PROCEEDINGS OF SCIENCE

Search for Higgs with H $\to WW^* \to l\nu l\nu (l = e, \mu)$ decay mode with the ATLAS detector at LHC

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This poster presents a Higgs boson search in the channel $H \to WW^* \to l\nu l\nu (l = e, \mu)$ over a large mass range from 120 to 240 GeV using an integrated luminosity of about 1 fb^{-1}. No significant excess has been observed (the largest excess being 2.7 σ at mass values around 130 GeV), exclusion limits have been derived excluding a Standard Model Higgs from 158 to 186 GeV at 95% confidence level.

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1. Introduction

The Standard Model (SM) of particle physics describes 12 types of fermions (six quarks and six leptons), 4 types of vector gauge bosons (gluon, photon, W, Z), one scalar particle, the Higgs boson. All the particles of the SM have been observed except for the Higgs boson, which appears as a consequence of the breaking of electroweak symmetry and is responsible for giving masses to all other massive particles. The $H \to WW^* \to l\nu l\nu$ channel has high sensitivity in the intermediate mass range of $120 < M_H < 240\,\text{GeV}$ which covers most of the range preferred by the global electroweak fits [2]. A Higgs boson search in the $H \to WW^* \to l\nu l\nu$ decay mode has been performed using $1.04\,\text{fb}^{-1}$ of proton-proton collision data at a centre-of-mass energy of 7 TeV collected with the ATLAS detector [1].

2. Event Selection

The pp collision events are preselected to have a primary vertex with at least three tracks that is consistent with the beam spot position. Overall quality criteria are applied to suppress fake E_T^{miss} produced by non-collision activities such as cosmic rays, beam-related backgrounds, or noise in the calorimeter. A $H \to WW^* \to l\nu l\nu$ candidate sample is obtained by selecting two opposite sign isolated leptons with no additional leptons in the event, and by imposing other kinematic selection cuts described is as follows:

$$P_{T,e}\text{>25 GeV, 20 GeV (leading, subleading)}, |\eta| < 2.47 \text{ (excluding } 1.37 < |\eta| < 1.52)\,,$$
$$P_{T,\mu}\text{>25 GeV, 15 GeV (leading, subleading)}, |\eta| < 2.4\,.$$

In each event, cuts on E_T^{miss}, M_{ll}, $P_{T,ll}$ are applied to suppress Drell-Yan (γ^*, Υ, Z) background contributions. The remaining events are then categorized by number of jets as H+0-jet and H+1-jet cases before topological cuts. The M_T distribution after all cuts in the H+0-jet case for an example mass value of 150 GeV is shown on the left plot of Figure 1.

3. Background Estimation

Several data driven methods are performed to normalize the background by using the control samples selected from data.

- WW control region: $M_{ll} > 80\,\text{GeV}$ after Z veto ($|M_{ll} - M_Z| > 15\,\text{GeV}$) for the same flavours.
- Top control region:
  H+0-jet: Using jet veto survival probability, which is calculated based on a b-tagged control sample, to estimate the full jet veto survival probability of both $t\bar{t}$ and single top events. [3]
  H+1-jet: Requires the presence of a b-jet.
- Z+jet: Data are divided into four regions in two dimensional plane of E_T^{miss} and invariant mass of two leptons. Ratio of events with high E_T^{miss} over all events in a Z mass window is used to scale the MC prediction to data in the signal region.

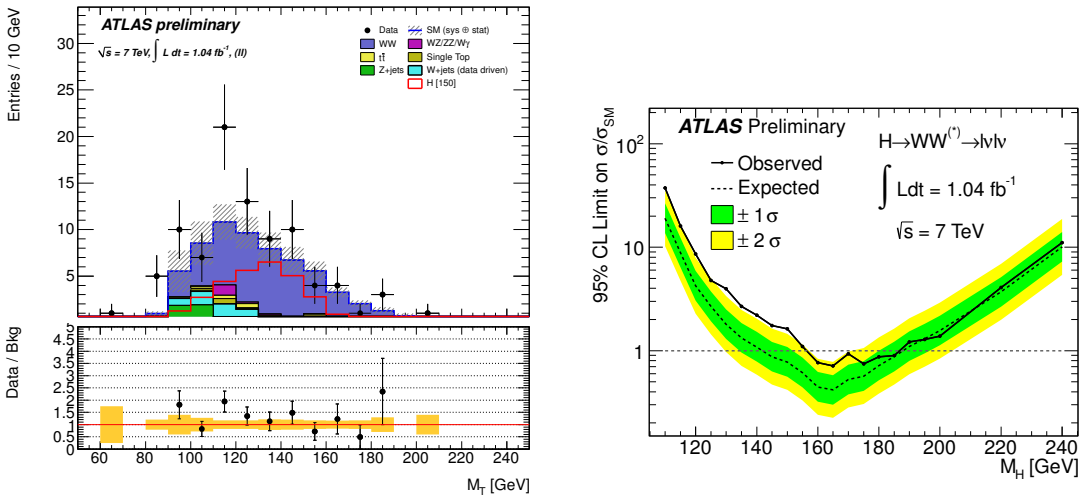

Figure 1: Left: M_T distribution after all cuts in H+0-jet case for a 150 GeV Higgs mass. Right: Exclusion limits at 95% confidence level using 1.04 fb^{-1} 2011 collision data.

- W+jets: A control sample is defined with one lepton satisfying tight lepton identification and isolation cuts, the other lepton satisfying only loose identification and isolation cuts. In a jet enriched sample fake rate is estimated as the number of fakeable(loose) leptons that pass the tight lepton identification. The accuracy of the fake rate has been checked by estimating W+jets in a same-sign control sample.

4. Results

No significant evidence of the SM Higgs boson is found in this search. The SM Higgs boson with a mass in the range from 158 GeV to 186 GeV is excluded at 95% confidence level, while the expected Higgs boson mass exclusion range is $142 < M_H < 186$ GeV. An excess of events in data corresponding to more than 2σ significance is observed for the Higgs boson mass range from 126 GeV to 158 GeV, with the largest deviation being 2.7σ for a Higgs boson mass of 130 GeV. The exclusion limits as a function of Higgs mass are shown in the right plot of Figure 1.

References

[1] Atlas Collaboration, *Search for the Higgs boson in the* $H \rightarrow WW^* \rightarrow l\nu l\nu$ *decay mode with the ATLAS Detector* , [ATLAS-CONF-2011-124].

[2] The ALEPH, DELPHI, L3, OPAL, SLD, CDF, and D0 Collaborations, and the LEP Tevatron SLD Electroweak Working Group 2010, CERN-PH-EP-2010-095, 2010.

[3] B. Mellado, X. Ruan and Z. Zhang, *Extraction of Top Backgrounds in the Higgs Boson Search with the* $H \rightarrow WW^* \rightarrow ll + E_T^{miss}$ *Decay with a Full-Jet Veto at the LHC*, [arXiv:1101.1383], accepted for publication in Phys. Rev. D.