Pion-kaon femtoscopy in Au+Au collisions at $\sqrt{s_{NN}}$ = 39 GeV at STAR

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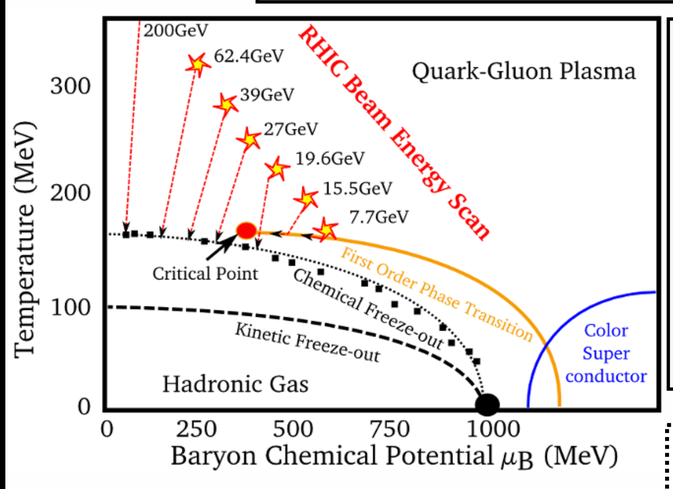
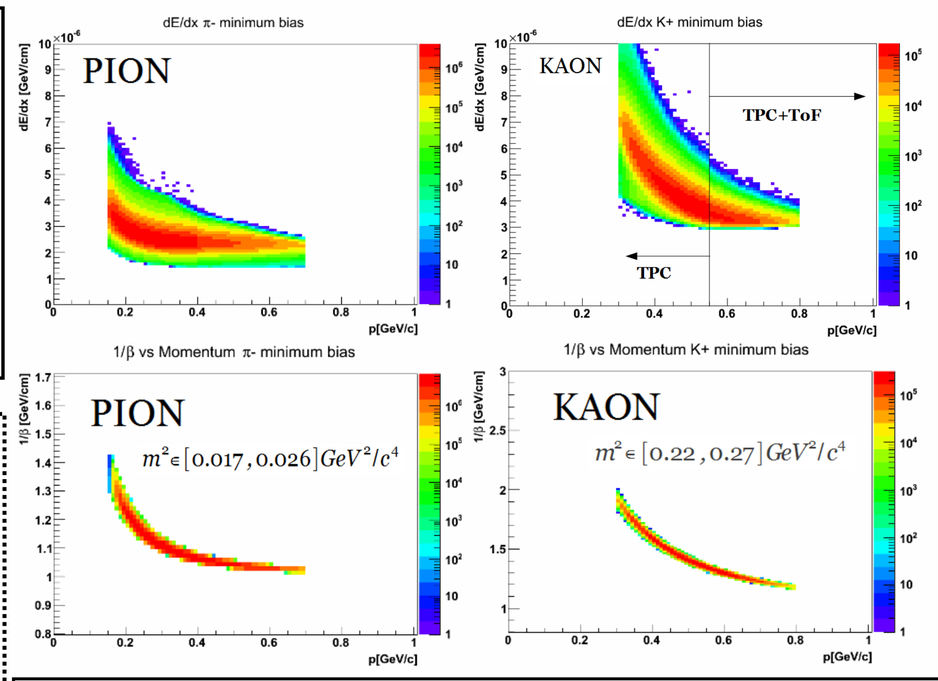
Abstract

The main task of the Beam Energy Scan (BES) program at RHIC is to scan the QCD phase diagram with heavy-ion Au+Au collisions ($\sqrt{s_{NN}}$ = 7.7 - 62.4 GeV) to find signatures for the 1st-order phase transition and the critical point. Femtoscopy analysis allows us to extract information about the size of the emission source.
In particular, from the non-identical particles correlations, e.g. pion-kaon femtoscopy, one can obtain information about asymmetry in emission processes of pions and kaons. This asymmetry gives knowledge of which type of particles is emitted first/second or/and from which area of the source. In this talk, we will present STAR results of pion-kaon femtoscopy analysis at mid-rapidity in Au+Au collisions $\sqrt{s_{NN}}$ = 39 GeV.



Motivation

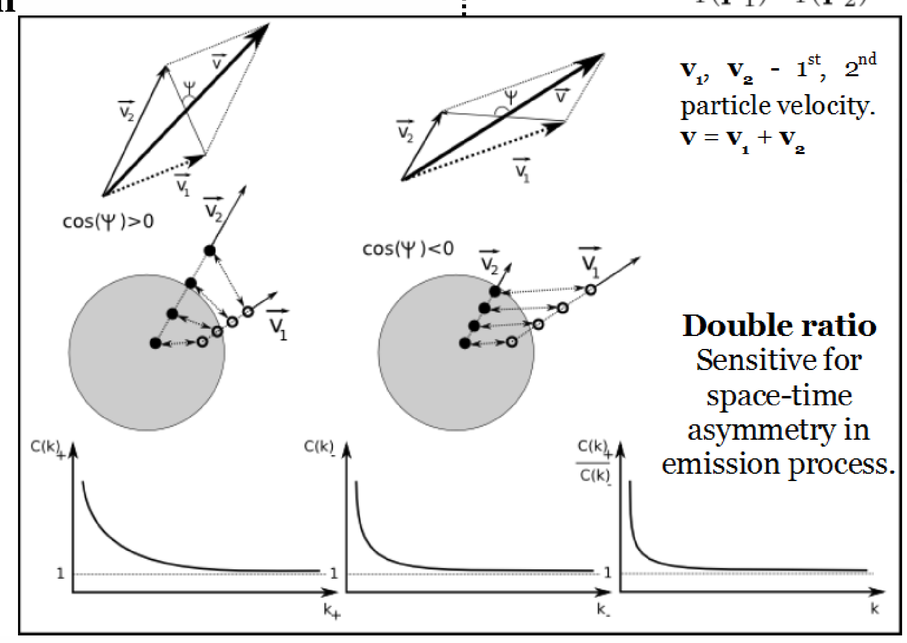
Analyze all BES energies and find answers:
- If or how pion-kaon source changes with energy?
- If or how pion-kaon asymmetry in emission process looks for all BES energies?
- If or how the flow affects the pion-kaon system, which consists of particles of different mass?



Correlation functions

cos(Ψ)>0
Catching up
Long time of effective interaction.
Strong correlation.

cos(Ψ)<0
Run away
Short time of effective interaction.
Weak correlation.

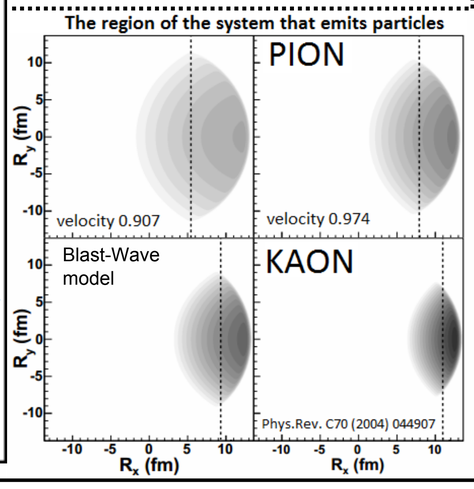


$$C(\mathbf{p}_1, \mathbf{p}_2) = \frac{P_2(\mathbf{p}_1, \mathbf{p}_2)}{P_1(\mathbf{p}_1) P_1(\mathbf{p}_2)}$$

$\mathbf{v}_1$, $\mathbf{v}_2$ - 1st, 2nd particle velocity.
$\mathbf{v} = \mathbf{v}_1 + \mathbf{v}_2$

$P_2(p_1, p_2)$ – the probability of observing two particles with momentum p_1, and p_2 at the same time and the same place.
$P_1(p_1)$, $P_1(p_2)$ – the probability of observing two particles with momentum p_1, and p_2 separately.

Double ratio
Sensitive for space-time asymmetry in emission process.

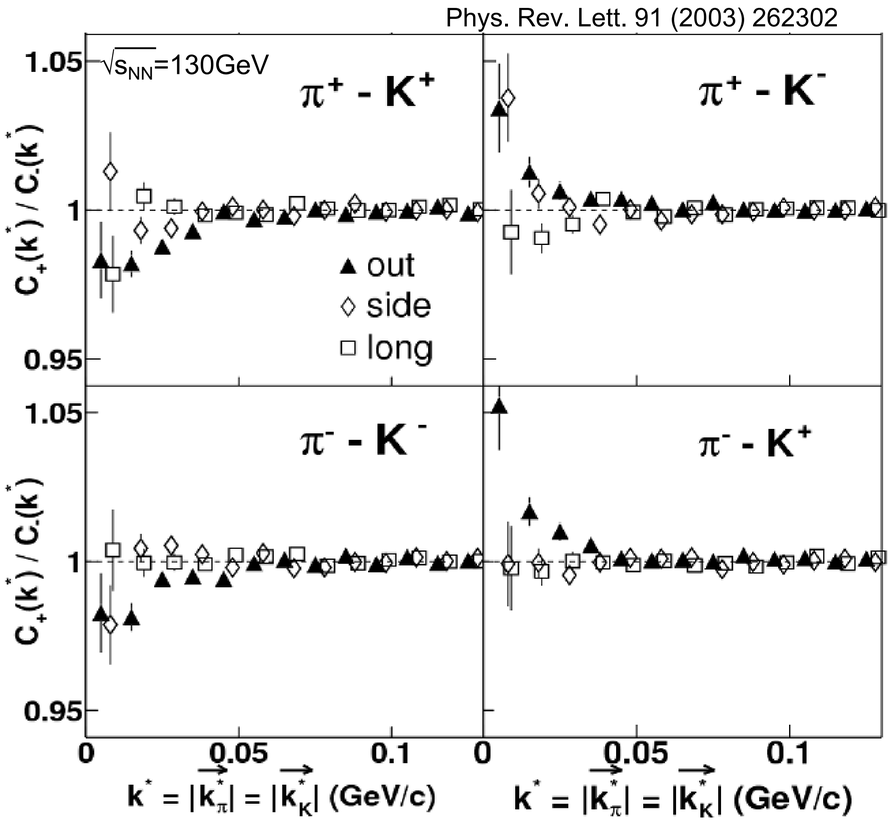


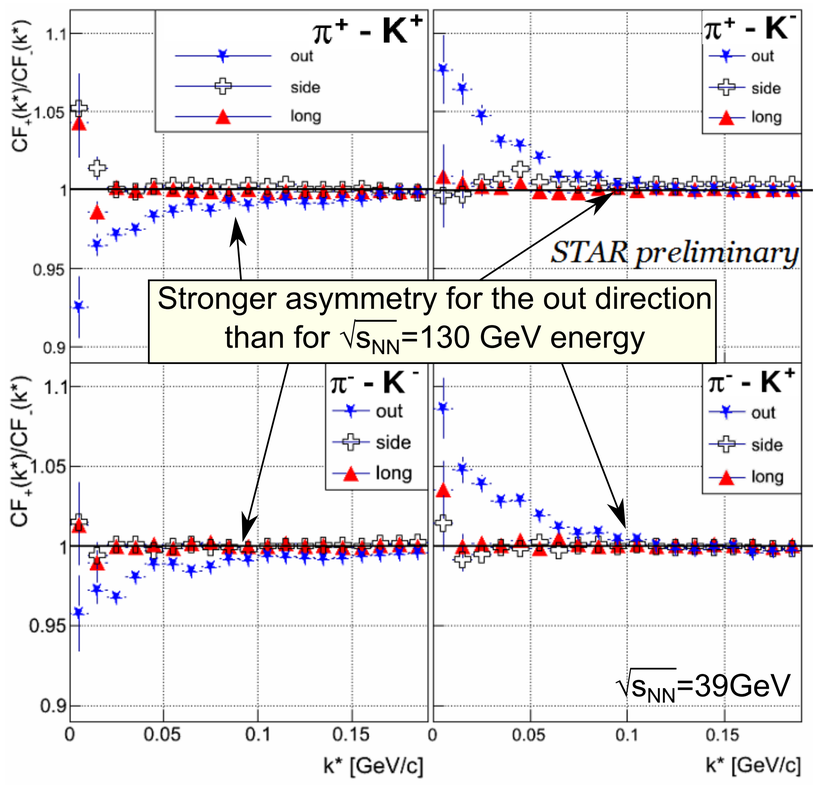
Charged-particle Identification

- For momentum p smaller than 0.55 GeV/c, pions and kaons are identified by Time Projection Chamber (TPC) and by Time of Flight (TOF), if information is available.
- For momentum greater than 0.55 GeV/c, particles are identifed by TPC and TOF.
- In the TPC, pions and kaons are identified by requiring the measured energy loss to be within 3 standard deviation from the expected dEdx band.
- Pions are selected in momentum range [0.15,0.7] GeV/c and kaons [0.3,0.8] GeV/c.
- Pseudorapidity $|\eta| < 0.5$

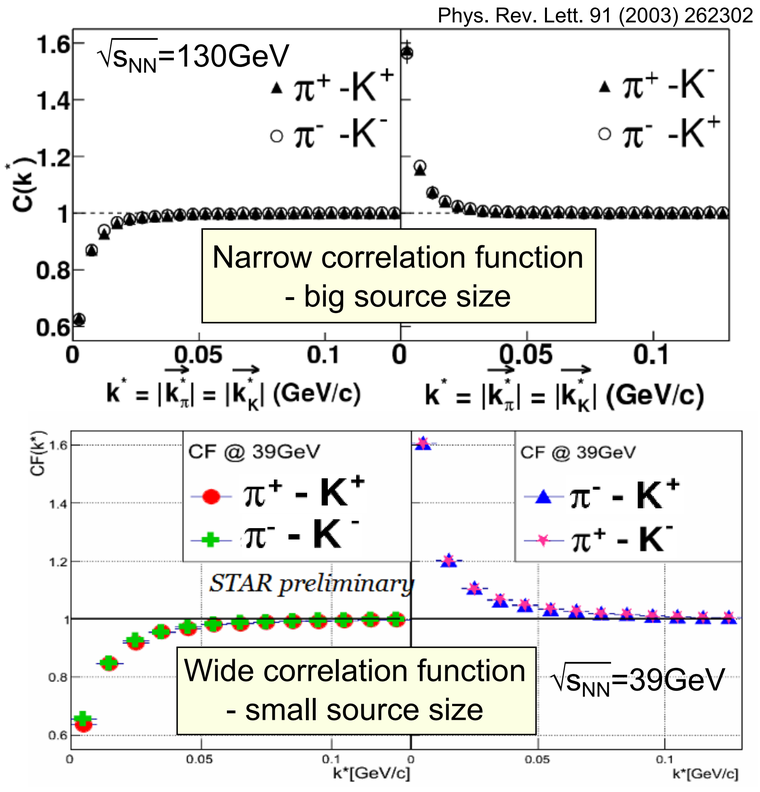
Results

Double ratio functions





Correlation functions



Summary

- Pions are emitted closer to the system's center or/and later than kaons - it is known from the shape of double ratio function.
- Correlation functions (Coulomb force) and double ratio (asymmetry) are the same for like/unlike sign systems.
- The correlation functions for 39 GeV are stronger than the correlation functions for 130 GeV, so source size must be smaller for lower collision energies.
- The asymmetry in the emission process in double ratio functions for the out direction for 39 GeV are stronger than for 130 GeV.

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