

Discussion on “BSM Higgs Searches”

Sven Heinemeyer, IFT/IFCA (CSIC, Madrid/Santander)

Paris, 07/2018

Talks:

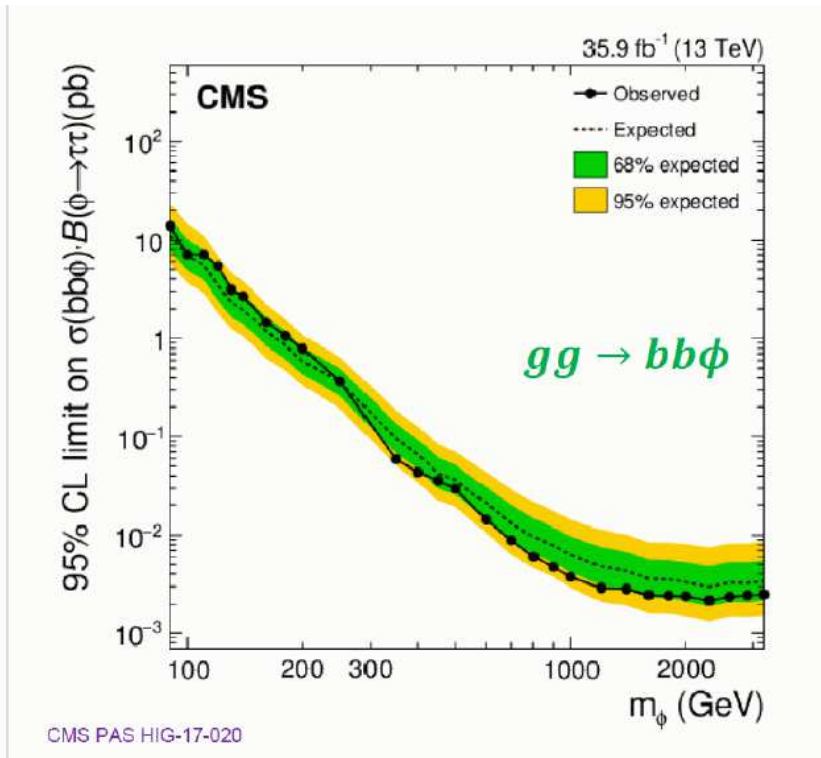
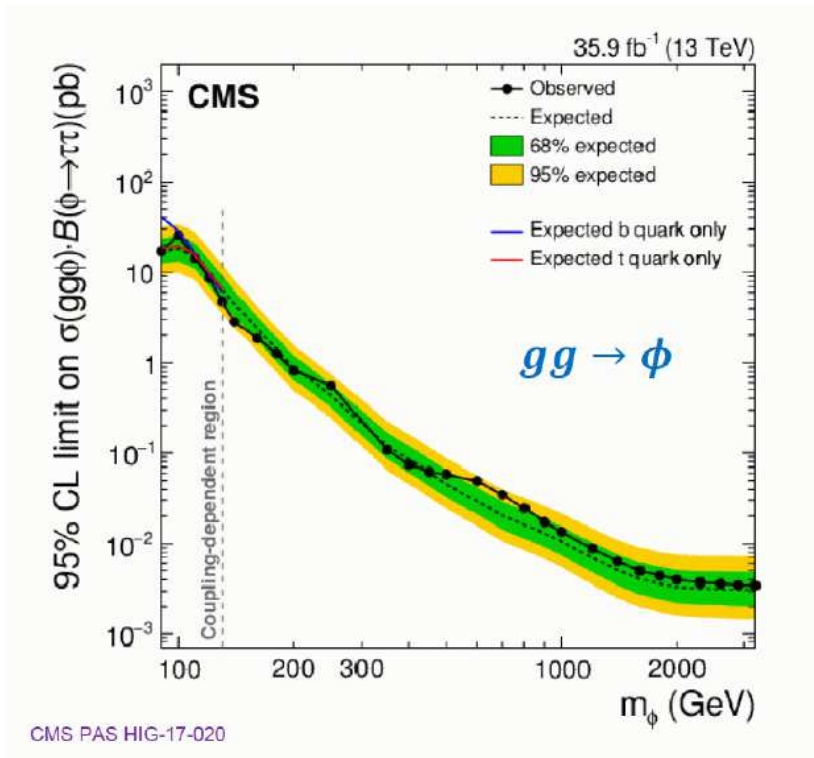
- S. Mazza: ATLAS BSM Higgs searches
- L. Finco: CMS BSM Higgs searches
- K. Hamano: ATLAS rare and BSM decays
- S. Taroni: CMS rare and BSM decays

⇒ no full ATLAS – CMS comparison ...

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

Perhaps slightly provocative ... :-)

My personal favorite: $pp \rightarrow \phi \rightarrow \tau^+ \tau^-$:



What theorists need:

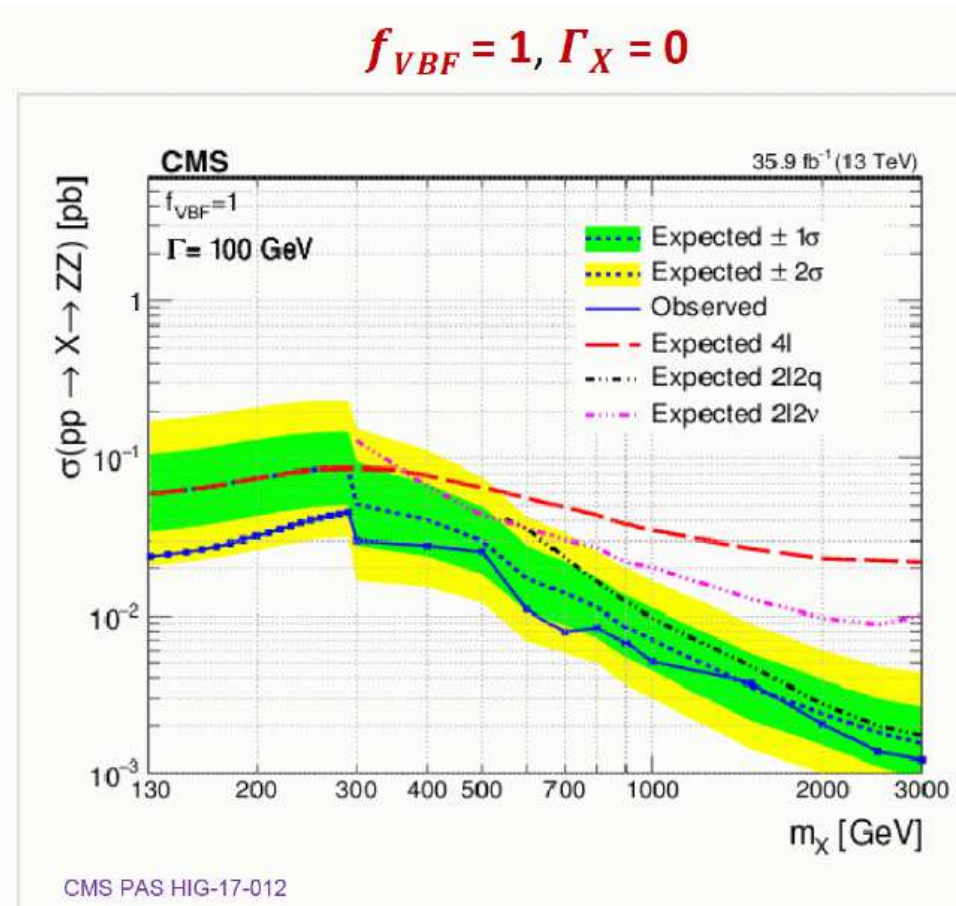
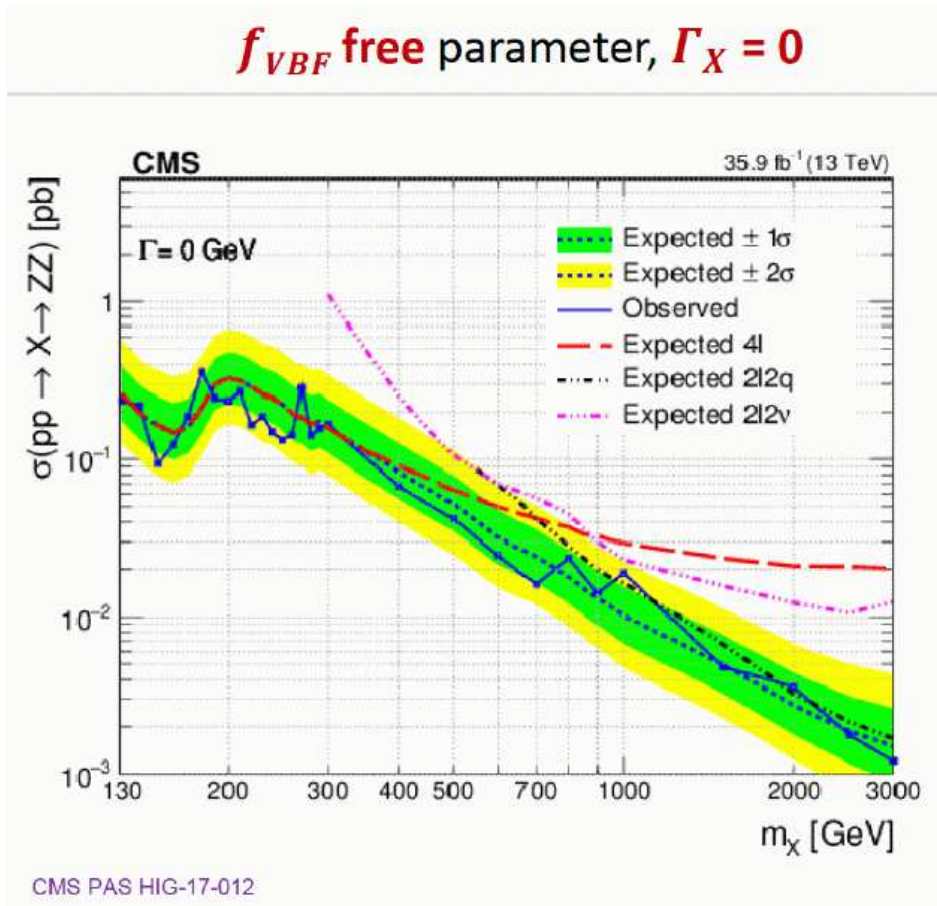
Full likelihood information (obs. \oplus exp.) in 3-dim space

$(m_\phi, \sigma(gg \rightarrow \phi), \sigma(bb \rightarrow \phi))$

\Rightarrow CMS :-| ATLAS :-|

\Rightarrow still no $\phi \rightarrow t\bar{t}$ update ...

Please keep up with it: $pp \rightarrow \phi \rightarrow ZZ$

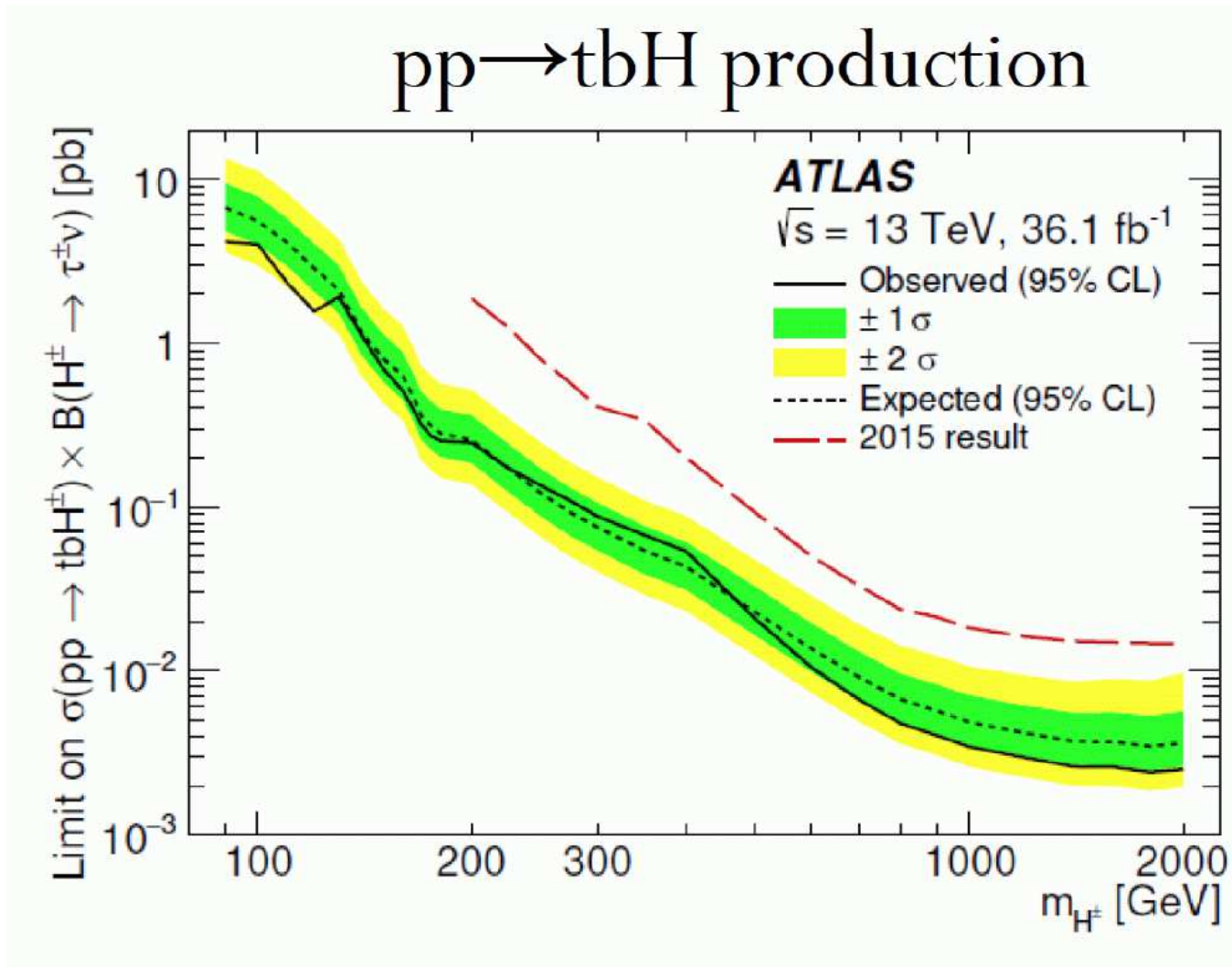


⇒ VERY important for re-interpretation for BSM models

(somewhere the “remaining” SM doublet component c/should show up!)

⇒ best way to (re)present this??

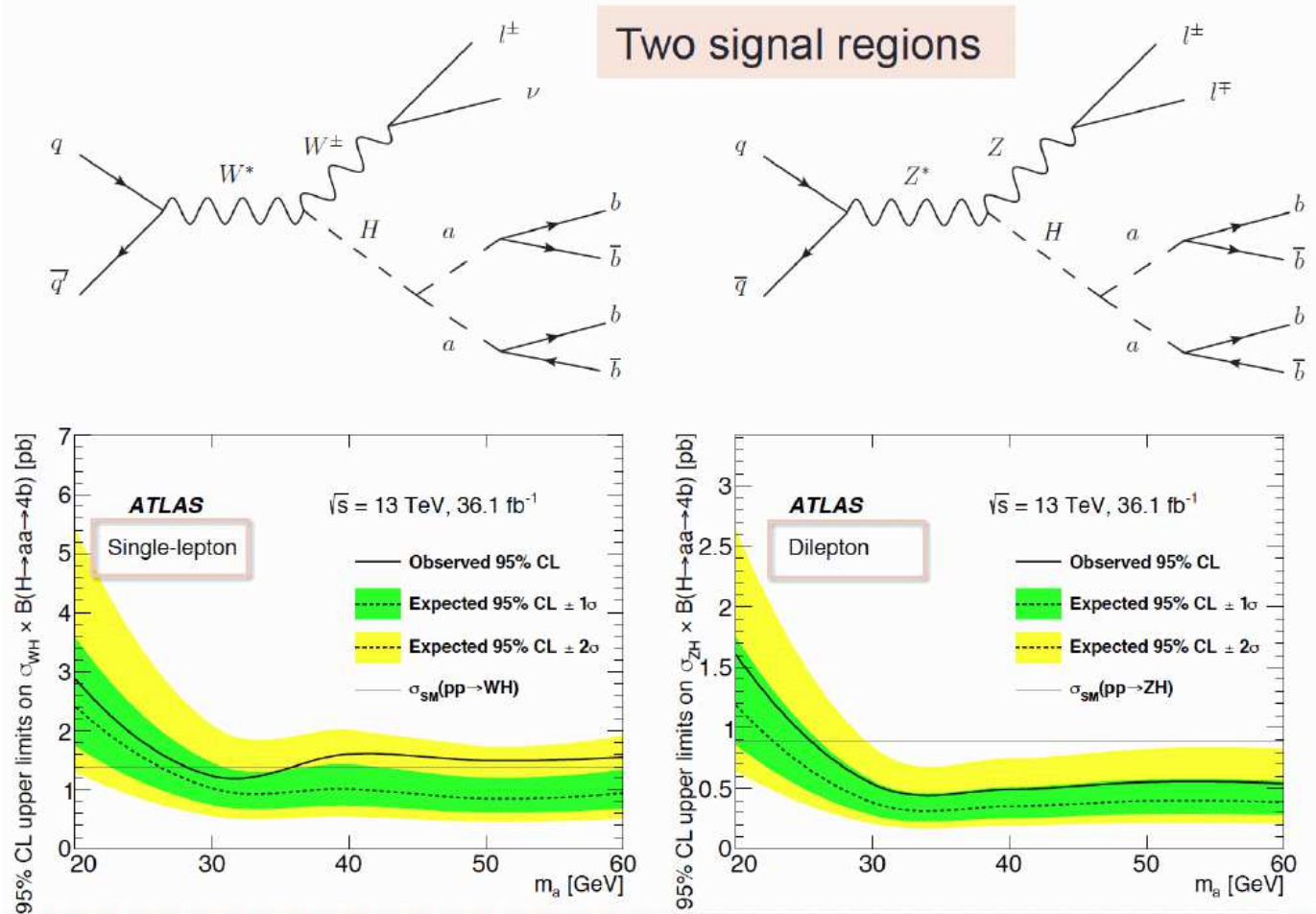
Finally: $H^\pm \rightarrow \tau\nu$ over the “full” mass range



⇒ important to close gaps where BSM models may be hiding!

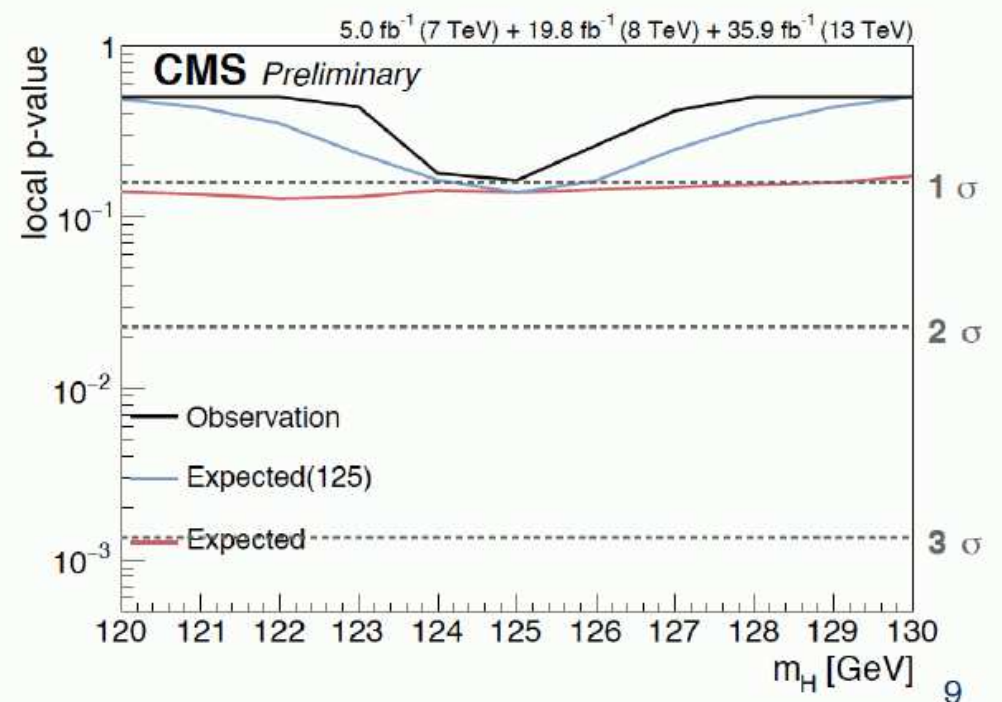
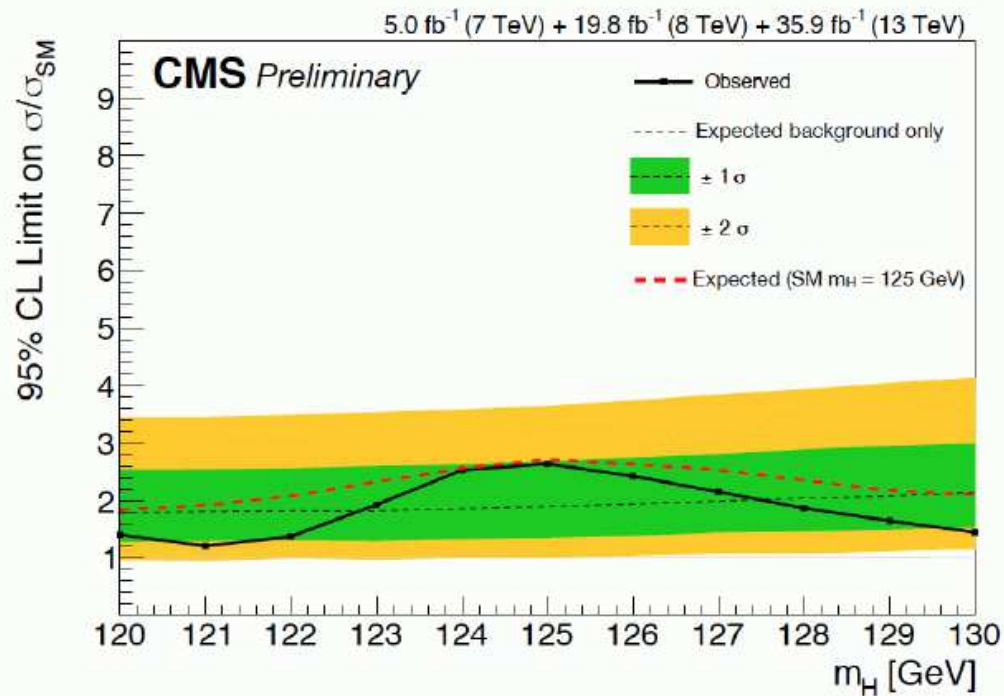
Happy to see (I): $h \rightarrow aa \rightarrow 4b$ (or other final states)

- WH/ZH production \rightarrow lepton trigger



\Rightarrow important to check other BSM models

Happy to see (II): $h \rightarrow \mu^+ \mu^-$



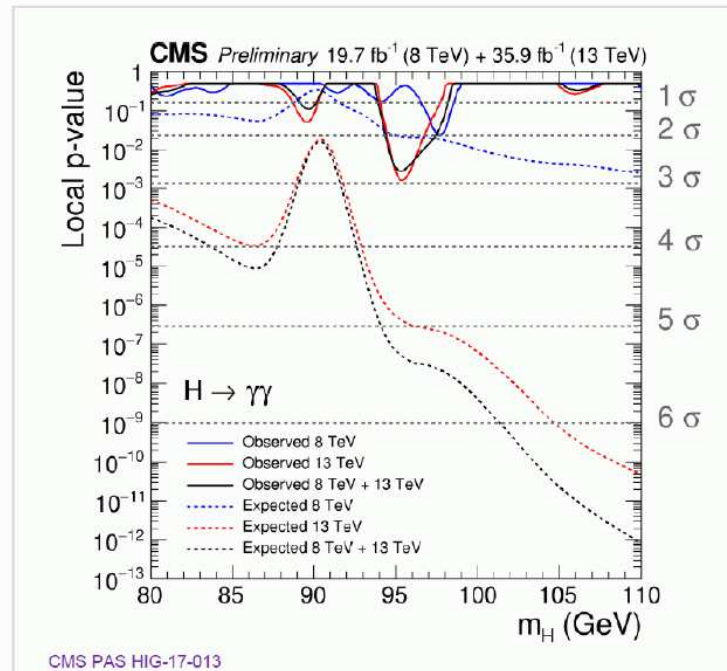
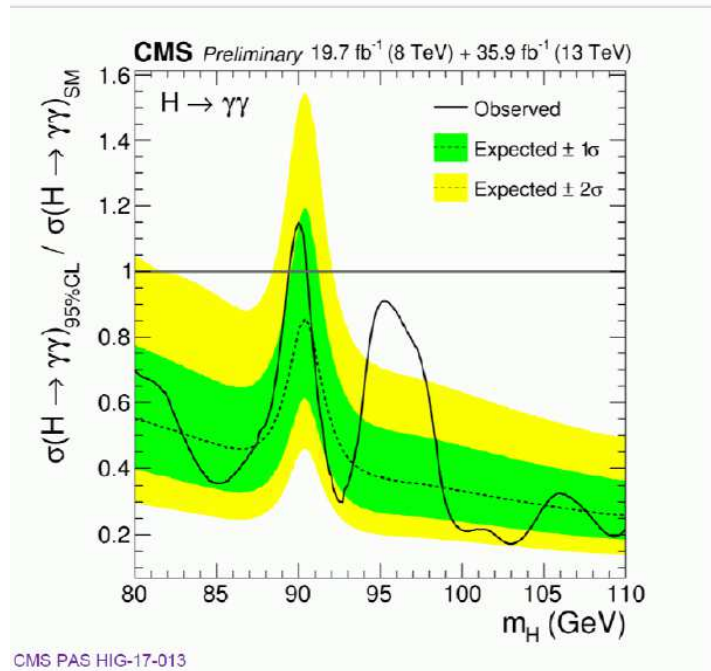
⇒ better than expected?

⇒ SM reached in Run 3?

⇒ why not larger mass range? (BSM limits!)

Only excess that is not excluded by ATLAS or CMS: ϕ_{96}

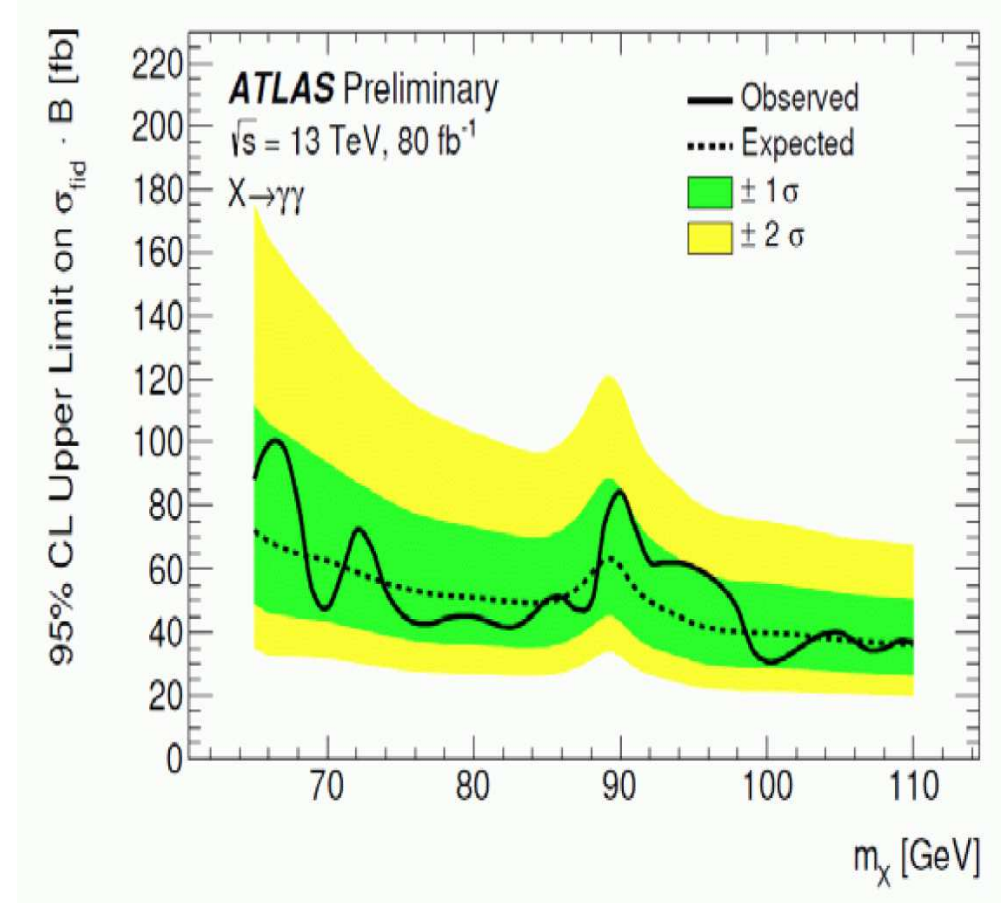
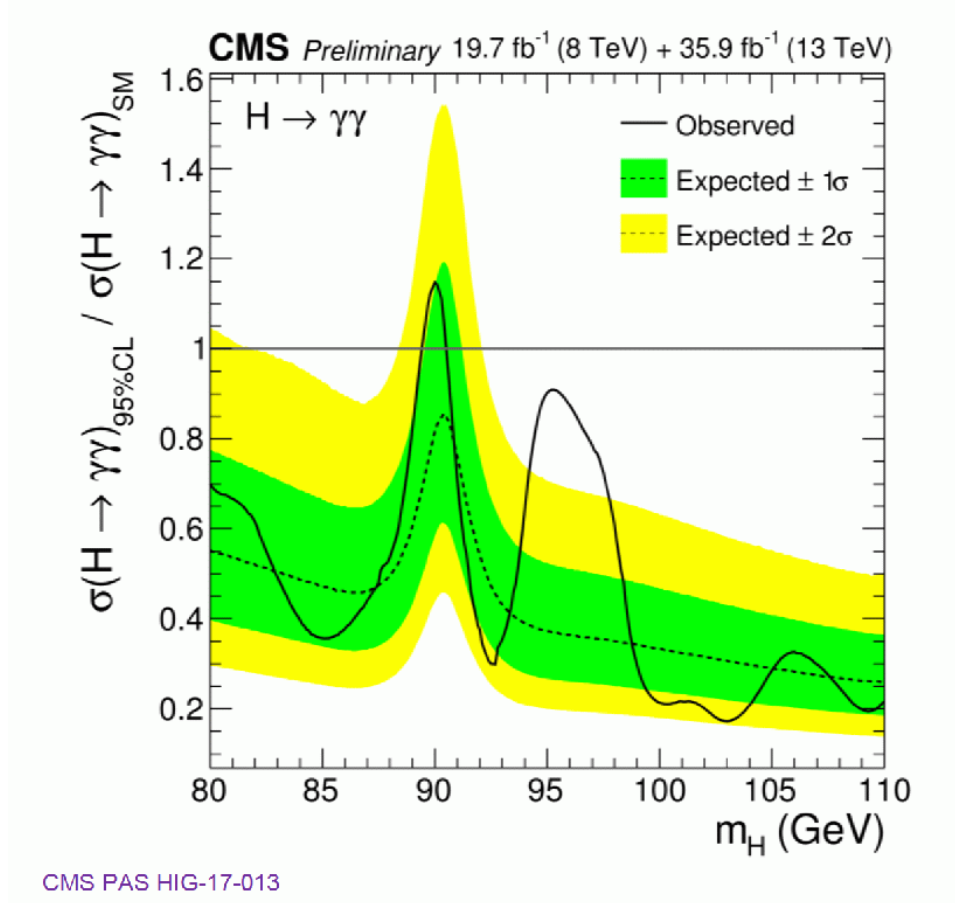
- **Combined 8 TeV + 13 TeV $\sigma \times \text{BR}$ limit** normalized to SM expectation:
 - Production processes assumed in SM proportions
 - **No significant excess** with respect to background expectations
- Expected and observed local p-values for **8 TeV**, **13 TeV** and their **combination**



Questions for CMS:

- Run 1 / Run 2 compatibility? (shift in Z-peak!)
- When do you dare to something “significant”?

Only excess that is not excluded by ATLAS or CMS: ϕ_{96}



Questions for ATLAS and CMS:

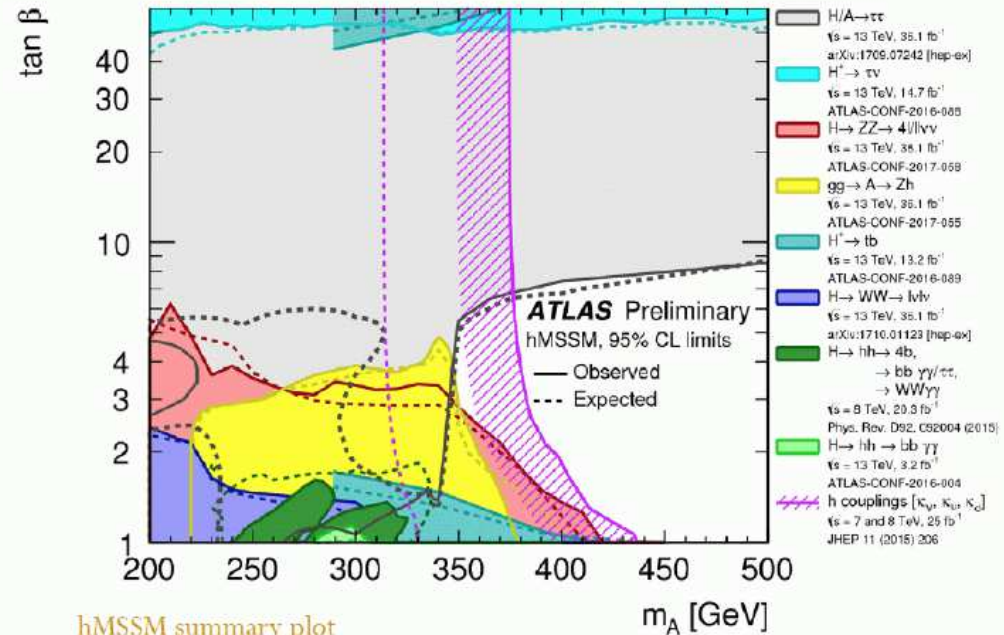
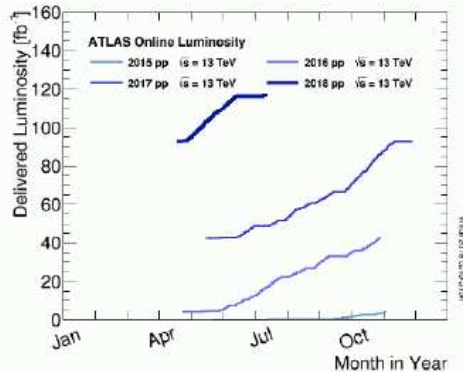
— Are the XS limits compatible?

~ 60 fb for ATLAS, ~ 120 fb for CMS at 96 GeV

A final word: **WHY?**

Conclusion

- Lots of interesting new results on Higgs models beyond the Standard Model
 - Using full dataset of 2015+2016: 36.1 fb^{-1}
 - Some results also include full 2017 dataset: 80 fb^{-1}
- Combination of hMSSM Run-II exclusion
 - (slightly outdated)
- 2018 data taking campaign going forward
 - $\sim 120 \text{ fb}^{-1}$ accumulated so far in total for Run II
- **Thanks for the attention**



hMSSM summary plot

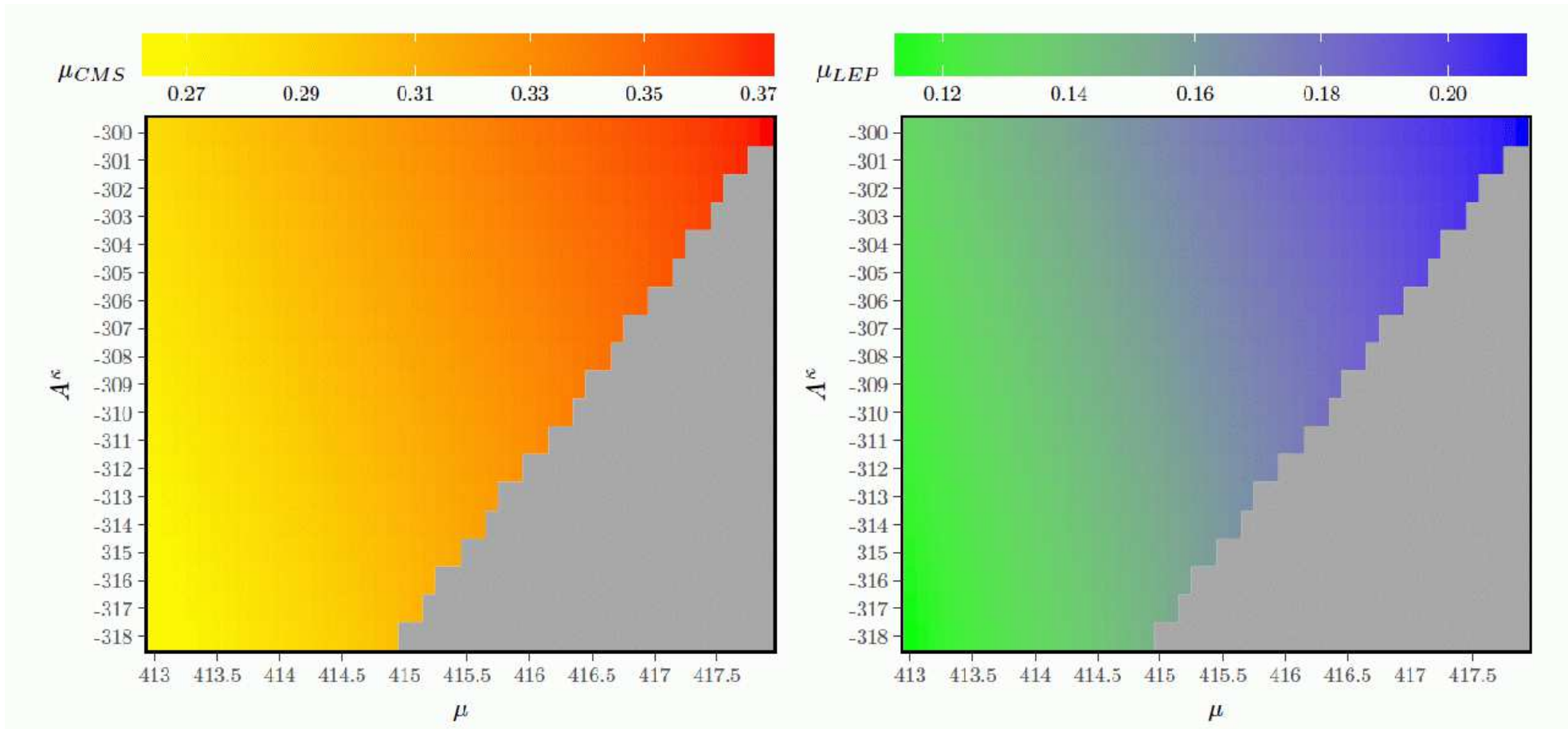
- Why to you “neglect” the results in the non-trivial scenarios?
- Are people still aware of the hMSSM restrictions?
- ⇒ the MSSM is much² richer than the hMSSM!



Further Questions?

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

[*T. Biekötter, S.H., C. Muñoz, arXiv:1712.07475*]



⇒ **YES, WE CAN! :-)**

(at the $1 - 1.5\sigma$ level)

⇒ even better when the ATLAS results are taken into account! ;-)