# SEARCH FOR DISPLACED LEPTONS IN THE ATLAS DETECTOR

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*Ohana* means family.
Family means nobody gets left behind, or forgotten.

— Lilo & Stitch

Dedicated to the loving memory of Rudolf Miede.

1939 – 2005

# ABSTRACT

Short summary of the contents. . . a great guide by Kent Beck how to write good abstracts can be found here:

https://plg.uwaterloo.ca/~migod/research/beckOOPSLA.html

# PUBLICATIONS

Some ideas and figures have appeared previously in the following publications:

Put your publications from the thesis here. The packages `multibib` or `bibtopic` etc. can be used to handle multiple different bibliographies in your document.

*We have seen that computer programming is an art,*
*because it applies accumulated knowledge to the world,*
*because it requires skill and ingenuity, and especially*
*because it produces objects of beauty.*

— Donald E. Knuth [1]

## ACKNOWLEDGEMENTS

Put your acknowledgements here.

Many thanks to everybody who already sent me a postcard!

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*Regarding LyX*: The LyX port was initially done by *Nicholas Mariette* in March 2009 and continued by *Ivo Pletikosić* in 2011. Thank you very much for your work and the contributions to the original style.

1 Members of GuIT (Gruppo Italiano Utilizzatori di TeX e LaTeX)

# CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# LISTINGS

IBL Insertable B-Layer

MS Muon Spectrometer

ID Inner Detector

SCT Silicon Microstrip Tracker

TRT Transition Radiation Tracker

ToT Time Over Threshold

MDT Monitored Drift Tube

CSC Cathode-Strip Chamber

RPC Resistive Plate Chamber

TGC Thin Gap Chamber

L1 Level One

HLT High Level Trigger

L1Calo L1 Calorimeter Trigger

L1Topo L1 Topological Trigger

CTP Central Trigger Processor

TTC Trigger Timing and Control

ROB Read Out Board

RoI Region of Interest

LHC Large Hadron Collider

LEP Large Electron-Positron

SPS Super Proton Synchrotron

ATLAS A Toroidal LHC Apparatus

CMS Compact Muon Solenoid

ALICE A Large Ion Collider Experiment

LHCb Large Hadron Collider beauty

RF Radiofrequency

PSB Proton Synchrotron Booster

PS Proton Synchrotron

OR Overlap Removal

EM Electromagnetic

MC Monte Carlo simulation

SM Standard Model

BSM Beyond the Standard Model

SUSY Supersymmetry

QCD Quantum Chromodynamics

PDF Parton Distribution Function

DM Dark Matter

LO Leading Order

NLO Next to Leading Order

NLO+NLL Next-to-Leading-Logarithmic Accuracy

SUSY Supersymmetry

MSSM Minimal Supersymmetric Standard Model

LSP Lightest Supersymmetric Particle

AOD Analysis Object Data

dAOD derived AOD

SR Signal Region

VR Validation Region

CR Control Region

FS Flavor Symmetric

CL Confidence Level

HL-LHC High Luminosity Large Hadron Collider

# Part I

# INTRODUCTION

# Part II

# THEORY AND MOTIVATION

# 1 THEORY

# 2 LONG LIVED PARTICLES

## 2.1 MOTIVATION

## 2.2 BASICS

# Part III

# EXPERIMENT

# 3

# PARTICLE ACCELERATORS

# 4

# THE ATLAS DETECTOR

# 5 DATA ACQUISITION

# 6 EVENT RECONSTRUCTION

Event reconstruction is the process by which detector signals are turned into objects that can be used for physics analysis. This is a complex process that requires a great deal of focused effort by the A Toroidal LHC Apparatus (ATLAS) collaboration. First, digital signals from the detector are collected into tracks and clusters, then they are combined to form first-stage physics objects. Then, a identification steps is performed, where quality requirements are placed on the first-stage objects to classify them into particles like electrons, muons, and jets that can be used in physics analyses.

These algorithms are centrally developed by the collaboration and designed to reconstruct and identify prompt objects ($|d_0| < 10|$mm). This section describes this process for objects which are relevant to this analysis, as well as the changes to these algorithms that we have implemented to be able to study displaced objects. Other objects, such as jets, taus, and missing transverse energy, are also reconstructed in this analysis, though the final event selection remains agnostic to their existence or quality, but does perform a overlap removal process to ensure that the same particle is not accidentally reconstructed as two different objects.

Reconstruction of tracks, including modifications to reconstruct tracks with high impact parameter, is described in Section 6.1. Electron and muon reconstruction, as well as their modifications, are described in Section 6.2 and Section 6.3, respectively.

## 6.1 TRACK RECONSTRUCTION

### 6.1.1 *Primary Vertex Identification*

### 6.1.2 *Large Radius Tracking*

## 6.2 ELECTRONS

### 6.2.1 *Standard Reconstruction and Identification*

### 6.2.2 *Modifications*

## 6.3 MUONS

### 6.3.1 *Standard Reconstruction and Identification*

### 6.3.2 *Modifications*

# Part IV

# SEARCH FOR DISPLACED LEPTONS

# 7 ANALYSIS STRATEGY

# 8 EVENT SELECTION

# 9 BACKGROUNDS

## 9.1 FAKES

### 9.1.1 *Electrons*

#### 9.1.1.1 *Identification*

#### 9.1.1.2 *Systematic Uncertainties*

### 9.1.2 *Muons*

#### 9.1.2.1 *Identification*

#### 9.1.2.2 *Systematic Uncertainties*

## 9.2 COSMICS

### 9.2.1 *Identification*

### 9.2.2 *Cosmic Events*

### 9.2.3 *Systematic Uncertainties*

## 9.3 OTHER BACKGROUNDS

### 9.3.1 *Heavy Flavor*

### 9.3.2 *Conversions*

### 9.3.3 *Material Interactions*

# 10 SYSTEMATICS

# 11

# RESULTS.TEX

## 11.1 SIGNAL YIELD

## 11.2 INTERPRETATION

## 11.3 FUTURE PROSPECTS

# Part V

# CONCLUSIONS

# Part VI

# APPENDIX

# BIBLIOGRAPHY

[1] Donald E. Knuth. "Computer Programming as an Art." In: *Communications of the ACM* 17.12 (1974), pp. 667–673.

# DECLARATION

Put your declaration here.

*Chicago, IL, July, 2020*

Lesya Horyn

## COLOPHON

This document was typeset using the typographical look-and-feel `classicthesis` developed by André Miede. The style was inspired by Robert Bringhurst's seminal book on typography "*The Elements of Typographic Style*". `classicthesis` is available for both LaTeX and LyX:

https://bitbucket.org/amiede/classicthesis/

Happy users of `classicthesis` usually send a real postcard to the author, a collection of postcards received so far is featured here:

http://postcards.miede.de/

*Final Version* as of December 11, 2019 (`classicthesis` version 0.0).