NMSSM studies

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Enhancement of Higgs mass: how?

- NMSSM: MSSM + $\hat{S}$
  - minimal $\lambda S H_u H_d$ (symmetries forbid $\mu H_u H_d$)
  - harmless (unification OK)
  - welcome ($\mu = \lambda \langle S \rangle \approx$ susy scale)
- Extra tree level contribution $m_h^2 = M_Z^2 \cos^2 2\beta + \lambda^2 v^2 \sin^2 2\beta + \text{loops}$

Lines

1. Post-LHC fine-tuning level (present and LHC-14 reach)

2. Relation with stop/gluino reach in simplified models
   (LHC-14, HL-LHC, LHC-33, 100TeV)
   specific signatures?

3. Higgs sector reach: i) direct production of new states, ii) deviation from SM couplings and invisible channels. In particular at HL-LHC. Is ii) competitive with direct searches, are there chances of measuring a deviation?

4. Benchmark points (ebbene sì), one within LHC-14 and one not (and their FT)

5. Theoretical background (realistic model)

SUSY & NMSSM

	1	2	3	4	5
Enrico Bertuzzo	☑	☐	☐	☐	☐
Maria Ilaria Besana	☐	☑	☐	☐	☐
Dario Buttazzo	☐	☐	☑	☐	☐
Roberto Franceschini	☐	☑	☐	☐	☐
Tommaso Lari	☐	☑	☐	☐	☐
Giacomo Polesello	☐	☑	☐	☑	☐
Andrea Romanino	☑	☐	☐	☑	☑
Filippo Sala	☐	☐	☑	☐	☐
Andrea Tesi	☐	☐	☑	☐	☐
Riccardo Torre	☐	☑	☐	☐	☐
Count	**2**	**5**	**3**	**2**	**1**

1: fine-tuning level

Gherghetta, von Harling, Medina, Schmidt

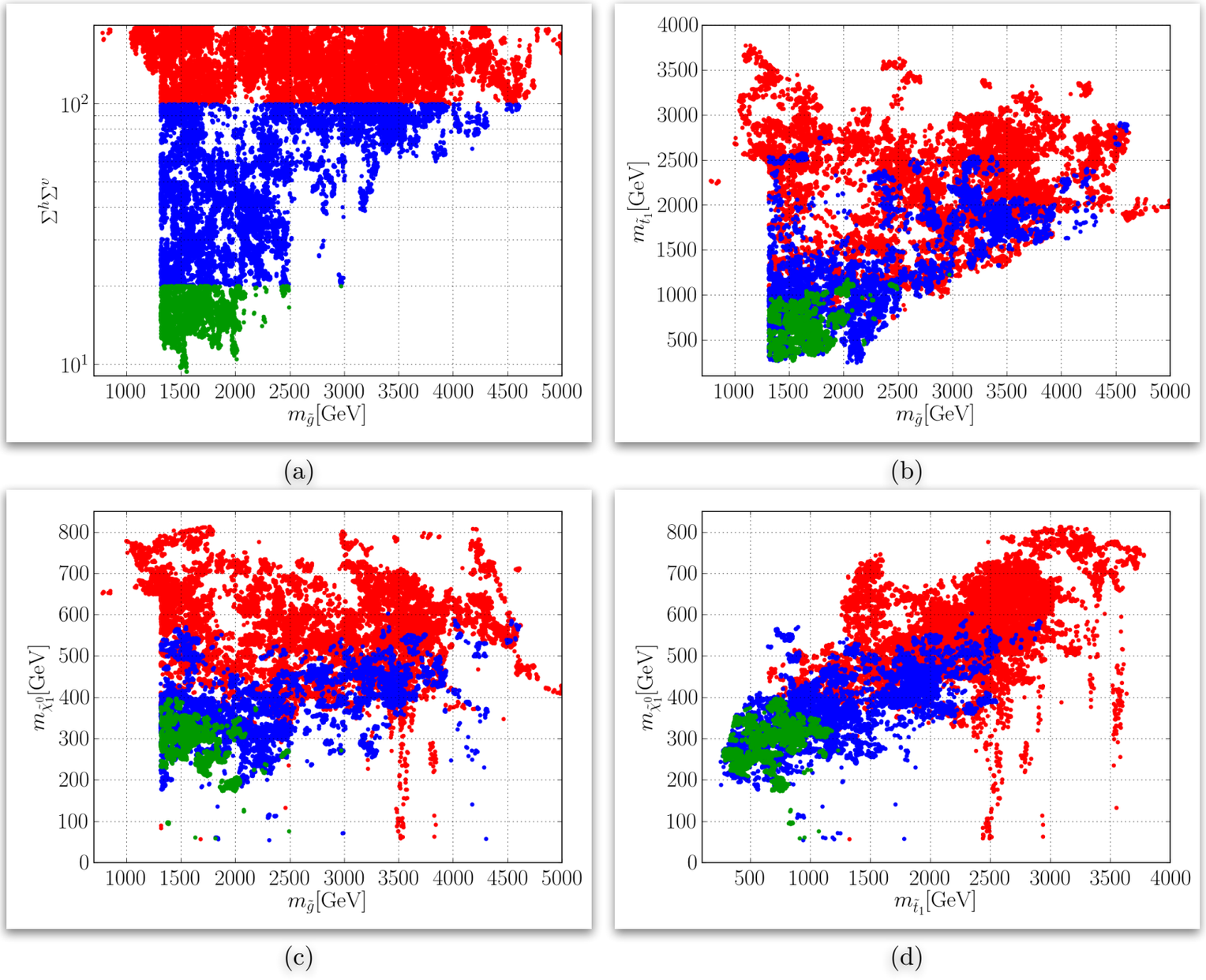
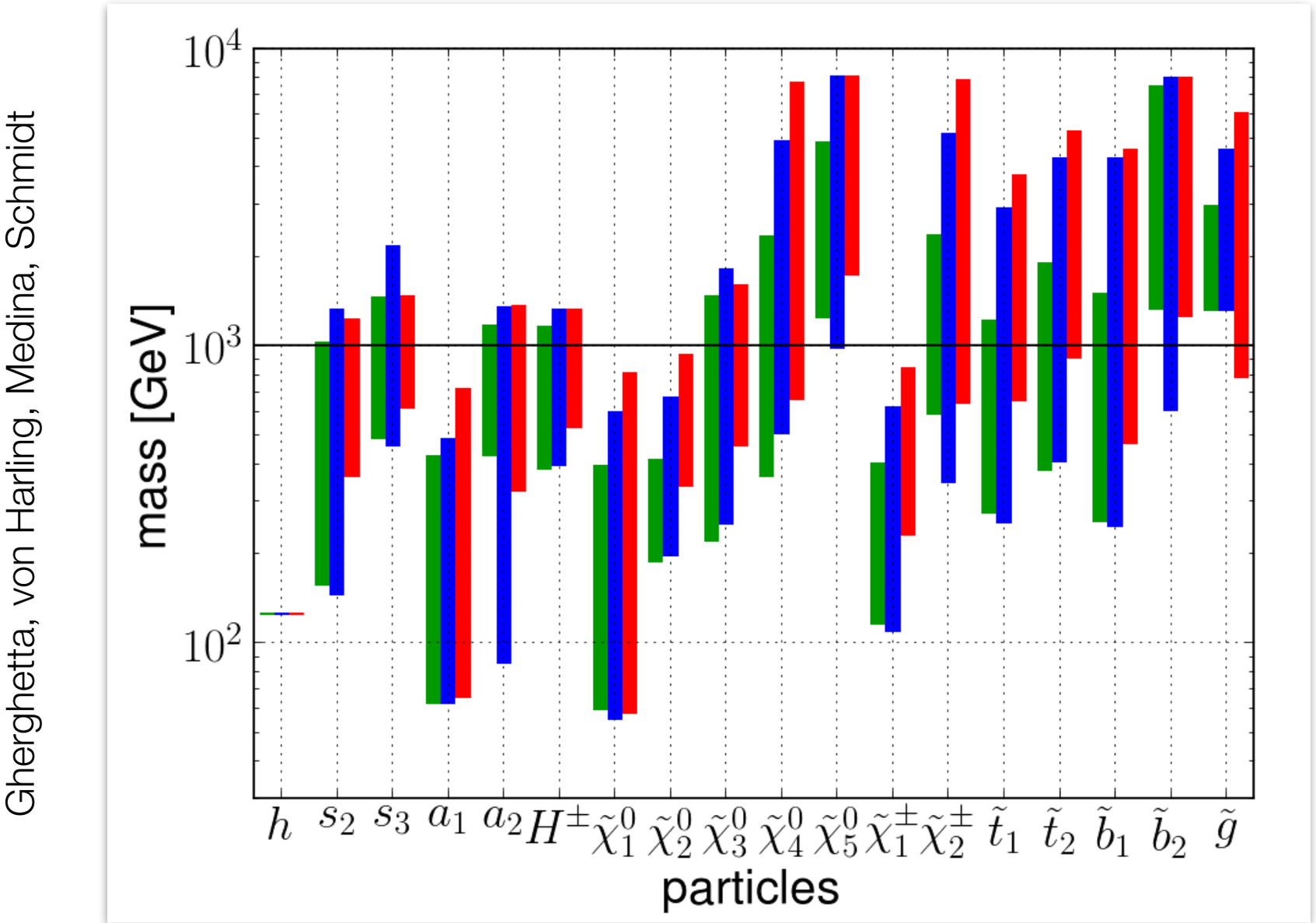


Figure 8: *Scatter plots of (a) the combined tuning $\Sigma^h\Sigma^v$ and (b) the lightest stop mass $m_{\tilde{t}_1}$, as a function of the gluino mass $m_{\tilde{g}}$. The scatter plots in (c) and (d) show the lightest neutralino mass $m_{\tilde{\chi}_1^0}$ as a function of (c) the gluino mass $m_{\tilde{g}}$ and (d) the lightest stop mass $m_{\tilde{t}_1}$. The green, blue and red points correspond to a combined tuning ($\Sigma^h\Sigma^v$) better than 5%, between 1% and 5%, and worse than 1%, respectively. All points satisfy the constraints discussed in sec. 5.*

1: fine-tuning level



2: reach, signatures

- Neutralino spectrum: $N_1 \ldots N_4 \rightarrow \mathbf{N_0}\ N_1 \ldots N_4$ (fermion component of S)

- Possibly longer decay chains. E.g. with a light singlino $N_1 \rightarrow N_0\ X$
  gluino $\rightarrow$q q' N_1 becomes gluino $\rightarrow$q q' X N_0

- Smaller mET, determined by N_1 (and further reduced by M_X) → weaker limits compensated by the richer final state (10% reduction)?

- Connection with DM: if LSP is mainly a singlino, it needs to mix significantly with Higgsino (hence similar masses, hence smaller mET)

  → Giacomo and Tommaso

3: Higgs sector

- new scalar S = s+ia

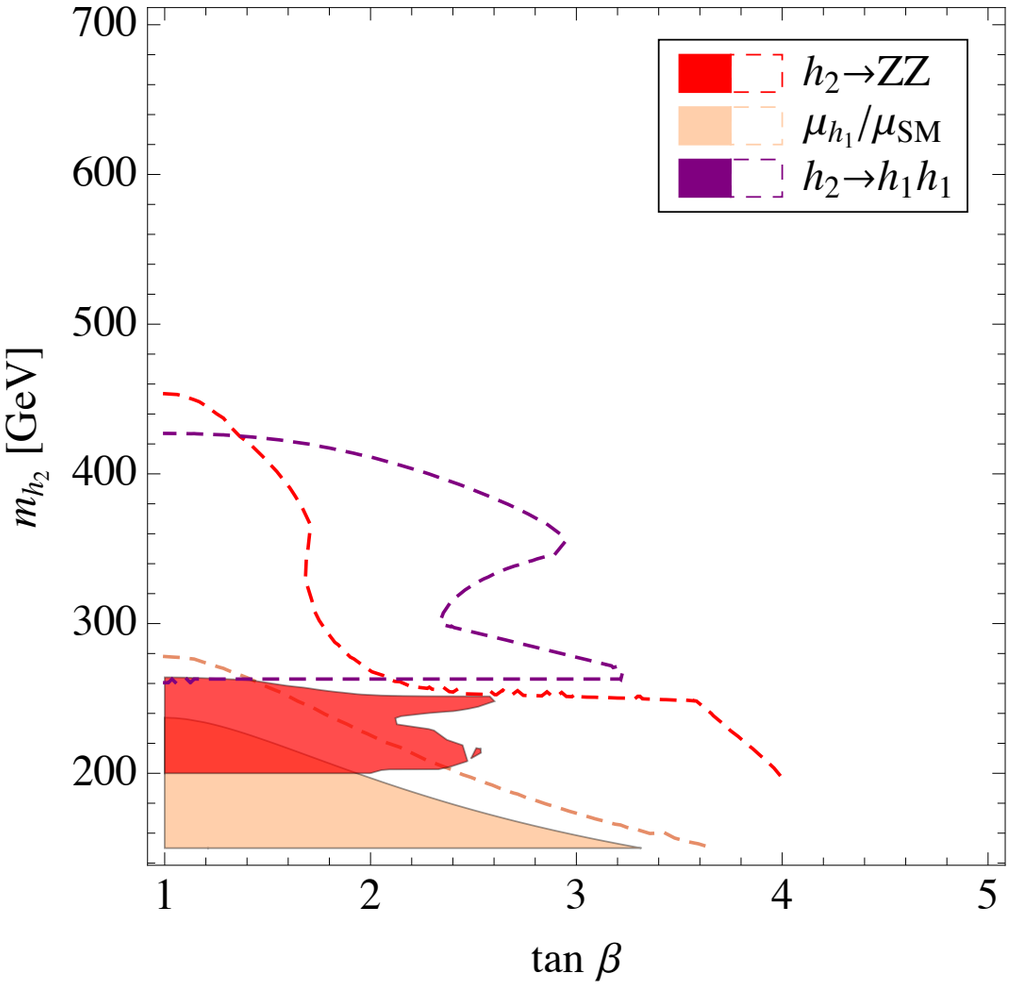
- neutral CP-even Higgs:
  - h_u h_d s alternatively
  - h H s (h linear combination getting vev)

- h_{126} is mainly h, with up to 30% s, and small H component

- implications for Higgs couplings and invisible channels?

- h_{126} is lightest or next-to-lightest?

- connection with neutralino spectrum?



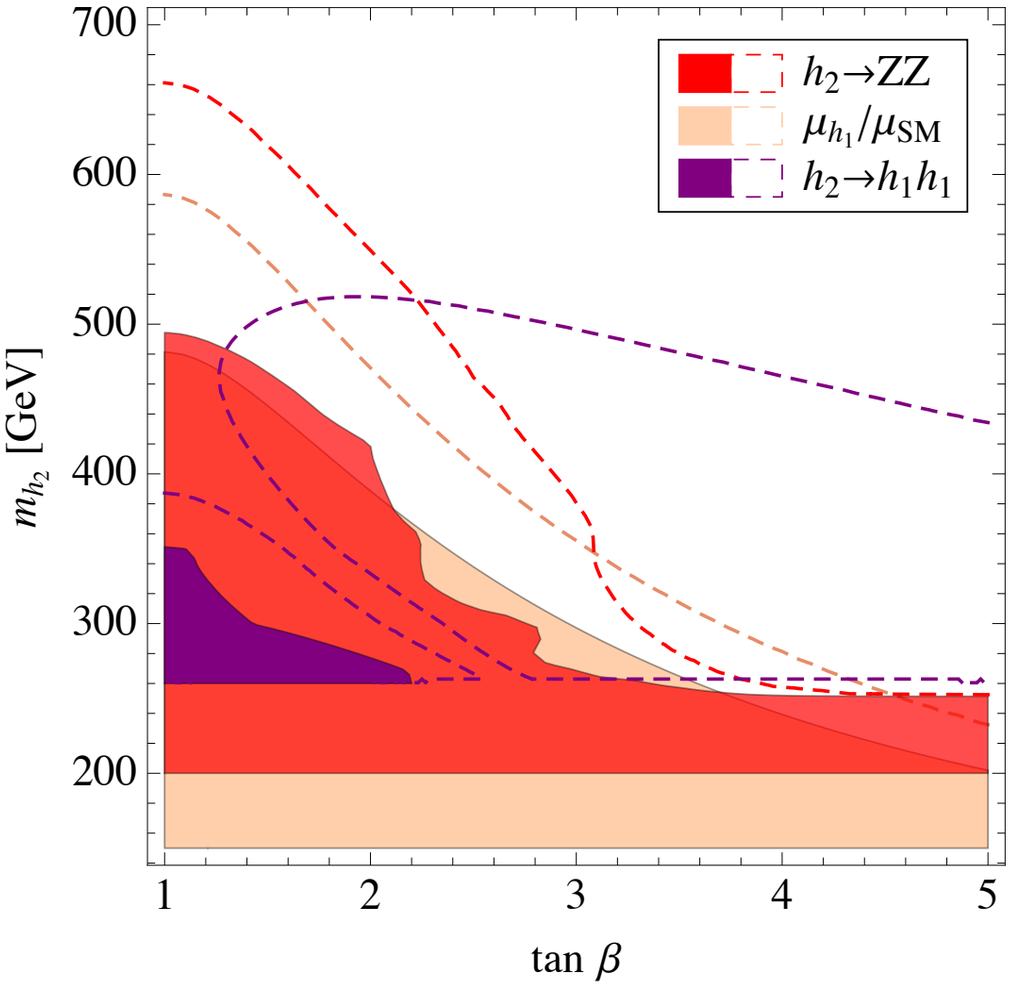


Figure 1. Current and foreseen LHC reaches for $\lambda = 0.8$ (left) and $\lambda = 1.4$ (right). The colored regions are excluded at 95% C.L.; the dashed lines are the expected limits.