LATEST JET RESULTS FROM TEVATRON

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This contribution reports preliminary jet results in $p\bar{p}$ collisions at $\sqrt{s} = 1.96$ TeV from the CDF and DØ experiments. The jet inclusive cross section, measured using both the Midpoint and the K_T jet clustering algorithm, is compared to next-to-leading order QCD prediction in different rapidity regions. The b-jet inclusive cross section measured exploiting the long lifetime and large mass of B hadrons is presented and compared to QCD prediction. A complementary measurement, using the large branching fraction of B hadrons into muons, is also described. The measurement of two-particle momentum correlation in jets is presented and compared to predictions.

The QCD program at the Tevatron hadron collider revolves around the jet physics. Jets are collimated sprays of hadrons generated by the fragmentation of partons originating from the hard scattering. In hadron collisions, jets receive soft contributions from the initial state radiation and the multiple parton interaction between the beam remnants (underlying event (UE)). Jets are experimentally observed by adding the energy measured in each calorimeter cell associated to a cluster by a defined jet algorithm. Both the CDF [1] and the DØ [2] collaboration are exploring new and alternative jet algorithms with respect to the cone-based used in Run I (JetClu) that is not collinear and infrared safe. Jets are now reconstructed with the k_T algorithm [3] or the MidPoint algorithm [4]. The latter is an iterative seed-based cone algorithm but it uses midpoints between pairs of protojets as additional seeds in order to make the clusterization procedure infrared safe. The k_T algorithm merges pairs of nearby protojets in order of increasing relative transverse momentum, it is infrared and collinear safe to all orders in pQCD. Regardless of the jet algorithm used, proper comparisons with the theory require corrections for non-perturbative contributions. These contributions come from the underlying event and the hadronization processes and become more and more important as p_T^{jet} decreases. The Underlying event has been studied by CDF in Run I [5] and Run II. To phenomenologically reproduce the activity of the underlying event with the PYTHIA [6] Monte Carlo a special set of parameters (Tune A) has been determined. Tune A

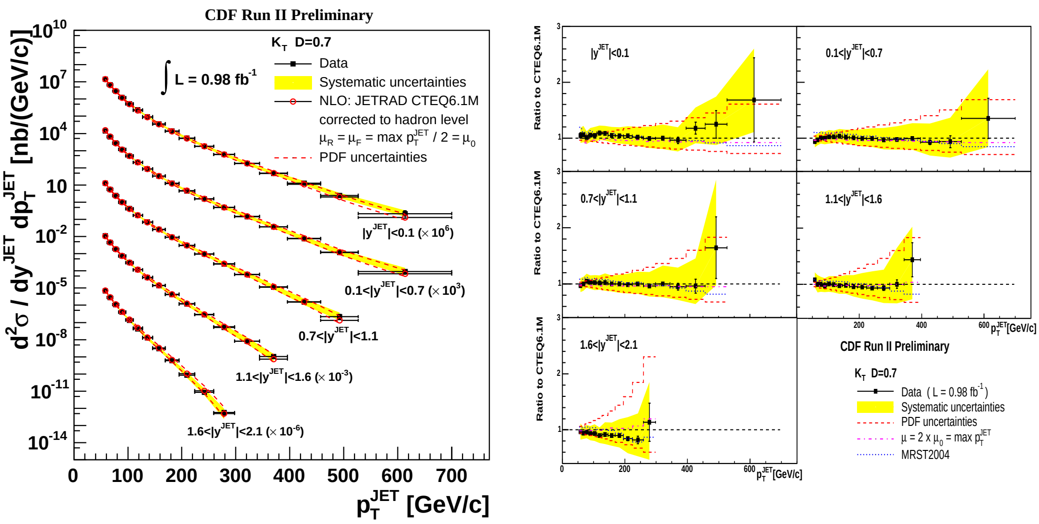

Figure 1: Left: inclusive jet cross section measured using the k_T algorithm. Right: ratio of measured and theoretical cross sections.

has been shown to properly describe the jet shapes [7] measured in Run II.

To further investigate the fuzzy boundary between domains of perturbative QCD and non-perturbative hadronization processes, CDF has studied the two-particle momentum correlation inside jets. The measurement is based on $\sim 400pb^{-1}$ of dijet data. The correlation function is introduced in terms of the variable $\xi = log(E_{jet})/P_{hadron}$ and is measured as the ratio of two- and one-particle inclusive momentum distribution functions:

$$C(\xi_1, \xi_2) = \frac{D(\xi_1, \xi_2)}{D(\xi_1)D(\xi_2)}; \quad D(\xi_1, \xi_2) = \frac{d^2N}{d\xi_1 d\xi_2}, \quad D(\xi_1) = \frac{dN}{d\xi_1} \tag{1}$$

Only charged particles in a restricted cone with a smaller opening angle of $\theta_c = 0.5$ around the jet axis are considered. The theoretical prediction for the correlation function is [8]:

$$C(\Delta\xi_1, \Delta\xi_2) = C_0 + C_1(\Delta\xi_1 + \Delta\xi_2) + C_2(\Delta\xi_1 - \Delta\xi_2)^2; \quad \Delta\xi = \xi - \xi_0 \tag{2}$$

ξ_0 being the position of the peak of the inclusive particle momentum distribution in jets. The parameters C_0, C_1 and C_2 define the strength of the correlation and depend on a variable $log(Q/Q_{eff})$ where $Q = E_{jet}\theta_c$ is the jet hardness and Q_{eff} is the parton shower cut-off scale used in theory. The evolution of the C_1 and C_2 parameters as a function of jet hardness Q is fitted with the analytical next-to-leading Log approximation (NLLA) function leaving Q_{eff} as a free parameter. The value of Q_{eff} obtained from the fit of C_1 is $\sim 147 \pm 10(stat) \pm 79(syst)MeV$, and from the fit of C_2 is $\sim 131 \pm 12(stat) \pm 86(syst)MeV$. The results are found to be in agreement with the re-summed NLLA calculation. Correlation clearly survives the hadronization process giving further support to the hypothesis of local-parton-hadron-duality.

The measurement of the inclusive jet production cross section represents a fundamental test of perturbative QCD predictions over almost nine orders of magnitude. The high p_T^{jet} tail probes distances down to about $10^{-19}m$ and is sensitive to new physics. This measurement helps constrain the Parton Distribution Functions (PDF) at high x and high Q^2. In particular at large rapidities, where no effect from new physics are expected, jet measurements can reduce the uncertainty on the gluon density in the proton. The preliminary results presented here use $\sim 1fb^{-1}$ of data collected at CDF during Run II. The jet production rate at high p_T^{jet} has significantly increased thanks to the higher Tevatron center of mass energy, from 1.8 TeV in Run

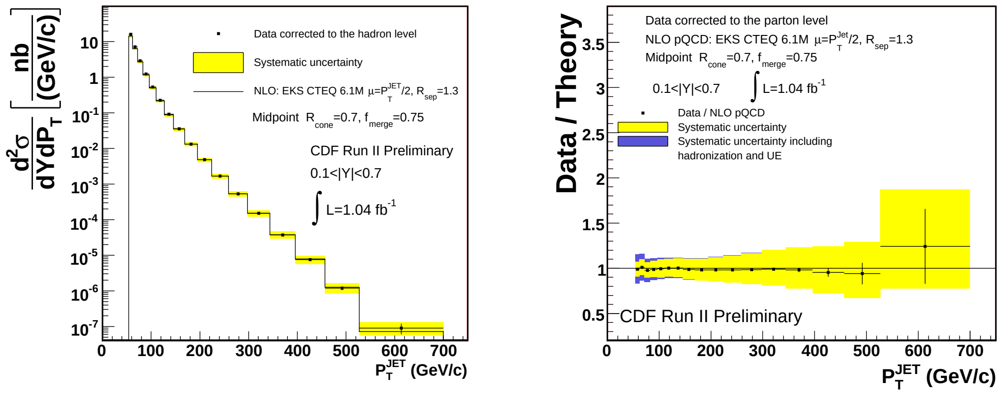

Figure 2: Left: inclusive jet cross section measured using the MidPoint algorithm. Right: ratio of measured and theoretical cross sections.

I to 1.96 TeV in Run II, extending the p_T^{jet} coverage by about 150 GeV/c. In order to compare with NLO pQCD, the measured cross section has been corrected for non perturbative effects. The corresponding parton-to-hadron correction is determined with PYTHIA Tune A as the ratio of the predicted inclusive jet cross sections at the hadron level with UE and at the parton level without UE. This correction was also evaluated with HERWIG [9]. The difference between the two Monte Carlos was considered as the systematic uncertainty on the correction. Figure 1 shows the inclusive jet cross section measured using the k_T algorithm in 5 different rapidity regions up to $|y| < 2.1$. The measured cross sections are compared to NLO pQCD obtained with JETRAD [10] using CTEQ6.1M [11] PDF and setting the renormalization and factorization scales to $max(p_T^{jet}/2)$. Similarly, figure 2 shows the comparison between data and theory using the MidPoint algorithm with a cone radius of 0.7. In this case the measurement covers $0.1 \leq |y| \leq 0.7$, and the NLO pQCD cross section was obtained with EKS [12]. An additional 6% normalization uncertainty associated with the luminosity measurement is not included on both figures. The experimental uncertainties are dominated by the uncertainty on the absolute jet energy scale which is known at the level of 2% at low p_T^{jet} and 3% at high p_T^{jet} [13]. The main uncertainty in the pQCD prediction comes from the PDF, especially from the limited knowledge of the gluon PDF at high x. The uncertainty on the parton-to-hadron correction factor is also important at low p_T^{jet}. For both the k_T and the midpoint algorithms, the measured cross sections are in good agreement with the predictions. A jet inclusive cross section measurement has also been performed by the DØ collaboration using $\sim 380pb^{-1}$ [14]. Here jet are clustered with the MidPoint algorithm. In the 2 rapidity regions covered by the measurement ($|y| \leq 0.4$ and $0.4 \leq |y| \leq 0.8$) there is good agreement with NLO pQCD.

CDF has also measured the inclusive b-jet cross section using $\sim 300pb^{-1}$ of data. Jets are reconstructed using the MidPoint algorithm with a cone radius of 0.7. Only jets in the central rapidity region ($|y| \leq 0.7$) are considered. The analysis exploits the good tracking capabilities of the detector and rely on b-jet identification done by secondary vertex reconstruction. The b-tagging algorithm uses displaced tracks within the jet cone ($R = 0.4$). To determine the heavy flavor content of a tagged jet, thus to extract the fraction of b-jets, the shape of the secondary vertex mass (SVM) distribution is used. The presence of neutral particles and neutrinos originating from the secondary vertex make not possible a full reconstruction of the hadron invariant mass. This results in a dependence on the jet transverse momentum. The SVM fit is thus performed considering independently each P_T^{jet} bin. In this way the dependence on P_T^{jet} of the b-fraction and of the tagging efficiency is also taken into account. Figure 3 shows the inclusive b-jet cross section over a P_T^{jet} range between 38 and 400 GeV/c. The main contribution to the

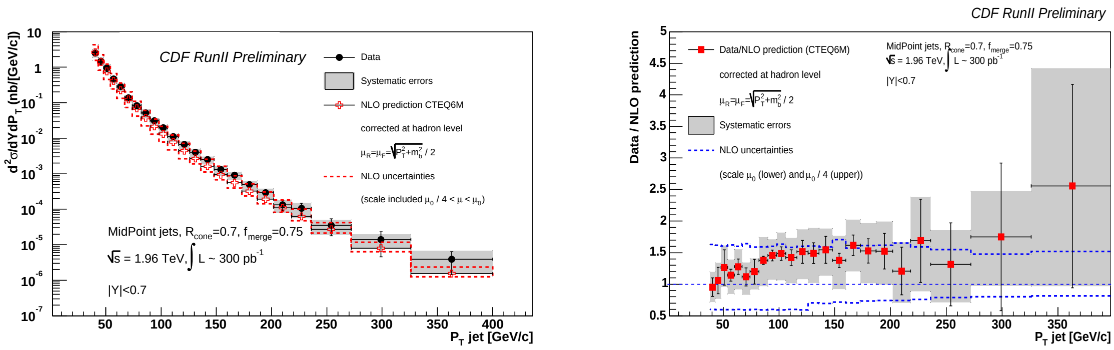

Figure 3: Left: inclusive b-jet cross section. Right ratio of measured and NLO cross section.

systematic error is coming from the jet energy scale. The measured cross section is compare to NLO pQCD [15] showing a data to NLO ratio of ~ 1.4. The theoretical uncertainty is dominated by the renormalization and factorization scale choice showing that higher order contributions could play a major role. DØ has also performed an inclusive jet cross section for $\mu-$tagged jets using $\sim 300 pb^{-1}$. Jet containing a muon are expected to have an enhanced heavy flavor content. Jets are determined with the MidPoint algorithm using a cone radius of 0.5 within $|y| < 0.5$. The presented results is restricted to only jets with muons from heavy flavor decay (i.e. muons for whom their creation was within few cm of the primary vertex). The cross section is corrected to remove muons from pion and kaon decay, and an unsmearing algorithm is applied. This results in a particle level measurement of $\mu-$tagged jet cross section that has been found in good agreement with PYTHIA prediction.

Acknowledgments

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