

#### Universiteit Gent

#### **DOCTORAL THESIS**

## Search for heavy neutral leptons in events with three charged leptons in pp collision at $\sqrt{s}=13$ TeV at CMS detector

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A thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

in the

Experimental Particle Physics Department of Physics and Astronomy "porca paletta."

MV

#### **UNIVERSITEIT GENT**

#### Summary

Faculty Name Department of Physics and Astronomy

Doctor of Philosophy

Search for heavy neutral leptons in events with three charged leptons in pp collision at  $\sqrt{s}=13$  TeV at CMS detector

by Martina VIT

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too...

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For/Dedicated to/To my...

#### Introduction

introduction

# Part I Physics introduction

#### The Standard Model and Beyond

- 1.1 Introduction
- 1.2 The Standard Model of Elementary Particles
- 1.3 The mathematical framework of the Standard Model

#### 1.4 Beyond the Standard Model

#### 1.4.1 ?Heavy Neutral Leptons?

#### The LHC and the CMS Experiment

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- 2.3.6 The muon detector
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- 2.4 Event reconstruction
- 2.4.1 Track reconstruction
- 2.4.2 Reconstruction performances

# Part II Search for heavy neutral leptons

#### Theory introduction to HNL

- 3.1 Heavy neutral leptons
- 3.1.1 Previous and current results

### Search for HNL in events with three charged prompt leptons

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- 4.7.1 Low mass results
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- 4.7.3 Summary
- 4.8 Interpretation
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- 4.9 Conclusion

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- 5.1.1 Displaced signature at CMS
- 5.2 Signal simulation
- 5.3 Datasets
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Muons

#### **Electrons**

- 5.5.2 Displaced vertices
- 5.5.3 Displaced leptons

Muons

**Electrons** 

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- 6.2 Displaced HNL analysis possible improvements
- 6.3 HNL searches perspectives and LHC and beyond
- 6.4 Conclusions

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#### **Frequently Asked Questions**

#### A.1 How do I change the colors of links?

The color of links can be changed to your liking using:

\hypersetup{urlcolor=red}, or

\hypersetup{citecolor=green}, or

\hypersetup{allcolor=blue}.

If you want to completely hide the links, you can use:

\hypersetup{allcolors=.}, or even better:

\hypersetup{hidelinks}.

If you want to have obvious links in the PDF but not the printed text, use:

\hypersetup{colorlinks=false}.

#### Acknowledgements

The acknowledgments and the people to thank go here, don't forget to include your project advisor...