K^+K^+ correlation functions in Au+Au collisions at 3.0 - 3.9 GeV

Bijun Fan (bjfan@mails.ccnu.edu.cn) Central China Normal University,
for the STAR Collaboration

Abstract

Two-particle correlations are used to extract the space-time and dynamical information of the particle-emitting source created in heavy-ion collisions. The source radii extracted from these correlations characterize the system at the kinetic freeze-out, i.e., the last stage of particle interactions. Kaons can provide a more direct view of the particle-emitting source than pions as they have smaller hadronic cross section and less contribution from long lifetime resonances.

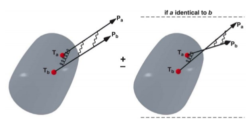
In this poster, the measurements of K^+K^+ correlation functions in Au+Au collisions at $\sqrt{s_{NN}}$ = 3.0, 3.2, 3.5, and 3.9 GeV recorded by the STAR experiment will be presented. One-dimensional source size (R_{inv}) and correlation strength parameter (λ) of the system are extracted from the correlation functions using the Bowler-Sinyukov formula.

Introduction

➢ **Femtoscopy, based on HBT correlations for identical particles, can be used to extract the space-time and dynamical information of emission source.**

➢ **Kaons can provide a more direct view of the particle-emitting source than pions due to**

- ➢ **less contribution from long lifetime resonances**
- ➢ **smaller rescattering cross-section**



arXiv:nucl-ex/0505014

➢ **Correlation function [1]:**

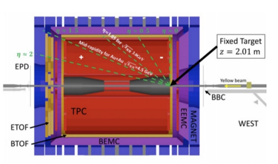
$$C(q_{inv}) = \int dr|\psi(q_{inv}, r)|^2 S(r) = \frac{Same(q_{inv})}{Mixed(q_{inv})} \text{ (Experimental)}$$

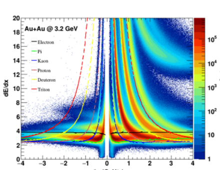
➢ **Sinyukov-Bowler method used to fit correlation function [2][3]:**

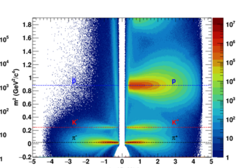
$$C(q_{inv}) = N\left[(1-\lambda) + K_{coul}(q, R_{inv})\lambda\left(e^{-q^2 R_{inv}^2} + 1\right)\right]$$

q_{inv}: invariant relative momentum
r: relative distance between two particles
$\Psi(q_{inv}, r)$: two-particle wave function
S(r): emission function
Same(q_{inv}): qinv distribution from same event
Mixed(q_{inv}):normalized q_{inv} distribution from mixed events
λ: correlation strength parameter
R_{inv}: Source size
$K_{coul}(q, R_{inv})$: Coulomb factor

STAR Fixed-Target Program and Particle Identification



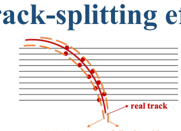




➢ **Good particle identification of TPC and TOF**

➢ **For p (0.2, 2) GeV/c, Purity > 95%**

Track-splitting effect



➢ **Track splitting effect: due to finite position resolution of TPC, single track will be reconstructed as two with similar momenta.**

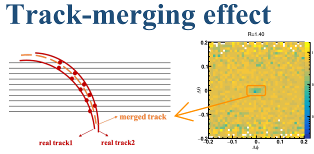
➢ **This effect results in an increase in pairs of particles, amplifying the signal of the correlation function.**

➢ **remove: -0.5 < SL < 0.6**

$$SL \equiv \frac{\sum_i S_i}{Nhits_1 + Nhits_2}$$

$$\text{where } S_i = \begin{cases} +1 & \text{one track leaves a hit on pad} - row \\ -1 & \text{both tracks leave a hit on pad} - row \\ 0 & \text{neither track leaves a hit on pad} - row \end{cases}$$

Track-merging effect



➢ **Track merging effect: two tracks with similar momentum will be reconstructed into a track with a high probability.**

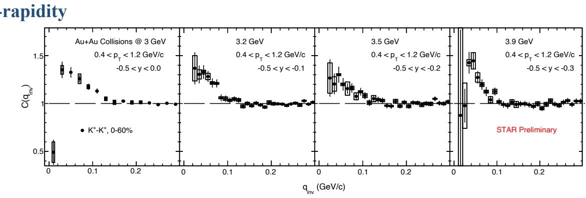
➢ **These merged tracks cause a reduction of pairs at low relative momentum, thus reducing the signal of the correlation function.**

➢**remove:** $|\Delta\theta| > 0.02 \;||\; |\Delta\phi^*(R = 1.4m)| > 0.04$

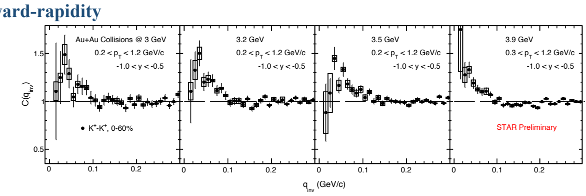
i - the pad-row number
$Nhits_1$ & $Nhits_2$ - the total number of hits associated to each track in the pair

Correlation Function

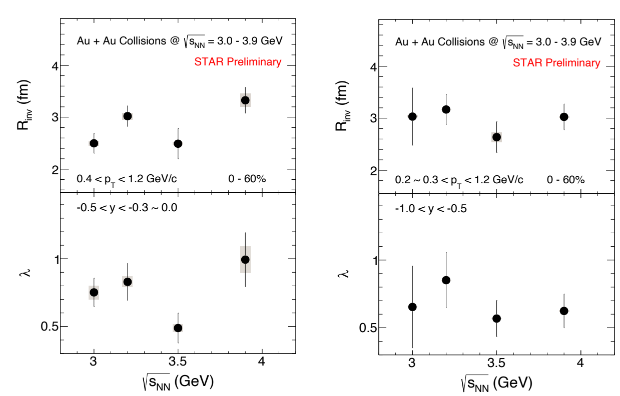
Mid-rapidity



Forward-rapidity



Energy dependence of extracted parameters



➢ **3.0 – 3.9 GeV: weak energy dependence of R_{inv} & λ.**

Summary

➢ **The Kaon CF at $\sqrt{s_{NN}}$ = 3.0, 3.2, 3.5, and 3.9 GeV has been measured;**

➢ **Extract source size information: weak energy dependence of R_{inv} & λ.**

References

[1] M. Lisa, S. Pratt, R. Soltz, et al., Annu. Rev. Nucl. Part. Sci., 55: 357-402 (2005).

[2] Yu. Sinyukov et al. Phys. Lett. B 432, 248 (1998).

[3] M. Bowler Phys. Lett. B 270, 69 (1991).

Supported in part by the
U.S. DEPARTMENT OF ENERGY Office of Science

The STAR Collaboration
https://drupal.star.bnl.gov/STAR/presentations

華中師範大學 CENTRAL CHINA NORMAL UNIVERSITY