

Probing the QCD Phase Structure with Elliptic Flow in Au+Au Collisions at $\sqrt{s_{NN}}$ = 3.0-19.6 GeV at RHIC

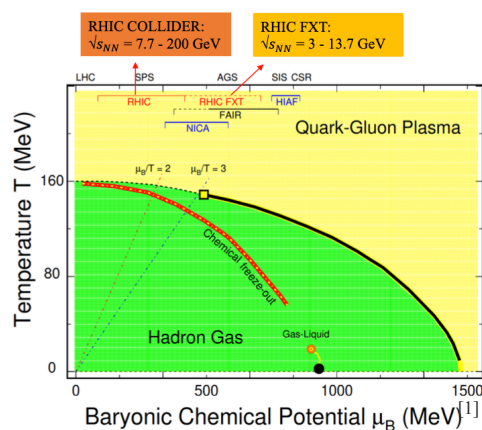
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Abstract

In heavy-ion collisions, the elliptic flow (v_2) represents the second harmonic coefficient in the Fourier expansion of the azimuthal distribution relative to the second order event plane. It serves as a sensitive indicator of the interaction strength among the system's constituents and offers a valuable means to explore its degrees of freedom.

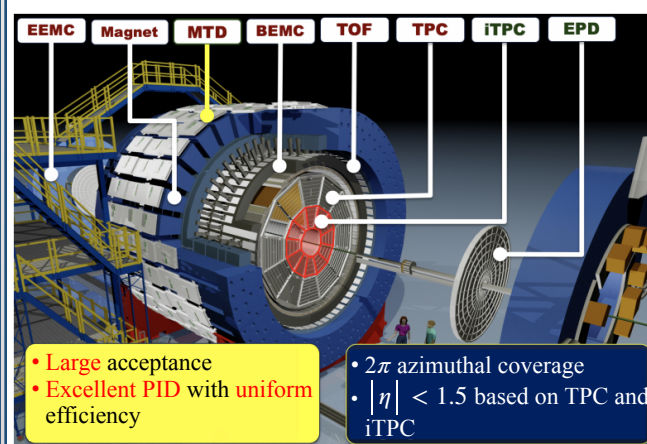
In this poster, we present v_2 measurements for a variety of hadrons, including $\pi^\pm$, $K^\pm$, p , $\bar{p}$, K_S^0 , ϕ , Λ , $\bar{\Lambda}$, $\Xi^\pm$ and $\Omega^\pm$ in Au + Au collisions, based on high-statistics datasets from the second phase of the RHIC Beam Energy Scan (BES-II) program measured by STAR. The scaling of v_2 according to the Number of Constituent Quarks (NCQ) for both particles and antiparticles is examined. In addition, the NCQ-scaled v_2 ratios of particles such as π^+/K^+ , p/K^+ , π^-/K^- , $\bar{p}/K^-$, ϕ/K^- , Λ/K_S^0 and $\bar{\Lambda}/K_S^0$, across the energy range $\sqrt{s_{NN}} = 3.0 - 19.6$ GeV are presented. The inferred information related to the QCD phase structure is discussed.

Motivation



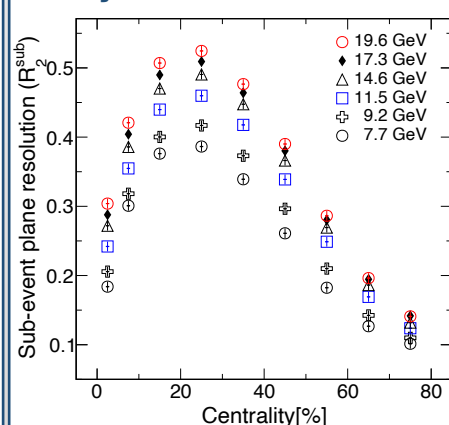
- Elliptic flow is sensitive to the degrees of freedom and the equation of state of the produced medium.

Experimental setup



- Large acceptance
- Excellent PID with uniform efficiency
- 2π azimuthal coverage
- $|\eta| < 1.5$ based on TPC and iTPC

Analysis method



$$R_2 \propto v_2 \sqrt{M}$$

$$\eta^A \in (0.05, 1.5) \quad \eta^B \in (-1.5, -0.05)$$

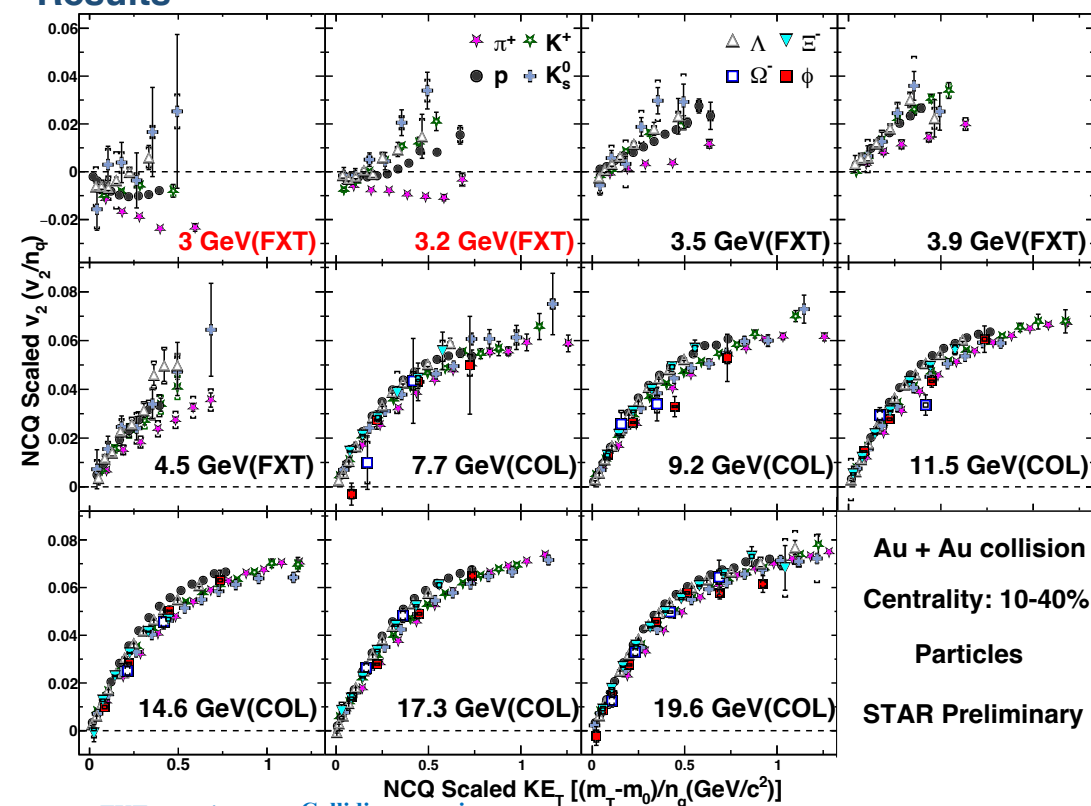
$$R_2^{sub} = \sqrt{\langle \cos[2(\Psi_2^A - \Psi_2^B)] \rangle^{[2]}}$$

$$N^R \propto 1 + 2v_2^R \cos[2(\phi^{A(B)} - \Psi_2^{A(B)})]$$

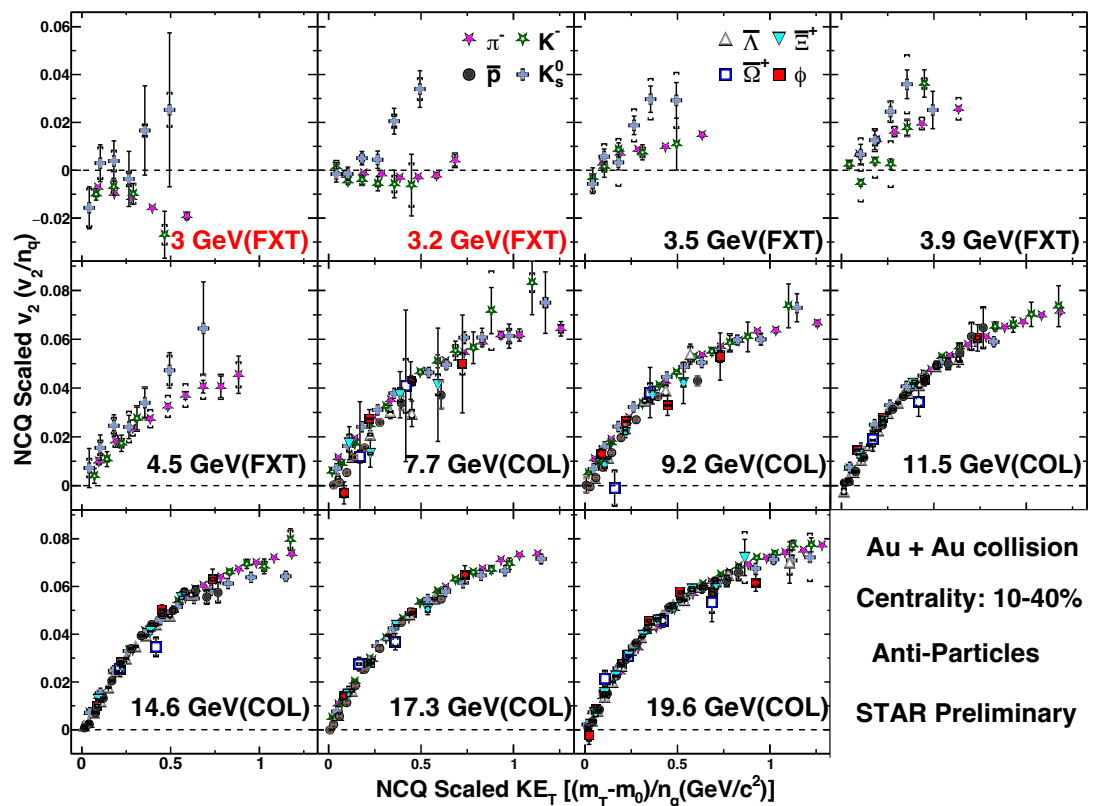
$\langle v_2 \rangle = \langle v_2^R \rangle \langle 1/R_2^{sub} \rangle^{[3]}$
where N^R is the number of particles as a function of $\phi - \Psi_2$, weighted for each centrality bin with the inverse of the event plane resolution

- The second order event plane (Ψ_2) is determined by the TPC
- v_2 is measured using the event plane method with a correction for event plane resolution^{[2][3]}

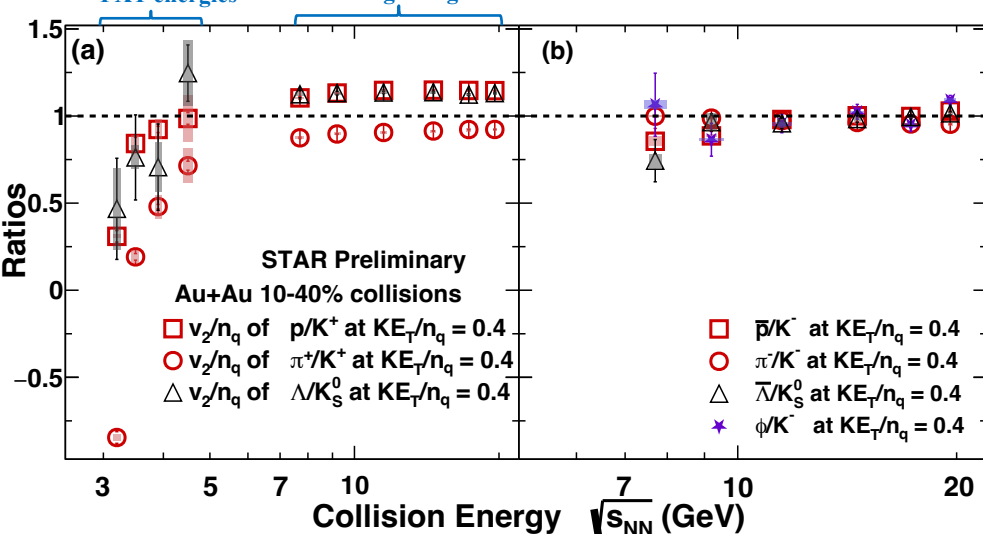
Results



Au + Au collision
Centrality: 10-40%
Particles
STAR Preliminary



Au + Au collision
Centrality: 10-40%
Anti-Particles
STAR Preliminary



Conclusions

- NCQ scaling breaks completely ≤ 3.2 GeV but gradually restores > 3.5 GeV.
- The ϕ meson and multi-strange hadrons v_2/n_q do not deviate from other particles at $\sqrt{s_{NN}} \geq 7.7$ GeV.
- The NCQ scaled v_2 ratios are close to 1 and are less dependent on the collision energy between 7.7 and 19.6 GeV.
- Partonic collectivity in Au + Au collisions at $\sqrt{s_{NN}} \geq 7.7$ GeV.

References

- [1] X.Luo, S.Shi, Nu Xu et al. Particle 3, 278 (2020)
- [2] A. M. Poskanzer, S. A. Voloshin, Phys. Rev. C 58, 1671 (1998)
- [3] H. Masui, A. Schmah, A.M. Poskanzer, Nucl. Instrum. Meth. A 833, 181-185 (2016)

