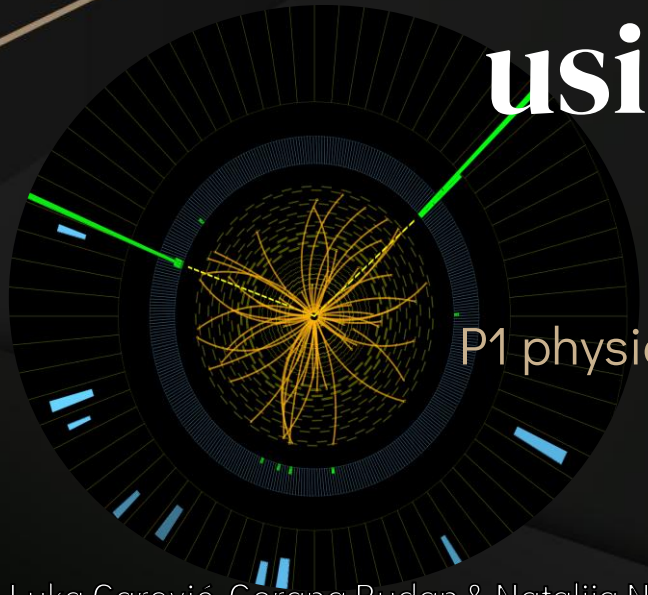
Discovering the Higgs boson in Hγγ decay channels using the ATLAS open data



P1 physics project – Serbian HSSIP in CERN

Luka Carević, Gorana Rudan & Natalija Nikolić

Mentors: Marko Stamenković & Prof. Predrag Milenović

- Elementa
- What is th
- Origin of
- Why is the

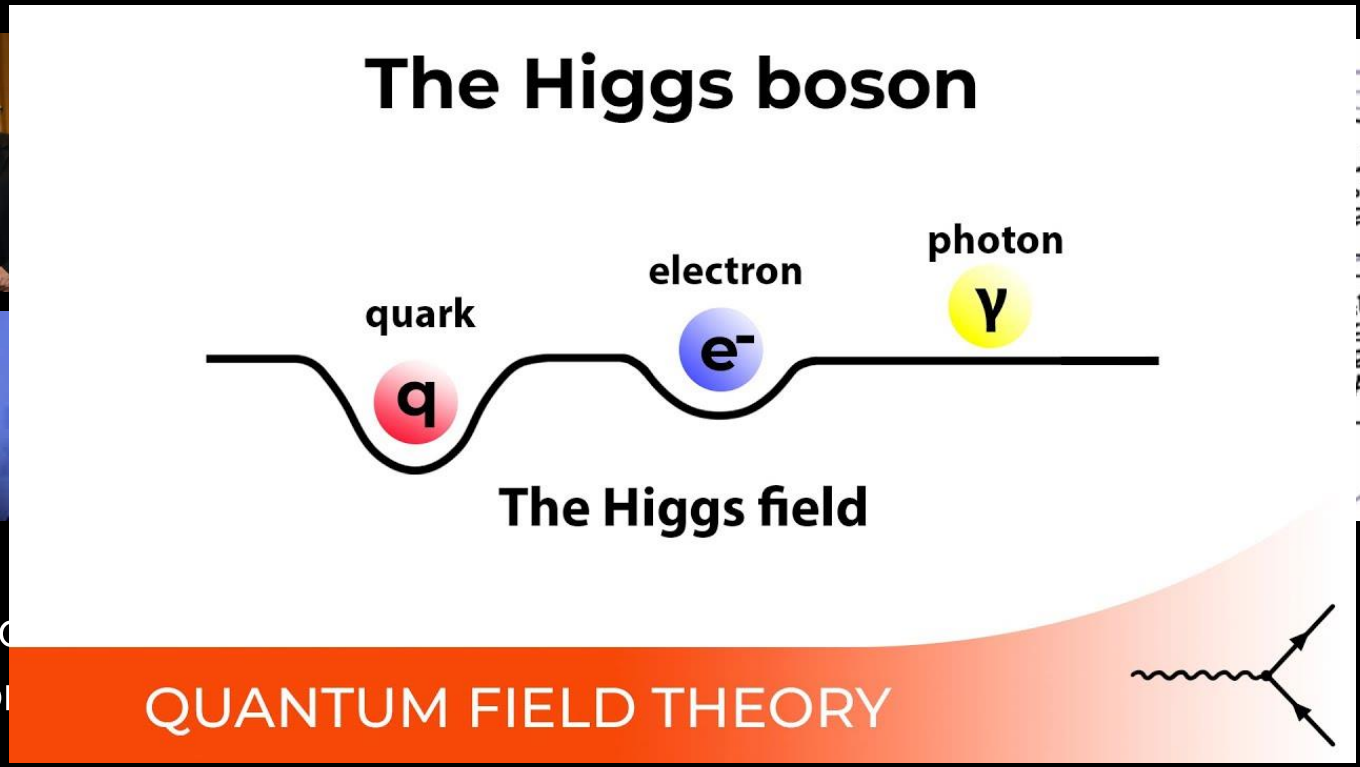
  between

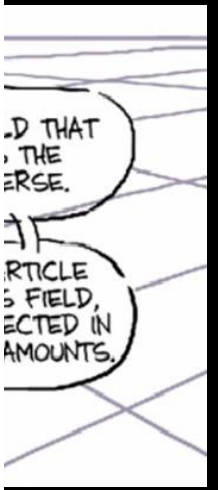
g
gluon
γ
photon
.19 GeV/c²
Z
Z boson
.39 GeV/c²
W
W boson

1964 - Birth Of The New Theory

Peter Higgs

Francois Englert





- Theoretico
- Interactio

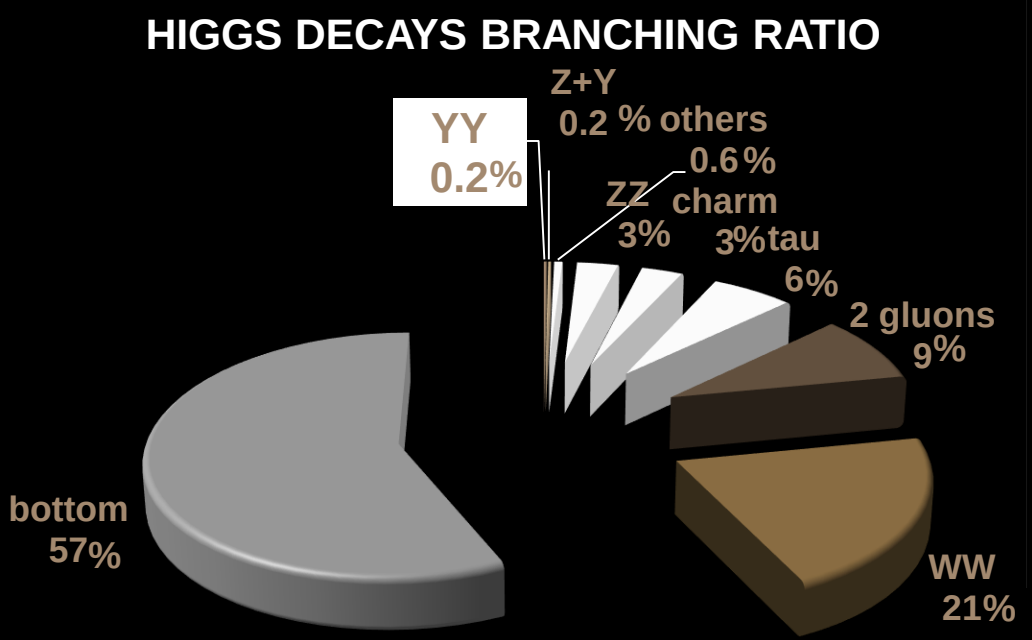
2011 - LHC Comes To The Rescue

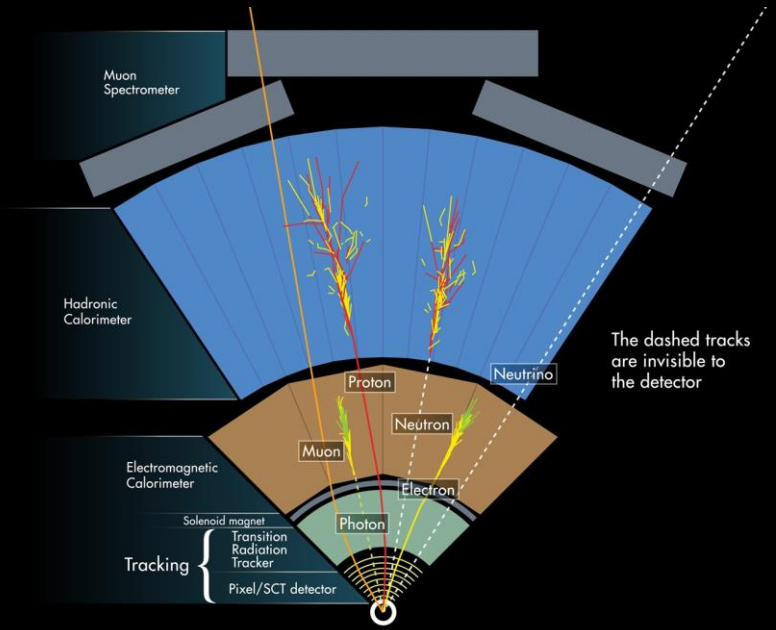
- LHC - The first collisions were achieved in 2010
- One of the goals is to confirm or refute the Higgs theory
- Higgs discovery – 2012
- Why did it take 48 years to find?

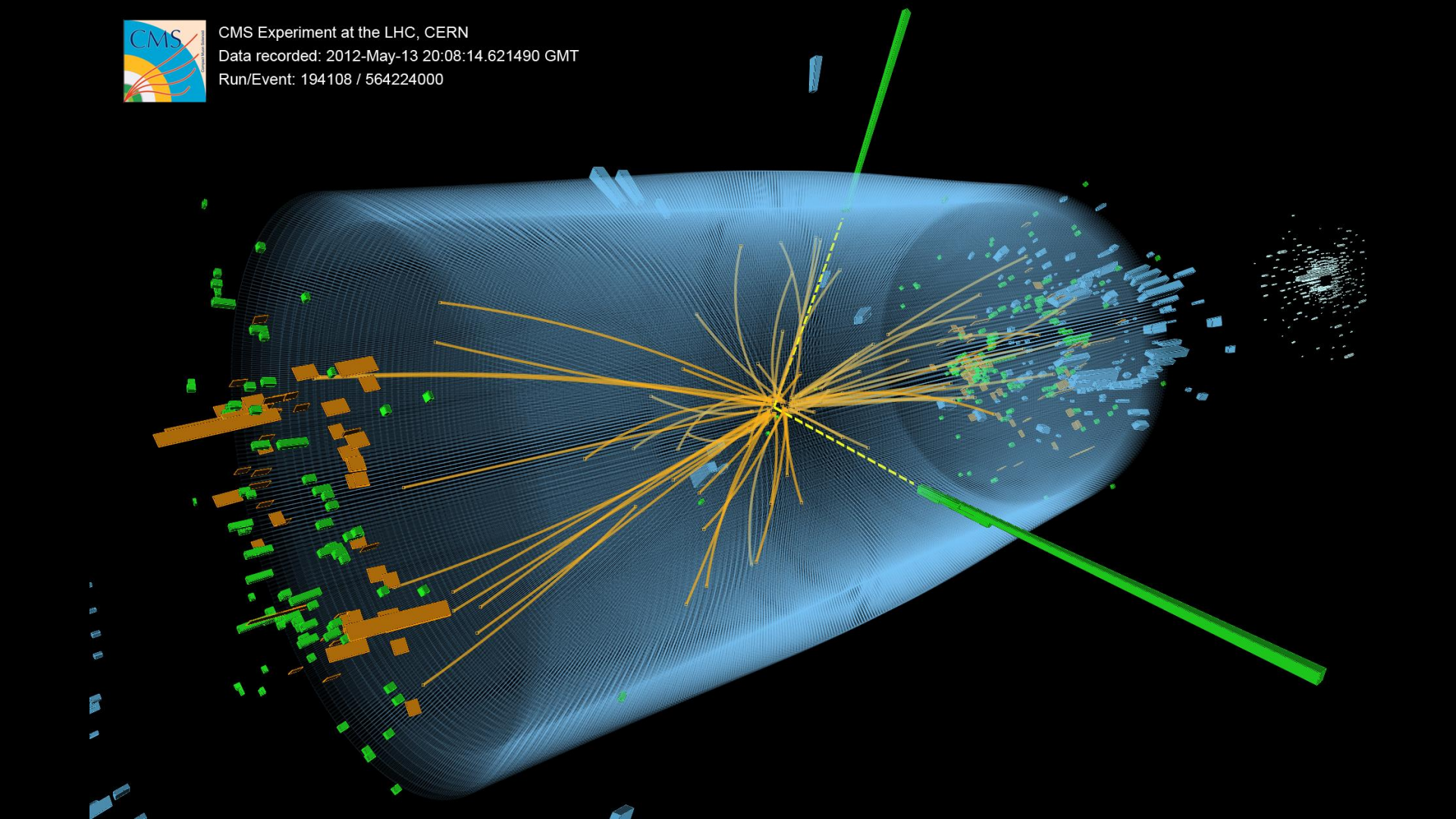
What did we need for this research?

Higgs decays - why measure gamma gamma?

- Only 2 out of the 1000 Higgs decays are HYY






CMS Experiment at the LHC, CERN
Data recorded: 2012-May-13 20:08:14.621490 GMT
Run/Event: 194108 / 564224000

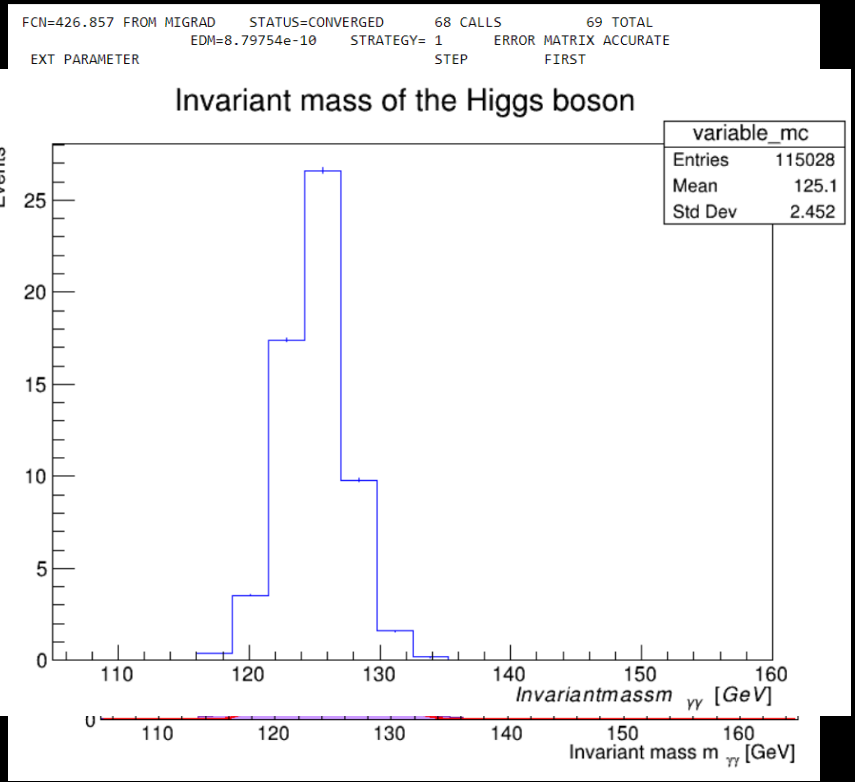
Monte Carlo simulation

- Creating an artificial data – set – the
- Scaling simulation to match expected

peak is clearly visible at 125GeV
signal data

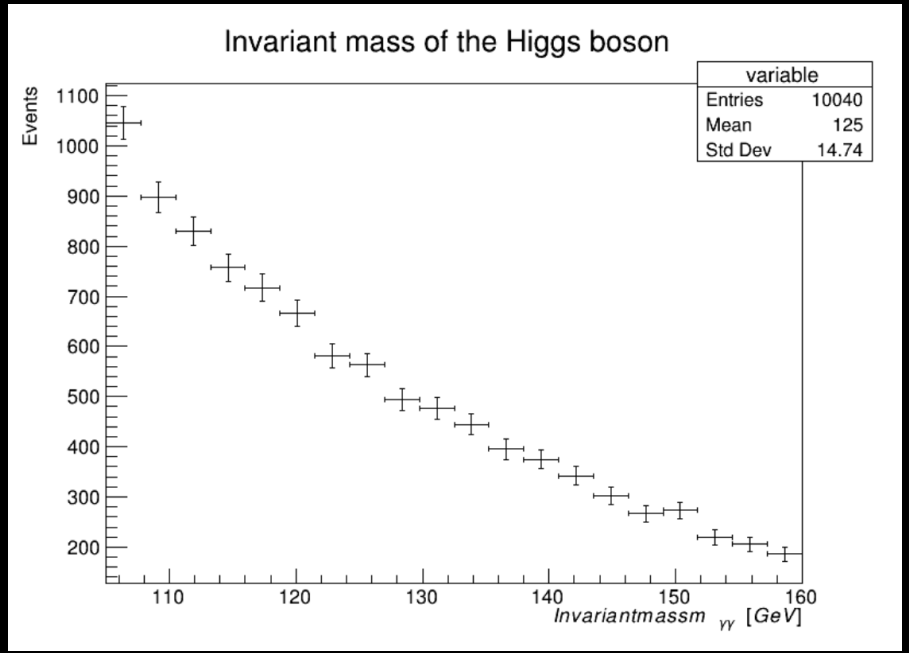
- Event selection
- Number of expected events = 60

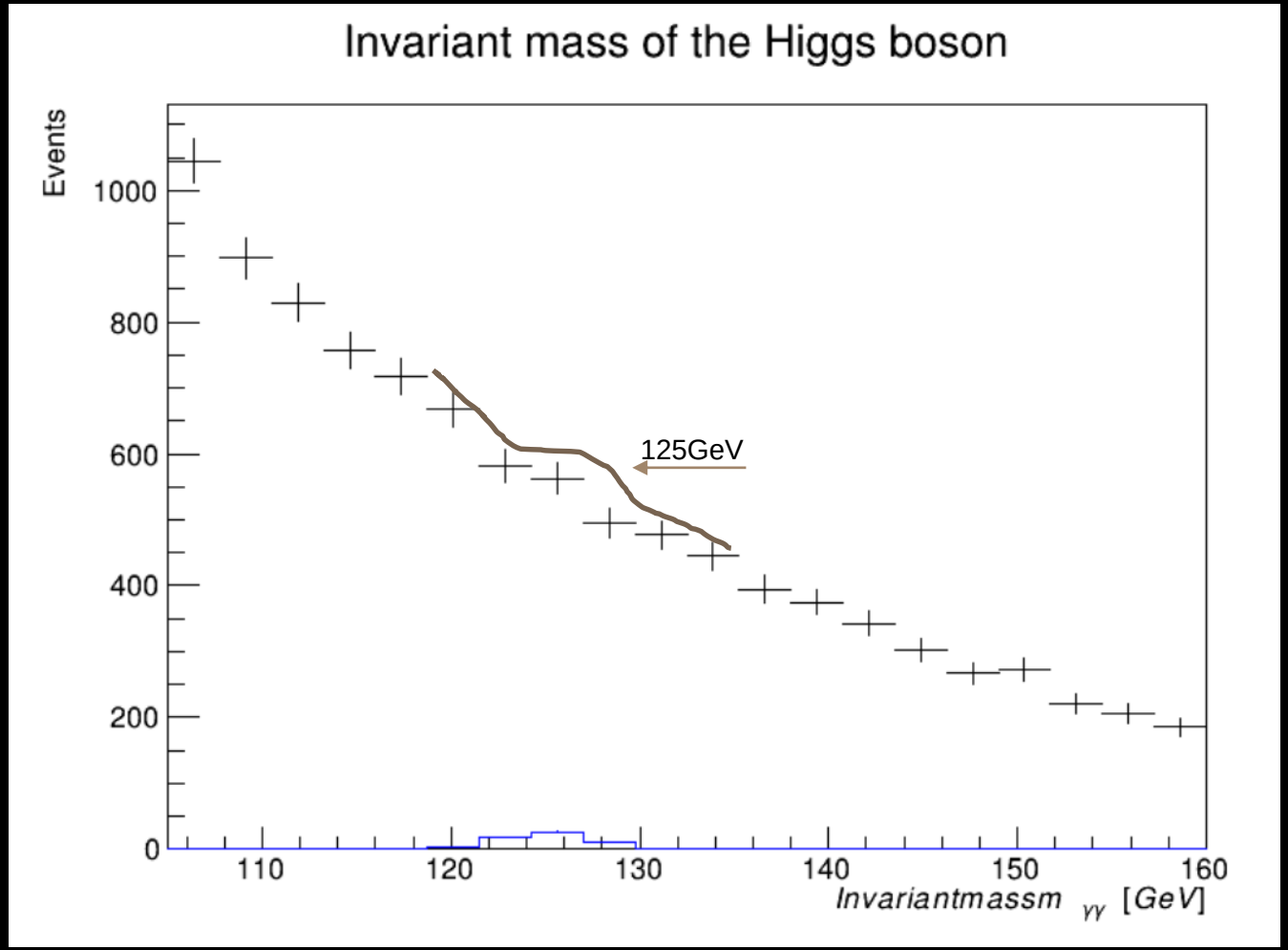
- Diphoton events

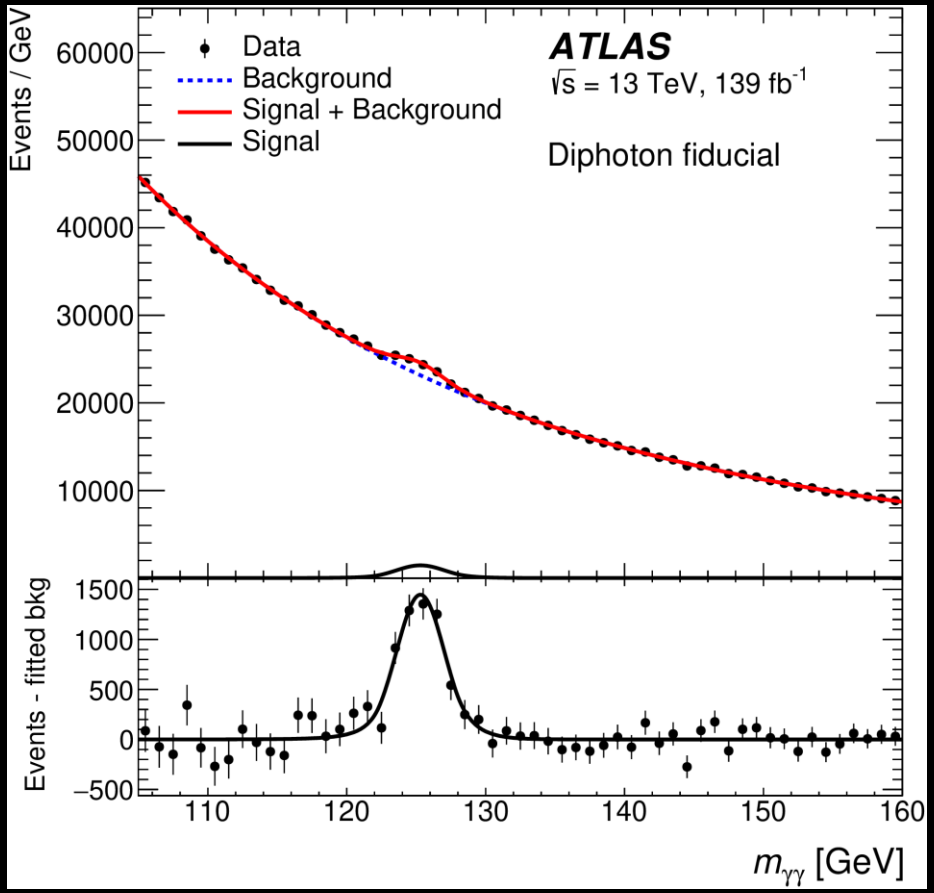


Not so easy in real life – using the ATLAS open data

- 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

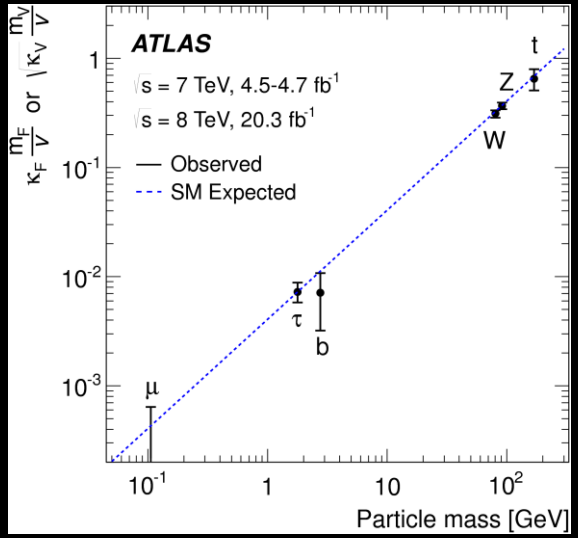


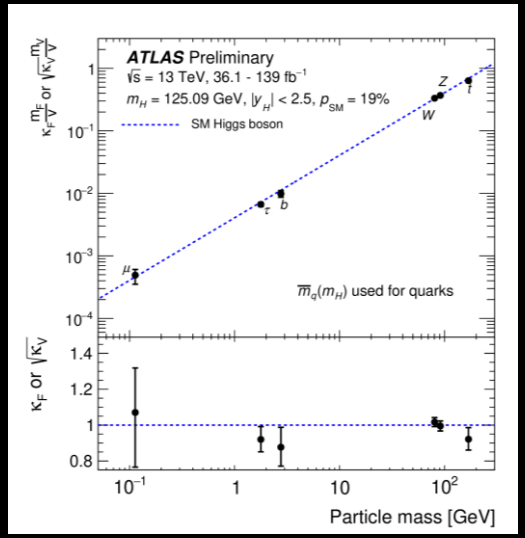

Invariant mass of the Higgs boson
Events
1000
800
600
400
200
0
125GeV
110
120
130
140
150
160
Invariantmassm γγ [GeV]



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

The new particle is born





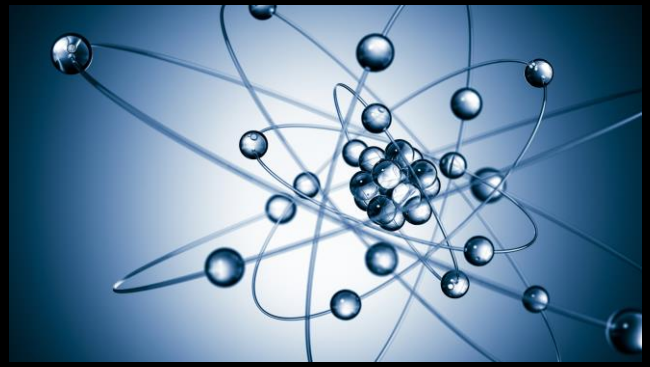
Fit results from 2012 (left) and 2018 (right)

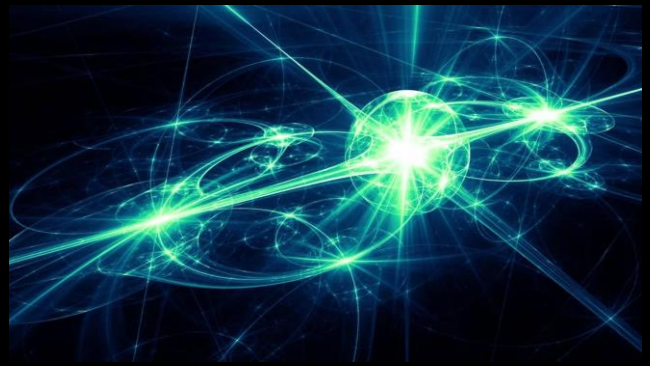
- Agreement with the Standard model
- In 2018, the interaction has been measured with higher precision

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!