Very forward photon production in proton-proton collisions measured by the LHCf experiment at the Large Hadron Collider

Author: Alessio Tiberio **Supervisor:** Lorenzo Bonechi

The LHC-forward (LHCf) experiment, situated at the LHC accelerator, has measured neutral particles production in a very forward region (pseudo-rapidity $\eta > 8.4$) in proton-proton and proton-lead collisions. The main purpose of the LHCf experiment is to test hadronic interaction models used in ground based cosmic rays experiments to simulate cosmic rays induced air-showers in the Earth's atmosphere.

Highest energy cosmic rays can only be detected from secondary particles which are produced by the interaction of the primary particle with nuclei of the atmosphere. Studying the development of air showers, it is possible to reconstruct the type and kinematic parameters of primary particle. For this reason, Monte Carlo (MC) simulations with accurate hadronic interaction models are needed to reproduce the development of air-showers. Since the energy flow of secondary particles is concentrated in the forward direction, measurements of particle production at high pseudo-rapidity (i.e. small angles) are very important. Furthermore, soft QCD interactions (non perturbative regime) dominates in the very forward region and MC simulations of air showers are based on phenomenological model, so inputs from experimental data are crucial.

The experiment is composed by two independent detectors (*Arm1* and *Arm2*) located at 140 m from the ATLAS's interaction point (IP1) on opposite sides [1]. Detectors are placed inside the Target Neutral Absorber (TAN), where the beam pipe from IP1 turns into two separates tubes: the position between the two beam pipes allows to measure particles produced at zero degrees. Since charged particles are deviated by the D1 dipole magnet (which bends colliding beams into the two separate beam pipes), only neutral particles, mainly photons and neutrons, reach the detector. Each detector is composed by two sampling and position sensitive calorimeters. All the calorimeters use tungsten layers as absorber and plastic scintillators as active media. Arm1 uses scintillating fibres to measure the transverse position, while Arm2 uses microstrip silicon detectors.

The aim of the project is to derive the energy spectra of photons produced in proton-proton collisions at $\sqrt{s} = 13$ TeV in two pseudo-rapidity regions, $\eta > 10.94$ and $8.81 < \eta < 8.99$, and compare them to the predictions of several MC generators: DPMJET, EPOS, PYTHIA, QGSJET and SIBYLL. LHCf acquired data from 9th to 13th of June 2015 in a dedicated low luminosity run. The integrated luminosity of the data set used in this analysis is 0.23 nb^{-1}. Before and after the data taking at $\sqrt{s} = 13$ TeV, two test beam at the Super Proton Synchrotron of CERN were done on October 2014 and August 2015 to calibrate the detectors. Electron beams from 100 to 250 GeV/c, proton beams at 300 and 350 GeV/c and muon beams at 150 and 250 GeV/c were used for the calibration and to check detectors performance. The comparison between results at $\sqrt{s} = 13$ and already published results at $\sqrt{s} = 7$ and 0.9 TeV [2, 3] will be useful to check if the Feynman scaling hypothesis holds at these energies [4].

References

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