Precision measurements, extra generations and heavy neutrino

by A. Rozanov (CPPM, France)

on behalf of

M. Maltoni (Univ. Valencia, Spain), V. Ilyin (Moscow Univ., Russia)

V. Novikov, L. Okun, M. Vysotsky(ITEP, Russia), A. Rozanov (CPPM, France)

- **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**

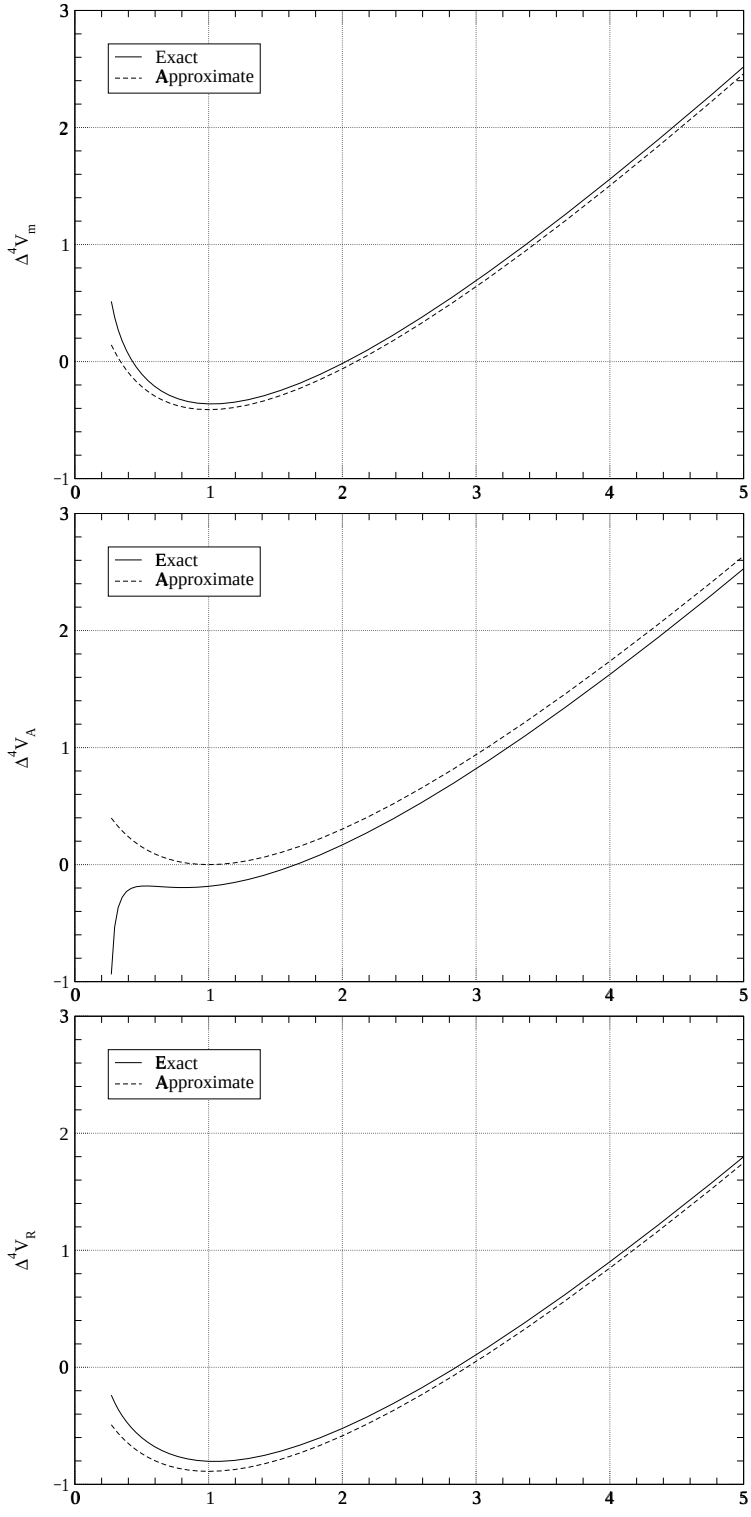
Publications:

- 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

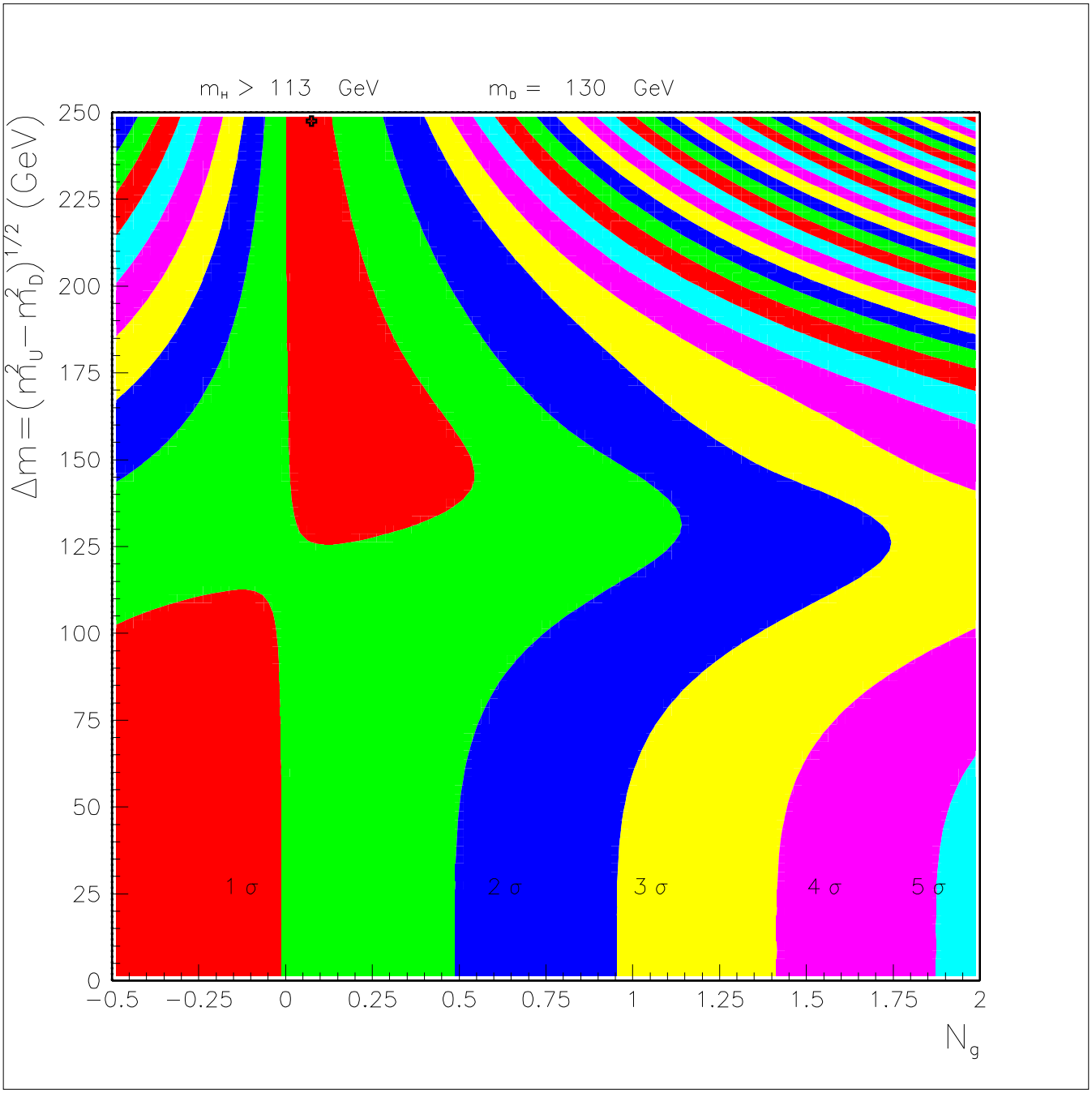
Observable	Exp. data	LEPTOP fit	Pull
Γ_Z [GeV]	2.4952(23)	2.4964(16)	-0.5
σ_h [nb]	41.541(37)	41.479(15)	1.7
R_l	20.767(25)	20.739(18)	1.1
A_{FB}^l	0.0171(10)	0.0164(3)	0.7
A_τ	0.1439(42)	0.1480(13)	-1.0
A_e	0.1498(48)	0.1480(13)	0.4
R_b	0.2165(7)	0.2157(1)	1.2
R_c	0.1709(34)	0.1723(1)	-0.4
A_{FB}^b	0.0990(20)	0.1038(9)	-2.4
A_{FB}^c	0.0689(35)	0.0742(7)	-1.5
$s_l^2(Q_{FB})$	0.2321(10)	0.2314(2)	0.7
s_l^2 (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_W^2 (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



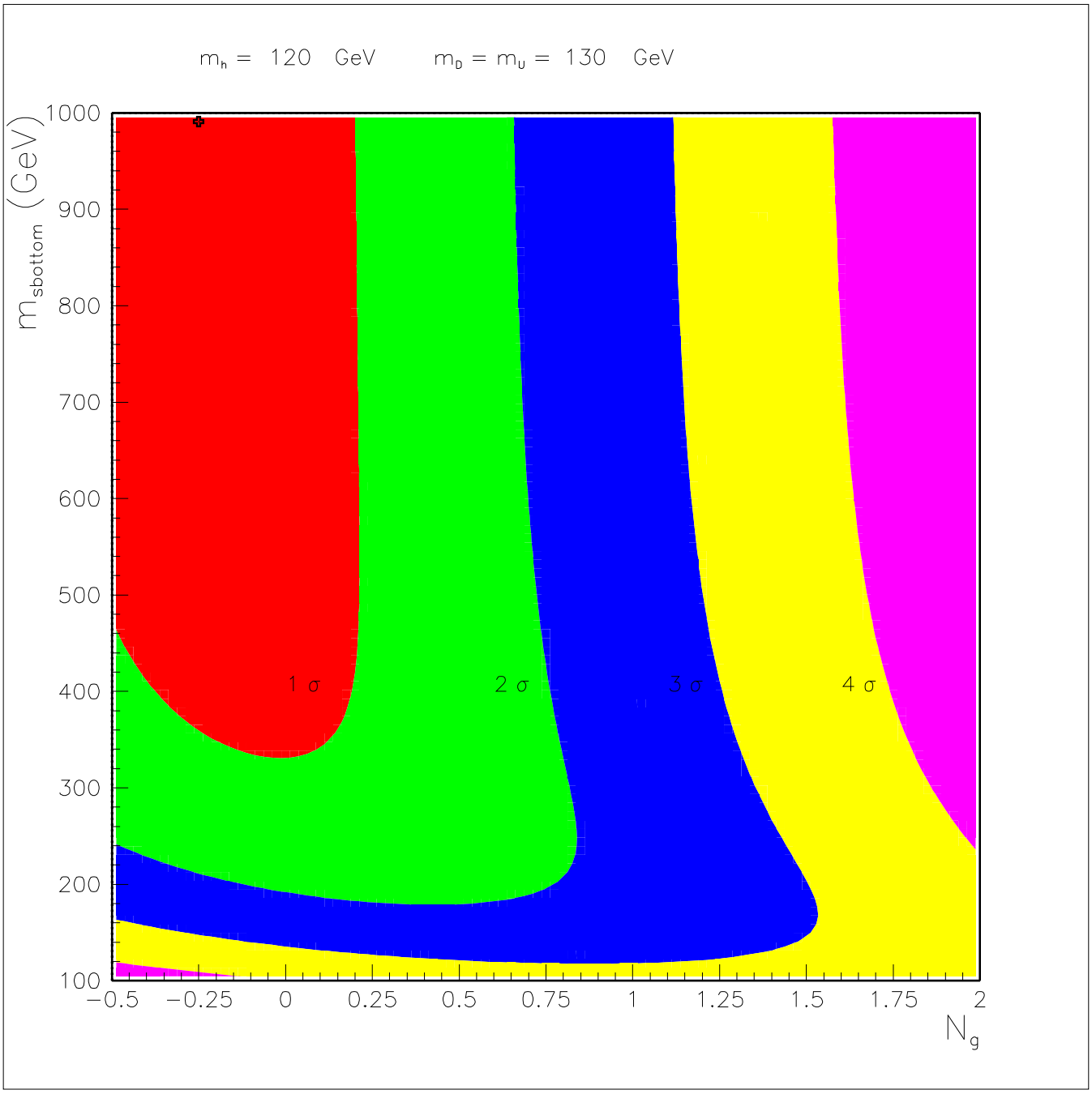
Assuming: $m_D = m_E = 130$ GeV , $m_U = m_N$

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

Four-parameter fit $(m_t, m_H \hat{\alpha}_s, \bar{\alpha})$ to OSAKA-2000 data, using LEP-200 limit

$m_H > 113.3$ GeV.

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 $m_{\chi^\pm} >> m_z$

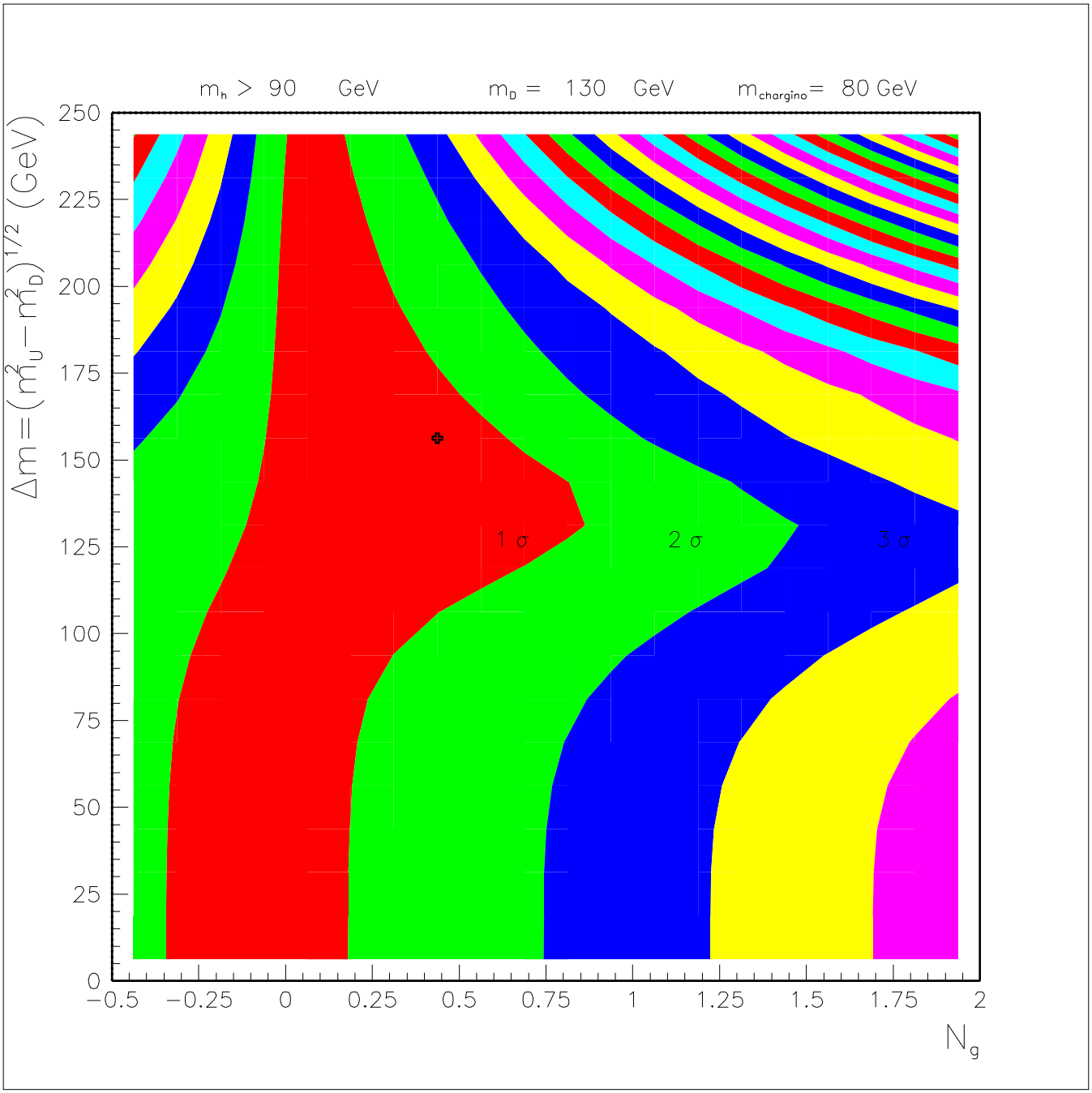
Higgsino-dominated scenario

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

Gaugino-dominated scenario

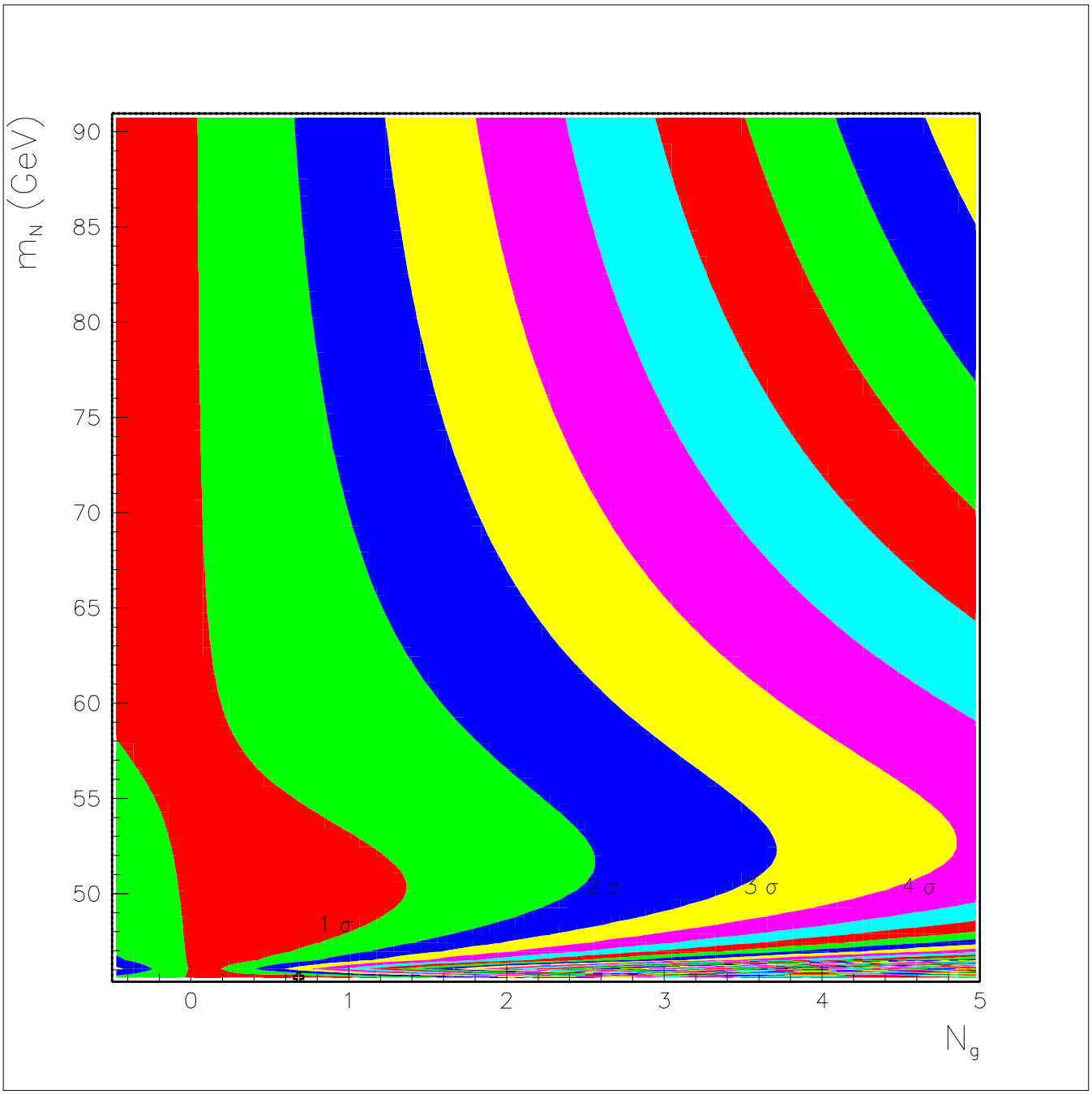
- $M_2 >> \mu$ - SU(2) triplet of Majorana fermions
- From LEPTOP electroweak precision fit fit $m_{\chi^\pm} > 61$ GeV at 95 % CL
- Independent of the assumption of scalar neutrino mass

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

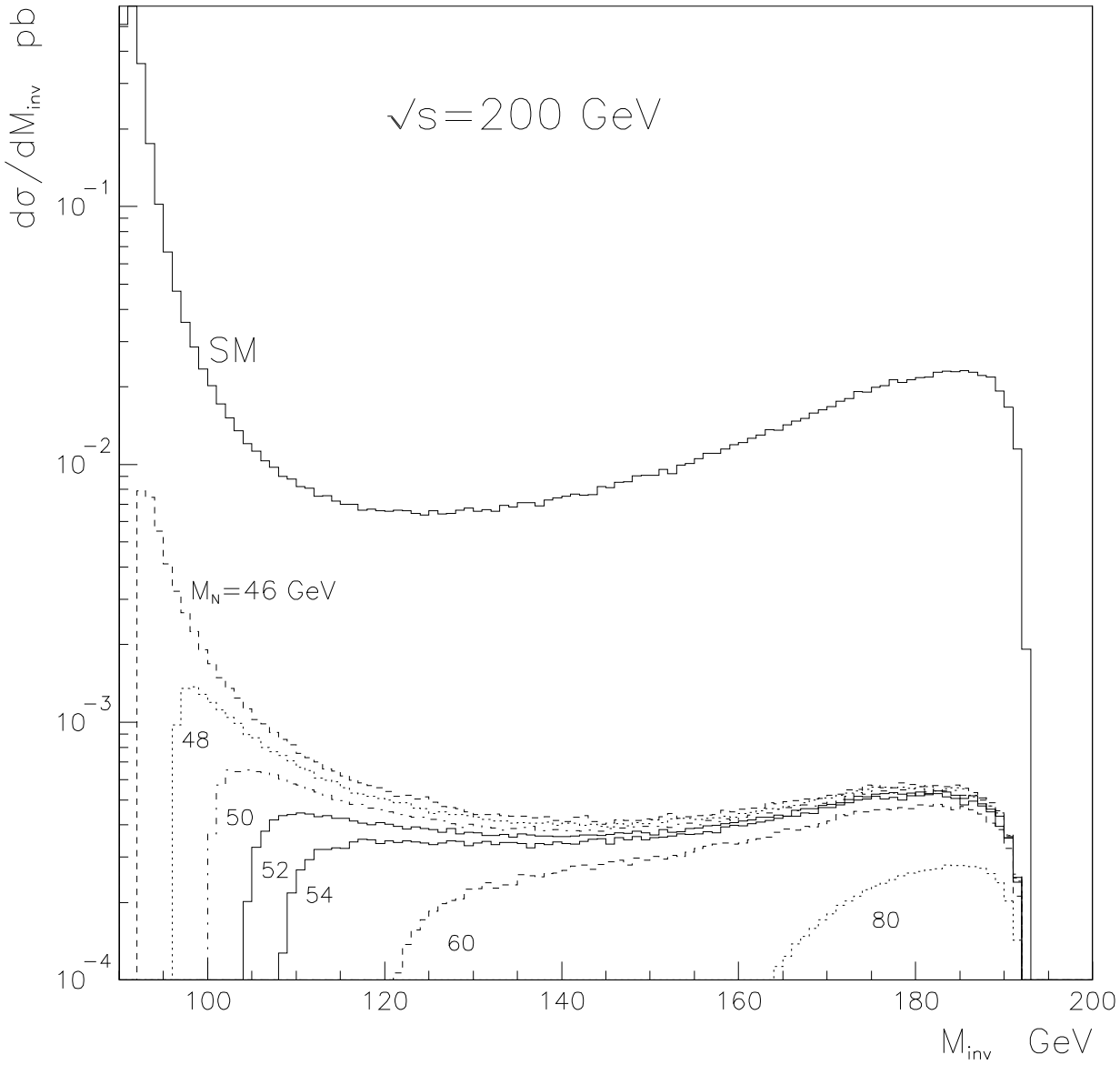


$m_U = 220$ GeV, $m_D = 200$ GeV and $M_E = 100$ GeV.

Four-parameter fit $(m_t, m_H, \hat{\alpha}_s, \bar{\alpha})$ is done to OSAKA-2000 data, using LEP-200 limit $m_H > 113.3$ GeV.

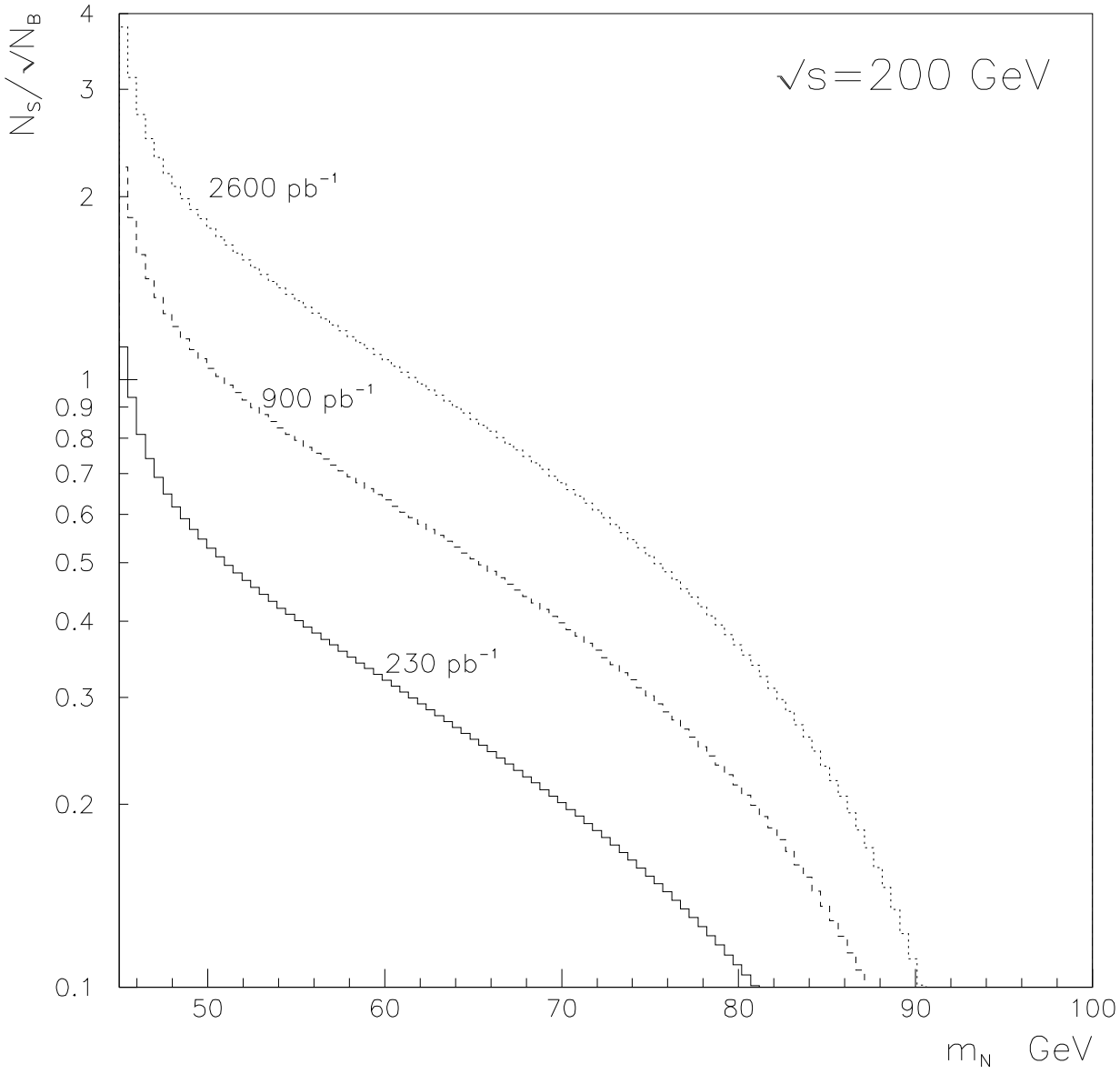
50 GeV neutrino at LEP-200

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



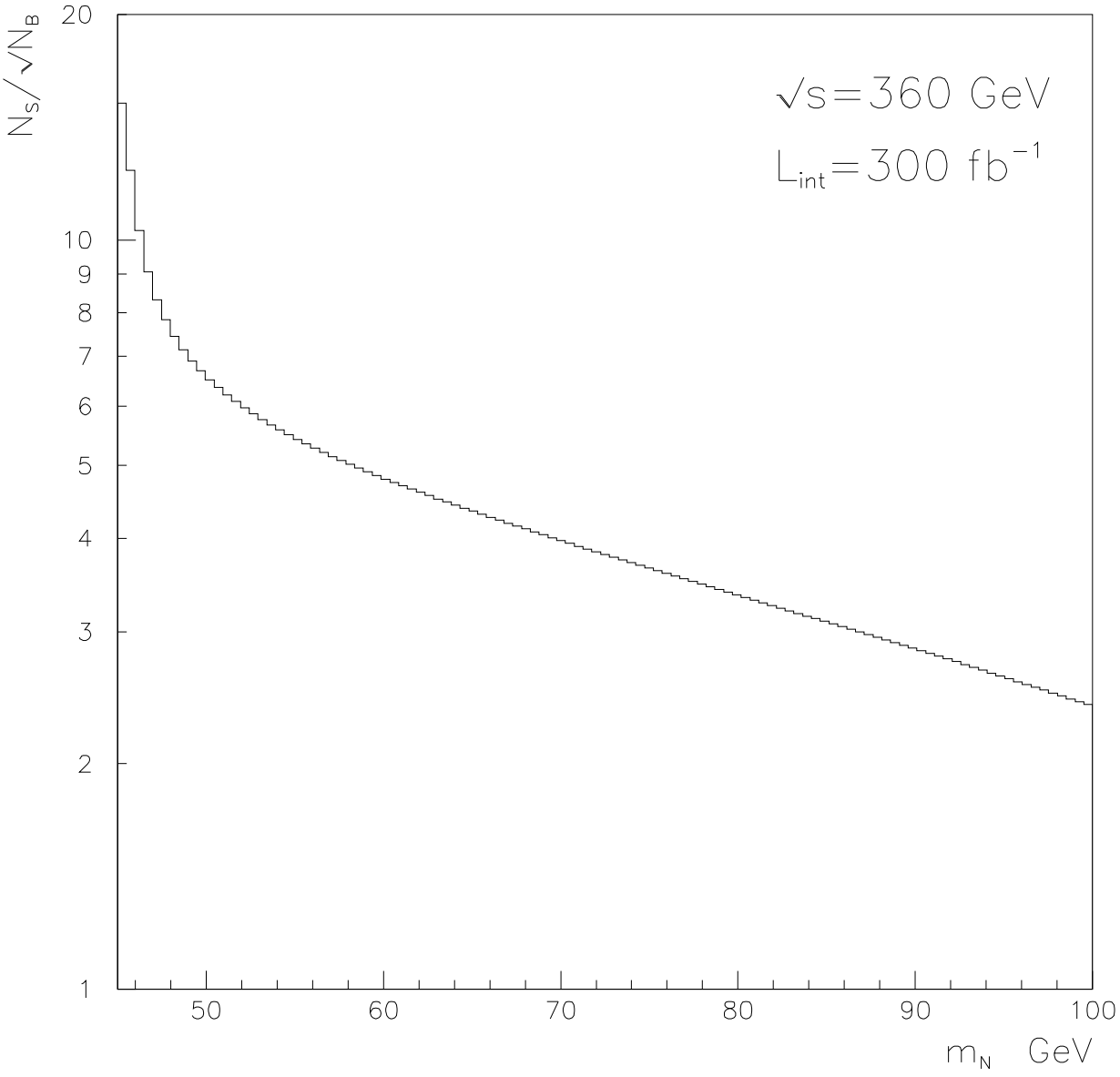
$d\sigma/dM_{inv}$ (in pb) for Standard Model and for the different values of m_N. Cuts applied: $|\cos\vartheta_\gamma| < 0.95$ and $p_T^\gamma > 0.0375\sqrt{s}$. The photon detection efficiency 74%.

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`