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Study of $D^0/\overline{D}^0 \to \pi^0\pi^+\pi^-$

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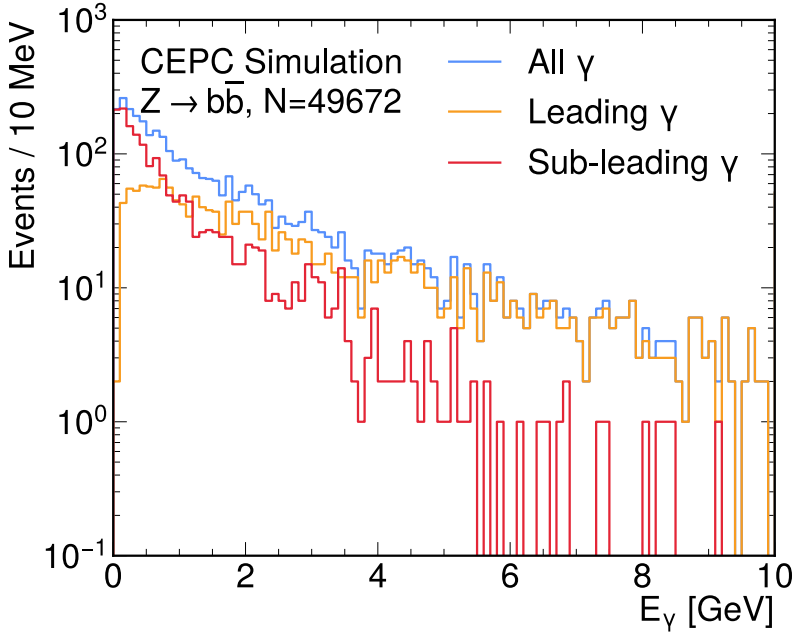
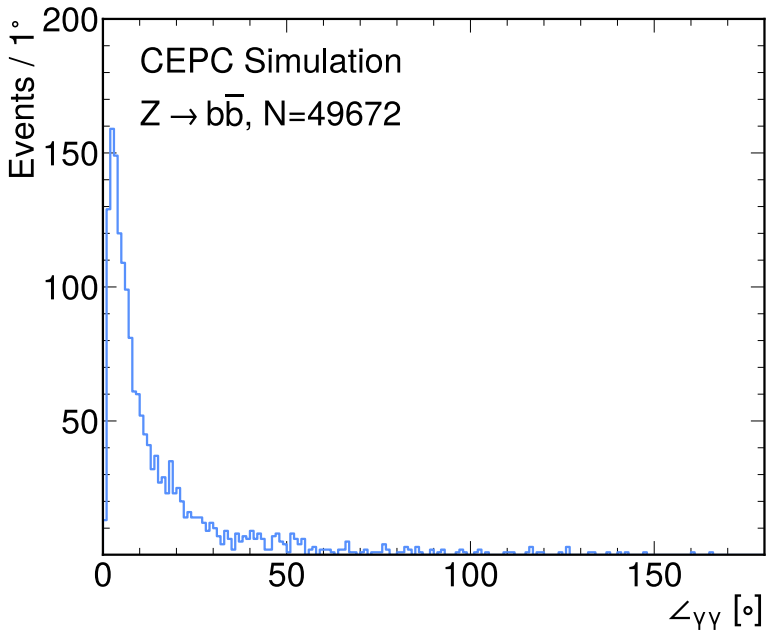
Introduction

- I'm trying to select the process $D^0/\bar{D}^0 \to \pi^+\pi^-\pi^0$ to check the performance of PID and vertex fit.
- The MC samples are updated to the new version, which are from $e^+e^- \to Z \to b\bar{b}$ at $\sqrt{S} = 91.2$ GeV,
  - /cefs/higgs/zhangkl/Production/25035/E91.2_eebb/ /Reco/rec_E91.2_eebb_*.root
- The version of CEPCSW is **tdr.25.3.2**, and I tried to get the truth distributions of photons from π^0.

Preliminary results

- The truth distributions of E_γ and $\angle_{\gamma\gamma}$ from π^0 in the process $D^0/\bar{D}^0 \to \pi^+\pi^-\pi^0$.



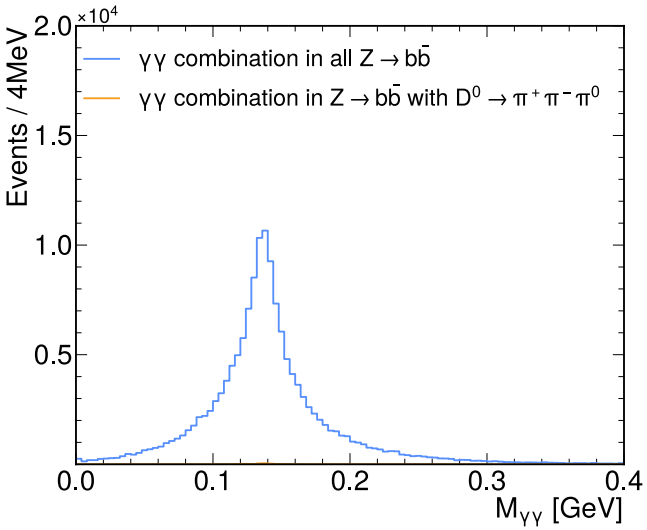


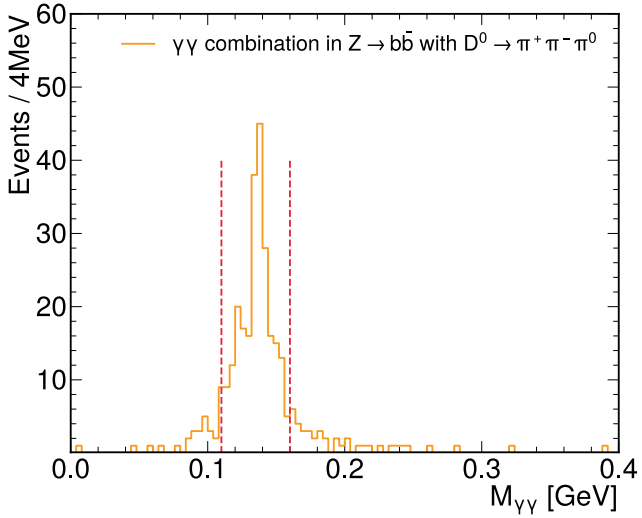
- I only required the energy of leading photon $E_{\gamma 1} > 0.5$ GeV to suppress the possible backgrounds.

- I also required that the open angle between 2 photons is less than 20 degree.

Preliminary results

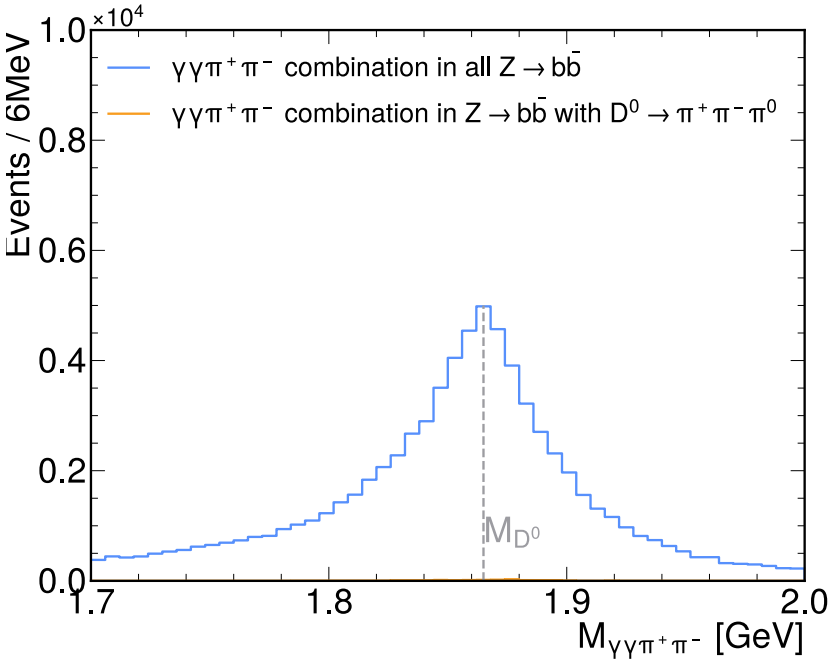
- I tried to select the D^0 and D^* candidates by requiring the $M_{\pi^+\pi^-\gamma\gamma}$ and $M_{\gamma\gamma}$ closest to M_{D^0} and M_{π^0} simultaneously.
  - The combination with smallest $|M_{\gamma\gamma} - m_{\pi^0}| + |M_{\pi^+\pi^-\gamma\gamma} - m_{D^0}|$ is chosen to construct D^0 and π^0 candidates.
- I also required the energy of leading photon $E_{\gamma 1} > 0.5$ GeV and the open angle between 2 photons $\angle_{\gamma\gamma} < 20^\circ$ to suppress the possible backgrounds.
- The distributions of $M_{\gamma\gamma}$, and the 0.11 < $M_{\gamma\gamma}$<0.16 GeV is used to select π^0 candidate.

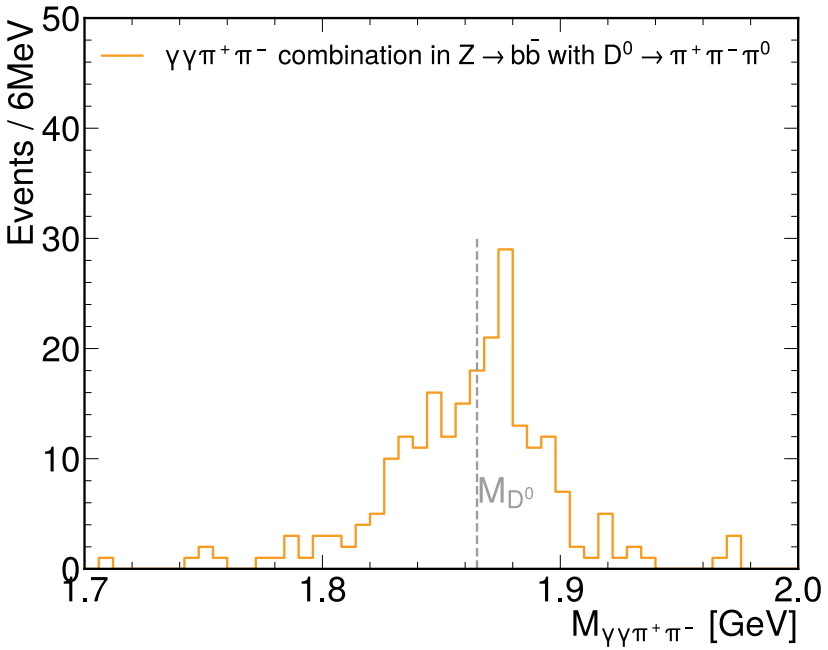




Preliminary results

- The distributions of $M_{\pi^+\pi^-\gamma\gamma}$.





- Need further requirements to suppress the backgrounds.

Preliminary results

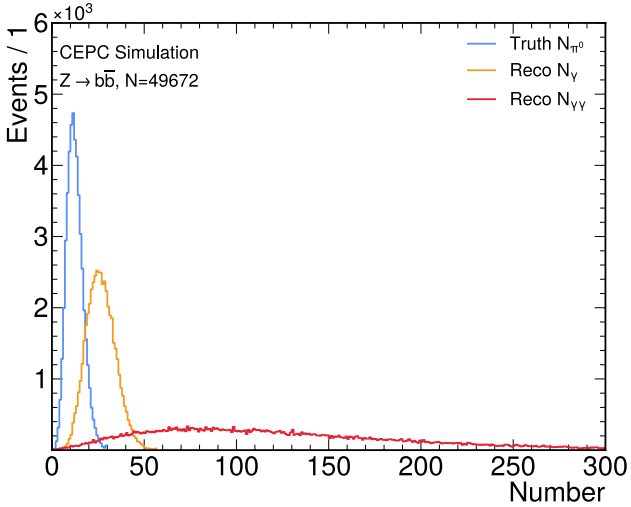
- The efficiency is calculate by $\frac{N_{selected}(D^0\to\pi^+\pi^-\pi^0)}{N_{truth}(D^0\to\pi^+\pi^-\pi^0)}$. The purity is calculated by $\frac{N_{selected}(D^0\to\pi^+\pi^-\pi^0)}{N_{selected}(Z\to b\bar{b})}$, which is much smaller than previous result.
- The main reason could be that the truth information of D^0 decay was employed to require the $N_{\pi^0\ from\ D^0,truth} = 1$ and $N_{other\ neutral\ from\ D^0,\ truth} = 0$ in the previous result.

Cuts	Efficiency [%]	Purity[%]
Vertex reconstructed	63	1e-2
charged pair	62	2e-2
Kinematic > 0	61	3e-2
Chi2 < 4	52	9e-2
PID	51	9e-2
$E_{\gamma 1} > 0.5$ GeV	38	0.16
$\angle_{\gamma\gamma} < 20^{\circ}$	31	0.21
$0.11 < M_{\gamma\gamma} < 0.16$ GeV	24	0.28
$1.8 < M_{\gamma\gamma\pi^+\pi^-} < 1.9$ GeV	20	0.40

π^0 reconstruction in $Z \to b\bar{b}$

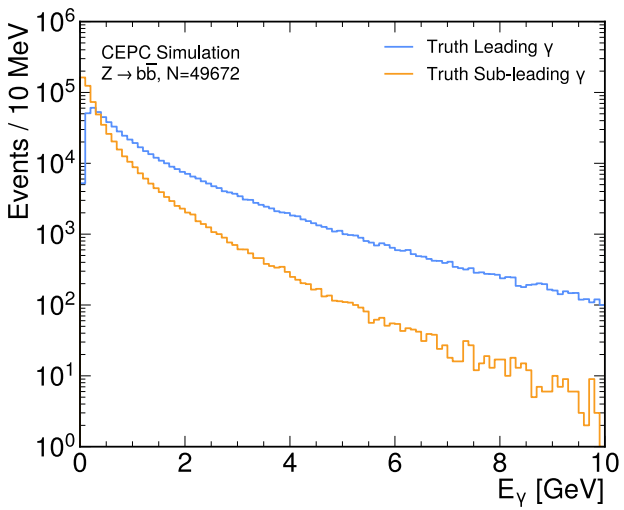
π^0 reconstruction in $Z \to b\bar{b}$

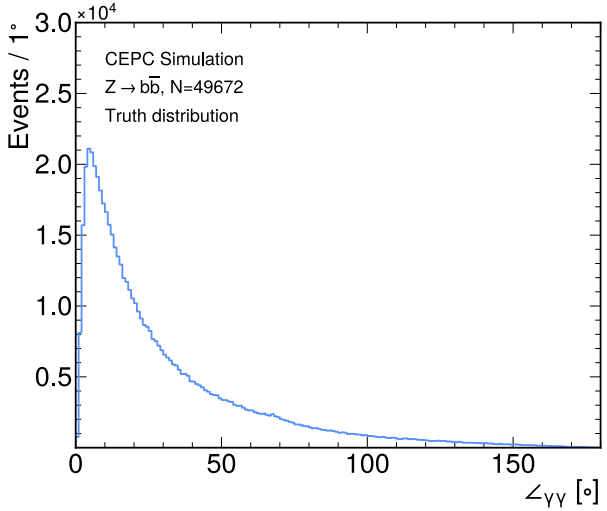
- The distributions of $N_{\pi^0,truth}$, $N_{\gamma,reco}$ and $N_{\gamma\gamma,reco}$.



I tried to reconstruct all of π^0 in an event by forming a π^0 candidate with 2 photons.

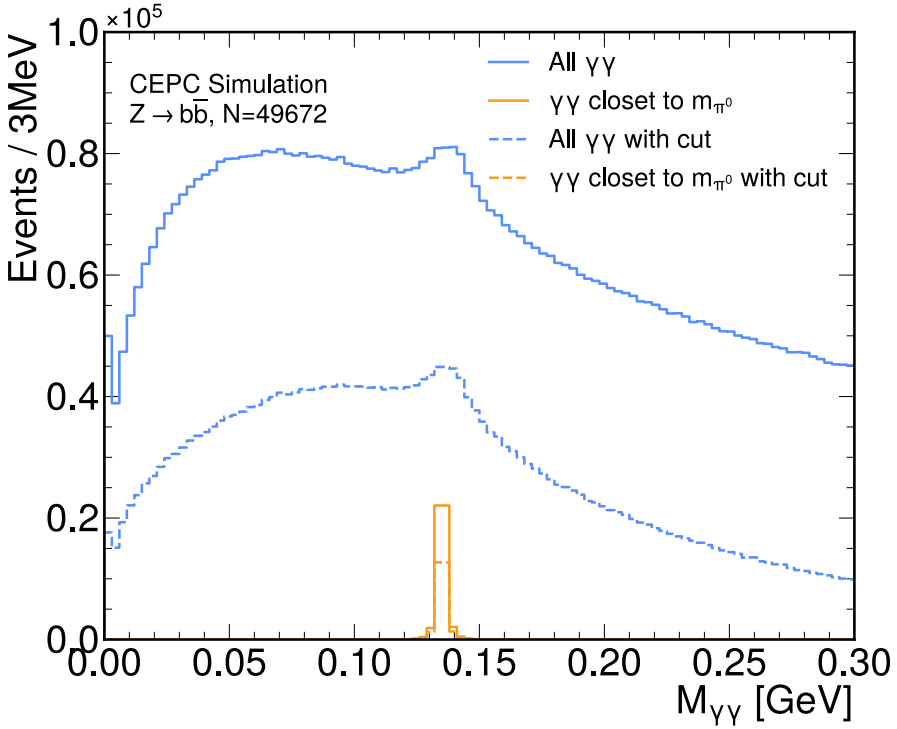
- The truth distributions of photons from π^0.



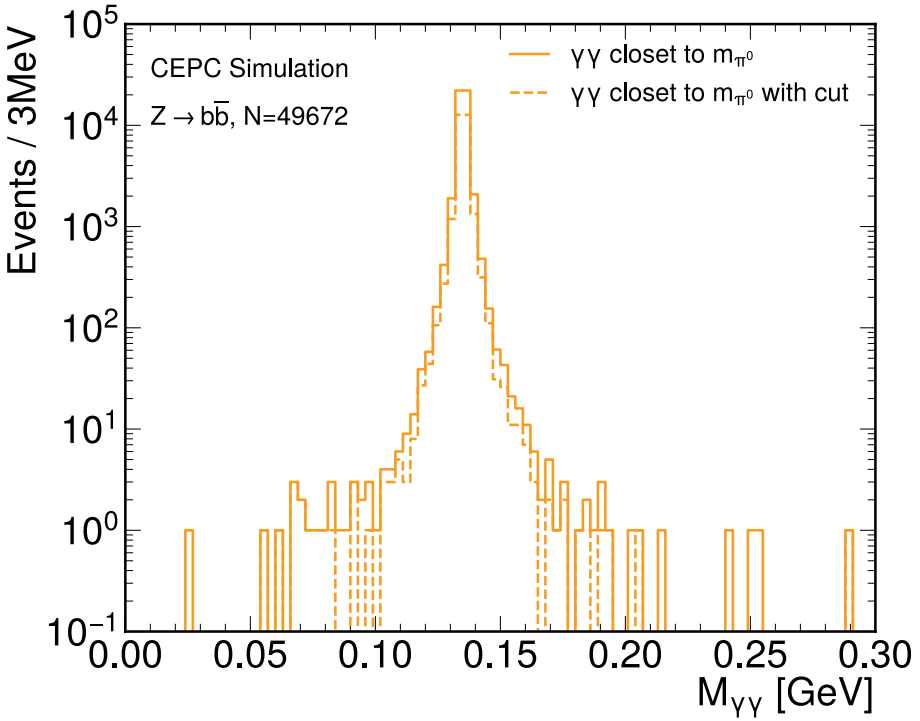


π^0 reconstruction in $Z \to b\bar{b}$

- The distributions of $M_{\gamma\gamma}$ for all combinations. The cut means $E_{\gamma 1} > 0.5$ GeV and $\angle_{\gamma\gamma} < 20^{\circ}$.



All of $\gamma\gamma$ combination

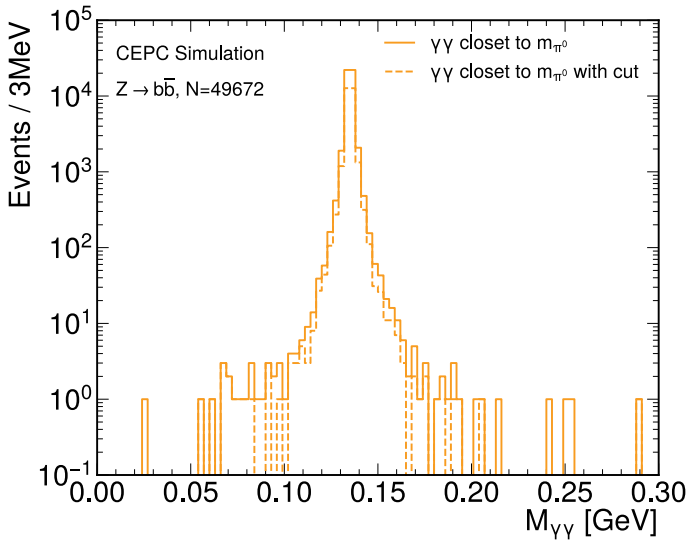


The combination with smallest $|M_{\gamma\gamma} - m_{\pi^0}|$

π^0 reconstruction in $Z \to b\bar{b}$

- The combination with smallest $|M_{\gamma\gamma} - m_{\pi^0}|$ is employed to form a π^0 candidate.

- And I did a truth match by minimizing $\left|E_{\gamma1}^{truth} - E_{\gamma1}^{reco}\right| + \left|Px_{\gamma1}^{truth} - Px_{\gamma1}^{reco}\right| + \left|Py_{\gamma1}^{truth} - Py_{\gamma1}^{reco}\right| + \left|Pz_{\gamma1}^{truth} - Pz_{\gamma1}^{reco}\right| + \left|E_{\gamma2}^{truth} - E_{\gamma2}^{reco}\right| + \left|Px_{\gamma2}^{truth} - Px_{\gamma2}^{reco}\right| + \left|Py_{\gamma2}^{truth} - Py_{\gamma2}^{reco}\right| + \left|Pz_{\gamma2}^{truth} - Pz_{\gamma2}^{reco}\right|$

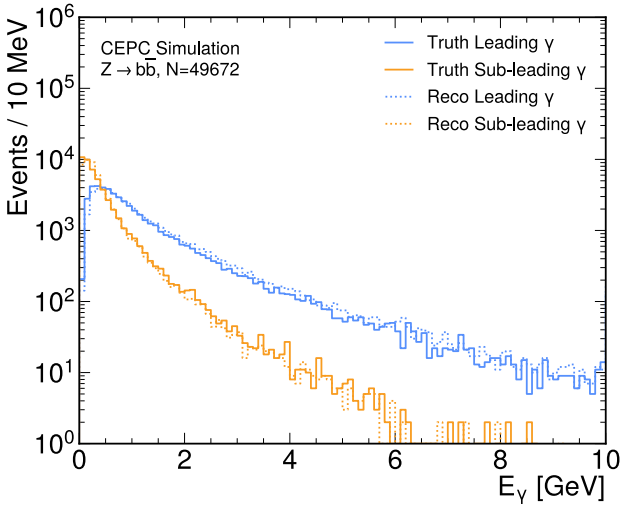


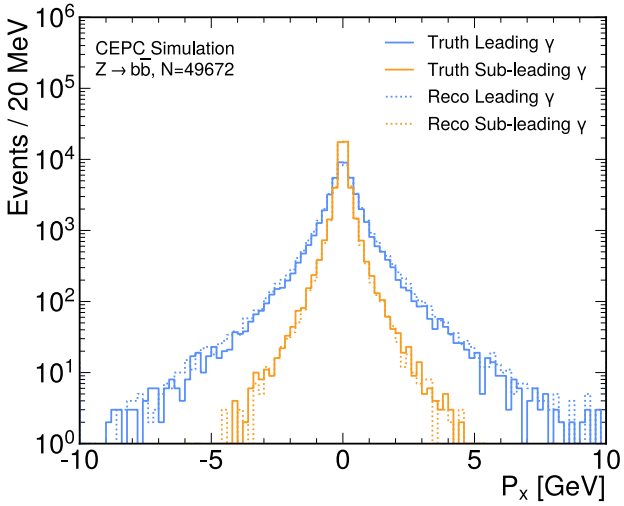
Almost all of the reconstructed π^0 candidates can be matched with a truth π^0.

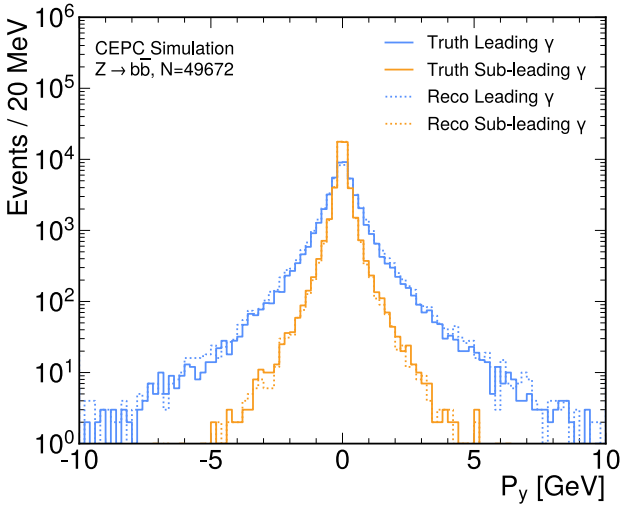
$$\frac{49666}{49671} \approx 99.99\%$$

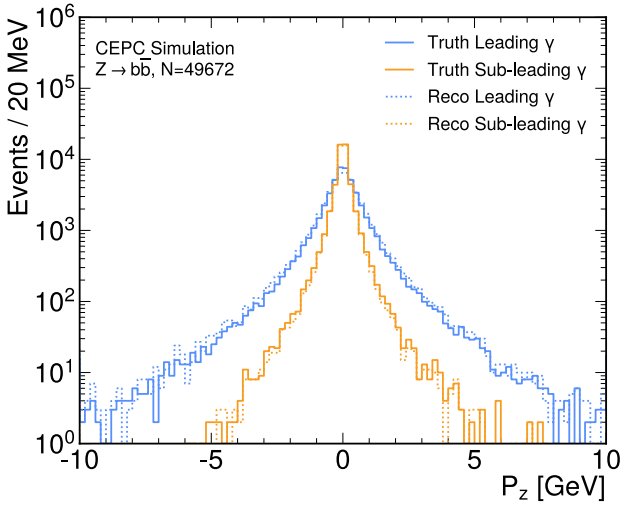
π^0 reconstruction in $Z \to b\bar{b}$

- The combination with smallest $|M_{\gamma\gamma} - m_{\pi^0}|$ is employed to form a π^0 candidate.

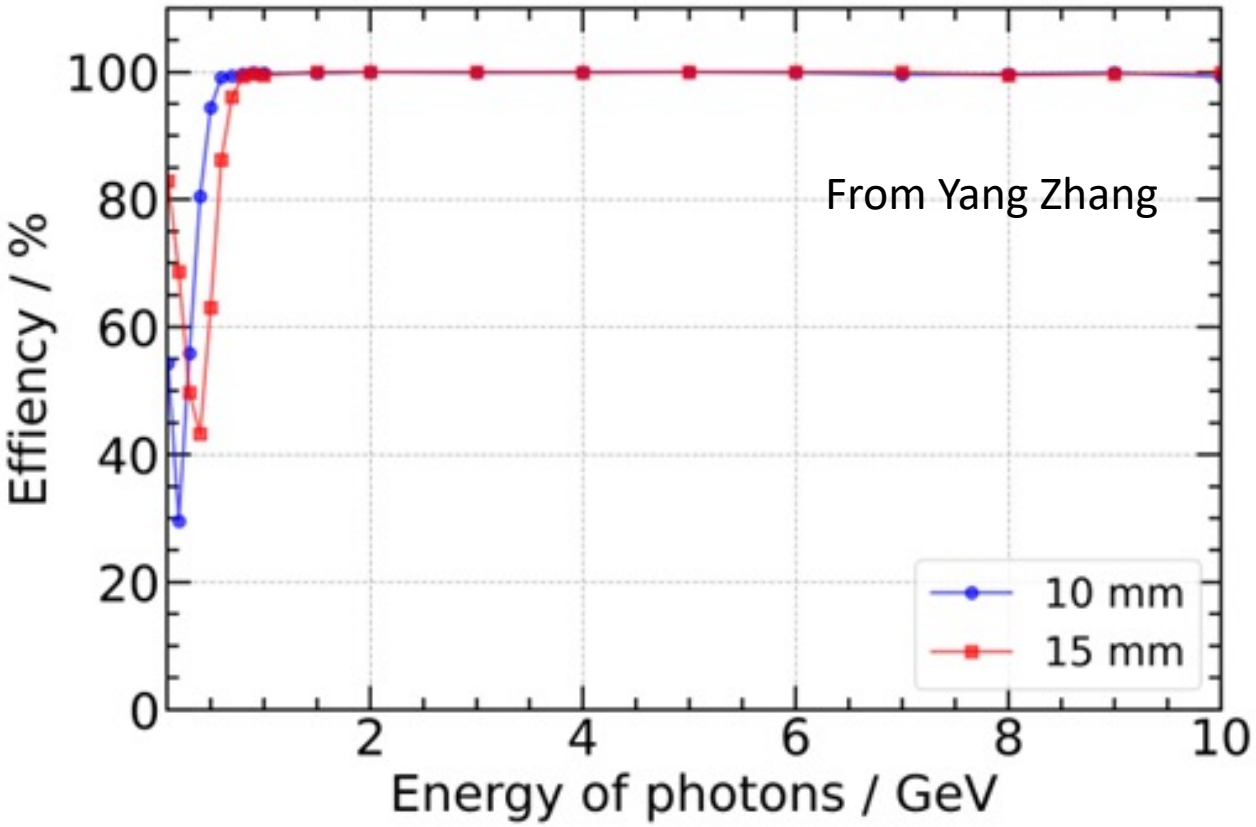








Backup


From Yang Zhang
Effiency / %
Energy of photons / GeV
10 mm
15 mm
0
20
40
60
80
100
2
4
6
8
10