Study of $h \to z\gamma$ Decay at CEPC

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Outline

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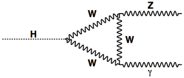
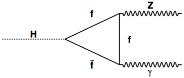
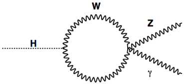
- Data samples and event selections
- Signal and background contributions
- Results
- Conclusion

Introduction

- One of goals for CEPC is to measure $B(h \to \gamma\gamma, z\gamma)$ precisely, which arises at the one-loop level in SM, sensitive to the new Physics.
- $B(h \to z\gamma) = 0.124\%$ is very small in SM and difficult to measure.
- The current limit at ATLAS in Run1: $< 18.2\times$ SM at 95% CL and it can be measured to 15% with 3 ab^{-1} at HL-LHC.







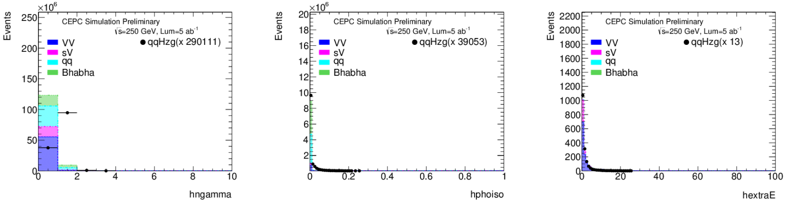
Data Samples

- Full CEPC samples are used and normalized to 5 ab^{-1}.
- Background: VV, sV, QQ, bhabha and qqH.
- Signal: $B(zh \to zz\gamma \to qq\nu\nu\gamma) = 0.1\%$.
- Selecting tracks and PFO within the detector fiducial.
- Jet clustering with anti-Kt exclusively to 2 jets.

Event Selection

- Signal consists of two jets from z decay, one iso-photon and missing recoiling z mass.
- $10 <$ntracks< 30, nclusters> 25, and nPFO< 70.
- isolated photon $20 < Pt < 50$ and $|\eta| < 1.5$
- two jet $(E_T > 10)$ mass: $dm < 12$ GeV of z mass.
- Recoiling mass: $dm < 15$ GeV of z mass.
- Pt, Pz of z $<$ 65 GeV.
- Extra energy out of jet cone $<$ 5 GeV.
- $1 < \Delta R_{z\gamma} < 3.2$ and $1 < \Delta R_{recoil\gamma} < 3.2$

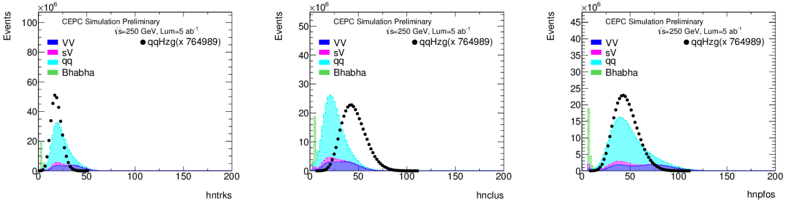
Photons, isolation, and extra Energy



(a) nphotons (b) Isolation (c) ExtraE

Figure : Number of photons, isolation, and Extra energy outside of jet cone > 72.6 degree.

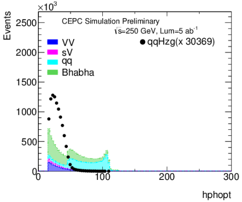
10<nTracks<30, nclus>25, nPFOs<70



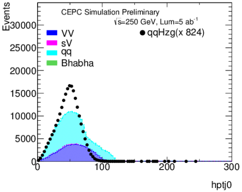
(a) nTracks (b) nClus (c) nPFOs

Figure : Number of Tracks, Clusters, and PFOs.

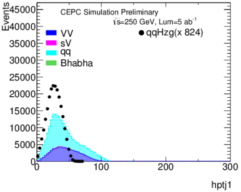
$P_t^{\gamma} > 15$, and $P_t^{j} > 10$ GeV



(a) Photon Pt



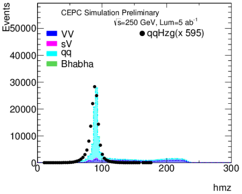
(b) Jet0 Pt



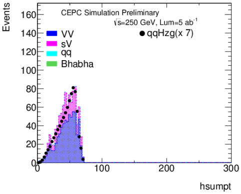
(c) Jet1 Pt

Figure : Photon Pt, Jet0 Pt, Jet1 Pt

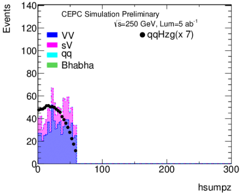
$|m_{jj} - m_z| < 12,\ P_t^{jj} < 70,\ P_z^{jj} < 60$ GeV



(a) dijet mass



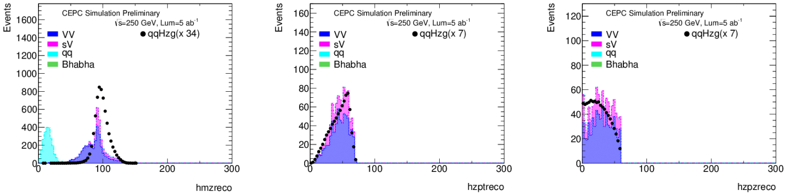
(b) pt



(c) pz

Figure : Dijet mass, pt, and pz.

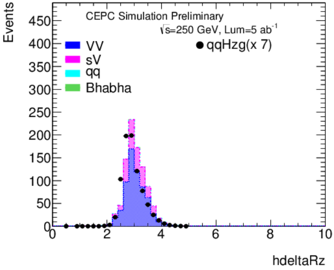
$|m_{reco} - m_z| < 15,\ P_t^{reco} < 70,\ P_z^{reco} < 60\text{GeV}$



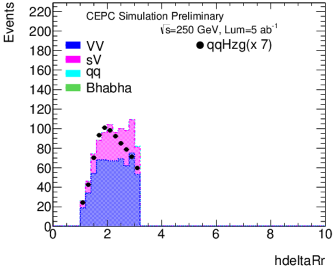
(a) Recoiling mass (b) pt (c) pz

Figure : Recoiling mass, pt and pz.

$1 < \Delta R_{z\gamma}, \Delta R_{reco\gamma} < 3.2$



(a) a

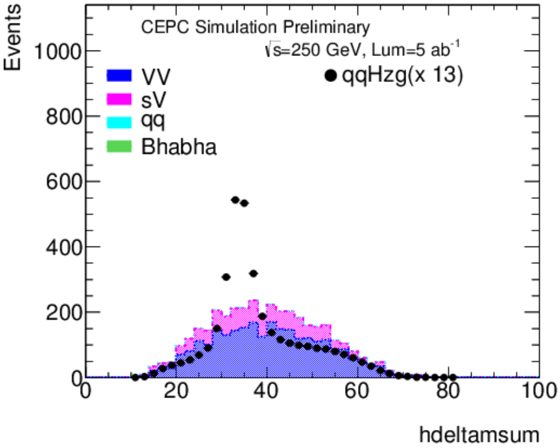


(b) b

Figure : (a) ΔR between z and γ, (b) recoiling and the γ

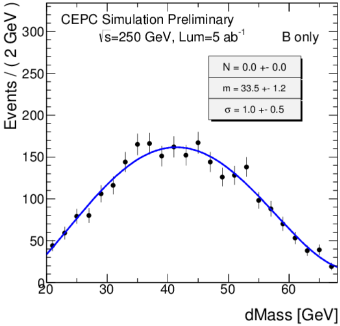
Mass Difference: $\Delta m = m_{z\gamma} - m_z$

- Δm has a better resolution, less sensitive to z mass.
- Useful to discriminate the signal and background.

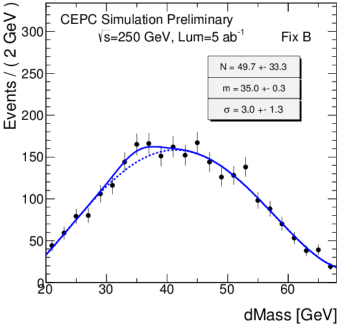


Δm for Background only

- The background shape seems not smooth, there are some excess of events near the signal region.



(a) Polynomial

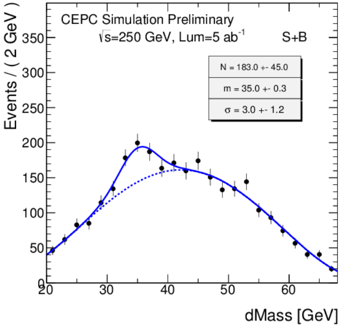


(b) Gaussian+Polynomial

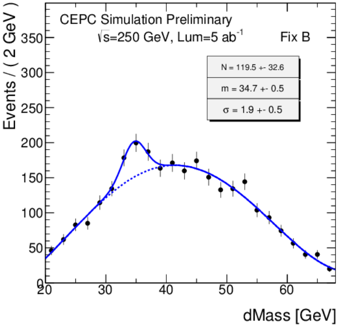
Figure : Fit with background polynomial only and plus Gaussian.

Δm for Signal + Background

- The excess of events seems close to 4 sigma in the signal region.



(a) Signal+background



(b) Fixing background

Figure : Fit with signal + background polynomial and fixing the background shape

Conclusion

- Initial study of $zh \rightarrow zz\gamma \rightarrow qq\nu\nu\gamma$ is promising, close to 4σ.
- Work is ongoing to include additional z decay channels of $zh \rightarrow zz\gamma \rightarrow (qqqq, llqq, ll\nu\nu)\gamma$, a factor of 3 more statisticals for 15% of measurement.
- Need to understand the background shape better.
- The analysis can be optimized further.
- Precise measurement of the ratio of $H \rightarrow \gamma\gamma$ and $H \rightarrow Z\gamma$ can be used to constrain new physics at the loop level.