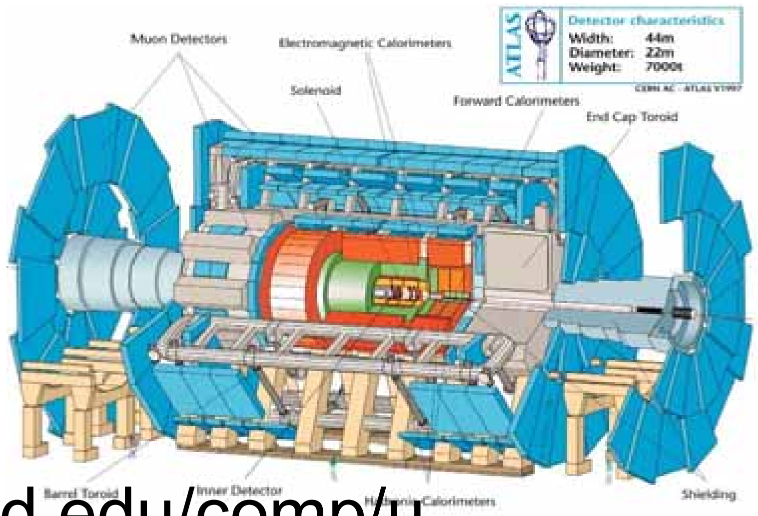
Supersymmetry Without Prejudice



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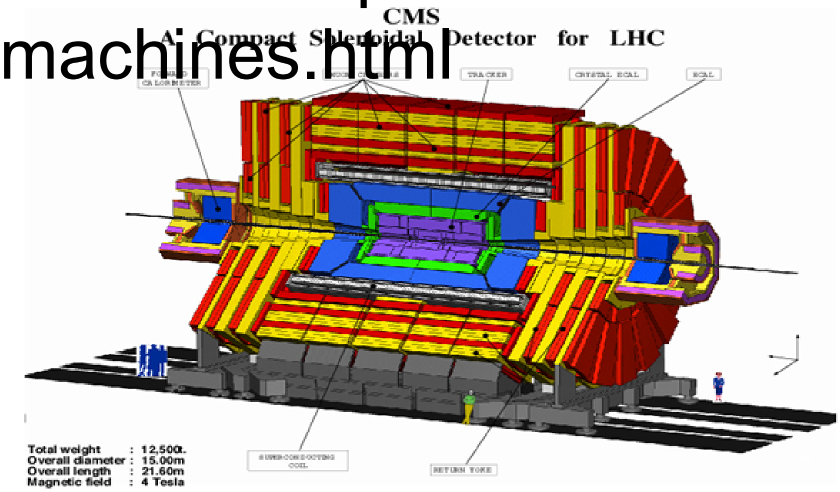

SLAC NATIONAL ACCELERATOR LABORATORY

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J. L. Hewett & TGR

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The MSSM has many nice features but is very difficult to study in any detailed, model-independent manner due to the very large number of soft SUSY breaking parameters (~ 100).

To circumvent this issue, authors generally limit their analyses to a specific SUSY breaking scenario(s) such as mSUGRA, GMSB, AMSB,… which determines the sparticle (e.g., the LSP’s) couplings & signatures in terms of a few parameters.

But how well do any or all of these reflect the true breadth of the MSSM?? Do we really know the MSSM as well as we think??

Is there another way to approach this problem & yet remain *more general*? *Some* set of assumptions are necessary to make any such study practical. But what? There are many possibilities.

FEATURE Analysis Assumptions :

- The most general, CP-conserving MSSM with R-parity
- Minimal Flavor Violation
- The lightest neutralino is the LSP.
- The first two sfermion generations are degenerate (sfermion type by sfermion type).
- The first two generations have negligible Yukawa's.
- No assumptions about SUSY-breaking or GUT

This leaves us with the pMSSM:

→ the MSSM with 19 real, TeV/weak-scale parameters…

What are they??

19 pMSSM Parameters

sfermion masses: m_{Q_1}, m_{Q_3}, m_{u_1}, m_{d_1}, m_{u_3}, m_{d_3}, m_{L_1},
m_{L_3}, m_{e_1}, m_{e_3}

gaugino masses: M_1, M_2, M_3
tri-linear couplings: A_b, A_t, A_τ
Higgs/Higgsino: μ, M_A, $\tan\beta$

Note: These are TeV-scale Lagrangian parameters

What are the Goals of this Study???

- Prepare a large sample, ~50k, of MSSM models (= parameter space points) satisfying ‘all’ of the experimental constraints. A large sample is necessary to get a good feeling for the variety of possibilities. (Done)

- Examine the properties of the models that survive. Do they look like the model points that have been studied up to now???? What are the differences? (In progress)

- Do physics analyses with these models for LHC, ILC/CLIC, dark matter, etc. etc. – all your favorites! (In progress)

How? Perform 2 Random Scans

Linear Priors

10^7 points – emphasizes moderate masses

$100\ \text{GeV} \le m_{\text{sfermions}} \le 1\ \text{TeV}$

$50\ \text{GeV} \le |M_1, M_2, \mu| \le 1\ \text{TeV}$

$100\ \text{GeV} \le M_3 \le 1\ \text{TeV}$

$\sim 0.5\ M_Z \le M_A \le 1\ \text{TeV}$

$1 \le \tan\beta \le 50$

$|A_{t,b,\tau}| \le 1\ \text{TeV}$

Log Priors

$2\text{x}10^6$ points – emphasizes lower masses but extends to higher masses

$100\ \text{GeV} \le m_{\text{sfermions}} \le 3\ \text{TeV}$

$10\ \text{GeV} \le |M_1, M_2, \mu| \le 3\ \text{TeV}$

$100\ \text{GeV} \le M_3 \le 3\ \text{TeV}$

$\sim 0.5\ M_Z \le M_A \le 3\ \text{TeV}$

$1 \le \tan\beta \le 60$

$10\ \text{GeV} \le |A_{t,b,\tau}| \le 3\ \text{TeV}$

→Comparison of these two scans will show the prior sensitivity.

→This analysis required ~ 1 processor-century of CPU time.. this is the real limitation of this study.

Constraints

- $-0.0007 < \Delta\rho < 0.0026$ (PDG'08)
- $b \to s\,\gamma$: $B = (2.5 - 4.1) \times 10^{-4}$; (HFAG) + Misiak etal. &
  Becher & Neubert
- $\Delta(g-2)_\mu$??? $(30.2 \pm 8.8) \times 10^{-10}$ (0809.4062)
  $(29.5 \pm 7.9) \times 10^{-10}$ (0809.3085)
  $[\sim 14.0 \pm 8.4] \times 10^{-10}$ [Davier/BaBar-Tau08]
  → $(-10 \text{ to } 40) \times 10^{-10}$ to be conservative..
- $\Gamma(Z \to \text{invisible}) < 2.0$ MeV (LEPEWWG)
- Meson-Antimeson Mixing $0.2 < R_{13} < 5$
- $B \to \tau\nu$ $B = (55 \text{ to } 227) \times 10^{-6}$ Isidori & Paradisi, hep-ph/0605012 &
  Erikson etal., 0808.3551 for loop corrections
- $B_s \to \mu\mu$ $B < 4.5 \times 10^{-8}$ (CDF + D0)

- Direct Detection of Dark Matter → We find a factor of ~ 4 uncertainty in the nuclear matrix elements. This factor was obtained from studying several benchmark points in detail & so we allow cross sections 4x larger than the usually quoted limits. Spin-independent limits are completely dominant here.

- Dark Matter density: $\Omega h^2 < 0.1210$ → 5yr WMAP data +…. We treat this only as an *upper bound* on the LSP DM density to allow for multi-component DM, e.g., axions, etc. Recall the lightest neutralino is the LSP & is a thermal relic here

- LEP and Tevatron Direct Higgs & SUSY searches : there are *many* of these searches but they are very complicated with many caveats…. We need to be cautious here in how the constraints are used.

Example :

Zh, h-> bb, ττ

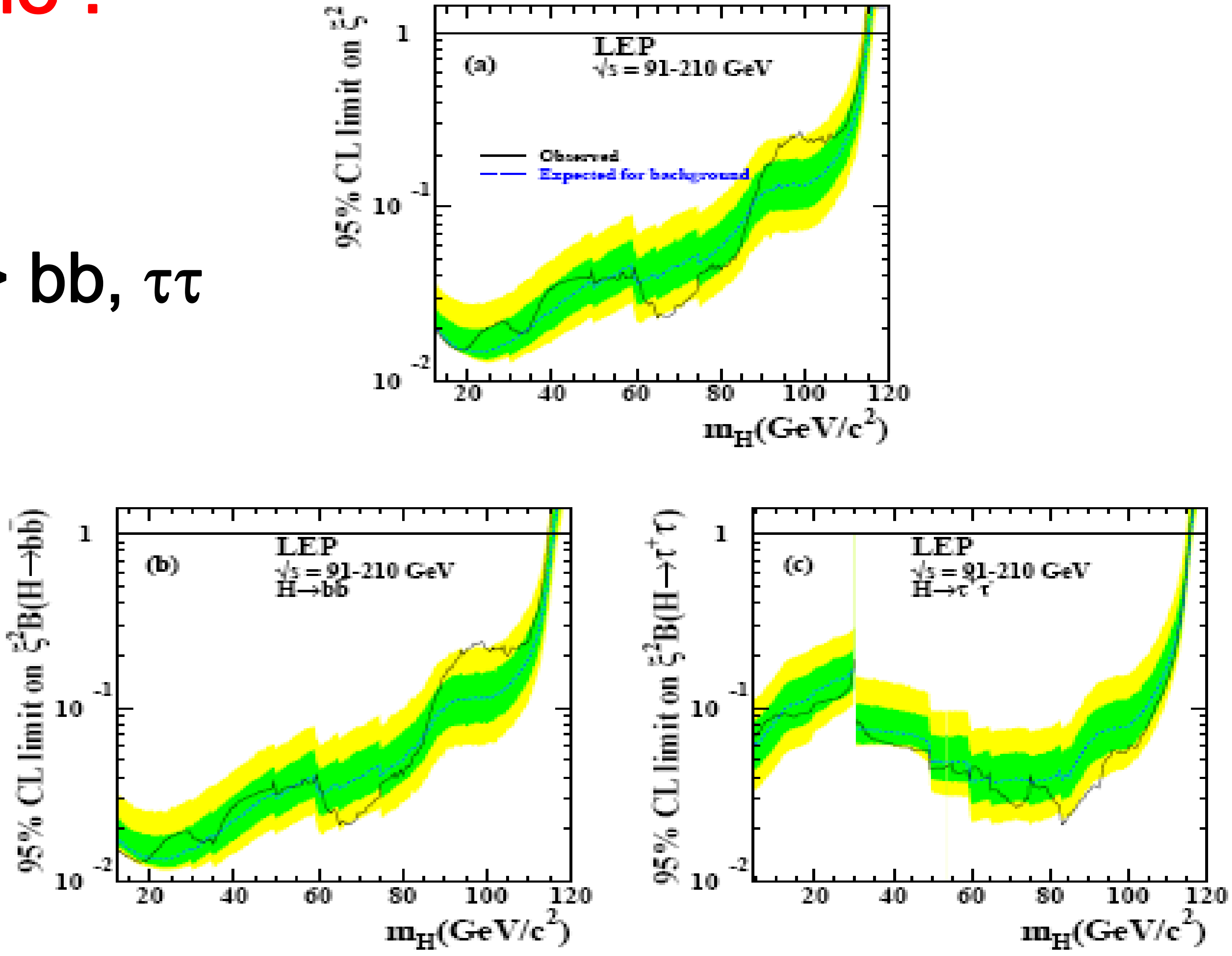
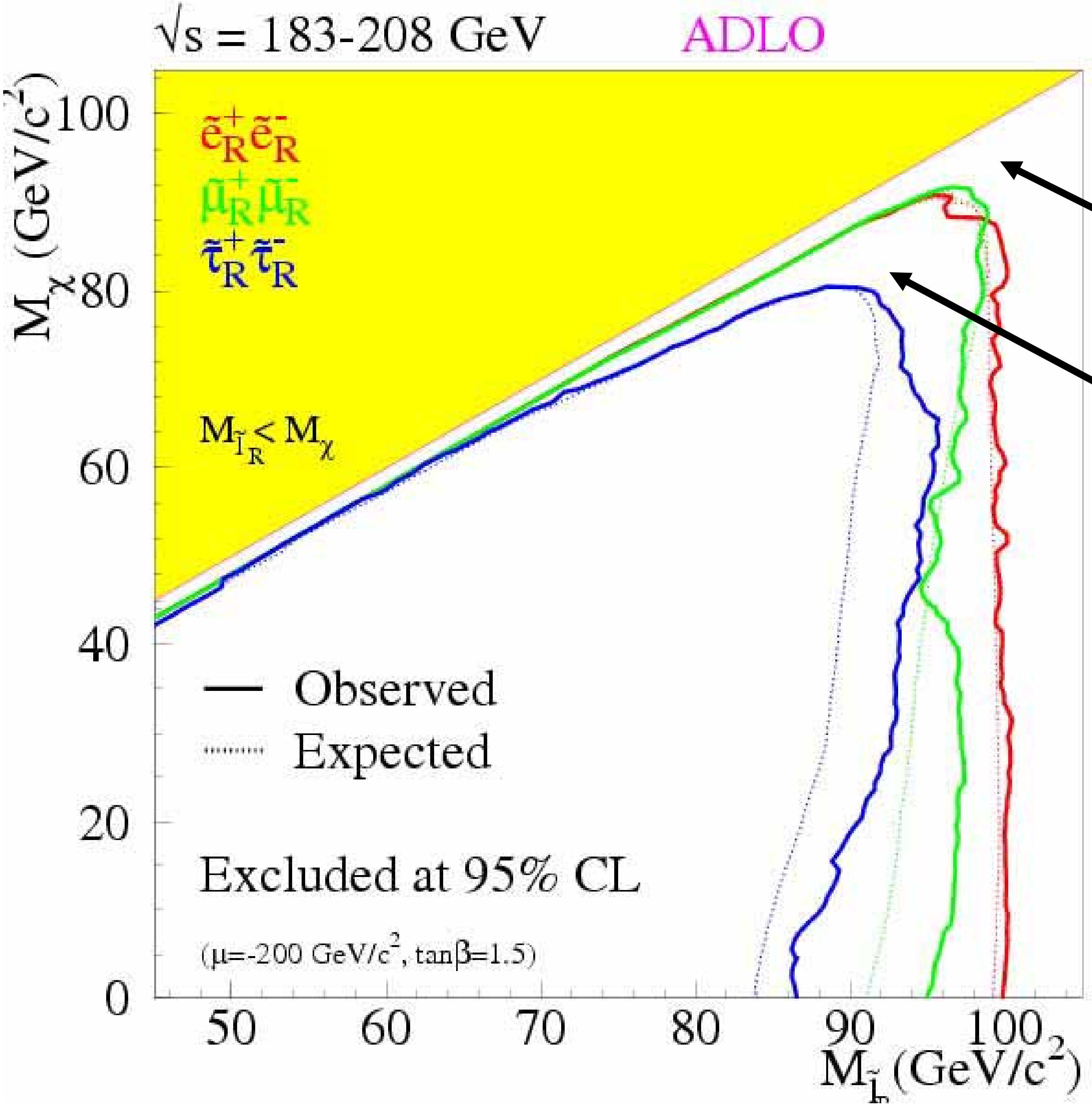


Figure 1: *The 95% c.l. upper bound on the coupling ratio* $\xi^2 = (g_{HZZ}/g^{SM}_{HZZ})^2$ *(see text). The dark (green) and light (yellow) shaded bands around the median expected line correspond to the 68% and 95% probability bands. The horizontal lines correspond to the Standard Model coupling. (a): For Higgs boson decays predicted by the Standard Model; (b): for the Higgs boson decaying exclusively into* $b\bar{b}$ *and (c): into* $\tau^+\tau^-$ *pairs.*

Example :

RH Sleptons



Note the holes where the leptons are too soft…

We need to allow for a mass gap w/ the LSP & also in the squark case when soft jets are possible..light guys may slip through

Example :

Tevatron Constraints : I   Squark & Gluino Search

- This is the first SUSY analysis to include these constraints
- 2,3,4 Jets + Missing Energy (D0)

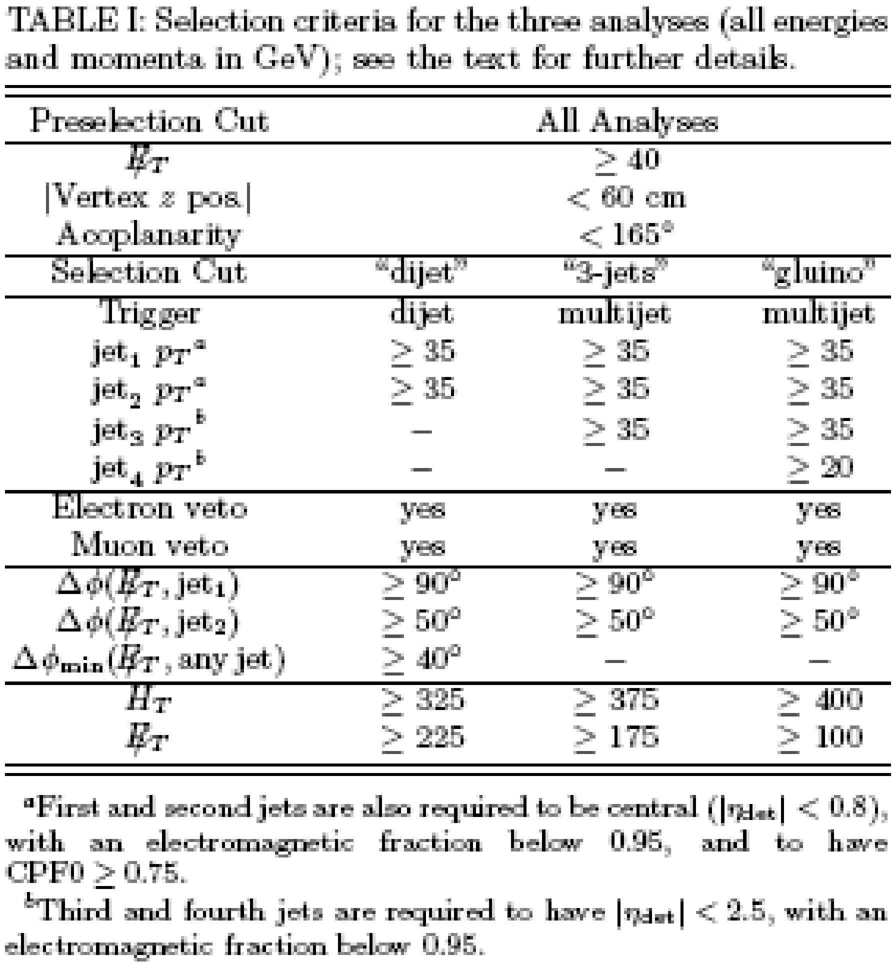


TABLE I: Selection criteria for the three analyses (all energies and momenta in GeV); see the text for further details.

Preselection Cut	All Analyses		
$\not\!\!E_T$	≥ 40		
|Vertex z pos.|	< 60 cm		
Acoplanarity	$< 165°$		
Selection Cut	**"dijet"**	**"3-jets"**	**"gluino"**
Trigger	dijet	multijet	multijet
jet$_1$ p_T[a]	≥ 35	≥ 35	≥ 35
jet$_2$ p_T[a]	≥ 35	≥ 35	≥ 35
jet$_3$ p_T[b]	–	≥ 35	≥ 35
jet$_4$ p_T[b]	–	–	≥ 20
Electron veto	yes	yes	yes
Muon veto	yes	yes	yes
$\Delta\phi(\not\!\!E_T, \mathrm{jet}_1)$	$\geq 90°$	$\geq 90°$	$\geq 90°$
$\Delta\phi(\not\!\!E_T, \mathrm{jet}_2)$	$\geq 50°$	$\geq 50°$	$\geq 50°$
$\Delta\phi_{\min}(\not\!\!E_T, \text{any jet})$	$\geq 40°$	–	–
H_T	≥ 325	≥ 375	≥ 400
$\not\!\!E_T$	≥ 225	≥ 175	≥ 100

[a] First and second jets are also required to be central ($|\eta_{\mathrm{det}}| < 0.8$), with an electromagnetic fraction below 0.95, and to have CPF0 ≥ 0.75.

[b] Third and fourth jets are required to have $|\eta_{\mathrm{det}}| < 2.5$, with an electromagnetic fraction below 0.95.

Multiple analyses keyed to look for:

Squarks-> jet +MET
Gluinos -> 2 j + MET

The search is based on mSUGRA type sparticle spectrum assumptions which can be VERY far from our model points

D0 benchmarks

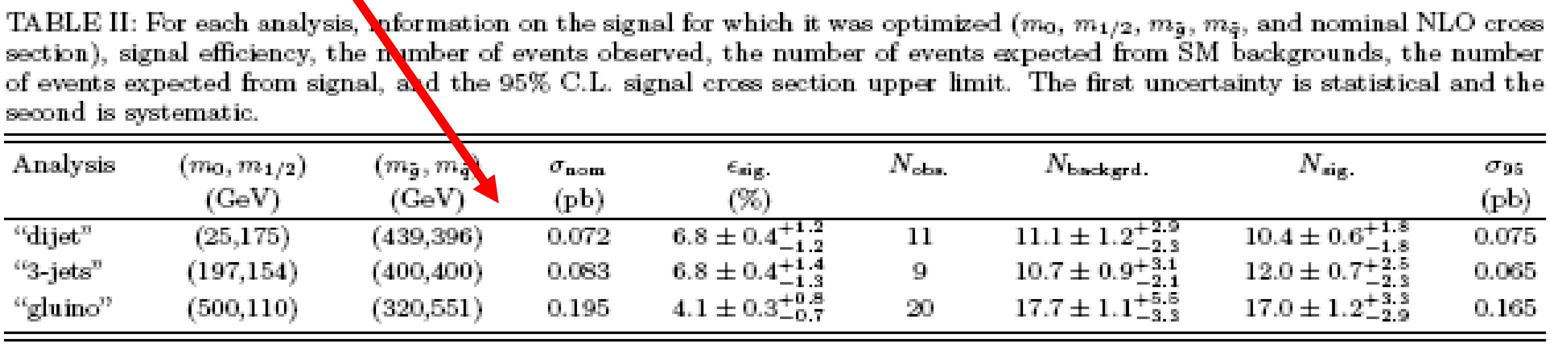


TABLE II: For each analysis, information on the signal for which it was optimized (m_0, $m_{1/2}$, $m_{\tilde{g}}$, $m_{\tilde{q}}$, and nominal NLO cross section), signal efficiency, the number of events observed, the number of events expected from SM backgrounds, the number of events expected from signal, and the 95% C.L. signal cross section upper limit. The first uncertainty is statistical and the second is systematic.

Analysis	$(m_0, m_{1/2})$ (GeV)	$(m_{\tilde{g}}, m_{\tilde{q}})$ (GeV)	σ_{nom} (pb)	$\epsilon_{\mathrm{sig.}}$ (%)	$N_{\mathrm{obs.}}$	$N_{\mathrm{backgrd.}}$	$N_{\mathrm{sig.}}$	σ_{95} (pb)
"dijet"	(25,175)	(439,396)	0.072	$6.8 \pm 0.4^{+1.2}_{-1.2}$	11	$11.1 \pm 1.2^{+2.9}_{-2.3}$	$10.4 \pm 0.6^{+1.8}_{-1.8}$	0.075
"3-jets"	(197,154)	(400,400)	0.083	$6.8 \pm 0.4^{+1.4}_{-1.3}$	9	$10.7 \pm 0.9^{+3.1}_{-2.1}$	$12.0 \pm 0.7^{+2.5}_{-2.3}$	0.065
"gluino"	(500,110)	(320,551)	0.195	$4.1 \pm 0.3^{+0.8}_{-0.7}$	20	$17.7 \pm 1.1^{+5.5}_{-3.3}$	$17.0 \pm 1.2^{+3.3}_{-2.9}$	0.165

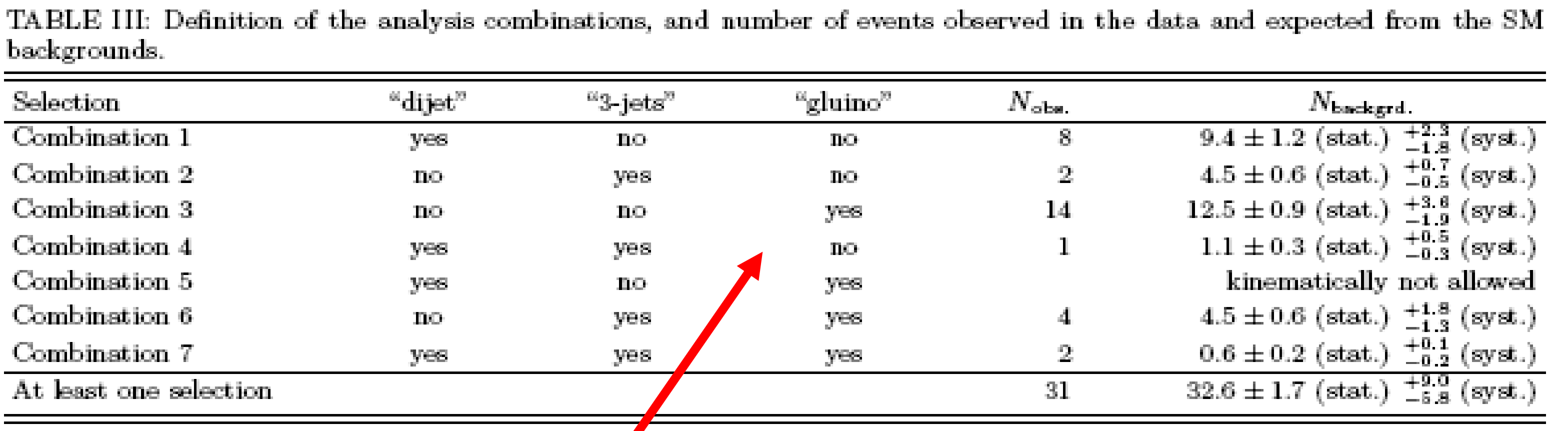


TABLE III: Definition of the analysis combinations, and number of events observed in the data and expected from the SM backgrounds.

Selection	"dijet"	"3-jets"	"gluino"	$N_{\mathrm{obs.}}$	$N_{\mathrm{backgrd.}}$
Combination 1	yes	no	no	8	9.4 ± 1.2 (stat.) ${}^{+2.3}_{-1.8}$ (syst.)
Combination 2	no	yes	no	2	4.5 ± 0.6 (stat.) ${}^{+0.7}_{-0.5}$ (syst.)
Combination 3	no	no	yes	14	12.5 ± 0.9 (stat.) ${}^{+3.6}_{-1.9}$ (syst.)
Combination 4	yes	yes	no	1	1.1 ± 0.3 (stat.) ${}^{+0.5}_{-0.3}$ (syst.)
Combination 5	yes	no	yes		kinematically not allowed
Combination 6	no	yes	yes	4	4.5 ± 0.6 (stat.) ${}^{+1.8}_{-1.3}$ (syst.)
Combination 7	yes	yes	yes	2	0.6 ± 0.2 (stat.) ${}^{+0.1}_{-0.2}$ (syst.)
At least one selection				31	32.6 ± 1.7 (stat.) ${}^{+9.0}_{-5.8}$ (syst.)

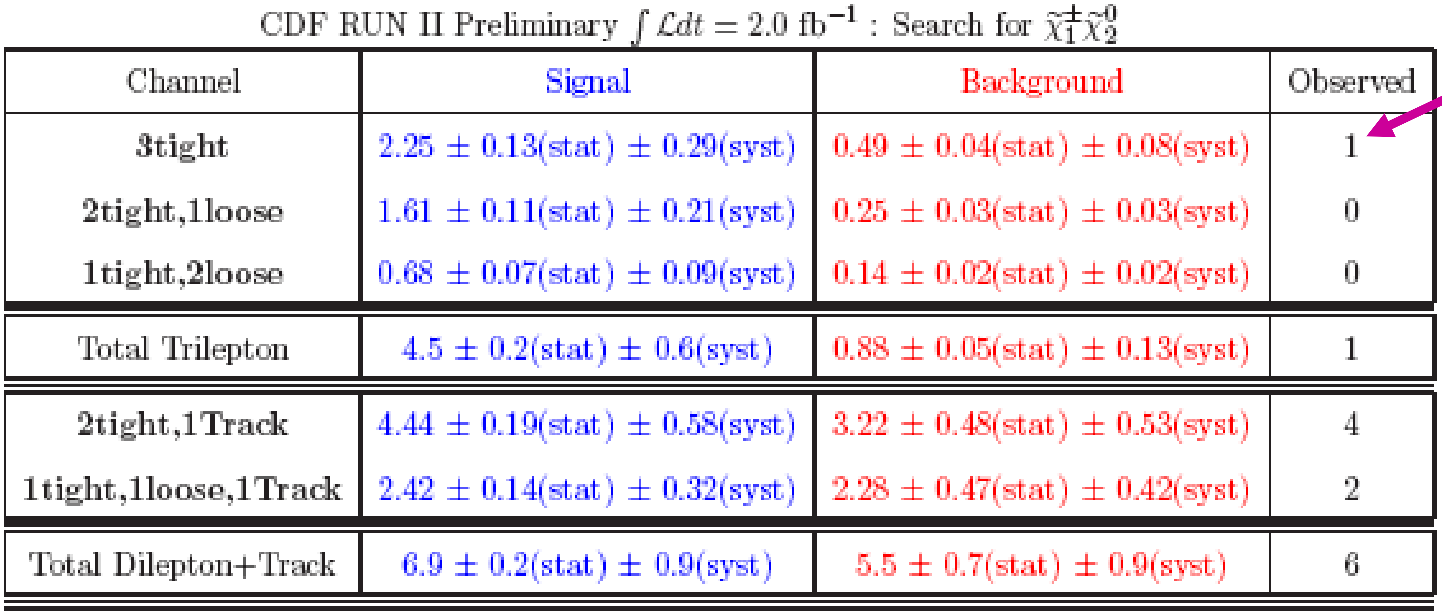
Combos of the 3 analyses

→ Feldman-Cousins 95% CL Signal limit: 8.34 events

SuSpect -> SUSY-Hit -> PROSPINO -> PYTHIA -> D0-tuned PGS4 fast simulation (to reproduce the benchmark points)…

redo this analysis ~ 10^5 times !

Tevatron II: CDF Tri-lepton Analysis



CDF RUN II Preliminary $\int \mathcal{L}dt = 2.0\ \mathrm{fb}^{-1}$: Search for $\tilde{\chi}_1^{\pm}\tilde{\chi}_2^{0}$

Channel	Signal	Background	Observed
3tight	2.25 ± 0.13(stat) ± 0.29(syst)	0.49 ± 0.04(stat) ± 0.08(syst)	1
2tight,1loose	1.61 ± 0.11(stat) ± 0.21(syst)	0.25 ± 0.03(stat) ± 0.03(syst)	0
1tight,2loose	0.68 ± 0.07(stat) ± 0.09(syst)	0.14 ± 0.02(stat) ± 0.02(syst)	0
Total Trilepton	4.5 ± 0.2(stat) ± 0.6(syst)	0.88 ± 0.05(stat) ± 0.13(syst)	1
2tight,1Track	4.44 ± 0.19(stat) ± 0.58(syst)	3.22 ± 0.48(stat) ± 0.53(syst)	4
1tight,1loose,1Track	2.42 ± 0.14(stat) ± 0.32(syst)	2.28 ± 0.47(stat) ± 0.42(syst)	2
Total Dilepton+Track	6.9 ± 0.2(stat) ± 0.9(syst)	5.5 ± 0.7(stat) ± 0.9(syst)	6

Table 3: Number of expected signal and background events and number of observed events in 2 fb^{-1}. Uncertainties are statistical(stat) and full systematics(syst). The signal is for the benchmark point described in section 5.

We need to perform the 3 tight lepton analysis ~ 10^5 times

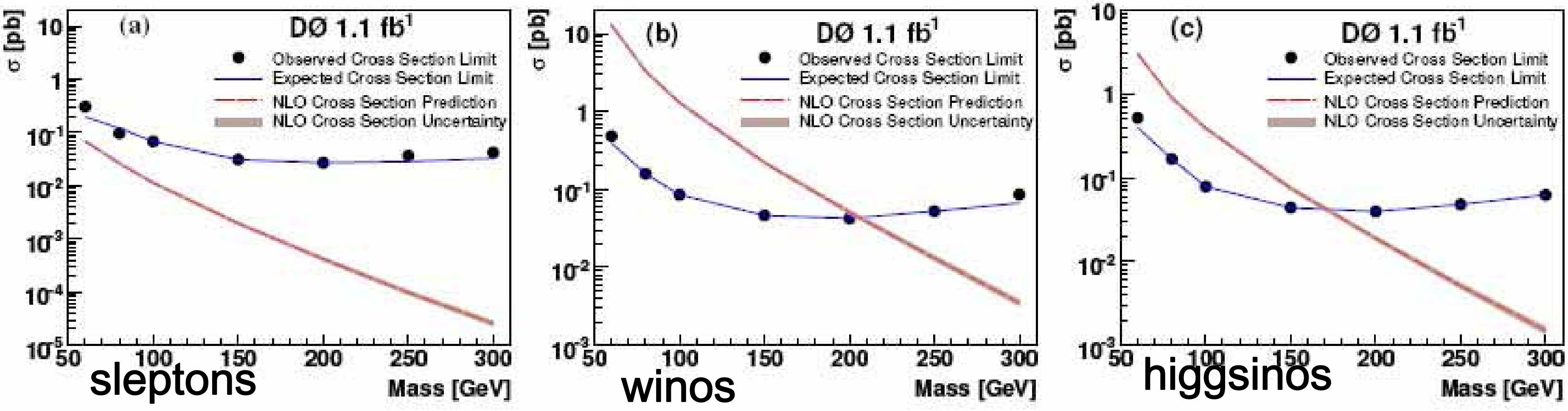
We perform this analysis using CDF-tuned PGS4, PYTHIA in LO plus a PROSPINO K-factor

→ Feldman-Cousins 95% CL Signal limit: 4.65 events

- This is the first SUSY analysis to include these constraints

The non-‘3-tight’ analyses are not reproducible w/o a better detector simulation

Tevatron III: D0 Stable Particle (= Chargino) Search



sleptons winos higgsinos

FIG. 2: The observed (dots) and expected (solid line) 95% cross section limits, the NLO production cross section (dashed line), and NLO cross section uncertainty (barely visible shaded band) as a function of (a) stau mass for stau pair production, (b) chargino mass for pair produced gaugino-like charginos, and (c) chargino mass for pair produced higgsino-like charginos.

Interpolation: $M_\chi > 206\,|U_{1w}|^2 + 171\,|U_{1h}|^2$ GeV

This is an *incredibly* powerful constraint on our model set as we will have many close mass chargino-neutralino pairs. This search cuts out a huge parameter region as you will see later.

- No applicable bounds on charged sleptons..the cross sections are too small.
- This is the first SUSY analysis to include these constraints

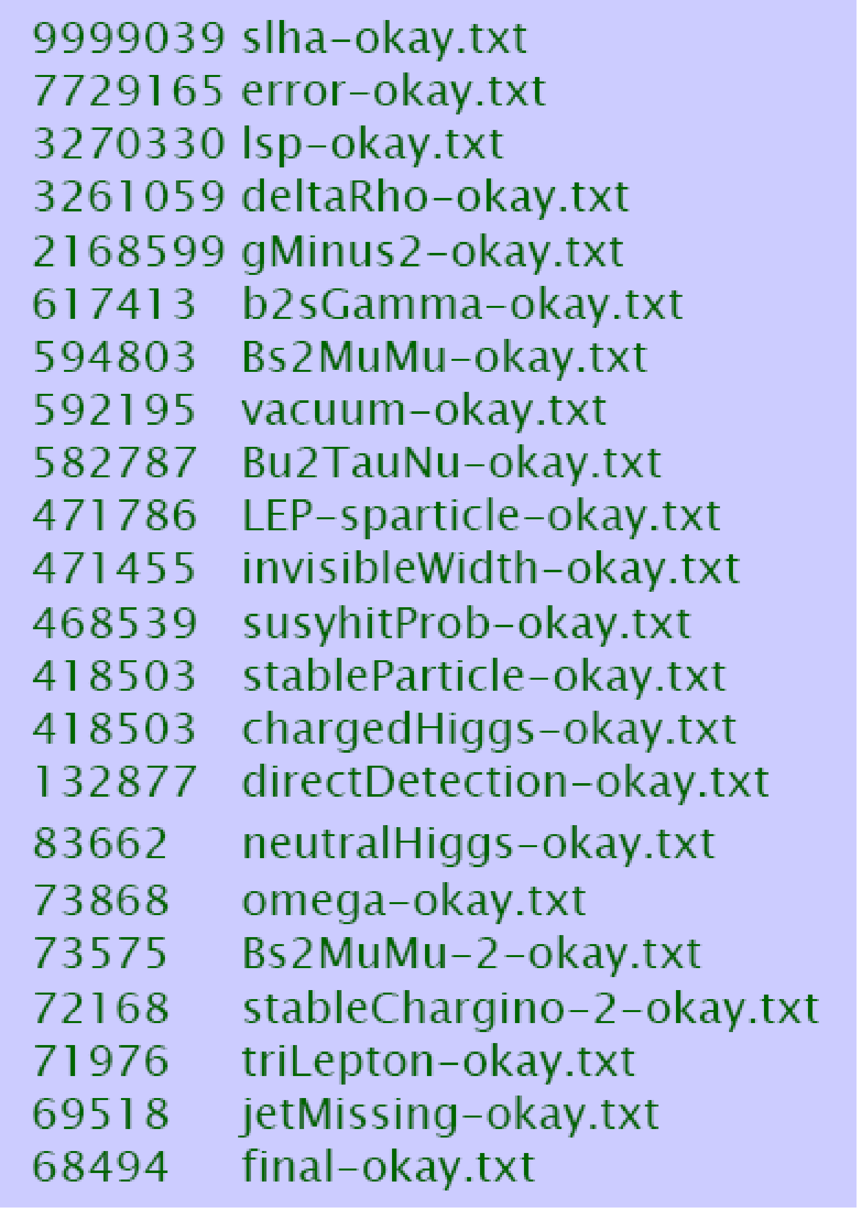
Survival Rates

- Flat Priors :

  - 10^7 models scanned
  ~ 68.5 K (0.68%) survive

- Log Priors :

  - 2x10^6 models scanned
  ~ 3.0 K (0.15%) survive



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592195   vacuum-okay.txt
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68494     final-okay.txt
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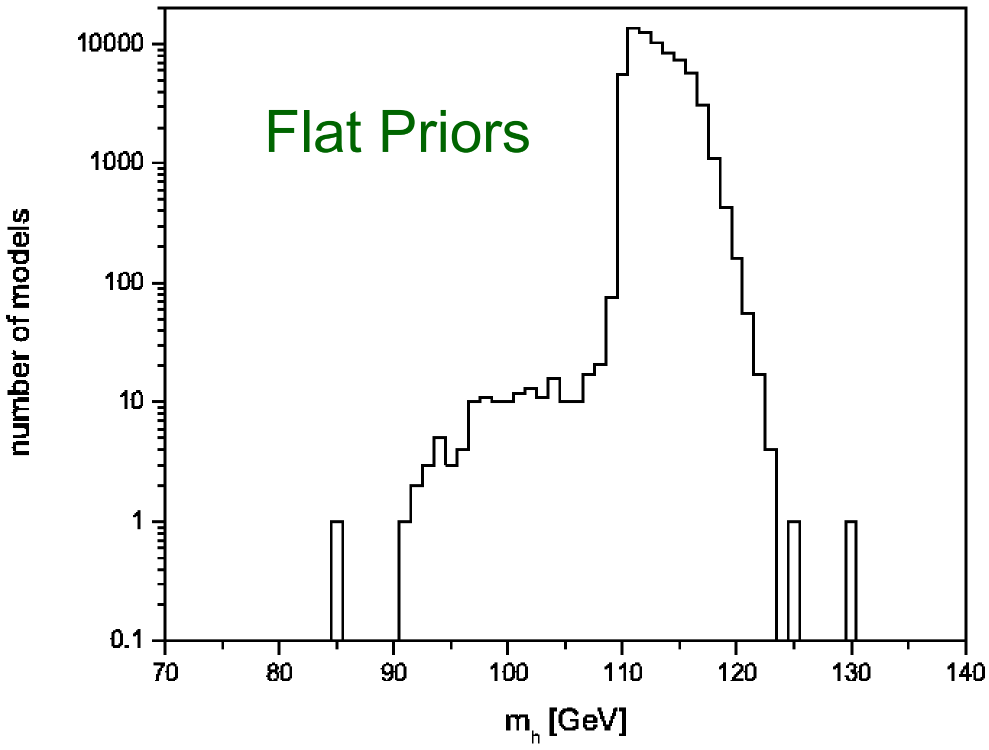
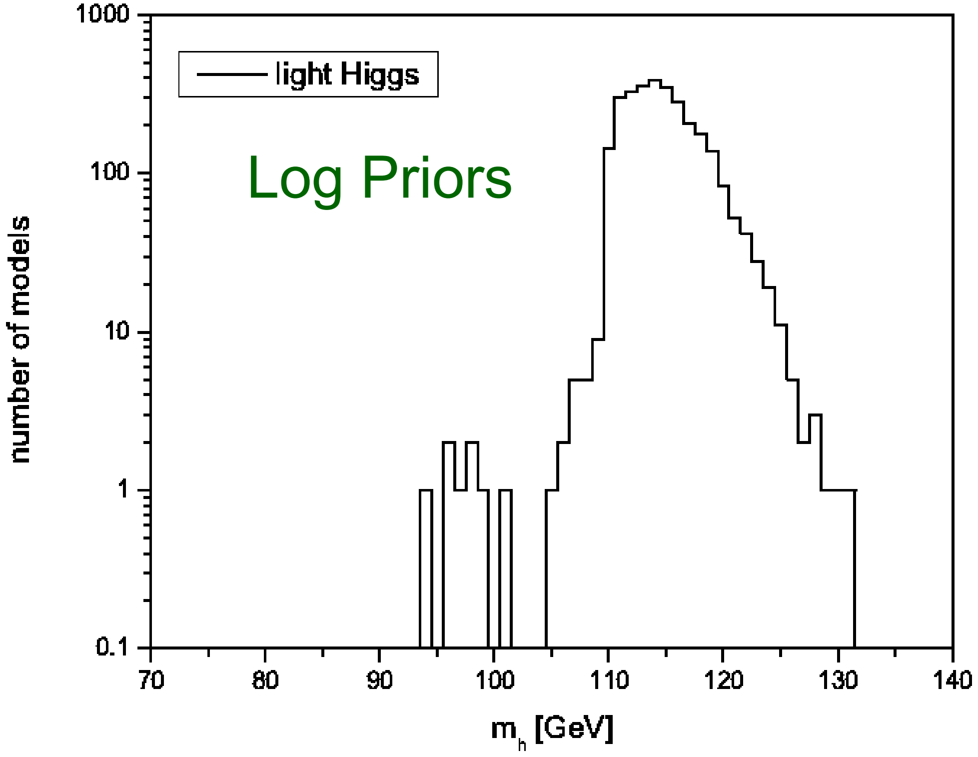
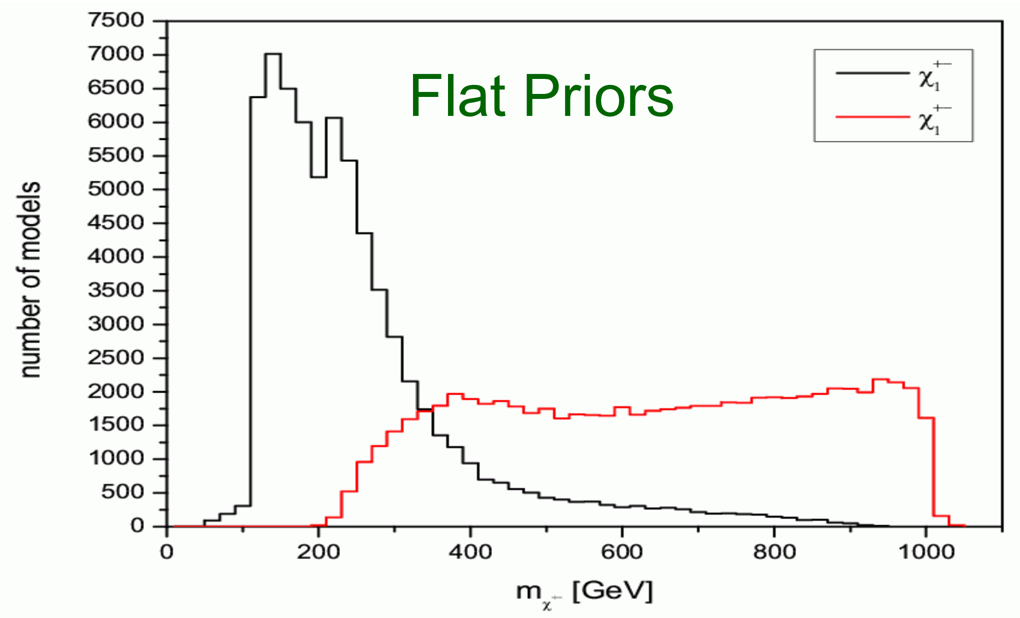
Light Higgs Mass Predictions

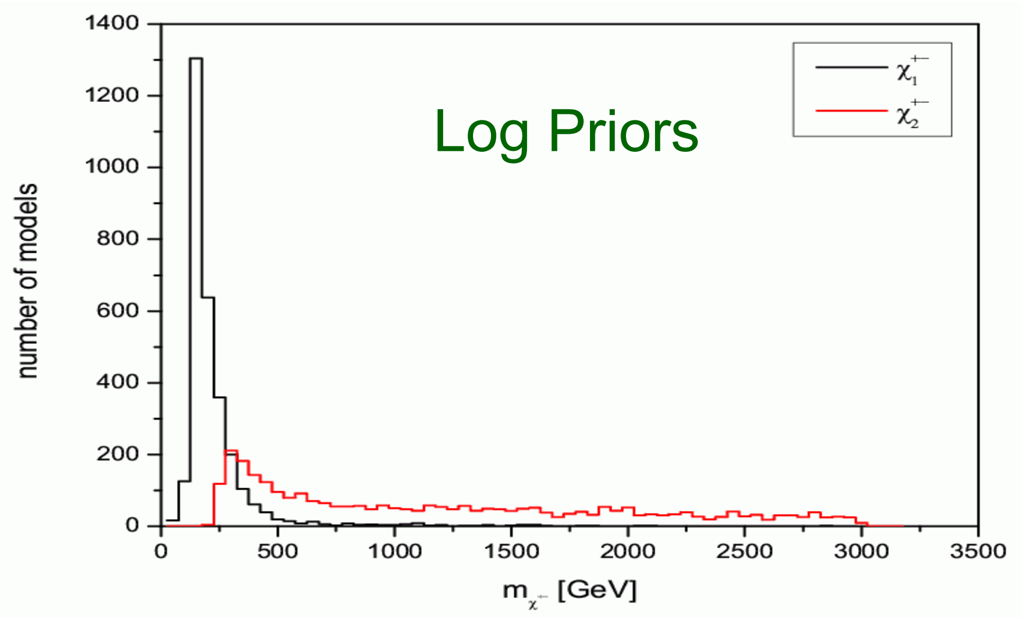


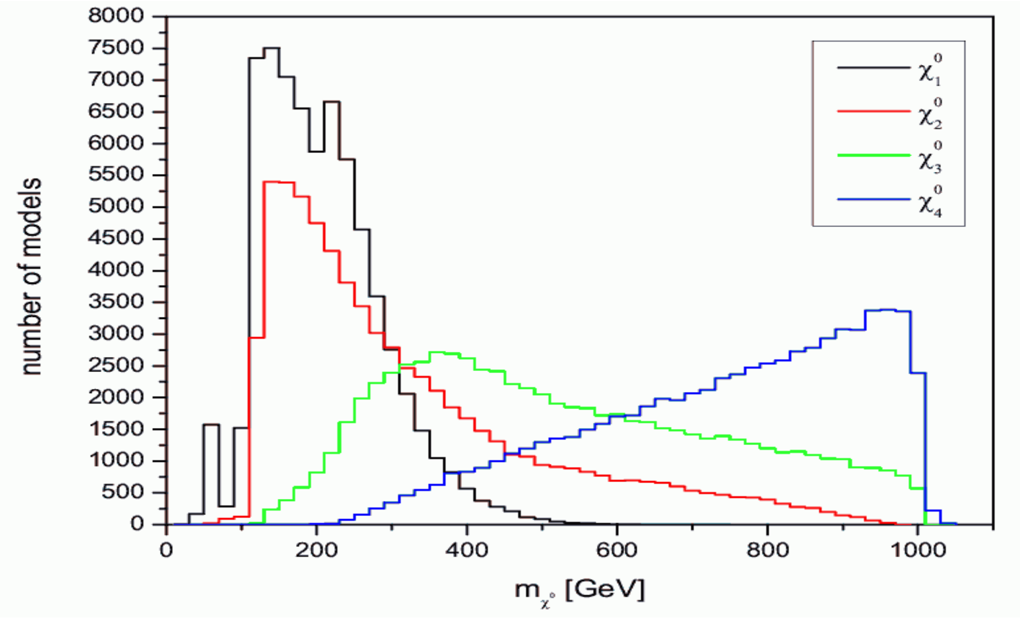


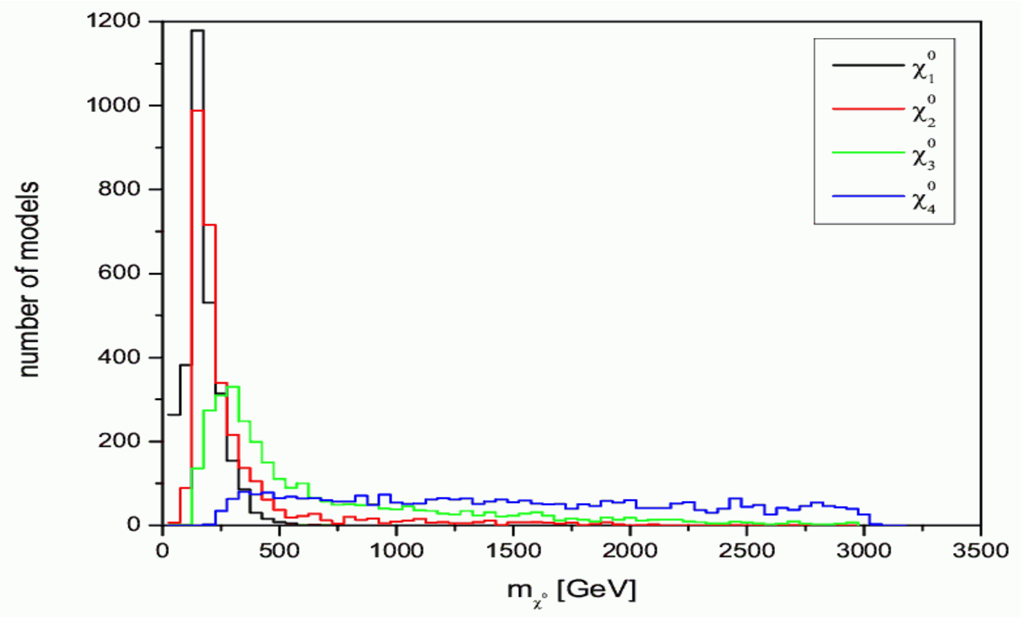
LEP Higgs mass constraints avoided by either reducing the ZZh coupling and/or reducing the, e.g., $h \rightarrow \bar{b}b$ branching fraction by decays to LSP pairs. We have both of these cases in our final model sets.

Distribution of Sparticle Masses By Species

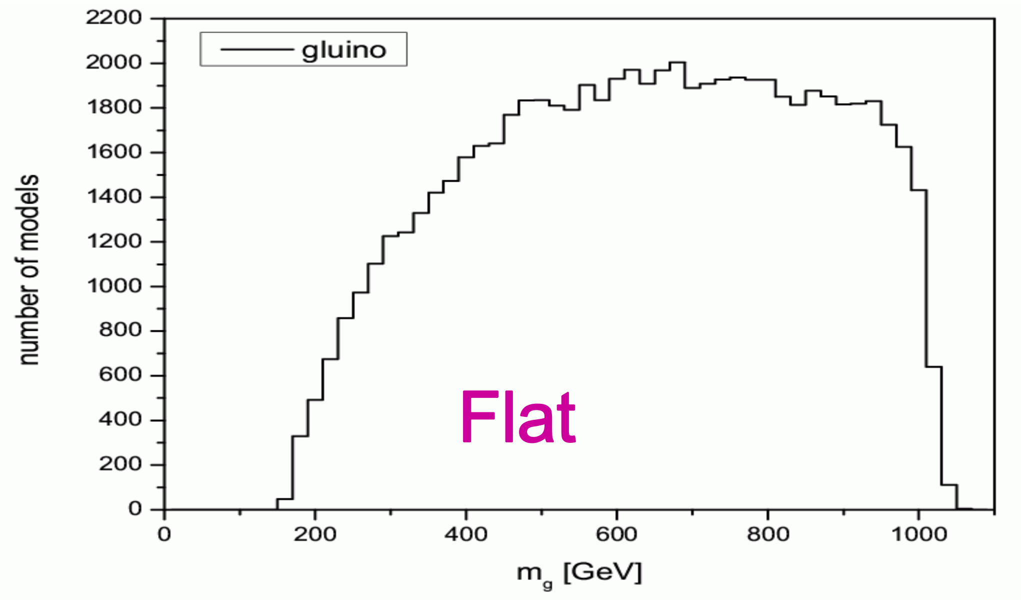


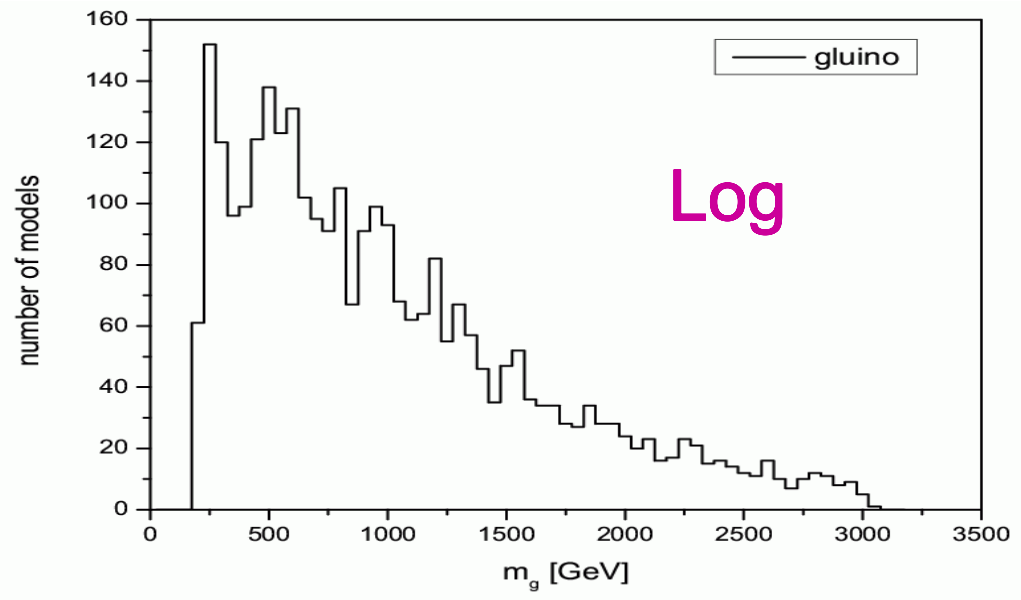


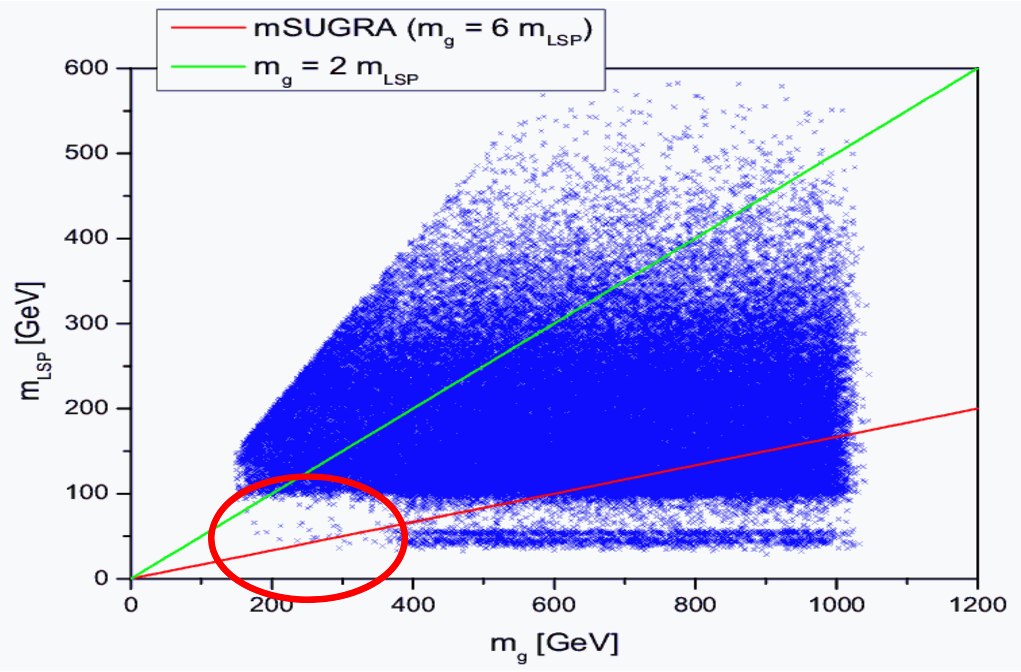


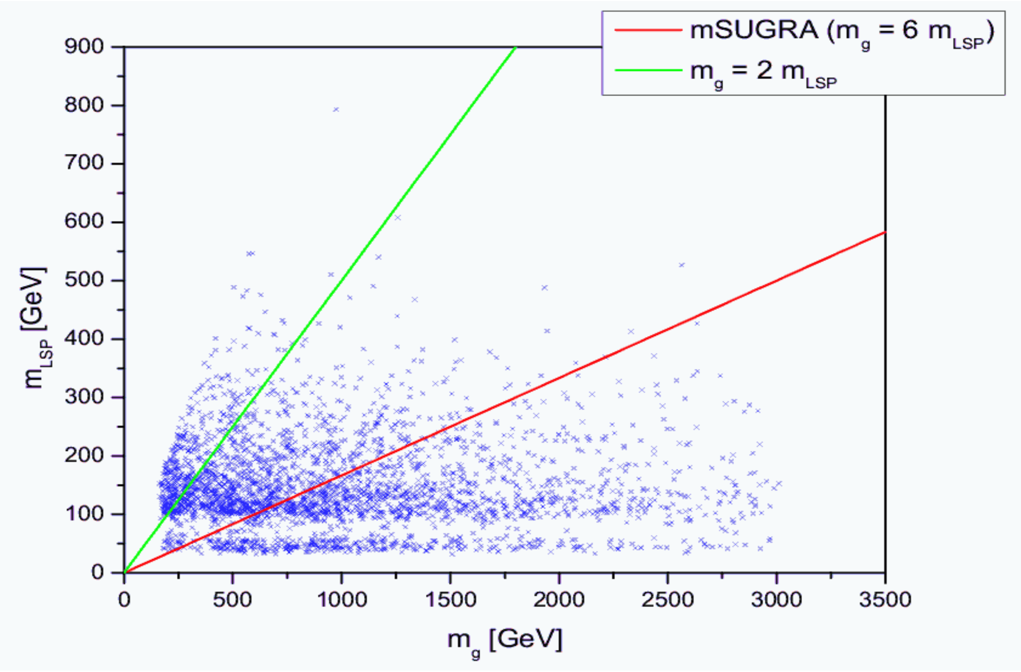


Gluino Can Be Light !!

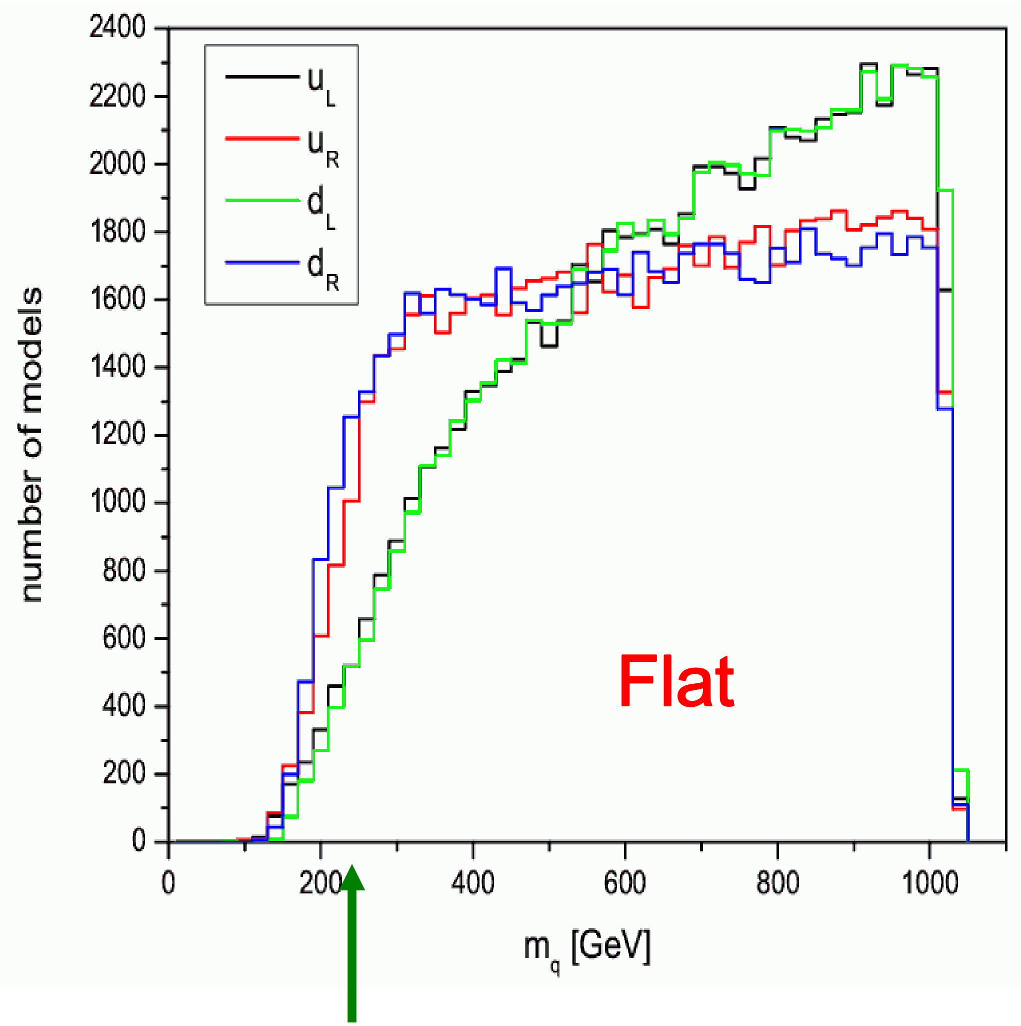


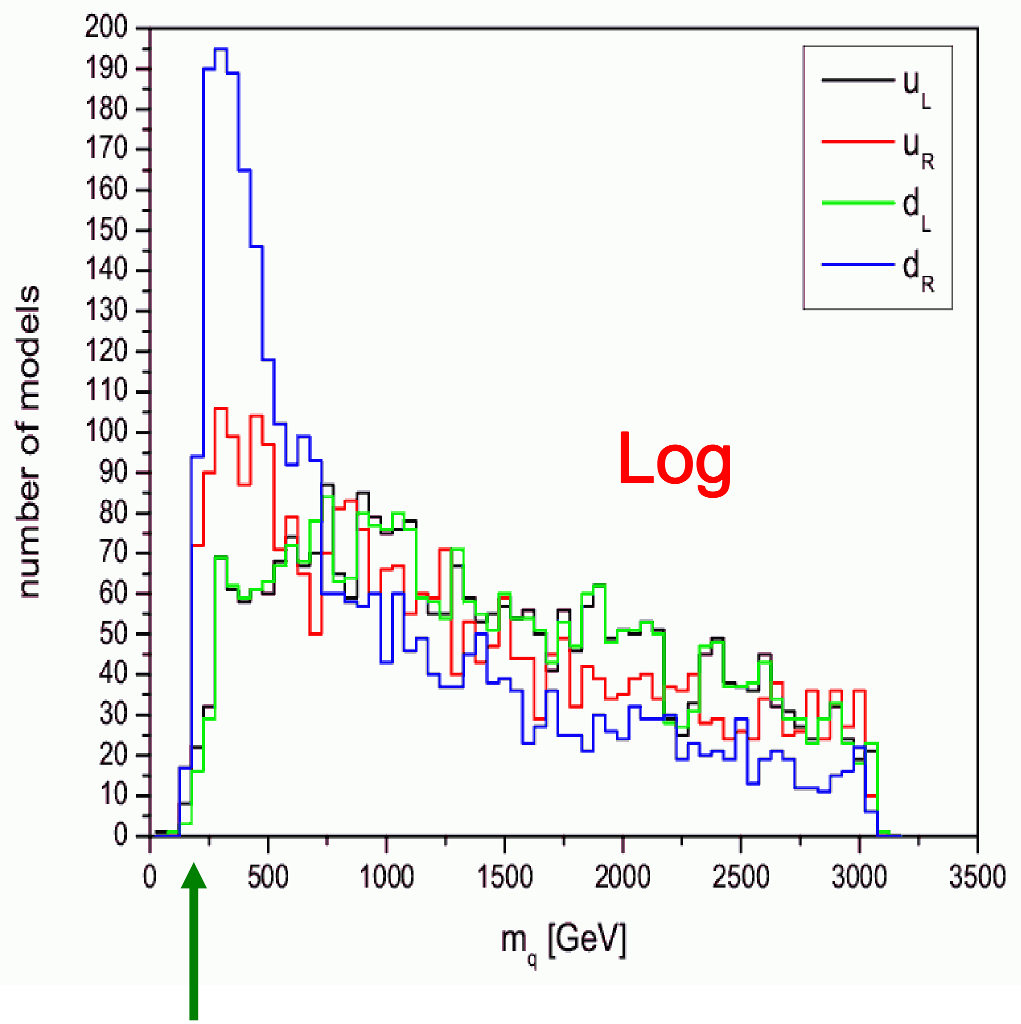






Squarks CAN Be Light !!!

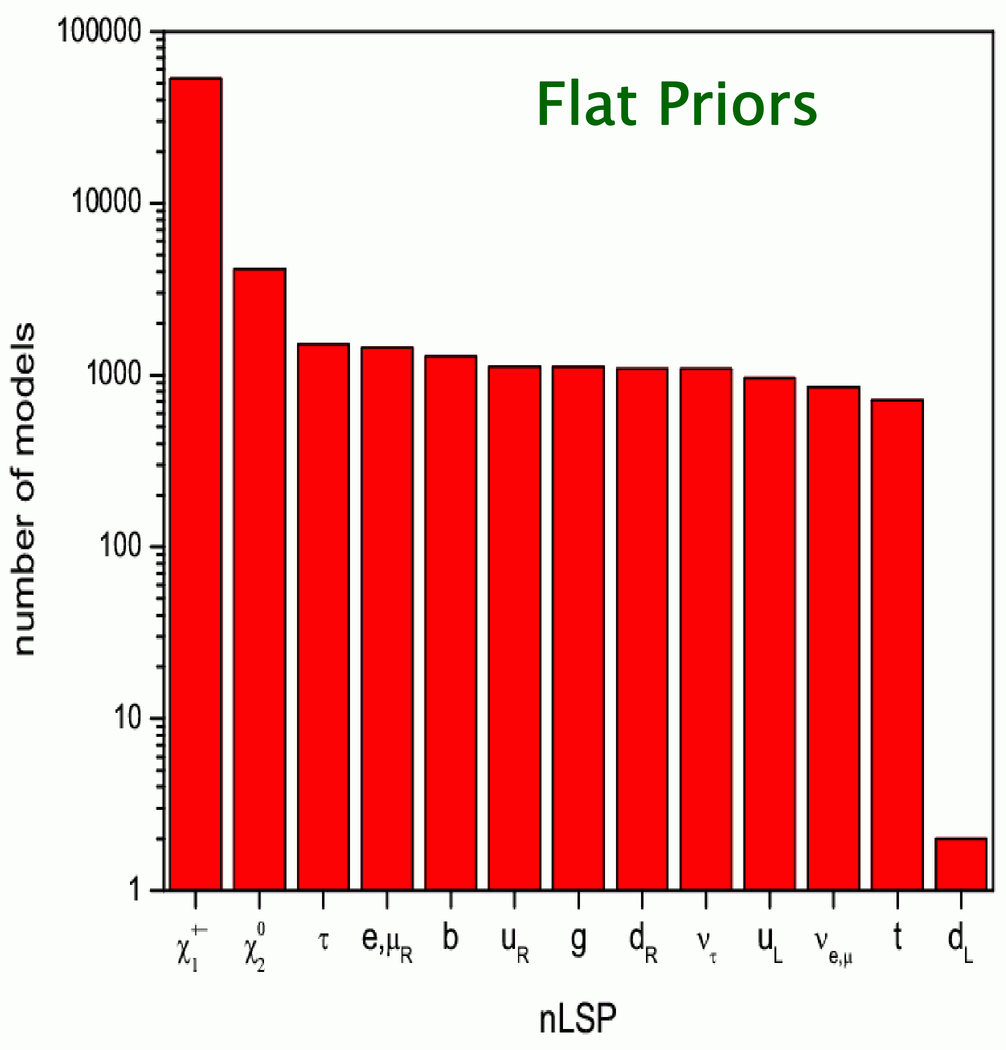


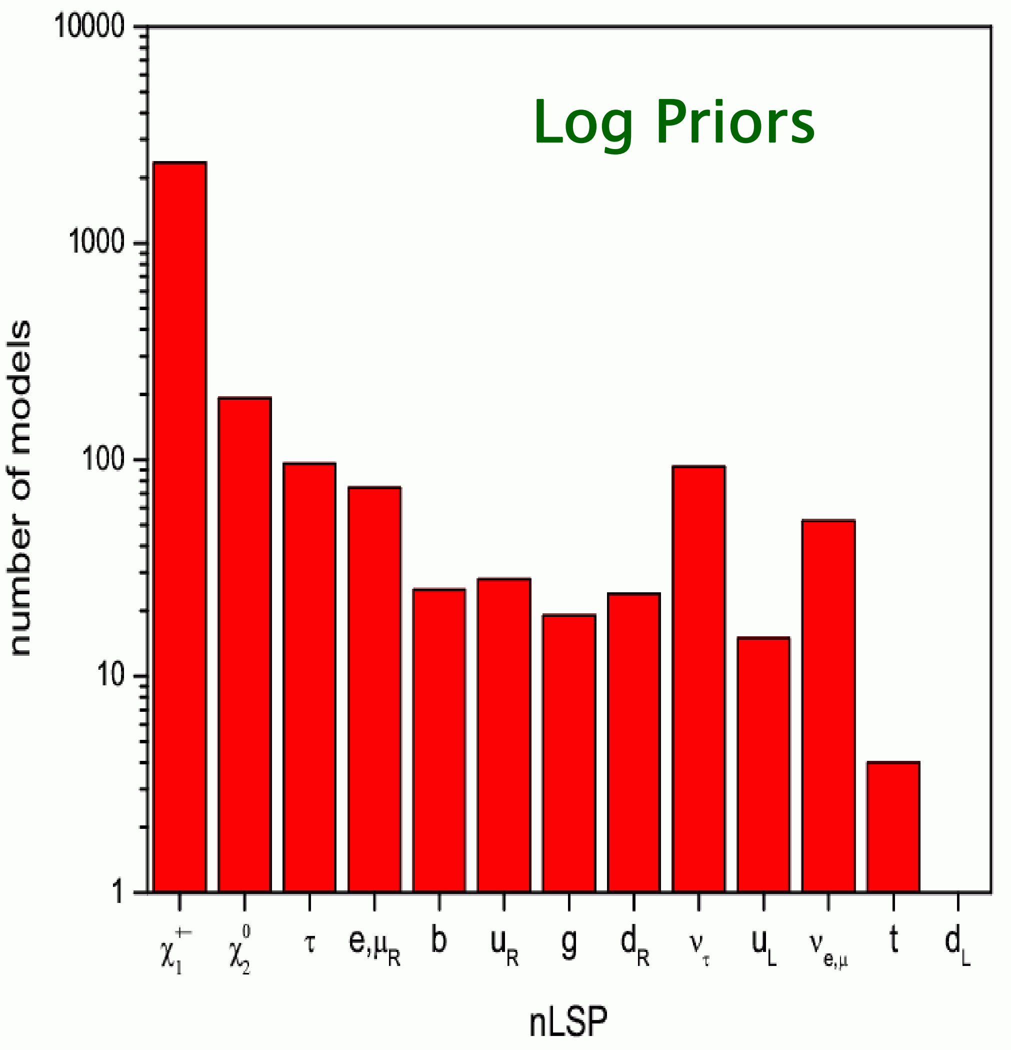


Light squarks can be missed by Tevatron searches for numerous reasons..

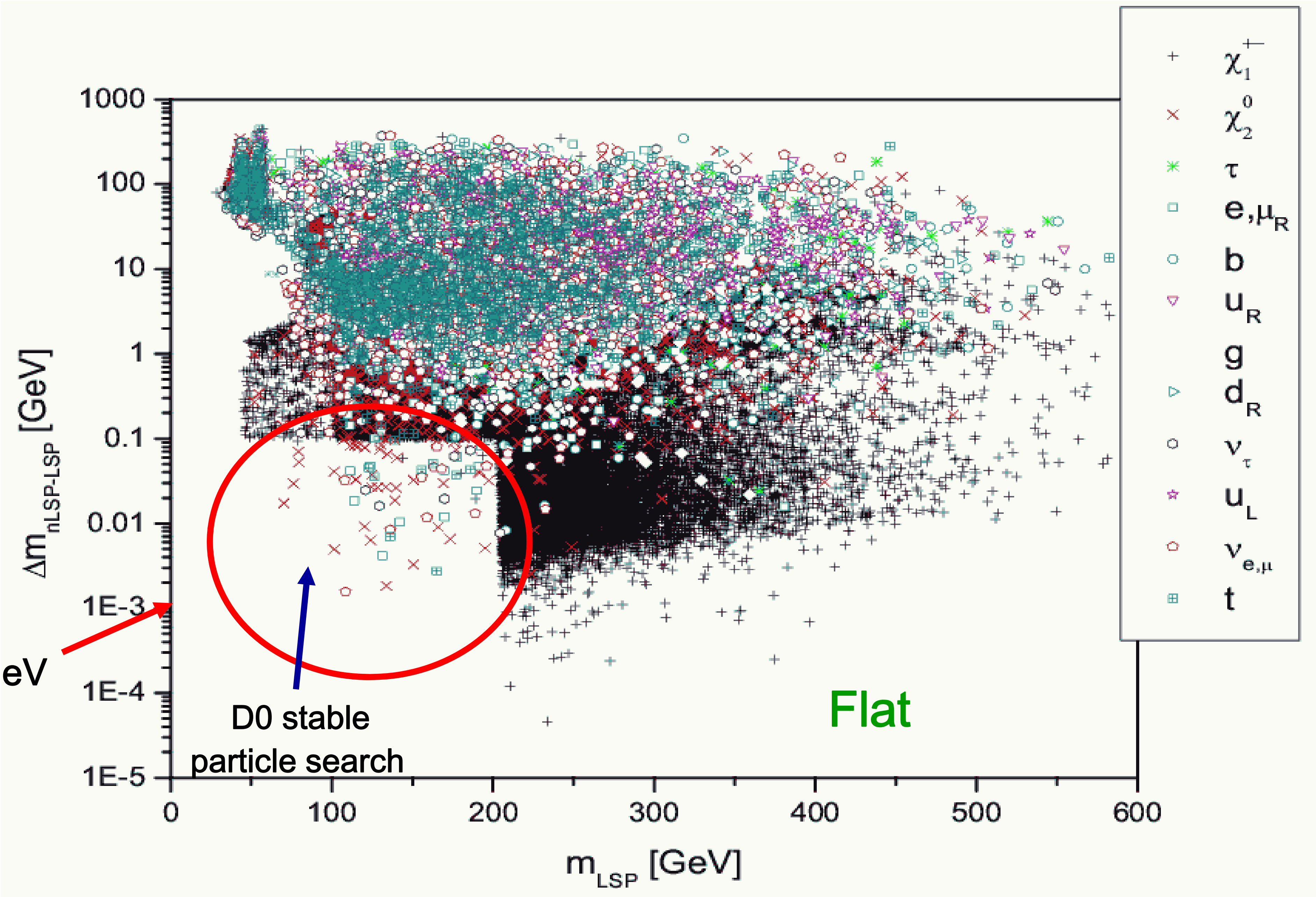
The identity of the nLSP is a critical factor in looking for SUSY signatures..who can play that role here?????   Just about

ANY of the 13 possibilities !





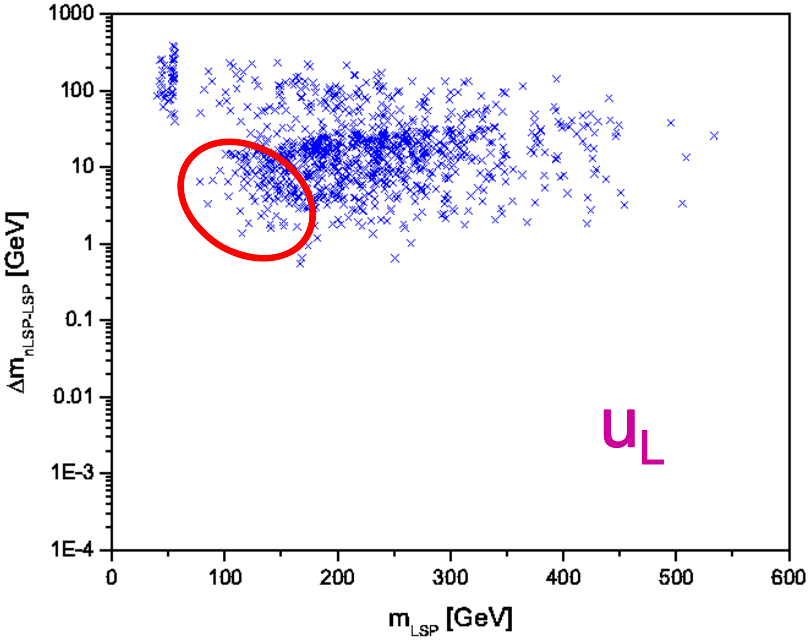
nLSP-LSP Mass Difference



1 MeV

D0 stable particle search

Flat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m_{LSP} [GeV]
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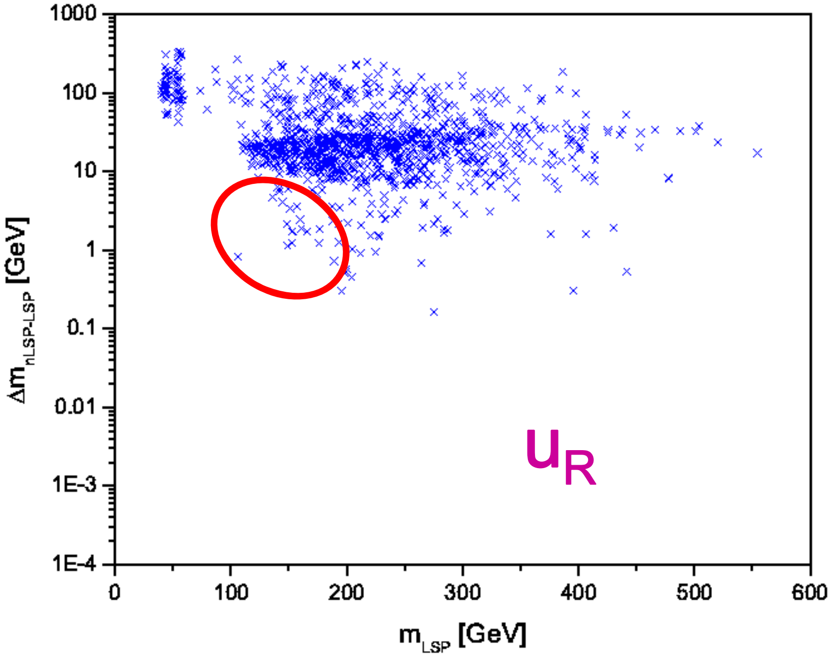
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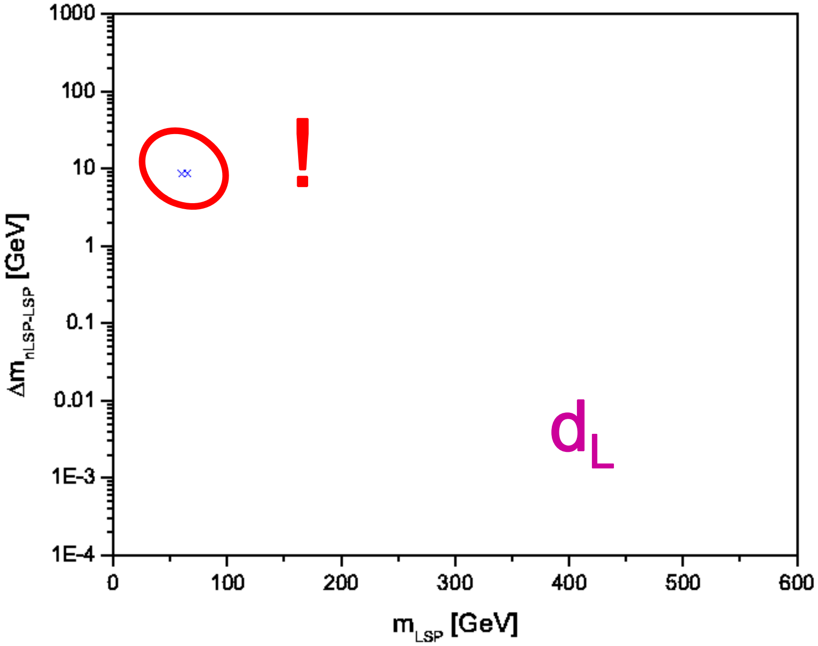
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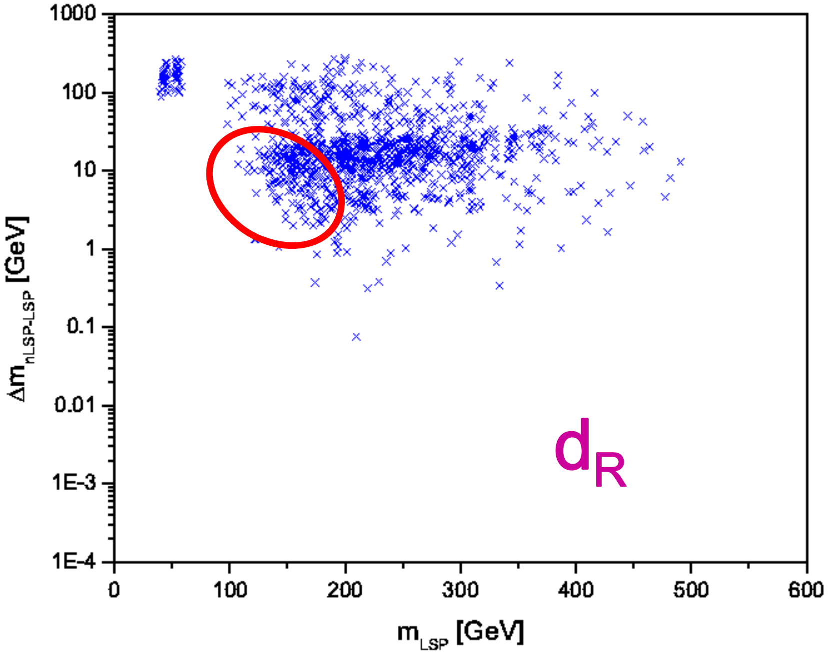
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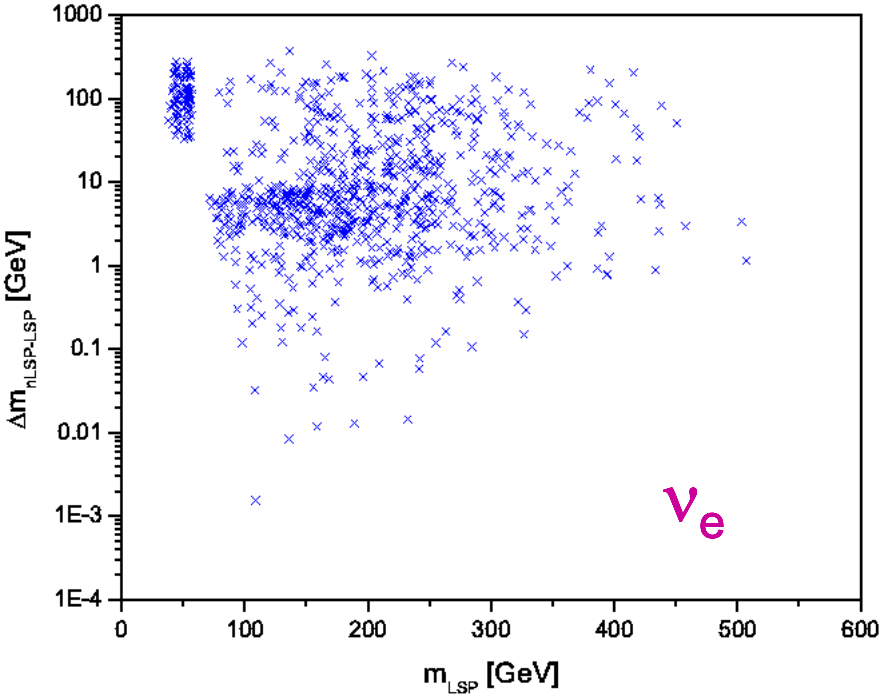
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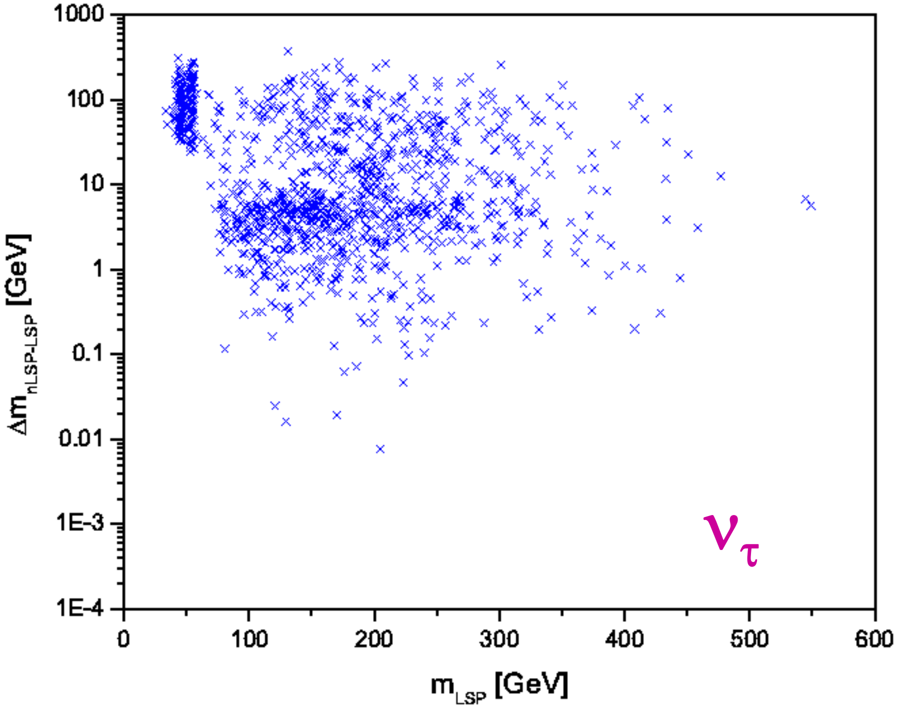
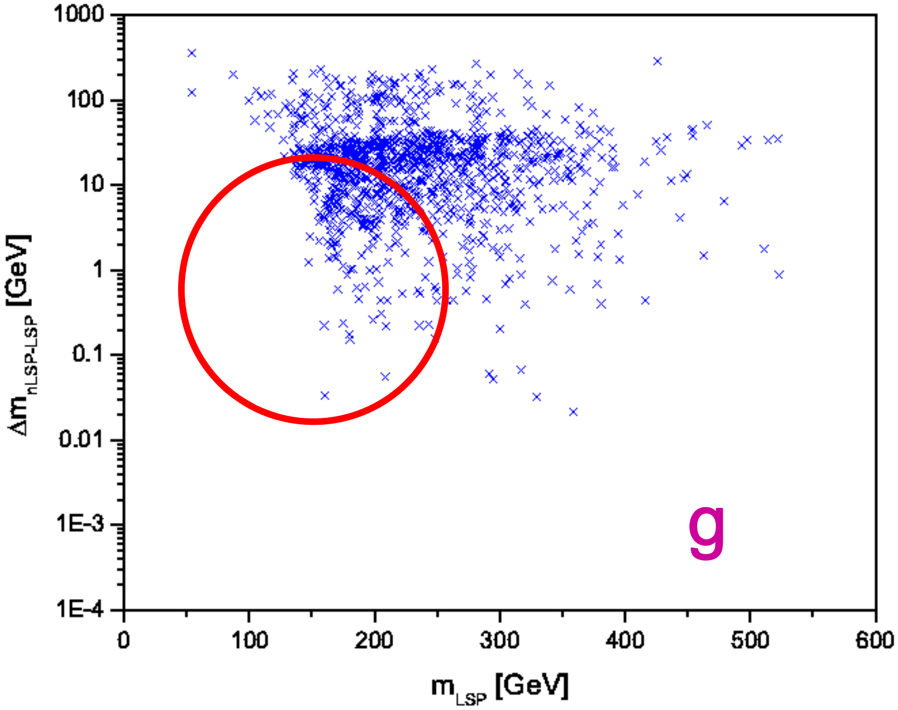
600
m_{LSP} [GeV]
ν_e

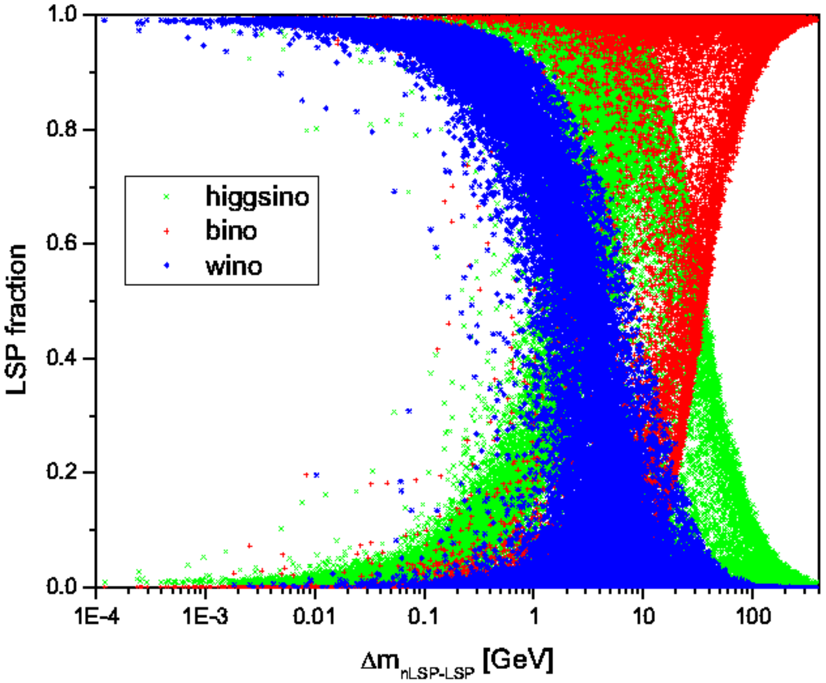

1000
100
10
1
0.1
0.01
1E-3
1E-4
$\Delta m_{nLSP-LSP}$ [GeV]
0
100
200
300
400
500
600
m_{LSP} [GeV]
ν_τ


1000
100
10
1
0.1
0.01
1E-3
1E-4
$\Delta m_{nLSP-LSP}$ [GeV]
0
100
200
300
400
500
600
m_{LSP} [GeV]
g

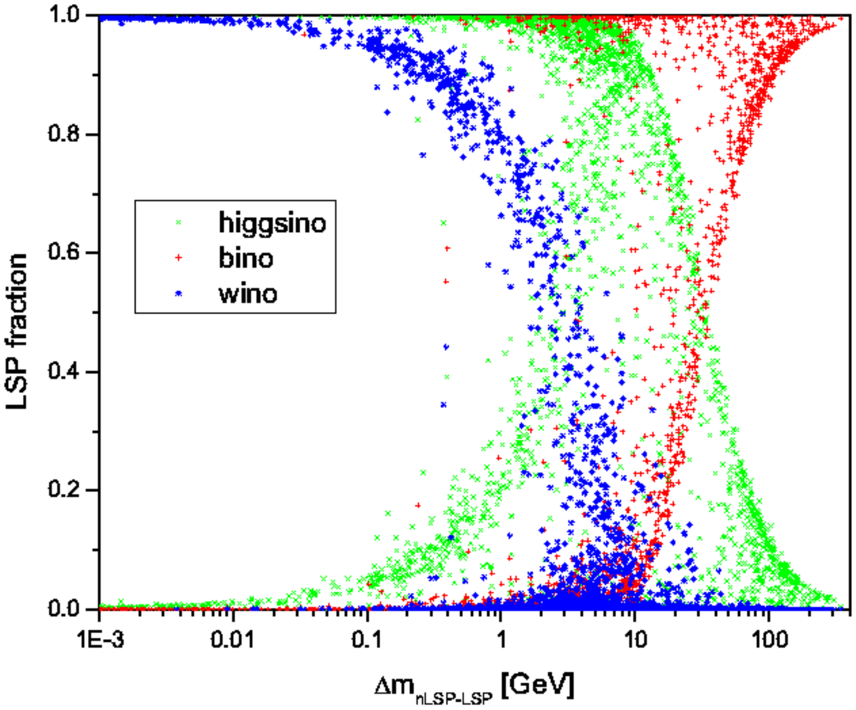
LSP Composition

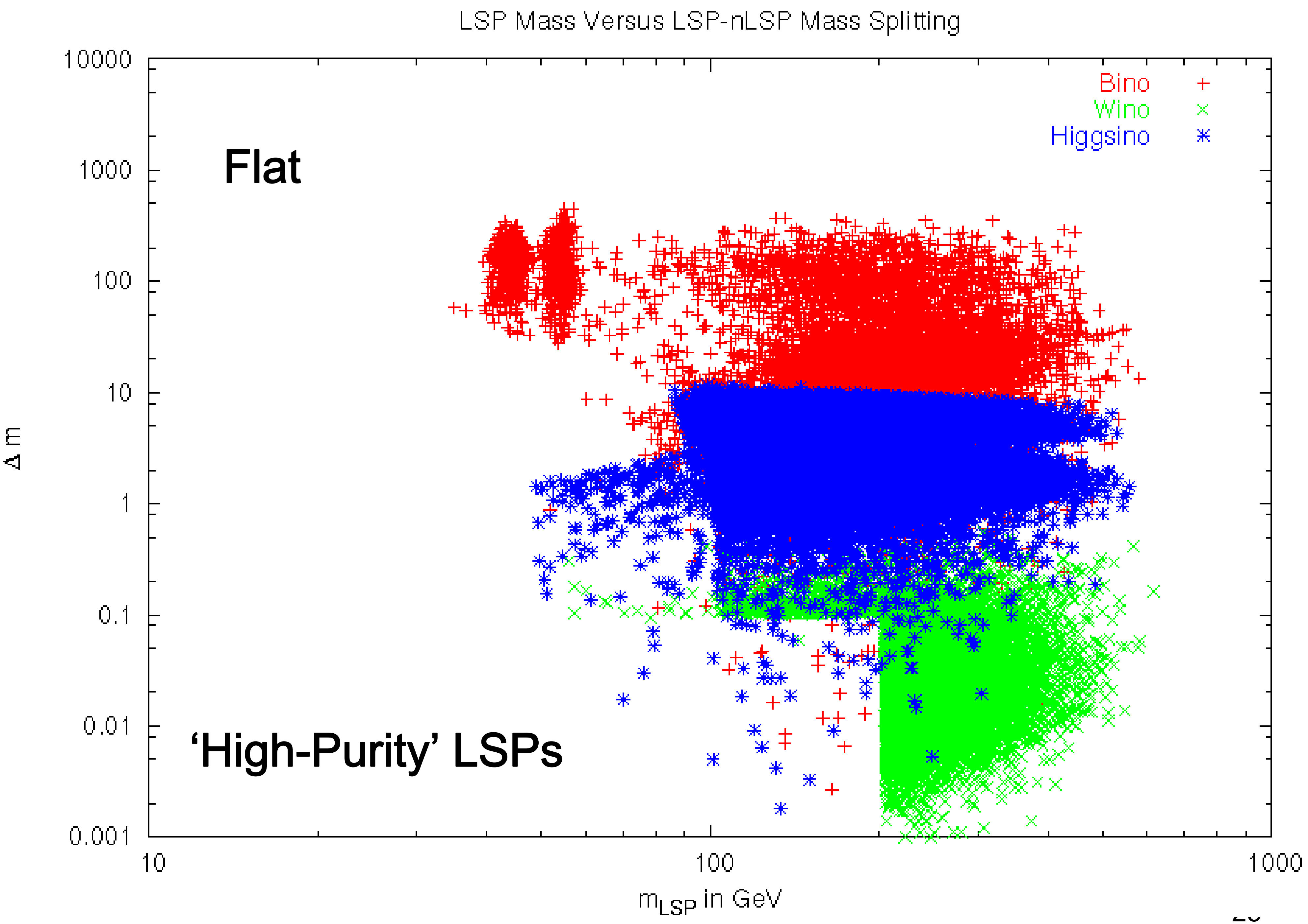
The LSP composition is found to be both mass dependent as well as (no surprise) sensitive to the nLSP-LSP mass splitting…models with 'large' mass splittings have LSPs which are bino-like but VERY small mass splittings produce wino-like LSPs. Higgsino-like LSPs have 'intermediate' splittings.

Flat



Log





Flat

‘High-Purity’ LSPs

Summary

- The pMSSM has a far richer phenomenology than any of the conventional SUSY breaking scenarios. The many sparticle properties can be vastly different, e.g., the nLSP can be any other sparticle!

- Light partners may exist which have avoided LEP & Tevatron constraints and may be difficult to observe at the LHC due to rather common small mass differences

- Squarks may exist within the range accessible to a 500 GeV ILC but have not been well studied there.

- With the WMAP constraint employed as a bound the LSP is not likely to be the dominant source of DM…but it can be.

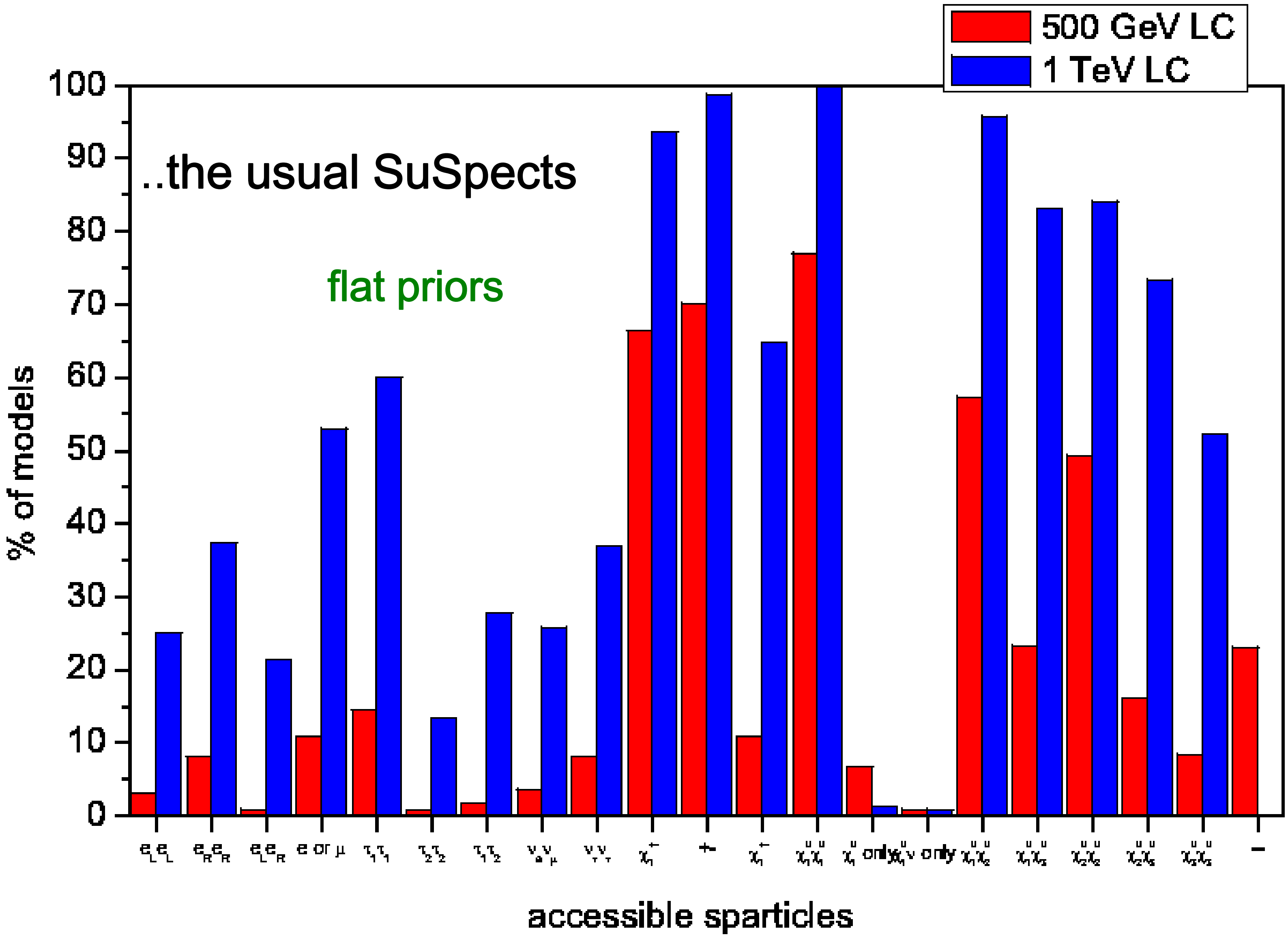
- The study of these complex models is still at early stage..

Advertisement

See talks by John Conley on the implications of this study for LHC SUSY searches and James Gainer on implications for Dark Matter searches during the parallel sessions P4.I and P6.H, respectively.

BACKUP SLIDES

Kinematic Accessibility at the ILC : I

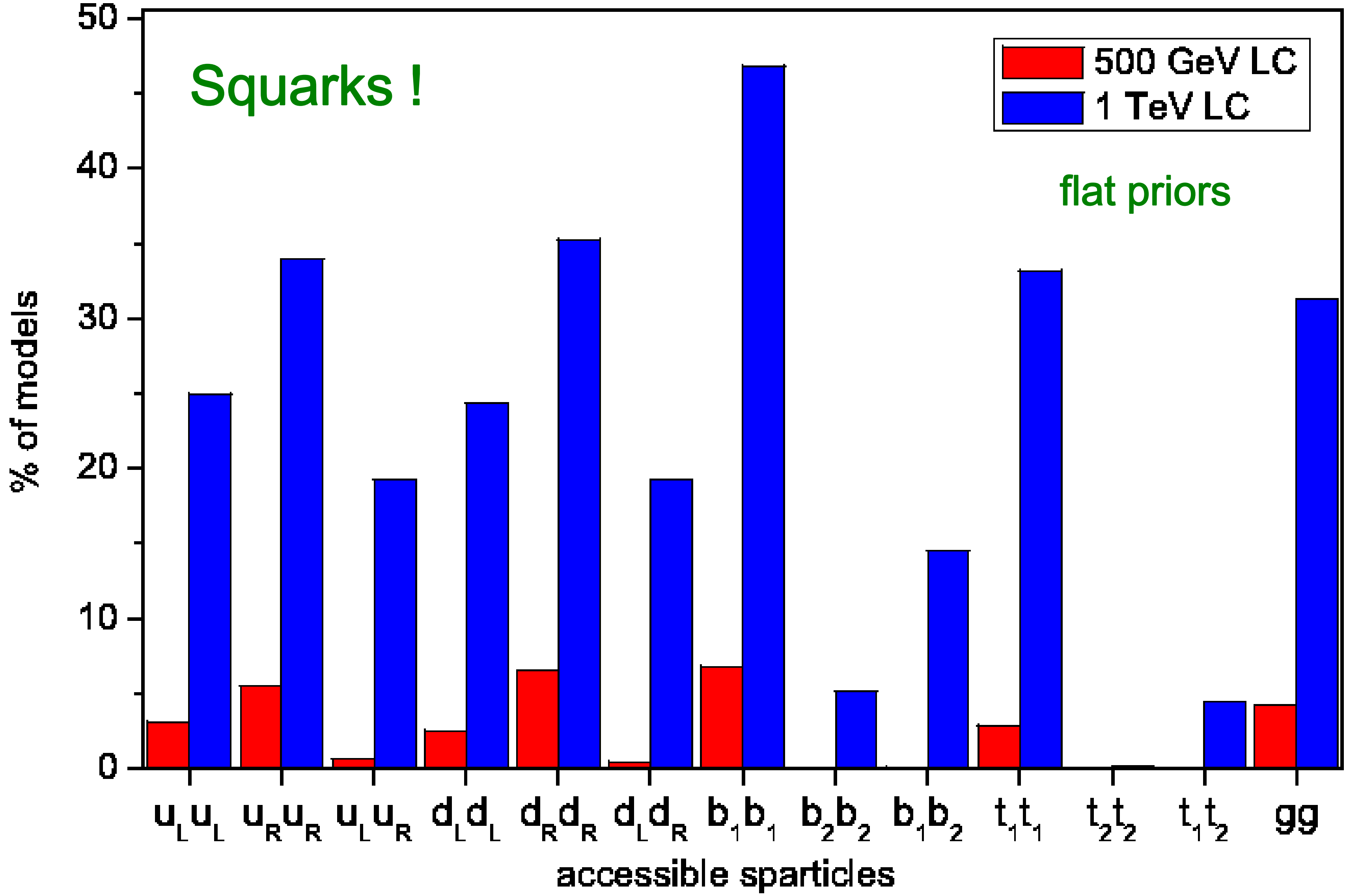


..the usual SuSpects

flat priors

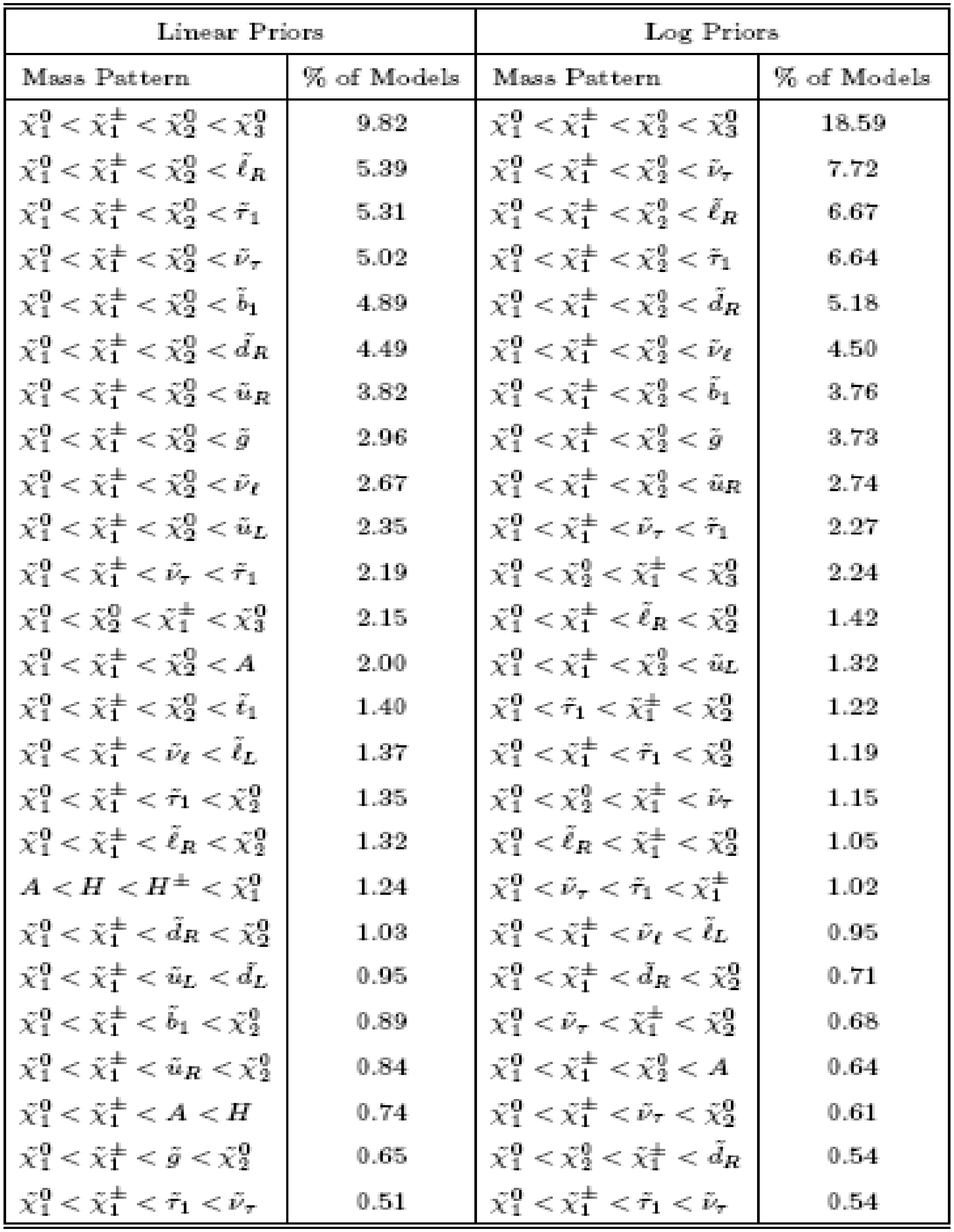
Final State
$\tilde{e}_L^+\tilde{e}_L^-$
$\tilde{e}_R^+\tilde{e}_R^-$
$\tilde{e}_L^\pm\tilde{e}_R^\mp$
$\tilde{\mu}_L^+\tilde{\mu}_L^-$
$\tilde{\mu}_R^+\tilde{\mu}_R^-$
Any selectron or smuon
$\tilde{\tau}_1^+\tilde{\tau}_1^-$
$\tilde{\tau}_2^+\tilde{\tau}_2^-$
$\tilde{\tau}_1^\pm\tilde{\tau}_2^\mp$
$\tilde{\nu}_{e\mu}\tilde{\nu}_{e\mu}^*$
$\tilde{\nu}_\tau\tilde{\nu}_\tau^*$
$\tilde{\chi}_1^+\tilde{\chi}_1^-$
Any charged sparticle
$\tilde{\chi}_1^\pm\tilde{\chi}_2^\mp$
$\tilde{\chi}_1^0\tilde{\chi}_1^0$
$\tilde{\chi}_1^0\tilde{\chi}_1^0$ only
$\tilde{\chi}_1^0+\tilde{\nu}$ only
$\tilde{\chi}_1^0\tilde{\chi}_2^0$
$\tilde{\chi}_1^0\tilde{\chi}_3^0$
$\tilde{\chi}_2^0\tilde{\chi}_2^0$
$\tilde{\chi}_2^0\tilde{\chi}_3^0$
$\tilde{\chi}_3^0\tilde{\chi}_3^0$
Nothing

Kinematic Accessibility at the ILC : III



Flat

Log



Linear Priors		Log Priors	
Mass Pattern	% of Models	Mass Pattern	% of Models
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{\chi}_3^0$	9.82	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{\chi}_3^0$	18.59
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{\ell}_R$	5.39	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{\nu}_\tau$	7.72
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{\tau}_1$	5.31	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{\ell}_R$	6.67
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{\nu}_\tau$	5.02	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{\tau}_1$	6.64
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{b}_1$	4.89	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{d}_R$	5.18
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{d}_R$	4.49	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{\nu}_\ell$	4.50
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{u}_R$	3.82	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{b}_1$	3.76
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{g}$	2.96	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{g}$	3.73
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{\nu}_\ell$	2.67	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{u}_R$	2.74
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{u}_L$	2.35	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\nu}_\tau < \tilde{\tau}_1$	2.27
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\nu}_\tau < \tilde{\tau}_1$	2.19	$\tilde{\chi}_1^0 < \tilde{\chi}_2^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_3^0$	2.24
$\tilde{\chi}_1^0 < \tilde{\chi}_2^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_3^0$	2.15	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\ell}_R < \tilde{\chi}_2^0$	1.42
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < A$	2.00	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{u}_L$	1.32
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < \tilde{t}_1$	1.40	$\tilde{\chi}_1^0 < \tilde{\tau}_1 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0$	1.22
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\nu}_\ell < \tilde{\ell}_L$	1.37	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\tau}_1 < \tilde{\chi}_2^0$	1.19
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\tau}_1 < \tilde{\chi}_2^0$	1.35	$\tilde{\chi}_1^0 < \tilde{\chi}_2^0 < \tilde{\chi}_1^\pm < \tilde{\nu}_\tau$	1.15
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\ell}_R < \tilde{\chi}_2^0$	1.32	$\tilde{\chi}_1^0 < \tilde{\ell}_R < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0$	1.05
$A < H < H^\pm < \tilde{\chi}_1^0$	1.24	$\tilde{\chi}_1^0 < \tilde{\nu}_\tau < \tilde{\tau}_1 < \tilde{\chi}_1^\pm$	1.02
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{d}_R < \tilde{\chi}_2^0$	1.03	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\nu}_\ell < \tilde{\ell}_L$	0.95
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{u}_L < \tilde{d}_L$	0.95	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{d}_R < \tilde{\chi}_2^0$	0.71
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{b}_1 < \tilde{\chi}_2^0$	0.89	$\tilde{\chi}_1^0 < \tilde{\nu}_\tau < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0$	0.68
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{u}_R < \tilde{\chi}_2^0$	0.84	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\chi}_2^0 < A$	0.64
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < A < H$	0.74	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\nu}_\tau < \tilde{\chi}_2^0$	0.61
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{g} < \tilde{\chi}_2^0$	0.65	$\tilde{\chi}_1^0 < \tilde{\chi}_2^0 < \tilde{\chi}_1^\pm < \tilde{d}_R$	0.54
$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\tau}_1 < \tilde{\nu}_\tau$	0.51	$\tilde{\chi}_1^0 < \tilde{\chi}_1^\pm < \tilde{\tau}_1 < \tilde{\nu}_\tau$	0.54

SUSY decay chains are very important…especially the end of the chain at the LHC.

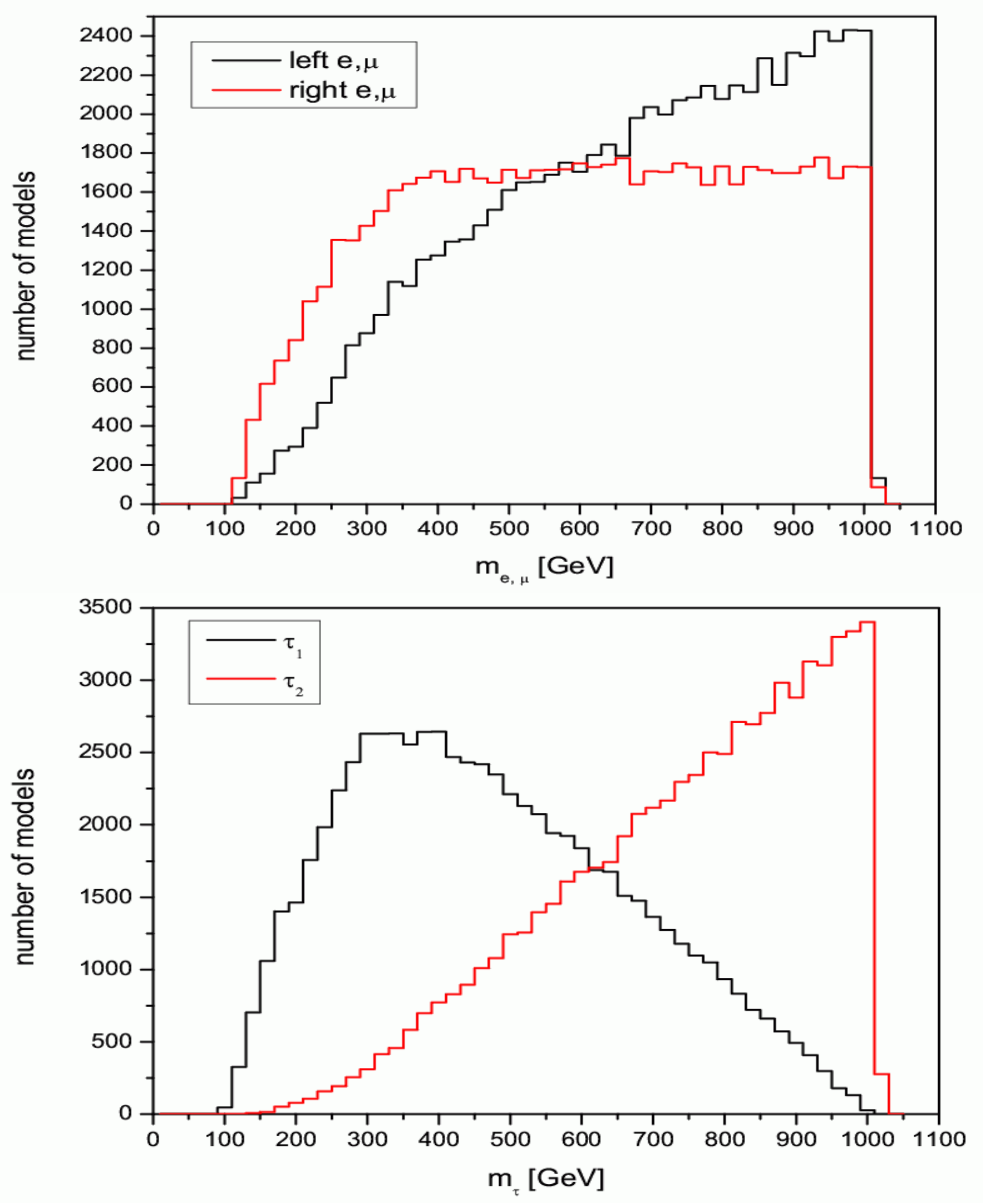
Top 25 most common mass patterns for the 4 lightest SUSY & heavy Higgs particles.

There were 1109 (267) such patterns found for the case of flat (log) priors

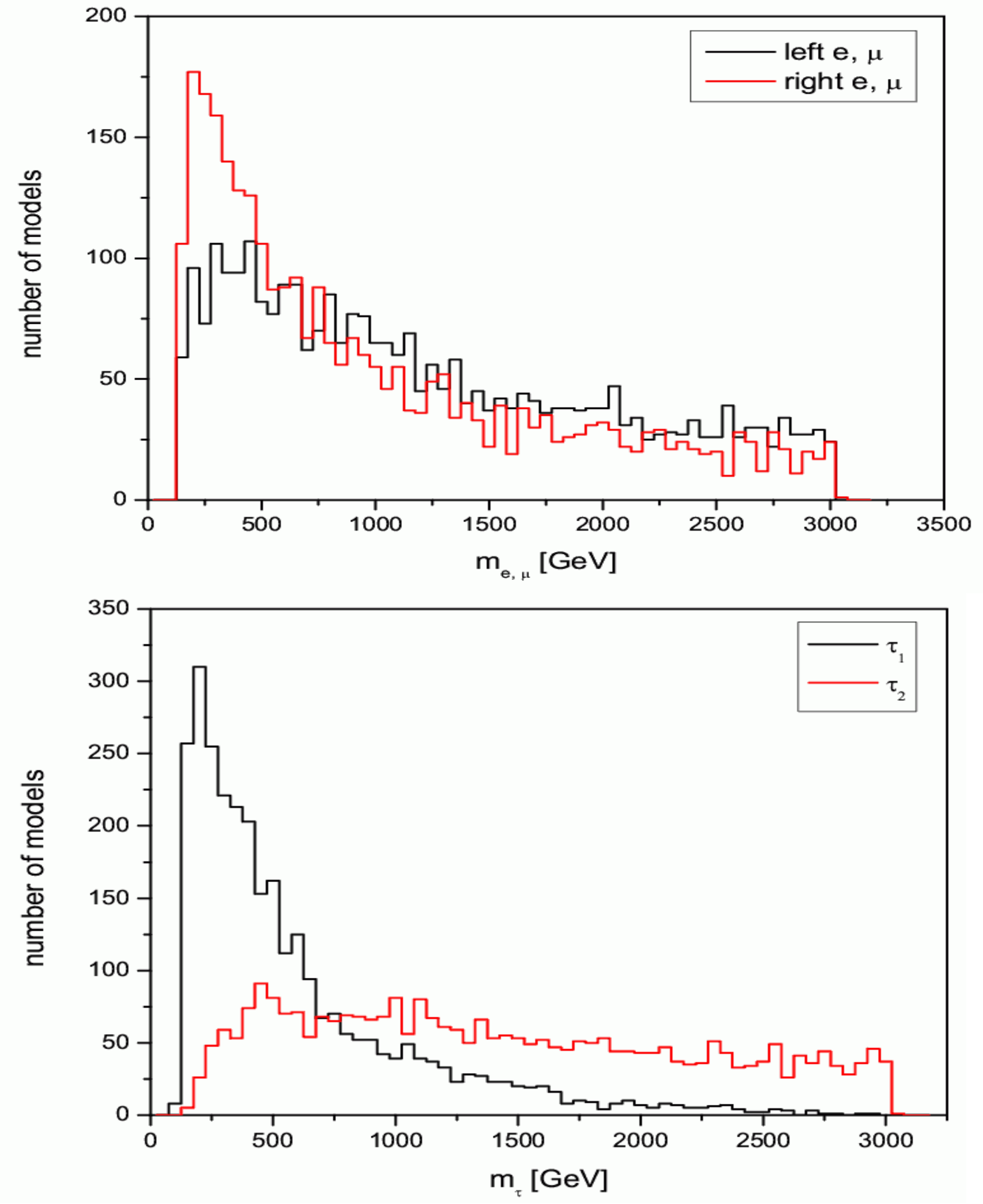
Only ~20 are found to occur in mSUGRA!!

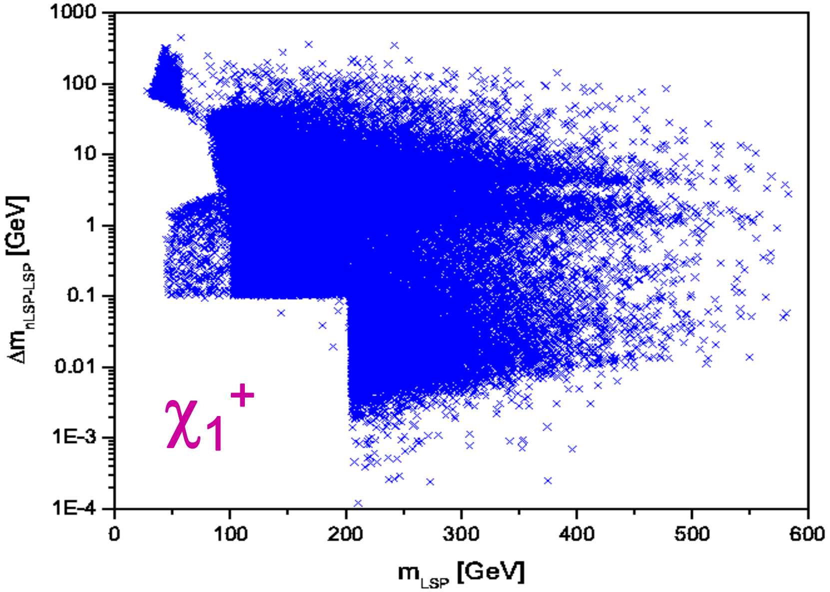
Distribution of Sparticle Masses By Species

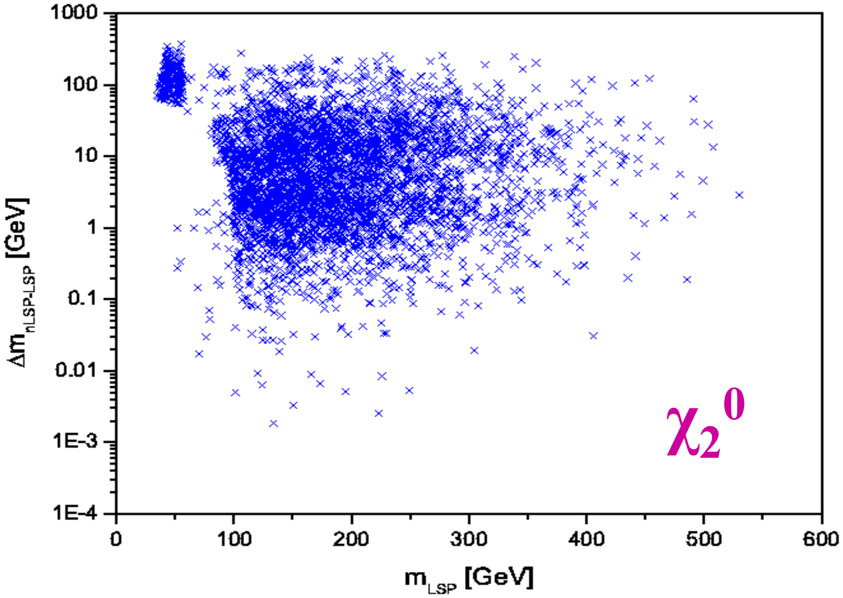
Flat Priors

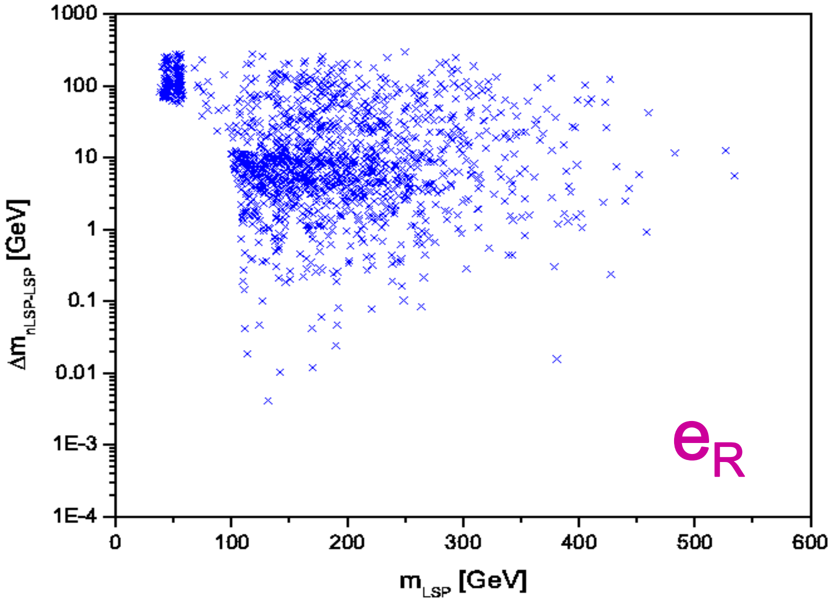


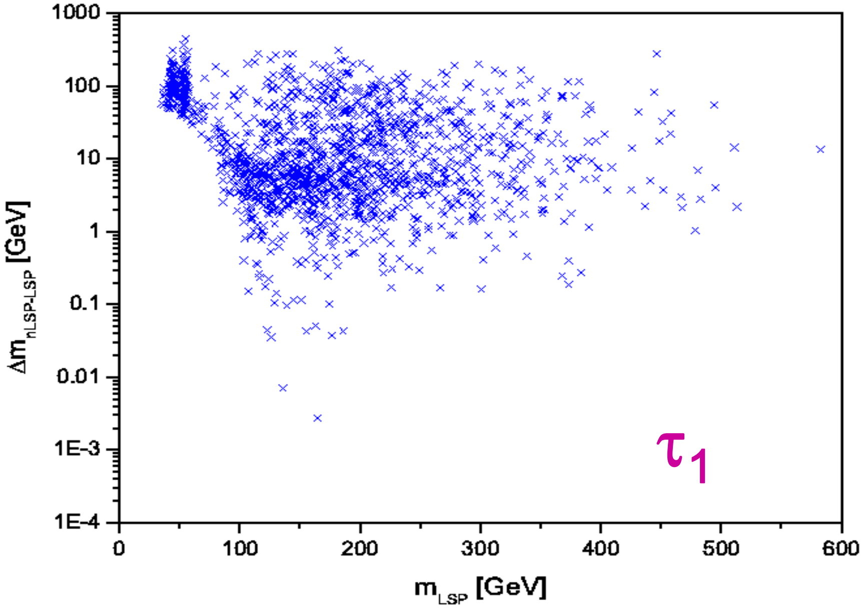
Log Priors




χ_1^+
$\Delta m_{nLSP-LSP}$ [GeV]
1000
100
10
1
0.1
0.01
1E-3
1E-4
0
100
200
300
400
500
600
m_{LSP} [GeV]


χ_2^0
$\Delta m_{nLSP-LSP}$ [GeV]
1000
100
10
1
0.1
0.01
1E-3
1E-4
0
100
200
300
400
500
600
m_{LSP} [GeV]


e_R
$\Delta m_{nLSP-LSP}$ [GeV]
1000
100
10
1
0.1
0.01
1E-3
1E-4
0
100
200
300
400
500
600
m_{LSP} [GeV]


τ_1
$\Delta m_{nLSP-LSP}$ [GeV]
1000
100
10
1
0.1
0.01
1E-3
1E-4
0
100
200
300
400
500
600
m_{LSP} [GeV]

Predicted Dark Matter Density : Ωh^2

It is not likely that the LSP is the dominant component of dark matter in ‘conventional’ cosmology…but it can be in some model cases.. (1240+76)