3. Search for the Standard Model Higgs Boson produced in association with a Vector Boson and decaying to a pair of b-quarks

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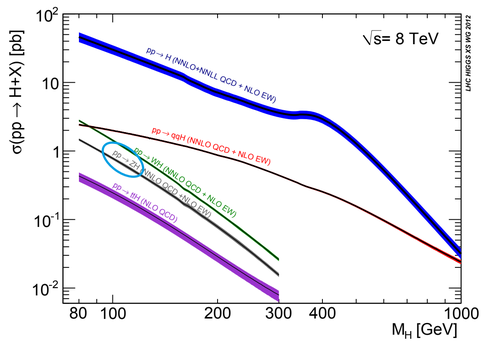
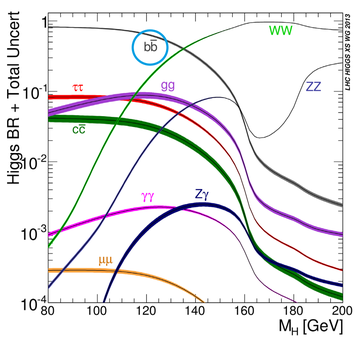
Since its discovery a large effort has been made to improve the sensitivity of analyses and make precision measurements of the properties of the Higgs Boson. At a mass of 125 GeV Higgs to bb is the dominant decay mode, however large QCD backgrounds mean that the gluon-gluon fusion production mode is not directly accessible at the LHC. Instead an analysis of Higgs to bb is considered where the Higgs is produced in association with a Vector Boson (W/Z). An ATLAS analysis of the full 7 + 8 TeV run 1 data is presented.

MOTIVATION

At 125 GeV the Higgs preferentially decays to a b-quark pair. Observing the Higgs coupling to fermions is important to confirm the SM Higgs hypothesis. Higgs to $b\bar{b}$ can supply direct constraint on coupling to quarks, specifically the b-quark.

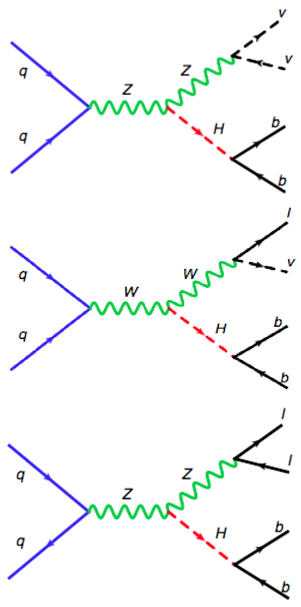




Unfortunatly high multi-jet background makes search of its inclusive production impossible. Associated production mechanisms are utilised in order to reduce these backgrounds.

SEARCH STRATEGY

Three channels, 0-, 1- and 2- lepton (e or μ) are simultaneously explored and combined to maximise the sensitivity of the search.



- Veto loose leptons
- E_T^{Miss} › 120 GeV
- p_T^{Miss} › 30 GeV
- QCD rejection cuts

- 1 tight lepton
- 0 loose leptons
- E_T^{Miss} › 25 GeV
- m_{W^T} ‹ 120 GeV

- 1 medium + 1 loose lepton
- No further loose leptons
- 83 ‹ m_{ll} ‹ 99 GeV
- E_T^{Miss} ‹ 60 GeV

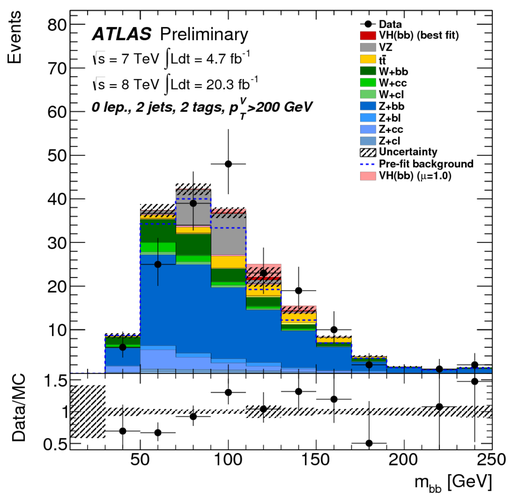
All events must contain 2 or 3 jets, of which exactly 2 are *b*-tagged, with lead *b*-jet pT › 45 GeV.

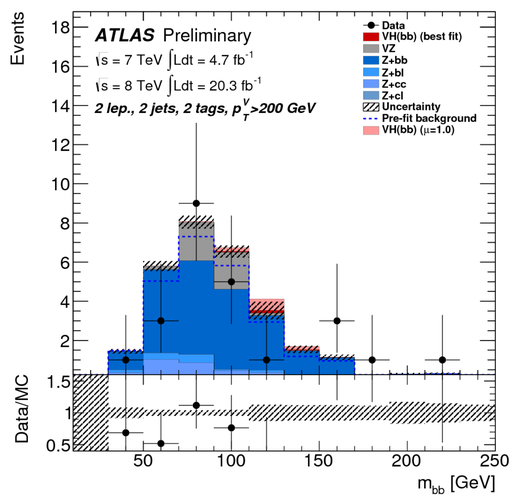
Events are categorised based on njet and p^T_V in order to exploit different S/B and increase overall sensitivity

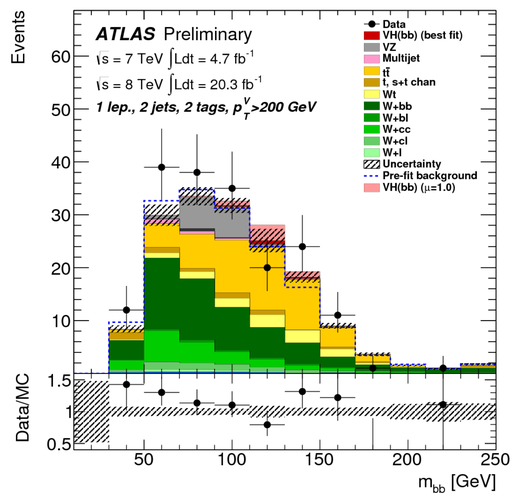
Category dependant ΔR_{bb} selection cuts help to improve modelling and increase sensitivity of the search

GLOBAL FIT

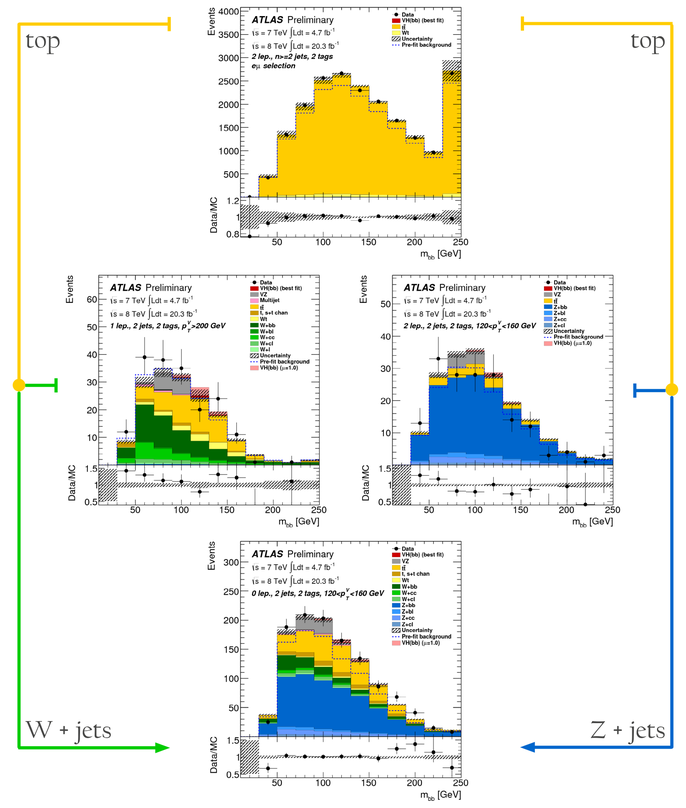
Perform analysis simultaneously in 0-, 1- and 2- lepton channels using a global binned likelihood fit to 26 2 b-tag signal regions and 31 control regions. The table below shows regions used in the fit and the backgrounds they help constrain, examples of some post fit plots are also shown for 0-, 1- and 2- lepton in the p^T_V › 200 GeV bin.







Even in the VH channel S/B is still small. The remaining background is made up of a diverse selection of processes over a wide phase space. Interplay between the different control regions regions guide the fit and constrain the different backgrounds.



Normalisation of $t\bar{t}$, Wb, Wcl, Zb, and Zcl backgrounds are allowed to float freely in the fit

QCD backgrounds are derived through data driven methods, other backgrounds are contrained by theoretical uncertainties

Common nuisance parameters across the regions, additional systematics placed on extrapolations of the backgrounds between regions

	2 Jet, 1 b-Tag	3 Jet, 1 b-Tag		2 Jet, 2 b-Tag		3 Jet, 2 b-Tag	Top e-μ CR
0-lepton	W+jets/Z+jets	W+jets/Z+jets/Top		Z+b/Top		Z+b/Top	-
1-lepton	W+c	W+c	Top	W+b	Top	Top	-
2-lepton	Z+c	Z+c		Z+b		Z+b	Top

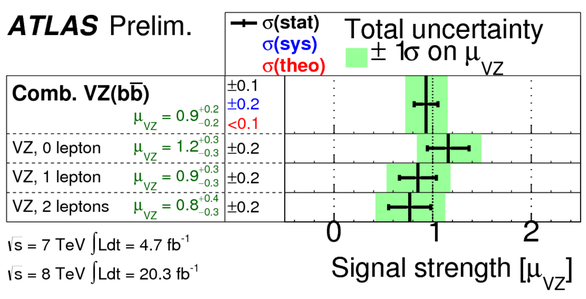
VALIDATION

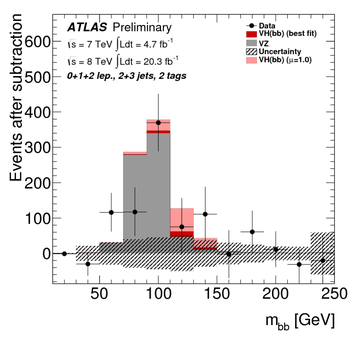
By using a similar SM process, VZ(bb) it is possible to validate the fit. VZ(bb) is a known SM signal with a cross-section five times that of VH(bb).

VZ(bb) is observed at 4.8 sigma, a best fit signal strength is measured

$\mu = 0.9 \pm 0.2$

Consistent with SM expectation





RESULTS

Results show no significant excess. For a m_H = 125 GeV Higgs Boson the observed (expected) upper-limit on the cross-section times the branching ratio was found to be 1.4 (1.3) times the standard model prediction

A best fit signal strength is measured

$\mu = 0.2^{+0.7}_{-0.6}$

Measurement compatible with SM both with and without SM Higgs