Energy and system-size dependence of neutral mesons production at the Large Hadron Collider with ALICE

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Introduction

The measurement of π^0 and η mesons spectra in a wide $p_{\rm T}$ range is important to characterise particle production mechanisms. In pp collisions it provides a test of perturbative quantum chromodynamics (pQCD) predictions and allows to constrain parton distribution functions (PDF) and fragmentation functions (FF). In heavy-ion collisions it allows to study parton energy loss in the hot and dense medium. Such a medium, comprised of deconfined quarks and gluons, is known as Quark-Gluon Plasma. The neutral meson spectra measured in p-Pb collisions are important to study cold nuclear effects, and to disentangle suppression originating from initial state effects in the colliding nuclei from final state effects in the Pb-Pb collisions. The low $p_{\rm T}$ of the neutral meson spectra measured in p-Pb and Pb-Pb collisions is sensitive to the collective flow effects.

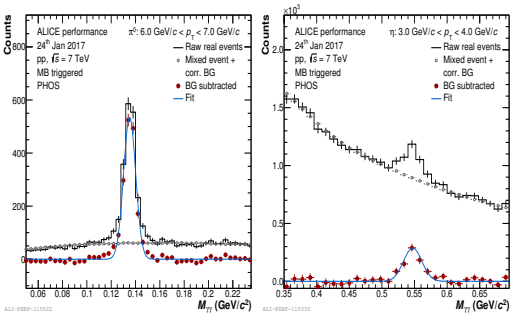

FIG. 1: Invariant mass spectrum of photon candidates around the π^0 mass (left) and η mass (right).

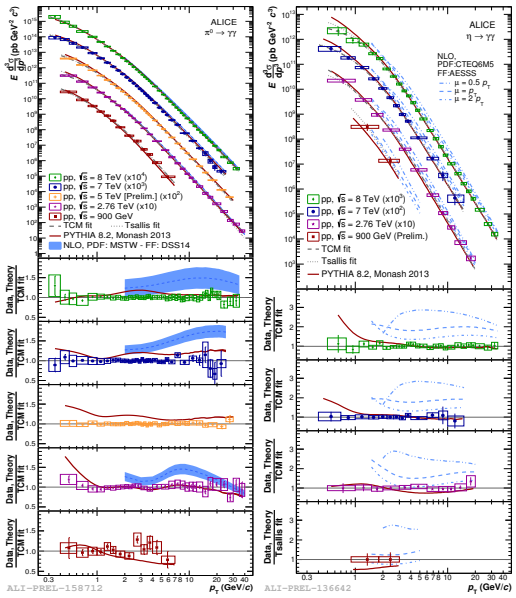

FIG. 2: Invariant cross-section of π^0 (left) and η meson (right) production at midrapidity in pp collisions at different LHC energies, compared to PYTHIA 8 and NLO pQCD predictions. Error bars represent statistical and boxes systematic uncertainties. Bottom panel show ratio of measured π^0 (η meson) production cross-sections and theoretical calculations to the fit to data.

Measurement of π^0 and η mesons

In the ALICE experiment at the CERN LHC neutral mesons are reconstructed by two-photon invariant mass analysis. Photons are measured in the electromagnetic calorimeters, EMCal and PHOS, or reconstructed as e^+e^- pair created by the photon conversion in material of central tracking detectors. The two-photon candidates invariant mass distribution in PHOS is shown in Fig.1. The large acceptance and good momentum resolution of the

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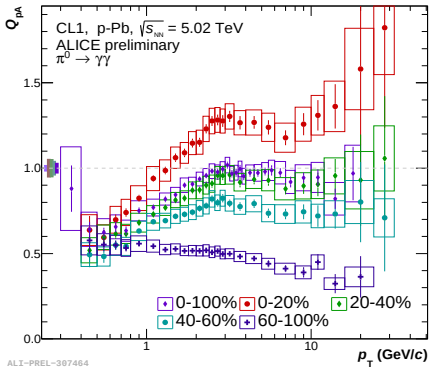

FIG. 3: Nuclear modification factors $Q_{\rm pA}$ for π^0 using CL1 multiplicity estimator.

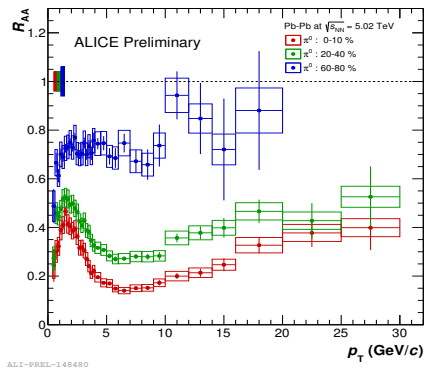

FIG. 4: Nuclear modification factors $R_{\rm AA}$ for π^0.

tracking system help to measure the π^0 up to very low $p_{\rm T}$, whereas good energy resolution of calorimeters and trigger capability allows π^0 measurement at high $p_{\rm T}$. Results from different techniques are combined to provide precise measurements of π^0 and η mesons in pp collisions over a very wide $p_{\rm T}$ range.

Results

In ALICE, π^0 is measured in pp collisions at several collision energies $\sqrt{s} = 0.9, 2.76, 5, 7$ and 8 TeV [1–3] as shown in Fig.2 (left). The results are compared with predictions from PYTHIA 8 Monash Tune and NLO pQCD calculations. The bottom part of the panel shows the ratio of data and theory predictions to the fit to data with a two-component model function. PYTHIA 8 approximately reproduces the data, while NLO pQCD calculations overestimate the data by 20-30% at all colliding energies. η mesons cross-section is also measured in all these energies [1–3], as shown in Fig.2 (right). PYTHIA 8 agrees with the experimental measurement whereas NLO pQCD predictions overestimate the η yield similar to π^0. Furthermore, the η/π^0 ratio is universal for all collision energies and in agreement with PYTHIA 8 and NLO pQCD calculations.

ALICE has measured the π^0 and η meson production in p-Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV in different multiplicity classes [4]. The nuclear modification factors $Q_{\rm pA}$ show multiplicity dependence for CL1 multiplicity estimator based on tracks with $|\eta| < 1.4$, shown in Fig.3. The $Q_{\rm pA}$ for π^0, η and D-meson agree with each other but unidentified charged particles show increase at $p_{\rm T} \sim 3$ GeV/c. The η/π^0 ratio does not show any multiplicity dependence and is consistent with the pp results.

Neutral mesons nuclear modification factors $R_{\rm AA}$ are measured in Pb-Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ and 5.02 TeV by ALICE. The $R_{\rm AA}$ for π^0 depends on centrality and is the lowest for central collisions, shown in Fig.4, which represents the strongest suppression [4, 5]. In this talk, an overview of neutral mesons production at the ALICE experiment is presented for different collision systems at different centre-of-mass energies. Results from $Q_{\rm pA}$ and $R_{\rm AA}$ for neutral mesons with heavy flavour and charged particles at the LHC energies are compared.

References

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