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SUPERSYMMETRY SEARCHES AT THE TEVATRON

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Abstract

We review some of the latest results on Supersymmetry searches at the Fermilab tevatron Collider.

1 Overview

The final states for supersymmetric processes are preferably described in terms of the physical signatures produced by the particles involved. Accordingly we look at: missing transverse energy, $\not\!\!E_T$, related to the presence of neutral and stable supersymmetric particles; jets, from the decay of squarks or gluinos; leptons, coming for instance from gaugino decays; photons, predicted in gauge-mediated models.

We discuss here some of the most recent results on SUSY searches performed at the Fermilab Tevatron by the CDF and D0 collaborations. The CDF and D0 detectors[1, 2] collected, during the 1992-96 period (Run I), about 100 pb^{-1} of $p\bar{p}$ collisions. The most relevant upgrades for the current run (Run II, started in March 2001) refer mainly to the tracking and trigger system, with minor improvements to the calorimetry and muon systems.

2 Signature based searches

2.1 Trilepton events for gaugino search

In mSUGRA gauginos ($\tilde{\chi}$'s) are usually lighter than squarks ($\tilde{q}$) or gluinos ($\tilde{g}$) and might be, therefore, the only SUSY particles accessi-

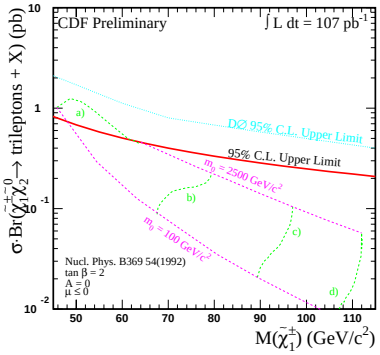

Figure 1: Chargino-neutralino production: $\sigma \cdot BR$ limit vs chargino mass.

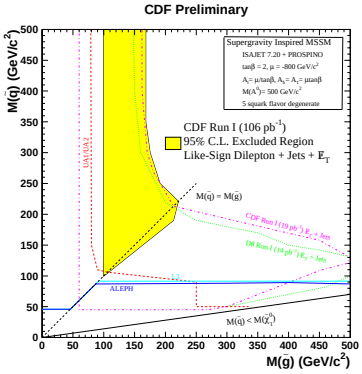

Figure 2: Exclusion region in the $\tilde{q} - \tilde{g}$ mass plane.

ble at the Tevatron. The search is based on the trilepton signature: $p\bar{p} \to \tilde{\chi}_1^{\pm}\tilde{\chi}_2^0$, $\tilde{\chi}_2^0 \to \ell\ell\tilde{\chi}_1^0$, $\tilde{\chi}_1^{\pm} \to \ell\nu\tilde{\chi}_1^0$. The main backgrounds come from $\gamma^*, Z, \Upsilon, J/\psi \to \ell\ell$ plus fake leptons, WW, WZ, ZZ events with leptonic decays, and semileptonic decays of b/c pairs with additional fake leptons. CDF[3] and D0[4] searches are based on eee, $ee\mu$, $e\mu\mu$, $\mu\mu\mu$ events requiring $P_T > 5 - 11$ GeV/c for the leptons, $\not\!\!E_T > 10 - 15$ GeV, with additional topological cuts. CDF expects 1.2 ± 0.2 events and sees none. D0 expects 1.3 ± 0.4 events and sees none. Fig. 1 shows the limits on production cross section times branching ratio, versus the chargino mass.

2.2 Dilepton + jets events for squark/gluino search

CDF searches[5] for $\tilde{q}/\tilde{g}$ in event with 2 like-sign isolated leptons (e or μ) with $P_T > 5 - 11$ GeV/c, 2 jets ($E_T > 15$ GeV) and $\not\!\!E_T \geq 25$ GeV. The observation of 0 candidates matches the expectation of $0.55 \pm 0.25 \pm 0.08$ events. Exclusion regions on the $\tilde{q}/\tilde{g}$ mass plane are derived (Fig.2).

D0 performs a similar search[6] finding no events beyond expectations.

2.3 Multijet + $\not\!\!E_T$ events for squark/gluino search

A new search[7] from CDF for $\tilde{q}/\tilde{g}$ production looks for an excess of events with ≥ 3 jets ($E_T > 15$ GeV) and large missing energy ($\not\!\!E_T \geq 30$ GeV). Jets are an indication of $\tilde{q}/\tilde{g}$ decay into quarks while $\not\!\!E_T$ would originate from the two LSP's. Standard model backgrounds are from diboson production, $t\bar{t}$ production and mismeasured jets. The signal

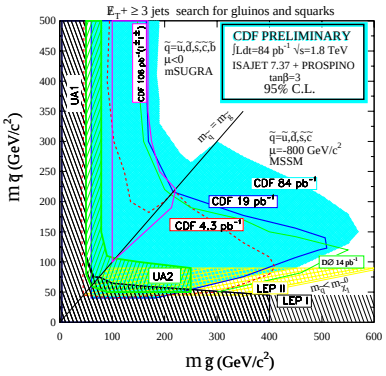

Figure 3: Exclusion region in the $\tilde{q} - \tilde{g}$ mass plane.

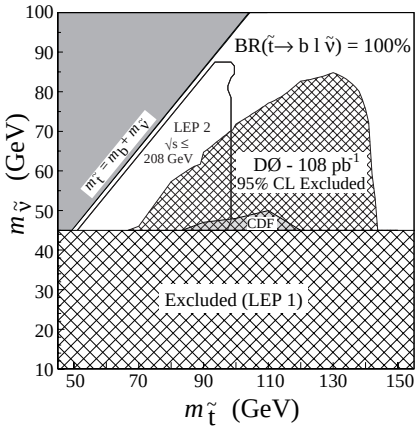

Figure 4: Exclusion region in the $\tilde{\nu}$ vs $\tilde{t}$ mass plane.

sample is defined by $\not\!\!E_T \geq 70$ GeV, $H_T = E_{T(2^{nd}jet)} + E_{T(3^{rd}jet)} + \not\!\!E_T \geq 150$ GeV and the isolated track multiplicity $N_{trk}^{iso} = 0$, while 8 control samples are defined from the negation of the three requirements. Events observed and expected agree in all the 8 control samples, while in the signal sample ("blind box") 74 events are observed with respect to 76 ± 13 expected from SM sources. The exclusion region in the $m_{\tilde{q}} - m_{\tilde{g}}$ plane is shown in Fig.3.

2.4 $e\mu + \not\!\!E_T$ events for scalar top search

The direct $\tilde{t}\bar{\tilde{t}}$ production and the successive decays $\tilde{t} \to b\ell\nu\tilde{\chi}_1^0$ or $\tilde{t} \to b\ell\tilde{\nu}$ lead to final state with two b's, two leptons, and missing energy from the $\tilde{\nu}$ or $\tilde{\chi}_1^0$. D0 has searched[8] the production of light stop in events with 1 e ($E_T > 15$ GeV), 1 μ ($P_T > 15$ GeV/c) and $\not\!\!E_T \geq 20$ GeV. The number of events observed is 10 while the expected SM background amounts to 13.7 ± 1.5 events. The corresponding exclusion region in the $m_{\tilde{\nu}} - m_{\tilde{t}}$ plane is shown in Fig.4.

2.5 Diphoton events

Events enriched in photons arise naturally in models with gauge-mediated or global supersymmetry breaking. D0 for instance has studied[9] the process $p\bar{p} \to \tilde{\chi}_i^{\pm}\tilde{\chi}_i^0 \to X(\gamma\tilde{G})(\gamma\tilde{G})$ with light gravitinos: events are in agreement with standard model prediction. CDF has studied[10] instead the production of massive sgoldstinos and their decay into $\gamma\gamma$, defining limits on the breaking scale, $\sqrt{F}$, as a function of the sgoldstino mass.

3 Conclusions and prospects

We have presented here only a few results out of a vaste collection of CDF/D0 analyses involving SUSY processes. These results, obtained within specific models of SUSY-breaking and under certain assumptions on the corresponding parameters, lead to limits on masses or cross sections. These limits will be improved during the current run: with 2 fb^{-1} we expect a reach as high as 400 GeV/c^2 for $\tilde{q}$ and $\tilde{g}$, and of about 200 GeV/c^2 for $\tilde{t}$ or $\tilde{\chi}$, approximately doubling the current experimental limits.

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