

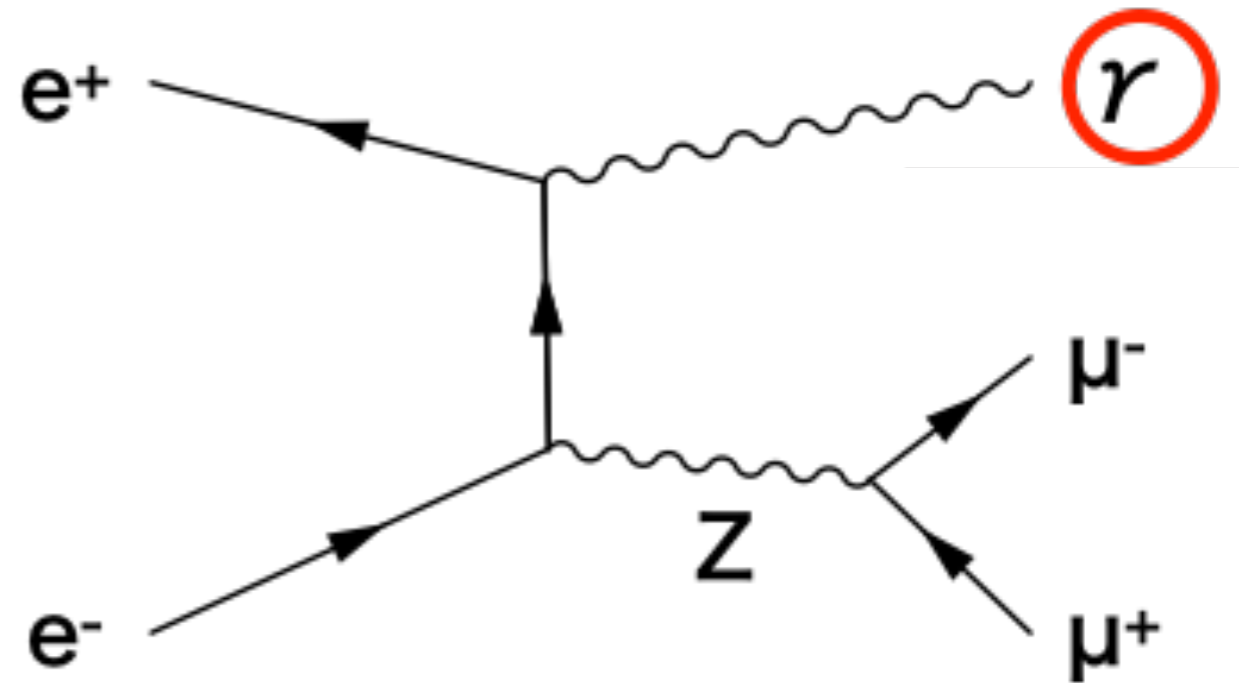
**$e^+e^- \rightarrow Z \text{ gamma}$, first look
at the new 250 GeV sample**

**Takahiro Mizuno
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Simulation Setup

Full simulation (ILCSOFT version v02-02)

- Using new **2f_z_1** samples
- E_{CM} of e^+e^- is 250 GeV.
- Signal sample: $e^+e^- \rightarrow \gamma Z, Z \rightarrow \mu^+\mu^-$
- Several samples are merged, and overall number of events are below.
eLpR: 208868
eRpL: 200540



Sometimes comparing with conventional IDR-L samples, in which photon energy and phi biases were reported, though whose E_{CM} of e^+e^- are 500 GeV.

Event Selection

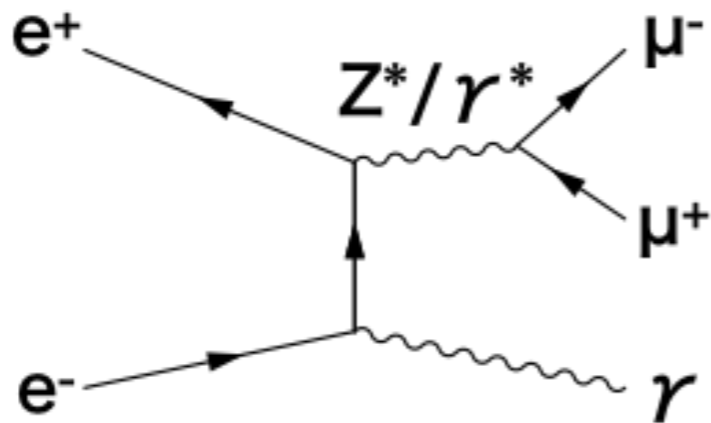
Signatures of the signal events:

$\mu^+\mu^-$ pair + one energetic isolated photon

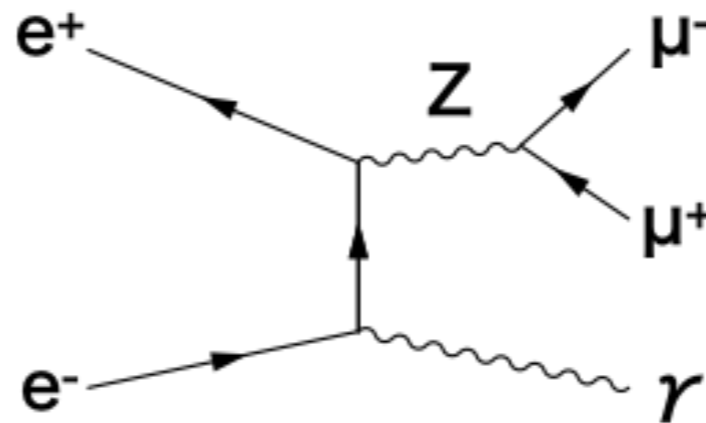
In order to pick up our required process, following cuts are applied.

Step1: Select events with two isolated muons.

Step2: Demand events to have one isolated photon with more than 50 GeV.



Photon ~125 GeV



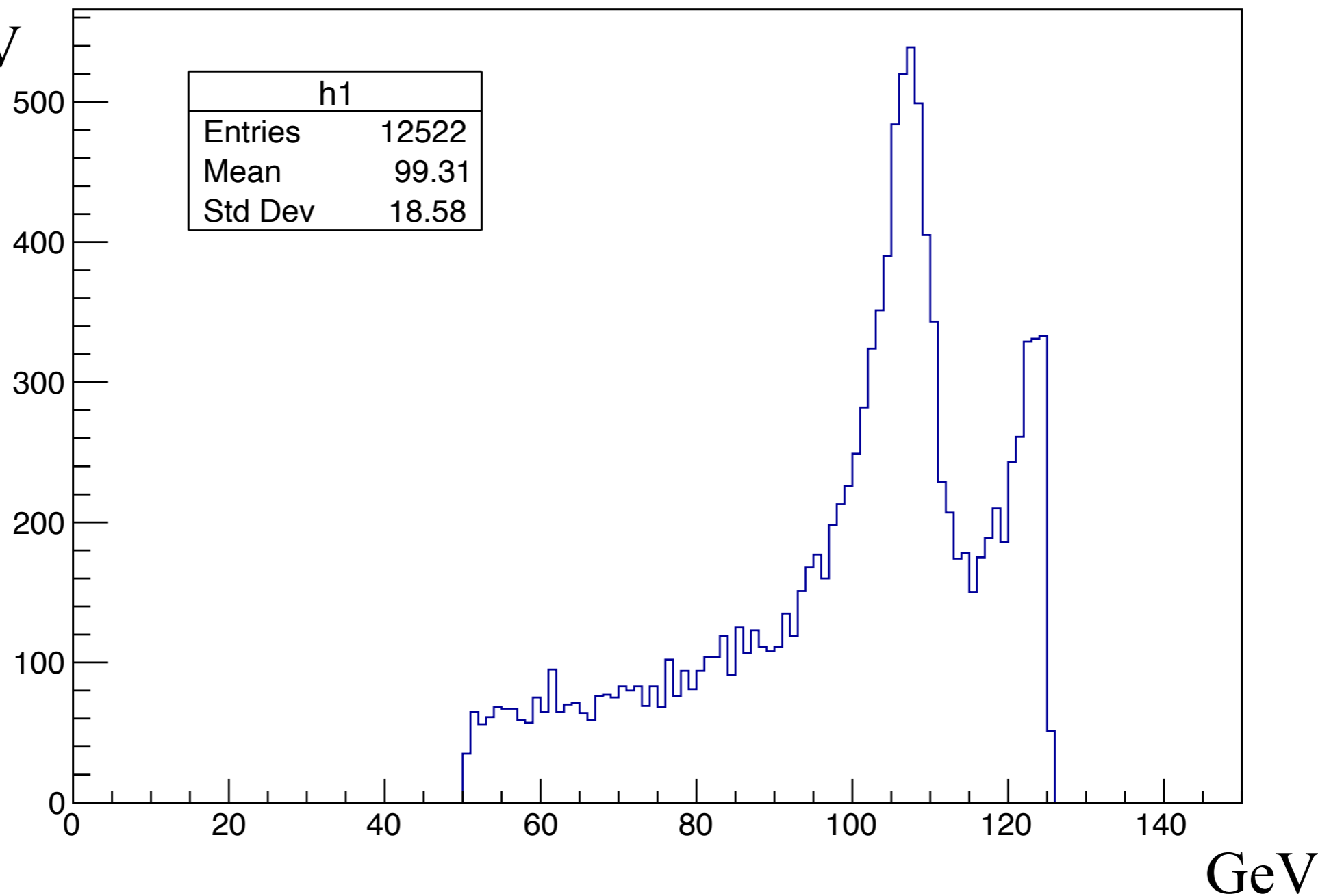
Photon ~109 GeV

Event Selection

MCTruth Energy of Photon

eLpR sample

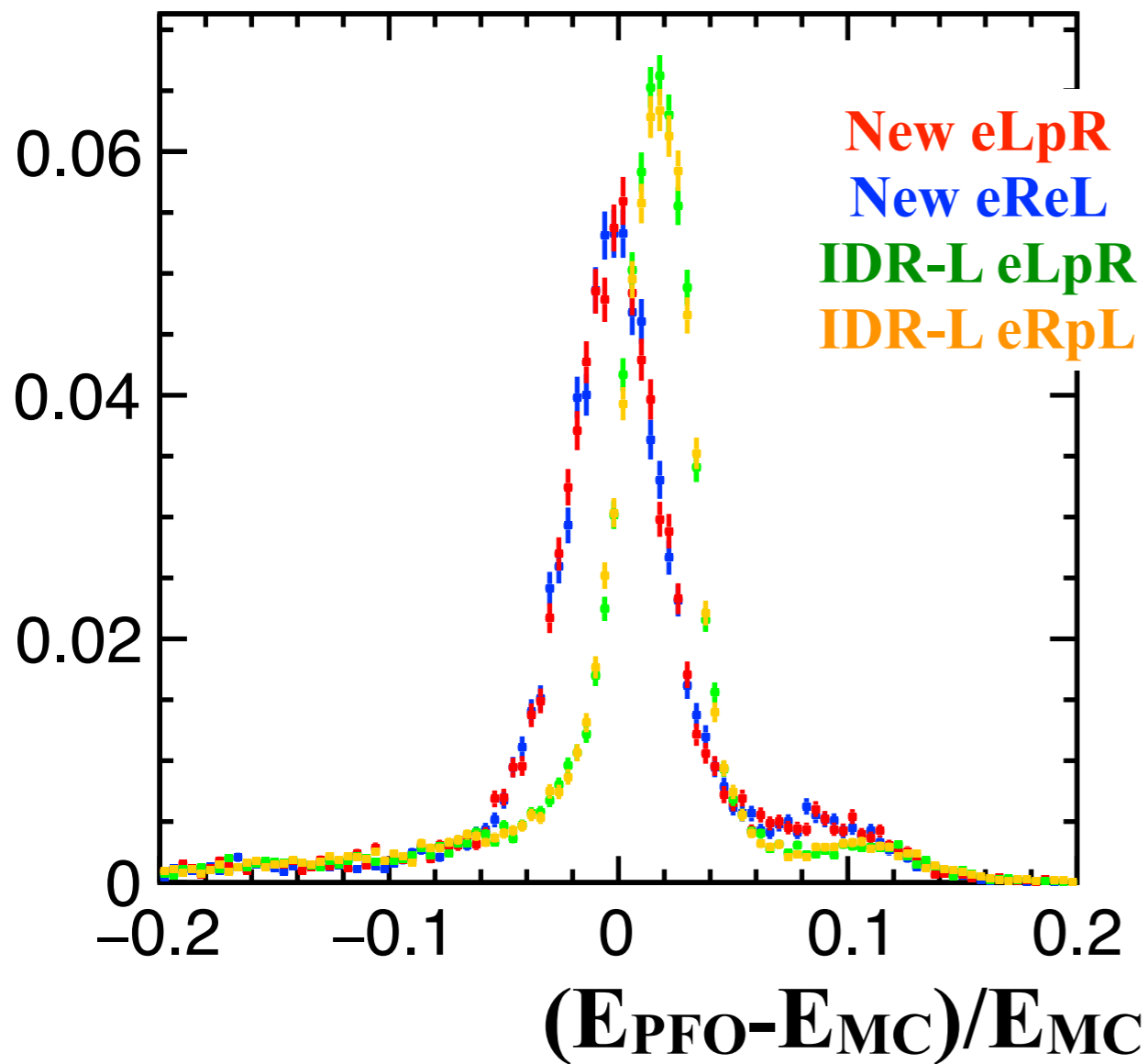
Entries/GeV



Distribution of PFO Photon Energy Difference

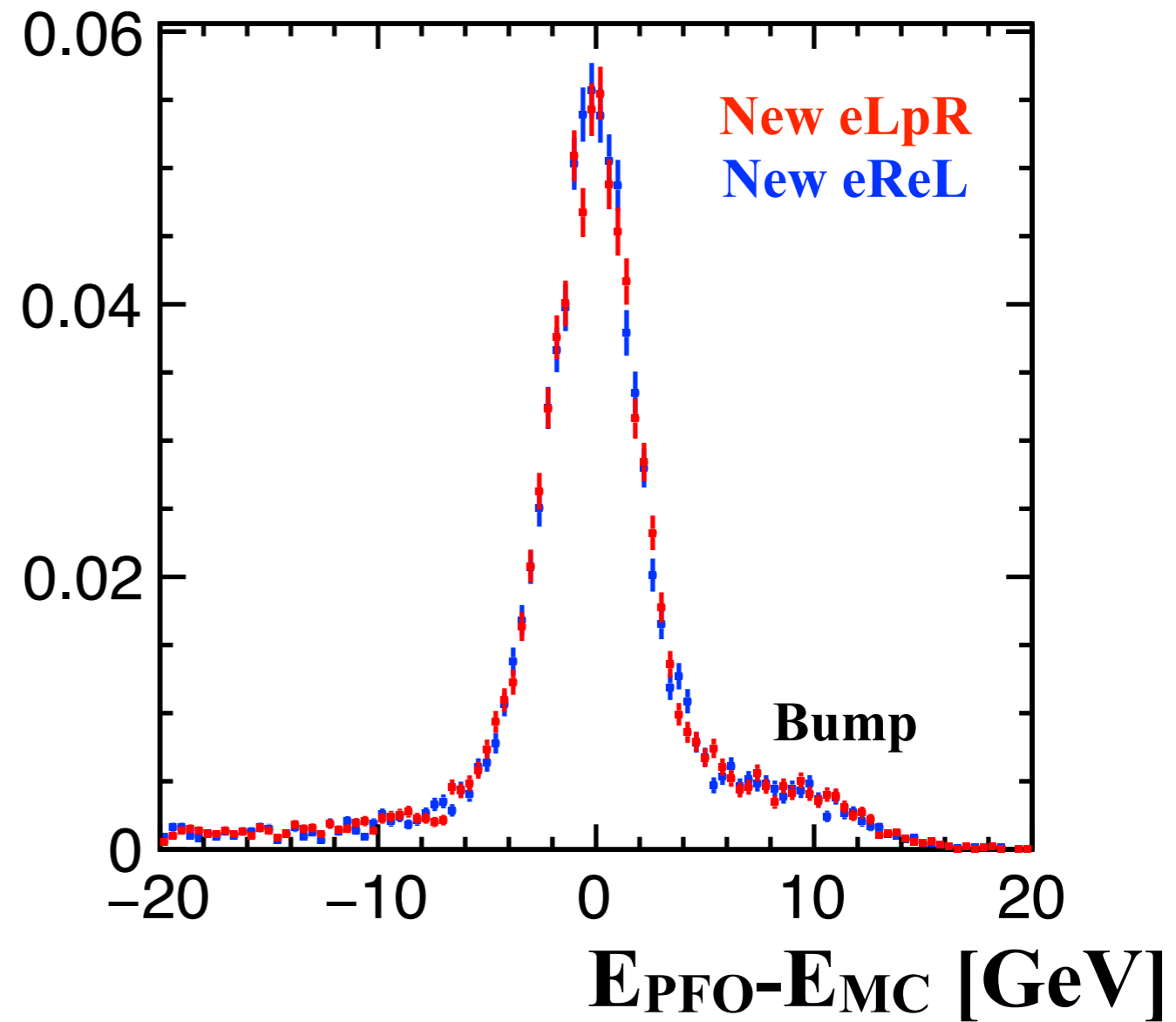
Normalized
Entries

$(E_{\text{PFO}} - E_{\text{MC}}) / E_{\text{MC}}$



Normalized
Entries

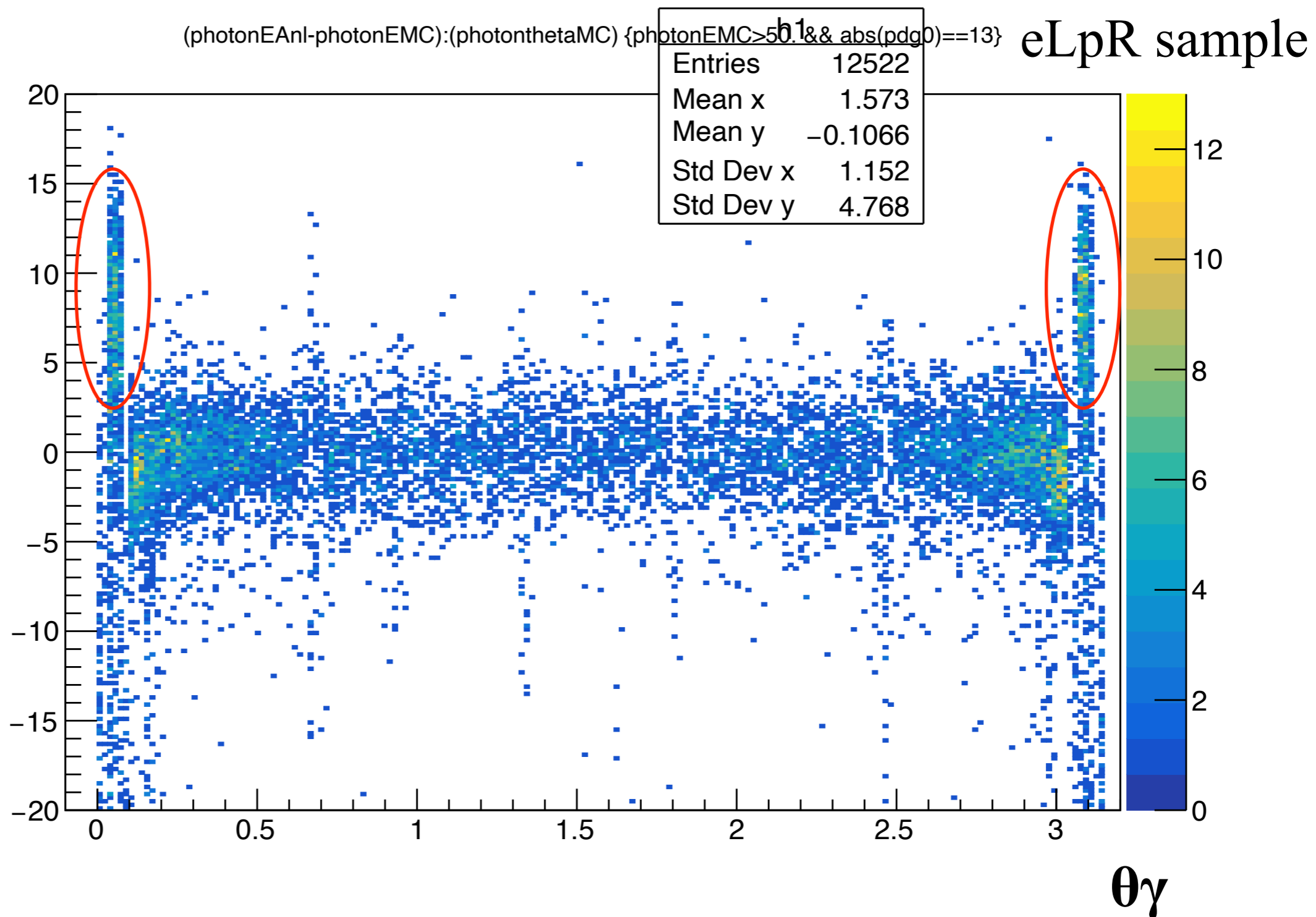
$E_{\text{PFO}} - E_{\text{MC}}$ [GeV]



Mean value is corrected to 0, but a bump exists in positive region.

The bump in the photon energy difference

$E_{\text{PFO-EMC}}$
[GeV]

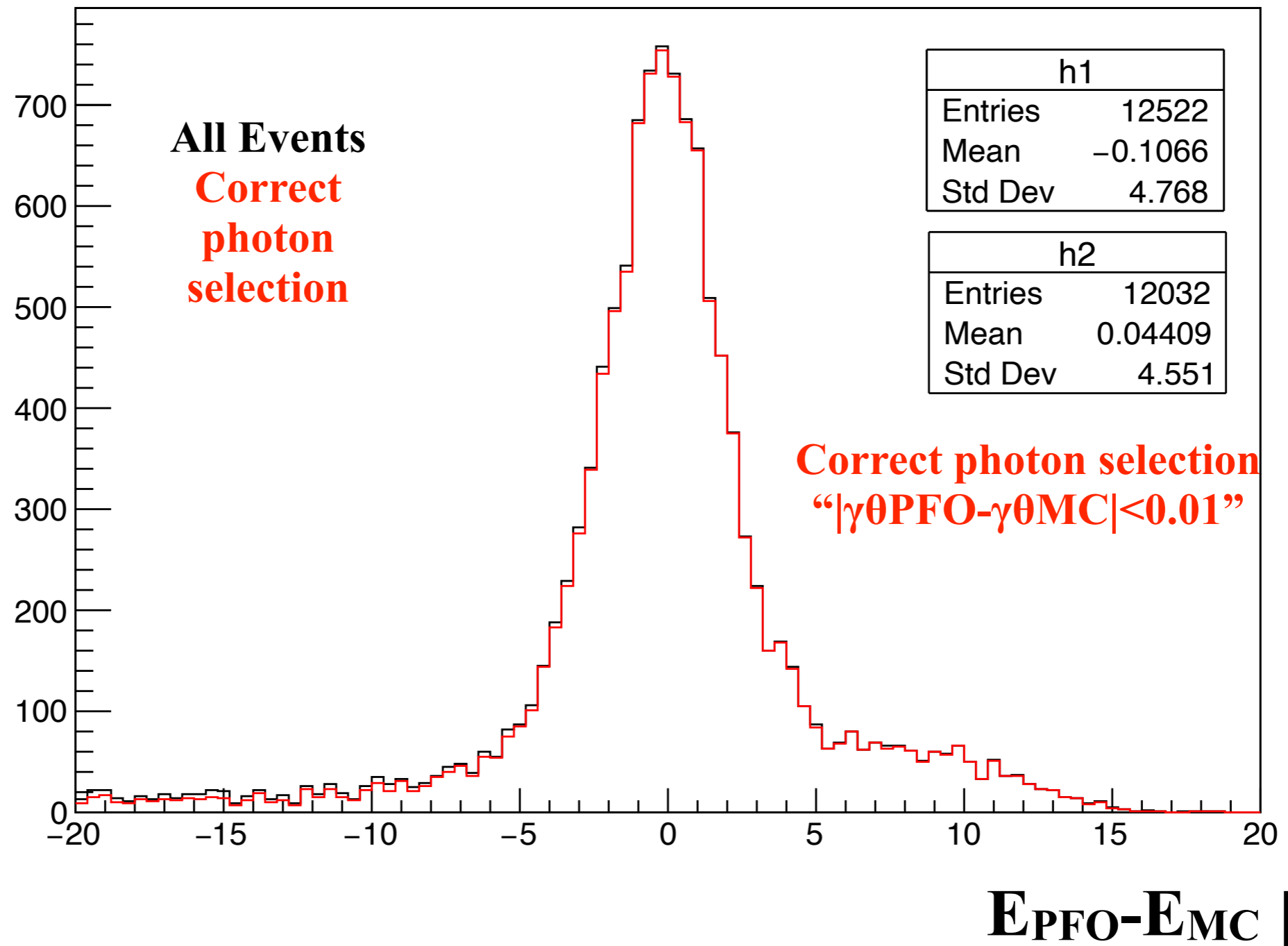


Very forward and backward photons are likely to make bumps.

The bump in the photon energy difference

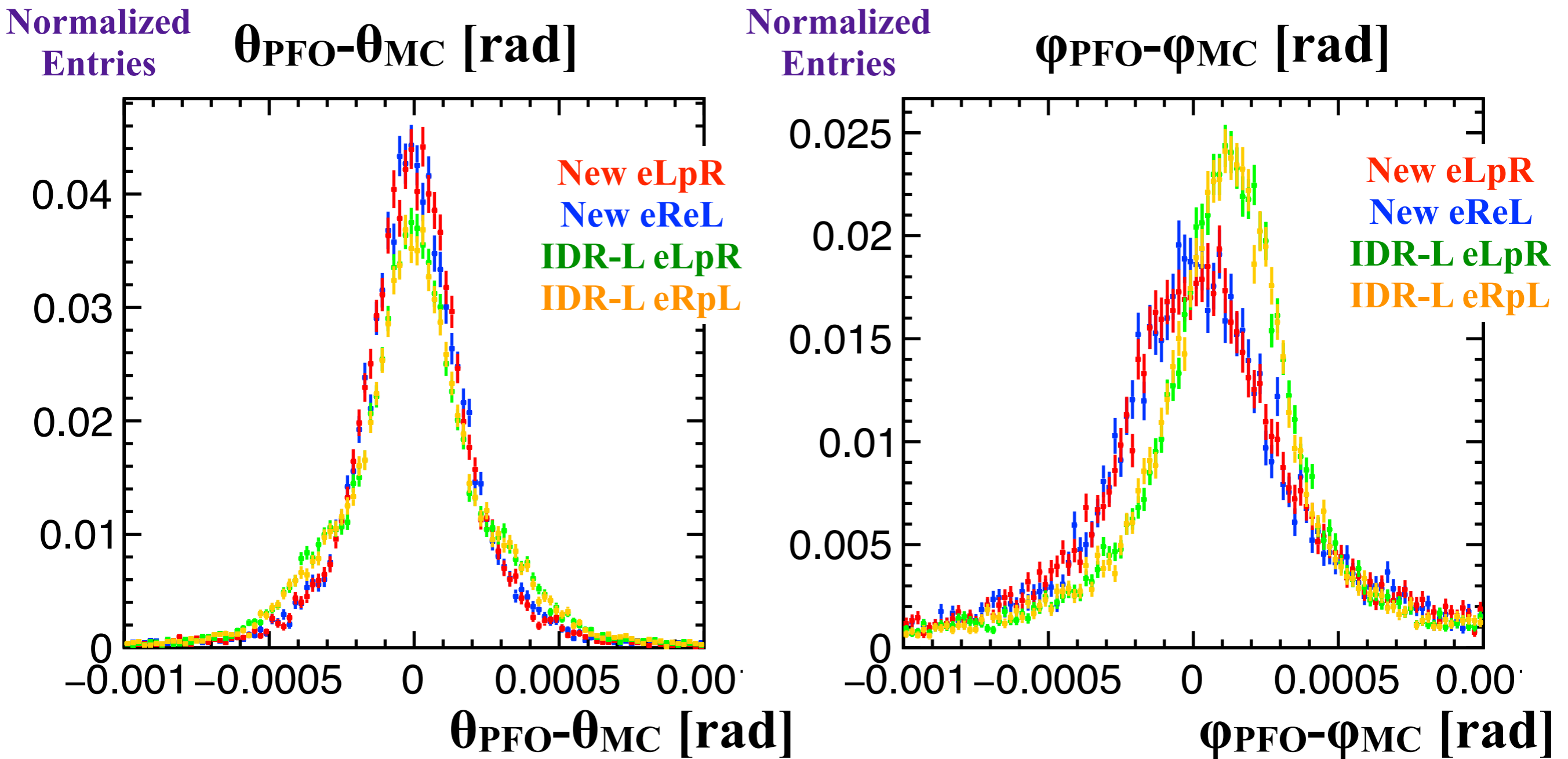
(photonEAnl-photonEMC) {photonEMC>50.&& abs(pdg0)==13} eLpR sample

Entries



In the correct photon selection case, the bump remains.

Distribution of PFO Photon Angles Differences



For both θ and φ , mean value is corrected to 0.

Conclusion

- **As for the photon energy, mean value is corrected to 0, though a bump exists in positive region. Very forward and backward photons are likely to make bumps.**
- **For both θ and φ , mean value is corrected to 0.**

Back up

Signal Photon Selection

In order to choose the signal photon,

1. choose neutral particles with particle ID = 22
(Pandora PFA ID)

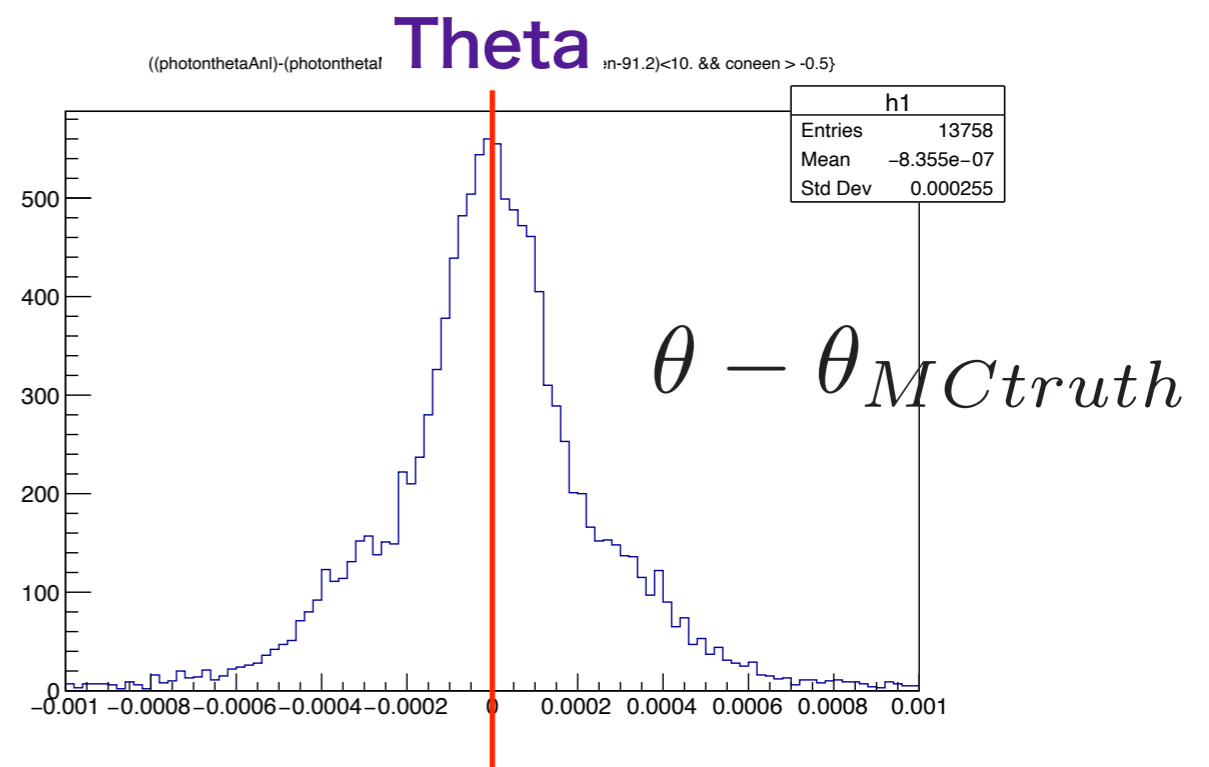
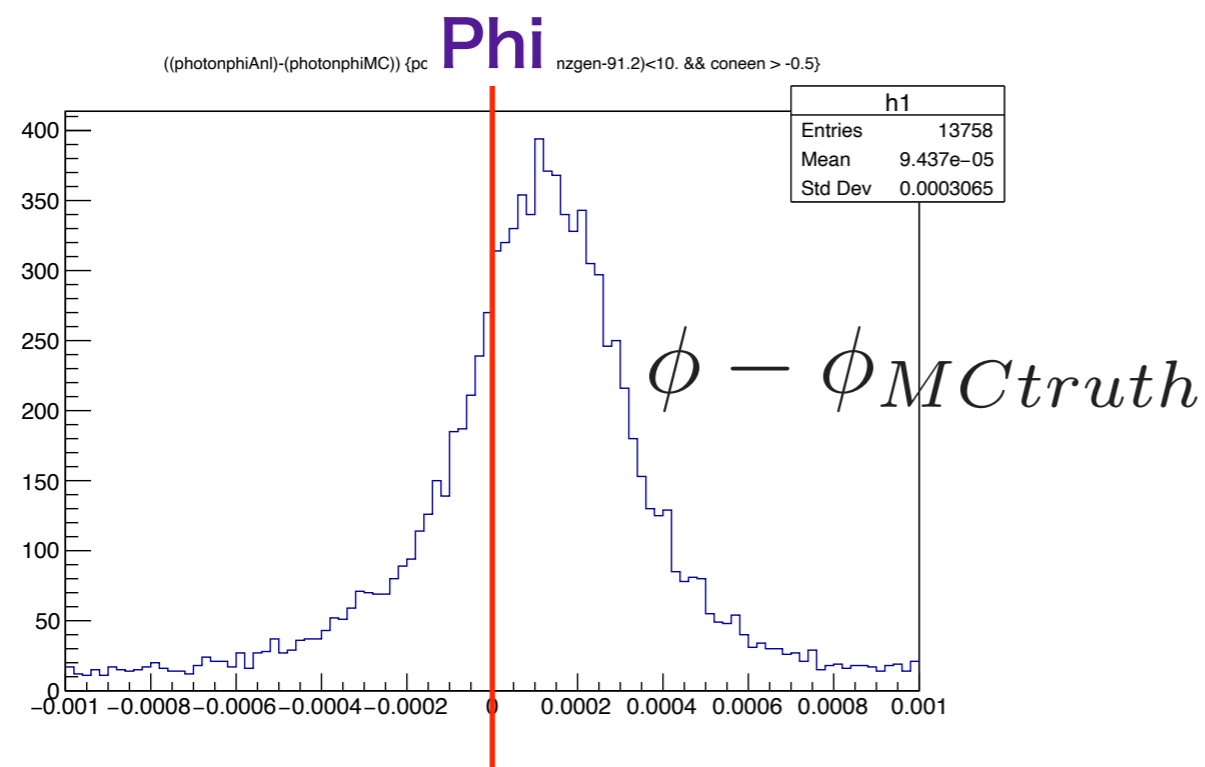
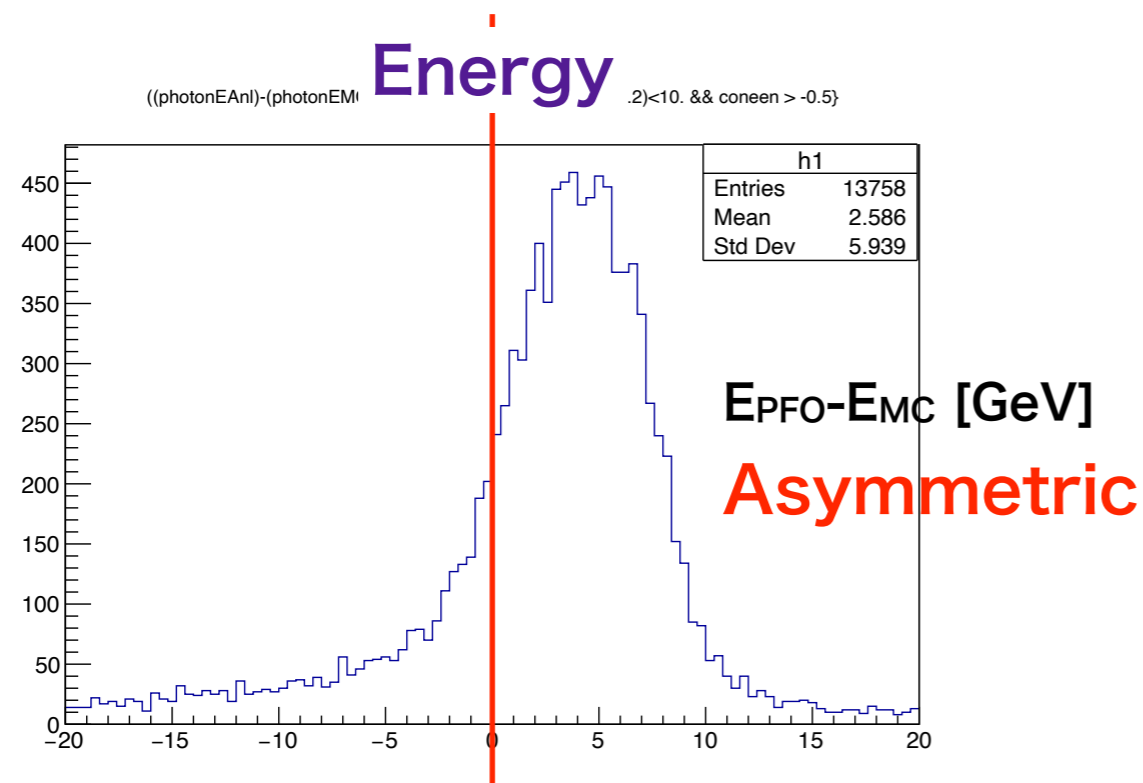
2. energy > 50 GeV

3. choose the particle closest to 109 (242) GeV

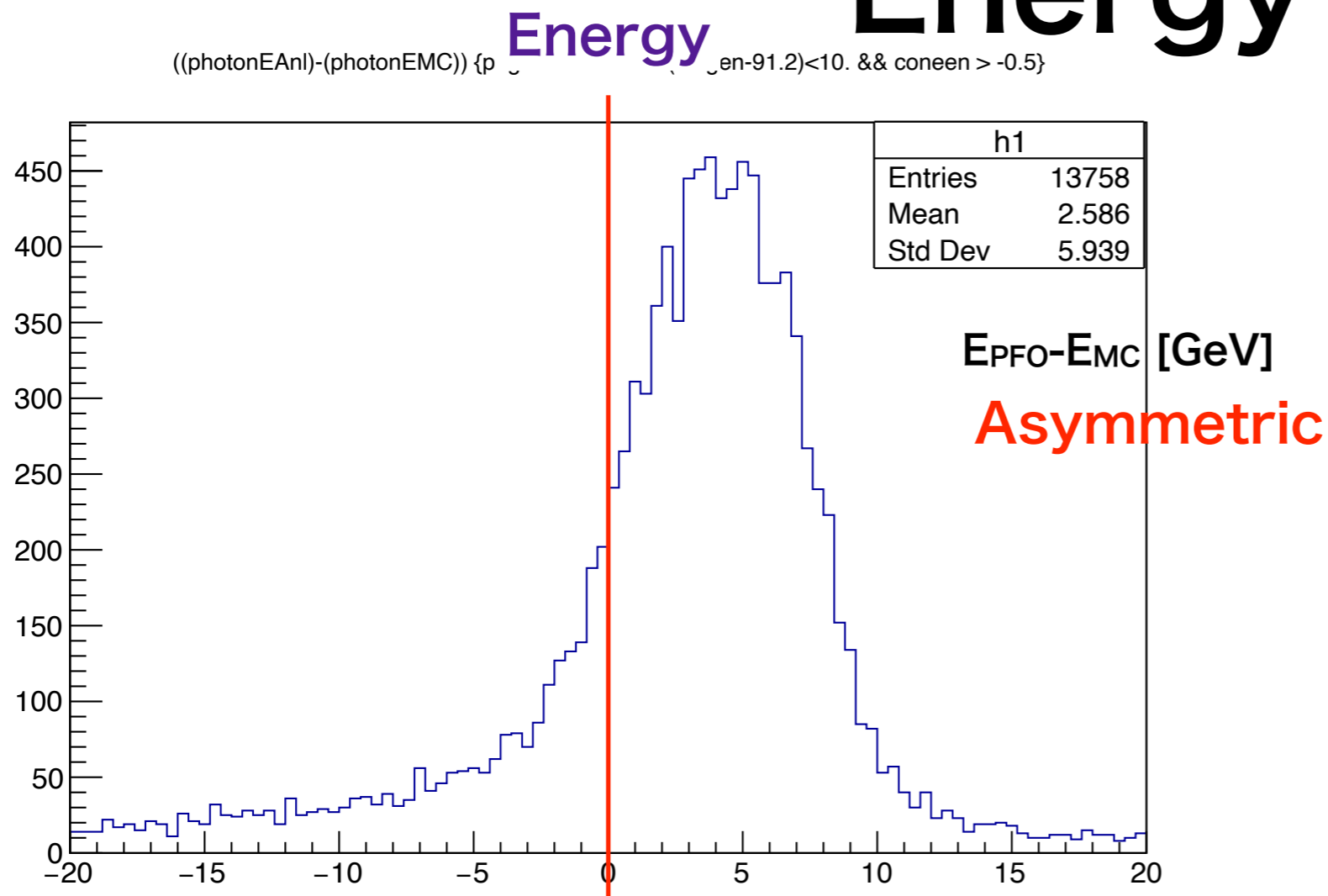
If another photon is inside the cone (with the angle $\cos\theta > 0.998$ from the signal photon), it is merged with the signal photon.

Distribution of PFO Photon Energy and Angle

Samples:
 $|M(\mu^+\mu^-) - 91.2| < 10 \text{ GeV}$
 Large ILD model



Distribution of PFO Photon Energy

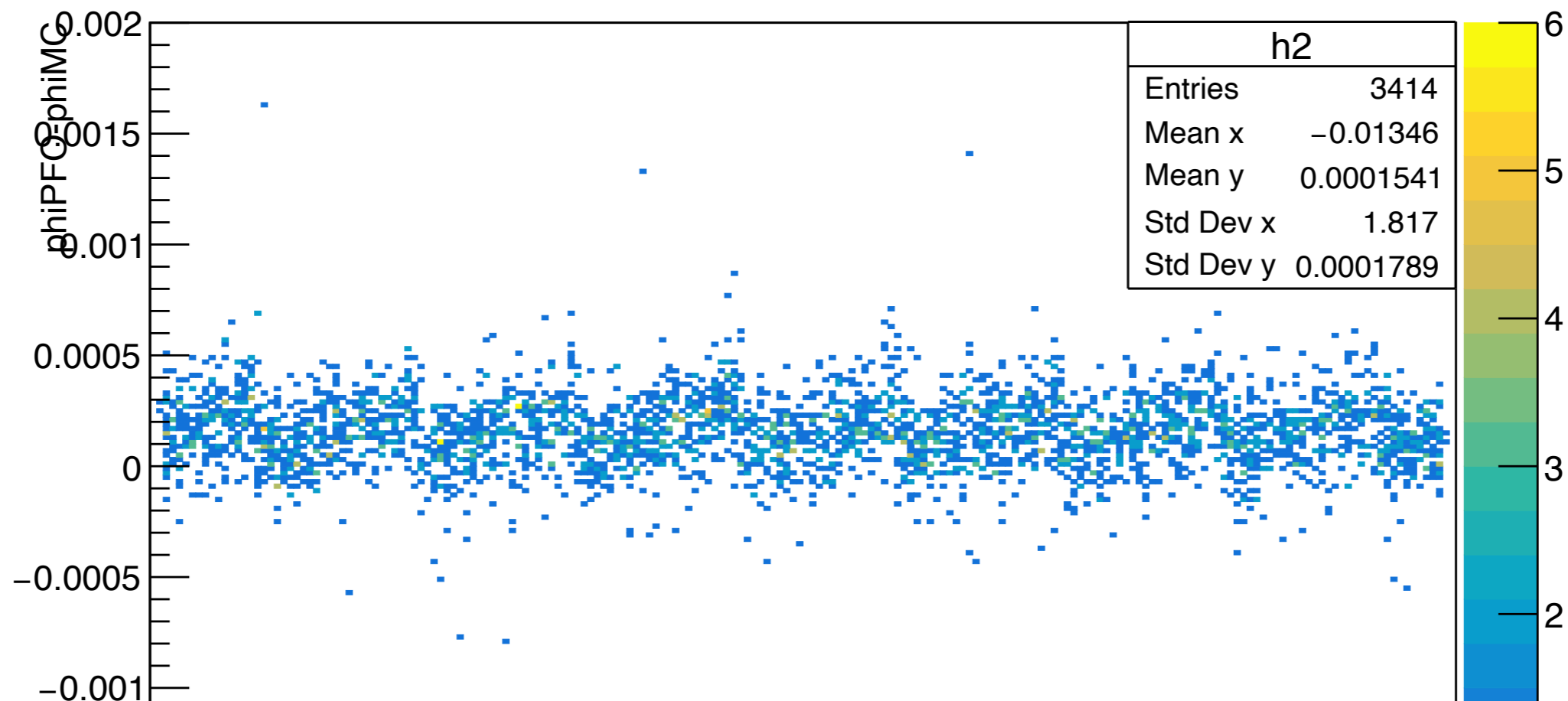


- Most likely it seems to come from a miscalibration of the electromagnetic scale for the HCal in PandoraPFA.

$\phi_{\text{PFO}} - \phi_{\text{MC}}$ against ϕ_{MC}

photonphiAnl-photonphiMC:photonphiMC {pdg0==13 && coneen>.5 && abs(mzgen-91.2)<10 && abs(cos(photonthetaMC))<.75}

Samples:
 $|M(\mu^+\mu^-)-91.2| < 10 \text{ GeV}$
 $|\cos\theta(\gamma)| < 0.75$
 Large ILD model



- Although fluctuation due to the overlap region in the octagonal shaped detector has appeared, all ϕ_{PFO} seems to be soaring evenly. The deviation of the mean corresponds to $\sim 280 \mu\text{m}$ deviation (at the ECal inner surface).