Invariant Mass Study in CEPC Crystal ECAL
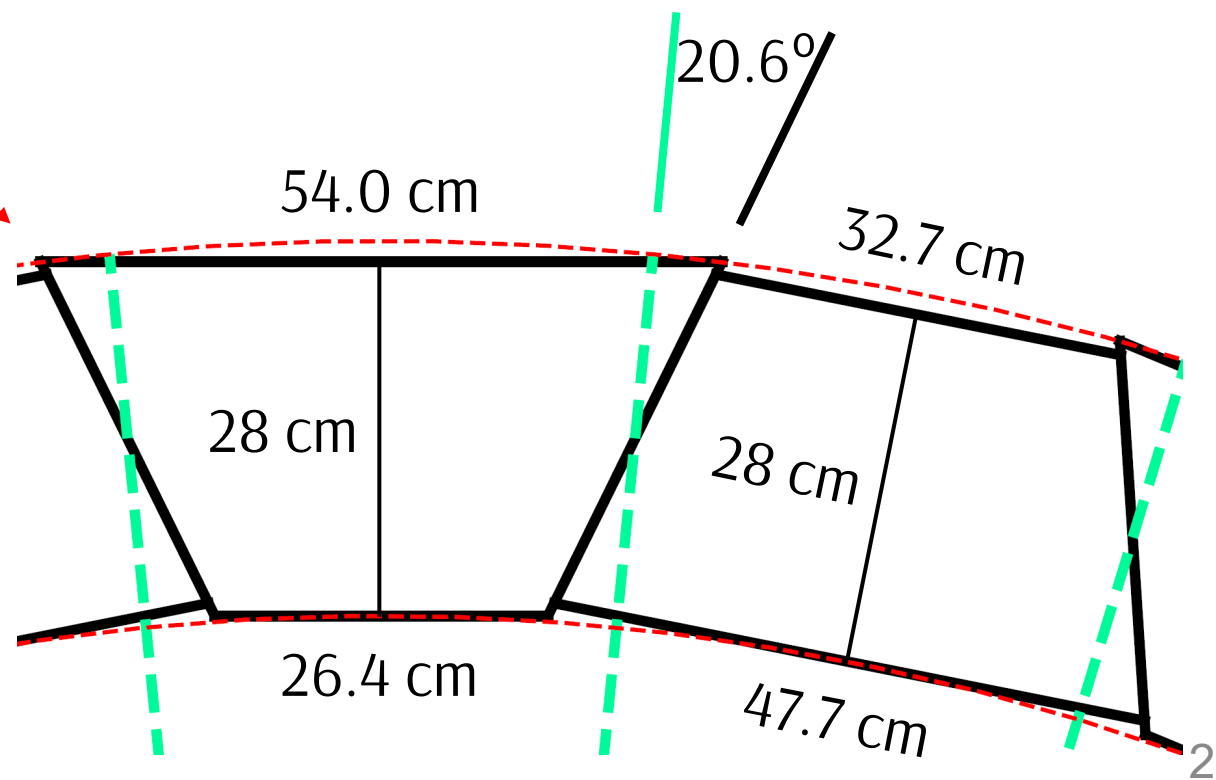
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ECAL Set-up

1.90 m

< 2.20 m

54.0 cm

20.6°

32.7 cm

28 cm

28 cm

26.4 cm

47.7 cm

2
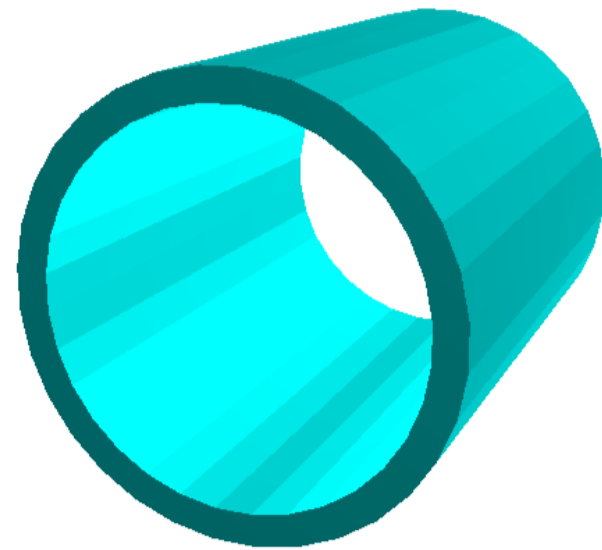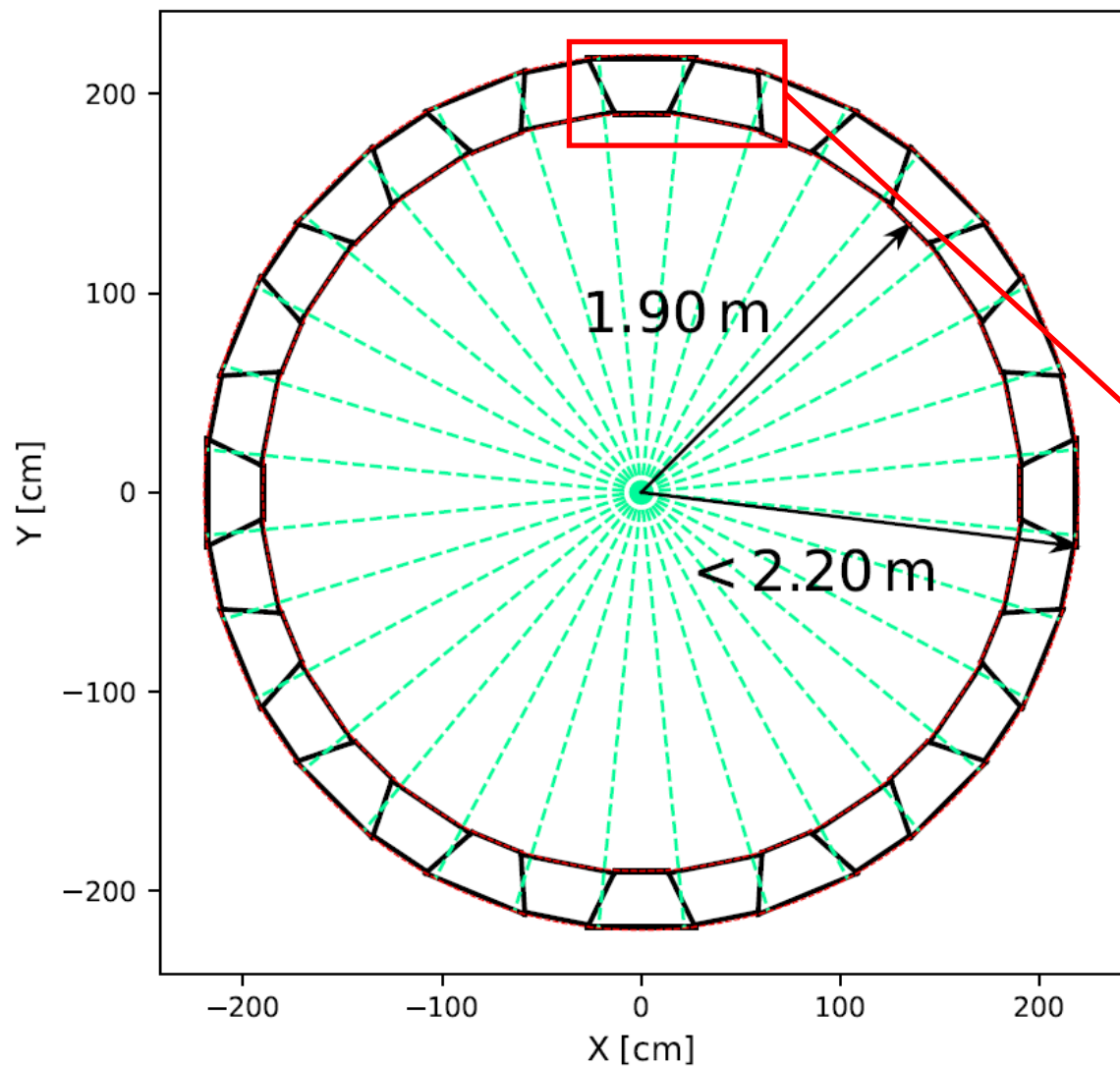
ECAL Set-up

- **Crystal size:** $1 \times 1 \times 1\ \text{cm}^3$.

- **Barrel length:** 5.9 m. 15 blocks in z direction, each with length ~39 cm.

- **Dead material:** PCB, Cu, ESR, SiPM, with thicknesses in the order of nm for now.

- **Layer thickness:** ~1 cm.

- **Layer correspondence:** Same thickness, but layer does not correspond to layer in adjacent positive–negative trapezia modules.

- **Edge effect:** Stair-like edges between modules, 1st-order effect; ignore for now.

- **Others:** Staggered structure in φ direction (one shift per 3 or 4 layers).

MC Samples

- **Detector construction:** Beam pipe, vertex detector, Si tracker, TPC, barrel ECAL, barrel HCAL. No endcap detector.

- **Physics process:** $H \rightarrow \gamma\gamma$, 5k events.

- **Digitisation:** Very preliminary algorithm.

Selecting the 'Good' Photons

- A 'good' event must have 2 'good' photons.
- Selection criteria (cut flow), at least one 'good' photon:
  - Generator status = 1; ⎤
  - PDGID = 22;   ⎦ Prerequisite
  - Direction: $\theta \in \left[\frac{\pi}{4}, \frac{3\pi}{4}\right]$; → 4324
  - Momentum (energy): $p \geq 30$ GeV; → 4320
  - Endpoint position: $r = \sqrt{x^2 + y^2} \geq 1900$ (mm). → 4149
- Number of 'good' events: 2571/5000.
- Branch 'ArborPFO' in reconstruction file was used in the following studies.
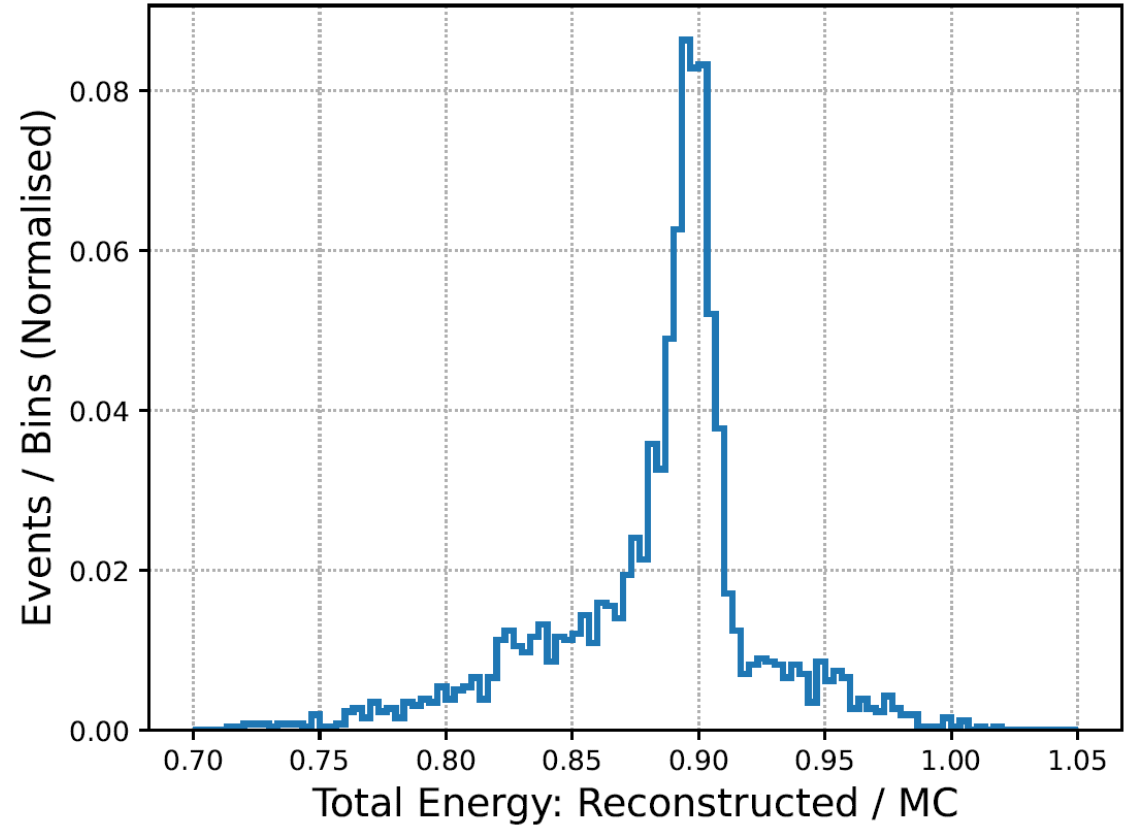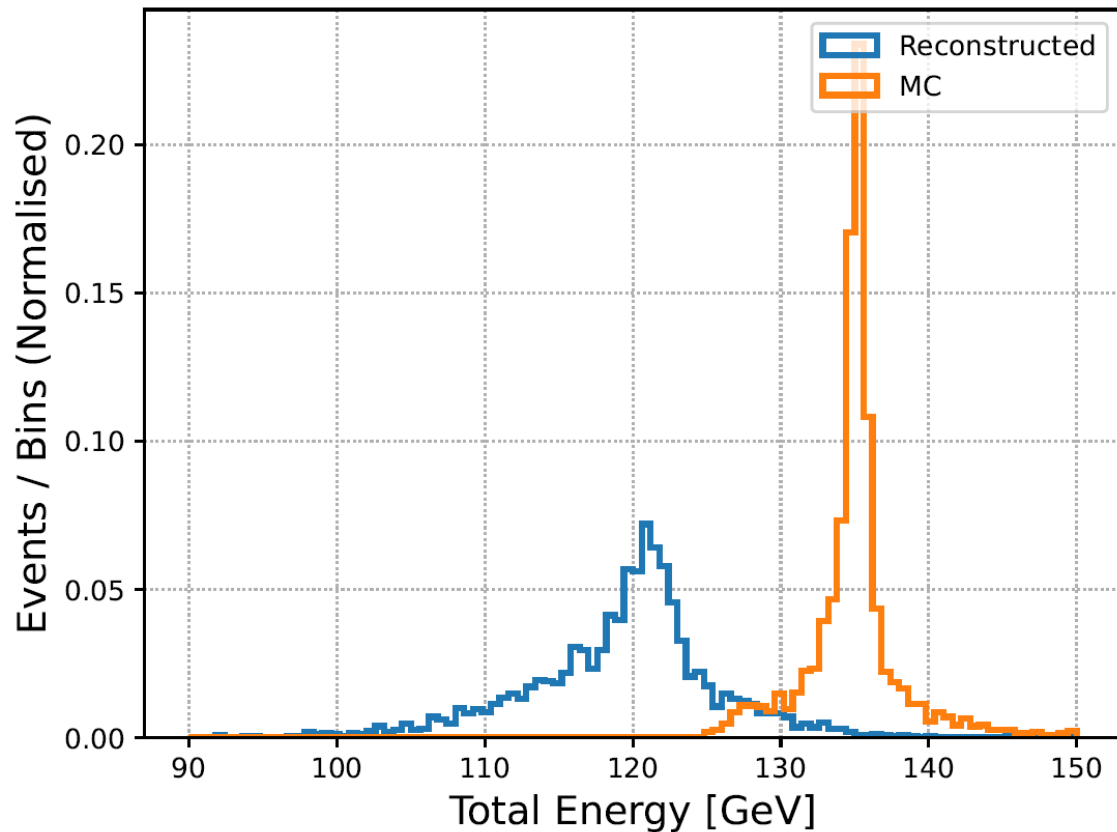- Core energy threshold for Marlin Arbor: 20 MeV.
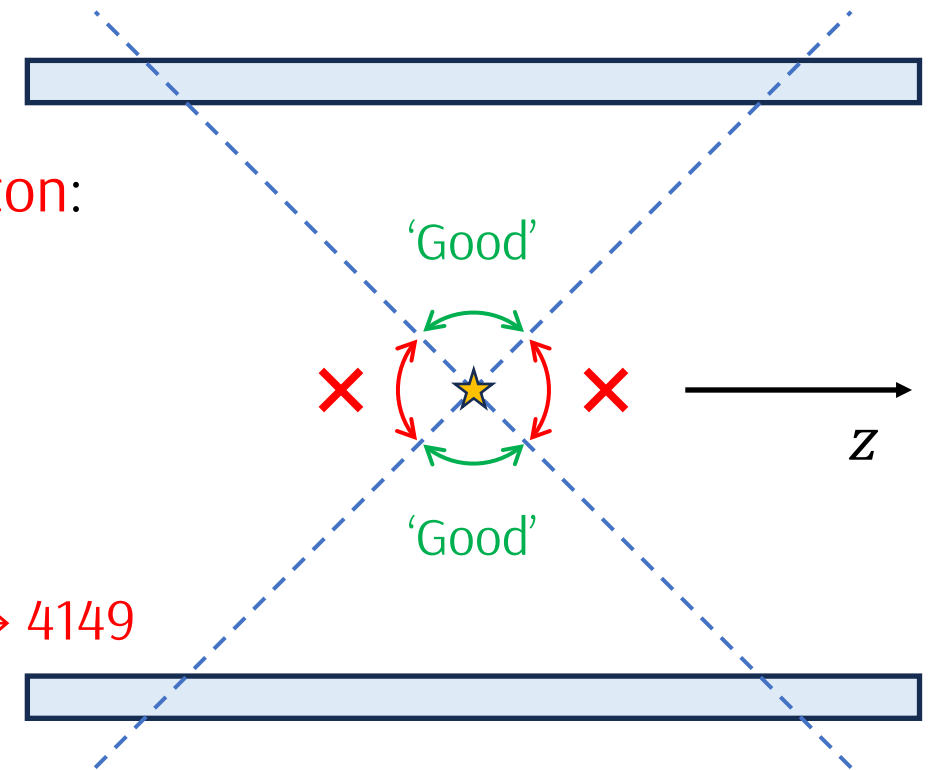
Number of Reconstructed Objects

- **Figure:** The number of reconstructed objects. The most probable value is 2.
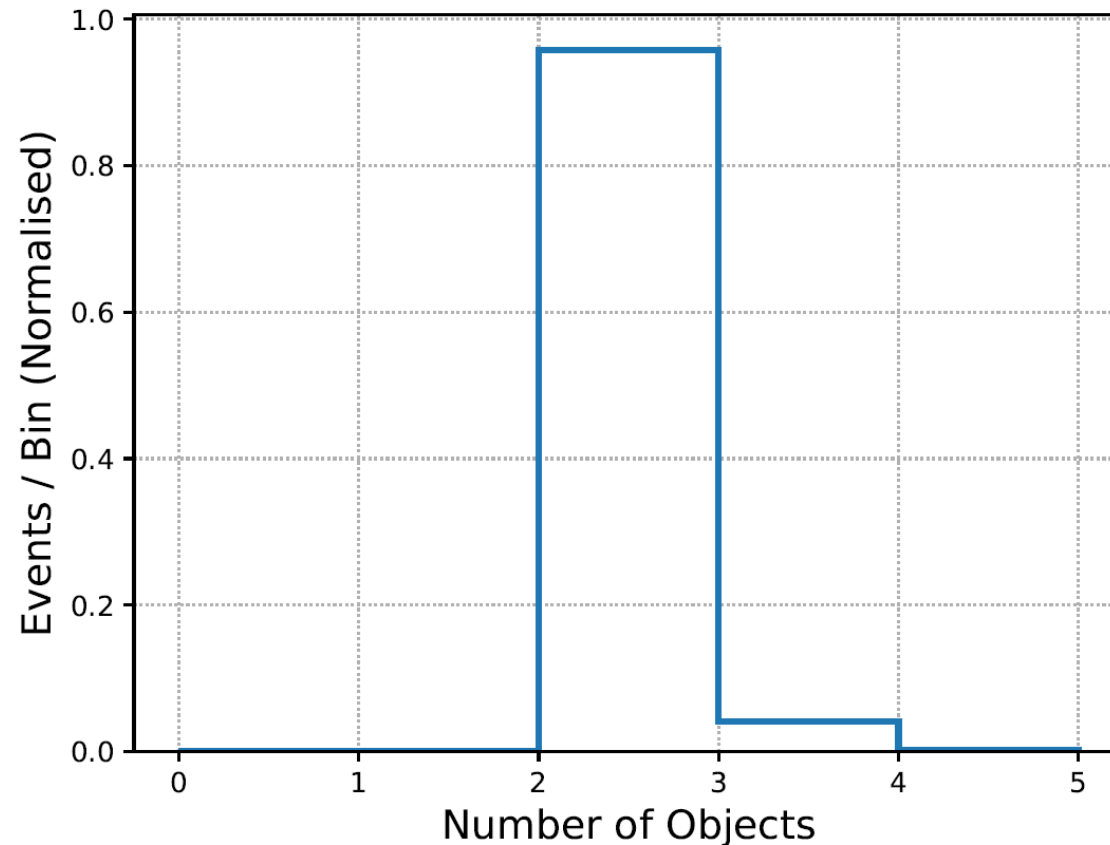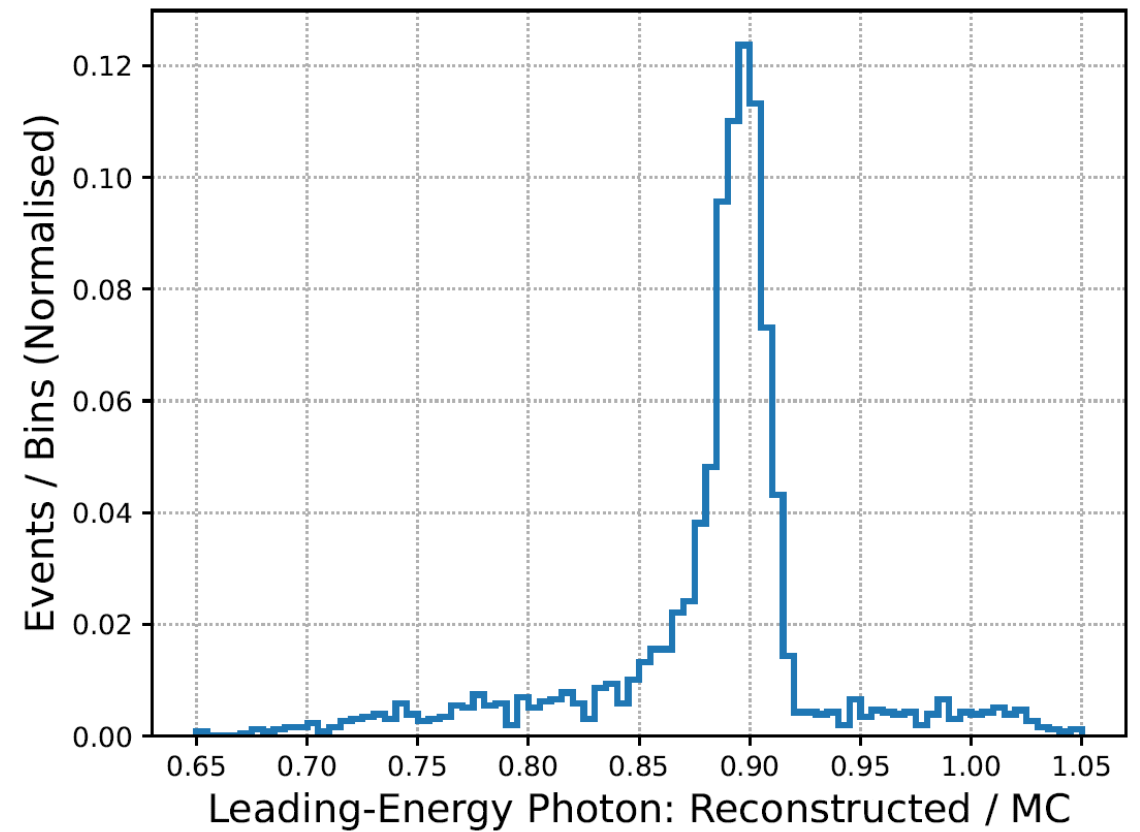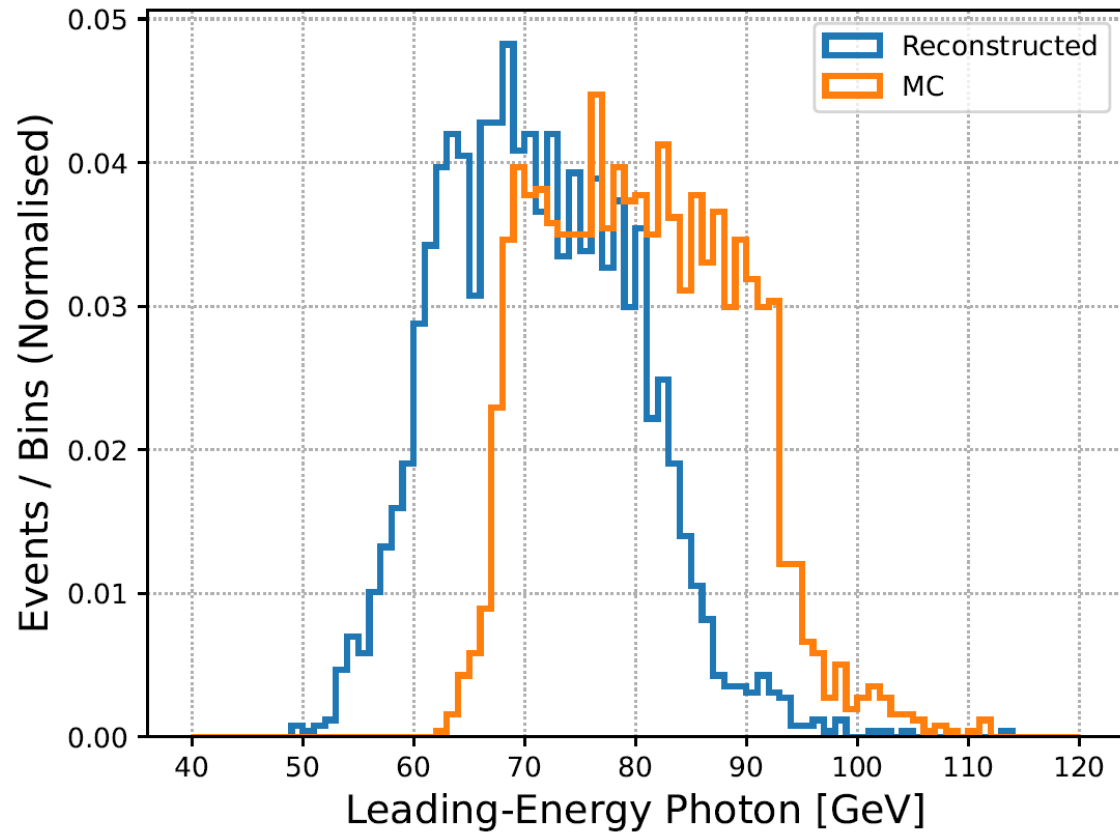
Energy Reconstruction
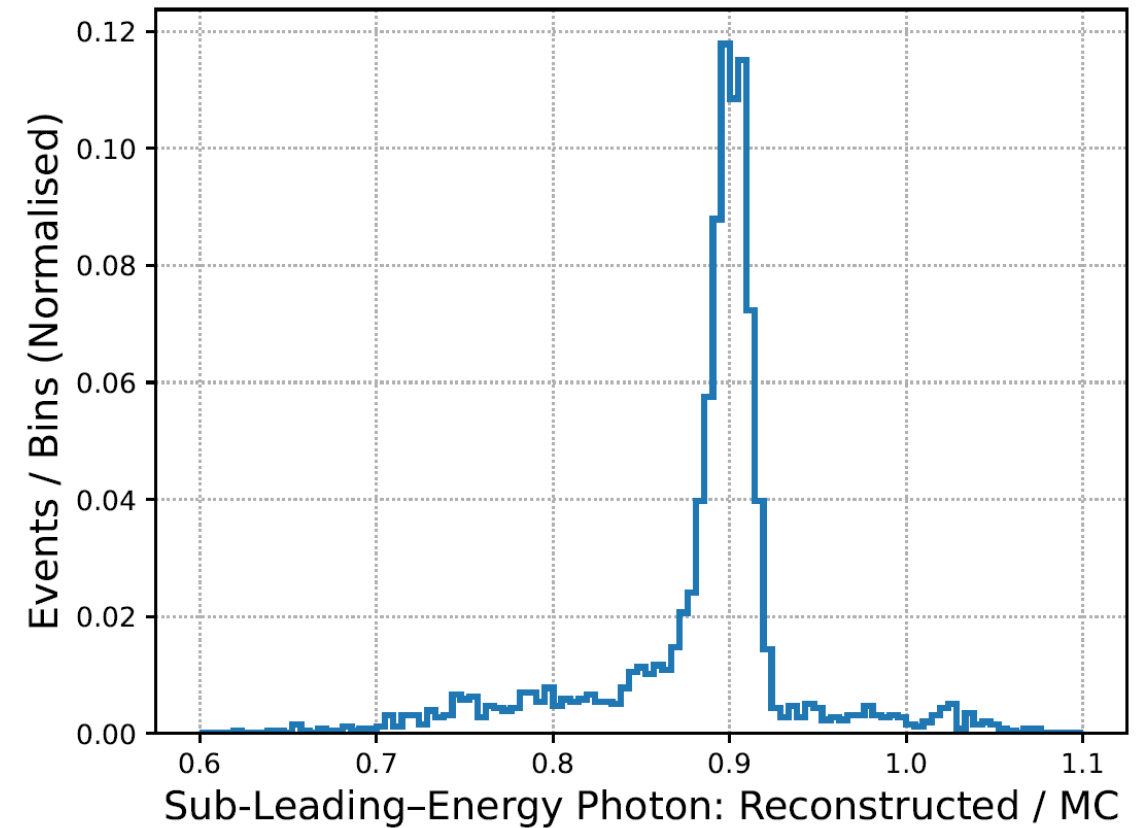
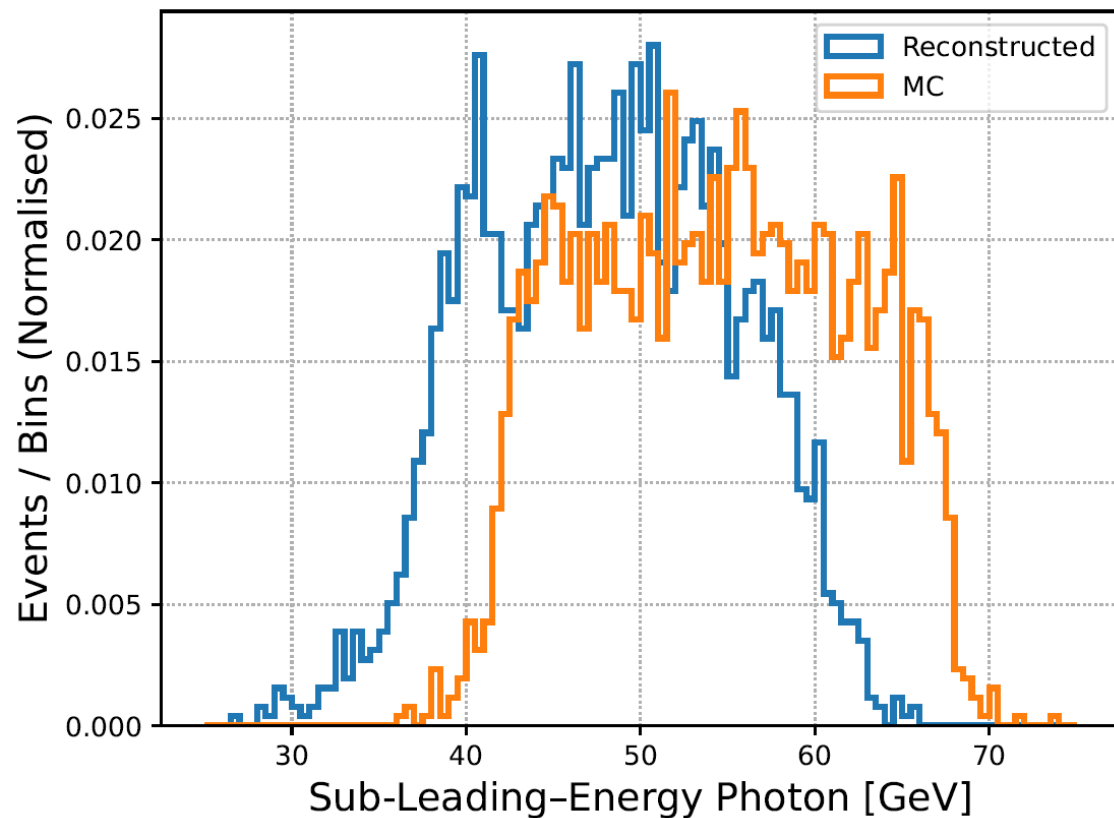- **Figures:** Total energy (left) and ratio (right).

Leading-Energy Photon

- **Figures:** Energy reconstruction of leading-energy photon (left) and ratio (right).
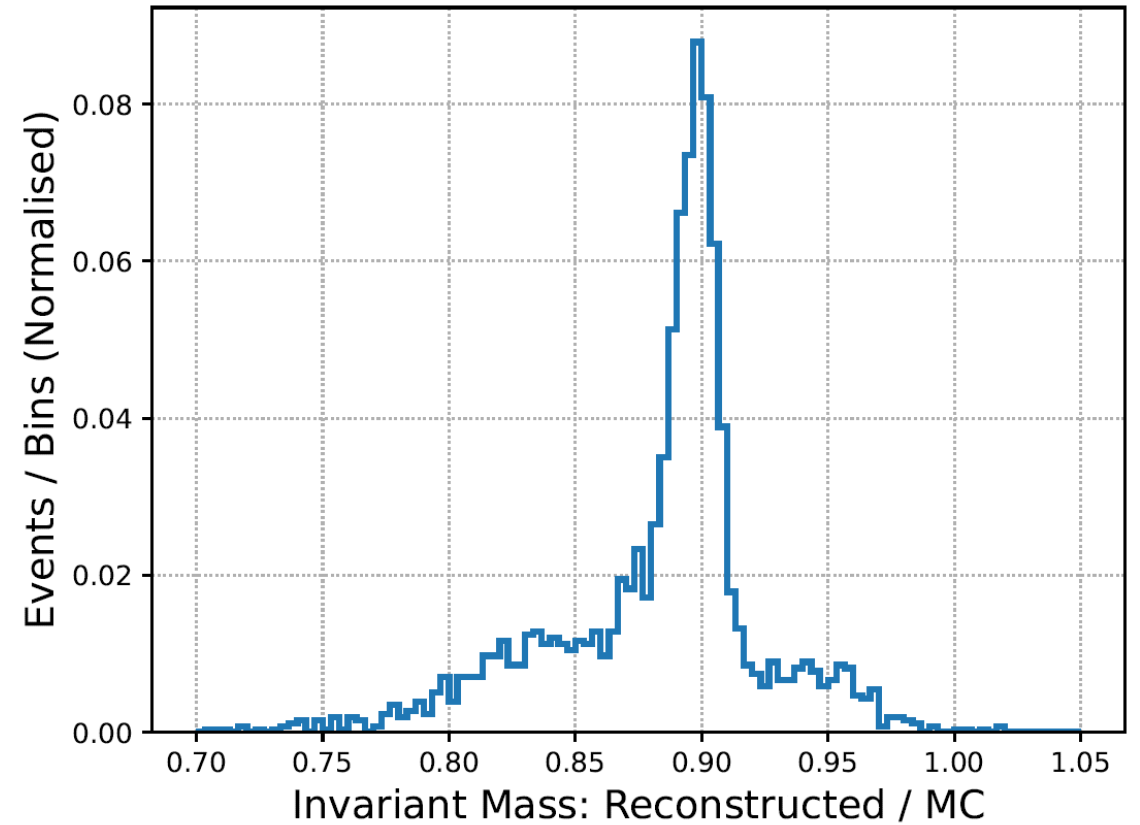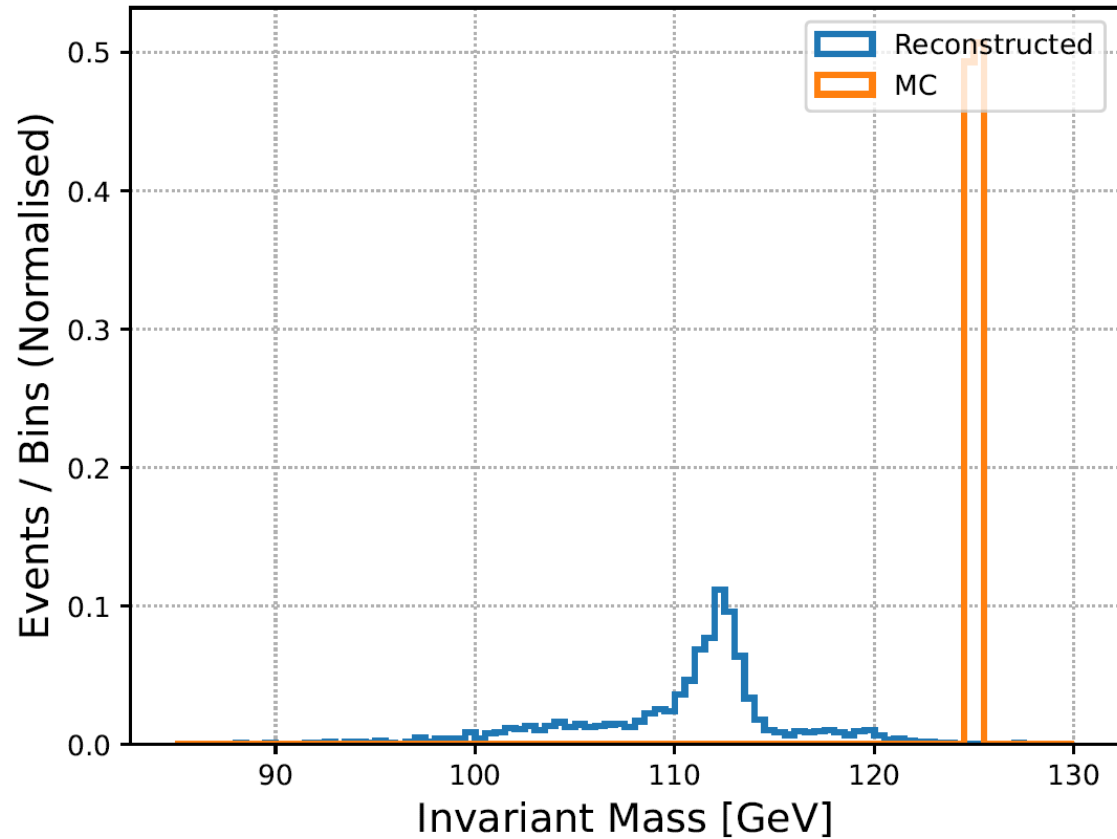
Sub-Leading–Energy Photon

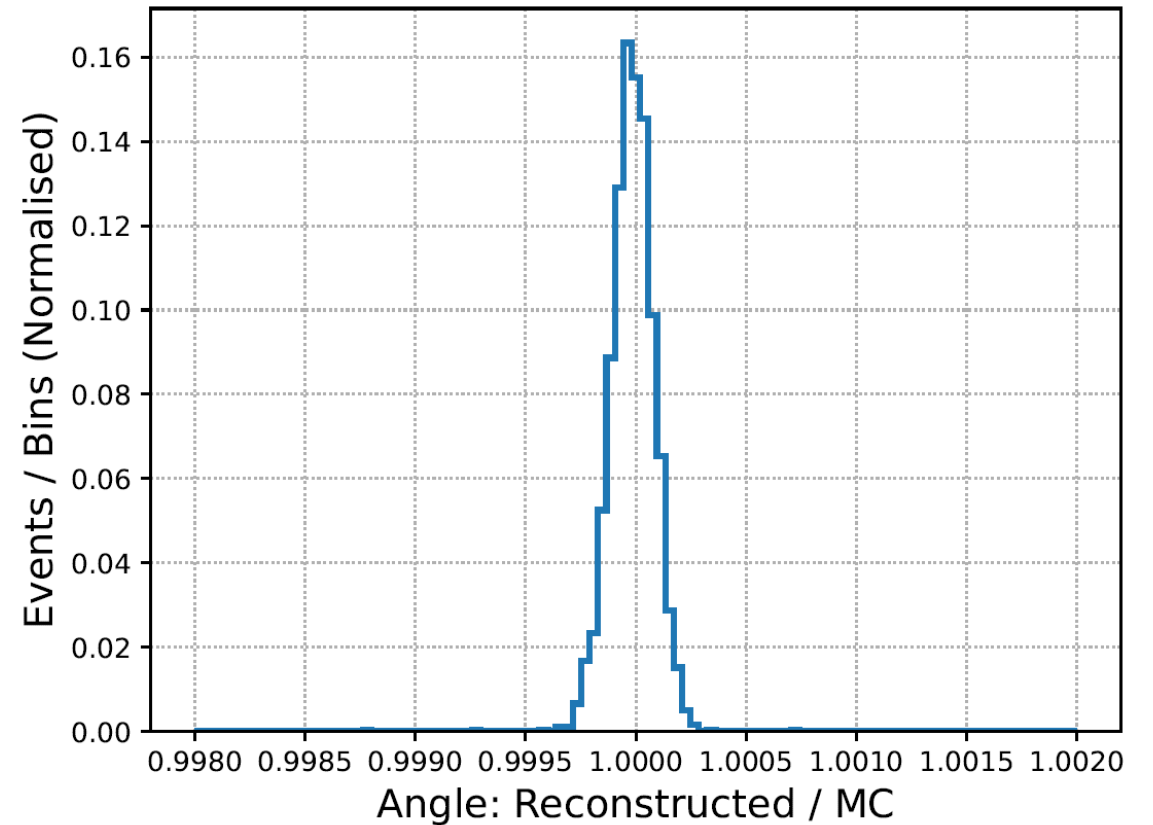- **Figures:** Energy reconstruction of sub-leading–energy photon (left) and ratio (right).

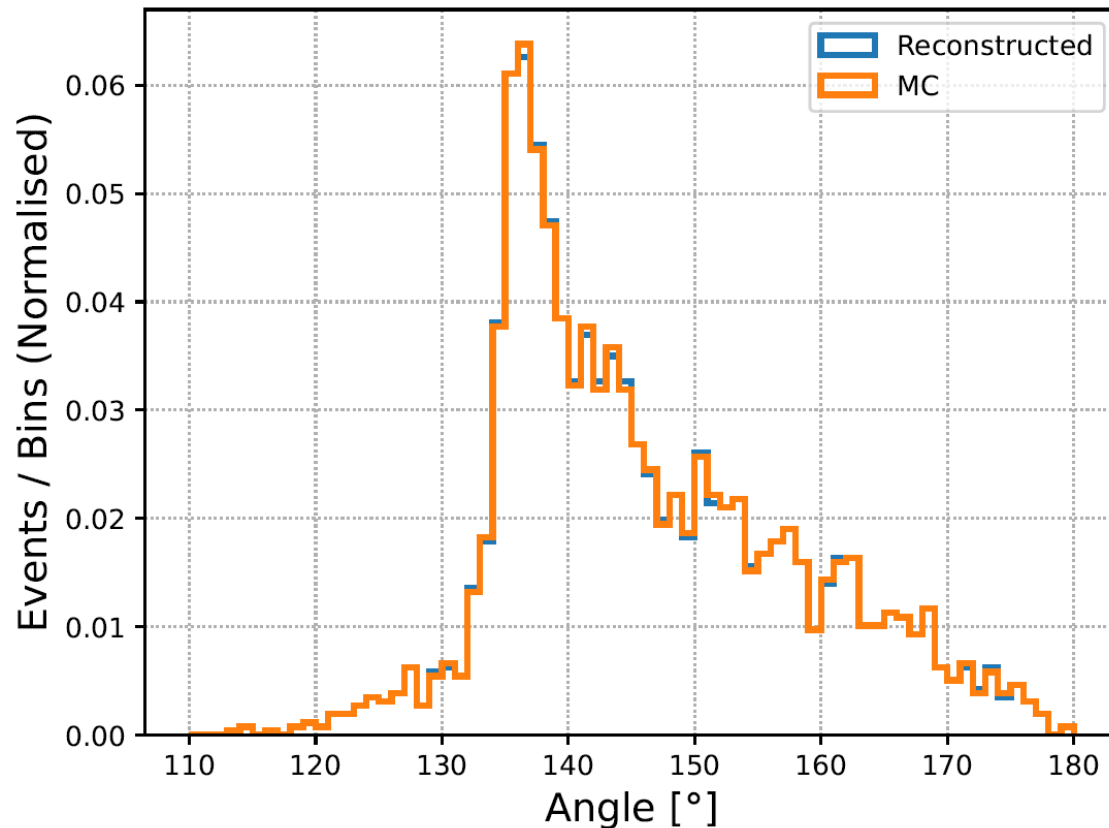# Invariant Mass

- **Figures:** Invariant mass of $H \to \gamma\gamma$ process (left) and ratio (right).

Angle Between Photons

- **Figures:** Angle between photons (left) and ratio (right).

Results

- In terms of spatial distribution, the reconstructed photons match MC photons well.

- In terms of energy, the peak satisfies $E_{\mathrm{rec}} \approx 0.9 E_{\mathrm{MC}}$.

- According to previous studies by Zhiyu, for the energy-related figures, photon-on-edge events contribute to the long tail on two sides.

- It seems that not all hits are used to correctly reconstruct PFOs, especially in photon-on-edge events...