Precision measurements, extra generations and heavy neutrino

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on behalf of

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- **SM fit to electroweak precision data with LEPTOP**
- **Extra quark-lepton generations**
- **New generations and SUSY**
- **Possibility for 50 GeV neutrino**
- **Heavy neutrino at LEP-200 and TESLA**

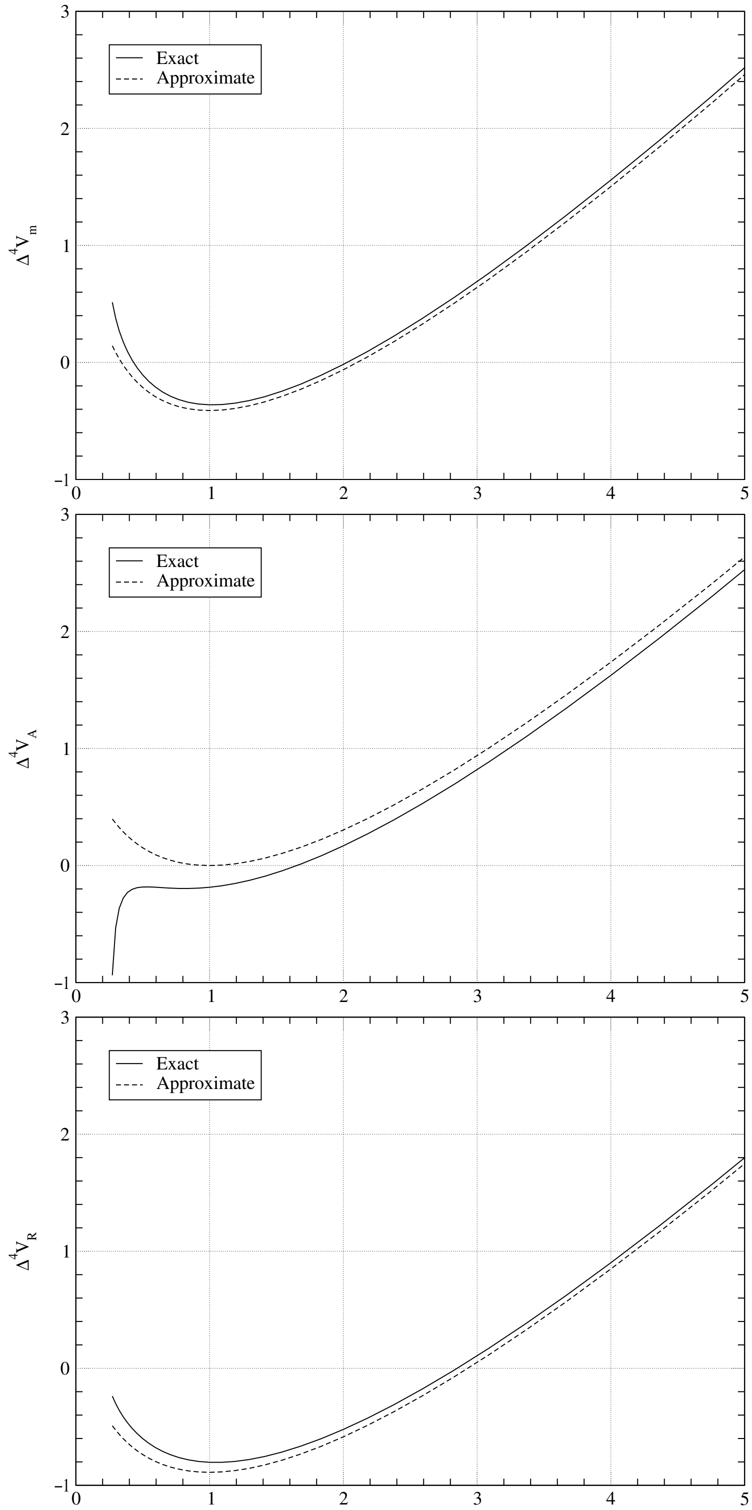
Publications:

- M.Maltoni, V.Novikov, L.Okun, A.Rozanov, M.Vysotsky, Extra quark-lepton generations and precision measurements; hep-ph/9911535; Phys. Lett. B476 (2000) 107-115.
- M.Maltoni, M.Vysotsky, Diminishing “charginos nearly degenerate with the lightest neutralino” slit using precision data; hep-ph/9907219 ; Phys. Lett., B463 (1999) 230-233.
- V.Ilyin, M.Maltoni, V.Novikov, L.Okun, A.Rozanov, M.Vysotsky, On the search for 50 GeV neutrinos; hep-ph/0006324.

LEPTOP fit to electroweak observables

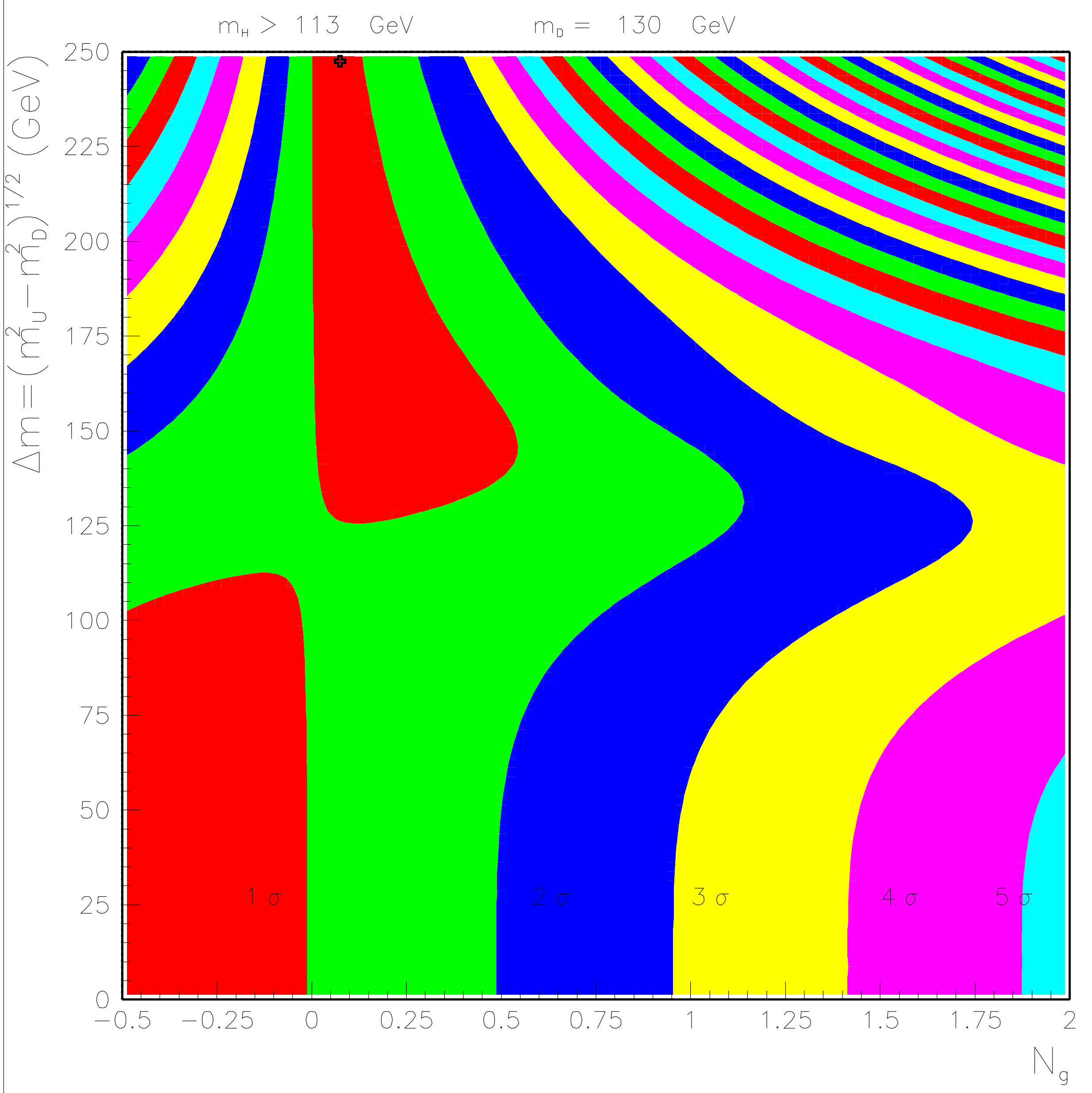
Observable	Exp. data	LEPTOP fit	Pull
Γ_Z [GeV]	2.4952(23)	2.4964(16)	-0.5
σ_h [nb]	41.541(37)	41.479(15)	1.7
R_l	20.767(25)	20.739(18)	1.1
A^l_{FB}	0.0171(10)	0.0164(3)	0.7
A_τ	0.1439(42)	0.1480(13)	-1.0
A_e	0.1498(48)	0.1480(13)	0.4
R_b	0.2165(7)	0.2157(1)	1.2
R_c	0.1709(34)	0.1723(1)	-0.4
A^b_{FB}	0.0990(20)	0.1038(9)	-2.4
A^c_{FB}	0.0689(35)	0.0742(7)	-1.5
$s^2_l(Q_{FB})$	0.2321(10)	0.2314(2)	0.7
s^2_l (A_{LR})	*0.2310(3)*	*0.2314(2)*	-1.5
A_b	0.9110(250)	0.9349(1)	-1.0
A_c	0.6300(260)	0.6683(6)	-1.5
m_W [GeV]	80.434(37)	80.397(23)	1.0
s^2_W (νN)	0.2255(21)	0.2231(2)	1.1
m_t [GeV]	174.3(5.1)	174.0(4.2)	0.1
m_H [GeV]		55^{+45}_{-26}	
$\hat{\alpha}_s$		0.1183(27)	
$\chi^2/n_{d.o.f.}$		21.4/14	

Fourth generation contributions



Values of the δV_m, δV_A and δV_R as a function of $u \equiv (m_U/m_Z)^2$. It is assumed: $m_N = m_U$ and $m_E = m_D = m_Z$

Limits on the fourth generation



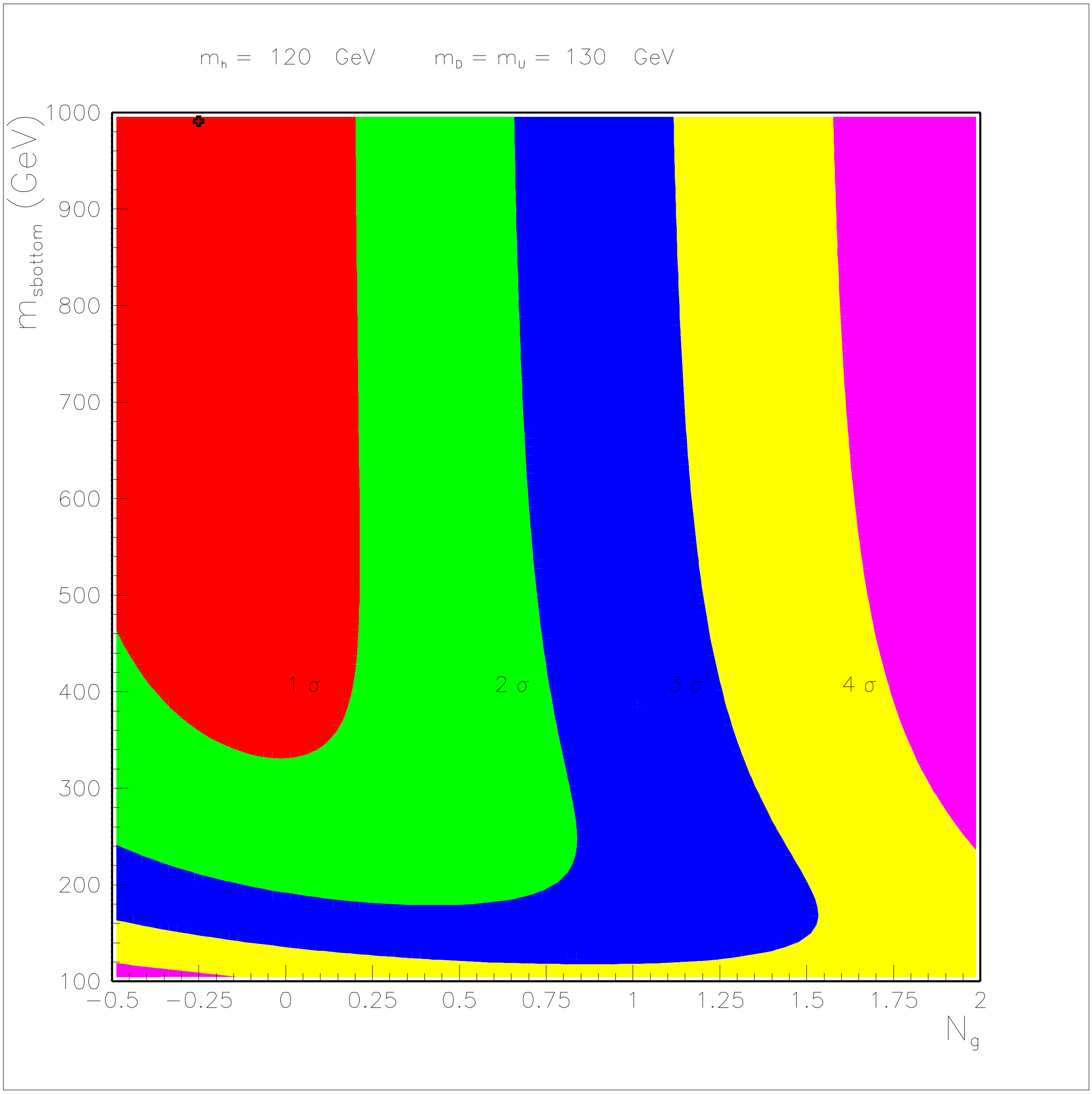
Assuming: $m_D = m_E = 130$ GeV , $m_U = m_N$

Fourth generation contribution: $\delta^4 V_i = 4|m_U^2 - m_D^2|/3m_Z^2$

Four-parameter fit $(m_{\rm t}, m_{\rm H}\hat{\alpha}_{\rm s}, \bar{\alpha})$ to OSAKA-2000 data, using LEP-200 limit $m_H > 113.3$ GeV.

A.Rozanov, Osaka 29 July 2000

Extra generation exclusion in SUSY versus $m_{\tilde{b}}$



N_g degenerate extra generations and the mass of sbottom $m_{\tilde{b}}$ in SUSY models and for the choice $m_D = m_U = m_E = m_N = 130$ GeV, $m_h = 120$ GeV, $m_{\tilde{g}} = 200$ GeV and absence of $\tilde{t}_L - \tilde{t}_R$ mixing.

Mass degenerate chargino and neutralino

- $\tan\beta$ - ratio of the two Higgs vacuum expectation values
- μ - Higgs mixing parameter
- M_1 - U(1) gaugino mass
- M_2 - SU(2) gaugino mass
- radiative corrections with $m_{\chi^\pm} \sim m_{\chi^0} \sim m_z/2$ are large
- decoupling property of SUSY: rad. corrections are small if $m_{\chi^\pm} >> m_z$

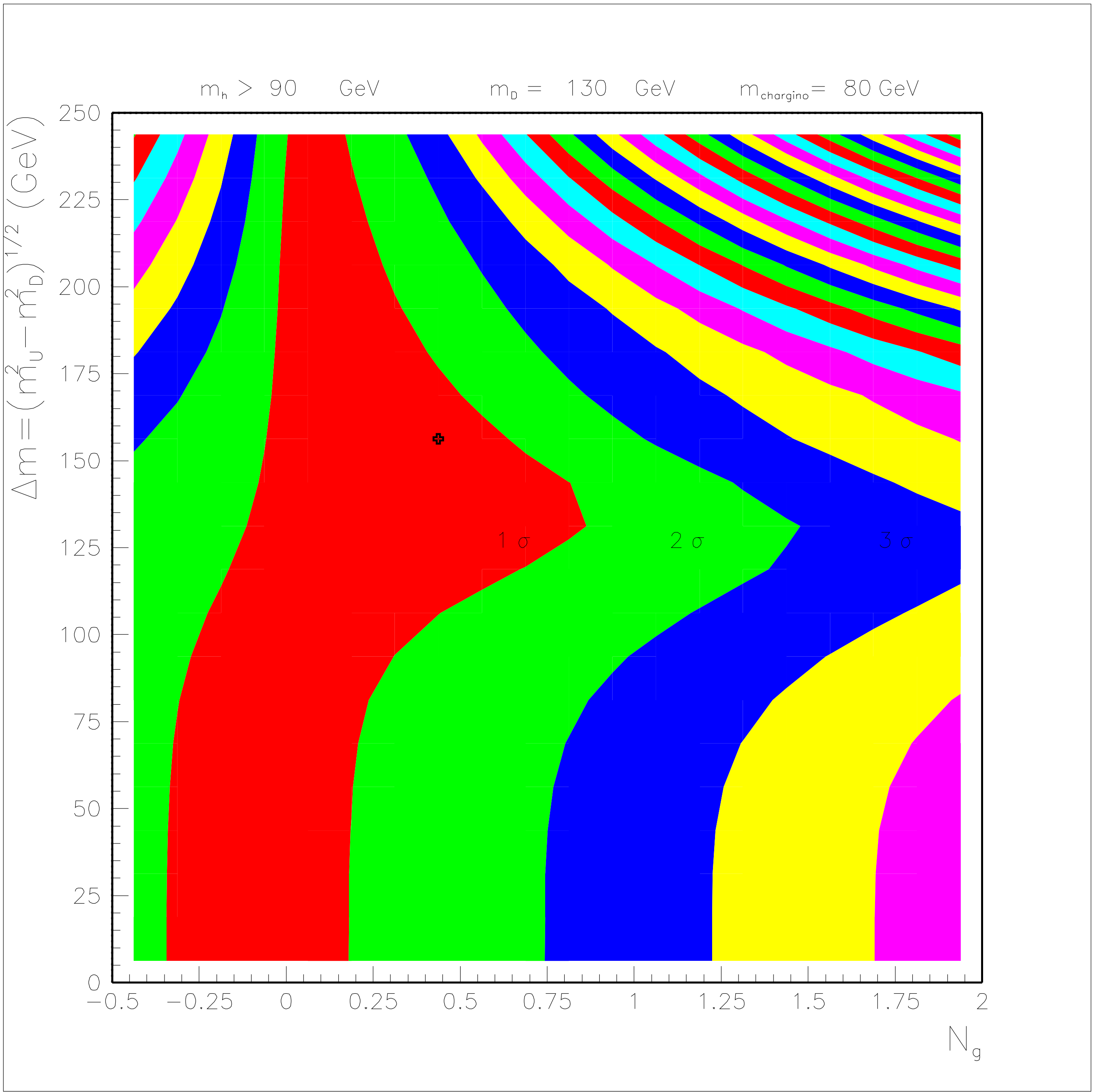
Higgsino-dominated scenario

- $M_2 >> \mu$ - SU(2) doublet of Dirac fermions
- From LEPTOP electroweak precision fit $m_{\chi^\pm} > 54$ GeV at 95 % CL

Gaugino-dominated scenario

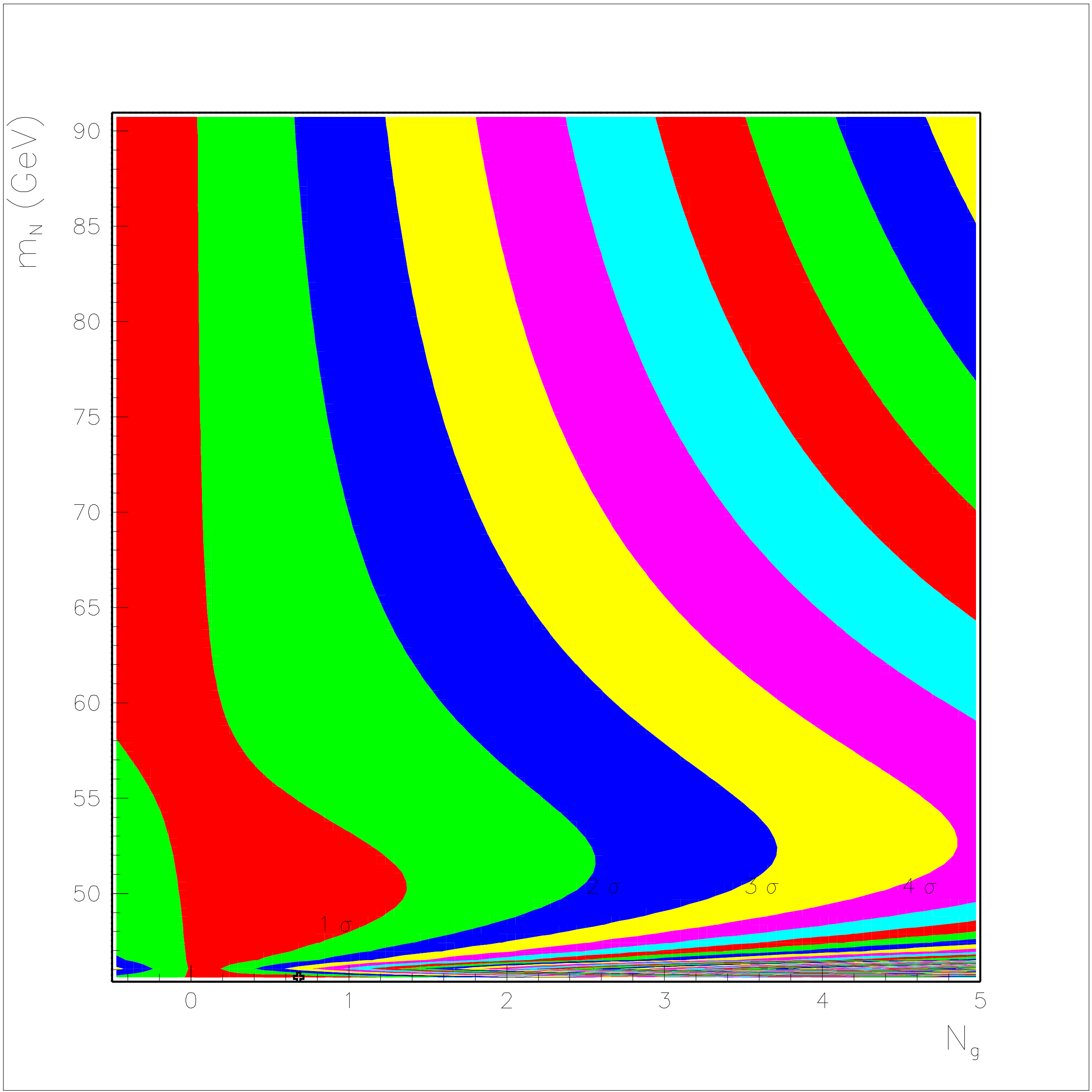
- $M_2 >> \mu$ - SU(2) triplet of Majorana fermions
- From LEPTOP electroweak precision fit fit $m_{\chi^\pm} > 61$ GeV at 95 % CL
- Independent of the assumption of scalar neutrino mass

Higgsino-dominated quasi degenerate chargino and neutralino



Number of extra generations N_g and the mass difference in the extra generations Δm in case of 80 GeV higgsino-dominated quasi degenerate chargino and neutralino. $m_D = 130$ GeV was used and $m_E = m_D, m_N = m_U$ was assumed. All electroweak precision data and $m_h > 90.5$ GeV used in the fit.

Constraints on neutral heavy lepton

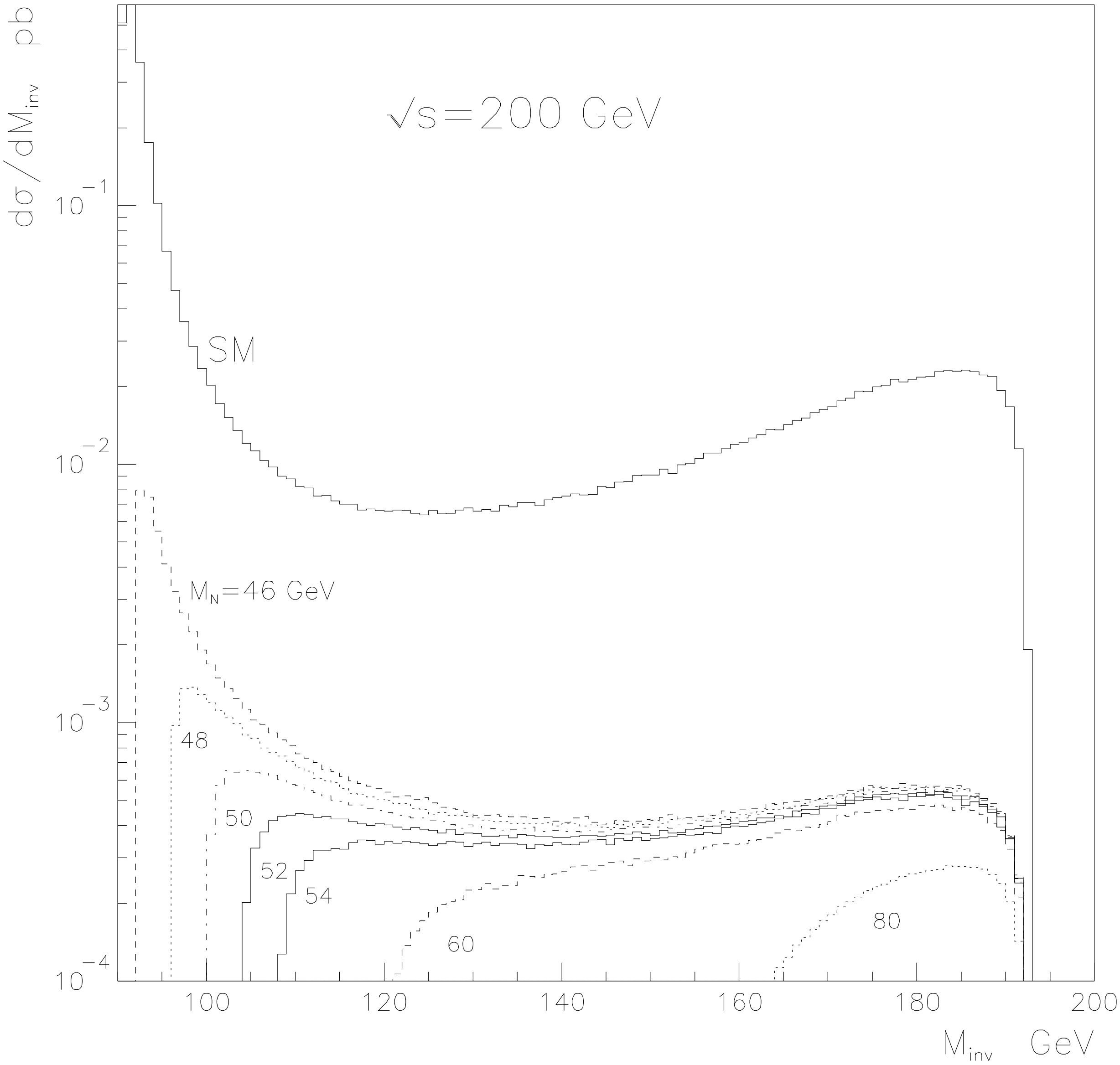


$m_U = 220$ GeV, $m_D = 200$ GeV and $M_E = 100$ GeV.

Four-parameter fit $(m_{\rm t}, m_{\rm H}, \hat{\alpha}_{\rm s}, \bar{\alpha})$ is done to OSAKA-2000 data, using LEP-200 limit $m_H > 113.3$ GeV.

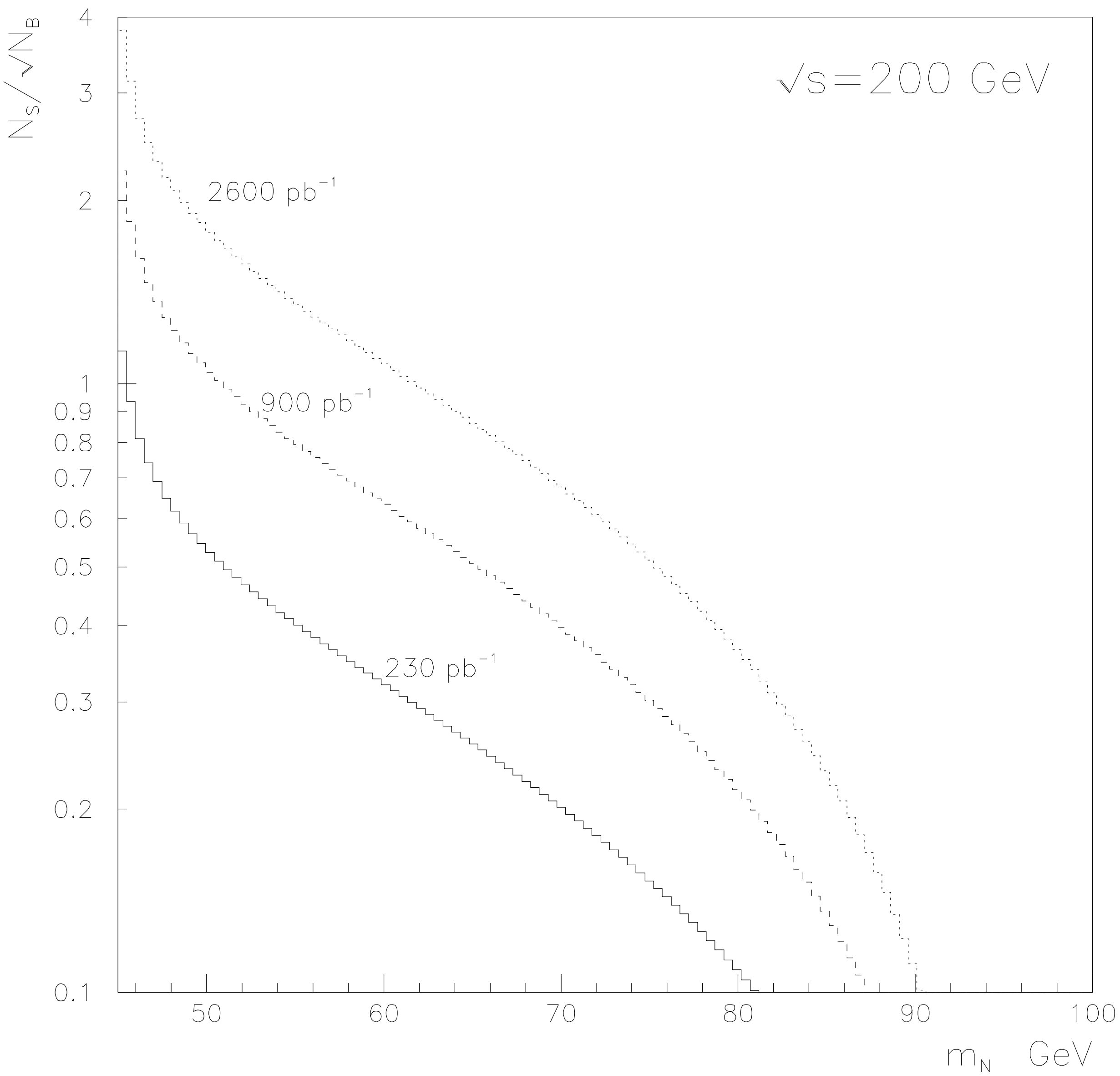
50 GeV neutrino at LEP-200

$e^+e^- \to \gamma +$ N$\bar{\text{N}}$



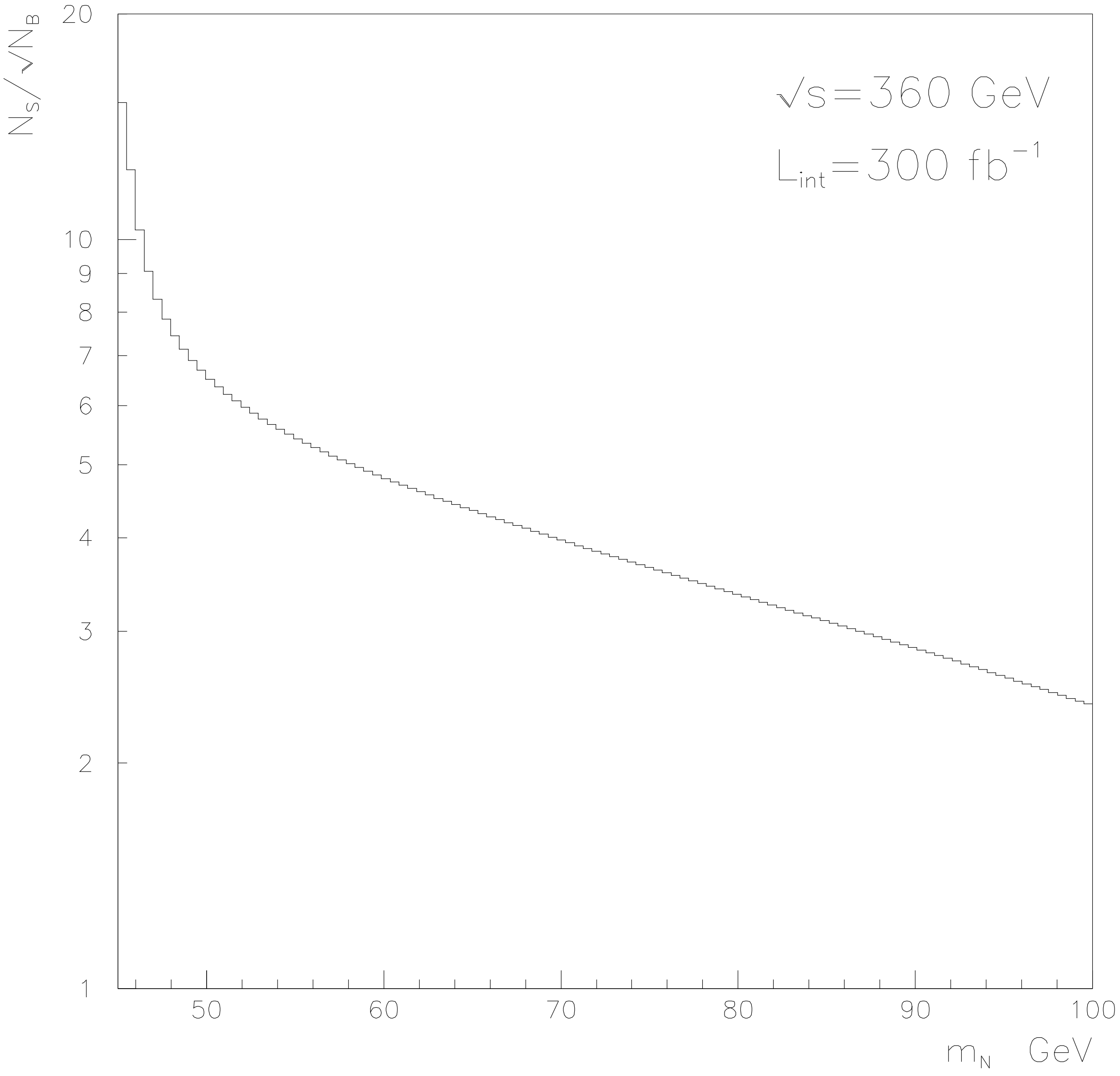
$d\sigma/dM_{inv}$ (in pb) for Standard Model and for the different values of m_N. Cuts applied: $|\cos\vartheta_\gamma| < 0.95$ and $p_T^\gamma > 0.0375\sqrt{s}$. The photon detection efficiency 74%.

Significance of heavy neutrino at LEP-200



$N\bar{N}$ signal significances as function of the neutrino mass. Cuts: $M_{inv} > 2m_N$, $|\cos\vartheta_\gamma| < 0.95$ and $p_T^\gamma > 0.0375\sqrt{s}$.

Significance of heavy neutrino at TESLA



$N\bar{N}$ signal significances as function of the neutrino mass. Cuts: $M_{inv} > 2m_N$, $|\cos\vartheta_\gamma| < 0.95$ and $p_T^\gamma > 0.0375\sqrt{s}$.

Conclusions

- **Extra generations with heavy fermions are strongly disfavoured by precision data**
- **With SUSY inclusion new heavy generations are also disfavoured**
- **In case of quasi-degenerate light chargino/neutralino extra generations are less forbidden**
- **Heavy neutrino of 50 GeV allowed by precision data**
- **Possibility to exclude 50 GeV neutrino with full statistics of LEP-200**
- **Search for heavy neutrino at TESLA is promising**

Available on WWW at:

`http://marwww.in2p3.fr/leptop/intro_leptop.html`