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High-p_T W and Z production at the Fermilab Tevatron

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In previous work, we and others have put together a full computation of $d\sigma/dq_T$ for the inclusive production of high-transverse-momentum W's and Z's to second order in QCD. Here, we present the results in graphs from which relevant cross sections may be extracted at a glance. Specifically, we plot $d\sigma/dq_T$ and $\int_{q_T} dq_T(d\sigma/dq_T)$ for the Fermilab Tevatron.

In this paper we present a quick reference for high-transverse-momentum W and Z production at the Fermilab Tevatron. We consider only inclusive production of a single W or Z. The computations are based on previous work[1,2] where we calculated the full second-order QCD result for this process. These results included qg, gg, and singlet $q\bar{q}+qq$ collisions in addition to older calculations of the nonsinglet $q\bar{q}+qq$.

In Fig. 1 we show the differential cross section $d\sigma/dq_T$ for W and Z production as a function of q_T. In Fig. 2 we show the total cross sections for making the bosons with transverse momentum larger than q_T. In both graphs, we have integrated over all rapidity and have not included any branching ratios for the subsequent decay of the W's or Z's. Both graphs were generated using the structure functions of Diemoz, Ferroni, Longo, and Martinelli.[3] The renormalization and factorization scales have been chosen equal. The bands show our estimate of the theoretical error which we determine by (1) varying the renormalization scale from q_T to M_W or M_Z and (2) varying the four-flavor value of $\Lambda_{\rm QCD}$ from 160 to 360 MeV. When $\Lambda_{\rm QCD}$ is varied, the structure functions used are varied correspondingly. The two sources of error are added, and the result is $\pm 15\%$ error from the center of the band. We have not explicitly analyzed some sources of error such as the resummation of higher-order terms for q_T around 20–30 GeV.

Our results are somewhat lower than those that might be interpolated from the work of Ref. 4. This is mostly because of (1) the use of two-loop rather than one-loop

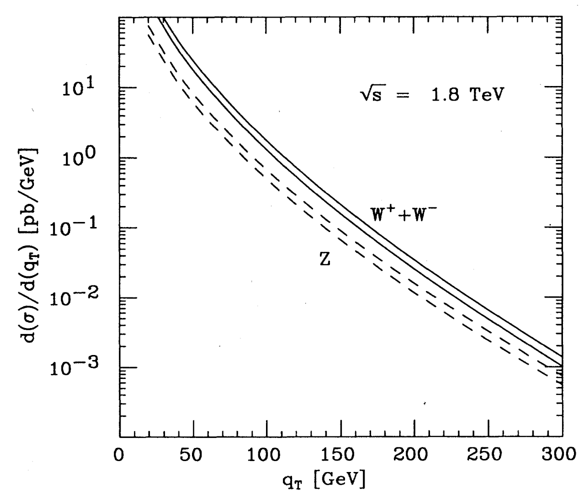

FIG. 1. The differential cross section $d\sigma/dq_T$ in pb/GeV as a function of q_T in GeV for $\sqrt{s}=1.8$ TeV. The solid band is for single-W production of either charge; the dashed band is for Z production.

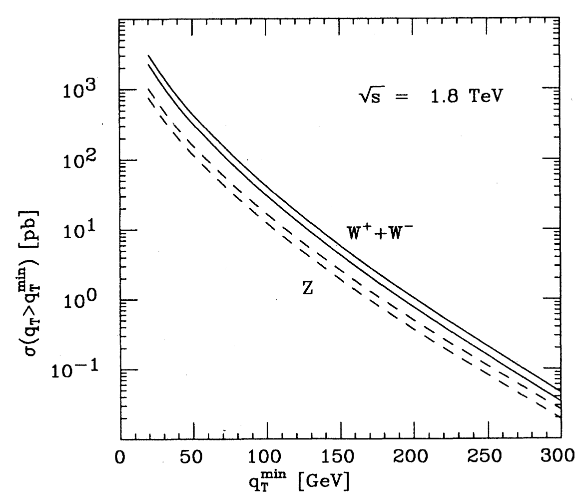

FIG. 2. The results of Fig. 1 integrated over all transverse momenta larger than q_T.

evolution of α_s, and (2) differences in structure functions.

The results presented here are intended for quick reference and span many orders of magnitude in differential cross section. So we should note that, since the second-order corrections are order 10–50 %, they are hardly noticeable in these graphs. We refer the reader to previous work[1] for a complete description of the importance of higher-order corrections.

[1]P. Arnold and H. Reno, Fermilab Reports Nos. PUB-88/168-T and PUB-88/59-T, 1988 (unpublished); Nucl. Phys. B (to be published). For an independent computation of these processes, we refer the reader to R. J. Gonsalves, J. Pawlowski, and C.-F. Wai, Report No. UB-HET-89/2 (unpublished).

[2]R. K. Ellis, G. Martinelli, and R. Petronzio, Nucl. Phys. **B211**, 106 (1983).

[3]M. Diemoz, F. Ferroni, E. Longo, and G. Martinelli, Z. Phys. C **39**, 21 (1988).

[4]G. Altarelli, R. K. Ellis, and G. Martinelli, Z. Phys. C **27**, 617 (1985).