

Atlas Higgs Boson results in bosonic decay channels

Peter Kluit Nikhef

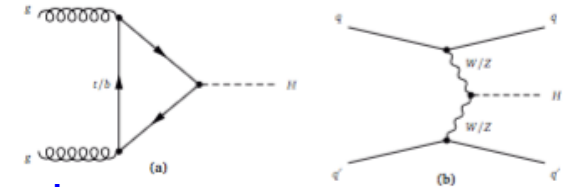
on behalf of the ATLAS experiment
SUSY 2016 Melbourne

To be presented 4 July 2016

Introduction

Present ATLAS results for the Higgs boson in the bosonic channels $\gamma\gamma$, ZZ and WW

- experimentally clean
- precise mass measurement
- fiducial cross section measurements



Main H production modes
ggF VBF

Theoretically motivated arguments:

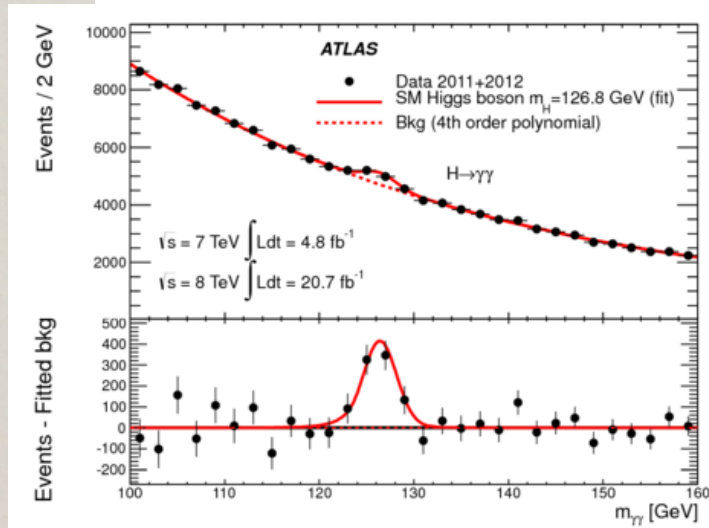
- allow precise test of SM predictions
- test of custodial symmetry
- sensitive to e.g. an extended Higgs sector

Presence of another high mass e.g. 2HDM scalar CP even Higgs boson (H) or a CP odd Higgs (A).

First review what we know from Run I with focus on the most recent results.

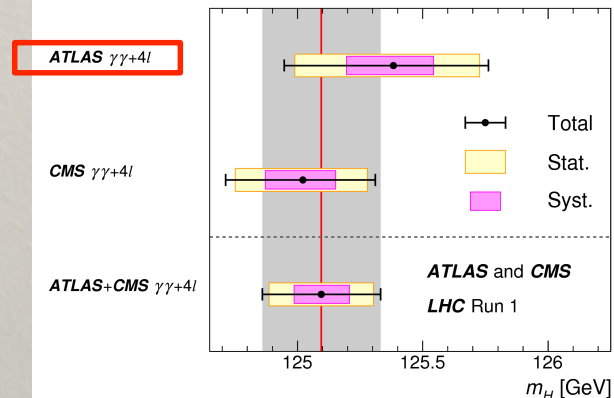
Lastly present the preliminary results from Run II.

Run I Discovery: Boson decay

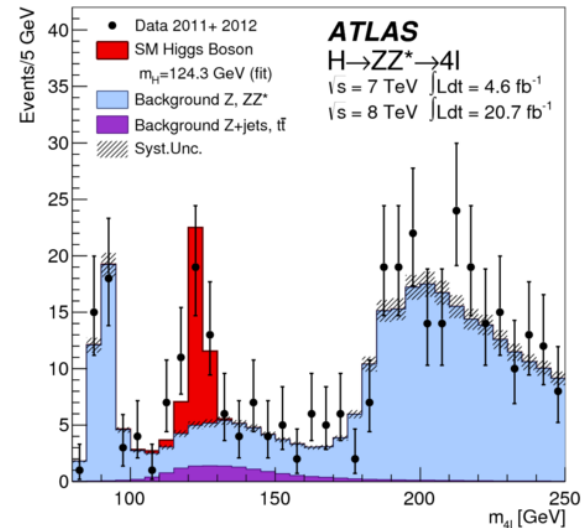


Phys. Lett. B 726 (2013) 88

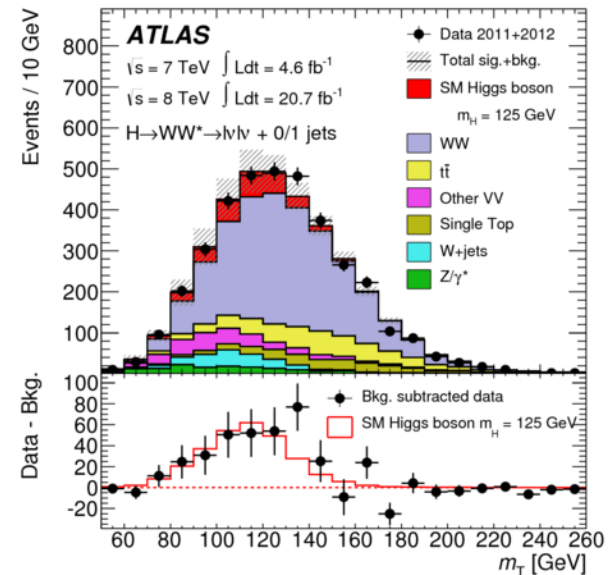
Precise mass measurement



Phys. Rev. Lett. 114 (2015), 191803

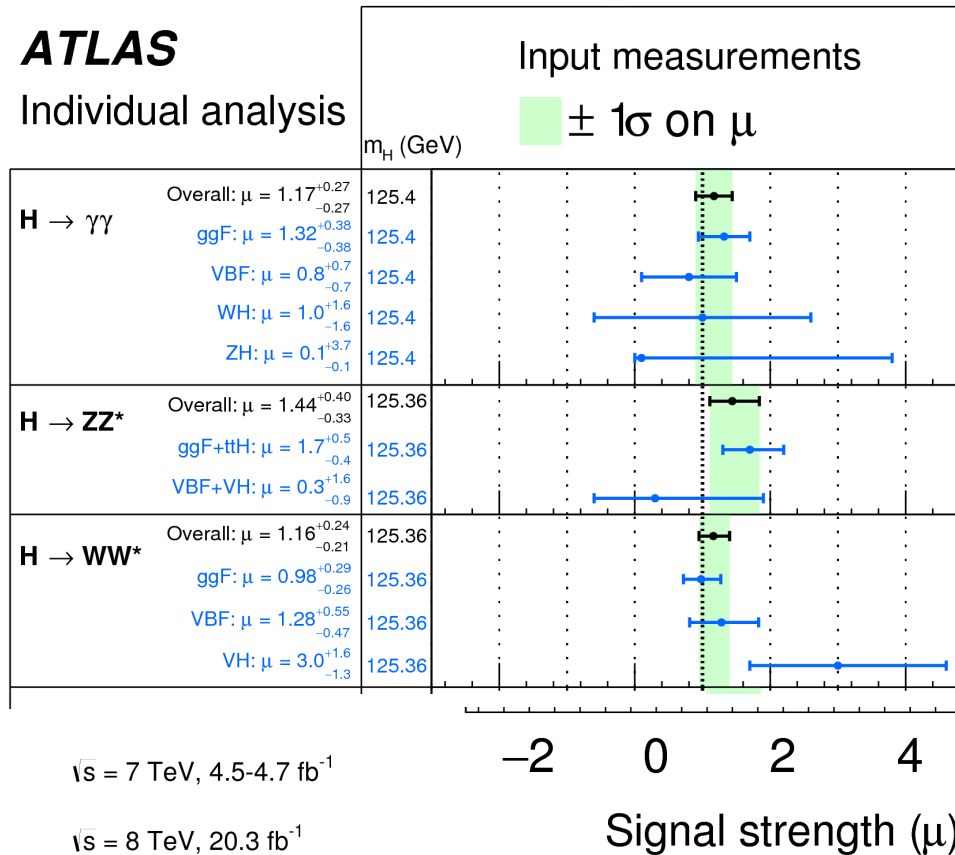


Phys. Lett. B 726 (2013) 88



Run I Boson signal strength

ATLAS
Individual analysis



Eur. Phys. J. C76 (2016) 6

Signal strength the ratio between observed rate and SM Higgs expectation:

$$\mu = \sigma \times \text{BR (measured)} / \sigma \times \text{BR (SM)}$$

Precise measurements that allow testing of $\mu = 1$
 Assumes σ VBF/ggF and σ 7 TeV/8 TeV SM

Run I: W & Z Boson couplings custodial symmetry

$$g_V = m_V^2 / v$$

$$\kappa = g / g_{SM}$$

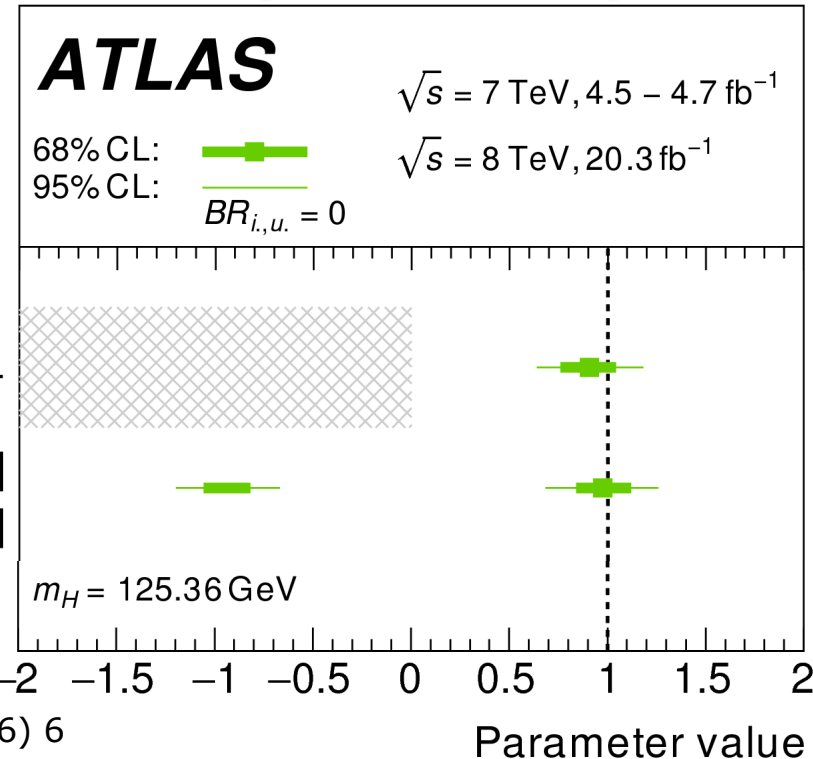
$$\kappa_W = 0.91 \pm 0.14$$

$$\kappa_Z \in [-1.06, -0.82] \cup [0.84, 1.12]$$

Assumes e.g. $BSM = 0$

Narrow SM Lagrangian

Eur. Phys. J. C76 (2016) 6

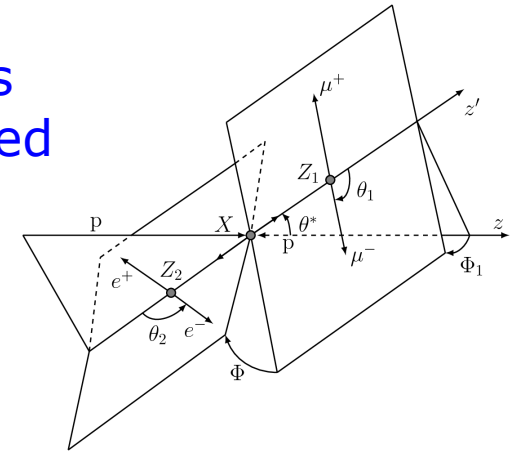


Standard Model predicts the coupling strength of the Higgs to W and Z bosons from custodial symmetry. The ratio of the couplings $\lambda_{WZ} = \kappa_W / \kappa_Z$ is measured directly in the Higgs sector arXiv:1606.02266 (2016):

$$\lambda_{WZ} = 0.92 \pm 0.14$$

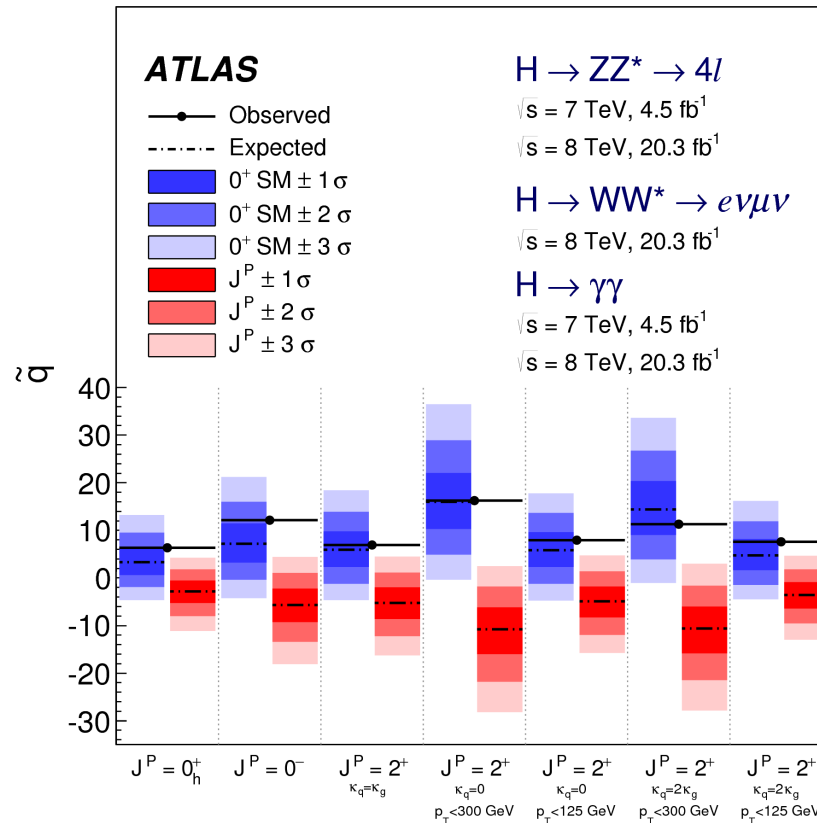
Run I Higgs Spin and CP

One can test different hypotheses for the spin and CP of the observed particle using e.g. angles and kinematical variables



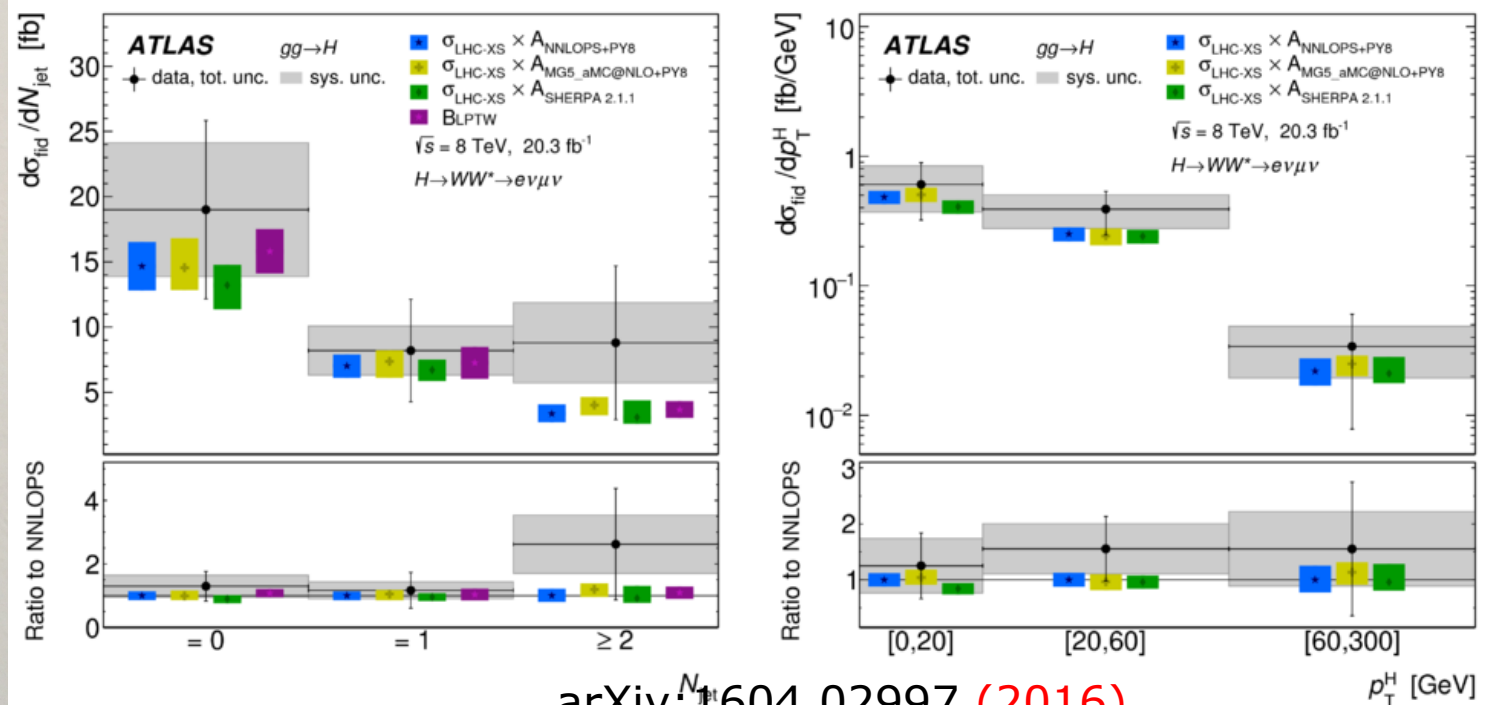
Confirms the spin 0 nature of the boson

Excludes other hypotheses at 99.9 % CL



Run I: WW Boson fiducial cross sections

In order to allow for more detailed SM model testing and more model independent tests. ATLAS published fiducial boson cross sections for $\gamma\gamma$, ZZ and WW. Here the recent gg fusion WW cross sections.



arXiv:1604.02997 (2016)

Extended Higgs sector

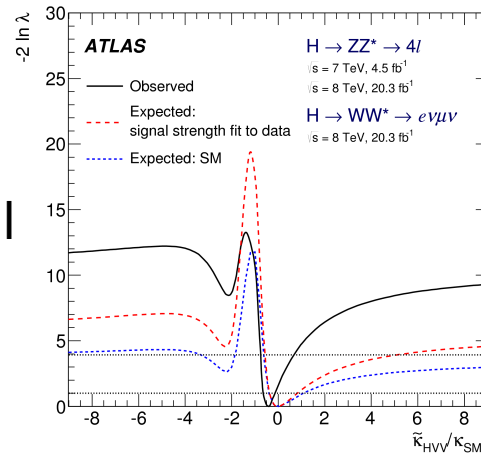
Strong constraints on the existence of new Higgs bosons come from the high mass searches that are **not covered** in this talk (later today).

Other constraints come from the ZZ and WW boson cross sections (slide 4). In e.g. Two Higgs Doublet Models these will be modified by a term proportional to $\sin^2(\alpha-\beta)$.

A further constraint comes from the fact that the presence of new Higgs bosons will modify the angular and kinematical distributions of the final state bosons. This is analyzed in an effective field theory with additional couplings $\kappa_{HVV}(AVV)$:

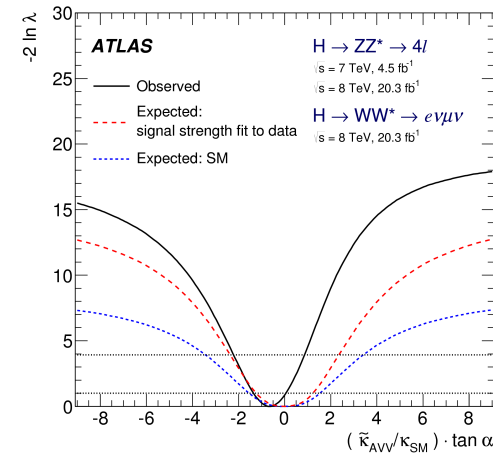
$$\mathcal{L}_0^V = \left\{ \cos(\alpha)\kappa_{SM} \left[\frac{1}{2}g_{HZZ}Z_\mu Z^\mu + g_{HWW}W_\mu^+ W^{-\mu} \right] - \frac{1}{4}\frac{1}{\Lambda} \left[\cos(\alpha)\kappa_{HZZ}Z_\mu Z^\mu Z^{\mu\nu} + \sin(\alpha)\kappa_{AZZ}Z_\mu Z^{\mu\nu} \right] - \frac{1}{2}\frac{1}{\Lambda} \left[\cos(\alpha)\kappa_{HWW}W_\mu^+ W^{-\mu\nu} + \sin(\alpha)\kappa_{AWW}W_\mu^+ \tilde{W}^{-\mu\nu} \right] \right\} X_0.$$

Additional CP even



Eur. Phys. J. C75 (2015) 476

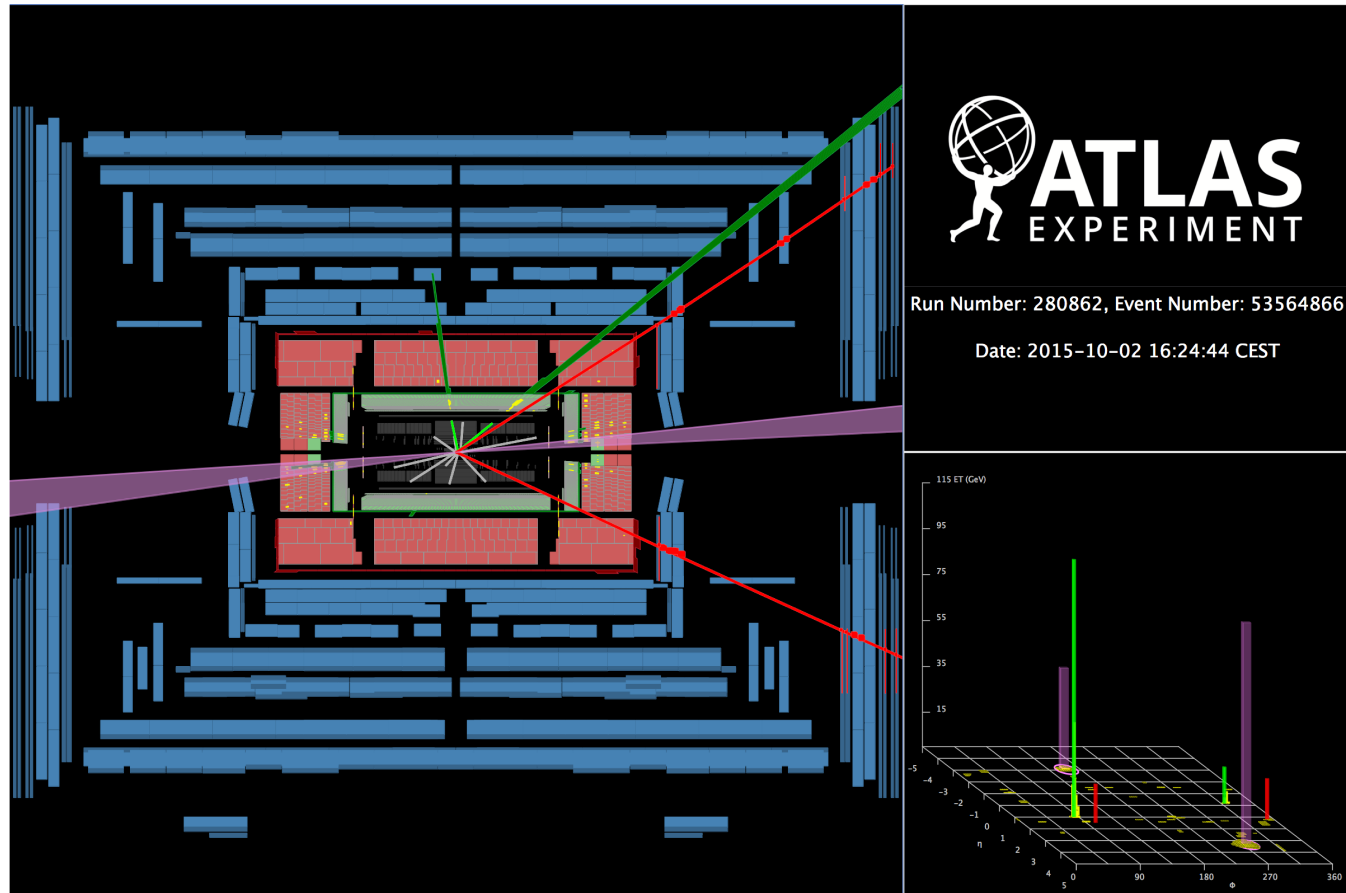
Additional CP odd



Higgs search at 13 TeV

Production cross section SM ggF factor 2.3 higher than at 8 TeV.

Below a $H \rightarrow ZZ \rightarrow 4l$ candidate.

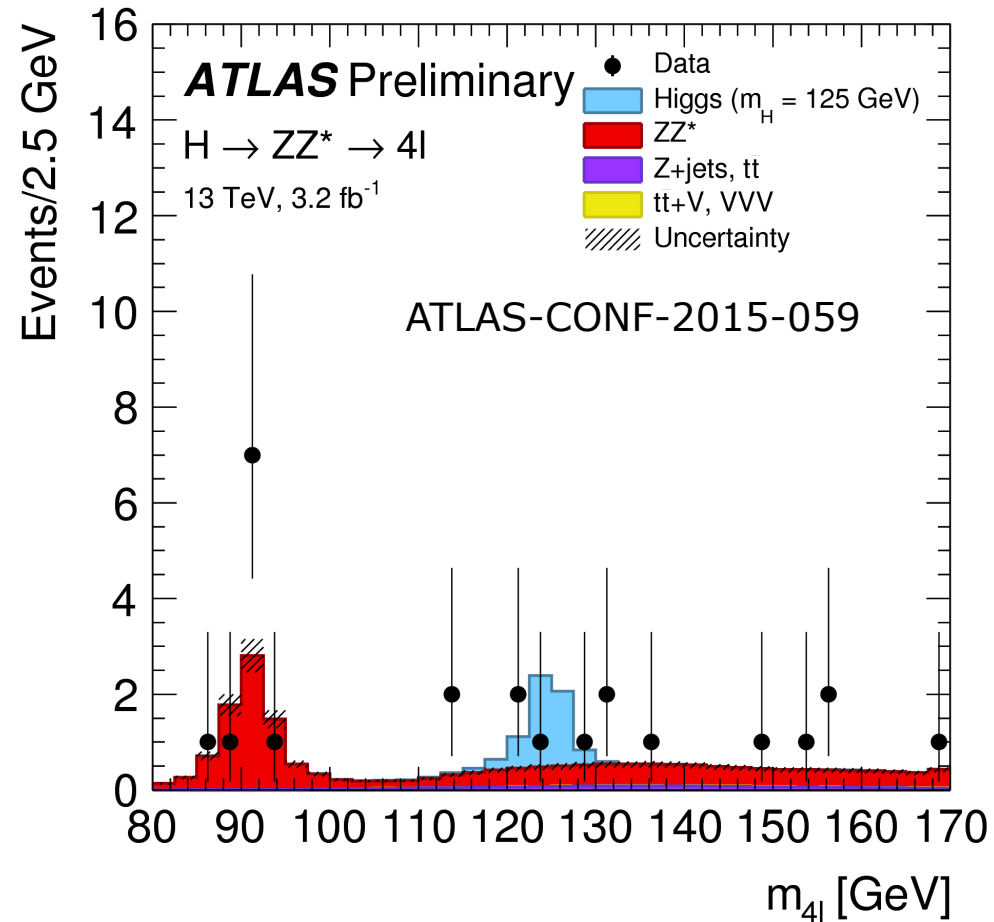


Run II Higgs ZZ search

Similar analysis as in Run I.

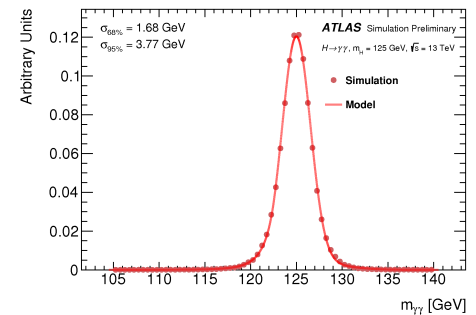
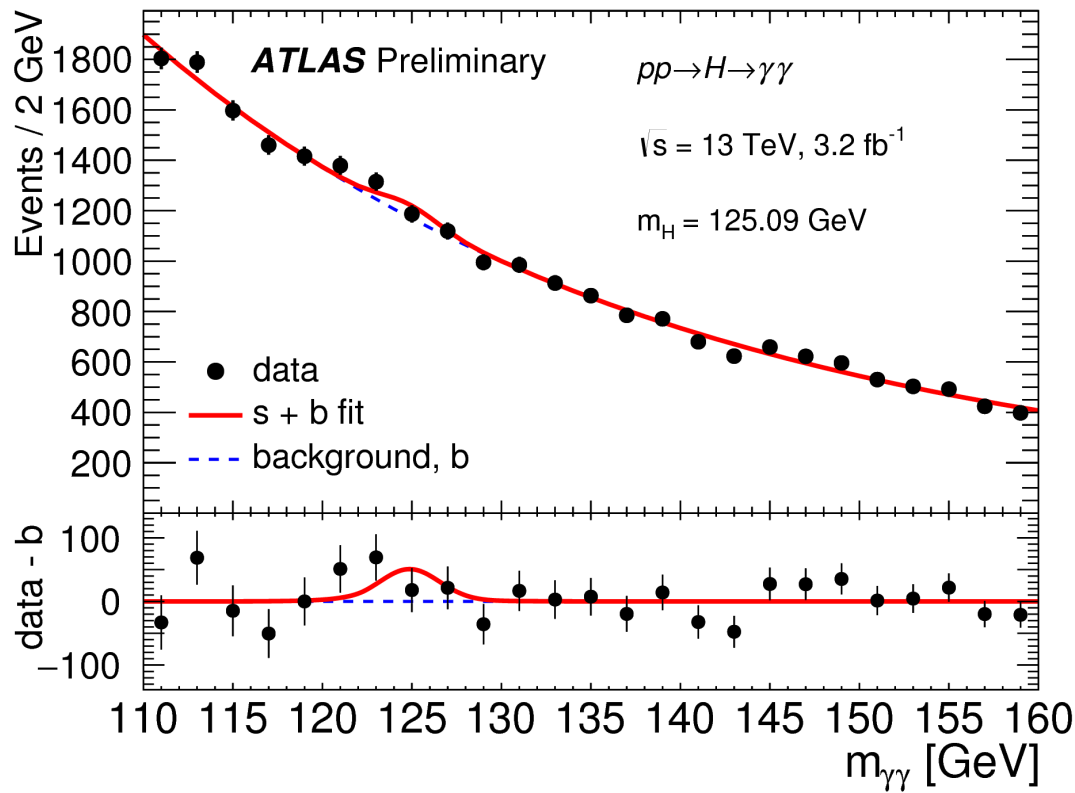
Small excess of events around 125.09 GeV.

Production cross section see slide 12.



Run II Higgs $\gamma\gamma$ search

Similar analysis as in Run I.
Small excess of events around 125.09 GeV.

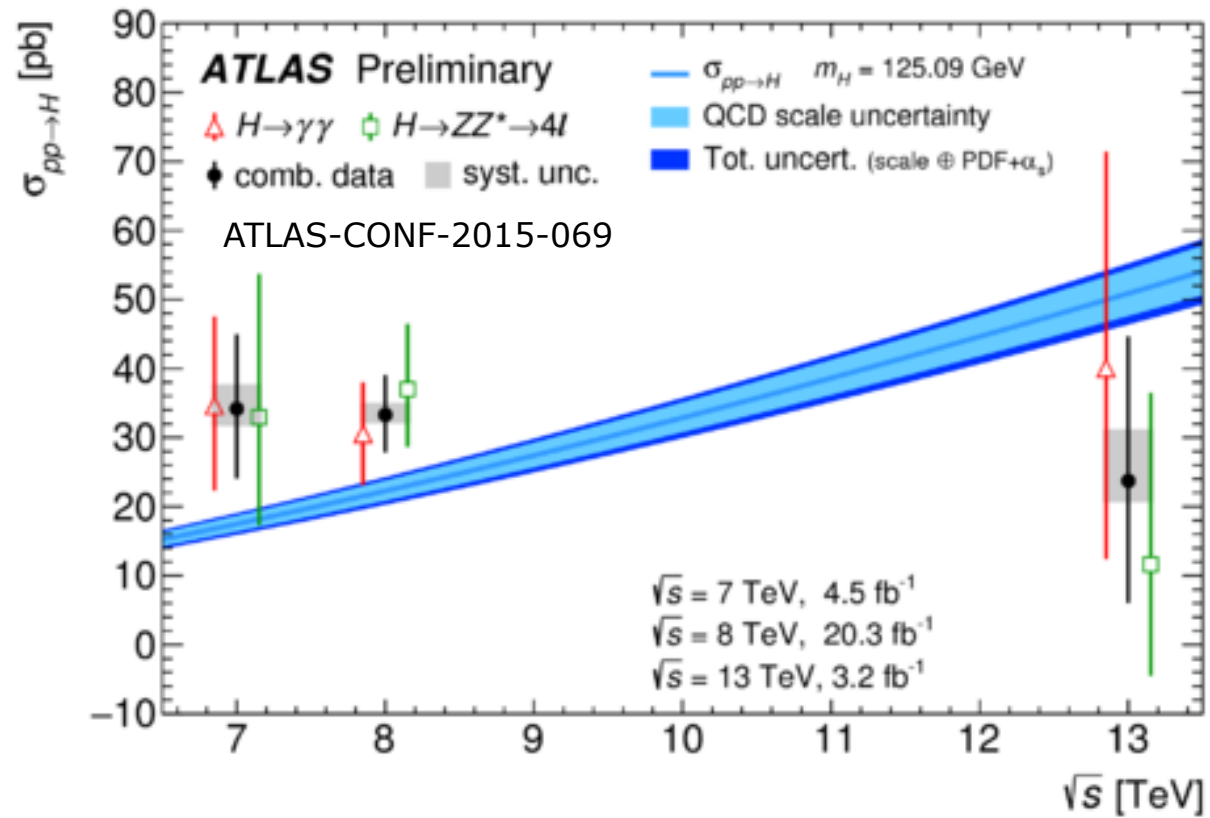


Expected
signal shape

ATLAS-CONF-2015-060



Higgs cross sections



- Clearly needs more statistics to clarify the situation.

Summary and Outlook

- Presented the run I Higgs results in bosonic final states that confirm a Standard Model 0^+ boson compatible with custodial symmetry
- Preliminary results from run II need clarification
- As LHC is running very well, we can look forward to exciting results.

Yawkyawk Spirit by Owen Yalandja

