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CDF

Production Properties of Jets in Z Boson Events at CDF

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PRODUCTION PROPERTIES OF JETS IN Z BOSON EVENTS AT CDF

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We present a study of the production properties of hadronic jets in Z boson events from 1.8 TeV $\overline{p}p$ collisions using 106 pb^{-1} of Run 1A and 1B CDF data. We compare distributions of several kinematic variables in the data to leading-order QCD predictions generated using the VECBOS Monte Carlo program.

The production of Z bosons in high energy $\overline{p}p$ collisions provides a clean sample of events useful for testing QCD calculations of jet production properties. The presence of the heavy boson insures a high Q^2 parton-level process that is calculable using perturbative QCD. Furthermore, the leptonic decay of the Z is well-measured with very small backgrounds.

In this paper we describe an analysis using $Z \to e^+e^-$ events extracted from 106 pb^{-1} of 1.8 TeV $\overline{p}p$ collisions collected during Fermilab Tevatron Runs 1A and 1B using the CDF detector.[1] We select a sample of $Z \to e^+e^-$ events by identifying an isolated central electron in events passing a high transverse energy (E_T) electron trigger. The electron is required to pass tight quality criteria and have $E_T > 20$ GeV. A second electron, passing looser quality cuts, is required in the central, plug, or forward region with $E_T > 20$, 15, or 10 GeV, respectively. An invariant mass cut of $76 < M_{ll} < 106$ GeV/c^2 results in a final sample of 6708 Z events.[2]

Hadronic jets are selected in the Z event sample using an algorithm that clusters calorimeter tower energies in cones of $R_j = 0.4$ in $\eta - \phi$ space. The jet energies are corrected for variations in calorimeter response, out-of-cone energy, and underlying event energy within the jet cone. When the separation between two jets with $E_T > 12$ GeV is less than $\Delta\mathrm{R} = 0.52$, they are combined vectorially into a single jet. Final jets are selected with $E_T > 15$ GeV and $|\eta_d| < 2.4$, where η_d is the pseudorapidity measured from the center of the collision region. Of the 6708 Z events, 1310 have $\geq$1 jet, 279 have $\geq$2 jets, 57 have $\geq$3 jets, and 11 have $\geq$4 jets.

The dominant Z background occurs when hadronic jets fake electrons. We estimate backgrounds in the Z sample as a function of the number of jets, and find that that they are small even at high jet multiplicities. The 1σ upper limits are 1.1%, 2.3%, 3.0%, and 4.0% for $n \geq 0$, 1, 2, and 3 jet events, respectively.

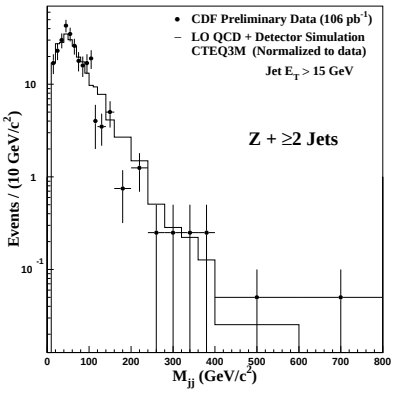

Figure 1: The invariant mass of the two highest-E_T jets in $Z + \geq 2$ jet events.

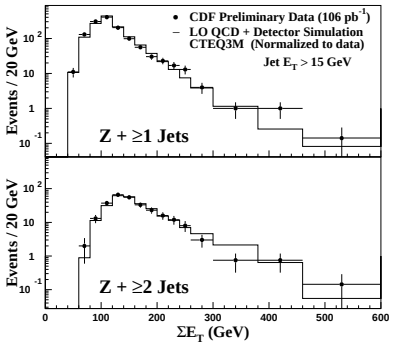

Figure 2: ΣE_T for $Z + \geq 1$ jet events and $Z + \geq 2$ jet events.

In order to compare QCD predictions to data, we employ the leading-order QCD Monte Carlo program VECBOS [3] to generate $Z + n$ parton events ($n =$ 1, 2, 3) using CTEQ3M parton density functions, two-loop α_s evolution, and $Q^2 = \langle p_T \rangle^2$. Hadronic fragmentation is applied to the parton-level events using the HERWIG [4] shower simulation algorithm, which also adds initial and final state gluon radiation. Next, the events are passed through a full CDF detector simulation that models tracking and the calorimeter response of the electrons and jets. The resulting output is subject to the same selection cuts as the data, which allows us to make direct comparisons between QCD predictions and data for a variety of kinematic quantities.

One quantity of particular interest is the invariant mass of the two highest-E_T jets for $Z + \geq 2$ jet events, shown in Figure 1 with the leading-order QCD prediction. In Figure 2 we present the ΣE_T for events with ≥ 1 jets and ≥ 2 jets, including in the sum only the transverse energies of jets and the electrons from Z boson decay. Figure 3 shows the E_T of the first, second, and third highest E_T jets in ≥ 1, ≥ 2, and ≥ 3 jet events, respectively. Distributions of the same quantities for W + jet events are given for comparison.[5] The E_T distributions are corrected for background jets from additional interactions in the same crossing and for photons that are counted as hadronic jets; each effect contributes background to the low-E_T bins at the 3–5% level. In general, we observe reasonable agreement between the Z data and leading-order QCD predictions in all of the distributions.

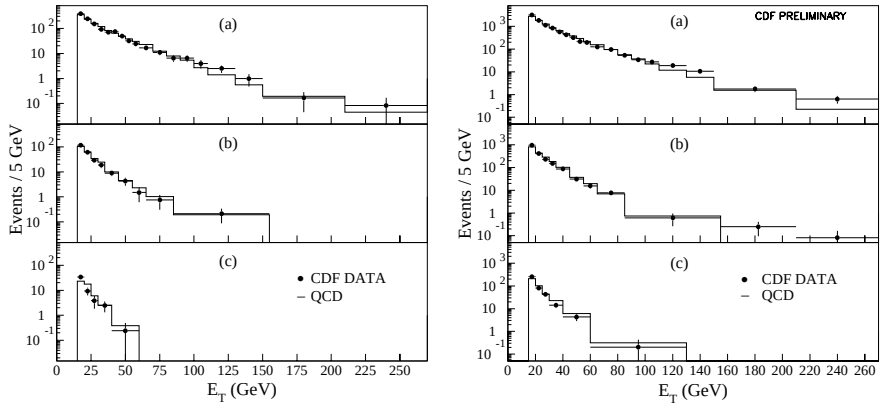

Figure 3: The E_T of the (a) first, (b) second, and (c) third highest E_T jets in events with $\geq$1, $\geq$2, and $\geq$3 jets, respectively. Z (W) boson events are shown on the left (right).

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References

1. For a detailed description of the CDF detector see F. Abe *et al.*, *Nucl. Instrum. Methods* A **271**, 387 (1988) and references therein.
2. F. Abe *et al.*, *Phys. Rev. Lett.* **77**, 448 (1996) provides a complete description of the Z + jets event selection.
3. F.A. Berends, W.T. Giele, H. Kuijf, and B. Tausk, *Nucl. Phys.* B **357**, 32 (1991).
4. G. Marchesini and B. Webber, *Nucl. Phys.* B **310**, 461 (1988), and G. Marchesini *et al.*, Comput. Phys. Commun. **67**, 465 (1992).
5. See D. Cronin-Hennessy, *Jets in W Events from 1.8 TeV $\overline{p}p$ Collisions* in these proceedings.