

# MSSM BR Report & YR4

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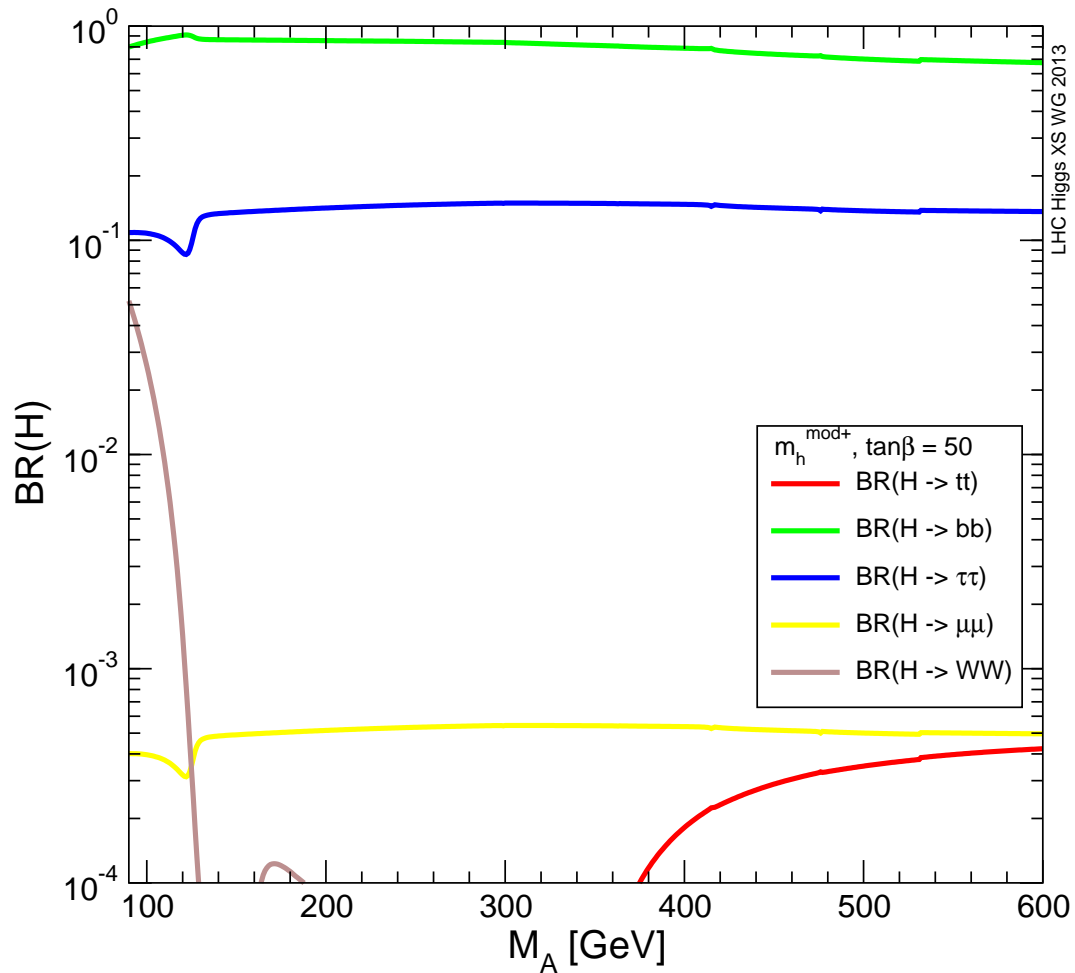
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- MSSM Higgs decays
- Exotic MSSM Higgs decays
- YR4

# MSSM Higgs Decays



Status:

Predictions for MSSM decay channels based on [FeynHiggs](#) and [Hdecay](#)

Results: “classic benchmarks”

- $m_h^{\text{max-up}}$
- $m_h^{\text{mod+}}$
- $m_h^{\text{mod-}}$
- light-stop
- light-stau
- tau-phobic
- low- $M_H$

## Previous new additions:

- $H \rightarrow hh$  (FH) and  $A \rightarrow hZ$  (FH) included  
→ request by ATLAS/CMS
- Extended range of  $M_A = 5 \dots 90$  GeV included  
→ request for light charged Higgs searches
- Extended range of  $\mu = \pm 1000, \pm 500, \pm 200$  GeV  
→ request by the  $\phi \rightarrow b\bar{b}$  group

## New additions:

- $H \rightarrow ZA$  (FH),  $h/H \rightarrow AA$  (FH),  $H \rightarrow W^\pm H^\mp$  (HD) included
- Extended range of  $M_A = 1 \dots 2$  TeV included  
⇒ everything to be recalculated with FH2.11.2 and HD6.3.1  
⇒ now (finally) done!
- New scenarios for low  $\tan \beta$  ⇒ see Stefan's talk yesterday  
→ request by ATLAS/CMS to have a scenario valid at low  $\tan \beta$   
to get large  $BR(H \rightarrow hh)$ ,  $BR(A \rightarrow hZ)$   
→ evaluated for “low-tb-high” (“hMSSM” based on Hdecay)

## Rare SM decays:

–  $H \rightarrow \gamma + \text{meson } (J/\psi, \Upsilon, \dots)$

⇒ done by Frank Petrielle and Matthias Neubert

–  $H \rightarrow W/Z + \text{meson}$

⇒ done by Gino Isidori and Mike Trott

⇒ total SM width sufficient for BR

Uncertainty calculations?

## Exotic MSSM Higgs decays

New, interesting decays/scenarios?

Possibly interesting decays:

$$h \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0 \rightarrow (\gamma \tilde{G}) (\gamma \tilde{G})$$

(with  $\tilde{G}$  the gravitino and  $\tilde{\chi}_1^0$  mainly bino).

⇒ “GMSB type” scenario

⇒ “Sgoldstino” scenario ??

$\text{BR}(h \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0)$  is in principle evaluated in our machinery. So far it did not play a role, because in the benchmark scenarios so far  $m_{\tilde{\chi}_1^0} > M_h/2$ .

⇒ treat  $M_1$  and  $M_2$  independent parameters.

⇒ ensure that search bounds are not violated!

⇒ check/adjust  $\mu$  and  $M_2$ !

- start with a known benchmark scenario: [mhmod+](#)

- Treat  $M_1$  as independent parameter

⇒ scan over  $M_1, M_A, \tan \beta$

Choose “better” values:  $\mu = 400 \text{ GeV}, M_2 = 400 \text{ GeV}$  to avoid search bounds for very low  $M_1$

→  $M_1 \sim M_2/2$  still similar to original mhmod+ scenario

- Evaluate:  $m_{\tilde{\chi}_1^0}, \text{BR}(h \rightarrow \tilde{\chi}_1^0 \tilde{\chi}_1^0), \text{decay length } c\tau$

[[arXiv:0909.3523](#)]

$$c\tau = 48\pi \frac{m_{3/2}^2 M_{\text{Pl}}^2}{m_{\tilde{\chi}_1^0}^5} \frac{1}{|P_{1\gamma}|^2}$$

$$P_{1\gamma} = N_{11}c_W + N_{12}s_W$$

–  $m_{3/2} = 0.6\text{eV}$ : gravitino mass

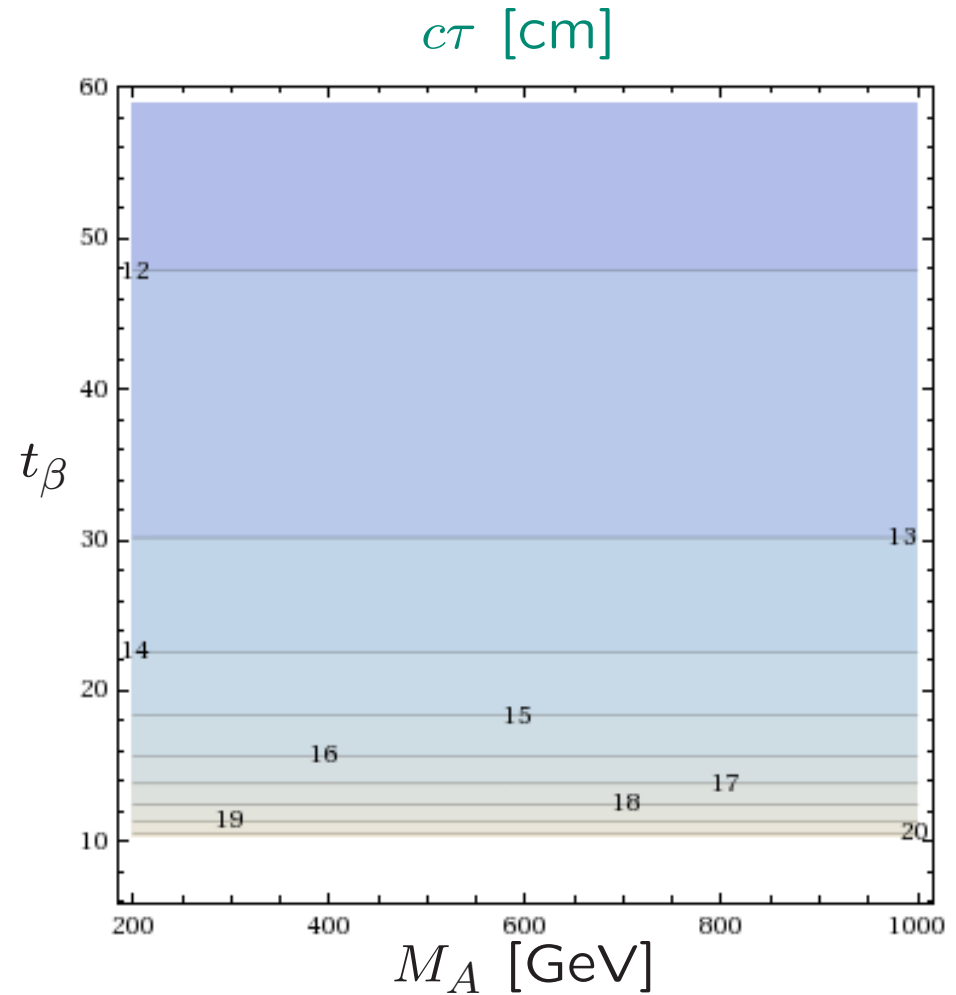
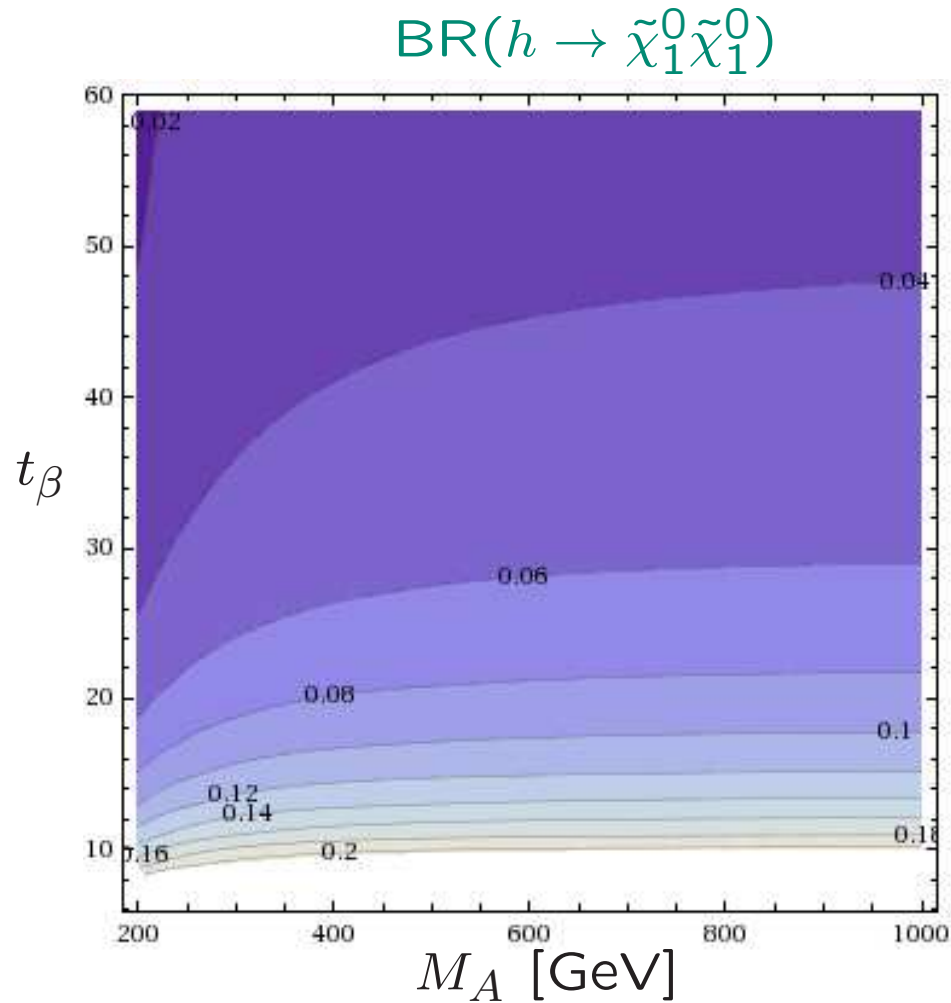
–  $M_{\text{Pl}}$ : Planck mass

–  $N_{ij}$ : neutralino mixing matrix

→ evaluated with FH2.11.2

⇒ check for numbers in Sgoldstino scenario?

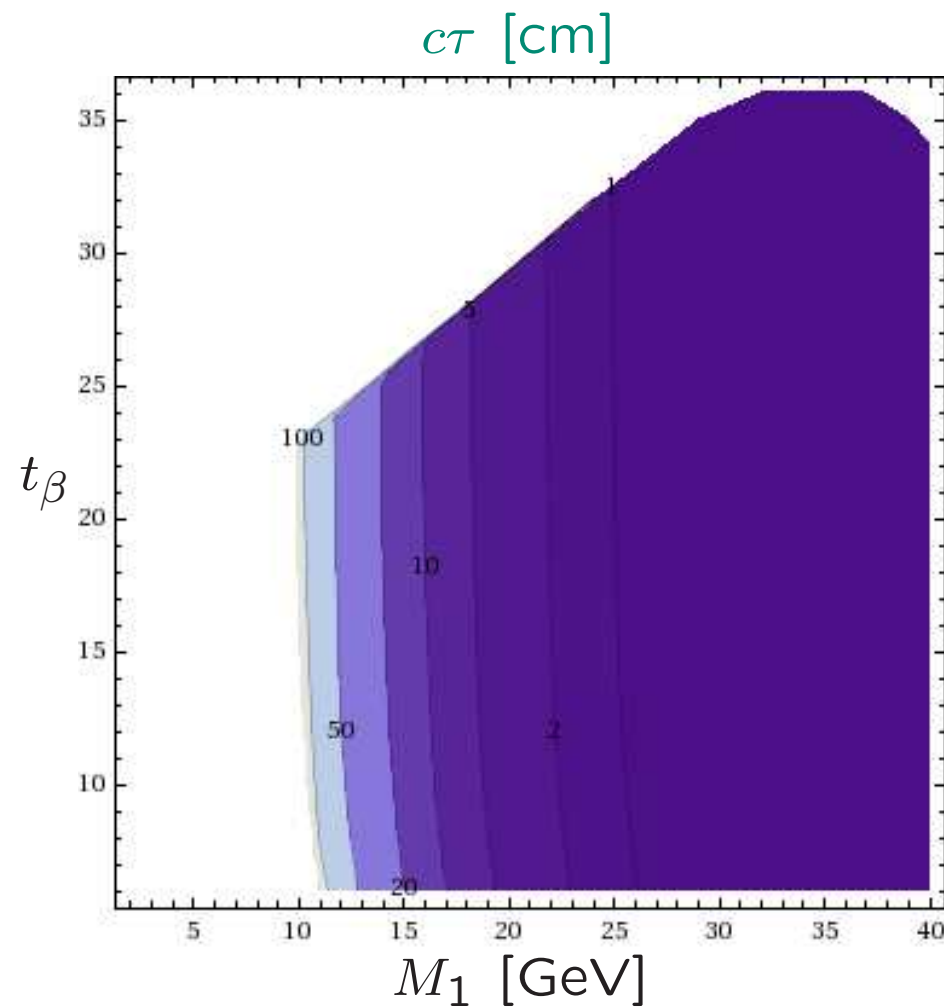
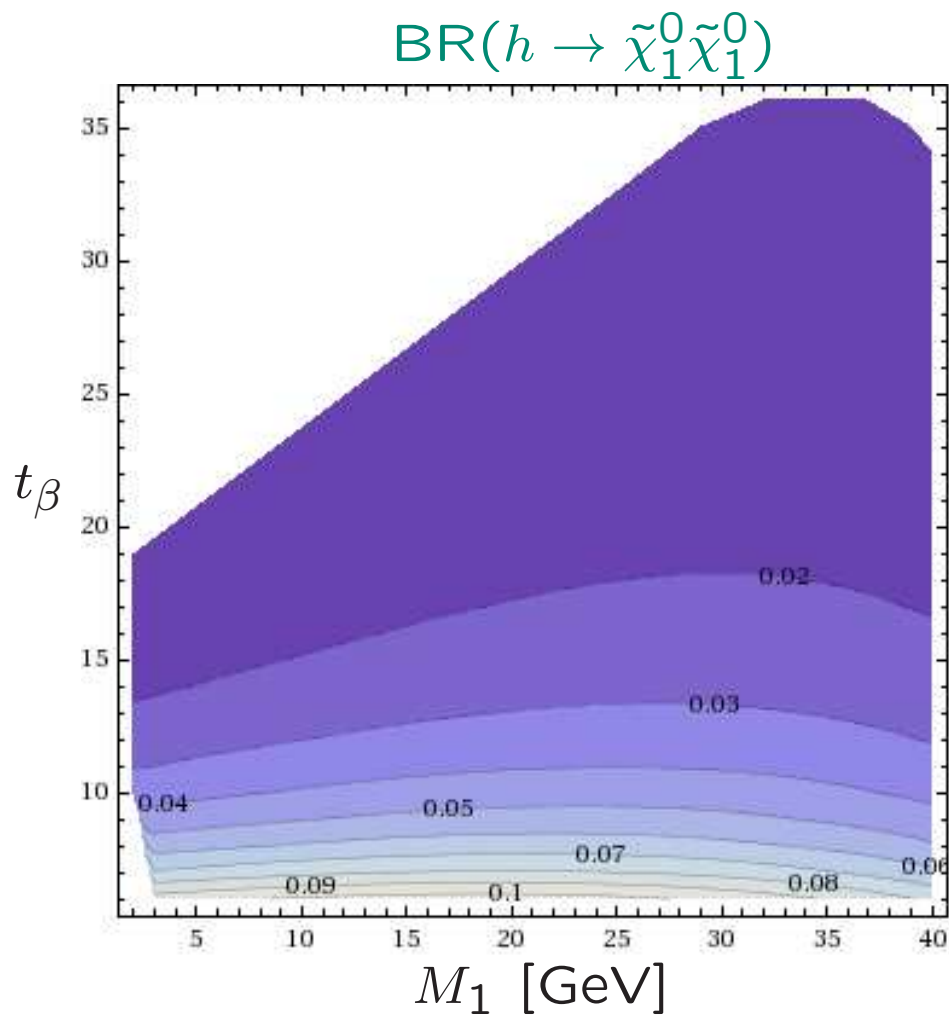
Example: mhmod+ with  $M_1 = 16$  GeV:



$\Rightarrow$  decay length of  $\mathcal{O}(10\text{cm})$

$\Rightarrow$  mostly independent of  $M_A \Rightarrow$  better  $M_1$ - $\tan\beta$  plane!

mhmod+ with  $M_A = 1000$  GeV:



$\Rightarrow$  decay length between 1 cm and 1 m



## YR4 status

- SM BR update (see previous talk)

- Dalitz decays

Despite efforts not sufficient interest (ATLAS/CMS ...) to include a recommendation

- Update of MSSM BRs  
(additional channels, very brief ...)

- Description of exotic decay evaluation?!  
→ coordinate with Exotic decay group!

# Higgs Days at Santander 2016

Theory meets Experiment  
19.-23. September



<http://hdays.csic.es>

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Back-up