Anisotropic flow of ϕ mesons in Au+Au collisions at $\sqrt{s_{NN}}$ = 19.6 GeV in second phase of beam energy scan program

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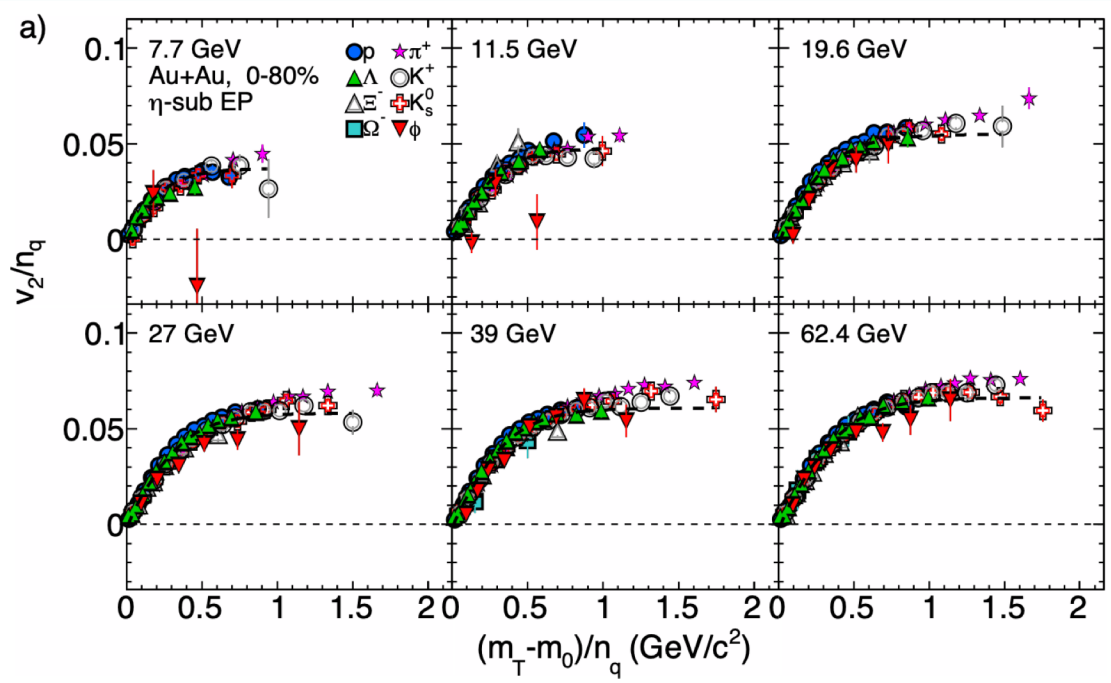

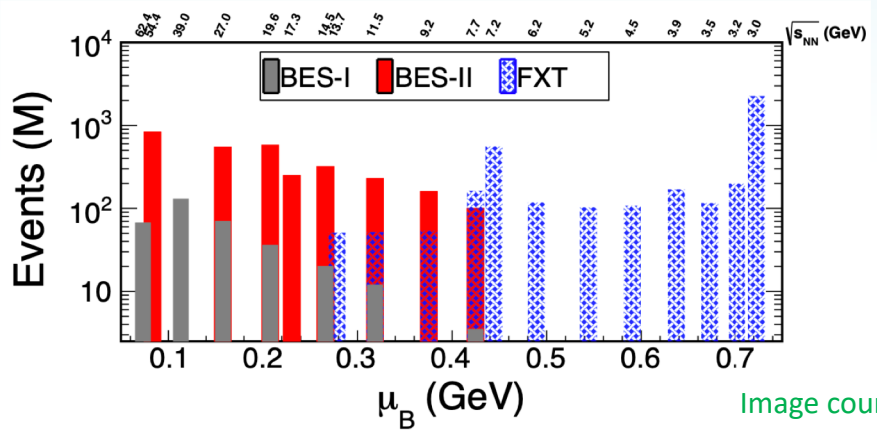

Image courtesy: Zaochen Ye

- ϕ (~1020 MeV/c^2) is a special meson, with mass comparable to a proton, having lower hadronic cross-section
- Falling off the NCQ scaling of the v_2 of ϕ mesons below $\sqrt{s_{NN}}$ = 19.6 GeV in BES-I → requires precision measurements [1]
- Observation of finite v_3 indicates event-by-event fluctuations in the initial density profile of colliding nuclei [2]
- Enhanced statistics and better precision measurement in BES-II [3]

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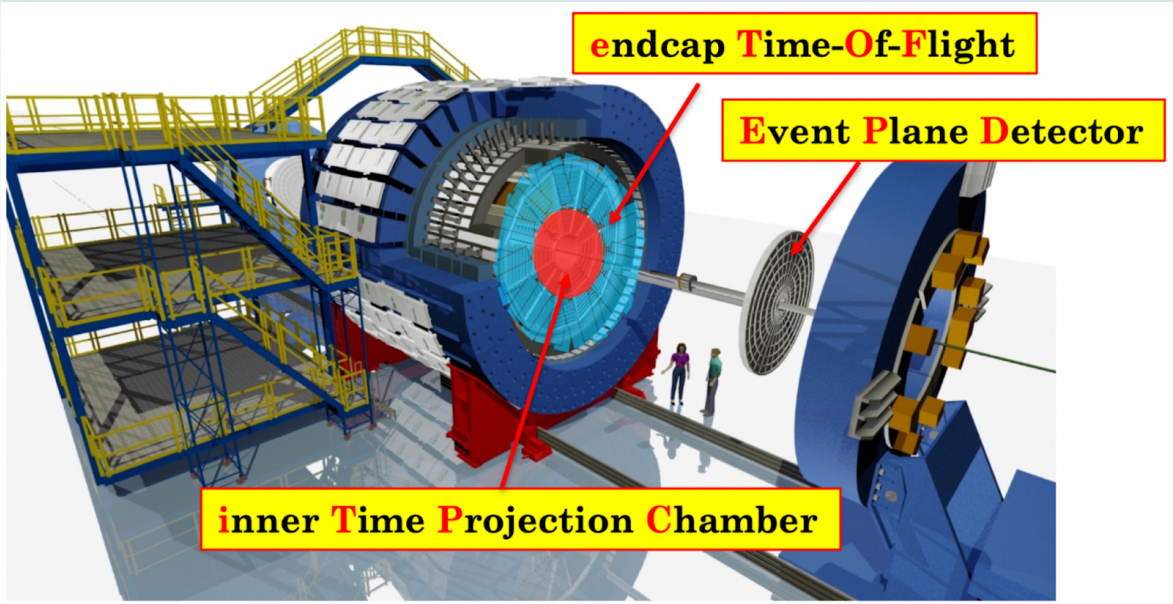
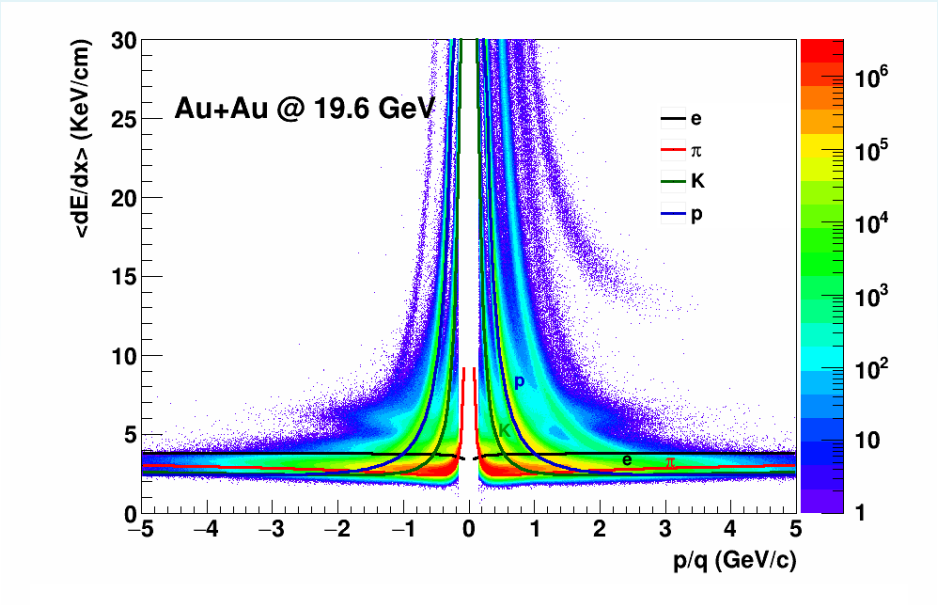
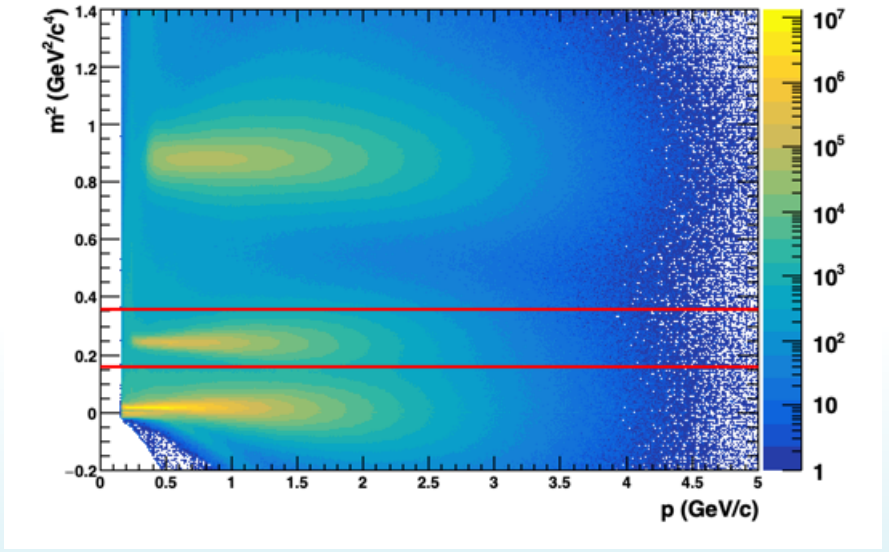
STAR Experiment



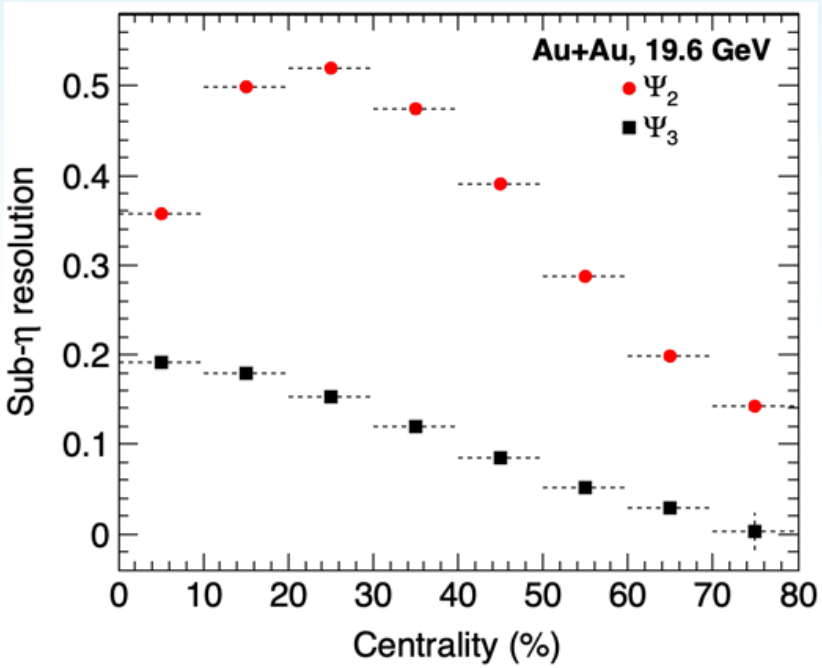


- Time Projection Chamber (TPC) and Time of Flight (TOF) are used for the particle identification at STAR [4]
- Recent upgrades like inner-TPC gives better precision at low p_T and wider acceptance ($|\eta| < 1.5$) [5]
- Energy loss information (<dE/dx>) from TPC and m^2 measurement from TOF is used to identify kaons to reconstruct ϕ mesons via the decay channel: $\phi \rightarrow K^+ + K^-$ (Branching Ratio: 48.9%)

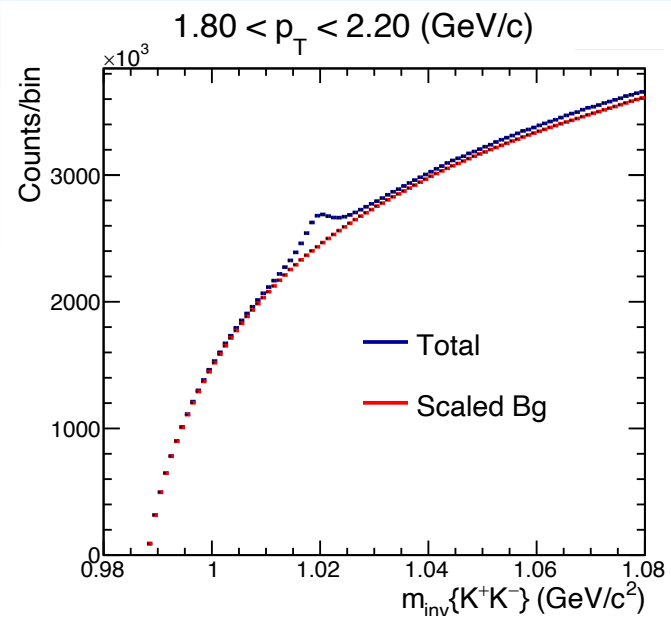


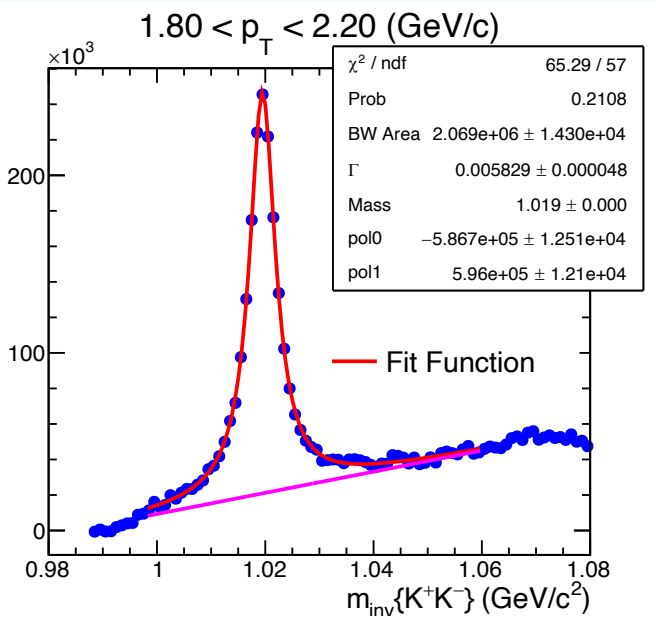
Analysis technique

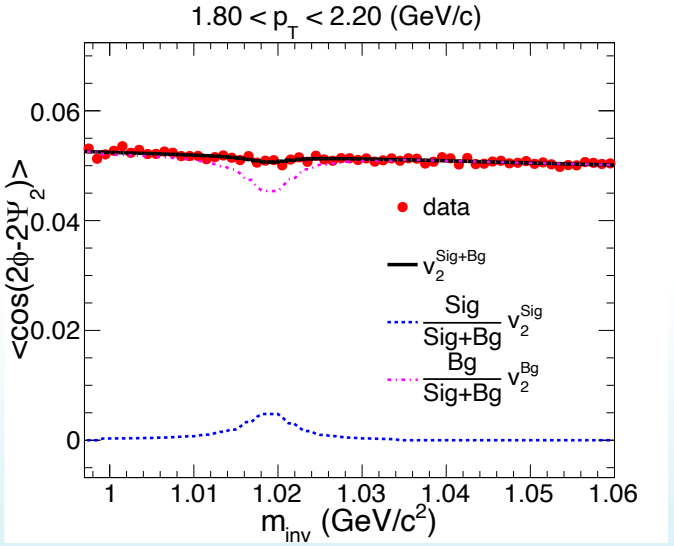
Event plane resolution



ϕ reconstruction

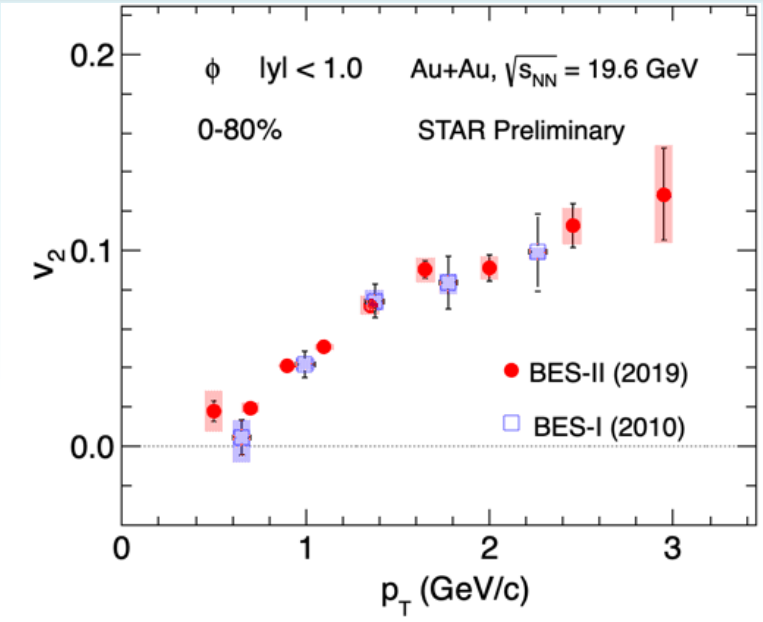


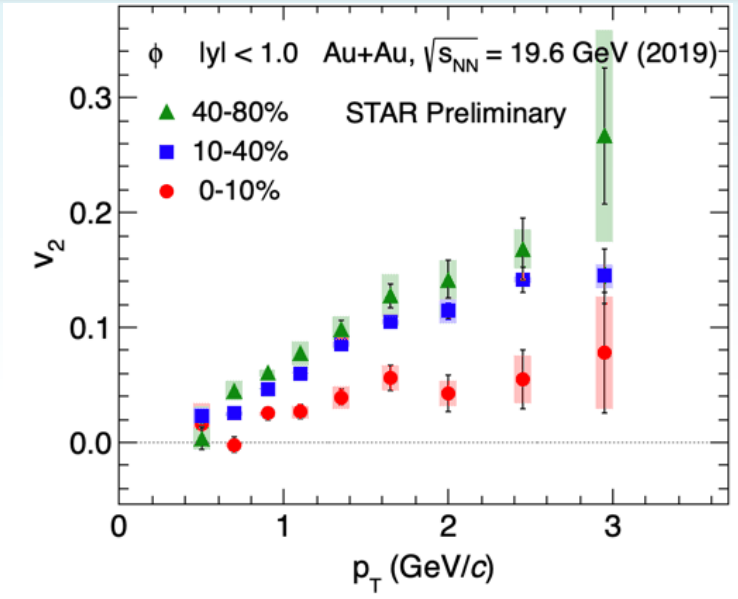


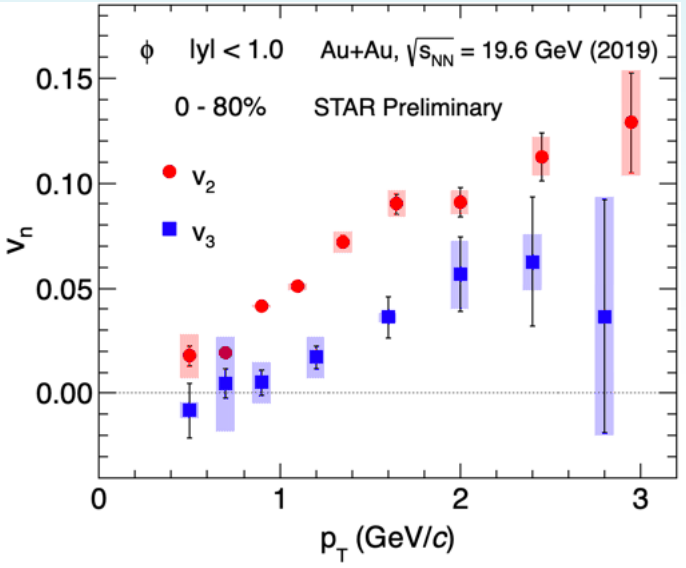


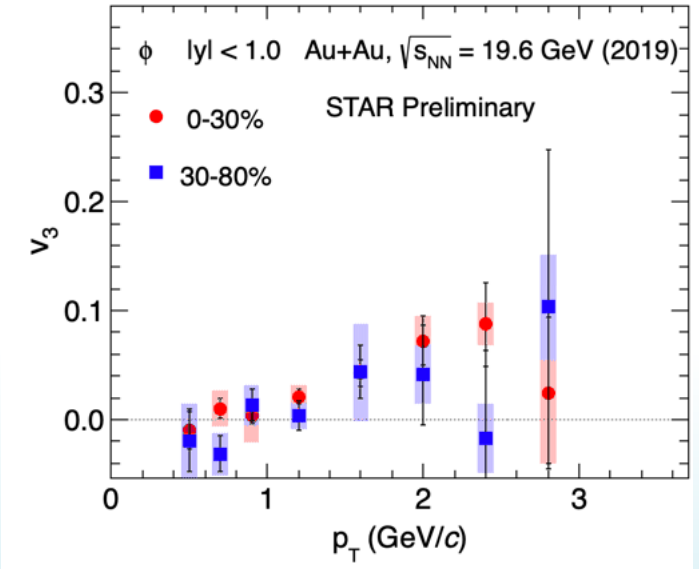
- Event plane reconstructed using TPC (sub-events : $-1.5 \le \eta \le -0.05$ and $0.05 \le \eta \le 1.5$)
- v_2 and v_3 extracted using event-plane and invariant mass methods
- Correlated background has been estimated from mixed event technique
- Invariant mass technique: $v_n^{Sig+Bg}(m_{inv}) = v_n^{Sig}\frac{Sig}{Sig+Bg}(m_{inv}) + v_n^{Bg}(m_{inv})\frac{Bg}{Sig+Bg}(m_{inv})$
- Event-plane method: $\frac{dN}{d(\phi - \psi_2)} = p_0(1 + 2p_1\cos(2(\phi - \psi_2)))$

Anisotropic flow





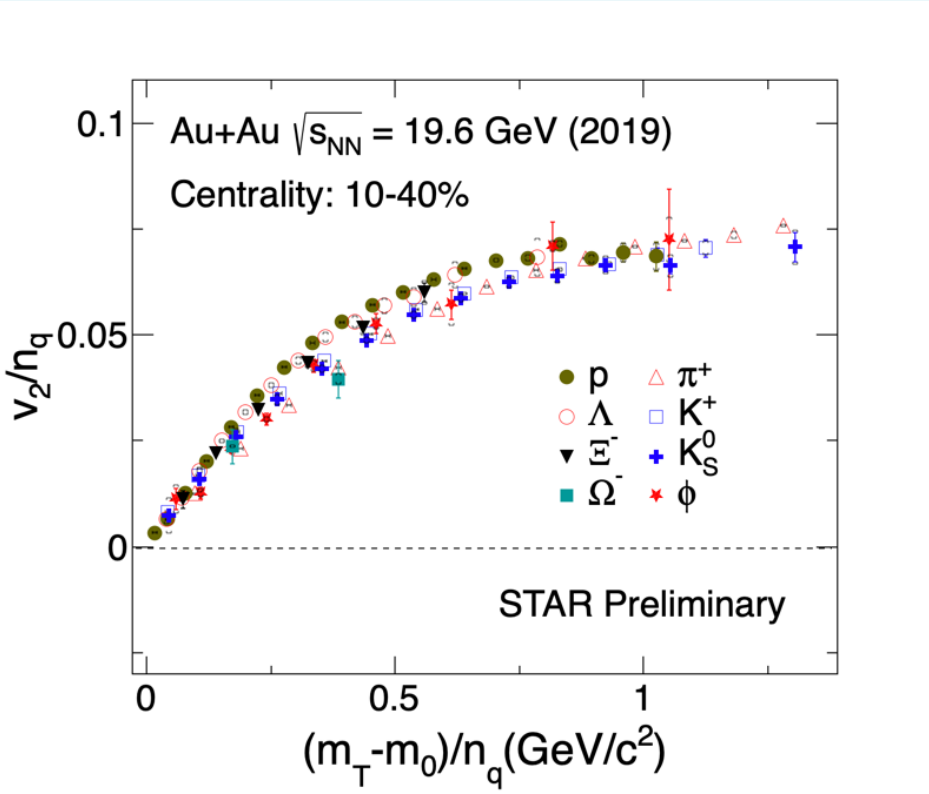




- Factor ~2 reduction in error in BES-II data for v_2 of ϕ-mesons as compared to BES-I
- First measurement of v_3 of ϕ-mesons at $\sqrt{s_{NN}} = 19.6$ GeV
  - ✓ v_3 is lower than v_2 across the measured p_T range
- Clear centrality dependence for v_2 of ϕ-mesons
  - ✓ Higher v_2 in peripheral collisions while lowest in central collisions
- No clear centrality dependence for v_3 within statistical uncertainties at this energy

Summary

- Elliptic and triangular flow of ϕ-mesons measured in minimum bias Au+Au collisions at $\sqrt{s_{NN}}$ = 19.6 GeV using BES-II data
- v_2 for ϕ-mesons are measured more precisely with extended p_T using BES-II data
- Clear centrality dependence of v_2 of ϕ-mesons has been observed
- ϕ-mesons follow NCQ scaling at $\sqrt{s_{NN}}$ = 19.6 GeV
  - ✓ Partonic collectivity at this BES energy
- First measurement of v_3 of ϕ-mesons at $\sqrt{s_{NN}}$ = 19.6 GeV
  - ✓ Fluctuations in nucleon distribution of colliding nuclei



References

[1] L. Adamczyk et. al. (STAR Collaboration), Phys. Rev. C 88, 014902 (2013).

[2] L. Adamczyk et. al. (STAR Collaboration), Phys. Rev. C 88, 014904 (2013).

[3] https://science.osti.gov/-/media/np/nsac/pdf/2015LRP/2015_LRPNS_091815.pdf

[4] M. Anderson et. al., Nucl Nucl. Instr. Meth. A 499, 659 (2003).

[5] STAR BES-II White paper: https://drupal.star.bnl.gov/STAR/starnotes/public/sn0598

[6] L. Adamczyk et. al. (STAR Collaboration), Phys. Rev. C 93, 014907 (2016).