ETH ZÜRICH

DOCTORAL THESIS

Same-sign dileptons as a search tool at CMS

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D-PHYS

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Declaration of Authorship

I, Marc Dünser, declare that this thesis titled, 'Same-sign dileptons as a search tool at CMS' and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed: ______________________________

Date: ______________________________

"Thanks to my solid academic training, today I can write hundreds of words on virtually any topic without possessing a shred of information, which is how I got a good job in journalism."

Dave Barry

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Abstract

Faculty Name
D-PHYS

Doctor of Science

Same-sign dileptons as a search tool at CMS

by Marc Dünser

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…

Acknowledgements

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

For/Dedicated to/To my…

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Chapter 1

Introduction

The construction of the Large Hadron Collider (LHC) and its experiments at CERN in Geneva over the few last decades has been just the last step in a long and successful history of particle accelerators that started roughly 100 years ago. Just as the first specimens of its kind, the LHC serves – first and foremost – the purpose of fundamental research. It has been conceived in order to answer some of the most fundamental questions of modern day physics, such as *'how do particles acquire mass?'* or *'what is dark matter?'*. Despite the purely scientific origin of these questions and the improbability of any 'practical' application from any possible answer to them, it is important to note that fundamental research in general and the research at the LHC in particular do serve a greater and more applicable purpose.

The invention of the world wide web and HTML FIXME(CITE), early developments on touch screens, research on medical physics with high-power magnet systems as well as medical imaging and the use of high energy ion beams for tumor treatment are only a few examples of the direct consequences on daily life which fundamental research on particle physics entails.

This thesis is dedicated almost exclusively to data analysis of high-energy particle collisions which took place in the CMS experiment at the LHC. By looking at such collisions, the aforementioned question about the origin of mass has already been answered FIXME(CITE) with the discovery of the Higgs boson in 2012 by both the CMS and ATLAS collaborations. The second question, however, remains unanswered and the work presented in the following is largely devoted to a search for particles which could provide physicists with a suitable candidate for a dark-matter particle.

Chapter 2 describes the fundamentals of particle physics from a theoretical standpoint, Chapter FIXME will provide on overview of the CMS experiment. Chapters FIXME to FIXME will then describe the search for new physics etc. blabla.

Chapter 2

Theory

In order to interpret any experimental result, it is of paramount importance to understand the underlying model governing the physical processes in question. Modern physics knows a large number of rather successful theories all dedicated to describing different mass and energy scales. An example is the theory of classical mechanics, which manages to describe the physics of 'daily life' very well. However, it breaks down when velocities approach the speed of light and has to be incorporated into a broader theory, namely that of relativity.

This specific example already suggests that different physical theories are valid only in a certain energy range and describe only a certain 'type'[1] of physical process. This fact is also true for the case of particle physics. The relevant theory is called the *'Standard Model'* and will be described hereafter. Further into the chapter, a short description of the pitfalls of the standard model will be given with some explanation on possible solutions.

2.1 The Standard Model

The Standard Model (SM) of particle physics provides the theoretical framework that describes all fundamental particles and the forces that act between them, with the one exception of gravity. Despite a few drawbacks that will be described later (see Section XXX) it has been an overwhelmingly successful theory, capable of describing experimental data with a precision that is simply outstanding.

[1] In this particular example electromagnetic interactions are – for instance – not described at all.

Chapter 3

The Experiment

0.3×10^{45}

Appendix A

Dummy Appendix

You can defer lengthy calculations that would otherwise only interrupt the flow of your thesis to an appendix.

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Abbreviations

LAH **L**ist **A**bbreviations **H**ere

Physical Constants

Speed of Light $c = 2.997\,924\,58 \times 10^{8}\ \mathrm{ms}^{-\mathrm{S}}$ (exact)

Symbols

a	distance	m
P	power	W (Js^{-1})
ω	angular frequency	$rads^{-1}$

Bibliography

[1] Stephen P. Martin. A Supersymmetry Primer. 1997.