Institute of High Energy Physics
Chinese Academy of Sciences

Prospect of $t\bar{t}$ Analysis at CEPC

Mustapha Biyabi, Siya Feng, Jiabao Gong, Shudong Wang, Xiaoxu Zhang, Yaquan Fang, Gang Li, Hongbo Liao, Lei Zhang

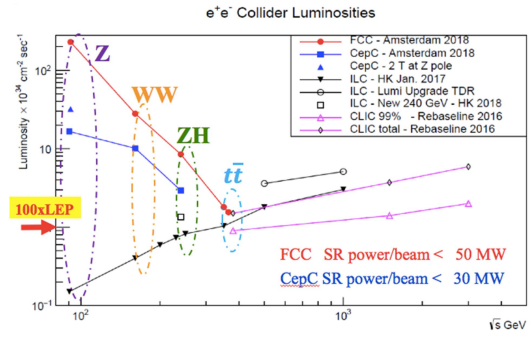
Introduction

The versatility and capabilities of CEPC make it an exciting prospect for advancing our understanding of particle physics.

CEPC provides an ideal environment for studying ttbar processes at ~360GeV.

By precisely measuring the properties of ttbar system, valuable insights into the top electroweak couplings can be gained.

Moreover, it is of significant importance for Higgs complementary measurements and BSM searches.



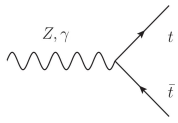
Top Electroweak Couplings

The importance of studying top electroweak couplings:

①Setting constraints on new physics scale

②High sensitivity to BSM physics

③Test of composite Higgs models



At the CEPC, the ttV(V=γ, Z) couplings could be probed directly through the top pair production process.

The most general Lorentz-invariant vertex function describing the interaction of a neutral vector boson V with two on-shell top quarks can be written:

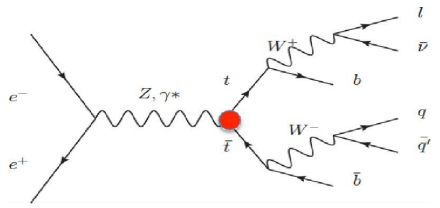
$$\Gamma^{\mu}_{ttV} = \frac{g}{2}\left[\gamma^{\mu}\{(A_V+\delta A_V)-\gamma_5(B_V+\delta B_V)\}+\frac{(p_t-p_{\bar{t}})^{\mu}}{2m_t}(\delta C_V-\delta D_V\gamma_5)\right]$$

The energy and angular distributions of the decay products, in particular, the charged lepton and the b-quark, are powerful tools to disentangle and access different components of the ttZ and ttγ.

For the interaction between top quarks and neutral vector bosons, there are two observables can be measured:

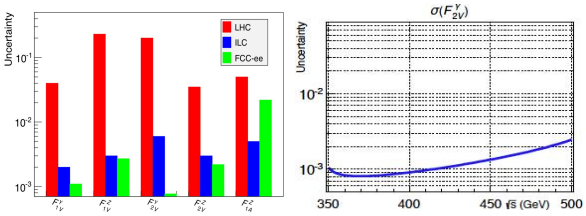
①Cross-section: to measure the strength of the interaction.

②FB asymmetry: can be calculated by measuring the angular distribution of the charged leptons, providing insights into the interaction.



The present LHC precision in measuring top electroweak couplings is not very constraining. However, similar to the FCC-ee scenario, CEPC could reduce the statistical uncertainties by orders of magnitude.

With conservative assumptions on lepton identification, b-tagging efficiencies, and lepton angular and momentum resolutions, the estimated precisions at FCC-ee are at the order of 10^{-2} to 10^{-3} at the energy of 365 GeV.



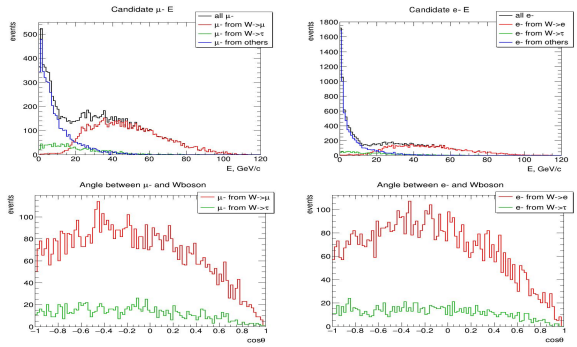
Analysis at CEPC

Detailed studies about selecting and reconstructing ttbar events at CEPC are in progress.

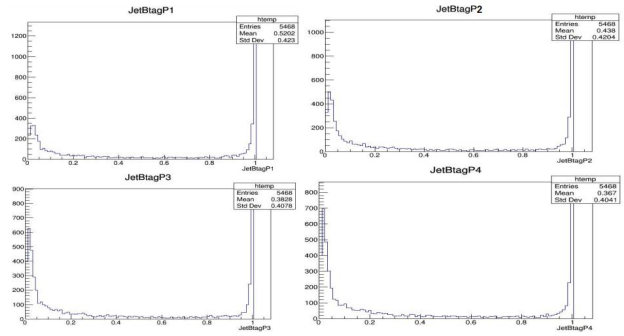
The top EW coupling can be measured by studying the energy-angle distribution of the lepton from the semileptonic decay:

$$e^+e^- \to t\bar{t} \to b\bar{b}q\bar{q}'\ell\nu_\ell \ (\ell = e,\mu)$$

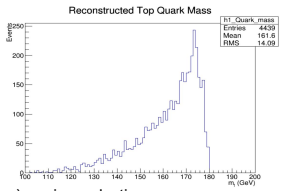
The figures show energy and angle distribution of lepton(muon and electron) in this decay:



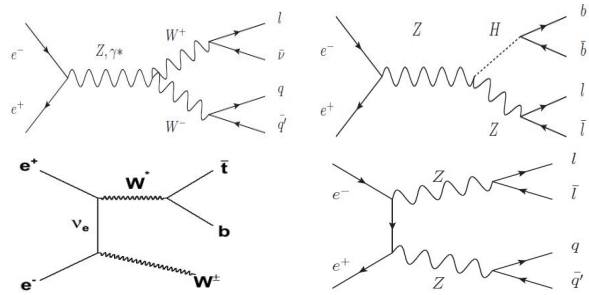
And these figures show the Btagging of 4 jets:



Reconstruction of top quark mass is tried but there is still a long tail:



And background samples (diboson and single top) are in production:



To tag the semileptonic ttbar events, background rejection is performed by using discriminating variables, and muons and electrons originating from tau decays are excluded.

Summary and Future Perspectives

Studying the top EW couplings is highly significant due to its sensitivity to new physics. This measurement can be performed at CEPC, and it is expected to achieve satisfactory precision.

Regarding the future perspectives of ttbar analysis:

①Optimize event selection and reconstruction to improve the analysis.

②Improve the analysis including fully leptonic final states.

③Improve the analysis including b quark energy-angle distribution