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Search for Scalar Top

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Abstract

We report results of a search for direct production of scalar top quark decaying to charm + LSP. The observed number of events is consistent with expectations from Standard Model processes. Assuming BR=100% we set a 95% CL in the $m_{\tilde{t}}$–$m_{\tilde{\chi}_1^0}$ parameter space.

Supersymmetry (SUSY) assigns to every fermionic SM particle a bosonic superpartner and vice versa. Therefore, the SM quark helicity states q_L and q_R acquire scalar SUSY partners $\tilde{q_L}$ and $\tilde{q_R}$ which are also the mass eigenstates for the first two generations to a good approximation. However, a large mixing can occur in the third generation leading to a large splitting between the mass eigenstates [1]. This can lead to a stop quark which is not only the lightest squark but also lighter than the top quark.

At the Tevatron, stop is produced in pairs via gg and $q\overline{q}$ fusion diagrams. The cross section depends only on stop quark mass at leading order [2]. The dominant next-to-leading order SUSY corrections depend on the other squark masses and are small ($\sim$ 1%). For $m_{\tilde{t}}$= 115 GeV/c^2, $\sigma(\tilde{t}\bar{\tilde{t}})$ = 6.8 pb in the next-to-leading order.

Whenever kinematically allowed, $\tilde{t} \longrightarrow b\tilde{\chi}_1^+$. If this channel is closed but sneutrino ($\tilde{\nu}$) is light, then $\tilde{t} \longrightarrow bl\tilde{\nu}$ dominates. If neither of these channels is allowed, then stop decays via a one-loop diagram to charm+neutralino: $\tilde{t} \longrightarrow c\tilde{\chi}_1^0$, which is the mode considered for this search. We assume that $\tilde{\chi}_1^0$ is the lightest SUSY particle and that R-parity is conserved. Hence the $\tilde{\chi}_1^0$ is undetected and causes an imbalance of energy. In this scenario, the signature of $\tilde{t}\bar{\tilde{t}}$ is 2 acolinear charm jets, significant missing transverse energy ($\not\!\!E_T$), and no lepton(s) in the final state.

We have searched data corresponding to a total integrated luminosity of 88±6 pb^{-1} collected using the CDF detector during the 1993-95 Tevatron run.

Sample	N_{exp}
$W^{\pm}(\rightarrow \mu^{\pm}\nu_{\mu})+ \geq 2$ jets	1.5 ± 0.8
$W^{\pm}(\rightarrow \tau^{\pm}\nu_{\tau})+ \geq 1$ jet	6.9 ± 2.6
$Z^{0}(\rightarrow \nu\overline{\nu})+ \geq 2$ jets	1.3 ± 0.6
$t\overline{t}$	0.7 ± 0.4
total W/Z/Top bkg	10.5 ± 3.6
QCD	3 ± 2.5
total backgroung	13.4 ± 4.3
Data	11

Table 1: The number of data and expected background events after final cuts.

CDF is a general purpose detector consisting of tracking, vertexing, calorimeter components and a muon system. Events from this analysis were collected using a trigger which required $\not\!\!E_T > 35$ GeV.

We select events with 2 or 3 jets which have $E_T \geq 15$ GeV and $|\eta| \leq 2$. The $\not\!\!E_T$ cut is increased beyond trigger threshold to 40 GeV and we require that $\not\!\!E_T$ is neither parallel nor antiparallel to any of the jets in the event to reduce the contribution from the processes where missing energy comes from jet energy mismeasurement: $min\ \Delta\phi(\not\!\!E_T, j) > 45°$, $\Delta\phi(\not\!\!E_T, j_1) < 165°$, and $45° < \Delta\phi(j_1, j_2) < 165°$. The jet indices are ordered by decreasing E_T. We reject events with an identified electron or muon.

To select events with a charm jet, we determine the probability that the ensemble of tracks within a jet is consistent with coming from the primary vertex. We require that at least one jet has a probability of less than 5%.

The dominant source of background for this analysis is W/Z+jets production where the vector boson decays to a lepton (e/μ) that is not identified or to a τ lepton which decays hardonically. There is also a small contribution from QCD multijet production.

We observe 11 events which is consistent with 13.4±4.3 events from Standard Model processes (see Table 1). We interpet this as an excluded region in the $m_{\tilde{t}} - m_{\tilde{\chi}_1^0}$ parameter space as shown in figure 1. The maximum $m_{\tilde{t}}$ excluded is 122 GeV/c^2 for $m_{\tilde{\chi}_1^0} = 37$ GeV/c^2.

References

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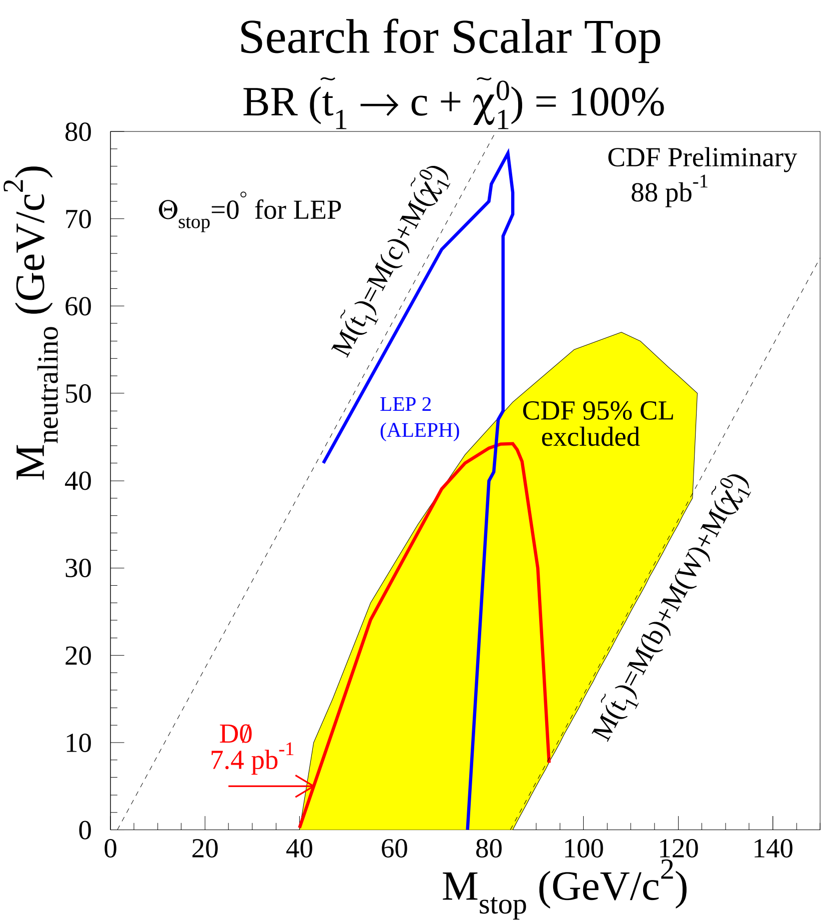

Figure 1: 95% CL limit for $\tilde{t} \longrightarrow c\tilde{\chi}_1^0$. Also shown are results from D0 [3] and from ALEPH [4]