

CP-sensitive simplified template cross-sections for $t\bar{t}H$

The CP structure of the Higgs boson is a fundamental property which has not yet been constrained with high precision. CP violation in the Yukawa coupling between the Higgs boson and top quark pair can be probed directly at the Large Hadron Collider by measuring top-quark-associated Higgs production. Multivariate analysis techniques commonly developed so far by the experiments are designed for a specific signal model and, therefore, complicate reinterpretations and statistical combinations. With this motivation in mind, we propose a CP-sensitive extension of the simplified template cross-section (STXS) framework. Considering multiple Higgs decay channels, we perform an in-depth comparison of CP-sensitive observables and combinations thereof. Our resulting proposal is to extend the existing binning in the transverse momentum of the Higgs boson $p_{T,H}$ by either the pseudorapidity difference of the two top-quarks $\Delta\eta_{t\bar{t}}$, or a variable that is based on the top quark momenta, namely b_2 or the Collins-Soper angle $|\cos\theta^*|$. We demonstrate that this variable selection provides close to optimal sensitivity to the CP mixture in the top Yukawa coupling for an integrated luminosity of 300 fb^{-1} , by comparing it to the results of a multivariate analysis. Our results also suggest a benefit of the two-dimensional STXS extension at 3000 fb^{-1} .

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