Thrilling free-time activities that you can practice with 6 feet distance.

BSM Higgs Bosons at the ILC
(and other e^+e^- colliders)

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virtual, 02/2022

1. Introduction
2. Direct detection of "heavy" BSM Higgs bosons
3. Inirect detection of "heavy" BSM Higgs bosons
4. Direct detection of "light" BSM Higgs bosons
5. Conclusions

1. Introduction

We have discovered an SM-like Higgs!

The SM cannot be the ultimate theory!

Conclusion: The discovered Higgs cannot be “the SM Higgs”!

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$\Rightarrow$ any hints from LHC results (as guideline/toy example)?
Q': Which model?

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$\Rightarrow$ any hints from LHC results (as guideline/toy example)?
Q': Which model?

A1: check changed properties of the h_{125}

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

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

The "sum rule": $\sum_i g^2_{h_i VV} = g^2_{H_{\rm SM} VV}$ (and we know $g^2_{h_{125} VV} \sim g^2_{H_{\rm SM} VV}$)

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

Toy example:

Two Higgs Doublet Model (2HDM):

Fields:

$$\Phi_1 = \begin{pmatrix} \phi_1^+ \\ \frac{1}{\sqrt{2}}(v_1 + \rho_1 + i\eta_1) \end{pmatrix}, \quad \Phi_2 = \begin{pmatrix} \phi_2^+ \\ \frac{1}{\sqrt{2}}(v_2 + \rho_2 + i\eta_2) \end{pmatrix}$$

Potential:

$$\begin{aligned} V \; = \; & m_{11}^2|\Phi_1|^2 + m_{22}^2|\Phi_2|^2 - m_{12}^2(\Phi_1^\dagger\Phi_2 + h.c.) + \frac{\lambda_1}{2}(\Phi_1^\dagger\Phi_1)^2 + \frac{\lambda_2}{2}(\Phi_2^\dagger\Phi_2)^2 \\ & + \lambda_3(\Phi_1^\dagger\Phi_1)(\Phi_2^\dagger\Phi_2) + \lambda_4(\Phi_1^\dagger\Phi_2)(\Phi_2^\dagger\Phi_1) + \frac{\lambda_5}{2}[(\Phi_1^\dagger\Phi_2)^2 + h.c.] \end{aligned}$$

Physical states: h, H, ($\mathcal{CP}$-even), A ($\mathcal{CP}$-odd), $H^\pm$ (charged)

"Physical" input parameters:

$$c_{\beta-\alpha}\,, \quad \tan\beta\,, \quad v\,, \quad M_h, \quad M_H\,, \quad M_A\,, \quad M_{H^\pm}\,, \quad m_{12}^2$$

Assumption (for now): $h \sim h_{125}$

Z_2 symmetry to avoid FCNC:

$$\Phi_1 \to \Phi_1\,,\ \Phi_2 \to -\Phi_2\,,\ \Phi_S \to \Phi_S$$

Extension of the Z_2 symmetry to fermions determines four types:

	u-type	d-type	leptons	
type I	Φ_2	Φ_2	Φ_2	
type II	Φ_2	Φ_1	Φ_1	$\to$ MSSM type
type III (lepton-specific)	Φ_2	Φ_2	Φ_1	
type IV (flipped)	Φ_2	Φ_1	Φ_2	

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

Unitarity/perturbativity and EWPO: $\Rightarrow M_A \sim M_H \sim M_{H^\pm}$

Second toy example:

Next-Two Higgs Doublet Model (N2HDM): $\rightarrow$ (nearly) NMSSM type

Fields:

$$\Phi_1 = \begin{pmatrix} \phi_1^+ \\ \frac{1}{\sqrt{2}}(v_1 + \rho_1 + i\eta_1) \end{pmatrix}, \quad \Phi_2 = \begin{pmatrix} \phi_2^+ \\ \frac{1}{\sqrt{2}}(v_2 + \rho_2 + i\eta_2) \end{pmatrix}, \quad \Phi_S = v_S + \rho_S$$

Potential:

$$\begin{aligned} V &= m_{11}^2|\Phi_1|^2 + m_{22}^2|\Phi_2|^2 - m_{12}^2(\Phi_1^\dagger\Phi_2 + h.c.) + \frac{\lambda_1}{2}(\Phi_1^\dagger\Phi_1)^2 + \frac{\lambda_2}{2}(\Phi_2^\dagger\Phi_2)^2 \\ &\quad +\lambda_3(\Phi_1^\dagger\Phi_1)(\Phi_2^\dagger\Phi_2) + \lambda_4(\Phi_1^\dagger\Phi_2)(\Phi_2^\dagger\Phi_1) + \frac{\lambda_5}{2}[(\Phi_1^\dagger\Phi_2)^2 + h.c.] \\ &\quad +\frac{1}{2}m_S^2\Phi_S^2 + \frac{\lambda_6}{8}\Phi_S^4 + \frac{\lambda_7}{2}(\Phi_1^\dagger\Phi_1)\Phi_S^2 + \frac{\lambda_8}{2}(\Phi_2^\dagger\Phi_2)\Phi_S^2 \end{aligned}$$

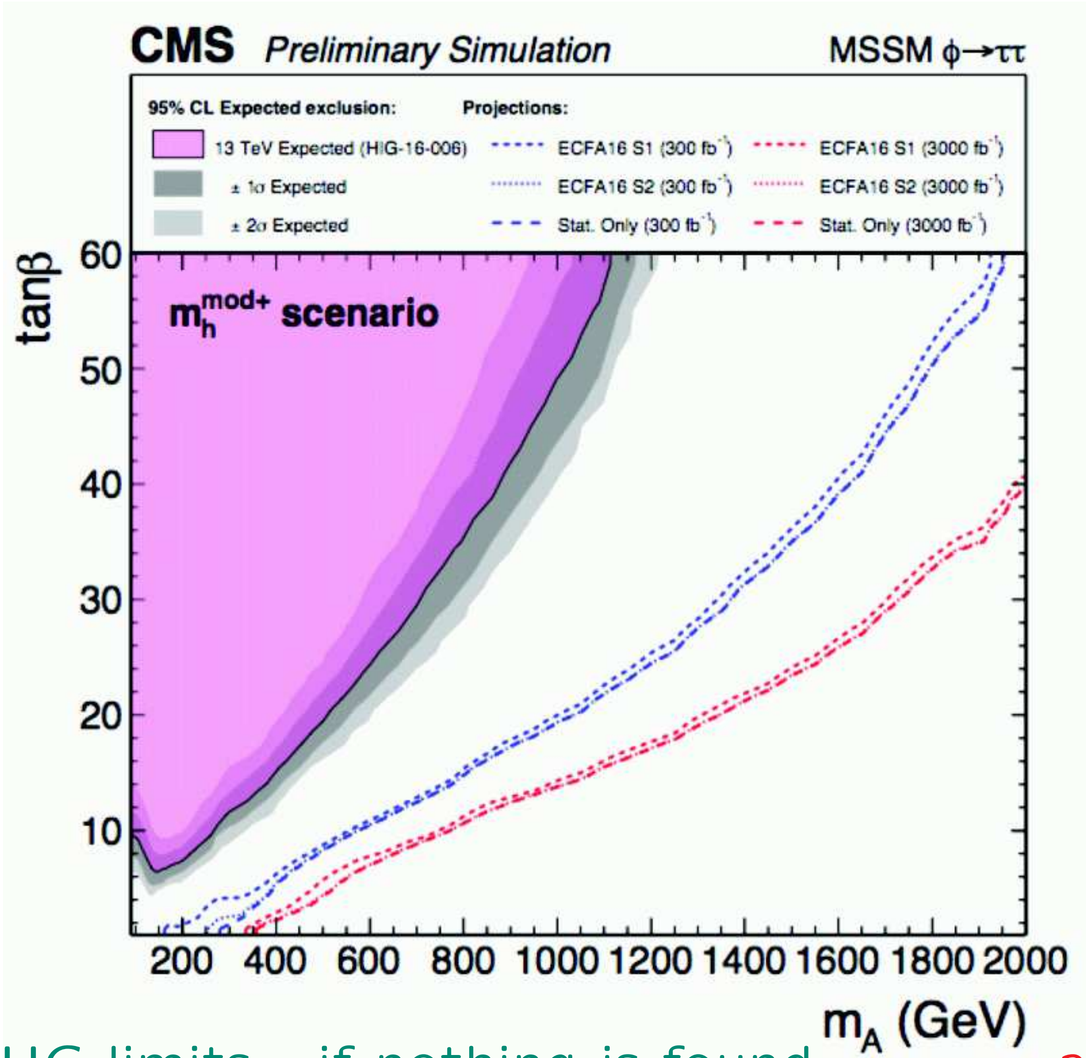
Z_2 symmetry: $\Phi_1 \rightarrow \Phi_1$, $\Phi_2 \rightarrow -\Phi_2$, $\Phi_S \rightarrow \Phi_S$

Z_2' symmetry: $\Phi_1 \rightarrow \Phi_1$, $\Phi_2 \rightarrow \Phi_2$, $\Phi_S \rightarrow -\Phi_S$ (broken by $v_S \Rightarrow$ no DM)

Physical states: h_1, h_2, h_3 ($\mathcal{CP}$-even), A ($\mathcal{CP}$-odd), $H^\pm$ (charged)

2. Direct Detection of "heavy" BSM Higgs bosons

Reach in the MSSM (type II 2HDM Higgs sector):

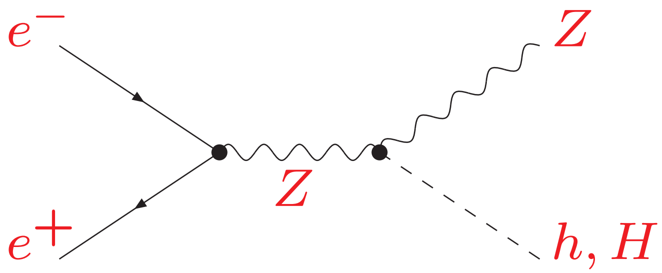


⇒ strong (HL-)LHC limits - if nothing is found analyzed in detail

⇒ but if there is something in the kinematical e^+e^- reach, it can be

Search for neutral Higgs bosons in the 2HDM at e^+e^- colliders:

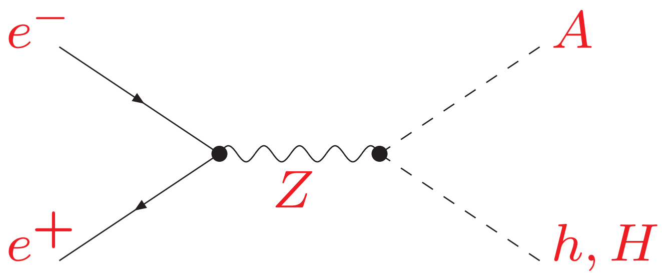
$e^+e^- \to Zh, ZH$



$$\sigma_{hZ} \approx \sin^2(\beta - \alpha)\sigma_{hZ}^{\text{SM}}$$

$$\sigma_{HZ} \approx \cos^2(\beta - \alpha)\sigma_{hZ}^{\text{SM}}$$

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



$$\sigma_{hA} \propto \cos^2(\beta - \alpha)\sigma_{hZ}^{\text{SM}}$$

$$\sigma_{HA} \propto \sin^2(\beta - \alpha)\sigma_{hZ}^{\text{SM}}$$

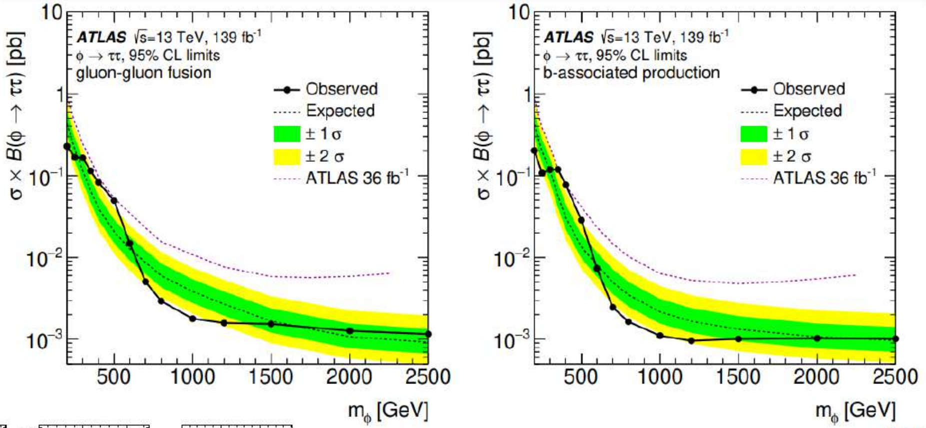
$\Rightarrow$ only pair production of heavy Higgs bosons! reach: $M_A \lesssim \sqrt{s}/2$

$\Rightarrow$ maximum ILC reach: $\sim$ 500 GeV, CLIC $\sim$ 1500 GeV

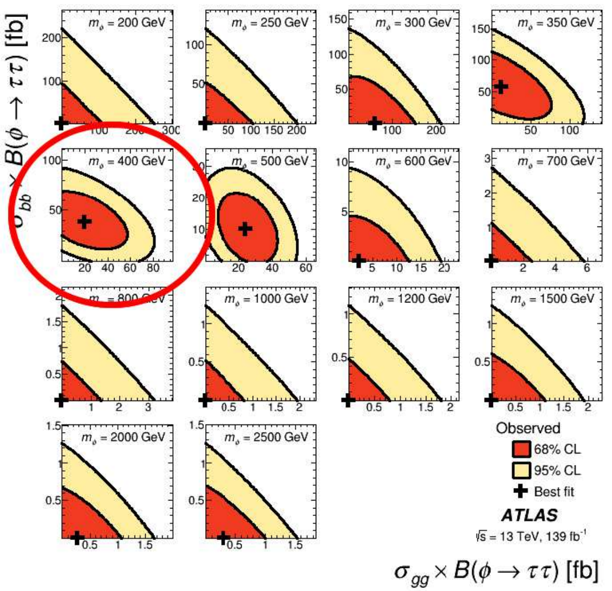
Possible hint for heavy Higgses at the LHC (I):

[*taken from T. Biekötter '21*]

"The $\tau^+\tau^-$ excess" at $\sim$ 400 GeV



[ATLAS: 2002.12223]



[ATLAS: 2002.12223]

Local excess of 2.7σ at $\sim$ 400 GeV
Global significance below 2σ

Here: $\chi^2_{\tau^+\tau^-}(\sigma_{gg} \times B_{\phi\to\tau^+\tau^-}, \sigma_{bb} \times B_{\phi\to\tau^+\tau^-})$
for $m_\phi = 400$ GeV

Both prodution modes relevant:
$\Rightarrow \sigma_{bb} \sim 2\sigma_{gg}$

No excess in CMS analyses, but only 35.9fb^{-1}
[CMS: 1803.06553]

2 / 17

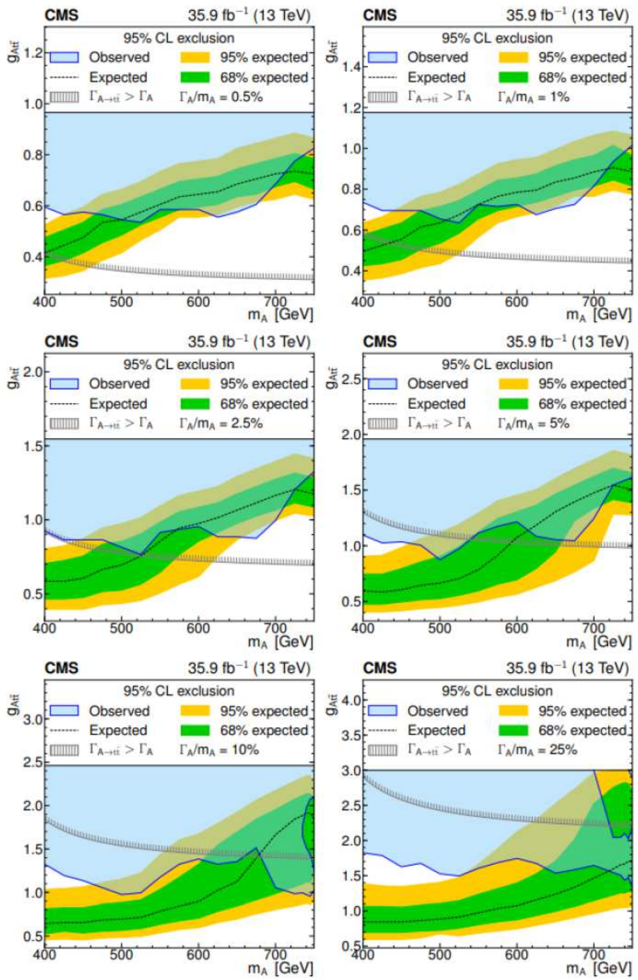
$\Rightarrow$ can be explained in the N2HDM/NMSSM for $\tan\beta \sim 8$ $\Rightarrow$ in ILC reach

[*T. Biekötter, A. Grohsjean, S.H., C. Schwanenberger, G. Weiglein '21*]

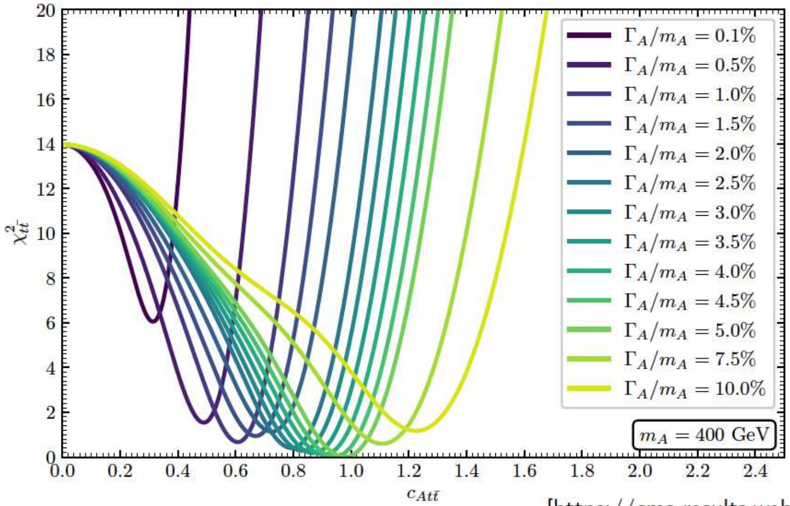
Possible hint for heavy Higgses at the LHC (II):

[taken from T. Biekötter '21]

"The $t\bar{t}$ excess" at ~ 400 GeV



[CMS: 1908.01115]



[https://cms-results.web.cern.ch]

Local excess of 3.5σ at ~ 400 GeV
Global significance below 2σ

Consistent with a pseudoscalar Higgs boson at ~ 400 GeV

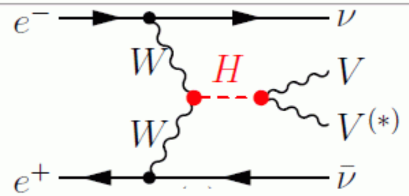
Most significant for $\Gamma_A/m_A = 4\%$ and $c_{At\bar{t}} \sim 1$, but also consistent with slightly different m_A and Γ_A/m_A
$\to \chi^2_{t\bar{t}}(m_A, \Gamma_A/m_A, c_{At\bar{t}})$

Corresponding ATLAS limits only for $m_A > 500$ GeV and only 8 TeV data [ATLAS: 1707.06025]

$\Rightarrow$ can be explained in the N2HDM/NMSSM for $\tan\beta \sim 1.5$ $\Rightarrow$ in ILC reach

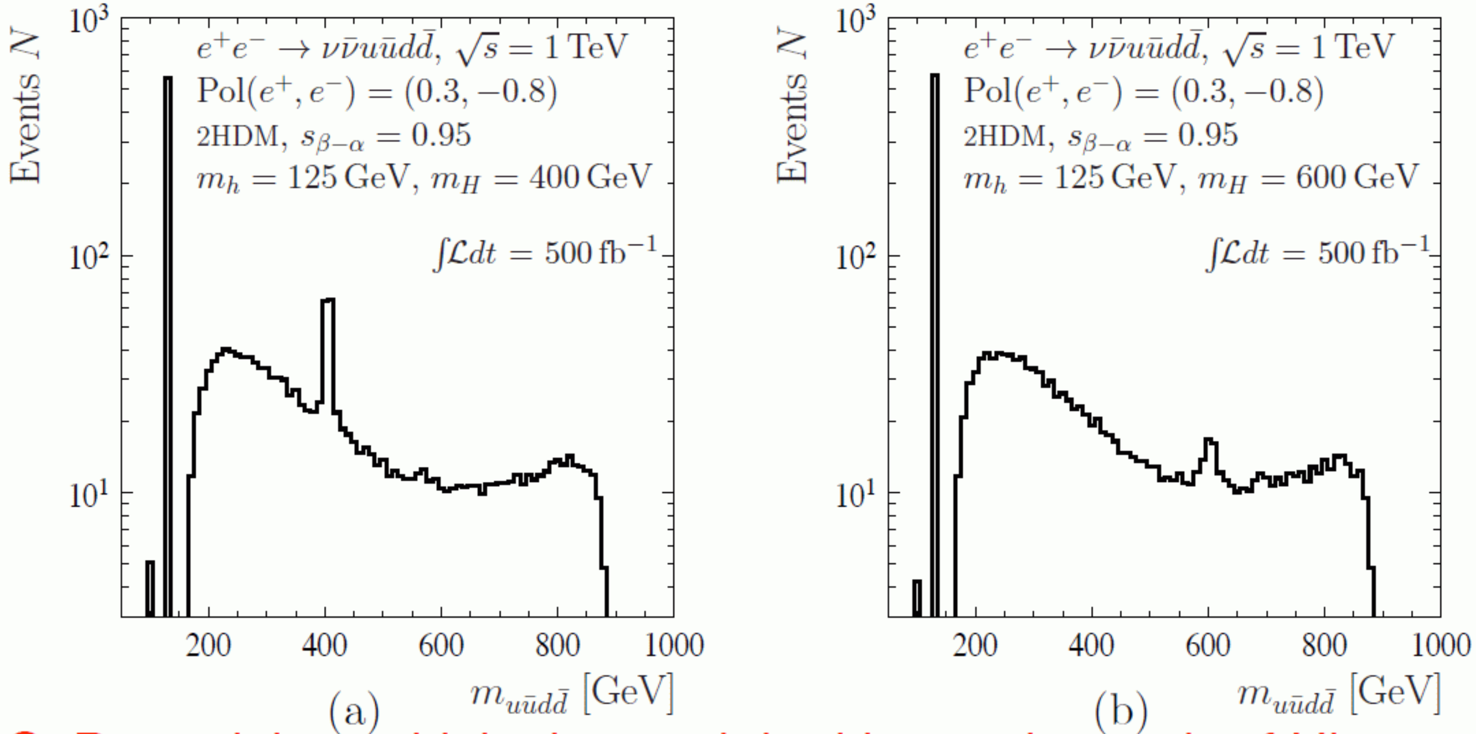
[T. Biekötter, A. Grohsjean, S.H., C. Schwanenberger, G. Weiglein '21]

Sensitivity to the small signal of an additional heavy Higgs boson in a Two-Higgs-Doublet model (2HDM)



[S. Liebler et al. '15]

$$g_{\rm hVV} = \sin(\beta-\alpha)\, g^{\rm SM}_{\rm HVV}, \quad g_{\rm HVV} = \cos(\beta-\alpha)\, g^{\rm SM}_{\rm HVV}, \quad V = W^\pm, Z$$

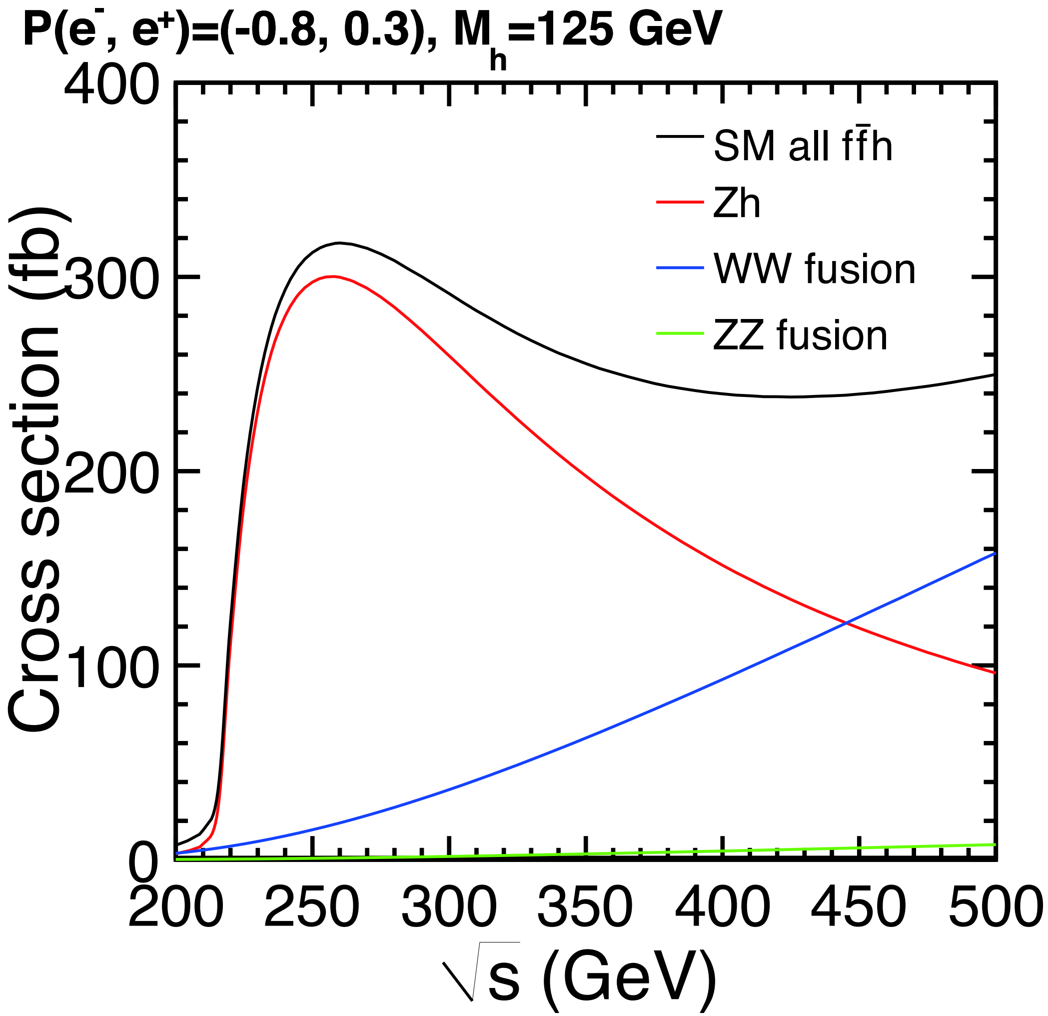


$\Rightarrow$ ILC: Potential sensitivity beyond the kinematic reach of Higgs pair production

[Taken from G. Weiglein '18]

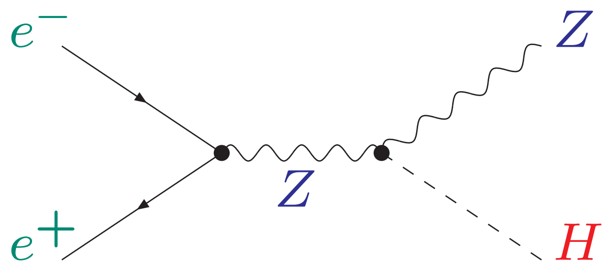
3. Indirect Detection of "heavy" BSM Higgs bosons

⇒ via h_{125} coupling measurements



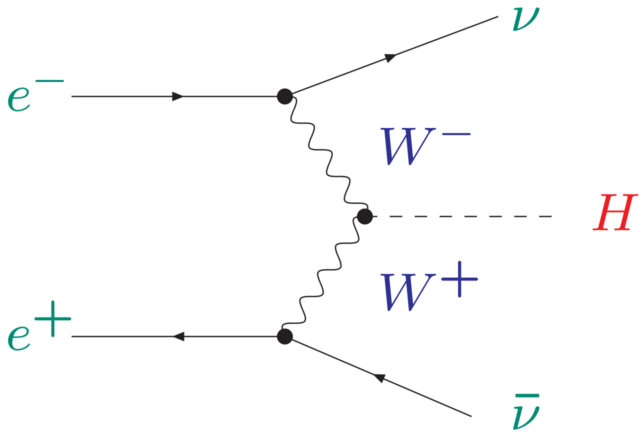
Higgs-strahlung:

$e^+e^- \to Z^* \to ZH$



weak boson fusion (WBF):

$e + e- \to \nu\bar{\nu}H$



$\sqrt{s} \sim 250$ GeV, Higgs-strahlung dominated

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:

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

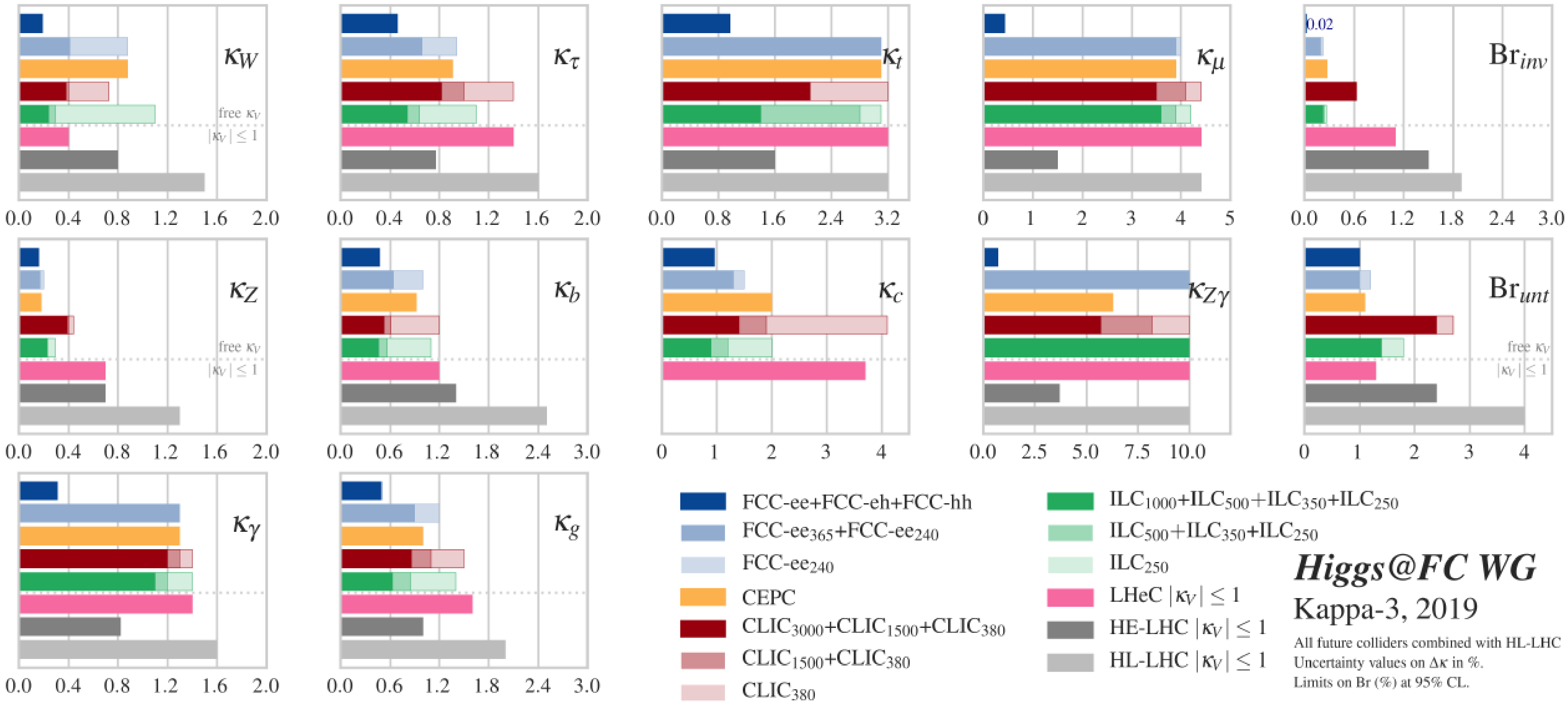
$$\kappa_F \approx 1 - (3-9)\% \left(\frac{1\ \text{TeV}}{f}\right)^2$$

$\Rightarrow$ couplings to bosons in the per mille range

$\Rightarrow$ couplings to fermions in the per cent range

$\Rightarrow$ at which collider can this be reached?

Future expectations for κ (kappa-3 framework)



$\Rightarrow$ ILC shows strong improvement over HL-LHC in many cases

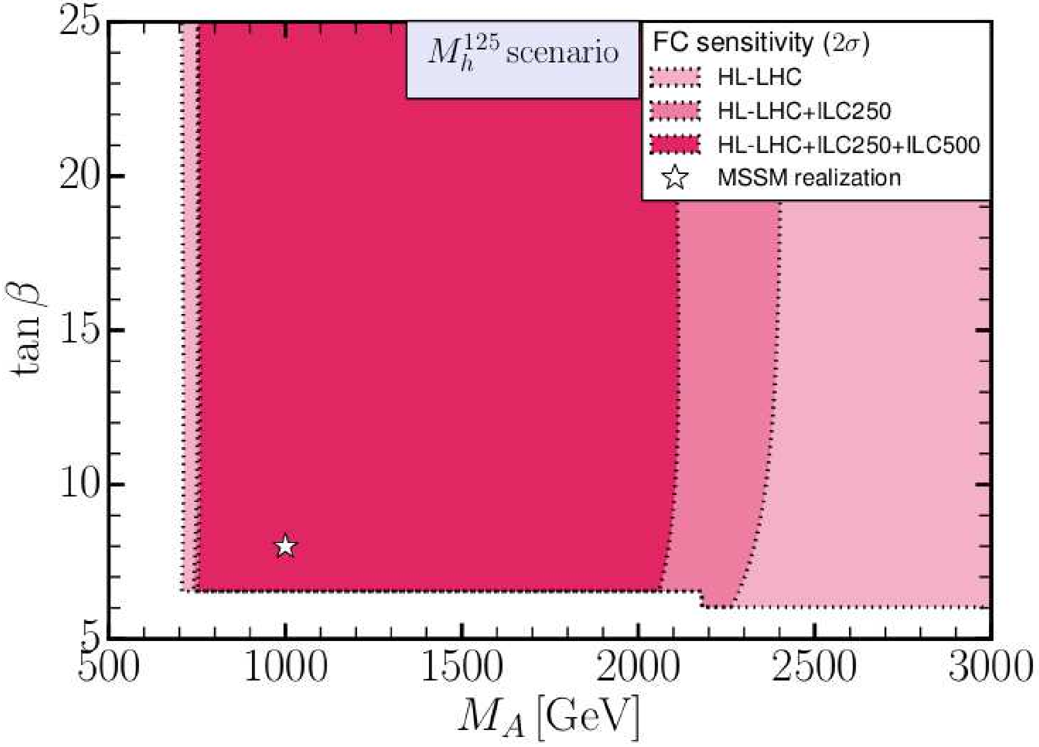
$\Rightarrow$ . . . and without theory assumptions

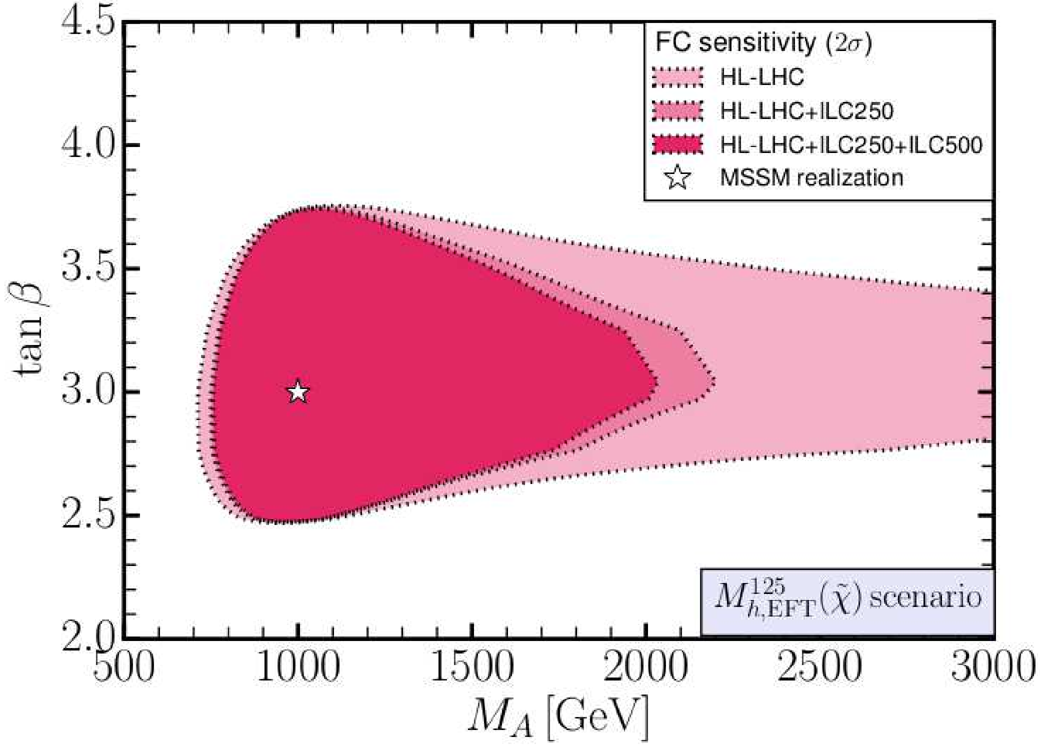
$\Rightarrow$ and this improvement could be decisive!

Relevance of ILC measurements:

[H. Bahl et al., '20]

– Assume a realization of an MSSM point: $M_A = 1$ TeV, $\tan\beta = 7/3$
– What limits can be set from rate/coupling measurements?



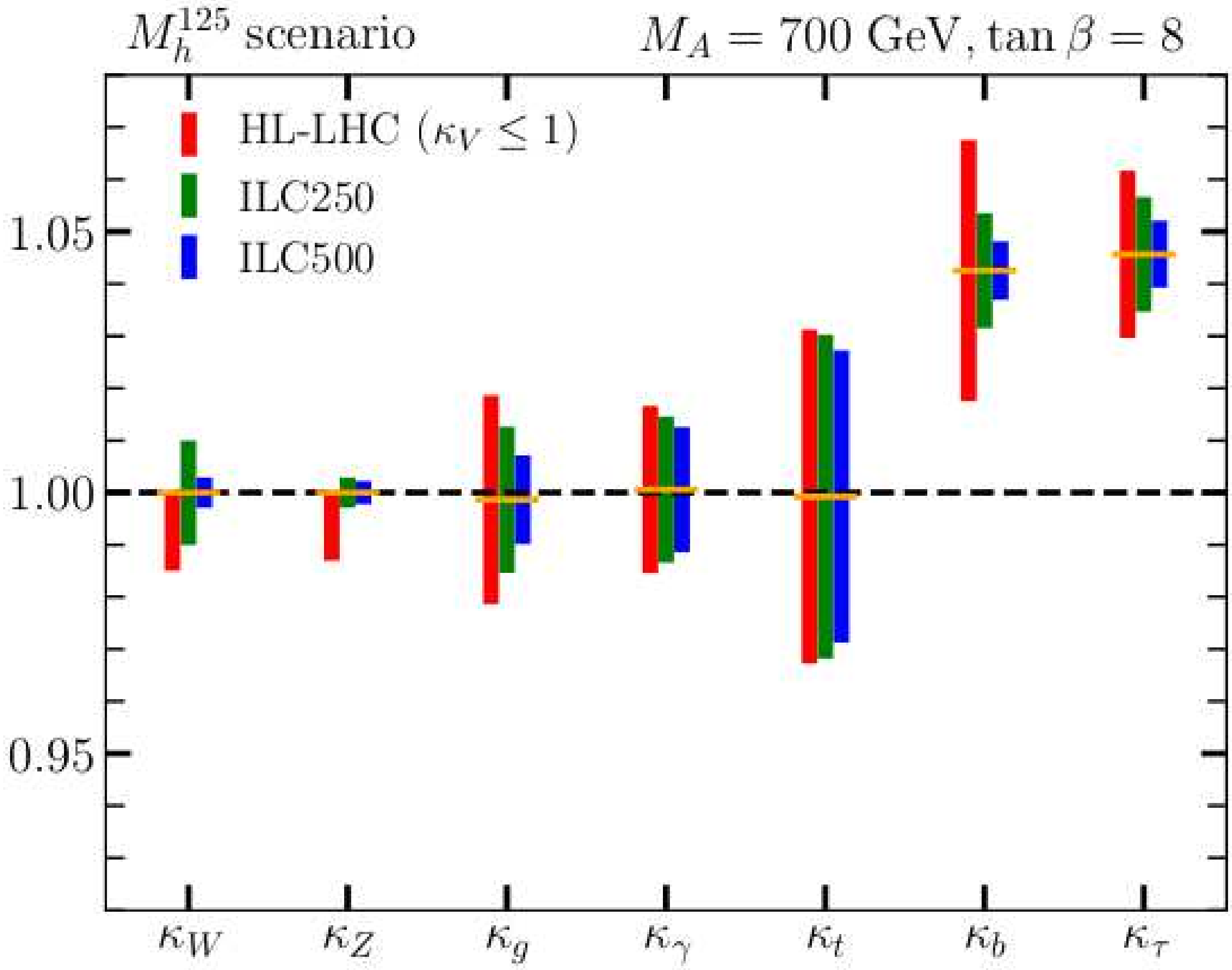


⇒ only ILC measurements give upper limit on M_A

⇒ limits on $\tan\beta$ only for small(er) $\tan\beta$

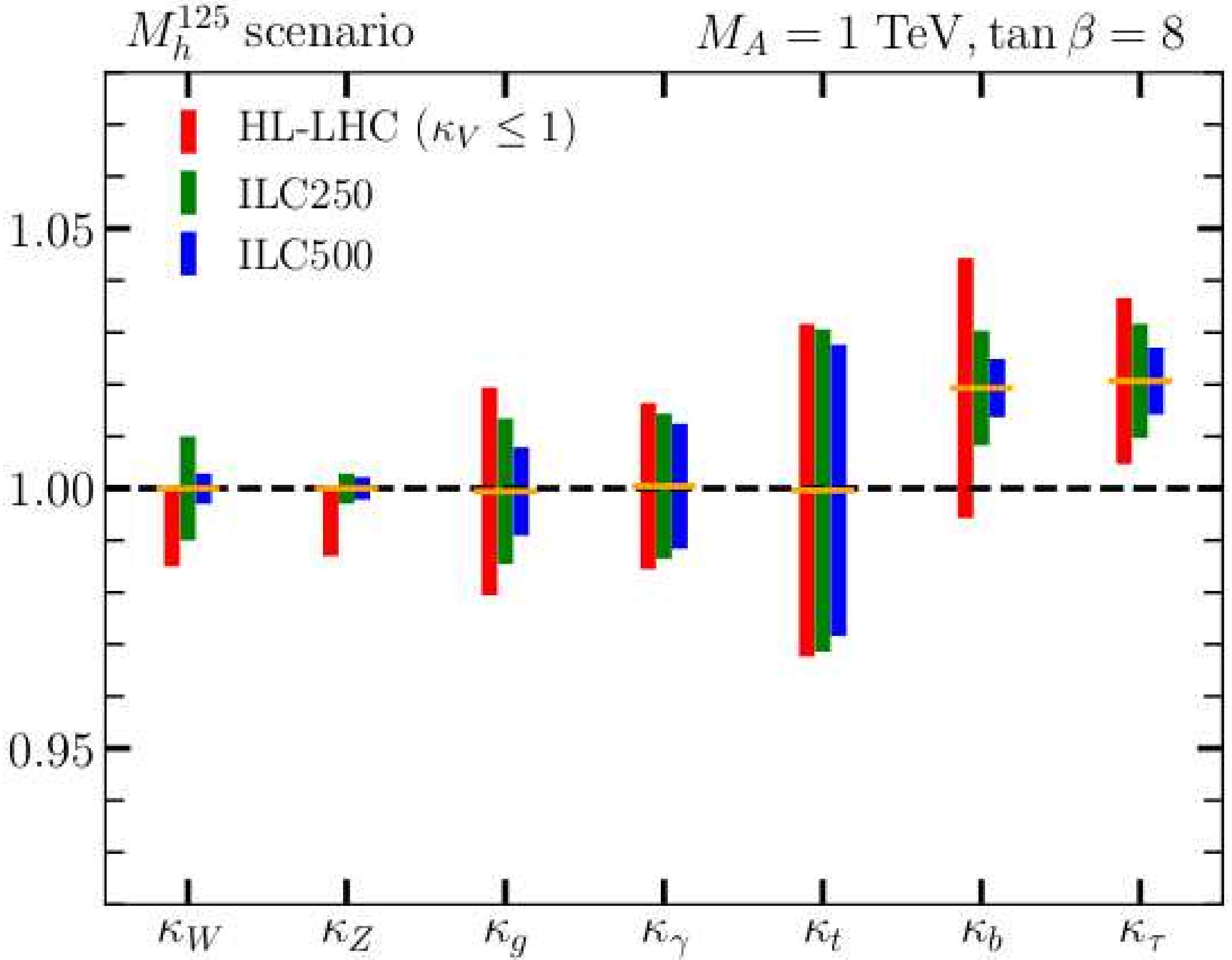
MSSM Wäscheleine I: e^+e^- precision vs. M_h^{125} ($M_A = 700$ GeV, $\tan\beta = 8$)

[*H. Bahl et al. '20*]



MSSM Wäscheleine II: e^+e^- precision vs. M_h^{125} ($M_A = 1000$ GeV, $\tan\beta = 8$)

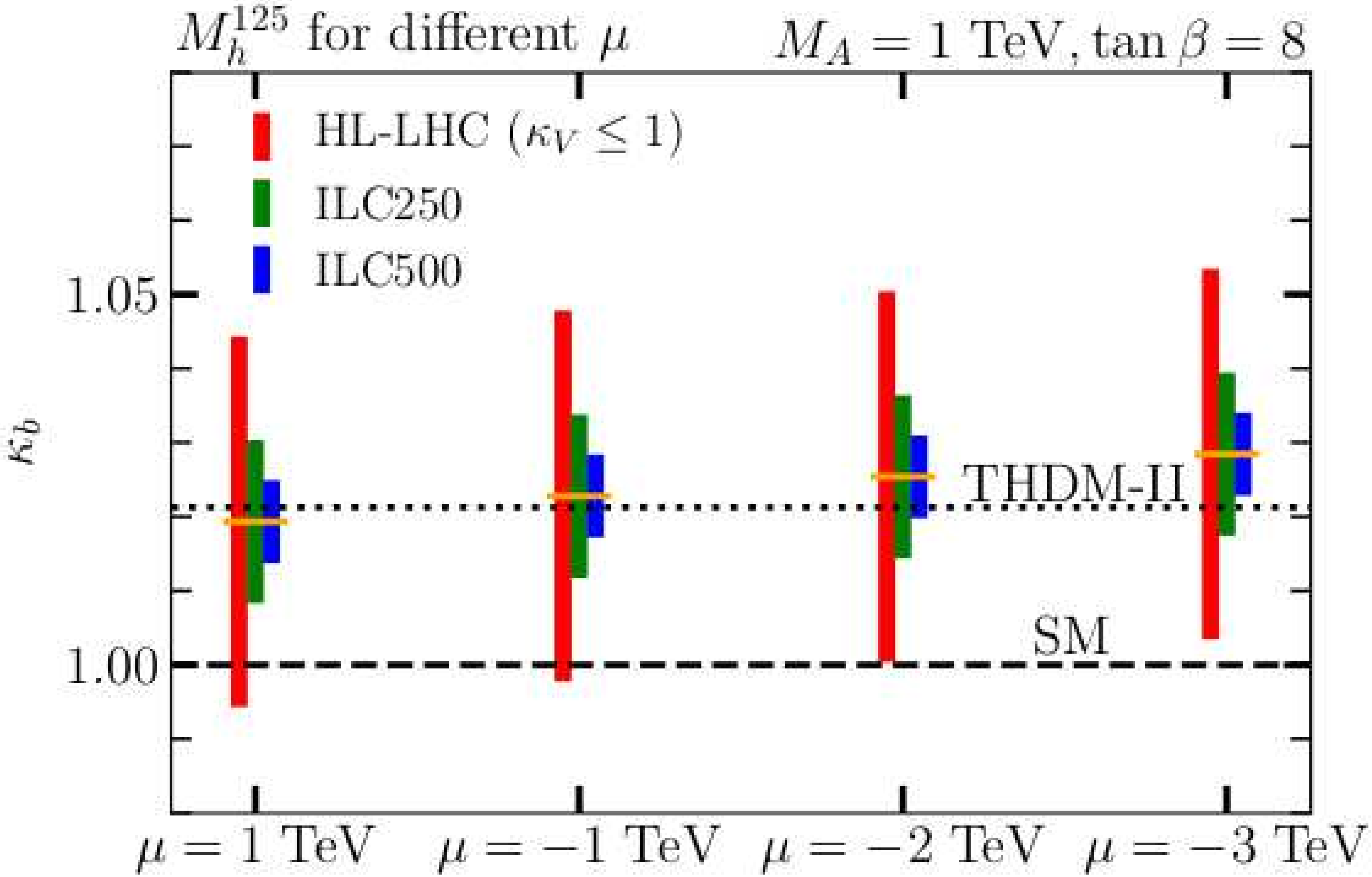
[*H. Bahl et al. '20*]



$\Rightarrow$ only e^+e^- measurements allows to set upper limit on M_A

MSSM Wäscheleine V: e^+e^- vs. M_h^{125} ($M_A = 1000$ GeV, $\tan\beta = 8$)

[*H. Bahl et al. '20*]

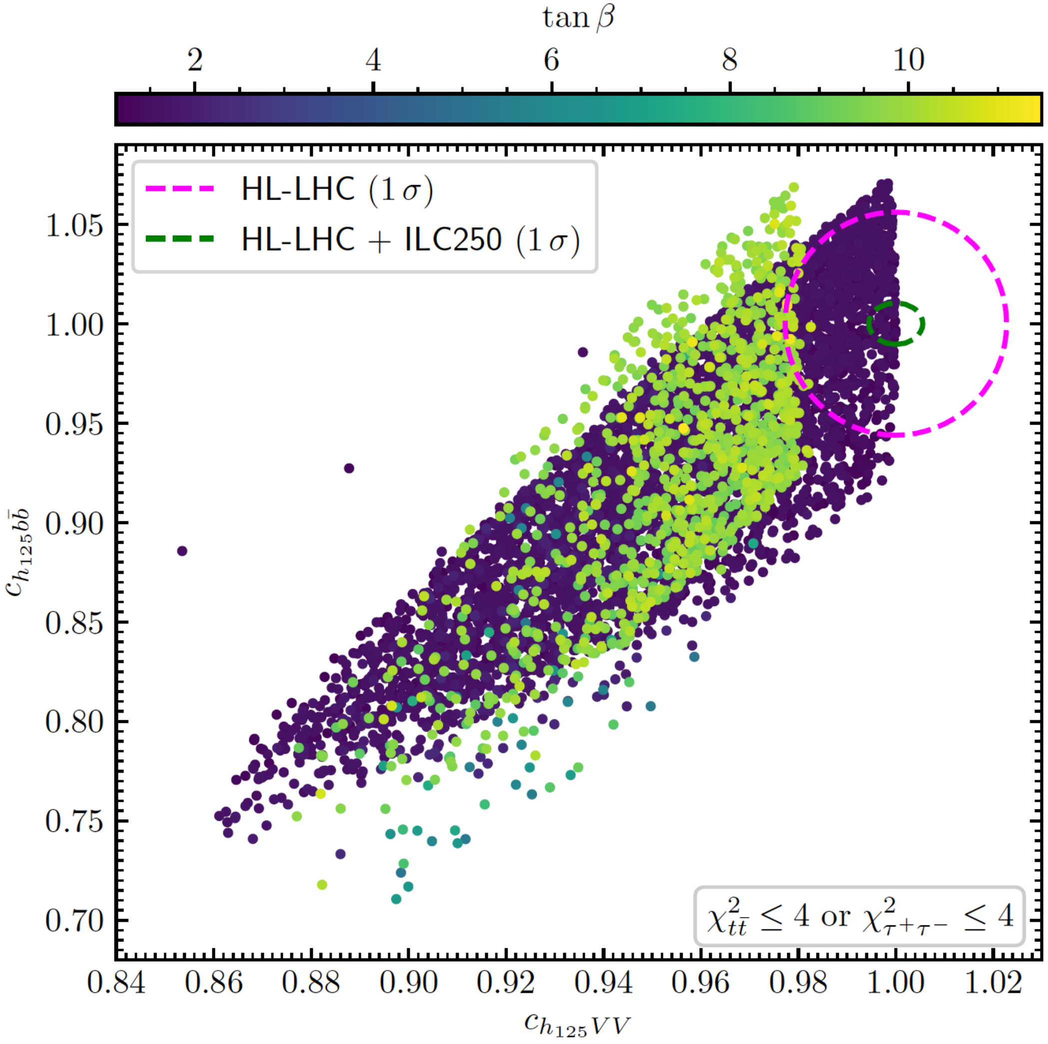


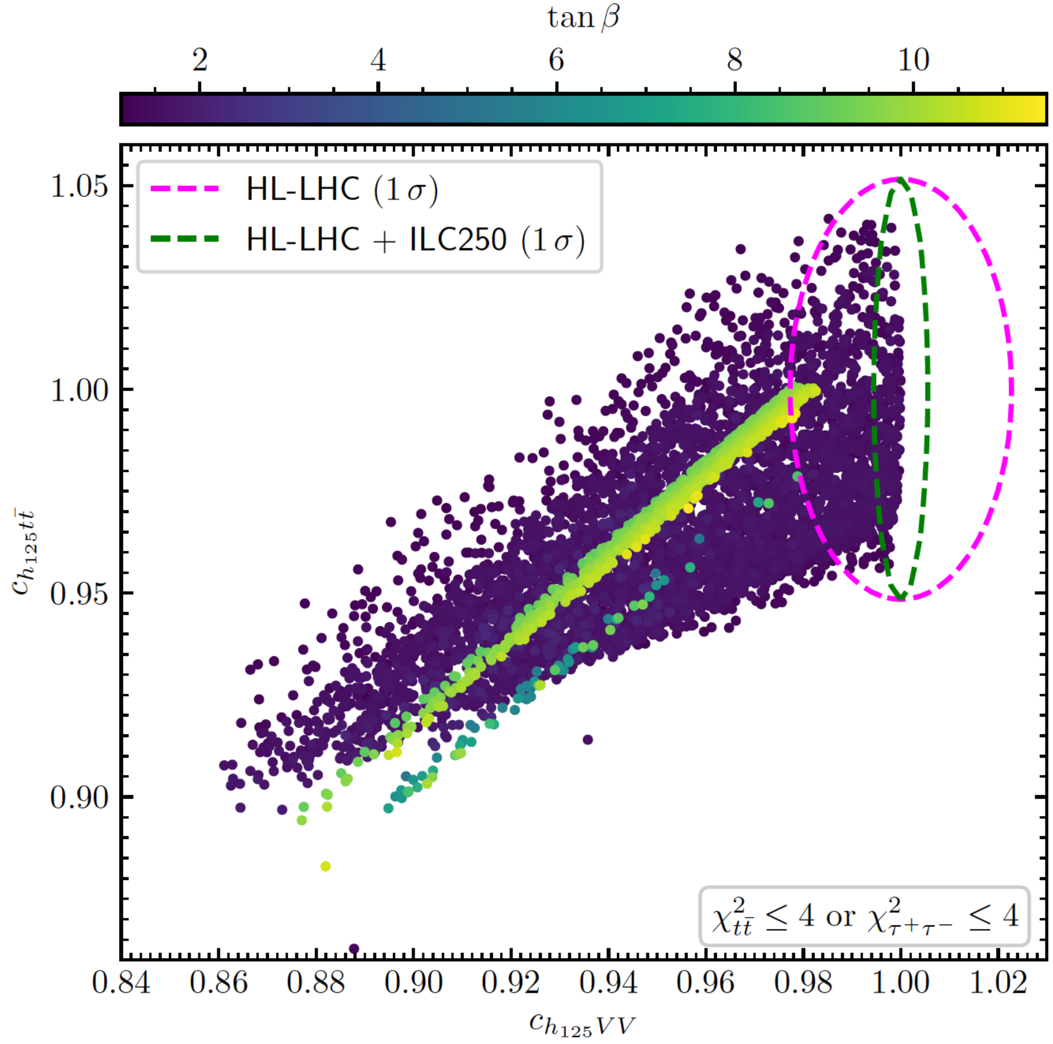
⇒ MSSM vs. 2HDM: very challenging!

What about the "real hints" at ~ 400 GeV? $\rightarrow$ N2HDM: (NMSSM similar)

What about the "real hints" at $\sim$ 400 GeV? $\to$ N2HDM: (NMSSM similar)

[*T. Biekötter, A. Grohsjean, S.H., C. Schwanenberger, G. Weiglein '21*]



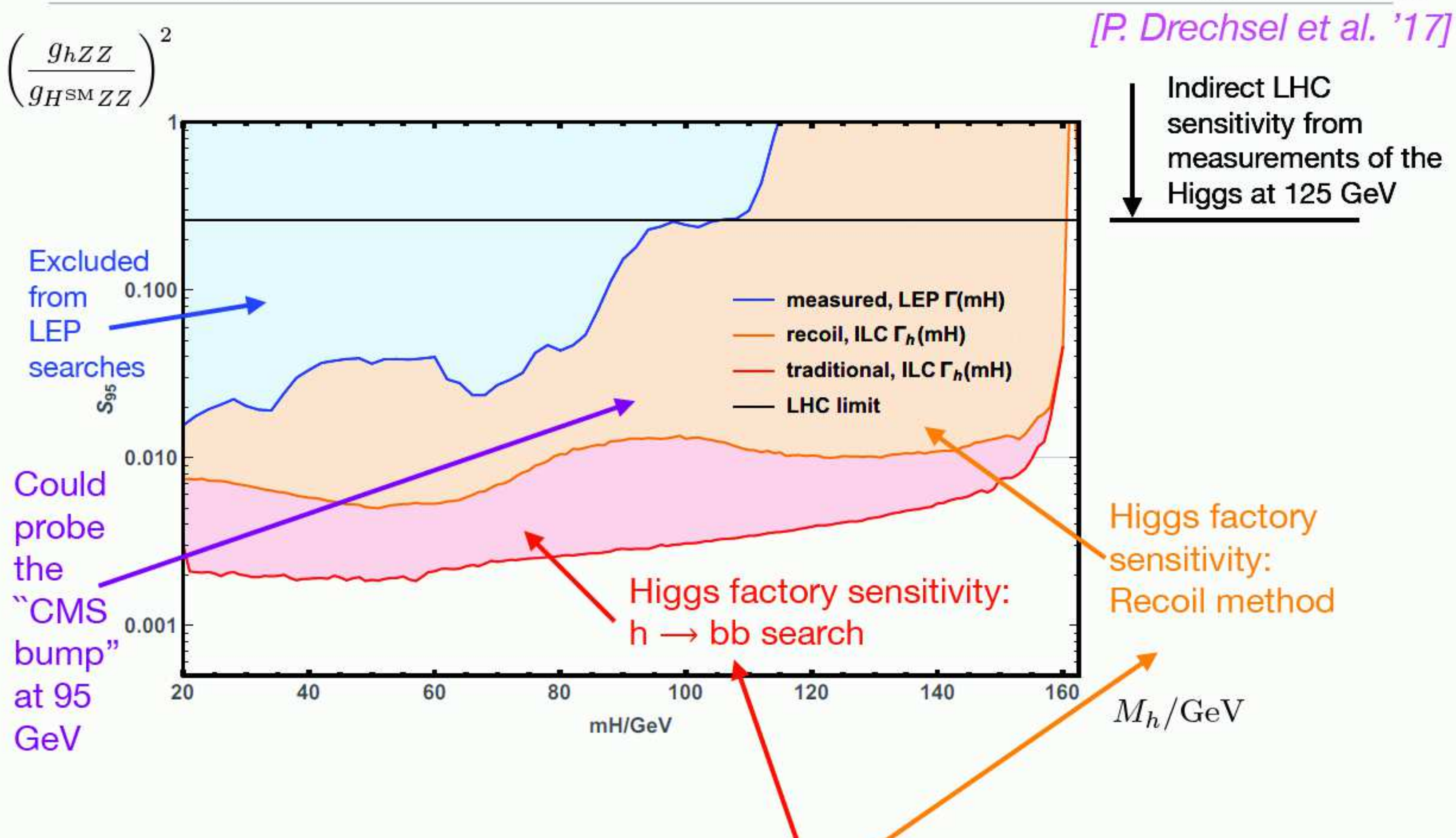


low $\tan\beta$ ($t\bar{t}$): SM limit reached, but many points show large deviation

high $\tan\beta$ ($\tau^+\tau^-$): ILC can always distinguish the SM from the N2HDM

4. Direct detection of “light” BSM Higgs bosons

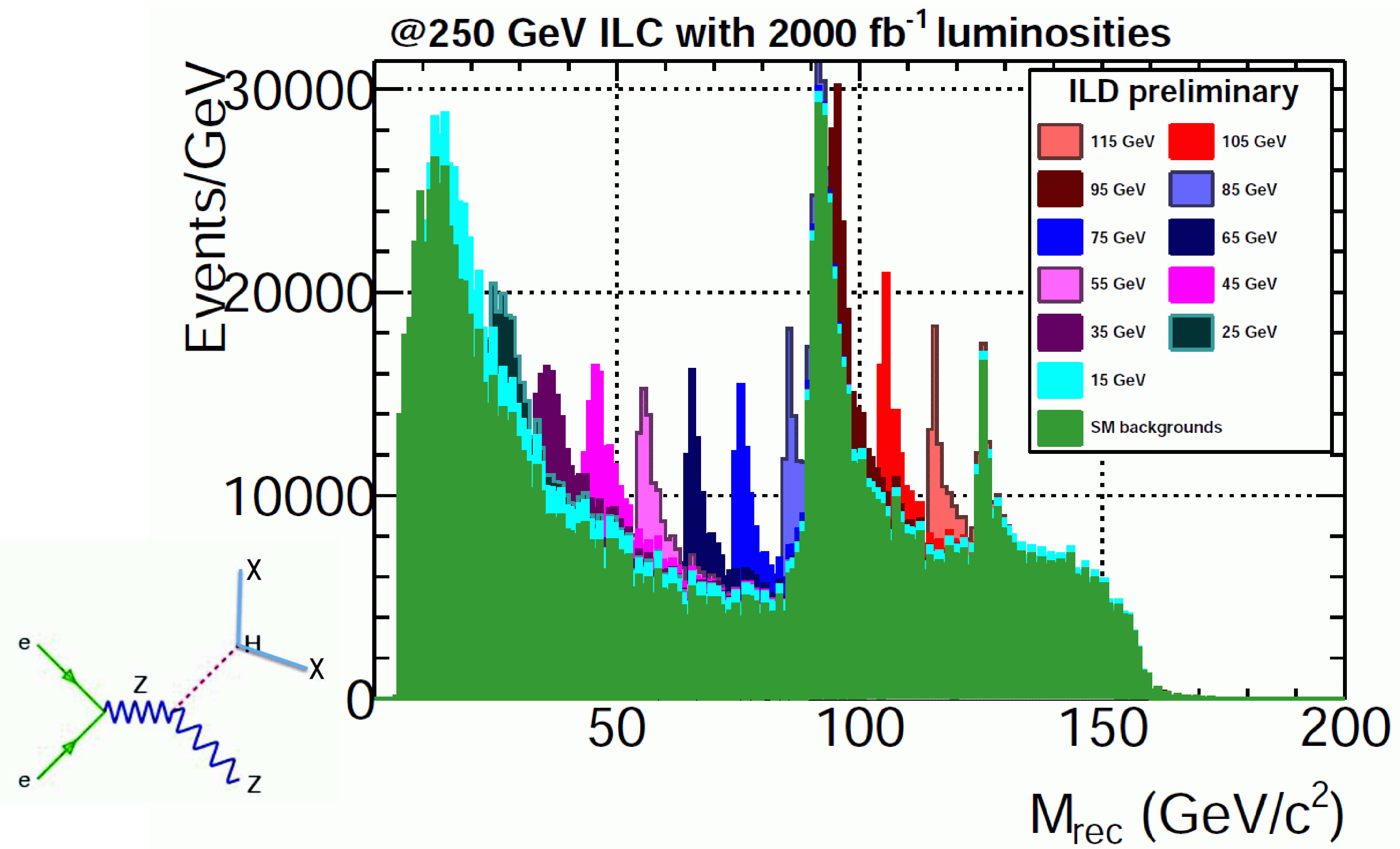
Example for discovery potential for new light states:
Sensitivity at 250 GeV with 500 fb^{-1} to a new light Higgs



⇒ Higgs factory at 250 GeV will explore a large untested region!

[*Taken from G. Weiglein ’18*]

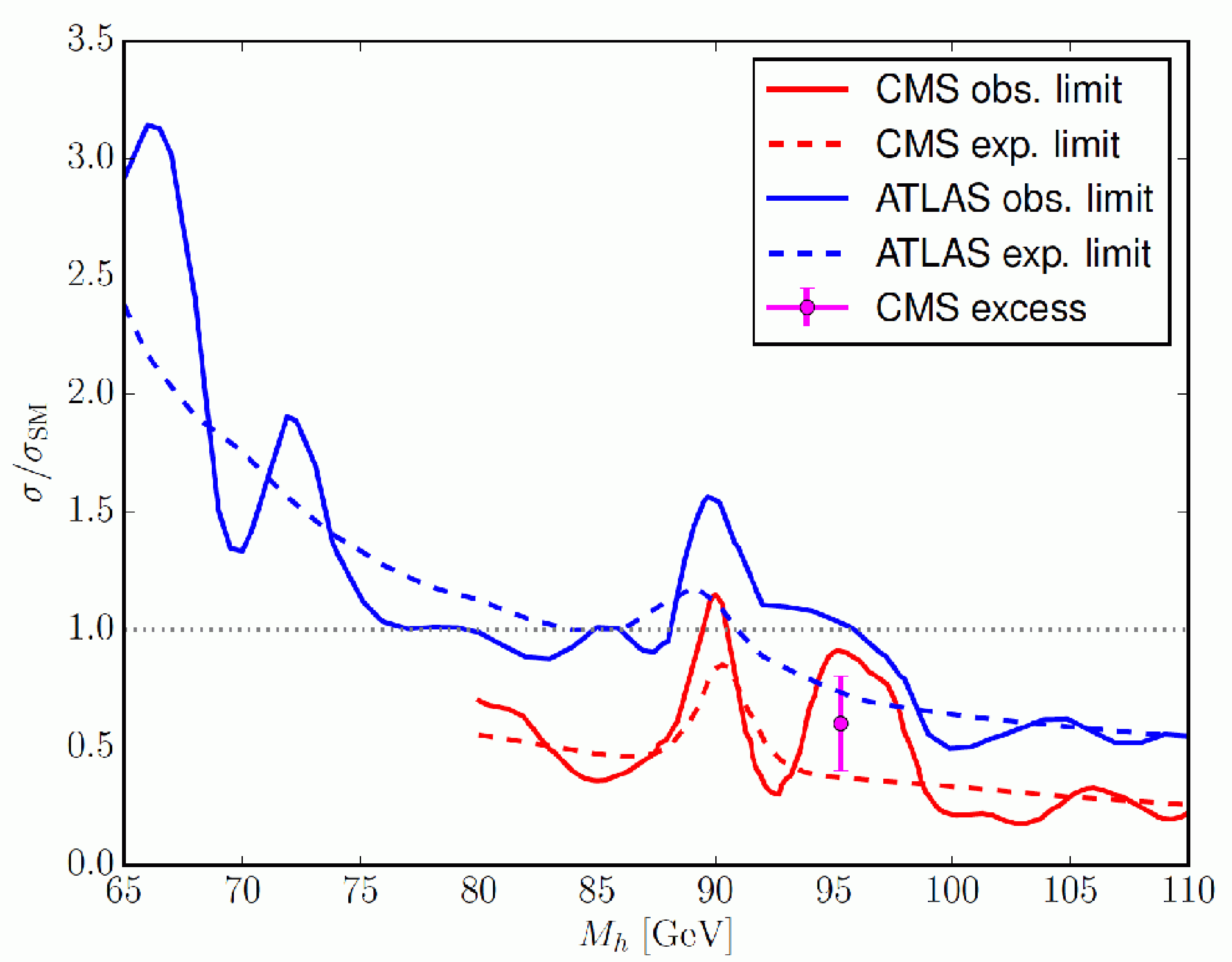
Search for invisibly decaying light Higgses via recoil method: [*Y. Wang et al. '18*]



Case study: Search for $pp \to \phi \to \gamma\gamma$ with $m_\phi \leq 125$ GeV

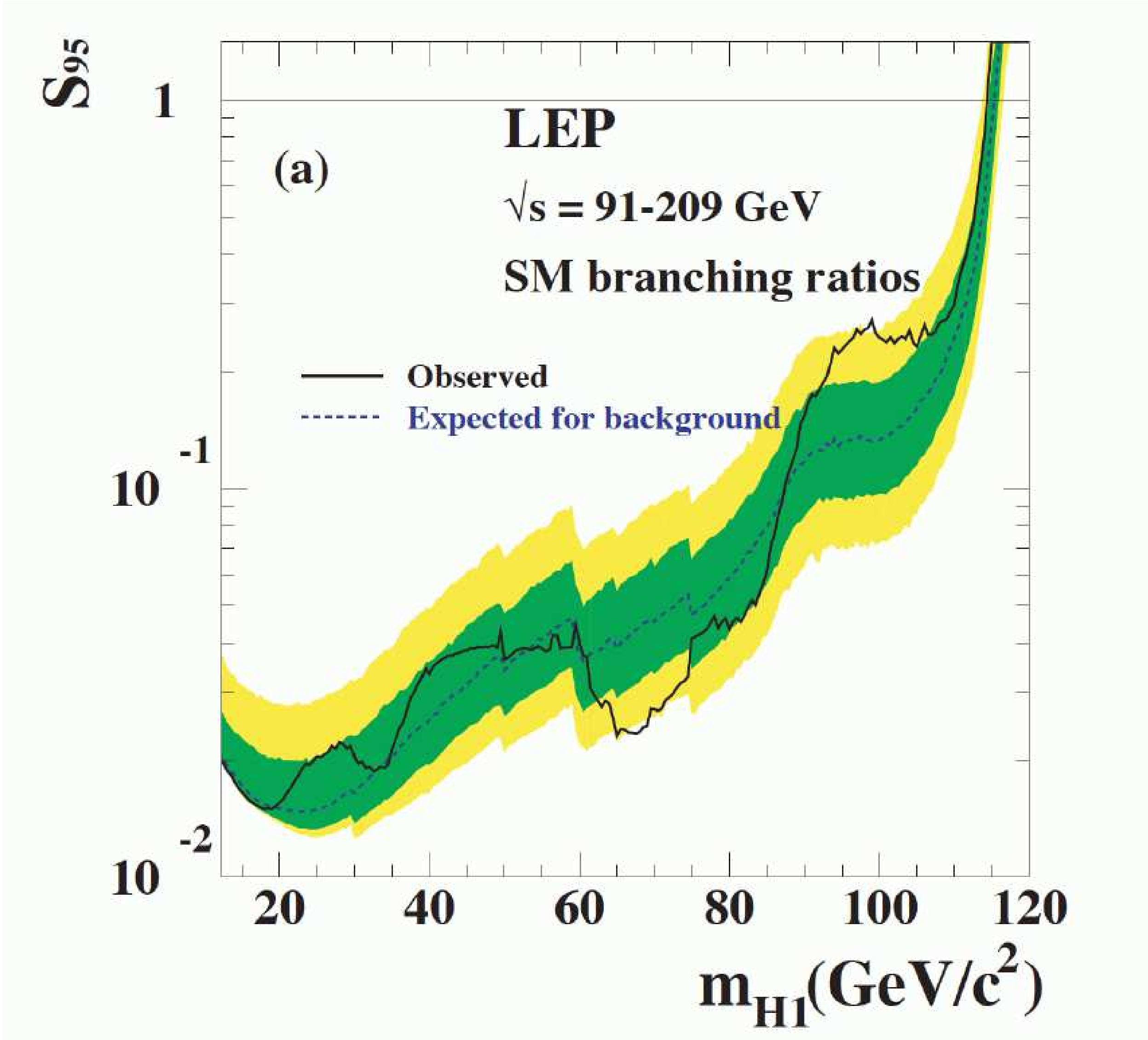
[CMS '17, ATLAS '18, S.H., T. Stefaniak '18]

$\mu_{\text{CMS}} = 0.6 \pm 0.2$



⇒ if there is something, it would look exactly like this!

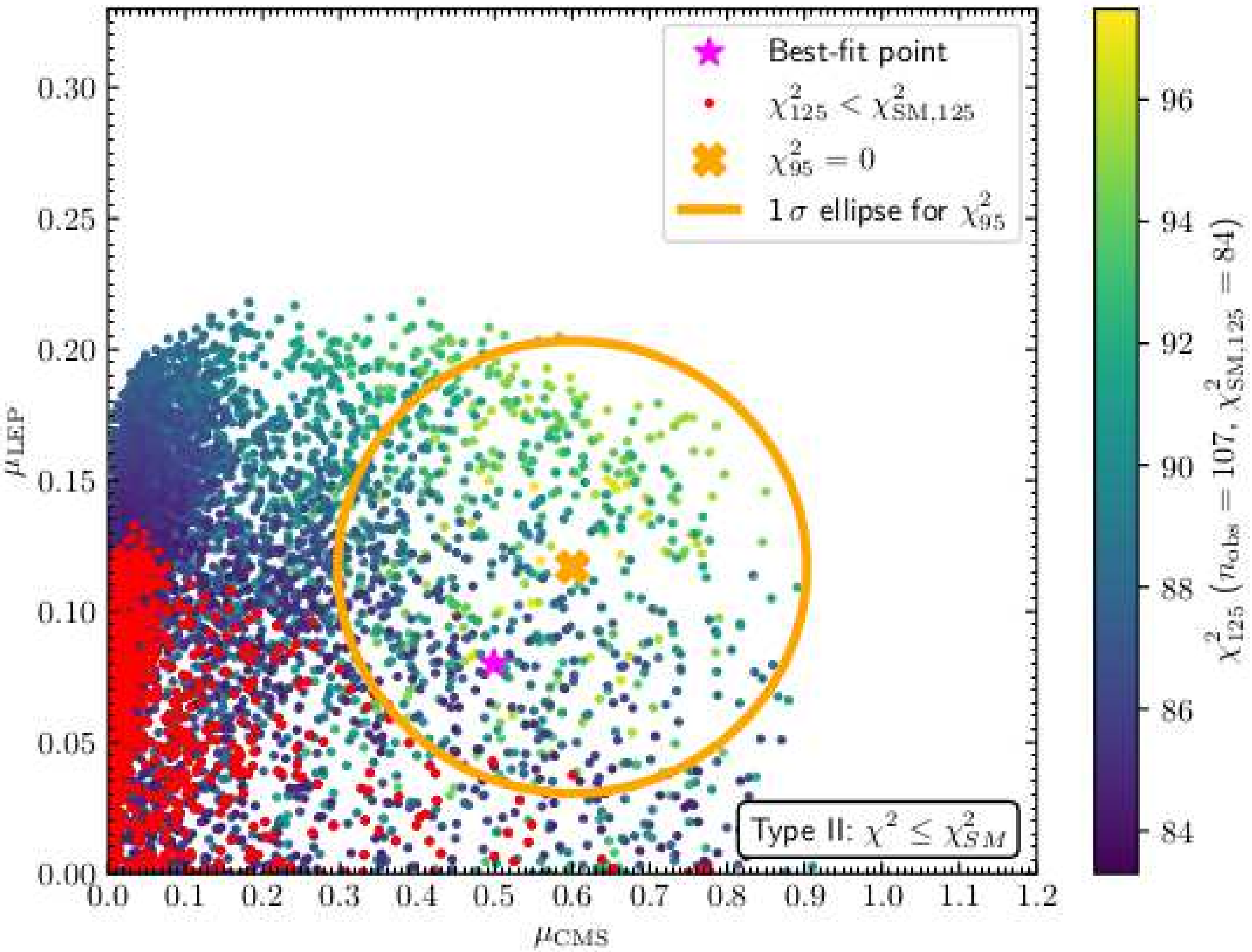
Remember the LEP excess?



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

Fitting the excesses in the N2HDM: [T. Biekötter, S.H., G. Weiglein – PRELIMINARY]

type I: NO type II: BEST type III: NO type IV: OK ⇒ SUSY?

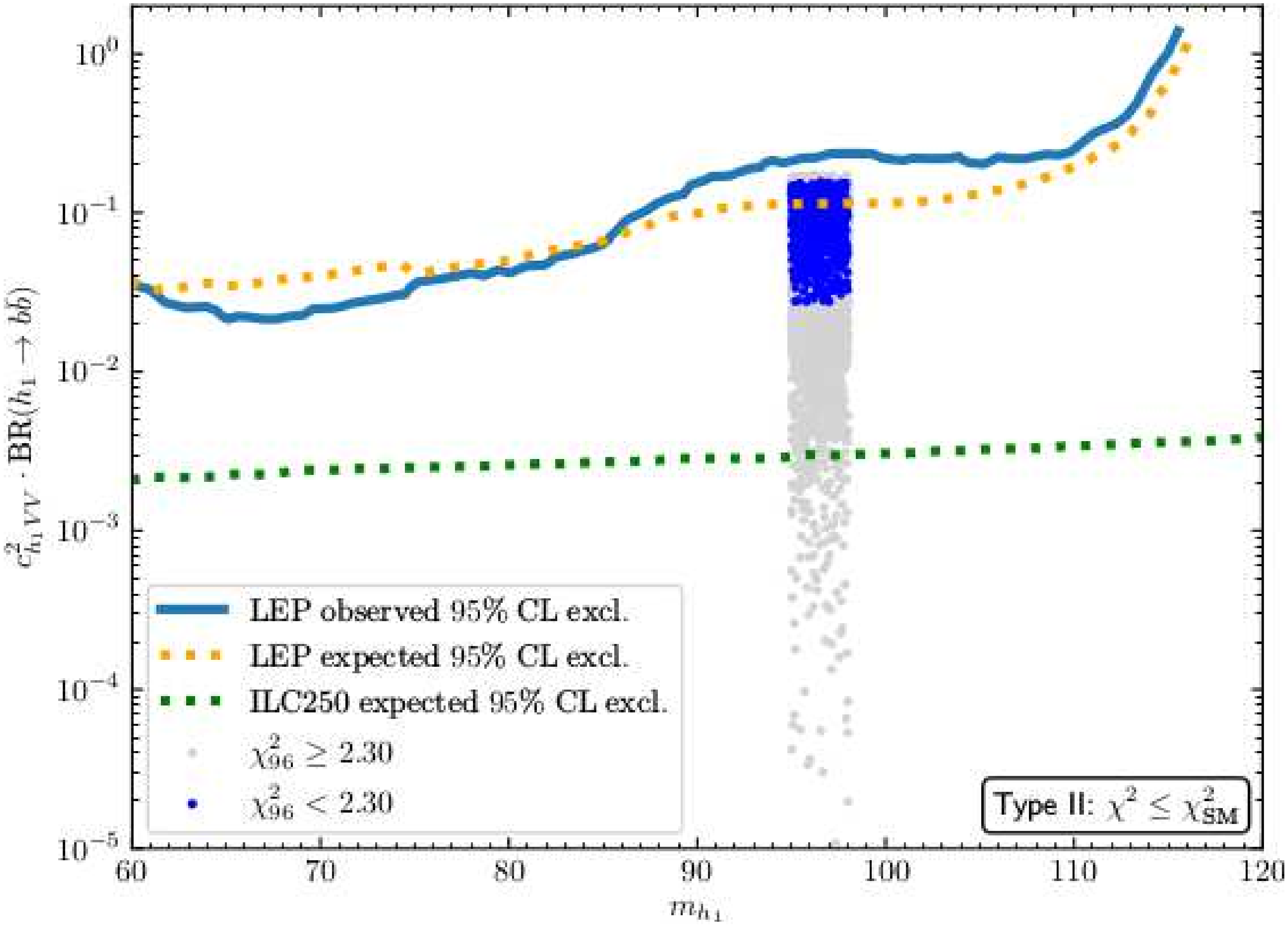


⇒ excesses well fitted, with good χ^2_{125}

red points have $\chi^2_{125} < \chi^2_{\rm SM,125}$

ILC production of the light scalar in the N2HDM type II:

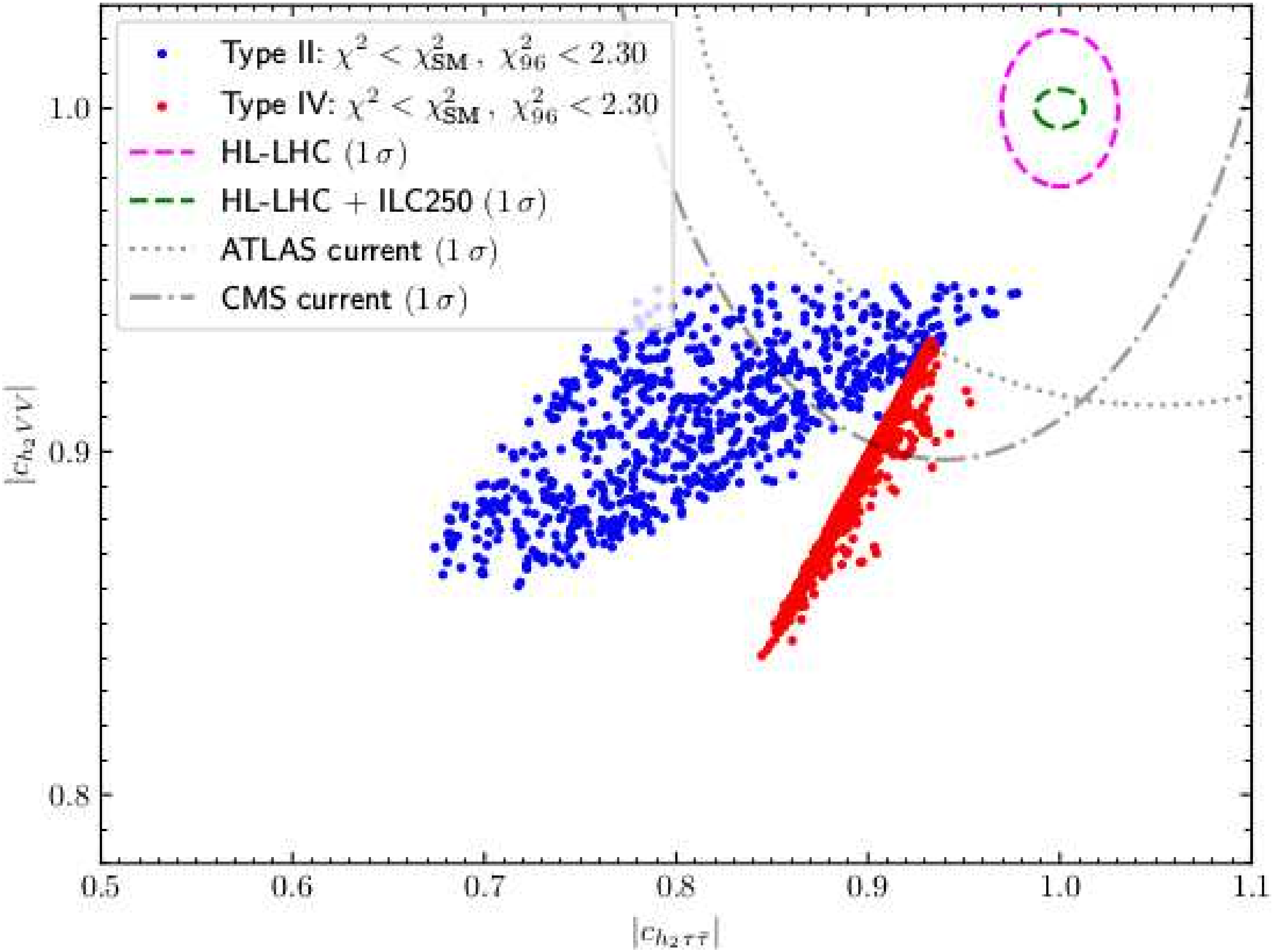
[*T. Biekötter, S.H., G. Weiglein – PRELIMINARY*]



$\Rightarrow$ new state easily in the reach of the ILC $\Rightarrow$ coupling measurements

HL-LHC/ILC h_{125} coupling measurements

[*T. Biekötter, S.H., G. Weiglein – PRELIMINARY*]



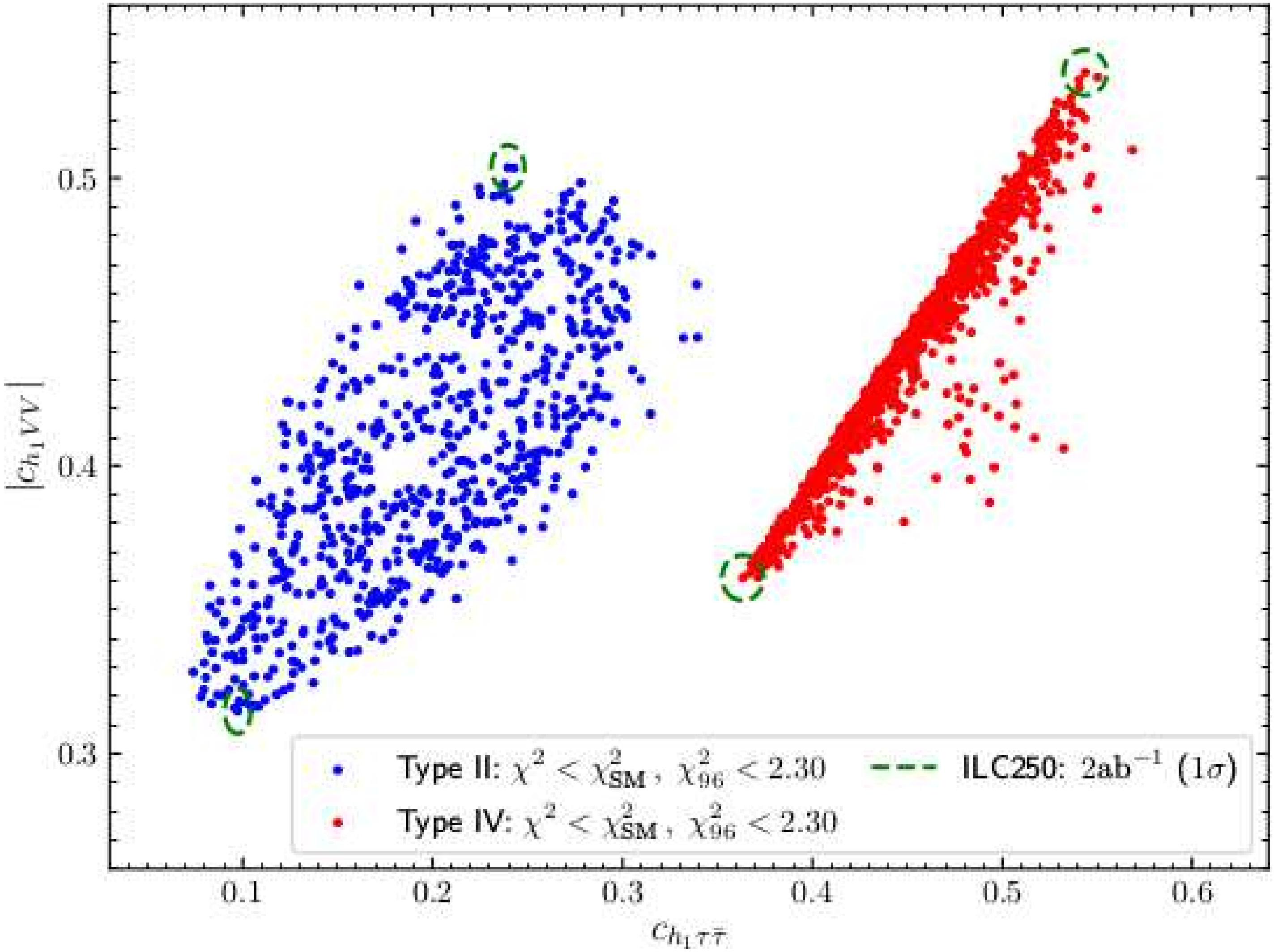
⇒ type II and IV show strong deviations from SM

⇒ N2HDM can always be distinguished from SM at the ILC

ILC ϕ_{96} coupling measurements at the ILC

[*T. Biekötter, S.H., G. Weiglein – PRELIMINARY*]

green circles: ϕ_{96} coupling precision at the ILC250



$\Rightarrow$ model distinction possible via coupling measurements at the ILC

5. Conclusinos

- The discovered Higgs boson cannot be the SM Higgs boson
  - check changed properties of h_{125}
  - search for additional Higgs bosons above and below 125 GeV

- Experimental hints (as motivation/toy examples)
  - $t\bar{t}$ (CMS) and $\tau^+\tau^-$ (ATLAS) at $\sim$ 400 GeV
  - $\gamma\gamma$ (CMS) and $b\bar{b}$ (LEP) at $\sim$ 96 GeV

- ILC physics opportunities:
  - ILC direct detection (at least) up to $\sqrt{s}/2$ (400 $<$ 500 :-)
  - ILC250: light Higgs bosons up to $\sim$ 160 GeV detectable
  - ILC250/500: h_{125} coupling meas. are likely to see a deviation
    $\Rightarrow$ ILC can set upper limits on NP scales
  - ILC250: precision study of light Higgs bosons possible
    $\Rightarrow$ to disentanble the underlying model


Further Questions?

Possible hint for heavy Higgses in the N2HDM:

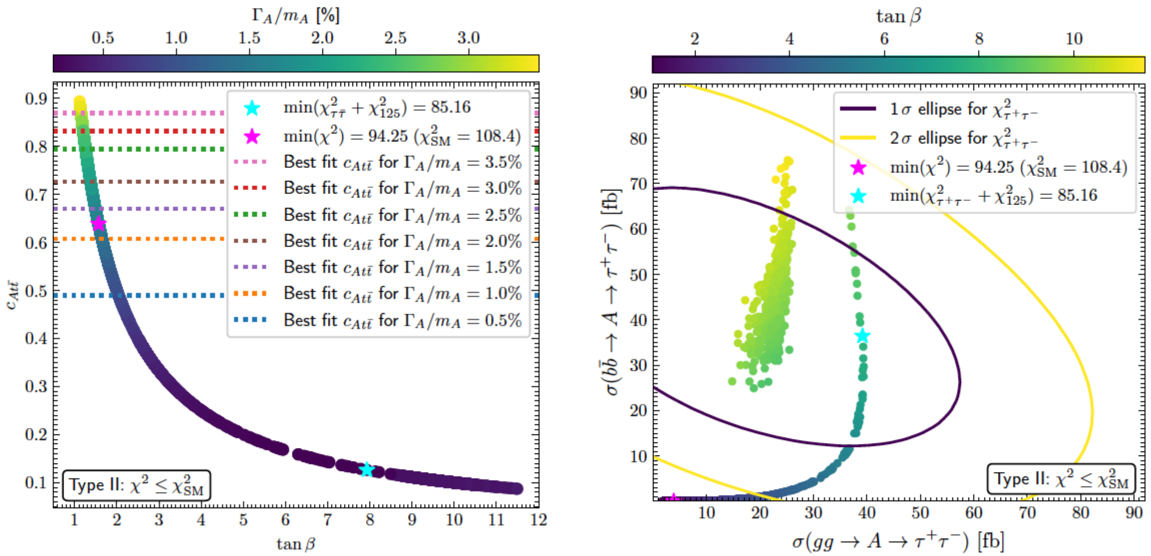
[*taken from T. Biekötter '21*]

A 400 GeV pseudoscalar in the type II N2HDM

$$\chi^2 = \chi^2_{125} + \chi^2_{t\bar{t}} + \chi^2_{\tau^+\tau^-} \text{ , we demand: } \chi^2 \leq \chi^2_{\rm SM}$$

$$20 \text{ GeV} \leq m_{h_{a,c}} \leq 1000 \text{ GeV} , \quad m_{h_b} = 125.09 \text{ GeV} , \quad m_A = 400 \text{ GeV} ,$$

$$550 \text{ GeV} \leq m_{H^\pm} \leq 1000 \text{ GeV} , \quad 10 \text{ GeV} \leq v_s \leq 1500 \text{ GeV} , \quad 0.5 \leq \tan\beta \leq 12.5$$



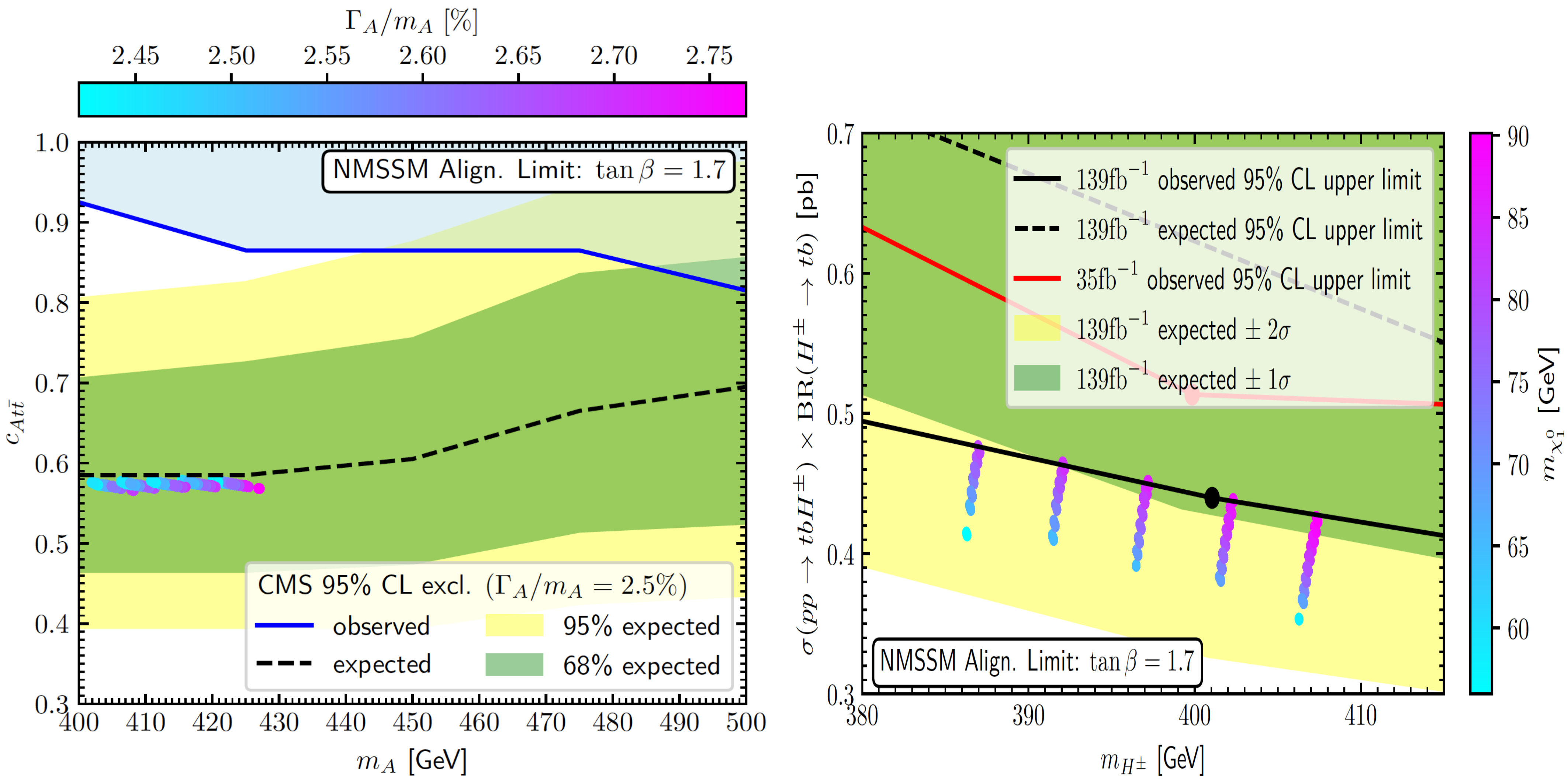
(Also the "$A \to Zh$" excess can be realized)
$\to$ Later

Both the $t\bar{t}$ and the $\tau^+\tau^-$ excesses can be realized, but not simultaneously

$\tan\beta \lesssim 2.5$ for $t\bar{t}$ excess
$\tan\beta \gtrsim 5.5$ for $\tau^+\tau^-$ excess

[*T. Biekötter, A. Grohsjean, S.H., C. Schwanenberger, G. Weiglein '21*]

Possible hint for heavy Higgses in the NMSSM (with $\tan\beta = 1.7$):



$\Rightarrow$ $t\bar{t}$ excess can be explained in the NMSSM (with $\tan\beta \sim 1.7$)

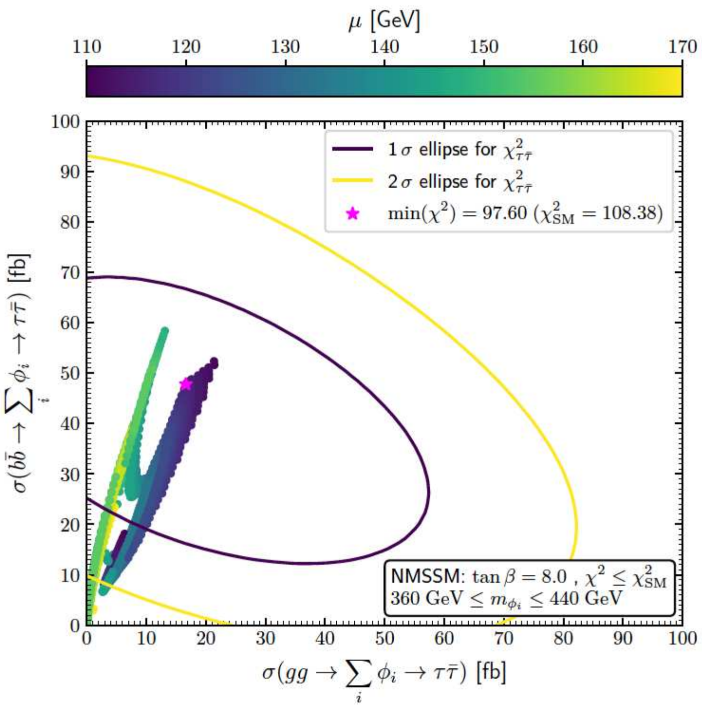
[*T. Biekötter, A. Grohsjean, S.H., C. Schwanenberger, G. Weiglein '21*]

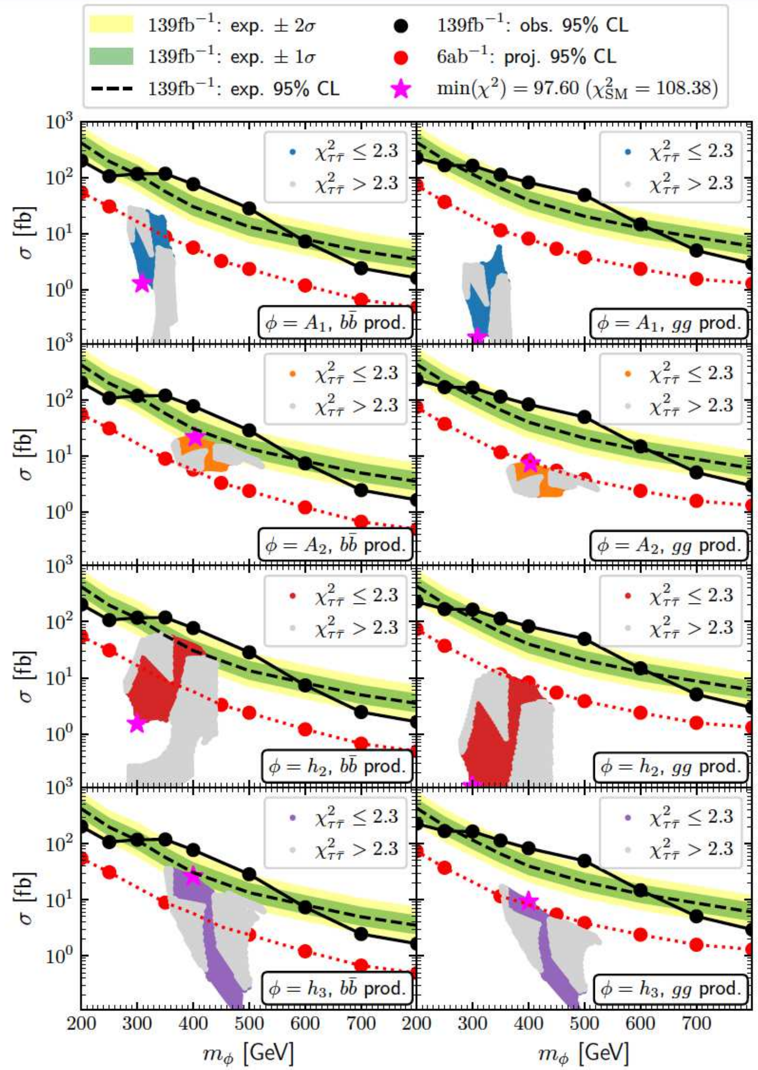
Possible hint for heavy Higgses in the NMSSM (with $\tan\beta = 8$):

[*taken from T. Biekötter '21*]

A pseudoscalar at ~ 400 GeV in the NMSSM

$\tau^+\tau^-$ **excess** $\to$ moderate $\tan\beta = 8$





Interference effects not important:

$$m_{h_3} - m_{h_2} \gg \Gamma_{h_2} + \Gamma_{h_3}$$

$$m_{A_2} - m_{A_1} \gg \Gamma_{A_1} + \Gamma_{A_2}$$

[*T. Biekötter, A. Grohsjean, S.H., C. Schwanenberger, G. Weiglein '21*]

What about the "real hints" at $\sim$ 400 GeV? $\rightarrow$ NMSSM:

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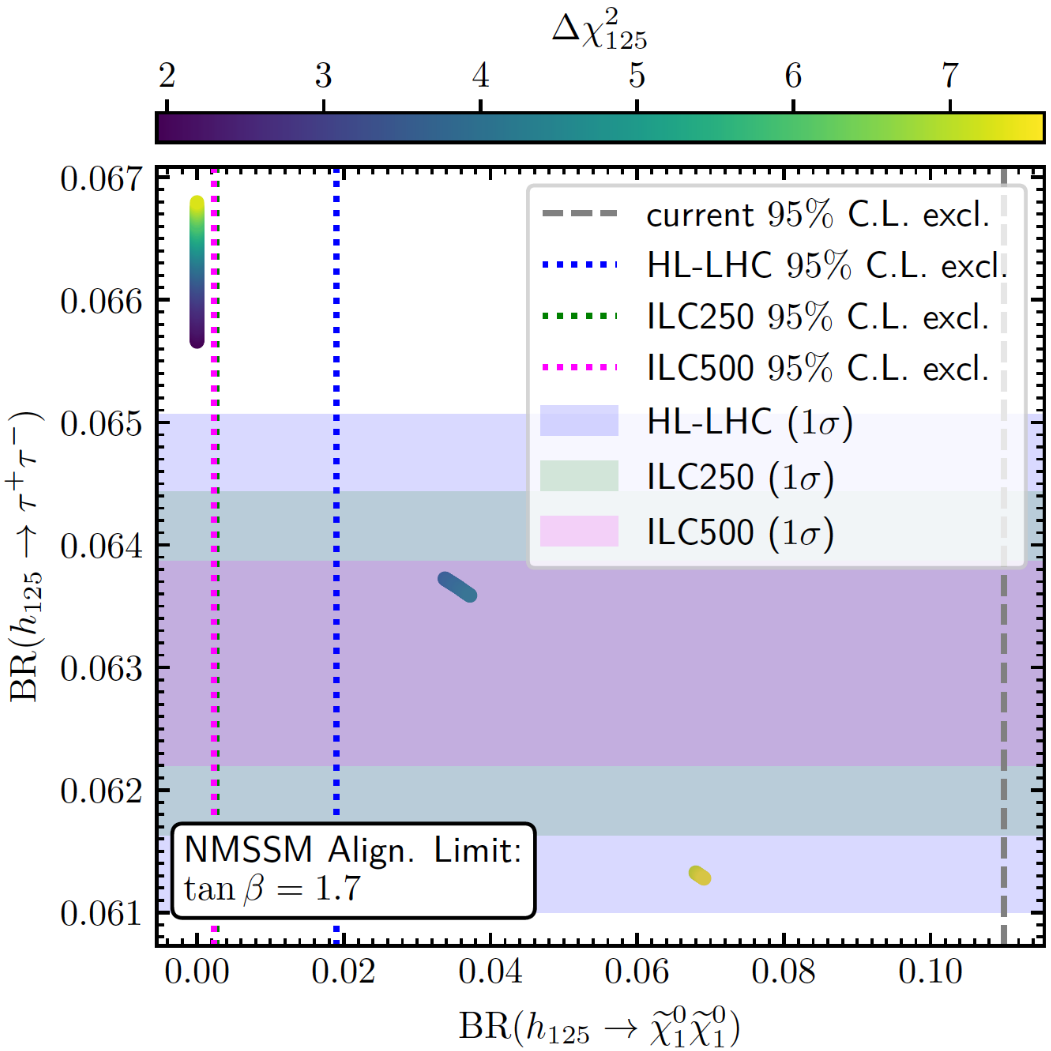
[T. Biekötter, A. Grohsjean, S.H., C. Schwanenberger, G. Weiglein '21]

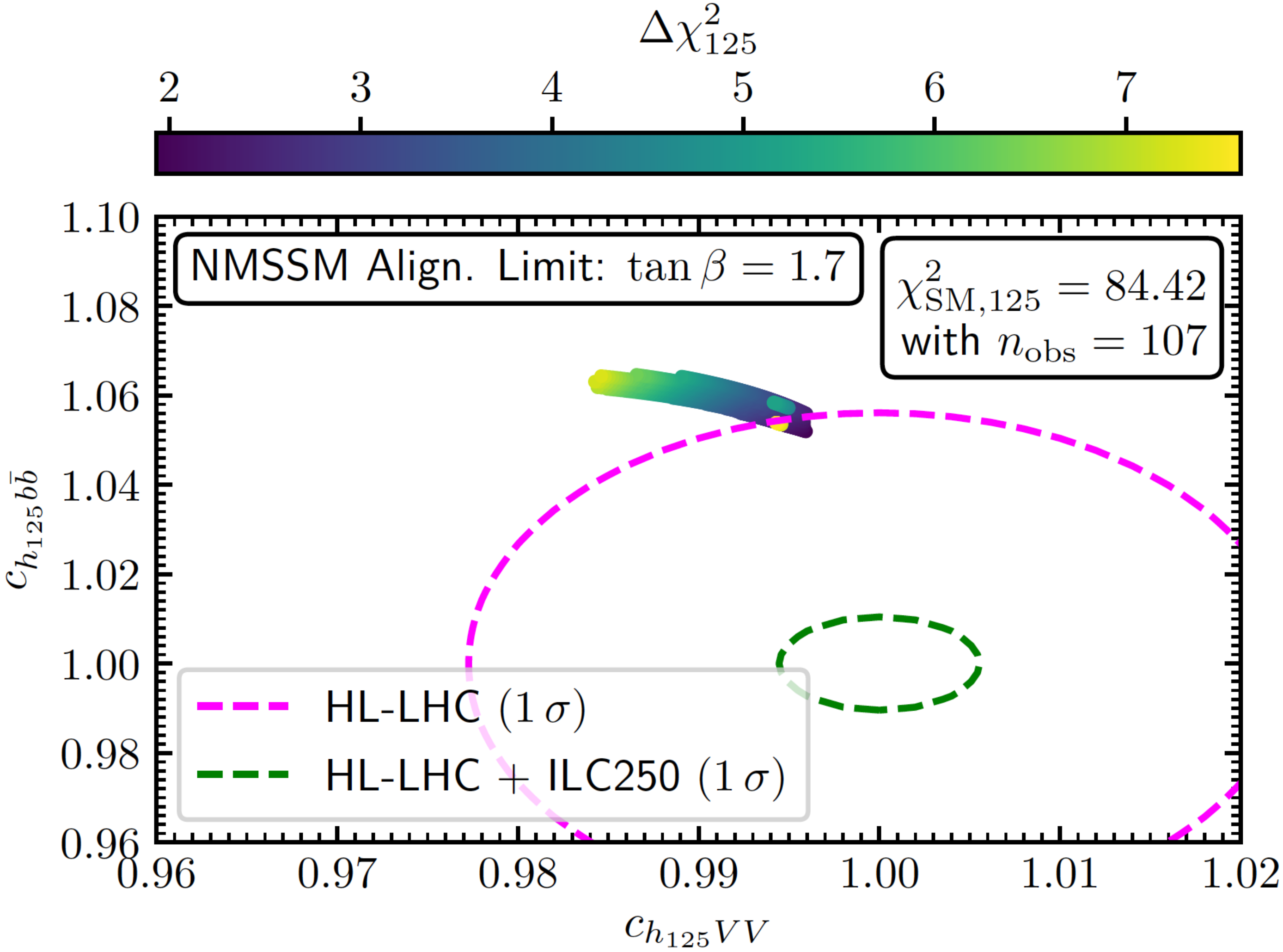


$\Rightarrow$ HL-LHC can test $h_{125} \to \tilde{\chi}^0_1\tilde{\chi}^0_1$ (small part of allowed parameter space)

$\Rightarrow$ ILC can test all points via $h_{125} \to \tau^+\tau^-$ (and via $h_{125} \to \tilde{\chi}^0_1\tilde{\chi}^0_1$)

What about the "real hints" at ~ 400 GeV? → NMSSM:

[T. Biekötter, A. Grohsjean, S.H., C. Schwanenberger, G. Weiglein '21]



⇒ HL-LHC cannot resolve the h_{125} coupling deviations

⇒ ILC can easily test this scenario via $c_{h_{125}VV}$ and $c_{h_{125}bb}$

SUSY realizations

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Q: Can the models fit the excesses despite the additional SUSY constraints on the Higgs sector **???**

What about the NMSSM?

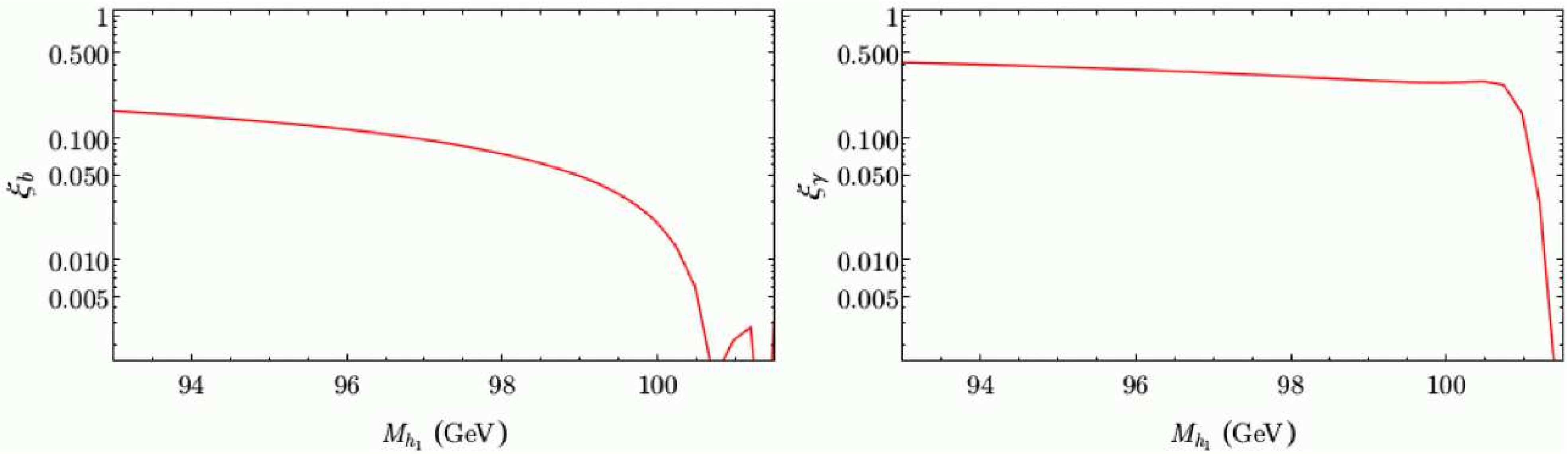
[*F. Domingo, S.H., S. Passehr, G. Weiglein '18*]

Parameters:

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

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

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



$\Rightarrow$ both excesses can be fitted simultaneously (at $1 - 1.5\,\sigma$)!

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

[*T. Biekötter, S.H., C. Muñoz '17*]

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^e_{33}	$A^e_{11,22}$
200	1500	800^2	800^2	800^2	0	0	800^2	0	0

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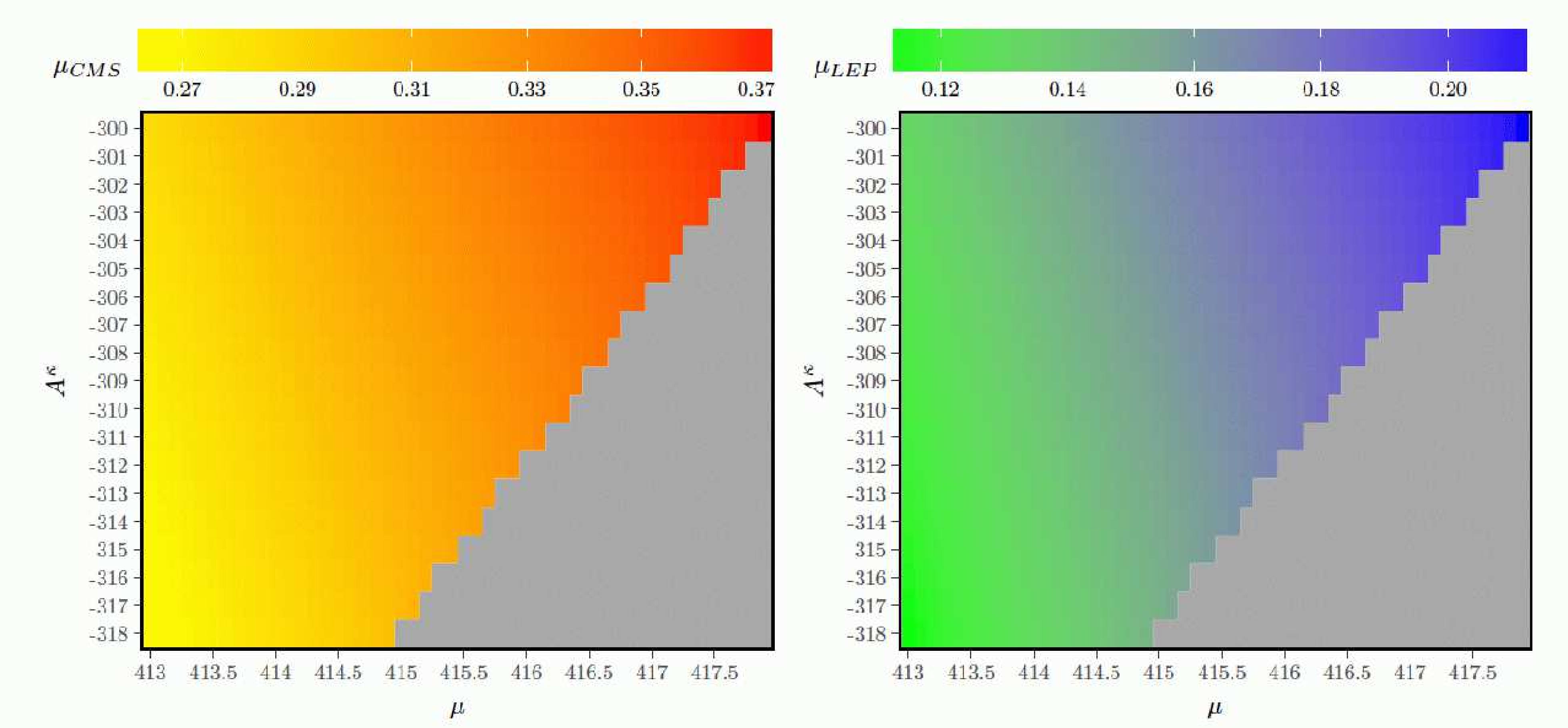
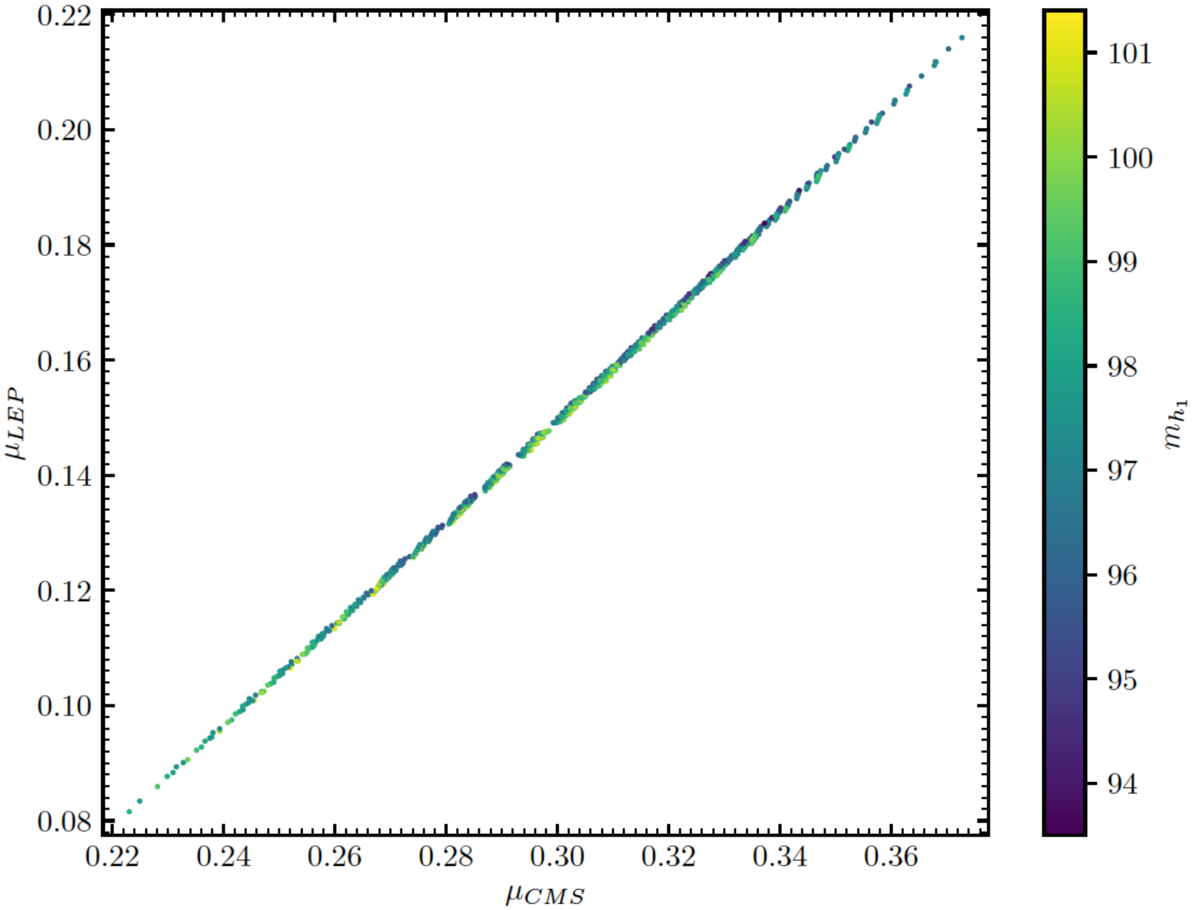


⇒ YES, WE CAN! :-)

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

Why can SUSY explain the excesses only at $1 - 1.5\,\sigma$?

[*T. Biekötter, S.H., C. Muñoz '19*]



$\Rightarrow$ SUSY enforces strong correlation!

$\Rightarrow$ note: ATLAS limits and CMS "observation"
will likely result in a lower $\mu_{\rm LHC}$!

The final challenge:
can the excesses at 400 GeV and 96 GeV be explained simultaneously?

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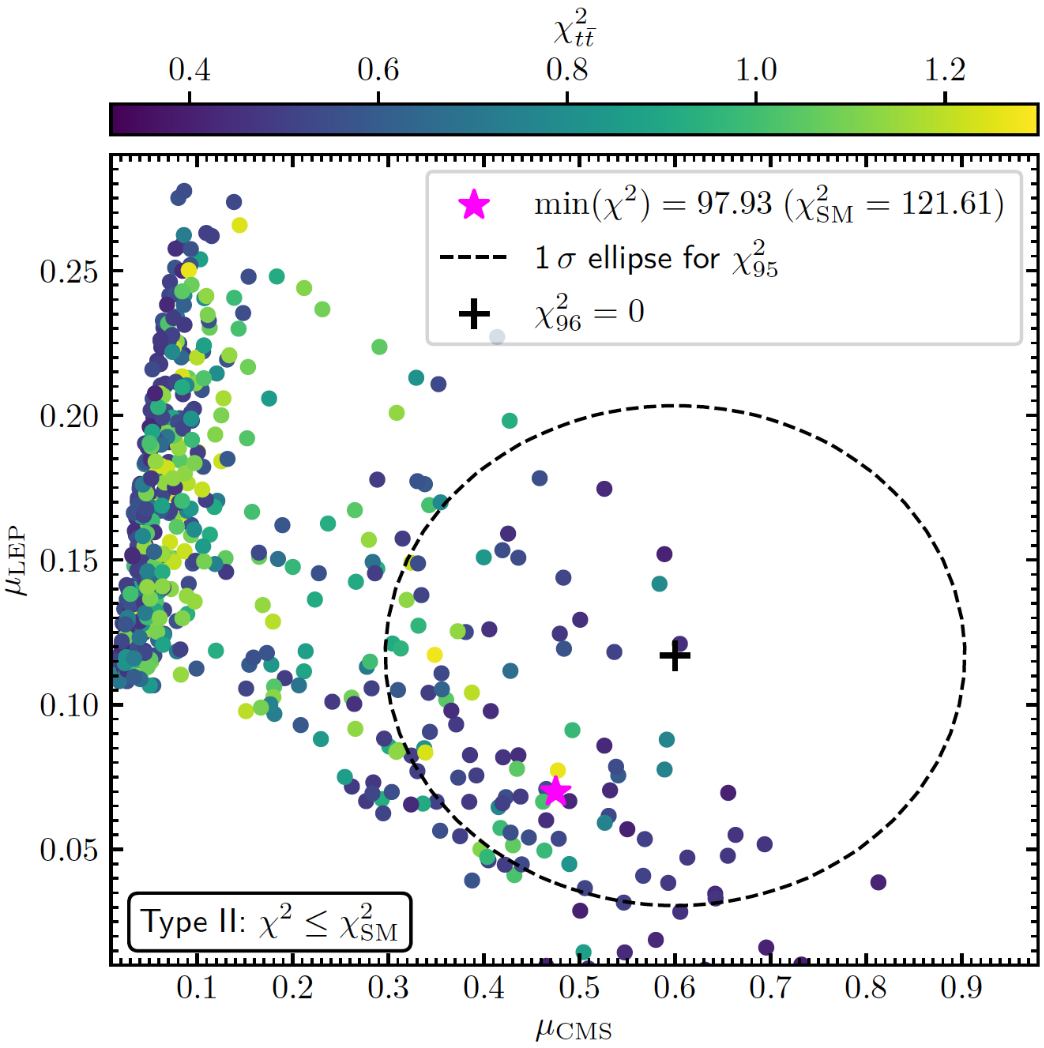
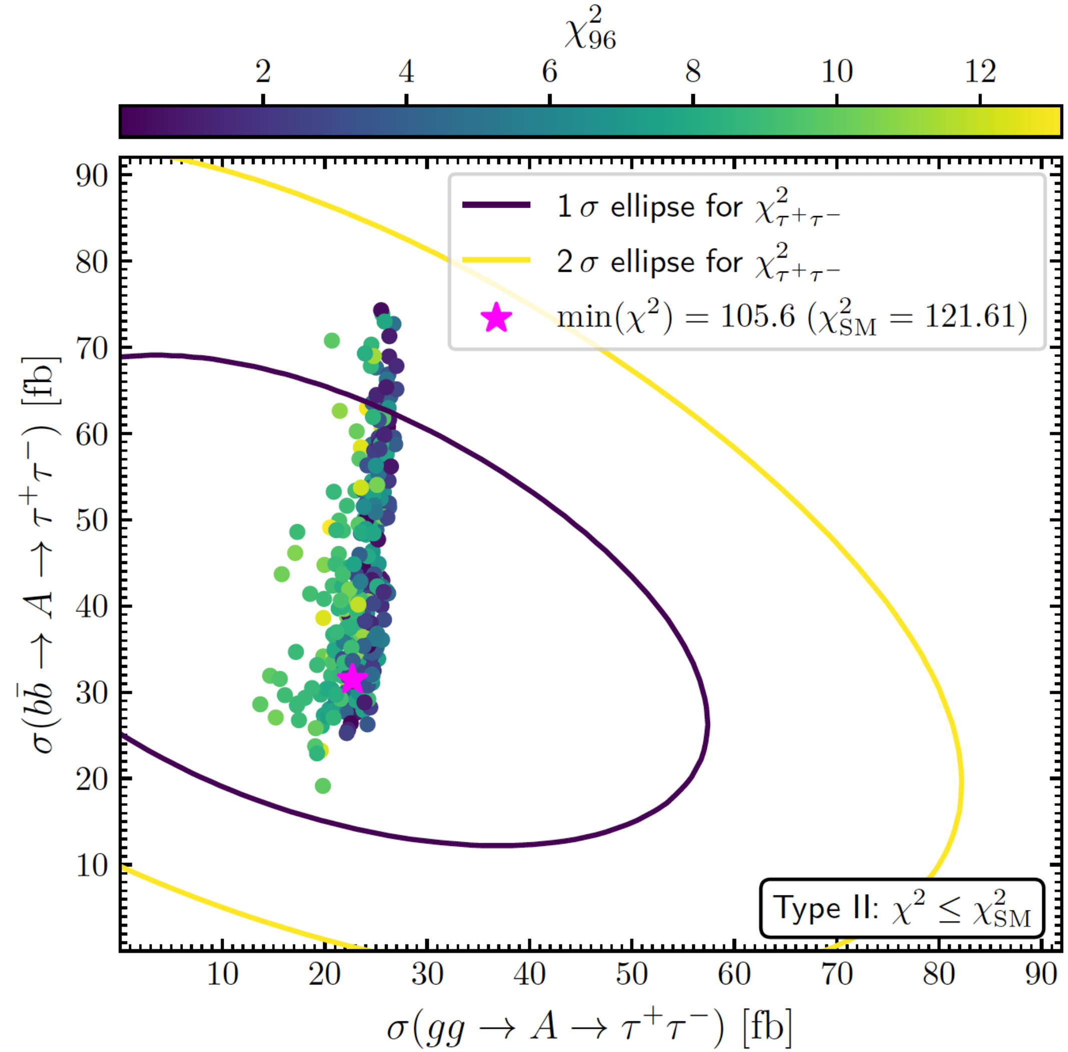
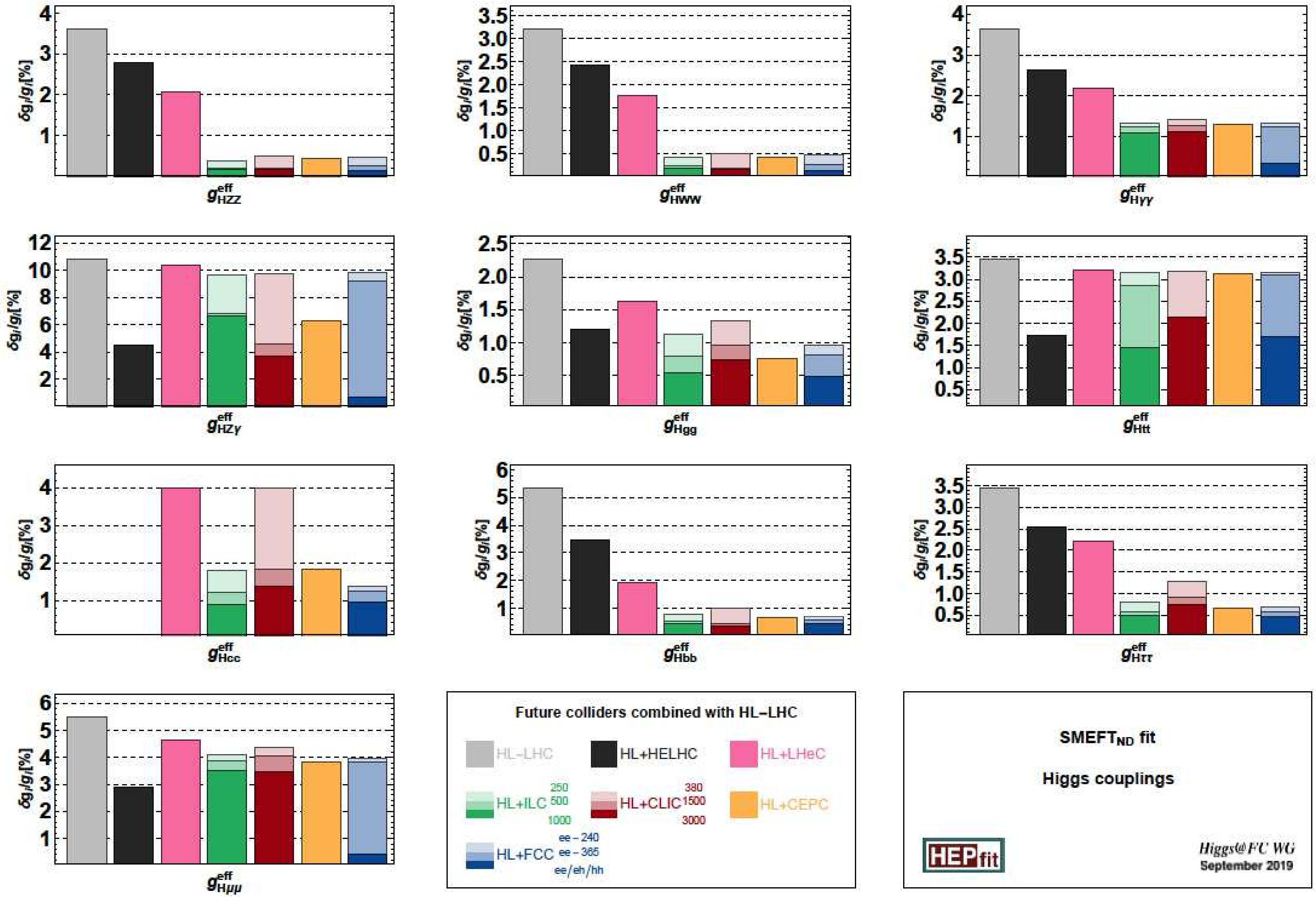
⇒ Yes, in the N2HDM





[*T. Biekötter, A. Grohsjean, S.H., C. Schwanenberger, G. Weiglein '21*]

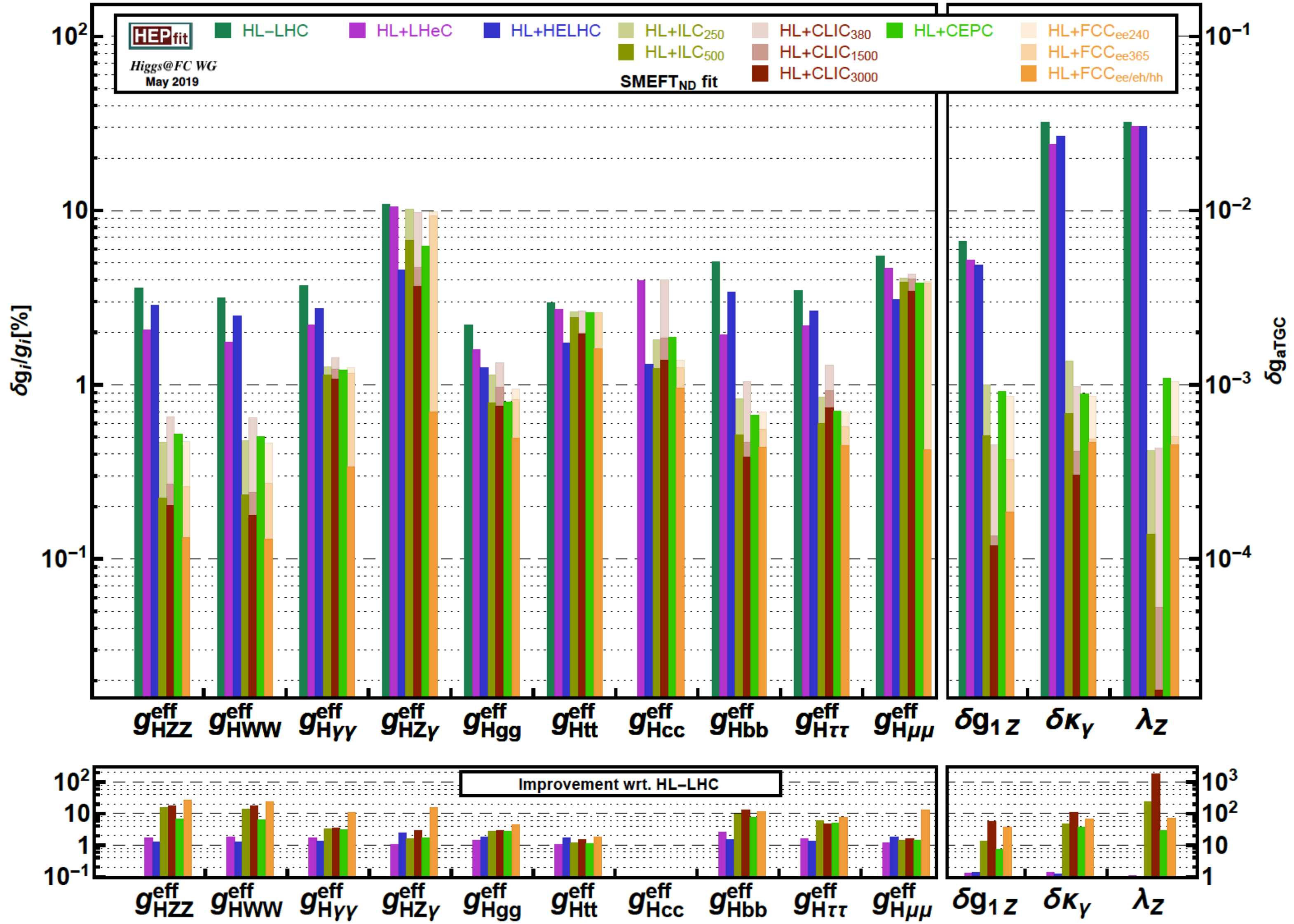
Future expections for Higgs couplings in SMEFT (I)



⇒ clear improvement with the ILC!

⇒ polarization important to disentangle BSM coupling structures

Future expections for Higgs couplings in SMEFT (II)



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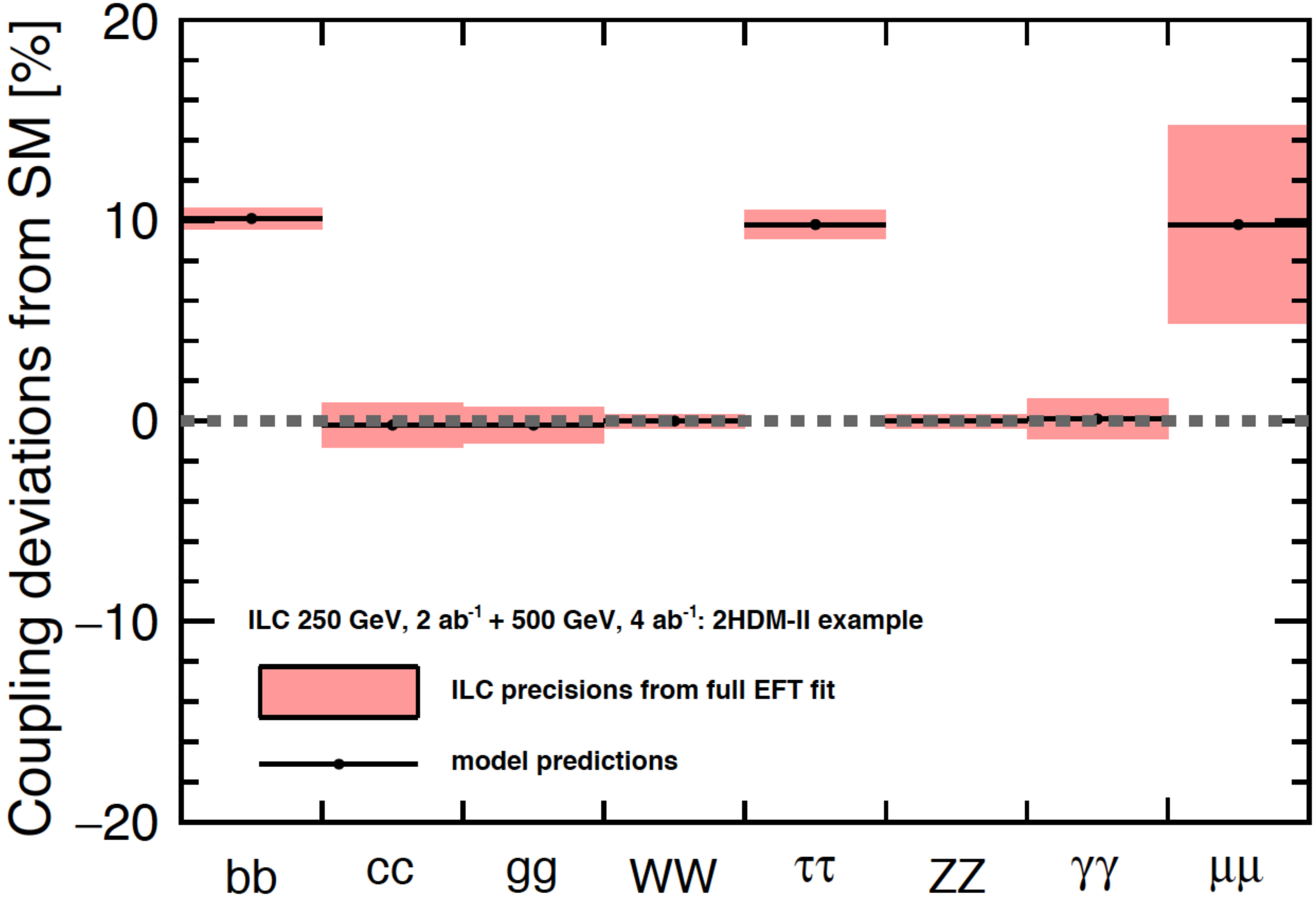
Wäscheleine I: e^+e^- precision vs. 2HDM type II prediction:

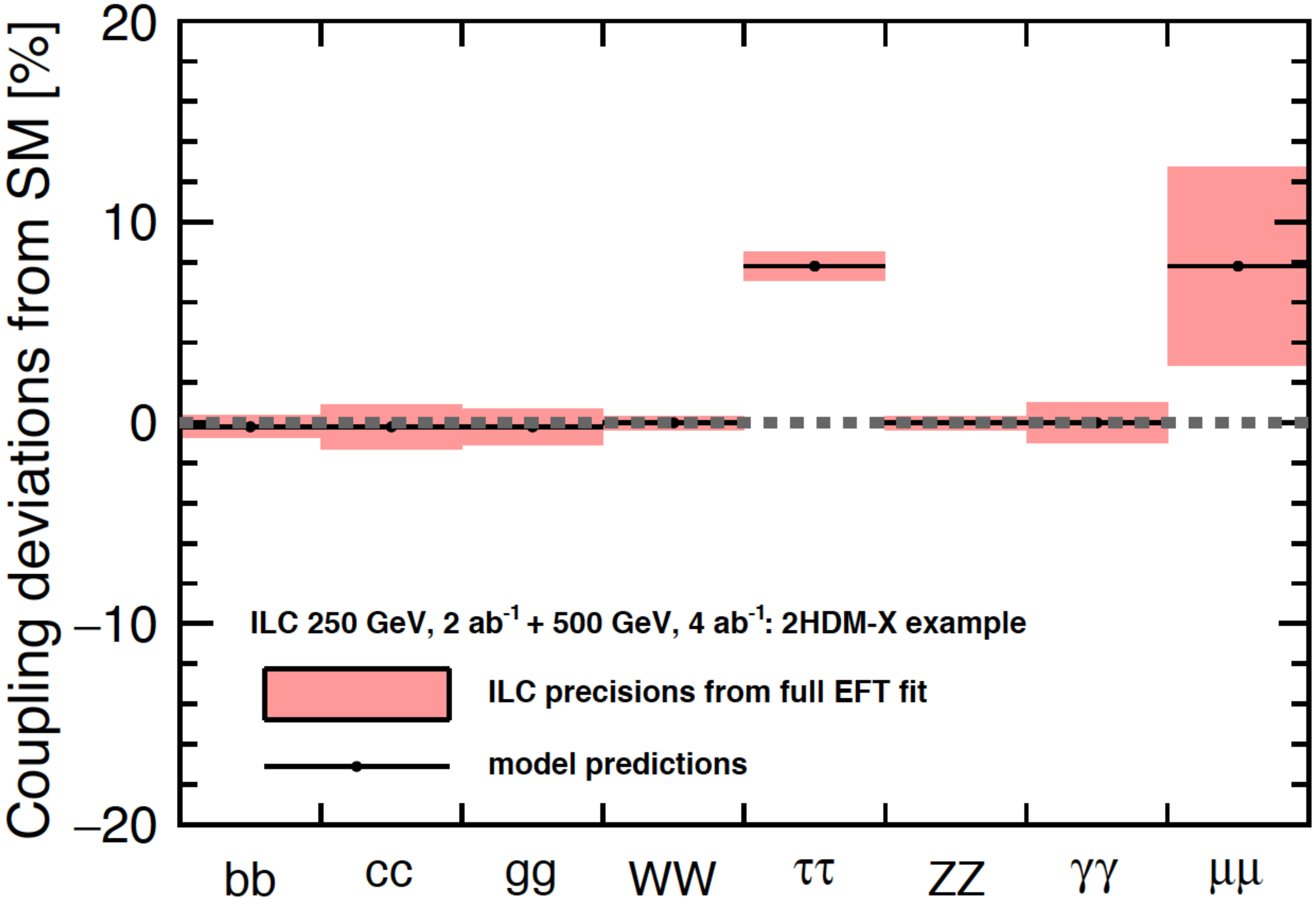
[*T. Barklow et al., '17*]



⇒ clear pattern, distinctive for 2HDM type II?!

Wäscheleine II: e^+e^- precision vs. 2HDM type X prediction:

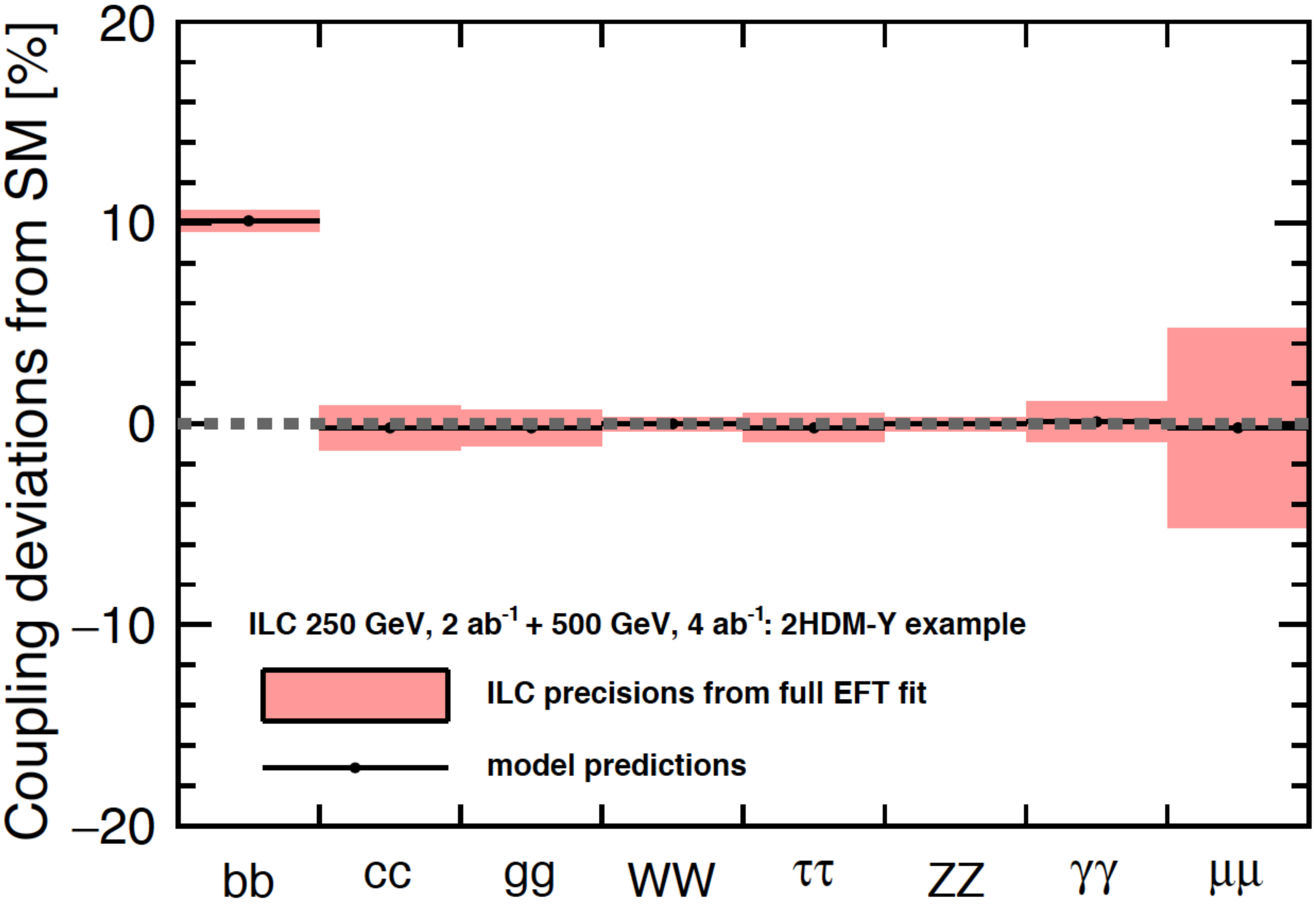
[*T. Barklow et al., '17*]



⇒ clear pattern, distinctive for 2HDM type X?!

Wäscheleine III: e^+e^- precision vs. 2HDM type Y prediction:

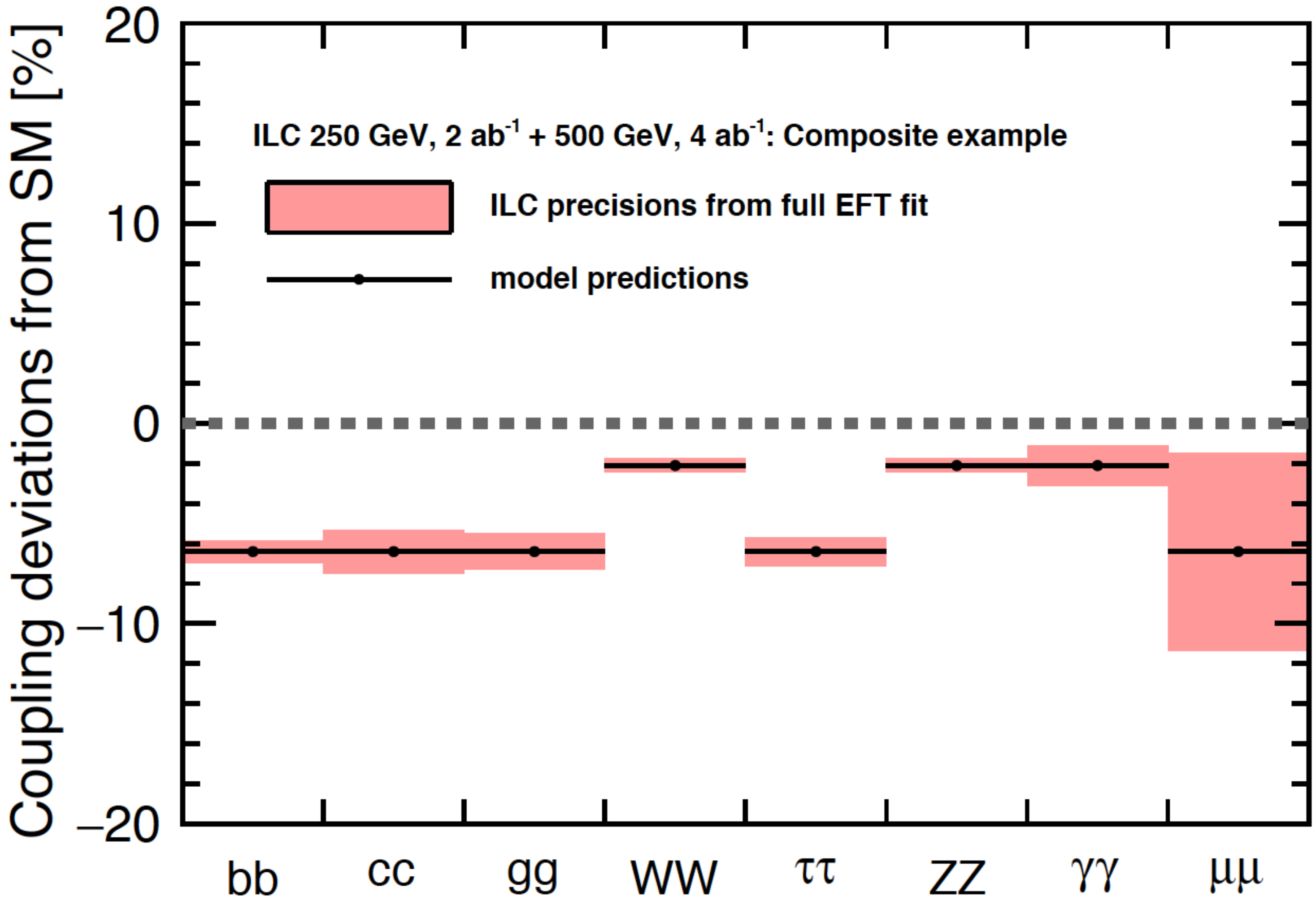
[*T. Barklow et al., '17*]



⇒ clear pattern, distinctive for 2HDM type Y?!

Wäscheleine IV: e^+e^- precision vs. Composite Higgs prediction:

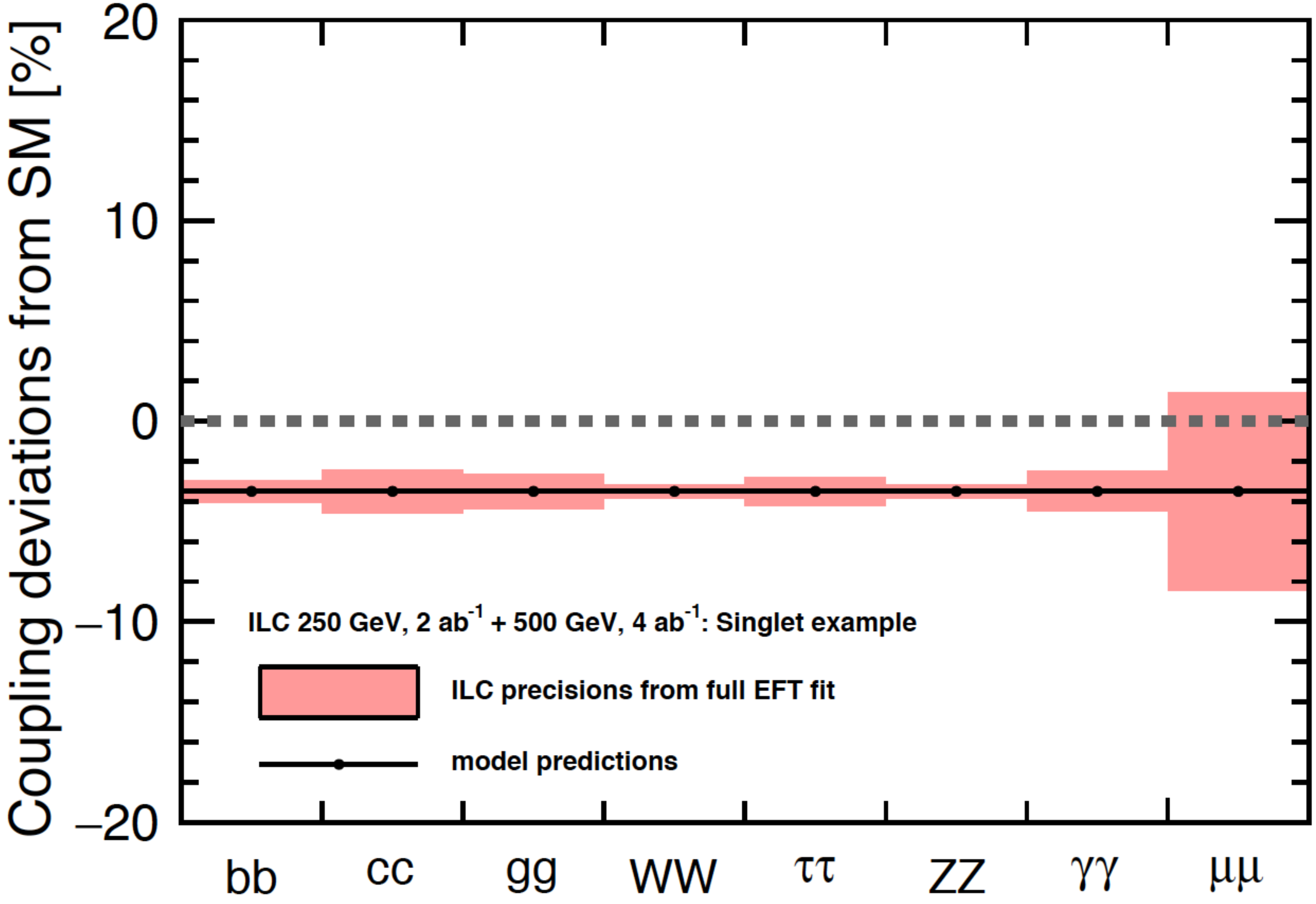
[*T. Barklow et al., '17*]



⇒ clear pattern, distinctive for Composite Higgs?!

Wäscheleine V: e^+e^- precision vs. HxSM prediction:

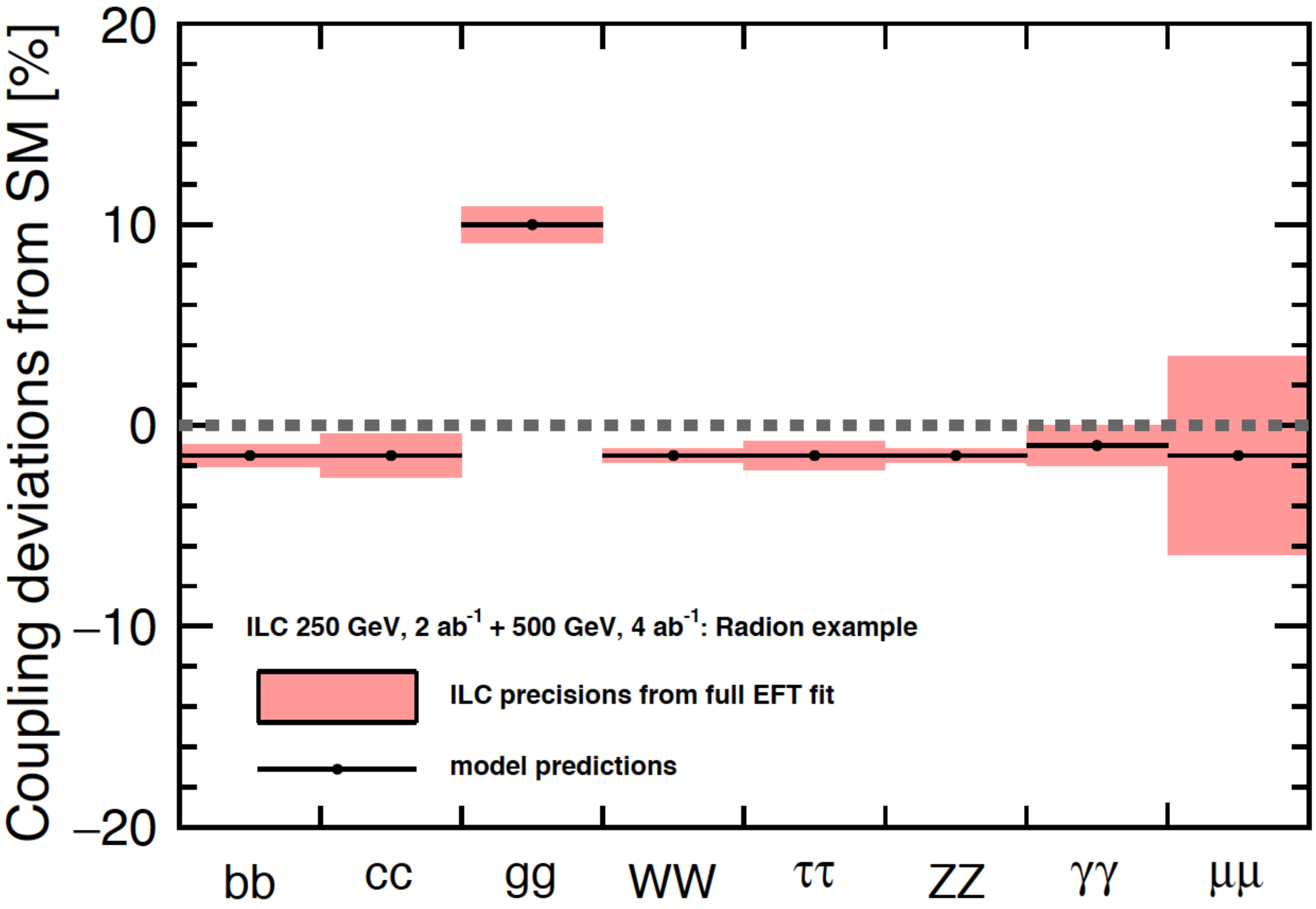
[*T. Barklow et al., '17*]



⇒ clear pattern, distinctive for HxSM?!

Wäscheleine VI: e^+e^- precision vs. Higgs-Radion prediction:

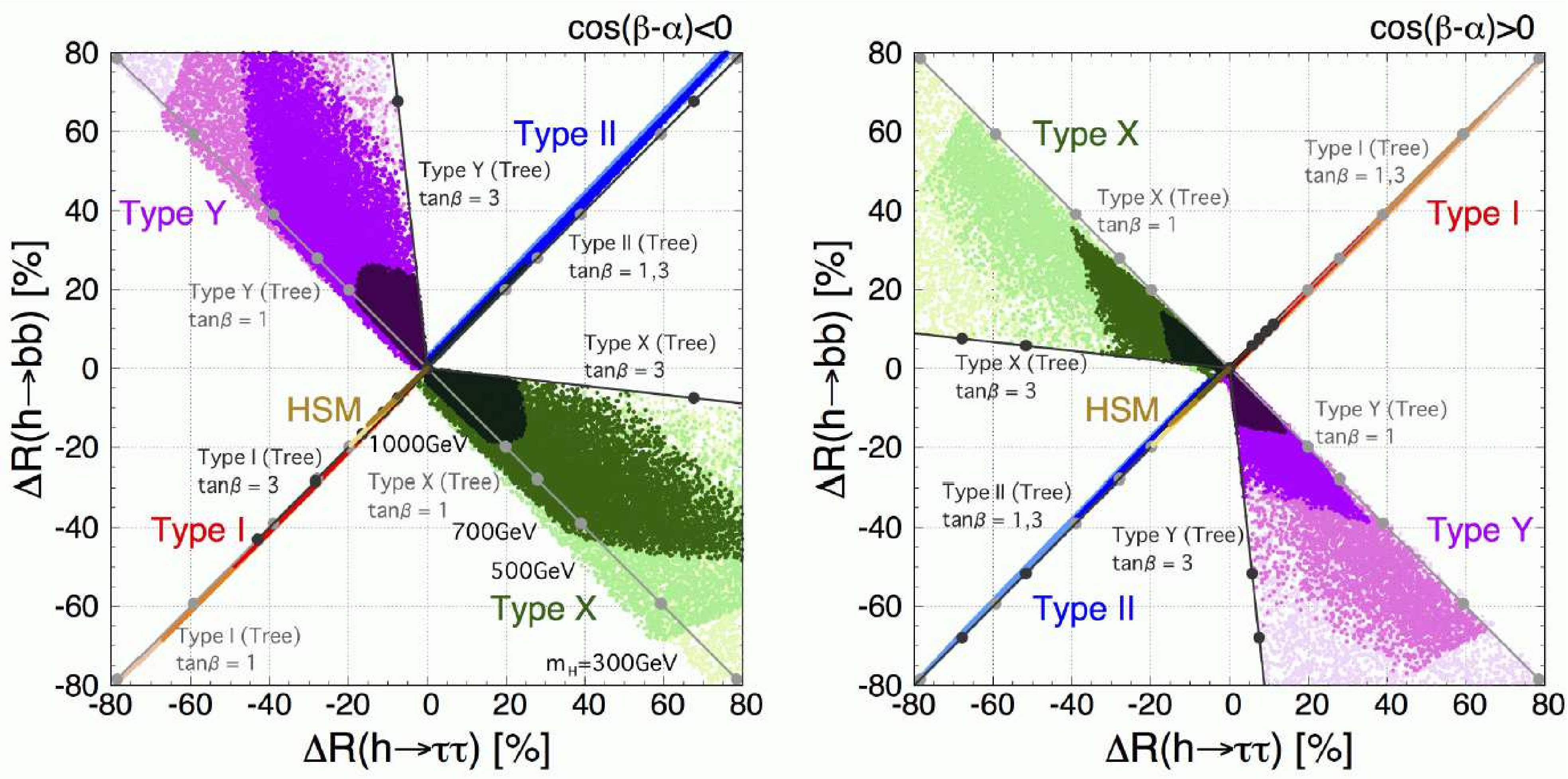
[*T. Barklow et al., '17*]



⇒ clear pattern, distinctive for Higgs Radion?!

2HDM example (I):

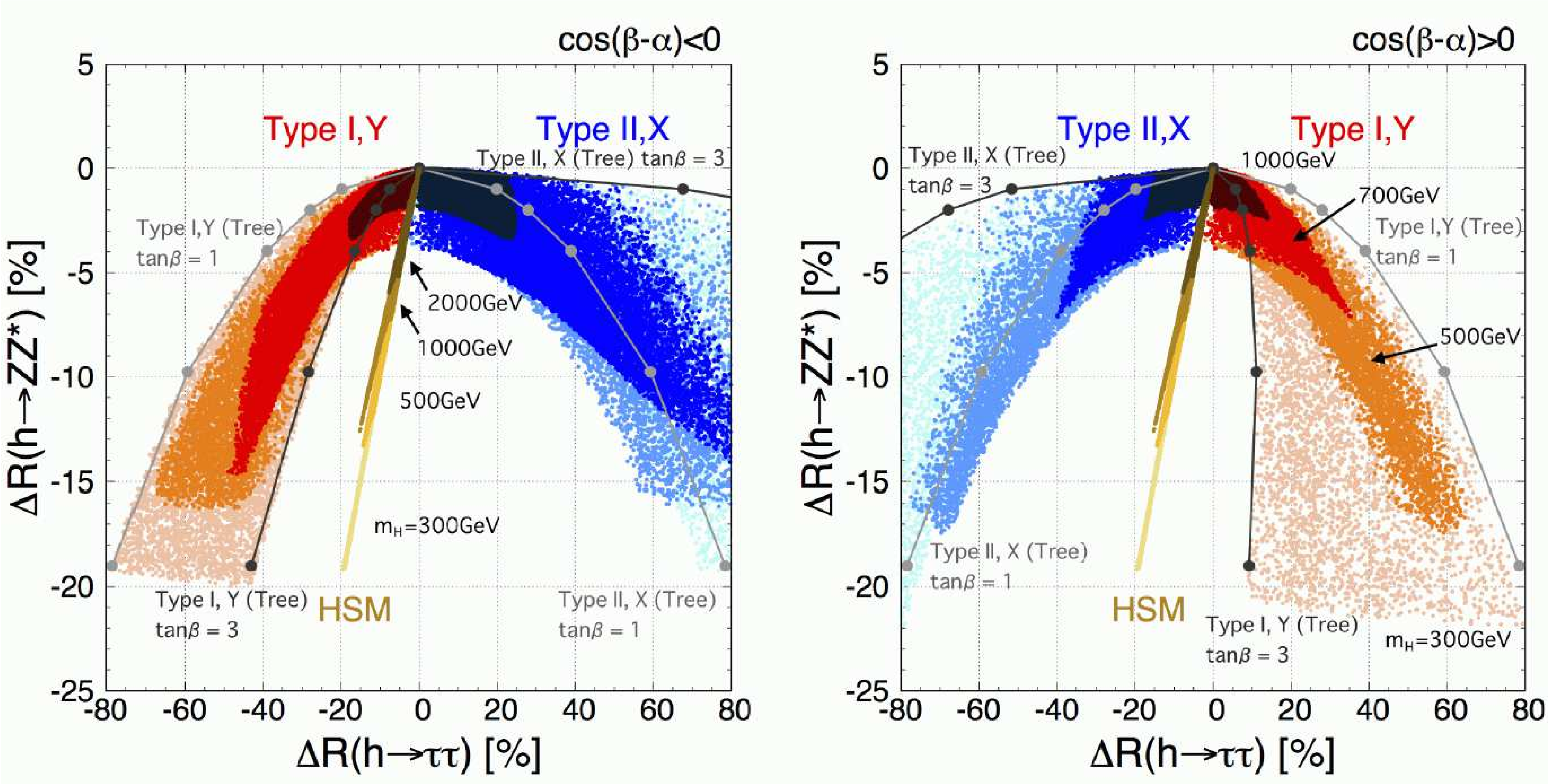
[*S. Kanemura et al. '18*]



⇒ LC precision has a great potential to discriminate the models!

2HDM example (II):

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



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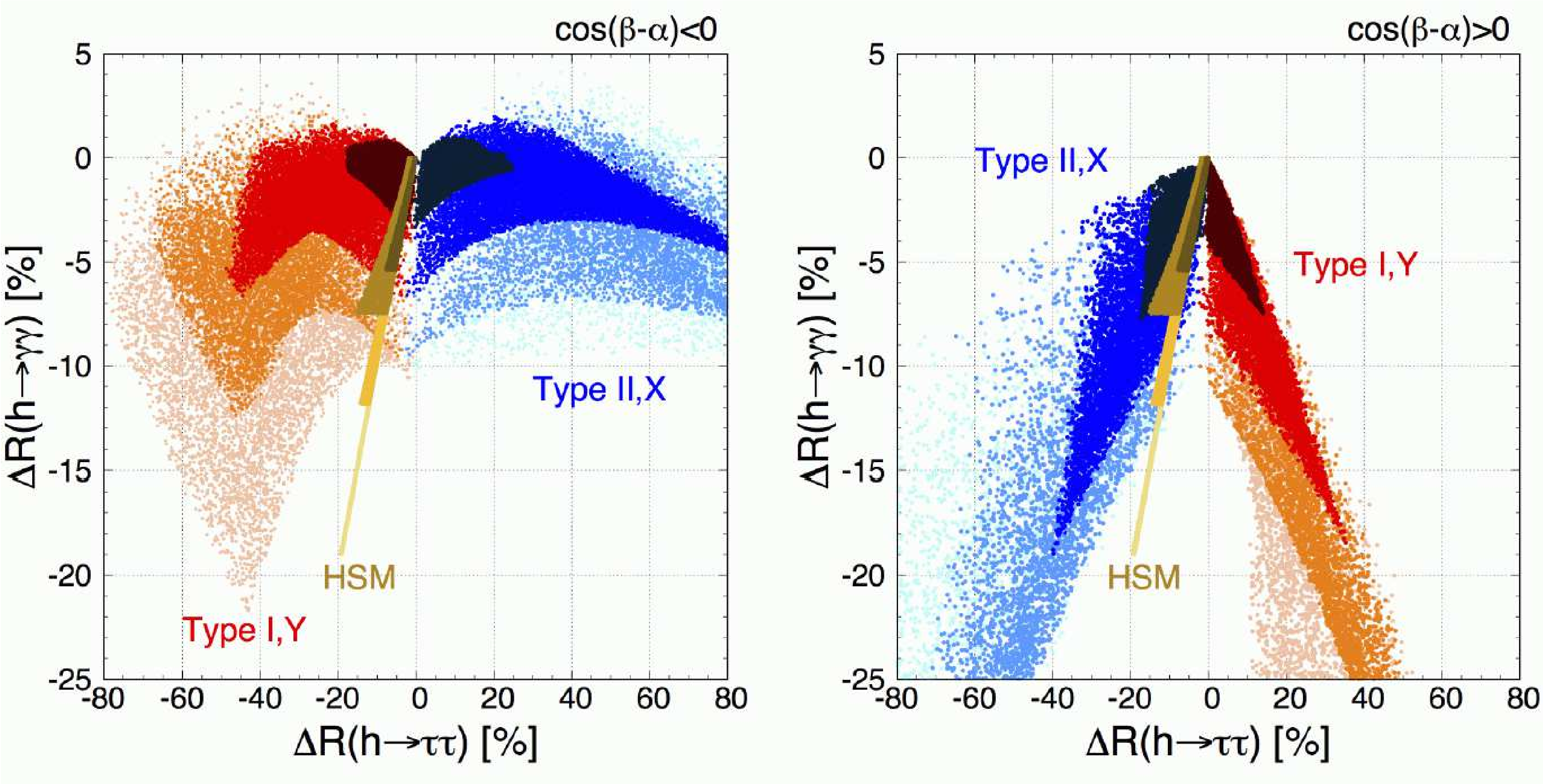
2HDM example (III):

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



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