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JET PRODUCTION AT DØ

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We report on a new measurement of the rapidity dependence of the inclusive jet production cross section in $p\overline{p}$ collisions at $\sqrt{s} = 1.8$ TeV using 92 pb^{-1} of data collected by the DØ detector at the Tevatron collider. The differential cross sections, $\langle d^2\sigma/(dE_T d\eta)\rangle$, are presented as a function of jet transverse energy (E_T) in five pseudorapidity (η) intervals, up to $|\eta| = 3$, significantly extending previous measurements beyond $|\eta| = 0.7$. We also present recent results on the ratio of central ($|\eta| < 0.5$) inclusive cross sections from two center-of-mass energies, 0.63 TeV and 1.8 TeV, as a function of jet x_T. Experimental results are compared to next-to-leading order QCD predictions.

1 Introduction

Over the last decade, impressive progress has been made in both theoretical and experimental understanding of collimated streams of particles or "jets" resulting from inelastic hadron collisions. The Fermilab Tevatron $p\overline{p}$ Collider, operated at center-of-mass energies (CM) of 1.8 TeV and 0.63 TeV, has been a prominent arena for studying hadronic jets. Theoretically, jet production in $p\overline{p}$ collisions is understood within the framework of quantum chromodynamics (QCD) as a hard scattering of constituents of protons, the quarks and gluons (or partons) that manifest themselves as jets in the final state. The study of the inclusive jet cross sections in various kinematic regions and at two CM energies by the same experiment, constitutes a stringent test of QCD.

Perturbative QCD calculations of jet cross sections[1], using new and accurately determined parton distribution functions (PDF's)[2], add particular interest to the corresponding measurements at the Tevatron. These measurements test the short range behavior of QCD, the structure of the proton in terms of PDF's, and any possible substructure of quarks. The measurements we report are based on integrated luminosities of 92 pb^{-1} at $\sqrt{s} = 1.8$ TeV and 0.54 pb^{-1} at $\sqrt{s} = 0.63$ TeV collected by the DØ experiment during the 1994–95 Tevatron run.

At DØ, jets are reconstructed using an iterative cone algorithm with a fixed cone radius of $\mathcal{R} = 0.7$ in $\eta - \varphi$ space, where the pseudorapidity η is related to the polar angle (relative to the proton beam) θ via $\eta = \ln[\cot\theta/2]$, and φ is the azimuth. Offline data selections eliminate contamination from background caused by electrons, photons, noise, or cosmic rays. This is achieved by applying an acceptance cutoff on the z–coordinate of the interaction vertex, flagging events with large missing transverse energy, and applying jet quality criteria. Details of data selection and corrections due to noise and/or contamination are described elsewhere[3,4,5].

A correction for jet energy scale accounts for instrumental effects associated with calorimeter response, showering and noise, as well as for contributions from spectator partons, and corrects on average jets from their reconstructed to their "true" E_T. The effect of calorimeter resolution on jet cross section is removed through an unfolding procedure. In DØ, the energy scale and resolution corrections are determined mostly from data and applied in two separate steps.

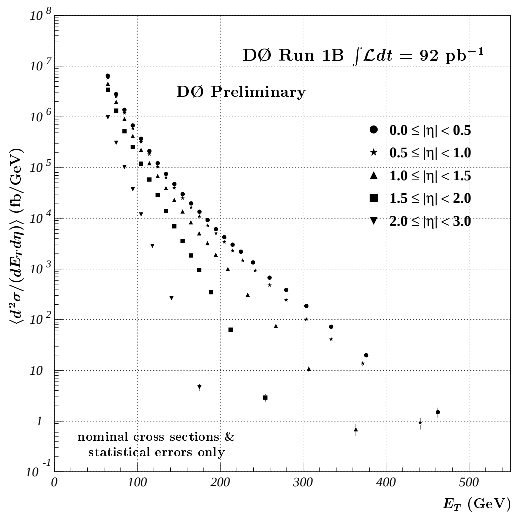

Figure 1. DØ preliminary measurement of rapidity dependence of single inclusive jet production cross section presented as a function of jet E_T in five jet $|\eta|$ intervals.

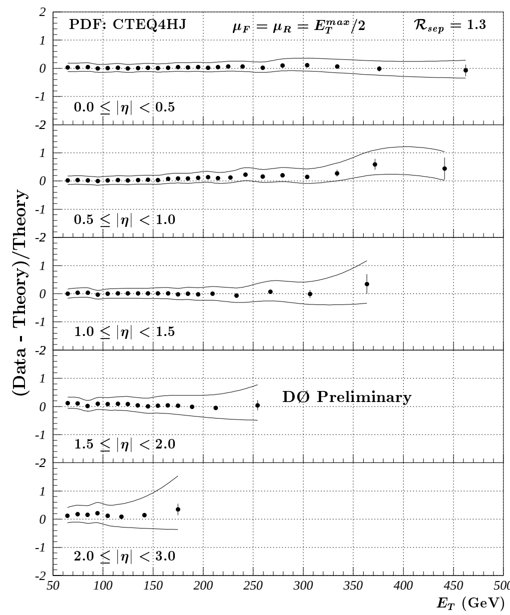

Figure 2. Comparisons of the DØ inclusive jet cross section preliminary measurements in five $|\eta|$ intervals with α_s^3 QCD predictions calculated by JETRAD with CTEQ4HJ PDF. The error bars are statistical, while the error bands indicate systematic uncertainties.

2 Inclusive Jet Cross Sections at $\sqrt{s} = 1.8$ TeV

DØ has recently completed a measurement of the rapidity dependence of the inclusive jet production cross section[4]. The differential cross section, $\langle d^2\sigma/(dE_T d\eta)\rangle$, is determined as a function of jet E_T in five intervals of $|\eta|$, up to $|\eta| = 3$, thereby significantly extending previously available measurements from CDF and DØ beyond $|\eta| = 0.7$. The cross section is calculated from the number of jets in each η–E_T bin, scaled by the integrated luminosity, selection efficiencies, and the unfolding correction. The preliminary results in each of the five $|\eta|$ regions are presented in Fig. 1. The measurement spans about seven orders of magnitude in E_T, and extends to the highest energies ever reached.

The results are compared to the α_s^3 predictions from JETRAD (Giele, *et al.* [1]), with equal renormalization and factorization scales set to $\mu = E_T^{max}/2$, and using the parton clustering parameter $\mathcal{R}_{sep} = 1.3$. Comparisons have been made using all recent PDF's of the CTEQ and MRST families. Figure 2 shows the comparisons on a linear scale with the CTEQ4HJ PDF, which appears to best describe the data in all η intervals. The error bars are statistical, while the error bands indicate one standard deviation systematic uncertainties. Theoretical uncertainties are on the order of the systematic uncertainties. Work is currently underway to obtain a more quantitative comparison with predictions (such as a χ^2 test), taking into consideration correlations in E_T and in $|\eta|$. The extended range of the measurement promises to provide greater discrimination among different PDF's.

3 The Ratio of Inclusive Jet Cross Sections

DØ has measured the ratio of dimensionless inclusive jet cross sections $(\frac{E_T^3}{2\pi} \cdot d^2\sigma/dE_T d\eta)$ at two CM energies, $\sqrt{s} = 0.63$ TeV and 1.8

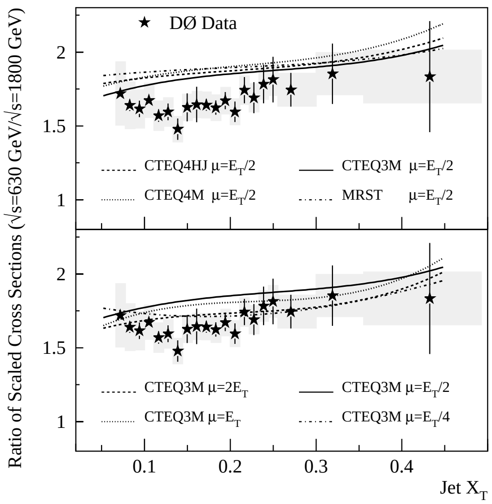

Figure 3. Ratio of dimensionless jet cross sections (numerator $\sqrt{s}$ = 630 GeV, denominator $\sqrt{s}$ = 1800 GeV) compared to NLO QCD as given by JETRAD. The error bars are statistical, while the error bands indicate systematic uncertainties.

TeV, in the central region of pseudorapidity, $|\eta| < 0.5$[5,6]. The strength of this measurement is that several theoretical uncertainties (notably due to the choice of various PDF's) are reduced significantly in the ratio, as are many experimental uncertainties due to their correlated nature at the two CM energies.

Figure 3 shows the ratio of dimensionless jet cross sections as a function of jet $x_T = 2E_T/\sqrt{s}$, along with theoretical predictions from JETRAD for different choices of the input parameters (μ scales and PDF's). A covariance matrix χ^2 test for the ratio of the cross sections shows that there is no significant difference in shape between data and NLO QCD. However, the absolute values of the predictions lie systematically higher than the data throughout most of the measured x_T range, in particular between x_T of 0.1 and 0.2, where the ratio has the smallest statistical uncertainty. Choice of PDF has little effect on the prediction — only the renormalization/factorization scales change the prediction appreciably.

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