

Inclusive photon production in p–Pb collisions at forward rapidity using MC event generators

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Introduction

We present the performance studies of two correction methods for obtaining the pseudorapidity distributions of inclusive photons at forward rapidity ($2.3 \leq \eta \leq 3.9$) in p–Pb collisions at $\sqrt{s}_{\text{NN}} = 5.02$ TeV using DPMJET [1] and HIJING [2] Monte Carlo (MC) event generators. The simulated data samples are obtained from the Photon Multiplicity Detector (PMD) which is a very granular proportional counter based gaseous detector built in ALICE. The goal of the PMD is to characterise the system formed in heavy-ion collisions by measuring the multiplicity and pseudorapidity distributions of photons in the forward pseudorapidity region [3] on an event-by-event basis. The PMD provides the information of clusters produced by both photons and charged particles. We obtain the γ_{like} clusters that are those clusters satisfying the photon-hadron discrimination threshold mentioned later. The Monte Carlo samples from these two event generators consist of 0.51 million and 0.27 million minimum bias events, respectively. All detector effects are implemented using GEANT3 in the AliRoot framework.

Method of correction for detector effects

Firstly, we determined the distributions of γ_{like} clusters and incident photons (γ_{true}) using both generators and these are shown in Fig. 1. The γ_{like} clusters are obtained by setting the following discrimination thresholds; cluster ADC > 6MPV and cluster $n_{\text{cell}} > 2$, where, MPV is Most Probable Value of the pion ADC distribution (72 ADC) and n_{cell} is the number of cells contained in a cluster. It

can be seen from Fig. 1 that due to detector effects [e.g., inefficiency, limited acceptance, finite resolution etc.], the γ_{like} distributions differ from that of incident photons (γ_{true}). We, therefore, need to develop correction methods to recover the original distribution from the measured distribution. In this work, we studied the performance of two correction methods: (i) Efficiency-Purity correction and (ii) Unfolding method.

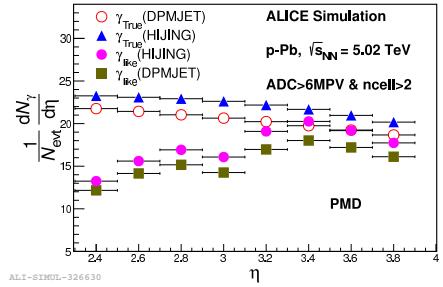


FIG. 1: Pseudorapidity distribution of incident photons and γ_{like} clusters in p–Pb collisions using both DPMJET and HIJING.

To study the Efficiency-Purity, we have taken two disjoint sets of DPMJET simulations, one for obtaining the correction factors (efficiency and purity) and the other for obtaining the pseudorapidity distribution of photons. Efficiency (ϵ_γ) and purity (f_p) are calculated using the following relations:

$$\epsilon_\gamma = \frac{N_{\gamma_{\text{detected}}}}{N_{\gamma_{\text{incident}}}}; f_p = \frac{N_{\gamma_{\text{detected}}}}{N_{\gamma_{\text{like}}}}$$

where $N_{\gamma_{\text{detected}}}$ is the number of detected photon clusters above the discrimination threshold, $N_{\gamma_{\text{incident}}}$ is the number of incident photons and $N_{\gamma_{\text{like}}}$ is the number of clusters above the discrimination threshold. Figure 2 shows the efficiency and purity as function of η

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in p–Pb collisions at $\sqrt{s}_{\text{NN}} = 5.02$ TeV. Using these estimated values of ϵ_{γ} and f_p , we have corrected the distribution using the relation:

$$N_{\gamma \text{Corrected}} = \frac{f_p}{\epsilon_{\gamma}} * N_{\gamma \text{like}}$$

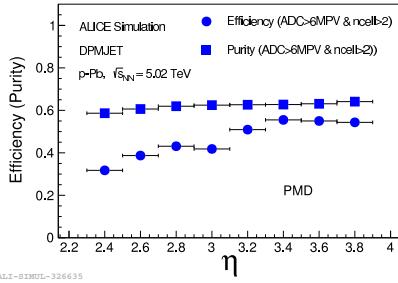


FIG. 2: Efficiency and purity as a function η .

Unfolding is another correction method [4] where the detector effects are described by a response matrix (R). The matrix element R_{mn} represents the conditional probability that an event with true multiplicity n is measured as an event with the multiplicity m . The true distribution (T) is distorted by several detector effects. The measured distribution (M) can be written as $M = RT$. In order to test the performance of this method, we used similar sets of simulation (mentioned before). We constructed the response matrices for different η bins. These matrices are used to unfold the measured distributions. Fig. 3 shows the response matrix constructed within $2.3 < \eta < 2.5$. Similar matrices were produced for other eta bins which are not shown here. We applied the method of χ^2 -minimization with the best combination of regularization function (logarithmic) and β values.

Results and discussions

Fig. 4 shows the pseudorapidity distribution of photons obtained from the efficiency-purity method ($\gamma_{\text{Corrected-efppurity}}$) and unfolding method ($\gamma_{\text{Corrected-unfolding}}$). It is observed that the performance of both correction methods are satisfactory as the corrected and unfolded pseudorapidity distribution of photons matches with the incident photon distribution. Therefore, we can use both or any

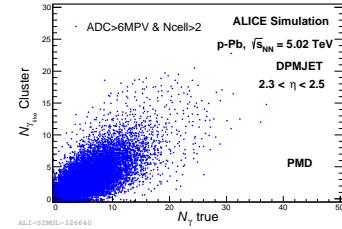


FIG. 3: Response matrix in terms of measured and incident multiplicity for $2.3 < \eta < 2.5$.

one of them to correct the distorted measured distribution obtained from the experimental data.

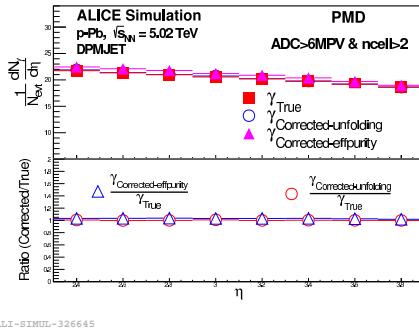


FIG. 4: Test of the unfolding and efficiency-purity method as a function of pseudorapidity using simulation.

Summary

We studied the performance of two correction methods for obtaining the pseudorapidity distributions of inclusive photons at forward rapidity ($2.3 \leq \eta \leq 3.9$) in p–Pb collisions at $\sqrt{s}_{\text{NN}} = 5.02$ TeV using DPMJET and HI-JING MC generators. It is observed that both methods performed reasonably well in determining the corrected pseudorapidity distributions.

References

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