Results on diffraction from the D0 collaboration

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Abstract. We discuss the most recent results on diffraction from the D0 collaboration, the search for exclusive events in the jet channel at high dijet mass and the measurement of the elastic cross section using the Forward Proton Detector.

Keywords: Diffraction, Tevatron, D0 experiment, exclusive diffraction, elastic
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SEARCH FOR EXCLUSIVE DIFFRACTIVE EVENTS IN THE JET CHANNEL AT HIGH DIJET MASS

The search for exclusive diffractive events in different channels at the Tevatron is particularly motivated by the projects to extend the physics programme at the LHC by adding detectors in the forward regions to measure intact protons [1], mainly for the search for the Higgs boson and anomalous couplings between W, Z and γ [2, 3, 4]. The advantage of exclusive events is that the whole Pomeron energy is transferred to the final state or in other words, there is no energy loss in the pomeron remnants. Tagging the protons allow to fully constrain the final state and to measure precisely the mass of the produced particles — for instance the Higgs boson — or their spins with an unprecedent accuracy. The CDF collaboration looked for the presence of exclusive diffractive events in many different channels such as dijet, diphoton, b-jets, χ_C... [5]. The D0 collaboration chose to look for exclusive events in the dijet channel at high dijet mass.

To select high dijet mass events, the D0 collaboration requested the presence of a high p_T jet with a trigger threshold of 45 GeV. We restrict ourselves to low instantaneous luminosity (5-100 10^{30} cm^{-2} s^{-1}) to limit the number of multiple interactions in the same bunch crossing which would fill the rapidity gaps with large energy. The total luminosity of the sample is 30 pb^{-1}. The data requirements are two jets (only) in the central region ($|y_{1,2}| < 0.8$) with $p_{T_1} >$60 GeV, $p_{T_2} >$40 GeV. Additional requirements are made on the dijet mass and the difference in azimuthal angle between the two jets ($M_{jj} >$100 GeV, $\Delta\phi >$3.1).

The comparison between data and MC on the dijet invariant mass distribution leads to a good description of data [6] if the Pythia [7] and Pomwig [8] generators are used respectivley for non-diffractive (NDF) and inclusive diffractive events (single diffraction (SD) and double pomeron exchange (IDP)). In order to distinguish between exclusive, inclusive diffractive and non-diffractive events, a new estimator was built:

$$\Delta = \frac{1}{2}\exp\left(-\Sigma_{2.0<|\eta|<3.0}E_T\right) + \frac{1}{2}\exp\left(-\Sigma_{3.0<|\eta|<4.2}E_T\right). \quad (1)$$

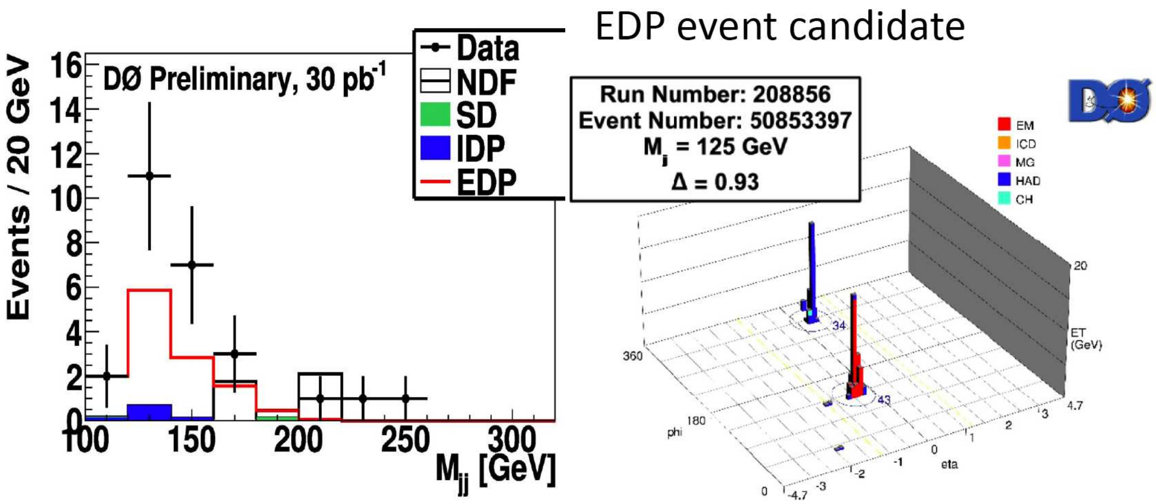

FIGURE 1. Left: Dijet mass distribution in data compared with Monte Carlo expectations at large $\Delta\eta$. Right: Example of an exclusive double pomeron exchange candidate.

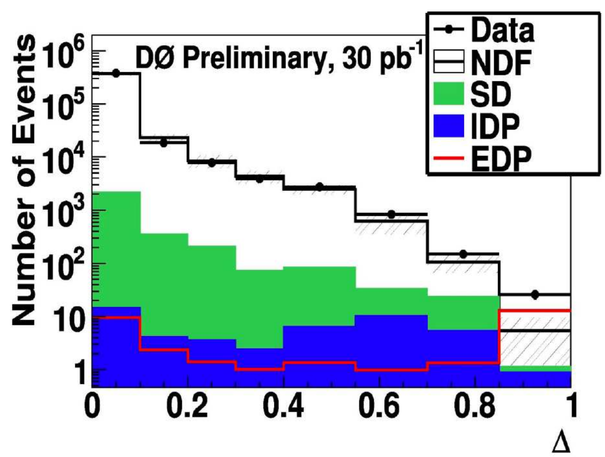

FIGURE 2. Δ distribution in data compared with the prediction from the non-diffractive, single diffractive and inclusive double pomeron exchange Monte Carlo.

The general idea is to use the fact that the rapidity gap is larger for exclusive events since there is no pomeron remnant and the gap will cover both regions in the calorimeter $2.0 < |\eta| < 3.0$ and $3.0 < |\eta| < 4.2$ far away from the central jets. In Fig. 1, left, we give the dijet mass distribution for events with $\Delta > 0.85$. There is a clear excess in data with respect to the NDF, SD and IDP contributions. The expected exclusive diffractive contribution is given using the Khoze Martin Ryskin [4] model implemented in the FPMC Monte Carlo [9]. An example of an exclusive event in data is shown in Fig. 1, right, where we can see the presence of two jets and nothing else.

The Δ distribution in data is shown in Fig. 2. There is a clear excess of data with respect to NDF, SD and IDP Monte Carlo expectations at high values of Δ. The excess

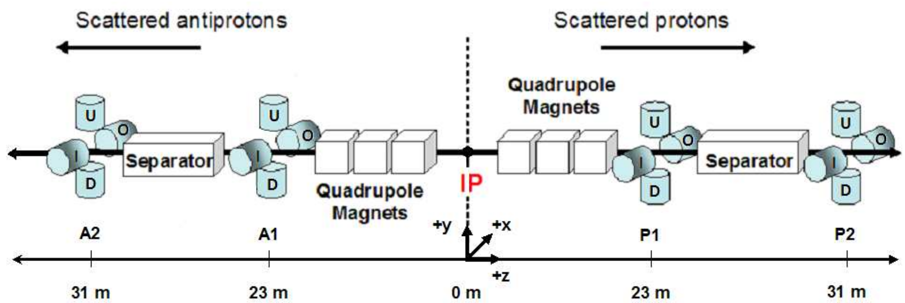

FIGURE 3. Scheme of the Forward Proton Detector.

significance is 4.1 σ (26 events observed in data for 5.3 expected). This measurement confirms the observation of the existence of the exclusive events performed by the CDF collaboration at high dijet mass.

MEASUREMENT OF THE ELASTIC SLOPE

Another diffractive measurement performed by the D0 collaboration is the measurement of the elastic slope. For this sake, the forward proton detector (FPD) was installed. It consists of 8 quadrupole spectrometers (Up, Down, In and Out) located on each side of the D0 experiment as shown in Fig. 3. To measure the elastic slope, a special high $\beta^* = 1.6$ m (5 times larger than normal) has been used with single bunches of p and $\bar{p}$. The total integrated luminosity for these special runs is 30 nb^{-1}. To reconstruct ξ and t of the protons, a scintillating fiber detector located inside the roman pots is used. The detector consists of three kinds of layers (U and V at 45 degrees to X). Each layer consists of two planes offset by 2/3 of a fiber. A combination of two fibers in two different planes gives a segment and two segments in different planes (X, U or V) give a hit. In addition, a central scintillator is used for timing purposes, which allows to reject out-of-time hits coming from halo events. In order to align relatively the detectors, over-constrained tracks that pass through horizontal and vertical detectors are used and the hit distributions are used to align the detectors with respect to the beam [10].

In order to select elastic events, tracks in diaginally opposite spectrometers are used. Since more halo was found in the horizontal detectors, only the Up and Down combinations of the detectors was used. The measurement of the elastic cross section and slope [10] is given in Fig. 4. The value of the elastic slope is $b = 16.5 \pm 0.1 \pm 0.8$ GeV^{-2}, compatible with the E710 and CDF results at lower center-of-mass energies [11]. The dip for $|t| \sim 0.6$ GeV^{-2} can also be clearly seen.

To summarize, we described in these proceedings two diffractive measurements by the D0 experiment, namely the evidence for the existence of exclusive diffractive events at high dijet mass, and the measurement of the elastic slope using dedicated low luminosity runs.

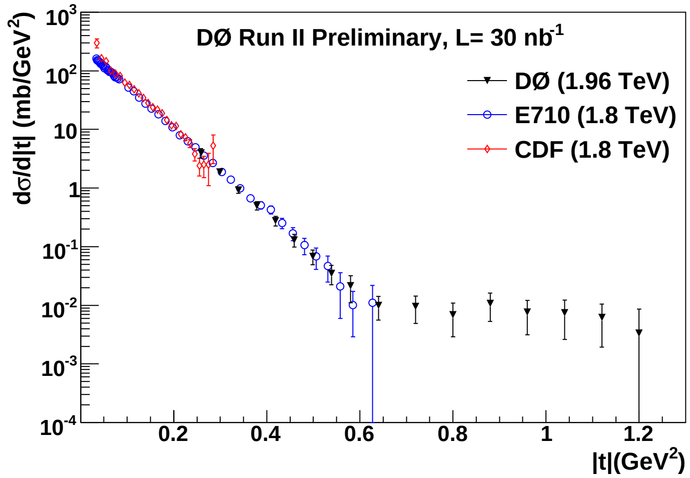

FIGURE 4. Measurement of the elastic slope by the D0 collaboration and comparison with the E710 and CDF collaboration results.

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