# Muon ID using muon chamber hits

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# Samples

- Under the newest release: 25.3.4, available in the master branch

- **Particle gun samples from Changhua:**
  - /afs/ihep.ac.cn/users/h/haochanghua/higgs/analysis/new/034
  - /afs/ihep.ac.cn/users/h/haochanghua/higgs/analysis/new/036
  - $P \in [1, 90]$ GeV, $\theta \in [10, 90]°$
  - Muon, electron, pion
  - 1k events per point

- **Particle gun samples from Chenguang:**
  - /cefs/higgs/zhangcg/cepc/10Mar/CEPCSW/tuplestrkresol*
  - $Pt \in [1, 100]$ GeV, $\theta \in \{15, 85, 165\}°$
  - Muon
  - 1k events per point

# Track-hit matching

- **Muon hits**
  - From 25.3.1, hits in muon chambers are constructed during tracking.
  - Not fitted to reconstruct muon standalone tracks
  - No magnetic fields outside of the center of the solenoid
  - Not possible to measure momentum, but can be used to perform muon ID
- **Match tracks to muon hits**
  - Obtain the 5 parameters at the last hit of the track to build the helix
  - Extrapolate the helix to the border of the magnetic field (R = 3885, z = 4075)
  - Obtain the position and momentum at the border of the magnetic field (point M)
  - Compare the relative position of the muon hits, and the track momentum at M
- **Distinguishment**
  - Only muons can enter muon chambers
  - Within a small cone of the extrapolated track, only muon track have large enough number of muon hits.
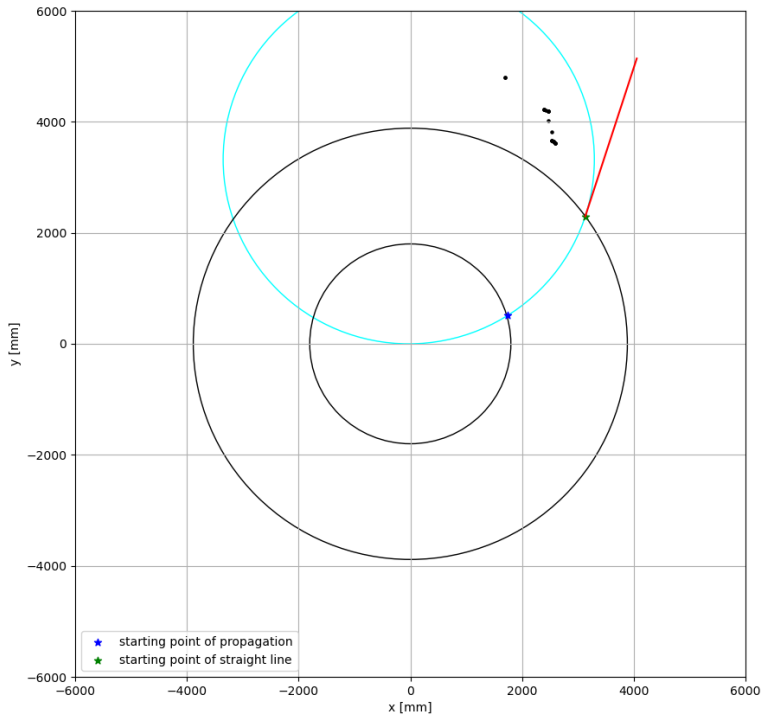
# ΔR(track, hit)

- With samples from Changhua: each event has one muon, one electron, and one pion with random φ.
- Remove electrons or pions too close to muons (ΔR<0.5).
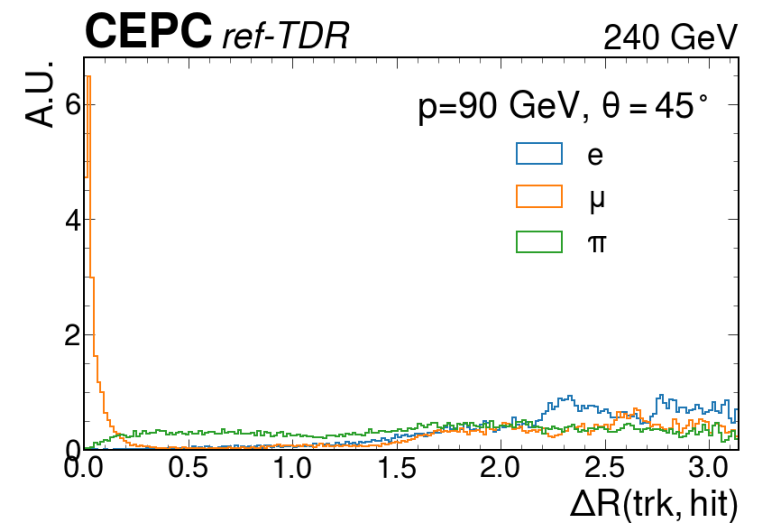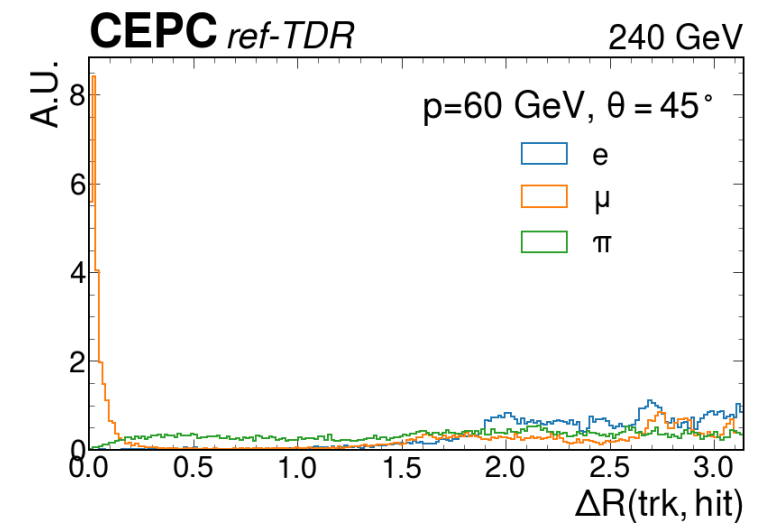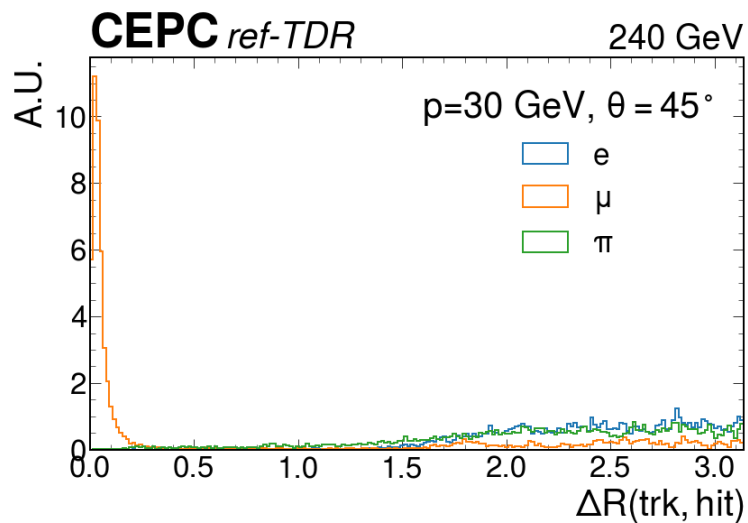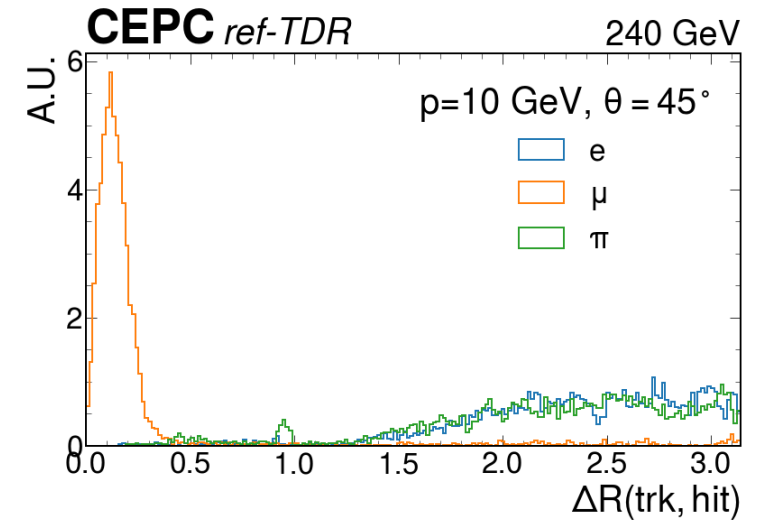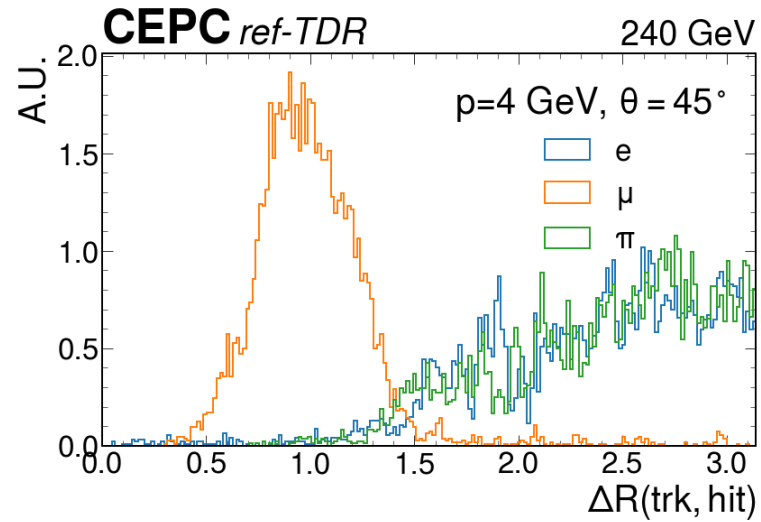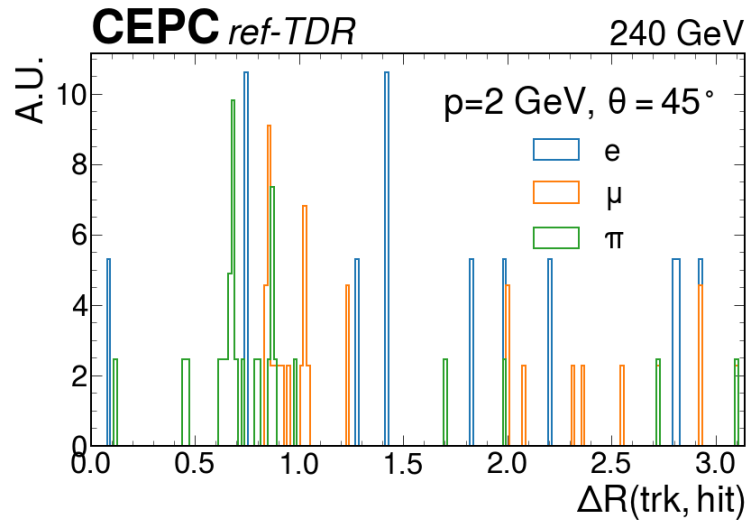
# Event display
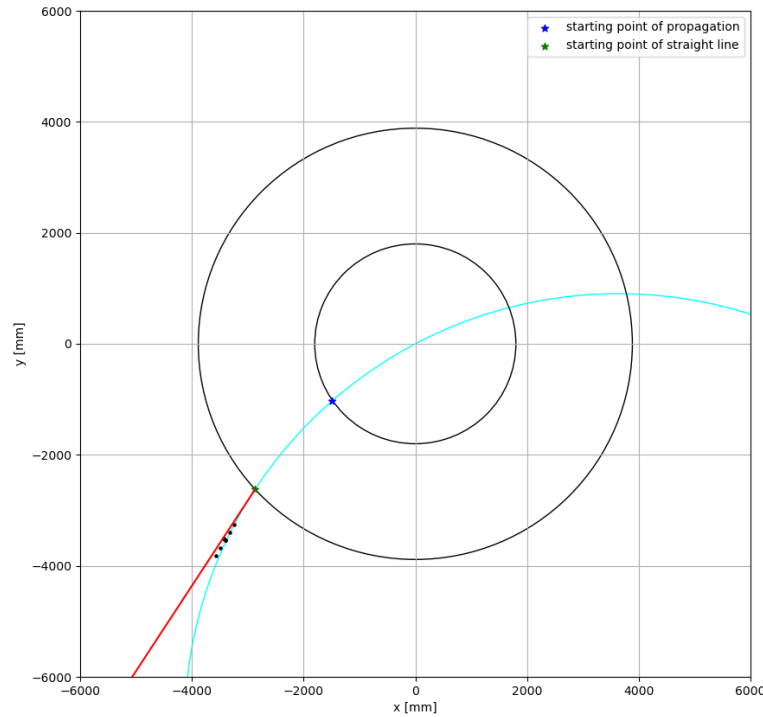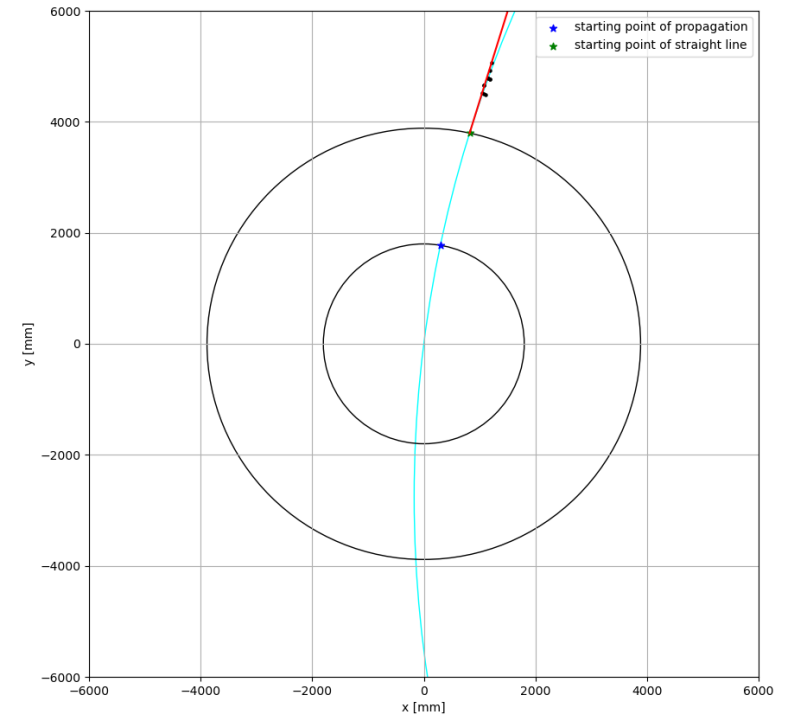
Pt = 3 GeV, θ = 85°            Pt = 7 GeV, θ = 85°            Pt = 20 GeV, θ = 85°
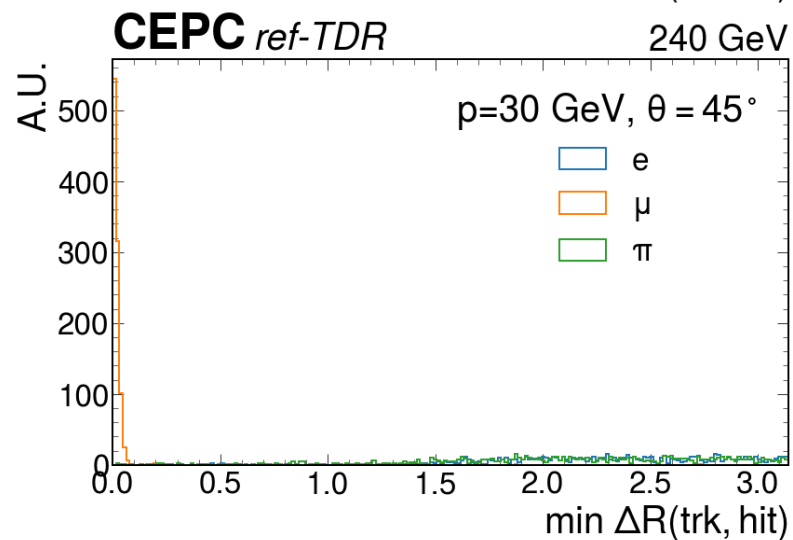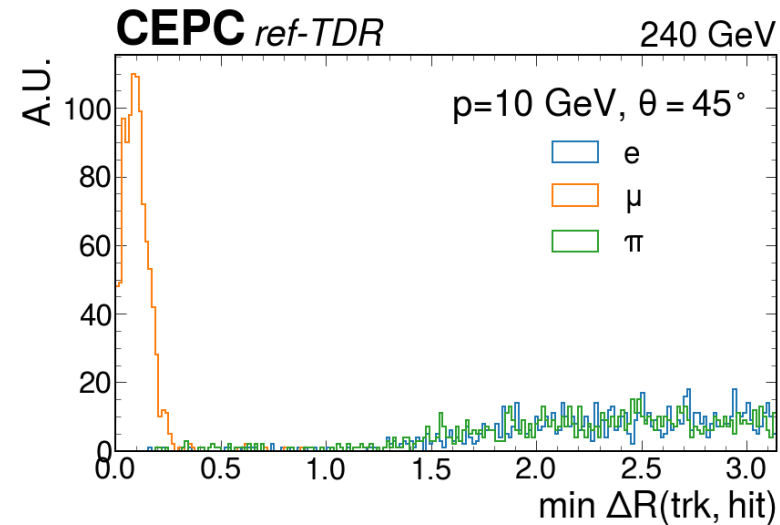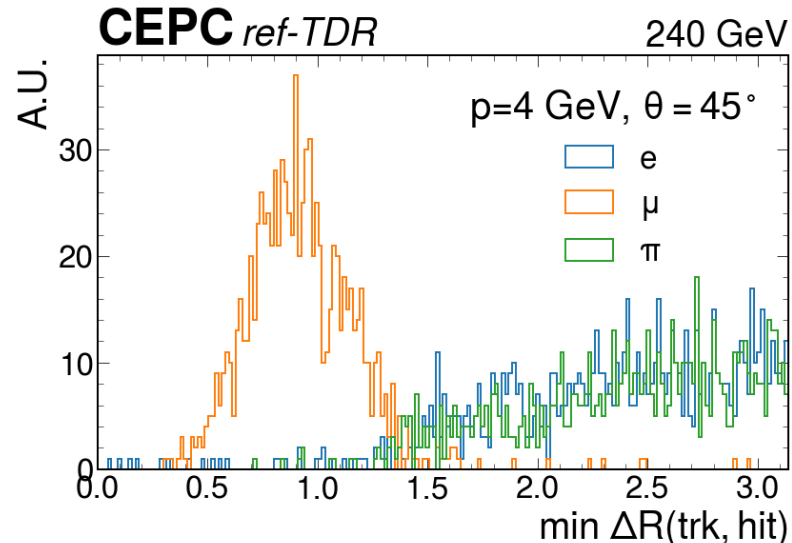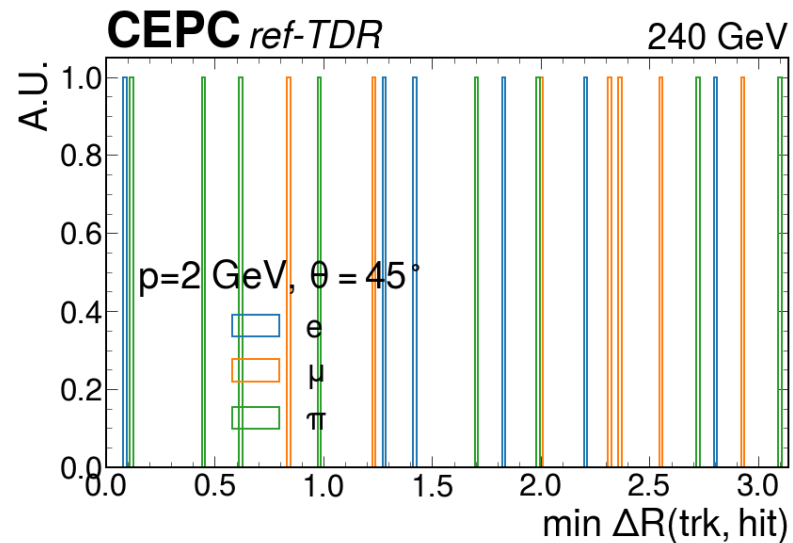


o   Muons can only enter muon chambers if its pt is above ~ 1.75 GeV
o   At low momentum, the energy loss during calorimeters can have visible impacts and are
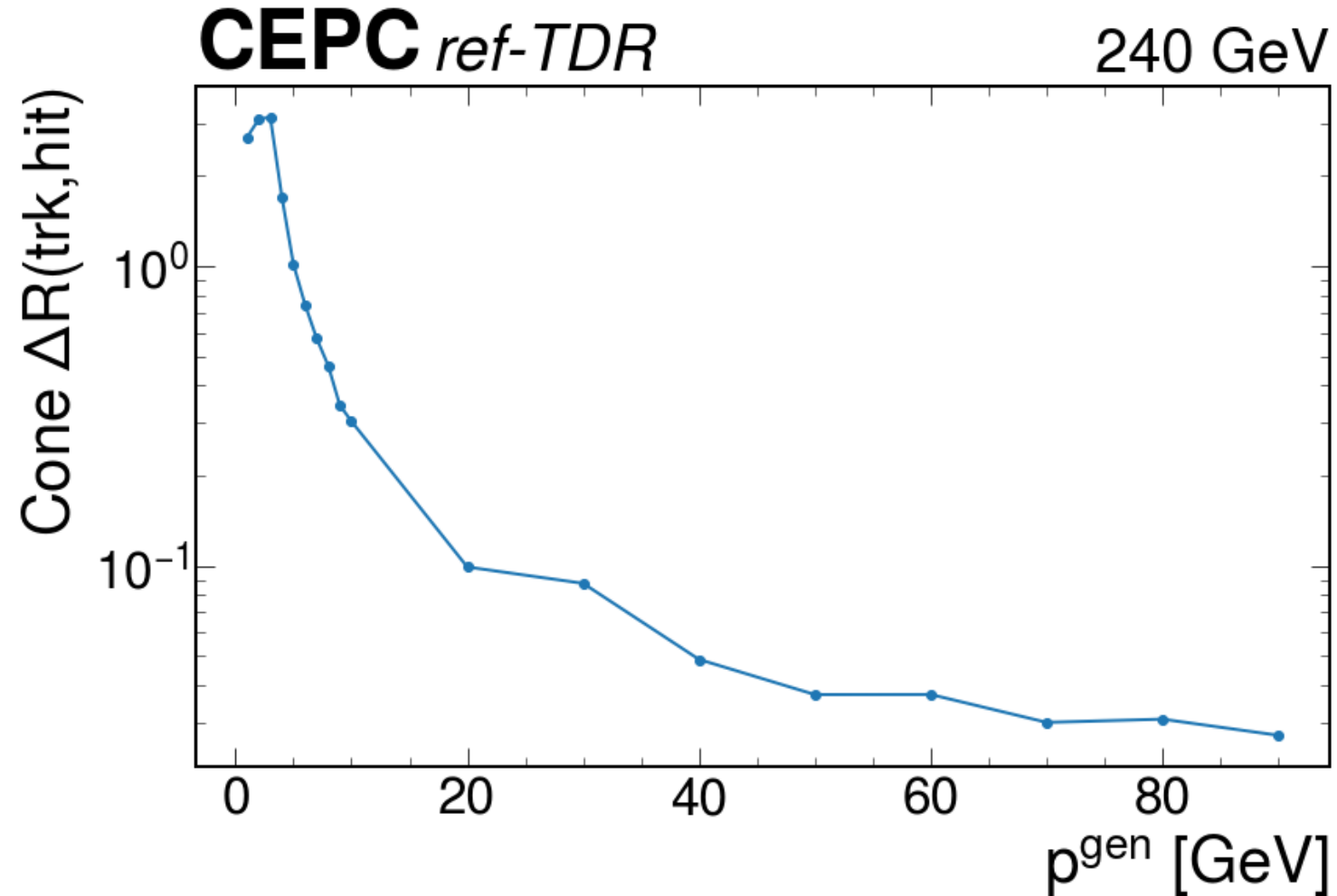    not taken into account by the helix extrapolation.

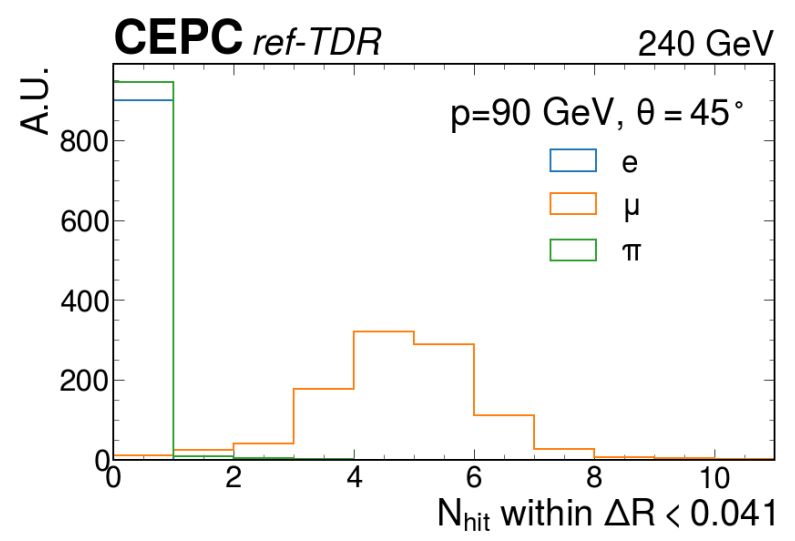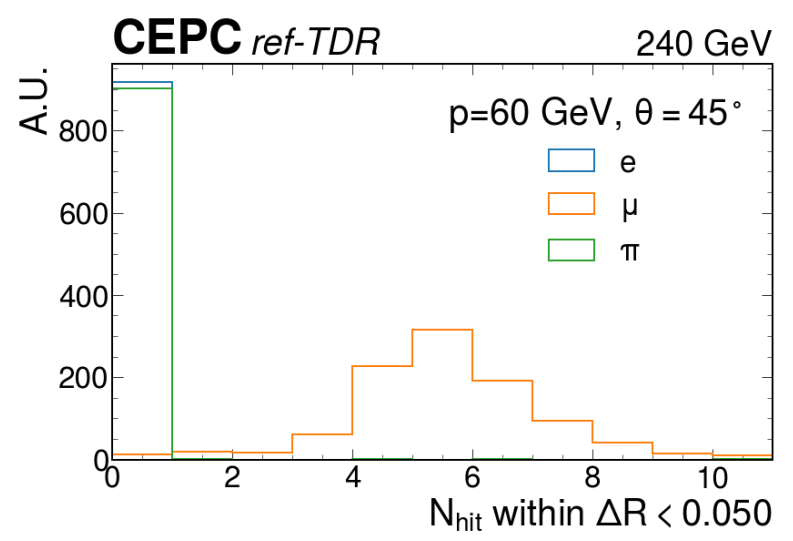# minimum ΔR(track, hit)

- Compute minimum ΔR among all hits
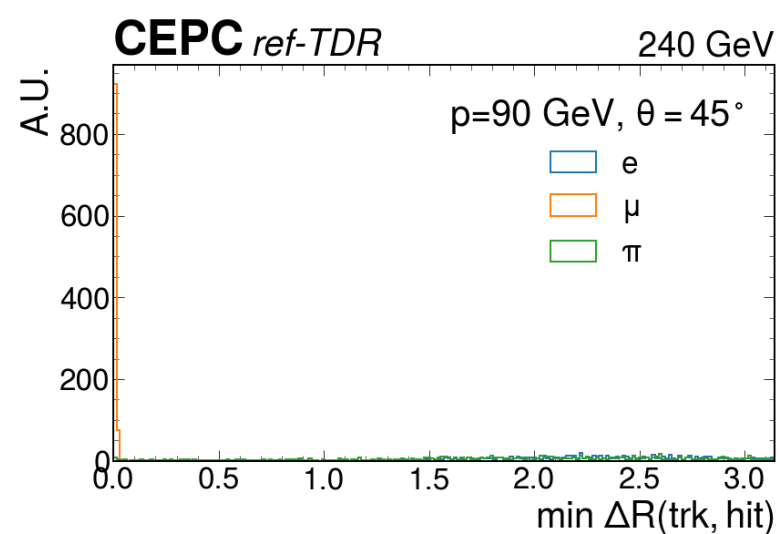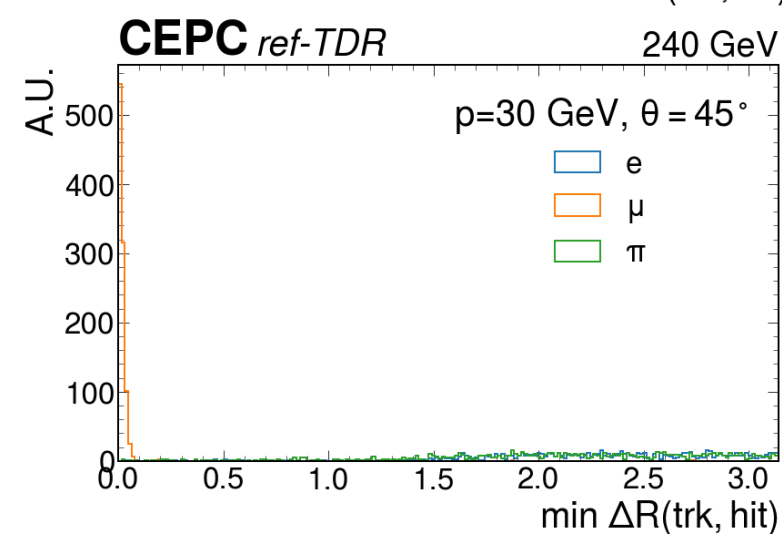
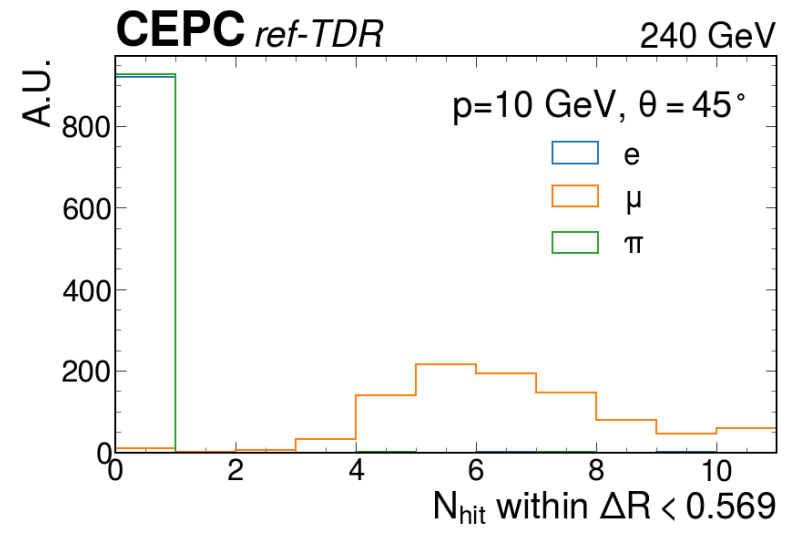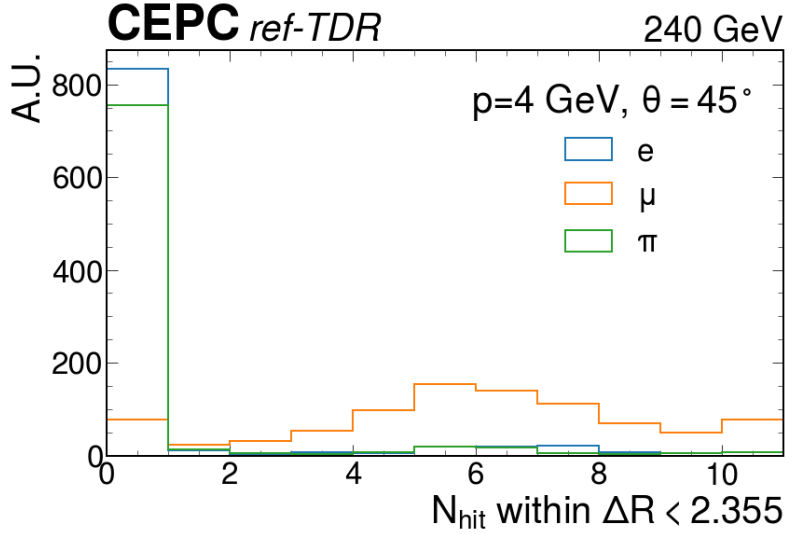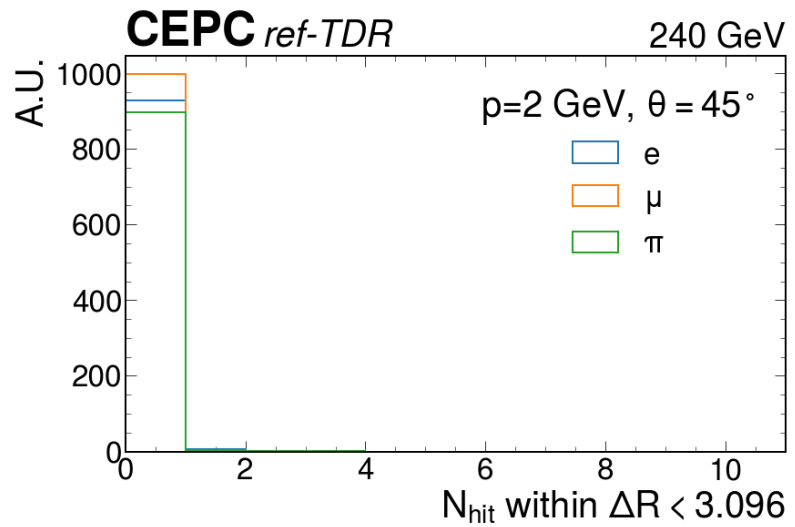# Cone size

- 99% percentile of the minimum ΔR(track, hit) distribution of muons:
    - o 99% percent of muons have at least 1 hit around ΔR(track, hit) < cone size

# Number of hits within the cone

- Count number of muon hits within the cone
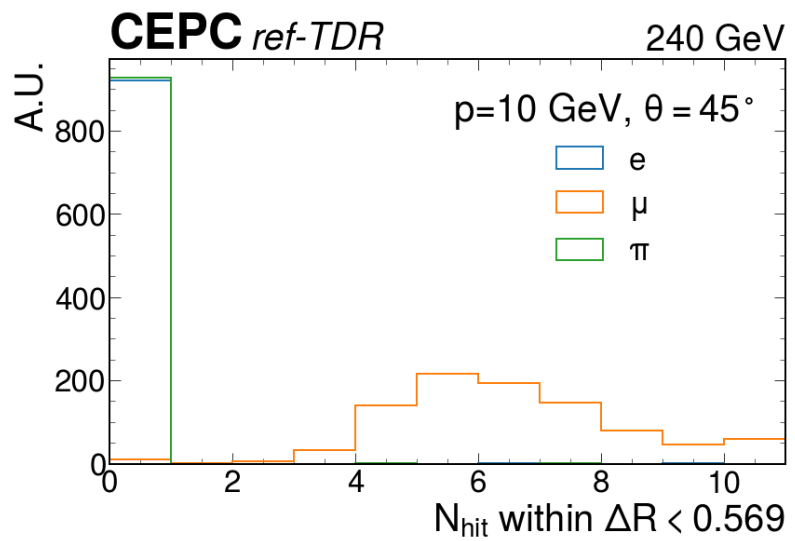
# Muon ID requirement

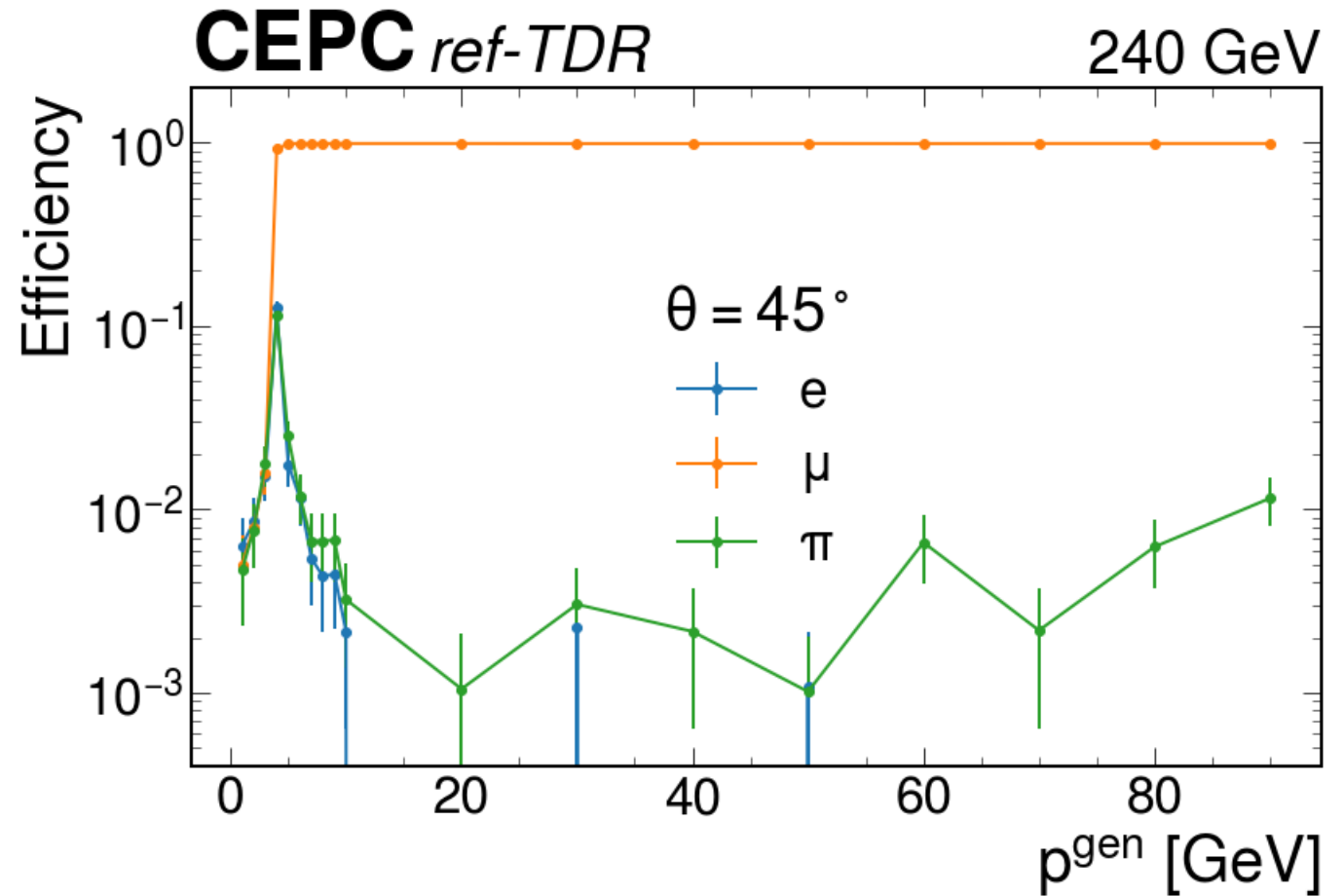**At least one muon hit within the cone**

- eff(μ) ~ 99% at p > 4 GeV
- eff(e) and eff(π) ~ 1% at p > 4 GeV

By adjusting the cone size, we get different WPs

# Next steps

➢ **Optimization of ID using muon hits**
- Other angles waiting to be checked
- Layer information?
- Probably not needed since the performance is already good

➢ **At low pt (< 3.5 GeV)**
- Muon hits not reliable
- Need to combine with TOF, TPC, E_ECAL, E_HCAL information

➢ **Will have a complete PID soon**
- Muon to be identified first
- Electrons identified based on TOF, TPC and E/p
- Hadrons are identified further

➢ **Trying to have a user-friendly package for analyzers**