SPP

CEA-Saclay

Direction des Sciences de la Matière

Institut Laboratoire de recherche sur les lois fondamentales de l'Univers

Search for the Standard Model Higgs boson in the $H \to WW^{(*)} \to l\nu l\nu$ decay mode using 1.7 fb^{-1} of data collected with the ATLAS detector at $\sqrt{s}$ = 7 TeV

Meng Xiao on behalf of ATLAS Collaboration

Introduction

All the particles of the Standard Model have been observed except for the Higgs boson. This particle, which appears as a consequence of the breaking of electroweak symmetry, is responsible for giving masses to all particles.

Why $H \to WW^{(*)}$?

The $H \to WW^{(*)} \to l\nu l\nu$ (l = e, μ) channel is particularly sensitive in the intermediate mass range $120 < m_H < 240$ GeV which covers most of the range preferred by the global electroweak fits. It takes advantage of the large branching ratio for Higgs bosons decaying to WW when $m_H \geq 130$ GeV.

Searches use 1.7 fb^{-1} of $p\,p$ collisions at $\sqrt{s}$ = 7 TeV recorded in the spring and summer of 2011.

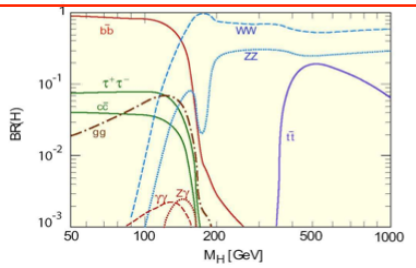

Figure 1: Higgs decay branching ratio

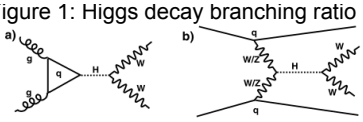

Figure 2: gluon-gluon fusion and vector fusion processes.

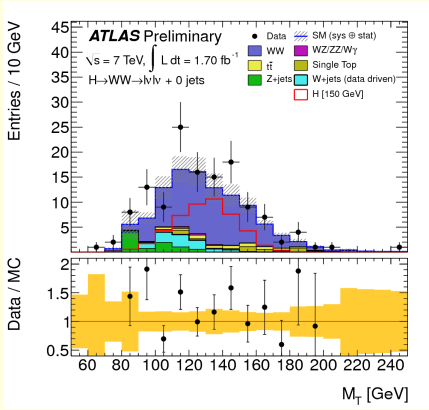

Figure 3: The transverse mass m_T distribution in the H + 0 jet analysis after all the cuts except for the cut on the m_T itself. The expected signal is shown for m_H = 150 GeV.

Signal signature:

- **2 high p_T leptons**
- **high missing energy**
- **small jet activity**

- **Background**
  - ***WW***
  - ***Single top and ttbar:***
  - ***W+jet***
  - ***Z+jet***
  - ***WZ/ZZ/WY***

Event Selection

- **Preselection**: a primary vertex with at least three tracks
- **Opposite sign dilepton events with high missing energy**
  - Leading lepton $p_T > 25$ GeV, sub-leading muon (electron) $p_T > 15$ (20) GeV.
  - $E_T^{Miss}(rel) > 40(25)$ GeV for ee, μμ (eμ), Δφ is between E_T^{Miss} and the nearest lepton or jet

$$E_T^{Miss}(rel) = \begin{cases} E_T^{Miss}, if \Delta\varphi > \pi/2 \\ E_T^{Miss} \cdot \sin(\Delta\varphi), if \Delta\varphi \leq \pi/2 \end{cases}$$

- **Analysis is split by jet multiplicity in 0,1,2 jets cases**
  - Dilepton p_T cut in 0-jet to suppress Drell-Yan
  - b-veto in 1-jet analysis to reject ttbar and single top
- Common topological cuts in 0,1,2 jets analysis

$$-m_H < 170 GeV$$
$$m_{ll} < 50 GeV, \Delta\varphi_{ll} < 1.3, 0.75 \cdot m_H < m_T < m_H$$
$$-170 \leq m_H < 220 GeV$$
$$m_{ll} < 65 GeV, \Delta\varphi_{ll} < 1.8, 0.75 \cdot m_H < m_T < m_H$$
$$-m_H \geq 220 GeV$$
$$50 < m_{ll} < 180 GeV, 0.6 \cdot m_H < m_T < m_H$$

Background estimation

Most of the backgrounds estimation is using control region in data to normalize simulation, the control region is defined as

•WW

removing $\Delta\varphi_{ll}$ and m_T cuts
$m_{ll} > 80$ GeV ($m_H < 220$ GeV)
$m_{ll} > 180$ GeV or $m_{ll} < 50$ GeV ($m_H \geq 220$ GeV)

•Top (1 jet)

reversing the b-jet veto cut
removing the cuts on $\Delta\varphi_{ll}$, m_{ll}, and m_T

•W+jet

loosening one of the lepton isolation and identification cut

In other cases

• Z+jet

Applying scale factors for potential Missing E_T mis-modeling

•WZ/ZZ/WY

Directly from simulation

•Top (0 jet)

$$N_{\mathrm{Top}}^{\mathrm{Bkg}}(0\text{-jet}) = N_{\mathrm{Top}}^{Data} \times \mathrm{SF} \times \frac{N_{\mathrm{Top}}^{\mathrm{MC}}(0\text{-jet})}{N_{\mathrm{Top}}^{\mathrm{MC}}}$$

- N^{Data} is top events from data after preselection, other background contribution is extracted using MC
- SF is from control sample, asking b-tag jets.
- prob jet defined as jet with dR>0.1 to the b-jet
- $SF = (P^{btag,data} / P^{btag,MC})^2$, P^{btag} is the fraction of events with no prob jet in data or simulation

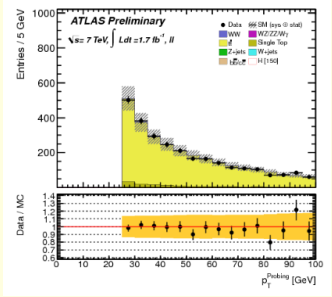

Figure 4: in H+0 jet analysis, top control region probing jet pt distribution

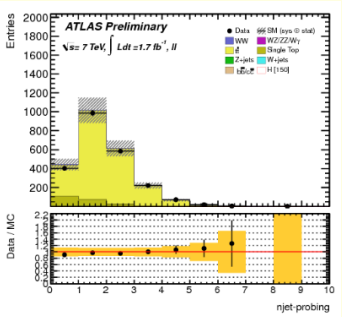

Figure 5: in H+0 jet analysis, top control region probing jet multiplicity distribution

Result

- A 95% Confidence Level upper bound is set on the Higgs boson production rate as a function of m_H using the Profile Likelihood Ratio and the CLs formalism .
- Standard Model Higgs boson with 154 GeV to 186 GeV is excluded at 95% Confidence Level.

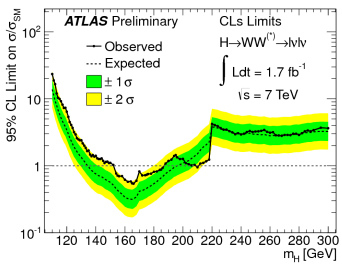

Figure 6: The expected (dashed) and observed (solid) 95% Confidence Level upper limits on the cross-section, normalized to the Standard Model cross-section, as a function of the Higgs boson mass.