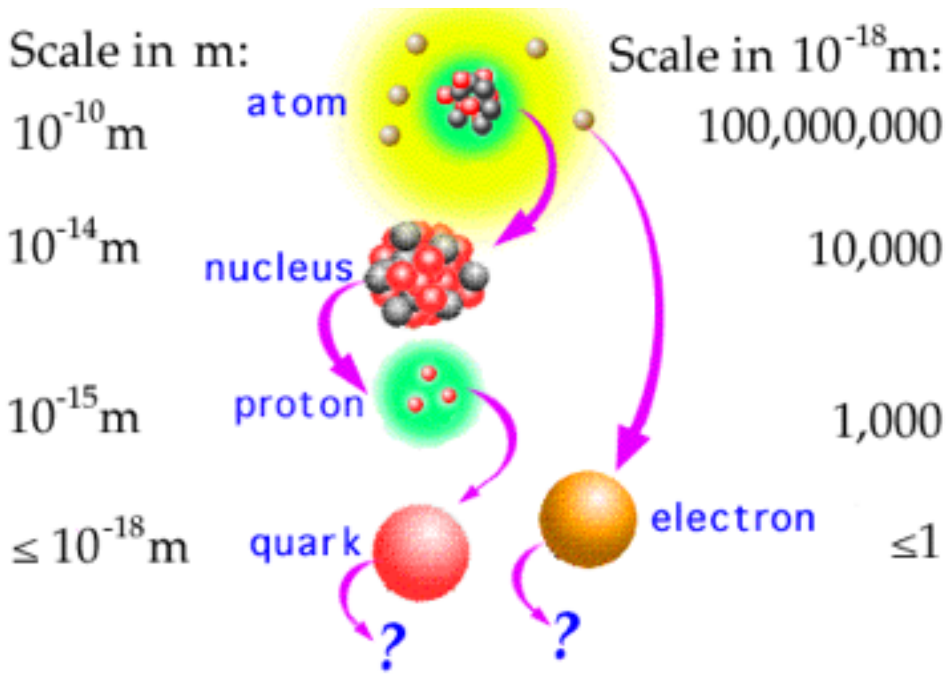
The Higgs boson - a first of its kind?

Liron Barak

CERN

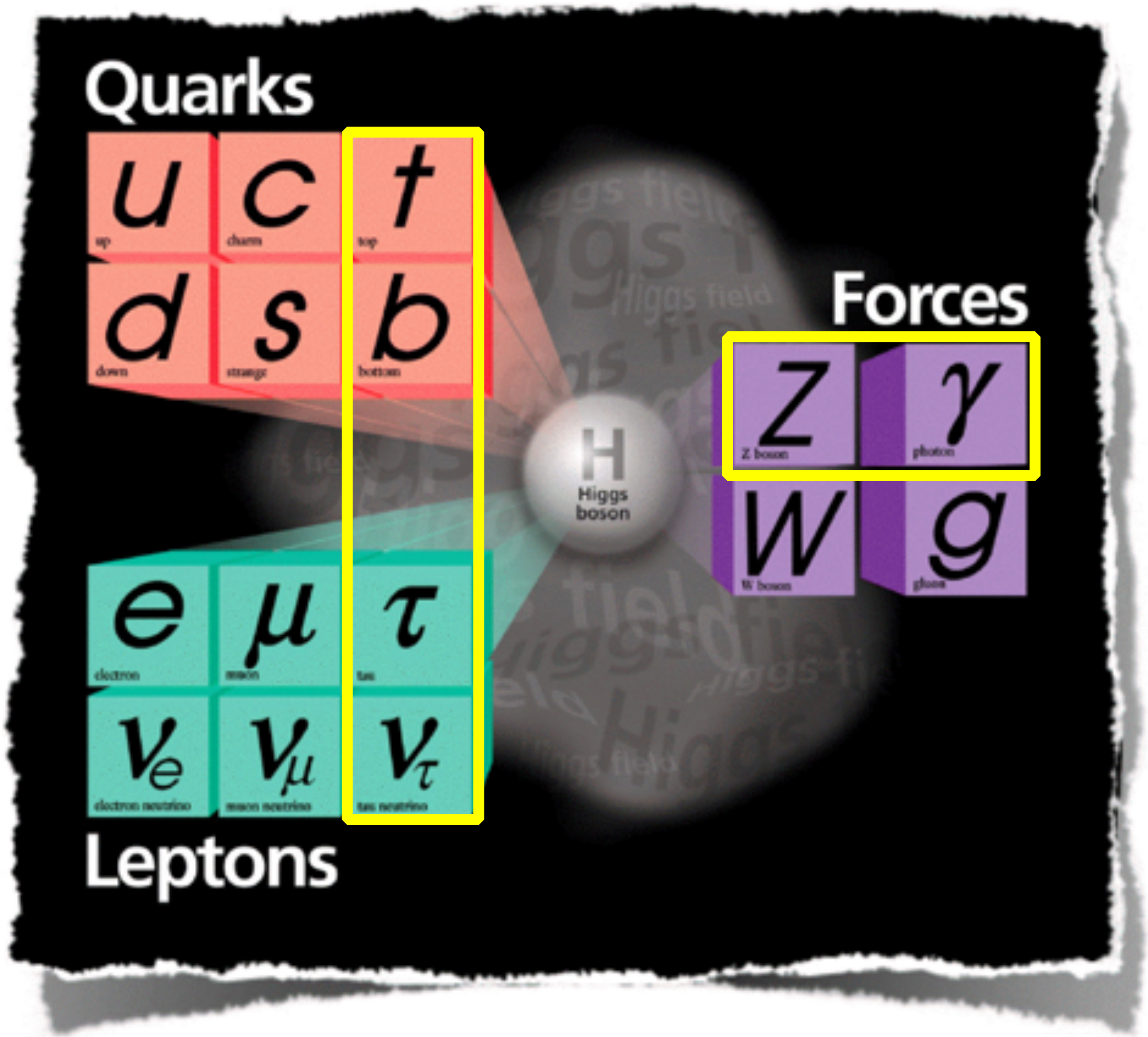
High Energy Physics

- Probing matter with very high energy in order to study the particles that made the universe.
- In the LHC, we can probe for the first time the highest energy ever (100GeV-1TeV) and the smallest distance ever (10^{-18}-10^{-19}m).



Particle Content

SU(3)×SU(2)×U(1)

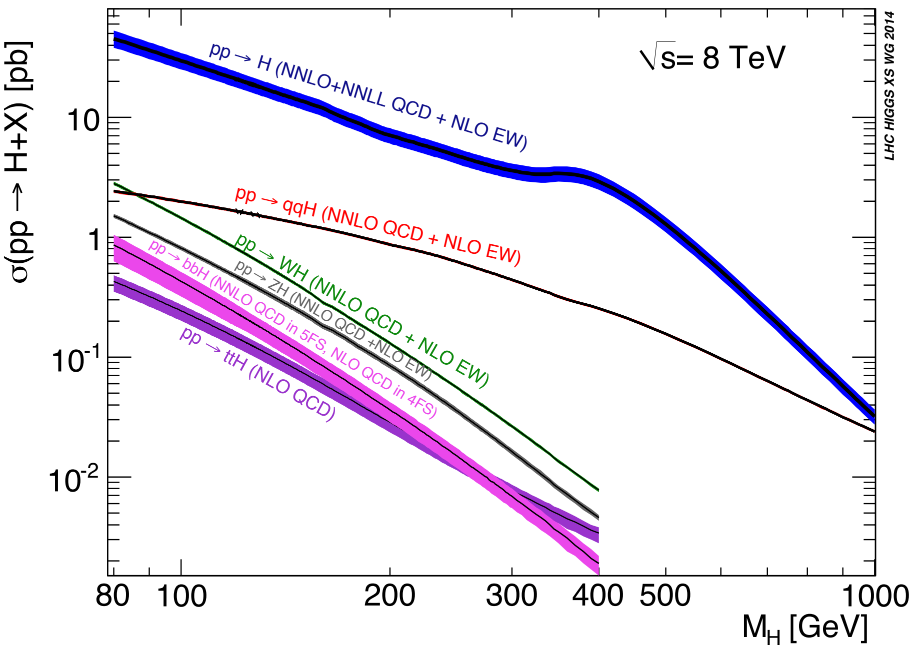


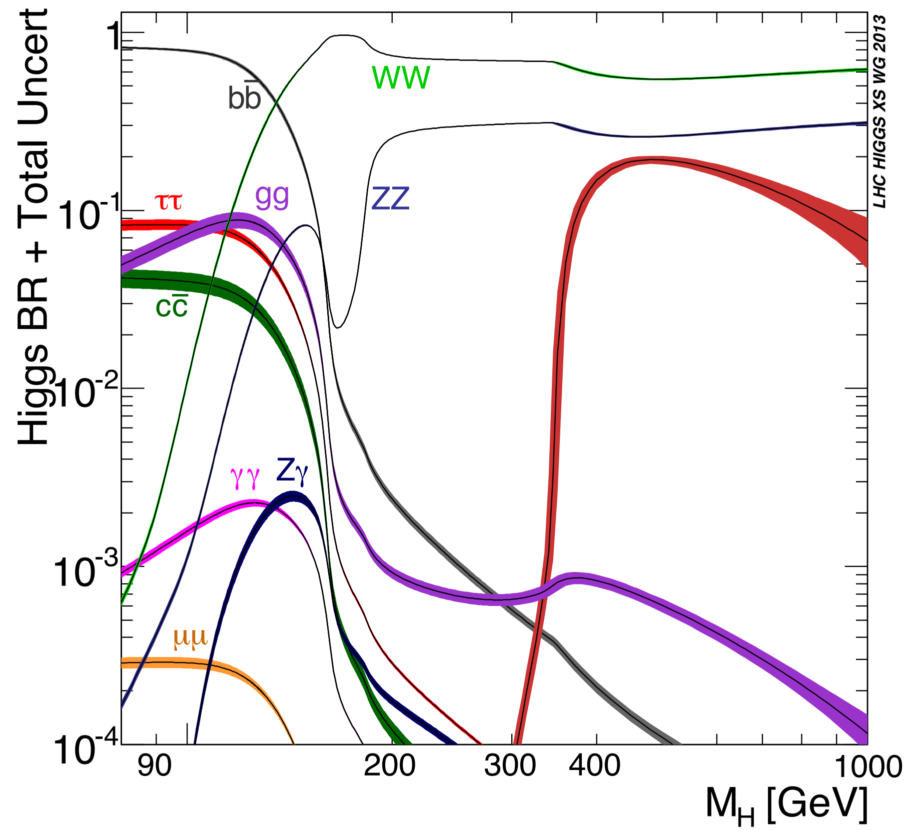
The Higgs Boson

Made by God, 0.0000000001 sec AB ©:

Theory Inputs

- XS and BRs

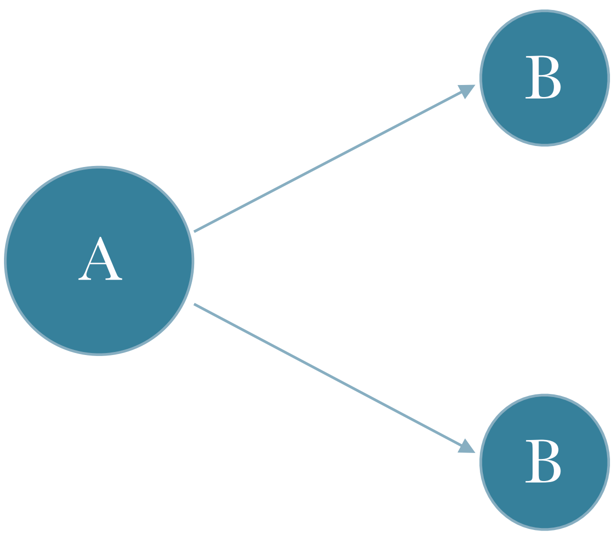




Needle in the Haystack

Bump Hunter (H->γγ)

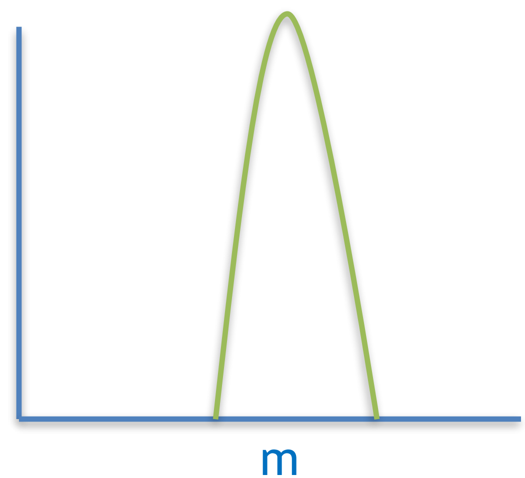
- Hunting a new short lived particle means looking for a bump in the invariant mass ($m_{inv}^2 = (p_1+p_2)^2$) distribution of its decay products.
- The significance of the bump must be high enough to make a statistical fluctuation of the known background highly unlikely.



$$\boxed{m_A^2 = p_A^2}$$

$$\boxed{p_A = p_B + p_C}$$

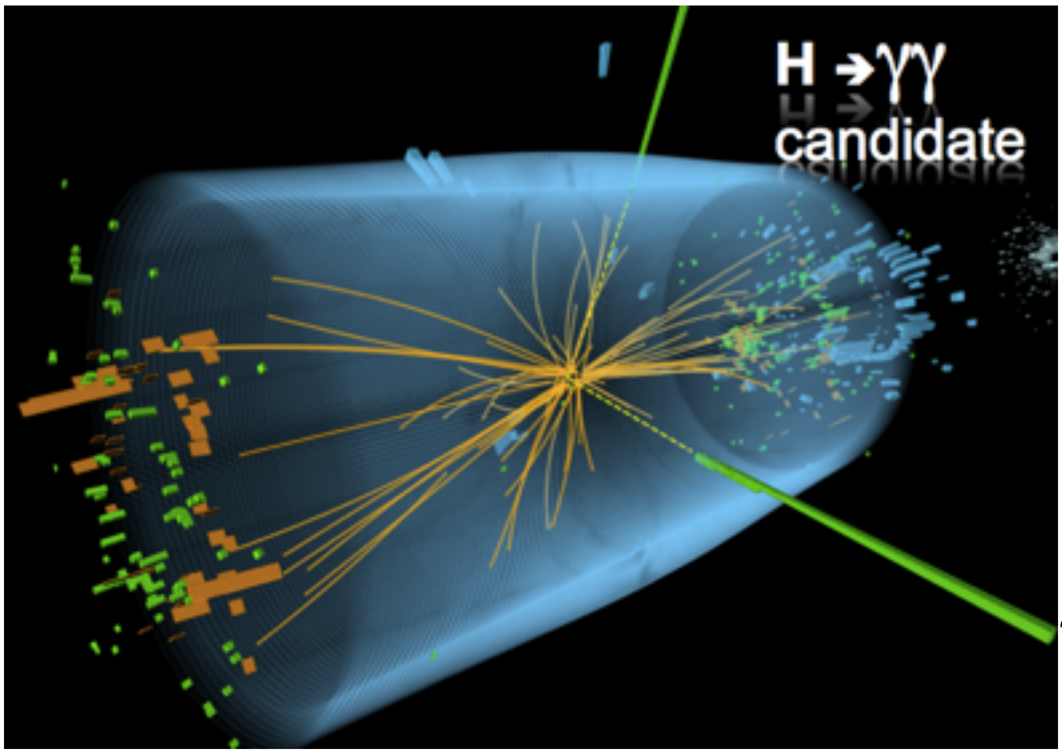
$$\boxed{m_A^2 = (p_B + P_C)^2}$$



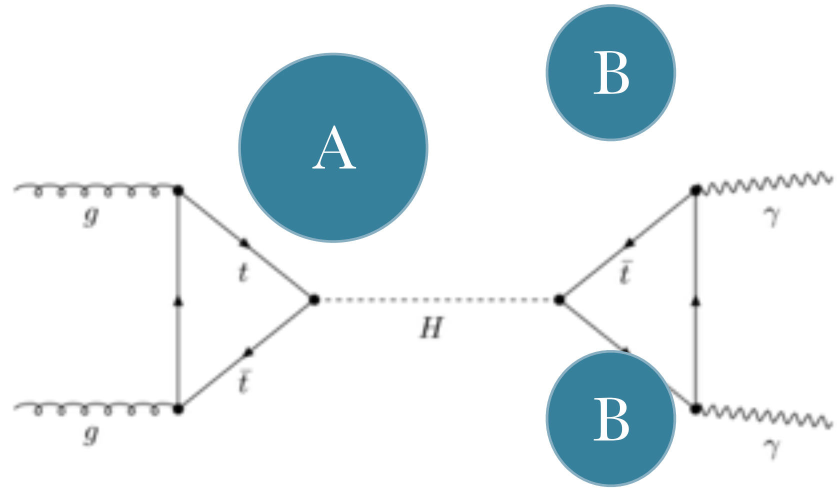
Bump Hunter (H->γγ)

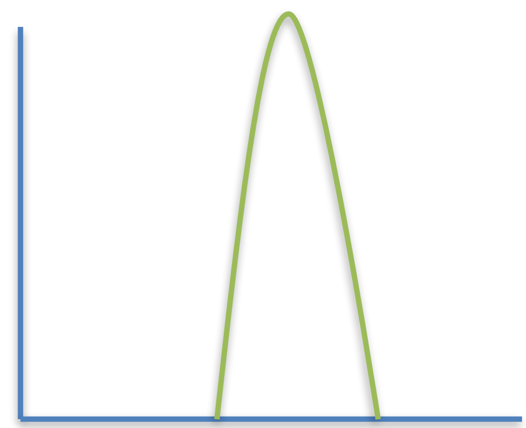
- We have two photons.

γ



γ



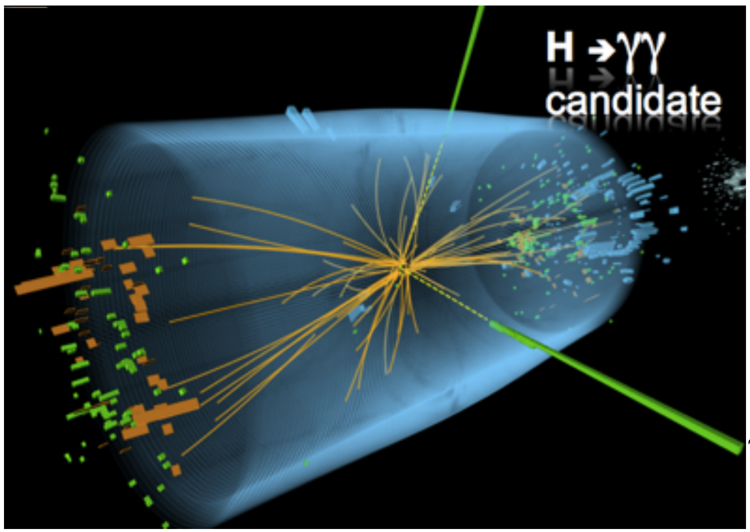


m

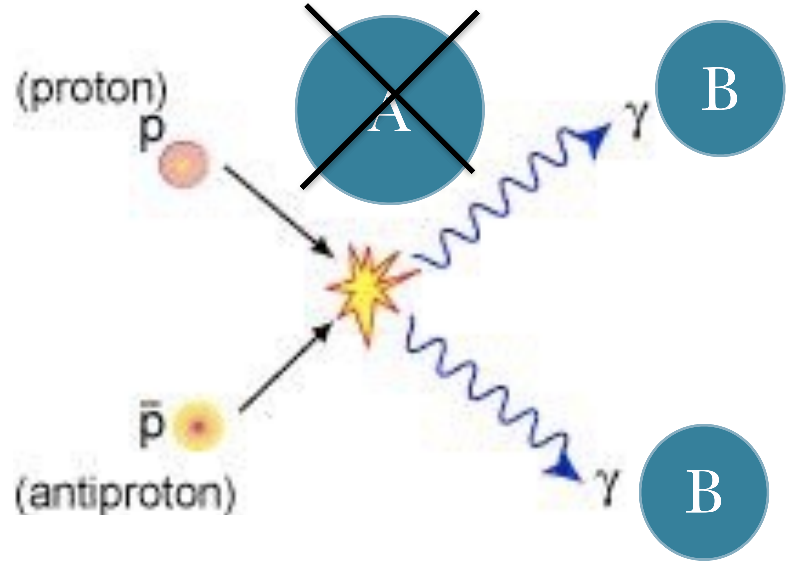
Bump Hunter (H->γγ)

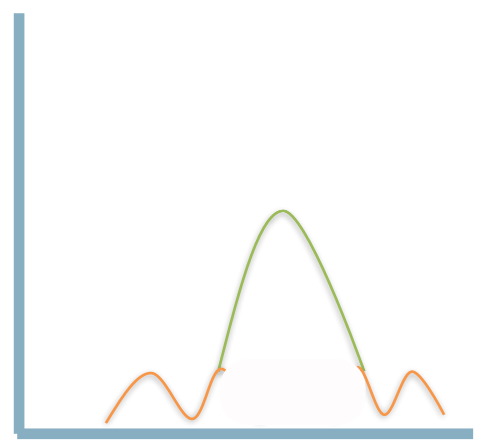
- We have two photons in the background too:

γ



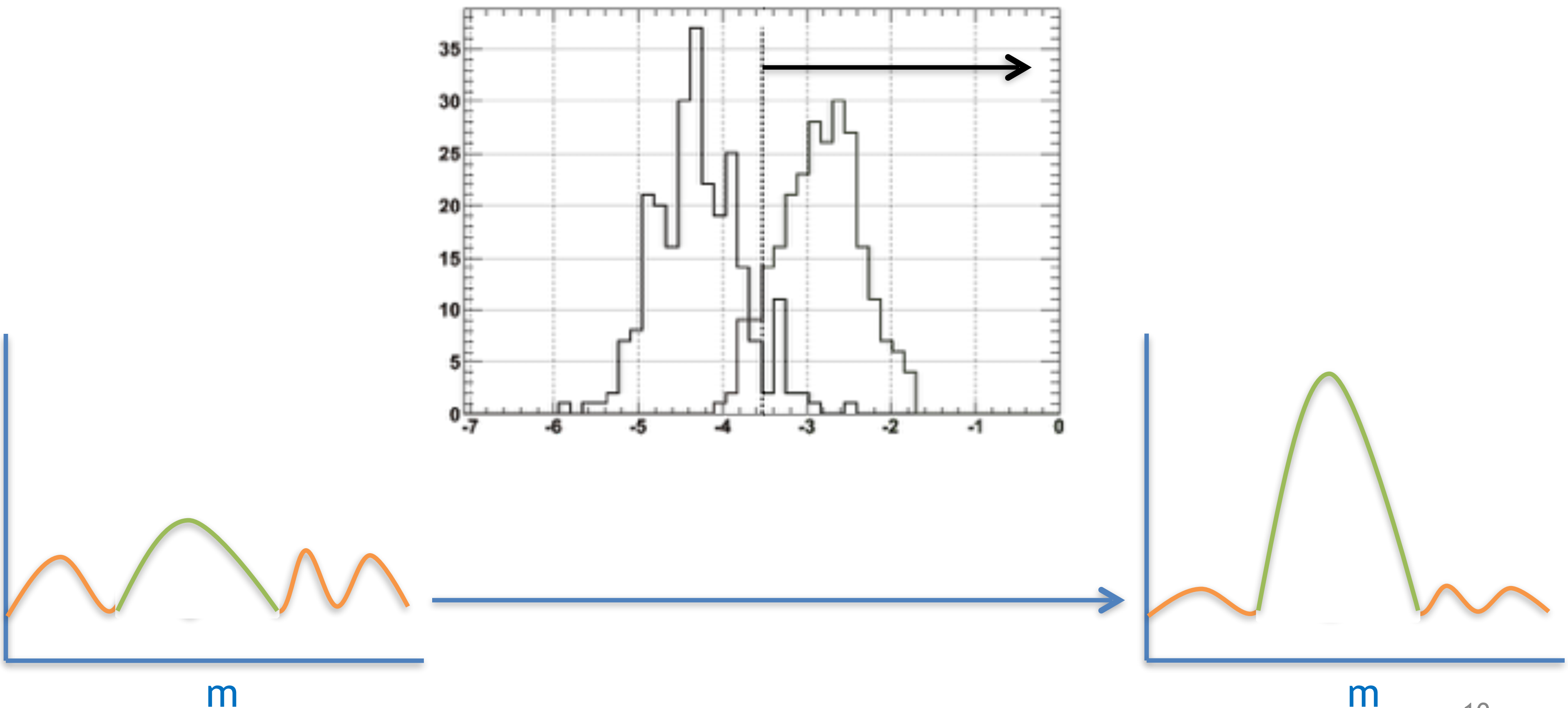
γ





What should we do?

- Identify discriminating variables to suppress our backgrounds.



H->$\gamma\gamma$

- How did we do it? https://twiki.cern.ch/twiki/pub/AtlasPublic/HiggsPublicResults//Hgg-FixedScale-Short2.gif

H->γγ

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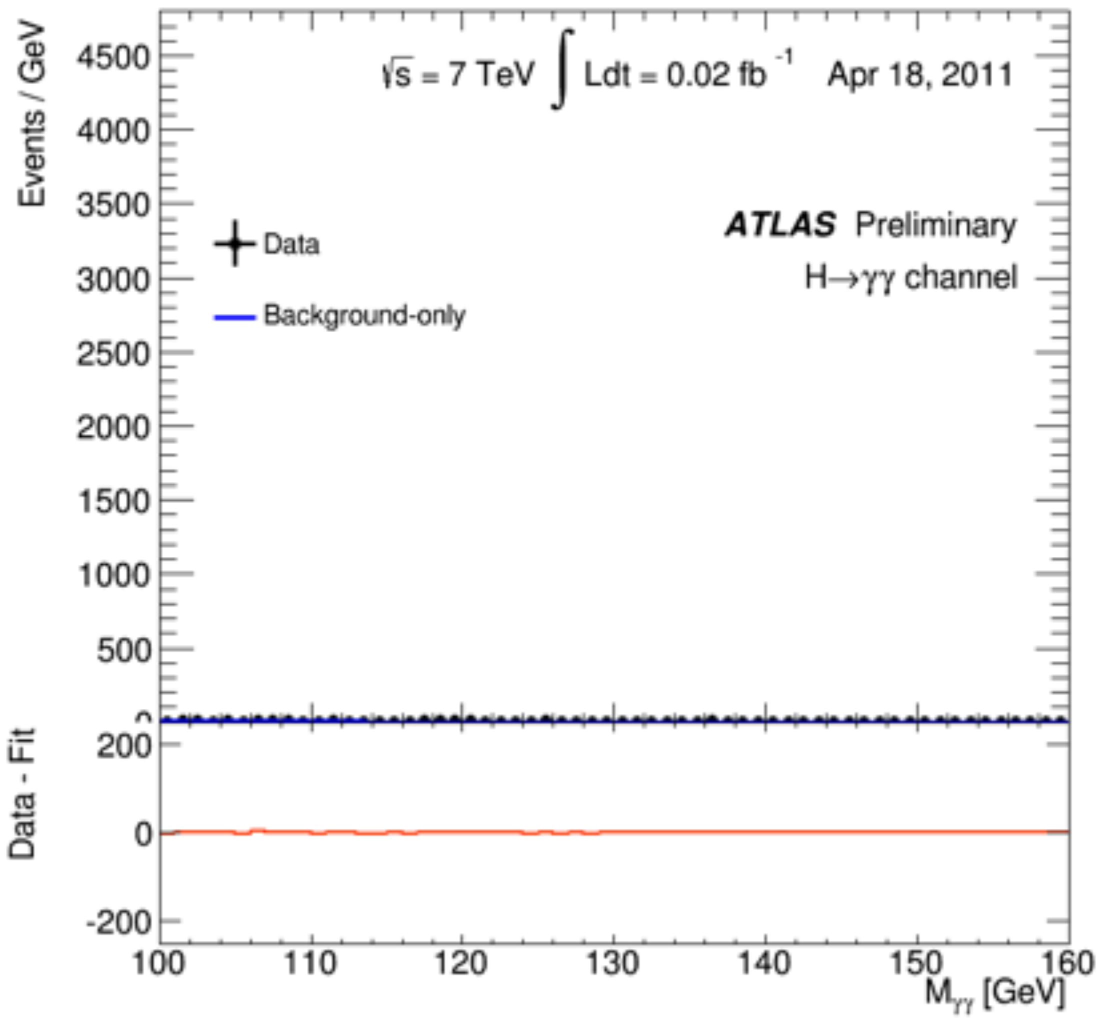
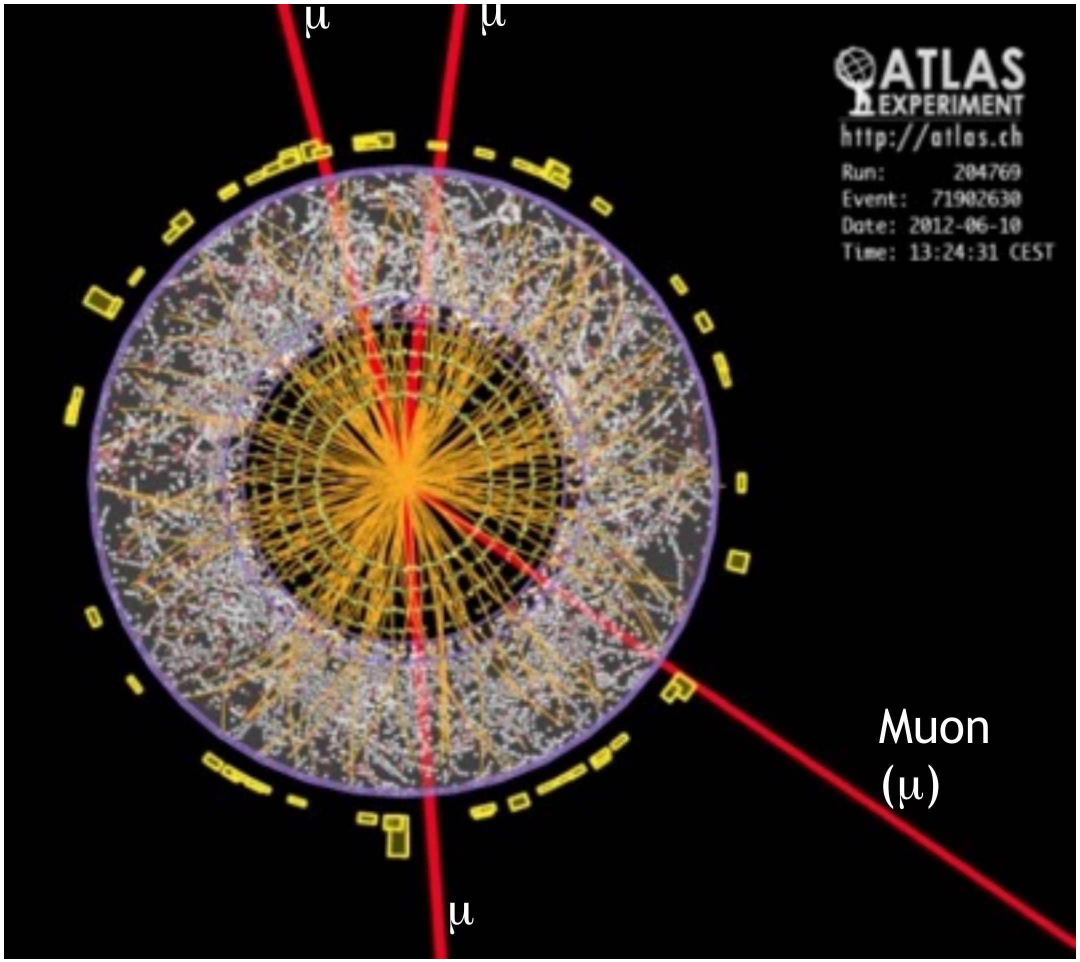
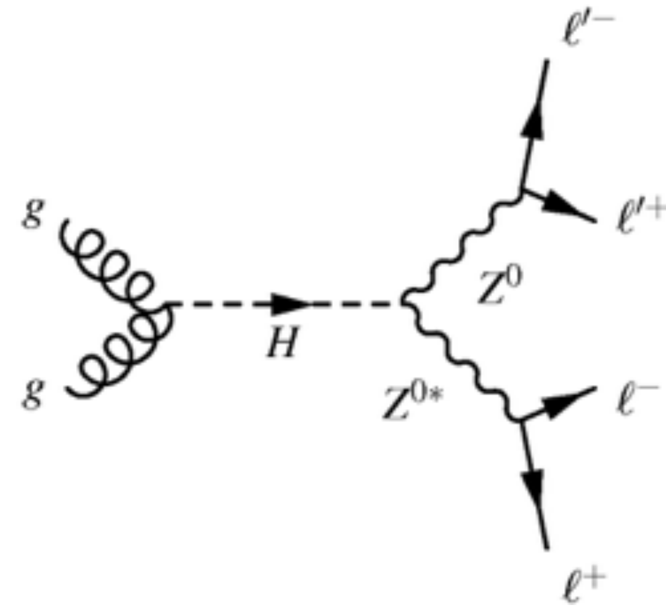


The Golden Channel

- H->ZZ events in ATLAS





The Golden Channel

- How did we do it? https://twiki.cern.ch/twiki/pub/AtlasPublic/HiggsPublicResults//4l-FixedScale-NoMuProf2.gif

The Golden Channel

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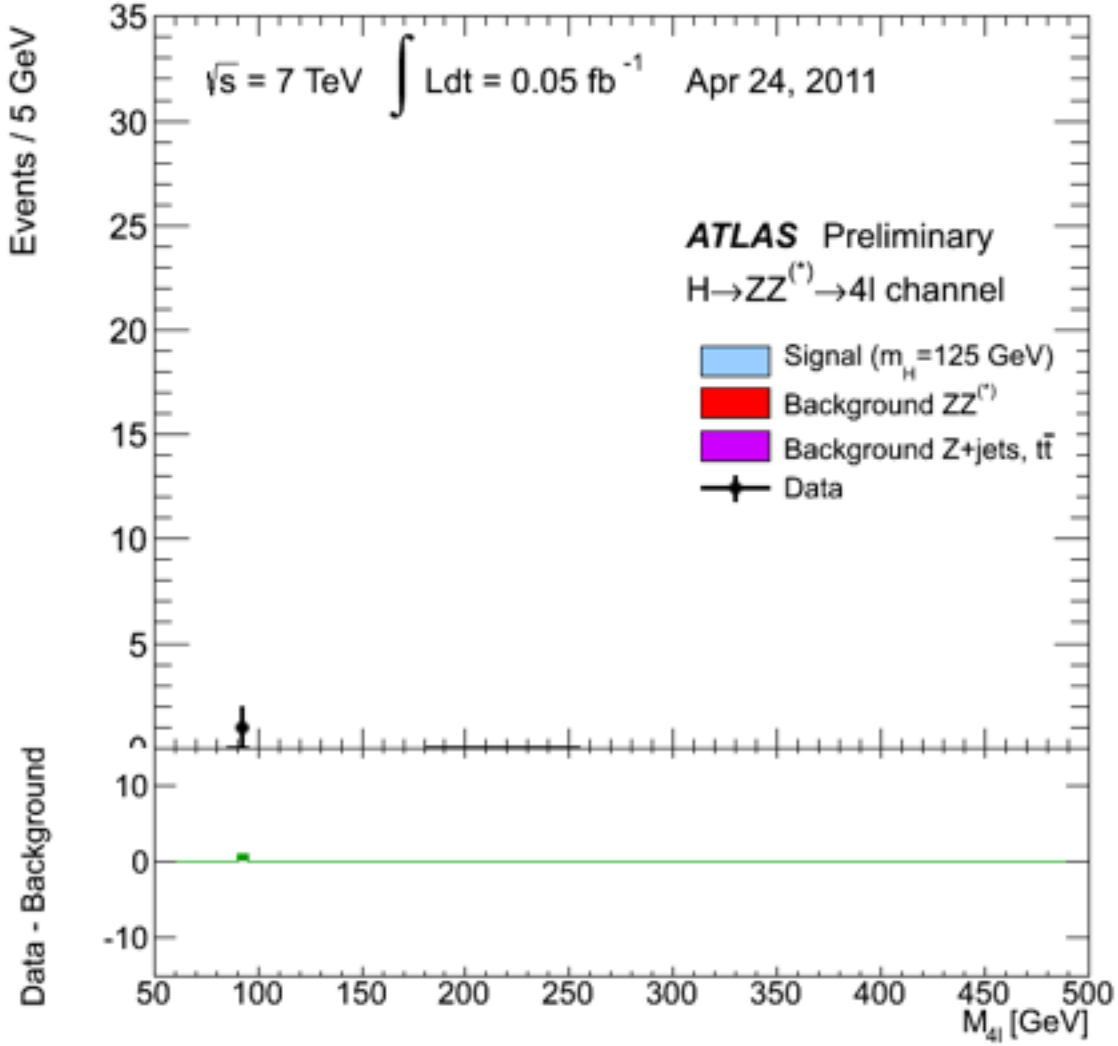
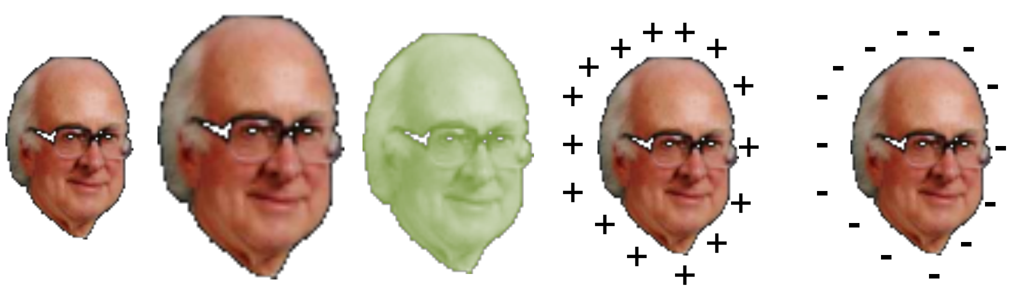


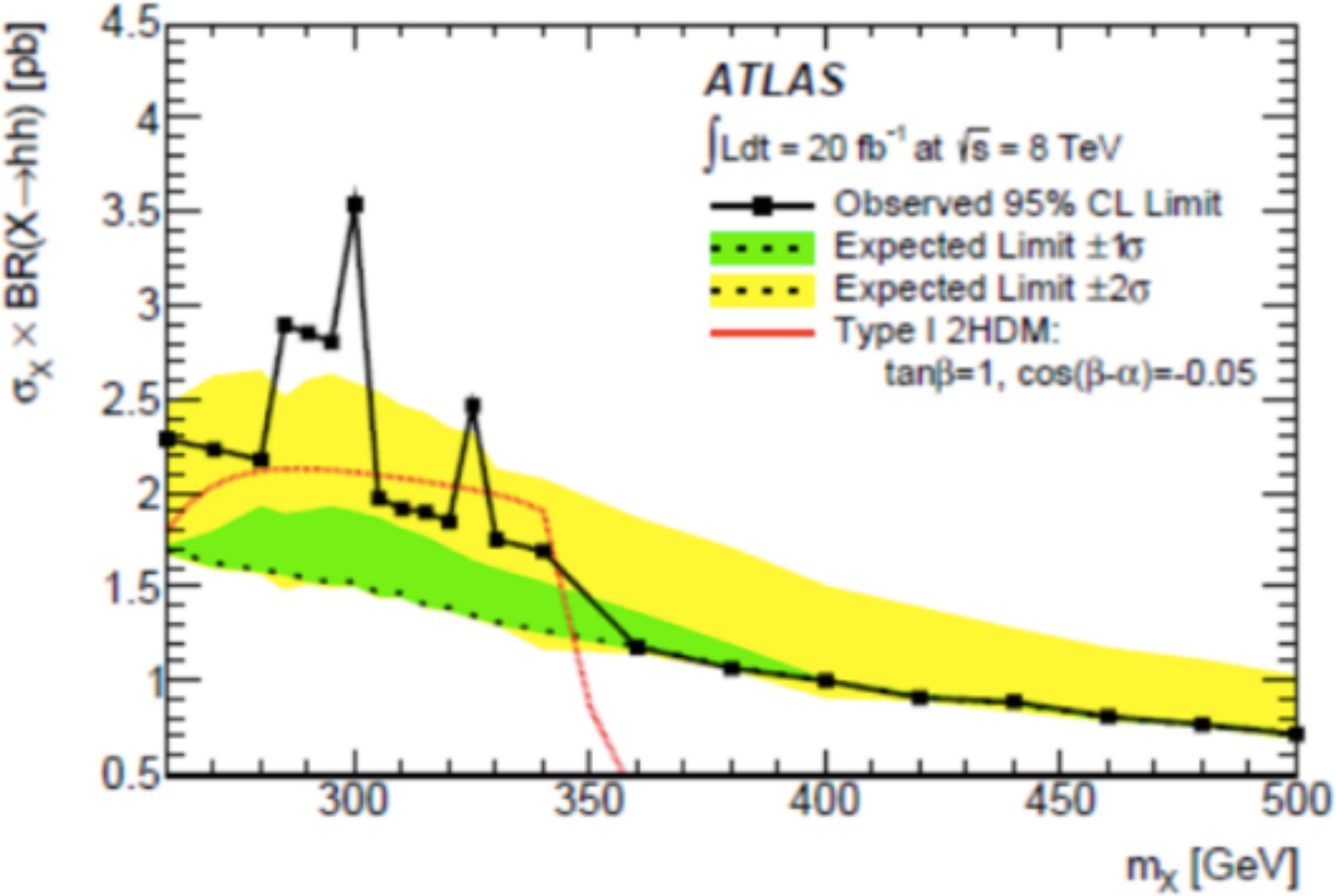
The Glory Day

Beyond the Standard Model

- Problems in the Standard Model (Neutrino mass, dark matter…).
- Fermions come in three families, why only one Higgs family?
- With two Higgs families, five states; Charged Higgs – the smoking gun.



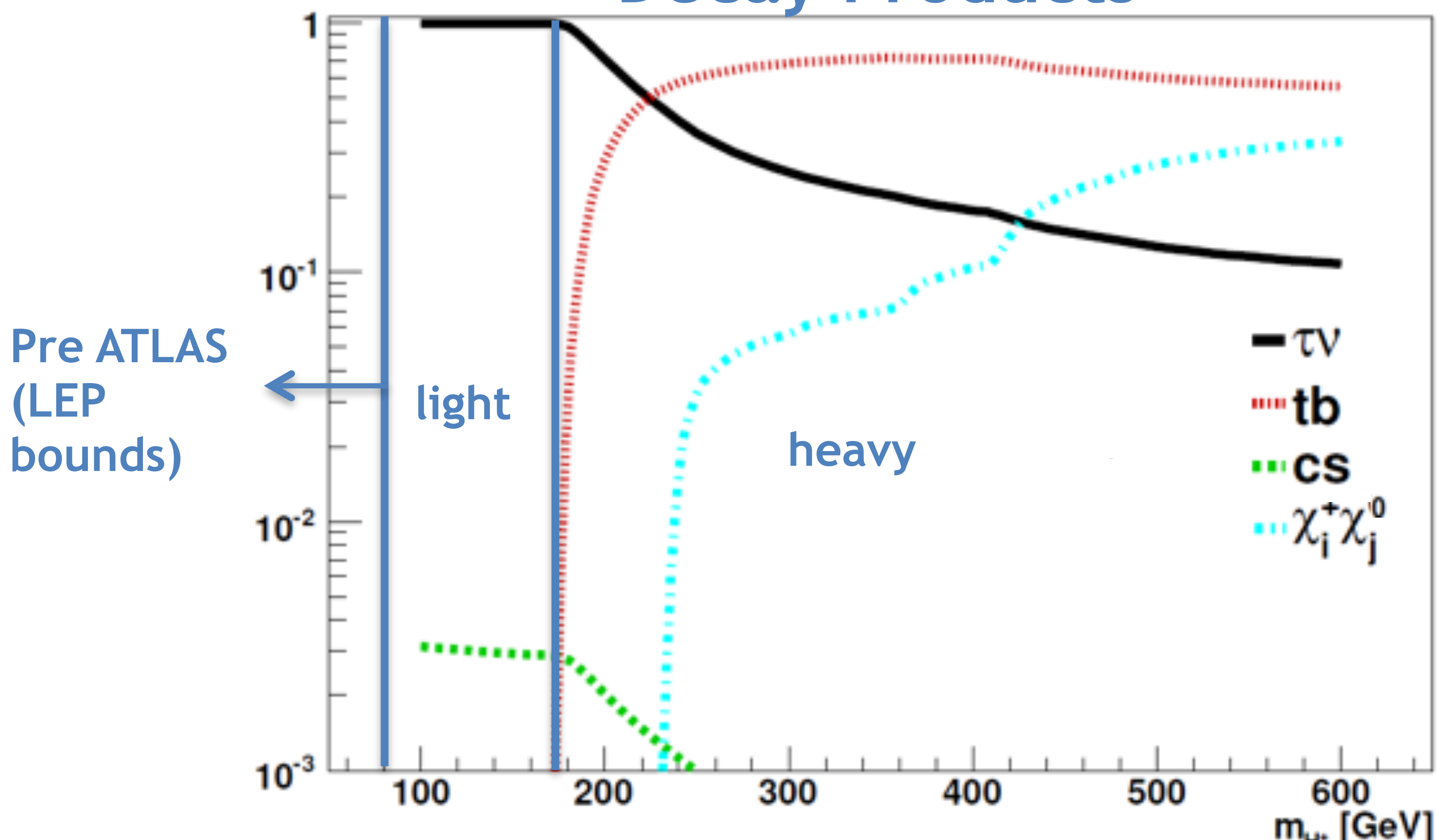
Motivation from Run1



Charged Higgs

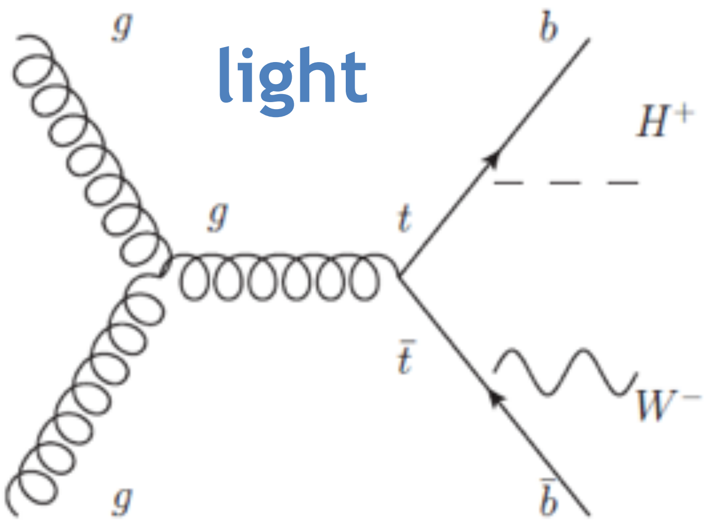
- How to find it? Depends on its mass.

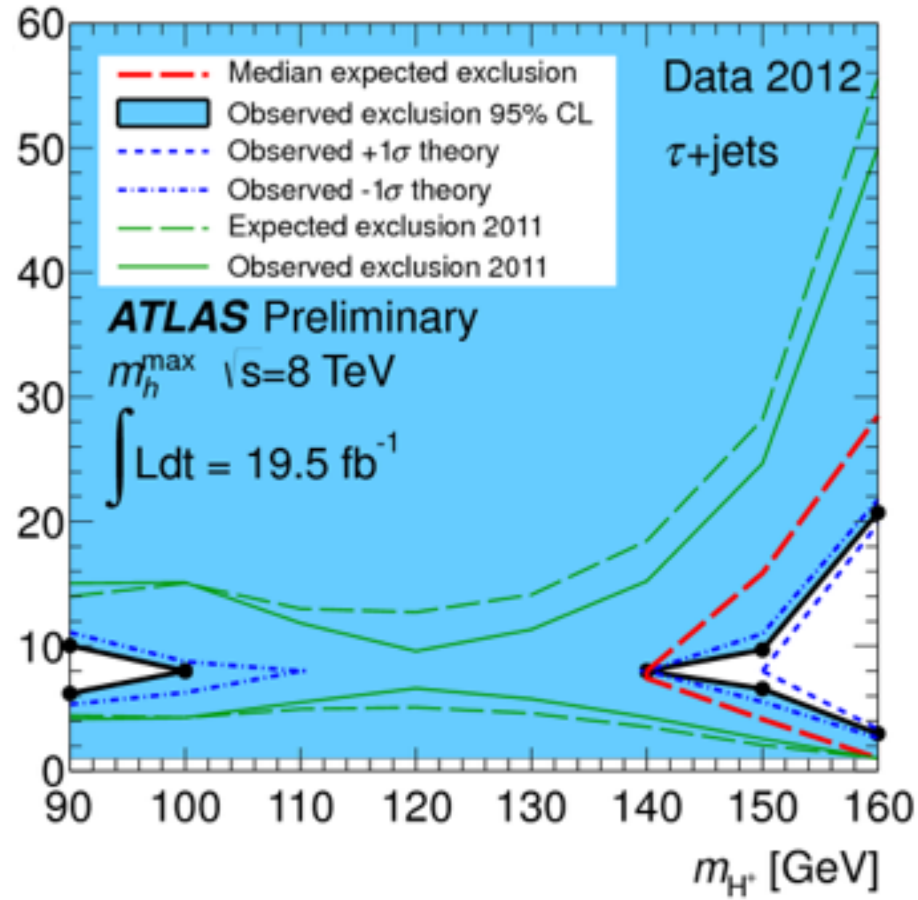
Decay Products



Light Charged Higgs

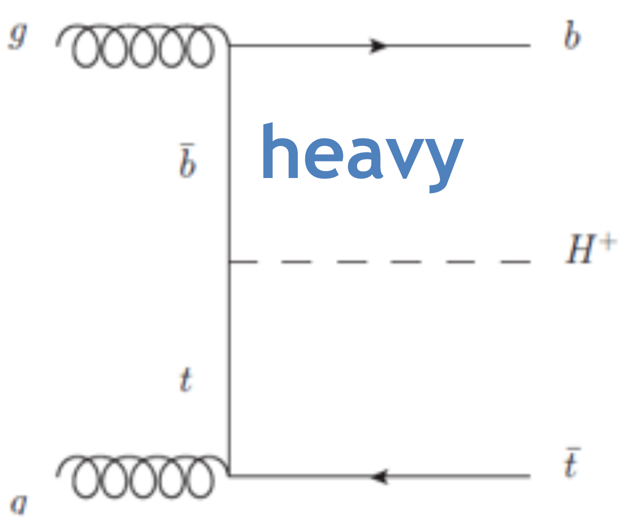
- How is it produced?

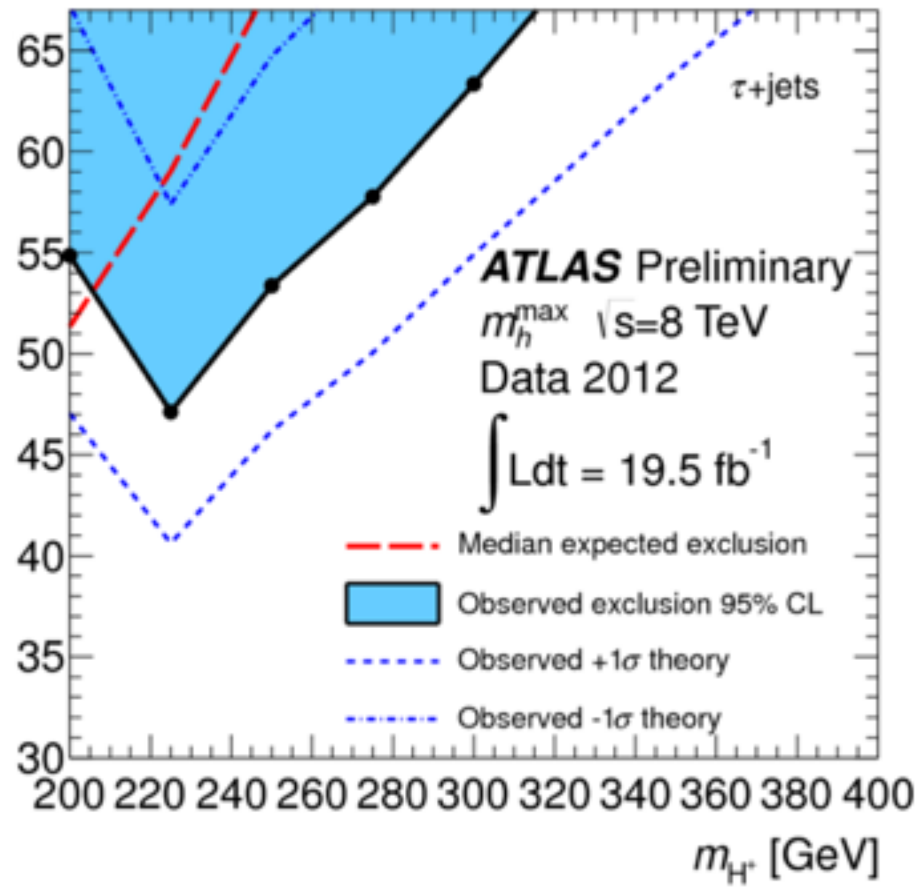




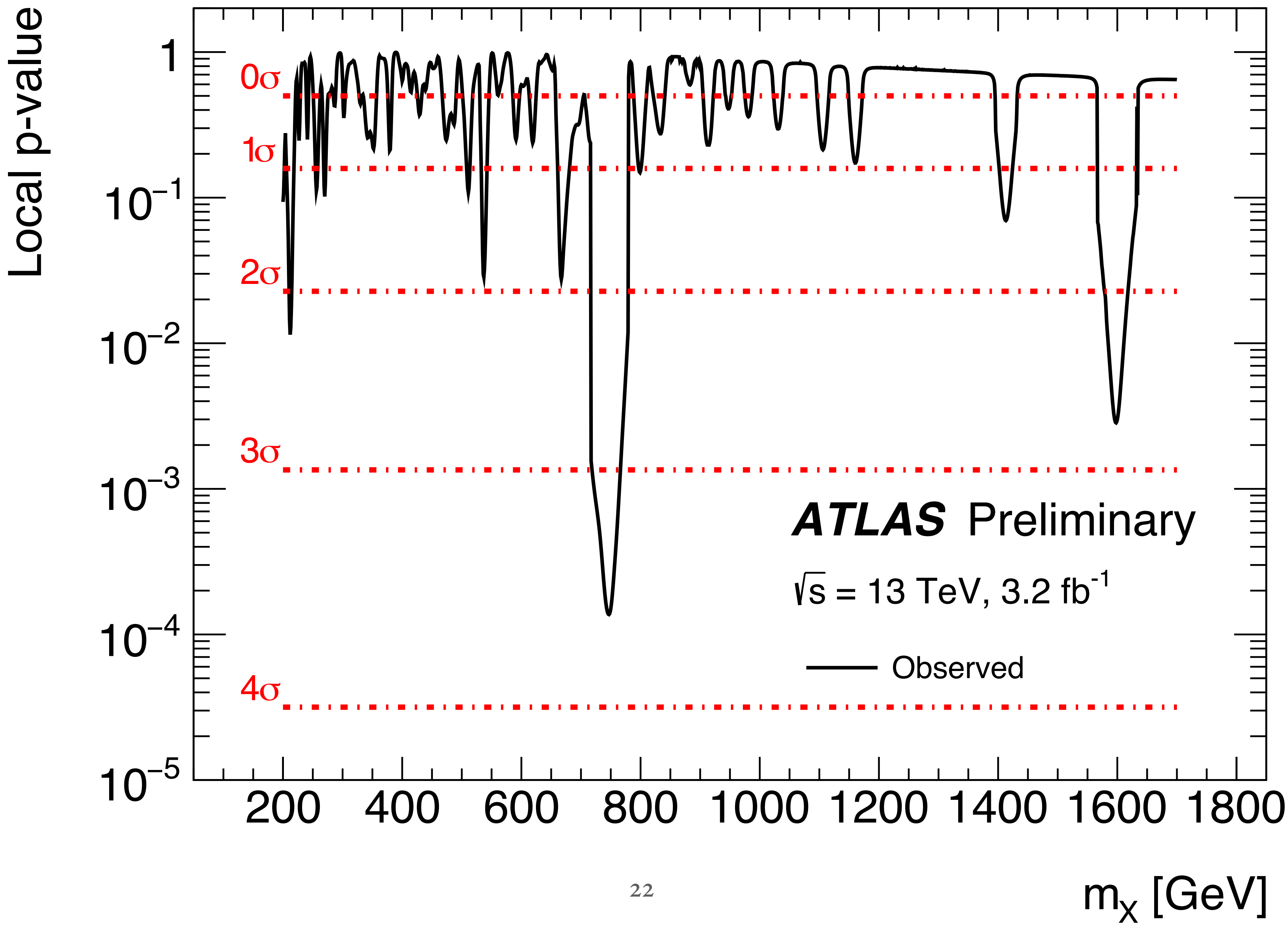
Heavy Charged Higgs

- How is it produced?



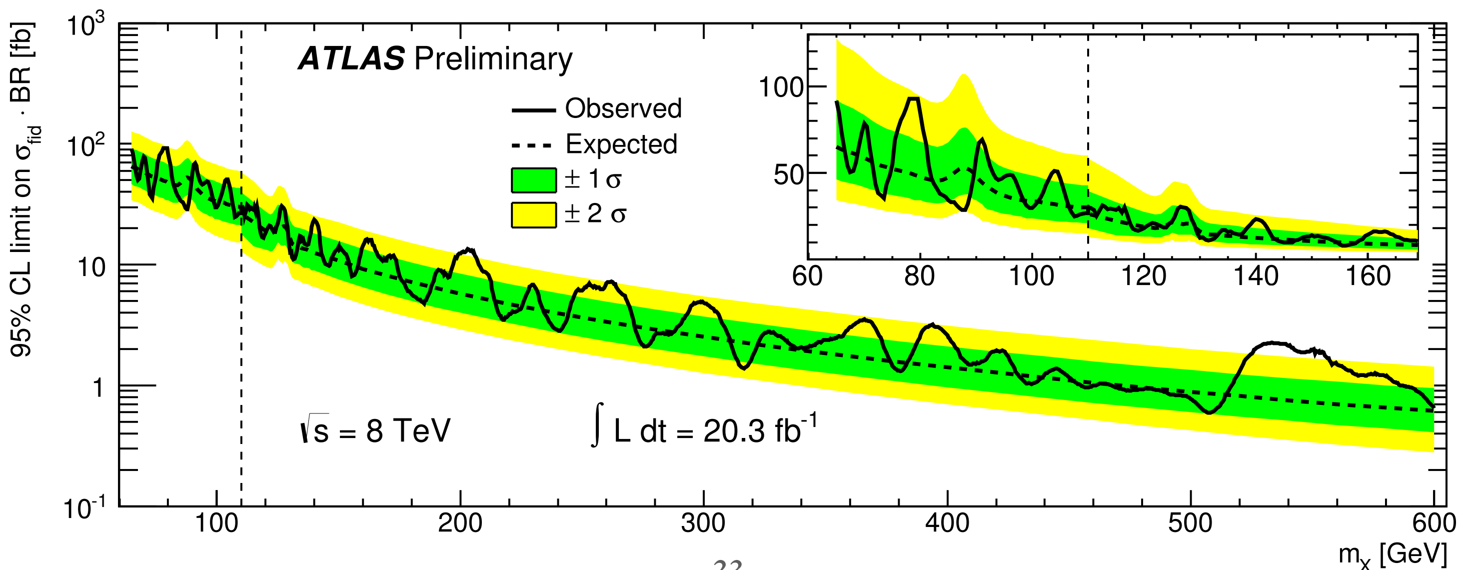


Getting there....



Recap

- Run1 (65-600GeV):
  - Two regions: low mass (65-110GeV) and high (110-600GeV). Extending the SM Higgs search that was done form 100-160GeV.



?

Run 2

- Changes from run1 to run2:
  - New energy, upgraded detector ->
    Re-optimization of the cuts (pT, isolation -> BG reduction).
  - Improving analysis:
    - Background modelling.
    - Signal parametrization.

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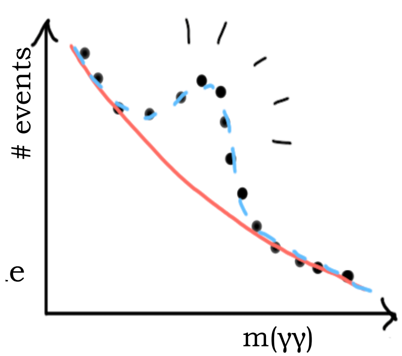

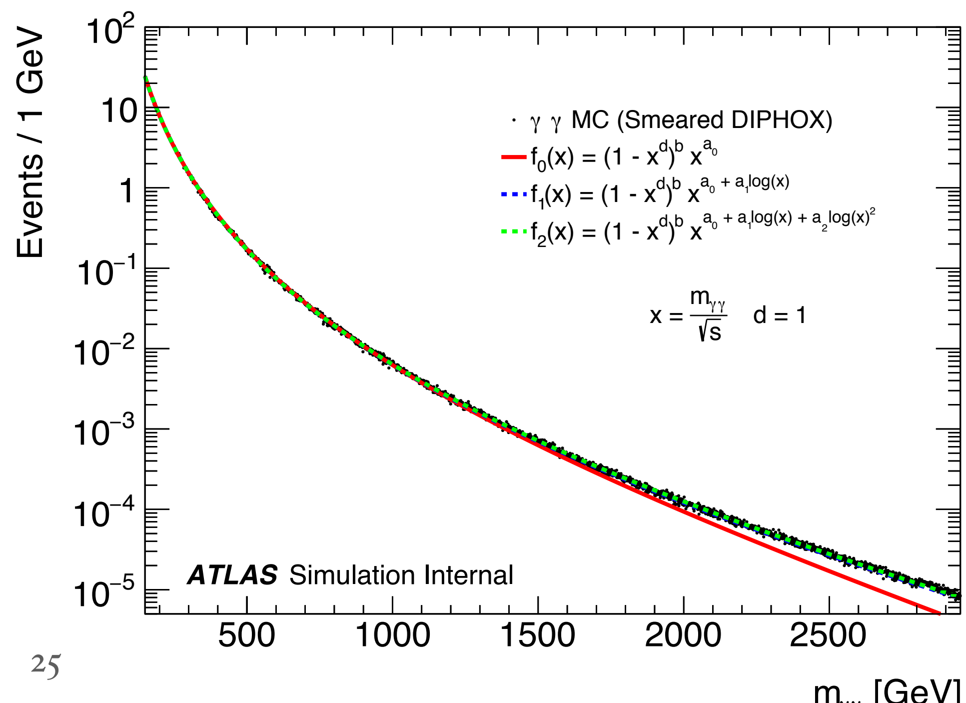

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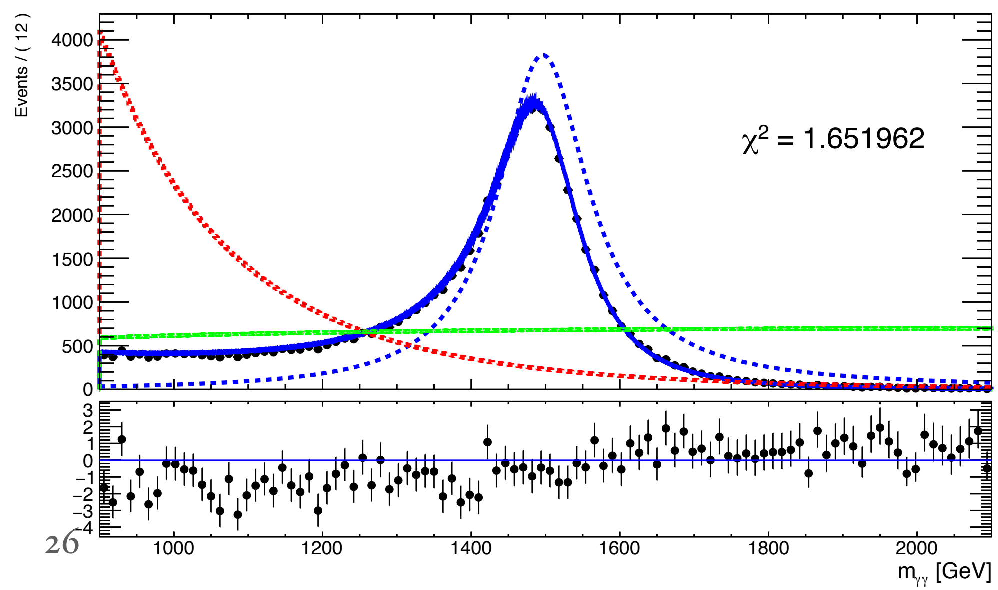
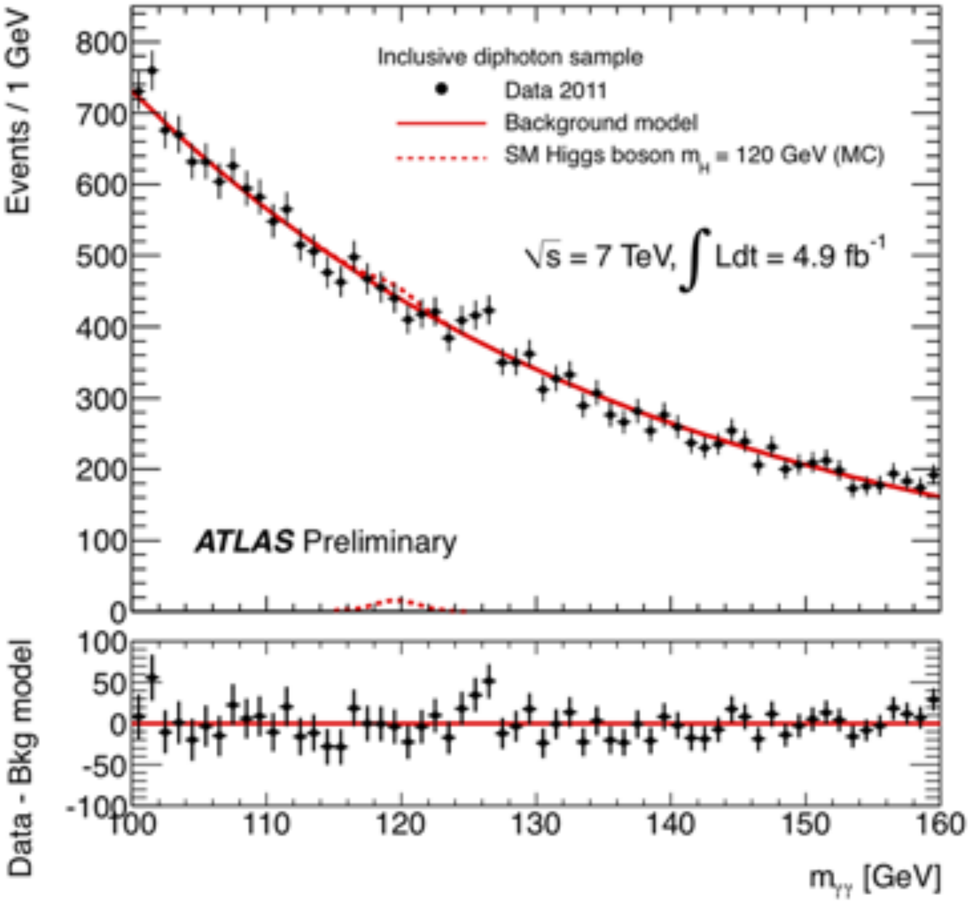
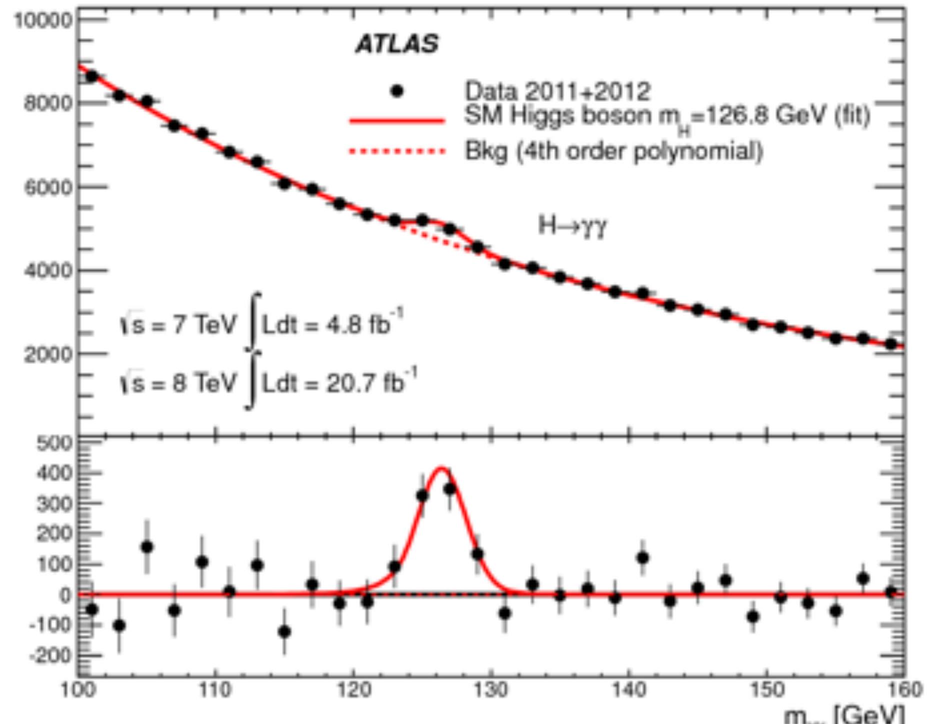


Mass spectrum





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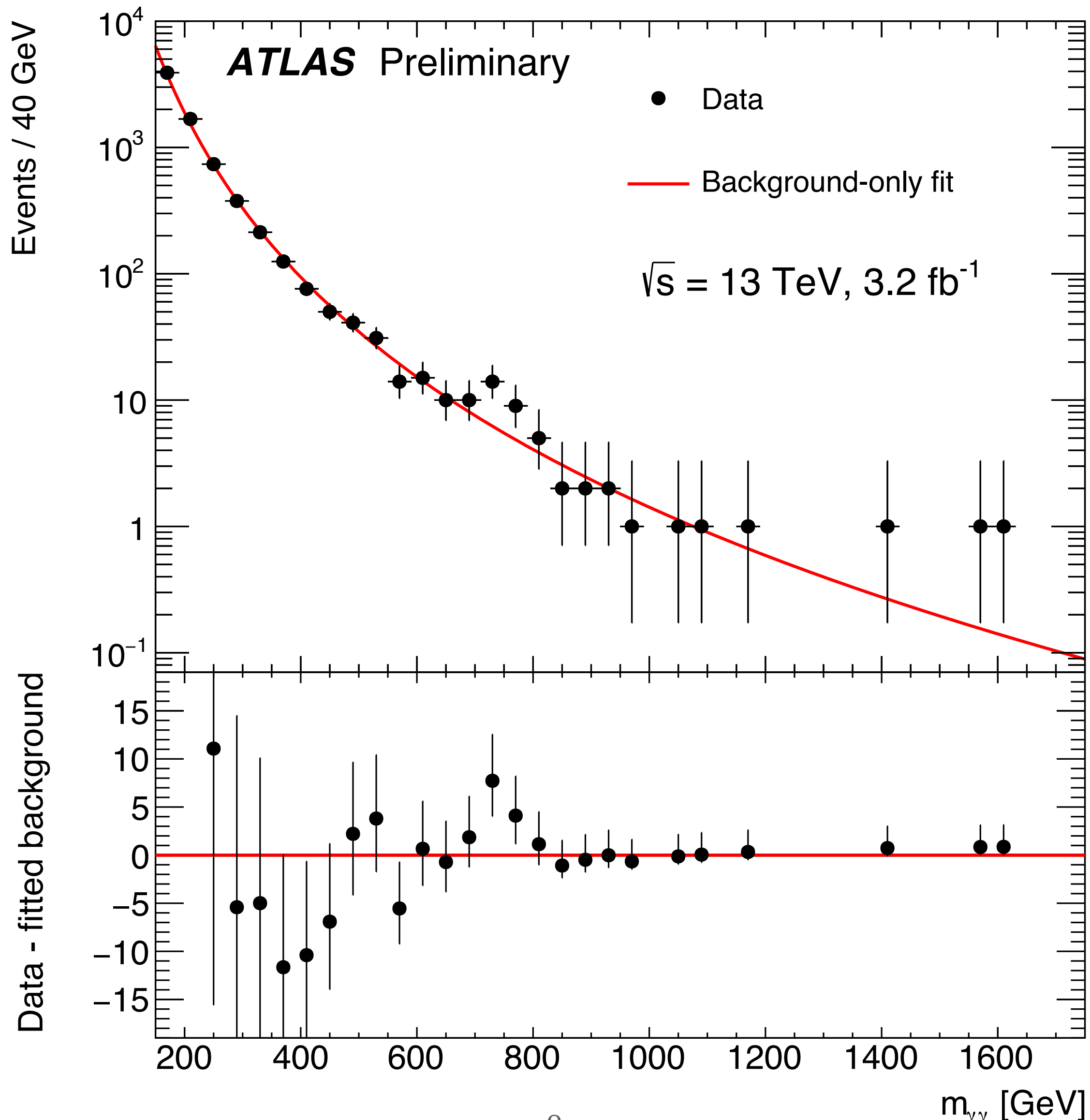
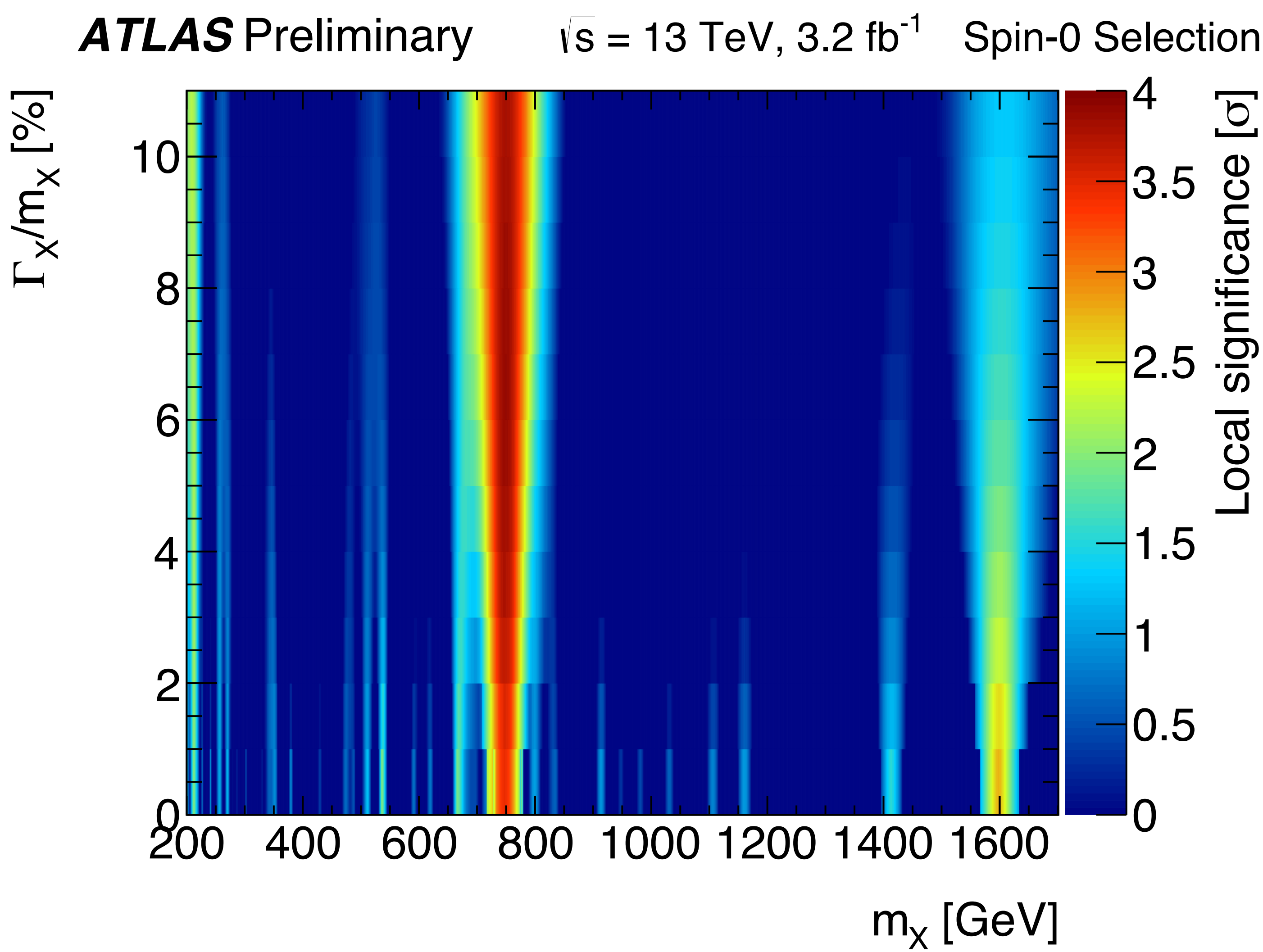


Final Result



THANK YOU
FOR YOUR ATTENTION