

# Measurement of the Higgs boson transverse momentum spectrum in the $WW$ decay channel at 8TeV and first results at 13TeV

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# Abstract

The cross section for Higgs boson production in pp collisions is studied using the  $H \rightarrow W^+W^-$  decay mode, followed by leptonic decays of the W bosons, leading to an oppositely charged electron-muon pair in the final state. The measurements are performed using data collected by the CMS experiment at the LHC with pp collisions at a centre-of-mass energy of 8TeV, corresponding to an integrated luminosity of  $19.4\text{fb}^{-1}$ . The Higgs boson transverse momentum ( $p_T$ ) is reconstructed using the lepton pair  $p_T$  and missing  $p_T$ . The differential cross section times branching fraction is measured as a function of the Higgs boson  $p_T$  in a fiducial phase space defined to match the experimental acceptance in terms of the lepton kinematics and event topology. The production cross section times branching fraction in the fiducial phase space is measured to be  $39 \pm 8 \text{ (stat)} \pm 9 \text{ (syst)}\text{fb}$ . The measurements are compared to theoretical calculations based on the standard model to which they agree within experimental uncertainties.



# Contents

<b>1</b>	<b>Electroweak and QCD physics at LHC</b>	<b>3</b>
<b>2</b>	<b>The CMS experiment at the LHC</b>	<b>5</b>
<b>3</b>	<b>Objects reconstruction with CMS</b>	<b>7</b>
<b>4</b>	<b>Higgs boson properties in the <math>H \rightarrow WW</math> decay channel</b>	<b>9</b>
<b>5</b>	<b>Measurement of the Higgs boson transverse momentum at 8TeV using <math>H \rightarrow WW \rightarrow 2\ell 2\nu</math> decays</b>	<b>11</b>
5.1	Introduction . . . . .	11
<b>6</b>	<b>First <math>H \rightarrow WW</math> results at 13 TeV</b>	<b>13</b>
<b>7</b>	<b>Conclusions</b>	<b>15</b>









# Chapter 1

## Electroweak and QCD physics at LHC



## **Chapter 2**

# **The CMS experiment at the LHC**



## Chapter 3

# Objects reconstruction with CMS



## Chapter 4

Higgs boson properties in the  
 $H \rightarrow WW$  decay channel





# Chapter 5

## Measurement of the Higgs boson transverse momentum at 8TeV using $H \rightarrow WW \rightarrow 2\ell 2\nu$ decays

### 5.1 Introduction

The discovery of a new boson consistent with the standard model (SM) Higgs boson has been reported by ATLAS and CMS Collaborations in 2012. The discovery has been followed by a comprehensive set of studies of properties of this new boson in several production and decay channels and no evidence of deviation from the SM expectation has been found so far. The CMS studies in the  $H \rightarrow WW \rightarrow 2\ell 2\nu$  decay channel include the measurement of the Higgs properties, as well as constraints on the Higgs total decay width and gauge bosons anomalous couplings.

In this section the measurement of the transverse momentum spectrum of the Higgs boson, produced in proton-proton collisions at a center-of-mass energy of  $\sqrt{s} = 8\text{TeV}$ , is reported. This measurement can be used to directly inspect the perturbative QCD theory in the Higgs sector. In particular the  $p_T^H$  variable is sensitive to the Higgs production mode and the differential distribution in this variable can be used to inspect the effects of the top quark mass in the gluon fusion top loop. Moreover, any observed deviation from the SM expectation, especially in the tail of the  $p_T^H$  distribution, could be a hint of physics beyond the SM.

Similar measurements have already been performed by CMS and ATLAS experiments

in the  $ZZ$  and  $\gamma\gamma$  Higgs decay channels. The measurement reported here is the first measurement of the Higgs  $p_T$  spectrum in the  $WW$  decay channel.

The cross section has been measured in a fiducial phase space defined using generator level variables in order to mimic the experimental acceptance and reduce the systematic uncertainties on the procedure of extrapolating the results in a larger phase space.

The Higgs transverse momentum has been reconstructed calculating the vector sum of the dilepton system transverse momentum plus missing transverse energy

$$\vec{p}_T^H = \vec{p}_T^{\ell\ell} + \vec{p}_T^{\text{miss}} \quad (5.1)$$

The signal has been extracted subtracting all backgrounds by means of a binned Maximum Likelihood fit and has been then corrected for the efficiency of the analysis selections and for the detector resolution effects using an unfolding procedure.

The differential measurement has been performed in six bins of  $p_T^H$  with variable widths, chosen to have approximately the same purity in each bin, as explained in section ??.

## Chapter 6

### First $H \rightarrow WW$ results at 13 TeV



## Chapter 7

## Conclusions





