Insight into the hadronic cascade-time effect on final state observables in Xe+Xe collisions at $\sqrt{s_{\rm NN}}$ = 5.44 TeV using AMPT model

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Introduction

The ultra-relativistic heavy-ion collisions such as Relativistic Heavy-ion Collider (RHIC) and the Large Hadron Collider (LHC) aim to create a system of deconfined quarks and gluons known as quark-gluon-plasma (QGP) under extreme conditions of temperature and energy density. In such a collision, expansion of the system run through various complex processes, which may guide a thermalized system. The hadronized final state particles hold the information on the initial-state effects of the produced system, which gives rise to spatial anisotropy, which later results in the momentum anisotropy of the final state particles in off-central collisions. Anisotropic flow quantifies the momentum anisotropy of the produced system, which is one of the signatures of QGP. Additionally, Xenon (Xe) is a deformed nucleus that provides access to the effect of initial geometry on final state particle production. This analysis concentrates on the impact of nuclear deformation and hadron cascade-time on the particle production and elliptic flow using A Multi-Phase Transport (AMPT) model in Xe+Xe collisions at $\sqrt{s_{\rm NN}}$ = 5.44 TeV. The strength of anisotropic flow can be estimated from the flow coefficients ($v_{\rm n}$) with the help of Fourier expansion of the momentum distribution of the final state particles given by,

$$E\frac{d^3N}{dp^3} = \frac{d^2N}{2\pi p_{\rm T} dp_{\rm T} dy}\left[1+2\sum_{n=1}^{\infty} v_n\, cos[n(\varphi-\psi_n)]\right]. \quad (1)$$

Where, the second-order Fourier coefficient of the anisotropic flow known as elliptic flow (v_2), φ is the azimuthal angle of emission of a final state particle and ψ_n is the angle with respect to the reaction plane.

In this article, we have investigated $p_{\rm T}$-differential particle ratios and v_2 for identified particles in different centrality classes for Xe+Xe collision at $\sqrt{s_{\rm NN}}$ = 5.44 TeV. The study is performed using the AMPT-SM generated events where the deformation effect of Xe-nuclei is considered for the colliding nuclei. The details of the work can be found in Ref. [1].

Results and Discussion

Fig.1 represents the $p_{\rm T}$-differential particle ratios of $p(\bar{p})$ and ϕ to $\pi^{\pm}$ in Xe+Xe collisions at $\sqrt{s_{\rm NN}}$ = 5.44 TeV for (20-30)% centrality class as a function of transverse momentum in different hadronic cascade-time ($\tau_{\rm HC}$). The production rate of these identified particles as compared to pion increases with $p_{\rm T}$ which attain a maximum value in the intermediate $p_{\rm T}$ (2–3 GeV/c). This similar behaviour is also observed for all the hadronic cascade-time. At lower transverse momentum region ($p_{\rm T}$ $<$ 1 GeV/c), we see a significant effect of the hadronic cascade-time on ϕ/π and p/π which have a maximum deviation of $\sim$ 40% for τ_{HC} = 5 fm/c with respect to 25 fm/c. Similar behavior is observed for (50–60)% centrality class.

The elliptic flow is estimated by employing the two-particle correlation method, which

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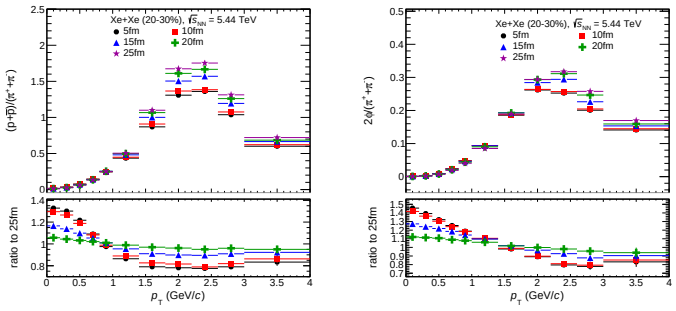

FIG. 1: (Color online) Shows $p_{\rm T}$-differential particle ratios of $p(\bar{p})$ and ϕ to $\pi^{\pm}$ in Xe+Xe collisions at $\sqrt{s_{\rm NN}}$ = 5.44 TeV for (20–30)% centrality class [1].

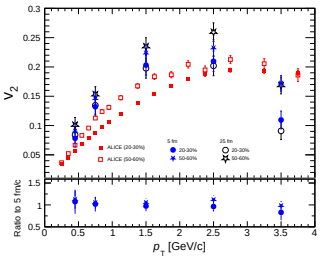

FIG. 2: (Color online) Shows $p_{\rm T}$-differential elliptic flow of charged particles in Xe+Xe collisions at $\sqrt{s_{\rm NN}}$ = 5.44 TeV for (20-30)% and (50-60)% centrality classes [1]. The results are compared with the ALICE data [2].

has the advantage of construction with a proper pseudo-rapidity cut. It removes the residual non-flow effects in the elliptic flow. Figure 2 represents the charged particle elliptic flow as a function of $p_{\rm T}$ for both 20–30% and 50–60% centrality classes. Here, we have compared the $p_{\rm T}$-differential elliptic flow for the two extreme cases, *i.e.* τ_{HC} = 5 fm/c and 25 fm/c for both the centrality classes. We observe that with different centrality classes and cascade times, the elliptic flow increases with $p_{\rm T}$ and gets a maximum value for $p_{\rm T}$ around 2–2.5 GeV/c. Higher v_2 is obtained for the peripheral collisions (50–60%) as compared the semi-central collisions (20–30%). The results are compared with the $p_{\rm T}$-differential elliptic flow of the charged particles obtained from the ALICE for both 20–30% and 50–60% centrality classes. A higher elliptic flow is observed for the 50–60 % centrality class, which is in line with the experimental observations[2].

Summary

1. The particle production relies on the scattering cross-section among the final state particles and the duration of the hadronic phase. Significance effect of hadron cascade time on $p_{\rm T}$-differential identified particle ratios for ϕ/π and p/π on $\tau_{\rm HC}$ is observed.

2. The $p_{\rm T}$-differential charged-particle elliptic flow is higher for $\tau_{\rm HC}$ = 25 fm/c compared to 5 fm/c, indicating anisotropy in the azimuthal distribution of the charged particles might arise from multiple scattering in the hadronic phase with higher $\tau_{\rm HC}$.

Acknowledgments

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References

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