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Search for  $tWZ$  production in the Full Run 2 ATLAS  
dataset using events with four leptons

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October 2021

# Abstract

# Declaration

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# Acknowledgements

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# Chapter 1

## Introduction

Hello bois

# Chapter 2

## Theory

### 2.1 Standard Model of Particle Physics

#### 2.1.1 Electroweak Theory

#### 2.1.2 Top Quark

### 2.2 $tWZ$

#### 2.2.1 Tetra-lepton Channel

#### 2.2.2 Comparison to Tri-lepton Channel

### 2.3 Machine Learning in the Context of Particle Physics Analyses

### 2.4 Statistical Techniques

#### 2.4.1 Maximum Likelihood Fitting

#### 2.4.2 Significance

#### 2.4.3 Limit Setting



# Chapter 3

## The ATLAS Detector

### 3.1 Coordinate System and Kinematics

### 3.2 Tracking Detectors

### 3.3 Calorimeter System

#### 3.3.1 Electromagnetic Calorimeter

#### 3.3.2 Hadronic Calorimeter

### 3.4 Muon Spectrometer

### 3.5 Trigger and Data Acquisition System

# Chapter 4

## Analysis Setup and Strategy

### 4.1 Data and Monte Carlo Simulation

#### 4.1.1 Data Samples

#### 4.1.2 Monte Carlo Samples

### 4.2 Object Reconstruction

#### 4.2.1 Leptons

#### 4.2.2 Jets

#### 4.2.3 b-tagging

### 4.3 Regions and Event Selection

### 4.4 Machine Learning Techniques

### 4.5 Fake Lepton Estimation

### 4.6 Analysis Framework: TRExFitter

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## Search for $tWZ$ Production

### 5.1 Backgrounds

#### 5.1.1 $t\bar{t}Z$

#### 5.1.2 $ZZ$

#### 5.1.3 other

### 5.2 Control Plots

### 5.3 Post-Fit Plots

### 5.4 Results

# Chapter 6

## Conclusion and Outlook

Appendix A

Appendix