Update on e+e- -> Z gamma benchmark analysis

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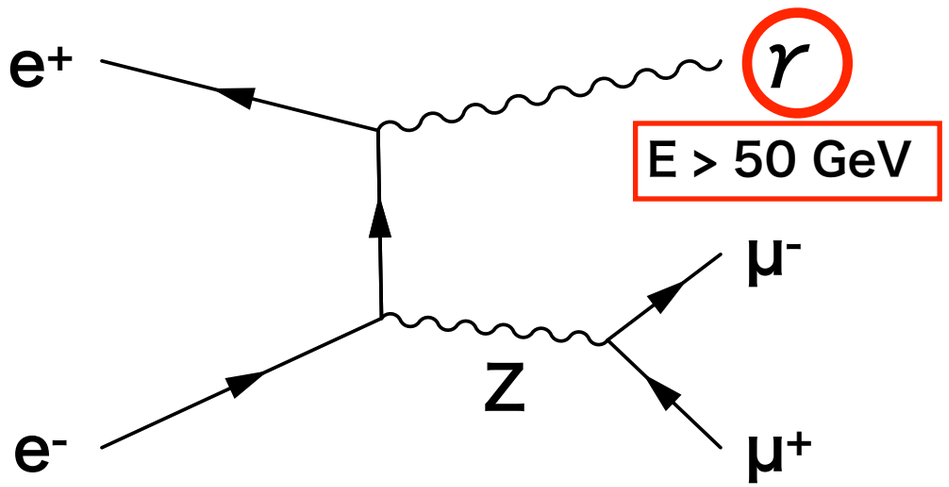
Status report on e^+e^- -> gamma Z analysis

- I'm working on **photon energy calibration** using **measured direction angles of μ^-, μ^+ and γ.**

- I checked
  (1) the correspondence between reconstructed energy and MCtrue energy
  (2) photon energy resolution

Determine the energy of photon and muons based on measured direction angle



Direction Angle
θ: azimuthal angle
ϕ: polar angle

- **4-momentum conservation is considered.**
- **The mass of muon is neglected.**

Case 1:
Using ($\theta_{\mu^-}, \theta_{\mu^+}, \theta_{\gamma}, \phi_{\mu^-}, \phi_{\mu^+}, \phi_{\gamma}$)
-> Determine ($E_{\mu^-}, E_{\mu^+}, E_{\gamma}$)

Case 2: Consider **Beamstrahlung**
Using ($\theta_{\mu^-}, \theta_{\mu^+}, \theta_{\gamma}, \phi_{\mu^-}, \phi_{\mu^+}, \phi_{\gamma}$)
-> Determine ($E_{\mu^-}, E_{\mu^+}, E_{\gamma}, E_{ISR}$)

Case 3: Consider **Beamstrahlung** and **Crossing Angle**
Using ($\theta_{\mu^-}, \theta_{\mu^+}, \theta_{\gamma}, \phi_{\mu^-}, \phi_{\mu^+}, \phi_{\gamma}$)
-> Determine ($E_{\mu^-}, E_{\mu^+}, E_{\gamma}, E_{ISR}$)

- **Case 1**

$$\begin{cases} E_\mu + E_{\mu^+} + E_\gamma = 500 \\ E_\mu sin\theta_\mu cos\phi_\mu + E_{\mu^+} sin\theta_{\mu^+} cos\phi_{\mu^+} + E_\gamma sin\theta_\gamma cos\phi_\gamma = 0 \\ E_\mu sin\theta_\mu sin\phi_\mu + E_{\mu^+} sin\theta_{\mu^+} sin\phi_{\mu^+} + E_\gamma sin\theta_\gamma sin\phi_\gamma = 0 \\ E_\mu cos\theta_\mu + E_{\mu^+} cos\theta_{\mu^+} + E_\gamma cos\theta_\gamma = 0 \end{cases}$$

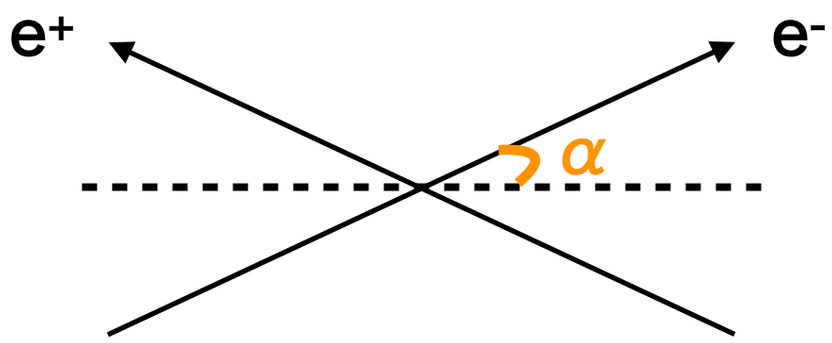
- **Case2: Consider Beamstrahlung**

$$\begin{cases} E_\mu + E_{\mu^+} + E_\gamma + |P_{ISR}| = 500 \\ E_\mu sin\theta_\mu cos\phi_\mu + E_{\mu^+} sin\theta_{\mu^+} cos\phi_{\mu^+} + E_\gamma sin\theta_\gamma cos\phi_\gamma = 0 \\ E_\mu sin\theta_\mu sin\phi_\mu + E_{\mu^+} sin\theta_{\mu^+} sin\phi_{\mu^+} + E_\gamma sin\theta_\gamma sin\phi_\gamma = 0 \\ E_\mu cos\theta_\mu + E_{\mu^+} cos\theta_{\mu^+} + E_\gamma cos\theta_\gamma + P_{ISR} = 0 \end{cases}$$

- **Case 3: Consider Beamstrahlung + Crossing Angle**

$$\begin{cases} E_\mu + E_{\mu^+} + E_\gamma + |P_{ISR}| = 500 \\ E_\mu sin\theta_\mu cos\phi_\mu + E_{\mu^+} sin\theta_{\mu^+} cos\phi_{\mu^+} + E_\gamma sin\theta_\gamma cos\phi_\gamma + |P_{ISR}| sin\alpha = 500 sin\alpha \\ E_\mu sin\theta_\mu sin\phi_\mu + E_{\mu^+} sin\theta_{\mu^+} sin\phi_{\mu^+} + E_\gamma sin\theta_\gamma sin\phi_\gamma = 0 \\ E_\mu cos\theta_\mu + E_{\mu^+} cos\theta_{\mu^+} + E_\gamma cos\theta_\gamma \pm |P_{ISR}| cos\alpha = 0 \end{cases}$$

Crossing Angle ($\equiv 2\alpha$)



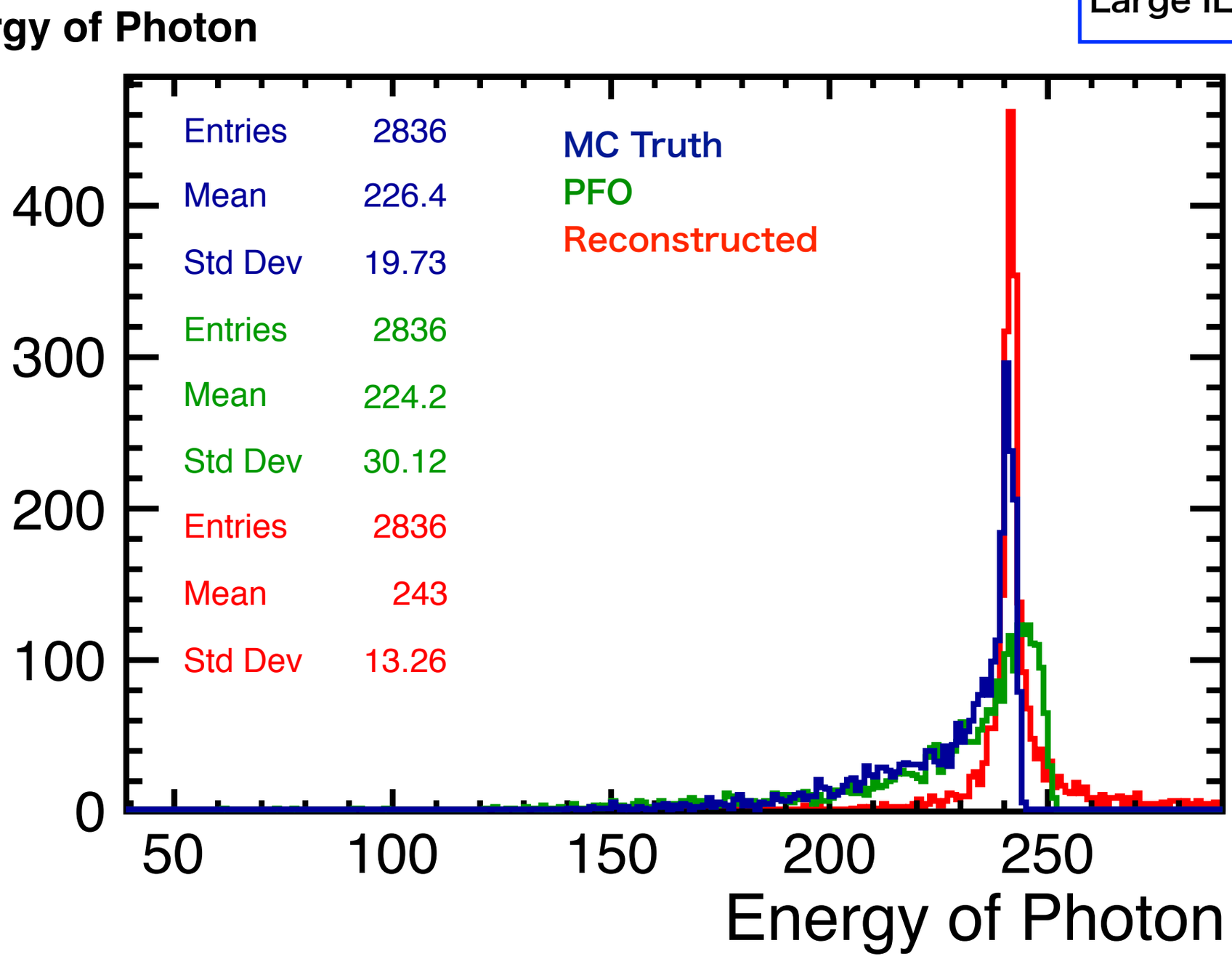
α = 7.2993 mrad

Case 1:

Using (θ_{μ^-}, θ_{μ^+}, θ_{γ}, ϕ_{μ^-}, ϕ_{μ^+}, ϕ_{γ})

-> Determine (E_{μ^-}, E_{μ^+}, E_{γ})

Samples:
|cos(μ)| < 0.75
$|M(\mu^+\mu^-)-91.2| < 10$ GeV
Large ILD model



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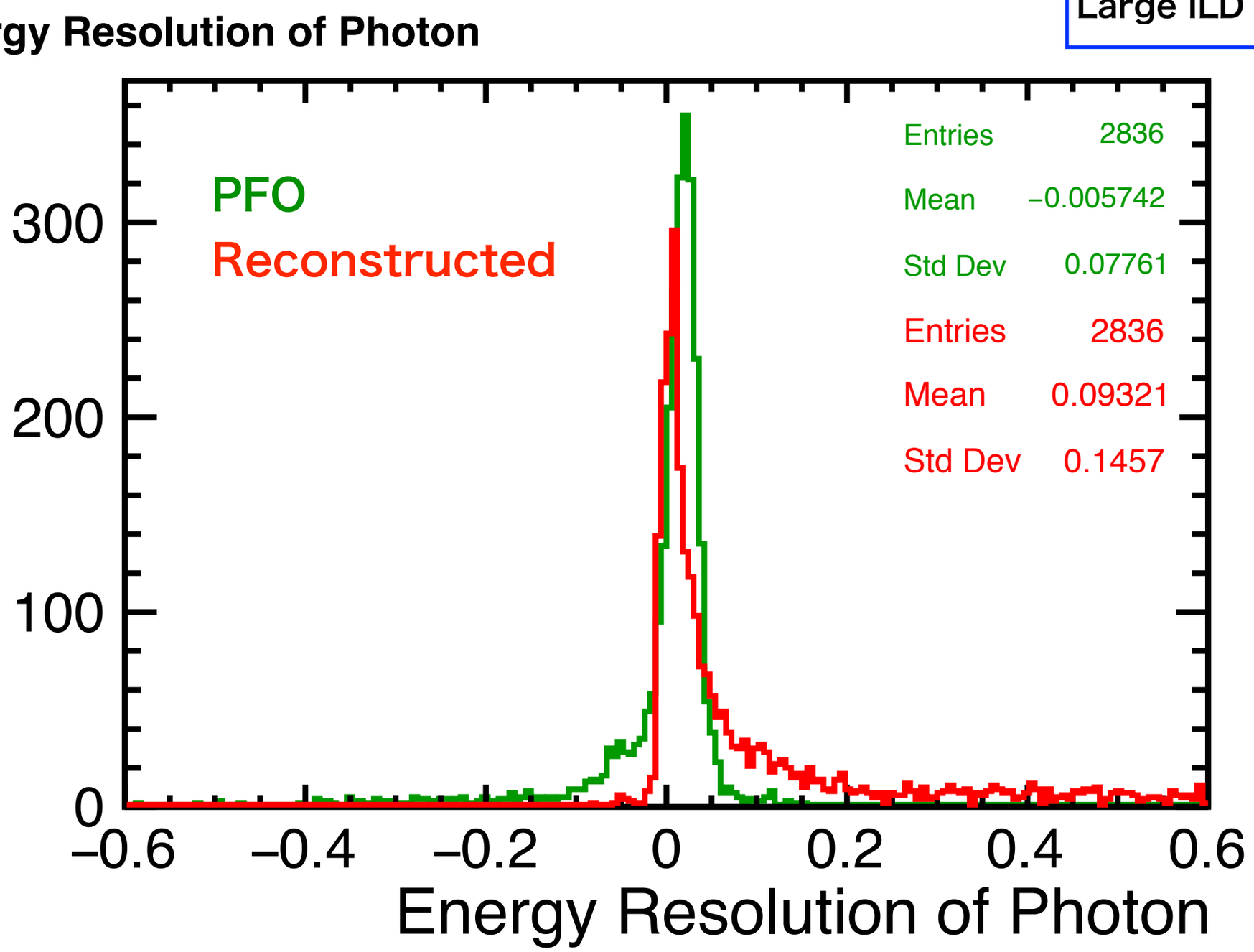

Case 2: Consider Beamstrahlung

Using (θ_{μ^-}, θ_{μ^+}, θ_{γ}, ϕ_{μ^-}, ϕ_{μ^+}, ϕ_{γ})

-> Determine (E_{μ^-}, E_{μ^+}, E_{γ}, E_{ISR})

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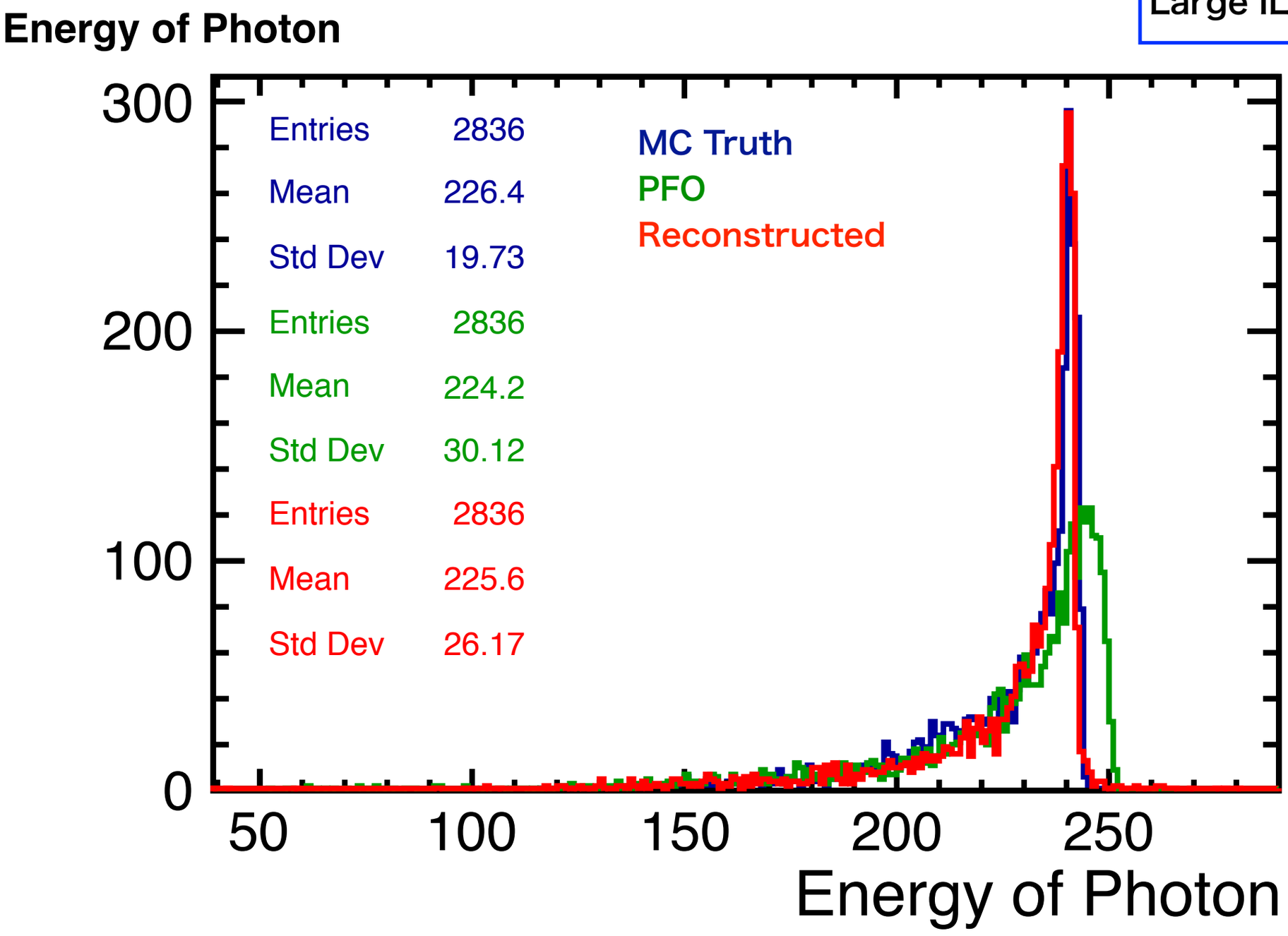

Case 2: Consider **Beamstrahlung**

Using (θ_{μ^-}, θ_{μ^+}, θ_{γ}, ϕ_{μ^-}, ϕ_{μ^+}, ϕ_{γ})

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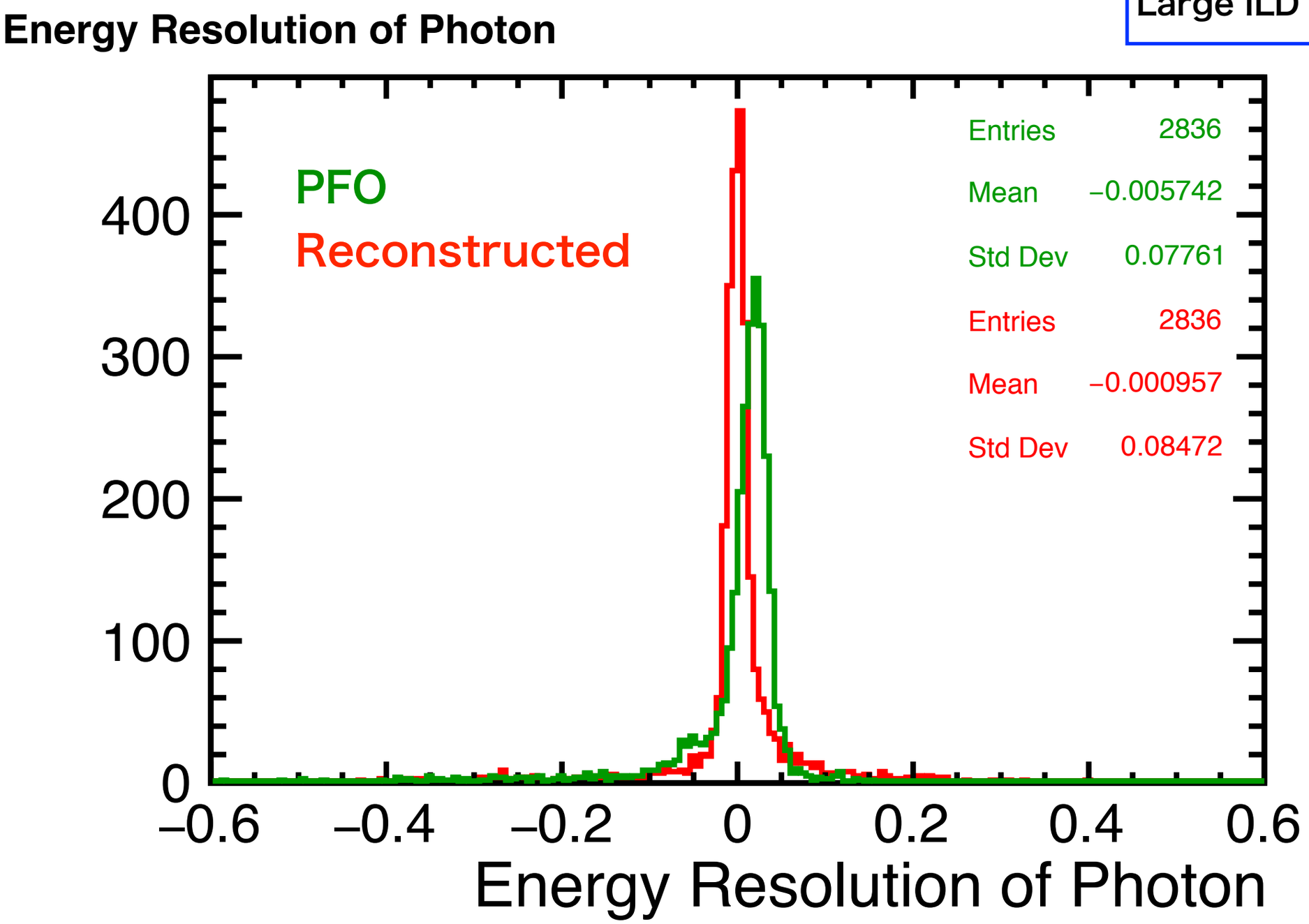

Case 3: Add the effect of Crossing Angle

Using (θ_{μ^-}, θ_{μ^+}, θ_{γ}, ϕ_{μ^-}, ϕ_{μ^+}, ϕ_{γ})

-> Determine (E_{μ^-}, E_{μ^+}, E_{γ}, E_{ISR})

Samples:
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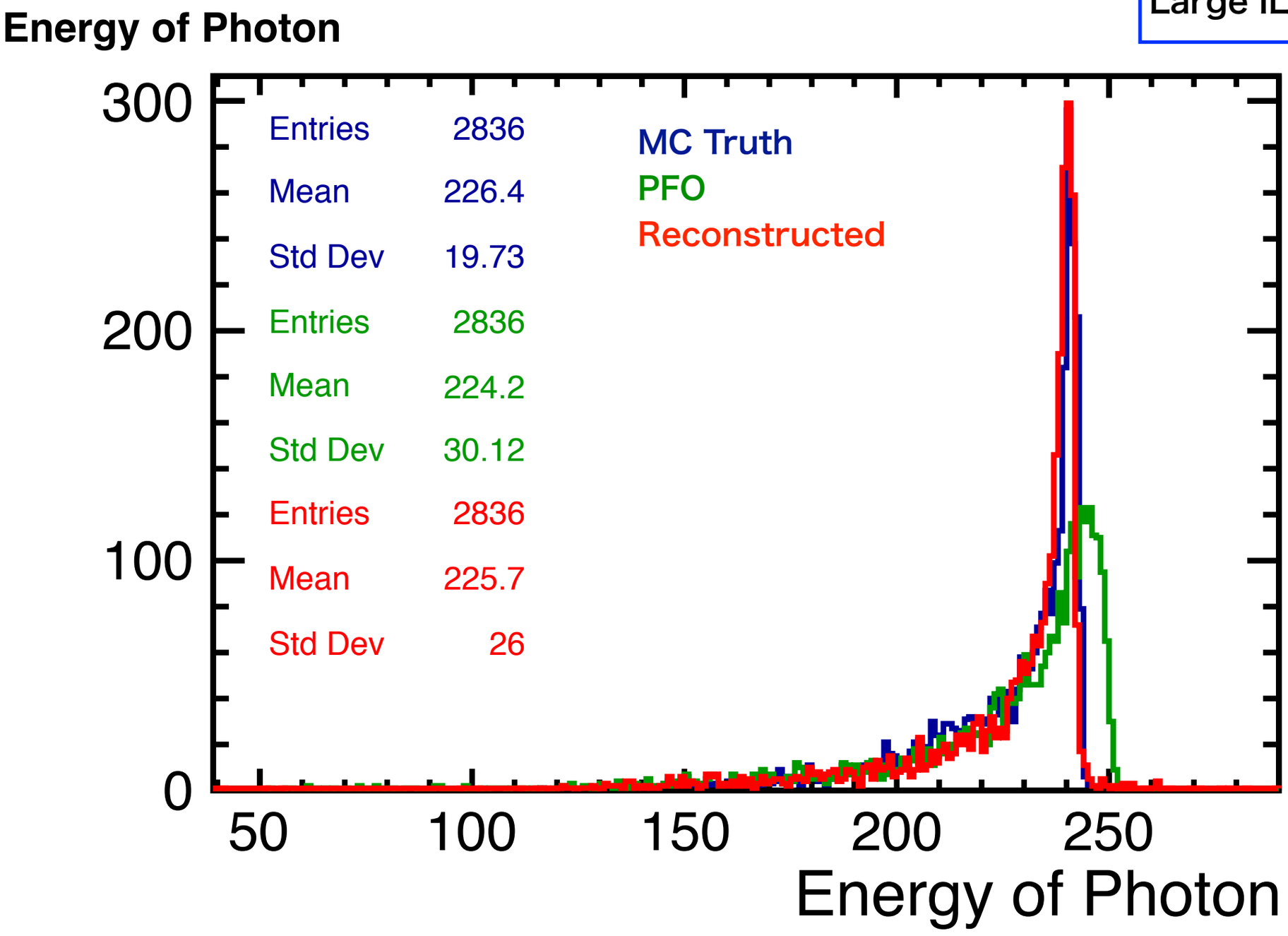
Large ILD model



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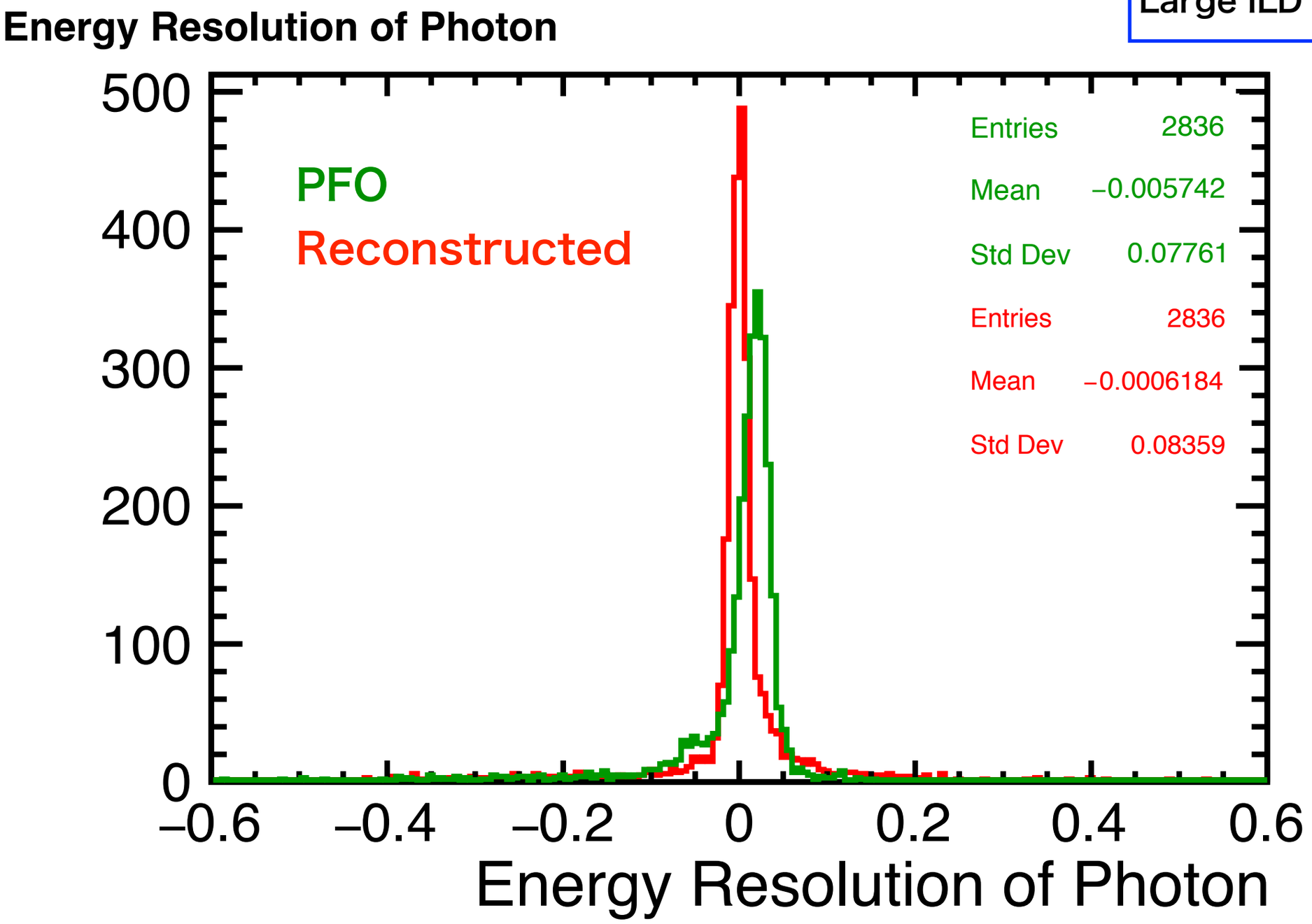

Results

Samples:
|cos(μ)| < 0.75
|M(μ⁺μ⁻)-91.2| < 10 GeV
Large ILD model