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

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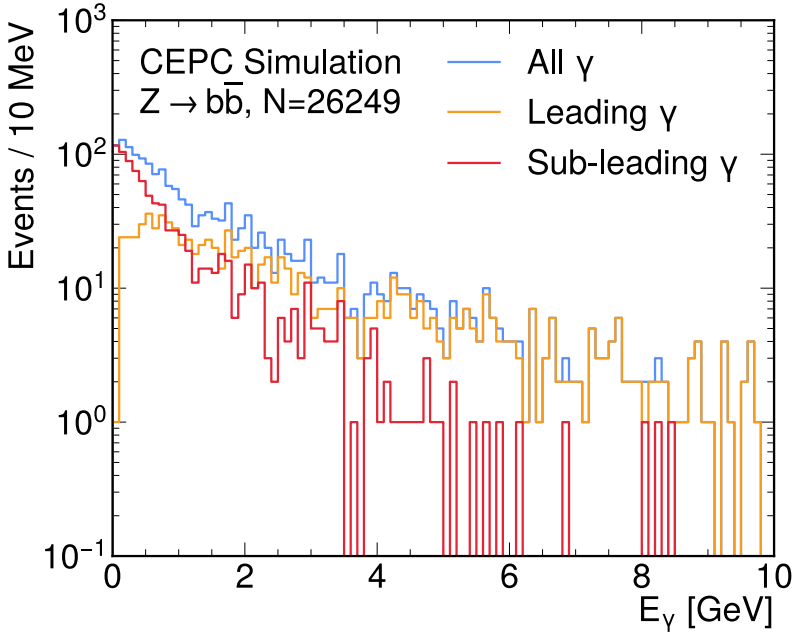
Introduction

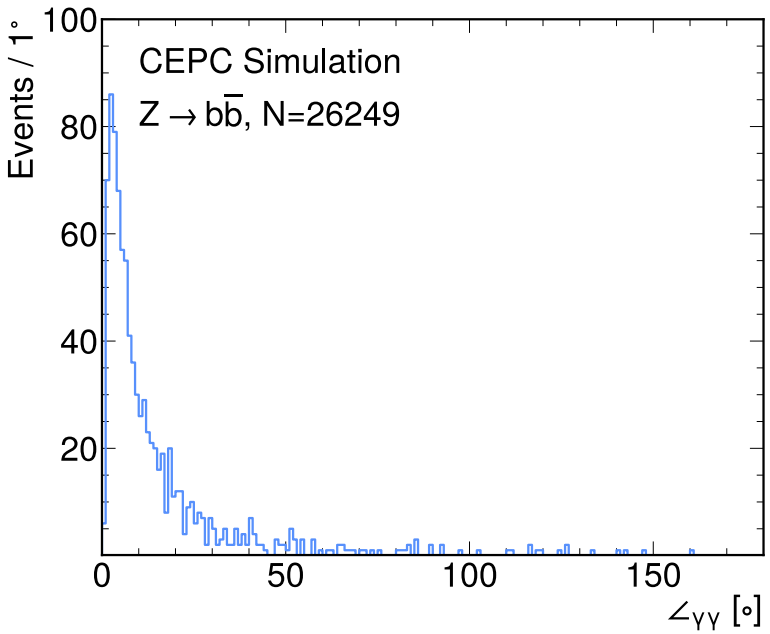
- I'm trying to select the process $D^0/\bar{D}^0 \to \pi^+\pi^-\pi^0$ to check the performance of PID and vertex fit.
- The MC samples are updated to the new version, which are from $e^+e^- \to Z \to b\bar{b}$ at $\sqrt{S} = 91.2$ GeV,
  - /cefs/higgs/zhangkl/Production/25035/E91.2_eebb/ /Reco/rec_E91.2_eebb_*.root

- The version of CEPCSW is **tdr.25.3.2**, and I tried to get the truth distributions of photons from π^0.
- I also tried to select the D^0 and D^* candidates by requiring the $M_{\pi^+\pi^-\gamma\gamma}$ and $M_{\pi^+\pi^-\gamma\gamma\pi^\pm}$ closest to M_{D^0} and M_{D^*}, respectively.

Preliminary results

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

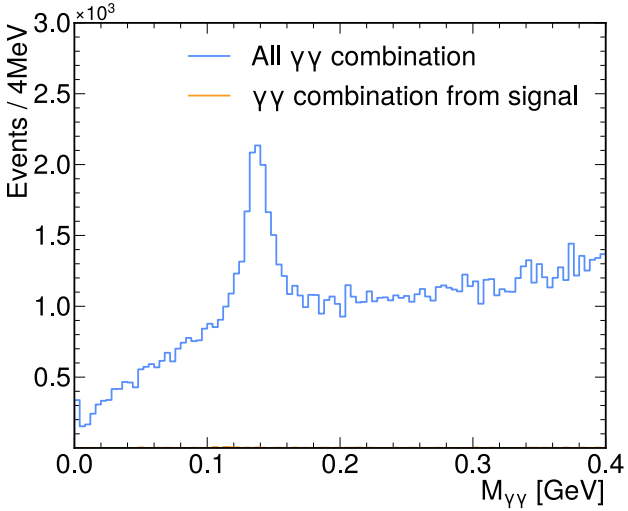


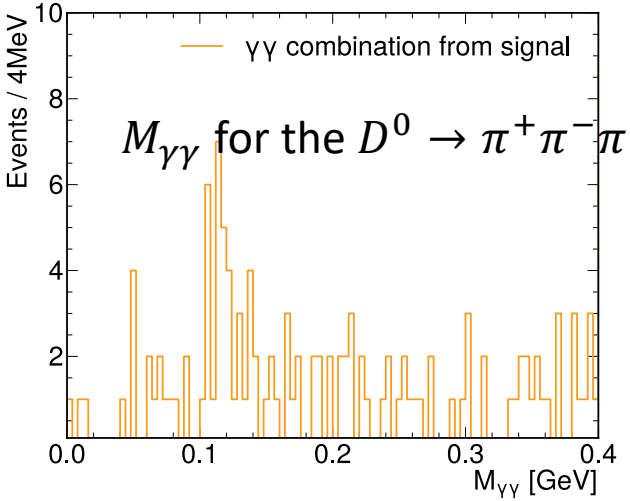


- I required the $E_\gamma > 0.5$ GeV to suppress the possible backgrounds.
- I also could require that the open angle between 2 photons is less than 20 degree for the next step.

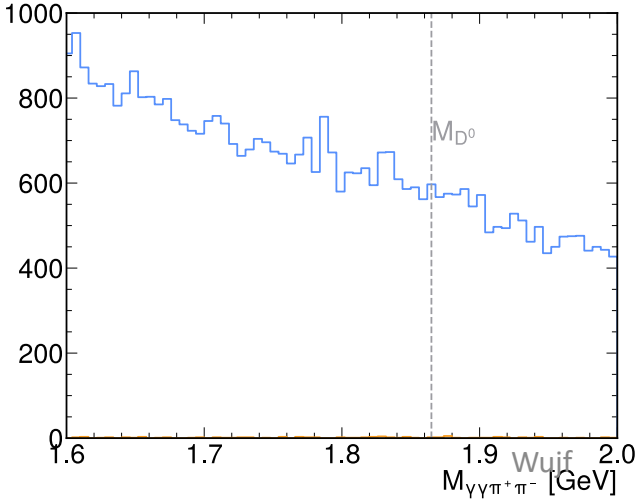
Preliminary results

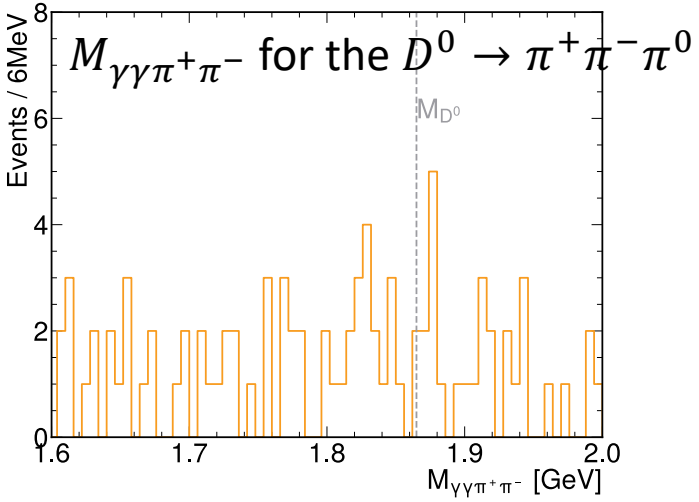
- The distributions of $M_{\gamma\gamma}$ for all combinations.





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





Preliminary results

- The cut-flow is below, where we lose lots of efficiency after the $0.11 < M_{\gamma\gamma} < 0.15$ GeV.

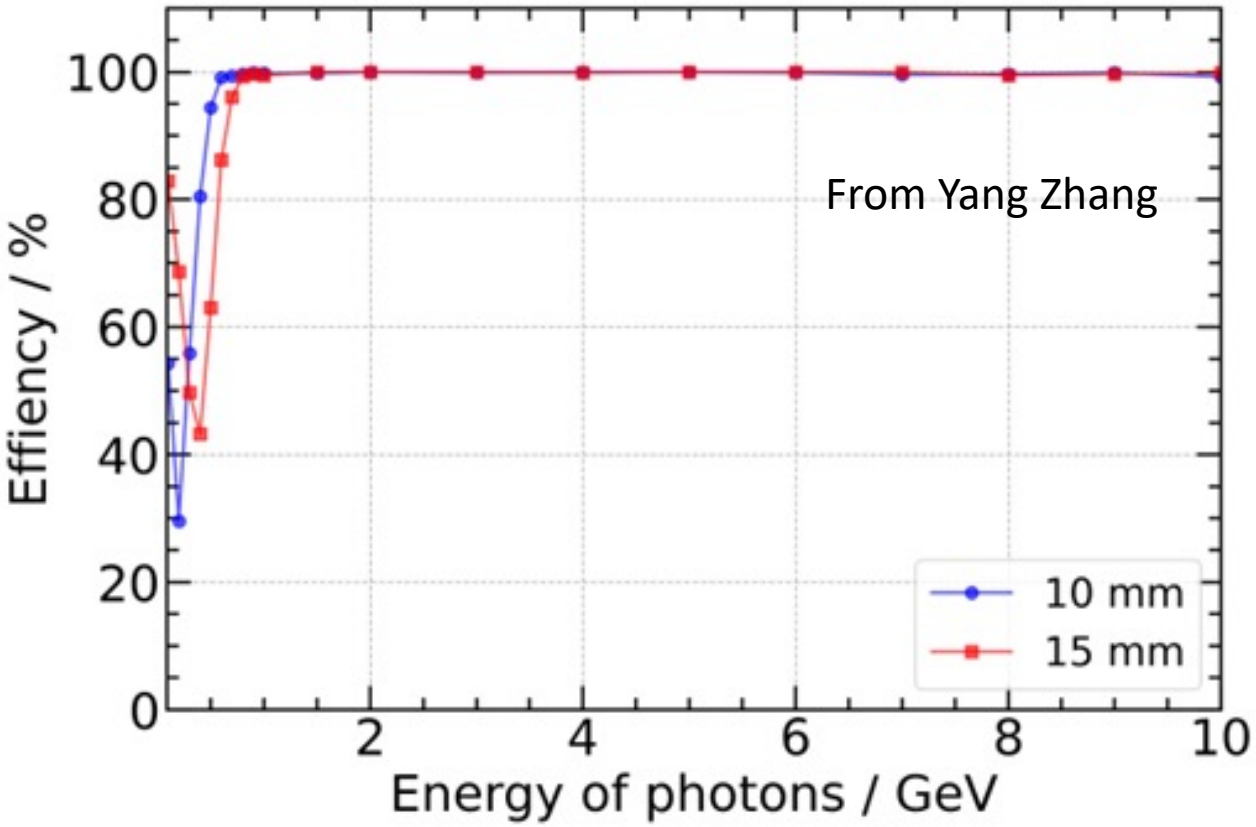
Cuts	Efficiency [%]
Vertex reconstructed	65
charged pair	64
Kinematic > 0	63
Chi2 < 4	54
PID	54
$E_\gamma > 0.5$ GeV, $\Delta_{m_{\pi^0}}$ <0.3 GeV, $\Delta_{m_{D^0}}$ <0.5 GeV, $\Delta_{m_{D^*}}$ <0.5 GeV	25
$0.11 < M_{\gamma\gamma} < 0.15$ GeV	6

- The $\Delta_{m_{\pi^0}} = |M_{\gamma\gamma} - m_{\pi^0}|$, $\Delta_{m_{D^0}} = |M_{\gamma\gamma\pi^+\pi^-} - m_{D^0}|$, $\Delta_{m_{D^*}} = \left|M_{\gamma\gamma\pi^+\pi^-\pi^\pm} - m_{D^*}\right|$. I chose the cut points arbitrarily, and need to do some optimization.

Summary

- Discussed with Fangyi and Yang, the reconstruction efficiency for the photon with energy less than 1 GeV drops very fast.
  - 100%@1GeV, ~50%@0.5GeV, ~20%@0.2GeV
  - The energies of most photons are less than 1GeV in this analysis.
- The next step
  - We need to break down the cut-flow to check the main reason for efficiency drop.
  - We can try to optimize the selection of di-photon combination to reconstruct π^0.
    - Lose the cut on E_γ, maybe only cut on the leading photon.
    - Use the open angle information of di-photons, maybe require the sub-leading photon around the leading photon
  - Maybe use the $D^0 \to K^+\pi^-\pi^0$ to increase the statistic.

Backup


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