Latest results from Mastercode

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Experimentalists

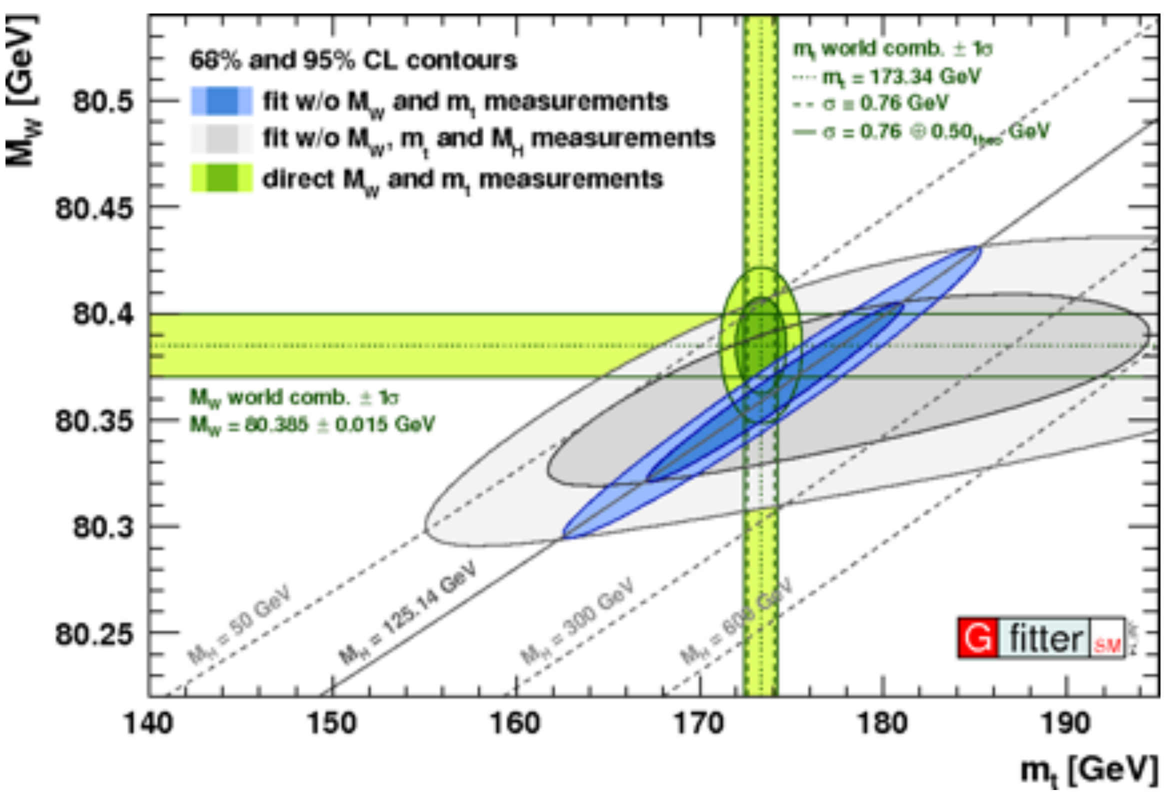
O.Buchmueller, R.Cavanaugh, M.Citron, A.De Roeck, H.Flacher, S.Mallik, J.Marrouche, D.Martinez-Santos, K.J.de Vries,

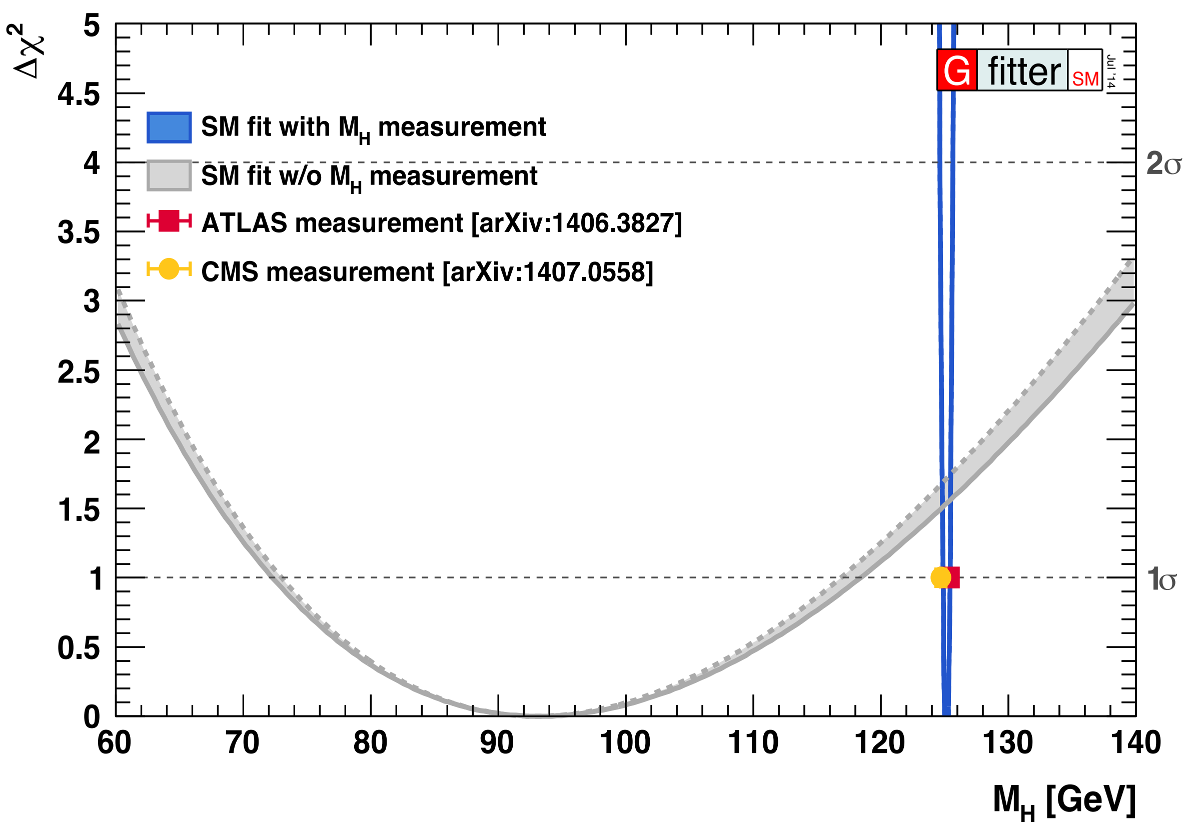
Theorists

E.Bagnaschi, M.Dolan, J.Ellis, S.Heinemeyer, G.Isidori, K.Olive, K.Sakurai, G.Weiglein

15/12/2015 @ University of Heidelberg

Global fit I SM





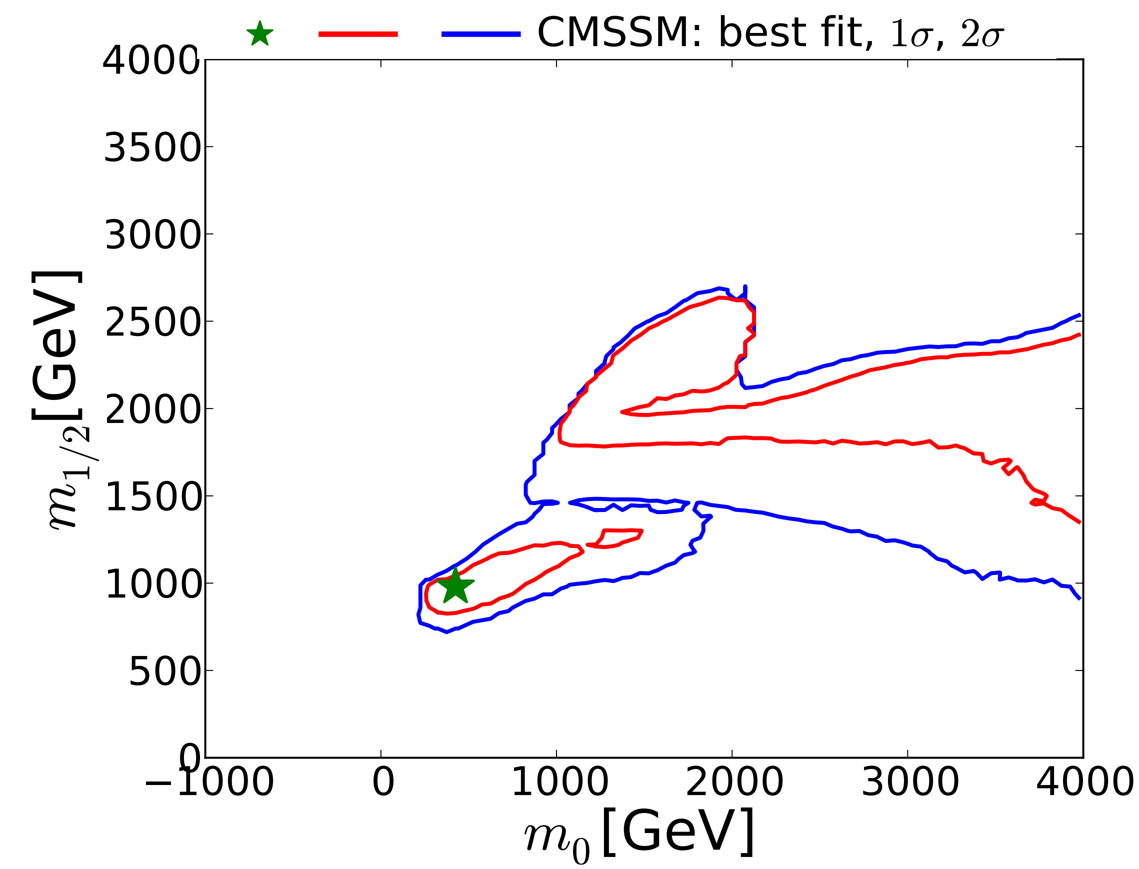
- confront theory predictions with the experimental values

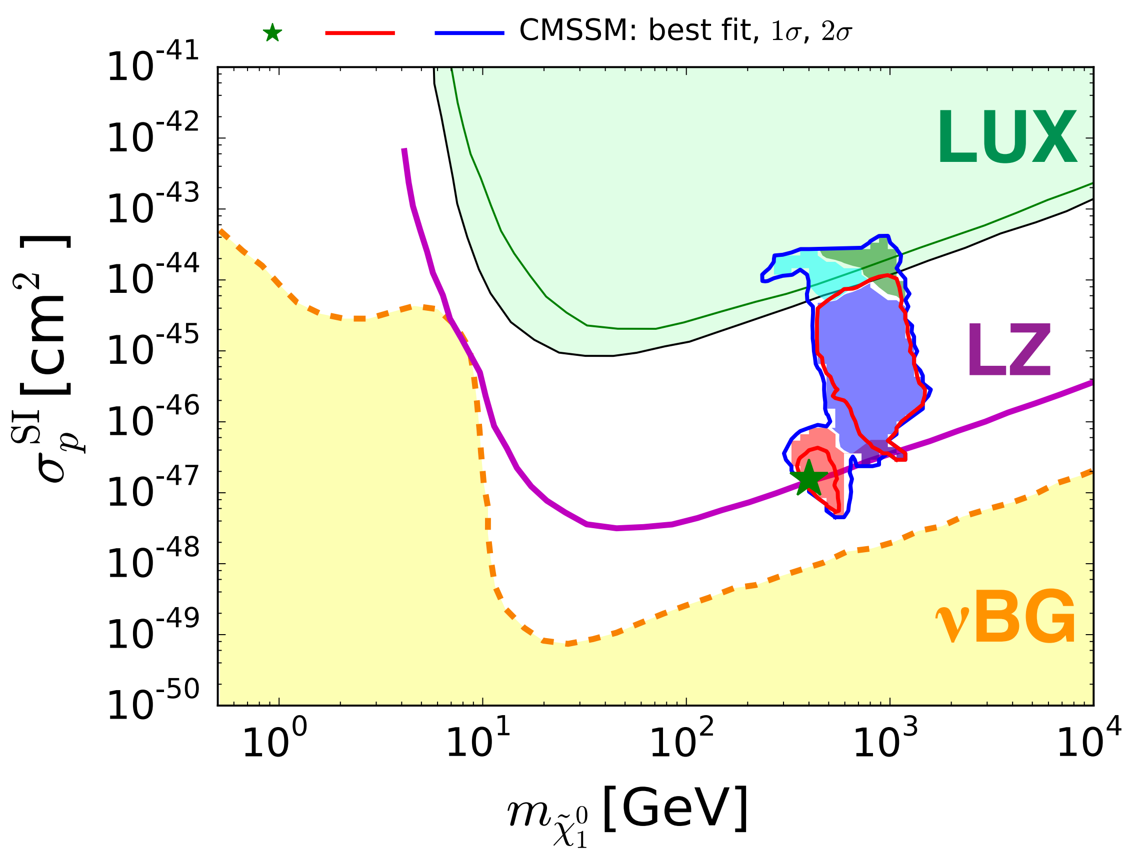
$$\chi^2 = \sum_i \left(\frac{\mathcal{O}_i^{theo.} - \mathcal{O}_i^{meas.}}{\sigma_i} \right)^2$$

- the *status of the model*
- min χ^2 after marginalising other parameters
- the *most likely values* for *unconstrained parameters* and *unmeasured observables*

→ search strategies
implication to the model

Global fit | SUSY





- confront theory predictions with the experimental values

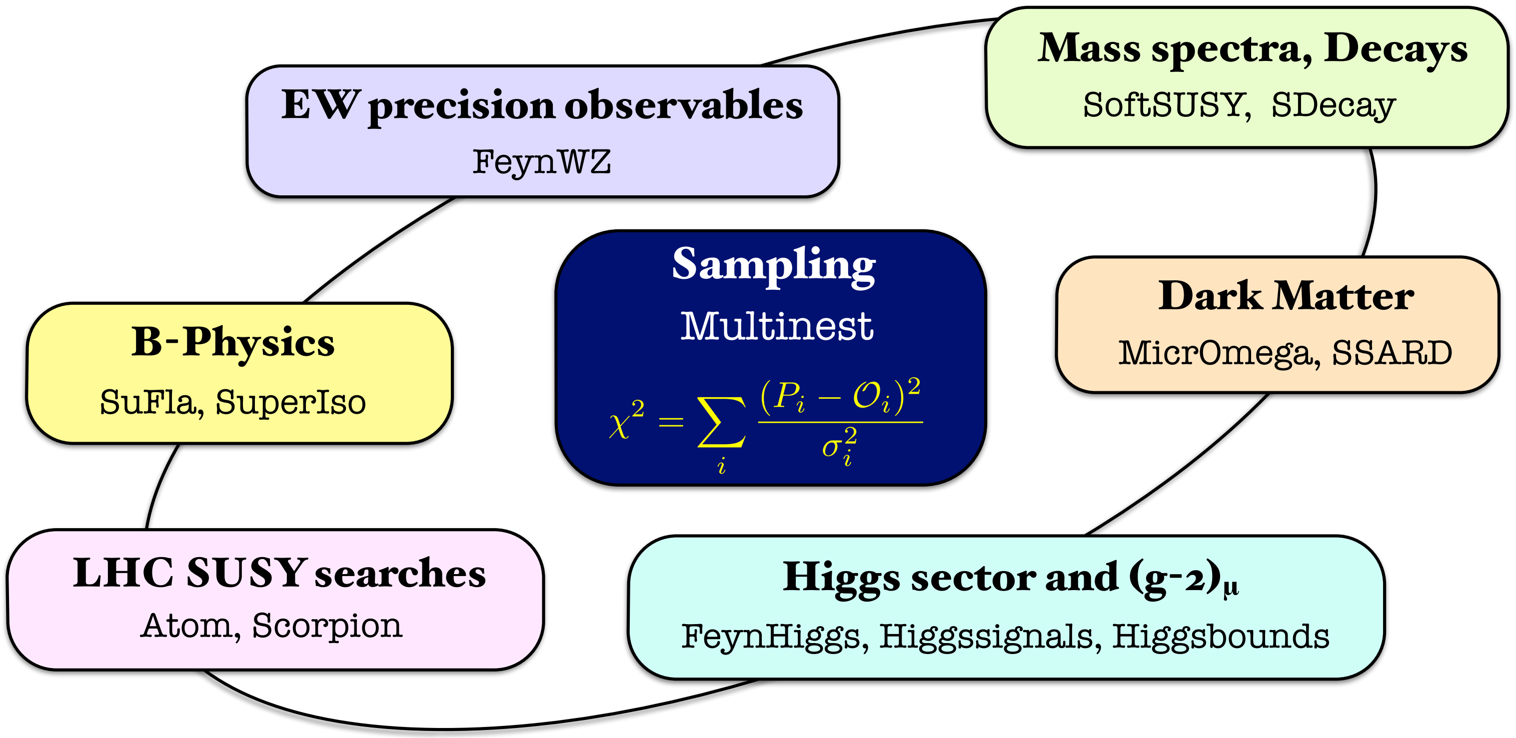
$$\chi^2 = \sum_i \left(\frac{\mathcal{O}_i^{theo.} - \mathcal{O}_i^{meas.}}{\sigma_i} \right)^2$$

- the *status of the model*
- always marginalising other parameters: $tan\beta, A_0, \ldots$
- the *most likely values* for *unconstrained parameters* and *unmeasured observables*

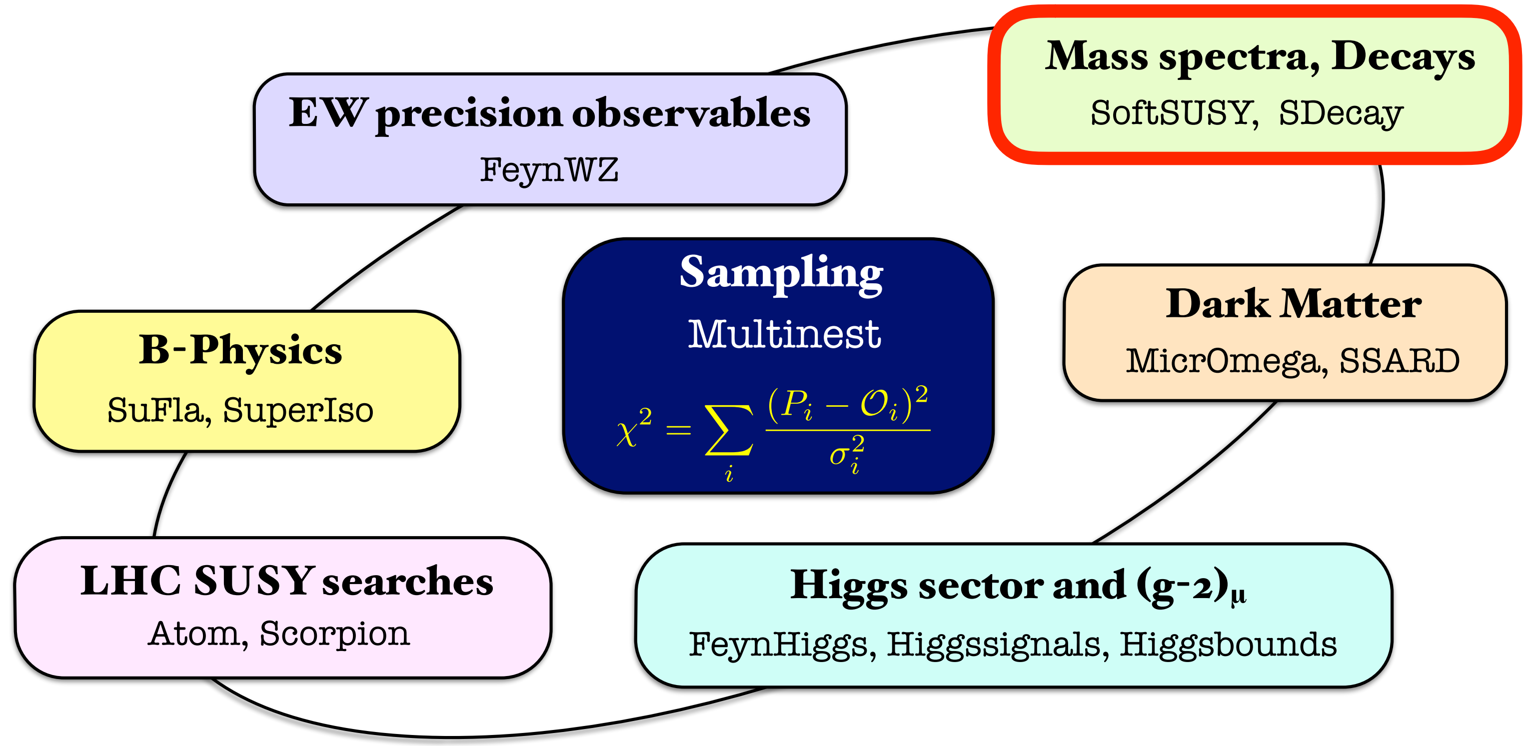
→ search strategies
implication to the model

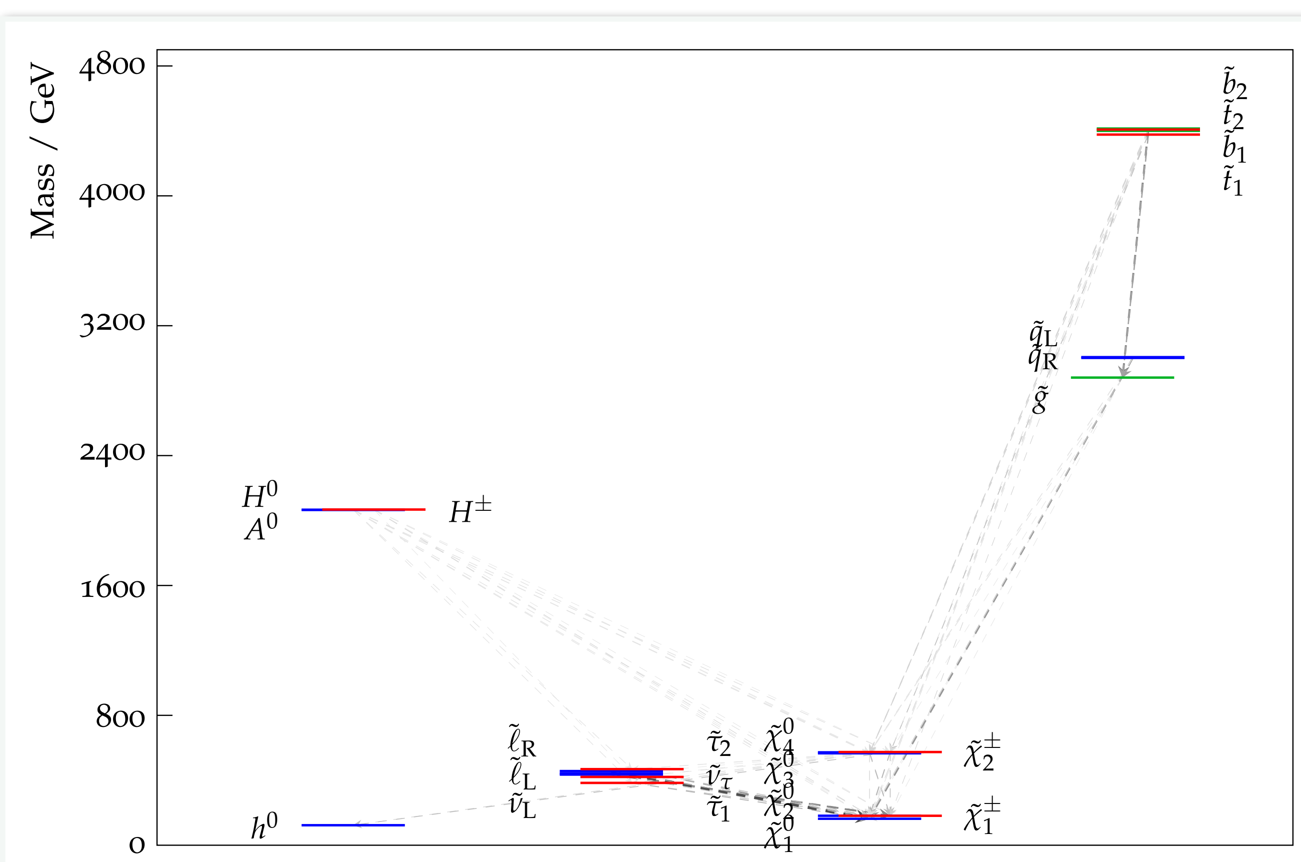
Particularly important after NP discovery

MasterCode


EW precision observables
FeynWZ
Mass spectra, Decays
SoftSUSY, SDecay
Sampling
Multinest
$\chi^2 = \sum_i \frac{(P_i - \mathcal{O}_i)^2}{\sigma_i^2}$
B-Physics
SuFla, SuperIso
Dark Matter
MicrOmega, SSARD
LHC SUSY searches
Atom, Scorpion
Higgs sector and $(g-2)_\mu$
FeynHiggs, Higgssignals, Higgsbounds

MasterCode



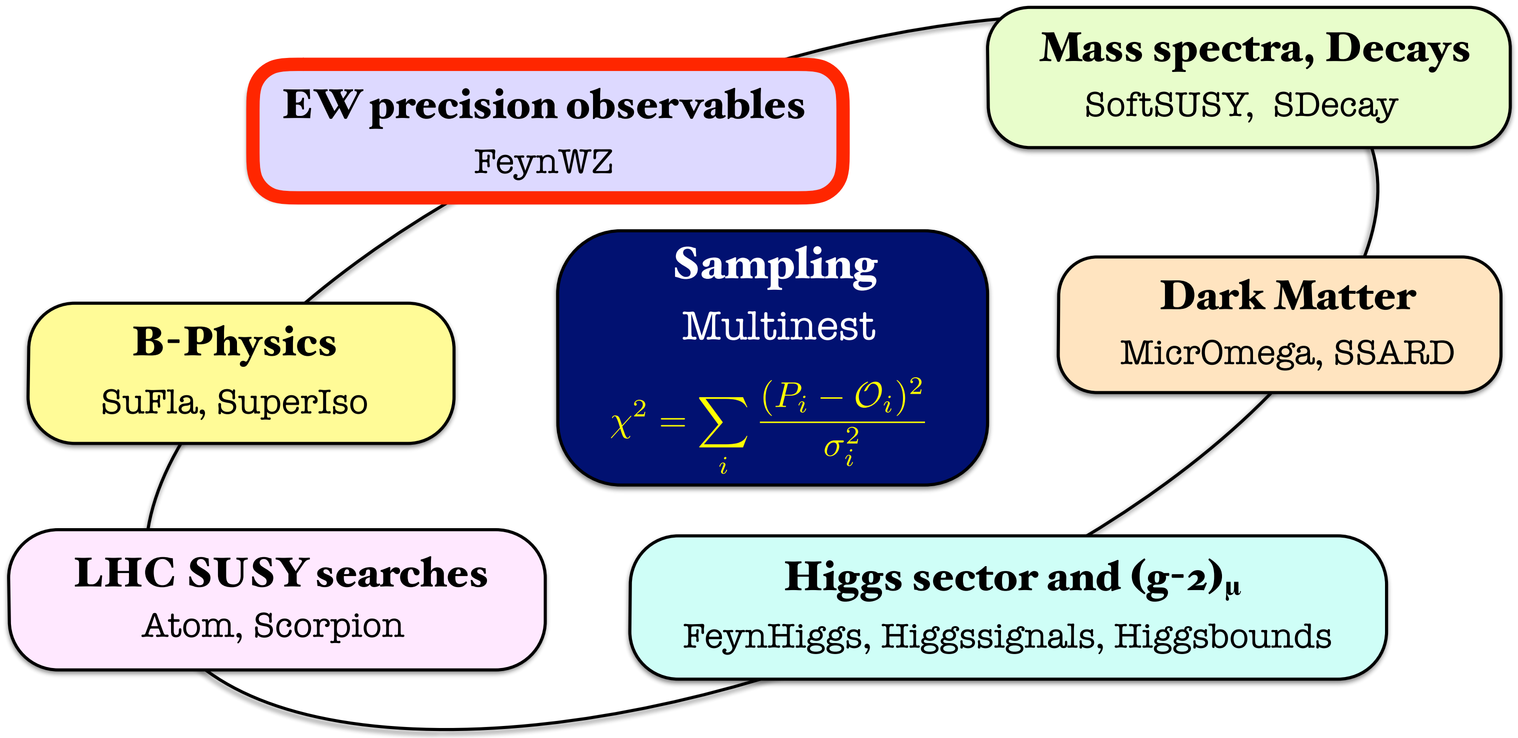


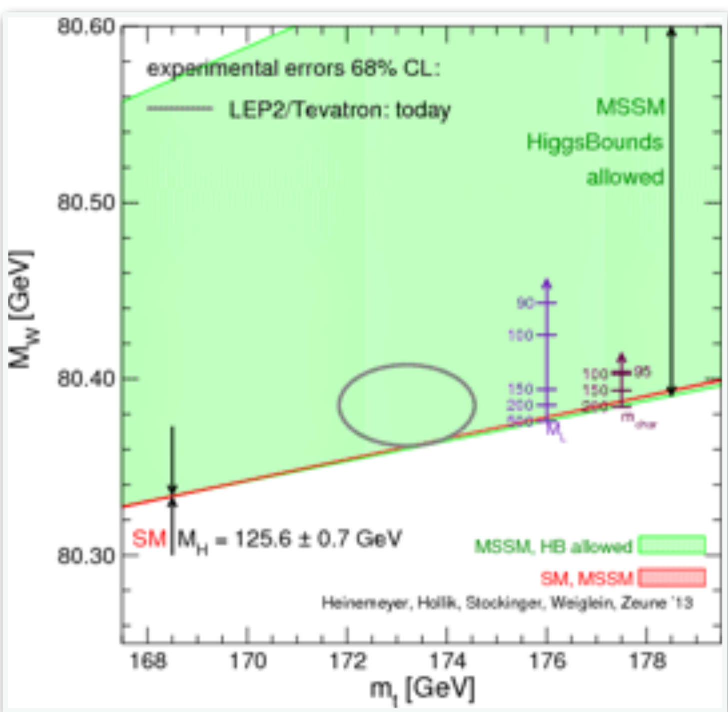
Mass spectra: SoftSUSY

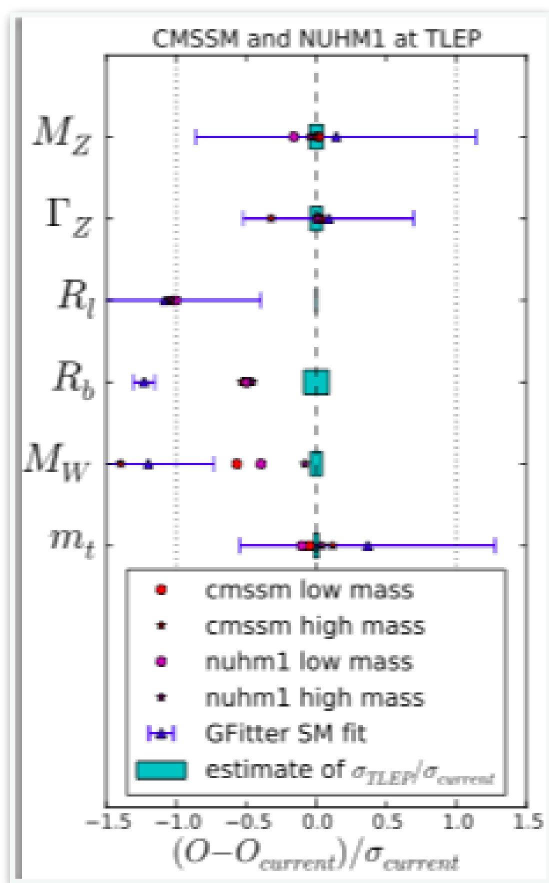
Decays: SDecay

- The spectrum is used for calculation of other observables.
- The decay info is used for the direct SUSY search constraints.

MasterCode



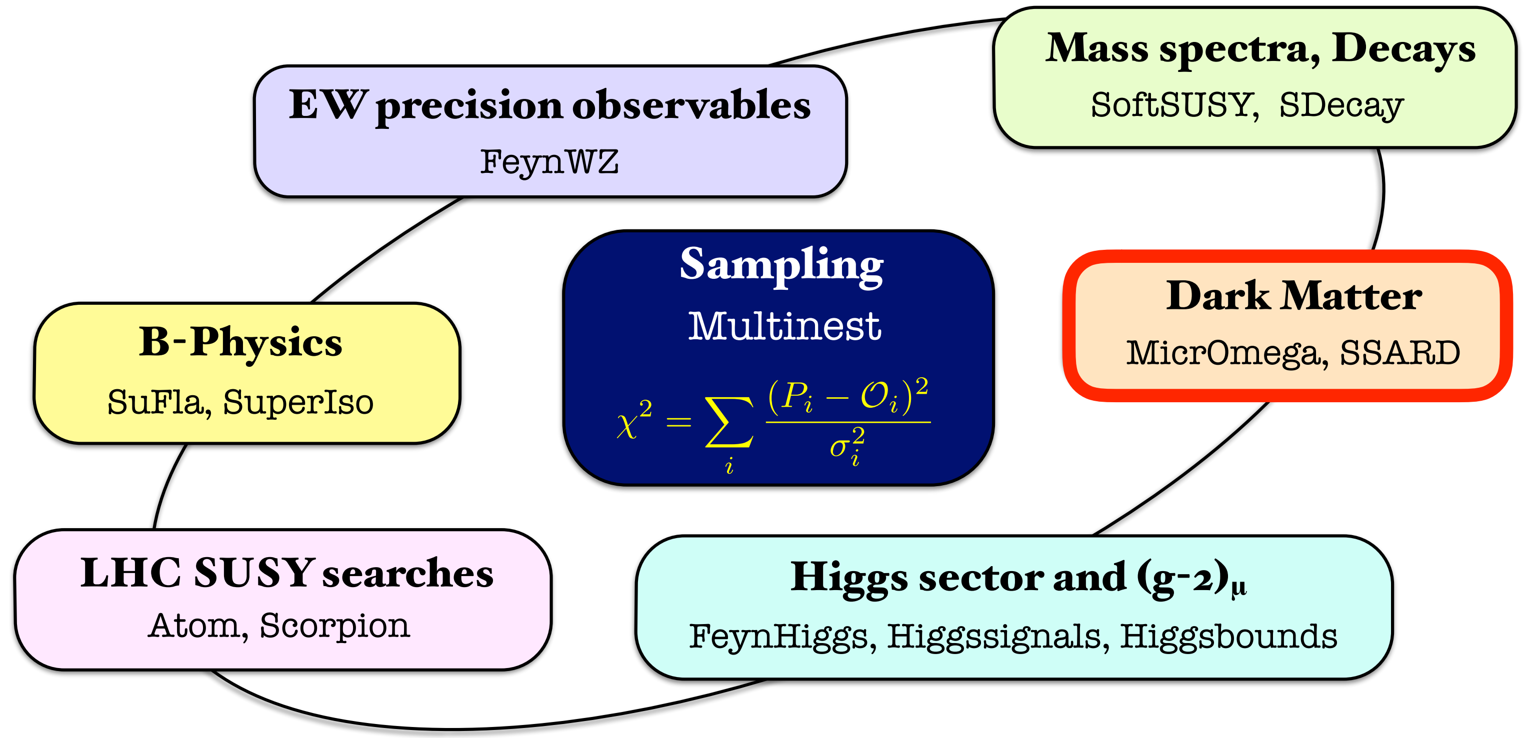


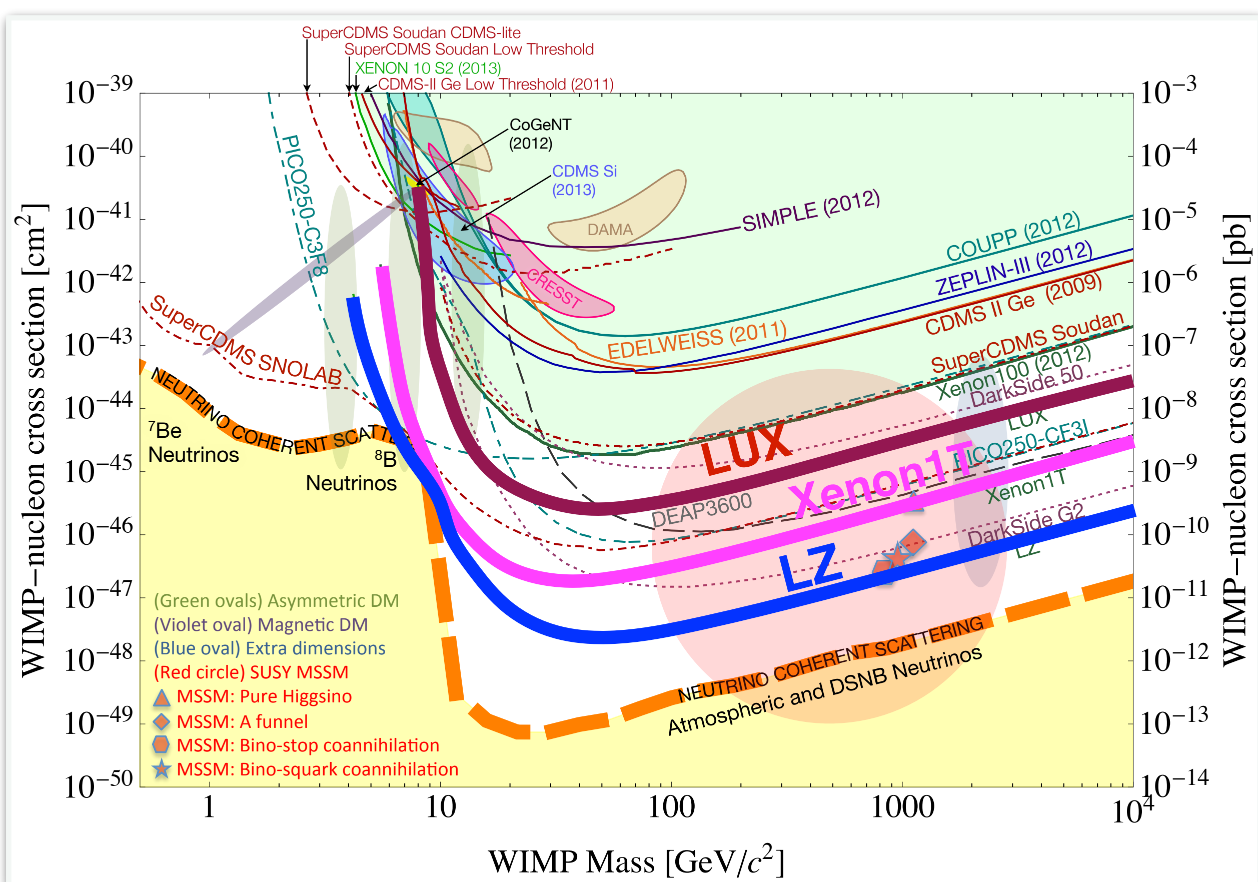


EW precision obs: FeynWZ

Observable	Constraint
$\Delta\alpha^{(5)}_{\rm had}(M_Z)$	0.02756 ± 0.00010
M_Z [GeV]	91.1875 ± 0.0021
Γ_Z [GeV]	$2.4952 \pm 0.0023 \pm 0.001_{\rm SUSY}$
$\sigma^0_{\rm had}$ [nb]	41.540 ± 0.037
R^0_ℓ	20.767 ± 0.025
$A^{0,\ell}_{\rm FB}$	0.01714 ± 0.00095
$\mathcal{A}_\ell(P_\tau)$	0.1465 ± 0.0032
$\mathcal{A}_\ell$(SLD)	0.1513 ± 0.0021
$R^0_{\rm b}$	0.21629 ± 0.00066
$R^0_{\rm c}$	0.1721 ± 0.0030
$A^{0,b}_{\rm FB}$	0.0992 ± 0.0016
$A^{0,c}_{\rm FB}$	0.0707 ± 0.0035
$\mathcal{A}_b$	0.923 ± 0.020
$\mathcal{A}_c$	0.670 ± 0.027
$\sin^2\theta^\ell_{\rm eff}(Q^{\rm had}_{\rm FB})$	0.2324 ± 0.0012

MasterCode





DM relic : MicrOmega

$\sigma^{SI}{}_{\chi\text{-}N}$: SSARD

Require

thermal neutralino = observed DM

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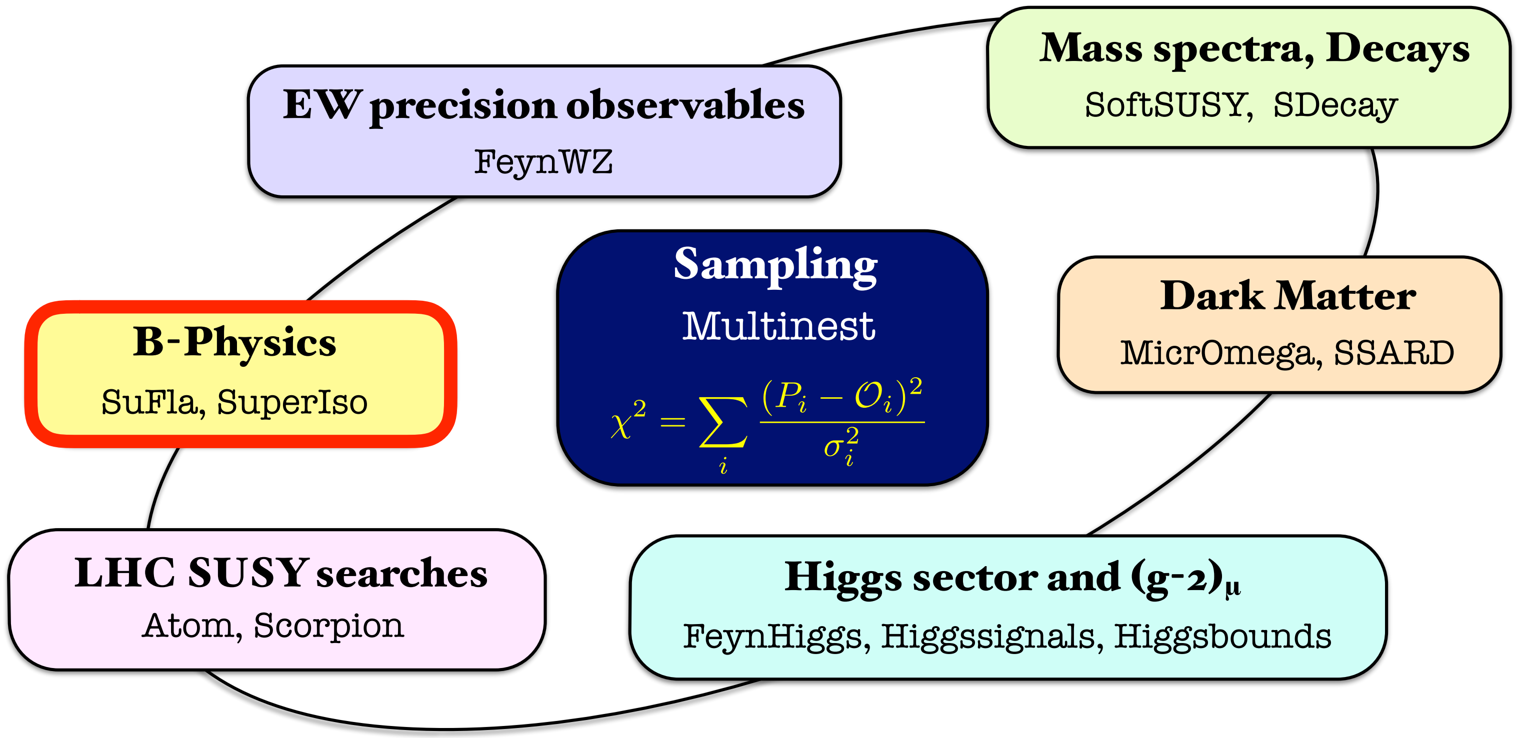
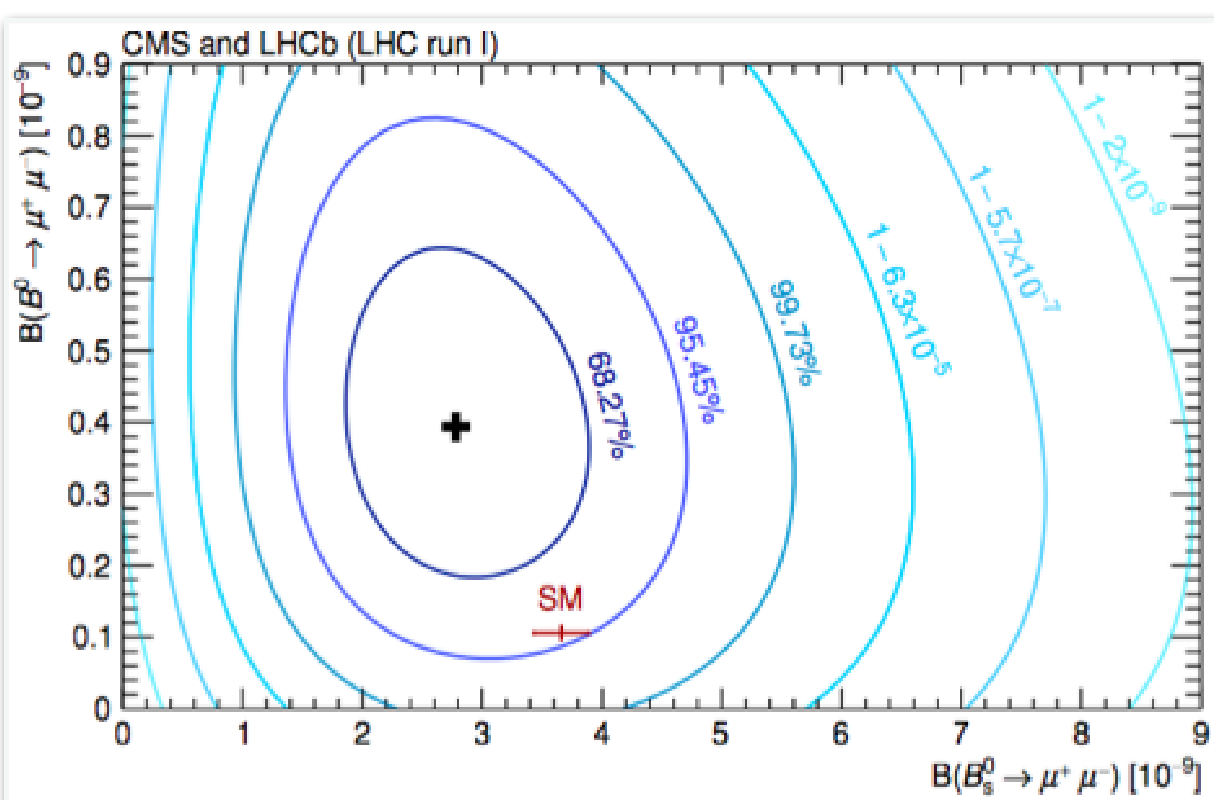
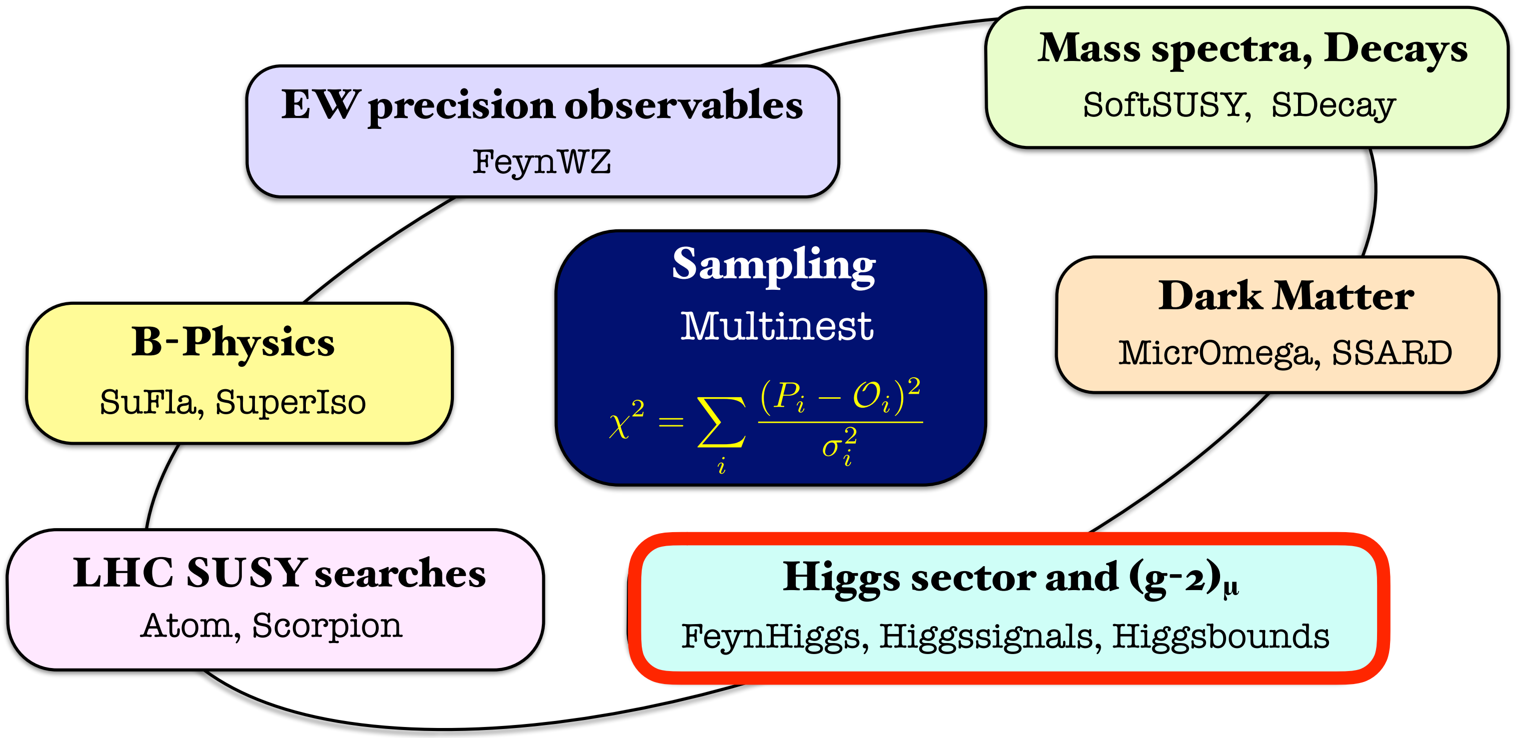


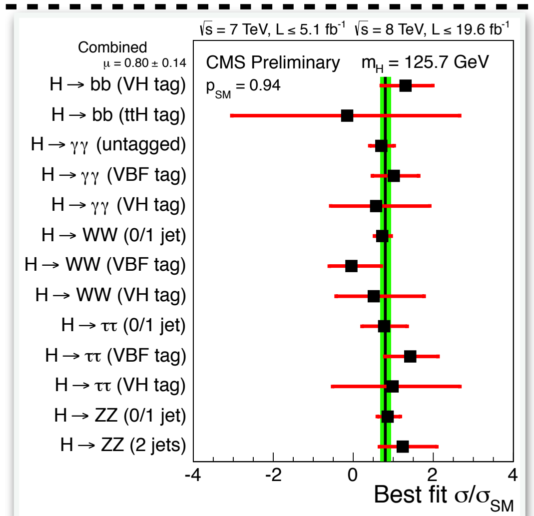


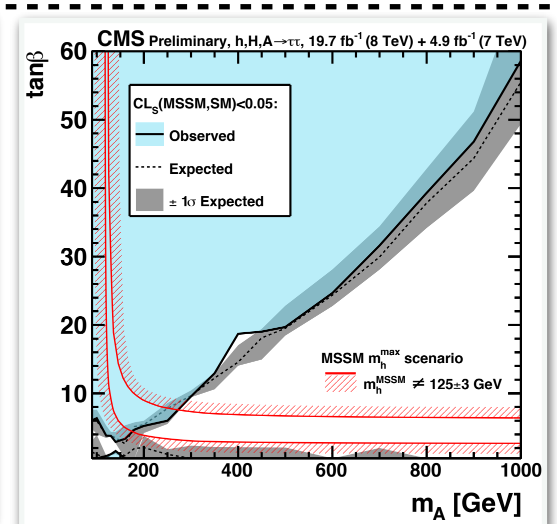
B-Physics: SuFla, SuperIso

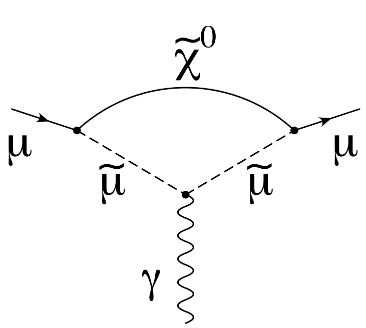
Observable	Constraint
$\mathrm{BR}(B_{s,d} \to \mu^+\mu^-)$	CMS & LHCb (unofficial) combination
$\mathrm{BR}^{\mathrm{EXP/SM}}_{B\to X_s\gamma}$	$1.089 \pm 0.070_{\mathrm{EXP}} \pm 0.080_{\mathrm{SM}} \pm 0.050_{\mathrm{SUSY}}$
$\mathrm{BR}^{\mathrm{EXP/SM}}_{B\to\tau\nu}$	$1.39 \pm 0.28_{\mathrm{EXP}} \pm 0.13_{\mathrm{SM}}$
$\mathrm{BR}^{\mathrm{EXP/SM}}_{B\to X_s\ell\ell}$	0.99 ± 0.32
$\mathrm{BR}^{\mathrm{EXP/SM}}_{K\to\mu\nu}$	$1.008 \pm 0.014_{\mathrm{EXP+TH}}$
$\mathrm{BR}^{\mathrm{EXP/SM}}_{K\to\pi\nu\bar{\nu}}$	< 4.5
$\Delta M^{\mathrm{EXP/SM}}_{B_s}$	$0.97 \pm 0.20_{\mathrm{SM}}$
$\frac{\Delta M^{\mathrm{EXP/SM}}_{B_s}}{\Delta M^{\mathrm{EXP/SM}}_{B_d}}$	$0.86 \pm 0.14_{\mathrm{SM}}$
$\Delta\epsilon^{\mathrm{EXP/SM}}_K$	$1.14 \pm 0.10_{\mathrm{EXP+TH}}$

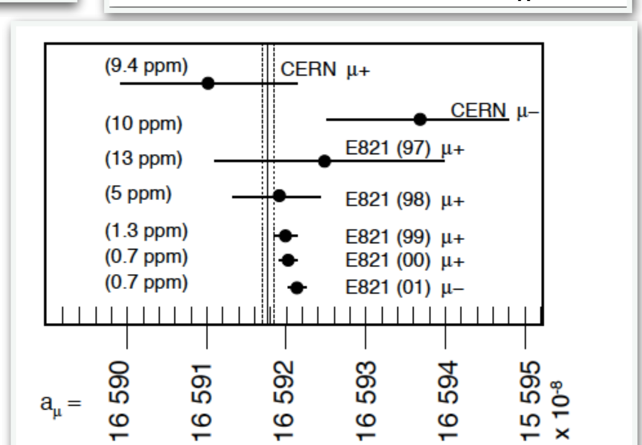
MasterCode











Higgs & $(g-2)_\mu$:

FeynHiggs, Higgssignals, Higgsbounds

$$M_h = 125.09 \pm 0.24_{\mathrm{EXP}} \pm 1.5_{\mathrm{SUSY}}\ \mathrm{GeV}$$

$$m_t = 173.2 \pm 0.87\ \mathrm{GeV}$$

~3.6 σ deviation in $(g-2)_\mu$

pushing the SUSY scale low

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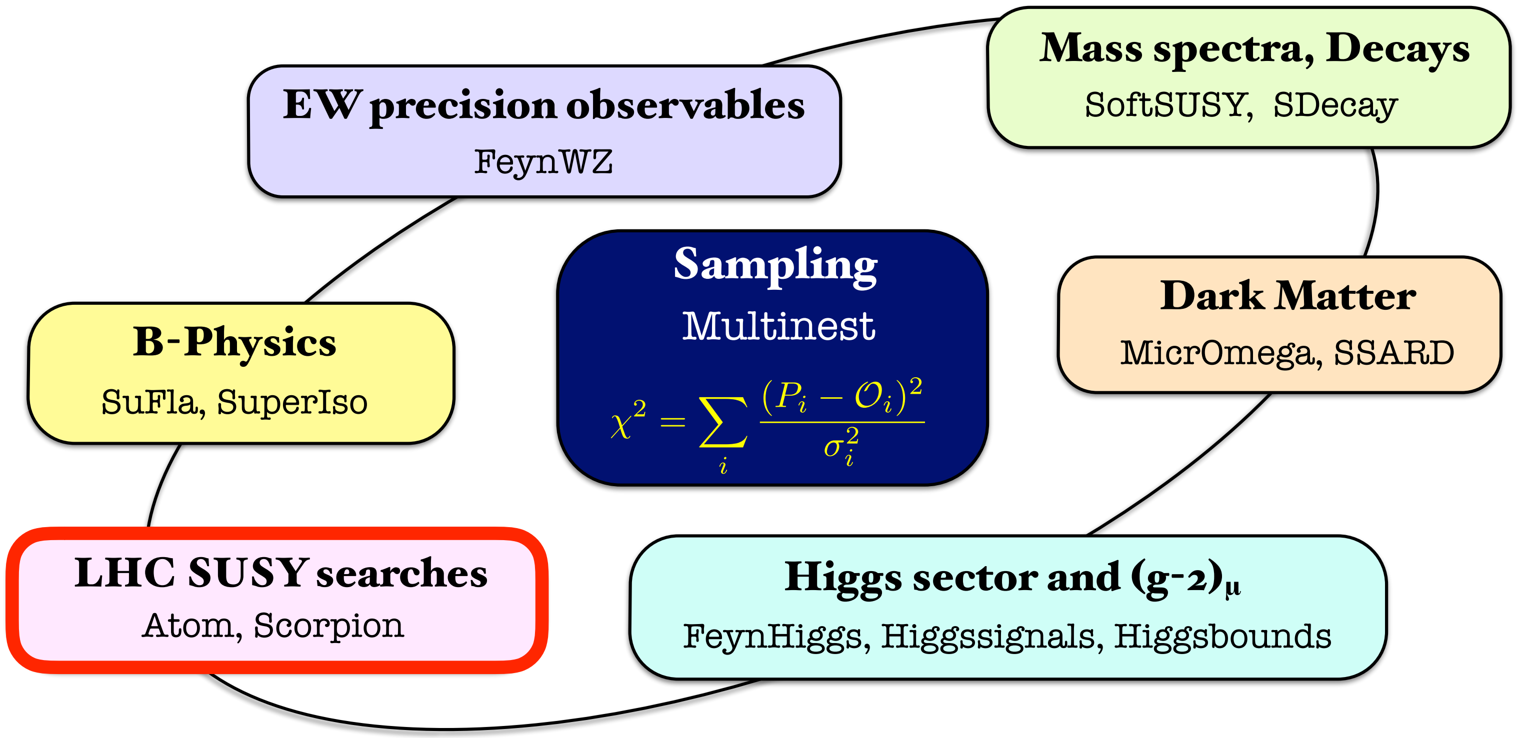
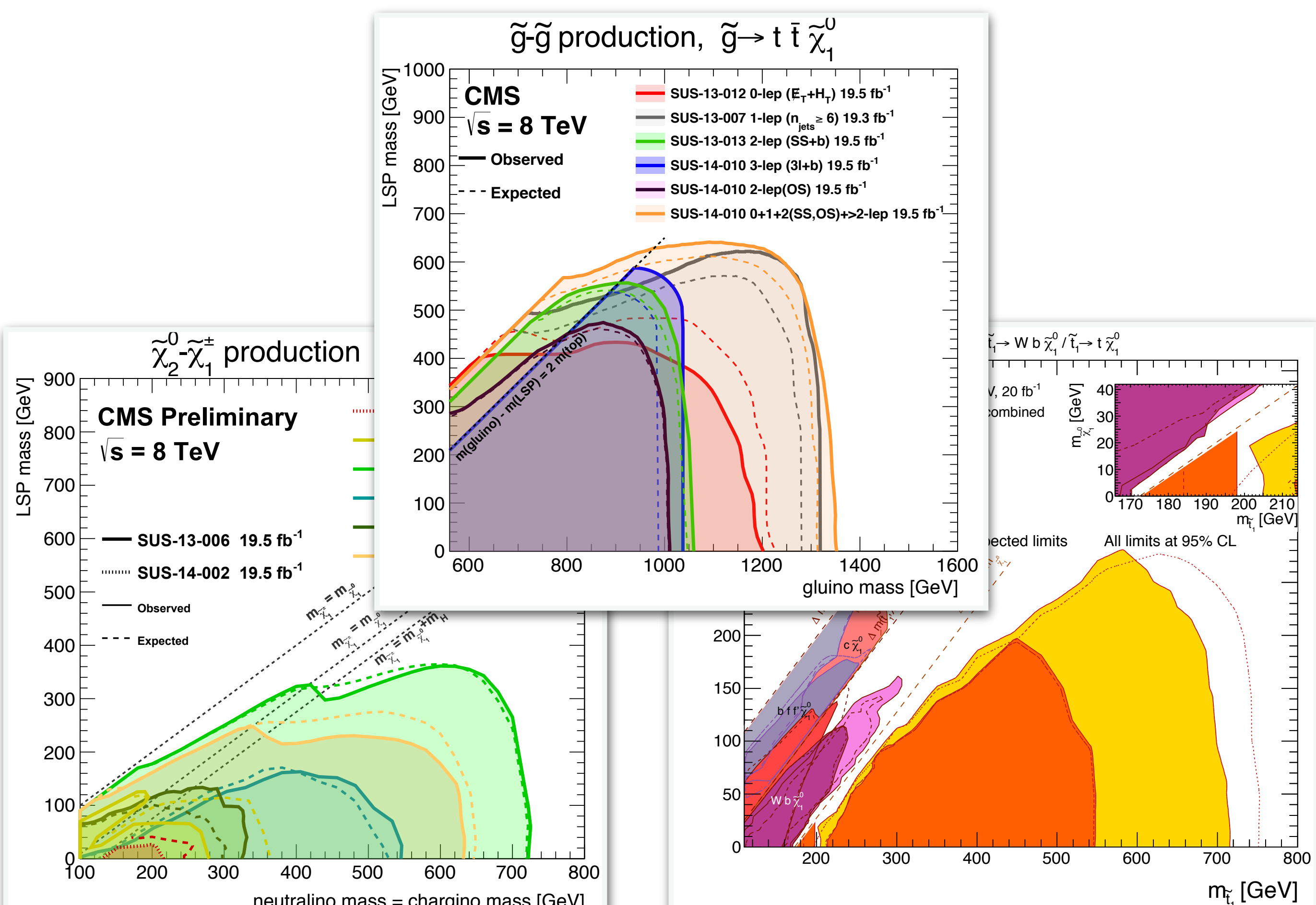


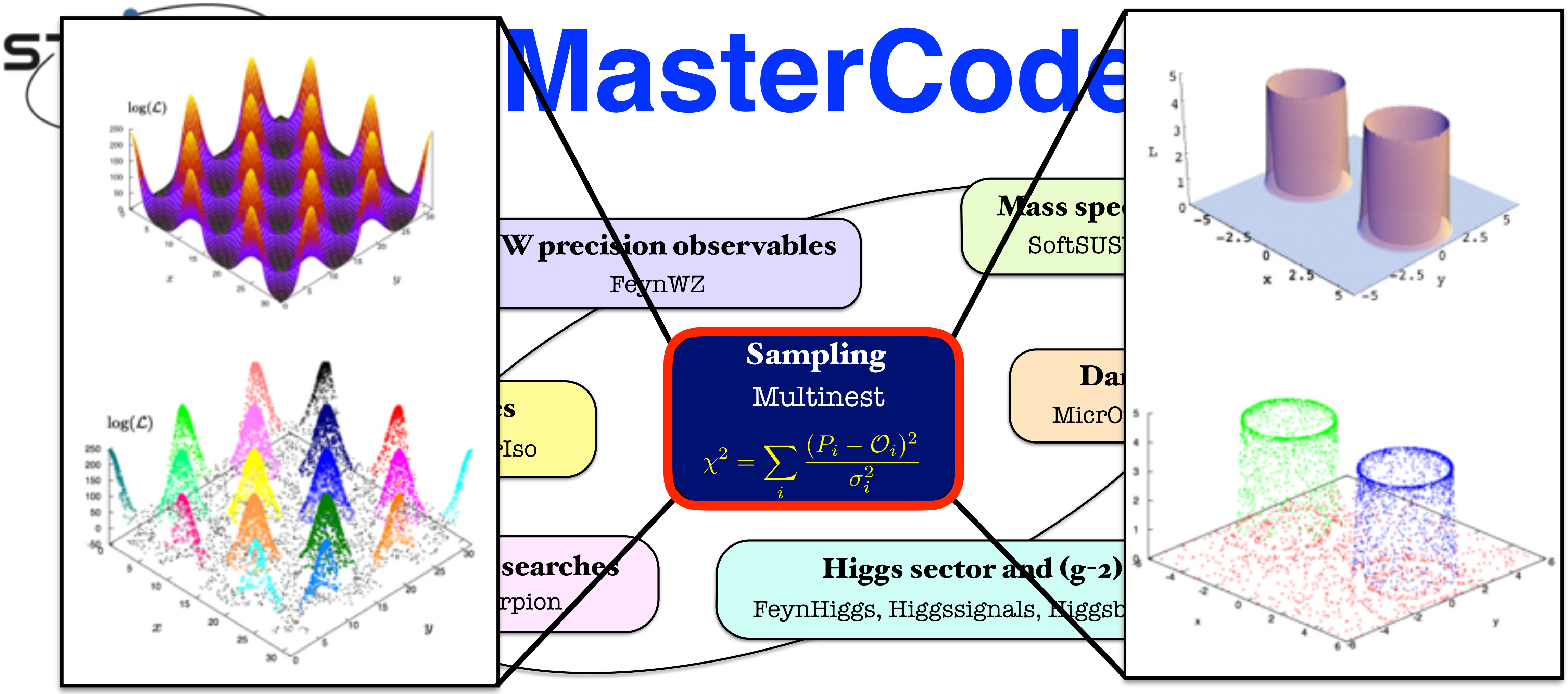


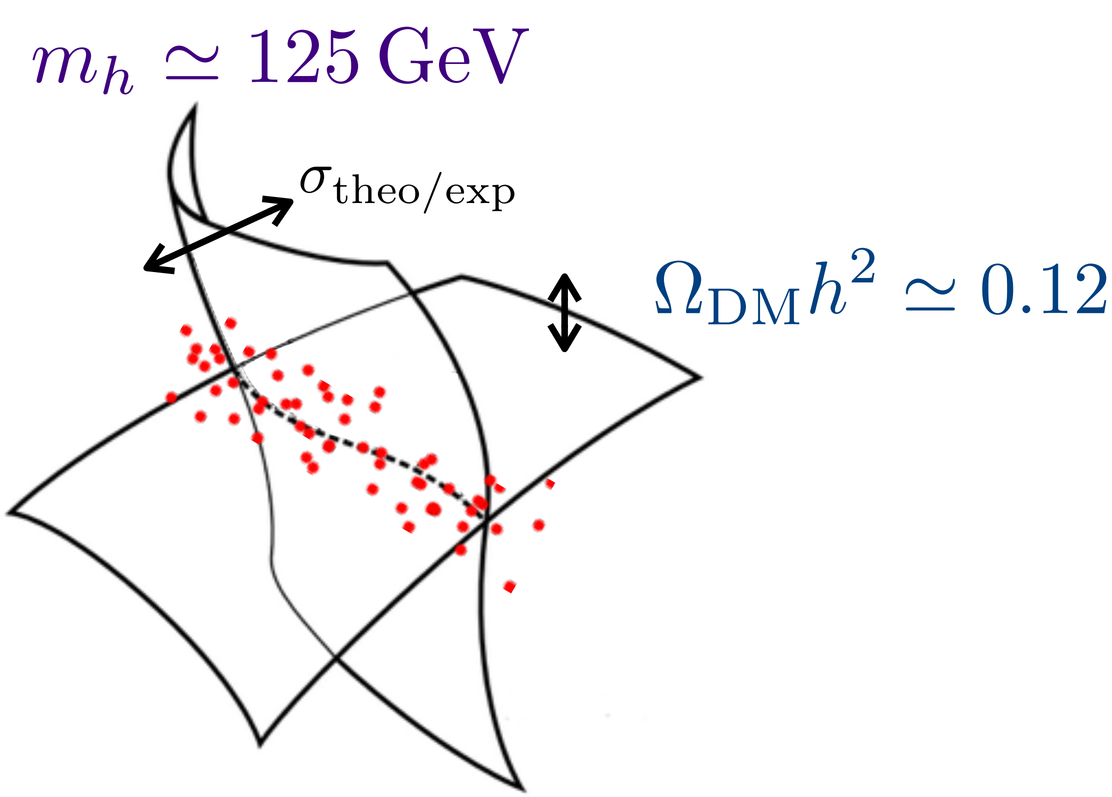
LHC SUSY searches:

Atom, Scorpion

important constraints but challenging to estimate

MasterCode





Sampling: Multinest

reduce the effective dim. of parameter space

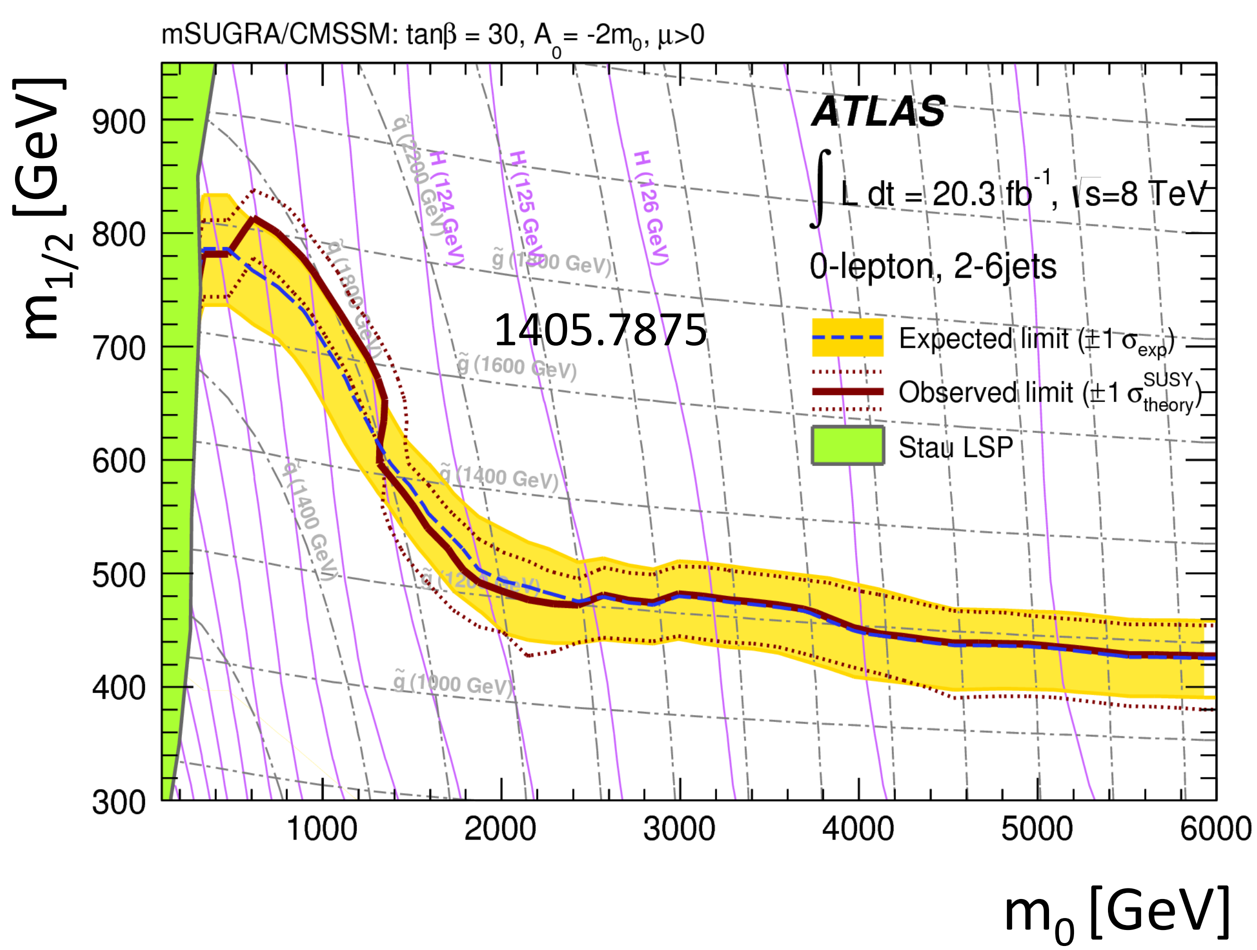
GUT inspired Models

CMSSM: $m_0, m_{1/2}, A_0, \tan\beta$ [1312.5250]

NUHM1: $m_0, m_{1/2}, A_0, \tan\beta, m^2_{H_u} = m^2_{H_d}$ [1312.5250]

NUHM2: $m_0, m_{1/2}, A_0, \tan\beta, m^2_{H_u}, m^2_{H_d}$ [1408.4060]

LHC constraint depends (almost) only on $m_0, m_{1/2}$.

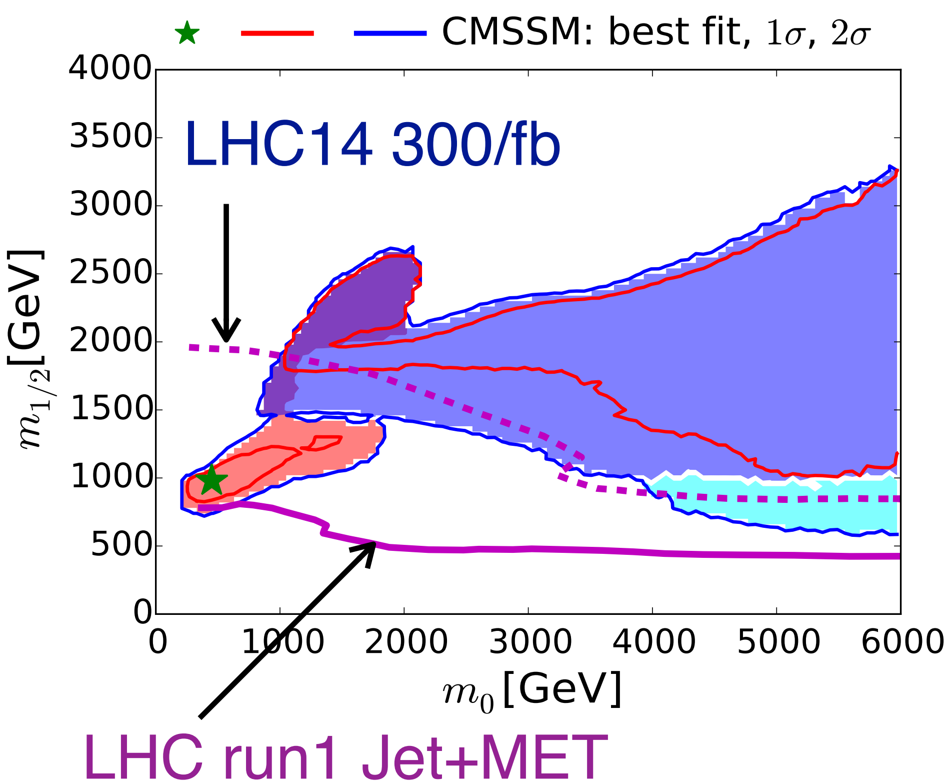


$$\mathcal{M} \equiv \sqrt{m_0^2 + m_{1/2}^2}$$

$$\chi^2 = 5.99 \cdot \left(\frac{\mathcal{M}}{\mathcal{M}_c}\right)^{\alpha}$$

$$\alpha = 4$$

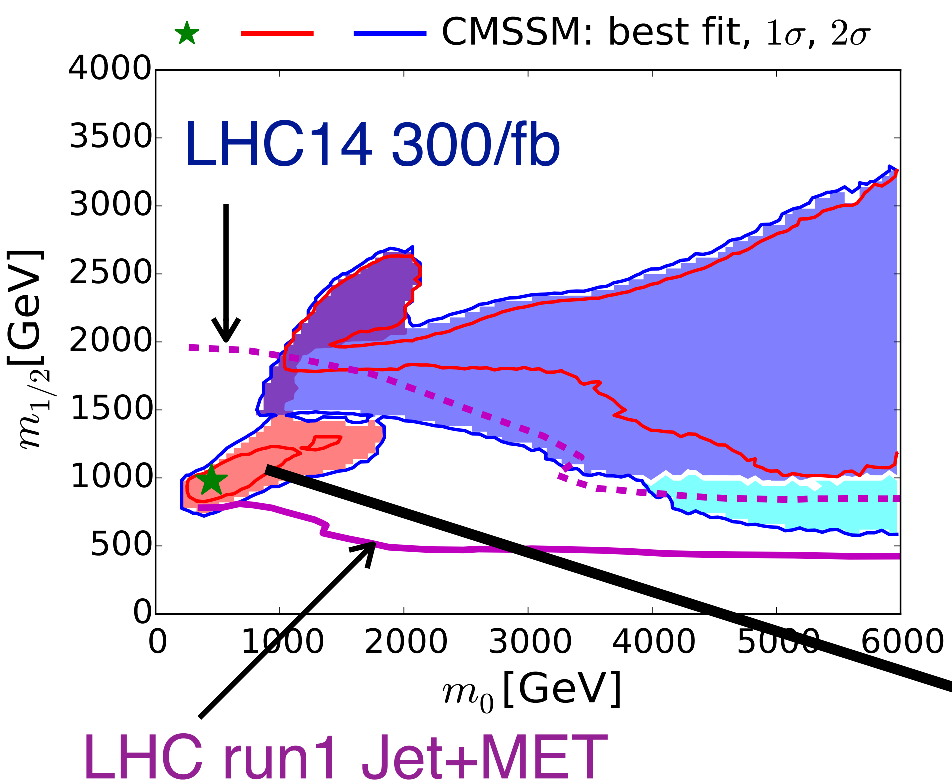
GUT inspired Models



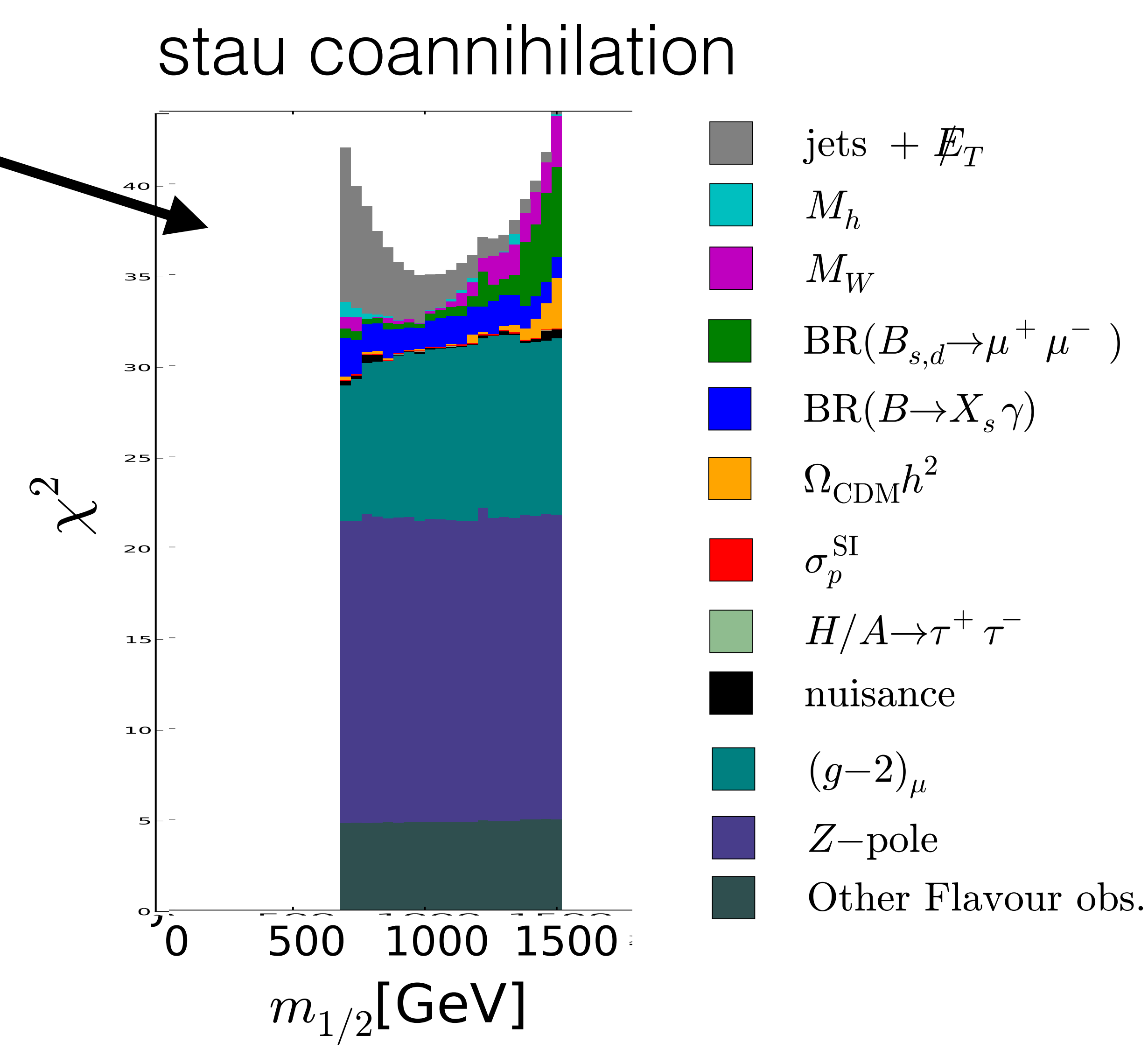
← shaped by **DM**, **Jet + MET**, m_h

	stau coan.	$\left(\frac{m_{\tilde{\tau}_1}}{m_{\tilde{\chi}_1^0}} - 1\right) < 0.15$
	hybrid ↕️	
	A/H funnel	$\left\lvert\frac{M_A}{m_{\tilde{\chi}_1^0}} - 2\right\rvert < 0.4$
	focus point	$\left(\frac{\mu}{m_{\tilde{\chi}_1^0}}\right) - 1 < 0.3$
	chargino coan.	$\left(\frac{m_{\tilde{\chi}_1^\pm}}{m_{\tilde{\chi}_1^0}} - 1\right) < 0.1$

GUT inspired Models



shaped by **DM**, **Jet + MET**, m_h



- stau coan. $\left(\frac{m_{\tilde{\tau}_1}}{m_{\tilde{\chi}_1^0}} - 1\right) < 0.15$
- hybrid ↕
- A/H funnel $\left|\frac{M_A}{m_{\tilde{\chi}_1^0}} - 2\right| < 0.4$
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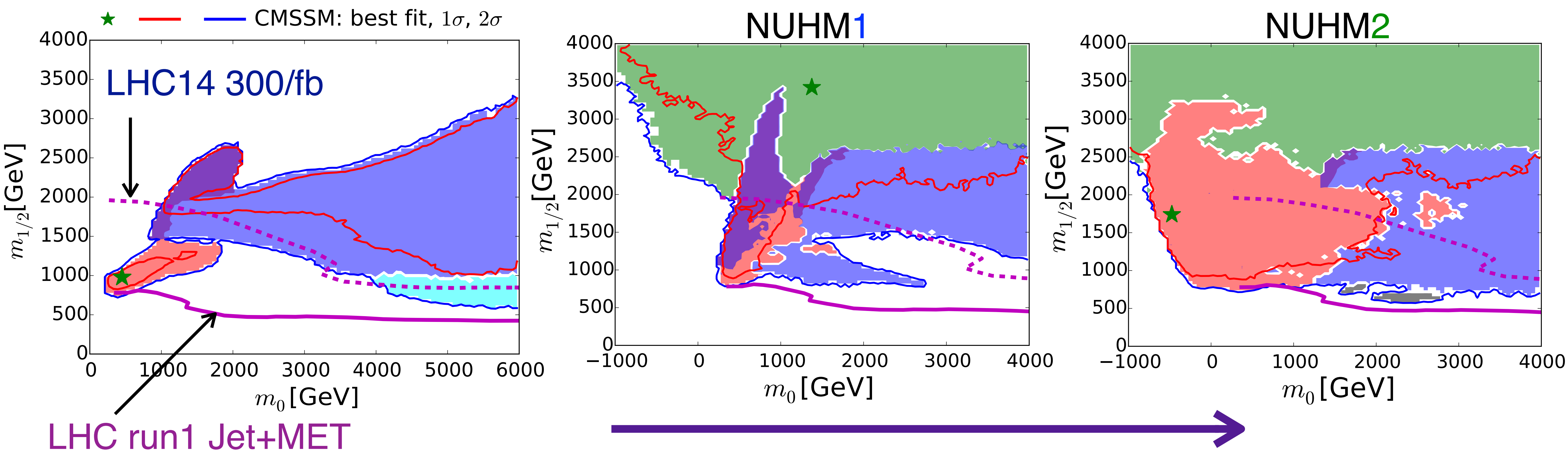
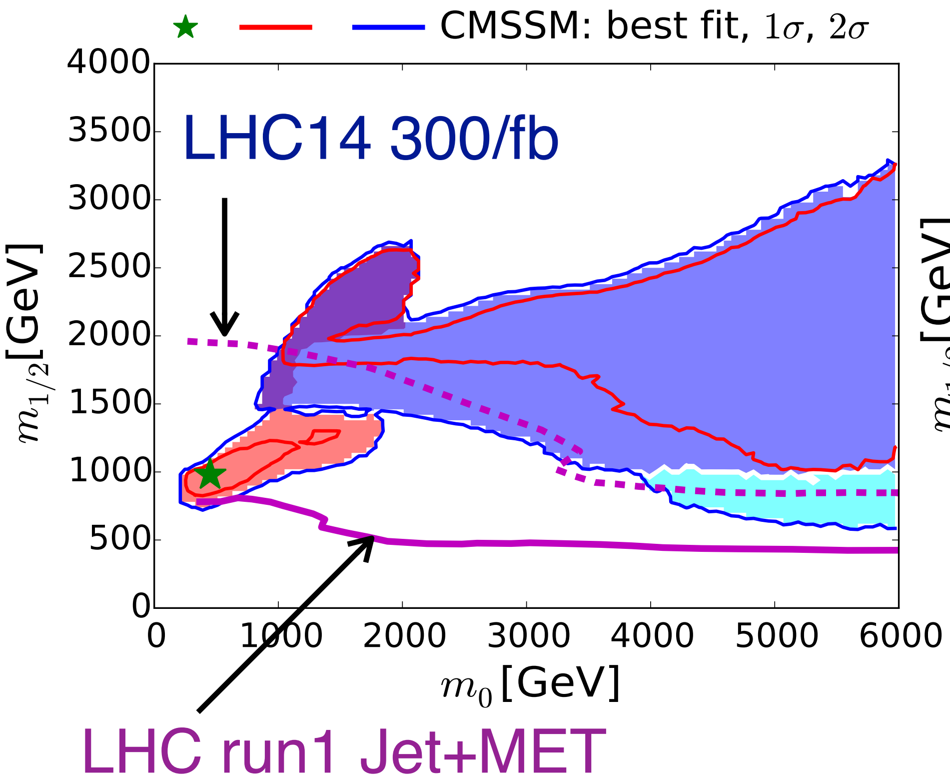
GUT inspired Models

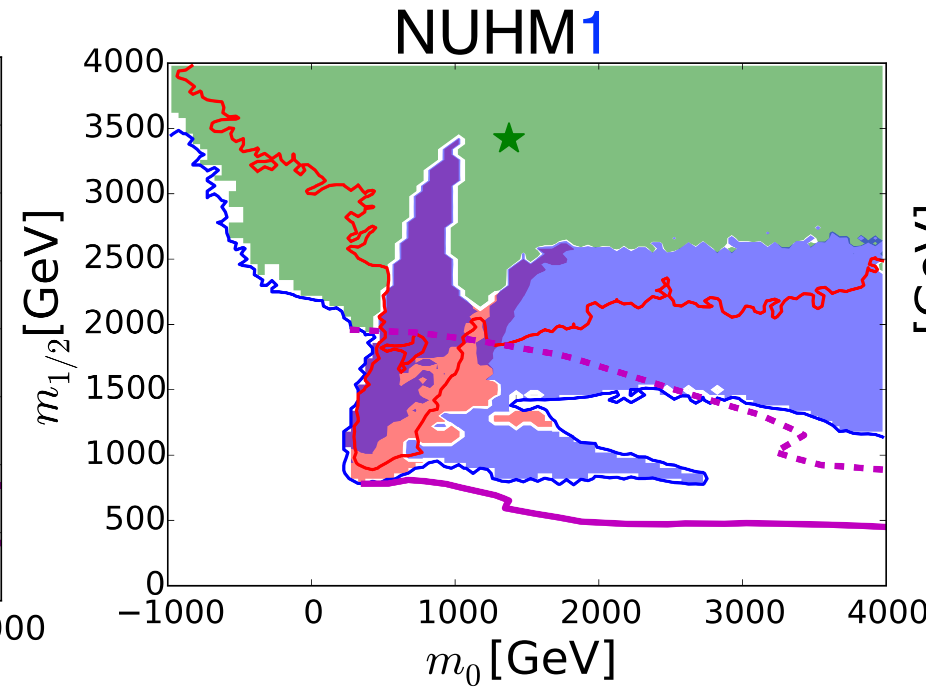


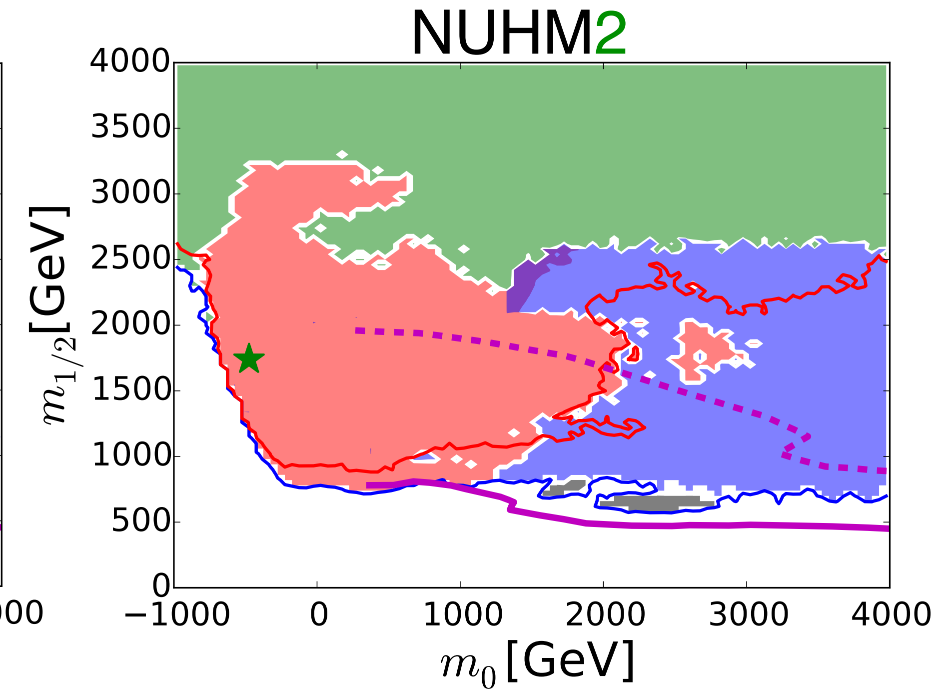
more freedom, featureless

- stau coan. $\left(\frac{m_{\tilde{\tau}_1}}{m_{\tilde{\chi}^0_1}} - 1\right) < 0.15$
- hybrid ↕️
- A/H funnel $\left|\frac{M_A}{m_{\tilde{\chi}^0_1}} - 2\right| < 0.4$
- focus point $\left(\frac{\mu}{m_{\tilde{\chi}^0_1}}\right) - 1 < 0.3$
- chargino coan. $\left(\frac{m_{\tilde{\chi}^\pm_1}}{m_{\tilde{\chi}^0_1}} - 1\right) < 0.1$

GUT inspired Models







more freedom, featureless

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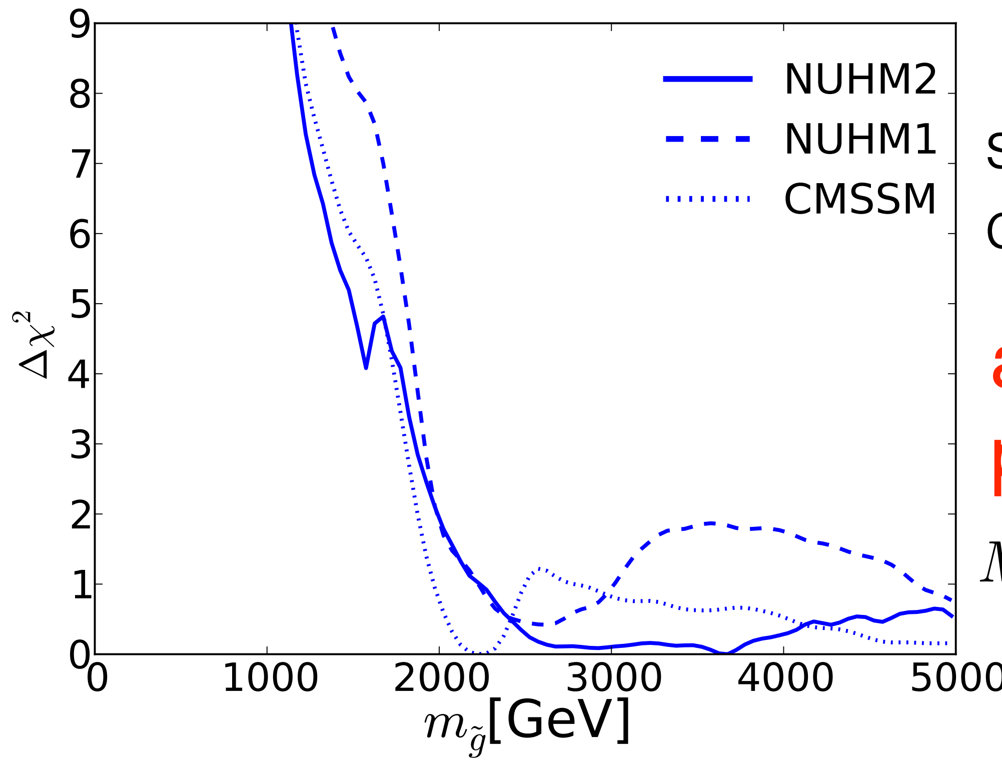


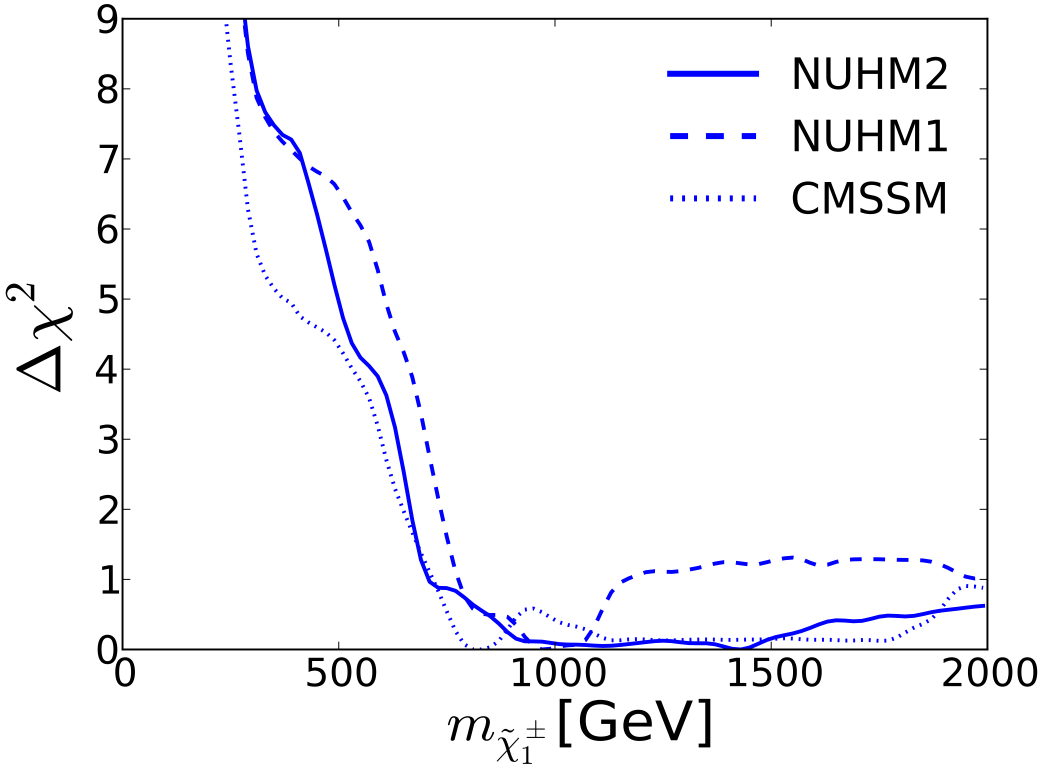
strong boundary condition + RGE:

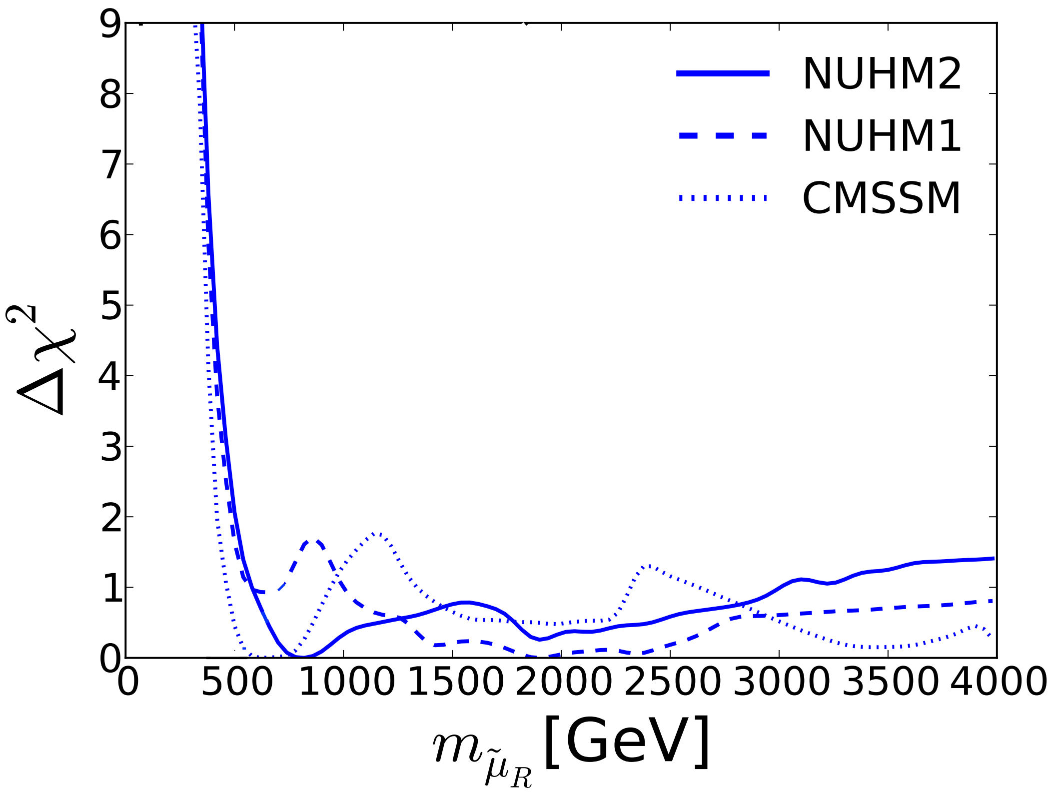
all SUSY particles heavy

$M_3 : M_2 : M_1 \simeq 6 : 2 : 1$

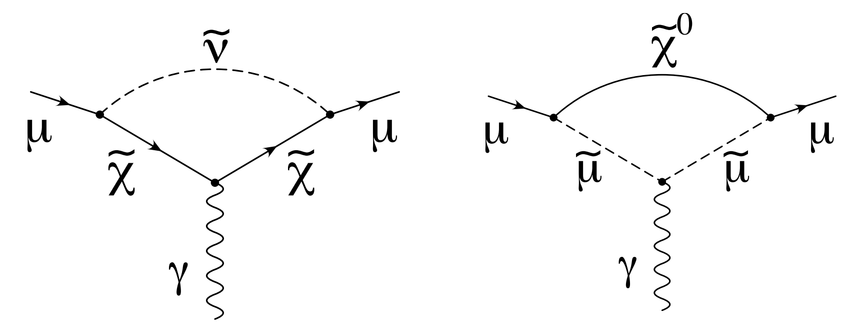
GUT inspired Models

$M_3 : M_2 : M_1 \simeq 6 : 2 : 1$

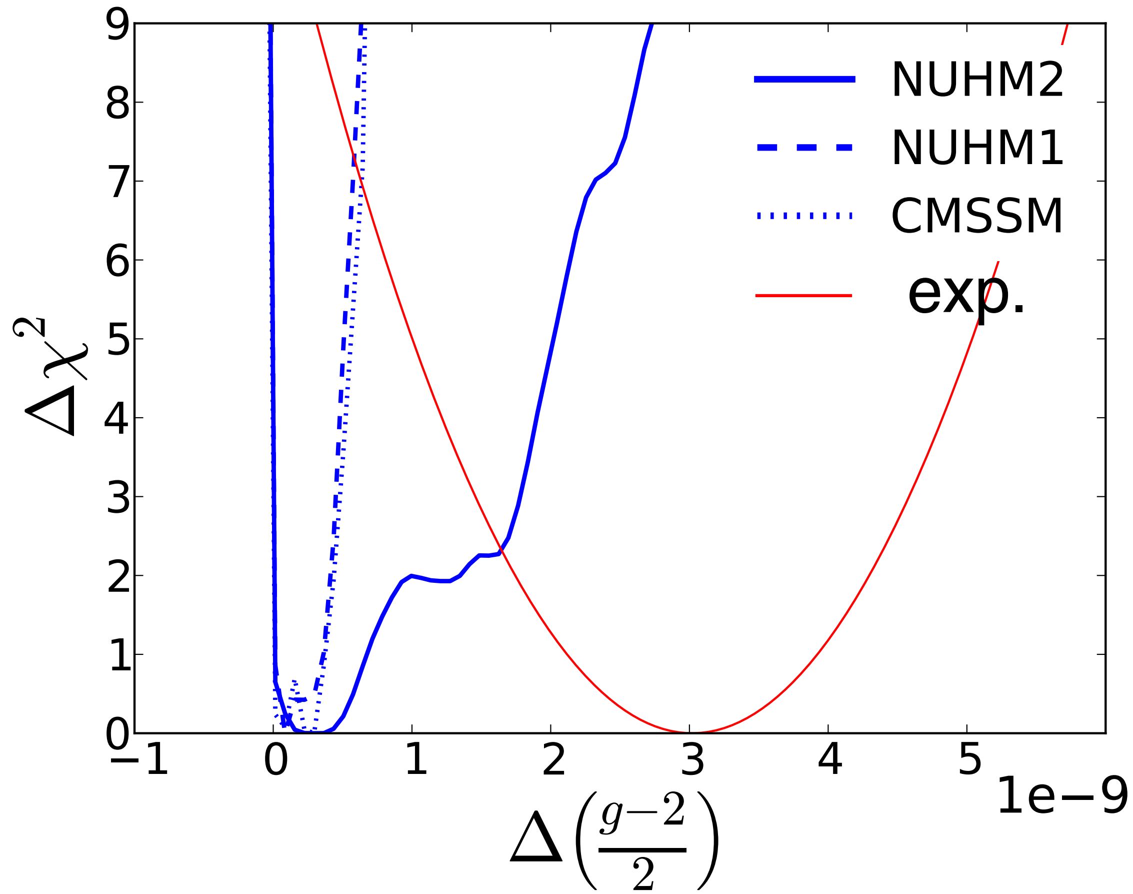




difficult to explain *(g-2)*$_\mu$



$$\delta a_\mu \sim 1.3 \times 10^{-9} \left(\frac{100\,\mathrm{GeV}}{m_{\mathrm{SUSY}}} \right)^2 \tan\beta$$



phenomenological MSSM

pMSSM-19

M_1, M_2, M_3 } **3** gaugino masses

$m_{\tilde{q}_{1,2}}, m_{\tilde{q}_3},$
$m_{\tilde{u}_{1,2}}, m_{\tilde{u}_3},$
$m_{\tilde{d}_{1,2}}, m_{\tilde{d}_3},$
$m_{\tilde{\ell}_{1,2}}, m_{\tilde{\ell}_3},$
$m_{\tilde{e}_{1,2}}, m_{\tilde{e}_3},$
} **10** sfermion masses

A_u, A_d, A_ℓ } **3** A-terms

$m_A, \mu, \tan\beta$ } **3** others

phenomenological approach

- MSSM has >120 parameters but most are off-diagonal entries of $m_{\tilde{f}}, A_f$ and CP phases. → set them zero
- FCNC constraints (1-2 gen.)

$$\rightarrow \quad m_{\tilde{f}_1} = m_{\tilde{f}_2}$$

left with 19 parameters

= pMSSM-19

pMSSM-10

pMSSM-19

M_1, M_2, M_3 } **3** gaugino masses

$m_{\tilde{q}_{1,2}}, m_{\tilde{q}_3},$
$m_{\tilde{u}_{1,2}}, m_{\tilde{u}_3},$
$m_{\tilde{d}_{1,2}}, m_{\tilde{d}_3},$
$m_{\tilde{\ell}_{1,2}}, m_{\tilde{\ell}_3},$
$m_{\tilde{e}_{1,2}}, m_{\tilde{e}_3},$ } **10** sfermion masses

A_u, A_d, A_ℓ } **3** A-terms

$m_A, \mu, \tan\beta$ } **3** others

pMSSM global fit

Full pMSSM

19 parameter ⟶ 10^{19} points

⟶ 3 x 10^{11} CPU years

1point / 1sec

We define **10 param. pMSSM**

pMSSM-10

pMSSM-10

M_1, M_2, M_3 } **3** gaugino masses

$m_{\tilde{q}_{1,2}}, m_{\tilde{q}_3}, m_{\ell}$ } **3** sfermion masses

A_0 } **1** A-term

$m_A, \mu, \tan\beta$ } **3** others

Parameter	Range
M_1	(-1 , 1) TeV
M_2	(0 , 4) TeV
M_3	(-4 , 4) TeV
$m_{\tilde{q}}$	(0 , 4) TeV
$m_{\tilde{q}_3}$	(0 , 4) TeV
$m_{\tilde{l}}$	(0 , 2) TeV
M_A	(0 , 4) TeV
A	(-5 , 5) TeV
μ	(-5 , 5) TeV
$\tan\beta$	(1 , 60)

pMSSM global fit

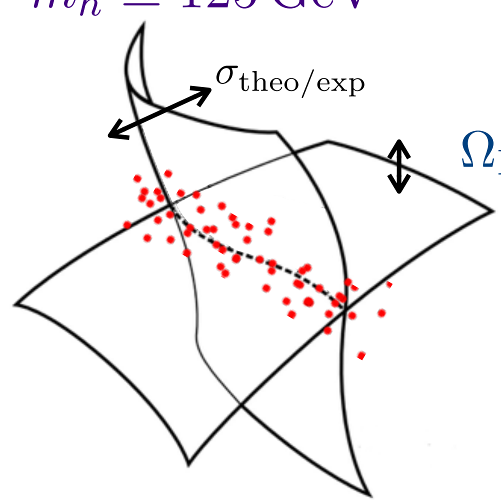
Full pMSSM

19 parameter ⟶ 10^{19} points

⟶ 3 x 10^{11} CPU years

1point / 1sec

We define **10 param. pMSSM**



sample **10^9** points

30 CPU years

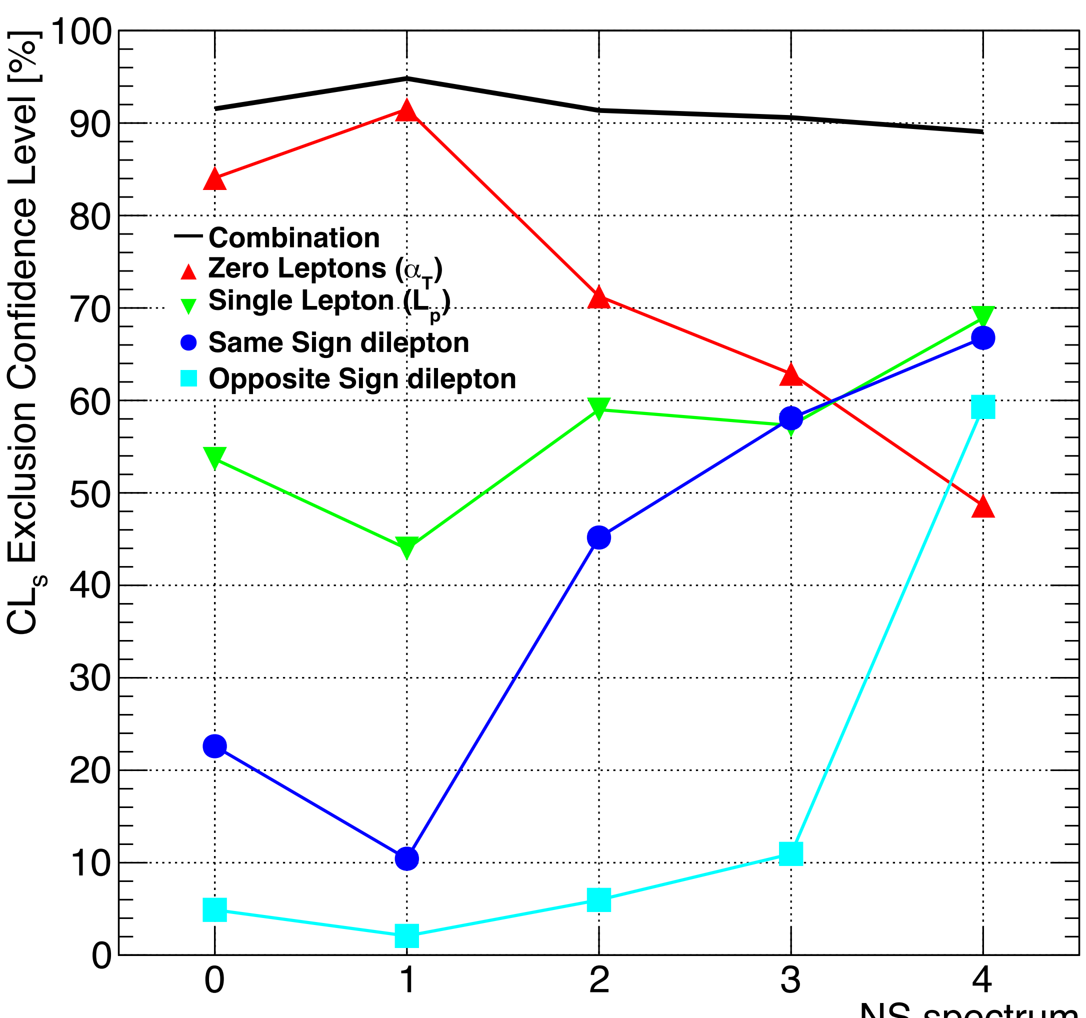
needs very fast evaluation of LHC constraints

pMSSM19 fit → JoAnne's talk

Universal Mass Limit

$$m_{\tilde{g}}, m_{\tilde{q}_3}, m_{\tilde{\chi}_1^0} = (1000, 700, 100)\ \mathrm{GeV}$$

Spectra	NS0	NS1	NS2	NS3	NS4
sparticle content	$\tilde{g}$ $\tilde{t}_1, \tilde{t}_2$ $\tilde{\chi}_0^1$	$\tilde{g}$ $\tilde{t}_1, \tilde{t}_2, \tilde{b}_1$ $\tilde{\chi}_0^1$	$\tilde{g}$ $\tilde{t}_1, \tilde{t}_2, \tilde{b}_1$ $\tilde{\chi}_0^2$ $\tilde{\chi}^\pm$ $\tilde{\chi}_0^1$	$\tilde{g}$ $\tilde{t}_1, \tilde{t}_2, \tilde{b}_1, \tilde{b}_2$ $\tilde{\chi}_0^2$ $\tilde{\chi}^\pm$ $\tilde{\chi}_0^1$	$\tilde{g}$ $\tilde{t}_1, \tilde{t}_2, \tilde{b}_1, \tilde{b}_2$ $\tilde{\chi}_0^2$ $\tilde{\chi}^\pm, \tilde{\ell}_{L,R}$ $\tilde{\chi}_0^1$
main decay chains	$\tilde{g} \to t\tilde{t}_{1,2}$ $\tilde{t}_{1,2} \to t\tilde{\chi}_0^1$	$\tilde{g} \to t\tilde{t}_{1,2},\ b\tilde{b}_1$ $\tilde{t}_{1,2} \to t\tilde{\chi}_0^1$ $\tilde{b}_1 \to b\tilde{\chi}_0^1$	$\tilde{g} \to t\tilde{t}_{1,2},\ b\tilde{b}_1$ $\tilde{t}_{1,2} \to t\tilde{\chi}_0^{1,2},\ b\tilde{\chi}^\pm$ $\tilde{b}_1 \to b\tilde{\chi}_0^2,\ t\tilde{\chi}^\pm$ $\tilde{\chi}^\pm \to W^\pm\tilde{\chi}_0^1$ $\tilde{\chi}_0^2 \to Z\tilde{\chi}_0^1$	$\tilde{g} \to t\tilde{t}_{1,2},\ b\tilde{b}_{1,2}$ $\tilde{t}_{1,2} \to t\tilde{\chi}_0^{1,2},\ b\tilde{\chi}^\pm$ $\tilde{b}_{1,2} \to b\tilde{\chi}_0^2,\ t\tilde{\chi}^\pm$ $\tilde{\chi}^\pm \to W^\pm\tilde{\chi}_0^1$ $\tilde{\chi}_0^2 \to Z\tilde{\chi}_0^1$	$\tilde{g} \to t\tilde{t}_{1,2},\ b\tilde{b}_{1,2}$ $\tilde{t}_{1,2} \to t\tilde{\chi}_0^{1,2},\ b\tilde{\chi}^\pm$ $\tilde{b}_{1,2} \to b\tilde{\chi}_0^2,\ t\tilde{\chi}^\pm$ $\tilde{\chi}^\pm \to W^\pm\tilde{\chi}_0^1$ $\tilde{\chi}_0^2 \to Z\tilde{\chi}_0^1,\ \tilde{\ell}\ell$ $\tilde{\ell} \to \ell\tilde{\chi}_0^1$

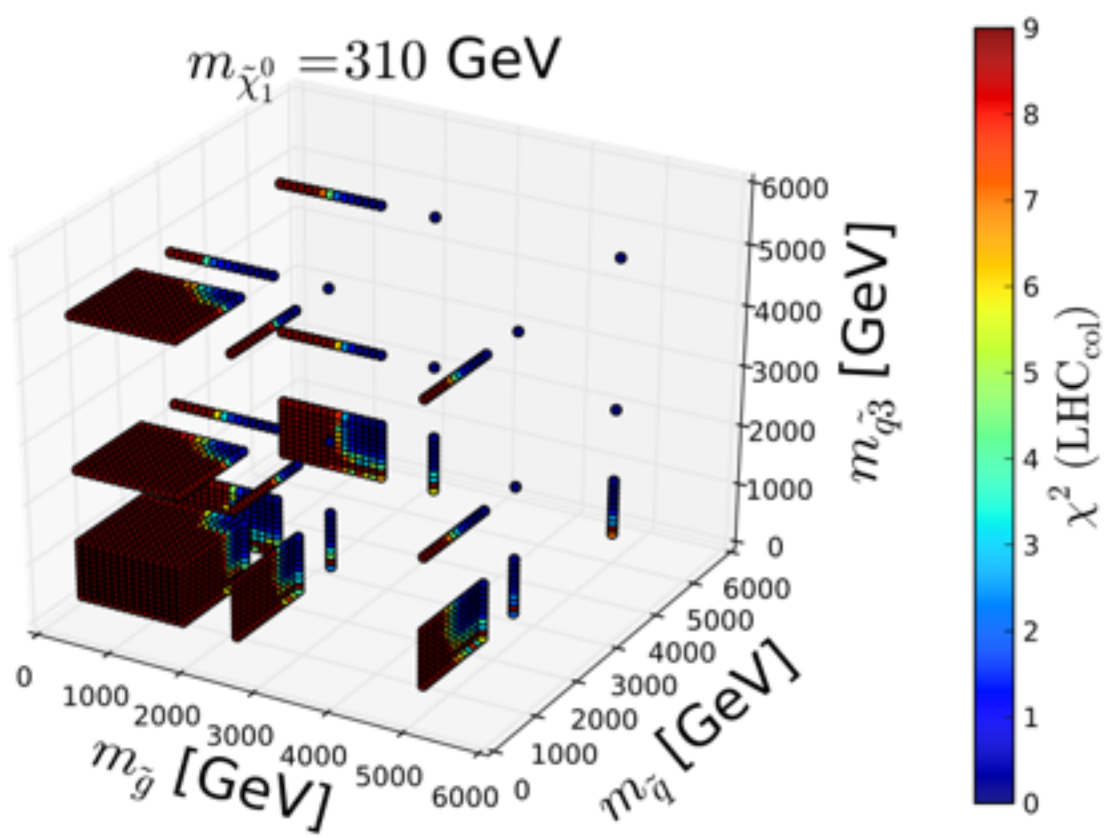


Universal Mass Limit

"If the variety of channels are combined, the limit becomes insensitive to the topology."

O.Buchmueller, J.Marrouche '14

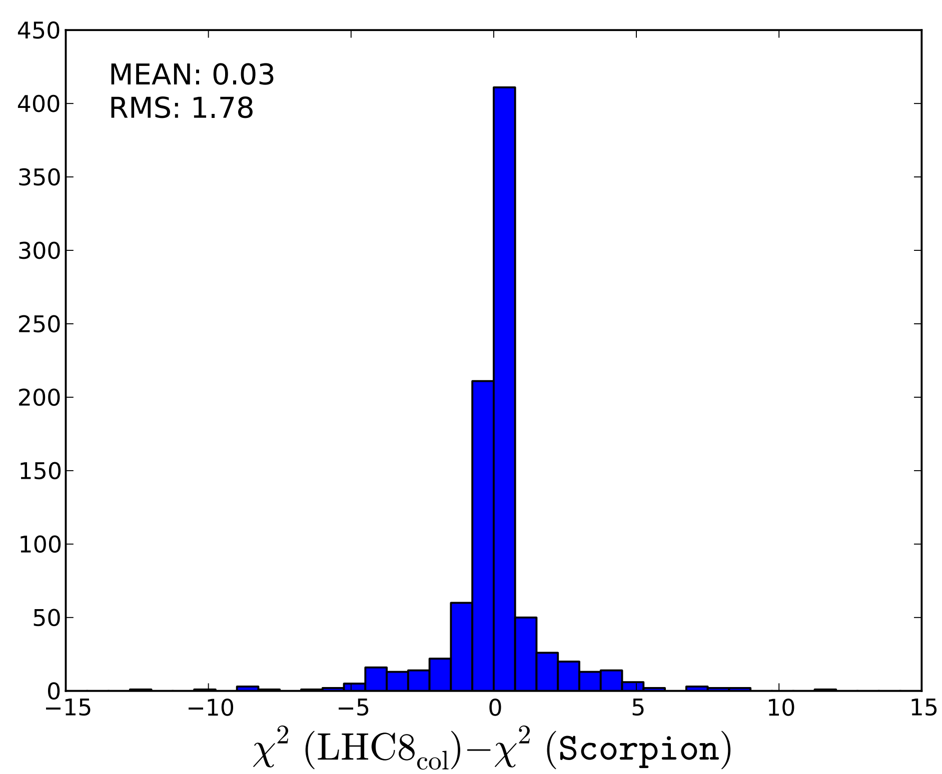
Universal Mass Limit



We create **4D lookup table** using the full simulation chain.

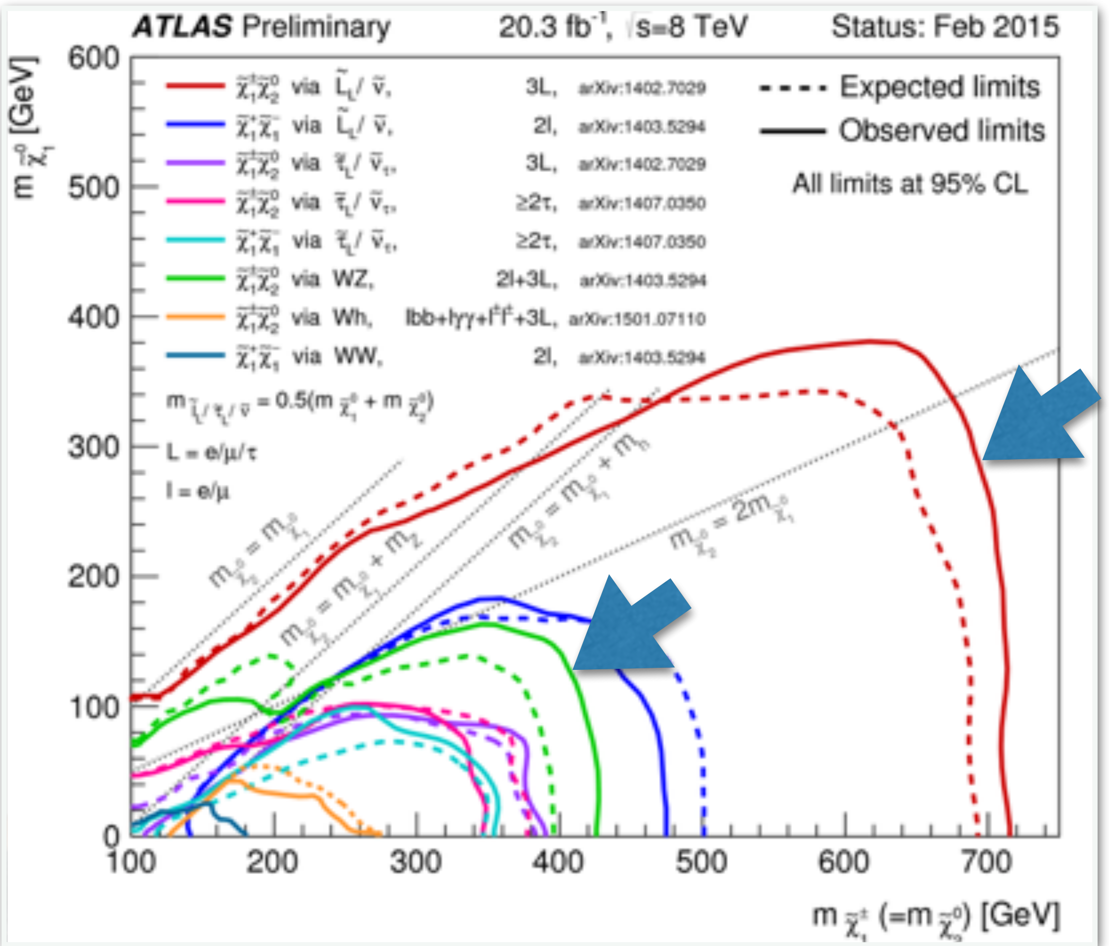
Grid: $(m_{\tilde{g}}, m_{\tilde{q}_{1,2}}, m_{\tilde{q}_3}, m_{\tilde{\chi}_1^0})$

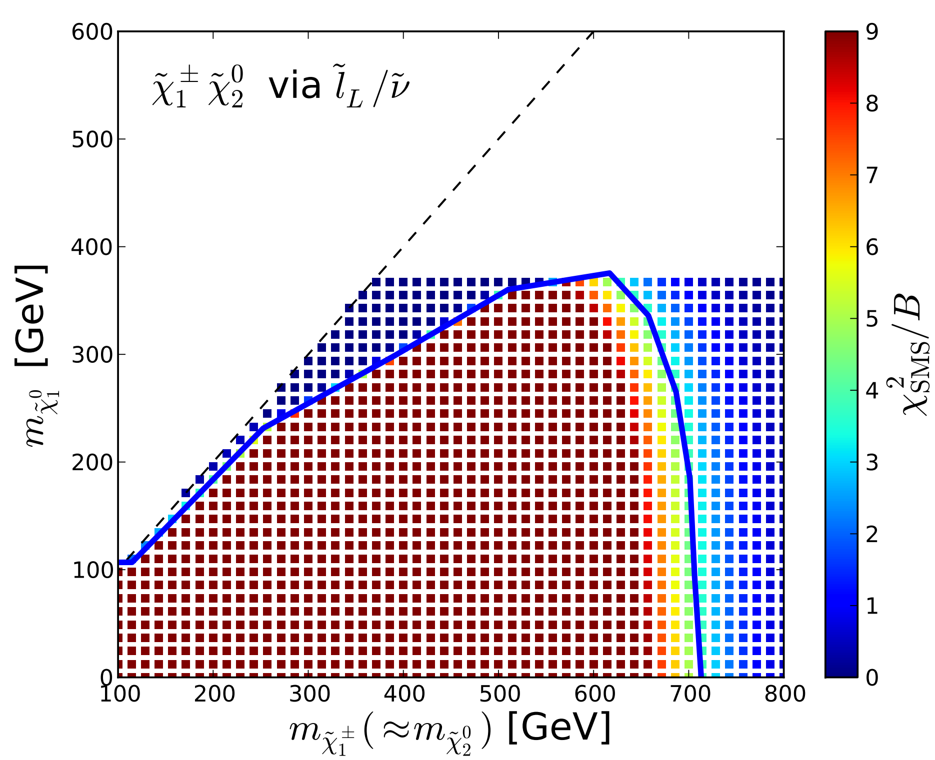
Searches
Monojet
0-lepton (M_{T2})
single-lepton (M_{T2}^{W})
SS-dilepton
OS-dilepton
$\geq$ 3-lepton



validated with the full simulation chain using random 10^3 points

EW SUSY searches





The universal mass limit does not work well for EW SUSY particles.

The EW SUSY sector is comprised of a few particles (effectively simplified model).

We construct χ^2 as

$$\chi^2_{\rm EW} = \sum_i^{\rm SMS} f_i(\tilde{m}, m_{\tilde{\chi}_1^0}) \times B_i$$

Branching Ratio

We use ATLAS run-1 searches of

$$\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \text{ via } \tilde{\ell}/\tilde{\nu}$$

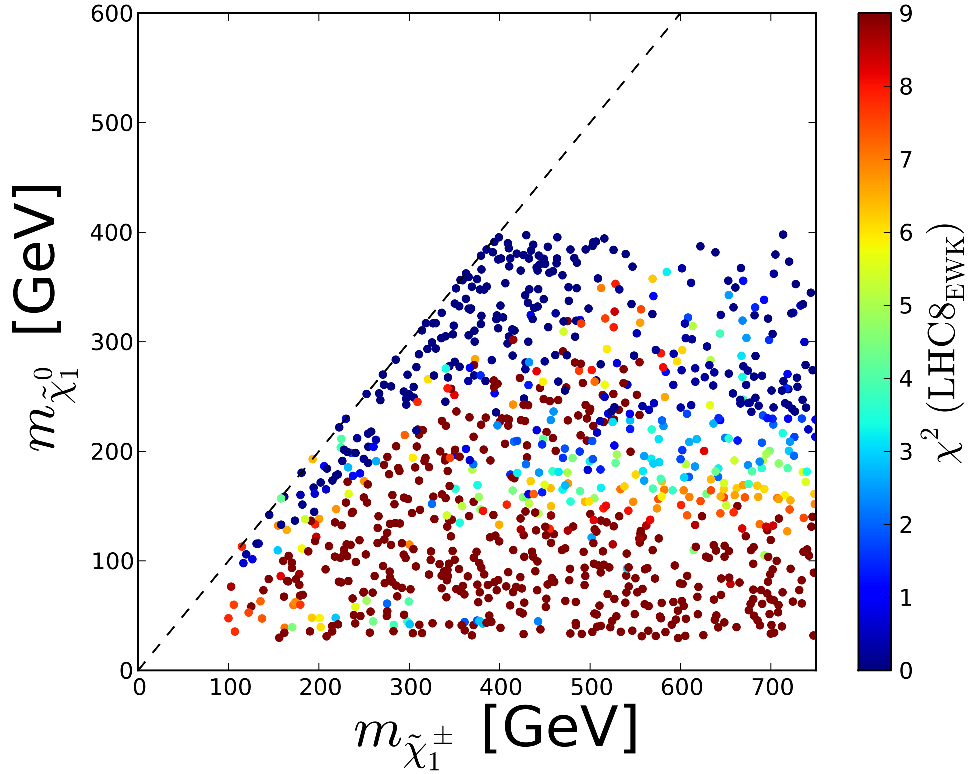
$$\tilde{\chi}_1^\pm \tilde{\chi}_2^0 \text{ via } WZ$$

$$\tilde{\ell} \to \ell \tilde{\chi}_1^0$$

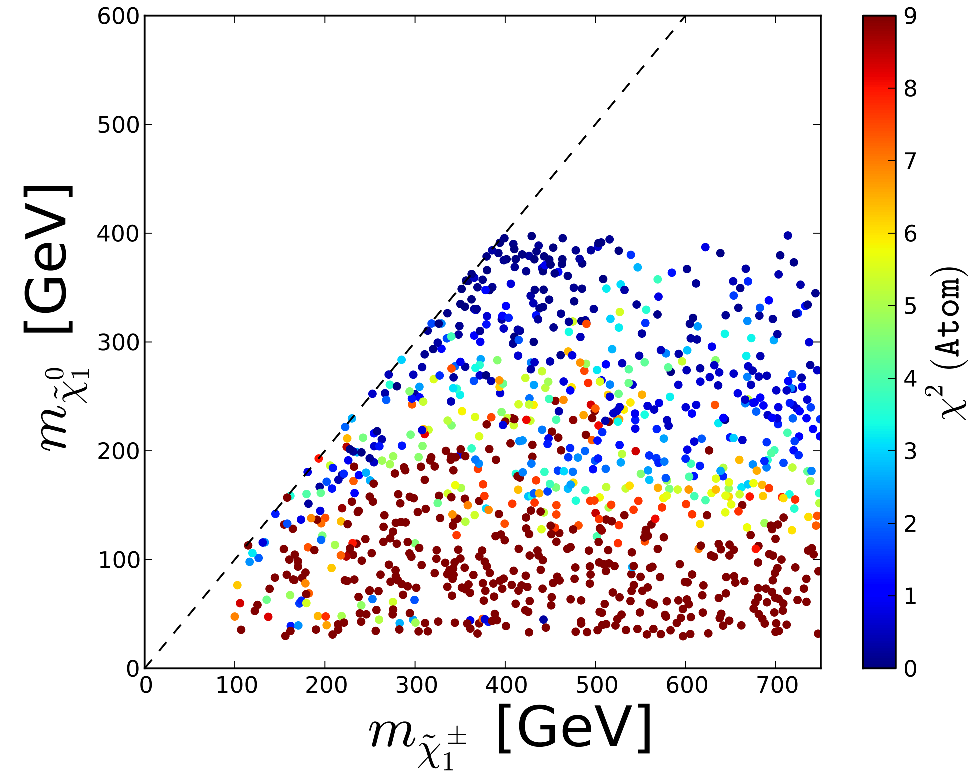
Validation

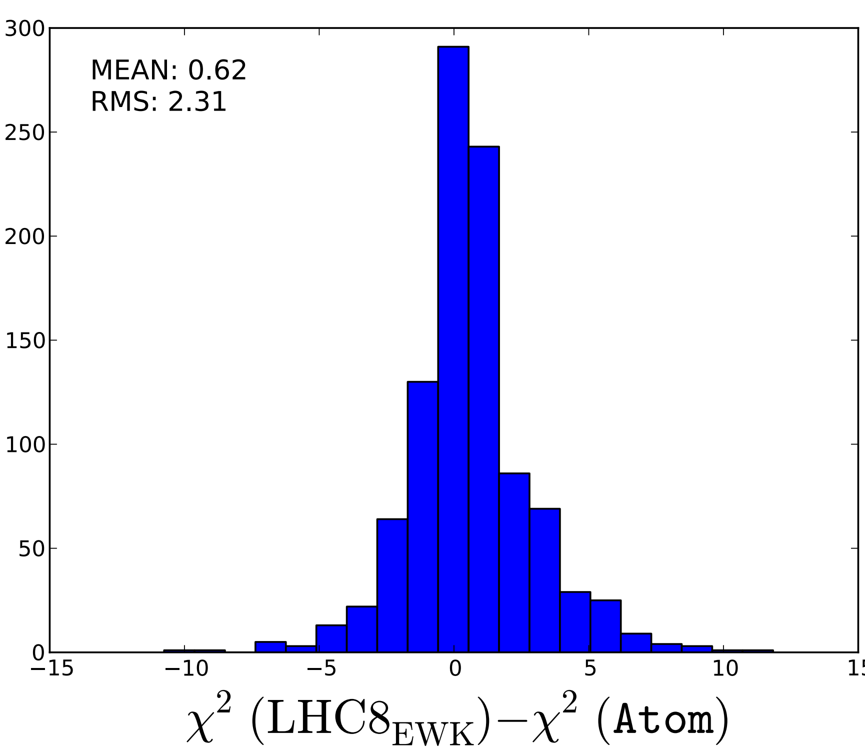
Comparison using random 10^3 points

Our procedure

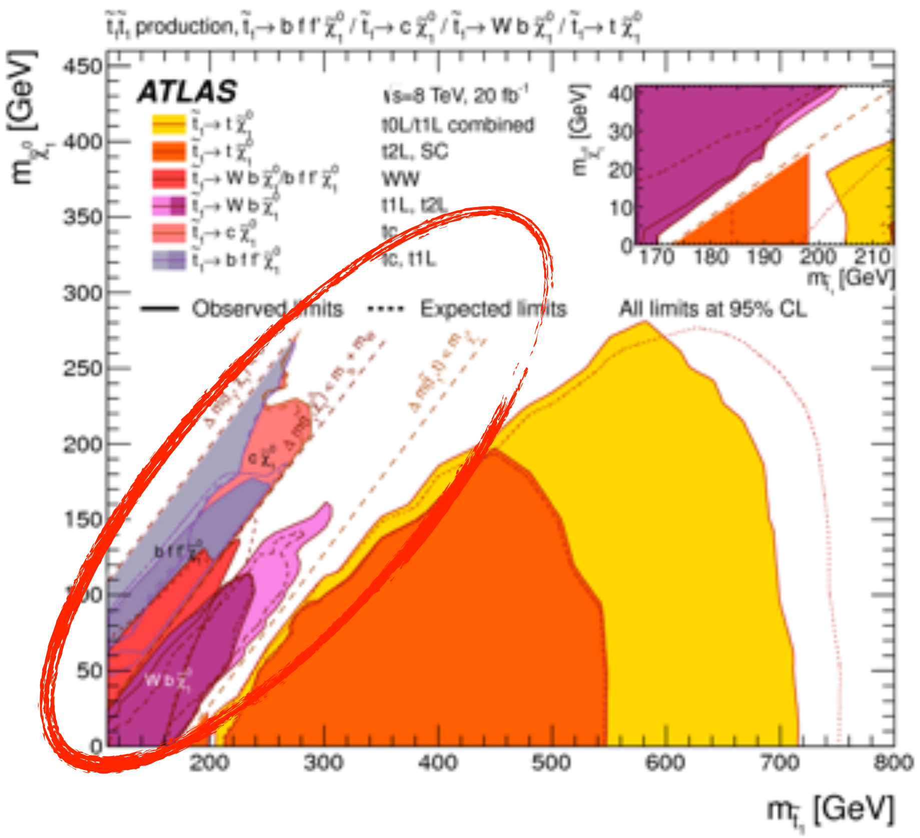


Full simulation





Compressed stop searches

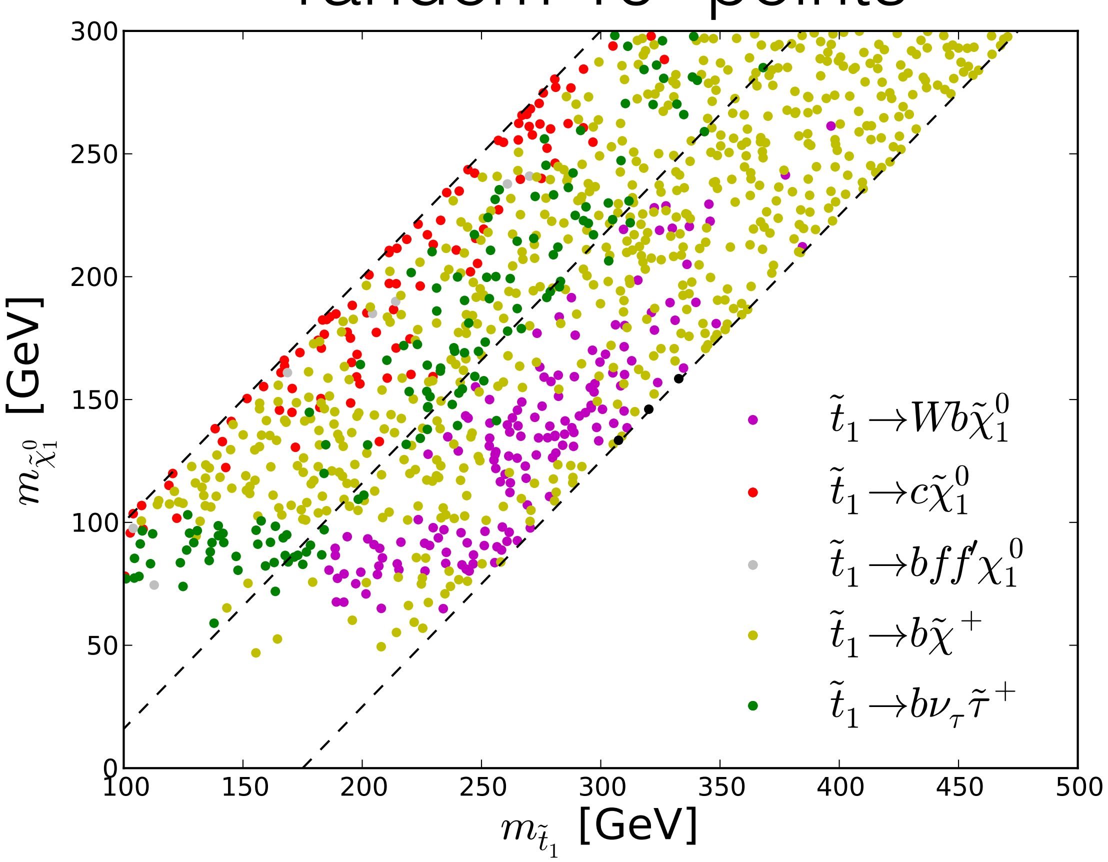


The universal mass limit does not work well for the compressed stop region.

We construct χ^2 as based on simplified models

$$\chi^2_{\rm stop} = \sum_i f_i(m_{\tilde{t}}, m_{\tilde{\chi}_1^0}) \times B_i$$

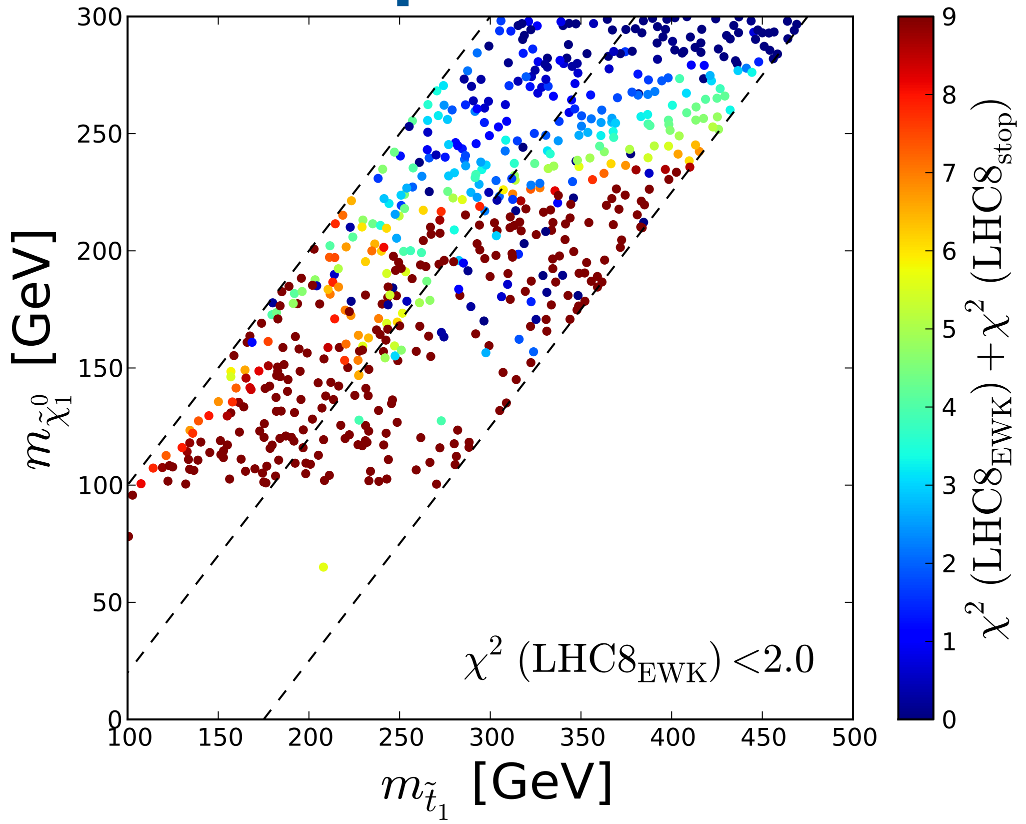
random 10^3 points



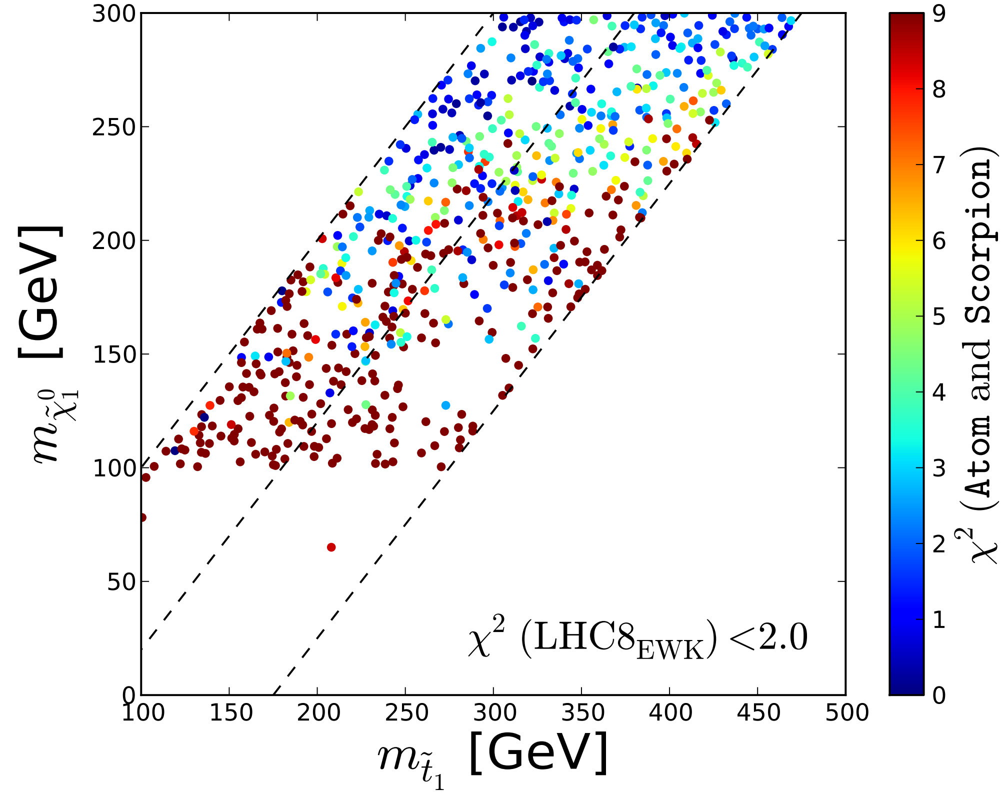
Decay	
$\tilde{t}_1 \rightarrow b\tilde{\chi}_1^\pm$	2b+MET: 1308.2631
$\tilde{t}_1 \rightarrow bW\tilde{\chi}_1^0$	1L+jets+MET: 1407.0583
$\tilde{t}_1 \rightarrow b\nu_\tau\tilde{\tau}_1$	MT2 had: 1502.04358
$\tilde{t}_1 \rightarrow c\tilde{\chi}_1^0$	MT2 had: 1502.04358

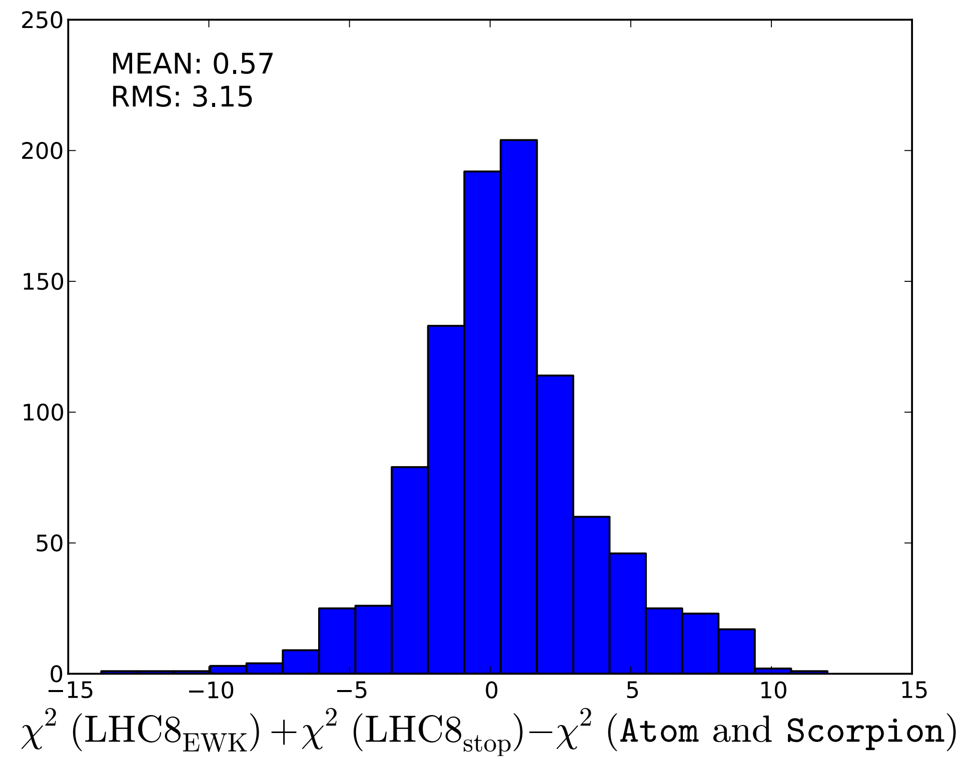
Validation

Our procedure



Full simulation

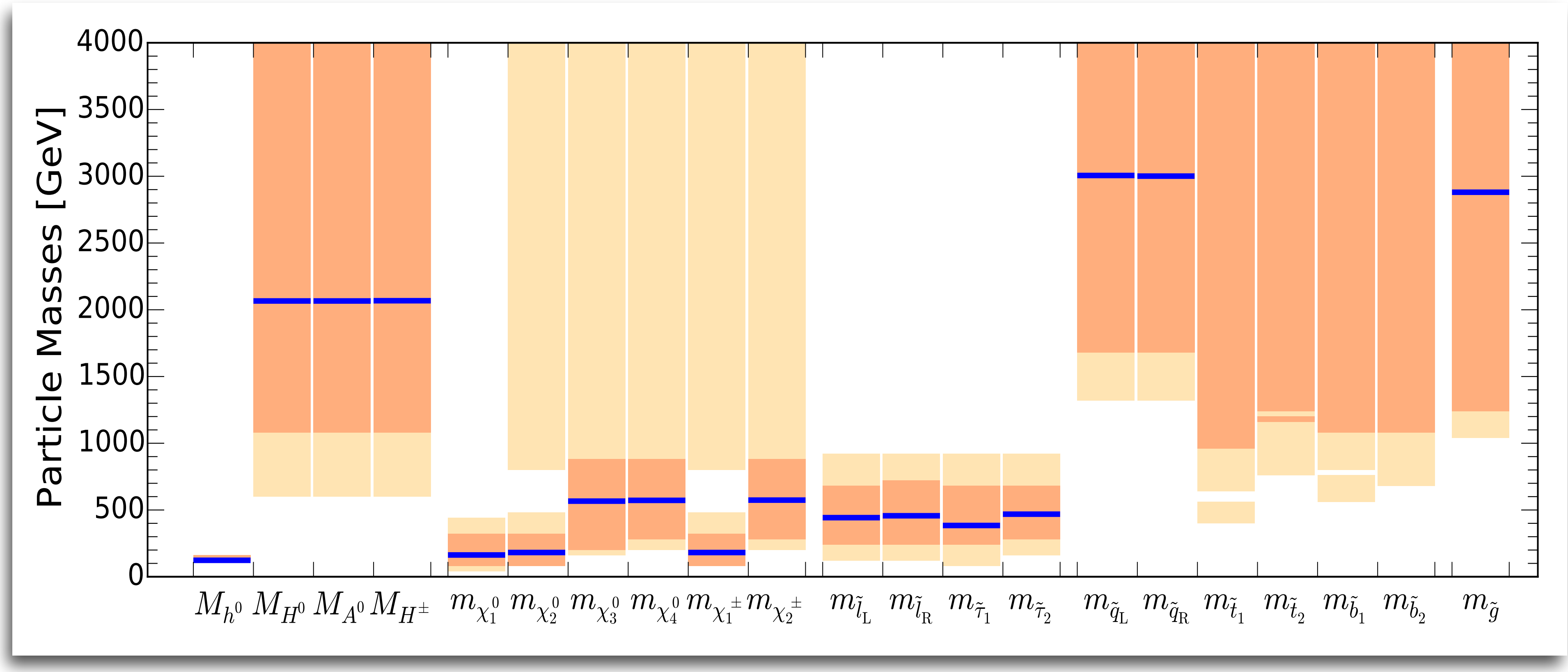




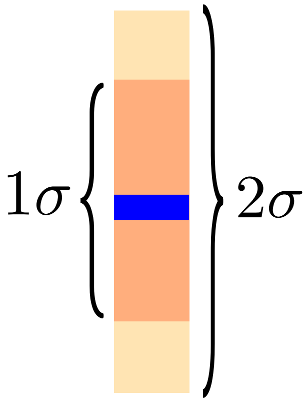
Result

mastercode

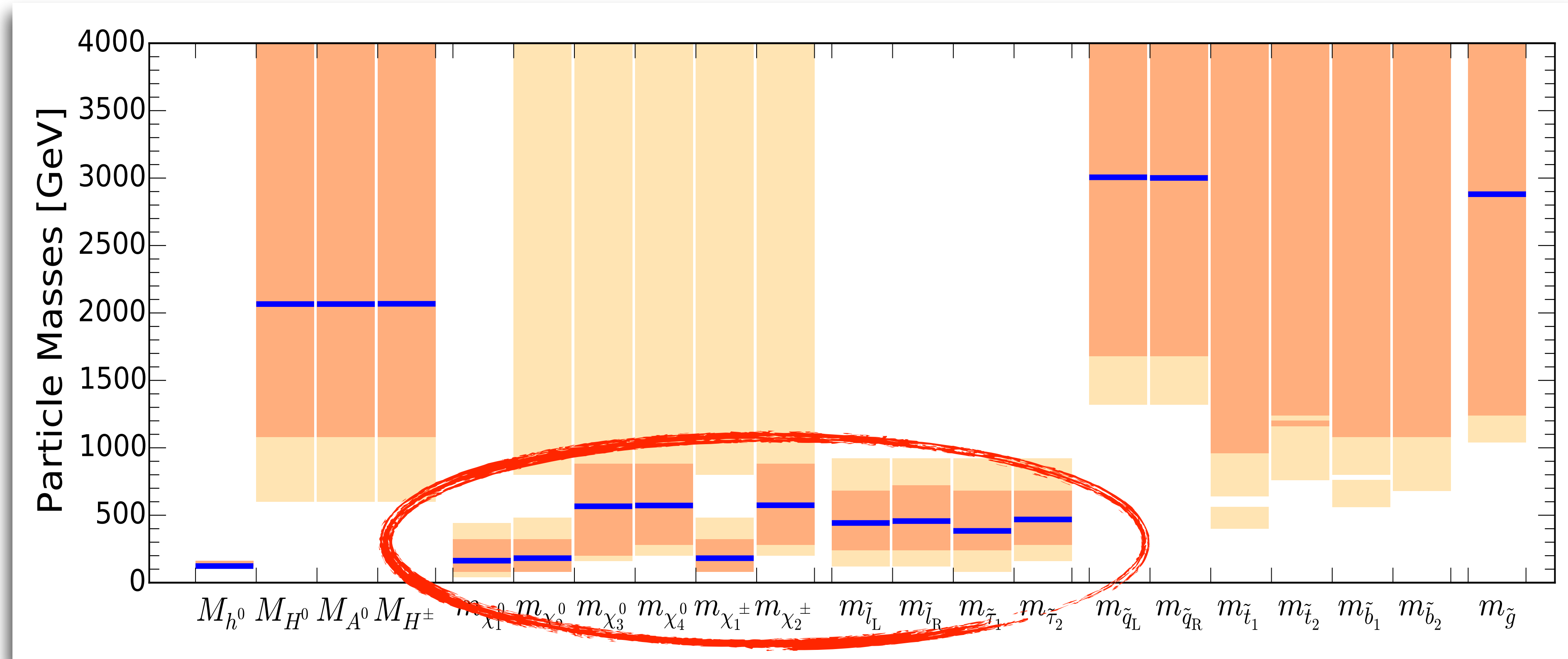
Best Fit



Parameter	Best-fit
M_1	170 GeV
M_2	170 GeV
M_3	2600 GeV
$m_{\tilde{q}}$	2880 GeV
$m_{\tilde{q}_3}$	4360 GeV
$m_{\tilde{l}}$	440 GeV
M_A	2070 GeV
A	790 GeV
μ	550 GeV
$\tan\beta$	37.6



Best Fit



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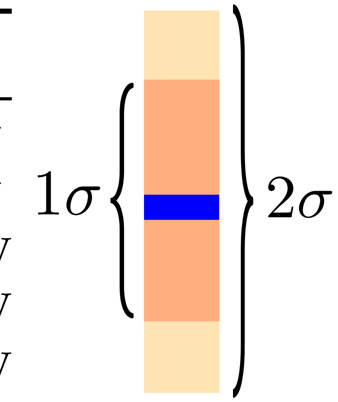


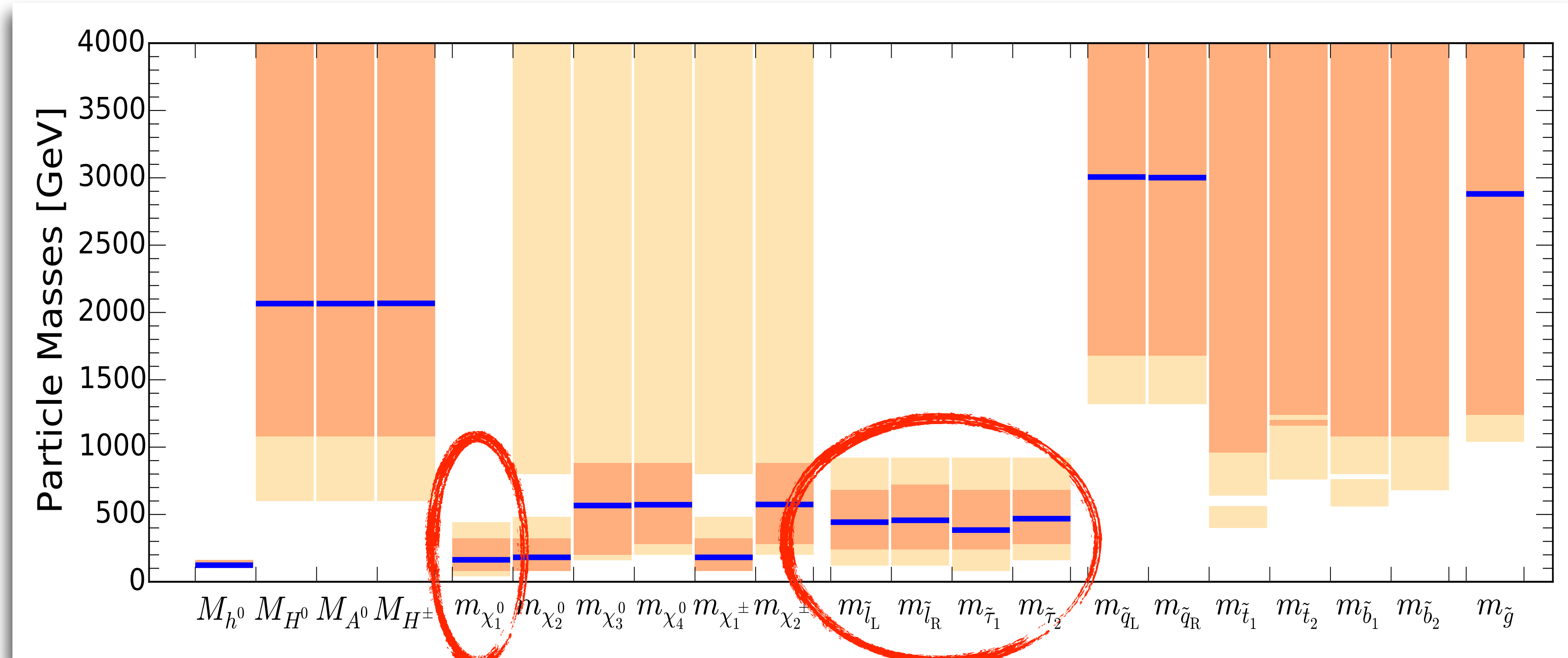
“prediction”

1σ: $|\mu| < 1\,\text{TeV}$

$M_1 \simeq M_2 < 500\,\text{GeV}$

$m_{\tilde{\ell}} < 1\,\text{TeV}$

Best Fit



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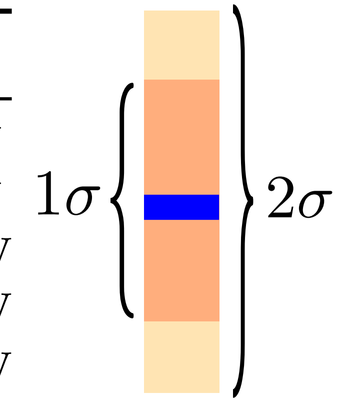
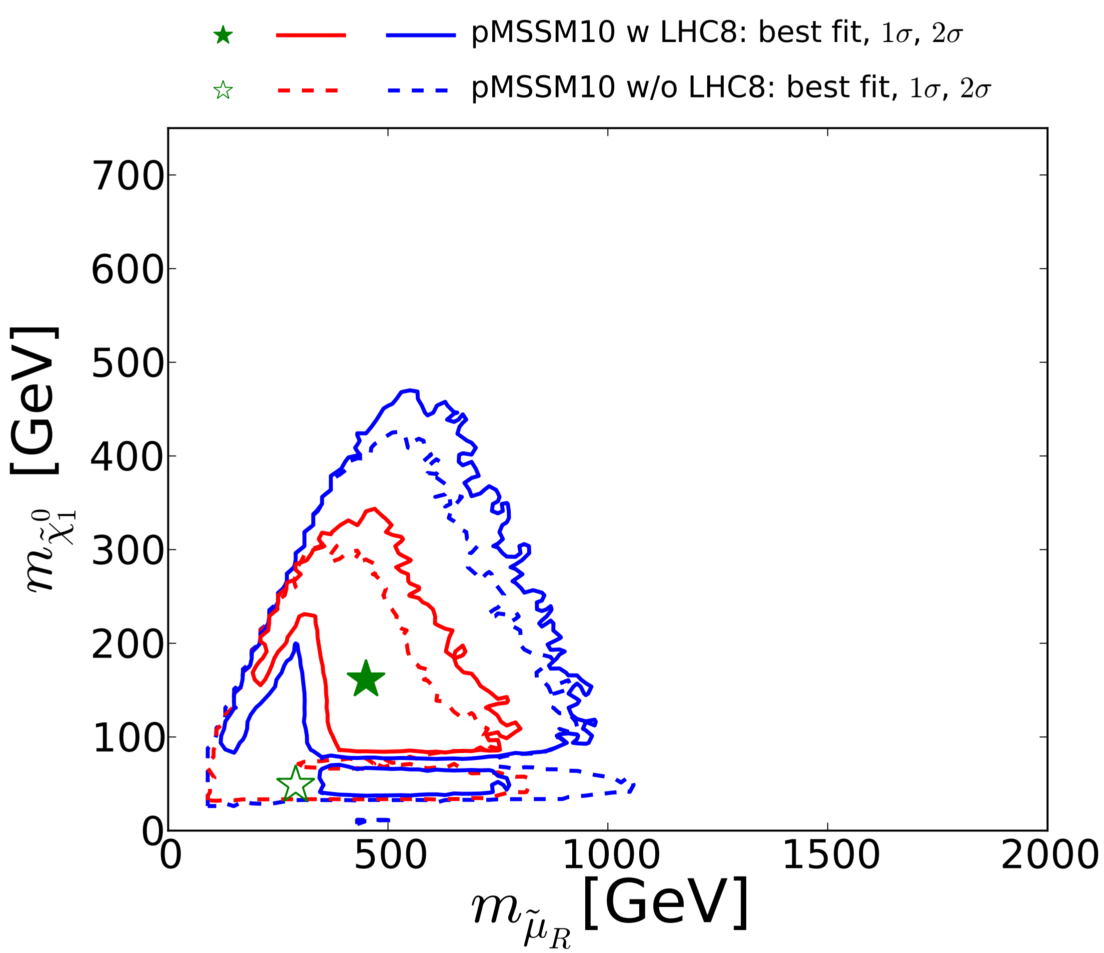




"prediction"

1σ: $|\mu| < 1\,\text{TeV}$

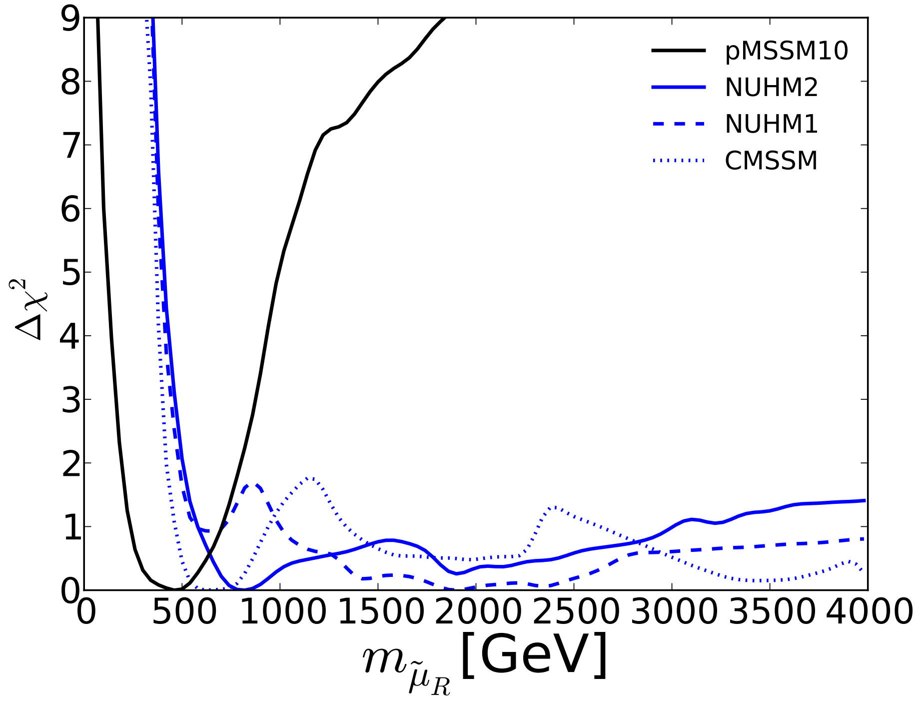
$M_1 \simeq M_2 < 500\,\text{GeV}$

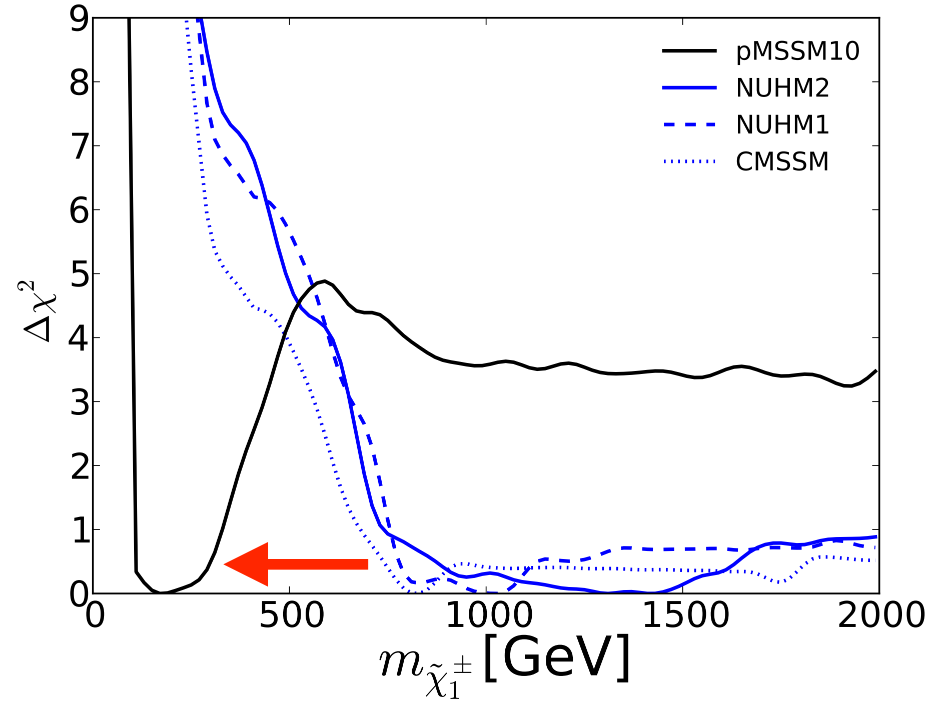
$m_{\tilde{\ell}} < 1\,\text{TeV}$

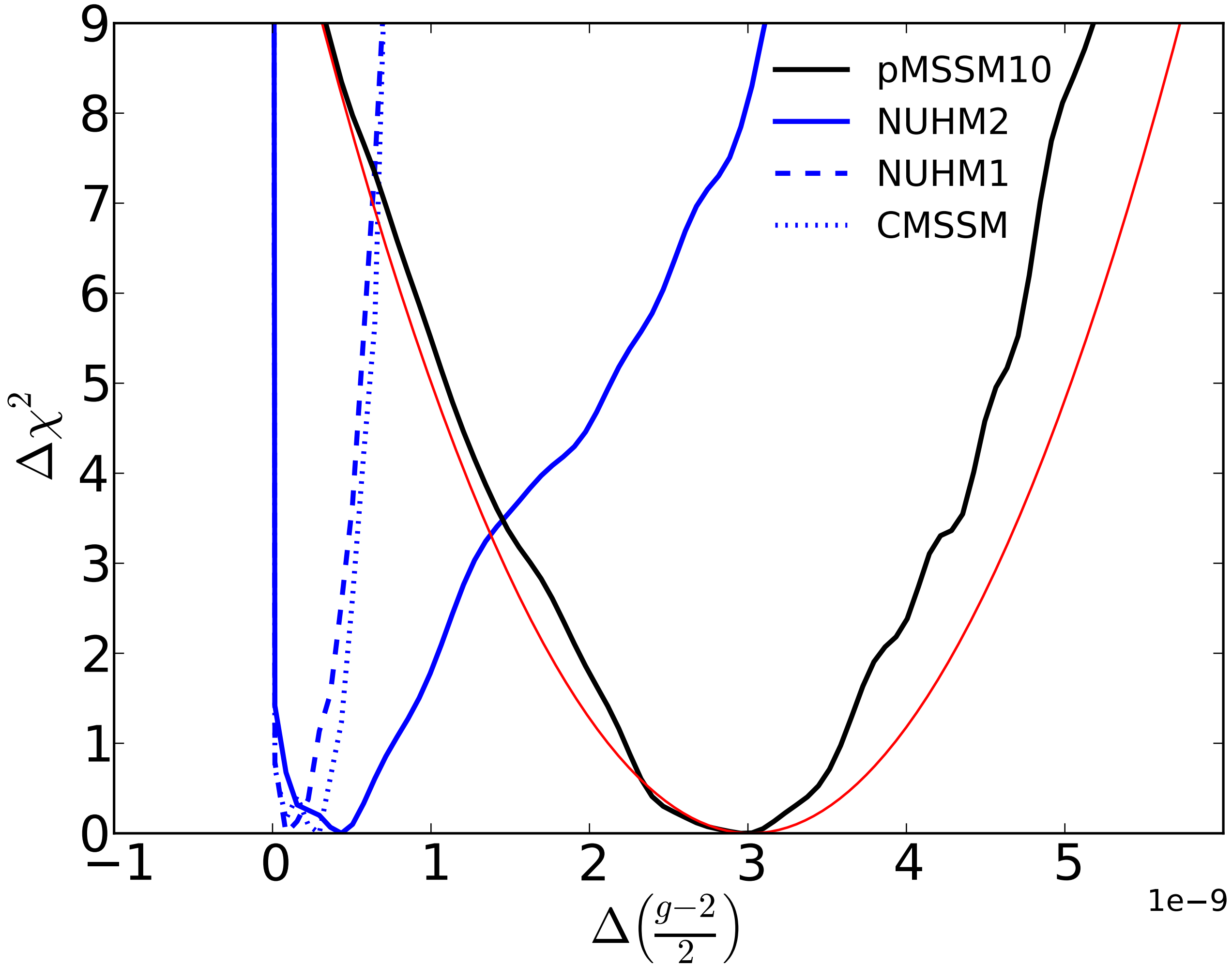
2σ: $M_1 < 500\,\text{GeV}$

$m_{\tilde{\ell}} < 1\,\text{TeV}$

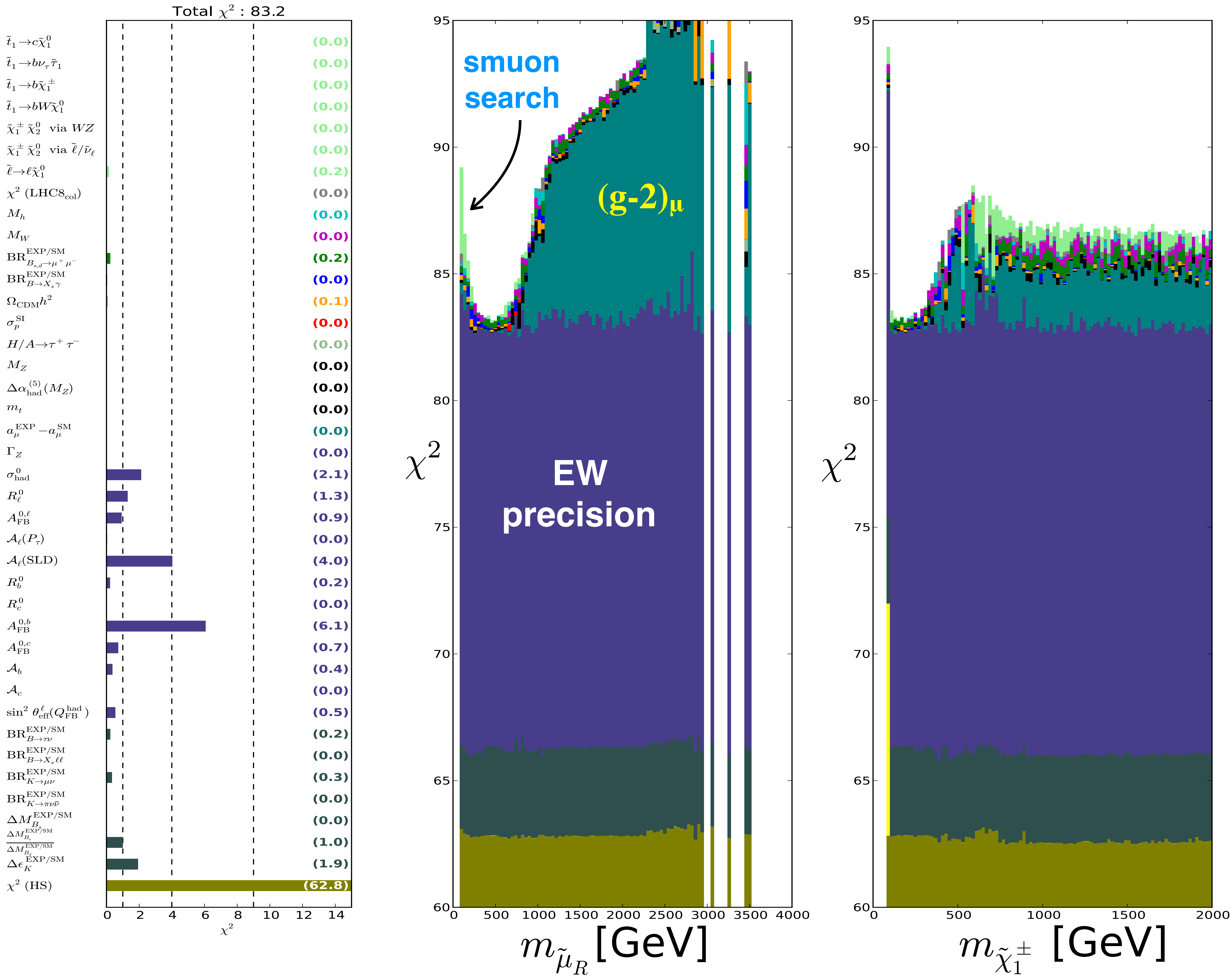
(g-2)μ





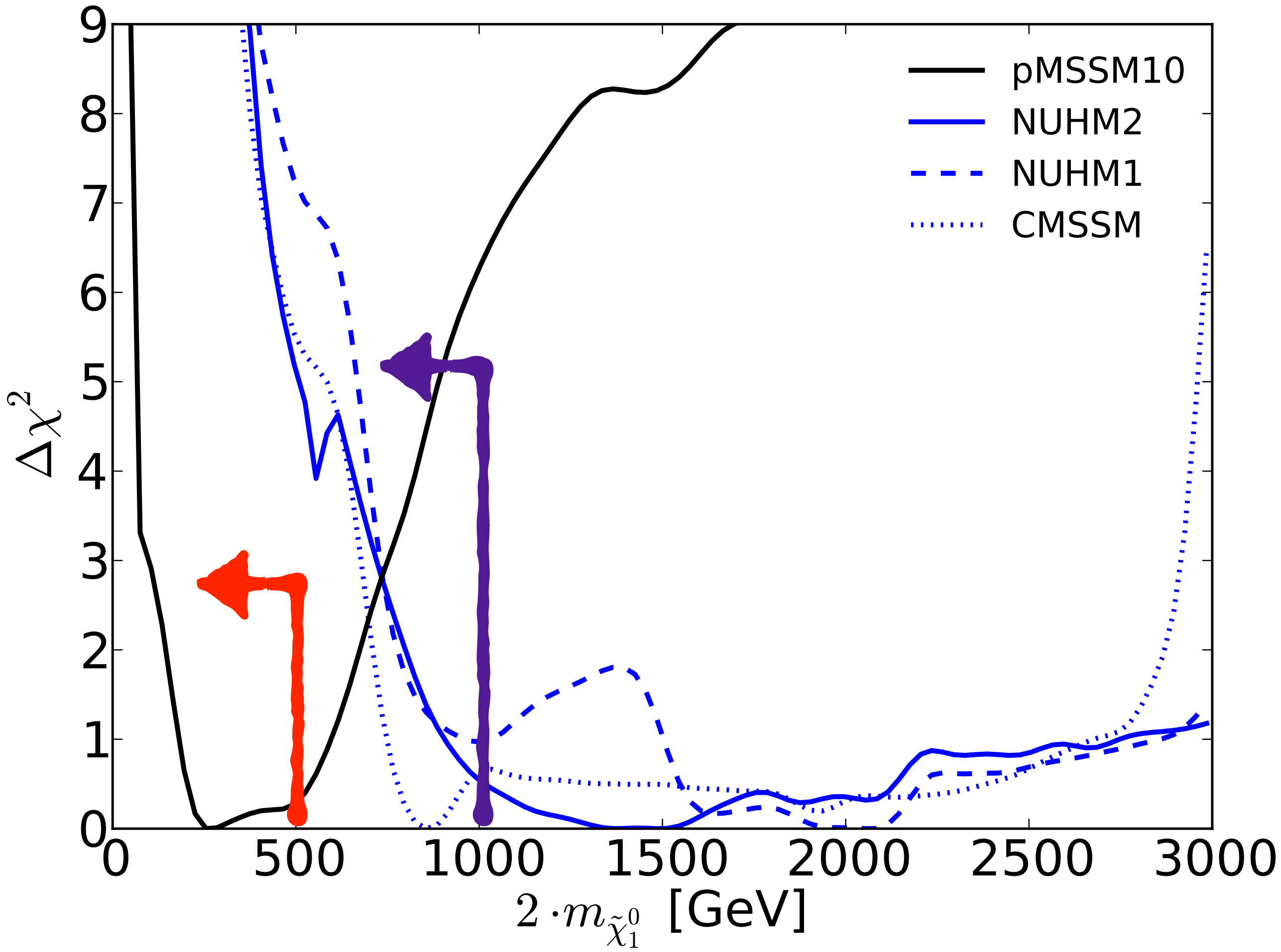


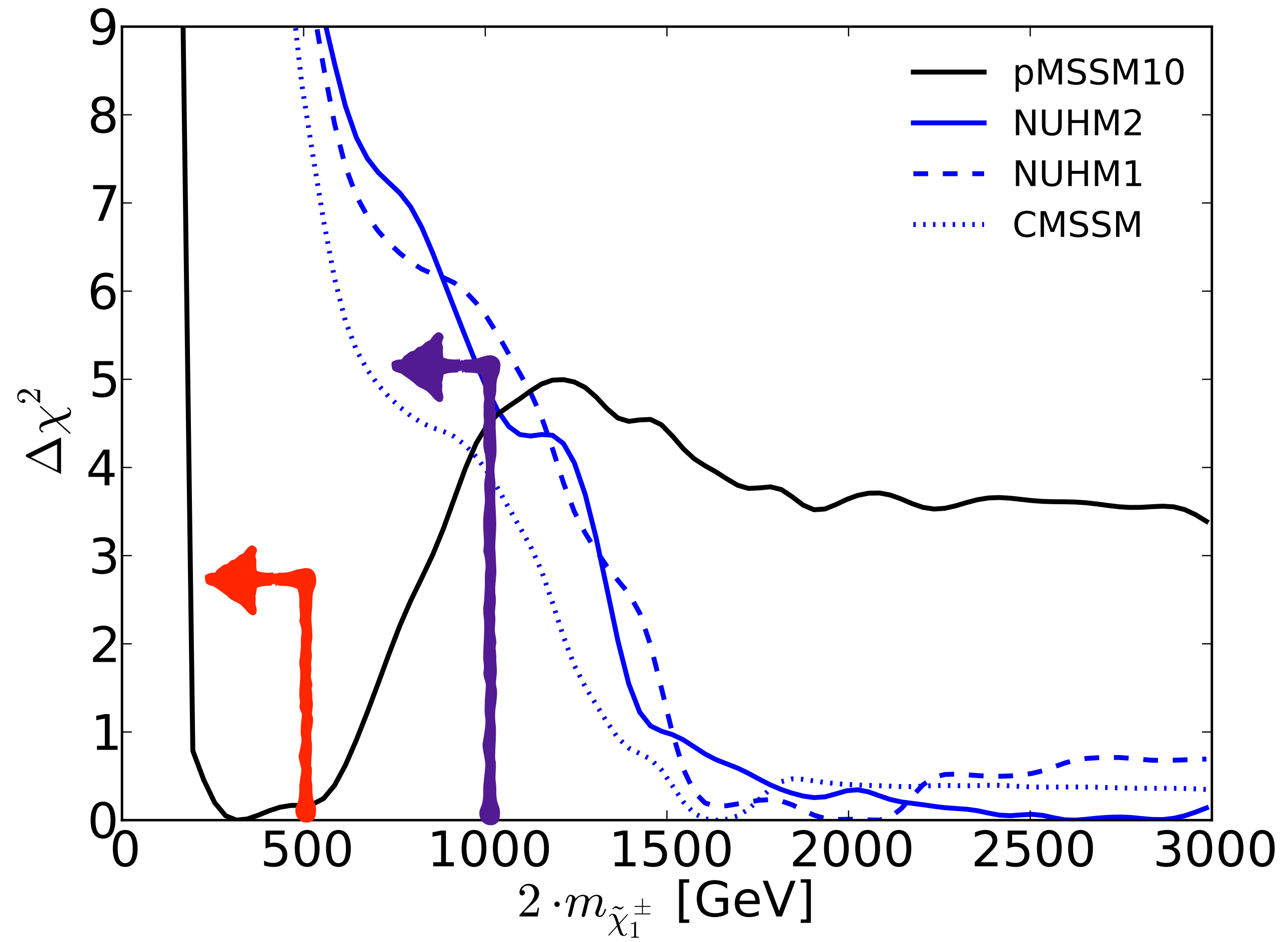
$(g\text{-}2)_\mu$ anomaly can be explained without tension from the LHC limit.



Total χ^2 : 83.2
$\tilde{t}_1 \to c\tilde{\chi}_1^0$ (0.0)
$\tilde{t}_1 \to b\nu_\tau\tilde{\tau}_1$ (0.0)
$\tilde{t}_1 \to b\tilde{\chi}_1^\pm$ (0.0)
$\tilde{t}_1 \to bW\tilde{\chi}_1^0$ (0.0)
$\tilde{\chi}_1^\pm\tilde{\chi}_2^0$ via WZ (0.0)
$\tilde{\chi}_1^\pm\tilde{\chi}_2^0$ via $\tilde{\ell}/\tilde{\nu}_\ell$ (0.0)
$\tilde{\ell} \to \ell\tilde{\chi}_1^0$ (0.2)
χ^2 (LHC8$_{\rm col}$) (0.0)
M_h (0.0)
M_W (0.0)
$\mathrm{BR}^{\rm EXP/SM}_{B_{s,d}\to\mu^+\mu^-}$ (0.2)
$\mathrm{BR}^{\rm EXP/SM}_{B\to X_s\gamma}$ (0.0)
$\Omega_{\rm CDM}h^2$ (0.1)
$\sigma_p^{\rm SI}$ (0.0)
$H/A \to \tau^+\tau^-$ (0.0)
M_Z (0.0)
$\Delta\alpha^{(5)}_{\rm had}(M_Z)$ (0.0)
m_t (0.0)
$a_\mu^{\rm EXP} - a_\mu^{\rm SM}$ (0.0)
Γ_Z (0.0)
$\sigma^0_{\rm had}$ (2.1)
R^0_ℓ (1.3)
$A^{0,\ell}_{\rm FB}$ (0.9)
$\mathcal{A}_\ell(P_\tau)$ (0.0)
$\mathcal{A}_\ell$(SLD) (4.0)
R^0_b (0.2)
R^0_c (0.0)
$A^{0,b}_{\rm FB}$ (6.1)
$A^{0,c}_{\rm FB}$ (0.7)
$\mathcal{A}_b$ (0.4)
$\mathcal{A}_c$ (0.0)
$\sin^2\theta^\ell_{\rm eff}(Q^{\rm had}_{\rm FB})$ (0.5)
$\mathrm{BR}^{\rm EXP/SM}_{B\to\tau\nu}$ (0.2)
$\mathrm{BR}^{\rm EXP/SM}_{B\to X_s\ell\ell}$ (0.0)
$\mathrm{BR}^{\rm EXP/SM}_{K\to\mu\nu}$ (0.3)
$\mathrm{BR}^{\rm EXP/SM}_{K\to\pi\nu\bar{\nu}}$ (0.0)
$\Delta M^{\rm EXP/SM}_{B_s}$ (0.0)
$\frac{\Delta M^{\rm EXP/SM}_{B_s}}{\Delta M^{\rm EXP/SM}_{B_d}}$ (1.0)
$\Delta\epsilon^{\rm EXP/SM}_K$ (1.9)
χ^2 (HS) (62.8)
0 2 4 6 8 10 12 14
χ^2
smuon search
(g-2)$_\mu$
EW precision
χ^2
$m_{\tilde{\mu}_R}$ [GeV]
χ^2
$m_{\tilde{\chi}_1^\pm}$ [GeV]

Discovery @ ILC

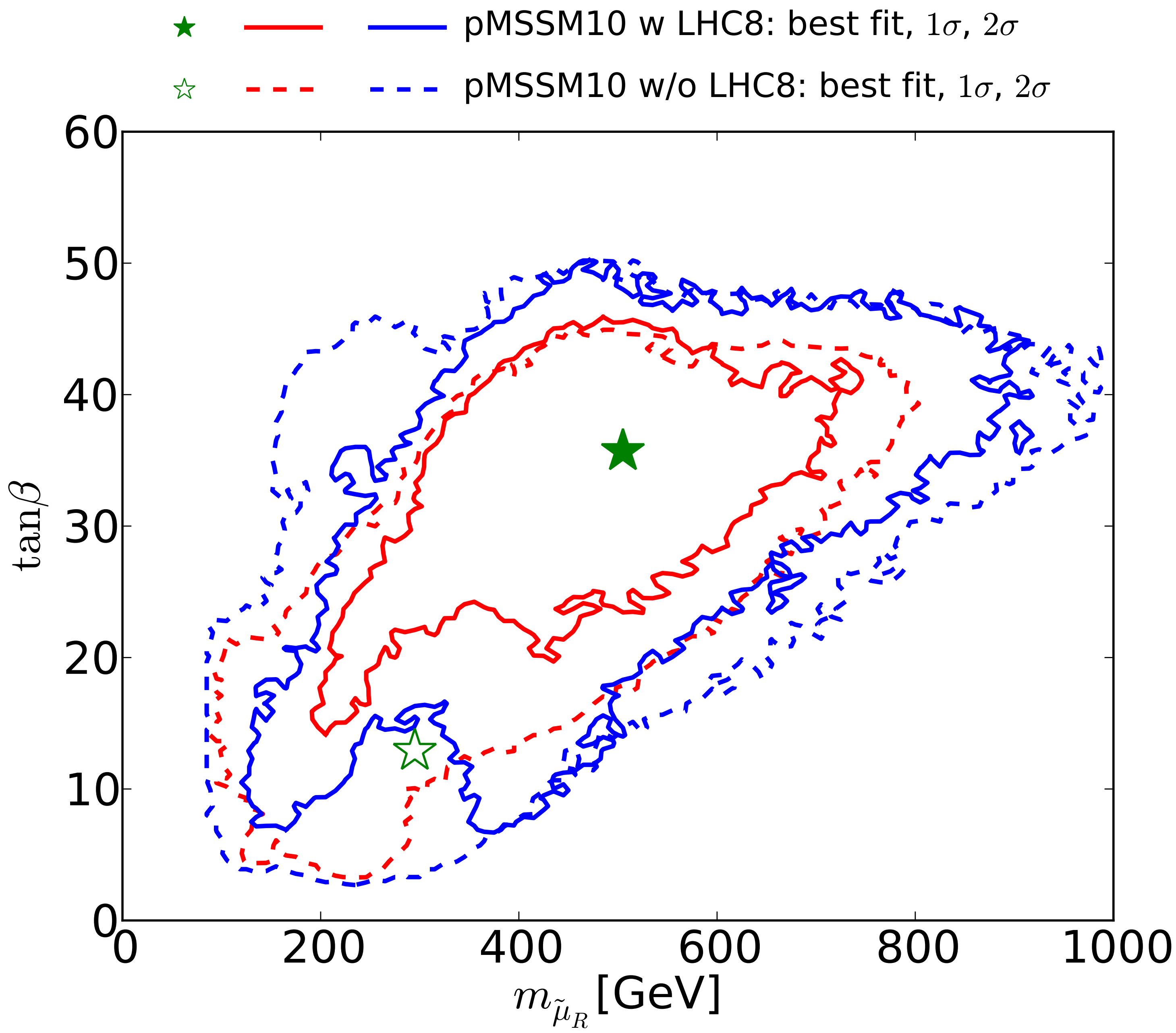




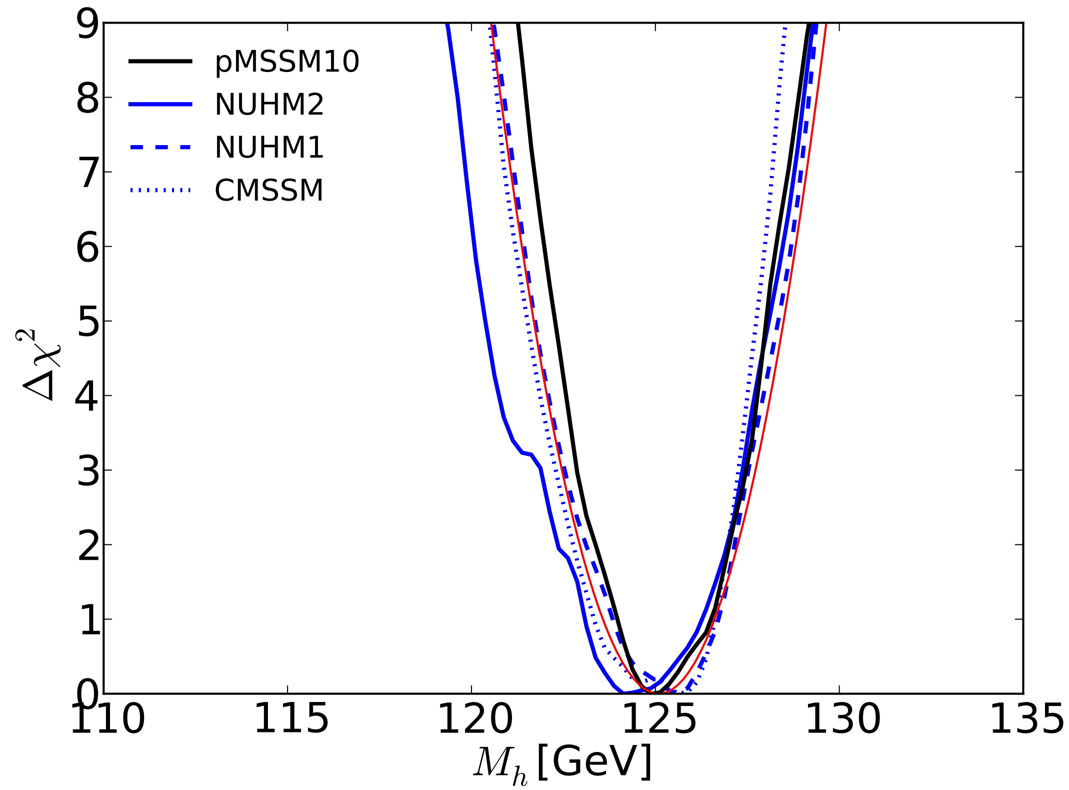
- The 500 GeV ILC can explore a large part of the low χ^2 region.
- The 1 TeV ILC can explore the low χ^2 region.

tanβ

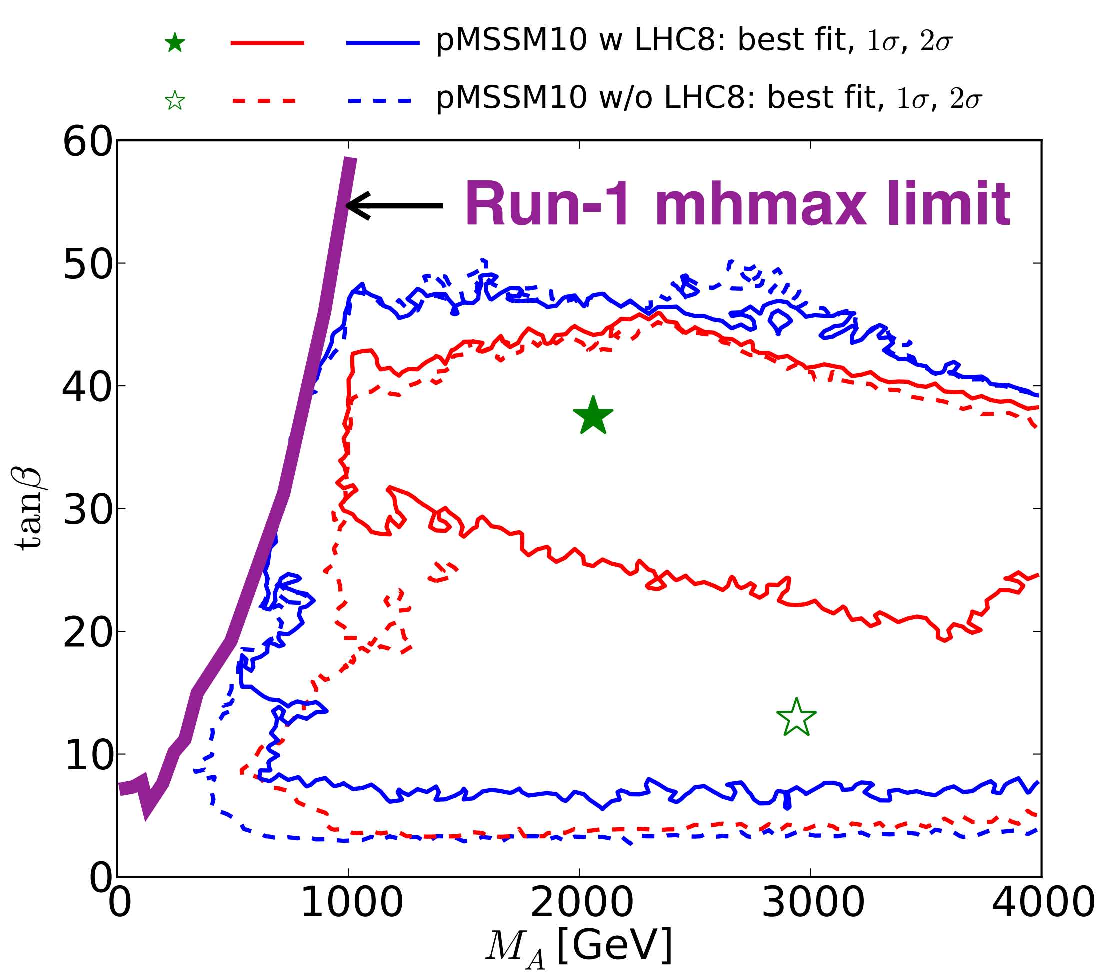
$$\delta a_\mu \sim 1.3 \times 10^{-9} \left(\frac{100\,\mathrm{GeV}}{m_{\mathrm{SUSY}}}\right)^2 \tan\beta$$



Higgses

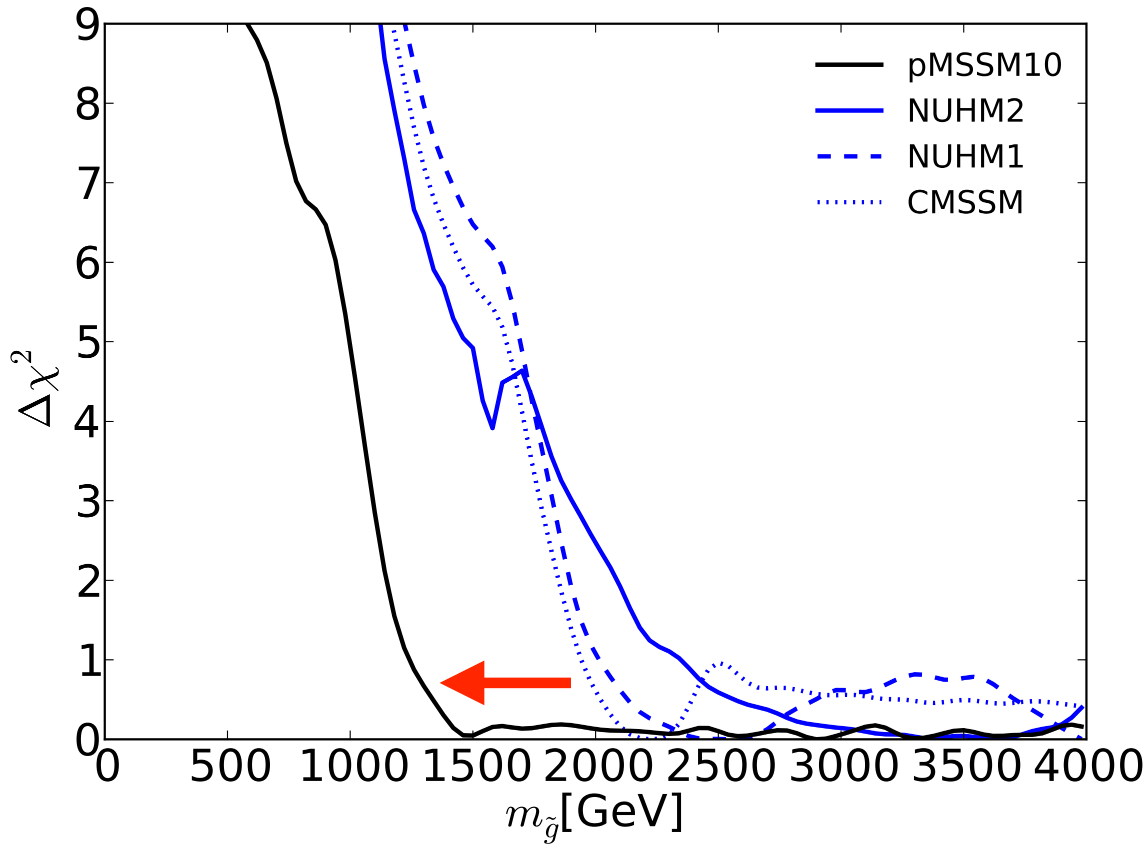


No tension with the Higgs mass



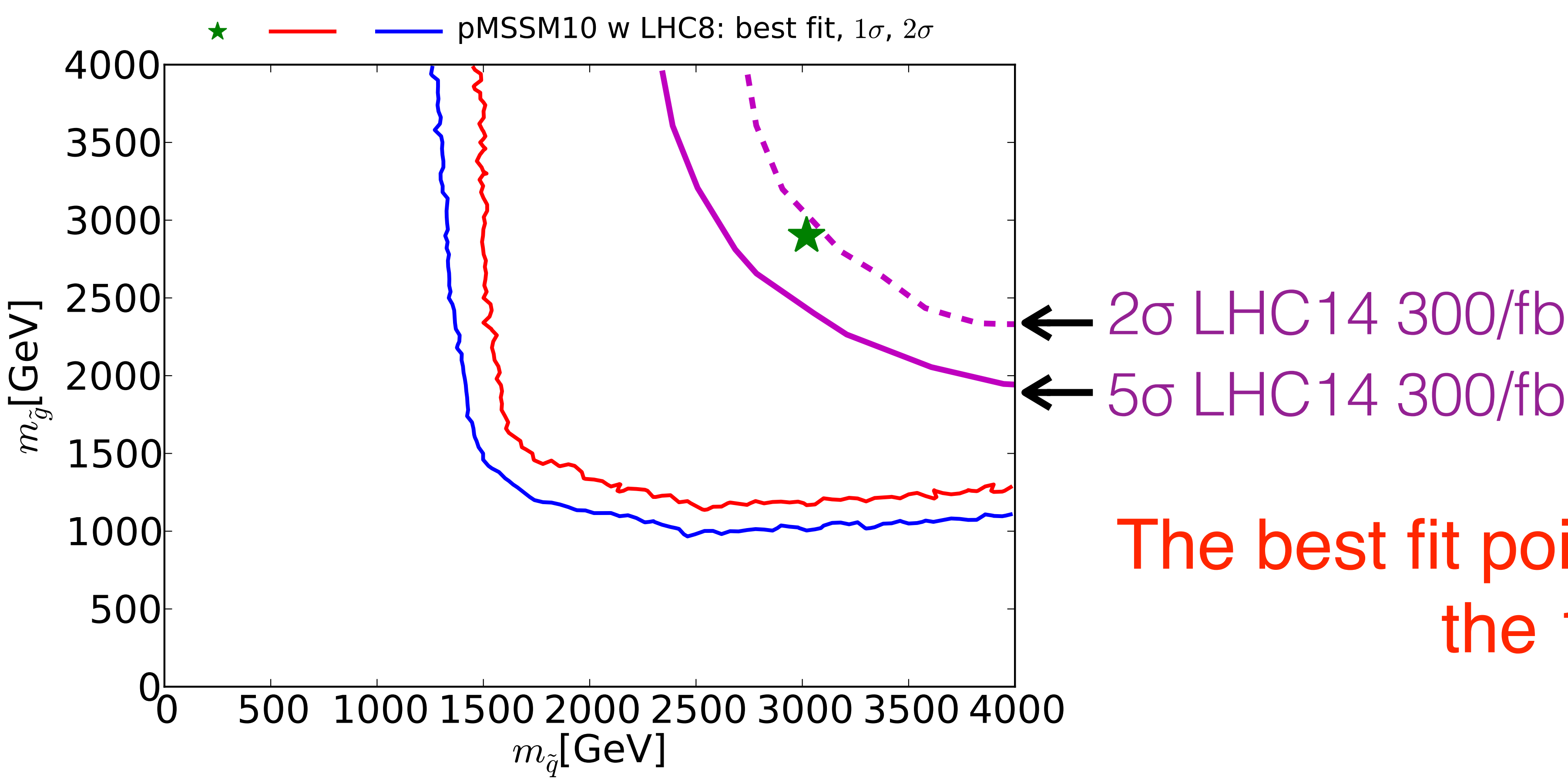
Heavy Higgses may be around the corner

Gluinos



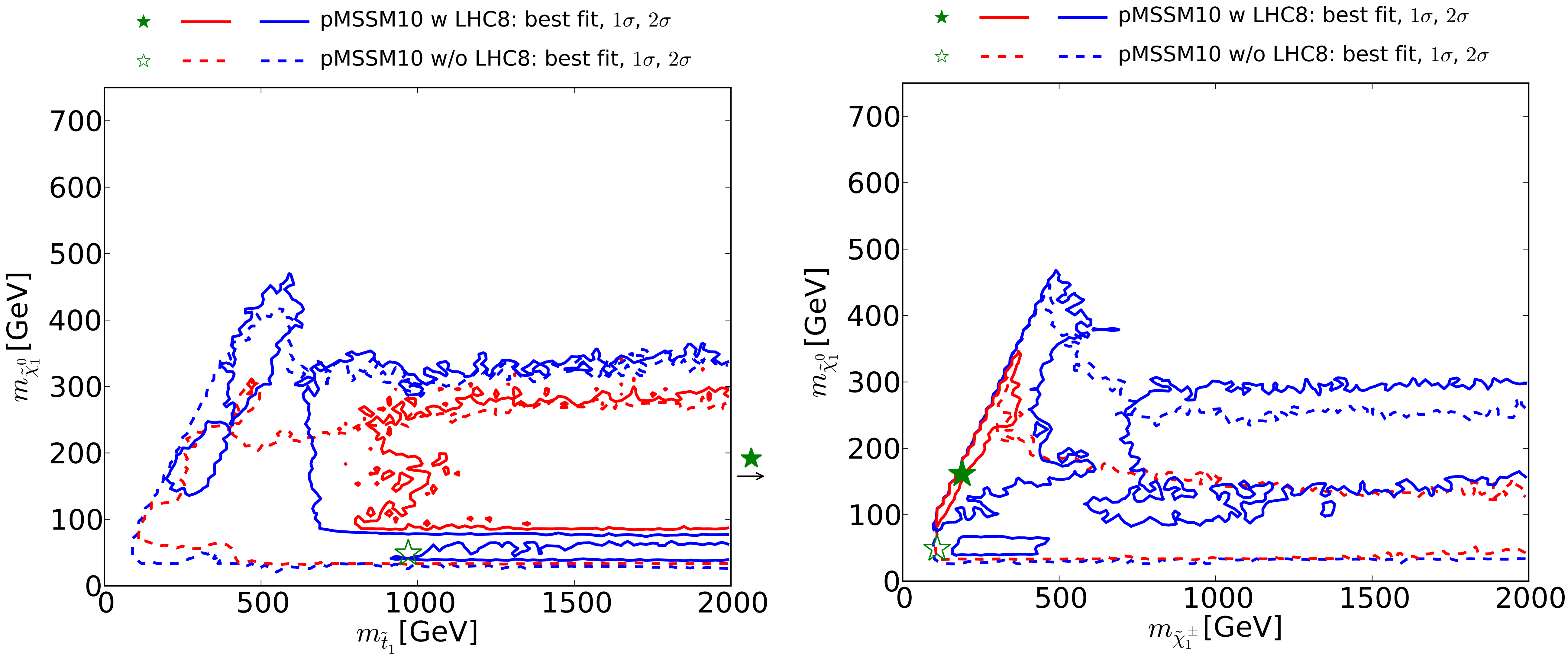
squarks can be decoupled from the gluino production

gluino mass can be as light as 1.2 TeV



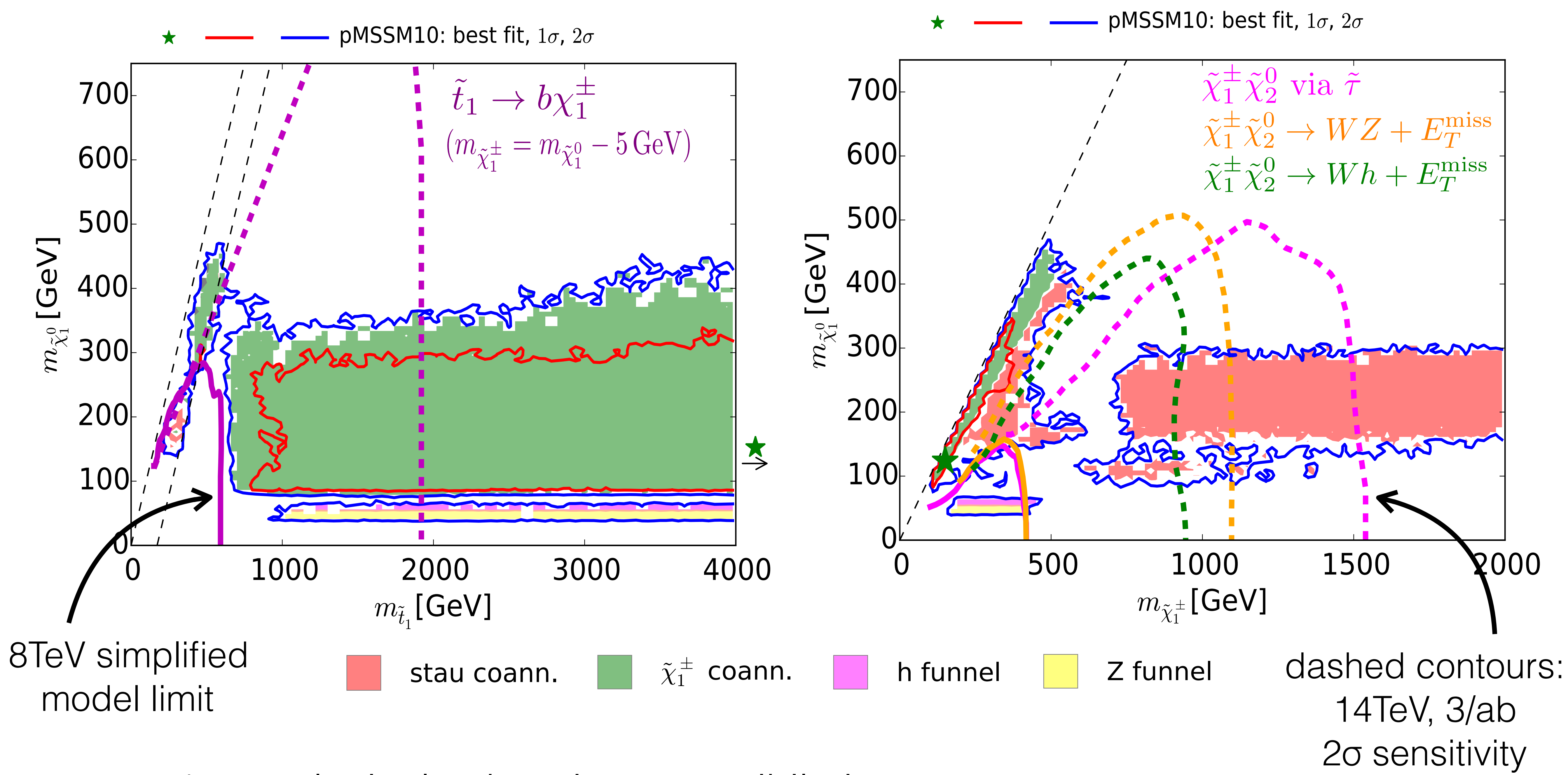
The best fit point can be explored by the 14TeV LHC

Stop, Chargino



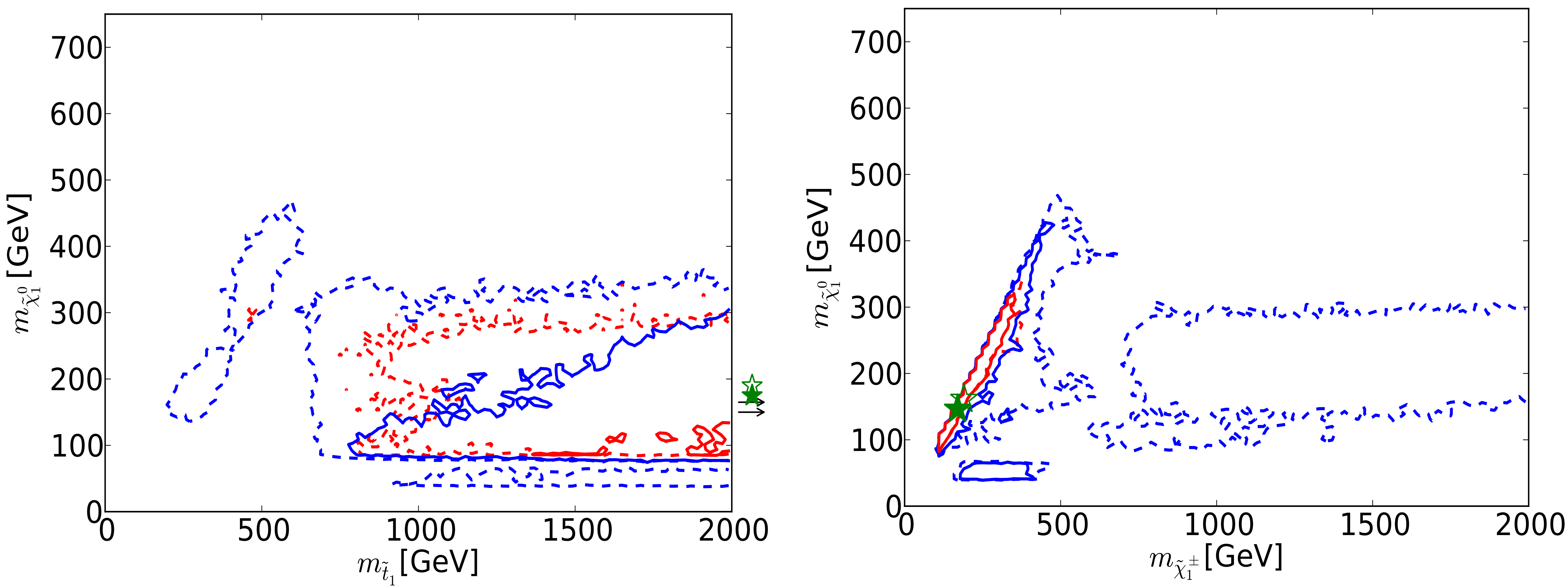
- Light stop (<500GeV) @ 2σ
- Stop mass > 800GeV @ 1σ ← after LHC constraints
- Chargino1 ~ Neutralino1 @ 1σ ← after LHC constraints

Stop, Chargino



- 1σ: exclusively chargino coannihilation
- 2σ: stau coannihilation, h/Z funnel
- large part of stau and funnel regions will be explored at LHC

No Tachyon @ GUT scale

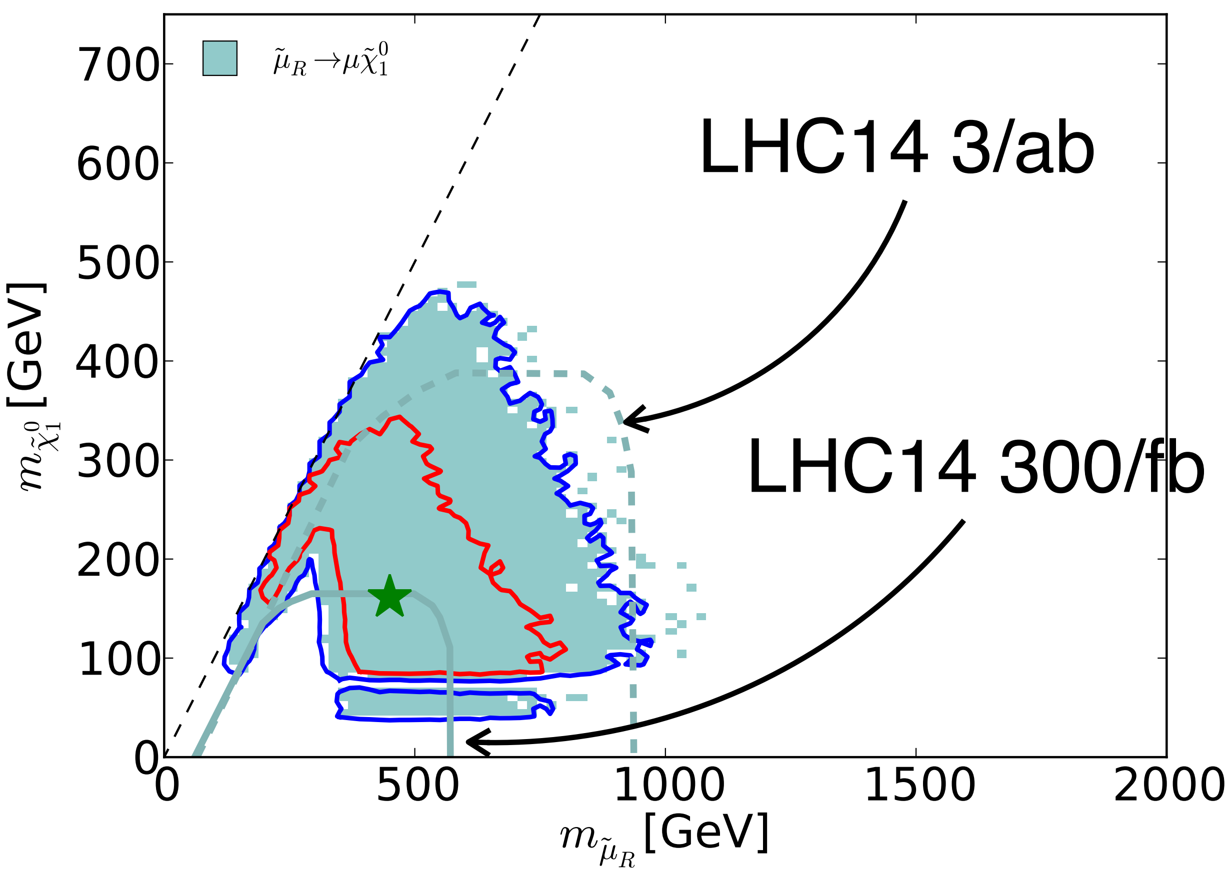


Require **no negative m² at GUT scale**

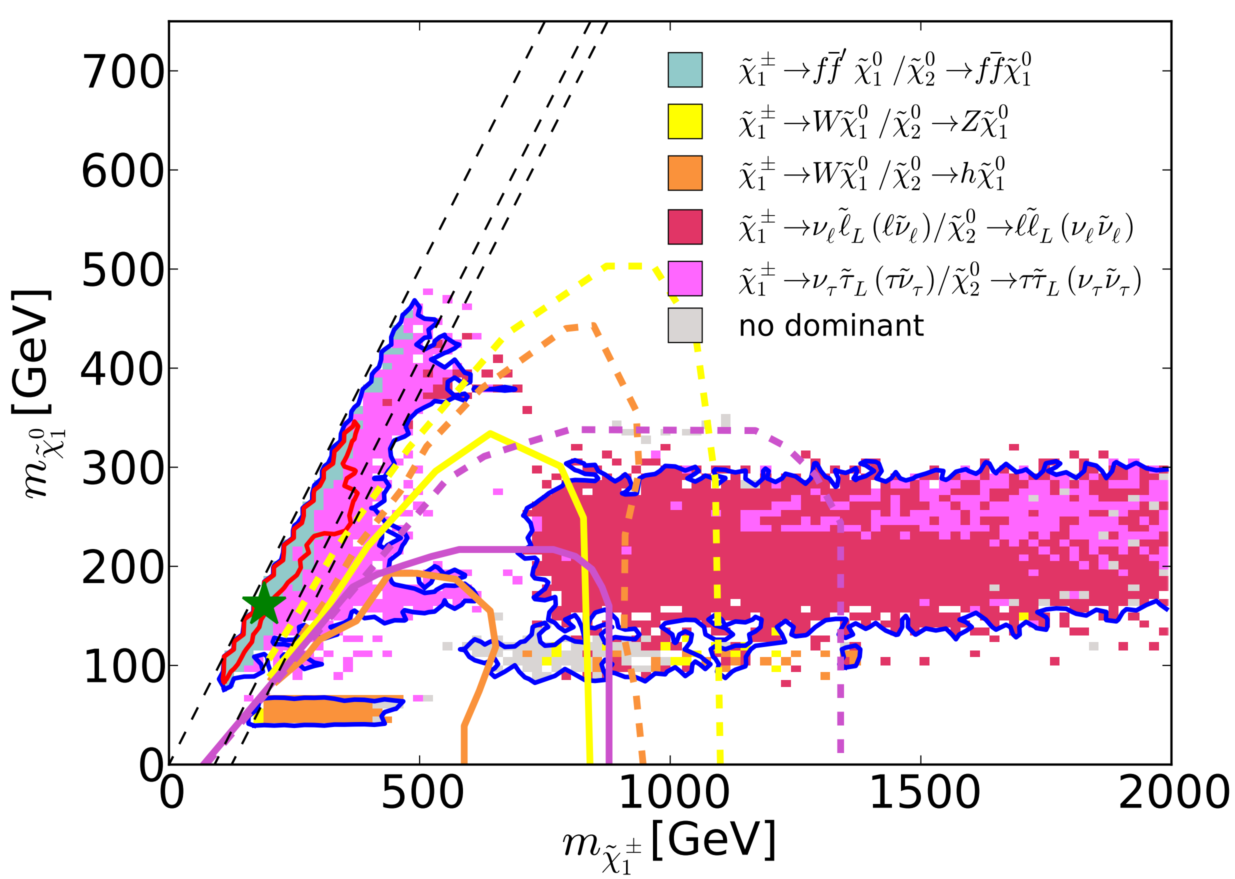
→ excludes small sfermion masses at low energy

- Stop mass > 800GeV @ 2σ
- Chargino1 ~ Neutralino1 @ 2σ

LHC Run-2

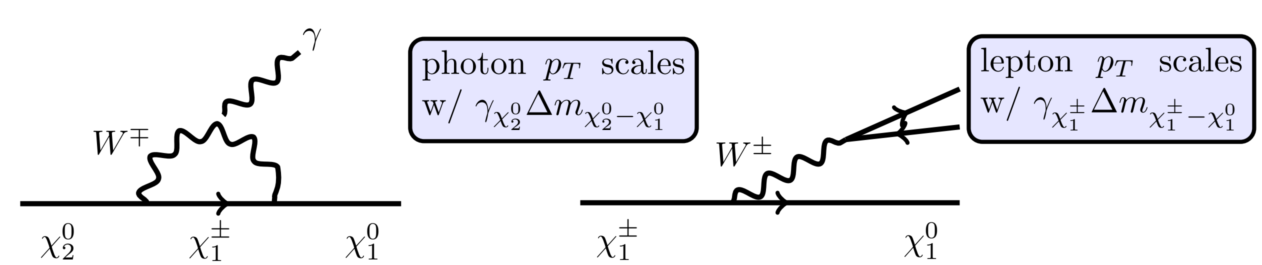


HL-LHC can cover most of the 2σ region



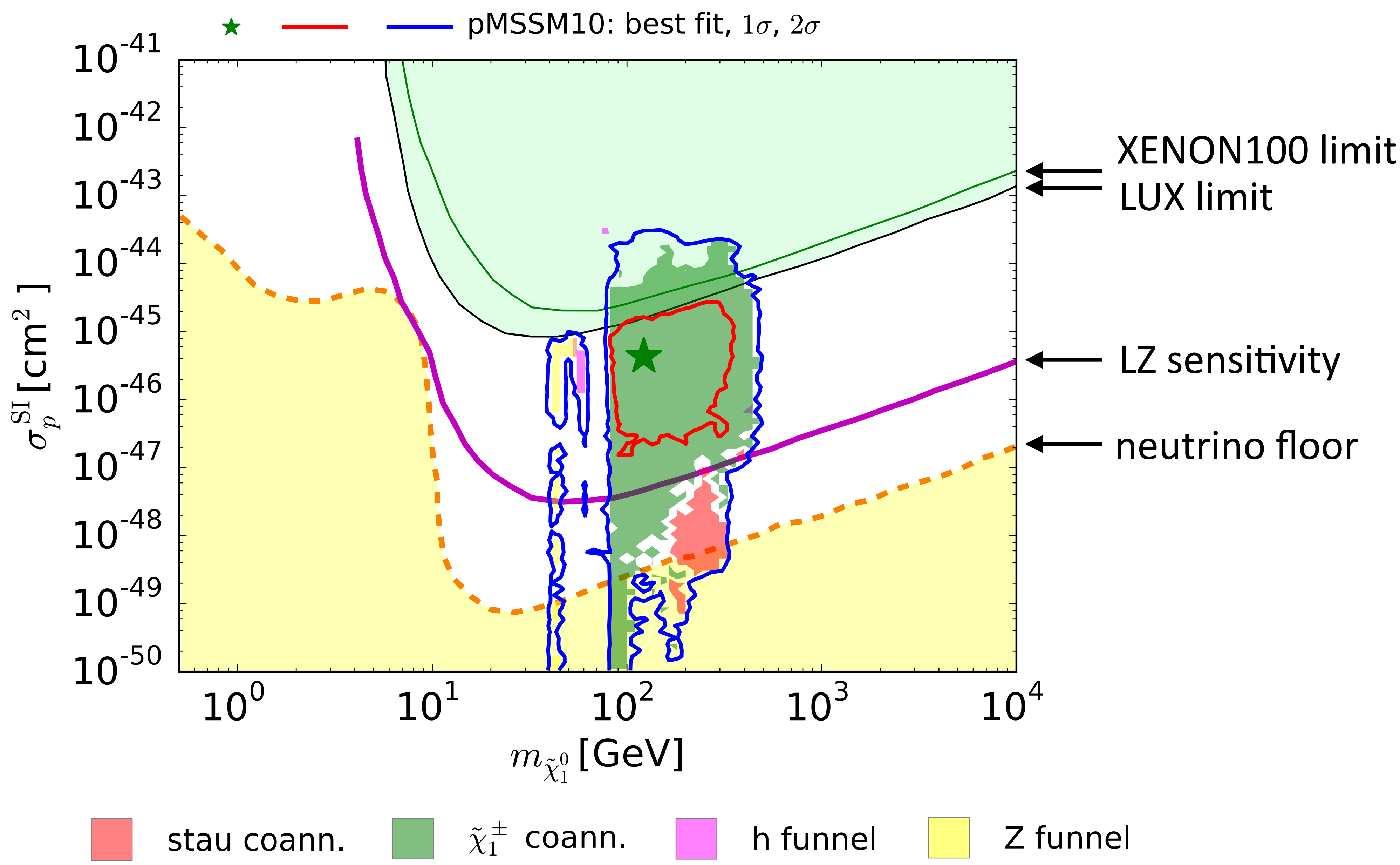
standard searches are not sensitive to the 1σ region

should look for soft objects



J.Bramante, et al. 1412.4789

DM direct detection



- 1σ: will be explored by LZ
- complementarity with the LHC SUSY searches

Summary

Global fit

tells us the status of models

helps us to come up with strategy of discovery

becomes more important after the discovery

Summary

pMSSM 10 fit

sampled 10^9 points

fast calculation of LHC limit

Result

	χ^2/n_{dof}	p-value
CMSSM	32.8/24	11 %
NUHM1	31.1/23	12 %
NUHM2	30.3/22	11 %
pMSSM10	20.5/18	31 %

pMSSM10 looks healthy

- ☑ Higgs
- ☑ Dark Matter
- ☑ $(g\text{-}2)_\mu$
- ☑ LHC SUSY limit

Implication

- $M_1 < 500$GeV, $M_{slepton} < 1$TeV @ 2σ
- Chargino1 ~ Neutralino1 @ 1σ

HL-LHC and **LZ** DM detection can explore the preferred region!