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The Higgs Hunting workshop expresses its deepest condolences to his family.

A few words . . .

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He was **Mr. NMSSM!** (no further details needed)

But he was much more . . .

In the theory community many emails were sent around after the news of Ulrich's passing. All of them remembering Ulrich's determined efforts to bring physics forward.

But I want to quote what [Howie Haber](#) wrote:

In addition to remembering Ulrich as a wonderful physics colleague, I want to also recall his superb music skills. I was fortunate to have had the chance to join Ulrich in a few jam sessions on the guitar (although Ulrich was the far better musician). My last encounter with him was in an Irish pub in Paris, where Ulrich's son was carrying out the family tradition.

This was at [HH22](#), and I was also lucky to be there.

And this is how I will Ulrich (also) remember.

[Photos curtesy to [Howie Haber](#), taken that evening]

At a break, with his son:



Also here with his wife:



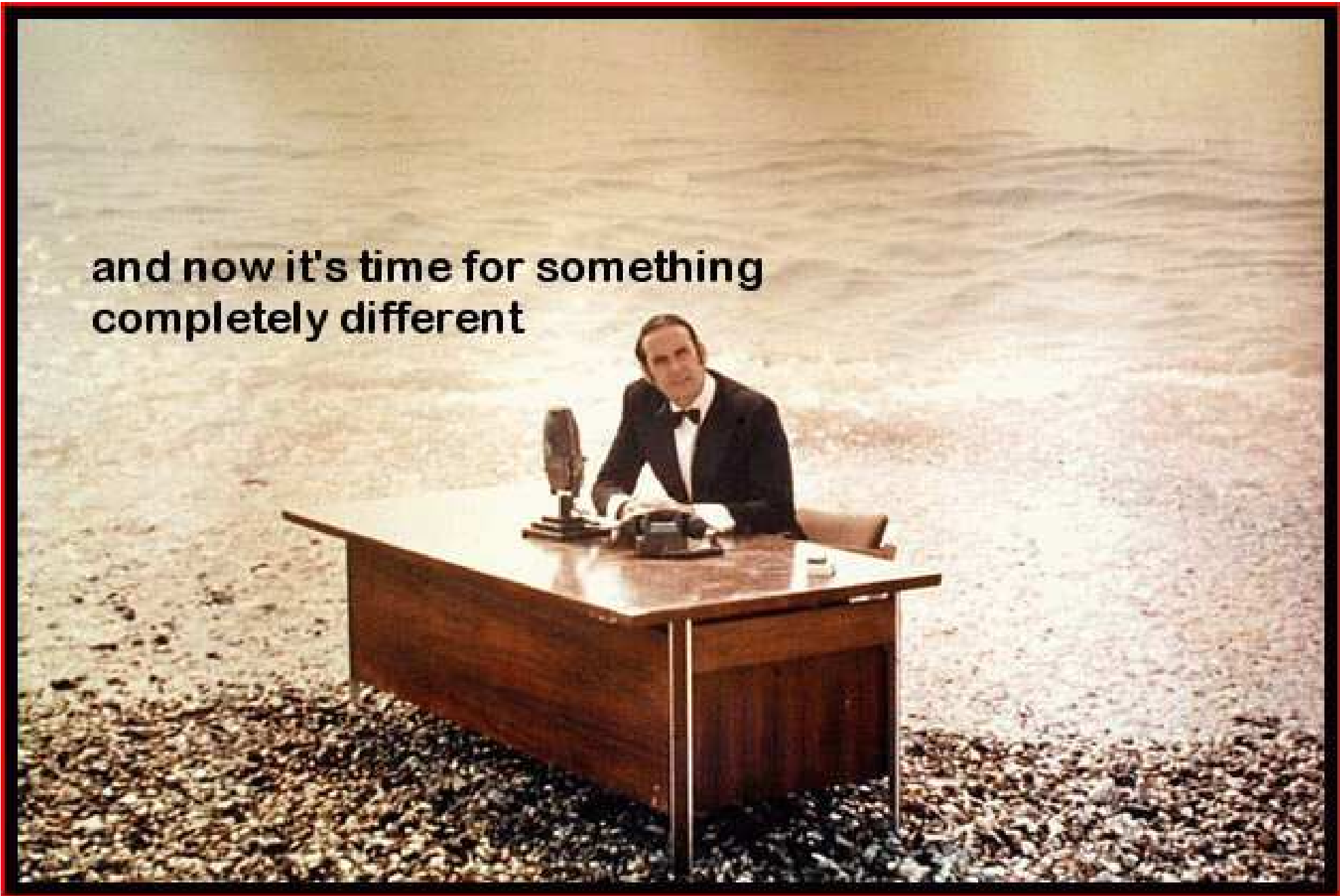
One more to remember: visiting St. Cruz



A good way to remember him. :-)

and now it's time ...

**and now it's time for something
completely different**



Discussion on “BSM Higgs Searches/Rare Higgs Decays”

Sven Heinemeyer, IFT (CSIC, Madrid)

Paris, 09/2024

Talks:

- Erich Varnes (ATLAS)
- Efe Yazgan (CMS)
- Huacheng Cai (ATLAS)
- Chen Zhou (CMS)
- + David d’Enterria (FCC-xx) (hard to fit in :-())

⇒ nearly no ATLAS – CMS comparison ... ⇒ not possible

⇒ just a few (personally biased) examples ...

⇒ interesting what is shown ...

⇒ even more revealing what is not shown!

List of ATLAS BSM topics:

Low-mass	High-mass
$\gamma\gamma$ resonances* arXiv:2407.07546	$A/H \rightarrow t\bar{t}$ (1 and 2 lepton)* JHEP 08 (2024) 013
$H \rightarrow Za \rightarrow Z\gamma\gamma$ Phys. Lett. B 848 (2024) 138536	$t\bar{t}A/H \rightarrow t\bar{t}t\bar{t}$ (1 and 2 OS lepton)* arXiv:2408.17164
$t \rightarrow H^+b \rightarrow csb^*$ arXiv:2407.10096	Heavy Higgs $\rightarrow WW$ JHEP 07 (2023) 200
$t \rightarrow H^+b \rightarrow cbb$ JHEP 09 (2023) 004	Multi-b, Multi-lepton JHEP 12 (2023) 081
$t \rightarrow qX \rightarrow qbb$ JHEP 07 (2023) 199	Heavy Higgs $\rightarrow Z\gamma$ Phys. Lett. B 848 (2024) 138394
	Heavy Scalar $\rightarrow 4\ell + \text{MET}$ arXiv:2401.04742

List of CMS BSM topics:

Selected recent CMS Measurements		
$tH \rightarrow t\bar{t}, t\bar{t}\bar{u}$	[PLB850(2024)138478]	g2HDM
$A \rightarrow Zh_{125} \rightarrow (\ell\ell)(\tau\tau)$	[CMS-PAS-HIG-22-004]	MSSM
$X \rightarrow ZZ \rightarrow 4\ell$	[CMS-PAS-HIG-24-002]	Model-independent
$X \rightarrow Yh_{125} \rightarrow 4b$	[CMS-PAS-HIG-20-012]	NMMSM
$A/H \rightarrow t\bar{t}$	[CMS-PAS-HIG-22-013]	2HDM, $t\bar{t}$ bound state

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Can you spot the overlap?

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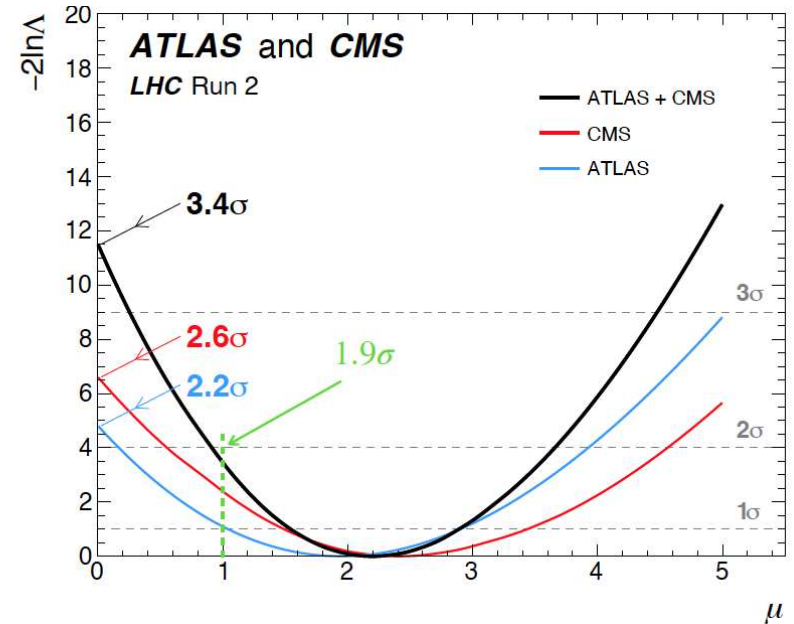
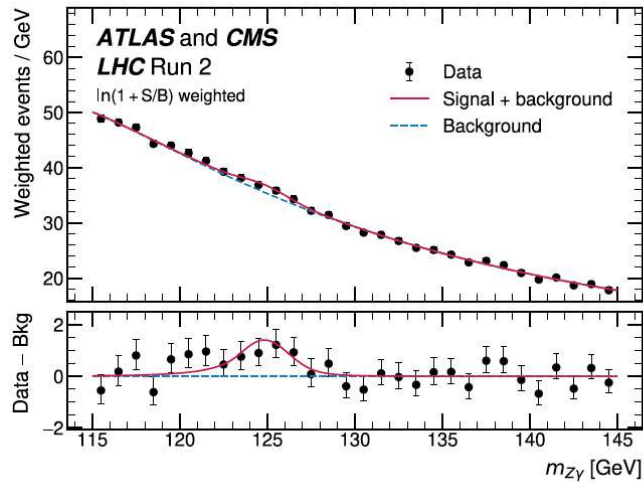
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Can you spot the overlap? \Rightarrow small, but important!

One revealing example for rare/exotic decays?!

Shown by both speakers:

▸ Likelihood scan gives the best-fit signal strength at 2.2 ± 0.7 times the SM prediction.

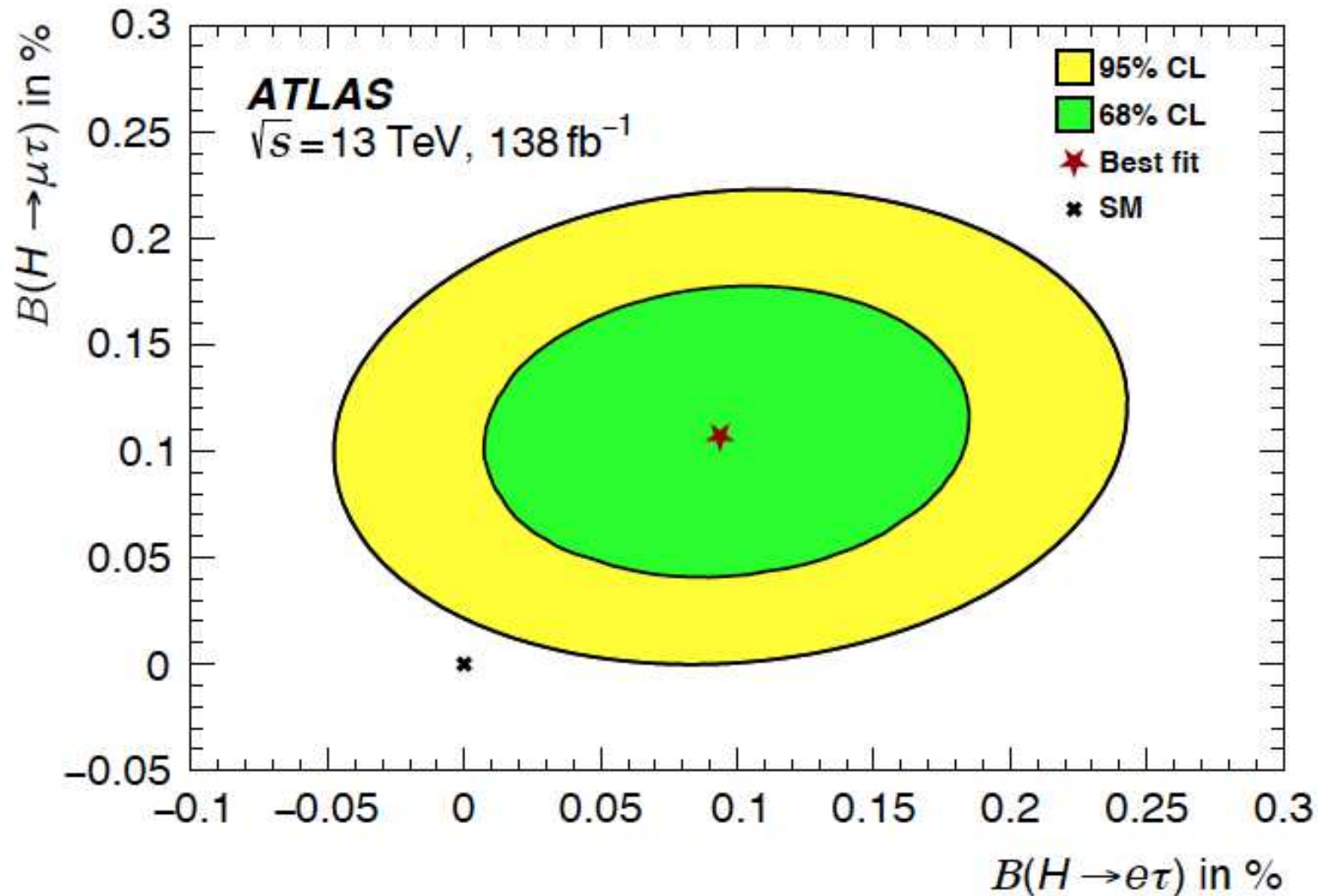


⇒ **ONLY** combination beyond Run 1 (to my knowledge)

SM process . . .

Part of the SM bias?

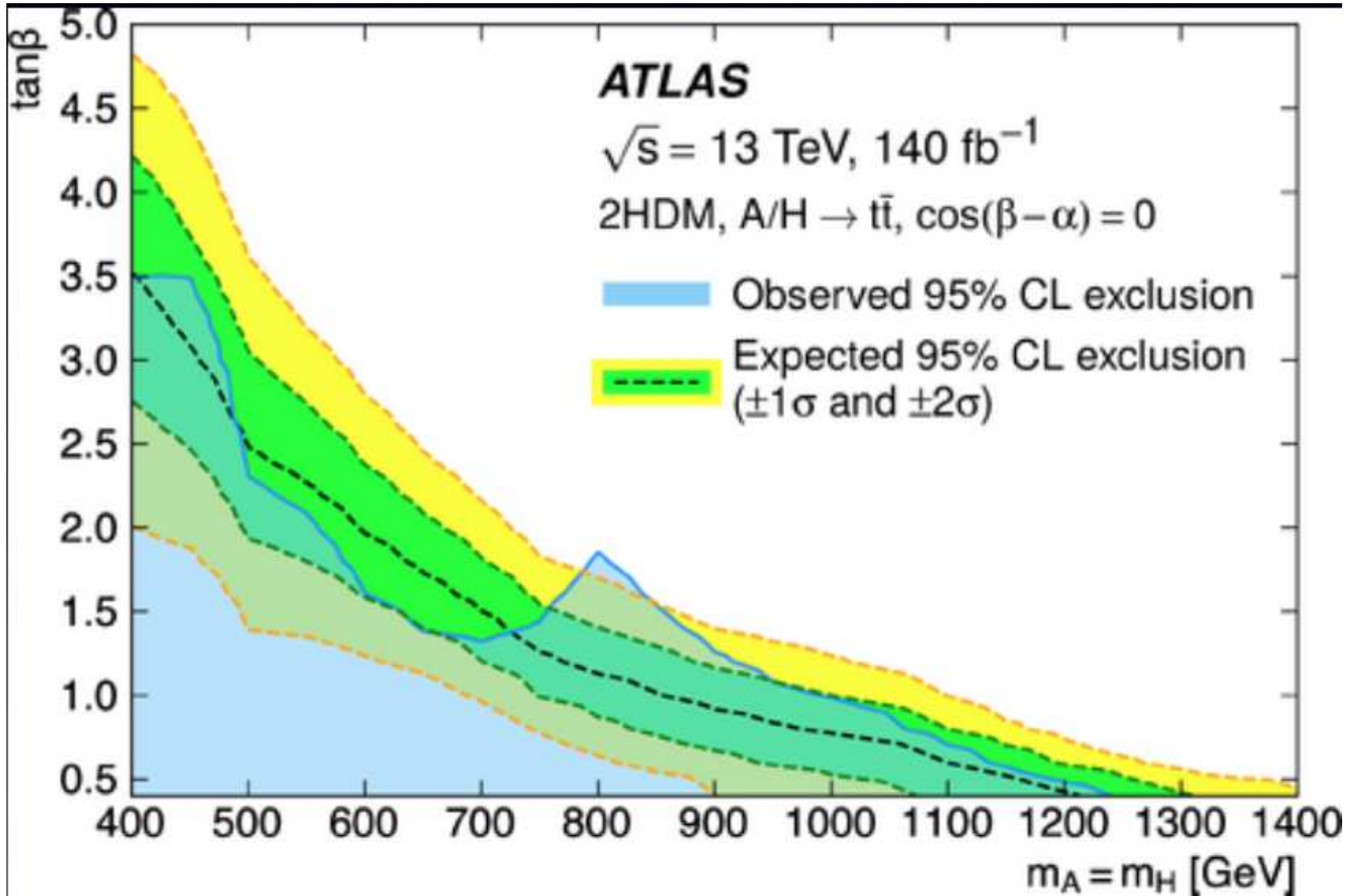
One (two?) interesting excess(es):



CMS?

Any model that could generate this (in an easy/non-baroque way)?

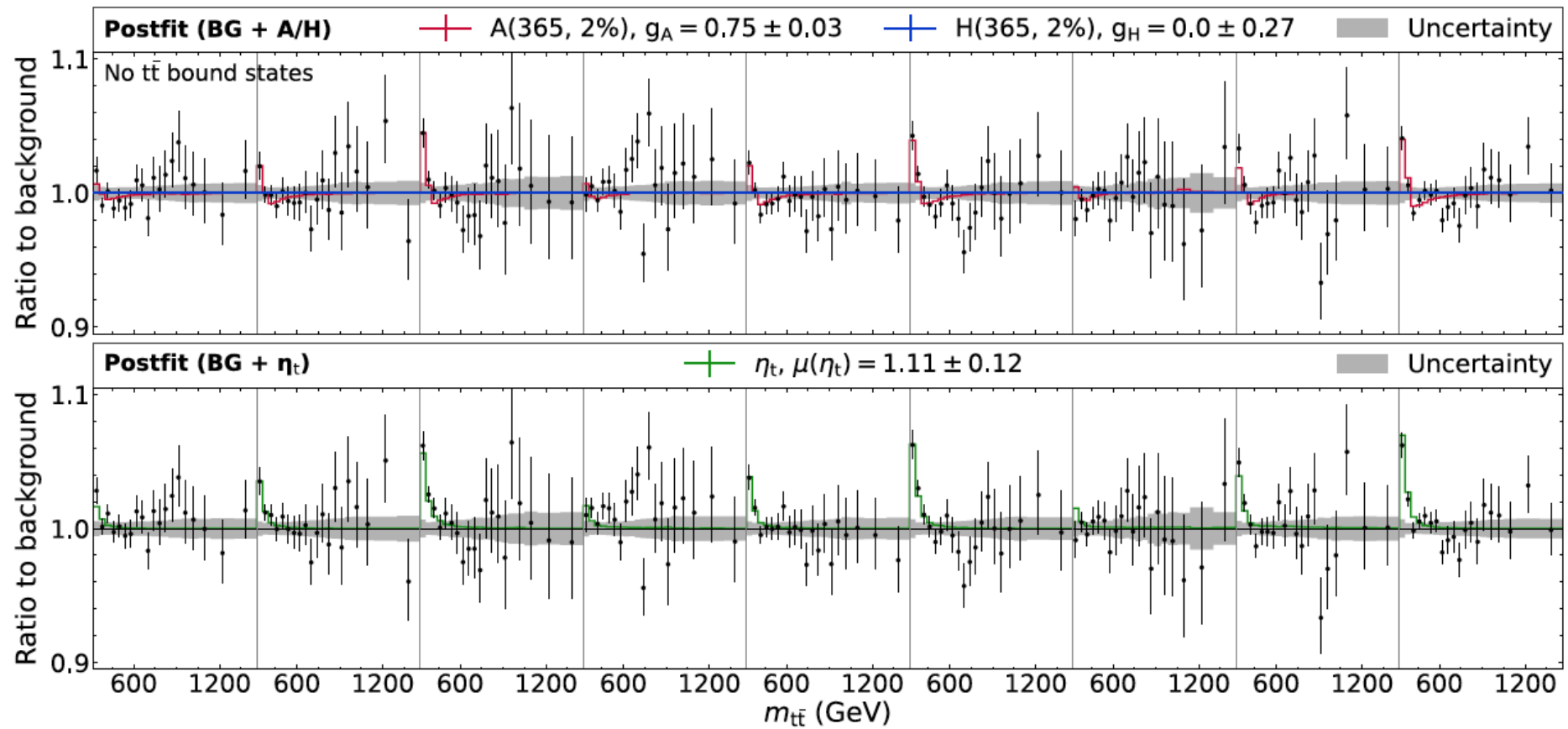
Hot topic: $pp \rightarrow X \rightarrow t\bar{t}$: ATLAS



\Rightarrow nothing?!

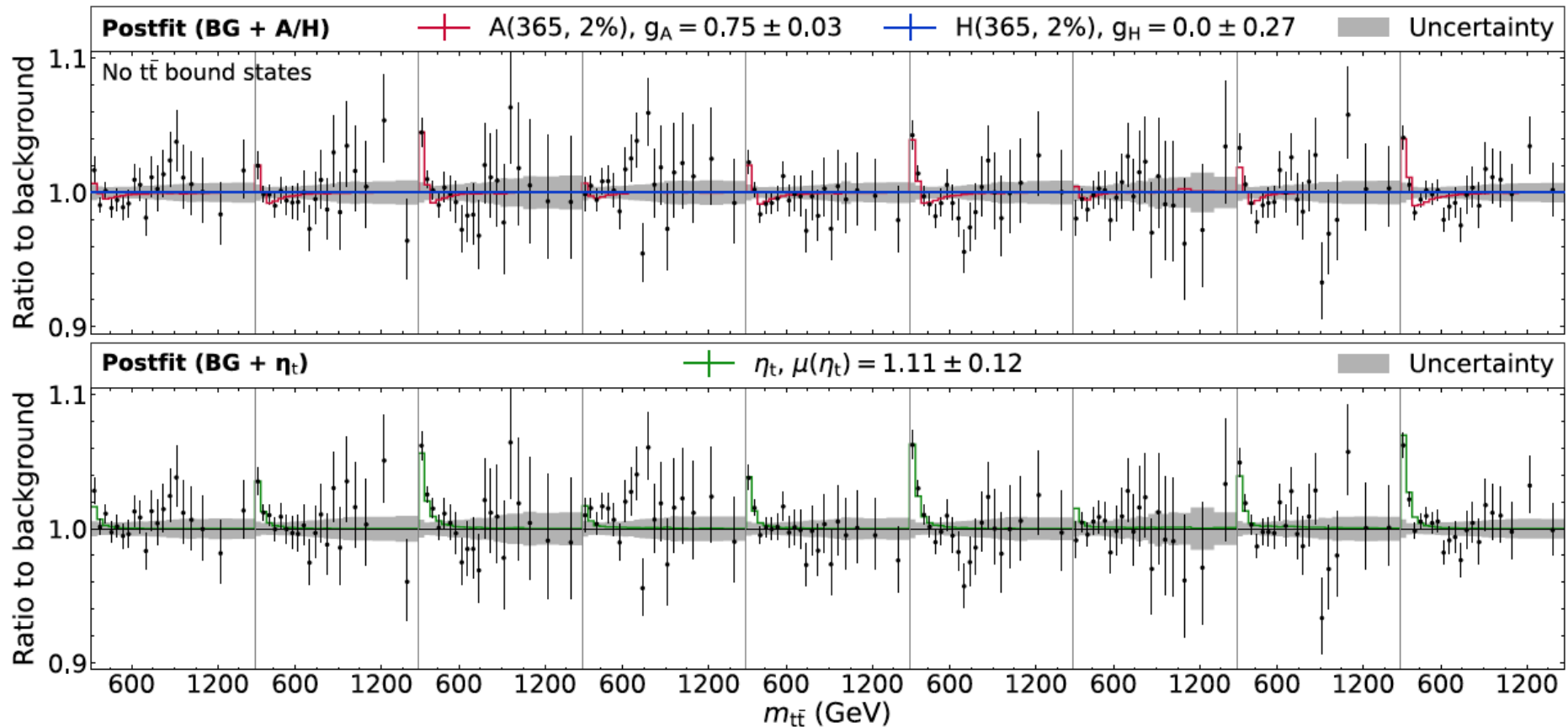
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Higgs vs. $t\bar{t}$ bound state:



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Higgs vs. $t\bar{t}$ bound state:



$$A/H \rightarrow t\bar{t}$$

NEW

CMS-PAS-HIG-22-013

> 5σ deviation.

More pronounced for A

\Rightarrow to be followed up!

There are several searches that may show excesses!

- h_{700}
- h_{650}
- h_{151}
- h_{95}
- ...

What was shown at HH24?

There are several searches that may show excesses!

- $h_{700} \Rightarrow$ new result \Rightarrow how good is the mass resolution?
- h_{650} (well, a tiny bit)
- h_{151} (nothing at all)
- h_{95} (well, a tiny bit)
- ...

What was shown at HH24?

And after that I stop :-)

Discussed: h_{700} :

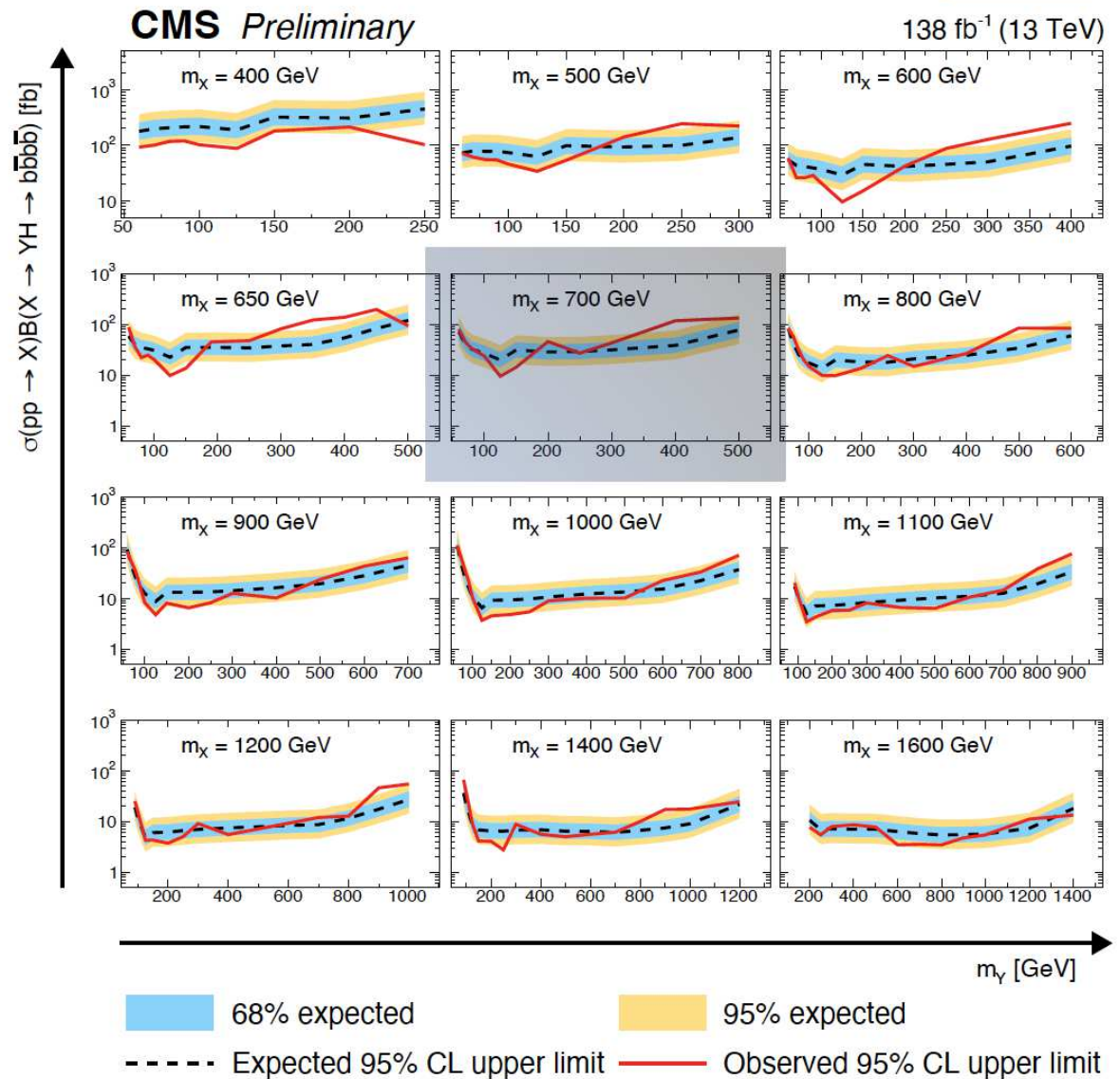
$$X \rightarrow Y h_{125} \rightarrow 4b$$

► Largest excess at $m_X^{reco} = 700$ GeV, $m_Y^{reco} = 400$ GeV with $4.1(2.5)\sigma$ local(global).

► Local significance is highly reduced by the look-elsewhere-effect because of high number of mass points.

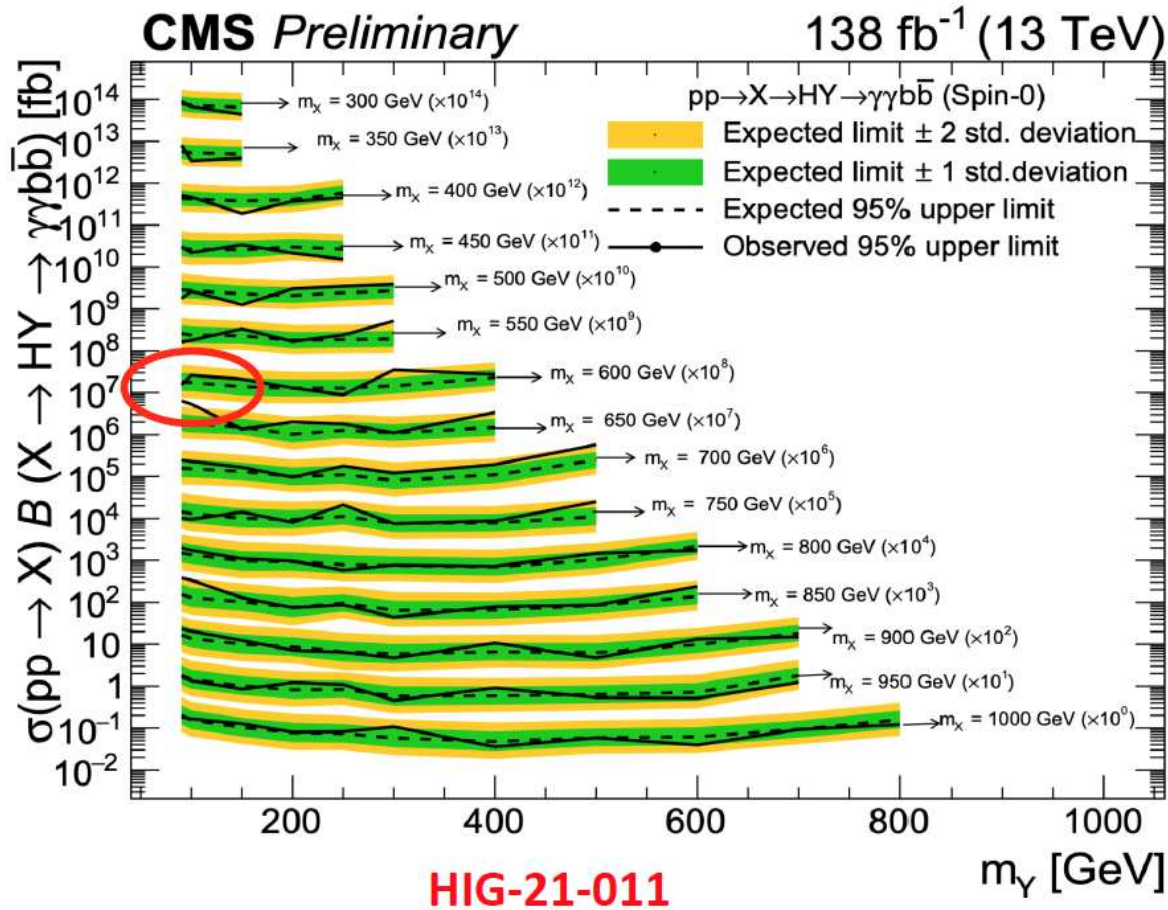
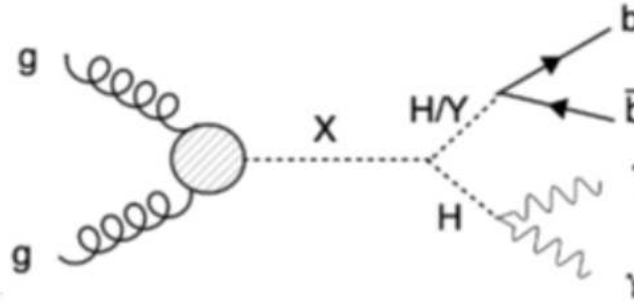
CMS-PAS-HIG-20-012

NEW

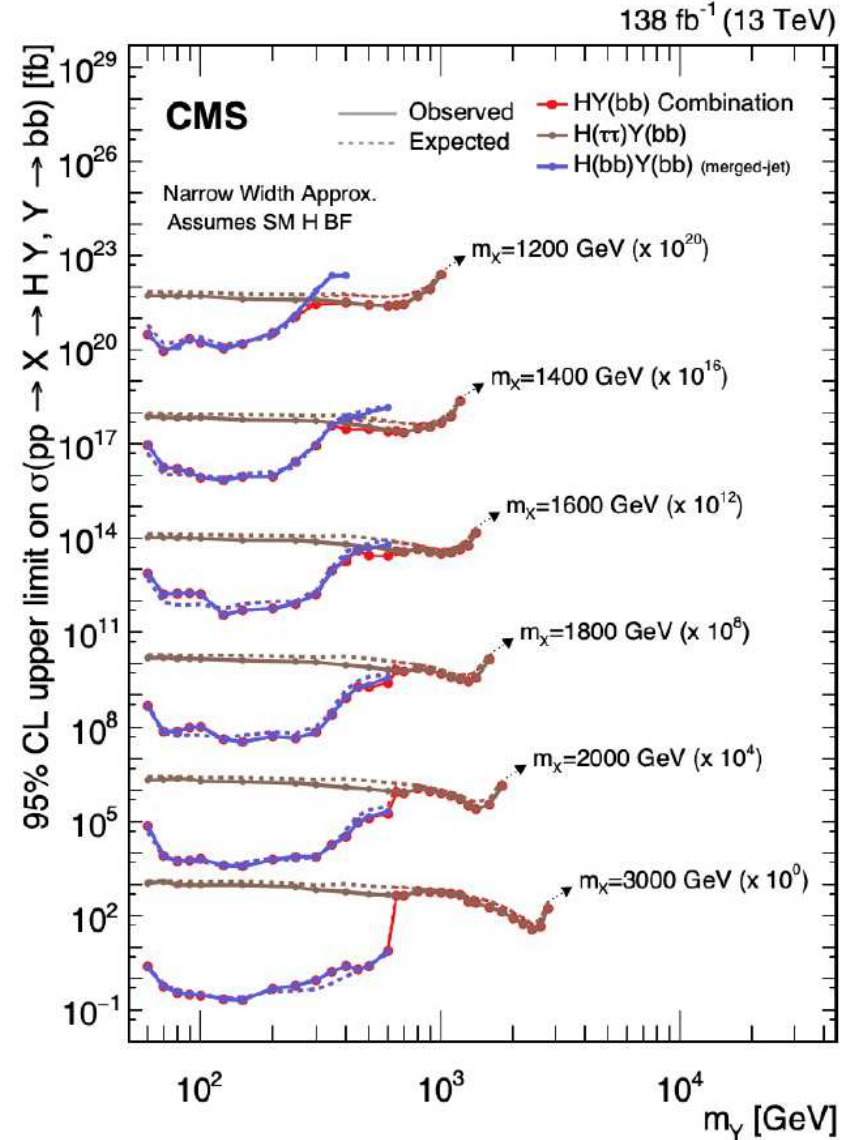
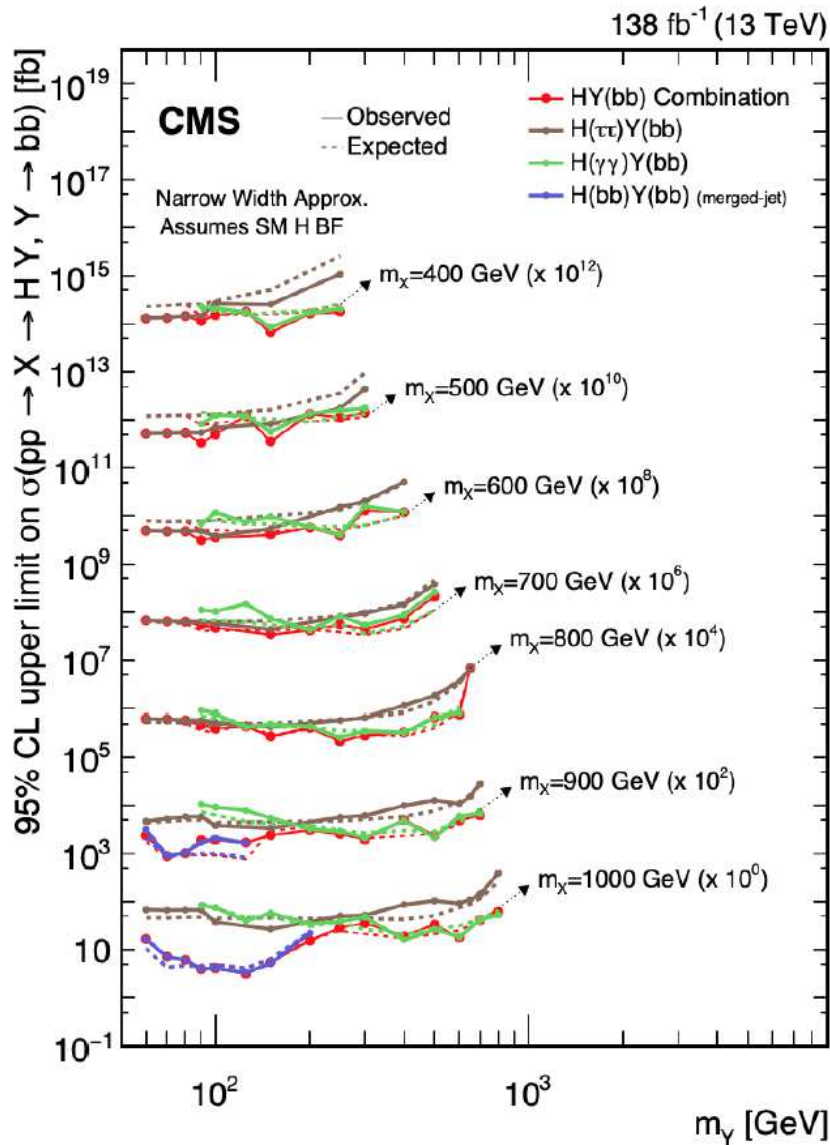


⇒ mass resolution? $700 \neq ??650$

Not discussed: h_{650} : $h_{650} \rightarrow h_{125}h_{95} \rightarrow \gamma\gamma b\bar{b}$:



2

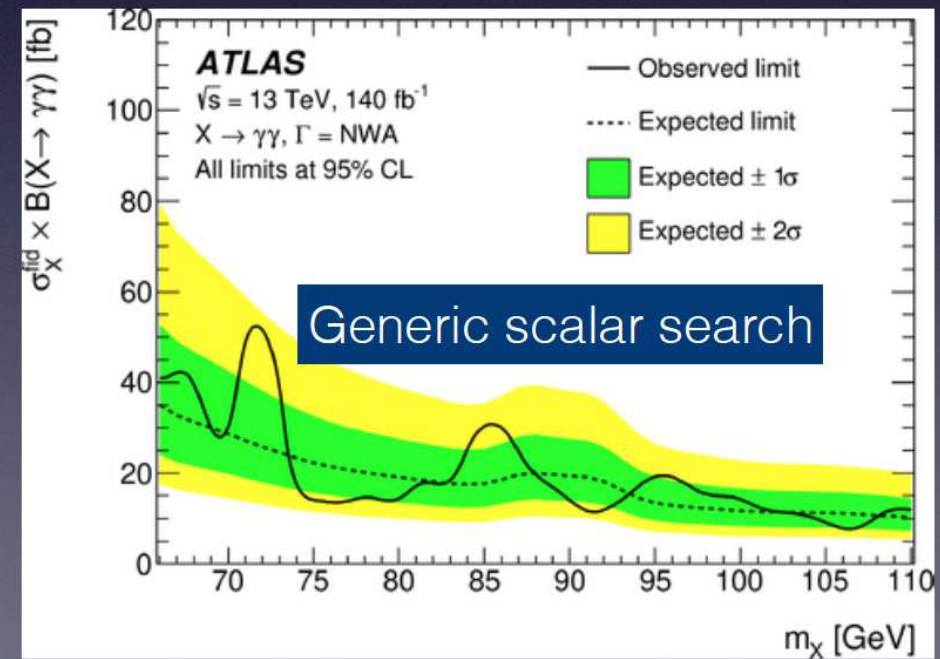
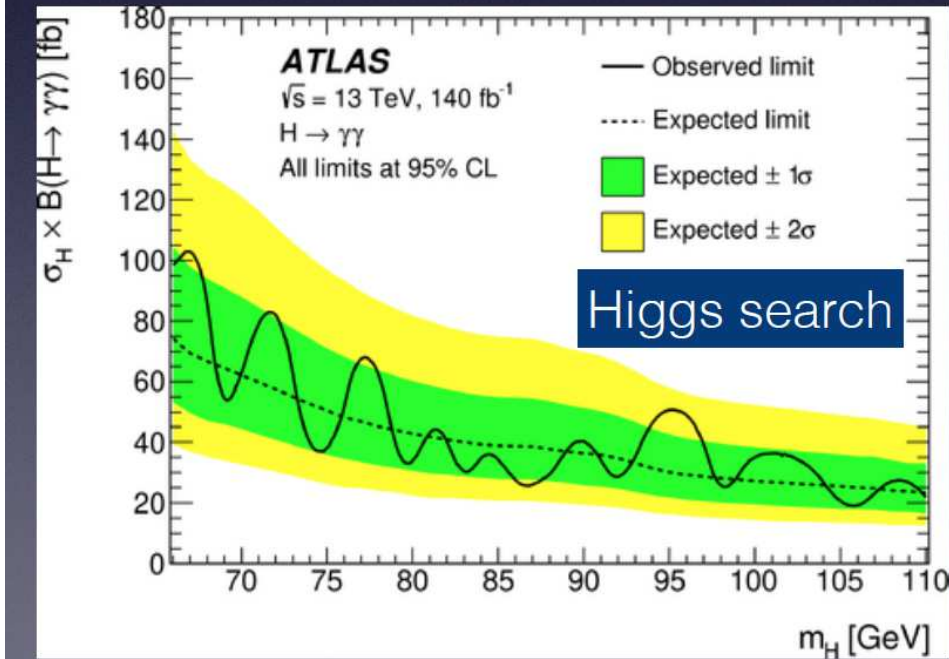


⇒ Where is the h_{650} ? Grrr...

⇒ several other h_{650} channels/excesses exist in ATLAS or CMS ...

Not discussed: h_{95} :

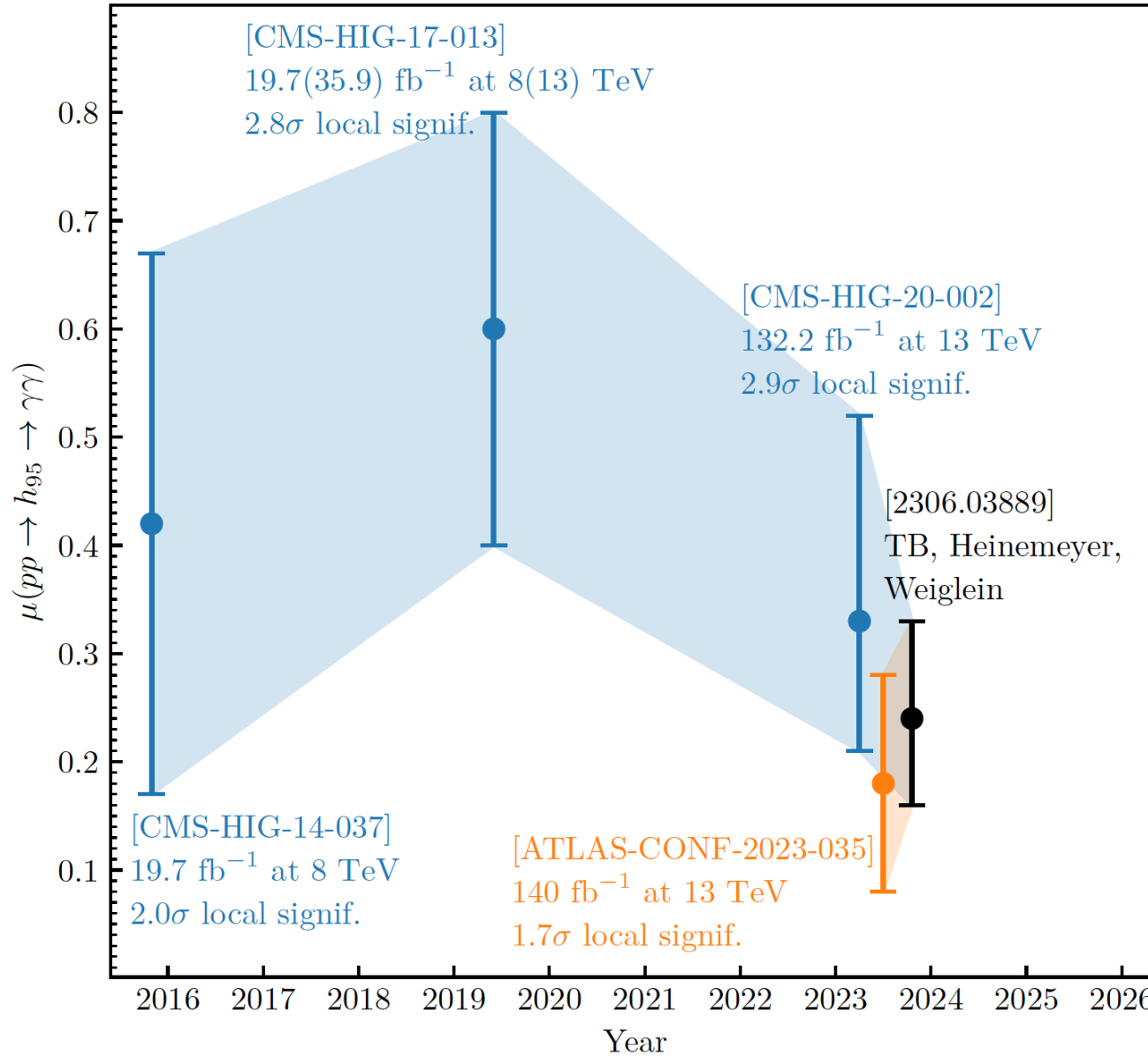
No significant deviations from background



\Rightarrow ATLAS sees 1.7σ at 95.4 GeV

\Rightarrow exactly where CMS sees 2.9σ

\Rightarrow “of course” no combination - by experimentalists



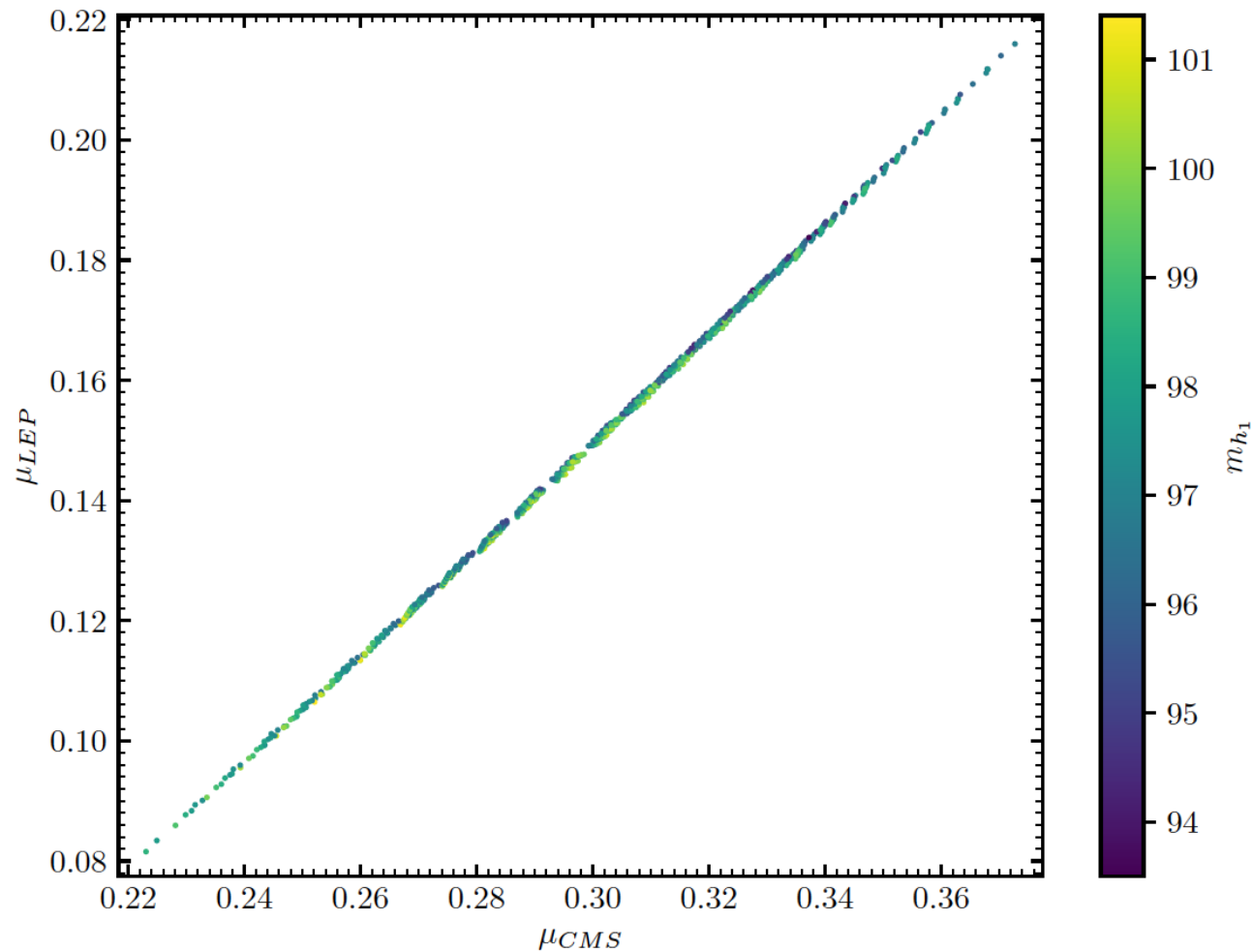
⇒ note the reduction of $\mu_{\gamma\gamma}$ over time! (as predicted by SUSY)



Further Questions?

SUSY enforces strong correlation:

[*T. Biekötter, S.H., C. Muñoz '19*]



⇒ LEP excess enforces $\mu_{\gamma\gamma} \lesssim 0.35$

⇒ SUSY predicted that $\mu_{\gamma\gamma}$ has to go down - as observed! :-)