A SEARCH FOR NEUTRAL HEAVY VECTOR GAUGE BOSONS IN $\overline{p}p$ COLLISIONS AT $\sqrt{s} = 1.8$ TeV

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A search for a neutral heavy vector gauge boson, Z', was conducted in $\overline{p}p$ collisions using 110pb^{-1} of data obtained at the Collider Detector at Fermilab. We present preliminary 95% CL limits on the production of Z' in different models using its e^+e^- and $\mu^+\mu^-$ decay modes.

The Z' is a heavy neutral vector gauge boson predicted to exist in several Grand Unified Theories and extensions of the Standard Model.[1,2] The Z' couplings[3] to dileptons are described by theory, but there are no constraints on its mass.

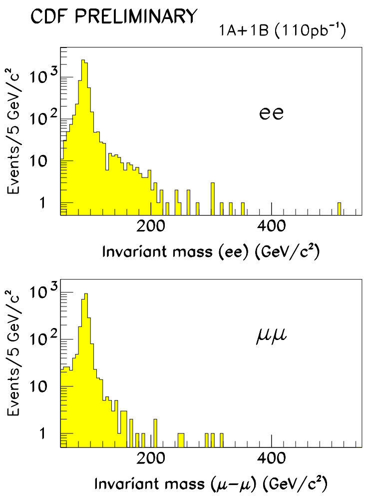

Figure 1: Distribution of dilepton events as a function of invariant mass in 110 pb^{-1} of data taken at CDF.

In this paper we describe a direct search for the Z' in its dielectron and dimuon decay modes at CDF.[4]

The calorimeters, the Central Tracking Chamber (CTC) and the Muon chambers are the principal detector components used for this search.[5] Data are collected with a multi-level trigger. The electron trigger requires a minimum E_t in the calorimeter with $\approx$ 100% efficiency. The muon trigger requires a match between a Central Muon Chamber stub and a high P_t track in the CTC with $\approx$ 90% efficiency.

Candidate events are selected by requiring one "tight" and one "loose" lepton. Dielectron events are required to have one isolated central electron with $E_t > 25$ GeV/c^2 , and $P_t > 13$ GeV/c. The second electron could be detected in the Central or in the Plug region of the detector. Muons are required to be minimum ionizing with $P_t > 20$ GeV/c. One muon is required to be isolated and detected in the Central Muon detector.

We find 7120 dielectron events and 2562 dimuon events. The distribution of these events as a function of invariant mass is shown in Figure 1. The highest mass e^+e^- and $\mu^+\mu^-$ events have invariant masses of 511 GeV/c^2 and 320 GeV/c^2 respectively.

Efficiencies of the lepton identification cuts are determined from a sample of dileptons from Z decays. The geometric and kinematic acceptance were determined from a Monte-Carlo sample of Z and Z' events generated at different masses. The overall acceptance times efficiency rises to a value of 48% for dielectrons and 20% for dimuons at very high Z' invariant mass.

Mass (GeV)	ee DY + QCD pred/data	$\mu\mu$ DY pred/data
> 150	68.0/70	16.5/17
> 200	21.7/19	6.2/7
> 250	8.1/9	2.8/4
> 300	3.3/6	1.4/2
> 350	1.4/2	0.7/0
> 400	0.7/1	0.4/0
> 450	0.3/1	0.2/0
> 500	0.2/1	0.1/0
> 550	0.1/0	0.0/0
> 600	0.0/0	0.0/0

Table 1: Predicted number of events from Drell-Yan and other backgrounds compared with the data.

When the data is compared with the Standard Model expectation and backgrounds, we find no significant excess (see Table 1). Systematic errors arising from the choice of structure functions and P_t distributions are less than 3%.

The dielectron and dimuon data are combined by assuming that lepton universality holds for Z' decays. Z' mass limits are obtained by comparing the observed data to a superposition of the Standard Model prediction and the expected distribution from Z' decays using the method of binned likelihood.

Fig 2(a) shows the 95% Confidence limit on the cross-section $\times$ branching ratio for a Z' decaying to dileptons, as a function of the Z' mass. For a Z' with Standard Model couplings, this translates into a limit of $M_{Z'} > 690$ GeV/c^2 at the 95% C.L. or a limiting cross-section of 42 fb for $M_{Z'} > 650$ GeV/c^2. We have also set limits for other interesting theoretical models [2](see figure 2(b)).

Acknowledgments

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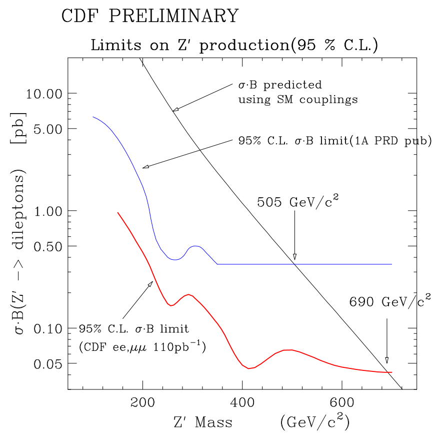
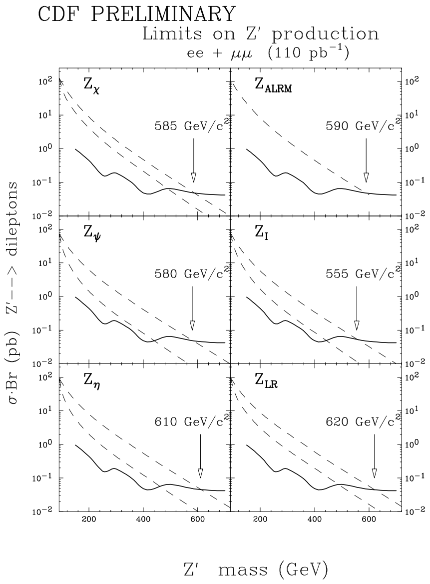


(a) Limits on Z' production as a function of the Z' mass for a standard model Z'



(b) Limits on Z' production as a function of Z' mass for several models

References

1. G. G. Ross, *Grand Unified Theories*, (Cambridge University Press, Cambridge, England, 1987), and references therein.
2. F. del Aguila, M. Quiros and F. Zwirner, *Nucl. Phys.* B **287**, 457 (1987),F. Feruglio,L. Maiani and A. Masiero, *Phys. Lett.* B **233**, 512 (1989)
3. H. Georgi and S. L. Glashow, in Harvard University Preprint **HUTP-96/A024**, (1996) and J. L. Rosner in CERN Preprint **CERN-TH/96-169**, (1996) discuss a Z' that does not couple to Standard Model leptons. No limits can be set on such a Z' from this analysis.
4. The previous direct search at CDF in the dielectron decay mode using 20 pb^{-1} of data is described in F. Abe *et al*,*Phys. Rev.* D **51**, R949 (1995)
5. For a detailed description of the CDF detector see F. Abe *et al*,*Nucl. Instrum. Methods* A **271**, 387 (1988) and references therein.