Chapter 1

Introduction

This thesis documents the evidence of Higgs boson decays to tau leptons with the ATLAS experiment at the LHC. Special emphasis is given to the VBF $H \to \tau_\ell \tau_{\text{had}}$ subset of the analysis. The data correspond to 25 fb^{-1} of proton collisions with $\sqrt{s} = 7$ or 8 TeV.

Chapter 2 gives a brief overview of the Standard Model of particle physics to provide theoretical context for searches for the Higgs boson. Chapter 3 describes the LHC and the ATLAS detector, which are the experimental apparatuses used here, and the process by which detector outputs are interpreted and classified as particles. Chapter 4 describes tau leptons and their experimental signatures at ATLAS. Details of classifying hadronic tau lepton decays are presented, especially discrimination against jets, electrons, and muons.

Chapter 5 discusses the search strategy for $H \to \tau\tau$ at ATLAS and motivates the use of machine learning. Chapter 6 reviews how physics processes relevant to the search are predicted, including a thorough description of the prediction of jets mis-identified as hadronic tau lepton decays. Chapter 7 gives the results of the searches and presents evidence for decays of the Higgs boson to tau leptons at ATLAS.

Chapter 8 discusses future prospects for $H \to \tau\tau$ analysis at ATLAS, both in the near- and long-term. Chapter 9 concludes this thesis with a synopsis.

Much of the work in this thesis is included in publications by the ATLAS experiment, including a description of hadronically decaying tau leptons at ATLAS [1] and evidence for decays of the Higgs boson to tau leptons at ATLAS [2].