A STUDY OF THE INCLUSIVE JET CROSS-SECTION AS A FUNCTION OF JET CONE SIZE WITH THE DØ DETECTOR

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ABSTRACT

Based on a $13pb^{-1}$ data sample recorded at DØ during the 1992-1993 run, we present preleminary results on the cone size dependence of the inclusive differential jet cross-section. The study has been done with three cones sizes, 0.7, 0.5 and 0.3. Cross-sections have been corrected for trigger efficiencies and standard jet cut efficiencies. We also present comparisons to next-to-leading order QCD calculations.

1. Introduction

Leading order, $O(\alpha_s^2)$, QCD describes fairly well the inclusive jet cross-section, $\sigma(p\bar{p}) \rightarrow jet + X$, in central pseudo-rapidities, $|\eta| < 1$, and over a wide range of centre of mass energies, $0.063TeV < \sqrt{s} < 1.8TeV$ [1], [2], [3]. However, leading order comparisions include a $30 - 50\%$ theoretical normalization uncertainity. Recent next-to-leading order, $O(\alpha_s^3)$, calculations reduce the theoretical uncertainities to $\sim 5\%$ [4], [5].

At NLO, QCD predicts the inclusive jet cross-section to be a function of the jet cone size(R=$\sqrt{(\delta\eta)^2 + (\delta\phi)^2)}$). Also, it predicts that the cross-section goes down with cone size. These can be tested with data.

The present study is done on a $13pb^{-1}$ data sample taken during the 1992-1993 data run at the Fermilab Tevatron Collider. A study of the cone size dependence of the inclusive jet cross-section has been done, using three different cone sizes, R=0.3,0.5 and 0.7. The η dependence of the inclusive jet cross-section for all the cone sizes are given over (a) $-1 < \eta < 1$, (b) $2 < |\eta| < 3$ and $30GeV \leq E_T \leq 480GeV$.

2. Data Sample and Analysis

The DØ detector described elsewhere [6], has a uranium-liquid argon calorimeter with a full coverage for a pseudo-rapidity range of $|\eta| < 4.1$, for detection of final state jets. The calorimeters are azimuthally symmetric and have electromagnetic and hadronic resolutions of $15\%/\sqrt{E}$ and $50\%/\sqrt{E}$, respectively.

The detector is read out if a hardware jet trigger based on E_T in calorimeter towars, followed by a software jet trigger, is satisfied. The integrated luminosity is $13pb^{-1}$ with a luminosity uncertainity of 12%.

*Representing the D0 Collaboration.

The jets were then reconstructed with cone algorithms with radii of 0.3, 0.5 and 0.7. The E_T of the jet is defined as the sum of E_T of each tower within the cone. After forming all the jets, jets sharing more than 50% of their energies were merged. The reconstruction efficiency is $> 99\%$ above 25GeV and for all η [7].

Backgrounds arising from isolated noisy electronic cells were eliminated by using two cuts. The first requirement is, the fraction of energy deposited in the electromagnetic(EM) modules must be within 5 and 95%. Secondly, the ratio between the second most energetic cell and the most energetic cell in a jet is required to be greater than 10%. Main Ring jets were eliminated by requiring the fraction of energy deposited in the coarse hadronic(CH) modules to be less than 40%. Backgrounds from cosmic ray bremsstrahlung were eliminated by requiring the missing E_T in an event to be less than 70%. Efficiencies of these cuts are more then 90% for all η's and for all three cone sizes(0.3,0.5,0.7) [8].

The E_T of jets have been corrected to account for nonlinearity of the calorimeter. These energy scale corrections are around 30% for $30GeV \leq E_T \leq 450GeV$ in the central region. This is the biggest source of systematic error and it becomes worse in the forward region as the cross-section falls more steeply in the forward region than in the central region. We have not yet attempted to unsmear the effects of detector E_T and η resolution. As described elsewhwere in these proceedings[9], the E_T resolution distorts the steeply falling cross-section but effect of the η resolution is negligible.

3. Results and Discussion

Fig.1 shows the ratio of cross-section for jet cone size 0.5 to that of jet cone size 0.7 and the same for jet cone size 0.3, in the central region($-1 < \eta < 1$). By taking the ratio, we have eliminated luminosity uncertainties and error from energy scale correction have been minimized. We have also made comparisions with NLO theory prediction using CTEQ2M parton distribution function. We have used two renormalization scales, $\mu = E_T$ and $E_T/4$. The theory is Jetrad which is a NLO loop level jet Monte Carlo(W.Giele et al.). However, the data has not been unsmeared. The error band that runs along the data points in Fig.1, is our estimate of systematic errors that will arise from unsmearing of the data. This systematic error is around 10% for jet cone size 0.5 and is double for jet cone size 0.3. While the ratio shows some dependence on E_T, it is not inconsistent with being flat, as predicted by NLO-QCD for both $R = 0.5/0.7$ and $R = 0.3/0.7$, given our systematic errors. As expected the inclusive jet cross-section goes down with jet cone size(R). We also observe sensitivity to the choice of the renormalization scale, μ. In future, we will extend these comparions to the forward region ($2 < |\eta| < 3$). Also, to quantify these results we need a better understanding of our systematics.

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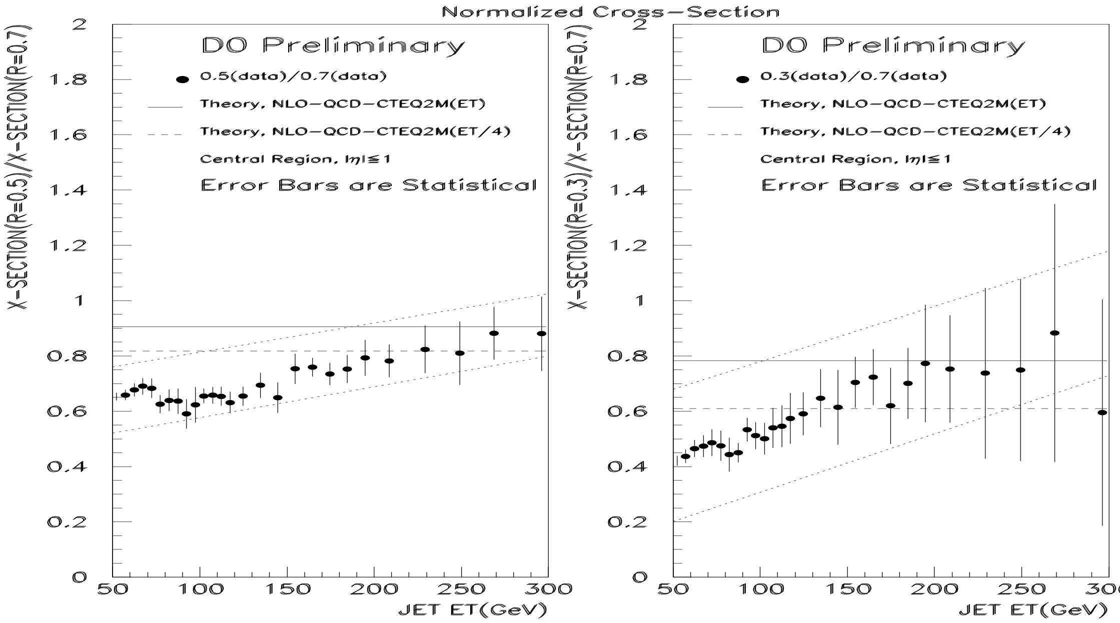

Fig. 1. Ratio of data cross sections, 0.5/0.7 (data) and 0.3/0.7, respectively, as compared to theory(Jetrad).