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Electroweak boson production in Pb + Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV with the ATLAS detector

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Abstract

This proceeding presents independent studies of W boson, Z boson, and photon production in lead–lead collisions at $\sqrt{s_{NN}} = 2.76$ TeV using data corresponding to an integrated luminosity of $0.14\ \text{nb}^{-1}$ collected with the ATLAS detector at the Large Hadron Collider in 2011. The measurements were conducted in a well-defined kinematic range as a function of the average number of participating nucleons $\langle N_{\text{part}} \rangle$ and (pseudo)rapidity. These results are compared to corresponding jet measurements as well as to predictions based on modified leading-order and next-to-leading-order calculations.

Keywords: ATLAS; Heavy ion; Electroweak boson; W boson; Z; Photon

1. Introduction

A primary signature of a quark–gluon plasma is the attenuation of color-charge carriers due to interactions with the strongly-coupled medium. This has been observed directly at the Large Hadron Collider in measurements of high transverse momentum (p_{T}) charged hadron yields as well as in measurements of the dijet transverse energy (E_{T}) imbalance.

Electroweak bosons (γ, W/Z) offer additional resources to study mechanisms that drive partonic energy loss. They do not interact with the medium and therefore can act as standard candles for strongly-interacting processes. In this work, these benchmarking properties are demonstrated by presenting the production yields of each boson as a function of the number of participating nucleons $\langle N_{\text{part}} \rangle$ and directly comparing these yields with the jet production rate.

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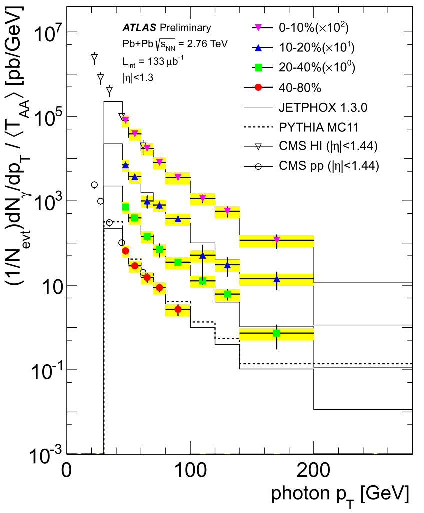

Fig. 1. Corrected prompt photon yields as a function of p_T binned in different centrality classes and compared to model predictions from JETPHOX and PYTHIA [1]. All distributions are scaled to the average nuclear thickness function $\langle T_{AA}\rangle$.

Electroweak bosons are also an excellent tool for studying modifications to parton distribution functions (PDF) in a multi-nucleon environment. This is because the rapidity of the boson is a function of the momentum fractions of the initial-state partons involved in the hard-scattering process. Therefore, this work also explores possible modifications to the nuclear PDF.

2. Boson yields

2.1. γ

Fig. 1 presents the photon yields in several centrality classes as a function of p_T. The largest background contribution comes from di-jet events, and this was estimated using a double side-band method. The yields are scaled by the mean nuclear thickness function $\langle T_{AA}\rangle = \langle N_{\mathrm{coll}}\rangle/\sigma_{pp}$, where $\langle N_{\mathrm{coll}}\rangle$ represents the mean number of binary collisions and σ_{pp} is the total inelastic pp cross section. The data agree well with model predictions that neglect jet modification. A full treatment of this analysis may be found in Ref. [1].

2.2. Z boson

The Z boson yields were measured using signal candidates from both the electron and muon channels. The signal region was defined within an invariant mass window of 66–102 GeV. Background sources in this analysis are mainly due to combinatorics. The fully corrected rapidity distribution of the Z boson using the combined lepton channels is shown in Fig. 2. The rapidity distribution was normalized to the number of minimum bias events and scaled by the $\langle T_{AA}\rangle$. An NNLO model comparison is also presented in this figure and agrees well with the data. A full description of this analysis may be found in Ref. [2].