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Inclusive Jet Production at CDF

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INCLUSIVE JET PRODUCTION AT CDF

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The CDF results on the inclusive jet cross section at $\sqrt{s} = 1800$ GeV are presented. The corrected cross section is compared with NLO QCD calculations.

1 Introduction

The measurement of the inclusive jet cross section is a simple but fundamental test of QCD. At high Q^2, it probes the distance scale of order 10^{-17} cm and hence provides a place to look for new physics [1]. However, the theory predictions depend on the input parameters (e.q. α_s, parton distributions functions (PDF's)) which may not be accurately determined by other experiments. This measurement can provide information about these parameters [2,3] and their uncertainties. In this paper, we present the inclusive jet cross section measured at $\sqrt{s} = 1800$ GeV at CDF. The data is compared with NLO QCD predictions.

2 Jet Identification and Unsmearing

The data set used in this analysis is from 1992-95 Fermilab collider run with total luminosity of 19 pb^{-1} during run 1A and 87 pb^{-1} during run 1B at $\sqrt{s}$=1800 GeV. The results from run 1A are already published [5] whereas the results from run 1B are still preliminary. Jets were reconstructed using a cone algorithm with radius $R \equiv (\Delta\eta^2 + \Delta\phi^2)^{1/2} = 0.7$. The ambient energy from fragmentation of partons not associated with the hard scattering is subtracted. No correction is applied for the energy falling outside the cone because this effect is supposed to be modelled by the NLO QCD calculations.

The measured jet E_T spectrum is corrected for detector and smearing effects caused by finite E_T resolution with the "unsmearing procedure" described in Ref. [6]. The jet energy scale is determined using the calorimeter response to single particles measured in the test beam and minimum bias data. The P_T spectrum of particles in a jet (fragmentation functions) is measured from CDF data, using the central tracking chamber. The calorimeter response ($E_T^{measured}$) to a jet is a convolution of fragmentation functions with the single

[a] Representing CDF collaboration

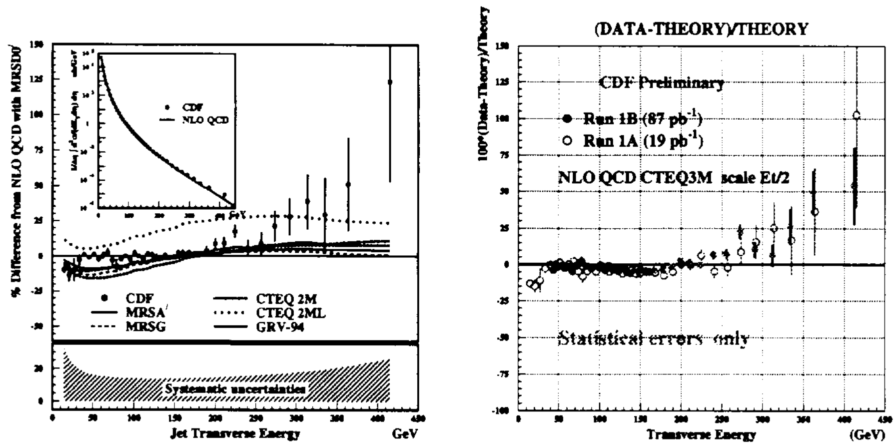

Figure 1: (a)Inclusive jet cross section (1A) at $s^{1/2}$=1800 GeV compared with NLO QCD predictions (b) Inclusive jet cross section (1B) at $s^{1/2}$=1800 GeV compared with NLO QCD using CTEQ3M PDF's

particle response. A trial true (unsmeared) spectrum is smeared with detector effects and compared to the raw data. This process is iterated to find the best true spectrum. The correspondence between the smeared and true spectra is used to correct the measured spectrum. The systematic uncertainties are evaluated using the procedures described in references[6] and[5]. The quadrature sum of the systematic uncertainties is typically less than 25% for run 1A. For run 1B, the systematic uncertainties have not been evaluated yet but are expected to be of same magnitude as run 1A.

3 Comparison with QCD Predictions

In Fig. 1(a) the corrected cross section is compared with the NLO QCD prediction [1] using MRSD0$'$ PDFs [7], with renormalization/factorization scale $\mu = E_T/2$. These results show good agreement in shape and in normalization for $E_T < 200$ GeV, while the cross section falls by six orders of magnitude. Above 200 GeV, the CDF cross section is significantly higher than the NLO QCD prediction. A similar excess is observed when we compare CDF data with HERWIG [8] Monte Carlo predictions. Other PDF's are compared with MRSD0$'$. Although they are not in as good agreement with our data at low E_T as MRSD0$'$, they all are below the data at high E_T. Figure 1(b), shows the preliminary inclusive jet cross section from run 1B data compared with run 1A using a more modern set of PDF's (CTEQ3M [9]). The run 1B data

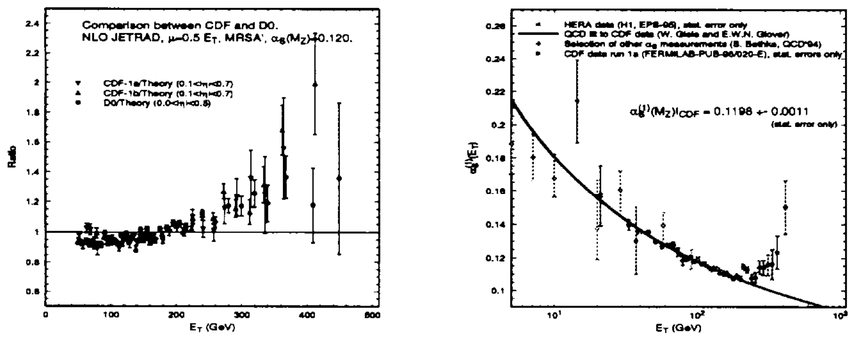

Figure 2: (a)CDF run 1A and run 1B cross sections compared with DØmeasurement using JETRAD calculations (b) The strong coupling constant $\alpha_s(Q^2)$ as a function of E_T as evaluated from the CDF run 1A inclusive jet measurement. For $E_T < 200$ GeV, the evolution has a very good agreement with QCD prediction

are consistent with run 1A results. Moreover, CTEQ3M does not profoundly reduce the excess at high E_T.

There has been an enormous amount of theoretical activity since the release of the final CDF Run 1A data. In particular, by allowing more flexibility in gluon distribution shape and forcing the fit at high E_T, the CTEQ collaboration has derived a new set of PDF's which are in reasonable agreement with other world data (direct photon, deep inelastic fixed target, HERA) and with the CDF and DØ jet data [10]. A new calculation of the multiple soft gluon emission has been performed [11] and shows roughly an 8% increase over the NLO predictions for a dijet mass of 1000 GeV. A NLO QCD calculation using DIS instead of $\overline{MS}$ factorization scheme shows a larger than expected scheme dependence [12].

Good agreement has been found between the CDF results and the preliminary DØ measurement using the EKS programs[13]. In addition, Fig.2(a) shows the CDF 1A, 1B and DØ 1B data compared to JETRAD [4] predictions. Only statistical uncertainties are plotted. More recently, the jet data from CDF and D0 has been used to constrain the PDF's in the medium x region, CTEQ4M [10], and also to extract α_s [14,2]. The results of the α_s analysis are shown in Fig.2(b). There has also been a flurry of "new physics" theoretical activity in response to the discrepancy between the very precise CDF jet data and the NLO QCD predictions. The new physics proposals include a new strong interaction [15], slower evolution of α_s [16,17] and new particles *e.g.* leptophobic Z' [18].

4 Conclusions

The CDF inclusive jet results from run 1A have been confirmed by a roughly 4.5 times larger data sample from run 1B. The preliminary DØinclusive jet cross section is also consistent with the CDF measurement. Although a likely explanation of the high E_T excess is larger than previously determined gluon distribution functions at large x, this can not currently be confirmed or refuted because of the lack of independent precise information.

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