Energy and system size depedence of hadronic resonance production with ALICE at the LHC

Dukhishyam Mallick for the ALICE colloboration*
School of Physical Sciences, National Institute of Science Education and Research, HBNI, Jatni - 752050, Odisha, INDIA

Introduction

The study of the hadronic resonance production serves as a unique tool to understand the properties of matter created in heavy-ion collisions. Due to their short lifetime ($\sim 10^{-23}$sec) , resonances are used as a sensitive probe to investigate the dynamical evolution of the hadronic medium produced in heavy-ion collisions. The resonances whose lifetime are comparable with the timespan of the hadronic phase (the time interval between chemical and kinetic freeze-out) are suited candidates for studying the regeneration and re-scattering processes. The resonance yields and particle ratios are expected to get modified due to the interaction of their decay daughters within the hadronic medium. Recent measurements in p-Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV and in pp collisions at $\sqrt{s} = 7$, 13 TeV as a function of multiplicity have uncovered various bulk properties similar to those seen in heavy-ion collisions [1], [2]. The particle ratio $\rm K^{*0}/K$ (resonance to the stable particle) decreases with the increase in the charged-particle multiplicity in small systems similar what is observed in heavy-ion collisions. Among the various resonances, $\rm K^*(892)^0$ has a lifetime of ~ 4 fm/c and $\phi(1020)$ has a lifetime nearly ten times larger than $\rm K^{*0}$. Therefore, the systematic comparison of measurements related to these resonance may enable us to investigate the hadronic phase and also help to extract lifetime of the collision hadronic phase. The nuclear modification factors (R_{pA}, R_{AA}) are used to study the energy loss of partons in the hot and dense medium. Measuring nuclear modification factor in small collision systems will provide the baseline for heavy-ion systems.

Analysis details

The $\rm K^*(892)^0$ and $\phi(1020)$ vector mesons are reconstructed through invariant mass analysis using their hadronic decay channels. The signals of $\rm K^*(892)^0$ and ϕ (1020) in different p_T intervals are obtained by subtracting combinatorial background from "unlike-sign charged-particle invariant-mass distributions" for the various multiplicity classes. The combinatorial background is estimated by using mixed event technique. After combinatorial background subtraction a residual background remains which mainly arises from other sources of correletd pairs and misidentified particle decay products. The extracted $\rm K^*(892)^0$ signal is fitted with a Breit-Wigner function and the ϕ (1020) signal is fitted with a Voigtian function (which is a convolution of Breit-Wigner and Gaussian function) and a polynomial function describing the residual background. The raw yields are obtained from the area under the curve reproducing the signal invariant mass distribution in each of the p_T intervals for the various multiplicity classes. To measure the corrected transverse momentum (p_T) spectra the raw yields are corrected for detector acceptance, reconstruction efficiency and decay branching ratio. The recent measurements of $\rm K^{*0}$ and ϕ mesons are performed in p-Pb, Pb-Pb and Xe-Xe collisions at $\sqrt{s_{\rm NN}} = 8.16$, 5.02 and 5.44 TeV respectively.

Results and Discussion

The particle yield ($\mathrm{d}N/\mathrm{d}y$) is obtained by integrating the p_T spectrum in the measured p_T region and estimating the yield in the unmeasured region using a Levy-Tsallis fit function. Figure 1 shows the $\mathrm{d}N/\mathrm{d}y$ normalized

*Electronic address: `dukhishyam.mallick@cern.ch`

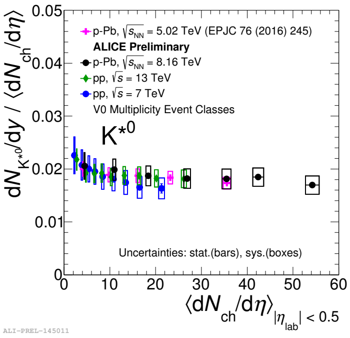

FIG. 1: The scaled $\mathrm{d}N/\mathrm{d}y$ of K^{*0} as a function of $< dN_{ch}/d\eta >_{|\eta_{lab}|<0.5}$ in pp collisions at $\sqrt{s}$ = 7 , 13 TeV and in p-Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 , 8.16 TeV respectively.

to the charged particle multiplicity in a given multiplicity class as the function of multiplicity for the $\mathrm{K}^*(892)^0$ in different colliding systems and energies is observed to be almost constant. The event multiplicity drives the particle production mechanism irrespective of collision systems and energies. Figure 2 shows nuclear modification factor of K^{*0} as a function of p_T measured at mid-rapidity ($|y| <$ 0.5) in Pb-Pb at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV and in Xe-Xe at $\sqrt{s_{\mathrm{NN}}}$ = 5.44 TeV collisions for similar charged particle multiplicity. A similar suppresion is observed in the R_{AA} for both Pb-Pb and Xe-Xe collisions. Hence, the result suggests no signficant system size depedence of R_{AA}. The ratio of resonances to the stable particle yields as a function of the cube root of the average charged particle multiplicity ($< \mathrm{d}N_{ch}/\mathrm{d}\eta >^{1/3}$) for various resonances in different collision systems and energies measured with ALICE the detector is shown in Figure 3. The decreasing trend in short-lived resonances ρ/π, $\mathrm{K}^*(892)^0/\mathrm{K}$, $\Lambda(1520)/\Lambda$ have seen with the increase in the charged particle multiplicity from peripheral to most central collisions. Whereas for the ratios $\Sigma^{*\pm}/\Lambda$, Ξ^{*0}/Ξ and ϕ/K are nearly independent across all systems and centrality classes relative to long-lived resonances measured. These results suggest dominance of re-scattering effect over regeneration in the hadronic phase. The results on particle ratios measured in ALICE at

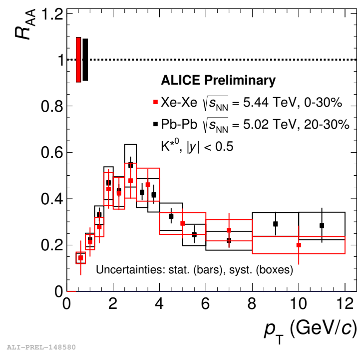

FIG. 2: Nuclear modification factor of K^{*0} as a function of p_T in Xe-Xe collisions at $\sqrt{s_{\mathrm{NN}}}$ 5.44 TeV and Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ 5.02 TeV for a similar charged particle multiplicity.

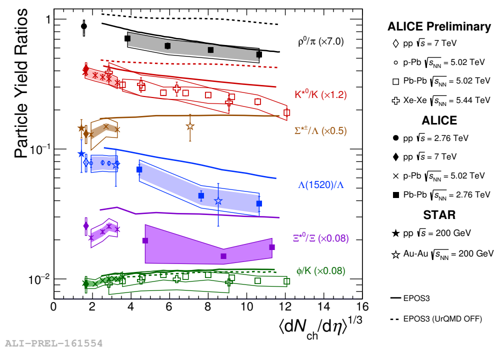

FIG. 3: The particle yield ratios ρ/π, $\mathrm{K}^{*0}/\mathrm{K}$, $\Lambda(1520)/\Lambda$, $\Sigma^{*\pm}/\Lambda$, Ξ^{*0}/Ξ and ϕ/K as a function of $< \mathrm{d}N_{ch}/\mathrm{d}\eta >^{1/3}$ in pp, p-Pb and Pb-Pb collisions.

the LHC energies are also compared the EPOS model (with and without UrQMD) [3].

Acknowledgments

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