國立清華大學

物理系

碩士學位論文

利用 ATLAS 偵測器探討由向量玻色子融合產生希格斯玻色子之 W 玻色子對衰變與其 WW 背景估計

Estimation of the WW background in the Vector Boson Fusion $H \rightarrow WW^{(*)}$ Analysis with the ATLAS Detector

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By

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Abstract

We present ....

摘要

此論文探討...

Acknowledgements

特別感謝...

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Chapter 1

Introduction

1.1 The Discovery of the Higgs Boson

The Higgs boson is discovered ..

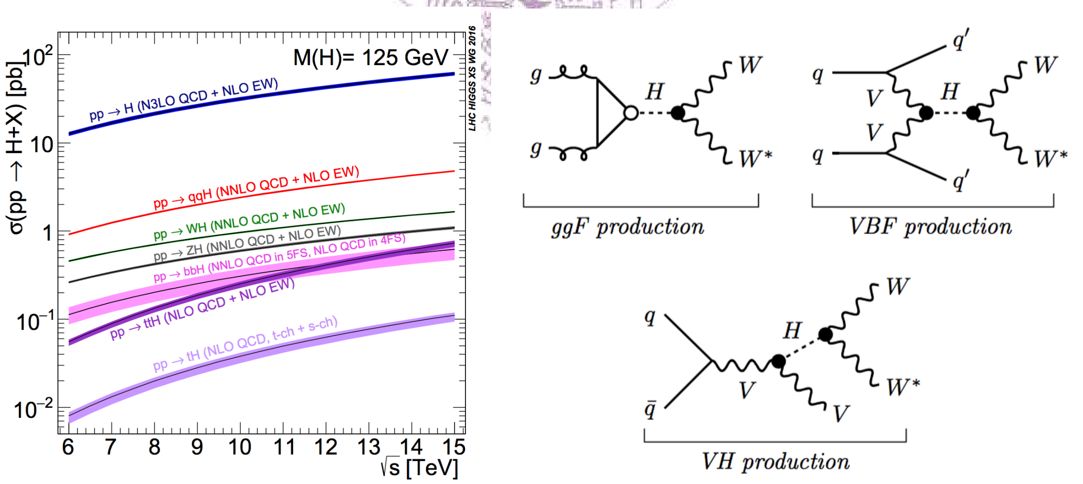

Figure 1.1: Expected cross-sections of the productions of the Higgs bosons (left). The Feynman diagrams of the leading production modes of the Higgs boson which further decays to $WW^{(*)}$ (right). Letter "V" represents a W or Z boson [3].

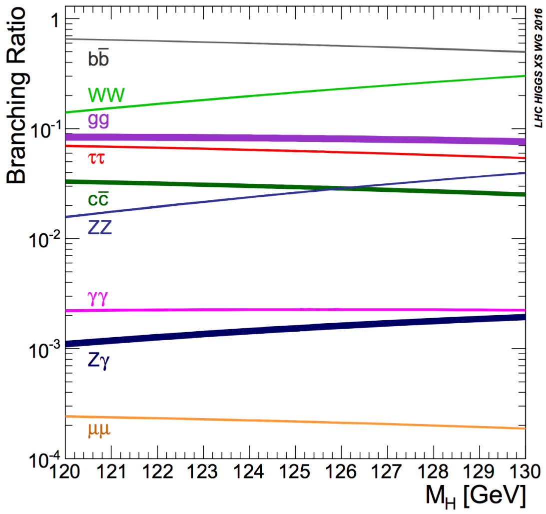

Figure 1.2: Branching ratios of decays of Higgs bosons [5].

Chapter 2

The ATLAS experiment

2.1 The ATLAS detector

The ATLAS detector [3, 6] is used for this analysis. ...

...

2.2 Data and MC samples

2.2.1 Data samples

The data samples ...

2.2.2 MC samples

...

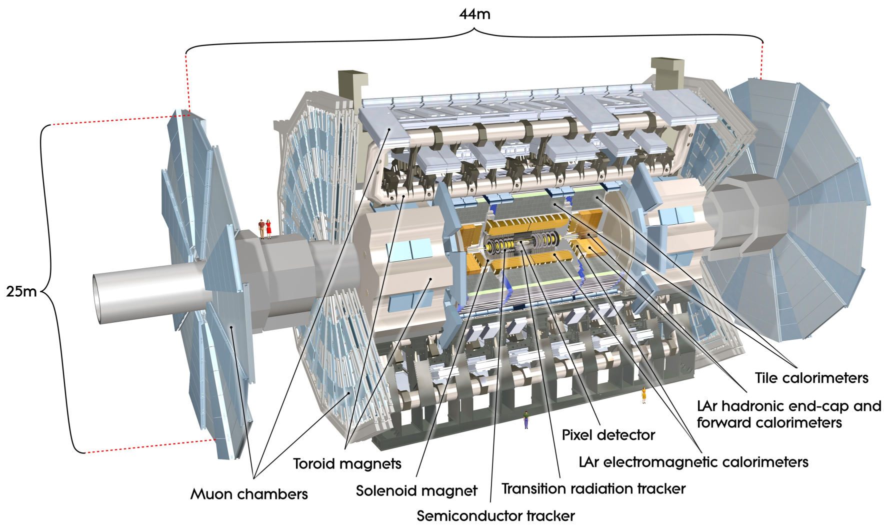

Figure 2.1: The structure of ATLAS detector [6].

Chapter 3

VBF $H \rightarrow WW^* \rightarrow \ell\nu\ell\nu$ analysis

This chapter is organized as follow. Section 3.1 provides ...

3.1 Common event selection

...

- Exactly two opposite charged and different flavor leptons ($e\mu + \mu e$)
- $p_{\mathrm{T}}^{\mathrm{lead}} > 22$ GeV, $p_{\mathrm{T}}^{\mathrm{sublead}} > 15$ GeV
- $m_{\ell\ell} > 10$ GeV

3.2 Construction of the VBF phase space

3.2.1 Experimental signature of VBF Higgs boson

The VBF production is characterized ...

3.2.2 Event selection for VBF-enriched phase space

After the common event selection ...

Table 3.1: Ranking of the BDT training variables [8].

Ranking	Variable	Importance [%]
1	$\mathrm{m_{jj}}$	19
2	$\mathrm{y_{jj}}$	zz
3	$\mathrm{m_{ll}}$	xx
4	m_T	yy
5	lepton η centrality	zz
6	ϕ_{ll}	aa
7	$\sum_{\mathrm{l,j}} \mathrm{M_{lj}}$	bb
8	$\mathrm{p_{tot}^{T}}$	cc

Table 3.2: Event yields in the VBF SR after fitting. Event yields in the highest BDT bin are also presented. The uncertainties include systematic and statistical uncertainties [9].

Process	$N_{\mathrm{jet}} \geq 2$ VBF	
	Inclusive	BDT: $[0.86, 1.0]$
H_{ggF}	42 ± 16	6 ± 3
H_{VBF}	xx ± yy	zz ± xx
WW	xx ± yy	zz ± xx
VV	xx ± yy	zz ± xx
$t\bar{t}/Wt$	xx ± yy	zz ± xx
Mis-Id	xx ± yy	zz ± xx
Z/γ^*	xx ± yy	zz ± xx
Total	xx ± yy	zz ± xx
Observed	2164	60

3.3 Results of VBF analysis in Run-2

The signal strength μ is the ratio of the measured signal yields to the signal yields predicted by the SM. The signal strength for VBF analysis in our final publication [9] is shown below:

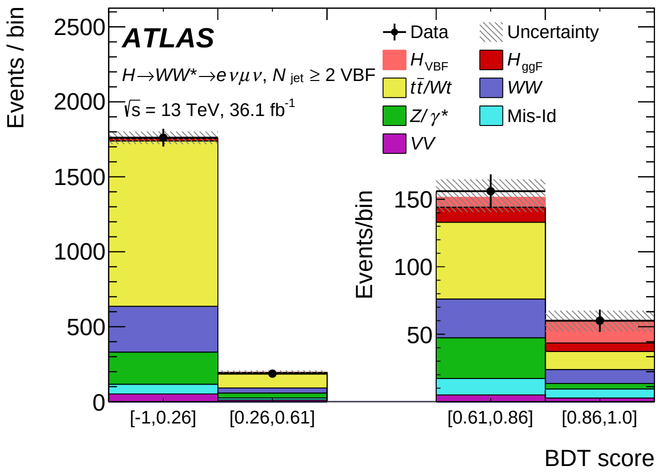

Figure 3.1: Distribution of BDT scores in the VBF SR after fitting is shown. The hatched error band shows the total uncertainty of signal and background MC prediction [9].

$$\mu_{\rm VBF} = 0.62^{+0.29}_{-0.27}(\text{stat.})^{+0.12}_{-0.13}(\text{theo syst.}) \pm 0.15(\text{exp syst.}) = 0.62^{+0.36}_{-0.35}. \tag{3.1}$$

Chapter 4

The estimation of WW background

In this chapter, ...

4.1 Normalization factor

4.2 Construction of a WW CR

4.2.1 m_T and m_{T2} variables

Chapter 5

Conclusion and Outlook

Appendix A

Appendix

A.1 Event displays for Higgs boson candidates

A.2 Re-estimation of WW theoretical uncertainties with the modified p_T^{tot} variable

A.3 Optimization of the selections for VBF phase space

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