

# BR Report and Plans for YR4

*Sven Heinemeyer, IFCA (CSIC, Santander)*

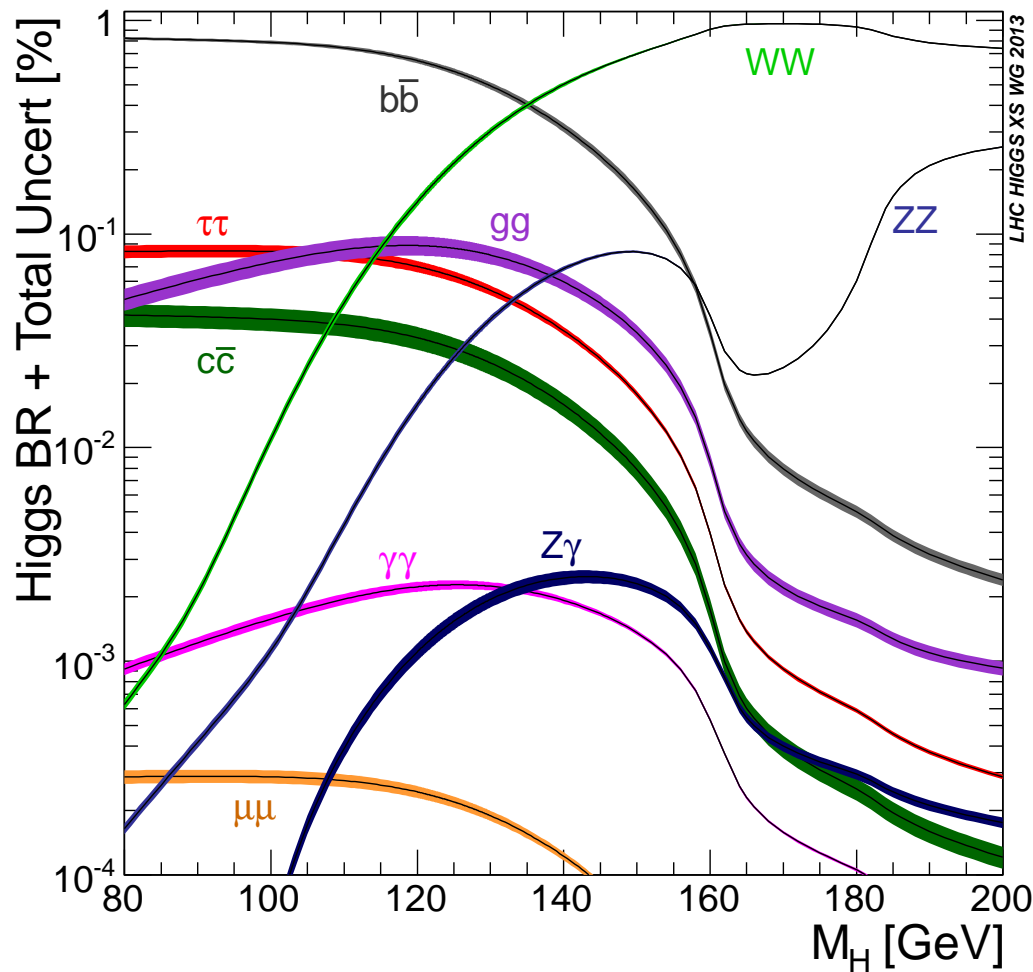
CERN, 01/2015

co-conv.: Ansgar Denner, Alexander Mück, Ivica Puljak, Daniela Rebutzi  
other contributors: Michael Spira, Heather Logan, Stoyan Emilov Stoynev

- SM Higgs decays
- MSSM Higgs decays
- Higgs decays in other BSM models

⇒ based on our write-up! :-)

# SM Higgs Decays



Status:

Predictions for SM decay channels based on [Hdecay](#) and [Prophecy4f](#)

Update:

[Hdecay](#) now with full EW corrections

⇒ re-evaluation,  
incl. uncertainty update

## Update of SM predictions:

- using the latest **Hdecay** version
- using improved quark mass uncertainties ?
- using improved intrinsic uncertainties !

## To-do:

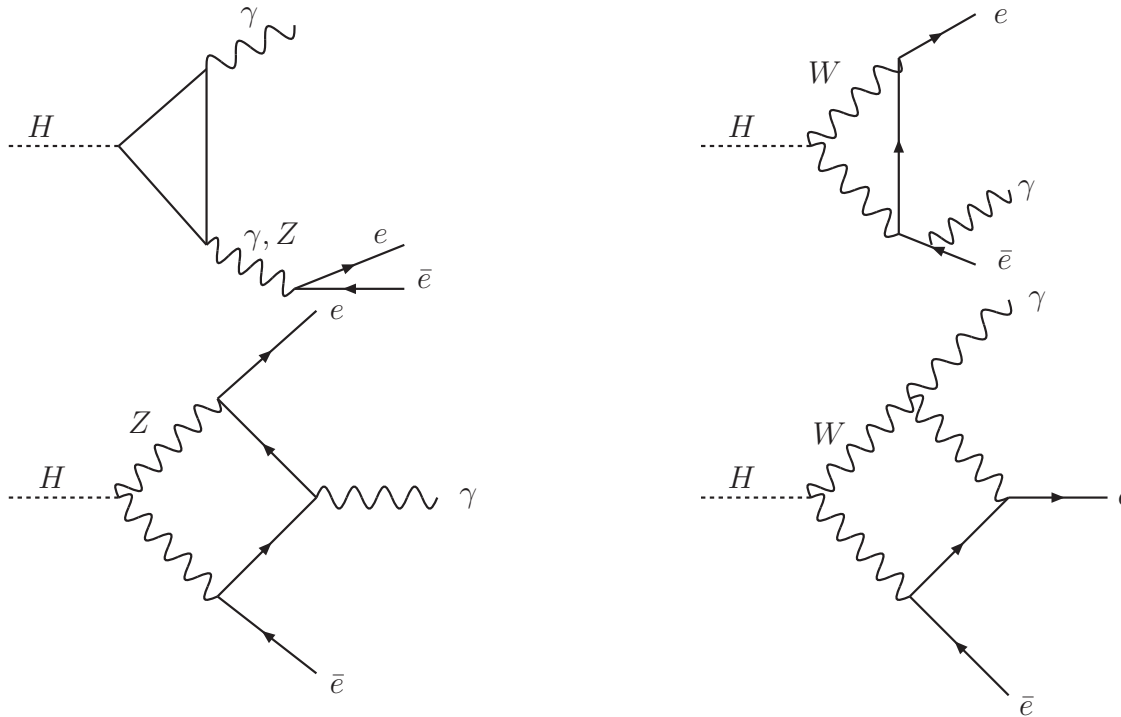
- estimate reduced intrinsic uncertainties
- clarify quark mass uncertainties
  - conservative? realistic? optimistic (a la Peskin)?
- redo runs :-)

## Question:

Concentrate on  $M_H = 122 \dots 128$  GeV?

## Proper inclusion of Dalitz decays:

$H \rightarrow e^+e^-\gamma$  not Yukawa suppressed at 1-loop



## To-do:

$H \rightarrow e^+e^-\gamma$  to be defined by **suitable cuts**  $\Rightarrow$  affects  $H \rightarrow Z\gamma$

$\Rightarrow$  agree on definition with ATLAS/CMS

$\Rightarrow$  include Dalitz decays into evaluation  
(implementation in **Hdecay** in progress)

## (Other) Rare SM decays:

What we thought:

- get input from ATLAS/CMS/TH which rare decays are interesting
- ask theorists to provide predictions
- example under discussion:  $H \rightarrow J/\Psi \gamma$

## (Other) Rare SM decays:

What we thought:

- get input from ATLAS/CMS/TH which rare decays are interesting
- ask theorists to provide predictions
- example under discussion:  $H \rightarrow J/\Psi \gamma$

Solution:

BSM Working Group installed [Higgs Exotic decay](#) group

## (Other) Rare SM decays:

What we thought:

- get input from ATLAS/CMS/TH which rare decays are interesting
- ask theorists to provide predictions
- example under discussion:  $H \rightarrow J/\Psi \gamma$

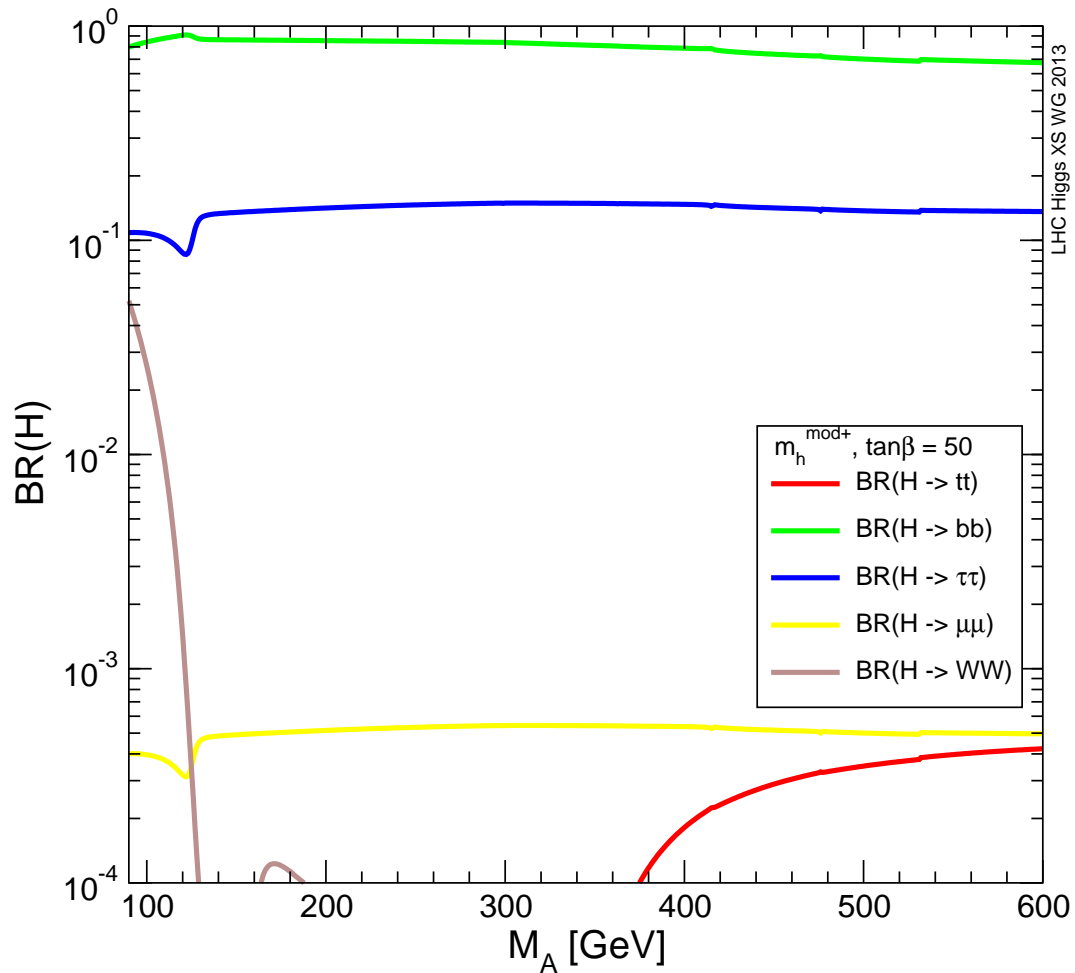
Solution:

BSM Working Group installed [Higgs Exotic decay](#) group

Question:

Inclusion in SM decay results?

# 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- $M_H$



## New additions:

- $H \rightarrow hh$  and  $A \rightarrow hZ$  included  
→ request by ATLAS/CMS
- Extended range of  $M_A = 5 \dots 90$  GeV included  
→ request for light charged Higgs searches
- $\text{BR}(t \rightarrow H^\pm b)$  included (in a preliminary way!)  
→ request for light charged Higgs searches

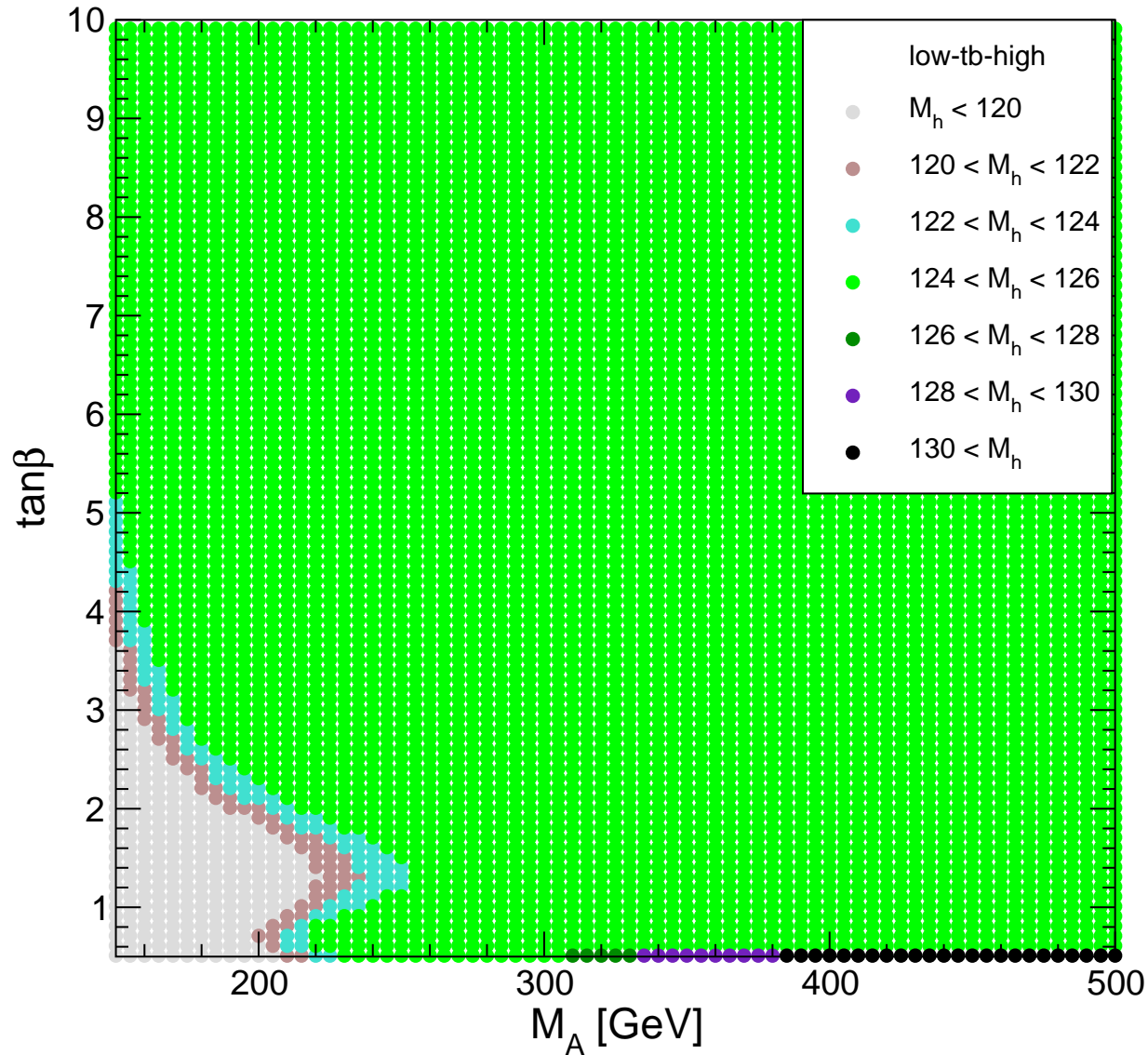
To-do: agree on code, redo runs!

- Extended range of  $\mu = \pm 1000, \pm 500, \pm 200$  GeV (wip)  
→ request by the  $\phi \rightarrow b\bar{b}$  group
- proposal for a new benchmark scenario: “low-tb-high”  
→ request by ATLAS/CMS to have a scenario valid at low  $\tan \beta$   
to get large  $\text{BR}(H \rightarrow hh)$ ,  $\text{BR}(A \rightarrow Ah)$   
⇒ to be scrutinized/approved/rejected by MSSM subgroup ...  
⇒ new parameter spaces, new problems, ... but we got it right!

New benchmark proposal: “low-tb-high”

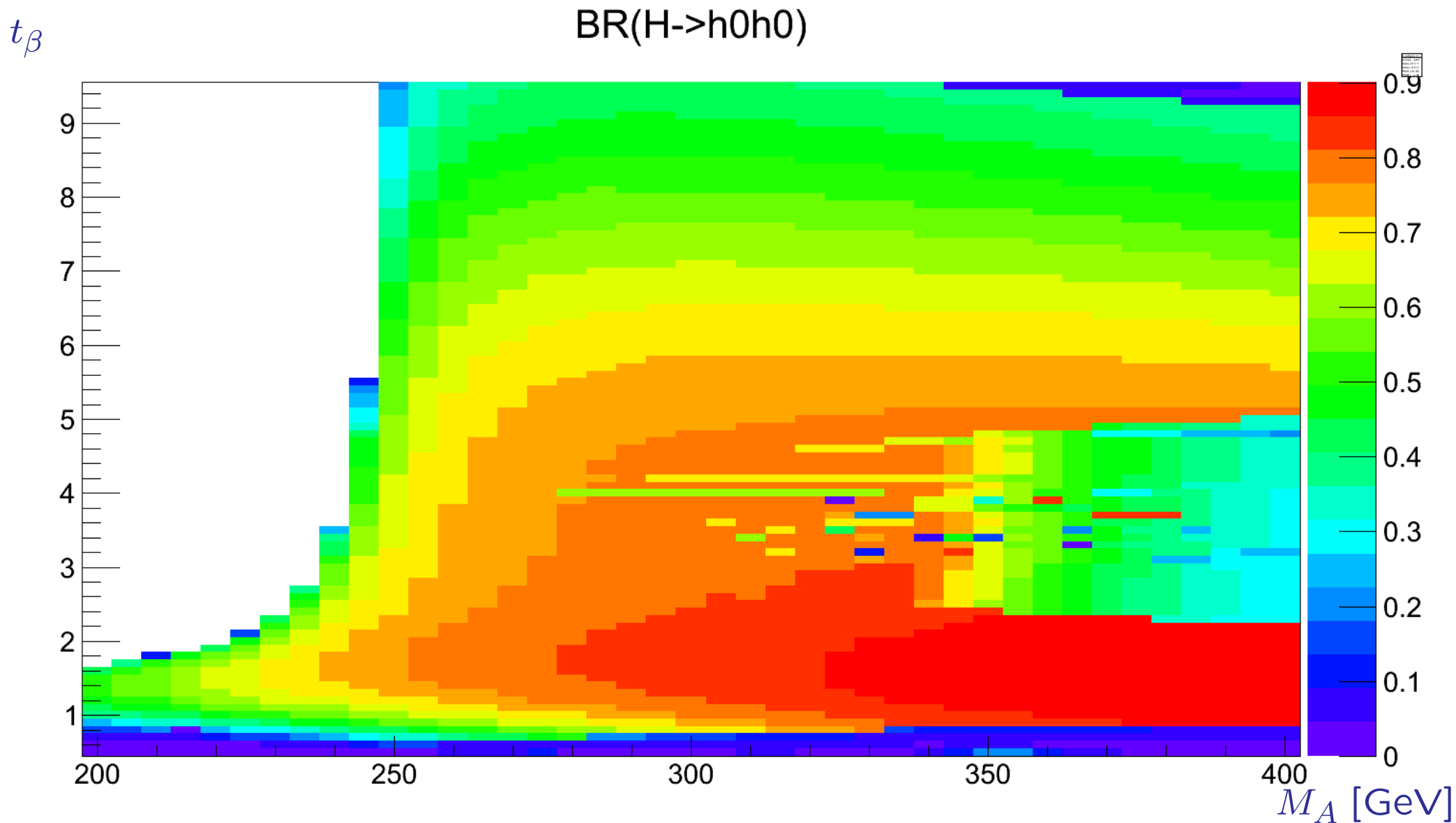
[S.H. (LHCHXSWG??) '14]

$M_{\text{SUSY}}$  and  $X_t$  adjusted to give  $M_h \sim 125$  GeV “everywhere” [FeynHiggs 2.10.2]

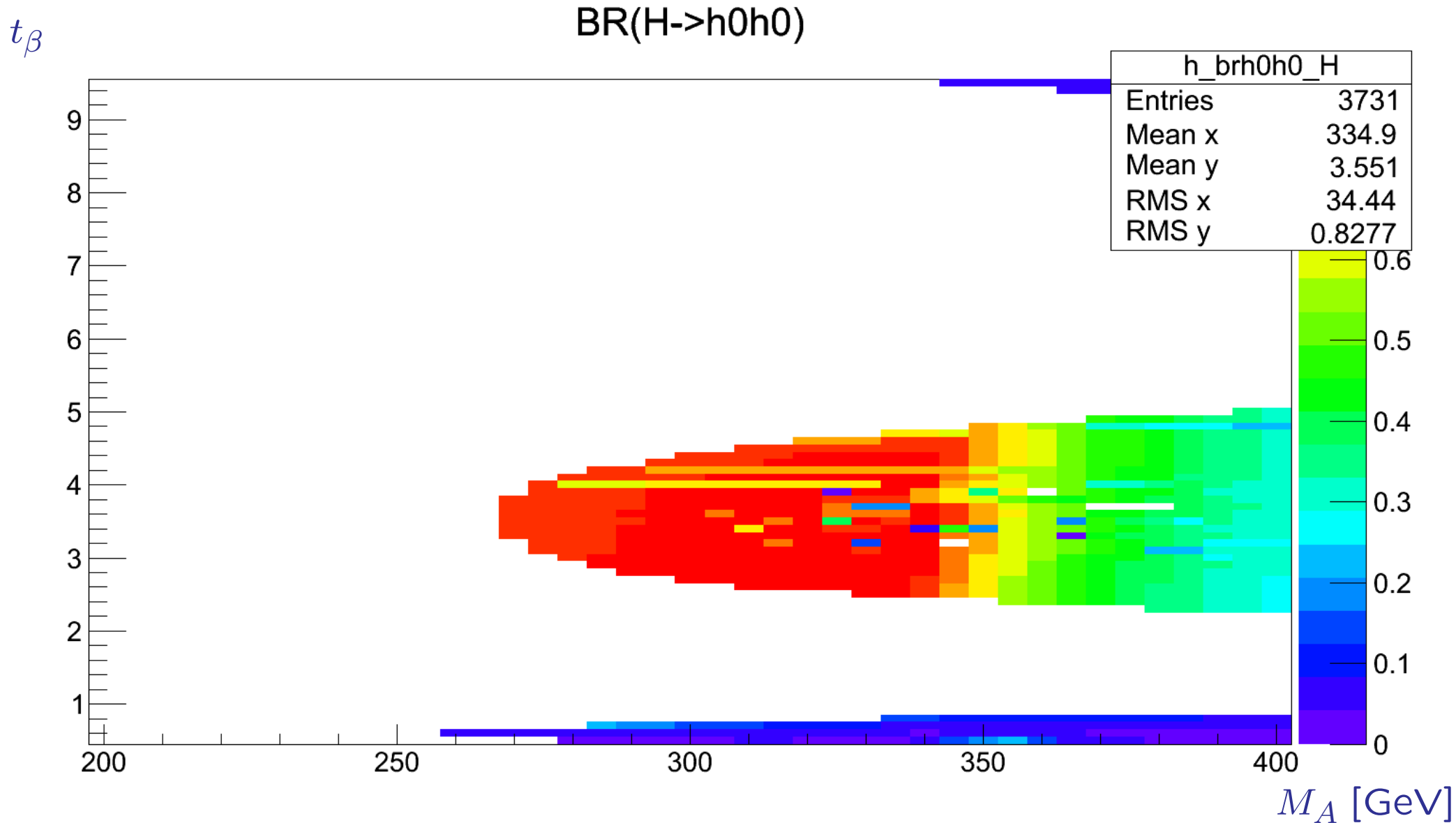


⇒ to be scrutinized/approved/rejected by MSSM subgroup ...

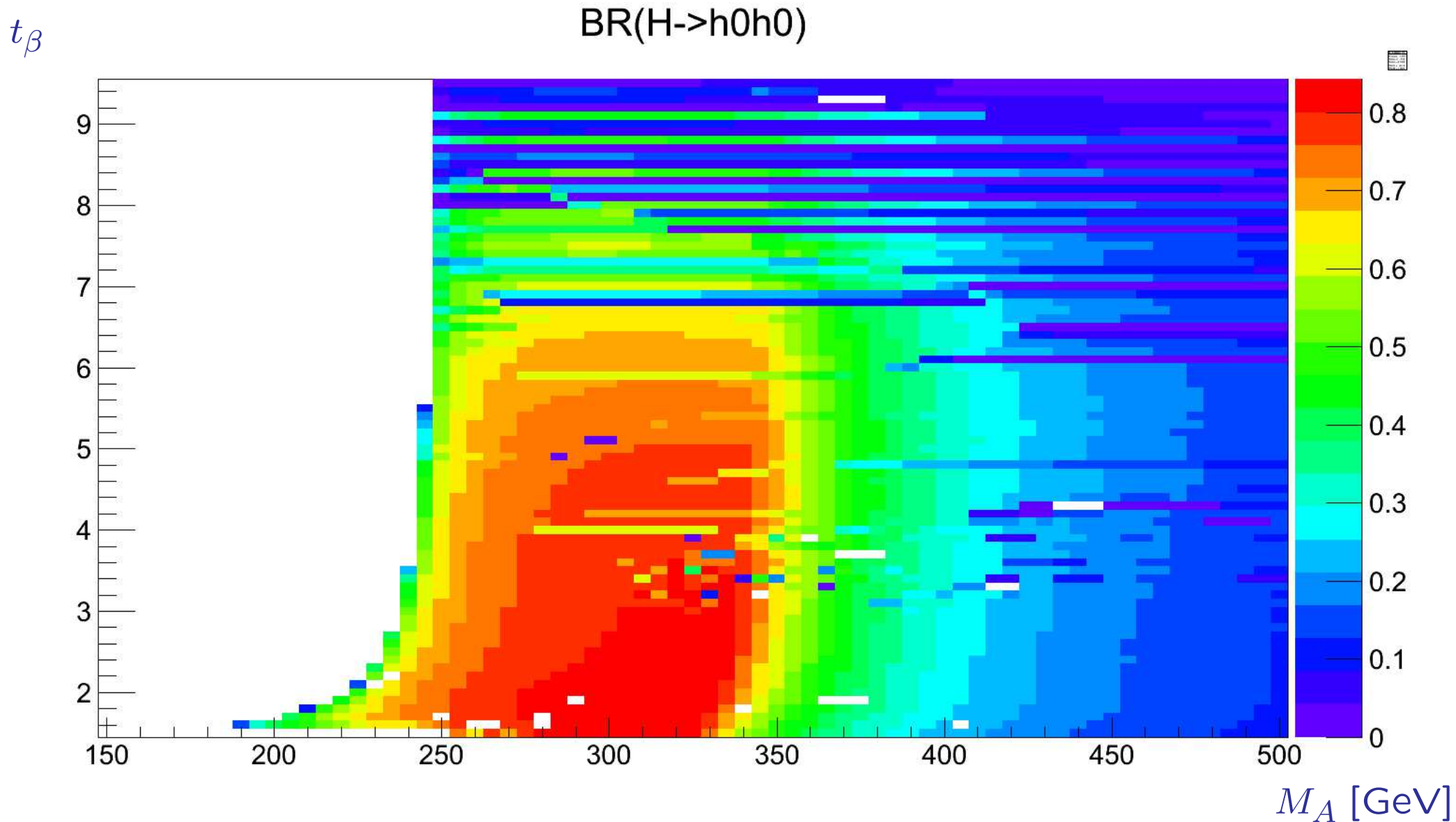
- ⇒ new parameter spaces, new problems, ...
- ⇒ thanks to Felix Frensch for re-plotting! :-)



- ⇒ new parameter spaces, new problems, ...
- ⇒ thanks to Felix Frensch for re-plotting! :-)



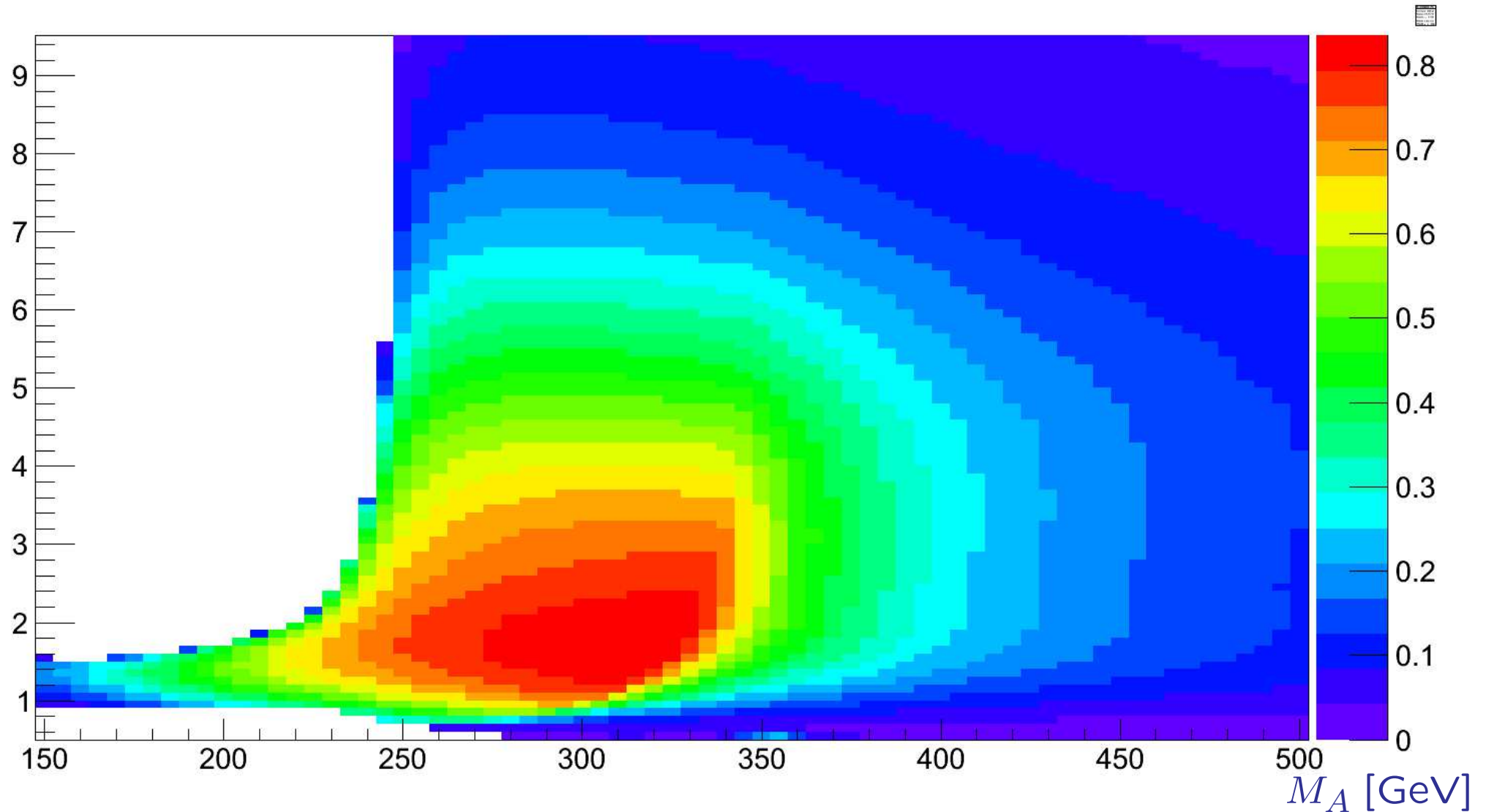
- ⇒ new parameter spaces, new problems, ...
- ⇒ thanks to Felix Frensch for re-plotting! :-)



- ⇒ new parameter spaces, new problems, ... but we got it right!
- ⇒ thanks to Felix Frensch for re-plotting! :-)

$t_\beta$

BR(H->h0h0)



## To-do for MSSM Higgs decays:

- Include Higgs decays to SUSY particles (scalar fermions, charginos, neutralinos)
  - Evaluation of TH uncertainties for decays to SM particles
    - evaluate TH uncertainties in the MSSM (add intrinsic SUSY uncertainties, parameter dependent!)
    - take over (new?) parametric uncertainties from the SM
- ⇒ redo runs

## Higgs Decays in other BSM Models

### Status:

So far nothing has been done by BR group ...

### General idea for the future:

- define interesting models and benchmark scenarios → BSM WG  
example: 2HDM
- organize responsibility with BSM WG
- possibly take care on production of numbers for specific benchmark scenarios  
example: 2HDM



Back-up

# Optimistic(?!) lattice expectations for the future:

## Input Parameters

Lepage, Mackenzie, Peskin [arXiv:1404.0319]

- How well can the **Higgs BRs** be predicted **in the future?**
- **Limitation** due to **parametric errors?**
- use **lattice** gauge theory **to improve**  $\alpha_s$ ,  $m_b$ , and  $m_c$   
(e.g. using current-current correlators)  
(stated errors already now quite small)
- **optimistic projection** for lattice improvements:

	$\delta m_b(10)$	$\delta \alpha_s(m_Z)$	$\delta m_c(3)$	$\delta_b$	$\delta_c$	$\delta_g$	
current errors [10]	0.70	0.63	0.61	0.77	0.89	0.78	
+ PT	0.69	0.40	0.34	0.74	0.57	0.49	
+ LS	0.30	0.53	0.53	0.38	0.74	0.65	
+ LS <sup>2</sup>	0.14	0.35	0.53	0.20	0.65	0.43	
+ PT + LS	0.28	0.17	0.21	0.30	0.27	0.21	
+ PT + LS <sup>2</sup>	0.12	0.14	0.20	0.13	0.24	0.17	
+ PT + LS <sup>2</sup> + ST	0.09	0.08	0.20	0.10	0.22	0.09	
ILC goal				0.30	0.70	0.60	(errors in %)

time-scale: 10-15 years

BR report – Alexander Mück – p.7/ 13

