Search for neutralino pair-production

Preliminary

DELPHI Collaboration

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Abstract

A search for pair-production of neutralinos at a LEP2 centre-of-mass energy of 189 GeV has been performed. No signal was found. Model-independent limits on neutralino production cross-section were obtained. These limits have been used together with limits on chargino production to exclude regions in the parameter space of the MSSM.

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1 Introduction

The 153 pb^{-1} of data collected by the DELPHI experiment at LEP during 1998 at centre-of-mass energy 188.7 GeV were used to search for neutralino pair production.

The search for neutralino production followed methods previously presented [2, 3]. Topologies with two acoplanar jets and leptons, were searched for. The search covers $\tilde{\chi}_k^0 \tilde{\chi}_1^0$ final states with $\tilde{\chi}_k^0 \rightarrow \tilde{\chi}_1^0 + f\bar{f}$. No excess over the expected Standard Model background was found and the negative results were used to place limits on the cross-section for neutralino pair production.

The results of the search presented here, together with those of a search for charginos at 189 GeV [1] and from lower energies [2, 3], were interpreted within the Minimal Supersymmetric Standard Model (MSSM) scheme with universal parameters at the high mass scale typical of Grand Unified Theories [4].

2 Results

A total of 120000 $\tilde{\chi}_1^0 \tilde{\chi}_2^0$ events was generated for 44 different combinations of $M_{\tilde{\chi}_2^0}$ and $M_{\tilde{\chi}_1^0}$ masses with $M_{\tilde{\chi}_2^0}$ ranging from 23 GeV/c^2 to 170 GeV/c^2, and for different $\tilde{\chi}_2^0$ decay modes ($q\bar{q}\tilde{\chi}_1^0$, $\mu^+\mu^-\tilde{\chi}_1^0$, $e^+e^-\tilde{\chi}_1^0$). The efficiencies for the neutralino selections are shown in Fig. 1

The number of background events expected in the different topologies is shown in table 1, together with the number of events selected in the data.

	Neutralino channels		
Topology:	jj	e^+e^-	$\mu^+\mu^-$
Obs. events:	27	11	16
background	29.3 ± 4.5	14.3 ± 3.3	14.9 ± 3.0

Table 1: The number of events observed and the expected number of background events in the different neutralino search channels.

Limits on neutralino production in the case of a stable $\tilde{\chi}_1^0$ were derived from the parametrised efficiencies, the observed number of events and predicted number of background events. The limits obtained for the $\tilde{\chi}_1^0 \tilde{\chi}_2^0$ production cross-section are shown in Fig. 2, assuming hadronic or leptonic decay modes.

The result of the searches for neutralinos and charginos [1] in the different topologies can be interpreted in the MSSM with a universal GUT scale gaugino mass parameter. This yields the exclusion regions in the (μ, M_2) plane shown in Fig. 3 for a value of $\tan\beta = 2$, assuming a heavy sneutrino and a heavy selectron ($m_0 = 1$ TeV/c^2). When different event selections contributed to the same physical production channel the efficiency and background of a logical or of the channels was used, otherwise the method of Ref. [7] was used to combine the selections.

3   Summary

Searches for neutralinos at $\sqrt{s} = 189$ GeV have been presented.

Limits on the cross-section for $\tilde{\chi}_1^0 \tilde{\chi}_2^0$ production of about 0.2 pb is obtained, and the excluded region in the (μ, M_2) plane is extended by the combined use of the neutralino and chargino searches.

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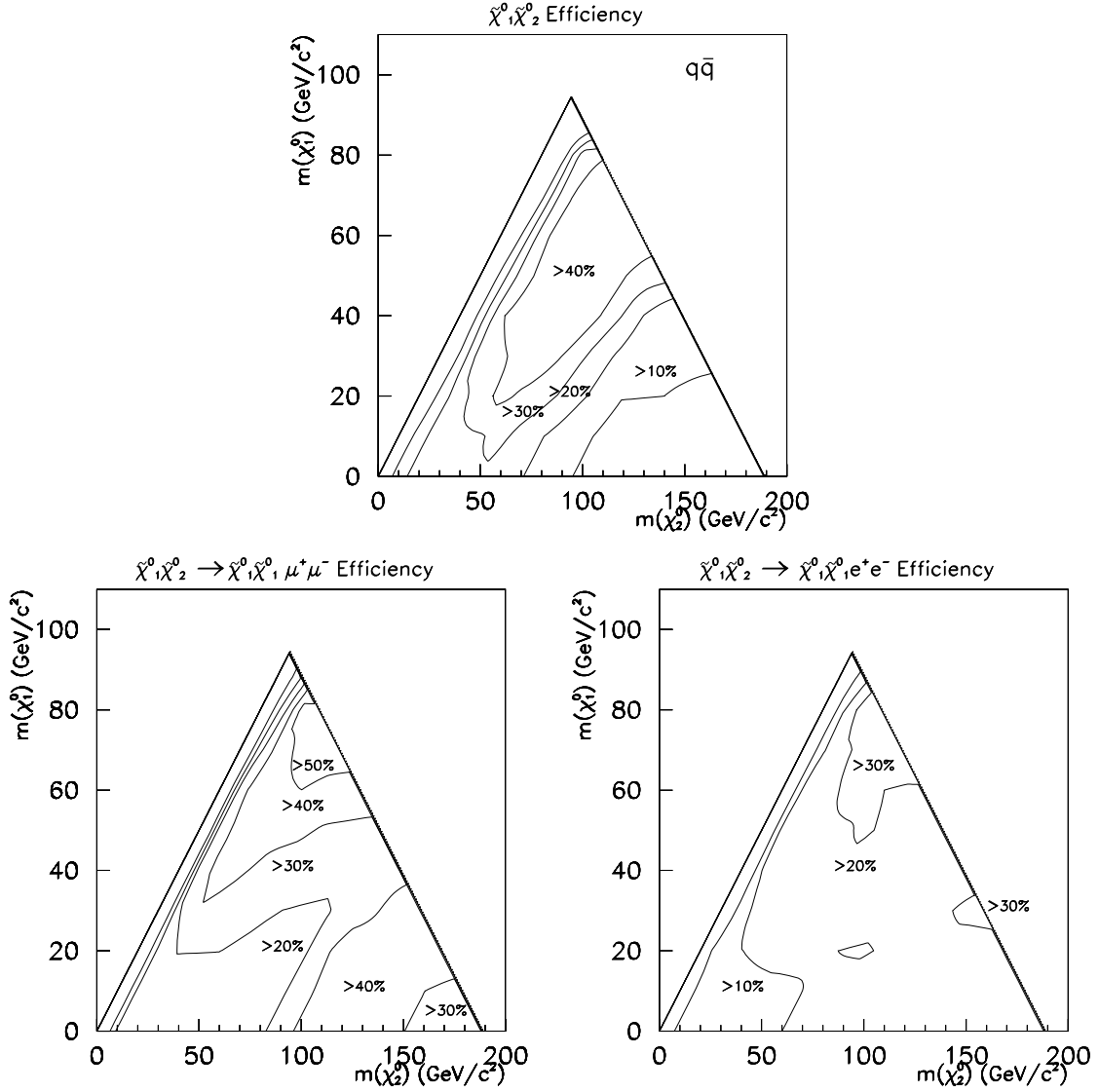
Figure 1: Contour plots of efficiencies for $\tilde{\chi}_1^0\tilde{\chi}_2^0$ production at $\sqrt{s}$ = 189 GeV. The mimimum efficiency is given for each outlined region. The upper plot gives the effiency for decays of $\tilde{\chi}_2^0$ into $\tilde{\chi}_1^0 q\bar{q}$, while the efficiencies for $\tilde{\chi}_1^0\mu^+\mu^-$ and $\tilde{\chi}_1^0 e^+e^-$ are shown below. The dotted lines indicate the kinematic limit and the defining relation $M_{\tilde{\chi}_2^0} > M_{\tilde{\chi}_1^0}$.
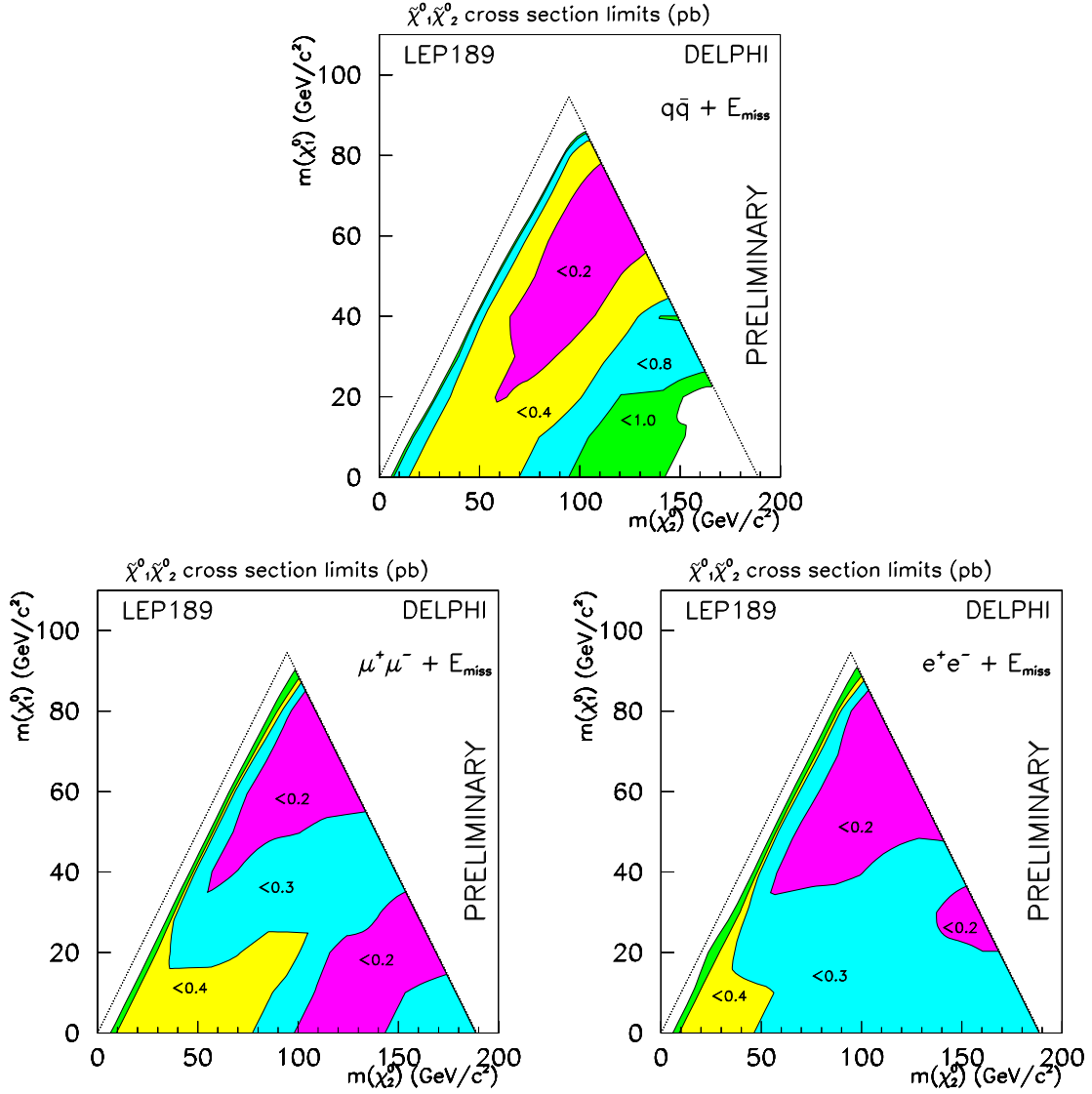
Figure 2: Contour plots of upper limits on the cross-sections at the 95% confidence level for $\tilde{\chi}_1^0 \tilde{\chi}_2^0$ production at $\sqrt{s} = 189$ GeV. In each plot, the different shades correspond to regions where the cross-section limit in picobarns is below the indicated number. In the upper plot decays of $\tilde{\chi}_2^0$ into $\tilde{\chi}_1^0 q\bar{q}$ were assumed to dominate, while in the two lower ones the dominant decays were assumed to be $\tilde{\chi}_1^0 \mu^+ \mu^-$ and $\tilde{\chi}_1^0 e^+ e^-$, respectively. The dotted lines indicate the kinematic limit and the defining relation $M_{\tilde{\chi}_2^0} > M_{\tilde{\chi}_1^0}$.
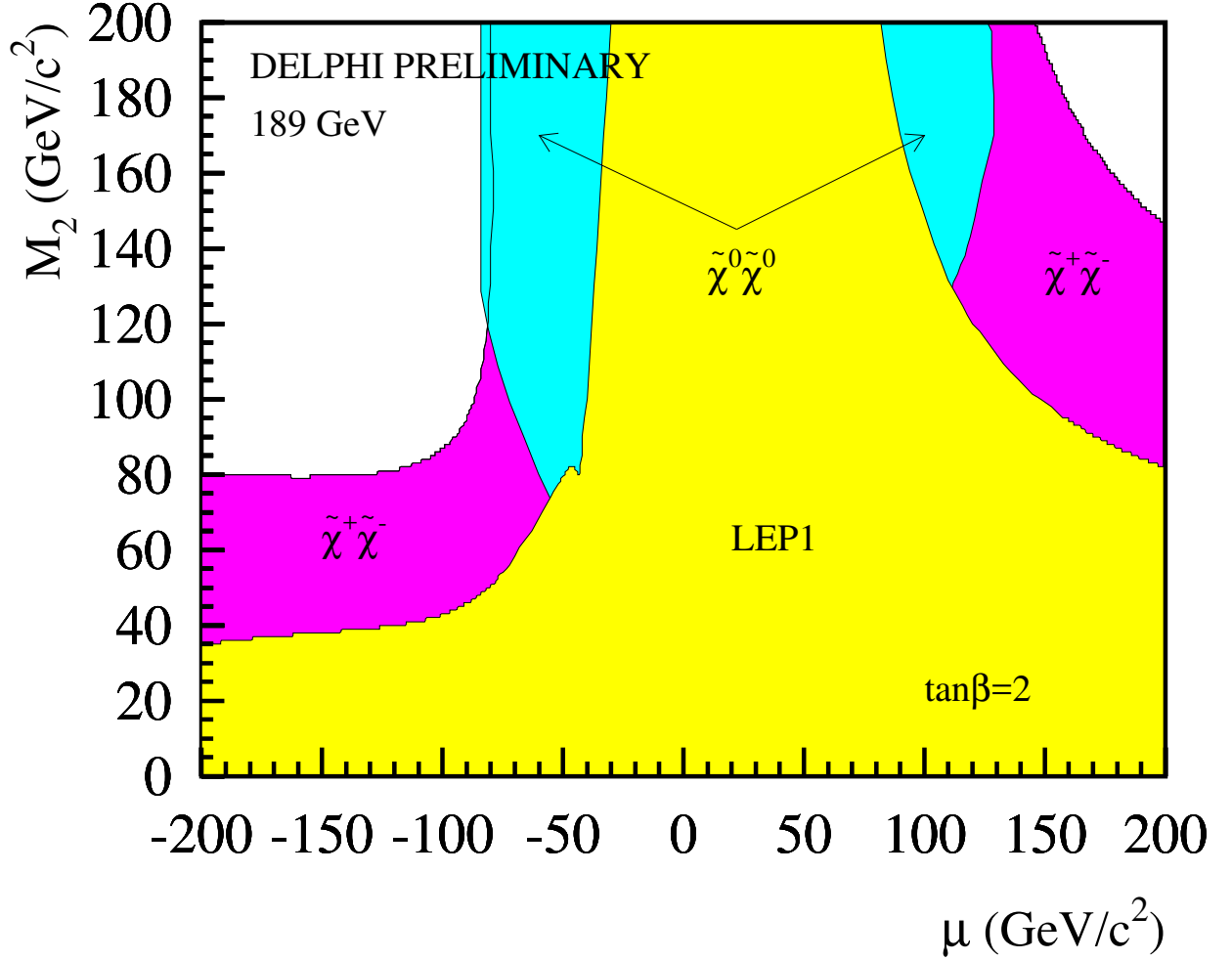
Figure 3: Regions in the (μ, M_2) plane excluded at 95% confidence level for $\tan\beta=2$, assuming heavy sneutrino and selectron $m_0=1$ TeV. The lightly shaded areas are those excluded by lower energy LEP1 results [8]. The dark shading shows regions excluded by the chargino search. Regions of intermediate shading are excluded by the neutralino search and also, except for the narrow vertical strip to the left in the figure, by the chargino search.