Performance for Ecal reconstruction

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Ecal reconstruction

A crystal bar design 3D EM calorimeter:

- Step1: Clustering, cluster splitting and shower formation in each layer.

- Step2: Link the showers in all layers.

  Cone-based clustering algorithm.

  Cone angle: $30°$

  step-back layer: 2.

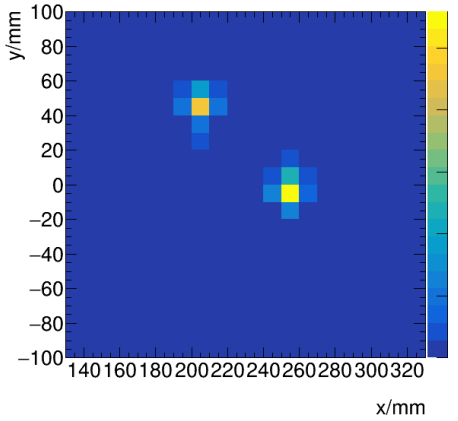
  Define good cluster: $N_{shower} \geq 3$ && $\left(\left(\frac{E_2}{E_1} > 3 \;\&\&\; \frac{E_3}{E_2} > 1.2\right) \;||\; \frac{E_3}{E_2} > 2\right)$.

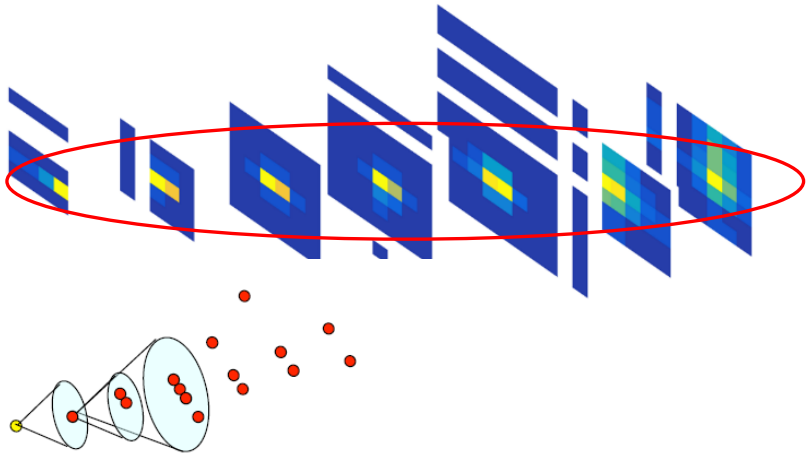
  Define bad cluster: !GoodCluster.

  Iteration: Use good clusters to predict the N_{shower} and position in each layer, then repeat Step1. (Can add predicted energy in addition).

  Merge bad clusters into closest good cluster.

- End. Create PFO from good cluster.

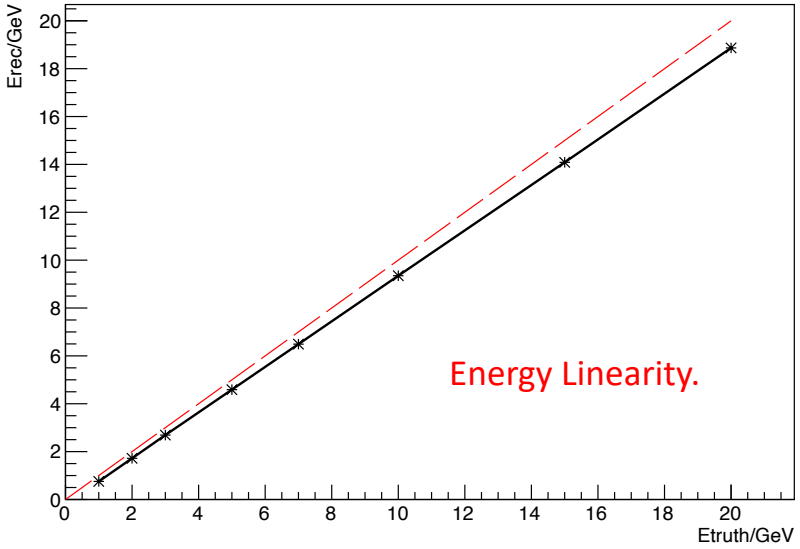


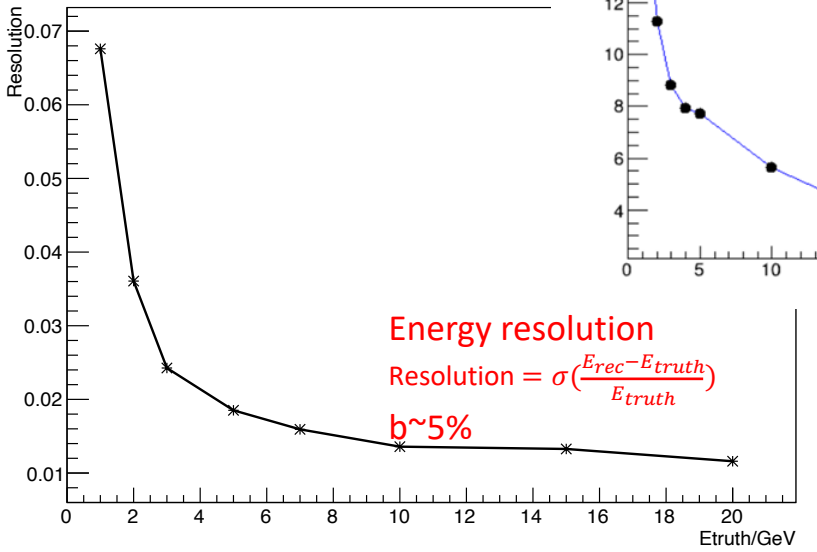


Single Photon

Generate single photon process to check the energy and angular resolution.

- Note: single photon would not be influenced much by Step2.
- Energy: 1~20GeV. Hit at the central of 40*40*28 block vertically.

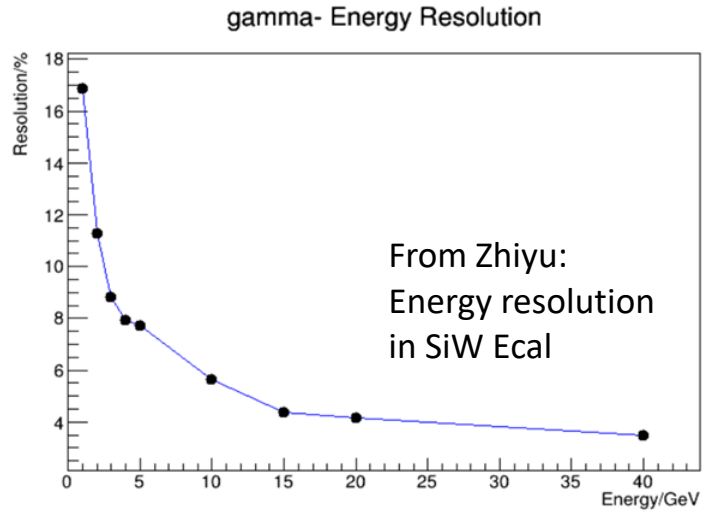




Energy resolution

Resolution = $\sigma(\frac{E_{rec}-E_{truth}}{E_{truth}})$

b~5%

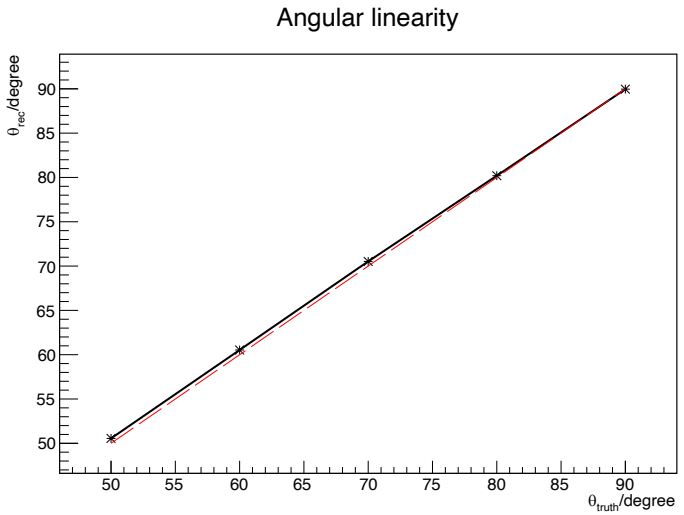


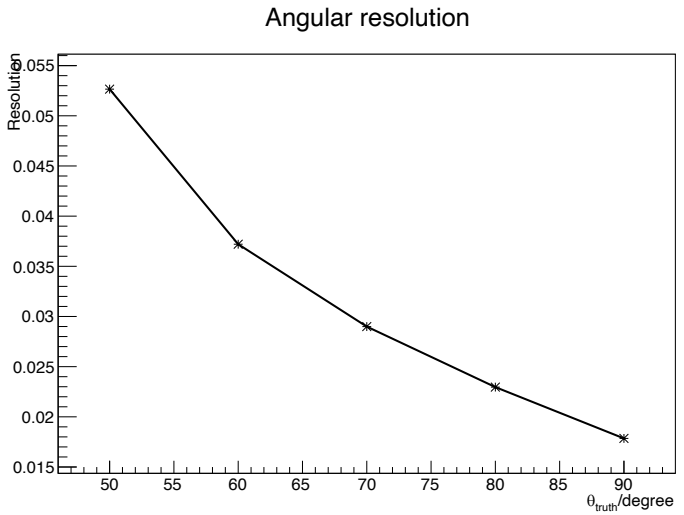
From Zhiyu:
Energy resolution
in SiW Ecal

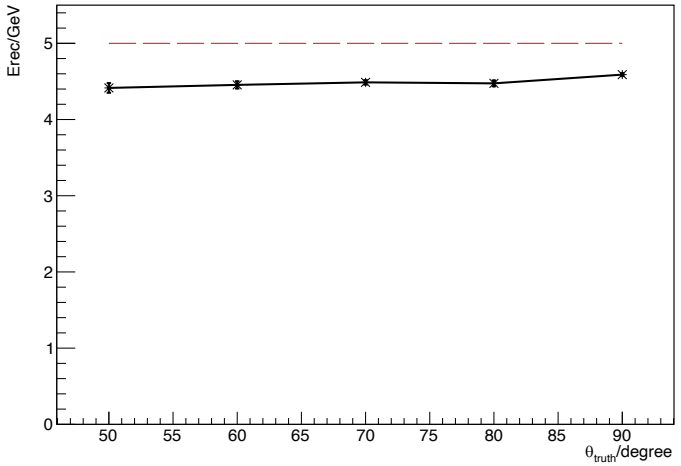
Could calibration fix this bias?

Single Photon

Angular linearity and resolution for $E_\gamma = 5GeV$





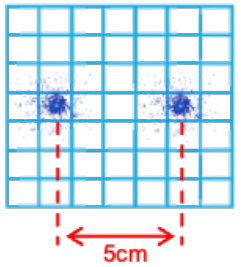


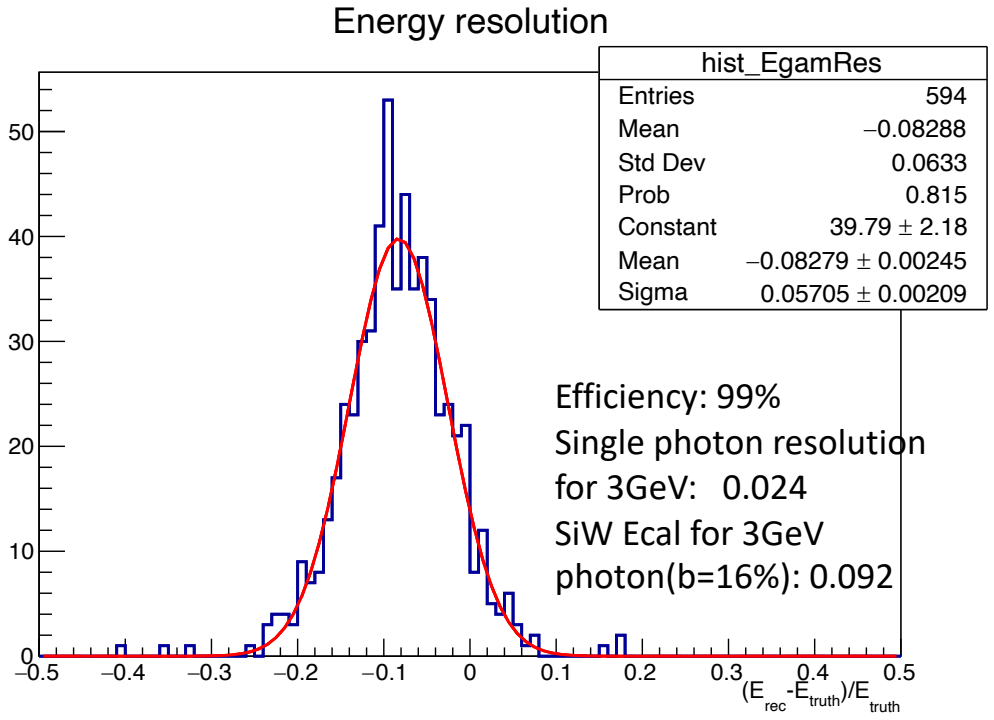
Angular reconstruction is well, and energy has nearly no dependence with theta.

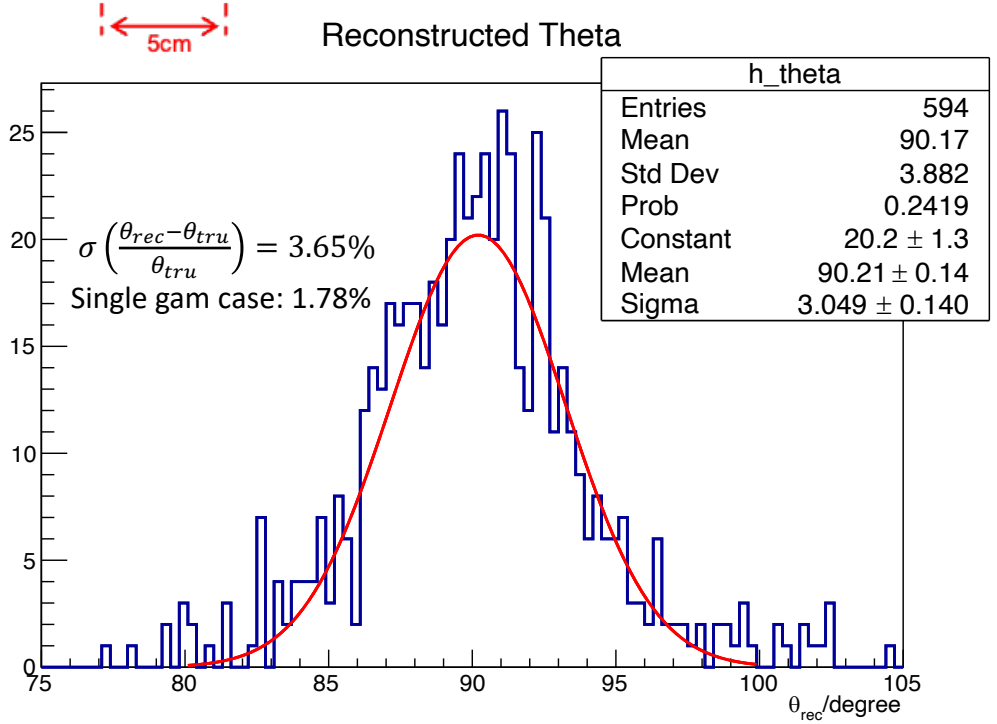
Di-photon

Case 1: two photon in parallel.

- $E_\gamma = 3GeV$, distance=5cm, 300 events (~600 photons).



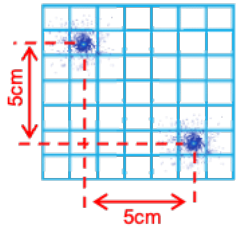


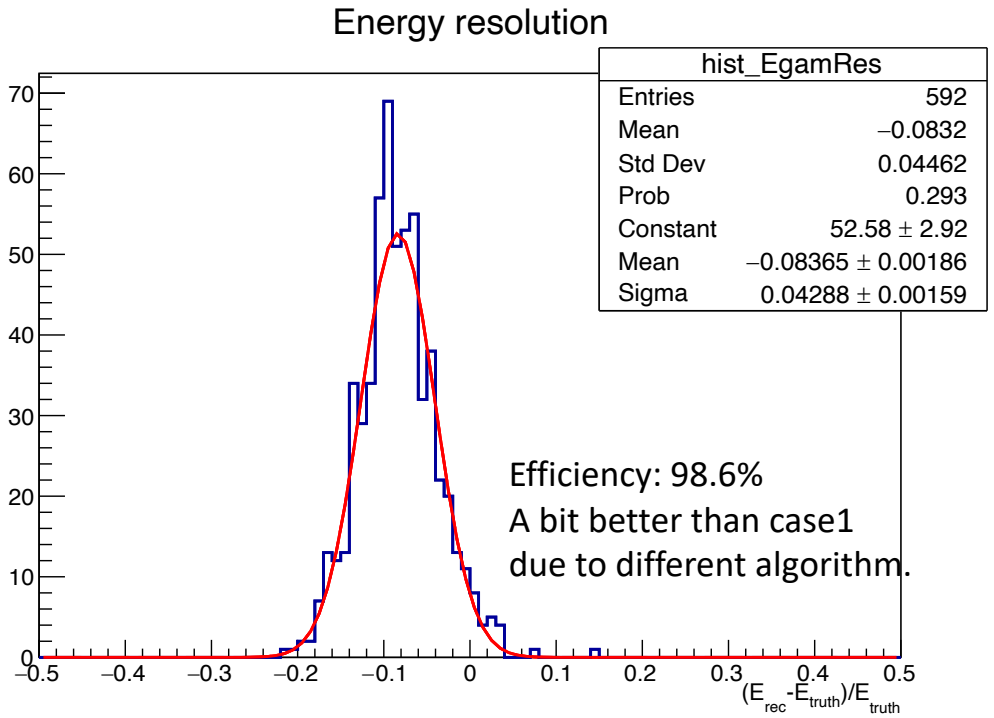


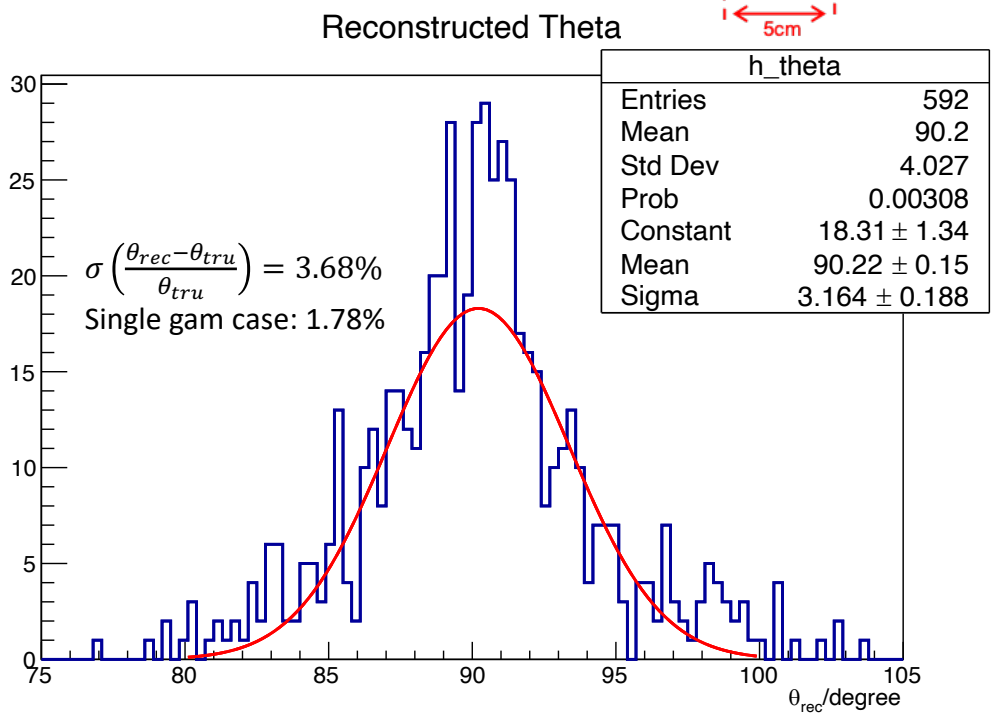
Di-photon

Case 2: 2 photons in diagonal position.

- $E_\gamma = 3GeV$, distance x=5cm, y=5cm, 300 events (~600 photons).





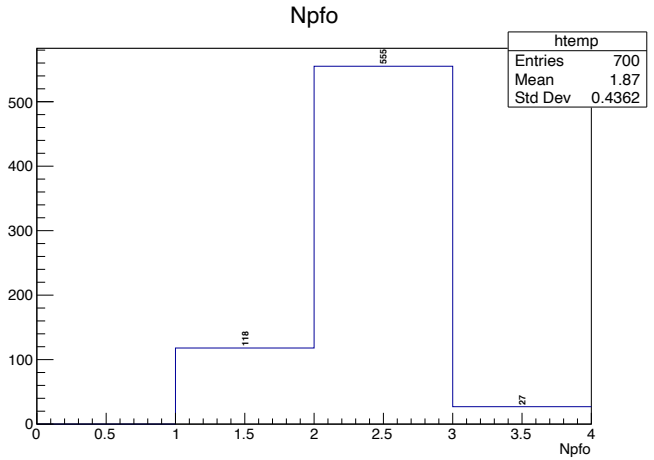


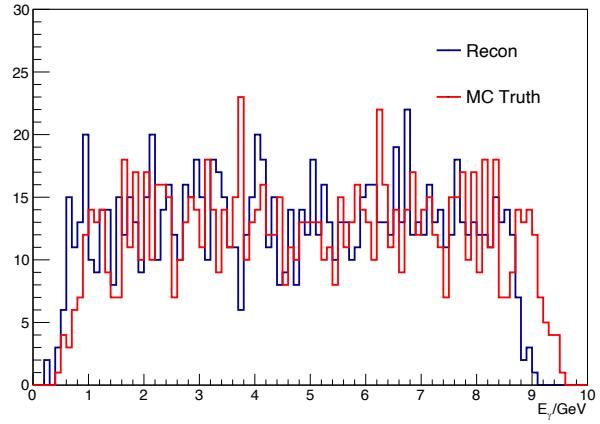
$\pi^0 \rightarrow \gamma\gamma$

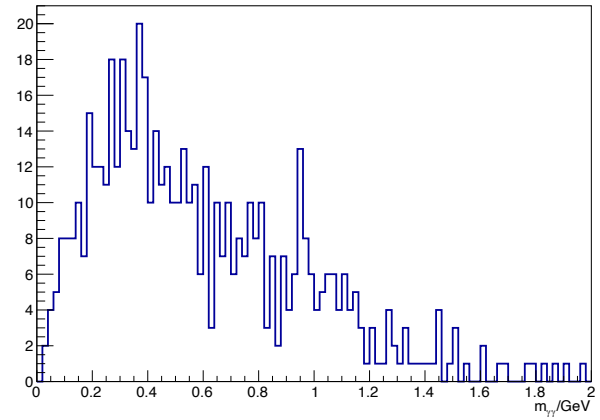
Single 10 GeV Pi0, 700 events.

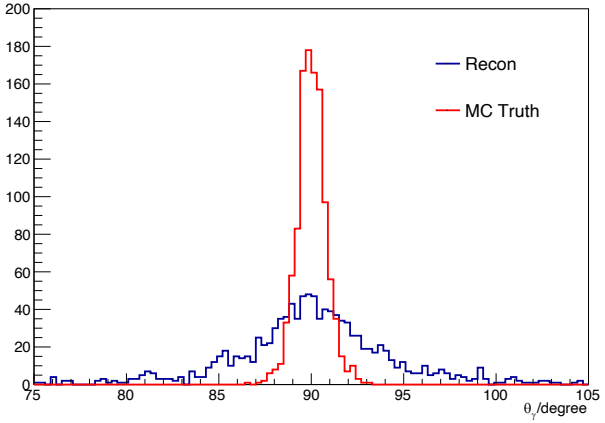
- Efficiency(Npfo==2)=79%.
- $m_{\gamma\gamma}$: No peak.

- Right: Energy and theta for 2 photons, MC truth vs. Reconstructed.
- $\sigma(\theta_{rec}) = 3.36°$, only a bit larger than di-photon case.
- Need to further check pi0 mass.





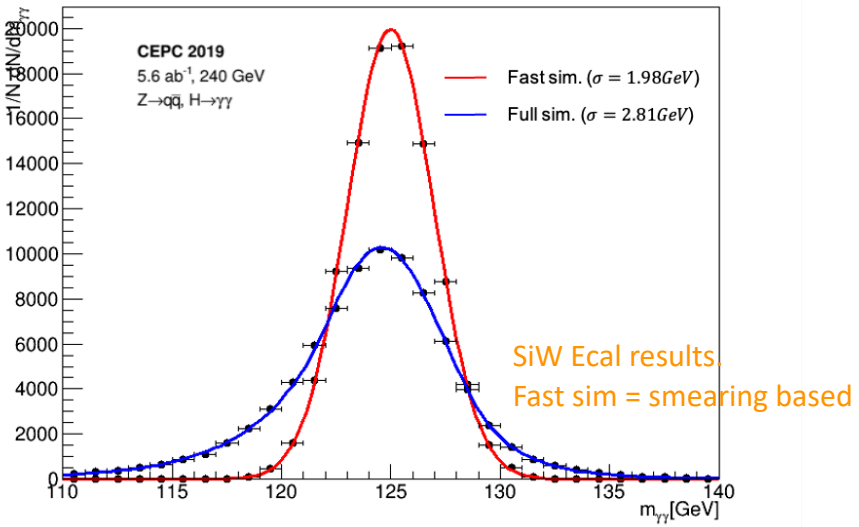




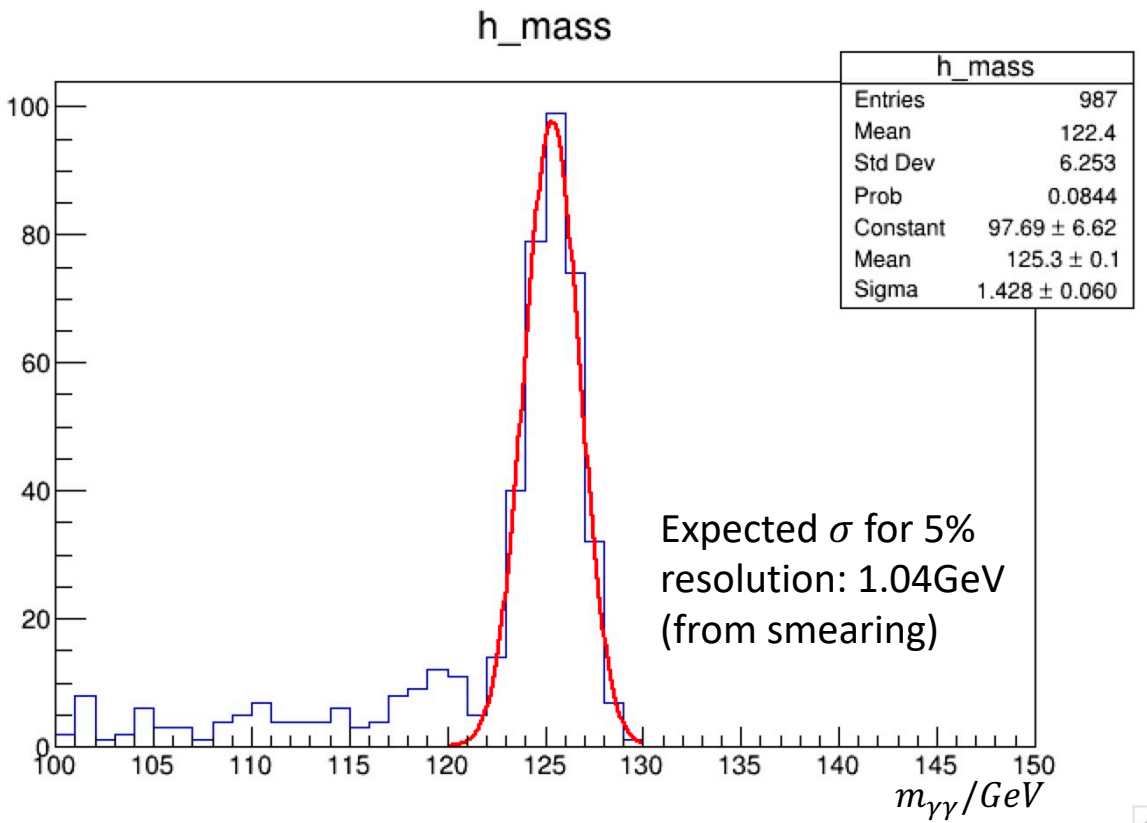
Higgs in $\nu\nu H \rightarrow \gamma\gamma$

From Zhiyu: Higgs mass

- Full crystal cube Ecal only.
- Reconstructed with Pandora.
- Correct the momentum with energy (to have $m_{pfo} = m_{\gamma} = 0$. After Pandora reconstruction it is $m_{neutron}$).



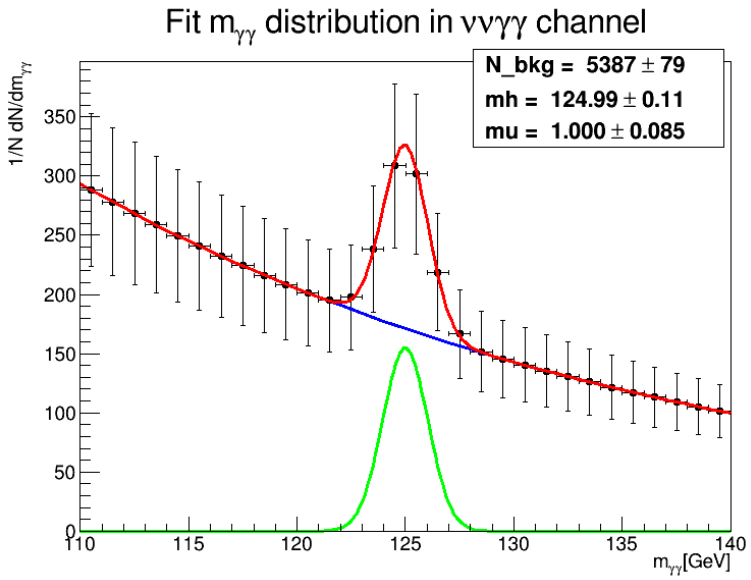
SiW Ecal results.
Fast sim = smearing based



Expected σ for 5% resolution: 1.04GeV (from smearing)

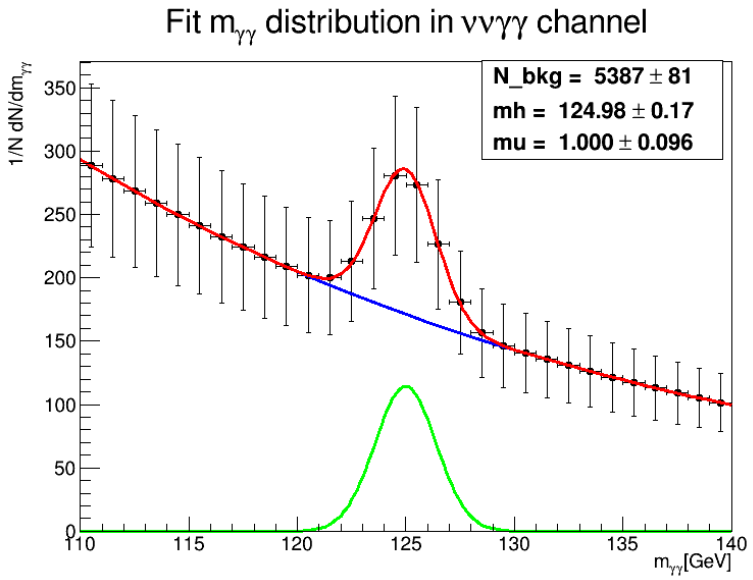
Higgs in $\nu\nu H \rightarrow \gamma\gamma$

Fit $m_{\gamma\gamma}$ in Asimov data to get signal strength and precision based on smearing.



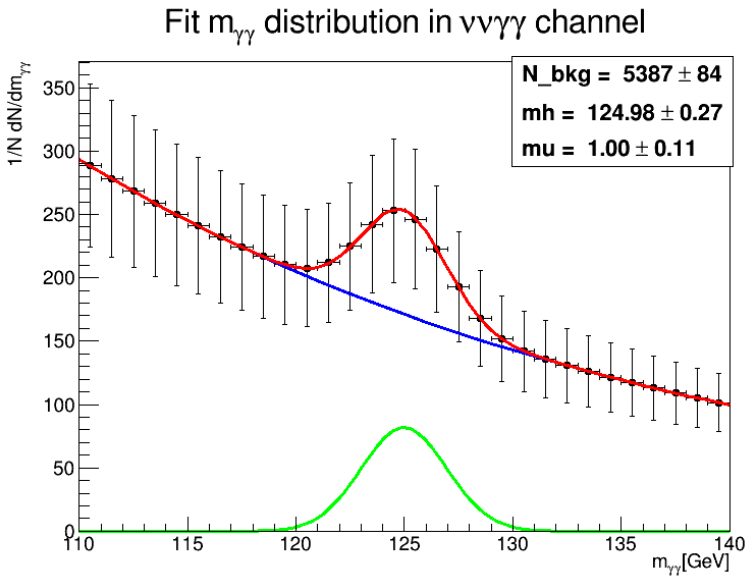
B=5%(Exp. crystal)

$\delta Br(H \rightarrow \gamma\gamma) = 8.5\%$



B=10%(Full sim. crystal)

$\delta Br(H \rightarrow \gamma\gamma) = 9.6\%$



B=16%(SiW in CEPC-v4)

$\delta Br(H \rightarrow \gamma\gamma) = 11\%$

Summary

Performance in ParticleGun events:

- Energy resolution is close to expected value for crystal ($\frac{\sigma_E}{E} \sim \frac{5\%}{\sqrt{E}}$) in single particle case.
- E_{rec} has some shift with E_{truth}, not sure if it could be fixed with calibration.
- Angular linearity and resolution look fine, $\sigma\left(\frac{\delta\theta}{\theta_{truth}}\right) < 5\%$ in barrel for single photon case, and a bit worse in 2 photon cases.
- Di-photon case would have some confusion term.

In 10GeV Pi0:

- Can not reconstruct a pi0 mass. Need to further check energy and angular reconstruction.

In Higgs:

- No results from crystal bar Ecal.
- From smearing: 23% improvement comparing with SiW in $\delta Br(H \to \gamma\gamma)$.