Central and Forward Inclusive Jets at the Tevatron

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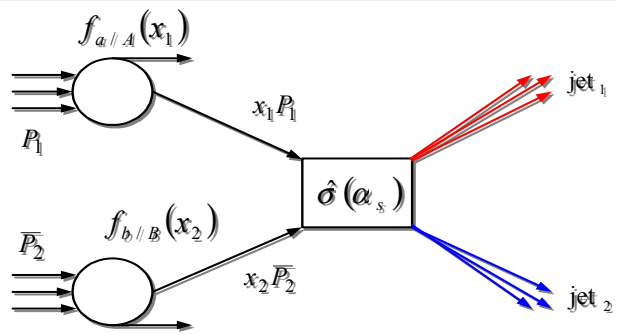
For the FD & DØ Collaborations

Inclusive Jet Cross Section - a Test of pQCD



$$\sigma(p_1 \bar{p}_2 \to 2\ jets) = \sum_{abcd} \int dx_1 dx_2 f_{a/A}(x_1) f_{b/B}(x_2) \hat{\sigma}(ab \to cd)$$

Inclusive jets: $p\bar{p} \to jet + X$

$$\frac{1}{\Delta E_T \Delta\eta} \iint d\eta dE_T \frac{d^2\sigma}{dE_T d\eta} \longleftrightarrow \frac{N_{jet}}{\Delta E_T \Delta\eta \varepsilon \int L dt} \text{ vs. } E_T$$

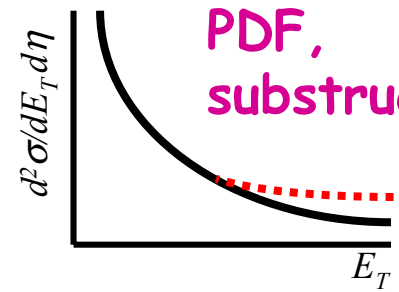
$\Delta E_T \to E_T$ bin size

$\Delta\eta \to \eta$ bin size

$N_{jet} \to$ # of jets in the bin

$\varepsilon \to$ selection efficiency

$L \to$ inst. Luminosity



PDF, substructure,..?

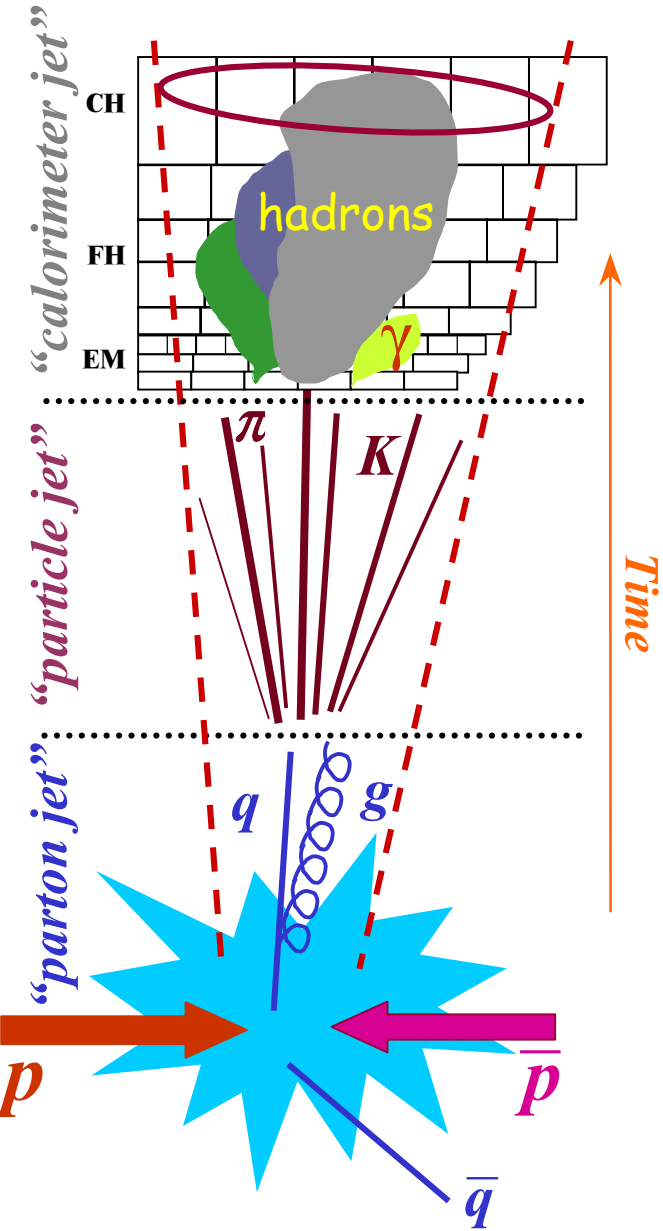
- How well do we know proton structure (PDF)?
- Is NLO (α_s^3) QCD "sufficient"?
- Are quarks composite?

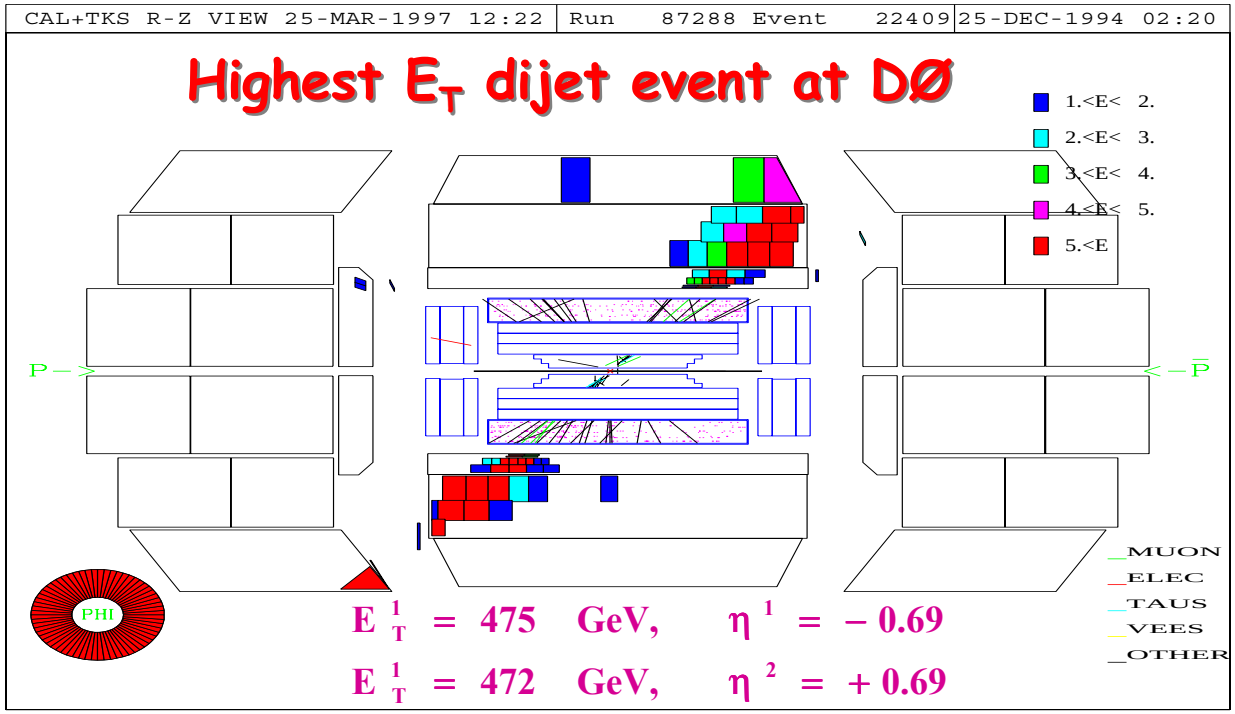
New Rapidity Dependence analysis extends previous measurements (which stopped at $|\eta| = 0.7$) to $|\eta|=3.0$:

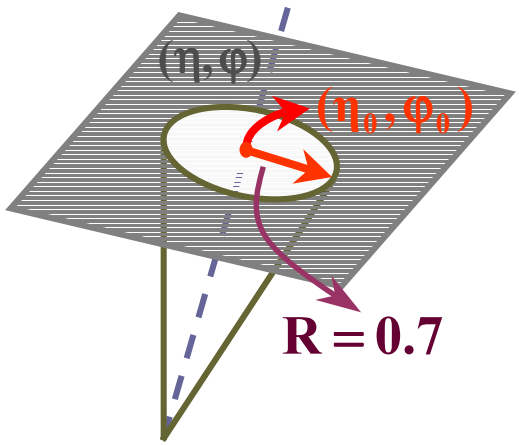
5 $|\eta|$ regions

$0.0 \le |\eta| < 0.5$
$0.5 \le |\eta| < 1.0$
$1.0 \le |\eta| < 1.5$
$1.5 \le |\eta| < 2.0$
$2.0 \le |\eta| < 3.0$

Jet Production and Reconstruction







- Fixed cone-size jets
- Add up towers

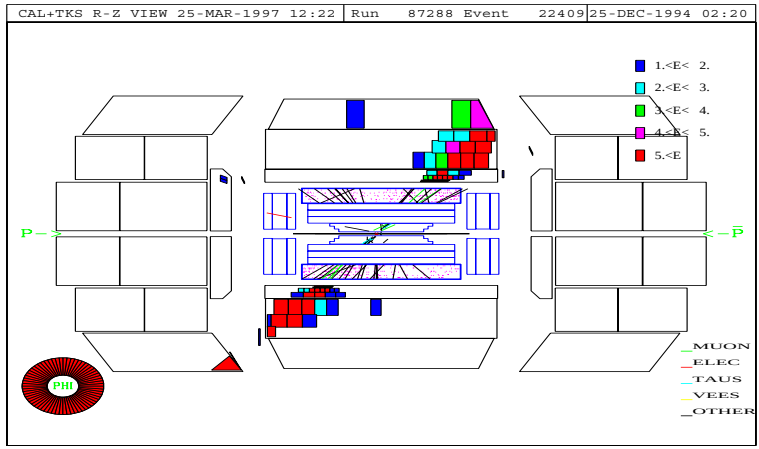
$$E_T^{jet} = \sum_{R_i \le 0.7} E_T^{tower}$$

- Iterative algorithm
- Jet quantities:

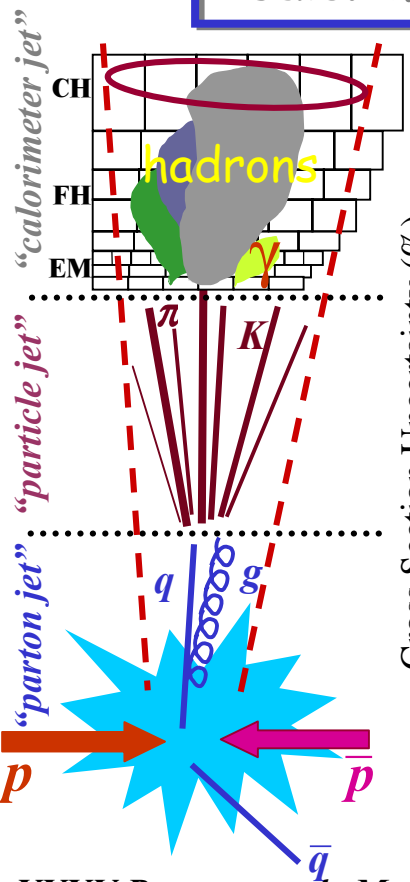
$$E_T, \eta, \varphi$$

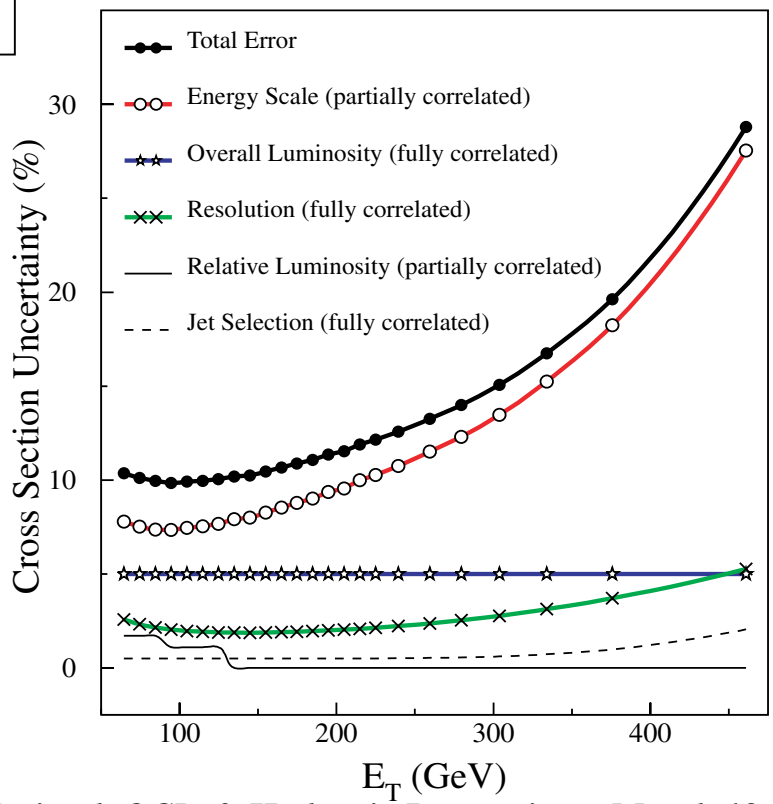
Data Selection and Corrections

- ∴ Acceptance cut on interaction vertex Z position
- ∴ Eliminate events with large missing transv energy
- ∴ Apply jet quality cuts

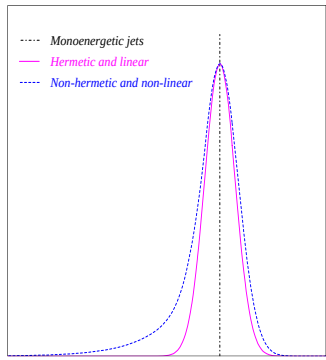


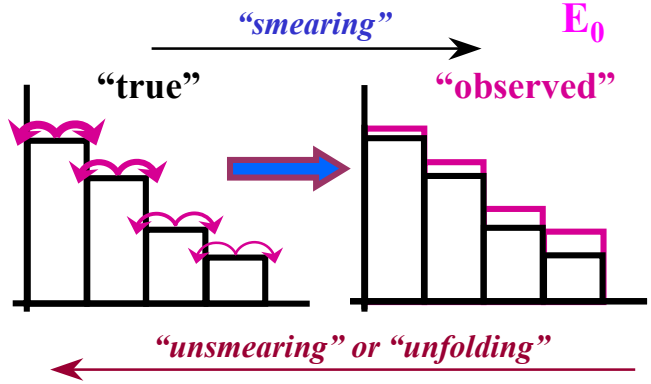
Jet energy scale correction: "calorimeter" → "particle" jet





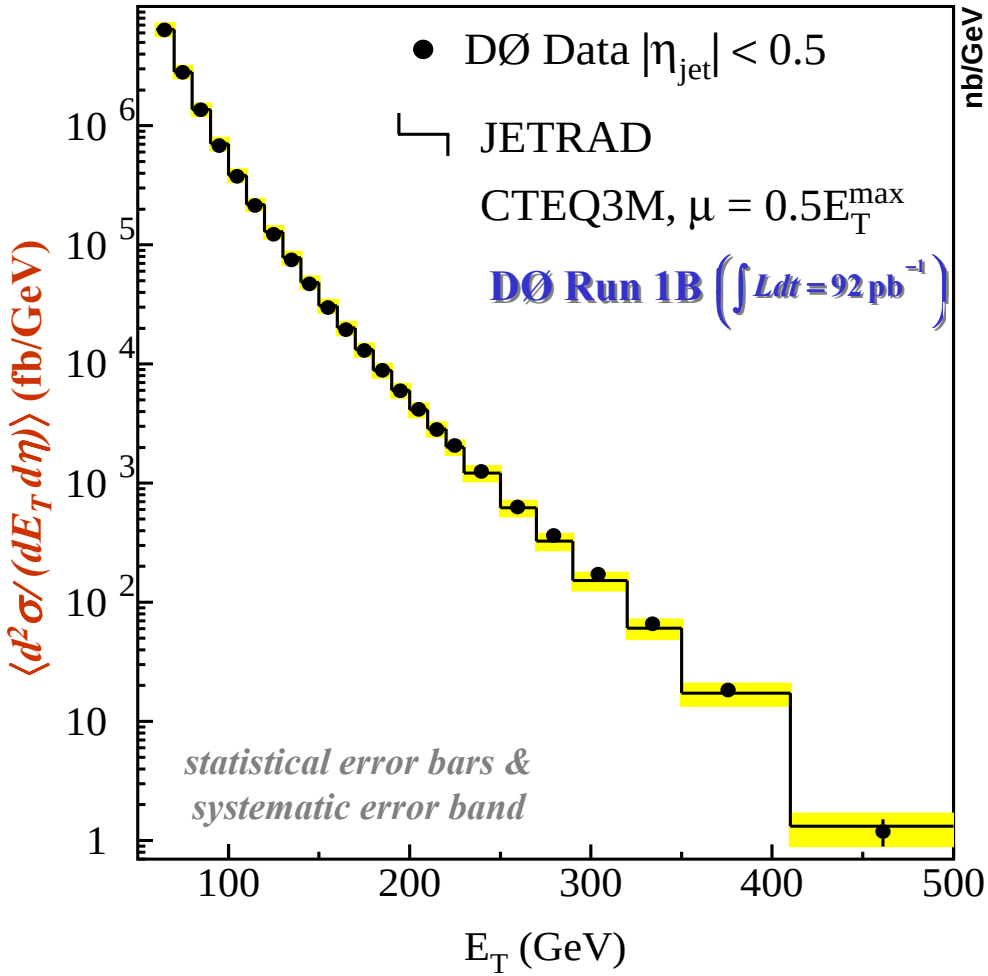
Unfold the effects of finite jet energy resolutions from very steeply falling inclusive jet cross sections

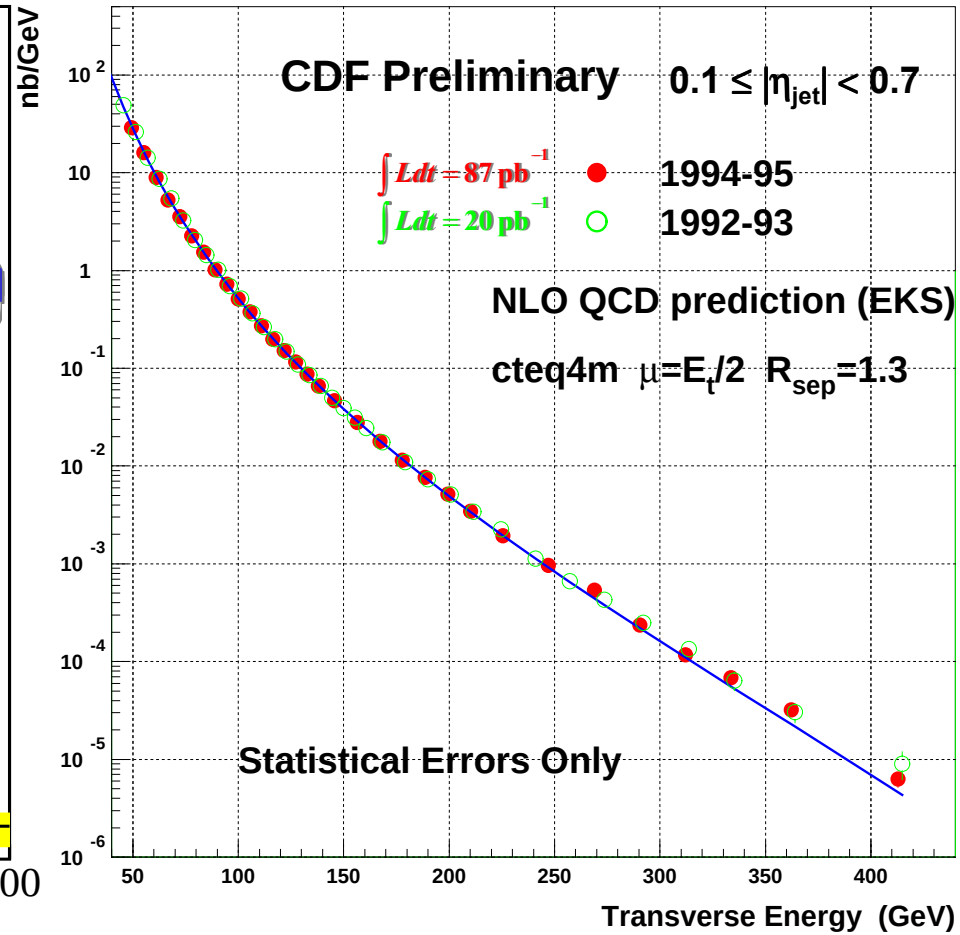




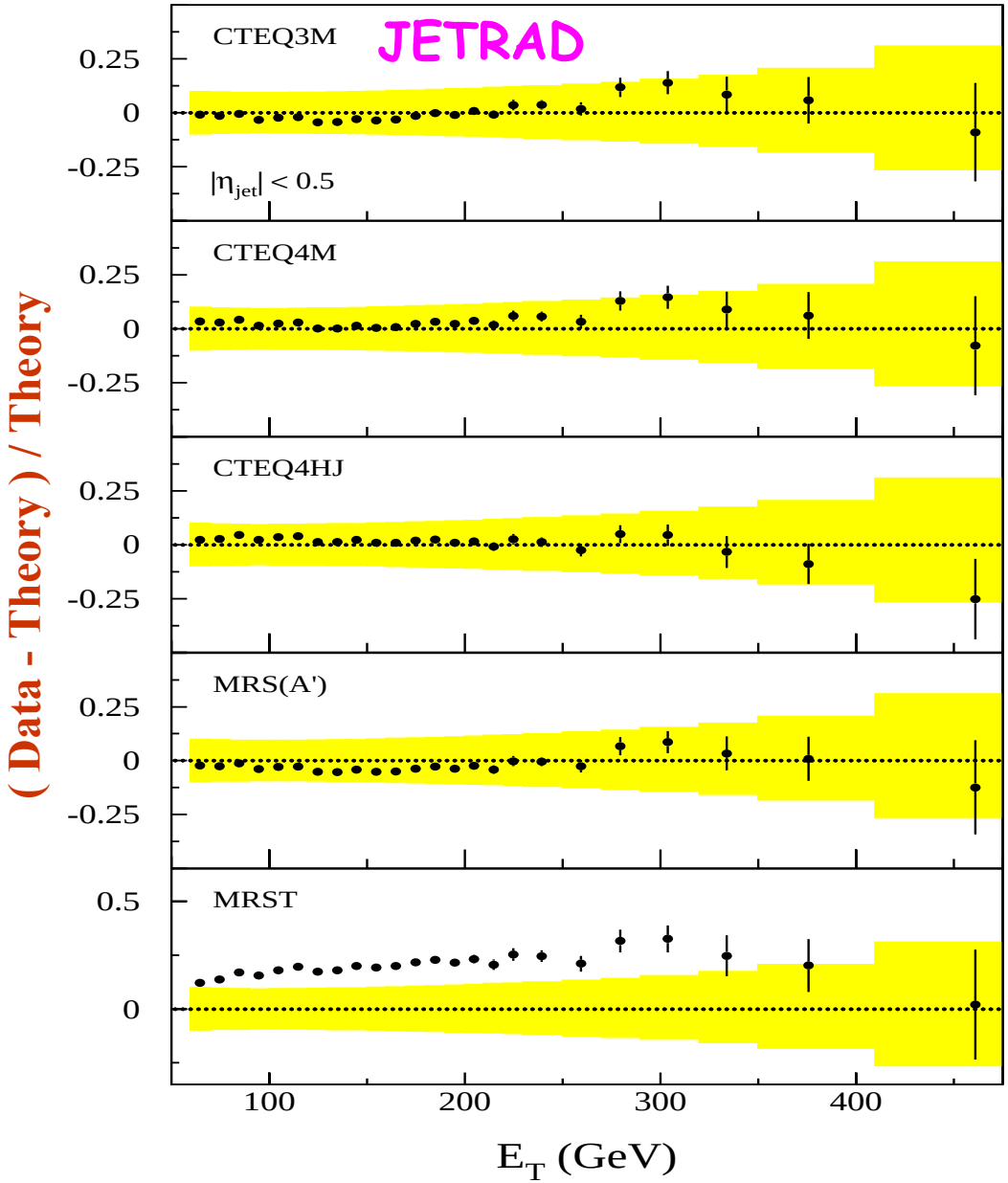
Central Inclusive Jet Cross Sections

$\left(\sqrt{s} = 1800\ \text{GeV}\right)$





Comparisons to Theoretical Predictions



$$\chi^2 = \sum_{i,j} (D_i - T_i) \times \left[Cov_{i,j}^{Full} \right]^{-1} \times (D_j - T_j)$$

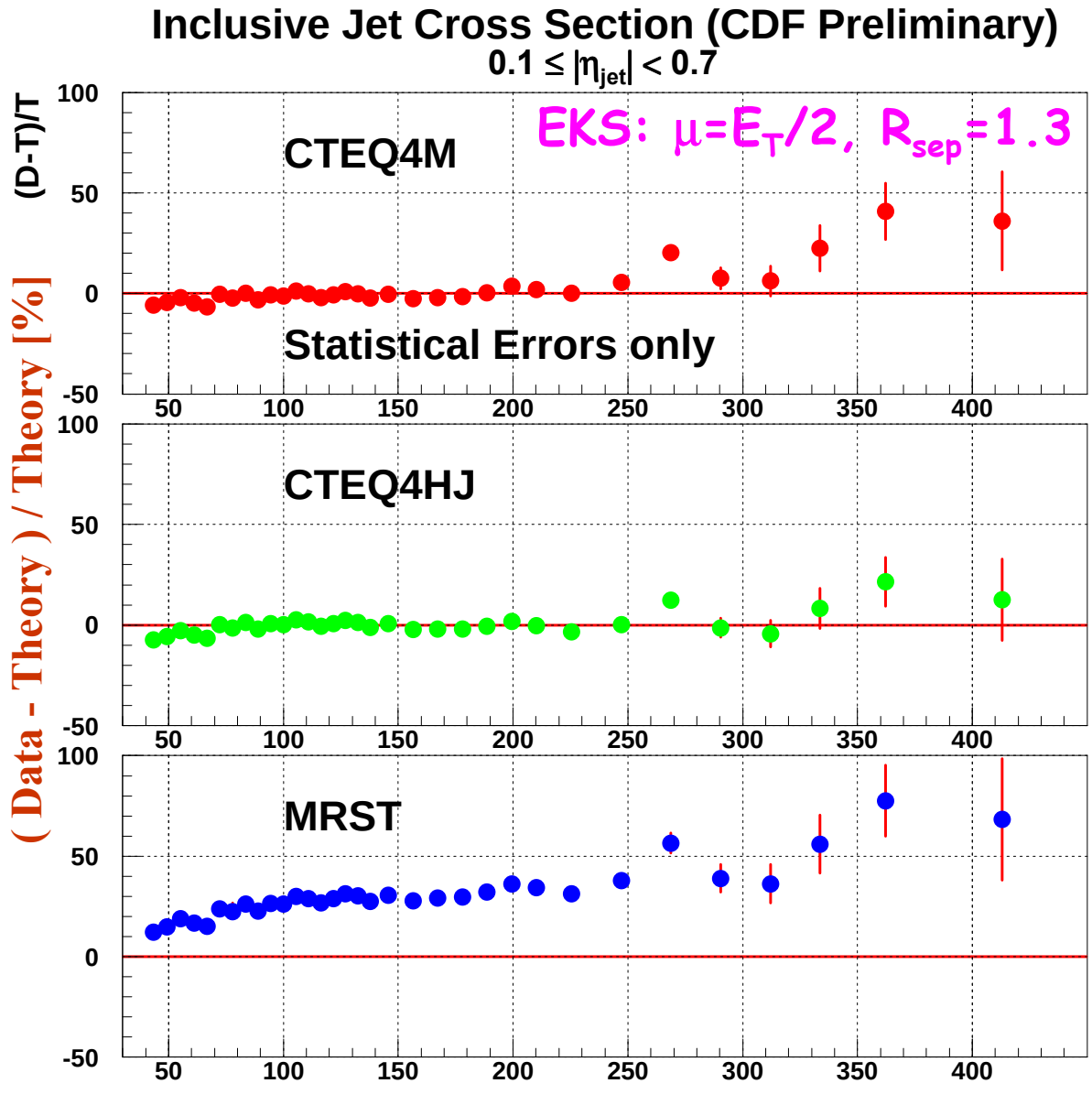
$$Cov_{i,j}^{Full} = \sum_{\beta}^{errors} \rho_{i,j}^{\beta} \times \sigma_i^{\beta} \times \sigma_j^{\beta}$$

PDF	$0.0 \le \lvert\eta\rvert \le 0.5$	$0.1 \le \lvert\eta\rvert \le 0.7$
CTEQ3M	26.1 (35%)	33.2 (10%)
CTEQ4M	20.5 (67%)	27.2 (30%)
CTEQ4HJ	16.6 (86%)	22.3 (56%)
MRSA'	20.8 (65%)	28.8 (23%)
MRST	25.2 (40%)	29.5 (20%)
MRSTg↑	21.5 (61%)	30.1 (18%)
MRSTg↓	47.3 (0.003%)	47.5 (0.003%)

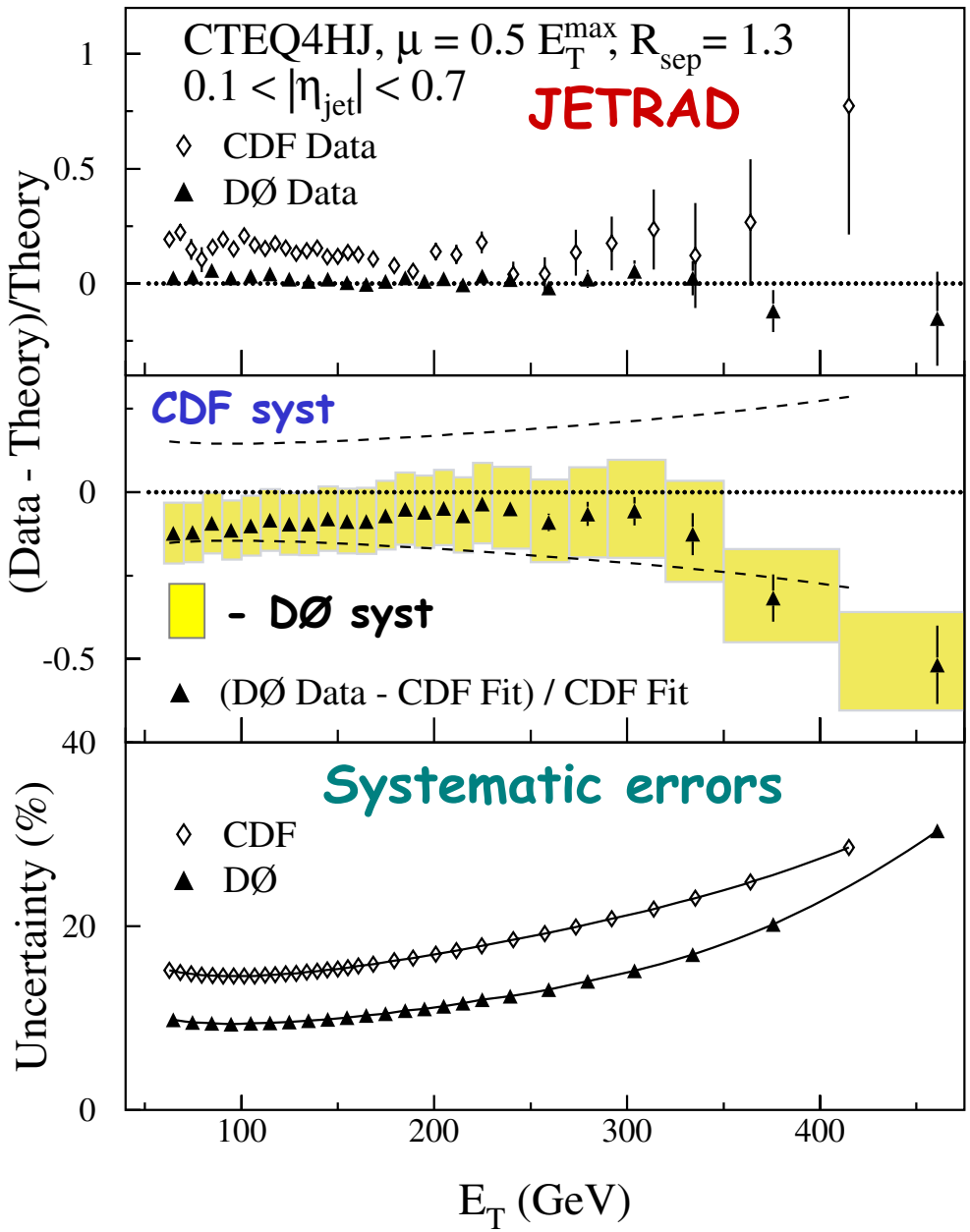
Comparisons to Theoretical Predictions

Statistical errors only, systematic errors (~15-30%) not plotted.

Some evidence of a possible excess at highest E_T's observed.



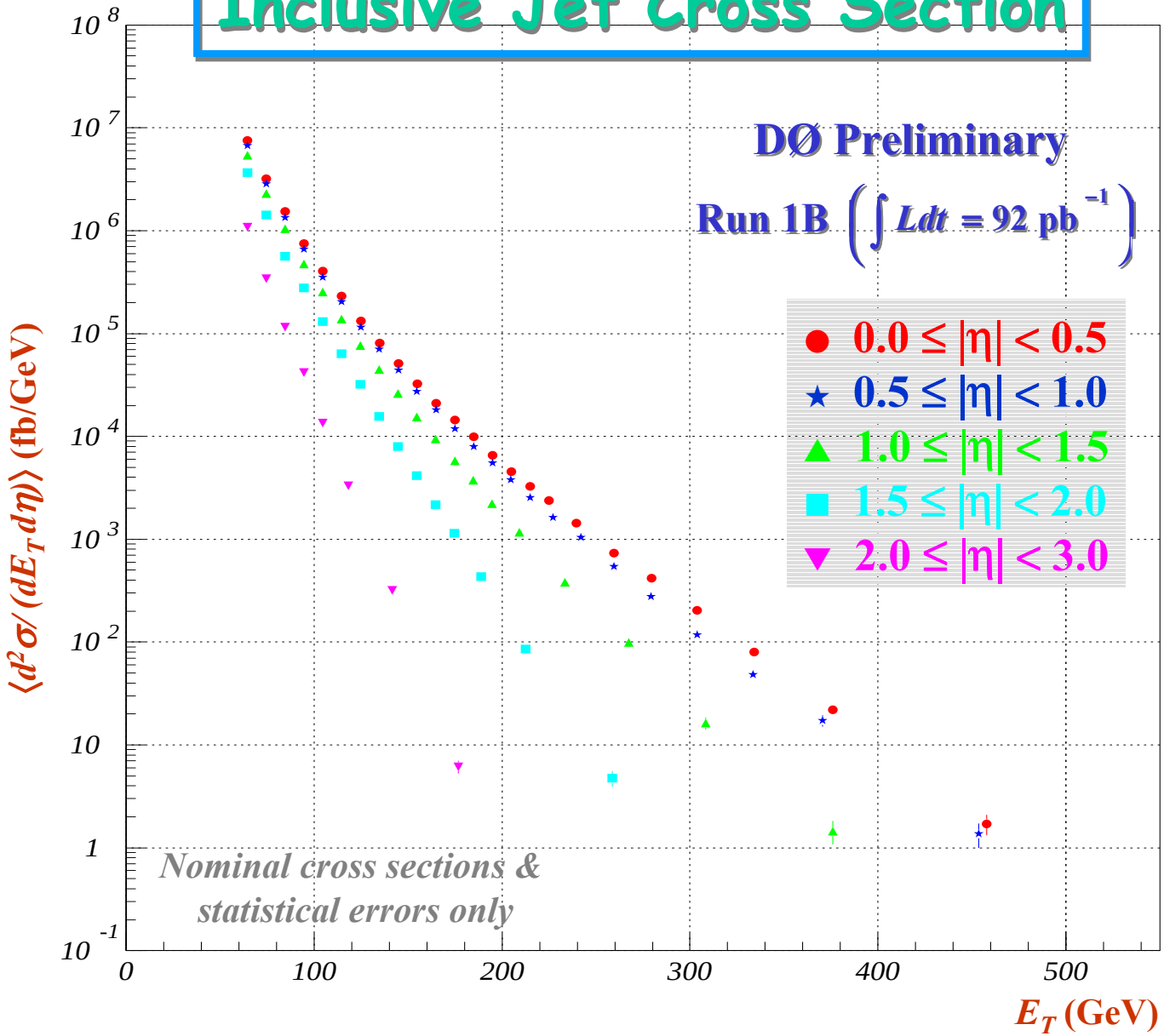
CDF to DØ Comparison



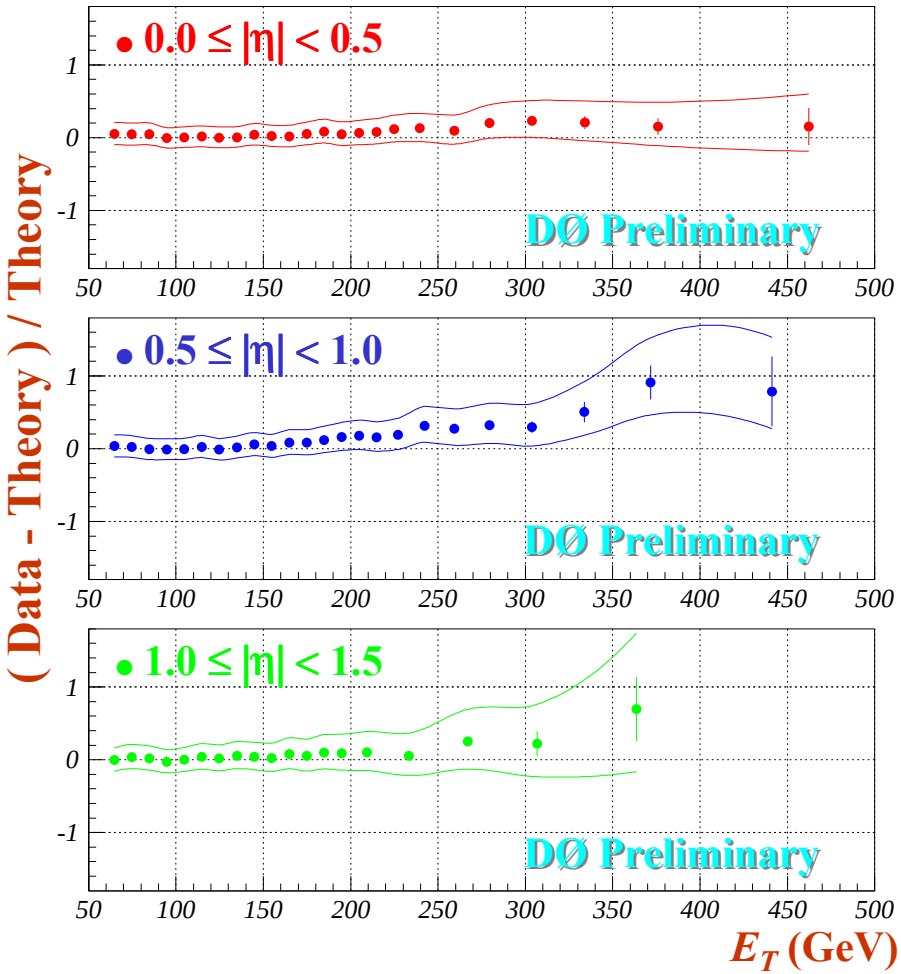
The two data sets from the two experiments are in acceptable agreement when systematic errors from both measurements are taken into account:

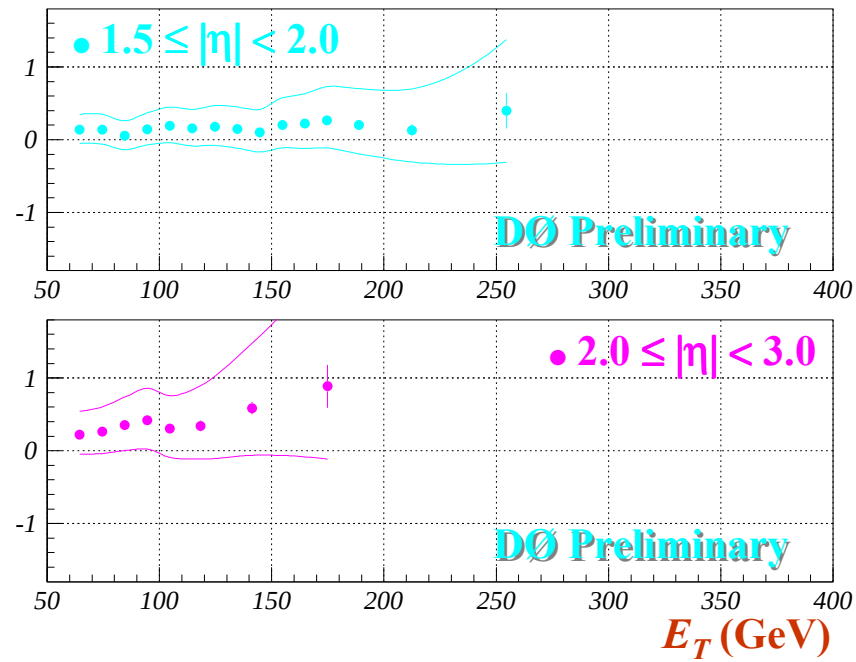
χ^2/ndf = 32.1/24 (12%).

Rapidity Dependence of Inclusive Jet Cross Section



Comparisons to Theoretical Predictions





Comparisons to JETRAD with:

PDF: CTEQ4M

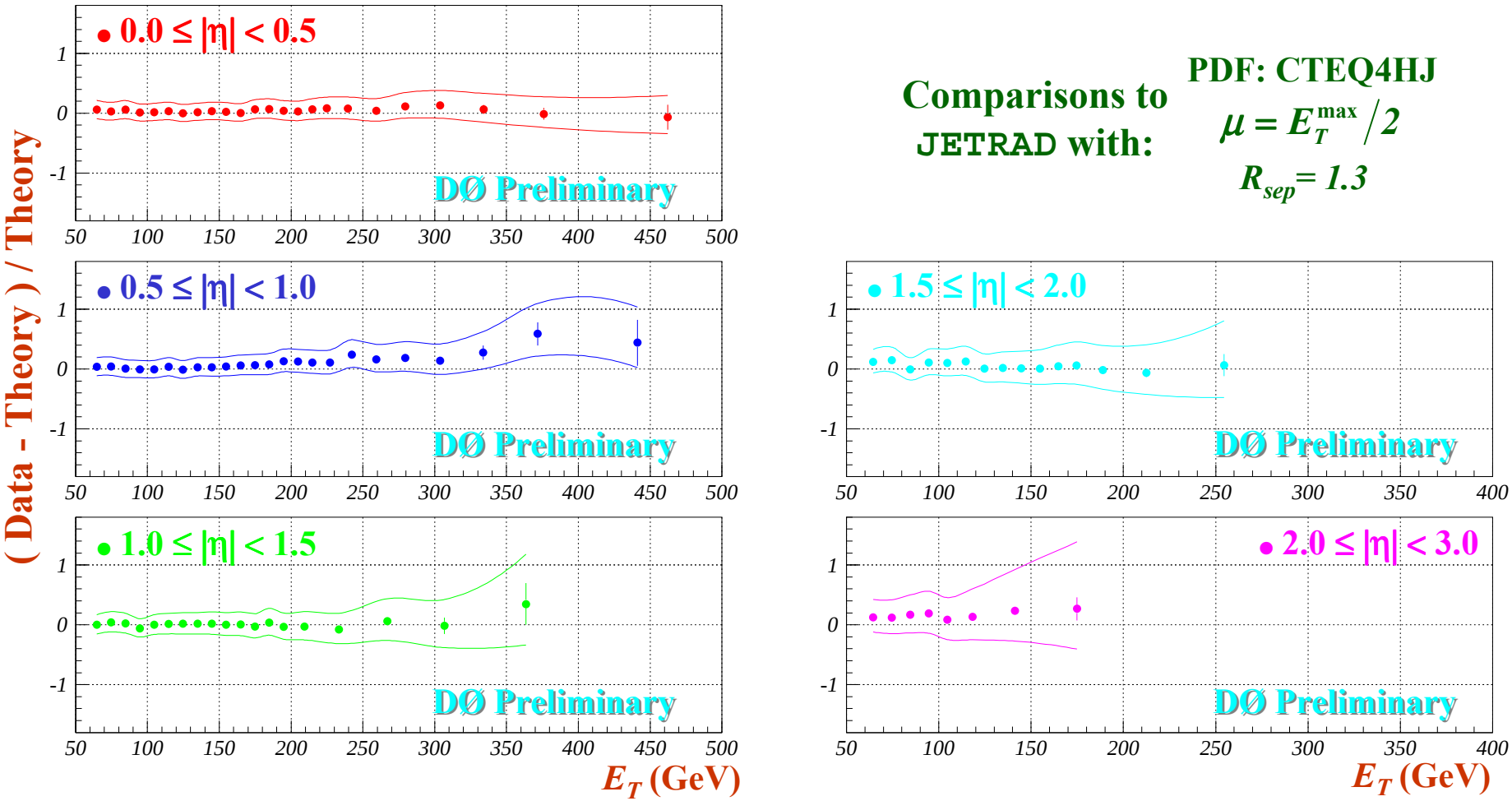
$\mu = E_T^{max}/2$

$R_{sep} = 1.3$

Deviations from QCD at highest E_T not significant within errors.

Good agreement with theory over ~seven orders!

Comparisons to Theoretical Predictions



Comparisons to JETRAD with:

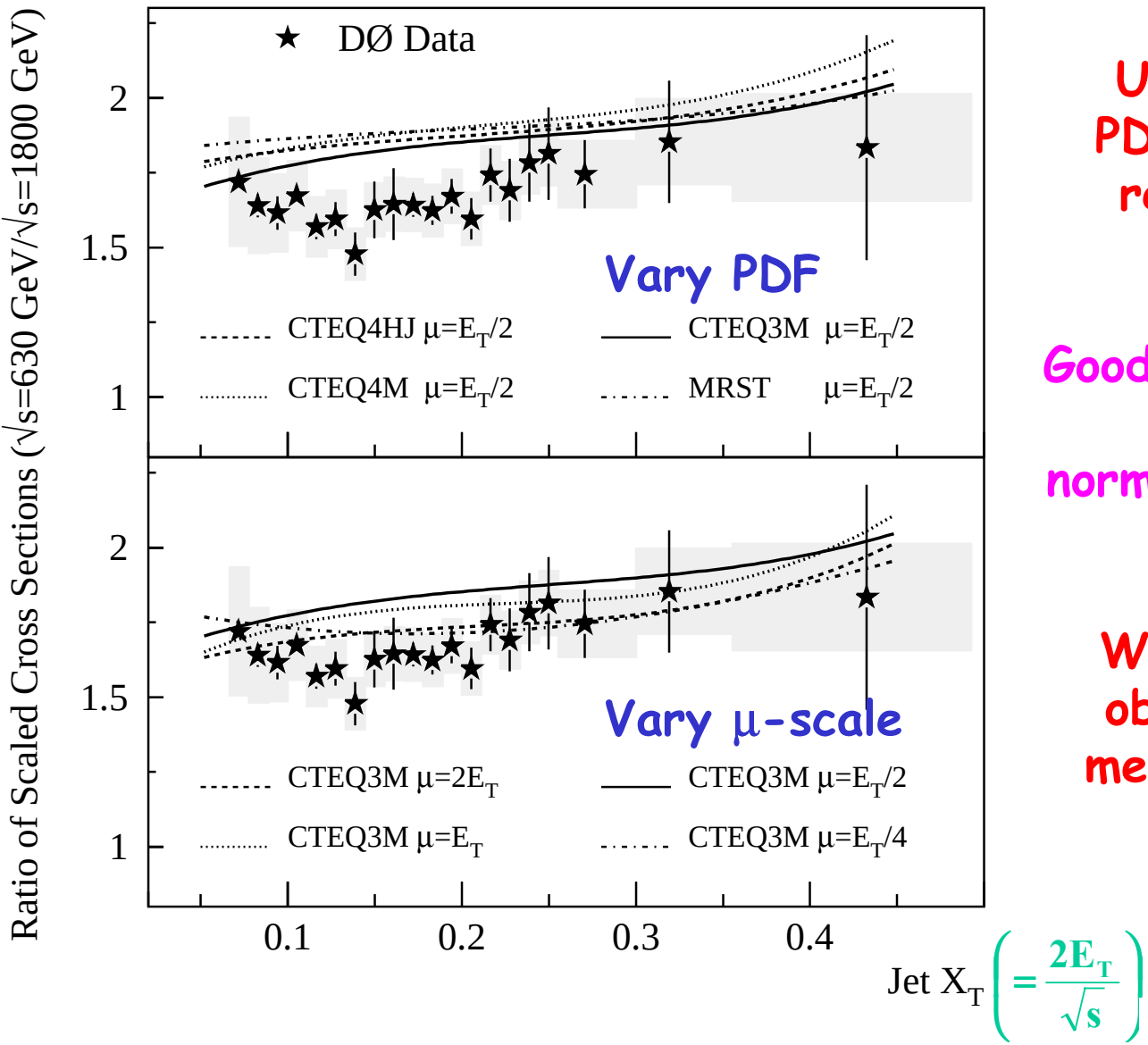
PDF: CTEQ4HJ

$\mu = E_T^{max}/2$

$R_{sep} = 1.3$

CTEQ4HJ appears to produce better agreement with the data.
Work is underway to obtain a quantitative measure of agreement.

630/1800 GeV Ratio Comparisons to Theory



Uncertainties due to PDF's are significantly reduced in the ratio.

Good agreement in shape, and normalization within 1-2σ.

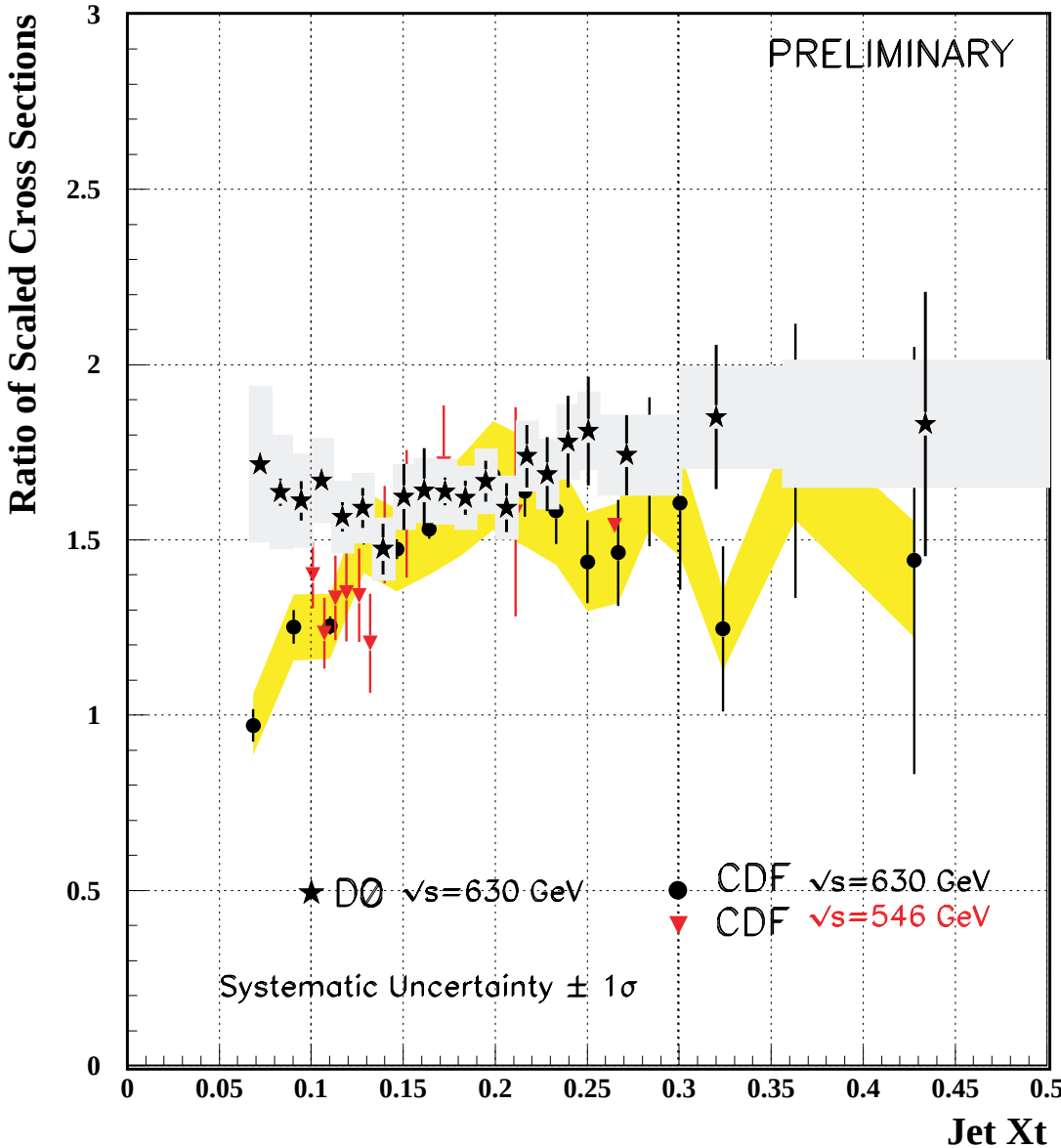
Work is underway for obtaining quantitative measure of agreement, such as χ^2.

630/1800 Ratio Comparisons to Theory

The two data sets from two experiments are qualitatively consistent at mid- and high values of x_T.

At low x_T's, the measurement is experimentally difficult and there are theoretical issues that could lead to disagreement with theory and between experiments.

Theoretical choices can be made that give a better agreement with the data.



Summary

CDF and DØ Collaborations have made measurements of inclusive jet cross sections in proton-antiproton collisions at 630 GeV and 1800 GeV CM energies and their ratios, thereby testing pQCD over large dynamic range and at highest Q^2.

Measurements show overall good agreement with NLO pQCD and thus far discrimination against various PDF's has not been possible.

Recently, DØ has significantly extended the η reach of the inclusive jet cross section measurement up to $|\eta| = 3.0$.
Work is underway to understand error correlations in E_T and η in order to obtain a quantitative measure (e.g. based on a χ^2 test) of agreement between this new measurement and pQCD predictions.

There is some preliminary evidence that this new measurement of Rapidity Dependence may discriminate among various sets of PDF's.