Directed Flow in STAR Fixed target Experiment

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Abstract

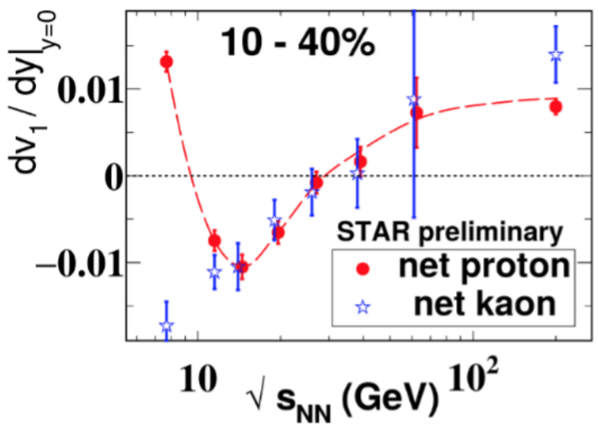
Some QGP signatures, such as number-of-constituent-quarks scaling of v_2, can be seen to persist down to $\sqrt{s_{NN}}$ = 7.7 GeV, while others, such as suppression R_{CP}, show a turn-on behavior. Fixed target collisions in STAR allow the center-of-mass energy to go as low as 4.5GeV. This would provide an opportunity to measure such signatures down to an energy range that can serve as a clean "control" energy in which only a pure hadron gas is expected. In this poster we will present Directed flow of strange hadrons K^0_S and .

Motivation

STAR Beam Energy Scan (BES-I) results suggest a softening of the equation of state (EOS) which hints at critical fluctuations

To help clarify these hints, STAR needs to access energies below 7.7 GeV where we expect no QGP formation

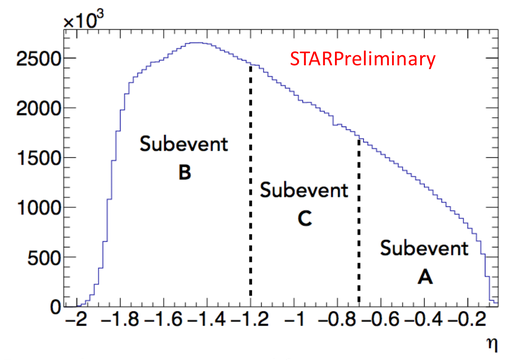
Hence we need to switch from the collider mode to fixed-target mode for collisions below $\sqrt{s_{NN}}$ < 7.7 GeV at RHIC



Goals of Beam Energy Scan

1) Observe the disappearance of QGP signatures
2) Find evidence of the possible first-order phase transition
3) Find the possible Critical point

Event Plane Reconstruction [2]



Event plane reconstructed from protons and deuterons from Subevent A

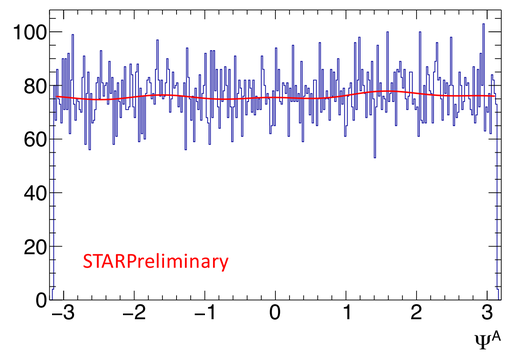
$$Q_x = \sum_i (y_{\text{lab}} - y_{\text{c.m.}}) p_T^{(i)} \cos\phi^{(i)}$$

$$Q_y = \sum_i (y_{\text{lab}} - y_{\text{c.m.}}) p_T^{(i)} \sin\phi^{(i)}$$

centering

$$\Psi = \tan^{-1}\left(\frac{Q_y^{\text{centered}}}{Q_x^{\text{centered}}}\right)$$

Flattening using Fourier expansion

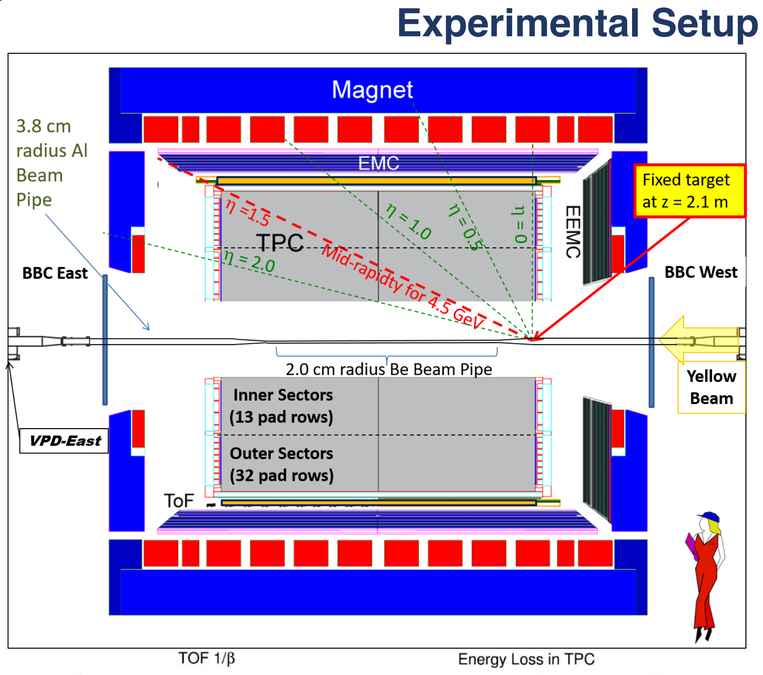


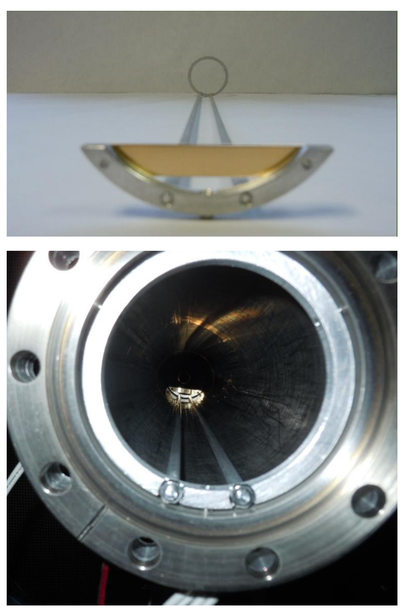
Event Plane Resolution

$$\langle\cos(\Psi^A - \Psi^R)\rangle = \sqrt{\frac{\langle\cos(\Psi^A - \Psi^B)\rangle\langle\cos(\Psi^A - \Psi^C)\rangle}{\langle\cos(\Psi^B - \Psi^C)\rangle}}$$

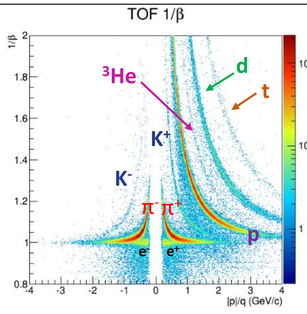
= 0.85 ± 0.03 for K^0_S (10-25%)
= 0.81 ± 0.03 for Λ (10-30%)

Experimental Setup

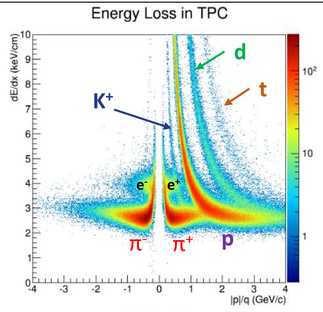




TOF 1/β



Energy Loss in TPC



The target foil was held 2 cm below of the beam axis
The foil was 1 mm thick

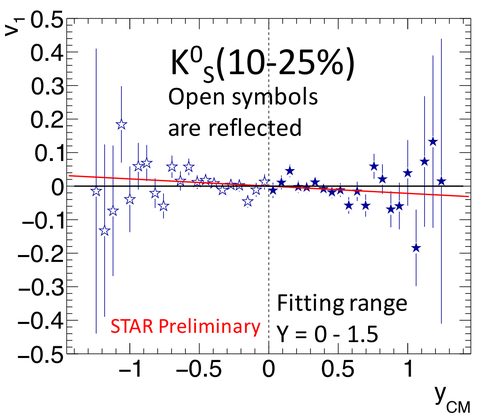
Particle Identification (PID) with STAR Time Projection Chamber (TPC) and Time of Flight (TOF) - outstanding for FXT

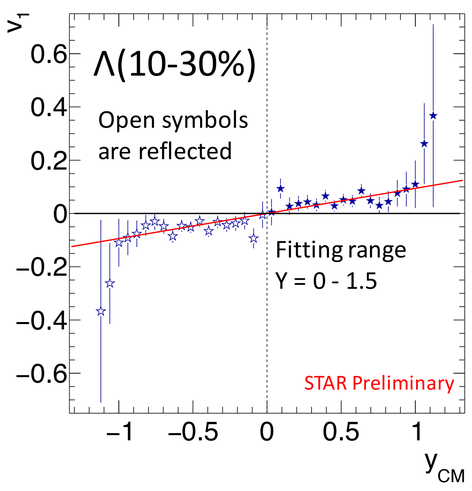
Results

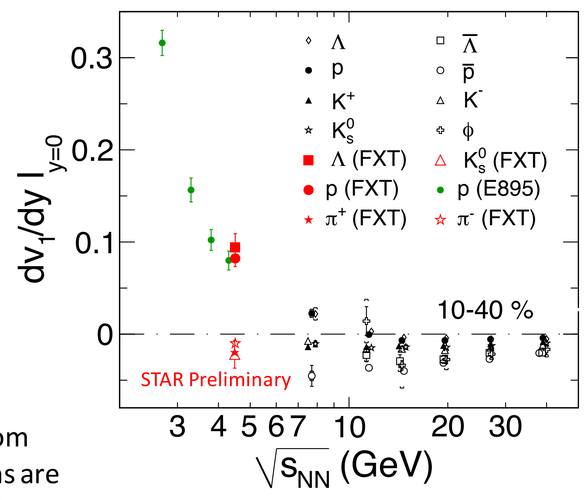
K^0_S or Λ taken from Subevent B

$$v_1^{\text{observed}} = \langle\cos(\phi - \Psi^A_{\text{corrected}})\rangle$$

$$v_1 = \frac{v_1^{\text{observed}}}{\langle\cos(\Psi^A - \Psi^R)\rangle}$$







v_1 of Both K^0_S and Λ follow the trend from the STAR Beam Energy Scan and protons are consistent with the trend from E895 [3]

Directed Flow

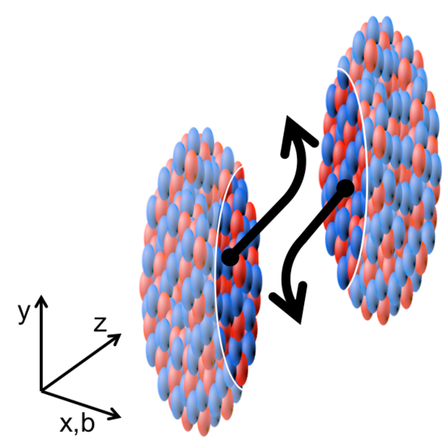
Directed flow describes the sideward motion of the particles within the reaction plane

Generated during the nuclear passage time (2R/γ ≈ 0.1 fm/c)

Therefore probes the very earliest stage of the collision dynamics

Calculated as

$$v_1 = \langle\cos(\phi - \Psi_{\text{R}})\rangle$$



ϕ angle in LAB

Ψ_R Reaction Plane angle

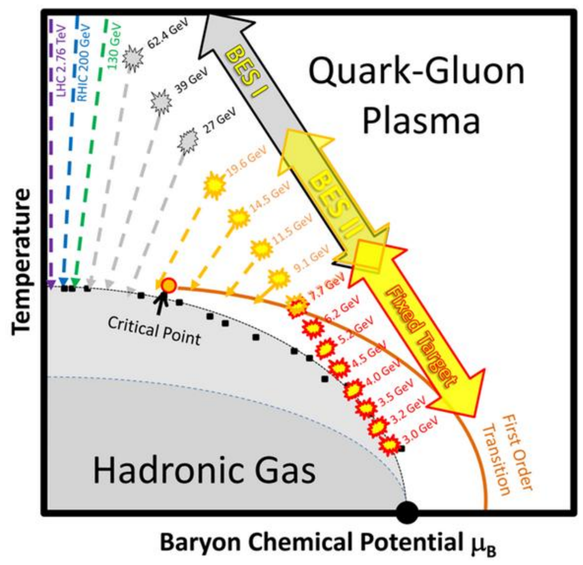
Summary

First directed flow v_1 results of 2015 STAR Fixed target test run were presented.

v_1 of both K^0_S and Λ follow the trend from the STAR Beam Energy Scan.

v_1 of protons is consistent with the trend from E895 experiment [3]

The FXT program extends BES-II down to $\sqrt{s_{NN}}$ = 3.0 GeV



References

[1] L. Adamczyk *et al.* (STAR Collaboration), Phys. Rev. Lett. **112,** 162301 (2014)
[2] A. M. Poskanzer, S. A. Voloshin, Phys. Rev. C **58**, 1671 (1998)
[3] P. Chung *et al.* (E895 Collaboration), Phys. Rev. Lett. **86**, 2533 (2001)

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The STAR Collaboration
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