Kaons femtoscopy for Beam Energy Scan program in STAR experiment

Martin Girard

Warsaw University of Technology

Outline

- Introduction
- Selections of events and particles
- Results
- Summary

Introduction

1D femtoscopic analysis of charged kaons

- 5 energies of BES at STAR: 7.7, 11.5, 19.6, 27, 39 GeV
- 2 centrality bins: 0-30%, 30-80%
- 2 k_T bins: [0.2-0.4], [0.4-0.6] GeV/c

Analysis is shown with statistical errors only. Study of systematic errors is under way

Motivation

- Information on space-time characteristics
- High Statistics needed $\Rightarrow$ π, K, p
- Most kaons are primary particles
- Strangeness $\Rightarrow$ Different processes if QGP is formed

Femtoscopy

Correlation function

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

$P_2(\vec{\mathbf{p_1}}, \vec{\mathbf{p_2}})$: probability to observe in one event two particles with momenta $\vec{\mathbf{p_1}}$ and $\vec{\mathbf{p_2}}$
$P_1(\vec{\mathbf{p_1}})$: probability to observe in one event one particle with momentum $\vec{\mathbf{p_1}}$

Femtoscopy

Event-mixing procedure

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

A(q): Real pairs from one event
B(q): Mixed pairs from different events

Femtoscopy

Sources of correlations

- Quantum Statistics: Bose-Einstein Correlation
- Final State Interaction
  - Strong
  - Coulomb

Previous results

- 3D Femtoscopic analysis at $\sqrt{s_{NN}} = 200\text{GeV}$
- Radii: rising trend at low m_T
  -Strongest in long direction

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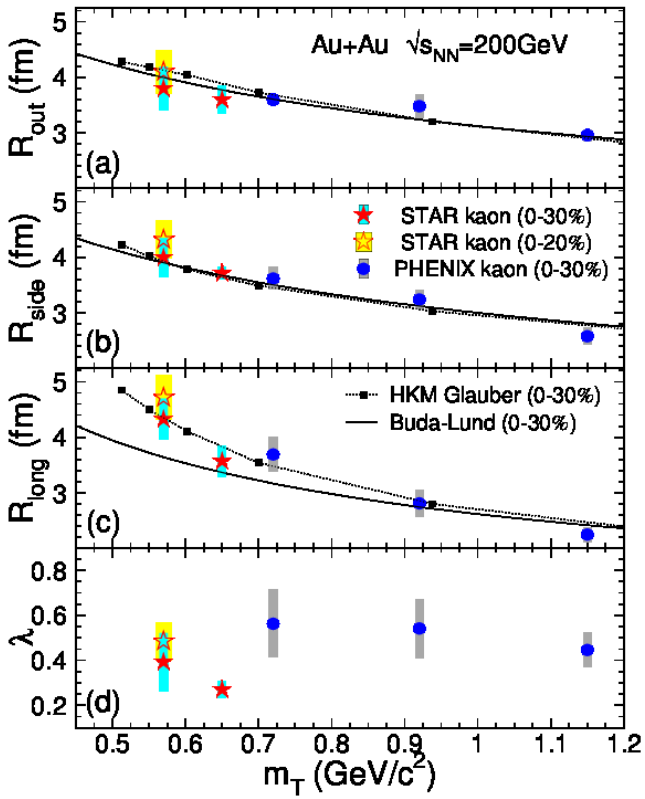


Buda-Lund: M. Csanád, 10.1140/epja/i2008-10605-7
HKM: PRC81, 054903 (2010)

Event selections

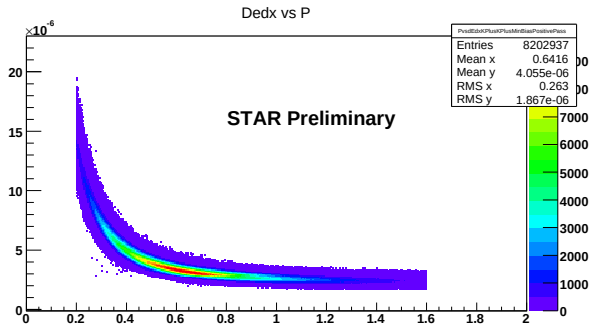
$\sqrt{s}[GeV]$	$V_Z[cm]$	$V_R[cm]$	MinBias
7.7	70	2	4.7M
11.5	70	2	16.1M
19.6	70	2	13.7M *
27	70	2	29.5M
39	40	2	76.8M *

* Not full statistics

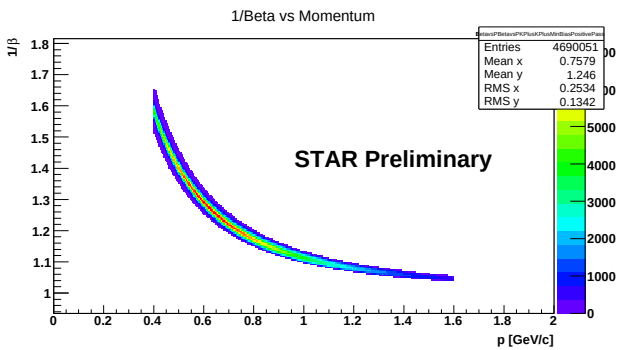
Particle selections

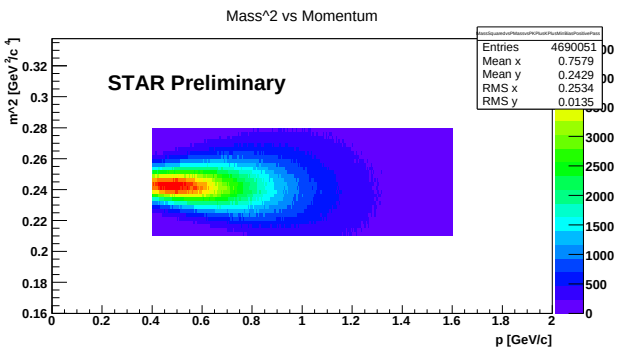
NHits $\in$ [15,45]
DCA $<$ 3 cm
Momentum 0.2 $<$ P $<$ 1.6 GeV/c
$|\eta| < 0.5$
Pair Cuts for merging and splitting

PID: TPC+TOF



$$|N_{\sigma,K}| < 2 \qquad |N_{\sigma,\pi}| > 2 \qquad |N_{\sigma,p}| > 2$$





$$0.21 < M^2 < 0.28 \ GeV^2/c^4$$

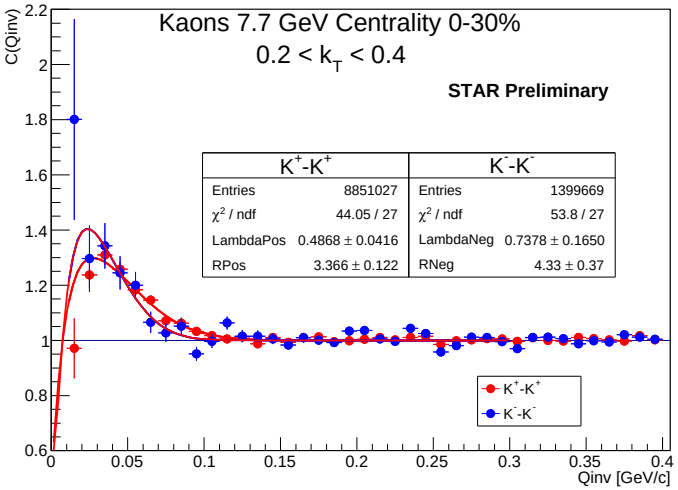
Fitting procedure

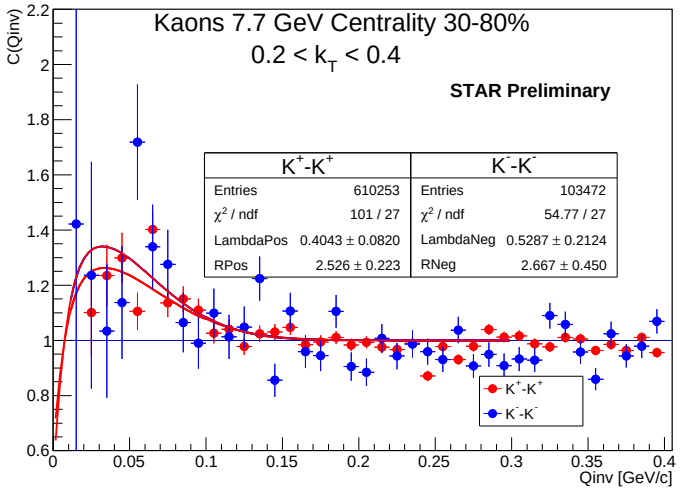
$$C(q) = (1 - \lambda) + \lambda K(q)(1 + e^{-q^2 R^2})$$

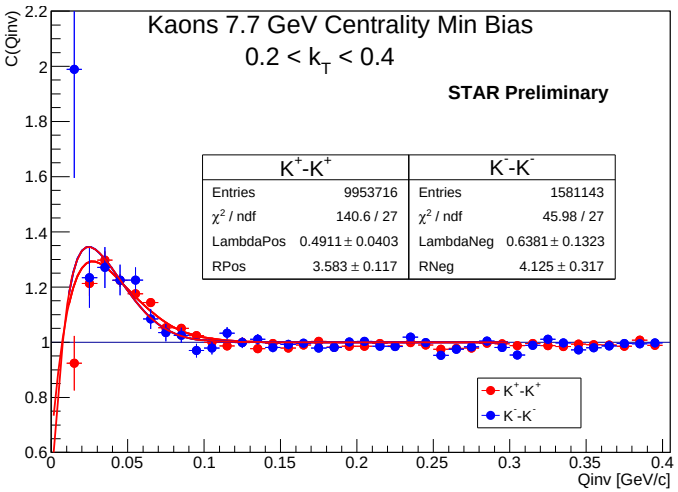
$$K(q) = \int d^3\mathbf{r} f(\mathbf{r}) |\Psi(\mathbf{k}, \mathbf{r})|^2$$

K(q) Coulomb factor obtained by simulation with URQMD model for r=5fm

7.7GeV
$0.2 < k_T < 0.4$GeV/c



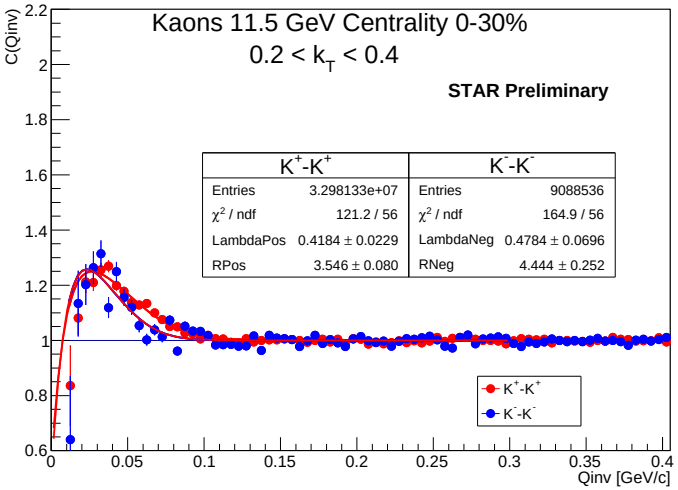


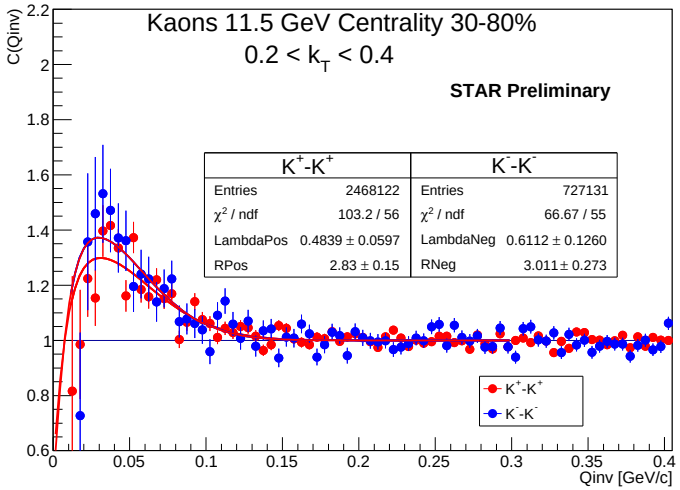


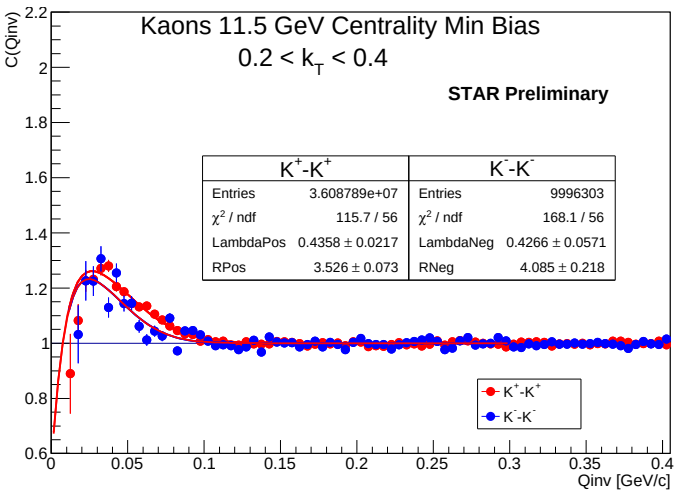
Low statistics

K^+ seems to have a larger correlation range than K^- for centrality 0-30%

11.5GeV
$0.2 < k_T < 0.4$GeV/c



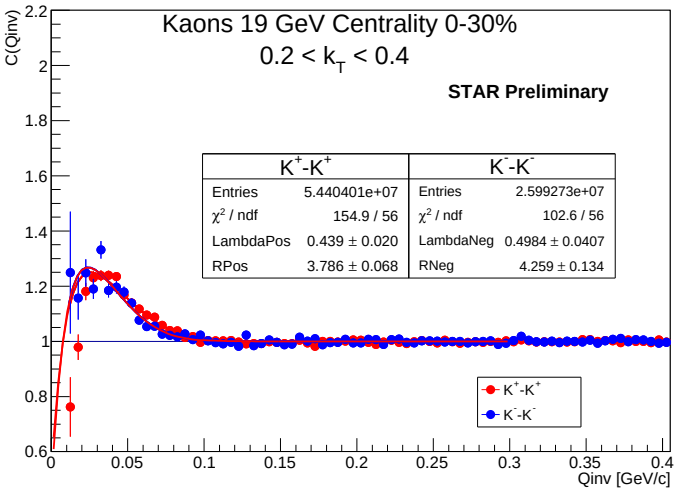


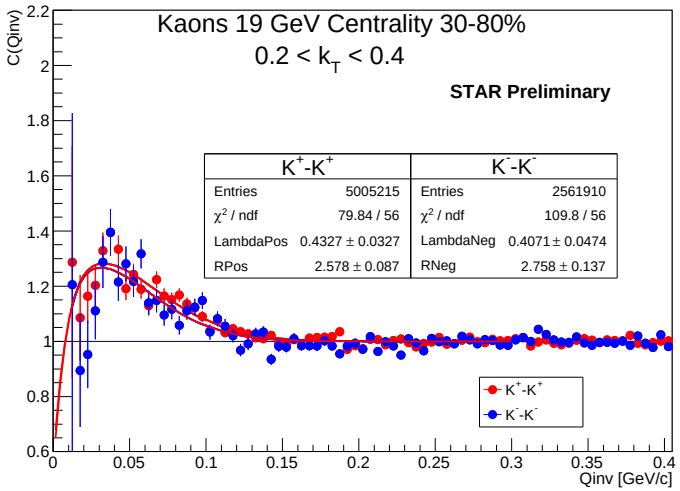


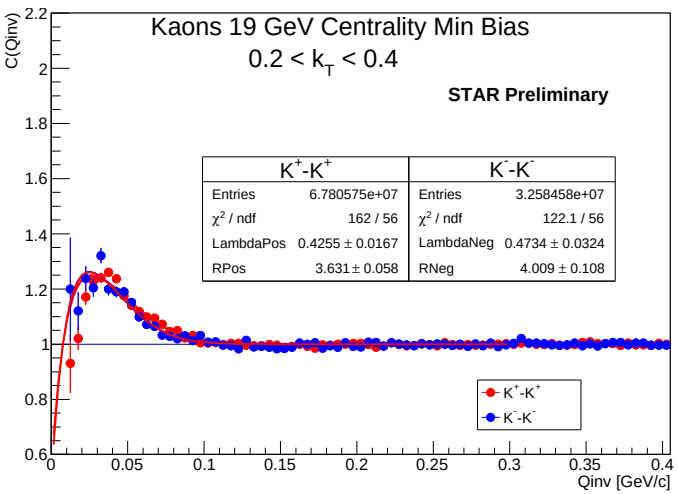
Low statistics

K^+ seems to have a larger correlation range than K^- for centrality 0-30%

19.6GeV
$0.2 < k_T < 0.4$GeV/c

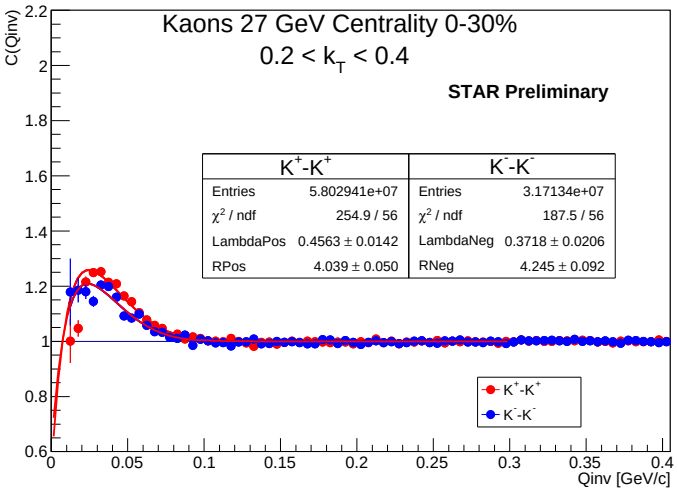


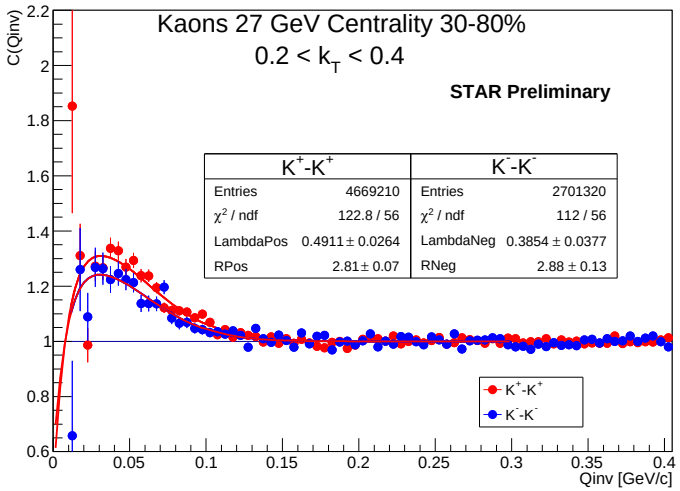


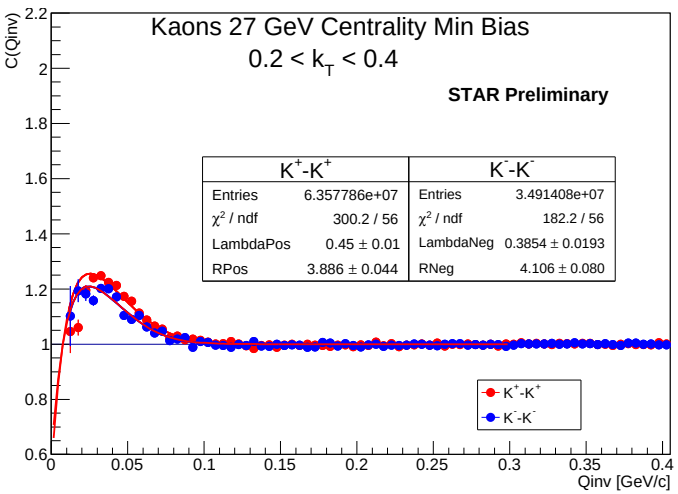


Similar correlation range for K^+ and K^-

27GeV
$0.2 < k_T < 0.4$GeV/c

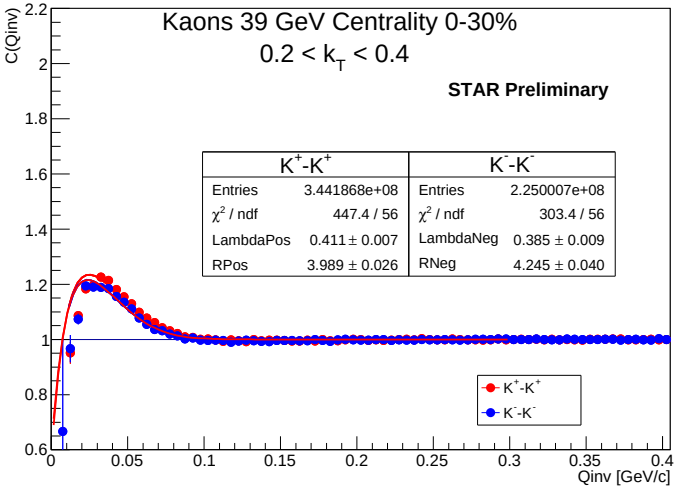


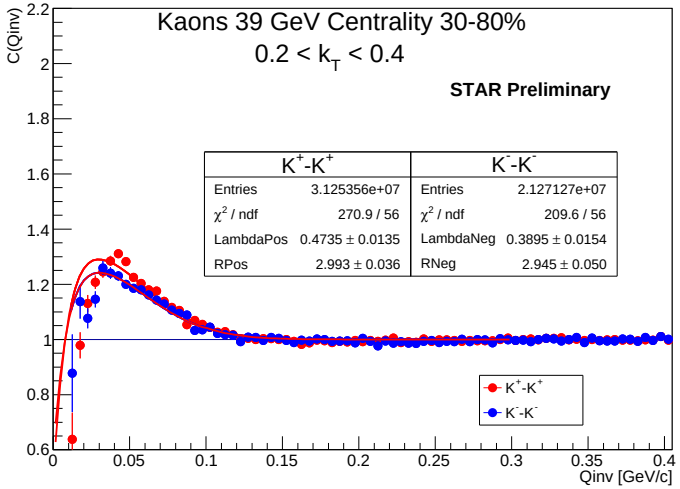


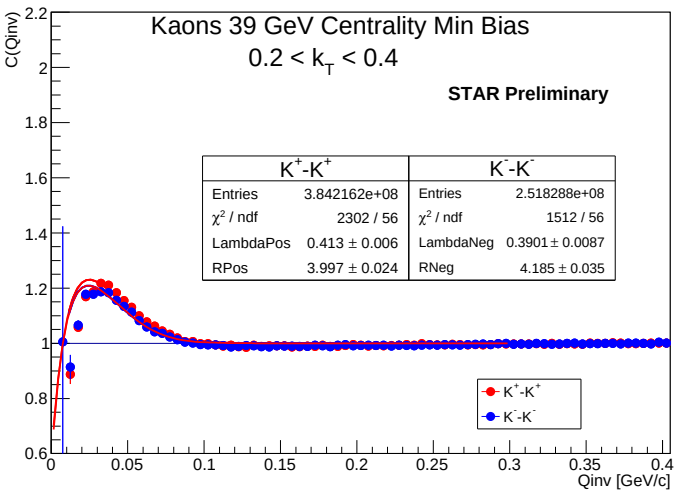


Similar correlation range for K^+ and K^-

39GeV
$0.2 < k_T < 0.4$GeV/c



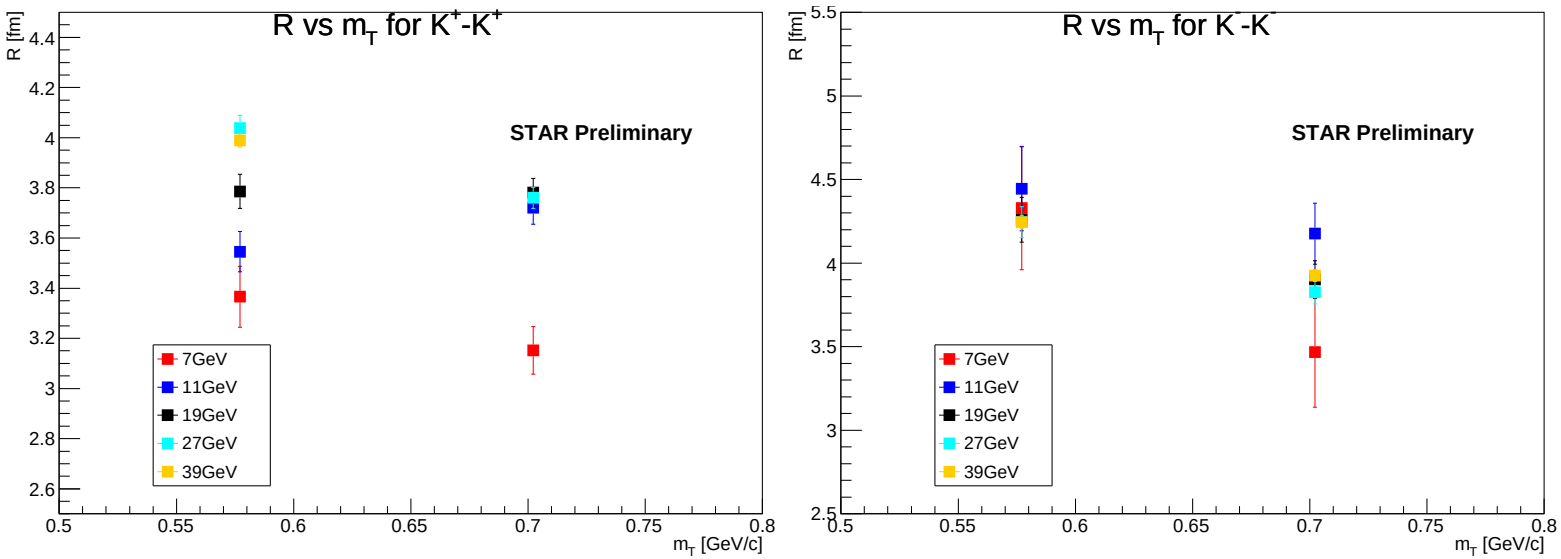




High statistics

Similar correlation range for K^+ and K^-

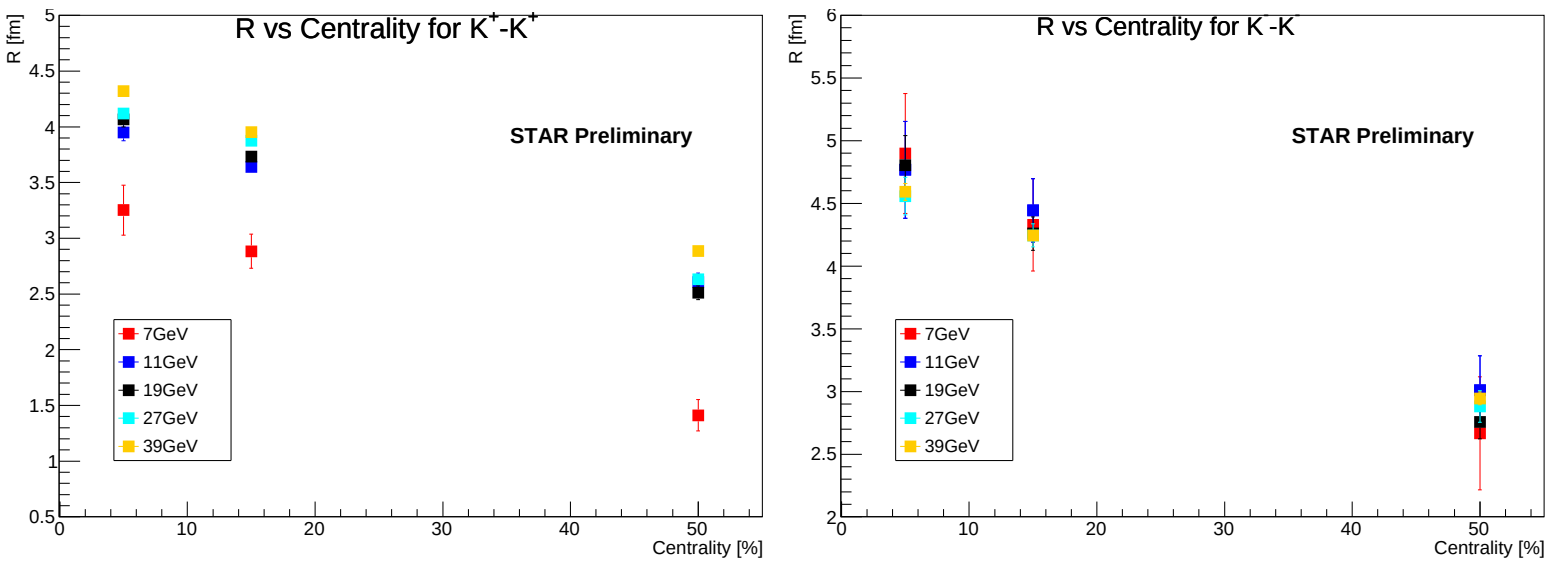
m_T dependence



R for MinBias Events vs m_T

R is decreasing for higher m_T

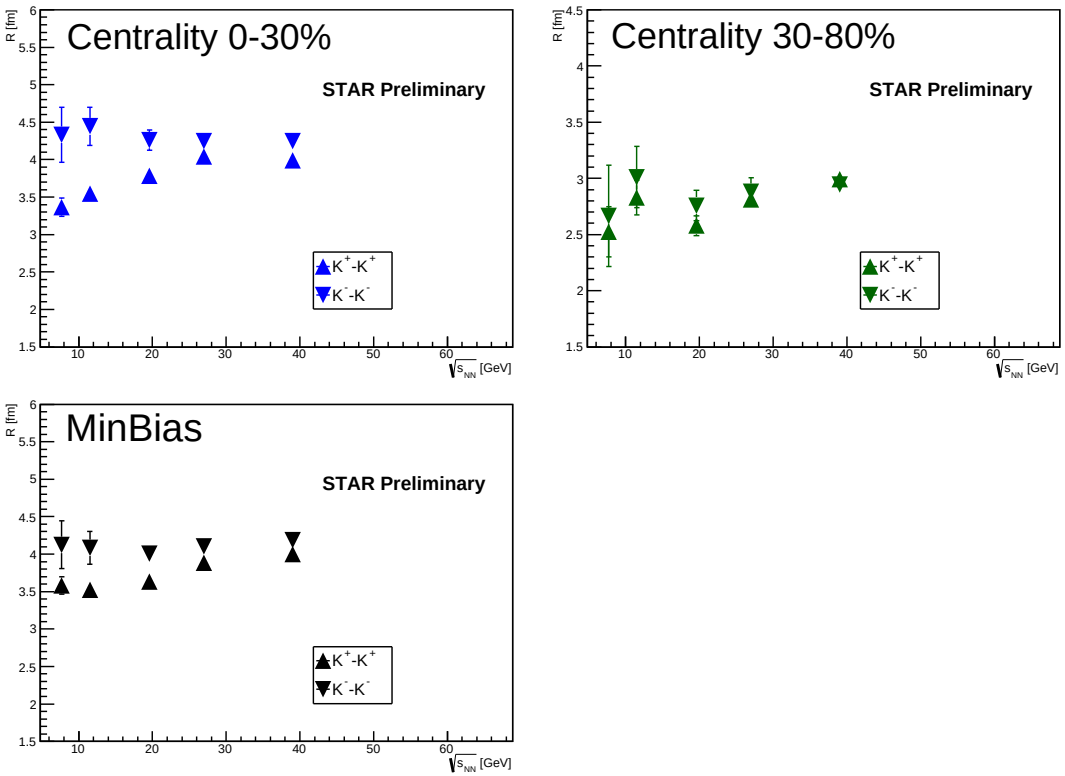
Centrality dependence



R for integrated k_T vs centrality

R is increasing for more central collisions

R for $0.2 < k_T < 0.4$ GeV/c

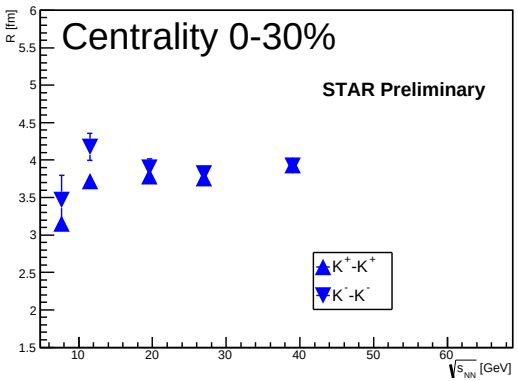


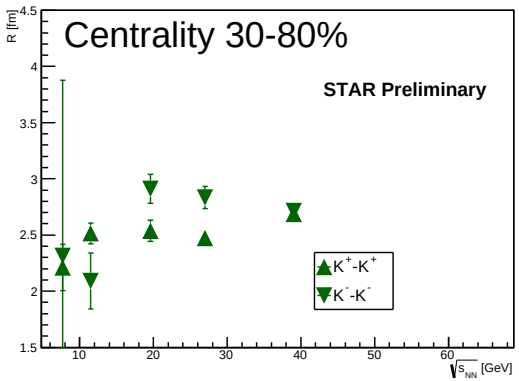
For centrality 0-30% K^+ and K^- seem to show different trends

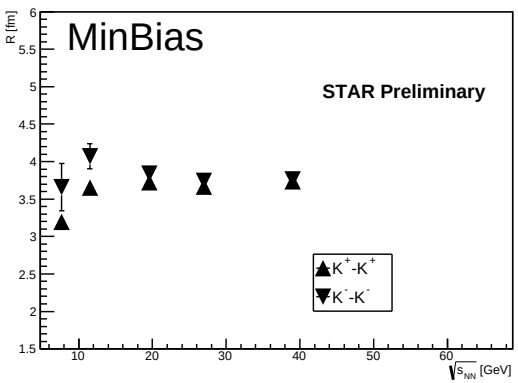
Different association process?

For peripheral collisions no differences between K^+ and K^- and no beam energy dependence

R for $0.4 < k_T < 0.6$ GeV/c







For higher k_T no differences between K^+ and K^- and no beam energy dependence

Summary

- Status of femtoscopic analysis for charged kaons was presented
- Centrality and m_T dependence as expected: bigger R for more central collisions and smaller R for higher m_T
- Hadronic interactions dominant below 20GeV?
- A study of systematic uncertainties has to be done

THANK YOU FOR YOUR ATTENTION!!