Search for a heavy resonance decaying into a Z/W boson and a Higgs boson in final states with leptons and b-jets with the ATLAS detector

ICHEP poster session, Bologna

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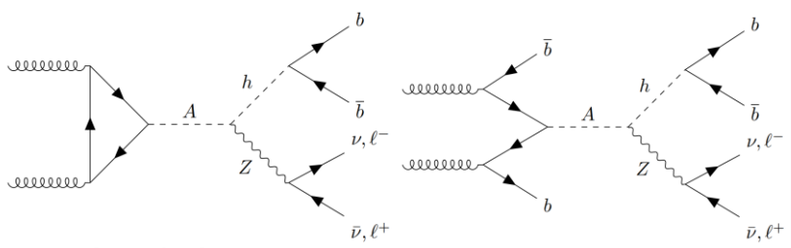
Introduction

- Search for a heavy resonance decaying into a Z/W boson and a SM Higgs boson in the $\ell^+\ell^- b\bar{b}$, $\ell^{\pm}\nu b\bar{b}$ and $\nu\bar{\nu}b\bar{b}$ final states
- Use full Run 2 ATLAS data corresponding to an integrated luminosity of 139 fb^{-1}
- Examine reconstructed invariant mass or transverse mass distributions of the Zh / Wh system
- No significant deviation from the SM has been observed
- Set 95% confidence level (CL) upper limits on the signal production cross section for a mass range of 220-5000 GeV
- Result interpreted in two Higgs doublet models (2HDM) or Heavy Vector Triplet models (HVT)

Signals

2HDM

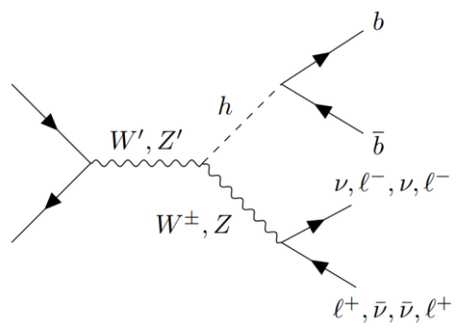
- Two complex scalar Higgs doublets
- Five Higgs bosons: two neutral CP-even bosons (h and H), two charged scalar bosons (H^+ and H^-) and a neutral CP-odd boson (A)
- Models specified by the Yukawa couplings of the Higgs doublets: type I, type II, lepton-specific and flipped



gluon fusion production (ggA) **b-associated production (bbA)**

HVT

- Simplified model with an additional SU(2) field
- Two new heavy vector bosons (W', Z') couple to SM particles
- Models specified by coupling strengths of the new field to SM fermions and gauge bosons: Type A and Type B

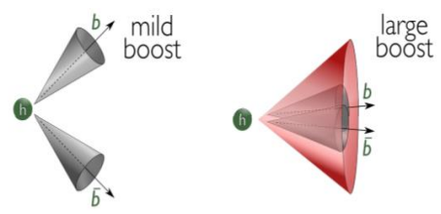


Drell–Yan production

Analysis Strategy

- Search for localised excess in the reconstructed invariant or transverse mass distributions of the Zh or Wh candidates
- Higgs boson candidates are reconstructed from either two small-radius jets (anti-k_T R=0.4) or one large-radius jet (anti-k_T R=1.0)
- Requiring at least one b-tagged small-radius jet or track jet associated with the large-radius jet
- Use 70% b-tagging efficiency working point

Resolved **Merged**



Backgrounds and Event Selections

Common selection

Jet p_T, mass of the Higgs boson candidate

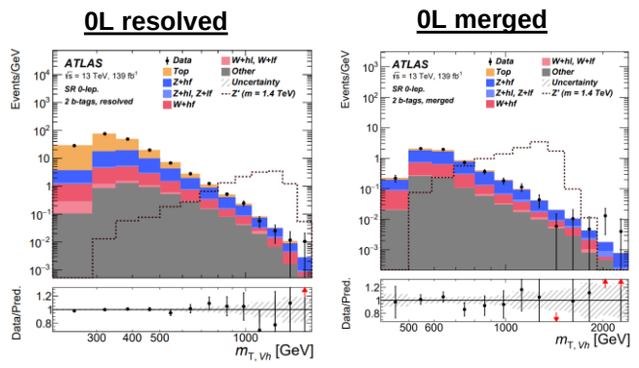
0 lepton channel

Missing transverse momentum, angular separation between jets and missing transverse energy

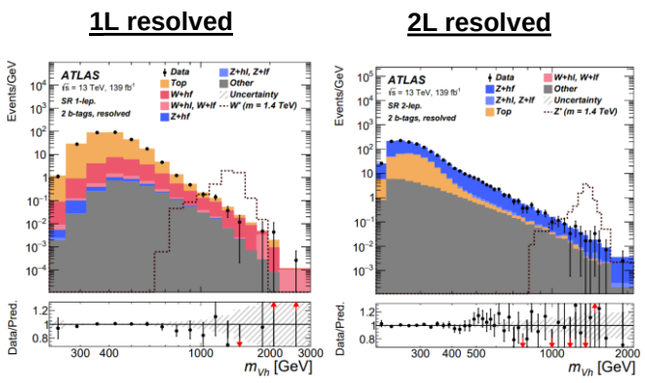
1,2 lepton channel

Lepton p_T, missing transverse energy, mass and p_T of the W/Z boson candidate

0L resolved **0L merged**

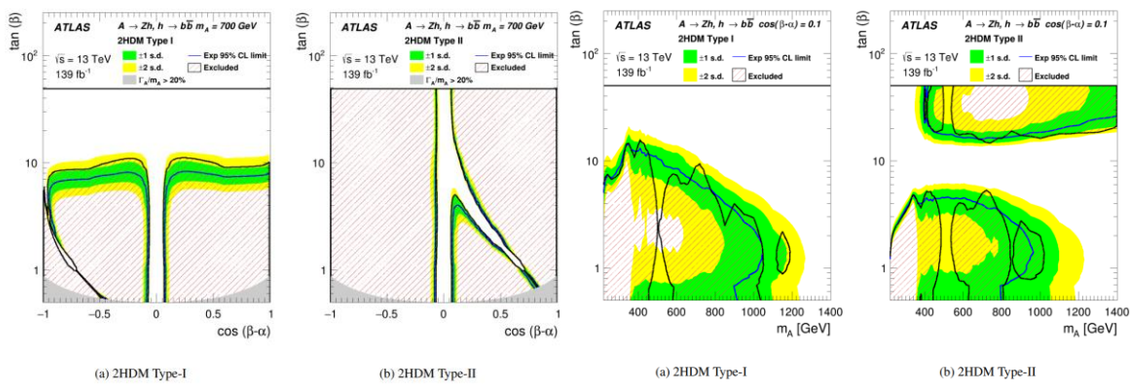


1L resolved **2L resolved**

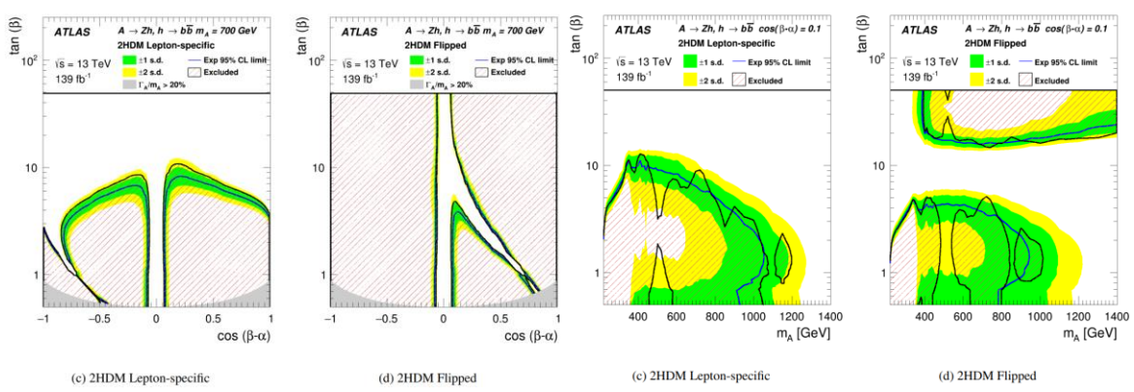


2HDM interpretation

- 2HDM parameters, α and β, describe the coupling of the Higgs doublets to the Standard Model particles (α is the mixing angle between two CP-even Higgs bosons, β is the ratio between vacuum expectation values)
- Exclusion limits set on the m_A-tanβ space and the cos (β - α)-tanβ space



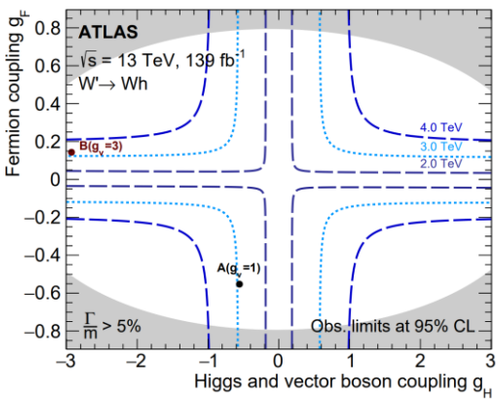
(a) 2HDM Type-I (b) 2HDM Type-II (a) 2HDM Type-I (b) 2HDM Type-II

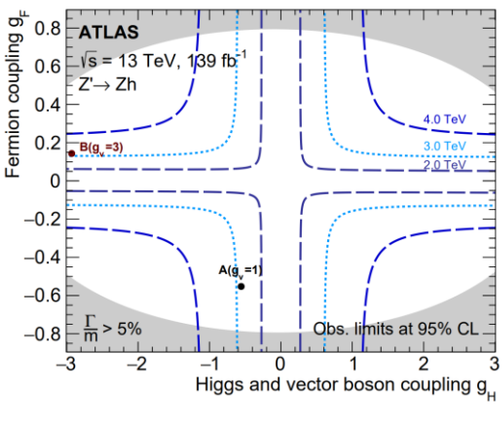


(c) 2HDM Lepton-specific (d) 2HDM Flipped (c) 2HDM Lepton-specific (d) 2HDM Flipped

HVT interpretation

Exclusion limits on the HVT parameters: fermion coupling g_F and Higgs and vector boson coupling g_H.

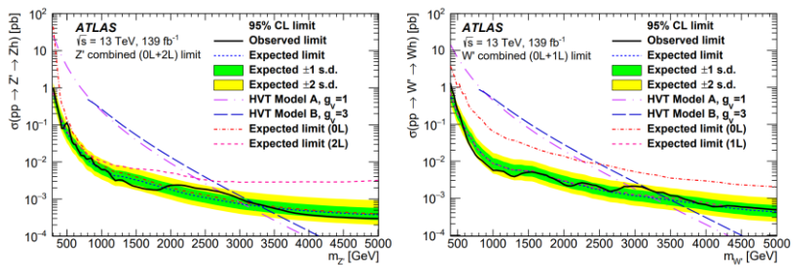




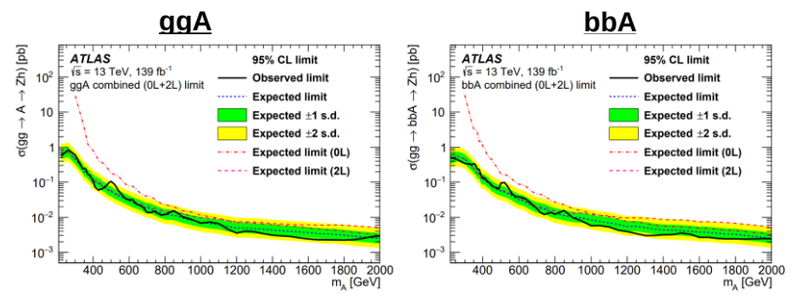
Results

- Combine the $\nu\bar{\nu}b\bar{b}$ + $\ell^+\ell^- b\bar{b}$ channels for ggA, bbA and Z' searches, and the $\nu\bar{\nu}b\bar{b}$ + $\ell^{\pm}\nu b\bar{b}$ channels for W' search
- Results are compatible with the Standard Model prediction
- Largest excess has a local significance of around 2σ

Z' **W'**



ggA **bbA**



Summary

- Search for a heavy resonance performed using ATLAS full Run 2 data corresponding to an integrated luminosity of 139 fb^{-1}
- No significant excess observed, and 95% confidence level (CL) upper limits set for the mass range 220-5000 GeV
- Expected limits on cross sections improved from about 50% for a resonance mass of 220 GeV to about 400% for a mass of 5 TeV with respect to the 36.1 fb^{-1} results
- Results interpreted in 2HDM models and HVT models.

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ATLAS EXPERIMENT