

University of California
Santa Barbara

**Search for new physics using the M_{T2} variable in
all-hadronic final states produced in 13 TeV
proton-proton collisions with the CMS detector**

A dissertation submitted in partial satisfaction
of the requirements for the degree

Doctor of Philosophy
in
Physics

by

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July 2019

The Dissertation of Bennett J. Marsh is approved.

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July 2019

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Acknowledgements

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Curriculum Vitæ

Bennett J. Marsh

Education

- 2020 Ph.D. in Physics (Expected), University of California, Santa Barbara.
2018 M.A. in Physics, University of California, Santa Barbara.
2015 B.Sc. in Physics and Mathematics, Purdue University, West Lafayette, IN.

Publications

- CMS Collaboration, “Search for new physics with the M_{T2} variable in hadronic final states, with or without disappearing tracks, in proton-proton collisions at $\sqrt{s} = 13$ TeV.” [**CMS-PAS-SUS-19-005**] (*In progress*).
- CMS Collaboration, “Constraints on models of scalar and vector leptoquarks decaying to a quark and a neutrino at $\sqrt{s} = 13$ TeV.” *Phys. Rev.* **D98** (2018), no. 3, 032005, [arXiv:1805.10228].
- CMS Collaboration, “Search for new phenomena with the M_{T2} variable in the all-hadronic final state produced in proton-proton collisions at $\sqrt{s} = 13$ TeV.” *Eur. Phys. J.* **C77** (2017), no. 10, 710, [arXiv:1705.04650].
- A. Ball et al. “A Letter of Intent to Install a milli-charged Particle Detector at LHC P5”. [arXiv:1607.04669].

Abstract

Search for new physics using the M_{T2} variable in all-hadronic final states produced in 13 TeV proton-proton collisions with the CMS detector

by

Bennett J. Marsh

Two related searches for Standard Model and beyond the Standard Model physics with a final state containing a pair of same-charged leptons and jets are performed using a sample of $\sqrt{s} = 13$ TeV data corresponding to an integrated luminosity of 137 fb^{-1} , collected by the CMS detector between 2016 and 2018. The first inclusive search observes no excess above the Standard Model and thus places constraints on R-parity violating and R-parity conserving supersymmetric models with pair production of gluinos and squarks. Gluino masses are excluded up to 2.1 TeV, while top and bottom squarks are excluded up to 0.9 TeV. The second search measures the cross-section of the production of four top quarks within the Standard Model using both cut-based and multivariate approaches. The observed (expected) significance of the multivariate approach is 2.6 (2.7) standard deviations, with a measured cross-section of $12.6^{+5.8}_{-5.2} \text{ fb}$, consistent with the Standard Model prediction of $12.0^{+2.2}_{-2.5} \text{ fb}$. These results are translated into constraints on the Yukawa coupling of the top quark, as well as constraints on heavy scalar or pseudoscalar production in a type II 2HDM scenario.

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Chapter 1

Introduction

1.1 Info

Some facts

- Standard model missing some stuff
- LHC smashes protons together very fast
- CMS detector is very big
- Analyze CMS data to find stuff beyond the standard model (e.g., SUZY)
- Did not find anything

[1]

Chapter 2

Theory

Chapter 3

The CMS Experiment

Chapter 4

Analysis

Chapter 5

Summary

Appendix A

Appendix Title

Bibliography

- [1] CMS Collaboration, “Search for new phenomena with the M_{T2} variable in the all-hadronic final state produced in proton-proton collisions at $\sqrt{s} = 13$ TeV.” *Eur. Phys. J. C* **77** (2017), no. 10, 710, [arXiv:1705.04650].