Search for Higgs with

H → WW* → lνlν(l = e, μ) decay mode with the ATLAS detector at LHC

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Introduction

The Standard Model (SM) of particle physics describes 12 fermions (six quarks and six leptons), four 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.

Why H->WW?

Sensitive in the intermediate mass range of 120 < mH < 240 GeV which covers most of the range preferred by the global electroweak fits.

A Higgs boson search in the *H→WW→lνlν(l = e, μ) decay mode has been performed using 1.04 fb⁻¹ of proton-proton collisions at a centre-of-mass energy of 7 TeV collected with the ATLAS detector.**

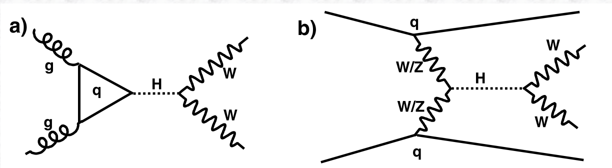


Figure 1: gluon-gluon fusion and vector boson fusion process

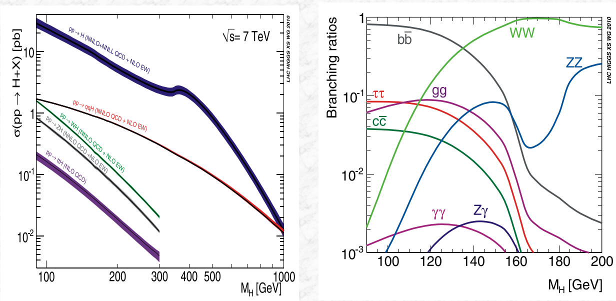


Figure . 2: Higgs Production cross section and decay branching ratio

Event Selection

$$m_T = \sqrt{(E_T^{ll} + E_T^{miss})^2 - (\mathbf{P}_T^{ll} + \mathbf{P}_T^{miss})^2}. \quad (2)$$

where $E_T^{ll} = \sqrt{|\mathbf{P}_T^{ll}|^2 + m_{ll}^2}$ [61], $|\mathbf{P}_T^{miss}| = E_T^{miss}$ and $\mathbf{P}_T^{ll}$ is the transverse momentum of the dilepton system.

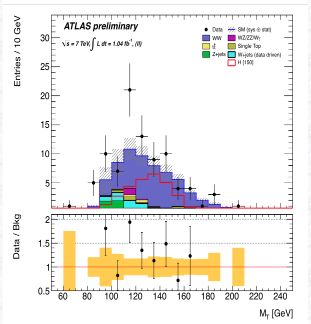


Figure 3: The transverse mass m_T distribution in the *H* + 0 jet analysis after all the cuts except for the cut on the m_T itself, for a selection of a Higgs boson with m_H = 150 GeV. Yellow band represents the systematic uncertainty.

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 activity such as cosmic rays, beam-related backgrounds, or noise in the calorimeter.

A *H→WW*→lνlν* candidate sample is obtained by selecting two opposite-sign isolated leptons with no additional leptons in the event, with a Pt threshold at 25GeV for leading lepton and 20GeV / 15GeV for subleading electron/muon.

In each event, cuts on E_T^{miss}, M_{ll}, P_{Tll} are applied to reject Drell Yan (γ*, Υ, Z) events. Then the events are categorized by number of jets (0 jet and 1 jet cases) before topological cuts.

Background Estimation

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

- **WW control region:** M_{ll}>80GeV (see figure 5)
- **Top control region:** H+0jet (see below), H+1jet (reverse b-jet veto)
- **Z+jet:** Data are divided into four regions in two-dimensional plane of E_T^{miss} and invariant mass with two leptons. (see figure 4)

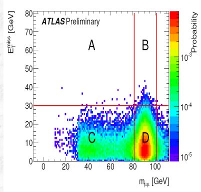


Figure 4. a scattered plot of $M_{\mu\mu}$ vs. E_t^{miss} in Monte carlo

$$A_{\rm MC}^{\rm corrected} = A_{\rm MC}\frac{B_{\rm data}}{B_{\rm data}+D_{\rm data}}\frac{B_{\rm MC}+D_{\rm MC}}{B_{\rm MC}}$$

- **W+jets:** control sample with one lepton required to satisfy the identification and isolation cuts, the other lepton required to satisfy only the loosened set of identification and isolation cuts. The former lepton is referred to as the "identified (id)" lepton and the latter as the "fakeable" (loose) lepton. Accuracy has been checked by estimating W+jets in same-sign control sample.

$$N_{\textbf{one id (from W) + one fake}} = \frac{N_{\textbf{id obj}}}{N_{\textbf{fakeable obj}}} \times N_{\textbf{one id (from W) + one fakeable}}$$

Estimated background — **W+iets normalization (observable)** — Fake factor (measured from dijet data)

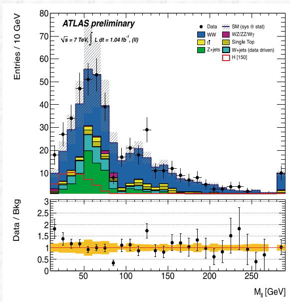


Figure 5: Invariant mass of two leptons after jet veto

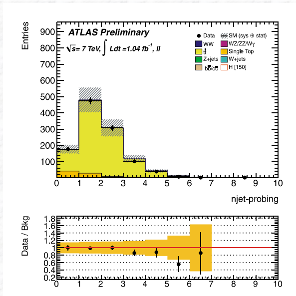


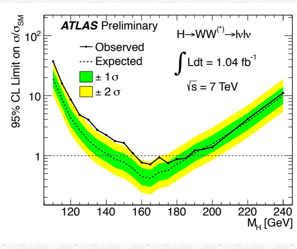
Figure 6: Number of probing jets (exclude the b-tagged jet) in top control region

Top background estimation in 0 jet channel: using jet veto survival probability (P_1^{Btag}, calculated from number of probing jets in control sample, 0jet bin/all bins) to estimate the full jet veto survival probability of both double and single top.

$$N^{\rm Exp}(ll+E_T^{\rm miss},0j) = \frac{N_{\rm Top}^{\rm Exp,control}}{N_{\rm Top}^{\rm MC,control}} N_{\rm Top}^{\rm MC}(ll+E_T^{\rm miss},0j)$$

$$N_{\rm Top}^{\rm Exp/MC,control} = N_{\rm Top}^{\rm Exp/MC}(ll+E_T^{\rm miss})\left(P_1^{\rm Btag,Exp/MC}\right)^2$$

Results



No significant evidence of a Standard Model Higgs boson is found. A 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<186GeV. An excess of events in data corresponding to more than 2 σ significance is observed for the Higgs boson mass range from 126GeV to 158GeV, with the largest deviation being 2.7 σ for a Higgs boson mass of 130GeV.

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