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Search for New Particles Decaying into $b\bar{b}$ Associated with $W^{\pm}$ Bosons at Tevatron

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We present searches for new particles decaying into $b\bar{b}$ and produced in association with $W^{\pm}$ bosons in $p\bar{p}$ collisions at $\sqrt{s} = 1.96$ TeV. The searches focus on the Standard Model Higgs boson or Technicolor particle decaying into $b\bar{b}$ using approximately 162 pb^{-1} of the dataset accumulated by the Collider Detector at Fermilab. The number of events and mass distribution are consistent with the Standard Model expectations and we set a 95% confidence level upper limit on the production cross section times branching ratio as a function of the new particle mass.

Keywords: Higgs; Technicolor; CDF II.

1. INTRODUCTION

This note summarizes searches for new particles decaying into $b\bar{b}$ and produced in association with $W^{\pm}$ bosons in $p\bar{p}$ collisions at $\sqrt{s} = 1.96$ TeV. The search signature considered here is $W^{\pm}X$ with $W \to e\nu$ or $\mu\nu$, and $X \to b\bar{b}$, giving final states with one high p_T lepton, large missing E_T ($\not\!\!E_T$), and two b jets. In this note we assume that X is either the Standard Model Higgs boson ($p\bar{p} \to W^{\pm}H \to \ell\nu b\bar{b}$) [1] or a new particle responsible for the dynamics of a new interaction such as Technicolor ($p\bar{p} \to \rho_T^{\pm} \to W^{\pm}\pi_T^0 \to \ell\nu b\bar{b}$) [2]. The CDF detector [3] and this analysis [4] are described in detail elsewhere.

2. RESULTS FOR THE STANDARD MODEL HIGGS SEARCH

We perform a direct search for a resonant mass peak in the reconstructed dijet invariant mass distribution. Figure 1 shows the dijet mass distribution. Since there is no mass peak as expected from the Higgs boson, we set an upper limit on the production cross section times branching ratio of $p\bar{p} \to W^{\pm}H$ as a function of the Higgs boson mass by using the number of events in $W^{\pm} + 2$ jets sample. Figure 2 shows the 95% C.L. upper limit as a function of the Higgs boson mass. The cross section of the Standard Model Higgs boson and the Technicolor process ($p\bar{p} \to$

$W^{\pm}\pi_T^0$) is also used in the comparison. Although we have a much improved limit over the Run 1 [5], the sensitivity of the present search is limited by statistics to a cross section approximately one order of magnitude higher than the predicted cross section for the Standard Model Higgs boson prediction.

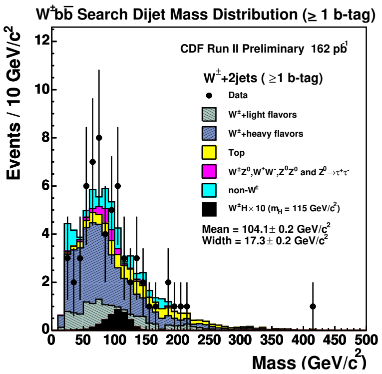

Fig. 1. The dijet mass distribution in the data along with the background expectations and the Higgs boson mass distributions scaled by a factor of 10. The Higgs boson mass is assumed to be 115 GeV/c^2.

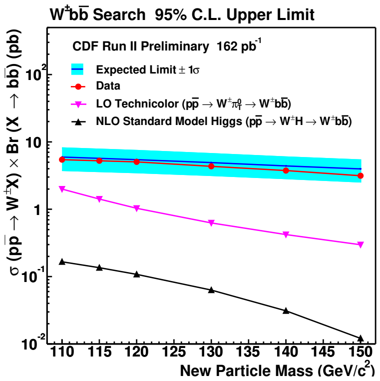

Fig. 2. The 95% C.L. upper limit on the $W^{\pm}H$ cross section as a function of the new particle mass.

3. RESULTS FOR TECHNICOLOR PARTICLE SEARCH

We perform a direct search for a mass peak in the reconstructed $W^{\pm}+2$ jets and dijet invariant mass distributions. To reconstruct the $W^{\pm}+2$ jets mass, we need to determine the neutrino p_z from $W^{\pm}$ boson. We use the $W^{\pm}$ mass constraint in the lepton-neutrino system and take the smaller p_z from the two solutions. If there is no solution, we take the real part of the solution of the quadratic equation. Figure 3 shows the $W^{\pm}+2$ jets and dijet mass distributions. Since there are no mass peaks observed from $\rho_T^{\pm}$ and π_T^0, we set an upper limit on the production cross section times branching ratio of $p\bar{p} \to \rho_T^{\pm} \to W^{\pm}\pi_T^0$ as a function of the Technirho and Technipion masses by using the number of events in the $W^{\pm}+2$ jets sample. Figure 4 shows the 95% C.L. upper limit. The sensitivity of the present search is still limited by statistics, but is getting close to some of theoretical cross sections.

4. Conclusion

We have performed a search for new particles decaying into $b\bar{b}$ and produced in association with a $W^{\pm}$ boson at the Run 2 dataset. The $W^{\pm}+2$ jets and dijet mass spectrum shows no significant excess of events in the b tagged $W^{\pm}+2$ jets events. We set a 95% C.L. upper limit on the production cross section times branching ratios as

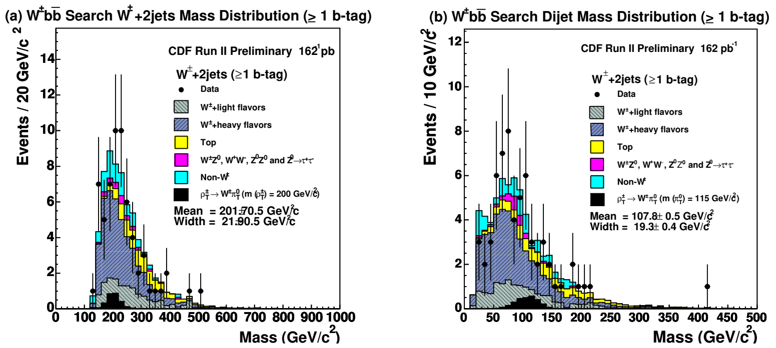

Fig. 3. The $W^{\pm} + 2$ jets and dijet mass distributions in the data along with the background expectations. (a)$W^{\pm} + 2$ jets mass distribution, (b)dijet mass distribution

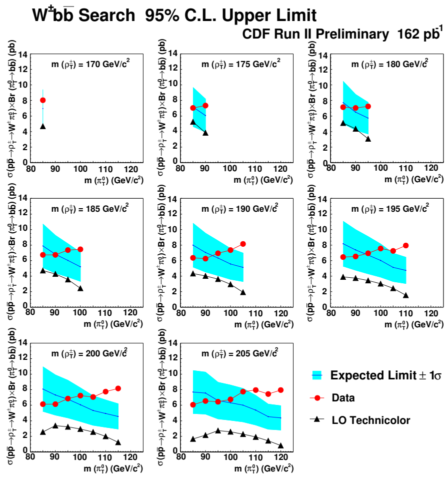

Fig. 4. The 95% C.L. upper limit (circle) on the $\rho_T^{\pm} \to W^{\pm}\pi_T^0$ cross section as a function of $\rho_T^{\pm}$ mass.

a function of a new particle mass. The sensitivity of the present search is limited by statistics to a cross section approximately close to some of theoretical cross sections for Technicolor particle production. We should be able to either discovering these new Technicolor particles or excluding them in the near future.

References

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