Photon Study and diPhoton channel

CEPC Physics Performance Wednesday Working Meeting

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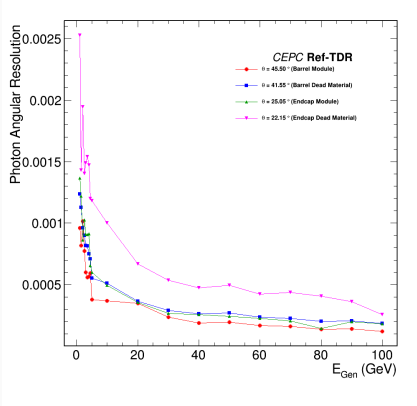
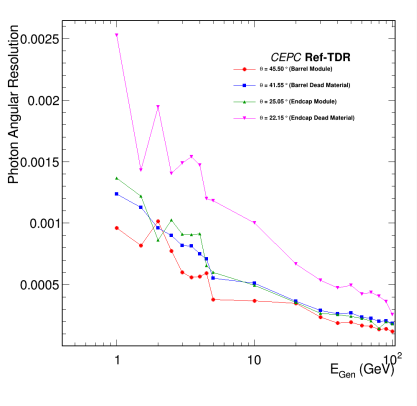
Progress

- More differential distribution plots for Ref-TDR: Photon θ & φ Angular Resolution (relative to the truth photon energy E_{gen})
- $H \to \gamma\gamma$ analysis proceeding
- Ref-TDR Draft contribution: $H \to \gamma\gamma$

Photon θ Angular Resolution

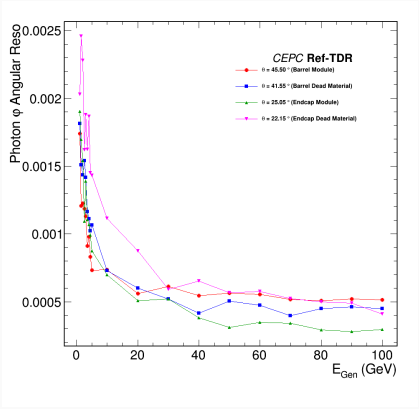


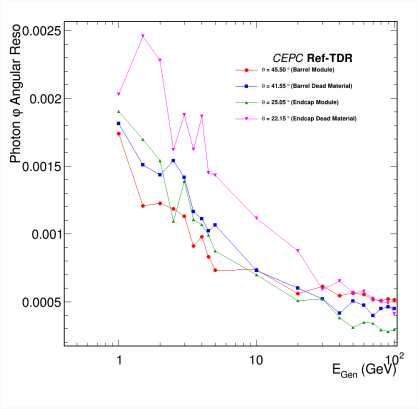


-From mid to high energies (10-100 GeV), the θ angular resolution is, as expected, somewhat flat (between 0.01%-0.03% for modules from both barrel and endcap and for barrel gaps/around 0.05% for endcap gaps ”dead material”)

-For low energies(1-5 GeV), the behavior seems erratic at few points (2, 4.5, 5 GeV) but the whole tendancy is expectable -> needs further investigation

Photon φ Angular Resolution





-Almost similar to θ angular reso, the φ resolution is somewhat flat for high energies (20-100 GeV), decrease from 10 GeV to 20 (values in rad not %)

-Need to investigate low energy regions

$H \to \gamma\gamma$ analysis

*Proceeding to make a package for the final state physics objects identification and selection within the signal samples
*One package for all the samples together (3 different signals but from collision Data indistinguisable):

- $e^+e^- \to ZH \to q\bar{q}H(H \to \gamma\gamma)$
  - 2 photons
  - 2 jets
- $e^+e^- \to ZH \to \mu^+\mu^- H(H \to \gamma\gamma)$
  - 2 muons
  - 2 photons
  - Nothing else
- $e^+e^- \to ZH \to \nu\bar{\nu}H(H \to \gamma\gamma)$
  - 2 photons
  - Missing energy

Ref-TDR Draft contribution

1.3.5 $H \to \gamma\gamma$ (Yaquan Fang, et al.)

The $H \to \gamma\gamma$ channel is an important rare decay mode of the Higgs boson. It was one of very first channels where an excess at a mass around the Standard Model Higgs was seen in the ATLAS and CMS experiments at LHC. [<**empty citation**>]

The diphoton channel can be used as a benchmark to optimize the detector for the γ reconstruction in the ECAL by studying the Photon Energy Resolution. It also enables the measurement of $\sigma(e^+e^- \to ZH) \times Br(H \to \gamma\gamma)$ in three Z decay channels $Z \to q\bar{q}/\mu^+\mu^-/\nu\bar{\nu}$ using the Reference detector with $\sqrt{s} = 240GeV$ at the Circular Electron Positron Collider(CEPC).

These measurements and benchmarks are essential for probing the precision of the Standard Model and searching for new physics, particularly in studying Higgs boson properties and this rare decay channel.

At the CEPC, Higgs bosons are produced via Higgs-strahlung ($e^+e^- \to ZH$) and W/Z fusion ($e^+e^- \to \nu\bar{\nu}H$, $e^+e^- \to e^+e^-H$). This analysis focuses on the dominant ZH process with Higgs decaying to diphotons ($e^+e^- \to ZH \to f\bar{f}\gamma\gamma$) at $\sqrt{s} = 240$ GeV. Three sub-channels are considered based on Z decays: $Z \to q\bar{q}$, $\mu^+\mu^-$, and $\nu\bar{\nu}$. The $Z \to e^+e^-$ channel is excluded due to overwhelming Bhabha background, and $Z \to \tau^+\tau^-$ is omitted due to the complexity of τ identification. The W/Z fusion process is included in the $Z \to \nu\bar{\nu}$ sub-channel.

The only background considered is the two-fermion process ($e^+e^- \to f\bar{f}$) with at least two photons from initial and final state radiation. Other potential backgrounds, including Higgs resonant contributions, four-fermion processes, and reducible backgrounds, are expected to be negligible.

Details to be added according to analysis proceeding:

Simulated signal samples in a full detector simulation using CEPCSW/Background samples with fast simulation Pythia+Delphes (More infos to be added)

Selections: Photon identification and isolation criteria./Kinematic constraints (photon transverse momentum, angular acceptance, etc.)

Supervised by Prof. Yaquan, first few paragraphs and main details noted waiting for the analysis to proceed

Perspectives

- Continue the single photon study
  - Investigate and fix differential plots
  - Gaps (dead material) impact in barrel and endcap
  - Focus on low energy photons to improve sensitivity/efficiency for flavour physics ($\pi^0 \to \gamma\gamma$?)
- Prepare the package for $H \to \gamma\gamma$ signal samples
- Maintain modifications in Ref-TDR for $H \to \gamma\gamma$ & Performance of Photons

Thank you!

Back-up