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Energy dependence of the transverse momentum distributions of charged particles in pp collisions measured by ALICE

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Abstract Differential cross sections of charged particles in inelastic pp collisions as a function of p_{T} have been measured at $\sqrt{s} = 0.9,\ 2.76$ and 7 TeV at the LHC. The p_{T} spectra are compared to NLO-pQCD calculations. Though the differential cross section for an individual $\sqrt{s}$ cannot be described by NLO-pQCD, the relative increase of cross section with $\sqrt{s}$ is in agreement with NLO-pQCD. Based on these measurements and observations, procedures are discussed to construct pp reference spectra at $\sqrt{s} = 2.76$ and 5.02 TeV up to $p_{\mathrm{T}} = 50$ GeV/c as required for the calculation of the nuclear modification factor in nucleus–nucleus and proton–nucleus collisions.

1 Introduction

The measurement of charged particle production in proton–proton collisions at high energy gives insight into the dynamics of soft and hard interactions. Hard parton–parton scattering processes with large momentum transfer are quantitatively described by perturbative Quantum Chromodynamics (pQCD). Measurements at high transverse momenta (p_{T}) at LHC-energies can help to constrain parton distribution and fragmentation functions in current next-to-Leading-Order (NLO) pQCD calculations [1] of charged particle production. As data at various $\sqrt{s}$ become available at the LHC, a systematic comparison with current NLO-pQCD calculations over a large span of $\sqrt{s}$ is now possible. However, most particles are produced at low momentum, where particle production is dominated by soft interactions and only phenomenological approaches can be applied (e.g. PYTHIA [2–4], PHOJET [5]) to describe the data. A systematic comparison to data at different values of $\sqrt{s}$ is an essential ingredient to tune these Monte Carlo event generators.

Furthermore, the measurement of charged particle transverse momentum spectra in pp collisions serves as a crucial reference for particle spectra in Pb–Pb collisions. To quantify final state effects due to the creation of a hot and dense deconfined matter, commonly referred to as the Quark–Gluon Plasma (QGP), p_{T} spectra in the two collision systems are compared. The observed suppression [6] in central Pb–Pb collisions at LHC-energies at high p_{T} relative to an independent superposition of pp collisions is generally attributed to energy loss of the partons as they propagate through the hot and dense QCD medium. To enable this comparison a pp reference p_{T} spectrum at the same $\sqrt{s}$ with the same p_{T} coverage has to be provided. Similarly, a pp reference spectrum is also needed for p–Pb collisions to investigate possible initial-state effects in the collision.

In this paper we present a measurement of primary charged particle transverse momentum spectra in pp collisions at $\sqrt{s} = 0.9,\ 2.76$ and 7 TeV. Primary charged particles are considered here as all charged particles produced in the collision and their decay products, except for particles from weak decays of strange hadrons. The measurement is performed in the pseudorapidity range $|\eta| < 0.8$ for particles with $p_{\mathrm{T}} > 0.15$ GeV/c. Reference spectra for comparison with Pb–Pb spectra at $\sqrt{s_{\mathrm{NN}}} = 2.76$ TeV and p–Pb spectra at $\sqrt{s_{\mathrm{NN}}} = 5.02$ TeV in the corresponding p_{T} range up to $p_{\mathrm{T}} = 50$ GeV/c are constructed.

2 Experiment and data analysis

The data were collected by the ALICE apparatus [7] at the CERN-LHC in 2009–2011. The analysis is based on tracking information from the Inner Tracking System (ITS) and the Time Projection Chamber (TPC), both located in the central barrel of the experiment. The minimum-bias interaction trigger was derived using signals from the forward scintillators (VZERO), and the two innermost layers of the ITS, the Silicon Pixel Detector (SPD). Details of the experimental setup used in this analysis are discussed in [8].

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