



JET PHYSICS AT TEVATRON

GIUSEPPE LATINO¹

(On behalf of the CDF and DØ Collaborations)

Department of Physics and Astronomy, University of New Mexico,
800 Yale Blvd. NE, Albuquerque NM 87131, USA

Abstract

An overview of Run I jet physics at the $p\bar{p}$ Fermilab Tevatron Collider with a particular emphasis on inclusive jet cross section measurements is given. The impact of these studies on PDFs constrain from global fits is underlined. Preliminary results on inclusive jet and di-jet mass cross section measurements in Run II are then summarized.

1 Introduction

Jet measurements at the Fermilab Tevatron Collider represent a fundamental test of next-to-leading order perturbative QCD (NLO pQCD) at the highest center-of-mass energy so far probed. Consequently, they are potentially sensitive to new phenomena beyond the Standard Model, the existence of new particles as well as of new interactions down to a distance scale of $\sim 10^{-19}$ m being expected to be revealed by deviations from theory. Furthermore, these measurements allow the extraction on a wider kinematical range of the fundamental parameters of QCD: α_s and the parton distribution functions (PDFs).

2 Run I Results: Inclusive Jet Cross Section

During Run I, the CDF [1] and DØ [2] Collaborations performed several jet measurements as part of their physics program at the Tevatron. Stringent

¹latino@fnal.gov

tests of LO and NLO pQCD were obtained from the study of final states with high E_T jets: inclusive jet and di-jet differential cross sections, di-jet mass, di-jet angular and multijet distributions as well as the Z/W + jets production cross sections were among the most significant measurements to be compared with theory. In general, QCD predictions gave a reasonable description of the observed data.

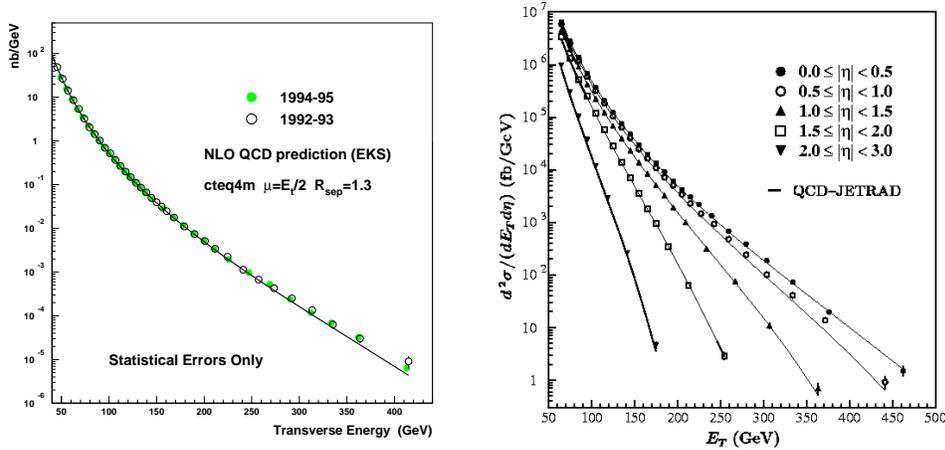


Figure 1: *Inclusive jet cross section as measured in CDF [5] (left) and $D\phi$ [6] (right) respectively using 87 and 95 pb^{-1} of Run I data at $\sqrt{s} = 1.8$ TeV.*

However, great interest was raised when initial inclusive jet cross section measurements showed an excess of data at high E_T over NLO theoretical predictions using then-current PDFs [3]. Global PDF analyses by CTEQ [4] have demonstrated that such excess can be explained in terms of a larger than expected gluon distribution at high x , a kinematical region where it is not yet well constrained. Subsequent measurements performed with an increased data sample [5, 6] (see fig. 1) showed a better data-theory agreement when PDFs with an increased high x gluon contribution (CTEQ4HJ) were considered in the NLO calculations. Given the flexibility allowed by current knowledge of PDFs, CDF and $D\phi$ data were found to be consistent between them, with previous results and with NLO pQCD.

Furthermore, results from these analyses have been used in most recent global PDFs fits where an enhanced statistical weight was given to Tevatron high E_T jet data in order to determine the high x gluon contribution. In particular, by involving jets in a range of rapidity intervals, the $D\phi$ measurement allowed to constrain the partons over a much wider x range (see fig. 2: left). These new PDFs sets (CTEQ6 [7] and MRST01 [8]) represent the most complete information available for Run II jet predictions, but are still characterized by a big uncertainty on high x gluon distributions (see

fig. 2: right). Run II jet measurements are expected to reduce this uncertainty before the LHC era.

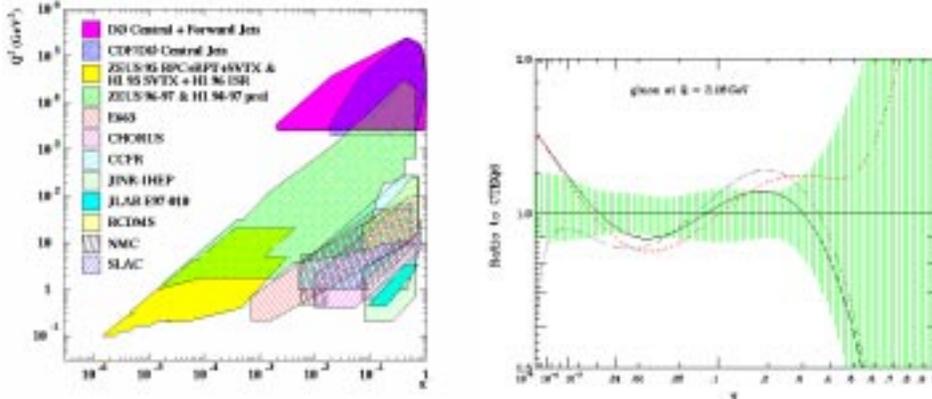


Figure 2: *Left: kinematical reach of CDF and $D\phi$ in the $x - Q^2$ plane as compared to other collider and fixed target experiments [6]. Right: uncertainty band for the gluon distribution function at $Q^2 = 10 \text{ GeV}^2$ in the CTEQ6M set [7]; comparisons to CTEQ5M1 (solid), CTEQ5HJ (dashed) and MRST01 (dotted) are also shown.*

3 Preliminary Run II Jet Measurements

QCD jet studies at Tevatron are expected to be greatly extended in Run II considering both the larger collected data samples and the higher cross section which is related to the increase of the center-of-mass energy \sqrt{s} from 1.8 to 1.96 TeV. The improved performances of the upgraded CDF and $D\phi$ detectors are also expected to play a role.

Both experiments have recently performed preliminary Run II measurements of the inclusive jet and di-jet mass cross sections. In order to compare the results at different \sqrt{s} , CDF adopted the same analysis techniques as in Run I. In particular, the same cone algorithm (JetClu [9], $R = 0.7$) and correction procedures (but Run II updated) were used in order to reconstruct jets and to properly correct them by taking into account both detector and physics effects. The same jet pseudorapidity ranges were also considered. $D\phi$ performed two completely new analyses. For both of them, central ($|\eta| < 0.5$) jets were reconstructed with an “optimized” cone algorithm (Mid-Point [10], $R = 0.7$) and then corrected with a new set of jet corrections as derived from γ -jet and di-jet balancing studies on data [11]. Results from the inclusive jet cross sections measurements are shown in fig. 3: in both experiments, a reasonably good agreement is found within errors between data and NLO pQCD theory using the latest CTEQ PDFs sets [7]². A reasonable

²Similar results were also found by $D\phi$ using the MRST01 set [8].

agreement was also observed, within errors, between data and theory for the di-jet mass cross section measurement. Systematic uncertainties were found to be dominated by the error on jet energy scale in data and on high x gluon distribution function in theoretical calculations.

Refined analysis techniques, a sensible increase in Run II data samples and a better understanding of Run II CDF and $D\phi$ detectors performances, are expected to update and improve the very preliminary results reported here.

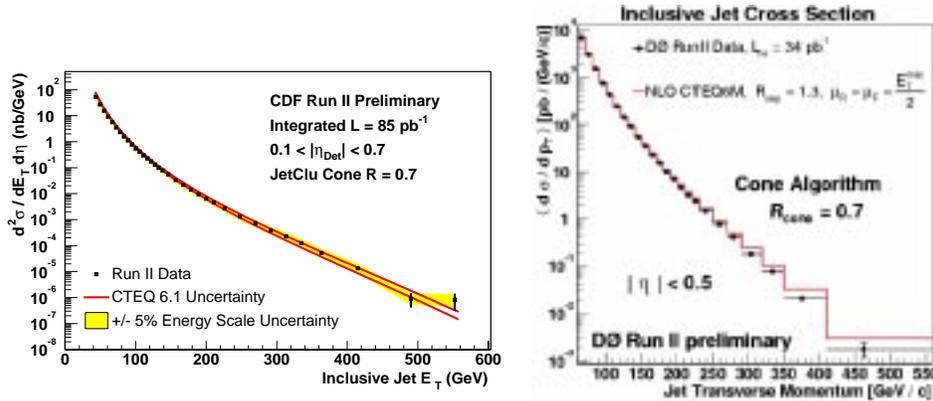


Figure 3: *Inclusive jet cross section as measured in CDF (left) and $D\phi$ (right) respectively analyzing 85 and 34 pb^{-1} of Run II data at $\sqrt{s} = 1.96 \text{ TeV}$. The results are compared to the NLO pQCD prediction from EKS [12] ($\mu = E_T^J/2$, CTEQ6.1M PDFs) in CDF and JETRAD [13] ($\mu = E_T^{max}/2$, CTEQ6M PDFs) in $D\phi$.*

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