

# Chapter 1

## Introduction

The work presented here represents a major step forward in experimentally understanding the behavior of muon neutrinos and antineutrinos. Apart from providing a world's-first measurement of these interactions in a mostly-unexplored energy region, these data advance the neutrino community's preparedness to search for an asymmetry between matter and anti-matter that may well provide the physical mechanism for the existence of our universe.

The details of these measurements are preceded by brief summaries of the history of the neutrino (Chap. 2), the phenomenon of neutrino oscillations (Chap. 3), and a description of their interactions (Chap. 4). Details of the experimental setup for the measurements are given in Chap. 5. Chapter 6 introduces the muon antineutrino cross-section measurement and motivates the need for dedicated, in situ background constraints. The world's first measurements of the neutrino component of an antineutrino beam using a non-magnetized detector, as well as other crucial background constraints, are presented in Chap. 7. The muon antineutrino cross-section measurement is given in Chap. 8. By exploiting correlated systematic uncertainties, combined measurements of the muon neutrino and antineutrino cross sections described in Chap. 9 maximize the precision of the extracted information from both results. Finally, the results are summarized in Chap. 10.