

# Status of Muon $g-2$ in the MSSM

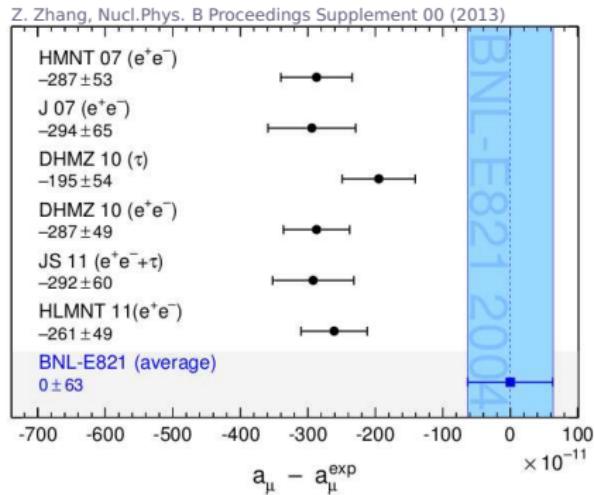
Andre Lessa  
University of Sao Paulo

SUSY13, Trieste - August 27th, 2013

# $g-2$ and New Physics

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$$a_\mu^{SM}(\tau) = (18.6 \pm 8) \times 10^{-10} (2.3\sigma)$$

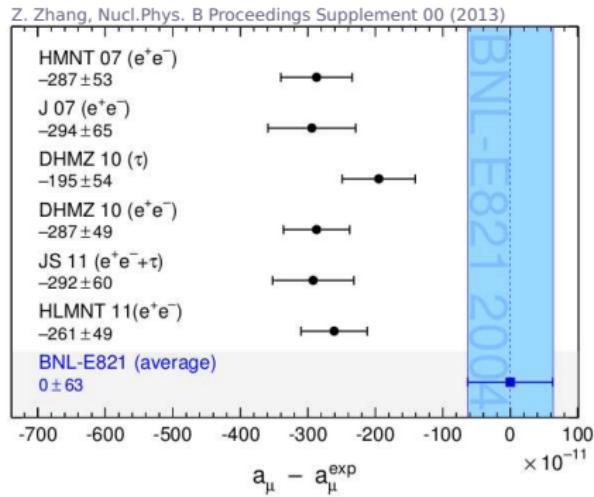


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(E. Jegerlehner and R. Szafron, Eur.Phys.J. C71 (2011) 1632), M. Benayoun Nucl.Phys.Proc.Suppl. 225-227 (2012) 288-292)
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- $g-2$  is one of the few *experimental motivations* for BSM physics

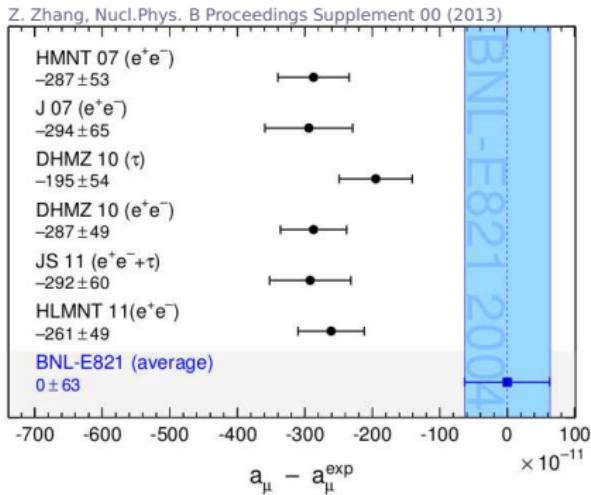


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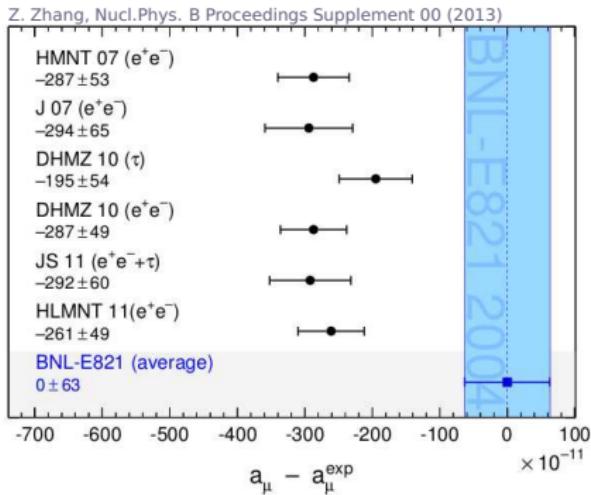


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*What is the status of  $g-2$  in the (unconstrained) MSSM?*

# Outline

- $g-2$  in the MSSM

- Dark Matter Constraints

- LHC Constraints

- Future Prospects

# $g-2$ in the MSSM

- Main MSSM contributions:

$$\tilde{W}^-, \tilde{H}^- \begin{array}{c} \nearrow \gamma \\ \text{---} \\ \mu \end{array} \tilde{\nu} + \begin{array}{c} \nearrow \gamma \\ \text{---} \\ \mu \end{array} \tilde{W}, \tilde{H}, \tilde{B} \simeq 12 \times 10^{-10} \frac{\tan \beta}{60} \frac{(775 \text{ GeV})^2}{M_2 \mu} \mathcal{O}(1)$$

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- Only depends on the EW gaugino and slepton sectors:  
 $\mu, M_1, M_2, m_{\tilde{\mu}_{L,R}}, \tan \beta$

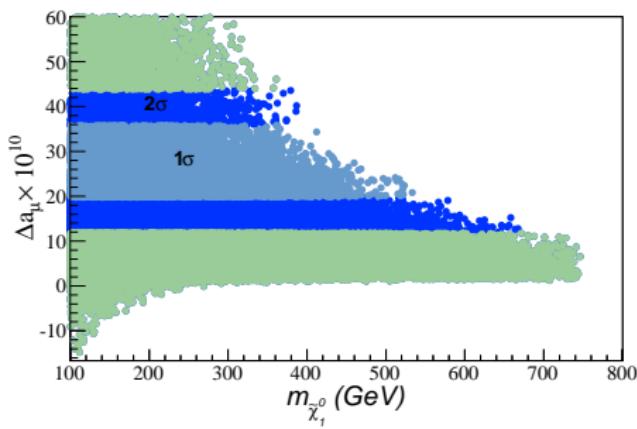
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 $\mu, M_1, M_2, m_{\tilde{\mu}_{L,R}}, \tan \beta$
- $m_{LSP} \lesssim 530 \text{ GeV}$  ( $670 \text{ GeV}$ ) at  $1\sigma$  ( $2\sigma$ )

General scan ( $\tilde{\chi}_1^0$  LSP):



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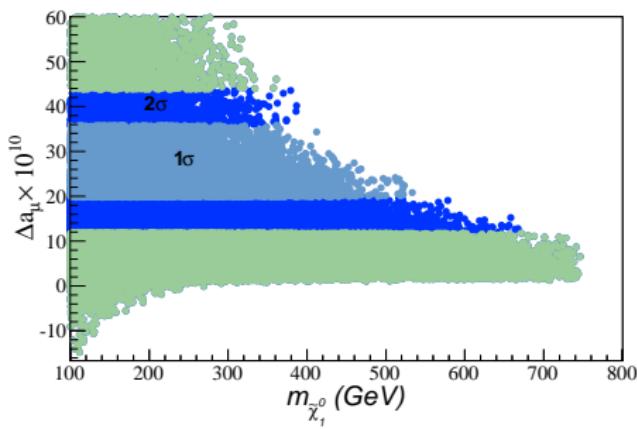
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*$g-2$  by itself does not guarantee a visible spectrum at the LHC-Run I*

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# $g-2$ in the MSSM

- Correlation with flavor observables:

$$\frac{b \tilde{H}^- \tilde{t}}{s \tilde{t}} + \frac{b \tilde{H}^- \tilde{b}}{s \tilde{b}} \propto \frac{\mu A_t}{m_{\tilde{t}}^2} \tan \beta$$

$(\Delta m_h^2 \propto \ln \left( \frac{m_{\tilde{t}}^2}{m_t} \right) + \frac{A_t^2}{m_{\tilde{t}}^2})$   
 $\rightarrow \text{large } A_t/m_{\tilde{t}} \text{ or } m_{\tilde{t}}/m_t$

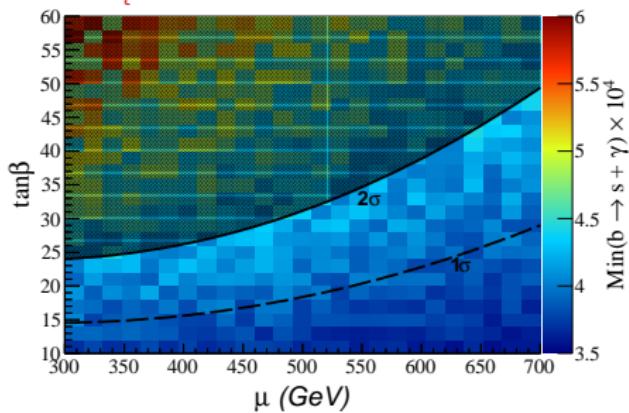
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- Correlation with flavor observables:

$$\text{Diagram 1: } b \tilde{H}^- \rightarrow s \gamma + b \tilde{H} \rightarrow s \gamma \propto \frac{\mu A_t}{m_{\tilde{t}}^2} \tan \beta$$
$$(\Delta m_h^2 \propto \ln \left( \frac{m_{\tilde{t}}^2}{m_t} \right) + \frac{A_t^2}{m_{\tilde{t}}^2})$$

→ large  $A_t/m_{\tilde{t}}$  or  $m_{\tilde{t}}/m_t$

$m_{\tilde{t}} = 1 \text{ TeV}$ :

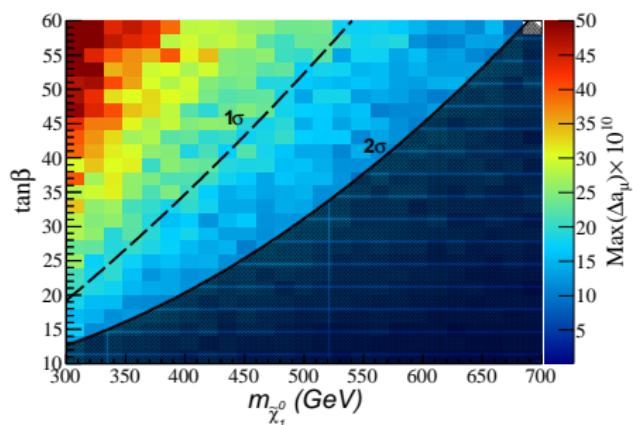
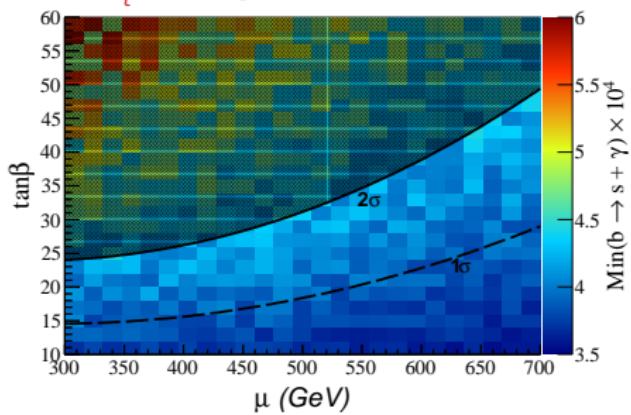


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$$\begin{array}{c} \text{Feynman diagram: } b \tilde{t} \rightarrow s \tilde{H}^- \gamma + b \tilde{t} \rightarrow \tilde{b} s \tilde{H} \gamma \\ \text{Correlation: } \propto \frac{\mu A_t}{m_{\tilde{t}}^2} \tan \beta \end{array}$$
$$(\Delta m_h^2 \propto \ln \left( \frac{m_{\tilde{t}}^2}{m_t} \right) + \frac{A_t^2}{m_{\tilde{t}}^2})$$
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Correlated if  $\mu \sim m_{\tilde{\chi}_1^0}$  (Higgsino LSP)

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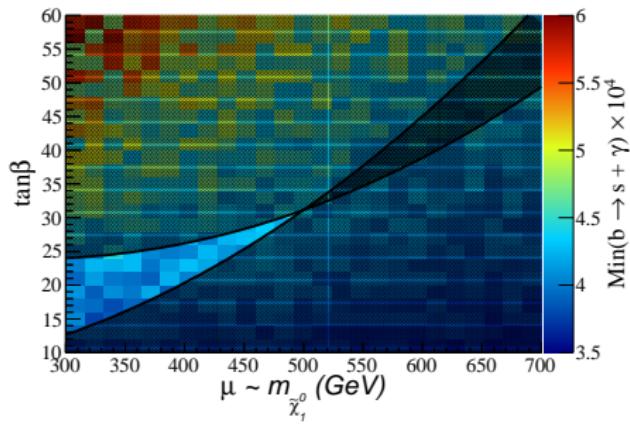
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  - ▶ In particular, the higgsino solution ( $\tilde{\chi}_1^0 \sim \tilde{H}$ ):
    - ★ is “favored” by Naturalness (small  $\mu$ )
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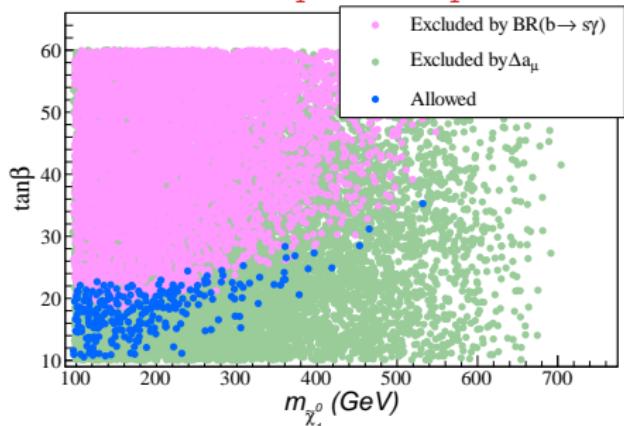
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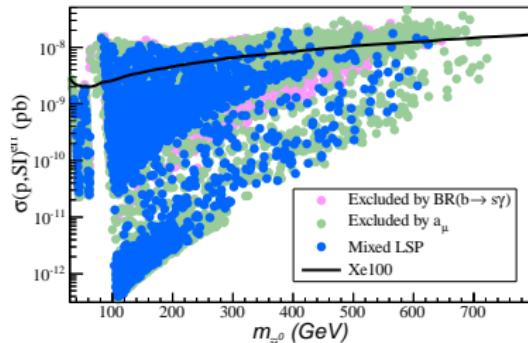
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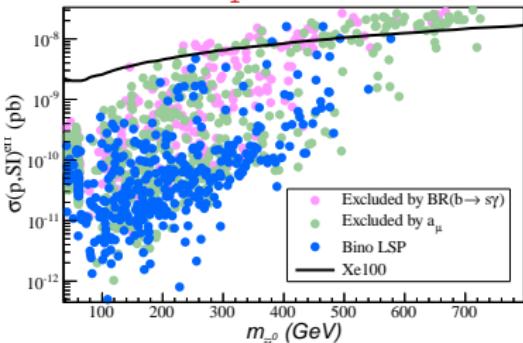
# Dark Matter Constraints: Xe100

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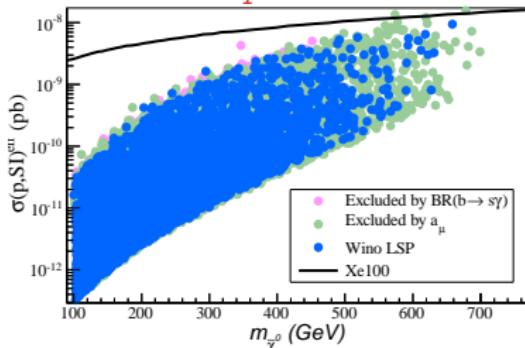
Mixed  $\tilde{\chi}_1^0$ :



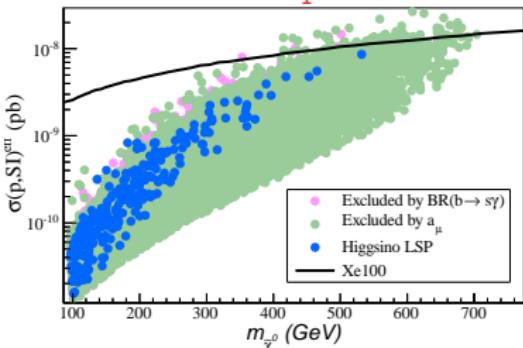
Bino  $\tilde{\chi}_1^0$  ( $m_{\tilde{\chi}_1^0} \simeq M_1$ ):



Wino  $\tilde{\chi}_1^0$  ( $m_{\tilde{\chi}_1^0} \simeq M_2$ ):



Higgsino  $\tilde{\chi}_1^0$  ( $m_{\tilde{\chi}_1^0} \simeq \mu$ ):



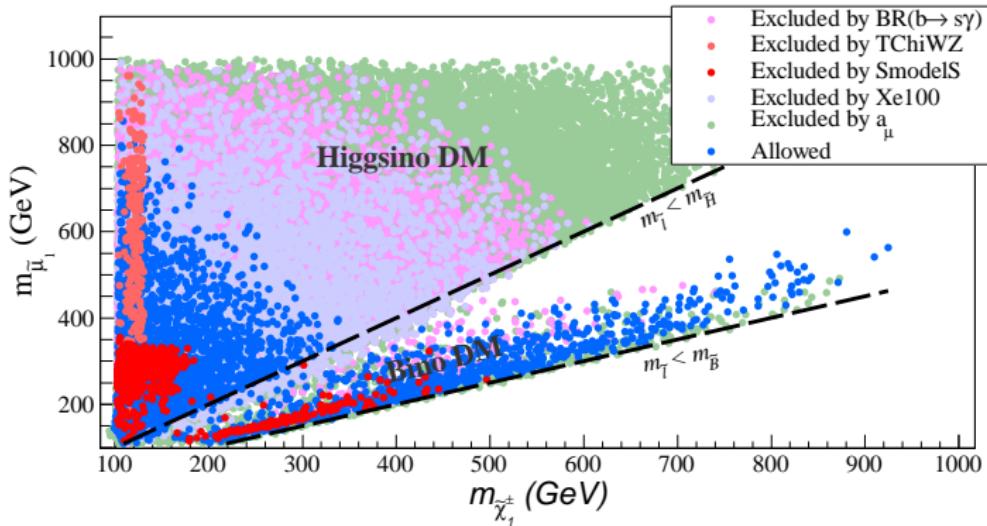
# LHC Constraints: $M_2 = 2M_1$ case

- For simplicity we take  $M_2 = 2M_1$  (no Wino LSP, small  $\tilde{W}$  contribution to  $a_\mu$ )
- No strong sector constraints ( $m_{\tilde{g}} = 1.5$  TeV and  $m_{\tilde{q}} = 2$  TeV)
- Degenerate sleptons (but  $m_{\tilde{l}_L} \neq m_{\tilde{l}_R}$ )
- $\sim 15$  LHC analyses for EW gauginos and sleptons
- Constraints on simplified models are implemented through SmodelS\*

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  - ▶  $\tilde{\tau}$  coannihilation:
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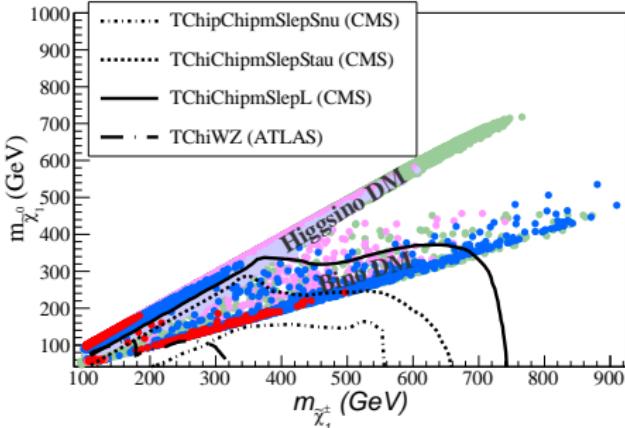
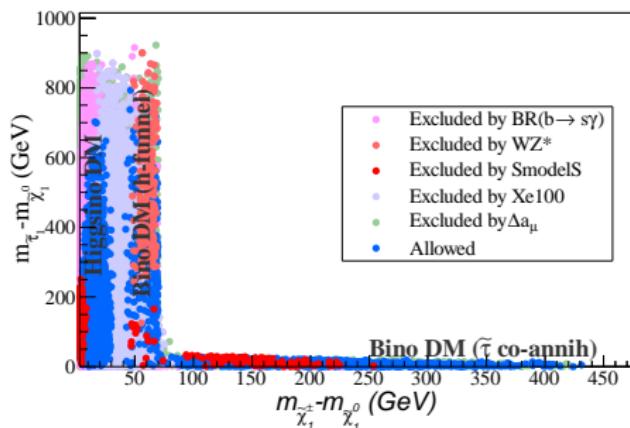
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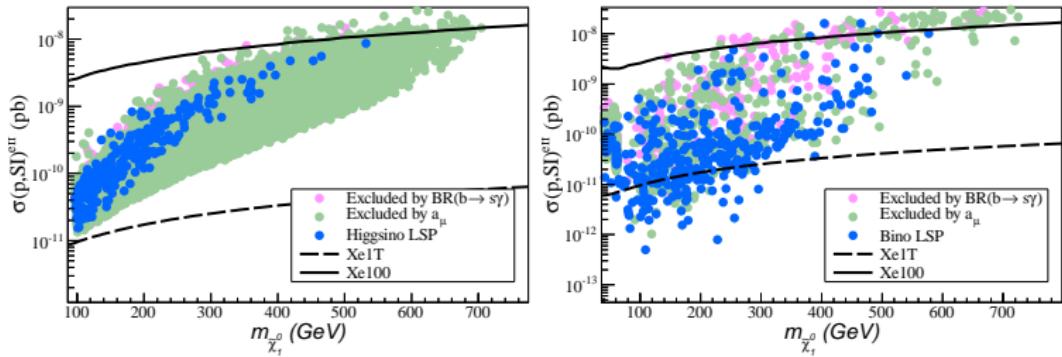
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- Xe1T will exclude all the  $\tilde{H}$  and most of the  $\tilde{B}$  solutions (2015-)



# Future Prospects

- Indirect Detection constraints start to exclude  $\tilde{W}$  LSP
- Collider searches are complementary:
  - ▶ Light  $\tilde{B}, \tilde{W}$  ( $m_{\tilde{\chi}_1^0} \lesssim 350$  GeV)
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*In these cases non-compressed scenarios are possible and more easily testable...  
...but it will be much more difficult to fully test the MSSM as a solution to  $g-2$  at the Run II*

Grazie!

SUSY 2013

