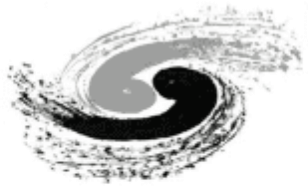

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Updates on photon PID

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Photon ID with XGBoost

Input features

- $\mathrm{l}_{\mathrm{ECAL}}$, $\mathrm{R}^{90}_{\mathrm{ECAL}}$, $\mathrm{W}^{\eta}_{\mathrm{ECAL}}$, $\mathrm{W}^{\phi}_{\mathrm{ECAL}}$
- $\mathrm{l}_{\mathrm{HCAL}}$, $\mathrm{R}^{90}_{\mathrm{HCAL}}$, $\mathrm{W}^{\eta}_{\mathrm{HCAL}}$, $\mathrm{W}^{\phi}_{\mathrm{HCAL}}$, $\mathrm{N}_{\mathrm{hadClus}}$
- $\mathrm{E}_{\mathrm{HCAL}}/\mathrm{E}_{\mathrm{ECAL}}$

Single particle 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_*

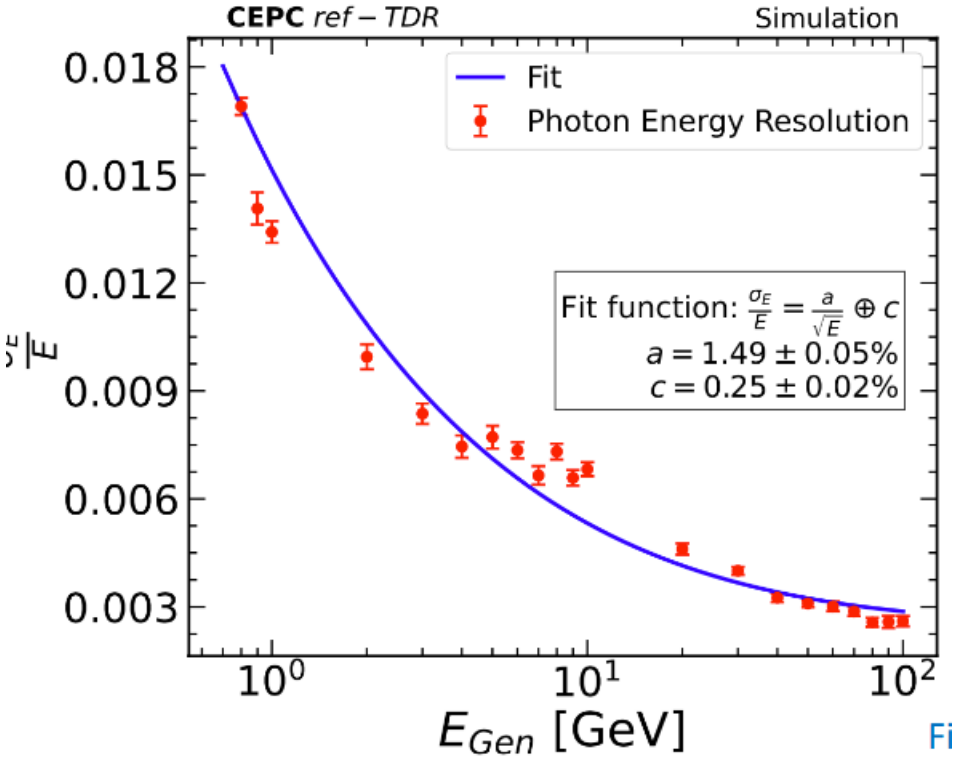
ZH inclusive samples

- /cefs/higgs/zhangkl/Production/25036/*HX

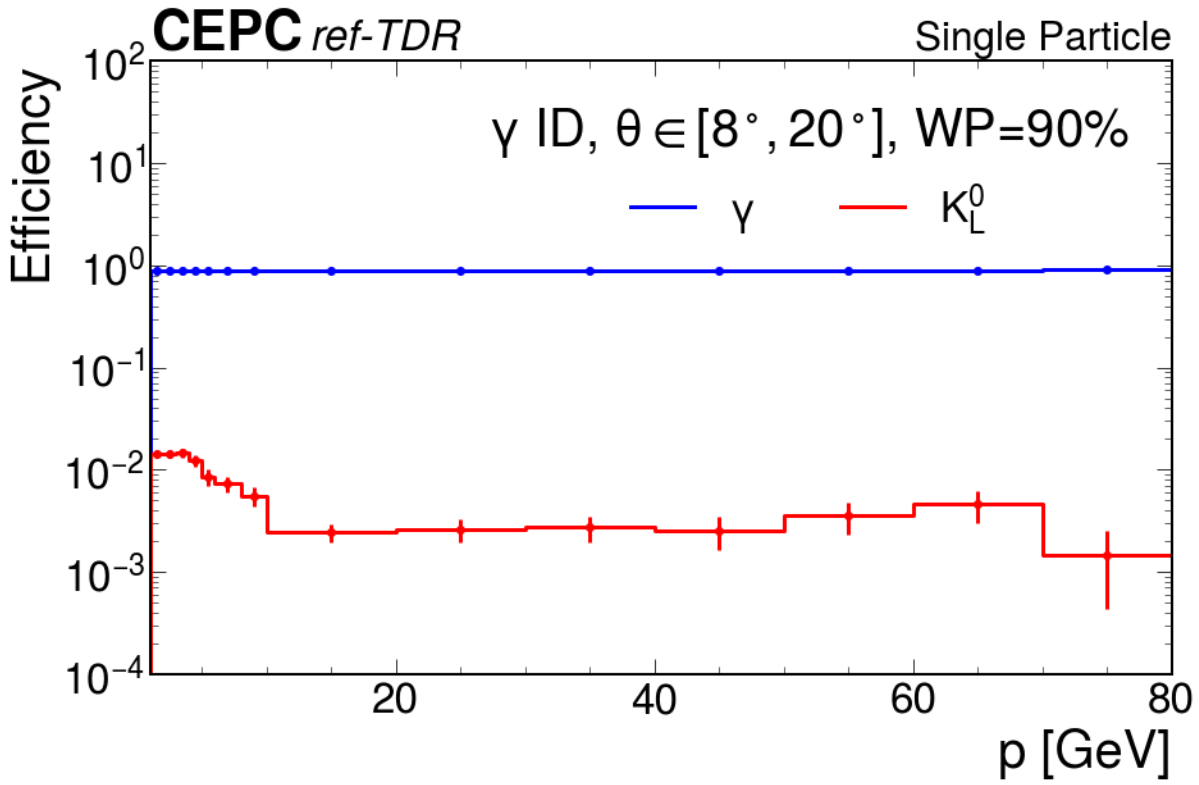
Gen match

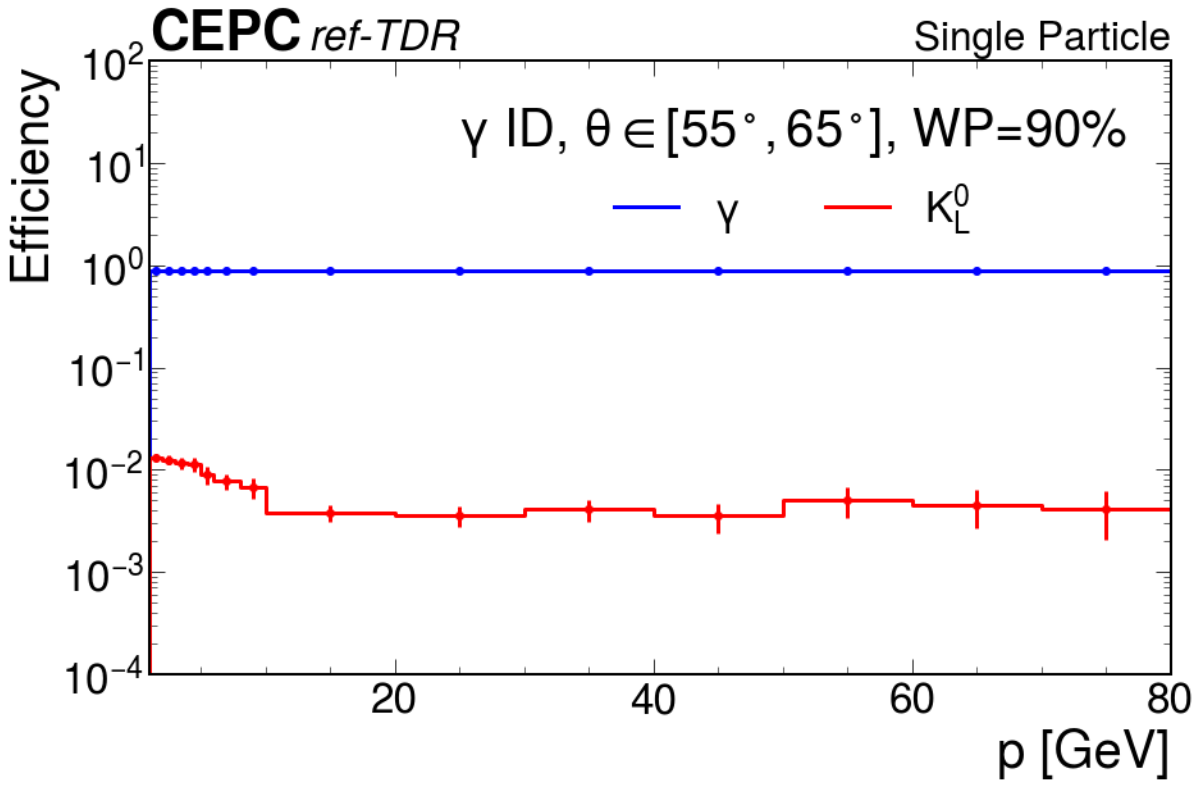
Not as trivial as charged particles because there is no truth link in calorimeters

- Photon match: $\Delta R < 0.1$, $\Delta E < 3\sigma_E$
- Neutral hadron (K_L^0 or neutron) match: $\Delta R < 0.5$
- If none of them are matched, or if they are matched to a charged particle, assign to a new category as “unmatched”.



Studies with particle gun samples





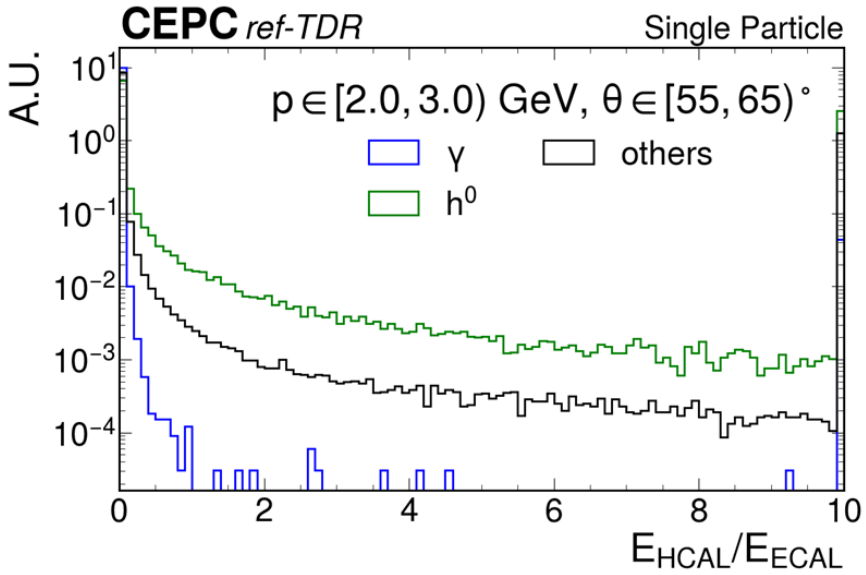
In general good separation between photon and neutral hadron.
See slides

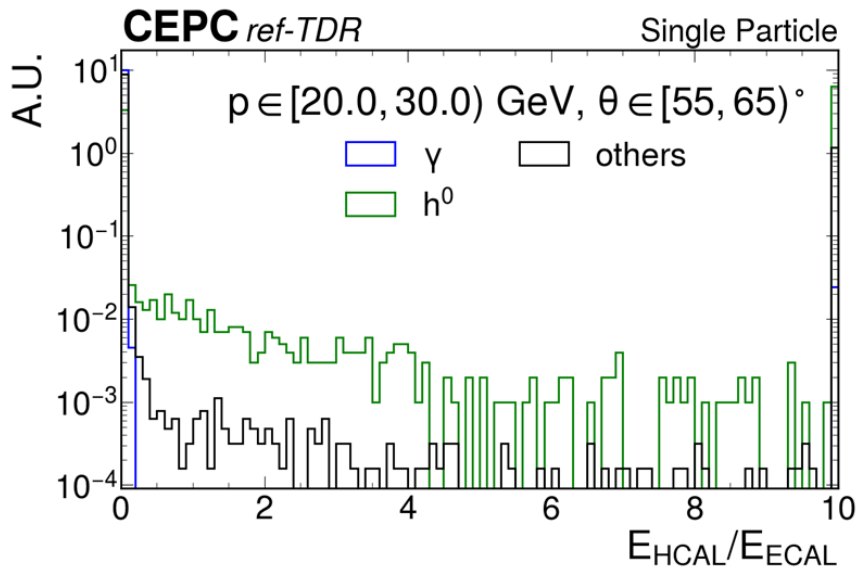
In ZH environments: input features

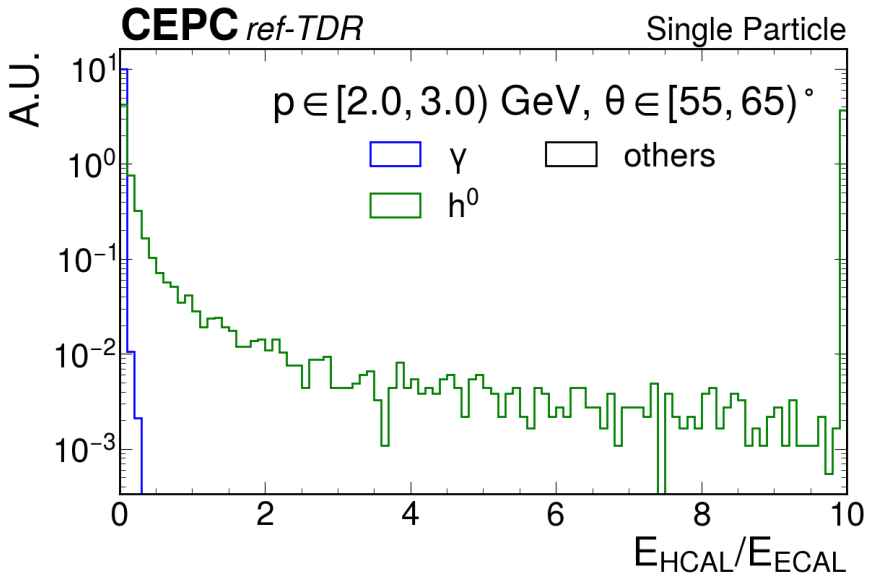
E_{HCAL}/E_{ECAL}

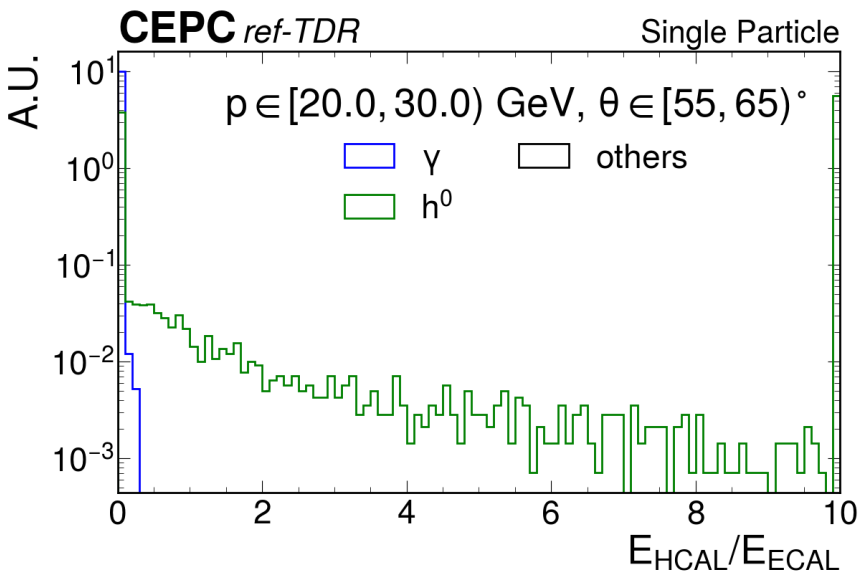
ZH

particle gun







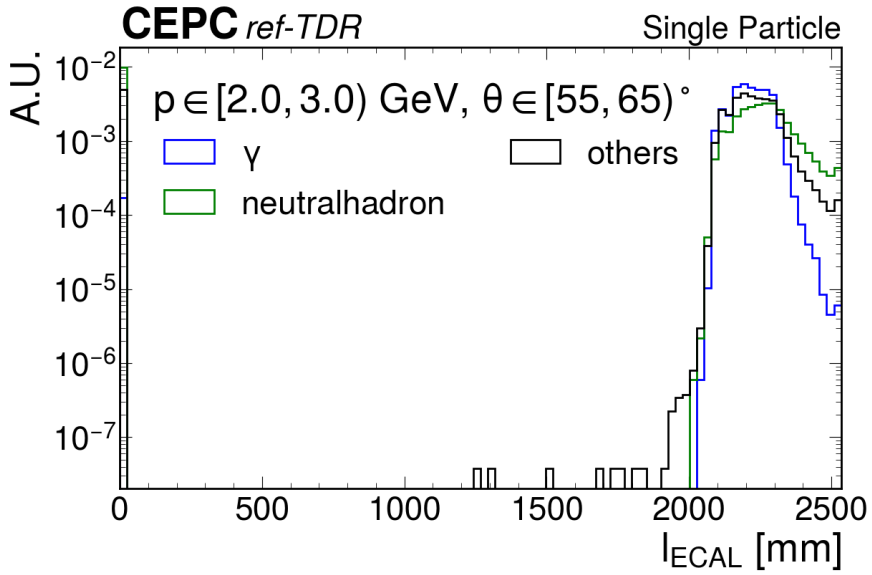


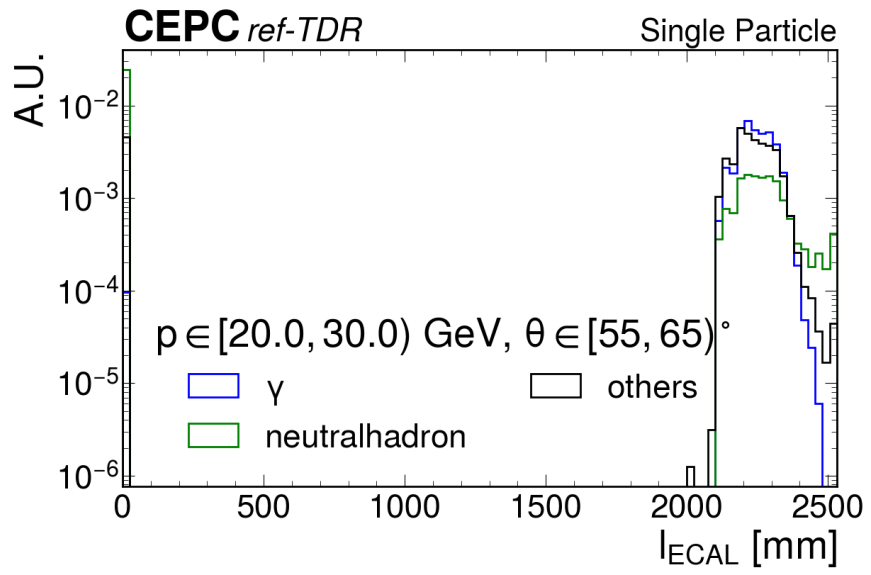
In ZH environments: input features

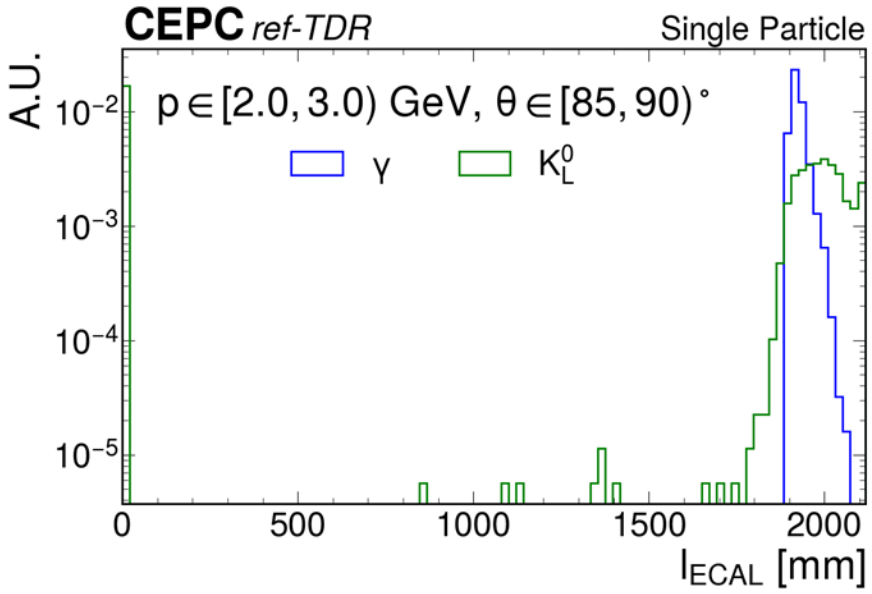
l_{ECAL}

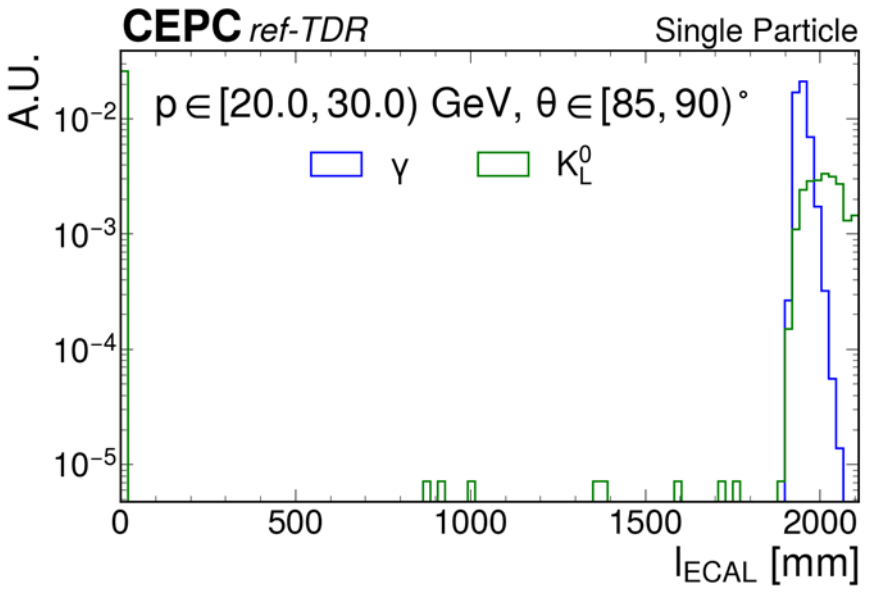
ZH

particle gun







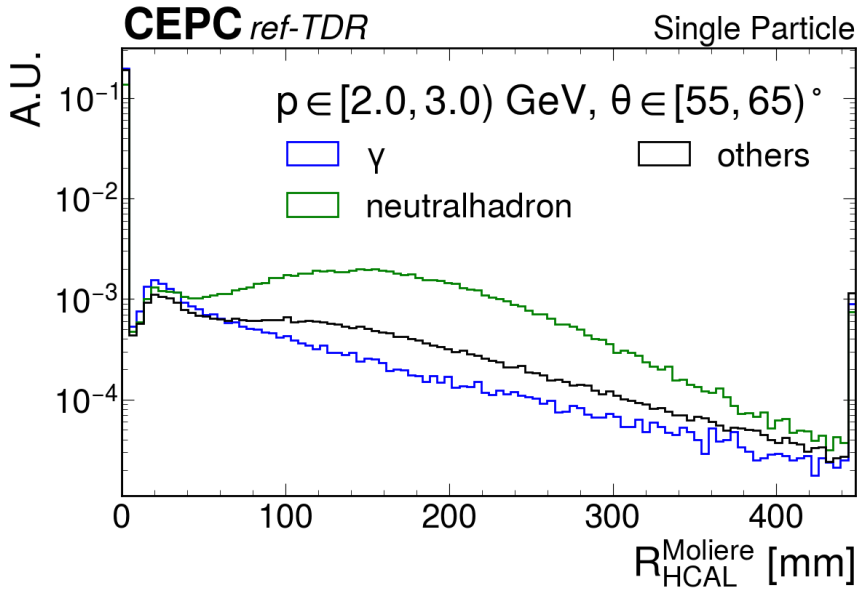


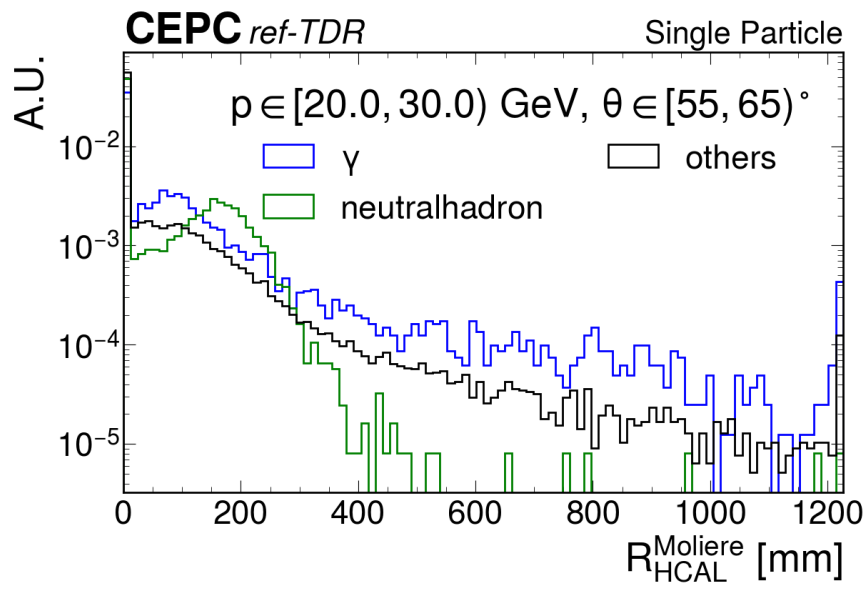
In ZH environments: input features

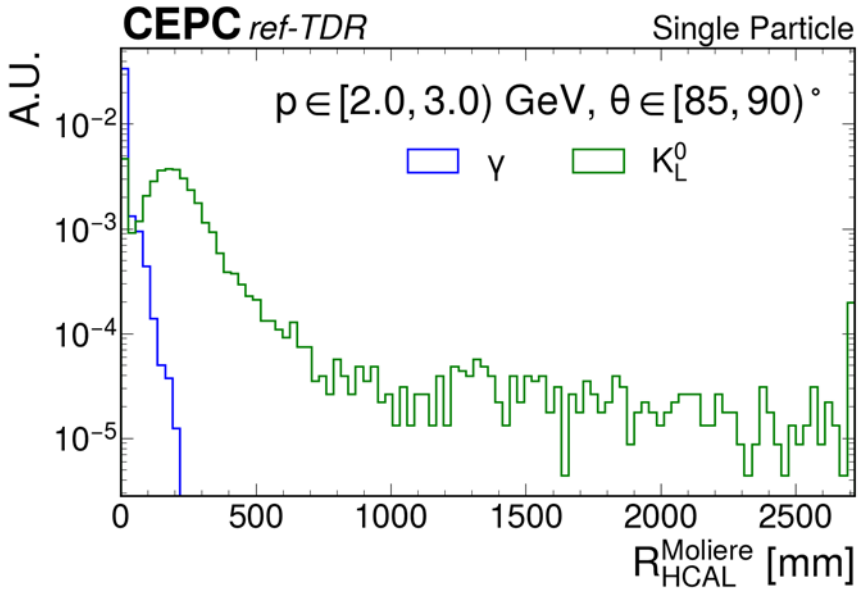
R^{90}_{HCAL}

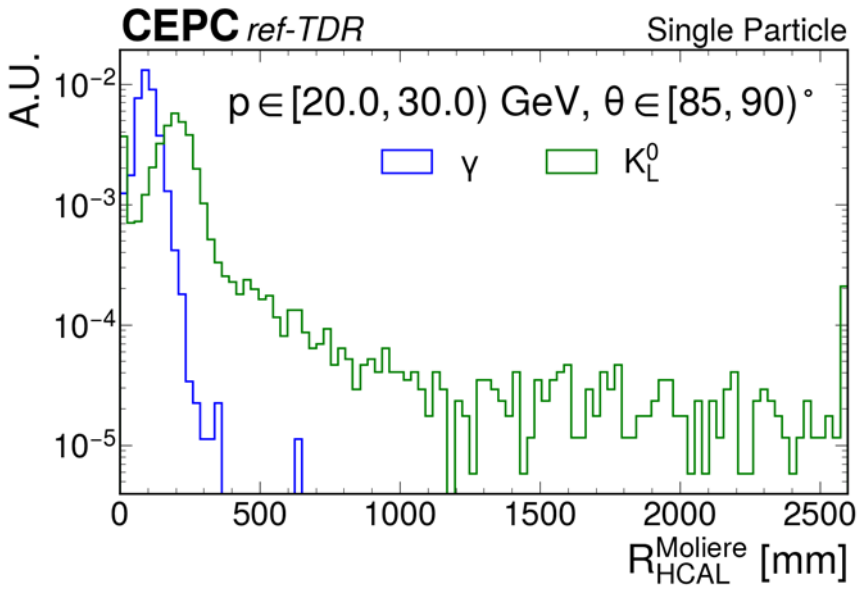
ZH

particle gun







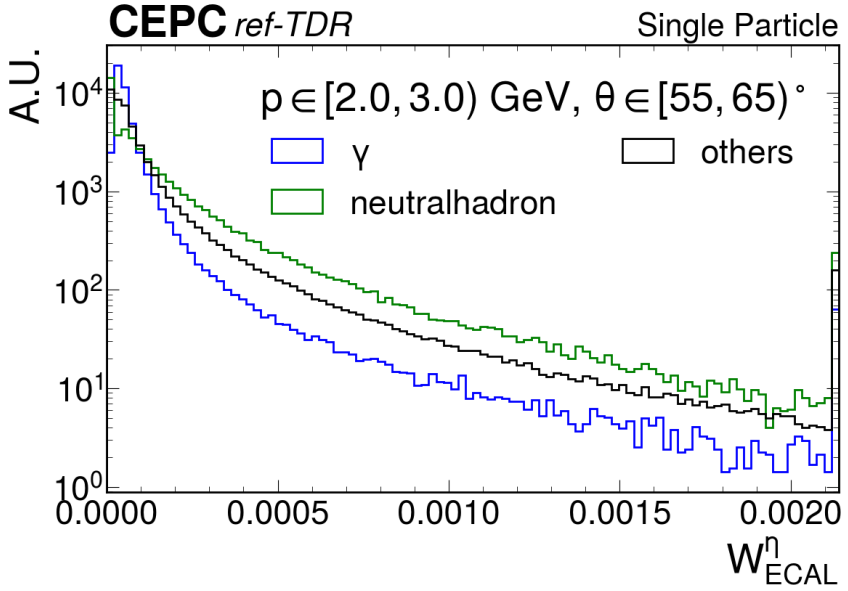


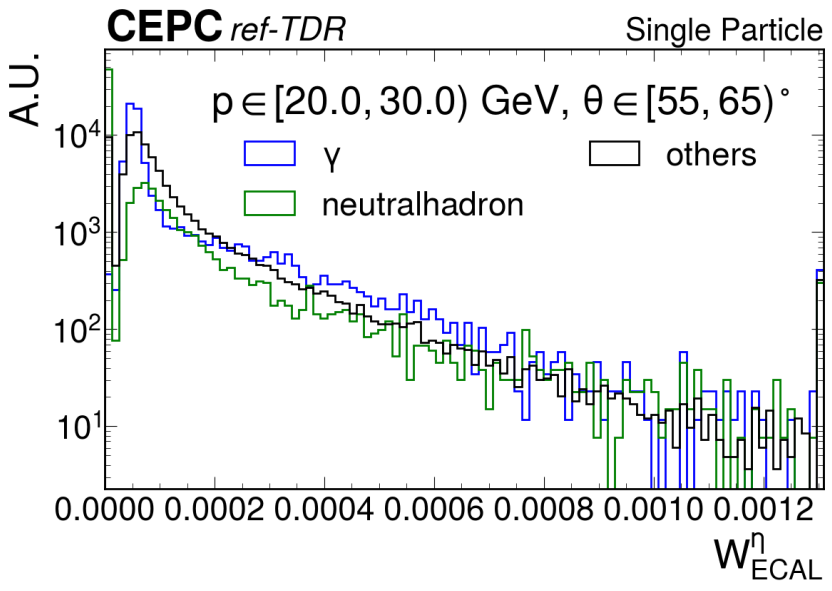
In ZH environments: input features

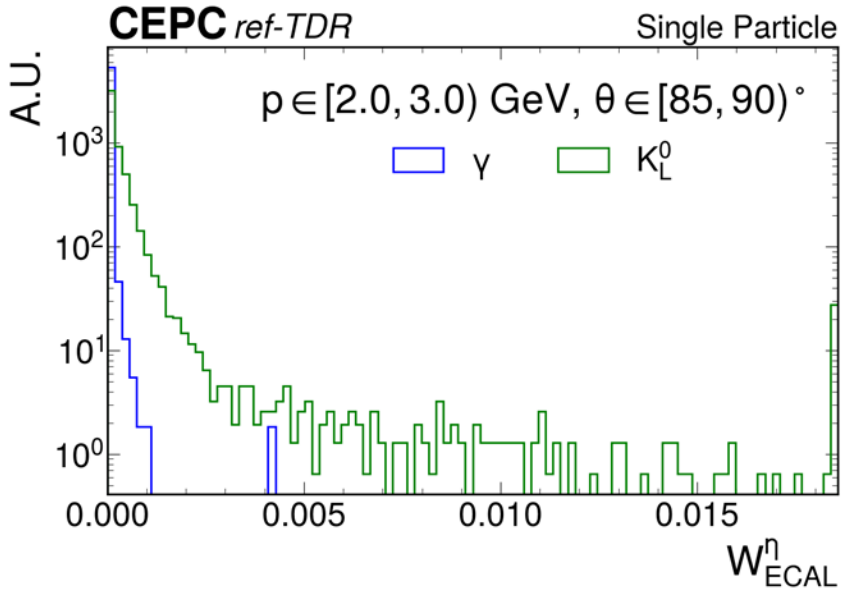
$\mathbf{Var}^{\eta}_{\mathbf{ECAL}}$

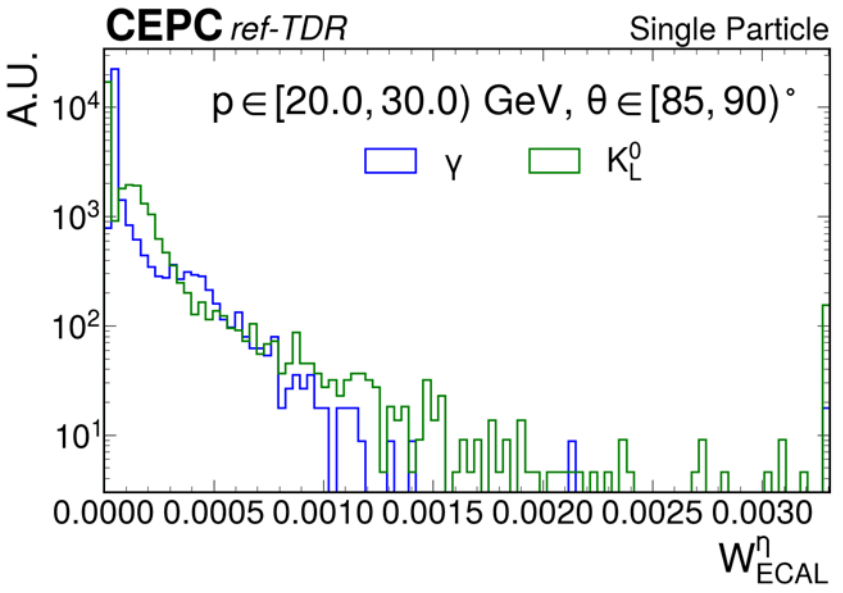
ZH

particle gun





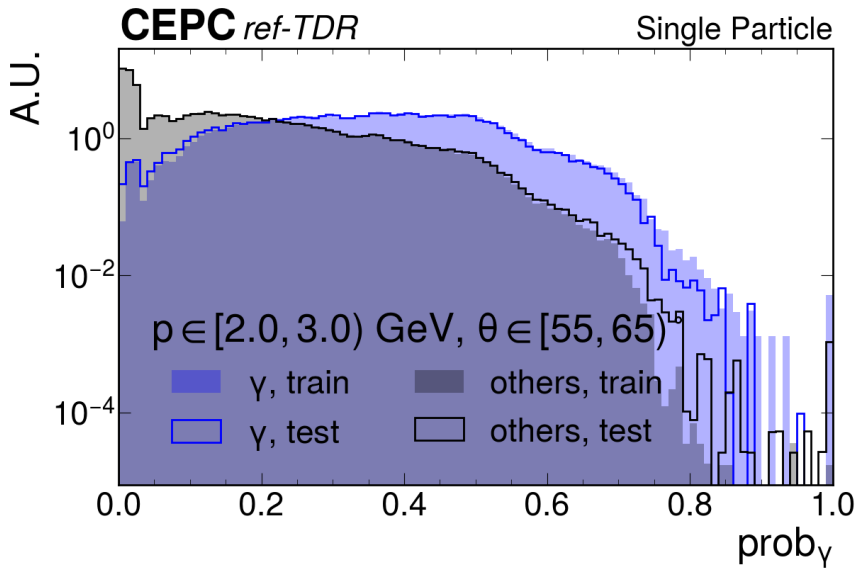


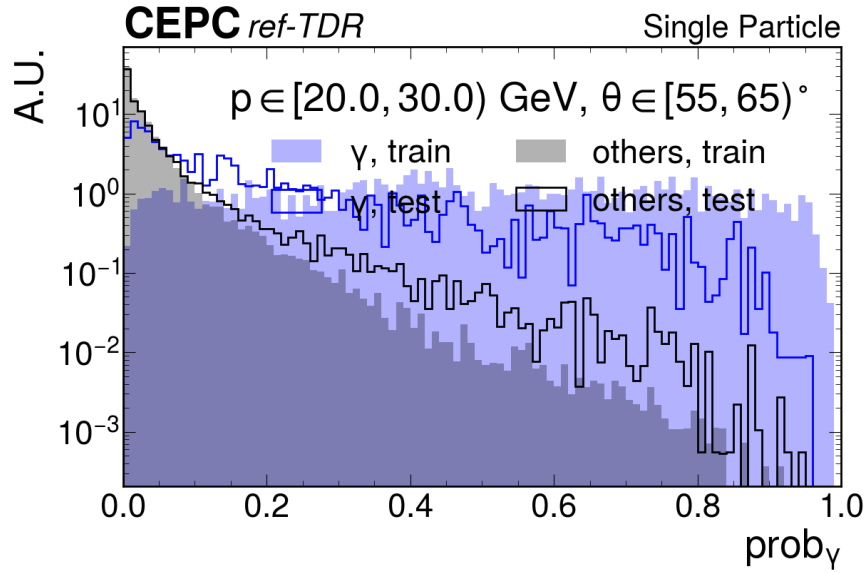


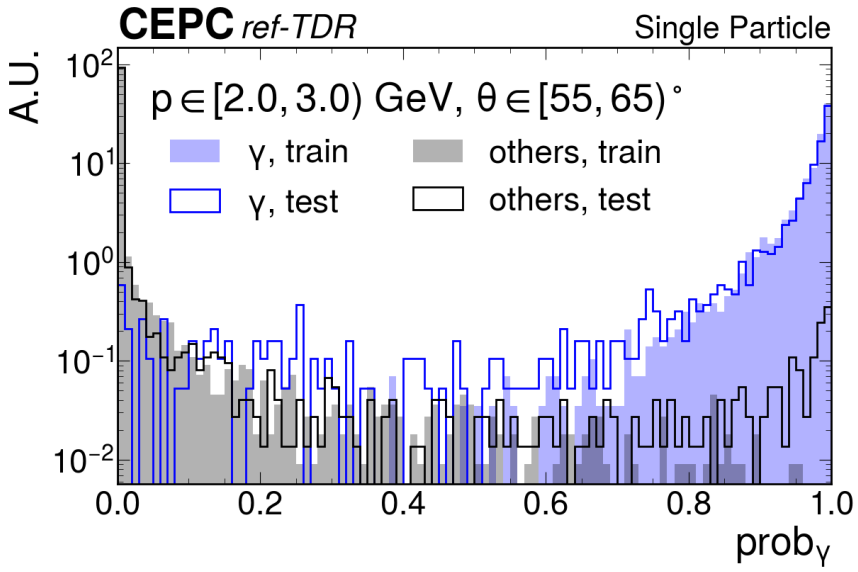
In ZH environments: train v.s. test

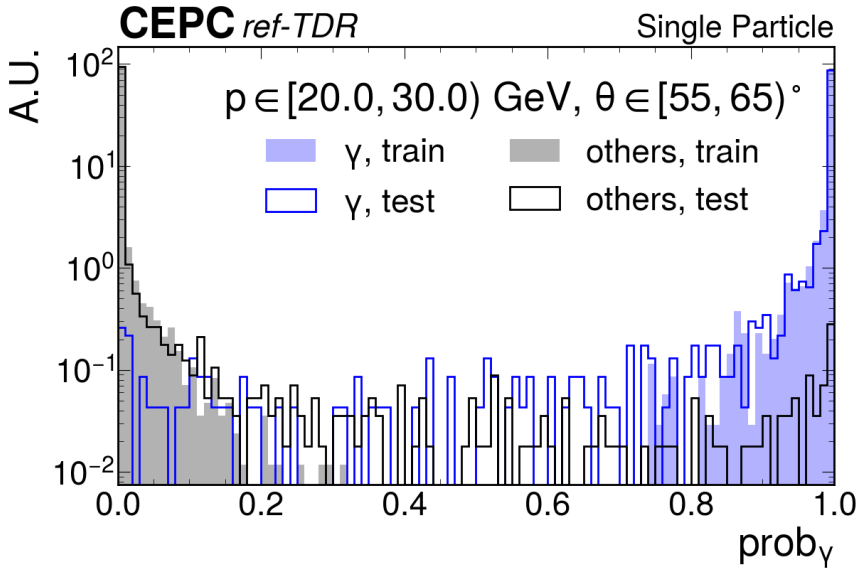
ZH

particle gun



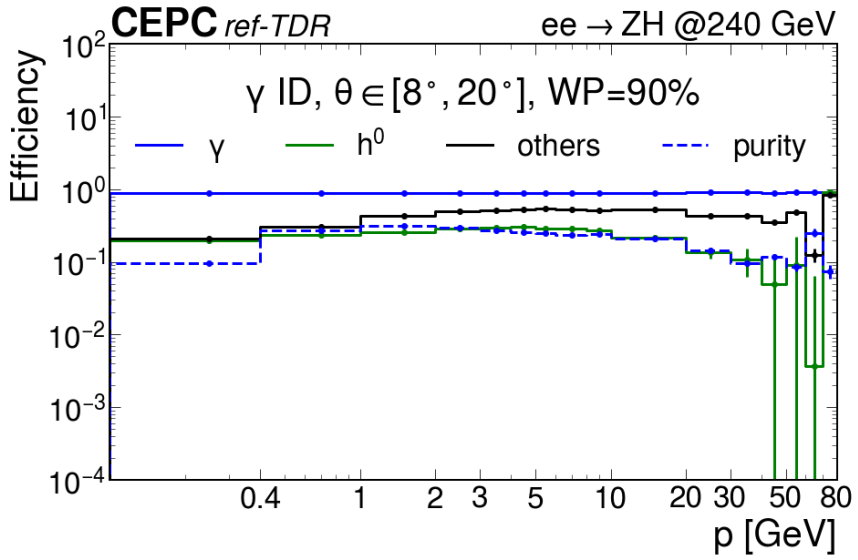


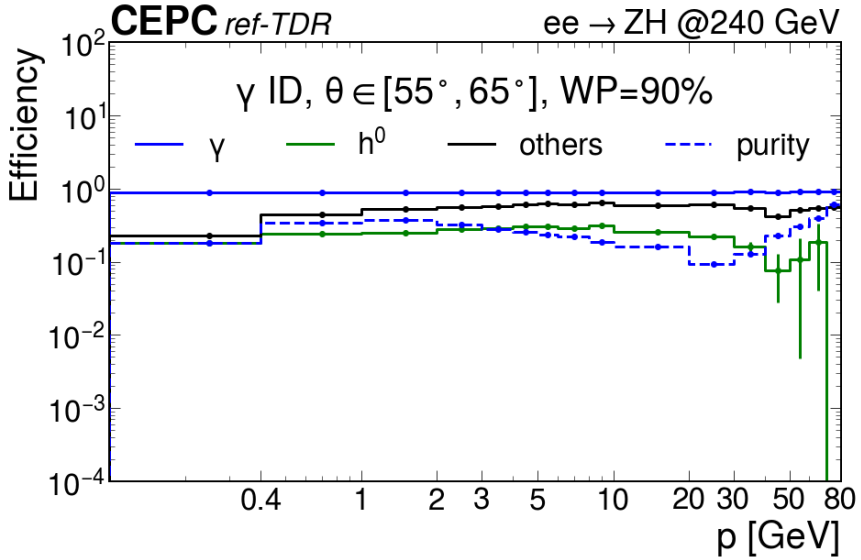




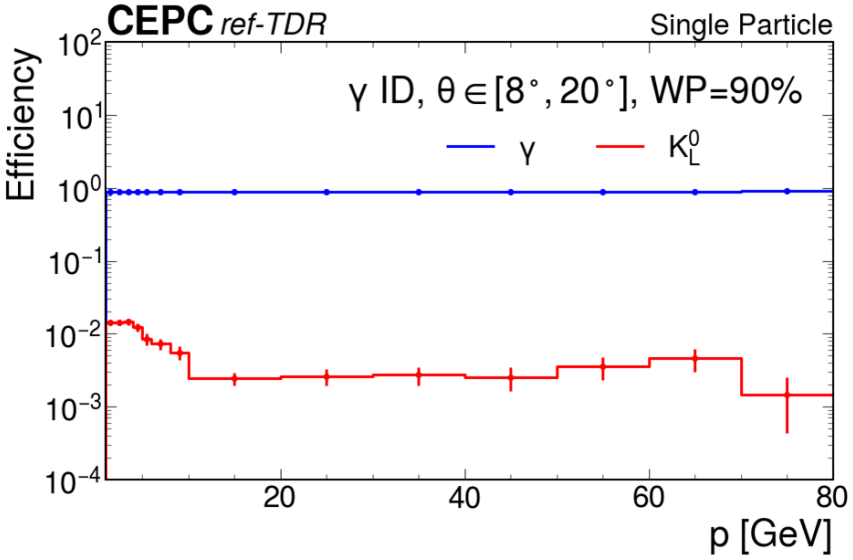
In ZH environments: efficiency

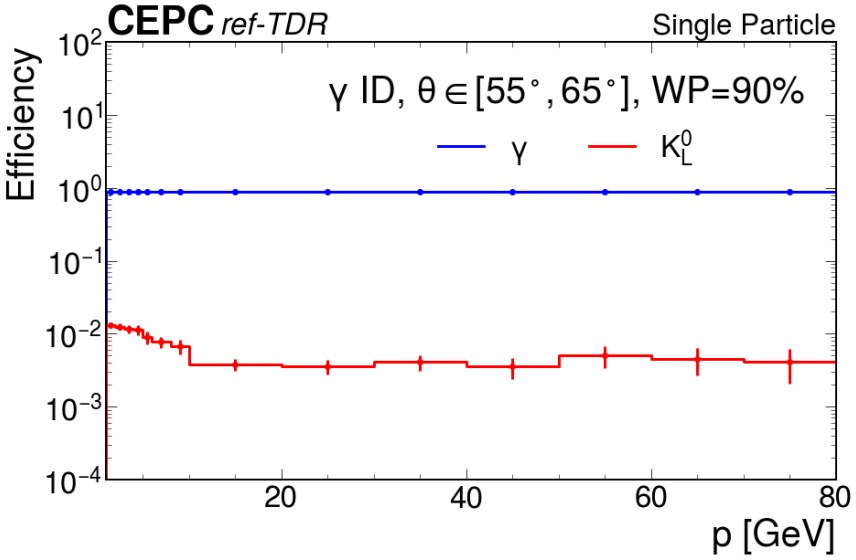
ZH





particle gun





Possible reasons for the worse performances

Gen match?

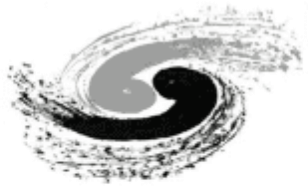
- Probably some genuine photons didn't pass the photon gen match and end up in the unmatched category.
- Especially, at high energy, the photon purity is also low, while no high-energy neutral photons are expected.

Energy clustering in calorimeters

- It seems that in the ZH environments, the photon has much wider showers than single particle samples.
- Neutral hadrons are less likely to have large E_{HCAL}.
- A lot of unmatched neutral clusters.

Overtraining

- As we see before.
- Probably need more samples to train.



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Backup

In ZH environments: fractions

ZH