Multiplicity dependence of π, K and p production in pp collisions at $\sqrt{s}$ = 13 TeV with ALICE at the LHC

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Introduction

The measurements of identified particle production in pp collisions are performed for a better understanding of the particle production mechanism and the dynamics of the collisions system. Different observables like transverse momentum ($p_{\rm T}$) spectra and yields of the identified particles are sensitive to the properties of the matter formed during the collisions. Recent observation of enhancement of (multi-) strange hadrons [1, 2], ridge-like structure [3], mass-dependent hardening of $p_{\rm T}$ spectra [2, 4] of the identified particle in high-multiplicity pp and p−Pb collisions suggests collective-like behaviour reminiscent of that observed in Pb−Pb collisions and are attributed to the creation of a thermally equilibrated medium. The yield ratios of different particles are also found to follow a smooth trend across multiplicity, independent of system size and centre-of-mass energy of the collisions [5].

The availability of a high statistics data sample for pp collisions at $\sqrt{s}$ = 13 TeV at the LHC allows one to study the multiplicity-dependent observables precisely. Therefore, the new results obtained by the ALICE Collaboration on identified particle production as a function of charged-particle multiplicity in pp collisions will provide further insight into the production mechanism of particle or dynamics of the collisions in small systems.

Analysis details and results

The excellent tracking and particle identification (PID) capabilities of the ALICE detector provides a unique opportunity for a systematic study of π, K and p production from very low to high $p_{\rm T}$. The data was collected using a minimum-bias trigger, which requires a hit in either V0 counters in coincidence with the arrival time of the proton bunches from both directions. The V0 detectors covering the pseudo-rapidity range -3.7 < η < -1.7 and 2.8 < η < 5.1 have been used to select event classes based on charged-particle multiplicity, whereas, $\langle {\rm d}N_{\rm ch}/{\rm d}\eta \rangle$ has been measured at mid-rapidity for each event class, to avoid auto-correlation biases. The events are then selected having primary vertex reconstructed in $|z|$<10 cm from the nominal interaction point in the longitudinal direction. Further requirement of at least one charged-particle is detected within $|\eta|$<1 (INEL>0) is also applied.

Pions, kaons and protons have been identified using the Inner Tracking System (ITS), the Time Projection Chamber and the Time of Flight (TOF) detectors.

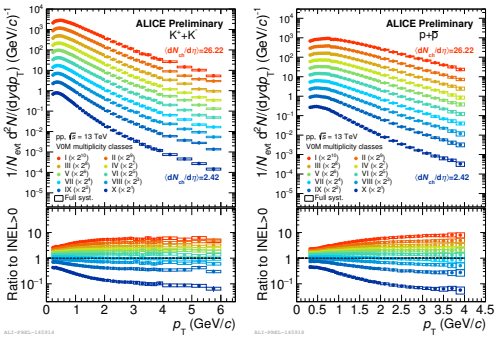

FIG. 1: $p_{\rm T}$ spectra of K and p in different V0 multiplicity classes in pp collisions at $\sqrt{s}$=13 TeV.

The $p_{\rm T}$ spectra of K and p measured in different V0 multiplicity classes in pp collisions

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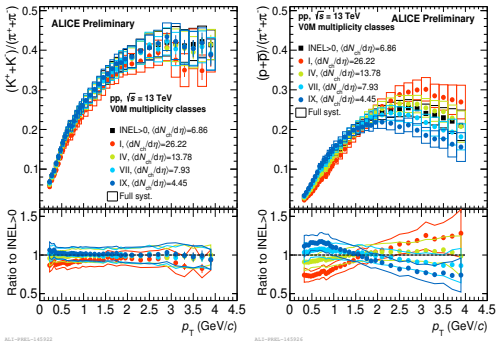


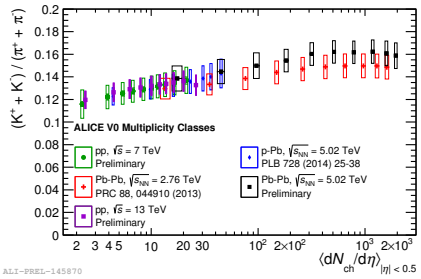
FIG. 2: p_{T}-differential K/π and p/π ratios in V0 multiplicity classes in pp collisions at $\sqrt{s}$=13 TeV.

at $\sqrt{s}$=13 TeV are shown in Fig. 1. p_{T} spectra are observed to flatten with the increase of multiplicity and the effect is more pronounced for higher mass particles.

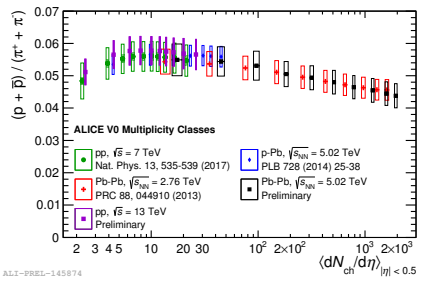
The p_{T}-differential K/π and p/π ratios in selected multiplicity classes are shown in Fig. 2. It is possible to observe that the K/π ratio shows no evolution with multiplicity, while the p/π ratio shows an enhancement at intermediate p_{T}. This enhancement of p/π ratio is similar to that observed in lower energy pp, p−Pb and Pb−Pb collisions [4, 5]. In Pb−Pb collisions, such behaviour can be described by considering the collective flow of the medium formed or possible quark recombination mechanism [6].

To obtain the p_{T}-integrated yields, the p_{T} spectra are parametrised by Levy-Tsallis function to extrapolate the yields in the unmeasured p_{T} regions.

The p_{T}-integrated K/π and p/π yield ratios measured in pp collisions at $\sqrt{s}$=13 TeV are plotted in Figs. 3(a), 3(b) respectively for different charged-particle multiplicity classes. These ratios are found to be in good agreement within the systematic uncertainties with those measured in pp, p−Pb and Pb−Pb collisions at lower energies. The results suggest that the hadrochemistry of the particles is driven by the charged-particle multiplicity and not by the centre-of-mass energy or collisions system. It is also observed that the K/π ratio increases from low to high multiplicity. This behaviour is attributed to enhanced production of strangeness or a reduced canonical suppression in larger freeze-out volume [4]. On the contrary, no significant changes in the p/π ratio could be observed with multiplicity.



(a)



(b)

FIG. 3: (a) K/π and (b) p/π yield ratios in pp collisions at $\sqrt{s}$=13 TeV compared with the results of lower energy pp, p−Pb and Pb−Pb collisions.

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References

[1] J. Adam *et al.*, ALICE Collaboration, Phys. Lett. B **758**, 389-401 (2016).
[2] J. Adam *et al.*, ALICE Collaboration, Nat. Phys. **13**, 535-539 (2017).
[3] B. Abelev *et al.*, ALICE Collaboration, Phys. Lett. B **719**, 29-41 (2013).
[4] B. Abelev *et al.*, ALICE Collaboration, Phys. Lett. B **728**, 25-38 (2014).
[5] S. Acharya *et al.*, ALICE Collaboration, Phys. Rev. C **99**, 024906 (2019).
[6] B. Abelev *et al.*, ALICE Collaboration, Phys. Rev. C **88**, 044910 (2013).