Elliptic flow of strange and multi-strange hadrons in isobar collisions at RHIC

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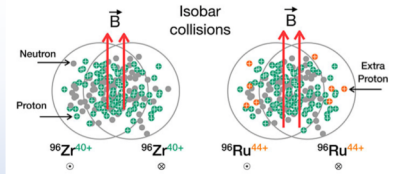
Abstract

Elliptic flow (v_2) primarily arises from the initial spatial anisotropy of the collision geometry. 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. v_2 measurements of strange and multi-strange hadrons 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. We report measurements of elliptic flow of K_s^0, Λ, $\bar{\Lambda}$, ϕ, Ξ^- and $\bar{\Xi}^+$ 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.

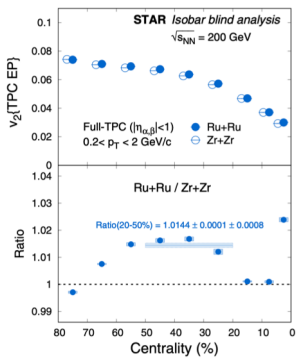


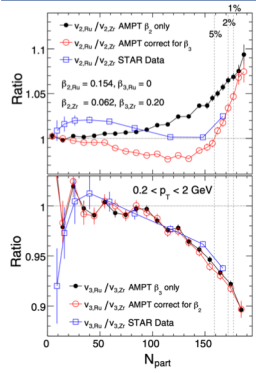
1. Motivation

- v_2 of strange and multi-strange hadrons is more sensitive than that of charged hadrons to anisotropies in the medium at early stage
- Insight into the nuclear density and deformation via elliptic flow [1-3]
- System size dependence of evolution of the system

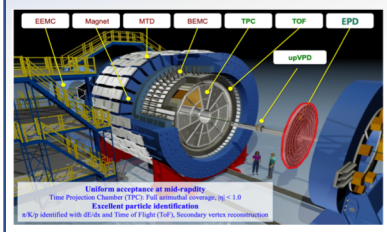
$$v_2 = \langle \cos(2(\phi - \Psi_R)) \rangle$$

$^{238}_{92}U$, $^{197}_{79}Au$, $^{96}_{44}Ru$, $^{96}_{40}Zr$, $^{63}_{29}Cu$





2. Experiment



- Time Projection Chamber (TPC) and Time of Flight (TOF) used for tracking, momentum measurement, and particle identification at STAR
- **Dataset:** Ru+Ru and Zr+Zr collisions at $\sqrt{s_{NN}}$ = 200 GeV (2018)

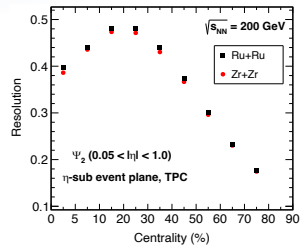
3. Methodology

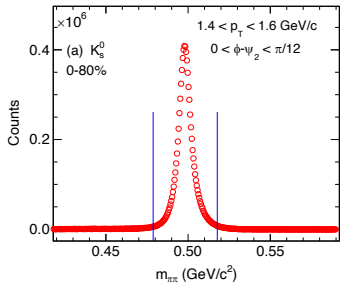
- Event plane reconstruction using TPC [4]

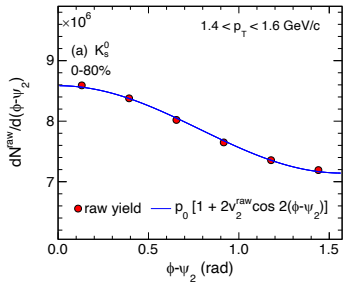
$$\Psi_2 = \left[\tan^{-1}\left(\frac{\sum_i w_i \sin(2\phi_i)}{\sum_i w_i \cos(2\phi_i)}\right)\right]/2$$

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

- Particle reconstruction using invariant mass method
- Background reconstruction using event-mixing method for ϕ-mesons and rotational method for K_s^0, Λ, and Ξ

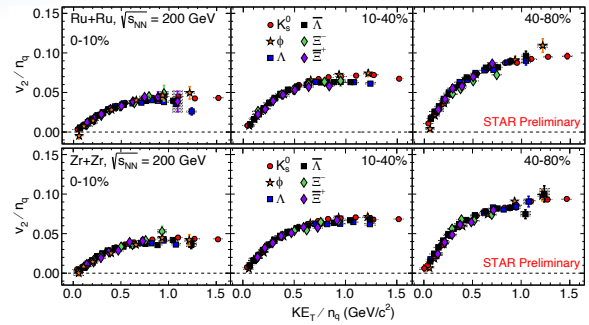




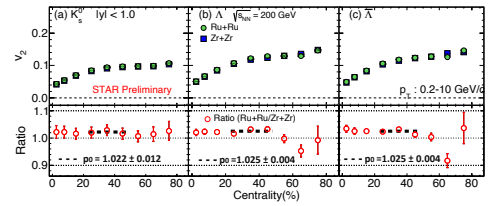


4. Results

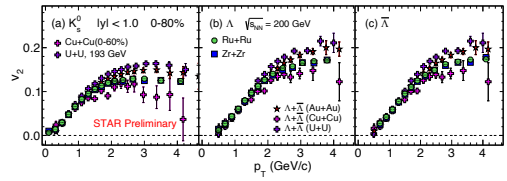
- NCQ scaling observed for all centralities in Ru+Ru and Zr+Zr collision
  - Indication of partonic collectivity



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



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



5. Summary

- NCQ scaling for (multi-)strange hadrons indicates partonic collectivity in isobar collisions
- v_2 ratio 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 size of colliding nuclei

6. References

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Supported in part by the U.S. DEPARTMENT OF ENERGY | Office of Science