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High-p_T W and Z Production at the Tevatron

P. ARNOLD

High Energy Physics Division
Argonne National Laboratory, Argonne, IL 60439

R.K. ELLIS

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

M.H. RENO

Departmento de Física
Centro de Investigacion y de Estudios Avanzados del I.P.N.
Apartado Postal 14-740, Mexico 07000, D.F.

ABSTRACT

In previous work, we and others have put together a full computation of $\mathrm{d}\sigma/\mathrm{d}q_T$ 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 $\mathrm{d}\sigma/\mathrm{d}q_T$ and $\int_{q_T} \mathrm{d}q_T \, (\mathrm{d}\sigma/\mathrm{d}q_T)$ for the Tevatron.

In this note, we present a quick reference for high transverse-momentum W and Z production at the 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 non-singlet $q\bar{q} + qq$.

In Fig. 1, we show the differential cross-section $\mathrm{d}\sigma/\mathrm{d}q_T$ for W and Z production as a function of q_T. In Figure 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 4-flavor value of Λ_{QCD} from 160 MeV to 360 MeV. When Λ_{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 to 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 2-loop rather than 1-loop 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 to 50 percent, 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.

REFERENCES

1. P. Arnold and H. Reno, FERMILAB-PUB-88/168-T (1988); errata, FERMILAB-PUB-89/59-T; to appear in *Nucl. Phys. B*. For an independent computation of these processes, we refer the reader to R.J. Gonsalves, J. Pawlowski and C.-F. Wai, Preprint UB-HET-89/2 (March 1989).
2. R.K. Ellis, G. Martinelli and R. Petronzio, *Nucl. Phys.* **B211** (1983), 106.
3. M. Diemoz, F. Ferroni, E. Longo, and G. Martinelli, *Z. Phys.* **C39** (1988), 21.
4. G. Altarelli, R.K. Ellis and G. Martinelli, *Z. Phys.* **C27** (1985), 617.

FIGURE CAPTIONS

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.

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

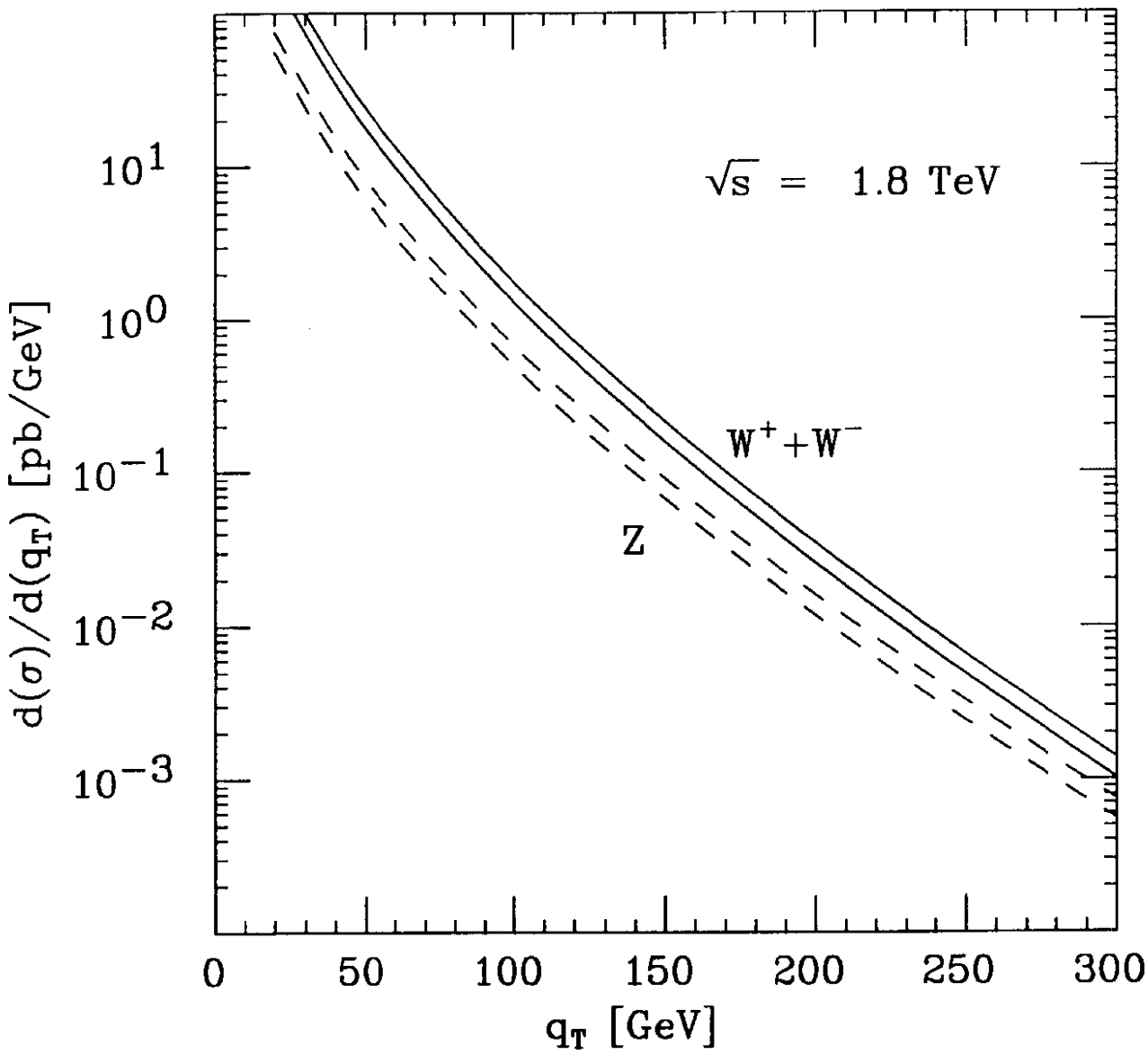
$\sqrt{s}$ = 1.8 TeV
$W^+ + W^-$
Z
$d(\sigma)/d(q_T)$ [pb/GeV]
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
0
50
100
150
200
250
300
q_T [GeV]

Figure 1.

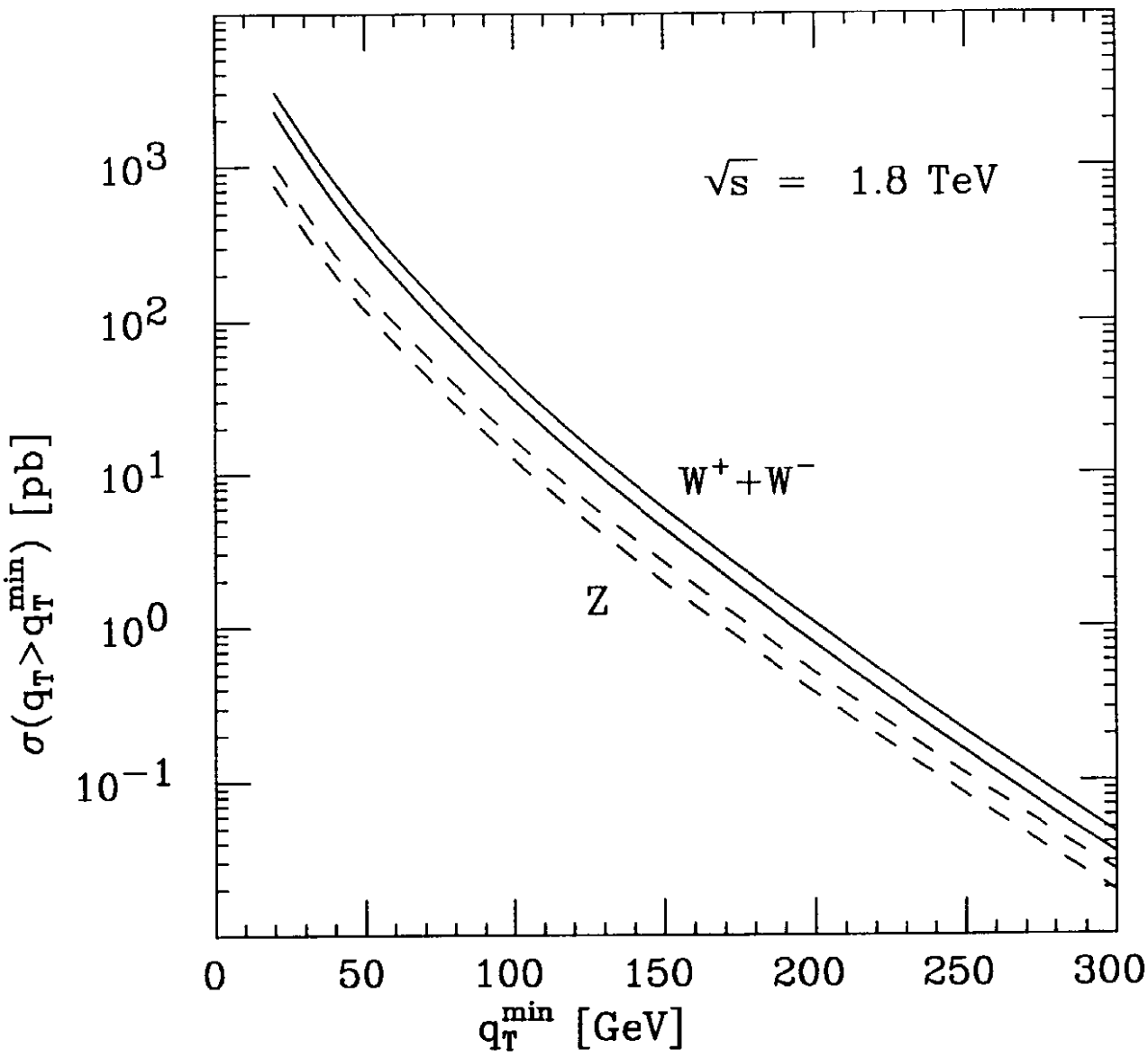
$\sqrt{s}$ = 1.8 TeV
$W^+ + W^-$
Z
$\sigma(q_T > q_T^{min})$ [pb]
10^3
10^2
10^1
10^0
10^{-1}
0
50
100
150
200
250
300
q_T^{min} [GeV]

Figure 2.