

## Discussion on:

# “H(125) BSM aspects and searches for new scalar bosons”

*Sven Heinemeyer, IFT (CSIC, Madrid)*

Paris, 09/2026

### Talks:

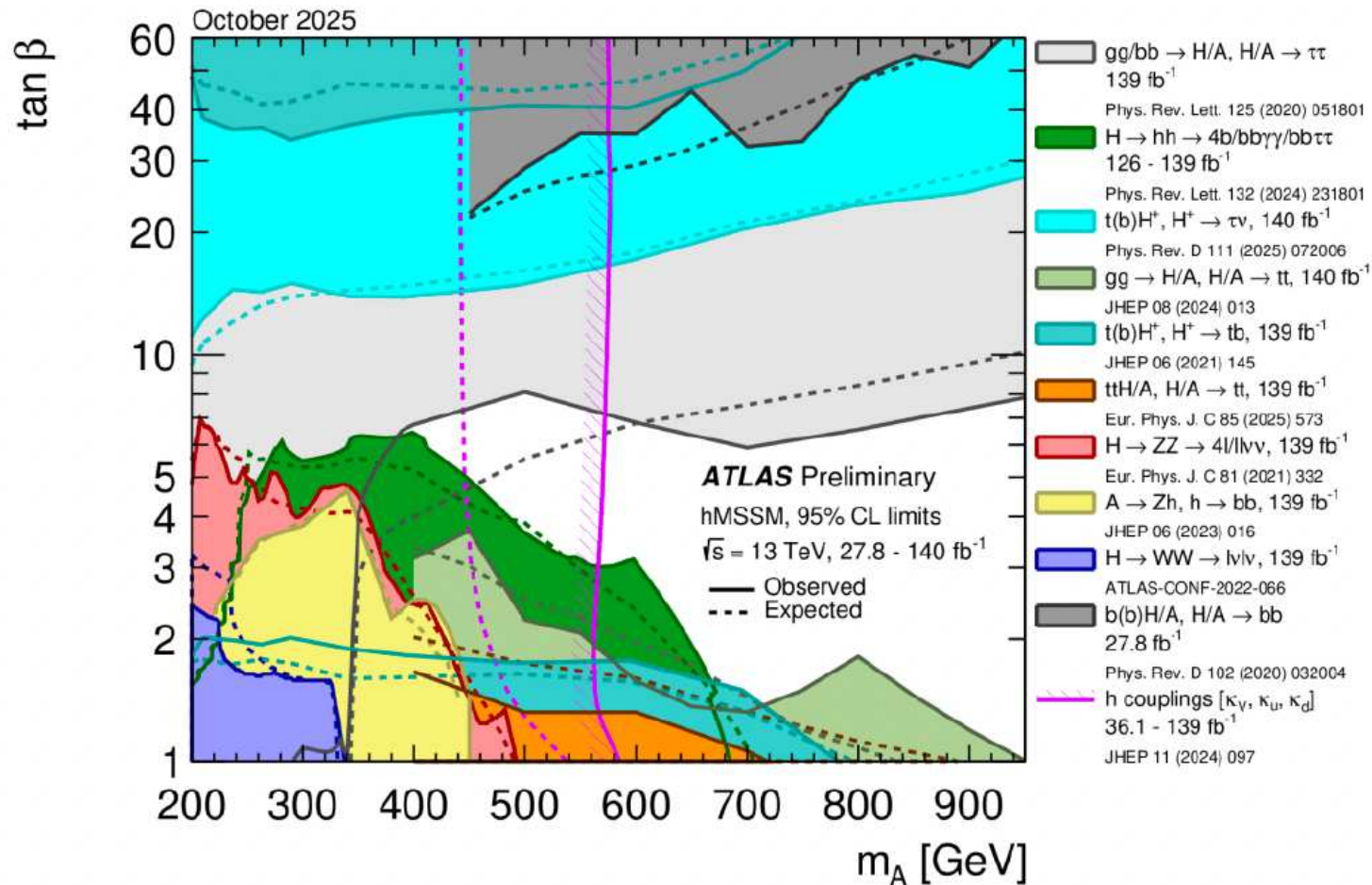
- Edson Carquin Lopez (ATLAS)
- Georgia Karapostol (CMS)
- Livia Soffi (LHC BSM WG)

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

Hopefully slightly provocative ... :-)

Let's start with the **(sadly) only SUSY result:**

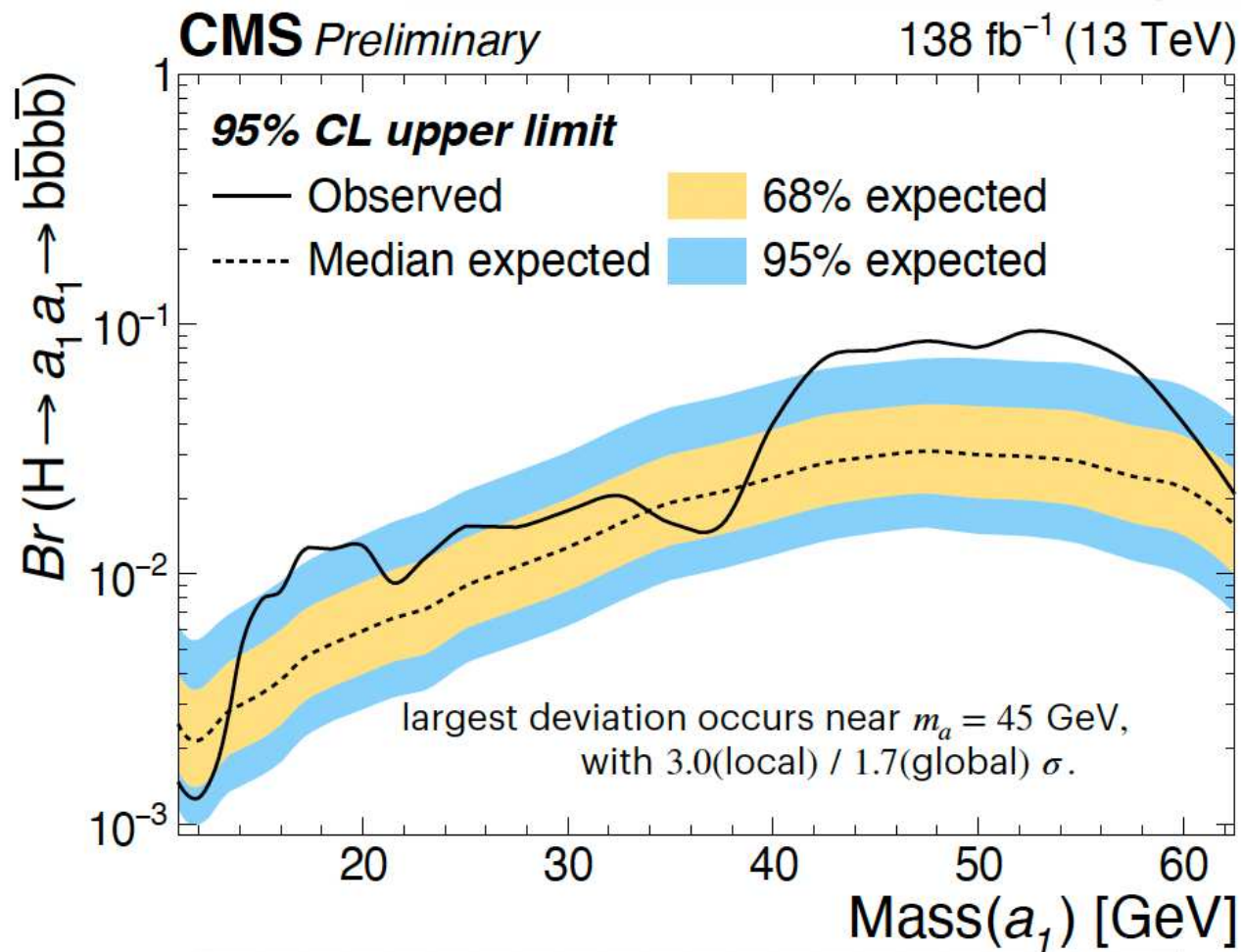
ATLAS hMSSM overview:



⇒ call it 2HDM type II (has hardly anything to do with SUSY)

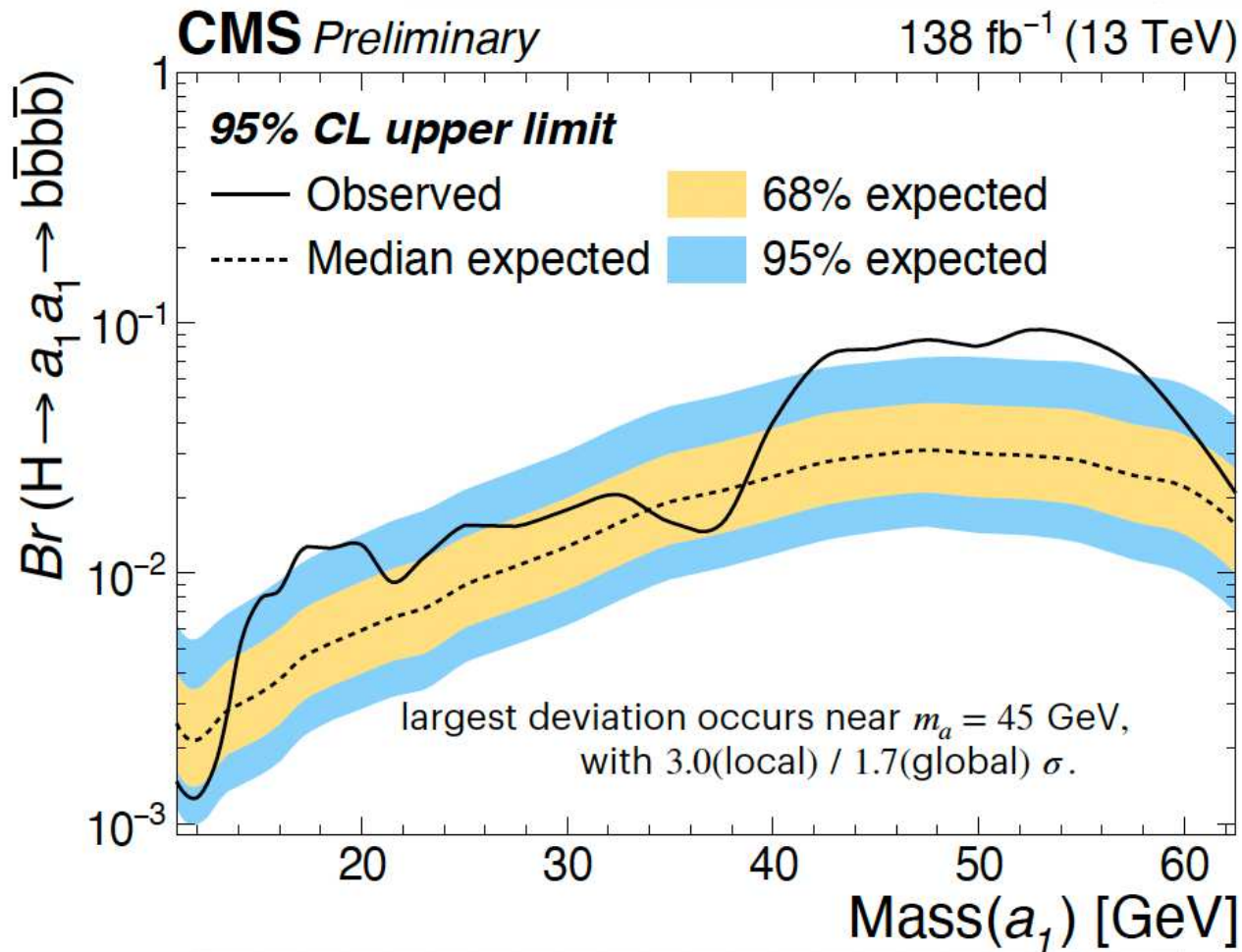
⇒ some real SUSY analysis would be interesting ...

From lower to higher masses: CMS:  $H \rightarrow aa \rightarrow 4b$



- broad excess - compatible with  $4b$  final state?!
- corresponding ATLAS result?

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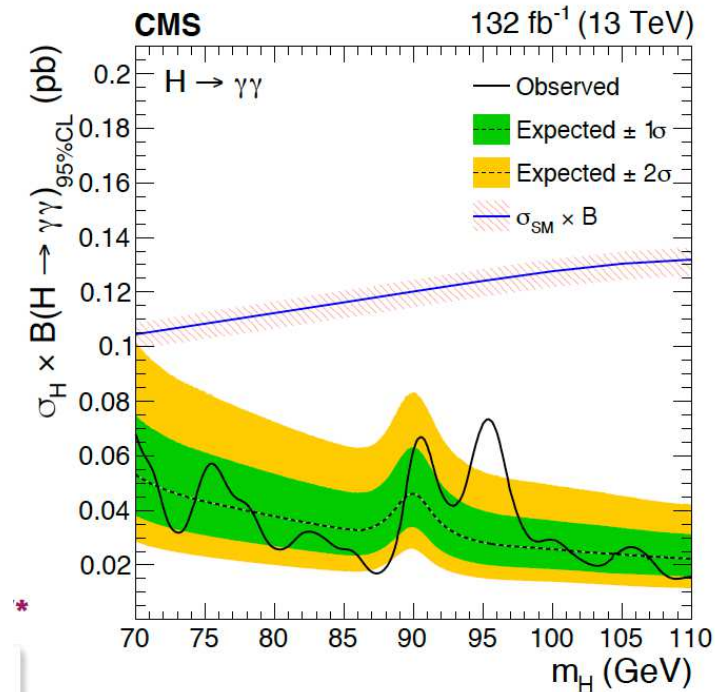
- broad excess - compatible with  $4b$  final state?!
  - corresponding ATLAS result?
- ⇒ **always say (in one line) what the other experiment sees!**

# From lower to higher masses: $h_{95}$ is discussed again! :-)

selection; categories target ggH,  $ggH \rightarrow \gamma\gamma$

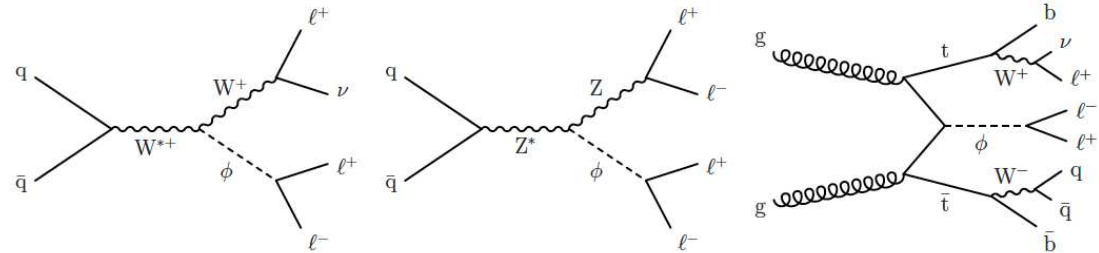
fits to the  $m_{\gamma\gamma}$  spectrum

$\sigma(\text{ggH} \rightarrow \gamma\gamma) = 15\text{--}73 \text{ fb}$



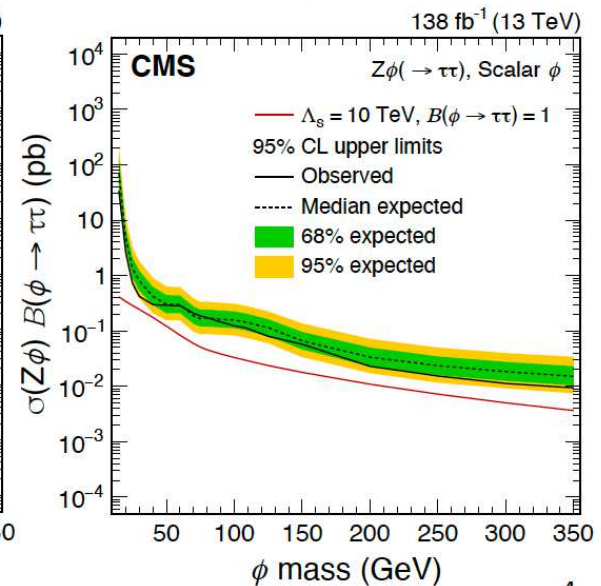
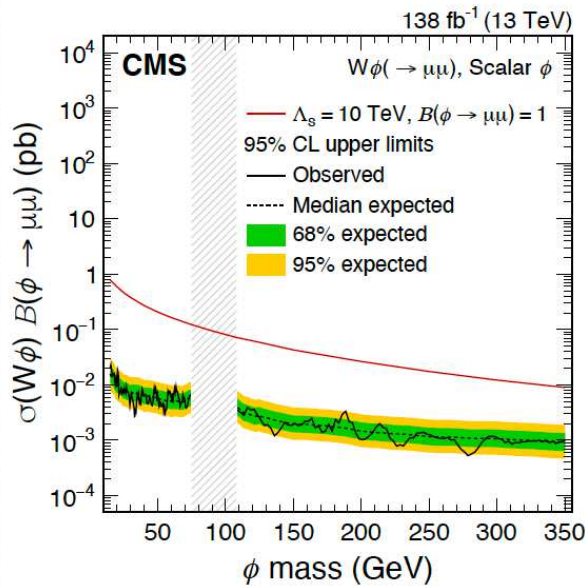
at 95.4 GeV seen in earlier combination

- Scalar or pseudoscalar  $\phi$ ,  $\phi \rightarrow ee, \mu\mu, \tau\tau$



- 15 <  $m_\phi$  < 350 GeV, 3 $\ell$  / 4 $\ell$  final states

- Search for a localized resonance in  $m_{\ell\ell}$



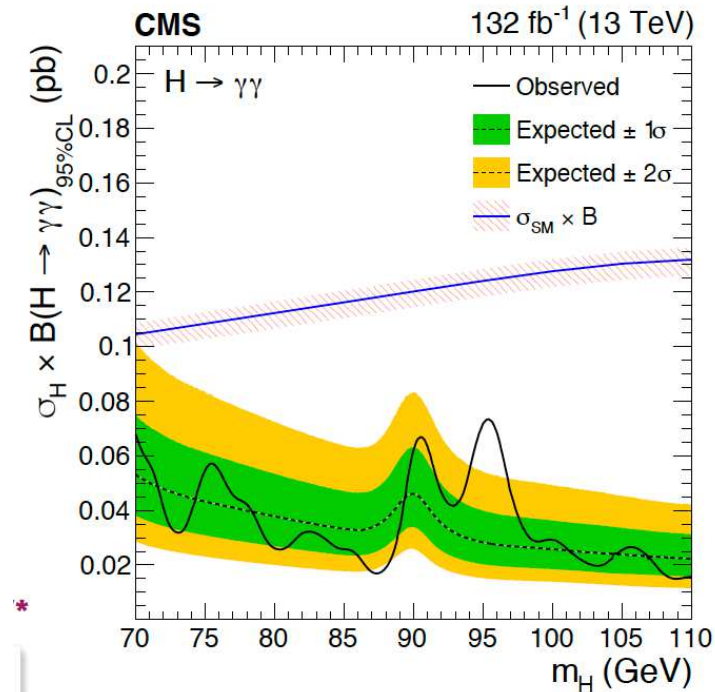
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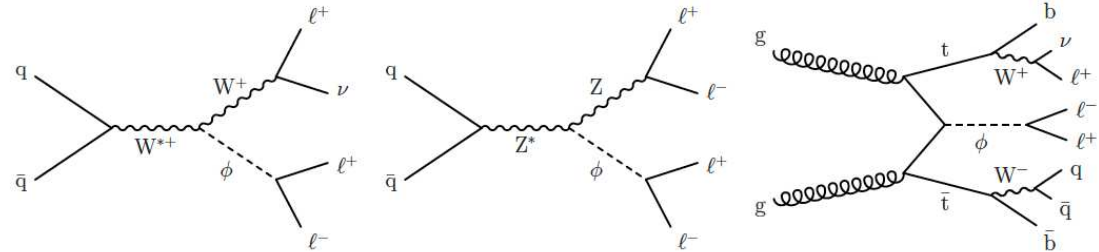
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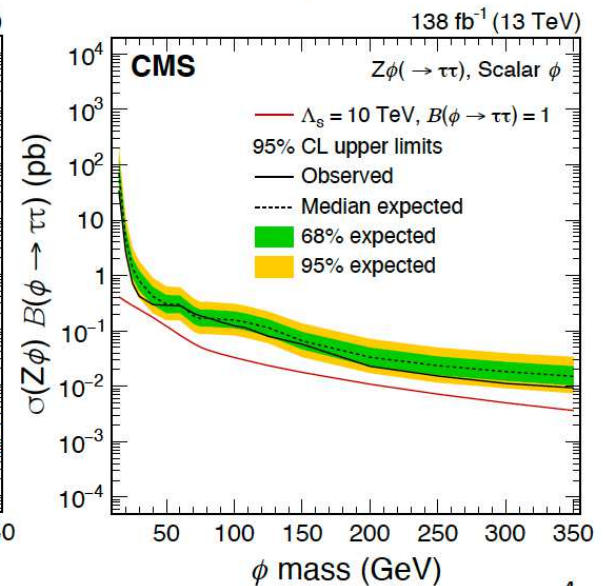
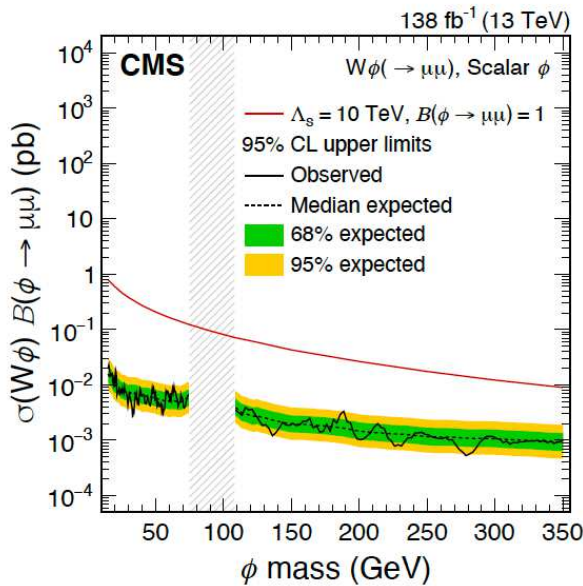
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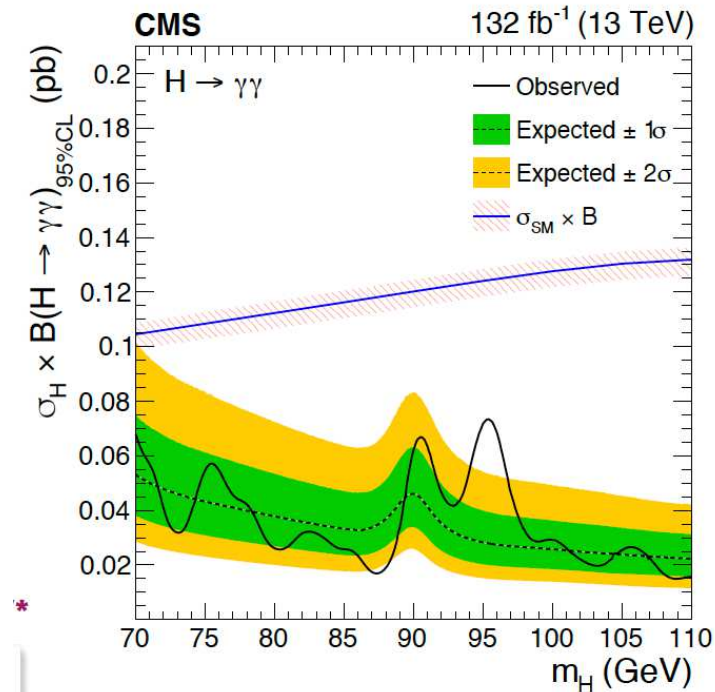
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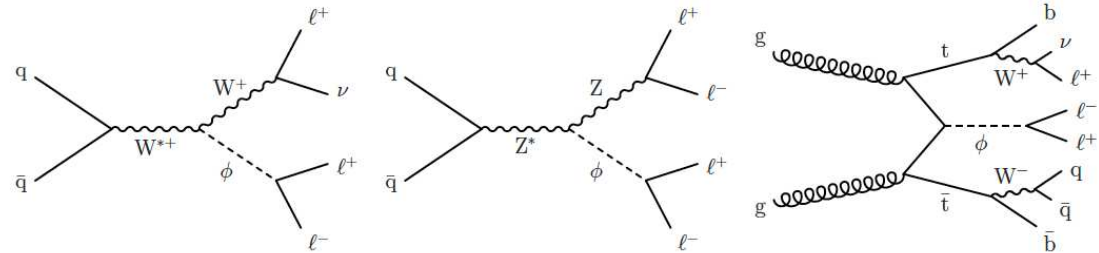
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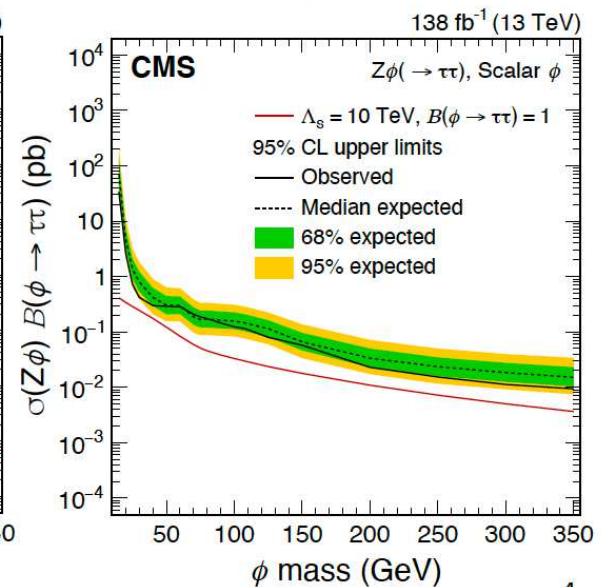
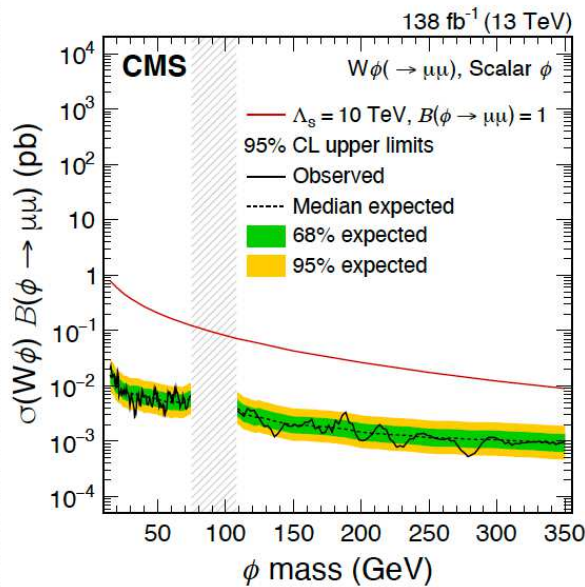
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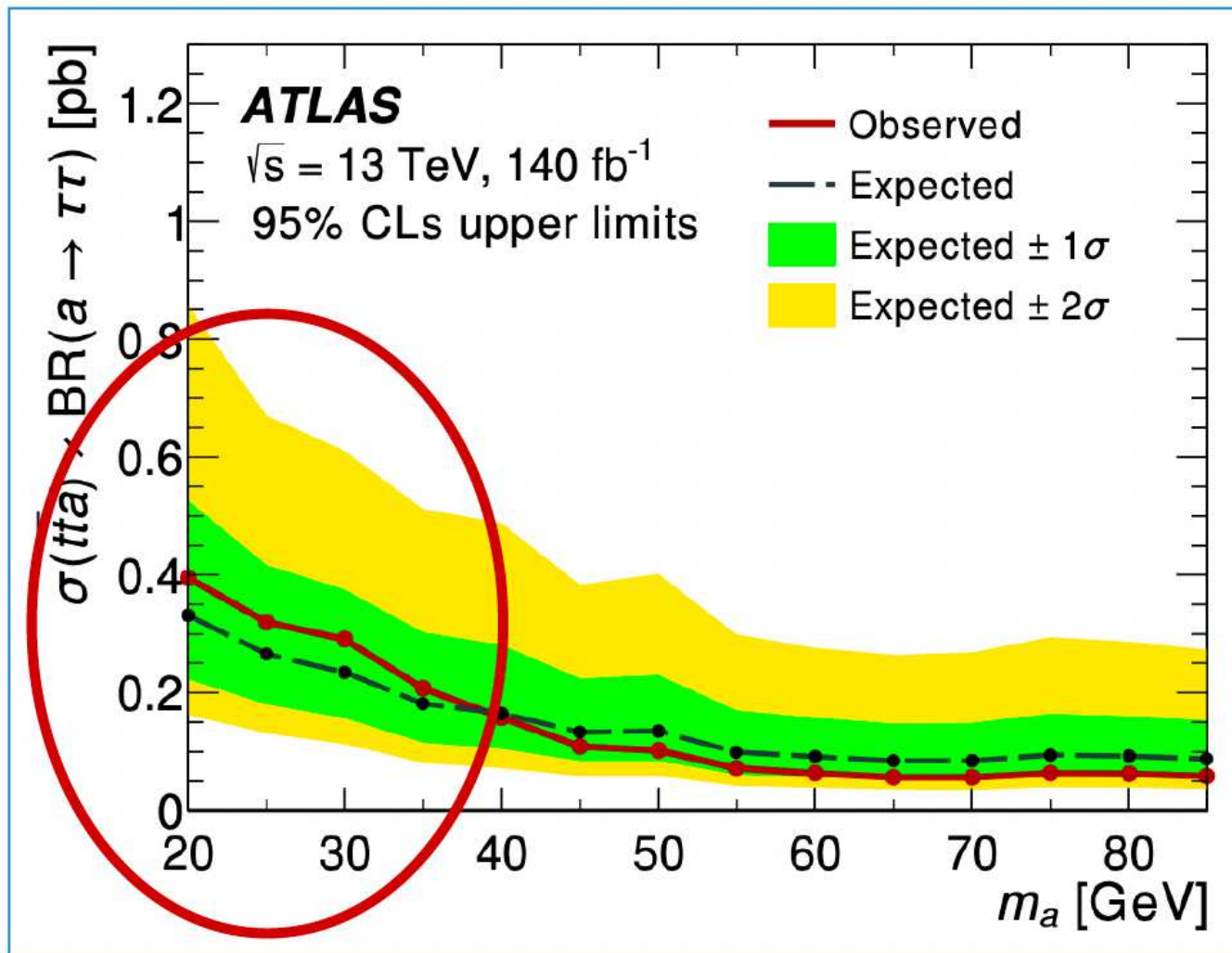
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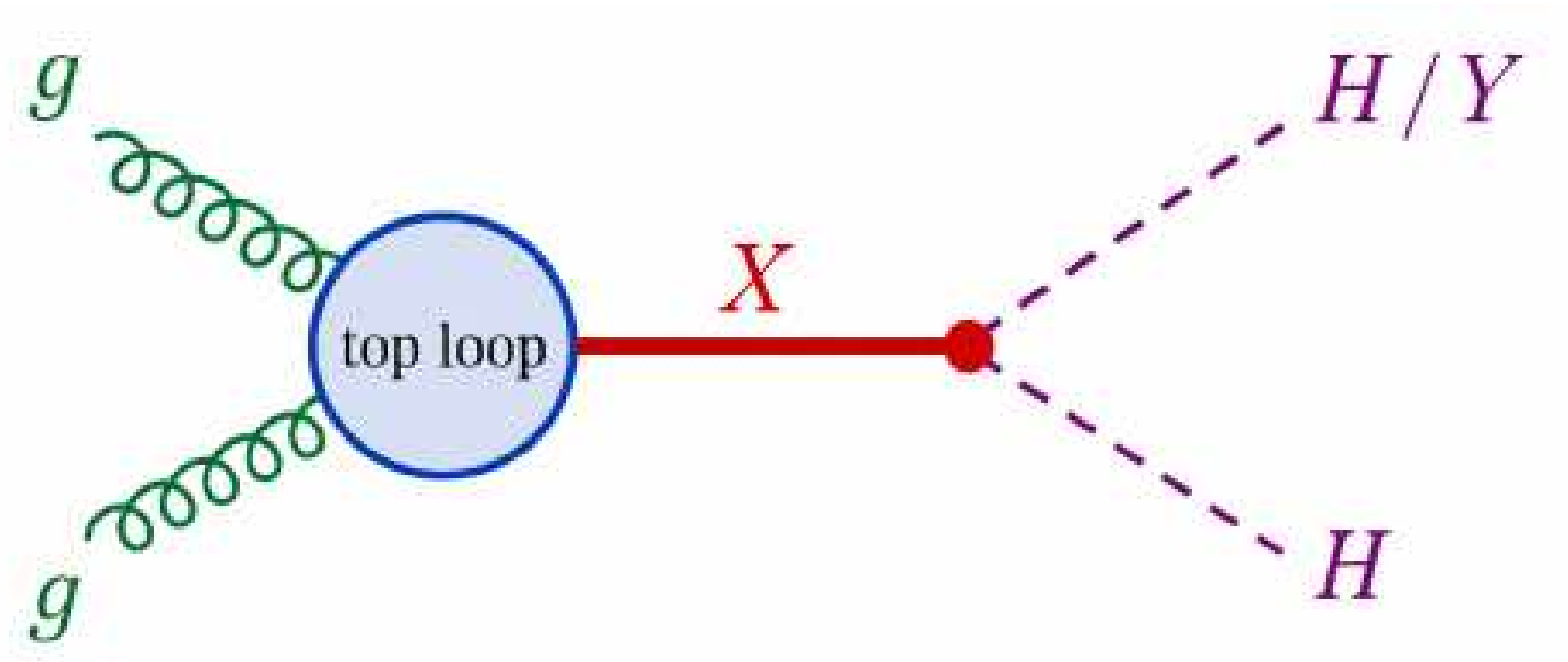
## From lower to higher masses: $h_{95}$ ATLAS analysis?



$\Rightarrow$  stops where it could become interesting  $\Rightarrow$  **ARGH!**

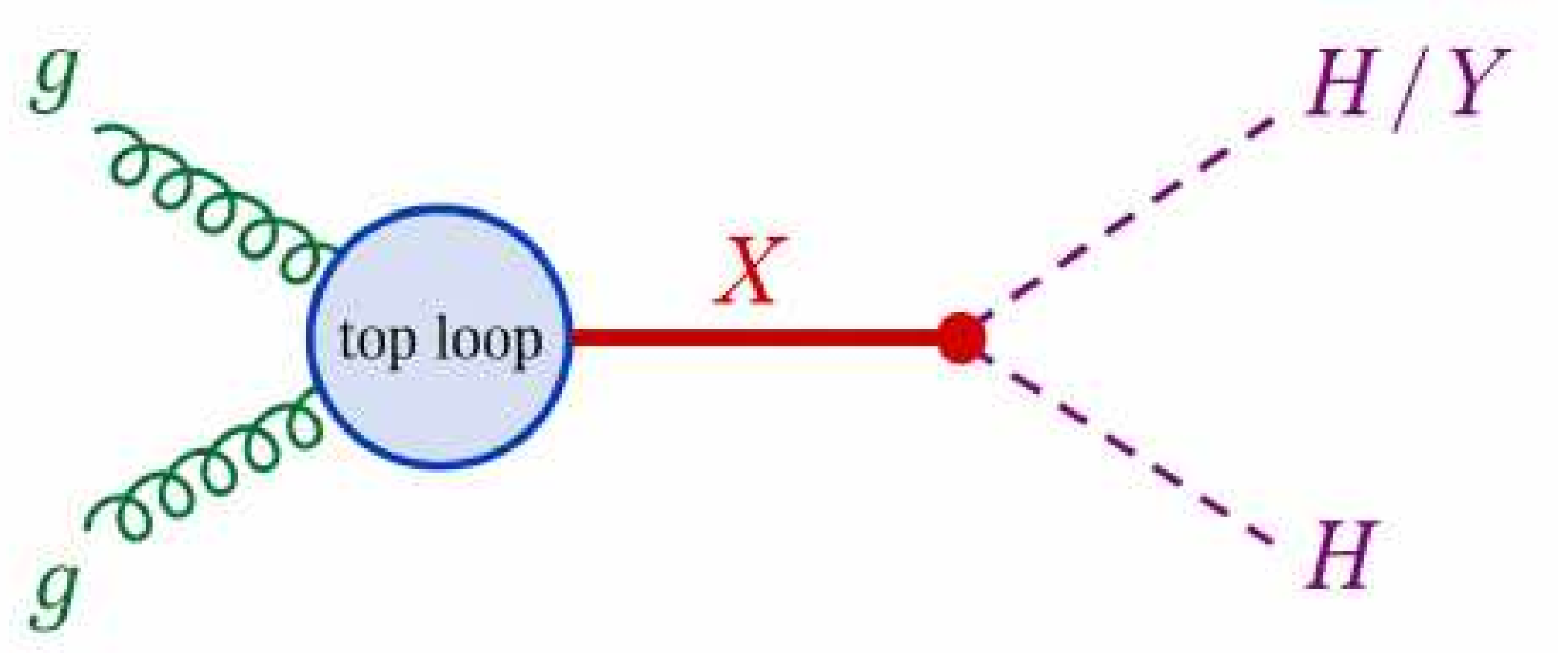
From lower to higher masses: resonant search for  $m_H > 250$  GeV

Mediated by this diagram:



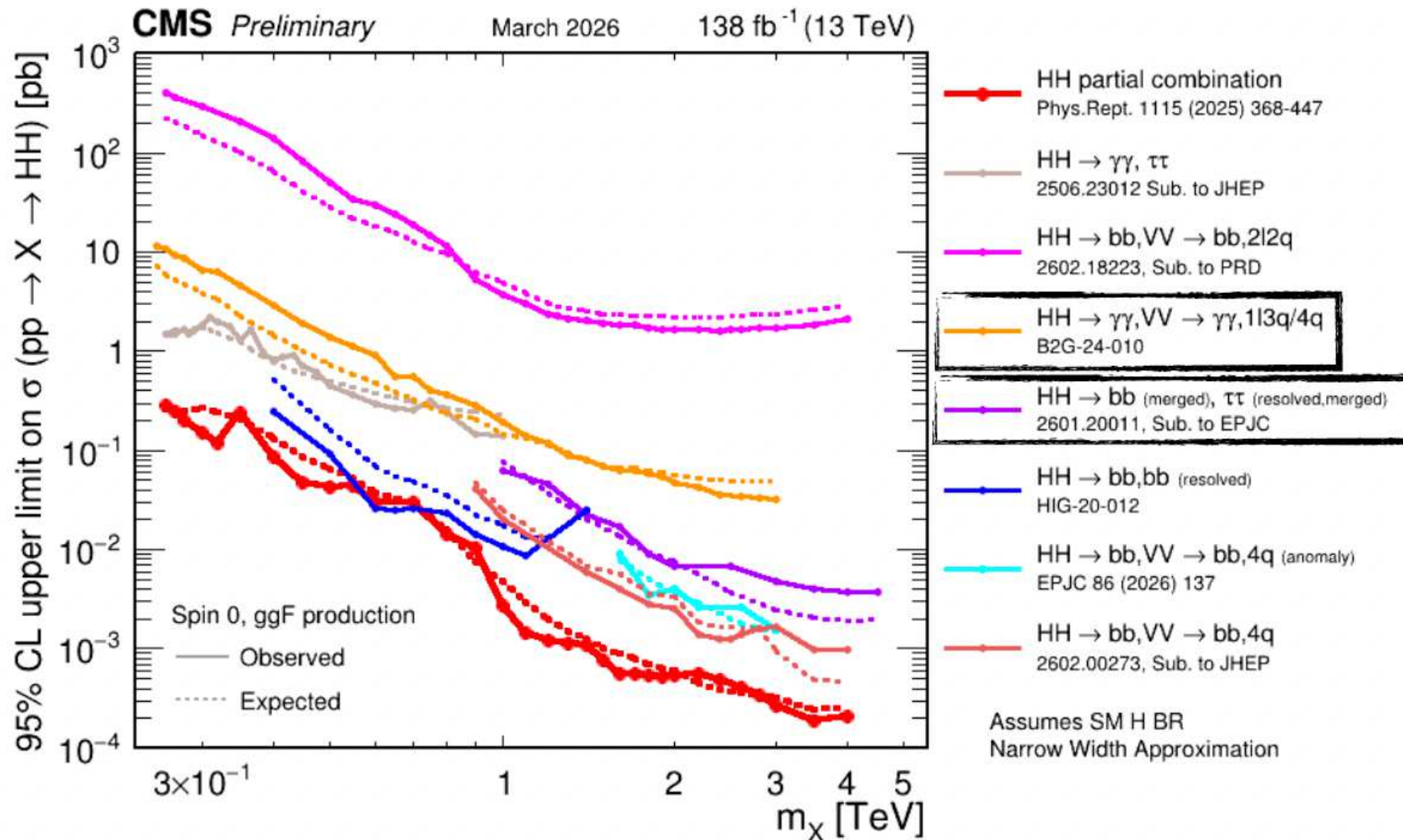
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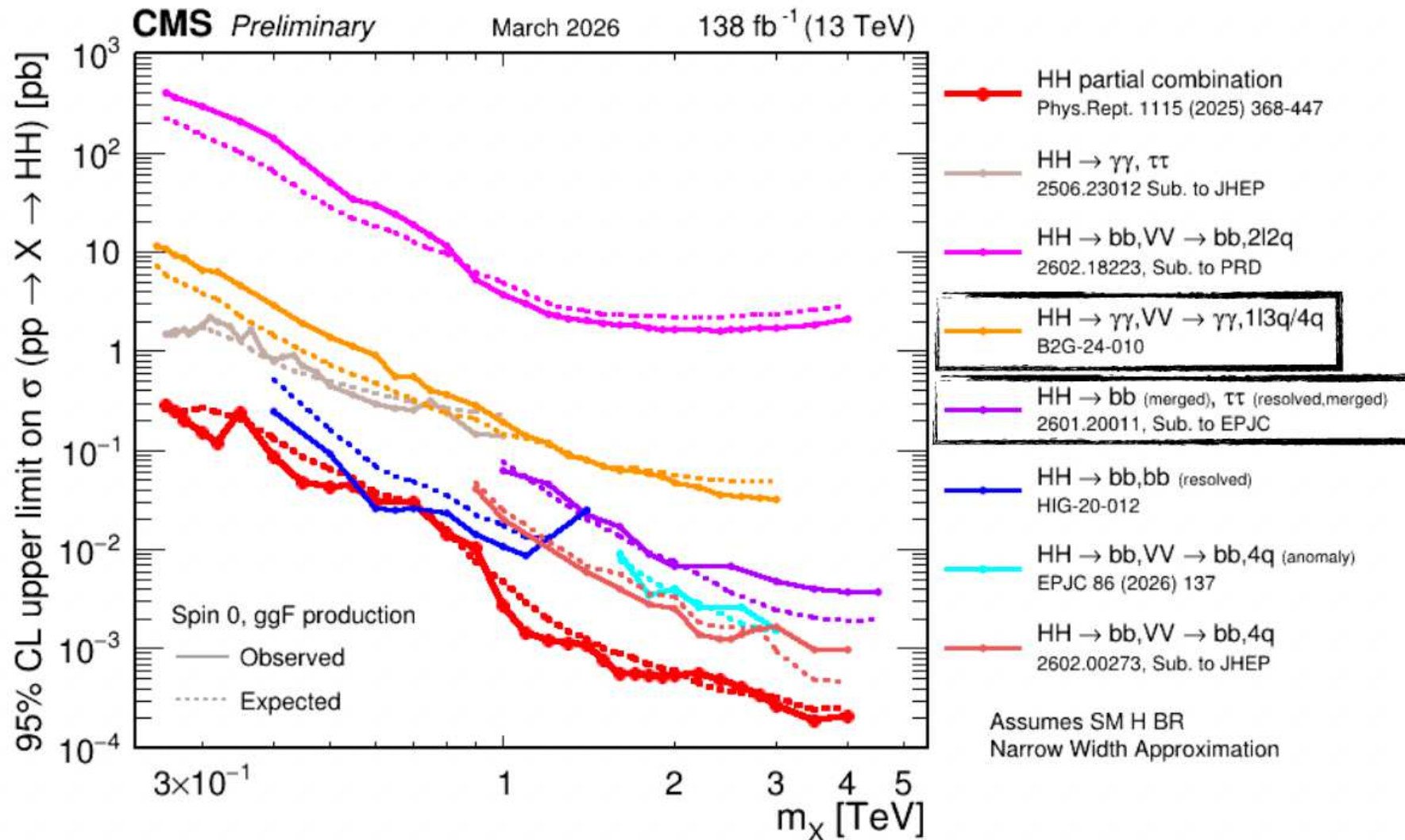
⇒ and incorrectly(!) by this diagram only ...

# From lower to higher masses: resonant search for $m_H > 250$ GeV



$\Rightarrow$  limits below  $m_H \lesssim 800 \dots 1000$  GeV questionable

# From lower to higher masses: resonant search for $m_H > 1000$ GeV



$\Rightarrow$  limits above  $m_H \gtrsim 1000$  GeV reliable

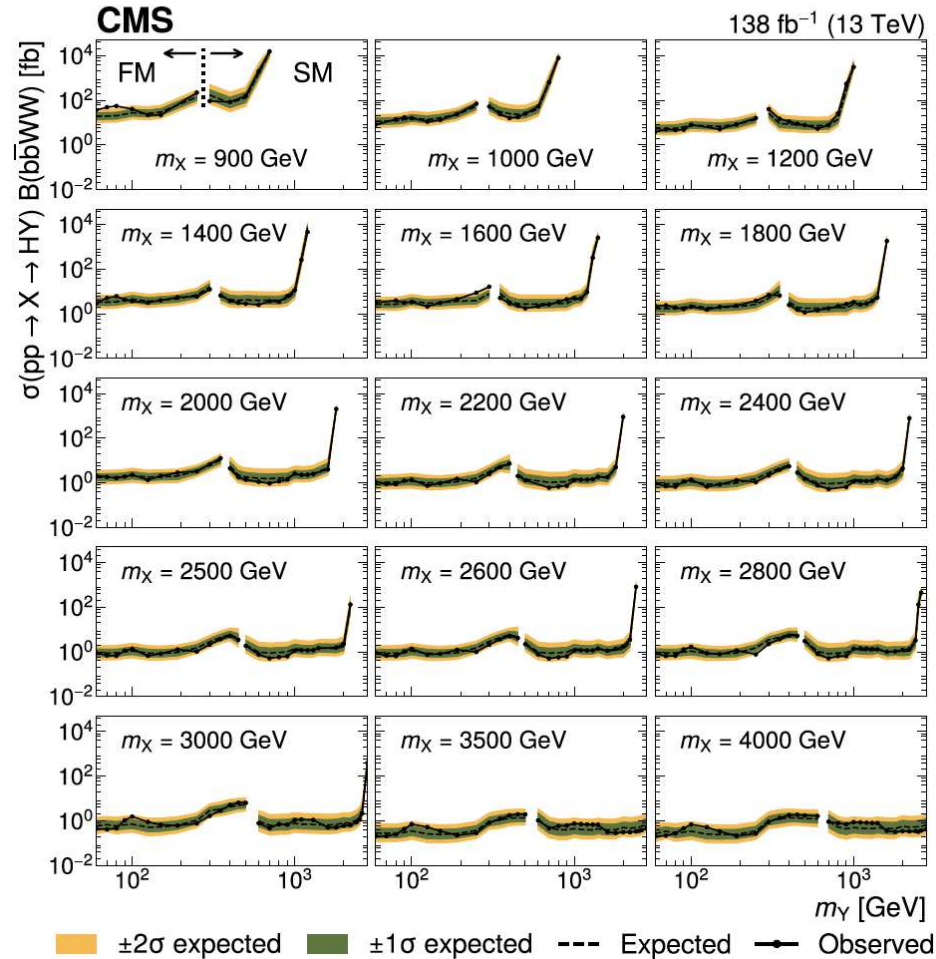
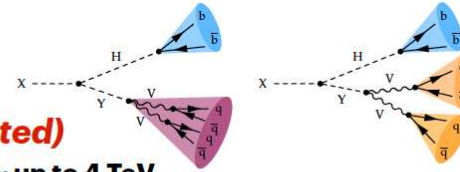
$\Rightarrow$  excesses? Compatible with “combined exclusion” ?

From lower to higher masses:  $m_X = 900 \dots 4000$  GeV

4b

$X \rightarrow YH \rightarrow bb(4q)$  (boosted)

high-mass boosted regime  $\rightarrow m_X$  up to 4 TeV



How is it statistically possible that **NO** (one?)  $2\sigma$  excess is found?

## Going in the right direction: LHC BSM WG :-)

I was very happy to see this!

... and with a map of promises.

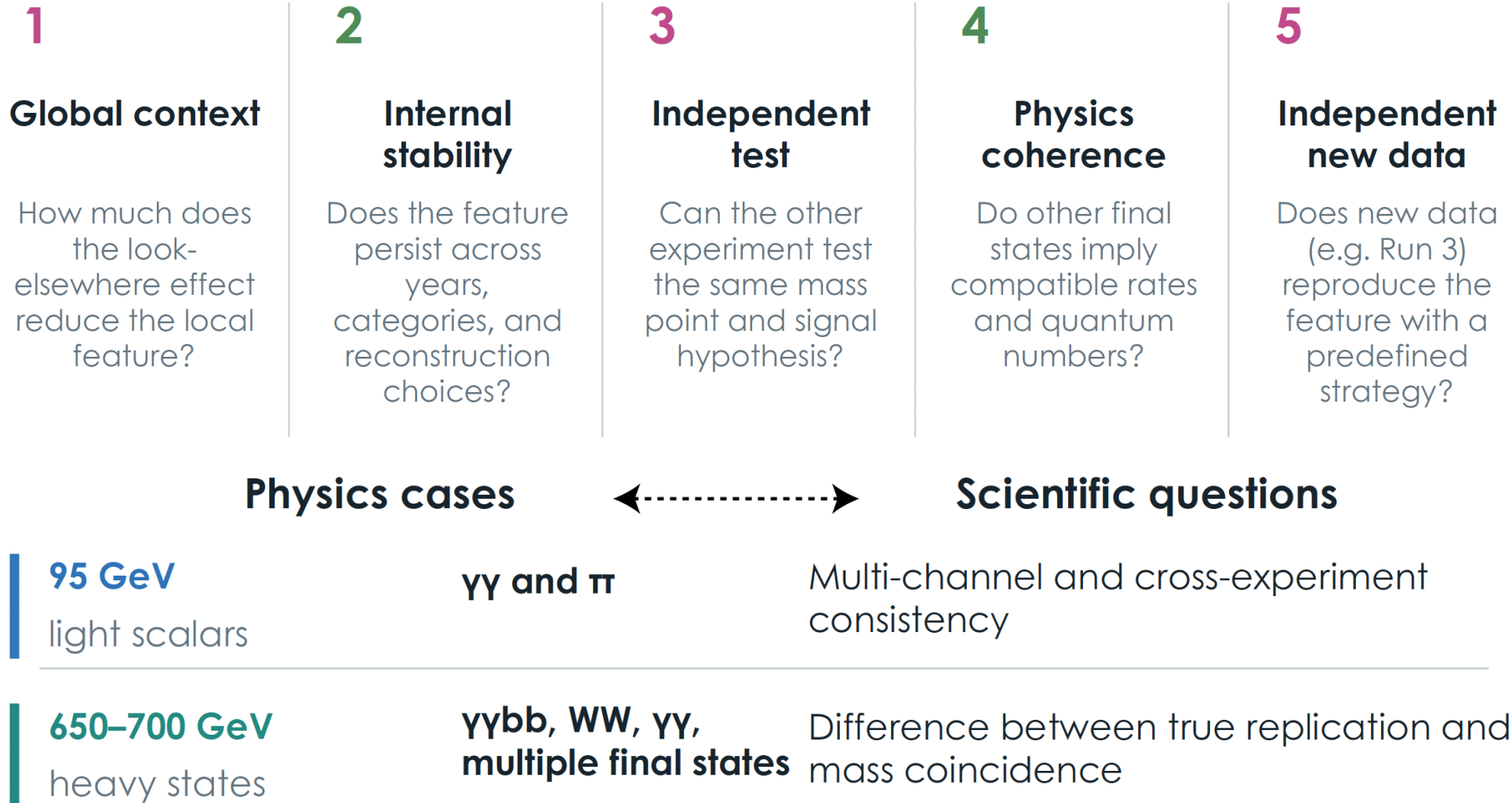
### ATLAS & CMS

| Categories containing at least one retained feature ( $> 2.4$ sigma local <sup>^^</sup> ) | Final states with a retained feature                                            |
|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| ★ Light scalar resonances                                                                 | $\gamma\gamma$ ; $\tau\tau$                                                     |
| ★ Heavy neutral / scalar pairs                                                            | $\gamma\gamma$ , $VV$ , $\tau\tau$ , $bb$ , $tt/tb$ , $e/\mu$ , merged jets     |
| ★ Charged Higgs / LFV                                                                     | $e\mu$ , $e\tau/\mu\tau$ , $cb$ and $WZ/WW$                                     |
| ★ $A \rightarrow XH$ cascades                                                             | $Zbb$ , $ZWW$ , $Ztt$ and $Zhh \rightarrow Z4b$                                 |
| ★ $X \rightarrow YH / HH$                                                                 | $\gamma\gamma bb$ , $\gamma\gamma\tau\tau$ , $4b/bb\tau\tau$ , $VV$ and $4\ell$ |
| ★ Exotic H125 decays                                                                      | $Z\gamma\gamma$ , $4\ell$ , $\mu\mu\tau\tau$ , $4b/6b$ and $bb\mu\mu$           |

⇒ finally a well ordered overview of excesses

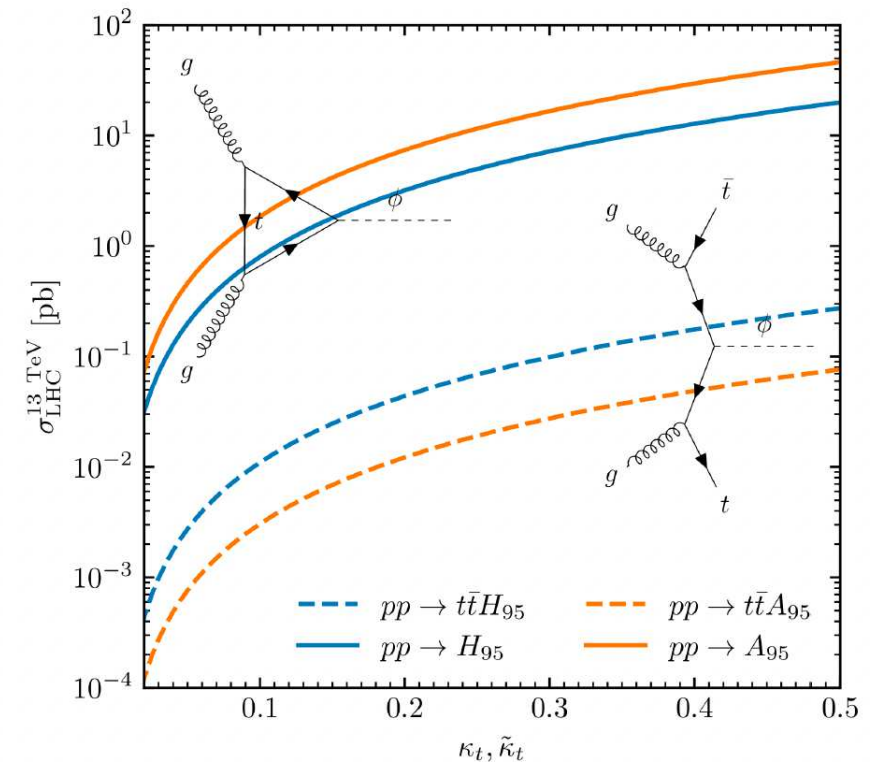
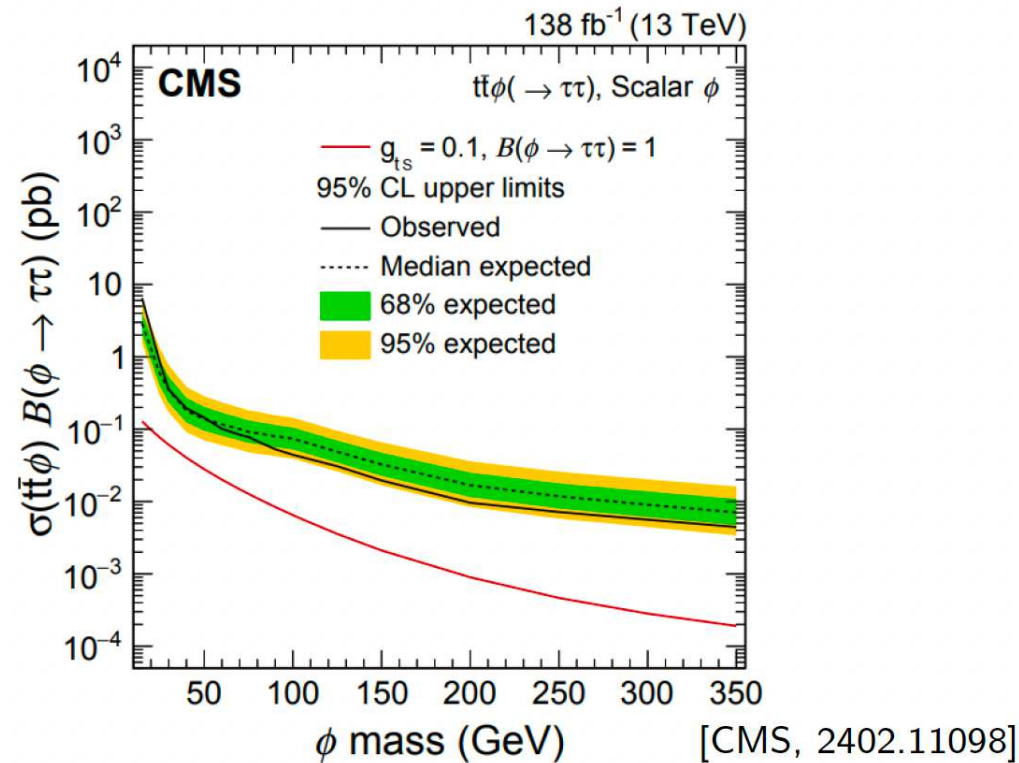
## LHC BSM WG:

⇒ asking the right questions:



⇒ 95 GeV looks most consistent?!

# CMS: $t\bar{t}h$ with $h \rightarrow \tau^+\tau^-$



$\Rightarrow$  For scalar:  $\mu_{\tau\tau} \lesssim 0.5 \quad \Rightarrow$  Excludes the  $\tau^+\tau^-$  excess at about  $2\sigma$   
 For pseudoscalar:  $\mu_{\tau\tau} \lesssim 4.0 \quad \Rightarrow$  No constraints

# The 95 GeV region

## ATLAS & CMS



- Some relevant questions: CMS **cross-channel consistency**, ATLAS **direct or neighbouring tests**, and whether the LEP mass coincidence adds physics coherence.

⇒ we urgently need the 1/2 Run3 analysis!!

# The 95 GeV region

## ATLAS & CMS



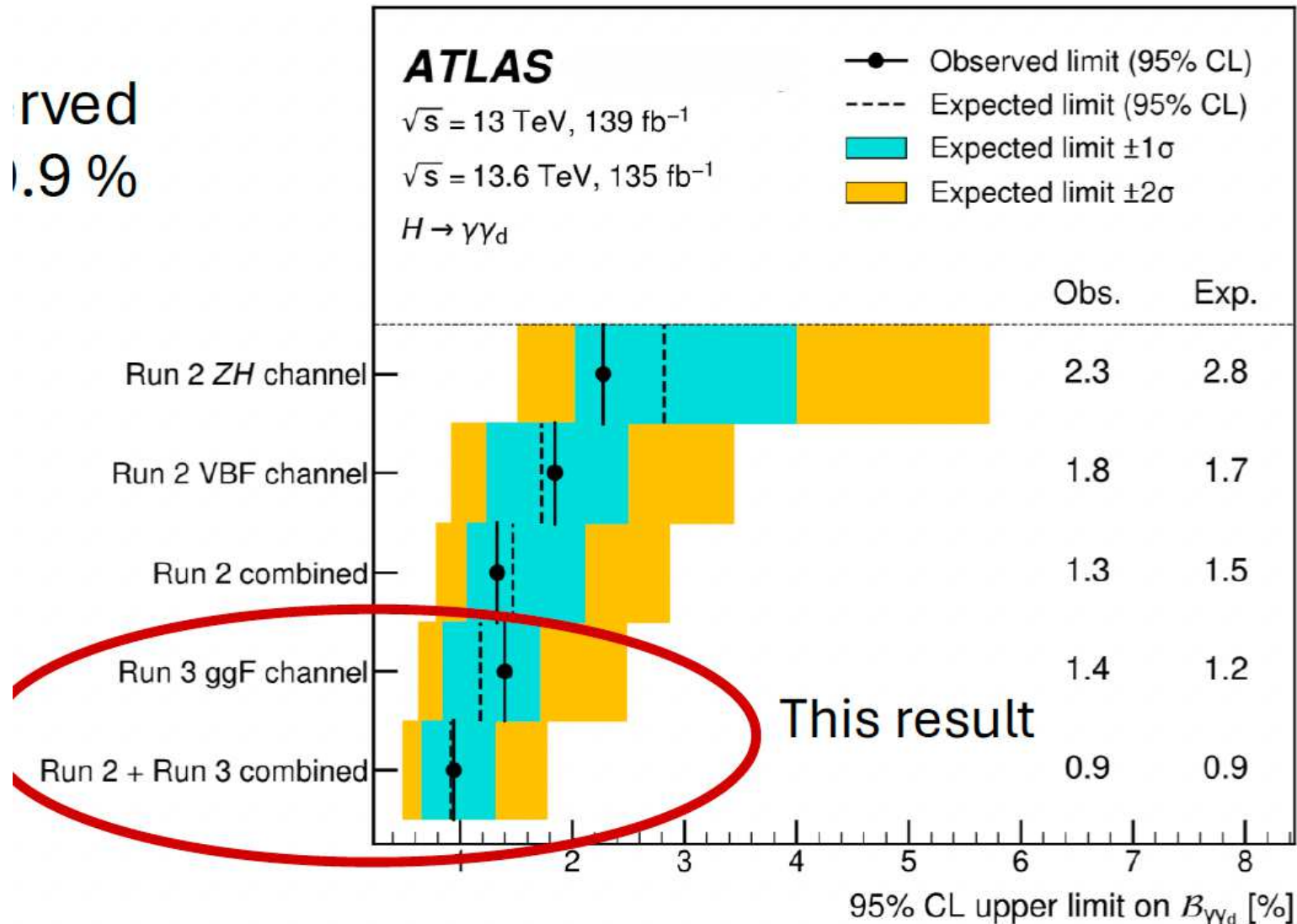
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⇒ we urgently need the 1/2 Run3 analysis!!

⇒ Wait! There are some Run2  $\oplus$  Run3 analyses!

## Finally: now we start to have Run2 $\oplus$ Run3 results

Observed  
0.9 %



$\Rightarrow$  but why **THIS** channel? Why not the really interesting ones?



Further Questions?