LHC phenomenology of SUSY model with vector-like matters

The University of Tokyo

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What is V-GMSB?

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- SUSY model

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- SUSY model
- GMSB

+ Vector-like matters

Why V-GMSB?

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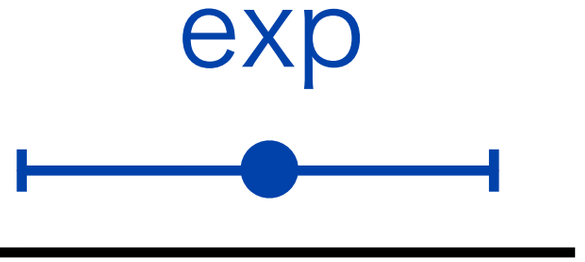
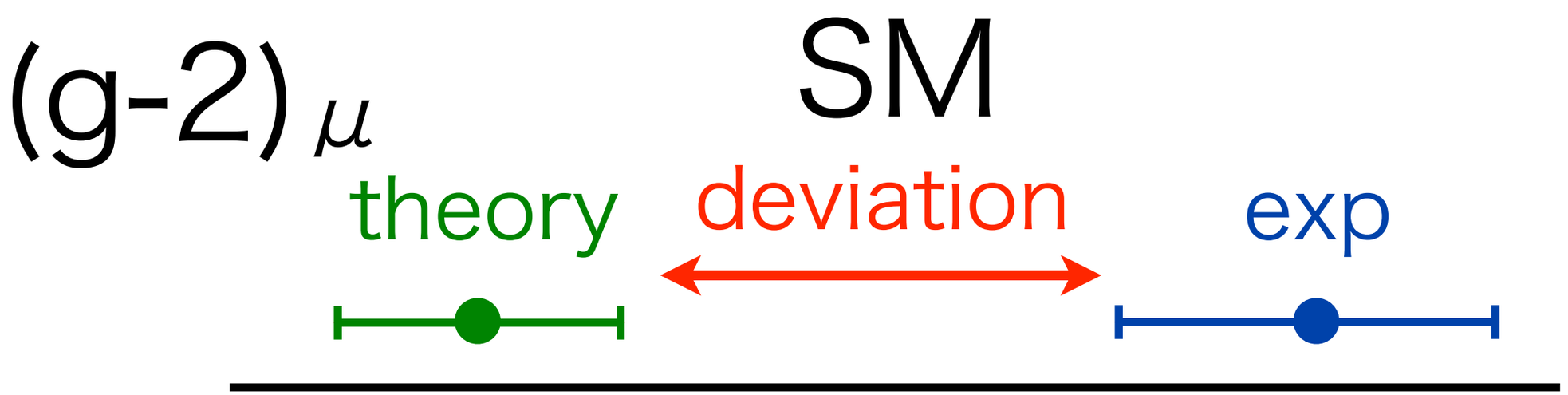
(g-2)$_\mu$



(g-2)$_\mu$/2×10^{10}	11659	182.8		11659 208.9

Why V-GMSB?



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Why V-GMSB?

(g-2)$_\mu$ SUSY

[T.Moroi(1996)]

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O(100GeV) slepton

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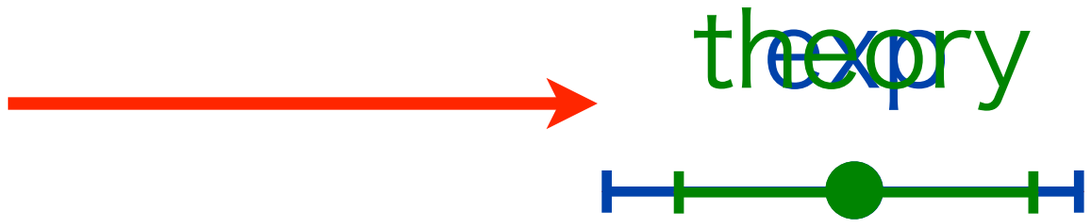

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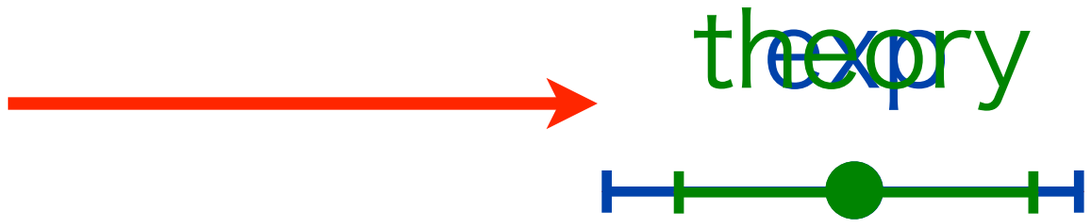

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Why V-GMSB?

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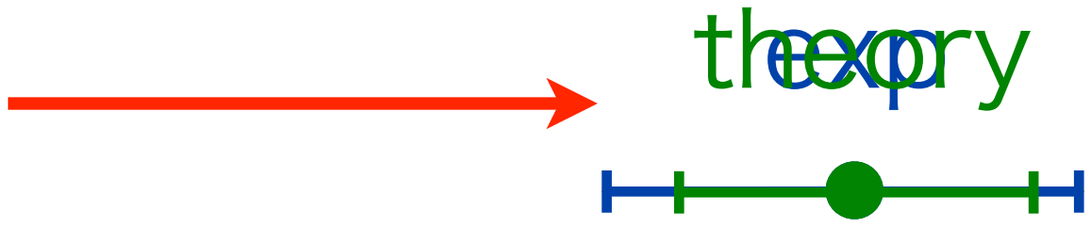

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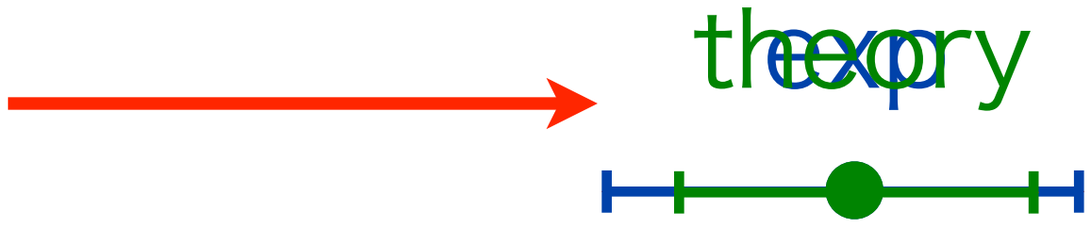
GMSB



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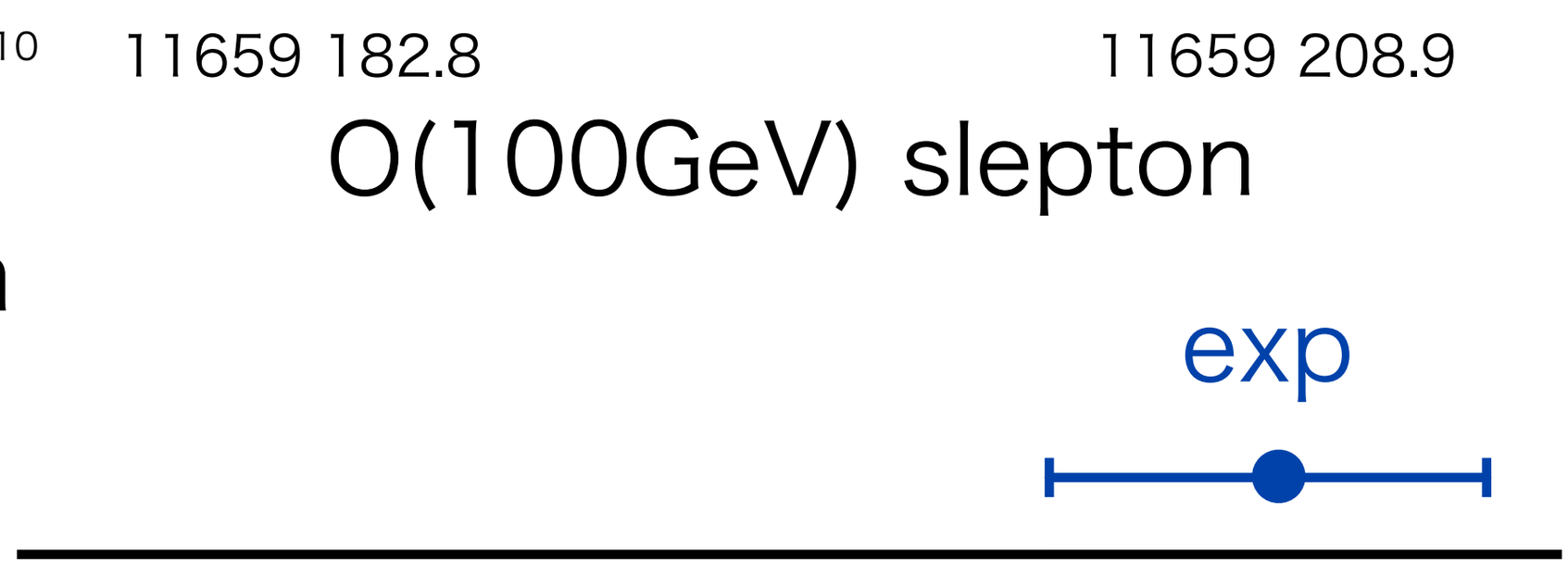
m_h

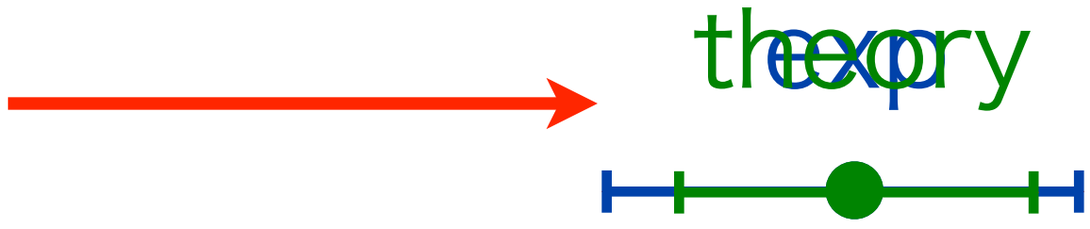


O(1TeV)squark

Why V-GMSB?

(g-2)$_\mu$

GMSB



(g-2)$_\mu$/2×10^{10}	11659 182.8	11659 208.9

O(100GeV) slepton

m_h

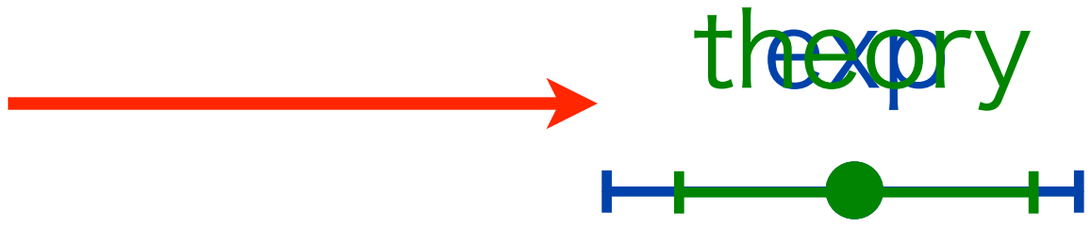
GeV 126

O(1TeV)squark

Why V-GMSB?

$(g-2)_\mu$

V-GMSB



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m_h

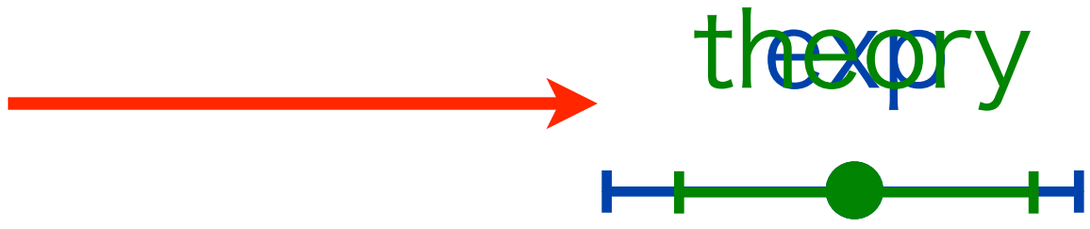
GeV

+ vectorlike matters!

Why V-GMSB?

$(g\text{-}2)_\mu$

V-GMSB



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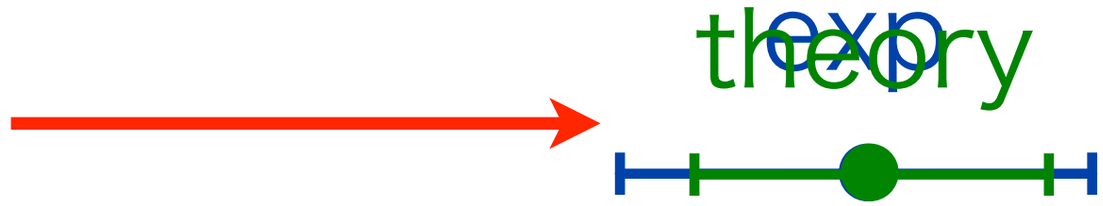
O(100GeV) slepton

m_h



GeV

+ vectorlike matters!

Why V-GMSB?

V-GMSB can explain

$(g-2)_\mu$ and m_h

simultaneously!!!

What is V-GMSB?

SUSY model

GMSB + Vectorlike matters

What is V-GMSB?

SUSY model $L \ni M_Q Q \overline{Q}$

GMSB + Vectorlike matters

→anomaly free

What is V-GMSB?

SUSY model $L \ni M_Q Q \overline{Q}$

GMSB + Vectorlike matters

→anomaly free

Vectorlike matters:

$$10 = (Q', \overline{U}', \overline{E}'), \overline{10} = (\overline{Q}', U', E')$$

→fermion: t'_1, t'_2, b', τ'

scalar : $\tilde{t}'_1, \tilde{t}'_2, \tilde{t}'_3, \tilde{t}'_4, \tilde{b}'_1, \tilde{b}'_2, \tilde{\tau}'_1, \tilde{\tau}'_2$

What is V-GMSB?

Superpotential

$$W = W_{MSSM} + Y' Q' H_u \overline{U}'$$
$$+ M_V Q' \overline{Q}' + M_V U' \overline{U}' + M_V E' \overline{E}'$$

new V-GMSB parameter:

$$M_V, \underline{Y' \sim 1}$$

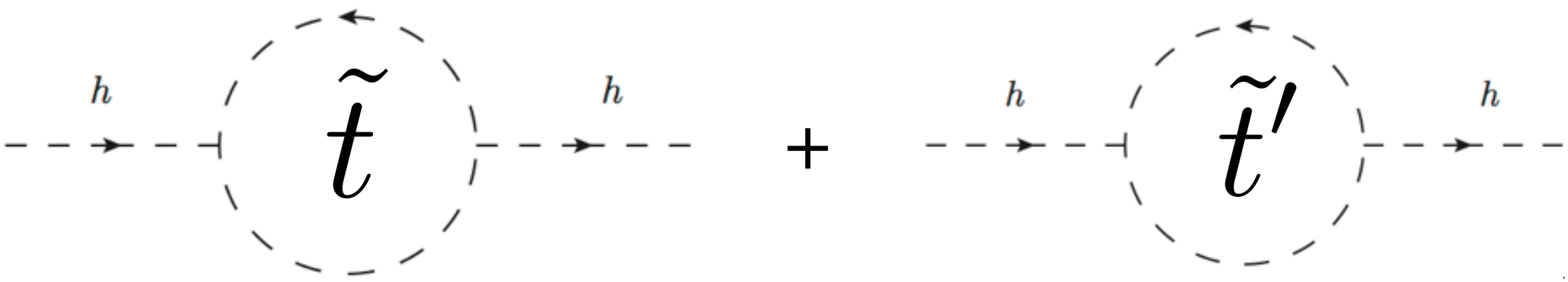
↑ quasi-infrared fixed point

What is V-GMSB?

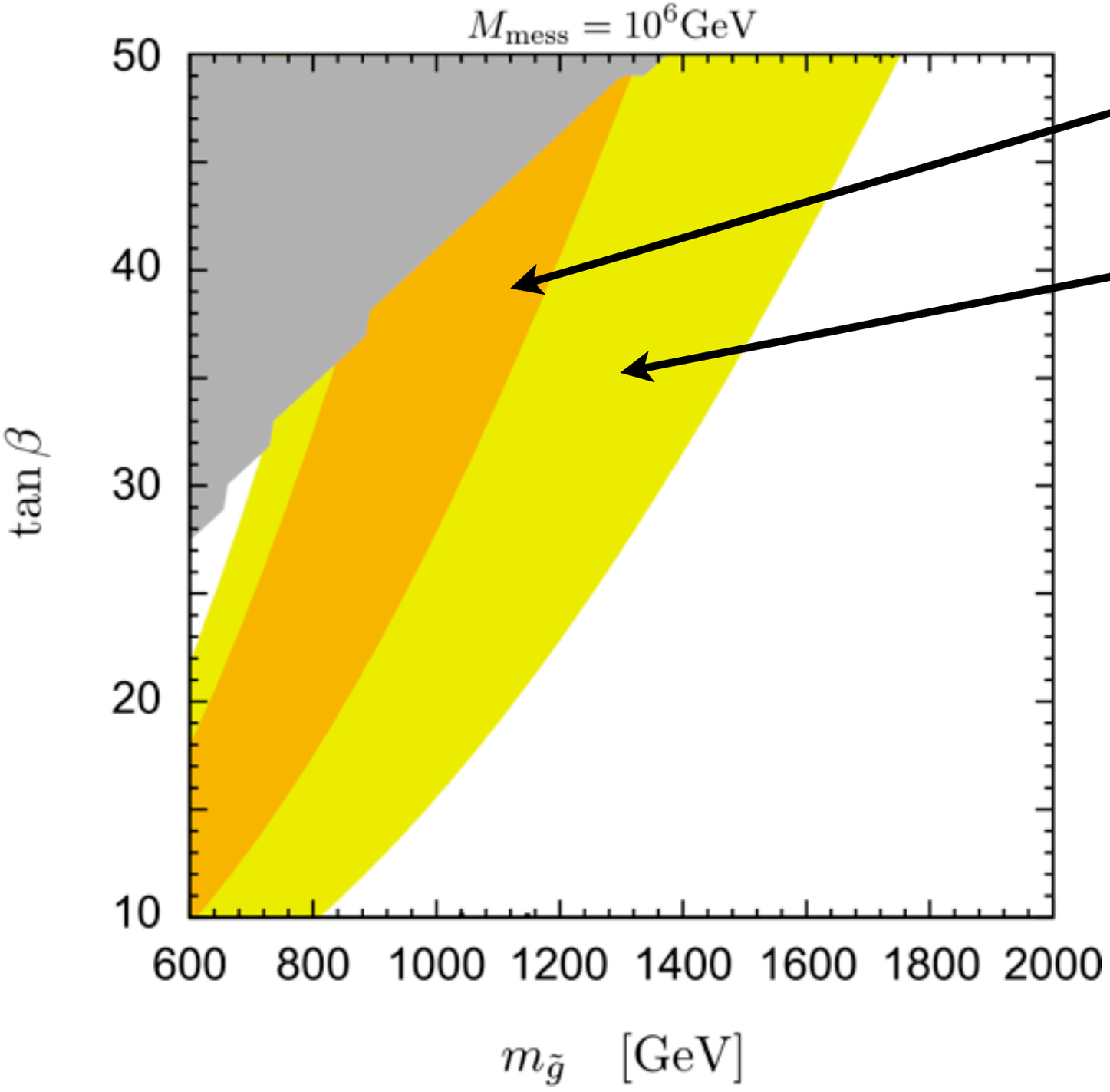
Superpotential

$$W = W_{MSSM} + Y'Q'H_u\overline{U}' + M_V Q'\overline{Q}' + M_V U'\overline{U}' + M_V E'\overline{E}'$$

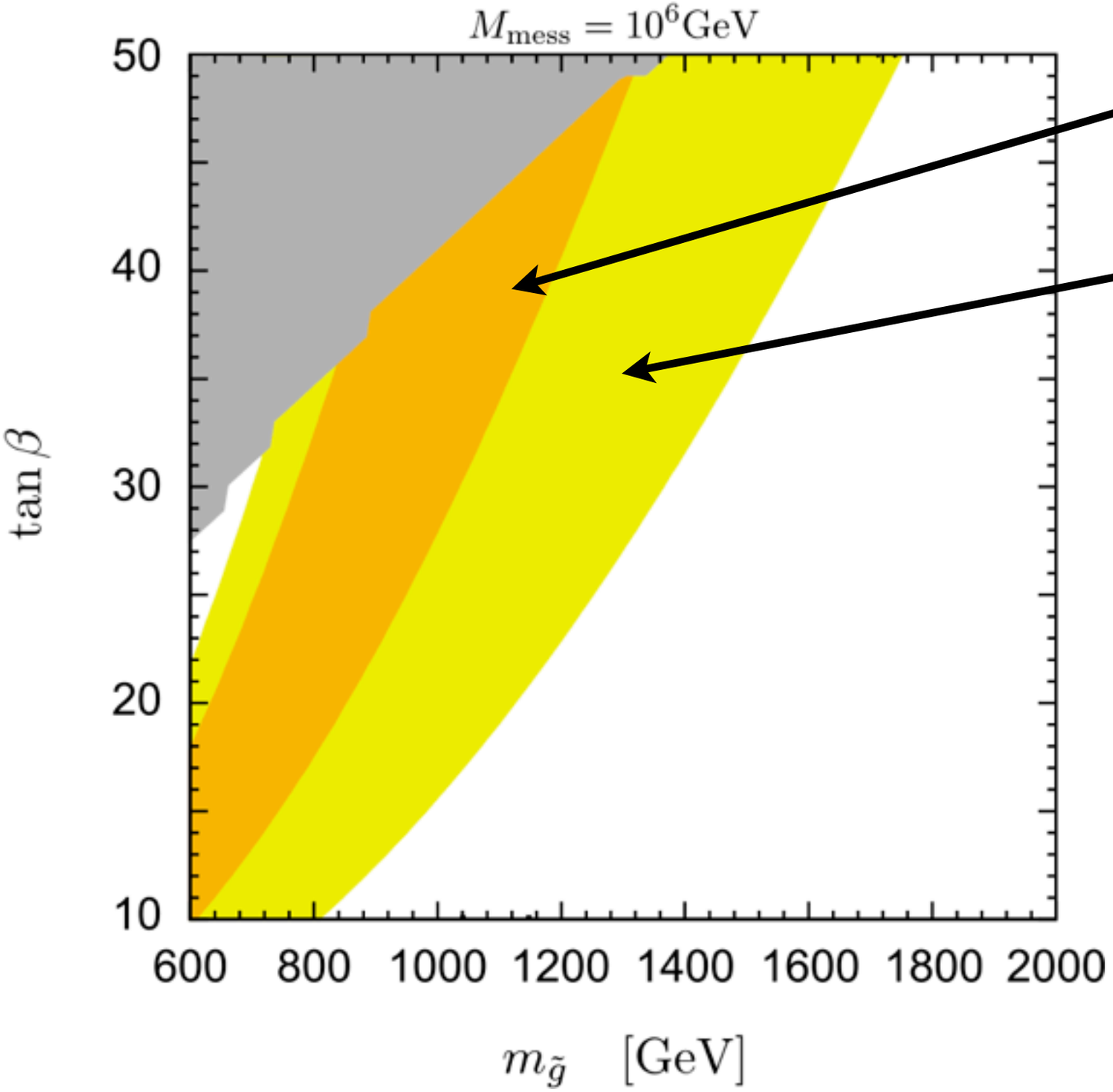
raise higgs mass
like stop/top contribution



(g-2) μ and m_h


$M_{\rm mess} = 10^6 {\rm GeV}$
50
40
30
20
10
600
800
1000
1200
1400
1600
1800
2000
$\tan\beta$
$m_{\tilde{g}}$ [GeV]
g-2:1 σ
g-2:2 σ

(g-2)$_\mu$ and m_h



g-2:1 σ

g-2:2 σ

m_h=126GeV
in all region
of this graph
with changing Mv.

V-GMSB is attractive.

↑ can explain (g-2)$_\mu$ and m_h

simultaneously.

But SUSY is not discovered.

Does V-GMSB conflict with

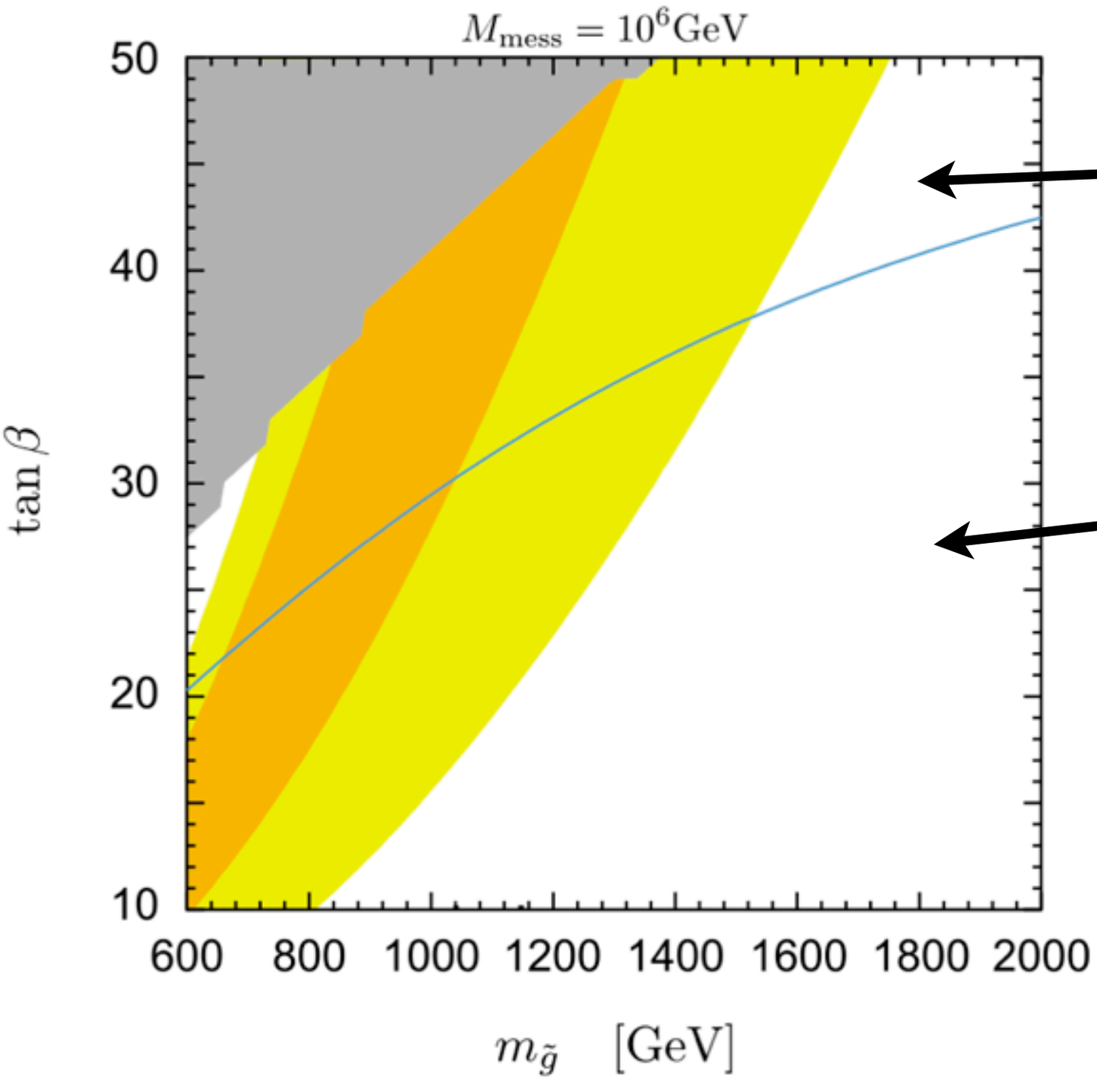
the fact?

LHC phenomenology

We explore LHC phenomenology
especially
SUSY particle searches.

LSP is gravitino
→ LHC phenomenology changes
by NLSP species.

LHC phenomenology



g-2:1 σ

g-2:2 σ

stau NLSP

neutralino NLSP

We consider
long-lived NLSP.

LHC phenomenology

In neutralino NLSP region

neutralino is not detected.

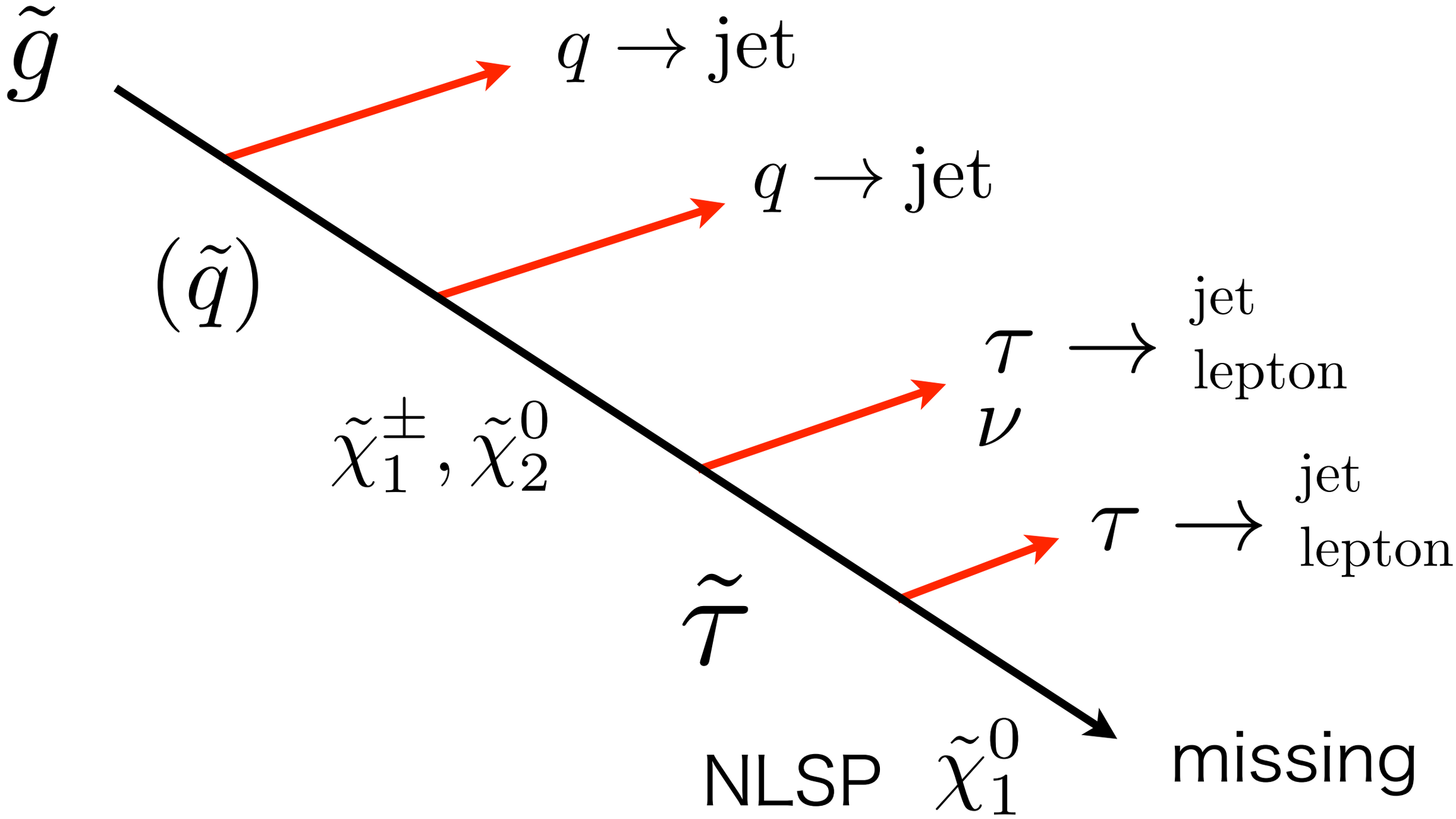
Typical phenomenology is

$$pp \to \tilde{g}\tilde{g}, \tilde{g}\tilde{q}, \tilde{q}\tilde{q}$$

→multi jets and missing energy

[ATLAS(CONF-NOTE2012-109)]
[ATLAS(CONF-NOTE2013-047)]

LHC phenomenology



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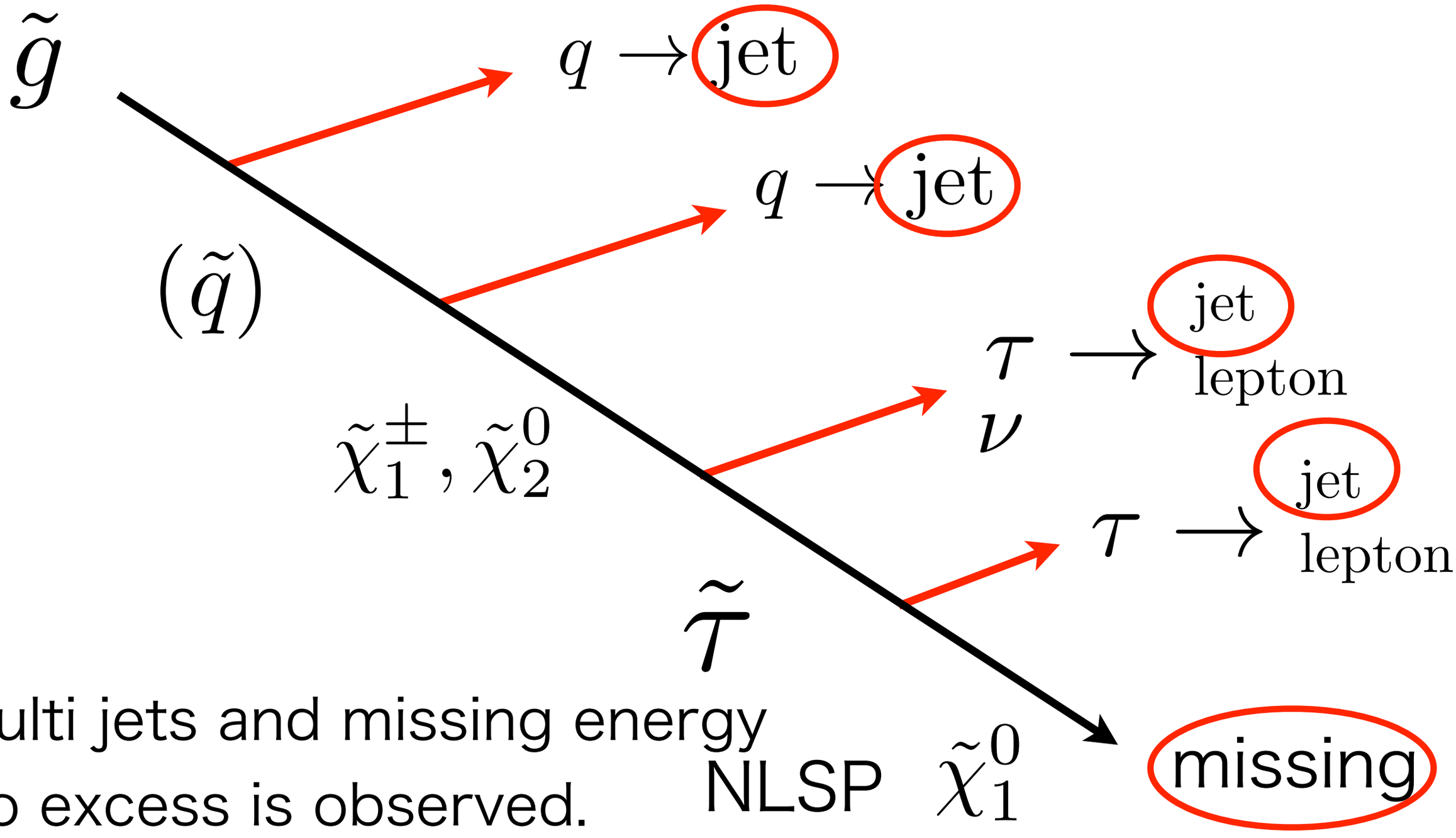
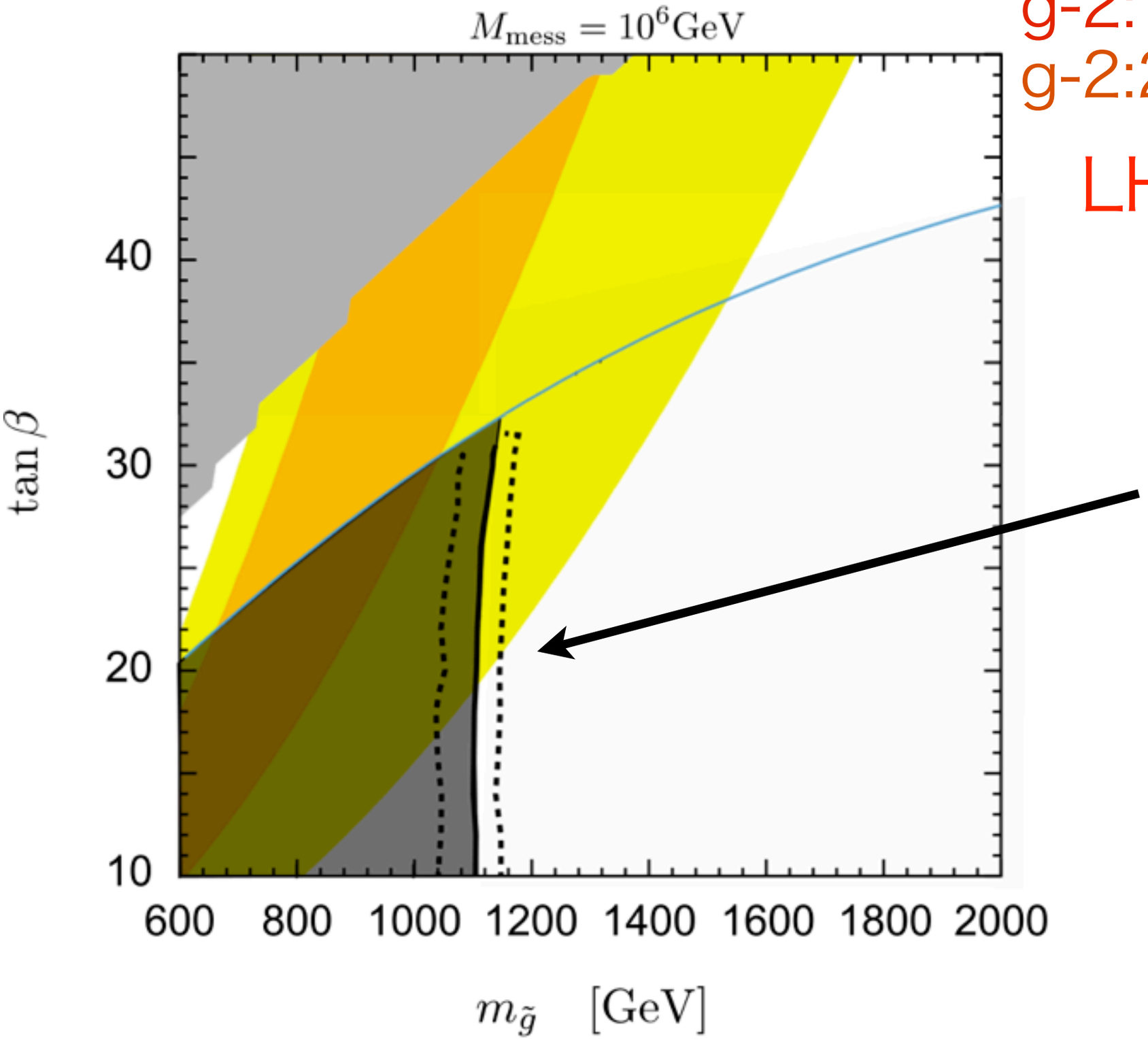


multi jets and missing energy

No excess is observed.

LHC phenomenology



g-2:1 σ
g-2:2 σ

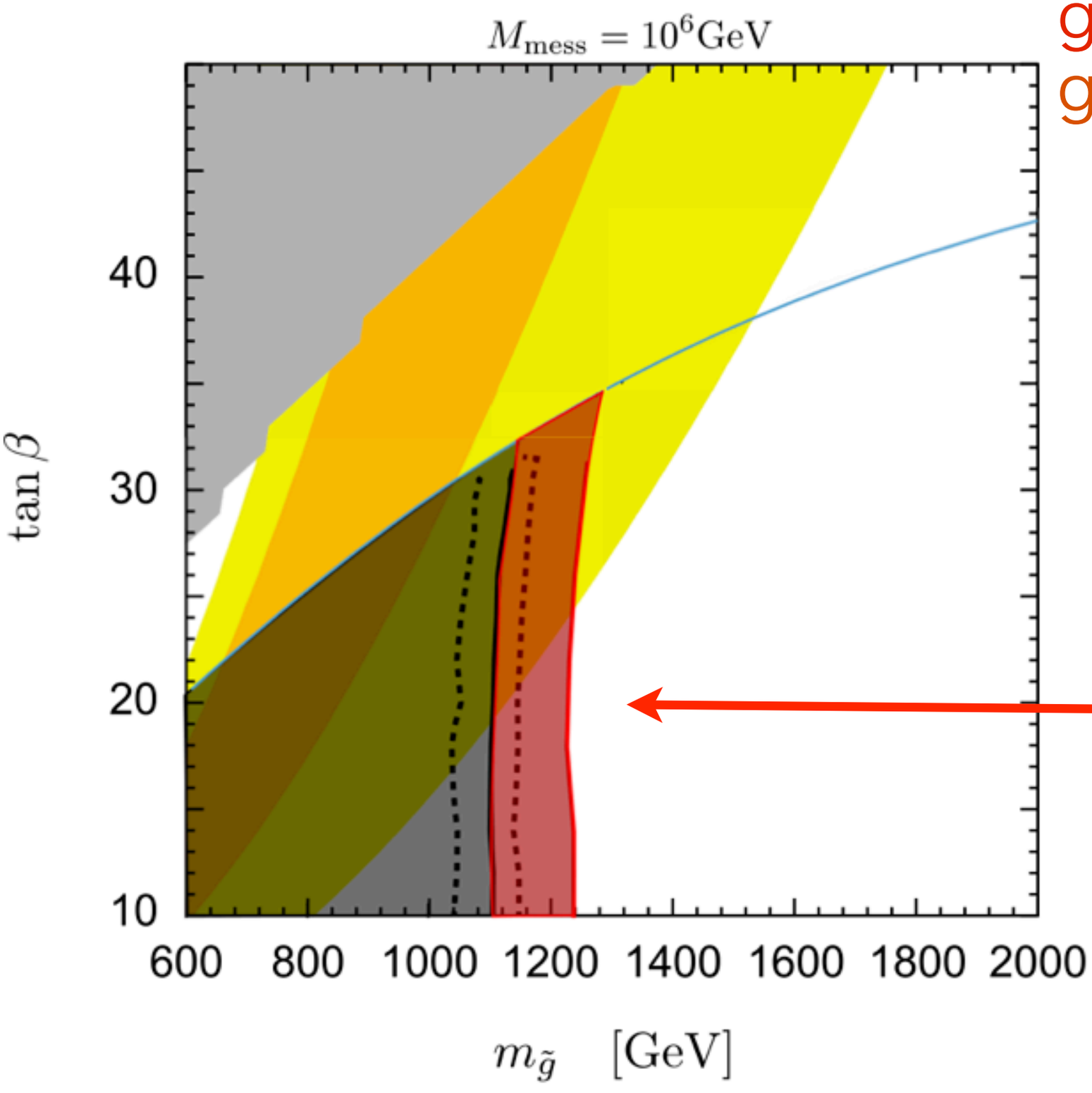
LHC simulation

Result

excluded

8TeV 5.8fb^{-1}

LHC phenomenology



g-2:1 σ

g-2:2 σ

LHC simulation

Result

excluded

8TeV 5.8fb^{-1}

8TeV 20.3fb^{-1}

LHC phenomenology

In stau NLSP region

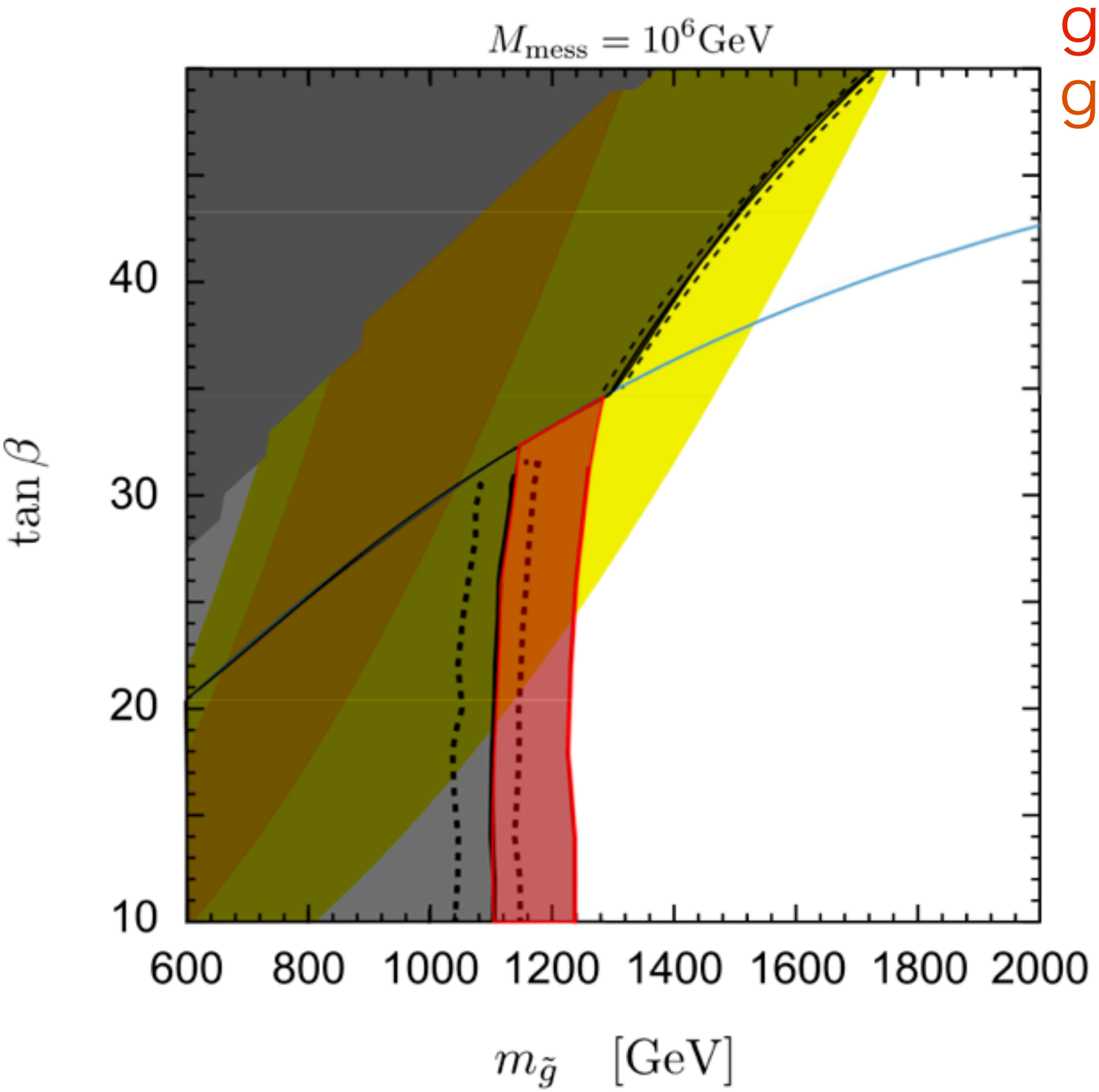
stau behaves as slow muon

No excess is observed.

→ constraints from stau direct production

[CMS(1205.0272)]
[CMS(1305.0491)]

LHC phenomenology



g-2:1 σ
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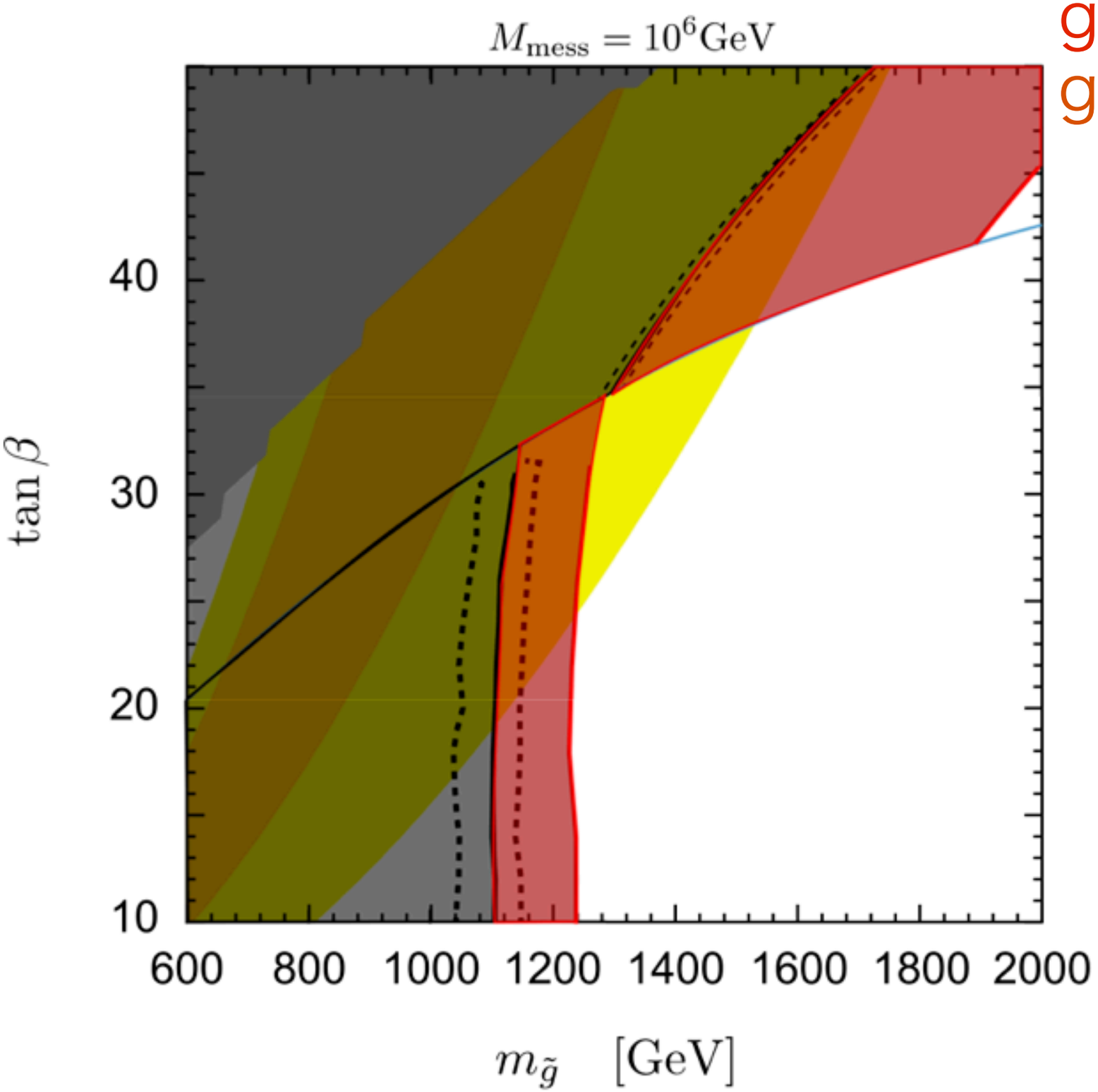
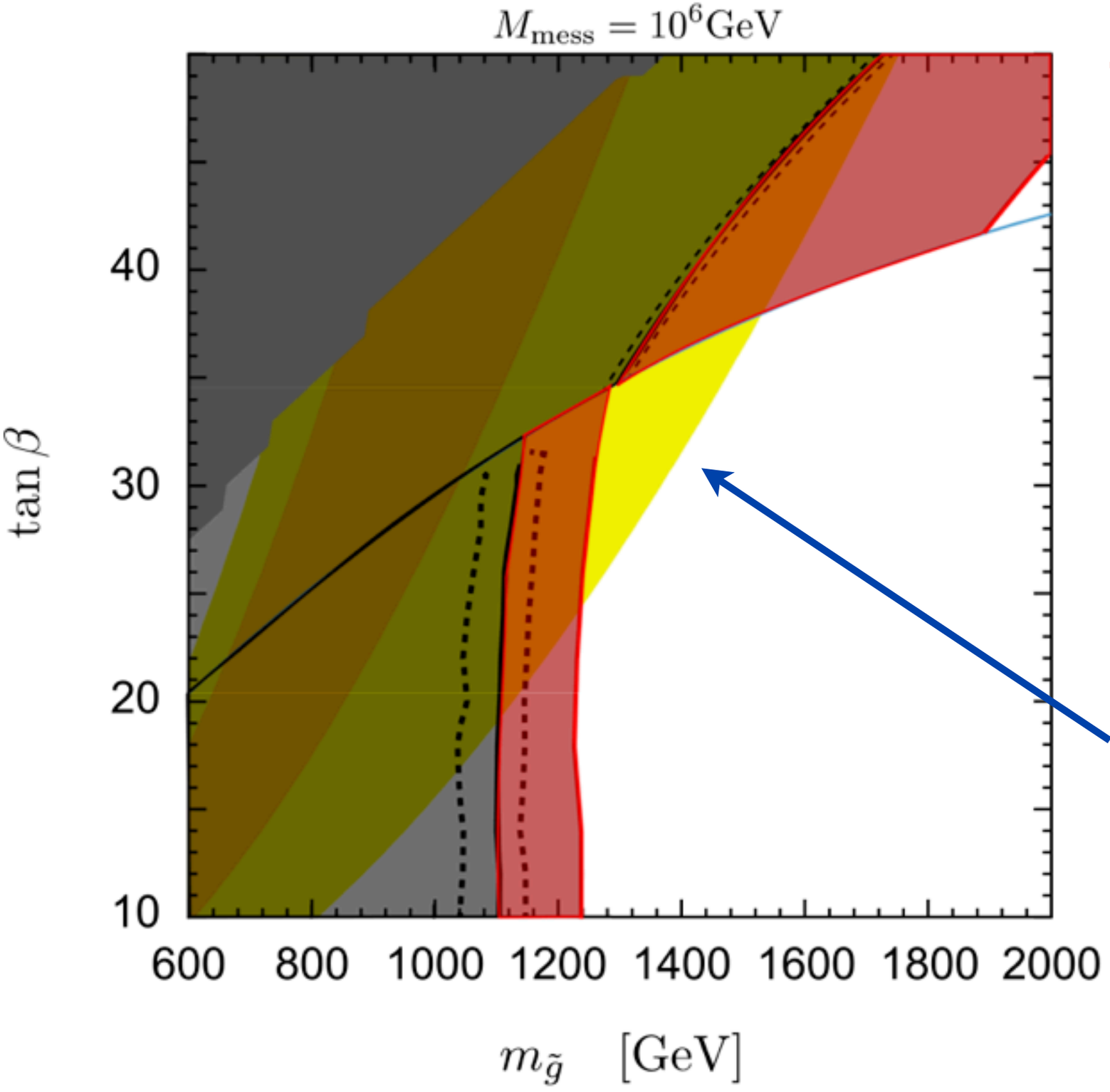
LHC phenomenology



g-2:1 σ
g-2:2 σ

excluded
7TeV 5.0fb^{-1}
+8TeV 18.8fb^{-1}

LHC phenomenology



The region where (g-2)μ can be explained at 1σ level is excluded.

2σ region is still viable.

Conclusion

- We explore LHC phenomenology of the attractive model V-GMSB.
- The region where (g-2)$_\mu$ can be explained at 1σ is excluded.
- 2σ region is still viable.

2σ region may be covered by LHC 13,14 TeV

Comments

- We explored SUSY particle searches
- Vector-like matters searches

  give weak constraints yet.

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- We explored SUSY particle searches
- Vector-like matters searches

  give weak constraints yet.

- We (M.Endo, K.Hamaguchi, KI, M.Stoll) are

  now investigating more effective

  methods for vectorlike matters searches.

$$t_1' \to th, tZ, bW$$