CLIC_ILD particle identification and tracking performance

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This talk in 2 parts:
→ Particle-ID performance: efficiencies, purities and mis-identification rate
→ Tracking performance: efficiency and fake rate

Part 1: Particle-Identification performance in CLIC_ILD

The particle-ID algorithm

- For Efficiency and purity we take a list of MC-Particle and PFO of ***same*** PDG type

- Create lists of findable PFOs and MC-Particles
  - Cuts used
    - Energy   > 7.5 GeV
    - Polar angle   > 8 degrees
    - MC-Particles with Generator status   equal to 1

- Match Energy and PFO on direction and Energy
  - Direction: PFO and MC-Particle inside a 1 degree cone
  - Energy/Momentum
    - For charged particles:
    - For neutral particles :

- Similarly when requiring to have particles with ***different*** PDG type, we look at the ***mistag rate***

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    - For charged particles: $|p_T(MC) - p_T(PFO)| < 5\% \times p_T^2(MC)$
    - For neutral particles : $|E_{MC} - E_{PFO}| < 200\% \times \sqrt{E_{MC}} + 50\%$

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- Similarly when requiring to have particles with *__different__* PDG type, we look at the *__mistag rate__*

Definitions

Efficiency:

→ matched MCParticles/findable MCParticles

Purity:

→ Matched PFOs/findable PFOs

Mistag rate:

→ matched –different PDG- MCParticles/findable MCParticles

→ These definitions are per MCParticle
and per Event

→ Plots in the next slides produced with particle guns electrons, photons, muons and pions generated in all the θ and φ spectrum with energies up to 400 GeV
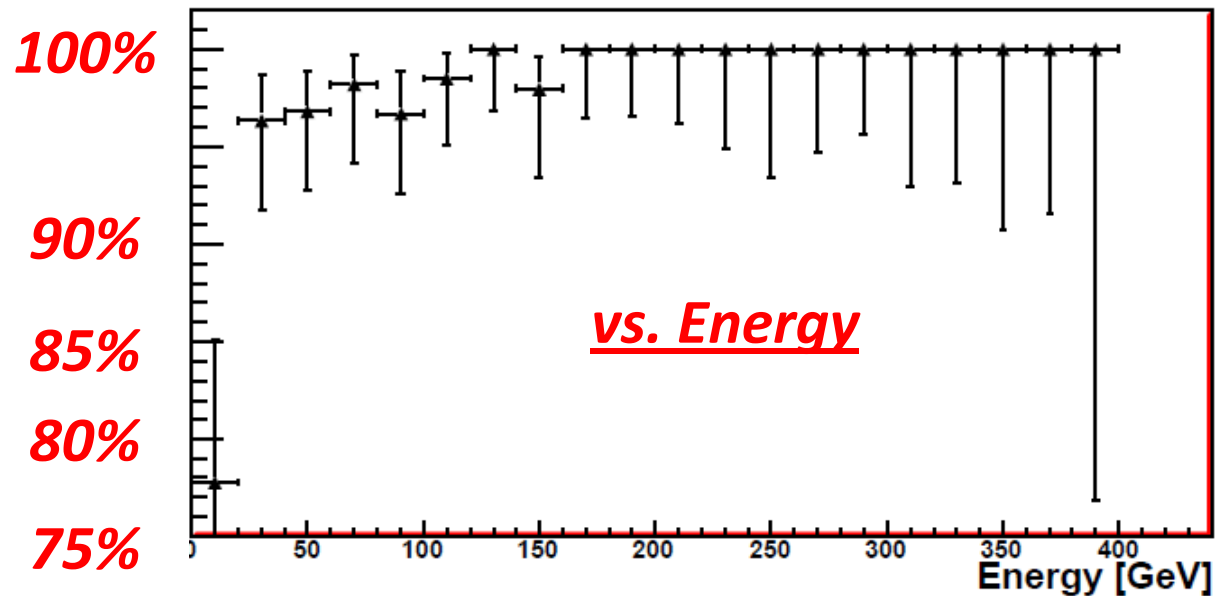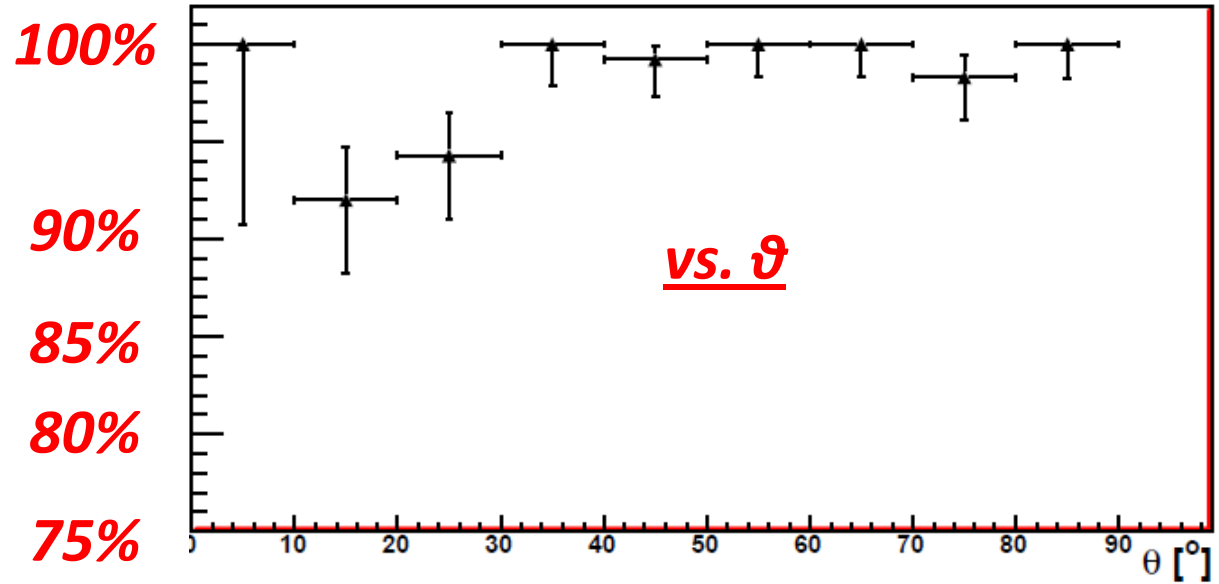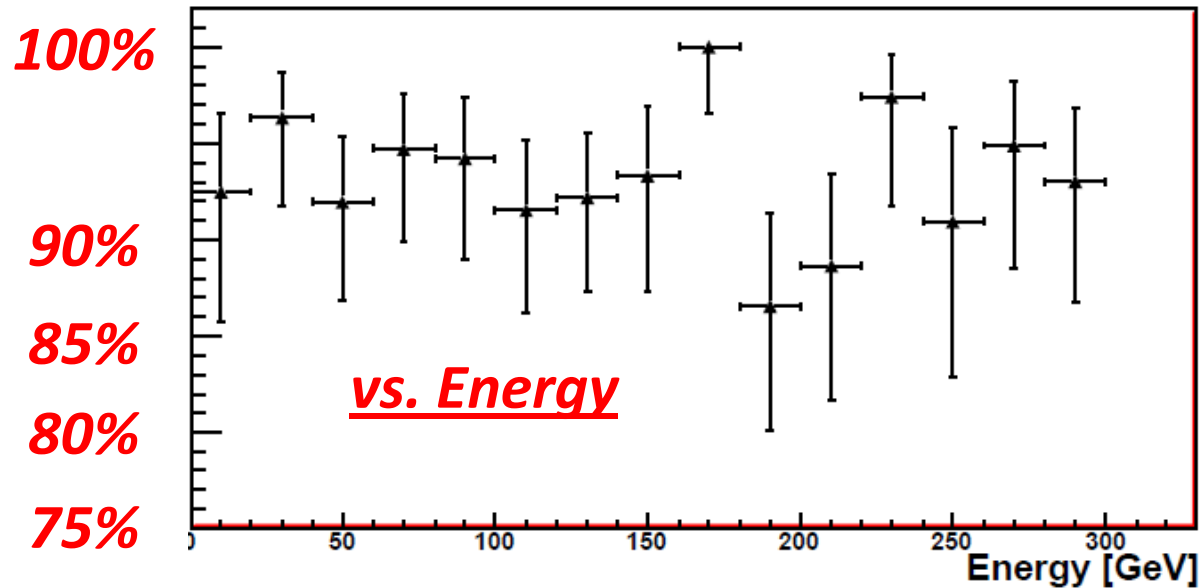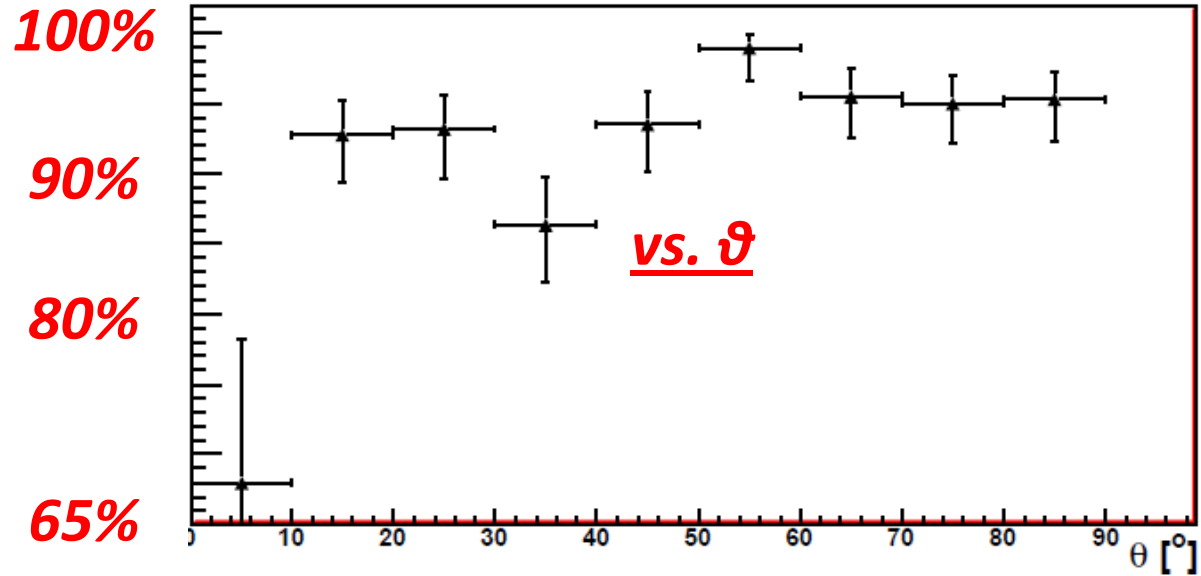
Electrons: Efficiency

vs. ϑ

vs. Energy

Electrons: Purity

vs. ϑ

vs. Energy

Photons: Efficiency

vs. ϑ

vs. Energy

Photons: Purity

vs. ϑ
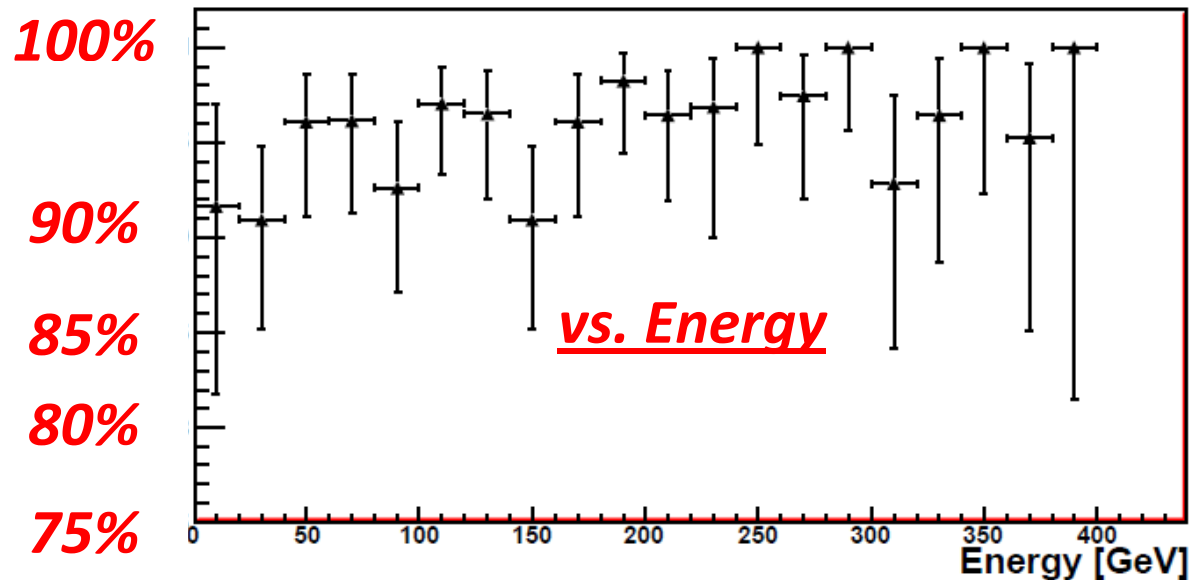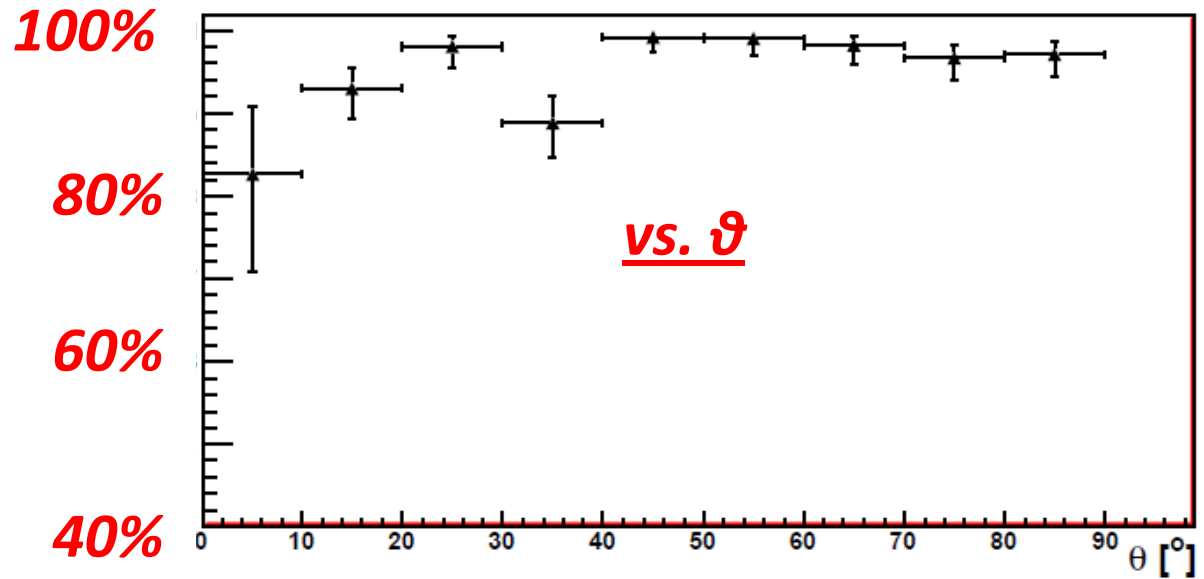
vs. Energy

Pions: Efficiency

vs. ϑ

vs. Energy

Pions: Purity

vs. ϑ
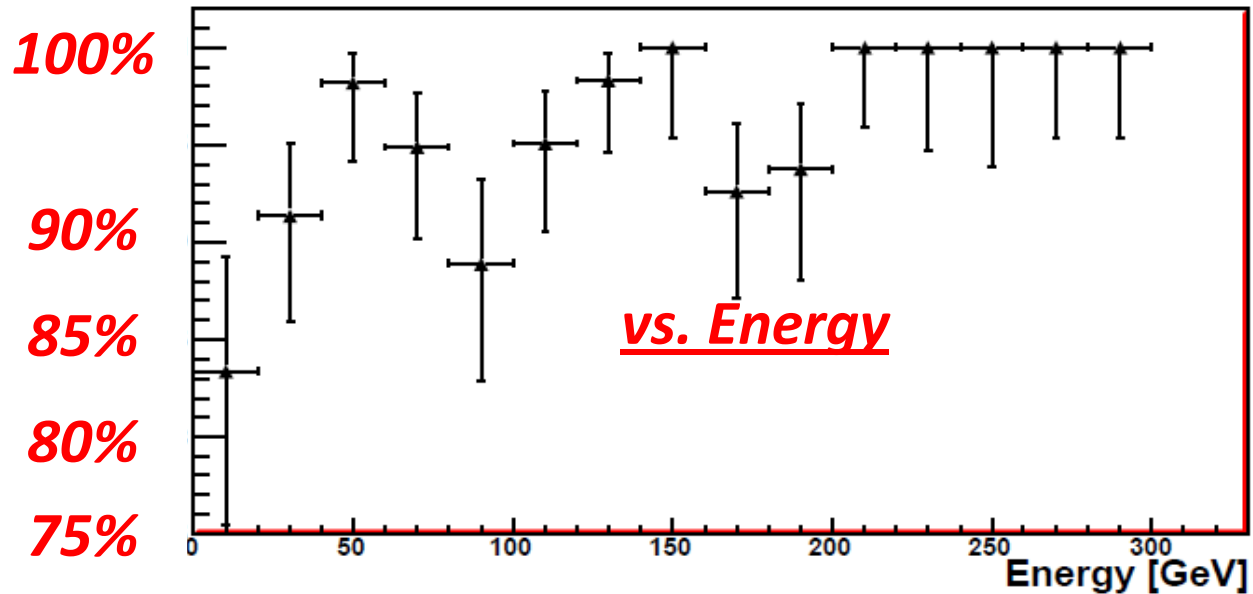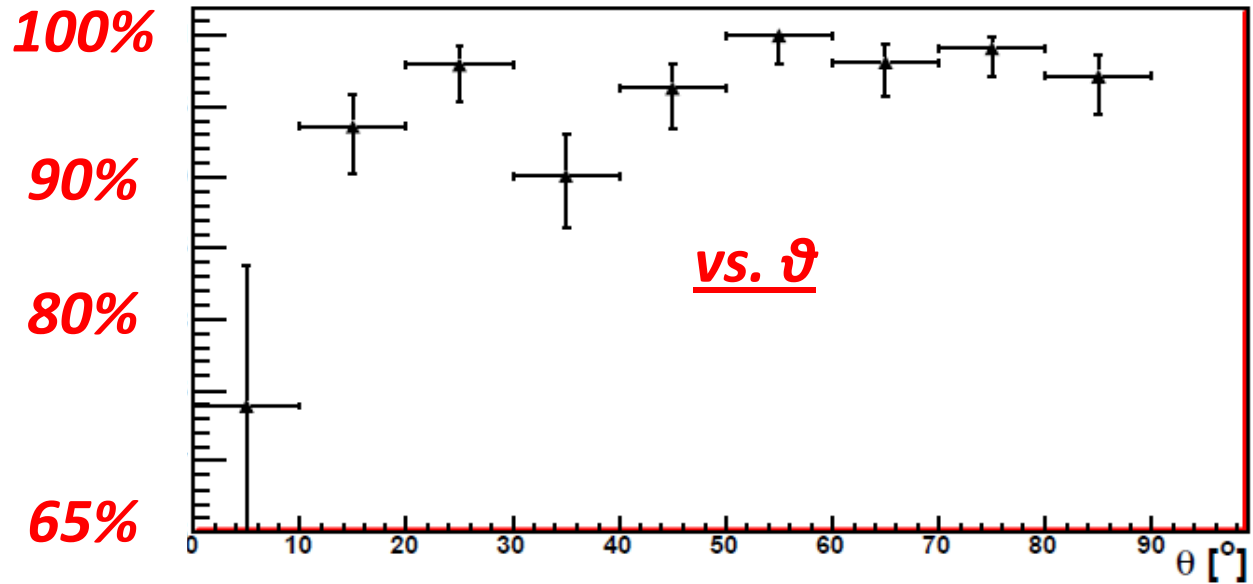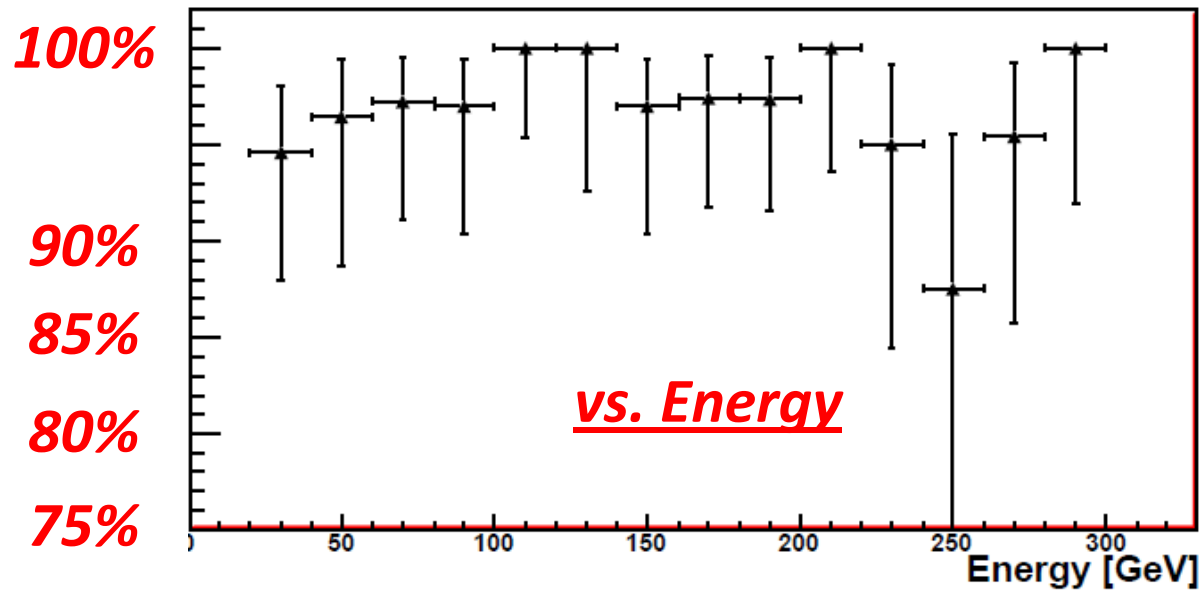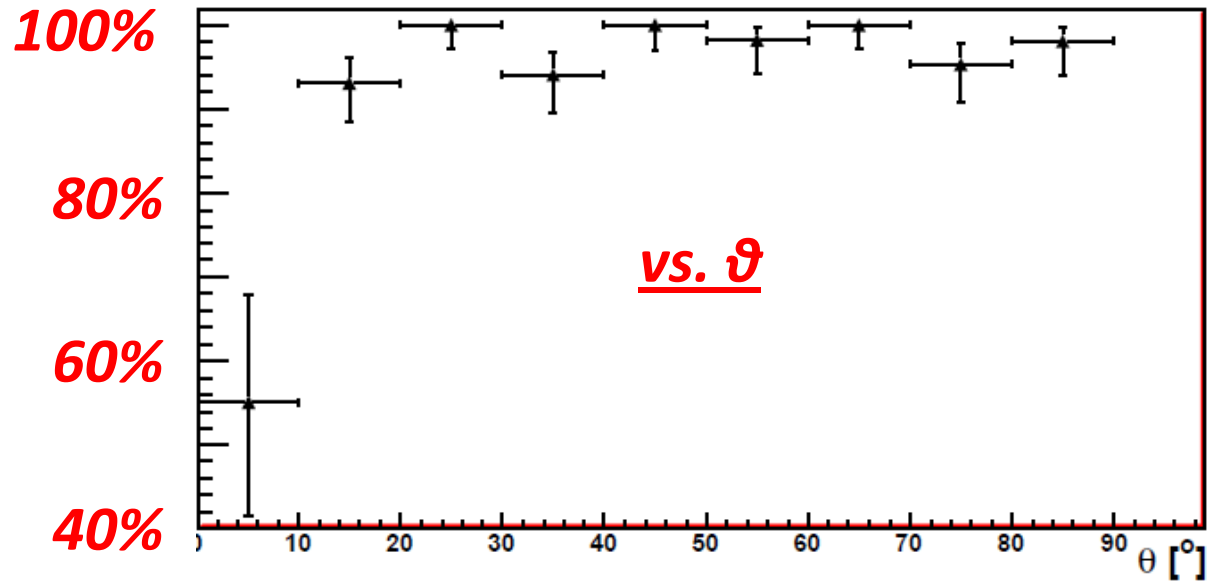
vs. Energy
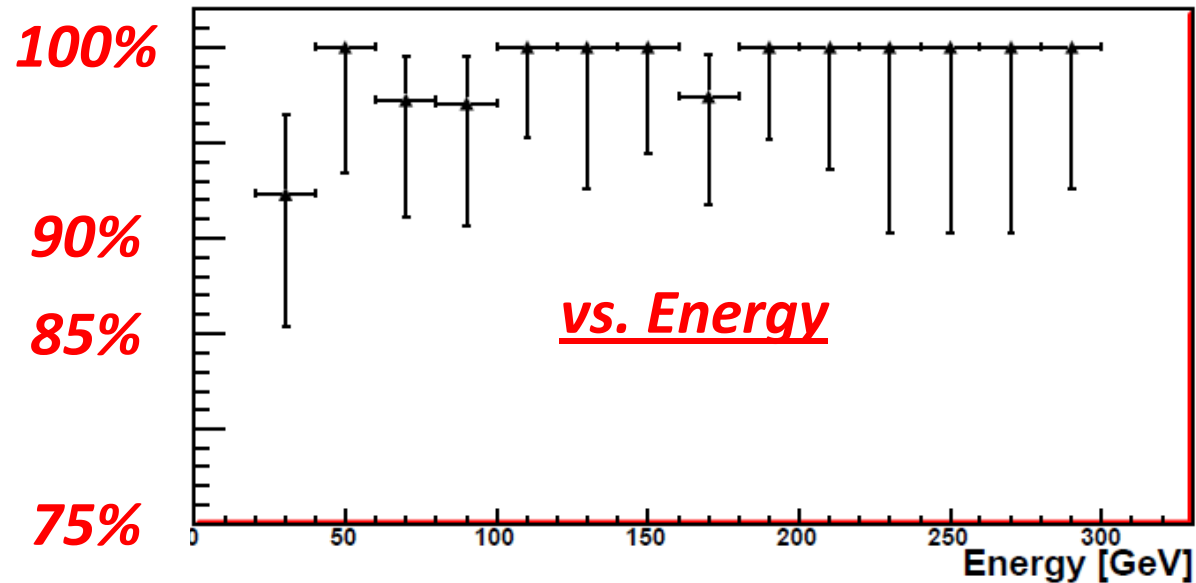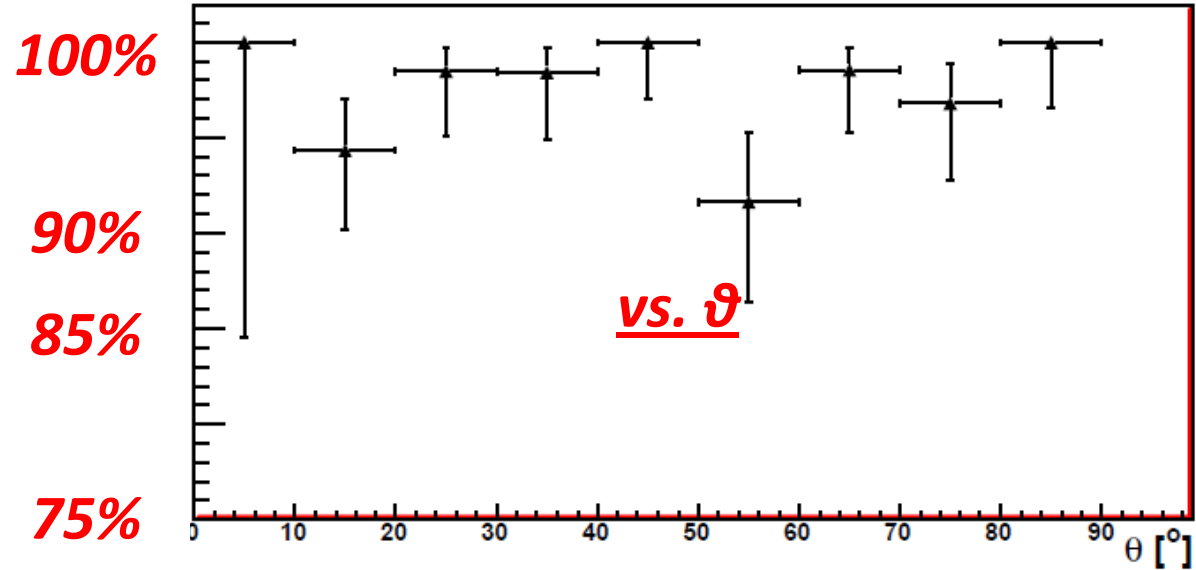
Muons: Efficiency and purity for 10 GeV particles

Efficiency vs. ϑ

Purity vs. ϑ
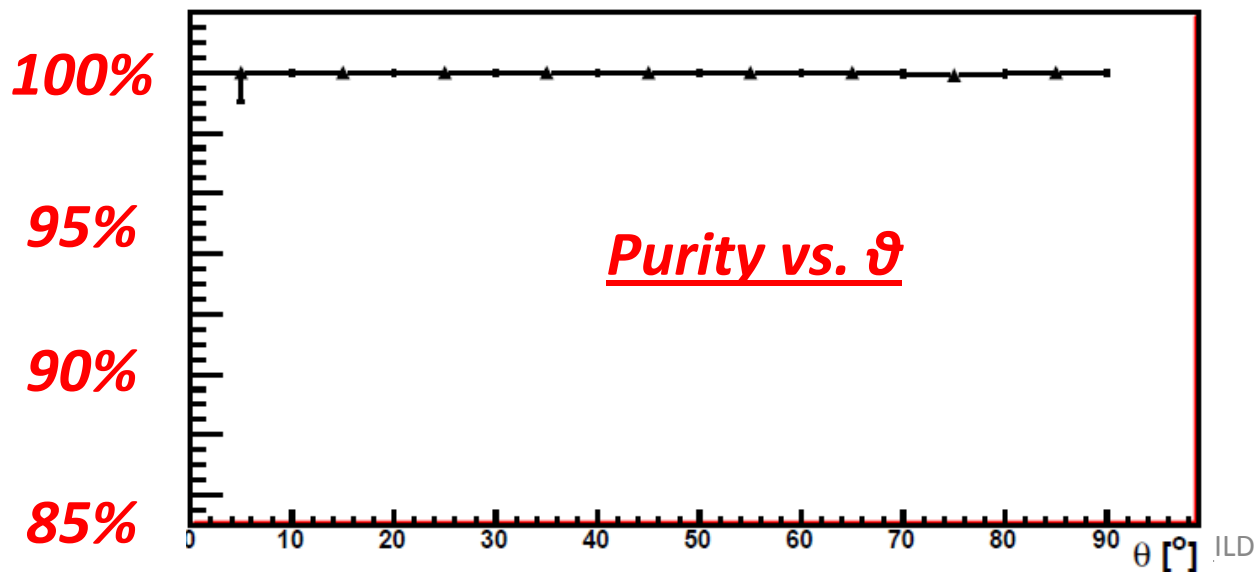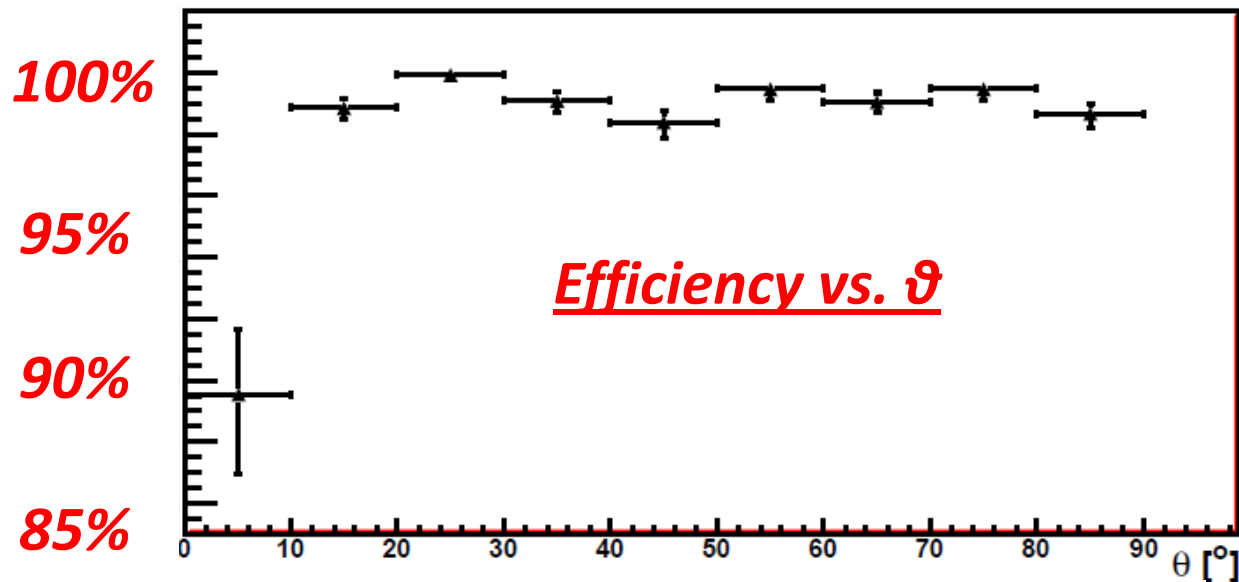
Muons: Efficiency for Z➔bb events

vs. ϑ

vs. Energy
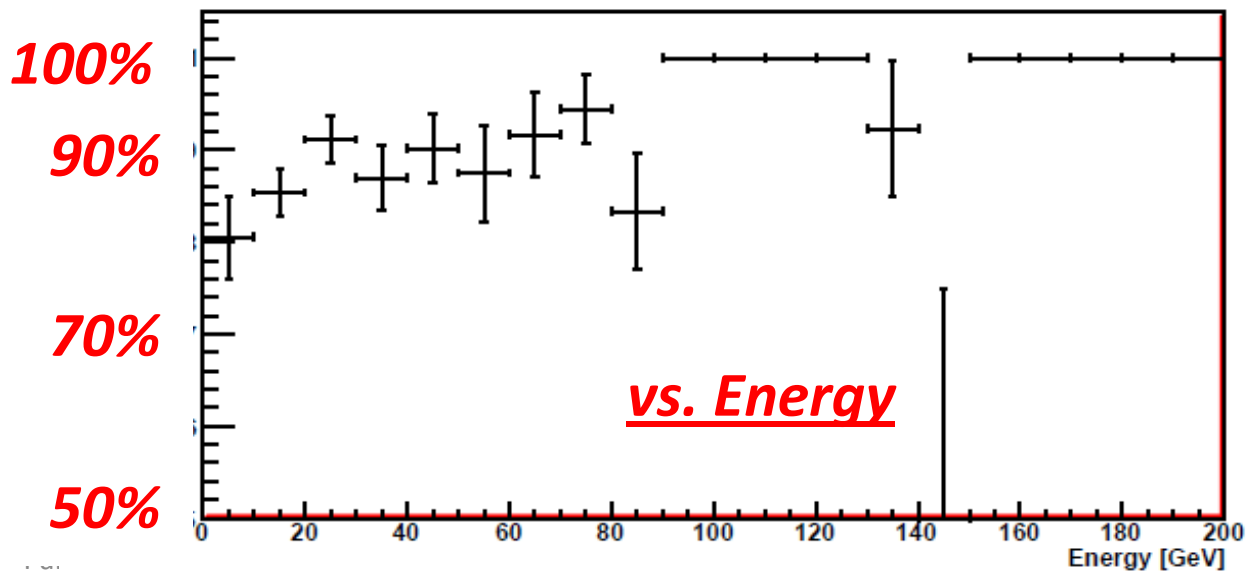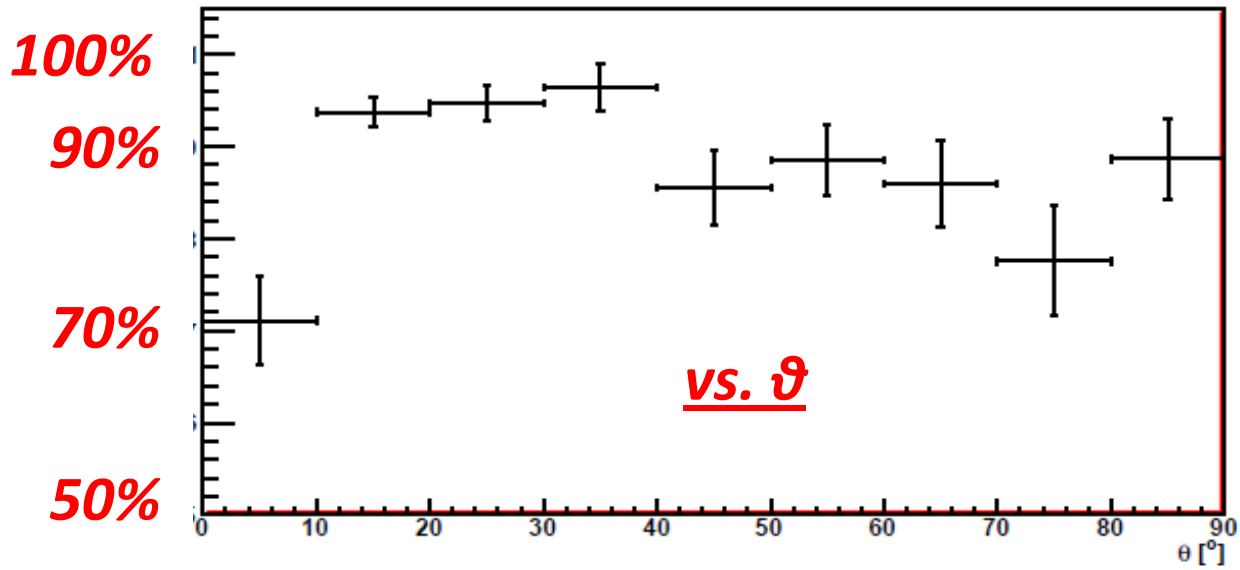
Average efficiency and purity for all particles in CLIC_ILD_CDR

Particle	Efficiency	Purity
Electron	96% ± 1%	97% ± 1%
Photon	93% ± 1%	96% ± 1%
Pion	96% ± 1%	99% ± 1%
Muon	99% ± 1%	100% ± 1%

→ Plots in the previous slides produced with particle guns electrons, photons, muons and pions generated in all the θ and φ spectrum with energies up to 400 GeV

Average mistag rate per event for all particles in CLIC_ILD_CDR

Mistag rate in CLIC_ILD_CDR

Conclusions
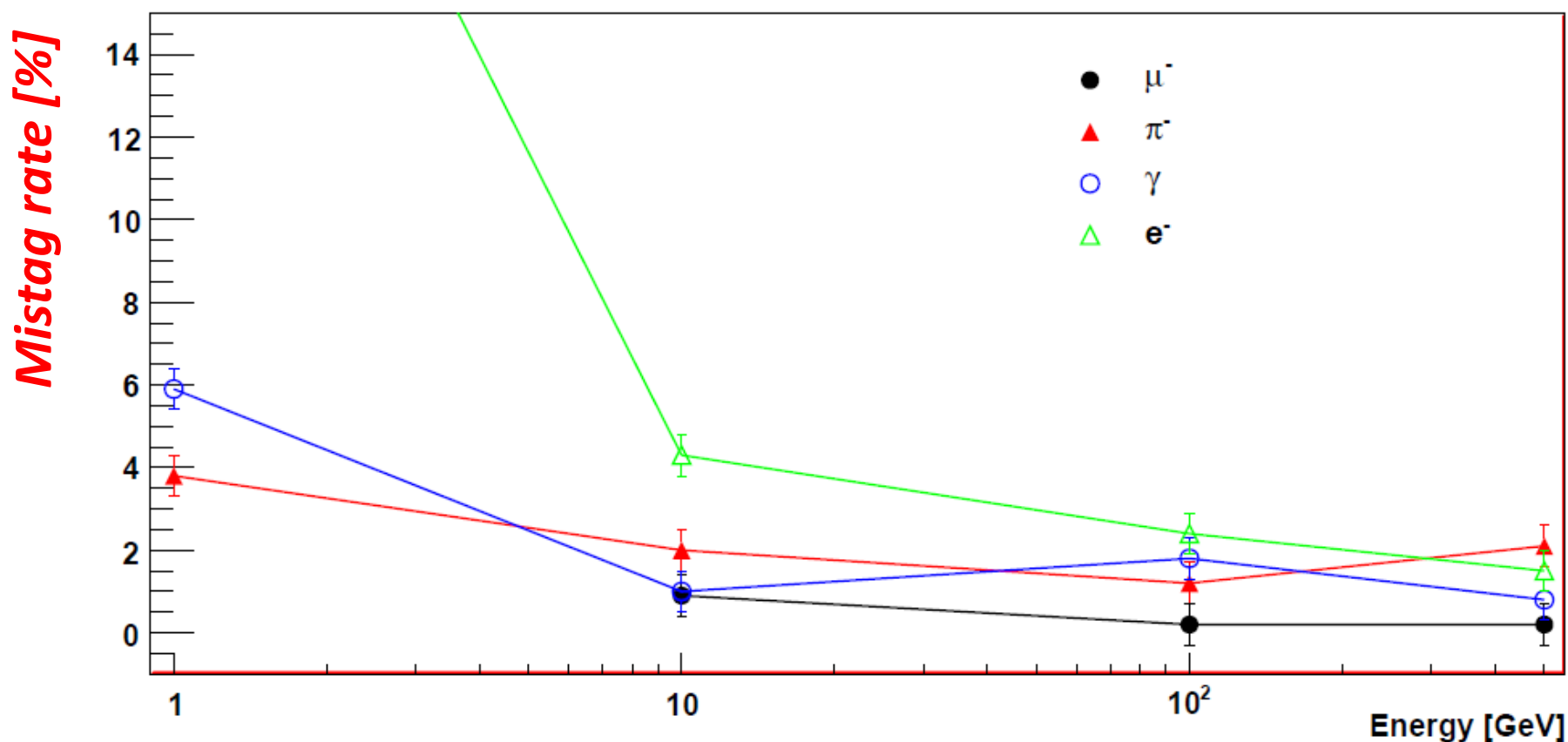
Efficiency and Purity

- Efficiency and purity are above 90% for all particles considered

Mistag rate

- Apart from the less interesting 1 GeV case

- For 100 and 500 GeV for all particles the mistag rate is always < 2%

- At 10 GeV we have higher values for electrons, mostly mistagged as pions

- Mistagged Pions are found mostly at PFO level as electrons

- Gammas are found as neutrons and Pions

Part 2: Tracking performance in CLIC_ILD

Tracking performance algorithm

- For the Tracking Efficiency we make a list of findable MC-Particles
  - Cuts used
    - Energy   > 250 MeV
    - Polar angle   > 8 degrees
    - Charge   different from 0
    - Flight distance cut   Default value > 50 mm
    - |Origin of MC – interaction point| Default value < 50 mm
- Then Loop over all the tracks and all the MC-Particles
- For every track try to match it to a MCParticle
  - If you succeed and your MC Particle is findable   → you're efficient
  - If you succeed and your MC Particle is NOT findable → your track is not a fake
  - If you do not succeed,   → your track is a fake
- Matching Criteria:
  - Nr of hits of a track, that belong to the MCParticle you want to match > 75%

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Definitions

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→matched Tracks/findable MCParticles

Fake Rate:

→Not Matched Tracks/All Tracks

Results: Signal Efficiency
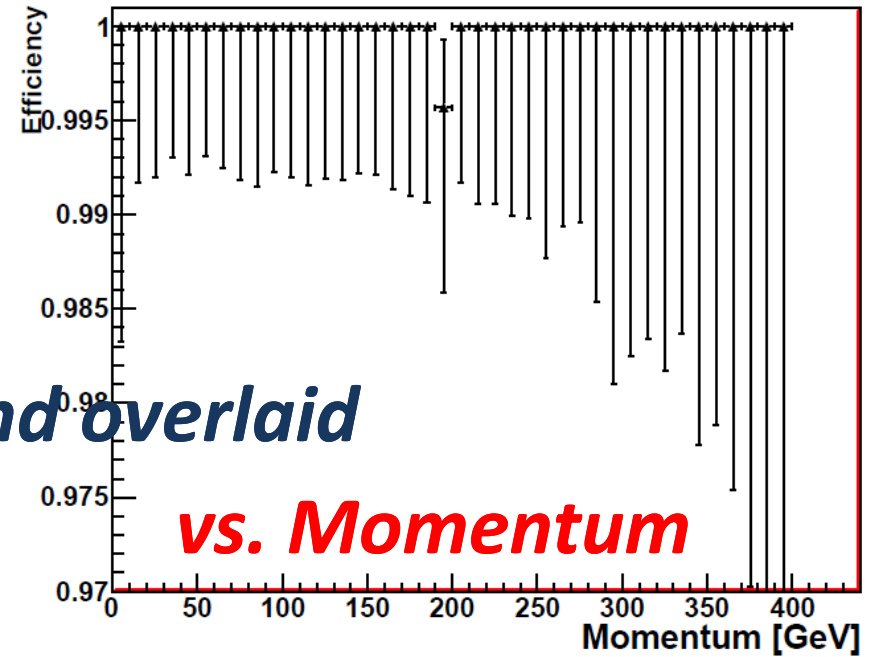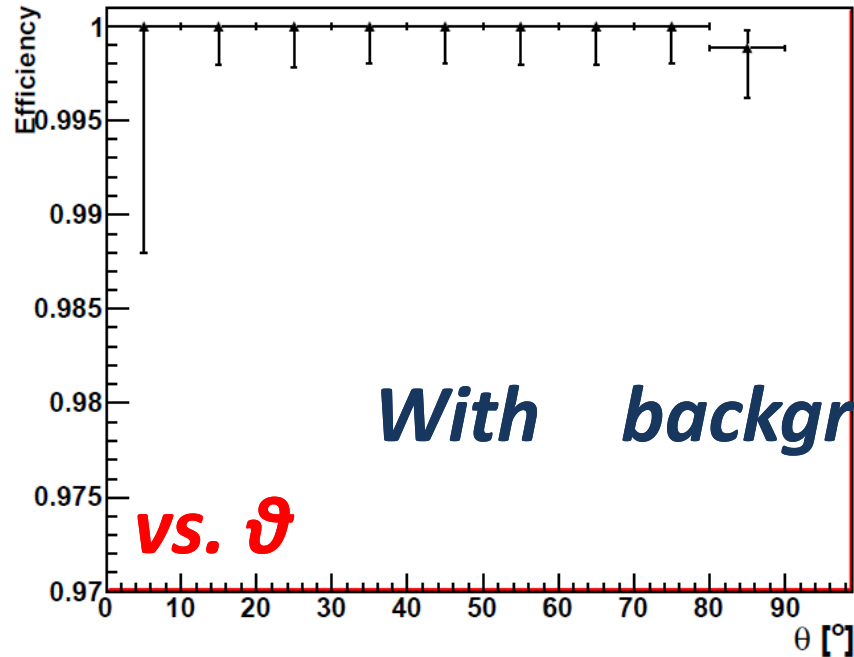
- Particle gun muons generated in all the θ and φ spectrum up to 400 GeV
- Reconstructed with and without background overlay [60 bunches of γγ → hadrons]

Without background overlaid

vs. ϑ

vs. Momentum

Without background the fake rate is at 0.005%

Results: Signal Efficiency
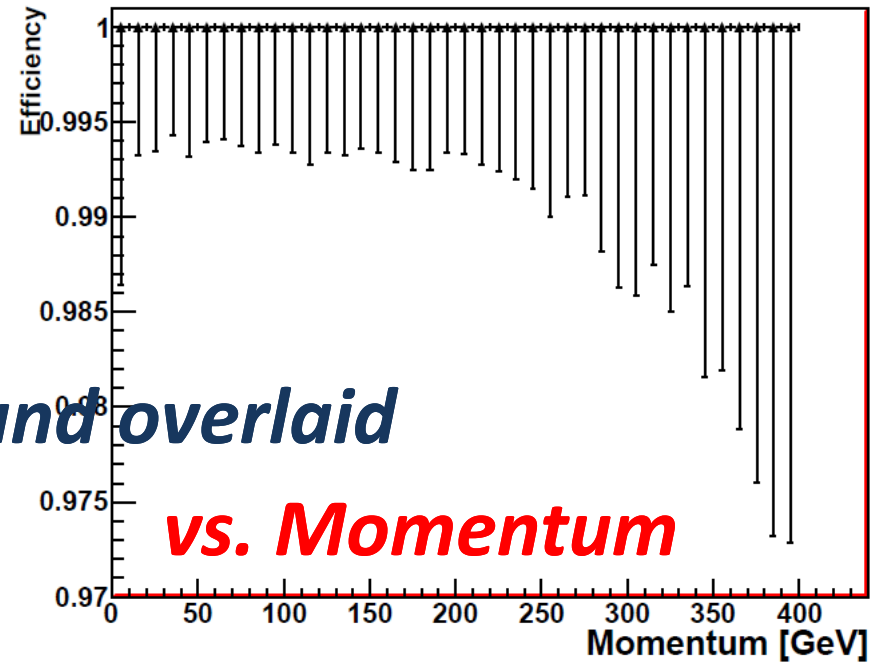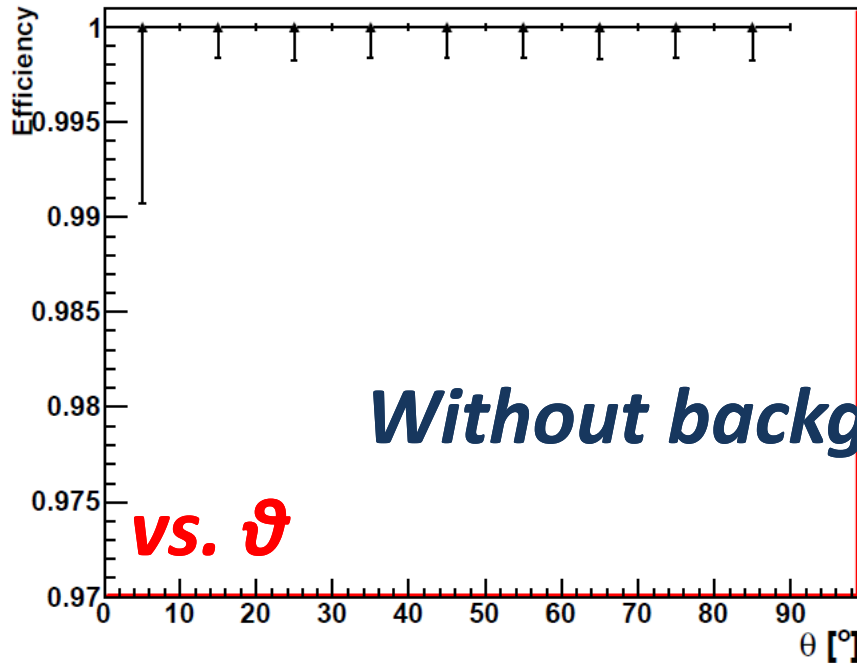
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With   background overlaid

vs. ϑ

vs. Momentum

With background the fake rate is at ~10% → see next slide

Results: Fake rate

- Particle gun muons generated in all the θ and φ spectrum up to 400 GeV
- Reconstructed with and without background overlay [60 bunches of γγ → hadrons]

vs. ϑ

vs. Pt

With   background overlaid

Conclusions
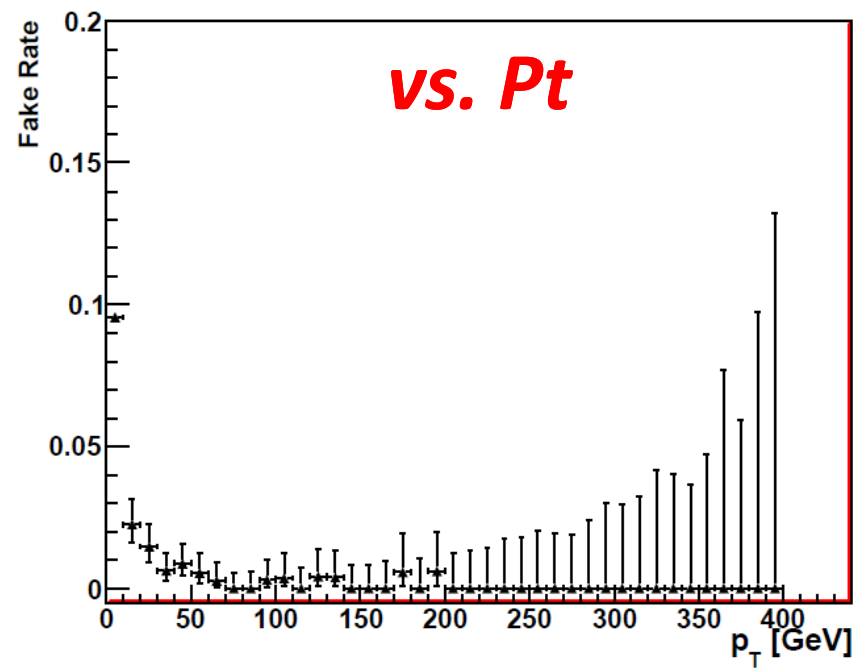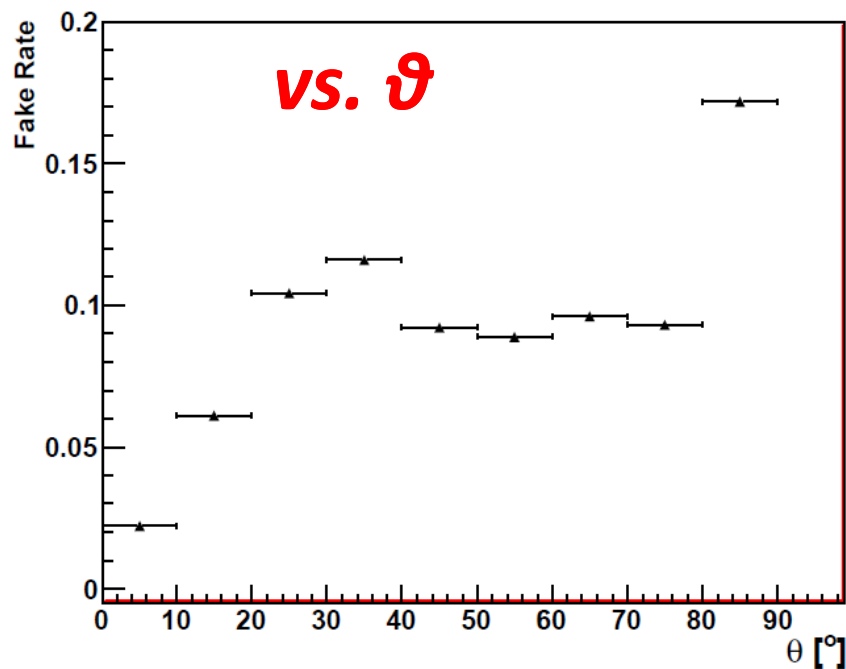
- For single muons without overlaid background the tracking efficiency is ~100% and the fake rate is at 0.005%

- The overlaid background does NOT deteriorate the tracking efficiency for single muons

- While it increases the fake rate which goes to ~10%