Universitat Autònoma de Barcelona

Ph.D. thesis

January 2014

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Searches for new physics in $t\bar{t}$ pair production at the Large Hadron Collider

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Professore: Lei ha una qualche ambizione?

Nicola: Ma... Non...

Professore: E Allora vada via... Se ne vada dall'Italia. Lasci l'Italia finché è in tempo. Cosa vuole fare, il chirurgo?

Nicola: Non lo so, non ho ancora deciso...

Professore: Qualsiasi cosa decida, vada a studiare a Londra, a Parigi... Vada in
3 America, se ha le possibilità, ma lasci questo Paese. L'Italia è un Paese da distruggere: un posto bello e inutile, destinato a morire.

Nicola: Cioè, secondo lei tra poco ci sarà un'apocalisse?

Professore: E magari ci fosse, almeno saremmo tutti costretti a ricostruire... Invece qui rimane tutto immobile, uguale, in mano ai dinosauri. Dia retta, vada via...

da La meglio Gioventù *di M.T. Giordana (2003)*

Introduccion

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Introduction

Chapter 1

The ATLAS experiment

Chapter 2

Going beyond the Standard Model

The Standard Model (SM) of particle physics is the most successful, beautyful and precise theory describing the interactions between fundamental particles. Its validity has been tested by precision measurements at the Large Electron-Positron Collider (LEP) at CERN and confirmed by the observation of all the particles it predicts, including the Higgs-like boson discovered at the Large Hadron Collider (LHC) in July of 2012 which up to now behaves as expected from the SM.

What makes the SM "only" and effective theory is the fact that unstabilities appear at high energy scales of the order of the Planck mass. In this Chapter we will show

2.1 Building the Standard Model

2.2 New Physics Models predicting vector-like quarks

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Chapter 3

Objects reconstruction

3.1 Electrons

3.2 Muons

3.3 Jets

3.4 Missing Transverse Energy

Chapter 4

Monte Carlo simulation

4.1 Parton shower

4.2 Hadronization

4.3 Underlying-event

4.4 Generators

Chapter 5

Search for vector-like top partners pairs decaying to $Wb + X$

5.1 Data sample

5.2 Monte Carlo simulated samples

5.2.1 SM processes

5.2.2 Signal samples

5.3 Multi-jet background

5.4 Object definition

5.4.1 Boosted W reconstruction

5.5 Control regions

5.6 Event selection

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Chapter 6

Statistical treatment and Results

6.1 The CL_s method

6.2 Systematics

6.3 Results

Conclusions

Appendix A

Appendix B

Appendix C

Search for $T\bar{T} \to Wb{+}X$ at $\sqrt{7}$ TeV

Appendix D

Preliminary search for $T\bar{T} \to Ht+X$

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