Fermi National Accelerator Laboratory

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CDF

Inclusive Jet Production at CDF

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CDF Note xxxx

Inclusive Jet Production at CDF

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The inclusive jet cross section was measured by CDF at center of mass energies of 1800 and 630 GeV. At $\sqrt{s}$=1800 GeV, the inclusive jet cross section is compared with NLO QCD predictions (with different sets of parton distribution functions) and with measurement by DØ Collaboration. Strong coupling constant is extracted (as a consistency check) from 1800 GeV inclusive jet data. The ratio of scaled inclusive jet cross sections measured at two values of $\sqrt{s}$ is compared with NLO QCD predictions. Comparison with DØ result is also shown.

1. Inclusive Jet Production at TEVATRON, $\sqrt{s} = 1800$ GeV

The inclusive jet cross section measured by CDF at $\sqrt{s} = 1800$ GeV in the 1992-1993 data agrees with the NLO QCD prediction up to a jet E_t of 250 GeV. For E_t above 250 GeV the measured cross section is higher than the NLO QCD prediction[1]. An independent measurement from 1994-1995 data confirmed the high E_t excess (Fig. 1). For the NLO QCD predictions, calculations by EKS[2] were used. The renormalization and factorization scale was chosen as $\mu = \frac{1}{2}E_t^{Jet}$.

Most of the discrepancy between theory and experiment can be accommodated by the choice of parton distribution function (pdf) in NLO QCD calculations. The CTEQ4HJ[3] pdf results from a global fit by CTEQ which includes the TEVATRON inclusive jet data with an increased weight. The photon data were excluded from the fit, but the agreement with other data sets which were included in the global fit did not change significantly. This fit was obtained by a modification of the gluon distribution function at large x.

Fig. 2 presents a direct comparison of the CDF and DØ measurements. Within systematic uncertainties there is overall agreement. The DØ data is about 10% lower than CDF; about 3% of this difference is due to the different values of total inelastic cross section used by the experiments to estimate the integrated luminosity.

2. Measurement of α_s

The inclusive jet cross section measured by CDF at $\sqrt{s} = 1800$ GeV was used for the extraction of α_s in the range of E_t from 40 to 250 GeV. The inclusive jet cross section at NLO level was expanded in powers of α_s:

$$\frac{d\sigma(E_t)}{dE_t} = \alpha_s^2(\mu)A(E_t) + \alpha_s^3(\mu)B(E_t)$$

where $\frac{d\sigma(E_t)}{dE_t}$ is the measured cross section, A and B are coefficients obtained from JETRAD[4] NLO QCD calculations. By solving this equation at each E_t value, $\alpha_s(E_t)$ was extracted. Fig. 3 and 4 present the extracted values of $\alpha_s(E_t)$ and recalculated $\alpha_s(M_Z^2)$; CTEQ4M was used for the calculation of coefficients A and B. Only experimental systematic uncertainties are shown on Fig. 3. Since the evaluation of pdf itself depends on α_s, this measurement is a consistency check. The extracted α_s value versus input α_s, presented on Fig. 4, gives an estimate of theoretical uncertainty of this method. The value of α_s, extracted with CTEQ4M pdf, is:

$$\alpha_s(M_Z^2) = 0.1129 \pm 0.0001(stat.)^{+0.0078}_{-0.0089}(exp.syst.)$$

*For CDF Collaboration

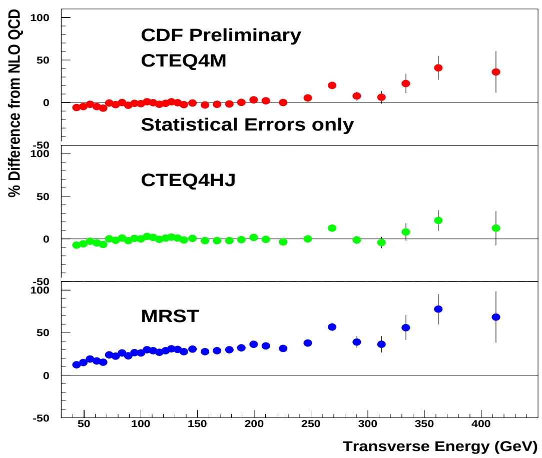

Figure 1. CDF inclusive jet cross section at $\sqrt{s}$ = 1800 GeV. There is agreement with NLO QCD (CTEQ4M) predictions up to 200 GeV and an excess at higher E_t. Most of the discrepancy can be accommodated by modification of the gluon distribution function (CTEQ4HJ).

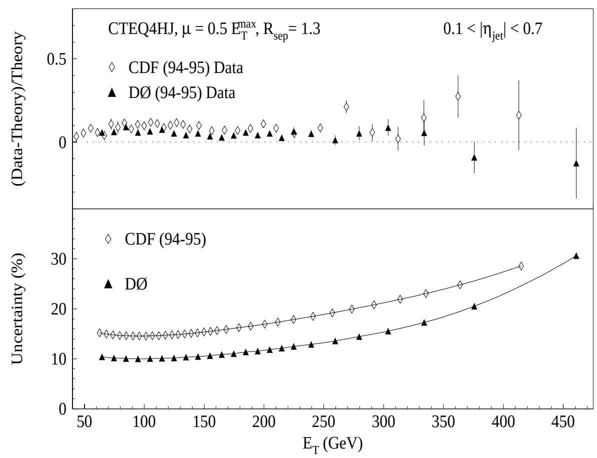

Figure 2. CDF inclusive jet cross section at $\sqrt{s}$ = 1800 GeV is consistent with DØmeasurements.

3. Inclusive Jet Production at $\sqrt{s}$ =630 GeV

The inclusive jet cross section had been measured by CDF at $\sqrt{s}$ =630 GeV. According to the Naive Parton Model, the dimensionless invariant cross section, $E_t^3 \times d^2\sigma/dE_t d\eta$ versus jet transverse momentum fraction, $x_T = 2E_t/\sqrt{s}$, is independent of center of mass energy $\sqrt{s}$. Thus, the ratio of the cross sections measured at two different $\sqrt{s}$ as a function of x_T is predicted to be unity (*scaling hypothesis*). Evolution of the parton distribution functions (pdf) and coupling constant (α_s) with the energy scale of the interaction, predicted by NLO QCD, leads to violation of the scaling hypothesis.

In 1993 CDF published the ratio[5] of the inclusive jet cross sections measured at $\sqrt{s}$ =546 and 1800 GeV. With 95% CL the scaling hypothesis was ruled out, however a discrepancy with NLO QCD prediction was observed. In 1995 CDF measured the inclusive jet cross section at $\sqrt{s}$ =630 GeV. The preliminary result of this measurement (Fig. 5) is consistent with CDF's published result.

Fig. 6 shows preliminary results from CDF and DØ. The results of two experiments are in agreement with each other for $x_T > 0.1$ but are 15% below NLO QCD prediction. For the lower values of x_T, the two experiments show completely different trends. The disagreement of the two measurements requires a detailed comparison of the approaches in determination of the jet transverse energy at low E_t's employed by two experiments.

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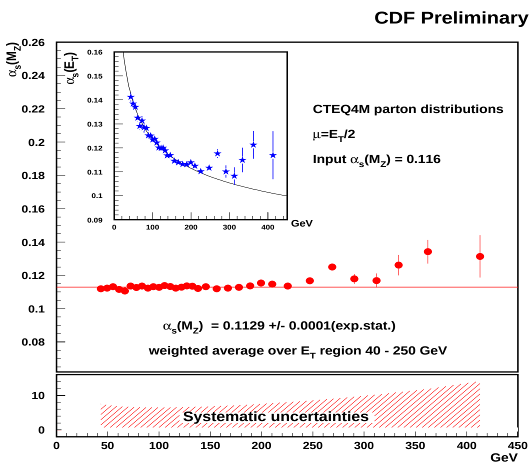

Figure 3. Extracted value of α_s. Stars show the running behavior of α_s, the dots represent the $\alpha_s(M_Z^2)$ as function of jet E_t. Only experimental uncertainties are shown (band).

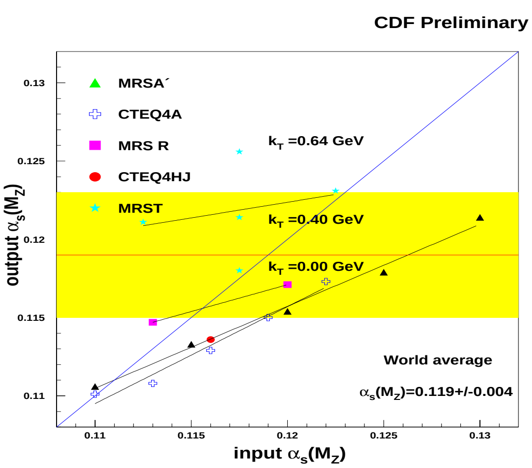

Figure 4. JETRAD uses "input" value of $\alpha_s(M_Z^2)$ for calculation of coefficients A and B. The extracted, "output" value of α_s is shown versus "input" value of $\alpha_s(M_Z^2)$. This plot gives an estimate of the magnitude of theoretical uncertainty of the method.

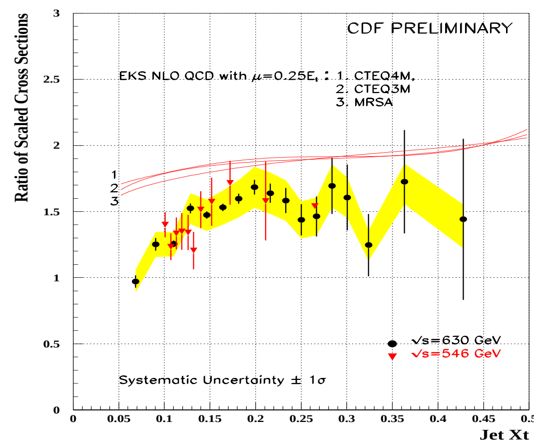

Figure 5. Comparison of the ratio of scaled cross section ($\sqrt{s}$=630 over $\sqrt{s}$=1800 GeV) measured by CDF with the previous CDF measurement ($\sqrt{s}$=546 over $\sqrt{s}$=1800 GeV).

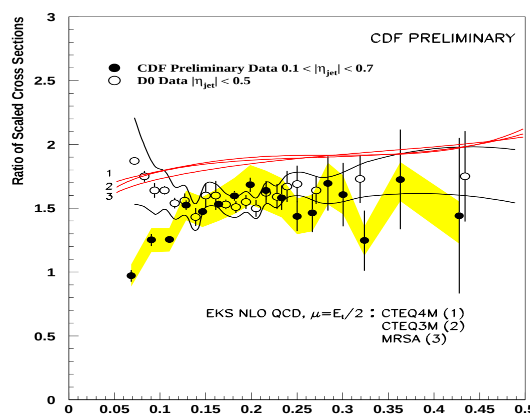

Figure 6. The ratio of scaled cross section ($\sqrt{s}$=630 over $\sqrt{s}$=1800 GeV) measured by CDF and DØ.