

ABSTRACT

SEARCH FOR CHARGED HIGGS BOSONS IN THE $\tau + \ell$ FINAL STATE WITH 36.1 fb⁻¹ OF pp COLLISION DATA AT $\sqrt{s} = 13$ WITH THE ATLAS EXPERIMENT

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This dissertation uses 139 fb⁻¹ of pp collision data collected at a center of mass energy of $\sqrt{s} = 13$ by the ATLAS detector to search for charged Higgs bosons decaying to a tau lepton and a neutrino ($H^\pm \rightarrow \tau^\pm \nu_\tau$) in association with a leptonically decaying top quark. No significant excess was found, therefore limits are set at the 95% confidence level on the charged Higgs production cross section times the branching fraction into the $\tau^\pm \nu_\tau$ ranging from XX pb to XX fb. These limits are interpreted in the hMSSM benchmark scenario as an exclusion at 95% confidence on $\tan\beta$ as a function of m_{H^\pm} . In this scenario, for $\tan\beta = 60$, the H^\pm mass range up to XXXX GeV is excluded, with all values of $\tan\beta$ excluded for $m_{H^\pm} \leq XXX \text{ GeV}$.

NORTHERN ILLINOIS UNIVERSITY
DE KALB, ILLINOIS

DECEMBER 2022

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EXPERIMENT**

BY

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A DISSERTATION SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE
DOCTOR OF PHILOSOPHY

DEPARTMENT OF PHYSICS

Dissertation Director:

Dhiman Chakraborty and Jahred Adelman

ACKNOWLEDGEMENTS

DEDICATION

To Dr. Dhiman Chakraborty. Thank you for everything.

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CHAPTER 1

THEORY

1.1 The Standard Model

1.1.1 Particles

NEEDS TO BE DONE

1.1.1.1 Fermions

NEEDS TO BE DONE

1.1.1.2 Bosons

NEEDS TO BE DONE

1.1.2 Interactions

NEEDS TO BE DONE

1.1.2.1 Electromagnetic Interaction

NEEDS TO BE DONE

1.1.2.2 Weak Interaction

NEEDS TO BE DONE

1.1.2.3 Strong Interaction

NEEDS TO BE DONE

1.1.3 The Higgs Mechanism

NEEDS TO BE DONE

1.2 Supersymmetry

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1.2.1 MSMM Particles

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1.2.2 R-Parity

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1.2.3 The MSSM Higgs Sector

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1.3 Charged Higgs Bosons

NEEDS TO BE DONE

1.3.1 Previous Result

NEEDS TO BE DONE

CHAPTER 2

THE LHC AND ATLAS EXPERIMENT

2.1 The Large Hadron Collider

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2.2 The ATLAS Detector

NEEDS TO BE DONE

2.2.1 Inner Detector

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2.2.1.1 Pixel

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2.2.1.2 Semiconductor Tracker

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2.2.1.3 Transition Radiation Tracker

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2.2.3.2 Cathode Strip Chambers

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2.2.3.4 Thin Gap Chambers

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2.2.4 Magnet Systems

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2.2.4.1 Solenoid Magnet

NEEDS TO BE DONE

2.2.4.2 Toroid Magnet

NEEDS TO BE DONE

CHAPTER 3

EVENT RECONSTRUCTION

3.1 Trigger

3.2 Inner Detector

3.3 Calorimeters

3.4 Muon

3.5 E Gamma

3.6 Jets

3.6.1 Flavor Tagging

3.6.2 Tau

3.7 $E_{\text{T}}^{\text{miss}}$

CHAPTER 4

SEARCH FOR CHARGED HIGGS BOSONS

4.1 Signature and Event Selection

NEEDS TO BE DONE

4.1.1 Object Definitions

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4.1.2 Event Selections

NEEDS TO BE DONE

4.2 Datasets

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4.2.1 Signal Modeling

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4.4.4 Hyperparameter Optimization

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4.5 Systematic Uncertainties

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4.6 Results

CHAPTER 5
CONCLUSION

Appendices

