Identified particle production as a function of multiplicity in proton–proton collisions at $\sqrt{s}$ = 7 TeV using the ALICE detector

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Introduction

Usually, measurements of particle production in proton-proton collisions are carried out for understanding the particle production mechanisms in small systems and to provide a reference for the Pb–Pb results. Out of a number of observables, the transverse momentum ($p_{\rm T}$) spectra and yields are fundamental tools to study the properties of the system created during the collisions. The $p_{\rm T}$ spectra of hadrons contain information about the collision dynamics and the entire space-time evolution from the initial to the final stage of the collision [1]. On the other hand, yields are sensitive to the particle production mechanisms [2]. Recent measurements of $p_{\rm T}$ spectra and baryon to meson ratios as a function of multiplicity in p–Pb collisions at $\sqrt{s} = 5.02$ TeV suggest a behaviour reminiscent of that observed in Pb–Pb collisions [2, 3]. The ratio of integrated yields for different particles w.r.t pions follow a universal trend across multiplicity from p–Pb to Pb–Pb collisions.

With increased energy for pp collisions, the high multiplicity pp events reach multiplicities comparable to that in p–Pb and peripheral Pb–Pb collisions. Thus a systematic study of π, K and p production as a function of multiplicity can provide information for a better understanding the collision dynamics in pp at $\sqrt{s}$ = 7 TeV.

Analysis details and Results

With its excellent particle identification, ALICE is capable to study particle production over a wide range of $p_{\rm T}$ at mid-rapidity ($|y| < 0.5$). The 7 TeV pp collision data was collected with a minimum bias trigger which required a hit in the mid-rapidity Silicon Pixel Detector or at least one hit in one of the forward rapidity V0 counters. The events are selected having a reconstructed vertex within $|z| < 10$ cm from the interaction point and at least one charged particles in $|\eta| < 1$. The V0 counters covering the pseudo-rapidity range $-3.7 < \eta < -1.7$ and $2.8 < \eta < 5.1$ have been used to select event classes based on the total charged particle multiplicity in their acceptance, whereas $\langle {\rm d}N_{\rm ch}/{\rm d}\eta \rangle$ has been measured at mid-rapidity for each event class, in order to avoid auto-correlation biases.

The identification of π, K and p was done

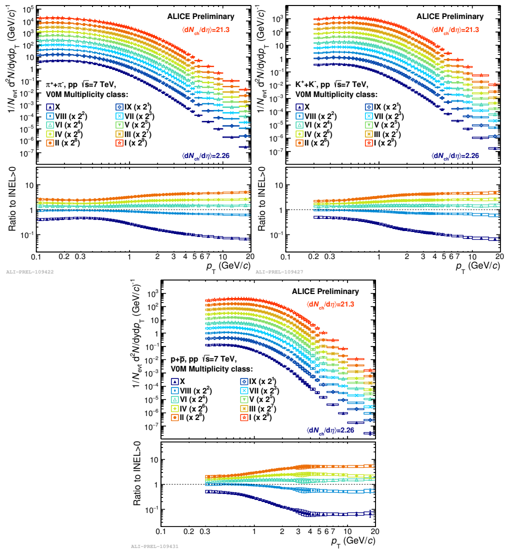

FIG. 1: $p_{\rm T}$-differential yields of π, K and p in different V0 multiplicity classes in pp collisions.

*Electronic address: `pranjal.sarma@cern.ch` with the inner tracking system (ITS), time projection chamber (TPC), time of flight (TOF) and high momentum particle identification (HMPID) detectors [4].

The $p_{\rm T}$ spectra of π, K and p are shown in Fig. 1 in different V0 multiplicity classes. A clear hardening of the spectra with increased multiplicity is observed which is more pronounced for heavier particles.

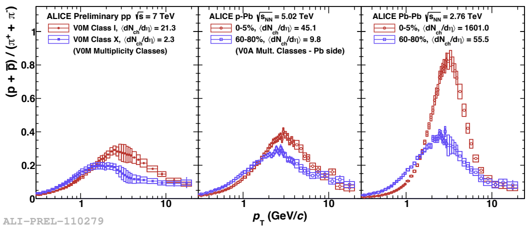

FIG. 2: $p_{\rm T}$-differential p/π ratio for pp, p–Pb and Pb–Pb collisions at two V0 multiplicity classes.

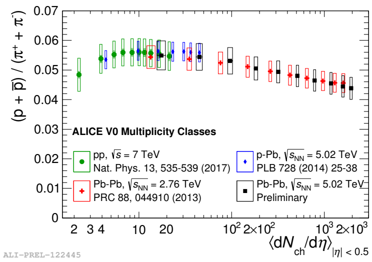

FIG. 3: $p_{\rm T}$-integrated p/π as a function of the charged particle multiplicity $\langle {\rm d}N_{\rm ch}/{\rm d}\eta \rangle$ in pp, p–Pb and Pb–Pb collisions.

The $p_{\rm T}$-differential p/π ratio is plotted for pp, p–Pb and Pb–Pb collisions for two multiplicity classes in Fig. 2. It is interesting to note that the shape of the p/π ratio is similar for all the colliding systems. The enhancement of p/π at intermediate $p_{\rm T}$ is observed for all the systems and is more pronounced for high multiplicity classes. The maximum value of the p/π ratio from low to high multiplicity classes is maximal for Pb–Pb followed by p–Pb to pp collisions. The enhancement of the p/π ratio at intermediate $p_{\rm T}$ in Pb–Pb collisions could be indicative of a large collective flow or possible quark recombination effects [2].

The $p_{\rm T}$ spectra are fitted with Levy–Tsallis function in pp and the Blast–Wave function in Pb–Pb collisions, to extrapolate the yield in the unmeasured region to obtain the $p_{\rm T}$-integrated yield.

In Fig. 3 and Fig. 4, the $p_{\rm T}$-integrated p/π and K/π ratios are plotted respectively as a function of multiplicity for different colliding systems and energies. No significant evolution of the p/π yield ratio with multiplicity is observed from low multiplicity pp collisions to central Pb–Pb collisions within the systematics. The study of centrality-uncorrelated systematics is ongoing, in order to further investigate the centrality dependence of the ratio.

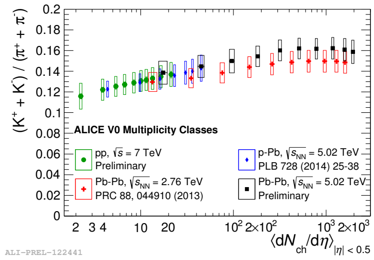

FIG. 4: $p_{\rm T}$-integrated K/π as a function of the charged particle multiplicity $\langle {\rm d}N_{\rm ch}/{\rm d}\eta \rangle$ in pp, p–Pb and Pb–Pb collisions.

On the other hand, a small increase in the yields of the K/π ratio with multiplicity could be seen in Fig. 4. This increase of K/π ratio with multiplicity can be described by an enhanced production of strangeness or may be due to a reduced canonical suppression of strangeness production in larger freeze-out volumes [3].

References

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