Event Plane Correlated Triangular Flow in $\sqrt{s_{NN}} = 3.0$ GeV Fixed Target Au+Au Collisions at STAR

Cameron Racz
for the STAR Collaboration
UC Riverside
(cracz001@ucr.edu)

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Motivation

- Triangular flow (v_3) is a measure of the average triangular anisotropy which is typically thought to arise from event-by-event fluctuations in the collision geometry [1]; hence it should have no correlation to the reaction plane.
- A UrQMD + hydro model has also suggested it should go to zero near $\sqrt{s_{NN}} \sim 5$ GeV [2].
- However, results from HADES show a clear correlation between v_3 and the first order event plane at 1.23 AGeV [3].
- Theoretical calculations yield a slope $dv_3/dy|_{y=0} \sim -0.025$ at 3.0 GeV for impact parameter $b = 6 - 9$ fm for a conjectured hard equation of state [4].
- This presentation shows results from the STAR collaboration of v_3 correlated with the first order event plane at $\sqrt{s_{NN}} = 3.0$ GeV.

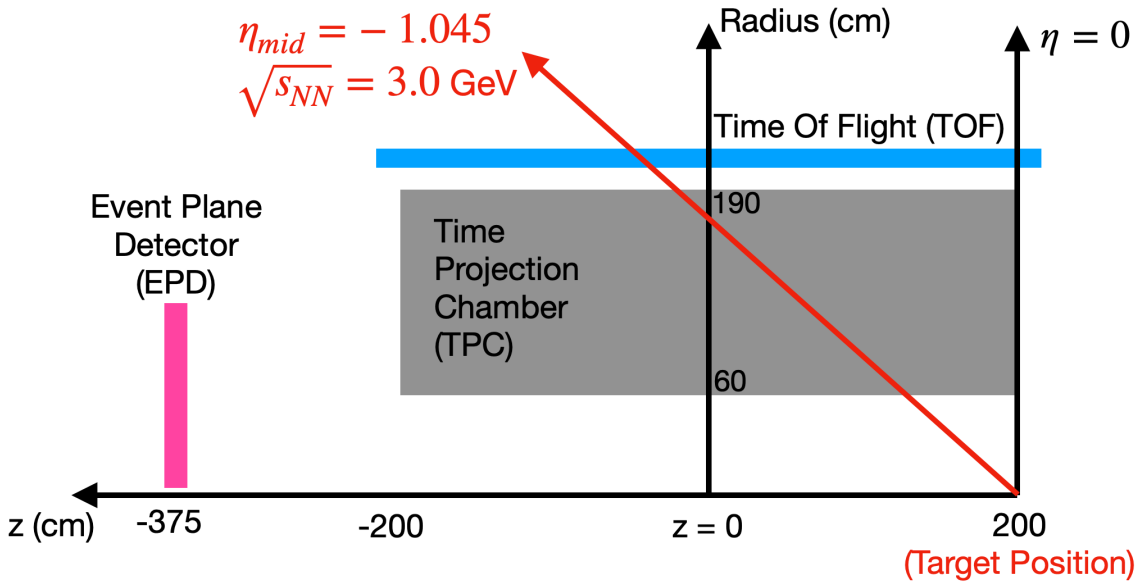
[1] B. Alver and G. Roland 2010 *Phys. Rev. C* **81** 054905
[2] J. Auvinen and H. Petersen 2013 *Phys. Rev. C* **88** 064908
[3] B. Kardan (HADES) 2019 *Nucl. Phys. A* **982** 431-434
[4] P. Hillmann *et al* 2018 *J. Phys. G: Nucl. Part. Phys.* **45** 085101

Dataset

~ 180 M events at $\sqrt{s_{NN}} = 3.0$ GeV Au+Au FXT

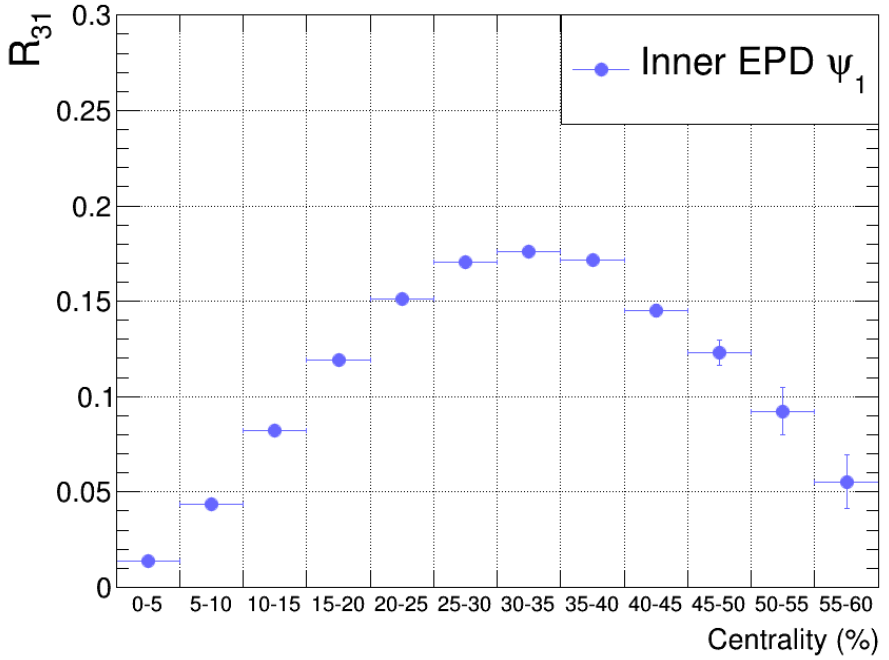
Particle Identification

- $\boldsymbol{\pi}$ – Ionization energy loss in TPC and velocity from the TOF
- $\boldsymbol{p}$ – Ionization energy loss in TPC



Analysis Method

- Event plane method with first order event plane (ψ_1).
- ψ_1 reconstructed using inner 8 rings of the Event Plane Detector (EPD); $-5.8 < \eta < -3.23$.
- 3 sub-event method used to calculate event plane resolution (R_{31}; shown here).
- Two reference sub-events are the outer 8 EPD rings and part of the TPC; $-3.23 < \eta < -2.54$ and $-1 < \eta < 0$, respectively.
- Triangular Flow is calculated as $v_3 = \langle \cos(3(\phi - \psi_1)) \rangle / R_{31}$



Results

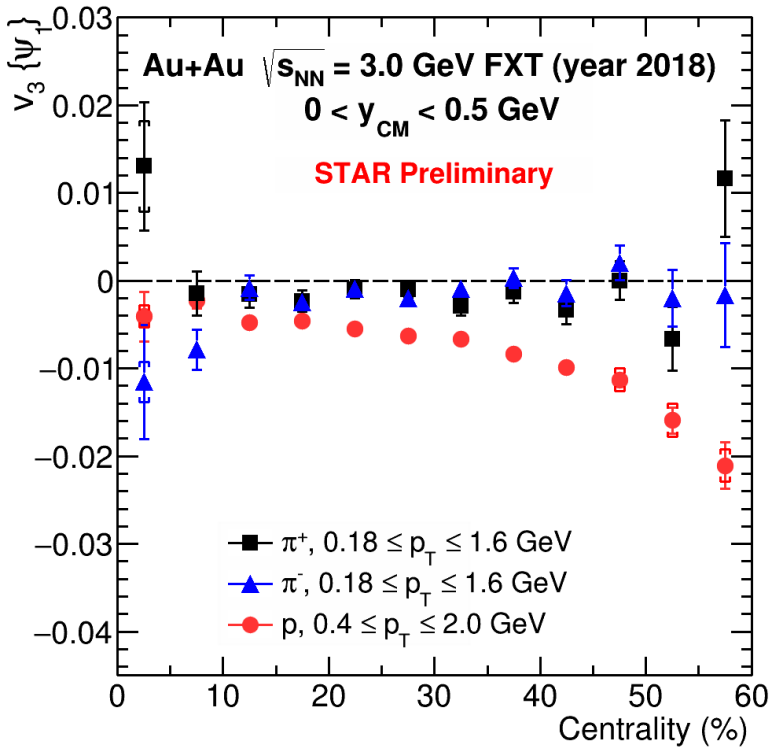


Figure 1: v_3 of p shows a clear centrality dependence while π seems to stay near zero.

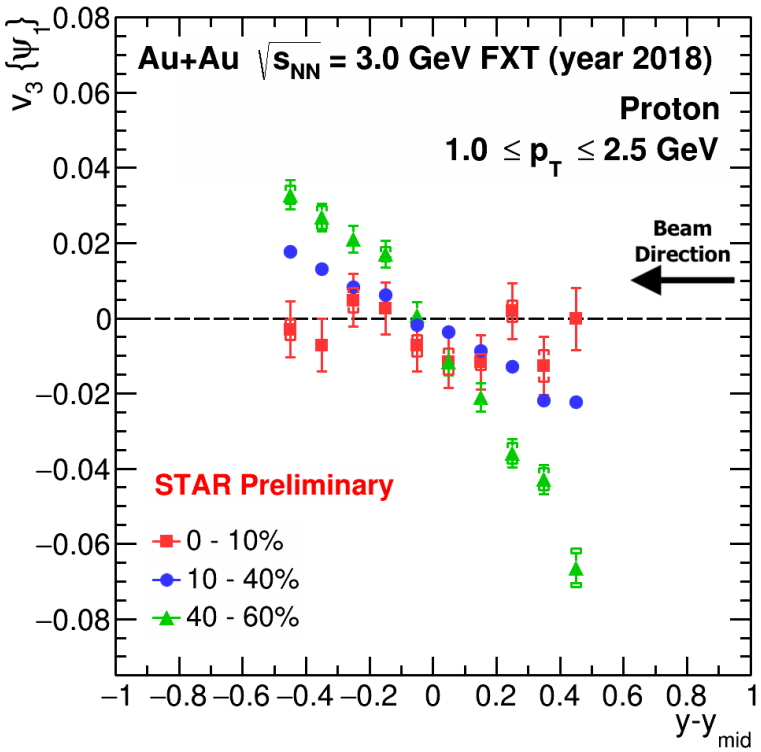


Figure 2: The v_3 seen in p is an odd function of rapidity.

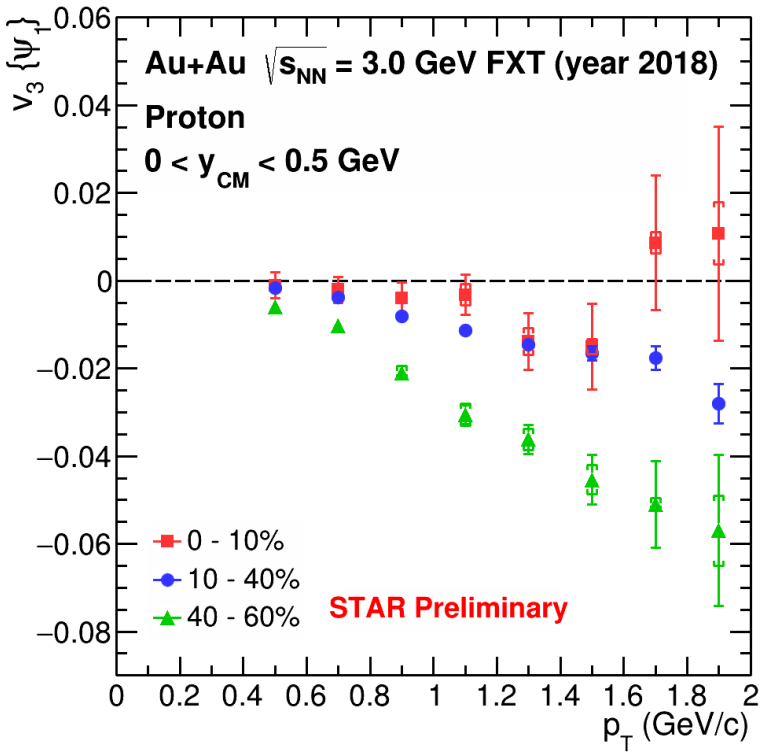


Figure 3: Along with centrality, p shows increasing v_3 with increasing p_T.

Summary

- First measurement of v_3 correlated with ψ_1 at $\sqrt{s_{NN}} = 3.0$ GeV is presented for π and p.
- A centrality and p_T dependent, rapidity-odd v_3 is found for p while v_3 is likely small for π.
- This v_3 is not likely to originate from initial state fluctuations since it is correlated to ψ_1; there must be a separate source.
- For p at 10 - 40% centrality, $0.4 \leq p_T \leq 2.0$ GeV (not shown here), we measure $dv_3/dy|_{y=0} = -0.025 \pm 0.005$, which currently supports the conjectured hard equation of state at this energy.
- Future plans for this study include analysis of data at higher energies, extending to more species (d, t), and comparing results with the cumulant method.