Energy dependence of resonance production with ALICE at the LHC

Sushanta Tripathy (for the ALICE collaboration)*
Discipline of Physics, School of Basic Sciences,
Indian Institute of Technology Indore, Indore- 453552, INDIA

Introduction

Resonances are important tools to probe the hadronic phase formed in heavy-ion collisions. Due to their short lifetimes of $\sim 10^{-23}$ sec, they enable us to study the mechanisms, such as regeneration and re-scattering [1], which alter the shape of transverse momentum ($p_{\rm T}$) spectra and can affect the measurable yields. Measurements in pp collisions constitute a baseline for heavy-ion measurements and provide a reference for the estimate of the nuclear modification factors and information for tuning event generators inspired by Quantum Chromodynamics.
This contribution focuses on the study of the energy dependence of resonance production, by comparing results in pp collisions at $\sqrt{s} =$ 2.76 [3], 5.02, 7 [2], 8 and 13 TeV and Pb-Pb collisions at $\sqrt{s_{\rm NN}} = 2.76$ [3] and 5.02 TeV at the LHC. In particular, resonance $p_{\rm T}$ spectra at different energies as well as $p_{\rm T}$-integrated particle ratios to long-lived hadrons will be compared. Two key questions will be addressed: the first is whether there is a dependence of relative resonance production in pp collisions on the increasing pp collision energy. The second question is whether the picture of the dominance of re-scattering effects over regeneration for the short-lived K*(892) in Pb–Pb collisions still holds at the higher energy, where the density and the volume of the system are expected to be larger.

Resonance reconstruction

Charged and neutral K*(892) and $\phi(1020)$ are reconstructed through invariant mass analysis with their hadronic decay channels [2, 3]. The signals of K*(892) and $\phi(1020)$ in different $p_{\rm T}$ intervals are obtained by subtracting the combinatorial background from the unlike-sign charged particle invariant mass distribution. The combinatorial background is estimated using an event mixing technique. After combinatorial background subtraction a residual background remains which arises mainly due to mis-identified particle decay products or from other sources of correlated pairs (e.g. mini-jets). The extracted K* signal is fitted with a Breit-Wigner function and the $\phi(1020)$ signal is fitted with a Voigtian function, which is a convolution of Breit-Wigner and Gaussian function [2, 3].

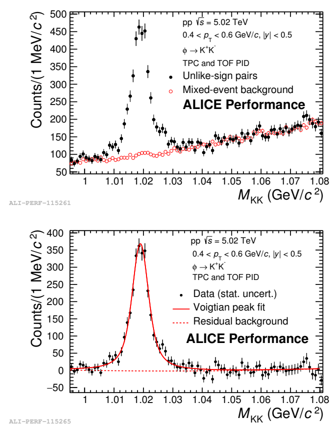

FIG. 1: Top panel: Invariant mass distribution of unlike charged KK pairs from the same event and normalized mixed events. Bottom Panel: Invariant mass distribution after subtraction of the combinatorial background for ϕ mesons.

Invariant mass distributions of unlike-sign charged KK pairs for pp collisions at $\sqrt{s} =$ 5.02 TeV from same events and mixed events in the $p_{\rm T}$ range $0.4 < p_{\rm T} < 0.6$ GeV/c are shown in the top panel of Fig. 1. The bottom panel shows the invariant mass distribution

*Electronic address: sushanta.tripathy@cern.ch

after subtraction of the combinatorial background for ϕ mesons, where a signal can be seen on top of a residual background. In different $p_{\rm T}$ intervals, raw yields are obtained from the residual background subtracted signal distributions. The raw yields are corrected with detector efficiency × acceptance and branching ratios to get the corrected $p_{\rm T}$ spectrum. Similarly, $p_{\rm T}$ spectra for different centralities are obtained for Pb–Pb collisions.

Results and discussion

$p_{\rm T}$-integrated particle yields ($\mathrm{d}N/\mathrm{d}y$) are obtained after integrating the $p_{\rm T}$ spectra in the measured $p_{\rm T}$ regions, with Lévy–Tsallis or blast-wave fits used to estimate the yield in unmeasured range [2, 3].

Fig. 2 shows new measurements of K*/K (top) and ϕ/K (bottom) as a function of $\sqrt{s_{\rm NN}}$. The new results from Pb–Pb collisions at $\sqrt{s_{\rm NN}} = 5.02$ TeV and pp collisions at $\sqrt{s} = 5.02$, 8 and 13 TeV are compared with lower energies and with other experiments. No significant energy dependence of the particle ratios in minimum bias pp collisions is observed from RHIC to LHC energies. However, the K*/K in central heavy-ion collisions are found to be lower compared to pp collisions, which may be due to re-scattering of K* decay daughters in the hadronic phase. In contrast, the ϕ meson lives 10 times longer than the K^{*0}, decays predominantly after the end of the hadronic phase and it is not affected by re-scattering and regeneration.

Fig. 3 shows the ratios of the integrated yields of K^{*0} to charged K and K^0_s measured in different collision systems as a function of the system size. The results on resonance particle ratios complement the energy dependence studies on identified particle production, that evidenced that there is no strong energy dependence of the chemistry of the system. In pp collisions a hardening of particle spectra is observed with the increase in $\sqrt{s}$ but at the same time it is also observed that relative particle abundances are driven by the event activity and not the collision energy.

In the conference presentation, more details on resonance spectra excitation functions will be given.

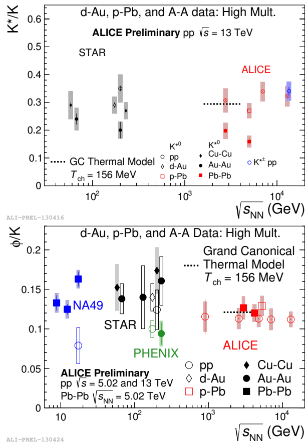

FIG. 2: New measurements of K*/K (top) and ϕ/K (bottom) as a function of $\sqrt{s_{\rm NN}}$ and comparison with previous measurements at lower energies.

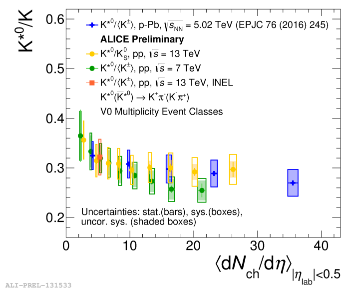

FIG. 3: Ratios of K^{*0} to charged K and K^0_s measured in various collision systems as a function of $\langle \mathrm{d}N_{\rm ch}/\mathrm{d}\eta \rangle$.

Acknowledgments

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References

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