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DIFFRACTIVE DIJET SEARCH WITH ROMAN POTS AT CDF

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We present the results of a search for diffractive dijets produced in $p\bar{p}$ collisions at $\sqrt{s}$=1.8 TeV from data collected by the Collider Detector at Fermilab using a Roman pot trigger. The dijet events exhibit additional diffractive characteristics such as rapidity gaps and boosted center-of-mass systems.

1 Introduction

Within Regge theory the pomeron trajectory is used to describe high energy diffractive processes[1]. Assuming that the pomeron is made up of quarks and gluons and that the diffractive cross section can be factorized[1] into a pomeron flux times a pomeron-proton total cross section, then the structure of the pomeron can be determined. Just as jets are used to probe the quark/gluon structure of the proton, diffractive dijets can be used to probe the structure of the pomeron. There is evidence from other experiments[2] that the pomeron has a hard parton distribution where the momentum is predominately shared by two gluons ("hard-gluon") or two quarks ("hard-quark"), which may be modelled as $\beta(1-\beta)$, where β is the fraction of the pomeron's momentum carried by the partons.

We model diffractive interactions using POMPYT[1], assuming a quark/gluon structure of the pomeron and a pomeron flux to generate (ξ, t), where ξ is the fraction of the proton's momentum carried by the pomeron and t is the 4-momentum transfer squared. PYTHIA then simulates the pomeron-proton interaction that produces dijets.

2 Analysis

Three Roman pot detectors were installed and used together with the CDF detector during the run 1C Tevatron run. Each Roman pot contained trigger scintillators and x, y position detectors using scintillating fibers read out by multichannel photomultiplier tubes. For diffractive events in which the antiproton loses 5% to 10% of its momentum by the emission of a pomeron ($0.05 < \xi < 0.10$), the antiproton gets bent out of the beam into the Roman pot detectors. The x, y track measured in the three Roman pots is projected back to the event vertex, using the accelerator magnetic transport matrix, to determine the ξ, t of the antiproton.

The data sample used in the search for diffractive dijets was taken during a special low luminosity (a few $\times 10^{29}$ cm^{-2}s^{-1}) running period in which a triple Roman pot coincidence triggered the CDF readout. There are 1.53 million events with a good x, y reconstructed track and $0.05 < \xi < 0.10$, consistent with coming from the CDF event vertex. These events show the expected correlations between the CDF event and the ξ measured in the Roman pots 55 meters away. Figure 1 (left plot) shows the expected correlation between the event mass, measured using calorimeter towers, and $\sqrt{\xi}$, where the center-of-mass energy available in a pomeron-proton collision is $1800\sqrt{\xi}$ GeV. Figure 1 (right plot) shows the correlation between the detected η_{max} (occupied tower with the largest η) and $\ln \xi$, where the size of the rapidity gap is expected to scale with $\ln \xi$. In addition to the tagged antiproton, rapidity gaps are also observed in the forward detectors on the same side.

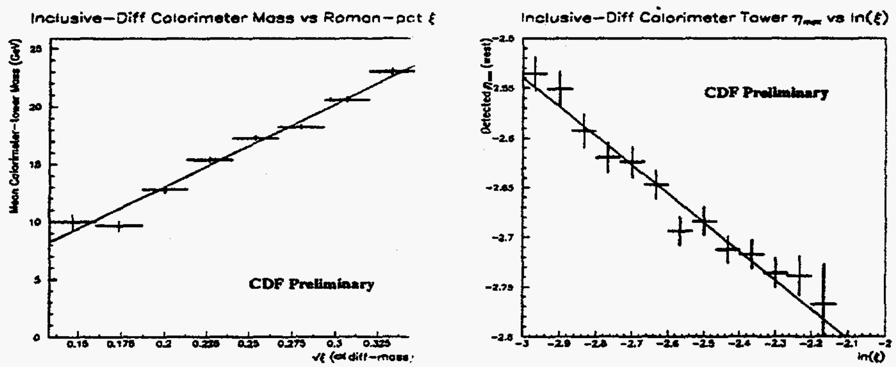

Figure 1: Calorimeter Mass vs $\xi^{1/2}$ and η_{max} vs $\ln(\xi)$. (The lines are linear fits to the data.)

The Roman pot cross section at 1800 GeV was measured by CDF[6] in 1989. The cross section for $0.05 < \xi < 0.10$ is expected to be 0.64 mb, of which the pomeron-induced diffractive component is $\sigma^{\mathcal{P}} \sim 0.15$ mb and the remainder is a non-diffractive background possibly due to Reggeon exchange.

Within our Roman pot triggered sample, there are 2546 dijets defined as two jets with $E_T > 10$ GeV. There is significantly lower activity observed (rapidity gaps) in the forward detectors on the Roman pot side (west) compared to the east side for these Roman pot dijet events, while non-diffractive events are west/east symmetric.

Figure 2 shows dijet variables for the dijets with Roman pot tracks compared to a non-diffractive sample (superimposed). The mean dijet η, $(\eta_1 + \eta_2)/2$, shows the expected boost away from the Roman pots compared to the η-symmetric non-diffractive sample. The leading jet E_T is similar for both Roman pot and non-diffractive dijets. The $\phi_1 - \phi_2$ distribution is more peaked than the non-diffractive dijets, which could be explained by the lower $\sqrt{s}$ in the diffractive interaction producing a smaller fraction of 3-jet events.

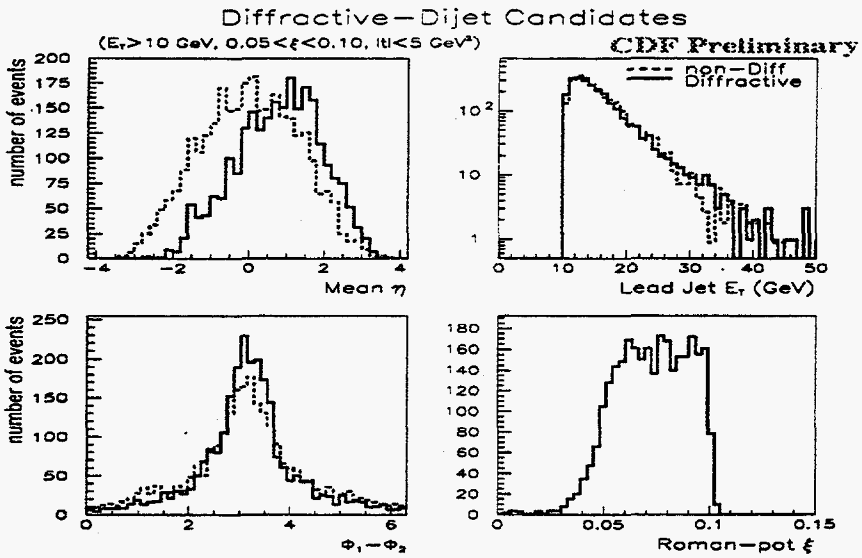

Figure 2: Dijet Sample Kinematic Distributions (non-diffractive is dashed histogram).

The dijet production rate is $\sigma = 0.64\text{mb} \times (2546\ \textit{dijets})/(1.53 \times 10^6\ \textit{incl}) \sim 1\mu\text{b}$. The rates predicted by POMPYT for a hard-gluon pomeron structure is $\sim 6\mu$b assuming the standard flux and $\sim 0.7\mu$b assuming a flux that scales with the soft single-diffractive cross section[1].

The comparison with the POMPYT diffractive simulation must be interpreted with the provision that we have not proven that all these dijets with Roman pot tracks are due to pomeron exchange (diffractive), as opposed to other colorless Regge exchanges.

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