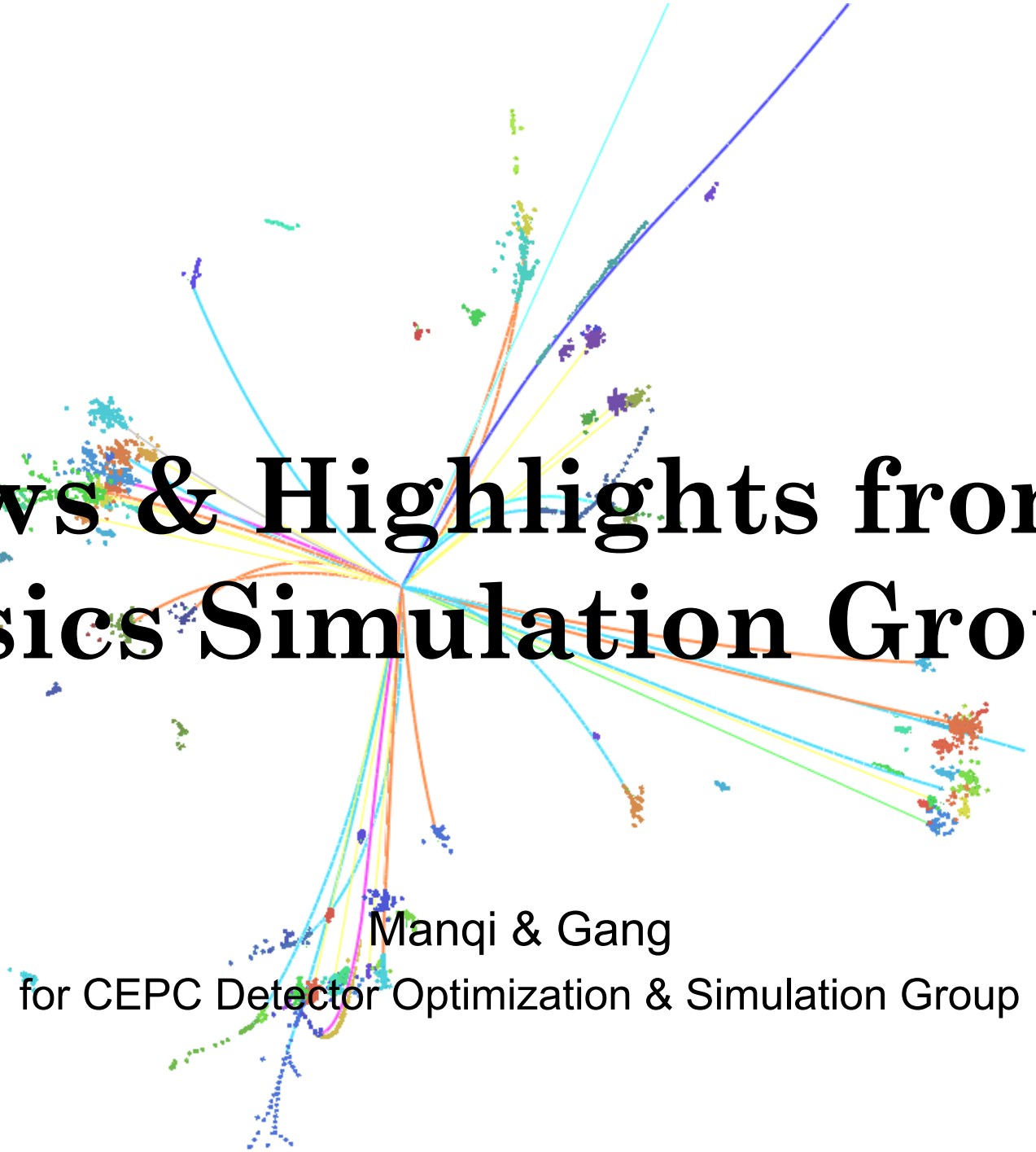


News & Highlights from Physics Simulation Group

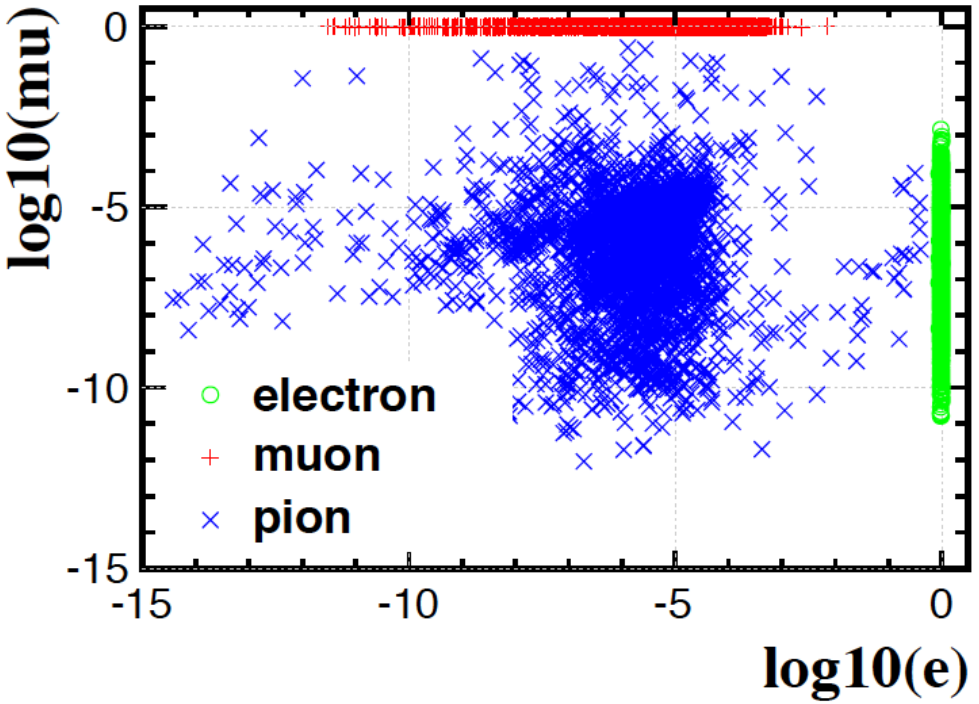
Manqi & Gang
for CEPC Detector Optimization & Simulation Group

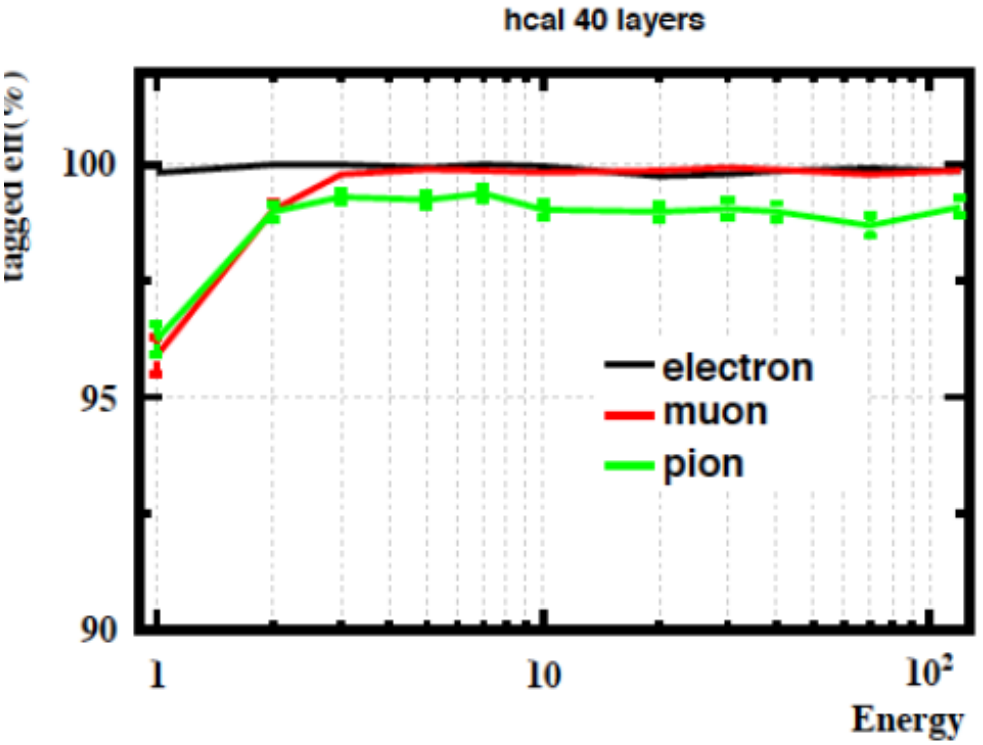
News

- Alignment study initialized
- Physics analysis
  - Br(H->bb, cc, gg) to be finalized
  - Br(H->exotic) keep on going
- PFA & Clustering: many things stay to be tuned.

- Recent HighLights:
  - Lepton ID
  - Calo optimization
  - Silicon Tracking

Dan Yu: general **L**epton **I**D for **C**alorimeter with **H**igh granularity (LICH)





BDT method using 4 classes of 24 input discrimination variables.

Test performance by requesting

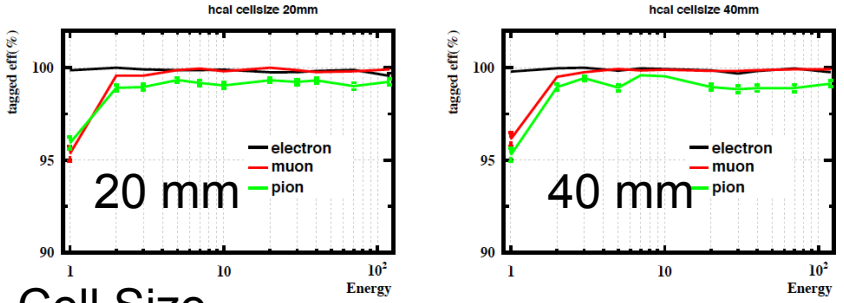
Electron = E_likeness > 0.5

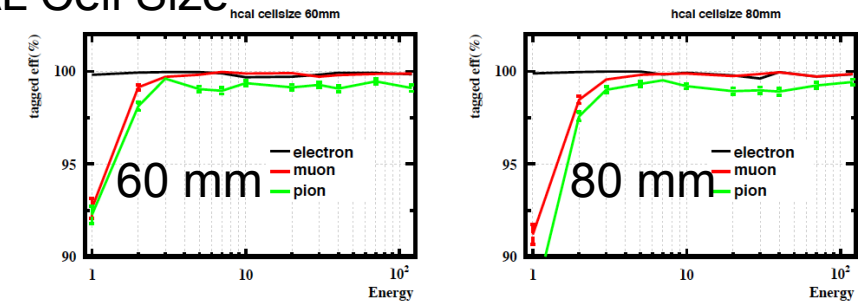
Muon = Mu_likeness > 0.5 (If both satisfied, identify as these with larger likelihood)

Single charged reconstructed particle, for E > 2 GeV: lepton efficiency > 99.5% && Pion mis id rate < 2%

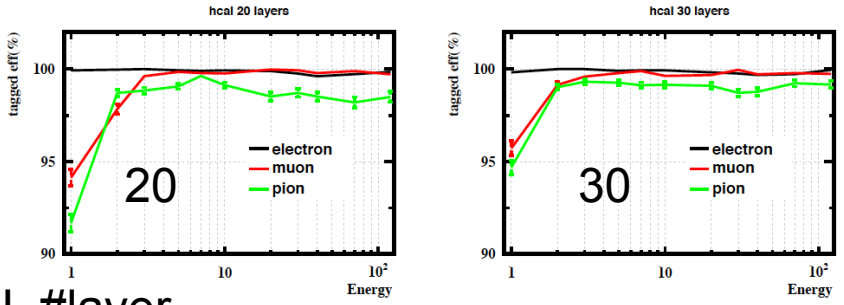
Vary the granularity

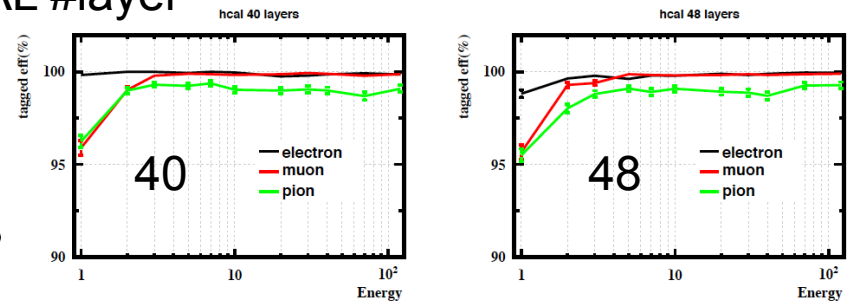
HCAL Cell Size



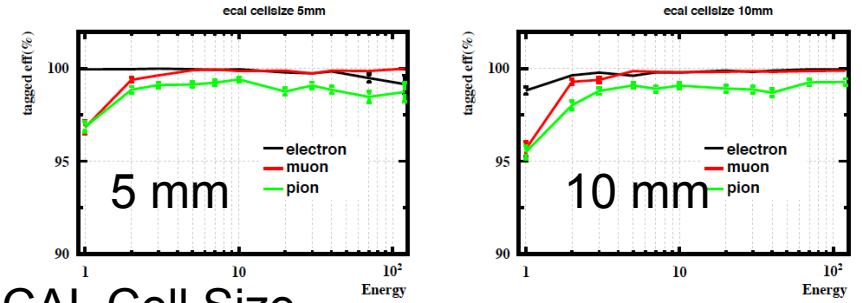


HCAL #layer

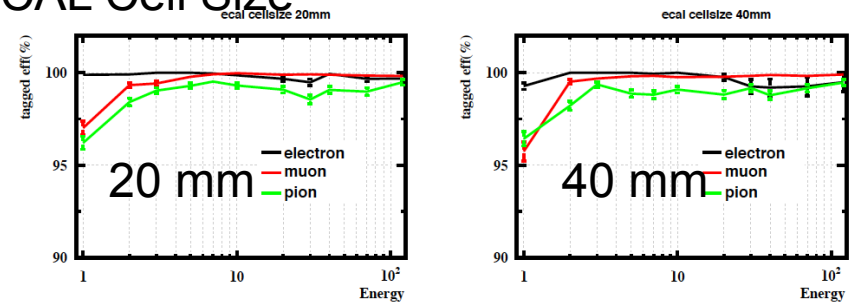


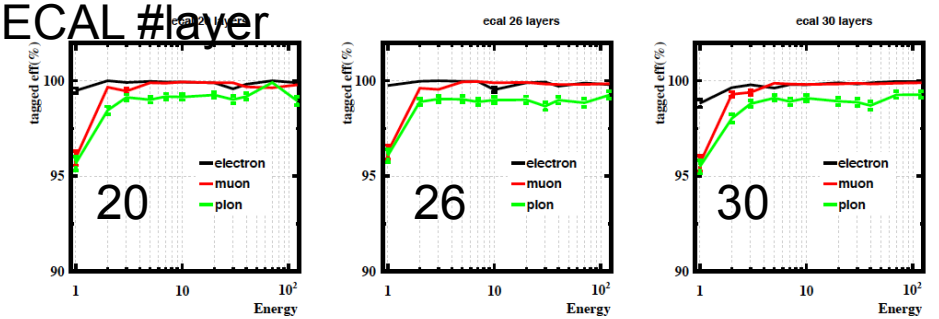


ECAL Cell Size



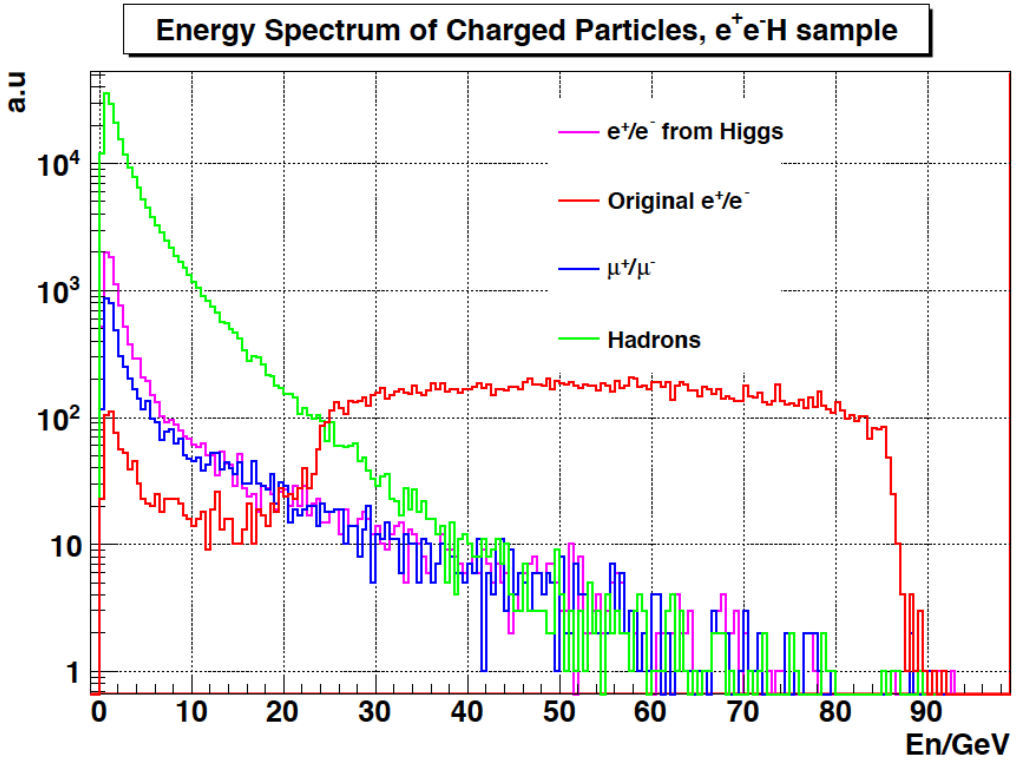
ECAL #layer

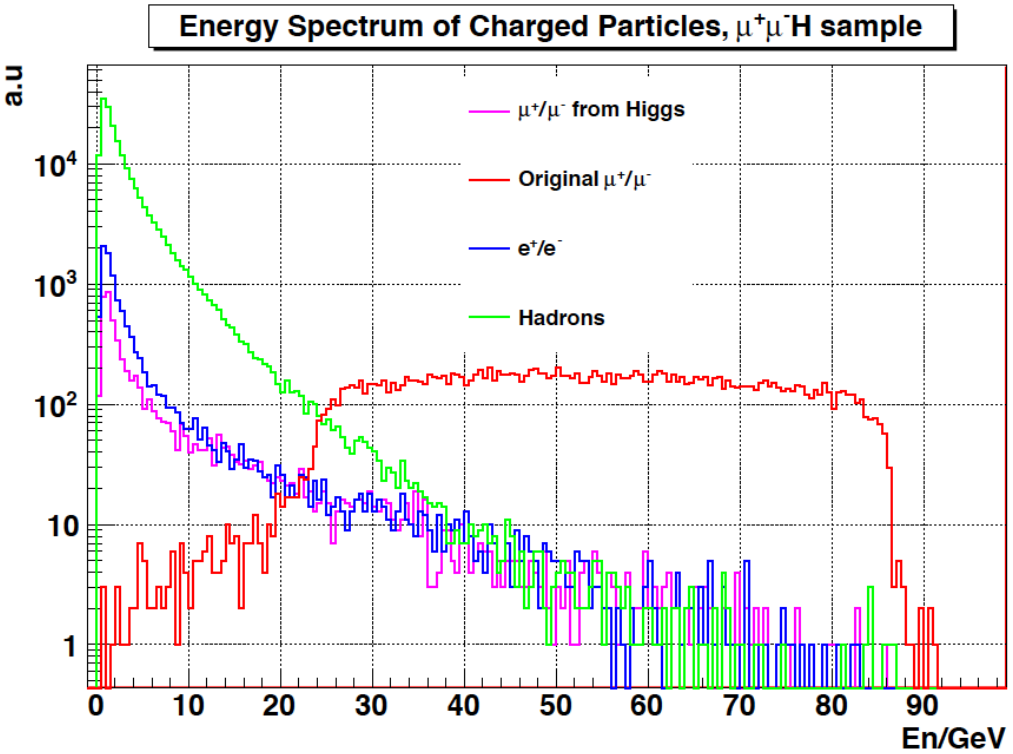


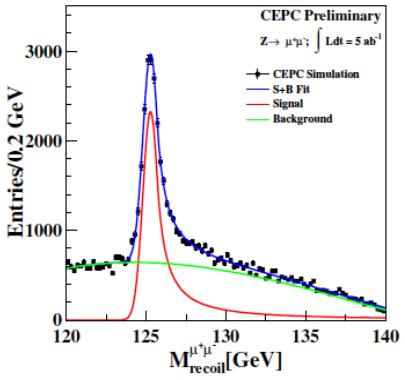


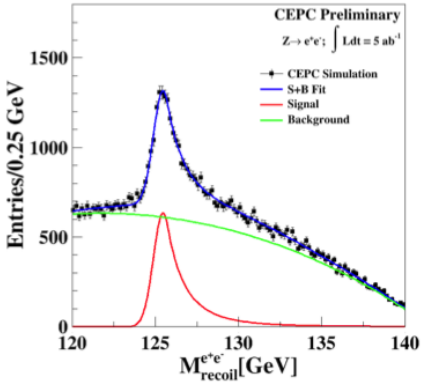
- Scanned Settings:
  - ECAL Cell Size: 5 - 40 mm
  - HCAL Cell Size: 10 - 80 mm
  - ECAL N Layer: 30 - 20
  - HCAL N Layer: 48 – 20
- No Significant effect for E > 2 GeV

@ llH events



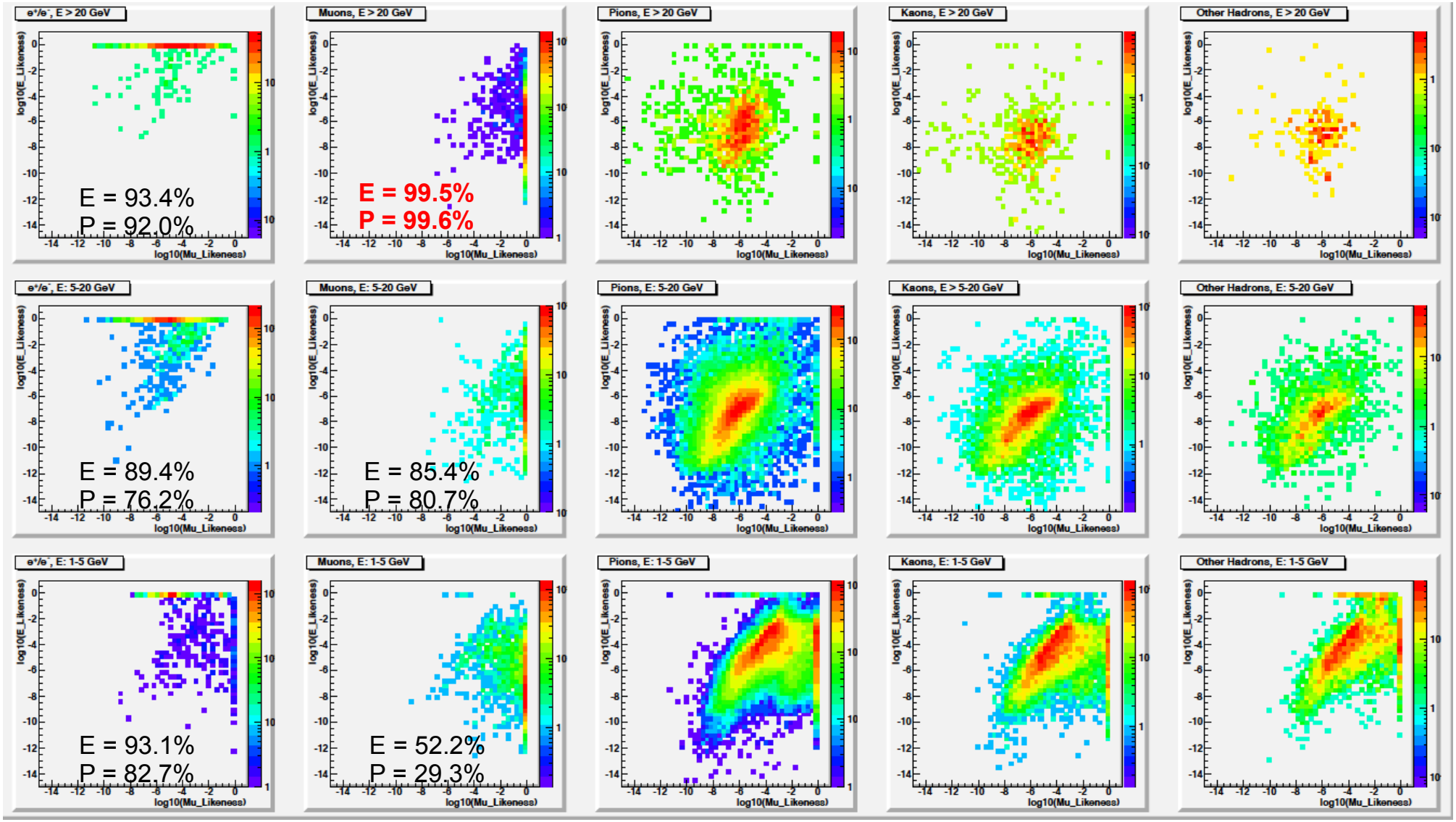






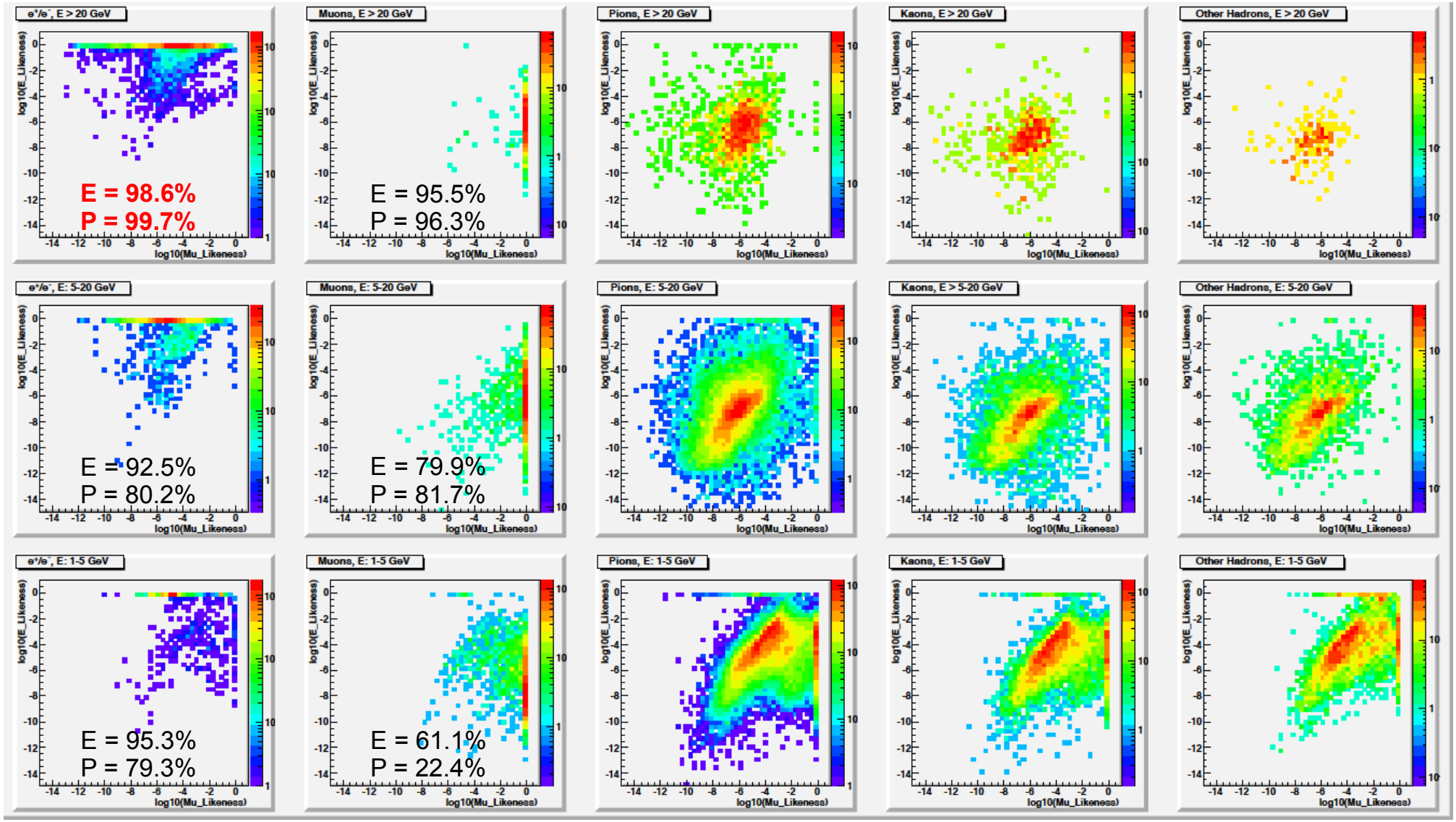
- Key objective: Identify the initial leptons
- Secondary: leptons generated in Higgs decay
  - H->WW/ZZ/tautau/mumu...
  - H->bb, cc;
  - Hadrons decays

Likelihoods @ mumuH

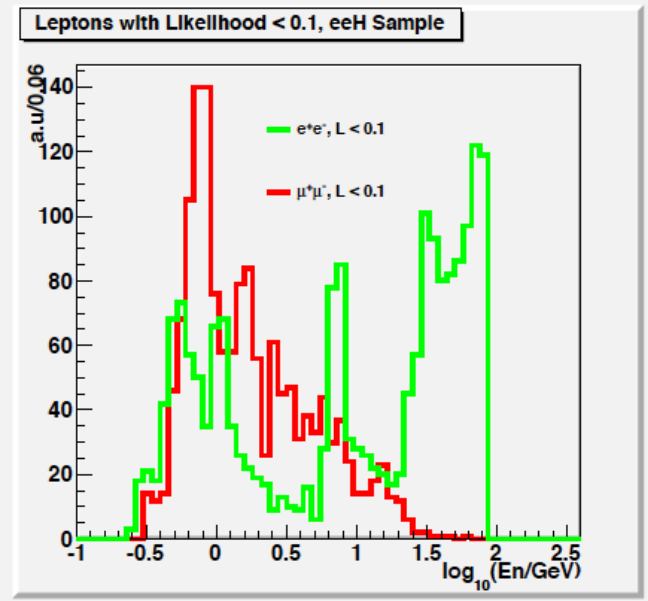


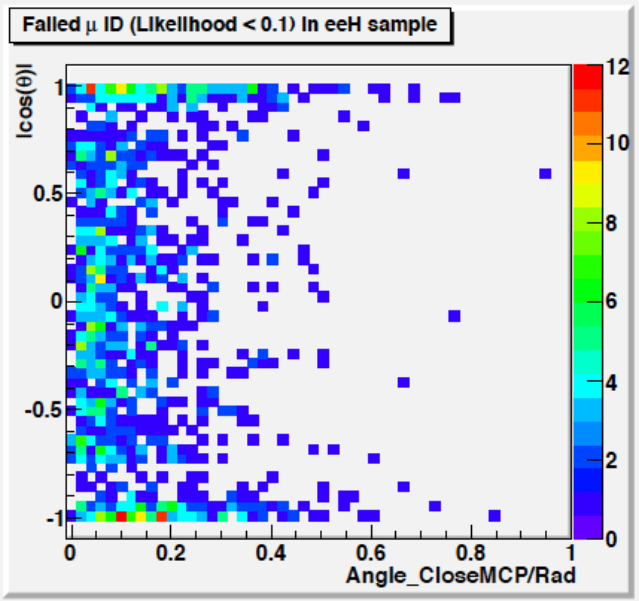
(E, mu, pion, kaon & other)*(E>20, 20>E>5, 5>E>1)

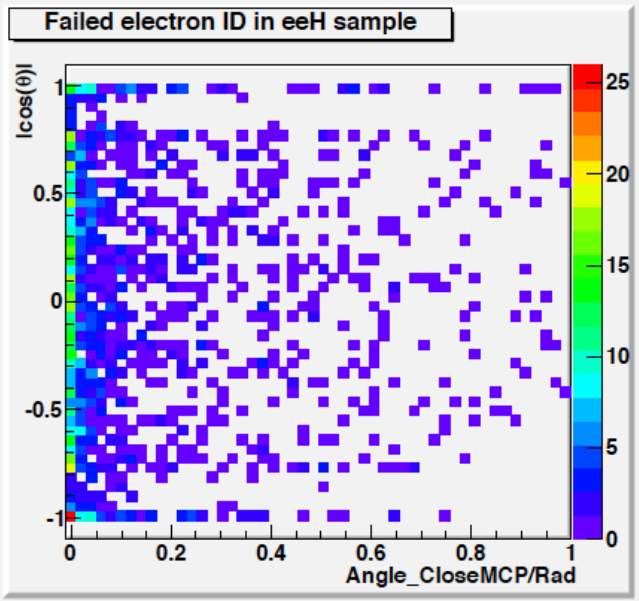
Likelihoods @ eeH

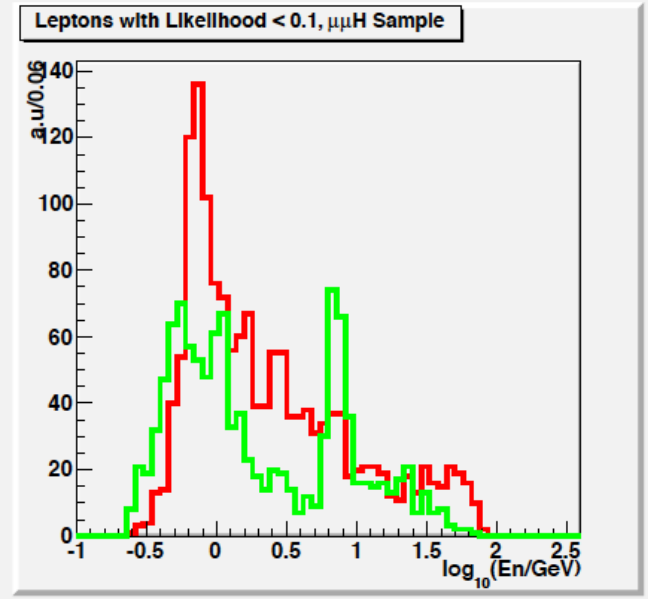


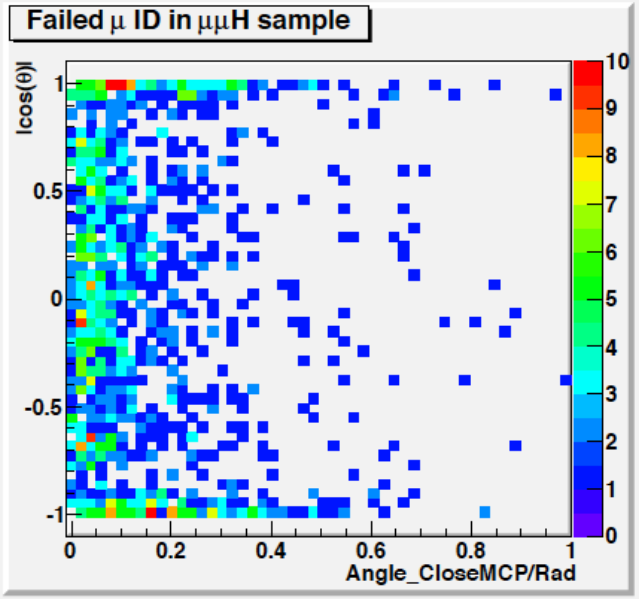
Failures: leptons with likelihood < 0.1

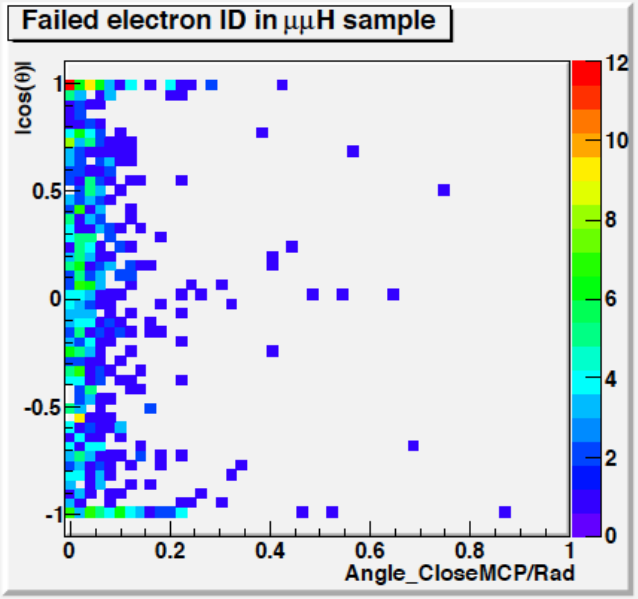








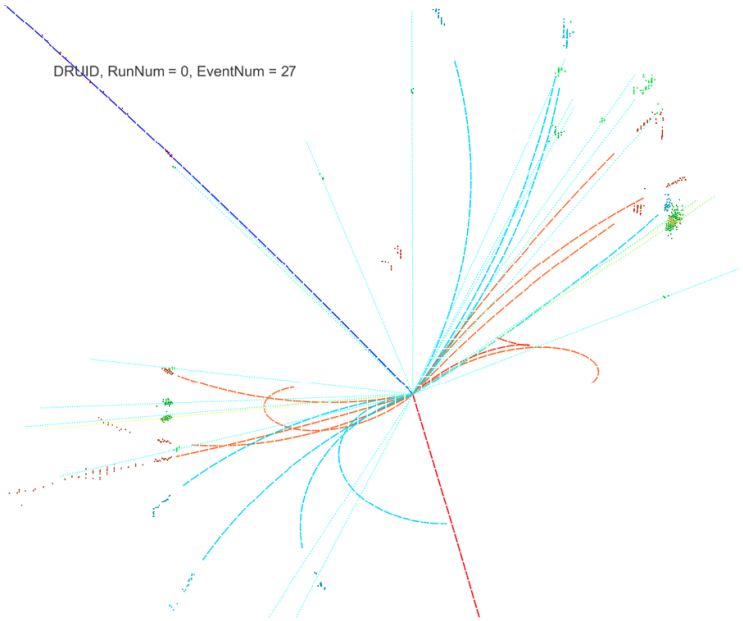




To be improved

Global efficiencies... preliminary

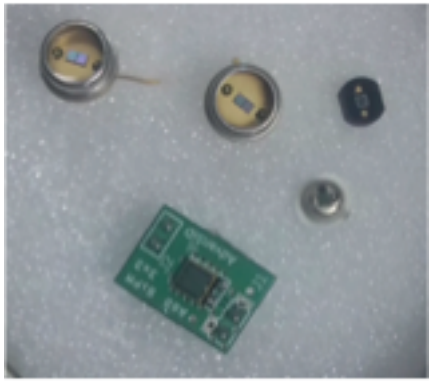
	Geom 1		Geom 2	
	$\mu\mu$H	eeH	$\mu\mu$H	eeH
Cut_μ	0.1	0.1	0.1	0.1
Cut_e	0.01	0.001	0.01	0.001
ε_E	93.41 ± 0.92	98.64 ± 0.08	91.60 ± 1.02	97.89 ± 0.11
η_E	92.02 ± 1.00	99.74 ± 0.04	89.89 ± 1.10	99.67 ± 0.04
ε_μ	99.54 ± 0.05	95.53 ± 0.76	99.19 ± 0.06	86.48 ± 1.26
η_μ	99.60 ± 0.04	96.31 ± 0.70	99.83 ± 0.03	95.38 ± 0.81
ε_{event}	98.92 ± 0.11	93.93 ± 0.24	97.92 ± 0.14	96.19 ± 0.19

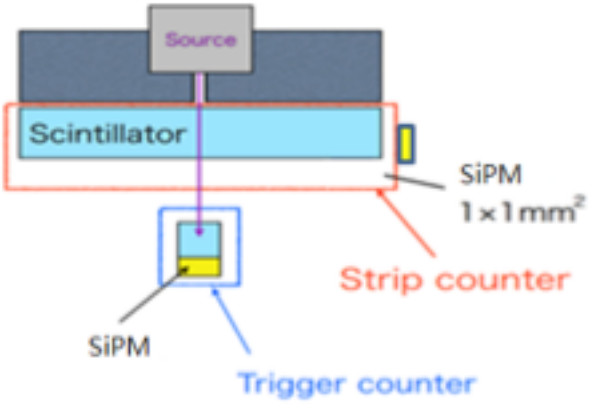


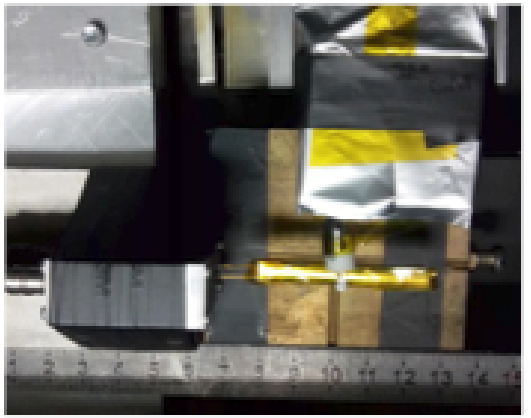
Result @ Sep. meeting

		CEPC_v1, ILD	Test Geo 1	TG 2	TG 3
ECAL	Cell Size/mm	5	10	20	20
	# Layers	30	30	30	20
HCAL	Cell Size/mm	10	10	20	20
	# Layers	48	48	48	20
Ratio of Channels (X/ILD)	ECAL	1	1/4	1/16	1/24
	HCAL	1	1	1/4	1/10
Event Recon. Efficiency	$\mu\mu$H	95.7%*	98.0%	96.5%	95.2%
	eeH	91.1%*	89.6%	89.1%	74.5%(???)

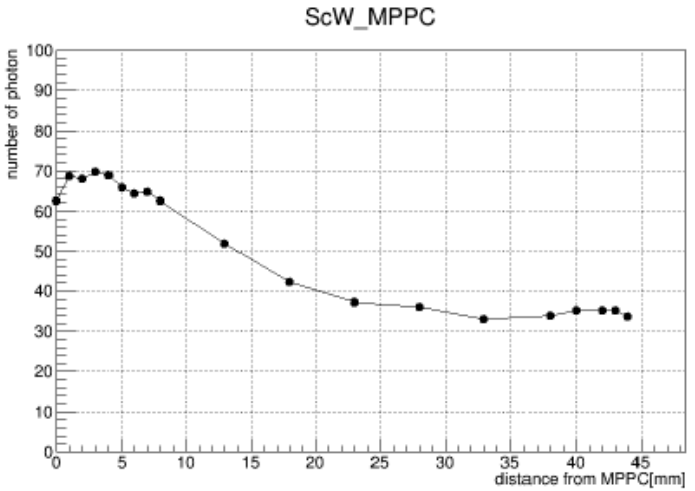
Testing on the Scintillator strip







- Test on the Scintillator strip response
  - Homogeneity
  - Light out put at different coating
  - Temperature
  - Dark current
  - Linearity...

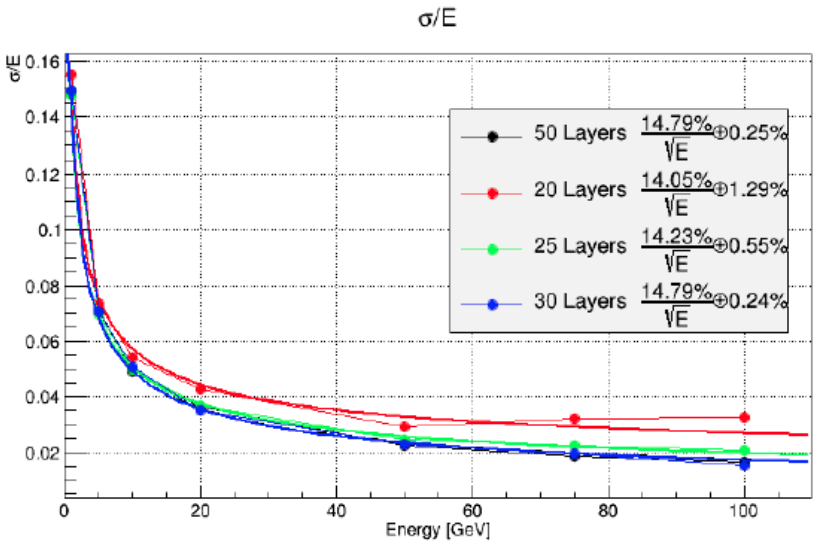


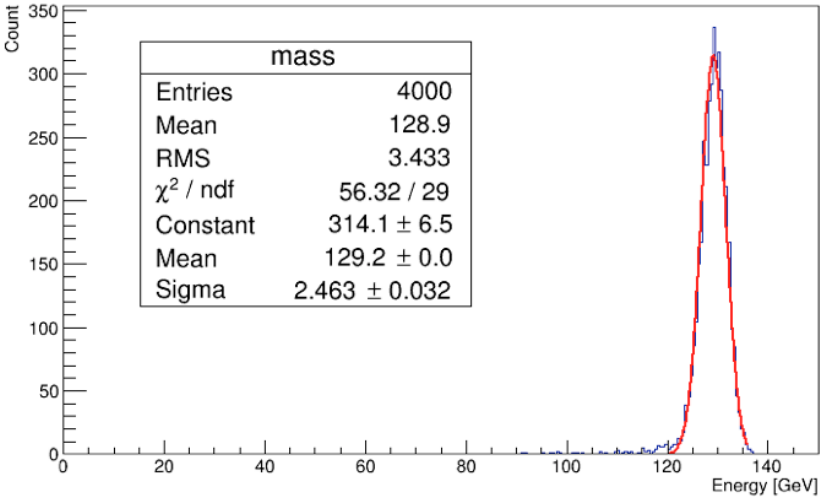
Testing on H→γγ invariant mass

- From Single Photon Energy Resolution: 2mm Thick Scintillator strips, 25 layer ECAL is recommended

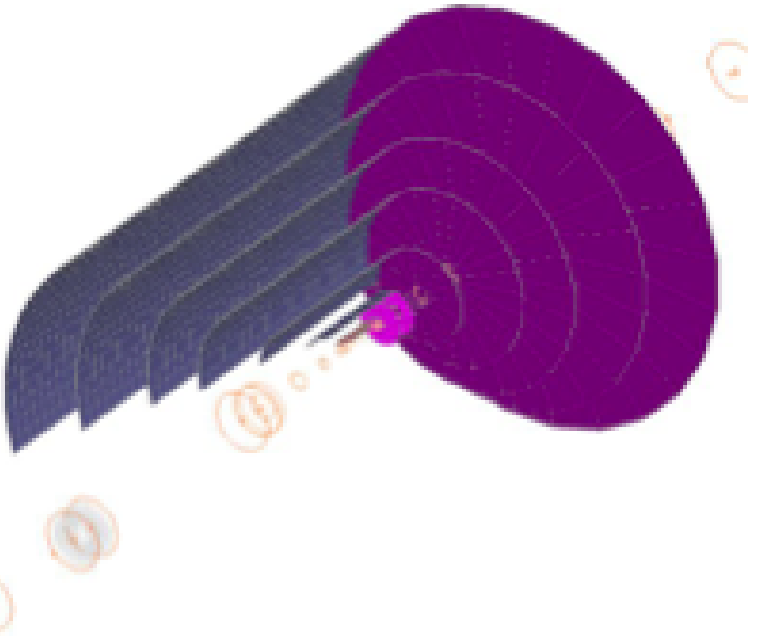
- Ideal cylinder geometry, no Tracker:
  - σ/M = 2% for Higgs->di photon

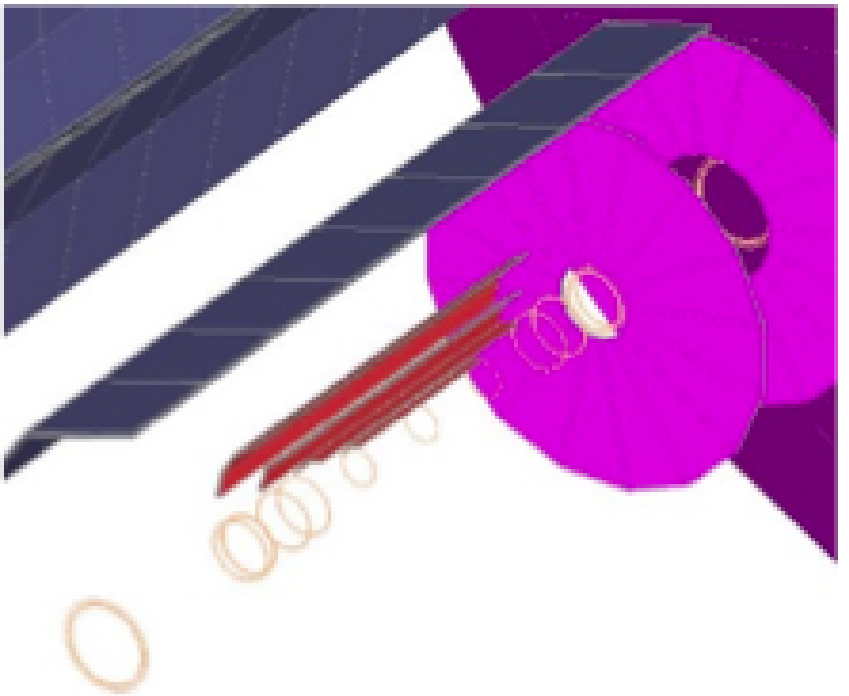
- Performance degrading
  - By the global dead zones between module/staves: 20% (σ/M ~ 2.5% @ CEPC_v1, with corrections)
  - By the photo yield in-homogenity: 12%
  - Local dead zone (1mm dead region along the strip for every 45 mm): 8%





Geometry & Digitization





- Digitization
  - Original ones: Hit position smeared by resolution
  - Implemented: Center of pixel with hits merging

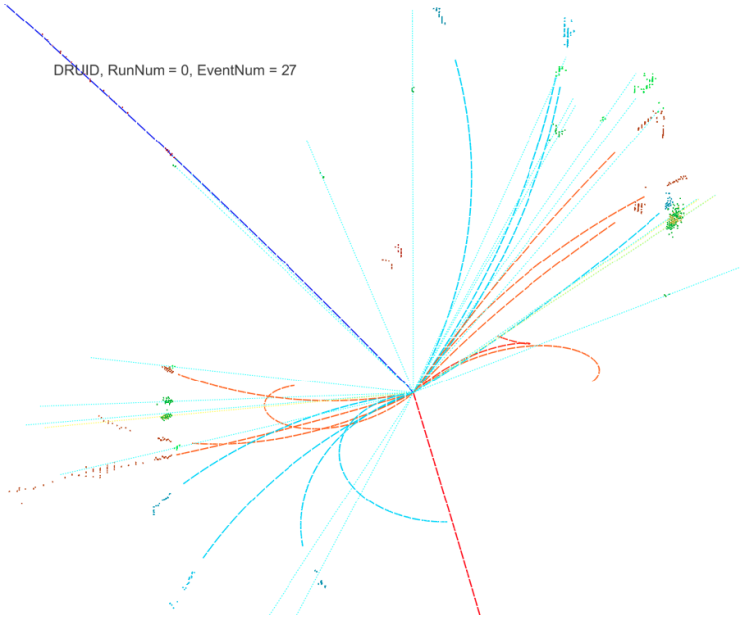
Advertise

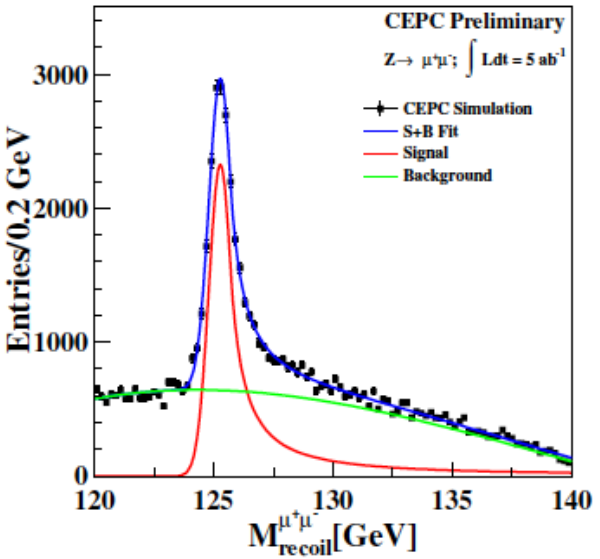
- The 3rd CEPC Physics/Software meeting to be held at Nov 28th - 30th , please register:

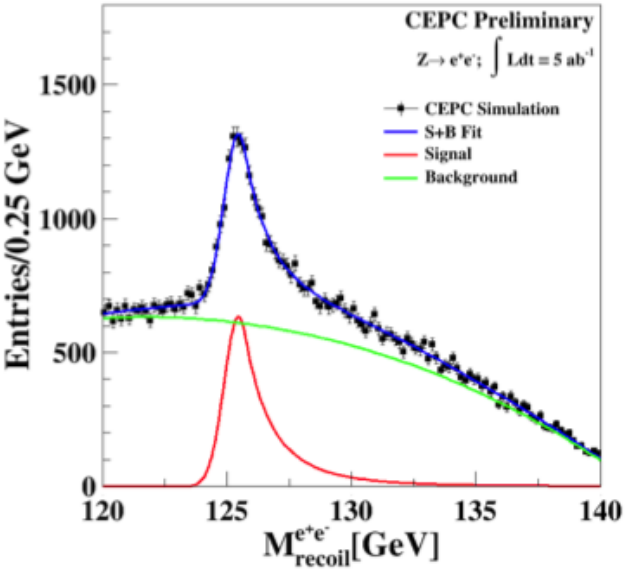
  http://indico.ihep.ac.cn/event/6495

Backup

Lepton: Higgs recoil via ZH, Z→ll







		CEPC_v1, ILD	Test Geo 1	TG 2	TG 3
ECAL	Cell Size/mm	5	10	20	20
	# Layers	30	30	30	20
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Event Recon. Efficiency	$\mu\mu$H	95.7%*	98.0%	96.5%	95.2%
	eeH	91.1%*	89.6%	89.1%	74.5%(???)

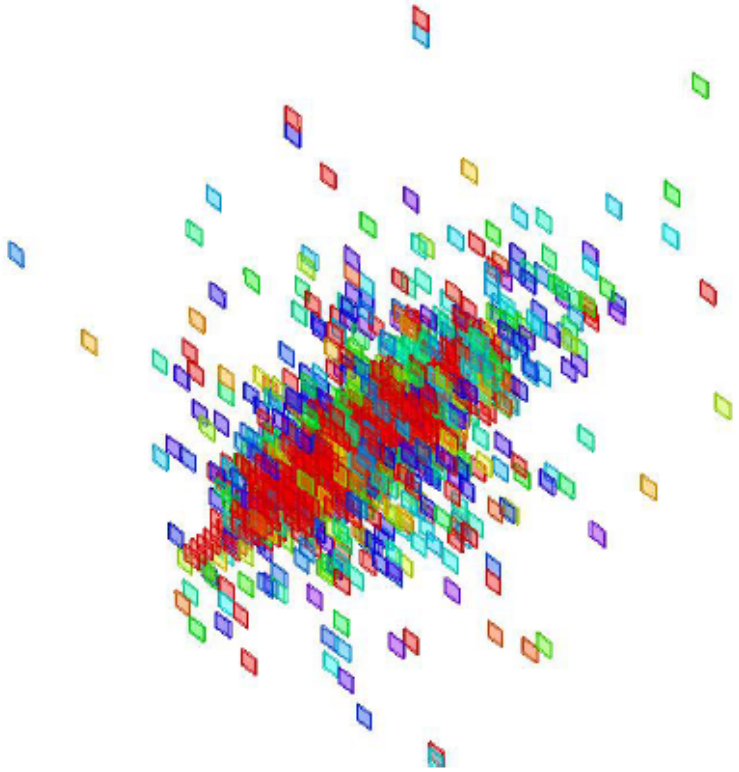
TG2/3: active cooling free...

Lepton id efficiency slightly reduced, presumably due to separation power degrading (shower overlap)

Electron id stay to be tuned

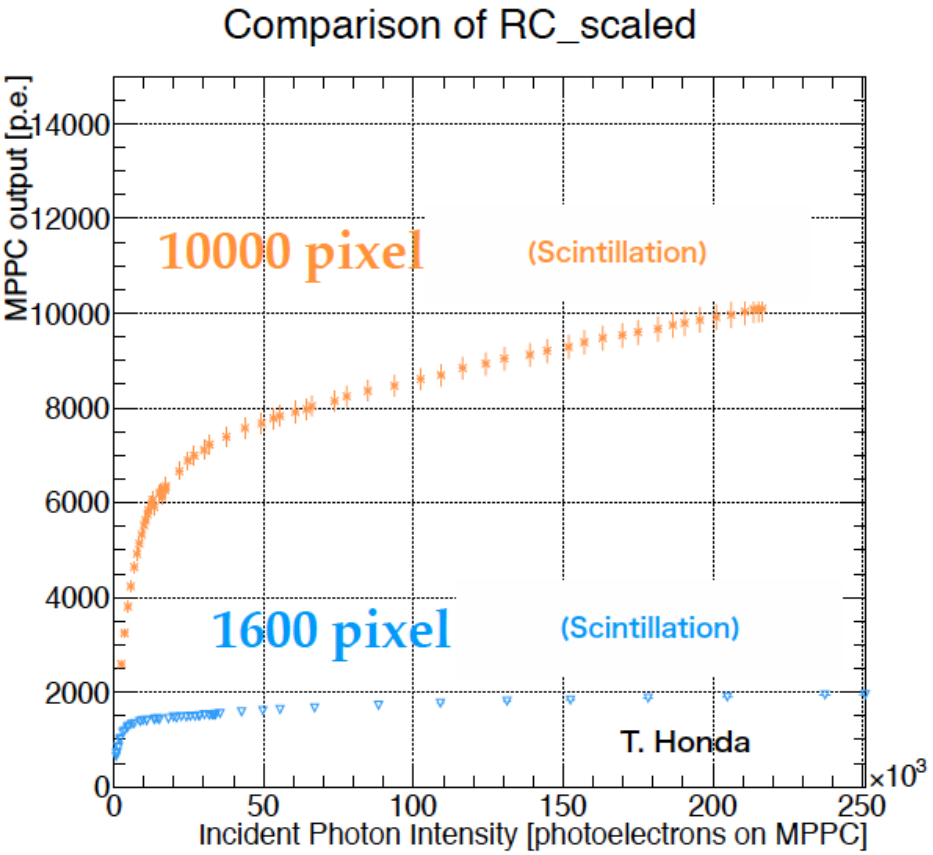
CEPC_v1 reconstructions uses old lepton id; Test Geometry models uses LICH
Sample statistic 35k (corresponding to 5 ab^{-1} integrated luminosity)

ECAL Saturation/Linear Range Study



50 GeV Photon Cluster
at ECAL with 10 mm Cell Size

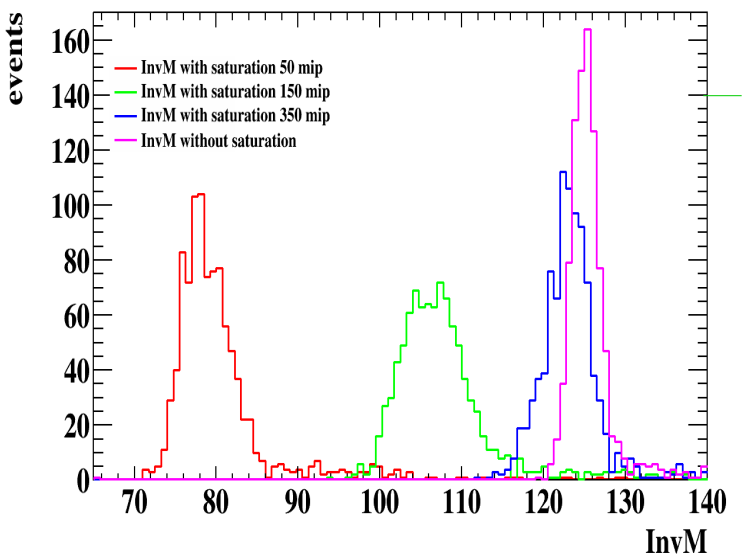
~o(1k) hits, hottest hit with E ~ 1k MIP.

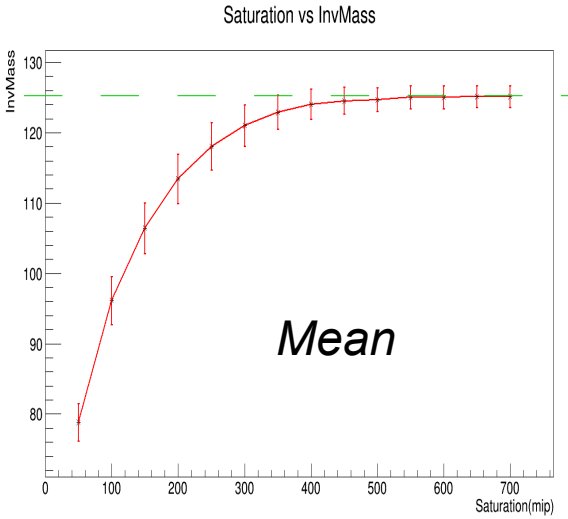


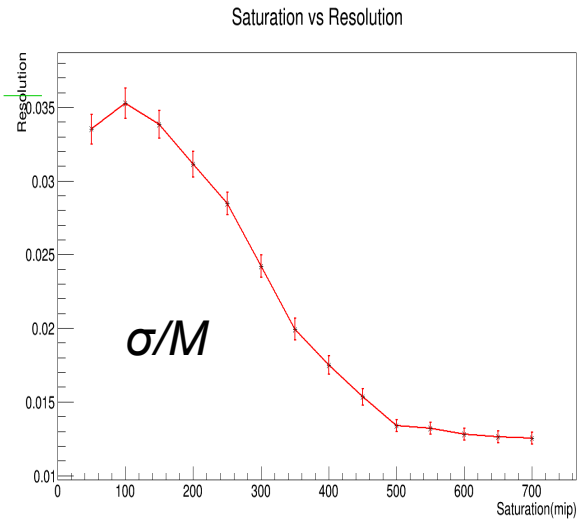
T.Takeshita, ILDDET@KEK

Scintillator: MIP→Photon→P.E

Impact on H→γγ measurement







ECAL Linear Ranger: recommended to be >1k/1.8k MIP (for 10/20 mm Cell)

10k pixel SiPM readout is very challenging (If Photon generation > 10 per mip)

Empirical formula on needed ranger of a single photon:

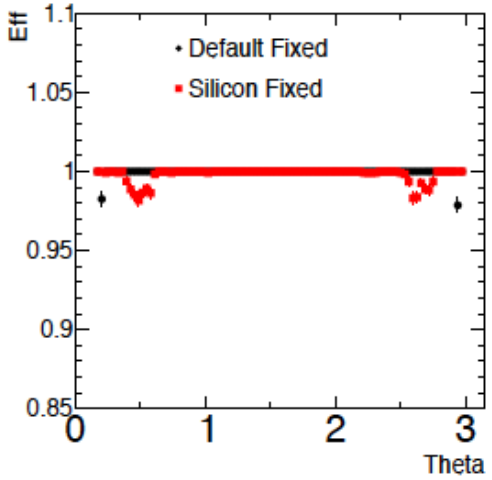
$$\log10(\text{Ranger}) = 0.87*x + 0.97*y - 0.24*y^2 + 1.26$$

x = log10(E), y = log10(Cell Size/cm)

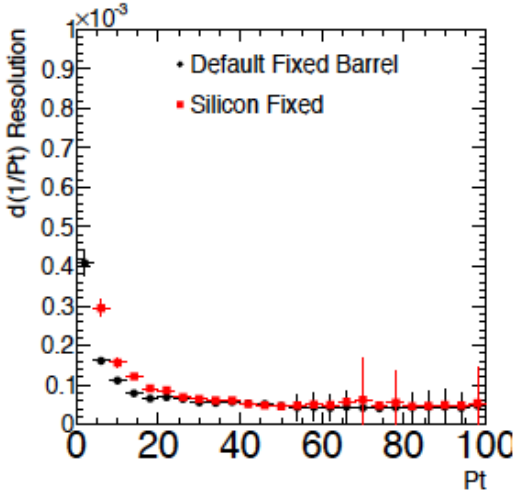
Shuzheng Wang

Full Detector Simulation and Reconstruction

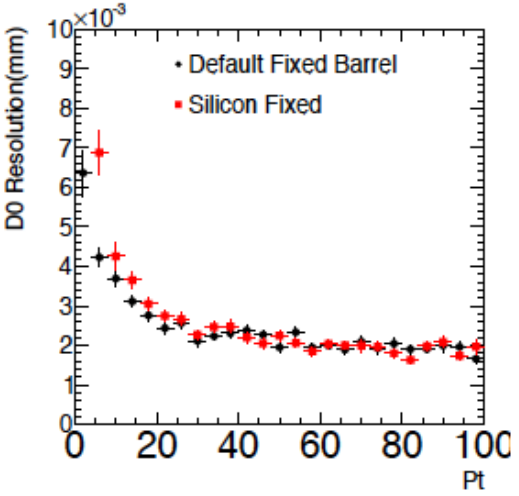
- Generated single muon with CEPC full silicon
- Reconstructed using Marlin Silicon only.
- The performance is comparable to CEPC V1.



(a) Eff vs theta

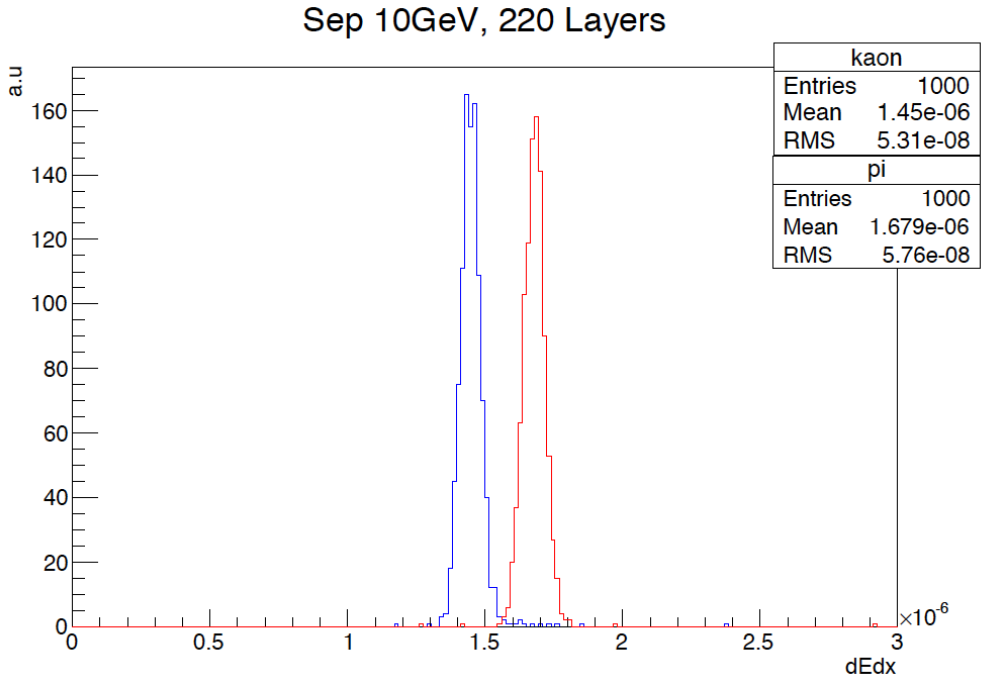


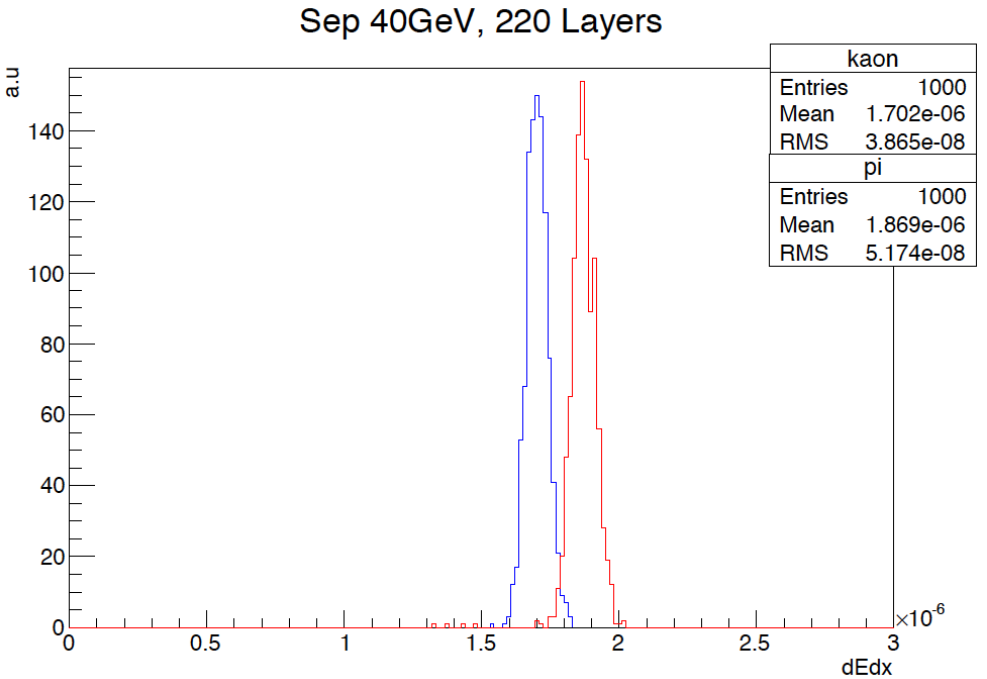
(b) sigma(1/pt) vs Pt



(c) sigma(D0) vs Pt

TPC





dEdx, GeV per Hit (6 mm wide)

dE/dx, clear pi-K separation at E up to 40 GeV...

1.8/0.3 m TPC outer/inner radius, Half Z 2.35m, > 200 layers,
layer thickness 6 mm, T2K Gas, Ar : CF4 : iC4H10 = 95 : 3 : 2

Key question: How to faithfully extract the dEdx information?

ILD Reference:
https://agenda.linearcollider.org/event/7020/contributions/34830/attachments/30307/45306/Top.pdf