Azimuthal Anisotropy of ϕ-meson in U-U collisions at RHIC

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Introduction

Azimuthal Anisotropy is an important tool for studying the hot and dense matter created in the early stages of high energy heavy ion collsions at Relativistic Heavy ion Collider (RHIC)[1]. It describes the momentum space anisotropy of produced particles in non-central heavy ion collisons caused by the pressure gradient developed in the early stage of collisions. The azimuthal distribution of the produced particles can be expanded as the Fourier series,

$$\frac{dN}{d\phi} \propto 1 + \sum_{n=1}^{\infty} 2v_n \cos\left[n(\phi - \psi_{rp})\right] \qquad (1)$$

where ψ_{rp} is the reaction plane angle. The reaction plane is defined by the beam direction and impact parameter vector between two colliding nuclei. The reaction plane angle ψ_{rp} is not directly measurable, so the Fourier coefficients are determined with respect to the estimated event planes,

$$v_n = < \cos n\left(\phi - \psi_n\right) > \qquad (2)$$

where ψ_n are the estimated event plane angles of various orders (n) for each event. The estimated event plane angle from detected particles is then corrected for the event plane angle resolution.

In year 2012, RHIC carried out the collisions of deformed nuclei ^{238}U + ^{238}U. It is believed to produce higher energy density and number of particles than is possible using spherical nuclei like Au+Au or Pb+Pb at the same incident energy[2].

In this work we have studied the Fourier coefficients v_n of ϕ-meson in U+U collisions at $\sqrt{s_{NN}}$ = 193 GeV using η-sub event plane method [1]. Total 295 million minimum bias events are analysed. Although the azimuthal anisotropy is an early time phenomenon but its magnitude might still be affected by the later stage hadronic interactions. Since the hadronic interaction cross section of ϕ-meson is smaller than the other hadrons, its v_n coefficients remain almost unaffected by the late stage interactions. Therefore ϕ-meson v_n will reflect the collective motion of the partonic phase. This makes the ϕ-meson a clean probe for the study of the properties of the matter created in heavy ion collisions.

Analysis and Results

Fig. 1 shows the invariant mass m_{inv} distribution of ϕ-meson from minimum bias (0-80%) U + U collisions at $\sqrt{s_{NN}}$ = 193 GeV. Solid line is a fit of the Breit-Wigner function plus a linear background. Fig. 2 shows

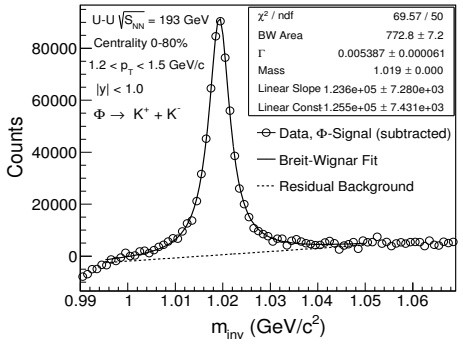

FIG. 1: Invariant mass distribution of ϕ-meson.

the azimuthal angle distribution of ϕ-meson raw yields with respect to the event plane angle for transverse momentum range 1.2 <

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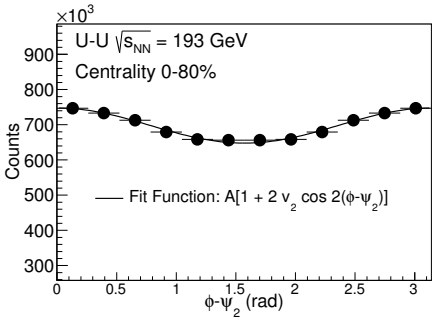

FIG. 2: Azimuthal angle distribution of raw ϕ-meson yield.

p_T < 1.5 GeV/c. Dashed line represents the fit to a function of the form: $\frac{dN}{d(\phi-\psi_n)} = A(1 + 2v_n \cos n(\phi - \psi_n))$, where A is the normalization constant. Fig. 3 shows the event plane resolution as a function of centrality. Centrality 0-5% corresponds to most central and centrality 70-80% corresponds to peripheral. Event plane resoultion first increases from peripheral to central collisions and then decreases for most central collisions. Fig. 4 shows p_T dependence of the v_n coefficients for ϕ-meson in minimum bias (0-80%) collisions. The error bars represent statistical errors only. Magnitude of higher order harmoincs(v_3,v_4) is small compare to v_2. Fig. 5 shows v_2 of ϕ-

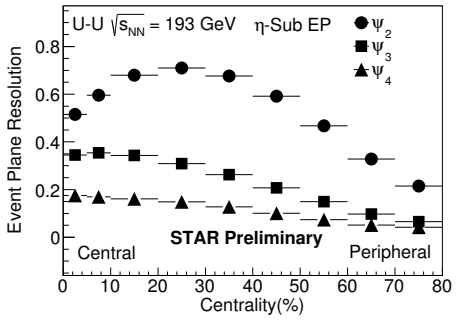

FIG. 3: Event plane resolution as a function of centrality.

mesons as a function of p_T in the centralities 0-30% and 30-80%. A clear centrality dependence can be seen from the figure.

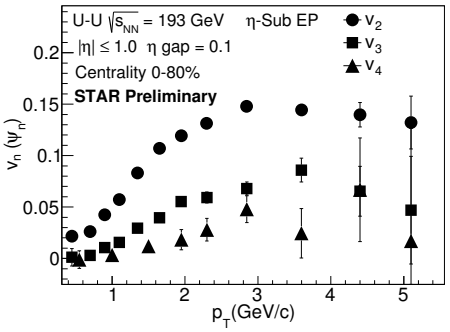

FIG. 4: p_T dependence of the v_n coefficients for ϕ-meson.

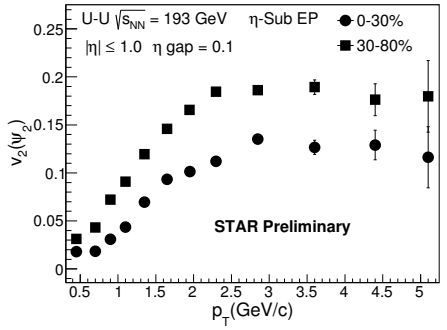

FIG. 5: Centrality dependence of ϕ-meson v_2.

Conclusions

We have carried out the measurement of various order azimuthal anisotropy in ϕ meson production in U+U collisions at $\sqrt{s_{NN}}$ = 193 GeV. Magnitude of higher order harmonics v_3, v_4 is small compare to v_2. Centrality dependence is observed for v_2 and for other harmonics.

Acknowledgments

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References

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