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Search for ttH(bb) in the all-jet final state

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We present a search for the standard model Higgs boson decaying into b quarks and produced in association with a pair of top quarks decaying in the all-jet final state. This search is performed on the full 13-TeV dataset of proton-proton collisions collected by the CMS experiment at the LHC in 2016. To separate the $t\bar{t}H$ signal from the irreducible $t\bar{t}+b\bar{b}$ background, this analysis takes advantage of a matrix element method. A data-driven method has been used to estimate the large multijet background.

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1. Introduction

The all-jet $t\bar{t}H$ events consist in a Higgs boson decaying into $H \to bb$ produced in association with a top quark pair decaying into $t \to W(jj)b$. The search for the all-jet $t\bar{t}H(bb)$ is complementary to the other leptonic $ttH(bb)$ searches and benefits of the large branching fraction of the W boson into jets ($\simeq 69\%$). However, the large multijet background due to the absence of isolated leptons in the final state reduces the sensitivity of this analysis. The other main background is $tt + (b)$jets and is estimated with simulations.

2. Trigger and event selection

This search [1] has been performed on data collected with the CMS experiment [2] corresponding to $35.9\,\text{fb}^{-1}$ of pp collisions at $\sqrt{s} = 13\,\text{TeV}$. The data were collected by two tailor-made triggers. The trigger efficiency is $> 99\%$ for signal events passing the following event preselection: scalar sum of jet p_T larger than 500 GeV, at least six jets with $p_T > 40\,\text{GeV}$, and two tight b tagged jet. The analysis has been divided in six categories depending on the number of jets with $p_T > 30$ GeV (7, 8, and ≥ 9) and b tags (3 and 4). Each category has been split in a signal region, requiring three or four tight jet b tagging and large quark-gluon likelihood ratio value [3], a control region defined inverting the tight b tagging, and a validation region inverting the quark-gluon likelihood ratio selection.

3. Multijet background estimate

The multijet background has been estimated entirely from data. The shape of the multijet distribution in signal regions is taken from the data distribution in the respective control region, after having subtracted the expected contributions of all other backgrounds using simulations. The normalizations of the multijet background in the signal regions are free parameters of the final fit. Kinematic differences due to the different b tagging applied in signal and control regions are corrected using jet-by-jet weight functions.

4. Results

The final fit is performed fitting simultaneously in all six signal regions a discriminator, defined as the ratio of the likelihood of an event to be originated from the hypothesis $tt + H(bb)$ or $tt + bb$. The best fitted signal strength is $\mu = \sigma/\sigma_{SM} = 0.9 \pm 0.7(\text{stat.}) \pm 1.3(\text{syst.})$.

References

[1] A. M. Sirunyan *et al.* [CMS Collaboration], JHEP **1806** (2018) 101 doi:10.1007/JHEP06(2018)101 [arXiv:1803.06986 [hep-ex]].

[2] S. Chatrchyan *et al.* [CMS Collaboration], JINST **3** (2008) S08004. doi:10.1088/1748-0221/3/08/S08004

[3] CMS Collaboration [CMS Collaboration], CMS-PAS-JME-16-003, `https://cds.cern.ch/record/2256875`.