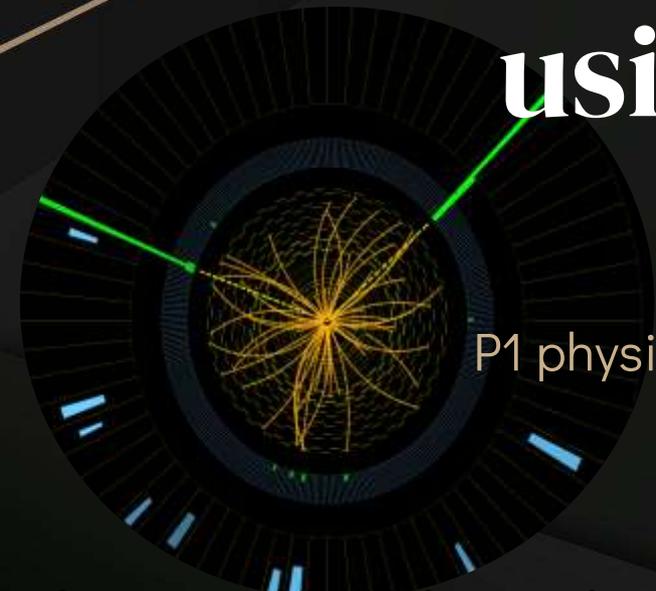
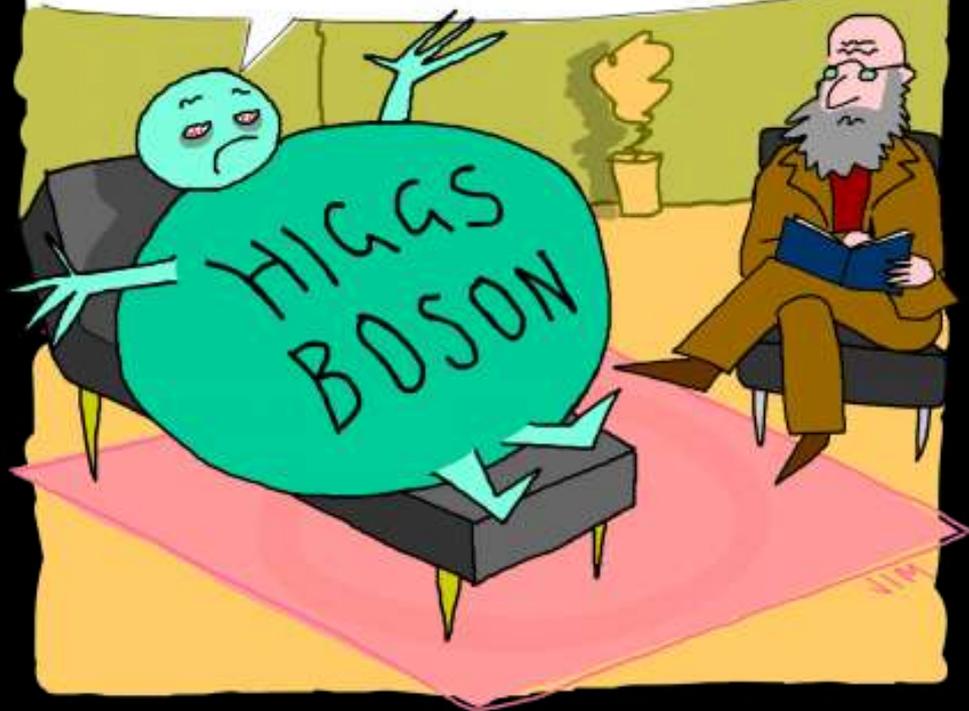


# Discovering the Higgs boson in $H\gamma\gamma$ decay channels using the ATLAS open data

P1 physics project – Serbian HSSIP in CERN



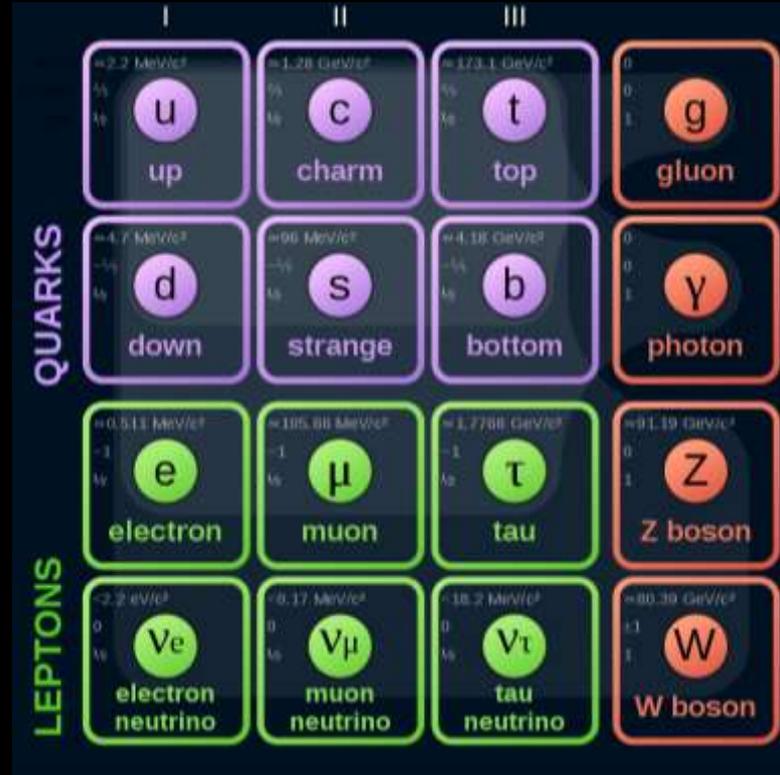
NOBODY UNDERSTANDS ME!





# Standard Model – What Is Missing?

- ▶ Elementary particles
- ▶ What is the world made of?
- ▶ Origin of mass?
- ▶ Why is there such a difference in mass between the electron and top quark?



# 1964 - Birth Of The New Theory

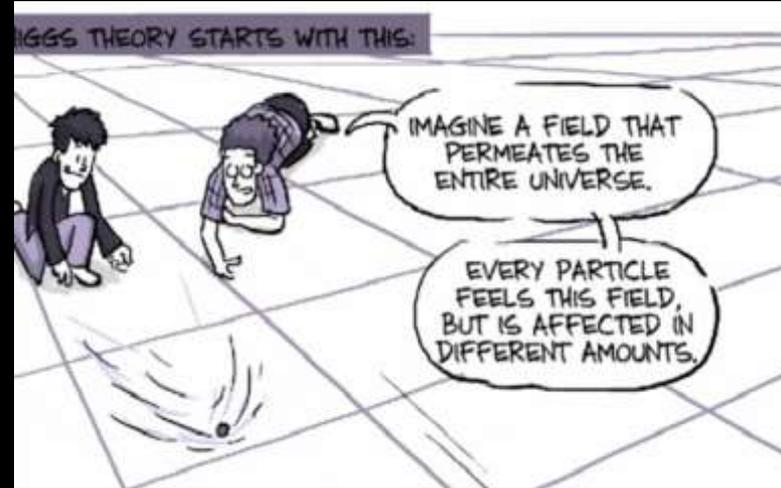
Peter Higgs



Francois Englert

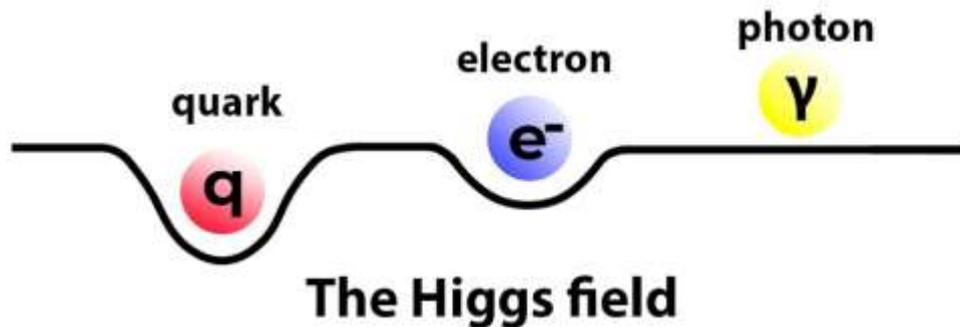


Robert Brout

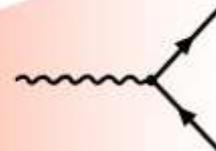


- Theoretical solution for the origin of mass
- Interaction is proportional to the mass

# The Higgs boson



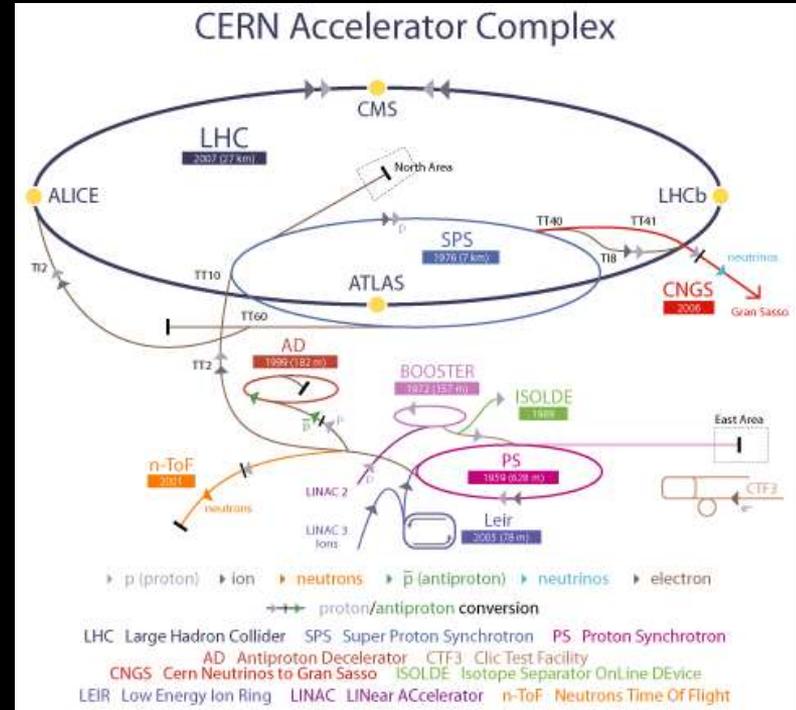
QUANTUM FIELD THEORY



# 2011 - LHC Comes To The Rescue

- ▶ LHC - The first collisions were achieved in 2010
- ▶ One of the goals is to confirm or refute the Higgs theory
- ▶ Higgs discovery – 2012
- ▶ Why did it take 48 years to find?

What did we need for this research?

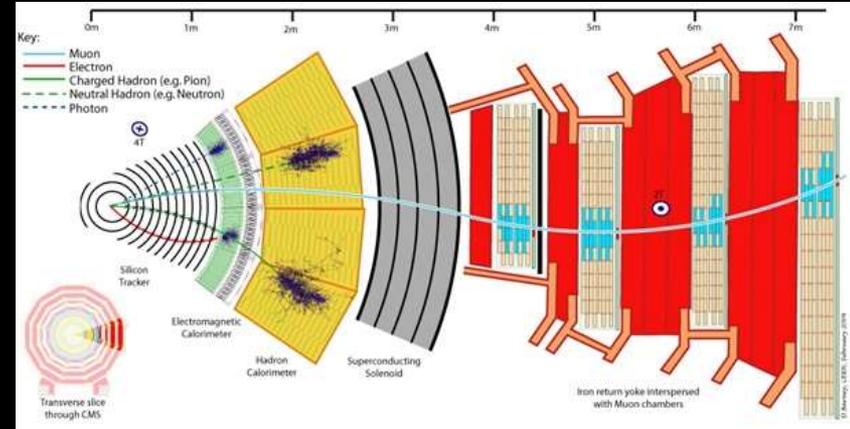


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## Detectors



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Computing



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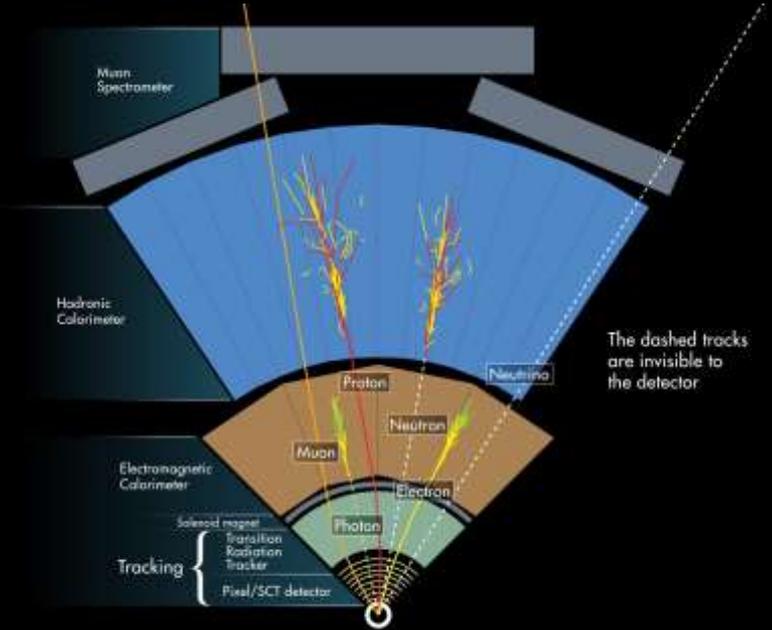
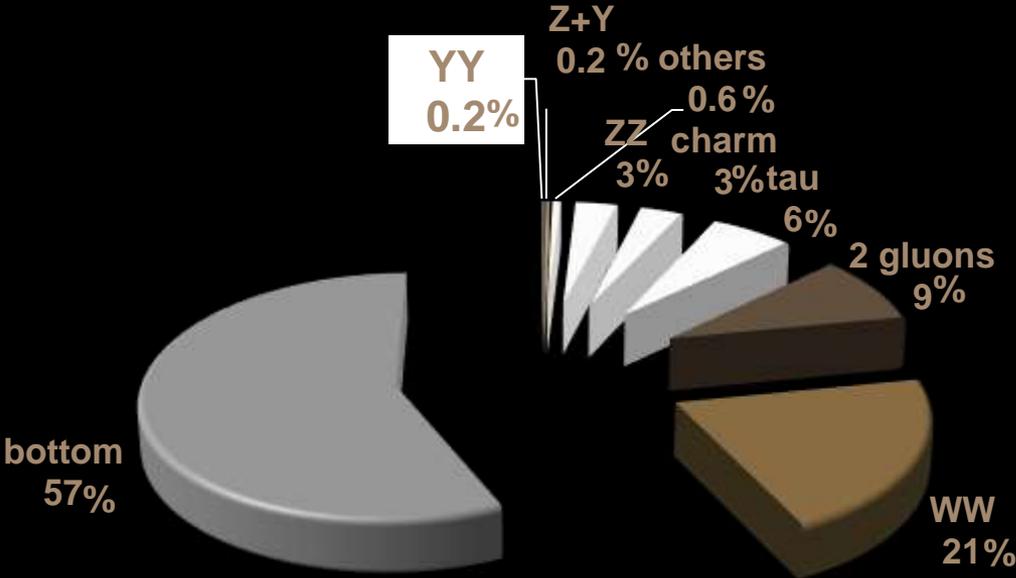
Collaboration



# Higgs decays - why measure gamma gamma?

- ▶ Only 2 out of the 1000 Higgs decays are HYY

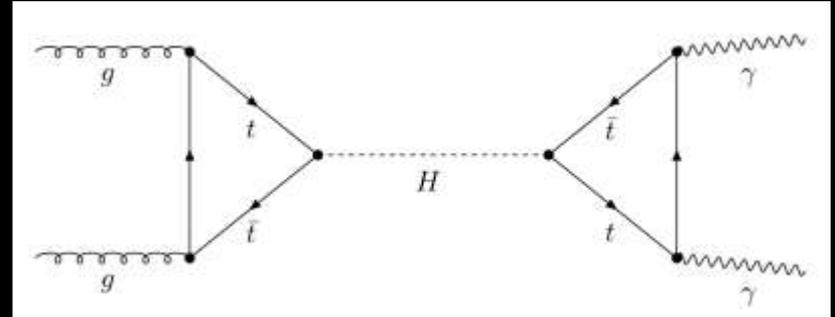
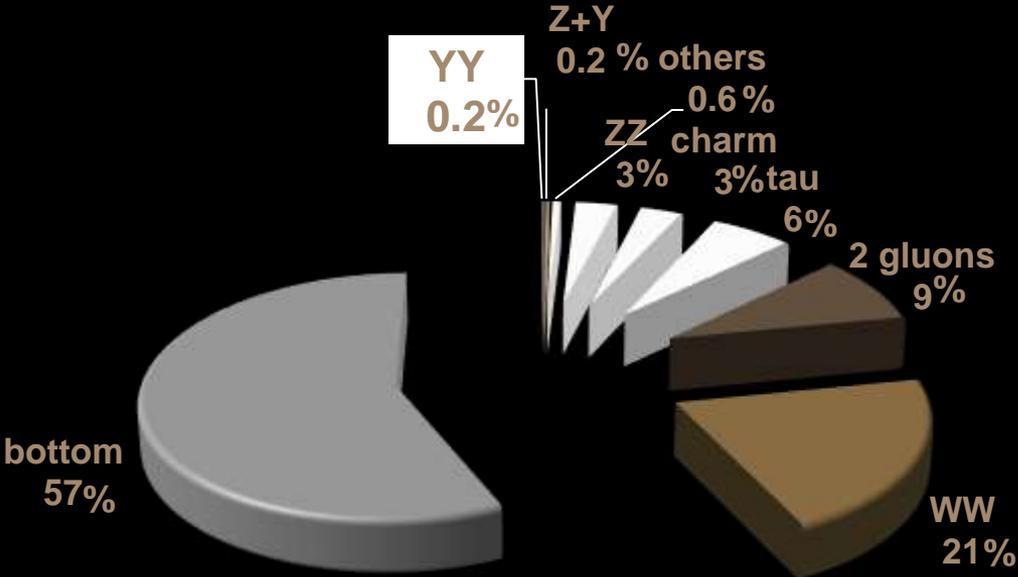
## HIGGS DECAYS BRANCHING RATIO



# Higgs decays - why measure gamma gamma?

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## HIGGS DECAYS BRANCHING RATIO

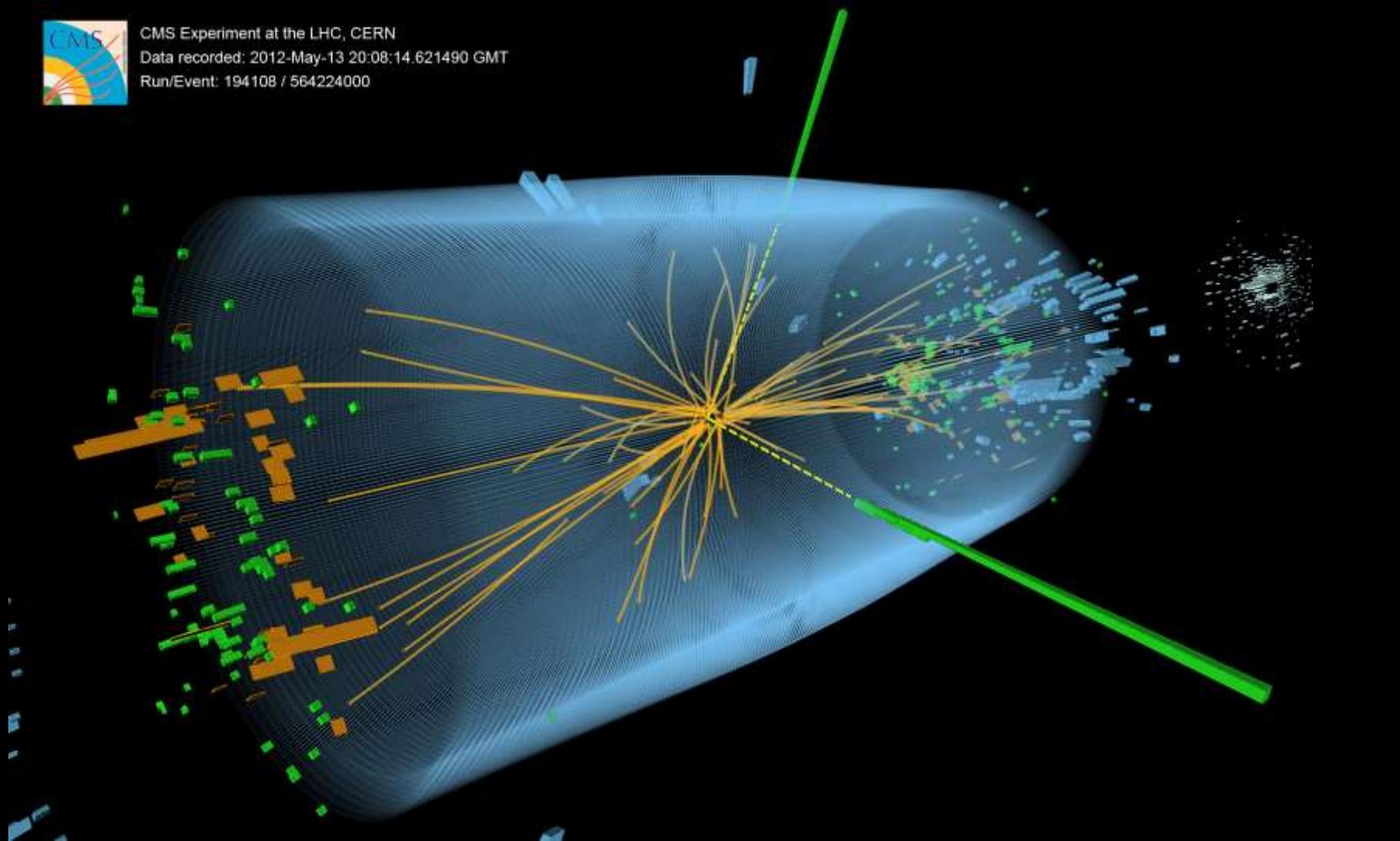




CMS Experiment at the LHC, CERN

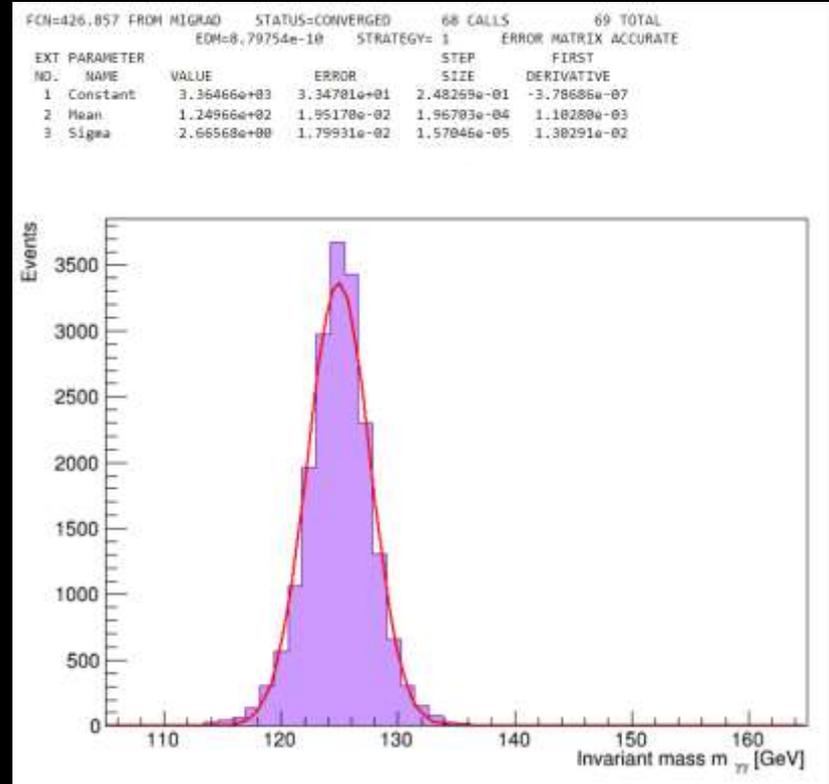
Data recorded: 2012-May-13 20:08:14.621490 GMT

Run/Event: 194108 / 564224000



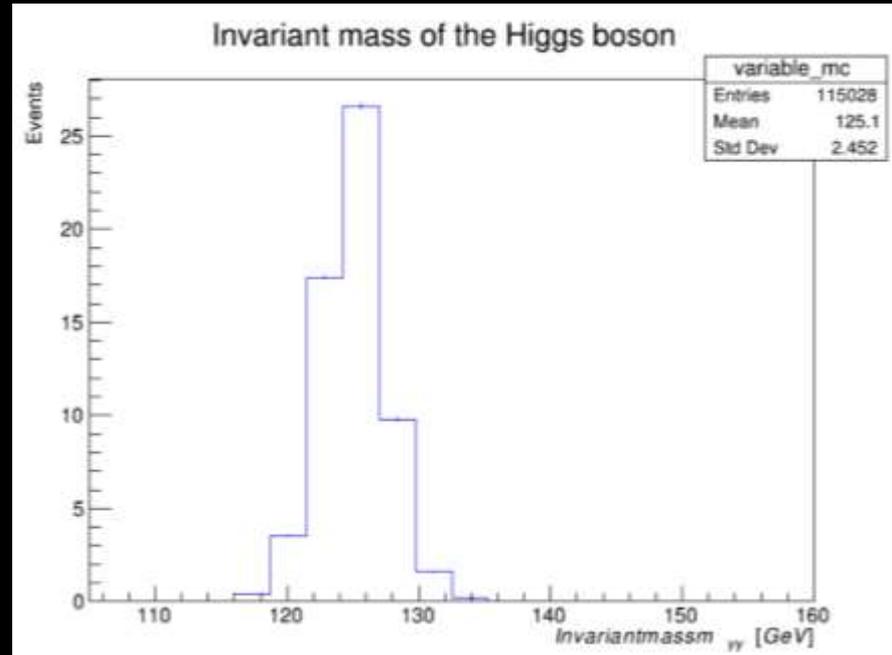
# Monte Carlo simulation

- ▶ Creating an artificial data – set – the peak is clearly visible at 125GeV
- ▶ Event selection
- ▶ Diphoton events



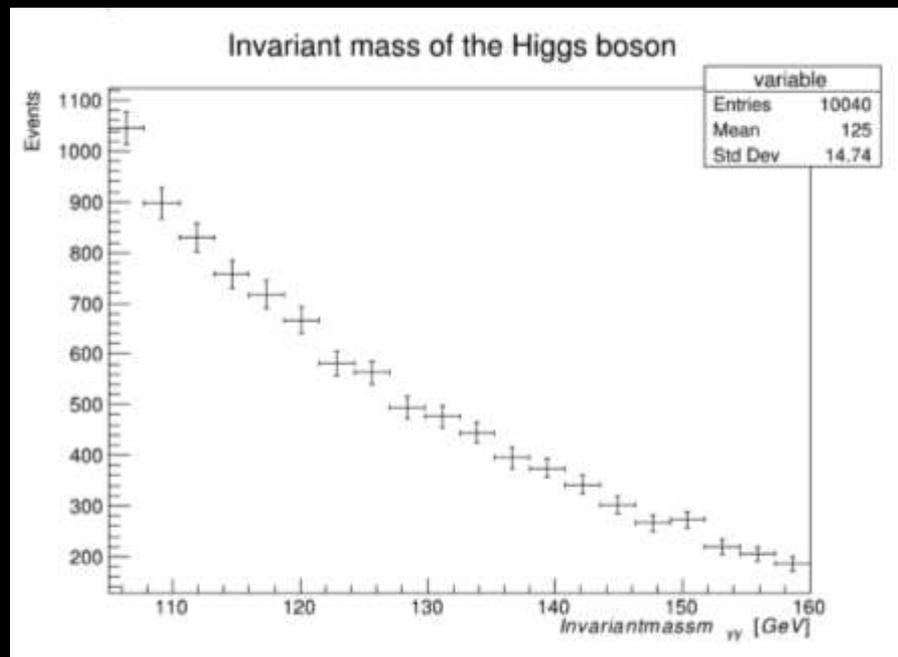
# Monte Carlo simulation

- ▶ Scaling simulation to match expected signal data
- ▶ Number of expected events = 60

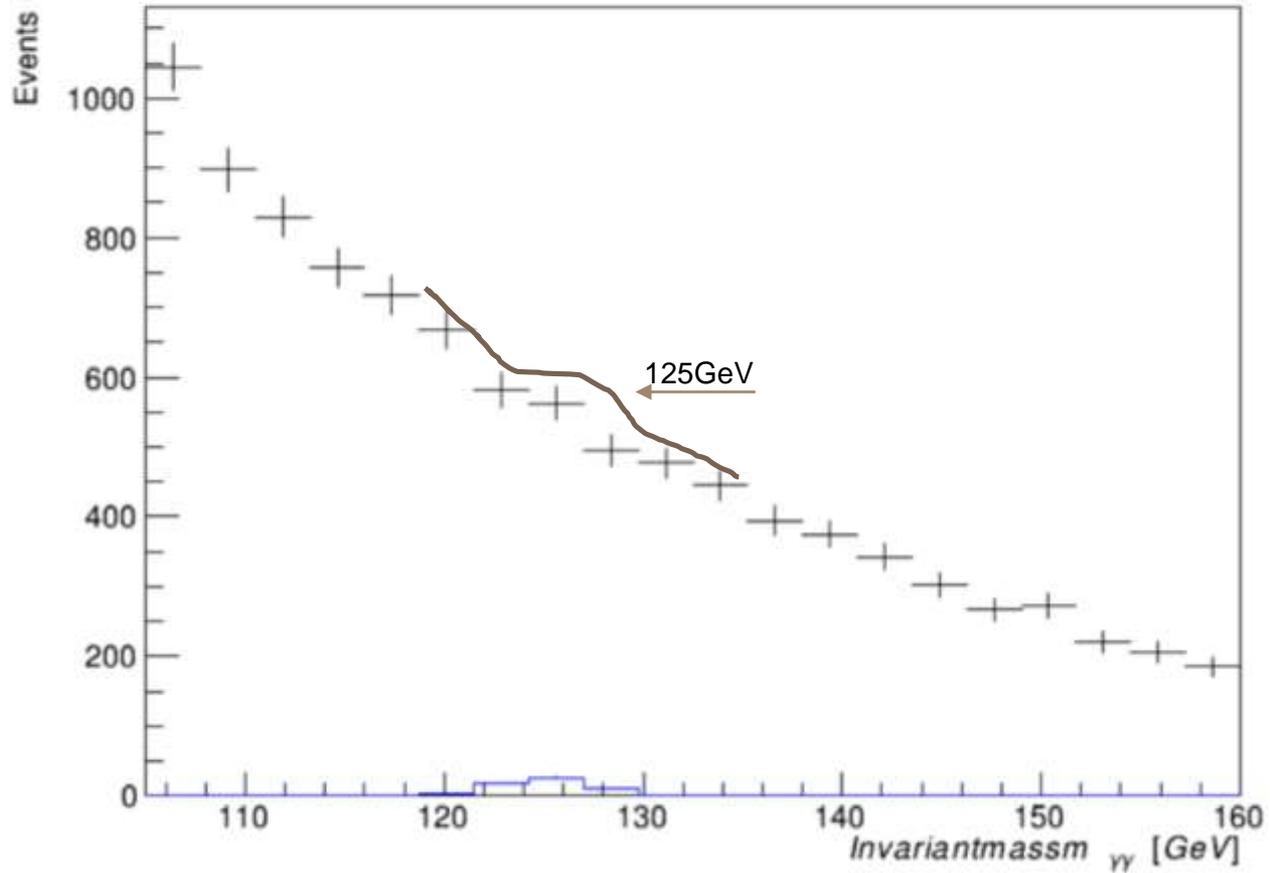


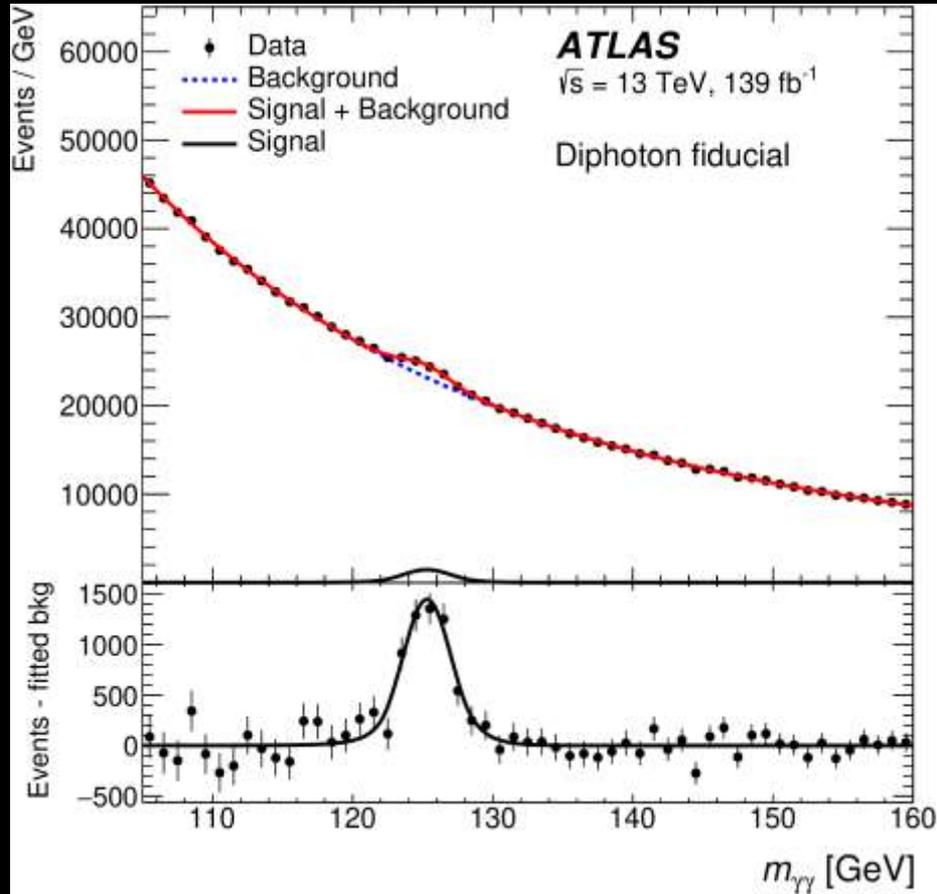
# Not so easy in real life – using the ATLAS open data

- ▶ The number of events decreases with the increase in mass
- ▶ A smaller peak at 125 GeV
- ▶ Comparing the results produced by the simulation to the ones in the ATLAS open data
- ▶ 11% events from the signal passes the selection



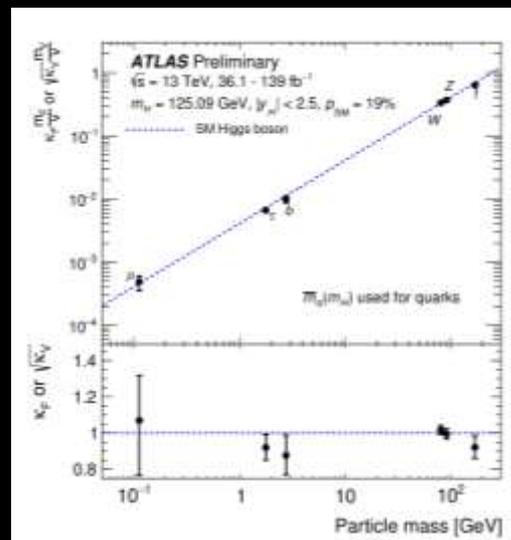
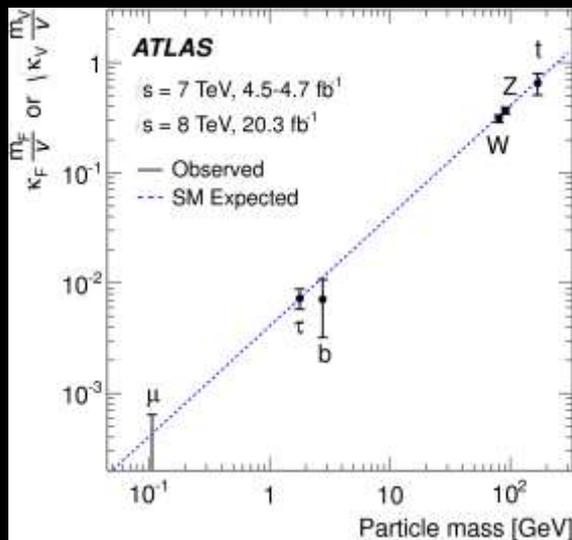
# Invariant mass of the Higgs boson





The results of the measurements conducted in 2012 by the ATLAS scientists

# The new particle is born



Fit results from 2012 (left) and 2018 (right)

- ▶ Agreement with the Standard model
- ▶ In 2018, the interaction has been measured with higher precision

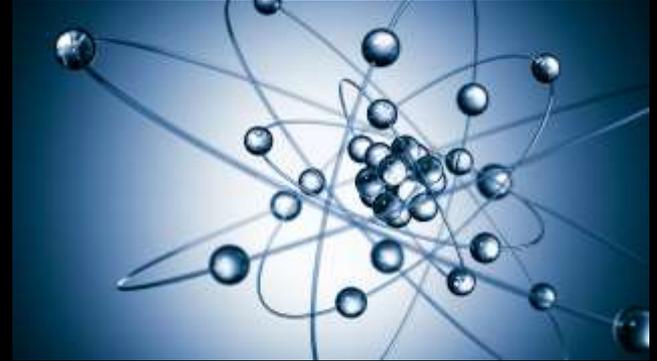
# What now?

! Many questions are still unanswered:

- ▶ How to explain the particle mass pattern?
- ▶ Is Higgs boson connected with Dark Matter?
- ▶ Where is the antimatter in the Universe?
- ▶ Higgs interacts with every massive particle.

Does it interact with itself?

- ▶ Is the Universe stable?



THANK YOU  
FOR YOUR  
ATTENTION

ХВАЛА НА ПАЖЊИ!