Rapidity dependence of strangeness enhancement factor at FAIR energies

Kalyan Dey[1,2*] and B. Bhattacharjee[2†]
[1] *Deptartment of Physics, Bodoland University, Kokrajhar - 783370, INDIA and*
[2] *Nuclear and Radiation Physics Research Laboratory, Department of Physics, Gauhati University, Guwahati - 781014, INDIA*

Introduction

In heavy ion collision net-baryon density plays a significant role on the rapidity distribution of hadrons containing leading quarks [1]. Depending upon the beam energy the rapidity distribution of net-baryon density differs quite significantly [1] and thus the width of the rapidity distribution of the particles containing up- and/or down-quarks are expected to be influenced. A number of other workers [2, 3] have reported the dependence of the excitation function of the rapidity width on the initial up- and down-quark content of hadrons. Further, Steinheimer *et al.* [4] from UrQMD calculation predicted that strangeness is not uniformly distributed over rapidity space leading to a local violation of strangeness conservation. Thus, the study of rapidity dependent strangeness enhancement is of considerable significance.

Strange particles are produced only at the time of collisions and thus expected to carry important information of collision dynamics. Strangeness enhancement is considered to be one of the traditional signatures [5] of formation of Quark Gluon Plasma (QGP). Due to the limitation of the detector acceptance, the past and ongoing heavy ion experiments could measure the strangeness enhancement at midrapidity only. But the future heavy ion experiment CBM at FAIR will have the access to the entire forward rapidity hemisphere and thus the experimental determination of rapidity dependent strangeness enhancement is a possibility. In this work, an attempt has therefore been made to study the rapidity dependent strangeness enhancement at FAIR energies with the help of a string based hadronic model (UrQMD). A sum of 93 million minimum biased UrQMD events have been used for the present analysis.

Results and Discussion

In this report, the strangeness enhancement factor E_S is defined as -

$$E_S = \left[\frac{(Yield)_{AA}}{< N_{\pi^-} >}\right]_{central} / \left[\frac{(Yield)_{AA}}{< N_{\pi^-} >}\right]_{peripheral} \quad (1)$$

where the number of produced pions N_{π^-}, instead of N_{part}, is chosen as a centrality variable as the later exhibits a nonlinear behavior with the volume of the participant zone.

The strangeness enhancement factor (E_S) has been calculated and plotted as a function of rapidity for various identified particles for $Au + Au$ collision at 30A GeV as shown in Fig.1. It could be readily seen from the figure that E_S depends strongly on rapidity. Further, the enhancement factor at mid-rapidity is found to be maximum for the particles containing leading quarks while the same is observed to be minimum at mid-rapidity for the particles containing produced quarks.

To understand the underlying dynamics of such rapidity dependent strangeness enhancement, the widths of the rapidity distribution of the identified particles are plotted as a function of impact parameter. It is readily evident from Fig.2 that the rapidity dependence of strangeness enhancement can be traced back to the dependence of rapidity width on centrality. The width of the rapidity distribution decreases with centrality for the particles containing leading quarks (*net-baryon density ef-*

*Electronic address: k.dey@gsi.de
†Electronic address: bb_22@rediffmail.com

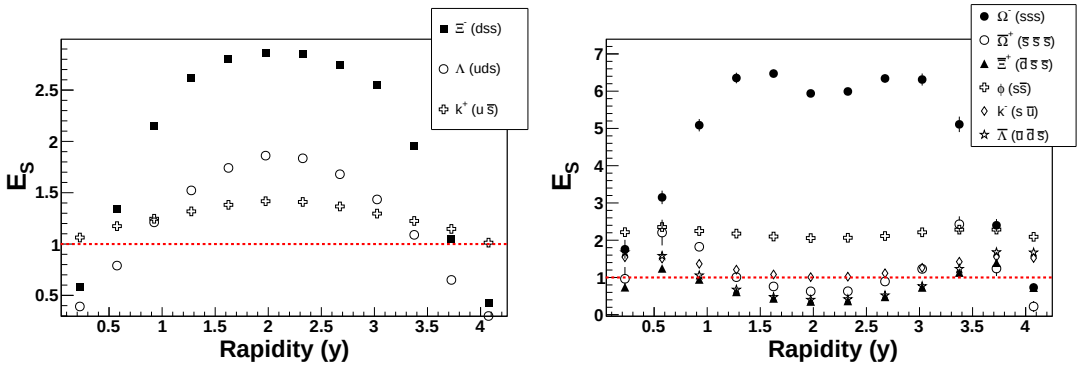

FIG. 1: Strangeness enhancement factor as a function of rapidity for particles containing produced quarks (left) and particles containing leading quarks (right) for $Au + Au$ collision at 30A GeV.

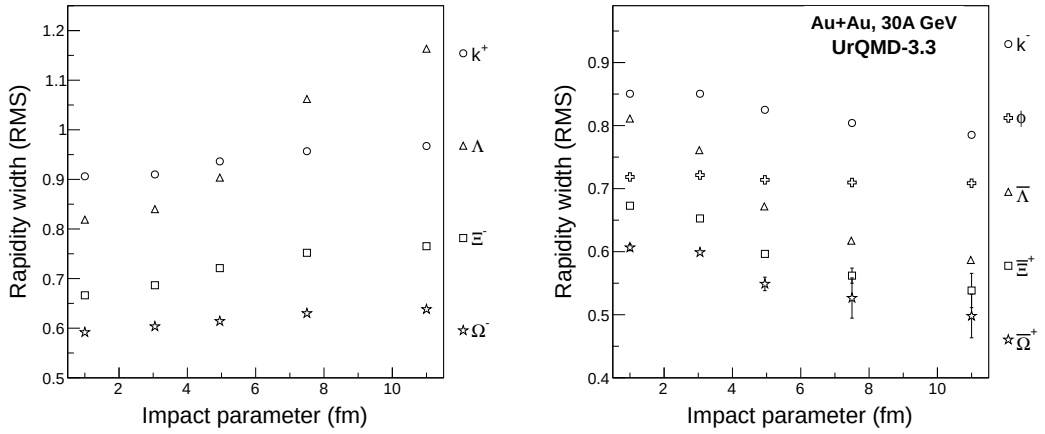

FIG. 2: Rapidity width as a function of impact parameter for identified particles for $Au + Au$ collision at 30A GeV.

fect [1]) while it shows an increasing pattern with centrality for the particles containing produced quarks (*as the size of the fireball increases with centrality*) except Ω^-. Although Ω^-(sss) contains produced quarks only, yet its production ($\Xi K^- \rightarrow \Omega\pi$) in UrQMD is influenced by Ξ^-(dss) which shows a decreasing pattern with centrality.

Acknowledgments

This work is supported by DST, Government of India through a research project vide project No. SR/MF/PS-012009. The authors are thankful to GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany for providing the computing resources.

References

[1] K. Dey, B. Bhattacharjee, Phys. Rev. C **89**, 054910 (2014).
[2] M. Bleicher, J. Phys.:CS **50**, 410 (2006).
[3] J.Steinheimer *et al.* EPJA **48**, 100 (2012).
[4] J.Steinheimer *et al.* Phys. Lett. **B676** (2009).
[5] J. Rafelski, B. Müller, Phys. Rev. Lett. **48** 1066 (1982); **56** 2334 (1986).