

d

Analysis Note:

Anti-flow of Kaon in Au+Au Collisions at

$\sqrt{s_{NN}} = 3 - 3.9 \text{ GeV}$

Zuowen Liu, Li-ke Liu, Xing Wu, Guoping Wang

Abstract

In this note, we present the measurement of anti-flow of mesons in Au+Au collisions at $\sqrt{s_{NN}} = 3-3.9$ GeV with the STAR experiment under its fixed target configuration at RHIC. Directed flow and elliptic flow of π , K_S^0 and Λ are presented in different centrality, transverse momentum and rapidity intervals. π^+ and K_S^0 show anti-flow at low p_T ($p_T < 0.6 \text{ GeV/c}$) at 3-3.9 GeV. And the result have been compared with JAM model. Anti-flow of mesons at low p_T could be explained by shadowing effect from spectator.

CONTENTS

1. Analysis setup	4
1.1. Introduction of FXT	4
1.2. Dataset and event selection	5
1.3. Badrun rejection and centrality determination	5
2. Analysis method	6
2.1. Event plane reconstruction	6
2.2. Particle identification	6
2.3. Efficiency correction	6
A. appendix	7
References	7

1. ANALYSIS SETUP

This section describes the setup of analysis. The first part of this section introduces STAR Fixed Target(FXT) mode. Second one is dataset and event selection used in the analysis. Third, badrun rejection and centrality determination are discussed.

1.1. Introduction of FXT

There are two modes at RHIC-STAR, Fixed Target mode and Collider mode. FXT mode of STAR experiment covers center of mass energy($\sqrt{s_{NN}}$) from 3 to 13.7 GeV, which extends the measurement to lower energy intervals. In this way, FXT mode could reach higher baryon density region(up to 750 MeV). To achieve this goal, One piece of gold foil would be fixed at the end of Time Projection Chamber(TPC) as target.[1] And the accelerated gold beam from west would collide with it. Fig. 1 shows the schematic plot for fixed target mode.

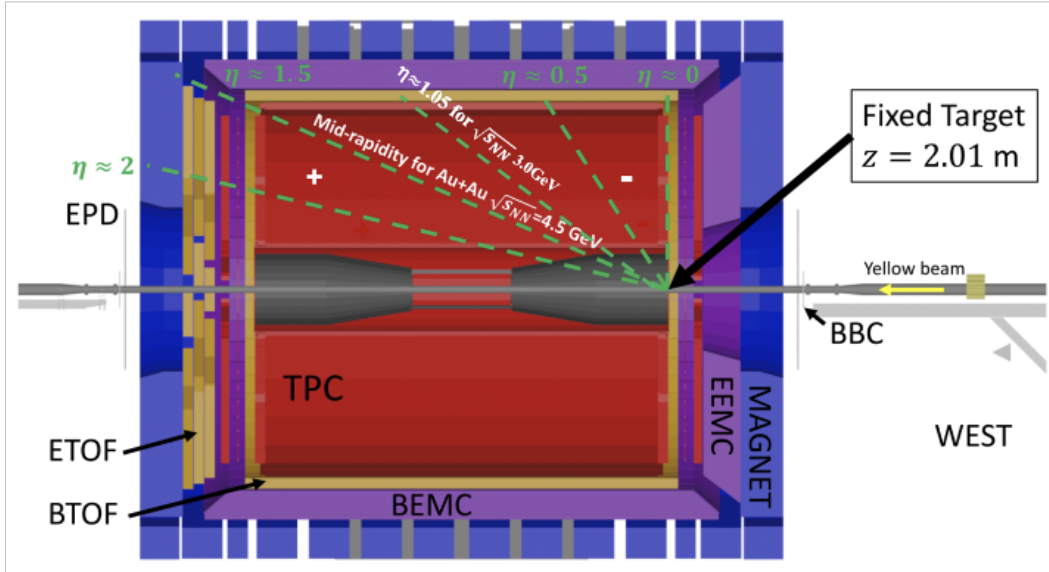


FIG. 1. The setup of Fixed Target mode at STAR.

The laboratory system should be transferred to the center of mass system, if one want to analysis physical observation conveniently. According to the Lorentz transformation, Rapidity(y) of the final state particle in the Center of Mass System(CMS) could be calculated as equation 1, where y_{lab} is rapidity of emitted particle in the laboratory frame, y_{beam} is rapidity of gold beam in the

TABLE I. Dataset and event cuts for $\sqrt{s_{NN}} = 3, 3.2, 3.5, 3.9 GeV$.

$\sqrt{s_{NN}}(GeV)$	production tag	library tag	trigger ID	Vz(cm)	Vr (cm)
3.0	P19ic	SL20d	620052	[198, 202]	2
3.2	?	?	?	[198, 202]	2
3.5	P21id	SL21d	720000	[198, 202]	2
3.9	?	?	?	[198, 202]	2

CMS. And we would discuss flow measurement based in the Center of Mass System.

$$y_{CMS} = y_{lab} - y_{beam} \quad (1)$$

1.2. Dataset and event selection

In this analysis, four energies($\sqrt{s_{NN}} = 3, 3.2, 3.5, 3.9 GeV$) from fixed target mode are involved. The events from minimum bias trigger are selected. And vertex cut in the X and Y direction applied to exclude the events from beam pipe, vertex cut along the Z direction to ensure that selection events are from collision on the gold foil. The detailed trigger and vertex cut are summarized in the TABLE. I

1.3. Badrun rejection and centrality determination

Data production at STAR is run-by-run type, and the data is tagged with different run number. Run-by-run QA is necessary to reject the bad runs, which may caused by the broken detector et al. This job was finished by STAR QA group, and the badrun list used in this analysis could be found at the [summary page](#) from QA group.

Moreover, the centrality determination work is vital in Heavy Ion Collision. Glauber Monte Carlo(MC) simulation[2] would describe the reference multiplicity distribution, which is corrected by pile-up rejection and luminosity correction. The number of participant particle(N_{part}) and the number of collision particles(N_{coll}) can be extracted by the formula 2 in MC model.

$$\frac{dN_{ch}}{d\eta} = n_{pp} \left[(1 - x) \frac{N_{part}}{2} + x N_{coll} \right] \quad (2)$$

This work was finished by STAR Centrality group, a class([StRefMultCorr](#)) is provided. One can call the class and get the refMult cut.

2. ANALYSIS METHOD

2.1. Event plane reconstruction

2.2. Particle identification

2.3. Efficiency correction

Appendix A: appendix

- [1] M. S. Abdallah *et al.* (STAR Collaboration), *Phys. Rev. C* **103**, 034908 (2021).
- [2] D. Kharzeev and M. Nardi, *Physics Letters B* **507**, 121 (2001).