Momentum Resolution and Particle Identification Performance in the Forward Region

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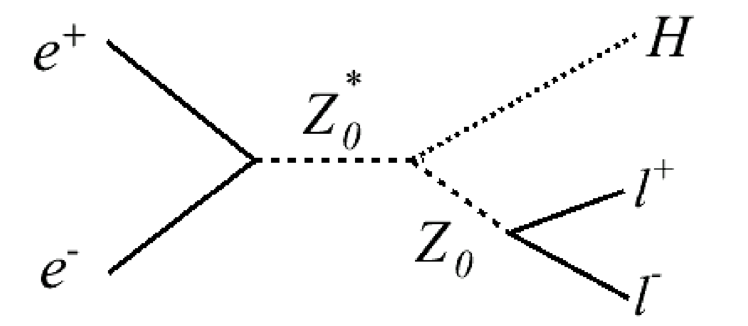
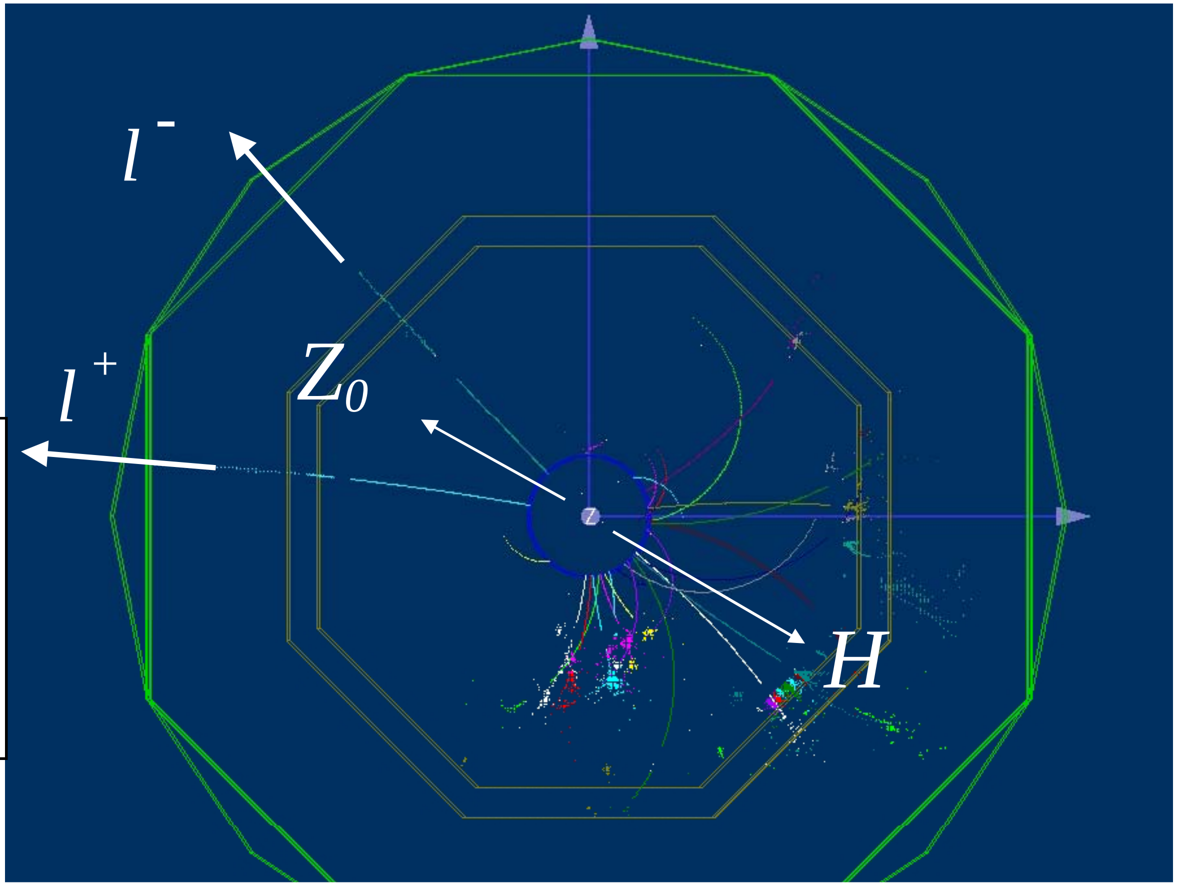
DESY and MPI Munich

Motivation

Higgs strahlungs process:





- Higgs Recoil Mass
- Coupling Strength (model independent)

$$m_h^2 = s + m_Z^2 - 2E_Z\sqrt{s}$$

$$g^2 \propto \sigma = N / L\varepsilon$$

Only leptons are used, critical issues:

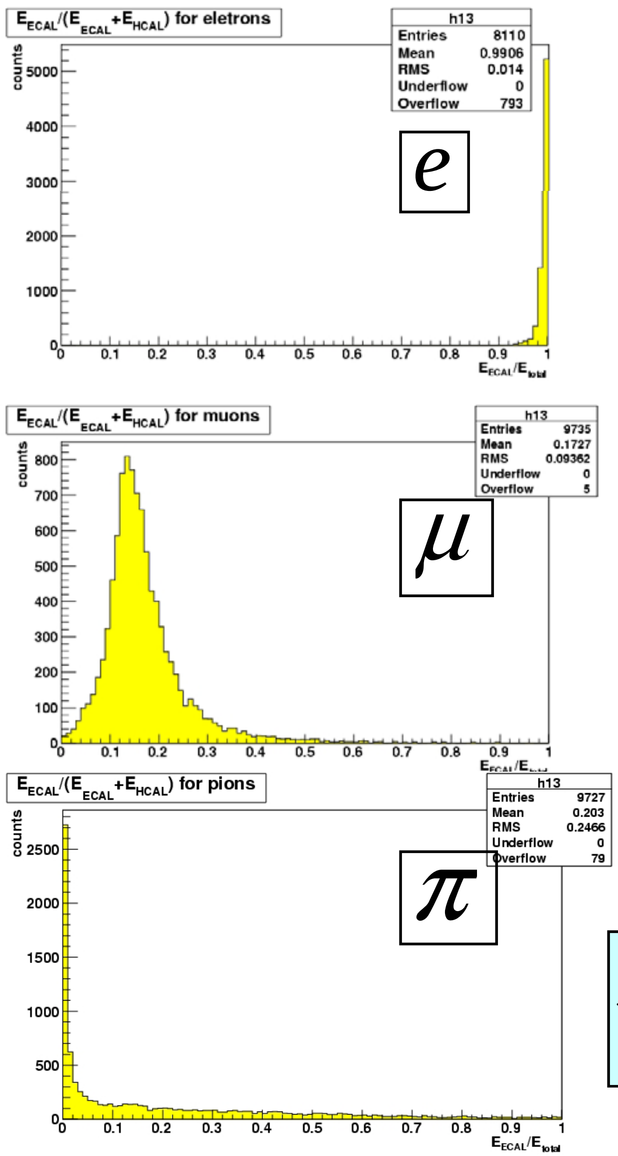
- Lepton Identification
- Lepton Momentum Measurement

Method and Tools

Whizard, Pythia BHWIDE → Mokka → Marlin / MarlinReco

- Generating Events including
  - beamstrahlung
  - ISR, FSR
- Full Detector Simulation
- Reconstruction of isolated Leptons
  (A. Raspereza's track reco)
  - ↳ Identification of leptons
  - ↳ Recoil mass calculation

Lepton Identification



- take *M* quantities $x_j;\ j=1,\dots,M$
- normalize histrograms for *N* particle types $f_i(x_j); i=1,\dots,N$
- create probability density functions

$$p_i(x_j)=\frac{f_i(x_j)}{\sum_{k=1}^{N} f_k(x_j)}$$

- Likelihood function for a certain particle type

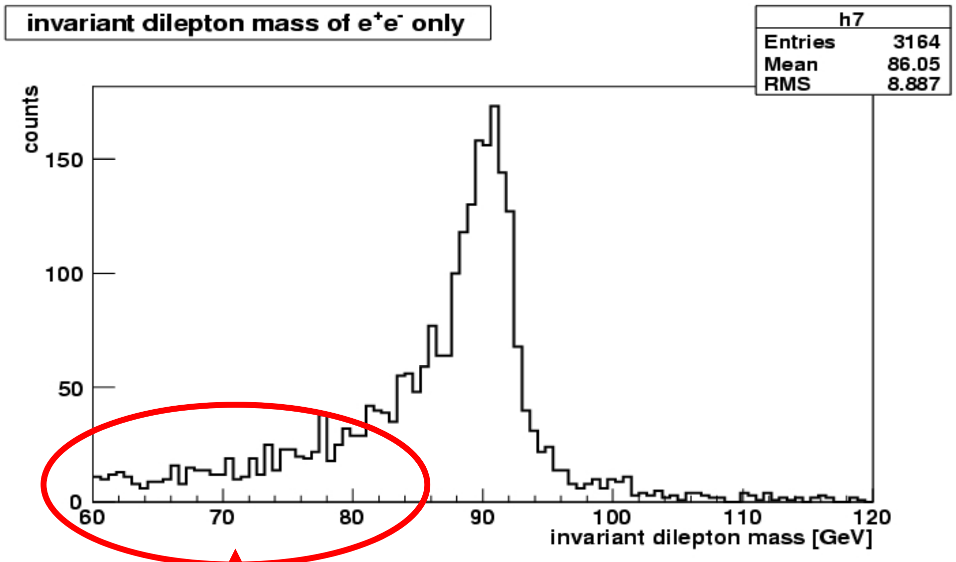
$$L_i=\frac{\prod_{j=1}^{M} p_i(x_j)}{\sum_{k=1}^{N}\prod_{l=1}^{M} p_k(x_l)}$$

Example

$$\frac{E_{ECAL}}{E_{ECAL}+E_{HCAL}}$$

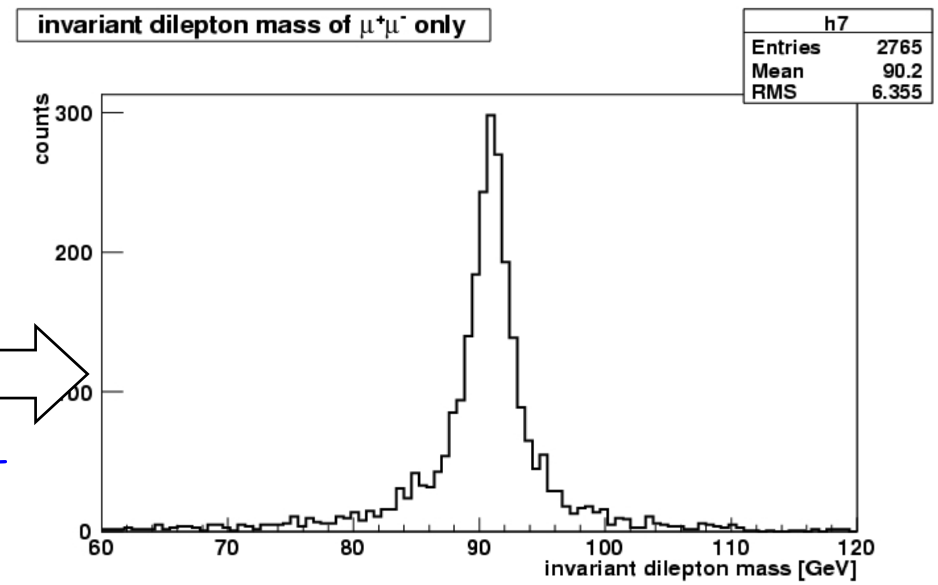
Recoil mass distribution

Using events with identified lepton pairs we get:



from e^+e^-

What happens here ?

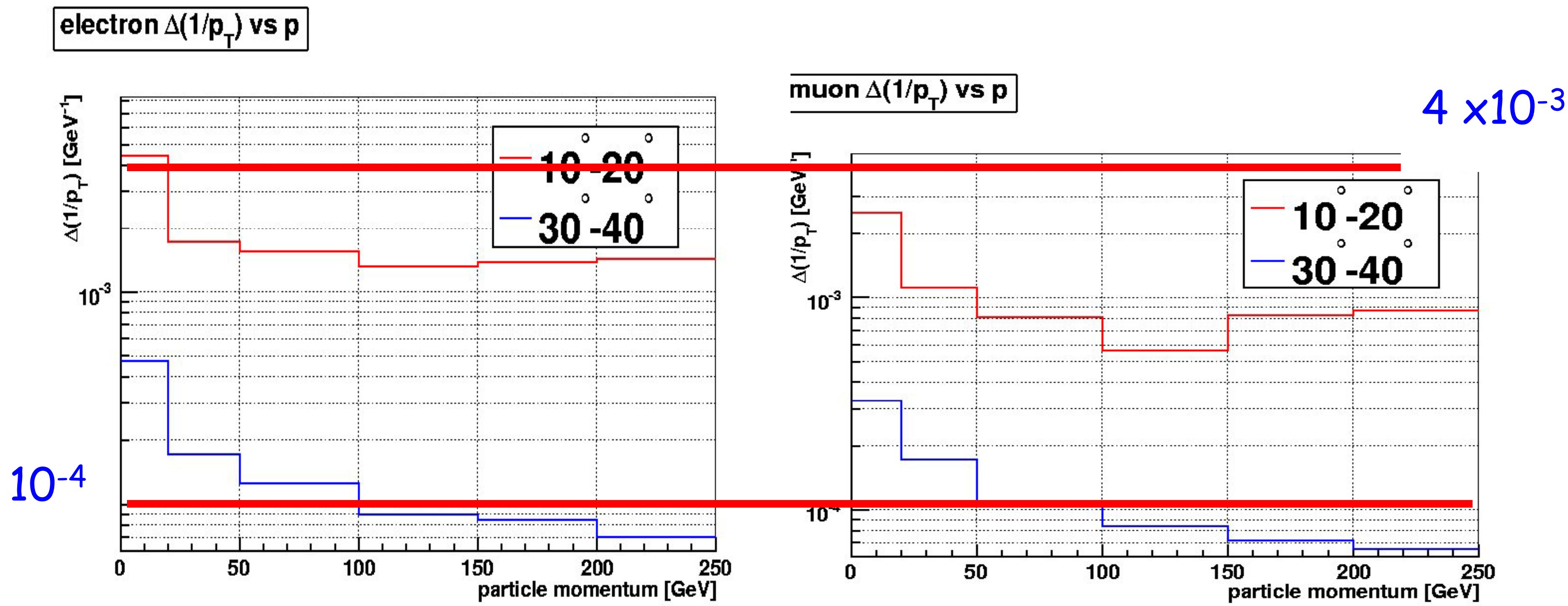


from $\mu^+\mu^-$

Momentum Resolution

electrons

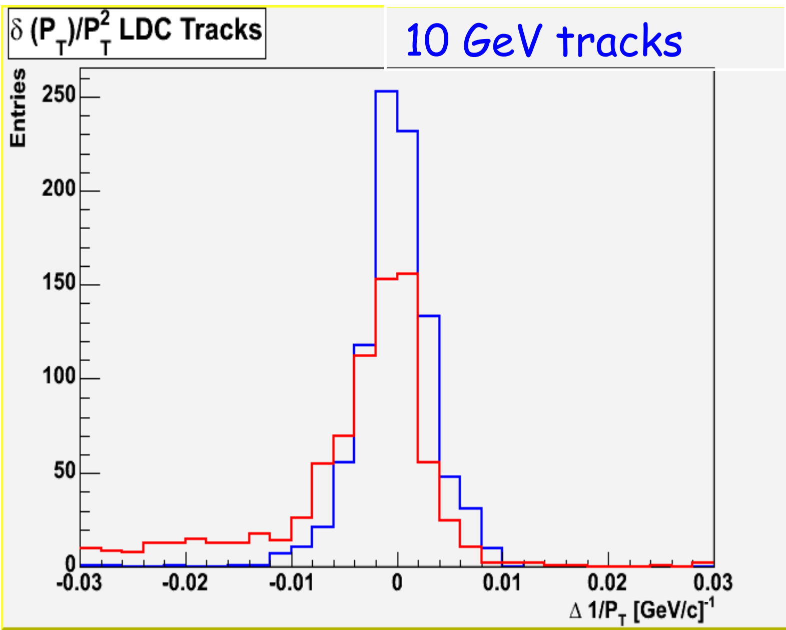
muons

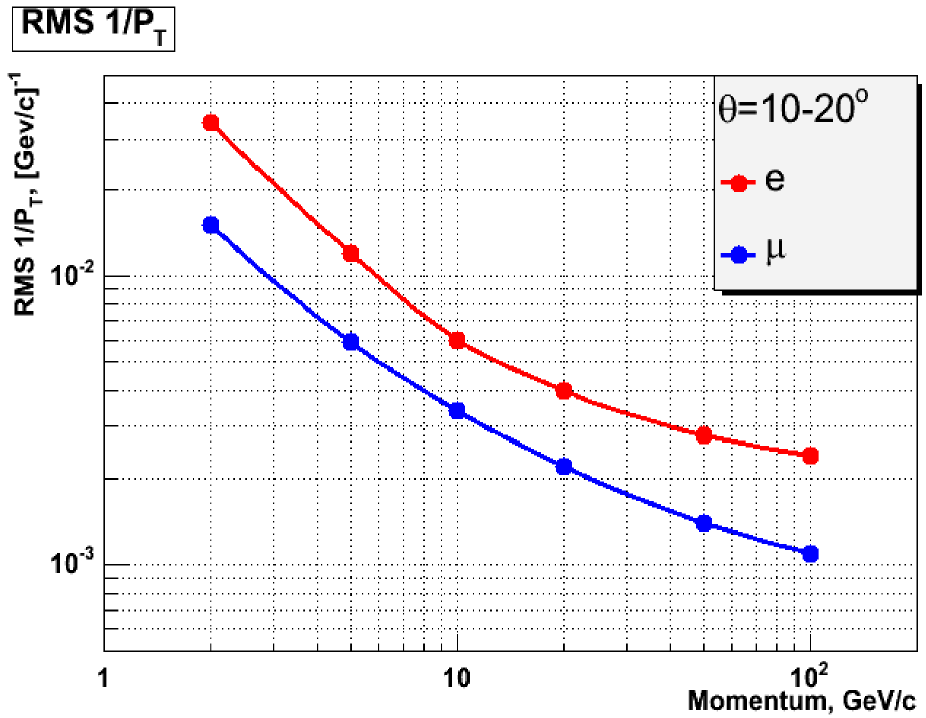


Electron momentum measurement is less performant !!

Momentum Resolution

Different pixel size, only mutual comparison!





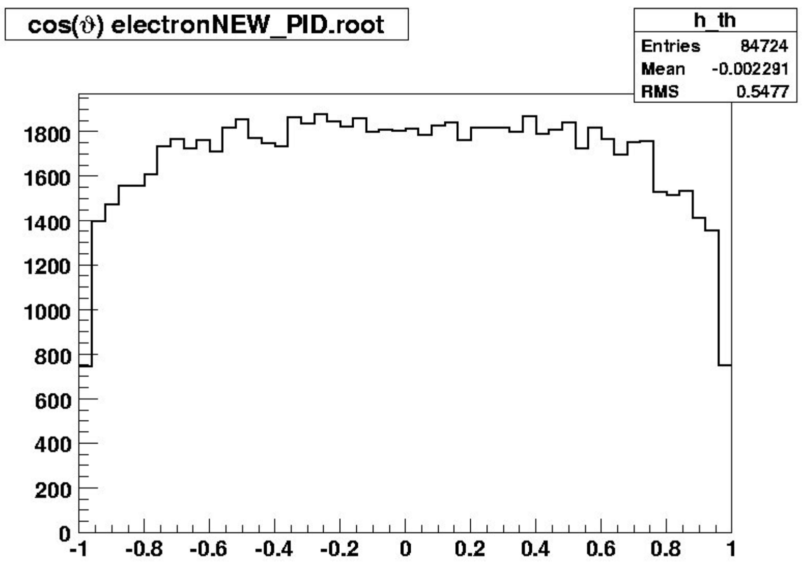
Electron momentum measurement is less performant,
Due to bremsstrahlung in the detector material

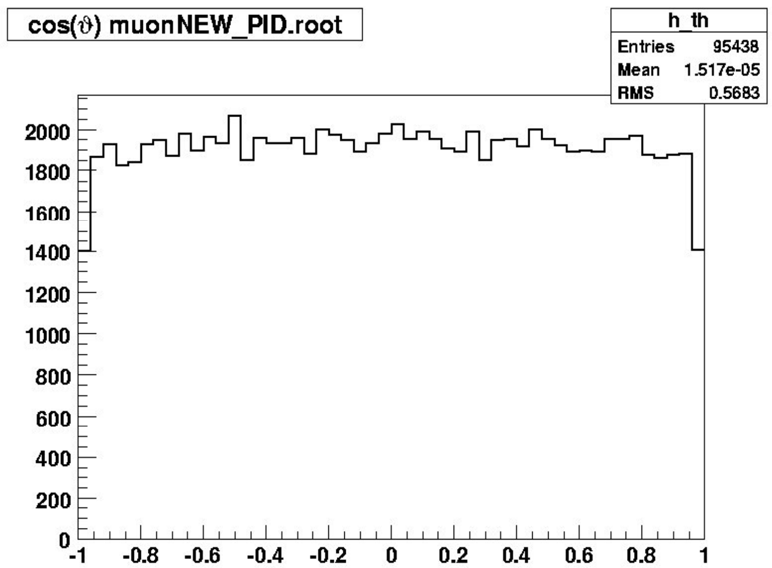
Particle ID performance

Electron, Muon, Pions, Photons, 10-250 GeV or from the Higgs-strahlung sample

Electron ID vs cos(θ) (10000 e^-)

Muon ID vs cos(θ) (100000 μ^-)

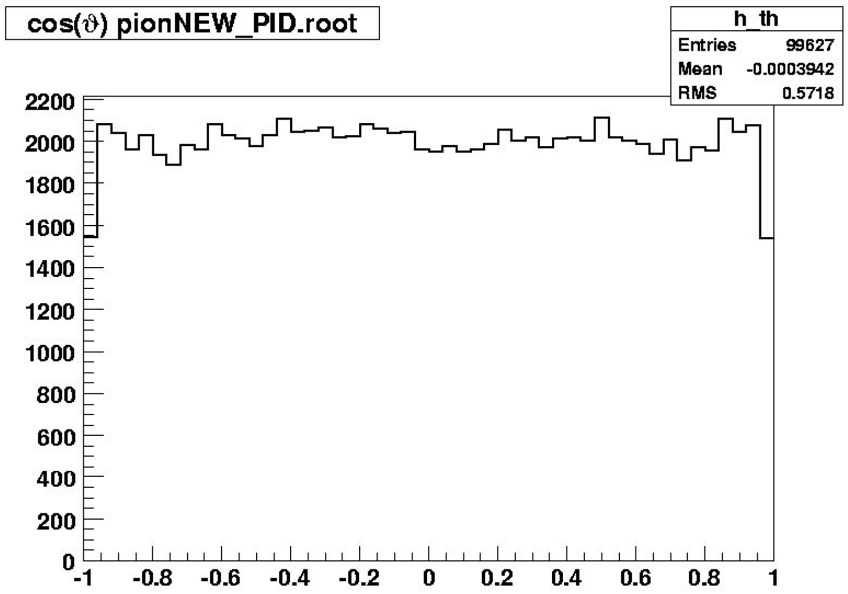




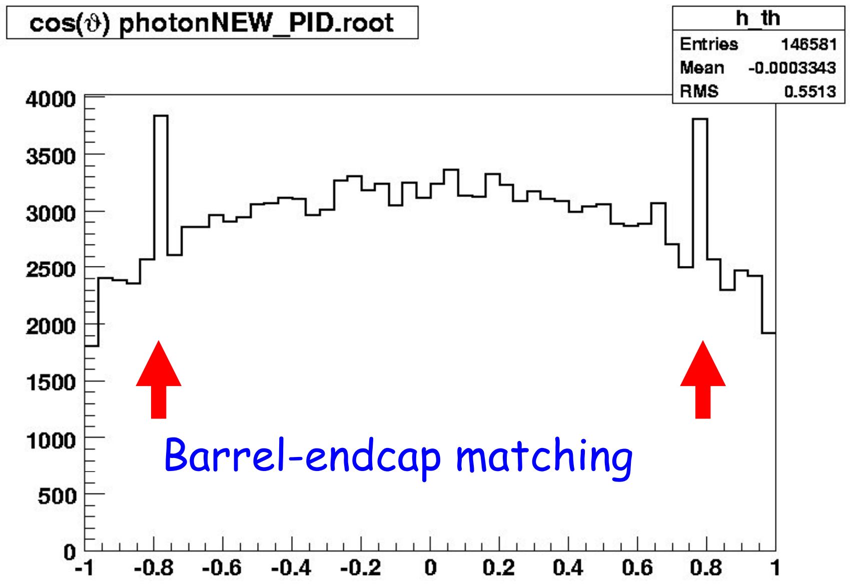
Particle ID performance

Electron, Muon, Pions, Photons, 10-250 GeV or from the Higgs-strahlung sample

pion ID vs cos(θ)



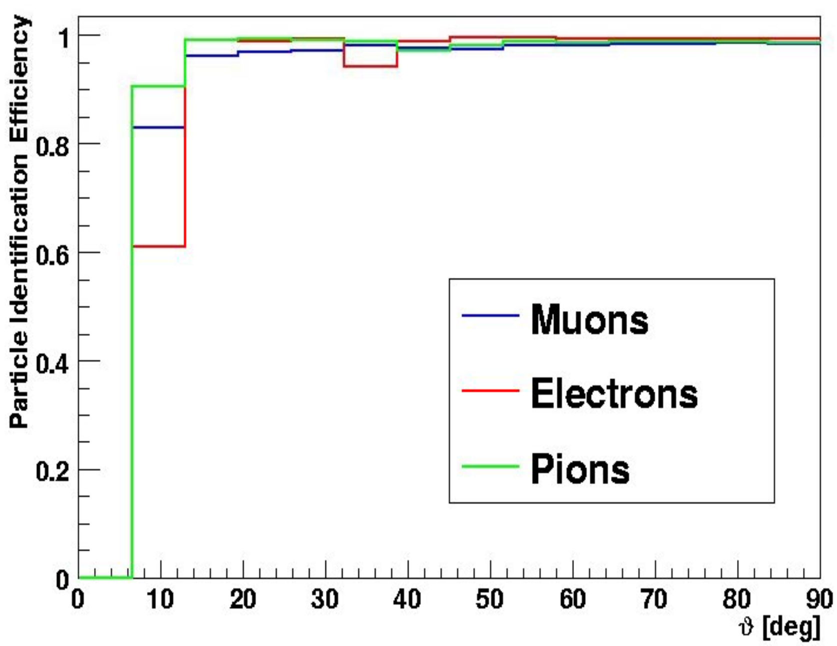
Photon ID vs cos(θ)



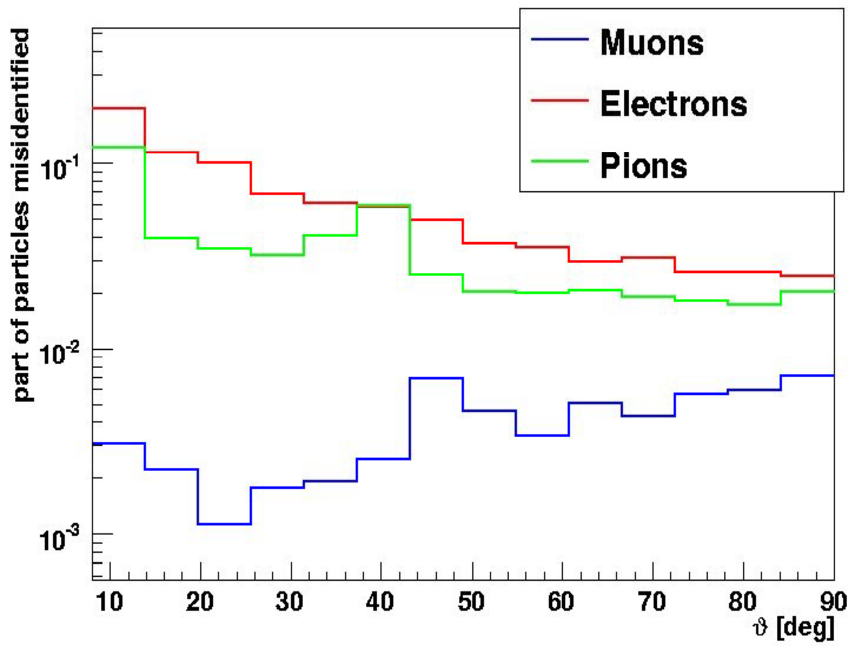
Particle ID performance

Electron, Muon, Pions, Photons, 10-250 GeV, equal amount

ID efficiency vs θ



ID purity vs θ

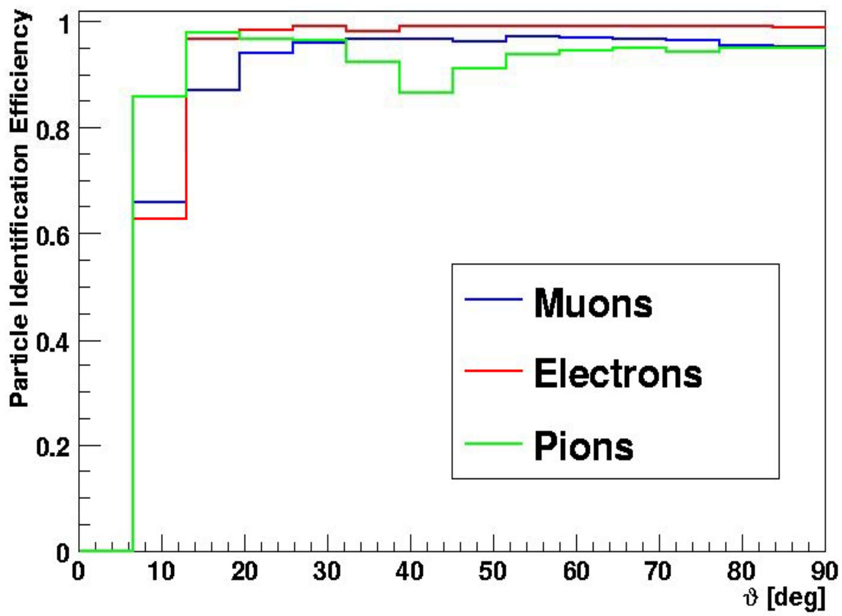


Electron sample contains photons, due to conversions

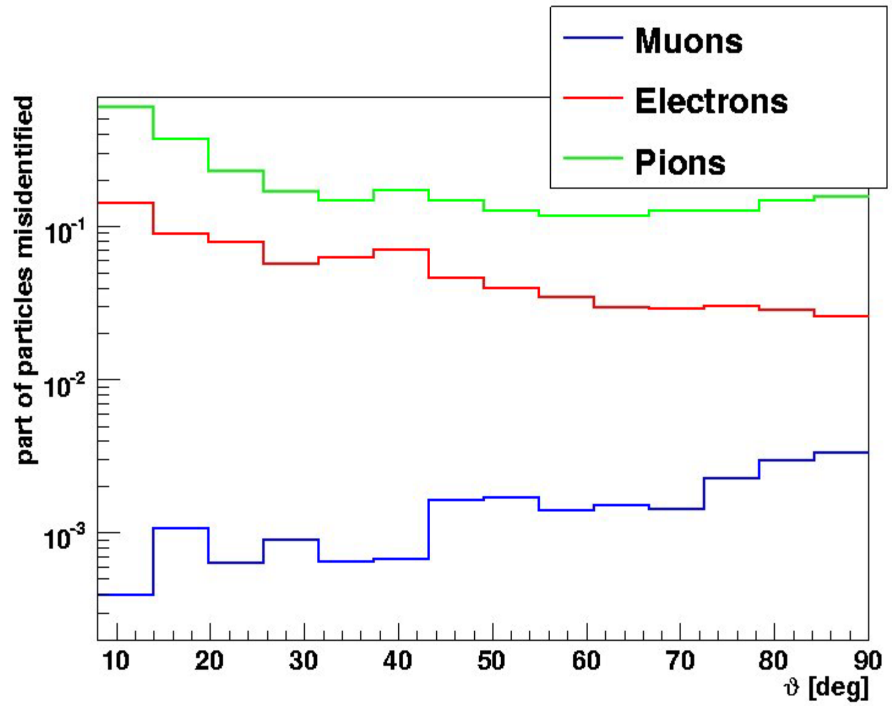
Particle ID performance

Electron, Muon, Pions, Photons, Higgs-strahlung sample

ID efficiency vs θ



ID purity vs θ



Electron sample contains photons, due to conversions,

Pion sample also contaminated by photons because of high particle density in jets

Conclusions

Performance of the electron track measurement suffers from bremsstrahlung in the material

Bremsstrahlung in the Material enhances tails in the resolution function

Electron ID efficiency suffers by bremsstrahlung

Electron purity is strongly affected by conversions

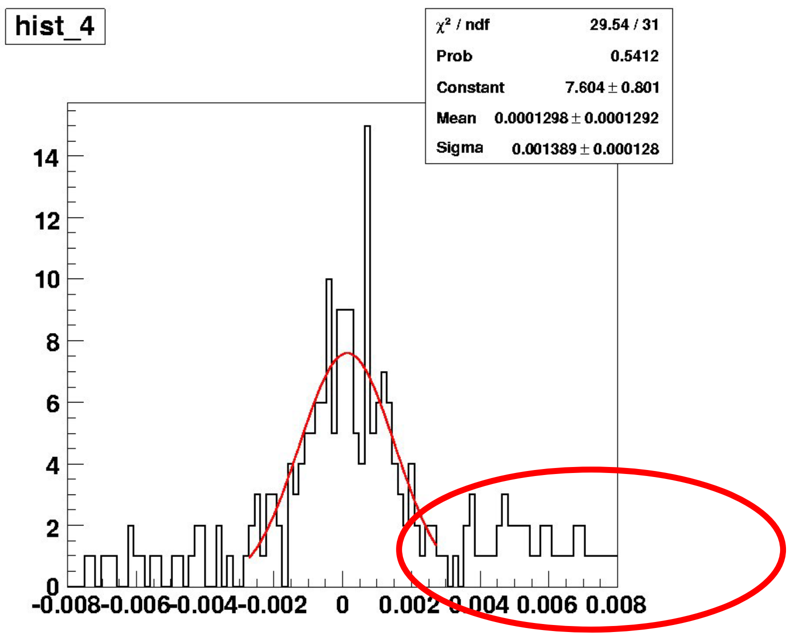
Photon ID is far from perfect in the transition region between barrel and endcaps

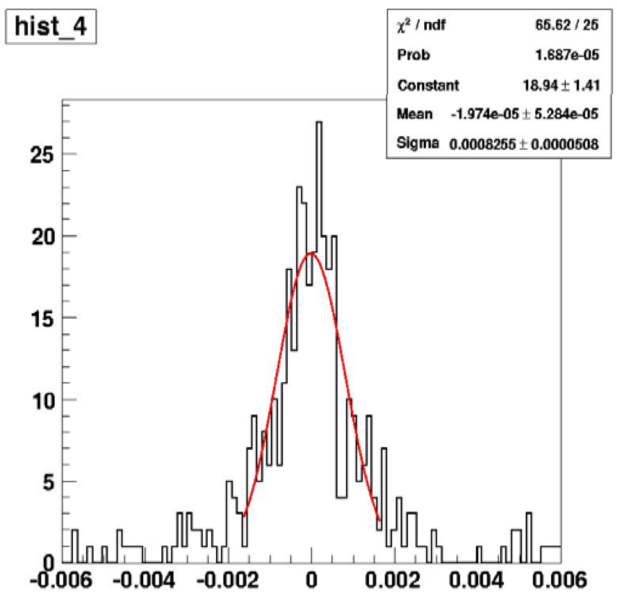
Momentum Resolution

electrons

$$\frac{p_{MC}-p_m}{p_{MC}^2}$$

muons





Relatively large positive tail -measured p_T is lower than generated !

Bremsstrahlung in the material