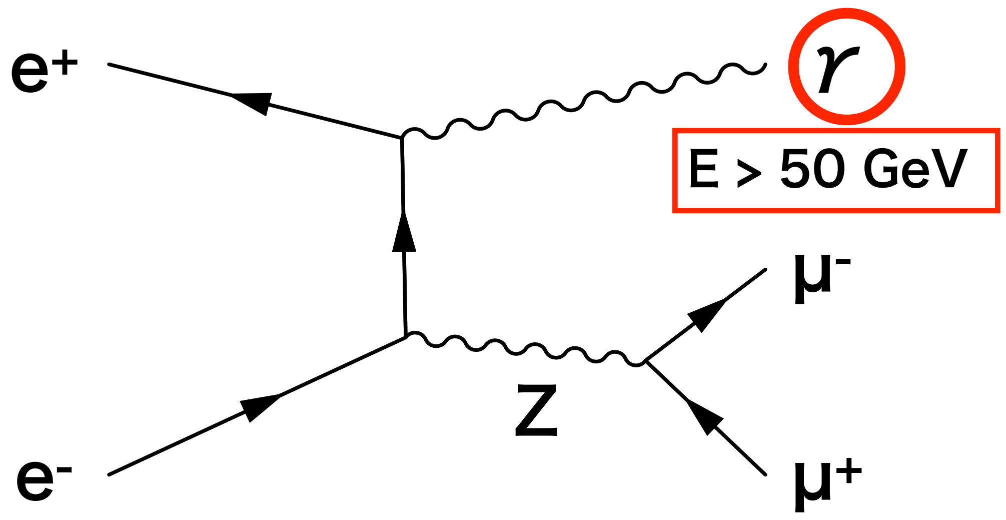
ee -> gamma Z
benchmark

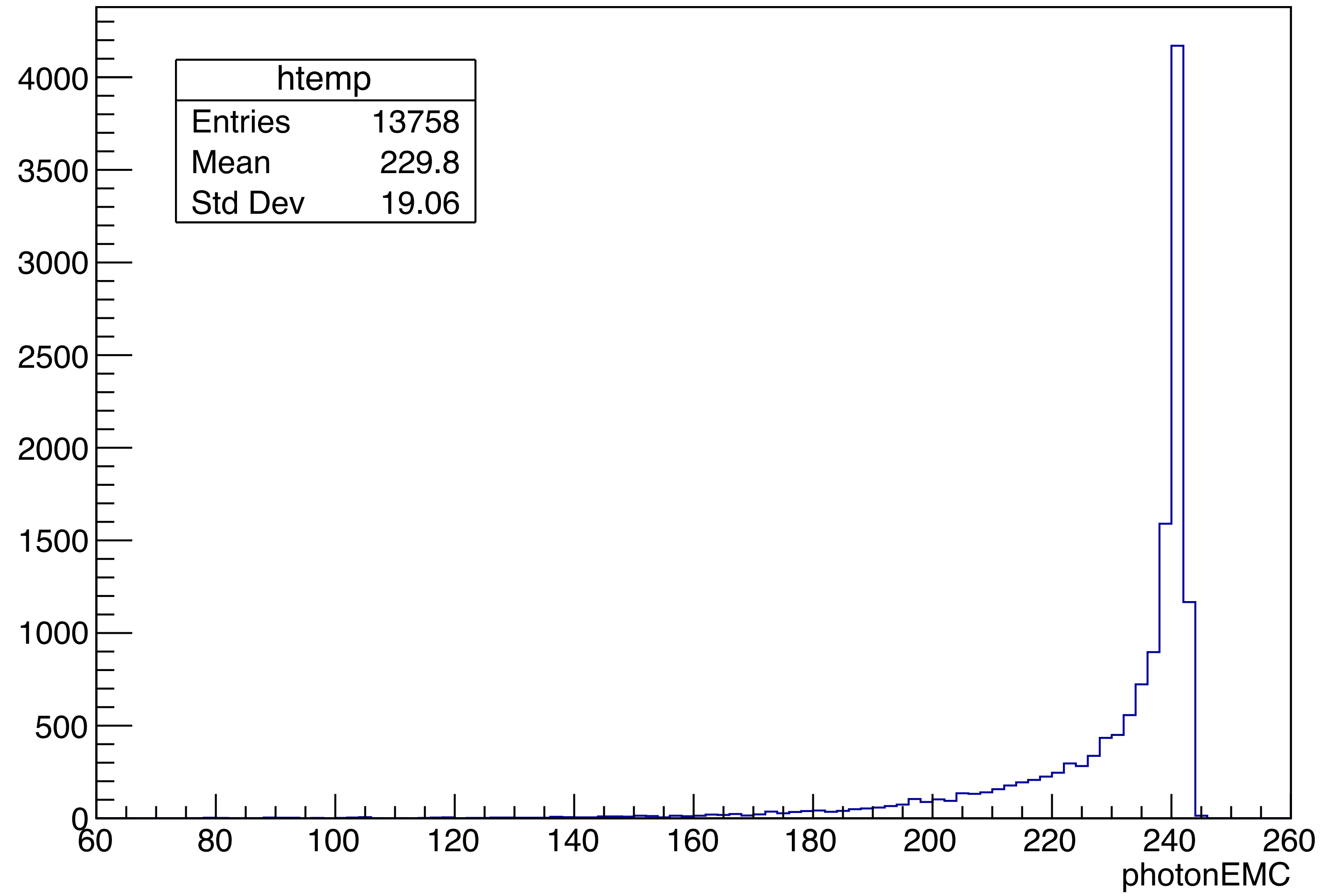
SOKENDAI
Takahiro Mizuno

Photon Energy Calibration



Direction Angle
θ: azimuthal angle
ϕ: polar angle

MCTruth Energy of Photon



GeV

Energy Reconstruction Method

Case B: Using ($\theta_{\mu-}$, $\theta_{\mu+}$, θ_{γ}, $\phi_{\mu-}$, $\phi_{\mu+}$, ϕ_{γ}, $E_{\mu-}$, $E_{\mu+}$)
-> Determine (E_{γ}, E_{ISR})

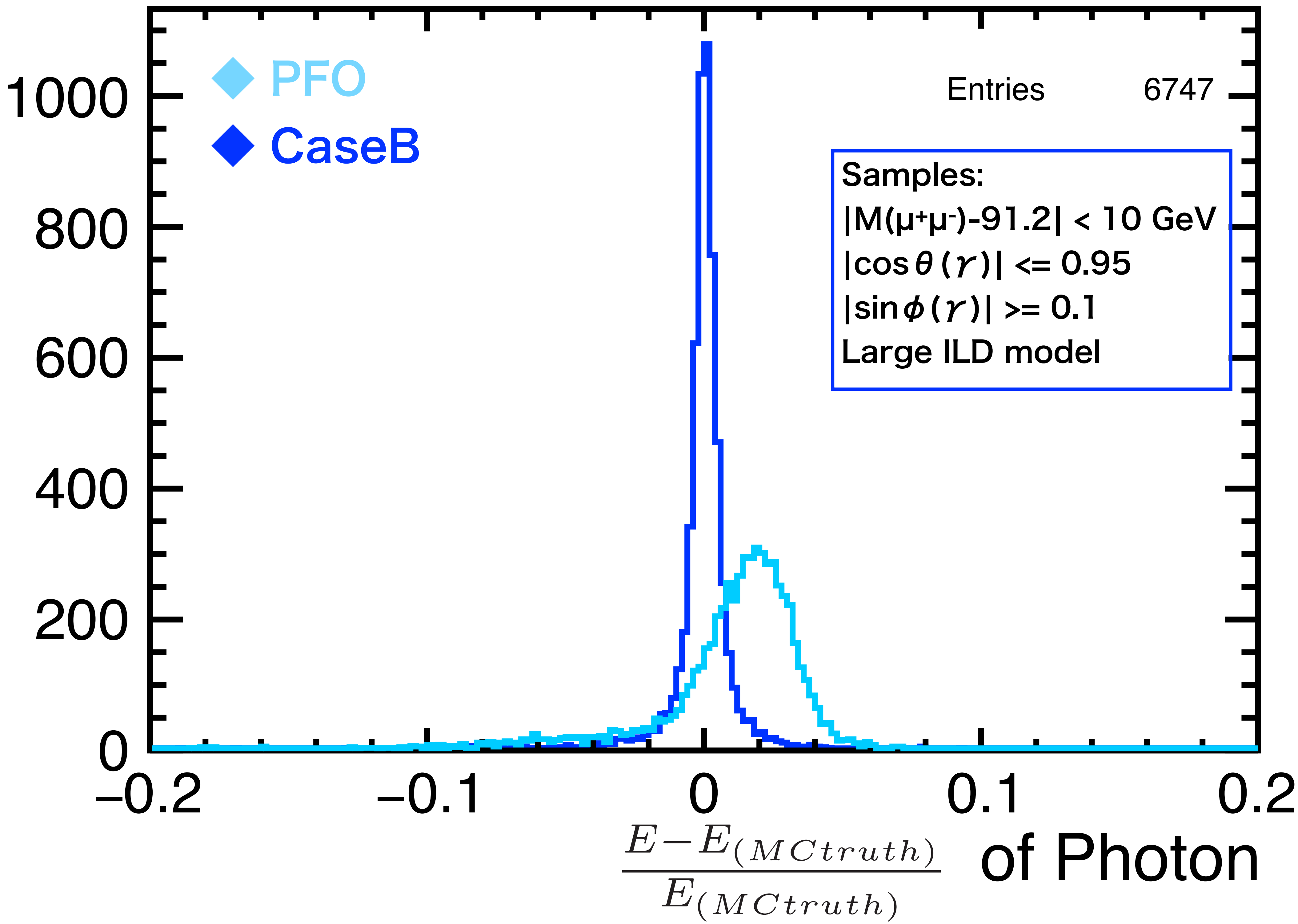
- **Energy and Py Conservation**

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

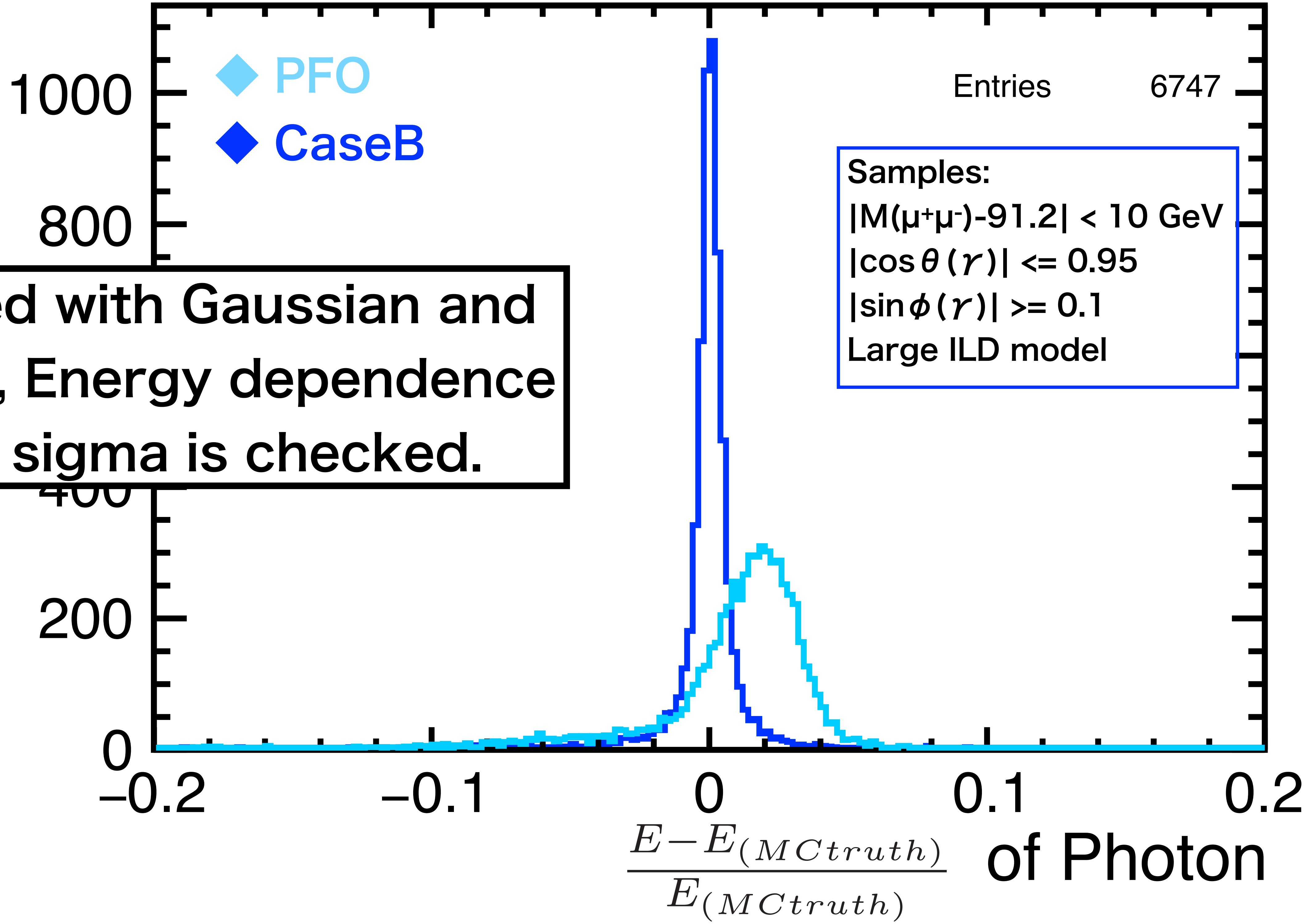
This is of no use when sin θ_{γ} or sin ϕ_{γ}=0 ??

However, photon energy can be determined without calculating P_{ISR}.

$\frac{E-E_{(MCtruth)}}{E_{(MCtruth)}}$ of Photon



$\frac{E - E_{(MCtruth)}}{E_{(MCtruth)}}$ of Photon

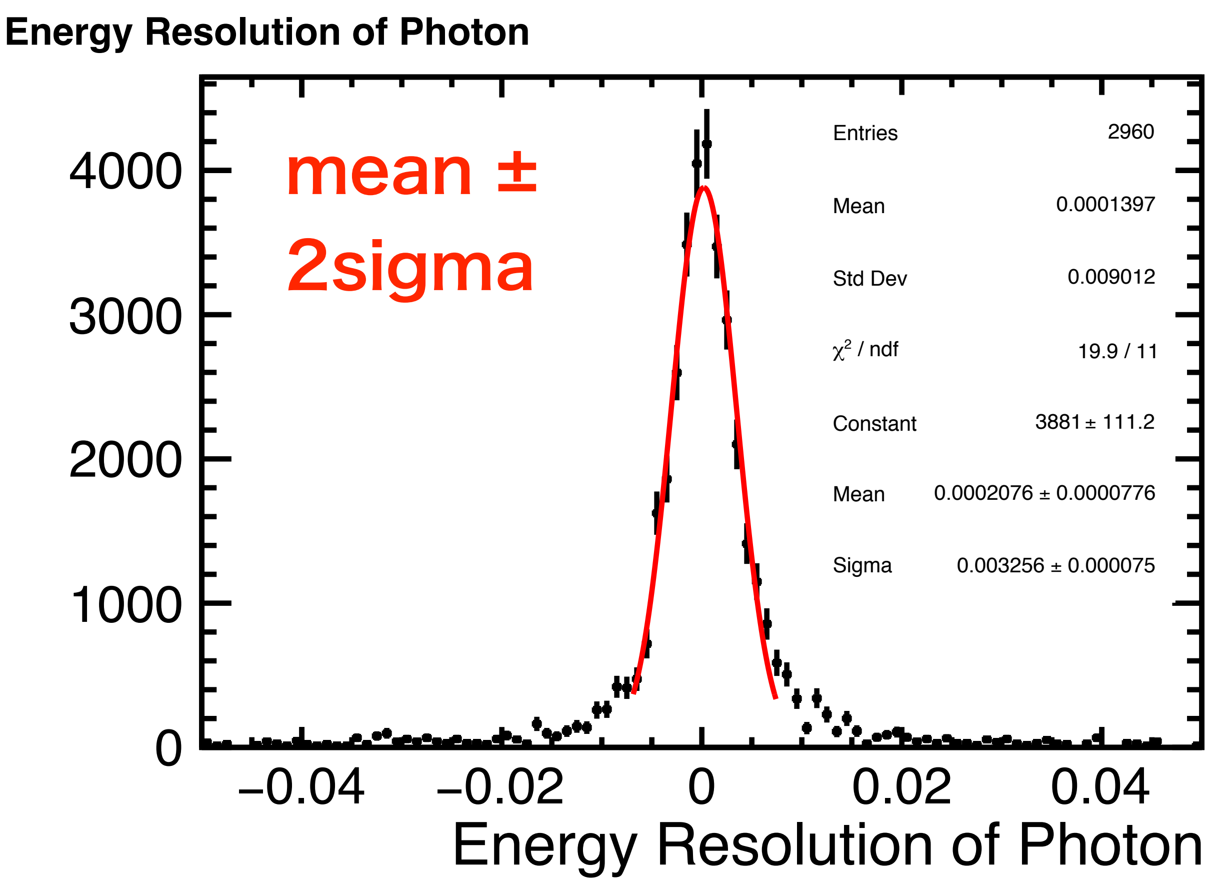


Fitted with Gaussian and θ, φ, Energy dependence of sigma is checked.

The number of events in the fitting region

$$\frac{E - E_{(MCtruth)}}{E_{(MCtruth)}}$$

0.6 <= |cosθ(γ)| < 0.8



To estimate the calibration constant, sigma/√n is evaluated first.

n is estimated as the number of events in the fitting region in the real ILC 500 GeV experiment

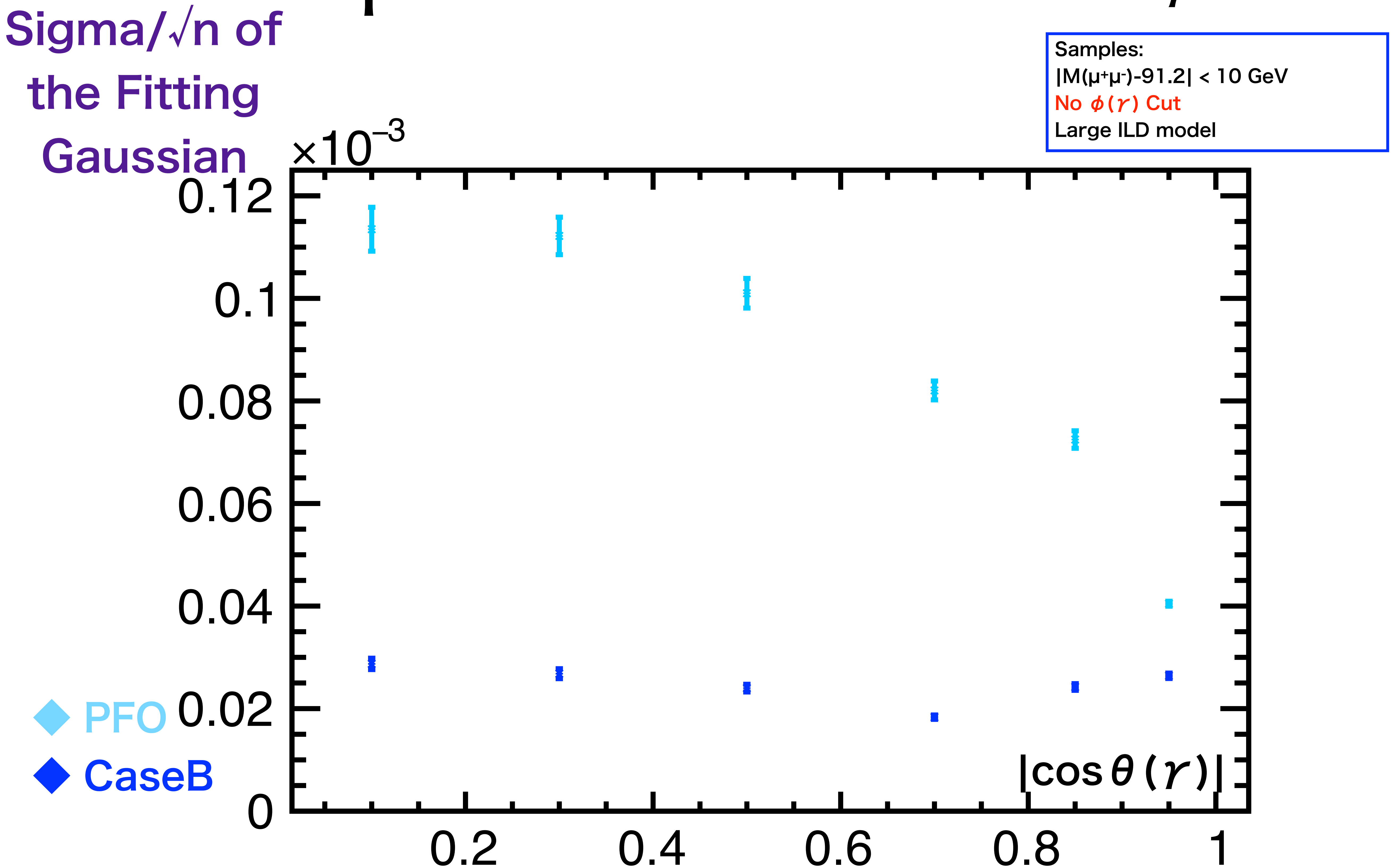
◆Fitting region: mean ± 2sigma

◆Luminosity

(0.8, -0.3): 1600fb^{-1}

(-0.8, 0.3): 1600fb^{-1}

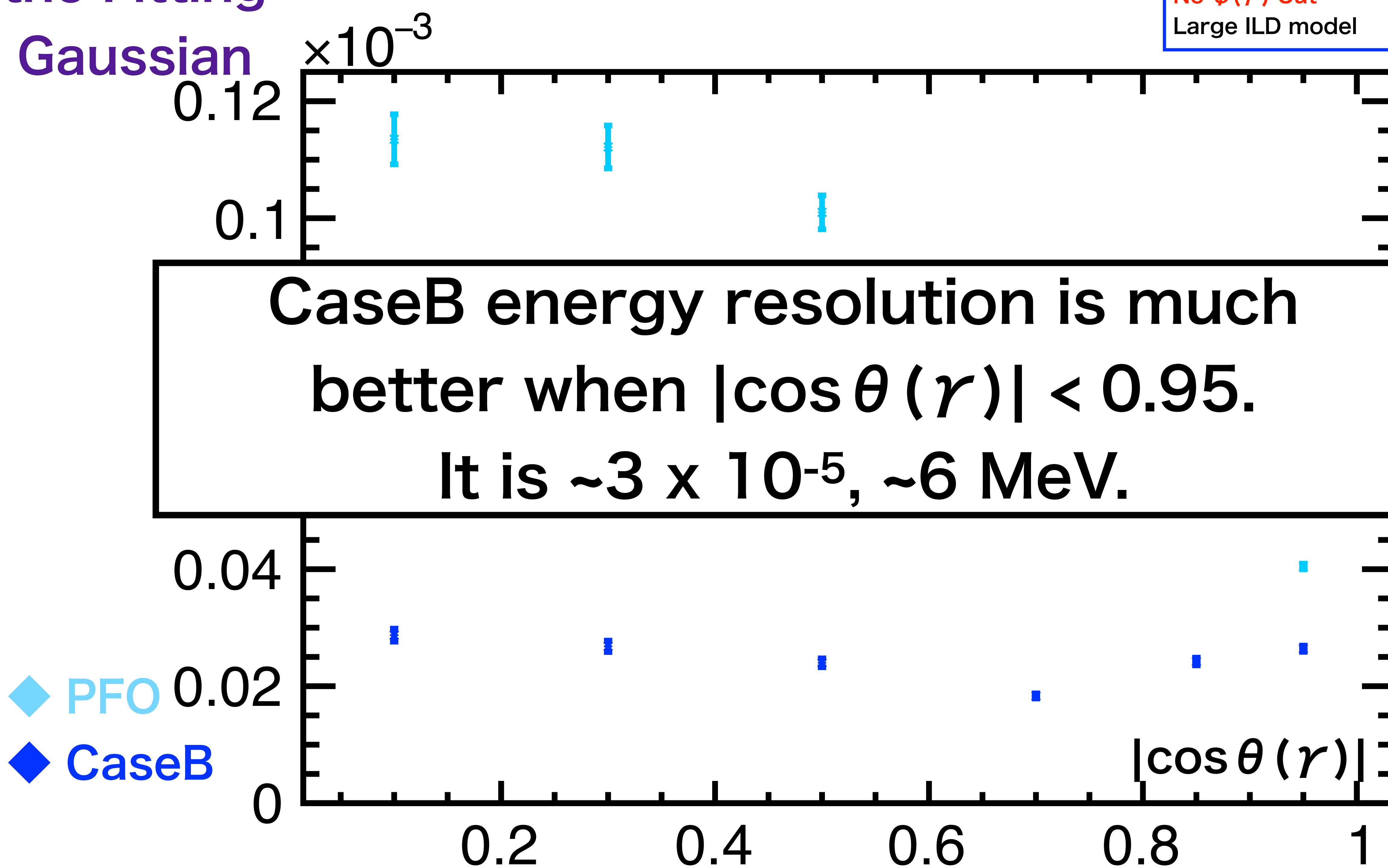
Dependence on θ_{γ}



Dependence on θ γ

Sigma/√n of the Fitting Gaussian

Samples:
|M(μ+μ-)-91.2| < 10 GeV
No ϕ(γ) Cut
Large ILD model

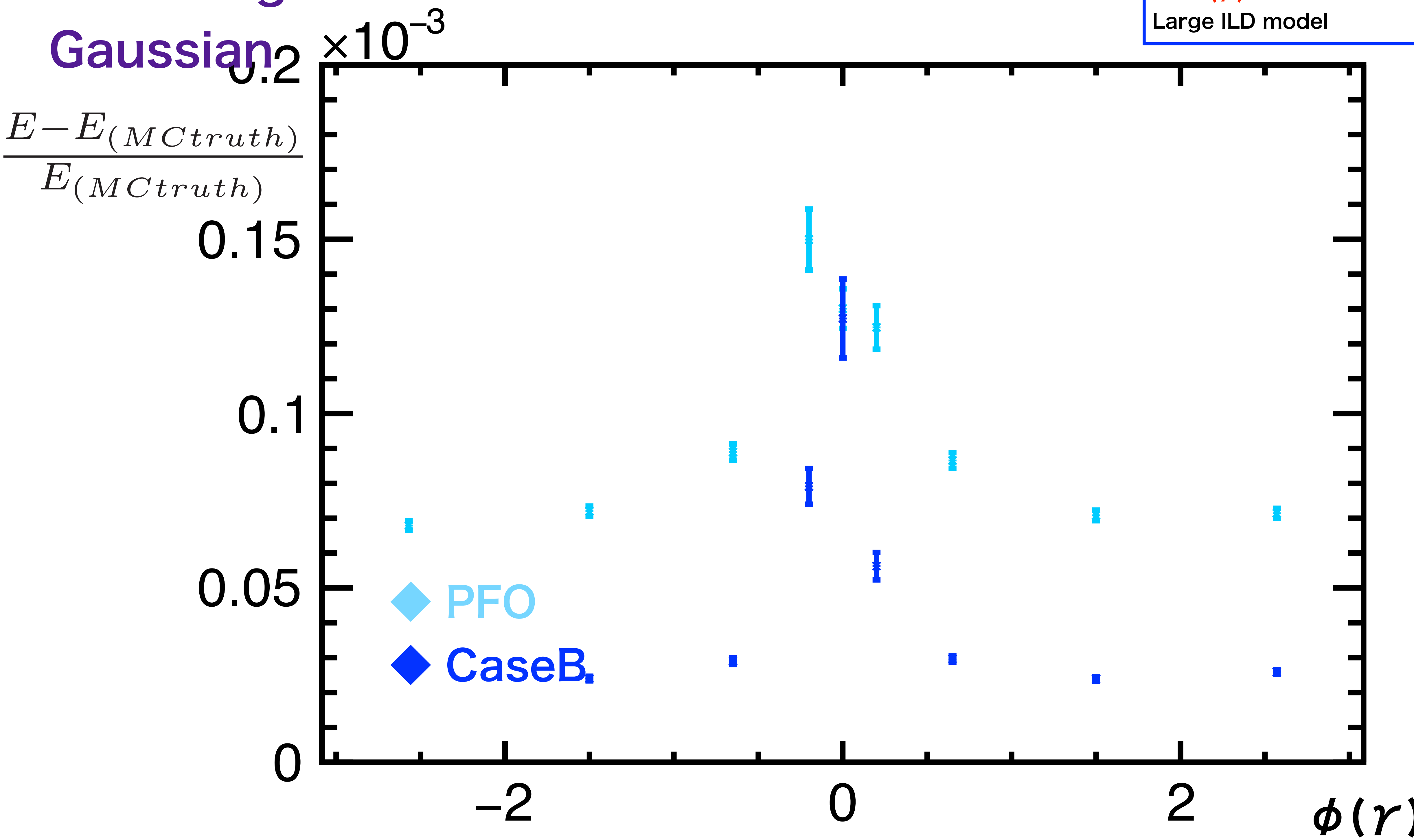


CaseB energy resolution is much better when |cos θ (γ)| < 0.95.
It is ~3 x 10^{-5}, ~6 MeV.

Dependence on ϕ_γ

Sigma/√n of the Fitting Gaussian

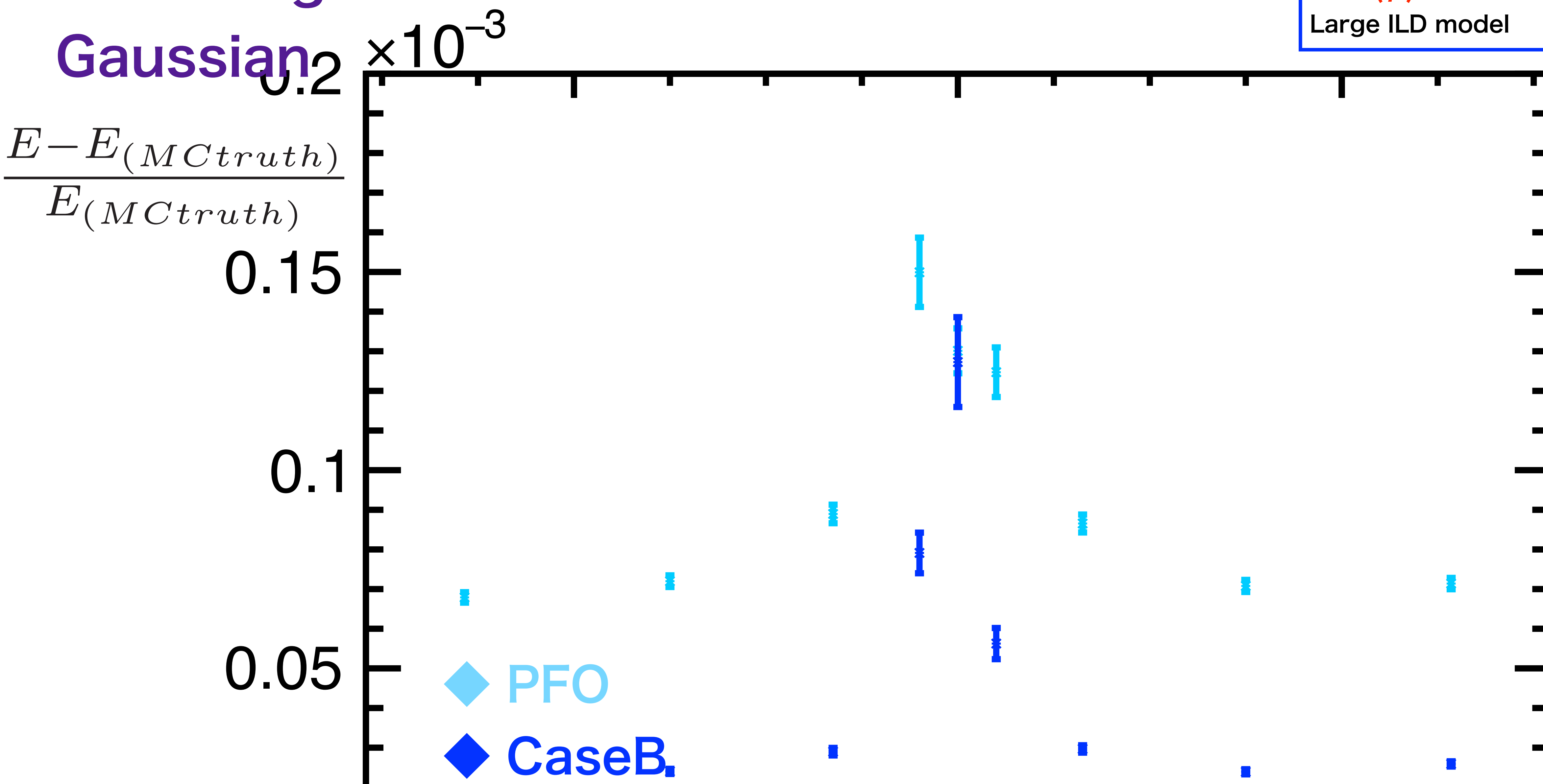
Samples:
|M(μ+μ-)-91.2| < 10 GeV
No $\theta(\gamma)$ Cut
Large ILD model



Dependence on $\phi\ \gamma$

Sigma/√n of the Fitting Gaussian

Samples:
|M(μ+μ-)-91.2| < 10 GeV
No $\theta(\gamma)$ Cut
Large ILD model

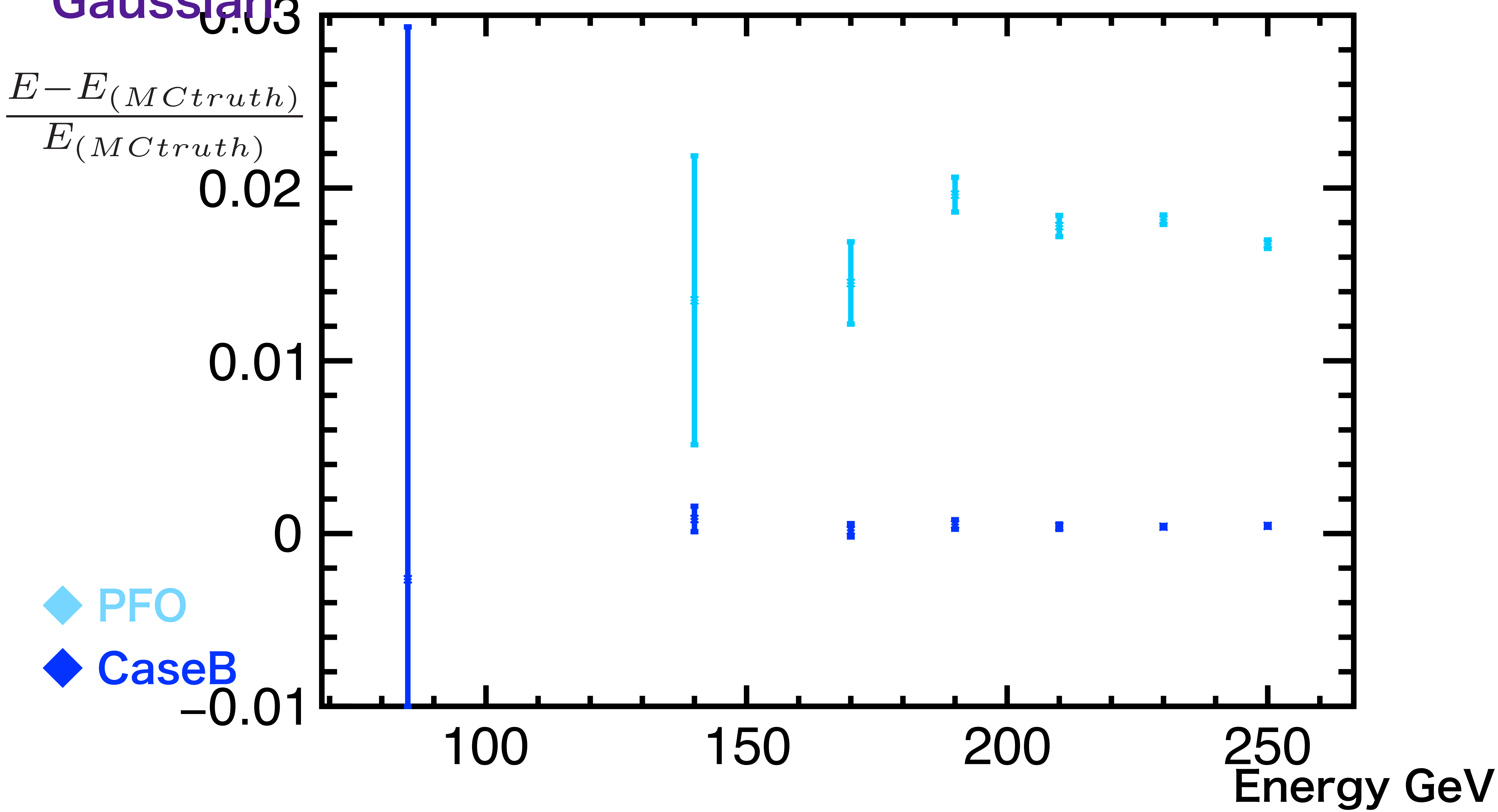


CaseB energy resolution is much better when $|\phi(\gamma)| > 0.1$.

Dependence on Energy

Mean of the Fitting Gaussian

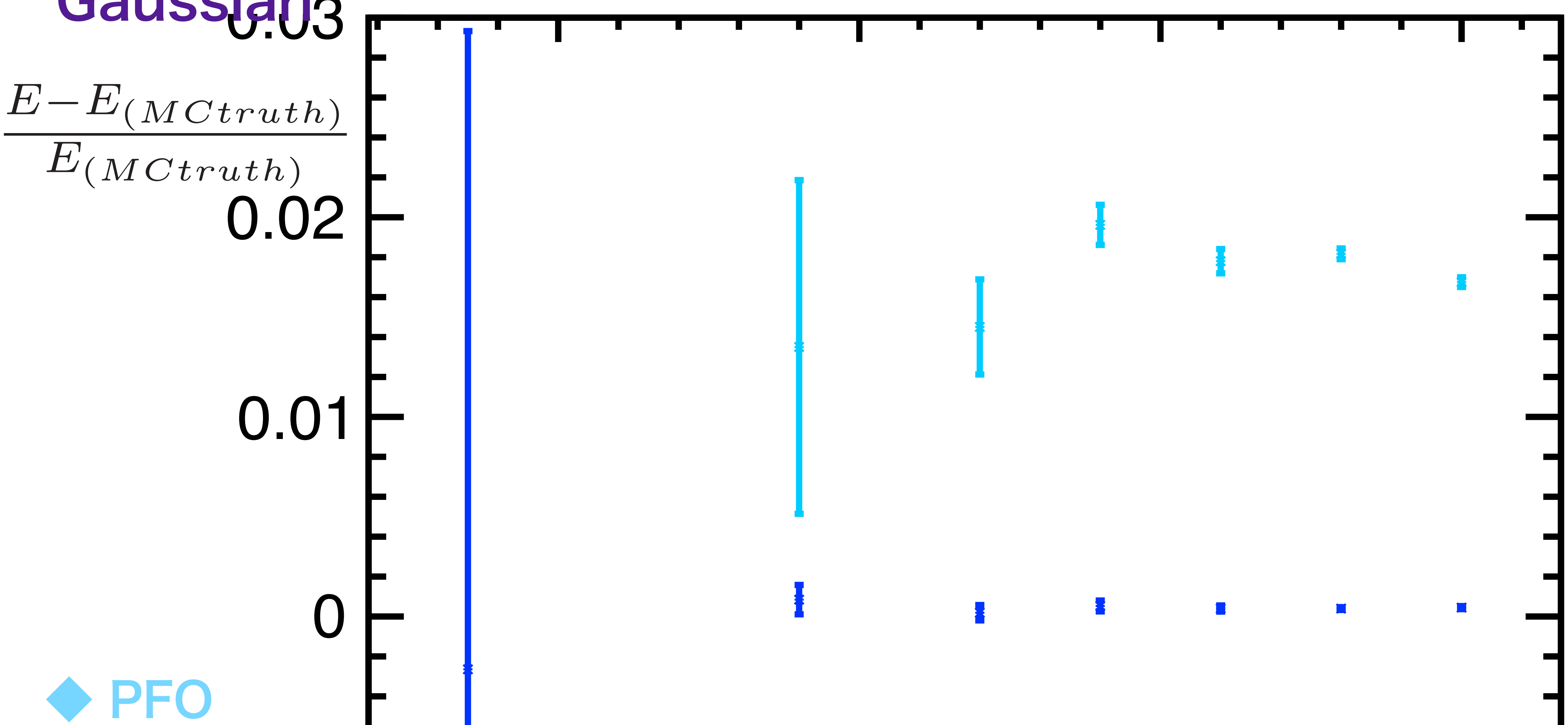
Samples:
|M(μ+μ-)-91.2| < 10 GeV
No θ(γ) and φ(γ) Cut
Large ILD model



Dependence on Energy

Mean of the Fitting Gaussian

Samples:
|M(μ+μ-)-91.2| < 10 GeV
No θ(γ) and φ(γ) Cut
Large ILD model



PFO
Ca

PFO energy is ~ 2% overestimated.
Center value of CaseB is almost correct.

Energy GeV

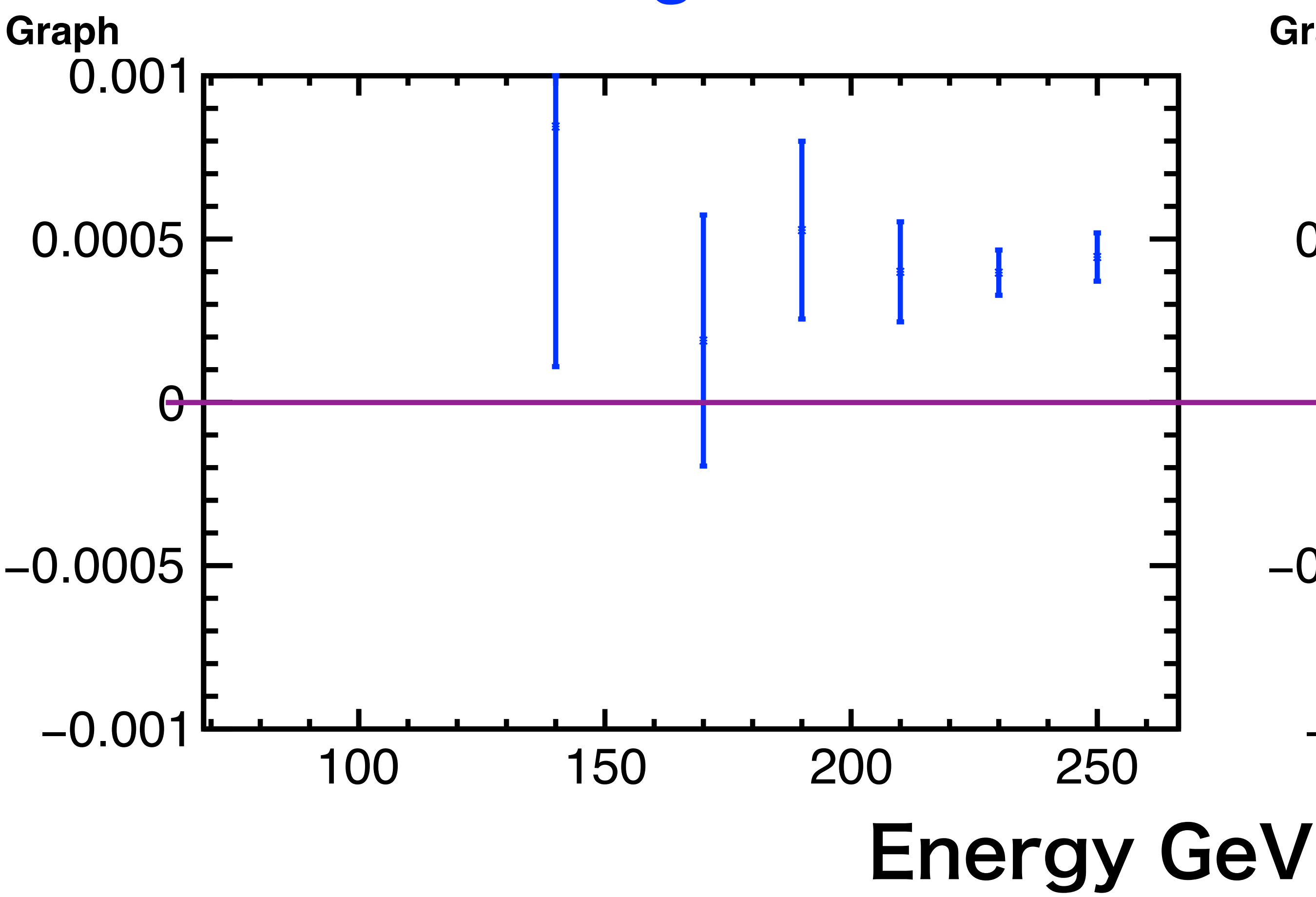
Dependence on Energy

As PFO angles of photon are biased,
The case when MCtrue θ_γ and ϕ_γ is used instead of PFO ones as inputs in caseB is evaluated.

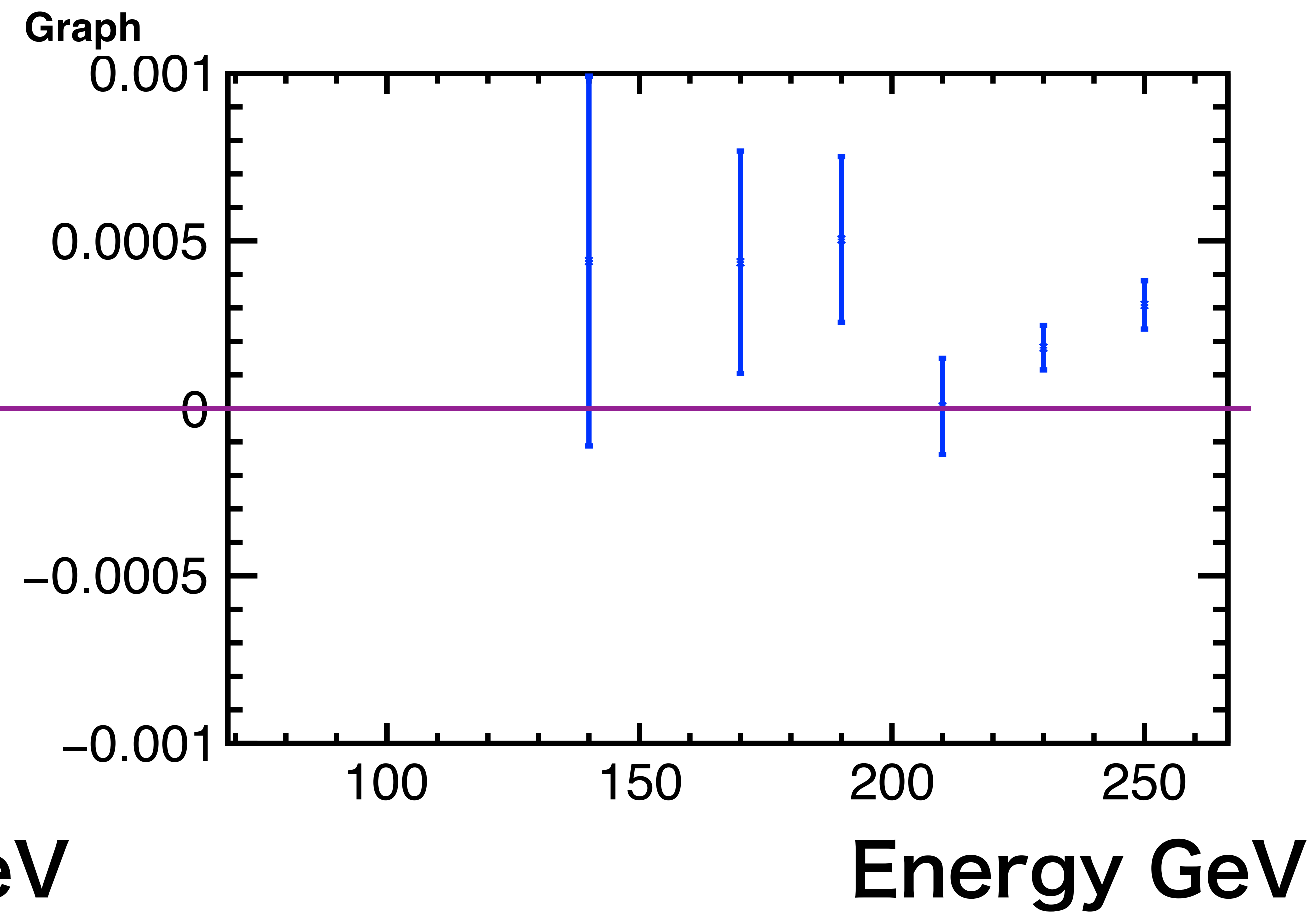
Samples:
|M(μ+μ-)-91.2| < 10 GeV
No $\theta(\gamma)$ and $\phi(\gamma)$ Cut
Large ILD model

Mean of the Fitting Gaussian

◆ **CaseB when using all PFO data**



◆ **CaseB when using MCtrue θ_γ and ϕ_γ**



Summary and Next Step

- CaseB energy resolution is < 20 MeV
  (as photons are ~200 GeV)
  when $|\phi(\gamma)| > 0.1$.
  Therefore it is useful for photon energy calibration.

- I will try large & small comparison next.
- Estimate calibration constant as a function of theta.