



Università degli studi di Padova  
Dipartimento di Fisica e Astronomia

Tesi di Dottorato

# Search for heavy resonances decaying into a $Z$ boson and a vector boson in the $\nu\nu\ q\bar{q}$ final state at CMS

Supervisor: Prof. Franco Simonetto  
Candidate: Lisa Benato

Scuola di Dottorato di Ricerca, XXX ciclo



"I have no special talent. I am only passionately curious."  
(A. Einstein)



# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>Theoretical motivation</b>	<b>3</b>
2.1	Beyond Standard Model theories . . . . .	3
2.1.1	Warped extra dimension . . . . .	3
2.1.2	Heavy Vector Triplet . . . . .	3
<b>3</b>	<b>Data and Monte Carlo samples</b>	<b>5</b>
<b>4</b>	<b>Physics objects</b>	<b>7</b>
<b>5</b>	<b>Diboson candidate reconstruction</b>	<b>9</b>
<b>6</b>	<b>Background estimation</b>	<b>11</b>
<b>7</b>	<b>Systematic uncertainties</b>	<b>13</b>
<b>8</b>	<b>Results</b>	<b>15</b>
<b>9</b>	<b>Conclusions</b>	<b>17</b>



**<sub>1</sub> Abstract**





---

# Chapter 1

## Introduction

This analysis searches for signal of heavy resonances decaying into a pair of heavy vector bosons. One Z boson is identified through its invisible decay ( $\nu\nu$ ), while the other is required to decay hadronically into a pair of quarks. The final states probed by this analysis therefore consists in two quarks and two neutrinos, reconstructed as missing transverse energy (met). The hadronically decaying boson (Z, W) is reconstructed as a fat jet, whose mass is used to define the signal region. Two purity categories are exploited, based on the n-subjettiness of the fat jet.

The search is performed by examining the distribution of the diboson reconstructed transverse mass of the resonance VZ (mtVZ) for a localized excess. The shape and normalization of the main background of the analysis (V+jets) are estimated with an hybrid approach using the distribution of data in the sidebands, corrected for a function accounting for potential differences between the signal region and the sidebands, while the minor background sources are taken from simulations. [?]



---

## <sup>17</sup> Chapter 2

### <sup>18</sup> Theoretical motivation

#### <sup>19</sup> 2.1 Beyond Standard Model theories

##### <sup>20</sup> 2.1.1 Warped extra dimension

##### <sup>21</sup> 2.1.2 Heavy Vector Triplet



---

## <sup>22</sup> Chapter 3

### <sup>23</sup> Data and Monte Carlo samples



---

## Chapter 4

24

## Physics objects

25





---

## <sup>26</sup> Chapter 5

### <sup>27</sup> Diboson candidate reconstruction



---

## <sup>28</sup> Chapter 6

### <sup>29</sup> Background estimation



---

## <sup>30</sup> Chapter 7

## <sup>31</sup> Systematic uncertainties

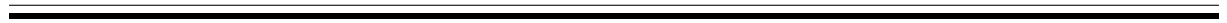


## <sup>32</sup> Chapter 8

## <sup>33</sup> Results







## <sup>34</sup> Chapter 9

## <sup>35</sup> Conclusions