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ttbb predictions at NLO in QCD and b-jet modelling

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One of the greatest achievements of the LHC has been the discovery of the Higgs boson in 2012. Since then, the properties of this newly discovered particle have been widely tested. For instance, we need to understand how this particle couples to the other fundamental particles. The coupling of the Higgs boson to the heaviest of the quarks, the top quark, has been probed first indirectly and, more recently, directly via the $t\bar{t}H$ process, first observed in 2018. The Higgs boson predominantly decays into a bottom-quark pair $H \to b\bar{b}$. Therefore, $t\bar{t}H(H \to b\bar{b})$ is a prime ingredient to extract information on the top-Yukawa coupling. Despite the larger statistics obtainable with this process, the large amount of jets present in the fully decayed final state complicates the picture. Indeed, this process suffers of a huge background. The top-quark production in association with a bottom-quark pair $t\bar{t}b\bar{b}$ represents an irreducible background to this process. Therefore, a correct description of this background is needed to discriminate it from the actual signal. In this talk I will present the latest theoretical results for $pp \to t\bar{t}b\bar{b}$ at the LHC in the dileptonic decay channel of the top quark. These predictions are NLO accurate in QCD and include all the full off-shell effects. I will also investigate the size of these full off-shell effects, comparing the full off-shell calculation to the one obtained in the Narrow-Width Approximation. The fully decayed final state presents at least four b-jets, two coming from the top-quark decays and two mainly from gluon splitting. I will refer to the latter as prompt b-jets. Hence, in this talk, I will also provide a prescription to distinguish the prompt b-jets from those coming from the decay of the top quarks. The importance of this study is again related to the fact that $t\bar{t}b\bar{b}$ has the same final state as $t\bar{t}H$ when the Higgs boson decays into $H \to b\bar{b}$. Therefore, this prescription can also be used for $t\bar{t}H(H \to b\bar{b})$ to distinguish between the decay products of the Higgs boson and the top quarks.

In-person participation

Yes

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