

Second Year Report

Alberto Rescia

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Status of Doctoral Project

My doctoral project focuses on high energy physics. Specifically, I am a member of the ATLAS Collaboration, one of the four major experiments at the Large Hadron Collider (LHC) at CERN.

My research interests lie mainly in jet physics. Jets are collections of particles which all originate from the same parent particle. The study of jets' substructure can give clues which help identify the parent particle and constitutes a study of precision QCD.

This past year, my project has mainly focused on my analysis. This analysis aims to study the substructure of heavy flavour (b) jets by measuring three relevant QCD observables, namely the primary Lund Jet Plane, the Colour Ring and D_2 . The analysis is in full swing: all preliminary studies have been completed, a team has been formed, I have learned how to use the analysis framework and some studies on the unfolding procedure have begun. Due to technical constraints within ATLAS, we are ambitiously aiming to complete this analysis by the end of the year.

As an interesting spin-off, I have also worked on applying the primary Lund Jet Plane to flavour tagging. B-tagging in ATLAS is currently based on techniques which rely entirely on the identification of a secondary vertex stemming from a b-hadron decay. Specifically, the outputs of a number of low-level algorithms are combined with kinematic information from the jet and used to train a neural network, the output of which is then used to decide if a jet is labelled as b, c, or light. Using substructure, I showed how even at reco-level, new unexploited information was still available which could improve the performance of the high-level neural network, specifically at high p_T where performance of the current tagger degrades.

In addition to this, I have completed my Qualification Task. This work was focused on the calibration of ATLAS' boosted object tagger on events containing the gluon. This calibration had presented problems for several years, and I successfully managed to understand the issues that were plaguing it. The original plan was to

complete the calibration of this tagger in software Release 21, but in the end, rather than aiding in the completion of this calibration, my work has directly helped in avoiding these same problems in the calibration in the next software release.

Lastly, while at a workshop in Les Houches, I started working on a comparative study of newly introduced jet clustering algorithms which include flavour in their definition. This study aims to understand if and how these theoretically more sound algorithms can be applied at the experimental level. The study is still in its infancy, though I plan on applying these new jet definitions in the truth-level unfolding as part of my analysis.

Courses & Schools Attended

- **Phenomenology of Physics Beyond the Standard Model**

Prof. Georg Weiglein & Prof. Gudrid Moortgat-Pick, University of Hamburg

Course attended in Autumn 2022. Exam passed in Feb. 2023. This was a Master's degree course and counts as two exams.

- **Python-based Methods and Applications in Physics**

Prof. Andrea Negri, University of Pavia

Course attended Spring 2022. Exam passed April 2023. To pass this exam I gave a presentation titled *Using the Lund Jet Plane to tag b-jets at high p_T* .

- **CERN Latin American School of HEP**

San Esteban, Chile

School attended in March 2023. I submitted the report titled *HAWC study of ultra high-energy spectrum of MGRO J1908+06*.

Conferences and Workshops

- **ATLAS Flavour Tagging Workshop 2022**

31 October - 4 November 2022, Amsterdam

At this conference, I gave a talk titled *Using the Lund Jet Plane to tag b-jets at high p_T*

- **PhysTev 2023**

12 - 21 June 2023, Les Houches

- **First Lund Jet Plane Institute**

3 - 7 July 2023, CERN

- **ATLAS Standard Model and Luminosity Workshop 2023**

11-14 September 2023, Prague

At this conference, I gave a talk titled *Measurement of jet substructure observables on $Z+bb$ jet events*