"Tell me that you have found no sign of
New Physics again, I dare you.
I double dare you. Tell me
one more goddamn time!"

Constraints on the SUSY Landscape from $(g-2)_\mu$ Measurements

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zoom, 11/2021

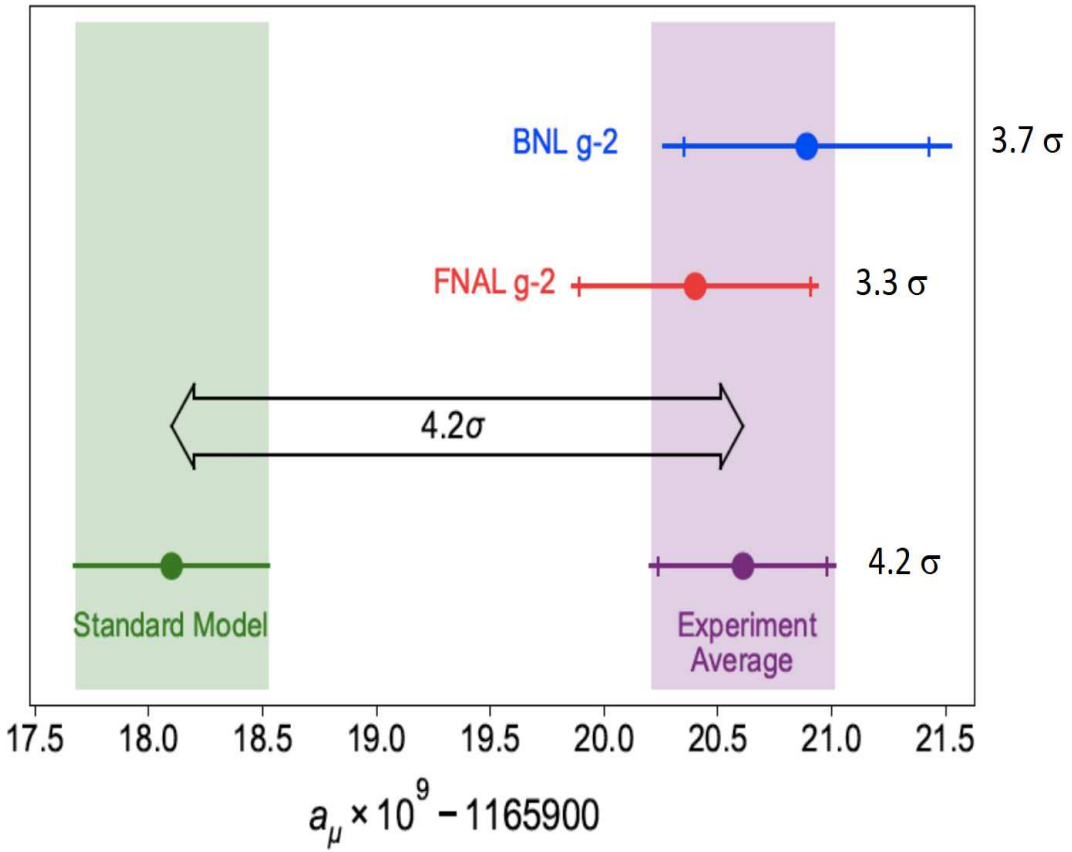
(mainly) with *Manimala Chakraborti* and *Ipsita Saha*

- Introduction
- Experimental constraints (LHC and more)
- Results for (nearly) all MSSM scenarios
- Implications for future LHC Runs?
- Conclusions

1. Introduction

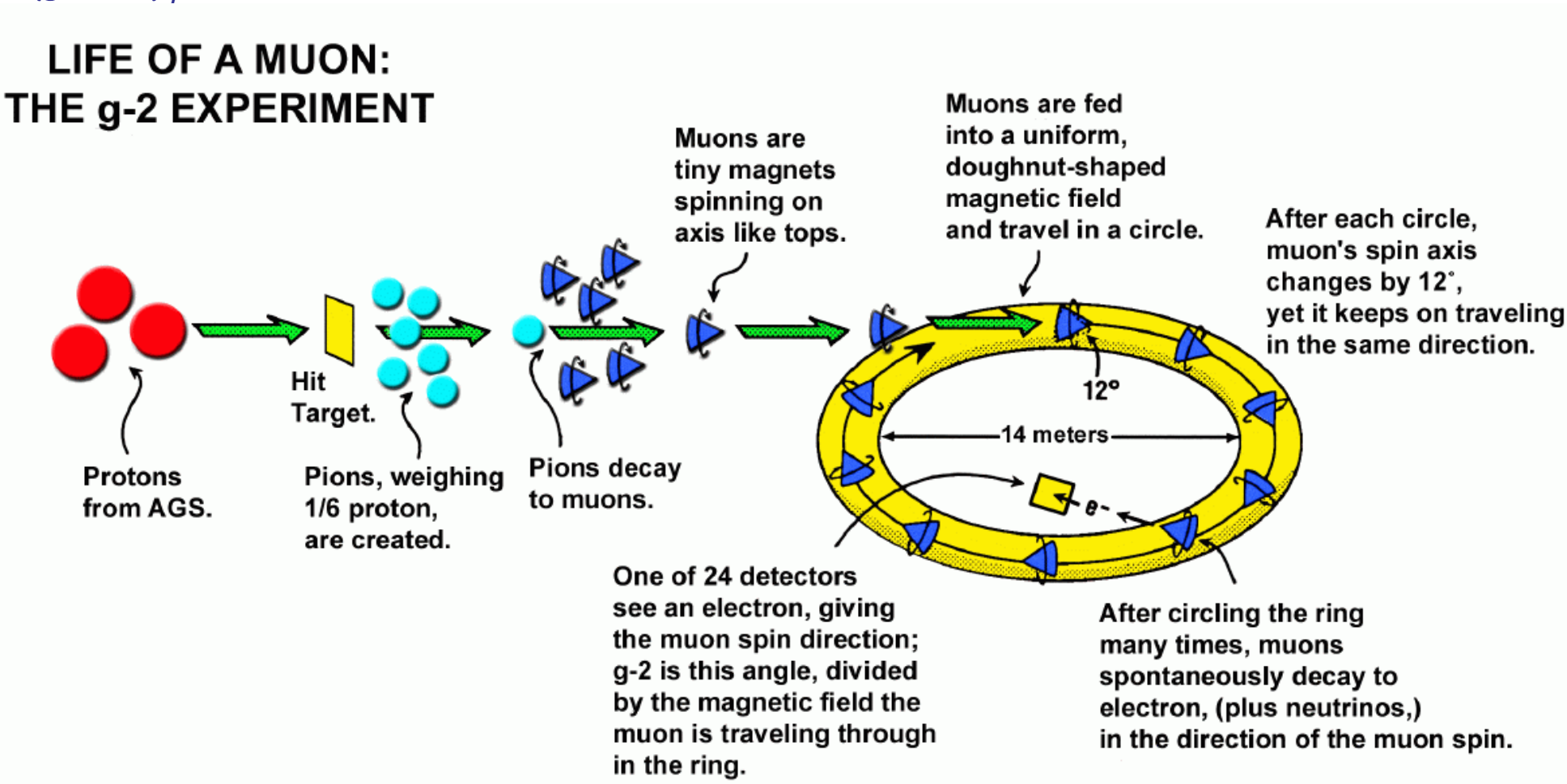
The anomalous magnetic moment of the muon: $a_\mu \equiv (g-2)_\mu/2$

Overview about the current experimental and SM (theory) result:



$$a_\mu^{\text{exp}} - a_\mu^{\text{theo,SM}} \approx (25.1 \pm 5.9) \times 10^{-10} \quad : 4.2\,\sigma$$

The $(g-2)_\mu$ experiment:

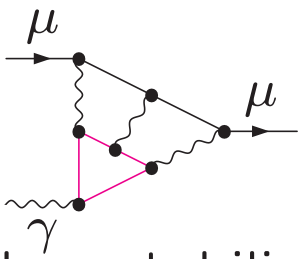


Coupling of muon to magnetic field : $\mu - \mu - \gamma$ coupling

$$\bar{u}(p')\left[\gamma^\mu F_1(q^2) + \frac{i}{2m_\mu}\sigma^{\mu\nu}q_\nu F_2(q^2)\right]u(p)A_\mu \qquad F_2(0) = a_\mu$$

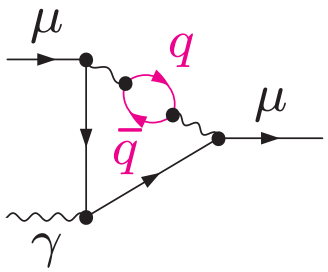
Theory of $(g-2)_\mu$:

– the light-by-light contribution:



2002: sign error discovered; since then stabilized
2021: confirmed by LQCD

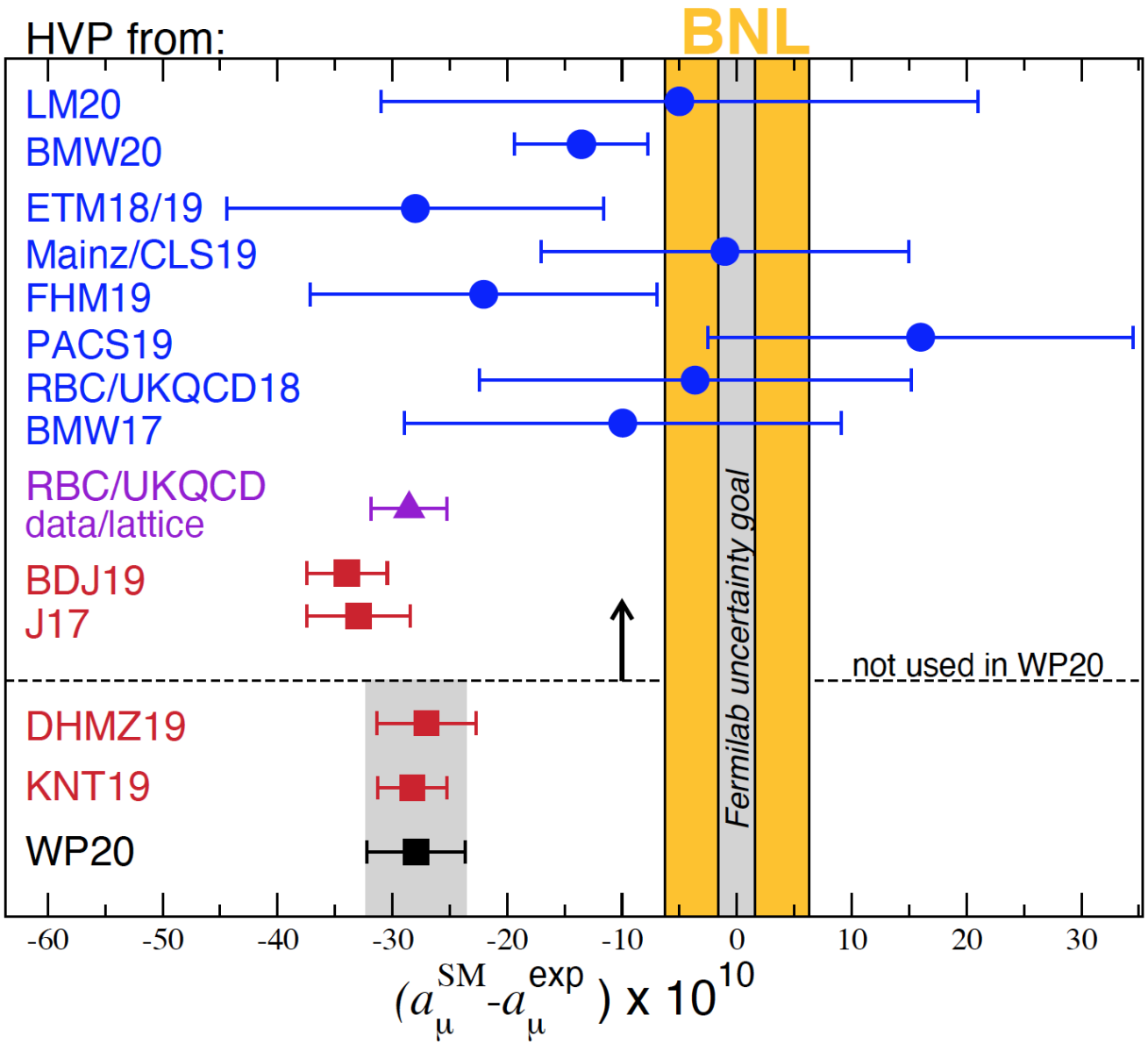
– the hadronic vacuum contribution:



'direct' e^+e^- data:
from CMD-II, SND, KLOE, BaBar (radiative return)
$\Rightarrow$ agree relarively well (also with old e^+e^- data)
$\Rightarrow$ tension with LQCD results

τ data:
tended to be closer to experimental result
inclusion of γ-ρ mixing: agreement with e^+e^- [*F. Jegerlehner, R. Szafron '10*]
$\Rightarrow$ still under discussion . . . $\Rightarrow$ effectively not used anymore

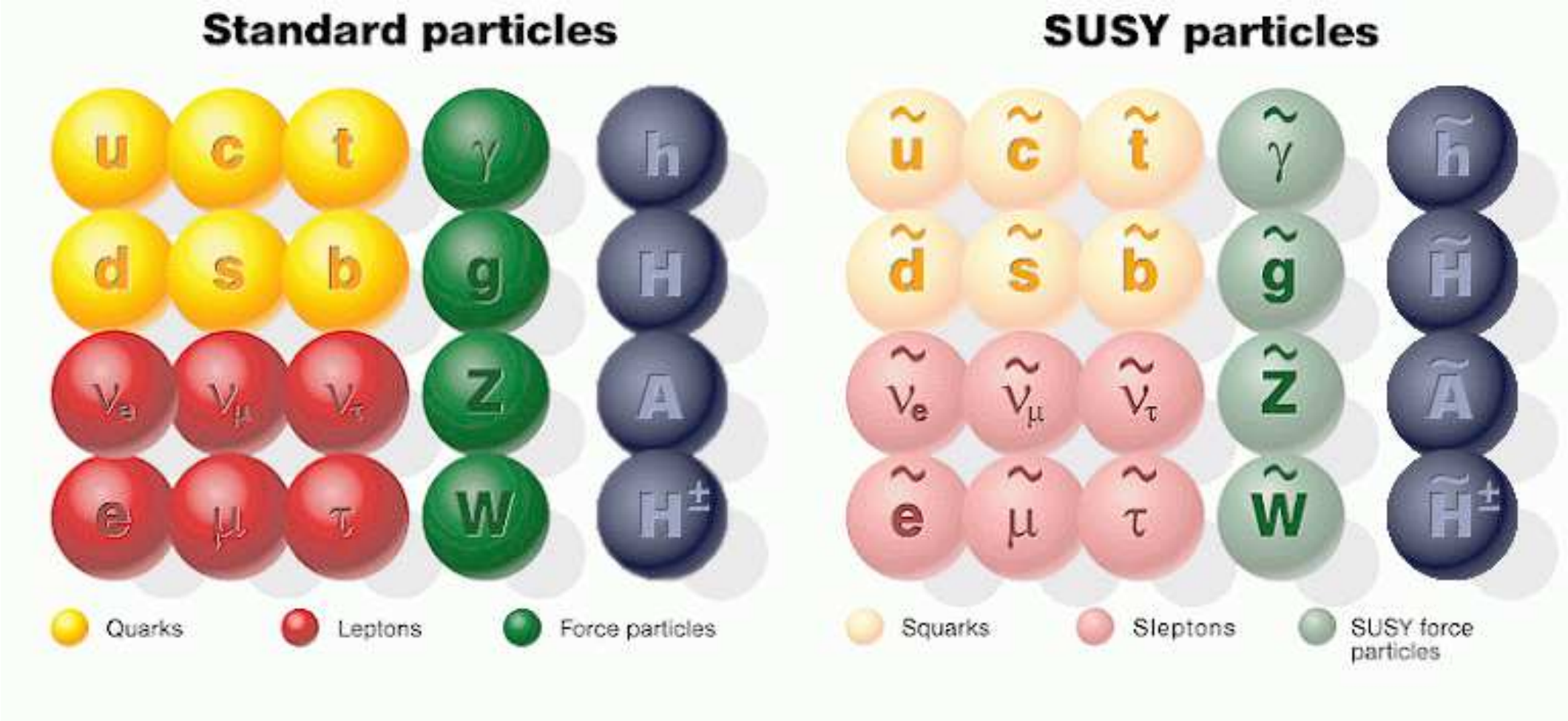
HVP summary:



$\Rightarrow$ BMW20: difference to experimental data $\sim 1.5\,\sigma$

The MSSM

Superpartners for Standard Model particles



⇒ large uncolored / EW sector

Neutralinos and charginos:

Higgsinos and electroweak gauginos mix

charged:

$$\tilde{W}^+, \tilde{h}_u^+ \to \tilde{\chi}_1^+, \tilde{\chi}_2^+, \qquad \tilde{W}^-, \tilde{h}_d^- \to \tilde{\chi}_1^-, \tilde{\chi}_2^-$$

Diagonalization of the mass matrix:

$$\mathbf{X} = \begin{pmatrix} M_2 & \sqrt{2}\sin\beta\, M_W \\ \sqrt{2}\cos\beta\, M_W & \mu \end{pmatrix},$$

$$\mathbf{M}_{\tilde{\chi}^-} = \mathbf{V}^* \mathbf{X}^\top \mathbf{U}^\dagger = \begin{pmatrix} m_{\tilde{\chi}_1^\pm} & 0 \\ 0 & m_{\tilde{\chi}_2^\pm} \end{pmatrix}$$

$\Rightarrow$ charginos: mass eigenstates

mass matrix given in terms of M_2, μ, $\tan\beta$

neutral:

$$\underbrace{\tilde{\gamma}, \tilde{Z}}, \tilde{h}_u^0, \tilde{h}_d^0 \rightarrow \tilde{\chi}_1^0, \tilde{\chi}_2^0, \tilde{\chi}_3^0, \tilde{\chi}_4^0$$
$$\tilde{W}^0, \tilde{B}^0$$

Diagonalization of mass matrix:

$$\mathbf{Y} = \begin{pmatrix} M_1 & 0 & -M_Z\, s_W \cos\beta & M_Z\, s_W \sin\beta \\ 0 & M_2 & M_Z\, c_W \cos\beta & -M_Z\, c_W \sin\beta \\ -M_Z\, s_W \cos\beta & M_Z\, c_W \cos\beta & 0 & -\mu \\ M_Z\, s_W \sin\beta & -M_Z\, c_W \sin\beta & -\mu & 0 \end{pmatrix},$$

$$\mathbf{M}_{\tilde{\chi}^0} = \mathbf{N}^* \mathbf{Y} \mathbf{N}^\dagger = \mathbf{diag}(m_{\tilde{\chi}_1^0}, m_{\tilde{\chi}_2^0}, m_{\tilde{\chi}_3^0}, m_{\tilde{\chi}_4^0})$$

$\Rightarrow$ neutralinos: mass eigenstates

mass matrix given in terms of M_1, M_2, μ, $\tan\beta$
$\Rightarrow$ only one additional parameter

$\Rightarrow$ MSSM predicts mass relations between neutralinos and charginos

Scalar lepton sector of the MSSM

Charged slepton mass matrices

$$\mathbf{M}^2_{\tilde{l}} = \begin{pmatrix} M^2_{\tilde{l}_L} + m^2_l + DT_{l_1} & m_l X_l \\ m_l X_l & M^2_{\tilde{l}_R} + m^2_l + DT_{l_2} \end{pmatrix} \xrightarrow{\theta_{\tilde{l}}} \begin{pmatrix} m^2_{\tilde{l}_1} & 0 \\ 0 & m^2_{\tilde{l}_2} \end{pmatrix}$$

with

$$X_l = A_l - \mu \tan\beta$$

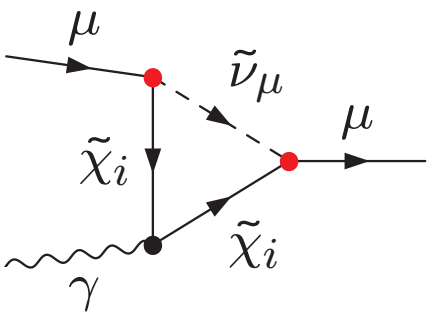
Sneutrino mass

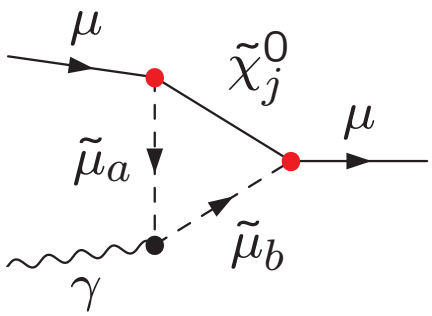
$$m^2_{\tilde{\nu}_l} = M^2_{\tilde{l}_L} + DT_\nu$$

Simplifying assumption: $M_{\tilde{l}_L}$ and $M_{\tilde{l}_R}$ identical for all three generations

SUSY can easily explain the deviation in a_μ:

Feynman diagrams for MSSM 1L corrections:





– Diagrams with chargino/sneutrino exchange

– Diagrams with neutralino/smuon exchange

Enhancement factor as compared to SM:

$$\mu - \tilde{\chi}_i^\pm - \tilde{\nu}_\mu \;:\; \sim m_\mu \tan\beta$$
$$\mu - \tilde{\chi}_j^0 - \tilde{\mu}_a \;:\; \sim m_\mu \tan\beta$$

SM, EW 1L: $\frac{\alpha}{\pi}\frac{m_\mu^2}{M_W^2}$

MSSM, 1L: $\frac{\alpha}{\pi}\frac{m_\mu^2}{M_{\text{SUSY}}^2} \times \tan\beta$

SUSY corrections at 1L:

$$a_\mu^{\text{SUSY,1L}} \approx 13 \times 10^{-10} \left(\frac{100\ \text{GeV}}{M_{\text{SUSY}}}\right)^2 \tan\beta\ \text{sign}(\mu)$$

$M_{\text{SUSY}}(= m_{\tilde{\mu}} = m_{\tilde{\nu}} = m_{\tilde{\chi}})$: generic SUSY mass scale

$$\begin{aligned} a_\mu^{\text{SUSY,1L}} &= (-100 \ldots + 100) \times 10^{-10} \\ a_\mu^{\text{exp}} - a_\mu^{\text{theo,SM}} &\approx (25.1 \pm 5.9) \times 10^{-10} \end{aligned}$$

$\Rightarrow$ SUSY could easily explain the "discrepancy"

$\Rightarrow$ a_μ can provide upper limits on the EW masses

(by requiering agreement at the 95% C.L.)

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(by requiering agreement at the 95% C.L.)

If SUSY exists, it should fix $(g-2)_\mu$!
$\Rightarrow$ there must be light EW SUSY particles!

The general idea:

- scan the relevant EW SUSY parameter space

- impose all relevant experimental constraints:
  - $(g-2)_\mu$
  - Dark Matter relic density
  - Dark Matter direct detection
  - LHC searches for EW particles

- Dark Matter relic density requires a mechanism to reduce the density in the early universe
  - bino/wino DM with chargino co-annihilation
  - bino DM with slepton co-annihilation
  - higgsino DM
  - wino DM

- obtain lower and upper limits on the various EW particle masses

- evaluate the prospects for future searches

2. Experimental constraints (LHC and more)

LHC searches:

Decay via sleptons (3l)

$$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to (\tilde{l}^{\pm}\nu)(\tilde{l}^{+}l^{-}) \to 3l + \not{E}_T \ ,$$
$$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to (l^{\pm}\tilde{\nu})(\tilde{l}^{+}l^{-}) \to 3l + \not{E}_T \qquad (5)$$

Decay via sleptons (2l)

$$\tilde{\chi}_1^{+}\tilde{\chi}_1^{-} \to (\tilde{l}^{+}\nu)(\tilde{l}^{-}\nu) \to 2l + \not{E}_T \ ,$$
$$\tilde{\chi}_1^{+}\tilde{\chi}_1^{-} \to (l^{+}\tilde{\nu})(l^{-}\tilde{\nu}) \to 2l + \not{E}_T \qquad (6)$$

Decay via gauge bosons

$$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to (W\tilde{\chi}_1^0)(Z\tilde{\chi}_1^0) \to 3l + \not{E}_T \ , \qquad (7a)$$
$$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to (W\tilde{\chi}_1^0)(Z\tilde{\chi}_1^0) \to 2l + \text{jets} + \not{E}_T \ , \qquad (7b)$$
$$\tilde{\chi}_1^{+}\tilde{\chi}_1^{-} \to (W^{+}\tilde{\chi}_1^0)(W^{-}\tilde{\chi}_1^0) \to 2l + \not{E}_T \qquad (8)$$

Decay via Higgs bosons

$$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to (W\tilde{\chi}_1^0)(h\tilde{\chi}_1^0) \to l + b\bar{b} + \not{E}_T \qquad (9)$$

$\tilde{l}$-pair production (2l)

$$\tilde{l}^+\tilde{l}^- \to (l^+\tilde{\chi}_1^0)(l^-\tilde{\chi}_1^0) \to 2l + \not{E}_T \qquad (10)$$

Compressed spectra

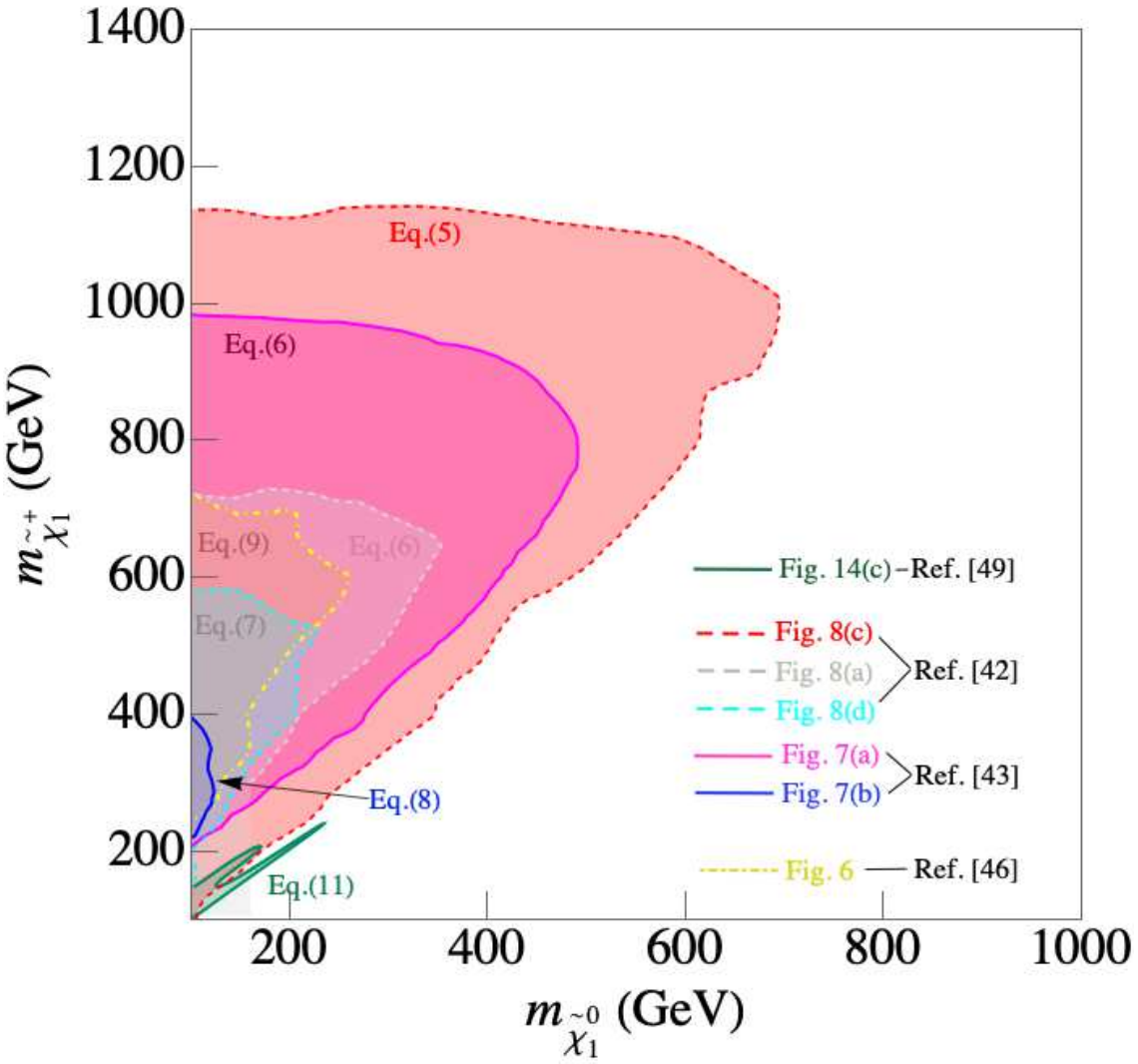
$$\tilde{\chi}_1^{\pm}\tilde{\chi}_2^0 \to (W^*\tilde{\chi}_1^0)(Z^*\tilde{\chi}_1^0) \to 2l + \not{E}_T \ + \text{ISR}\ , \qquad (11)$$
$$\tilde{l}^+\tilde{l}^- \to (l^+\tilde{\chi}_1^0)(l^-\tilde{\chi}_1^0) \to 2l + \not{E}_T \ + \text{ISR} \qquad (12)$$

Searches involving Staus

$\Rightarrow$ all newly included into CheckMate [*M.C & I.S.*]

Exception: compressed spectra $\Rightarrow$ direct application

LHC exclusion bounds (I) (as given for Simplified Model Spectra (SMS))



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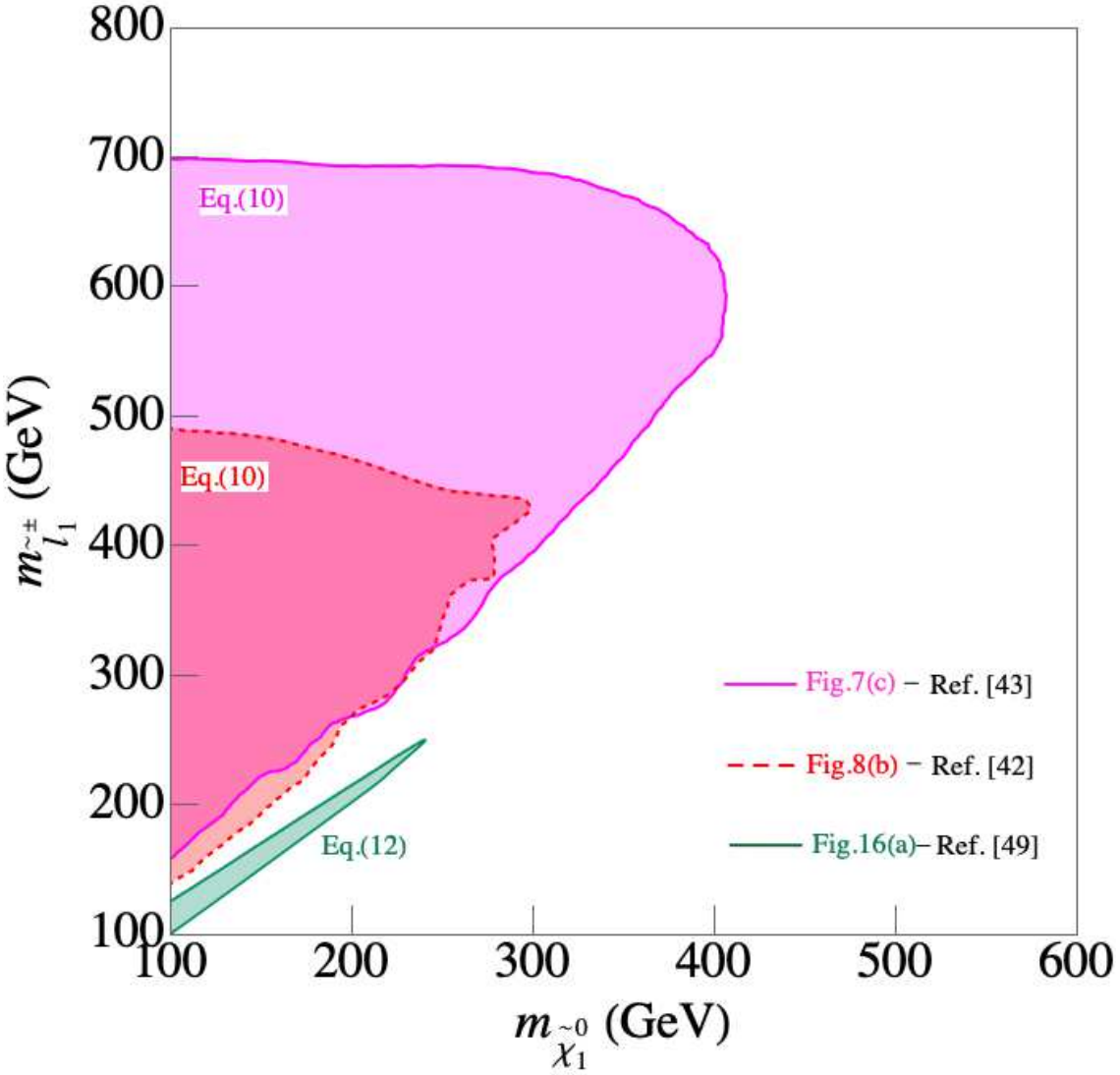
LHC exclusion bounds (II) (as given for Simplified Model Spectra (SMS))



⇒ all newly included into CheckMate [*M.C & I.S.*]

Exception: compressed spectra ⇒ direct application

$(g-2)_\mu$ constraint: (GM2Calc)

$$\text{old: } \Delta a_\mu^{\text{old}} = (28.0 \pm 7.4) \times 10^{-10}$$
$$\text{new: } \Delta a_\mu^{\text{new}} = (25.1 \pm 5.9) \times 10^{-10}$$

$\Rightarrow$ some results for $\Delta a_\mu^{\text{new}} (\equiv \Delta a_\mu)$
some results only available for $\Delta a_\mu^{\text{old}}$

Note: $\Delta a_\mu^{\text{old}} - 2\,\sigma^{\text{old}} \approx \Delta a_\mu^{\text{new}} - 2\,\sigma^{\text{new}}$
$\Rightarrow$ upper limits on SUSY masses are not expected to change

Dark Matter relic density: MicrOmegas

$$\Omega_{\text{CDM}} h^2 = 0.120 \pm 0.001$$
$$\text{or} \quad \Omega_{\text{CDM}} h^2 \leq 0.122$$

(as taken from [*Planck '18*])

Dark Matter direct detection: MicrOmegas
limit on spin independent scattering cross section (Xenon1T)
[*Xenon collab. '18*]

3. Results for (nearly) all MSSM scenarios

Possible scenarios:

1. bino/wino DM with chargino co-annihilation: $M_1 \lesssim M_2$
   $\Rightarrow$ full relic DM constraint $\Rightarrow$ updated with $\Delta a_\mu^{\text{new}}$

2. bino DM with slepton co-annihilation case-L: $M_1 \lesssim M_{\tilde{l}_L}$
   $\Rightarrow$ full relic DM constraint $\Rightarrow$ updated with $\Delta a_\mu^{\text{new}}$

3. bino DM with slepton co-annihilation case-R: $M_1 \lesssim M_{\tilde{l}_R}$
   $\Rightarrow$ full relic DM constraint $\Rightarrow$ updated with $\Delta a_\mu^{\text{new}}$

4. higgsino DM: $\mu < M_1, M_2 \Rightarrow m_{\tilde{\chi}_1^0} \approx m_{\tilde{\chi}_2^0} \approx m_{\tilde{\chi}_1^\pm}$
   full relic DM constraint $\Rightarrow m_{\tilde{\chi}_1^0} \sim 1$ TeV $\Rightarrow (g-2)_\mu$ not ok
   $\Rightarrow$ relic DM upper bound

5. wino DM: $M_2 < M_1, \mu \Rightarrow m_{\tilde{\chi}_1^0} \approx m_{\tilde{\chi}_1^\pm}$
   full relic DM constraint $\Rightarrow m_{\tilde{\chi}_1^0} \sim 3$ TeV $\Rightarrow (g-2)_\mu$ not ok
   $\Rightarrow$ relic DM upper bound

A) Bino/wino DM with chargino co-annihilation

Parameter scan:

$$100 \text{ GeV} \leq M_1 \leq 1 \text{ TeV} ,$$

$$M_1 \leq M_2 \leq 1.1 M_1 ,$$

$$1.1 M_1 \leq \mu \leq 10 M_1,$$

$$5 \leq \tan\beta \leq 60,$$

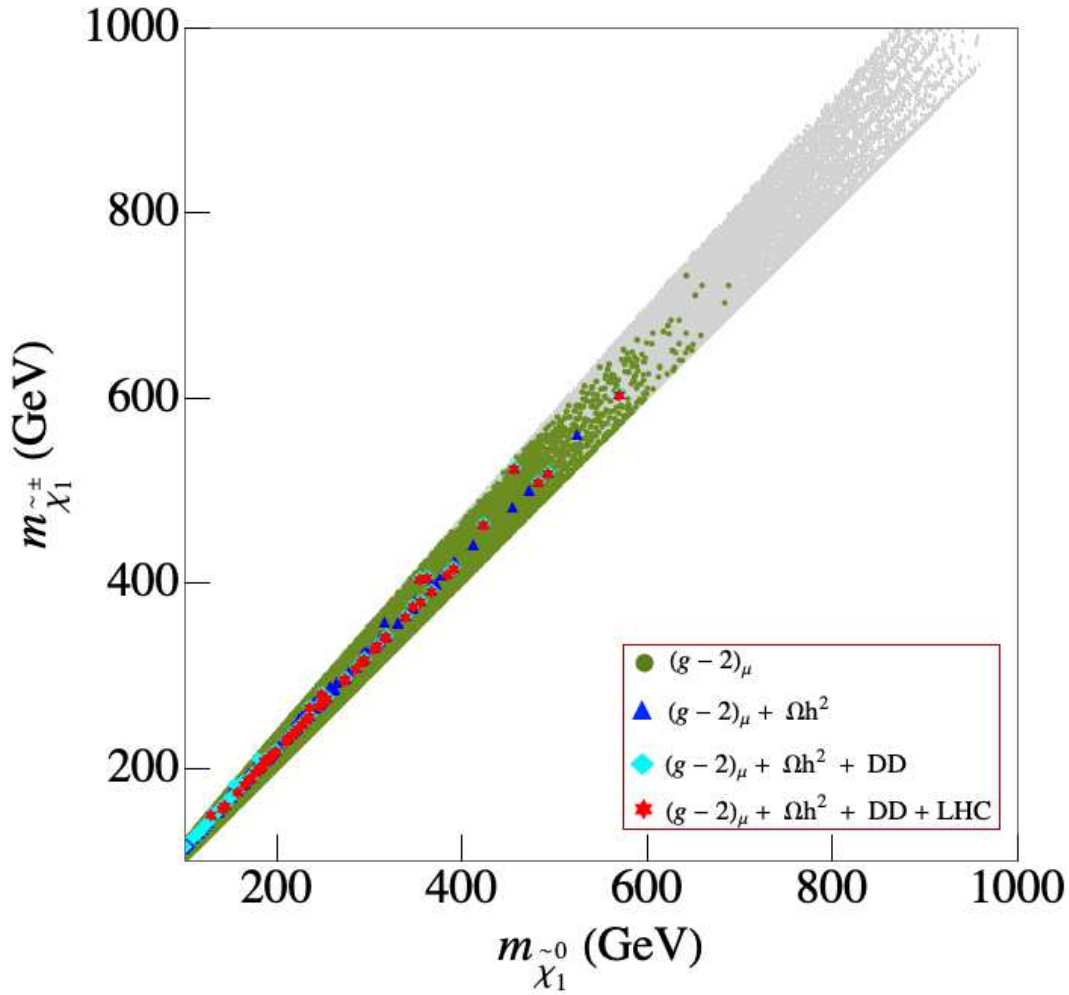
$$100 \text{ GeV} \leq m_{\tilde{L}} \leq 1 \text{ TeV},$$

$$m_{\tilde{R}} = m_{\tilde{L}} .$$

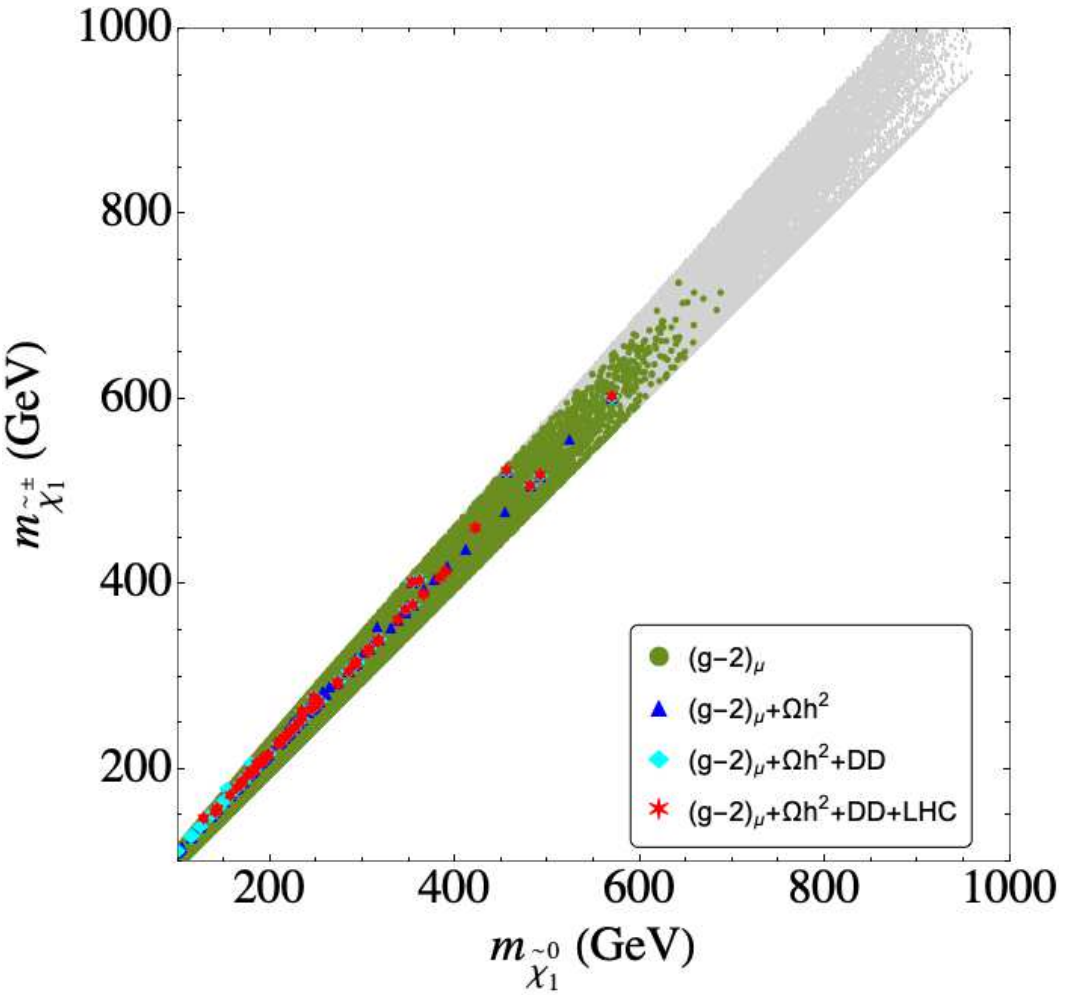
(latter condition only to make the analysis simpler, no relevant effect)

Results in the $m_{\tilde{\chi}_1^0}$-$m_{\tilde{\chi}_1^\pm}$ plane:

old $(g-2)_\mu$



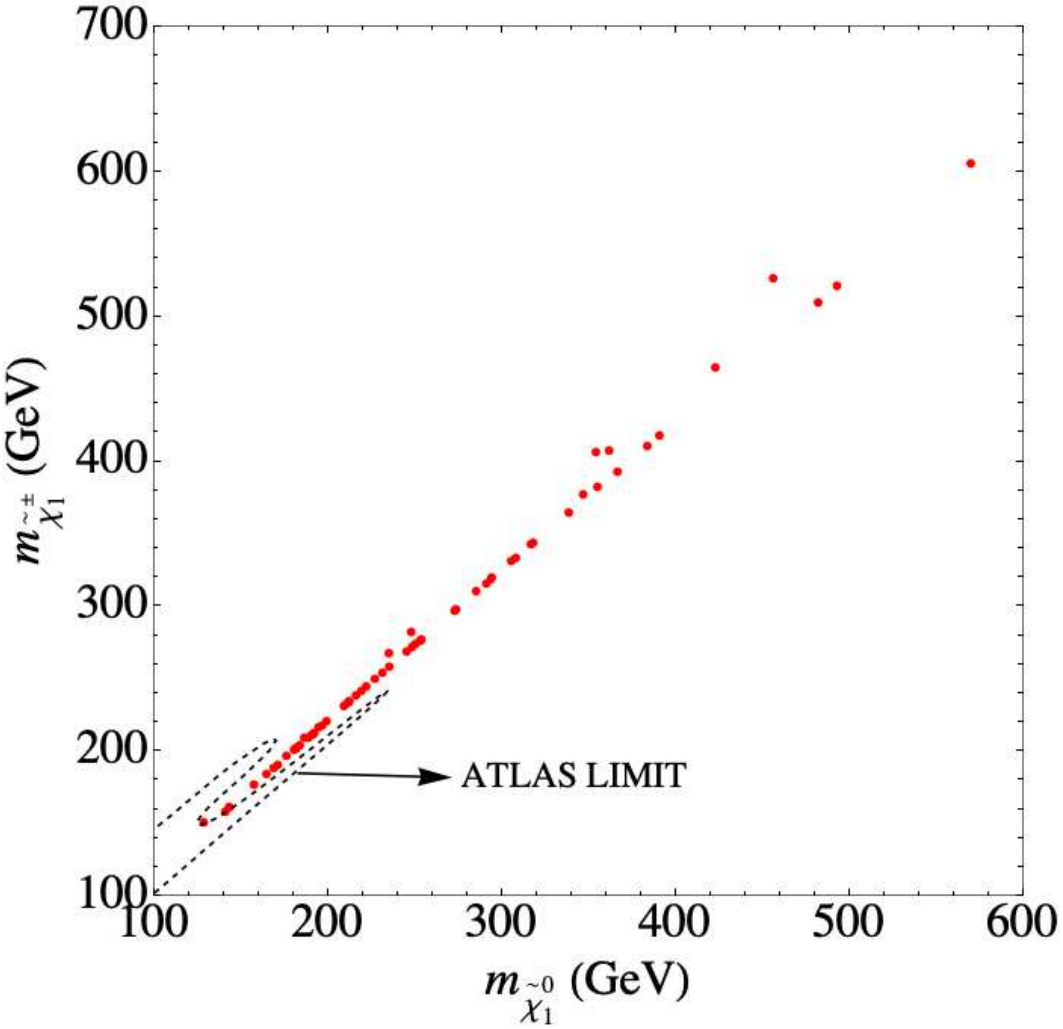
new $(g-2)_\mu$



$\Rightarrow$ compressed spectrum as expected

$\Rightarrow$ clear upper limits, $m_{\text{(N)LSP}} \lesssim 600(650)$ GeV confirmed

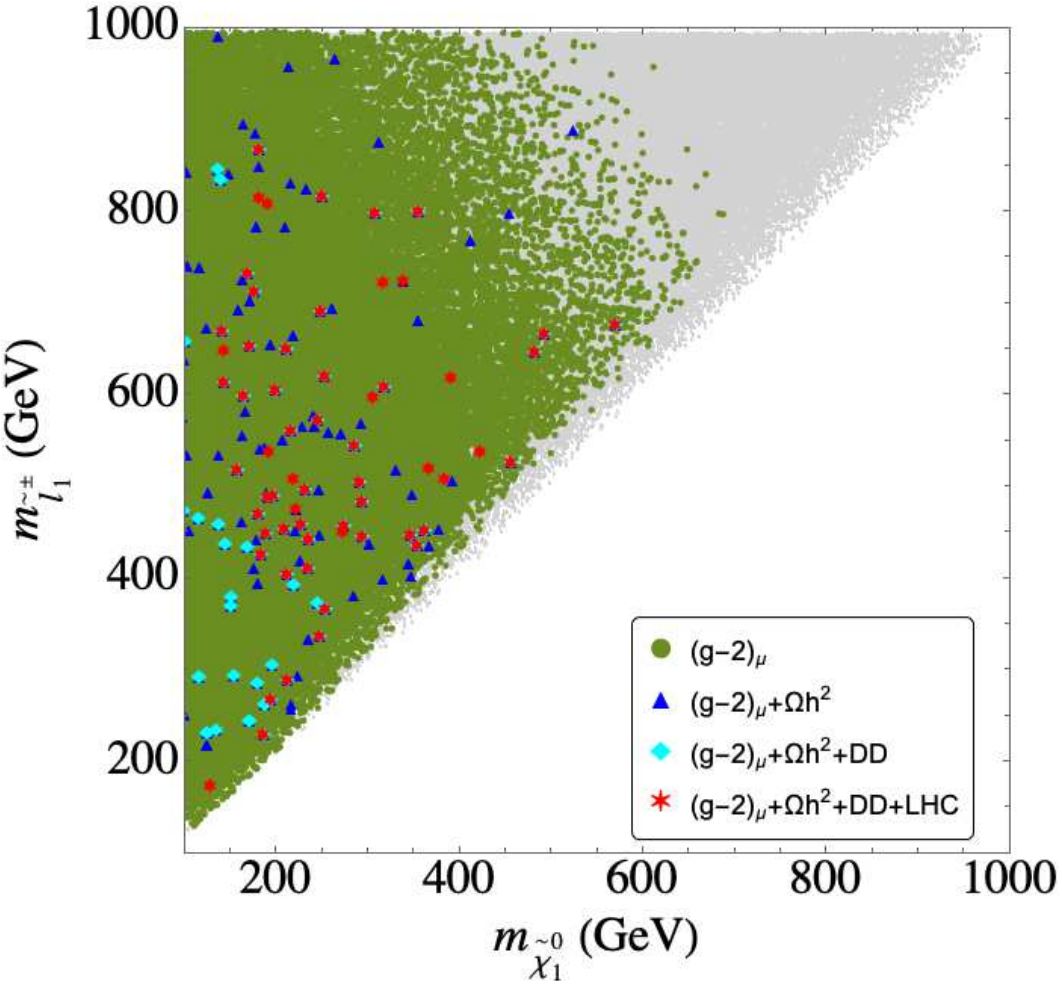
Comparison with the compressed spectra searches:



⇒ compressed spectrum avoids current bounds!

Results in the $m_{\tilde{\chi}_1^0}$-$m_{\tilde{l}_1}$ plane:

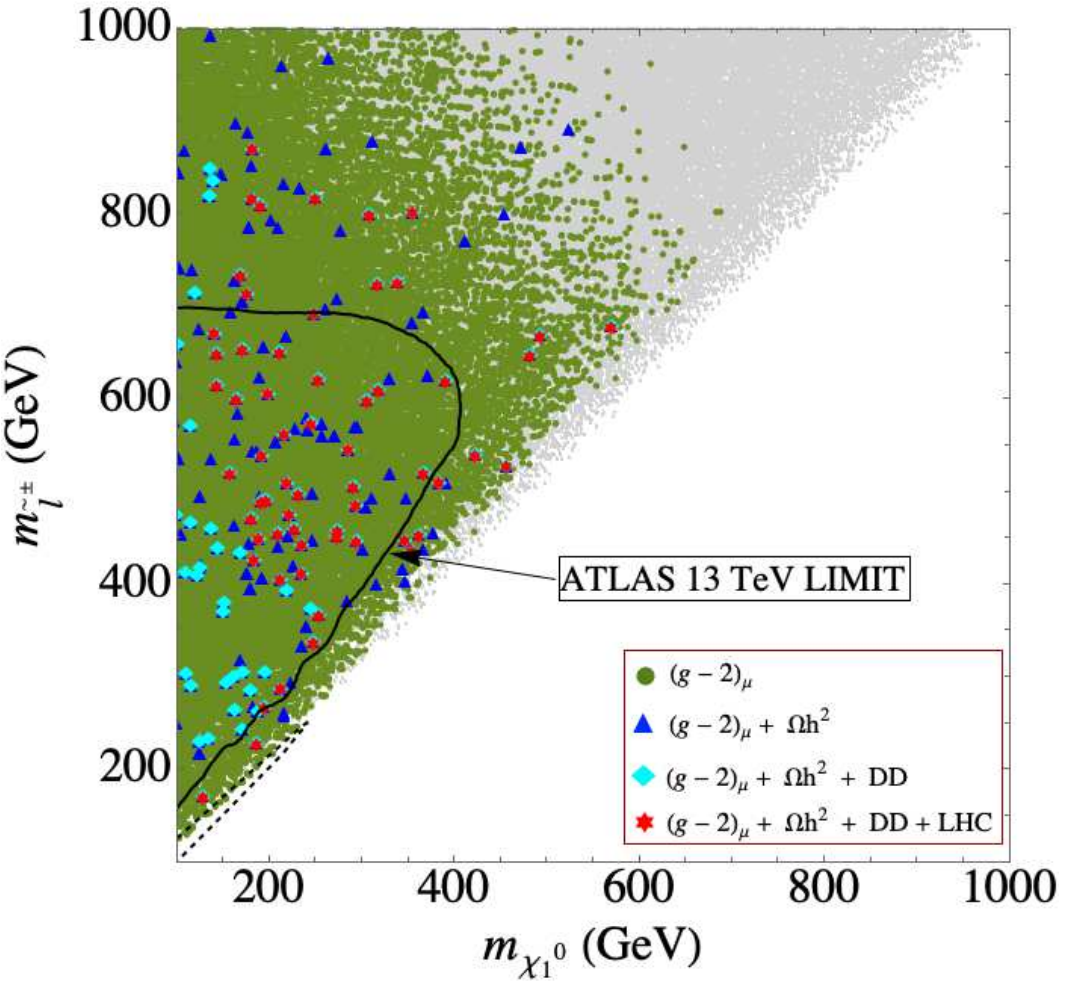
new $(g-2)_\mu$



$\Rightarrow$ important: $\tilde{l}$-pair production searches (10)

Results in the $m_{\tilde{\chi}_1^0}$-$m_{\tilde{l}_1}$ plane:

old $(g-2)_\mu$

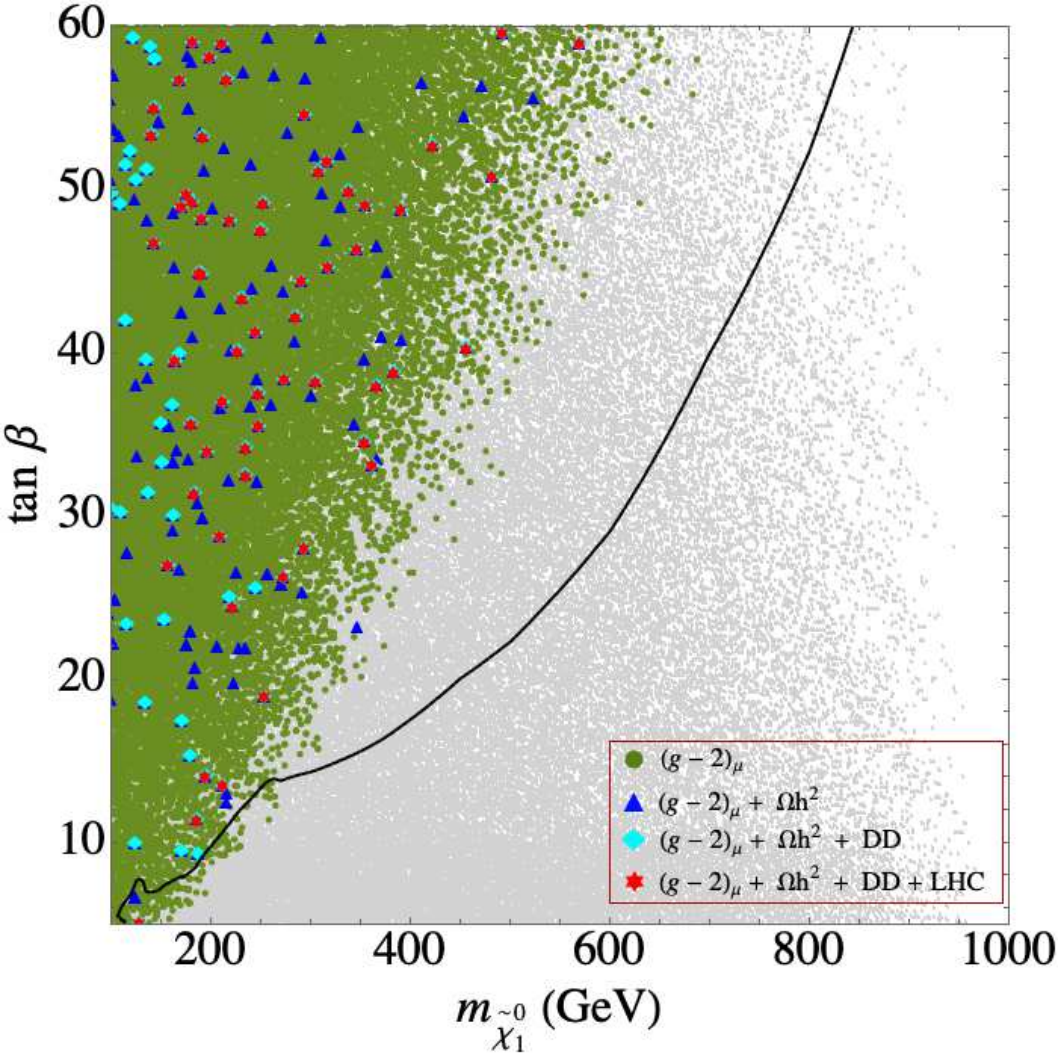


$\Rightarrow$ important: $\tilde{l}$-pair production searches (10)

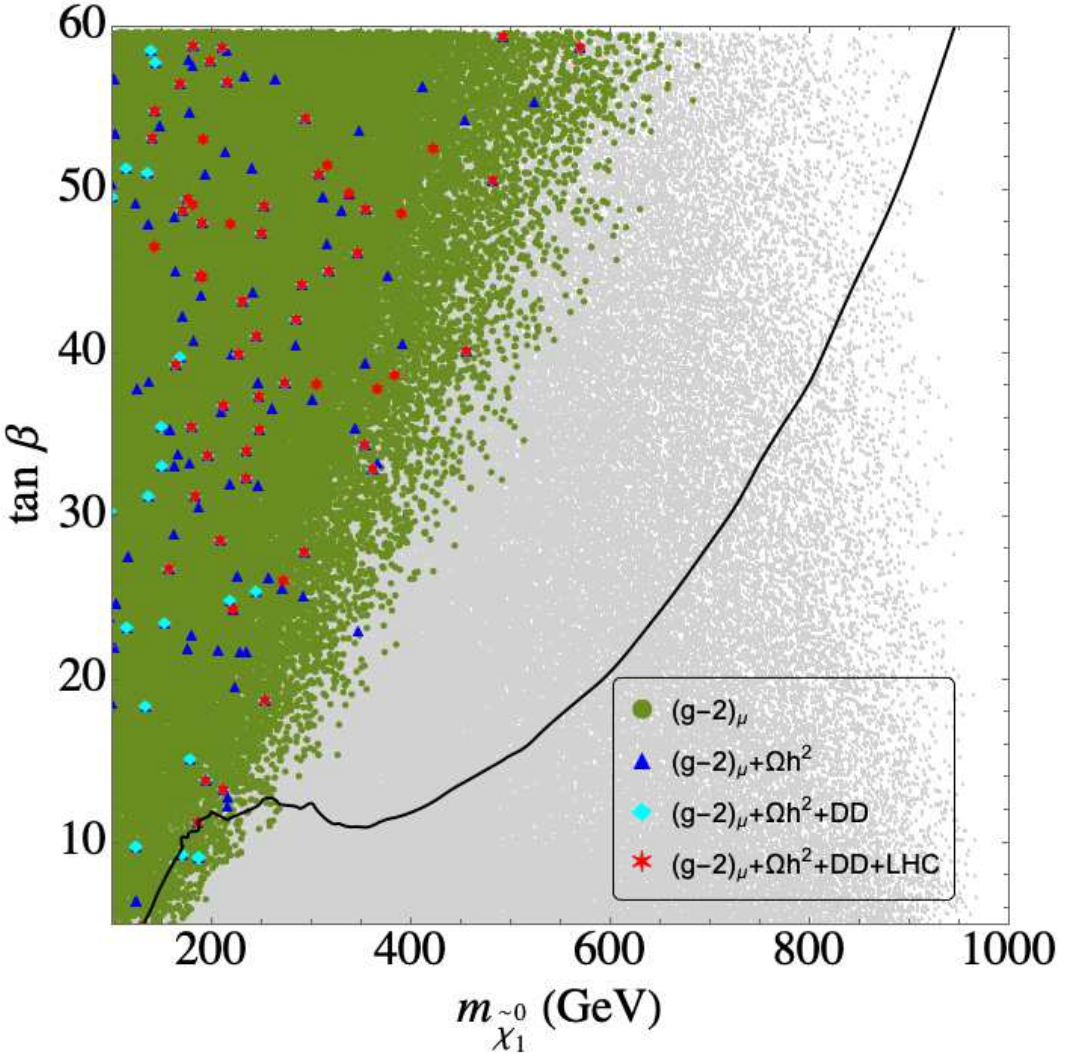
$\Rightarrow$ naive application of LHC bounds fails

Results in the $m_{\tilde{\chi}_1^0}$-tan β plane:

old $(g-2)_\mu$



new $(g-2)_\mu$



black contour: (simplified) application of $H/A \to \tau^+\tau^-$

$\Rightarrow$ A-pole annihilation effectively excluded

B/C) Bino DM with slepton co-annihilation

Parameter scan:

$$100 \text{ GeV} \leq M_1 \leq 1 \text{ TeV} ,$$

$$M_1 \leq M_2 \leq 10 M_1 ,$$

$$1.1 M_1 \leq \mu \leq 10 M_1,$$

$$5 \leq \tan\beta \leq 60,$$

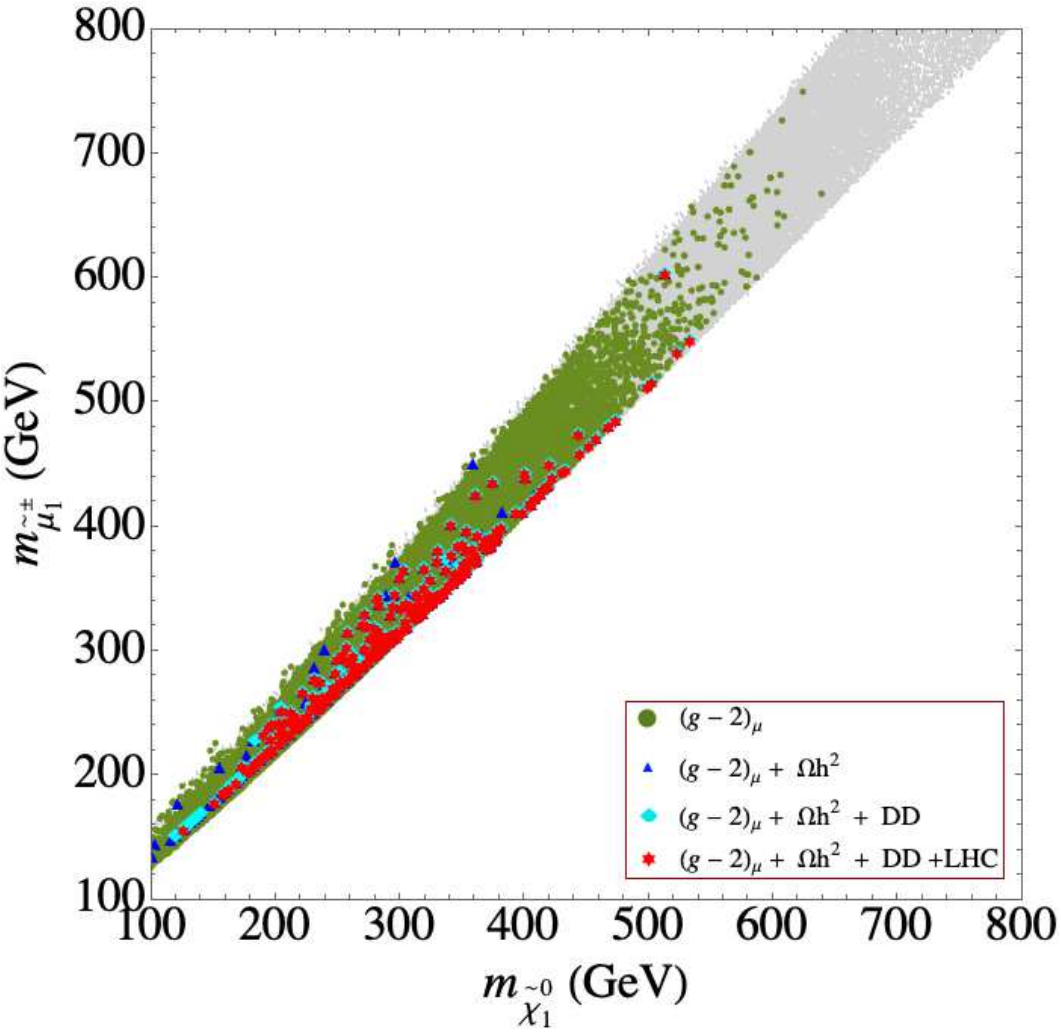
Case-L: $M_1 \leq m_{\tilde{L}} \leq 1.2 M_1,$ $M_1 \leq m_{\tilde{R}} \leq 10 M_1.$

Case-R: $M_1 \leq m_{\tilde{R}} \leq 1.2 M_1,$ $M_1 \leq m_{\tilde{L}} \leq 10 M_1.$

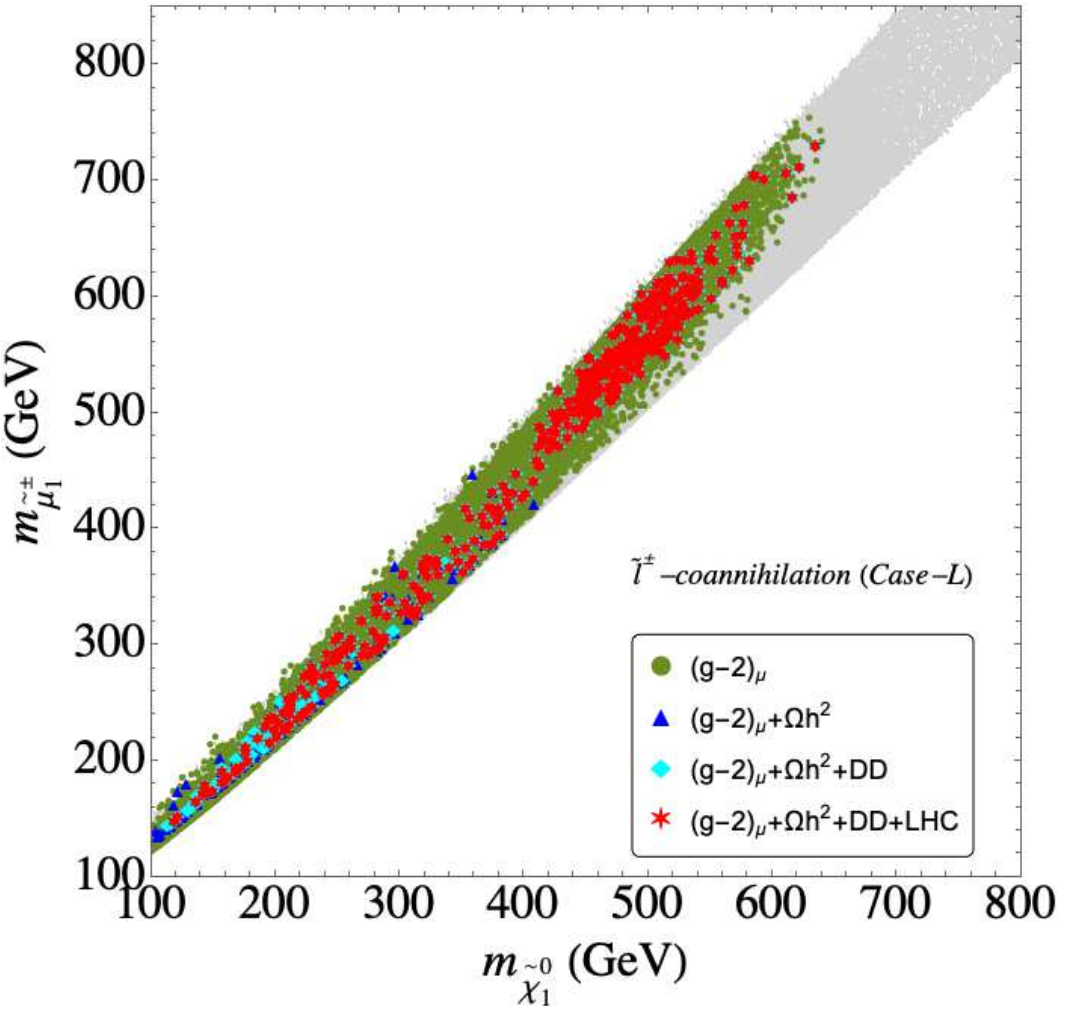
$\Rightarrow$ here focus on Case-L

Results in the $m_{\tilde{\chi}_1^0}$-$m_{\tilde{l}_1}$ plane:

old $(g-2)_\mu$



new $(g-2)_\mu$

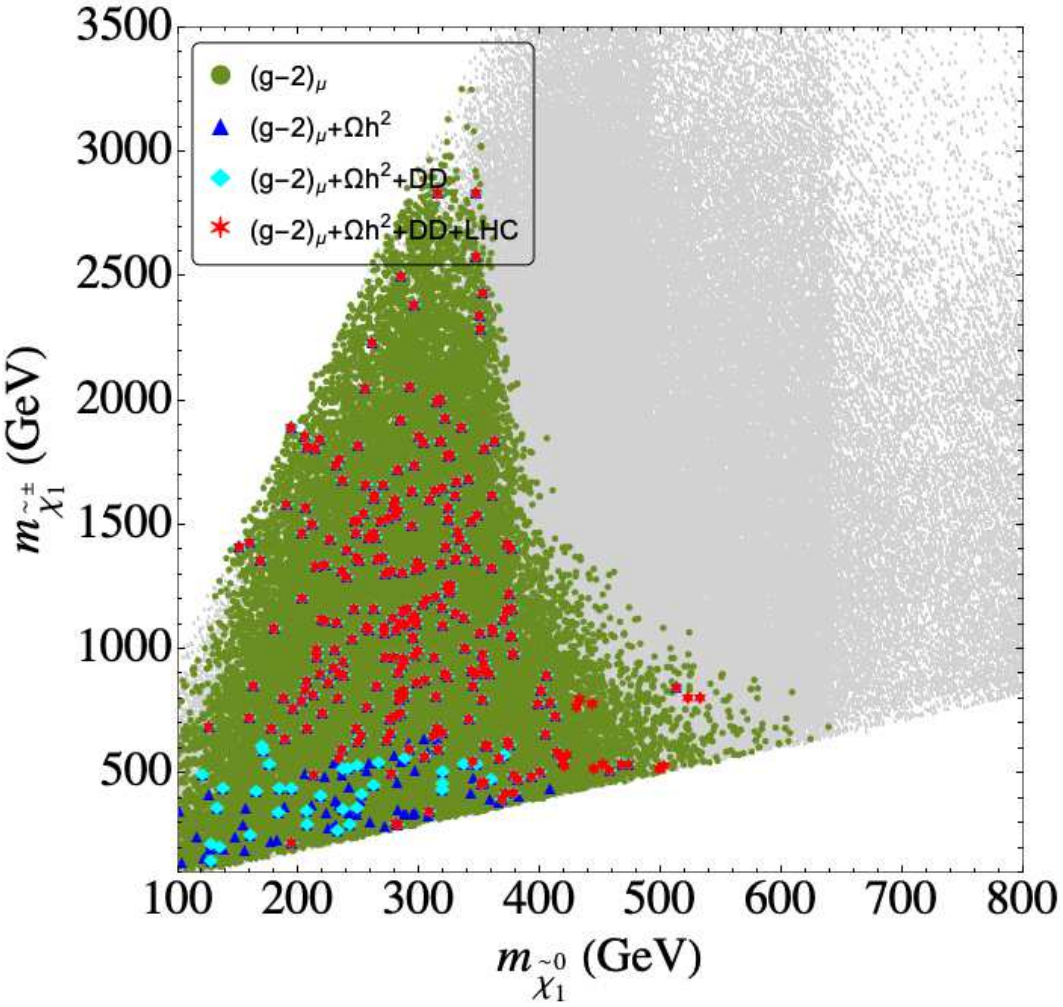


$\Rightarrow$ compressed spectrum as expected

$\Rightarrow$ clear upper limits, $m_{\text{(N)LSP}} \lesssim 650(700)$ GeV (after GM2Calc bug fix)

Results in the $m_{\tilde{\chi}_1^0}$-$m_{\tilde{\chi}_1^\pm}$ plane:

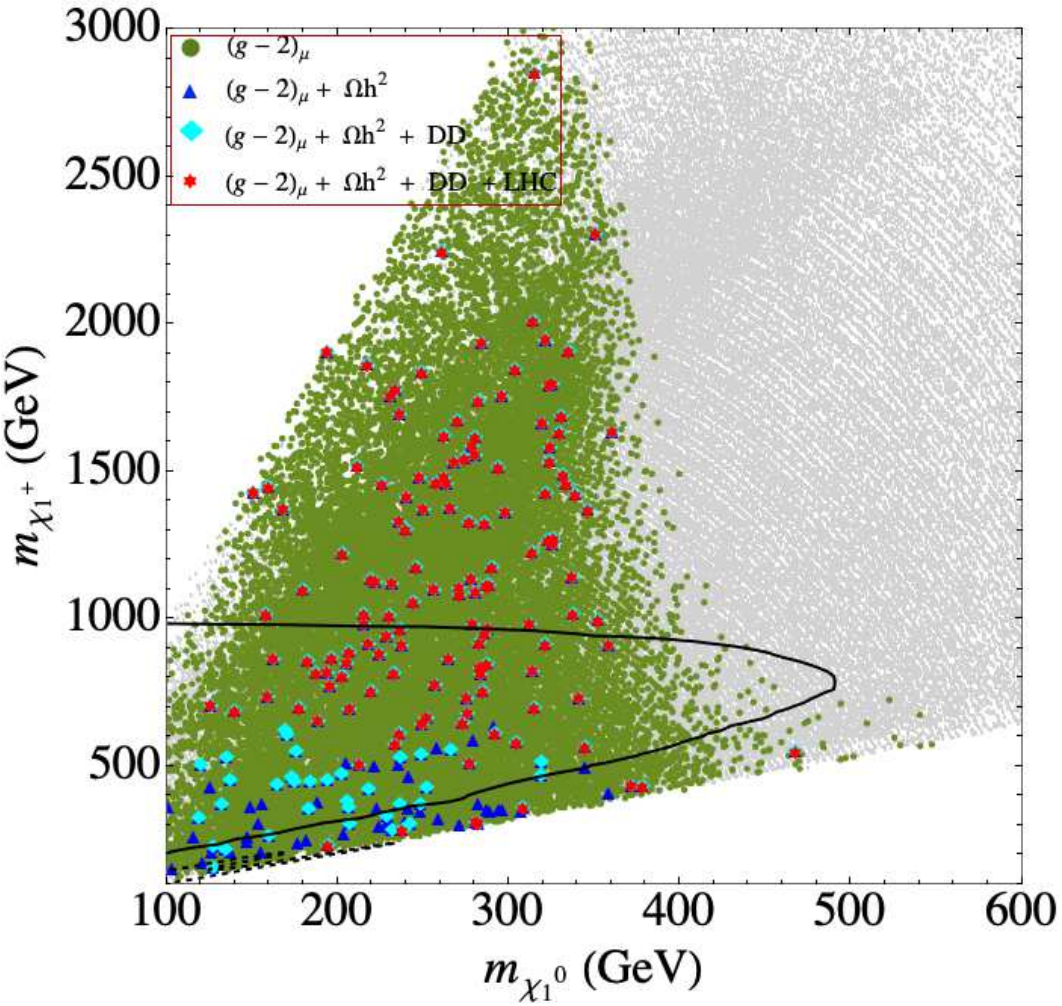
new $(g-2)_\mu$



$\Rightarrow$ important: $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ production searches (5)

Results in the $m_{\tilde{\chi}_1^0}$-$m_{\tilde{l}_1}$ plane:

old $(g-2)_\mu$

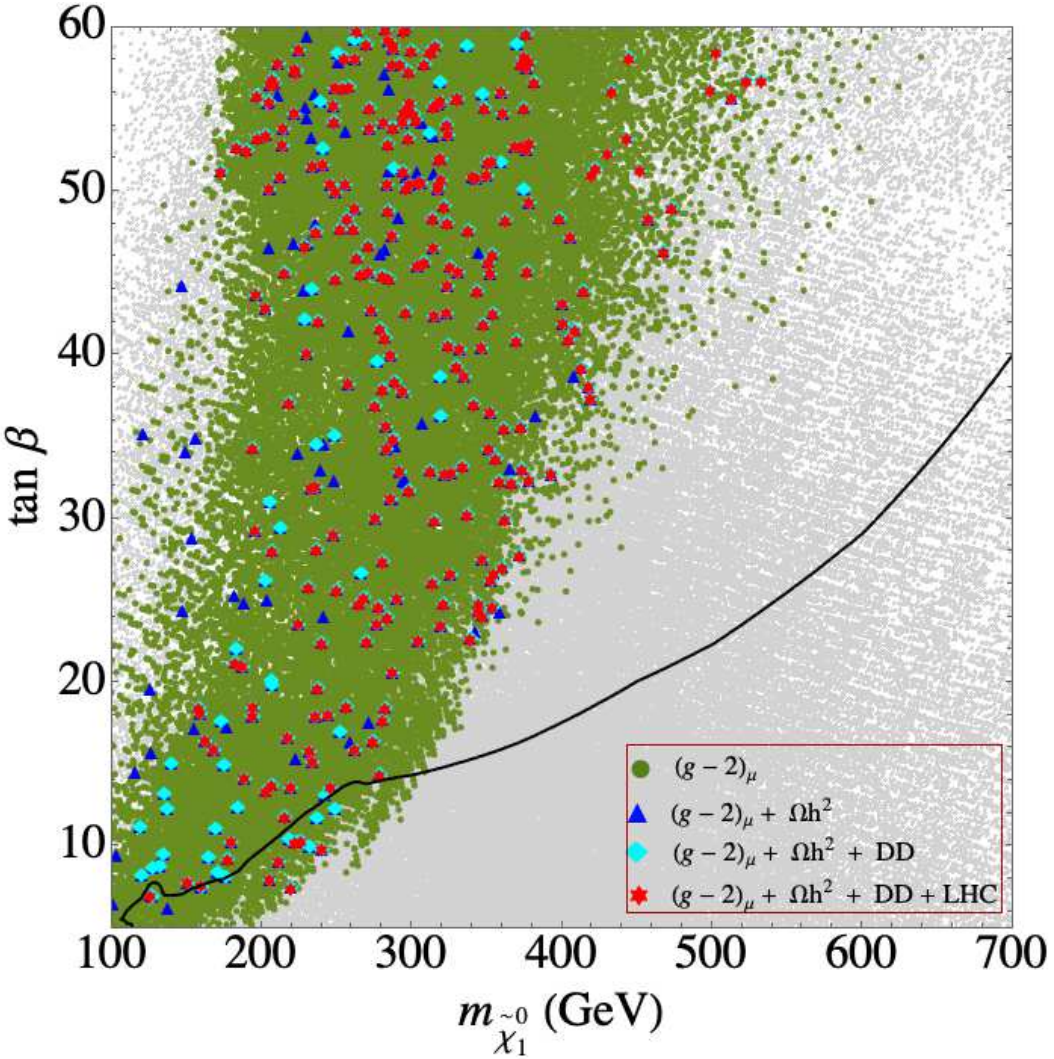


$\Rightarrow$ important: $\tilde{\chi}_1^\pm \tilde{\chi}_2^0$ production searches (5)

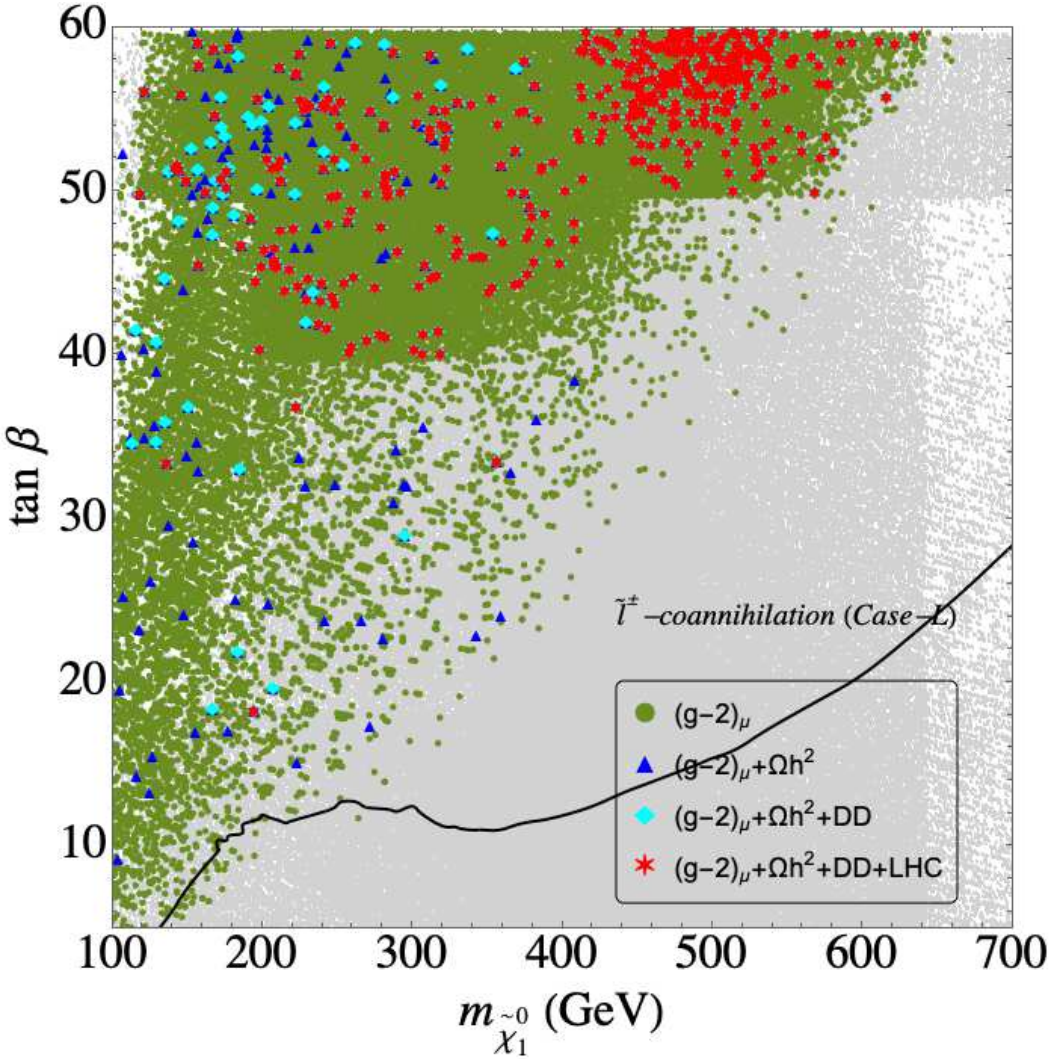
$\Rightarrow$ naive application of LHC bounds fails

Results in the $m_{\tilde{\chi}_1^0}$-tan β plane:

old $(g-2)_\mu$



new $(g-2)_\mu$



black contour: (simplified) application of $H/A \to \tau^+\tau^-$

$\Rightarrow$ A-pole annihilation largely excluded (after GM2Calc bug fix)

D) Higgsino DM

Parameter scan:

$$100 \text{ GeV} \leq \mu \leq 1.2 \text{ TeV} ,$$

$$1.1\mu \leq M_1 \leq 10\mu ,$$

$$1.1 M_2 \leq \mu \leq 10\mu ,$$

$$5 \leq \tan\beta \leq 60,$$

$$100 \text{ GeV} \leq m_{\tilde{L}}, m_{\tilde{R}} \leq 2 \text{ TeV},$$

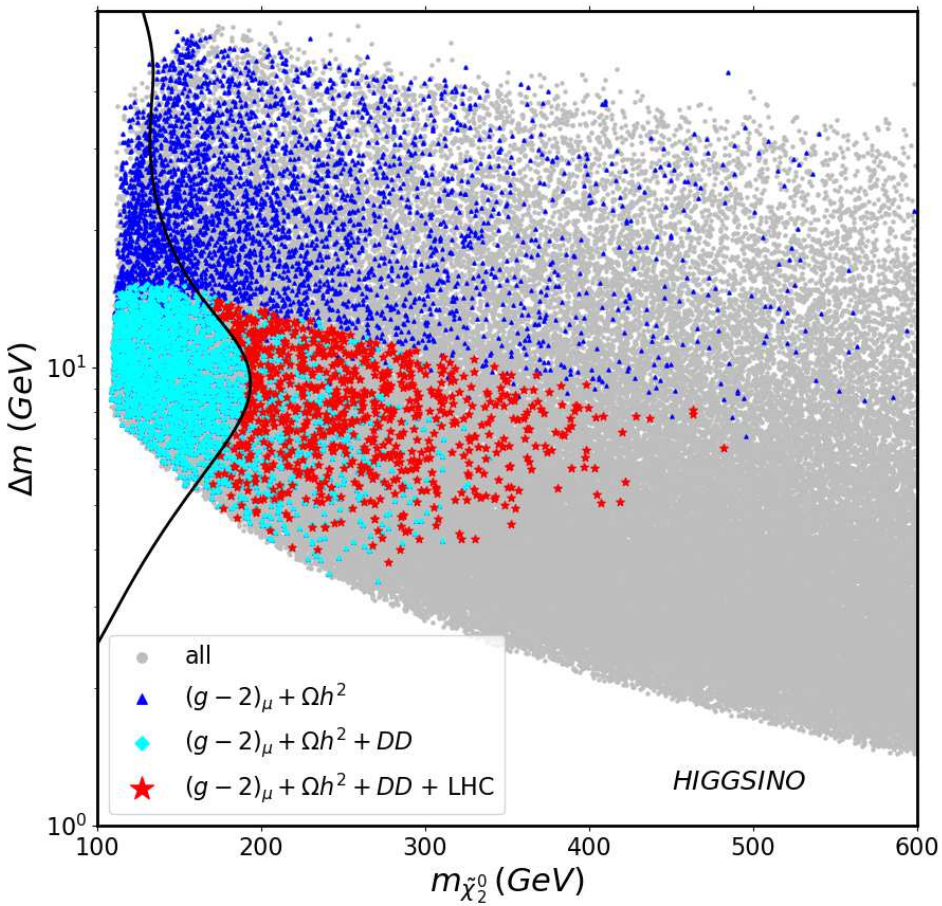
$\Rightarrow m_{\tilde{\chi}_1^0} \sim m_{\tilde{\chi}_2^0} \sim m_{\tilde{\chi}_1^\pm} \sim \mu$

Full DM relic density reached only for $m_{\tilde{\chi}_1^0} \sim 1$ TeV

$\Rightarrow$ incompatible with $(g-2)_\mu$

Results in the $m_{\tilde{\chi}_2^0}$-Δm plane:

old $(g-2)_\mu$

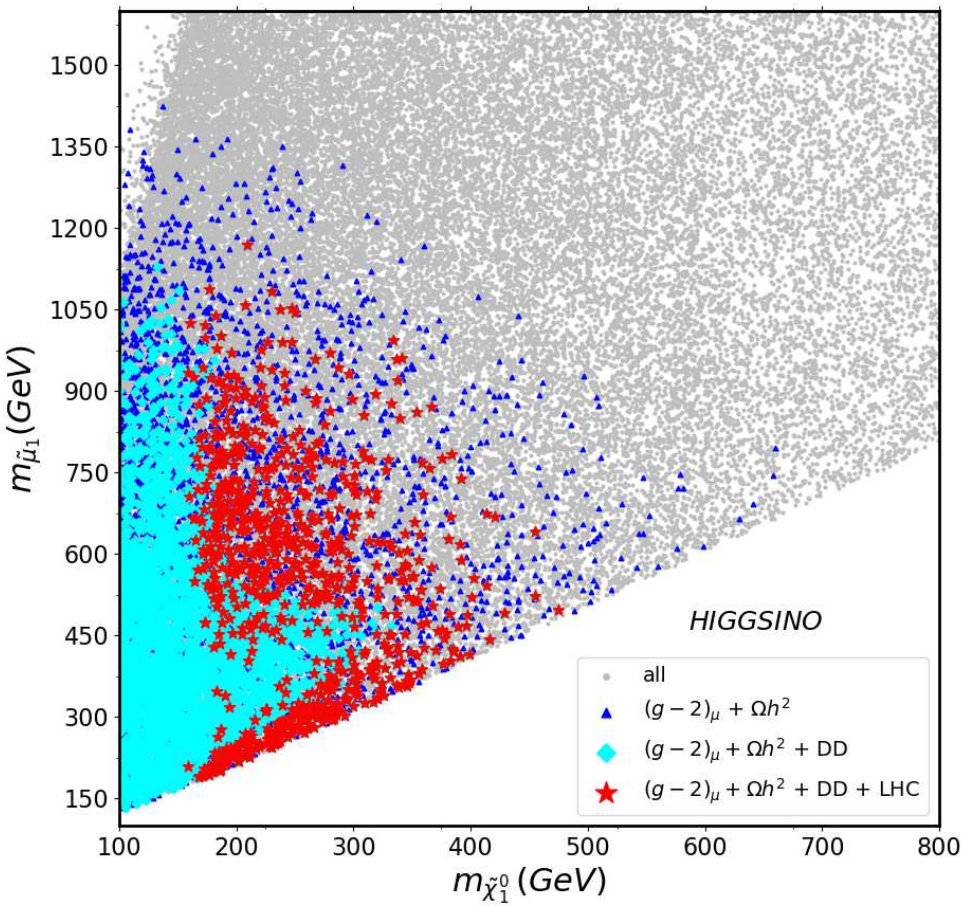


$\Rightarrow$ important: compressed spectra searches (11)

$\Rightarrow$ right where the model prediction sits $\Rightarrow$ very powerful

Results in the $m_{\tilde{\chi}_1^0}$-$m_{\tilde{l}_1}$ plane:

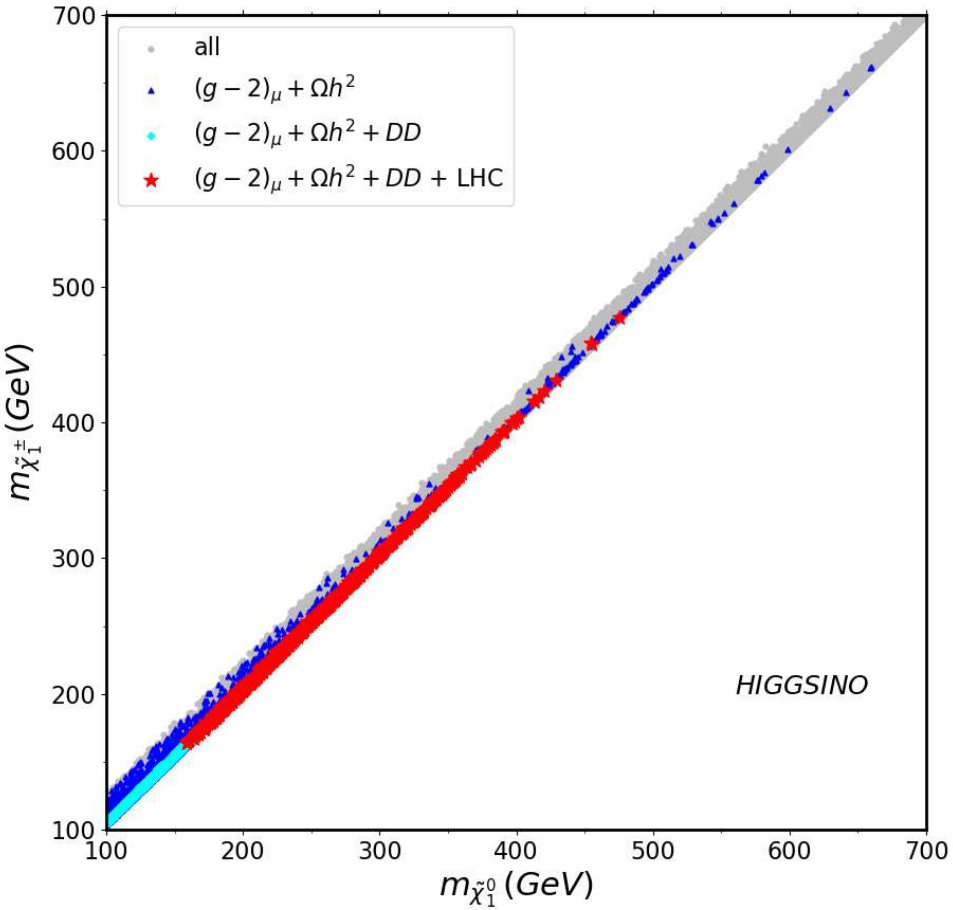
old $(g-2)_\mu$



$\Rightarrow$ upper limit on slepton masses: $m_{\tilde{l}_1} \lesssim 1.2$ TeV

Results in the $m_{\tilde{\chi}_1^0}$-$m_{\tilde{\chi}_1^\pm}$ plane:

old $(g-2)_\mu$

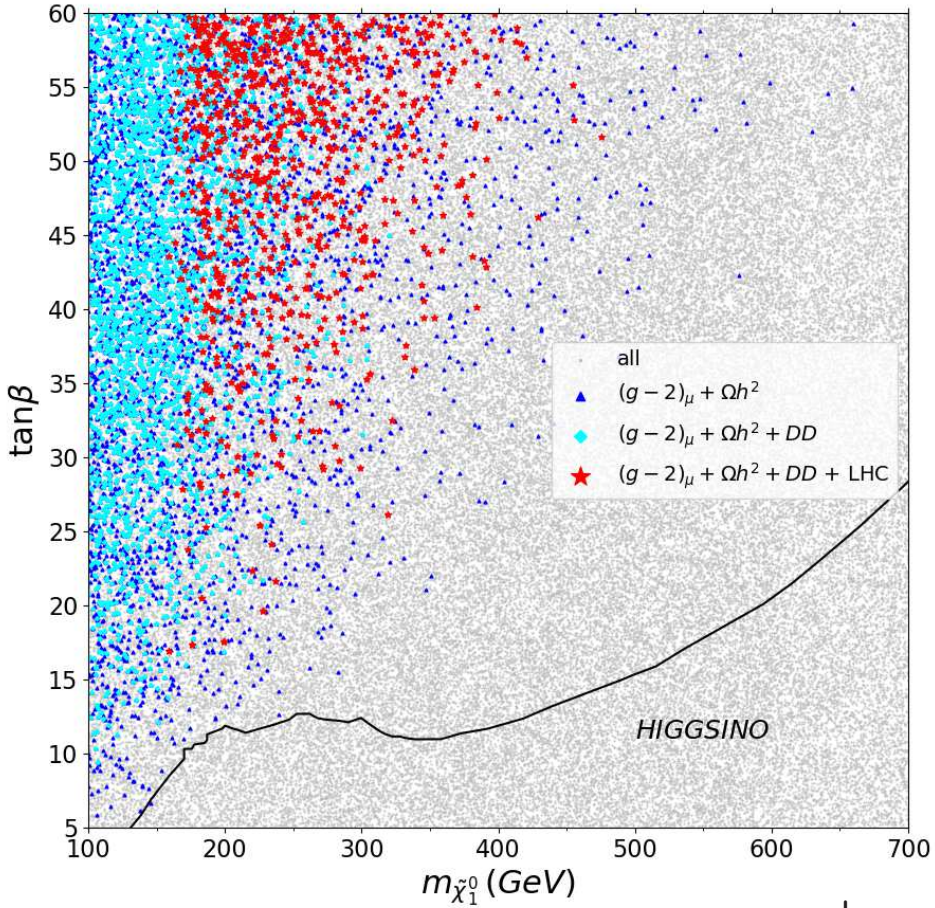


$\Rightarrow$ important: compressed spectra searches (11)

$\Rightarrow \tilde{\chi}_1^\pm \tilde{\chi}_2^0 \rightarrow (W^* \tilde{\chi}_1^0)(Z^* \tilde{\chi}_1^0) \rightarrow 2l + \not{E}_T$ + ISR $\quad \Rightarrow m_{\text{(N)LSP}} \lesssim 500$ GeV

Results in the $m_{\tilde{\chi}_1^0}$-tan β plane:

old $(g-2)_\mu$



black contour: (simplified) application of $H/A \to \tau^+\tau^-$

$\Rightarrow$ A-pole annihilation fully excluded

E) Wino DM

Parameter scan:

$$100 \text{ GeV} \leq M_2 \leq 1.5 \text{ TeV} ,$$

$$1.1 M_2 \leq M_1 \leq 10 M_2 ,$$

$$1.1 M_2 \leq \mu \leq 10 M_2 ,$$

$$5 \leq \tan\beta \leq 60,$$

$$100 \text{ GeV} \leq m_{\tilde{L}}, m_{\tilde{R}} \leq 2 \text{ TeV},$$

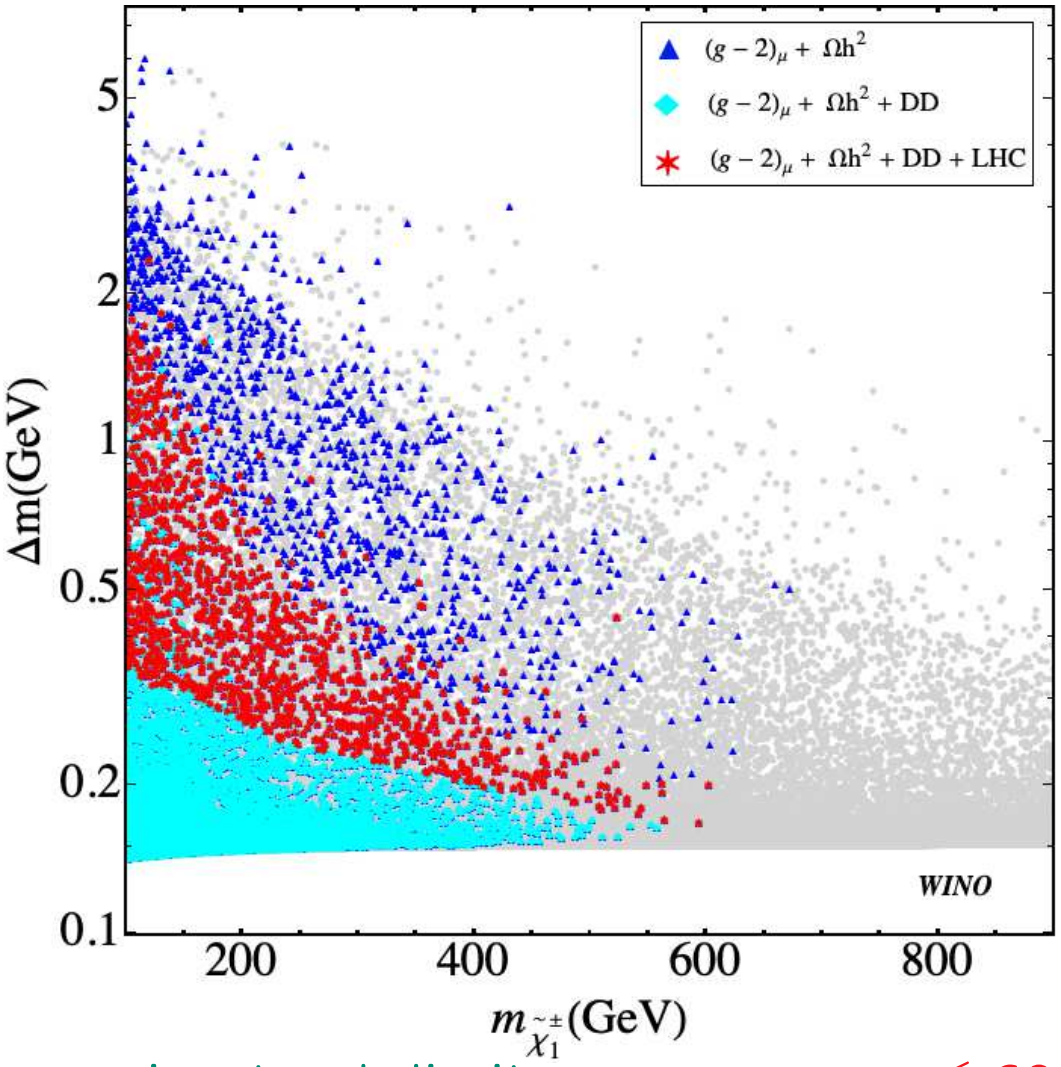
$\Rightarrow m_{\tilde{\chi}_1^0} \sim m_{\tilde{\chi}_1^\pm} \sim M_2$

Full DM relic density reached only for $m_{\tilde{\chi}_1^0} \sim 3$ TeV

$\Rightarrow$ incompatible with $(g-2)_\mu$

Results in the $m_{\tilde{\chi}_1^\pm}$-Δm plane:

old $(g-2)_\mu$

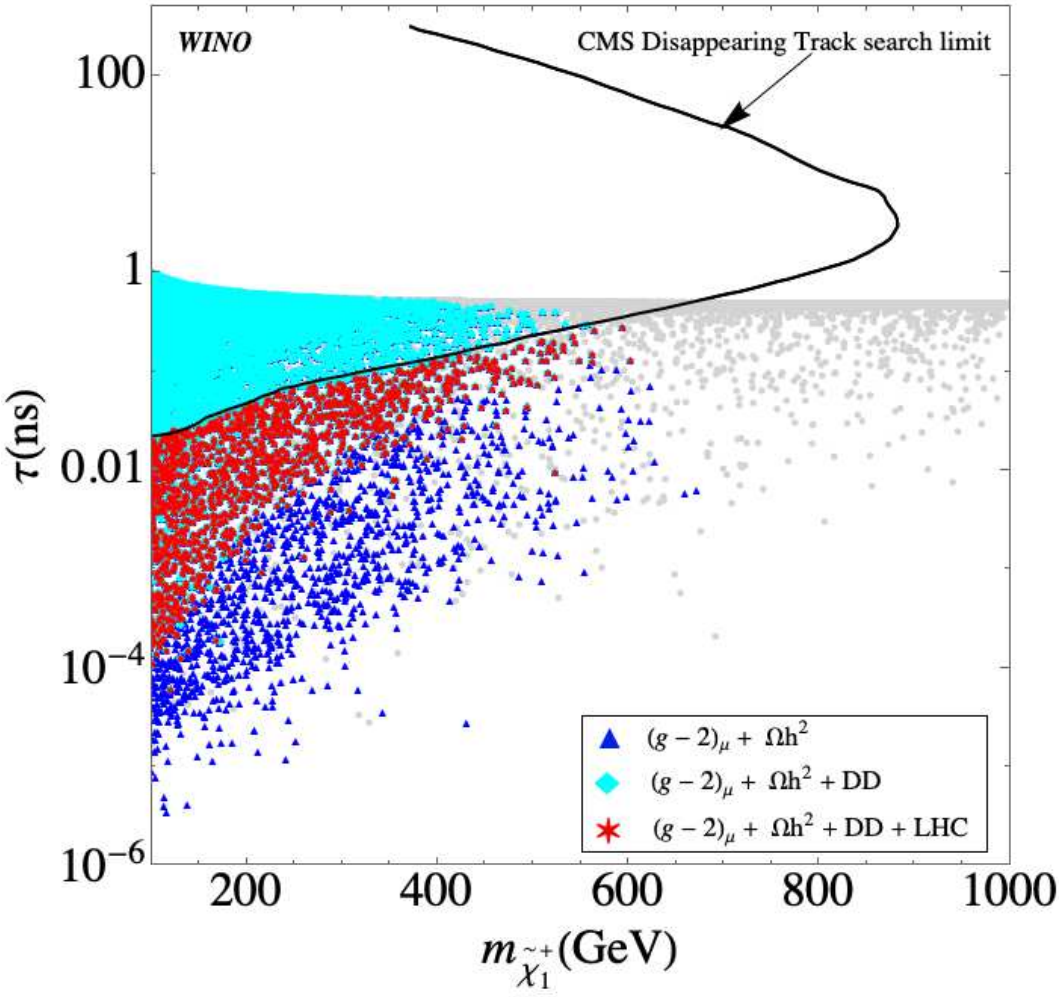


$\Rightarrow$ important: disappearing track limit $\Rightarrow m_{\text{(N)LSP}} \lesssim 600$ GeV

$\Rightarrow$ allowed parameter space squeezed by DD limits and disapp. tracks

Results in the $m_{\tilde{\chi}_1^\pm}$-$\tau_{\tilde{\chi}_1^\pm}$ plane:

old $(g-2)_\mu$

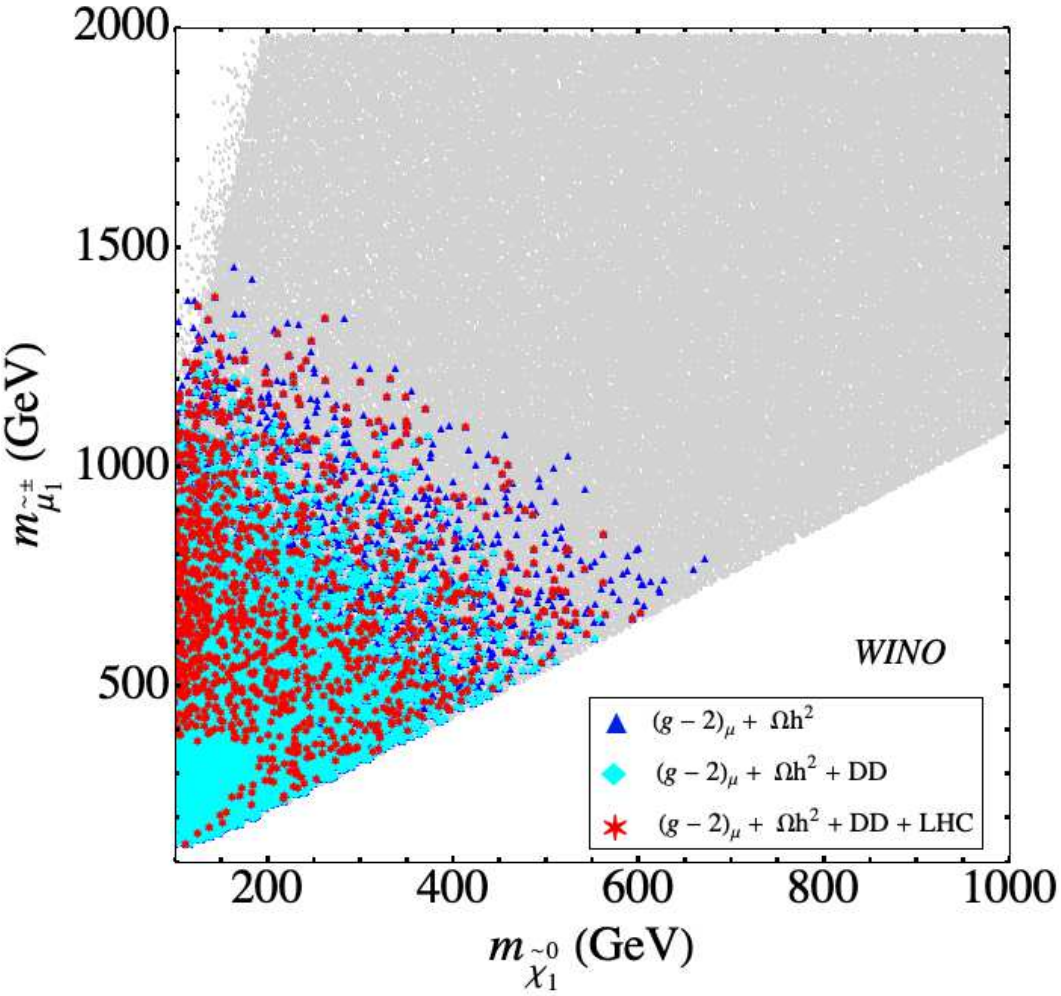


⇒ important: disappearing track limit ⇒ $m_{\text{(N)LSP}} \lesssim 600$ GeV

⇒ allowed parameter space squeezed by DD limits and disapp. tracks

Results in the $m_{\tilde{\chi}_1^0}$-$m_{\tilde{l}_1}$ plane:

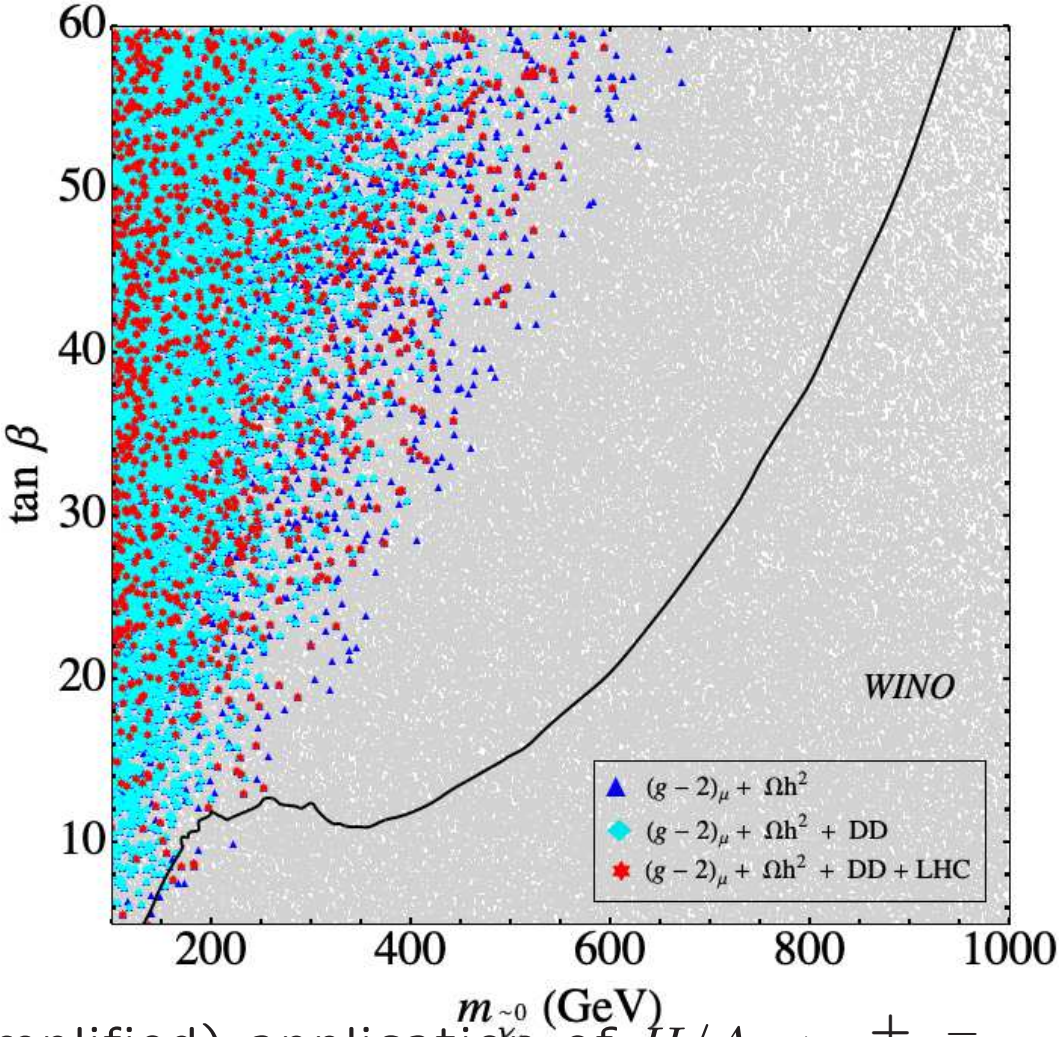
old $(g-2)_\mu$



$\Rightarrow m_{\tilde{l}_1} \lesssim 1400(1200)$ GeV

Results in the $m_{\tilde{\chi}_1^0}$-tan β plane:

old $(g-2)_\mu$



black contour: (simplified) application of $H/A \to \tau^+\tau^-$

$\Rightarrow$ A-pole annihilation largely excluded

Mini summary

A) bino/wino DM with chargino co-annihilation

relic DM density 100% fulfilled

$\Rightarrow m_{\text{(N)LSP}} \lesssim 600(650)$ GeV for new (and old) $(g-2)_\mu$

B/C) bino DM with slepton co-annihilation

relic DM density 100% fulfilled

$\Rightarrow m_{\text{(N)LSP}} \lesssim 650(700)$ GeV for new (and old) $(g-2)_\mu$

D) higgsino DM: $m_{\tilde{\chi}_1^0} \sim m_{\tilde{\chi}_2^0} \sim m_{\tilde{\chi}_1^\pm} \sim \mu$

relic DM density as upper limit (otherwise $m_{\tilde{\chi}_1^0} \sim 1$ TeV)

$\Rightarrow m_{\text{(N)LSP}} \lesssim 500$ GeV

E) wino DM: $m_{\tilde{\chi}_1^0} \sim m_{\tilde{\chi}_1^\pm} \sim M_2$

relic DM density as upper limit (otherwise $m_{\tilde{\chi}_1^0} \sim 3$ TeV)

$\Rightarrow m_{\text{(N)LSP}} \lesssim 600$ GeV

$\Rightarrow$ predictions for future LHC runs?!

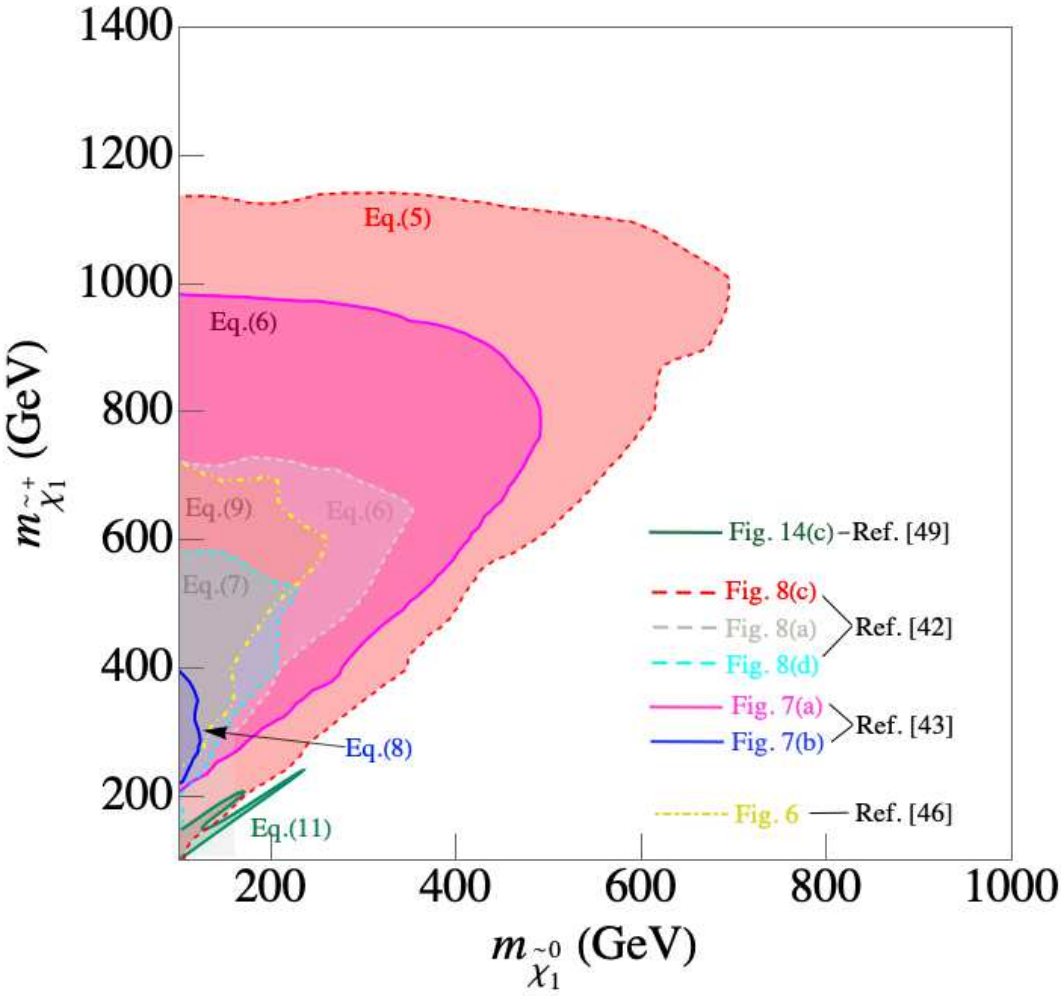
4. Predictions for future LHC runs

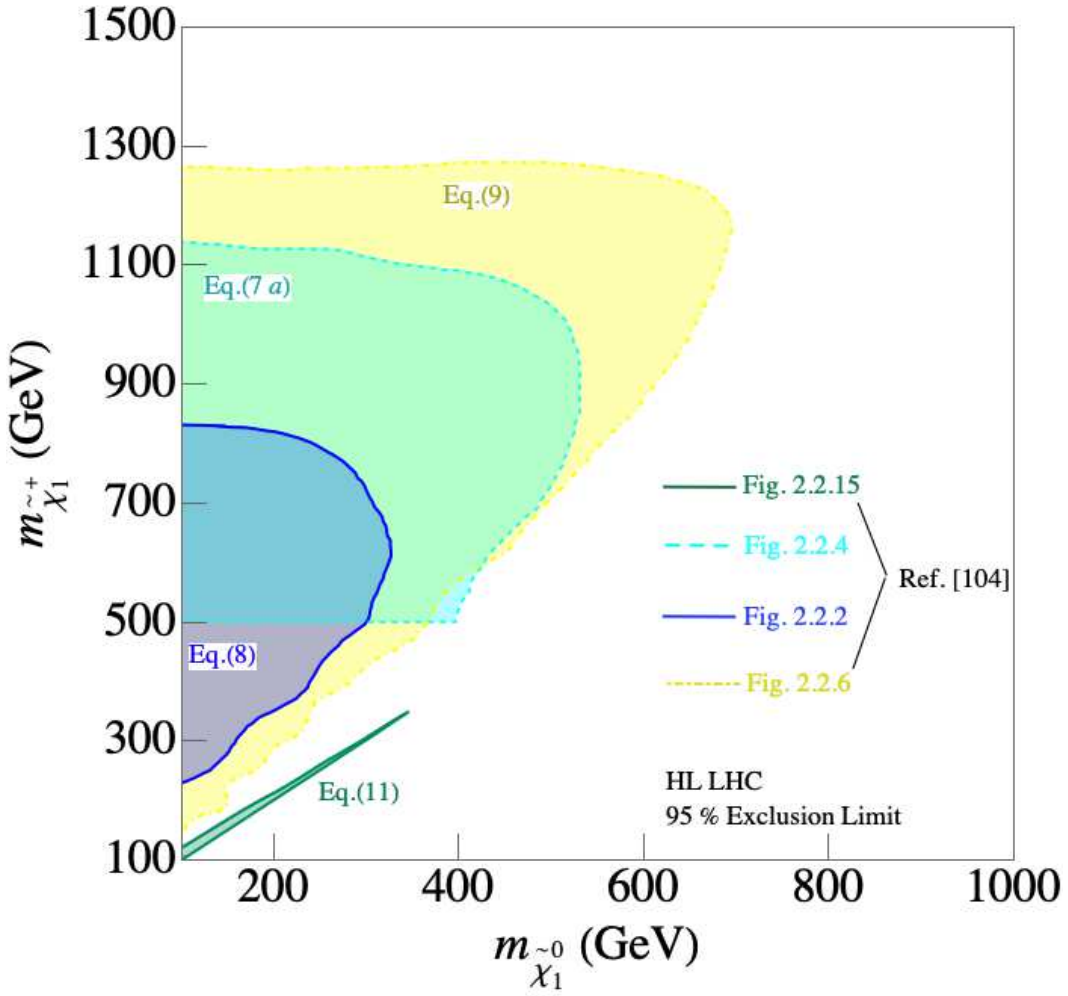
Possible predictions for future colliders:

- Run 3/HL-LHC direct search projections ⇐ focus
- Run 3/HL-LHC searches for compressed spectra ⇐ focus
- future collider prospects for compressed spectra
- direct production at e^+e^- colliders
- ...

LHC exclusion bounds vs. HL-LHC exclusion bounds

⇒ not all channels available [*YR18*]



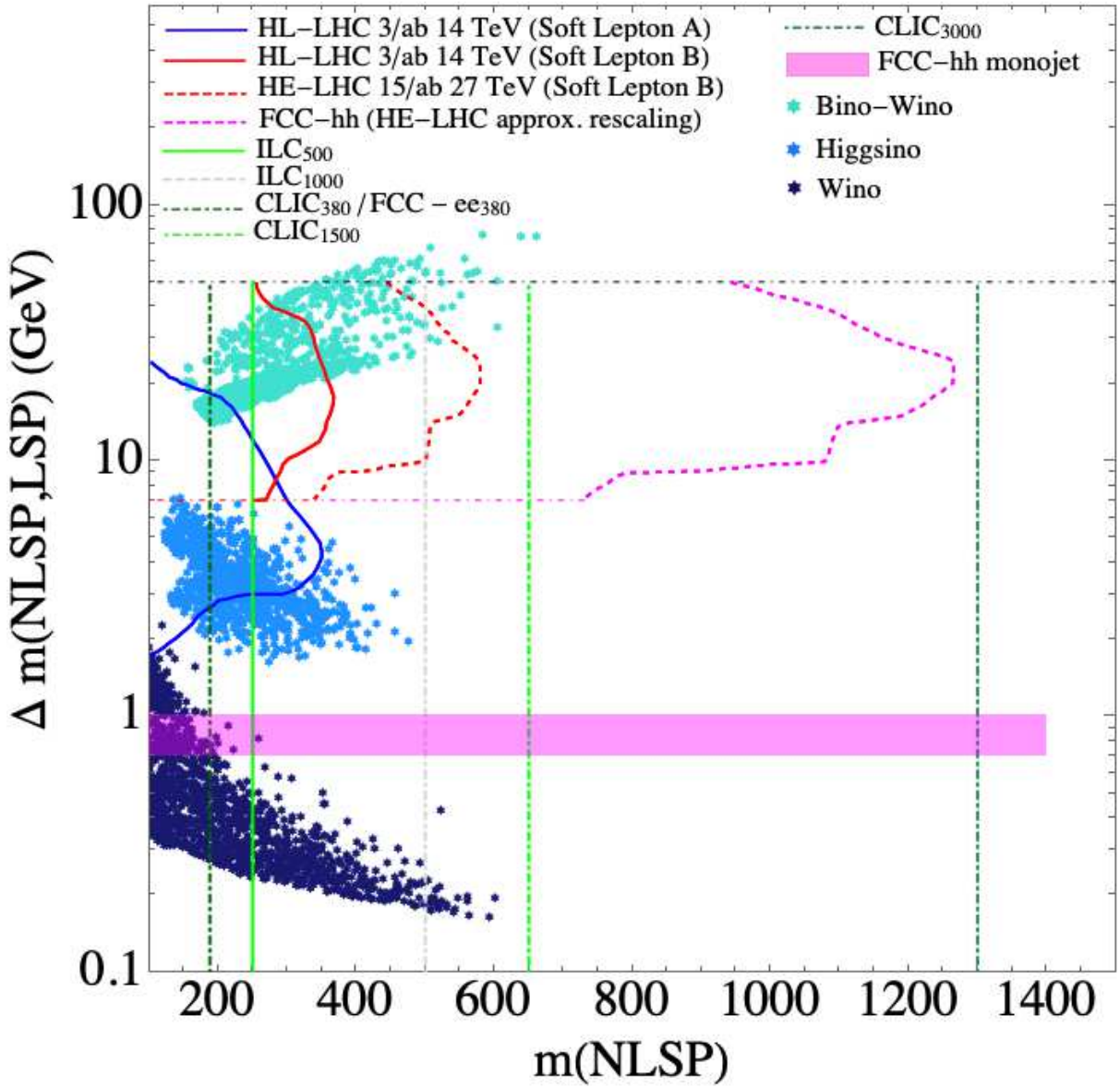


⇒ exclusion reach can be important

⇒ no CheckMate inclusion available . . .

Compressed spectra at current and future colliders

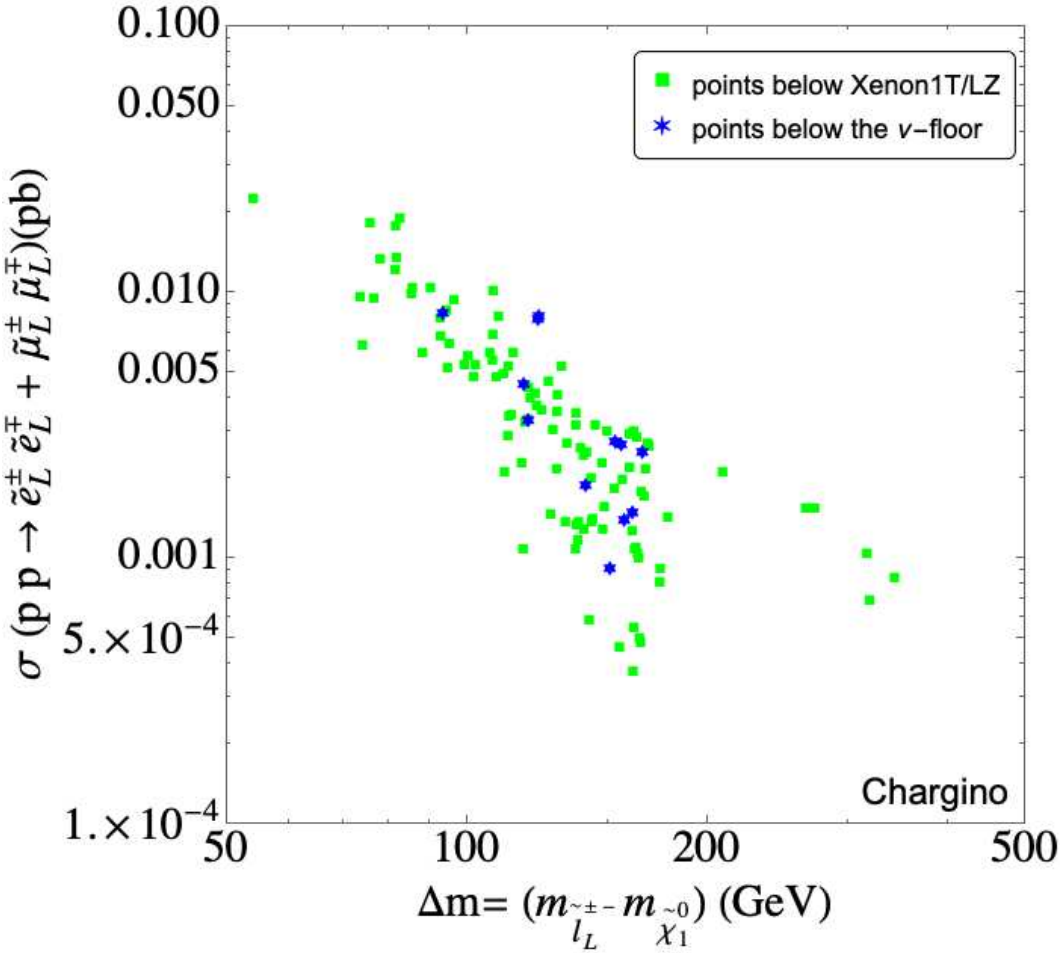
Higgsino, wino and bino/wino DM:

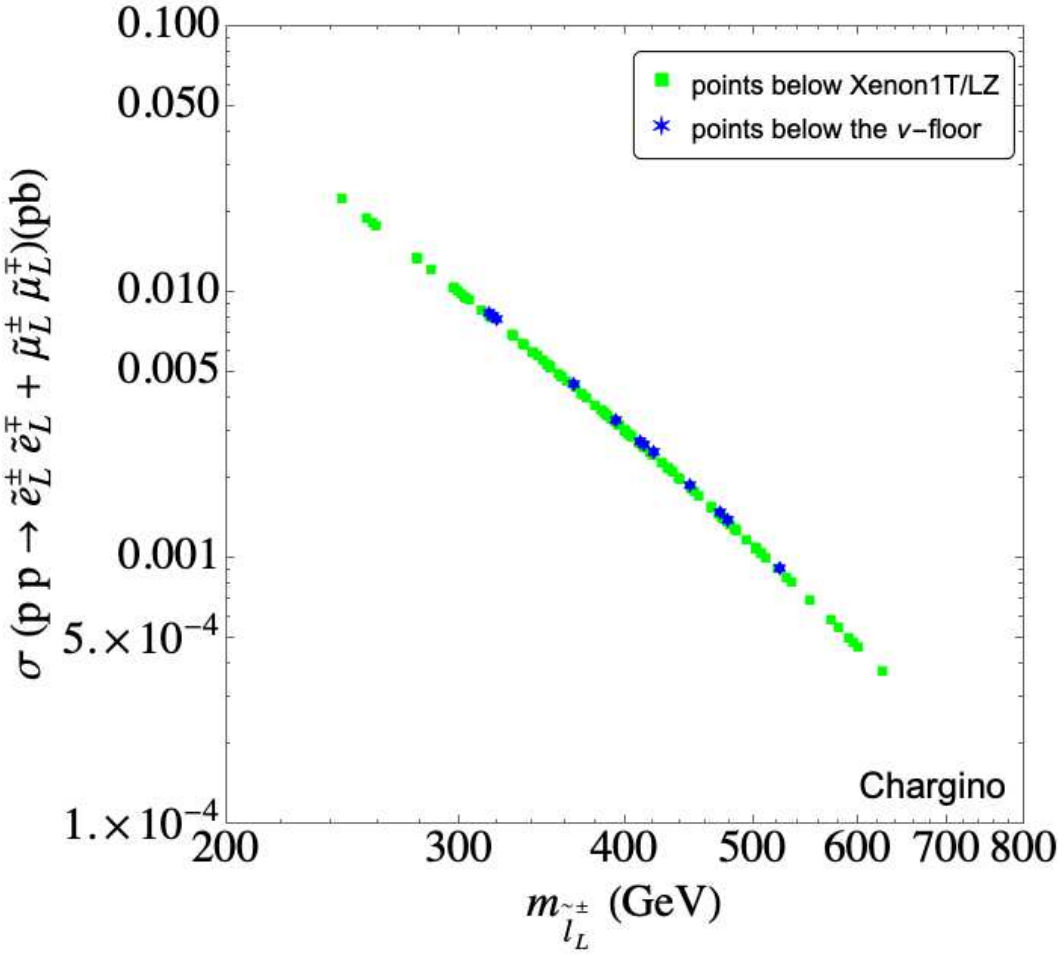


HL-LHC searches very powerful, but not all points covered

(HL-)LHC non-compressed cross sections for $\tilde{\chi}_1^{\pm}$-coannihilation:

⇒ points not covered by Direct Detection experiments: *[PRELIMINARY]*





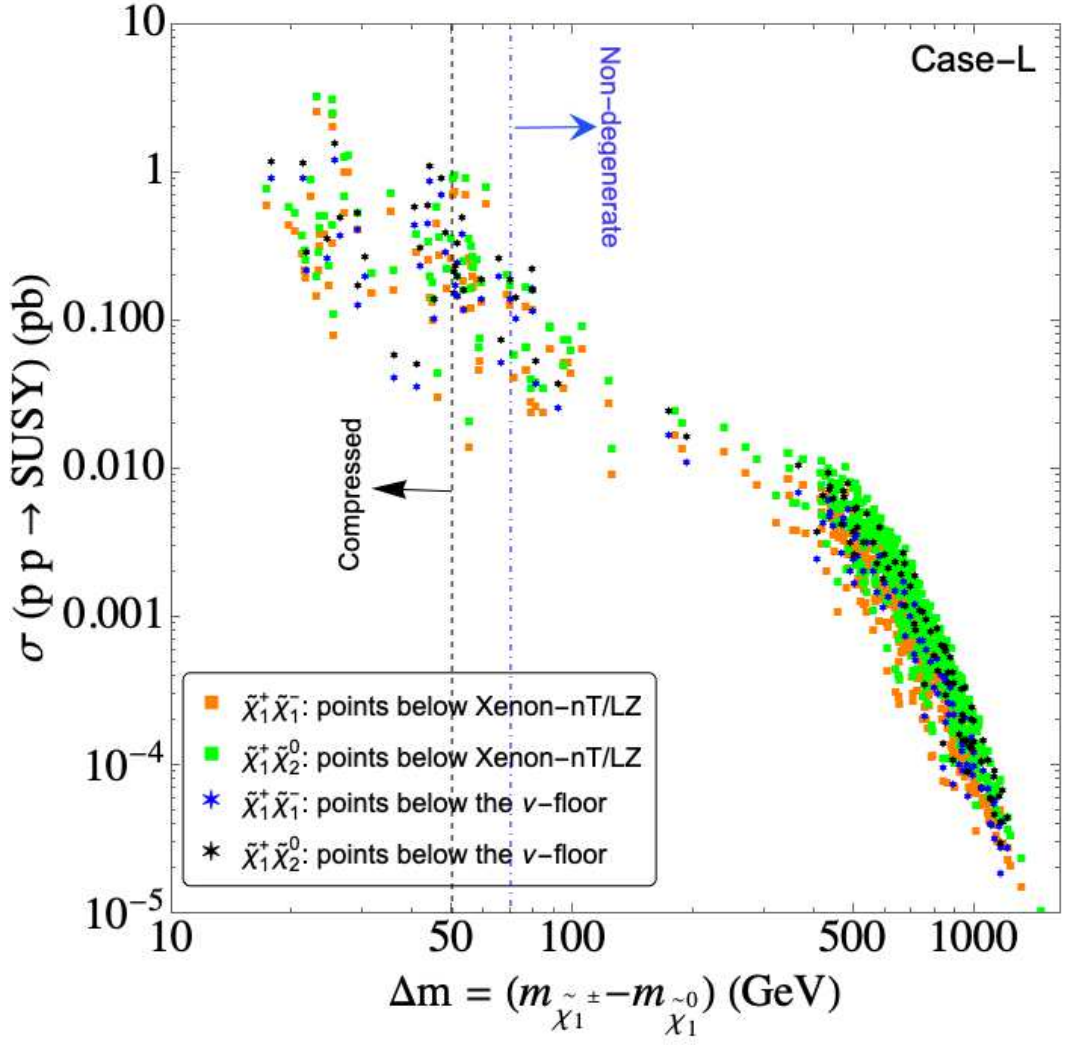
⇒ XS above 0.4 fb ⇒ more than 1200 events

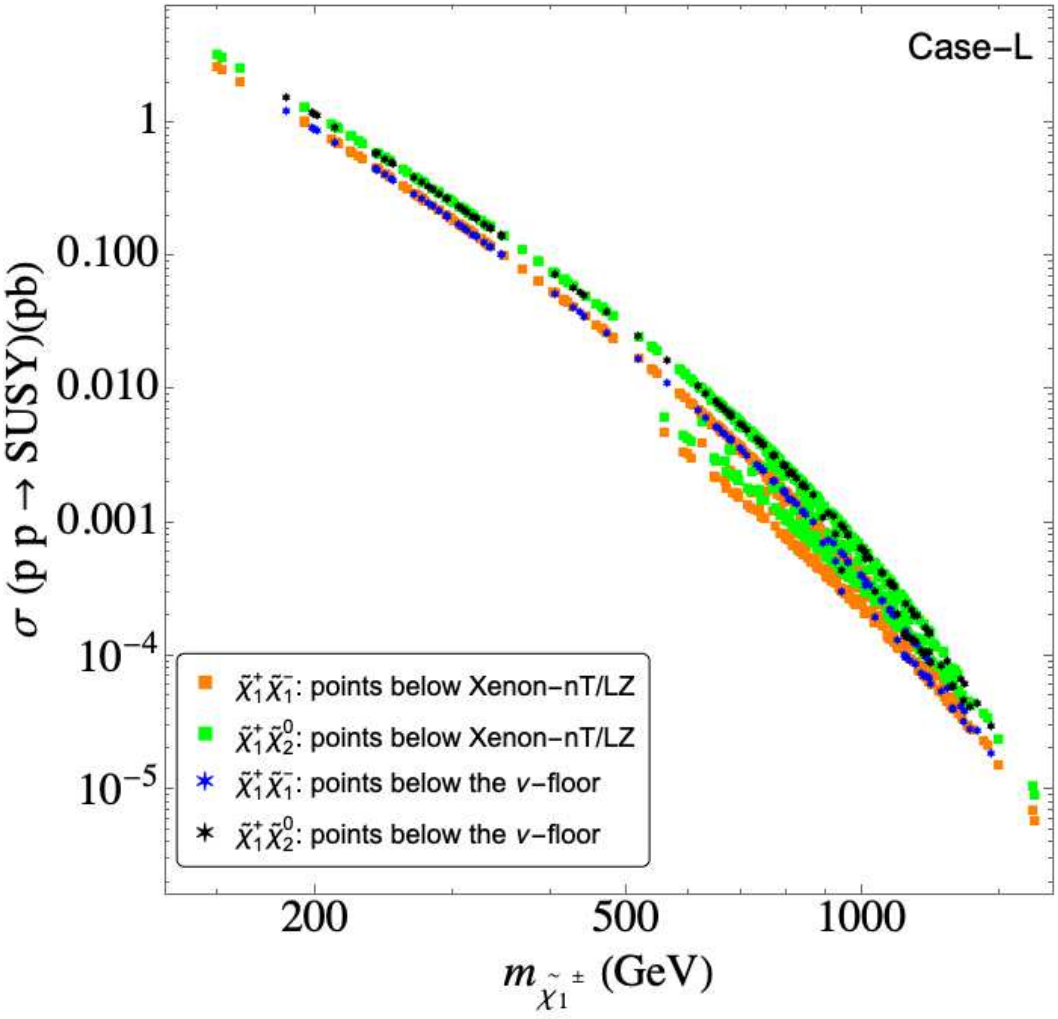
⇒ even better for "BNF" points: XS above 1 fb

But: detailed (HL-)LHC analysis missing! (spectra not too compressed!)

(HL-)LHC cross sections for $\tilde{l}$-coannihilation case-L: [*PRELIMINARY*]

⇒ points not covered by Direct Detection experiments:



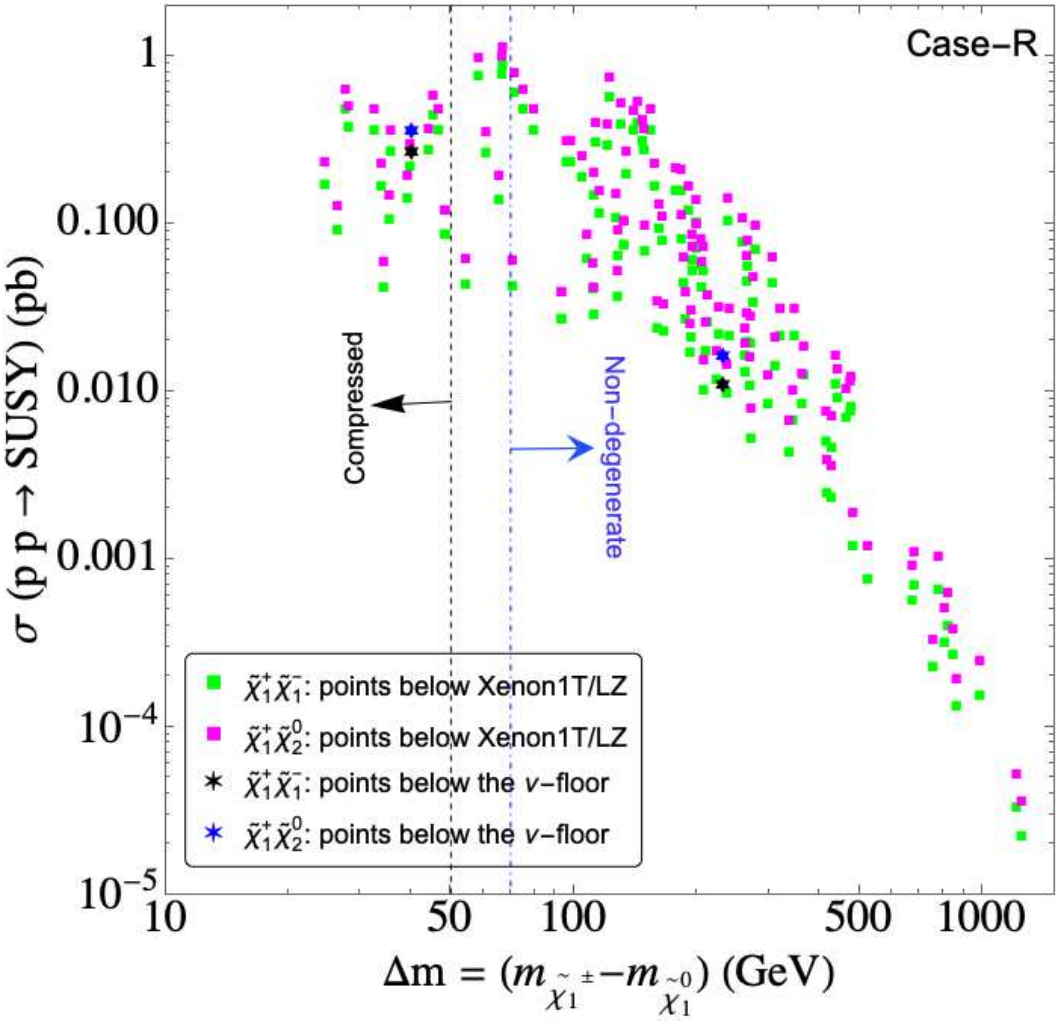


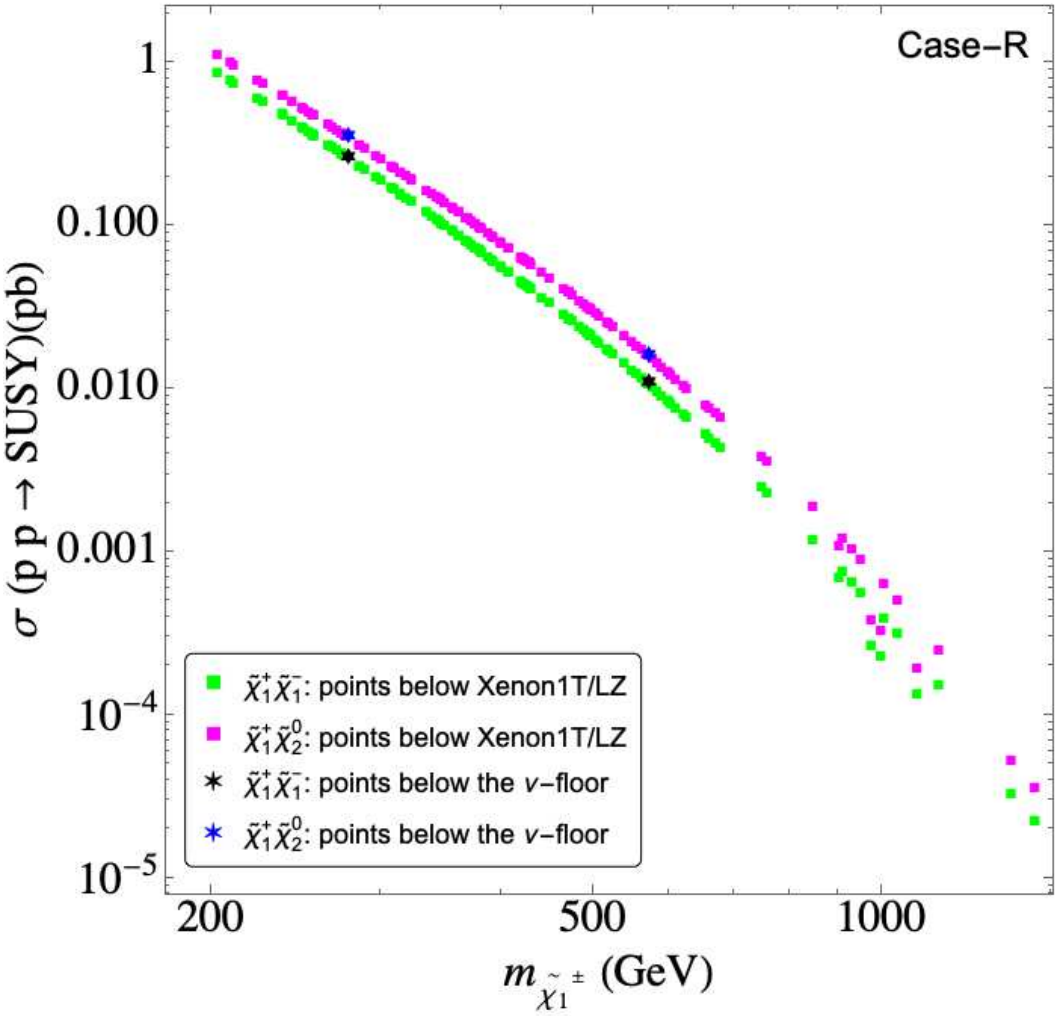
⇒ XS above 0.01 fb ⇒ more than 30 events

⇒ no improvement for "BNF" points!

(HL-)LHC cross sections for $\tilde{l}$-coannihilation case-R: *[PRELIMINARY]*

⇒ points not covered by Direct Detection experiments:





⇒ XS above 0.04 fb ⇒ more than 120 events

⇒ very good for "BNF" points: XS above 10 fb

But: detailed (HL-)LHC analysis missing! (spectra can be compressed!)

5. Conclusinos

- new $(g-2)_\mu$ result confirms old deviation from the SM $\Rightarrow 4.2\,\sigma$
  $(g-2)_\mu$ is real $\Rightarrow$ (relatively) light EW particles
- MSSM:
  - scan the EW sector of the MSSM with all constraints:
    $(g-2)_\mu$, DM relic density, DM DD, LHC EW searches
  - upper limits on EW masses $\Rightarrow$ evaluate future prospects

  LHC searches included via CheckMate $\Rightarrow$ crucial!
- A) bino/wino DM with chargino coann.: $M_1 \lesssim M_2$ (DM full)
  B/C) bino DM with slepton coann.: $M_1 \lesssim M_{\tilde{l}_L}, M_{\tilde{l}_R}$ (DM full)
  D) higgsino DM: $\mu < M_1, M_2$ $m_{\tilde{\chi}_1^0} \sim m_{\tilde{\chi}_2^0} \sim m_{\tilde{\chi}_1^\pm} \sim \mu$ (DM upper limit)
  E) wino DM: $M_2 < M_1, \mu$ $m_{\tilde{\chi}_1^0} \sim m_{\tilde{\chi}_1^\pm} \sim M_2$ (DM upper limit)

  $\Rightarrow$ clear upper limits, $m_{\text{(N)LSP}} \lesssim 600$ GeV confirmed
- Prospects for Run3/HL-LHC:
  - compressed spectra:
    good HL-LHC prospects, but not everything covered
  - points not covered by Direct Detection experiments:
    below X-nT/LZ: XS go down to $0.1 - 0.01$ fb $\Rightarrow$ prospects unclear


Further Questions?