The light stop window

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HASCO 2014

01.08.2014

arXiv:1212.6847v1 [hep-ph]

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Light: SUSY predicts **two stop mass eigenstates**

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Predictions for the **SUSY mass spectrum** based on...

- Recent measurement of $m_h = 126\,\text{GeV}$, Higgs decay rates
- Experimental flavor physics
- Theoretical arguments (renormalisation group)
- Cosmological arguments (Dark Matter)

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...giving a parameter window which is...

- Consistent with current data
- Naturally emerging from theory
- Predicts correct DM thermal abundance
- Observable at LHC14

SUSY prediction for lightest Higgs

$$m_h{}^2 = m_Z{}^2 \cos^2\beta + \frac{3 y_t{}^2 m_t{}^2}{(4\pi)^2}\left[\log\left(\frac{m_S{}^2}{m_t{}^2}\right) + X_t{}^2\left(1 - \frac{X_t{}^2}{12}\right)\right] + \ldots \quad (1)$$

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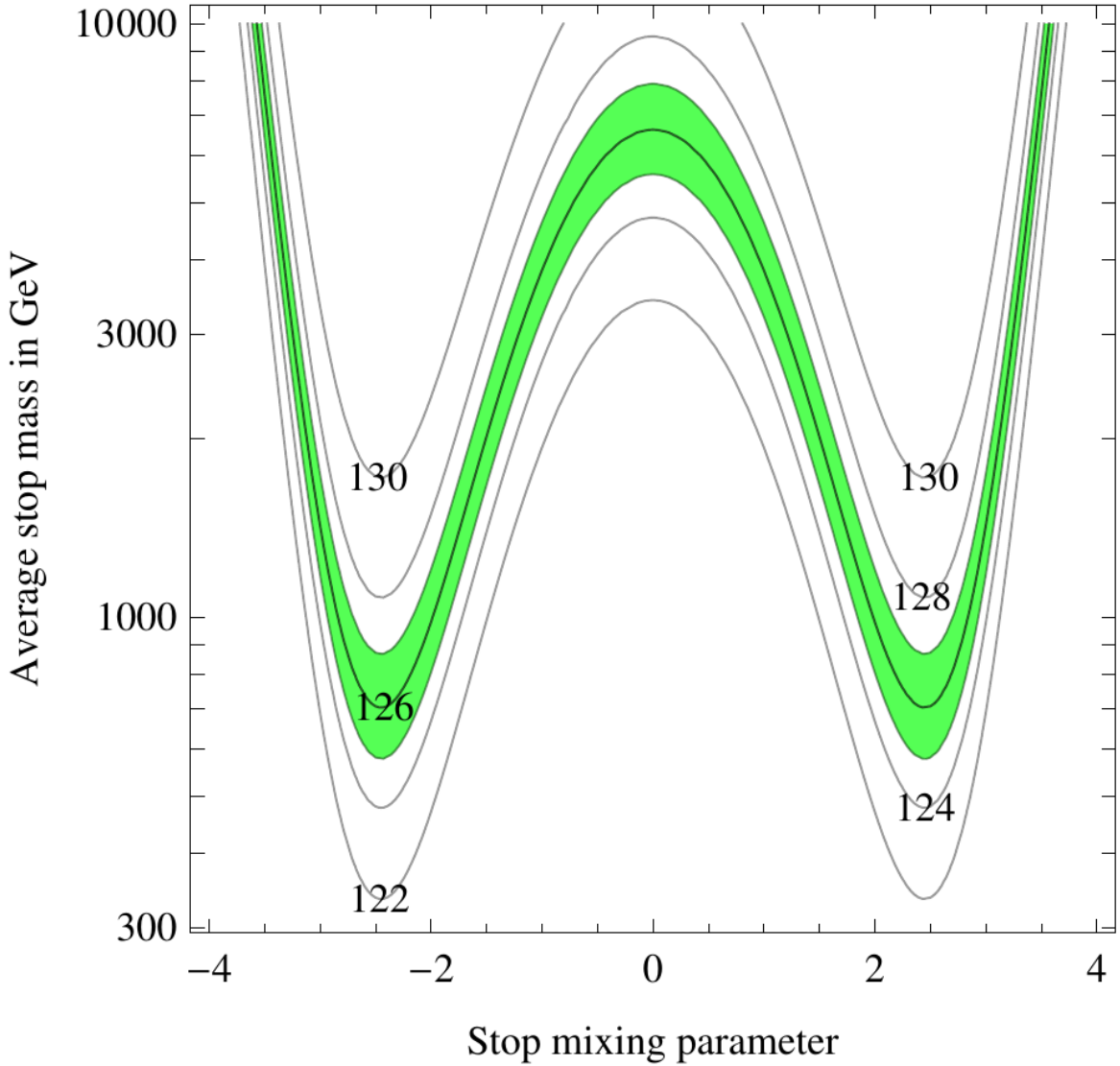
  X_t: Stop mixing parameter $X_t = (A_t + \mu \cot\beta)/m_S$

Constraints
Higgs mass



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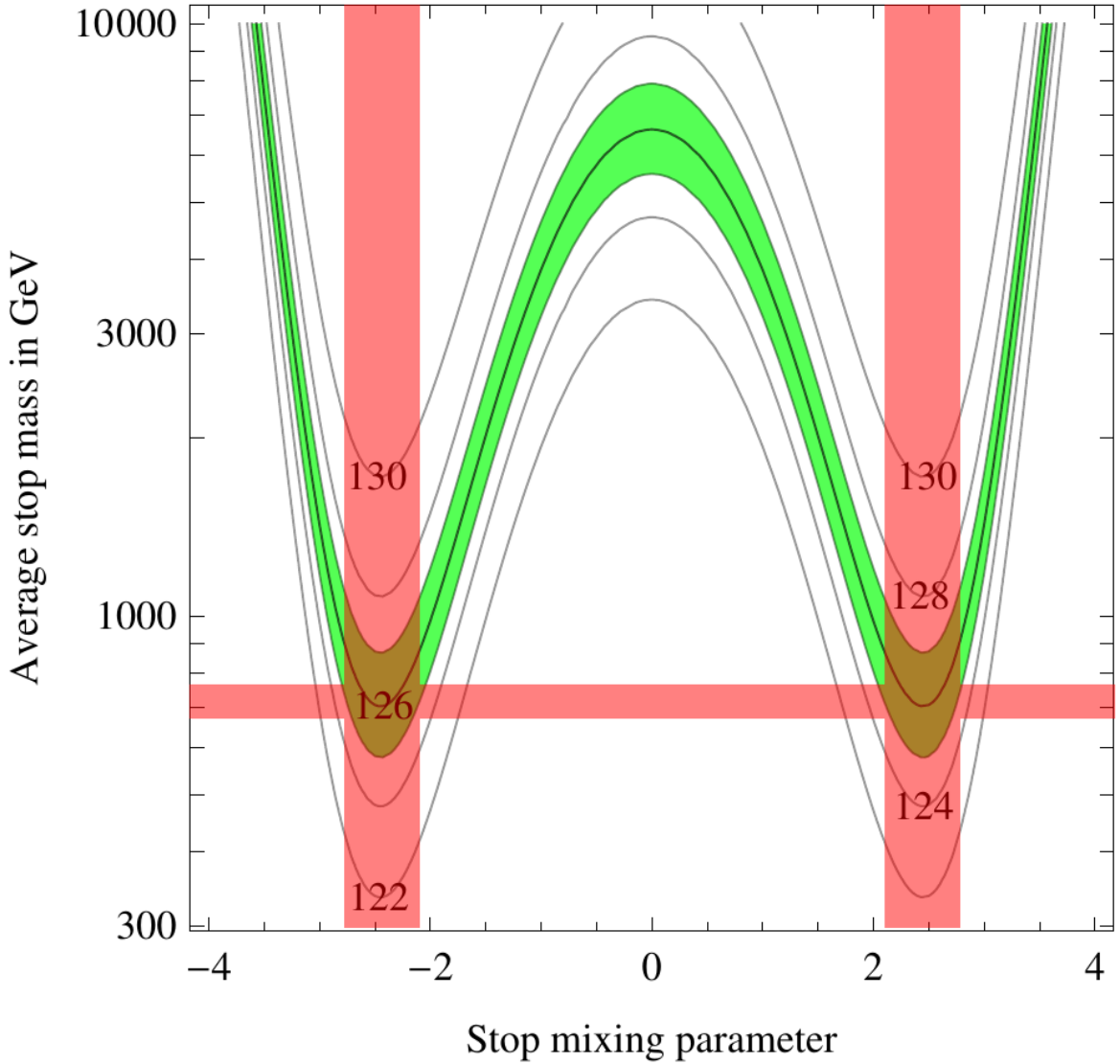

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- **"Maximal mixing"**

SUSY predicted corrections

$$\frac{\Gamma(h \leftrightarrow gg)}{\Gamma(h \leftrightarrow gg)_{\mathrm{SM}}} = (1 + \Delta_t)^2 \tag{2}$$

and

$$\frac{\Gamma(h \leftrightarrow \gamma\gamma)}{\Gamma(h \leftrightarrow \gamma\gamma)_{\mathrm{SM}}} = (1 - 0.28\Delta_t)^2 \tag{3}$$

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$$\Delta_t \approx \frac{m_t}{4}\left(\frac{1}{m^2_{\tilde{t}_1}} + \frac{1}{m^2_{\tilde{t}_2}} - \frac{X_t^2}{m_S^2}\right)$$

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From Higgs decays

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Combined

$$m_{\tilde{t}_1} \approx 200\,\text{GeV}$$
$$m_{\tilde{t}_2} \approx 1.2\,\text{TeV}$$

If we make some assumptions...

GUT scale: $m_{\tilde{t}_R} = m_{\tilde{t}_L}$

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Weak scale: $m_{H_u}^2 = -m_Z^2/2$

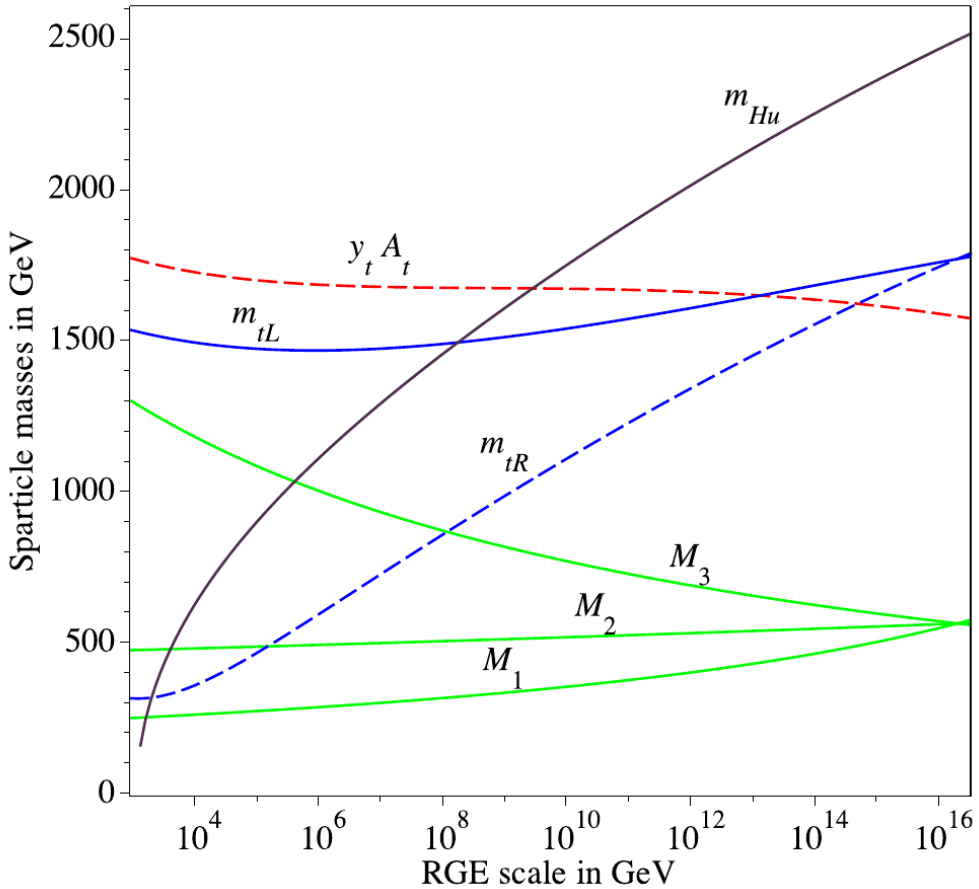
$M_3 = 1.3\,\text{TeV}$

$m_{\tilde{t}_R} < 300\,\text{GeV}$

M_1: B-ino mass

M_2: W-ino mass

M_3: Gluino mass



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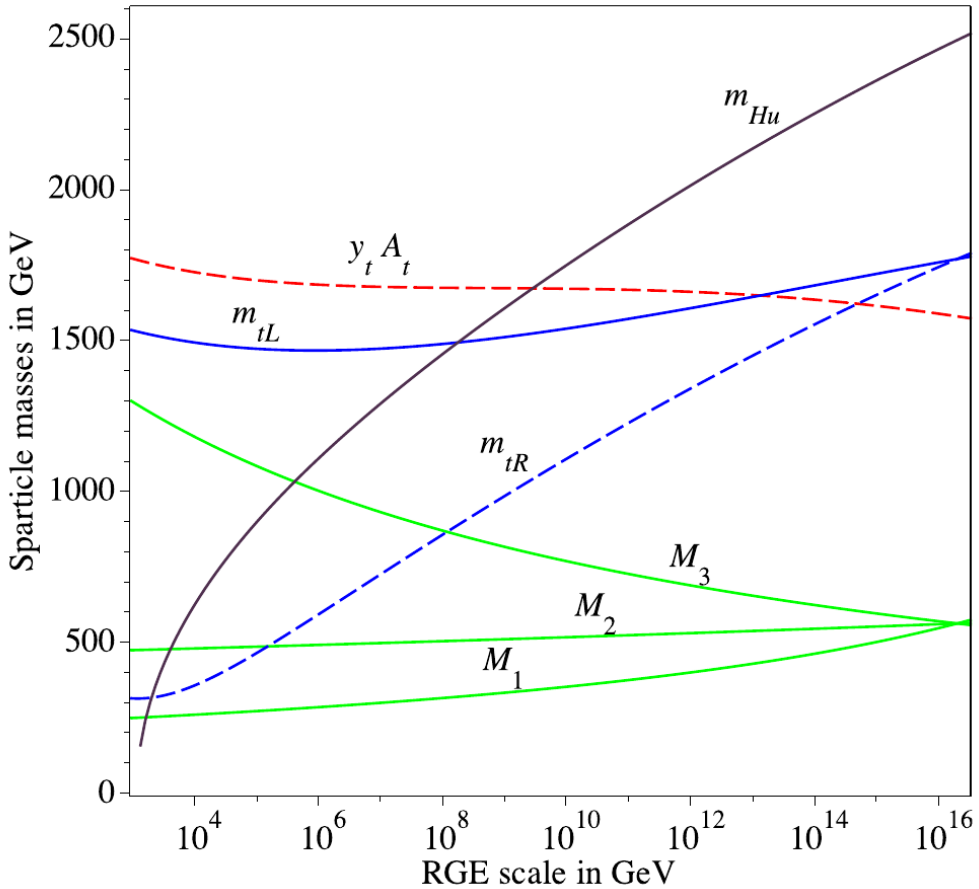
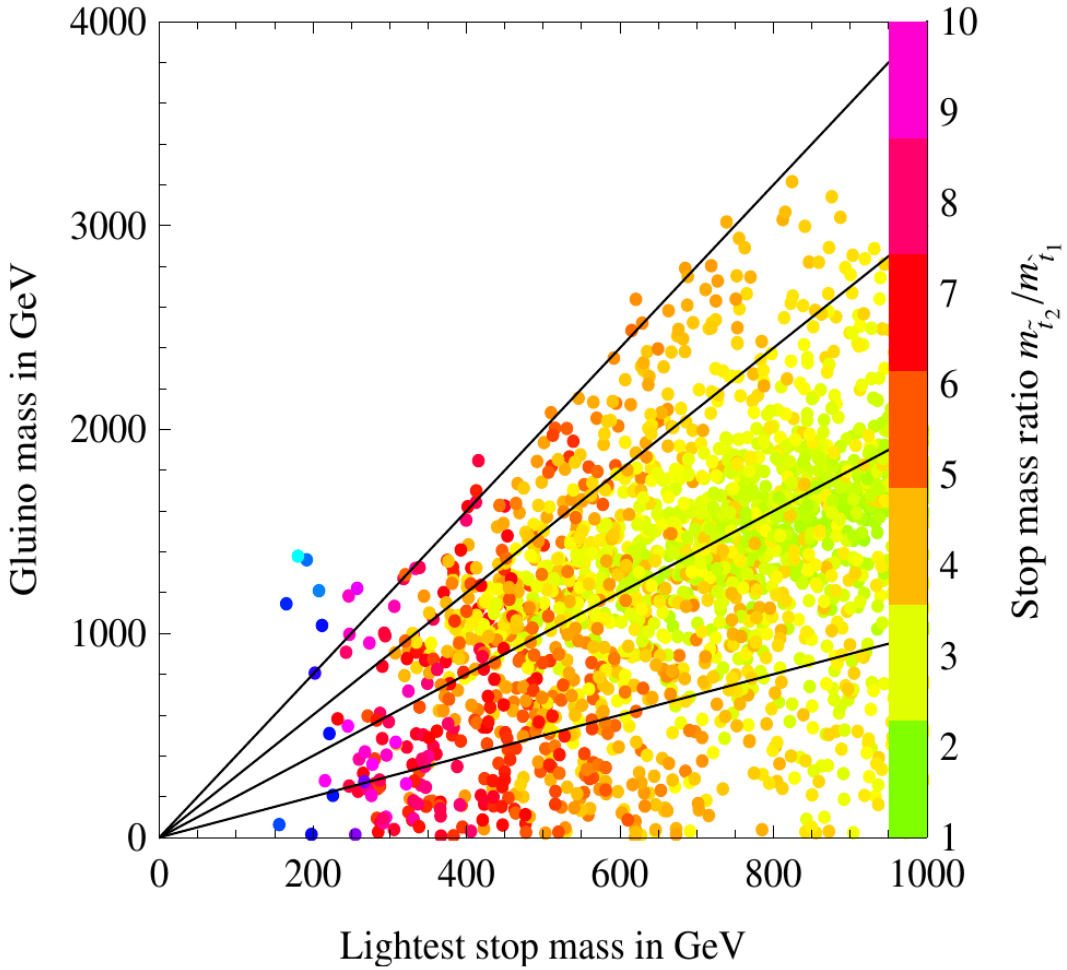


$$A_t \approx m_{\tilde{t}_L} \approx M_3 \approx 1 - 2 \text{ TeV}$$



Lines indicate $M_3/m_{\tilde{t}_1} = 1, 2, 3, 4$

The previous figure shows...

$$m_{\tilde{t}_R} \ll m_{\tilde{t}_L} \text{ at the weak scale}$$

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$$M_3 \lesssim 4 \cdot m_{\tilde{t}_1} \quad \Longrightarrow \quad M_3 \lesssim 1.6\,\text{TeV}$$

Two observables with SM predictions:

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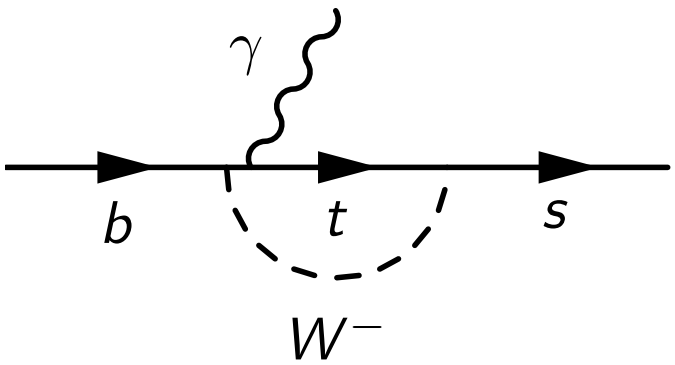
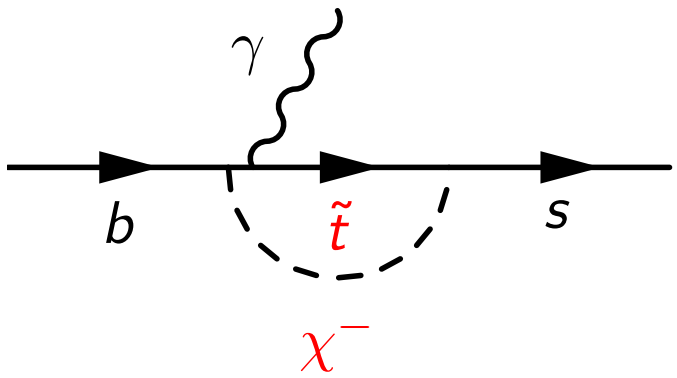
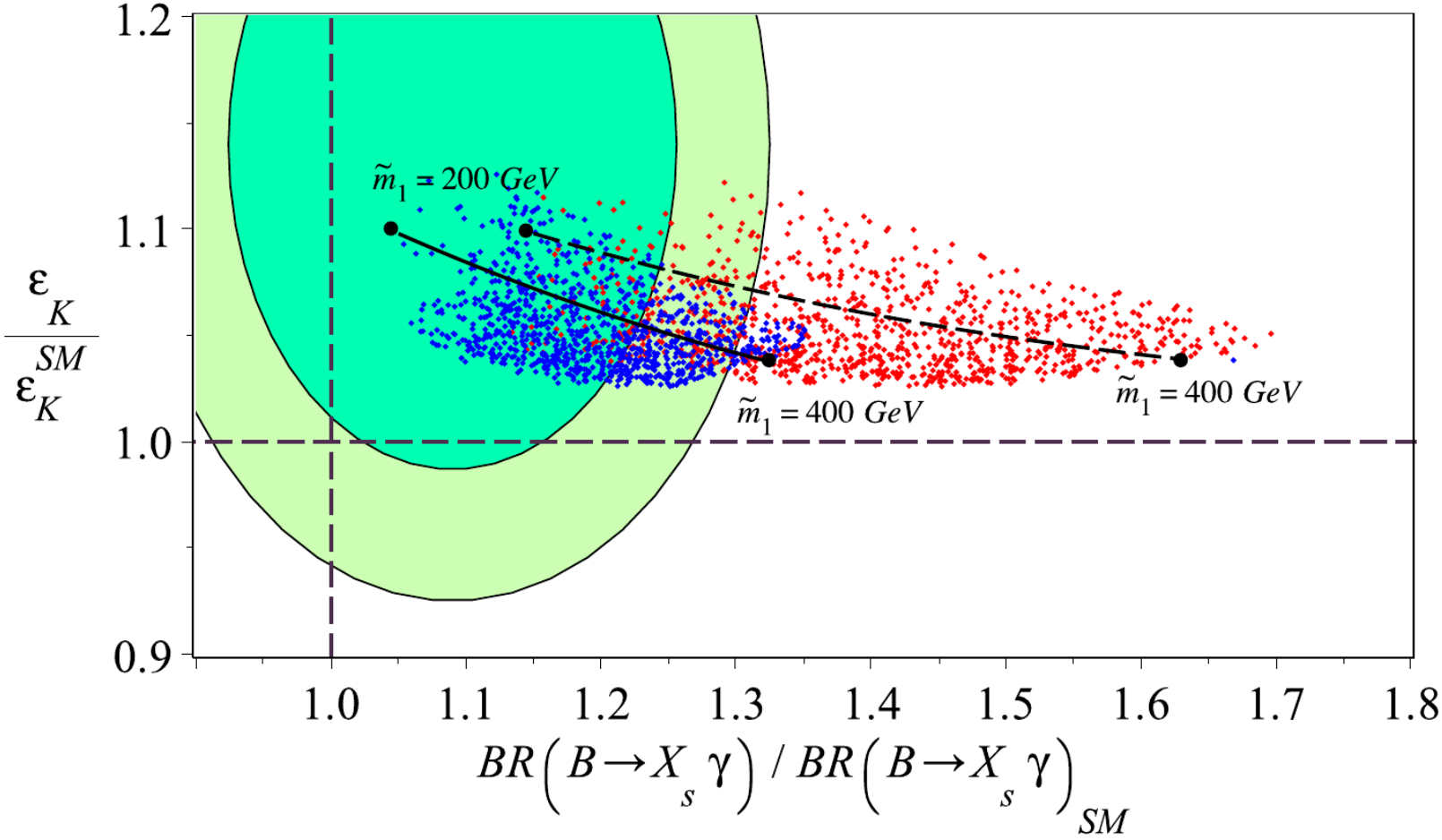
B physics: $\mathrm{BR}(B \to X_s\gamma)/\mathrm{BR}(B \to X_s\gamma)_{SM}$





SUSY correction


1.2
1.1
1.0
0.9
$\frac{\varepsilon_K}{\varepsilon_K^{SM}}$
$\tilde{m}_1 = 200\ GeV$
$\tilde{m}_1 = 400\ GeV$
$\tilde{m}_1 = 400\ GeV$
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
$BR\left(B \to X_s \gamma\right) / BR\left(B \to X_s \gamma\right)_{SM}$

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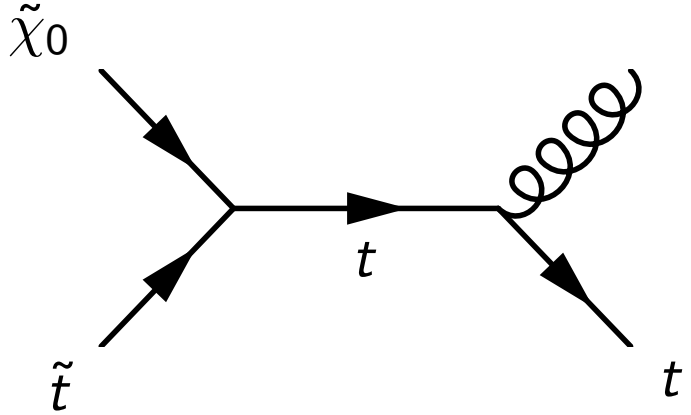

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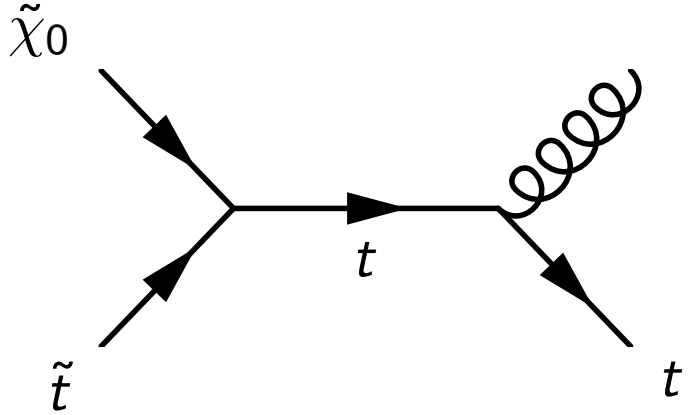

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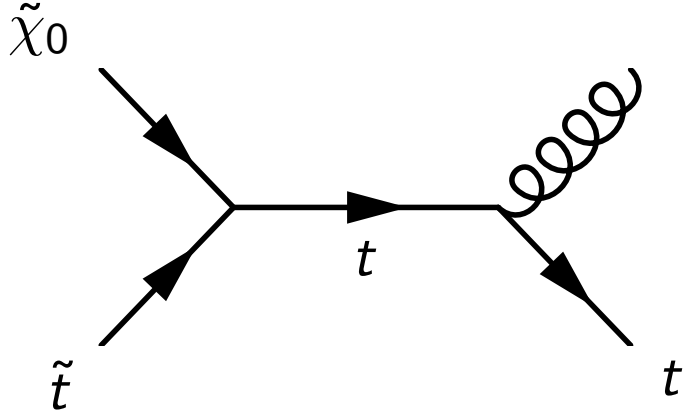

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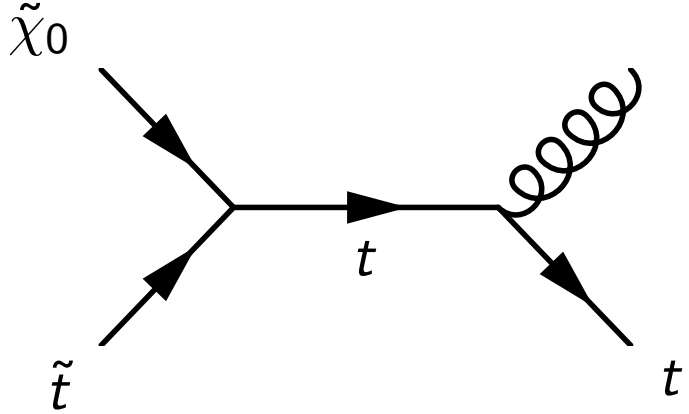

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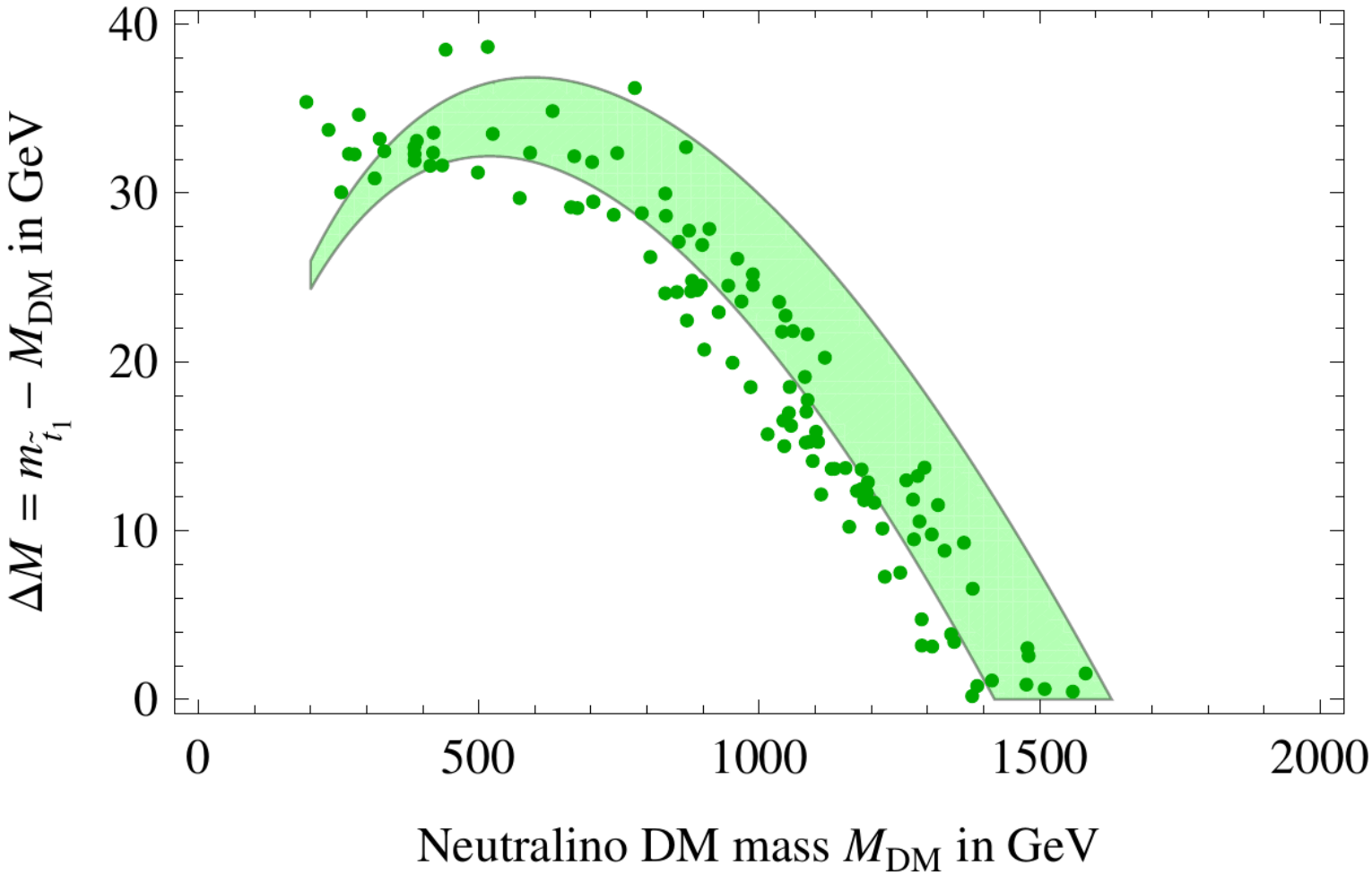
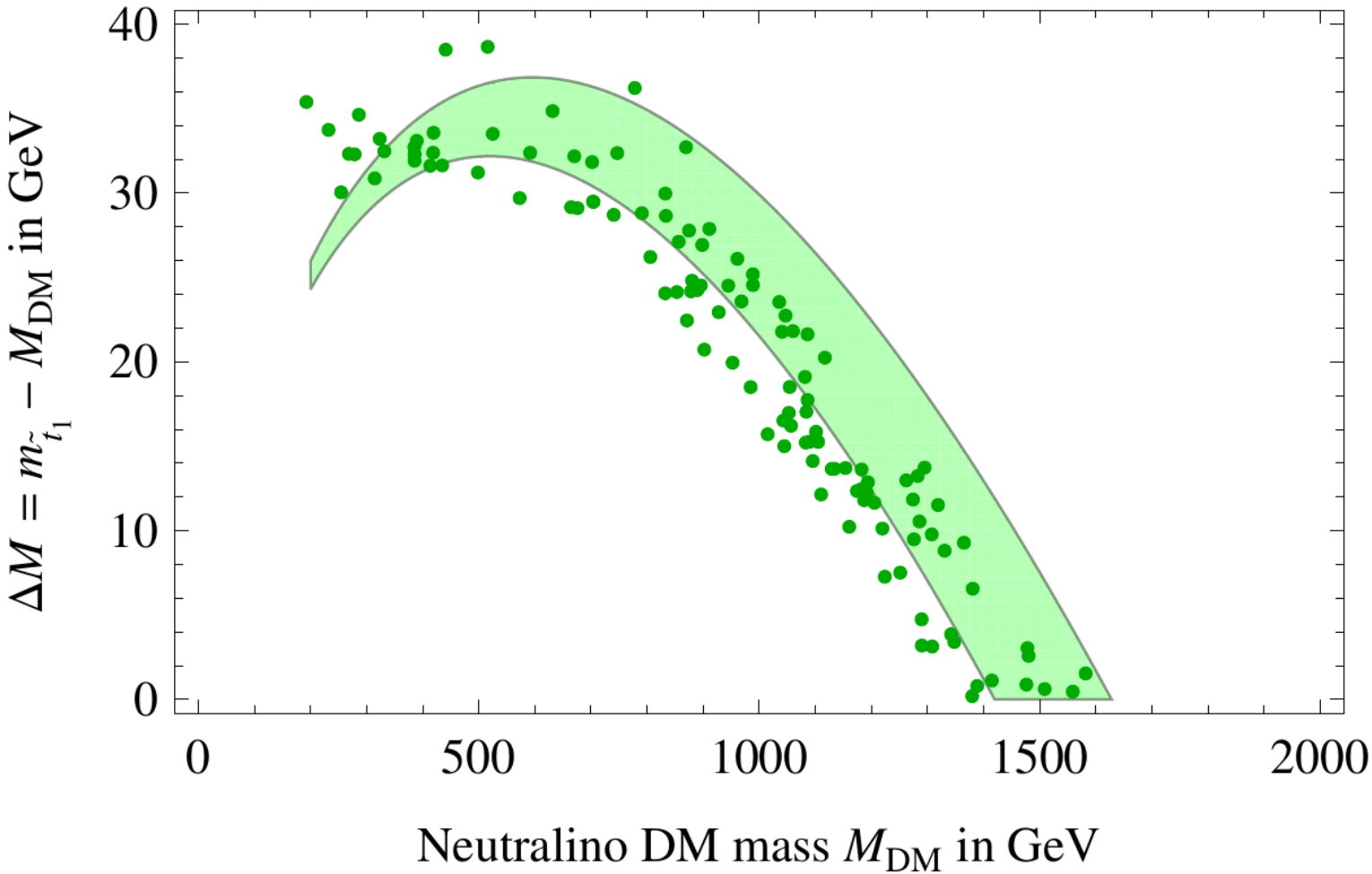
$\Longrightarrow$ DM abundance hints at ΔM constraint


40
30
20
10
0
0
500
1000
1500
2000
$\Delta M = m_{\tilde{t}_1} - M_{\mathrm{DM}}$ in GeV
Neutralino DM mass M_{DM} in GeV



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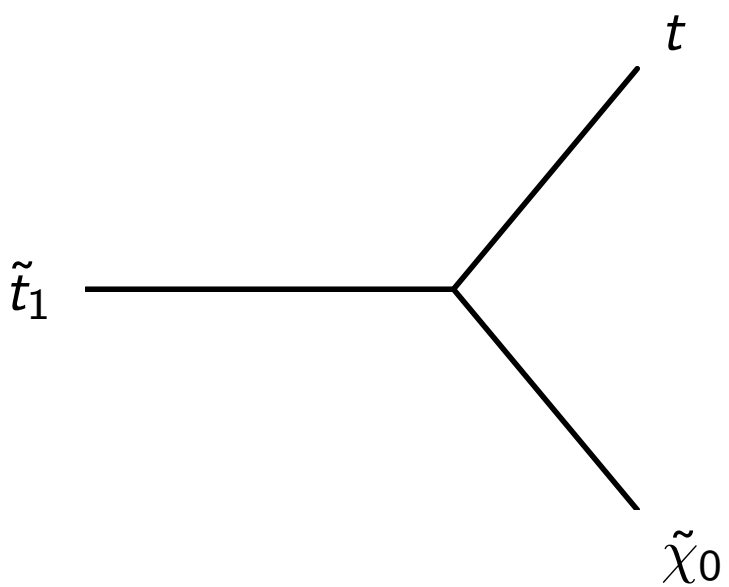

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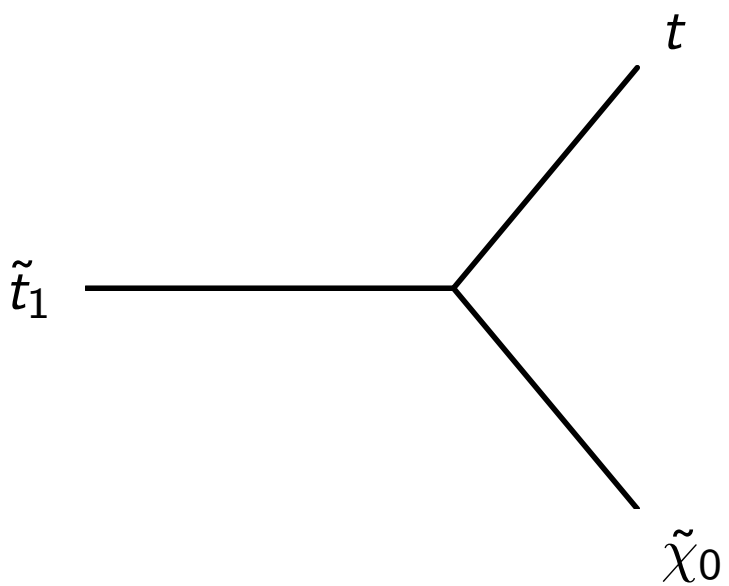
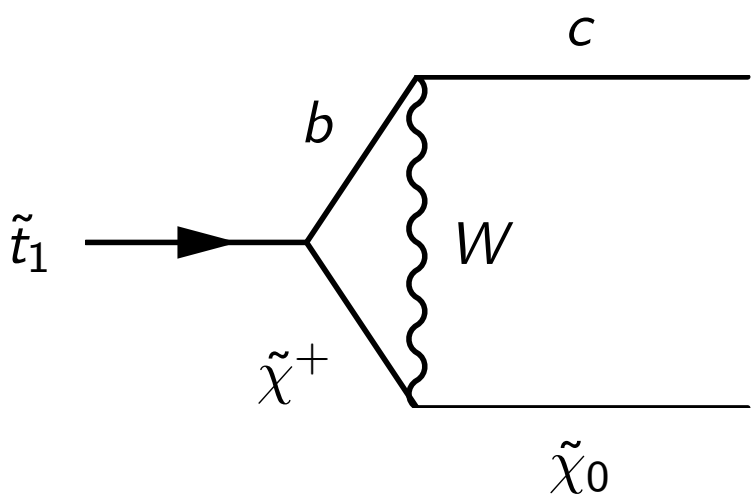


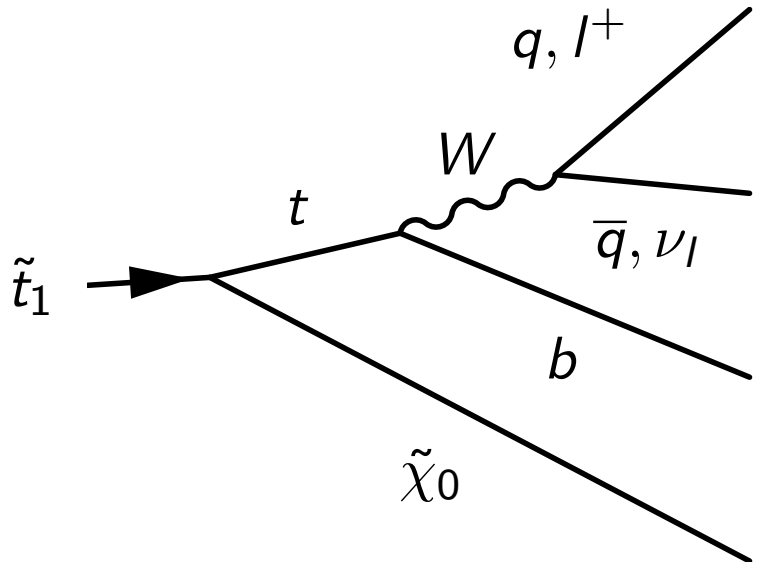
Impossible decay

Two important $\tilde{t}$ decays:



Two body decay

$\tilde{t}_1 \rightarrow cN$



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$\tilde{t}_1 \rightarrow Nbl^+\nu_l$
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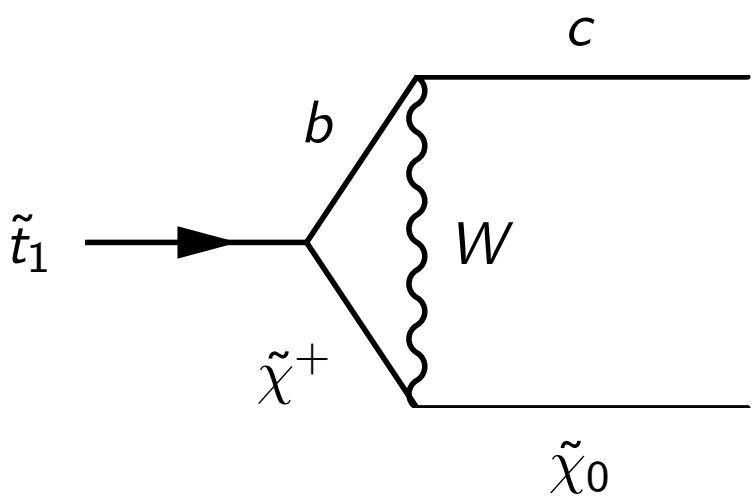

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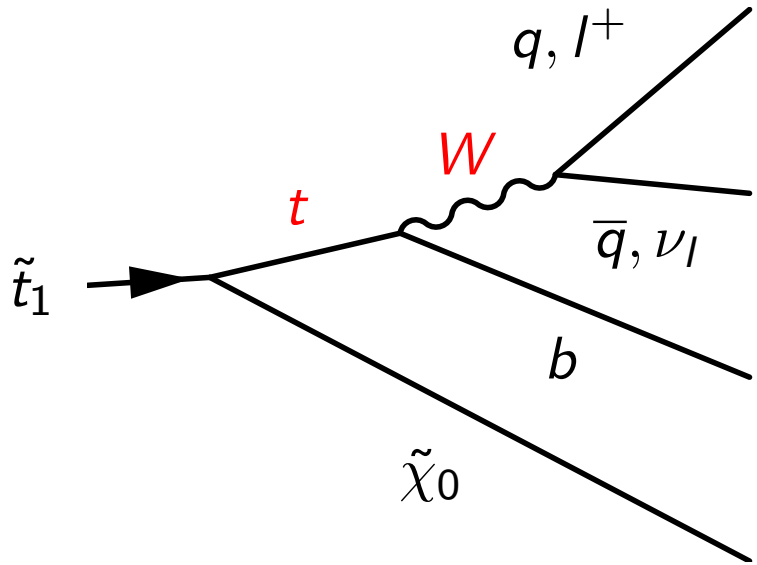

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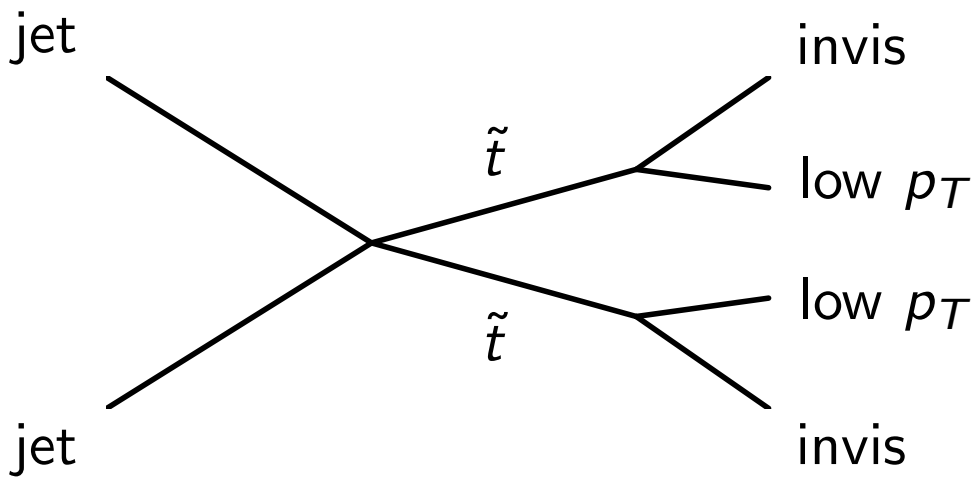

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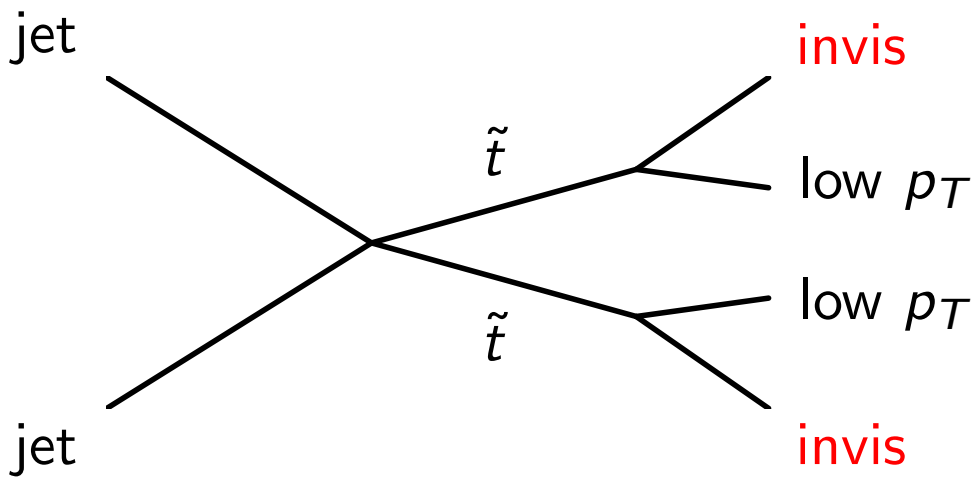

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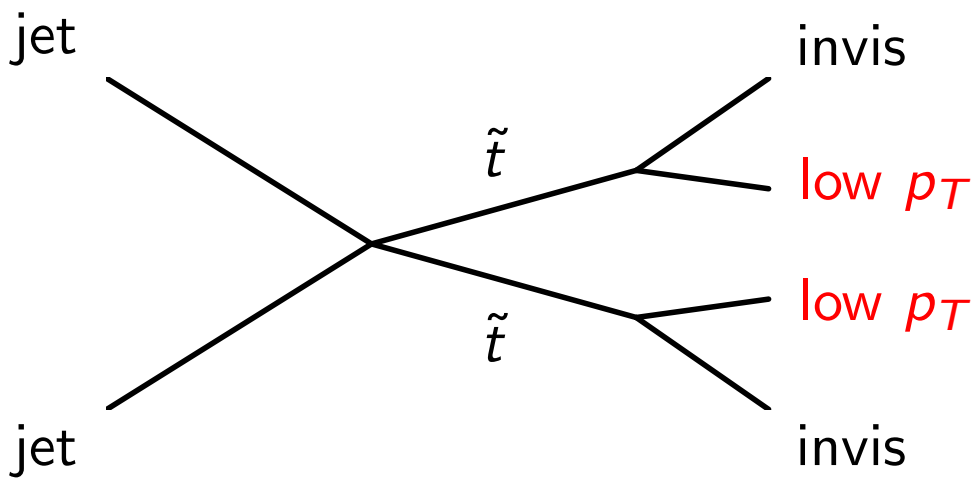
- Soft jets are not observable $\Rightarrow$ Detect recoiling jets



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- Detection with LHC14?
- $m_{\tilde{t}_1} < 250\,\mathrm{GeV}$ actually already excluded

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The proposed SUSY mass spectrum is:

- Lightest **right-handed** stop squark $m_{\tilde{t}_1} \approx 200 - 400$ GeV
- Heaviest **left-handed** stop squark $m_{\tilde{t}_1} \approx 1 - 2$ TeV

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Masses within reach of the next LHC run

Thank you for your attention

Any questions?

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