Dynamical Net-charge fluctuations in Au+Au collisions at BES energies ($\sqrt{s_{NN}}$ = 7.7 GeV to 39 GeV)

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Introduction

The STAR experiment at Relativistic Heavy Ion Collider (RHIC) provides the facility to investigate the behaviour of strongly interacting matter at high density and to search for the possible formation of Quark Gluon Plasma (QGP). In the year 2010 (Run 10), RHIC started its Beam Energy Scan (BES) program and collided Au+Au ions from $\sqrt{s_{NN}}$ = 39 GeV down to 7.7 GeV covering 112 < μ_B < 410 MeV. This allows us to access and probe broad region of the QCD phase diagram. Event-by-event net-charge fluctuation has been proposed as one of the indicators of QGP formation in heavy ion collisions. The fluctuation in net-charge depends on the squares of the charges present in the system, which depends on the state from which it originates. The system passing through a QGP phase which has quarks as charge carriers, should result in a significantly different net-charge fluctuation as compared to Hadron Gas (HG).

The variance of the ratio of positive and negative particles scaled by the total charged particle multiplicity, a quantity called D, should be approximately four times smaller than that of a gas of hadrons [1]. The charge fluctuation is measured in terms of D defined as :

$$D = 4\frac{\langle \delta Q^2\rangle}{\langle N_{ch}\rangle}, \quad (1)$$

where $Q = N_+ - N_-$ and $N_{ch} = N_+ + N_-$ here N_+ and N_- are the number of negative and positive particles, measured in specific transverse momentum (p_T) and pseudorapidity (η) window.

The value of D is 4 for uncorrelated pion gas and is reduced by about 30% in the presence of resonances. For a thermal system of free quarks and gluons, the value is significantly lower and has been calculated to be ≈ 1 [1].

The event-by-event net-charge fluctuations have been estimated by calculating the quantity $\nu_{+-,dyn}$ defined as [2–4] :

$$\nu_{+-,dyn} = \frac{\langle N_+(N_+ - 1)\rangle}{\langle N_+\rangle^2} + \frac{\langle N_-(N_- - 1)\rangle}{\langle N_-\rangle^2} - 2\frac{\langle N_- N_+\rangle}{\langle N_+\rangle\langle N_-\rangle}, \quad (2)$$

which is a measure of the relative correlation of ++, −− and +− pairs. The $\nu_{+-,dyn}$ has been found to be robust against random efficiency losses [5, 6]. The value of D is related to $\nu_{+-,dyn}$ as :

$$\langle N_{ch}\rangle \nu_{+-,dyn} = D - 4. \quad (3)$$

Analysis Details and Results

We report the measurements of net-charge fluctuations as a function of centrality in Au+Au collisions at $\sqrt{s_{NN}}$= 7.7, 11.5, 19.6, 27 and 39 GeV data collected in the years 2010 and 2011 by the STAR experiment. For this analysis, we use charged particle tracks from the Time Projection Chamber (TPC) for -1.0 < η < 1.0 with transverse momentum in the range 0.2 < p_T < 5.0 GeV/c.

For the centrality selection, uncorrected charged particles multiplicity measured within 0.5 < $|\eta|$ < 1.0 is used in order to avoid autocorrelation (or self-correlation) between parti-

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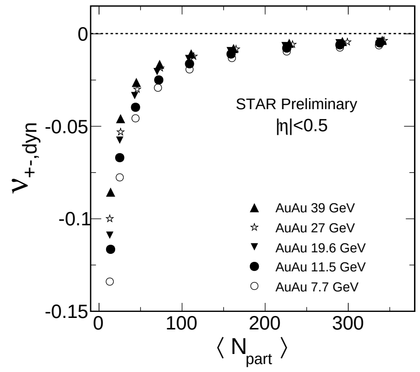

FIG. 1: Dynamical net-charge fluctuations, $\nu_{+-,dyn}$, of charged particles as a function of number of participating nucleons.

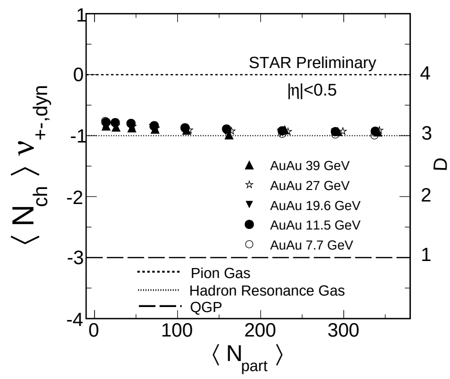

FIG. 2: $\langle N_{ch}\rangle\nu_{+,dyn}$ (left-axis) and D (right-axis) plotted for $|\eta| < 0.5$ as a function of the number of participating nucleons.

cles of interest and centrality.

Fig.1 shows $\nu_{+-,dyn}$ as a function of centrality for different energies. In all cases, the value of dynamical fluctuations are negative indicating that the produced positive and negative particles are correlated. The strength of correlation decreases while going from peripheral to central collisions involving increased number of participants. This may be due to a progressive dilution of the correlations with increased number of particle sources. The correlation strength increases with decreasing energy. The net-charge fluctuations scaled with charged particle multiplicity (Nch) as a function of the Npart is shown in Fig.2 within pseudorapidity range $|\eta| < 0.5$ for $\sqrt{s_{NN}}$= 7.7, 11.5, 19.6, 27 and 39 GeV Au+Au data. Lines in the plot indicate the predicted values of fluctuations for the three cases namely pion gas, HRG and QGP. Here, $< N_{ch} >$ is the uncorrected value of average number of charged particles produced in the pseudorapidity region of interest. It is observed that the results are near the Hadron Resonance Gas predictions for $N_{part} > 150$.

We will present centrality, pseudorapidity (η) and energy dependence of the dynamical net-charge fluctuations. The $\nu_{+-,dyn}$ results will be compared with model calculations from Heavy Ion Jet Interaction Generator(HIJING) and Ultra-relativistic Quantum-Molecular-Dynamics (UrQMD).

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