Multiparticle production in U-U collisions at $\sqrt{s_{NN}} = 193$ GeV by wounded quark approach

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Introduction

Relativistic Heavy-Ion Collider (RHIC) at Brookheaven National Laboratory has carried out U+U collisions in 2012 [1]. U+U collisions which have various possible initial geometrical configurations can provide a stringent testing ground for the particle production models. Most of these models are quite successful in describing particle multiplicity in symmetric and asymmetric spherical nuclei collisions. The behaviour of equation of state for QGP can be better understood by studying the U+U collisions since different initial configuration in these collisions can provide various kind of collision zones having different profile of temperature and density. The central collisions of U-U nuclei in tip-tip configuration can possibly be a good tool to characterize the signal of CME. In this article, our main motivation is to test our recent version of wounded quark model (WQM) [2, 3] in providing a reliable prediction of charged hadron production in U+U collisions and provide estimates for observables in various configurations which can be experimentally verifiedn in future. Here, we have extended our modified version of WQM [2, 3] with minimal number of parameters to explain and predict the charged hadron distributions with various controlling parameters in deformed U-U collisions for each centrality class at 193 GeV.

Model description

For deformed uranium nuclei we have used the modified form of Woods-Saxon nuclear density distribution in our WQM [2, 3] as given by Eq. 1 in which $Y_{20} = \sqrt{\frac{5}{16\pi}}(3\cos^2(\theta) - 1)$, $Y_{40} = \frac{3}{16\sqrt{\pi}}(35\cos^4(\theta) - 30\cos^2(\theta)+3)$ are the spherical harmonics with the deformation parameters β_2 and β_4. The different parameters value for uranium nuclei is taken from Refs. [2, 3]. The profile function $D_A(b)$ is related to nuclear density, $\rho(r,\theta)$ by the Eq. 2.

$$\rho(r,\theta) = \rho_0 \frac{1}{1+\exp\frac{(r-R(1+\beta_2 Y_{20}+\beta_4 Y_{40}))}{a}}, \quad (1)$$

$$D_A(b) = \sum_\theta \int_{-\infty}^{\infty}\int_0^{2\pi} \rho(r,\theta) dz d\phi, \quad (2)$$

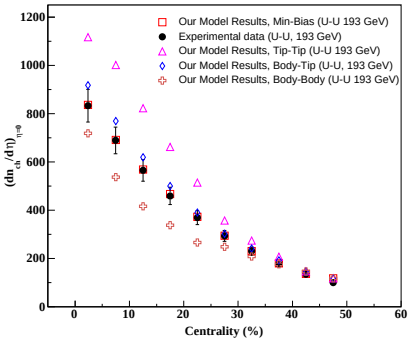

FIG. 1: Pseudorapidity density of charged hadrons produced in U-U collisions with respect to centrality. Experimental data is taken from Ref. [1]

Here, we have also shown the transverse energy density distribution of charged hadrons using the pseudorapidity distribution of WQM

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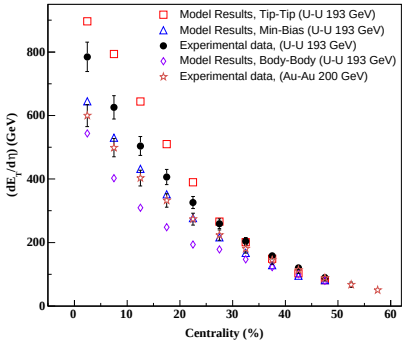

FIG. 2: Transverse energy density of charged hadrons produced in U-U collisions [1] with centrality.

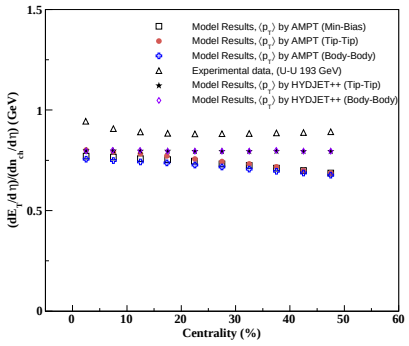

FIG. 3: $(dE_T/d\eta)/(dn_{ch}/d\eta)$ in our model as a function of centrality for various initial configurations of U-U collisions at $\sqrt{s_{NN}} = 193$ GeV.

as follows :

$$dE_T/d\eta \cong \frac{3}{2}\sqrt{\langle p_T\rangle^2 + m_\pi^2}(dn_{ch}/d\eta), \quad (3)$$

where $\langle p_T\rangle$ is the average transverse momentum of the produced charged particles and m_π is the mass of pion.

Results and Discussion

Fig. 1, demonstrates the variation of $(dn_{ch}/d\eta)_{\eta=0}$ with centrality; Our model result for minimum bias configuration suitably matches with the experimental data. In

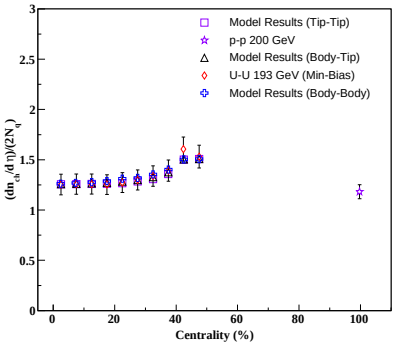

FIG. 4: Variation of $(dn_{ch}/d\eta)/(2N_q)$ as a function of centrality for U-U collisions at $\sqrt{s_{NN}} = 193$ GeV.

Fig. 2, we have shown the variation of $(dE_T/d\eta)_{\eta=0}$ in different centrality bins for possible configurations. Fig. 3 presents the variation of $(dE_T/d\eta)/(dn_{ch}/d\eta)$ with respect to centrality for various initial configurations of U-U collisions at $\sqrt{s_{NN}} = 193$ GeV. To calculate $dE_T/d\eta$, we need mean p_T which we took from two different models, AMPT [4] and HYDJET++ [5]. Fig. 4 presents the variation of the ratio $(dn_{ch}/d\eta)/(2N_q)$ as a function of centrality for U-U collisions. In conclusion we find that WQM describes the experimental findings satisfactorily for U-U collisions.

Acknowledgments

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