

Letter of Interest for Snowmass 2021 EF01 Topical Group: Search for exotic $t\bar{t}HH$ couplings at the HL-LHC

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Abstract

We propose a sensitivity study to study $t\bar{t}HH$ production and probe BSM couplings for the HL-LHC.

1 Introduction

Precision measurements of the Higgs boson couplings to SM particles is a central task at the LHC today and for the HL-LHC in the future. Due to the $\sim \text{nb}$ $t\bar{t}$ cross section and large Yukawa coupling, measurements of the interaction of the Higgs with top quarks is particularly compelling. Both $t\bar{t}H$ and $t\bar{t}HH$ signals can be used to probe this coupling and search for deviations signalling BSM physics. Current studies include analyses for composite Higgs models and EFTs, such as in [1] (see pp. 292-298), [2], [3],[4].

2 Status and Plans

We search for anomalous $t\bar{t}HH$ production at the HL-LHC. As a toy model, to study this signal independently of $t\bar{t}H$, we introduce both 6D and 8D gauge-invariant operators to modify $t\bar{t}HH$ while keeping $t\bar{t}H$ unchanged at tree level. Monte Carlo samples are produced in Madgraph, with Pythia and Delphes used for hadronization and detector simulation, respectively. In our simplified signal model which includes a BSM $t\bar{t}HH$ vertex, Higgs are produced at higher p_T compared with those from SM production. Due to the resulting Lorentz boost, we observe an enhancement around the Higgs mass in the single b-jet mass spectrum. Thus, boosted Higgs decaying to b-pairs appears to be a relevant signature to reduce the SM background for this search. To optimize signal efficiency, we will apply techniques such as ML based double b-tagging for clustered b-jet identification [5] and jet substructure variables such as N-subjettiness and energy correlation functions [6, 7], among others.

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References

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