Lepton Identification in CEPC

CEPC Physics Workshop

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Motivation

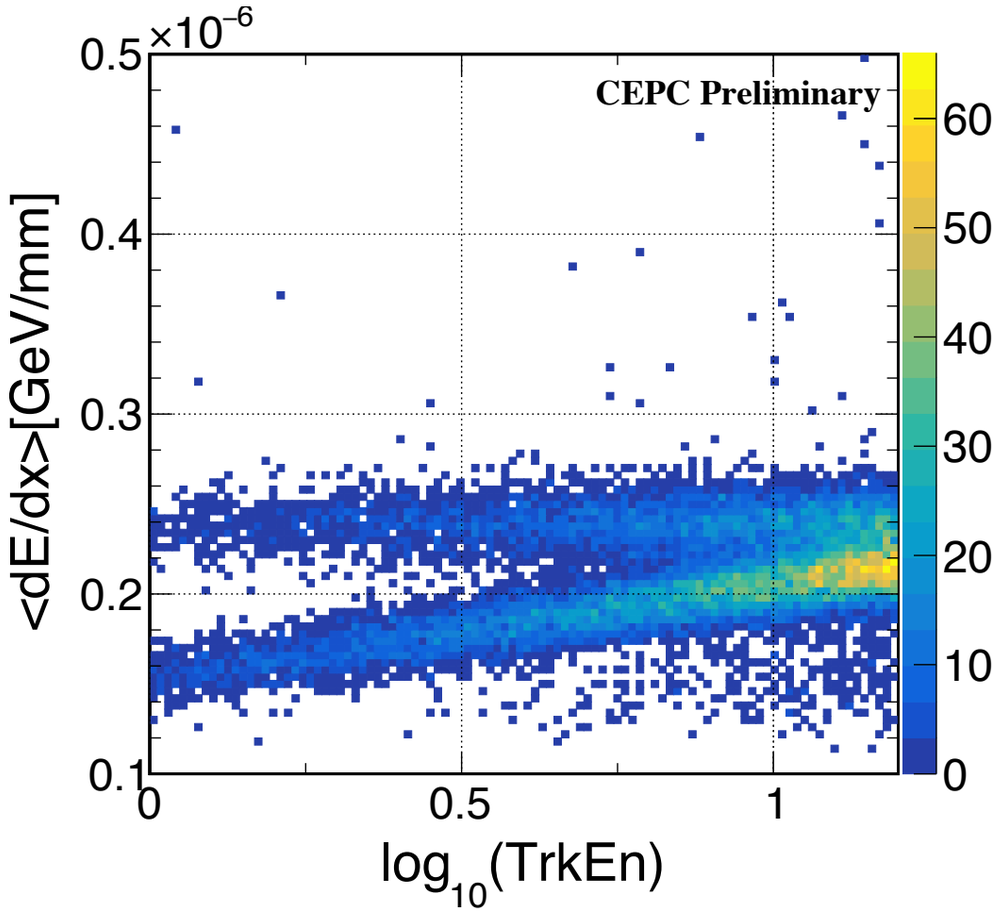
- Essential to the precise Higgs measurements
- Jet flavor tagging and the jet charge measurement
- Higgs boson generated together with leptons

LICH

- LICH (Lepton Identification for Calorimeter with High granularity)
  - Input: 24 variables from reconstructed charged particle
  - Tool: TMVA
  - Training samples: Single particle: e, μ, π (1 GeV ~ 120 GeV)
  - Output: likelihood

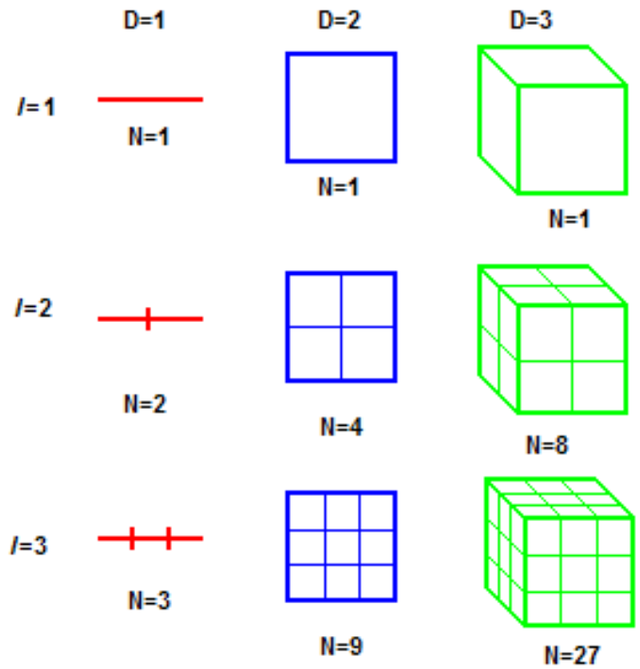
Variables:dE/dx

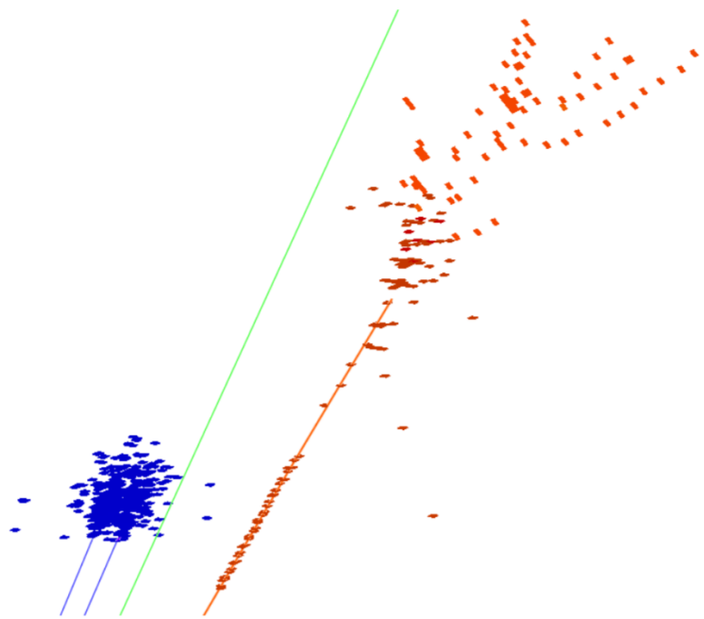
- For a track in TPC, the distribution of energy loss per unit of depth follows an approximately Landau distribution.

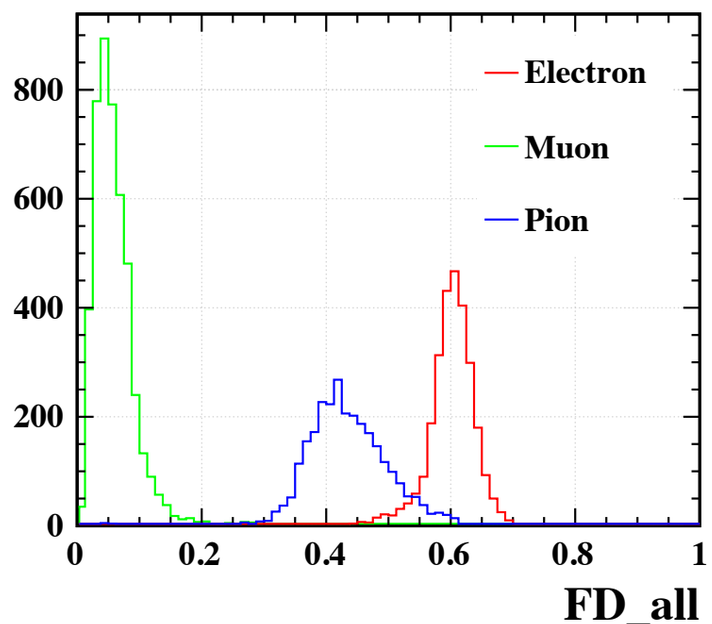


Variables: Fractal Dimension

- Describe the self-similar behavior of shower spatial configurations (compactness of the particle shower)
  - $FD_{\beta}=\langle \log(R_{\alpha,\beta})/\log\alpha \rangle+1$
    where $R_{\alpha,\beta} = N_{\beta}/N_{\alpha}$, α and ß are scales at which the shower is analysed.
- Average over range: 1cm - 120cm

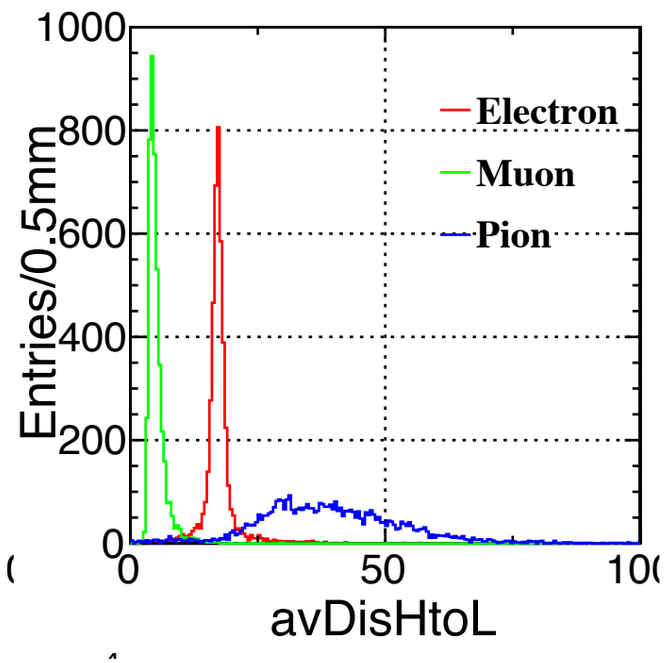


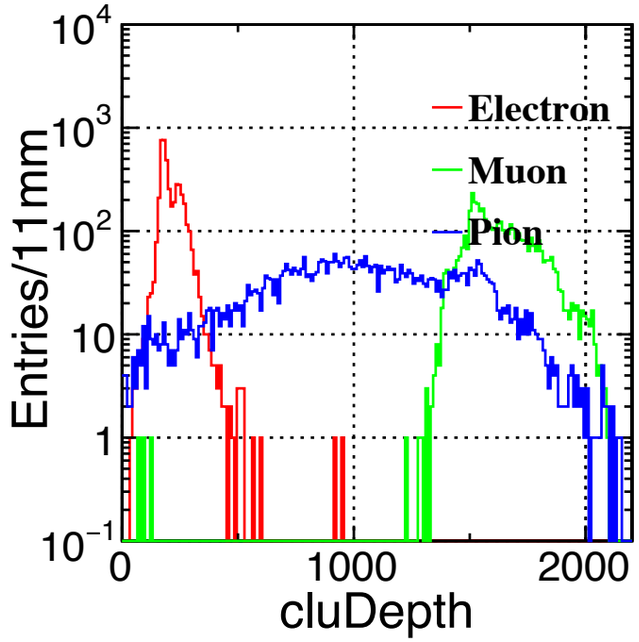


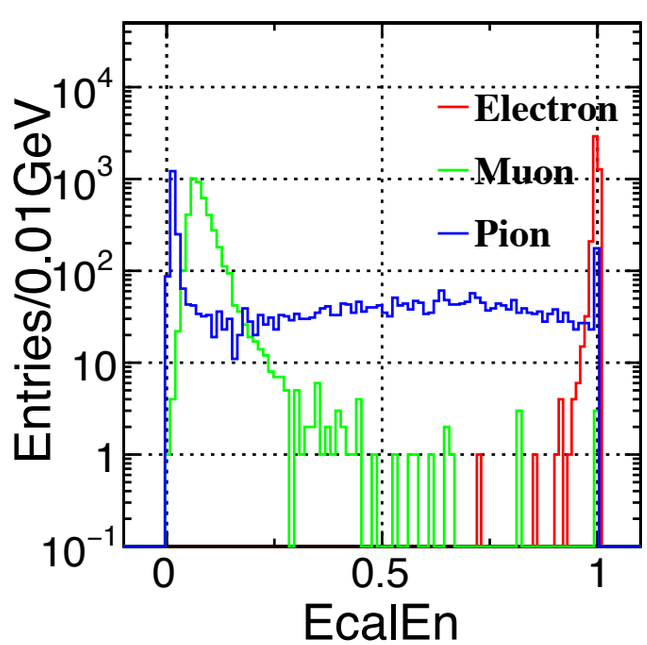


Variables: others

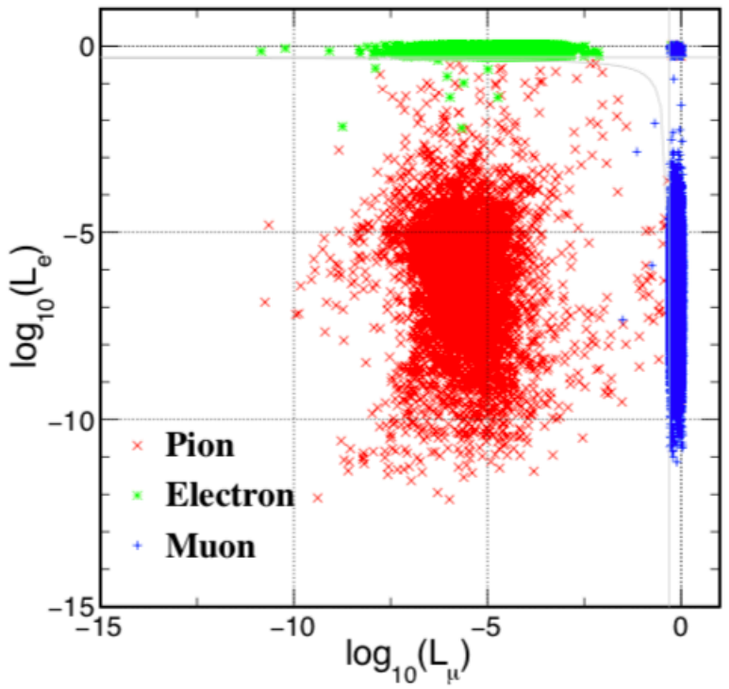
- Proportion of energy: Energy deposit in the first 10 layers in ECAL to the entire ECAL, or the energy deposit in a cylinder around the incident direction with a radius of 1 and 1.5 Moliere radius.
- Distance(max, min, avr) between hit and track / axis
- Number of hits / number of layers hit by the shower
- Depth
- ...

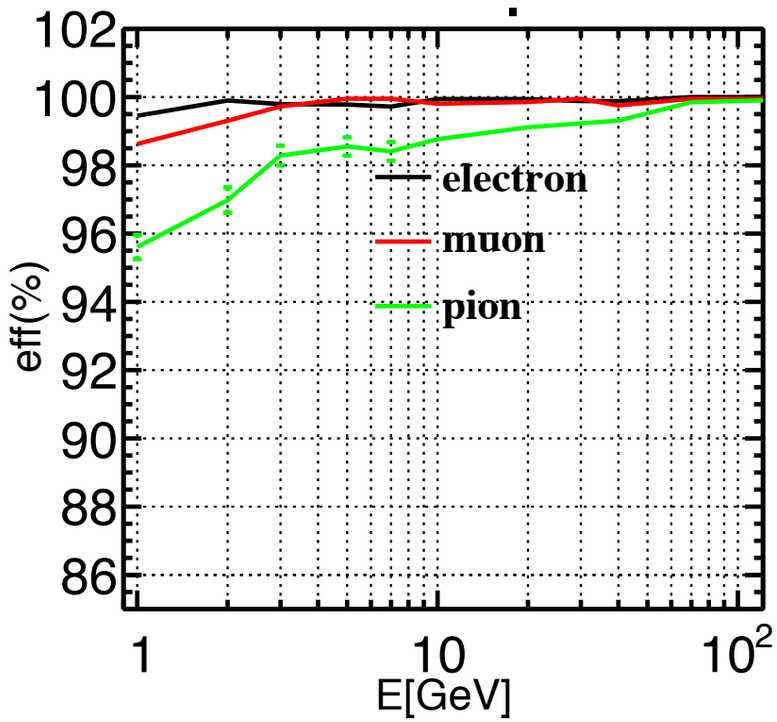


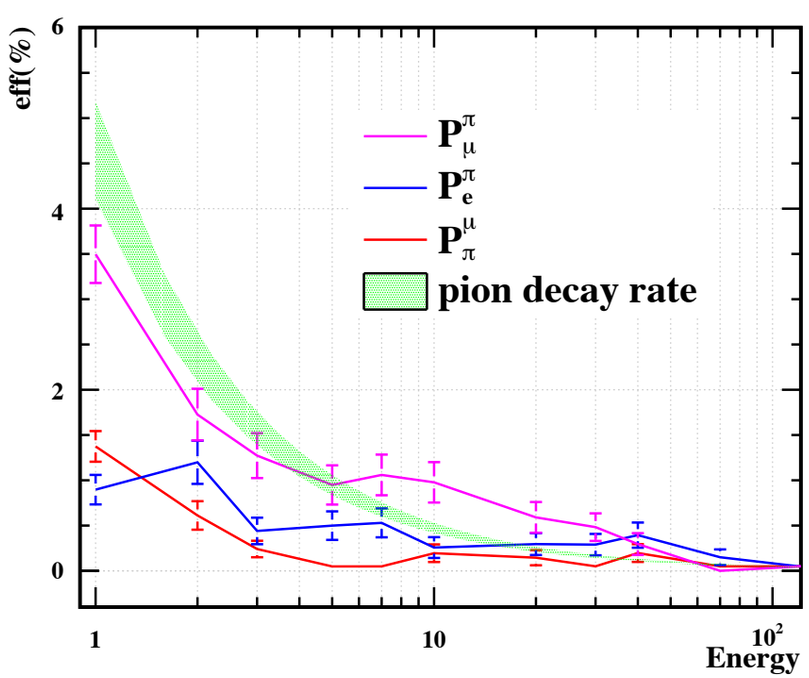




TMVA







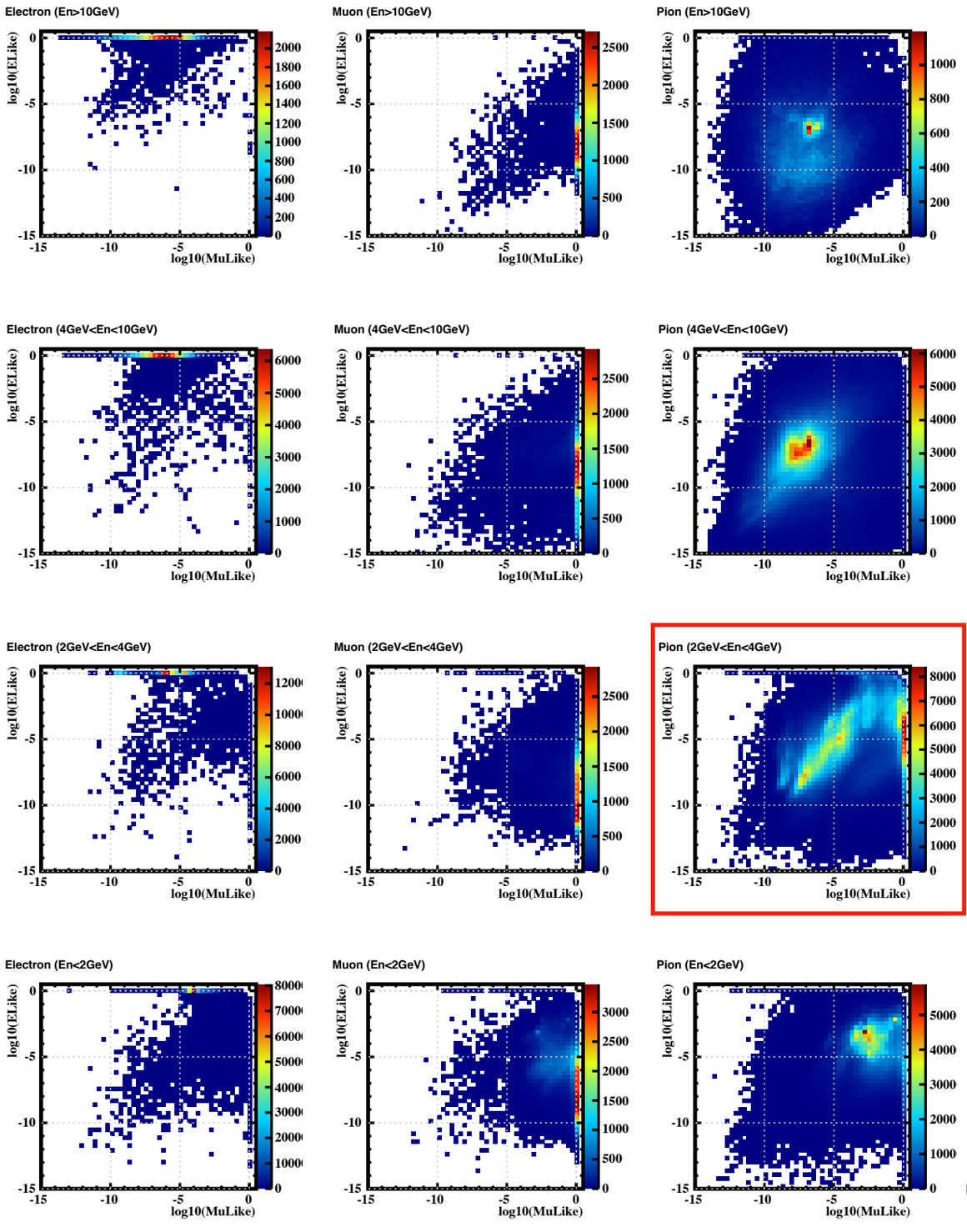
Migration Matrix at 40GeV (LICH)

Type	e^- *like*	μ^- *like*	π^+ *like*
e^-	99.71 ± 0.08	< 0.07	0.21 ± 0.07
μ^-	< 0.07	99.87 ± 0.08	0.05 ± 0.05
π^+	0.14 ± 0.05	0.35 ± 0.08	99.26 ± 0.12

Migration Matrix for ALEPH PID ($> 2GeV$)(*Eur.Phys.J.C20:401-430,2001*)

Type	e^- *like*	μ^- *like*	π^+ *like*	undefined
e^-	99.57 ± 0.07	< 0.01	0.32 ± 0.0	0.09 ± 0.04
μ^-	< 0.01	99.11 ± 0.08	0.88 ± 0.08	0.01 ± 0.01
π^+	0.71 ± 0.04	0.72 ± 0.04	98.45 ± 0.06	0.12 ± 0.03

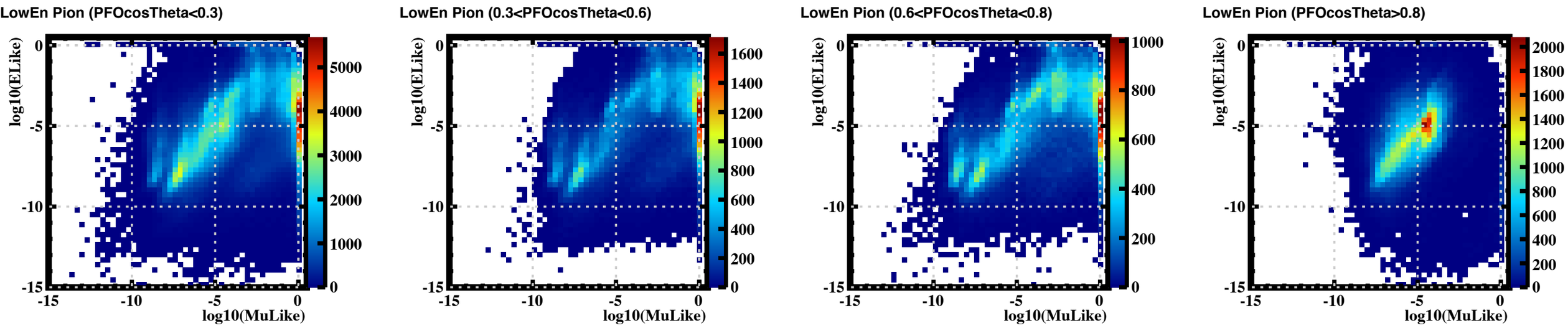
Physics Events



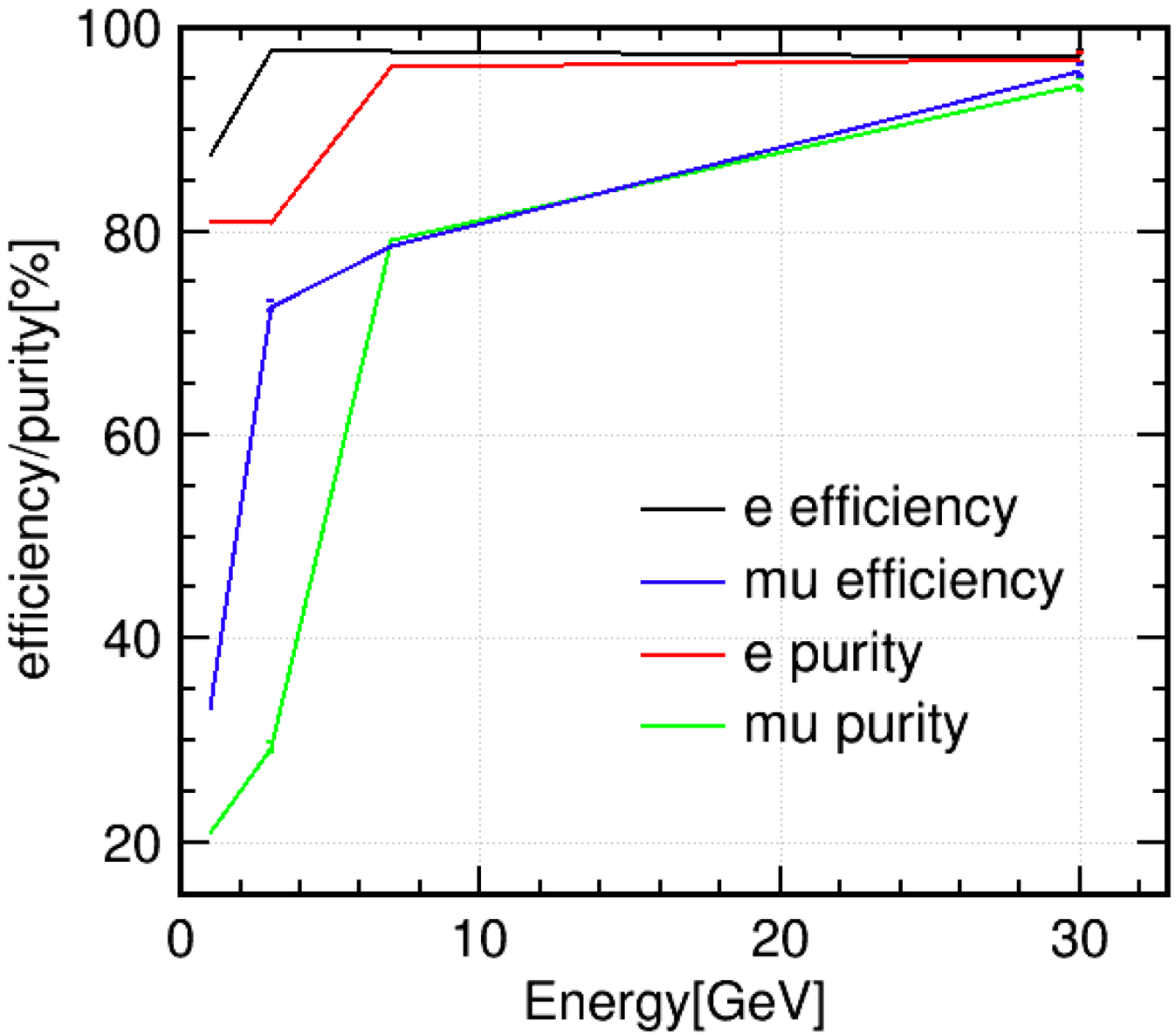
- Sample: Zpole->bb
- High Energy:
  - easy to separate
- Low Energy:
  - muons mixed with pions
  - large statistics of pions
  - What is wrong with pion (2GeV - 4GeV)?

Likelihood distribution

- The endcap is normal
- Training files smaller for low energy charged particles shooting to the barrels
- Low energy pions more likely to be looks like a muon

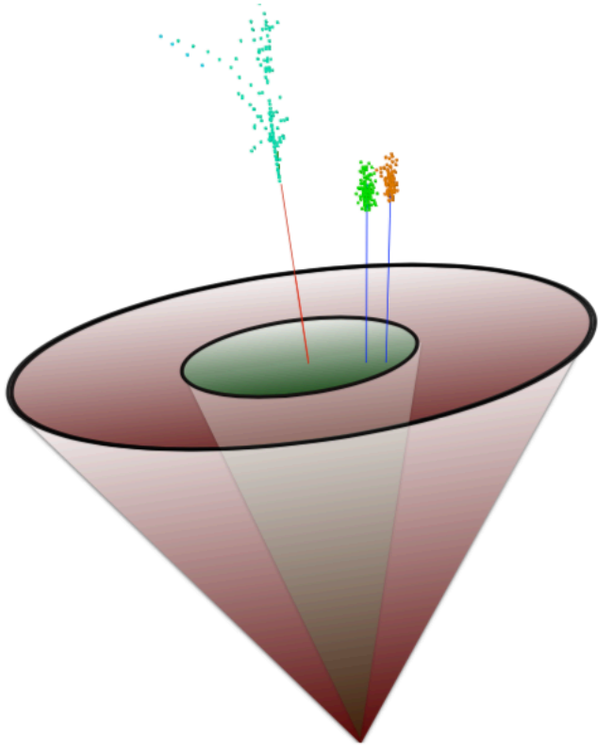


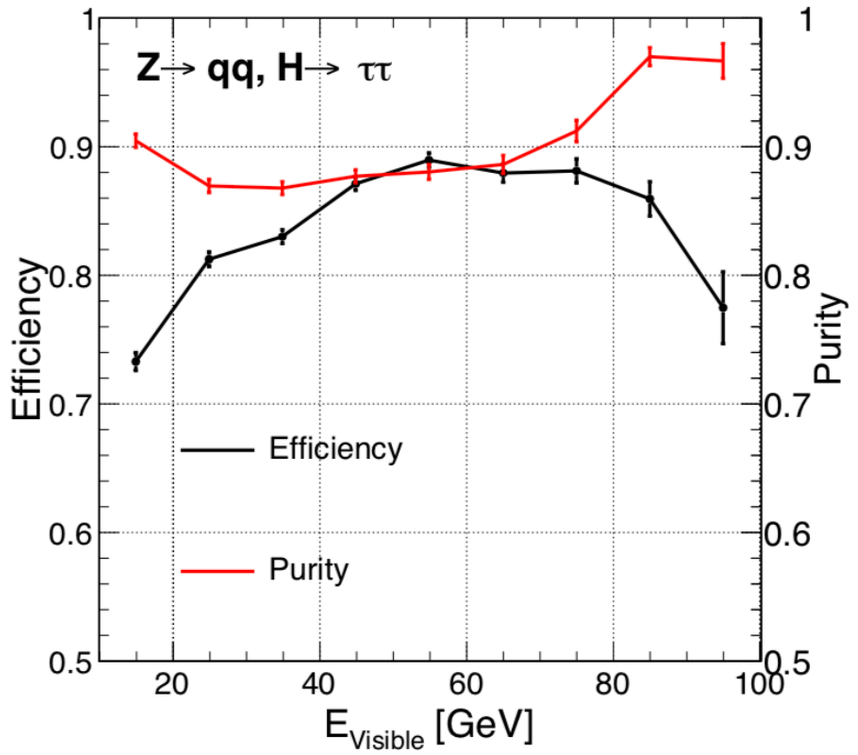
Zpole->bb


100
80
60
40
20
efficiency/purity[%]
0
10
20
30
Energy[GeV]
e efficiency
mu efficiency
e purity
mu purity

Tau identification

- TAURUS: A dedicate τ reconstruction package
- Leading τ pair as the Higgs products





Summary

- Comparable to ALEPH, mis-identification rates significantly improved

- Currently the best performance

- Integrated to ILCSOFT & applied for preparation of CEPC CDR

Thank you!