$H \to \gamma\gamma$ improvements

Physics benchmarks

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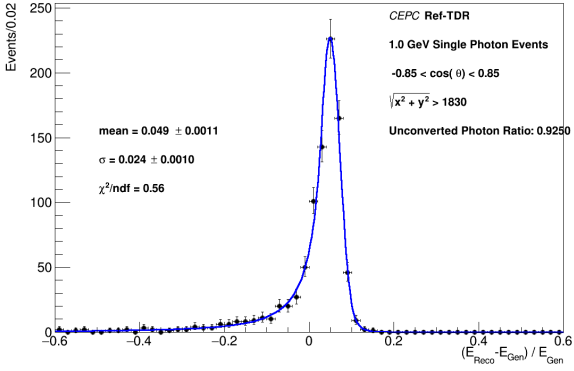
Selection on photons

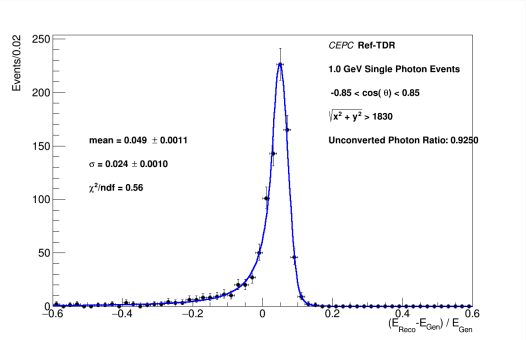
To get rid of converted photons that might leave a track ($e^- e^+ pair$) and get detected and reconstructed, we apply a new selection on the coordinate of the endpoint of our truth photon such as

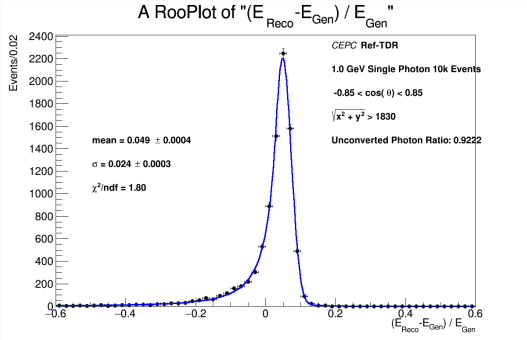
$$\sqrt{x^2 + y^2} > 1830$$

This is to make sure we do not take into consideration the particles reconstructed in the tracker



Fit w/ uncoverted photons selection

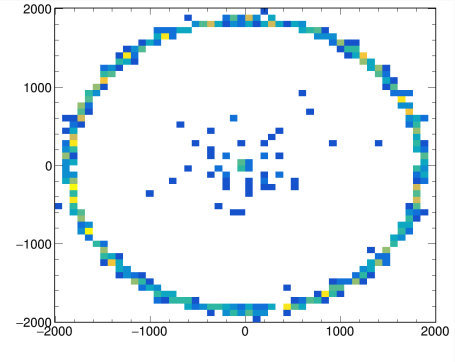




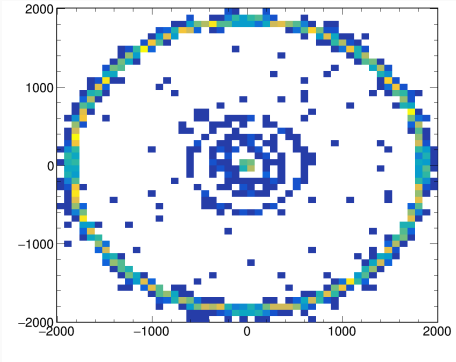
Ratio of converted photons around 8%

Photon endpoints in detector

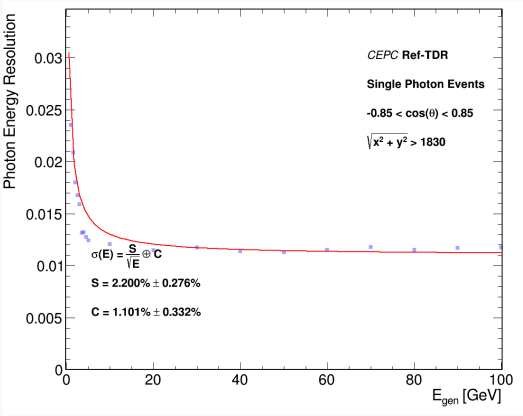
For 1k events sample: around 70 to 80 in the middle (tracker and not barrel) failling the endpoint selection)



For 10k events: around 700 to 800 in the middle (tracker and not barrel) failling the endpoint selection)



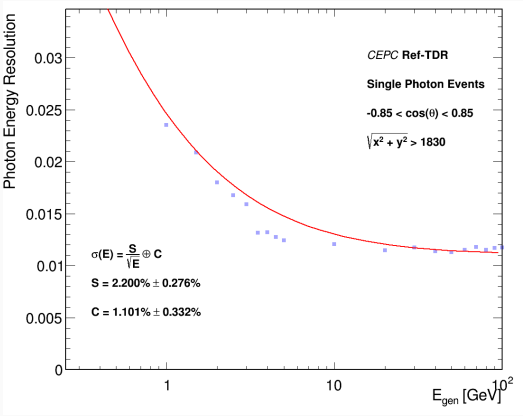
Differential Energy Resolution



In order to fit this distribution, we used a SC function which has a Stochastic term and Constant term

$$\sigma(E) = \frac{S\%}{\sqrt{E}} \oplus C\%$$

Differential Energy Resolution



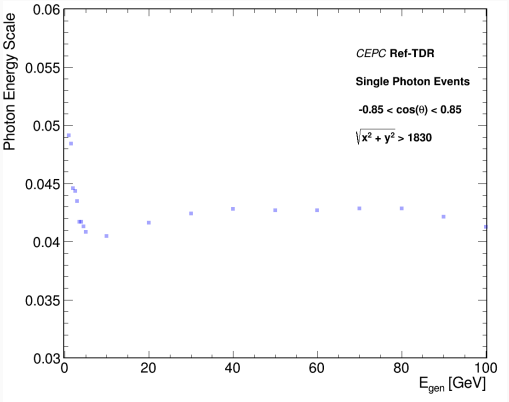
On a log scale plot, it becomes evident that we have different tendencies in different ranges (1-3GeV/3.5-5GeV/10-100GeV)

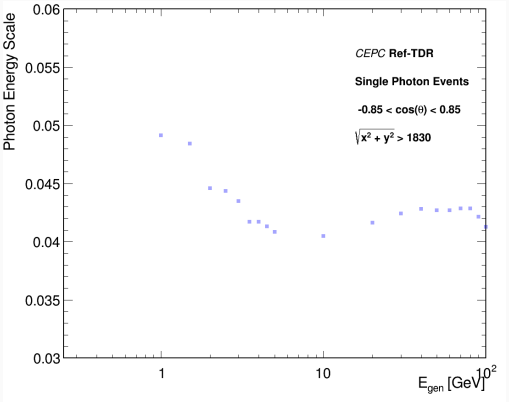
One explanation: the θ and ϕ are floating in our samples ($-0.85 < cos(\theta) < 0.85$ and $0 < \phi < 2\pi$)

To fix it, we will check with more statistics (10k events) that could mitigate this effect **or** by fixing the angles and variating them infinitesimaly then checking the resolution at different points

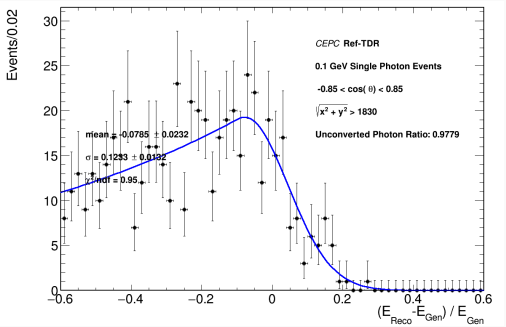
Other differential distributions

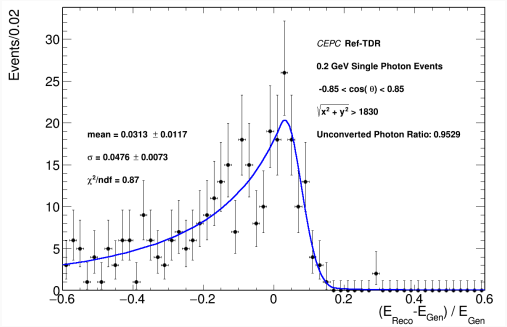
We took a look at differential distributions of Photon Energy Scale relative to the truth Energy





Lower energies





Conclusion

Main problem for the diphoton channel is lower tail energy loss (events lost for $m_{\gamma\gamma} < 120$ GeV)

Checking several differential distributions to try to see if we can figure out the problem from there

Checking the energy deposition at the ECAL/HCAL to check for any leakage

More samples generated in the upcoming days to get better distributions (w/ CEPCSW 24.12 once the bugs fixed)

Thank you

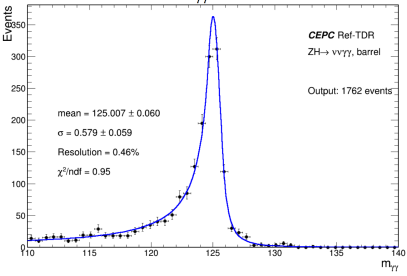
Back-up

Back-up

So far, this is what we have for the diphoton channel (Check Kaili's slides from the RefTDR meeting of 10.28)

Diphoton

$\alpha_{Hi} = 1.2826 \pm 0.1063$
$\alpha_{Lo} = 0.5913 \pm 0.0685$
$n_{Hi} = 3.1292 \pm 0.5072$
$n_{Lo} = 1.4994 \pm 0.1298$
$\sigma_{CB} = 0.5792 \pm 0.0588$
$m_{\gamma\gamma} = 125.01 \pm 0.0598$



• Total	2900	Events
• With 2 PFOs:	2854	98.4%
• $\lvert\cos\theta_{truth}\rvert < 0.85$:	2175	75.0%
• $110 < m_{yy_{reco}} < 140$:	1762	60.8%

Reco eff: 1762/2175 = 81.0%

In DSCB fit:

- Sigma: 0.58 GeV
- Resolution: 0.46%

Back-up

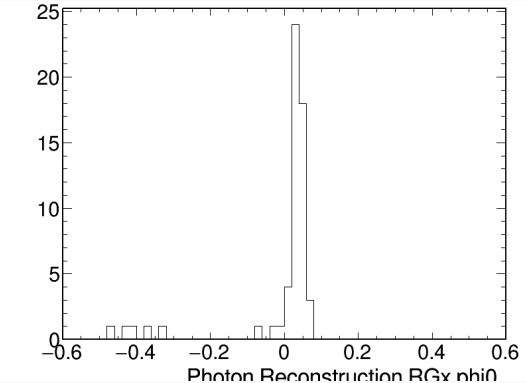
Fixing lower tail energy loss: One solution might be checking the clusters in ECAL and HCAL, and see the energy in both to check for leakage.

Samples using PGun one-type particule response (1k/10k single photon events):

- 100MeV-900MeV (100 MeV step)
- 1GeV-5GeV (0.5 GeV step)
- 10GeV-100GeV (10 GeV step)

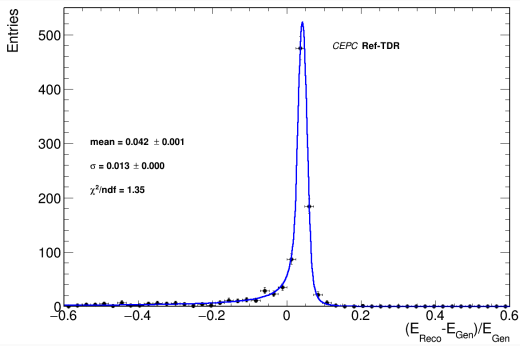
Back-up

RGmatch for Φ ranges not good either due to lack of events (range between 0 and 0.4 (0.4 step to get 15 points/bins))

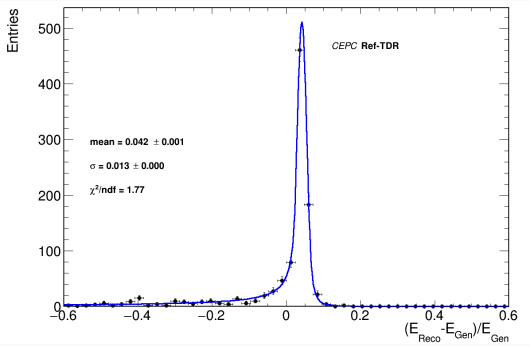


Back-up

5 GeV

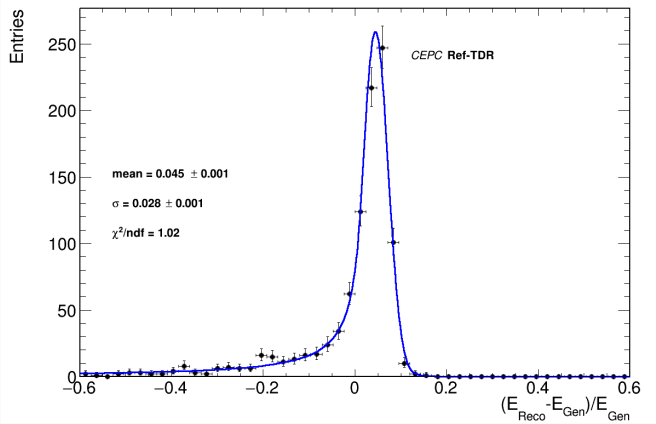


80 GeV



Rec-Gen matching

1 GeV events

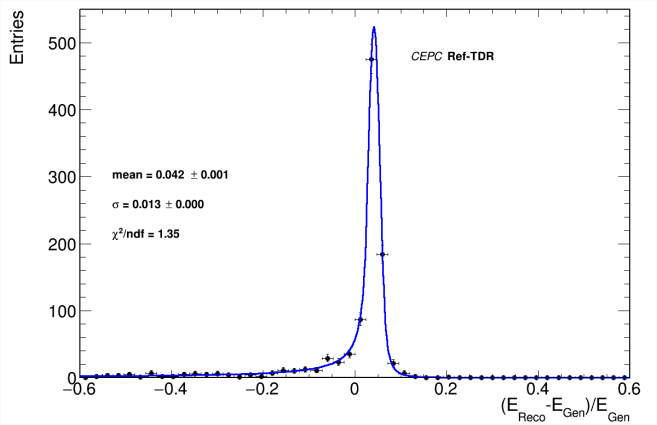


Out of that, we get:

- **Photon Energy Scale:**
  Mean value shifted ($\bar{x}$)
  PES = 4.5 %
- **Photon Energy Resolution:**
  Standard deviation (σ)
  PER = 2.8 %
- Number of events < -0.1 = 145
- Number of events < -0.2 = 88

Rec-Gen matching

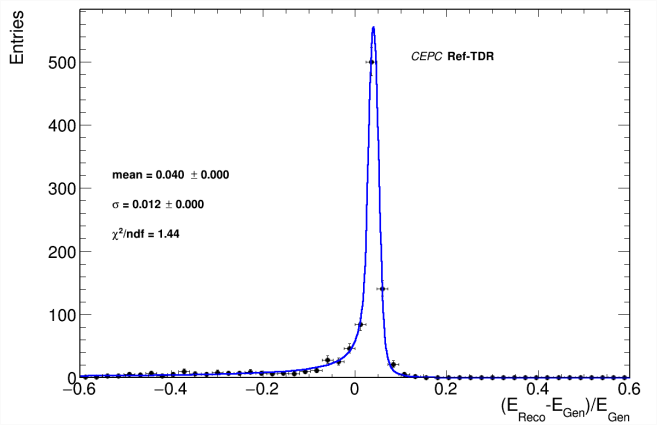
5 GeV events



- PES = 4.2 %
- PER = 1.3 %
- Number of events < -0.1 = 114
- Number of events < -0.2 = 75

Rec-Gen matching

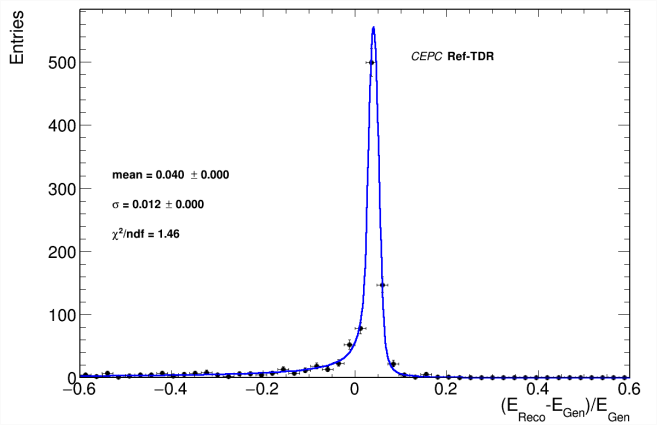
10 GeV events



- PES = 4.0 %
- PER = 1.2 %
- Number of events < -0.1 = 131
- Number of events < -0.2 = 99

Rec-Gen matching

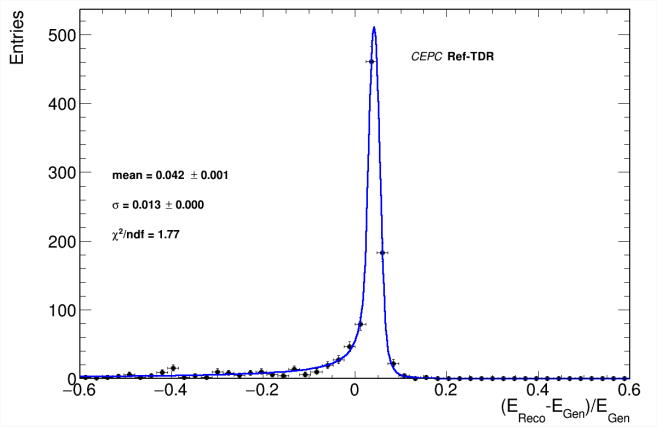
40 GeV events



- PES = 4.0 %
- PER = 1.2 %
- Number of events < -0.1 = 134
- Number of events < -0.2 = 97

Rec-Gen matching

80 GeV events



- PES = 4.2 %
- PER = 1.3 %
- Number of events < -0.1 = 143
- Number of events < -0.2 = 113

In average we have 9.44 % of events with relative energy difference < -0.2 and 13.34 % < -0.1