Multi-Strange Particle Production with ALICE at LHC Energies

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Introduction

The ALICE Experiment focuses on studying the physics of strongly interacting matter at extreme energy densities, i.e. the properties of the quark-gluon plasma (QGP) that is a state of matter produced in the laboratory by colliding Heavy Ions at ultra-relativistic energy. Strangeness enhancement in heavy-ion collisions relative to minimum-bias pp collisions was one of the predicted QGP signatures. Figure 1 shows the ratio of yields of strange hadrons to the pion yield $(\pi^{+}+\pi^{-})$ as a function of the average charged-particle multiplicity density $\langle dN_{ch}/d\eta \rangle$ for different collision energies and systems. The ratios follow a continuously increasing trend from low multiplicity pp to high-multiplicity Pb−Pb collisions, independent of the initial collision energy and colliding systems. It can also be seen that the enhancement is larger for the particles with larger strangeness content.

In addition, there are other features (like collective phenomenon), related to the formation of the QGP that were observed in large collision systems (Pb–Pb), which are observed in small collision system (pp, p–Pb) [1].

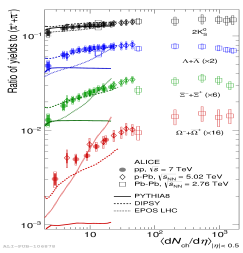

FIG. 1: The p_{T} integrated yield ratios to pions $(\pi^{+}+\pi^{-})$ as a function of charged particle multiplicity $\langle \mathrm{d}N_{ch}/d\eta \rangle$ measured in $|y| < 0.5$.

Analysis Details

In the ALICE experiment, the strange hadrons K^0_s, Λ, Ξ, Ω are reconstructed exploiting the topology of their decays. This analysis is focusing on Ω production in Run 3 pp collisions at $\sqrt{s}$ = 900 GeV. The sub-detectors involved in the analysis presented here include the Inner Tracking System (ITS), the Time Projection Chamber (TPC) and the Fast interaction trigger (FIT). The multiplicity intervals are based on the distribution of the sum of the signal amplitudes measured with the FT0A and FT0C (FT0M amplitude). A de-

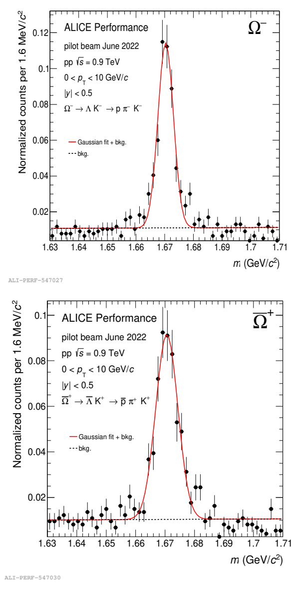

FIG. 2: Invariant mass distribution of Ω^{-} and Ω^{+} after applying some kinematic and topological selections

*Electronic address: upasana.sharma@cern.ch tailed description of the ALICE Run 3 can be found in [2]. The data used was collected in the Run 3 pilot run with pp collisions at $\sqrt{s} =$ 900GeV. Figure 2 shows the invariant mass distibution of $\Omega^-$and Ω^+.

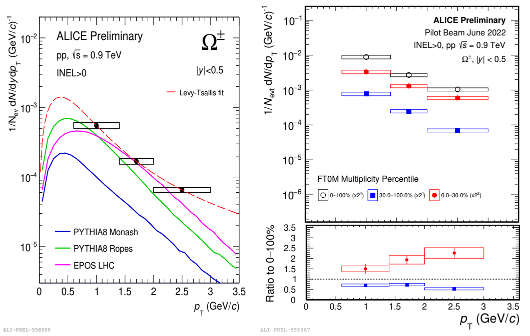

FIG. 3: [Left Figure] ($\Omega^{\pm}$) p_T Spectra in INEL>0 pp collisions at $\sqrt{s}$ = 900 GeV and comparison with models.[Right Figure] (top panel): p_T Spectra $\Omega^{\pm}$ in three Different FT0M multiplicity classes. (bottom panel): Ratio of p_T spectra in different multiplicity classes to the minimum bias p_T spectrum.

Results

The measurements of $\Omega^{\pm}$ are performed in INEL>0 pp collisions in the rapidity range $|y| < 0.5$ over the p_T ranges $0 < p_T < 10$ (GeV/c). Figure 3 shows the first measurement of Ω production in pp collisions at $\sqrt{s} =$ 900 GeV at the LHC, complementing previous ALICE results at Run 1. The p_T-dependent integrated yield is compared to different MC models like PYTHIA8 (Monash), PYTHIA8 (Ropes) and EPOS-LHC. The p_T spectra are obtained by applying the corrections extracted from a detailed simulation of the ALICE apparatus carried out with GEANT4. Figure 3 shows the $\Omega^{\pm}$ p_T spectra in three FT0M multiplicity classes along with their ratios to the corresponding spectrum in 0-100% FT0M class. The ratios suggest that the p_T spectra get harder with increasing multiplicity. The p_T integrated yield ratio $(\Omega^- + \Omega^+)/(\pi^+ + \pi^-)$ at $\sqrt{s}$ = 900 GeV and $\sqrt{s}$ = 13.6 TeV as a function of charged particle multiplicity and their comparison to Run 2 published result at

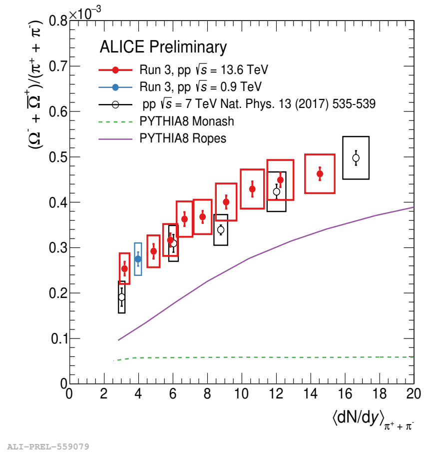

FIG. 4: Omega over pion ratio as a function of the pion yield in pp collisions at 900 GeV, 7 TeV and 13.6 TeV

7 TeV are shown in Figure 4. Here a smooth evolution is observed for this ratio going from low to high multiplicity and shows a trend compatible with Run 2 results. The Comparison with predictions from PYTHIA 8 Ropes models qualitatively describes the increase in ratio with multiplicity whereas PYTHIA 8 Monash predicts a flat ratio with multiplicity.

Acknowledgments

The author acknowledges financial support from DAE-DST projects.

References

[1] ALICE Collaboration, Nature Phys. **13** (2017) 535-539.

[2] D. Rohr [ALICE], "The ALICE Run 3 online/offline processing," Nucl. Instrum. Meth. A **1038** (2022), 166954 doi:10.1016/j.nima.2022.166954 [arXiv:2208.07412 [physics.ins-det]].