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Inclusive Jet Production at $\sqrt{s}$ =630 GeV and a Test of Scaling at CDF

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INCLUSIVE JET PRODUCTION AT $\sqrt{s}$ =630 GEV AND A TEST OF SCALING AT CDF

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A preliminary measurement of the inclusive jet cross section at $\sqrt{s} = 630$ GeV is presented. The data are compared with NLO QCD predictions. The ratio of scaled inclusive jet cross section at $\sqrt{s} = 1800$ and $\sqrt{s} = 630$ is presented and compared with previous CDF results and QCD predictions.

1 Introduction

The hypothesis of "scaling" predicts that the dimensionless jet cross section ($E_T^4 \frac{Ed^3\sigma}{dp^3}$), where E_T is the transverse energy of the jet, is independent of $\sqrt{s}$, the center of mass energy of the $\bar{p}p$ interaction. However, the QCD leads to scaling violation through running of strong coupling constant (α_s) and evolution of parton distribution functions. By taking the ratio of the dimensionless cross sections measured at two different beam energies many of the theoretical and experimental systematic uncertainties cancel [1], making it a more precise test of QCD than the individual inclusive jet cross sections.

The CDF collaboration tested the scaling hypothesis using 7.5 nb^{-1} of data at $\sqrt{s} = 546$ and 3.9 pb^{-1} of data at $\sqrt{s} = 1800$ collected during 1989 [1]. These data were inconsistent with the scaling hypothesis at the 95% C.L. and consistent with NLO QCD predictions at the 1.5-2.2σ level; the data favored a level of the ratio that was lower than the predictions.

In this paper, we present the one-jet inclusive cross section measured at $\sqrt{s} = 630$ GeV and compare it with NLO QCD predictions. The ratio of dimensionless cross sections at $\sqrt{s} = 630$ GeV and $\sqrt{s} = 1800$ is also presented.

2 Jet Identification and Data Set

This analysis is based on $600nb^{-1}$ of data taken at $\sqrt{s} = 630$ GeV in Dec. 1995. The data were collected using triggers with E_T thresholds of 5 GeV and 15 GeV. The 5 GeV data were prescaled by 150 and were used for 20-30 GeV E_T range. In addition a large sample of minimum bias events was collected and was used to study the trigger efficiency and the calorimeter energy scale.

[a]Representing CDF collaboration

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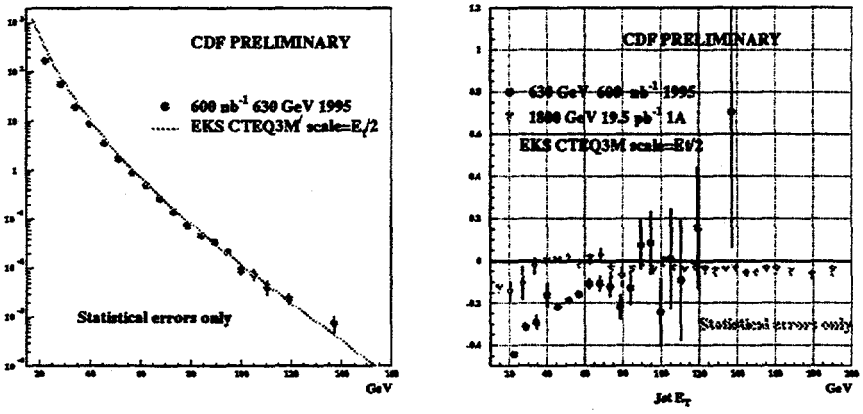

Figure 1: (a)Inclusive jet cross section at $s^{1/2}$=630 GeV compared with NLO QCD predictions (b) Inclusive jet cross section at $s^{1/2}$=630 GeV compared with NLO QCD using CTEQ3M PDF's. Also shown is the inclusive jet cross section at $s^{1/2}$=1800 GeV for $E_T <$ 200 GeV compared to the corresponding NLO prediction.

The CDF detector has been described in the detail elsewhere [2]. Cosmic rays and accelerator loss backgrounds were removed with cuts on event energy timing and on missing E_T significance $(E_T/\sqrt{\sum E_T})$ as described in reference [3]. All the events with a jet of $E_T > 80$ GeV, passing event requirement cuts, were scanned and no background was found. Finally in order to ensure a good E_T measurement, we require the jets to have $0.1 < |\eta| < 0.7$. The jet energy scale correction and unsmearing procedure is same as the one used to inclusive jet analysis at $\sqrt{s} = 1800$ GeV [4].

Jets were reconstructed using a cone algorithm [5] with radius $R \equiv (\Delta\eta^2 + \Delta\phi^2)^{1/2} = 0.7$. The QCD calculation used a similar algorithm [6]. The ambient energy from fragmentation of partons not associated with the hard scattering is subtracted. This ambient energy was measured using the minimum bias events collected at $\sqrt{s} = 630$ GeV and the same techniques as were used for the $\sqrt{s} = 1800$ GeV data [4]. No correction is applied for the energy falling outside the cone because this effect is supposed to be modelled by the NLO QCD calculations.

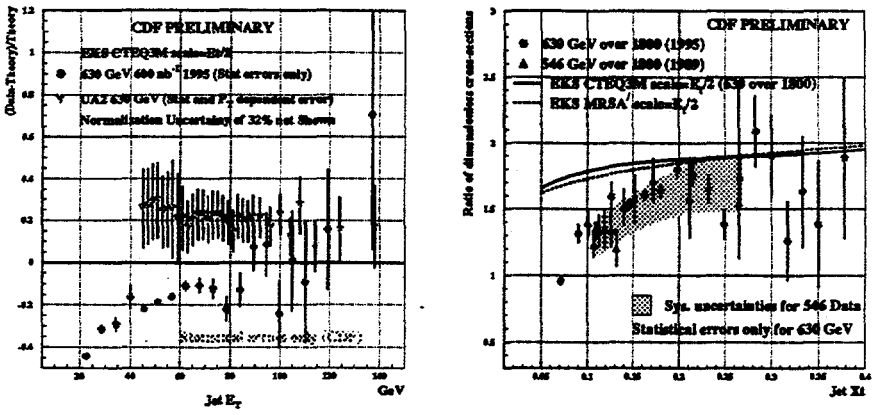

Figure 2: (a)Inclusive jet cross section at $s^{1/2}$=630 GeV compared wilt NLO QCD predictions (b) the ratio of dimensionless cross sections

3 Comparison with QCD

Fig.1(a) shows the corrected cross section compared to NLO QCD [6] using CTEQ3M [7] PDF's with the renormalization/factorisation scale $\mu = E_T/2$. The comparison is shown on a linear scale in Fig.1(b). The data are below the QCD predictions for $E_T < 80$ GeV. For $E_T > 80$, the data is in reasonable agreement with QCD within the large statistical errors. For $E_T < 60$, the CDF data has different slope than QCD predictions. The CDF data [4] at $\sqrt{s} = 1800$ GeV shows good agreement with the corresponding theory prediction for $35 < E_T < 200$ GeV. Detector effects such as energy loss or energy mis-calibration would be function of E_T and thus would affect the two $\sqrt{s}$ samples at same E_T value. We are currently working on evaluating the systematic uncertainties for the $\sqrt{s} = 630$ GeV sample. The systematic uncertainties for the $\sqrt{s} = 1800$ GeV sample are discussed in Ref. [4].

In Fig.2(a), the CDF data is compared with inclusive jet data from UA2 collaboration [8]. Statistical and P_T dependent systematic uncertainties are shown on the UA2 points while only statistical uncertainties are shown on the CDF data. In the region of overlap ($E_T > 45$ GeV), two data sets appear to agree in shape although there is a difference in normalisation. However, this difference is within the relative normalisation uncertainty of the two samples.

Fig.2(b) shows the ratio of the dimensionless cross sections at $\sqrt{s}$=630 GeV and $\sqrt{s}$=1800 GeV ($\bullet$) and the previous CDF result [1] ($\triangle$) as a function

of $x_T = 2E_T/\sqrt{s}$. The systematic uncertainties for the 546/1800 measurement are shown as the shaded band. The systematic uncertainties for the 630/1800 measurement are expected to be similar and are still under study. The two results are clearly consistent. Both measurements are lower the QCD predictions at low x_T using either CTEQ3M or MRSA'[9]. Evaluation of the significance of the disagreement must wait for the complete determination of the experimental systematic uncertainties.

4 Conclusions

We have presented a preliminary measurement of the inclusive jet cross section at $\sqrt{s}$= 630 GeV over the E_T range 20-140 GeV. The data are consistent with previous the CDF measurement and with UA2 results in region of overlap (E_T >45 GeV). Evaluation of the systematic uncertainties is underway, but they are expected similar to the previous CDF result. The preliminary measurement at $\sqrt{s}$= 630 GeV shows a deviation from the QCD predictions at low E_T which is not observed in $\sqrt{s}$= 1800 GeV data.

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