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SUSY Searches at the Tevatron

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Current results of searches for Supersymmetry from the CDF and DØ collaborations are summarized. Analyses include searches in jets and missing E_t, leptons and missing E_t, and searches for charged and neutral Higgs particles. The CDF $ee\gamma\gamma \not{E}_t$ event and related analyses are presented.

1. Introduction

The Tevatron, located at the Fermi National Accelerator Laboratory in Batavia Illinois, uses superconducting magnets to provide proton-antiproton collisions at a center-of-mass energy of 1800 GeV. Two collaborations, CDF and DØ, study these interactions with similar, but distinguishable, multi-purpose detectors.

The CDF detector[1] emphasizes tracking. Three tracking detectors are enclosed in solenoidal superconducting magnet producing a 1.4T field. Surrounding the interaction point there are four layers of silicon microstrips which can detect the displaced vertices from B-meson decays. Outside the microstrips is a time projection chamber (VTX) which tracks charged particles in the $r-z$ view. From a radius of 30cm to 130cm is the CTC, an open-cell drift chamber which measures charged particle momentum for particles with $|\eta| < 1$. Outside the tracking chambers and magnet coil there are electromagnetic and hadronic segmented calorimeters covering $|\eta| < 4$. Outside of the calorimeters there are muon detectors with coverage for $|\eta| < 1$.

The DØ detector[2] emphasizes calorimetry. Immediately outside the beampipe is a multiplane drift chamber with three-dimensional measurement capability for locating interaction vertices. At a larger radius is a transition radiation detector for electron identification. Between a radius of 50 cm and 75 cm is a another drift chamber for tracking charged particles. These tracking devices are not in a magnetic field. Outside of the these detectors is the calorimeter made from layers of uranium, copper or steel absorber and liquid argon. The calorimeter covers $|\eta| < 4.2$. At the largest radius is a set of muon chambers, including magnetic toroids for muon momentum measurement. The coverage is $|\eta| < 3.3$. Both experiments measure missing energy in the transverse plane ($\not{E}_t$) which can be caused by high-p_t particles that do not interact in the detector.

There have been two recent running periods for the Tevatron. In the first period, 1992-93, called Run Ia, CDF accumulated approximately 20 pb^{-1} and DØ accumulated approximately 15 pb^{-1}. In the second period, 1995-96, called Run Ib, 90 pb^{-1} and 109pb^{-1} were collected by CDF and DØ respectively. The Ia and Ib data is currently being analysed. Many topics have been published, some are public but not yet published, and more are underway.

The topics covered here begin with the classic jets and $\not{E}_t$, dilepton and trilepton searches. The discovery of the top quark gives us new opportunities to search for SUSY particles and one such analysis is presented. Next are searches for charged and neutral Higgs particles. The very unusual CDF $ee\gamma\gamma \not{E}_t$ event is presented followed by a discussion of the searches for photon-enriched SUSY.

2. Jets-and-$\not{E}_t$ Search for Squarks and Gluinos

The Tevatron, with its hadron beams and large center-of-mass energy, is ideally suited to search for the strongly-interacting squarks and gluinos. If the squark is heavier than the gluino, models typically predict $\tilde{q} \rightarrow q\tilde{g}$ and $\tilde{g} \rightarrow qq\chi_1^0$. If the gluino is heavier, we find $\tilde{g} \rightarrow q\tilde{q}$ and $\tilde{q} \rightarrow q\chi_1^0$. The χ_1^0 escapes the detector and causes $\not\!\!E_t$. In these cases, and even if other gauginos appear in the decay chain, we have the signature jets and $\not\!\!E_t$.

The DØ search [3] uses 80pb^{-1} of data. One jet with $E_t > 115$ GeV and two more with $E_t > 25$ GeV are required. A common instrumental background occurs when a jet's energy is mismeasured so the $\not\!\!E_t$ is required to not point in the same direction as, or opposite to, any jet. H_t, the scalar sum of jet E_t's, excluding the leading jet, must be $>$ 100 GeV and $\not\!\!E_t$ must be $>$75 GeV. The 15 remaining events are consistent with the standard model expectation from $t\bar{t}$ and QCD jet production with fake $\not\!\!E_t$.

To set limits, the minimal SUGRA model is used with $\tan\beta = 2$, $A_o = 0$ and $\mu < 0$. The remaining two parameters, m_0 and $m_{1/2}$, are varied to find the exclusion region. For each pair of parameter values, the $\not\!\!E_t$ and H_t cuts are reoptimized. The resulting limits are shown in figure 1. If squarks and gluinos have equal mass, $M < 260$ GeV is excluded.

CDF has published their search in jets and $\not\!\!E_t$ using 19pb^{-1} of data [4]. The search requires three or more jets with E_t >15 GeV and 60 GeV of $\not\!\!E_t$. For equal squark and gluino masses, M <220 GeV is excluded in the framework of the GUT-inspired MSSM model of ISAJET. The CDF search using the full 110pb^{-1} of luminosity is underway.

3. Dilepton Search for Squarks and Gluinos

The dilepton mode is also used to search for squarks and gluinos. Here the decay of squarks and gluinos often include quarks (which make jets) and charginos/neutralinos which decay to leptons. The χ_1^0 is also always present adding $\not\!\!E_t$ to the signature. This complements the jets and $\not\!\!E_t$ searches which do not require a particular decay of charginos/neutralinos or even that they are present - but at the cost of worse signal-to-noise.

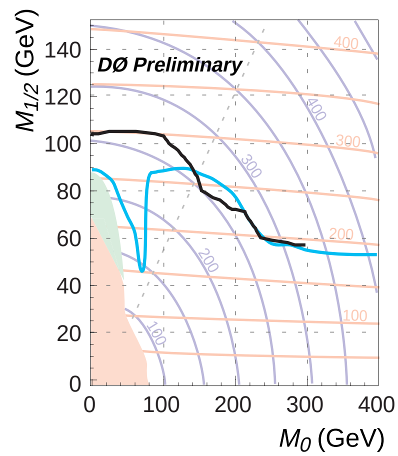

Figure 1. DØ limits from a search for squarks and gluinos in the jets and $\not\!\!E_t$ channel using 80pb^{-1} of data. The minimal SUGRA model is assumed with $\tan\beta = 2$, $A_o = 0$ and $\mu < 0$.

The DØ search[5] is in the dielectron mode with 93pb^{-1} of data, requiring two electrons with E_t >15 GeV and two jets with E_t >20 GeV. The event must have 25 GeV of $\not\!\!E_t$ or 40 GeV of $\not\!\!E_t$ if the dielectron mass is less than 12 GeV from the Z mass. Two events are left after cuts. The background from $t\bar{t}$ and $Z \rightarrow \tau\tau$ is estimated to be 3.0 ± 1.3.

The resulting limits are displayed in figure 2. The excluded region is shown in the $m_{1/2} - m_o$ plane with the indicated assumptions for the other three parameters of the minimal SUGRA model. For equal mass squarks and gluinos, $M < 267$ GeV is excluded. The model dependence of the limits can be seen in the dip of the excluded region around m_o =70 GeV. In this region $M(\tilde{\nu}) < M(\chi_2^0) < M(\tilde{e})$ and the χ_2^0 decays almost exclusively to $\nu\nu\chi_1^0$, decreasing the sensitivity in the lepton channel.

CDF has searched[7] in the dilepton mode with electrons and muons in 90pb^{-1} of data. The analysis is similar to the DØ analysis except the leptons are required to be same sign. DØ does not make this requirement since they cannot measure the sign of their electrons. This requirement greatly reduces the backgrounds which are pre-

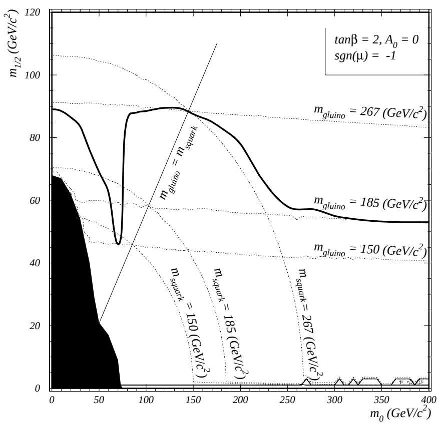

Figure 2. DØ limits on squark and gluino masses from the 2 leptons, 2 jets, and $\not\!\!E_t$ search.

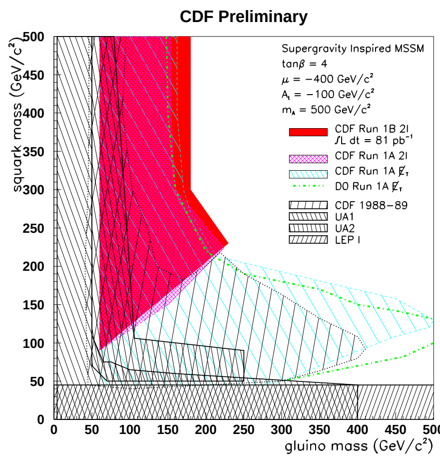

Figure 3. CDF limits on the squark and gluino masses from the 2 leptons, 2 jets, and $\not\!\!E_t$ search.

dominately opposite-sign and allows CDF to use lower p_t cuts than DØ. This is still efficient for signal since gluinos are Majorana particles and decay into either charge lepton with equal probability. However, the search is limited to squark-gluino and gluino-gluino production.

The primary lepton must have E_t >11 GeV and the second must have E_t >5 GeV. Two jets with E_t >15 GeV are required and the event must have 25 GeV of $\not\!\!E_t$. After cuts there are 23 opposite-sign events and only 2 like-sign events. The background from $t\bar{t}$ and Drell-Yan is estimated to be $1.28 \pm 0.62(stat) \pm 0.35(syst)$. Figure 3 shows the resulting limits in the squark-gluino mass plane with the indicated assumptions for the remaining ISAJET GUT-inspired MSSM model parameters.

4. Searches for a Light Stop

The large top mass allows the top's SUSY partners to mix resulting in one light and one heavy mass eigenstate. If this occurs, the light stop may the second lightest SUSY particle, much lighter than the other squarks. It would be produced strongly at the Tevatron and would decay to a charm quark and the χ_1^0. The signature is then two acolinear charm jets and $\not\!\!E_t$. CDF has not searched for this signature although a charm tagging algorithm currently being developed will be ideally suited for this search.

DØ has performed this search using 7.4pb^{-1} of data [8]. Two jets with E_t >30 GeV and $90° < \Delta\phi < 165°$, and 40 GeV of $\not\!\!E_t$ in the event form the basic requirements. In addition the $\not\!\!E_t$ may not lie along either jet to avoid fake $\not\!\!E_t$ from jet energy mismeasurements. Three events remain which is consistent with the 3.5 events expected in the standard model, mostly from W-and-jets production. Figure 4 shows the resulting limits.

DØ also has a second version of their dilepton search [9] tuned to be more sensitive to direct production of a light stop squark. At this time it does not exclude any squark masses.

Since the stop can be lighter than the top quark, the top could decay into the stop. An example of this kind of search is a CDF analysis of the SVX-tagged lepton-plus-jets top sample[6]. The standard model decay of top is $t \rightarrow Wb$ with the W decaying to $\ell\nu$ or two jets. If one W decays semileptonically and the other to jets the signature is $\ell\nu bjjb$. If the stop is light enough, the decay $t \rightarrow \tilde{t}\chi_1^0$ may be significant, depending on the model parameters. Furthermore, if the $\chi_1^\pm$ is lighter, $\tilde{t} \rightarrow \chi_1^\pm b$ and $\chi_1^\pm \rightarrow qq\chi_1^0$. If one of the top quarks decays by the standard model semileptonic route and the other by the proposed SUSY mechanism, the signature would be $\ell\nu b\chi_1^0 jj\chi_1^0 b$,

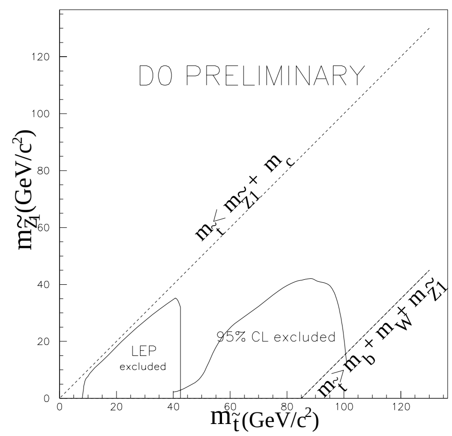

Figure 4. DØ limits from a search for the stop squark pair production assuming a 100% branching ratio for $\tilde{t} \rightarrow c\chi_1^0$.

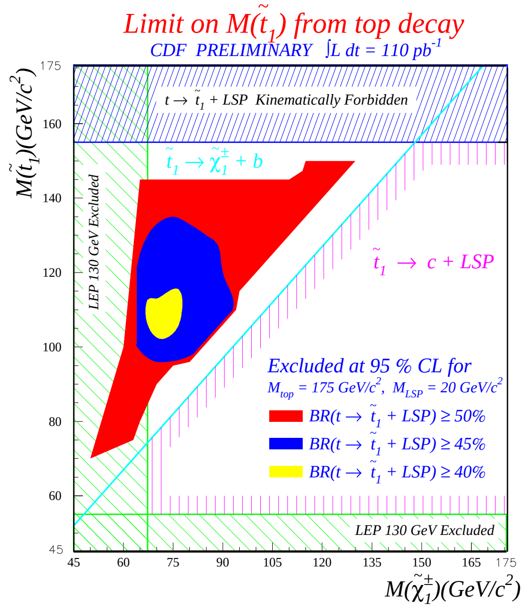

Figure 5. Exclusion space for the CDF analysis of lepton-plus-jets top sample for the SUSY decay $t \rightarrow \tilde{t}\chi_1^0 \rightarrow qq\chi_1^0\chi_1^0$

the same lepton plus jets as the standard model decay.

However, due to the mass of the χ_1^0 and the intermediate sparticles in the decay chain, the jets from the SUSY decay are significantly softer than the standard model jets. This difference is exploited as the basis of the search. A likelihood reflecting the probability that the 2$^{\text{nd}}$ and 3$^{\text{rd}}$ highest-E_t jets in the event are consistent with the stiffer standard model distribution is computed for each event. The distribution of this likelihood shows a significant separation of the two hypotheses. The region where the SUSY decays would populate is marked as a signal region. After cuts there are 9 events, all of which fall outside of the signal region. Limits on the masses of the chargino and stop under different assumptions for the branching ratio of top into stop are shown in figure 5.

The same data sample used for the stop-from-top search can be used for a search for direct production of stop pairs. As noted above, if the $\chi_1^\pm$ is lighter than the stop squark the decay of a stop pair would differ from top only in its kinematics. CDF has searched[10] for the direct production of stop squark pairs where one of the charginos decays semileptonically and one does not, yielding the lepton-plus-jets signature. In this analysis, the signal is separated from top pair production using the $\ell \not{E}_t$ transverse mass which is different due to the presence of the χ_1^0. At this time, this analysis is not sensitive to any stop masses but it is being re-optimized.

5. Trilepton Search for Gauginos

The trilepton mode is another very experimentally clean signature for SUSY. It arises from $\chi_2^0\chi_1^\pm$ production followed by the decays $\chi_2^0 \rightarrow \ell^\pm\ell^\mp\chi_1^0$ and $\chi_1^\pm \rightarrow \ell^\pm\nu\chi_1^0$ giving the signature of three leptons and $\not{E}_t$.

CDF has searched[7] for trileptons using 100pb^{-1} of muon and electron data. The first lepton has to pass tight cuts and have $E_t > 11$ GeV. The second two leptons must pass looser identification cuts and have $E_t > 5$ GeV. One pair of leptons must be e^+e^- or $\mu^+\mu^-$ as the χ_2^0 would produce. Mass cuts around the Z, J/Ψ and Υ remove standard model events. After these cuts 7 events remain. The background from Drell-Yan (with a fake third lepton), $b\bar{b}$ and $c\bar{c}$ is estimated to be 8.4 ± 2.9 events.

After requiring 15 GeV of $\not\!\!E_t$, no events remain. CDF limits the mass of the $\chi_1^{\pm}$ to be larger than 66 GeV at the point of maximum sensitivity in the minimal GUT-inspired MSSM ISAJET model which is $\tan\beta = 2$, $\mu = -400$ GeV and $M_{\tilde{q}} = 1.05 M_{\tilde{g}}$. Additional cases are presented in figure 6.

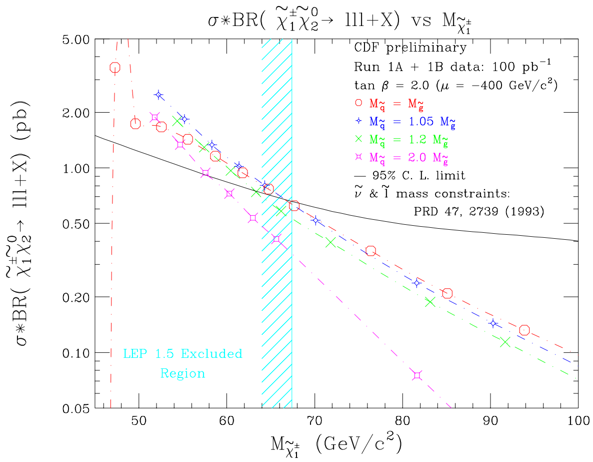

Figure 6. CDF limits on the chargino mass from the trilepton search.

DØ has searched[11] for trilepton events in 95pb^{-1} of electron and muon data. All leptons are required to have $E_t > 5$ GeV but due to the trigger, some leptons are required to be higher E_t. The Z and J/Ψ are vetoed and same flavor leptons are not allowed to be back-to-back to reject Drell-Yan. For the *eee* topology, 15 GeV of $\not\!\!E_t$ is required while 10 GeV is required in the other topologies. After cuts, no events are observed. An estimated 1.26 ± 0.37 events would be expected from Drell-Yan plus a fake lepton and from heavy flavors. A cross section limit is presented in figure 7.

6. Search for Neutral Higgs

Both collaborations have searched for a neutral Higgs particle which may be the standard model Higgs or the lightest SUSY Higgs. The primary search is for associated production $W^* \rightarrow Wh$.

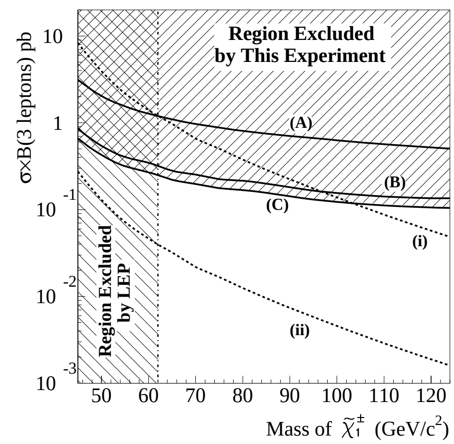

Figure 7. DØ cross sections limits on $\chi_1^{\pm}\chi_2^0$ production. A) Limit from the 1992-1993 data, B) limit from 1994-1995 data, C) combined limit i) prediction of the minimal SUGRA model with branching ratios of 1/9 for each sparticle to decay into leptons, ii) the prediction of the minimal SUGRA model with a branching ratios given by the particle's standard model counterparts.

The Higgs is assumed to decay primarily to $b\bar{b}$. The W is required to decay to $e\nu$ or $\mu\nu$.

DØ has searched[5] 100pb^{-1} of data. The electron (muon) is required to have $E_t > 25$ GeV (20 GeV) and the event must have $\not\!\!E_t$>25 GeV (20 GeV). Two jets with E_t >15 GeV, one of them associated with a muon (for b-tagging), are also required. Twenty-seven events remain, with 25.5 ± 3 expected from W plus jets and $t\bar{t}$. Limits are set by both a simple counting method and by fitting the dijet mass spectrum and the results are shown in figure 8.

CDF has recently completed a similar search for the same decay mode using 109pb^{-1} of data. An electron or muon with E_t >20 GeV, two jets with E_t >15 GeV and 20 GeV of $\not\!\!E_t$ are required. There are two ways of requiring evidence for b's. The first is to require that the SVX indicates a decay vertex well-separated from the interaction point. The second is to require that a lepton, well-separated from the interaction point, is associated with a jet. The sample is split into a single-tagged sample (one SVX tag) and a double-tagged sample (two SVX tags or one SVX and one lepton tag). The remaining 36 (6) single-tagged (double-tagged) events are consistent with the the 30 ± 5 (3.0 ± 0.6) expected from standard model W plus jets and $t\bar{t}$. Both the single- and double-tagged dijet mass distributions are fit simultaneously to set limits shown in figure 8.

Finally, CDF has searched for associated production where the W or Z is assumed to have decayed to two jets. The Higgs would contribute two b jets. The event selection is four jets with E_t >15 GeV, two of the jets have SVX b-tags, and the $b\bar{b}$ system has E_t >50 GeV (to suppress QCD). In 91pb^{-1} of data, 589 events remain, consistent with the expectation from QCD heavy-flavor or fake tags. To set limits, the $b\bar{b}$ dijet mass spectrum is fit. The limit is presented in figure 8. This analysis will be updated in the future with improved limits.

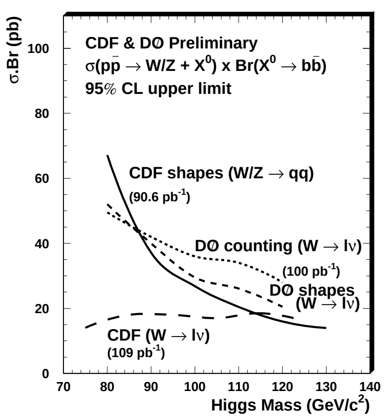

Figure 8. Limits on the associated production of the neutral Higgs. DØ has limits from $WH \rightarrow \ell\nu b\bar{b}$ using two methods. CDF has limits from $WH \rightarrow \ell\nu b\bar{b}$ and $(W,Z)H \rightarrow qqb\bar{b}$. "Shapes" refers to a limit obtained from fitting the $b\bar{b}$ mass spectrum for a peak.

7. Search for Charged Higgs

If the SUSY charged Higgs is lighter than the top quark and $\tan\beta$ is either less than about 1 or greater than about 100, the decay $t \rightarrow H^+b$ is competitive with standard model decays. In the low $\tan\beta$ region the Higgs would decay to $c\bar{s}$ while in the high $\tan\beta$ region the $\tau\nu$ decay would dominate.

Targeting the high $\tan\beta$ region, CDF searches[7] for hadronically decaying τ's which are identified as one or three isolated, high-p_t hadrons. Two other jets, one with an SVX b-tag, are required. The second top quark may decay in the standard model or the SUSY decay mode. To identify this top, another lepton (e, μ, or τ) or jet is required. The leading τ must have E_t >20 GeV, and the other objects must have E_t >10 GeV. To increase the acceptance for a heavy Higgs, events with two τ's (E_t >30 GeV and not back-to-back), but failing another selection cut, are allowed.

In 100pb^{-1}, 7 events pass the cuts. The largest source of backgrounds is from jets faking τ's and diboson production. The total estimated background is 7.4 ± 2.0 events consistent with the number of observed events. The limits from this search are presented in figure 9.

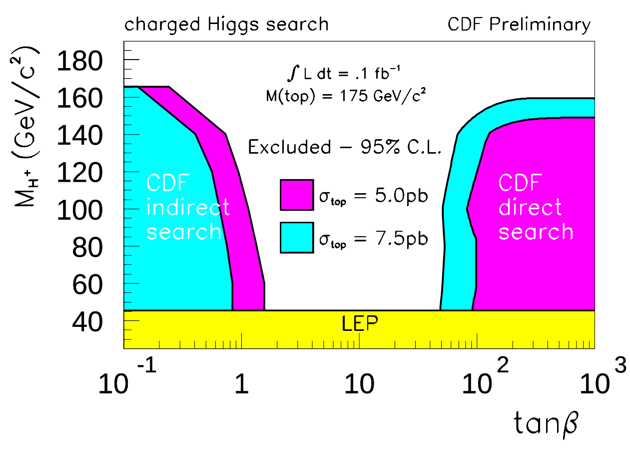

Figure 9. Limits on the charged Higgs from searches for $t \rightarrow H^+b$. The limit at low $\tan\beta$ is from the indirect search, the limit at large $\tan\beta$ is from a direct search based on the decay $H^+ \rightarrow \tau\nu$.

At low $\tan\beta$ a direct search is very difficult since the decay $H^+ \rightarrow c\bar{s}$ is difficult to distinguish from QCD backgrounds. However, with an added assumption, CDF can provide limits at low $\tan\beta$ as well as extend the limit at high $\tan\beta$. If a top cross section is assumed, then the standard model signals in the dilepton and lepton-plus-jets samples are predicted. If these events are observed, then the number of SUSY decays is limited. CDF can exclude $BR(t \to H^+ b) > 25$ (50)% for $\sigma_{t\bar{t}} = 5.0$ (7.0)pb if the Higgs has a mass between 60 and 165 GeV. The excluded region at low $\tan\beta$ is shown in figure 9 and the limit at high $\tan\beta$ is shown in 10.

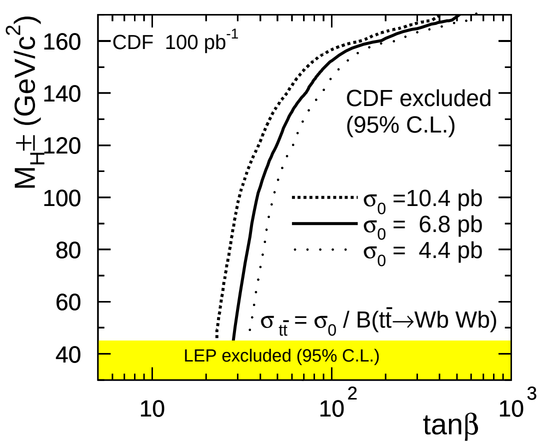

Figure 10. Limits on the charged Higgs from searches for $t \to H^+ b$. The limit is based on an indirect search

8. Photon-Enriched SUSY

In April 1995, the CDF experiment recorded an event with a very unusual topology. It has two isolated photons, two isolated electrons, and $\not\!\!E_t$. The display of the event is shown in figure 11.

The two electrons and the two photons easily pass nominal cuts for identifying these objects. The electron in the central region of the detector is well-isolated and associated with a track that has a p_t in good agreement with the e^- hypothesis. The two photons are also well-isolated and have no associated tracks.

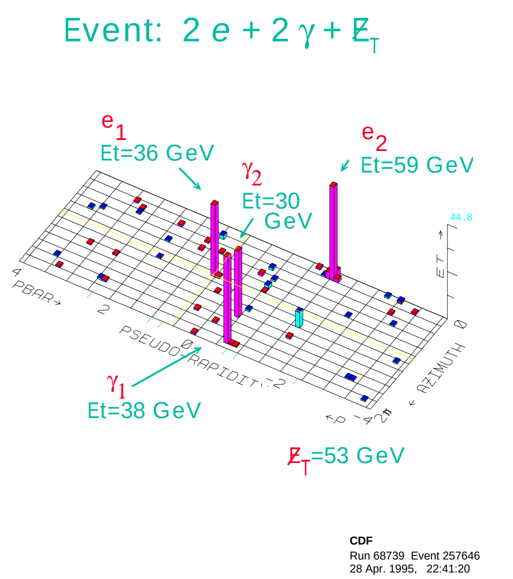

Figure 11. The very unusual CDF event containing two electrons, two photons and missing E_t. The display is the calorimeter cylinder unrolled into a plane. The towers represent energy deposition, with the height of the tower proportional to E_t.

The electron candidate at large η is more difficult to positively identify. The associated track should cross only a part of the inner CTC where the occupancy is too high to identify the track and its charge cannot be determined. The VTX has a track at the correct η for the electron hypothesis.

Estimates of the standard model rate for producing this signature or faking it are being estimated and are expected to be extremely small. The largest investigated so far is standard model $WW\gamma\gamma$ production which predicts many orders of magnitude below one event.

8.1. Could it be SUSY?

There have been two main proposals for a SUSY explanation of the event. The first is a gauge-mediated model of Supersymmetry [12].

These models are very similar to MSSM models with one important exception. The gravitino ($\tilde{G}$) is the lightest supersymmetric particle and the lightest neutralino therefore decays $\tilde{\chi}_1^0 \rightarrow \gamma \tilde{G}$. If the coupling between the gravitino and matter is large, then sparticle events will always contain two photons and $\not\!\!E_t$ in the final state. The event could then be, for example, $\tilde{e}\bar{\tilde{e}}$ with $\tilde{e} \rightarrow e\chi_1^0$ and the subsequent radiative decay of the χ_1^0. This proposal is called the light Gravitino scenario.

The second is a corner of MSSM parameter space where the radiative decay $\chi_2^0 \rightarrow \gamma\chi_1^0$ dominates [13]. The event is then $\tilde{e}\bar{\tilde{e}}$ with $\tilde{e} \rightarrow e\chi_2^0$ and the subsequent radiative decay of the χ_2^0 yielding the observed signature. This proposal is called the neutralino LSP scenario.

Both proposals suggest other signatures that could possibly confirm the models. The Tevatron collaborations have completed some of these searches which are discussed below.

8.2. Two Photons and $\not\!\!E_t$

These are generic searches for an excess of events with two photons and $\not\!\!E_t$ which could be a signature of either of the proposals. These data samples will contain standard model diphoton production. In addition, jets can fluctuate into pure electromagnetic clusters, faking one or both of the photons. Any $\not\!\!E_t$ in these events would have to come from detector mismeasurements.

Figures 12 and 13 show the $\not\!\!E_t$ distribution from the DØ [14] and CDF[7] diphoton events. The DØ search requires one photon with $E_t > 20$, a second photon with $E_t > 12$ GeV, and $|\eta| < 2$, excluding the region $1.2 < |\eta| < 1.5$. The shape of the $\not\!\!E_t$ spectra agrees well with that of events with two electromagnetic-like clusters selected such that one of the two fails the photon selection criteria. For setting limits, $\not\!\!E_t > 25$ GeV is required. Two events satisfy all selection criteria, with a predicted background, dominated by jets faking photons, of 2.3 $\pm$0.9 events.

CDF requires two photons with $E_t > 25$ GeV and $|\eta| < 1$. The shape of the $\not\!\!E_t$ distribution is in good agreement with the resolution derived from a $Z \rightarrow ee$ control sample, which should have similar $\not\!\!E_t$ resolution. The event with the largest $\not\!\!E_t$ is the $ee\gamma\gamma\not\!\!E_t$ event. The evaluation of limits is underway. Neither CDF nor DØ find any other diphoton events with large $\not\!\!E_t$ and leptons.

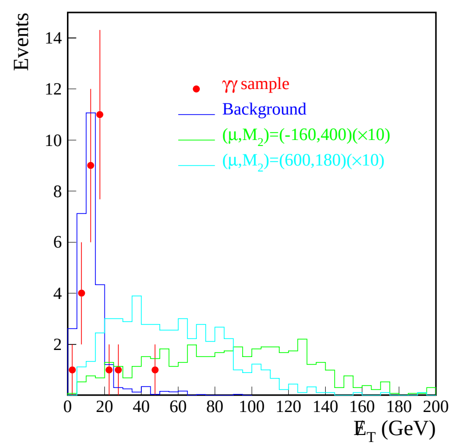

Figure 12. $\not\!\!E_t$ spectra in the DØ search for events with 2 photons.

DØ presents limits on the light gravitino scenario in the framework of the MSSM. Figure 14 shows the limit in the $M_2-\mu$ parameter plane. As can be seen from the plot, the limit is equivalent to excluding a $\chi_1^\pm$ with mass below 156 GeV. This mass limit is much higher than the SUGRA mass limit because of the 100% branching fraction.

Diphoton events are also produced in the neutralino LSP scenario and DØ has a limit on the cross section for $\tilde{e}\tilde{e} \rightarrow ee\chi_2^0\chi_2^0$, $\tilde{\nu}\tilde{\nu} \rightarrow \nu\nu\chi_2^0\chi_2^0$, and $\chi_2^0\chi_2^0 \rightarrow \gamma\gamma\chi_1^0\chi_1^0$ using the same data as for the light Gravitino search. This is shown in figure 15. The limit on the cross section for such processes is about 0.35 pb for $M(\chi_2^0) - M(\chi_1^0) > 30$ GeV.

8.3. Light Stop in Photon-Enriched SUSY

This analysis is based on the neutralino *LSP* ($\chi_2^0 \rightarrow \gamma\chi_1^0$) scenario together with the assumption of a light stop squark. In this scenario a $\chi_i^\pm\chi_2^0$ event would decay: $\chi_i^\pm \rightarrow \tilde{t}b \rightarrow c\chi_1^0 b$ and $\chi_2^0 \rightarrow \gamma\chi_1^0$ yielding a signature of $\gamma bc\not\!\!E_t$. CDF has searched for this topology in 85pb^{-1} of data.

The data sample contains events with an isolated photon with E_t >25 GeV and a SVX btag. The $\not\!\!E_t$ spectrum of these events can be seen in

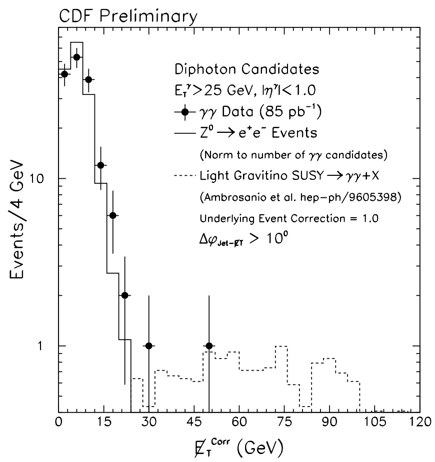

Figure 13. The $\not\!\!E_t$ spectrum for events with two central photons with $E_t > 25$ GeV and $|\eta| < 1$ (points). The histogram is the $\not\!\!E_t$ spectrum in a Z control sample, which should have similar resolution.

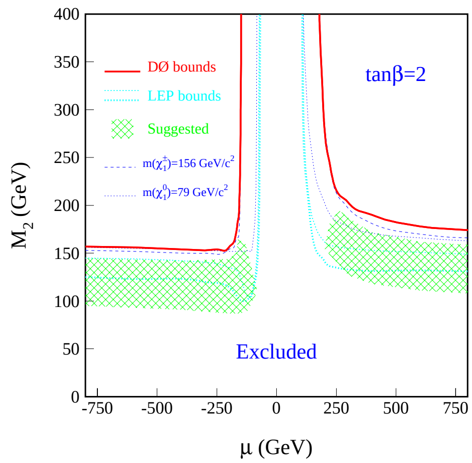

Figure 14. DØ cross section limit in the M_2-μ plane on sparticle production in gauge-mediated models[15] predicting diphoton events.

figure 16. Adding a $\not\!\!E_t$ cut of 20 GeV, 98 events remain. The distribution of the number of jets in the event is also shown in figure 16. There are more jets in the SUSY model than the signature indicates because the analysis is most sensitive to $\chi_i^{\pm}\chi_2^0$ in the decays of squarks and gluinos where the cross section and E_t boost is greater.

The estimated background to the 98 events is $77 \pm 23(stat) \pm 20(syst)$ events. About 60% of the background is due to jets faking photons, 13% to real photons and fake btags, and the remainder to standard model $\gamma b\bar{b}$ and $\gamma c\bar{c}$ production; all of these sources require fake $\not\!\!E_t$.

To set limits the $\not\!\!E_t$ cut is increased to 40 GeV and 2 events remain. Without attempting a background subtraction, more than 6.43 events of anomalous production in this topology is excluded. A baseline model [13] with a 40 GeV χ_1^0, 70 GeV χ_2^0, 60 GeV stop, 250 GeV squarks, and 225 GeV gluinos predicts 6.65 events, so this model is marginally excluded. Note that this result does not rule out the neutralino LSP mechanism, only the lowest mass versions of the model. Holding the lighter sparticle masses constant and varying the squark and gluino masses, squarks and gluinos less than 200 GeV, or 225 GeV if their masses are the same, are excluded.

9. Conclusion

Several recent results of searches for SUSY at the Tevatron are described. The lone CDF $ee\gamma\gamma\not\!\!E_t$ event remains a mystery because no hypothesis for it has been confirmed, although several channels have been analyzed by DØ and CDF. The standard SUSY searches continue to set limits. The analysis of the Ib data is still ongoing and several new results will be available soon - there may still be SUSY hidden in the data.

Run II for the Tevatron collider is scheduled to begin in 1999 when both detectors will be significantly upgraded[16,17] including the addition of a central magnetic field to the DØ detector. A total of 2000pb^{-1} is scheduled to be delivered with the center-of-mass energy increased to 2000 GeV. The combination of the luminosity, the upgraded detectors and the higher energy will maintain the Tevatron at the forefront of the search for SUSY.

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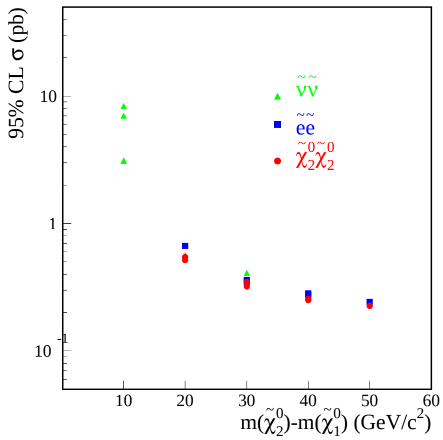

Figure 15. DØ cross section limit on $\tilde{e}\tilde{e}$, $\tilde{\nu}\tilde{\nu}$, and $\chi_2^0\chi_2^0$ production in the neutralino LSP model.

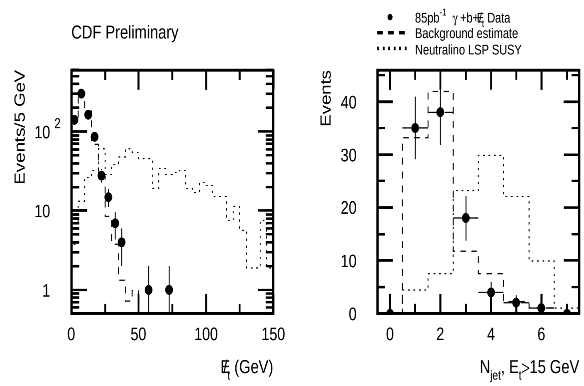

Figure 16. The missing E_t and the number of jets in events with a photon and a SVX btag (CDF). The search is for the signature $b\gamma \not{E}_t$ in a scenario where $\chi_2^0 \rightarrow \gamma\chi_1^0$ and the stop is light. The number-of-jets histogram is made by requiring $\not{E}_t$>20 GeV. The SUSY model is normalized to the area of the data histogram - this is scaling by a factor of 100 for the $\not{E}_t$ histogram and a factor of 10 for the njet histogram. The SUSY model is the neutralino *LSP* model[13].

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