SEARCH FOR NARROW WIDTH $t\bar{t}$ RESONANCES IN $p\bar{p}$ COLLISIONS AT $\sqrt{s} = 1.8$ TEV.

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We present a preliminary result on a search for narrow width resonances that decay into $t\bar{t}$ pairs using 130 pb$^{-1}$ of lepton plus jets data in $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV. No significant deviation from Standard Model prediction is observed. 95% C.L. upper limits on the production cross section of the narrow width resonance times its branching fraction to $t\bar{t}$ are presented for different resonance masses $M_X$.

We also exclude the existence of a leptophobic topcolor particle, $X$, with $M_X < 560$ GeV/c$^2$ for a width $\Gamma_X = 0.012M_X$.

Particles with narrow width that decay to $t\bar{t}$ pairs are predicted by several non Standard Model theories $^{1,2}$. For instance, in one of the scenarios of the topcolor-assisted technicolor model in Ref. $^2$, a heavy $Z'$ is predicted, that couples preferentially to the third quark generation.

At present, direct searches for these heavy particles or resonances are possible only at the Tevatron, the 1.8 TeV $p\bar{p}$ collider located at the Fermi National Accelerator Laboratory. Experiments seek an excess, beyond that predicted by the Standard Model (SM), in the distribution of the invariant mass of the $t\bar{t}$ decay products. Previous searches $^3$ from the Tevatron have limited a leptophobic $Z'$ to a mass higher than 480 GeV/c$^2$. In this paper we present a preliminary result based on a direct search for $t\bar{t}$ narrow width, heavy resonances in the inclusive decay modes $t\bar{t} \rightarrow \ell \nu + 4$ (or more) jets, where $\ell = e$ or $\mu$, using 130 pb$^{-1}$ of data recorded from 1992 to 1996 by the DØ experiment at the Tevatron.

We consider two orthogonal classes of events for this analysis, whose selection is based on: a) a purely topological selection of lepton+jets events which we denote as $e + jets$ and $\mu + jets$, and b) a selection based primarily on the presence of a non-isolated, soft muon ($\mu$ tag) from $b$ and $c$
quark semileptonic decays, with additional selections on the topology of the event. These events are denoted as $e + jets/\mu$ and $\mu + jets/\mu$. The principal sources of background are due to SM $t\bar{t}$ production, production of $W(\rightarrow l\nu)$ + $\geq 4$ jets, and production of multijets ($N_j \sim 5$), in which one of the jets is misidentified as a lepton, and instrumental effects simulate sufficient $E_T$ satisfying the neutrino requirement. The selection criteria used to reduce the contribution from non-$t\bar{t}$ sources are summarized in Table 1.

Table 1. Summary of event selections.

|                  | $e$+jets | $\mu$+jets | $e$+jets/$\mu$ | $\mu$+jets/$\mu$ |
|------------------|----------|------------|----------------|-----------------|
| **Lepton**       | $E_T > 20$ GeV, $|\eta| < 2$ | $p_T > 20$ GeV/c, $|\eta| < 1.7$ | $E_T > 20$ GeV, $|\eta| < 2$ | $p_T > 20$ GeV/c, $|\eta| < 1.7$ |
| $E_T$            | $E_T > 20$ GeV | $E_T > 20$ GeV | $E_T > 20$ GeV | $E_T > 20$ GeV |
| **Jets**         | $\geq 4$ jets, $|\eta| < 2$ | $\geq 4$ jets, $|\eta| < 2$ | $\geq 4$ jets, $|\eta| < 2$ | $\geq 4$ jets, $|\eta| < 2$ |
| $E_T$            | $E_T > 15$ GeV | $E_T > 15$ GeV | $E_T > 15$ GeV | $E_T > 15$ GeV |
| **$\mu$ tag**    | No       | No         | Yes            | Yes             |
| **Other**        | $E_T^{W}>60$ GeV, $|\eta^{W}|<2$ | $E_T^{W}>60$ GeV, $|\eta^{W}|<2$ | $E_T >35$ GeV, if $\Delta\phi(E_T,\mu) < 170^{\circ}$, if $|\Delta\phi(E_T,\mu)-90^{\circ}| < \frac{E_T}{300}$ GeV | $E_T >35$ GeV, if $\Delta\phi(E_T,\mu) < 170^{\circ}$, if $|\Delta\phi(E_T,\mu)-90^{\circ}| < \frac{E_T}{300}$ GeV |
| **Events selected** | 42       | 41         | 4              | 3               |

We consider the resonance signal ($X \rightarrow t\bar{t}$) at nine different masses $M_X$ between 400-1000 GeV/c$^2$, with a natural width $\Gamma_X = 0.012M_X$. We perform a three constraint kinematic fit to the $t\bar{t} \rightarrow l +$ jets, decay hypothesis $^4$, and apply a cut of $\chi^2<10$ to further reduce non-$t\bar{t}$ background, whereupon 41 events are left in the data sample of which 4 are $\mu$-tagged.

We then use Bayesian statistics $^5$ to fit the data $m_{t\bar{t}}$ distribution to a three-source model comprising signal ($X \rightarrow t\bar{t}$) and the SM backgrounds $^4$. No significant deviation is seen in the data $m_{t\bar{t}}$ distribution from SM expectations for any of the resonance masses considered.

To conclude, after investigating 130 pb$^{-1}$ of data, we find no statistically significant evidence for $t\bar{t}$ resonance, and so establish upper limits on $\sigma_X B(X \rightarrow t\bar{t})$ at 95% confidence for $M_X$ between 400 and 1000 GeV/c$^2$. These limits, as shown in Fig. 1, are used to constrain a model of topcolor assisted technicolor and exclude at 95% confidence level, the existence of a
leptophobic $Z'$ with mass $M_X < 560$ GeV/$c^2$ for a width $\Gamma_X = 0.012 M_X$.

![Graph showing upper limits on $\sigma X B$ as a function of resonance mass $M_X$. The graph includes predicted topcolor assisted technicolor cross sections for a width $\Gamma_X = 1.2\% M_X$.]

Figure 1. The DØ Run I 95% confidence level upper limits on $\sigma X B$ as a function of resonance mass $M_X$. Included for reference are the predicted topcolor assisted technicolor cross sections for a width $\Gamma_X = 1.2\% M_X$.

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