The Compact Muon Solenoid Experiment

Conference Report

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Measurement of Z+jets differential cross section at 8 and 13 TeV with the CMS detector

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Abstract

The production of a Z boson in association with hadronic jets is a cardinal process at the LHC providing a reference both for the physics measurements and for the understanding of the detector response. With the large energy in the center-of-mass of the colliding hadrons obtained with the LHC, jet production is present in almost all the processes under study. The decay of the Z boson to charged leptons allows for a clean and efficient selection of a signal sample, contaminated with only a marginal amount of background, and offering therefore the ideal conditions for the study of hadronic jet production. Differential cross section measurements of the Z boson production in association with jets are presented, using 8 TeV and 13 TeV proton-proton collisions data recorded by the CMS detector at the LHC. The cross sections are presented as a function of jet multiplicity, the jet transverse momenta, and the jet rapidity for different jet multiplicities. The cross section measurements are then compared with the predictions from a multileg next-to-leading-order Monte Carlo generator.

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Measurement of Z+Jets differential cross section at $\sqrt{s} = 8$ & 13 TeV with the CMS detector

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Keywords: CMS, Standard Model, computing

1 Introduction

The high centre-of-mass energy at the Large Hadron Collider (LHC) allows production of events with high jet transverse momenta and high jet multiplicities associated with an electroweak bosons. The data corresponds to 2.25 fb^{-1} of integrated luminosity of 13 TeV proton-proton (pp) collision data recorded by the Compact Muon Solenoid (CMS) [1] detector during the Run II of the LHC. The differential cross sections are measured as a function of the inclusive and exclusive jet multiplicities and jet kinematical variables including the jet transverse momentum (p_T), the absolute jet rapidity ($|y|$) and the jet transverse momenta scalar sum (H_T). The measurements are compared to multileg NLO predictions using the FxFX jet merging scheme.

2 Analysis strategy

The Z + jets signal process is generated with MG5_AMC interfaced with PYTHIA8, using the FxFx merging scheme. The $t\bar{t}$ and single top backgrounds are gener-

ated using POWHEG interfaced to PYTHIA8. Background MC samples corresponding to double vector boson electroweak production are generated with aMC@NLO (WZ), POWHEG (WW), both interfaced to PYTHIA8 and with PYTHIA8 alone (ZZ). The final state particles in Z + jets decays are identified and reconstructed with the particle-flow (PF) algorithm. The reconstruction of muons is described in detail in [3]. The trigger selects events with two isolated muons with transverse momenta of at least 8 and 17 GeV. After reconstruction, muons with $p_T > 20$ GeV and $|\eta| < 2.4$ are selected. We require that the two muons with highest transverse momenta to be oppositely charged and form a pair with an invariant mass within a window of 91 ± 20 GeV. Jets are reconstructed by clustering the PF candidates with the anti- k_T algorithm, with a size parameter of 0.4. Jets are required to have $p_T > 30$ GeV, $|y| < 2.4$ and to have a spatial separation from muon candidates of $\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2} > 0.4$. Jets are further required to satisfy the loose identification criteria.

The Z decay in $\tau^+\tau^-$ is considered as background and is subtracted during the unfolding procedure. The background contamination is below the percent level for the inclusive selection, but increases with the number of jets mainly due to $t\bar{t}$ production, reaching 15% for a jet multiplicity of 4 and above. The fiducial cross sections are obtained by subtracting the simulated backgrounds from the data distributions and correcting the background-subtracted data distributions back to the particle level using an unfolding procedure. This is performed using the iterative Bayesian method [2]. A response matrix is computed using the simulated Z + jets events.

In this analysis, the systematic uncertainties are considered from various sources. The dominant source of systematic uncertainty is the jet energy scale uncertainty, which is up to 7 % for a jet multiplicity of 1. The uncertainty on the cross section of the largest background contribution from top pairs, is estimated to be 10%. A systematic uncertainty associated with the generator used to build the unfolding response matrix is assessed by weighting the simulation to agree with the data in each distribution and constructing a reweighted response matrix to unfold the data. The difference between the unfolded results obtained using the weighted response matrix and the nominal results is taken as the systematic uncertainty associated with the unfolding response matrix. The uncertainty on the integrated luminosity is 2.6% for 8 TeV and 4.6% for 13 TeV.

3 Results and Summary

The measured cross sections for 8 and 13 TeV are shown in Fig. 1. For 8 TeV, measurements are compared with the three theoretical prediction [4]. For 13 TeV, measurements are compared with the prediction of MG5_AMC@NLO. Good agreement between reconstructed data and theoretical predictions is observed up to four jets. The predictions generally describe the measured cross sections within the uncertainties.

Fig. 1: Measured cross section as a function of the jets exclusive multiplicity at 8 TeV (left) [3] and 13 TeV (right) [4]. In the bottom plots, cross section is measured as a function of the leading jet p_T at 8 TeV (left) [3] and 13 TeV (right) [4].

References

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