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Preliminary results on New Particle Searches at $\sqrt{s} = 203 - 208$ GeV

L3 Collaboration

Abstract

A status of the searches for new particles is presented based on approximately 90 pb^{-1} of data collected at $\sqrt{s} \simeq 203 - 208$ GeV. The observed event rates in the studied search channels are consistent with the Standard Model expectations. All quoted result are preliminary.

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1 Introduction

The status of the searches for new particles based on about 88 pb^{-1} of data collected by L3 experiment at centre-of-mass energies ranging between 203 GeV and 208 GeV is presented. The bulk of the data is taken at 205.2 GeV and 206.6 GeV

2 Higgs Searches

The Higgs particles searches are performed in the framework of different models. The details of the analysis are described in our previous publications and in the notes prepared for this conference. For the Standard Model Higgs boson search [1] The number of observed events, the background and SM signal expectations are presented in Table 1, no excess is observed.

				$m_H \geq 100$ GeV		
Channel	Data	BG	Signal	Data	BG	Signal
qqqq	9	9.9	2.8	4	2.9	2.0
qq$\nu\nu$	5	4.6	X	1	2.8	X
qq$\ell\ell$	15	18.3	1.8	2	2.6	1.3
Sum	29	32.8		7	8.3	

Table 1: The number of expected signal (Signal), background (BG) events and observed candidates (Data) after a cut on the final discriminant.

The exclusion confidence level as a function of the Higgs mass hypothesis is shown in Fig. 1. The consistency of our observation with the background only is also presented in Fig. 1. It is in good agreement with the expectations of 0.5 over the entire studied interval of Higgs masses. The negative Log likelyhood ratio is presented in Fig. 2. Combining these new results with those recently published leads to a new observed limit on the Higgs boson mass, $m_{\mathrm{H}} > 107.6$ GeV at 95% CL, the expected median limit is 108.5 GeV One of the most significant candidate events is shown in Figure 3. It was collected at $\sqrt{s} = 205$ GeV, its mass 108.4 GeV is right above the observed limit.

The search for the lightest neutral scalar and neutral pseudoscalar Higgs bosons in the Minimal Supersymmetric Standard Model is also updated [2] Lower limits on the masses of the lightest neutral scalar and pseudoscalar Higgs bosons are given as a function of $\tan\beta$ as shown Fig. 4. Lower mass limits for large values of $\tan\beta$ are set at the 95% confidence level. The observed limits are $m_{\mathrm{h}} > 86.4$ GeV and $m_{\mathrm{A}} > 86.4$ GeV, the expected limits are $m_{\mathrm{h}} > 87.3$ GeV and $m_{\mathrm{A}} > 87.3$ GeV.

The search for pair–produced charged Higgs bosons is presented [3]. Higgs decays into a charm and a strange quark or into a tau lepton and its associated neutrino are considered. The observed events are consistent with the expectations from Standard Model background processes. Fig. 5 shows the excluded regions for the charged Higgs boson at 95% CL in the plane of the branching fraction $\mathrm{Br}(\mathrm{H}^{\pm} \rightarrow \tau\nu)$ versus mass. An observed lower limit of 66.3 GeV on the charged Higgs mass is derived at 95% confidence level, independent of the decay branching ratio $\mathrm{Br}(\mathrm{H}^{\pm} \rightarrow \tau\nu)$. The expected limits is 76.1 GeV.

The search for a Higgs boson decaying into invisible particles is updated [4]. The observed candidates are consistent with the expectations from Standard Model processes. Fig. 6 shows the observed and expected upper limits on the ratio of the invisibly-decaying Higgs boson cross section to that of the Standard Model Higgs boson, as function of the Higgs boson mass. In the hypothesis that the production cross section of this Higgs boson equals the Standard Model one and the branching ratio into invisible particles is 100%, a lower mass limit of 100.0 GeV is set at 95% confidence level.

The search for a fermiophobic Higgs [5] has been carried out primarily in the H$\rightarrow$ $\gamma\gamma$ 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$\rightarrow$WW*. Fig. 7 shows the observed upper limits on the Higgs cross section times the branching ratio into WW as function of the Higgs boson mass.

3 SUSY searches

The spectrum of particles as predicted by Supersymmetry has been searched for in R parity conserving and R parity violating scenarios and for different symmetry breaking mechanisms. The details of the analysis are described in our previous publications and in the notes prepared for this conference.

3.1 Scalar Leptons, Charginos and Neutralinos

R parity conserving searches [6] use the the main characteristic of missing energy and the topology of the final state, the number of leptons or the multiplicity of hadronic jets. The event energy is directly related to ΔM, ($\Delta M = M_{\mathrm{SUSY}} - M_{\tilde{\chi}^0_1}$). The signal topologies and the associated background sources depend strongly on ΔM. Therefore all selections are optimised separately for four different ΔM, ranges: the very low ΔM, the low ΔM, the medium ΔM and the high ΔM. In the low and very low ΔM, ranges, the background is dominated by two-photon interactions. For medium and high ΔM, ranges the background is dominated by WW and ZZ events.

	Low ΔM		Medium ΔM		High ΔM		Combined	
	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}
$\tilde{\chi}^0_2$	11	13.3	1	3.5	0	1.2	12	17.4

Table 2: Results for Neutralinos searches: N_{data} is the number of observed events and N_{exp} is the number of expected events from Standard Model backgrounds for 56.7 pb^{-1} of integrated luminosity collected at $\sqrt{s} \simeq 205$ GeV.

A summary of the Neutralinos and Charginos searches is given in Tables 2, 3, 4 and 5 showing the number of candidates and expected background events. Preliminary limits on chargino pair production are derived, Figure 8 shows the lower limit on chargino mass as a function of the sneutrino mass. Using the Charginos searches we derive a lower limit on the mass of the lightest neutralino of 38.2 GeV for any m_0 and any tanβ

L3 searched also for Charginos with a small mass difference 4 GeV between the Charginos and the the lightest supersymmetric particle [7], no evidence for charginos is found. Table 6, shows the number of candidates and expected background. The background expectations are

	Low ΔM		Medium ΔM		High ΔM		Combined	
	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}
$\tilde{\chi}_2^0$	4	3.3	0	0.9	0	0.3	4	4.3

Table 3: Results for Neutralinos searches: N_{data} is the number of observed events and N_{exp} is the number of expected events from Standard Model backgrounds in the high energy $\sqrt{s} \simeq 207$ GeV subsample corresponding to 14 pb^{-1} of integrated luminosity.

	Low ΔM		Medium ΔM		High ΔM		Combined	
	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}
$\tilde{\chi}^{\pm}$	20	17.7	17	10.5	9	13.8	44	37.4

Table 4: Results for Charginos searches: N_{data} is the number of observed events and N_{exp} is the number of expected events from Standard Model backgrounds for 84 pb^{-1} of integrated luminosity collected at $\sqrt{s} \simeq 205 - 207$ GeV.

	Low ΔM		Medium ΔM		High ΔM		Combined	
	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}
$\tilde{\chi}^{\pm}$	7	5.4	3	3.4	3	4.6	13	12.4

Table 5: Results for Charginos searches: N_{data} is the number of observed events and N_{exp} is the number of expected events from Standard Model backgrounds for 28 pb^{-1} of integrated luminosity collected at $\sqrt{s} \simeq 207$ GeV.

derived assuming no signal in 1998 and 1999 and rescaling the number of events to the luminosity collected this year.

selection	low ΔM $\Delta M \sim$ 3GeV	very low ΔM $\Delta M \sim$ 1GeV	ultra low ΔM $\Delta M \sim$ 300MeV	OR
1998 (176 pb^{-1})	6	1	1	8
1999 (232 pb^{-1})	8	4	2	9
2000 (76.5 pb^{-1})	3	1	3	5
98-99 scaled	2.6 ± 0.7	0.9 ± 0.4	0.6 ± 0.3	3.2 ± 0.8

Table 6: Results for Charginos searches at very low ΔM: at $\sqrt{s} \simeq 205 - 207$ GeV.

The search for Scalar leptons is updated [8] A summary of the searches is given in Table 7 showing the number of candidates and expected background events.

In this year data only a one standard deviation excess is observed in the high ΔM, $\tilde{\tau}$ analysis. Figures 9 show the exclusion contours in the $M_{\tilde{\chi}_1^0} - M_{\tilde{\ell}_R^{\pm}}$ plane.

In the search for $\tilde{\mathrm{e}}_L\tilde{\mathrm{e}}_R$ with $\tilde{\mathrm{e}}_R$ mass degenerate with $\tilde{\chi}_1^0$, we observe a slight excess of data in the single electron channel as it can be seen in in Table 8

	Low ΔM		Medium ΔM		High ΔM		Total	
	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}	N_{data}	N_{exp}
$\tilde{e}$	9	9.9	0	4.3	5	9.2	14	20.4
$\tilde{\mu}$	17	13.6	6	5.4	14	12.8	33	27.5
$\tilde{\tau}$	76	66.4	21	21.6	17	12.5	89	76.6

Table 7: Results for slepton searches: at $\sqrt{s} \simeq 205$ GeV.

$\sqrt{s}$	Single-electron		Hard + soft	
	N_{Data}	N_{Exp}	N_{Data}	N_{Exp}
192 GeV	2	1.8	3	2.2
196 GeV	7	6.0	8	7.0
200 GeV	9	6.4	10	7.3
202 GeV	5	2.8	8	3.4
205-207 GeV	8	7.0	9	7.9
All $\sqrt{s}$	31	24.0	38	27.8

Table 8: Results for $\tilde{e}_R$ $\tilde{e}_L$ ($\tilde{e}_R$mass degenerate with $\tilde{\chi}_1^0$) searches up to 205 GeV.

3.2 Scalar Quarks

The search for Scalar quarks is updated [9] A summary of the searches is given in Table 9 showing the number of candidates and expected background events. The overall results is: 47 events selected in data for 35.3 events expected from Standard Model backgrounds.

Channel	Vlow ΔM		Low ΔM		Medium ΔM		High ΔM		OR	
	Data	N_{MC}^{all}	Data	N_{MC}^{all}	Data	N_{MC}^{all}	Data	N_{MC}^{all}	Data	N_{MC}^{all}
$\tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$	21	14.2	0	2.1	3	2.0	4	3.0	28	21.1
$\tilde{t}_1 \rightarrow b\ \ell\ \tilde{\nu}$	10	8.1	5	2.5	1	0.2	-	-	16	10.6
$\tilde{t}_1 \rightarrow b\ \tau\ \tilde{\nu}$	4	5.0	2	4.1	1	0.9	-	-	7	9.3
$\tilde{b}_1 \rightarrow b\tilde{\chi}_1^0$	13	9.9	1	1.4	0	0.3	0	0.3	14	11.7

Table 9: Number of observed events, N_{data}, and Standard Model background expectations, N_{MC}^{all}, for the stop and sbottom selections at $\sqrt{s}$= 205 GeV with a luminosity of L=49.3pb^{-1}

3.3 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 ($\tilde{\mathrm{G}}\tilde{\mathrm{G}}$), or associated production of a neutralino and a gravitino ($\tilde{\chi}^0_1\tilde{\mathrm{G}}$). Neutralinos, according to different supersymmetric models, can either decay to $\tilde{\chi}^0_2 \rightarrow \tilde{\chi}^0_1\gamma$ or to $\tilde{\chi}^0_1 \rightarrow \tilde{\mathrm{G}}\gamma$. 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) which is stable under the assumption of R-parity conservation. In the Minimal Supersymmetric Standard Model (MSSM) with gravity-mediated supersymmetry (SUSY) breaking, the LSP is the lightest neutralino. There are models, where the LSP is instead the gravitino. A light gravitino as LSP appears in models with different SUSY breaking mechanisms like Gauge-Mediated SUSY Breaking (GMSB).

In the Standard Model single or two-photon events with missing energy are produced via the reaction $\mathrm{e^+e^-} \rightarrow \nu\bar{\nu}\gamma(\gamma)$ which can proceed through s–channel Z exchange or t–channel W exchange.

Single and multi-photon events with missing energy are analysed as described in [10]. Figure 10 shows the energy spectrum of the most energetic photon normalised to the beam energy for single and multi-photon events.

We analyse also two photons events as expected from the $\nu\bar{\nu}\gamma\gamma(\gamma)$ process. Here, the definition of events with two photons requires a minimum energy for the second photon of 1GeV. Figure 11 shows the two-photon recoil mass distribution for data and Monte Carlo prediction.

Figure 12 shows the exclusion in the $\tilde{\chi}^0_1 - \tilde{\mathrm{e}}_{\mathrm{L,R}}$ mass plane derived with our data for a neutralino being pure bino. The $\mathrm{ee}\gamma\gamma$ event observed by CDF also has an interpretation in supersymmetric models with gravitino LSP. Our analysis almost rules out this interpretation as shown in figure 12.

3.4 Charginos and Neutralinos with $\not{R}_p$ violating decays

Assuming that the LSP is the lightest neutralino ($\tilde{\chi}^0_1$) , for the λ'' coupling we study the following processes:

$$\mathrm{e^+e^-} \rightarrow \tilde{\chi}^0_1\ \tilde{\chi}^0_1\ \rightarrow qqqqqq$$

$$\mathrm{e^+e^-} \rightarrow \tilde{\chi}^+_1\ \tilde{\chi}^-_1\ \rightarrow \tilde{\chi}^0_1\ \tilde{\chi}^0_1\ W^{+*}\ W^{-*} \rightarrow qqqqqq\ f\ f'\ f''\ f'''$$

$$\mathrm{e^+e^-} \rightarrow \tilde{\ell}^+\tilde{\ell}^-\ \rightarrow \tilde{\chi}^0_1\ \tilde{\chi}^0_1\ ll \rightarrow \ell^+\ qqq\ \ell^-\ qqq$$

where q stands for quark or antiquark and f for any fermion or anti-fermion according to the charge of the mother particle.

The analysis described in [11] is updated. Table 10 contains the results of 192-202 GeV selections applied to the 203 - 208 GeV data sample collected this year, no excess is observed. Figure 13 shows the 95% C.L. lower limits on the masses of $\tilde{\chi}^0_1$ (a), $\tilde{\chi}^0_2$ (b) and $\tilde{\ell}^{\pm}$ as a function of $\tan\beta$, for different values of m_0.

4 Search for Excited Leptons

Excited leptons can be produced either in pairs ($e^+e^- \rightarrow l^*l^*$) or singly ($e^+e^- \rightarrow ll^*$). An excited lepton is expected to decay immediately into its corresponding standard lepton and a gauge boson. The decay of excited leptons is described by an effective Lagrangian with two

R–Parity violation results for $<\sqrt{s}> = 205.6$ GeV $\mathcal{L} = 92.1\ pb^{-1}$			
Signal	N observed	N expected	σ excluded (pb)
$\tilde{\chi}_1^0\tilde{\chi}_1^0 \rightarrow qqq\ qqq$	140	130	0.32–0.66
$\tilde{\chi}_1^+\tilde{\chi}_1^- \rightarrow W^*\ W^*\ qqq\ qqq$	87	88.0	0.28–0.39
$\tilde{\ell}^+\tilde{\ell}^- \rightarrow \ell^+\ qqq\ \ell^-\ qqq$	69	85.0	0.07–0.62

Table 10: Preliminary results from 205 GeV DATA analysis.

free parameters, f and f'. The corresponding branching ratios are determined by the flavour and mass of the excited lepton, and the ratio of the coupling constants f and f'.

We report on a search for excited electrons, muons, taus and neutrinos in e^+e^-collisions at centre-of-mass energies above 200 GeV, using the L3 detector at LEP. The analysis is similar to that described in our previous paper [12]. No evidence has been found for their existence. From a search for pair produced excited leptons, we determine lower mass limits for excited electrons, muons, taus, and neutrinos. From a search for singly produced excited leptons we derive upper limits on their coupling constants.

<table>
<tr><th>Signal</th><th colspan="3">Final State</th></tr>
<tr><td>e^*e^*</td><td>$ee\gamma\gamma$</td><td rowspan="3">$\nu\nu$WW</td><td>$e\gamma\nu$W</td></tr>
<tr><td>$\mu^*\mu^*$</td><td>$\mu\mu\gamma\gamma$</td><td>$\mu\gamma\nu$W</td></tr>
<tr><td>$\tau^*\tau^*$</td><td>$\tau\tau\gamma\gamma$</td><td>$\tau\gamma\nu$W</td></tr>
<tr><td>$\nu_e^*\nu_e^*$</td><td rowspan="3">$\nu\nu\gamma\gamma$</td><td>eeWW</td><td>$\nu\gamma e$W</td></tr>
<tr><td>$\nu_\mu^*\nu_\mu^*$</td><td>$\mu\mu$WW</td><td>$\nu\gamma\mu$W</td></tr>
<tr><td>$\nu_\tau^*\nu_\tau^*$</td><td>$\tau\tau$WW</td><td>$\nu\gamma\tau$W</td></tr>
</table>

Table 11: Final states considered in the search for excited leptons produced in pairs.

<table>
<tr><th>Signal</th><th colspan="3">Final State</th></tr>
<tr><td>ee^*</td><td>$ee\gamma$</td><td>$e\nu$W</td><td>eeZ</td></tr>
<tr><td>$\mu\mu^*$</td><td>$\mu\mu\gamma$</td><td>$\mu\nu$W</td><td>$\mu\mu$Z</td></tr>
<tr><td>$\tau\tau^*$</td><td>$\tau\tau\gamma$</td><td>$\tau\nu$W</td><td>$\tau\tau$Z</td></tr>
<tr><td>$\nu_e\nu_e^*$</td><td rowspan="3">$\nu\nu\gamma$</td><td>νeW</td><td rowspan="3">$\nu\nu$Z</td></tr>
<tr><td>$\nu_\mu\nu_\mu^*$</td><td>$\nu\mu$W</td></tr>
<tr><td>$\nu_\tau\nu_\tau^*$</td><td>$\nu\tau$W</td></tr>
</table>

Table 12: Final states considered in the search for excited leptons produced singly.

In tables 11 and 12 we summarise the final states considered in the pair and singly produced searches.

The detection efficiency for the signal is estimated with the EL2 (pair production) and EL1 (single production) Monte Carlo generators.

In tables 13 and 15 we summarise the number of candidates as well as the expected backgrounds and the efficiencies of the selections. In table 14 we show the 95% confidence level lower limits to the mass of excited leptons obtained from pair production searches.

Signal	Data	Bkg (S.M.)	Eff
$e^*e^* \to ee\gamma\gamma$	0	0.3	46.4%
$\mu^*\mu^* \to \mu\mu\gamma\gamma$	0	0.2	44.4%
$\tau^*\tau^* \to \tau\tau\gamma\gamma$	0	0.1	43.1%
$\nu^*\nu^* \to \nu\nu\gamma\gamma$	1	0.7	44.9%
$\ell^*\ell^* \to \nu\nu WW$	1311	1255	64.9%
$\nu_e^*\nu_e^* \to eeWW$	0	0.1	19.1%
$\nu_\mu^*\nu_\mu^* \to \mu\mu WW$	0	0.3	21.8%
$\nu_\tau^*\nu_\tau^* \to \tau\tau WW$	1311	1255	69.1%
$e^*e^* \to e\gamma\nu W$	3	2.6	51.4%
$\mu^*\mu^* \to \mu\gamma\nu W$	1	1.3	36.8%
$\tau^*\tau^* \to \tau\gamma\nu W$	15	13	31.7%
$\nu_e^*\nu_e^* \to \nu\gamma eW$			33.3%
$\nu_\mu^*\nu_\mu^* \to \nu\gamma\mu W$	2	2.3	24.7%
$\nu_\tau^*\nu_\tau^* \to \nu\gamma\tau W$			15.9%

Table 13: Results from the searches for pair produced excited leptons. The second column shows the number of selected events, whereas the third one shows the number of expected events from Standard Model. The fourth column shows the percentage of Monte Carlo signal events that were selected as candidates.

Excited Lepton	95% CL Mass Limit (GeV)		
Coupling	$f = f'$	$f = -f'$	Coup. Indep.
e^*	102.5	95.9	95.7
μ^*	102.5	95.9	95.9
τ^*	102.4	95.9	94.9
ν_e^*	101.5	102.1	101.3
ν_μ^*	101.8	102.1	101.3
ν_τ^*	93.5	101.9	92.7

Table 14: 95% confidence level lower mass limits for excited leptons. These limits are derived from the combined searches for pair produced excited leptons decaying radiatively and weakly.

Figures 14 shows the 95% confidence level upper limit on the coupling constant $|f|/\Lambda$, as a function of the excited lepton mass with $f = f'$.

5 Search for New Heavy Sequential Leptons

We report preliminary results of a search for unstable neutral and stable charged heavy leptons. The search on unstable heavy leptons is based on 88 of data collected at $\sqrt{s} = 203$ to 208 GeV. The search on stable charged heavy lepton is based on 23 pb^{-1} of data collected at $\sqrt{s} = 192$ GeV.

The expected experimental signature in the search for unstable neutral heavy lepton $L^0\overline{L}^0$ is at least two isolated leptons with the same flavour. The analysis approach is described in our

Signal	Data	Bkg (S.M.)	Efficiency for different m_* (GeV)		
			100	150	195
$ee^* \to ee\gamma$	283	307	51.6%	64.7%	66.0%
$\mu\mu^* \to \mu\mu\gamma$	23	29	59.6%	63.3%	59.8%
$\tau\tau^* \to \tau\tau\gamma$	17	26	44.3%	44.1%	38.7%
$\nu\nu^* \to \nu\nu\gamma$	65	86	53.1%	67.9%	70.0%
$ee^* \to e\nu_e W$	313	319	75.8%	74.0%	51.6%
$\nu_e\nu_e^* \to \nu_e e W$			59.5%	68.9%	66.2%
$\mu\mu^* \to \mu\nu_\mu W$	274	289	61.1%	64.6%	55.6%
$\nu_\mu\nu_\mu^* \to \nu_\mu \mu W$			67.8%	64.5%	62.8%
$\tau\tau^* \to \tau\nu_\tau W$	552	540	55.8%	54.5%	54.2%
$\nu_\tau\nu_\tau^* \to \nu_\tau \tau W$			46.4%	60.6%	61.4%
$ee^* \to eeZ$	287	287	70.9%	26.4%	75.6%
$\mu\mu^* \to \mu\mu Z$	243	255	62.3%	40.3%	52.9%
$\tau\tau^* \to \tau\tau Z$	529	509	42.5%	21.6%	37.7%
$\nu\nu^* \to \nu\nu Z$	143	149	31.9%	13.9%	40.2%

Table 15: Number of candidates for excited leptons obtained from the searches for singly produced excited leptons. The second column shows the number of selected events, whereas the third one shows the number of expected events from Standard Model. The columns 4-6 show the percentage of Monte Carlo signal events that were selected as candidates for different masses of excited leptons.

previous publication [13]. No signal was found after selection cuts. The number of candidates found in data are consistent with expected number of background events from known processes (see Table 16).

Channel	Data	Background
$L^0 \to e^\pm W^\mp$	1	1.5
$L^0 \to \mu^\pm W^\mp$	1	0.4
$L^0 \to \tau^\pm W^\mp$	15	19.3

Table 16: Numbers of the candidates and expected background

If the associated neutral heavy lepton L^0 is heavier than its charged partner $L^\pm$ and there is no or very small mixing into light neutrinos, then the charged heavy lepton should be stable in the detector. The experimental signature of the production of stable charged heavy lepton is two back to back highly ionising charged tracks, and the search for this particle is based on the ionisation loss measurement in the tracking device [13]. There were no signal events observed in the data (see Figure 15). This corresponds to a mass limit of $m_{L^\pm} > 102.4$ GeV.

6 Conclusions

Approximately 90 pb^{-1} of data collected at $\sqrt{s} \simeq 203 - 208$ GeV are used to update searches results. The observed event rates in the studied search channels are consistent with the Standard Model expectations. No evidence for production of new particles is observed.

References

[1] L3 Collaboration, M. Acciarri *et al.*, Phys. Lett. B 461 /4 (Sept.2, 1999) 376-386.
L3 Collab., L3 Note xxxx (2000)

[2] L3 Collaboration, M. Acciarri et al., Phys. Let. B 471 (1999) 321-331
L3 Collab., L3 Note 2573 (2000)

[3] L3 Collaboration, M. Acciarri et al., Phys. Lett. B 466/1 (28 October, 1999) 71-78.
L3 Collab., L3 Note 2549 (2000)

[4] L3 Collab., M. Acciarri et al., CERN-EP-2000-047; 29 March 2000.
L3 Collab., L3 Note 2593 (2000)

[5] L3 Collab., L3 Note 2590 (2000)
L3 Collab., L3 Note 2592 (2000)

[6] L3 Collaboration, M. Acciarri et al., Phys. Lett. B 472 (2000) 420-433
L3 Collab., L3 Note 2583 (2000)

[7] L3 Collab., L3 Note 2582 (2000)

[8] L3 Collaboration, M. Acciarri et al., Physics letters B 471 (1999) 280-292
L3 Collab., L3 Note 2586 (2000)

[9] L3 Collab., L3 Note 2587 (2000)

[10] L3 Collaboration, M. Acciarri et al., Phys. Lett. B 470 (1999) 268-280.
L3 Collab., L3 Note 2584 (2000)

[11] L3 Collab., M. Acciarri et al., Phys. Lett. B 459 (vol 1-3) (Jul-1999) 354-366
L3 Collab., L3 Note 2585 (2000)

[12] L3 Collab., M. Acciarri *et al.*, Phys. Let. B 473 (2000) 177-185
L3 Collab., L3 Note 2572 (2000)

[13] L3 Collaboration, M. Acciarri et al., Phys. Lett. B 462 /3-4 (Sept.16, 1999) 354-364.
L3 Collab., L3 Note 2550 (2000)

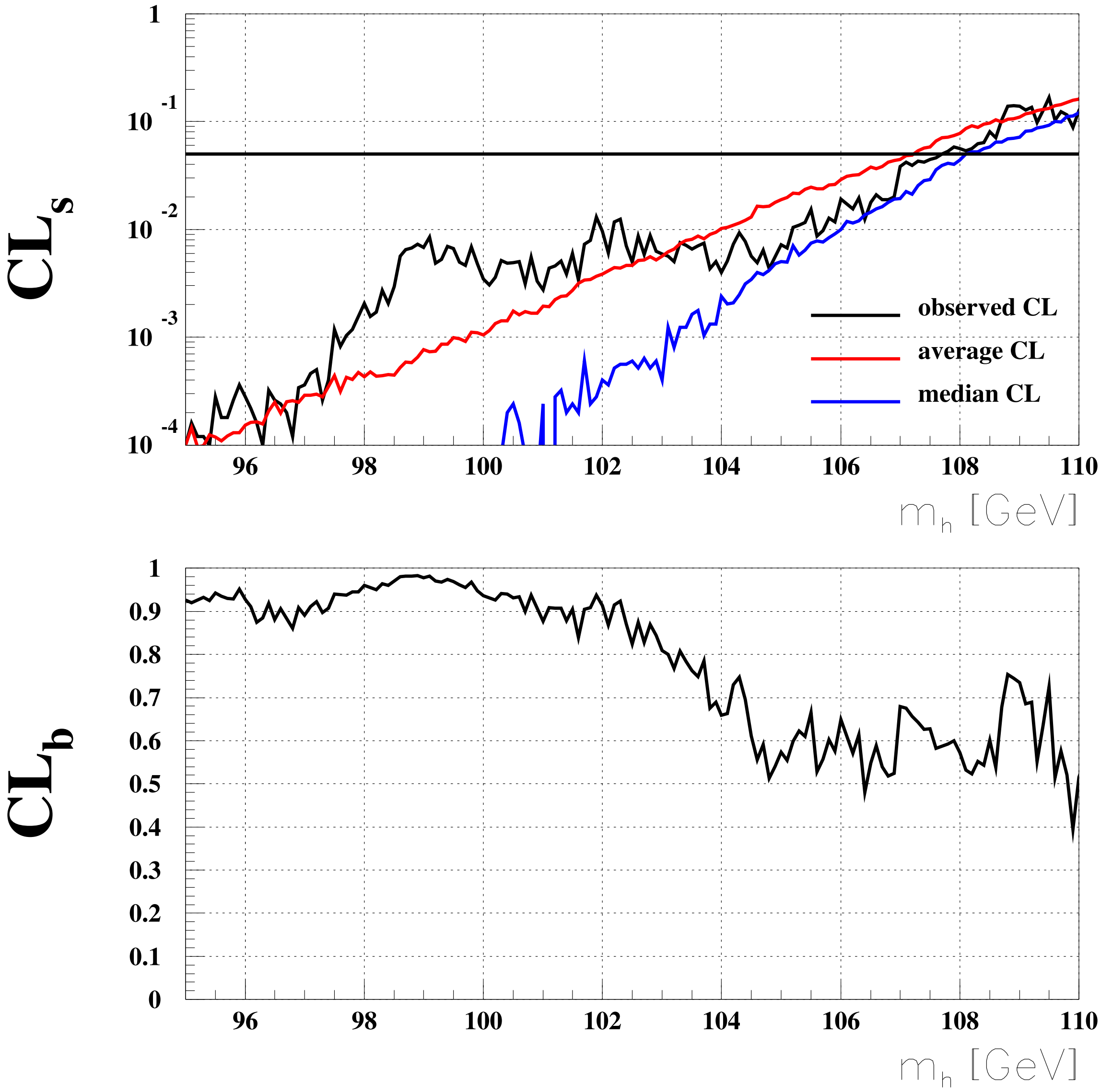

Figure 1: CLS: observed and expected median confidence levels as a function of the Higgs mass. CLB: probability that our observation is consistent with the "background only" hypothesis as a function of Higgs mass. New data are combined with previous L3 published results.

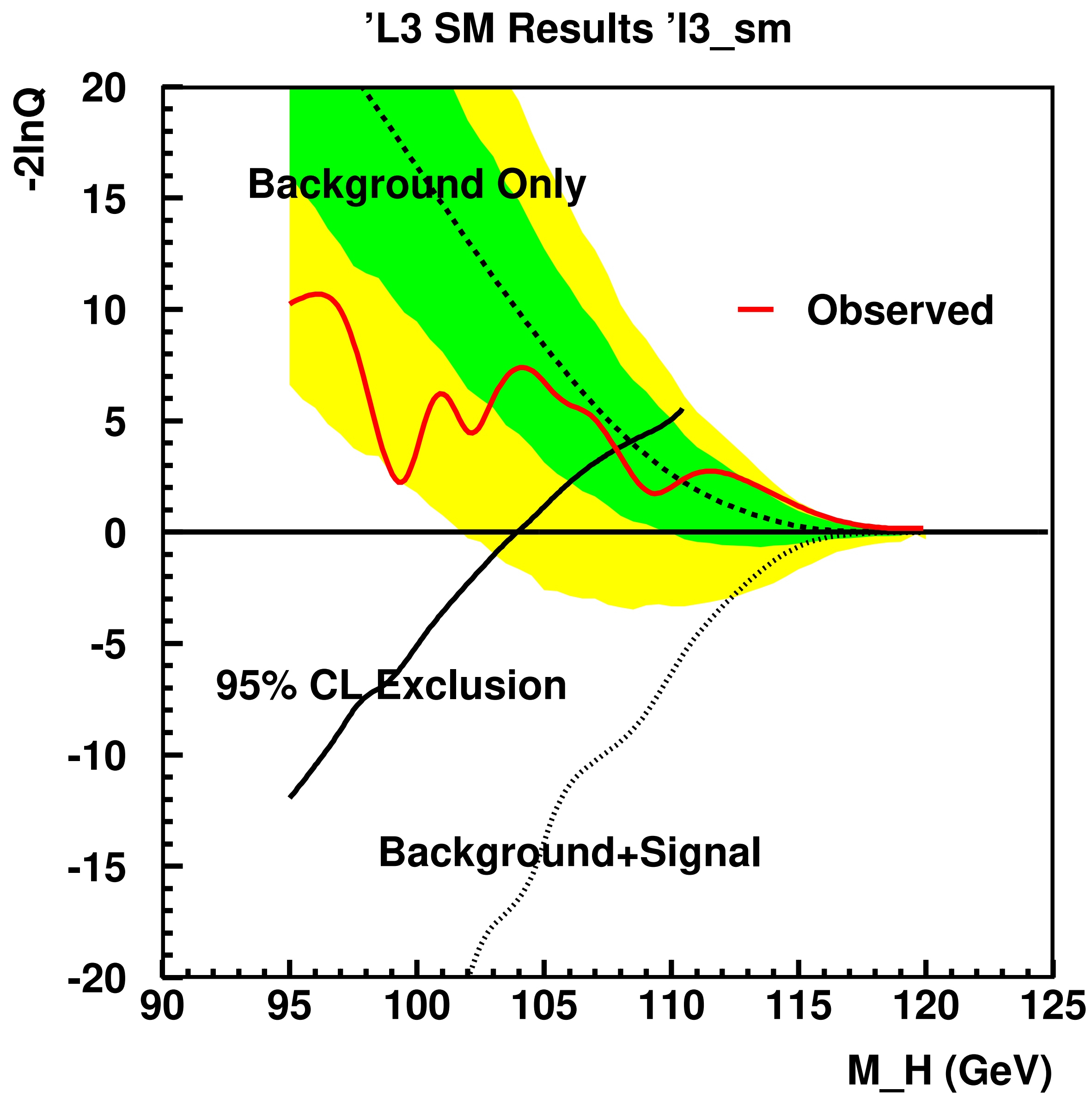

Figure 2: Negative Log Likelihood Ratio, $Q = \frac{\mathcal{L}(s+b)}{\mathcal{L}(b)}$

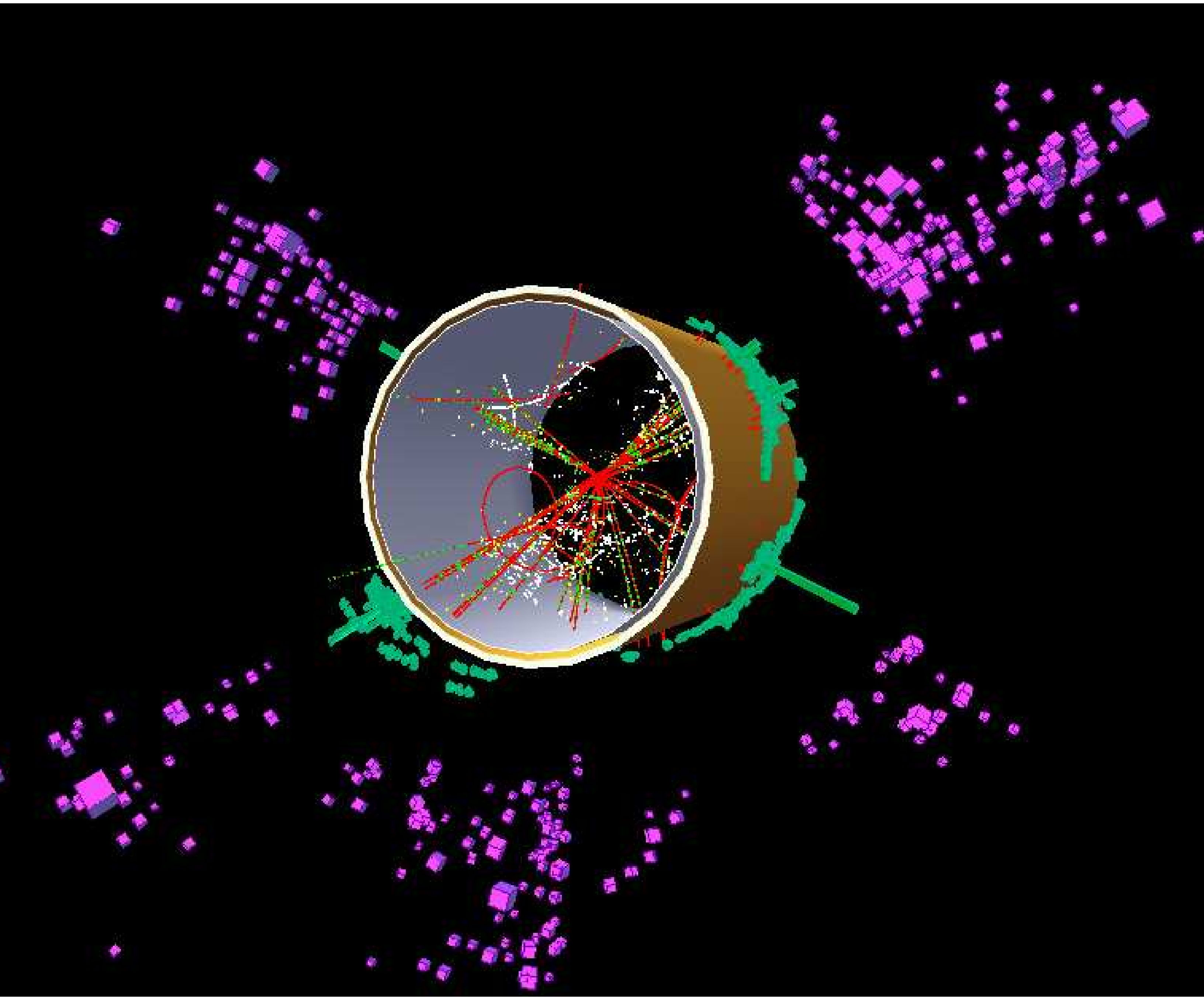

Figure 3: $e^+e^- \to HZ$ candidate event. It was collected at $\sqrt{s} = 205$ GeV, its mass is 108.4 GeV is right above the observed limit.

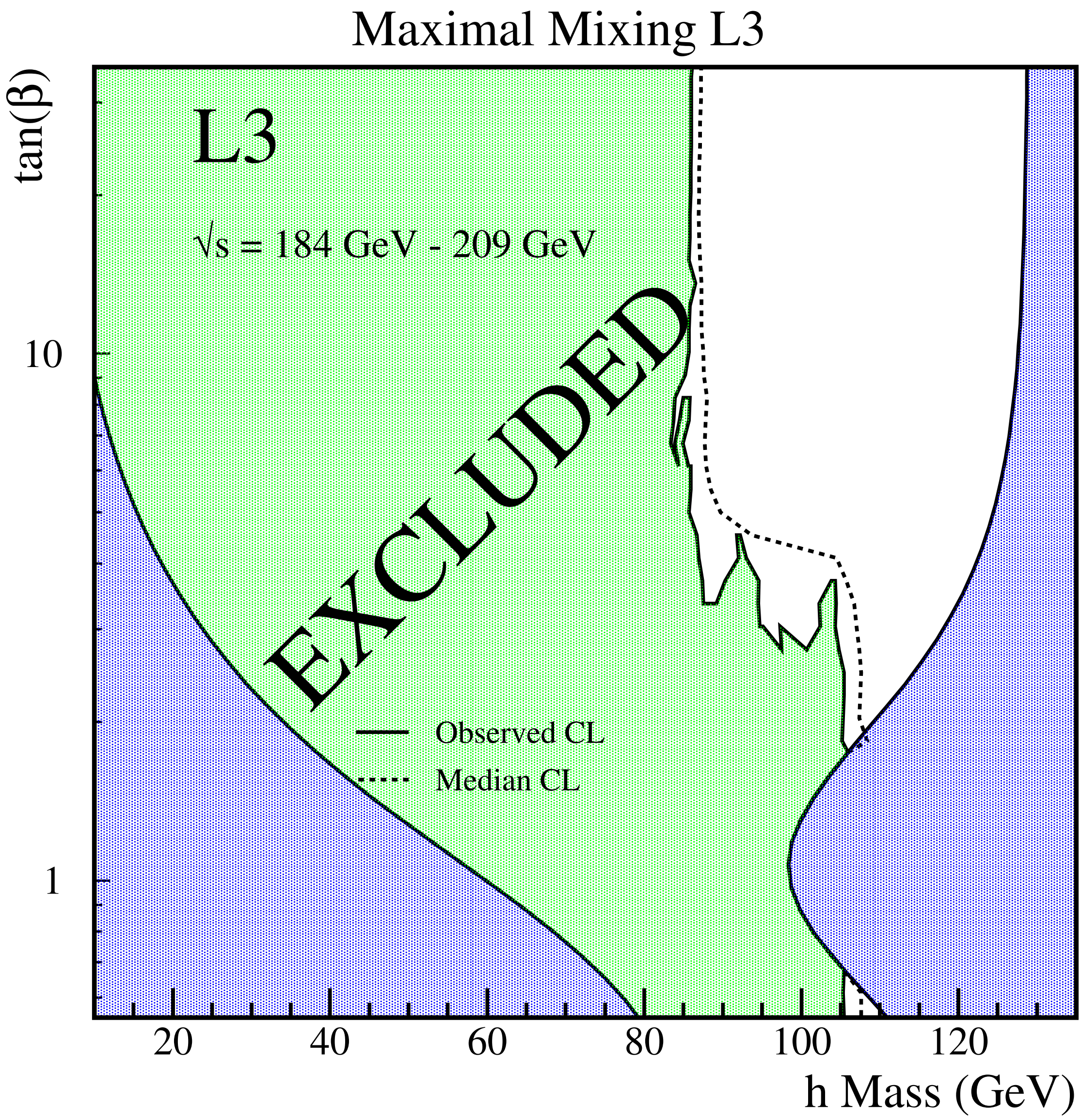

Figure 4: Exclusion plots of the Higgs mass m_{H} versus tanβ at the 95% confidence level. In all plots the area shaded by diagonal lines is the 95% exclusion, while the cross-hatched region is theoretically disallowed.

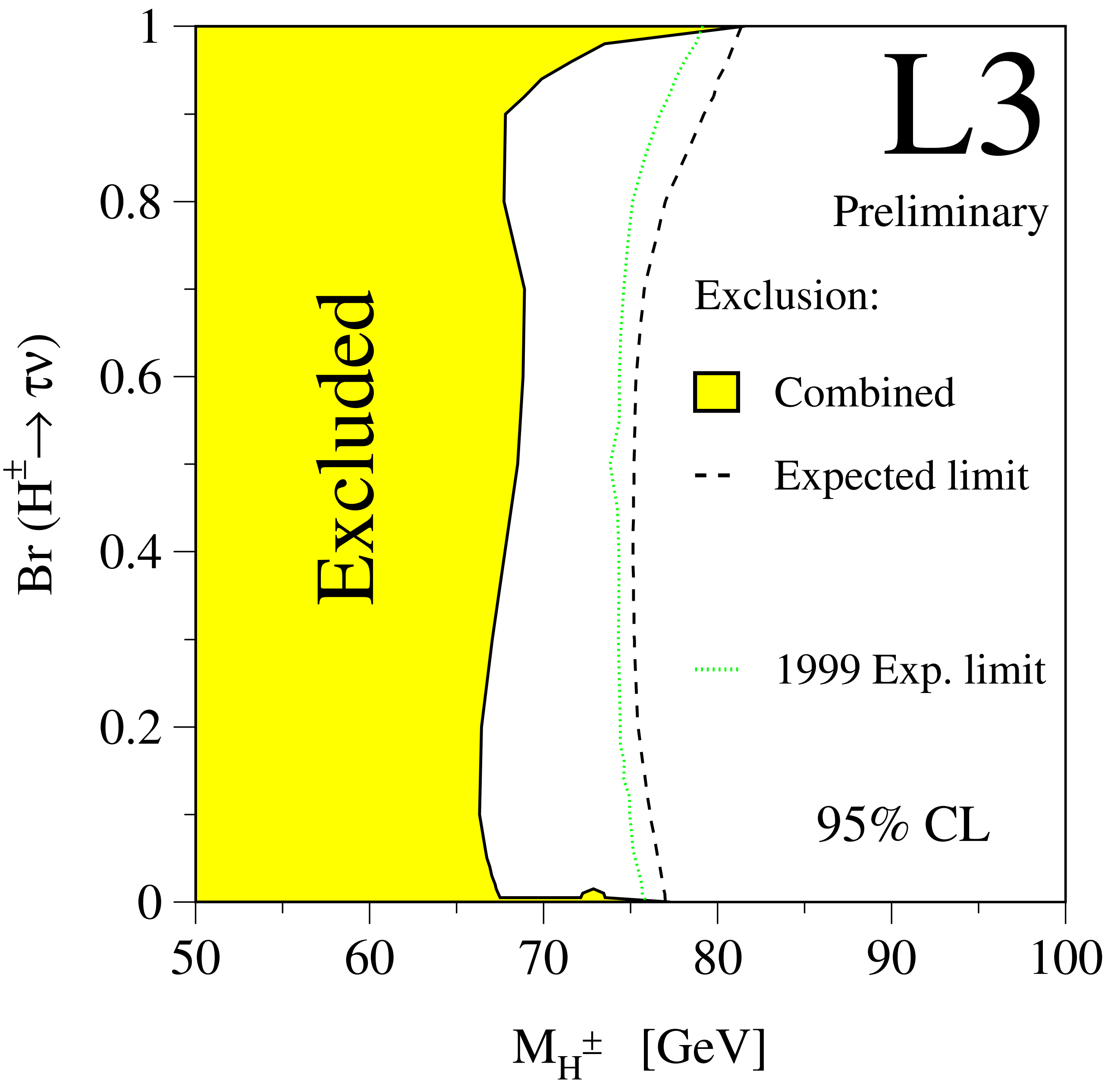

Figure 5: Excluded regions for the charged Higgs boson at 95% CL in the plane of the branching fraction $\mathrm{Br}(\mathrm{H}^{\pm} \rightarrow \tau\nu)$ versus mass. The dashed line indicates the median expected exclusion in the absence of a signal.

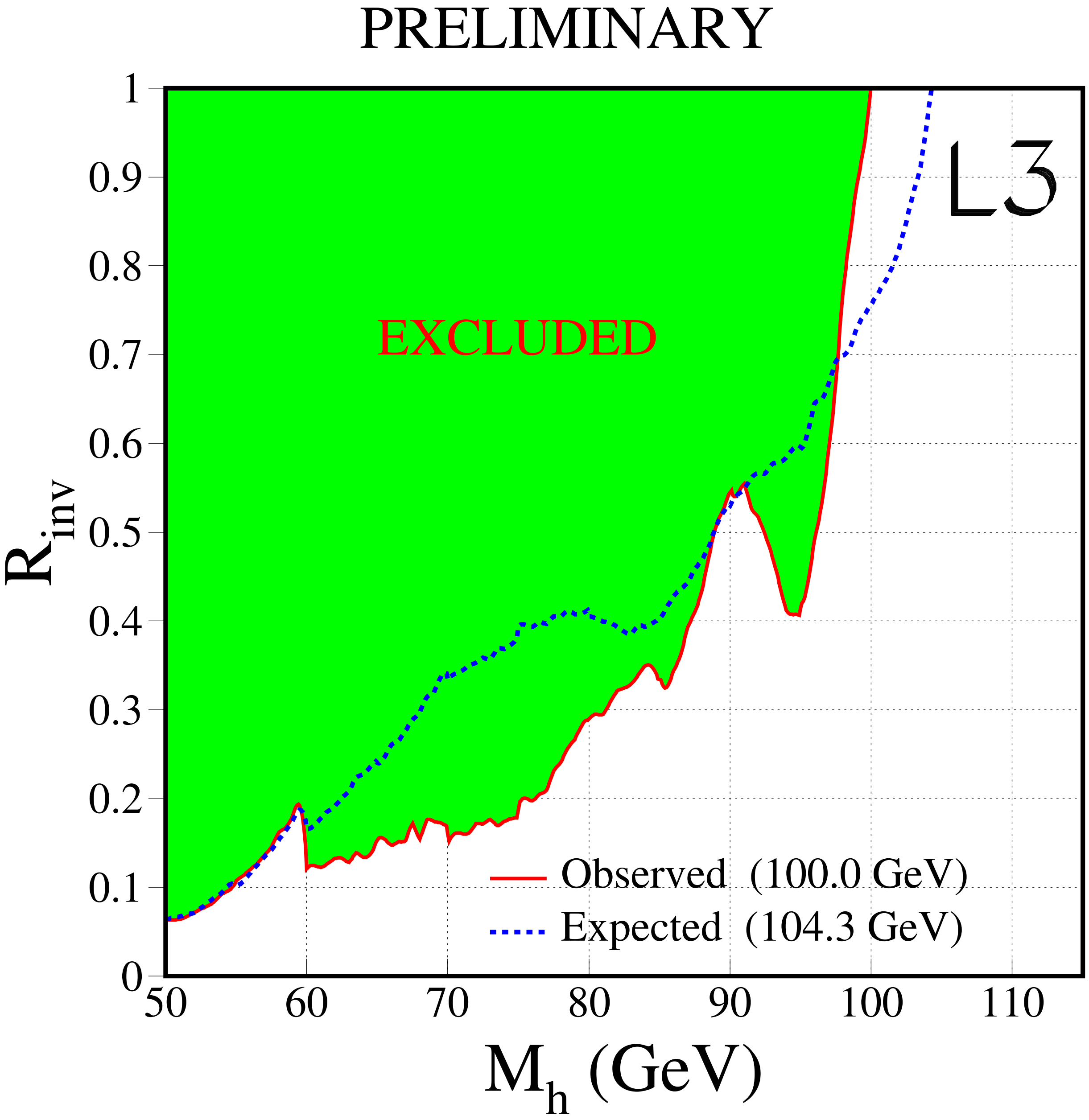

Figure 6: Observed and expected upper limits on the ratio of the invisibly-decaying Higgs boson cross section to that of the Standard Model Higgs boson, as function of the Higgs boson mass. The shaded area is excluded at least at 95% confidence level.

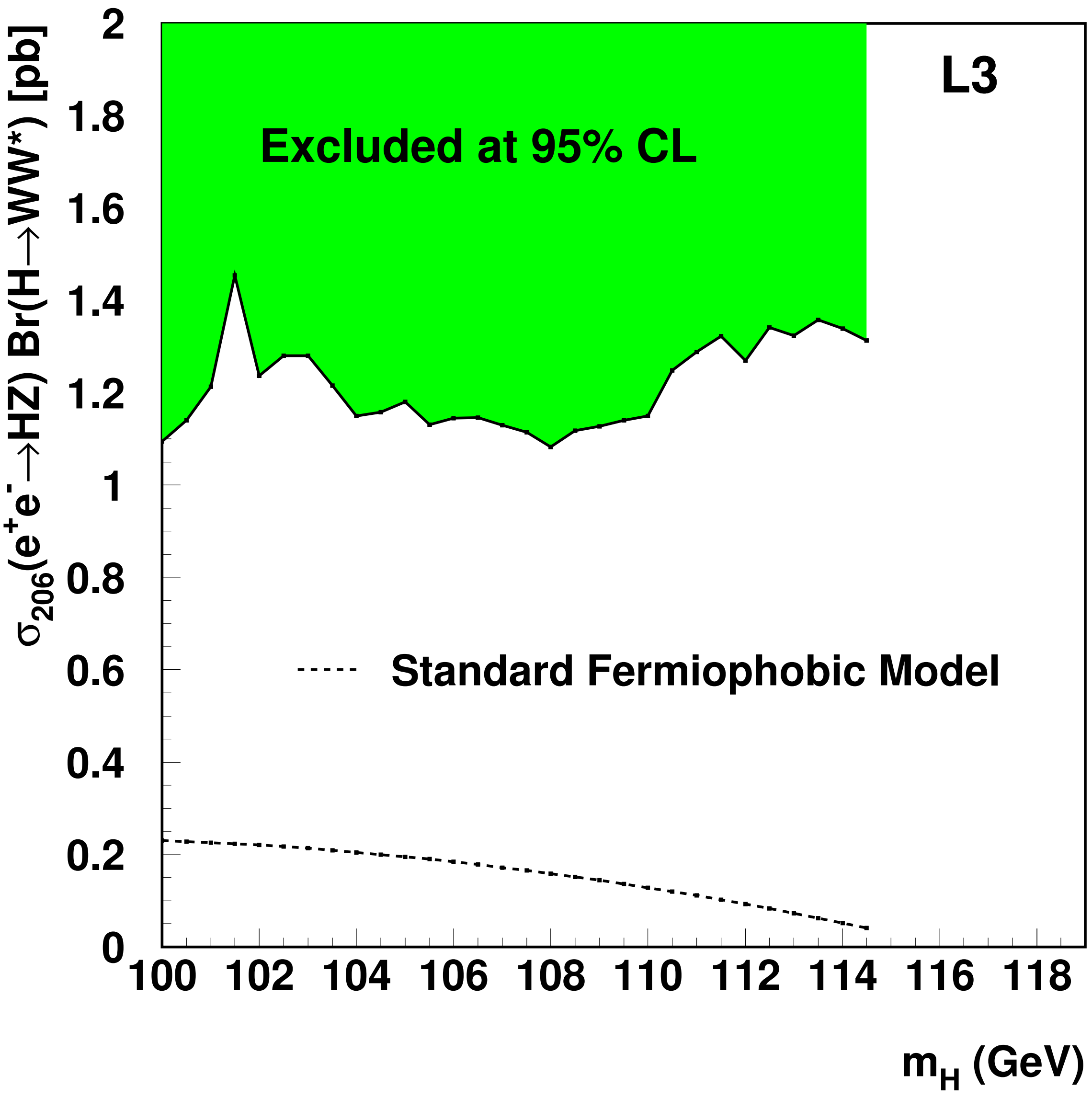

Figure 7: Observed upper limits on the Higgs cross section times the branching fraction into WW as function of the Higgs boson mass.

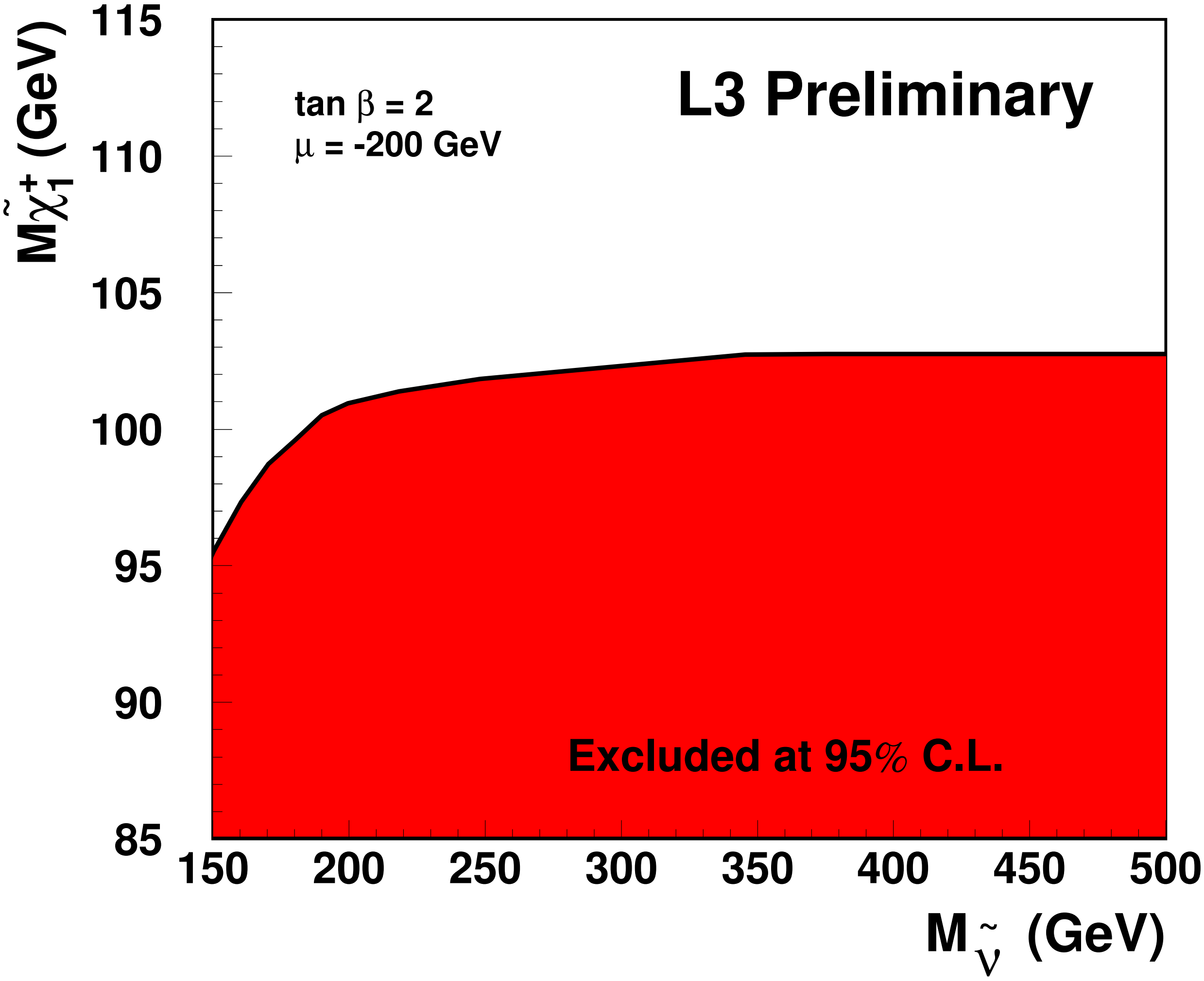

Figure 8: Lower limit on chargino mass as a function of sneutrino mass.

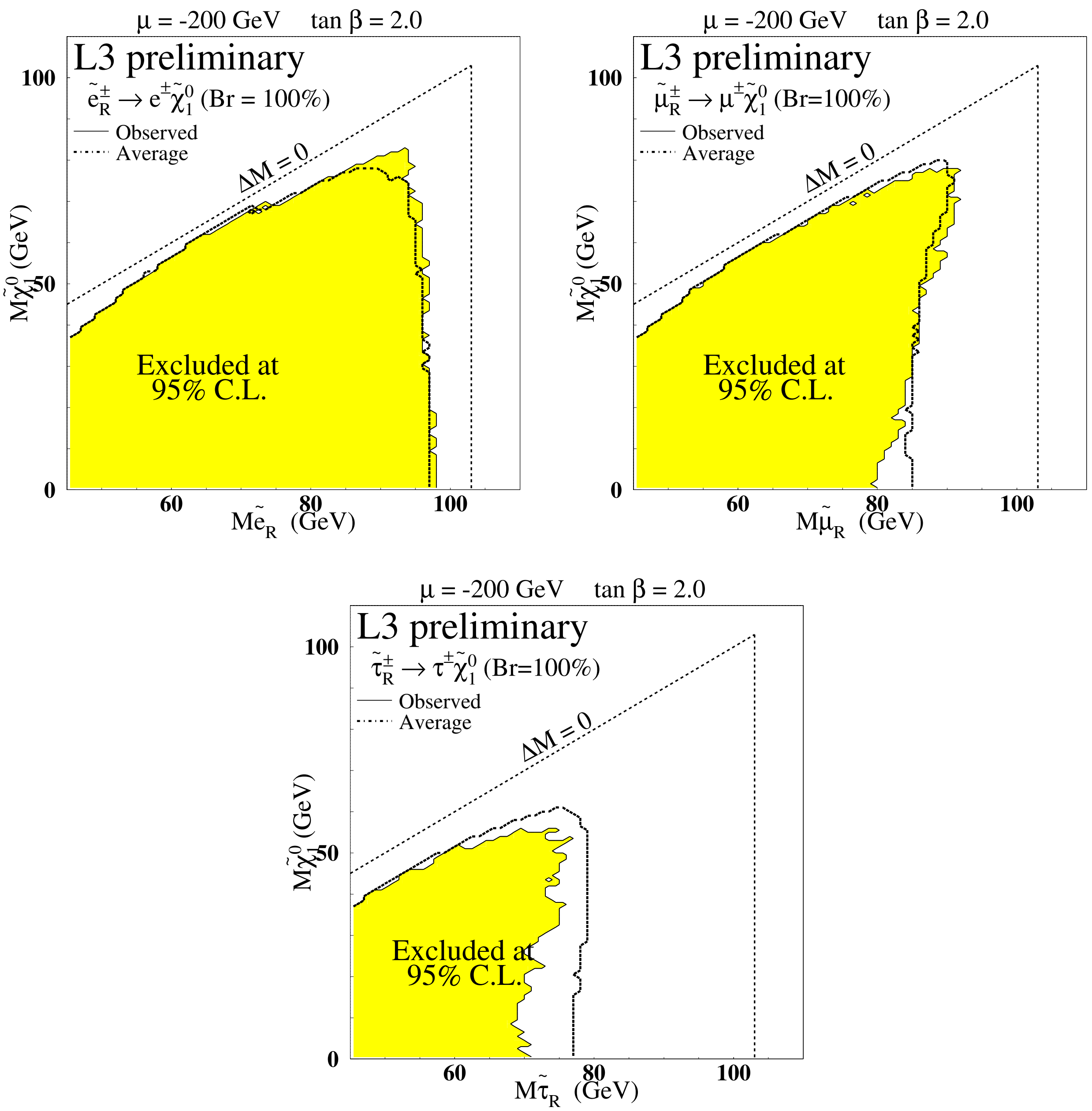

Figure 9: Mass limits on the scalar partners of right-handed electrons a), muons b) and taus c) as a function of the neutralino mass $M_{\tilde{\chi}^0_1}$.
The dashed lines show the average limits obtained with Monte Carlo trials with background only.

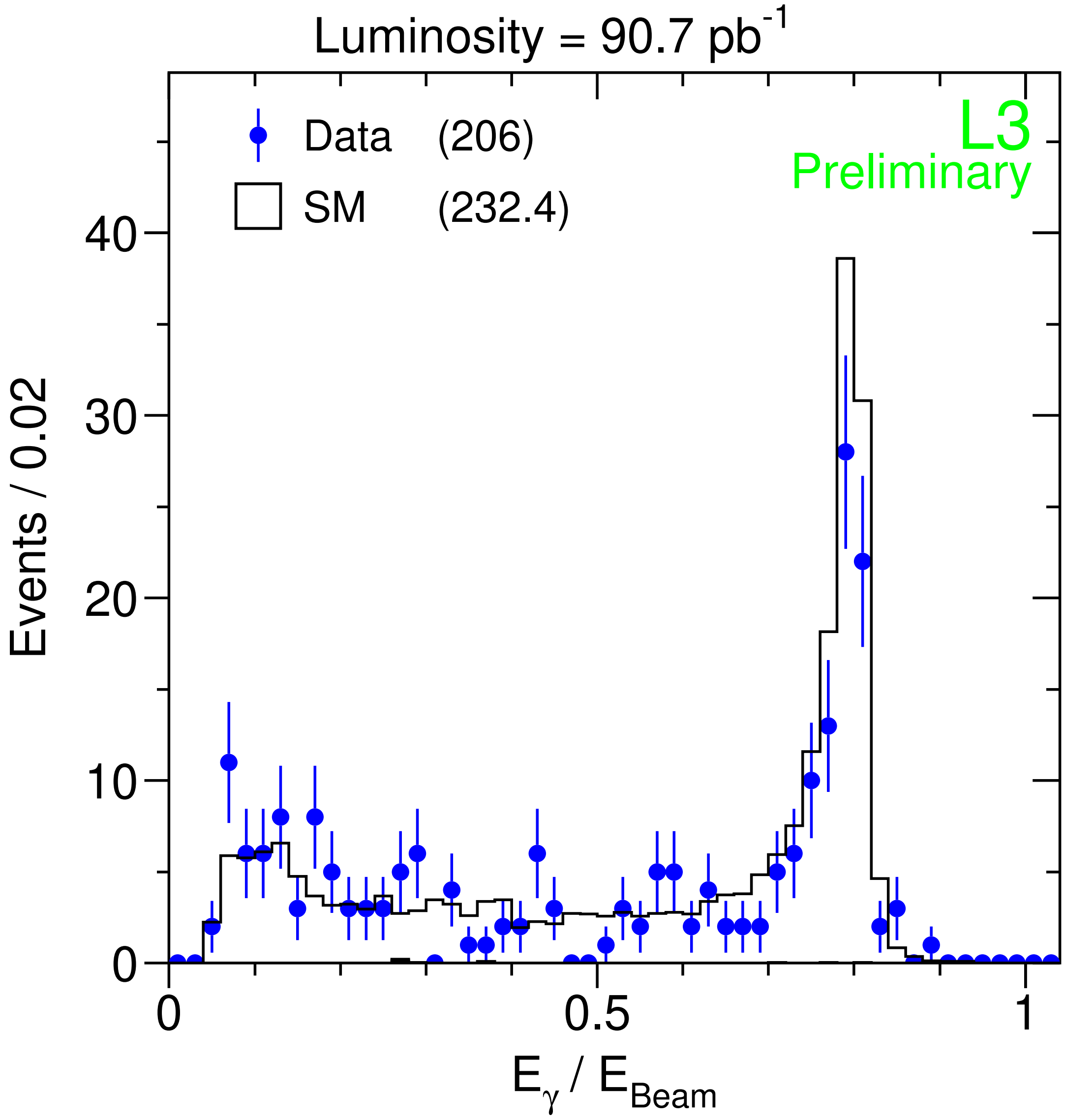

Figure 10: Observed energy spectrum of the highest energetic photon normalised to the beam energy for single and multi-photon events at 203–208GeV.

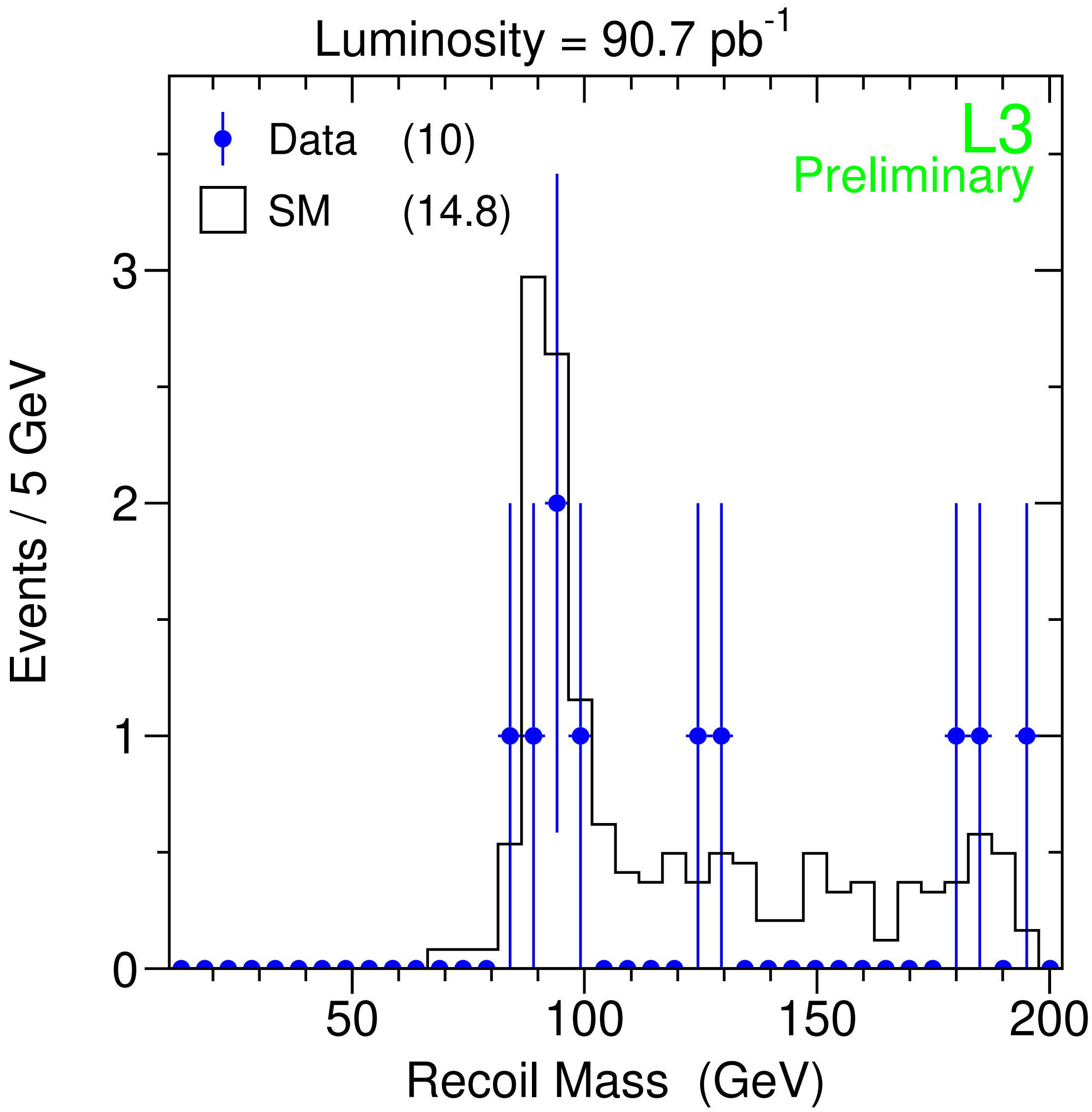

Figure 11: Recoil mass distribution for the two-photon sample at 203–208GeV.

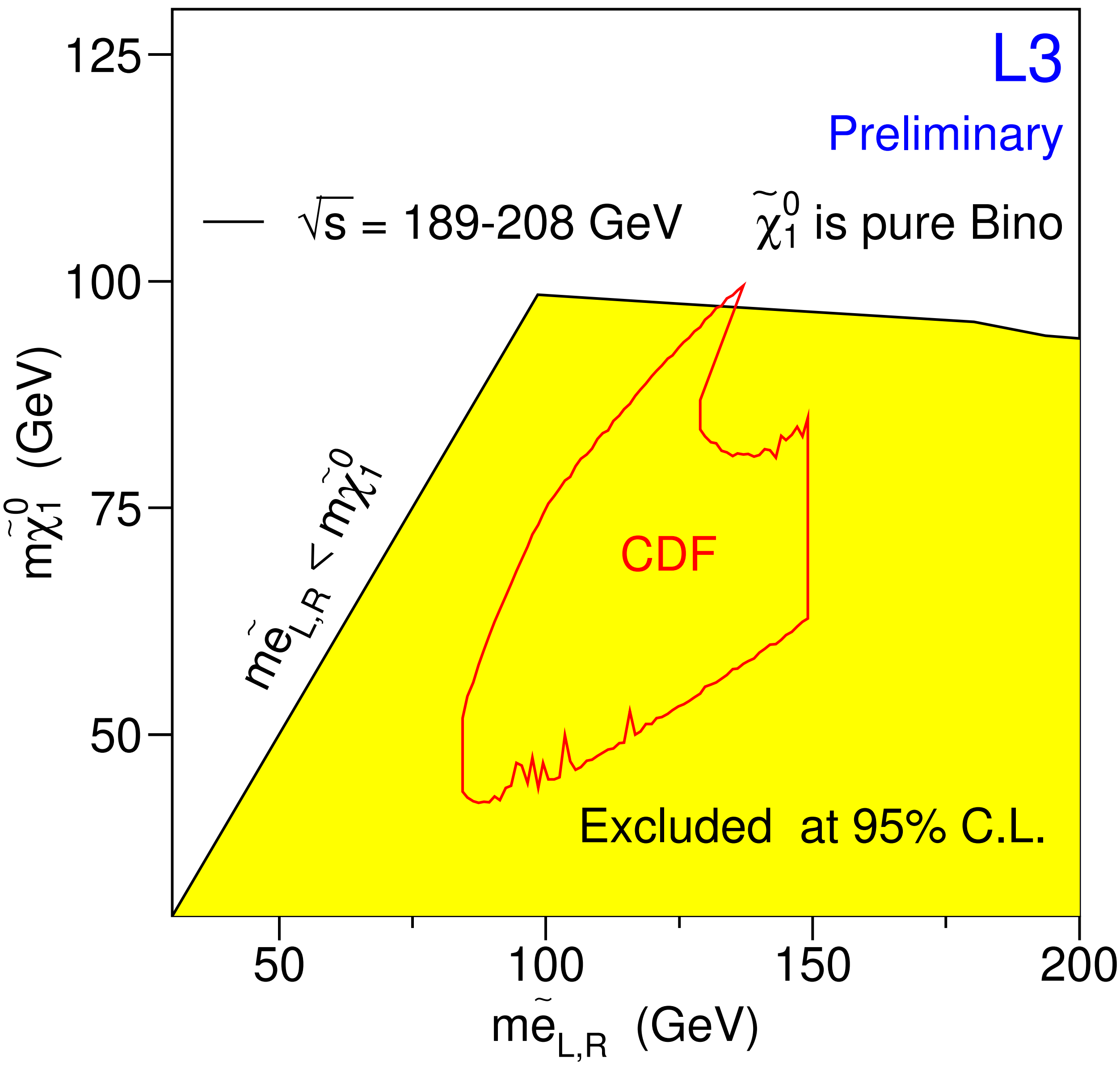

Figure 12: Excluded region for a pure bino neutralino model compared to the region consistent with the supersymmetric interpretation of the CDF event in the scalar electron scenario.

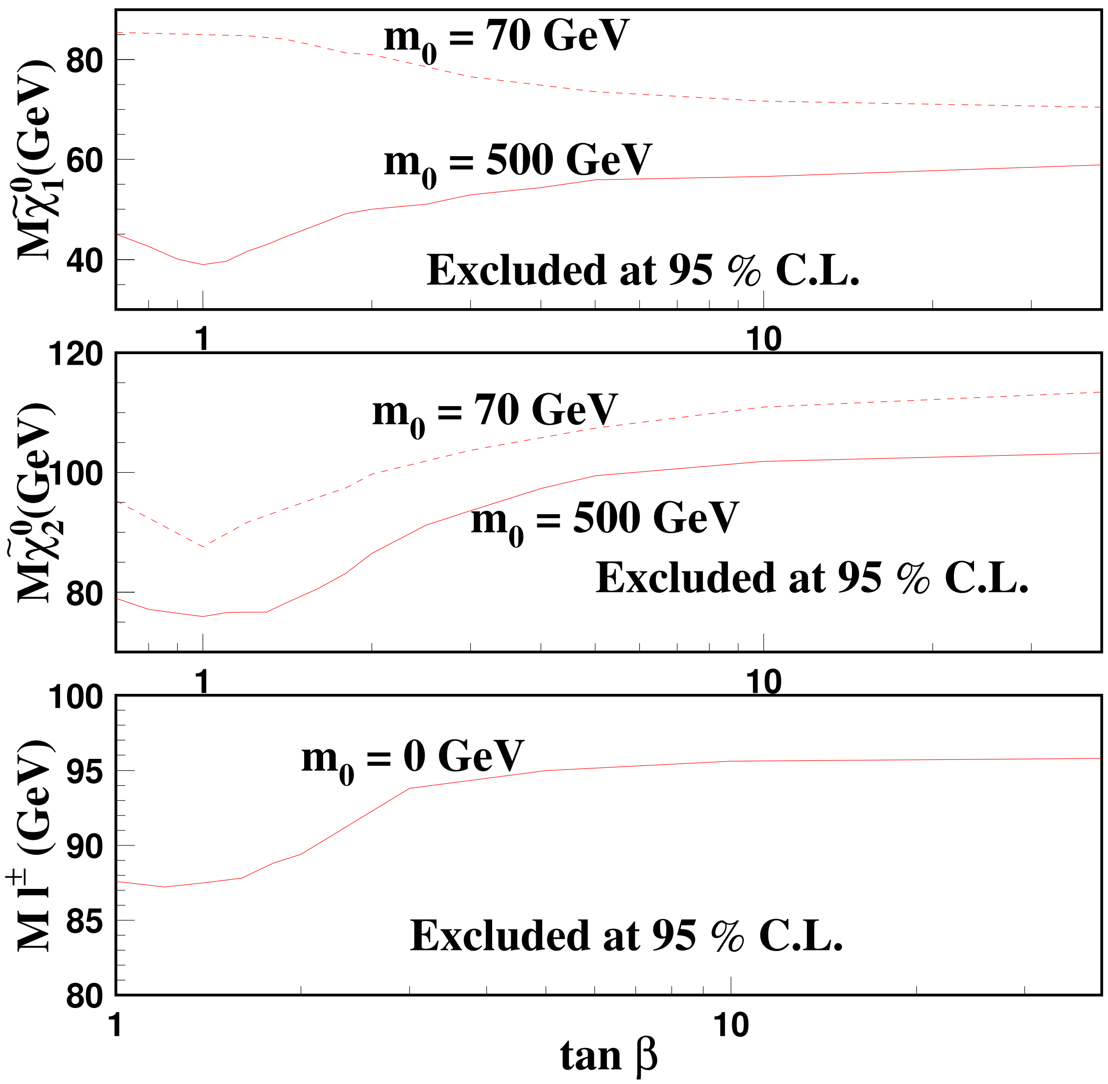

Figure 13: 95% C.L. lower limits on the masses of $\tilde{\chi}_1^0$ (a), $\tilde{\chi}_2^0$ (b) and $\tilde{\ell}^{\pm}$ (c) as a function of $\tan\beta$, for different values of m_0. The limits are obtained for the λ'' coupling analysis.

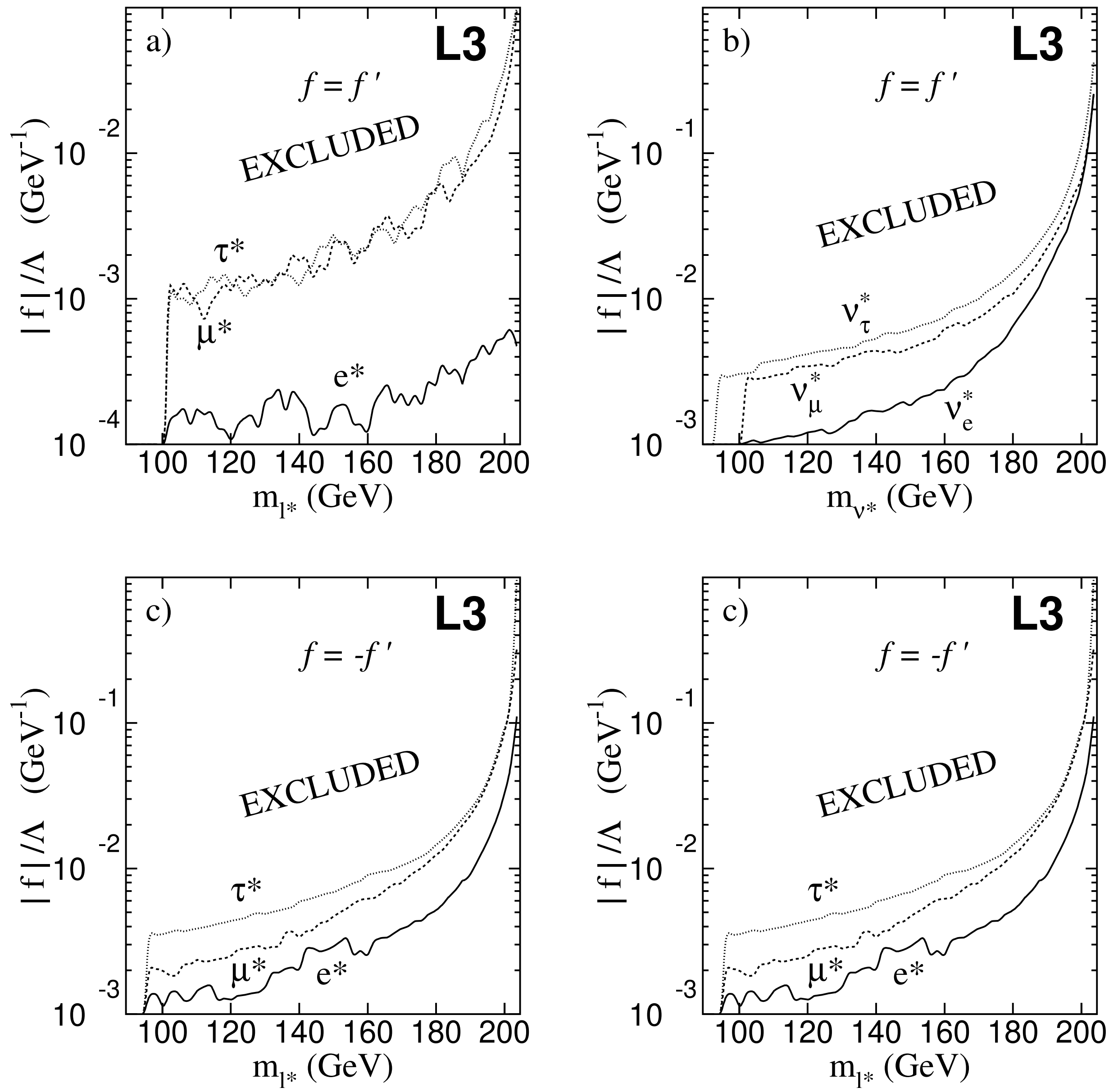

Figure 14: 95% confidence level upper limit on the coupling constant $|f|/\Lambda$, as a function of the excited lepton mass with $f = f'$: (a) e*, μ^* and τ^* , (b) $\nu^*_{\rm e}$, ν^*_μ and ν^*_τ, and with $f = -f'$: (c) e*, μ^* and τ^*, (d) $\nu^*_{\rm e}$, ν^*_μ and ν^*_τ.

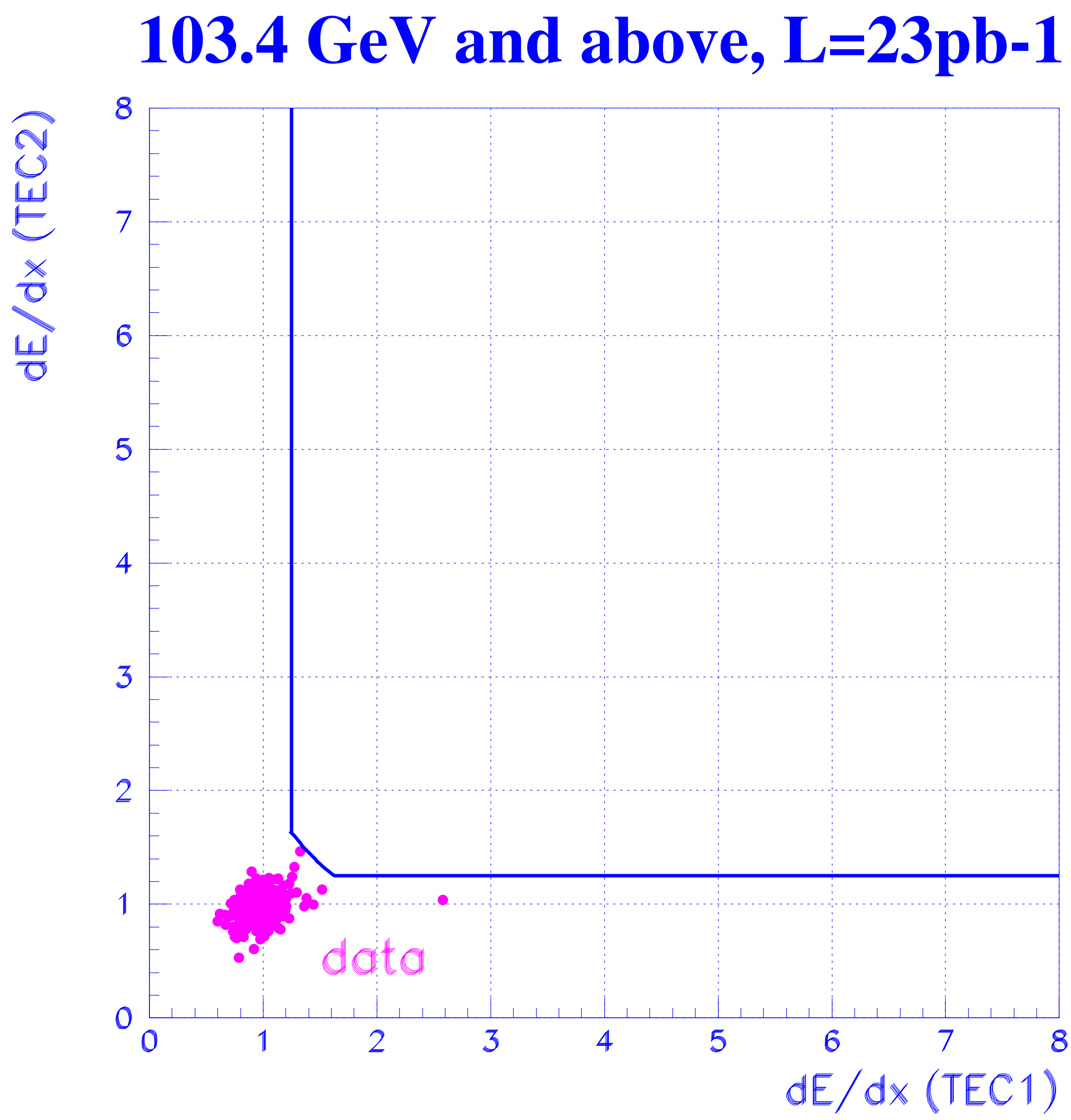

Figure 15: The normalised measured track energy loss of track 2 vs track 1 for the data (solid circles) taken at $\sqrt{s} \geq 103.4$ GeV. The lines represent the applied cut.