PRELIMINARY RESULTS OF THE L3 EXPERIMENT ON NEW PARTICLE SEARCHES AT $\sqrt{s} > 203$ GeV

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A brief status of the searches for new particles based on approximately 100 pb^{-1} of data collected by the L3 experiment at $\sqrt{s} \simeq 203-208$ GeV is presented. The observed event rates in the studied search channels are consistent with the Standard Model expectations. All quoted results are preliminary.

1 Introduction

The increased center-of-mass energy during year 2000, at $\sqrt{s} \simeq 203-208$ GeV, in e^+e^- collisions at LEP, opens a new window for the search of new physics. A preliminary analysis[1] searching for the Higgs Boson and also for supersymmetric particles in a data sample of approximately 100 pb^{-1}integrated luminosity collected by the L3 experiment is presented.

2 Higgs Searches

The Higgs particles searched are performed in the framework of different models.

In the Standard Model, the dominant Higgs production modes is $e^+e^- \rightarrow Z^* \rightarrow HZ$. All significant signal decay modes are considered. The analysis procedure is optimized for $H \rightarrow b\bar{b}$, which accounts about 85% of the Higgs branching fraction in the mass range of interest and Z decaying in $q\bar{q}$, $\nu\bar{\nu}$, e^+e^-, $\mu^+\mu^-$. The number of observed events is consistent with the background expectation over the entire studied interval of Higgs masses. No evidence of a signal is seen in any channel.

For illustrative purposes, in Fig. 1(a) the reconstructed Higgs mass is shown for a sample of signal-like events selected, with mass-independent requirements, such as a large b-tag value. The exclusion confidence level as a function of the Higgs mass hypothesis is shown in Fig. 1(b). Combining these new re-

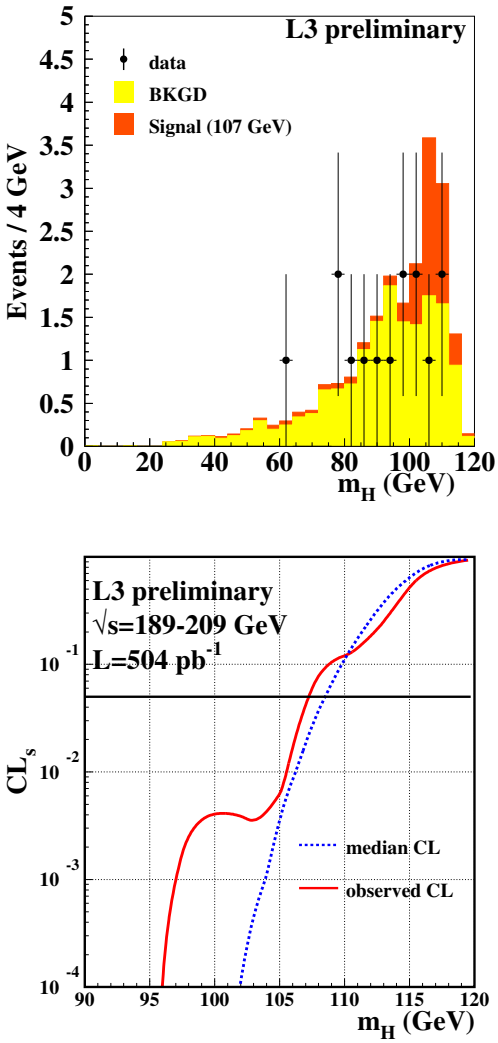

Figure 1. a) Reconstructed Higgs mass distributions in $\sqrt{s} = 203$-208 GeV data b) Observed and expected signal confidence level as a function of the Higgs mass.

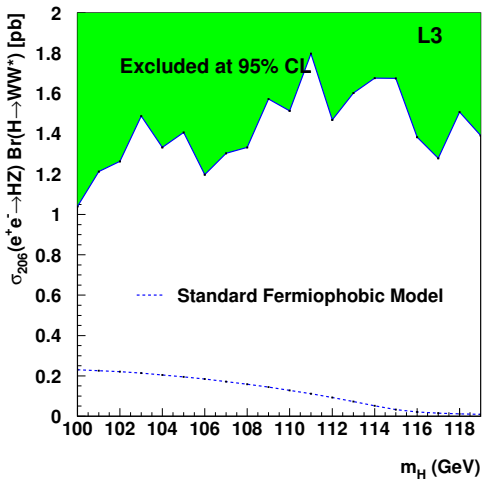

Figure 2. Observed upper limits on the Higgs cross section times the branching fraction into WWW as function of the Higgs boson mass.

sults with those of previous years a new limit on the Higgs boson mass is derived:

$$m_{\rm H} > 107.6 \text{ GeV at } 95\% \text{ CL}.$$

In the Minimal Supersymmetric Standard Model framework the search for the lightest neutral scalar and neutral pseudoscalar Higgs bosons is also updated. Lower mass limits for large values of $\tan\beta$ are set at the 95% confidence level. The observed limits are $m_{\rm h}$, $m_{\rm A} > 86.4$ GeV(expected 87.3 GeV). The search for pair produced charged Higgs bosons and for Higgs decaying in invisible particles is also updated. I want conclude with few remarks on a search performed in a new Higgs decay channel for the first time presented: the fermiophobic Higgs. The search for a fermiophobic Higgs has been carried out primarily in the H$\to\ \gamma\gamma$ channel, where the Higgs couples to the photons through a W loop. For Higgs scalars heavier than 90 GeV, however, the branching fraction of $\gamma\gamma$ predicted relative to WW* becomes very small. This motivates a search for H$\to\ WW^*$. Fig. 2 shows the observed upper limits on the Higgs cross section times the Higgs branching ratio into WW^* as function of the Higgs boson mass.

3 SUSY searches

3.1 Scalar Leptons, Scalar Quarks, Charginos and Neutralinos

In this section, the search for new particles predicted by supersymmetric theories (SUSY) is reported and limits in the Minimal Supersymmetric Standard Model (MSSM) framework are derived.

Besides the main characteristic of missing energy, supersymmetric particle signals can be further specified according to the number of leptons or the multiplicity of hadronic jets in the final state. Charginos, $\tilde{\chi}_1^{\pm}$, the supersymmetric partners of $W^{\pm}, H^{\pm}$ decay mainly to final states similar to W W, decays. For neutralinos, $\tilde{\chi}_i^0$, the supersymmetric partner of Z, γ and neutral Higgs boson we distinguish two classes of processes: $e^+e^- \to \tilde{\chi}_1^0\tilde{\chi}_2^0$ and $e^+e^- \to \tilde{\chi}_2^0\tilde{\chi}_2^0$. Both for charginos and neutralinos, the event energy is directly related to ΔM, ($\Delta M = M_{\rm SUSY} - M_{\tilde{\chi}_1^0}$), where the $\tilde{\chi}_1^0$ is supposed to be the lightest stable supersymmetric particle (LSP).

Five types of selection criteria have been optimized for all possible decays of charginos and used also for the selection of $\tilde{\chi}_2^0\tilde{\chi}_2^0$ events, which give rise to final states very similar to those of chargino pair production, even if with very different branching ratios. The signal topologies and the associated background sources depend strongly on ΔM. Therefore all six selections are optimised separately for four different ΔM ranges.

The scalar leptons, the supersymmetric partners of the right- and left- handed leptons, decay into their partner lepton and neutralino, $\tilde{\ell} \to \tilde{\chi}_1^0\ell$. Their signatures are simpler since most of the time the final state is given by two acoplanar leptons of the same family. To account for the three lepton types three different selections are performed. The

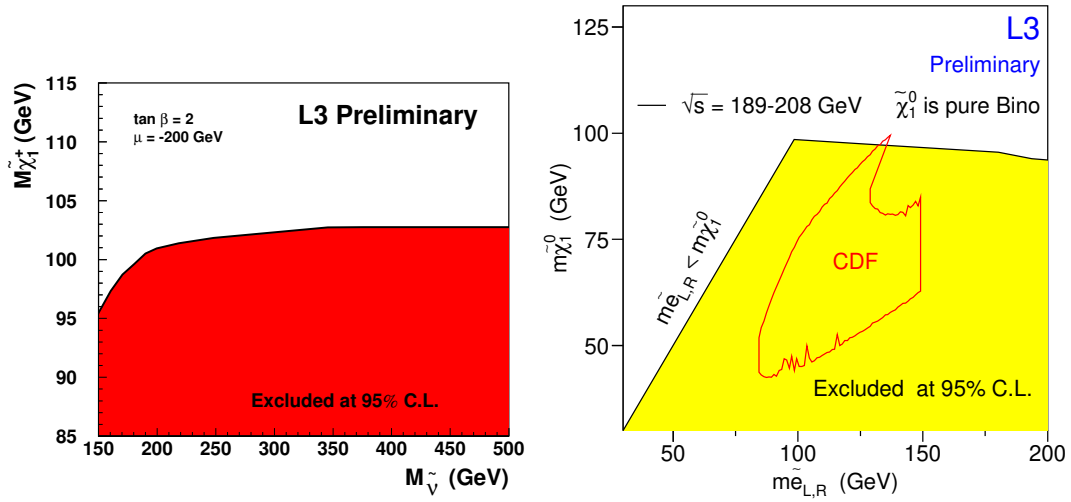

Figure 3. a) A lower limit on the chargino mass as a function of the s-neutrino mass. b) Excluded region for a pure bino neutralino model compared to the region consistent with supersymmetric interpretation of the CDF event in the scalar electron scenario.

dependence of the signals on ΔM is taken into account with three different optimisations for every selection. from Figure 3a) a limit value of $M_{\tilde{\chi}_1^1} > 102.6$ GeV is derived for high s-neutrino mass.

At LEP energies the most important process involving scalar quarks are the production of $\tilde{t}_1$ and $\tilde{b}_1$. The signal events of $\tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$ and $\tilde{t}_1 \rightarrow b\tilde{\chi}_1^0$ are characterised by two high multiplicity acoplanar jets containing c- or b-quarks. In addition to the jets two leptons are present for $\tilde{t}_1 \rightarrow b\tilde{\ell}\tilde{\nu}$ and $\tilde{t}_1 \rightarrow b\tau\tilde{\nu}$ modes. The two $\tilde{\chi}_1^0$ in the final state escape the detection leading to missing energy in the event.

No excess of events relative to what is expected from Standard Model processes is observed in scalar leptons and scalar quarks searches. The collected luminosity does not allow to improve our previous limits.

3.2 Models with light gravitinos

Single or two-photon events with missing energy could provide evidence for various processes involving supersymmetric particles like pair-production of neutralinos ($\tilde{\chi}_1^0\tilde{\chi}_1^0$, $\tilde{\chi}_1^0\tilde{\chi}_2^0$,$\tilde{\chi}_2^0\tilde{\chi}_2^0$, etc.), gravitinos ($\tilde{G}\tilde{G}$), or associated production of a neutralino and a gravitino ($\tilde{\chi}_1^0\tilde{G}$). Neutralinos, according to different supersymmetric models, can either decay as $\tilde{\chi}_2^0 \rightarrow \tilde{\chi}_1^0\gamma$ or $\tilde{\chi}_2^0 \rightarrow \tilde{G}\gamma$. Pair-production of gravitinos can be accompanied by initial state radiation. The missing energy is carried away by the weakly interacting lightest supersymmetric particle (LSP). In these models the LSP is the gravitino. In the Standard Model single or two-photon events with missing energy are produced via the reaction $e^+e^- \rightarrow \nu\bar{\nu}\gamma(\gamma)$.

The supersymmetric interpretation, with gravitino as LSP, of the $ee\gamma\gamma$ event, observed by the CDF collaboration, is almost completly ruled out by our L3 data,as shown from figure 3b.

Searches for excited leptons and for new heavy sequential leptons have been updated. No excess has been found in any channel.

References

1. L3 Collab., L3 Note 2601 (2000), contrib. paper 410 to this Conference and reference therein.