

Statement of Originality

This thesis and the work presented in it are my own and were produced by me as a result of my own original research. Results and figures from published works by others have been clearly attributed, and this work has not been submitted for another qualification at this or any other university.

After a brief introduction in Chapter 1, Chapter 2 gives an overview of the theory motivating the work presented in this thesis, which represents a summary of the work of others, for which all relevant sources have been referenced. Similarly, Chapters 4 and 5 represent a summary of the theory and tools that are the foundations of the work in this thesis, and are the work of others.

Chapter 3 describes the ProtoDUNE-SP experiment, whose data was analysed in this thesis. This chapter is predominantly a review of the work of others, however, I made contributions to the development of the online monitoring system. Therefore, I have included a statement of my contributions in Section 3.8.

The development of the hit tagging algorithm based on a convolutional neural network in Chapter 6 is my own work, as well as the analysis of the results for the ProtoDUNE-SP beam particles and cosmic-rays. The hit reconstruction and clustering algorithms that lead to the clustering of hits into tracks and showers were developed by others, and the relevant documentation has been referenced. In addition, Section 6.4 details the use of my hit tagging algorithm by others, whose work is referenced.

The work on Michel electron reconstruction in Chapter 7 and Appendix A is my own. As with Chapter 6, this work relies on the clustering algorithms developed by others. In addition, the energy calibration factors used in the Michel electron energy reconstruction were calculated by the work of others.

Finally, the conclusions presented in Chapter 8 are my own.

Acknowledgements

This thesis would not have been possible without the advice and support of many people. I would like to start by thanking my supervisor, Alfons Weber. He has been a brilliant advisor, and I would like to thank him in particular for all the opportunities he has given me. Thanks also to the rest of the Oxford Neutrino Physics group, particularly Justo Martin-Albo whose support during my first year helped me to settle into the DPhil, and my fellow students – Fabio, Alex, and Ciaran – who have made the office, both physical and virtual, an enjoyable place to work.

I have worked with many great collaborators from the DUNE experiment as part of my DPhil. I'd particularly like to thank the members of the ProtoDUNE-SP reconstruction and analysis group who have always given excellent feedback on my work. Special thanks go to Dorota Stefan and Robert Sulej, who were incredibly supportive during the early years of my DPhil, and to Leigh Whitehead and Tingjun Yang, whose insightful conversations have been invaluable.

I am very fortunate to have had the chance to work at CERN for part of my DPhil, and I would like to thank all of the members of the on-site ProtoDUNE-SP team. Especially Alex, Chris, Geoff, James, Milo, and Seb, who I thoroughly enjoyed working with during my time at CERN, and who I have learned so much from.

My greatest thanks go to my friends and family, for their continued support over the years. First, I'd like to thank Barbara Jones whose proof reading has improved the clarity of this thesis considerably. Next to my friends in Oxford: to Amy, Rory, and Helena, who have always been there to help me relax at the end of the day, and to the members of Oxford Ultimate, who have been so welcoming over the past year, you have kept me going during the final stages. Finally, to my family, who fostered a love of learning, which will always be with me, and to Ellie, who could never understand how much her support has meant to me over the years.