RECENT RESULTS ON QCD AND HEAVY ION PHYSICS FROM CMS*

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Results from a variety of QCD and Heavy Ion physics analyses are presented using *pp* and PbPb collision data collected by the CMS experiment at $\sqrt{s}$ = 7 TeV and 2.76 TeV, respectively. The data distributions are compared with the predictions of Monte Carlo event generators and with perturbative QCD calculations.

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1. Introduction

QCD processes dominate at the LHC due to their large cross-sections relative to other processes. In 2010, 43.17 $\text{pb}^{-1}$of the delivered data were recorded by the CMS detector [1] with a data taking efficiency greater than 90%. Moreover, 6.7 μb^{-1} of Pb + Pb collision data at $\sqrt{s}_{NN}$ = 2.76 TeV[1] were collected. Hadronic event shapes [2], inclusive jet cross-section measurement [3], dijet azimuthal decorrelations and angular distributions [4, 5] and jet quenching in Pb + Pb collisions [6] will be discussed in this paper. The other results, transverse momentum and pseudorapidity distributions of charged hadrons, charged particle multiplicities and observation of diffraction in proton–proton collisions — which are within the scope of this paper — can be found in [7, 8, 9].

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[1] *NN* subscript indicates the energy per nucleon–nucleon collision.

2. QCD results

2.1. First measurement of hadronic event shapes in pp collisions at $\sqrt{s}$=7 TeV

Hadronic event shapes have been measured in proton–proton collisions at $\sqrt{s} = 7$ TeV, with a data sample collected with the CMS detector at the LHC. The sample corresponds to an integrated luminosity of 3.2 pb^{-1}. The central transverse thrust and the central thrust minor are defined as [10]

$$\tau_{\perp,C} \equiv 1 - \max_{\hat{n}_T} \frac{\sum_i |\vec{p}_\perp \cdot \hat{n}_T|}{\sum_i p_{\perp,i}}, \qquad \tau_{m,C} \equiv \frac{\sum_i |\vec{p}_\perp \times \hat{n}_T|}{\sum_i p_{\perp,i}}. \tag{1}$$

Event-shape distributions, corrected for detector response, are compared with five models of QCD multijet production (Fig. 1). The event-shape distributions from Pythia6, Pythia8, and Herwig++ show satisfactory agreement with the data, while discrepancies are found between the data and predictions from Alpgen and MadGraph.

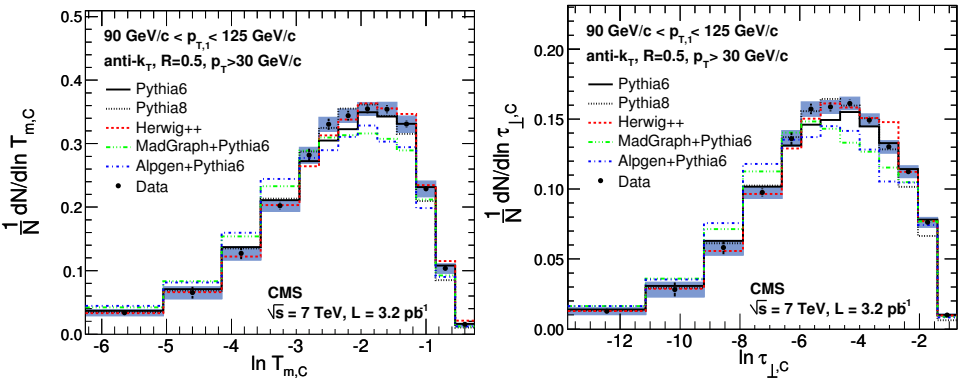

Fig. 1. Distributions of the logarithm of the central transverse thrust (left) and central thrust minor (right) for events with a leading jet p_T between 90 and 125 GeV/c, from data and from five Monte Carlo event generator models.

2.2. Measurement of the inclusive jet cross-section in pp collisions at 7 TeV

A measurement of the inclusive jet cross-section is performed using the 60 nb^{-1} of data from pp collisions at $\sqrt{s} = 7$ TeV. The measurement is made for jet transverse momenta (p_T) in the range 18–1100 GeV and for rapidity values less than 3. Within experimental and theoretical uncertainties, the measured cross-sections are in good agreement with next-to-leading-order (NLO) perturbative QCD predictions (Fig. 2).

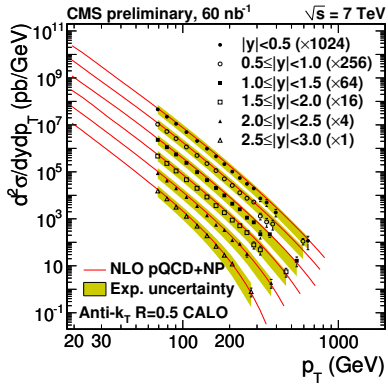

Fig. 2. Comparison between the unfolded measured spectra and the theory predictions for calorimeter jets.

2.3. Dijet azimuthal decorrelations in pp collisions at $\sqrt{s}$=7 TeV and measurement of dijet angular distributions and search for quark compositeness in pp collisions at $\sqrt{s}$=7 TeV

Measurements of dijet azimuthal decorrelation, $\Delta\phi_{\rm dijet} = |\phi_1 - \phi_2|$, and dijet angular distributions, $\chi = (1 + |\cos\theta^*|)/(1 - |\cos\theta^*|)$, are performed using a data sample of 2.9 pb^{-1}and 36 pb^{-1}in pp collisions, respectively. The

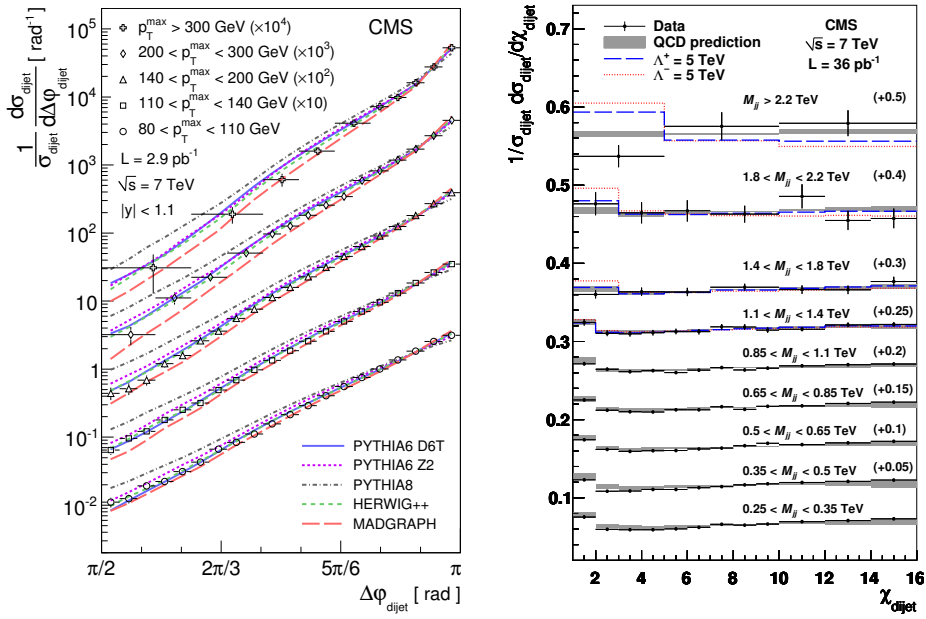

Fig. 3. Left: Normalized $\Delta\phi_{\rm dijet}$ distributions in several $p_{\rm T}^{\rm max}$ regions. Right: Normalized dijet angular distributions in several M_{jj} ranges.

PYTHIA6 and HERWIG++ event generators are found to be best to describe the shape of the measured distributions over the entire range of $\Delta\phi_{\text{dijet}}$. The dijet angular distributions are shown in Fig. 3 (right). Overall there is a good agreement between the measured distributions and the theoretical predictions for all M_{jj} ranges. A lower limit on the contact interaction scale of Λ^+ 5.6 TeV (Λ^- 6.7 TeV) for destructive (constructive) interference at the 95% confidence level is obtained.

3. Heavy ion results

3.1. Observation of jet quenching in PbPb collisions at $\sqrt{s}_{NN}$= 2.76 TeV

Jet production in PbPb collisions at a nucleon–nucleon center of mass energy of 2.76 TeV was studied, using a data sample corresponding to an integrated luminosity of 6.7 μb^{-1}. With increasing collision centrality, a notable imbalance in dijet p_{T} is observed (Fig. 4, where $A_J = \frac{p_{\text{T},1}-p_{\text{T},2}}{p_{\text{T},1}+p_{\text{T},2}}$ and $\Delta\phi_{12} = |\phi_1 - \phi_2|$). Correlations of charged particle tracks with jets indicate that the momentum imbalance is accompanied by a softening of the fragmentation pattern of the second most energetic away-side jet.

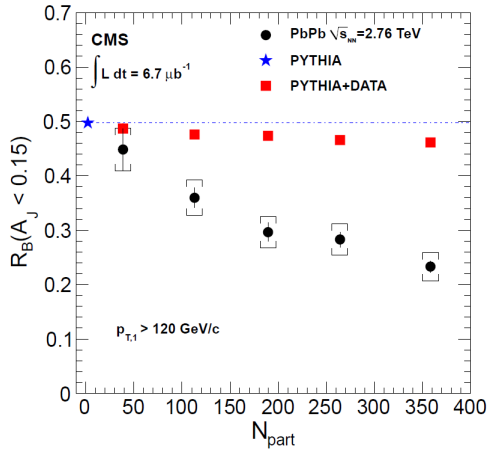

Fig. 4. Left: Fraction of all events with a leading jet with $p_{\text{T},1} > 120$ GeV/c for which a subleading jet with $A_J < 0.15$ and $\Delta\phi_{12} > 2\pi/3$ was found, as a function of N_{Part}.

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