Physics at LHC – 2012

SM Higgs in bb searches with the ATLAS detector at the LHC

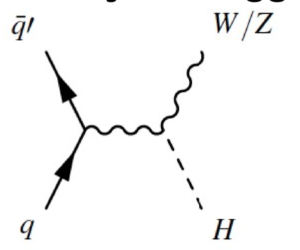
ATLAS-CONF-2012-015(*)

Mario Martínez on behalf of the ATLAS collaboration

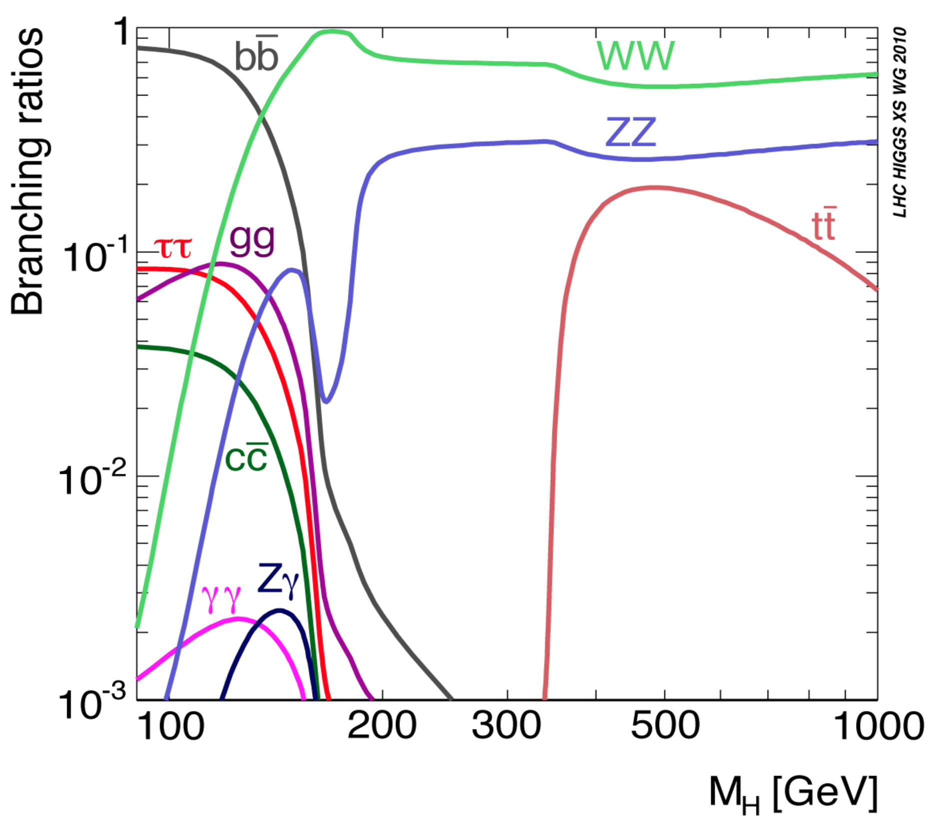
Institut de Física d'Altes Energies (IFAE-Barcelona)

Higgs Search

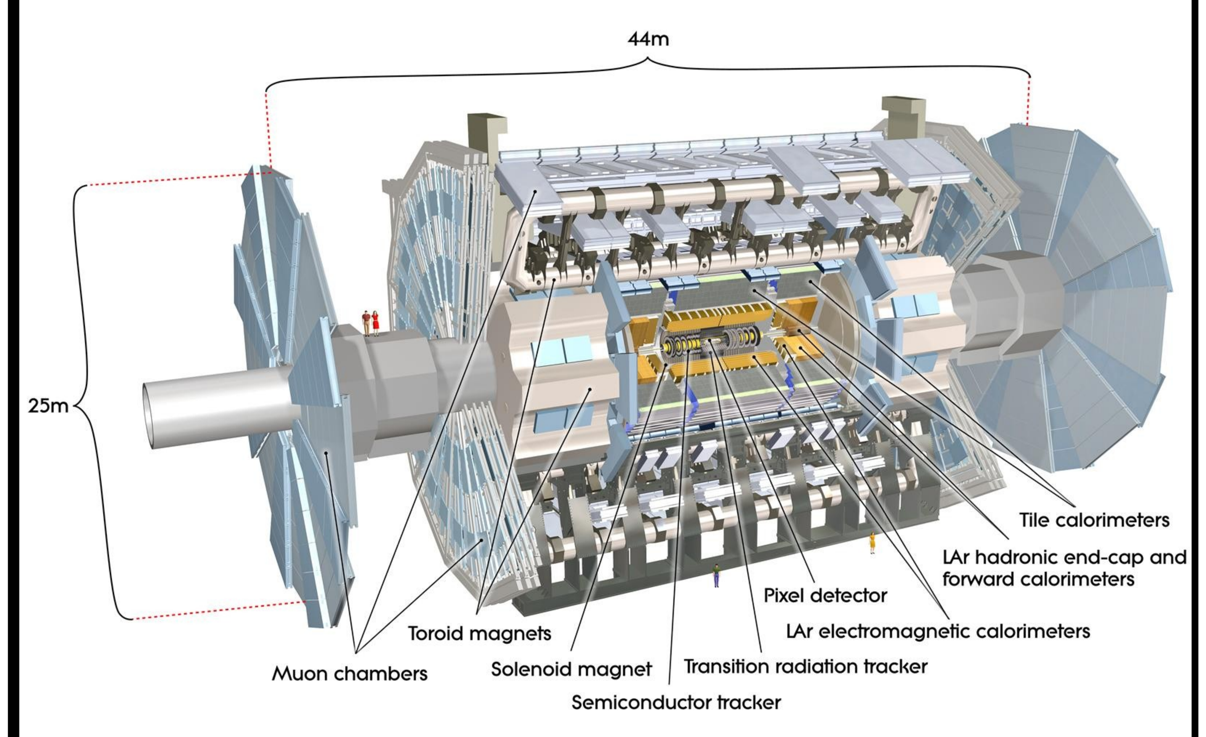
The search for the standard model (SM) Higgs boson is one of the most important goals at the Large Hadron Collider (LHC). The Higgs boson has been excluded at 95% confidence level (C.L.) below 114 GeV by the LEP experiments and above 130 GeV by previous Tevatron and LHC results. In the remaining mass range the Higgs to b-quark (anti)b-quark decay mode dominates and provides the means to study the Higgs coupling to quarks.



We present a search for the SM Higgs boson in the H → bb decay model in events where the Higgs is produced in association with an electroweak boson (W or Z) in the final state which decays into leptons. The study is based on 4.9 fb^{-1} of data collected by the ATLAS experiments during 2011.



ATLAS detector



Physics Objects

Jets
AntiKt with R=0.4
MC-based calibration
pT>25GeV |η|<2.5

Muons
Matched track in the inner detector and muon system
pT>20GeV |η|<2.5

ET,miss
from calibrated clusters in the calorimeter with |η|<4.9

b-tagged jets
based on the presence of a displaced secondary vertex from B-hadron decay

Electrons
Electromagnetic cluster with an associated inner detector track
pT>20GeV |η|<2.5

pT,miss
from tracks in the inner detector associated to the primary vertex

Event Selection

W(lν)bb
- e/μ,pT>25 GeV
- ET,miss > 25 GeV
- mT(e/μ, ET,miss)> 40 GeV
- Veto on additional leptons
- Two b-jets pT > 45, 25 GeV
- ΔR(bb) > 0.7 if pTW< 200 GeV
- Veto on additional jets

Z(ll)bb
- e+e-/μ+μ-,pT>20 GeV
- mll consistent with mZ
- ET,miss < 50 GeV
- Veto on additional leptons
- Two b-jets pT >45, 25 GeV
- ΔR(bb) > 0.7 if pTZ < 200 GeV
- Veto on additional b-jets

Z(νν)bb
- ET,miss > 120 GeV
- pT,miss > 30 GeV
- Δφ(ET,miss,pT,miss)<π/2
- Veto on leptons
- Two b-jets pT > 45, 25 GeV
- ΔR(bb) > 0.7 if ET,miss < 200 GeV
- Veto on additional jets

In order to maximize the sensitivity to the Higgs signal the analyses are performed in different exclusive regions in pT(W/Z) (for W(lν)bb and Z(ll)bb channels) and ET,miss (for Z(νν)bb channel)

→ 5 regions in pT(W/Z) : pT(W/Z) < 50 GeV, 50 < pT(W/Z) < 100 GeV, 100 < pT(W/Z) < 200 GeV, pT(W/Z) > 200 GeV
→ 3 regions in ET,miss : 120 < ET,miss < 160 GeV, 160 < ET,miss < 200 GeV, ET,miss > 200 GeV

SM background

- In the W(lν)H channel, the dominant backgrounds are top, W+jets and mutijets processes, followed by diboson (WW, WZ, ZZ) and Z+jets contributions.
- In the Z(ll)H channel, the background contributions come from Z+jets, top and diboson production.
- The Z(νν)H channel also receives contributions from W(lν)H with undetected leptons in the final state. The background contributions are dominated by Z+jets, top, W+jets and diboson production.

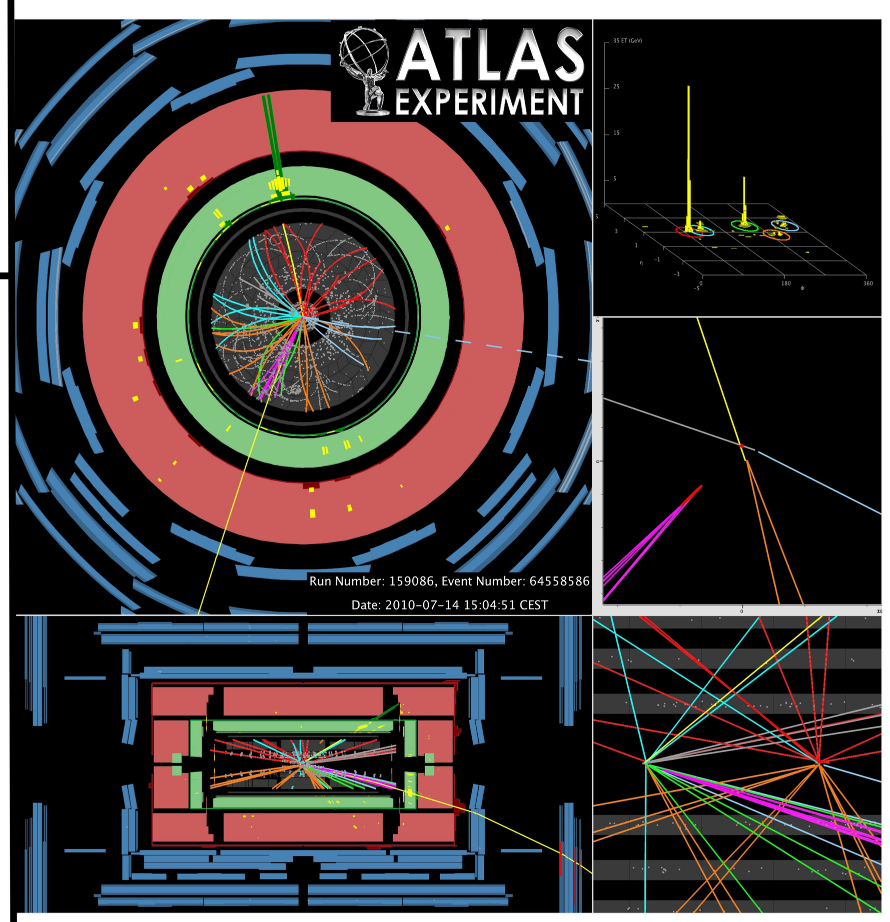
The shape of the M$_{bb}$ distribution for top and W+jets processes is taken from simulation and their normalization is constrained in top-enriched control regions and using the sidebands of the M$_{bb}$ measurement.

Similarly, the Z+jets normalization is determined from data using a dilepton control sample outside the Z-mass peak and the M$_{bb}$ sidebands.

The flavour composition (b-jets, c-jets and light-quark jets) of W/Z+jets contributions are determined from a fit to the secondary vertex discriminant in W/Z+2jets events.

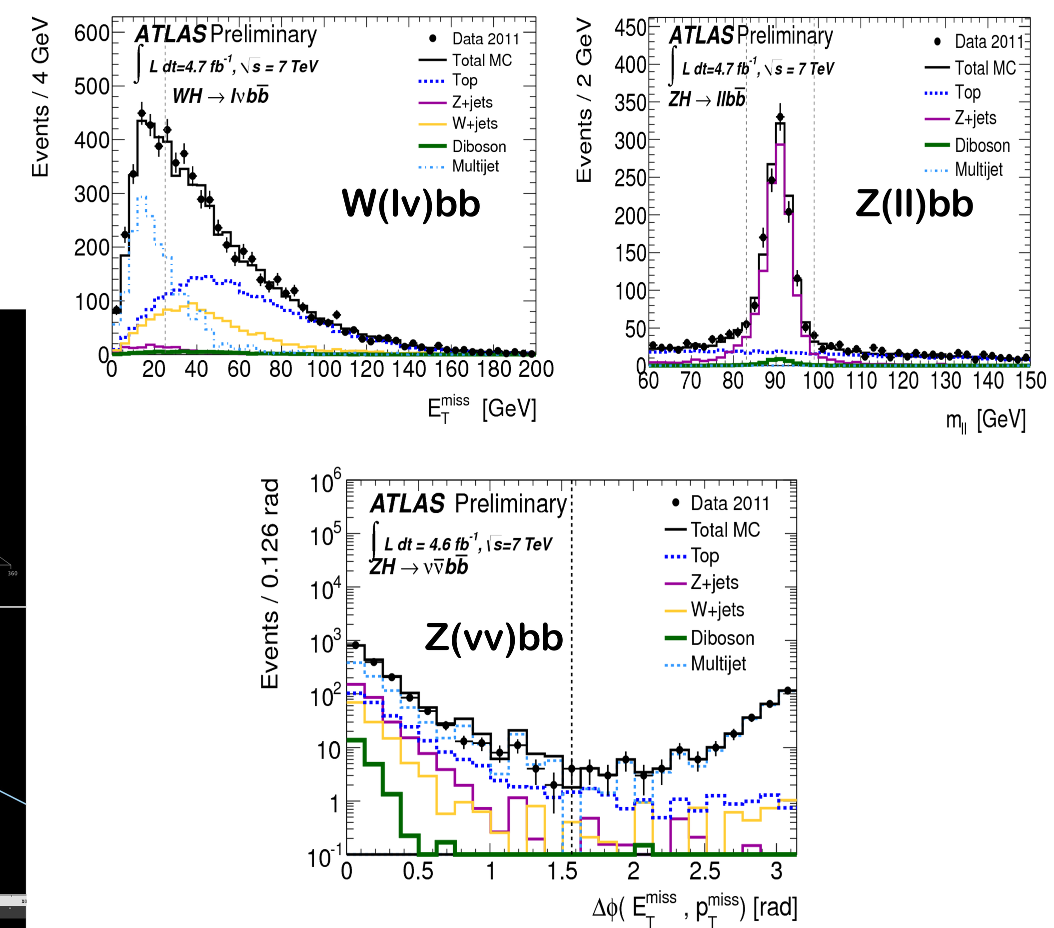
The background contribution from multijets is estimated from data in control regions dominated by QCD-jets.

Diboson processes are estimated from simulations normalized to NLO predictions.



ATLAS event display of a top-quark candidate as background contribution to the SM Higgs

The Figures below show relevant distributions for each final state after all selection criteria are applied apart from that on the variable shown (as indicated by the dashed lines).



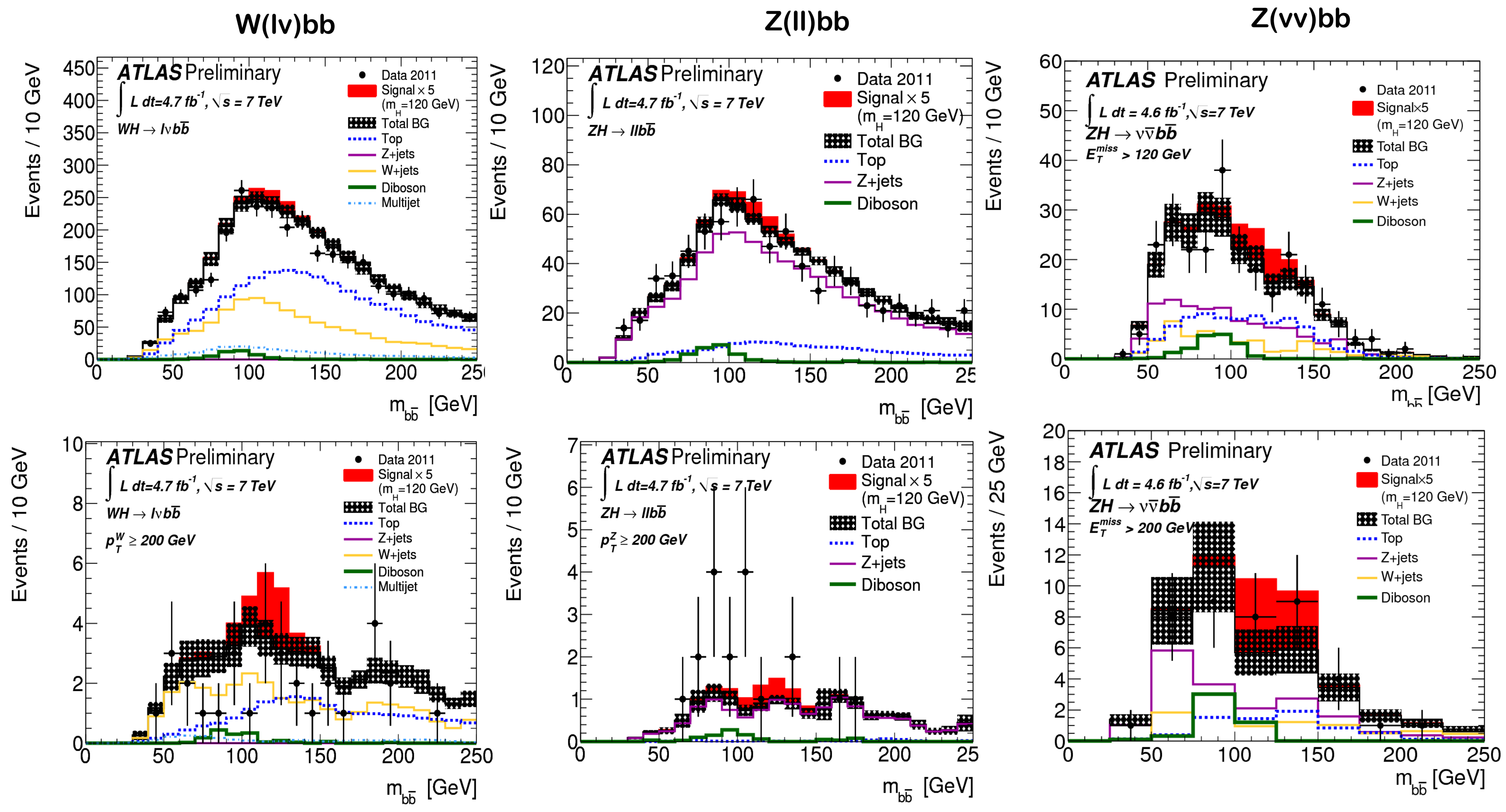
Sources of systematic uncertainty considered were those affecting: the efficiency, momentum or energy of physics objects reconstructed in the ATLAS detector, the normalization and shape of the invariant mass distribution for the signal and background processes, and the absolute luminosity.

Results

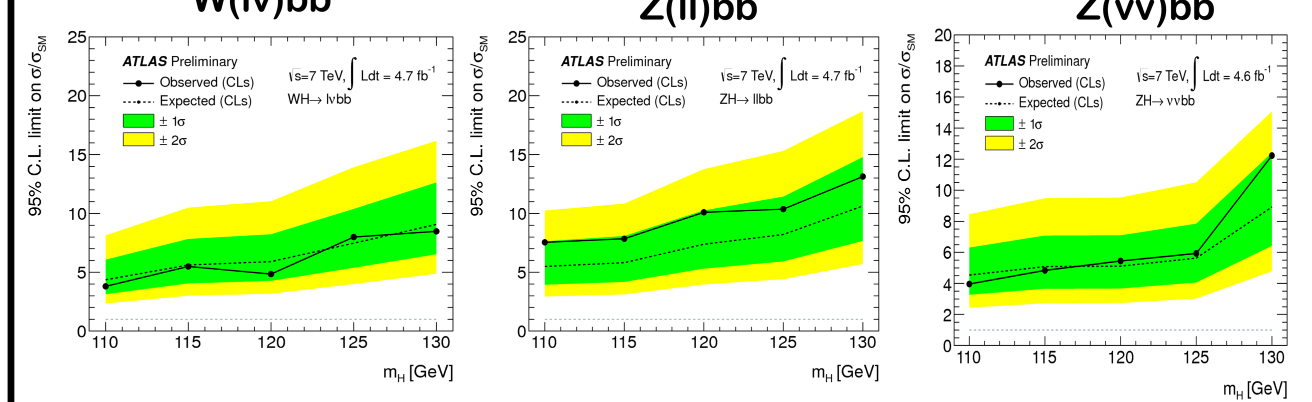
Good agreement observed between data and the background (no SM Higgs) predictions. In the table below the results for the highest pT(W/Z) and ET,miss regions are shown, together with the expectations for a Higgs boson with 120 GeV mass.

80 < M$_{bb}$ < 150 GeV	Events in data pT(W/Z), ET,mis > 200 GeV	Background pT(W/Z), ET,mis > 200 GeV	SM Higgs signal (Mass = 120 GeV) pT(W/Z), ET,mis > 200 GeV
W(lν)bb	15	23±4	1.4±0.3
Z(ll)bb	13	6±2	0.4±0.1
Z(νν)bb	24	20±5	1.8±0.5

Figures below present the measured bb invariant mass distribution for the different channels for all the selected events and in the highest pT(W/Z) and ET,miss regions considered.



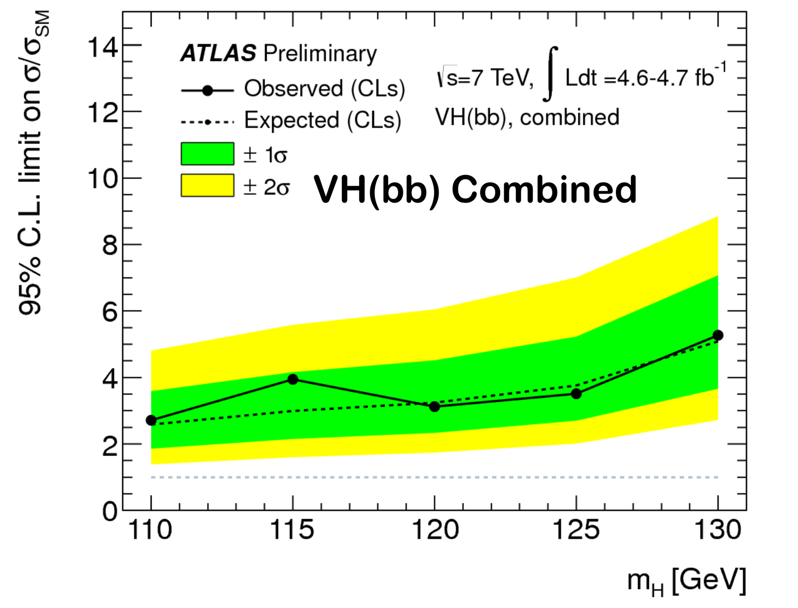
95% C.L. limits



Different channels are combined to obtain final limits on SM Higgs.

95% C.L. upper limits on Higgs boson production of 2.7 to 5.3 times the SM cross section for M$_{bb}$ within 110-130 GeV.

The expected exclusion limits range between 2.6 and 5.1 for the same mass interval.



(*) For more details see http://cdsweb.cern.ch/record/1429664