Measurements of the production of photons at forward rapidity in p–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV using ALICE PMD

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Important information about particle production mechanisms in high-energy collisions can be obtained by studying various global observables, such as multiplicity and pseudorapidity distributions of the produced final state particles. These observables are sensitive to, e.g., colliding species, center-of-mass energy, initial energy density, and collision centrality and are useful for tuning various phenomenological models. Measurements in p–Pb collisions provide an important baseline to interpret Pb–Pb results by disentangling the initial state effects from the final state effects. Measurements of inclusive photons, which are dominantly produced from π^0 decays, provide complementary information to those of charged particles [1, 2].

In this contribution, we report multiplicity and pseudorapidity distributions of inclusive photons (P(N_γ) and dN_γ/d$\eta_{\rm lab}$) at forward rapidity ($2.3 < \eta_{\rm lab} < 3.9$) in p–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV. The centrality dependence is studied for the first time and compared with theoretical predictions from Monte Carlo (MC) event generators such as DPMJET [3] or HIJING [4] and with the previous ALICE results on charged-particle production [5].

This analysis is performed using the data obtained with the Photon Multiplicity Detector (PMD) of ALICE experiment. The PMD is a preshower detector located at 367 cm from the interaction point and measures multiplicity and spatial distributions of inclusive photons on an event-by-event basis [1, 6]. Event selection and centrality determination are performed using forward scintillator detectors [7, 8]. The raw multiplicity distributions of photons are determined by counting the number of clusters which are satisfying the photon–hadron discrimination thresholds [1]. Corrections for instrumental effects (detection inefficiency, limited acceptance, etc.) and contaminations from hadron clusters are performed using a Bayesian unfolding method [1] for minimum bias results. The unfolded distributions are also corrected for trigger and vertex reconstruction efficiencies. Centrality dependent dN_γ/d$\eta_{\rm lab}$ are however corrected using the Efficiency-Purity method as described in Ref. [2]. Systematic uncertainties from various contributions (material effect, discrimination thresholds, unfolding methods, and parameters) are estimated and then added in quadrature to obtain the total systematic un-

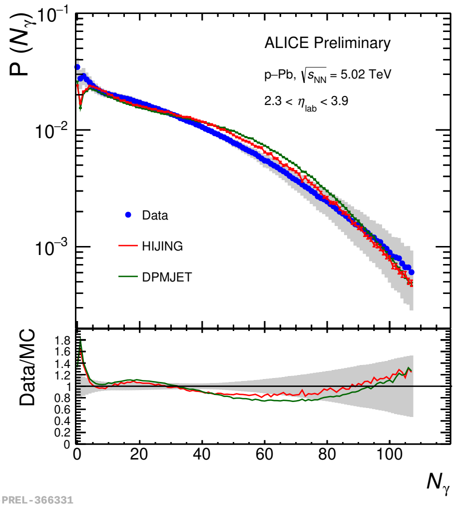

FIG. 1: Multiplicity distributions of photons in p–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV for NSD events. The results are compared with HIJING and DPMJET calculations. Shaded regions show the systematic uncertainties.

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Figure 1 shows the multiplicity distributions of photons for non-single diffractive (NSD) p–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV. Results are compared with theoretical predictions from HIJING and DPMJET. The bottom panel shows the ratios between the data and MC results. Both models describe the data at high multiplicities within uncertainties but underestimate it at low multiplicities ($N_\gamma < 10$).

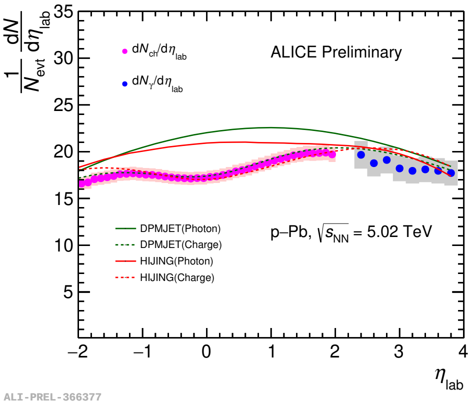

FIG. 2: dN_γ/d$\eta_{\rm lab}$ measured in p–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV. The results are compared with HIJING and DPMJET calculations and with similar measurements for charged particles [7]. Shaded regions show the systematic uncertainties.

Figure 2 presents the dN_γ/d$\eta_{\rm lab}$ (solid blue circles) measured for NSD events in p–Pb collisions at forward rapidity ($2.3 < \eta_{\rm lab} < 3.9$) together with the measurements of charged-particle production (solid magenta circles) at midrapidity [7]. Both MC generators considered are in good agreement with d$N_{\rm ch}$/d$\eta_{\rm lab}$ whereas DPMJET slightly overpredicts dN_γ/d$\eta_{\rm lab}$ towards midrapidity.

In Figure 3, the centrality dependence of pseudorapidity distributions of both photons and charged particles are presented and compared with the results from DPMJET. It is observed that the model is unable to explain the data for all centrality classes except for the most peripheral one (80%–100%). Similar conclusions can be drawn for HIJING (not shown).

In summary, multiplicity and pseudorapidity distributions of inclusive photons in p–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV are presented and compared with two MC models, DPMJET and HIJING. Both models fail to explain the P(N$_\gamma$) for $N_\gamma < 10$. HIJING is able to describe the dN_γ/d$\eta_{\rm lab}$ within uncertainties. A similar dependence of both photon and charged-particle productions on centrality classes is observed at forward rapidity. Both DPMJET and HIJING describe the data for low multiplicity events (80%–100%) but fail to reproduce the results for events with higher multiplicity. These results provide new constraints on model calculations to understand the photon production in p–Pb collisions.

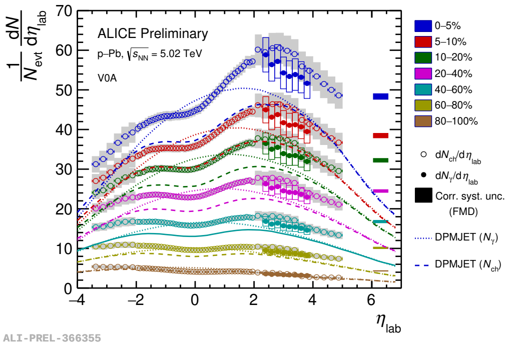

FIG. 3: dN_γ/d$\eta_{\rm lab}$ (solid circles) for various centrality classes in p–Pb collisions at $\sqrt{s_{\rm NN}}$ = 5.02 TeV. The results are compared with similar measurements for charged particles (open circles) [5]. Predictions from DPMJET are superimposed. Shaded regions and boxes show the systematic uncertainties for charged particles and photons respectively.

References

[1] ALICE Collaboration, Eur. Phys. J. C **75**, no.4, 146 (2015)
[2] STAR Collaboration, Phys. Rev. Lett. **95**, 062301 (2005)
[3] S. Roesler, R. Engel and J. Ranft, [arXiv:hep-ph/0012252 [hep-ph]].
[4] X. N. Wang and M. Gyulassy, Phys. Rev. D **44**, 3501-3516 (1991)
[5] ALICE Collaboration, Nucl. Phys. A **967**, 301-304 (2017)
[6] ALICE Collaboration, CERN-LHCC-99-32.
[7] ALICE Collaboration, Phys. Rev. Lett. **110**, no.3, 032301 (2013)
[8] ALICE Collaboration, Phys. Rev. C **91**, no.6, 064905 (2015)