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Searches for Technicolor Particles at DØ

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We present preliminary results of searches for technirho (ρ_T) and techniomega (ω_T) particles, using the decay channels $\rho_T, \omega_T \to e^+e^-$ and $\rho_T \to W(\to e\nu)+\pi_T(\to e\nu+b\bar{Q})$, where $\overline{Q} = \bar{b}, \bar{c}$-quark. These searches are based respectively on 200 pb^{-1} and 238 pb^{-1} of data collected in Run II of the Fermilab Tevatron. We select events with $b-$quark jets by identifying secondary vertices in the jets. We interpret our findings in terms of limits on the production of particles predicted by extended technicolor models. For the $W\pi_T$ analysis, in the absence of an excess over standard model background, we compute a 95% C.L. upper limit on the techniparticle production cross section for the mass combination $m(\rho_T) = 200$ GeV and $m(\pi_T) = 105$ GeV of 6.4 pb. In the e^+e^- channel, for certain model parameters, we exclude the existence of degenerate ρ_T and ω_T states with masses below 367 GeV; the most restrictive constraints on dilepton technicolor decays to date.

Keywords: Technicolor; DØ;

1. Introduction

Recent topcolor-assisted technicolor models with walking gauge coupling require many technihadron states. These models predict the existence of scalar mesons, the technipions ($\pi_T^{\pm}$ and π_T^0), and vector mesons (ρ_T and ω_T). These technihadron states are expected to be produced with substantial rates at the Tevatron [1]. The vector mesons decay to $\gamma\pi_T$, $W\pi_T$, $Z\pi_T$, or $f\bar{f}$.

The values of $\sigma(\rho_T, \omega_T) \times Br(\rho_T, \omega_T)$ depend on the following factors:

- masses of ρ_T (M_{ρ_T}) and ω_T (M_{ω_T})
- charges of the technifermions
- mass difference between the vector mesons (ρ_T, ω_T) and the technipions which determines the spectrum of accessible decay channels,
- mass parameters: M_A for axial-vector and M_V for vector couplings. [a]

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[a]The mass parameter M_V controls the rate for $\omega_T \to \gamma + \pi_T^0$. and is unknown *a priori*. Scaling from the decay $\omega \to \gamma + \pi^0$ the authors[2] suggest a value of several 100 GeV. We set $M_A = M_V$. For all other parameters, we use the default values quoted in Table 2 of Ref. 2.

2. $W\pi_T$ Searches

To select the event sample for the $W(\to e\nu)\pi_T$ search, we first identify events which have an electron with high transverse momentum (p_T). accompanied by substantial missing E_T, indicative of a W boson in the final state. Only those events which have at least 2 jets with p_T above 20 GeV are kept.

At this stage of the event selection, the dominant source of background is the production of a W boson accompanied by several light-quark and gluon jets. Events with π_T in the final state contain two b-jets (neutral π_T) or a b and c-jet (charged π_T). We can then enhance the signal events in the sample by requiring that at least one of the jets in the event is identified as originating from a b-quark (b-tagging). We utilize the secondary vertex algorithm to identify b-quark jets.

Even after requiring one b-tagged jet the technipion signal is still superseded by backgrounds from W+heavy flavor, mistags, $t\bar{t}$ and single top backgrounds.

In order to optimize the $W\pi_T$ signal over background, we study several topological variables:

- $\Delta\phi(jj)$: the difference in azimuth (ϕ) between the two jets,
- $p_T(jj)$: the transverse momentum of the dijet system,
- H_T^e: the scalar sum of p_T of the electron and the jets in the event.

We expect these particles to be seen as resonances in the distributions of the dijet invariant mass, $M(jj)$, and of the W-dijet invariant mass, $M(Wjj)$. For the final event selection, we impose a mass window cut in both of these quantities as shown in Fig. 1 . We find that for the combination, $m(\rho_T) = 200$ GeV and $m(\pi_T) = 105$ GeV the 95% C.L. upper limit on the cross section for the process $\rho_T \to W + \pi_T$ is 6.4 pb.

3. $\rho_T, \omega_T \to e^+e^-$ Searches

We require two EM objects in the event, with the transverse momenta above 25 GeV, which pass calorimeter energy isolation, EM energy fraction, and calorimeter shower shape cuts. At least one of the EM objects is required to have a matching track in the tracking detectors. Primary vertex in the event is defined via this track. We reject events that have more than two high-p_T EM objects.

The QCD background is estimated via the method of Ref. 3. The Drell-Yan background is simulated with the parton-level Monte Carlo generator of Ref. 4.

In order to set the limits on the $\rho_T, \omega_T \to e^+e^-$ cross section, we perform counting experiments in dielectron mass windows.

The results are shown in Fig. 1. We find that we can rule out ρ_T and ω_T with masses below 367 GeV (355 GeV), if the mass difference between ρ_T and $\pi_T^{\pm}$ is smaller (larger) than the W mass, for the mass parameter M_v set at 500 GeV. Figure 1 also shows the cross-sections predicted for various values of technicolor model parameter M_V and the mass difference $M(\rho_T) - M(\pi_T)$.

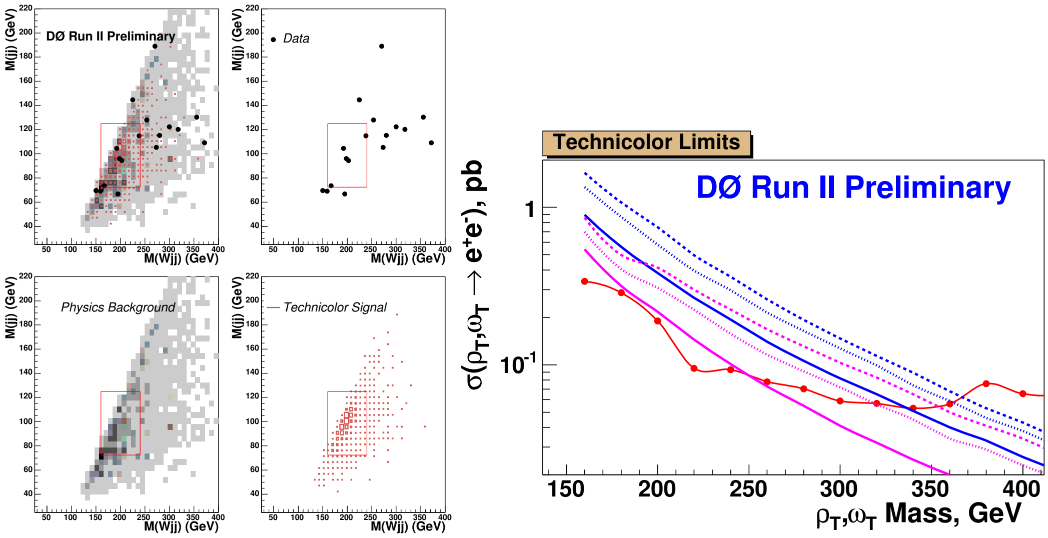

Fig. 1. Left: The invariant mass of W+dijet (ρ_T) vs the dijet invariant mass (π_T) in events with e+ν+2 jets (with one $b-$tagged jet) for the background (bottom left), the expected signal (bottom right) and the data sample (top right). The top left plot shows the overlay of the other three plots. Cuts on H_T^e, $\Delta\phi(jj)$, $p_T(jj)$ have been applied. Right: The thick solid (red) curve with points represents the 95% CL upper bounds on the ρ_T, ω_T production cross section times its branching fraction into ee. The set of blue curves show the prediction for a mass difference $M(\rho_T) - M(\pi_T)$ = 60 GeV (the set of magenta curves are for $M(\rho_T) - M(\pi_T)$ = 100 GeV). The three curves for each set corresponds to values of M_V=500 GeV (uppermost), 200 GeV (middle) and 100 GeV (lowermost) respectively.

References

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