Anisotropic flow measurements of strange and multi-strange hadrons in isobar collisions Ru+Ru and Zr+Zr from the STAR experiment at RHIC

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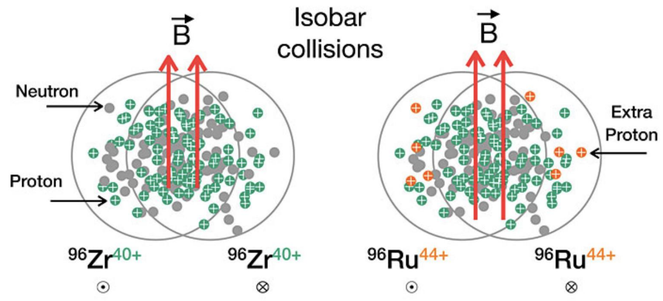
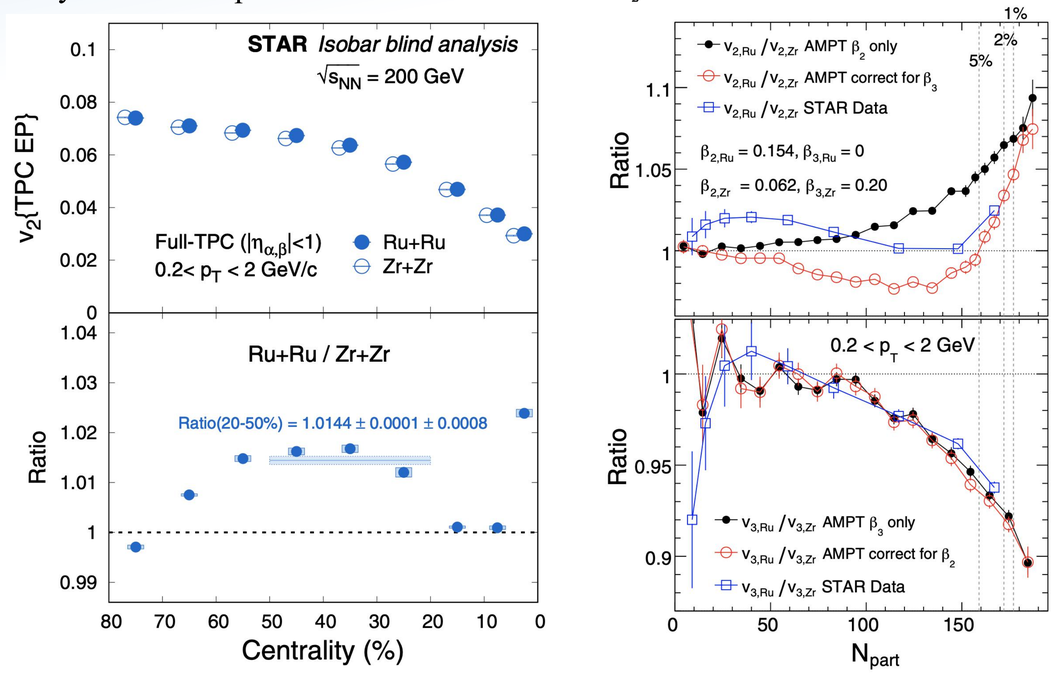
Abstract

Anisotropic flow primarily arises from the spatial anisotropy of the initial overlap region in heavy-ion collisions. The 2nd order anisotropic flow coefficient is elliptic flow (v_2). Measurements of strange and multi-strange hadrons v_2 are excellent probes for understanding the initial state anisotropies of the medium produced in these collisions, owing to their smaller hadronic cross-section compared to light hadrons. Moreover, elliptic flow of charged hadrons has been observed to differ in magnitude between the isobar collisions, $^{96}_{44}$Ru+$^{96}_{44}$Ru and $^{96}_{40}$Zr+$^{96}_{40}$Zr, at $\sqrt{s_{NN}}$ = 200 GeV despite the same mass number. This indicates a difference in nuclear structure and deformation between these nuclei. We report measurements of elliptic flow of K^0_S, Λ, $\overline{\Lambda}$, ϕ, Ξ^-, $\overline{\Xi}^+$, and $\Omega^-+\overline{\Omega}^+$ at mid-rapidity in isobar collisions. Centrality dependence, number of constituent quark (NCQ) scaling, and integrated v_2 for the two isobaric collisions have been studied to provide insight into the initial stages of these isobar collisions.



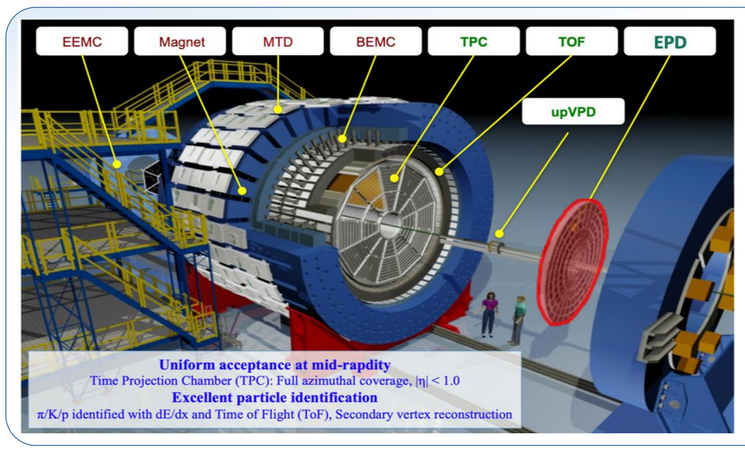
1. Motivation

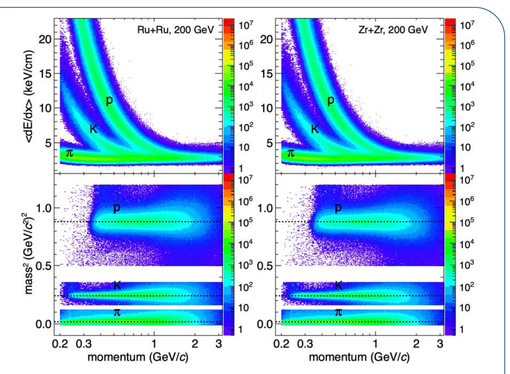
- Elliptic flow (v_2) of strange and multi-strange hadrons provides information on:
  - Initial state anisotropies
  - Insight into the nuclear density and deformation [1-3]
  - System size dependence of evolution of the system



- Charged hadrons v_2 and v_3 shows difference between Ru and Zr collisions both in theoretical and experimental measurements indicating effect of nuclear structure [1,3].
- (Multi-)strange hadron v_2 measurements are interesting as opposed to charge hadron v_2.

2. Experiment

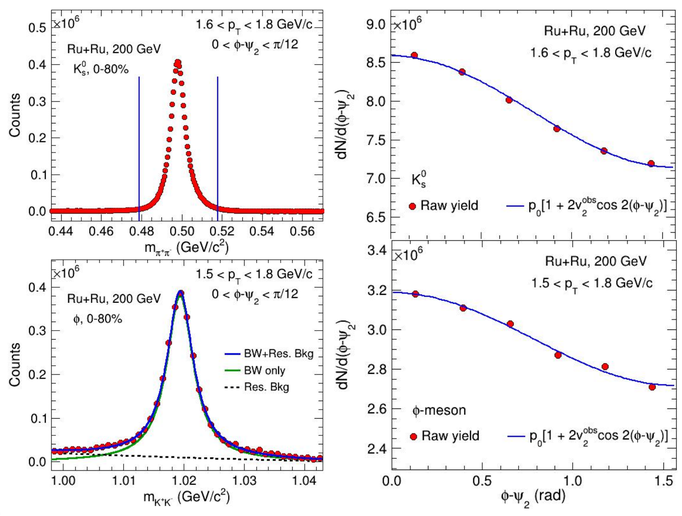




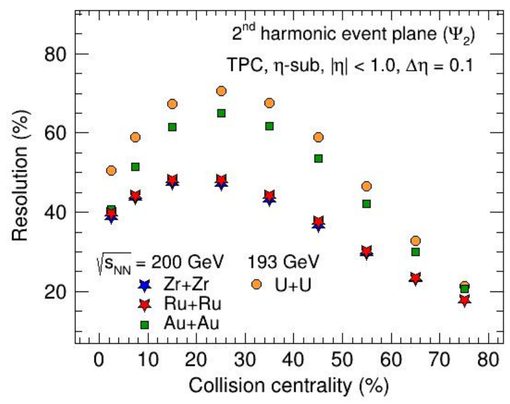
Dataset: ~3.6B events of Ru+Ru and Zr+Zr collisions at $\sqrt{s_{NN}}$ = 200 GeV

3. Methodology

- Event plane reconstruction using TPC [4] $\Psi_2 = \left[\tan^{-1}\left(\frac{\sum_i w_i \sin(2\phi_i)}{\sum_i w_i \cos(2\phi_i)}\right)\right]/2$
- v_2 calculated from η-sub event plane method
- Even plane angle resolution correction $v_2 = \langle\cos(2(\phi - \Psi_R))\rangle$
- Particle reconstruction using invariant mass method
- Background reconstruction using event-mixing method for ϕ-mesons and rotational method for K^0_S, Λ, Ξ, and Ω



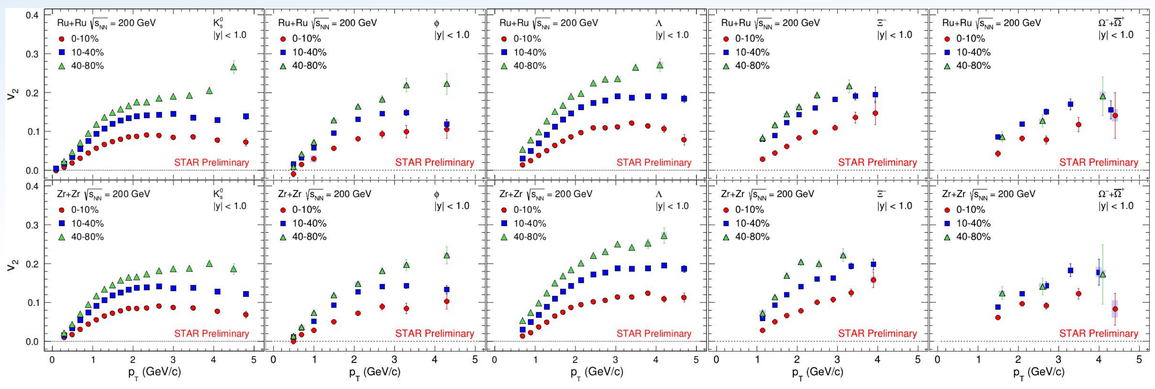
$$R = \sqrt{\langle\cos 2(\Psi_2^a - \Psi_2^b)\rangle}$$



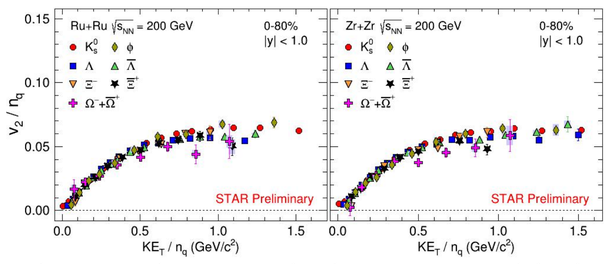
Even plane angle resolution

4. Results

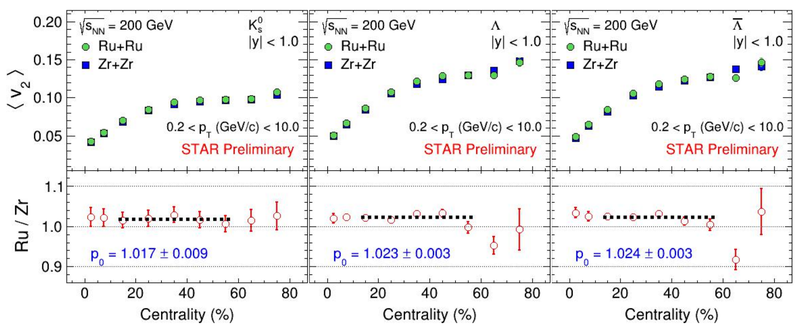
- Strong centrality dependence of v_2 indicate effect of initial collision eccentricity



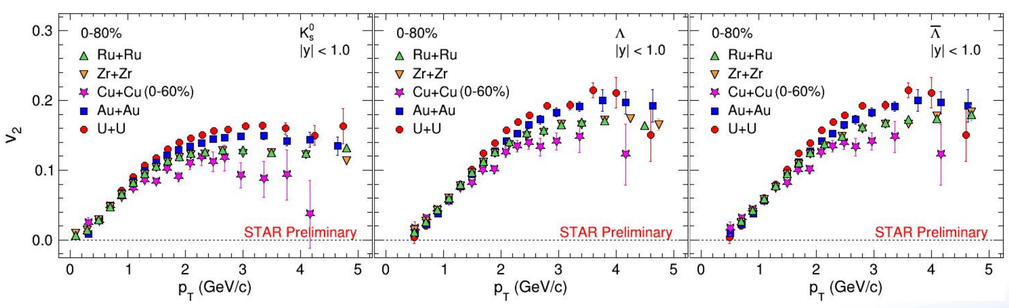
- NCQ scaling indicate partonic collectivity in isobar collisions at $\sqrt{s_{NN}}$ = 200 GeV



- Ratio of strange hadrons v_2 between isobar systems hinting at different nuclear structure



- Systemic increase in v_2 with increasing size of colliding nuclei [5,6]



5. Summary

- Strong centrality dependence and NCQ scaling for (multi-)strange hadrons shows the quark coalescence and partonic collectivity in isobar collisions
- Ratio of strange hadron v_2 seems to show a deviation of nearly 2% in mid-central collisions indicating a difference in nuclear geometry between Ru and Zr nuclei
- Elliptic flow of strange hadrons increases with larger size of incoming nuclei

6. References

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