Fermi National Accelerator Laboratory

FERMILAB-Conf-93/050-E

DO

Two Jet Energy and Rapidity Distributions

Gerald C. Blazey
for the DØ Collaboration

Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

November 1992

Presented at the *7th Meeting of the American Physical Society Division of Particles and Fields*, Fermi National Accelerator Laboratory, November 10-14, 1992

Operated by Universities Research Association Inc. under Contract No. DE-AC02-76CHO3000 with the United States Department of Energy

Disclaimer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

TWO JET ENERGY AND RAPIDITY DISTRIBUTIONS

GERALD C. BLAZEY
Department of Physics and Astronomy, University of Rochester
Rochester, New York 14627, U.S.A

for the

DØ COLLABORATION

ABSTRACT

The DØ detector has been recording data at the Tevatron $\bar{p}p$ Collider since May 1992. Because the DØ calorimeter is hermetic and has large acceptance it is well suited for semi-exclusive final state jet studies. We present a preliminary measurment of the distribution $d^3N/dE_{t1}/d\eta_1/d\eta_2$ at $\sqrt{s} = 1.8$ TeV over a large range of η. The sensitivity of this cross-section to parton momentum distributions and the ability of DØ to discriminate between possible parton distributions is discussed.

1. Introduction

The DØ detector consists of a central tracker, a liquid argon/uranium sampling calorimeter, and a muon tracking system. The calorimeter is distinguished by hermiticity, uniformity, fine segmentation, stability, and good energy resolution[1]. The extended coverage in pseudorapidity ($/\eta/ \leq 4.4$) makes DØ an ideal detector for testing the predictions of QCD. To date, nearly all published jet cross-sections are for $/\eta/ \leq 2.0$[2,3].

At large pseudorapidity the cross section $d^3\sigma/dE_{t1}/d\eta_1/d\eta_2$ where the numerical subscripts identify the leading two jets in the reaction $\bar{p}p \Rightarrow j_1 j_2 + X$ and E_t is the transverse energy is particularly sensitive to the parton momentum distribution. This is easily demonstrated by holding E_{t1} constant and η_1 at 0. As $/\eta_2/$ becomes larger conservation of transverse momentum requires that the energy of j_2 also increase. Eventually both the energy and η of the second jet reach kinematic limits. This high energy corresponds to a high parton momentum fraction. As a result, the shape of the cross-section close to these limits becomes a reflection of the parton distribution at high parton momentum fraction.

2. The Data

The results in this article are based on an integrated luminosity of 130 nb^{-1} taken during September 1992. One data set required at least one hadronic trigger tower above 7 GeV transverse energy and a second data set required two trigger towers each above 7 GeV transverse energy. (Trigger towers cover $\Delta\eta \times \Delta\phi = 0.2 \times 0.2$ in $\eta\phi$ space.) Because the production processes that pass these hardware requirements have large cross-sections and because the data acquisition has a limited bandwidth only a fraction of these triggers are passed to the on-line software trigger. The software trigger for the first data set required a jet of at least 30 GeV and the second data set required a jet of at least 50 GeV. The jets were reconstructed with a cone algorithm of size 0.7 in $\eta\phi$ space.[4] The data was required to pass the following offline cuts: each event contained two or more jets; the jets did not include noisy calorimeter cells[5]; the azimuthal difference of the two leading jets was required to be within 1 radian of π; after enumerating the two leading jets in the event by requiring $/\eta_1/ \leq /\eta_2/$, j_1 was further constrained to $/\eta_1/ \leq 1.0$; E_{t1} was required to be above 45 GeV for the lower threshold trigger and 75 GeV for the higher threshold trigger.

Figure 1 shows a preliminary event distribution for $d^3N/dE_{t1}/d\eta_1/d\eta_2$ as a function of $/\eta_2/$. The two data sets correspond to $45 \leq E_{t1} \leq 75GeV$ and $75 \leq E_{t1} \leq 100GeV$ and integrated luminosities of about 2 nb^{-1} and 8 nb^{-1}, respectively. The depletion at $/\eta_2/ = 0$ is due to phase space. The rapid decrease as $/\eta_2/$ increases reflects the decrease of the parton momentum distribution at high parton momentum. The dashed line is a prediction for $45 \leq E_{t1} \leq 75GeV$ generated with the leading order partonic Monte-Carlo PAPAGENO[6]. Only dijet events were generated and the final state energies and pseudorapidities were smeared with functions derived from a more complete detector GEANT simulation[7]. The Monte-Carlo curve was generated with the EHLQ1 structure function and has been normalized to the number of events in the data. The general agreement between the preliminary data and the generated curve indicate that the detector and trigger are operating as expected.

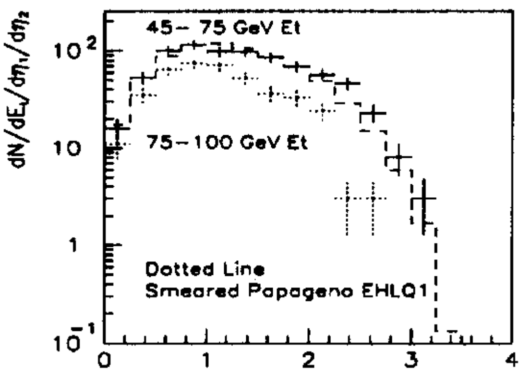

Fig 1. Dijet Distribution.

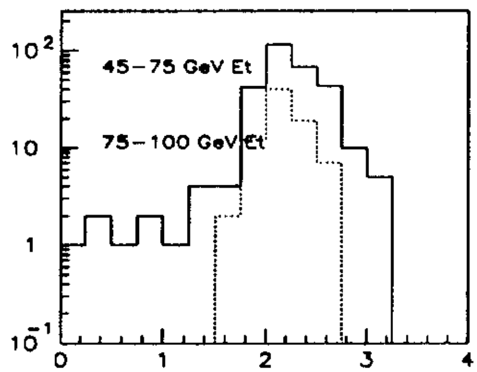

Fig 2. Forward Dijet Dist.

3. The Forward Triggers

The DØ jet trigger can be operated with pseudorapidity dependent jet transverse energy thresholds. Presently the jet triggers include two "forward" triggers which are analogs of the two inclusive triggers described earlier. In addition to one or two trigger towers above 7 GeV, the forward triggers also require that the towers exceeding threshold be above $/\eta/ = 2.0$. Since the forward jet cross-sections are much smaller than the central cross-sections a higher fraction of the forward triggers can be passed to the software trigger. This will provide statistical significance equivalent to that of the central trigger regions. Figure 2 displays data taken with the forward triggers. The analysis of this data was identical to that of the data shown in Figure 1. The higher energy data corresponds to an integrated luminosity of about 130 nb^{-1} and the lower data to 8 nb^{-1}. Notice the five events above $/\eta_2/ = 3.0$.

4. Conclusions and Prospects

The DØ calorimeter has sufficient kinematic and triggering coverage to make new measurements of jet production in the forward region ($/\eta/ \geq 2.0$). As implied by Figure 2, once the total integrated luminosity approaches 25 pb^{-1} the dijet data sample between 45 and 75 GeV and above $/\eta_2/ = 3.0$ will contain about 1000 events. This corresponds to a 3 percent statistical measurement. The dijet cross-section as predicted by PAPAGENO varies by 5-30 percent over the full rapidity range ($0.0 \leq /\eta_2/ \leq 3.0$) depending on the choice of parton structure function[8]. A three percent measurement will discriminate between the candidate distributions. In addition to testing parton momentum distributions, the high acceptance of the DØ calorimeter will also contribute to the understanding of jet inclusive, invariant mass, and rapidity gap cross-sections.

5. Acknowledgements

We would like to acknowledge the support of this research by the National Science Foundation and the Department of Energy.

6. References

1. Maris Abolins, et.al., *Nucl. Instr. and Meth.* **A280** (1989) 36.
2. J. Alitti, et.al., *Phys. Lett.* **257** (1991) 232.
3. F. Abe, et.al., *Phys. Rev. Lett.* **68** (1992) 1104.
4. C. Stewart, *Proceedings of the 3rd International Conference on Calorimetry in High Energy Physics*, Corpus Christi, Texas, (1992).
5. R. Astur, *Proceedings of the 7th Meeting of the American Physical Society Division of Particles and Fields*, Batavia, Illinois, (1992).
6. I. Hinchliffe, Lawrence Berkeley Laboratory, Berkeley, California
7. G. C. Blazey, *Internal DØ Note 1173*, The DØ Collaboration Fermi Natl. Accelerator Laboratory, Batavia, Illinois, (1991).
8. G. C. Blazey, *Internal DØ Note 1207*, The DØ Collaboration Fermi Natl. Accelerator Laboratory, Batavia, Illinois, (1991).