Azimuthal anisotropy measurement of (multi)strange hadrons and ϕ mesons in Au+Au collisions at $\sqrt{s_{NN}}$ = 3 - 19.6 GeV in BES-II at STAR

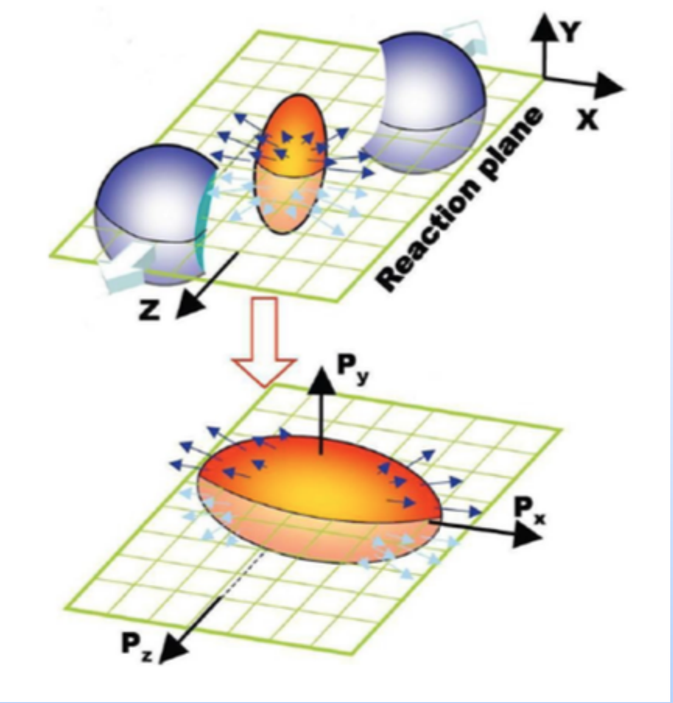
Li-Ke Liu (likeliu@mails.ccnu.edu.cn), Central China normal university, *for the STAR Collaboration*

Abstract

Azimuthal anisotropies are sensitive observables to the initial stage of heavy-ion collisions[1,2]. Strange and multi-strange hadrons are suitable candidates to measure these flow coefficients due to their small hadronic interaction cross section and early freeze-out from the medium[3,4]. In this poster, we present precise measurements of v_2 for $\pi^{\pm}, K^{\pm}, K^0_s, p, \bar{p}, \phi, \Lambda, \bar{\Lambda}, \Xi^{\pm}, \Omega^{\pm}$ at $\sqrt{s_{NN}}$ = 19.6 GeV and compare to 3 GeV at STAR. The test of number of constituent quark scaling will be shown for all the particles.

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

Motivation

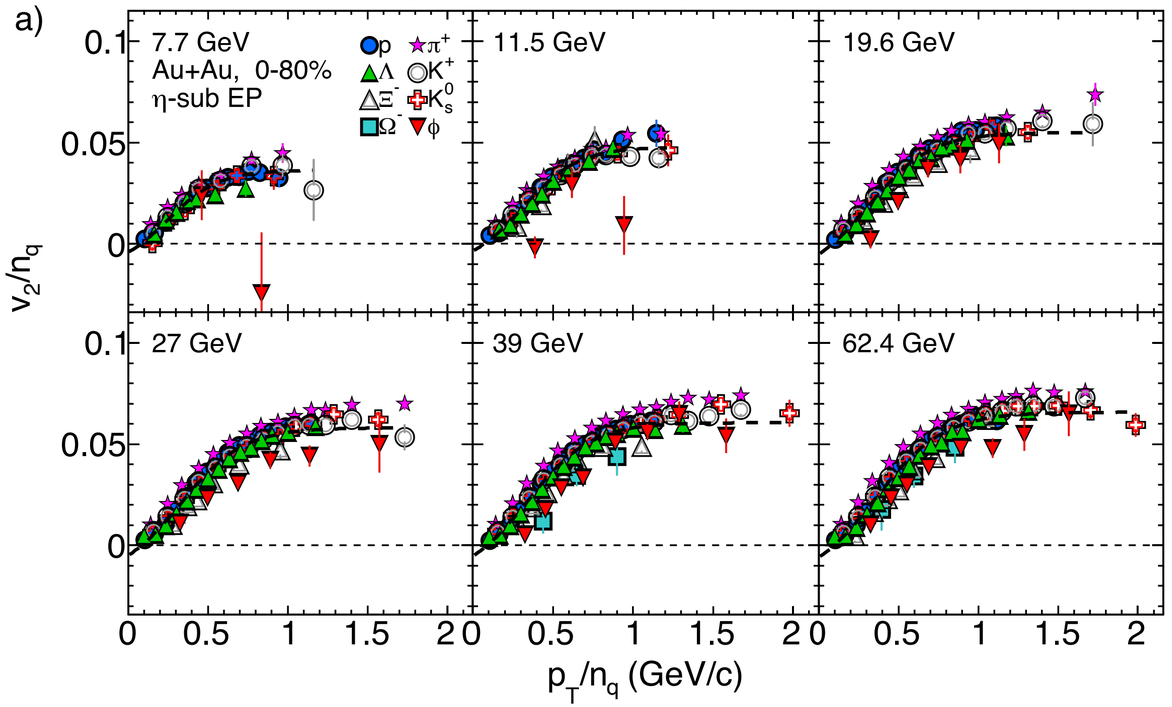


$$\frac{dN}{d\phi} \sim 1 + \sum_{n=1}^{\infty} 2v_n \cos(n(\phi - \Psi_r))$$

$$v_2 = \left\langle \cos\left[2\left(\phi - \Psi_r\right)\right] \right\rangle$$

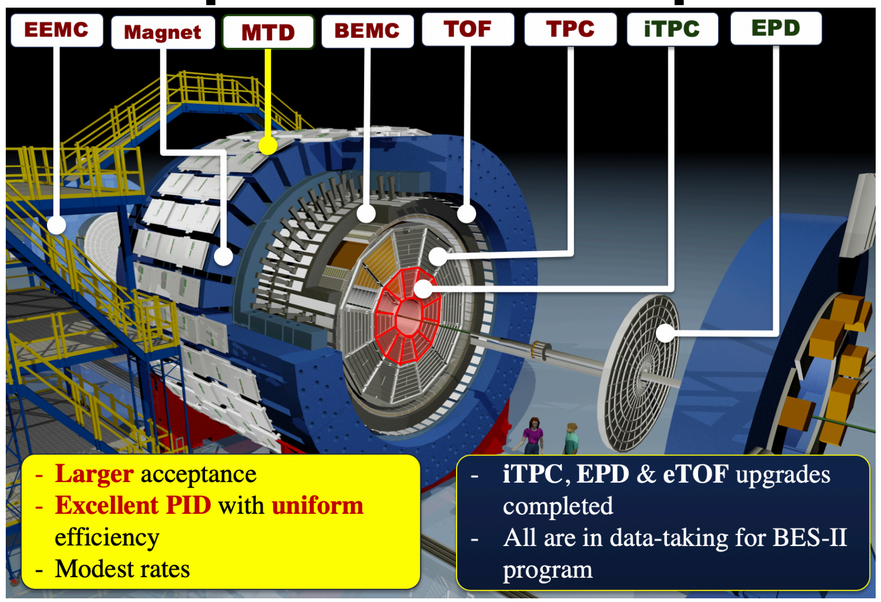
S. A. Voloshin, Phys. Rev. C 58, 1671–1678 (1998)

L. Adamczyk et al. (STAR): Phys. Rev. C 88, 014902(2013)



- v_2 is sensitive to early stage of heavy ion collisions: self-quenching effect[1,2]
- Multi-strange hadrons and ϕ mesons less sensitive to late hadronic re-scatterings and freeze out early from the medium[3,4]
- A hint that v_2 of ϕ mesons lower than other hadrons below 19.6 GeV from BES-I measurements[5,6]

Experimental setup



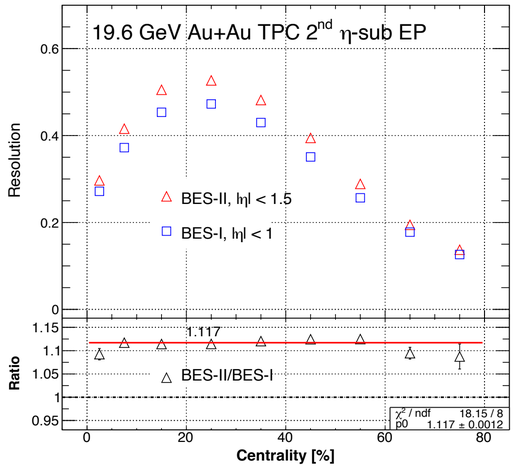
- The STAR Detector
  - Full 2π azimuthal coverage
  - Large acceptance at mid-rapidity
  - Excellent particle identification
- Upgrade of inner-TPC gives better precision at low pT and wider acceptance (|η| < 1.5)

Analysis method

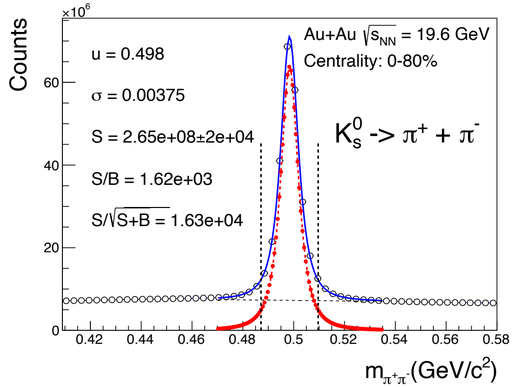
Event plane method

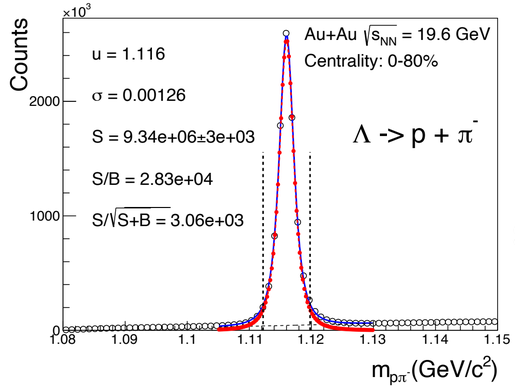
$$\Psi_n = \tan^{-1}\left(\frac{\sum_i w_i \sin\left(n\phi_i\right)}{\sum_i w_i \cos\left(n\phi_i\right)}\right)/n$$

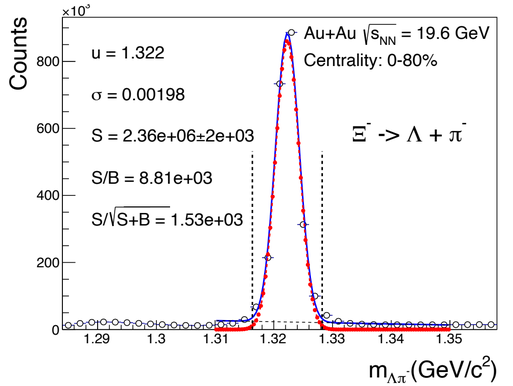
$$\vec{Q} = \begin{pmatrix} Q_y \\ Q_x \end{pmatrix} = \begin{pmatrix} \sum_i w_i \sin(n\phi_i) \\ \sum_i w_i \cos(n\phi_i) \end{pmatrix}$$

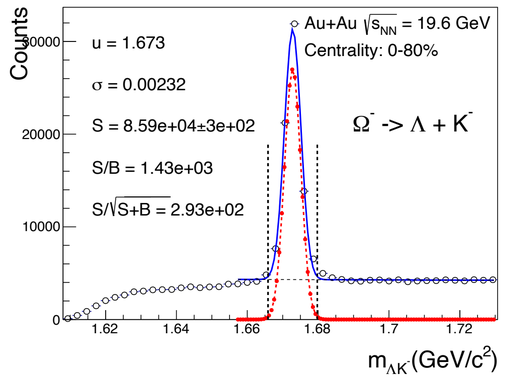


Particle reconstruction



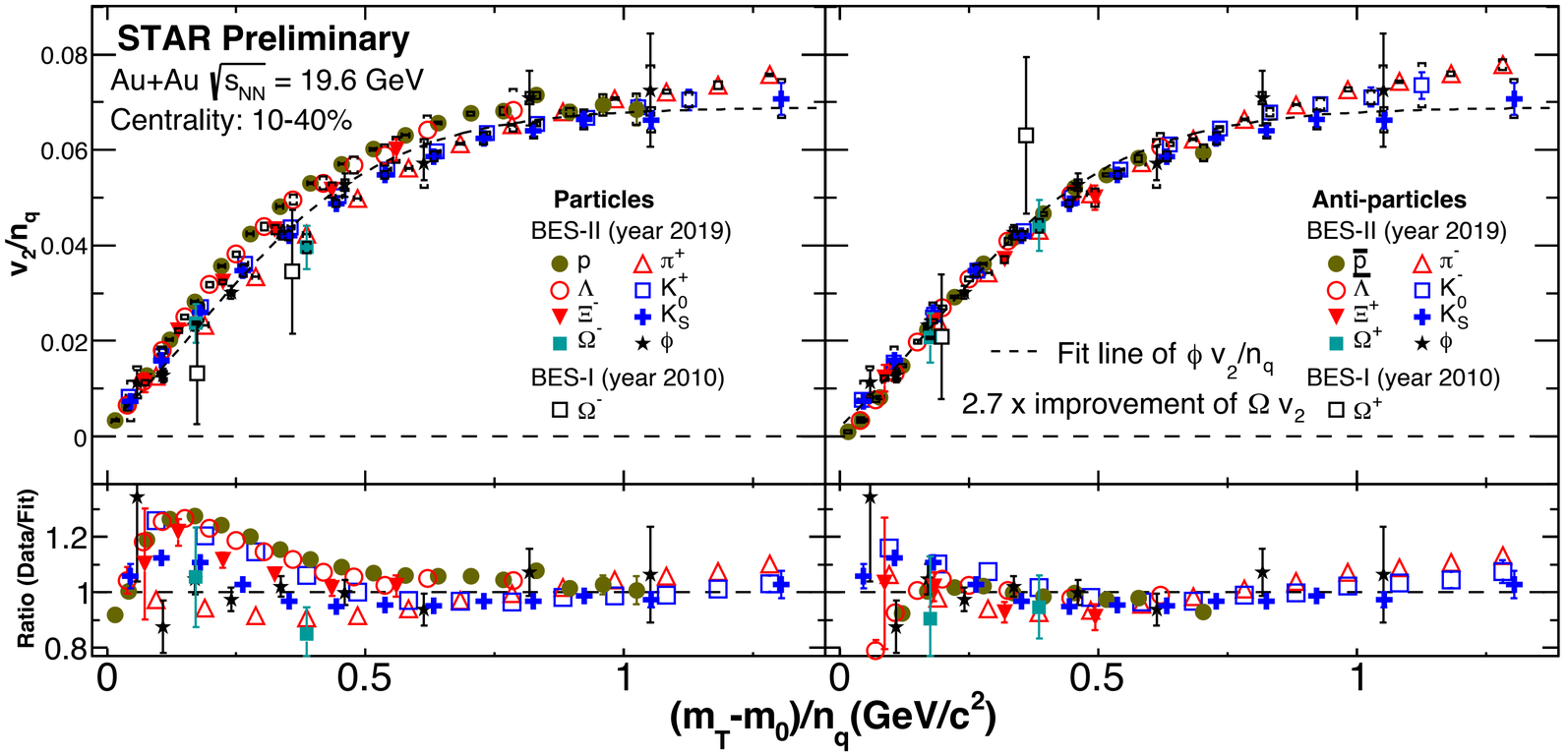






Statistical errors in u and σ are negligible

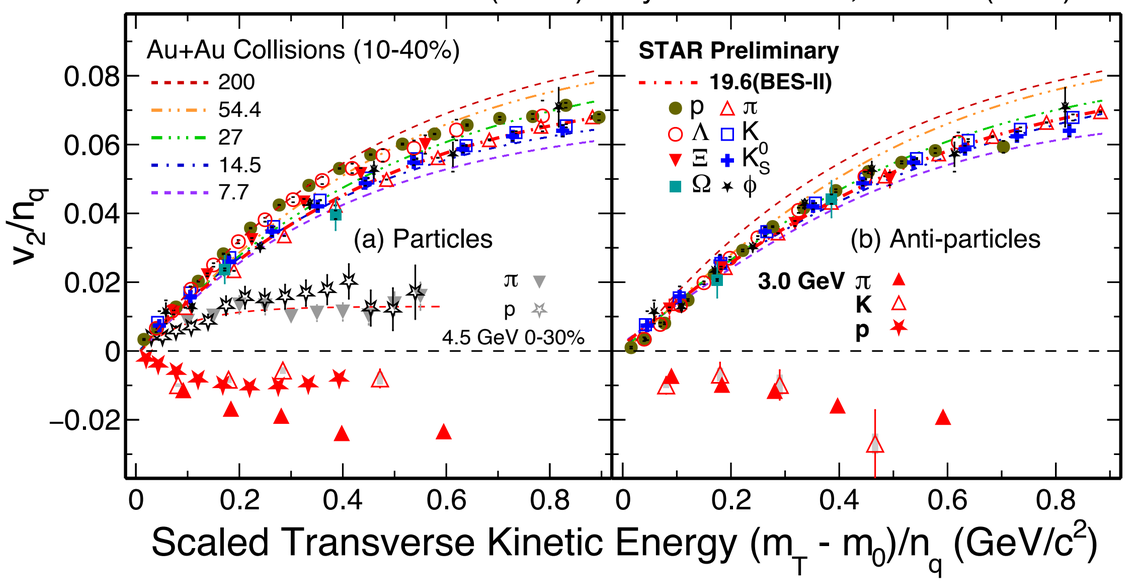
Results



- The NCQ scaling holds within 20% for particles and within 10% for anti-particles
- The NCQ scaling of anti-particles better than particles: produced vs. transported quarks

Results

M. S. Abdallah et al. (STAR): Phys. Lett. B 827, 137003 (2022)



- The NCQ scaling disappears at 3 GeV
  - Suggests partonic interactions no longer dominate

Summary

- v_2 measurements of identified particles at 19.6 GeV
- 3 GeV: hadronic degrees of freedom dominant
- 19.6 GeV: partonic degrees of freedom dominant

❖ Outlook: Mapping the QCD phase diagram with more collision energies from BES-II

Reference

[1] S. A. Voloshin, Phys. Rev. C 58, 1671–1678 (1998)
[2] S. A. Voloshin, Landolt-Bornstein 23, 293-333 (2010)
[3] M. Nasim et al. Physical Review C 87, 014903 (2013)
[4] B. Mohanty, N. Xu, Journal of Physics G 36, 064022 (2009)
[5] L. Adamczyk et al. (STAR): Phys. Rev. C 88, 014902 (2013)
[6] L. Adamczyk et al. (STAR): Phys.Rev.C 93, 014907 (2016)
[7] M. S. Abdallah et al. (STAR): Phys. Lett. B 827, 137003 (2022)