FERMILAB-Conf-03/149-E September 2003

First DØ Jet Measurements at $\sqrt{s} = 1.96$ TeV

Michael Begel
for the DØ Collaboration
Department of Physics and Astronomy, University of Rochester, Rochester NY 14627 USA

We present the first Run II measurements with the DØ detector of the inclusive jet and dijet cross sections at $\sqrt{s} = 1.96$ TeV. This analysis is based on an integrated luminosity of 34 pb^{-1}. The results from a next-to-leading order perturbative QCD calculation are compared to the measured cross sections. The theoretical calculation agrees with the data.

Measurements of jet production can be used to test QCD predictions for parton-parton scattering and to constrain the parton density functions (PDF) of the proton, particularly the gluon distribution [1]. Additionally, they can be used to search for new physics including quark compositeness, excited quarks, Z's, W's, and other exotic particles.

DØ is a collider detector located at the Fermi National Accelerator Laboratory near Chicago, Illinois. The detector has a central tracking spectrometer consisting of a silicon microstrip tracker and a scintillating fiber detector located within a 2 T solenoidal magnetic field. Particle energies are measured in a large uranium–liquid argon calorimeter supplemented by a scintillator-based preshower detector. Muons are detected in several layers of drift tubes and scintillators sandwiching a toroid magnet. Roman pot detectors have been deployed within the accelerator lattice to measure scattered protons and anti-protons. This is the second run for the DØ detector which has significant upgrades to the tracking systems and electronics compared with the previous run. The current center-of-mass energy of the Tevatron accelerator is 1.96 TeV. This is $\approx 9\%$ larger than the $\sqrt{s}$ for the previous run, but leads to a significant increase in the jet cross section at high-p_T (a factor of 2 increase at $p_T \approx 400$ GeV).

Outgoing partons from the hard scattering process hadronize to form jets of particles. These jets are measured in the DØ calorimeter. Jets are reconstructed using an iterative jet cone algorithm with $R = 0.7$ ($R^2 = \Delta\eta^2 + \Delta\phi^2$). The calorimeter energy is corrected back to the particle level using information from $\gamma +$ jet events, low bias triggers, and Monte Carlo simulations. There are large statistical uncertainties and substantial systematic uncertainties

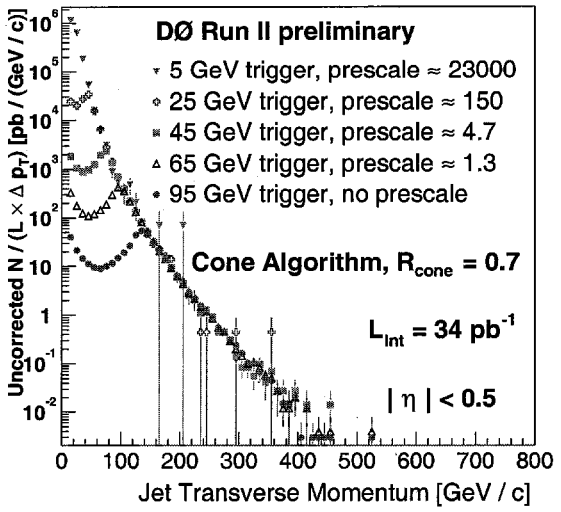

Figure 1: The uncorrected inclusive jet normalized p_T distribution for five jet triggers.

in this energy scale determination that increase with energy due to extrapolation. These are principally caused by small $\gamma +$ jet statistics above 200 GeV. This is the dominant systematic uncertainty in the jet cross section measurements. We restricted the jet measurements to $|\eta| < 0.5$ to limit the impact of these uncertainties.

Events chosen for this analysis required a good primary vertex ($\epsilon \approx 78\%$) and high quality jets where the jet selection was based on calorimeter characteristics to reduce fakes and noise ($\epsilon \approx 97\%$ per jet). The total integrated luminosity considered in this analysis was 34 pb^{-1}. Four inclusive jet triggers were used in this study. Each trigger required a localized energy deposited in the calorimeter and a "reconstructed" jet with p_T above a threshold: 25, 45, 65, or 95 GeV. These thresholds, and the corresponding prescales, were chosen to span a wide p_T range. The uncorrected jet p_T spectrum, normalized to the exposed luminosity (accounting for the prescales), is shown in Fig. 1. The figure also includes the jet spectrum from a trigger that only required a localized deposition of energy in the calorimeter. This trigger was used to study the lowest threshold trigger. These inclusive triggers were also used in the studies of dijet production.

The dijet sample was defined by events with at least two jets where the two leading jets with the highest p_T were required to have $|\eta| < 0.5$. The difference in the azimuthal angle of the two leading jets for two inclusive mass ranges is shown in Fig. 2. As expected, most jets in this sample are balanced in ϕ. The jet p_T resolution was measured from the p_T imbalance in these events. This resolution was used to estimate the unsmearing correction applied to both the inclusive jet p_T spectrum ($\approx$ 10–15%) and the dijet mass spectrum ($\approx$ 5–15%).

The inclusive jet differential cross section as a function of p_T is shown in Fig. 3 left. The dijet differential cross section as a function of mass is shown in Fig. 3 right. Overlayed on the data in Fig. 3 are the results of a NLO pQCD calculation JETRAD [2] using the CTEQ6M PDF [3]. The factorization and renormalization scales have been set equal to $p_T/2$ of the leading jet in the event and R_{sep} has been set to 1.3. Reasonable alterations to the scale choice or R_{sep} parameter lead to $\approx 10\%$ changes in the calculation.

Linear comparisons of the calculation to the data are presented in Figs. 4 and 5. Here we show JETRAD using both CTEQ6M and MRST2001 PDF [4]. The theory is well within the data uncertainties (dominated by the energy scale calibration). While the uncertainties are too large to prefer a PDF, it is interesting to note the different p_T dependence of the calculations due to PDF selection.

We presented the first Run II measurements of the inclusive jet and dijet cross sections with

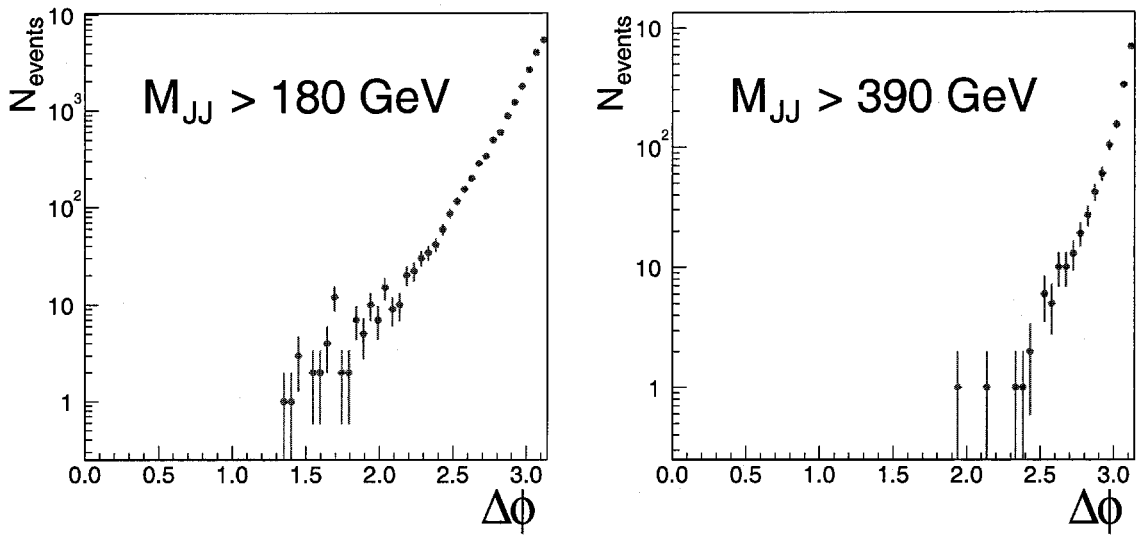

Figure 2: The $\Delta\phi$ distribution for dijets with $M_{JJ} > 180$ GeV (left) and $M_{JJ} > 390$ GeV (right).

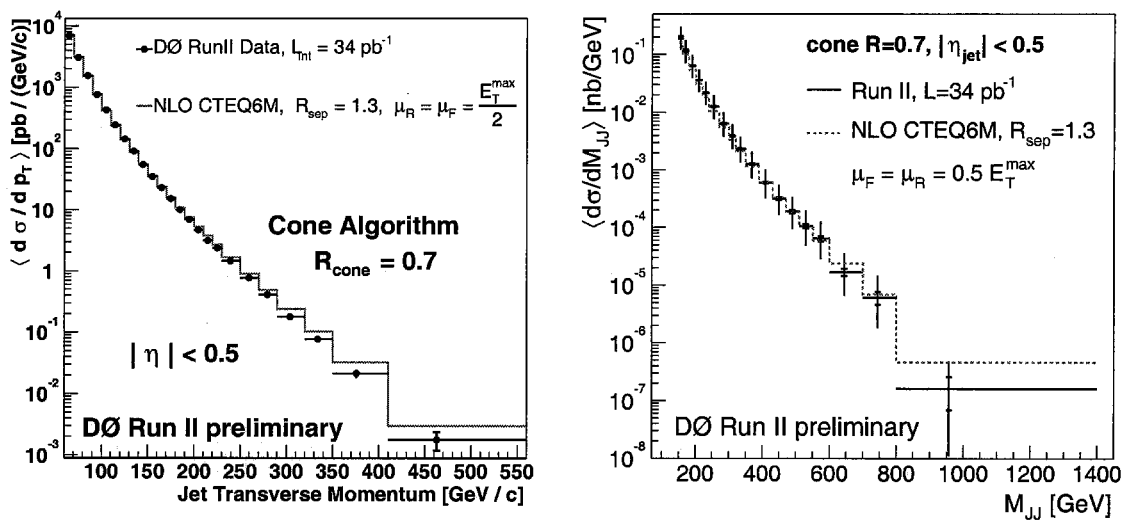

Figure 3: Left: the inclusive jet cross section as a function of p_T. Right: the dijet cross section as a function of dijet mass. Overlayed on the data are the predictions of a NLO pQCD calculation.

the DØ detector at $\sqrt{s} = 1.96$ TeV. This analysis was based on an integrated luminosity of 34 pb^{-1}. We have accumulated much more luminosity than was used in this study and plan to update these results with increased η coverage and decreased energy scale uncertainties in the near future.

1. D. Stump *et al.*, "Inclusive jet production, parton distributions, and the search for new physics," hep-ph/0303013.
2. W. T. Giele, E. W. Glover and D. A. Kosower, "Higher Order Corrections To Jet Cross-Sections In Hadron Colliders," Nucl. Phys. **B403**, 633 (1993).
3. J. Pumplin *et al.*, "New generation of parton distributions with uncertainties from global QCD analysis," JHEP **0207**, 012 (2002).
4. A. D. Martin *et al.*, "MRST2001: Partons and alpha(s) from precise deep inelastic scattering and Tevatron jet data," Eur. Phys. J. **C23**, 73 (2002).

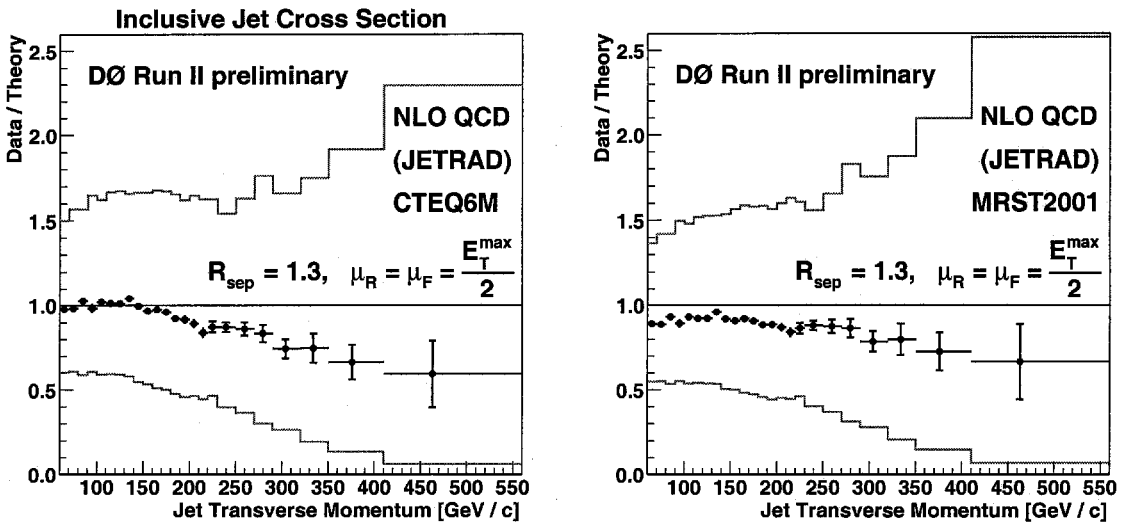

Figure 4: The inclusive jet cross section shown as data/theory as a function of p_T. Two PDFs were used in the theory calculation: CTEQ6M (left) and MRST2001 (right).

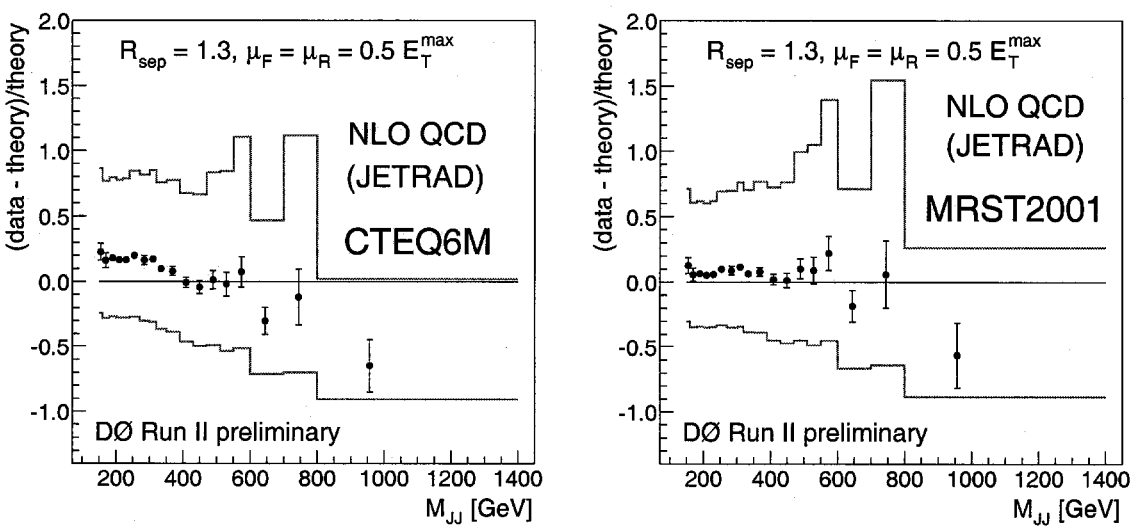

Figure 5: The dijet cross section shown as (data − theory)/theory as a function of M_{JJ}. Two PDFs were used in the theory calculation: CTEQ6M (left) and MRST2001 (right).