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DØ Papers on QCD Studies with Jets Submitted to DPF '96

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E. Gallas, S.Y. Jun, J. Krane, J. Perkins, R. Snihur and Y. Yu
For the DØ Collaboration

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Contents

Inclusive Jet Cross Section at DØ

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Preliminary measurements of the central ($|\eta| \leq 0.5$) inclusive jet cross section for jet cone sizes of 1.0, 0.7 and 0.5 at DØ based on the 1992-93 ($13.7pb^{-1}$) and 1994-95 ($90pb^{-1}$) data samples are presented. Comparisons to Next-to-Leading Order (NLO) Quantum Chromodynamics (QCD) calculations are made.

1 Introduction

Leading Order (LO) or $O(\alpha_s^2)$ QCD gives a fair description of the inclusive jet cross section, $\sigma(p\bar{p}) \rightarrow jet + X$, in central pseudorapidities, $|\eta| \leq 1.0$, and over a wide range of center-of-mass(CMS) energies, 0.063 TeV $< \sqrt{s} <$ 1.8 TeV [1,2,3]. However, LO comparisons include a $30-50\%$ theoretical normalization uncertainty. NLO QCD or $O(\alpha_s^3)$ predictions of the inclusive jet cross section [4,5,6] reduce theoretical uncertainties to $10-20\%$.

The inclusive jet cross section has been measured at the UA2 [2] and CDF [7] experiments and more recently, the CDF collaboration has reported an excess in jet production at large E_T relative to NLO QCD expectations [8]. The data recorded by DØ during the 1992-93 and 1994-95 runs are used to measure the inclusive jet cross section for $|\eta| \leq 0.5$. The cone size ($R=\sqrt{(\delta\eta)^2+(\delta\phi)^2}$) dependence of the inclusive jet cross section, studied at cone sizes of 1.0, 0.7 and 0.5, constitutes a strong test of NLO QCD.

2 Data Sample and Analysis

The DØ detector [9] has a liquid argon-uranium calorimeter with full pseudorapidity ($|\eta| \leq 4.1$) coverage for detection of final state jets. The calorimeter has azimuthal symmetry. The single particle electromagnetic and hadronic resolutions are $15\%/\sqrt{E}$ and $50\%/\sqrt{E}$, respectively.

The detector was read out if a hardware jet trigger based on E_T in calorimeter towers and a subsequent software jet trigger are satisfied. The integrated luminosity for the 1992-93 (1994-95) data sample is $13.7pb^{-1}$ ($90pb^{-1}$).

The jets are reconstructed using a cone algorithm with radii of 0.5, 0.7 and 1.0. The E_T of the jet is defined as the sum of E_Ts of each tower within the cone. The reconstruction efficiency is 100% in the range of interest.

[a]Representing the DØ Collaboration.

Fake jets arising from noisy electronic cells, accelerator losses, and cosmic rays are removed by applying offline cuts. The global efficiency of these cuts is $> 95\%$ in $|\eta| \leq 0.5$.

The transverse energy of each jet is corrected for offsets due to underlying events, pileup and uranium noise; showering losses from particles emitted within(outside) the jet cone that deposit some energy outside(inside) the cone; and detector hadronic response [10]. At 100 GeV, the mean correction to jet E_T is 17% for 0.7 cone jets. The uncertainty in the correction is $\sim 3\%$ at 100 GeV, which translates into an uncertainty of $\sim 20\%$ in the cross section at 100 GeV for 0.7 cone jets. After energy scale corrections, the cross sections are corrected for jet E_T resolution effects. This correction is of the order of 8% at 100 GeV in $|\eta| \leq 0.5$ for 0.7 cone jets.

3 Results and Conclusions

Figure 1 shows the (Data-Theory)/Theory plot in $|\eta| \leq 0.5$ for 0.7 cone jets. The plot shows cross sections from both the 1992-93 and 1994-95 data, compared separately to a NLO QCD prediction given by JETRAD[5]. The theory is evaluated using the CTEQ2ML parton distribution function (pdf) at a renormalization scale (μ) of $E_T/2$ of the leading jet in the event. The data are in excellent agreement with NLO QCD predictions.

Figure 2 shows the ratio of cross sections (1.0/0.7 and 0.5/0.7) in $|\eta| \leq 0.5$ and 80 GeV $\leq E_T \leq$ 480 GeV. This plot shows that the inclusive jet cross section decreases with decreasing cone size. The curves are NLO QCD predictions from JETRAD evaluated using CTEQ2ML at a μ scale of $E_T/2$ of the leading jet in the event. The ratio of cross sections do not depend on the choice of pdfs and parton clustering. However, there is a dependence on the μ scale. Our data seem to prefer a μ scale of $E_T/2$ of the leading jet. Most of the experimental errors (luminosity, selection, unsmearing and a part of the energy scale errors) vanish in a ratio so the systematic errors are expected to be small. These errors are under investigation. The plots show only statistical errors.

In conclusion, our data are in excellent agreement with NLO QCD predictions for production of jets with cone size of 0.7. The ratio of cross sections are in qualitative agreement with NLO QCD predictions and they are independent of pdf and clustering. However, the data seems to prefer $\mu = E_T/2$.

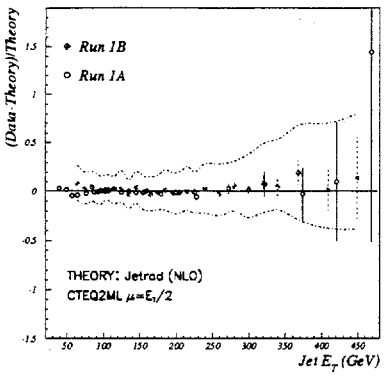

Figure 1: A comparison of the central, $|\eta| \leq 0.5$, inclusive cross section to a NLO QCD calculation with CTEQ2ML evaluated at $\mu = E_T/2$ of the leading jet. The points only include statistical errors. The band represents the total systematic error except the luminosity uncertainty. The solid (open) symbols are for the 1994–1995 (1992–1993) data.

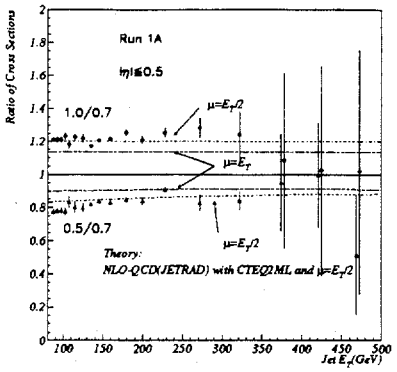

Figure 2: Cross sections for different cone sizes devided by the cross section for 0.7 jets compared to NLO QCD calculations in $|\eta| \leq 0.5$. The solid symbols are from the 1992-93 data. The theory (dotted and dashed dotted lines) is evaluated with CTEQ2ML at μ=E_T and $E_T/2$ of the leading jet. The errors are statistical. The line at 1 is for reference.

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