Search for supersymmetry in the single lepton final state in 13 TeV pp collisions with the CMS experiment

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This thesis is dedicated to
someone
for some special reason

Acknowledgements

bla bla bla bla

Abstract

FIXME The Standard Model of particle physics is like an old family car: likable but also with problems, like the hierarchy and the lack of explanation of Dark Matter. Many extensions of the Standard Model provide solutions to these problems, and Supersymmetry seems to be one of the most promising ones. A search for Supersymmetry in events with a single electron or muon is performed on proton-proton collisions at a center-of-mass energy of 13 TeV. The data were recorded by the CMS experiment during Run 2 of the LHC, corresponding to an integrated luminosity of 36.5 fb-1. The analysis is designed to look for signatures of the two different decays of pair-produced gluinos, superpartners of Standard Model gluons. In one of them each gluino decays to top quarks and a neutralino via a three-body decay. In the other one, each gluino decays to two light quarks and an intermediate chargino, with the latter decaying to a W boson and a neutralino. In these models, the neutralino is considered to be the stable lightest supersymmetric particle, or LSP. Hence, It is a strong candidate of Dark Matter. The main search variable of the analysis is the azimuthal angle between the lepton and four-vector sum of the missing energy and lepton. The angle for leading background processes tend towards low values while the expected signal events do not show dependence, due to the large missing transverse energy contribution from LSP. Thus, the region with high (low) values of this angle is chosen to be signal (control) region. To further increase the sensitivity several signal rich search regions are defined, based on the number of (b)jets, the scalar sum of all jet transverse momenta, and the scalar sum of the transverse missing momentum and transverse lepton momentum. The Standard Model background is estimated with a data-driven approach using control regions where no signal contribution is expected. Low jet multiplicity sidebands are used to obtain signal to control region transfer factor. Since no significant deviation from the predicted Standard Model background is observed, exclusion limits on gluino and neutralino masses are obtained.

Contents

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[ALICE] A Large Ion Collider Experiment

ATLAS A Toroidal LHC Apparatus

BSM Beyond the Standard Model

CERN European Organization for Nuclear Research

CM Center of Mass

CMS Compact Muon Solenoid experiment

CMSSW CMS SoftWare framework

DAQ Data Acquisition

ECAL Electromagnetic Calorimeter

HCAL Hadron Calorimeter

HF Hadron Calorimeter (Forward)

LHC Large Hadron Collider

LHCb the Large Hadron Collider Beauty Experiment

LINAC Linear particle Accelerator

PDG Particle Data Group

QFT Quantum Field Theory

SM Standard Model

SUSY Super Symmetry

GUT Grand Unified Theory

Chapter 1

Introduction

Bla bla

This thesis is organized as follows:

Chapter 2

Supersymmetry

Supersymmetry is an extension of the Standard Model of Particle Physics ..

2.1 Standard Model

2.1.1 Current Status of the Standard Model

Explain standard model particles Explain interations Maybe explain also latest experimental achivments supporting SM

2.1.2 Inadequacies of the Standard Model

Experimental and Theoratical puzzles..

2.2 Supersymmetry as a solution

2.2.1 Minimal Supersymmetric Standard Model

2.2.2 Short History of SUSY searches at colliders

Chapter 3

Experimental Setup

3.1 The LargeHadron Collider at CERN

3.1.1 The CERN accelerator complex

3.1.2 The future of the LHC

3.2 The Compact Muon Solenoid experiment at the LHC

3.2.1 Superconducting Magnet

3.2.2 Tracker

3.2.3 Electromagnetic Calorimeter

3.2.4 Hadron Calorimeter

3.2.5 Muon System

3.2.6 Trigger and Data Acquisition Systems

3.2.7 Luminosity measurement

3.2.8 Future of CMS

3.3 Event simulation

Chapter 4

Object reconstruction and identification

4.1 Particle-Flow algorithm

4.2 Physics Object reconstruction

4.2.1 Primery vertices

4.2.2 Electrons

4.2.3 Muons

4.2.4 Jets

4.2.5 b tagged Jets

mention fake rate

4.2.6 Missing transverse energy

Chapter 5

Event Selection

5.1 SUSY signature

kinematic variables DeltaPhi , HT , LT ....
Put inclusive plots which then will support baseline selection

5.2 Samples

5.2.1 Data Samples

Shortly explain triggers

5.2.2 MC Samples

5.3 Baseline selection

Chapter 6

Design of Search Regions

Explain MB , SB...

6.1 Signal Regions

6.1.1 Background and Signal composition in MB SR

6.2 Control Regions

6.2.1 Background composition in MB CR and SB SR/CR

6.2.2 Signal contamination in MB CR and SB SR/CR

Tell that It is negligible

Chapter 7

Background Estimation

7.1 R_{CS} method

refer background compositions from the previous chapter

7.1.1 R_{CS} method in ttbar events

Maybe mention: Previously : SB was 1 bjet events -¿ you studied the extension now
It is btagged region
Explain dilepton correction on kappa tt

7.1.2 R_{CS} method in w jets events

7.2 QCD background estimation

keep short you did nothing

7.3 Validation of the background estimation

Chapter 8

Systematic Uncertainties

8.1 Systemcatic Uncertanities on background estimation

8.1.1 Theoratical uncertinities

- $\sigma()$
- $\sigma(t\bar{t})$
- $\sigma(others)$

8.1.2 Experimental uncertinities

- Dilepton control sample
  will be long
- JES
- Tagging of b-jets
- W polarization
- nISR reweighting
- Pileup
- QCD

8.2 Systemcatic Uncertanities on signal modelling

- Trigger
- Pileup
- Lepton efficiency
- Luminosity
- ISR
- Tagging of b-jets
- JES
- Factorization/renormalization scale
- Reconstruction of MET

Chapter 9

Results and Interpretation

Chapter 10

Conclusion

Appendix A

Appendix