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Study of Charged Hadrons Elliptic Flow at 62.4 GeV

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***Abstract*— Elliptic flow is most important observable in studying about Quark Gluon Plasma. Its large value indicates significant space-momentum correlations, consistent with the rapid expansion of a strongly interacting Quark Gluon Plasma. The dependence of elliptic flow parameter for charged hadrons on centrality were studied using events generated by event generator AMPT at center of mass energy of 62.4 GeV per nucleon pair for Au+Au and Cu+Cu collisions. We analyzed the events falling in transverse momentum range p_t = 0.2 to 1 GeV/c and pseudorapidity range from -0.35 to 0.35. We compared the results obtained from simulated data and RHIC-PHENIX data.**

***Keywords*— RHIC, elliptic flow, heavy ion collisions, quark gluon plasma.**

I. INTRODUCTION

The hadrons, which compose our universe, take a state such that quarks and gluons are confined, and quantum chromo dynamics describes the state of the quarks and gluons. It is expected that under extreme condition such as high density and temperature and, a new state of matter may be created called QGP (Quark-Gluon plasma), where quarks and gluons are not confined [1-3]. On the earth, relativistic heavy ion collisions have been considered to be the only way which can provide the opportunity to create and study the QGP. Relativistic Heavy Ion Collider (RHIC) [4] at Brookhaven National Laboratory (BNL) has been constructed for this purpose. It is important to study azimuthal anisotropy to understand the underlying collision dynamics in heavy ion collisions [5]. The azimuthal anisotropy is usually characterized by the Fourier coefficients [6,7].

In this work we studied dependence of elliptic flow of charged hadrons on collision species Au+Au and Cu+Cu at centre of mass energy 62.4 GeV. We used AMPT generated data sets and PHENIX (RHIC) experimental data sets for analysis purpose.

II. EVENT GENERATION

We generated simulated events using event generator AMPT (A Multiphase Transport Model) with default setting. We obtained events for Au+Au and Cu+Cu at centre of mass energy 62.4 GeV per nucleon pair. AMPT is a hybrid transport model, which models an ultra-relativistic heavy ion collision using many tools of Monte Carlo simulations [8, 9]. We generated 400,000 events having parameters identical to experimental situation i.e. pseudorapidity range from -0.35 to 0.35.

III. ANALYSIS

A commonly used method the azimuthal distributions are expanded in Fourier series where the coefficients of expansion are the measures of different orders of anisotropy [3]. This method is also called event plane method. For small values of these coefficients, the first two terms describe an elliptic shape. The first order anisotropy v_1 is called directed flow; it measures the shift of the centroid of the distribution. The second order anisotropy v_2 is called elliptic flow; it measures the difference between the major and minor axes of the elliptic shape of the azimuthal distribution.

We can characterize this anisotropy in terms of a single-particle probability distribution for each collision event. By writing this distribution as a Fourier series with respect to the azimuthal angle of out-going particles Φ, one can define flow coefficients v_n and event plane angles Ψ_n:

$$\frac{2\pi}{N}\frac{dN}{d\phi} = 1 + 2\sum_{n=1}^{\infty} v_n \cos n(\phi - \psi_n) \qquad (1)$$

$$v_n e^{in\psi_n} \equiv \left\langle e^{in\phi} \right\rangle \quad (2)$$

Where the brackets indicate an average over the single particle probability and the event plane angles Ψ_n are chosen such that v_n are the (positive) magnitudes of the complex Fourier coefficients.

IV. RESULTS

We studied variation of elliptic flow parameter v_2 with various centrality percentile for simulated events generated for Au+Au and Cu+Cu collisions at 62.4 GeV. We estimated the elliptic flow parameter v_2 by above mentioned method for AMPT(default) events for 0-10%, 10-20%, 20-30%, 30-40% and 40-50% centrality bins for low transverse momentum ranging from 0.2-1.0 GeV/c. We compared our simulated data results with results calculated from data sets taken in Run-4 and Run-5 periods by PHENIX at RHIC [10]. Fig.1 shows elliptic flow parameter (v_2) variation with centrality for charged hadrons generated in Au+Au and Cu+Cu collisions at centre of mass energy 62.4 GeV per nucleon pair for p_t = 0.2 to 1 GeV/c and for $|\eta| <$ 0.35.

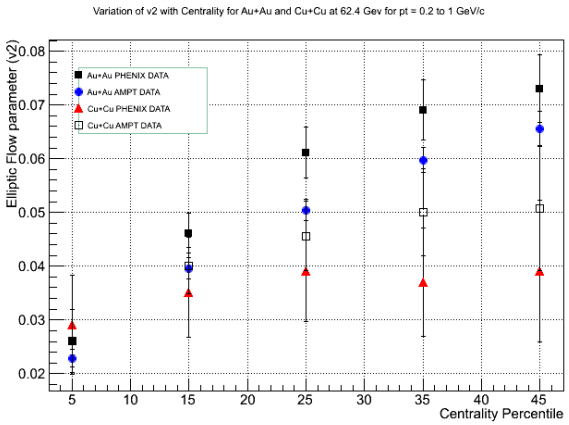

Fig. 1 Variation of Elliptic flow with centrality

V. CONCLUSIONS

It can be interpreted from the graphs that results from simulated data and from experimental data are approximately same within error limits. As centrality increases flow of particle increases as expected. For higher centrality experimental value differed from simulation value due to less number of particles in simulations. This is more in case for Cu+Cu collisions due to small size in comparision to Au+Au. Some of the difference in experimental and simulation results is due to detector effect.

This figure also shows mass dependency on the flow values. Elliptic flow of Au+Au is more than Cu+Cu at 62.4 GeV. It shows that a heavy ion which is heavier than the other ion shows more flow then a lighter heavy ion.

VI. REFERENCES

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