Chapter 9

Conclusions

This thesis described evidence of Higgs boson decays to tau leptons with the ATLAS detector at the LHC, with special emphasis given to the VBF $H \to \tau_\ell \tau_{\text{had}}$ subset of the analysis. The theoretical context, LHC, and ATLAS experiment were briefly reviewed. The signature of tau leptons at ATLAS was described in detail.

The data in the $H \to \tau\tau$ analysis correspond to 20.3 fb^{-1} and 4.5 fb^{-1} of proton collisions at 8 TeV and 7 TeV, respectively. Strong evidence for $H \to \tau\tau$ is observed (expected) of a 4.5σ (3.4σ) deviation from the background-only hypothesis. The measured signal strength, normalized to the Standard Model expectation, is $1.4^{+0.4}_{-0.4}$, which is consistent with the Standard Model prediction. A limiting factor of the measurement is the size of the available dataset.

Future LHC data-taking campaigns will offer substantially more data and at a higher collision energy, though the harsh conditions present challenges for triggering on τ_{had} and rejecting pileup jets mimicking the VBF signature. The VBF $H \to \tau_\ell \tau_{\text{had}}$ analysis projects to measure a signal strength uncertainty of 8% with the addition of a high performance, high coverage forward tracker.