Isolated photon production and correlations in pp and p-Pb collisions with the ALICE detector at LHC

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Introduction

In high-energy particle collisions, direct photons are those photons that are directly produced in elementary processes, and thus are not originating from hadronic decays. In pp and nuclear collisions, they act as colourless probes of QCD processes. Photons that originate from hard scatterings of partons from the incoming hadrons are called prompt photons and are probes of the initial state of protons or nuclei. Prompt photons are mainly produced via quark–gluon Compton scattering and quark–antiquark annihilation at the leading-order in pQCD. In addition, prompt photons are also produced by higher-order processes, like fragmentation or bremsstrahlung [1]. The study of prompt photons offer a great interest to test pQCD predictions and also to analyse parton fragmentation [2].

The fragmentation of the recoil scattered parton can be studied using the correlation between the direct photon and the charged particles emitted in the opposite direction. Photon–hadron correlation analysis is meant to characterise, energetically and topologically, hadron distributions from parton fragmentations. As photons are electromagnetic probes, direct photons produced in hard scatterings do not interact strongly, set the reference of the hard scattering kinematics, and tag the jets emitted in the opposite direction. Such measurements in pp and p–Pb collisions [3] serve as a baseline estimation for effects of the quark−gluon plasma (QGP) in nuclear (Pb–Pb) collisions, where modifications of the jet spectrum, fragmentation, and substructure have been observed [4].

Methodology

It is experimentally difficult to extract direct photon signals due to the contamination by decay photons, mainly from π^0 and η-meson decays. Also, distinguishing between the different types of prompt photons is challenging. The use of isolation criteria allows one to reject those decay photons as well as to suppress the contribution of fragmentation photons. Fragmentation photons are expected to be accompanied by fragments of the parton, while photons from $2 \rightarrow 2$ processes should be free of such associated fragments. The "isolated photon candidates" are selected by summing the transverse energies (or transverse momenta p_T) of the produced particles within an angular radius $R = \sqrt{(\Delta\varphi)^2+(\Delta\eta)^2}$ around the photon direction and requiring it to be smaller than a given threshold value, p_T^{iso}. Here, $\Delta\varphi$ and $\Delta\eta$ are, respectively, the differences between the azimuthal angles and the pseudorapidities of the photon and the produced particle.

Photon reconstruction was performed using the Electromagnetic Calorimeter (EMCal) system, whereas charged particles were reconstructed with the ALICE central tracking detectors, a combination of the Inner Tracking System (ITS) and the Time Projection Chamber (TPC) in the midrapidity region. Some of the results obtained are discussed in the following section.

Results and Discussions

Fig. 1 shows the isolated photon cross section as a function of the isolated photon transverse momentum p_T^{γ}, for pp collisions at $\sqrt{s} = 7$ TeV. The measurement covers a range of $|\eta| < 0.27$ and $10 < p_T^{\gamma} < 60$ GeV/c. The measurement is compared to next-to-leading order (NLO) pQCD calculations using JETPHOX 1.3.1 [5]. Within uncertainties, the isolated photon cross section in data and theoretical predictions are in agreement for the measured transverse momentum range.

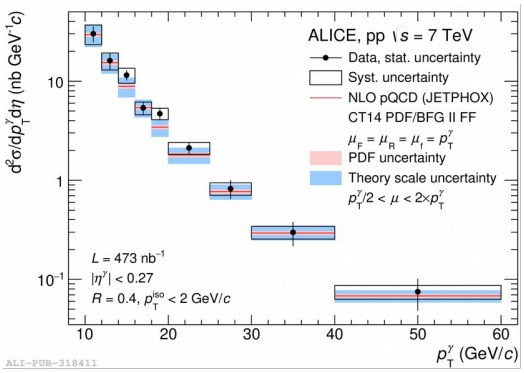

Fig. 1 Isolated photon differential cross section measured in pp collisions at $\sqrt{s}$ = 7 TeV. Error bars indicate the statistical uncertainties and boxes the systematic uncertainties [2]

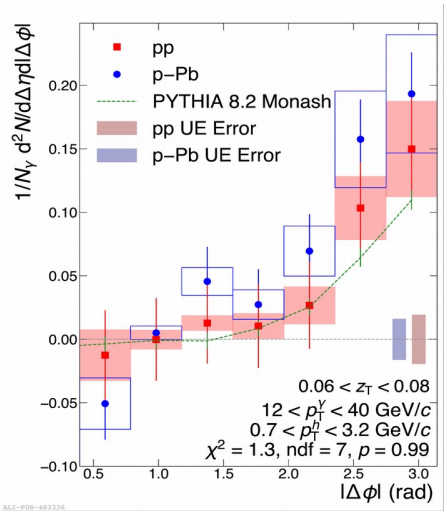

Fig. 2 γ^{isolated}–hadron correlation function for pp and p–Pb data at $\sqrt{s_{\text{NN}}}$ = 5.02 TeV, projected over the range $|\Delta\eta| < 1.2$ [3]

The isolated photon–hadron correlations are reported in z_T intervals for each trigger-photon p_T interval, where z_T is the ratio of the transverse momentum of the associated hadron, to the isolated photon transverse momentum, i.e. $z_T = p_T^h/p_T^\gamma$. The fully subtracted azimuthal correlations as a function of $\Delta\varphi$ are shown in Fig. 2 for pp and p–Pb data at $\sqrt{s_{\text{NN}}}$ = 5.02 TeV, in the interval $0.06 < z_T < 0.08$. Good agreement within uncertainties is observed between the results in pp, p–Pb, and PYTHIA 8.2 Monash Tune [6], indicating that there is no difference between the correlation functions of the two colliding systems.

The correlation functions as in Fig. 2 are then integrated in the region $|\Delta\varphi| > 7\pi/8$ for each z_T interval to obtain the γ^{isolated}-tagged fragmentation function. Fig. 3 shows the final fragmentation function. The ratio of the fragmentation functions in p–Pb and pp collisions is consistent with unity within total uncertainties as shown in the figure.

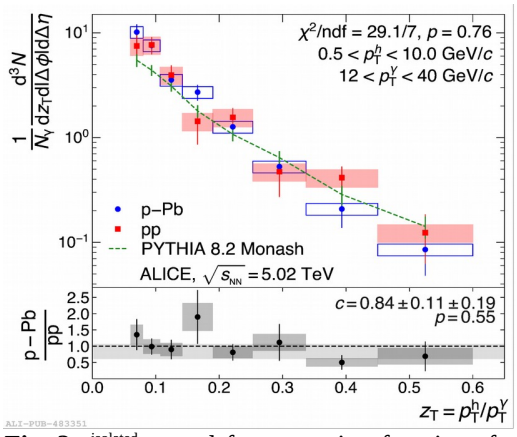

Fig. 3 γ^{isolated}-tagged fragmentation functions for pp and p–Pb data at $\sqrt{s_{\text{NN}}}$ = 5.02 TeV [3]

Detailed analysis procedure and more results on isolated photon production will be presented in the symposium.

References

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