FERMILAB-CONF-07-147-E

INCLUSIVE JET CROSS-SECTION MEASUREMENTS AT CDF

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Results on inclusive jet production in proton-antiproton collisions at $\sqrt{s}$=1.96 TeV based on $1fb^{-1}$ of CDF Run II data are presented. Measurements are preformed using the k_T algorithm in a wide range of jet transverse momentum and jet rapidity. The measured cross sections are compared to next-to-leading order perturbative QCD calculations.

The measurement of the inclusive jet cross section at the Tevatron is an important test of perturbative QCD (pQCD) predictions over more than 8 orders of magnitude, probing distances down to 10^{-19}m. The increased center-of-mass energy in Run II (from 1.8 TeV to 1.96 TeV), the highly upgraded CDF detector[1], and the amount of data collected allow jet measurements in an extended region of jet transverse momentum, p_T^{jet}, and jet rapidity, y^{jet}. Jet measurements at large rapidities are important because they are sensitive the gluon density in the proton in a kinematic region in $p_T^{\rm jet}$ where no effect from new physics is expected.

This contribution presents results on inclusive jet production in five jet rapidity regions up to $|y^{jet}| = 2.1$, based on $1fb^{-1}$ of CDF Run II data. CDF used the longitudinally-invariant k_T algorithm [2] to search for jets:

$$k_i = p_{T,i}^2; \qquad k_{ij} = min(p_{T,i}^2, p_{T,j}^2) \cdot \frac{(y_i - y_j)^2 + (\phi_i - \phi_j)^2}{D^2}, \tag{1}$$

where particles are clustered according to their relative transverse momentum. The algorithm includes a D parameter that approximately controls the size of the jet in the $\phi - y$ space. These algorithm is infrared/collinear safe to all orders in pQCD and it does not need to solve situations with overlapping jets, making possible a better comparison between data and theory. A previous

measurement using the k_T algorithm at the Tevatron during Run I [3] observed a marginal agreement with NLO pQCD at low p_T^{jet}, thus suggesting the k_T algorithm was particularly challenging in hadron collisions. However, these CDF results [4] show that this discrepancy is removed after non-perturbative corrections are included.

Figure 1 shows the measured inclusive jet cross sections using the k_T algorithm with D=0.7, for jets with $p_T^{jet} > 54$ GeV/c in five jet rapidity regions up to $|y^{\rm jet}| = 2.1$. For presentation, the different cross sections are scaled by a given factor. The measured cross sections have been corrected for detector effects back to the hadron level using PYTHIA-Tune A Monte Carlo [5], that provides an accurate description of the underlying event [6] and jet shapes [7] in Run II. The cross sections decrease over more than seven orders of magnitude as p_T^{jet} increases. The systematic uncertainties on the data, mainly dominated by a 2% to 3% uncertainty in the jet energy scale, vary from 10% at low p_T^{jet} to about 50% at high p_T^{jet}. The measurements are compared to NLO pQCD predictions as determined using JETRAD [8] with CTEQ6.1M PDFs [9] and renormalization and factorization scales set to $p_T^{max}/2$, where p_T^{max} is the p_T of the leading jet. The theoretical calculations include correction factors, C_{HAD}, to take into account non-perturbative effects related to the underlying event and fragmentation processes. The factors, presented in figure 2, have been evaluated with PYTHIA-Tune A as the ratios between the nominal cross sections at the hadron level and the ones obtained after turning off multiple parton interactions between remnants and fragmentation into hadrons. The difference obtained when HERWIG [10] is used instead of PYTHIA has been taken as the uncertainty on these factors. Figure 3 shows the ratios between the measurements and the theory are presented. A good agreement is observed over all p_T^{jet} ranges in all rapidity regions. The uncertainty in the theoretical prediction is dominated by the uncertainty on the gluon PDF at high x which, at high p_T^{jet}, goes from $^{+70}_{-30}$% to $^{+140}_{-40}$% for central and forward jets, respectively. The uncertanties in the data compared to that in the NLO pQCD calculations show that the measurements will contribute to a better knowledge of the parton distributions inside the proton.

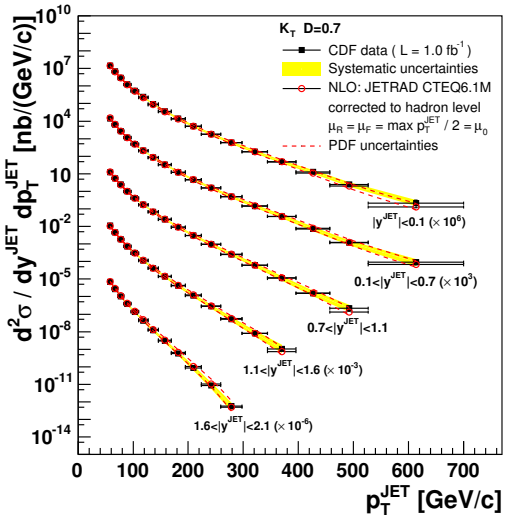


Figure 1: Inclusive jet cross sections measured using the k_T algorithm with D=0.7 for jets with $p_T^{jet} \geq 54 GeV/c$ in five rapidity regions up to $|y^{jet}| = 2.1$. The black squares represent the measured cross sections and the shaded bands indicate the total systematic uncertainty on the data. The measurements are compared to NLO pQCD calculations. The dashed lines represent the PDFs uncertainties on the theoretical predictions

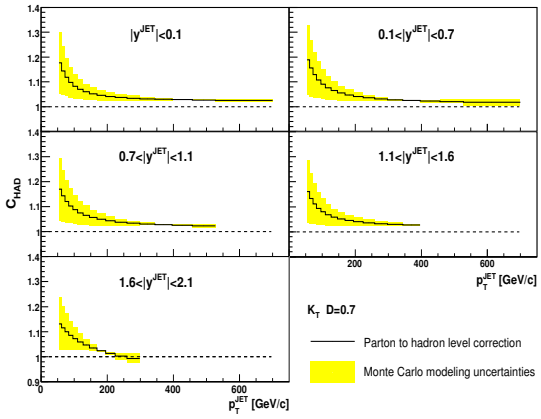


Figure 2: Parton to hadron level corrections applied to the NLO calculations to correct for underlying event and hadronization contribution in the different rapidity regions. The shaded bands represents the associated uncertainty coming from the Monte Carlo modeling.

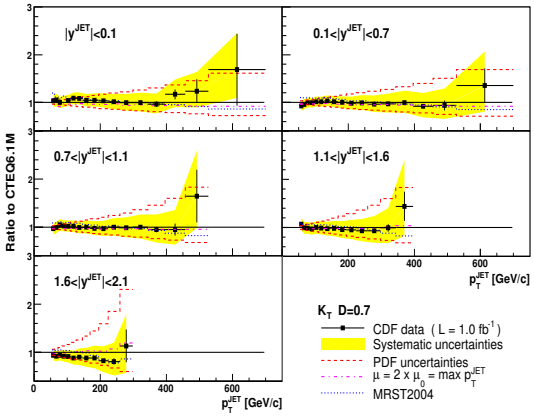


Figure 3: Comparison between the measurements and the pQCD calculations. The dots are the ratios Data/Theory, the shaded bands indicate the total systematic uncertainty on the data and the dashed lines represent the PDFs uncertainties on the theoretical predictions.

For central jets, $0.1 < |y^{jet}| < 0.7$, the measurements are repeated using a D parameter equal to 0.5 and 1.0. As D increases, the average size of the jet in $\phi - y$ space increases, and the measurement becomes more sensitive to underlying event contributions. Figure 4 shows the measurements. The good agreement still observed between the measured cross sections and the NLO pQCD predictions indicates that the soft contributions are well under control.

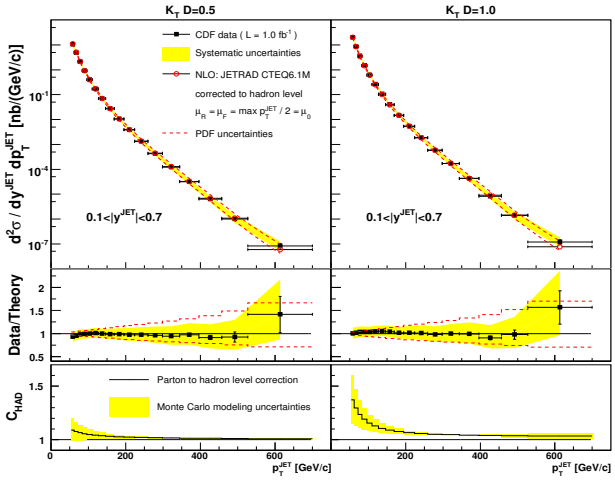


Figure 4: Inclusive jet cross sections measured using the k_T algorithm with D=0.5 (left) and D=1.0 (right) for jets with p_T^{jet} >54 GeV/c and $0.1 < |y^{jet}| < 0.7$. The black squares represent the measured cross sections and the shaded bands indicate the total systematic uncertainty on the data. The measurements are compared to NLO pQCD calculations. The dashed lines represent the PDFs uncertainties on the theoretical predictions. The bottom plots show the parton to hadron level corrections applied to the NLO calculations to correct for underlying event and hadronization effects, where the shaded bands represent the associated uncertainty coming from the Monte Carlo modeling.

In summary, this contribution reports results on inclusive jet production in proton-antiproton collisions at $\sqrt{s} = 1.96$ TeV, based on $1fb^{-1}$ of CDF Run II data, using the k_T algorithm. CDF also performed the measurement using the Midpoint cone-based algorithm[11]. The measurements are in a good agreement with NLO pQCD calculations. In particular, for central jets and at high p_T^{jet} no deviation with respect to the theory is found. In the most forward region, the total systematic uncertainty on the data is smaller than that on the theoretical calculations. Therefore, these new results will contribute to a better understanding of the gluon PDF in the proton at high x.

References

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