
HAVE YOU HEARD? THEY DISCOVERED THE GOD PARTI...
IT'S CALLED THE HIGGS BOSON!

LHC result interpretation:

SM Higgs-Boson Measurements

and BSM Higgs-Boson Searches

Sven Heinemeyer, IFT/IFCA (CSIC, Madrid/Santander)

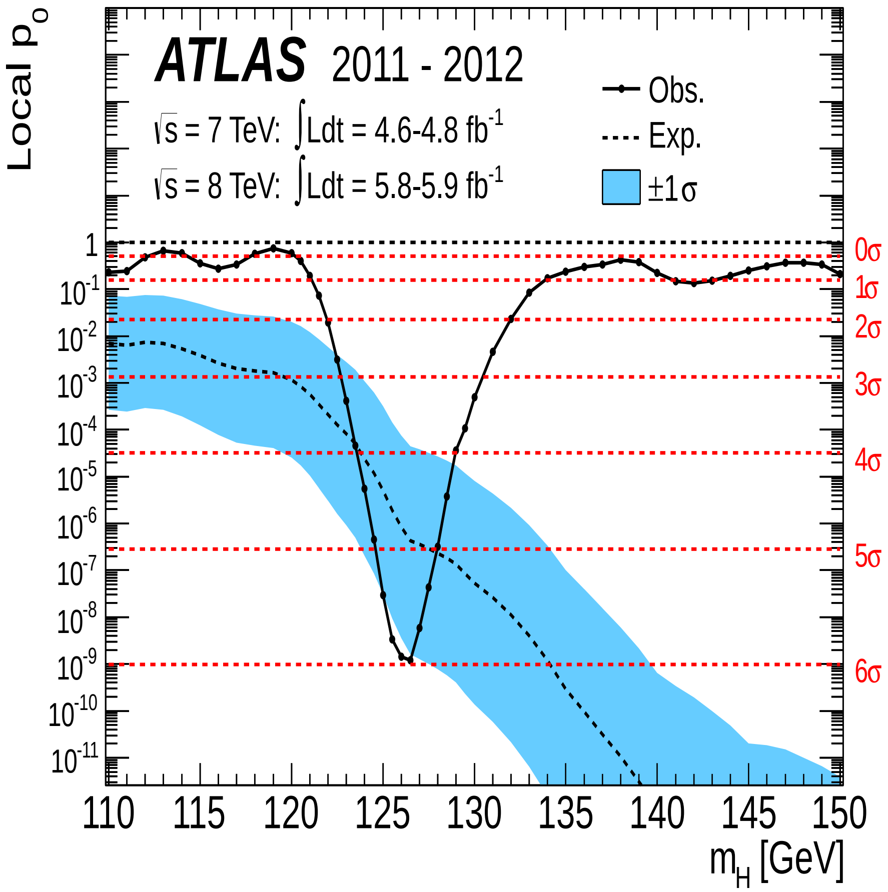
Uppsala, 09/2018

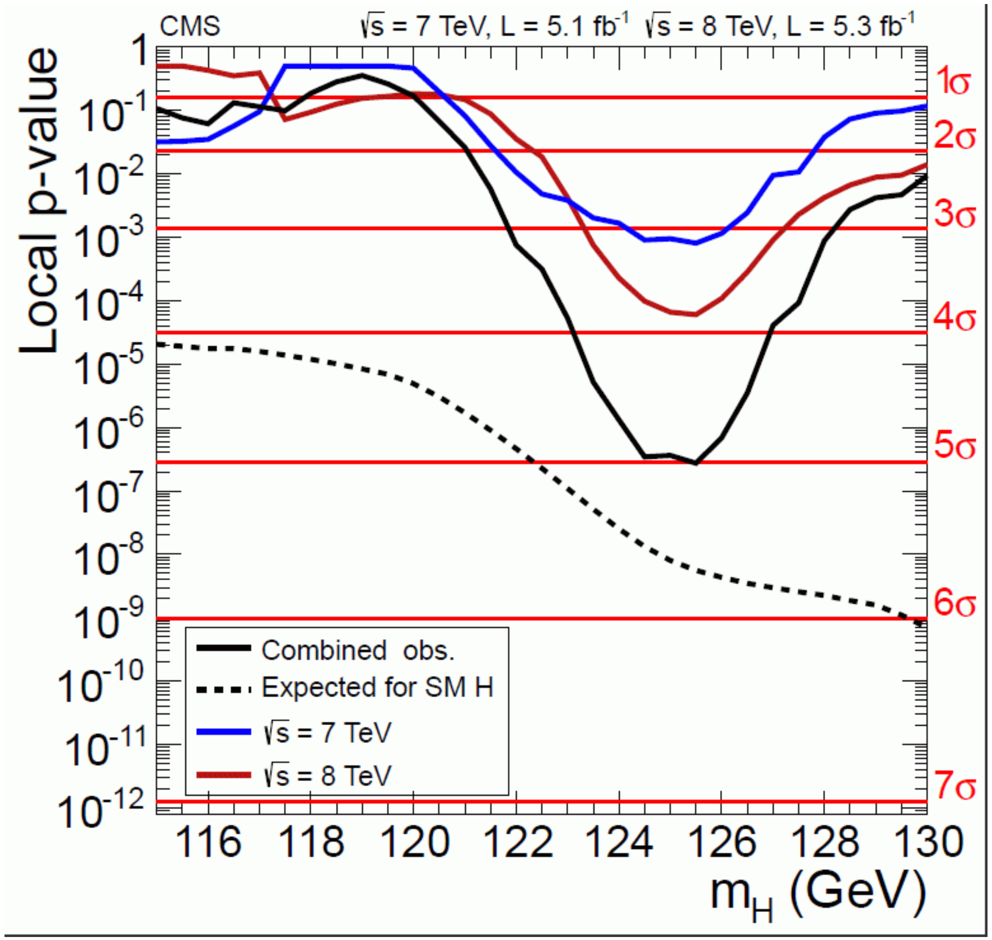
- Introduction
- SM Higgs-Boson measurements
- BSM Higgs-Bosonn searches
- A Higgs Boson at $\sim$ 96 GeV?!
- Conclusions

1. Introduction: Why it is not the SM Higgs

Fact I:

We have a discovery!

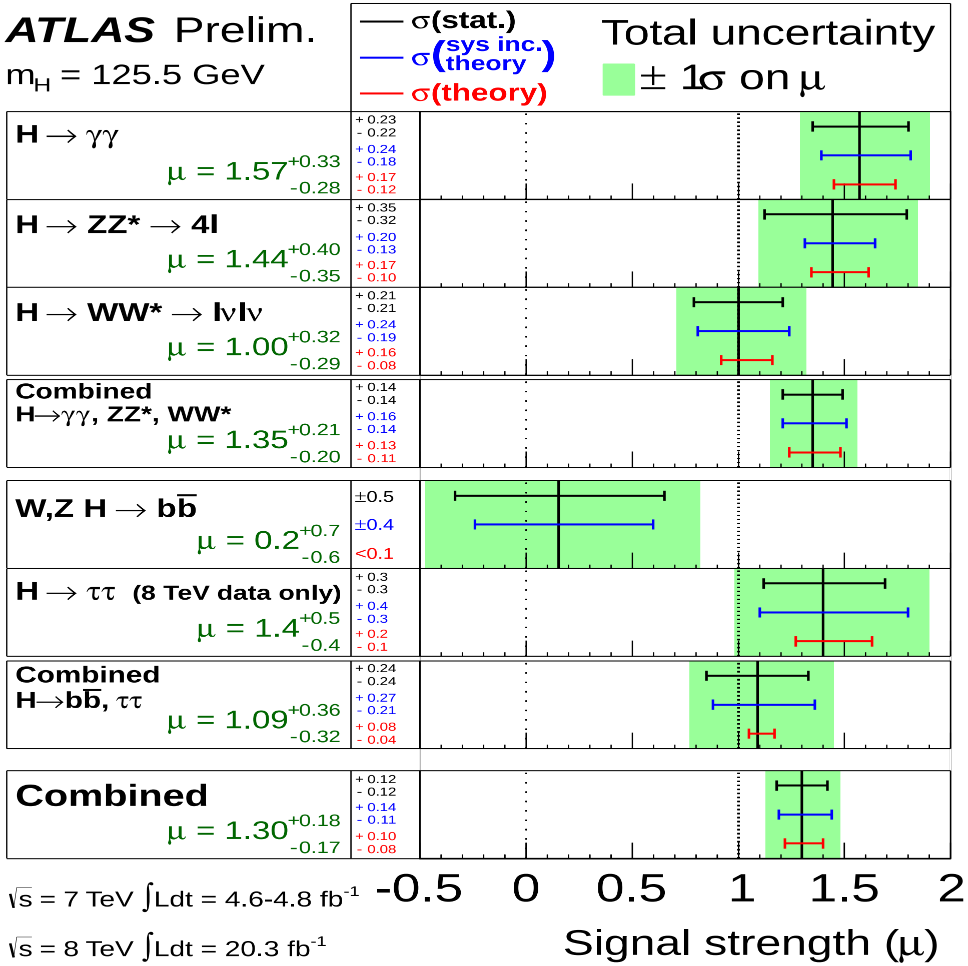


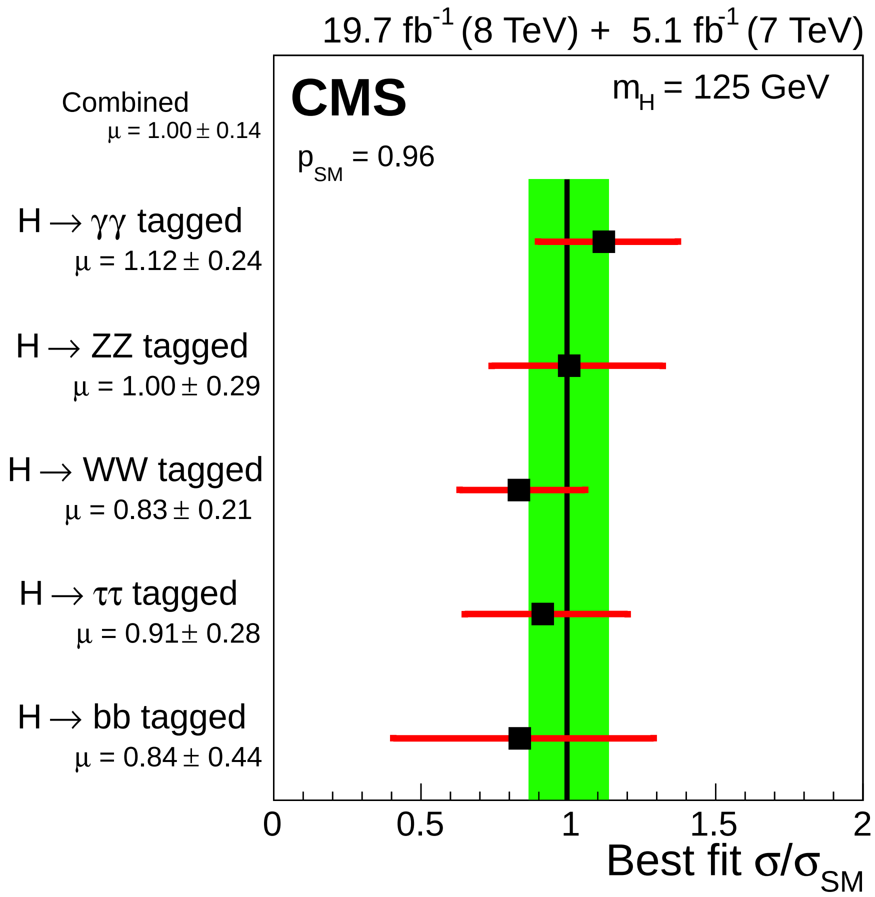


1. Introduction: Why it is not the SM Higgs

Fact I:

We have an SM-like discovery!





Fact II:

The SM cannot be the ultimate theory!

Some facts:

1. gravity is not included

2. the hierarchy problem

3. Dark Matter is not included

4. neutrino masses are not included

5. anomalous magnetic moment of the muon shows a $\sim 4\,\sigma$ discrepancy

Fact I & II:

We have a discovery!

The SM cannot be the ultimate theory!

Conclusion: It cannot be "the SM Higgs"!

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A1: check changed properties

A2: check for additional Higgs bosons
A2': check for additional Higgs bosons above and below 125 GeV

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Conclusion: It cannot be "the SM Higgs"!

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Q': Which model?

A1: check changed properties ⇒ SM Higgs measurements

A2: check for additional Higgs bosons ⇒ BSM Higgs searches
A2': check for additional Higgs bosons above and below 125 GeV

Models with extended Higgs sectors:

1. SM with addional Higgs singlet
2. Two Higgs Doublet Model (THDM): type I, II, III, IV
3. Minimal Supersymmetric Standard Model (MSSM)
4. MSSM with one extra singlet (NMSSM)
5. MSSM with more extra singlets
6. SM/MSSM with Higgs triplets
7. . . .

⇒ BSM models without extended Higgs sectors still have changed Higgs properties (quantum corrections!)

⇒ SM + vector-like fermions, Higgs portal, Higgs-radion mixing, . . .

The MSSM Higgs sector:

Enlarged Higgs sector: Two Higgs doublets

$$H_1 = \begin{pmatrix} H_1^1 \\ H_1^2 \end{pmatrix} = \begin{pmatrix} v_1 + (\phi_1 + i\chi_1)/\sqrt{2} \\ \phi_1^- \end{pmatrix}$$

$$H_2 = \begin{pmatrix} H_2^1 \\ H_2^2 \end{pmatrix} = \begin{pmatrix} \phi_2^+ \\ v_2 + (\phi_2 + i\chi_2)/\sqrt{2} \end{pmatrix}$$

$$V = m_1^2 H_1 \bar{H}_1 + m_2^2 H_2 \bar{H}_2 - m_{12}^2 (\epsilon_{ab} H_1^a H_2^b + \text{h.c.})$$

$$+ \underbrace{\frac{g'^2 + g^2}{8}} (H_1 \bar{H}_1 - H_2 \bar{H}_2)^2 + \underbrace{\frac{g^2}{2}} |H_1 \bar{H}_2|^2$$

gauge couplings, in contrast to SM

physical states: $h^0, H^0, A^0, H^\pm$ Goldstone bosons: $G^0, G^\pm$

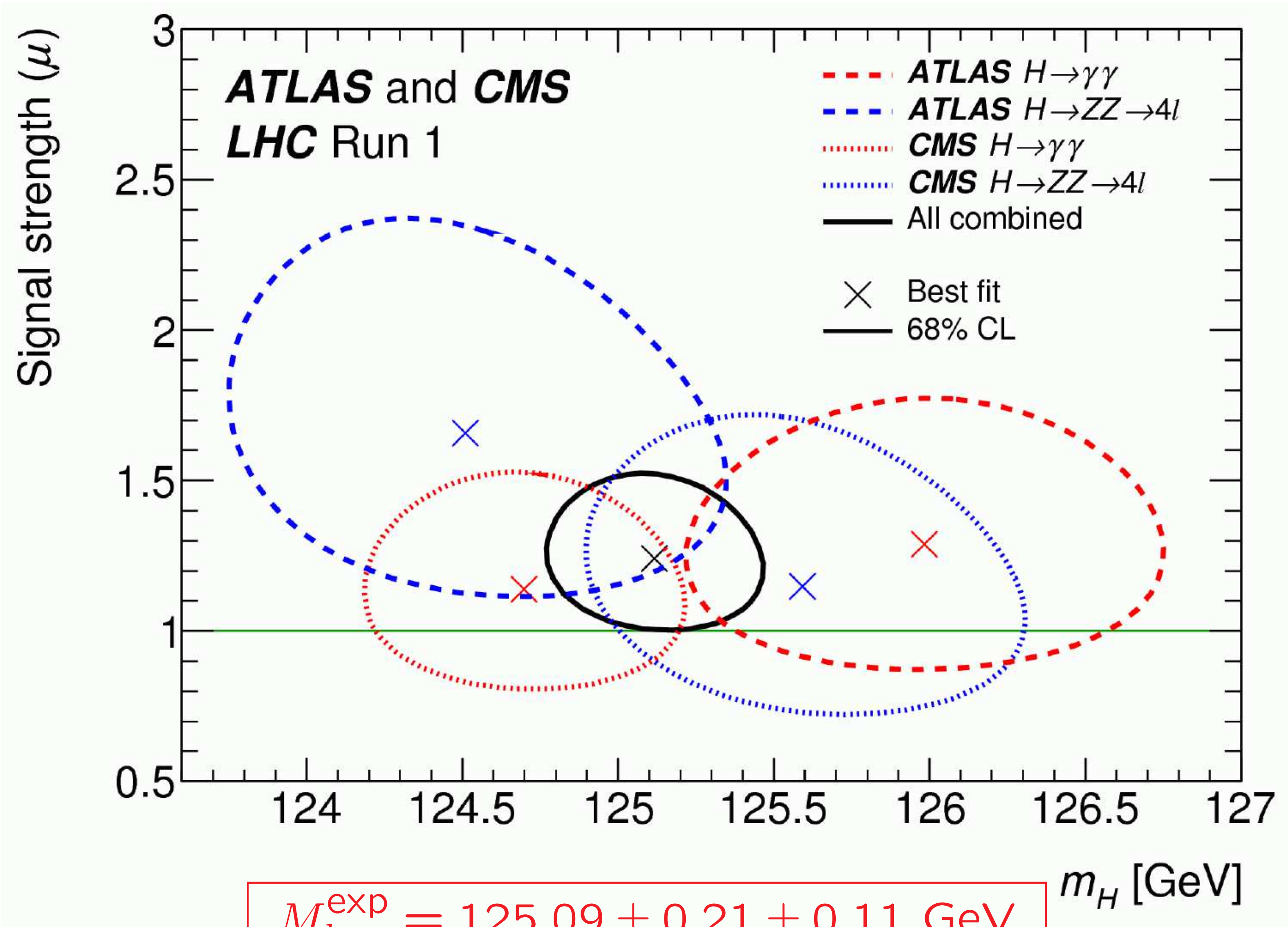
Input parameters: (to be determined experimentally)

$$\tan\beta = \frac{v_2}{v_1}, \qquad M_A^2 = -m_{12}^2 (\tan\beta + \cot\beta)$$

2. SM Higgs-Boson measurements

Latest combination for Higgs mass measurement in $\gamma\gamma$ and ZZ^*:

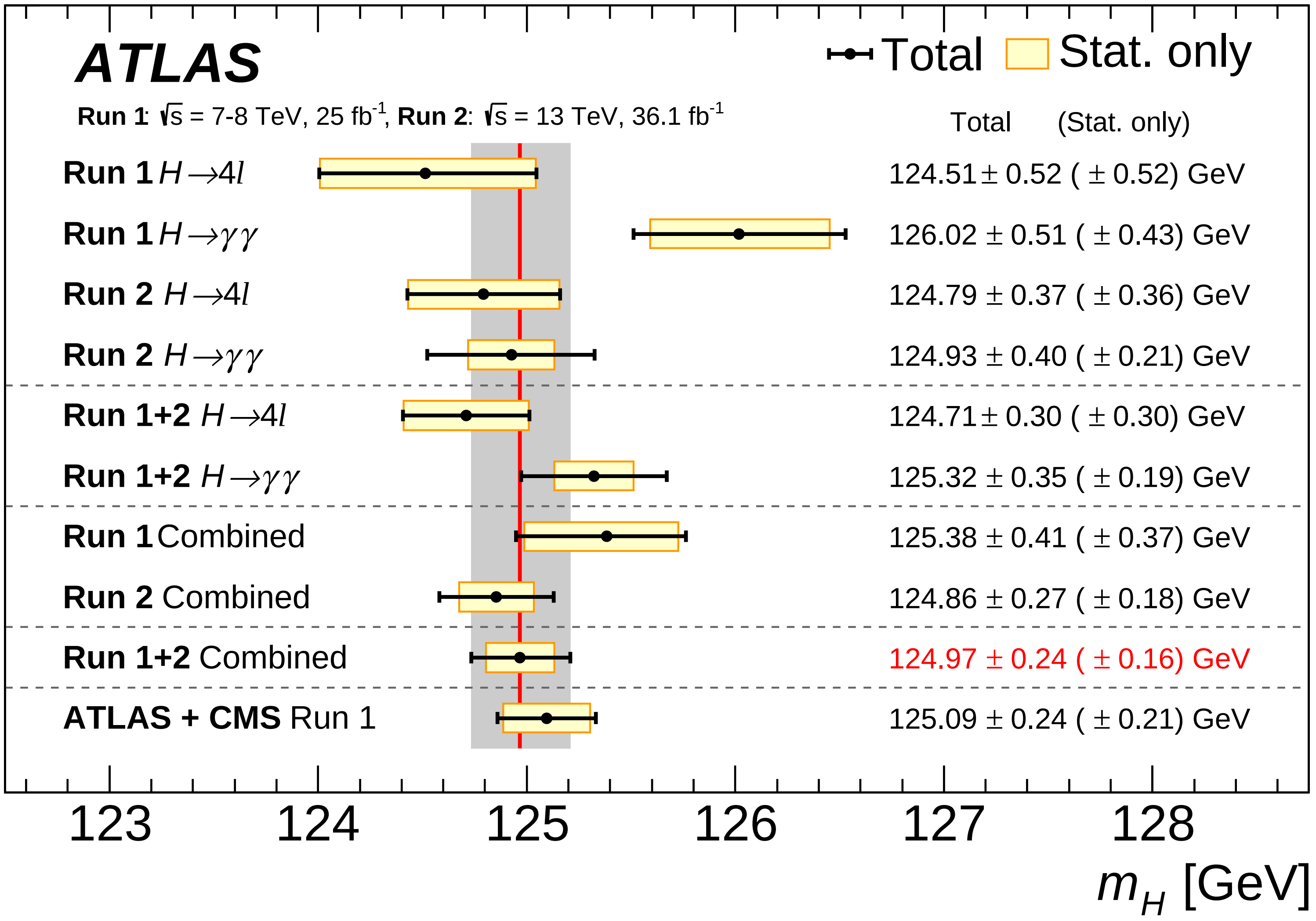
[*ATLAS, CMS '15*] $\Rightarrow$ newer measuements confirm



$$M_h^{\rm exp} = 125.09 \pm 0.21 \pm 0.11 \text{ GeV}$$

Latest mass measurement in $\gamma\gamma$ and ZZ^*:

[ATLAS, CMS '18]



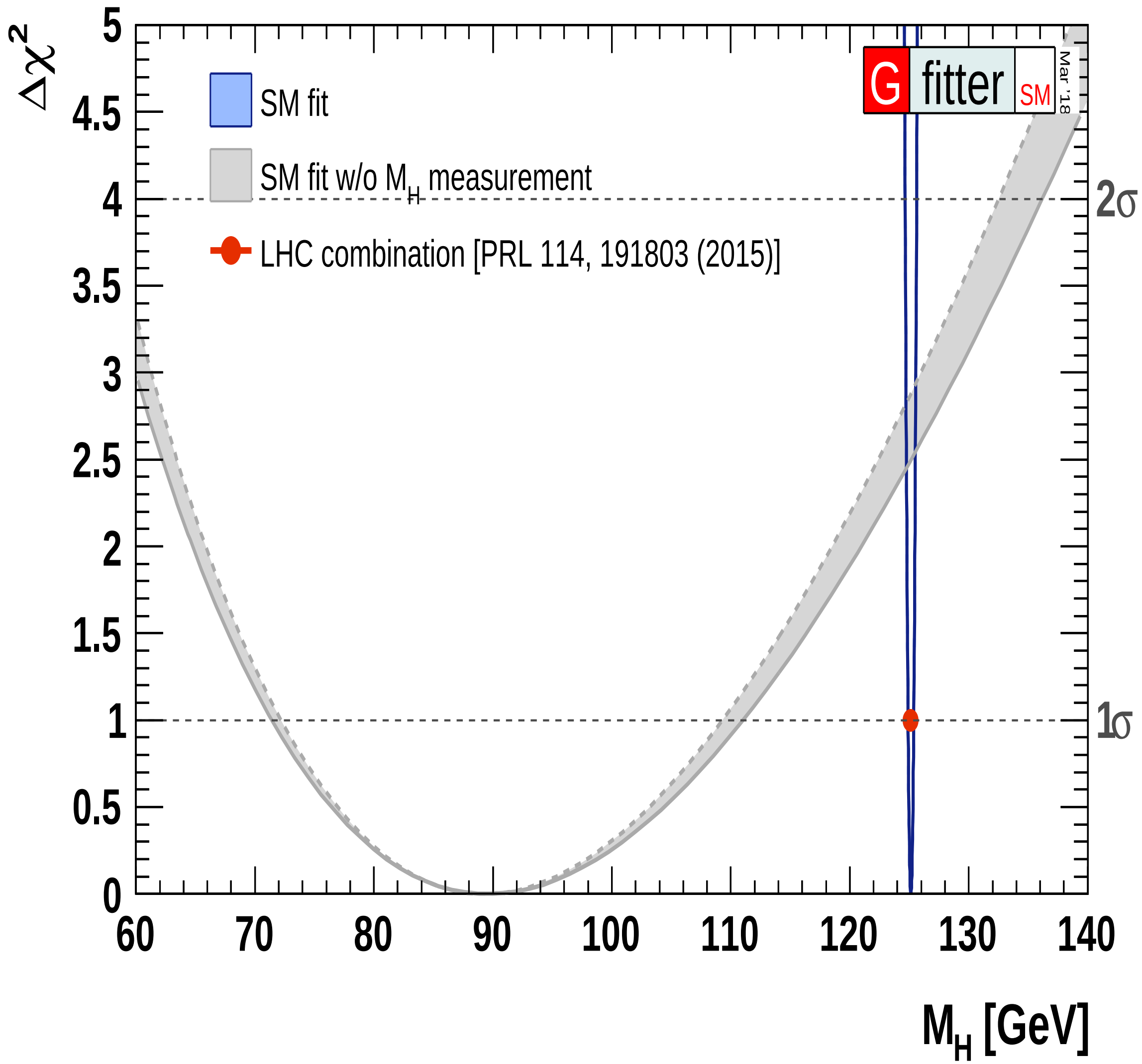
$\Rightarrow$ newer measurements confirm first combination

Comparison to SM prediction:

[GFitter '18]

$\Rightarrow M_H = 90^{+21}_{-18}$ GeV

"agreement" at $1.8\,\sigma$

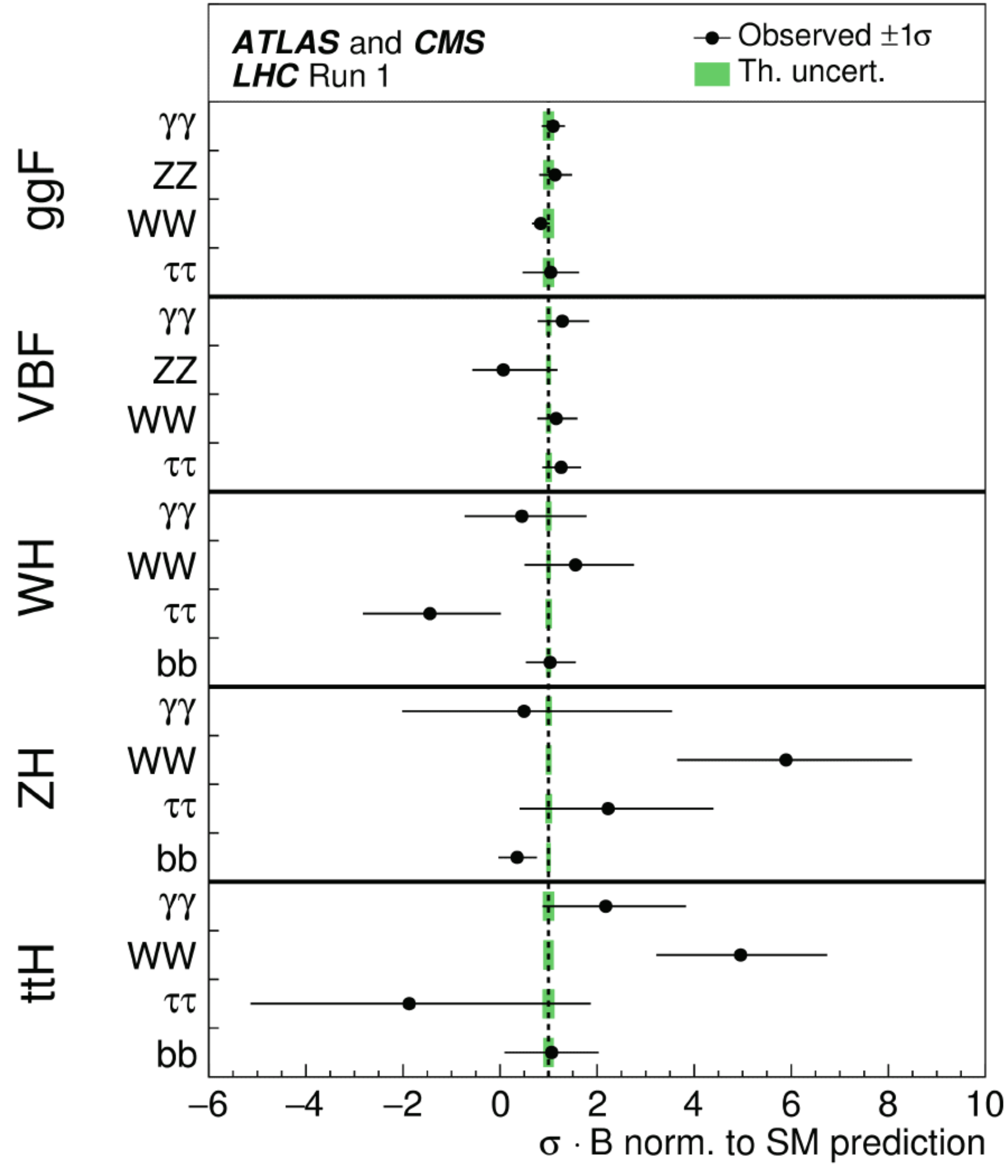


Assumption for the fit:
SM incl. Higgs boson

$\Rightarrow$ no confirmation of
Higgs mechanism

$\Rightarrow$ Observed Higgs well compatible with SM prediction (at $1.8\,\sigma$)

We have a SM-like Higgs at 125 GeV:



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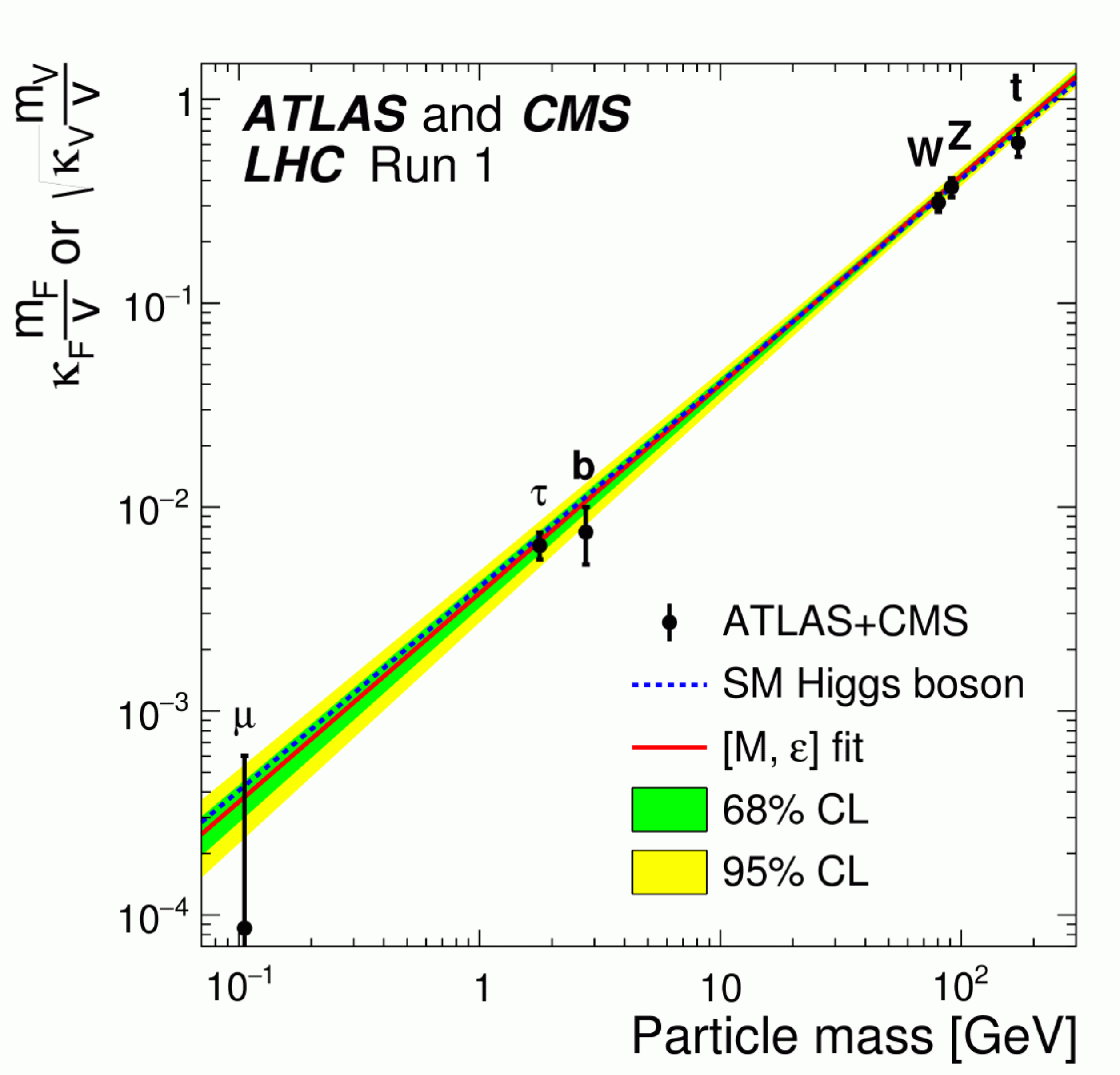


⇒ newer measurements confirm full compatibility with the SM

Extended Higgs sectors

Compatibility with the experimental results requires:

- A SM-like Higgs at ~ 125 GeV
- Properties of the other Higgs bosons (masses, couplings,. . .) have to be such that they are in agreement with the present bounds

Prediction for the mass of the SM-like Higgs vs. exp. result:

- Important constraints on parameter space of the model
- Limited by remaining theoretical uncertainties
- Very accurate Higgs-mass predictions needed

The "sum rule":

In a large variety of models with extended Higgs sectors the squared couplings to gauge bosons fulfill a ``sum rule":

$$\sum_i g^2_{H_i VV} = \left(g^{\rm SM}_{HVV}\right)^2$$

⇒ •The SM coupling strength is ``shared" between the Higgses of an extended Higgs sector, $\varkappa_V \leqq 1$

•The more SM-like the couplings of the state at 125 GeV turn out to be, the more suppressed are the couplings of the other Higgses to gauge bosons; heavy Higgses usually have a much smaller width than a SM-like Higgs of the same mass

• Searches for additional Higgs bosons need to test compatibility with the observed signal at 125 GeV!

[*Taken from G. Weiglein '18*]

Required precision for Higgs couplings?

MSSM example:

$$\kappa_V \approx 1 - 0.5\% \left(\frac{400 \text{ GeV}}{M_A}\right)^4$$

$$\kappa_t = \kappa_c \approx 1 - \mathcal{O}(10\%) \left(\frac{400 \text{ GeV}}{M_A}\right)^2 \cot^2\beta$$

$$\kappa_b = \kappa_\tau \approx 1 + \mathcal{O}(10\%) \left(\frac{400 \text{ GeV}}{M_A}\right)^2$$

Composite Higgs example:

$$\kappa_V \approx 1 - 3\% \left(\frac{1 \text{ TeV}}{f}\right)^2$$

$$\kappa_F \approx 1 - (3-9)\% \left(\frac{1 \text{ TeV}}{f}\right)^2$$

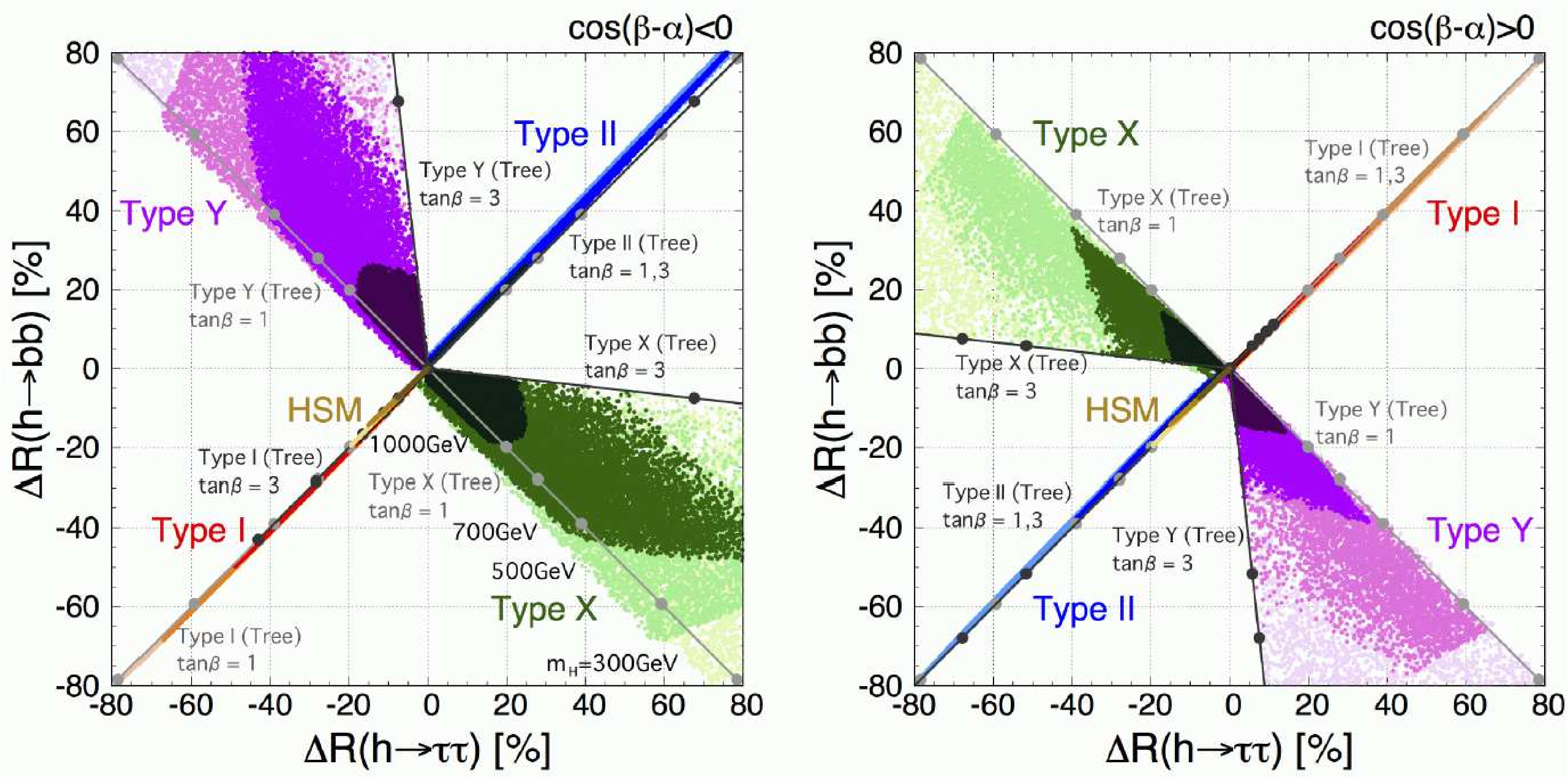
⇒ couplings to bosons in the per mille range
⇒ couplings to fermions in the per cent range

⇒ the more precise the better

⇒ LHC measurements not good enough (yet?)!

2HDM example (I):

[*S. Kanemura et al. '18*]



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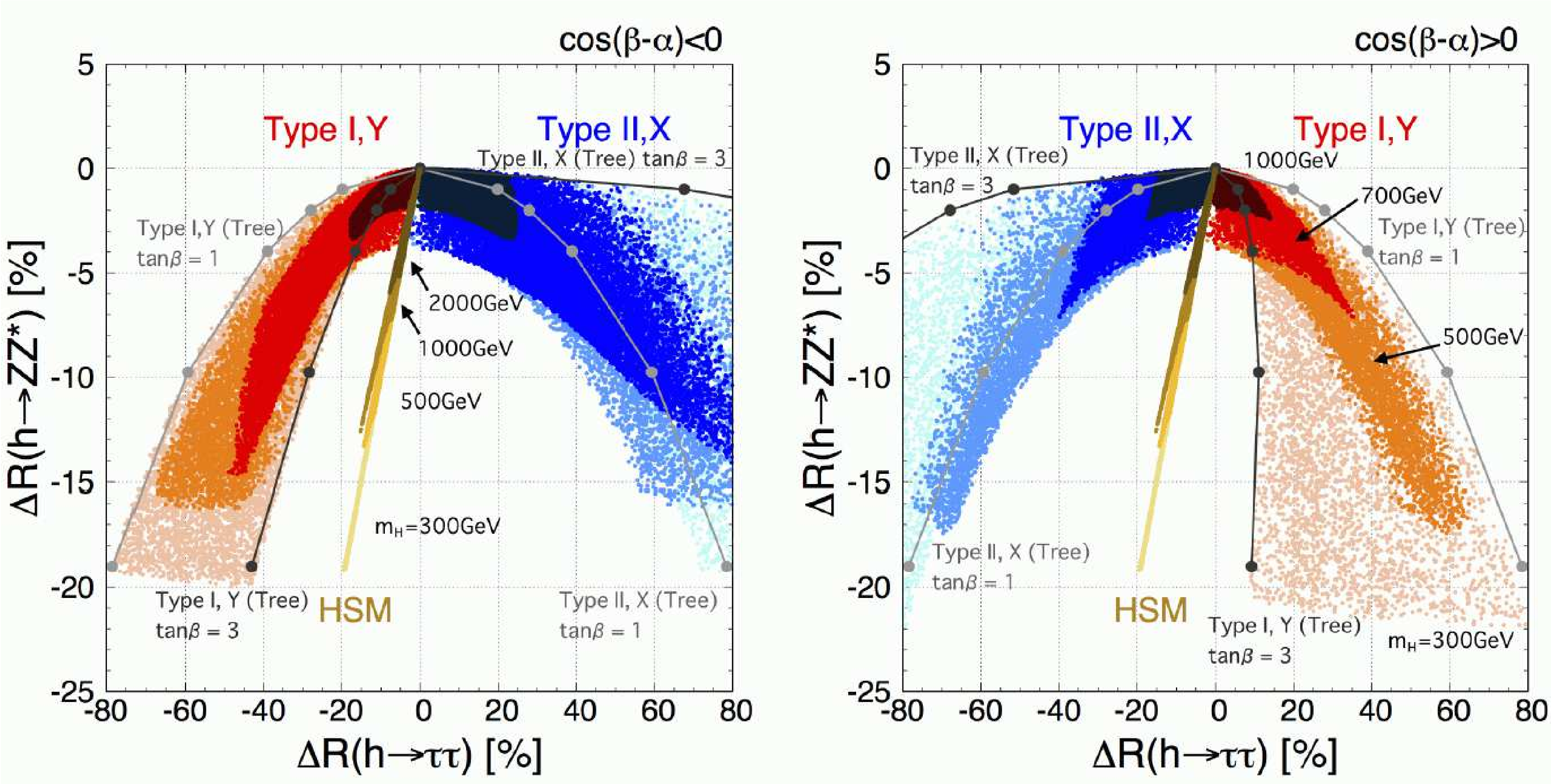

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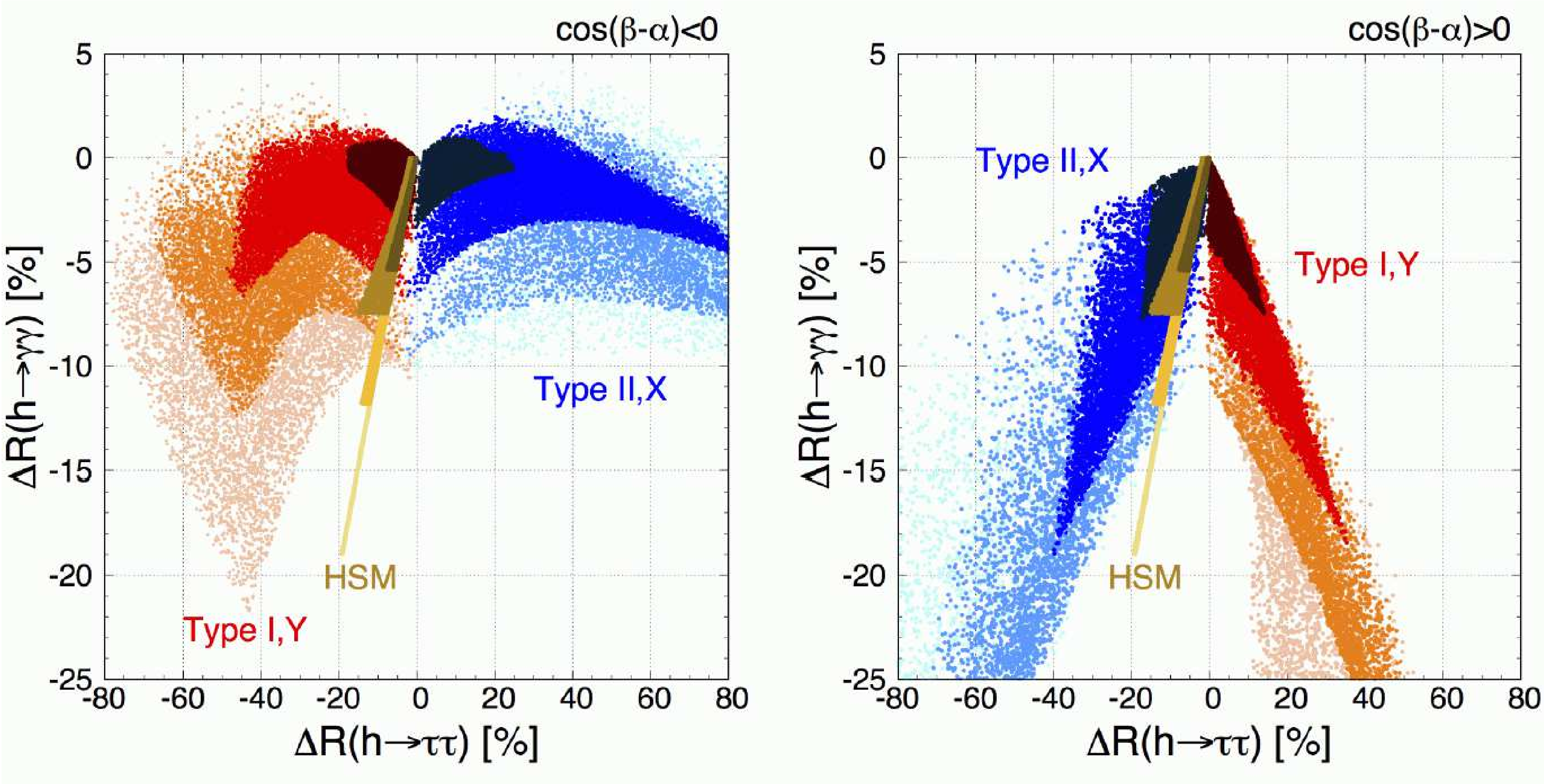


⇒ LHC measurements not good enough (yet?)!

We have a ~ 125 GeV SM-like Higgs boson

$\Rightarrow$ What are the options in the MSSM (or 2HDM)?

1. Decoupling limit:
   $M_A \gg M_Z \Rightarrow$ the light Higgs becomes SM-like

2. Alignment without decoupling:
   $\Rightarrow$ a $\mathcal{CP}$-even Higgs becomes SM-like due to an "accidental" cancellation

3. Heavy Higgs SM-like: (in the "alignment w/o decoupling" scen.)
   $\Rightarrow$ is the case with the heavy $\mathcal{CP}$-even Higgs being SM-like (still) a viable solution?

Obtaining a light Higgs with SM-like couplings

[*J. Gunion, H. Haber, hep-ph/0207010*]

$\to \mathcal{CP}$ conserving 2HDM in the Higgs basis ($\langle H_1 \rangle = v/\sqrt{2}$, $\langle H_2 \rangle = 0$)

$$\mathcal{V} = \ldots + \tfrac{1}{2} Z_1 (H_1^\dagger H_1)^2 + \ldots + \left[\tfrac{1}{2} Z_5 (H_1^\dagger H_2)^2 + Z_6 (H_1^\dagger H_1)(H_1^\dagger H_2) + \text{h.c.} \right] + \ldots$$

$\Rightarrow \mathcal{CP}$-even mass matrix:

$$\mathcal{M}^2 = \begin{pmatrix} Z_1 v^2 & Z_6 v^2 \\ Z_6 v^2 & M_A^2 + Z_5 v^2 \end{pmatrix}$$

with mixing angle $\cos(\beta - \alpha) \equiv c_{\beta-\alpha}$

Decoupling limit: $M_A^2 \gg Z_i v^2$

$\Rightarrow m_h^2 \sim Z_1 v^2$, $|c_{\beta-\alpha} \ll 1|$, h is SM-like

Alignment limit: $Z_6 = 0$ and $Z_1 < Z_5 + M_A^2/v^2$

$\Rightarrow h$ is identical to the SM Higgs, $c_{\beta-\alpha} = 0$

$Z_6 = 0$ and $Z_1 > Z_5 + M_A^2/v^2$

$\Rightarrow H$ is identical to the SM Higgs, $c_{\beta-\alpha} = 1$

Alignment limit: see e.g.

[M. Carena, I. Low, N. Shah, C. Wagner '13][M. Carena, H. Haber, I. Low, N. Shah, C. Wagner '14]

In the MSSM $Z_6 = 0$ can be obtained through an "accidental" cancellation between tree-level and loop contribution, roughly at:

$$\tan\beta \sim \left[M_h^2 + M_Z^2 + \frac{3m_t^2\mu^2}{4\pi^2 v^2 M_S^2}\left(\frac{A_t^2}{2M_S^2} - 1\right)\right] \Big/ \left[\frac{3m_t^2}{4\pi^2 v^2}\frac{\mu A_t}{M_S^2}\left(\frac{A_t^2}{6M_S^2} - 1\right)\right]$$

Compare: $m_h^{\text{mod}+}$ and m_h^{alt} :

$A_t/M_S = 2.45,\ A_t = A_f,$

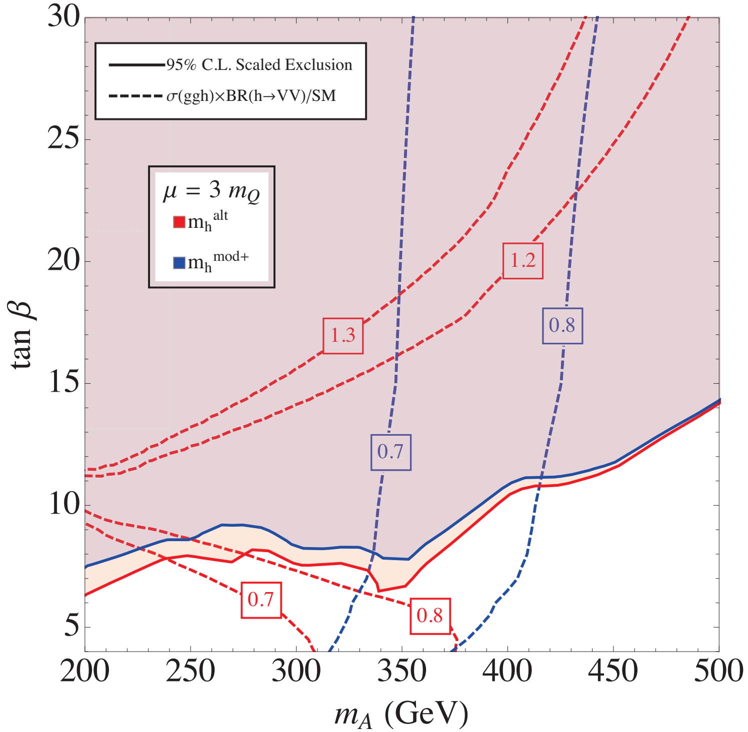
$M_S = m_{\tilde f} \geq 1$ TeV, $m_{\tilde g} = 1.5$ TeV,

$M_2 = 2\,M_1 = 200$ GeV, μ adjustable

(low M_A and $\tan\beta$: tune $M_S \geq 1$ TeV to obtain $M_h \geq 122$ GeV)

$\Rightarrow$ SM-like Higgs for all M_A

$\Rightarrow$ still realistic with all data?



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m_h^{alt}: HiggsSignals [P. Bechtle et al. '15]

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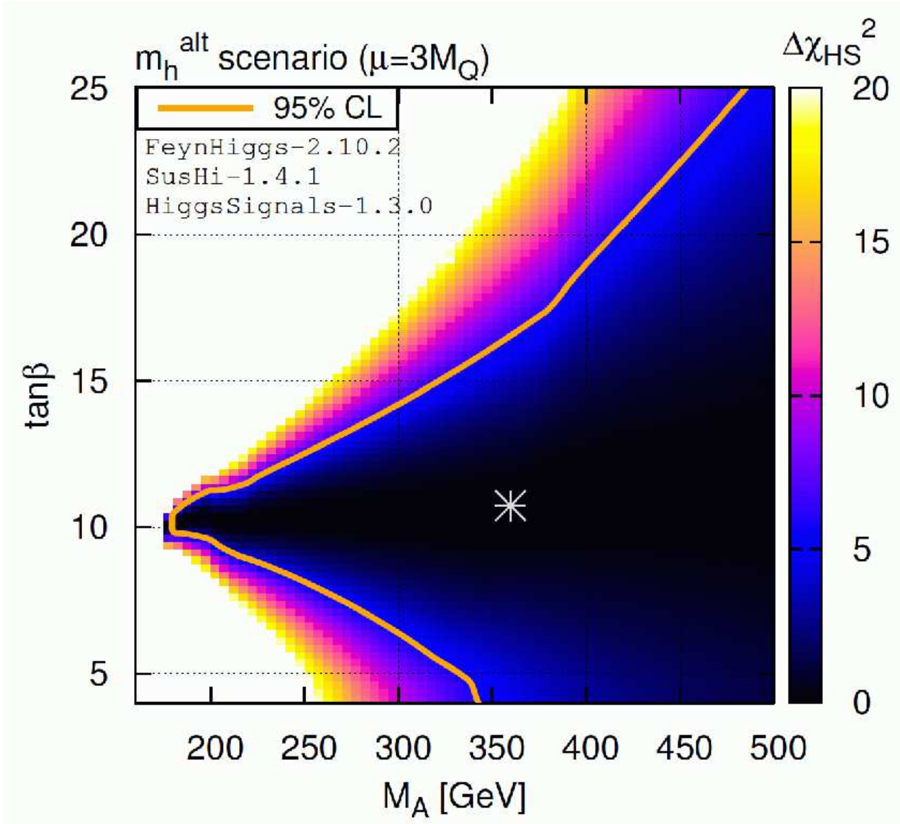
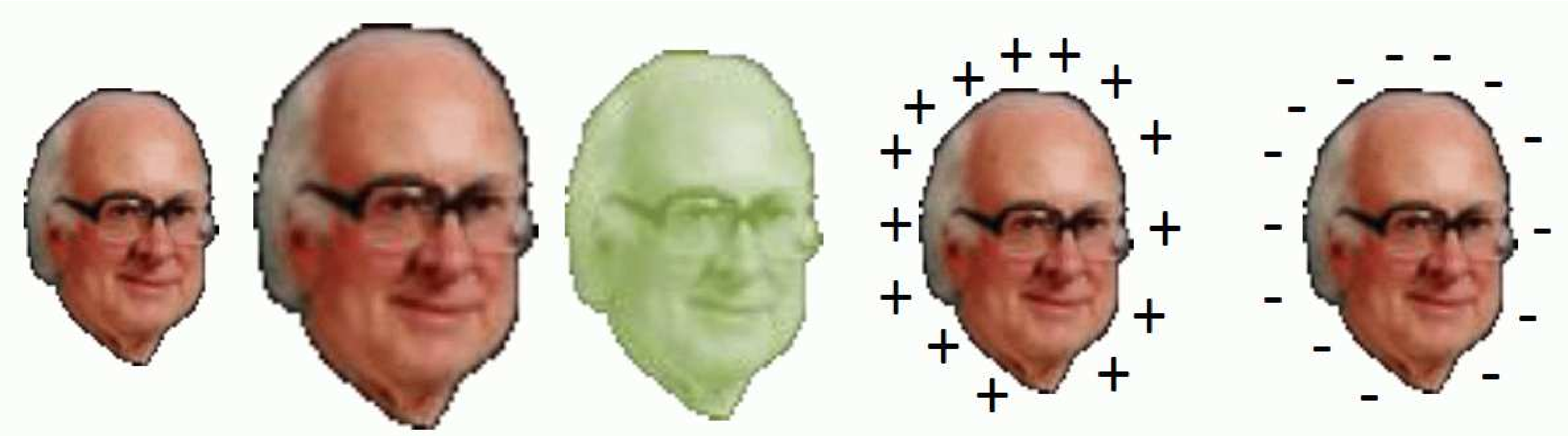
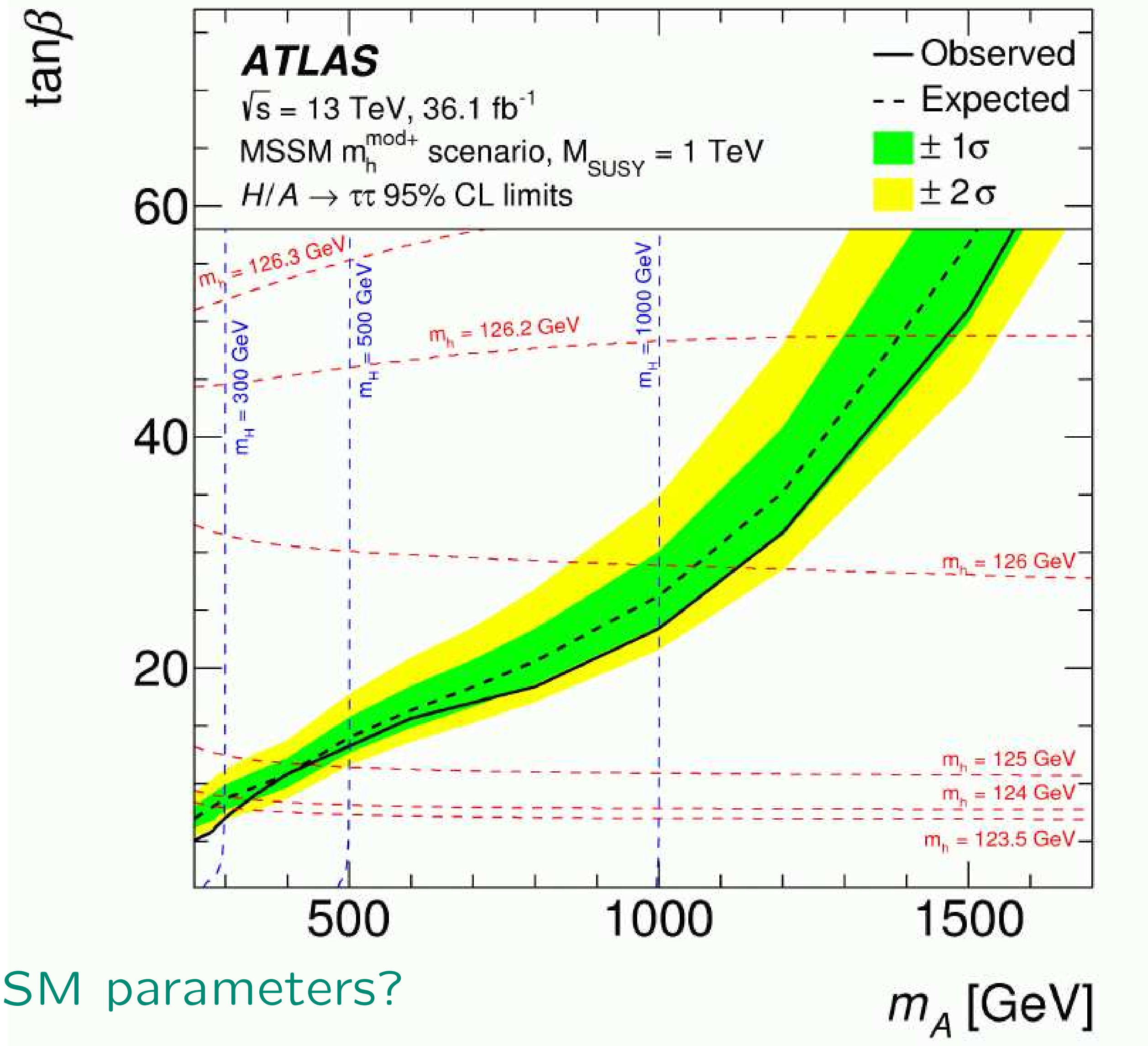


3. BSM Higgs-Boson searches

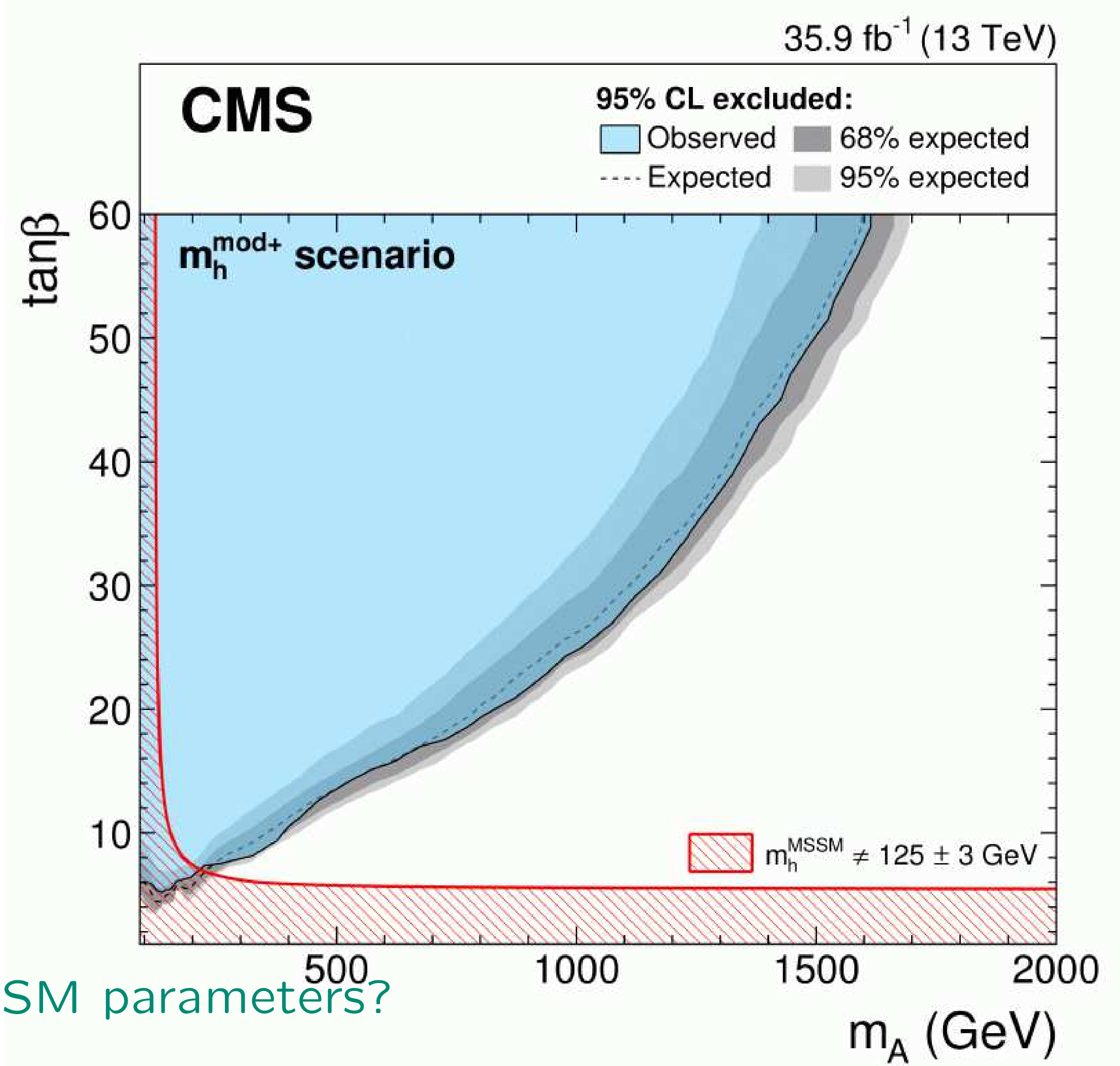


MSSM Higgs exclusion contours in M_A–$\tan\beta$ plane: $b\bar{b}, gg \to h, H, A \to \tau^+\tau^-$



Choice of MSSM parameters?

MSSM Higgs exclusion contours in M_A–$\tan\beta$ plane: $b\bar{b}, gg \to h, H, A \to \tau^+\tau^-$

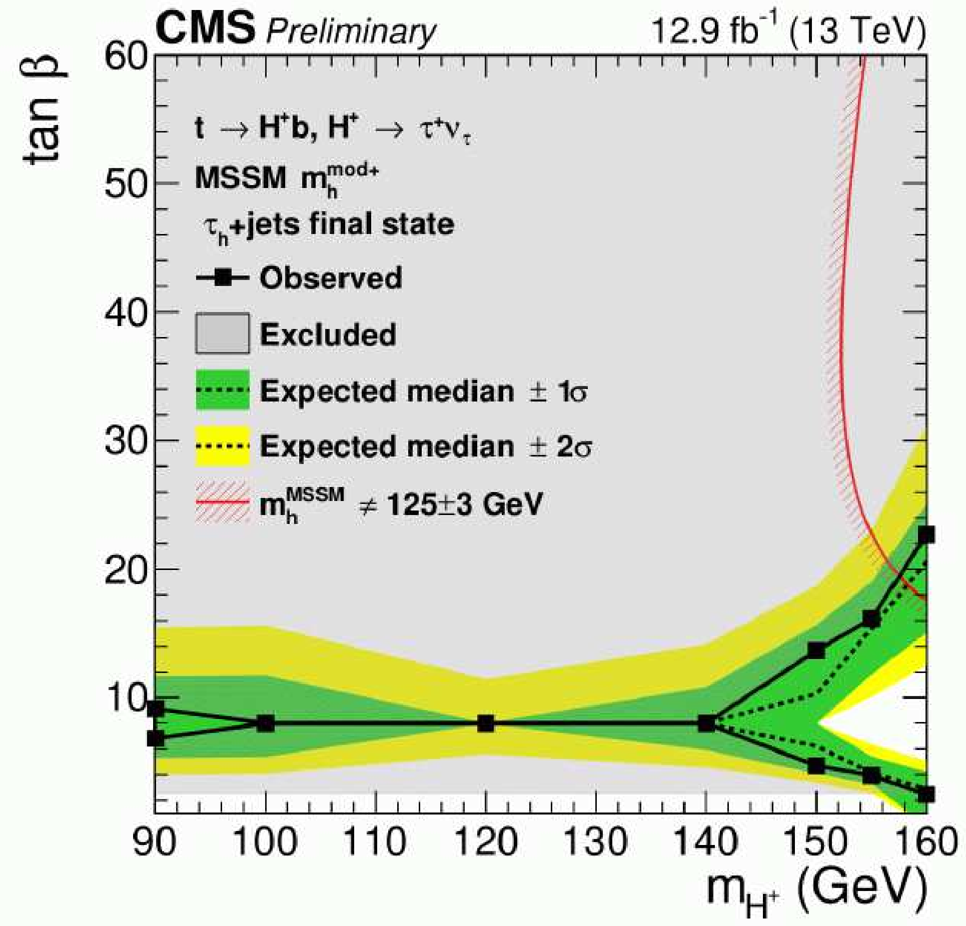


Choice of MSSM parameters?

Nearly latest results for charged Higgs bosons: [CMS '17]

MSSM Higgs exclusion contours in M_A–$\tan\beta$ plane: $pp \to H^\pm \to \tau\nu_\tau$

$M_{H^\pm} < m_t$



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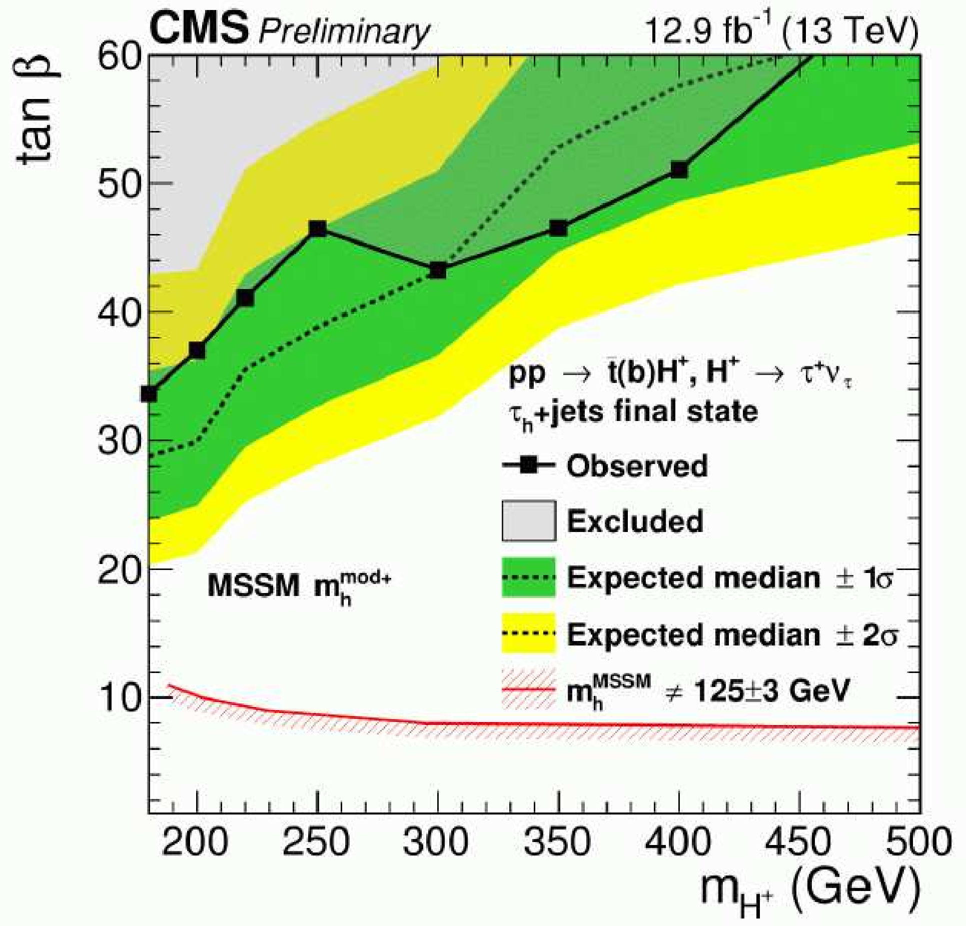


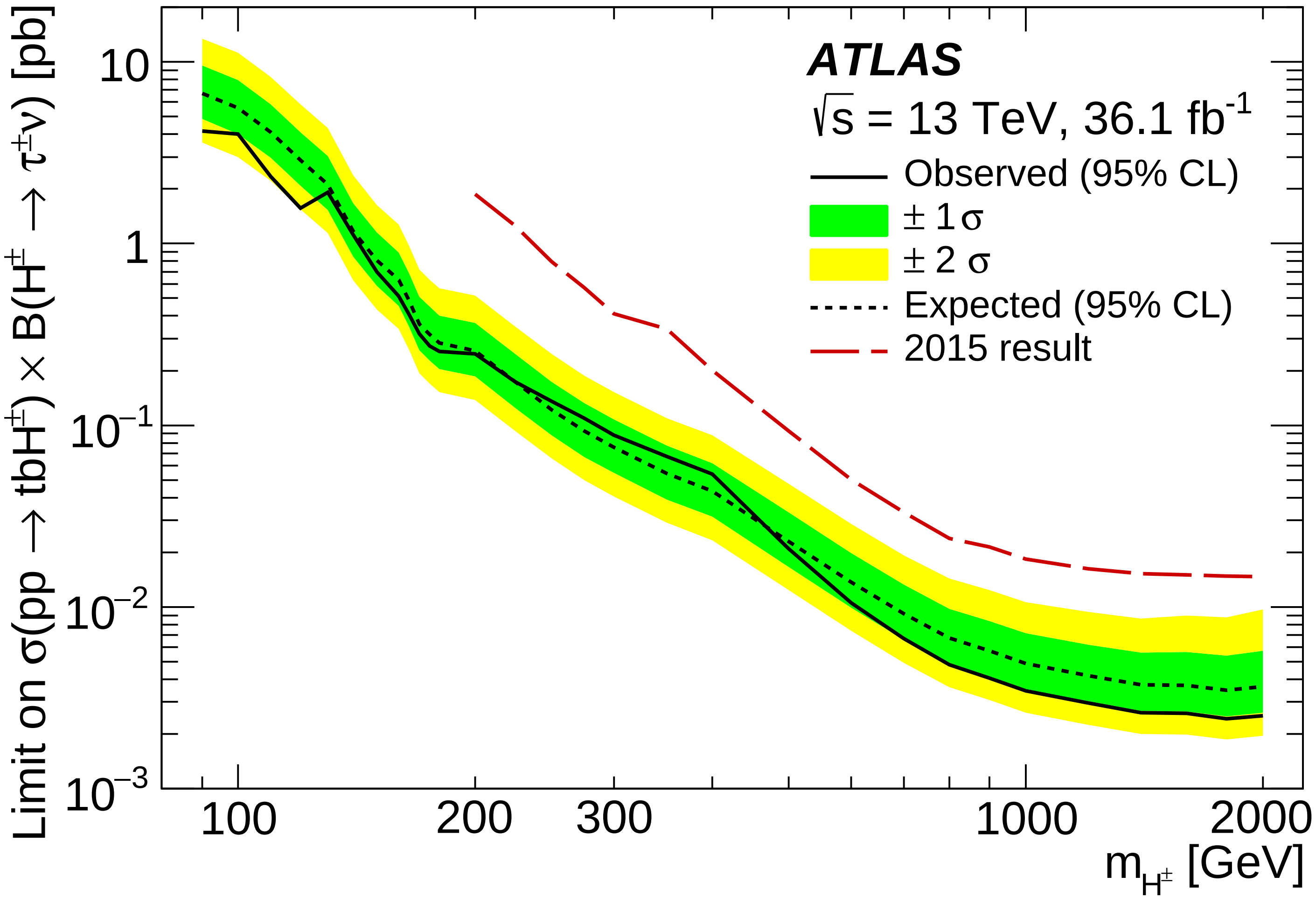
Choice of MSSM parameters?

Latest results for charged Higgs bosons:

[*ATLAS '18*]

2HDM type II results: $pp \to H^{\pm} \to \tau\nu_{\tau}$

$M_{H^{\pm}} < m_t$ $M_{H^{\pm}} > m_t$



⇒ gap finally closed!

Implications for the MSSM Higgs bosons:

$\Rightarrow$ most comprehensive MSSM Higgs analysis so far!

$\rightarrow$ investigate benchmark scenarios:

$\rightarrow$ Vary only M_A and $\tan\beta$
$\rightarrow$ Keep all other SUSY parameters fixed

[H. Bahl, E. Fuchs, T. Hahn, S.H., S. Liebler, S. Patel, P. Slavich, T. Stefaniak, C. Wagner, G. Weiglein '18]

1. M_h^{125} scenario: 2HDM-like model
2. $M_h^{125}(\tilde{\tau})$ scenario: light staus: $h \to \gamma\gamma$, $H/A \to \tilde{\tau}\tilde{\tau}$
3. $M_h^{125}(\tilde{\chi})$ scenario: light EW-inos: $H/A \to \tilde{\chi}_i^0\tilde{\chi}_j^0, \tilde{\chi}_k^\pm\tilde{\chi}_l^\mp$
4. M_h^{125} (alignment) scenario: h SM-like for very low M_A
5. M_H^{125} scenario: $M_H \sim 125$ GeV, all Higgses light
6. $M_{h_1}^{125}$ (CPV) scenario: complex phases, h_2-h_3 interference

Data to be taken into account:

– Higgs boson mass (LHC) $\Rightarrow$ FeynHiggs

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Data not necessarily to be taken into account:

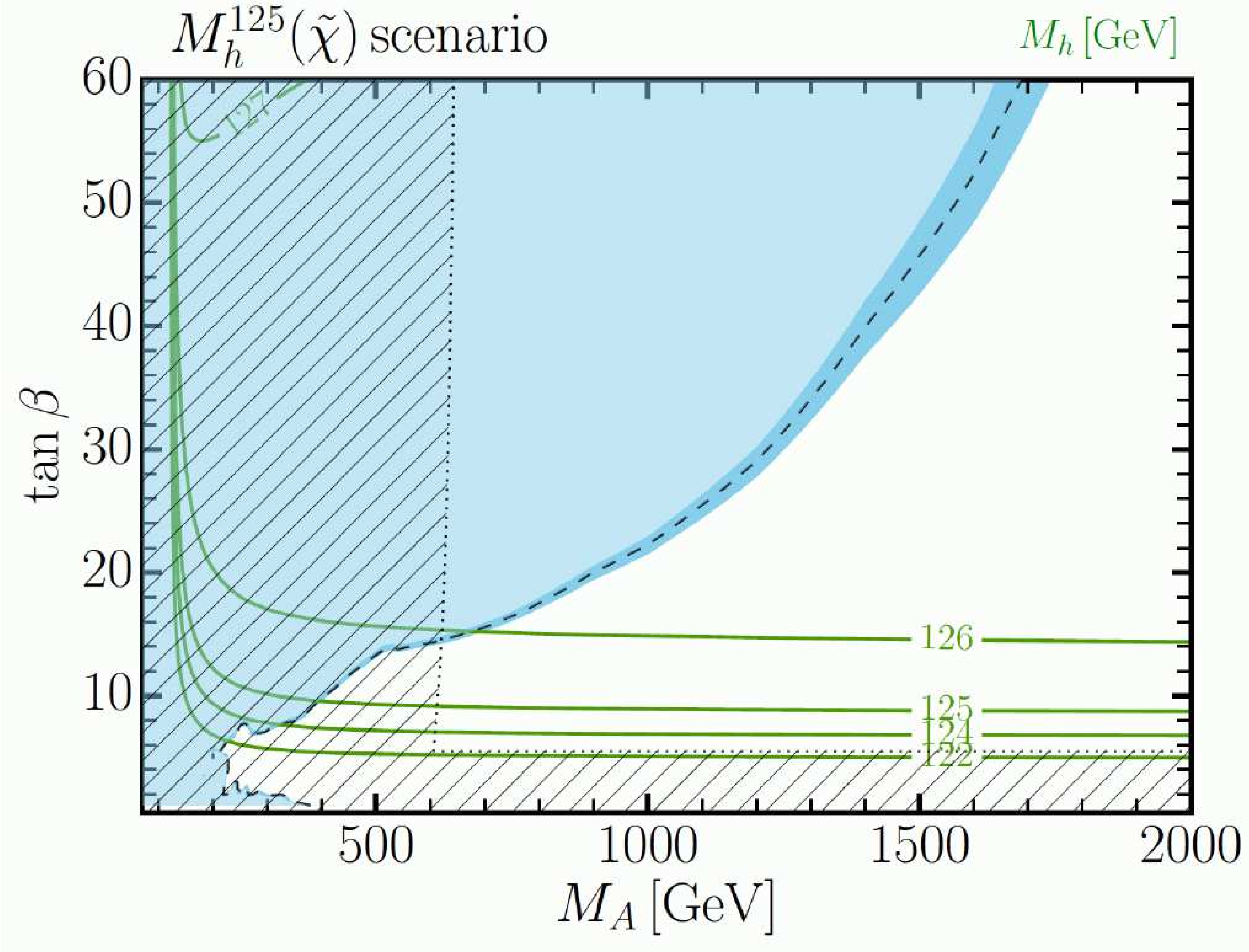
– electroweak precision data

– flavor data

– astrophysical data (DM properties)

New benchmark: $M_h^{125}(\tilde{\chi})$

[*H. Bahl et al., '18*]



⇒ strongly reduced heavy Higgs coverage

New benchmark: $M_h^{125}(\tilde{\chi})$

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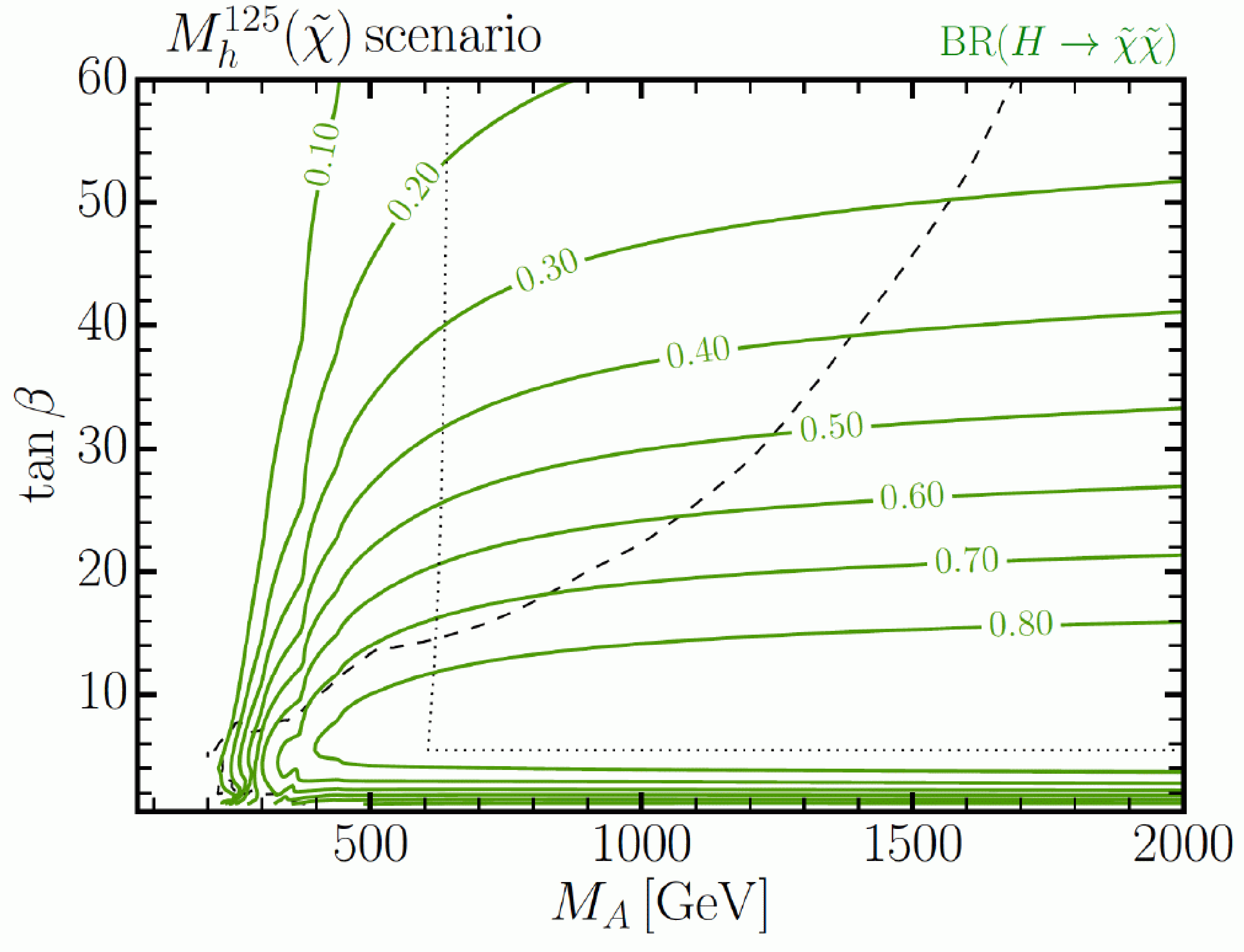
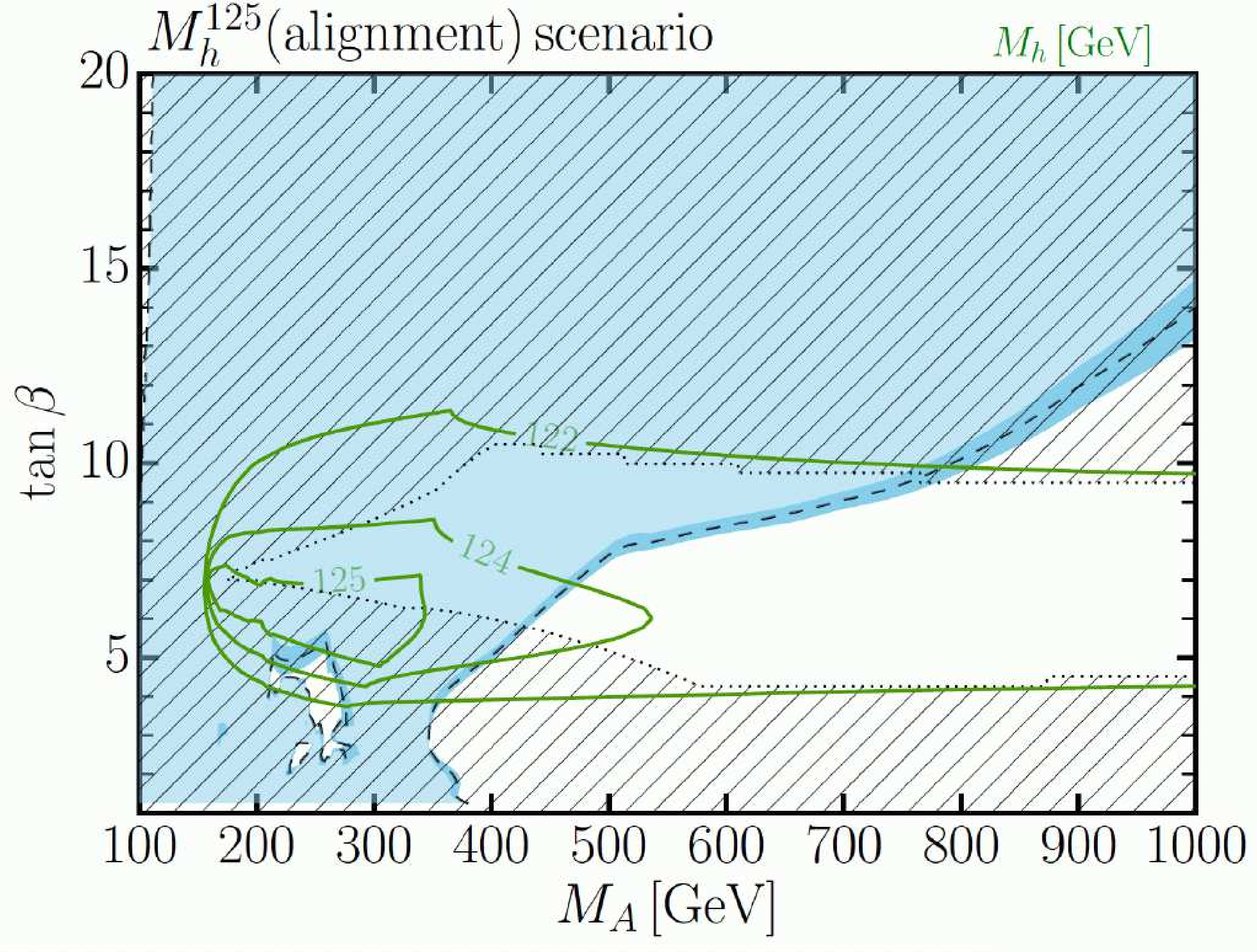


⇒ Huge BR of heavy Higgses to EW-inos

New benchmark: M_h^{125}(align)

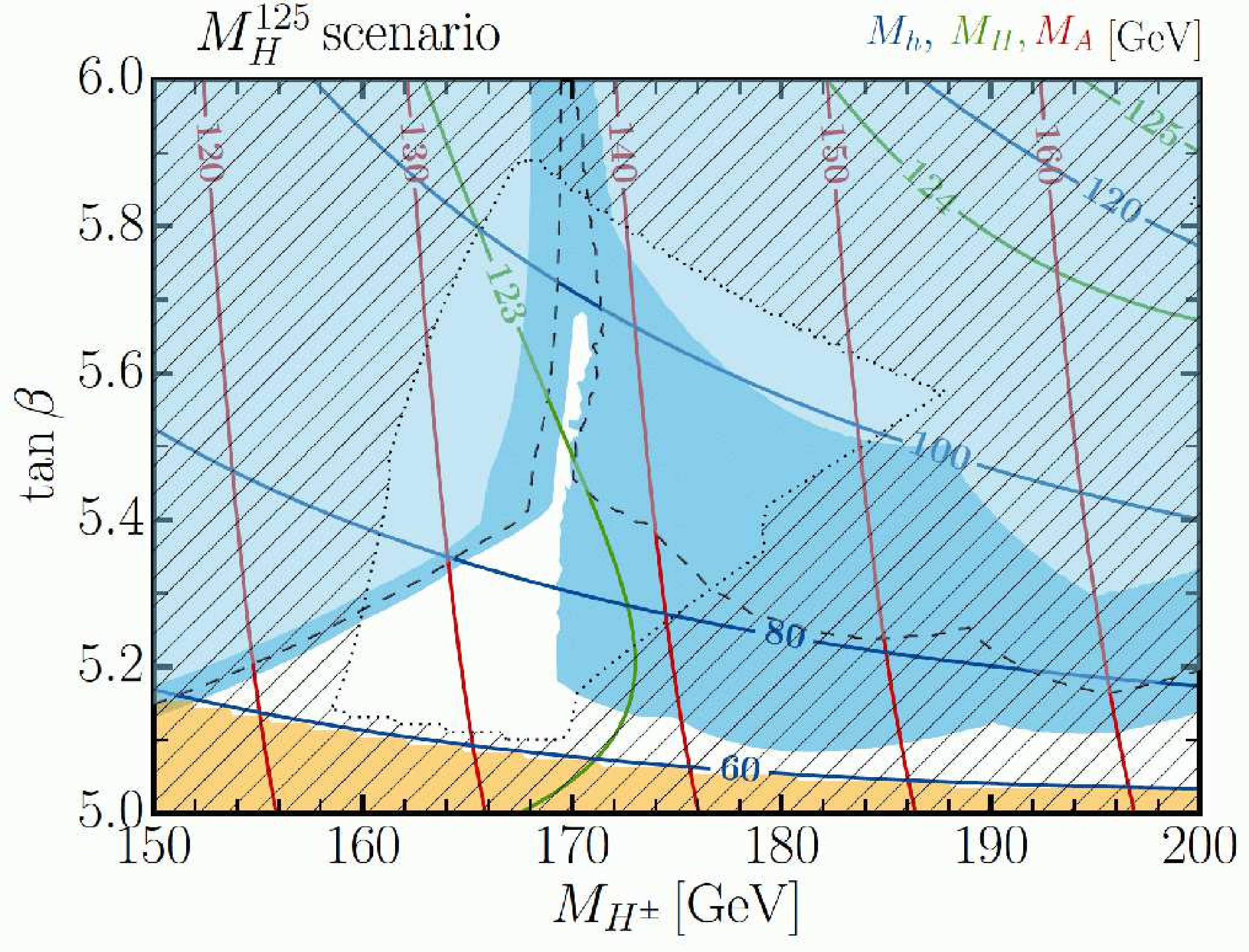
[*H. Bahl et al., '18*]



$\Rightarrow$ h SM-like for very low M_A

New benchmark: M_H^{125}

[*H. Bahl et al., '18*]



⇒ exotic solution still viable!

4. A Higgs Boson at 96 GeV?!

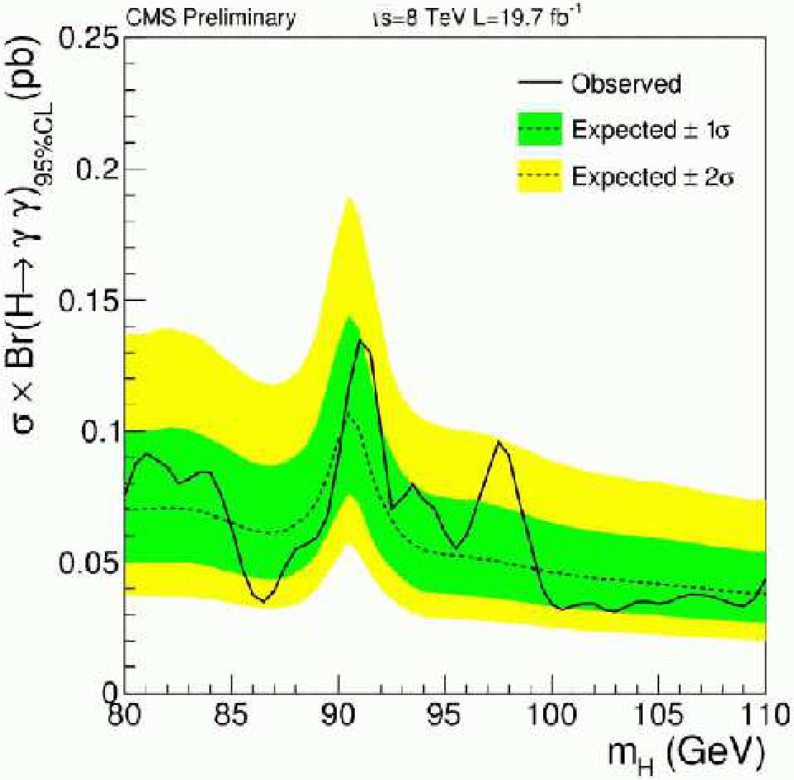
- What was seen in Run I?
- What was seen in Run II?
- What was seen at LEP?
- Should we get excited?
- Which model fits?

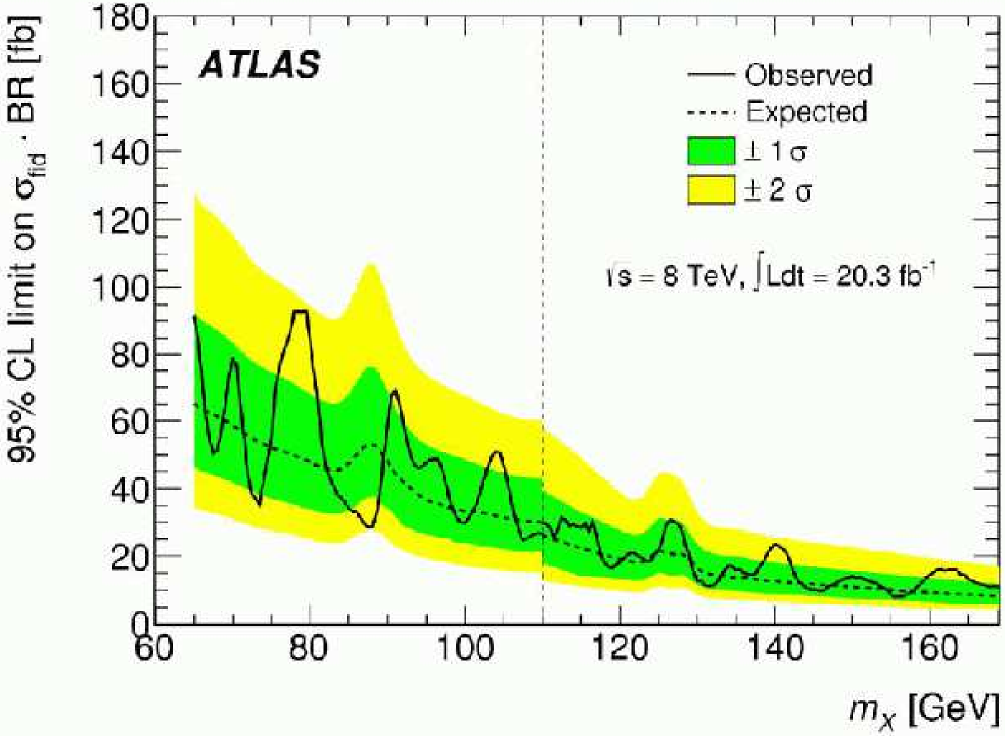
What was seen at Run I? [S. Shotkin, talk at HDays17]

h-->γγ (65-110GeV) Run 1

CMS PAS HIG-14-037

PRL 113 171801 (2014)





- ~2σ excursion @~97.5 GeV
- ~2σ excursion @~80 GeV

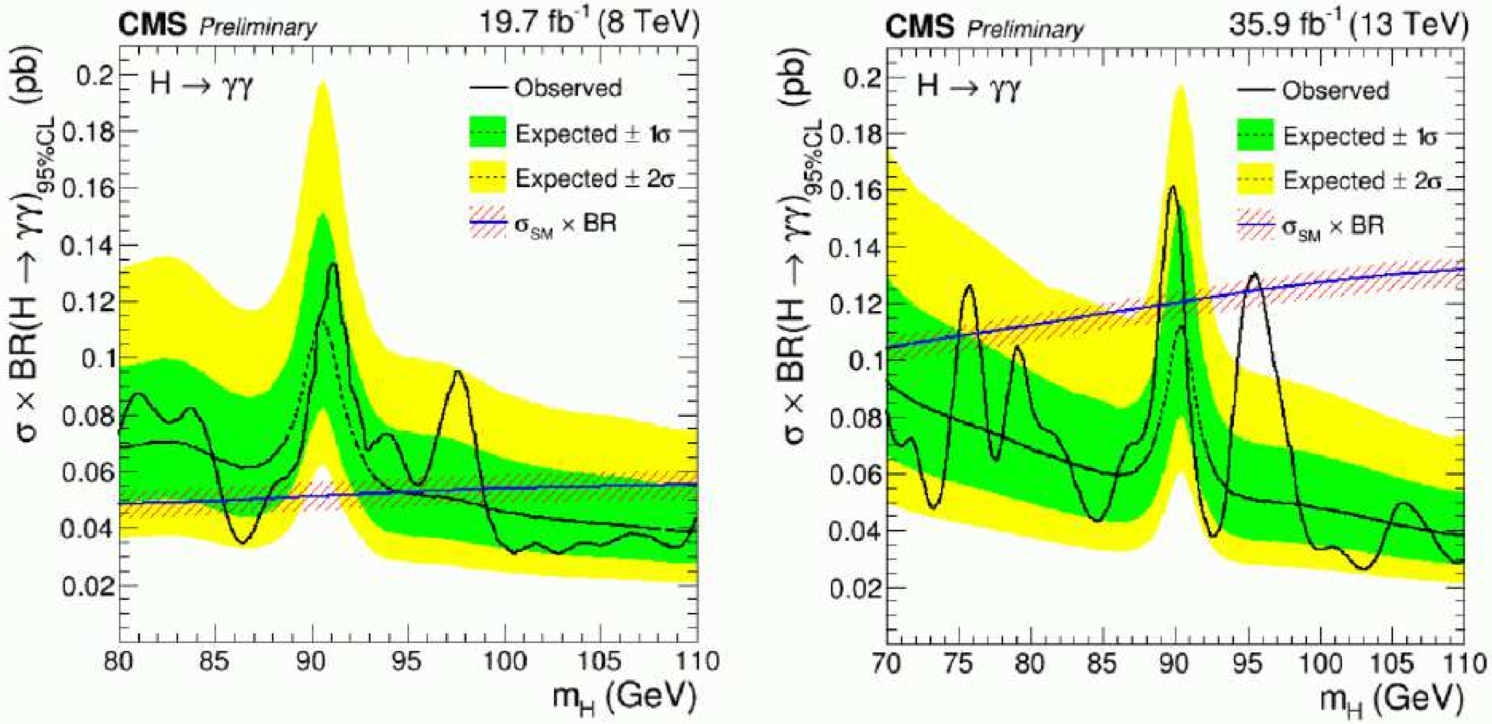
18

S. Gascon-Shotkin HDays17, Santander, ES Sept. 22 2017

What was seen at Run II? [*S. Shotkin, talk at HDays17*]

h-->γγ (70-110 GeV) Runs 1+2

New!



CMS PAS HIG-17-013

8 TeV:
minimum(maximum) limit on σ X Br : 31(133) fb at m=102.8(91.1)GeV

13 TeV:
minimum(maximum) limit on σ X Br : 26(161) fb at m=103.0(89.9)GeV

- 8 TeV limits on σ X Br redone with 0.1 GeV step. Production processes assumed in SM proportions. No significant excess with respect to expected limits observed.

26

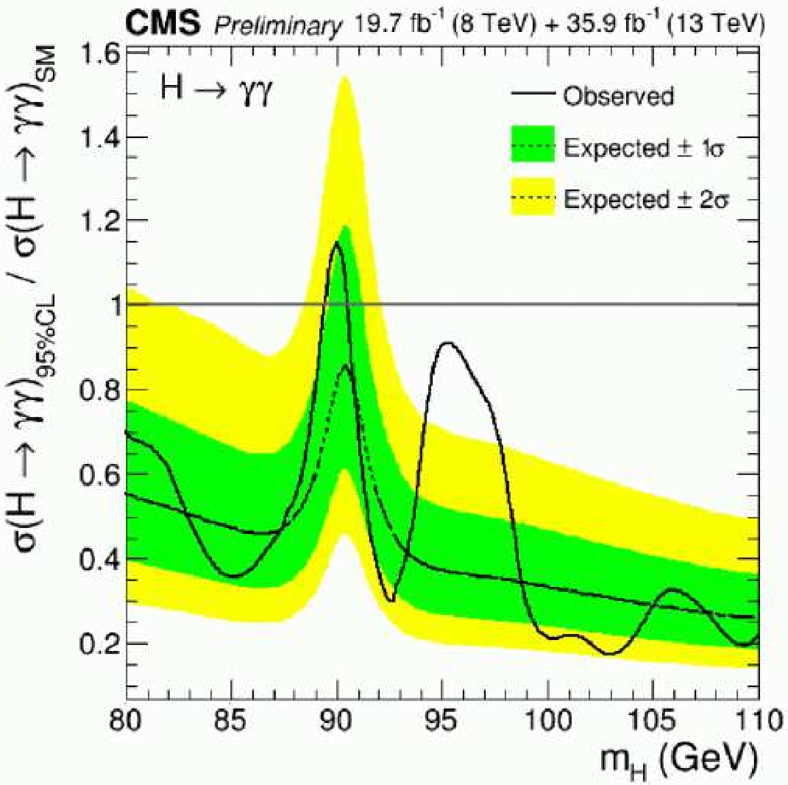
S. Gascon-Shotkin HDays17, Santander, ES Sept. 22 2017

h-->γγ (70-110 GeV) Runs 1+ 2

New!

CMS PAS HIG-17-013

All experimental + theoretical systematic uncertainties assumed uncorrelated except for those on signal acceptance due to scale variations + those on production cross sections (assumed 100% correlated).



8 TeV+13 TeV: minimum(maximum) limit on $(\sigma \times Br)/(\sigma \times Br)_{SM}$: 0.17(1.15) at m=103.0(90.0)GeV

- Combined 8 TeV+13 TeV σ X BR limit normalized to SM expectation (production processes assumed in SM proportions). No significant excess with respect to expected limits observed.

29

S. Gascon-Shotkin HDays17, Santander, ES Sept. 22 2017

What was seen at Run II?

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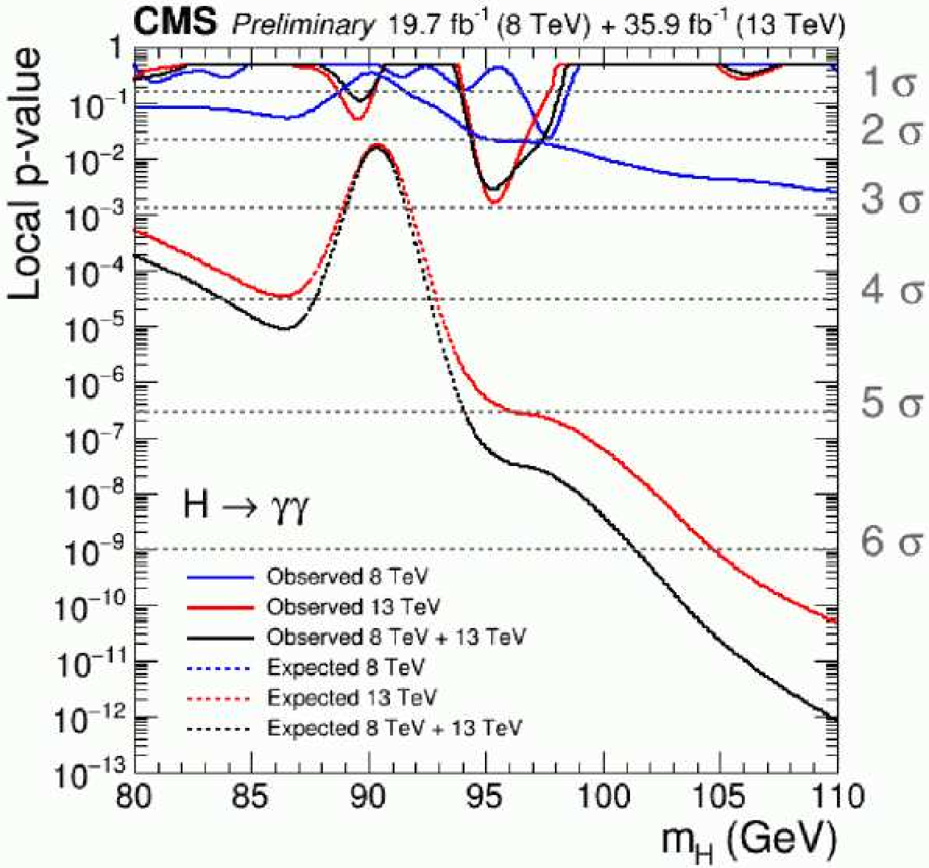
CMS PAS HIG-17-013



8 TeV: Excess with ~2.0 σ local significance at m=97.6 GeV

13 TeV: Excess with ~2.9 σ local (1.47 σ global) significance at m=95.3 GeV

8TeV+13 TeV: Excess with ~2.8 σ local (1.3 σ global) significance at m=95.3 GeV

More data are required to ascertain the origin of this excess

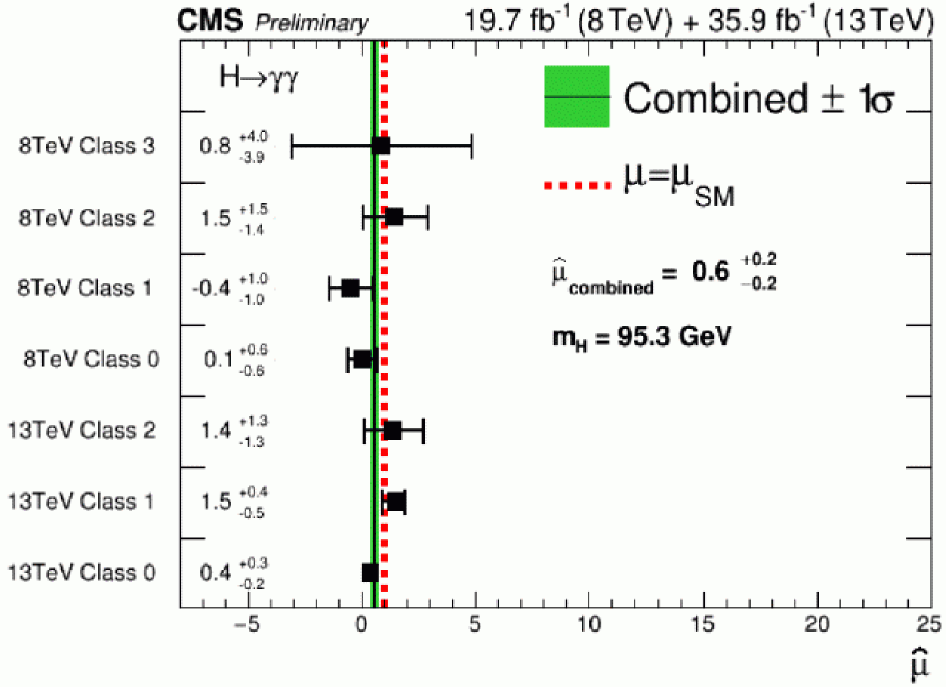
- Expected and observed local p-values for 8 TeV, 13 TeV and their combination

S. Gascon-Shotkin HDays17, Santander, ES Sept. 22 2017 30

h-->γγ (70-110 GeV) Runs 1+2

New!

CMS PAS HIG-17-013



Excess here mostly driven by class 1 (&2) at 13 TeV

χ^2 probability for the seven individual values to be compatible with a single signal hypothesis: 41%

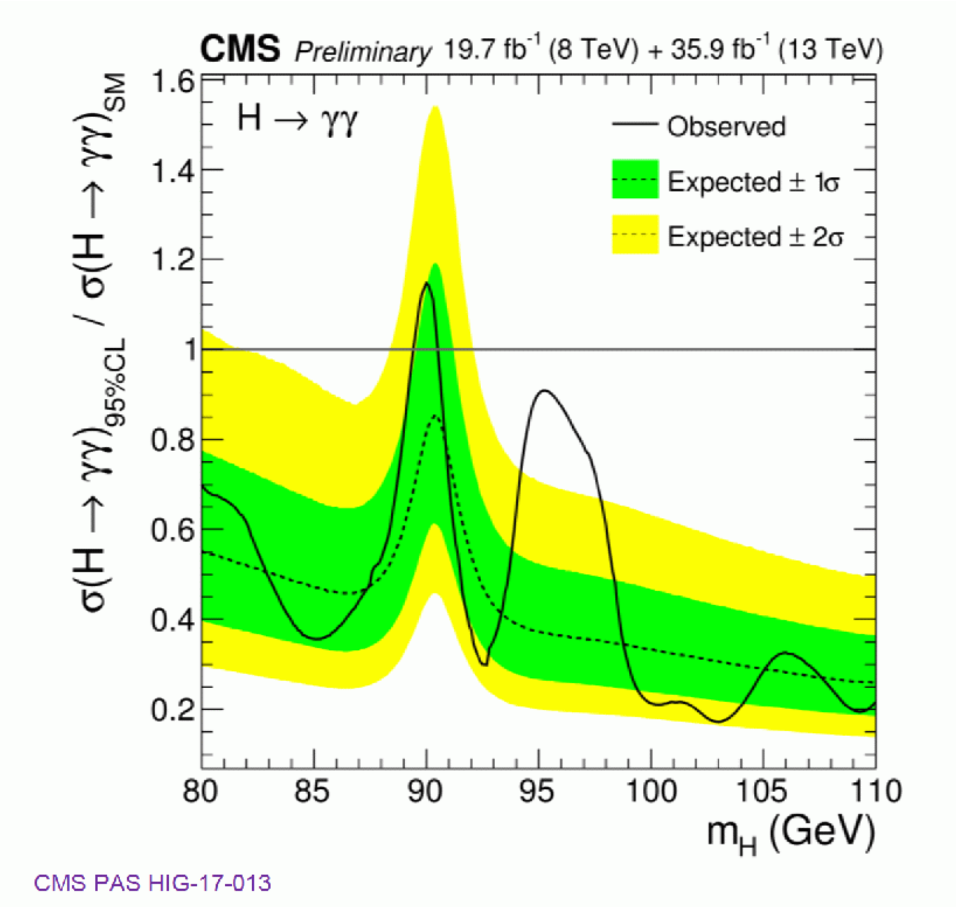
- 'Signal' strengths for the 7 event classes and overall, in the 8 TeV+13TeV combination, fixing m_H=95.3 GeV
- More data are required to ascertain the origin of this excess

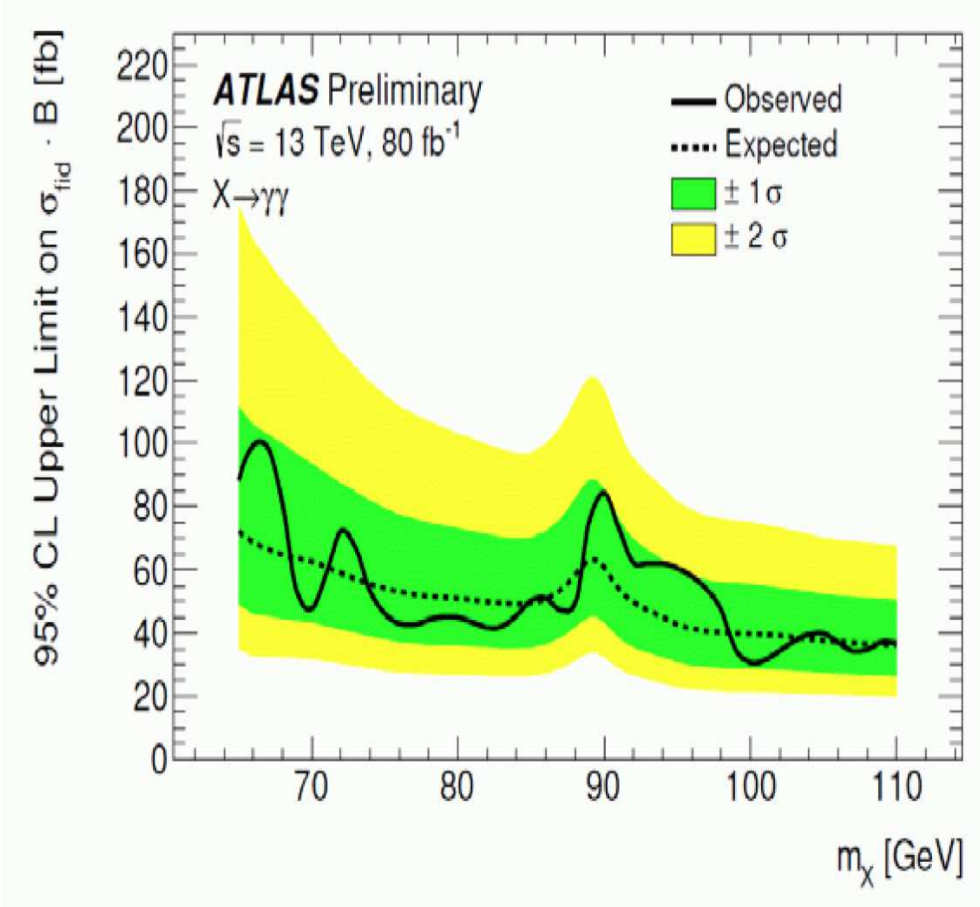
55

S. Gascon-Shotkin HDays17, Santander, ES Sept. 22 2017

$$\mu_{\text{CMS}}(96\ \text{GeV}) = [\sigma(pp \to h_1) \times \text{BR}(h_1 \to \gamma\gamma)]_{\text{exp/SM}} = 0.6 \pm 0.2$$

What about ATLAS?





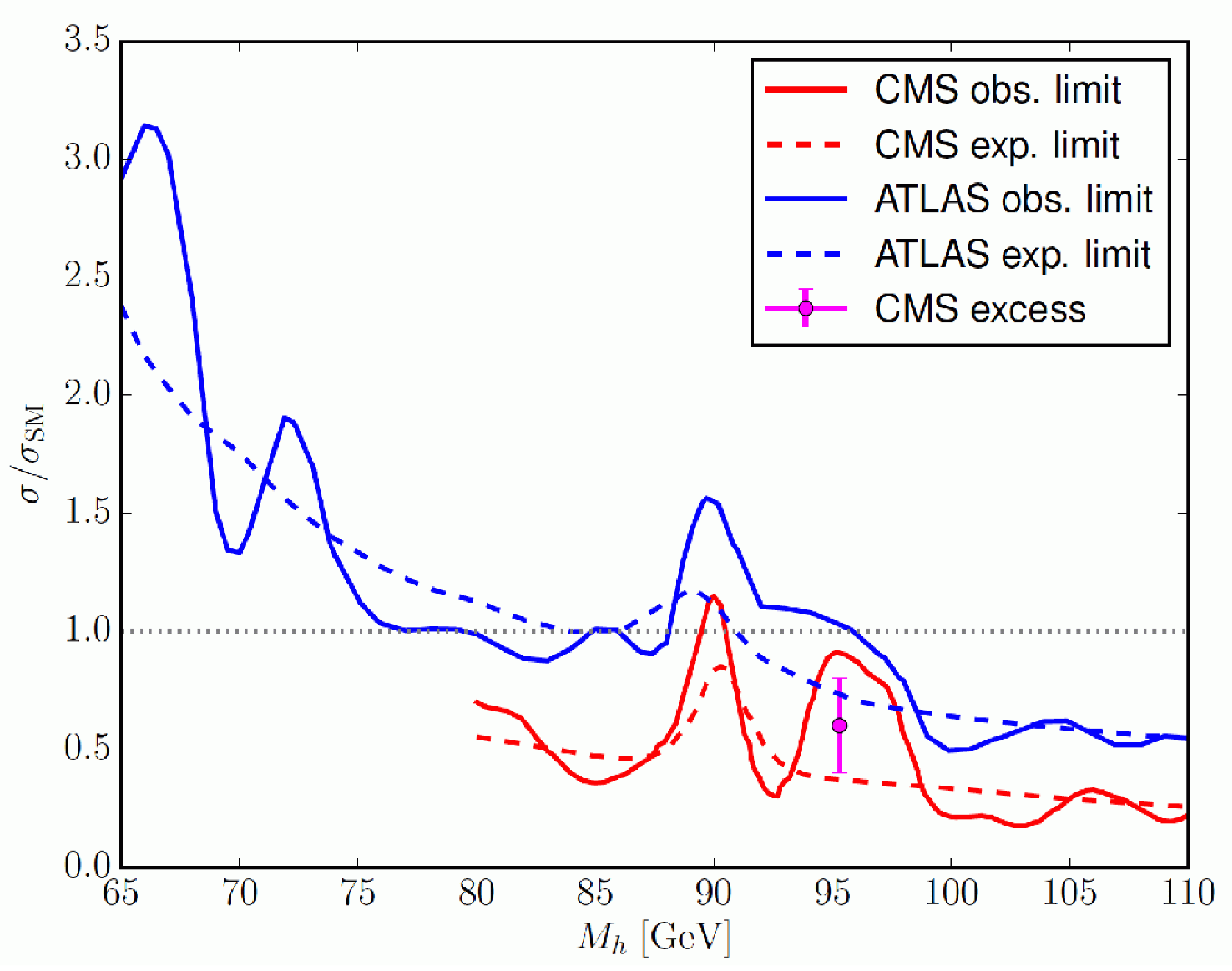
Note: ATLAS gives fiducial cross section! Conversion factor: 1/0.45

⇒ ATLAS and CMS exclusion limit **identical!** (120 fb)

Q: why does ATLAS has same sensitivity with twice amount of data?

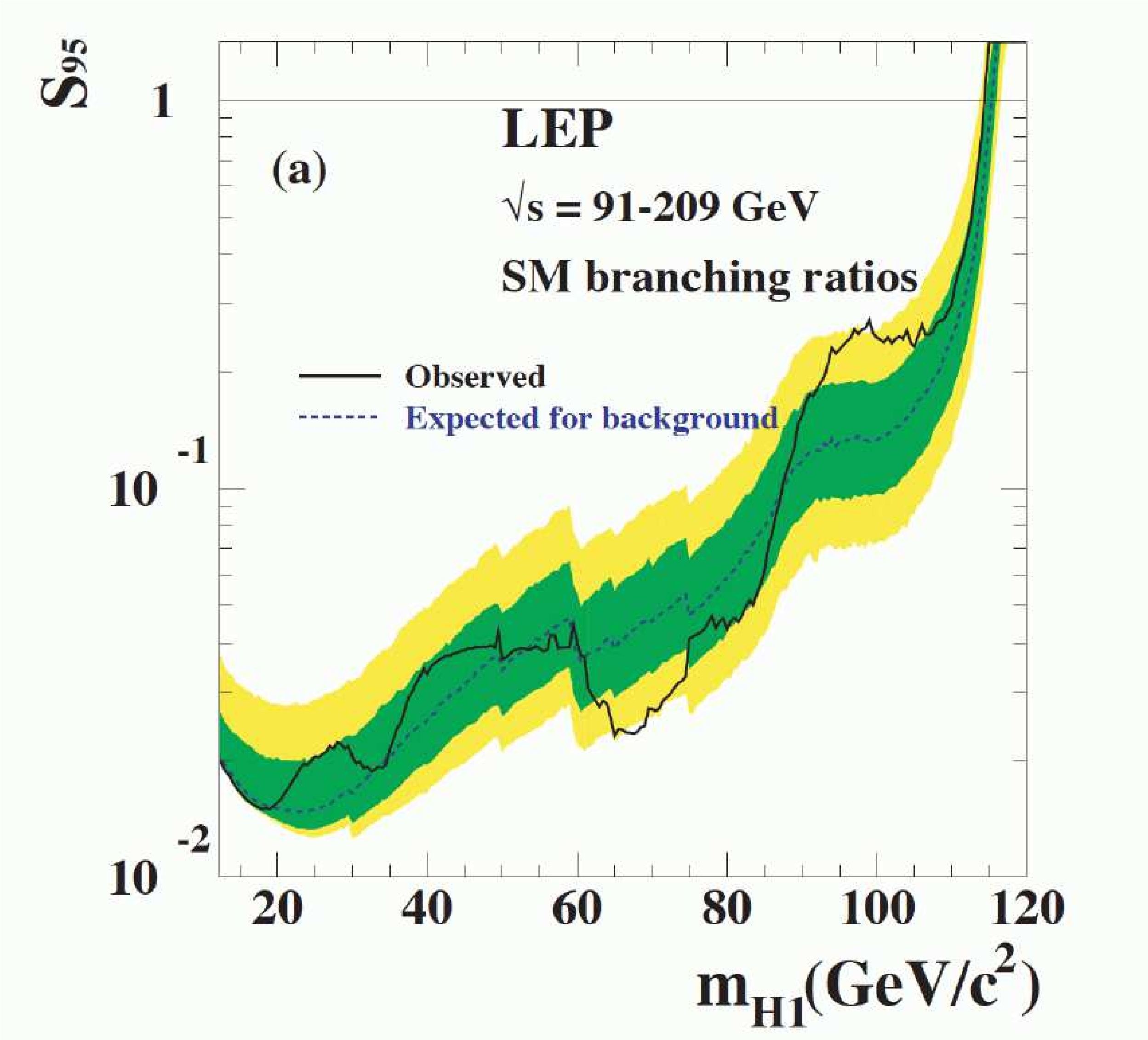
CMS and ATLAS in direct comparison:

[*T. Stefaniak et al. '18*]



⇒ everything well compatible with the excess!

What was seen at LEP?

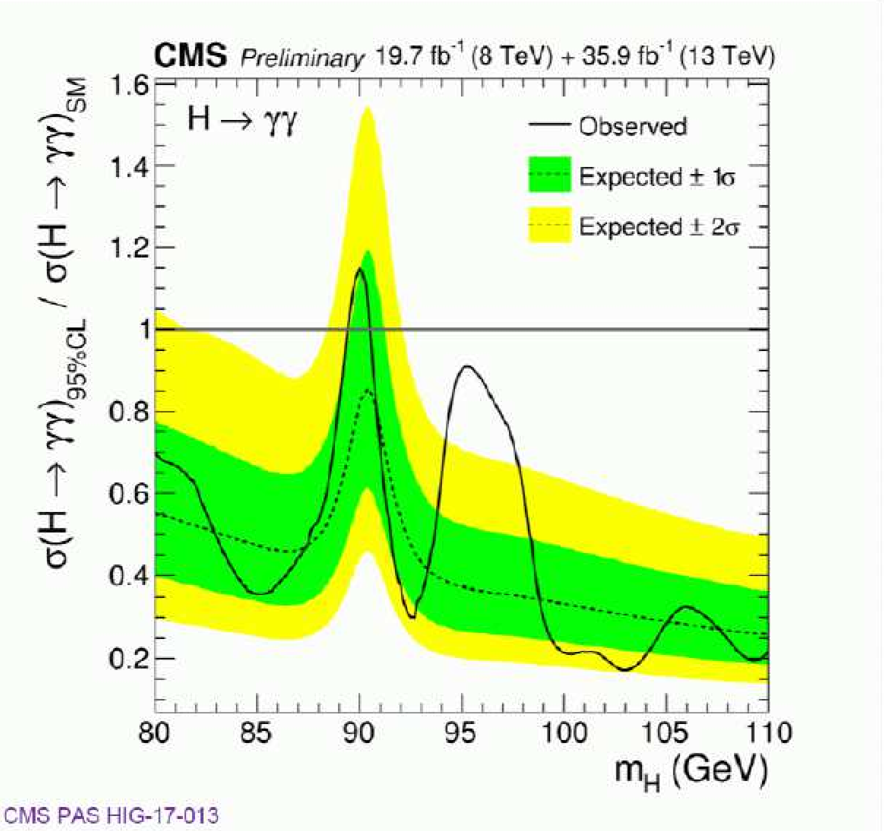


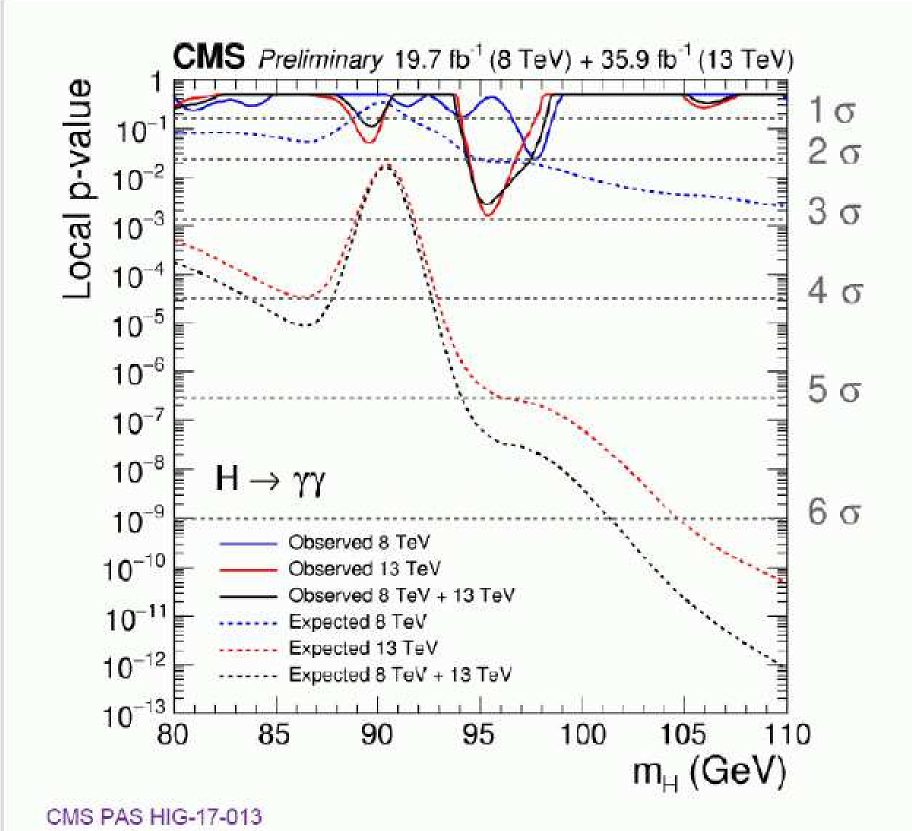
$$\mu_{\text{LEP}}(98\text{ GeV}) = \left[\sigma(e^+e^- \to Zh_1) \times \text{BR}(h_1 \to b\bar{b})\right]_{\text{exp/SM}} = 0.117 \pm 0.057$$

Should we get excited?

[*talk by L. Finco, HiggsHunting 18*]

- **Combined 8 TeV + 13 TeV** σ×BR limit normalized to SM expectation:
  - Production processes assumed in SM proportions
  - **No significant excess** with respect to background expectations
- Expected and observed local p-values for **8 TeV**, **13 TeV** and their **combination**

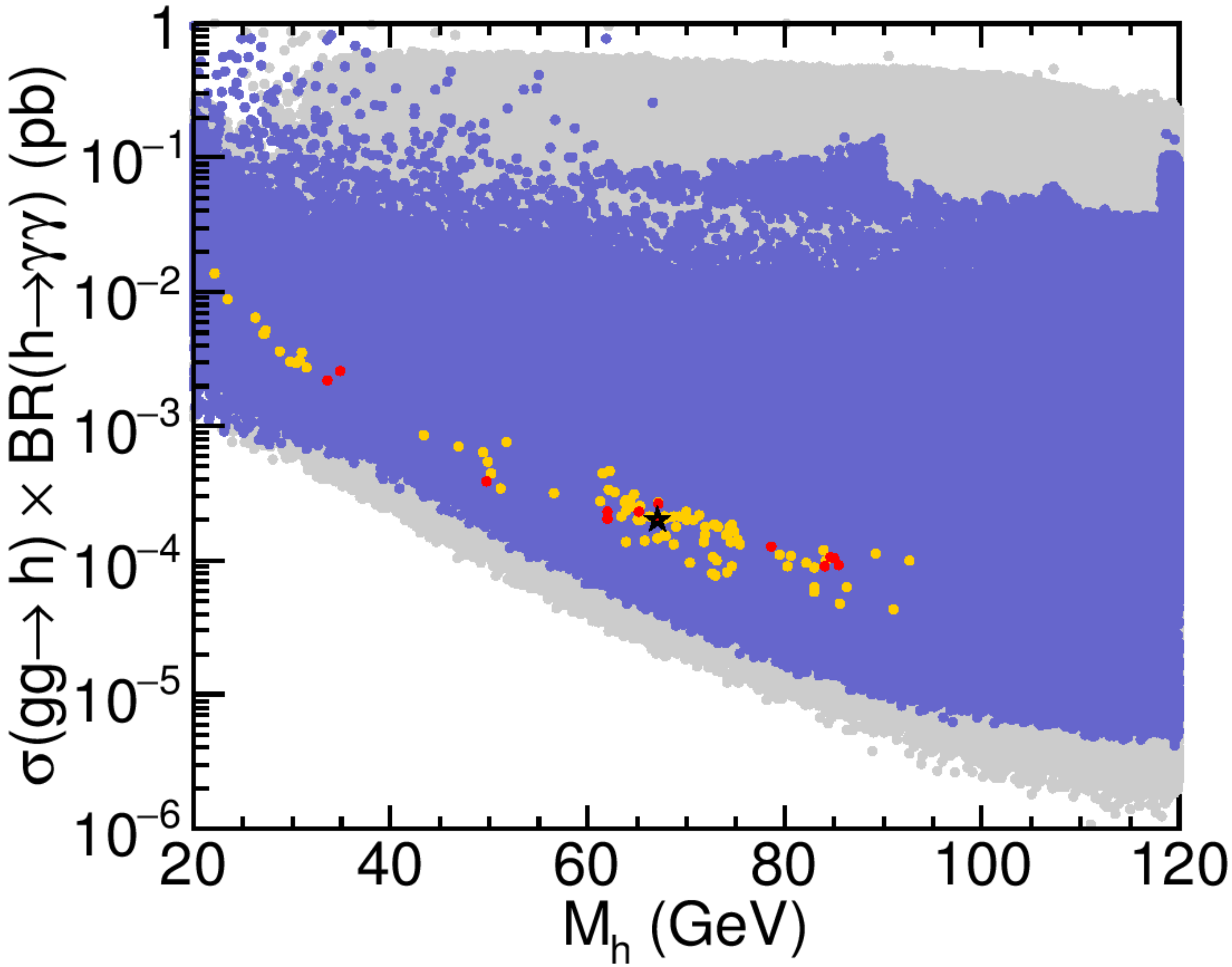




Q: When do you dare to call something "significant"?

What about the MSSM?

[*P. Bechtle, H. Haber, S.H., O. Stål, T. Stefaniak, G. Weiglein, L. Zeune '16*]



⇒ too small rates!

What about the NMSSM?

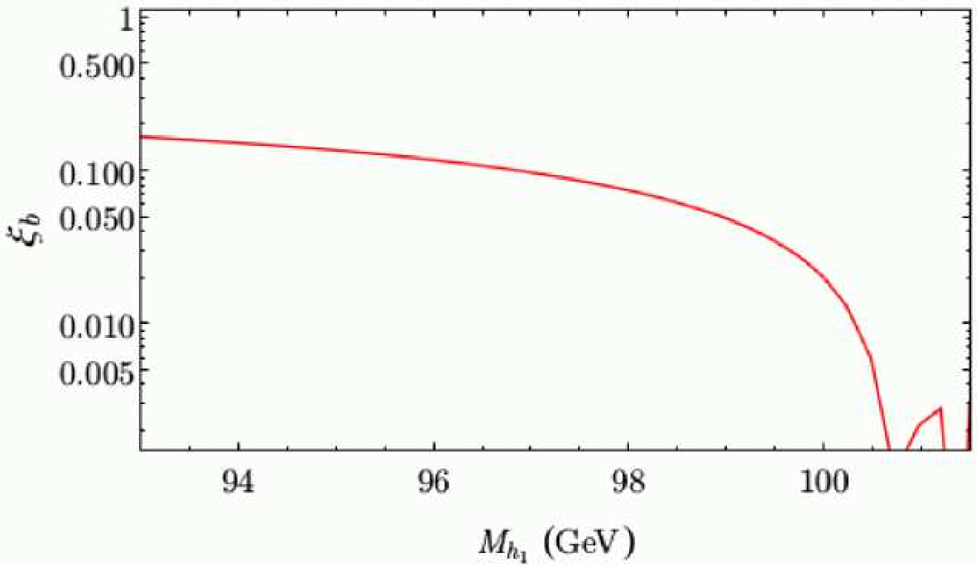
[*F. Domingo, S.H., S. Passehr, G. Weiglein '18*]

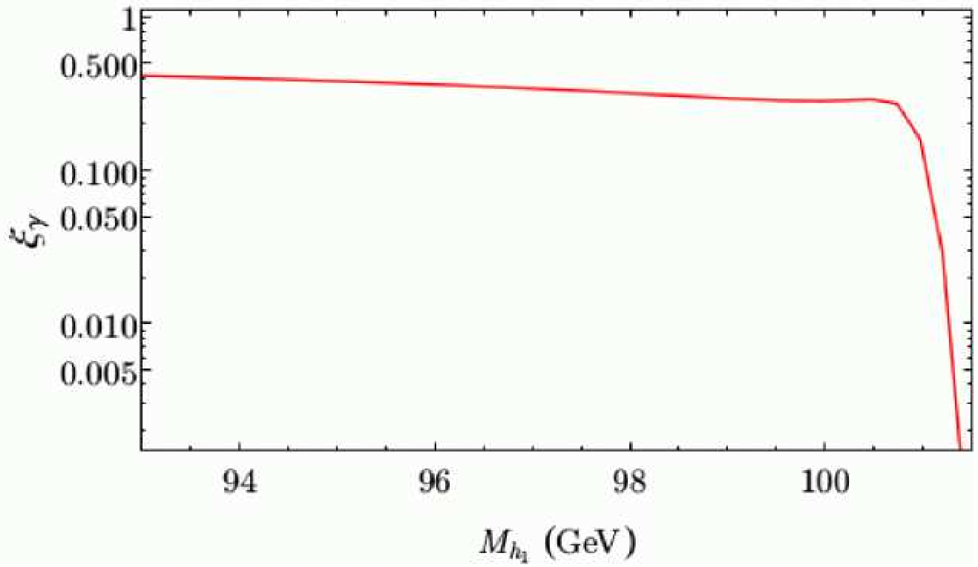
Parameters:

$\lambda = 0.6$, $\kappa = 0.035$, $\tan\beta = 2$, $\mu_{\rm eff} = (397 + 15x)$ GeV, $M_{H^\pm} = 1$ TeV, $A_\kappa = -325$ GeV, $M_{\rm SUSY} = 1$ TeV, $A_t = A_b = 0$

$$\xi_b \equiv \frac{\Gamma[h_1 \to ZZ] \cdot {\rm BR}[h_1 \to b\bar{b}]}{\Gamma[H_{\rm SM}(M_{h_1}) \to ZZ] \cdot {\rm BR}[H_{\rm SM}(M_{h_1}) \to b\bar{b}]} \sim \frac{\sigma[e^+e^- \to Z(h_1 \to b\bar{b})]}{\sigma[e^+e^- \to Z(H_{\rm SM}(M_{h_1}) \to b\bar{b})]}$$

$$\xi_\gamma \equiv \frac{\Gamma[h_1 \to gg] \cdot {\rm BR}[h_1 \to \gamma\gamma]}{\Gamma[H_{\rm SM}(M_{h_1}) \to gg] \cdot {\rm BR}[H_{\rm SM}(M_{h_1}) \to \gamma\gamma]} \sim \frac{\sigma[gg \to h_1 \to \gamma\gamma]}{\sigma[gg \to H_{\rm SM}(M_{h_1}) \to \gamma\gamma]} \, .$$





⇒ both "excesses" can be fitted simultaneously!

What about the $\mu\nu$SSM?

$\mu\nu$SSM: [*D. Lopez-Fogliani, C. Muñoz '06*]

$\mu\nu$SSM: NMSSM + well motivated RPV (in simple terms)

$\Rightarrow$ EW scale seesaw to reproduce the neutrino data

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$\mu\nu$SSM: NMSSM + well motivated RPV (in simple terms)

$\Rightarrow$ EW scale seesaw to reproduce the neutrino data

Can the $\mu\nu$SSM explain the two "excesses"?

[*T. Biekötter, S.H., C. Muñoz, arXiv:1712.07475*]

v_{iL}	Y_i^ν	A_i^ν	$\tan\beta$	μ	λ	A^λ	κ	A^κ	M_1
$\sqrt{2}\cdot 10^{-5}$	10^{-7}	-1000	2	$[413; 418]$	0.6	956.035	0.035	$[-300; -318]$	100

M_2	M_3	$m^2_{\tilde{Q}_{iL}}$	$m^2_{\tilde{u}_{iR}}$	$m^2_{\tilde{d}_{iR}}$	A_1^u	$A_{2,3}^{u,d}$	$(m^2_{\tilde{e}})_{ii}$	A_{33}^e	$A_{11,22}^e$
200	1500	800^2	800^2	800^2	0	0	800^2	0	0

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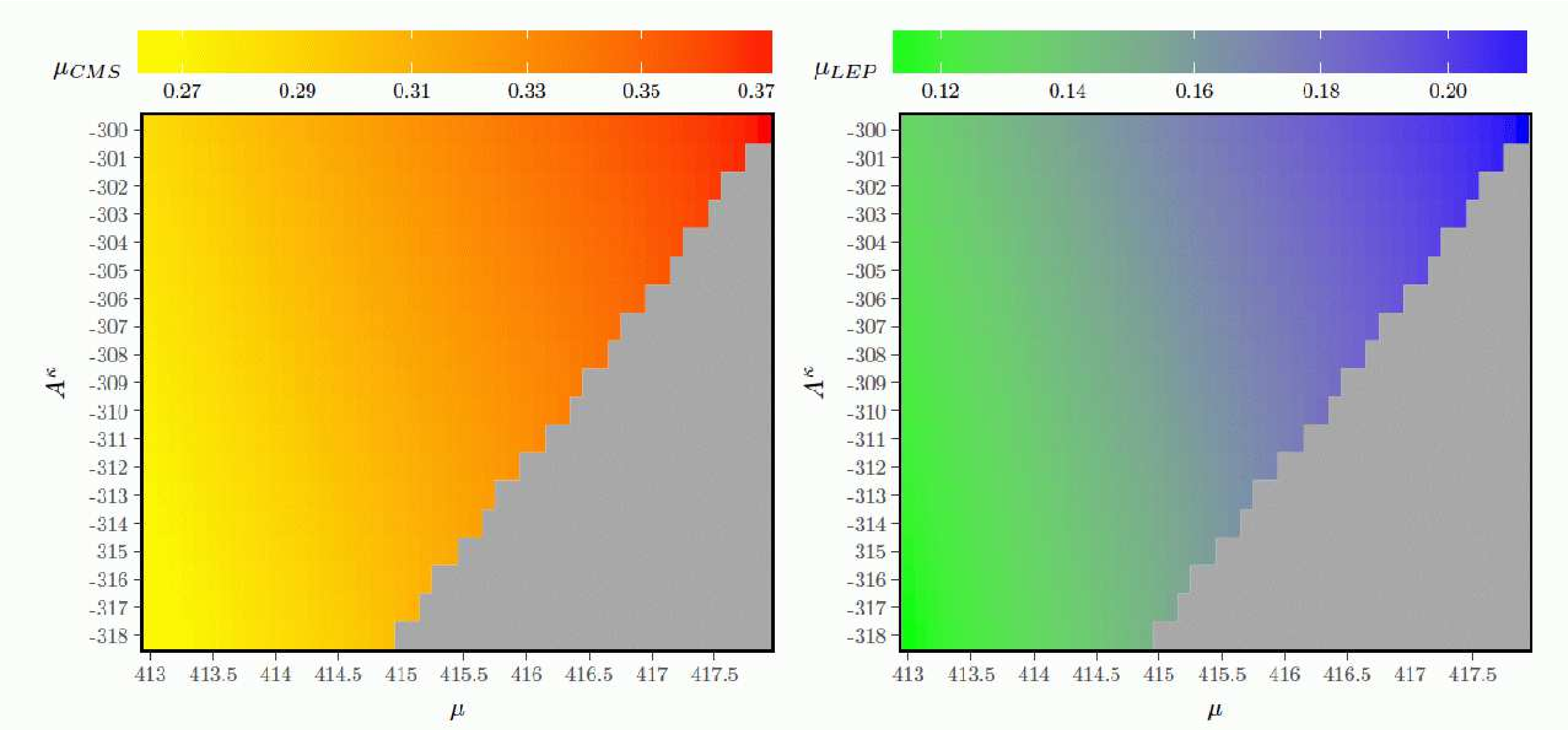


⇒ YES, WE CAN! :-)

(at the $1 - 1.5\,\sigma$ level)

5. Conclusinos

- The Higgs boson found is not the SM Higgs!
  $\Rightarrow$ check for modified properties
  $\Rightarrow$ check for additional Higgs bosons

- LHC coupling measurements not (yet?!) sensitive to new physics

- Decoupling is always a (boring) option

- Alignment w/o decoupling is a viable option in 2HDM, MSSM, . . .
  In combination with direct searches we are pushed to higher masses

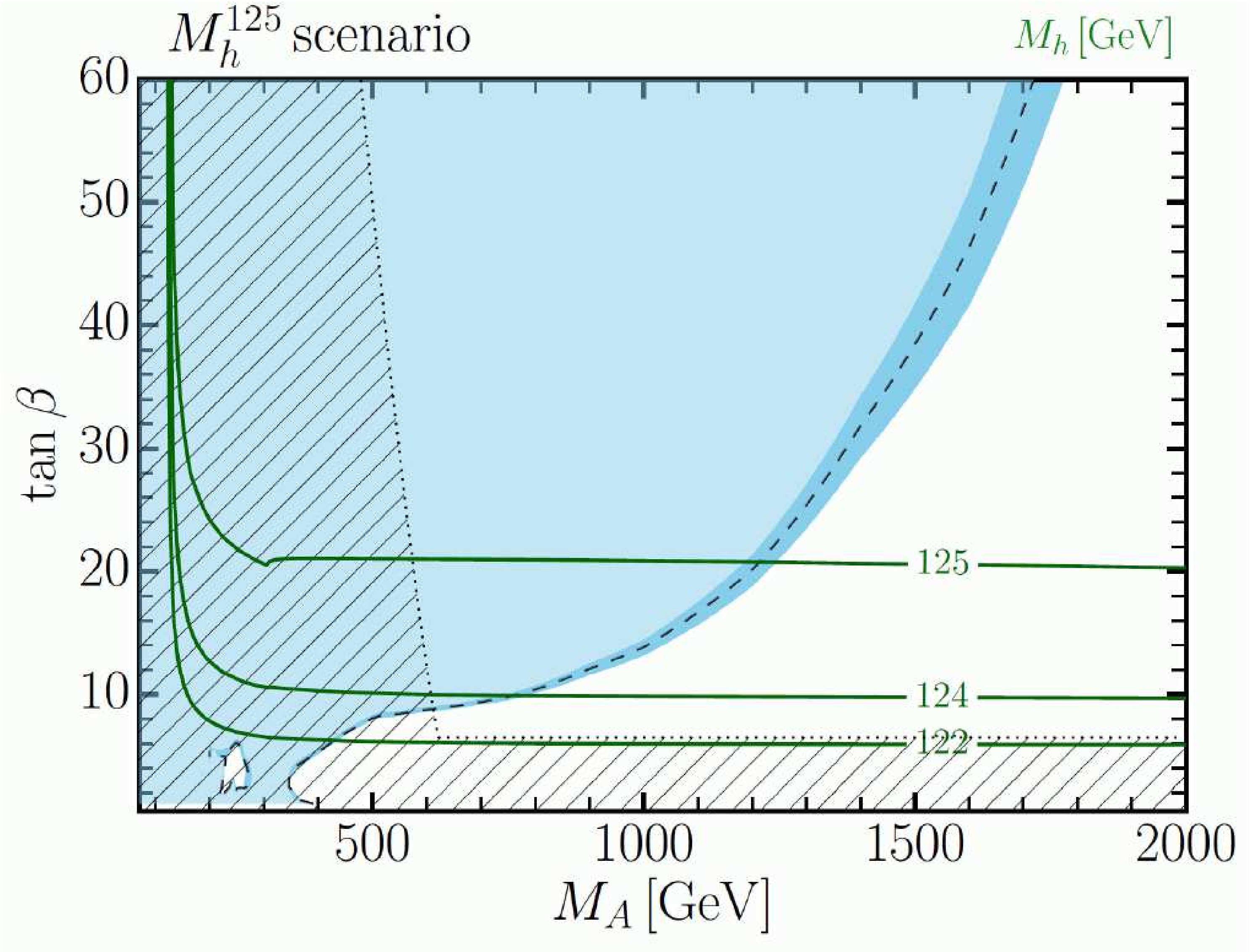
- Taking all (relevant) searches and prec. measurements into account:
  – interesting MSSM Higgs phenomenology
  – new search strategies requiered to cover the allowed parameter space
  – Higgses $\lesssim$ 125 GeV are viable (2HDM, MSSM, NMSSM, . . .)

- A light Higgs at 96 GeV?
  new CMS/ATLAS result (and old LEP result) possibly interesting!
  – NMSSM can explain CMS(/ATLAS) and LEP "excesses"
  – $\mu\nu$SSM can explain CMS(/ATLAS) and LEP "excesses"


Further Questions?

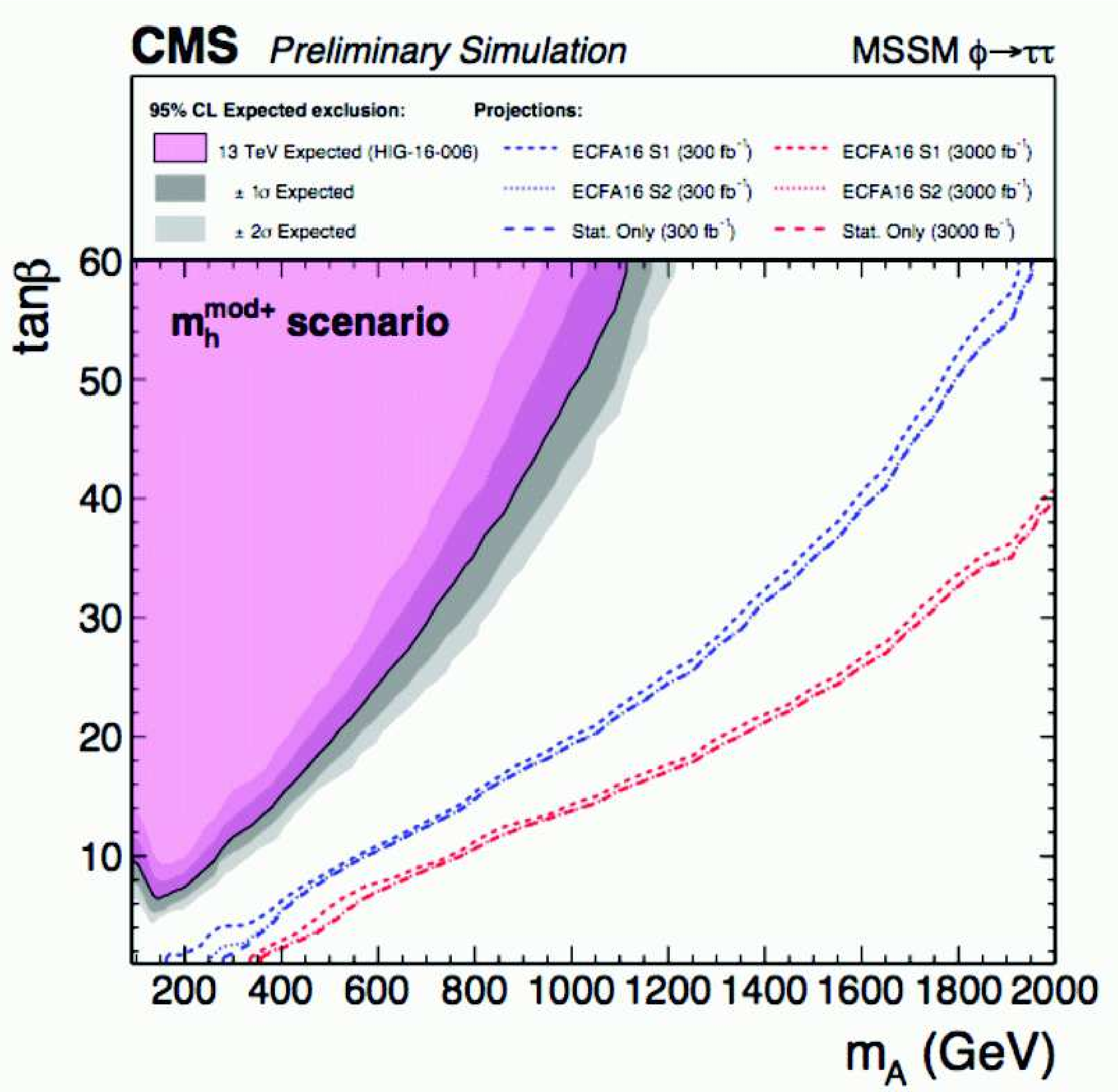
New benchmark: M_h^{125}

[H. Bahl et al., '18]



⇒ new vanilla benchmark model

Future LHC expectations: (still in the $m_h^{\rm mod+}$ scenario)

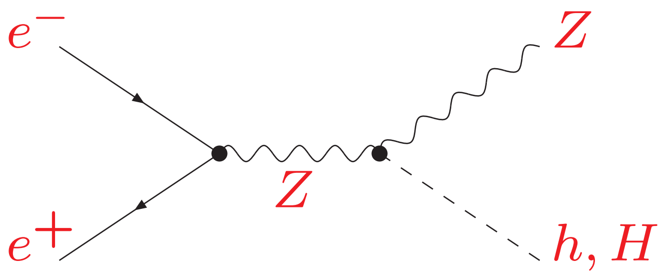


⇒ strong (HL-)LHC limits

Sum rule in the MSSM with h SM-like: $\sin(\beta-\alpha) \approx 1$, $\cos(\beta-\alpha) \approx 0$

Search for neutral SUSY Higgs bosons at ILC/CLIC:

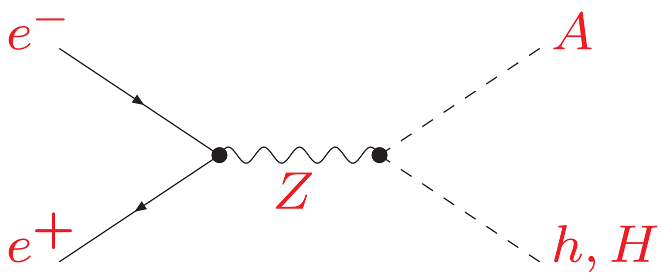
$e^+e^- \to Zh, ZH$



$$\sigma_{hZ} \approx \sin^2(\beta-\alpha_{\rm eff})\sigma_{hZ}^{\rm SM}$$

$$\sigma_{HZ} \approx \cos^2(\beta-\alpha_{\rm eff})\sigma_{hZ}^{\rm SM}$$

$e^+e^- \to Ah, AH$



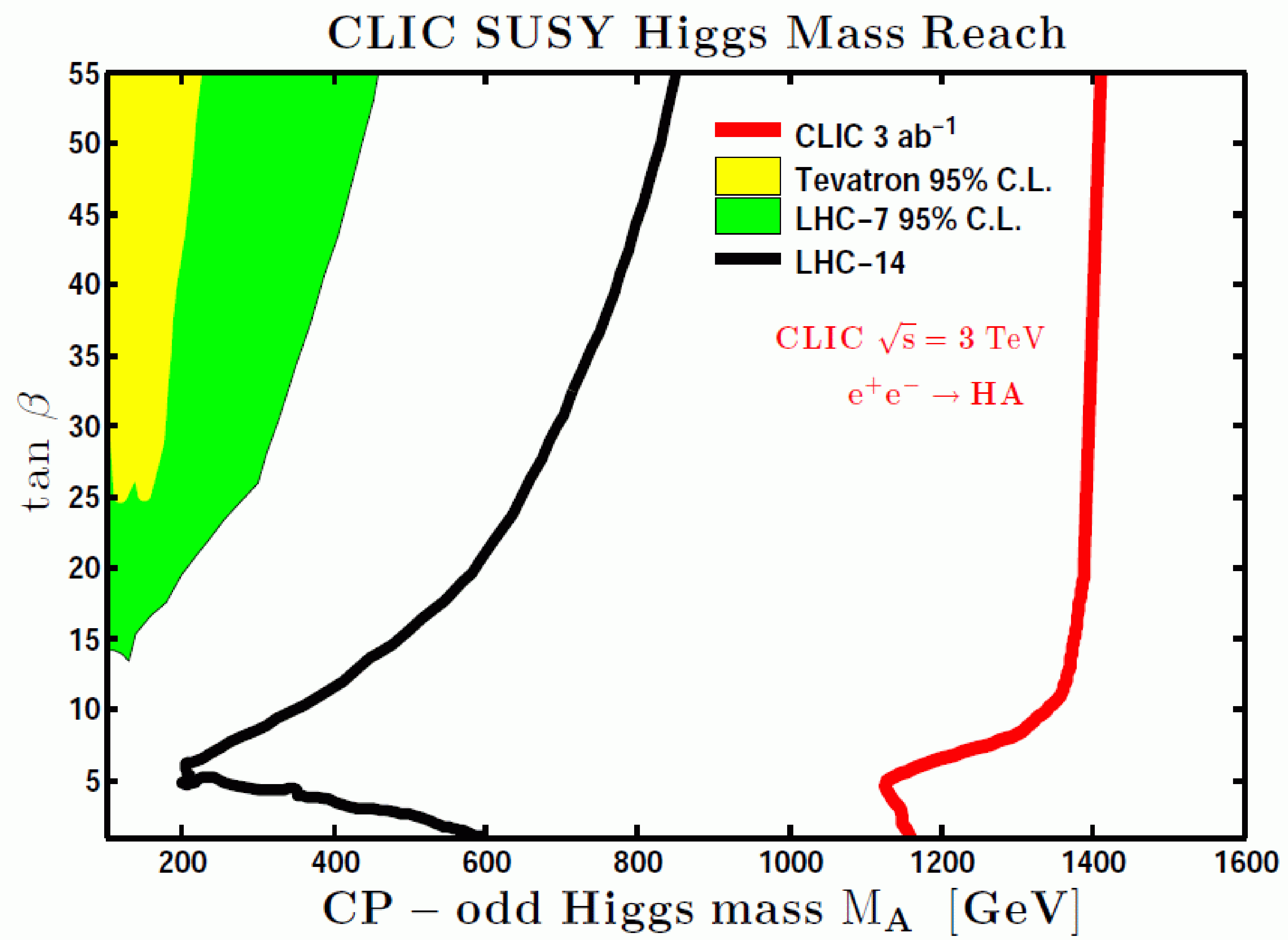
$$\sigma_{hA} \propto \cos^2(\beta-\alpha_{\rm eff})\sigma_{hZ}^{\rm SM}$$

$$\sigma_{HA} \propto \sin^2(\beta-\alpha_{\rm eff})\sigma_{hZ}^{\rm SM}$$

$\Rightarrow$ only pair production of heavy Higgs bosons! reach: $M_A \lesssim \sqrt{s}/2$

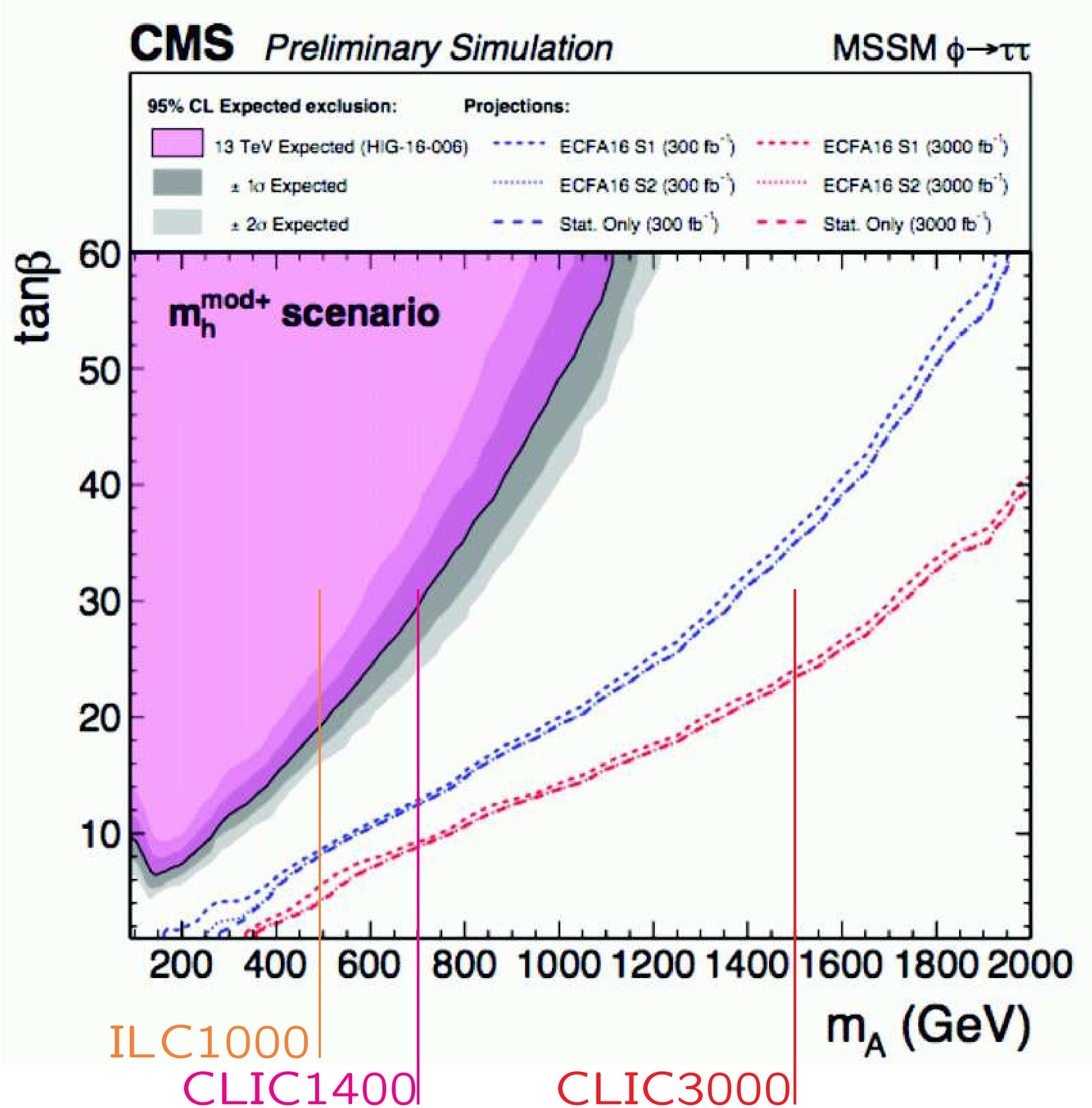
CLIC reach:

[*L. Linssen et al. '12*]



⇒ close to kinematic limit

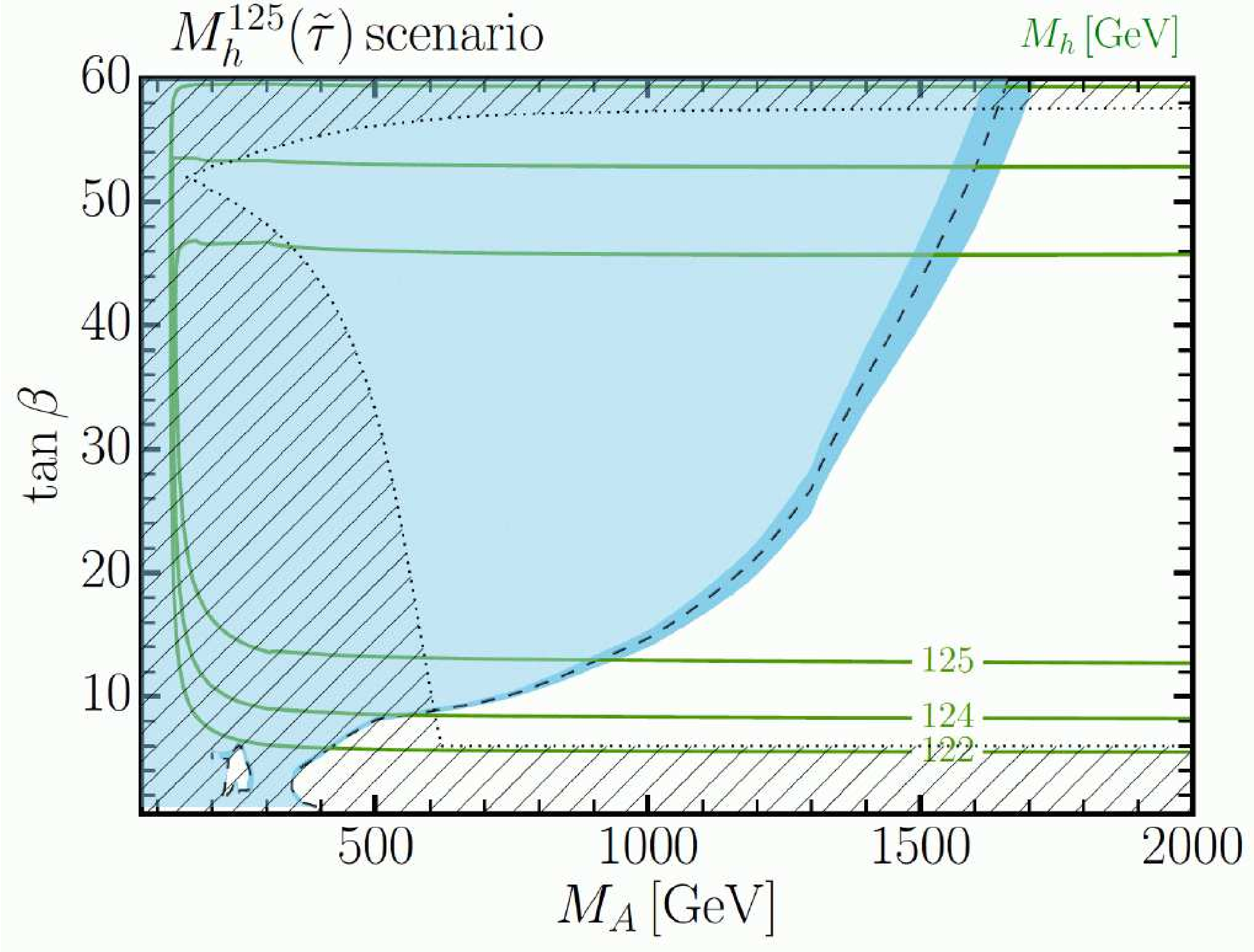
"Simple" LC reach in the MSSM (neglecting $t\bar{t}$ final states)



⇒ unique opportunities!

New benchmark: $M_h^{125}(\tilde{\tau})$

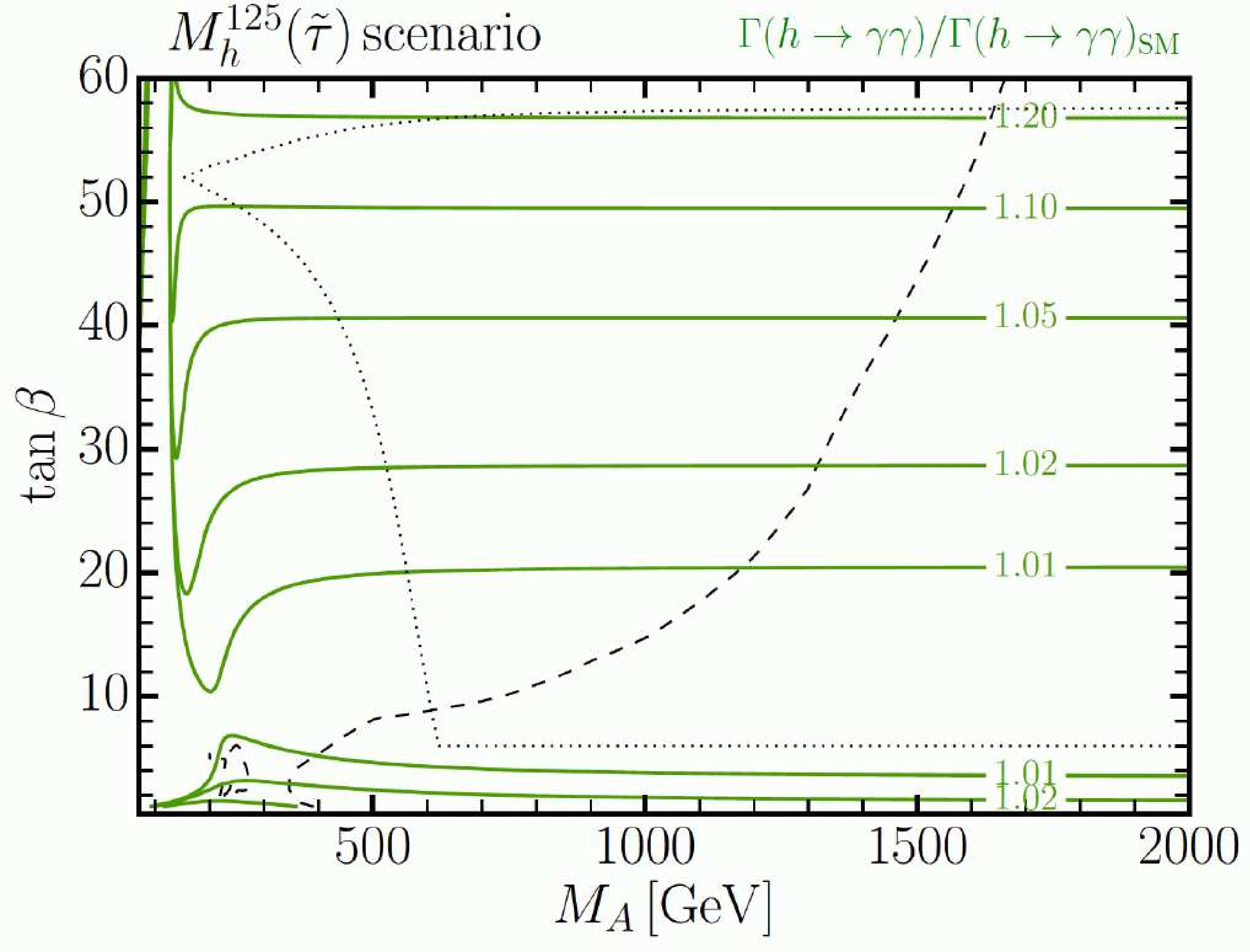
[*H. Bahl et al., '18*]



⇒ slightly reduced heavy Higgs coverage

New benchmark: $M_h^{125}(\tilde{\tau})$

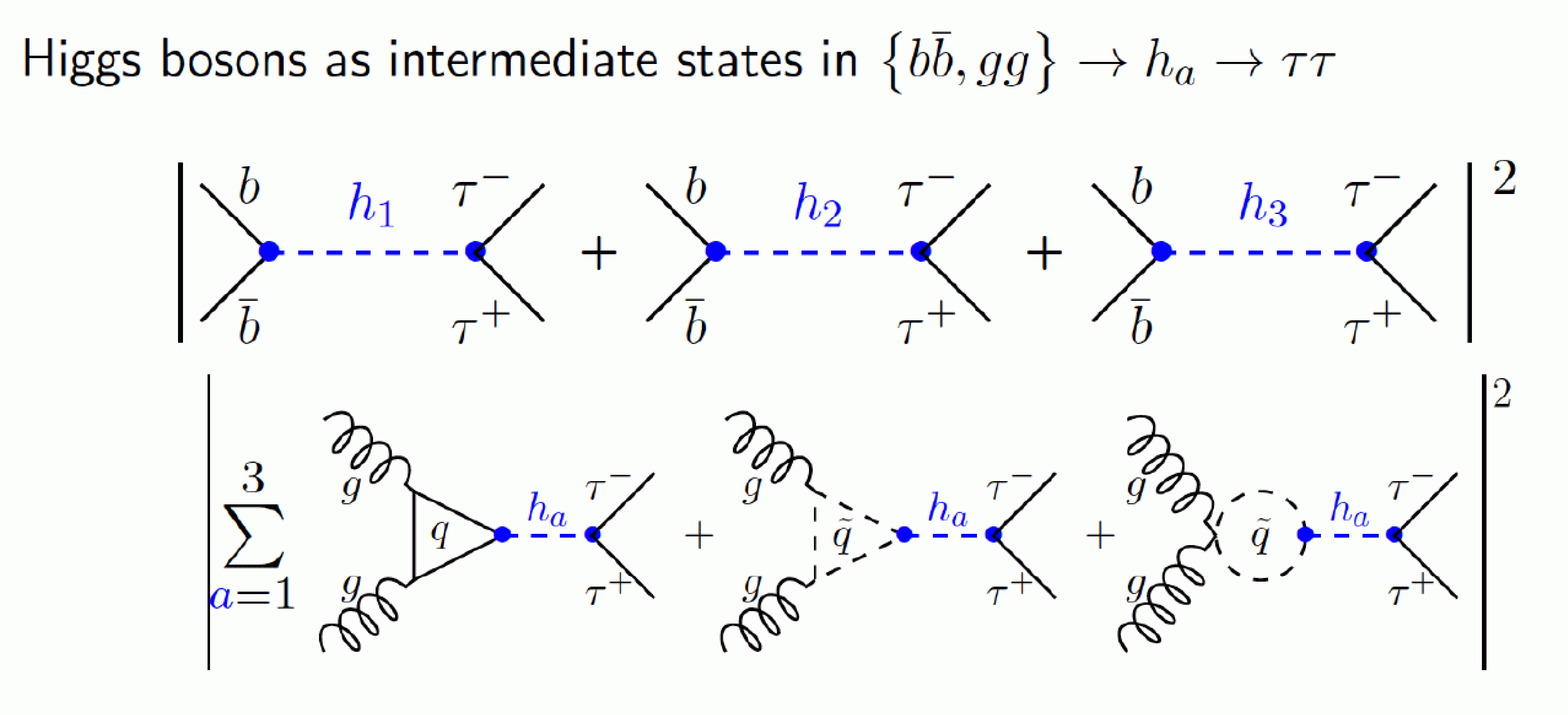
[*H. Bahl et al., '18*]



$\Rightarrow$ strong impact on $\Gamma(h \to \gamma\gamma)$

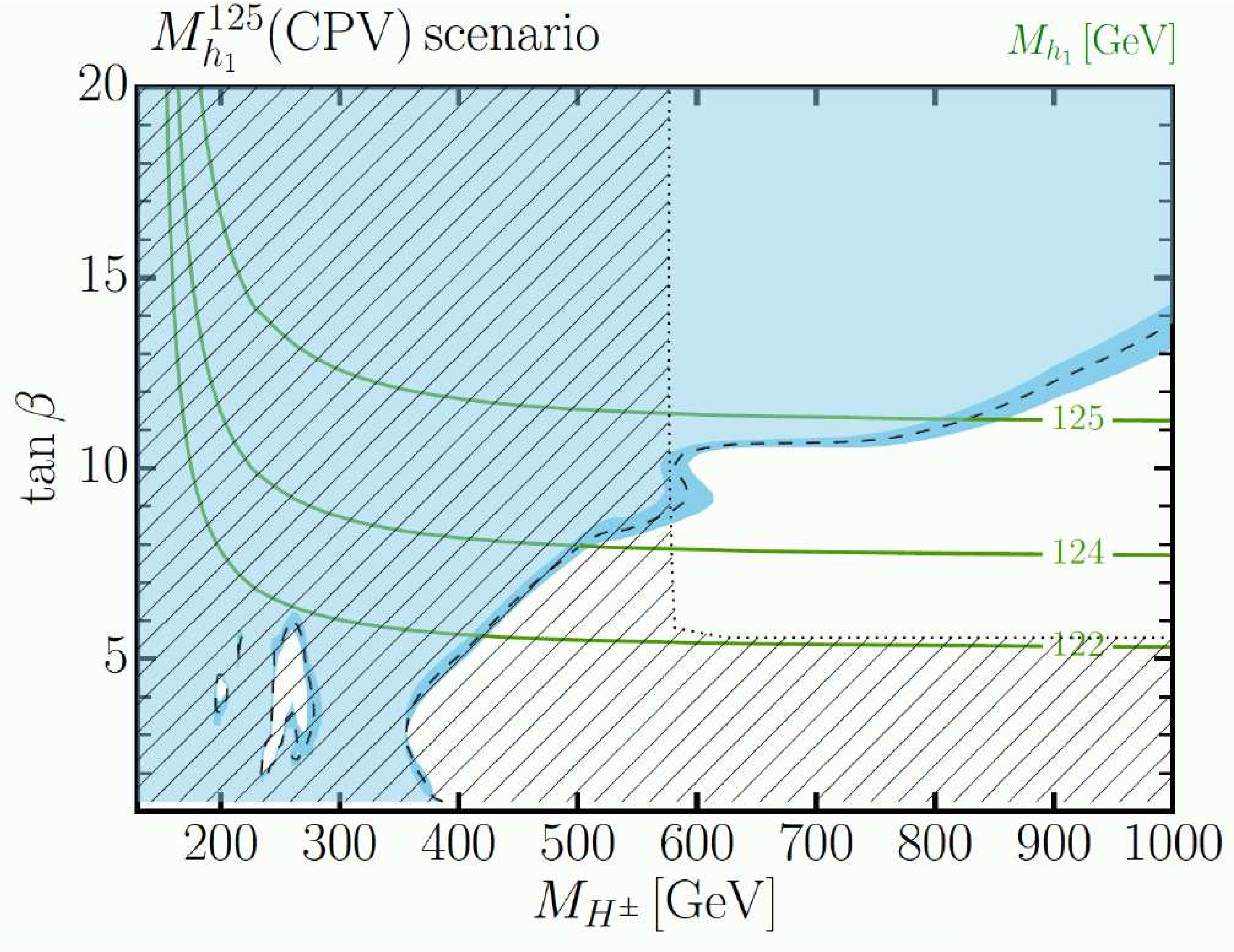
LHC Higgs searches for complex parameters:

$h_1 \sim H_{125}$, $M_{h_2} \approx M_{h_3}$, CPV: large h_2-h_3 mixing possible:



New benchmark: $M_{h_1}^{125}$(CPV)

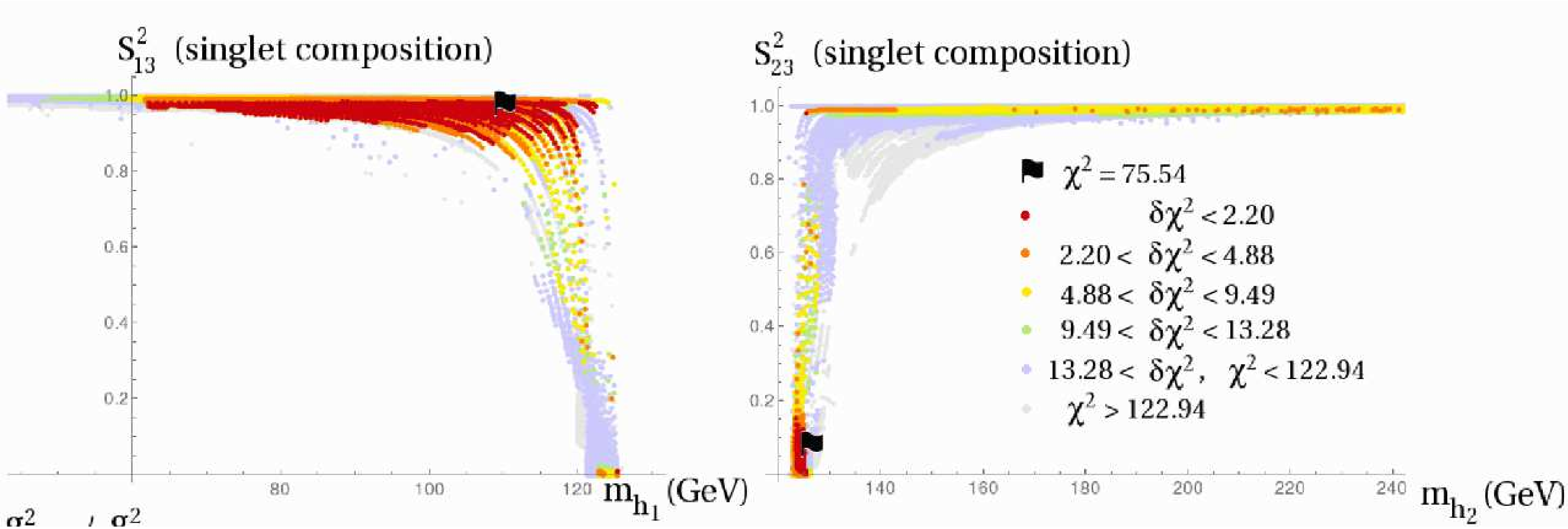
[*H. Bahl et al., '18*]



⇒ reduced coverage due to h_2-h_3 interference

Parameters:

$\tan\beta = 8$, $M_A = 1$ TeV, $A_\kappa = -2...0$ TeV, $\mu = 120...2000$ GeV,
$2M_1 = M_2 = 500$ GeV, $M_3 = 1.5$ TeV, $m_{\tilde{Q}_3} = 1$ TeV, $m_{\tilde{Q}_{1,2}} = 1.5$ TeV,
$A_t = -2$ TeV, $A_{b,\tau} = -1.5$ TeV



⇒ light Higgs below 125 GeV has large singlet component

⇒ second Higgs is SM-like