

Measurement of $t\bar{t}$ cross sections in association with b jets and inclusive jets and their ratio using dilepton final states in pp collisions at $\sqrt{s}=13$ TeV

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The cross sections for the production of $t\bar{t}b\bar{b}$ and $t\bar{t}jj$ and their ratio $\sigma_{t\bar{t}b\bar{b}}/\sigma_{t\bar{t}jj}$ are measured using data corresponding to an integrated luminosity of 2.3 fb^{-1} collected in pp collisions at $\sqrt{s}=13$ TeV with the CMS detector at the LHC. Events with two leptons (e or μ) and at least four reconstructed jets, including at least two identified as b quark jets, in the final state are selected. In the full phase space, the measured ratio is 0.022 ± 0.003 (stat) ± 0.006 (syst), the cross section $\sigma_{t\bar{t}b\bar{b}}$ is 4.0 ± 0.6 (stat) ± 1.3 (syst) pb and $\sigma_{t\bar{t}jj}$ is 184 ± 6 (stat) ± 33 (syst) pb. The measurements are compared with the standard model expectations obtained from a powheg simulation at next-to-leading-order interfaced with pythia.

The 39th International Conference on High Energy Physics (ICHEP2018) 4-11 July, 2018 Seoul, Korea

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1. Introduction

Experimental measurements of production cross section $pp \rightarrow t\bar{t}jj(\sigma_{t\bar{t}jj})$ and $pp \rightarrow t\bar{t}b\bar{b}(\sigma_{t\bar{t}b\bar{b}})$ can provide an important test of NLO quantum chromodynamics (QCD) theory calculations and important input for describing the main background in the search for the $t\bar{t}H$ process. The measurements of the cross sections $\sigma_{t\bar{t}b\bar{b}}$ and $\sigma_{t\bar{t}jj}$ and their ratio are presented using a data sample of pp collisions collected at 13 TeV at the CERN LHC by the CMS experiment [1], and corresponding to an integrated luminosity of 2.3 fb^{-1} in full and visible phase space.

2. Cross section measurement

The $t\bar{t}b\bar{b}$ events are selected by requiring at least four reconstructed jets with $p_T > 30 \text{ GeV}$ and $|\eta| < 2.4$, of which at least two jets must be identified as b jets, using the combined secondary vertex (CSV) algorithm (v2), which combines secondary vertex information with lifetime information of single tracks to produce a b tagging discriminator. The third and fourth jets in decreasing order of the b tagging discriminator from $t\bar{t}jj$ events are mostly light-flavour jets, while these are heavy-flavour jets for $t\bar{t}b\bar{b}$ events as shown in Figure 1. To extract the ratio of the number of events $t\bar{t}b\bar{b}$ to $t\bar{t}jj$ events, a binned maximum-likelihood fit is performed on the 2D distribution of the CSV b tagging discriminators of the third and the fourth jets.

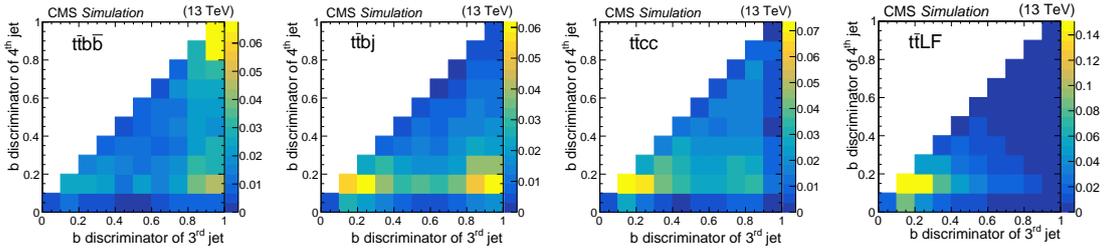


Figure 1: Normalized 2D distributions of the b jet discriminators of the third (x-axis) and the fourth (y-axis) jets sorted in decreasing order of b tagging discriminator value, after the full event selection for $t\bar{t}b\bar{b}$, $t\bar{t}bj$, $t\bar{t}cc$, $t\bar{t}LF$ processes.

3. Conclusions

The measured cross section ratios in the visible and the full phase space $\sigma_{t\bar{t}b\bar{b}}/\sigma_{t\bar{t}jj}$ are $0.024 \pm 0.003 \text{ (stat)} \pm 0.007 \text{ (syst)}$ and $0.022 \pm 0.003 \text{ (stat)} \pm 0.006 \text{ (syst)}$, respectively, where a minimum transverse momentum for the particle-level jets of 20 GeV is required. More details can be found in [2].

References

- [1] CMS Collaboration, “The CMS experiment at the CERN LHC”, JINST 3 (2008) S08004
- [2] CMS Collaboration, “Measurement of $t\bar{t}$ cross sections in association with b jets and inclusive jets and their ratio using dilepton final states in pp collisions at $\sqrt{s}=13 \text{ TeV}$ ”, Physics Letters B 776 (2018) 355-378