Abstract

Currently, the Large Hadron Collider (LHC) at CERN in Geneva accelerates protons up to an energy of 3.5 TeV resulting in collisions of a center-of-mass energy of $\sqrt{s} = 7\,\text{TeV}$. To study the production of b-quarks in proton-proton collisions is part of the physics program of the ATLAS experiment, which is one of the experiments at the LHC. The b-quarks produced in the hard scattering of the protons are measured as jets in the ATLAS detector. The aim of this PhD thesis is to study prospects of a differential p_{T} b-jet cross section measurement in the jet p_T range of $p_{\text{T}_{jet}} > 30\,\text{GeV}$. This study is based on simulated Monte Carlo (MC) data assuming a center-of-mass energy of $\sqrt{s} = 10\,\text{TeV}$.

The trigger selection is based on a combination of single jet triggers considering the different prescale factors of the different jet triggers. The MC data samples contain signal b-jets and background jets from other QCD physics processes in the proton-proton collision. In order to identify the b-jets and to reject background jets, b-tagging algorithms based on the on average longer lifetime of particles containing a b-quark compared to other hadrons, which decay before reaching the detector, are used. Since the b-tagging performance is not uniform over the jet p_{T} region considered, different b-tagging efficiency scenarios are studied. The jet p_{T} independent b-tagging efficiency scenarios of $\epsilon_{Tag} = 0.5$ and $\epsilon_{Tag} = 0.6$ as well as an optimized b-tagging efficiency scenario in order to minimize the statistical uncertainty of the measurement in each jet p_{T} bin are presented.

An unfolding algorithm is applied to the measured b-jet spectrum in order to correct for detector effects due to the measuring process. The expected systematic uncertainties for different jet p_{T} regions are studied and an estimate for the evolvement of the statistical uncertainties as a function of the integrated luminosity is given. Once an integrated luminosity of at least $100\,\text{pb}^{-1}$ has been collected the differential b-jet cross section at the ATLAS experiment can be measured up to $p_{\text{T}_{jet}} < 750\,\text{GeV}$. For $750\,\text{GeV} < p_{\text{T}_{jet}} < 1.1\,\text{TeV}$ an integrated luminosity of approximately $400\,\text{pb}^{-1}$ is needed to reduce the statistical uncertainty to the level of the systematic uncertainty. The systematic uncertainty is dominated by the uncertainty of the jet energy scale calibration of the calorimeters. The systematic uncertainties vary from about 25% in the lower jet p_T region to about 50% in the higher jet p_{T} region.