Femtoscopic measurements in the frame of theoretical models

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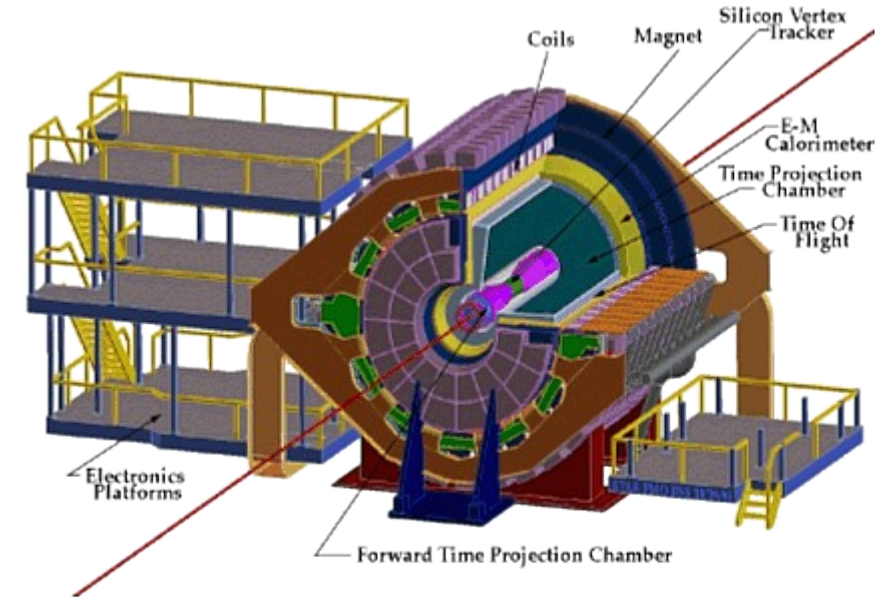
NICA days 2017, Warsaw 6.11 – 10.11.2017

Outline

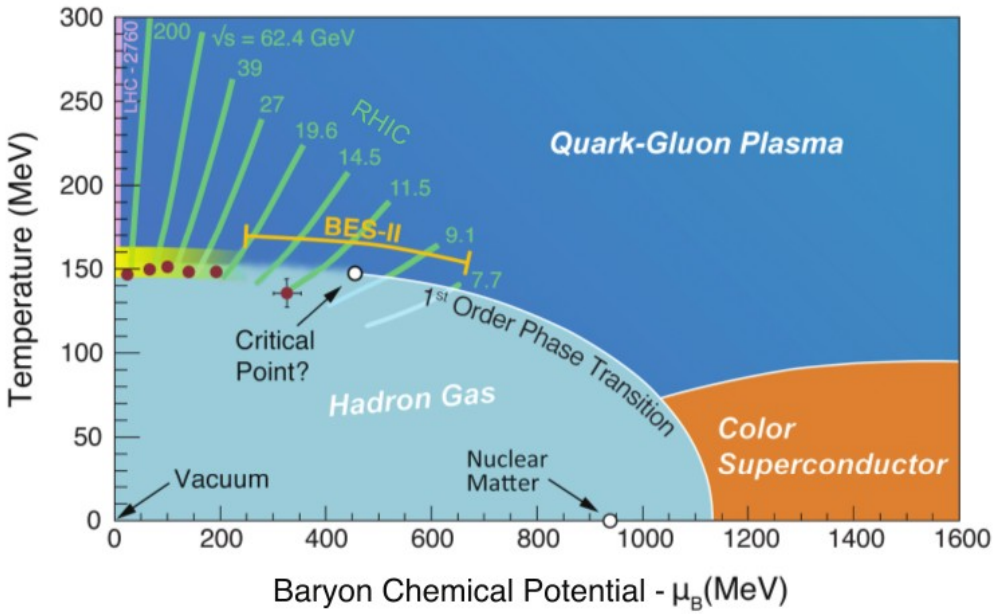
1. The STAR experiment
   - Beam Energy Scan program
2. Heavy-ion collision models
   - UrQMD
   - EPOS
   - Therminator
3. Two particle correlations
4. Results
5. Summary

The STAR experiment

The Solenoidal Tracker At RHIC



Beam Energy Scan Program



Main aims:

- turn-off QGP signature
- find critical point
- examine first order phase transition

Heavy-ion collision models

Types of models

Microscopic:

- dynamic simulation of the collision process inspired by QCD
- based on traking of individual objects
- propagation of individual particles throught a cascade of collisions and decays

UrQMD

EPOS

Macroscopic:

- do not consider of the dynamics of individual objects in detail
- statistical description of the multiparticulate system

UrQMD

Ultra**r**elativistic **Q**uantum **M**olecular **D**ynamic

Main goals are to gain understanding about the following physical phenomena within a single transport model:

- creation of dense hadronic matter

- creation of mesonic matter and antimatter

- properties of nuclear matter

Monte Carlo simulation.

EPOS

Energy conserving quantum mechanical multiple scattering approach, based on
Partons (parton ladders)
Off-shell remnants, and
Saturation of partons

String model based on the Gribov-Regge theory and the parton model.

Include QED and QCD.

Therminator

Thermal heavy-**i**o**n** gener**ator**

Generates collisions of relativitic ions.

Uses Monte Carlo methods.

Implements thermal models of particle production with single freeze-out, which means that chemical and thermal freeze-out happen at the same time.

Two particle correlations

The 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

P_1 - the probability of finding particle 1 and 2 separately

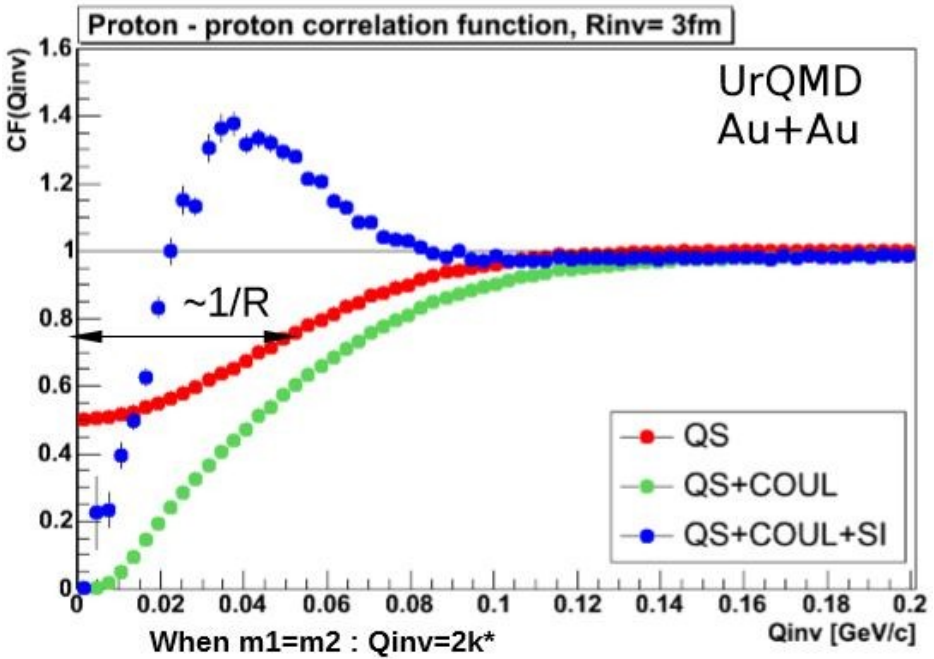
The correlation function

$$C_2(\vec{q}) = \frac{A(\vec{q})}{B(\vec{q})}$$

A - **signal**, distribution of the difference in momentum of two particles deriving from the same collision
B - **background**, distribution of the difference in momentum between two particle which derive from the different collisions

The correlation function

- Quantum Statistics (QS)
- Final State Interactions (FSI)
  - Coulomb Interaction (COUL)
  - Strong Interaction (SI)



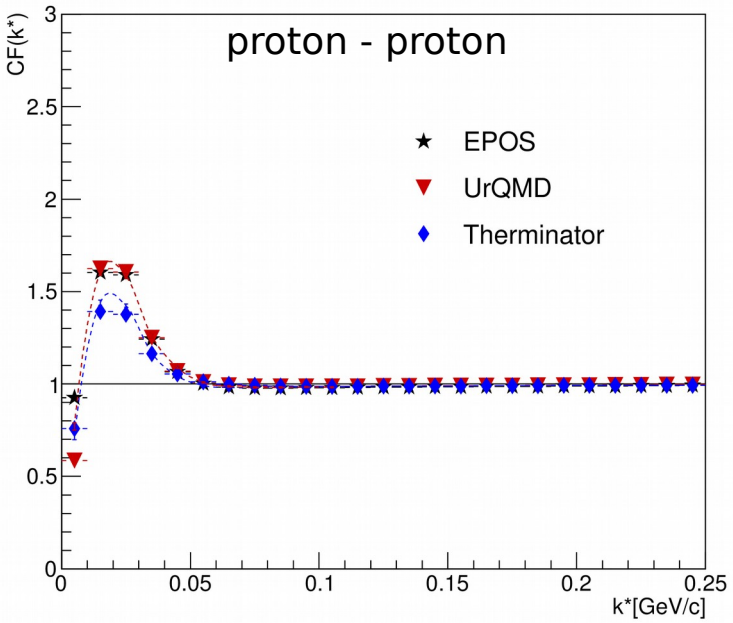
Results

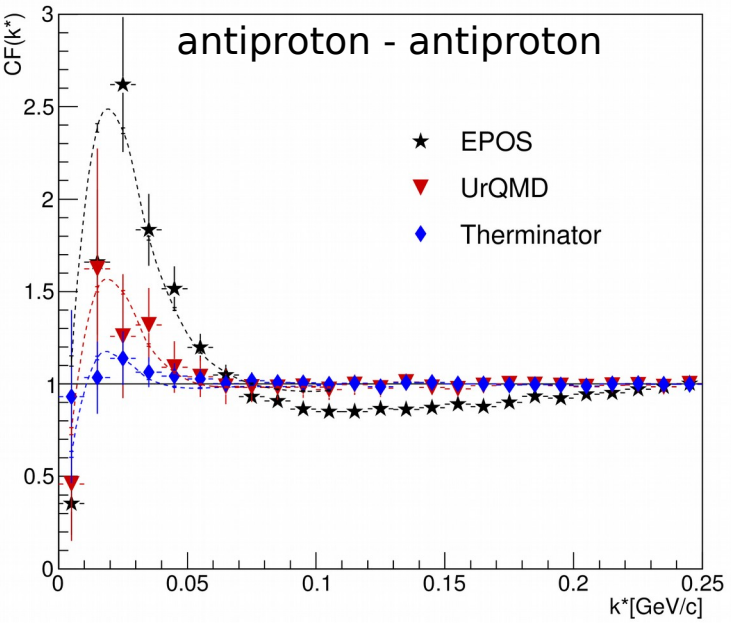
(Anti)proton correlations

Number of analysed events.

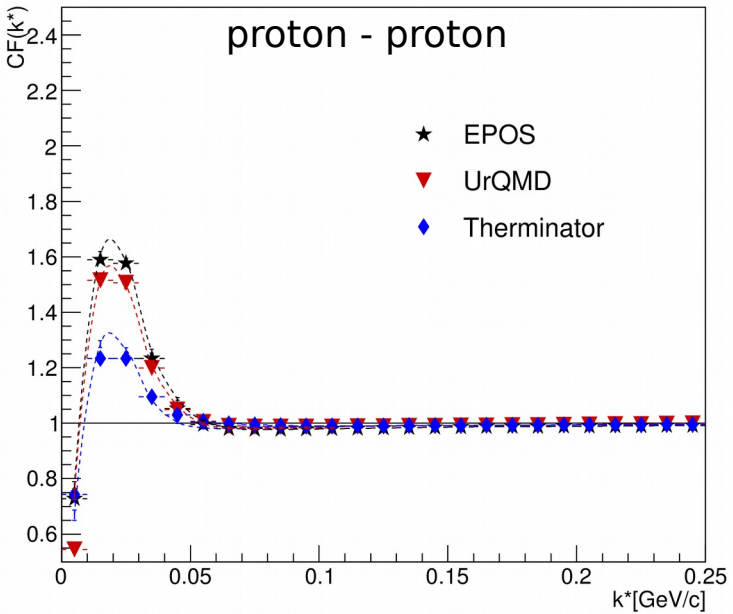
$\sqrt{s_{NN}}$ [GeV]	UrQMD	EPOS	Therminator
7.7	400 000	500 000	50 000
11.5	400 000	500 000	50 000
39	400 000	250 000	50 000
62.4	150 000	250 000	50 000

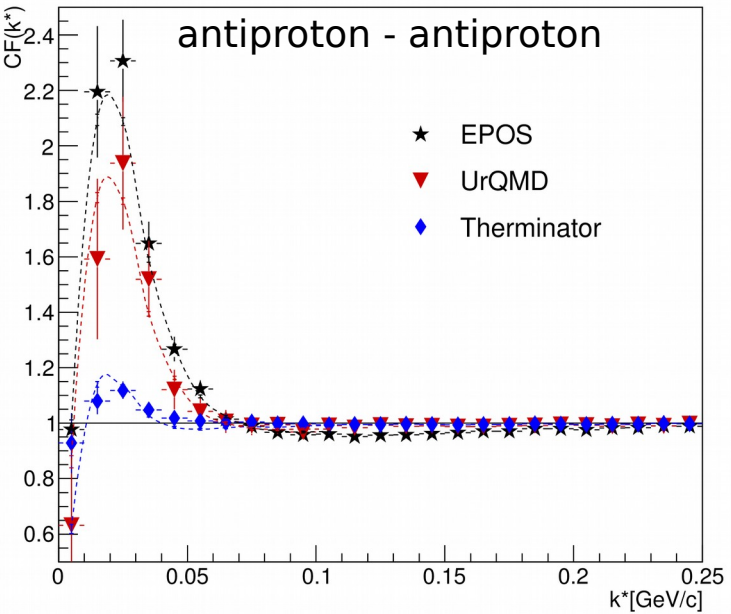
The correlation function – 7.7 GeV



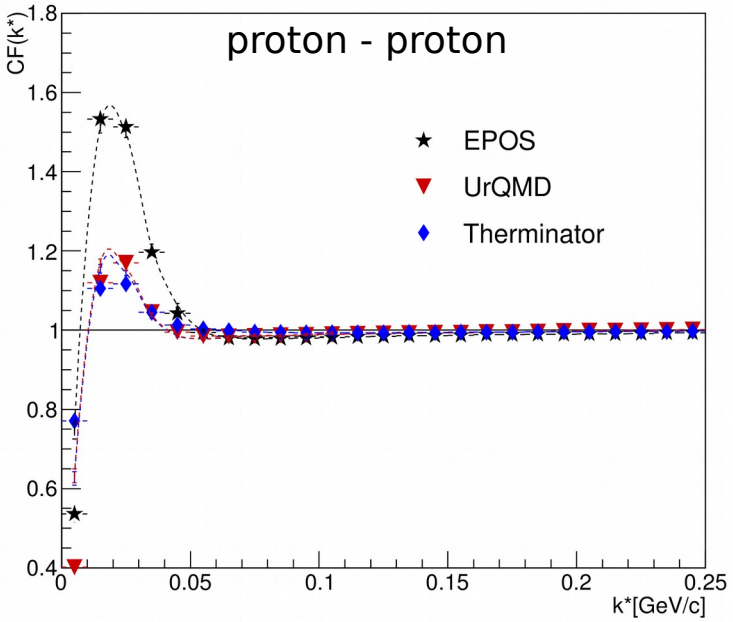


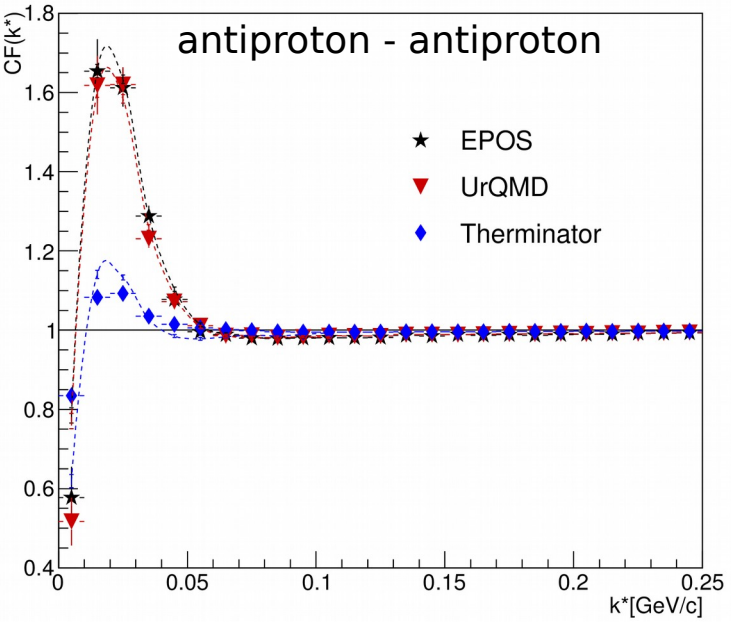
The correlation function – 11.5 GeV



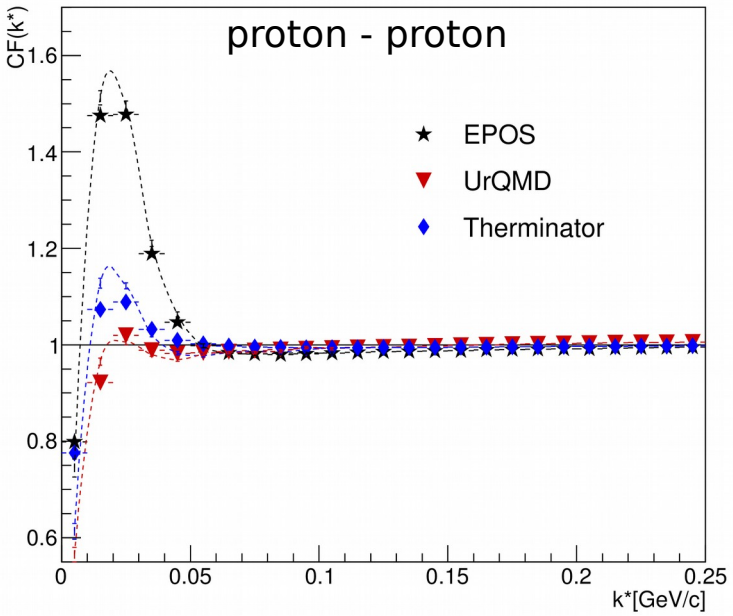


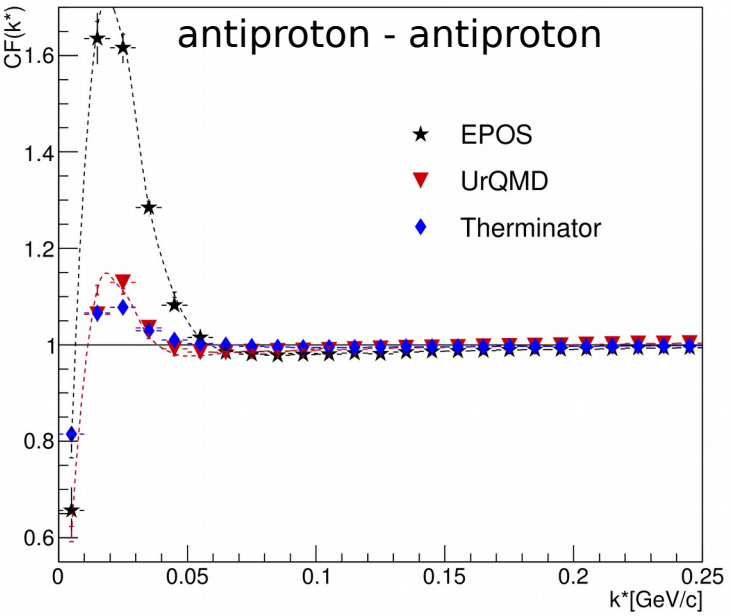
The correlation function – 39 GeV





The correlation function – 62.4 GeV

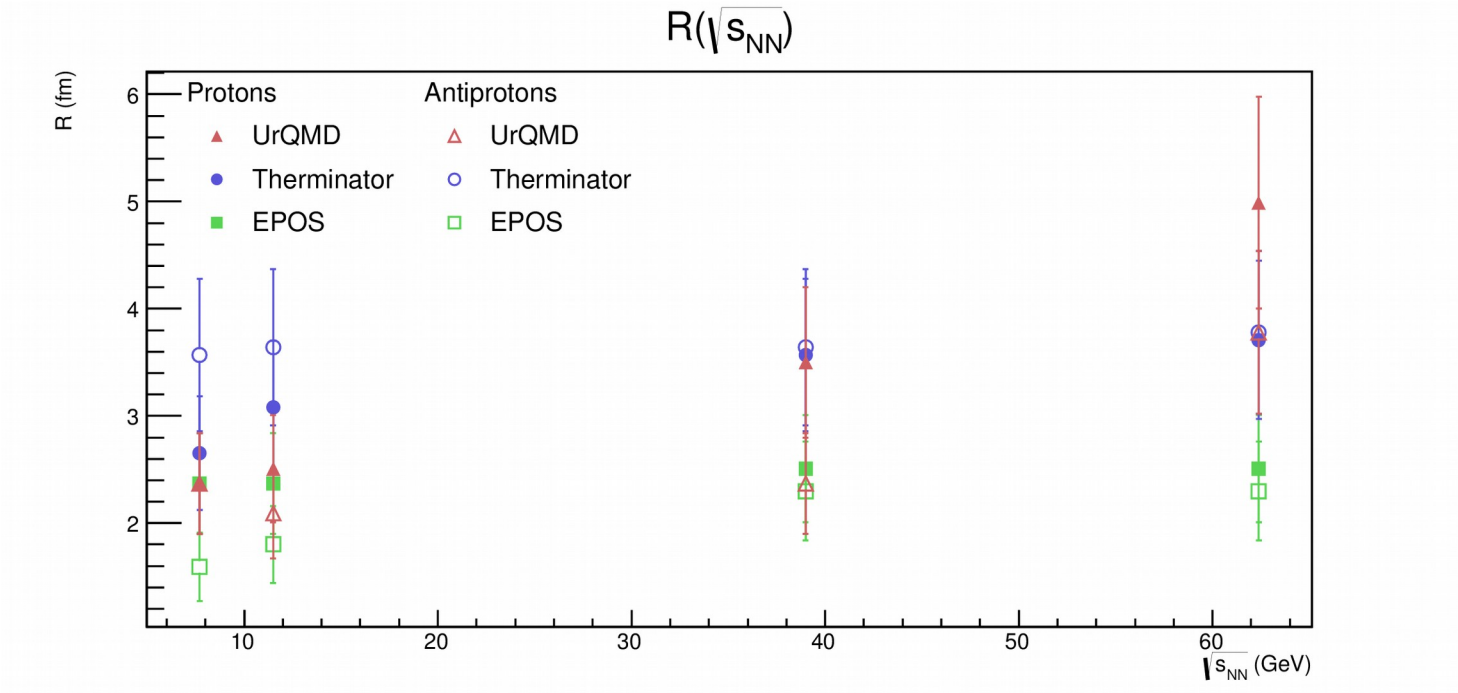




Radii of the source [fm]

	UrQMD		EPOS		Therminator	
$\sqrt{s_{NN}}$ [GeV]	protons	antiprotons	protons	antiprotons	protons	antiprotons
7.7	2.37±0.47	2.37±0.47	2.37±0.47	1.59±0.32	2.65±0.53	3.57±0.71
11.5	2.5±0.5	2.09±0.42	2.37±0.47	1.80±0.36	3.08±0.62	3.64±0.73
39	3.5±0.7	2.37±0.47	2.5±0.5	2.30±0.46	3.57±0.71	3.64±0.73
62.4	4.99±0.99	3.78±0.76	2.5±0.5	2.30±0.46	3.71±0.74	3.78±0.76

Radii of the source



Statistical tests

	UrQMD		EPOS		Therminator	
$\sqrt{s_{NN}}$ [GeV]	λ	chi²/NDF	λ	chi²/NDF	λ	chi²/NDF
7.7	0.058	0.0044	0.221	0.067	0.065	0.0074
11.5	0.194	0.0094	0.221	0.035	0.026	0.0032
39	0.159	0.0187	0.041	0.0011	0.0089	0.00026
62.4	0.046	0.0016	0.031	0.0026	0.0054	0.000086

Hypothesis - antiprotons correlation functions look similar to protons

Summary

Data analysed: **7.7 GeV, 11.5 GeV, 39 GeV** and **62.4 GeV**

Heavy-ion collisions model UrQMD, EPOS and Therminator are checked

- difference between proton-proton and antiproton-antiproton correlations that may be due to measurement of the total correlation function including residual correlations

The radii increase with energy

$$R(62.4\ \text{GeV}) > R(39\ \text{GeV}) > R(11.5\ \text{GeV}) > R(7.7\ \text{GeV})$$

The results of the statistical tests show that the hypothesis can not be ruled out

Thank you for your attention!