

Introduction

The aim of the project is the measurement of the jet inclusive cross section in proton proton collisions at a center of mass energy of 7 TeV using the ATLAS detector and the Large Hadron Collider (LHC), the most powerful particle collider in the world. The measurement serves as one of the main benchmark observables in high-energy particle physics. The high reach in transverse jet momentum, p_T , allows to probe the shortest possible distances probing our knowledge on the structure of the proton and our understanding of space-time. It is an important tool for the understanding the strong interaction and searching for physics beyond the standard model –the current theoretical model that describes the interaction between elementary particles–.

The ATLAS detector

The ATLAS detector is a general purpose detector designed to exploit the full physics potential that the LHC offers. It is divided in several subdetectors, the most relevant for the measurement proposed in this project are the calorimeters, both electromagnetic and hadronic together measure the energy and the direction of jets. A very detailed description of the ATLAS detector and its physics goals can be found in [1].

Before the start of the fellowship the researcher played an important role in the construction of the ATLAS calorimeter, particularly in the hadronic barrel calorimeter.

The data acquisition

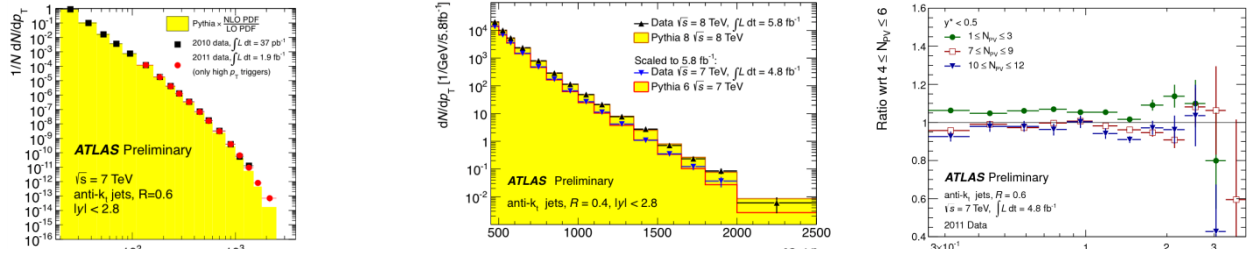
The data used for the measurement was acquired during the years 2010 and 2011. In 2010 the ATLAS detector recorded a dataset that corresponds to an integrated luminosity of 37 pb^{-1} whereas in 2011 we collected 5 fb^{-1} . This later period set the most challenging conditions with record breaking instantaneous luminosity and unprecedented level of pile up interactions.

The researcher of this project hold high responsibilities in the data acquisition period in both 2010 and 2011 as one of the run coordinators of the calorimeter system –the main detector system for jet reconstruction– organizing the shift crew and assuring an efficient data acquisition. The main achievements were the 100% data taking efficiency and the decrease of the percentage of recovery failures after low voltage power supply trips, from 50% to less than 1%.

Jet reconstruction and calibration

A particle jet is defined by a jet reconstruction algorithm. The ATLAS collaboration uses the anti- k_t jet reconstruction algorithm [2]. This reconstruction algorithm provides a theoretically sound jet definition (collinear and infrared safe) and it is experimentally easy to use and calibrate. The calibration of the jet energy measurement (JES) is obtained using isolated jets in the Monte Carlo simulation as a function of energy and pseudorapidity of the reconstructed jet [3]. A correction using *in situ* techniques assessing differences between data and MC further improves the calibration and reduces the uncertainty. The uncertainty of the JES dominates the uncertainty in the jet inclusive cross section. Thus any improvement in the JES has an immediate large impact in the measurement of the jet inclusive cross section. In 2011 the uncertainty on the JES is around 1% for jets in the central region with a p_T between 55 and 500 GeV, that builds to a jet inclusive cross section uncertainty of around 5% is the same p_T interval.

The researcher played an important role in the ATLAS jet calibration; first as a co-convener of the jet calibration task force and later on studying the impact of the parts of the calorimeter with read-out failures in the jet energy measurement and energy resolution. In addition the researcher contributed to the Monte Carlo simulation generation effort as the MC production manager of the jet performance group.



Left: Observed inclusive jet p_T distribution, reconstructed with anti- k_t $R=0.6$, as function of the p_T of the jet in central rapidity at $\sqrt{s}=7$ TeV, compared to MC simulation based on Pythia. Middle: same with full 2011 statistical sample and the 5.8 fb $^{-1}$ 8 TeV data. Right: Relative dependency of the two leading jets invariant mass cross section for three bins

Results

The figures above show the main results obtained during the project. They all have been shown in international conferences. The figure on the left shows the uncorrected jet inclusive cross section as a function of p_T for all the 2011 data collected before summer 2011 (1.9 fb $^{-1}$ of integrated luminosity) compared with the 2010 data and the theoretical prediction. The event display –a graphical representation of the particles detected by ATLAS in a single event– at the cover of this report shows one of the most energetic jets ever seen in particle physics. The figure on the middle shows the jet inclusive cross section as a function of the p_T of the jet. It combines the full 2011 dataset at $\sqrt{s}=7$ TeV (4.8 fb $^{-1}$) with part of the 2012 $\sqrt{s}=8$ TeV data. The figure demonstrates a very good understanding of the detector performance, mainly the calorimeter operation, the efficiency of the inclusive jet triggers, the removal of fake jets and the measurement of luminosity. However the understanding of the impact of pile up iterations in the measurement is the most challenging topic. The right figure on the top of this page shows the dependence of the dijet invariant mass cross section in three different bins of number of primary vertexes. It shows a 5% increase of the cross section when selecting events with a low number of primary vertices (see [4] for more details). This point was finally understood in terms of a bias in the primary vertex reconstruction. The measurement probe for the first time ever QCD kinematic regions never explored before validating the SM beyond the TeV domain.

Conclusions

The researcher has made important contributions to the jet inclusive cross section effort within the ATLAS collaboration. The contributions involve data taking, jet calibration and performance, MC generation and physics analysis. The result of his work was presented in the most important international conferences in particle physics, both by himself or by others ATLAS collaborators. His work did not show a significant deviation from the standard model prediction thus validating QCD beyond previous limits [5].

Bibliography

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- [4] The ATLAS Collaboration, **Measurement of high mass dijet production in pp collisions at $\sqrt{s}=7$ TeV using the ATLAS detector**. ATLAS-CONF-2012-021.
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