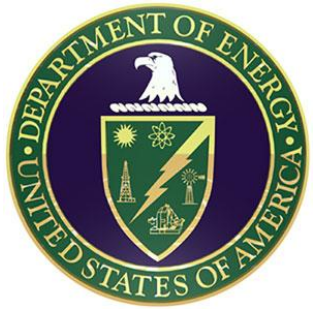
Partially funded by



Pion femtoscopy in Au+Au collisions at $\sqrt{s_{NN}}$=3 GeV in the STAR experiment

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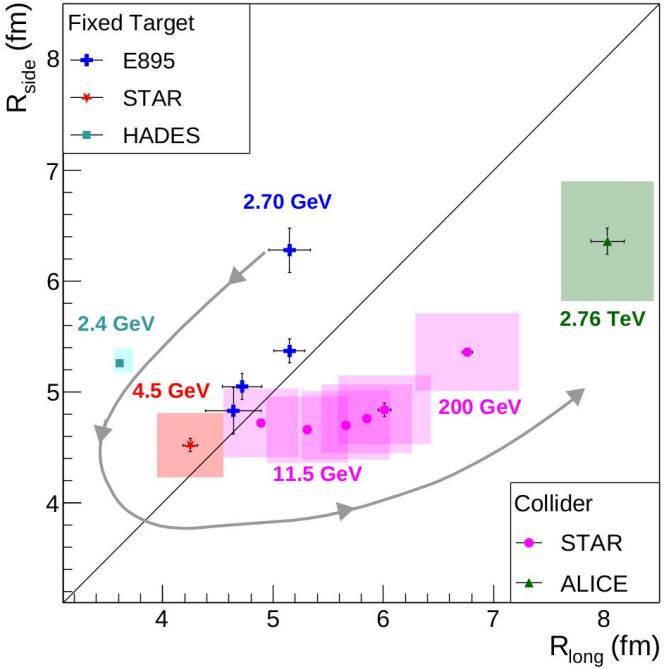
Motivation:

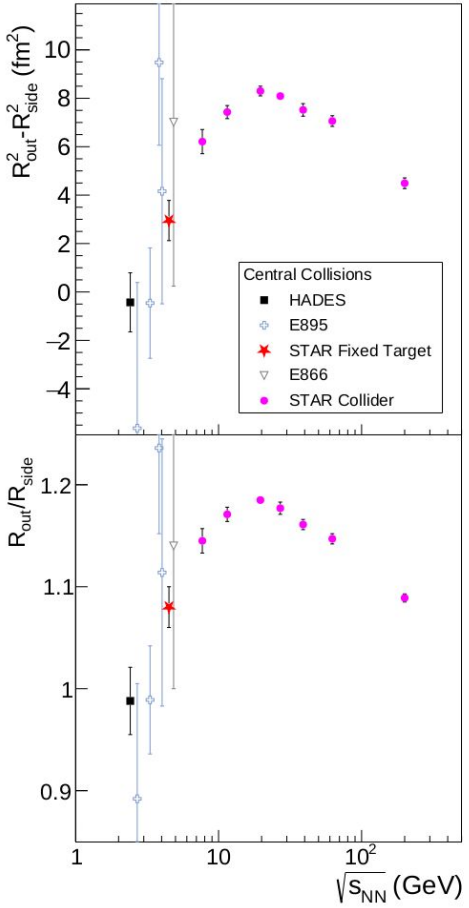
- The energy dependence of femtoscopic scales may reveal fundamental insights into the QGP equation of state
- The low energy results help reveal the structure of the particle emission region where deconfinement is not expected and help complement the presented shape dependence as the collision energy increases

Goal:

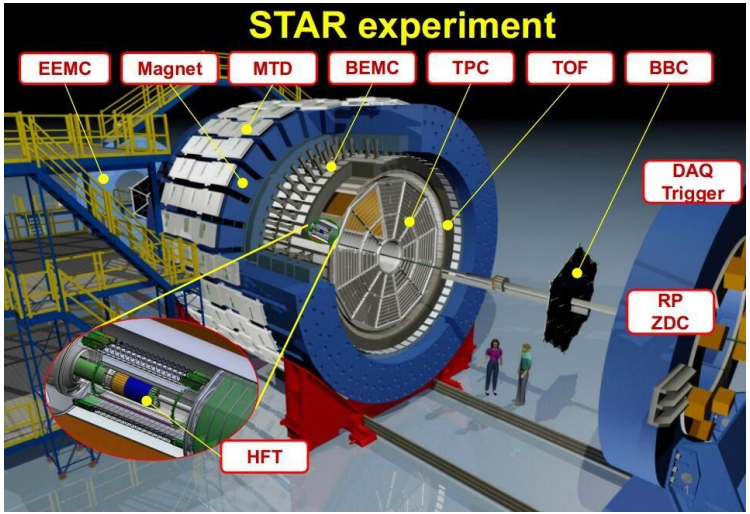
- Investigation of spatial and temporal parameters of the particle emission region in collisions of gold nuclei at an energy of 3 GeV



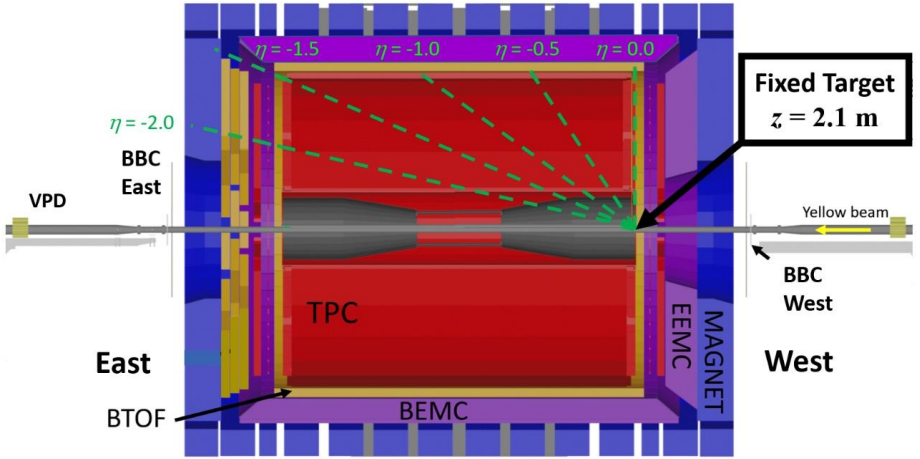
M. S. Abdallah et al. (STAR Collaboration)
Phys. Rev. C 103, 2021



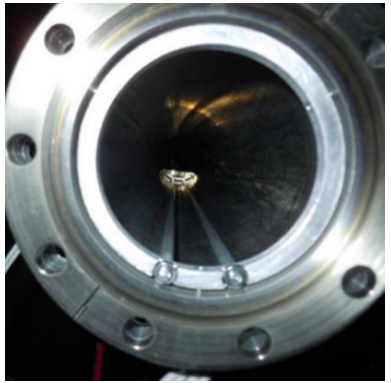
Experiment STAR



Program on a fixed target



Fixed-target program: a beam of gold nuclei collides with a **gold target 1 mm thick** (the density of the foil is 1.93 g/cm^2). The target was installed in a vacuum pipe 211 cm west of the STAR center and 2 cm below the beam axis.



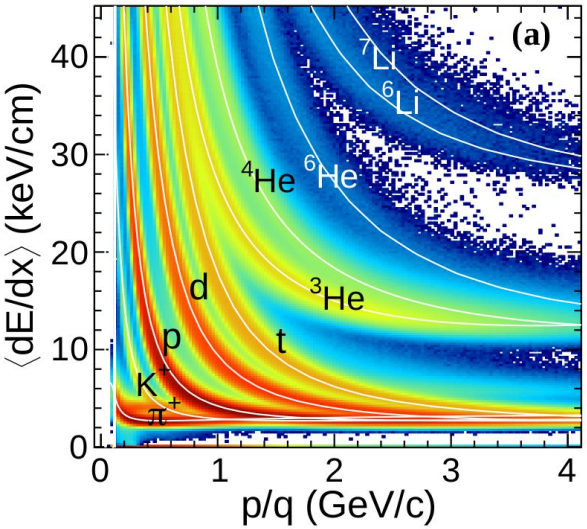
Dataset:
- $\sqrt{s_{NN}} = 3$ GeV Fixed-Target 2018
- ~ $2.6 \cdot 10^8$ events

Tracks:
- $-2 < \eta < 0$
- $0.15 < p_T < 1.5$ GeV/c

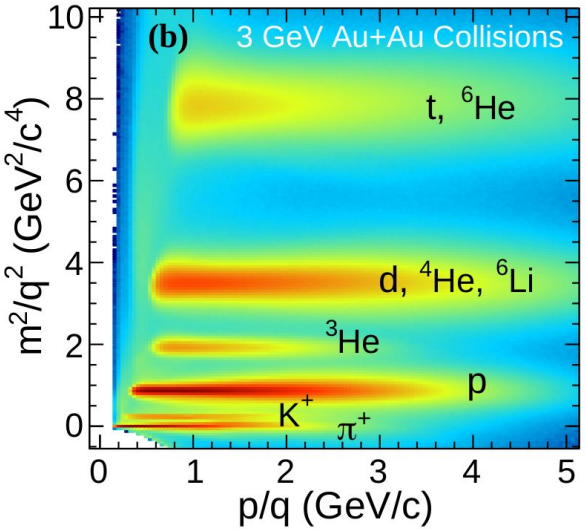
Identification of particles:

$0.15 < p < 0.55$ GeV/c: TPC; $0.55 < p < 1.5$ GeV/c: TPC+TOF

TPC PID



TOF PID



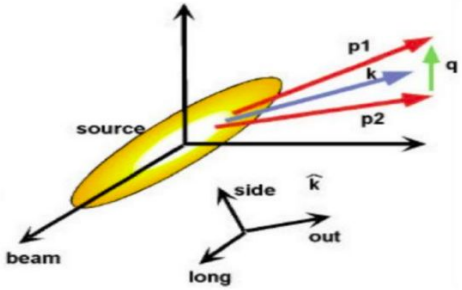
Pion identification was carried out using combination of TPC and TOF in a wide range of momentum $0.15 < p < 1.5$ GeV/c

Two-particle correlation function experimentally:

$$C(q) = \frac{A(q)}{B(q)}$$, where $A(q)$ - formed using pairs where both tracks are from the same event. It is contains quantum-statistical correlations (QS) and final state interactions

$B(q)$ - obtained via mixing technique, where the two tracks are from separate events. Physics correlations are absent

q - relative momentum



Yu. Sinyukov et al. Phys. Lett. B 432 (1998) 248
M. Bowler Phys. Lett. B 270 (1991) 69

Femtoscopic radii are extracted by fitting C(q) with Bowler-Sinyukov:

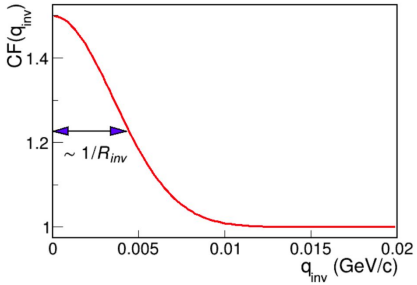
$$C(q) = N[(1-\lambda) + \lambda K(q)(1+G(q))]\text{, where}$$

$$G(q) = exp(-q_o^2 R_o^2 - q_s^2 R_s^2 - q_l^2 R_l^2 - 2q_o q_s R_{os}^2 - 2q_s q_l R_{sl}^2 - 2q_o q_l R_{ol}^2)$$

LCMS system was used

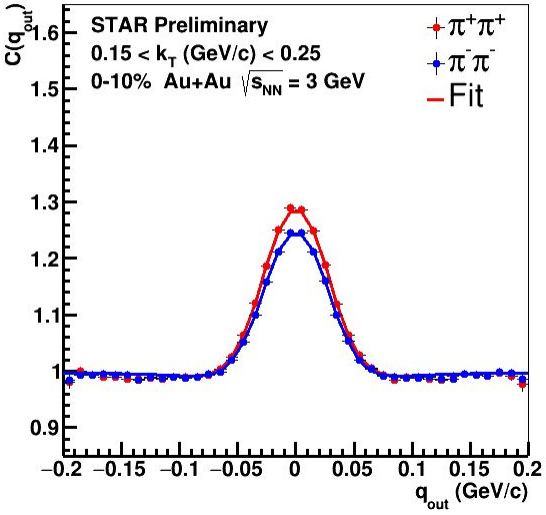
N - normalization factor,
λ - correlation strength,
K(q) - Coulomb correction factor,
q_{long} - along the beam direction,
q_{out} - along the transverse momentum of the pair,
q_{side} - perpendicular to longitudinal and outward directions

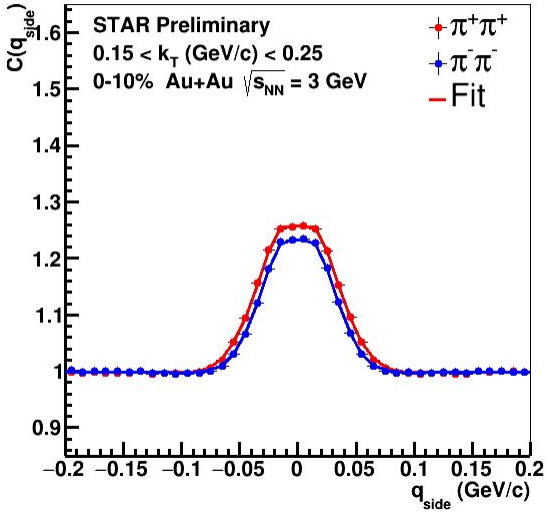
R_{side} ~ geometrical size of the system,
R_{out} ~ geometrical size + particle emission duration
R_{long} ~ medium lifetime

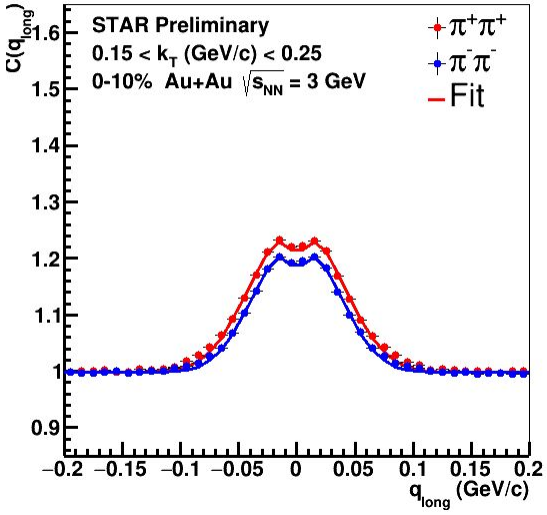


Correlation functions of positive and negative pions pairs at centrality 0-10% in range $0.15<k_T<0.25$ GeV/c of momentum

$$\vec{k}_T = (\vec{p}_{1,T} + \vec{p}_{2,T})/2$$



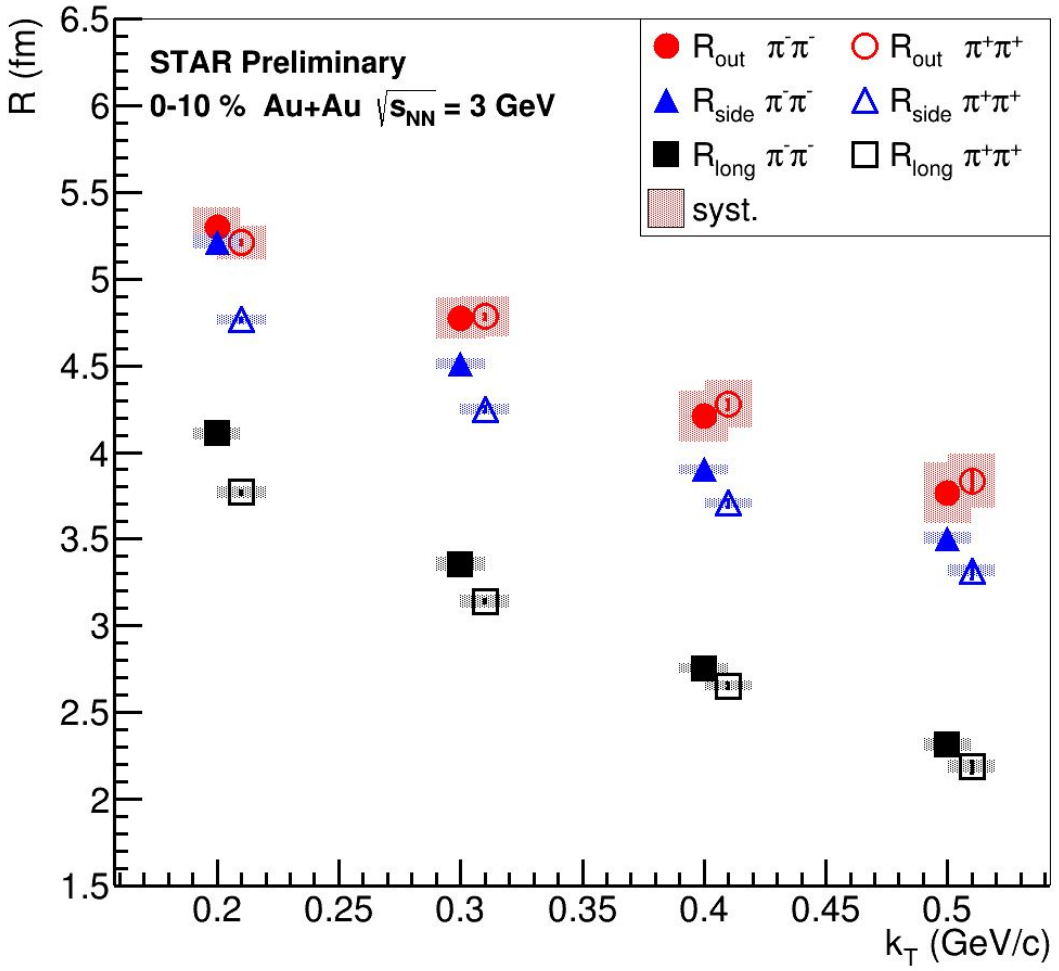




- The correlation functions of identical pions were constructed for all ranges in kT.
- Femtoscopic radii are extracted by fitting correlation function with Bowler-Sinyukov.

Charged pion femtoscopic radii

- **The femtoscopic radii** of the emission region in the out, side and long projections for positive and negative pions **decrease with increasing transverse momentum of pairs**
- Femtoscopic radii decrease with increasing k_T due to a decrease in the emission region of the system due to transverse flow



Summary

- Femtoscopic measurements of charged pions produced in Au+Au collisions at $\sqrt{s_{NN}} = 3$ GeV are presented
- Three-dimensional correlation functions of identical charged pions are constructed for 4 k_T bins and for 0-10% central collisions
- The transverse momentum dependence of emitting source radii (R_{out}, R_{side}, R_{long}) was measured
  - Femtoscopic radii decrease with increasing k_T due to a decrease in the emission region of the system due transverse flow

Back up

Selected cuts on events, tracks, particles:

Tracks:

- nHits > 15
- $0.15 < p < 1.5$ GeV/c
- $0.15 < p_T < 1.5$ GeV/c
- $-2 < \eta < 0$
- $0 <$ DCA < 3 cm

Particles:

$p > 0.55$ GeV:

- $-0.05 < m^2 < 0.08$ GeV^2/c^4
- $-0.015 < 1/\beta - 1/\beta(\pi) < 0.015$
- $|$nSigma(Pion)$| < 3$

$p < 0.55$ GeV/c:

- $|$nSigma(Pion)$| < 2$
- $|$nSigma(others)$| > 2$