EPJ Web of Conferences **60**, 20017 (2013)
DOI: 10.1051/epjconf/20136020017

Measurement of Multijet Ratios and a Determination of α_s at the Tevatron

Lee Sawyer[1, a] , on behalf of the DØ Collaboration

[1] *Louisiana Tech University*

Abstract. In this poster we present several recent results for the production of multijet final states in $p\bar{p}$ collisions at a center of mass energy of 1.96 TeV, taken with the DØ experiment at the Fermilab Tevatron collider.. These measurements, defined as ratios of three-jet to two-jet quantities, reduce the dependence of the results on Parton Distribution Functions (PDFs) and experimental systematic uncertainties. Based on one of these ratio measurements, a value of α_s is determined and the running of α_s tested over a wide range of jet transverse momenta.

1 Introduction

Measurements of multi-jet production take advantage of the fact that these processes have the same PDF sensitivity as dijet production, but are sensitive to processes to third order in the strong coupling constant α_s. Studies dedicated to the dynamics of the interaction are preferably based on observables which are insensitive to the PDFs. Such observables can be constructed as ratios of cross sections for which the PDF sensitivity cancels. In this note we report a measurement of three multijet ratios: $R_{\Delta\phi}$ [1], defined as the ratio of events having an azimuthal opening angle $\Delta\phi$ between the leading two jets (in transverse momentum p_T) less than a cut-off $\Delta\phi_{max}$, to the inclusive dijet sample; $R_{\Delta R}$, which is defined as the number of events with a neighboring jet within a separation ΔR, divided by the number of inclusive jets (where $\Delta R = \sqrt{(\Delta y)^2 + (\Delta\phi)^2}$ in plane of rapidity (y) and ϕ); and $R_{3/2}$, which is the ratio of the inclusive three-jet to the inclusive 2-jet cross-sections.

These measurements are based on $p\bar{p}$ collisions at a center of mass energy of 1.96 TeV which were recorded with the DØ experiment [2] at the Fermilab Tevatron collider. The data analyzed were recorded using a single jet triggers at a variety of thresholds, corresponding to an integrated luminosity of 0.7 fb−1. The event selection, jet reconstruction, jet energy and momentum corrections in these measurements follow closely those used in our recent measurements of inclusive jet and dijet distributions[3–5]. Jets are defined by the Run II midpoint cone jet algorithm [6] with a cone radius (for most jet studies) of $R_{\rm cone} = \sqrt{(\Delta y)^2 + (\Delta\phi)^2} = 0.7$.

2 Measurements of $R_{\Delta\phi}$, $R_{\Delta R}$, and $R_{3/2}$

The ratio of inclusive three-jet to two-jet production, $R_{3/2}$, was measured as a function of the p_T of the leading jet in the event ($p_{T\max}$). Events were selected to have at least two (three) jets above a p_T threshold $p_{T\min}$ for the two-jet (three-jet) sample. Four values of $p_{T\min}$ were studied: 30, 50, 70, and 90 GeV. In figure 1 we show the values of $R_{3/2}(p_{T\max}; p_{T\min})$ compared to the predictions of next-to-leading quantum chromodynamics as obtained from FastNLO [7]. Details of the analysis, including estimation of uncertainties and non-perturbative corrections to the theoretical predictions and comparisons to several event generators, are given in [8]

The ratio $R_{\Delta\phi}$ was measured in events having at least two jets with $p_T > 30$ GeV, in bins of $H_T = \sum p_T^{jet}$ and $y^* = \frac{1}{2}|y_1 - y_2|$, where the subscripts 1,2 refer to the leading and next-to-leading jet in the event ordered in p_T. Then $R_{\Delta\phi}(H_T, y^*, \Delta\phi_{\max})$ was formed as the ratio of events with dijet opening angle $\Delta\phi < \Delta\phi_{max}$ to the inclusive dijet sample. The ratio was measured for three values of $\Delta\phi_{max}$ - $\frac{3\pi}{4}, \frac{5\pi}{6}, \frac{7\pi}{8}$ - and four ranges of y^*: $0 < y^* < 0.5, 0.5 < y^* < 1.0$, and $1.0 < y^* < 2.0$. the results are shown in figure 2. Details of the analysis, including estimation of uncertainties and non-perturbative corrections to the theoretical predictions, are given in [9]

The angular correlation of jets in an inclusive jet sample is calculated be computing the ratio $R_{\Delta R} = \sum_{i=1}^{N_{\rm jet}(p_T)} N_{\rm nbr}^{(i)}(\Delta R, p_{T\min}^{\rm nbr})/N_{\rm jet}(p_T)$ where $N_{\rm jet}(p_T)$ is the number of inclusive jets in a bin of inclusive jet p_T, and $N_{\rm nbr}^{(i)}(\Delta R, p_{T\min}^{\rm nbr})$ is the number of neighboring jets with transverse momenta greater than $p_{T\min}^{nbr}$ and separated from the i^{th} inclusive jet by ΔR. The inclusive jet sample was defined as all events having at least one jet with $p_T > 50$ GeV and $|y| < 1.0$. Results are shown in figure 3 for four values of $p_{T\min}^{\rm nbr}$ (30, 50, 70, and 90 GeV). Details of the analysis, including estimation of uncertainties and non-perturbative corrections to the theoretical predictions, are given in [10]

Using the data for $p_{T\min}^{nbr}$ of 50, 70, and 90 GeV and combining ΔR regions, we determine the strong coupling constant α_s and test the two–loop Renormalization Group

a. e-mail: sawyer@phys.latech.edu

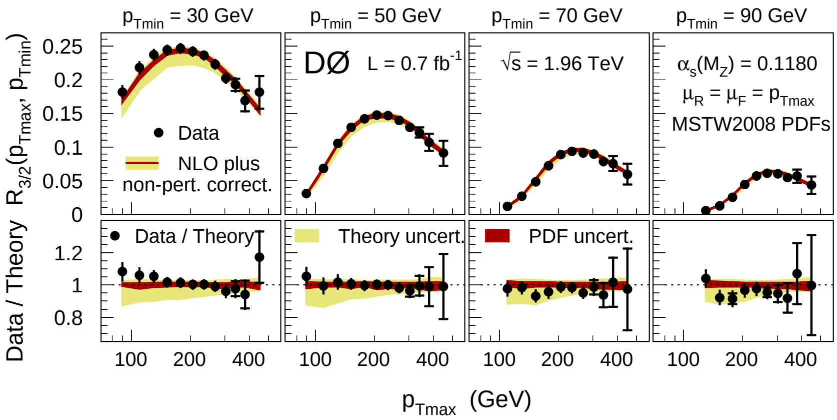

Figure 1. The measured $R_{3/2}$ results, compared to the predictions from NLO pQCD corrected for non-perturbative effects (top), and the ratio of data to theoretical predictions (bottom). The results are presented as a function of the highest jet p_T, $p_{T\max}$, for different $p_{T\min}$ requirements.

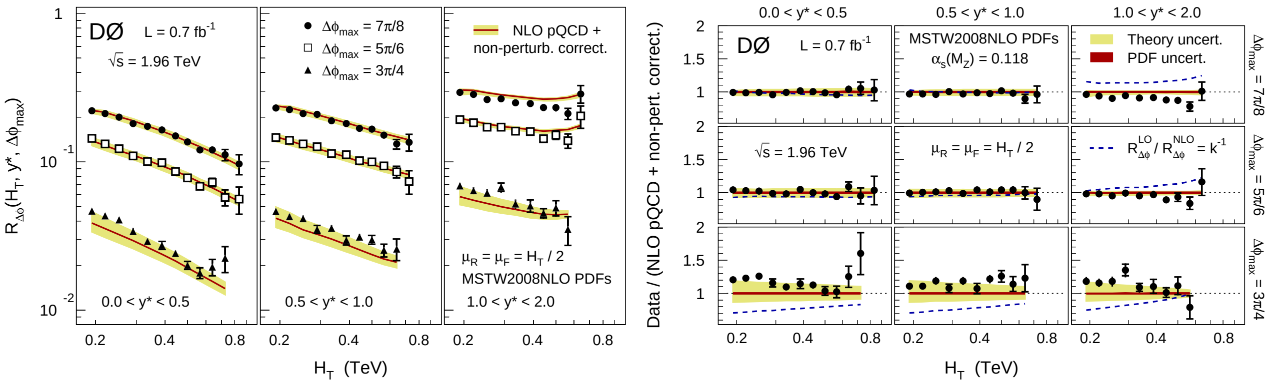

Figure 2. (left) The results for $R_{\Delta\phi}$ as a function of H_T in three different regions of y^* and for three different $\Delta\phi_{max}$ requirements. (right) Ratios of the results of $R_{\Delta\phi}$ and the theoretical predictions obtained for MSTW2008NLO PDFs [11] and $\alpha_s(MZ) = 0.118$.

Equation (RGE) prediction of its running as a function of the momentum scale, taken to be the inclusive jet p_T. Details are given in [10]. In figure 4 we show the resulting values of α_s and $\alpha_s(M_Z)$.

References

[1] M. Wobisch, *et al*, JHEP **1301**, 172 (2012).

[2] V. M. Abazov *et al.* (D0 Collaboration), Nucl. Instrum. Methods Phys. Res. A **565**, 463 (2006).

[3] V. M. Abazov *et al.* (D0 Collaboration), Phys. Rev. Lett. **103**, 191803 (2009).

[4] V. M. Abazov *et al.* (D0 Collaboration), Phys. Lett. B **693**, 531 (2010).

[5] V. M. Abazov *et al.* (D0 Collaboration), Phys. Rev. D **85**, 052006 (2012).

[6] G. C. Blazey *et al.*, in: U. Baur, R.K. Ellis, and D. Zeppenfeld (Eds.), *Proceedings of the Workshop: QCD and Weak Boson Physics in Run II,* Fermilab-Pub-00/297 (2000).

[7] T. Kluge, K. Rabbertz, and M. Wobisch, arXiv:hep-ph/0609285v2.

[8] V. M. Abazov *et al.* (D0 Collaboration), Phys. Lett. B **720**, 6 (2013).

[9] V. M. Abazov *et al.* (D0 Collaboration), Phys. Lett. B **721**, 212(2013)

[10] V. M. Abazov *et al.* (D0 Collaboration), Phys. Lett. B **718**, 56 (2012)

[11] A. D. Martin, W. J. Stirling, R. S. Thorne, and G. Watt, Eur. Phys. J. C **63**, 189 (2009).

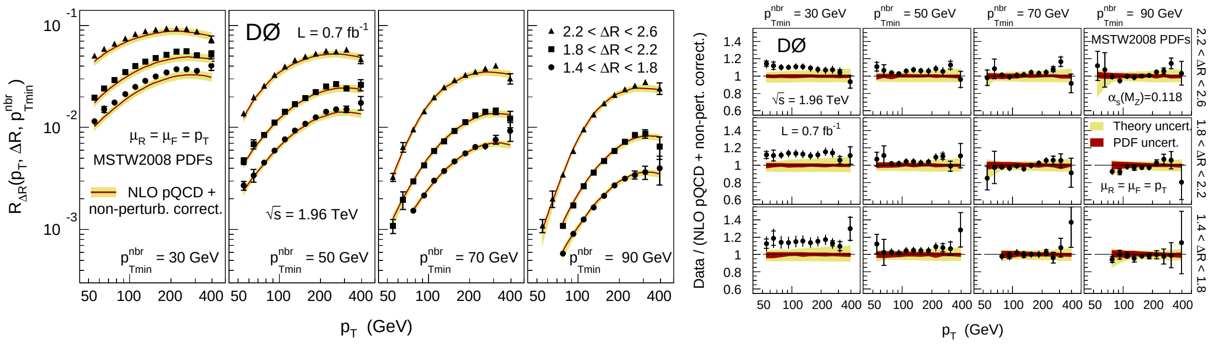

Figure 3. The measurement of $R_{\Delta R}$ as a function of inclusive jet p_T for three different intervals in ΔR and for four different requirements of $p_{T\min}^{nbr}$. On the right the ratio of data to theory is shown.

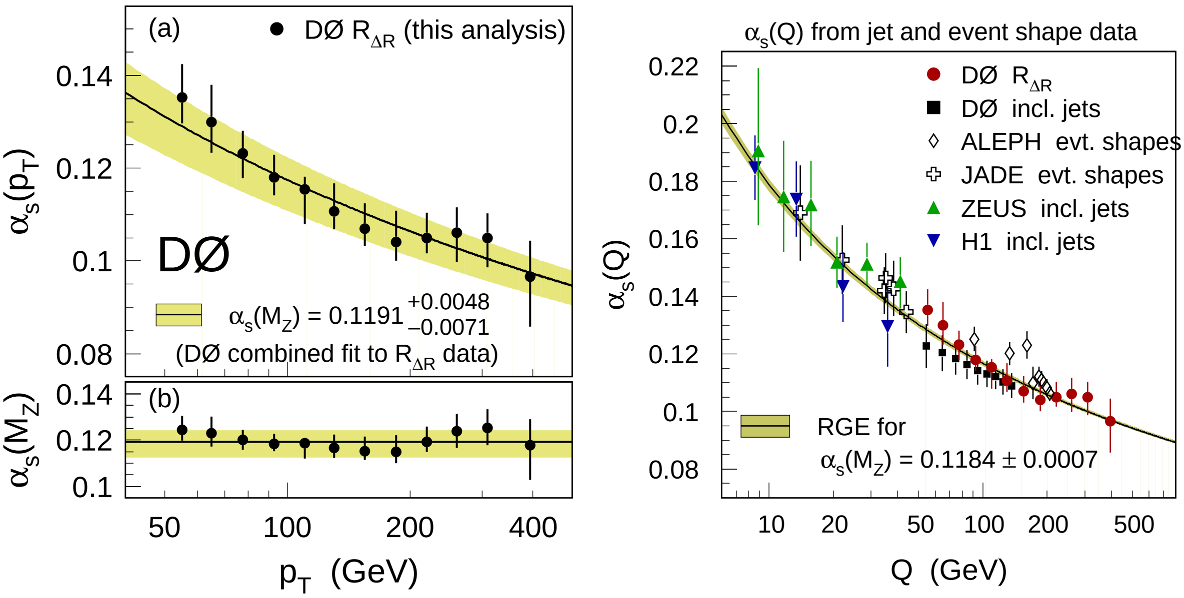

Figure 4. (left) The strong coupling α_s at large momentum transfers, Q, presented as $\alpha_s(Q)$ (a) and evolved to M_Z using the RGE (b). (right) Our result from the $R_{\Delta R}$ measurement, compared to previous results.