Status of CuAu flow measurement

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The quark-gluon plasma(QGP) is a phase of matter in quantum chromodynamics (QCD). This phase is predicted to exist at high temperature and high density. Currently at RHIC and LHC, QGP is created by colliding nuclei. In the heavy-ion collistions, azimuthal anisotropy of produced particle emmission exists. Collectively, this anisotropy is a quite important probe to understand the properties of QGP because this collectivity is sensitive to initial collision geometry and early time evolution. The strength of anisotropic flow is expressed as $v_n(n = 1, 2, 3)$ and the azimuthal distribution of emitted particles $dN/d\phi$ is expressed as follows using v_n .

$$\frac{dN}{d\phi} \propto 1 + \sum_{n=1} 2v_n \cos(n[\phi - \Psi_n]), \qquad (1)$$

where $v_n =< \cos(n[\phi - \Psi_n]) >$ with $n = 1, 2, 3..., \phi$ is the transverse angle of an emitted particle and Ψ_n is an event plane. The event plane is defined as the average angle of all emmitted particles that are detected. Thus even-order flow(v_2) which is called elliptic flow has been studied. These studies provide initial spatial conditions and the information of specific viscosity η/s of QGP in the hydrodynamic. The anisotropic flow is originated from initial spatial anisotropy. The initial spatial anisotropy lead to anisotropic collectivity in momentumu space. However, the hydrodynamic model does not completely agree with experimental data completly. There is still uncertainty in the theoretical model. Recently, the fluctuation of initial spatial anisotropy was focused upon. The fluctuation of eccentricity can lead to initial spatial triangularity. The initial spatial triangularity from the fluctuation is the origin of v_3 which is triangular flow strength. This Fourier coefficient is important to determine the initial state anisotropy and η/s.

In 2012, Cu+Au collisions were investigated at RHIC. Such asymmetric collisions of heavy nuclei can provide different participant profiles through symmetric collisions of heavy nuclei such as Au+Au and Cu+Cu because of uniqe initial geometry. In symmetric collisions, initial geometry fluctuations lead to odd harmonics. However in Cu+Au collisions such an uniqe initial geometry could lead to non-zero odd harmonics. Cu+Au v_3 could come from such a initial geometrical triangularity, rather than fluctuation. Therefore, the measurement of Cu+Au non-zero harmonics is quite important to determine initial conditions.

In this paper, we report the current status of v_2,v_3 measurement at midrapidity in Cu+Au collisions. In order to measure v_2, v_3, an event-plane method is applied. To apply the event-plane method, the following relation between true v_n^{tr}, Ψ_n^{tr} that could not be measured experimentally and observed v_n, Ψ_n is needed.

$$v_n^{tr} = v_n^{ob} / < \cos(n[\Psi_n - \Psi_n^{tr}]) >, \qquad (2)$$

where $< \cos(n[\Psi_n - \Psi_n^{tr}]) >$ correspond to the event-plane resolution. The event plane is determined by

$$Q_{xn} = \sum_{i=1} w_i \cos(n\phi_i), Q_{yn} = \sum_{i=1} w_i \sin(n\phi_i), \qquad (3)$$

$$\Psi_n = \tan^{-1}(Q_{yn}/Q_{xn})/n, \qquad (4)$$

where Ψ_n is the measure of the event plane and $Q_{x(y)n}$ is the projection of Ψ_n to the x(y) axis. w_i is the weight and ϕ_i is the angle of a particle.

In this analysis, the event plane is determined by beam beam counter(BBC) and a forward silicon vertex detector(FVTX). These detectors are located at foward/backward rapidity. In order to measure v_n precisely, there should be rapidity gap between the regions of measurement of v_n and Ψ_n because if are not separeted these regions, v_n would include a non-flow contribution. This non-flow is a correlation that dose not originate from the event plane. Thus, it is better to choose the detector that is located at forward/backward rapidity as the event plane measrement detector.

Figure1 shows the event plane resoluiton of BBC and FVTX for Ψ_2. In the central region $(0-20\%)$, the resolution of FVTX South resolution is larger than that of FVTX North. This behavior is also found in BBC. This behavior originate from the multiplicity that is used to measure the event plane and strength of v_2. Currently, I have calibrated Ψ_3 and am working on calculating Ψ_3 resolution.

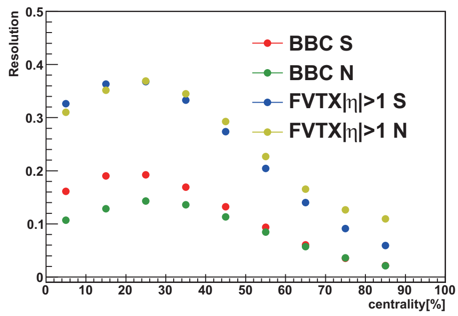

Fig. 1. FVTX/BBC Ψ_2 resolution as a function of centrality.

References
1) PRL 107, 252301 **40**, L1299 (2011).
2) arXiv:1111.5095v1 Lett. **2011**
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