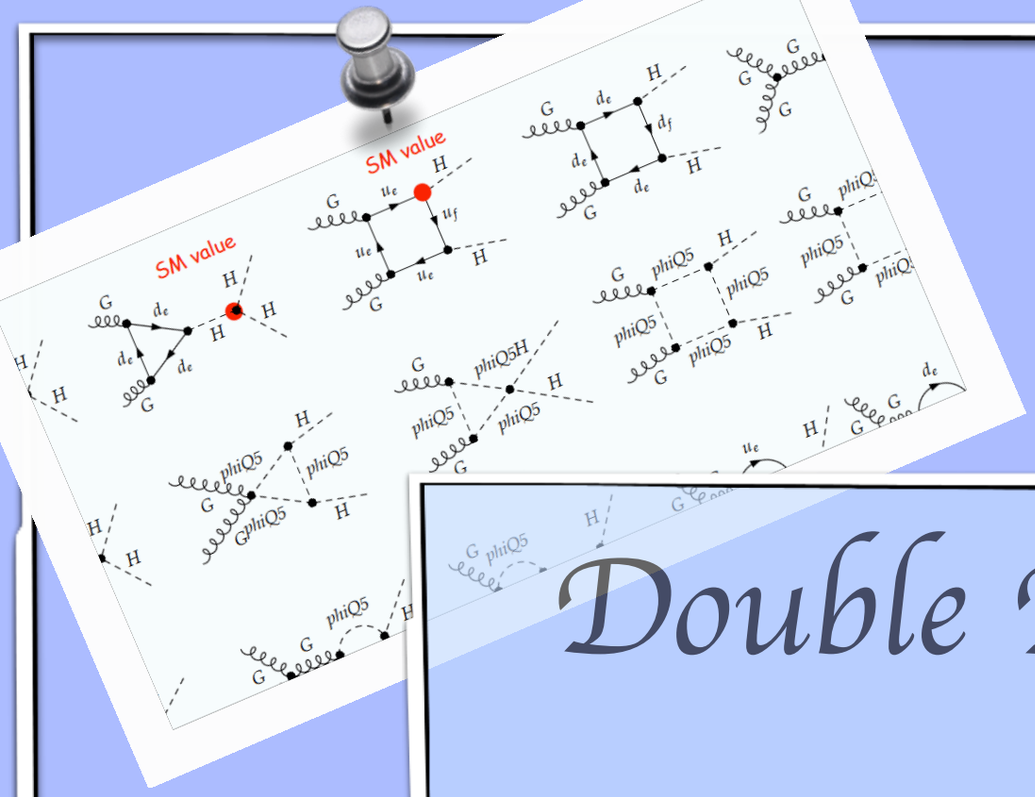
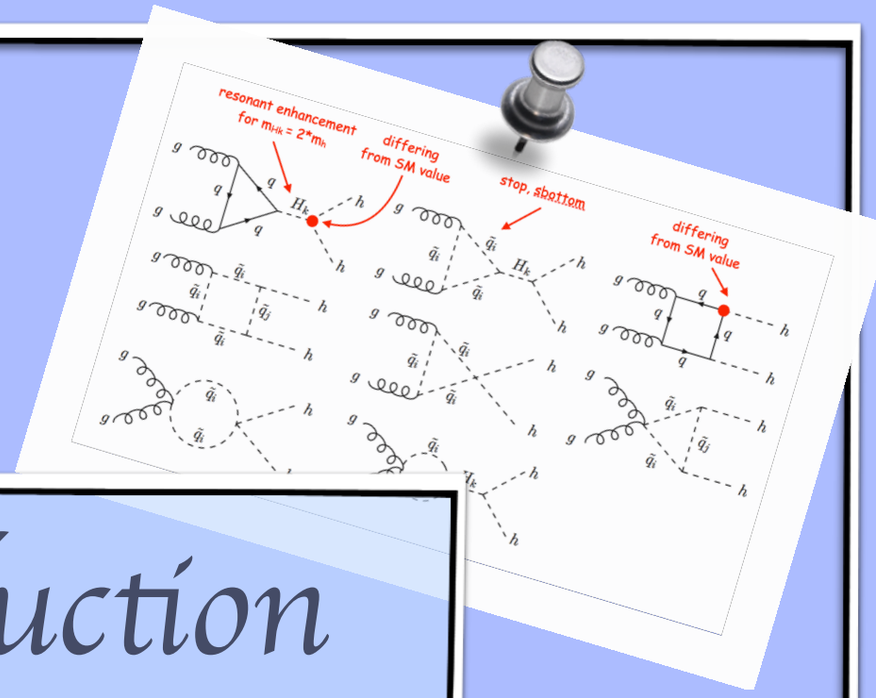




Double Higgs Production in Extended Higgs Sectors

M. Margarete Mühlleitner, KIT

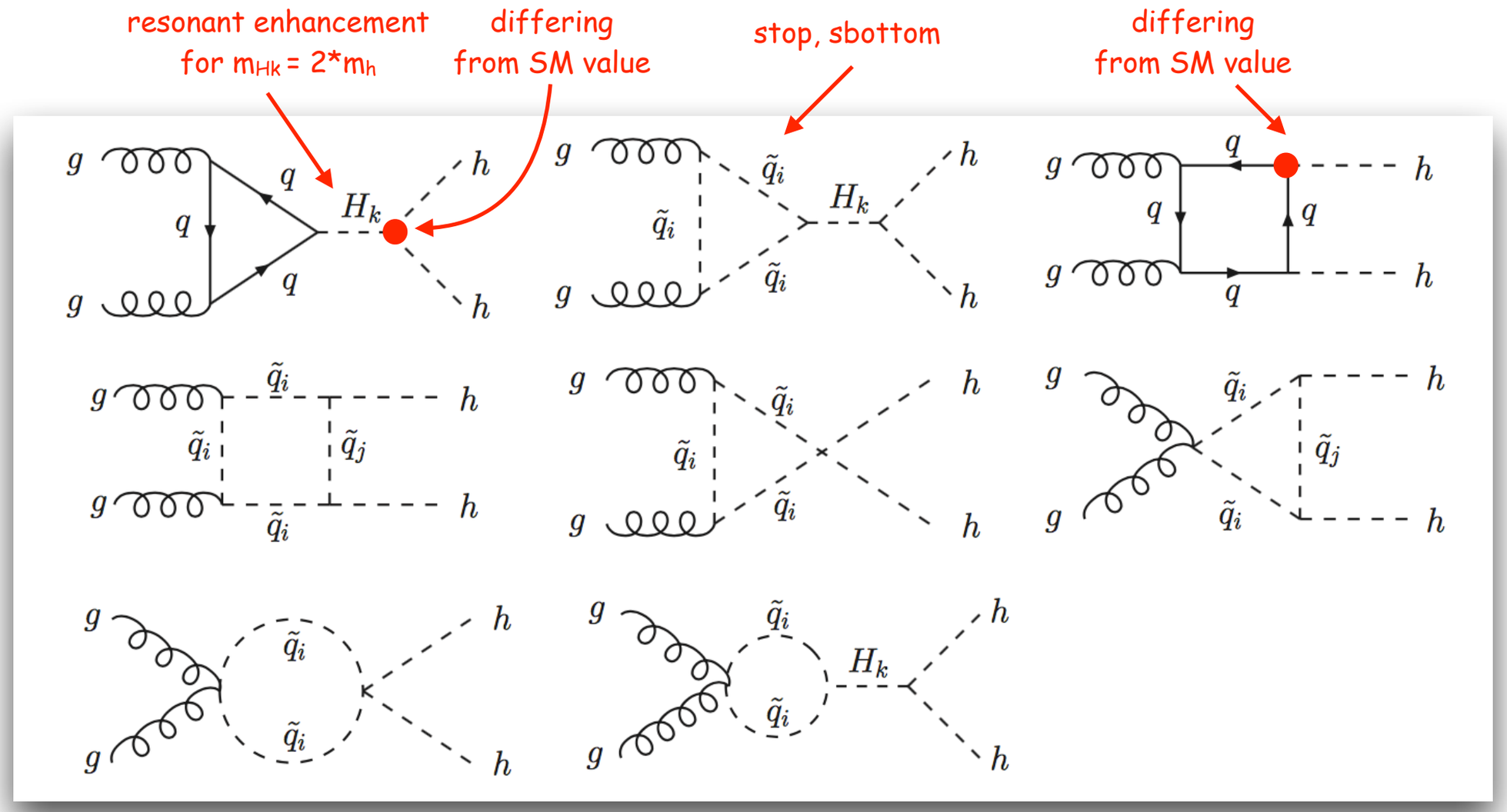
19th Workshop of the LHC Higgs Working Group
28-30 Nov 2022, CERN

New Physics Effects in Higgs Pair Production

- Cross section: - different trilinear couplings - different Yukawa couplings
  - novel particles in the loops - resonant enhancement - novel couplings

- Example NMSSM:

[taken from Dao,MM,Streicher,Walz,´13]

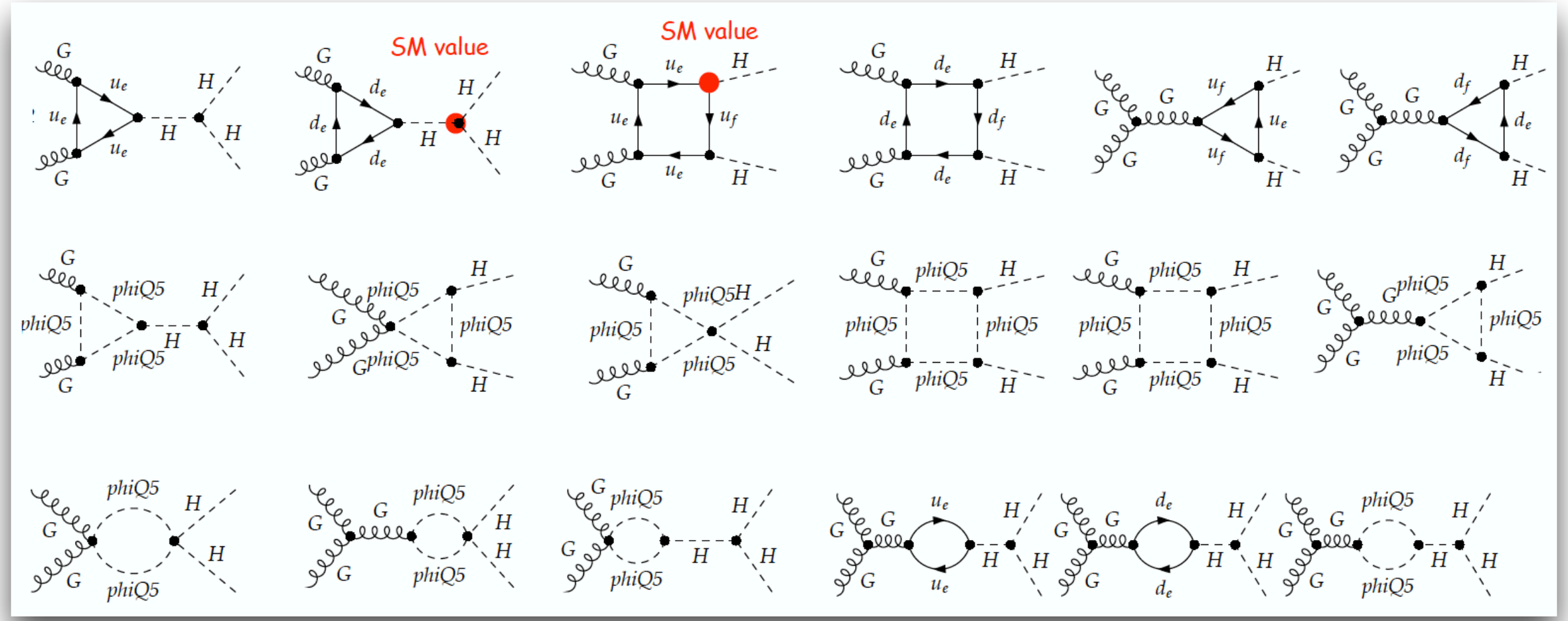


New Physics Effects in Higgs Pair Production

- Cross section: - different trilinear couplings - different Yukawa couplings
  - novel particles in the loops* - resonant enhancement - novel couplings

- Example extension w/ strange Dark sector:

[thanks to D. Neascu]



*talk by Felix Egle: composite 2HDM w/ partial compositeness

with/without SUSY
with/without singlet

2 Higgs doublets
without/with CP violation

2HDM

Overview of Higgs Pair production possibilities
including theoretical and experimental
constraints in archetypical BSM Higgs sectors
including different symmetries

NMSSM

C2HDM

Provide benchmark points / lines / planes
for experiment

singlet extensions
with/without SUSY

N2HDM

without/with CP violation
with/without singlet

2HDM	C2HDM	N2HDM	NMSSM
2 Higgs doublets	CP-violating	Singlet extension	Supersymmetry
h,H,A,H^+,H^-	H1,H2,H3,H^+,H^-	H1,H2,H3,H^+,H^-	H1,H2,H3,A,H^+,H^-
SFOEWPT, DM, plus charged Higgs	plus CP violation baryogenesis	rich pheno, DM	a lot (DM, CPviol, Hierarychy, …)

Resonant Enhancement

Higgs-to-Higgs Cascade decays

- Following results based on:

  Abouabid, Arhrib, Azevedo, El Falaki, Ferreira, MMM, Santos, „Benchmarking Di-Higgs Production in Extended Higgs Sectors“, JHEP 09 (2022) 011

Parameter Point Samples

- Scans in parameter spaces of the models w/ ScannerS:

  take into account all relevant theoretical and experimental constraints
  + limits from di-Higgs searches

  4b: [ATLAS-CONF-Note-2021-030, ATLAS,1804.06174], WWγγ: [ATLAS,1807.08567]
  bbγγ: [ATLAS,1807.04873]; bbWW: [ATLAS,1811.04671, bbZZ: [CMS,2006.06391]
  bbττ: [ATLAS,1808.00336;ATLAS-CONF-Note-2021-035;ATLAS,2007.14811], 4W: [ATLAS,1811.11028]

- Computation of Higgs pair production cxn:

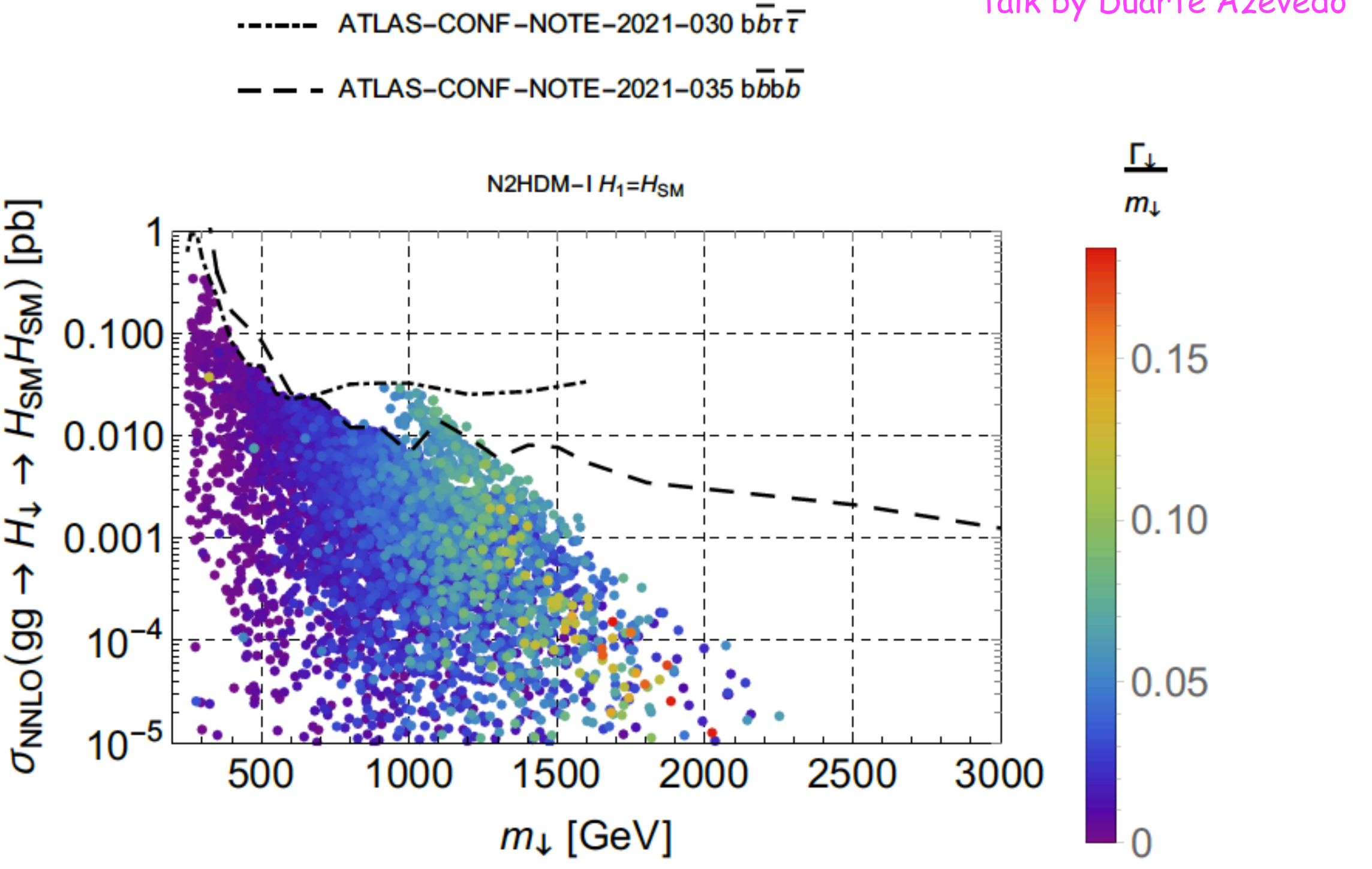
  HPAIR [Spira] for C2HDM [Gröber,MM,Spira,'17], NMSSM [Dao,MM,Streicher,Walz,'13],
  2HDM [MM], N2HDM [MM]: Born-improved HTL cxn; K-factors 1.4-2.1

- Scatter plots:

  LO cxn times factor 2 (to approx. account for NLO QCD), benchmark points include
  NLO QCD calculated w/ HPAIR

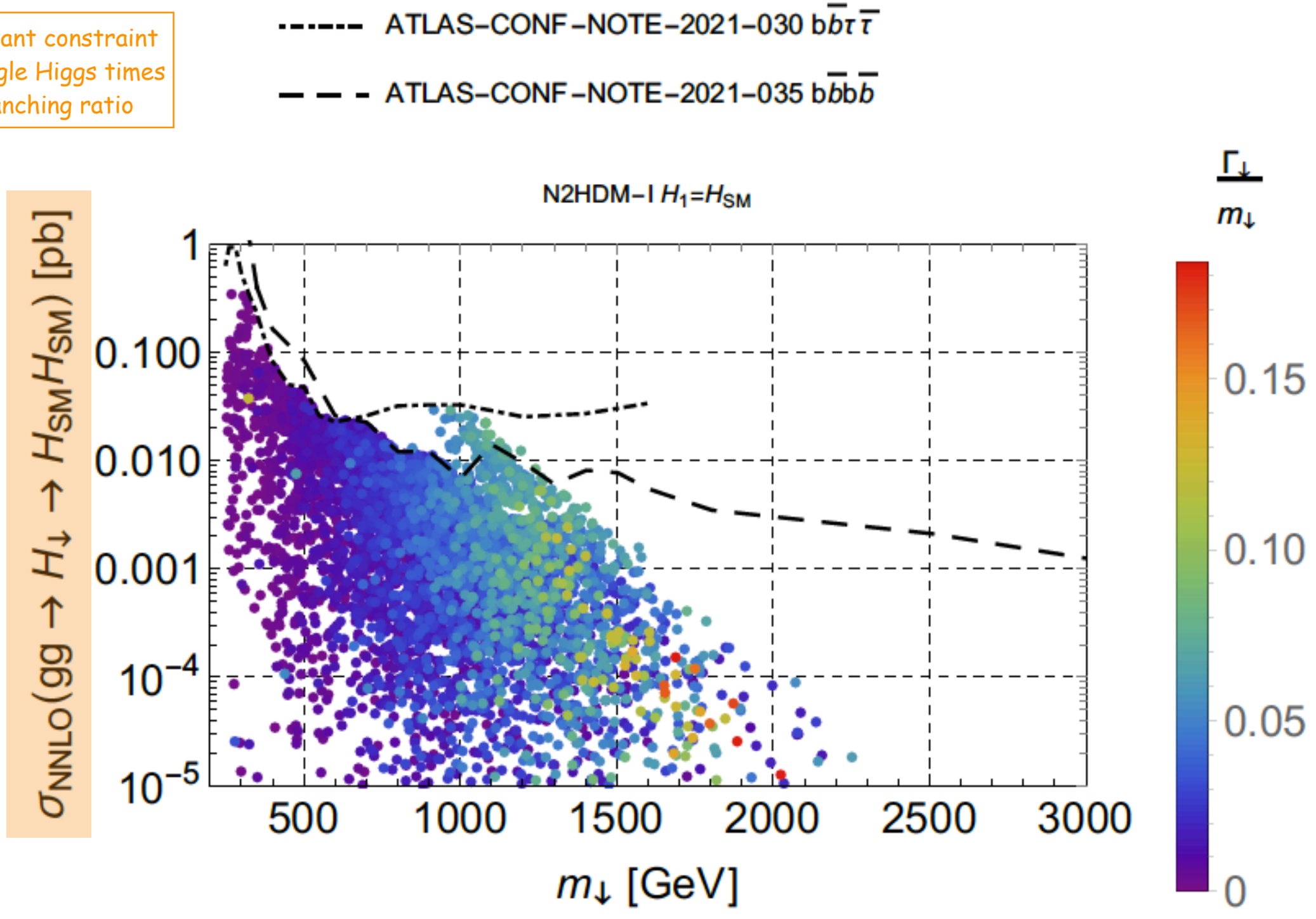
Impact of Resonant Searches - Ex. N2HDM H1 SM-like

*talk by Duarte Azevedo



Impact of Resonant Searches - Ex. N2HDM H1 SM-like

resonant constraint on single Higgs times branching ratio



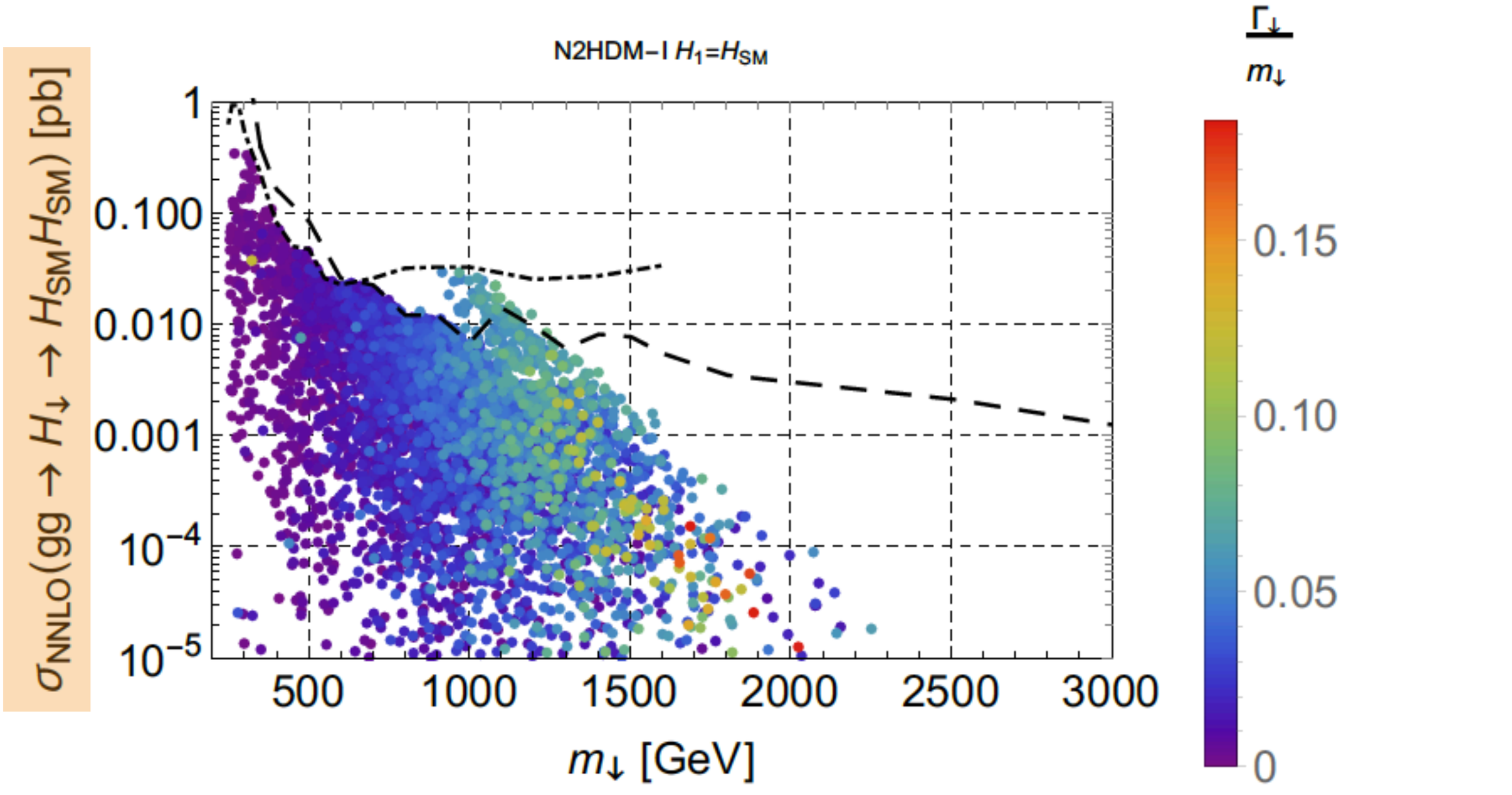
Impact of Resonant Searches - Ex. N2HDM H1 SM-like

resonant constraint on single Higgs times branching ratio

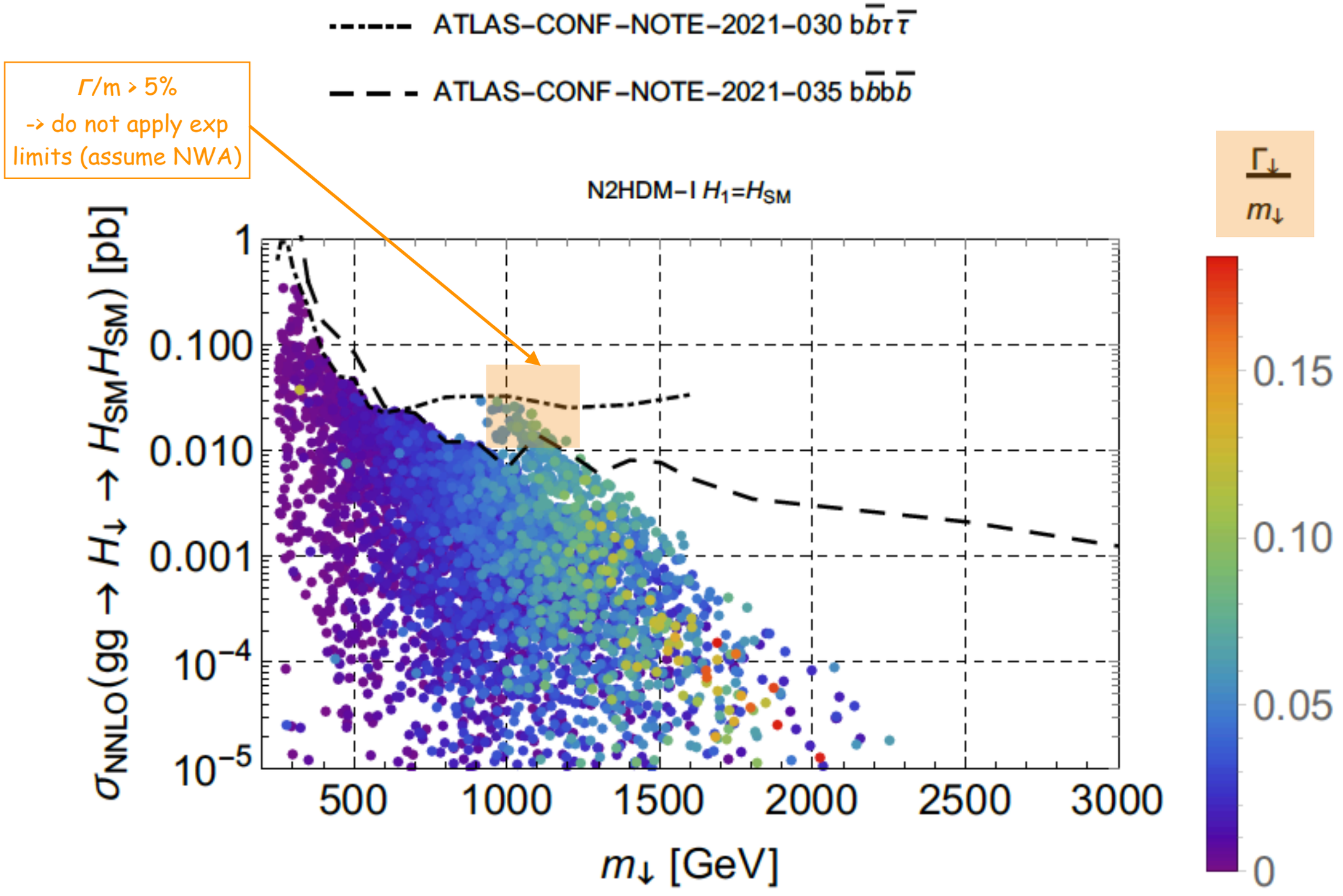
ATLAS-CONF-NOTE-2021-030 $b\bar{b}\tau\bar{\tau}$

ATLAS-CONF-NOTE-2021-035 $b\bar{b}b\bar{b}$

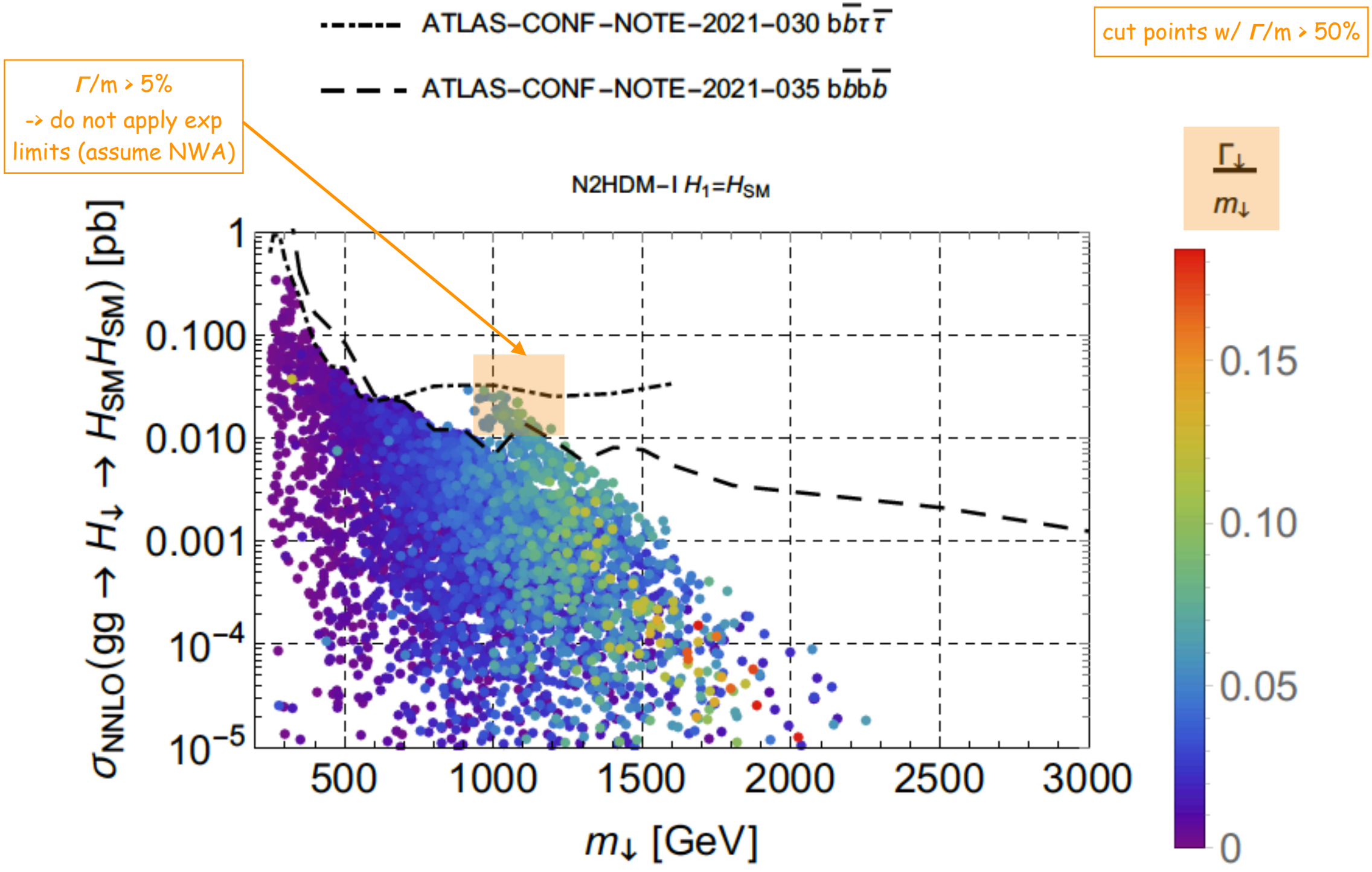
assume non-resonant contribution is SM-like and no interference effects



Impact of Resonant Searches - Ex. N2HDM H1 SM-like



Impact of Resonant Searches - Ex. N2HDM H1 SM-like



Impact of Non-resonant Searches

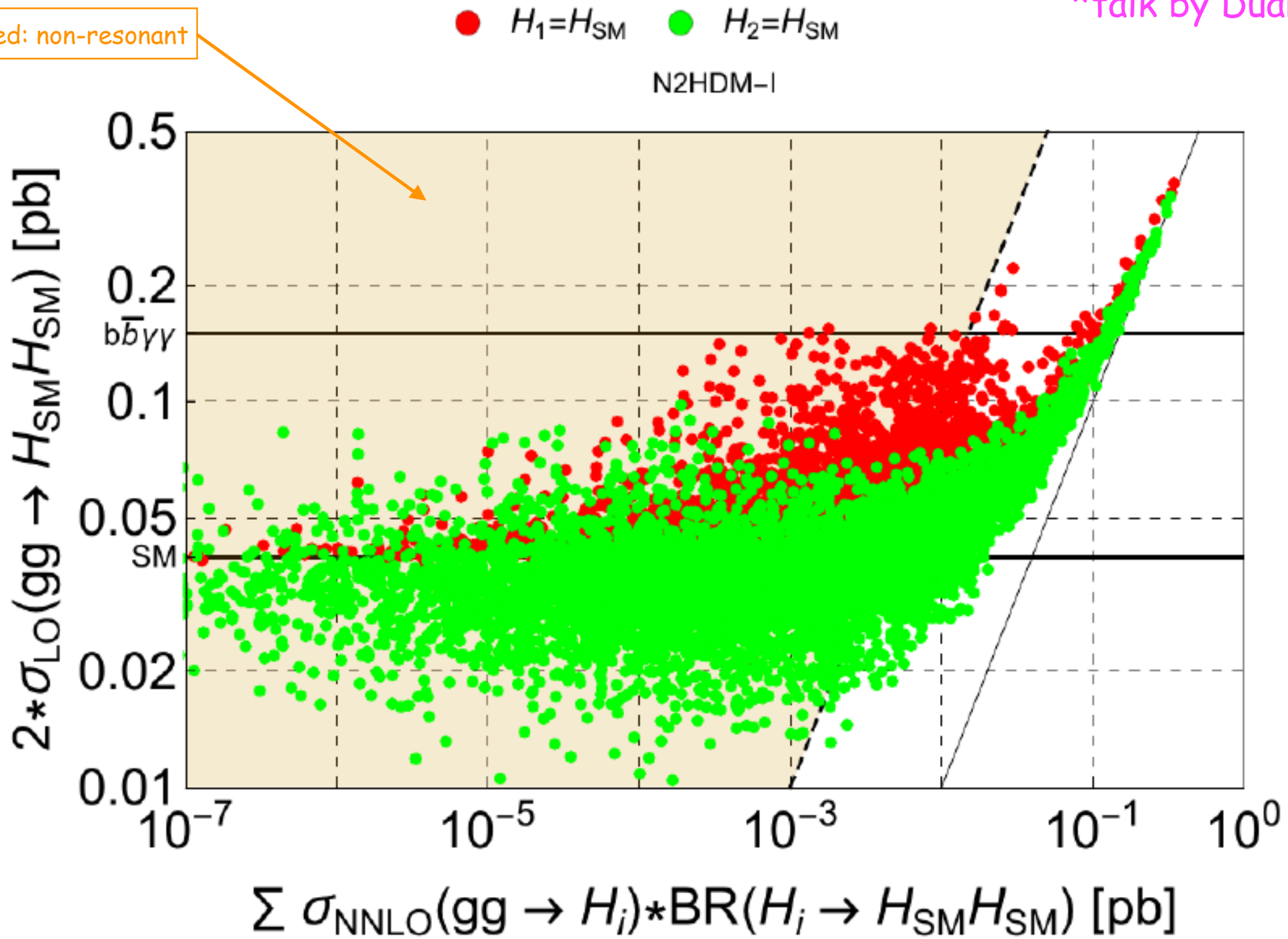
- Our definition:

take into account all relevant theoretical and experimental constraints
+ limits from di-Higgs searches

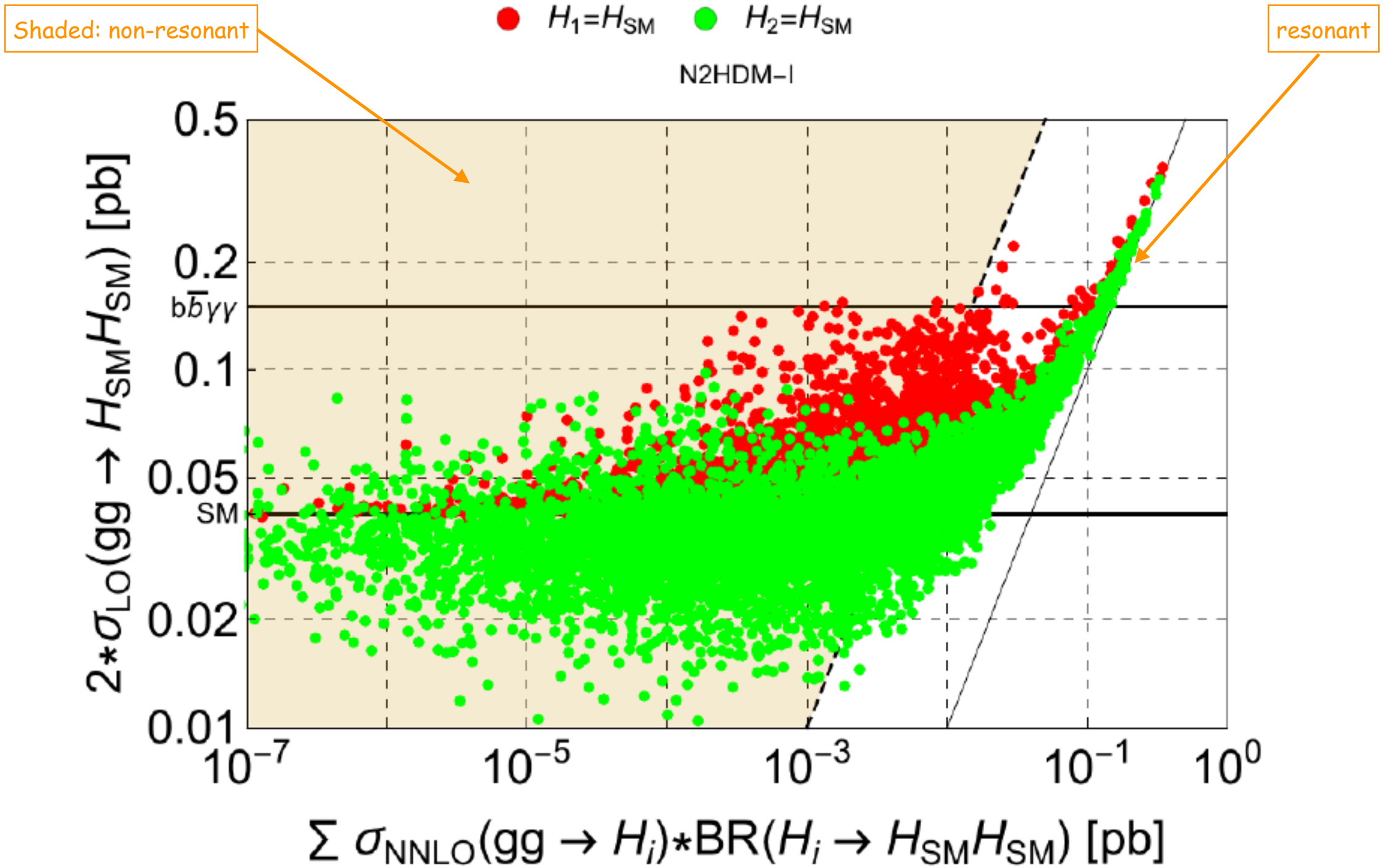
$\sigma_{res}^{HH} < 0.1 * \sigma_{full}$ -> non-resonant production

Impact of Non-resonant Searches - Example N2HDM

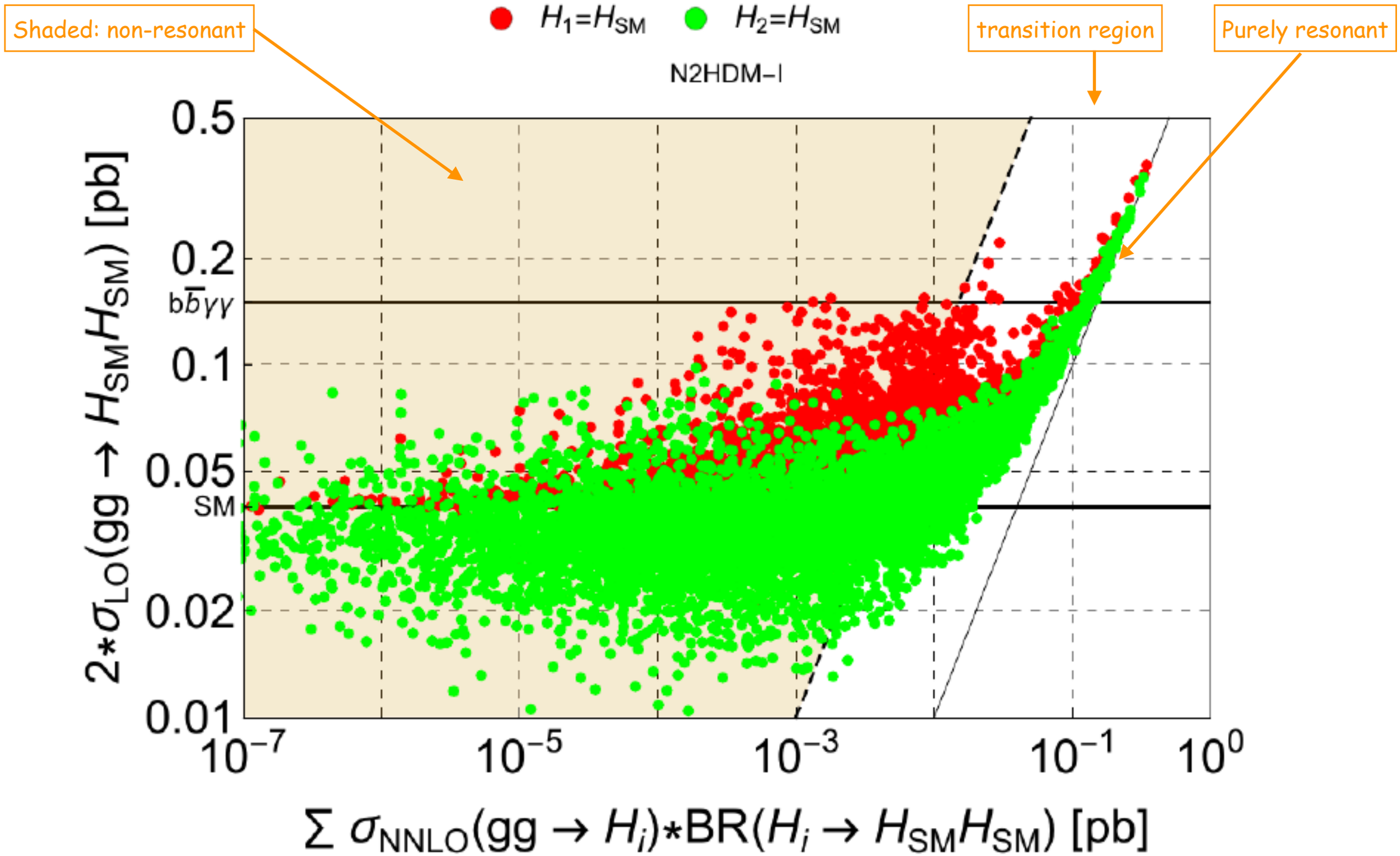
*talk by Duarte Azevedo



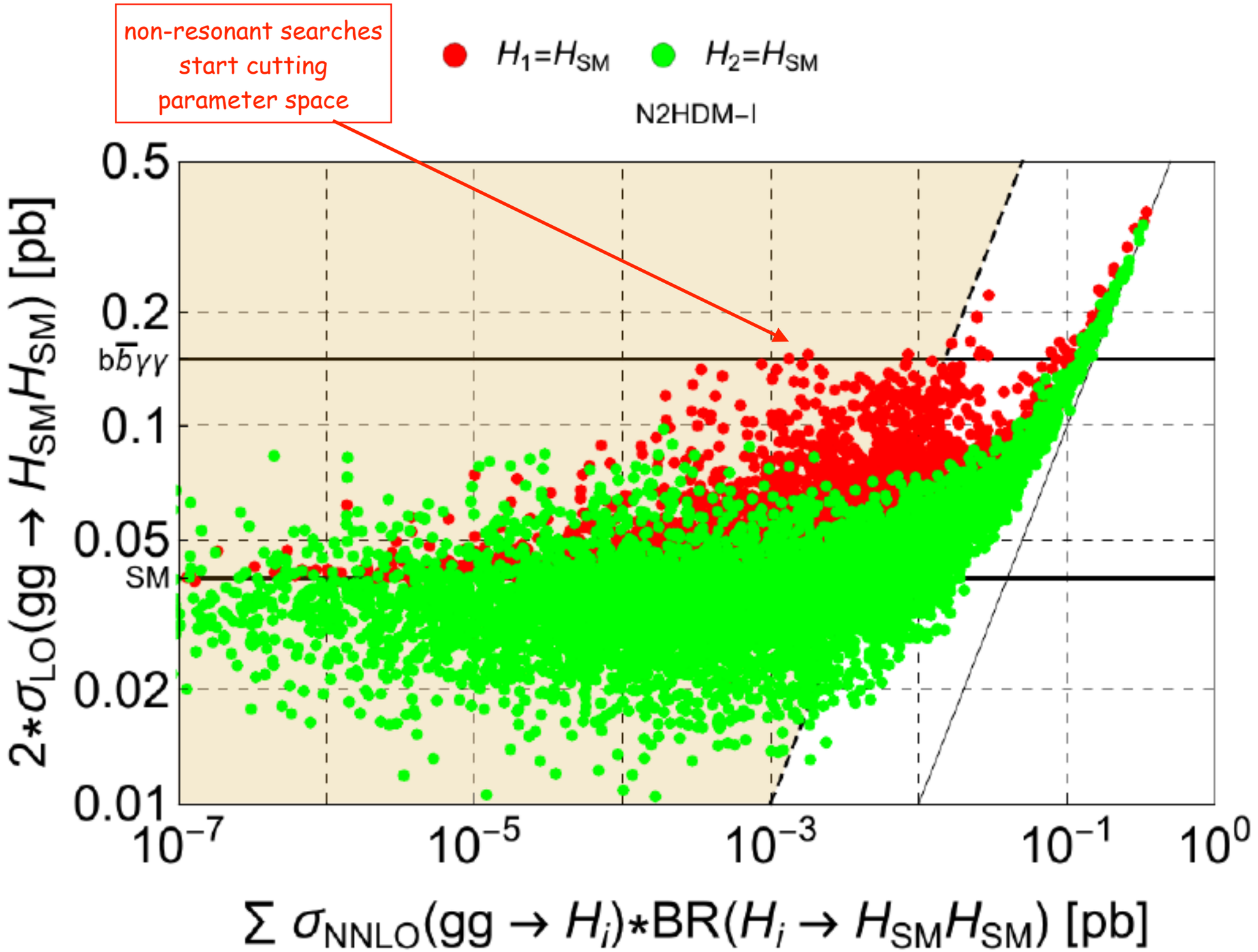
Impact of Non-resonant Searches - Example N2HDM



Impact of Non-resonant Searches - Example N2HDM

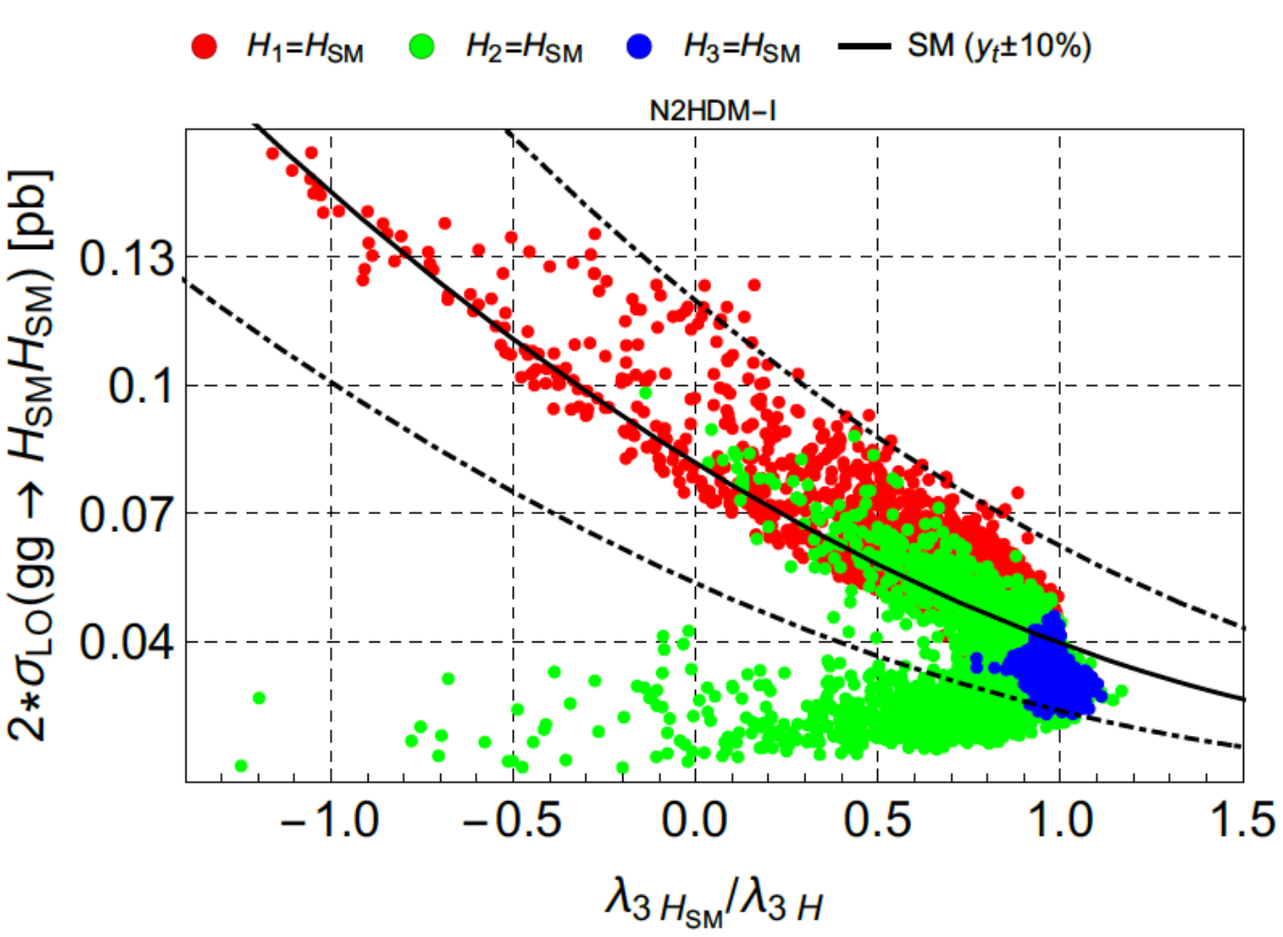


Impact of Non-resonant Searches - Example N2HDM

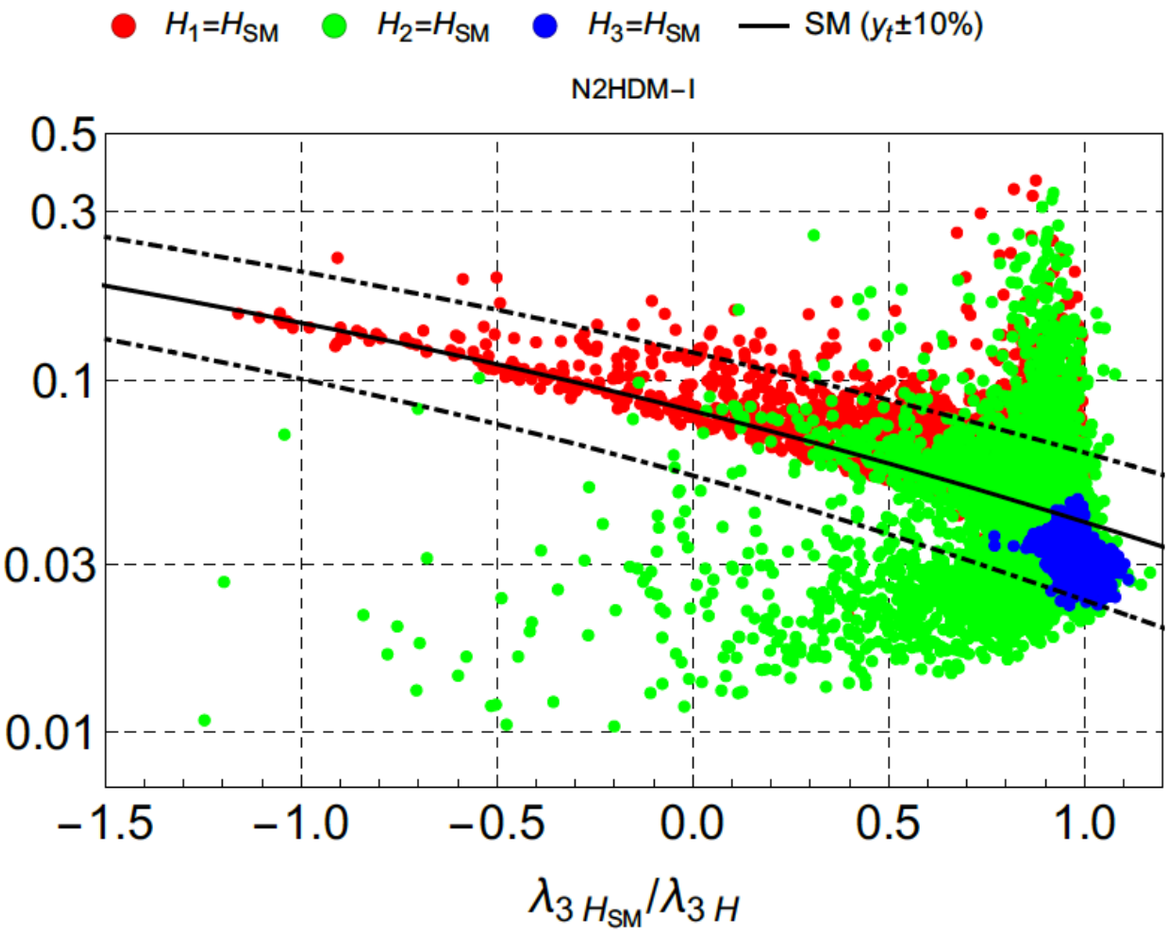


Required: combination Non-resonant and Resonant Searches

non-resonant production



total



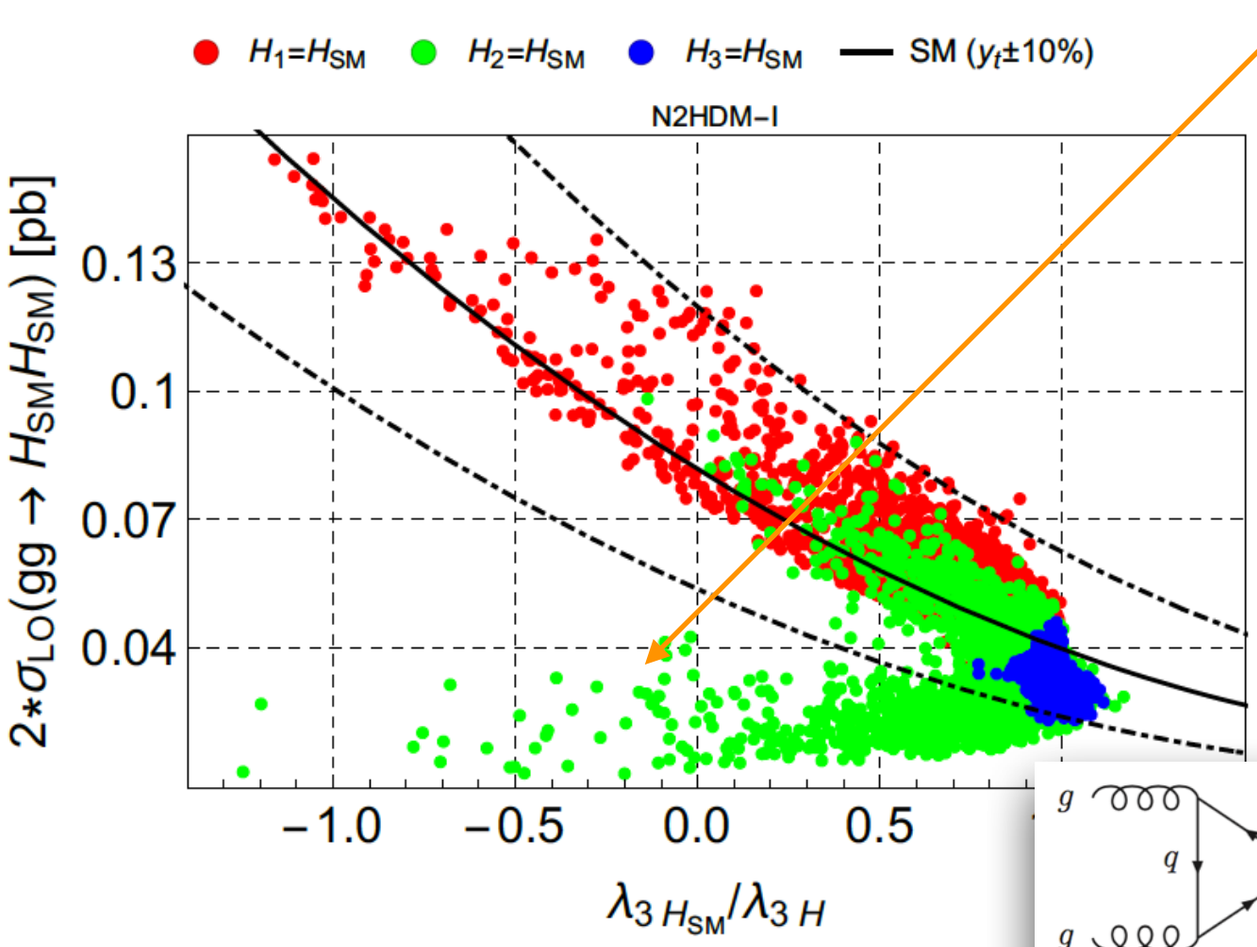
- full/dashed lines: top-Yukawa coupling = SM value/+-10%
- Combination of resonant and resonant searches required to constraint trilinear coupling

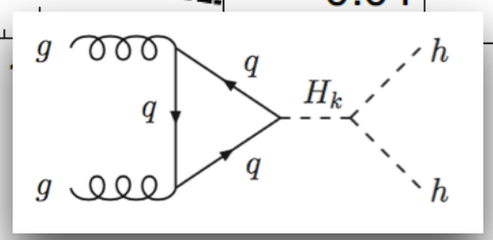
Required: combination Non-resonant and Resonant Searches

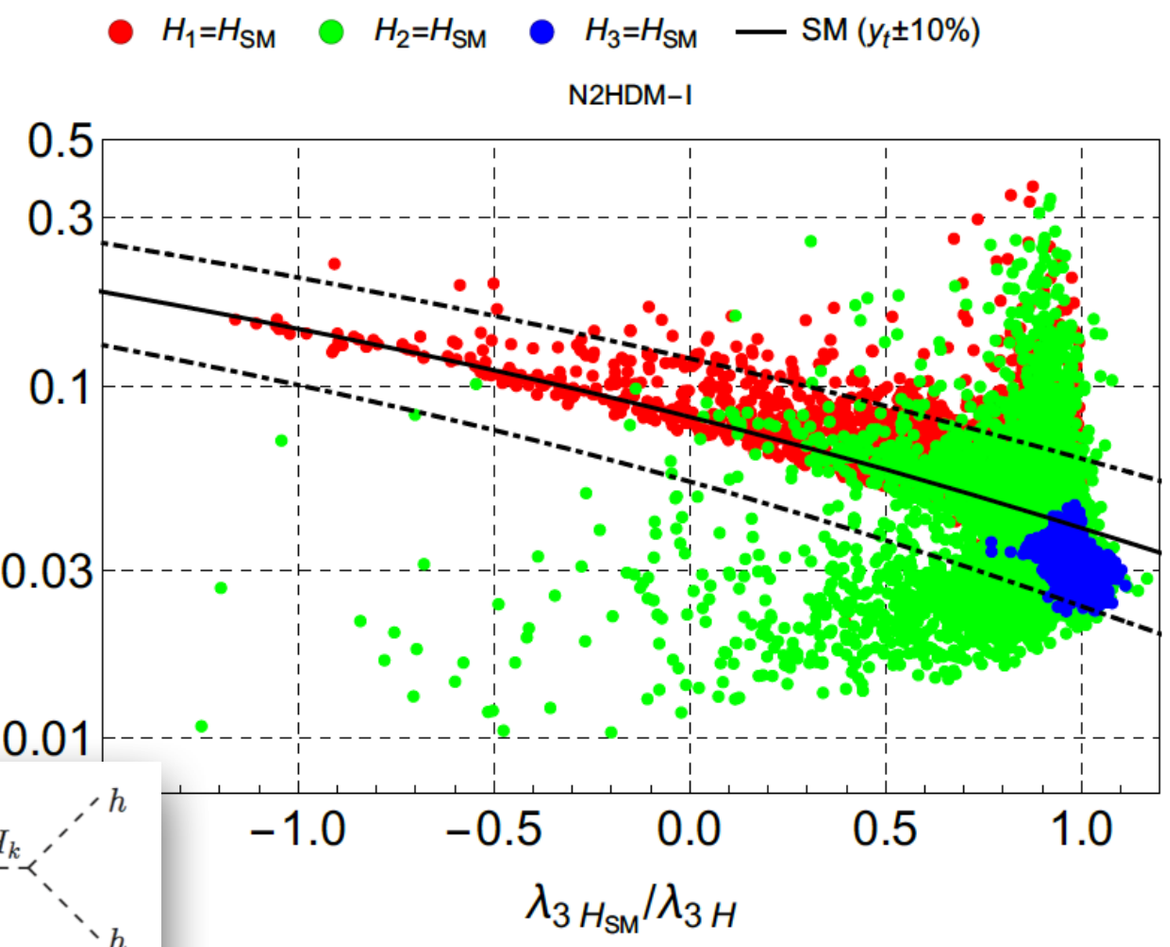
non-resonant production

negative interference of
H1 and H2 triangle contributions

total

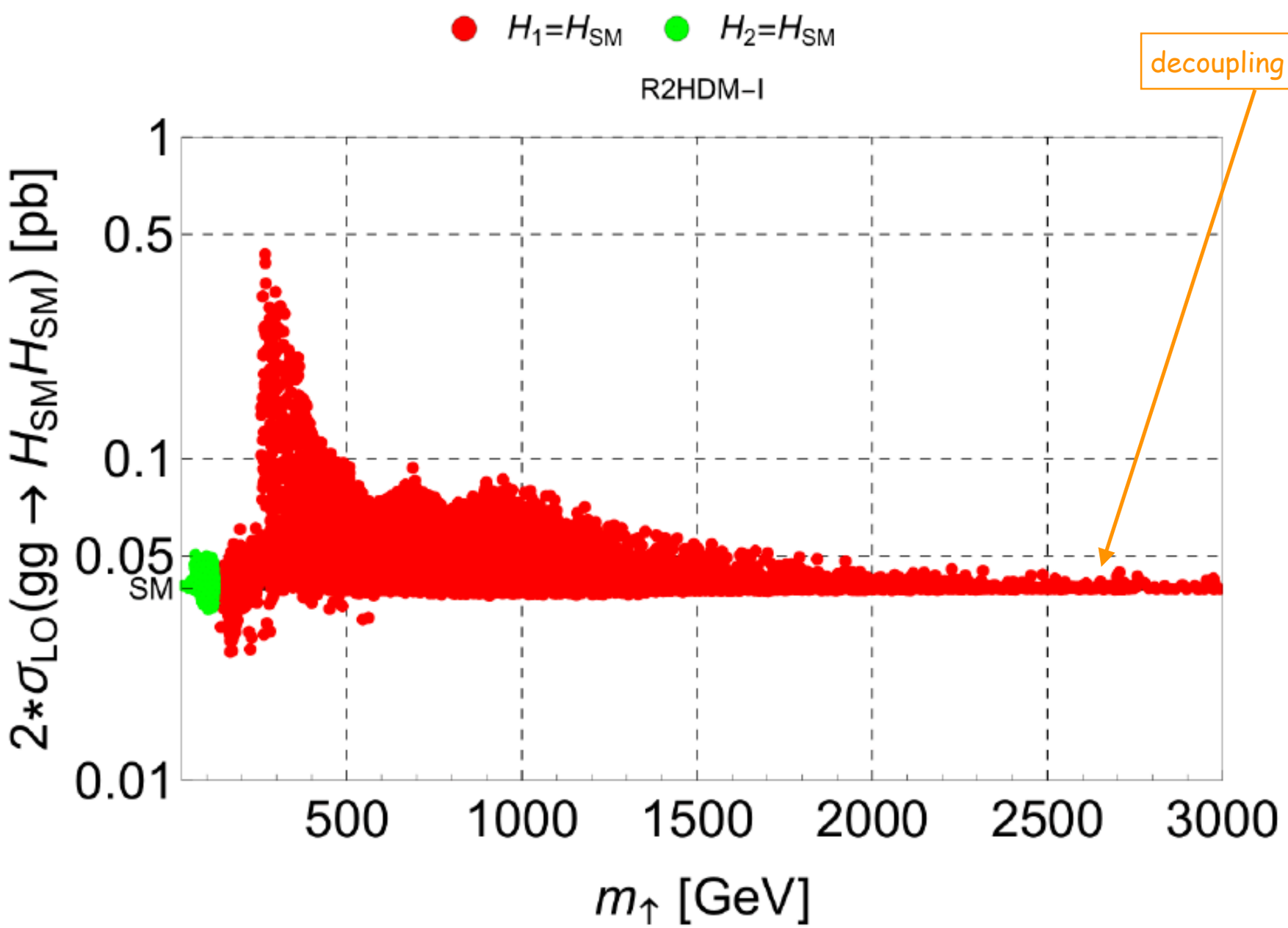




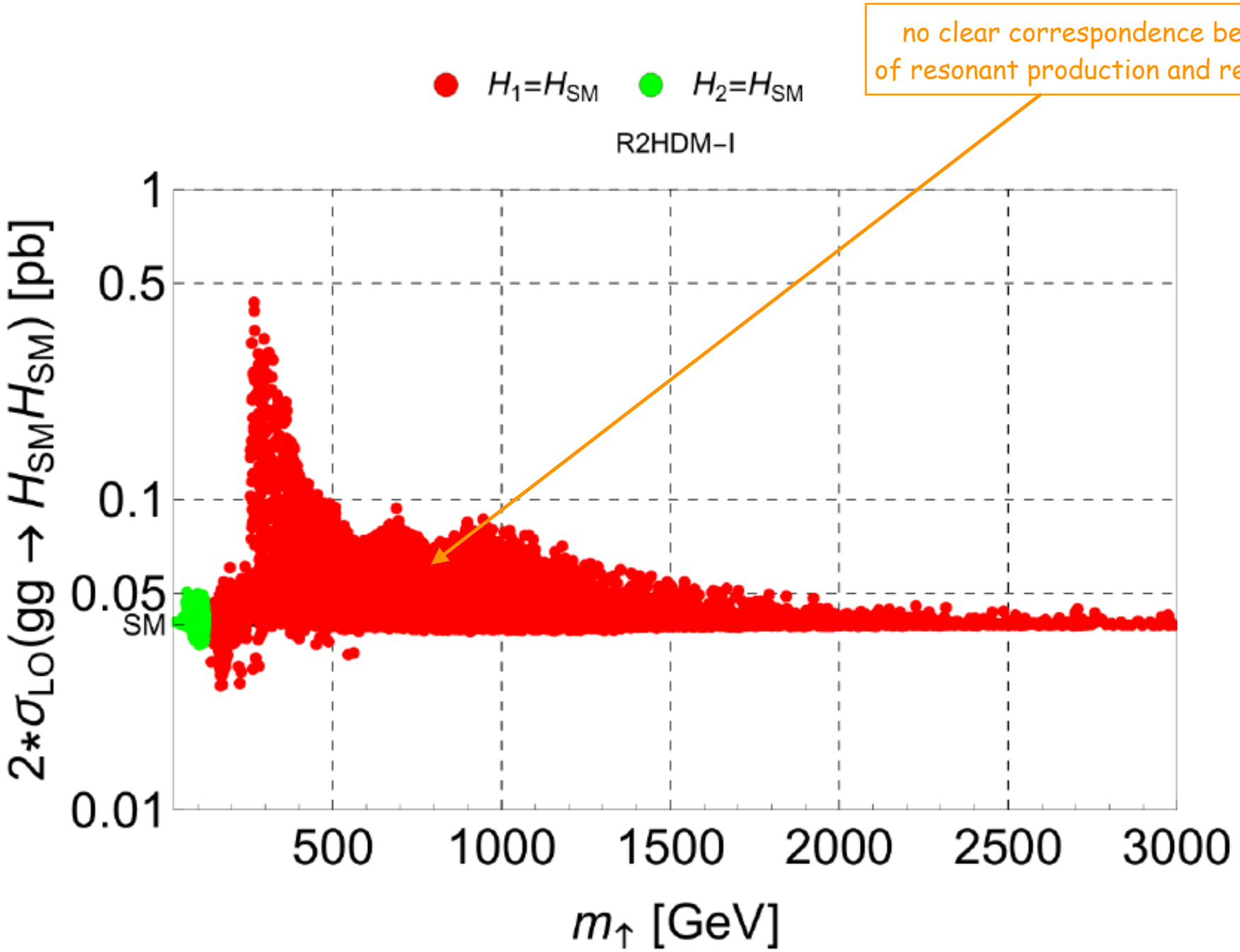


- full/dashed lines: top-Yukawa coupling = SM value/+-10%
- Combination of resonant and resonant searches required to constraint trilinear coupling

Parameter dependence - Ex. R2HDM T1

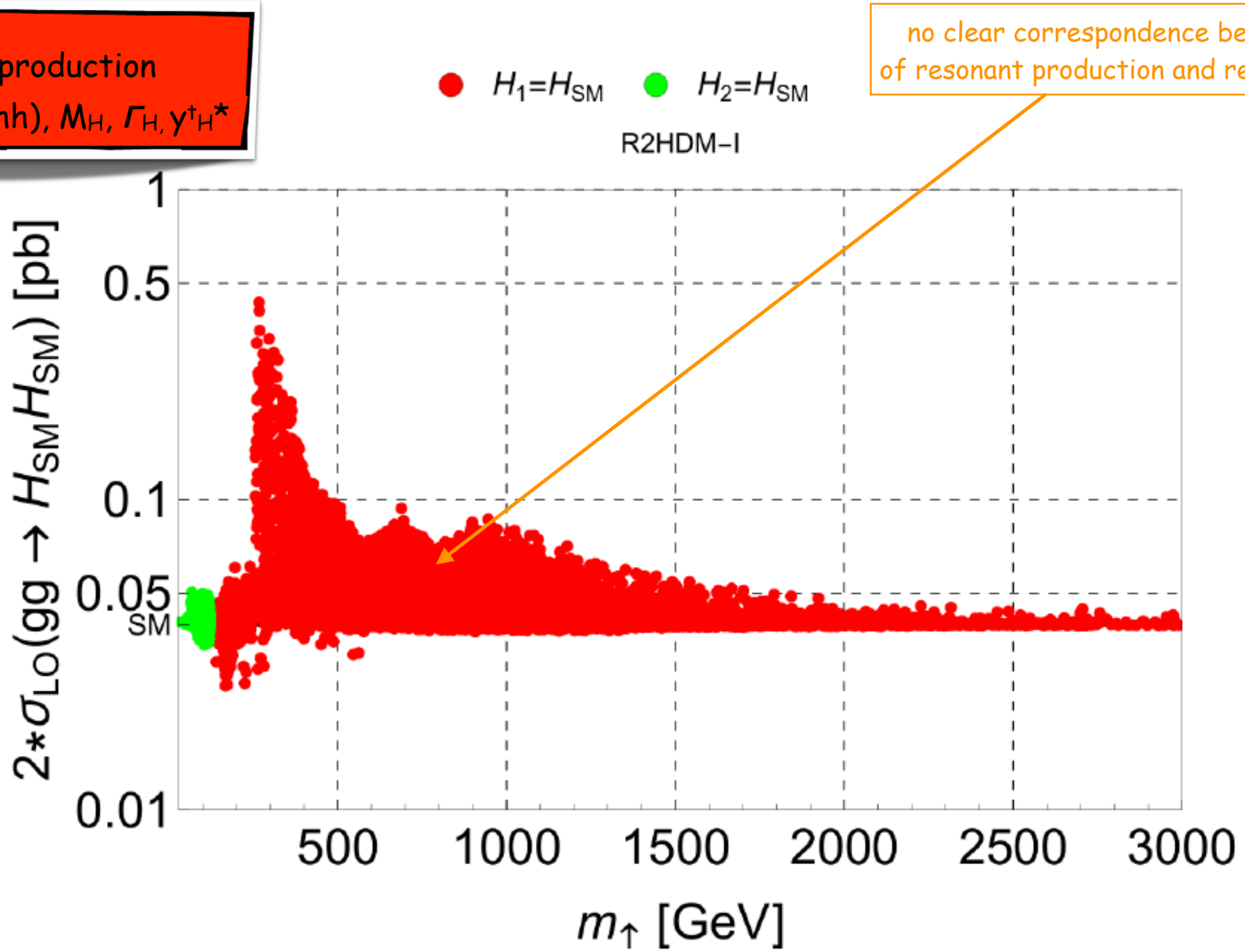


Parameter dependence - Ex. R2HDM T1



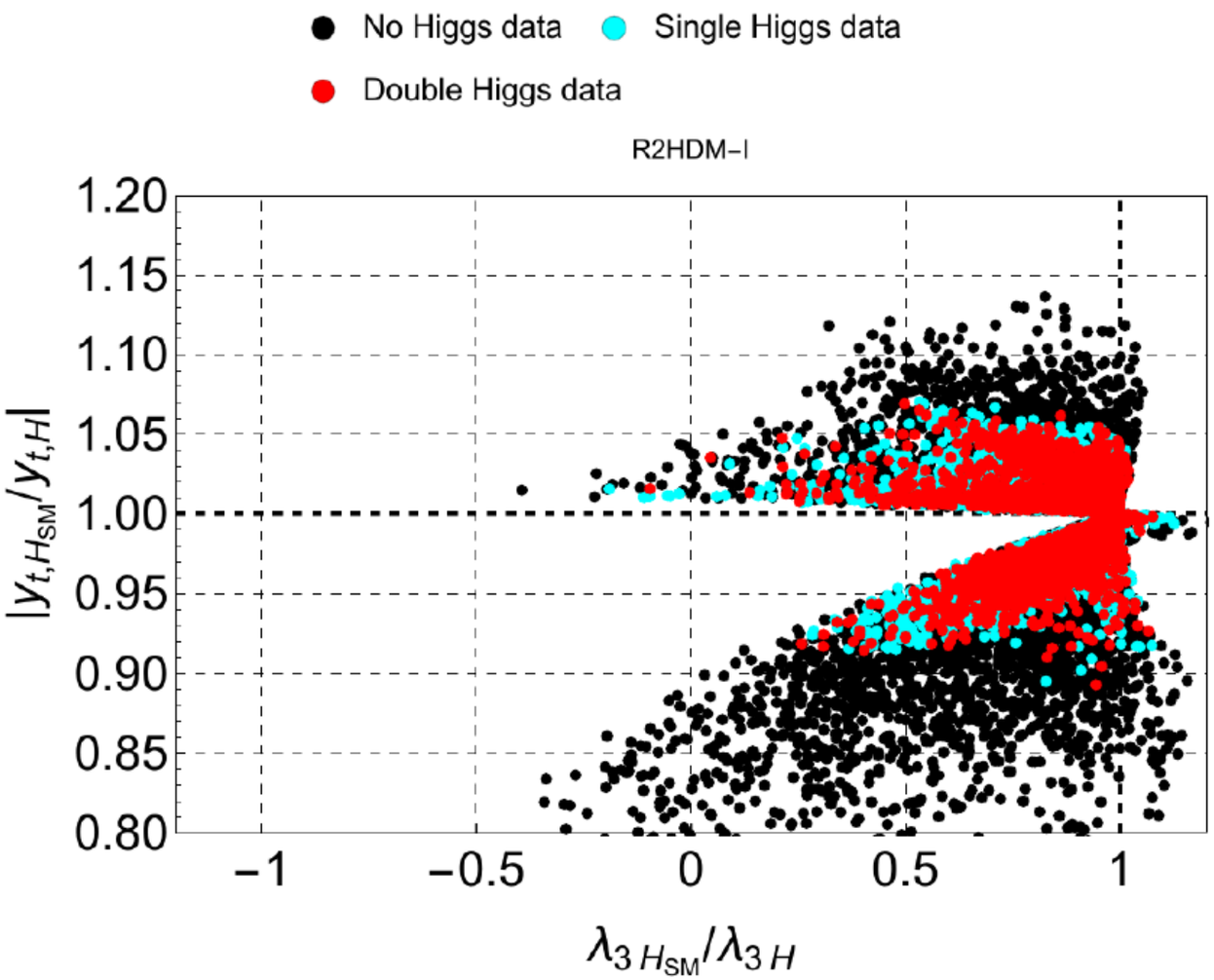
Parameter dependence - Ex. R2HDM T1

Resonant production depends on $\lambda(Hhh)$, M_H, Γ_H, y^t_H*

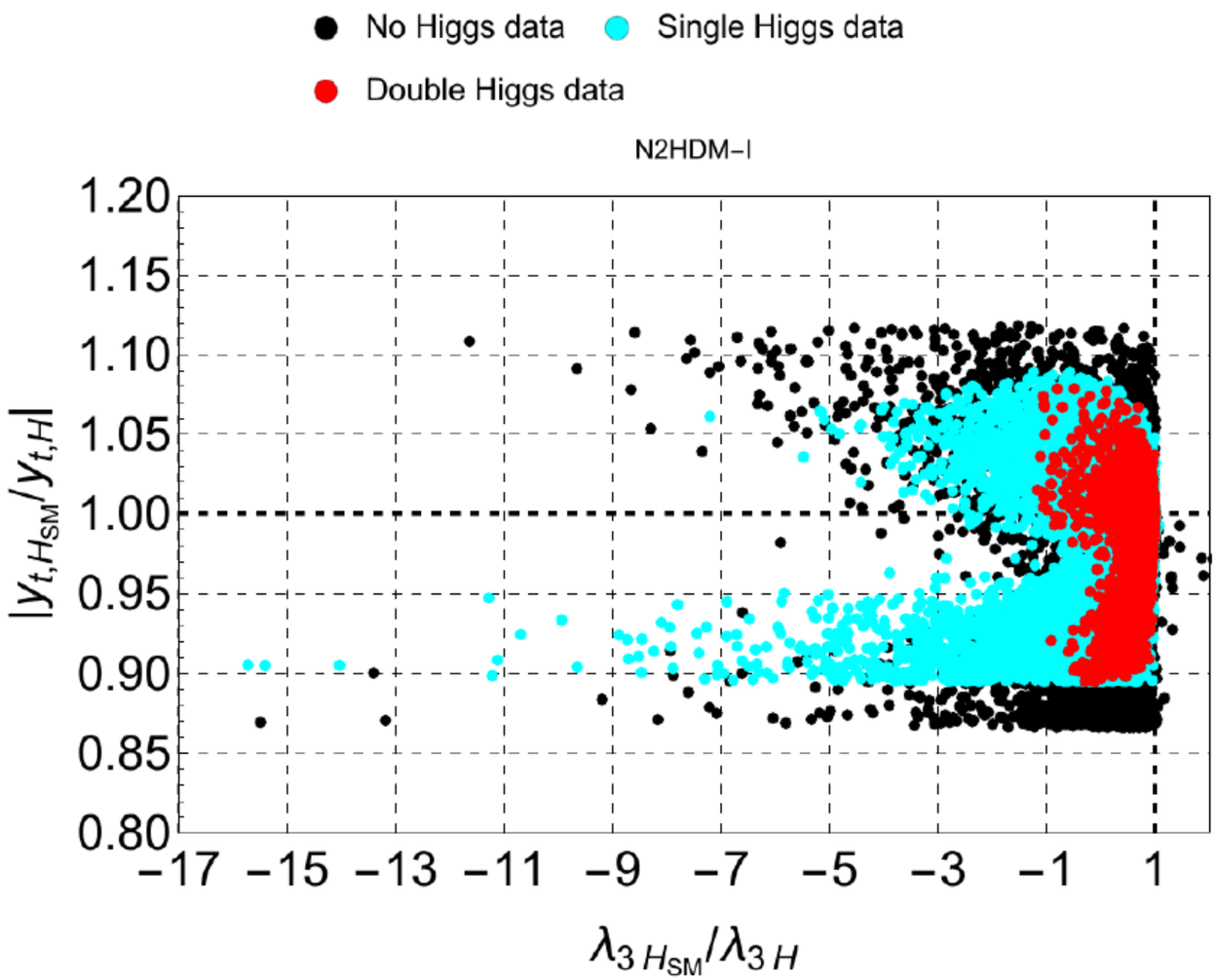


*: even more in models with several resonant Higgs bosons

Impact of Single- & Di-Higgs Constraints on trilinear Higgs couplings



- single Higgs constrains yt -> affects λ_{HHH}
- di-Higgs does not lead to much further restriction



- increased yt precision affects here λ_{HHH} more strongly
- λ_{HHH} reduction mostly due to unitarity constraints (specific to N2HDM)

„wedge": non-SM λ_{HHH} comes with non-SM yt

Allowed values of the trilinear Higgs self-coupling

	R2HDM		C2HDM	
	$y_{t,H_{\rm SM}}^{\rm R2HDM}/y_{t,H}$	$\lambda_{3H_{\rm SM}}^{\rm R2HDM}/\lambda_{3H}$	$y_{t,H_{\rm SM}}^{\rm C2HDM}/y_{t,H}$	$\lambda_{3H_{\rm SM}}^{\rm C2HDM}/\lambda_{3H}$
light I	0.893...1.069	-0.096...1.076	0.898...1.035	-0.035...1.227
medium I	n.a.	n.a.	0.889...1.028	0.251...1.172
heavy I	0.946...1.054	0.481...1.026	0.893...1.019	0.671...1.229
light II	0.951...1.040	0.692...0.999	0.956...1.040	0.096...0.999
medium II	n.a.	n.a.	–	–
heavy II	–	–	–	–

	N2HDM		NMSSM	
	$y_{t,H_{\rm SM}}^{\rm N2HDM}/y_{t,H}$	$\lambda_{3H_{\rm SM}}^{\rm N2HDM}/\lambda_{3H}$	$y_{t,H_{\rm SM}}^{\rm NMSSM}/y_{t,H}$	$\lambda_{3H_{\rm SM}}^{\rm NMSSM}/\lambda_{3H}$
light I	0.895...1.079	-1.160...1.004	n.a.	n.a.
medium I	0.874...1.049	-1.247...1.168	n.a.	n.a.
heavy I	0.893...1.030	0.770...1.112	n.a.	n.a.
light II	0.942...1.038	-0.608...0.999	0.826...1.003	0.024...0.747
medium II	0.942...1.029	0.613...0.994	0.916...1.000	-0.502...0.666
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heavy II	–	–	–	–

no parameter points compatible w/ constraints found

Allowed values of the trilinear Higgs self-coupling

	R2HDM		C2HDM	
	$y_{t,H_{\rm SM}}^{\rm R2HDM}/y_{t,H}$	$\lambda_{3H_{\rm SM}}^{\rm R2HDM}/\lambda_{3H}$	$y_{t,H_{\rm SM}}^{\rm C2HDM}/y_{t,H}$	$\lambda_{3H_{\rm SM}}^{\rm C2HDM}/\lambda_{3H}$
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heavy II	–	–	–	–

Experimental results cut on λ_{HHH} and hence on the parameter space

ATLAS; $-0.4 \leqq \kappa_\lambda \leqq 6.3$

Allowed values of the trilinear Higgs self-coupling

	R2HDM		C2HDM	
	$y_{t,H_{\rm SM}}^{\rm R2HDM}/y_{t,H}$	$\lambda_{3H_{\rm SM}}^{\rm R2HDM}/\lambda_{3H}$	$y_{t,H_{\rm SM}}^{\rm C2HDM}/y_{t,H}$	$\lambda_{3H_{\rm SM}}^{\rm C2HDM}/\lambda_{3H}$
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Experimental results cut on λ_{HHH} and hence on the parameter space

CMS; $-1.24 \leqq \kappa_\lambda \leqq 6.49$

Allowed values of the trilinear Higgs self-coupling

	R2HDM		C2HDM	
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	$y_{t,H_{\rm SM}}^{\rm N2HDM}/y_{t,H}$	$\lambda_{3H_{\rm SM}}^{\rm N2HDM}/\lambda_{3H}$	$y_{t,H_{\rm SM}}^{\rm NMSSM}/y_{t,H}$	$\lambda_{3H_{\rm SM}}^{\rm NMSSM}/\lambda_{3H}$
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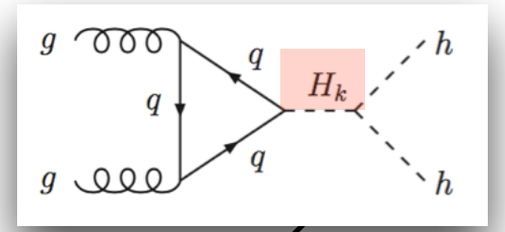
heavy II	–	–	–	–

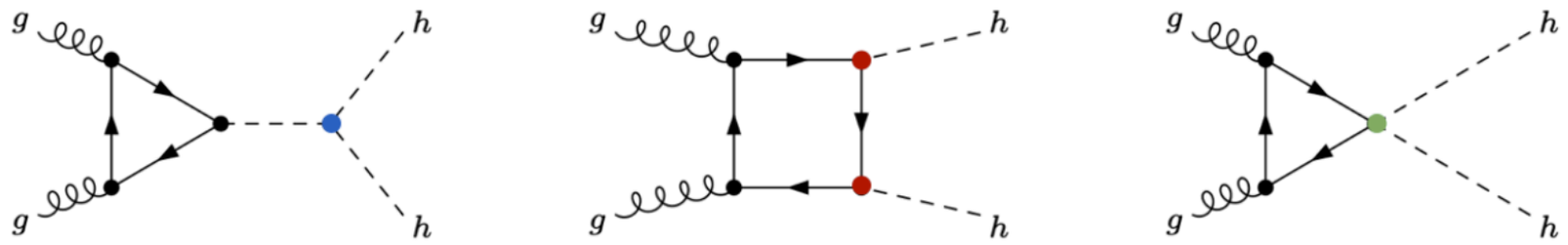
some models: λ_{HHH} compatible w/ zero still possible

Comparison with EFT

- Effective Lagrangian: $$\Delta\mathcal{L}_{\text{non-lin}} \supset -m_t t\bar{t}\left(c_t\frac{h}{v}+c_{tt}\frac{h^2}{2v^2}\right)-c_3\frac{1}{6}\left(\frac{3M_h^2}{v}\right)h^3$$

c_3: trilinear coupling modification; c_t: top-Yukawa coupling modification;
c_{tt}: effective two-Higgs-two-fermion coupling
no c_g, c_{gg}: no new heavy colored BSM particles assumed





- Matching relations of our specific BSM models:

Higgs-top Yukawa coupling	:	$g_t^{H_{\text{SM}}}(\alpha_i,\beta)$	$\to$	c_t
trilinear Higgs coupling	:	$\frac{g_3^{H_{\text{SM}}H_{\text{SM}}H_{\text{SM}}}(p_i)}{3M^2_{H_{\text{SM}}}/v}$	$\to$	c_3
two-Higgs-two-top quark coupling	:	$\sum_{k=1}^{k_{\max}}\left(\frac{-v}{m^2_{H_k}}\right) g_3^{H_k H_{\text{SM}}H_{\text{SM}}}(p_i)\, g_t^{H_k}(\alpha_i,\beta)$	$\to$	c_{tt}

2HDM versus EFT

- R2HDM T2 sample parameter point:

m_{H_1} [GeV]	m_{H_2} [GeV]	m_A [GeV]	$m_{H^\pm}$ [GeV]	α	$\tan\beta$	m_{12}^2 [GeV^2]
125.09	1131	1082	1067	-0.924	0.820	552749

- corresponding EFT values:

$$g_t^{H_2} = -1.126$$

$$c_3 = 0.782\,,\ c_t = 0.951\,,\ c_{tt} = -0.122$$

- goodness of approximation?:

m_{H_2} [GeV]	Γ_{H_2} [GeV]	c_{tt}	$g_3^{H_2H_1H_1}$ [GeV]	$\sigma_{\rm R2HDM}^{\rm w/\ res}$ [fb]	$\sigma_{\rm SMEFT}^{c_{tt}\neq 0}$ [fb]	ratio
1131	78.80	-0.1222	-504.52	30.5	26.1	86%
1200	89.74	-0.1031	-479.29	27.7	24.8	90%
1500	470.2	$-4.853\,10^{-2}$	-352.42	21.8	21.4	98%

- Remark:

$$\sigma_{\rm R2HDM}^{\rm w/o\ res} = 18.6\ {\rm fb} \quad \text{and} \quad \sigma_{\rm SMEFT}^{c_{tt}=0} = 18.6\ {\rm fb}$$

N2HDM versus EFT

- N2HDM T1 sample parameter point:

m_{H_1} [GeV]	m_{H_2} [GeV]	m_{H_3} [GeV]	m_A [GeV]	$m_{H^\pm}$ [GeV]	$\tan\beta$
125.09	269	582	390	380	4.190

α_1	α_2	α_3	v_s [GeV]	$\mathrm{Re}(m_{12}^2)$ [GeV^2]	
1.432	-0.109	0.535	1250	28112	

$$g_t^{H_2} = 0.179 \quad \text{and} \quad g_t^{H_3} = 2.337 \times 10^{-2}$$

- corresponding EFT values:

$$c_3 = 0.877\,,\ c_t = 1.012\,,\ c_{tt} = 4.127 \times 10^{-2}$$

- goodness of approximation?: (m_{H3} kept fixed)

m_{H_2}	Γ_{H_2}	$c_{tt}^{H_2}$	c_{tt}	$g_3^{H_2H_1H_1}$	$\sigma_{\mathrm{N2HDM}}^{\text{w/ res}}$ [fb]	$\sigma_{\mathrm{SMEFT}}^{c_{tt}\neq 0}$ [fb]	ratio
269	0.075	4.410×10^{-2}	4.127×10^{-2}	-72.42	183.70	20.56	11%
300	0.083	3.170×10^{-2}	2.877×10^{-2}	-64.80	162.80	21.28	13%
400	0.177	9.544×10^{-3}	6.721×10^{-3}	-34.68	43.33	22.60	52%
420	0.229	6.895×10^{-3}	4.063×10^{-3}	-27.62	31.70	22.76	72%
440	0.284	4.600×10^{-3}	1.767×10^{-3}	-20.22	26.26	22.90	87%
450	0.315	3.564×10^{-3}	7.323×10^{-4}	-16.39	24.84	22.96	92%
500	2.567	-7.132×10^{-4}	-3.545×10^{-3}	4.05	23.56	23.22	99%

Single Higgs versus Di-Higgs Cascade Decays

- Singlet extended N2HDM, NMSSM: non-SM Higgs is singlet-like and/or more down- than up-type like => suppressed direct production rate

- Sample parameter point N2HDM T1:

m_{H_1} [GeV]	m_{H_2} [GeV]	m_{H_3} [GeV]	m_A [GeV]	$m_{H^\pm}$ [GeV]	$\tan\beta$
125.09	281.54	441.25	386.98	421.81	1.990

α_1	α_2	α_3	v_s [GeV]	$\mathrm{Re}(m_{12}^2)$ [GeV^2]	
1.153	0.159	0.989	9639	29769	

$$\sigma^{\mathrm{NLO}}_{H_1H_2} \times \mathrm{BR}(H_2 \to H_1H_1) \times \mathrm{BR}(H_1 \to b\bar{b})^3 = 509 \cdot 0.37 \cdot 0.60^3 \text{ fb} = 40 \text{ fb}$$

$$\sigma^{\mathrm{NNLO}}(H_2) \times \mathrm{BR}(H_2 \to H_1H_1) \times \mathrm{BR}(H_1 \to b\bar{b})^2 = 161 \cdot 0.37 \cdot 0.60^2 \text{ fb} = 21 \text{ fb}$$

H2 has tiny couplings to b-quarks => better chances to be discovered in di-Higgs than single Higgs channels

CP-Violating Decays

- CP-violating 2HDM (C2HDM): BSM CP violation required in electroweak baryogenesis*

- Example C2HDM T1:

m_{H_1} [GeV]	m_{H_2} [GeV]	$m_{H^\pm}$ [GeV]	α_1	α_2	α_3	$\tan\beta$	$\mathrm{Re}(m_{12}^2)$ [GeV^2]
125.09	265	236	1.419	0.004	-0.731	5.474	9929

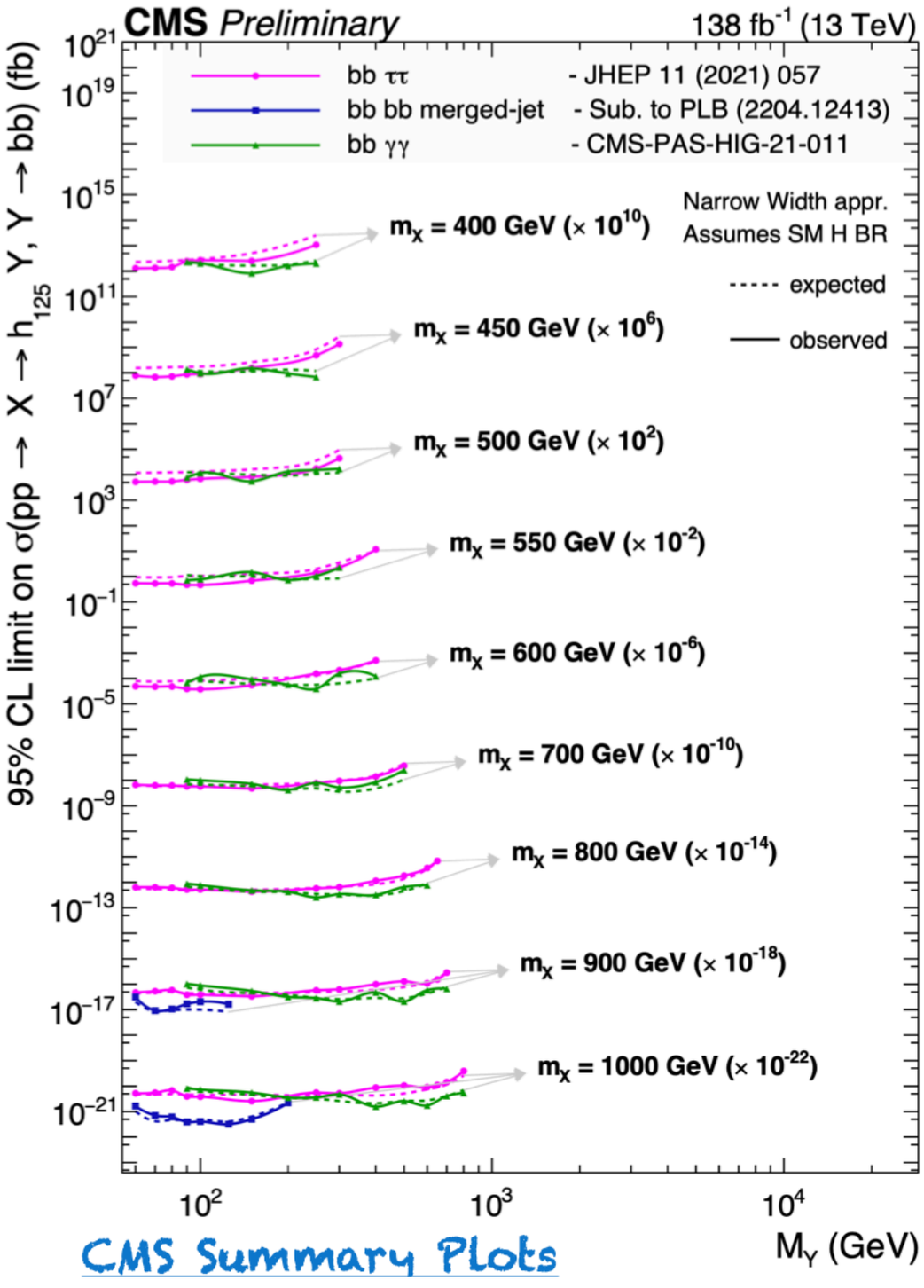
$\sigma^{\rm NLO}_{H_1H_1}$ [fb]	K-factor	$\Gamma^{\rm tot}_{H_1}$ [GeV]	$\Gamma^{\rm tot}_{H_2}$ [GeV]	$\Gamma^{\rm tot}_{H_3}$ [GeV]	$\Gamma^{\rm tot}_{H^\pm}$ [GeV]
387	2.06	4.106×10^{-3}	3.625×10^{-3}	4.880×10^{-3}	0.127

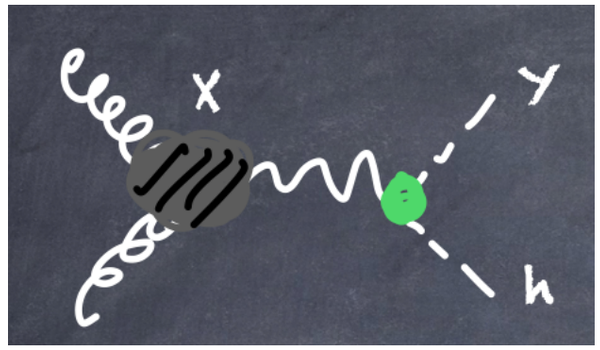
$\lambda_{3H_1}/\lambda_{3H}$	$y^e_{t,H_1}/y_{t,H}$	$\sigma^{\rm NNLO}_{H_1}$ [pb]	$\sigma^{\rm NNLO}_{H_2}$ [pb]	$\sigma^{\rm NNLO}_{H_3}$ [pb]	
0.995	1.005	49.75	0.76	0.84	

$$
\begin{aligned}
\sigma(H_2)\times \mathrm{BR}(H_2\to H_1H_1) &= 191\ \mathrm{fb}\,, & \sigma(H_2)\times \mathrm{BR}(H_2\to WW) &= 254\ \mathrm{fb}\\
\sigma(H_2)\times \mathrm{BR}(H_2\to ZZ) &= 109\ \mathrm{fb}\,, & \sigma(H_2)\times \mathrm{BR}(H_2\to ZH_1) &= 122\ \mathrm{fb}\\
\sigma(H_3)\times \mathrm{BR}(H_3\to H_1H_1) &= 235\ \mathrm{fb}\,, & \sigma(H_3)\times \mathrm{BR}(H_3\to WW) &= 315\ \mathrm{fb}\\
\sigma(H_3)\times \mathrm{BR}(H_3\to ZZ) &= 136\ \mathrm{fb}\,, & \sigma(H_3)\times \mathrm{BR}(H_3\to ZH_1) &= 76\ \mathrm{fb}\,.
\end{aligned}
$$

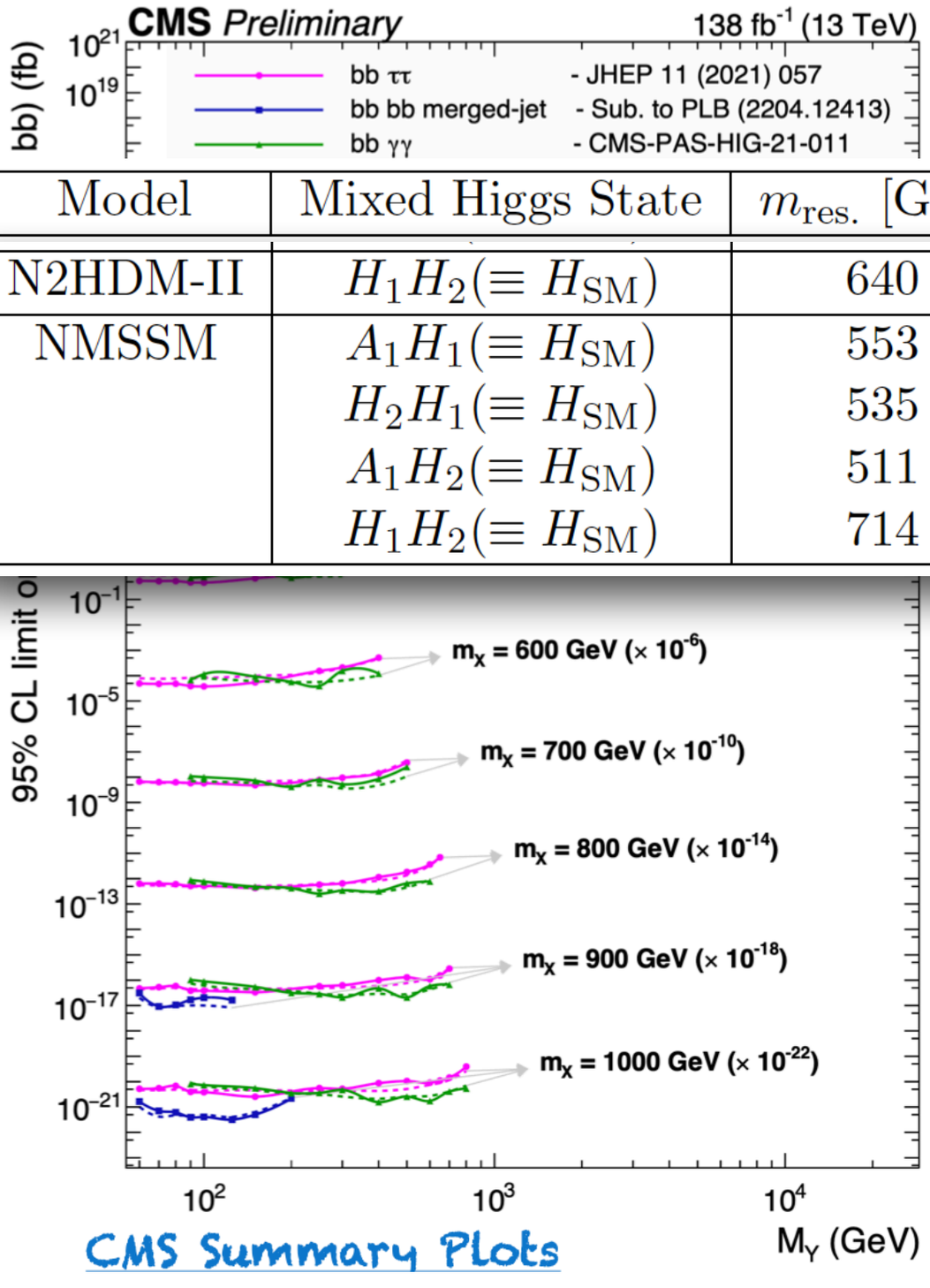
*talk by Lisa Biermann

Mixed Higgs Pairs: h+Φ





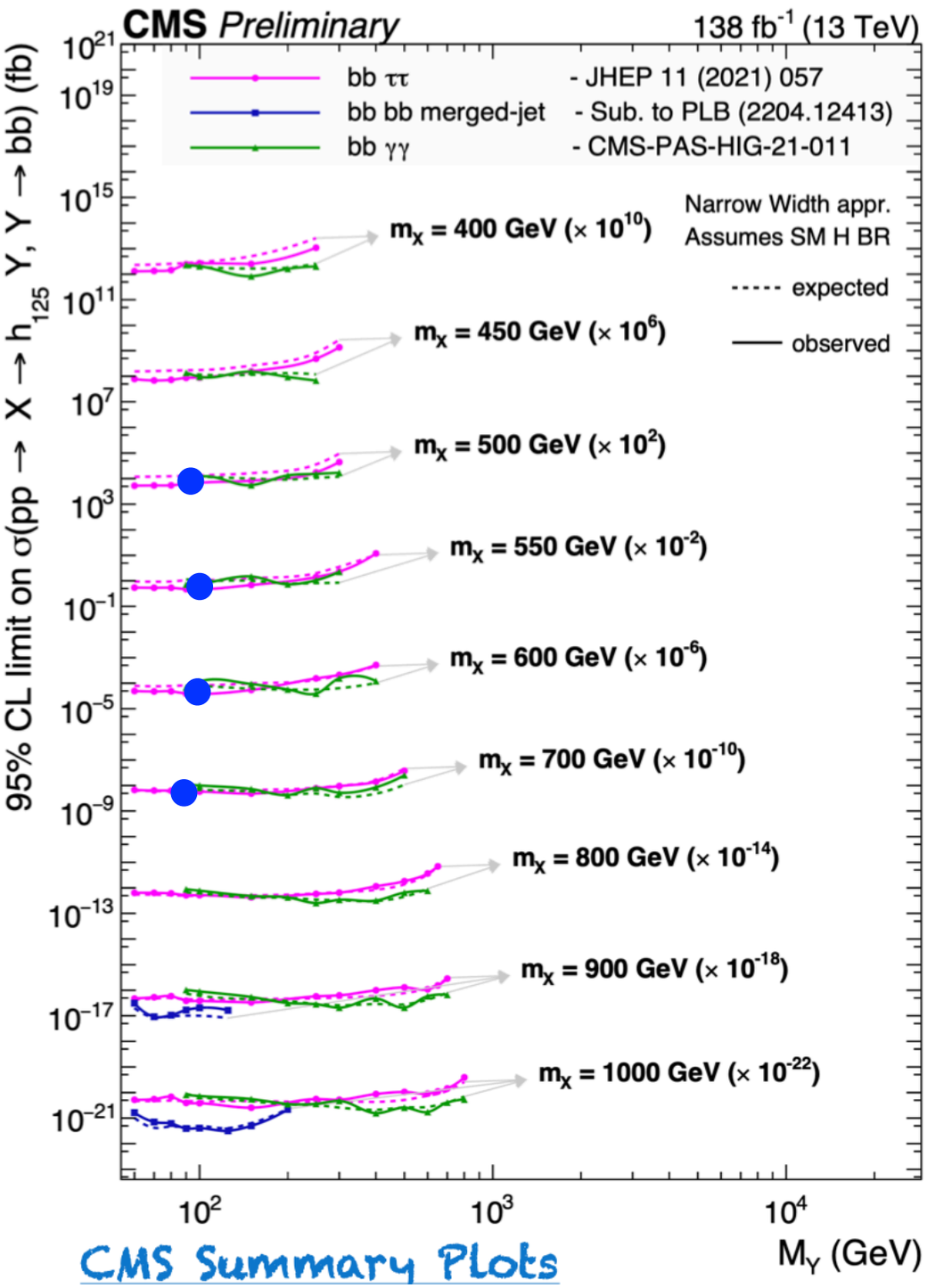
Mixed Higgs Pairs: h+Φ

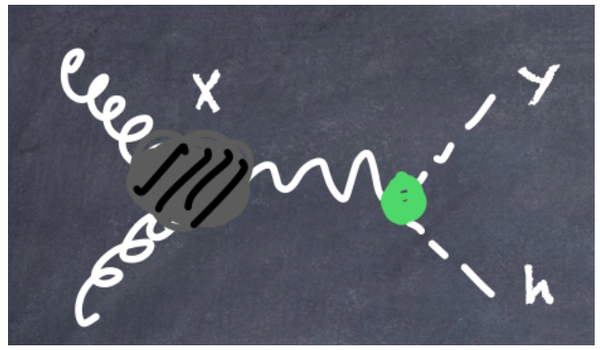


4b

Model	Mixed Higgs State	$m_{\text{res.}}$ [GeV]	res. rate [fb]	m_Φ [GeV]	Rate [fb]	K-factor
N2HDM-II	$H_1H_2(\equiv H_{\text{SM}})$	640 X	18	103	18	1.86
NMSSM	$A_1H_1(\equiv H_{\text{SM}})$	553 X	210	113	201	1.92
	$H_2H_1(\equiv H_{\text{SM}})$	535	42	167	43	1.91
	$A_1H_2(\equiv H_{\text{SM}})$	511 X	42	87	40	1.94
	$H_1H_2(\equiv H_{\text{SM}})$	714 X	58	80	59	1.90

Mixed Higgs Pairs: h+Φ



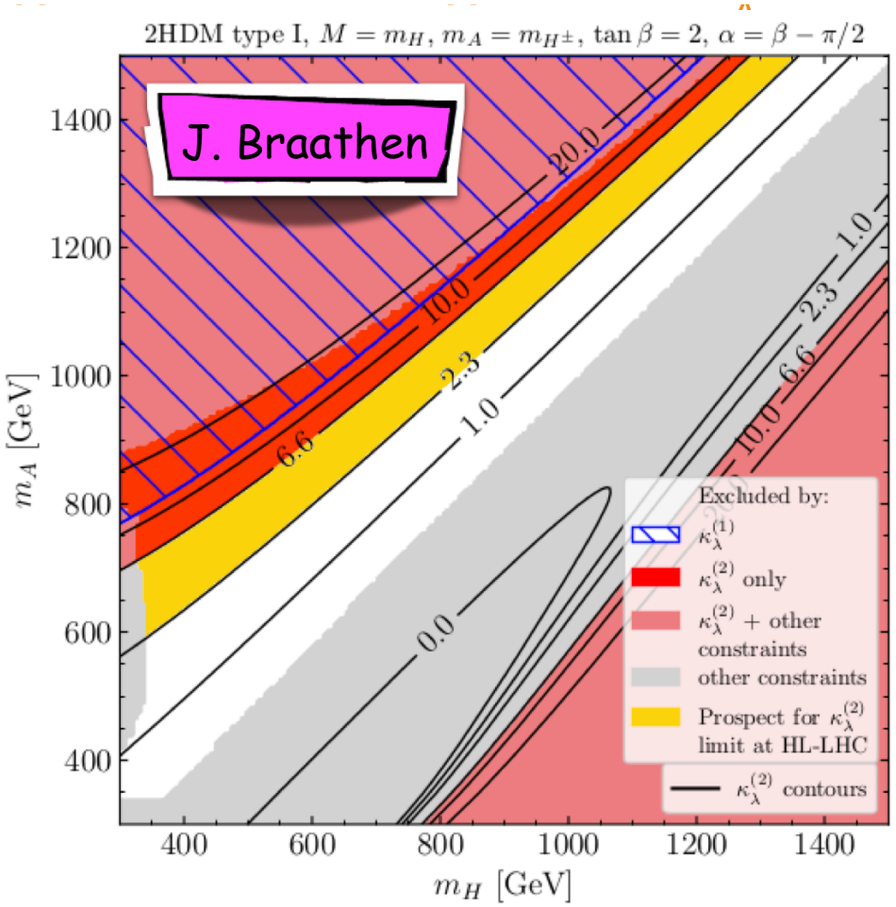


Non-SM Higgs Pair Final States

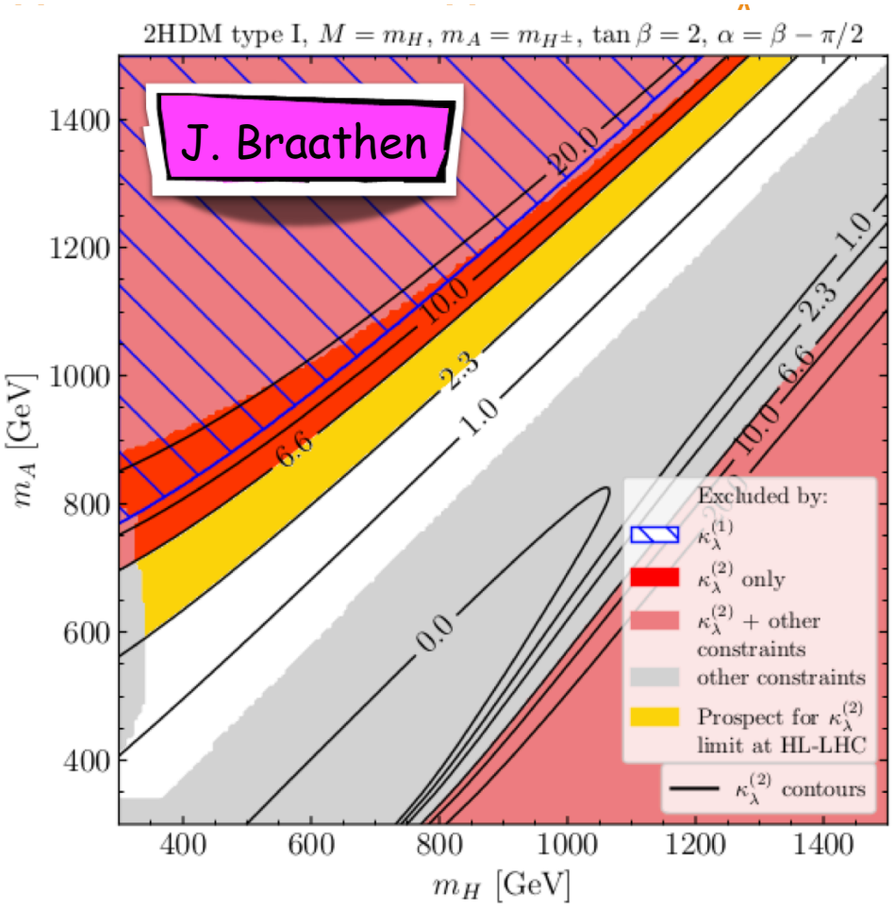
Model	SM-like Higgs	Signature	m_Φ [GeV]	Rate [fb]	K-factor
N2HDM-I	H_3	$H_1H_1 \to (b\bar{b})(b\bar{b})$	41	14538	2.18
	H_3	$H_1H_1 \to (4b);(4\gamma)$	41	4545 ; 700	2.24
	H_1	$AA \to (b\bar{b})(b\bar{b})$	75	6117	2.11
	H_1	$H_2H_2 \to (b\bar{b})(b\bar{b})$	146	73	2.01
	H_2	$AA \to (b\bar{b})(b\bar{b})$	80	2875	2.13
	H_2	$AH_1 \to (b\bar{b})(b\bar{b})$	m_A : 87 m_{H_1} : 91	921	2.09
	H_2	$H_1H_1 \to (b\bar{b})(b\bar{b})$	47	8968	2.17
N2HDM-II	H_2	$H_1H_1 \to (b\bar{b})(b\bar{b})$	44	1146	2.18
C2HDM-I	H_1	$H_2H_2 \to (b\bar{b})(b\bar{b})$	128	475	2.07
	H_2	$H_1H_1 \to (b\bar{b})(b\bar{b})$	66	814	2.16
	H_3	$H_1H_1 \to (b\bar{b})(b\bar{b})$	84	31	2.09
NMSSM	H_1	$A_1A_1 \to (b\bar{b})(b\bar{b})$	166	359	1.95
	H_1	$A_1A_1 \to (\gamma\gamma)(\gamma\gamma)$	179	34	1.96
	H_2	$H_1H_1 \to (b\bar{b})(b\bar{b})$	48	3359	2.18
	H_2	$A_1A_1 \to (b\bar{b})(b\bar{b})$	54	1100	2.18
	H_1	$A_1A_1 \to (t\bar{t})(t\bar{t})$	350	20	1.82

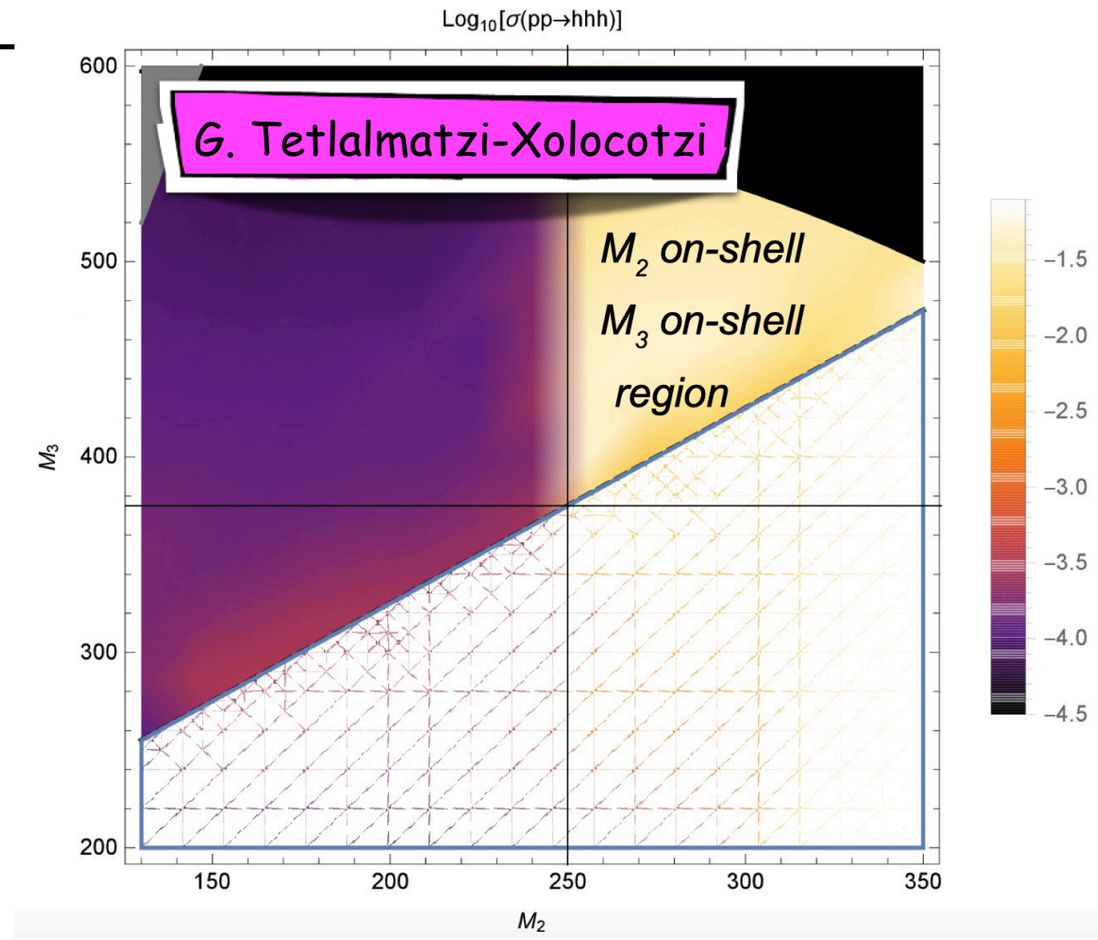
Model	Signature	$m_{\text{res.}}$ [GeV]	res. rate [fb]	$m_{\text{res.}}$ 2 [GeV]	res. rate 2 [fb]
N2HDM-I	$H_1H_1 \to (b\bar{b})(b\bar{b})$	125.09	621	98	17137
	$H_1H_1 \to (4b);(4\gamma)$	125.09	126; 19	94	5445;839
	$AA \to (b\bar{b})(b\bar{b})$	1535	<0.1	323	482
	$H_2H_2 \to (b\bar{b})(b\bar{b})$	360	76	—	—
	$AA \to (b\bar{b})(b\bar{b})$	178	3191	—	—
	$AH_1 \to (b\bar{b})(b\bar{b})$	—	—	—	—
	$H_1H_1 \to (b\bar{b})(b\bar{b})$	588	22	125.09	997
N2HDM-II	$H_1H_1 \to (b\bar{b})(b\bar{b})$	520	< 0.1	125.09	1330
C2HDM-I	$H_2H_2 \to (b\bar{b})(b\bar{b})$	266	497	—	—
	$H_1H_1 \to (b\bar{b})(b\bar{b})$	151	598	—	—
	$H_1H_1 \to (b\bar{b})(b\bar{b})$	—	—	—	—
NMSSM	$A_1A_1 \to (b\bar{b})(b\bar{b})$	552	31	453	332
	$A_1A_1 \to (\gamma\gamma)(\gamma\gamma)$	796	< 0.01	444	34
	$H_1H_1 \to (b\bar{b})(b\bar{b})$	882	<0.1	125.59	4173
	$A_1A_1 \to (b\bar{b})(b\bar{b})$	676	< 0.1	122.99	1353
	$A_1A_1 \to (t\bar{t})(t\bar{t})$	741	7	705	14

Many other contributions on BSM Higgs Pair Production

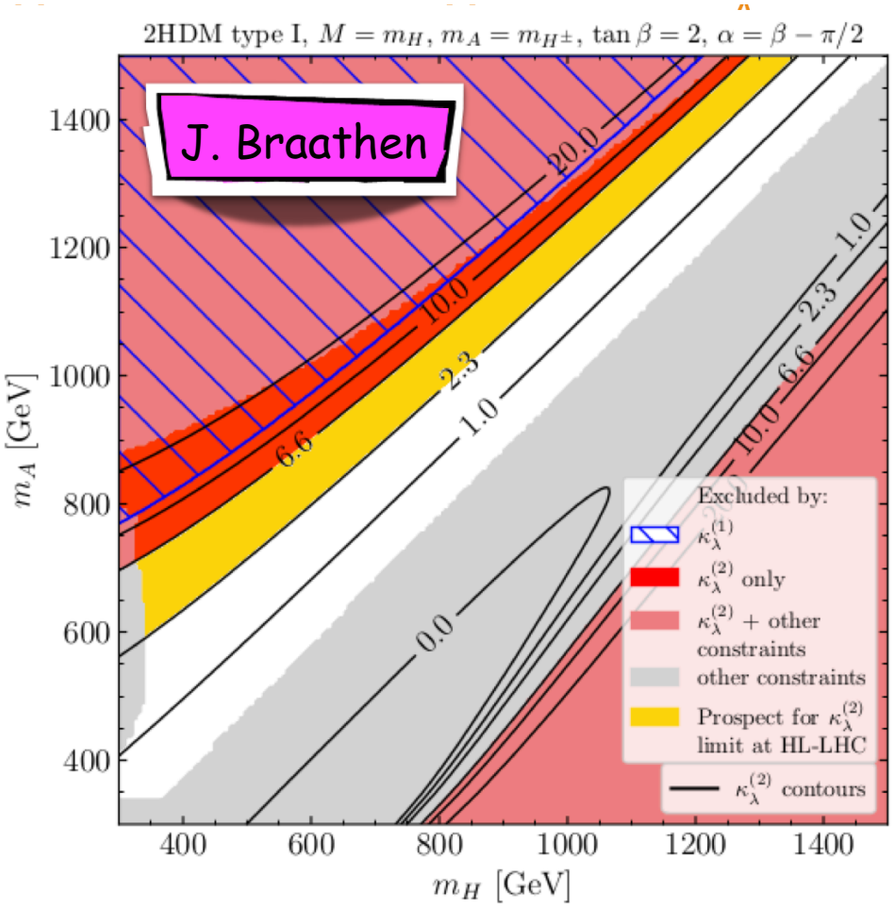


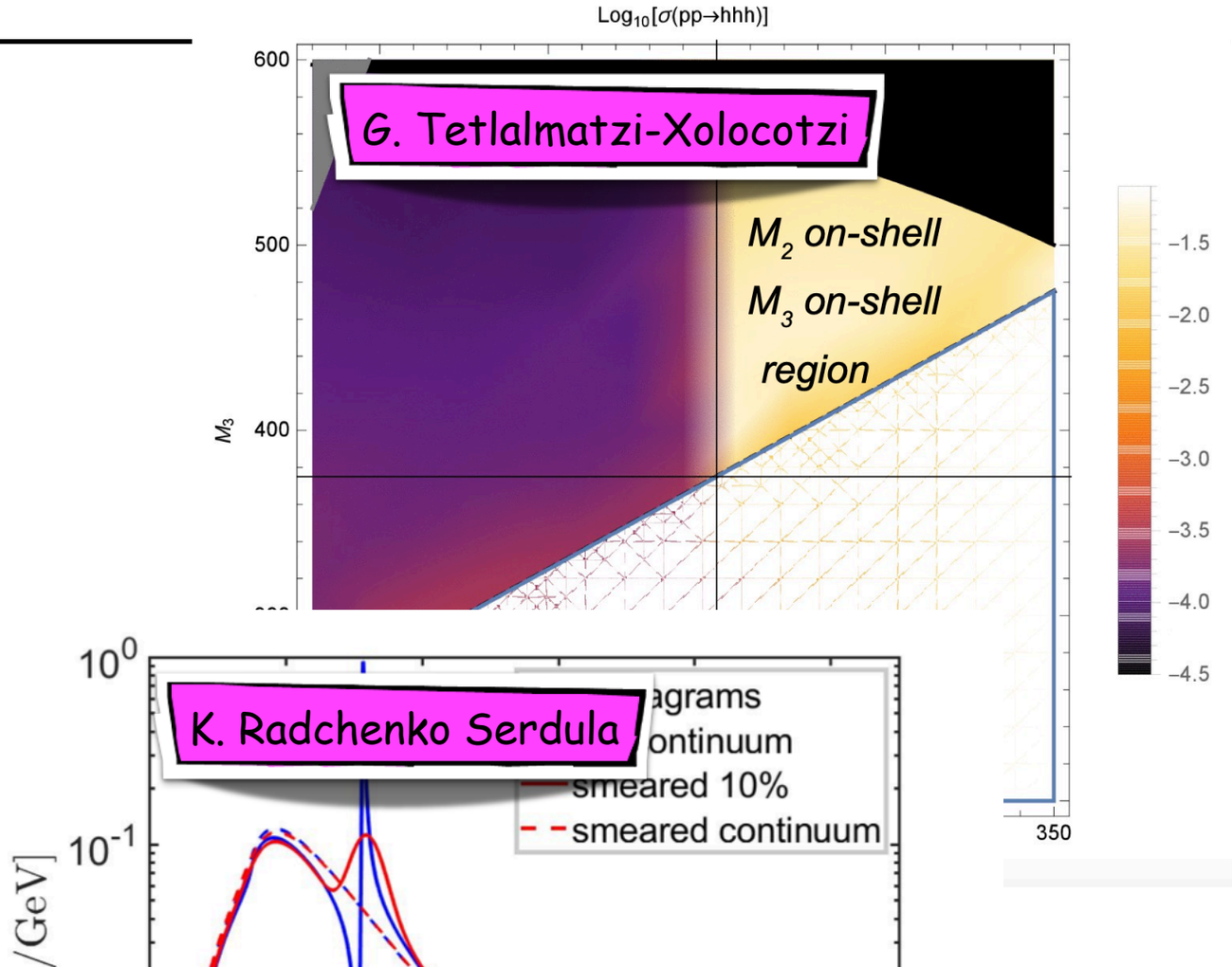
Many other contributions on BSM Higgs Pair Production

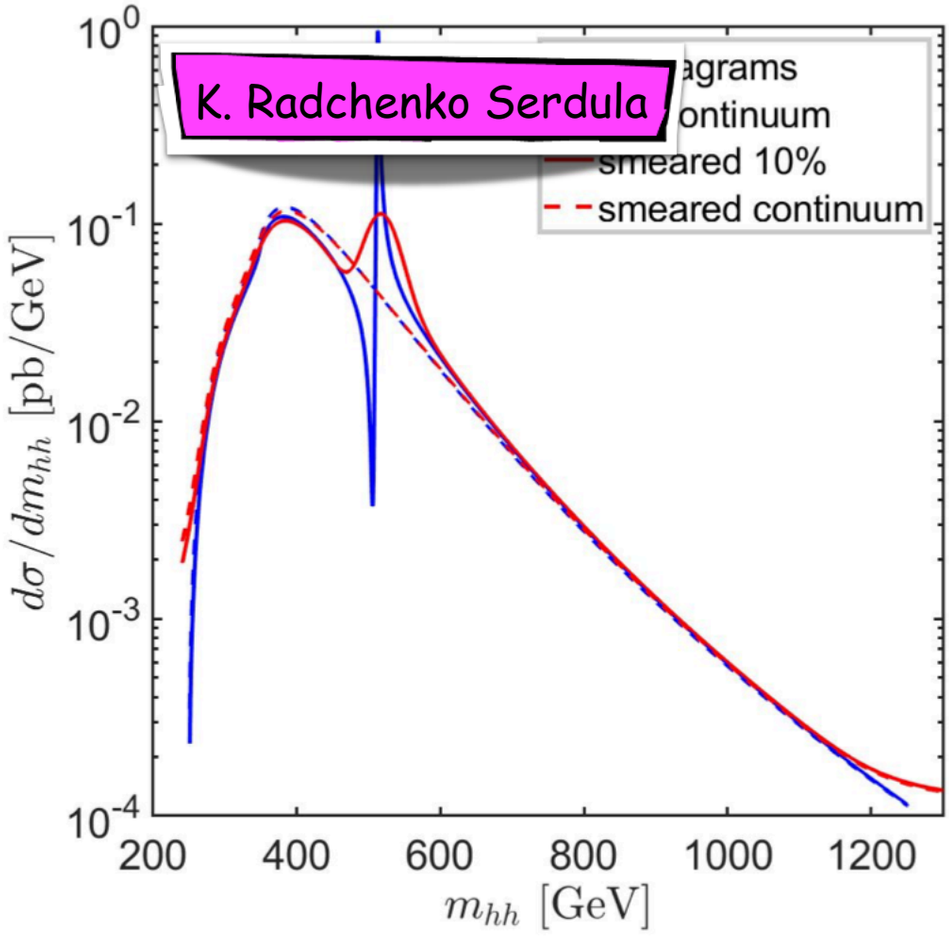




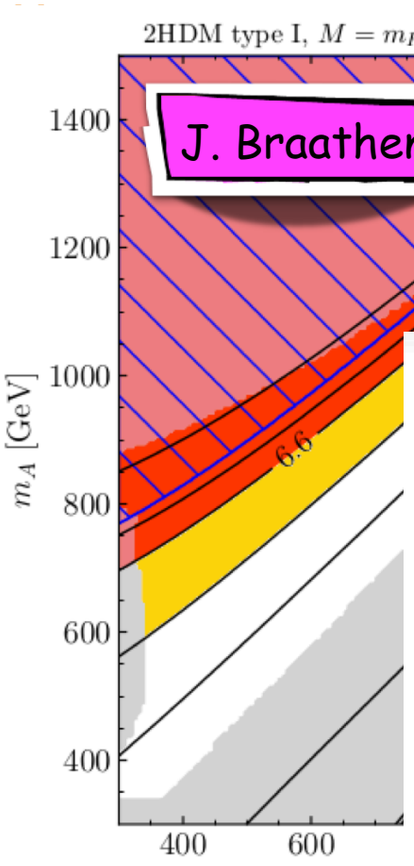
Many other contributions on BSM Higgs Pair Production

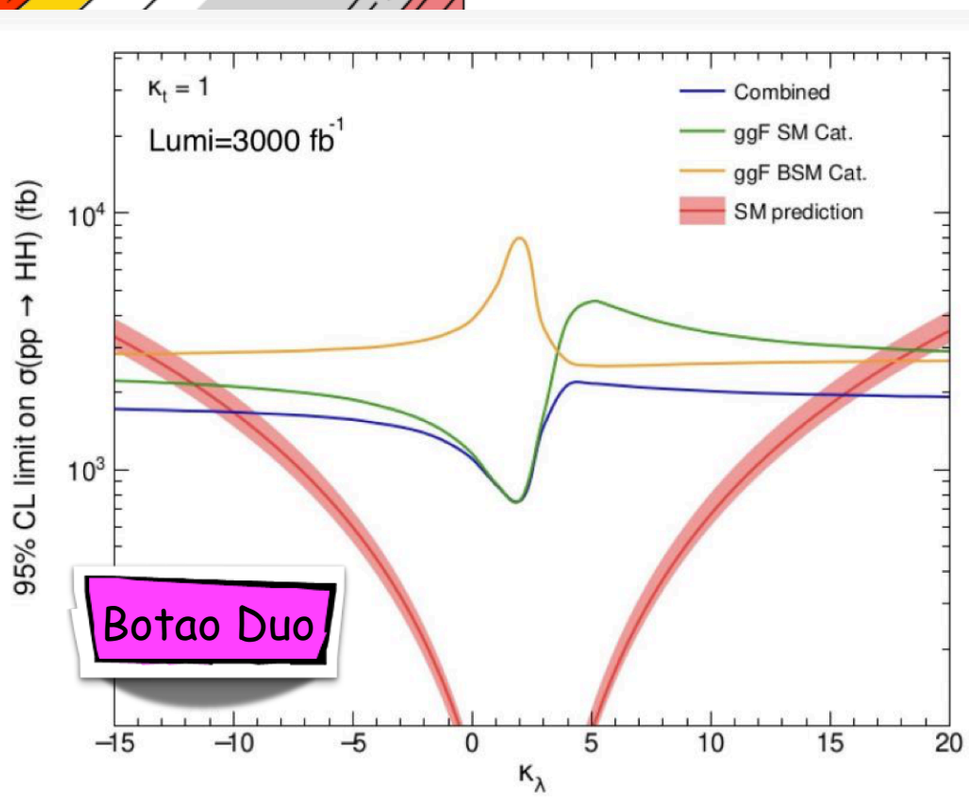


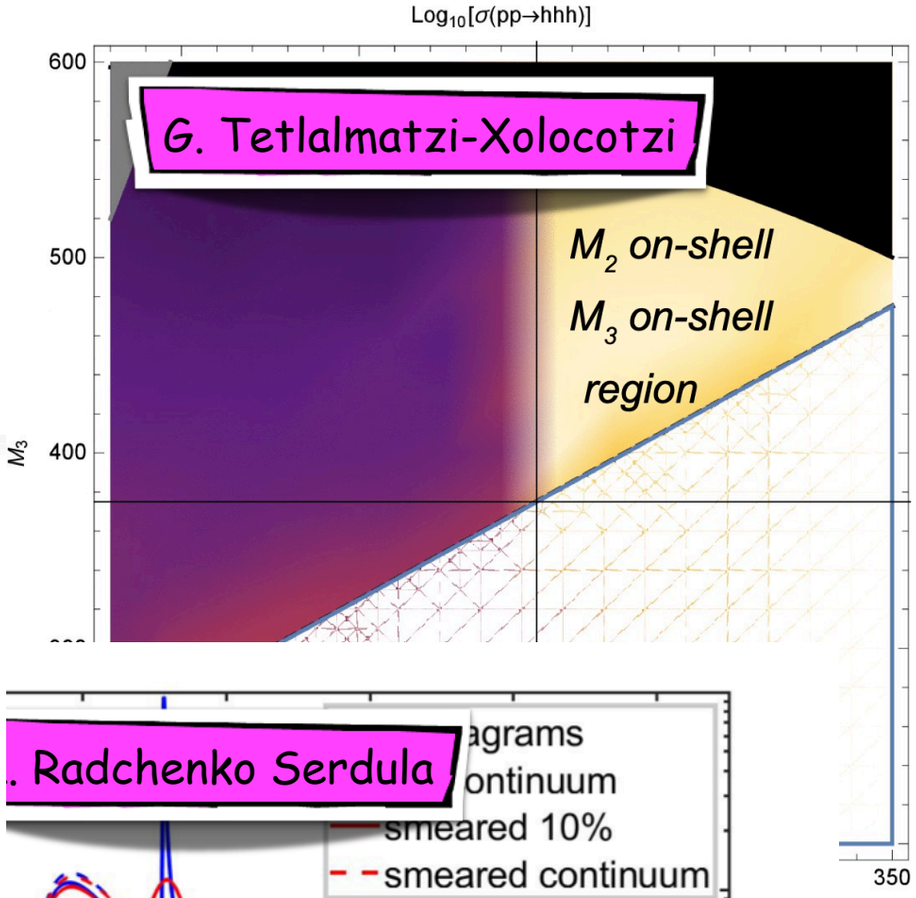


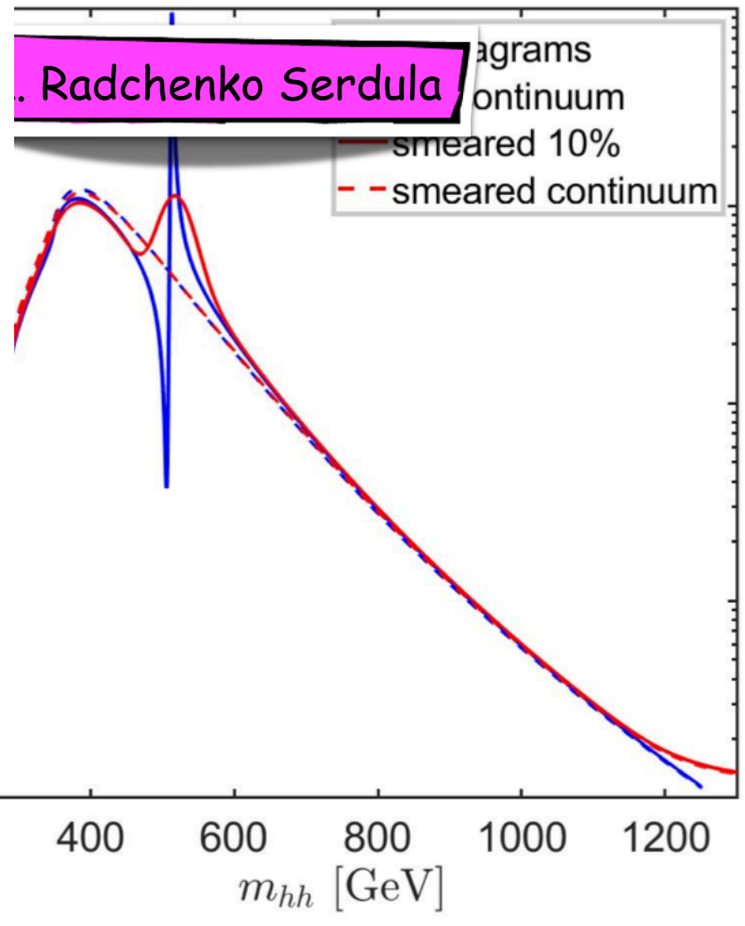


Many other contributions on BSM Higgs Pair Production

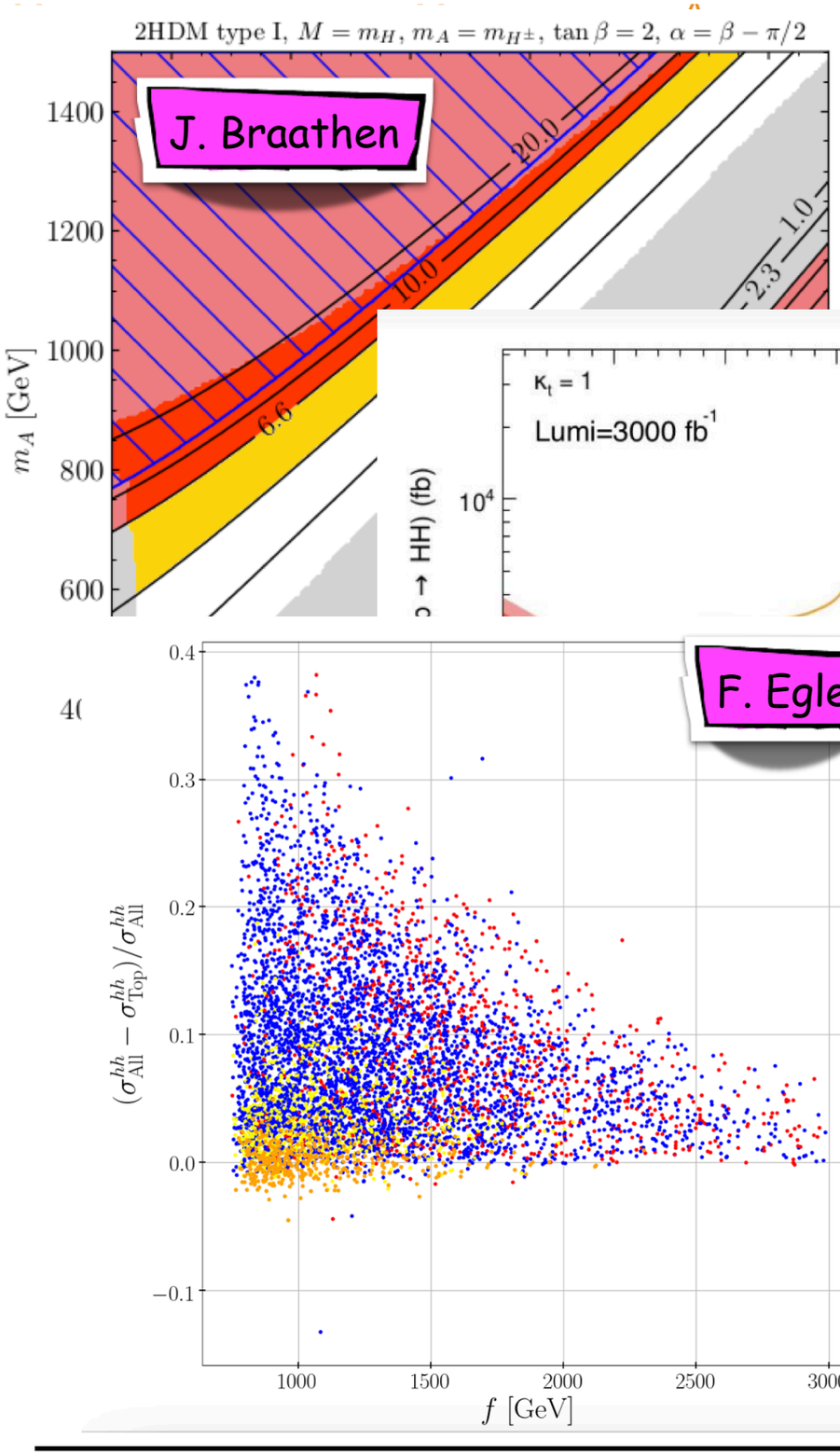


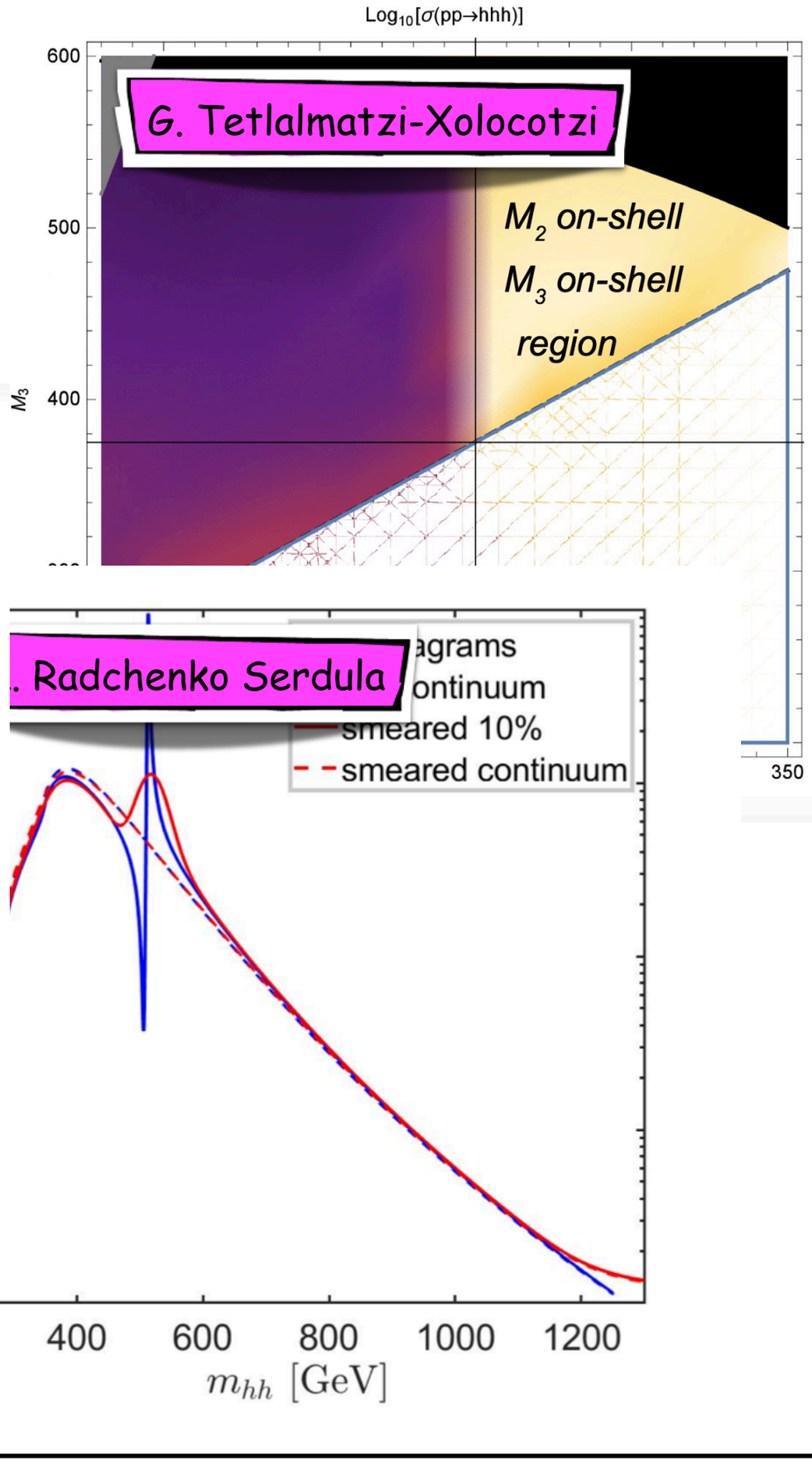






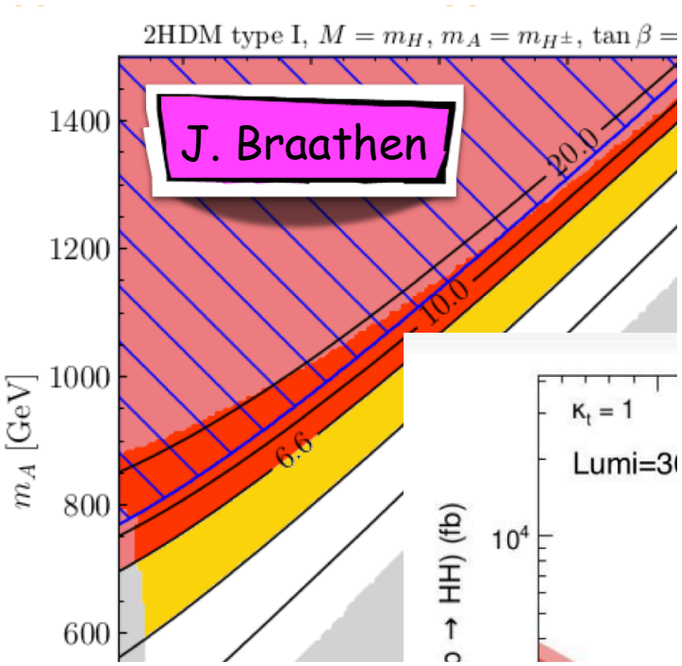
Many other contributions on BSM Higgs Pair Production

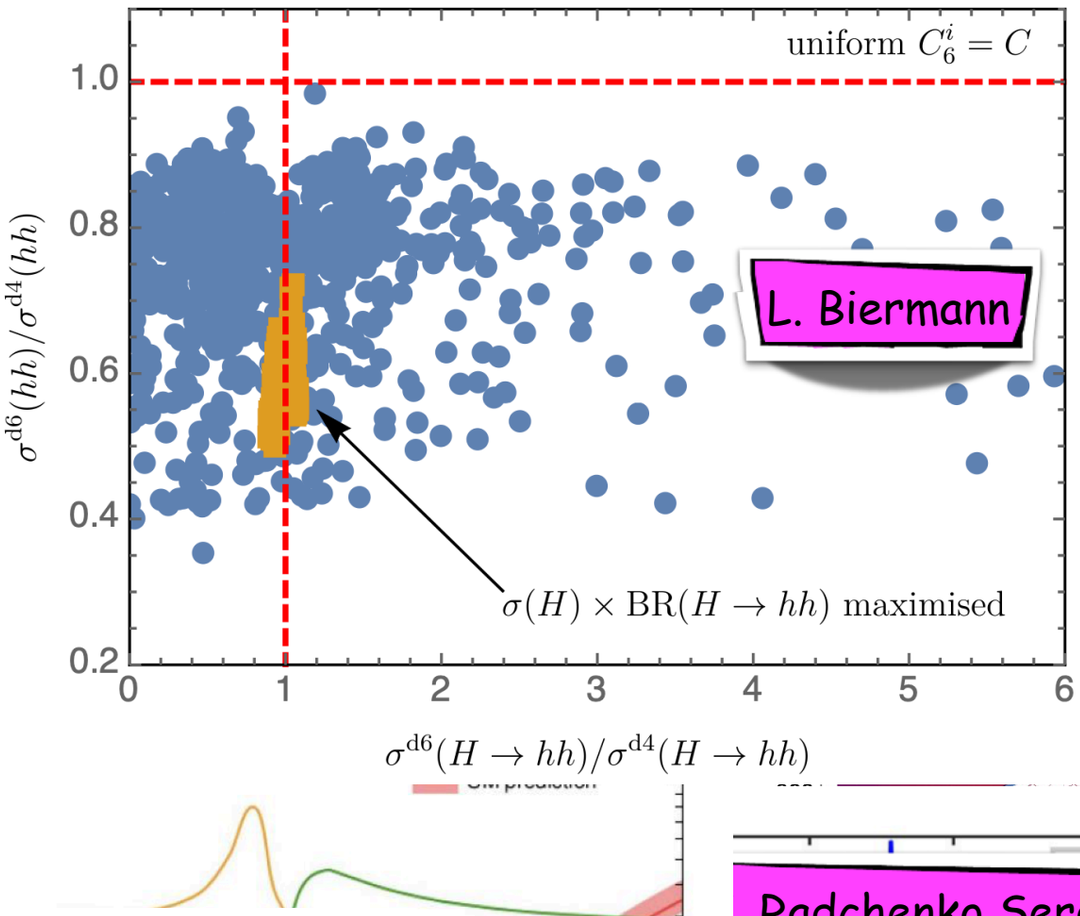


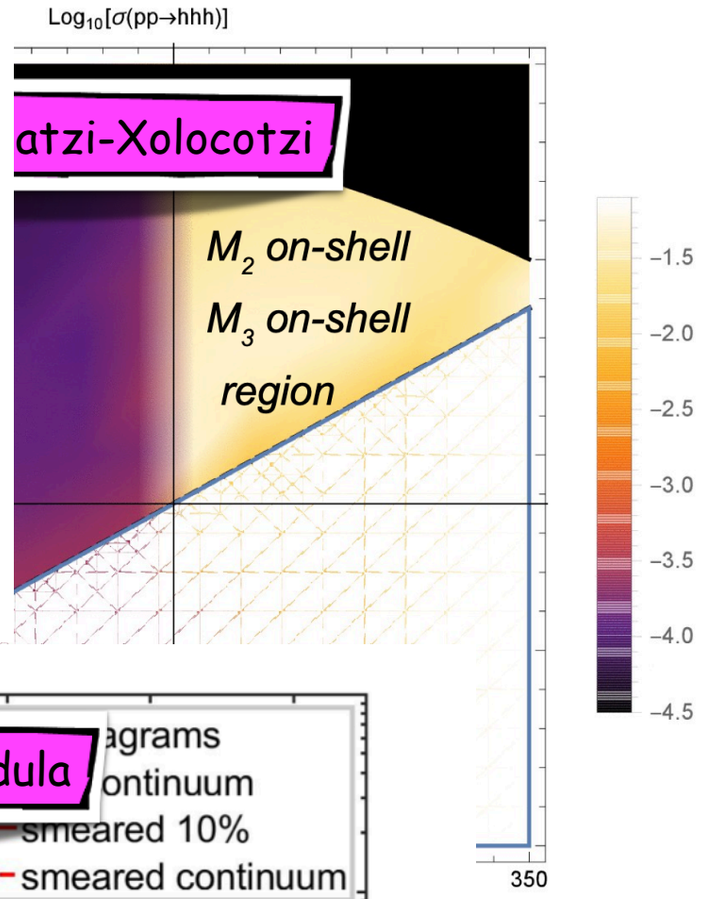


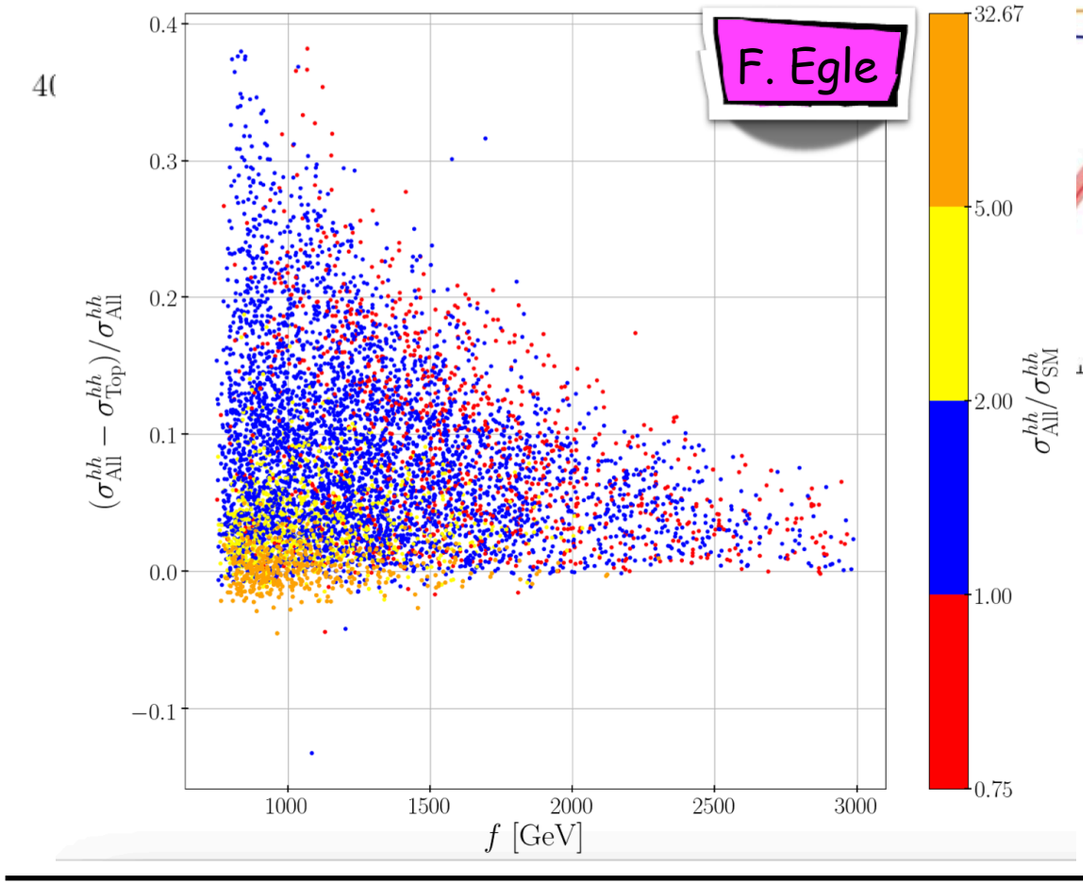
Many other

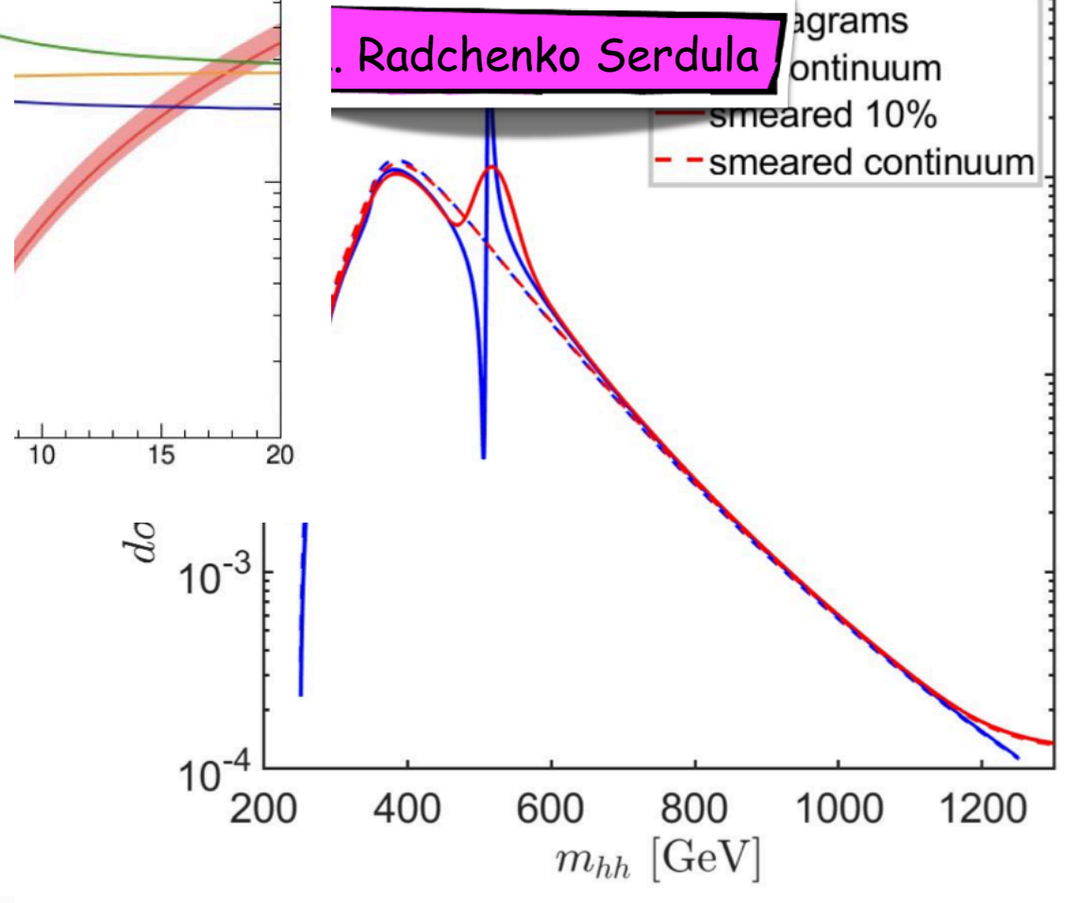
Pair Production











Many other

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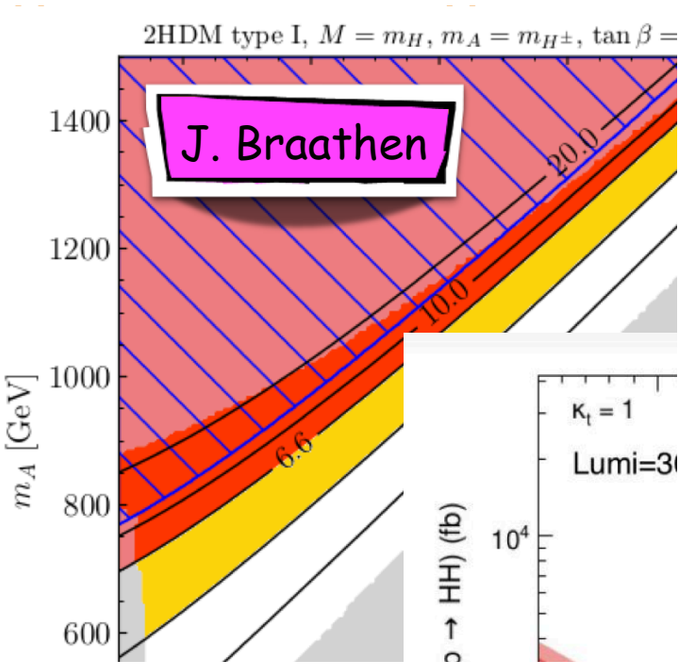
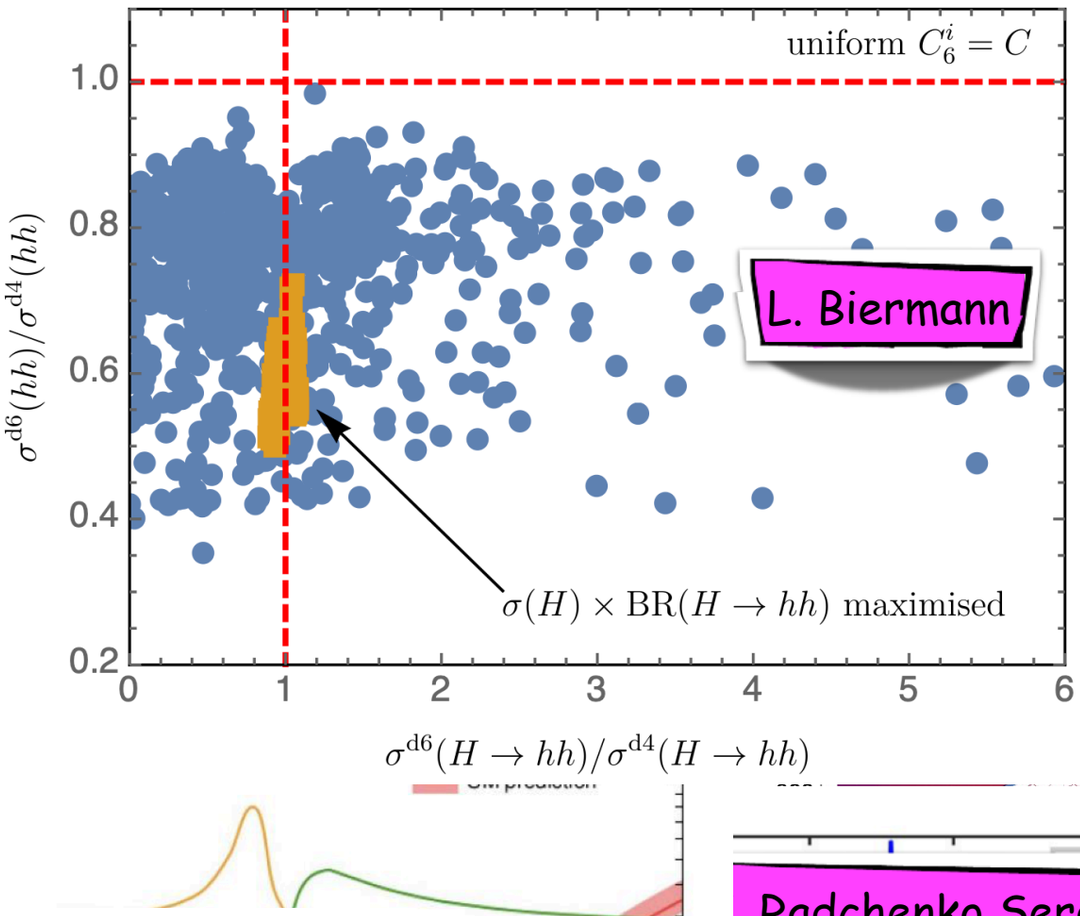
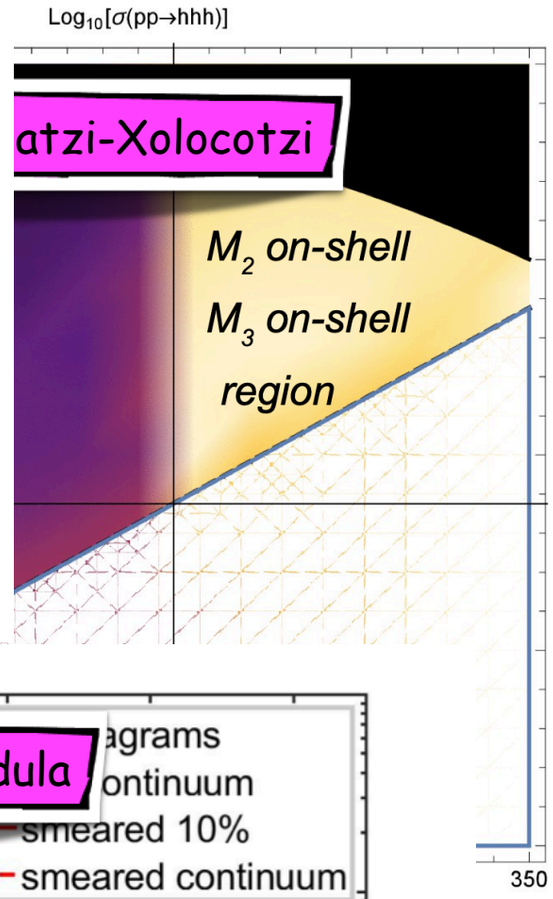
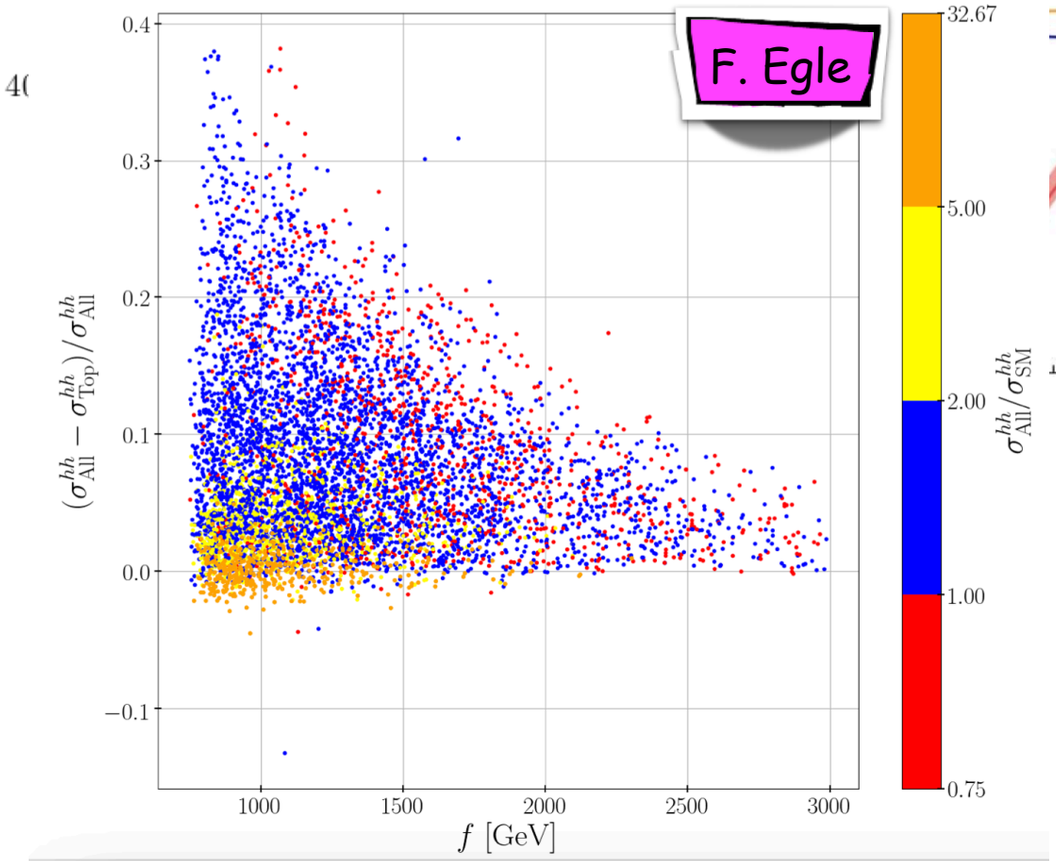
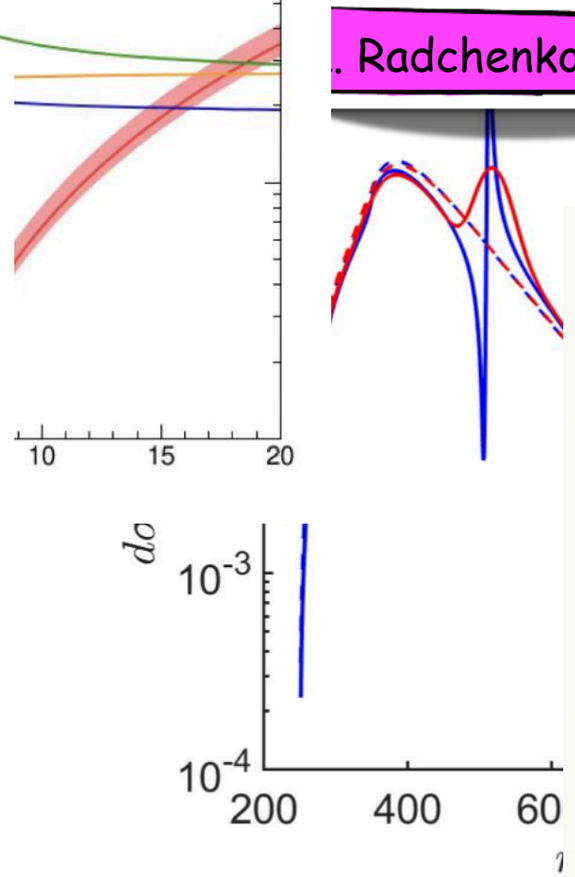
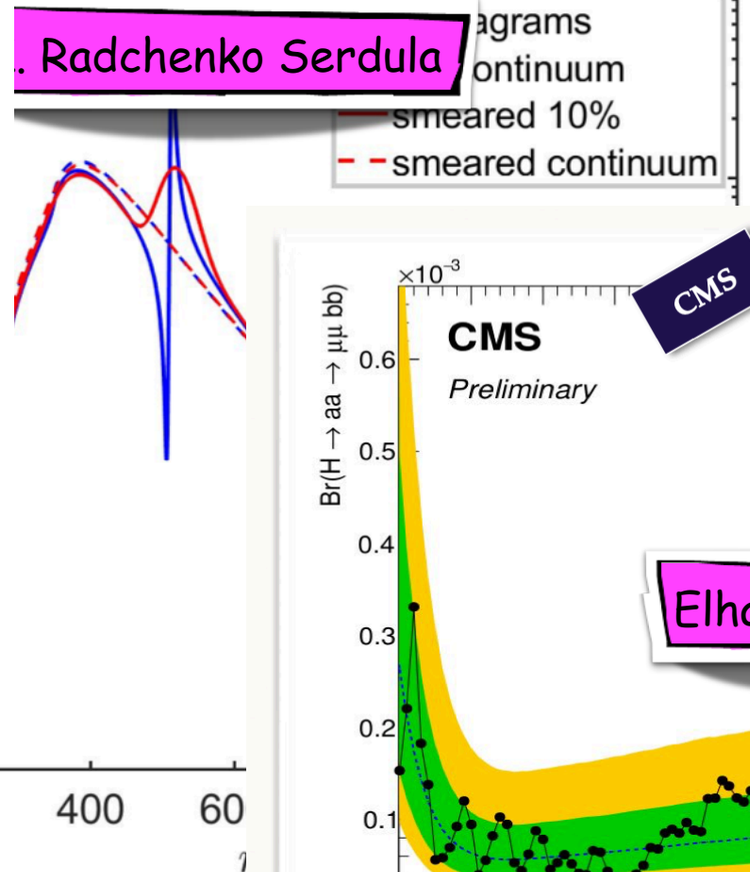


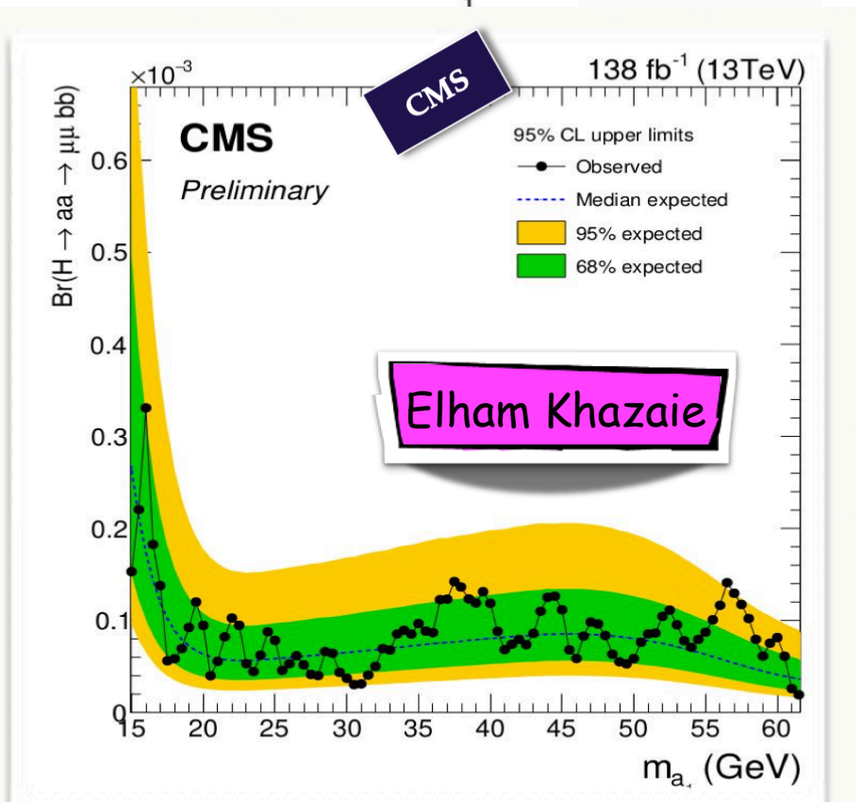






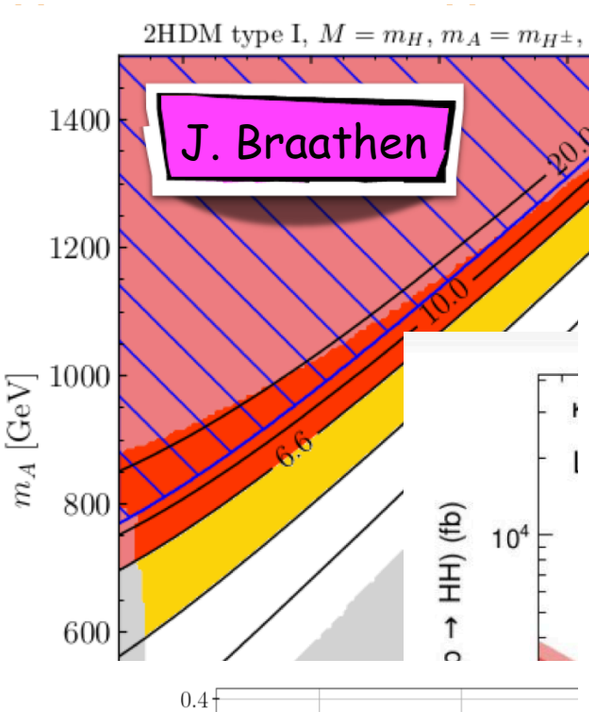


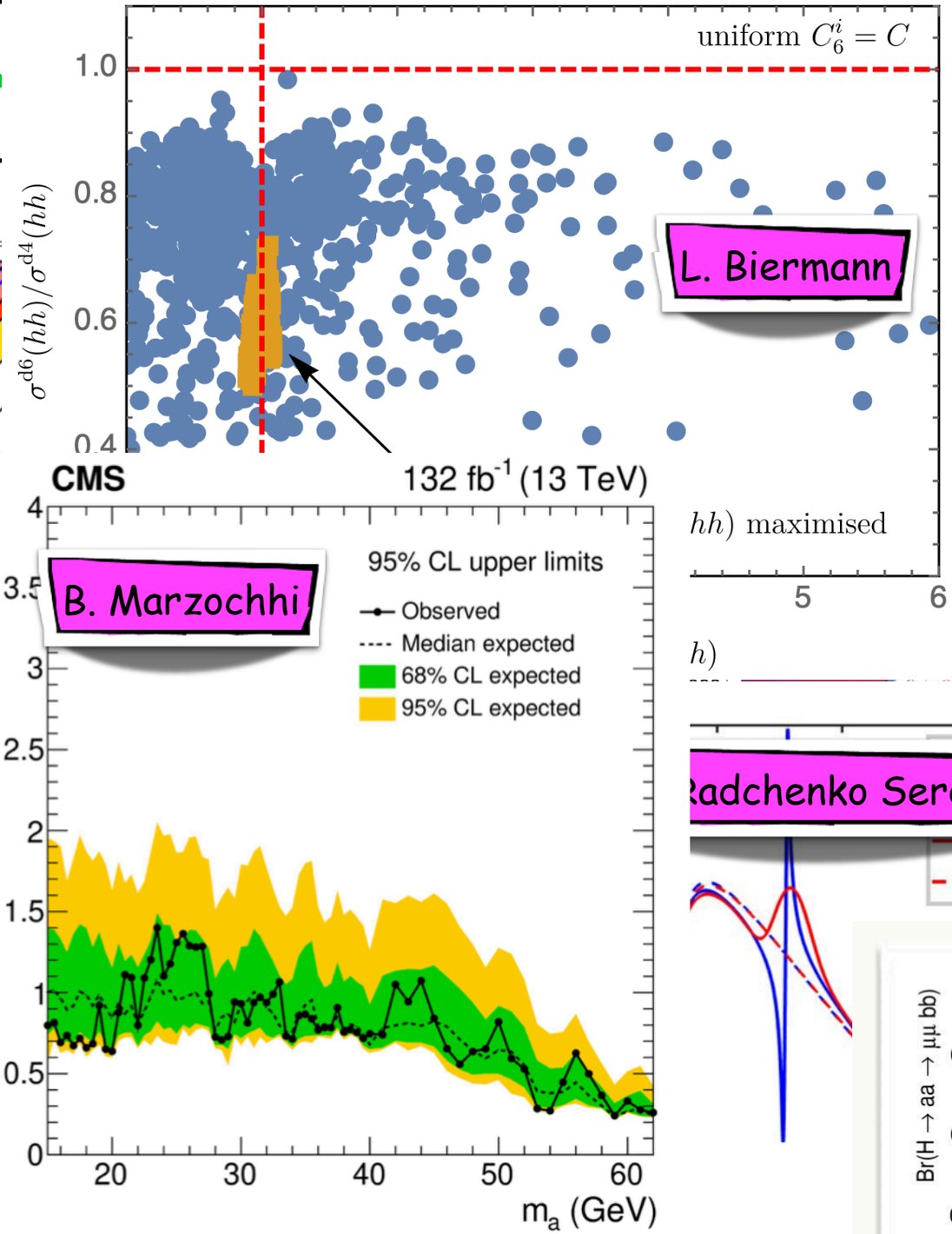


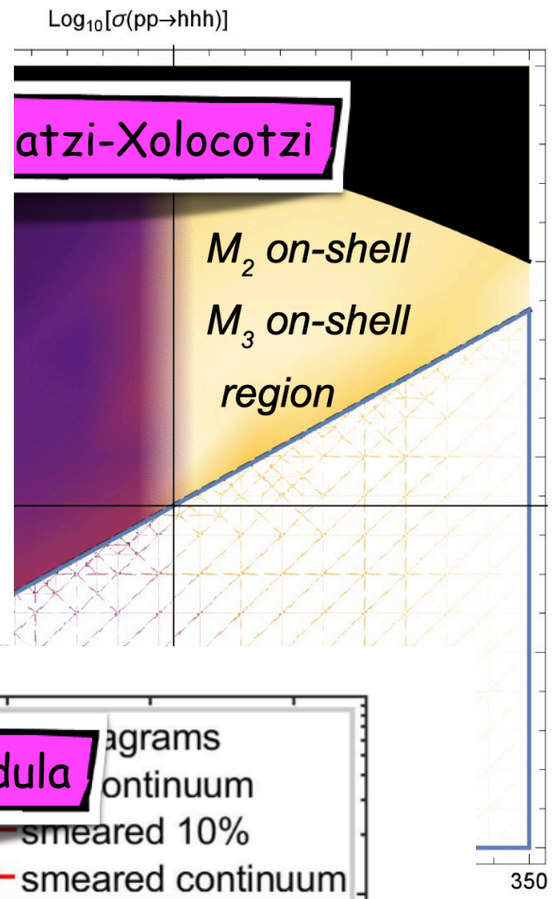


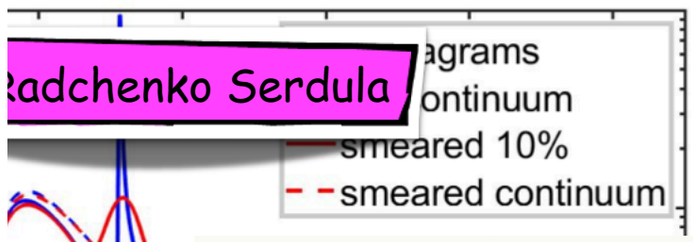
Many other

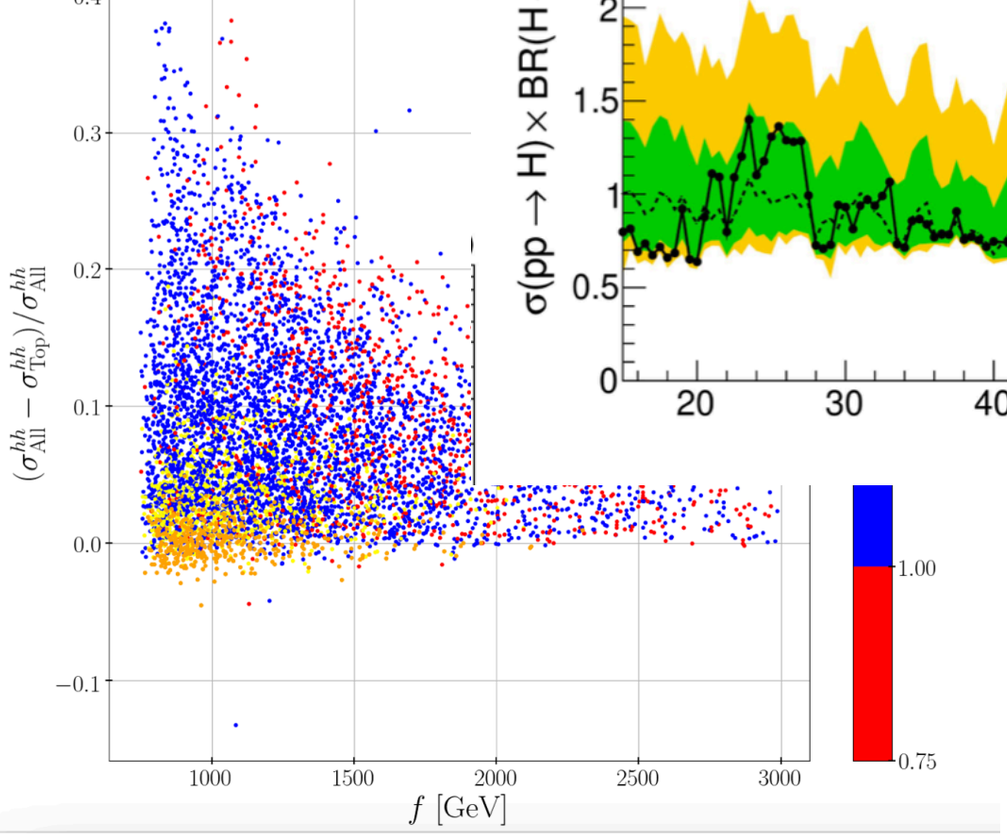
Pair Production

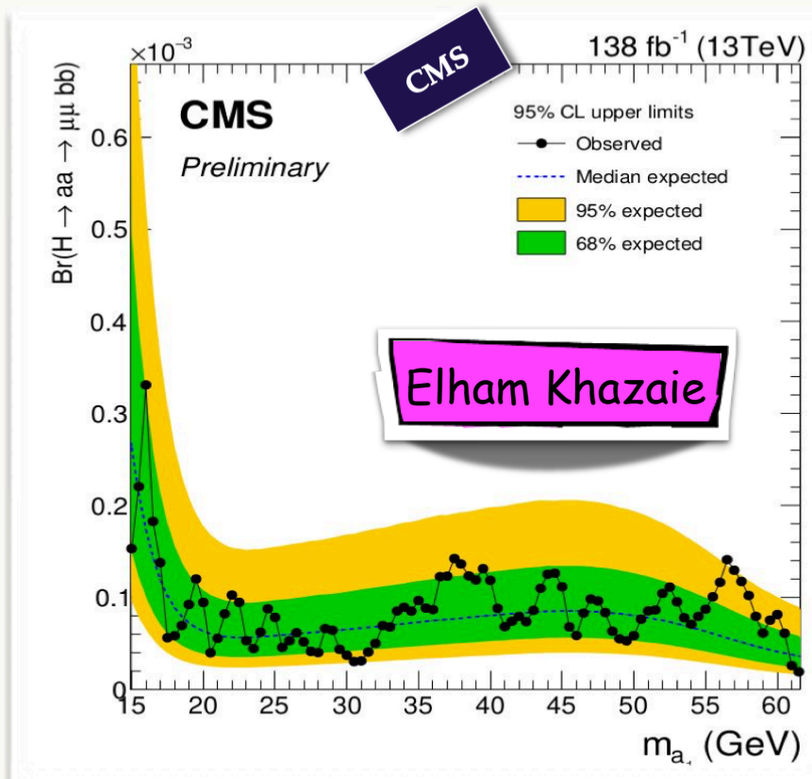












Many other

Pair Production

J. Braathen

B. Marzochhi

Borschensky et al.

Elham Khazaie

Many other

Pair Production

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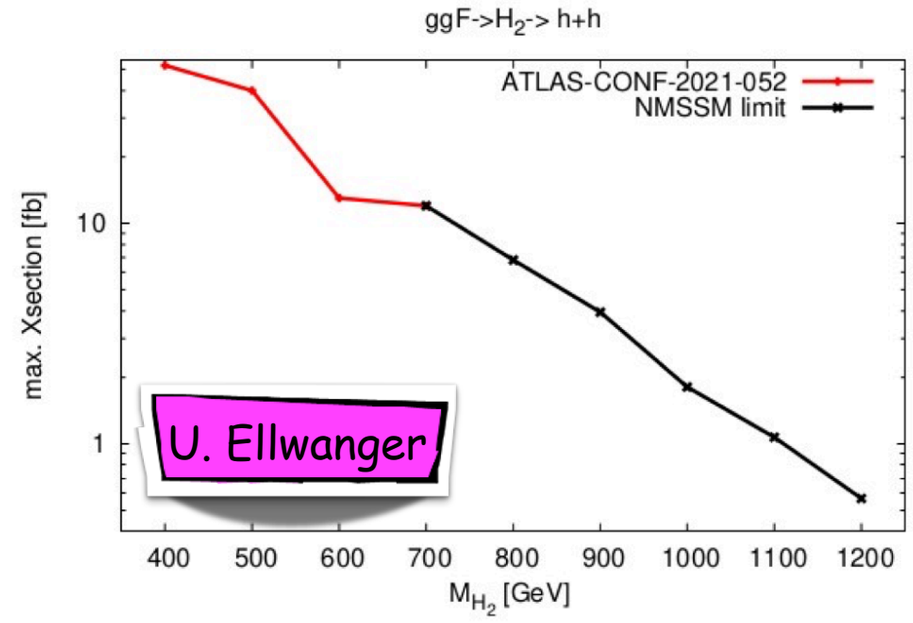
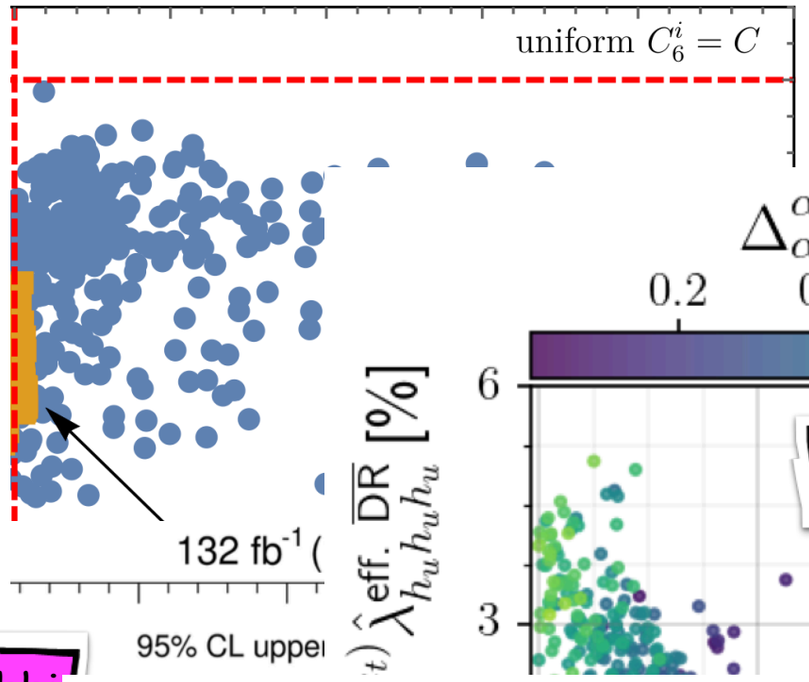
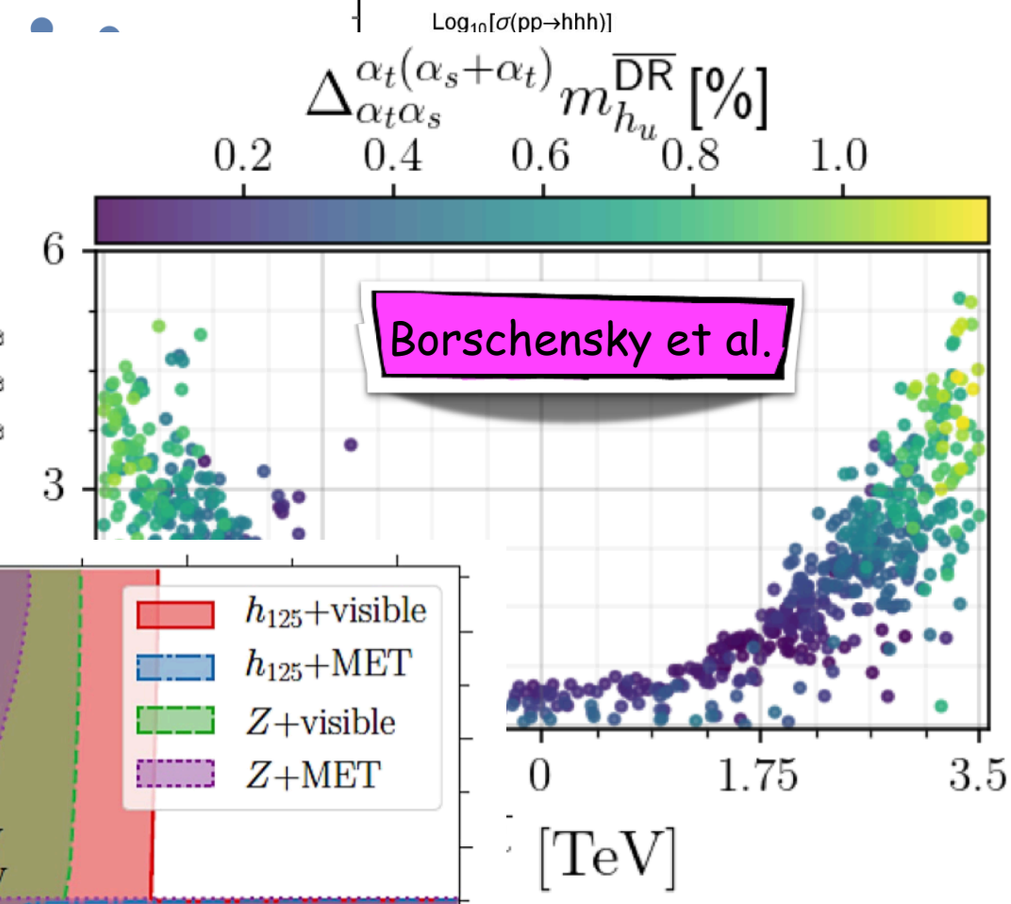
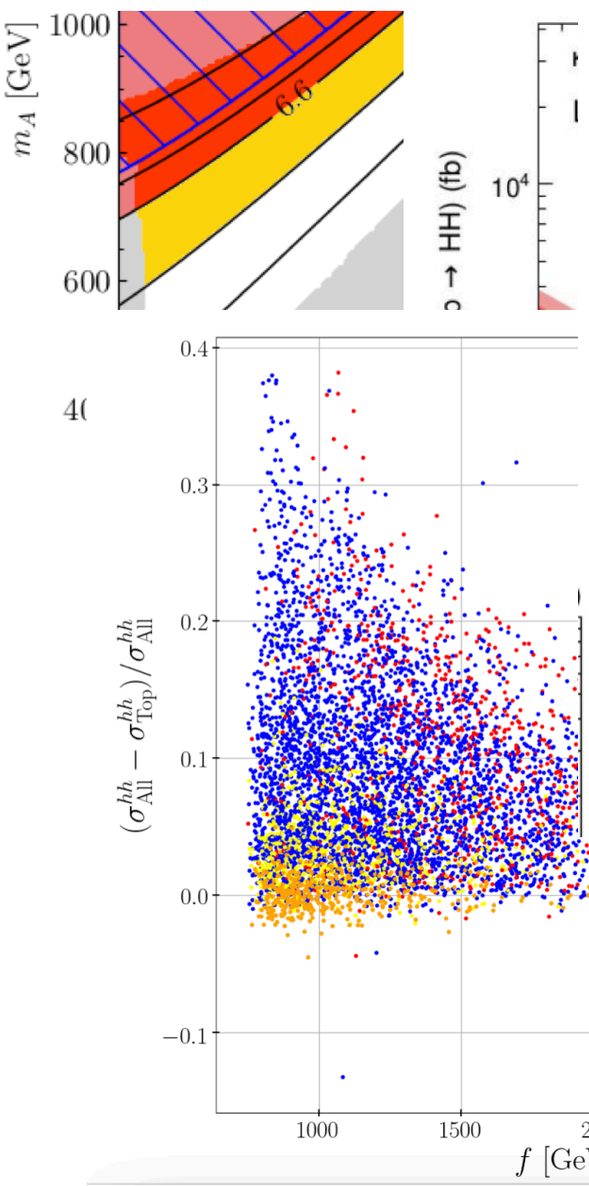
Elham Khazaie

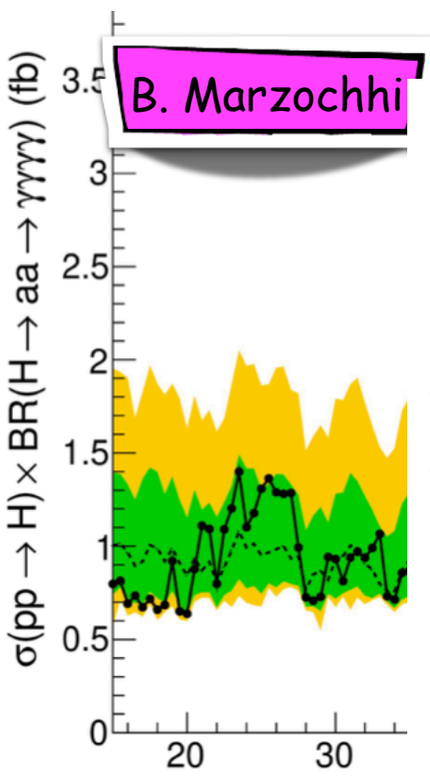
Pair Production

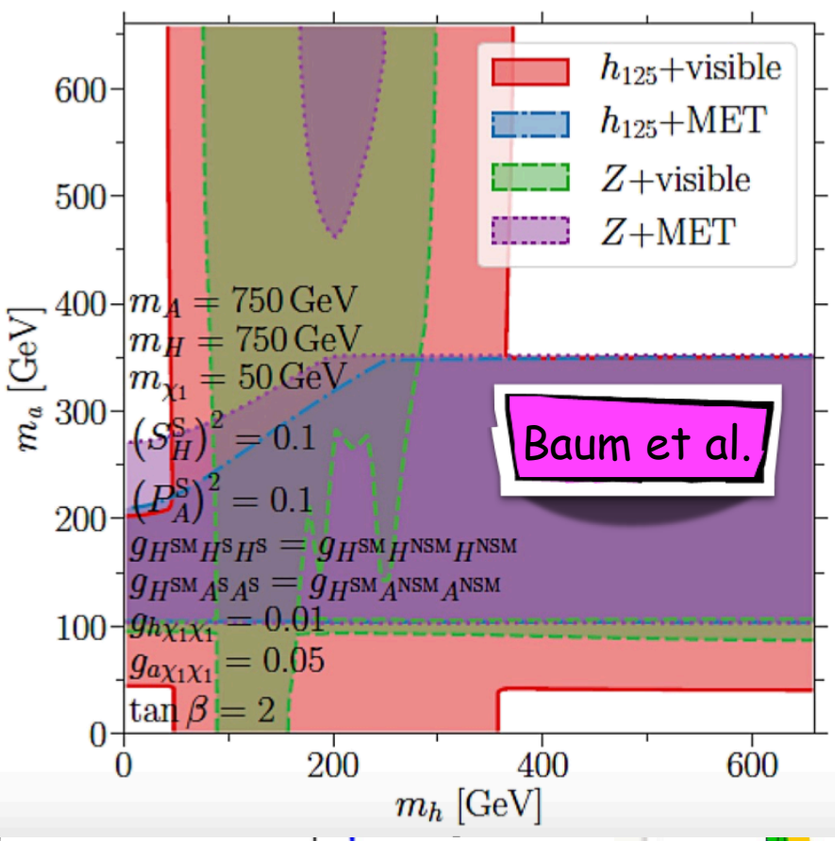


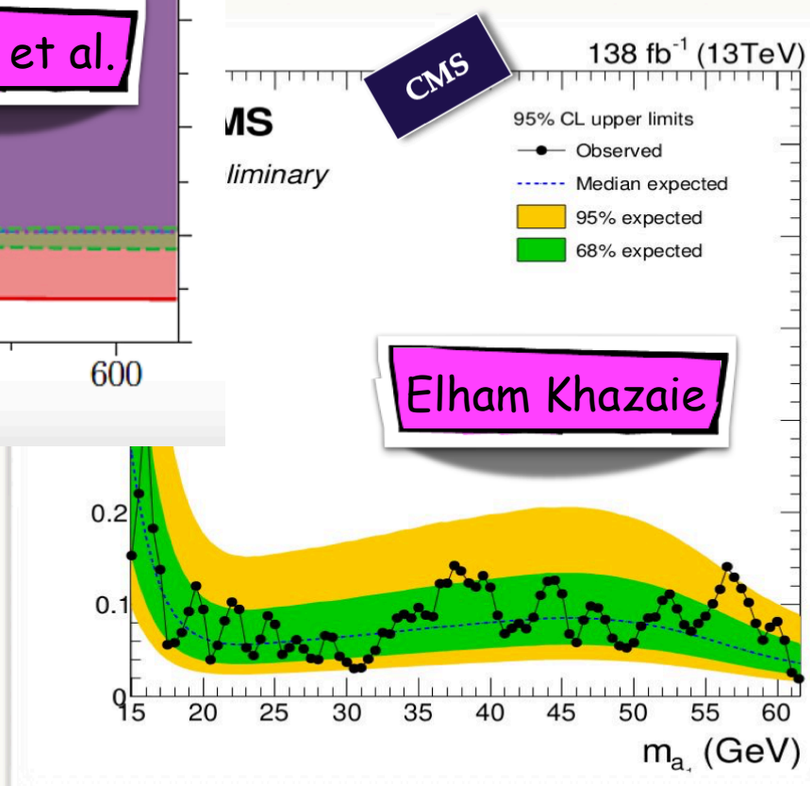




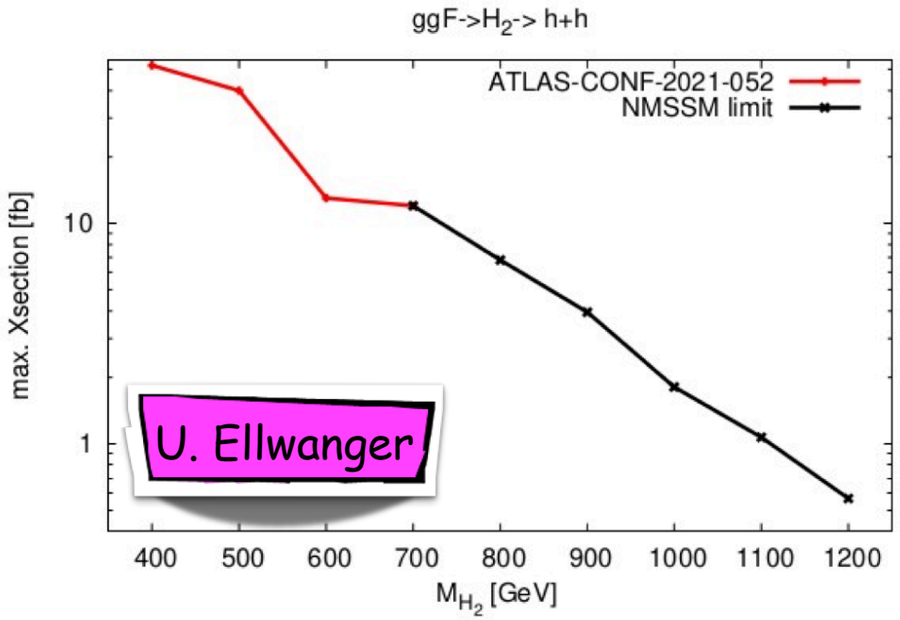




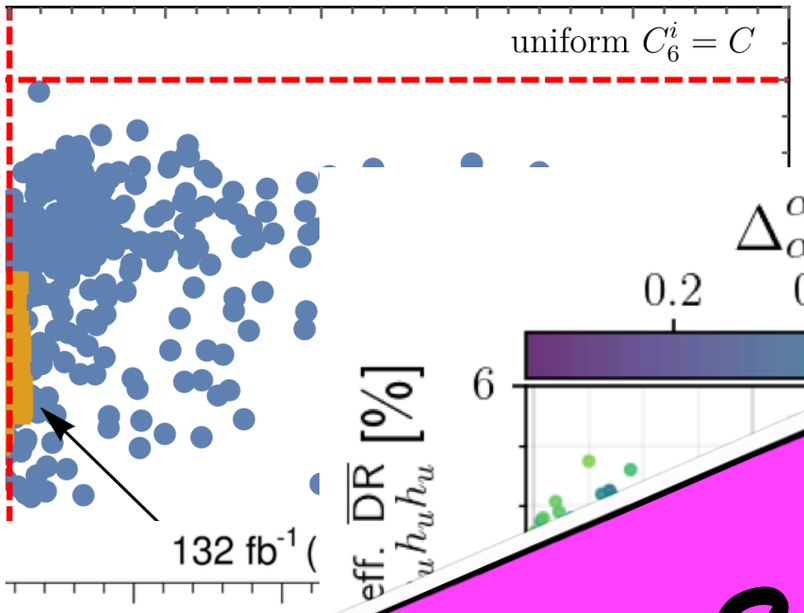


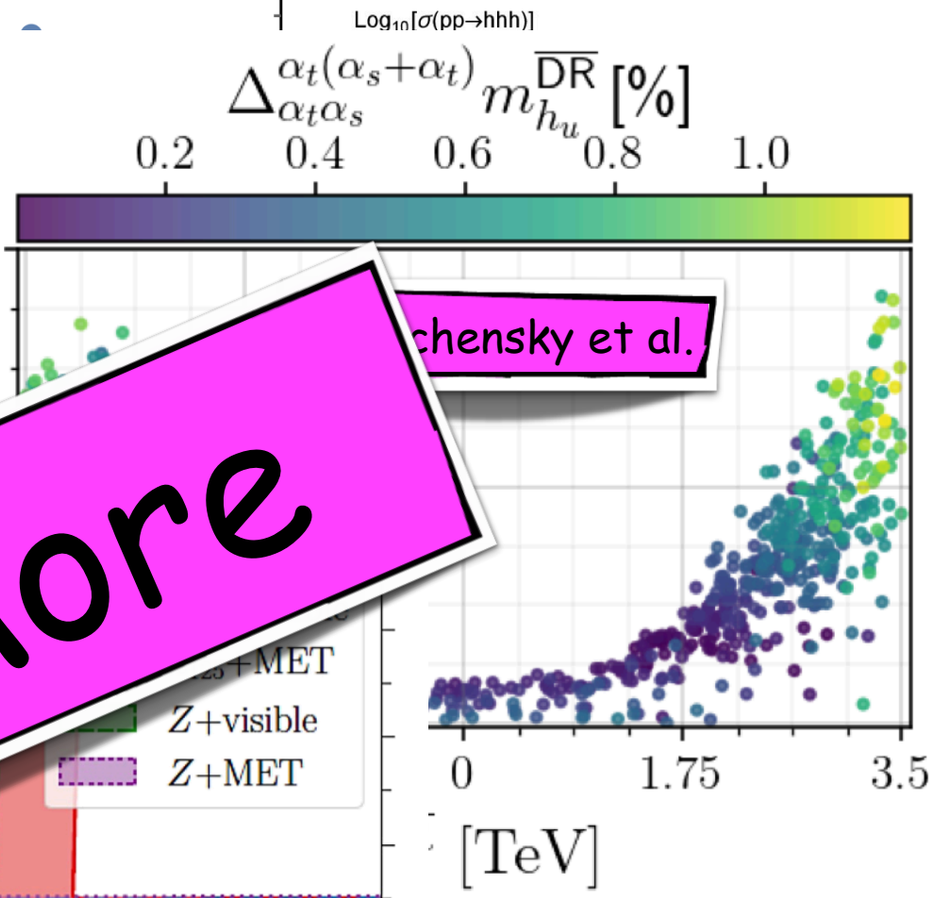


Pair Production

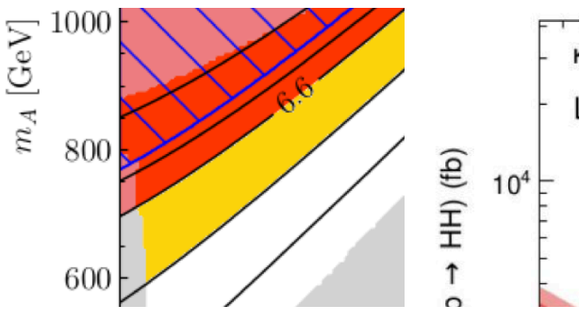


U. Ellwanger

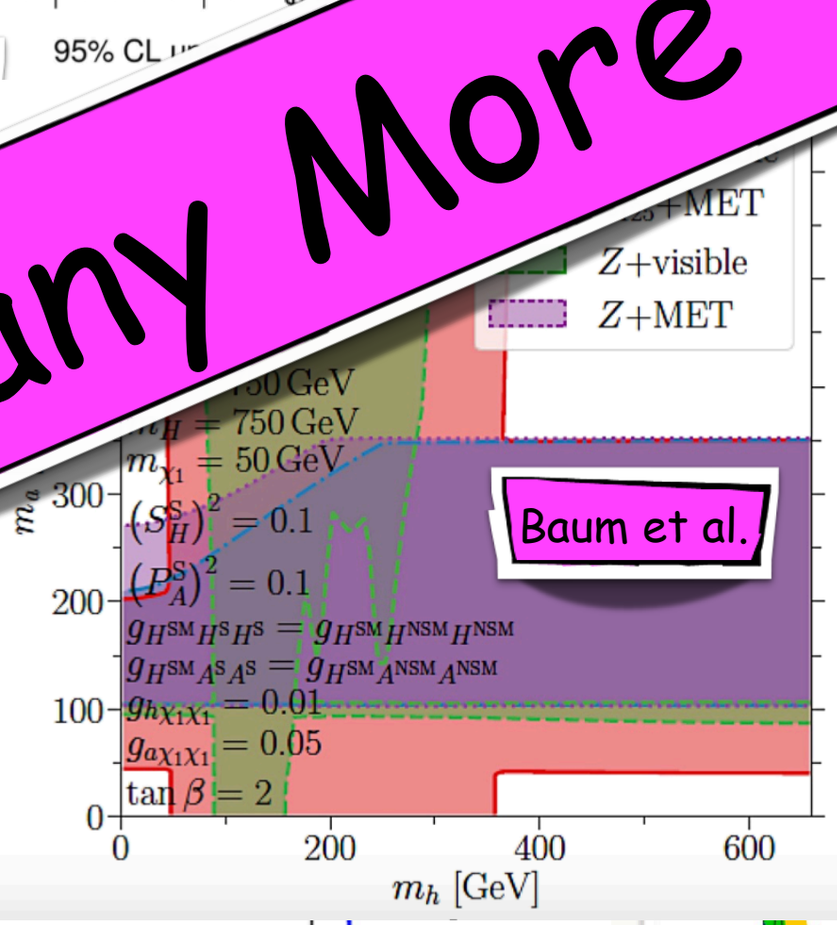




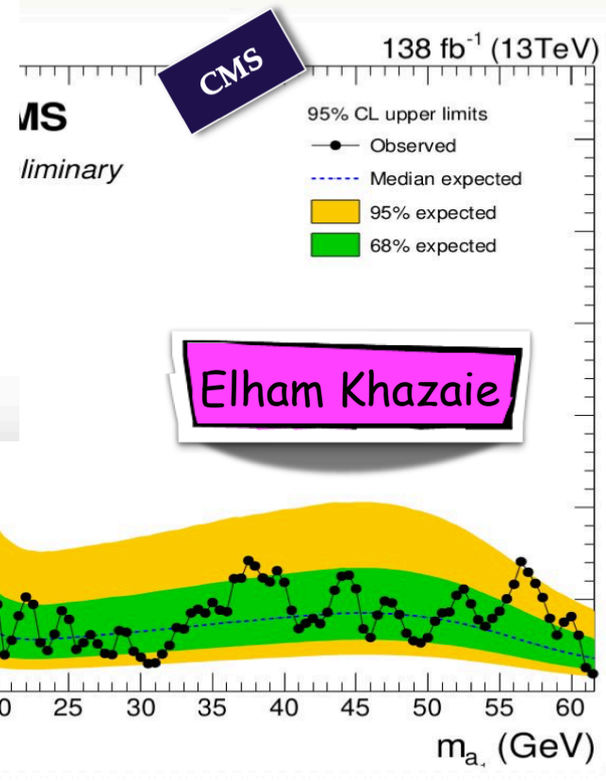
chensky et al.



B. Marzochhi



Baum et al.



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Many More

Conclusions

- Parameter scans in typical BSM models (R2HDM, C2HDM, N2HDM, NMSSM) <- CP-viol, SUSY, singlet taking into account theoretical and experimental constraints; interference effects
- Application of resonant and non-resonant di-Higgs constraints
- Combination of single- and di-Higgs production: effect on allowed coupling values
- Comparison with (non-linear) EFT results
- Di-Higgs beats single Higgs in heavy Higgs boson discovery
- Test of CP violation: combination of various multi-boson final states
- Many more studies that are interesting for cross topics

Thank you for your attention