SUSY SEARCHES AT THE TEVATRON LATEST RUN I RESULTS, PROSPECTS FOR RUN II*

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In this article we will present resent results of SUSY searches for Run I and we will give an outlook on prospects for SUSY searches in selected channels for Run II.

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1. Introduction

After major upgrades of the Tevatron accelerator and both detectors CDF and D0, data taking at a center of mass energy of 1.96 TeV has started in the spring of 2001. The goal of the first phase of Run II is to collect 2 fb^{-1} per experiment and thus increase the statistics available from Run I by a factor of 20. Both, the increased statistics and major upgrades of the detectors will increase the reach for SUSY signatures significantly. For selected channels the Run II prospects will be shown. With the currently available statistics it is not jet possible to improve the Run I results. The data has however been used to calibrate the detector and to study the detector performance for signals relevant to SUSY searches like missing transverse energy or dilepton mass spectra in detail.

In Run I each Tevatron experiment collected about 100 pb^{-1}. Since data taking ended in 1995, resent analyzes are therefore either very sophisticated approaches trying to optimize the use of the available data or they cover more exotic SUSY decay channels sometimes reinterpreting existing analyzes in light of these channels.

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2. Search for heavy particles decaying into electron and muon

The CDF collaboration performed a search for heavy particles decaying into an electron and a muon. Figure 1 shows preliminary results for the invariant electron muon mass. The largest background is due to $Z^0/\gamma \to \tau^+\tau^-$ events where one τ decays into an electron plus neutrinos and the other into a muon plus neutrinos. Because of the missing neutrino momentum the invariant mass peak is shifted below the Z^0 resonance. There is only one event left above 100 GeV. The analysis can therefore be used to set limits on the R-Parity Violating (RPV) decay of sneutrinos into an electron and a muon. In the right plot of figure 1 the preliminary limit is expressed in terms of the sneutino production cross section times its branching ratio into an electron plus a muon. The cross section is normalized to the cross section of the process $Z^0 \to e^+e^-$. The structure below 100 GeV is due to the candidate events; above that the change in the limit is caused by the dependence of the event selection efficiency on the sneutrino mass. To illustrate how this limited can be used to test SUSY parameters, the expected cross section for a special set of RVP couplings is given. For these parameters sneutrino masses smaller than the value at which both curves intersect can be excluded.

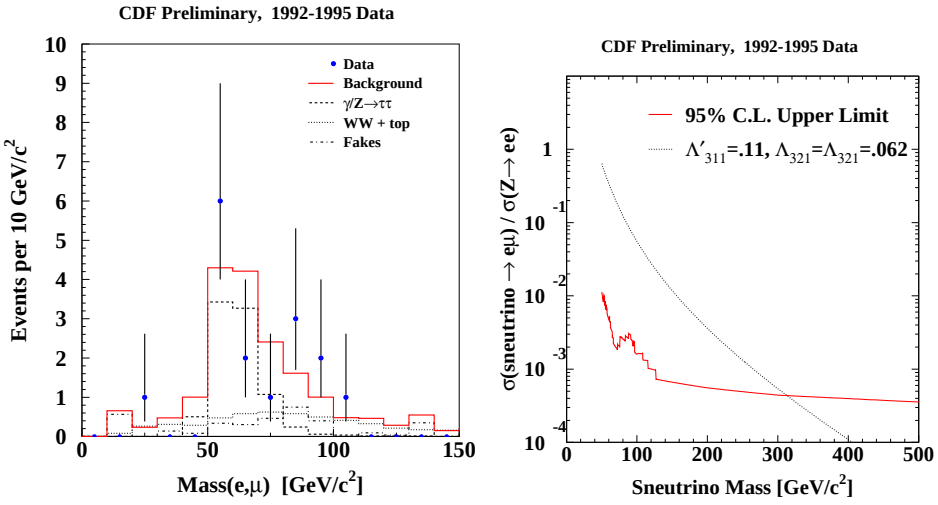

Fig. 1. Invariant electron muon mass and limit on the sneutrino mass.

3. Trilepton channel

One of the most promising SUSY search channels in Run II will be the trilepton plus missing energy channel. The dominating SUSY source for trilepton events will be $p\bar{p} \to \chi_2^0\chi_1^\pm$ with the decays $\chi_2^0 \to l^+l^-\chi_1^0$ and $\chi_1^\pm \to l^\pm\nu\chi_1^0$. Figure 2 shows as an example the expected reach in Run II

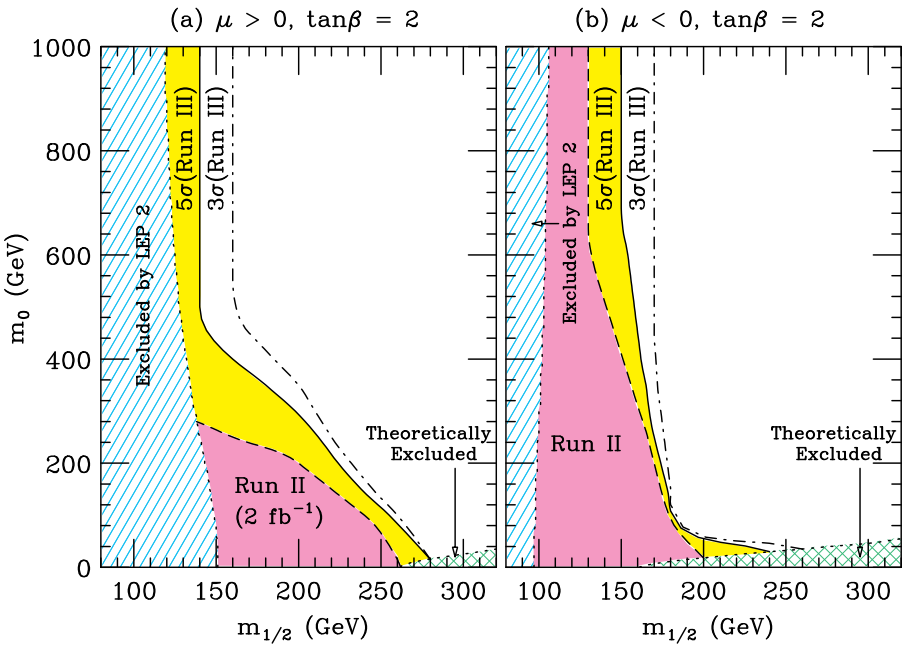

Fig. 2. Expected Run II reach of the trilepton analysis in the $m_{1/2}$–m_0 plane for two vales of $\tan\beta$ and μ.

in the $m_{1/2}$–m_0 plane for two values of $\tan\beta$ and μ [1]. In order to increase the selection efficiency for early Run II analysis, one can also search for this type of decays by requiring two same sign leptons. This will at the same time increase the background.

The Run I trilepton searches have been interpreted by the D0 Collaboration in the context of R parity violation decays of the Lightest Supersymmetric Particle (LSP) [2]. If one assumes only a small RPV contribution the production and decays of SUSY particles will be exactly the same as in models without RPV except that the LSP will decay. For this analysis a decay into two charged leptons and a neutrino were assumed. This gives a total of 4 charged leptons from which three are required by the event selection. Figure 3 shows the derived limits in the $m_{1/2}$–m_0 plane. In principle the analysis does not depend on the strength of the RPV coupling since the LSP decay is the only place where this coupling enters. However, if in the case of weak RPV the lifetime of the LSP get so large that it only decays after it moved a significant distance in the detector. Since he sensitivity of the analysis has not been tested for this effect only points above one of the dashed curves (depending on the assumed strength of the RPV coupling),

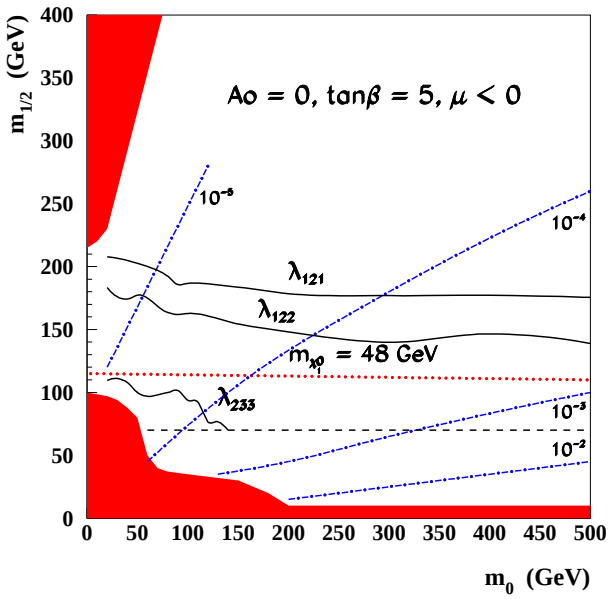

Fig. 3. Limits in the $m_{1/2}$–m_0 plane from RPV decays of the LSP. Events below the solid and above the dashed and dashed-doted lines are excluded.

where the decay length is smaller than 1 cm, are excluded. The flavors of the leptons in the LSP decay depend on the RPV couplings which dominates the decay. Points below the corresponding curve are excluded. The dashed line gives the limit in sensitivity in $m_{1/2}$ for the least favored channel (λ_{233})

4. Squark and gluino search

The CDF Collaboration updated their squarks and gluino search by an analysis based on a multi-jet plus missing transverse energy signal [3]. The analysis requires three jets, large missing transverse energy and a large value of H_{T} defined as the scalar sum of the missing transverse energy as well as the transverse energies of the second and third jet. In addition events with high energetic isolated tracks were rejected because these tracks could be due to charged leptons from W decays which also would produce a high energetic neutrino. For the analysis it was important that the missing momentum did not point along one of the jet directions or in directions not fully covered by the detector. Figure 4 compares the data with the standard model prediction for the expected events. A total of 74 events where observed while 76 ± 15 are expected from standard model backgrounds (41 from QCD and 35 from electroweak processes). The figure also shows the improved limit in the $m_{\tilde{g}}$–$m_{\tilde{q}}$ plan.

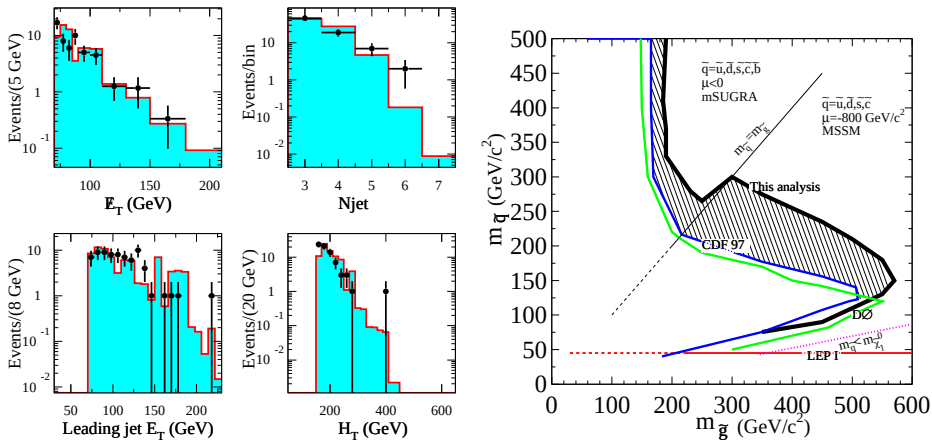

Fig. 4. Compassion of data (points) and standard model prediction (histograms). Improved exclusion region in the $m_{\tilde{g}}$–$m_{\tilde{q}}$ plan.

For Run II one expects to improve the limit on the gluino mass to about 400 GeV independently of the squark mass.

5. Conclusion

The analysis of the Run I data is nearly completed. For Run II large improvements of the SUSY reach are expected because of the 20 fold increase in statistics, the 10% increased center of mass energy and the significantly improved detectors.

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