LXXI International conference "NUCLEUS – 2021.
Nuclear physics and elementary particle physics.
Nuclear physics technologies"

Production of K*(892)^0 mesons in small collision systems at PHENIX experiment

Vladislav Borisov
For PHENIX collaboration

Co-Authors: *Yaroslav Berdnikov, Alexander Berdnikov, Dmitry Kotov, Iurii Mitrankov*

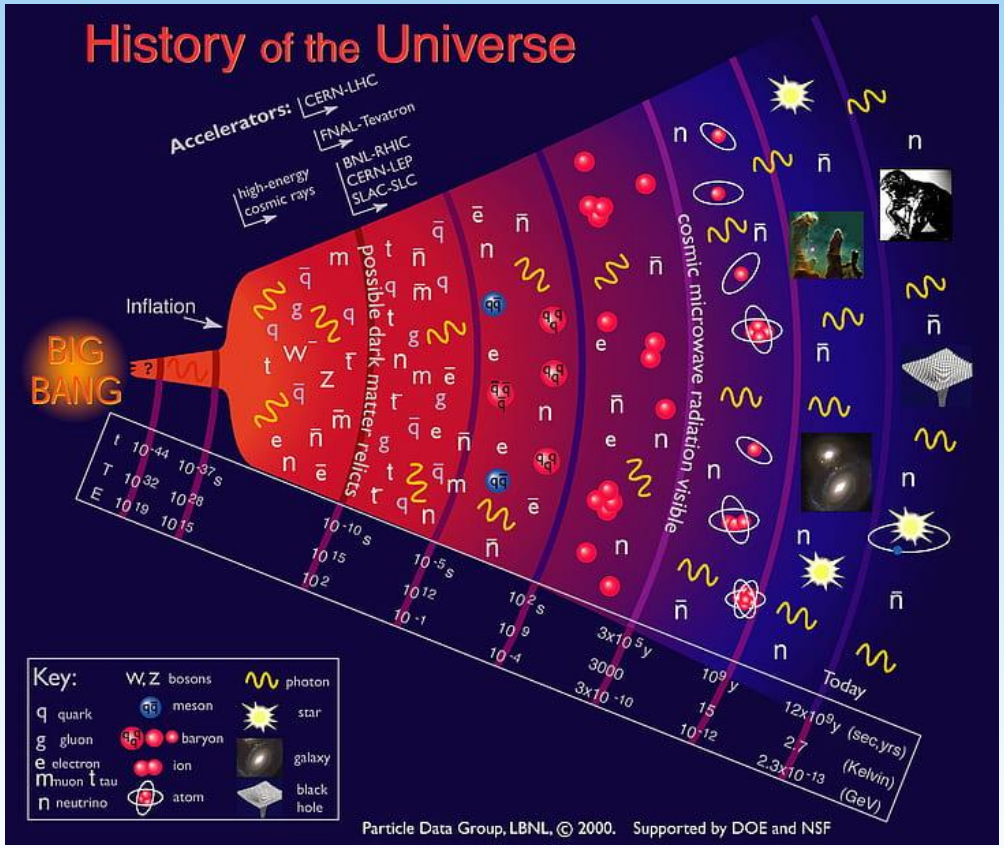
We acknowledge support from Russian Ministry of Education and Science, state assignment for fundamental research (code FSEG-2020-0024) in the φ meson part of the analysis.

Motivation

Big Bang → QGP formation

↓

Hadronic phase

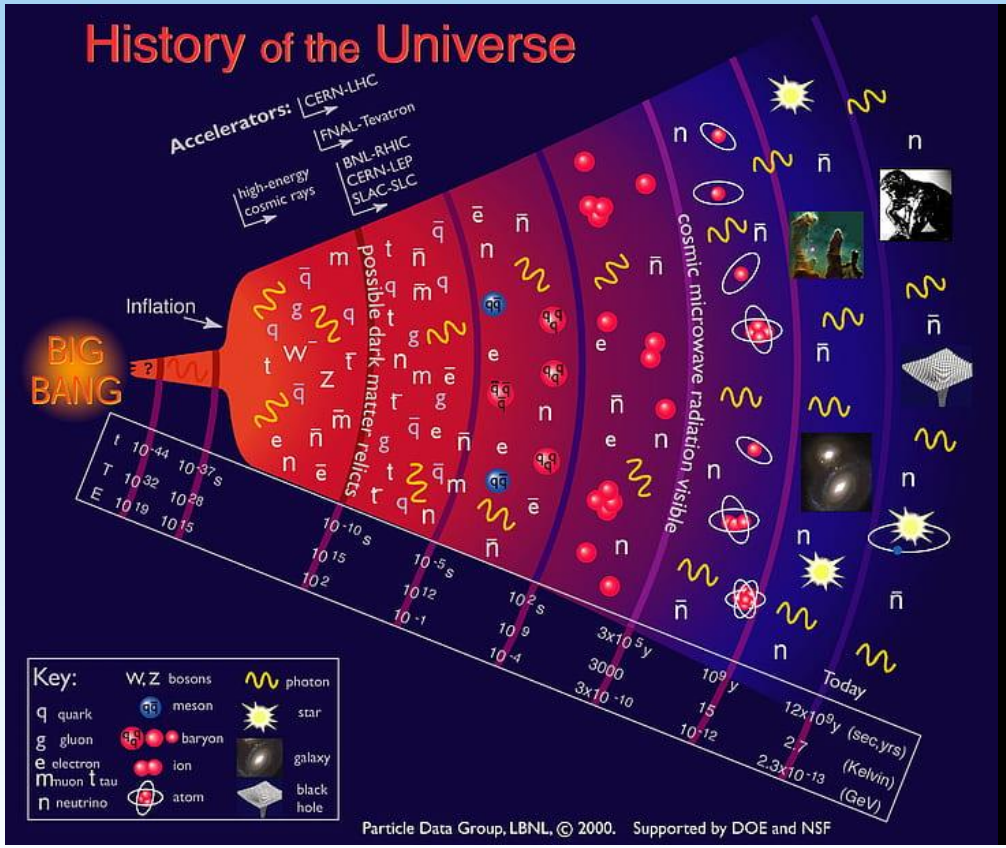


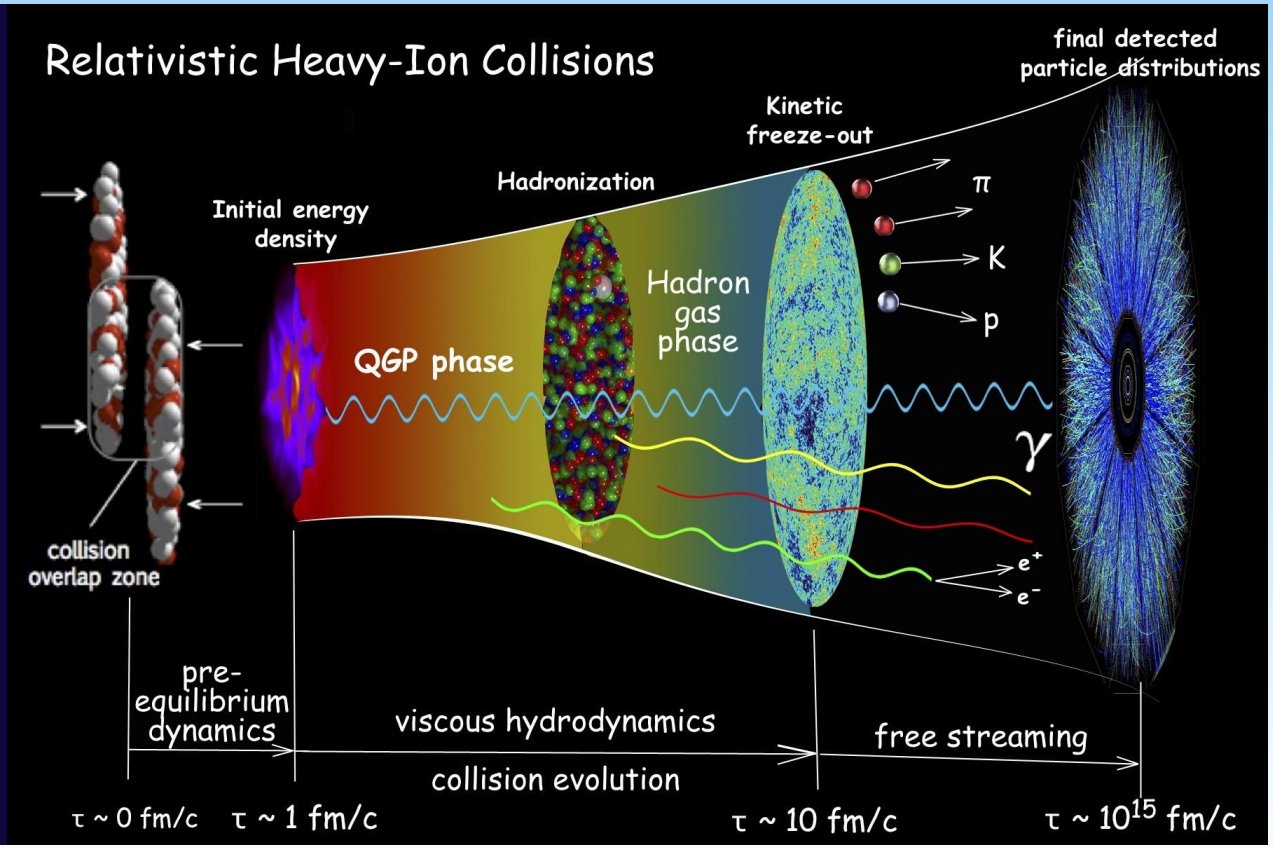
Motivation

Big Bang → QGP formation ← Relativistic Ion collisions

↓

Hadronic phase



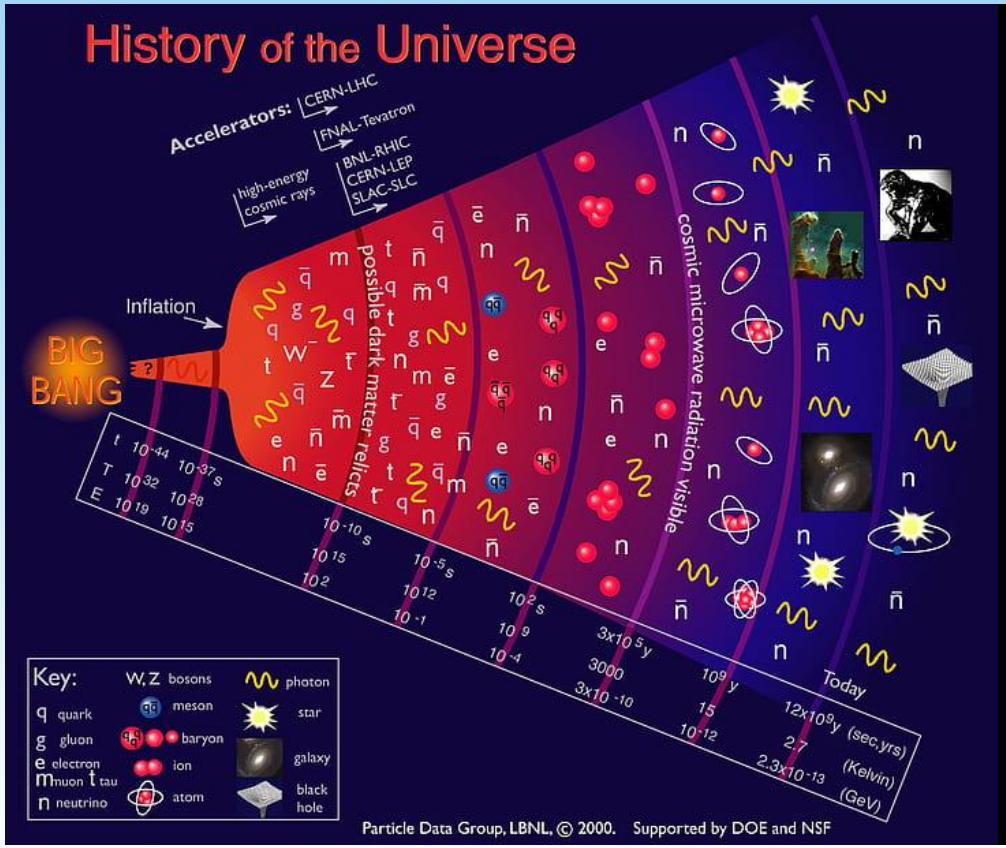


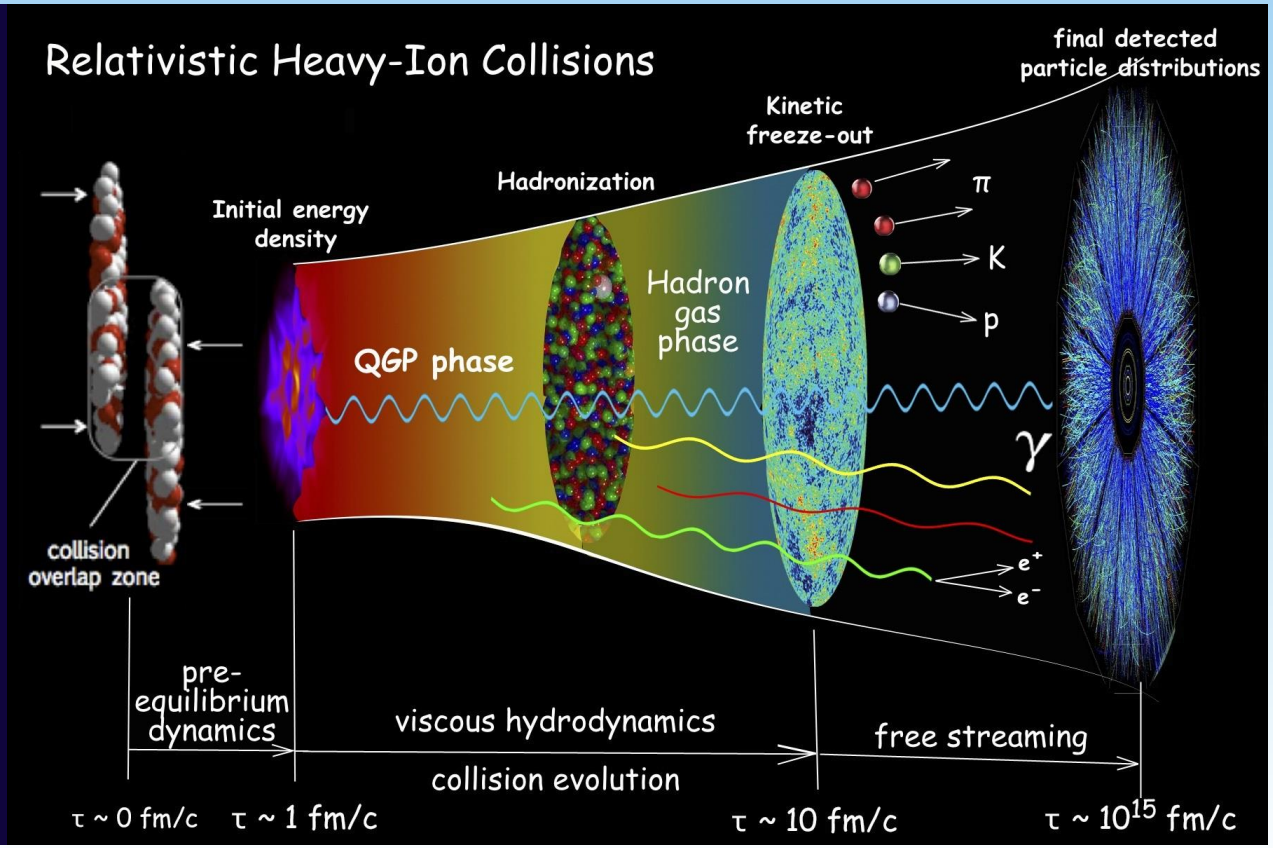
Motivation

Big Bang → QGP formation ← Relativistic Ion collisions

↓ ↓

Hadronic phase → Study of hadron production





Motivation

K^{*0} vs φ meson

About φ-meson

- $\tau_{QGP} < \tau_{\varphi}$ (46.3 fm/c)

Clean probe to investigate the properties of QGP

Motivation

K^{*0} vs φ meson

About φ-meson

- $\tau_{QGP} < \tau_{\varphi}$ (46.3 fm/c)

Clean probe to investigate the properties of QGP

- $\tau_{K^{*0}}$ (4.16 fm/c)

re-scattering of the decay products

Motivation

K^{*0} vs φ meson

About φ-meson

- $\tau_{QGP} < \tau_{\varphi}$ (46.3 fm/c)

Clean probe to investigate the properties of QGP

- $\tau_{K^{*0}}$ (4.16 fm/c)

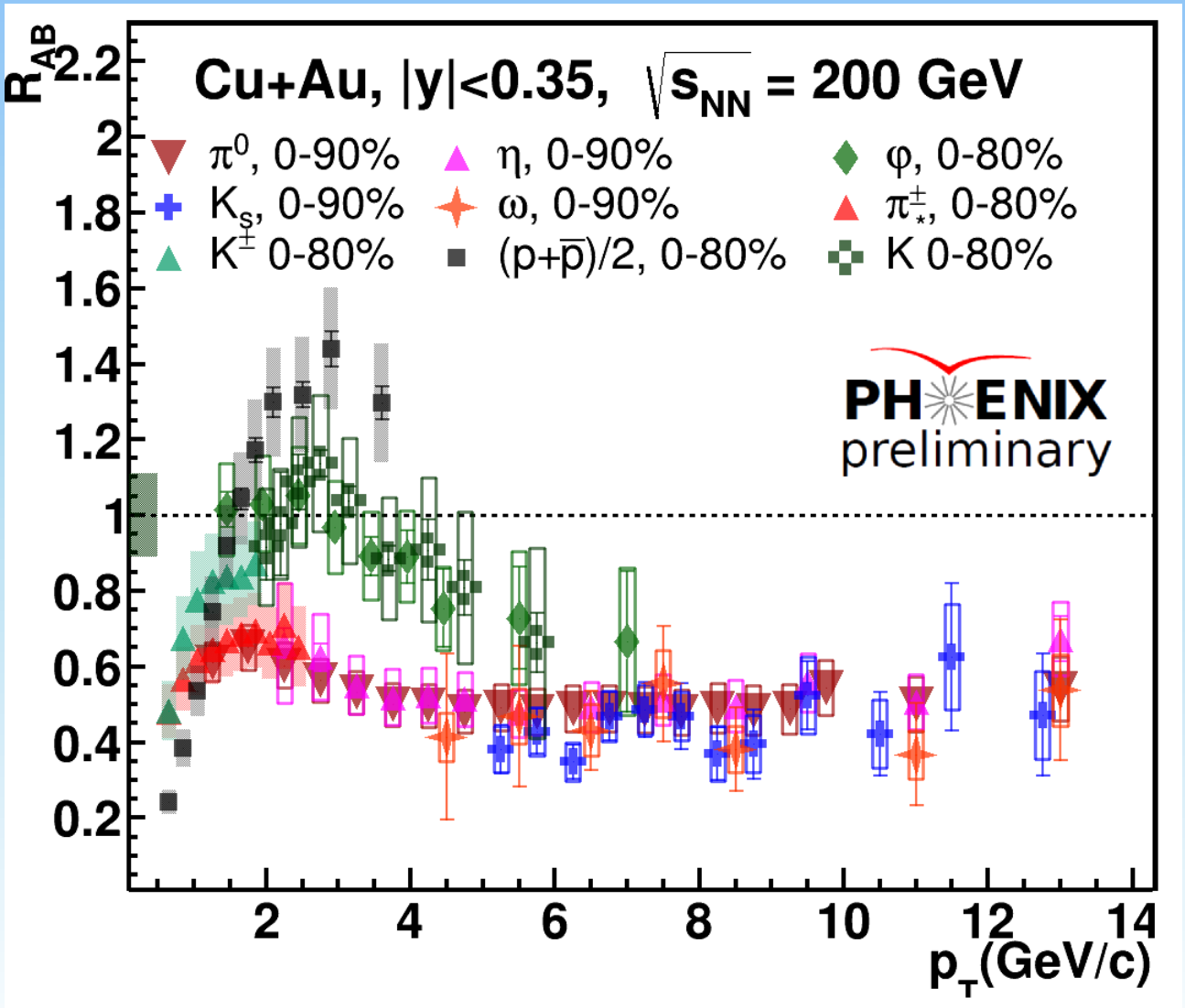
re-scattering of the decay products

- K^{*0} $(d\bar{s})$
- Measurable up to high-p_T

Signatures of QGP:
Strangeness enhancement
Jet quenching

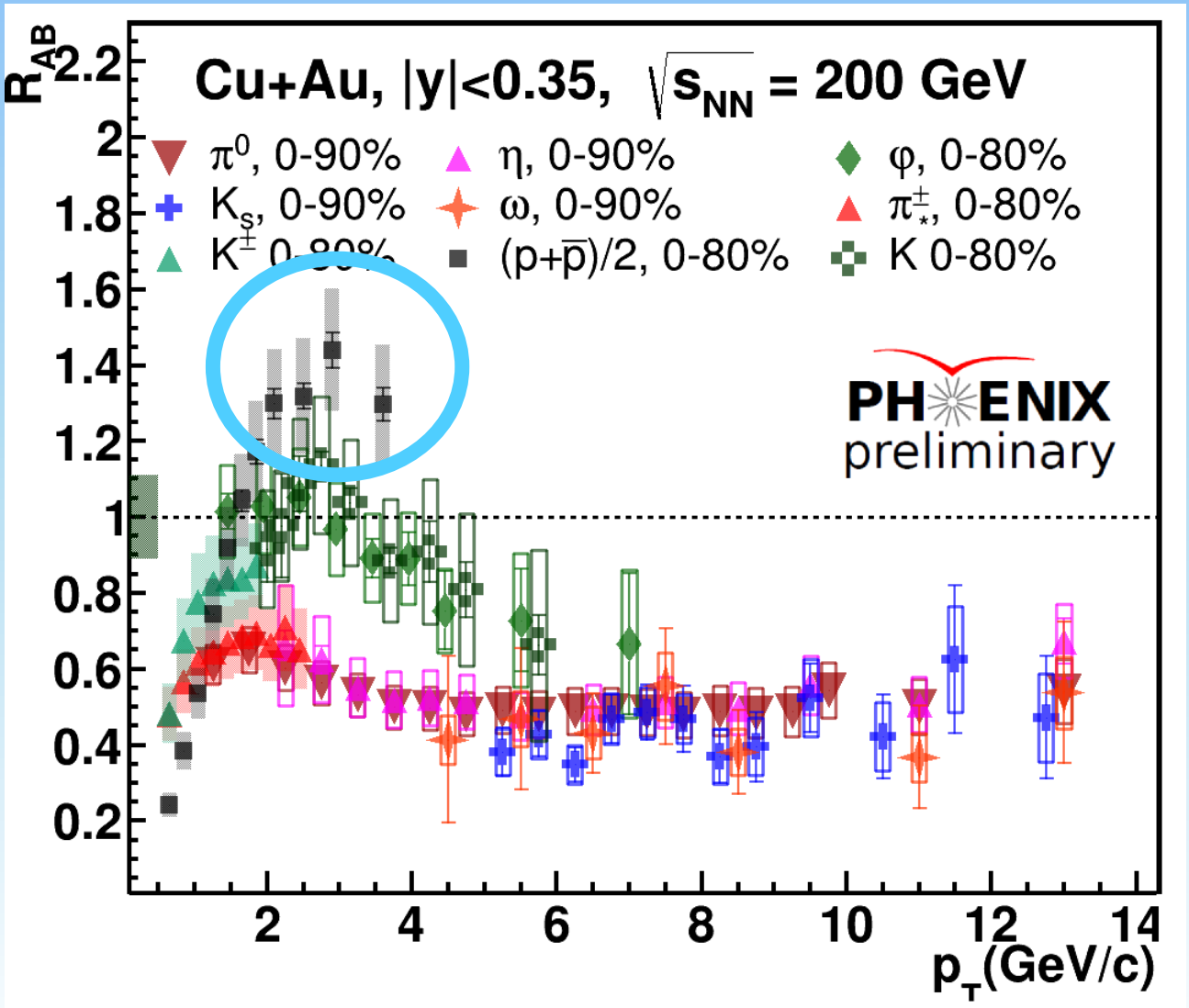
Motivation

Heavy Ion collisions



Motivation

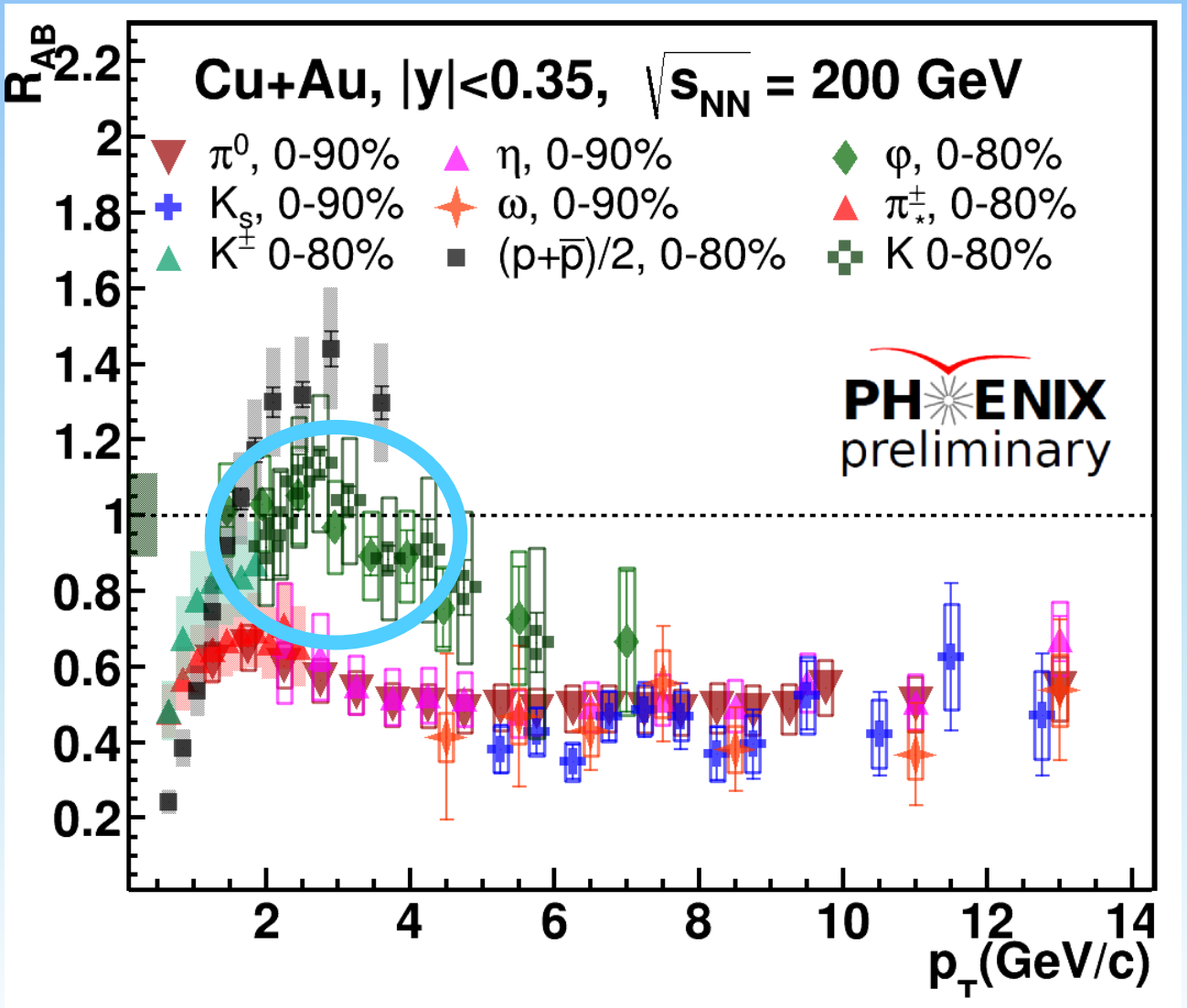
Heavy Ion collisions



Baryon enhancement

Motivation

Heavy Ion collisions

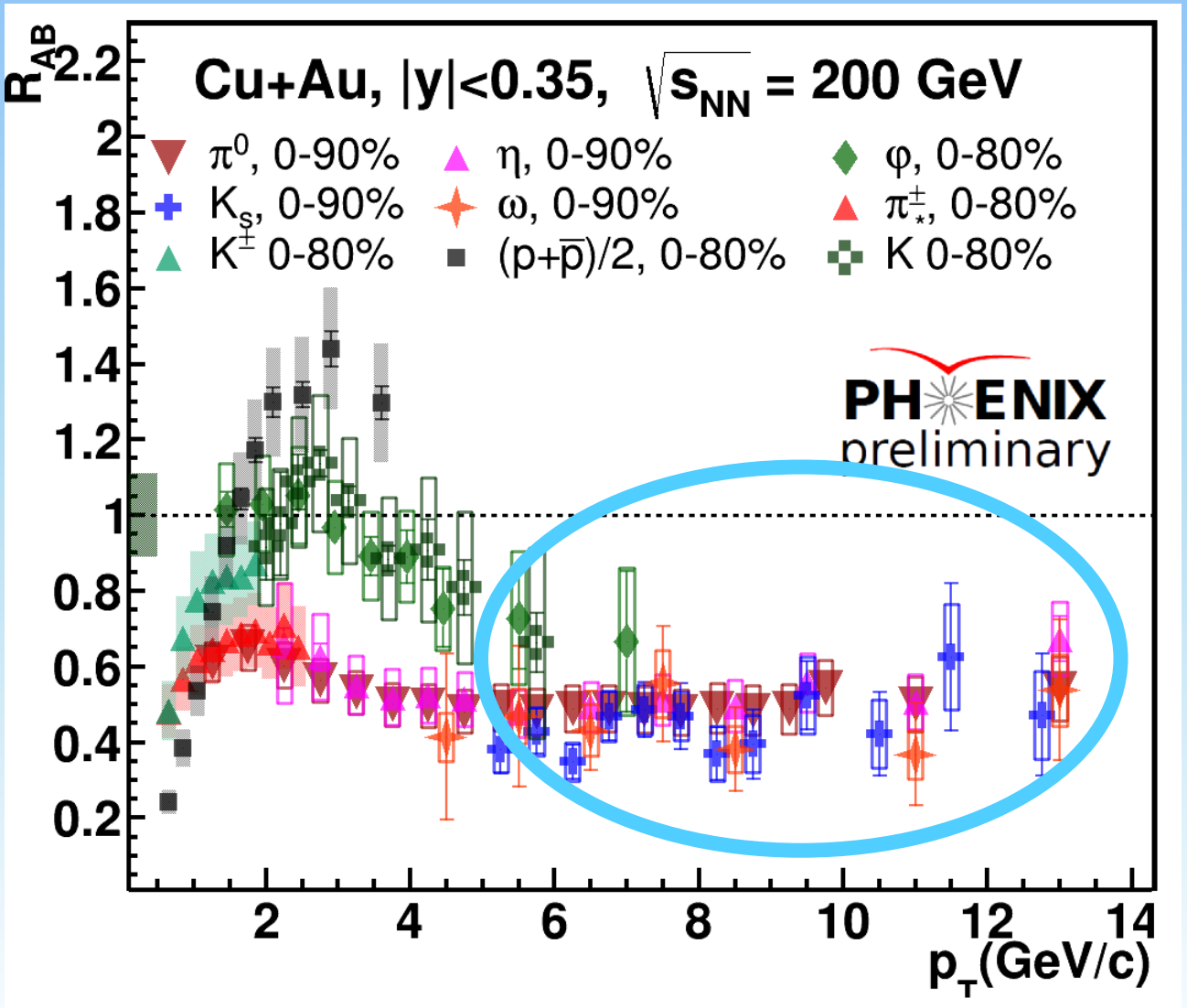


Baryon enhancement

Strangeness enhancement

Motivation

Heavy Ion collisions



Baryon enhancement

Strangeness enhancement

High-p_T suppression

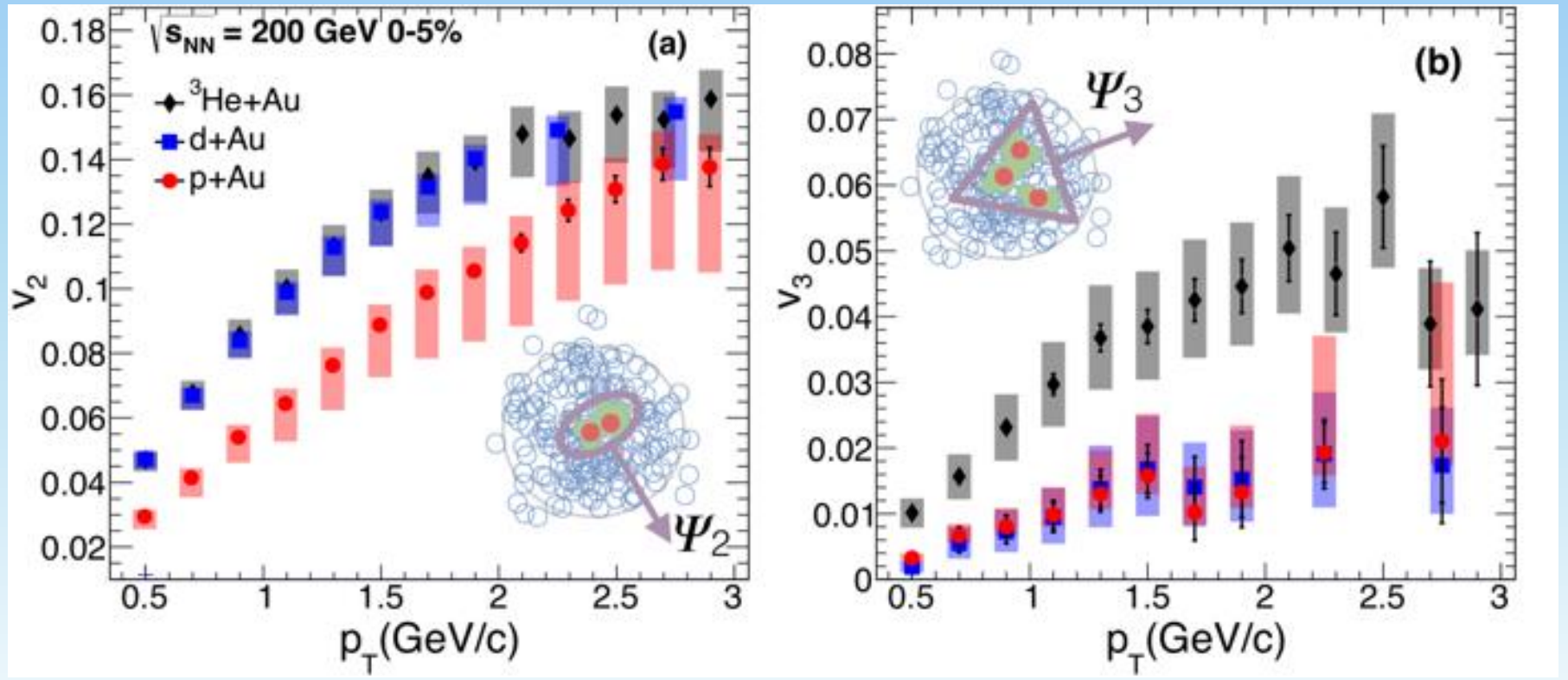
Motivation

Small systems

Flow measurements → evidence for QGP droplets in small systems

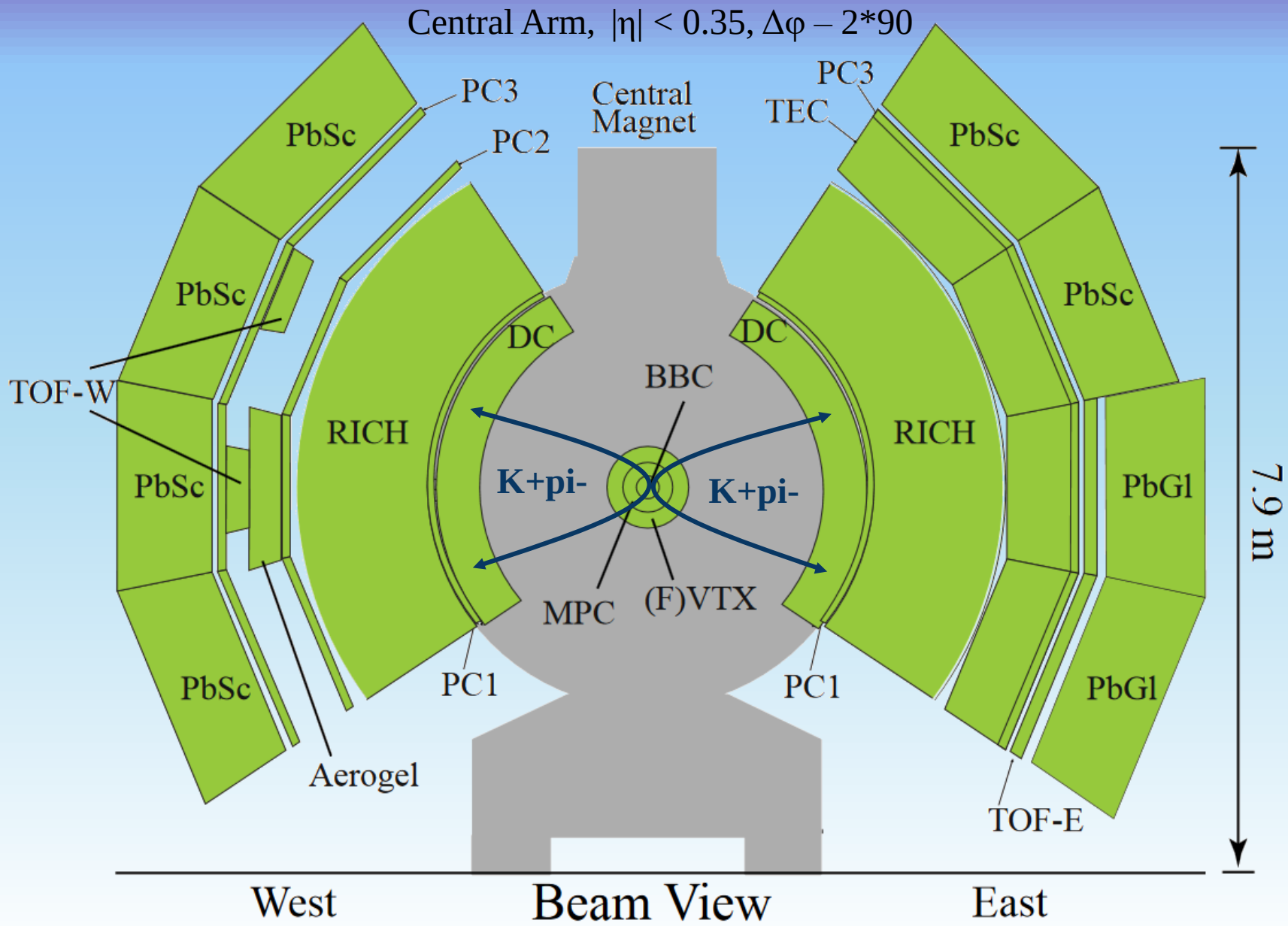
Energy loss in the plasma?

If so, it would present itself in the hadrons spectra

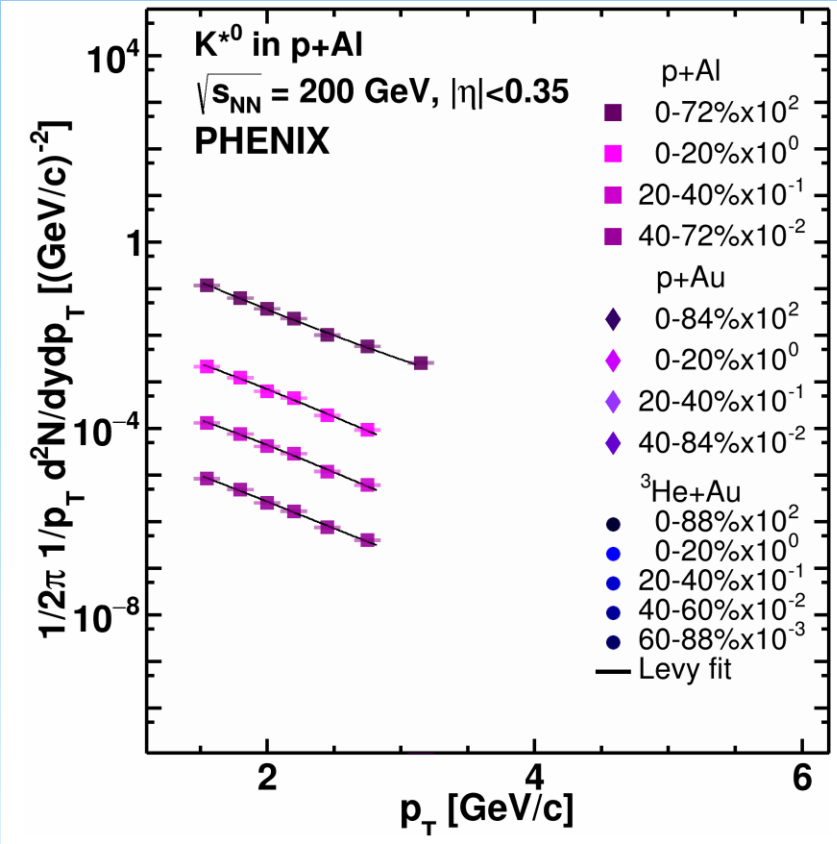


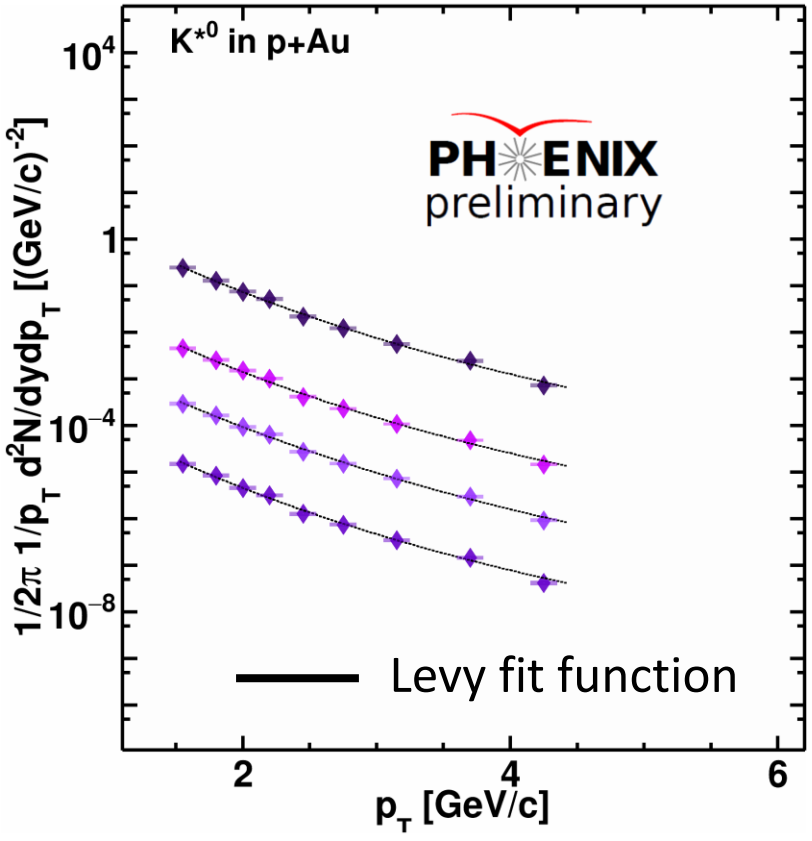
Nat. Phys. 15, p. 214–220

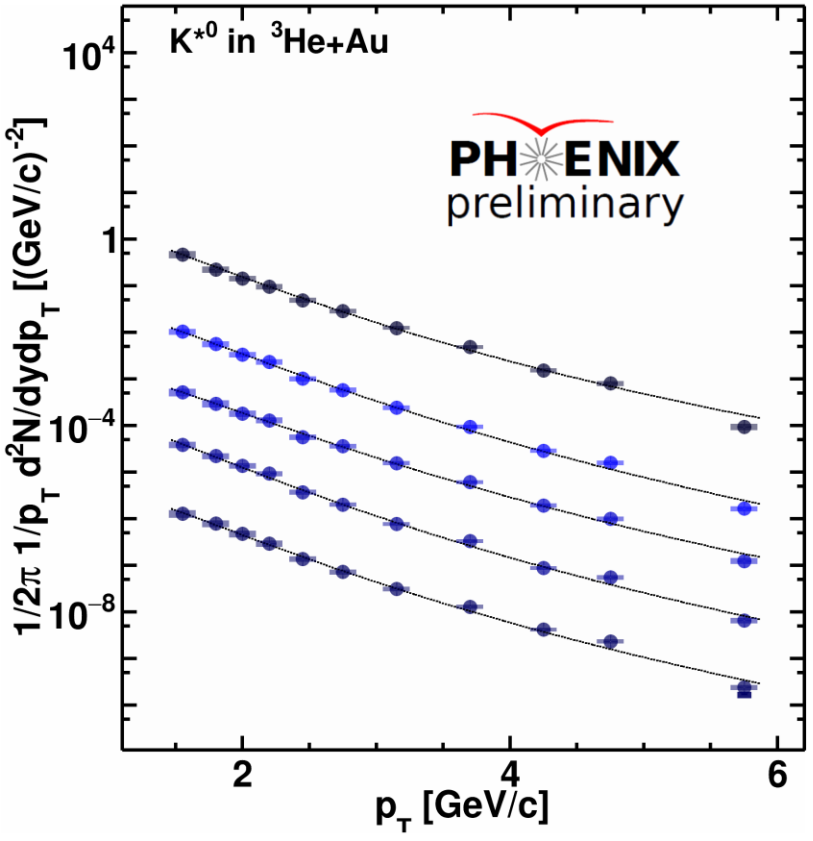
The PHENIX experiment



Invariant yields







Nuclear modification factors

Nuclear modification factors of nuclei collisions are used to study collective effects, affecting the spectra

$$R_{AB} = \frac{\sigma_{pp}^{inel}}{\langle N_{coll} \rangle} \cdot \frac{d^2 N_{AB}/dydp_T}{d^2\sigma_{pp}/dydp_T}$$

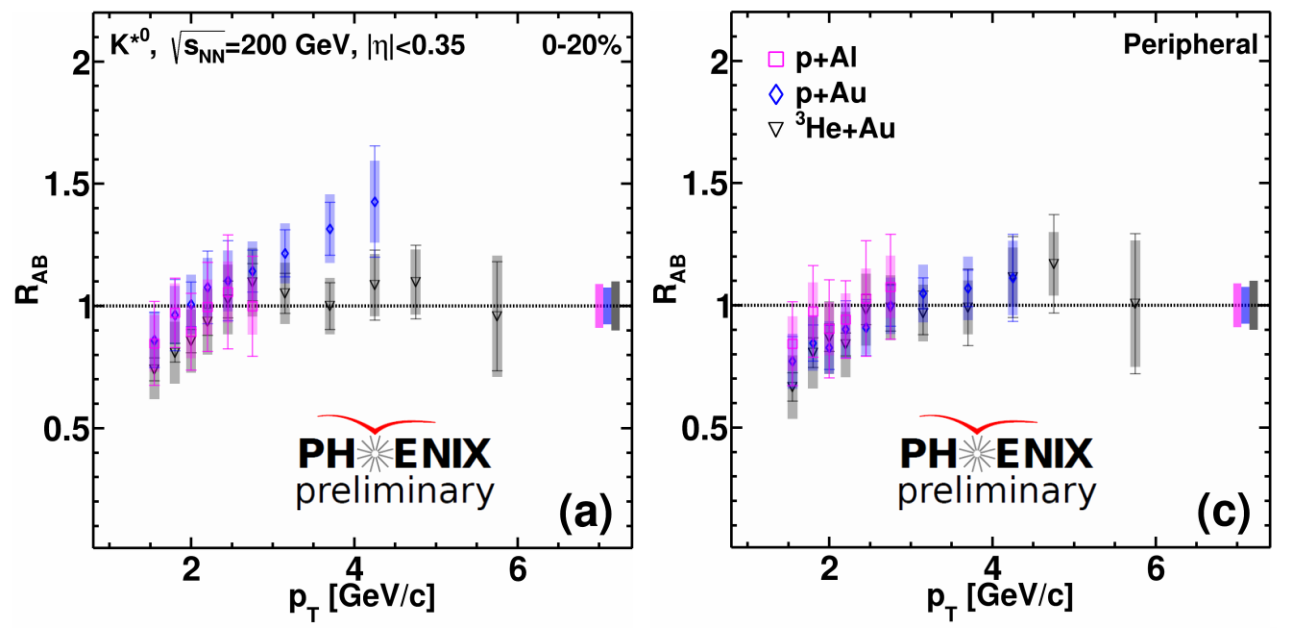
$d^2 N_{AB}/dydp_T$ – per-event yield of particle production in A+B collision

$d^2\sigma_{pp}/dydp_T$ – the production cross section in p+p collision

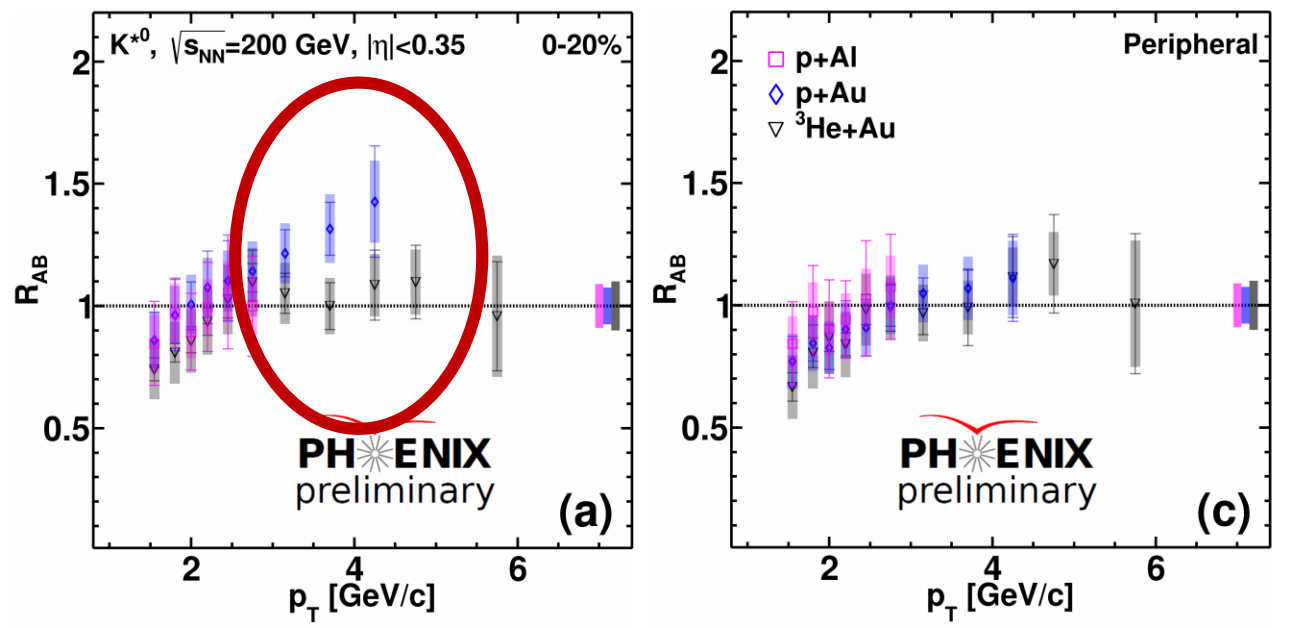
$\langle N_{coll} \rangle$ – number of nucleon-nucleon collisions in A+B system for selected centrality interval

$\sigma_{pp}^{inel} = 42.2$ mb – total inelastic proton-proton cross section

K^{*0} R_{AB} in p+Al, p+Au, ^{3}He+Au



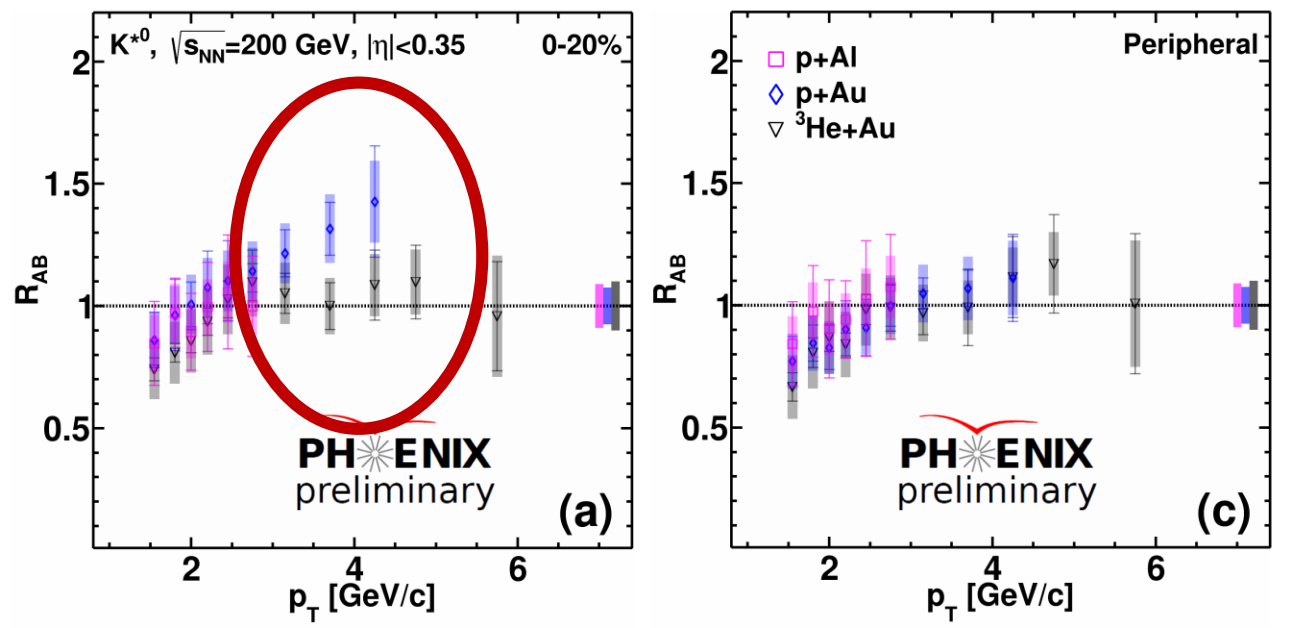
K^{*0} R_{AB} in p+Al, p+Au, ^{3}He+Au



AT INTERMEDIATE p_T RANGE:

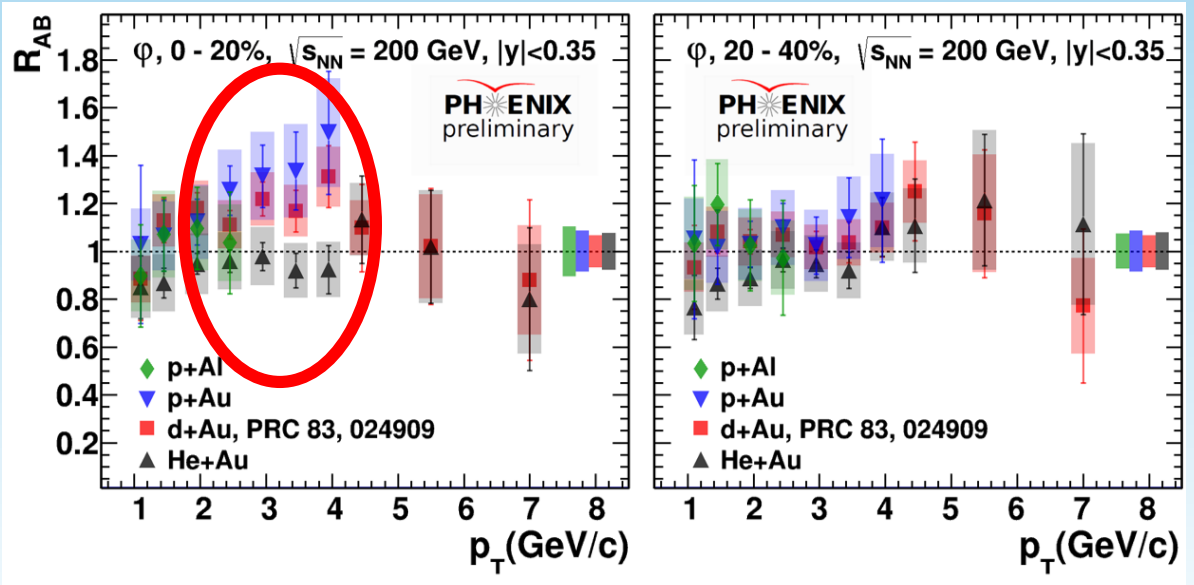
- $R_{pAu} \gtrsim R_{HeAu}$ in 0-20%

K^{*0} R_{AB} in p+Al, p+Au, ^{3}He+Au

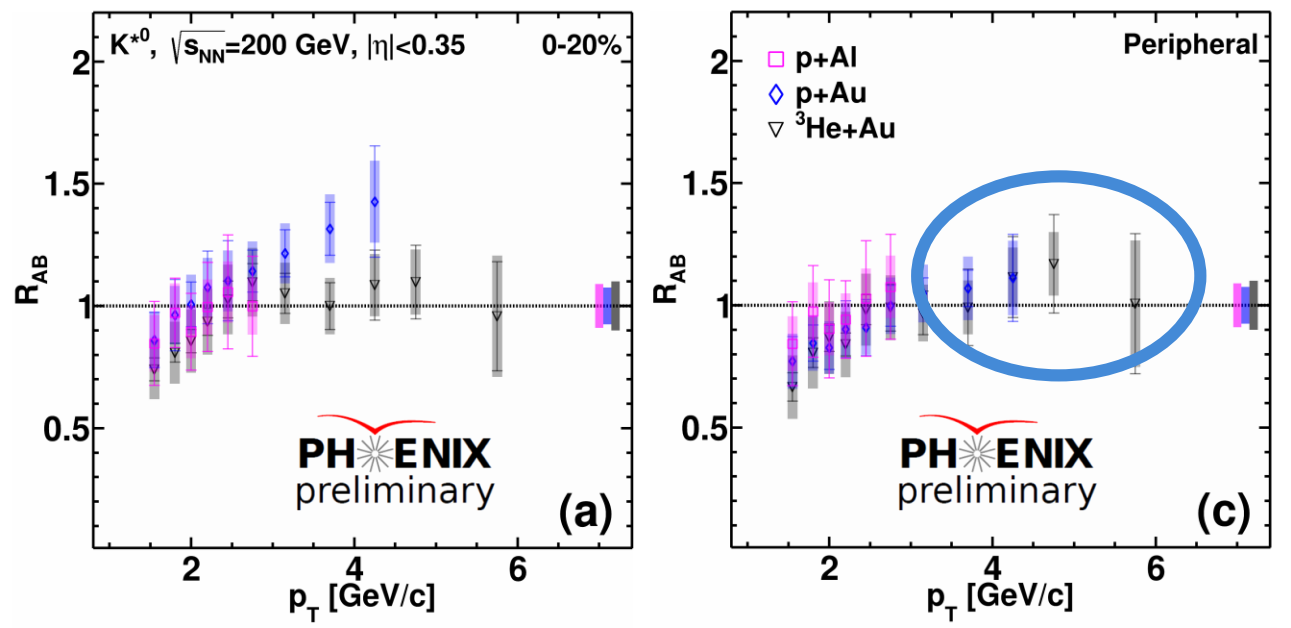


AT INTERMEDIATE p_T RANGE:

- $R_{pAu} \gtrsim R_{HeAu}$ in 0-20%



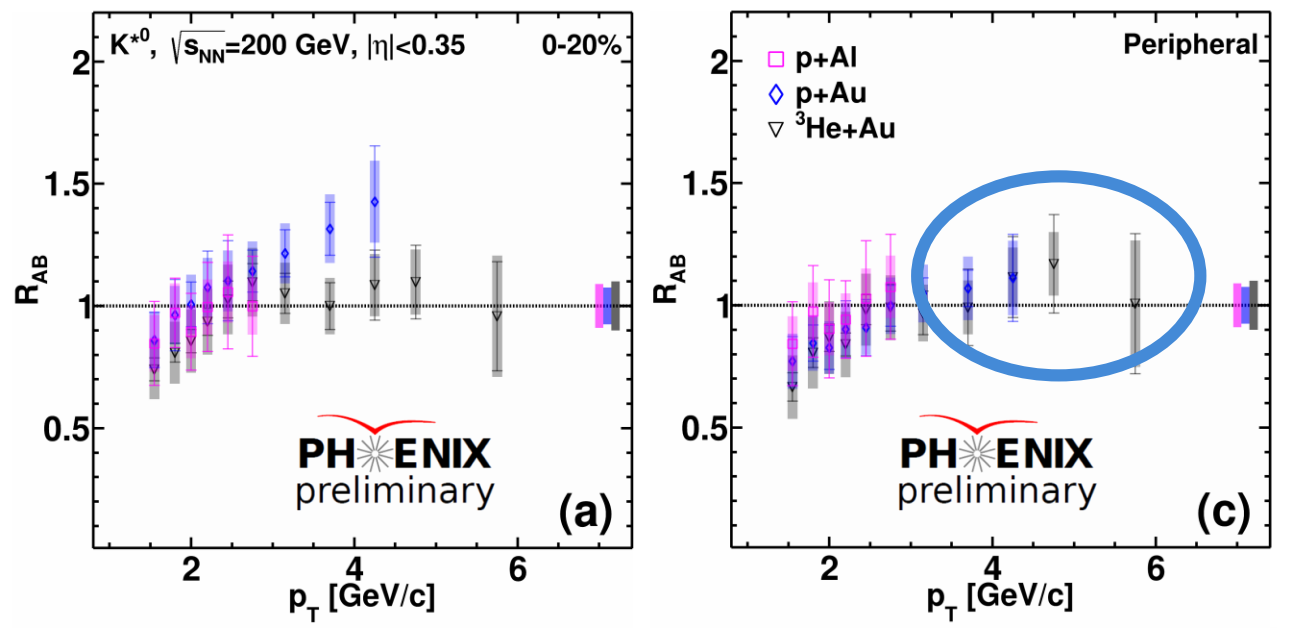
K^{*0} R_{AB} in p+Al, p+Au, ^{3}He+Au



AT INTERMEDIATE p_T RANGE:

- $R_{pAu} \gtrsim R_{HeAu}$ in 0-20%
- K^{*0} $R_{pAu} \approx R_{HeAu}$ in peripheral collisions

K^{*0} R_{AB} in p+Al, p+Au, ^{3}He+Au



AT INTERMEDIATE p_T RANGE:

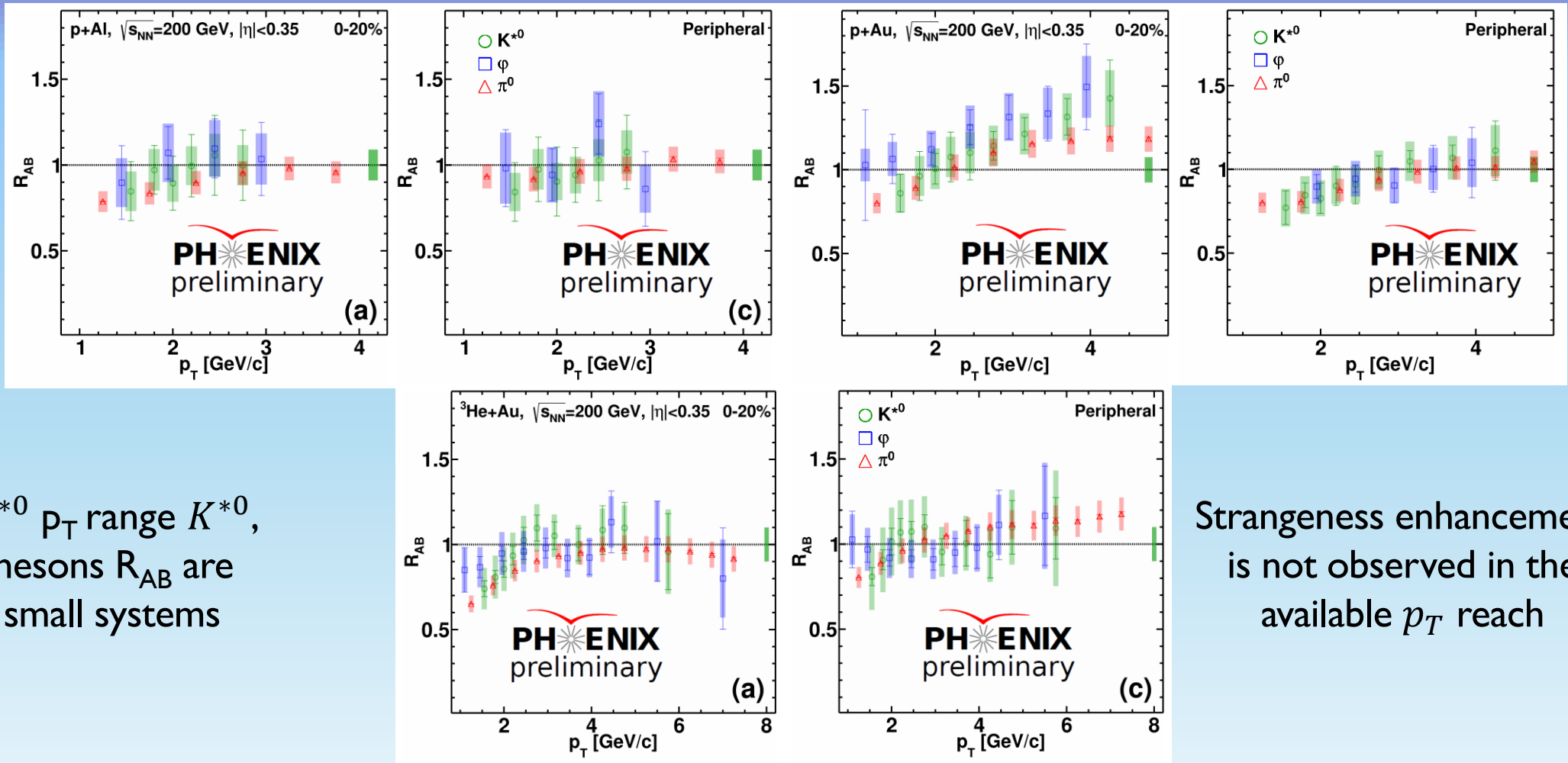
- $R_{pAu} \gtrsim R_{HeAu}$ in 0-20%
- K^{*0} $R_{pAu} \approx R_{HeAu}$ in peripheral collisions

AT HIGH-p_T RANGE:

- K^{*0} R_{AB} in small systems consistent with each other at high-p_T

Jet quenching is not observed in the available p_T reach

K^{*0}, φ & π^0 R_{AB} in p+Al, p+Au, ^{3}He+Au

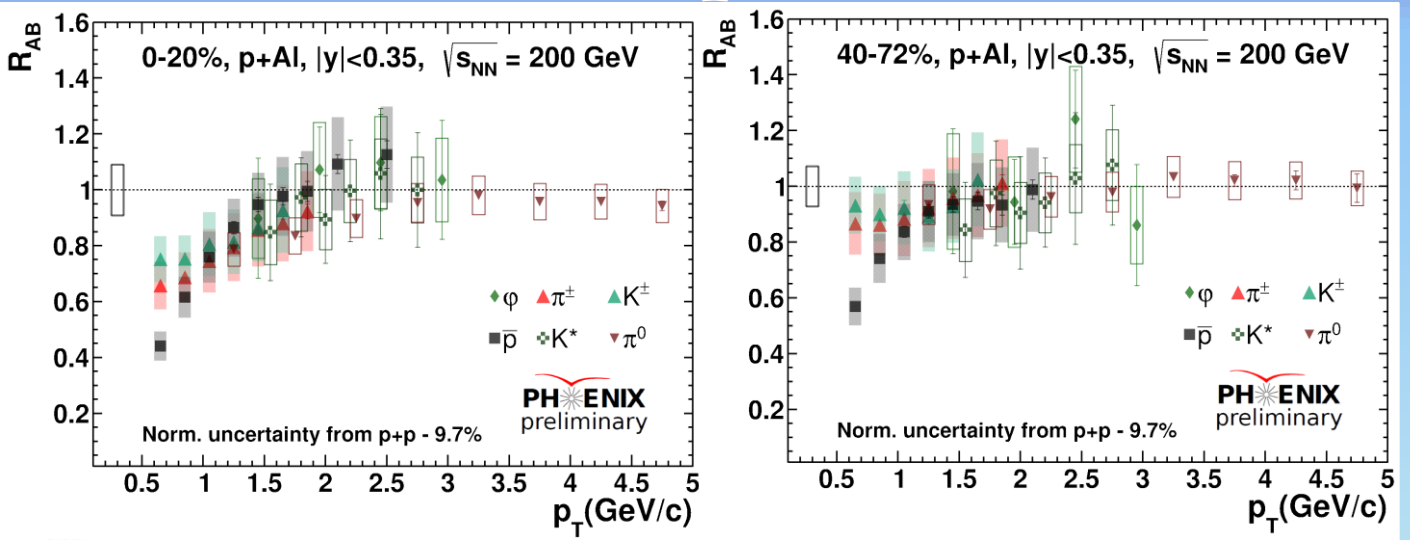


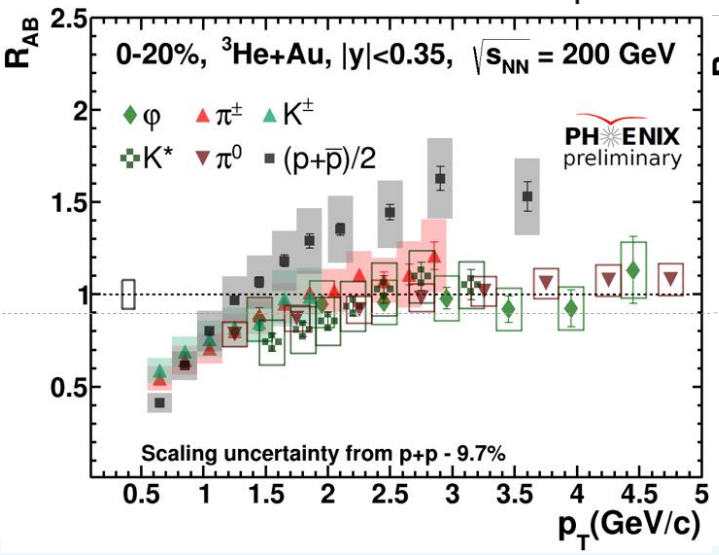
In whole K^{*0} p_T range K^{*0}, φ and π^0 mesons R_{AB} are similar in small systems

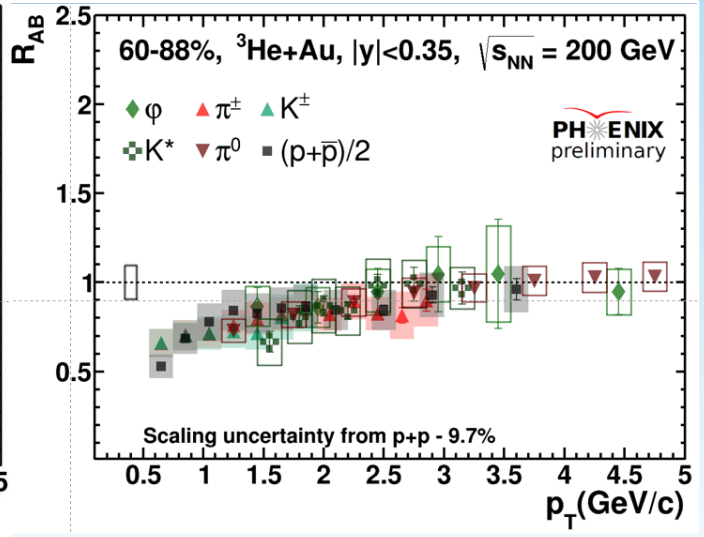
Strangeness enhancement is not observed in the available p_T reach

Might indicate that CNM effects seem to be not responsible for the differences between K^{*0}, φ and π^0 seen in A+A

Comparisons to other light hadron's R_{AB} in p+Al and He+Au collisions







Light mesons R_{AB} exhibit similar shape in contrast to heavy-ion

Protons R_{AB} shows enhancement at moderate p_T as in heavy-ion

Qualitatively consistent with the recombination model.

Summary

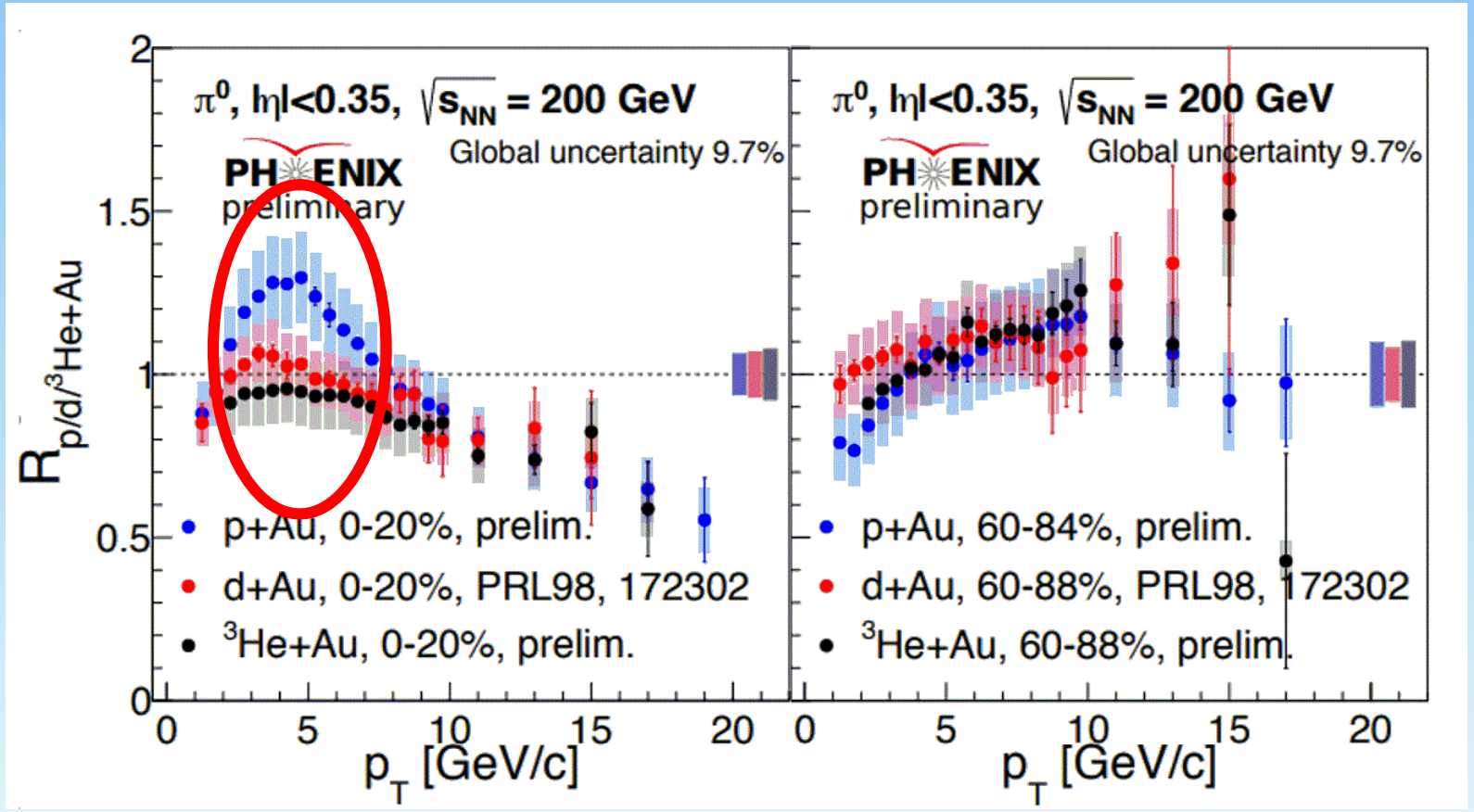
- $R_{pAu} \gtrsim R_{HeAu}$ in 0-20% at intermediate p_T range
- In other centralities in all p_T ranges K^{*0} meson nuclear modification factors for all light systems exhibit similar shape and equal to unity within uncertainties
  - Jet quenching is not observed in the available p_T reach
- K^{*0}, φ & π^0 mesons R_{AB} are consistent in all centralities
  - Strangeness enhancement is not observed in the available p_T reach
  - Cold nuclear matter effects seem to be not responsible for the difference seen in heavy-ion collisions
- K^{*0}, φ & π^0 mesons R_{AB} are consistent in all centralities, while protons R_{AB} show enhancement in central collisions
  - Qualitatively consistent with the recombination model

Summary

- $R_{pAu} \gtrsim R_{HeAu}$ in 0-20% at intermediate p_T range
- In other centralities in all p_T ranges K^{*0} meson nuclear modification factors for all light systems exhibit similar shape and equal to unity within uncertainties
  - Jet quenching is not observed in the available p_T reach
- K^{*0}, φ & π^0 mesons R_{AB} are consistent in all centralities
  - Strangeness enhancement is not observed in the available p_T reach
  - Cold nuclear matter effects seem to be not responsible for the difference seen in heavy-ion collisions
- K^{*0}, φ & π^0 mesons R_{AB} are consistent in all centralities, while protons R_{AB} show enhancement in central collisions
  - Qualitatively consistent with the recombination model

THANK YOU FOR ATTENTION!

Back up


π⁰, |η|<0.35, √s_NN = 200 GeV
Global uncertainty 9.7%
PHENIX
preliminary
p+Au, 0-20%, prelim.
d+Au, 0-20%, PRL98, 172302
³He+Au, 0-20%, prelim.
π⁰, |η|<0.35, √s_NN = 200 GeV
Global uncertainty 9.7%
PHENIX
preliminary
p+Au, 60-84%, prelim.
d+Au, 60-88%, PRL98, 172302
³He+Au, 60-88%, prelim.
R_p/d/³He+Au
p_T [GeV/c]
p_T [GeV/c]