The azimuthal anisotropy of particle production in non-central collisions is sensitive to the early stage of high-energy heavy ions collision and, the strength of the elliptic anisotropy ($v_2$) is a sensitive probe for studying properties of the hot dense matter made by heavy ion collisions (quark-gluon plasma).

**Introduction**

The initial geometrical anisotropy is transferred by the pressure gradients into a momentum space anisotropy and the behavior of $v_2$ can be mostly explained by a hydro-dynamical model and initial pressure gradient at transverse momentum, $p_T < 2$GeV/c, but not at higher $p_T$.

1. $v_2$ at 62.4GeV and 200GeV in Au+Au are consistent.

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3. $v_2$/eccentricity(e) agree well between Au+Au and Cu+Cu collision at the same number of participants($N_{part}$) as shown in the right figures. We find that $v_2$ depends on $e$ and $N_{part}$. We observe that $v_2$ divided by $e$ monotonically increases with $N_{part}$ and scales as $N_{part}^{1/3}$.

4. For identified hadrons, $v_2$ divided by the number of constituent quarks($n_q$) is independent of hadron species as a function of transverse kinetic energy ($K_T=m_n$) between 0.1<$K_T$/$n_q<$1GeV. Combining all of the above scaling and normalizations, we observe a near-universal scaling, with the exception of the Cu + Cu data at 62.4 GeV, of $v_2/(n_q e N_{part}^{1/3})$ vs. $K_T/n_q$ for all measured particles.

At higher $p_T$:

The Hydro-dynamical model begins to break down at $p_T>~2$ GeV/c. High $p_T$ particles result from the fragmentation of high $p_T$ initial state partons. Such high $p_T$ partons, are produced in the overlap region between nuclei and are not related to the reaction plane. However, a non zero $v_2$ is observed in the high $p_T$.

One possible explanation is that the parton loses its energy in the medium and jet production are suppressed. Since the collision overlap region forms an almond shape (not round) in non-central collisions, high $p_T$ partons go through less medium and lose less energy in the in-plane direction compared to the out-of-plane direction.

The difference in how much the jets are suppressed between the in-plane and out-of-plane directions makes the $v_2$ positive.

**Future Plan ; Advantage of the going analysis**

1. We are analyzing the data at Year2014 (Run14), 20 billion events, which is about ~30 time more than previous analysis shown above.

2. We use silicon vertex detector(VTX) to reject fake tracks which are the dominate background for the high $p_T$ charged particle analysis at PHENIX. VTX is installed from Run11. Previous analysis used energy cut provided by EMCalorimeter which reduce the background beautifully but reduce the signal significantly too as shown the right.

3. To determine the reaction plane we have option to use MPC which has better resolution than BBC.