$H \to \gamma\gamma$ progress

CEPC Physics Performance Wednesday Working Meeting

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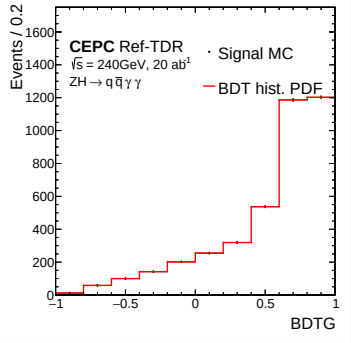
Statistical tool

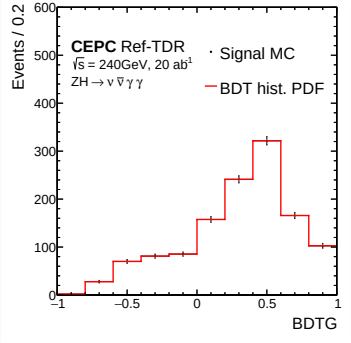
Use of ATLAS official tool for combination to verify our results and improve the study sensitivity:

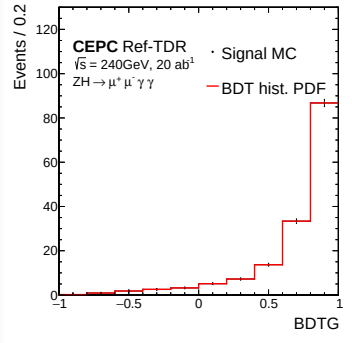
- Considering our BDTG training and from output, fitting for each bin using **quickFit**
- Fixed background issue (previously using unweighted data)

BDT output

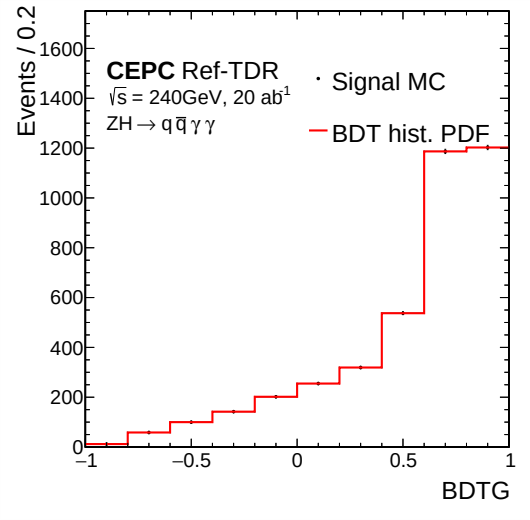
- For signal



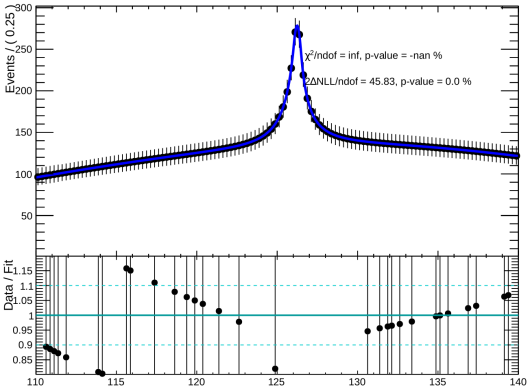




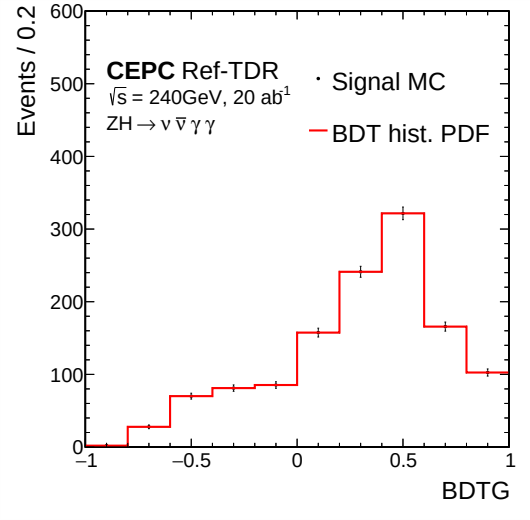
$q\bar{q}\gamma\gamma$ sub-channel



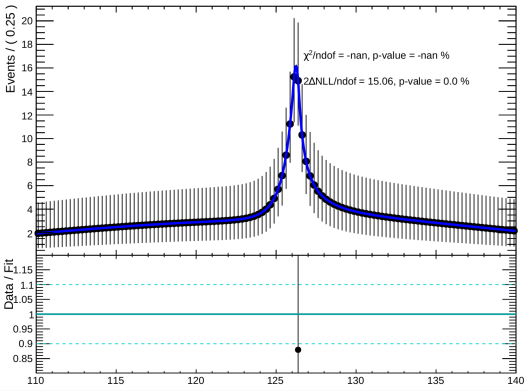
Fit in bin 10:



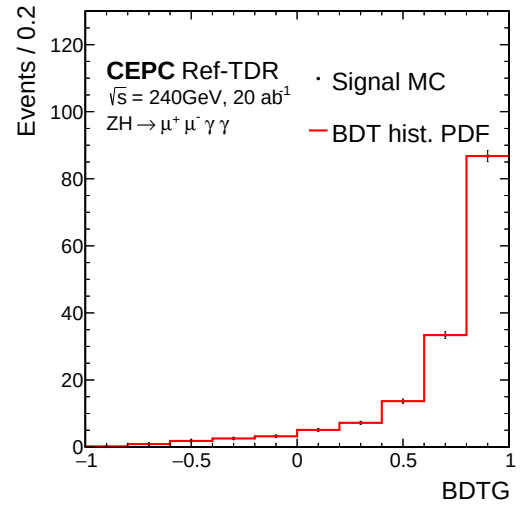
$\nu\bar{\nu}\gamma\gamma$ sub-channel



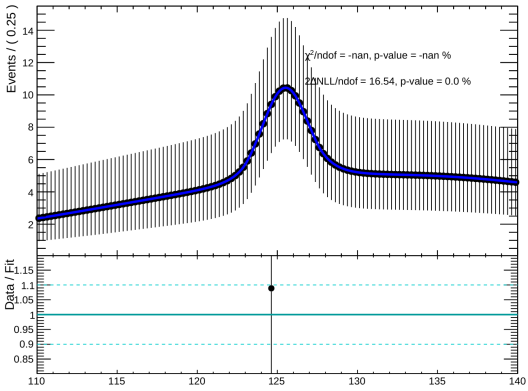
Fit in bin 8:



$\mu^+\mu^-\gamma\gamma$ sub-channel



Fit in bin 10:



Fit Results

Table 1: Expected statistical precision on $\sigma(ZH) \times \text{Br}(\to \gamma\gamma)$ from Asimov data fitting in the three channels and their combination with 20 ab^{-1} data.

	$\Delta(\sigma \times \text{Br})/(\sigma \times \text{Br})_{SM}$
$q\bar{q}\gamma\gamma$	0.048
$\mu^+\mu^-\gamma\gamma$	0.188
$\nu\bar{\nu}\gamma\gamma$	0.056
Combined	0.036

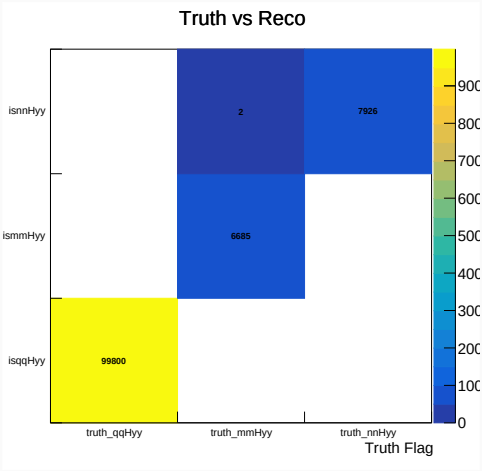
Corrected results (w/ weighted bkg data) much closer to 2D model but not as sensitive $\to$ need further investigating (different selections for better background rejection?)

Additional selections

In analysis package, all signal mixed and developing an event discriminator with flags for each signal:

- $\mu^+\mu^-\gamma\gamma$ sub-channel:
  jet-veto: $N_{PFO} < 20$
  2 muons: 2 leading energy charged PFOs (exactly 2 charged PFOs to veto all other charged particles) & $|m_{\mu\mu} - m_Z| < 10$ GeV
  neutrino veto: ($|E_{missing}| < 10$ GeV & $|M_{missing}| < 10$ GeV)
- $\nu\bar{\nu}\gamma\gamma$ sub-channel:
  jet-veto: $N_{PFO} < 20$
  0 charged particle required to get rid of all tracks (selections on missing energy/mass in cutflow)
- $q\bar{q}\gamma\gamma$ sub-channel:
  2 jets!

Contamination matrix



Little to no contamination between channels after using these flags

Cutflow

- Keeping the same cutflow as previously with some selections to consider depending on background efficiency ($M^{\gamma\gamma}_{recoil}$ in $\mu^+\mu^-$ channel for example)
- For signal, all channels with practically same number of Final selected events except $\mu^+\mu^-$ as the new flag for our two muons has an efficiency of 66.85 % (vs. previously Exclusive 2 photons & 2 muons: 72.01 % (7201 events)
- To be run on background after using new flags for sub-channeld (Different package: FastSim Delphes file structure different than CEPCSW reco files) $\rightarrow$ expected somewhat better rejection especially for $\nu\bar{\nu}$ & $\mu^+\mu^-$ channels

To-do

- Currently smearing the data to evaluate main systematics: PER, PES, γ eff. - by order of priority (will do it with new selections)
- Adapting analysis package to background ntuples
- Considering other backgrounds to get full background shape (mainly 4-fermions and checking 2-fermions FullSim data)
- Training BDTG after these new selections for better sensitivity (new variables to account for in $\nu\bar{\nu}$ sub-channel)

Thank you!

Back-up

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