We have the Higgs, Now What?
SUSY Implications

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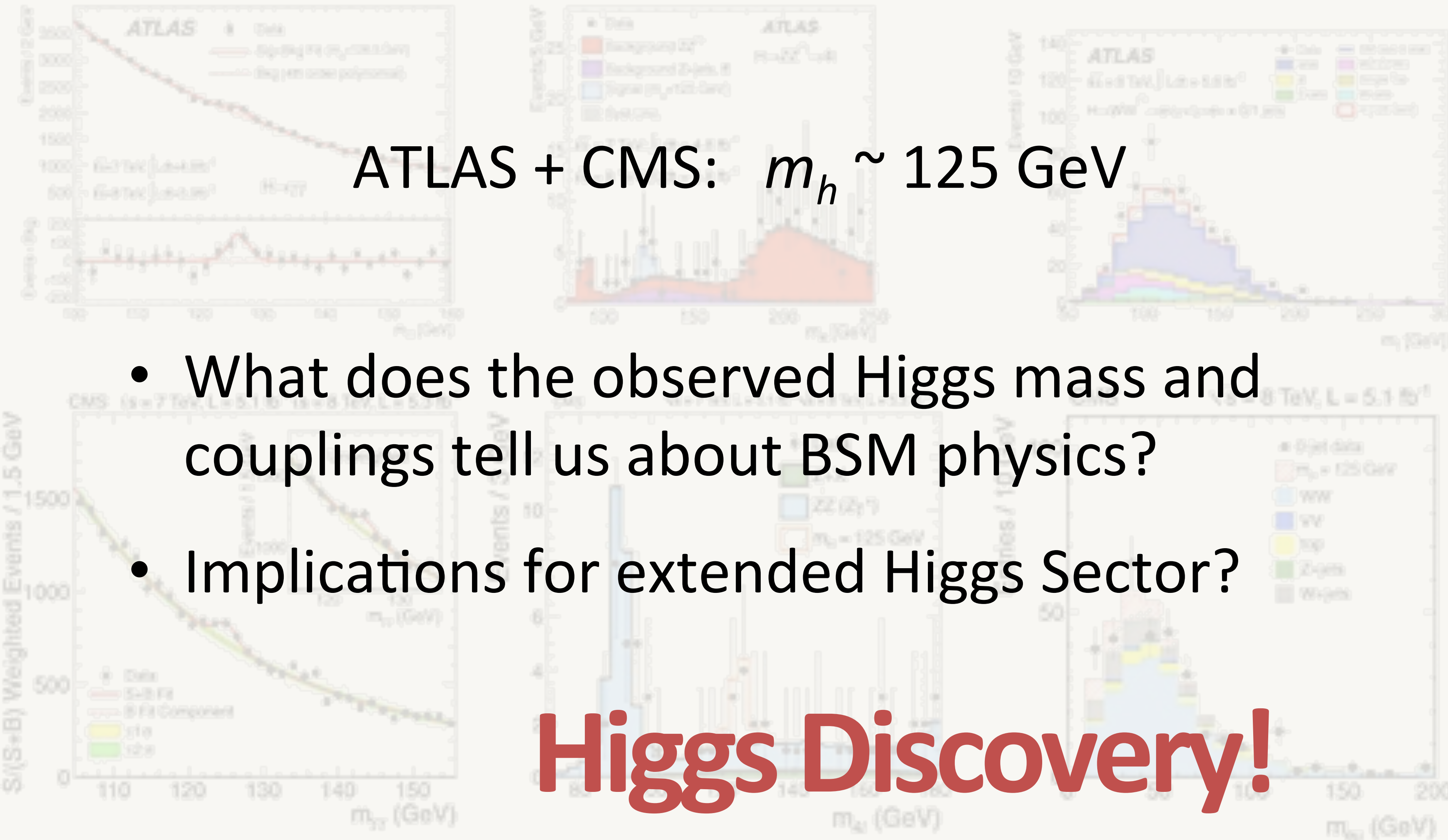
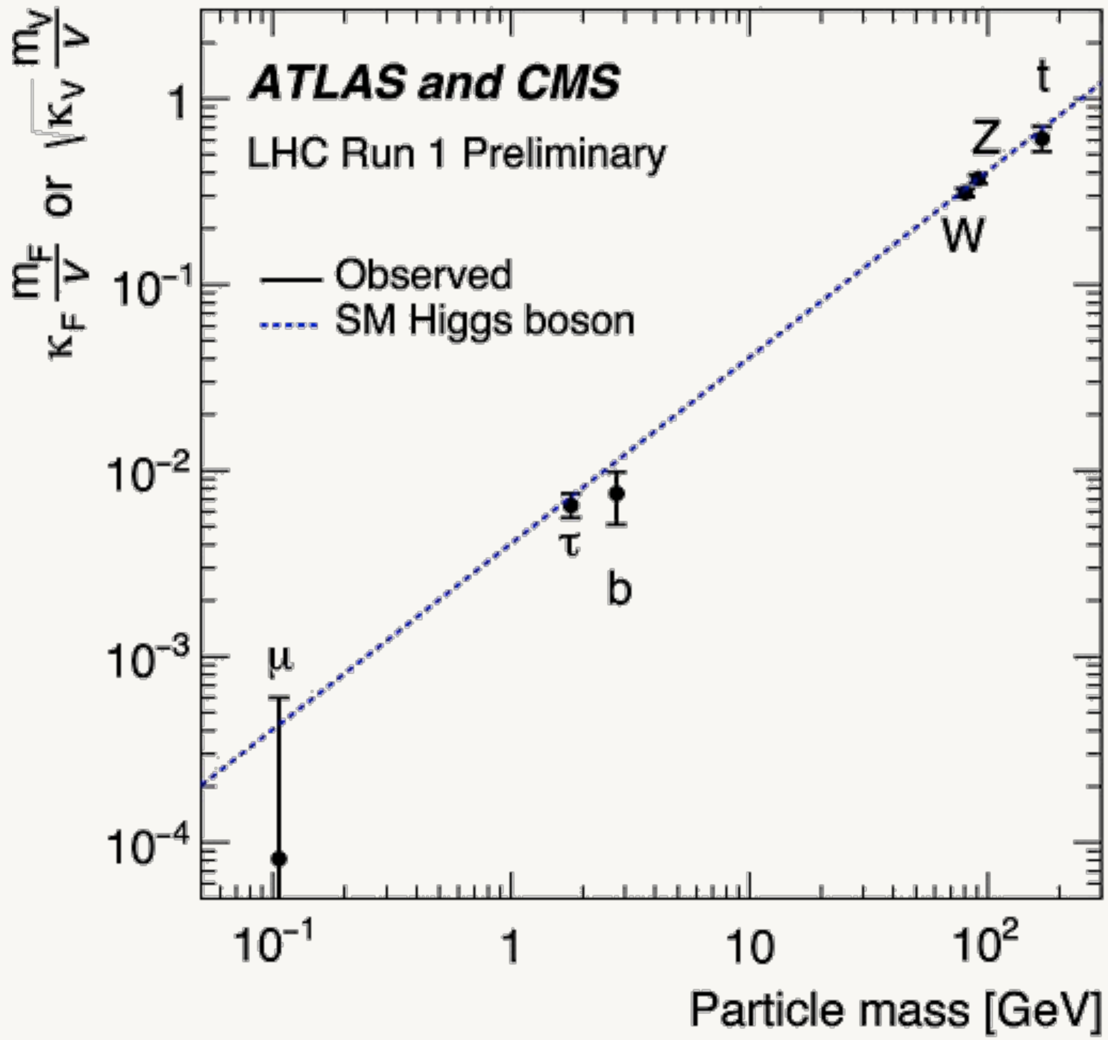
ATLAS + CMS: m_h ~ 125 GeV



- What does the observed Higgs mass and couplings tell us about BSM physics?
- Implications for extended Higgs Sector?

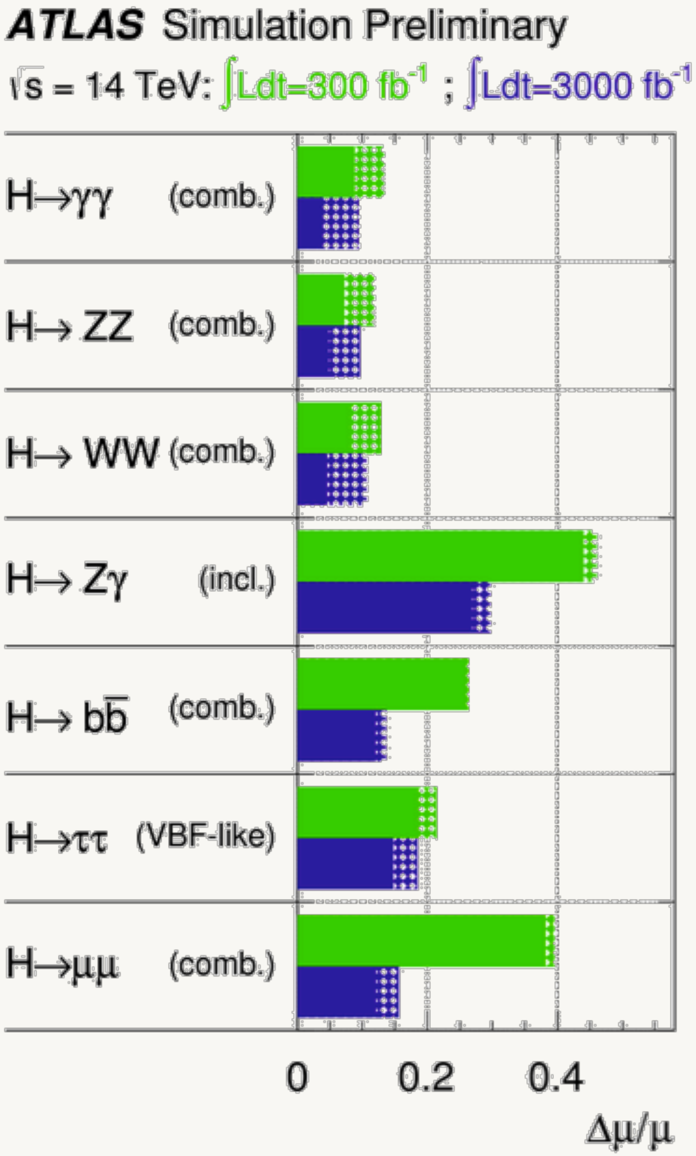
Higgs Discovery!

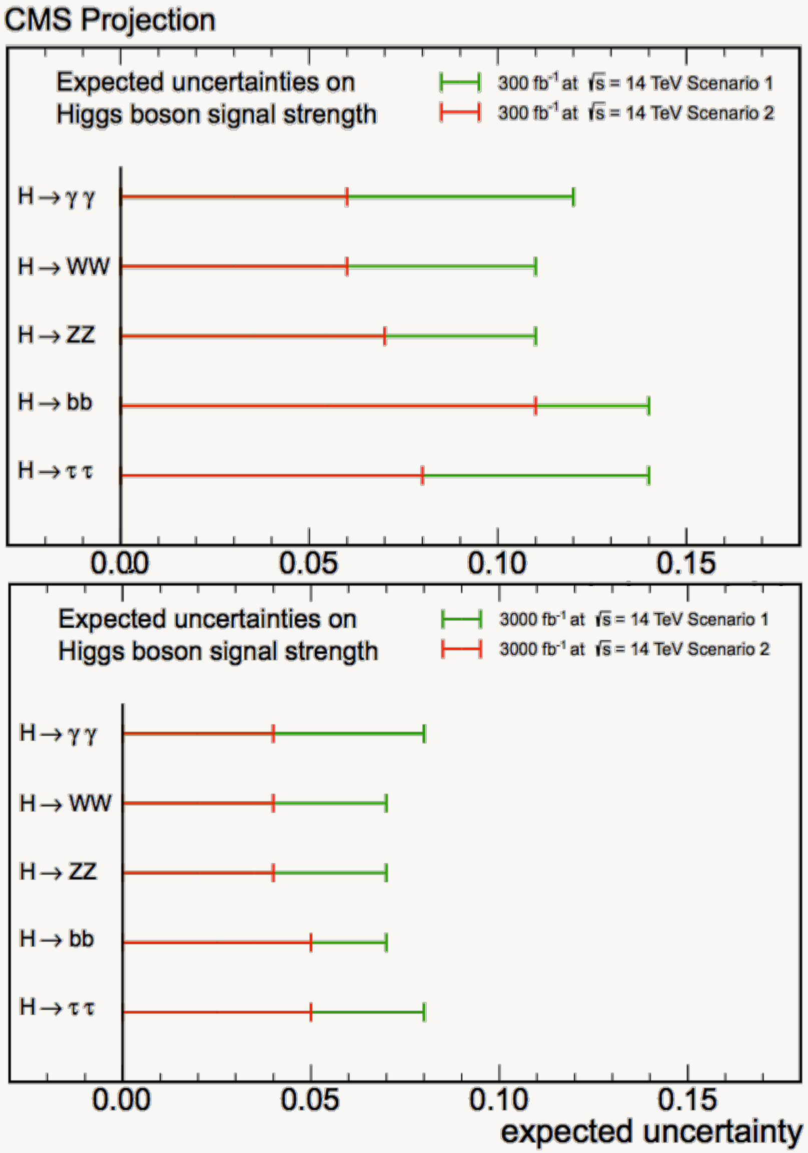
Still large uncertainties in couplings…



ATLAS-CONF-2015-044
CMS-PAS-HIG-15-002

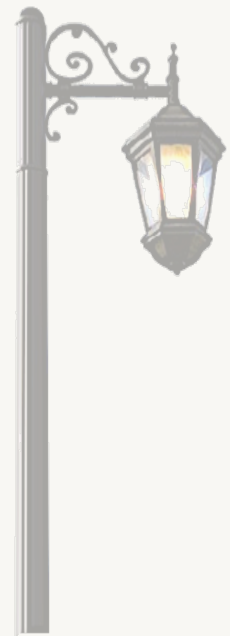
but approximately consistent with SM.





Projected Higgs Precision

The Higgs Lamp Post: $m_h \sim 125$ GeV + SM-like



Alignment

SUSY → MSSM +NMSSM

No New States at the LHC... (YET!!)

Many theoretical extensions to the Standard Model

Frequently include additional particles coupling to the Higgs

Extended symmetries demanding additional Higgs bosons

Supersymmetry

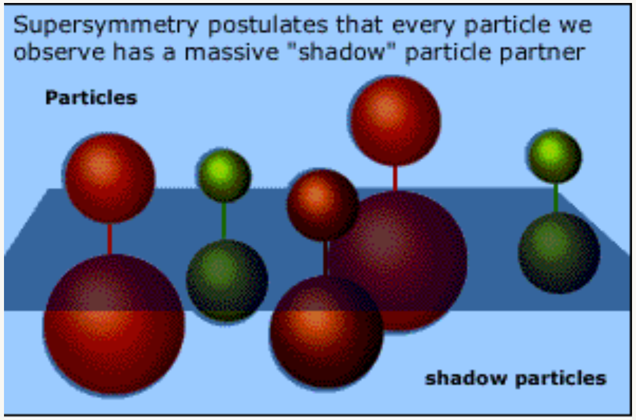
Supersymmetry:

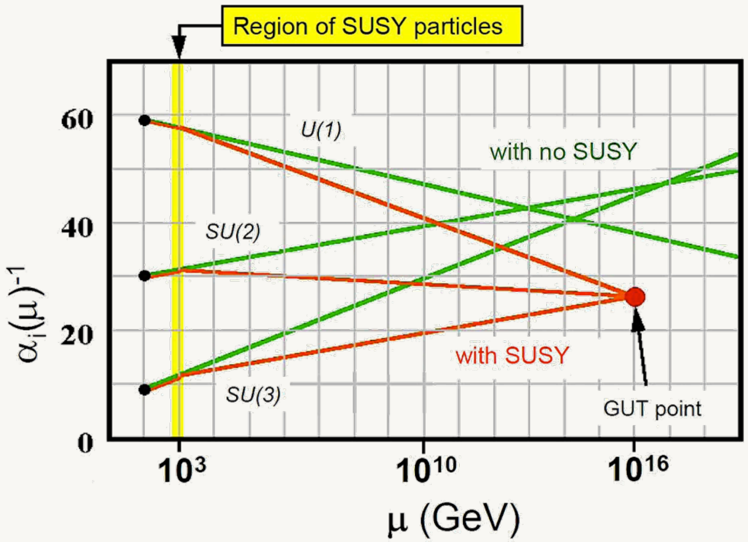
Explains hierarchy between the EW scale and the Planck/unification scales.

Generates electroweak symmetry breaking (EWSB).

Allows unification of gauge couplings at energies ~10^{16} GeV.

Provides a good dark matter candidate: The Lightest SUSY Particle (LSP)





Minimal Supersymmetric SM (MSSM).

For every fermion there is a boson of equal mass and couplings and visa versa.

DM: Gauginos + Higgsinos

No new couplings.

SUSY has to be broken.

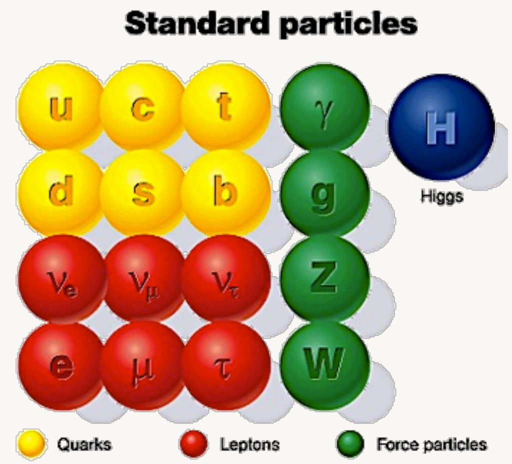
Need 2 Higgs doublets:

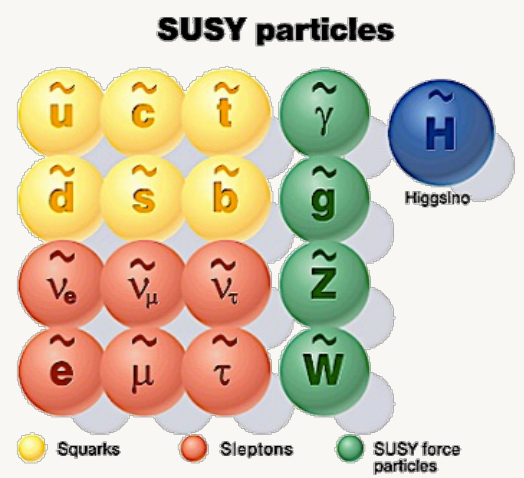
H_u – Couples only to up-type quarks

H_d – Couples only to down-type quarks and leptons.

$$m_A \sim m_H,\ m_{H+}$$

$$\tan\beta = v_u/v_d$$



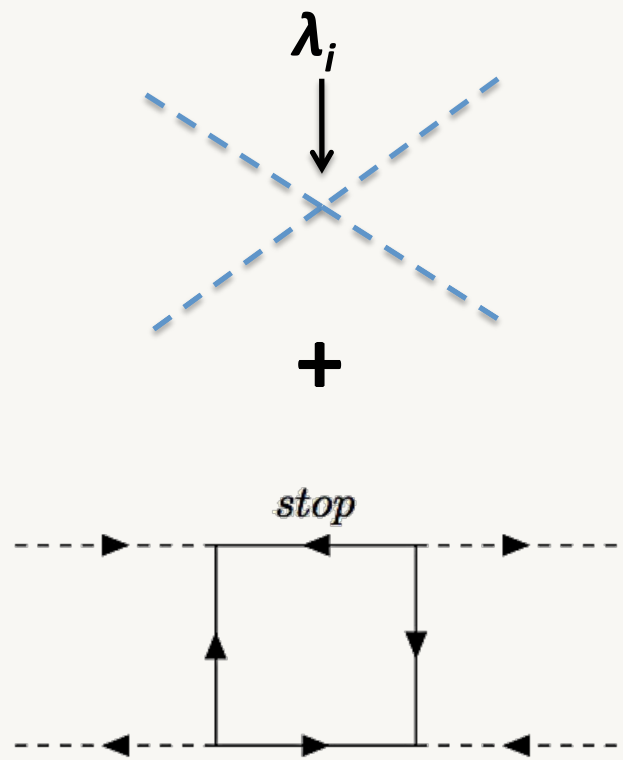


MSSM Higgs Sector: Type II 2HDM.

$$V = m_{ij}^2 \Phi_i^\dagger \Phi_j + \lambda_i \Phi_j^\dagger \Phi_k \Phi_l^\dagger \Phi_m$$

H. Haber and J. Gunion, '03

7 quartic coupings



Quartics at tree-level related only to SM couplings.

Largest radiative corrections due to *stops*, the superpartner of the top quark.

Higgs mass bounded by m_Z at tree-level.

91 ≠ 125

Large stop corrections!

Higgs Basis

$$H_{SM} = \sin\beta\Phi_1 + \cos\beta\Phi_2$$
$$H_{NSM} = -\cos\beta\Phi_1 + \sin\beta\Phi_2$$
$$\langle H_{SM}\rangle = v$$
$$\langle H_{NSM}\rangle = 0$$

$$\tan\beta = \frac{v_1}{v_2}$$

- H_{SM} has completely SM-like couplings.
- Mixing between H_{SM} and H_{NSM}, "***cos (β-α)***", gives non-SM behavior of observed h125.

If

cos (β-α) = 0

SM-like HIGGS!!

ALIGNMENT

mh125 + MSSM Alignment?

$$(m_h^2 - \lambda_1 v^2) + (m_h^2 - \tilde{\lambda}_3 v^2) t_\beta^2 = v^2 (3\lambda_6 t_\beta + \lambda_7 t_\beta^3) \ ,$$

$$(m_h^2 - \lambda_2 v^2) + (m_h^2 - \tilde{\lambda}_3 v^2) t_\beta^{-2} = v^2 (3\lambda_7 t_\beta^{-1} + \lambda_6 t_\beta^{-3})$$

Large corrections to tree-level Higgs mass from stops:

Heavy Stops, M_S or large L-R mixing, $X_t = (A_t - \mu/t\beta)$

$$t_\beta \, c_{\beta-\alpha} \simeq \frac{-1}{m_H^2 - m_h^2} \left[m_h^2 + m_Z^2 + \frac{3 m_t^4}{4\pi^2 v^2 M_S^2} \left\{ A_t \mu t_\beta \left(1 - \frac{A_t^2}{6 M_S^2} \right) - \mu^2 \left(1 - \frac{A_t^2}{2 M_S^2} \right) \right\} \right]$$

Alignment at low $t\beta$:

Large μ/M_S (heavy Higgsinos)and A_t/M_S

Only Decoupling:

mh125 precision measurements independent of $t\beta$

Additional Higgs Bosons Searches: A/H → ττ

Precision Higgs Physics: h → WW/ZZ

— σ(bbH/A+ggH/A) × BR(H/A → τ τ) (8 TeV)

--- σ(bbh+ggh) × BR(h → WW)/SM

No Alignment (Decoupling):
H/A Direct searches Weaker
h_{125} Precision measurements Stronger

Alignment:
H/A Direct searches Stronger
h_{125} Precision measurements Weaker

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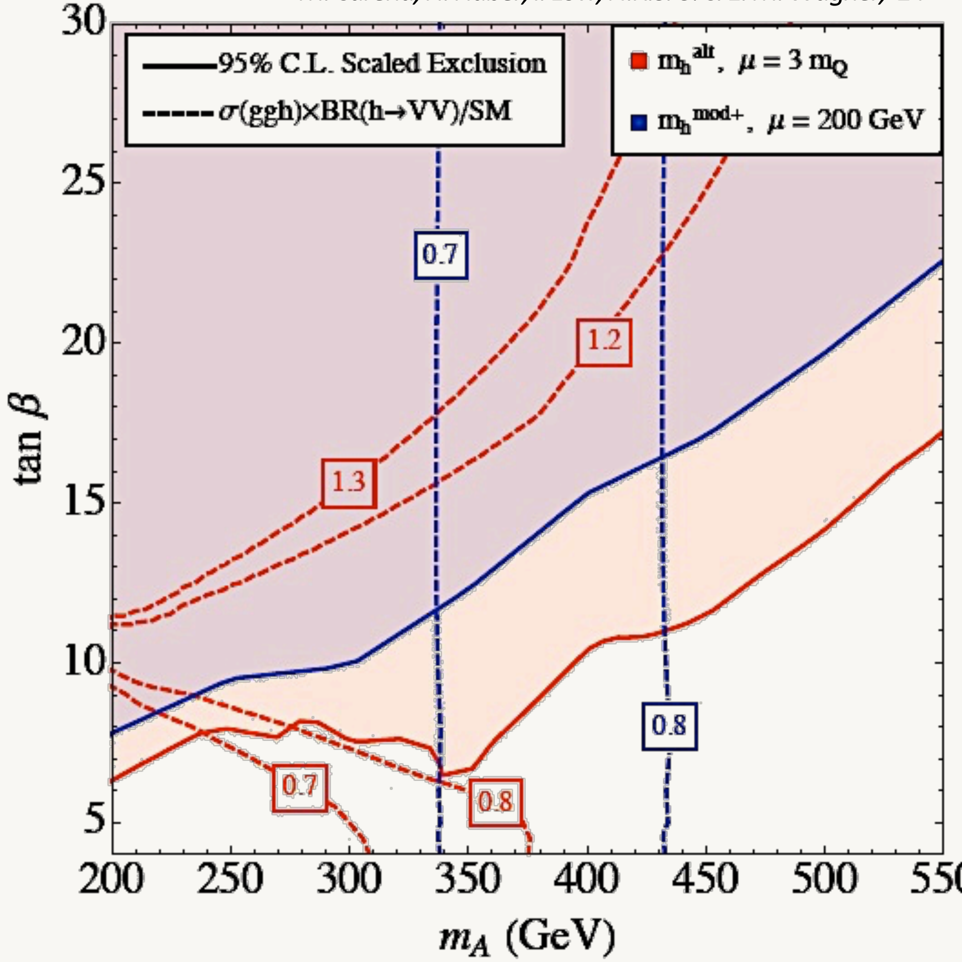

Connections crucial to probe SUSY Higgs sector.

Correlations between deviations from SM expectations may reveal underlying physics

Next to Minimal Supersymmetric SM (NMSSM).

$$W = \lambda S H_u H_d + \frac{\kappa}{3} S^3$$

$$-\mathcal{L}_{\text{soft}} = \lambda A_\lambda S H_u H_d + \frac{1}{3}\kappa A_\kappa S^3$$

m_A (from A_λ) $\quad$ m_{AS}/m_{hS} (from A_κ)

Singlet acquires vev: $\mu = \lambda v_s$
Singlino mass: $2 \kappa \mu/\lambda$
Singlet-like CP-even and odd masses *anti*-correlated.

2 Doublets (H_u, H_d) + Singlet (S)
Singlet couples only to the Higgs Sector.

3 CP-Even Higgses: h, H, S
h ~ 125 GeV, h-H and h-S mixing

2 CP-Odd Higgses: A, A_S
Mixtures of "MSSM" M_A and singlet.

5 Neutralinos: $\chi = N_{11}\tilde{B} + N_{12}\tilde{W} + N_{13}\tilde{H}_d + N_{14}\tilde{H}_u + N_{15}\tilde{S}.$

- Interaction basis: (H_u, H_d, S)
  - H_u: Couples only to up-type fermions
  - H_d: Couples only to down-type fermions
  - S: Only couples to Higgses

$\langle H_u \rangle = v_u$
$\langle H_d \rangle = v_d$
$t_\beta = v_u/v_d$
$\langle S \rangle = \mu/\lambda$

CP-Even Higgs Bases

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$\langle S \rangle = \mu/\lambda$

- "Extended" Higgs basis: (H_{NSM}, H_{SM}, S)
  - H_{NSM}: (down, up, V) = ($y_d\, t_\beta$, $y_u/\, t_\beta$, 0)
  - H_{SM}: (down, up, V) = (y_d, y_u, g_{hVV})

$\langle H_{NSM} \rangle = 0$
$\langle H_{SM} \rangle = v$

CP-Even Higgs Bases

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$\langle H_{NSM} \rangle = 0$
$\langle H_{SM} \rangle = v$

- Mass basis: (H^3, H^2, H^1)
  - $H^i = \kappa^i_{NSM}\, H_{NSM} + \kappa^i_{SM}\, H_{SM} + \kappa^i_S\, S$

CP-Even Higgs Bases

- Interaction basis: (H_u, H_d, S)
  - H_u: Couples only to up-type fermions
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$\langle S \rangle = \mu / \lambda$

- "Extended" Higgs basis: (H_{NSM}, H_{SM}, S)
  - H_{NSM}: (down, up, V) = $(y_d\, t_\beta,\, y_u/ t_\beta,\, 0)$
  - H_{SM}: (down, up, V) = $(y_d,\, y_u,\, g_{hVV})$

$\langle H_{NSM} \rangle = 0$
$\langle H_{SM} \rangle = v$

- Mass basis: $(H^3, H^2, H^1) \rightarrow (H, h125, hS)$
  - $H^i = \kappa^i_{NSM}\, H_{NSM} + \kappa^i_{SM}\, H_{SM} + \kappa^i_S\, S$

Alignment:
$\kappa^{h125}_{NSM} = 0$
$\kappa^{h125}_{S} = 0$

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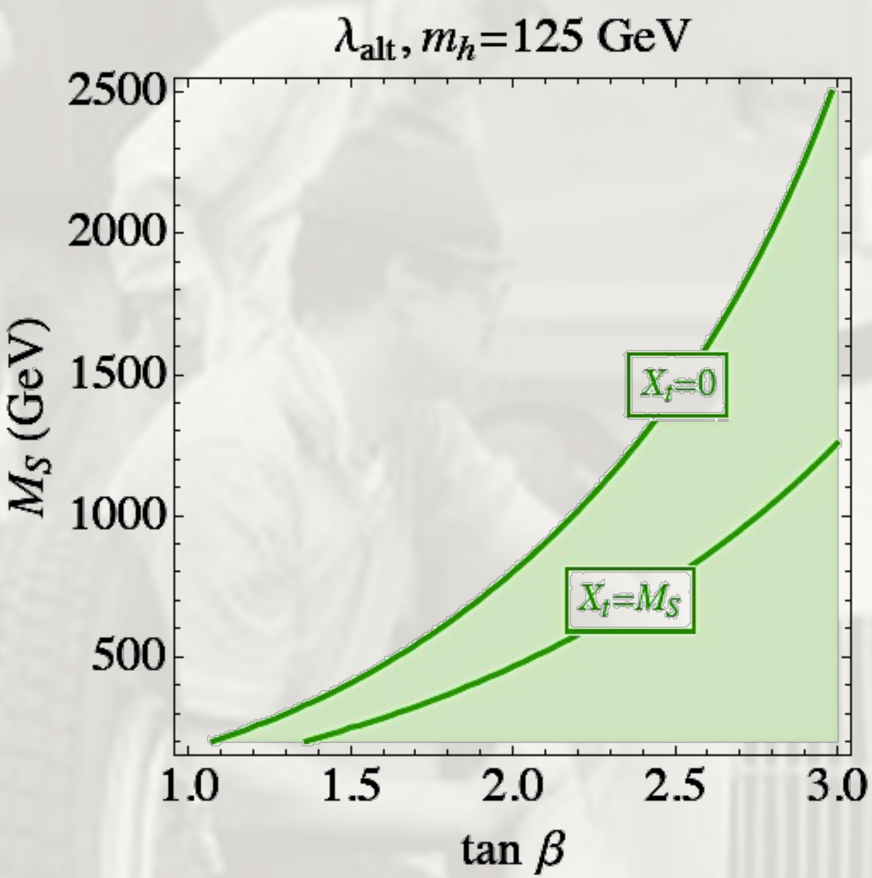

Alignment (No-Mixing):

$$m_h^2 \simeq \lambda^2 \frac{v^2}{2} \sin^2 2\beta + M_Z^2 \cos^2 2\beta + \Delta_{\tilde{t}}$$

$$\Delta_{\tilde{t}} = -\cos 2\beta (m_h^2 - M_Z^2)$$

Well Known

- 125 GeV Higgs
  - Tree-level contribution to Higgs mass from λ.
  - λ ~ 0.65-0.7
- Low tan β
- Light Stops

125 GeV Higgs Naturally!

- Perturbative up to GUT scale.
  - $\lambda_{max} \sim 0.7$, $\kappa_{max} \sim \lambda/2$

Not so well known:

- Leads to excellent Alignment (very little mixing with Heavy Higgs) in the m_A- tan β plane.

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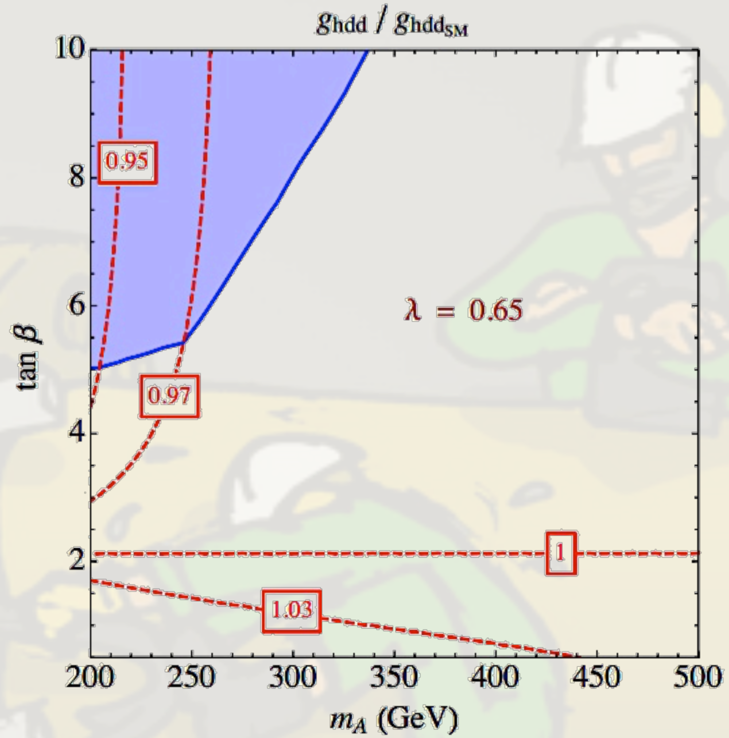

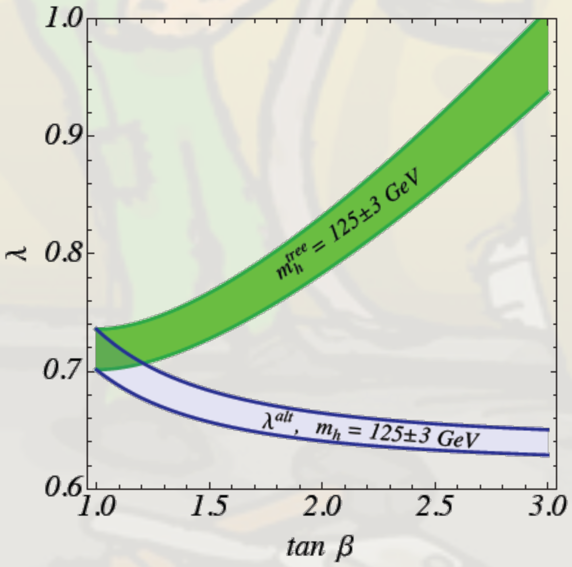

$$\lambda_{\rm alt}^2 = \frac{m_h^2 - M_Z^2 c_{2\beta}}{v^2 s_\beta^2}$$

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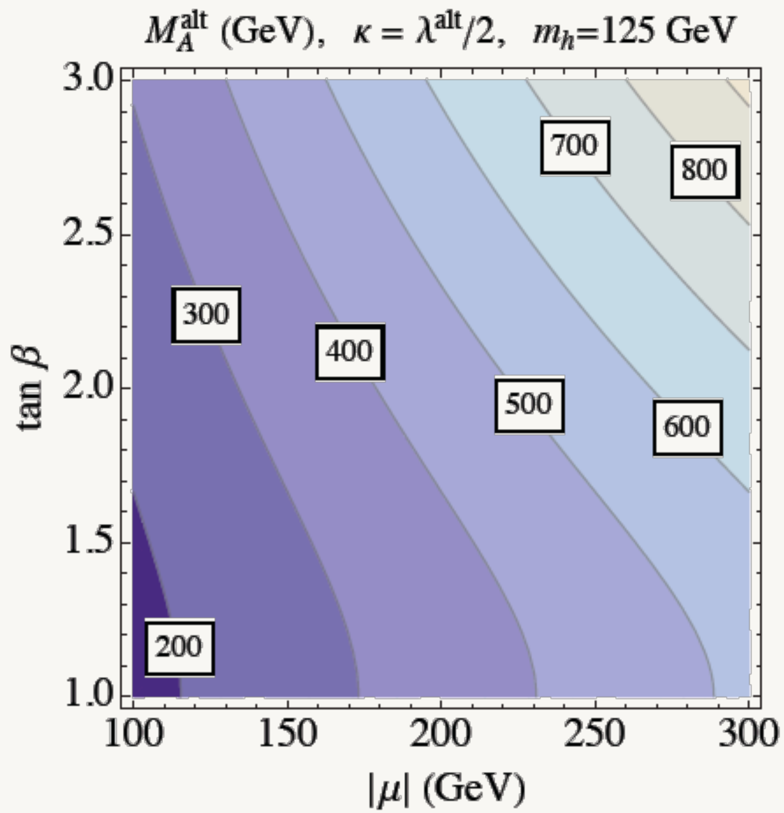
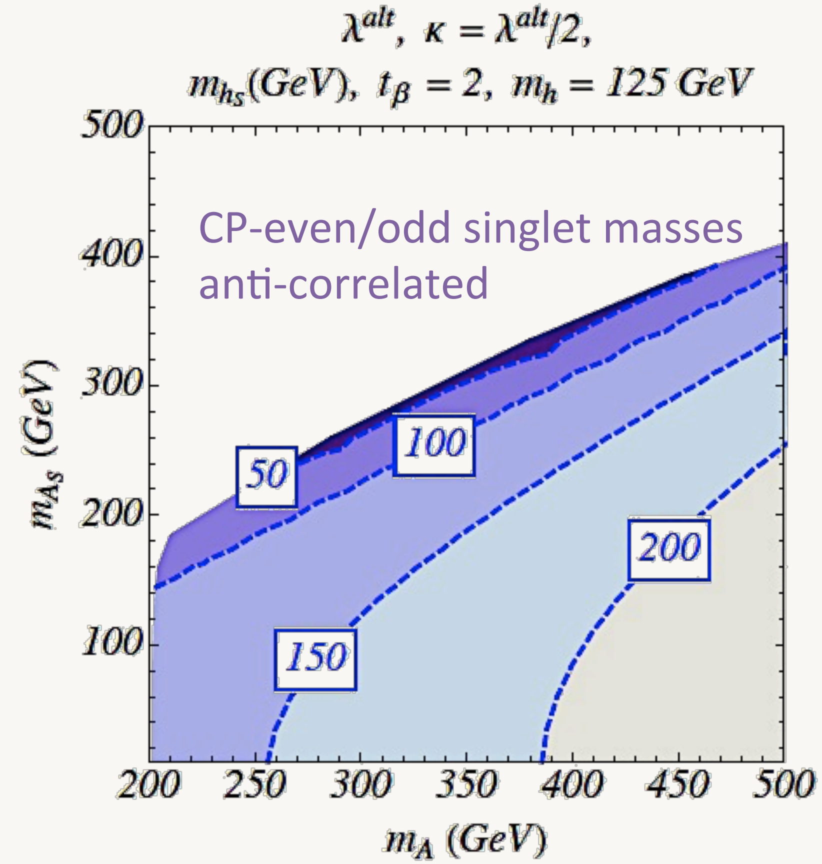
SM-Like Higgs Naturally!





$$1 - \frac{m_A^2}{4\mu^2} s_{2\beta}^2 - \frac{\kappa}{2\lambda} s_{2\beta} = 0$$

h125 = H_{SM}

LIGHT SPECTRUM

Singlino: **2 κ μ/λ $\lesssim$ μ**

Singlet Alignment

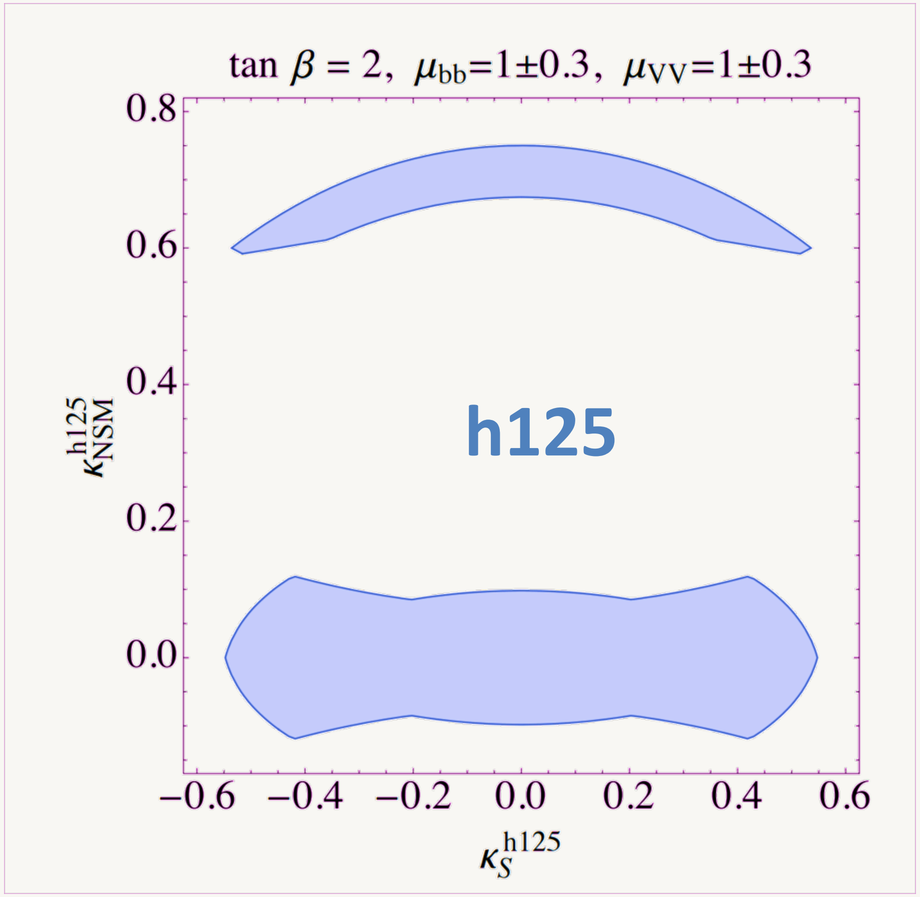
- How much "non-standardness" is allowed by h125 measurements??

– κ_{NSM} H_{NSM} + κ_{SM} H_{SM} + κ_S S

- Singlet: Only couples to Higgses

- Ratios to SM:
  – $g_{hgg} = (\kappa_{SM} + \kappa_{NSM}/t_\beta)$
  – $g_{hdd} = (\kappa_{SM} - \kappa_{NSM}\, t_\beta)$
  – $g_{hVV} = \kappa_{SM}$

- **Significant κ_S OK**
- **Large κ_{NSM} from sign change of g_{hdd}**

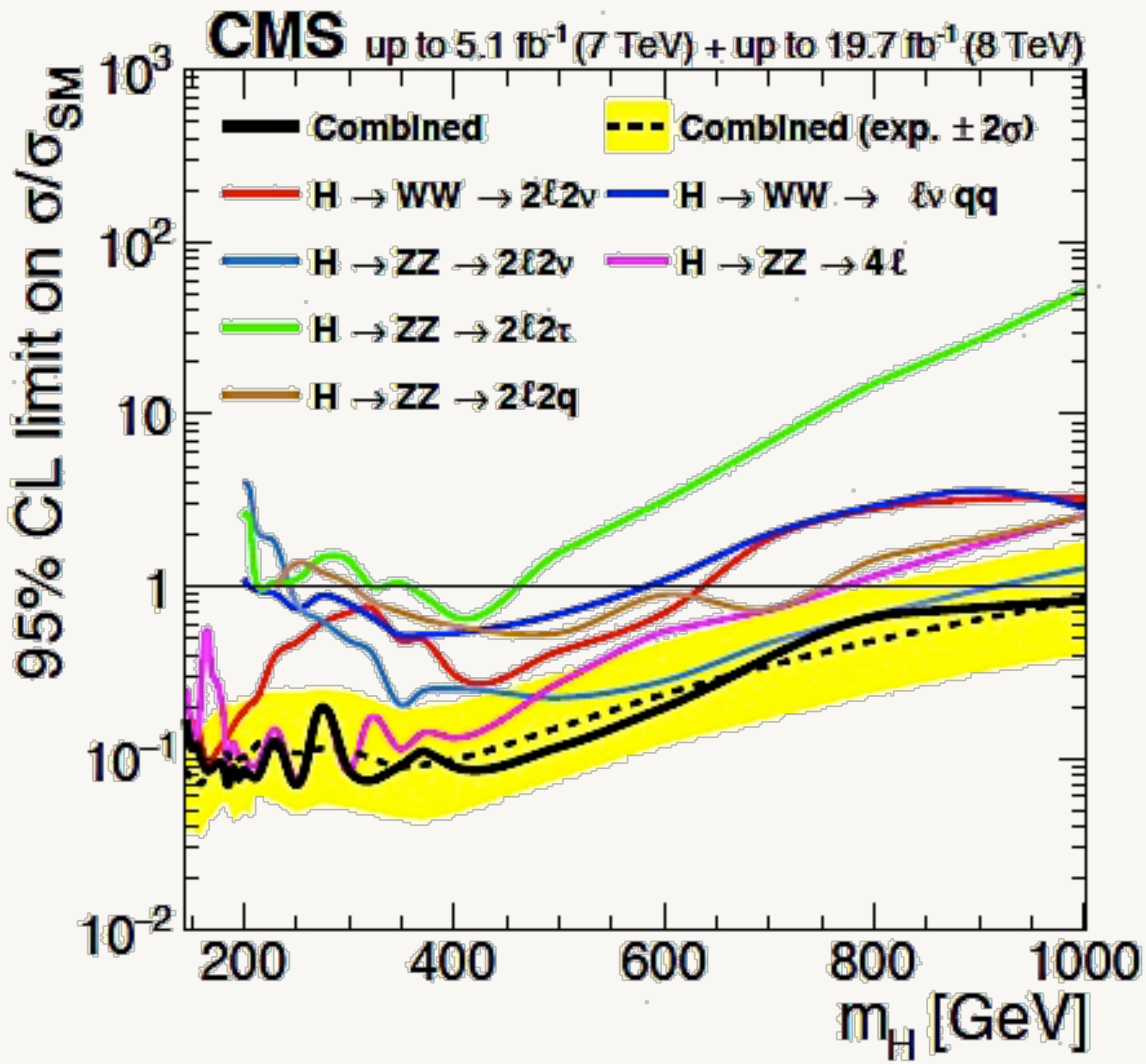


Contamination allowed in h125 ??

Heavy H to V V ?

- CMS 1505.03831

- Strong constraints on SM-like Higgs decay to V V ~12-6% SM value for masses 160-500 GeV.



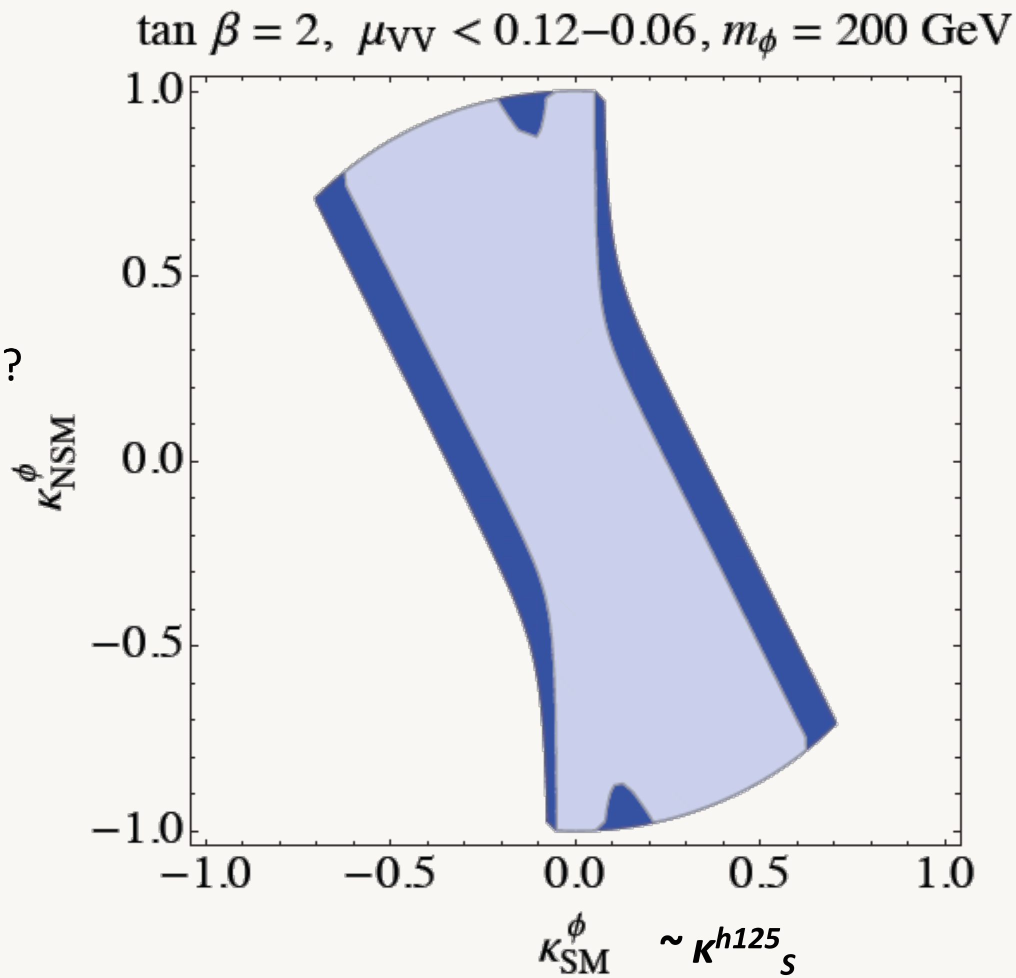
Direct Searches for heavy resonances?

- Strong constraints on SM-like Higgs decay to V V ~12-6% SM value for masses 160-500 GeV.

- **Only κ^{i}_{SM} couples to V V**

- What does this imply for SM and NSM components of extra Higgs??
  - 160 GeV < m_{hS} < 350 GeV
  - BR(WW+ZZ) ~1
  - gF production XS impacted.

- With κ^{h125}_{NSM} ~ 0
  - $\kappa^{hS}_{SM} \sim \kappa^{h125}_{S}$
  - κ^{h125}_{S} smaller than allowed by h125 measurements!



~ κ^{h125}_{S}

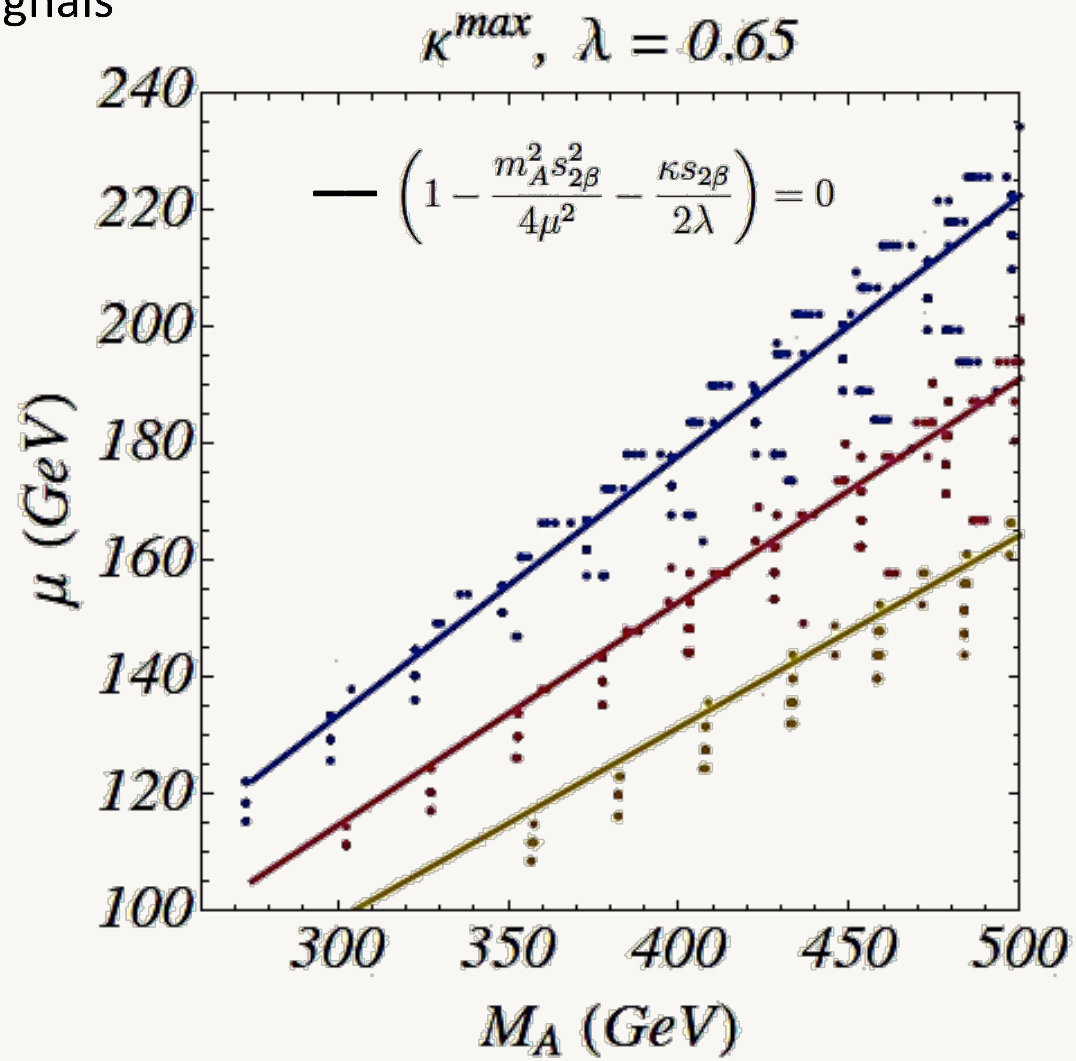
Misalignment

- NMSSMTools + HiggsBounds/Signals
- Allowed "misalignment"

. tan β =2

. tan β =2.5

. tan β =3



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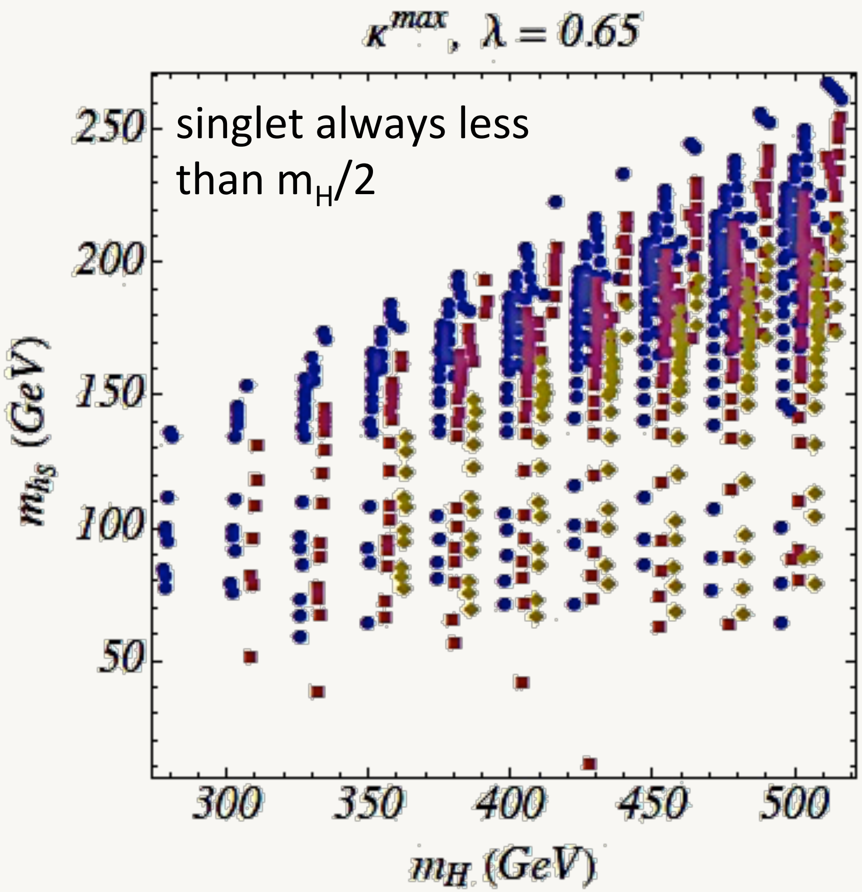
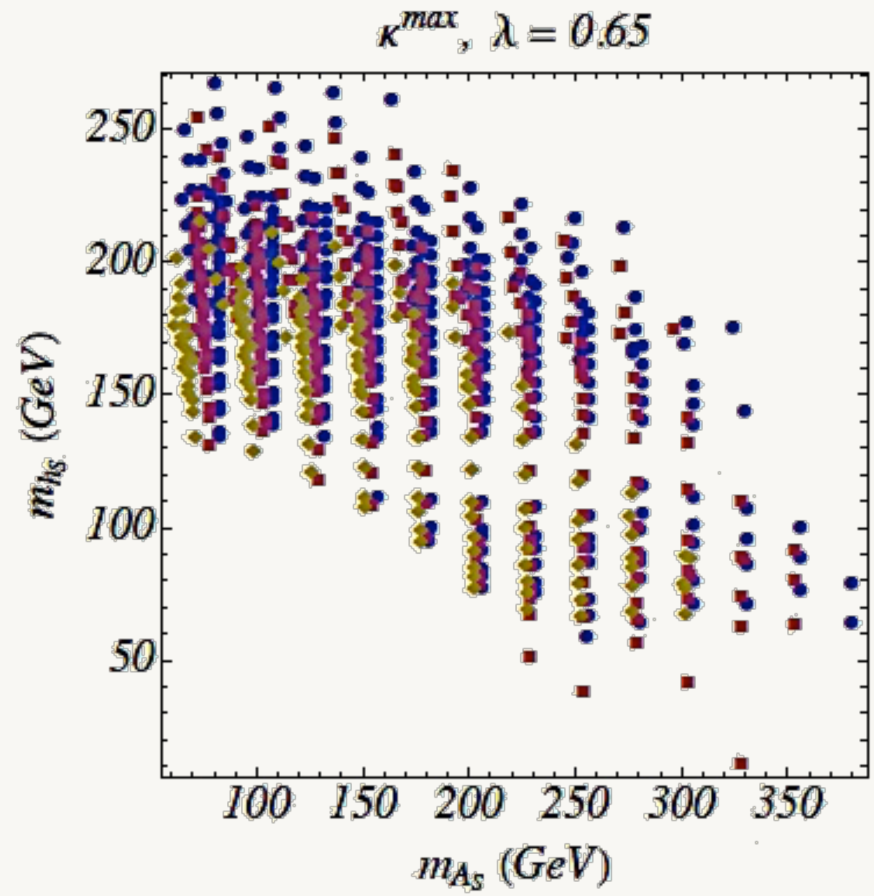
Density of scan not relevant

Singlet Spectra

CP-even/odd singlet masses Anti-correlated





. tan β =2 . tan β =2.5 . tan β =3

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- Decay BR depends on tan β

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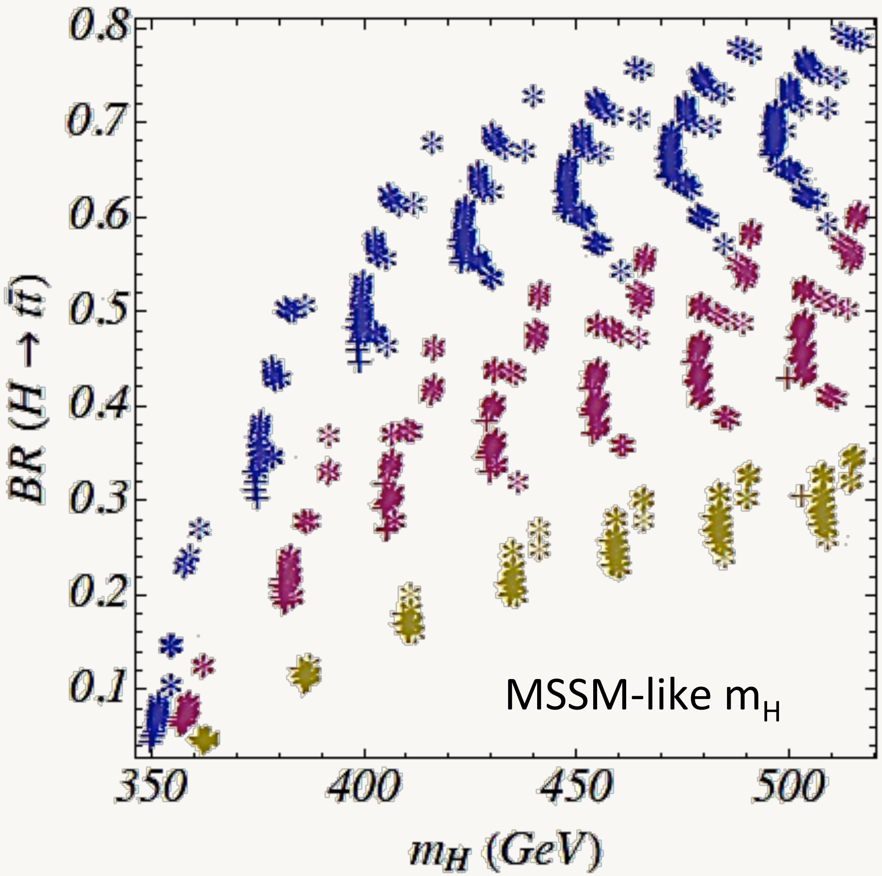
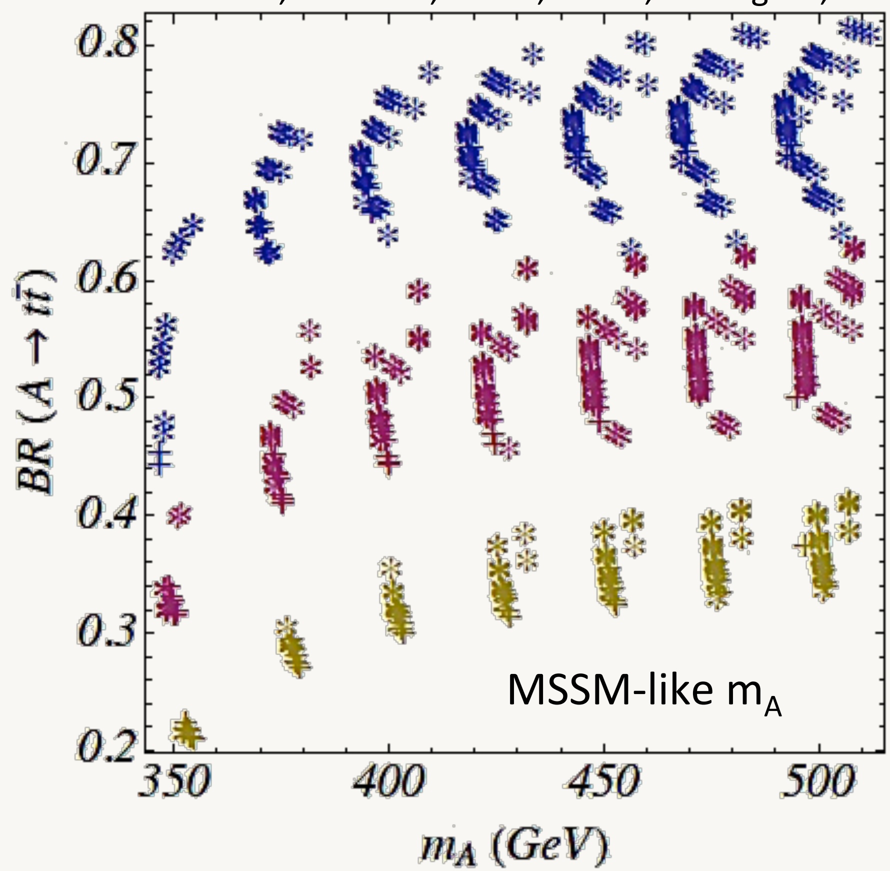
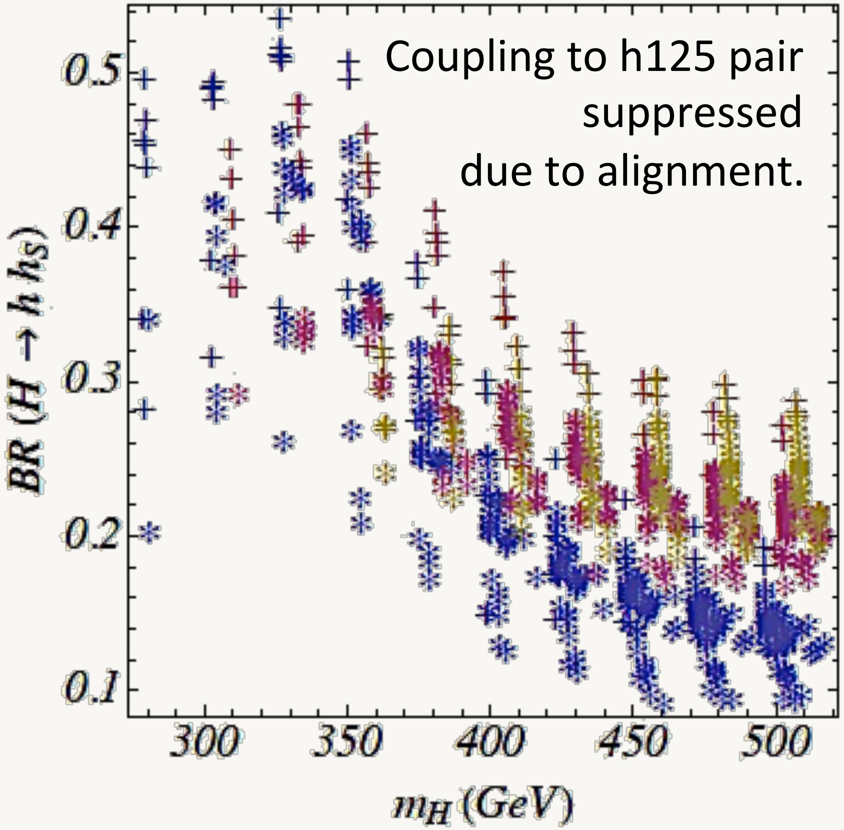


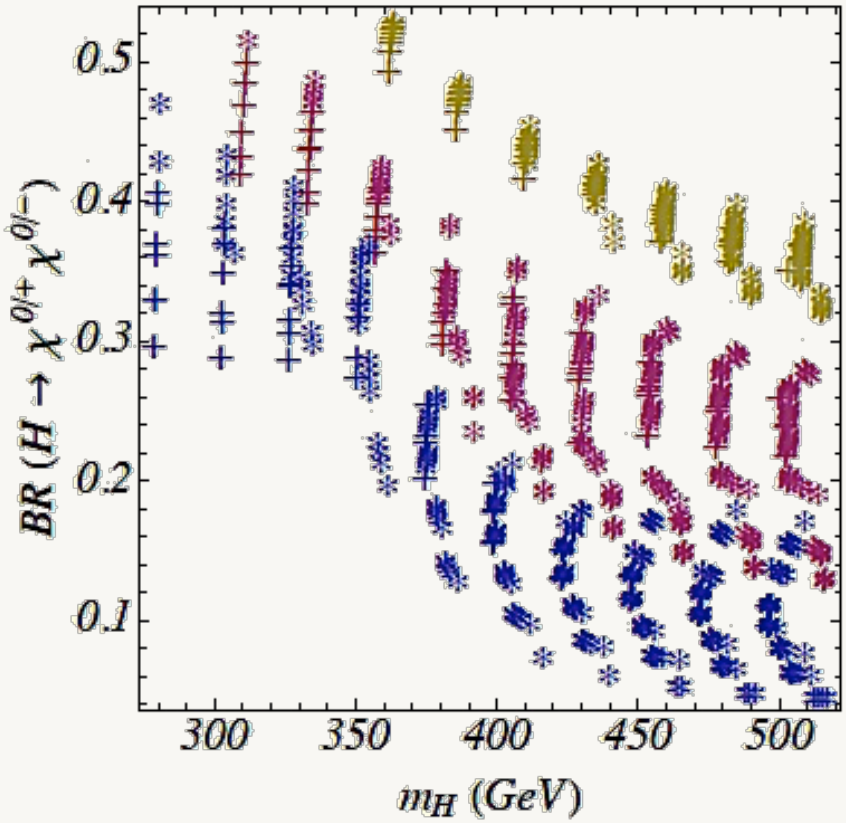


. tan β =2 . tan β =2.5 . tan β =3

MSSM-like A and H decays into tt

- Apart from tt, significant decays into H2+H1 and neutralino/charginos





. tan β =2 . tan β =2.5 . tan β =3

MSSM-like H BR

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MSSM-like A BR

- Into singlet-like H1/H2-Z and inos

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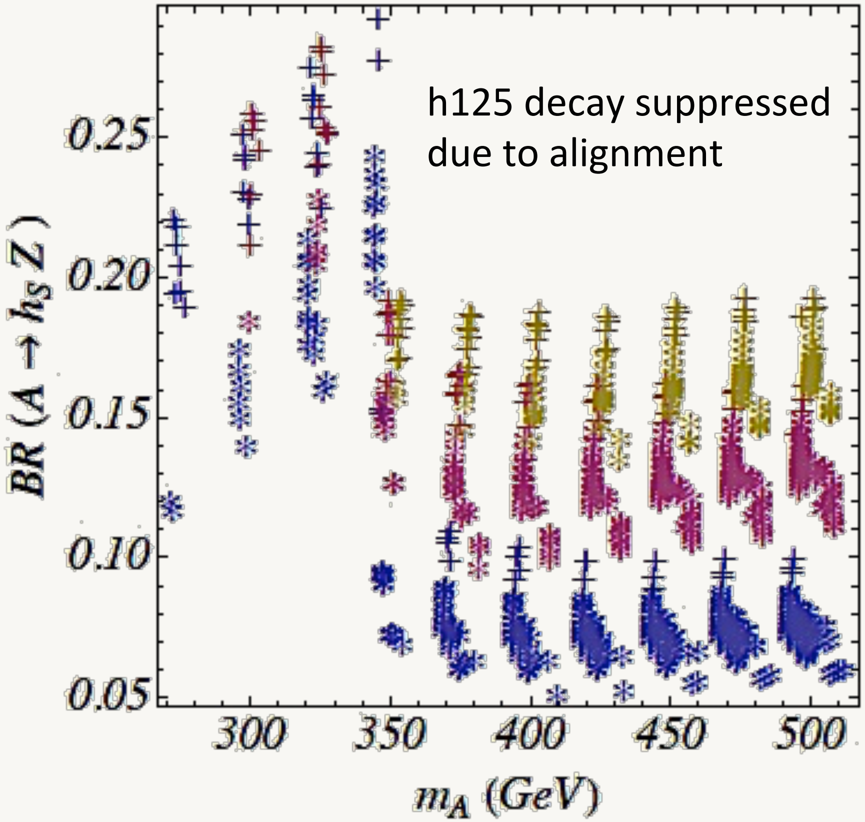
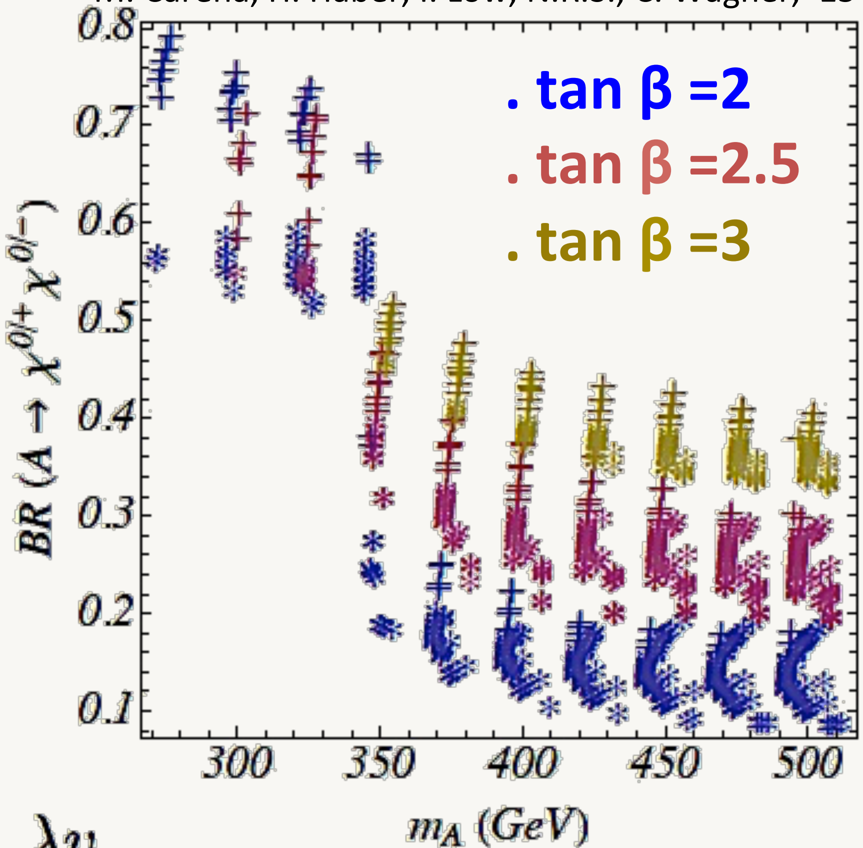
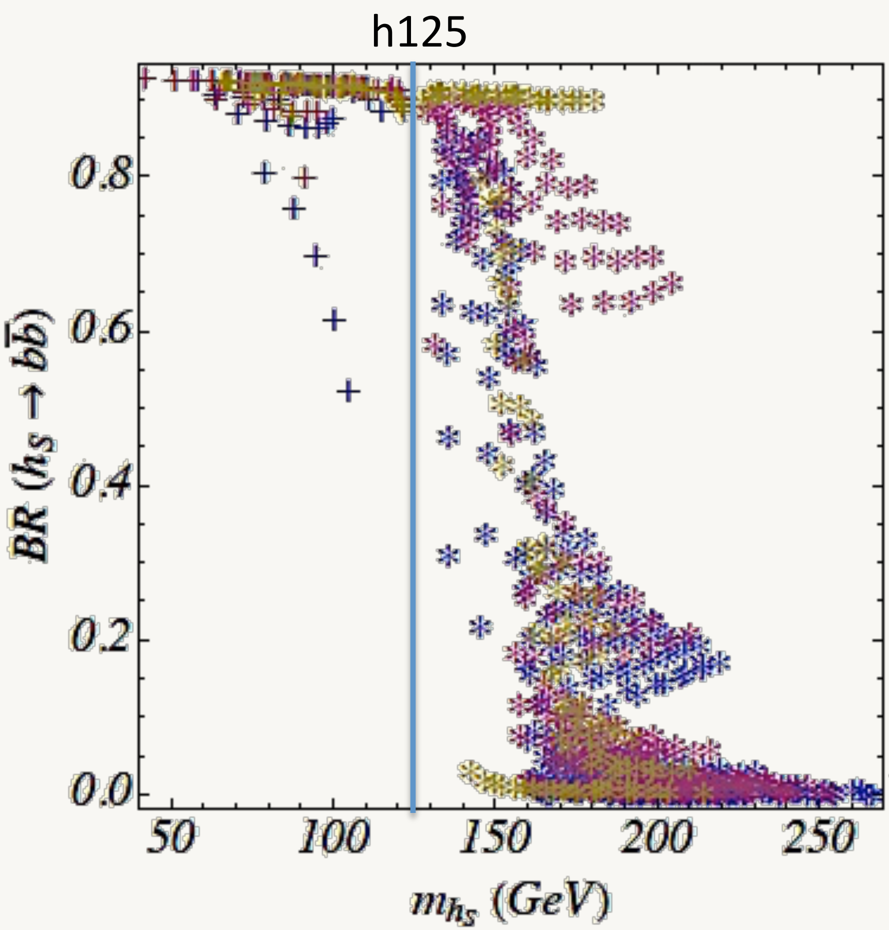
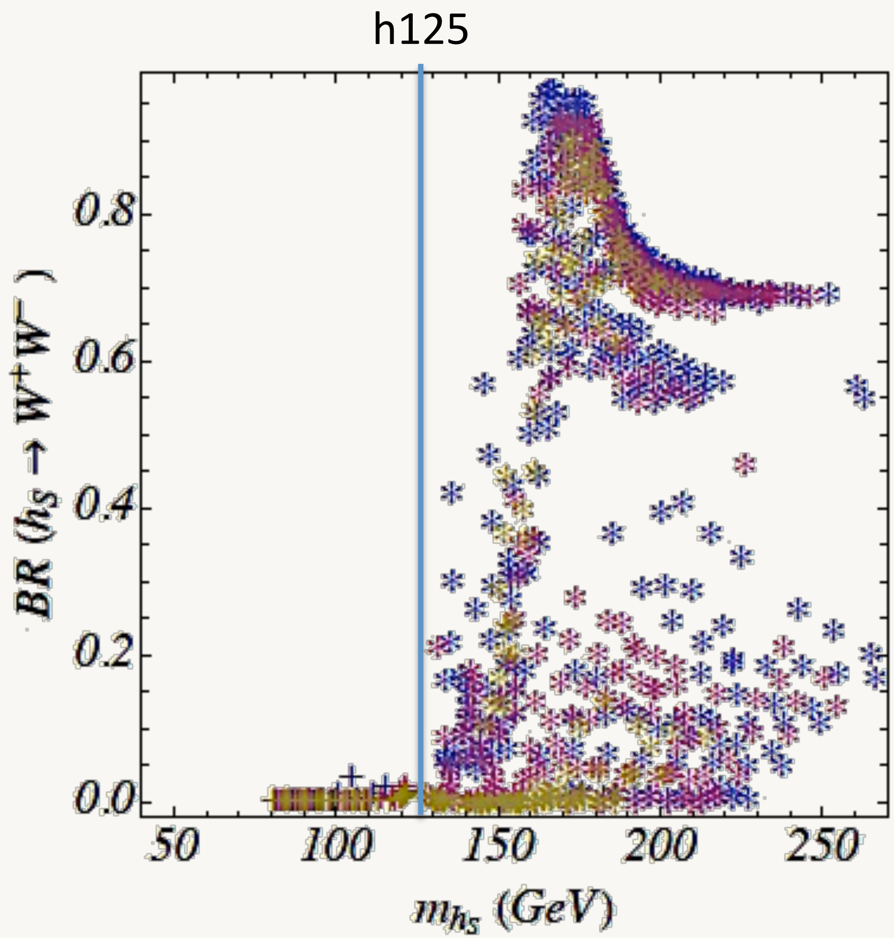




$$S_{H,s} \approx -\frac{\lambda v}{2\mu} c_{2\beta} s_{2\beta}$$

- Singlet mainly decays to bb and WW





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Singlet-like h_S BR

XS factor ~ 4 at 14 TeV compared to 8 TeV

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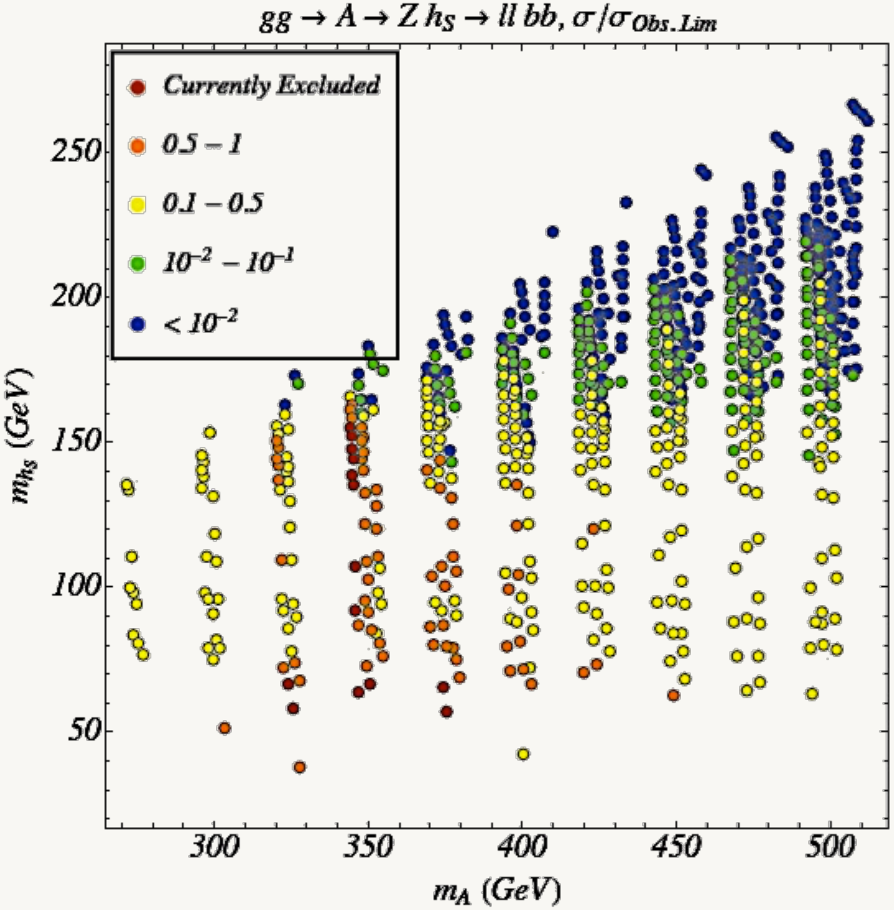
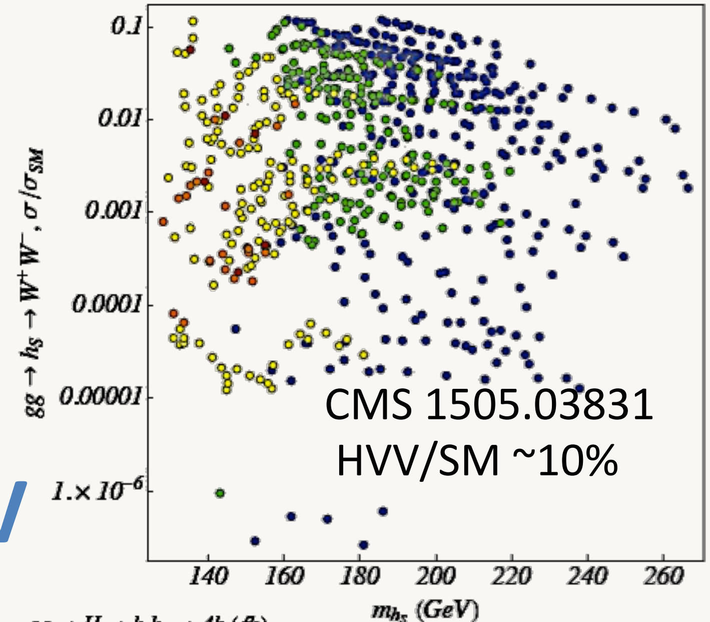
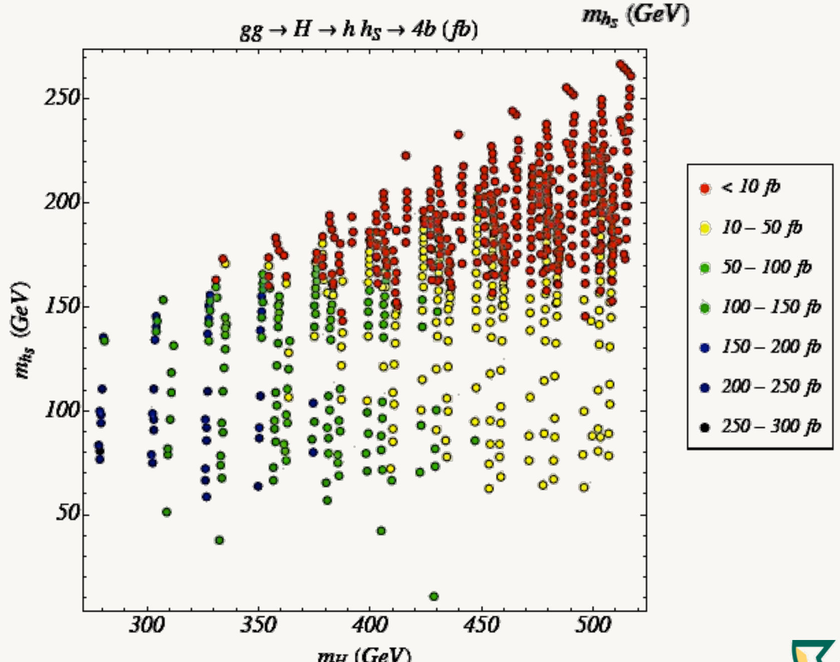
CMS PAS HIG-15-001





8 TeV



Now & Future

XS factor ~ 4 at 14 TeV compared to 8 TeV

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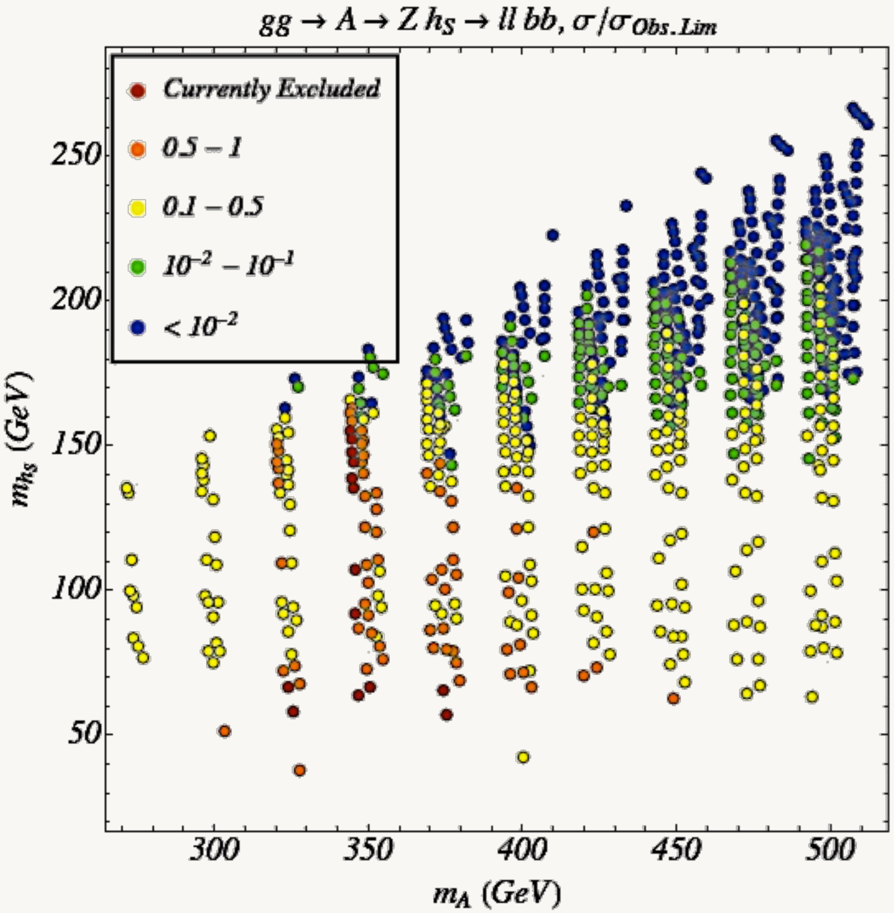
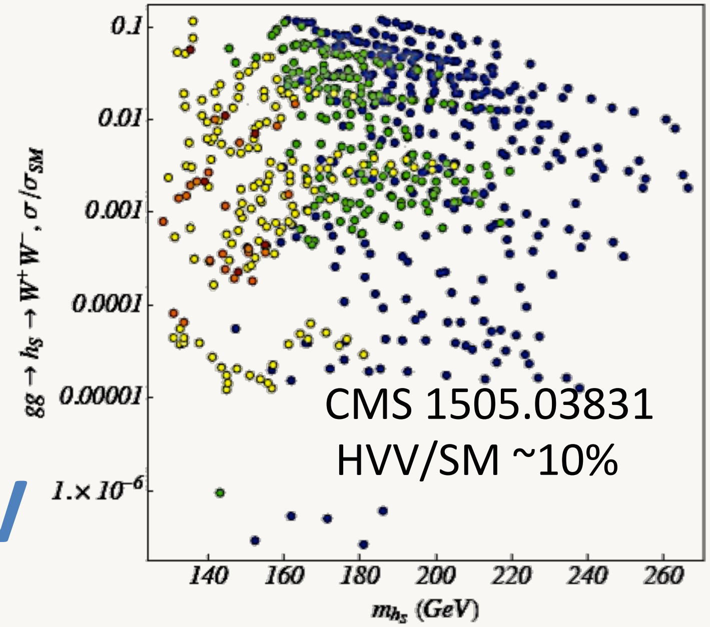
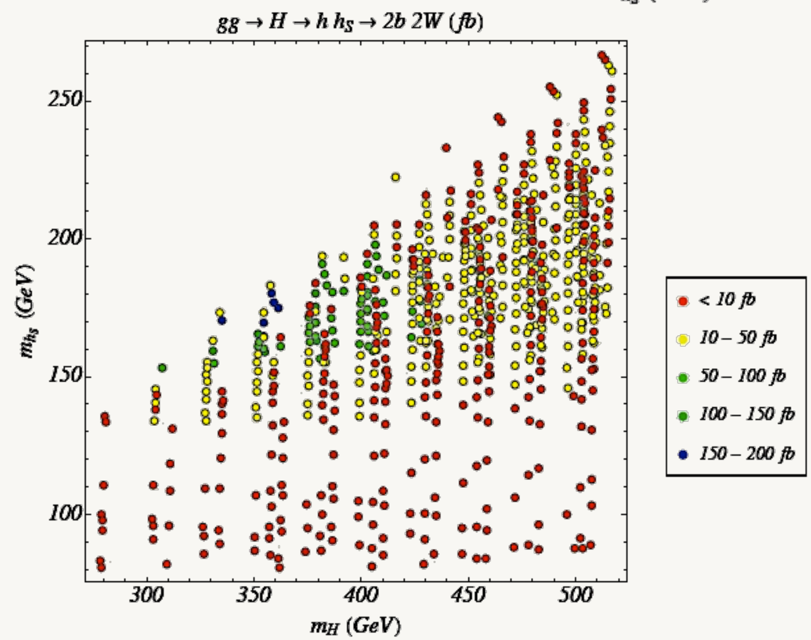
CMS PAS HIG-15-001





8 TeV



Now & Future

Conclusions and Outlook.

m_h = 125 GeV + SM - like

Alignment: Decoupling or Prediction for parameters.

MSSM:

125 GeV Higgs : Heavy Stops with large L-R mixing

Alignment requires large μ and A_t ; Decoupling independent of tβ

Complementarity between Heavy Higgs searches and precision measurements of h125
Probe low m_A /tβ

NMSSM:

Naturally obtain 125 GeV Higgs (light stops):

Leads to alignment with the non-SM like Higgs.

Perturbativity uptp GUT scale and the requirement of alignment with the singlet:

light singlets (both CP-even and odd) and singlino + higgsinos (charged and neutral).

LIGHT SPECTRUM!
Due to large BR of non-SM Higgs into singlet like states + inos, very interesting LHC phenomenology.

Thank you.

Backup slides.

SM-like Higgs boson mass in the MSSM

depends on: **CP-odd mass m_A, tanβ, m_t** **and Stop masses & mixing**

For large m_A

$$M^2_{\tilde{t}} = \begin{pmatrix} m^2_Q + m^2_t + D_L & m_t X_t \\ m_t X_t & m^2_U + m^2_t + D_R \end{pmatrix}$$

$$m_h^2 = \underbrace{M_Z^2 \cos^2 2\beta}_{< (91\ \mathrm{GeV})^2} + \Delta m_h^2$$

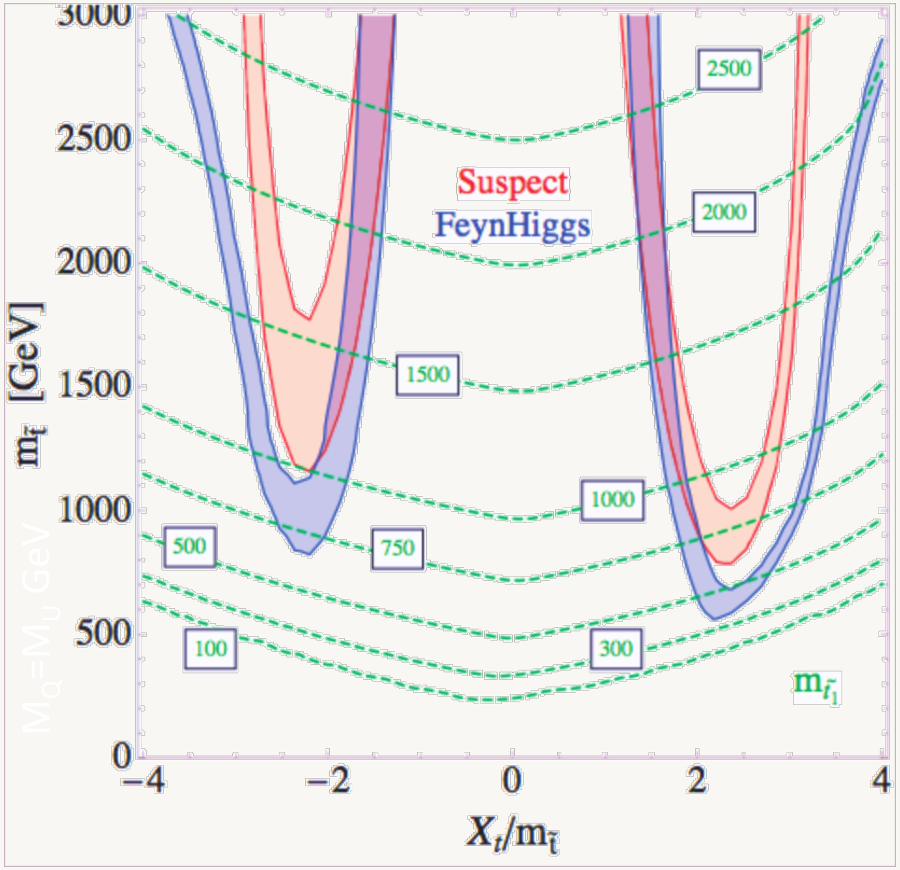
$$\Delta m_h^2 = \frac{3}{4\pi^2}\frac{m_t^4}{v^2}\left[\frac{1}{2}\tilde{X}_t + t + \frac{1}{16\pi^2}\left(\frac{3}{2}\frac{m_t^2}{v^2} - 32\pi\alpha_3\right)\left(\tilde{X}_t t + t^2\right)\right]$$

m_h depends logarithmically on the averaged stop mass scale $\mathbf{M_{SUSY} \sim m_Q \sim m_U}$ **and has a quadratic and quartic dep. on the stop mixing parameter X_t.**
[and on sbottom/stau sectors for large tβ]

$$t = \log(M^2_{SUSY}/m_t^2) \qquad \tilde{X}_t = \frac{2X_t^2}{M^2_{SUSY}}\left(1 - \frac{X_t^2}{12M^2_{SUSY}}\right) \qquad X_t = A_t - \mu/\tan\beta \rightarrow \text{LR stop mixing}$$

Two-loop computations: Brignole, M.Carena, Degrassi, Diaz, Ellis, Espinosa, Haber, Harlander, Heinemeyer, Hempfling, Hoang, Hollik, Hahn, Martin, Pilaftsis, Quiros, Ridolfi, Rzehak, Slavich, Wagner,Weiglein, Zhang, Zwirner

Soft Supersymmetry Breaking Parameters in the MSSM



Hall, Pinner, Ruderman'11

Large mixing in the stop sector
A_t > 1 TeV
[Unless stop very heavy (5-10 TeV)]

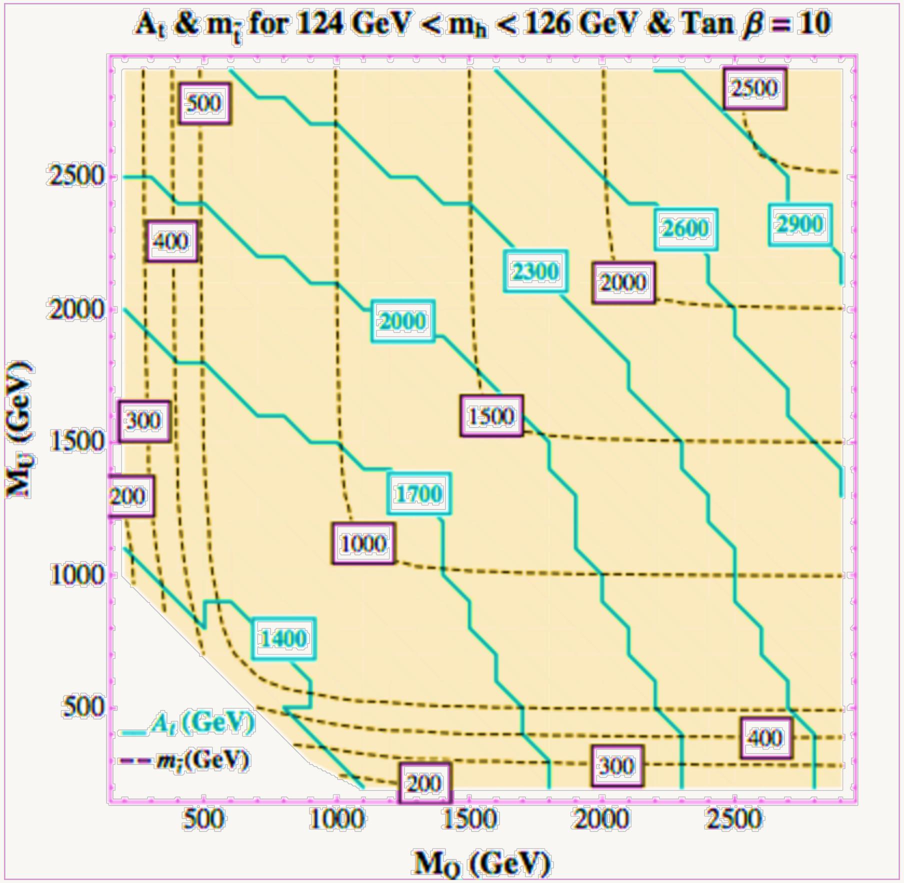
One stop can be light and the other heavy
or
in the case of similar stop soft masses
both stops can be below 1TeV

Direct Stop searches at LHC
are probing these mass regime

Large mixing also constrains SUSY breaking model building

Similar results from
Arbey, Battaglia, Djouadi, Mahmoudi, Quevillon; Draper Meade, Reece, Shih
Heinemeyer, Stal, Weiglein'11; Ellwanger'11; Shirman et al.

Soft supersymmetry Breaking Parameters in the MSSM



M. Carena., S. Gori, N. R. S, C. Wagner '11
+L.T.Wang '12

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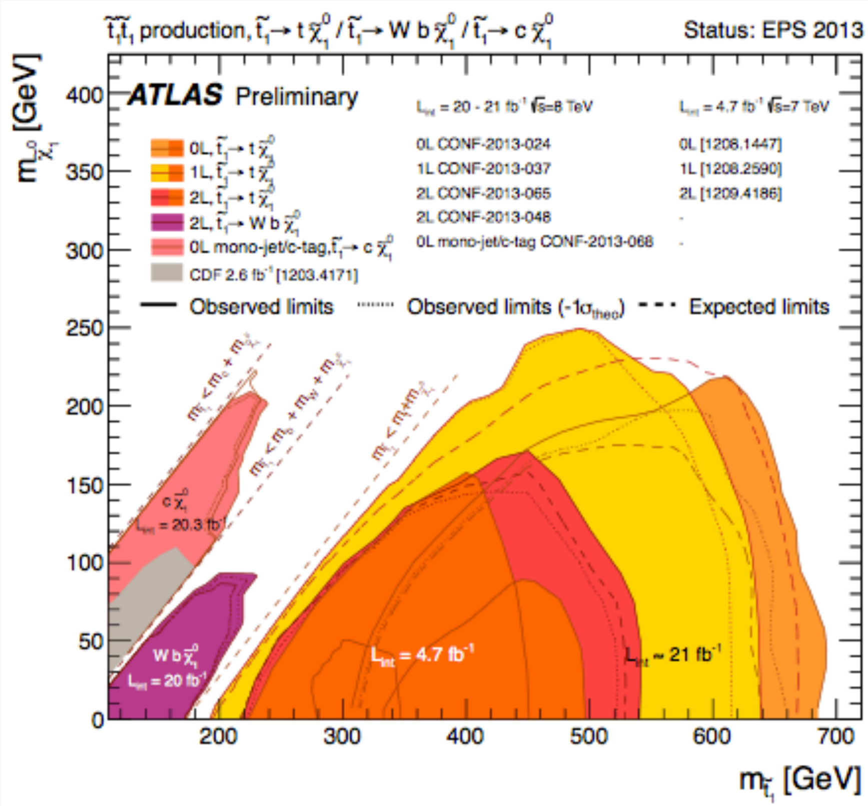
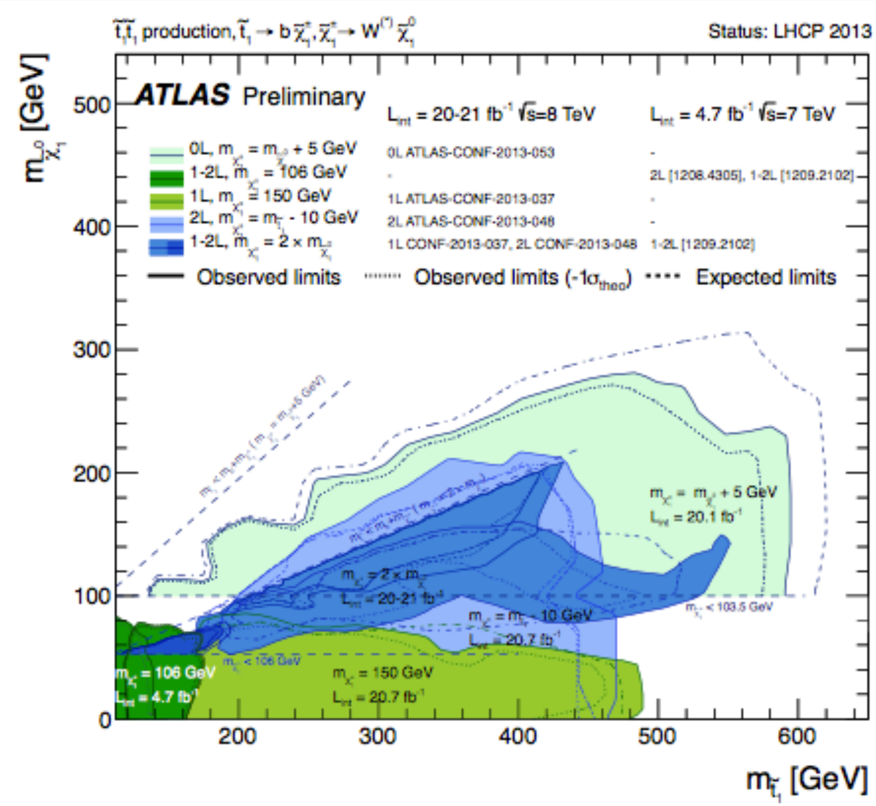
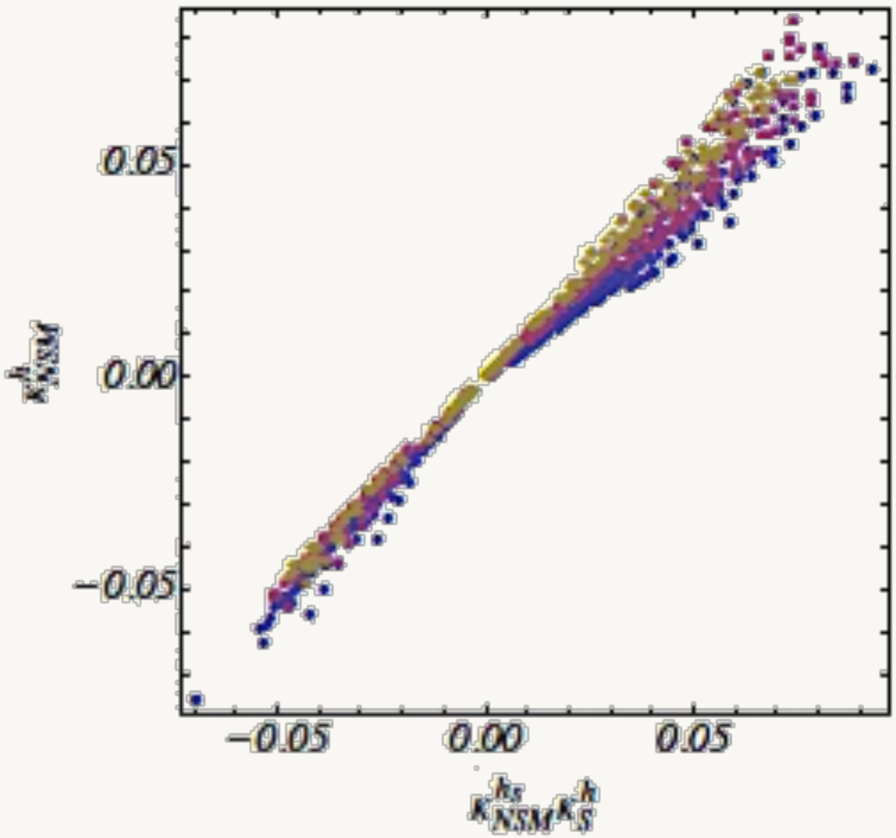


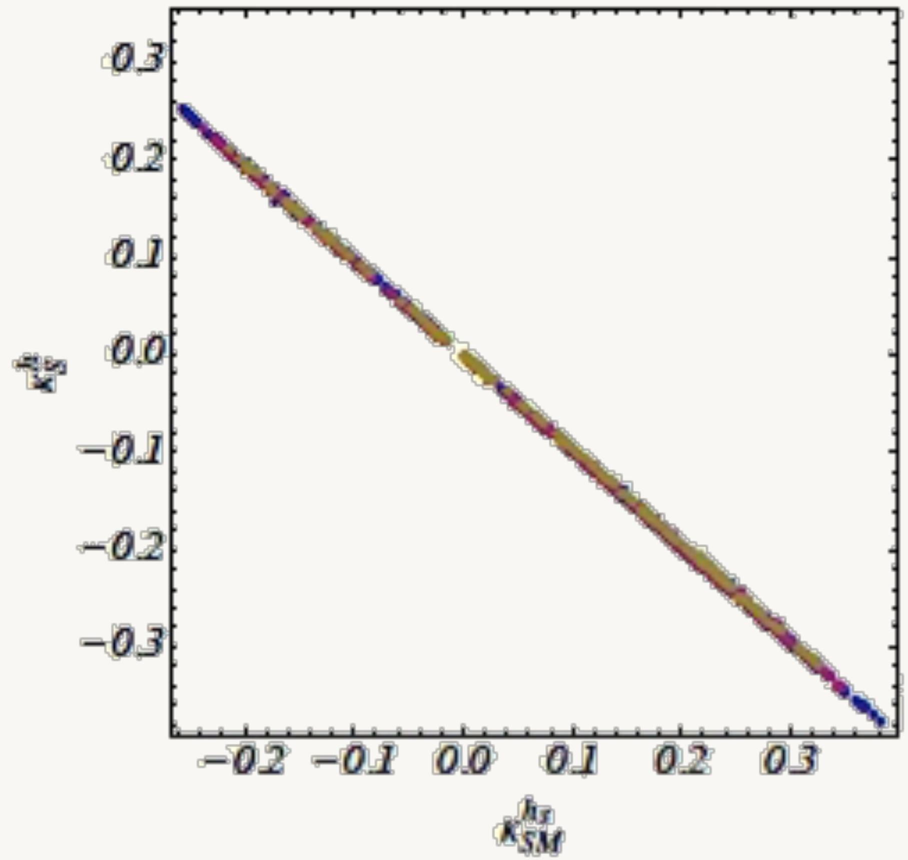


Direct Search Limits on Stops

$$\begin{pmatrix} h \\ H \\ h_S \end{pmatrix} \simeq \begin{pmatrix} 1 & -\eta\eta' & \eta' \\ \mathcal{O}(\epsilon) & -1 & -\eta \\ -\eta' & -\eta & 1 \end{pmatrix} \begin{pmatrix} H^{\rm SM} \\ H^{\rm NSM} \\ H^{\rm S} \end{pmatrix}$$

h125 Components





Tree-level mass matrix in the (H_{NSM}, H_{SM}, S) basis:

$$\begin{pmatrix} m_A^2 + s_{2\beta}^2\left(m_Z^2 - \frac{1}{2}\lambda^2 v^2\right) & s_{2\beta}c_{2\beta}\left(m_Z^2 - \frac{1}{2}\lambda^2 v^2\right) & -\frac{\lambda v \mu}{\sqrt{2}} c_{2\beta}\left(\frac{m_A^2}{2\mu^2}s_{2\beta} + \frac{\kappa}{\lambda}\right) \\ & c_{2\beta}^2 m_Z^2 + \frac{1}{2}\lambda^2 v^2 s_{2\beta}^2 & \sqrt{2}\lambda v \mu\left(1 - \frac{m_A^2}{4\mu^2}s_{2\beta}^2 - \frac{\kappa}{2\lambda}s_{2\beta}\right) \\ & & \frac{\lambda^2 v^2 s_{2\beta}}{4}\left(\frac{m_A^2 s_{2\beta}}{2\mu^2} - \frac{\kappa}{\lambda}\right) + \frac{\kappa\mu}{\lambda}\left(A_\kappa + \frac{4\kappa\mu}{\lambda}\right) \end{pmatrix}$$

- **Alignment: Mixing between HNSM-SM=0 & SM-S =0**
- Alignment conditions, (+ stop corrections to always obtain h125):

$$\mathcal{M}_S^2(1,2) = \frac{1}{t_\beta}\left[c_{2\beta}m_Z^2 - \mathcal{M}_S^2(2,2) + \lambda^2 v^2 s_\beta^2 + \frac{3m_t^4 X_t\,(X_t - Y_t)}{4\pi^2 v^2 M_S^2}\left(1 - \frac{X_t^2}{6M_S^2}\right)\right] = 0$$

$$\mathcal{M}_S^2(2,3) = 2\lambda v \mu\left(1 - \frac{m_A^2 s_{2\beta}^2}{4\mu^2} - \frac{\kappa s_{2\beta}}{2\lambda}\right) = 0$$

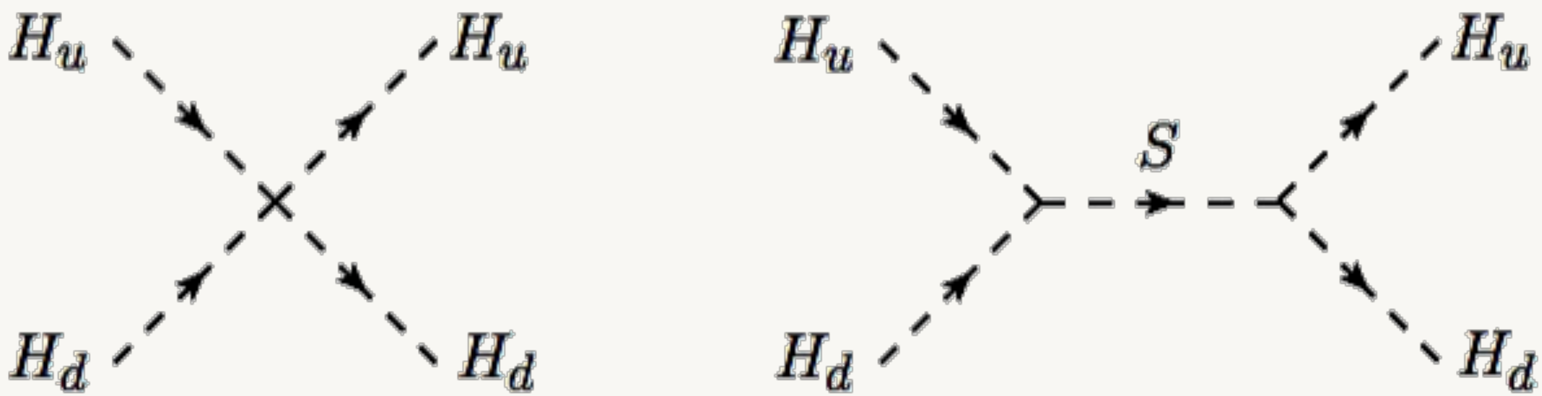
NSM-SM mixing cancels for $\lambda_{\rm alt}^2 = \frac{m_h^2 - M_Z^2 c_{2\beta}}{v^2 s_\beta^2}$

"Extended" Higgs Basis

X. Lu, H. Murayama, J. Ruderman, K. Tobioka '13

$$W \supset \lambda S H_u H_d + \frac{M}{2} S^2 + \mu H_u H_d \qquad V_{\text{soft}} \supset m_S^2 |S|^2$$

$$V \supset |F_S|^2 = |\lambda H_u H_d + M S|^2$$



$$\delta m_h^2 = \lambda^2 v^2 \sin^2 2\beta \left(1 - \frac{M^2}{M^2 + m_S^2}\right)$$

- It is well known that in the NMSSM there are new contributions to the lightest CP-even Higgs mass,

$$W = \lambda S H_u H_d + \frac{\kappa}{3} S^3$$

$$m_h^2 \simeq \lambda^2 \frac{v^2}{2} \sin^2 2\beta + M_Z^2 \cos^2 2\beta + \Delta_{\tilde{t}}$$

- It is perhaps less known that it leads to sizable corrections to the mixing between the MSSM like CP-even states. In the Higgs basis,

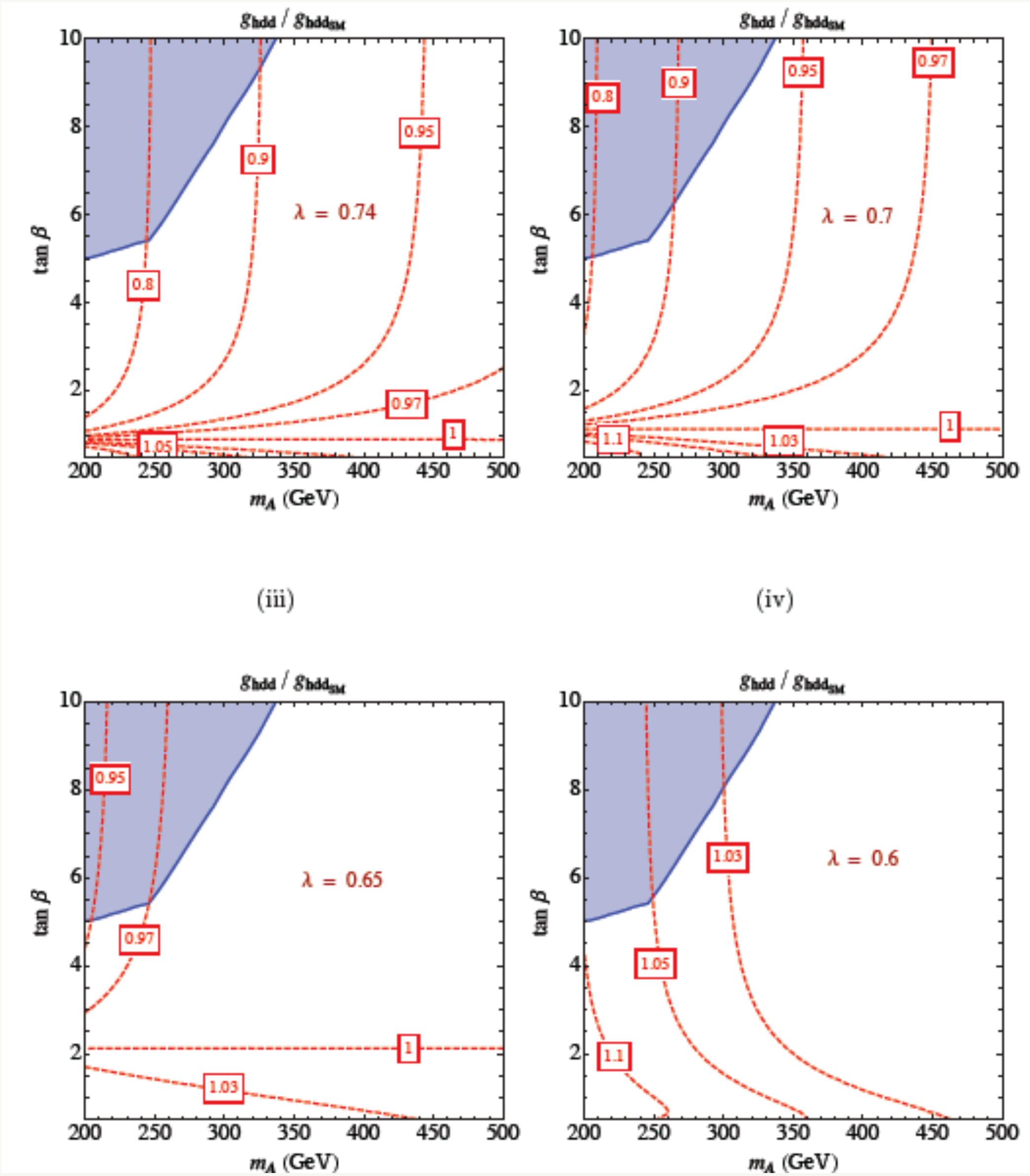
$$M_S^2(1,2) \simeq \frac{1}{\tan\beta} \left(m_h^2 - M_Z^2 \cos 2\beta - \lambda^2 v^2 \sin^2\beta + \delta_{\tilde{t}}\right)$$

- The last term is the one appearing in the MSSM, that are small for moderate mixing and small values of $\tan\beta$

- So, alignment leads to a determination of lambda,

- The values of lambda end up in a very narrow range, between 0.65 and 0.7 for allvalues of tanbeta, that are the values that lead to naturalness with perturbativity up to the GUT scale

$$\lambda^2 = \frac{m_h^2 - M_Z^2 \cos 2\beta}{v^2 \sin^2\beta}$$



M. Carena, I. Low, N.R.S, C. Wagner, '13

It is clear from these plots that the NMSSM does an amazing job in aligning the MSSM-like CP-even sector, provided lambda is of about 0.65

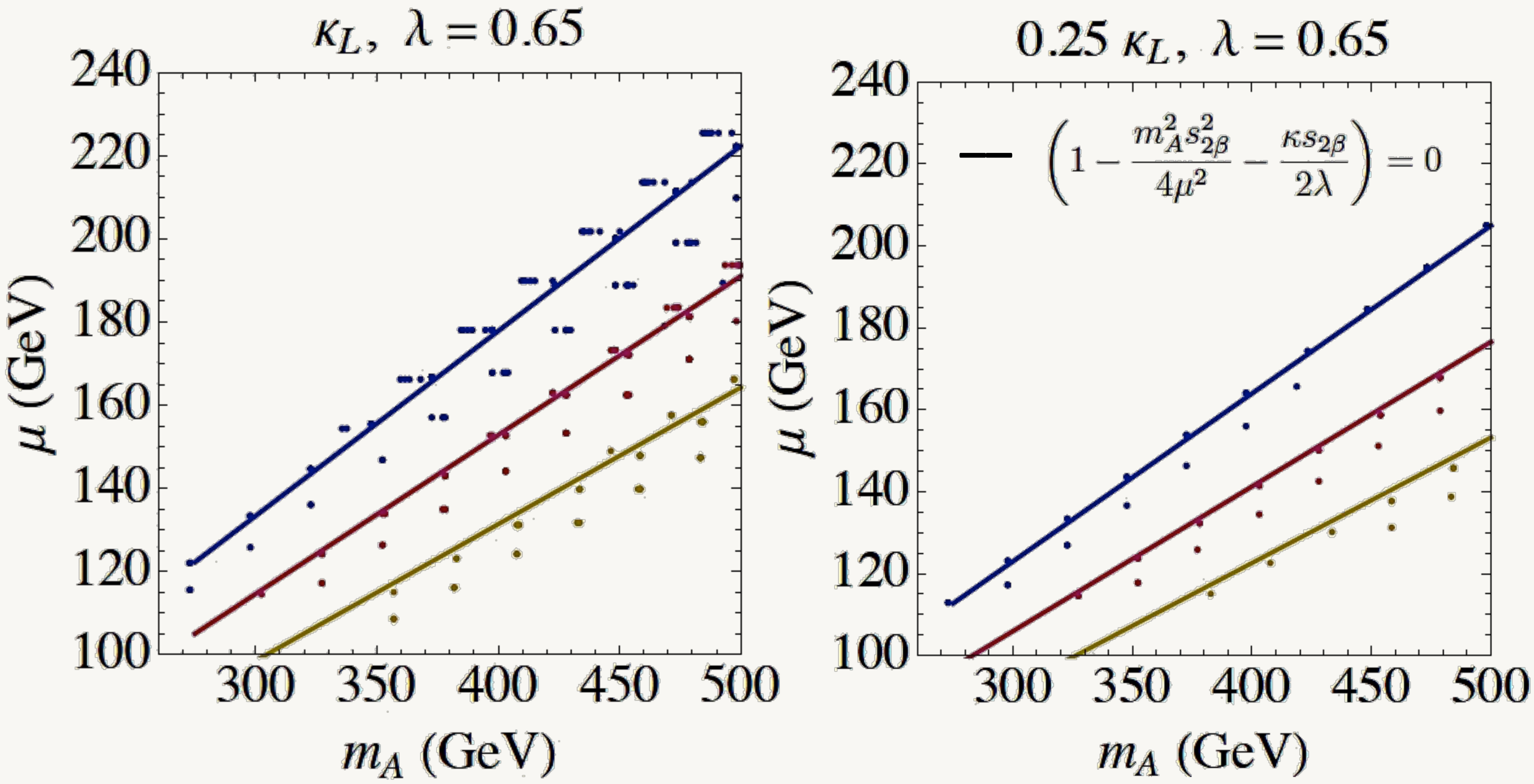
In the (“MSSM m_A”, Singlet) basis:

$$\mathcal{M}_P^2 = \begin{pmatrix} m_A^2 & \frac{\lambda v}{\sqrt{2}}\left(\frac{m_A^2}{2\mu}s_{2\beta} - \frac{3\kappa\mu}{\lambda}\right) \\ & \frac{1}{2}\lambda^2 v^2 s_{2\beta}\left(\frac{m_A^2}{4\mu^2}s_{2\beta} + \frac{3\kappa}{2\lambda}\right) - \frac{3\kappa A_\kappa \mu}{\lambda} \end{pmatrix}$$

$$m_A^2 = \frac{\mu}{s_\beta c_\beta}\left(A_\lambda + \frac{\kappa\mu}{\lambda}\right).$$

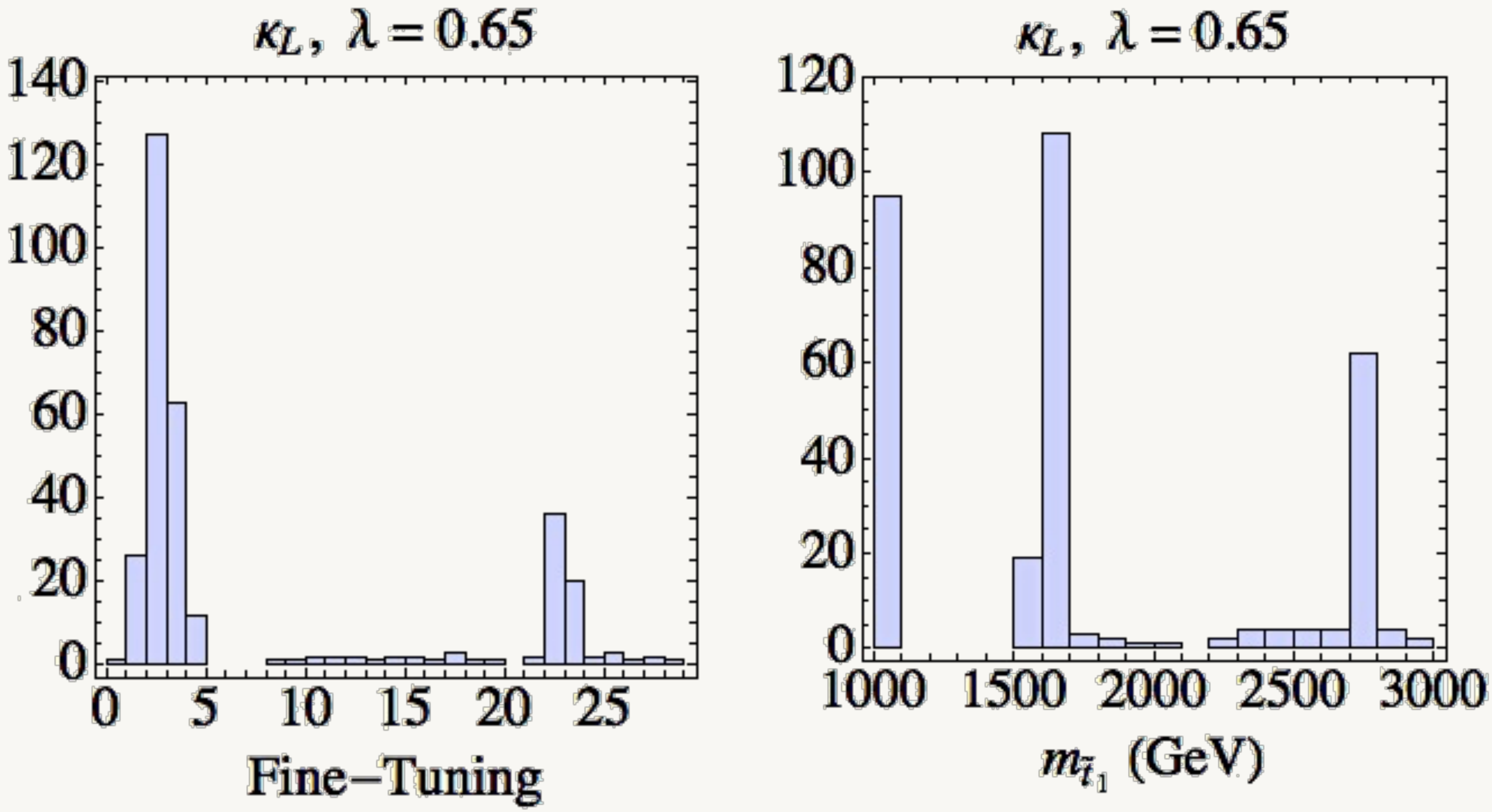
CP-Odd Mass Matrix

. tan β =2 . tan β =2.5 . tan β =3



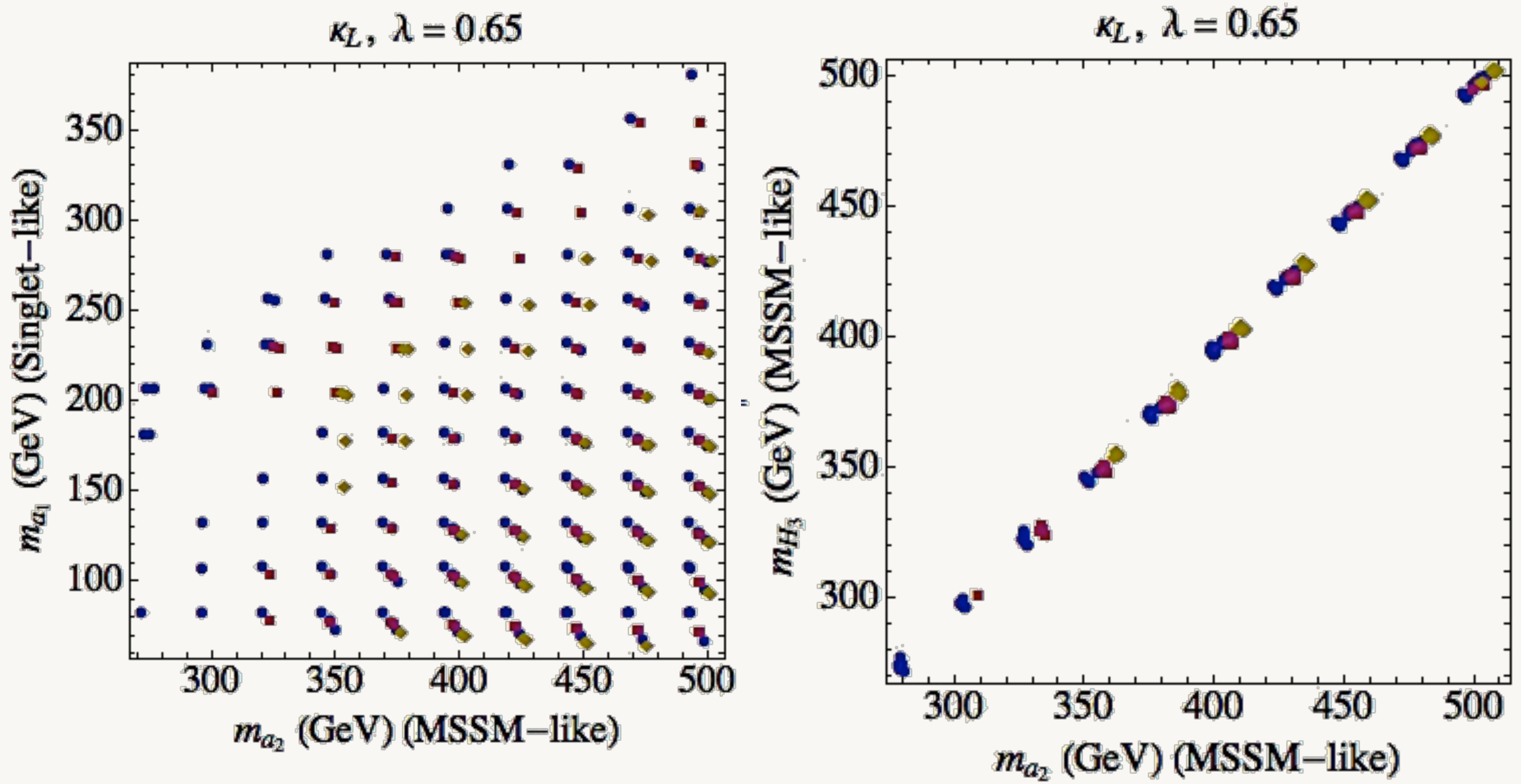
Misalignment

Larger tan β => Heavier Stops => Larger Fine Tuning



Fine-Tuning (No-mixing in stops)

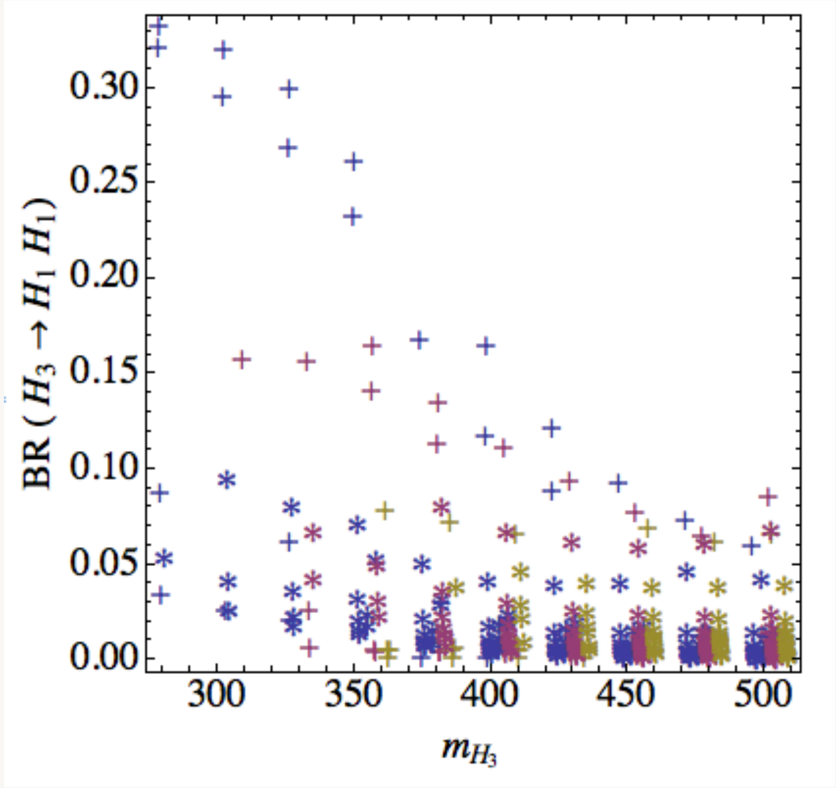
- CP-even vs. Odd

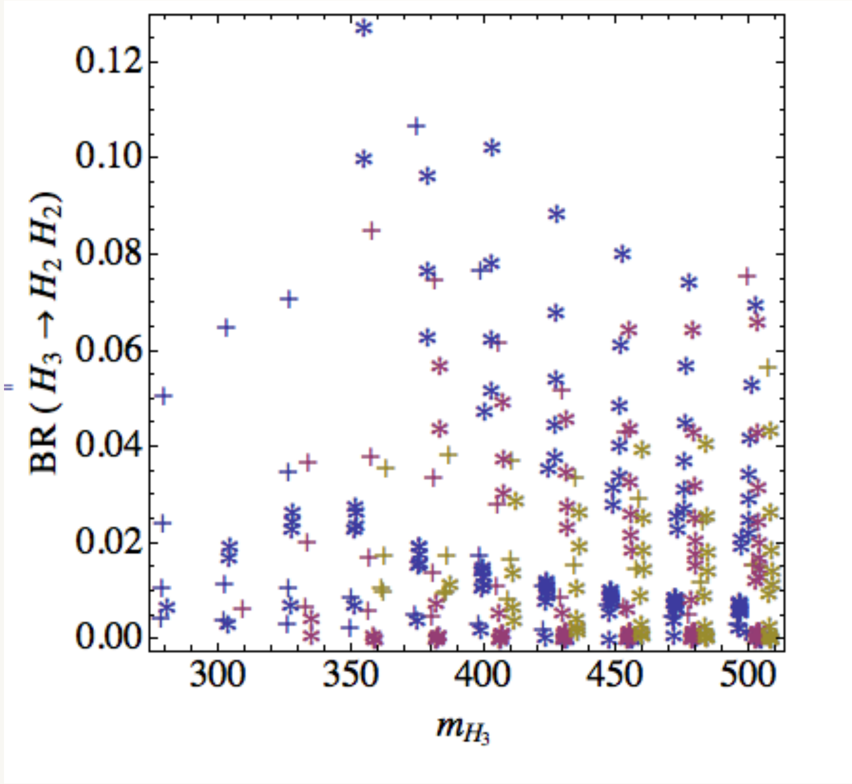


Higgs Spectra

H3 BR

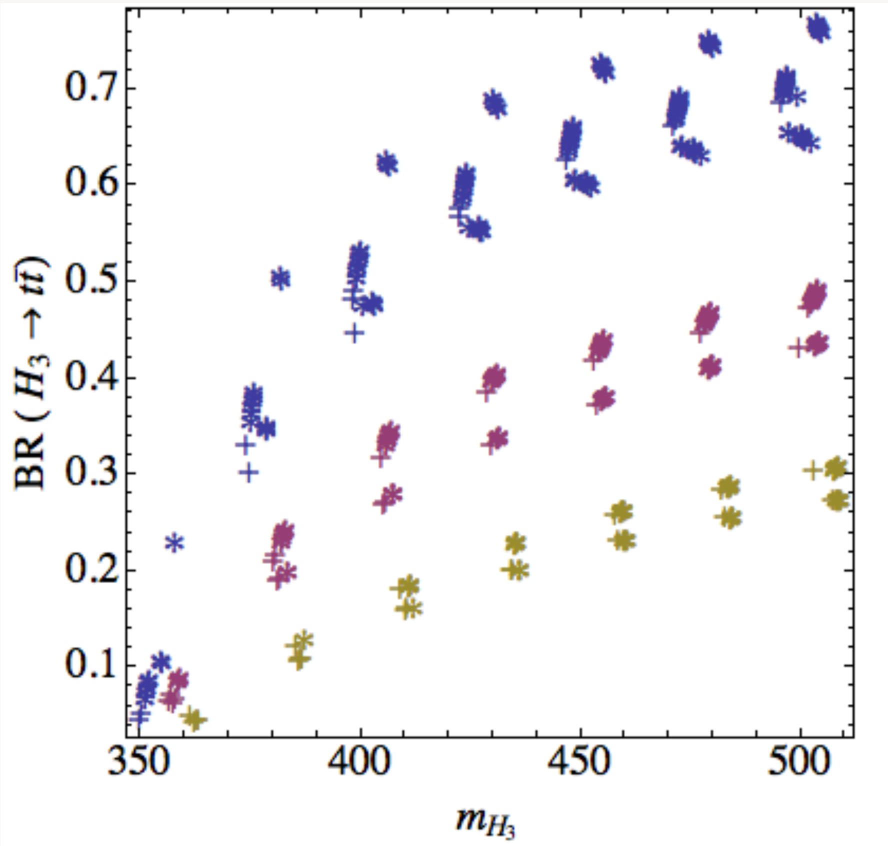
- H1 H1 /H2 H2



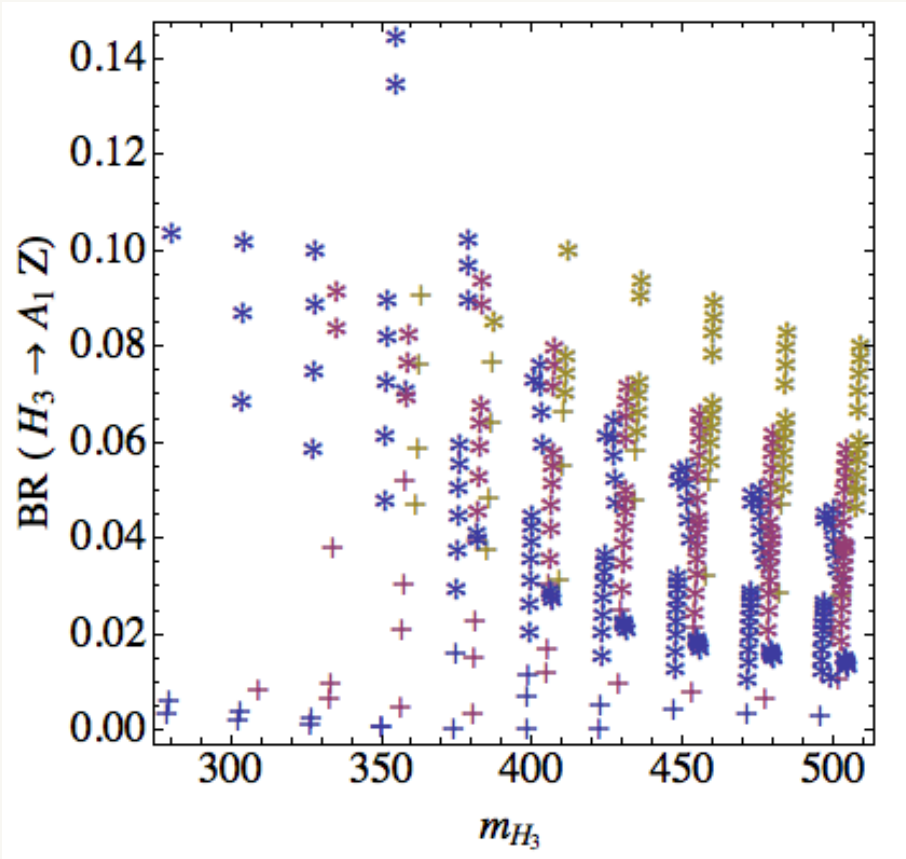


BR H3

- tt + a Z

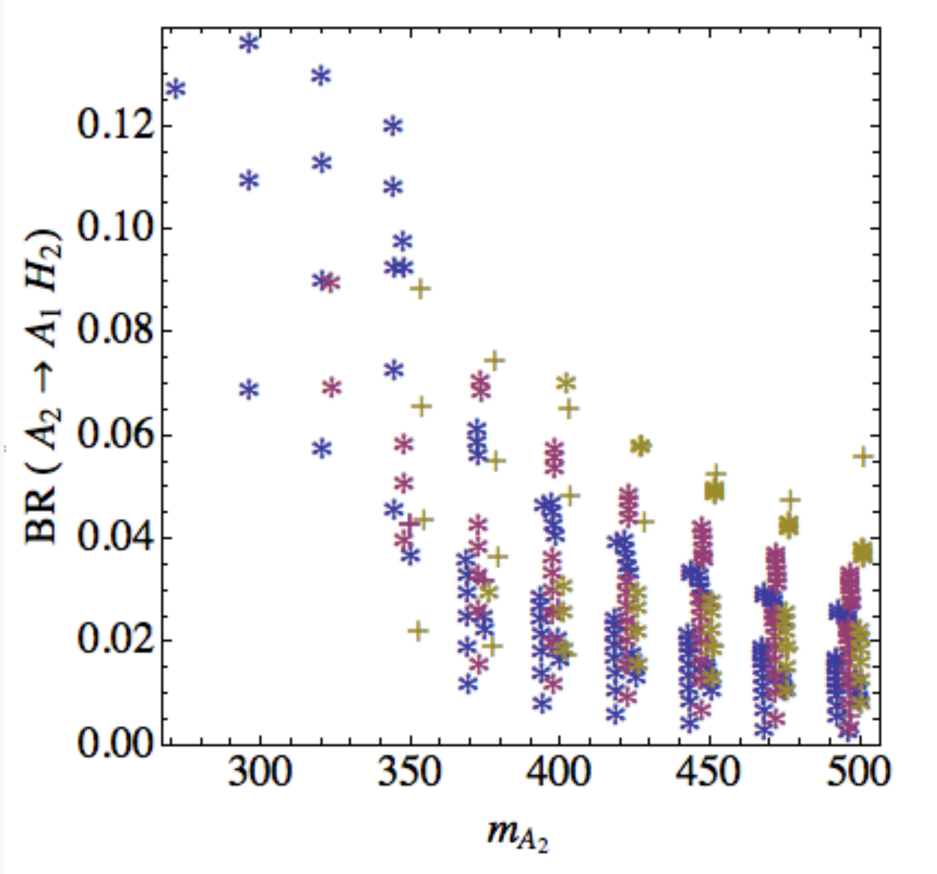


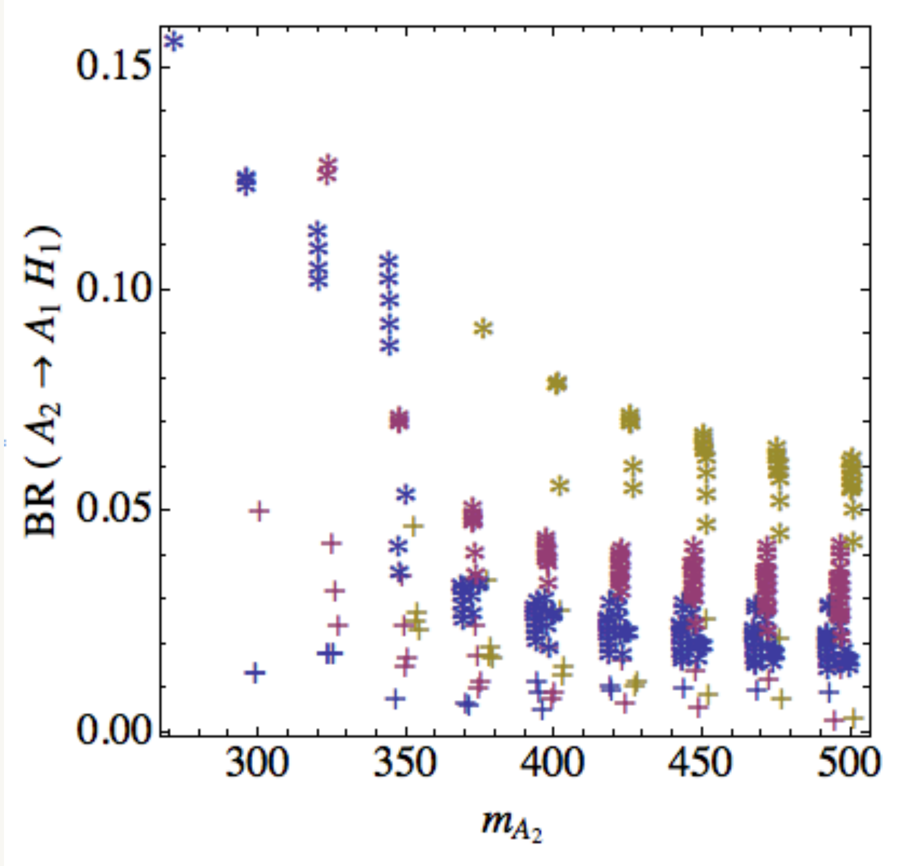
0.7
0.6
0.5
0.4
0.3
0.2
0.1
350
400
450
500
BR ($H_3 \to t\bar{t}$)
m_{H_3}



0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
300
350
400
450
500
BR ($H_3 \to A_1 Z$)
m_{H_3}

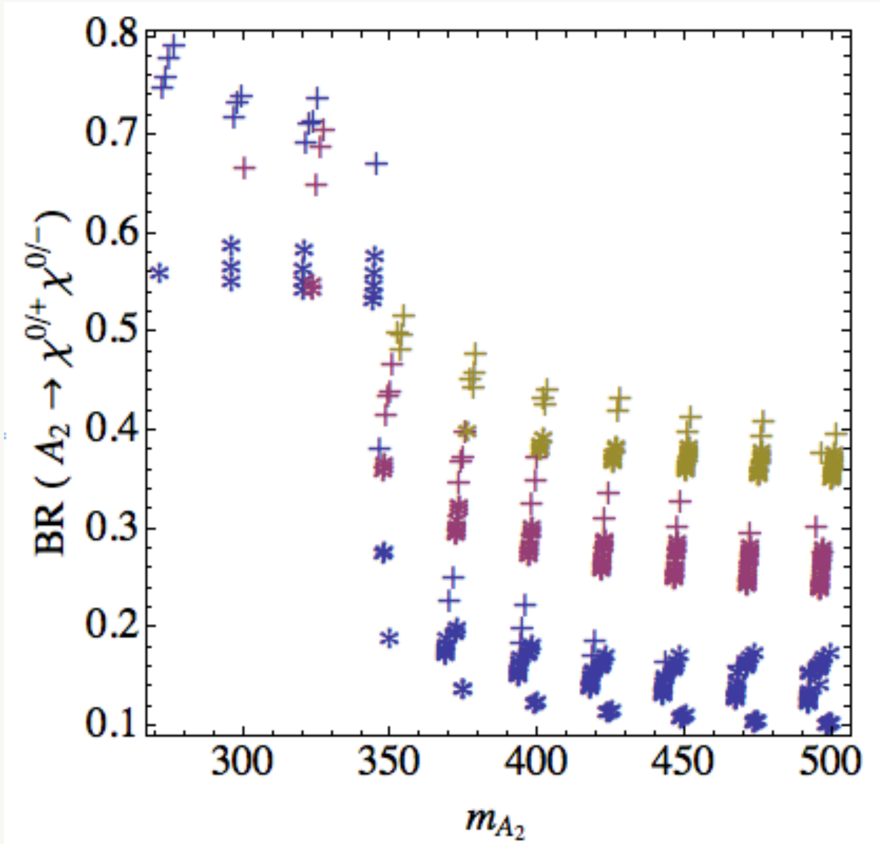
- A1 H1 / A1 H2

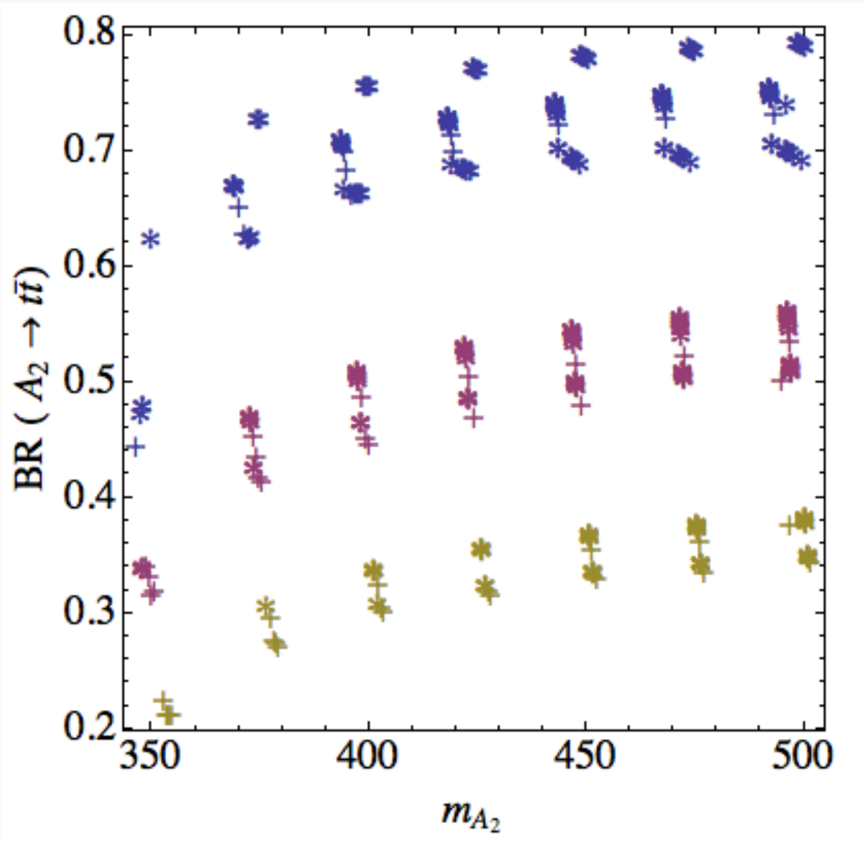

BR ($A_2 \to A_1 H_2$)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
300
350
400
450
500
m_{A_2}


BR ($A_2 \to A_1 H_1$)
0.00
0.05
0.10
0.15
300
350
400
450
500
m_{A_2}

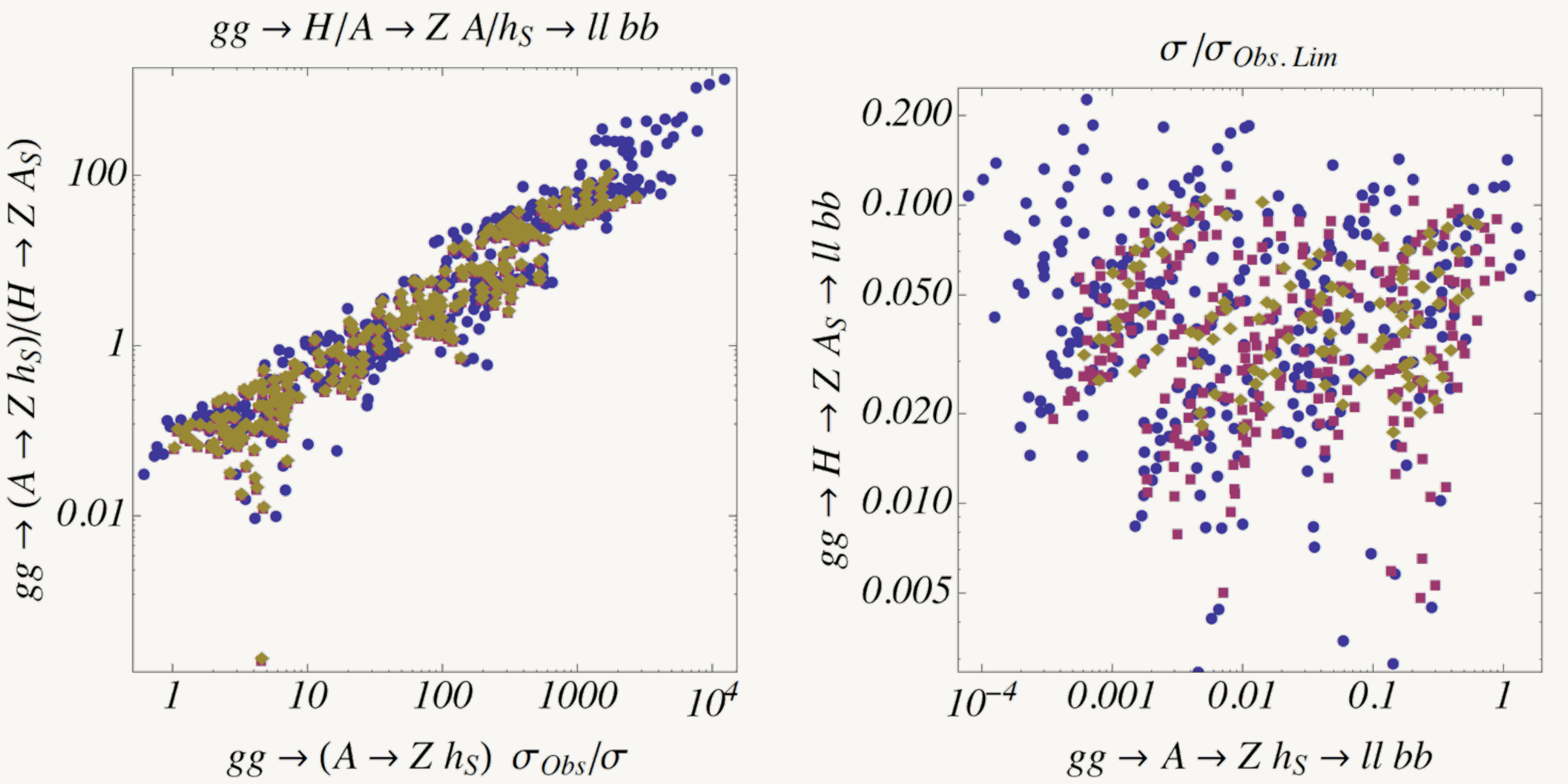
A2 BR

- tt + chargino/neutralinos



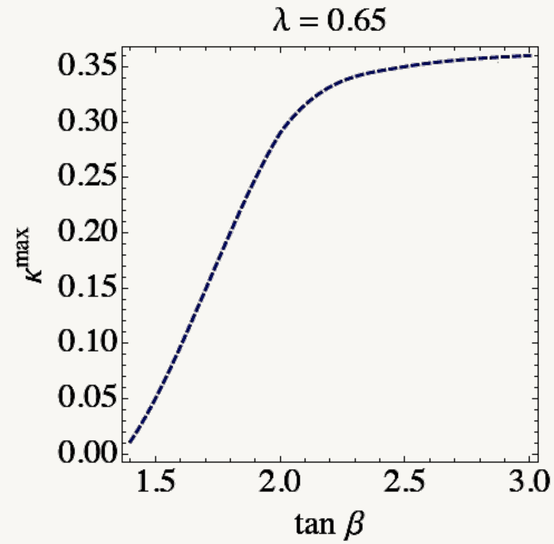


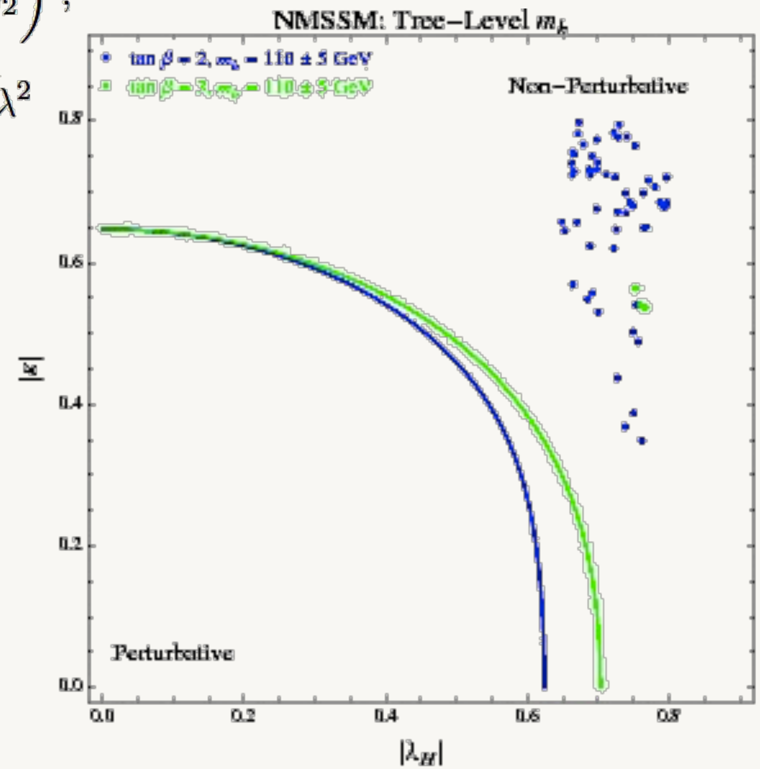
$H \to Z A_S$ vs. $A \to A h_S$



RGE

$$
\begin{aligned}
16\pi^2 \frac{d\lambda^2}{dt} &= \lambda^2\Big(3h_t^2 + 3h_b^2 + h_\tau^2 + 4\lambda^2 + 2\kappa^2 - g_1^2 - 3g_2^2\Big) \\
&+ \frac{\lambda^2}{16\pi^2}\Big(-10\lambda^4 - 9h_t^4 - 9h_b^4 - 3h_\tau^4 - 8\kappa^4 - 9\lambda^2 h_t^2 - 9\lambda^2 h_b^2 \\
&- 3\lambda^2 h_\tau^2 - 12\lambda^2\kappa^2 - 6h_t^2 h_b^2 + 2g_1^2\lambda^2 + \frac{4}{3}g_1^2 h_t^2 - \frac{2}{3}g_1^2 h_b^2 + 2g_1^2 h_\tau^2 \\
&+ 6g_2^2\lambda^2 + 16g_3^2 h_t^2 + 16g_3^2 h_b^2 + \frac{23}{2}g_1^4 + \frac{15}{2}g_2^4 + 3g_1^2 g_2^2\Big)\,, \\
16\pi^2 \frac{d\kappa^2}{dt} &= \kappa^2\Big(6\lambda^2 + 6\kappa^2\Big) + \frac{\kappa^2}{16\pi^2}\Big(-24\kappa^4 - 12\lambda^4 - 24\kappa^2\lambda^2 \\
&- 18h_t^2\lambda^2 - 18h_b^2\lambda^2 - 6h_\tau^2\lambda^2 + 6g_1^2\lambda^2 + 18g_2^2\lambda^2\Big)\,.
\end{aligned}
$$





1. The gluon fusion production cross section of the would be heavy MSSM states (**A** and **H**) is enhanced due to the top Yukawa contributions at low tan β, and can be of the order of a few *pb*.

2. The non-standard Higgs bosons may have relevant decays into the lighter singlet like Higgs bosons as well as into the light electroweakinos.

3. The decay of non-standard Higgs bosons into taus and bottoms will be suppressed due to the small values of tan β and the presence of additional decays.

Phenomenological Consequences