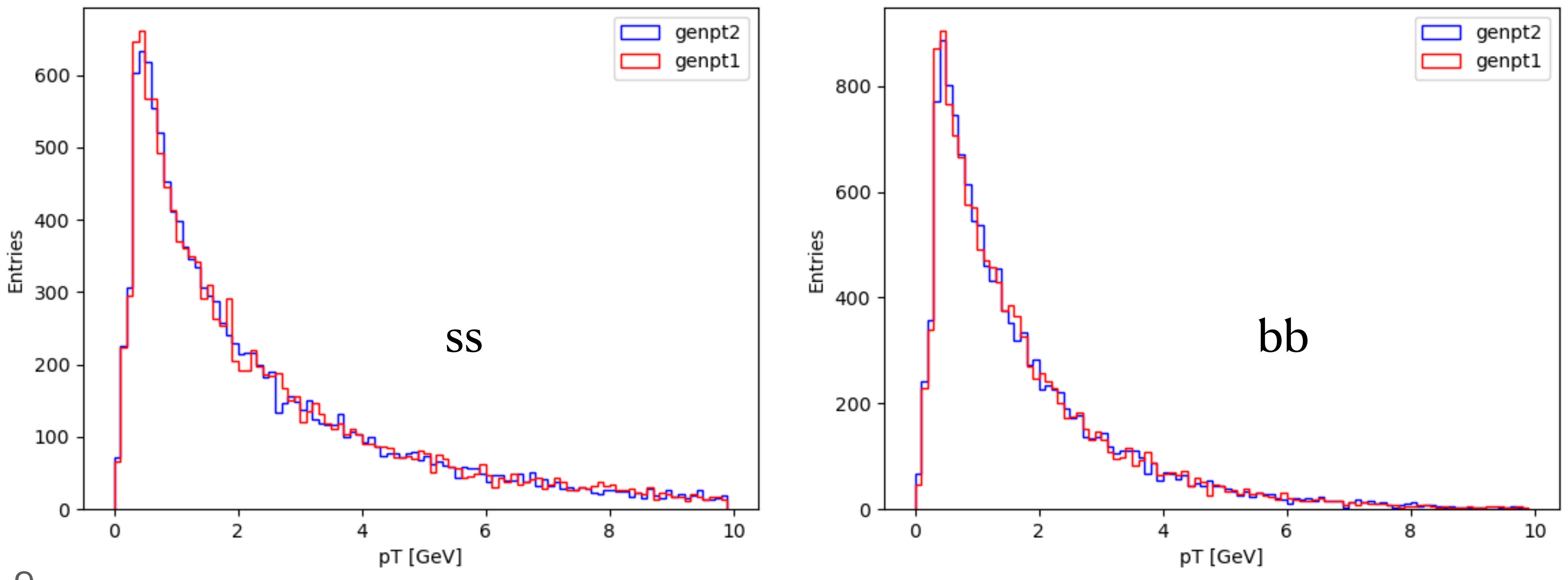
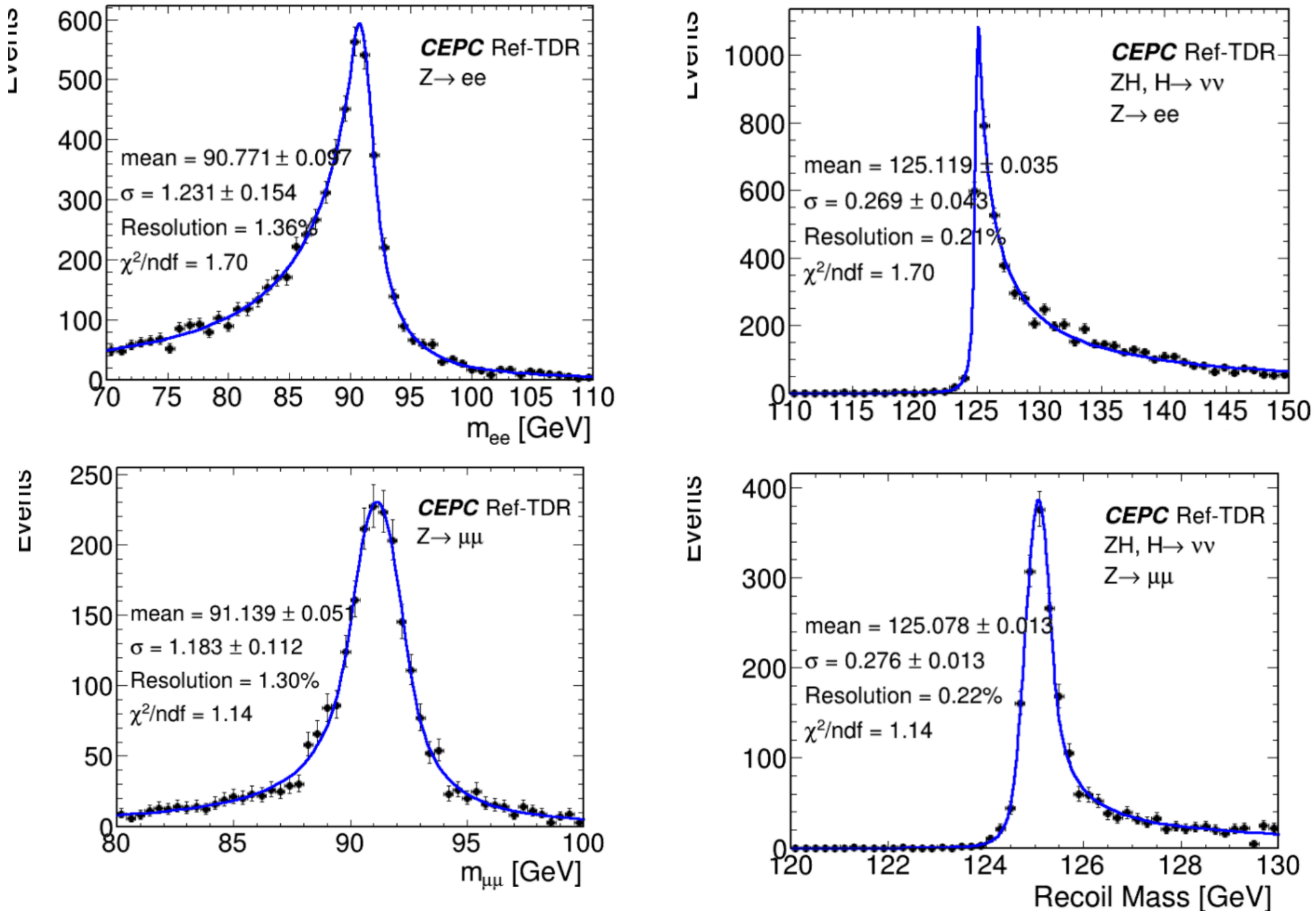


Higgs recoil mass

A brief summary from Yuji Li

Results (Fitting with TwosidedCB)



- Lepton pair selection using gen-matching
- To add backgrounds

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