The Compact Muon Solenoid Experiment
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Forward jets and forward-central jets at CMS

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Abstract

We report on a measurement of the inclusive production of forward jets as well as of associated production of forward and central jets in pp collisions at $\sqrt{s} = 7$ TeV. Forward jets are reconstructed with the anti-kT ($R = 0.5$) algorithm in the Hadronic Forward (HF) calorimeter at pseudorapidities $3.2 < |\eta| < 4.7$, in the transverse momentum range $p_T = 35 - 140$ GeV/c. The single differential cross section as function of the forward and central jet transverse momentum is presented and compared to next-to-leading order perturbative QCD calculations, the PYTHIA and HERWIG parton shower event generators, as well as to the CASCADE Monte Carlo.

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Abstract. We report on a measurement of the inclusive production of forward jets as well as of associated production of forward and central jets in pp collisions at $\sqrt{s} = 7$ TeV. Forward jets are reconstructed with the anti-kT ($R = 0.5$) algorithm in the Hadronic Forward (HF) calorimeter at pseudorapidities $3.2 < |\eta| < 4.7$, in the transverse momentum range $p_T = 35 - 140$ GeV/c. The single differential cross section as function of the forward and central jet transverse momentum is presented and compared to next-to-leading order perturbative QCD calculations, the PYTHIA and HERWIG parton shower event generators, as well as to the CASCADE Monte Carlo.

1 Introduction

Jet production in hadron-hadron collisions is sensitive to the underlying partonic QCD processes, to the details of parton radiation and to the parton density functions (PDF) of the colliding hadrons. Measured jet cross sections at large transverse momenta (p_T) are successfully described by perturbative QCD (pQCD) calculations based on Dokshitzer-Gribov-Lipatov-Altarelli-Parisi (DGLAP) evolution equation [1–4] over several orders of magnitude when jets belong to central rapidities [5]. Calorimetric coverage of the CMS detector [6] extends to pseudorapidity $|\eta| < 5.0$ which allows to measure jet production at previously unexplored forward rapidities. Measurements with jets in forward region allow to access small values of momentum fraction of incoming parton, x , where PDFs are less constrained by DIS data. In jet production at large c.m. energy contribution of semihard parton interactions ($\sqrt{s}/2 \gg p_T > \Lambda_{QCD}$) would become significant, such interactions are described by Balitski-Fadin-Kuraev-Lipatov (BFKL) [7–9] kinematics regime. BFKL contribution is enhanced for multijet production involving jets with large rapidity separation [10]. Measurements of simultaneous production of forward-central jets or forward-backward jets may reveal effects beyond conventional DGLAP description.

Jet clustering algorithm used by CMS is anti-kT ($R=0.5$) [11]. For the analyses described here it is applied to calorimetric energy deposits. Presented measurements are performed in pp collisions at $\sqrt{s} = 7\text{TeV}$ c.m. energy recorded in 2010.

2 Inclusive forward jet cross section measurement

Measurement of inclusive jet production at pseudorapidities $3.2 < |\eta| < 4.7$ is performed in the analysis at Ref. [12]. The p_T range considered is $35 < p_T <$

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Figure 1: Ratio of forward jet inclusive cross section measurement to predictions of various MC generators and pQCD calculations.

150. Measurement corrected for detector effects is compared with predictions obtained from MC generators PYTHIA 6.422 [13], PYTHIA 8.135 [14], HERWIG6.510.3 [15] (with underlying event modelled with Jimmy [16]), and CASCADE 2.2.04 [17]. CASCADE MC generator accounts for combined DGLAP + BFKL evolution. Also the data is compared to NLO pQCD predictions obtained either at the parton level with NLOJET++ [18] or with POWHEG package [19] matched with PYTHIA parton showers. Measurements are described within experimental and theoretical uncertainty by all MC generators and pQCD NLO calculations considered.

3 Measurement of cross section of simultaneous productions of forward and central jets

Production of forward jets was measured for the case when forward jet is accompanied by central jet in the analysis at Ref. [20]. For each event it was required that there is at least one jet with $p_T > 35$ GeV present in each of pseudorapidity ranges of $|\eta| < 2.8$ and $3.2 < |\eta| < 4.7$. Measured cross sections are compared with predictions from PYTHIA 6, PYTHIA 8, HERWIG 6 + Jimmy, HERWIG++ [21], CASCADE, POWHEG matched with PYTHIA and HERWIG parton showers and HEJ [22] an MC generator which also, like CASCADE, accounts for the BFKL effects in jet production in hadron collisions. While the description of forward cross-section is more successful, description of central jet production shows substantial discrepancies for PYTHIA, POWHEG+PYTHIA and CASCADE (Fig.2). Better agreement is demonstrated for HERWIG and HEJ.

Figure 2: Cross section of production of central jets associated with forward jets production compared to various MC generator predictions.

Figure 3: Measurement of $R = \sigma_{incl}/\sigma_{excl}$ corrected for detector effects and compared to various MC generator predictions.

4 Measurement of inclusive and exclusive dijet production ratio at large rapidity intervals

A measurement of inclusive over exclusive dijet production ratio $R = \sigma_{incl}/\sigma_{excl}$ at large rapidity intervals is a sensitive probe for effects beyond DGLAP description [23]. For the measurement at Ref. [24] jets with $p_T > 35$ GeV and $y < 4.7$, where y is jet rapidity, were used. Inclusive dijets are defined as all pairwise combinations of jets passing the selection, exclusive dijets are jet pairs from events where just two jets are found. Measurement corrected for the detector effects was compared to predictions of DGLAP-motivated MC generators PYTHIA 6, HERWIG 6 and HERWIG++. It was found that the measurement is well described by PYTHIA 6 tunes while HERWIG++ and HERWIG 6 predictions significantly overestimate the ratio R especially at large values of $|\Delta y|$ (Fig.3).

5 Conclusions

It has been shown that variety of MC predictions for inclusive jet production in forward region are in good agreement with the data. At the same time MC description of measurements involving dijets with large rapidity separation becomes problematic.

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