WG1 - considerazioni teoriche

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Theoretical framework for the WG program

- Assume new dofs exist at $M \gg m_H$
  - Gravity
  - Unification
  - Neutrino masses
  - and other SM puzzles
  - (who knows)
  - (maybe an accident)
  - (maybe Dirac or vMSM)
  - (who cares)

  (→ further work?)

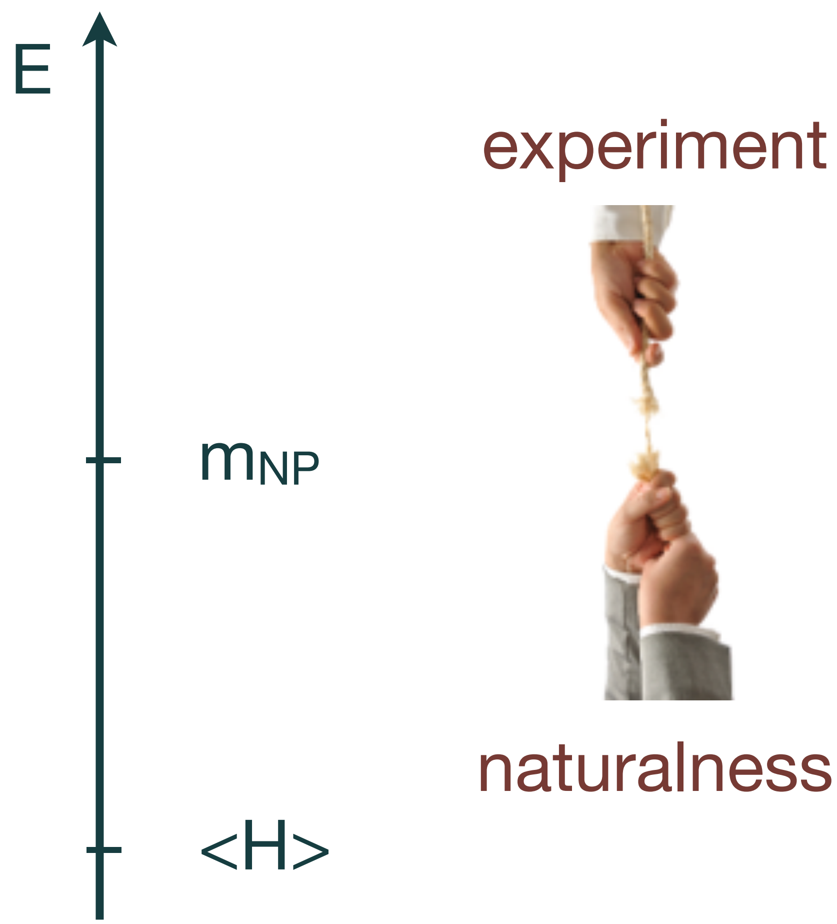
Theoretical framework for the WG program

- THEN
  - The sensitivity of m_H to M is suppressed by a structural change at a scale m_{NP} related to m_H (the Higgs is composite, a supersymmetry is restored)

(so far)

- OR
  - The cancellation takes place and is explained by a different principle (environmental selection, an unknown dynamical principle)

This case faces the known tension



relax the experimental bounds
“difficult spectra”

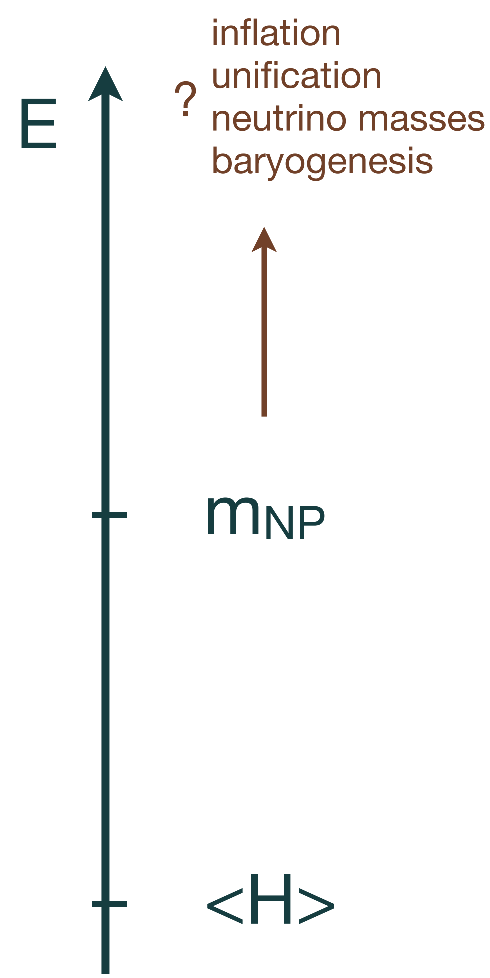
keep the bounds as they are
make them palatable

weakly interacting way

strongly interacting way

(long live the CMSSM)

The weakly interacting way - supersymmetry



Where does FT comes from?

$$m_Z^2 \approx -2m_{H_u}^2 - 2|\mu|^2$$

$$\downarrow$$

$$\delta m_{H_u}^2 \sim -12\frac{\lambda_t^2}{(4\pi)^2}\tilde{m}_t^2 \log\frac{M}{\tilde{m}_t}$$

$$\downarrow$$

$$\delta\tilde{m}_t^2 = \frac{32}{3}\frac{g_3^2}{(4\pi)^2}M_3^2 \log\frac{M}{M_3}$$

susy messengers

Ways out

- Lower M
- Relatively light stop
- Enhancement of Higgs mass

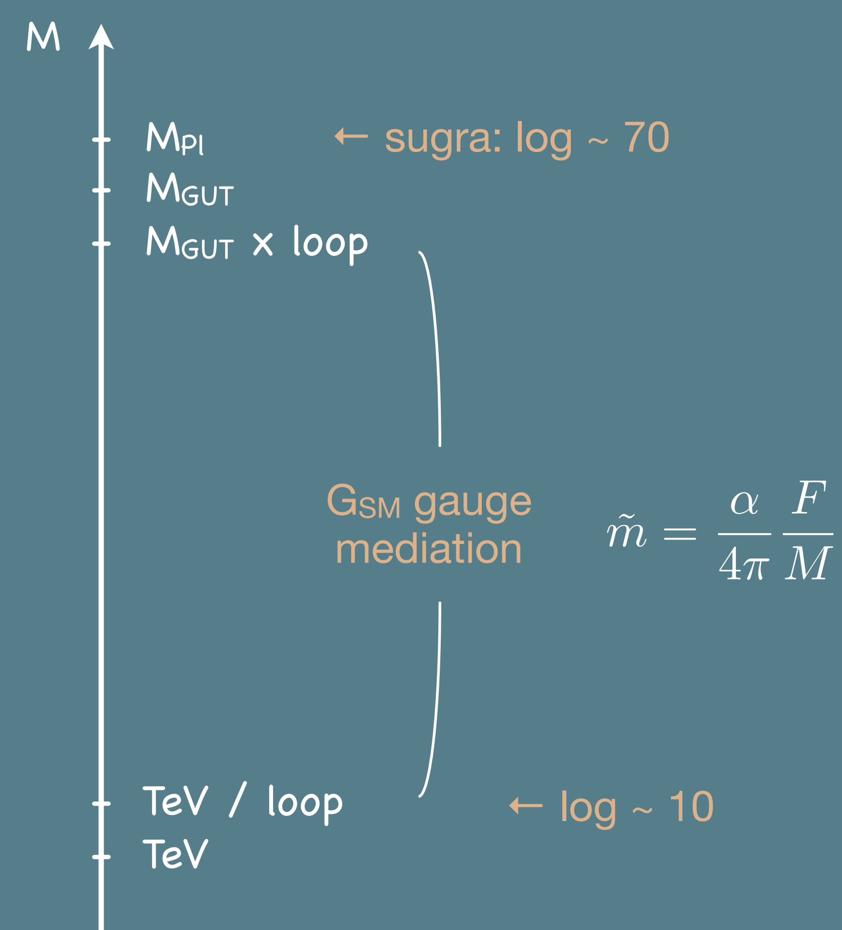
simple
plausible
preserve virtues

- Dirac gluinos
- Give up E_T-miss signature

complete model
in which they coexist
and full analysis

Lower M: how low?

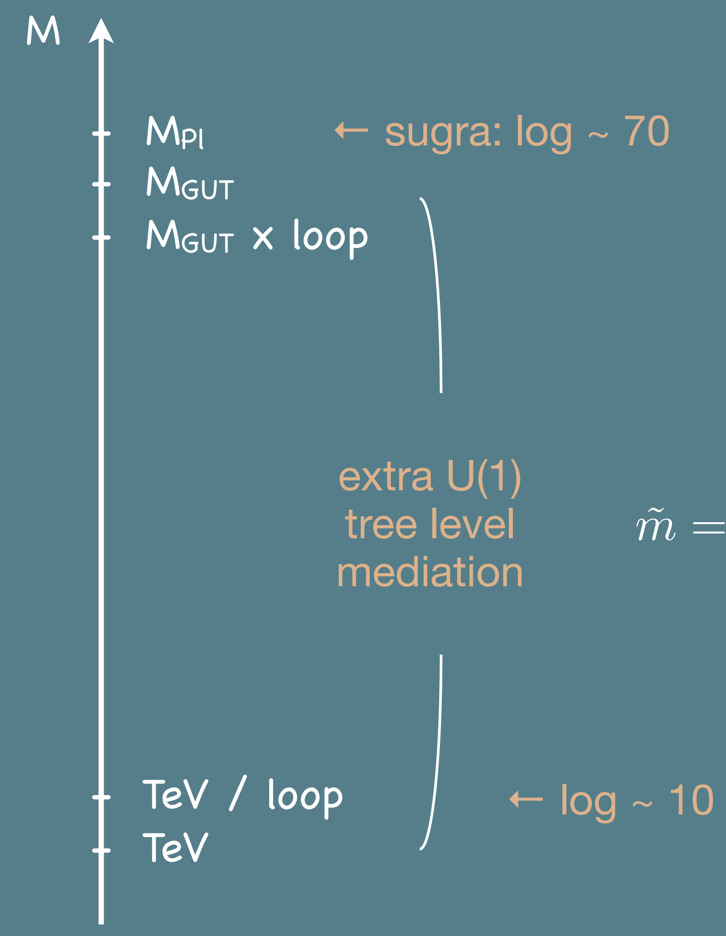
$$\Delta \sim \left(\frac{\tilde{m}}{0.5\,\mathrm{TeV}/\sqrt{\log}}\right)^2$$



M ~ (10-100) TeV

Lower M: how low?

$$\Delta \sim \left(\frac{\tilde{m}}{0.5\,\mathrm{TeV}/\sqrt{\log}} \right)^2$$

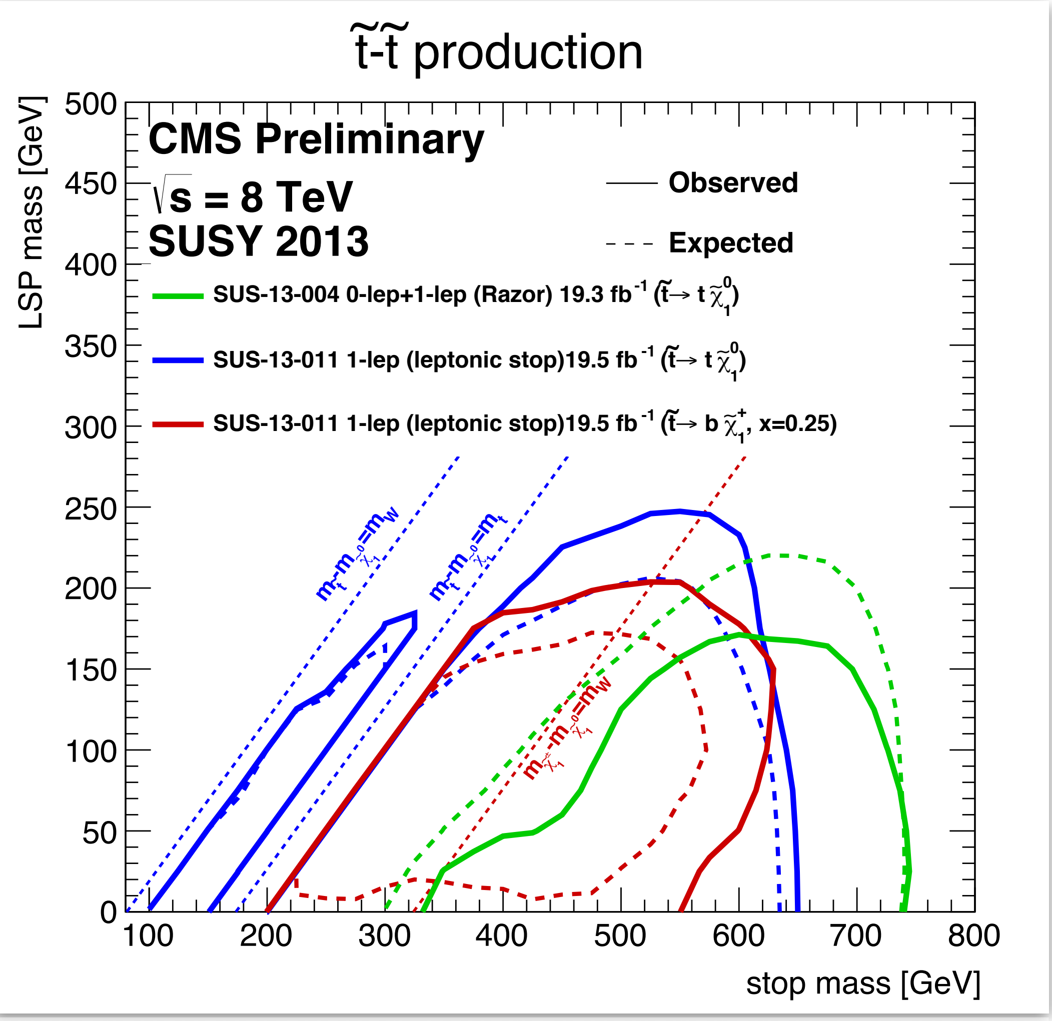


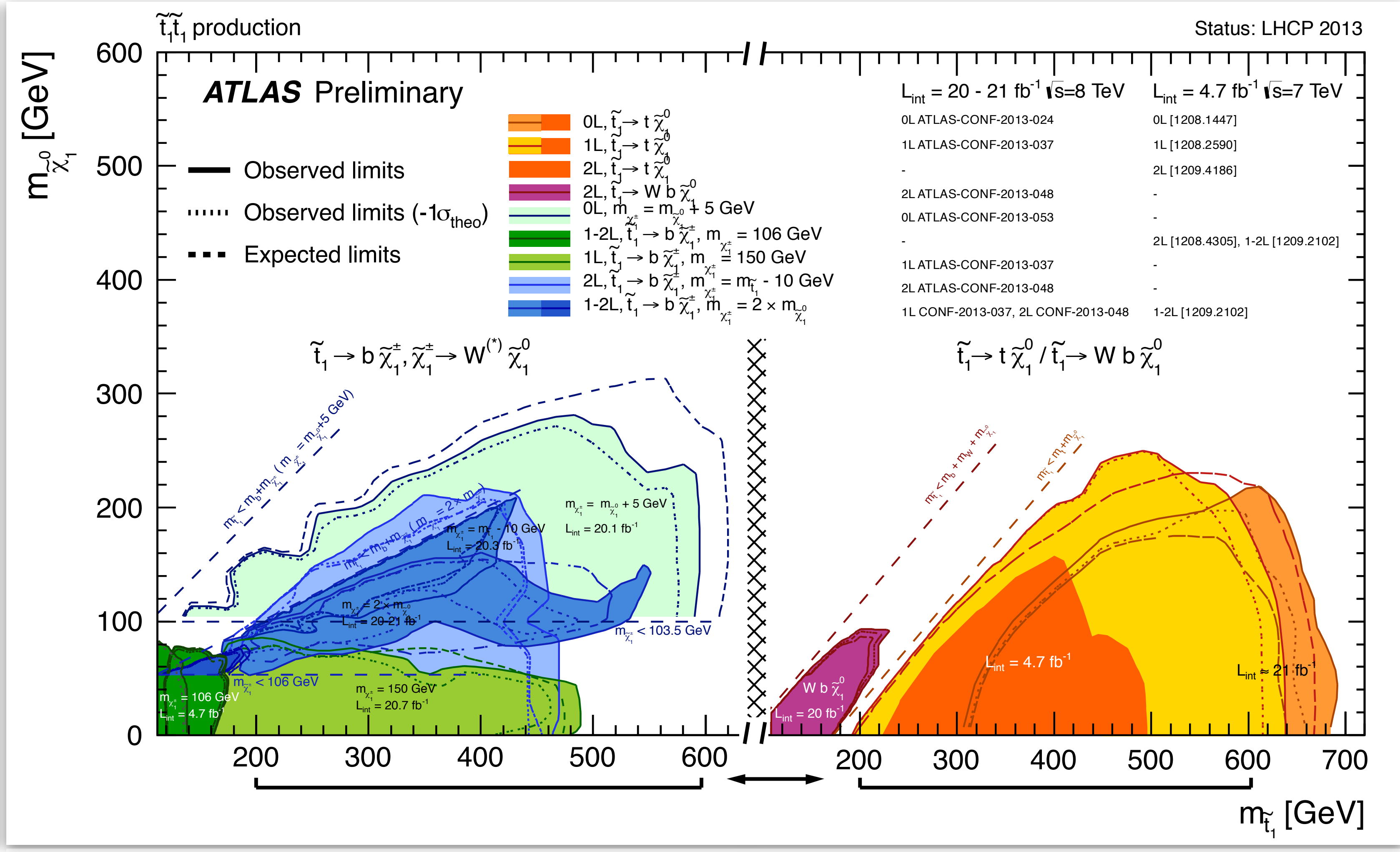
$$\tilde{m} = \frac{F}{M}$$

M ~ (10-100) TeV

Relatively light stop: how light?

(see Lari)



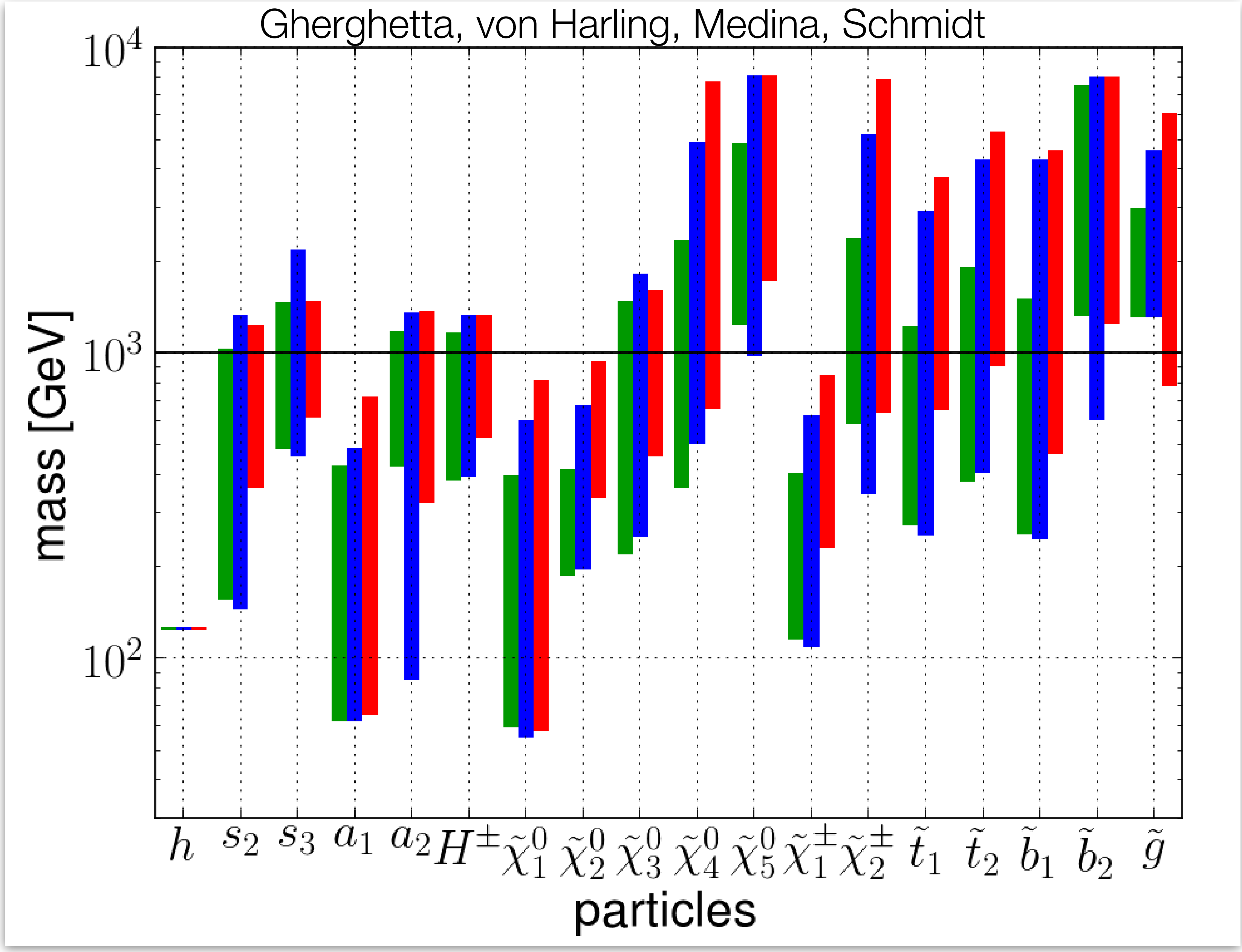


Enhancement of Higgs mass: how?

- NMSSM: MSSM + $\hat{S}$
  - harmless (unification OK)
  - minimal $\lambda S H_u H_d$ (symmetries forbid $\mu H_u H_d$)
  - welcome ($\mu = \lambda \langle S \rangle \approx$ susy scale)
- Extra tree level contribution $m_h^2 = M_Z^2 \cos^2 2\beta + \lambda^2 v^2 \sin^2 2\beta + \text{loops}$
- Moreover:
  - Higgs spectrum: h H → h_1 h_2 **h_3**, A → A_1 **A_2** (scalar components of S)
  - Neutralino spectrum: $N_1 \ldots N_4$ → **N_0** $N_1 \ldots N_4$ (fermion component of S)

Highly preliminary collection of results

- Natural ranges



Highly preliminary collection of results

- Natural ranges
- Longer decay chains, richer final state, smaller mET → slightly weaker limits
- Higgs sector: new scalar S = s+ia
  h_{126} is mainly $h = s_\beta h_u + c_\beta h_d$, with up to 30% s
  implications for Higgs couplings and invisible channels?

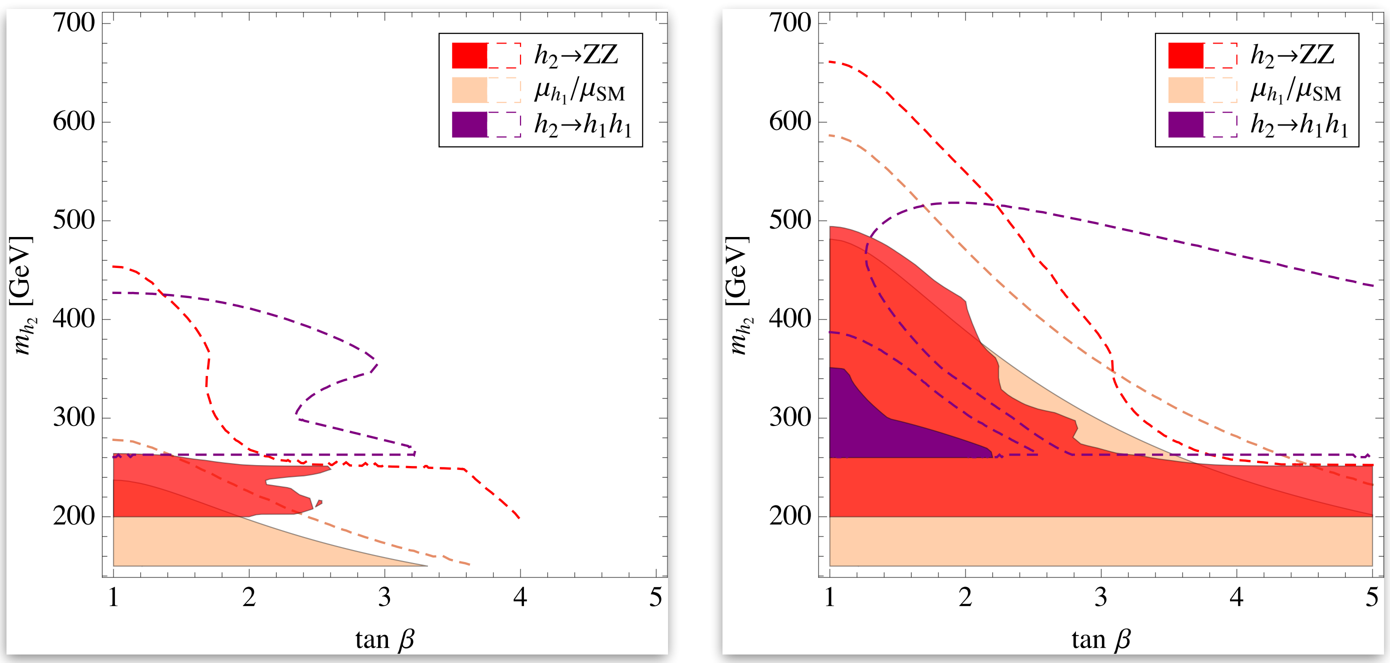
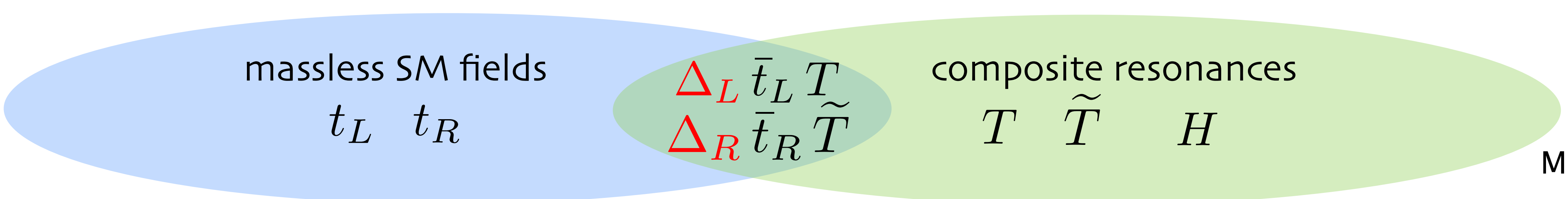


Figure 1. Current and foreseen LHC reaches for $\lambda = 0.8$ (left) and $\lambda = 1.4$ (right). The colored regions are excluded at 95% C.L.; the dashed lines are the expected limits.

The strongly interacting option → Matsedonskyi, Panizzo

- Higgs as a composite pseudo-Goldstone boson
  - explicitly broken SO(5) → approximate SO(4)
  - partial compositeness
    larger for heavier masses



Matsedonskyi

- Composite partners of top: light Higgs needs light top partners

The strongly interacting option

- Tuning > 10% if light top partners do not require tuning

$$\Delta \sim \left(\frac{m_T}{0.5\,\mathrm{TeV}/\sqrt{\log}} \right)^2 \qquad \log \equiv \log(\Lambda/m_T)^2$$

- Addressing model dependence in connection of theory and experiment

- Take into account single production of top partners

- Experimental analyses