Exploring the baryon-to-meson transition region at NICA energies

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RADPyC 2023

CINVESTAV, June 12, 2023

DPC-SMF

Instituto de Ciencias Nucleares UNAM

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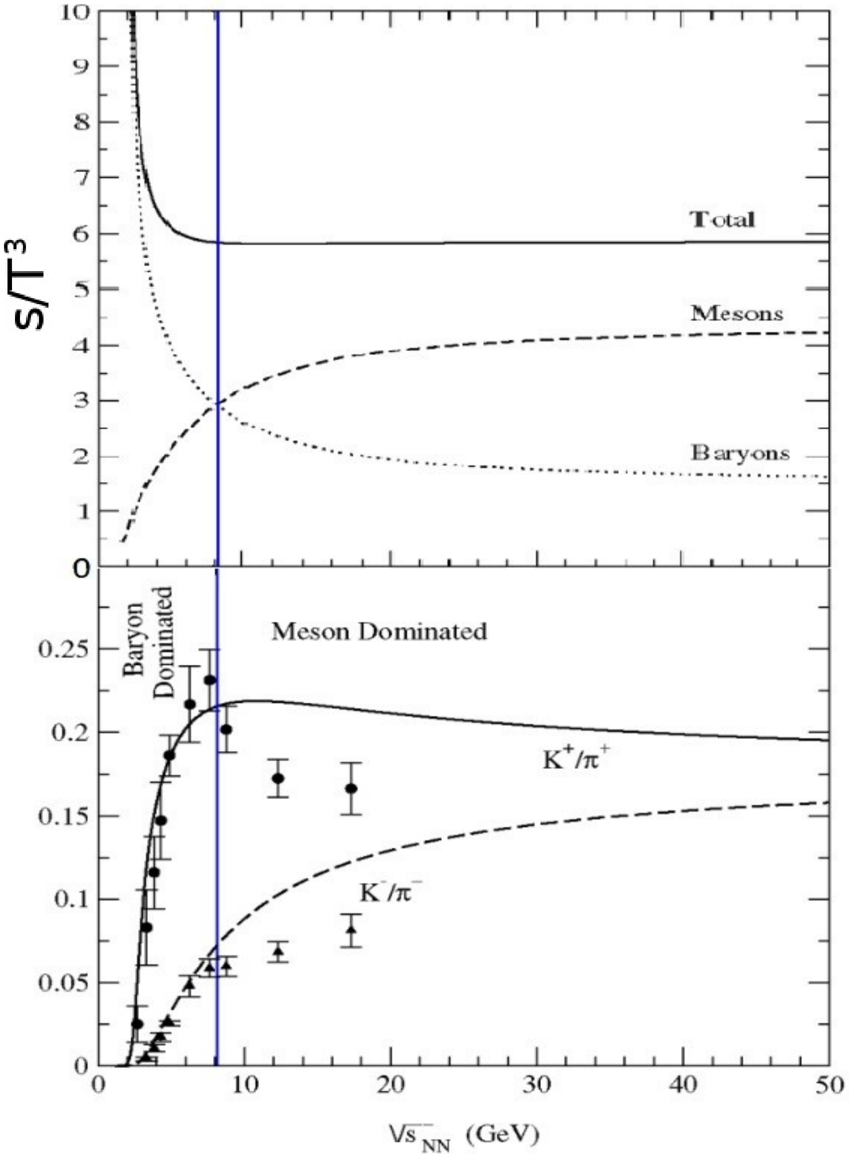
Motivation



The strangeness enhancement is one of the variables proposed to study the existence of the Quark-Gluon Plasma (QGP).

In the framework of the Statistical Model, a rapid change is expected as the hadronic gas undergoes a transition from a baryon- to a meson-dominance.[1]

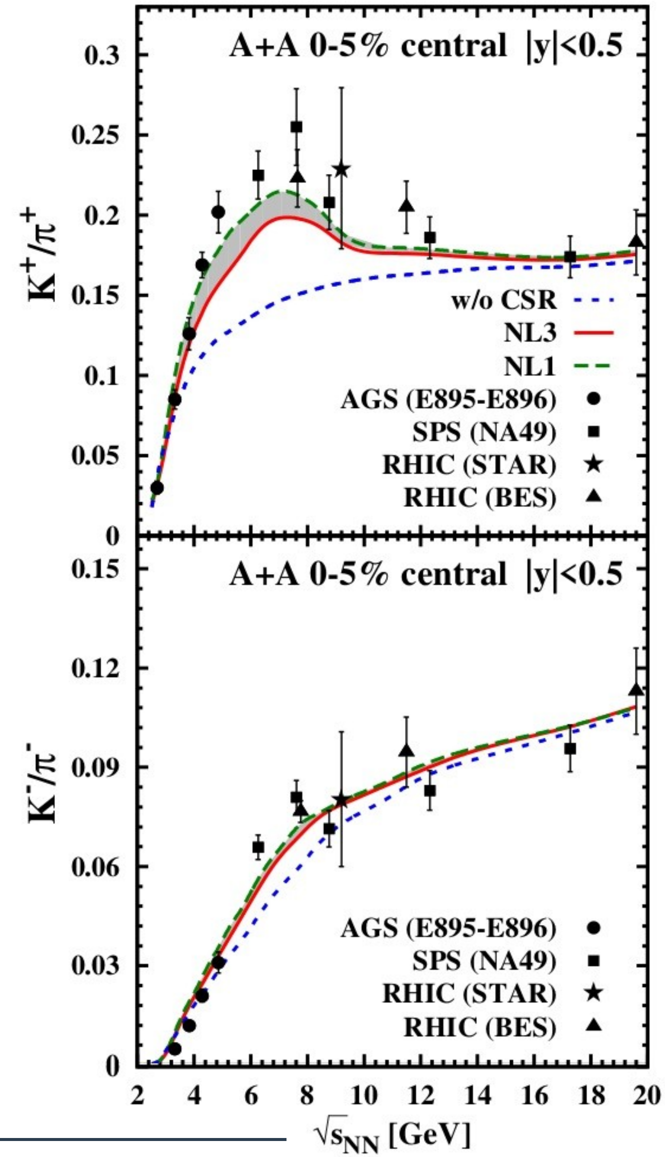
The maximum in the K^+/π^+ ratio is predicted in this model which corresponds to this transition region.[1]

[1] J. Cleymans *et al.*, PLB **615** (2005) 50

Motivation

The Chiral Symmetry Restoration (CSR) in the hadronic phase produces a steep increase of this particle ratio, while the drop at higher energies is associated with the appearance of a deconfined partonic medium.[2]

As in the case of QCD deconfinement phase transition, the boundaries of CSR phase transition line are not well known. Different models support the idea that at finite chemical potential a partially restored phase is achieved before deconfinement occurs.[2]



[2]E. L. Bratkovskaya *et al.*, IWDP **878** (2017) 012018

Data sample analyzed

About the data :

Au+Au collisions at $\sqrt{s_{NN}}$ = 4.5, 7.7, 9.2, 11.5 GeV

UrQMD v3.4
150,000 events
Minimum Bias (0<b<20 fm)
b: impact parameter

Selection criteria

Au+Au collisions

p_T: Transverse momentum=$\sqrt{(p_x{}^2+p_y{}^2)}$

y: rapidity=0.5*Ln((E+p_z)/(E-p_z))

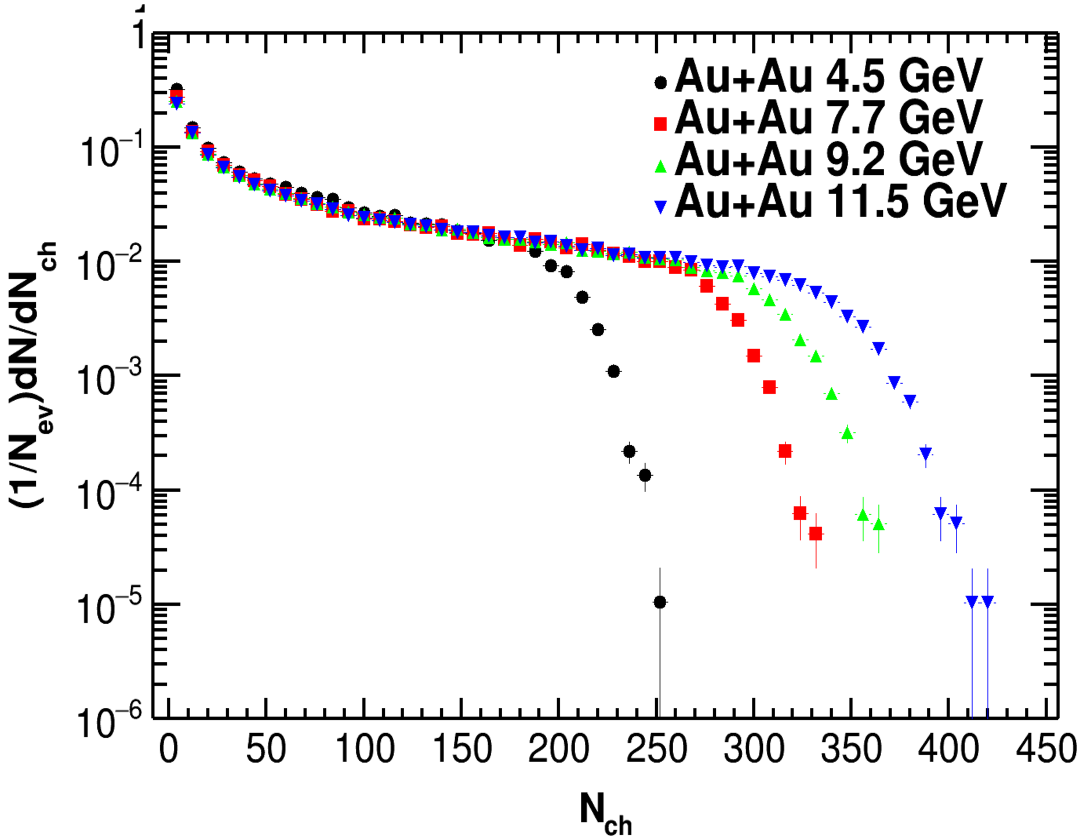
At all energies, the selection criteria are the same:

0.1 GeV/c<p_T , |y|<0.5

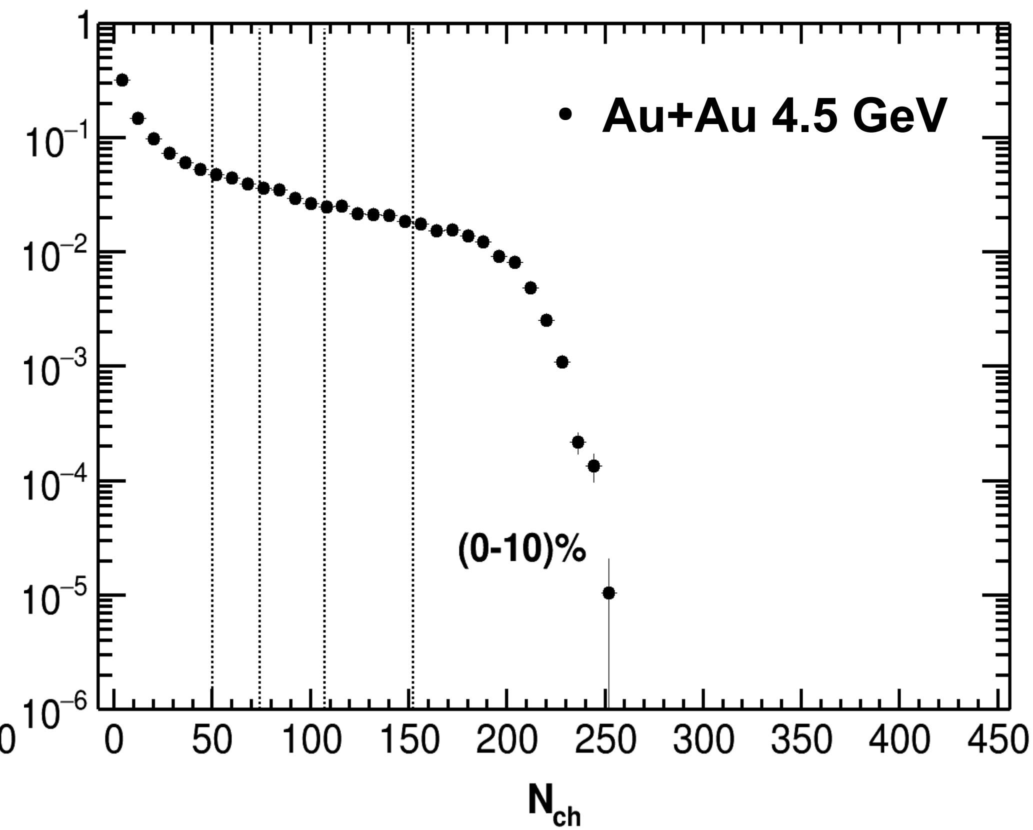
RESULTS

Multiplicity distribution (N_{ch})

|y|<0.5



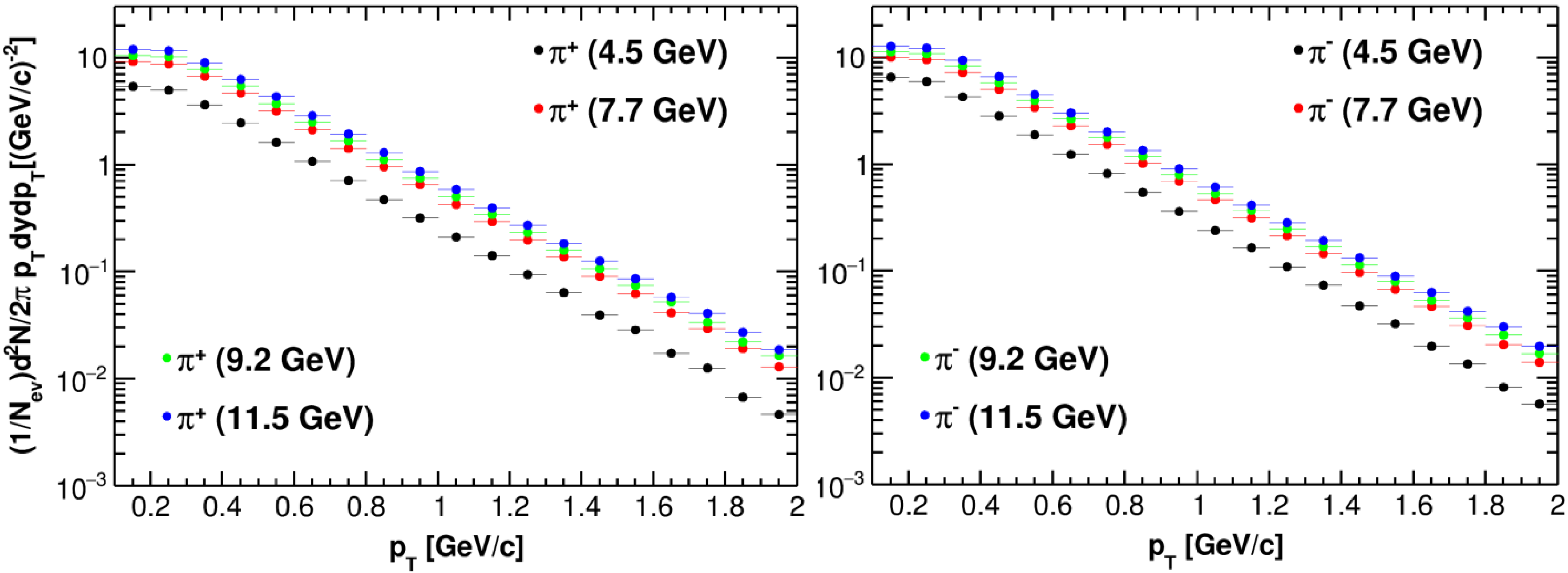
As energy increases, multiplicity reaches higher values.



Centrality represents fractions of the cross section.

Transverse momentum distributions for $\pi^{\pm}$

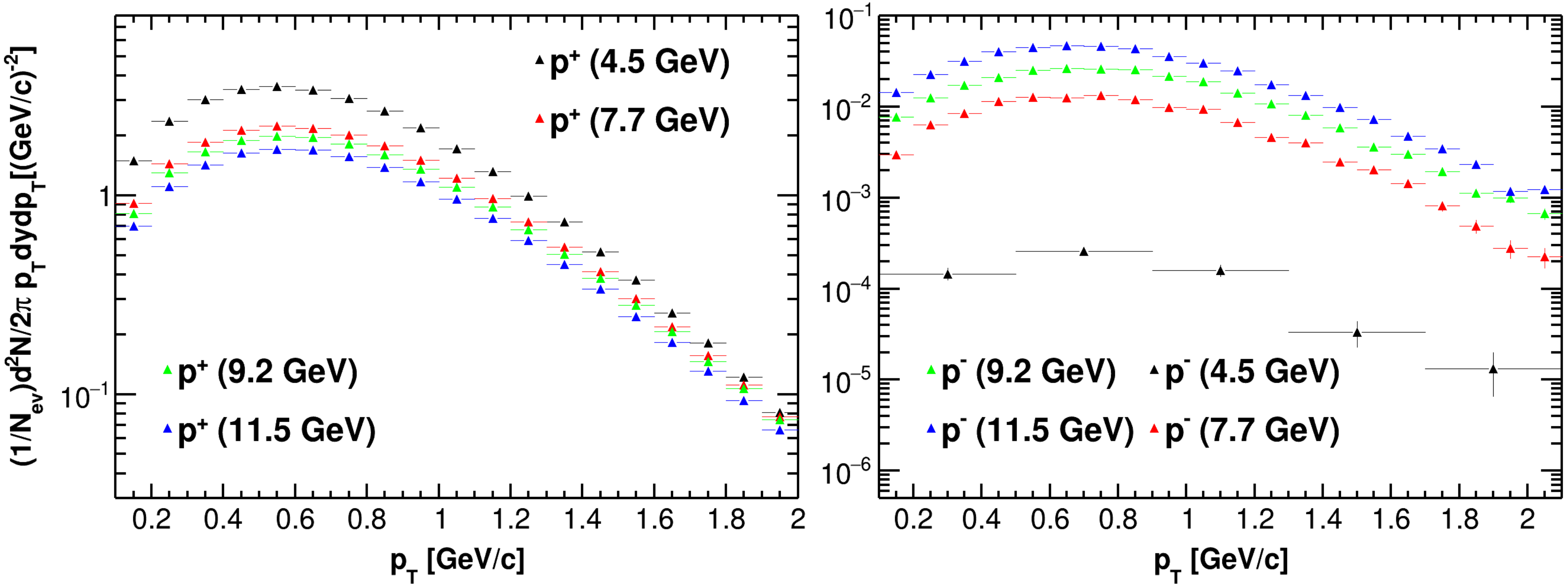
- Au+Au collisions |y|<0.5



Positive and negative pion distributions become more similar to each other as we increase the collision energy.

Transverse momentum distributions for $p^{\pm}$

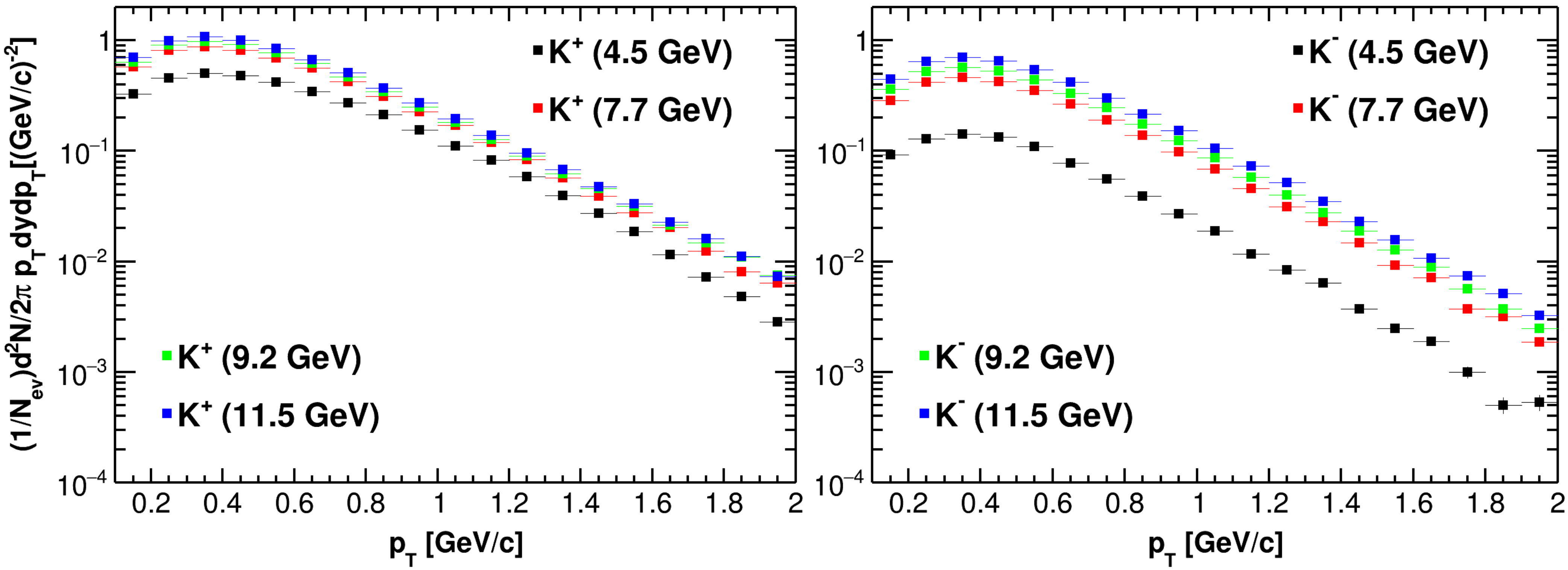
- Au+Au collisions |y|<0.5



Low energy collisions produce more protons.
Antiprotons are produced ~100 times less than protons.

Transverse momentum distributions for $K^{\pm}$

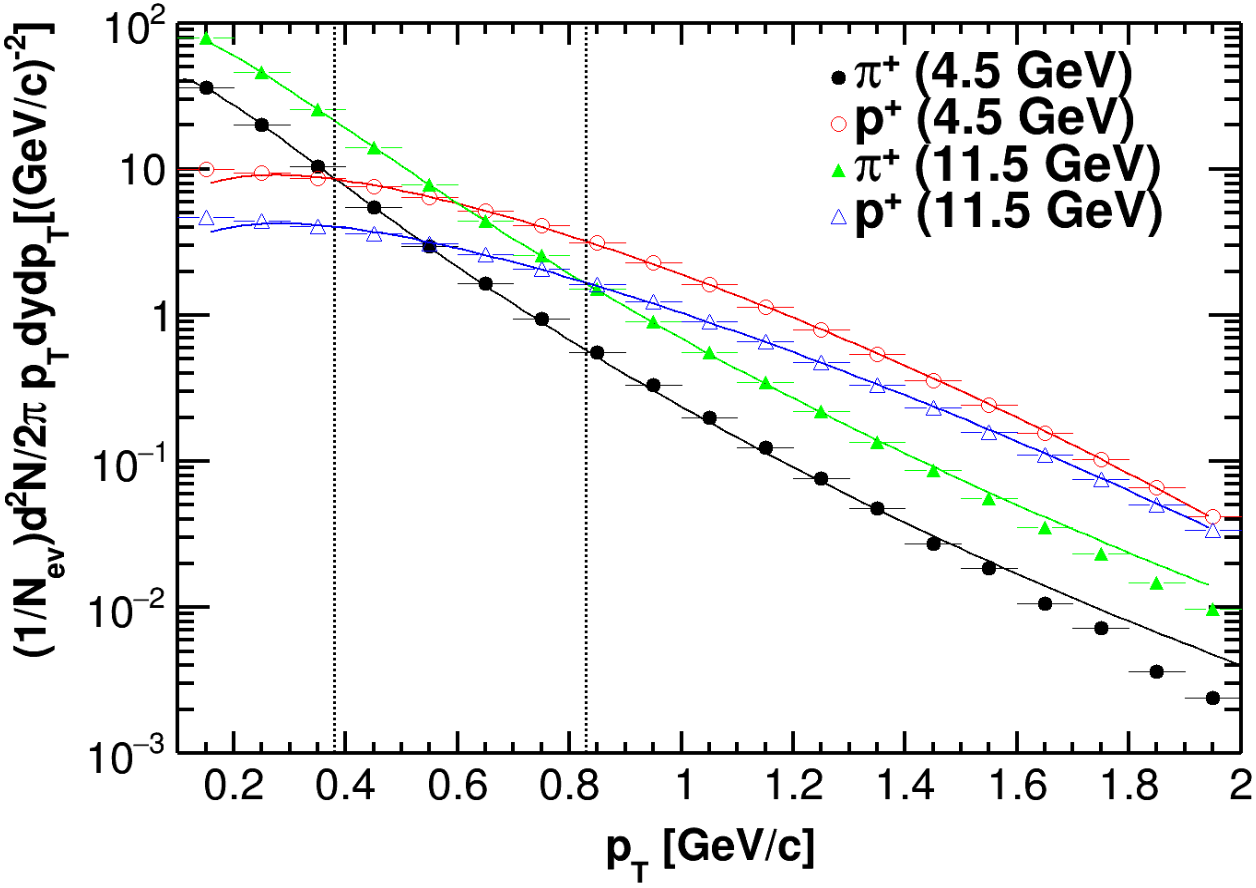
- Au+Au collisions |y|<0.5



Negative kaons are less abundantly produced than positive kaons, which means they are mostly produced by different mechanisms.

Crossing point

- Au+Au collisions |y|<0.5



Fit function

$$f(p_T) = a_1\left(1 + \frac{p_T}{a_2}\right)^{-a_0} p_T$$

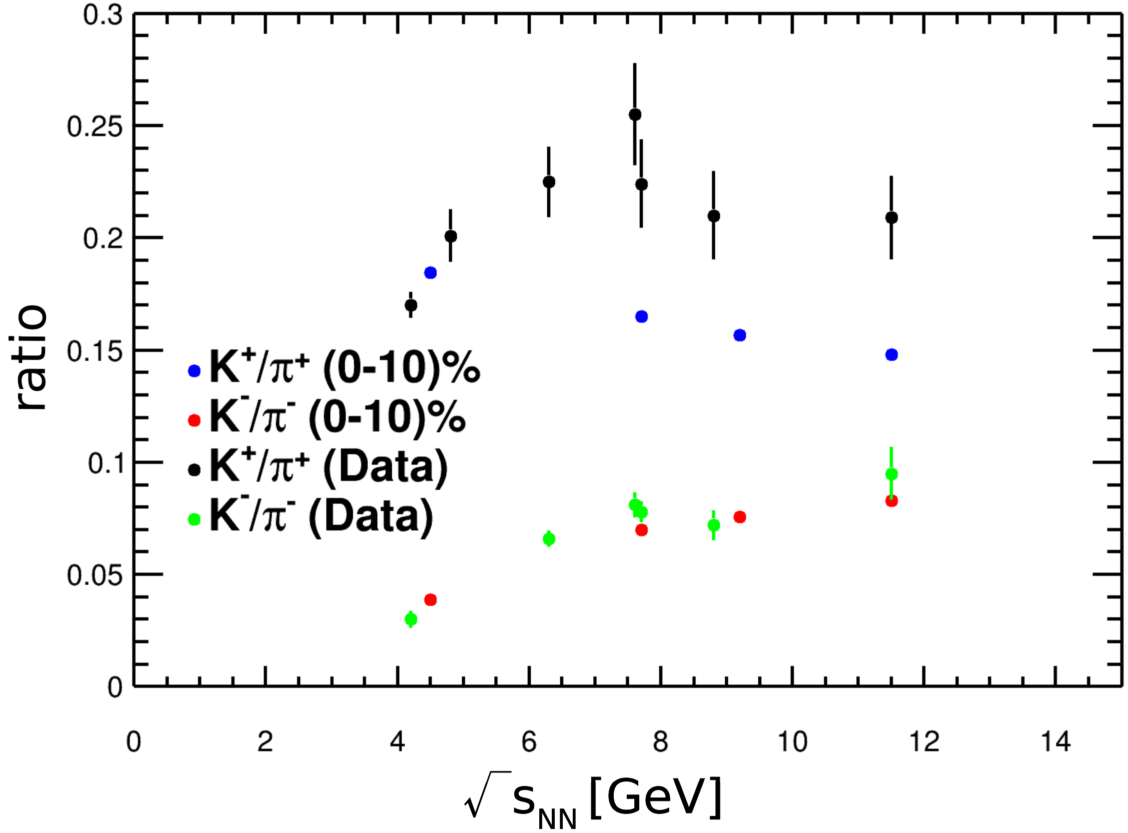
Fit parameters

$$a_0, a_1, a_2$$

Crossing occurs at ~0.38 GeV/c (4.5 GeV) and at ~0.83 GeV/c (11.5 GeV).

Particle ratios

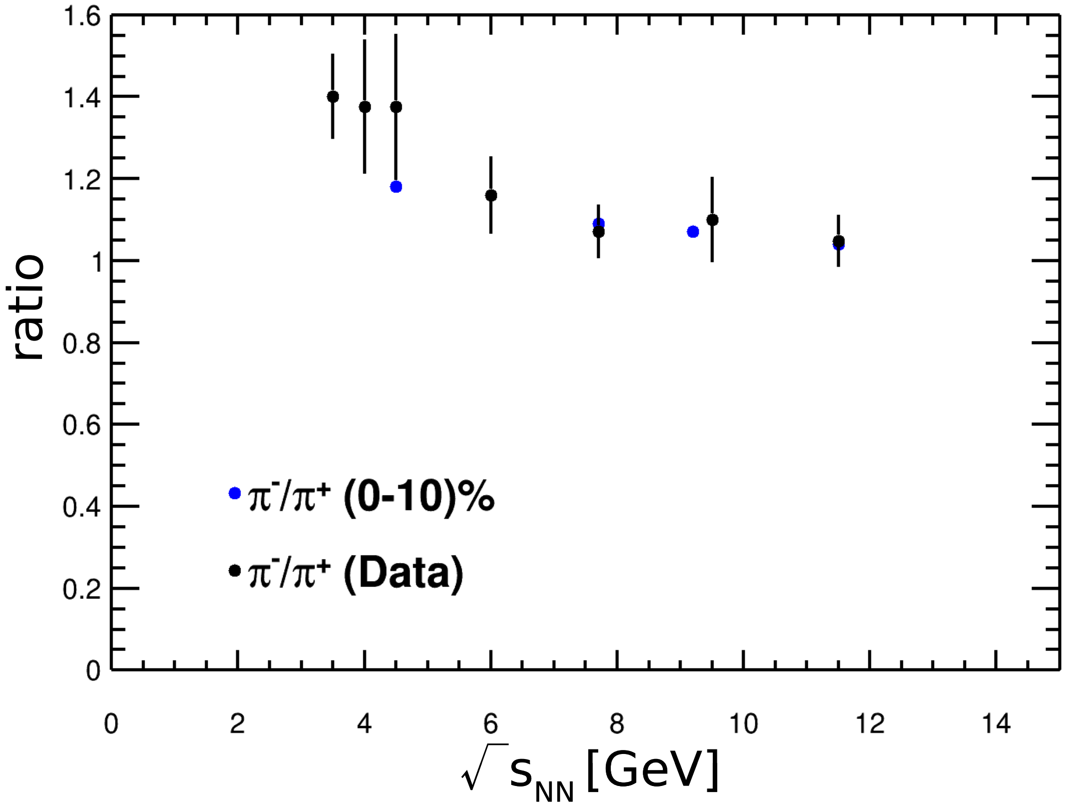
- Au+Au collisions |y|<0.5

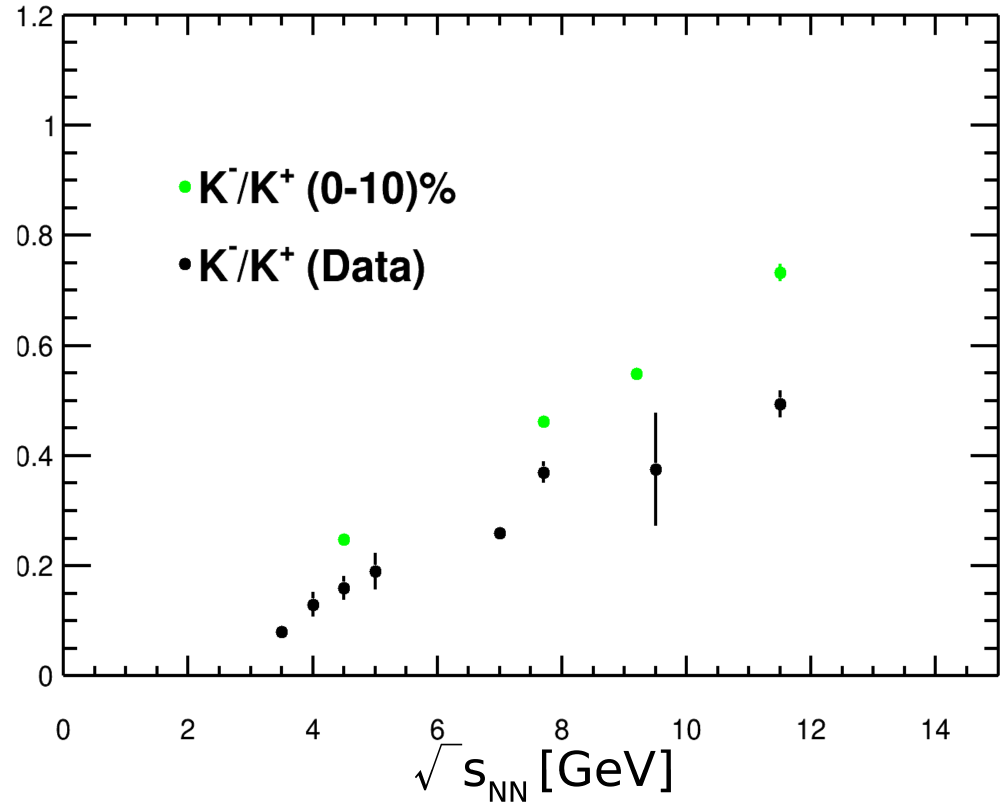


Data includes measurements from RHIC , SPS and AGS (0-5)%.
A horn structure appears in the K^+/π^+ ratio data, but not reproduced in the UrQMD model.

Particle ratios

- Au+Au collisions |y|<0.5

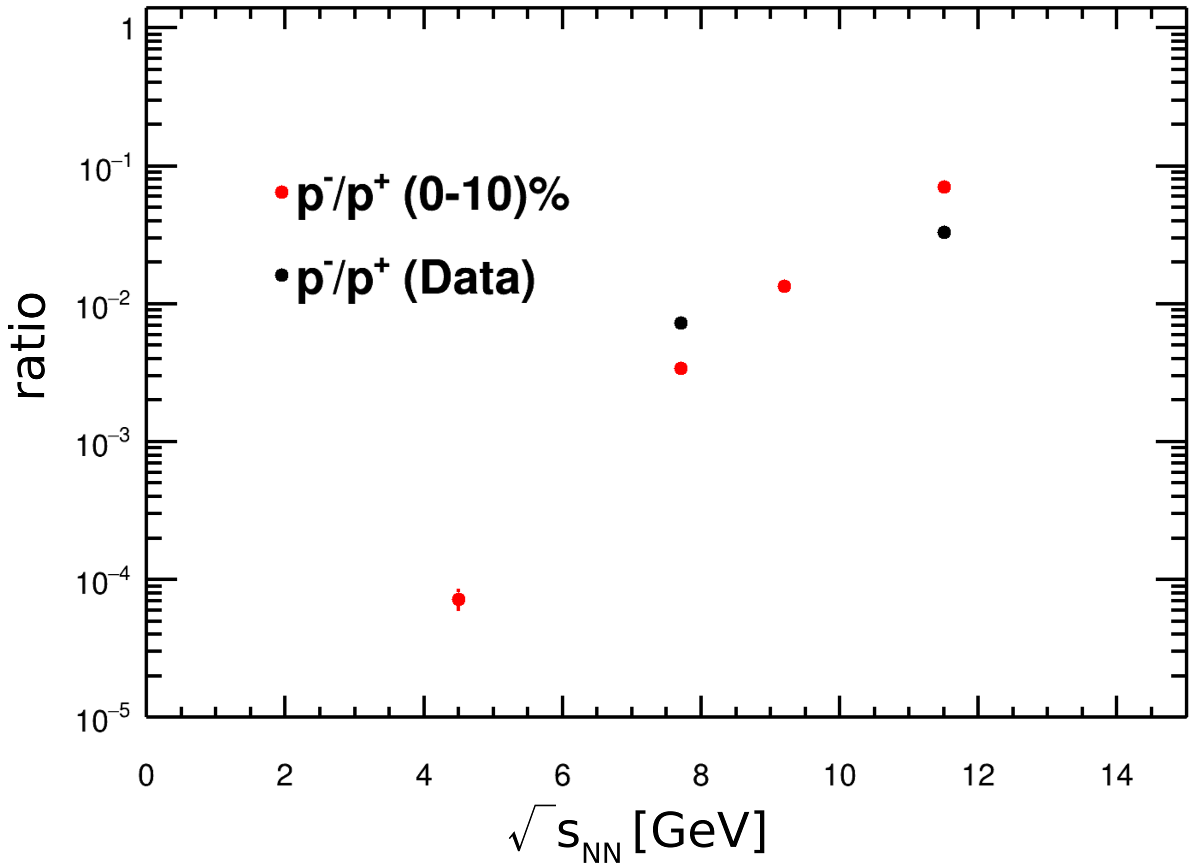




Data includes measurements from RHIC, SPS and AGS (0-5)%.
The model does not predict the kaon ratio, most likely due to the lack of positive kaons.

Particle ratios

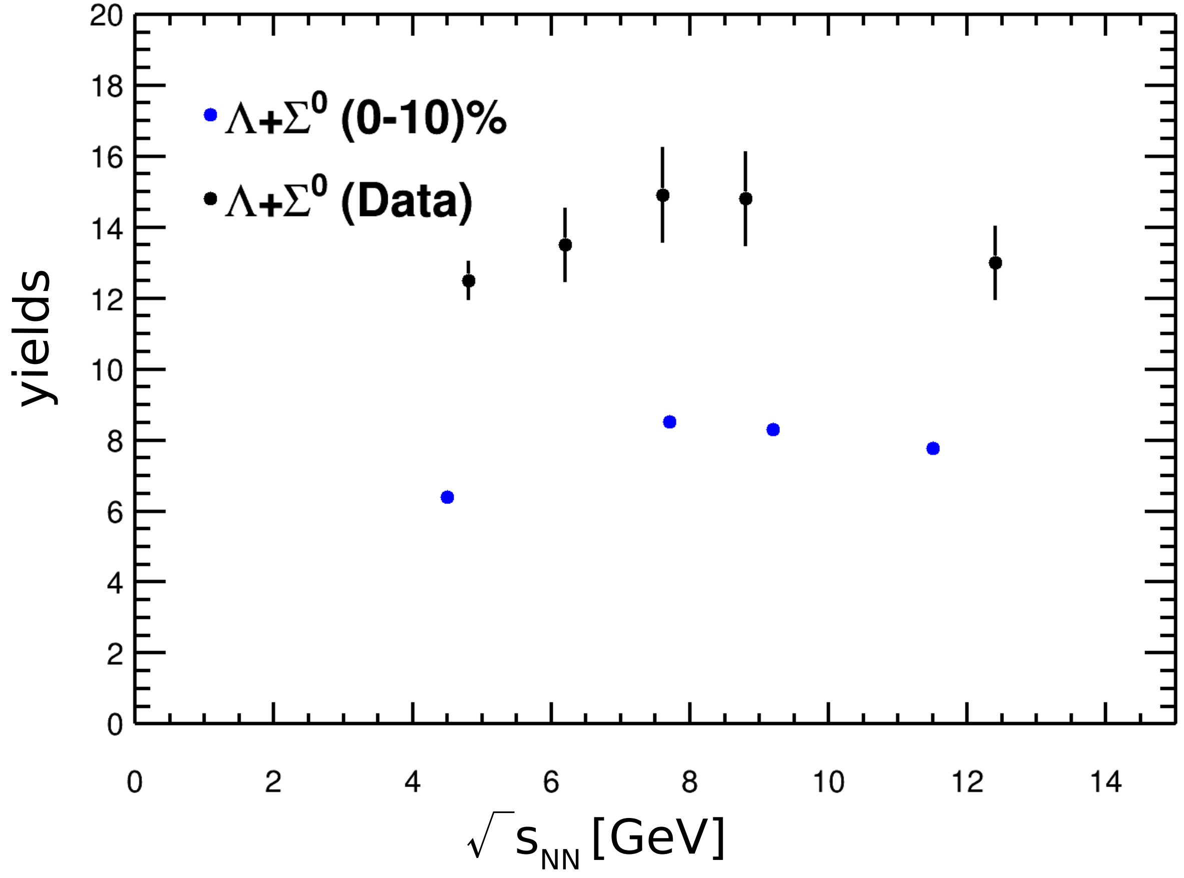
- Au+Au collisions |y|<0.5



Data shows measurements from STAR (0-5)%.

Particle yields

- Au+Au collisions |y|<0.5



Data includes measurements from AGS and SPS (0-5)%.
Strange baryons behave qualitatively similar to the data, with a maximum at 7.7 GeV, but there is a discrepancy by a factor of ~2.

Conclusions

We have presented an analysis of particle production, transverse momentum, antiparticle-particle ratios, $K^{\pm}/\pi^{\pm}$ with the UrQMD event generator.

- We studied the evolution of the transverse momentum of mesons and baryons, and the crossing point between them as a function of the collision energy.

- We studied the $K^{\pm}/\pi^{\pm}$ ratio as a function of the collision energy. In the K^{-}/π^{-} case, agreement with experimental data is observed, whereas the K^{+}/π^{+} ratio is not reproduced.

- A prediction is made for the p^{-}/p^{+} ratio at low energy (4.5 GeV).

Those results will be studied in experiments like the MPD-NICA.

Analysis under development: We could extract the freeze-out parameters; further studies for the production mechanisms of strange hadrons...

Thank you for your attention.
Special thanks to E. Cuautle, W. Bietenholz, A. Ayala, R. García