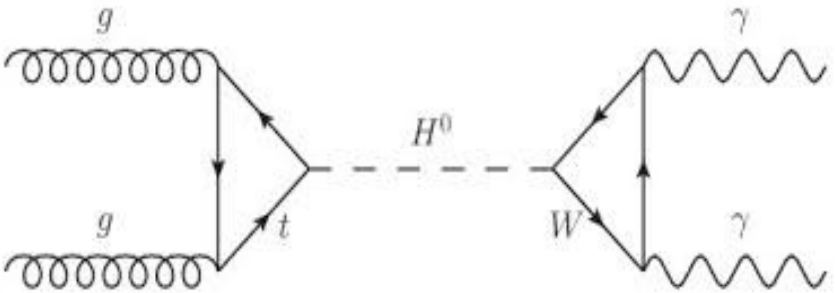
Higgs boson discovery

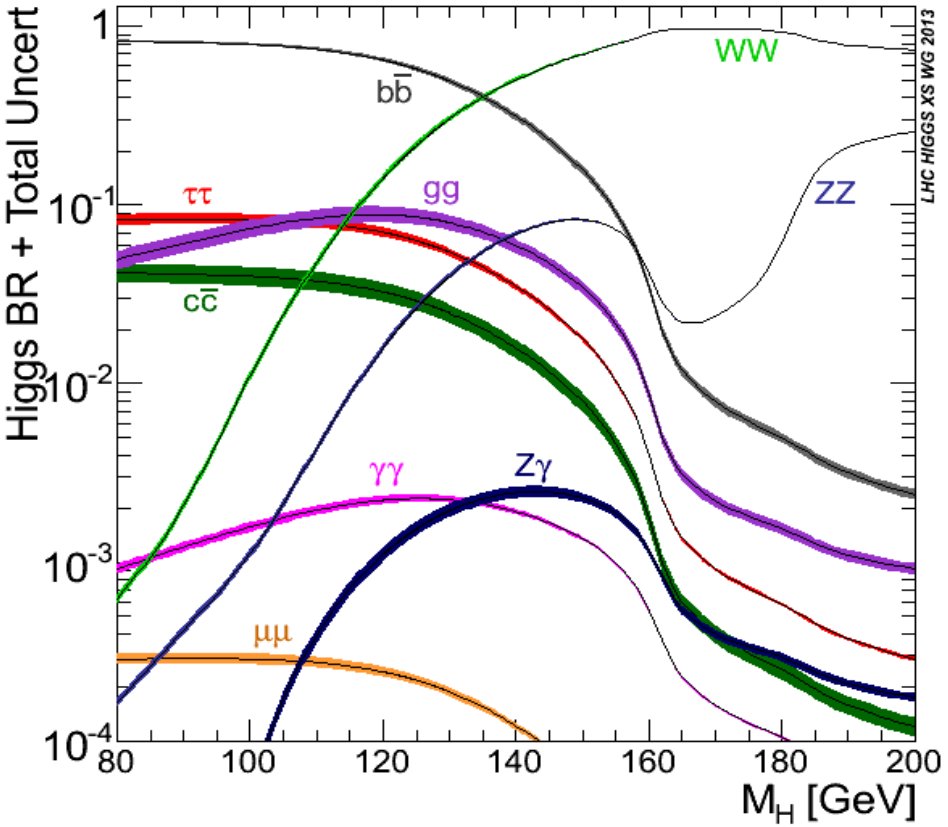
Why the H → γγ channel?

- Higgs boson production and decay at higher orders :



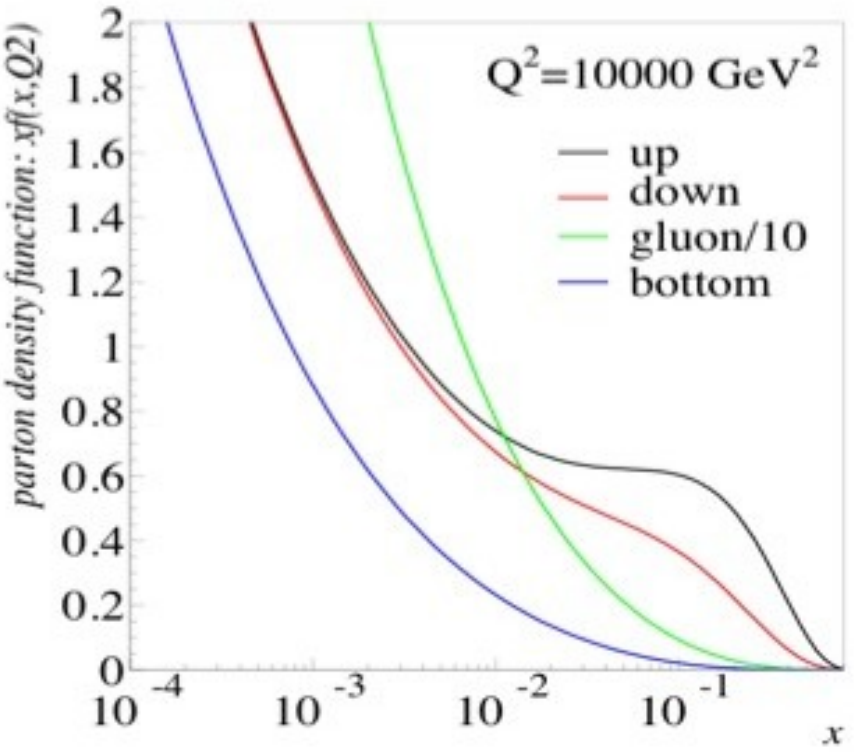
Top, and possibly other heavy quarks contribute to the production

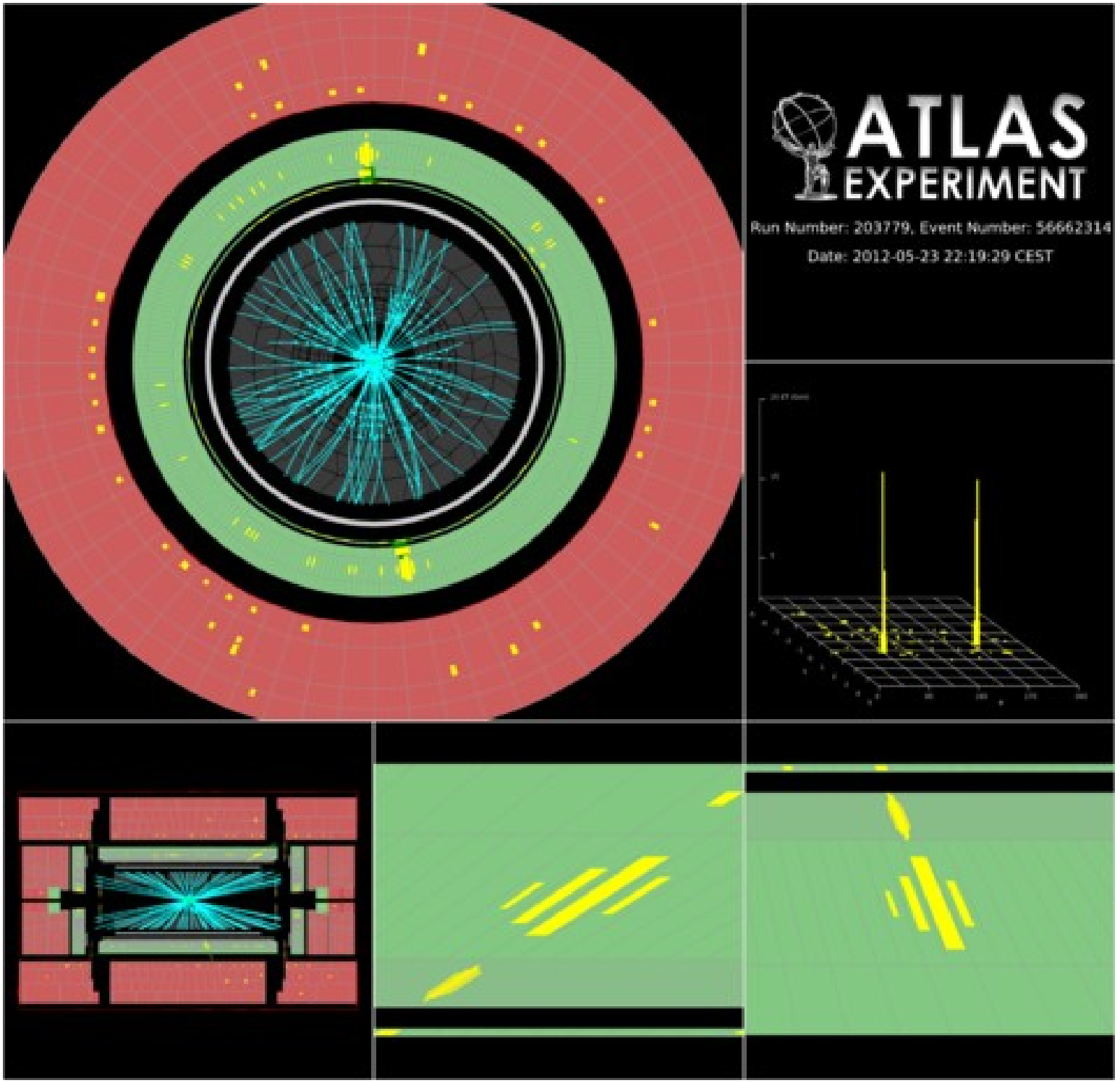
W and top are the main contributions to the decay loop



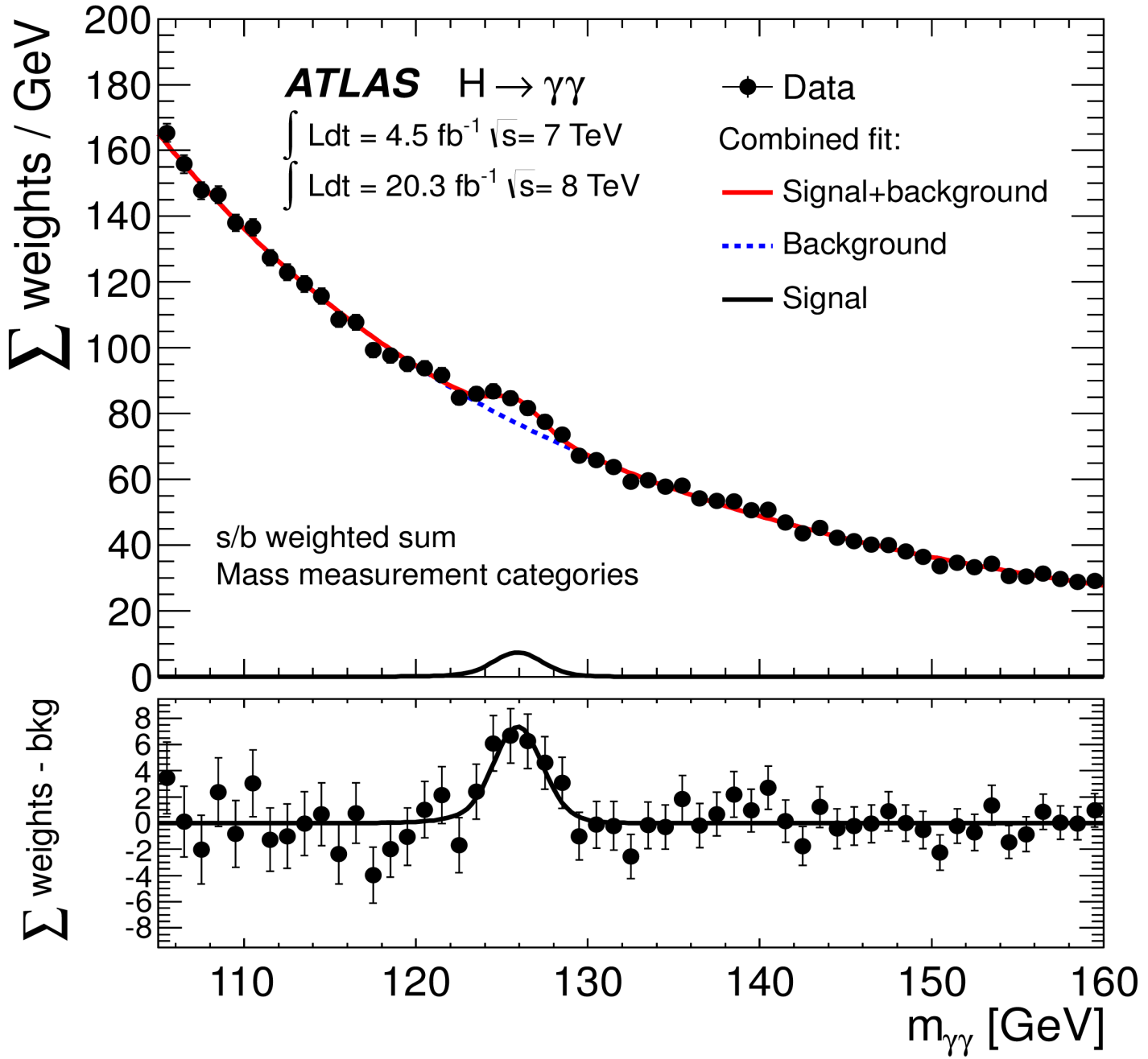
Why the H → γγ channel?

- Signal and backgrounds, assuming mH~125 GeV
  - Main decay mode
    - BR(H → bb) ~ 56%
    - Main background : g g → b b, $\sim\alpha_S^2$
    - Mass resolution ~15 GeV
  - Photon pair decay mode
    - BR(H → γγ) ~ 0.23%
    - Main background : q q → γ γ, $\sim\alpha_{QED}^2$
    - Mass resolution ~1.5 GeV
- Signal : γγ / bb ~1/200
- Backgtround : γγ / bb ~1/100000




ATLAS
EXPERIMENT
Run Number: 203779, Event Number: 56662314
Date: 2012-05-23 22:19:29 CEST

Analysis result : full LHC data set



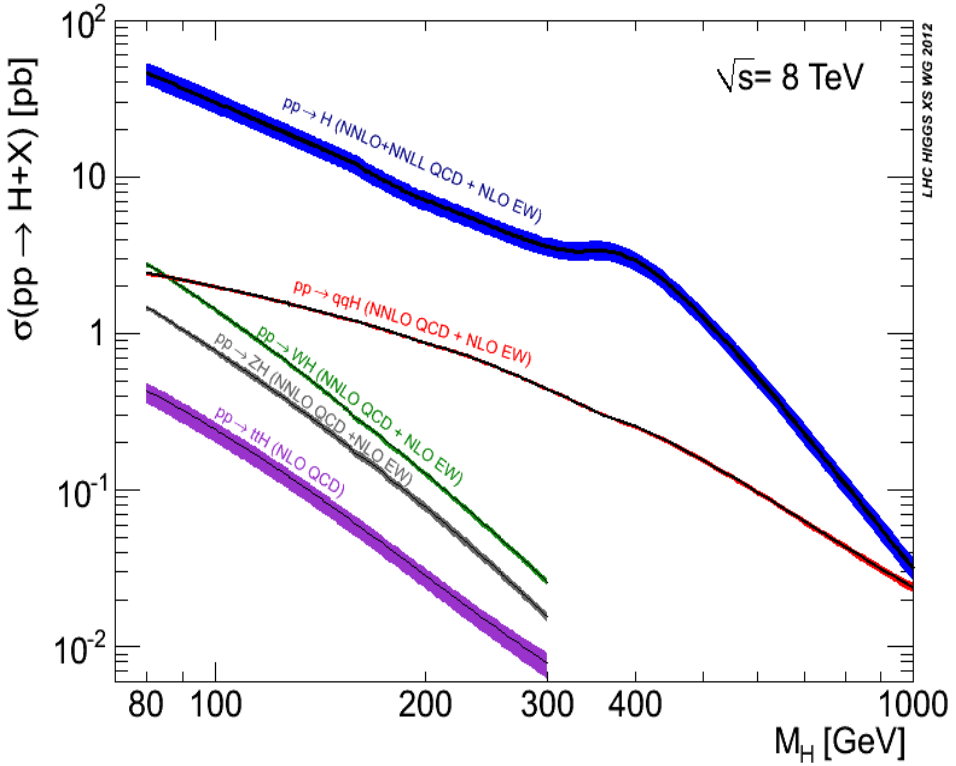
Interpretation

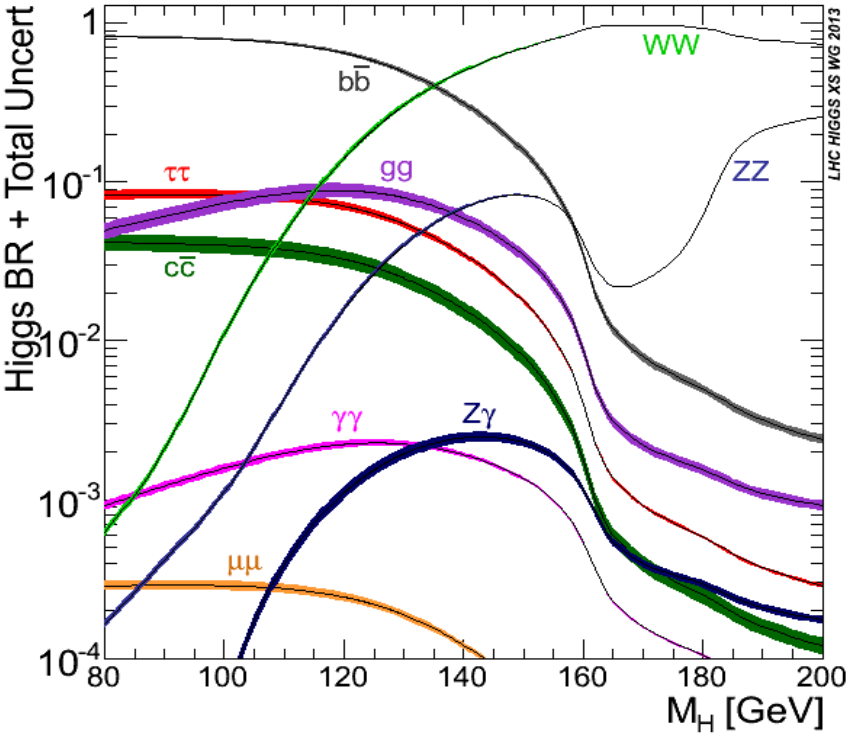
At ~125 GeV, in the Standard Model :

- $\sigma(gg \rightarrow H) = 19$ pb
- $BR(H \rightarrow \gamma\gamma) = 0.23\%$

Analysis summary:

- 550 +- 120 signal events
- $\varepsilon A \sim 0.4$
- $L = 25 +- 1$ fb^{-1}



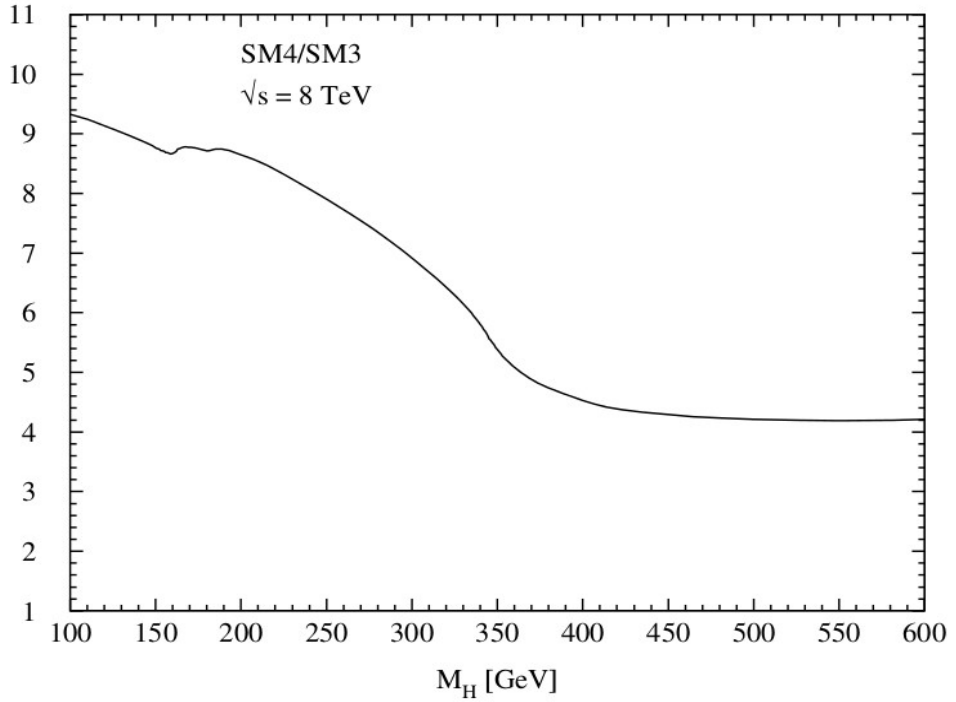


Interpretation

- How does the measured Higgs boson signal compare with the Standard Model? I.e. calculate $\sigma_{MEASURED} / \sigma_{SM}$

- Look at the following plots, taken from http://inspirehep.net/record/963361

  Can we exclude a 4th generation?



Last words

- You have seen the elaboration of the Electroweak Theory, and its experimental validation, step by step!

- The discussion was kept as simple as possible, the idea being to introduce you some very-day concepts in High Energy physics:
  - relating theory and experiment
  - exploiting data statistically
  - Final states in lepton and hadron colliders
  - ...

- I hope you enjoyed, and I hope to see those of you who will choose this field sooner or later in our big laboratories.

- If you have questions you can always mail me: maarten.boonekamp@cern.ch