Anisotropic flows of ϕ-meson in Au+Au collisions at 3 GeV, 7.2 GeV FXT from STAR

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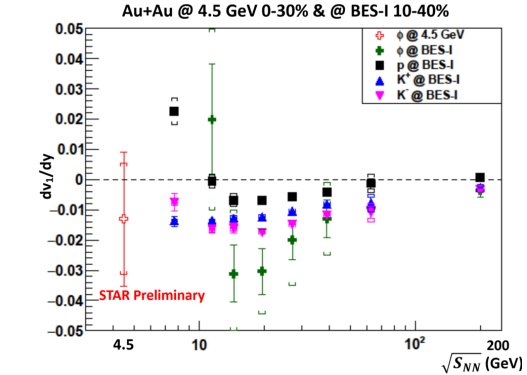
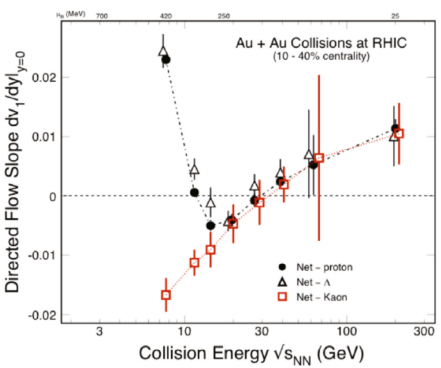
Outline

Motivation

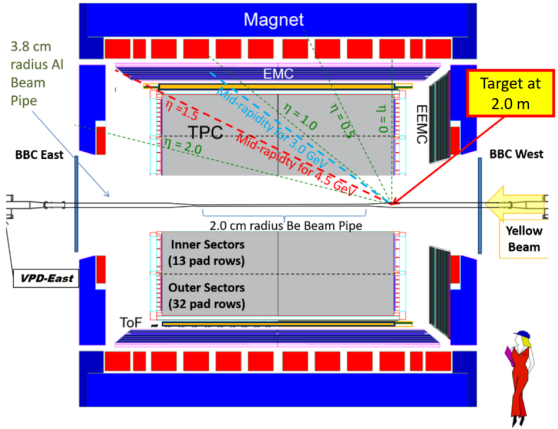


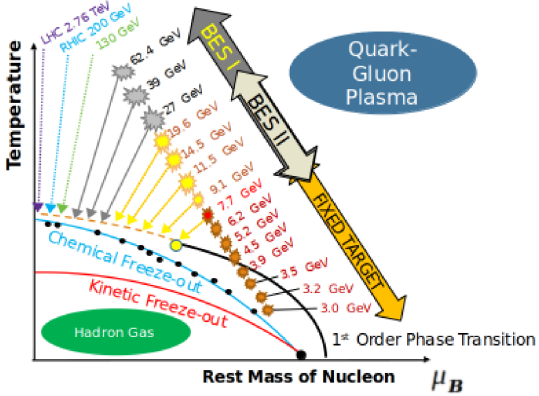


- The ϕ-meson has small cross-section with hadronic matter - sensitive to early stage of collisions
- BES-I show hint of sign change of ϕ-meson dv_1/dy around 11.5 GeV, with large error bars
- The minimum of net-proton and net-Λ dv_1/dy may indicate the softest point of EoS[1], does the ϕ-meson dv_1/dy have a minimum as collision energy decrease?

[1] L. Adamczyk et al. (STAR). *Phys. Rev. Lett. 120 062301.*

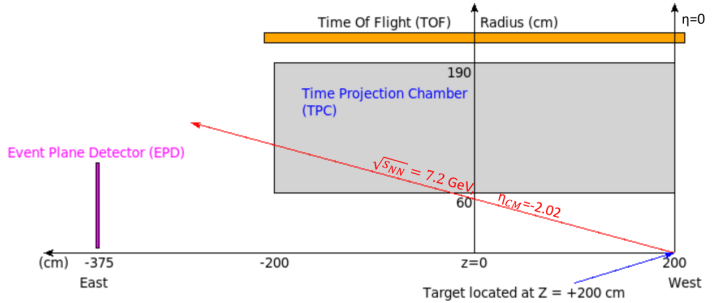
Fixed Target (FXT) Collisions

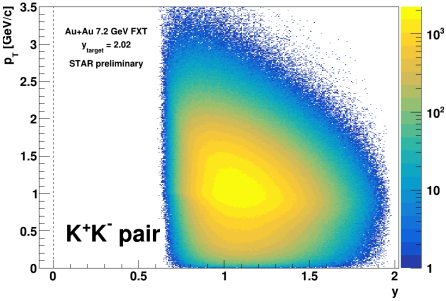


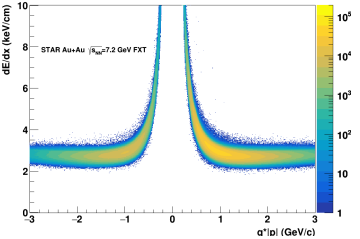


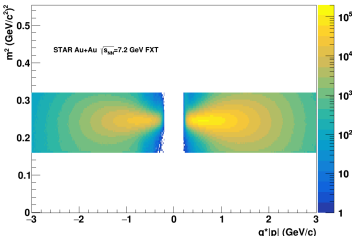
- FXT program at STAR enables us to scan a range of low collision energies that collider mode (COL) cannot reach ($\sqrt{s_{NN}} < 7.7$ GeV down to a minimum of 3 GeV)

Kaon Identification





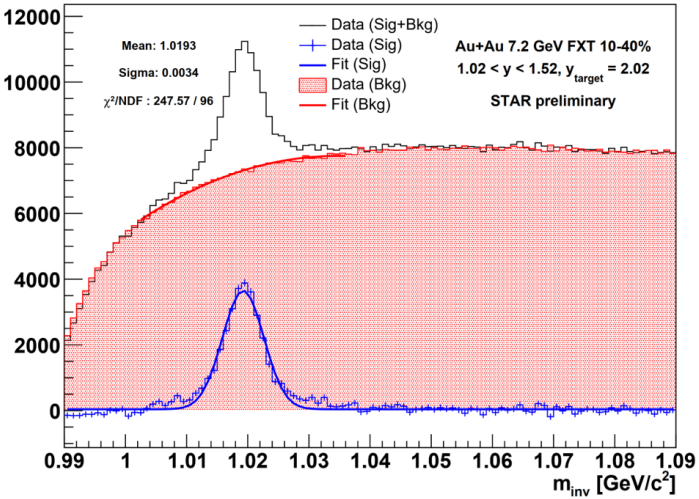




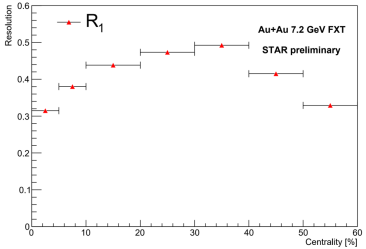
- ϕ-mesons are reconstructed by K^+K^- pairs
- Kaons are identifed by dE/dx from TPC and $mass^2$ from TOF
- TOF acceptance doesn't cover mid-rapidity at this energy
- Convention used in this analysis:
  $y = y_{Lab} - y_{mid}$, $y_{mid} = -2.02$

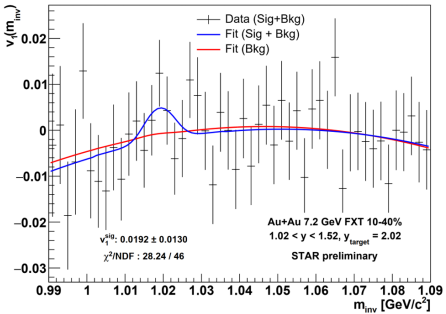
Invariant Mass

- Plot K^+K^- pairs from the same event data (Sig+Bkg) and mixed event data (Bkg), subtract them to get ϕ-meson signal
- Fitting Function:
  - Sig : Gaussian + Constant
  - Bkg : 2^{nd} order polynomial



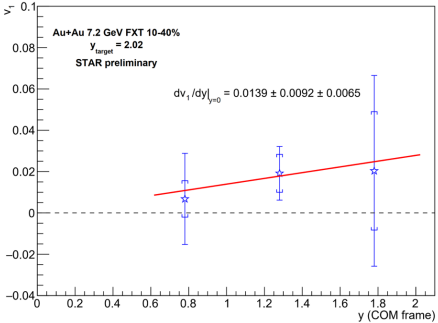
Flow Extraction: Invariant Mass Method

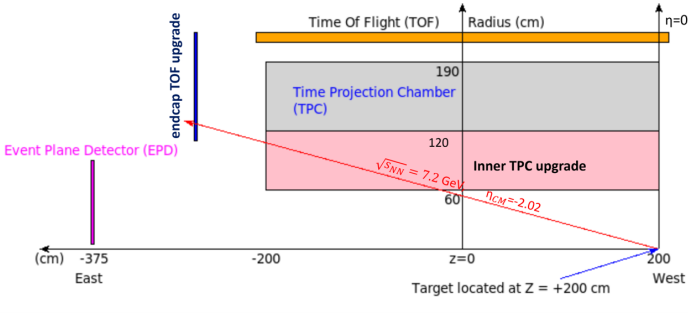




- ϕ-meson v_1 is measured by event plane method with event plane from EPD ($-5.1 < \eta < -2.1$), corrected by the first-order event plane resolution R_1 of EPD
- Fitting Function:
  - Sig + Bkg: $Y_R v_1^{Sig}(m_{inv}) + (1 - Y_R) v_1^{Bkg}(m_{inv})$
  - Bkg : $(1 - Y_R) v_1^{Bkg}(m_{inv})$
  - $Y_R = \frac{Yields(Sig)}{Yields(Sig)+Yields(Bkg)}$
  - v_1^{Bkg}: Estimated with 2^{nd} order polynomial

Results and comparison

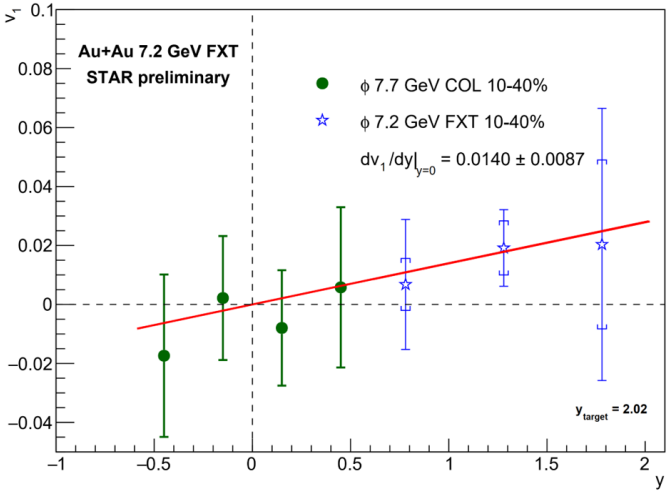




- Fitting function $f(y) = p_1 y$, where p_1 is the slope dv_1/dy

- Future FXT dataset with eTOF and iTPC will have PID coverage at mid-rapidity

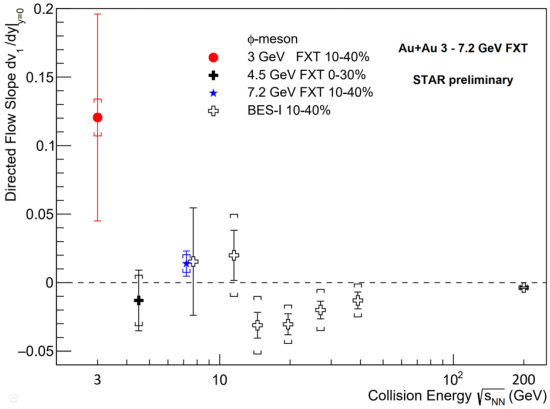
Results and comparison

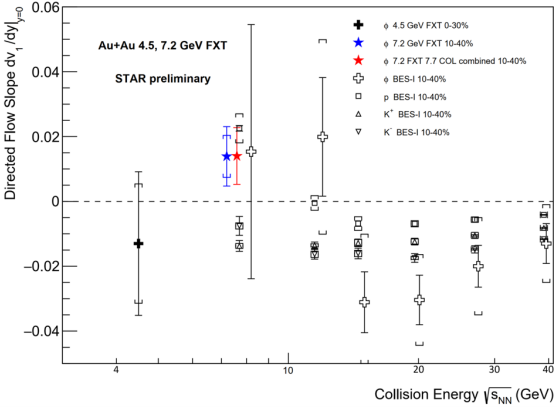


- Plot collider mode (COL) 7.7 GeV[1] and FXT 7.2 GeV phi-meson v_1 together
- It shows good agreement between COL and FXT modes
- FXT mode provides a lever arm to improve linear fit

[1](STAR), *Phys. Rev. Lett. 120 062301*

Results and Comparison





Right plot: BES-I data for ϕ-meson are shifted by $+0.5$ GeV

As the collision energy decreases the $dv_1/dy|_{y=0}$ of ϕ-meson shows sign of turning negative to positive

Summary and Outlook

Summary

- The $dv_1/dy|_{y=0}$ of ϕ-meson at intermediate centrality (10-40%) shows sign of turning positive below 7.7 GeV Au+Au collision
- This may indicate a softest point of EoS for produced particles - call for theory/model calculations
- Results from fixed target and collider modes connect well. At same collision energy, combine FXT and COL modes can improve the flow measurements

Outlook

- More FXT data with upgraded detectors from STAR are in production as well as COL data, which will help to map out the trend of ϕ-meson flows at 3 - 20 GeV
- ϕ-meson v_2 analysis at 7.2 GeV FXT is in progress