Charged kaon femtoscopy in Au+Au collisions

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Outline

- Main goals

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- study the size of the kaon emitting source
- check if $\frac{R_{K^+K^+}}{R_{K^-K^-}}$ depends on the energy, centrality and range of pair transverse momentum

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Why do we analyse kaons?

Kaons can provide complementary information to pions:

- contain strange quarks
- less affected by the feed-down from resonance decays
- smaller cross-section with the hadronic matter

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- Results
  - Analysis details
  - Centrality dependence
  - k_T dependence
  - Beam energy dependence

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Femtoscopy

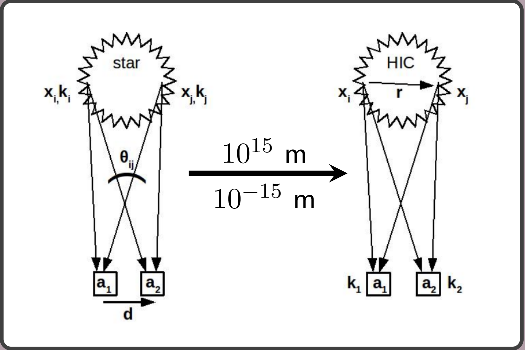
Hanbury Brown and Twiss interferometry

Original

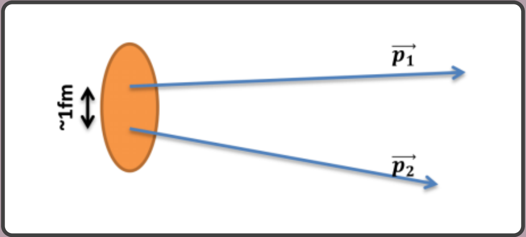
measuring the angular size of astronomical objects was through the use of Michelson interferometry

HBT

examine the particle emitting source by measuring a momentum distribution



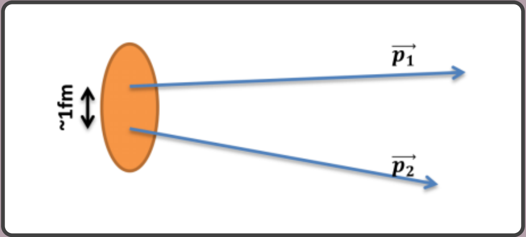
Correlation function



$$C_2(\vec{p_1}, \vec{p_2}) = \frac{P_2(\vec{p_1}, \vec{p_2})}{P_1(\vec{p_1}) P_1(\vec{p_2})}$$

P_2 - the probability of finding two particles at the same place and time
P_1 - the probability of finding particle 1 and 2 separately

Correlation function



$$C(\vec{q}) = \frac{A(\vec{q})}{B(\vec{q})}$$

$$\vec{q} = \vec{p_2} - \vec{p_1}$$

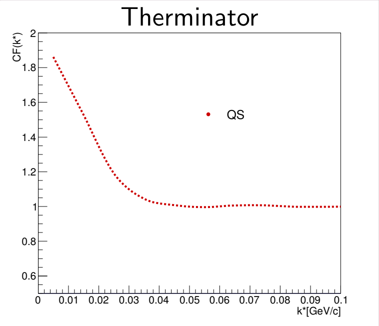
$A(\vec{q})$ - the measured distribution of pairs from the same event

$B(\vec{q})$ - the reference distribution of pairs from mixed events

Correlation function

The shape of the kaons correlation function depends on:

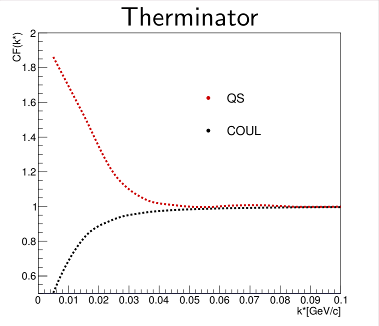
- Quantum Statistical effects (QS)



Correlation function

The shape of the kaons correlation function depends on:

- Quantum Statistical effects (QS)
- Final State Interactions (FSI)
  - Coulomb Interaction (COUL)



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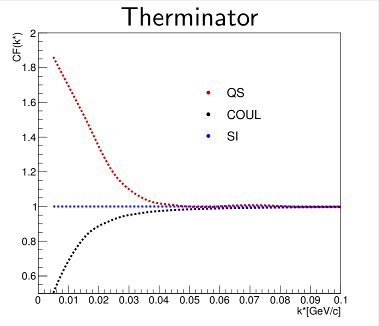

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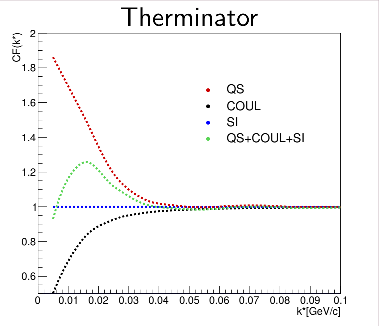
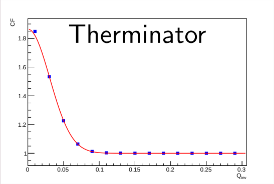


Fitting procedure

- **The QS correlation function:**

$$C(q_{inv}) = 1 + \lambda \exp[-R_{inv}^2 q_{inv}^2]$$



λ - the correlation strength

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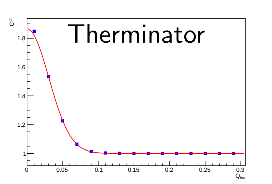
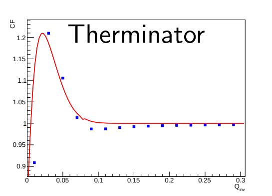


- **Bowler-Sinyukov formula:**

$$C(q_{inv}) = 1 - \lambda + \lambda K(q_{inv})(1 + \exp[R_{inv}^2 q_{inv}^2])$$

M. Bowler, Phys. Lett. B270 (1991) 69

Y. Sinyukow, Phys. Lett. B432 (1998) 248



λ - the correlation strength

$K(q_{inv})$ - Coulomb factor (the two-particle Coulomb wavefunction integrated over a static spherical Gaussian source)

Results

Analysis details

- **1D Femtoscopy of K^+K^+ and K^-K^- pairs**
- **Au+Au** collisions at **BES** energies

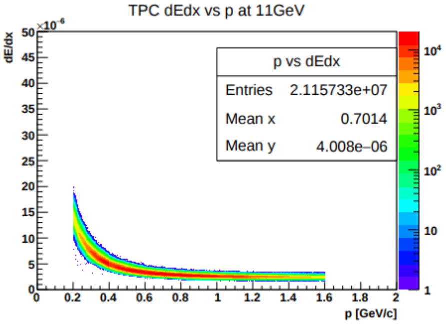
$\sqrt{s_{NN}}$ [GeV]	z_{Vert} [cm]	R_{Vert} [cm]	N_{Events}
7.7	[-70,70]	[0,2]	4.7M
11.5	[-50,50]	[0,2]	12.1M
14.5	[-30,30]	[0,1]	8.7M
19.6	[-30,30]	[0,2]	17.2M
27	[-30,30]	[0,2]	68.7M
39	[-30,30]	[0,2]	75.1M

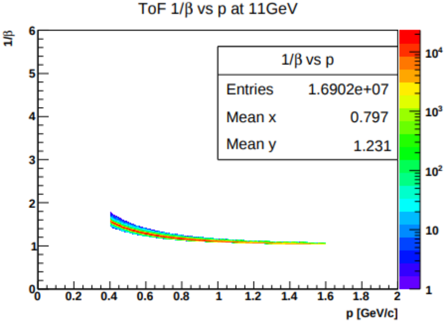
- **2 centralities**: 0-30%, 30-80%
- **3 k_T ranges**: [0.2,0.4], [0.4,0.6], [0.6,0.8] GeV/c
- $p \in$ [0.2, 1.6] GeV/c

Kaon identification

TPC and ToF

- p > 0.4 GeV/c => **TPC+ToF**
- p < 0.4 GeV/c and information from ToF => **TPC+ToF**
- p < 0.4 GeV/c and no information from ToF => **TPC**





Kaon identification

only TPC

$|N_{\sigma,K}| < 2$

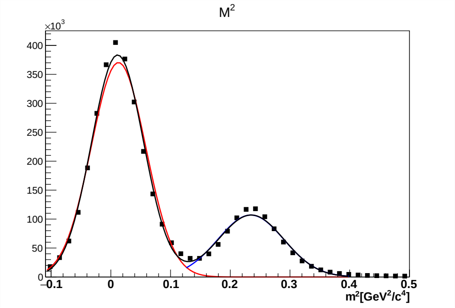
$|N_{\sigma,\pi}| > 2$

$|N_{\sigma,p}| > 2$

TPC and ToF

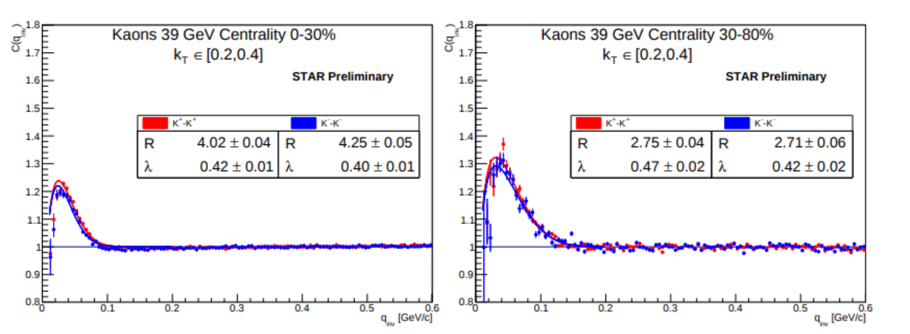
$|N_{\sigma,K}| < 2$

$m^2 \in [0.18, 0.35]$



Centrality dependence

Au+Au collisions



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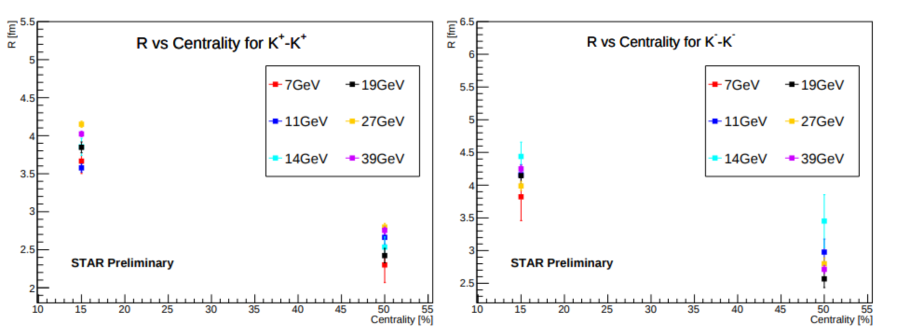
Clear centrality dependence

For central collisions smaller correlation => larger radii

Centrality dependence

Au+Au collisions



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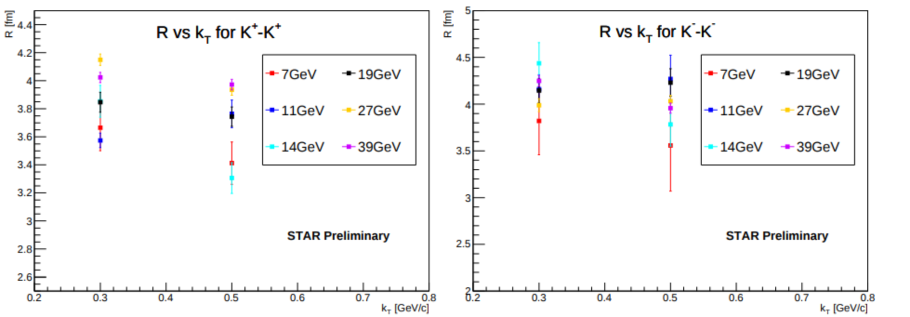
Radii are larger for central collisions as compared to the peripheral ones

k_T dependence

Au+Au collisions (min. bias events)



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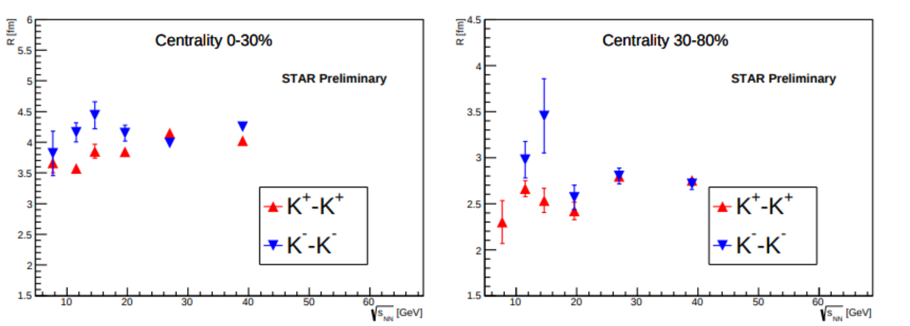
Clear k_T dependence

Beam energy dependence

$k_T \in [0.2, 0.4]$ GeV/c



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No clear beam energy dependence

Conclusion

- similar source sizes for K^+K^+ and K^-K^-
- clear centrality dependence
  - R_{inv} increases with centrality
- clear k_T dependence
  - R_{inv} decreases with higher k_T
- no clear beam energy dependence

Future plan: measure the correlation function for neutral kaons

Thank you for your attention!