

Preface

Every measurement and search for new physics performed at the Large Hadron Collider is affected by aspects of Quantum Chromodynamics (QCD) in some way. The uncertainty associated with the modelling of quark and gluon emissions can be large, and it is therefore crucial to perform precision measurements in a variety of final states that are sensitive to these emissions. Such measurements assist the particle physics theory and phenomenology communities in understanding the properties and features of QCD. They also allow the uncertainties associated with the QCD modelling to be constrained, which ensures that experimental measurements can be made with as much precision as possible.

The work presented in this thesis focusses on the quark and gluon radiation produced in association with $t\bar{t}$ and $Z + \text{jets}$ final states using proton–proton collision data collected by the ATLAS experiment at both $\sqrt{s} = 7 \text{ TeV}$ and $\sqrt{s} = 8 \text{ TeV}$. Phenomenological studies were also performed that demonstrate how quark and gluon radiation can be exploited to discriminate between the production of differently coloured heavy resonances, and also how some aspects of QCD can disrupt such attempts.

This thesis is organised as follows. In Chap. 1, a brief review of the Standard Model is given and the concept of jet vetoing is introduced, which is a recurring theme in the analyses and phenomenological studies presented. Chapter 2 introduces the Large Hadron Collider and the ATLAS detector, and Chap. 3 details how the physics objects required to perform an experimental analysis are reconstructed from the output of the various tracking detectors and calorimeters. The commissioning of an event filter isolated muon trigger is presented in Chap. 4. In Chap. 5 the analysis of $t\bar{t}$ production with a veto on additional central jet activity is documented, which is a precision measurement of the hadronic jet activity produced in association with a $t\bar{t}$ system. Additional quark and gluon emission in $t\bar{t}$ systems is again the subject of the phenomenological studies presented in Chap. 6. A jet veto is shown to be a useful tool in determining the colour of a new heavy resonance, and in a follow-up study the efficiency of tagging top-jets produced in the decay of

such a resonance is shown to depend strongly on the event colour structure. In Chap. 7, measurements of the quark and gluon emission produced in association with a boson are made, and the extraction of the electroweak component of the $Z + 2$ jet production cross-section is presented. Finally, Chap. 8 provides a summary of the work presented.

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Precision Measurements at ATLAS

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