Highlights of BRAHMS results for heavy ion collisions at RHIC-BNL energies

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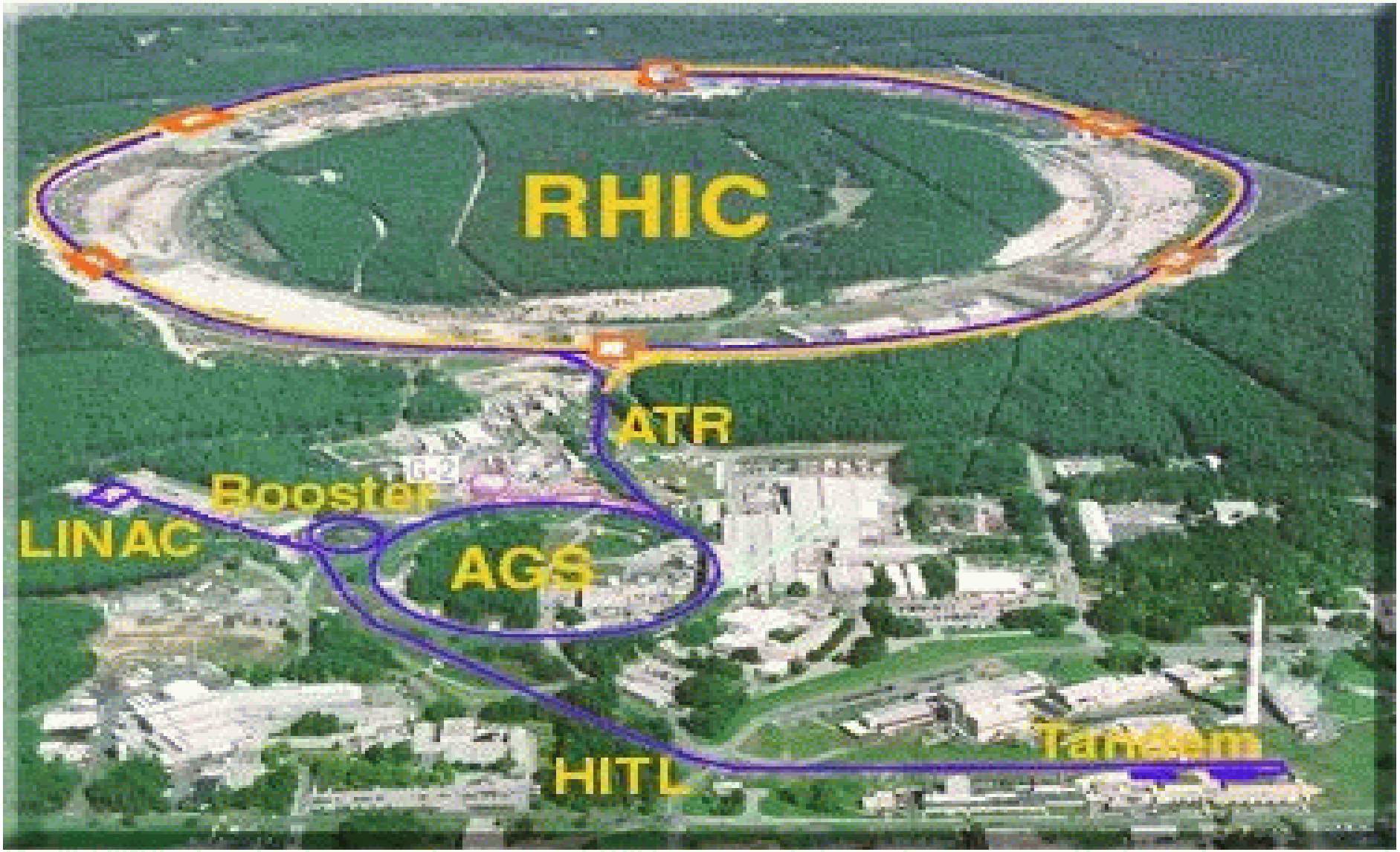
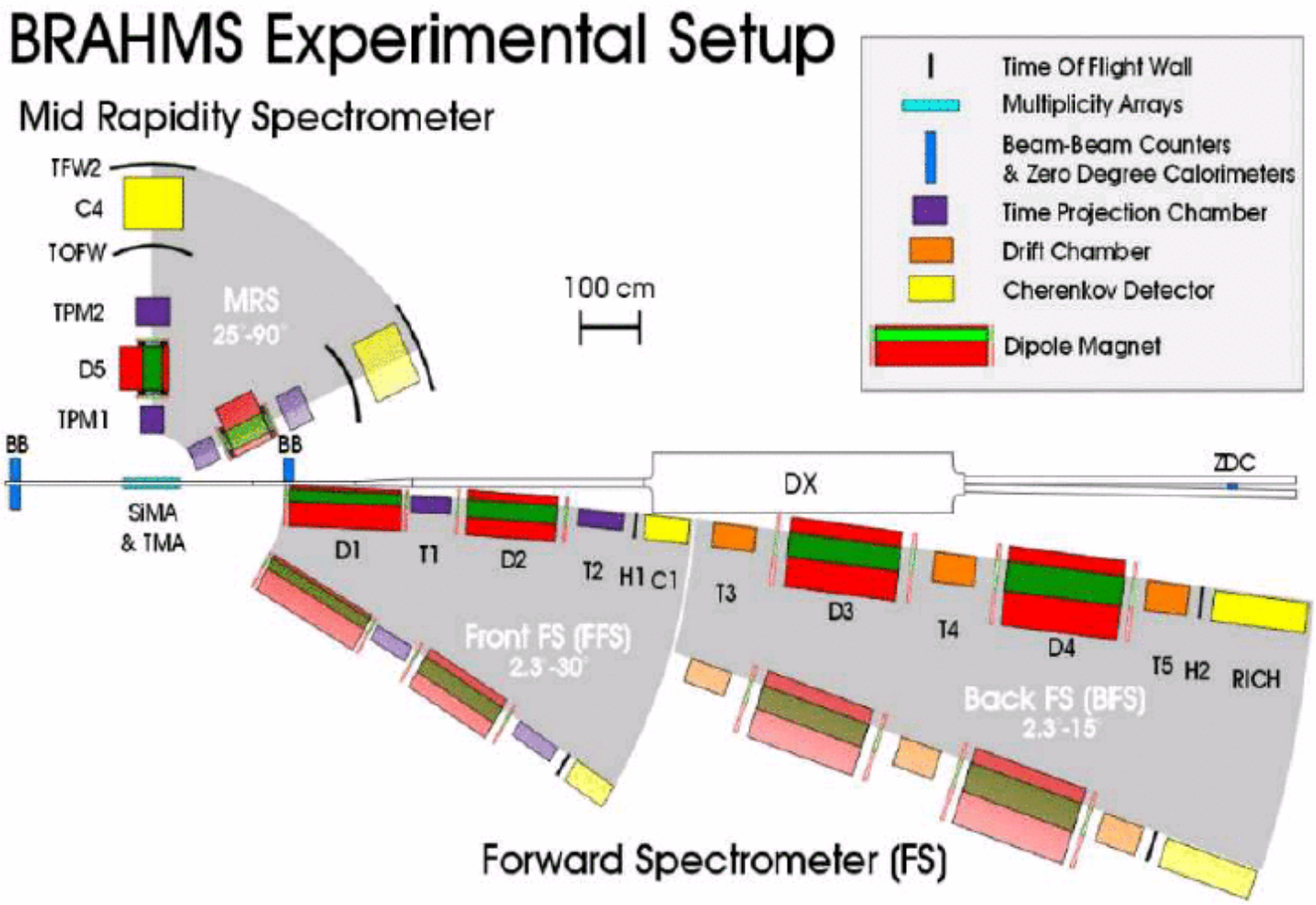
Relativistic Heavy Ion Collider (RHIC)



Brookhaven National Laboratory, USA

Broad RAnge Hadronic Magnetic Spectrometer (BRAHMS)



PID capabilities:

$0 < y < 1$

K/π up to 2.5 GeV/c

K/p up to 4.0 GeV/c

$1.5 < y < 4$

K/π up to 4.5 GeV/c

K/p up to 7.5 GeV/c

Extension using the Cherenkov detectors:

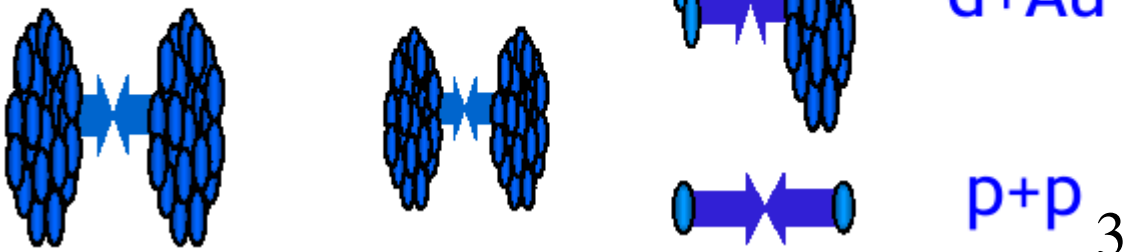
K/π up to 20 GeV/c

K/p up to 35 GeV/c

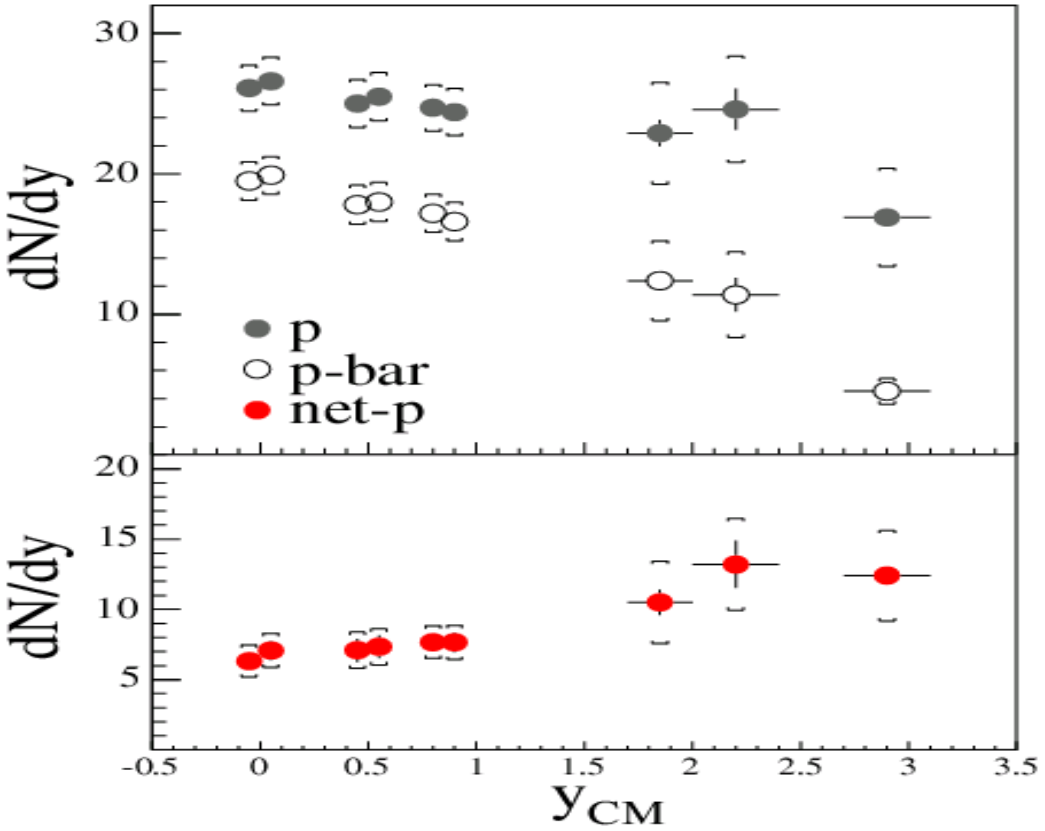
Energies

- 200 AGeV
- 130 AGeV
- 62.4 AGeV

Nucl.Instr. and Meth. A499, 437 (2003)



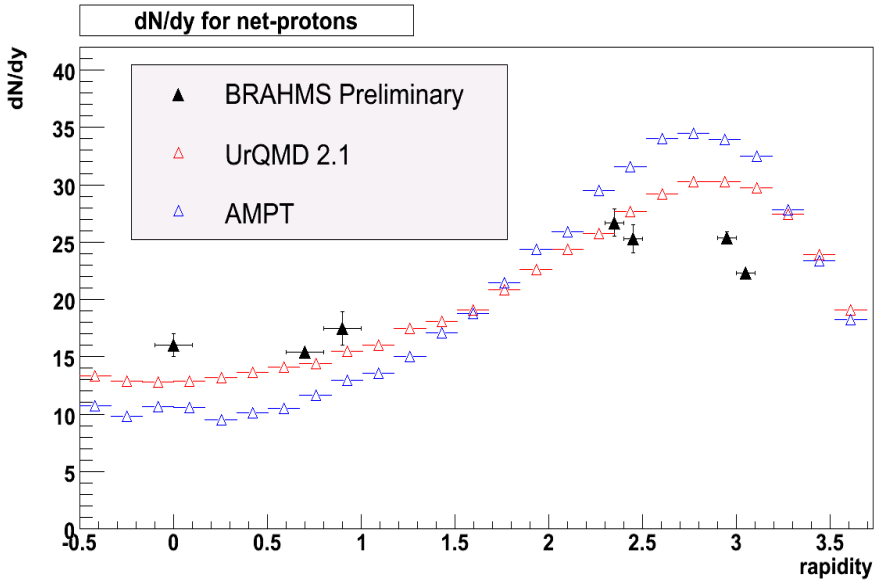
Stopping and average energy loss



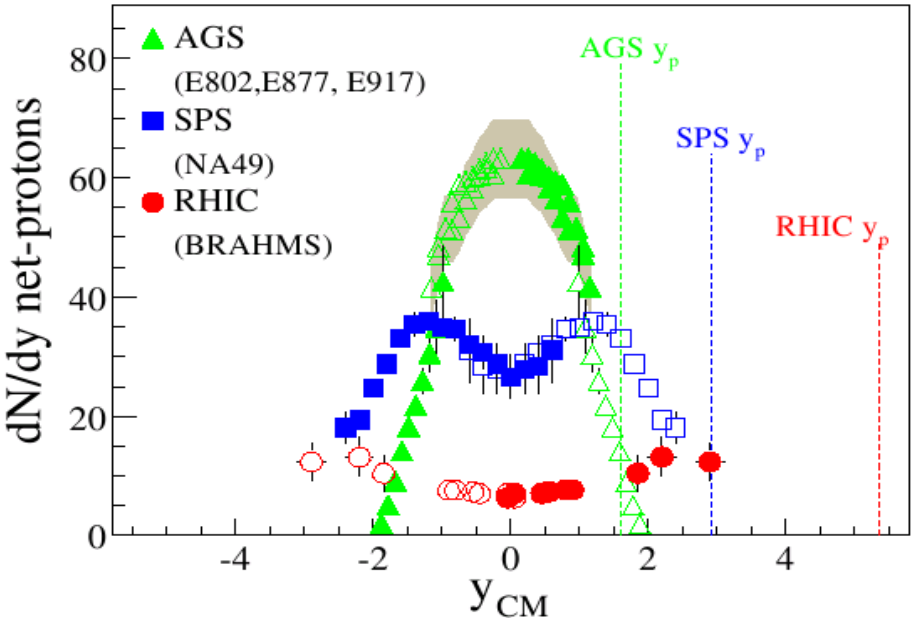
Central Au+Au collisions at 200 AGeV

BRAHMS Coll., PRL 93, 1020301 (2004)

The net-proton distribution measured at RHIC is both qualitatively and quantitatively different from those at lower energies indicating a significantly different system formed at mid-rapidity.



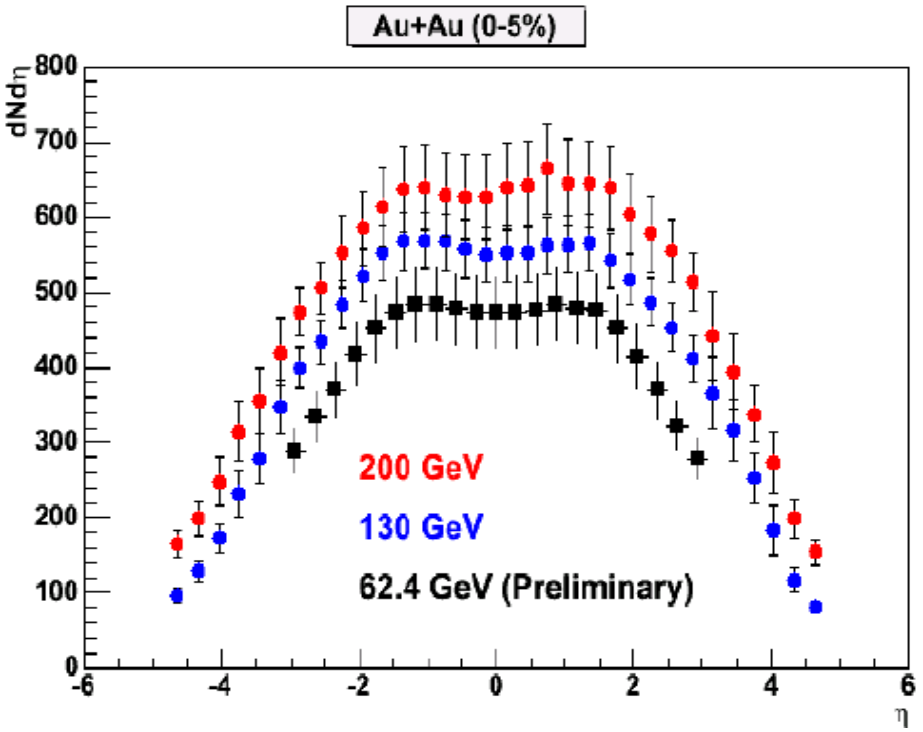
Net-protons in Au+Au 62.4 GeV

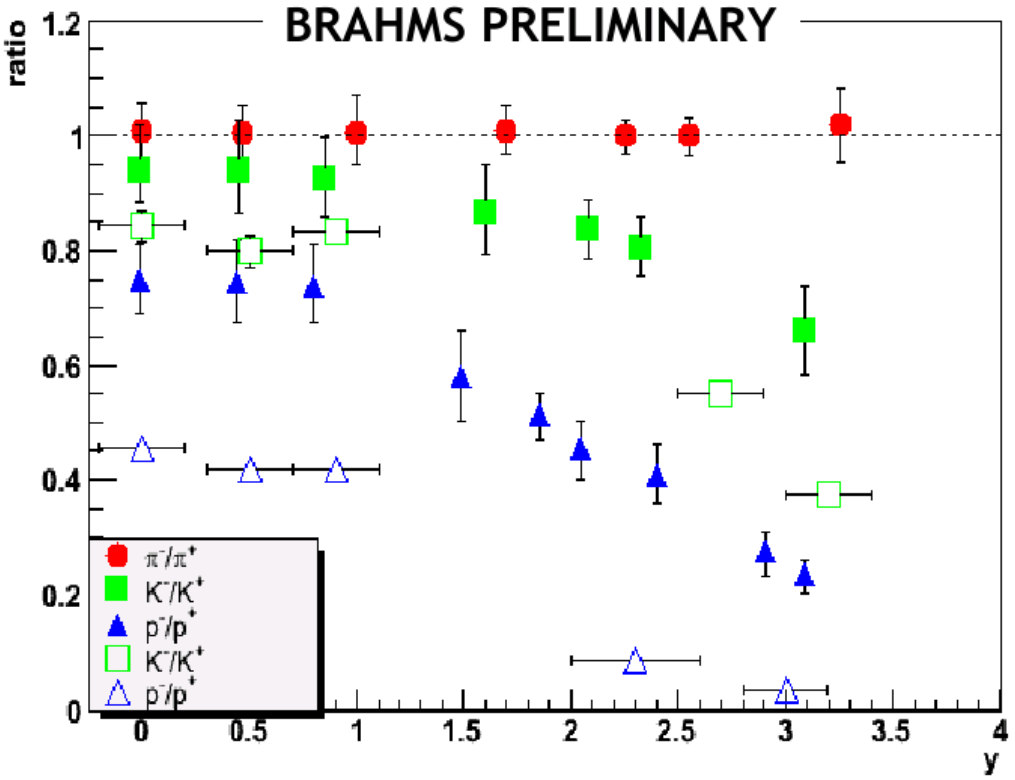


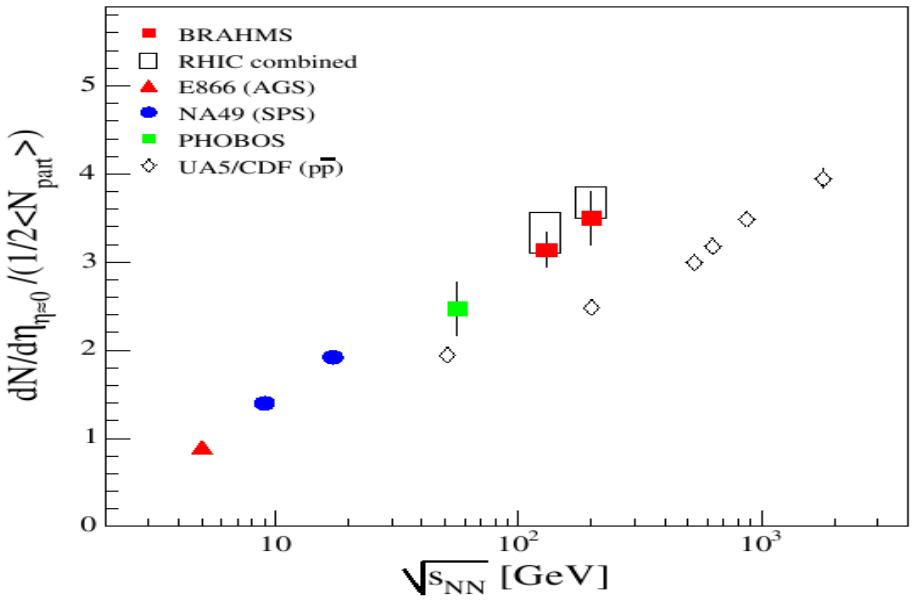
$\Delta E = 25.7 \pm 2.1$ TeV

ΔE/nucleon = 72 ± 6 GeV

Rapidity distributions of charged particles







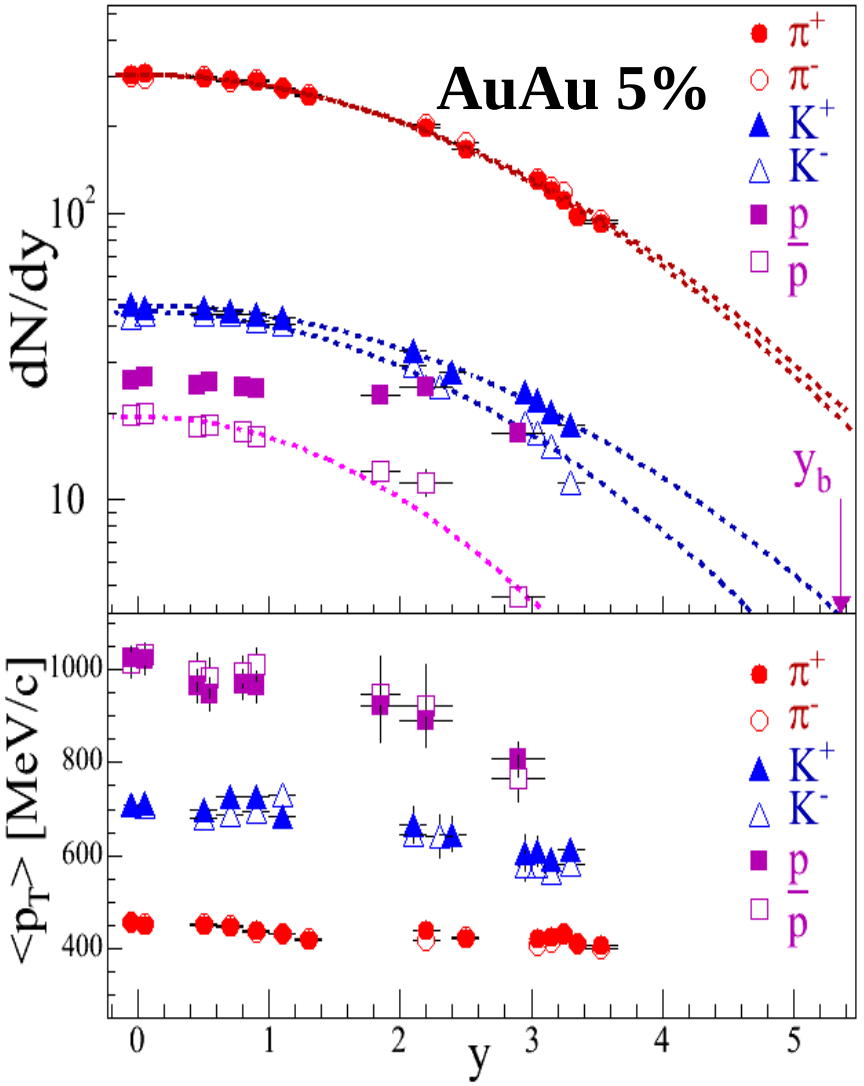
Filled symbols are for Au+Au collisions at 200 AGeV, while open symbols are from Au+Au coll. at 62.4 AGeV.

An approximate balance between particles and anti-particles is first seen around mid-rapidity.

Particle production in central collisions exceeds the particle production seen in p+p collisions at the same energy by 40-50%.

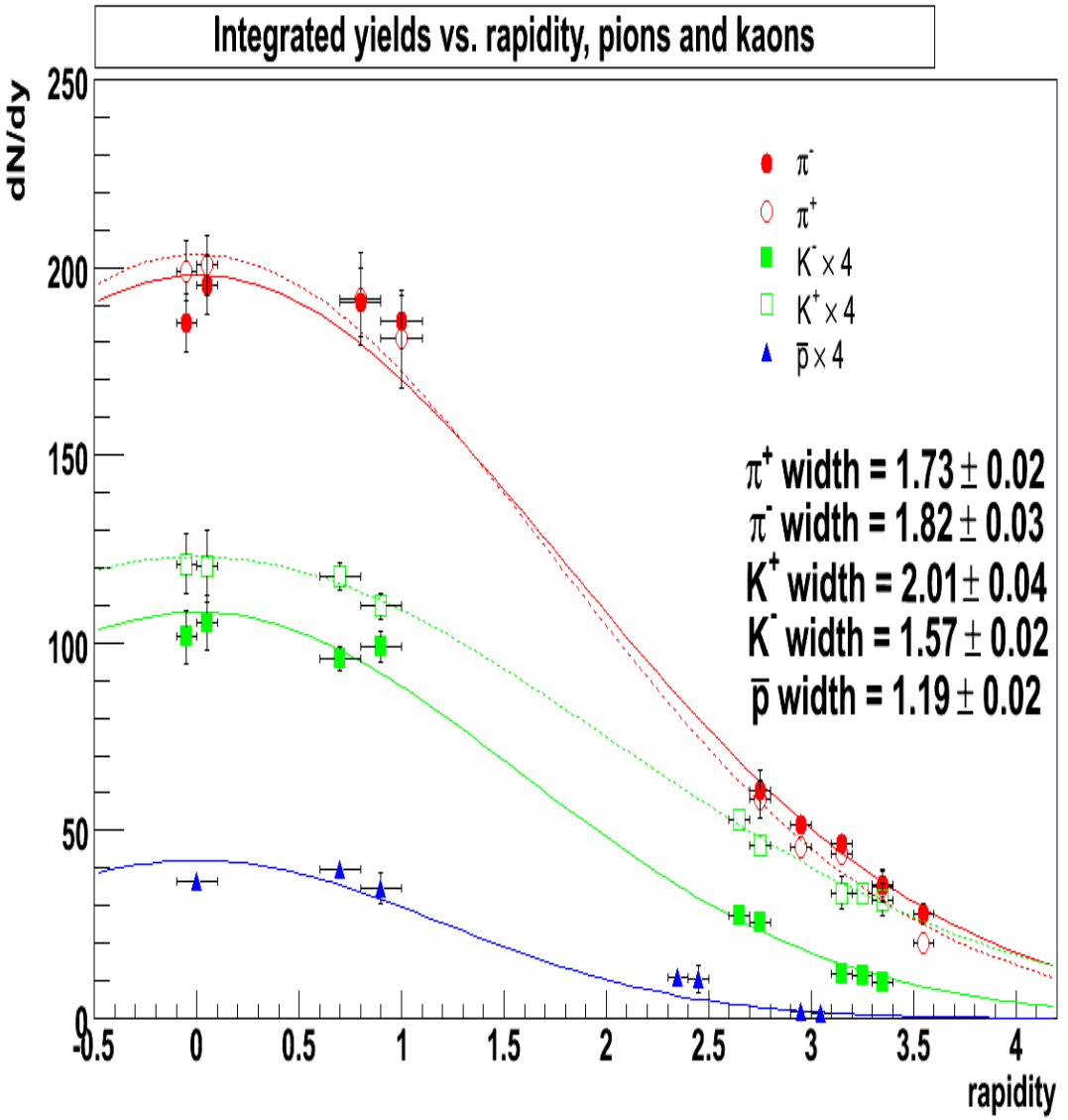
I.G.Bearden et al., PRL 90, 102301 (2003)

Identified particle rapidity distributions



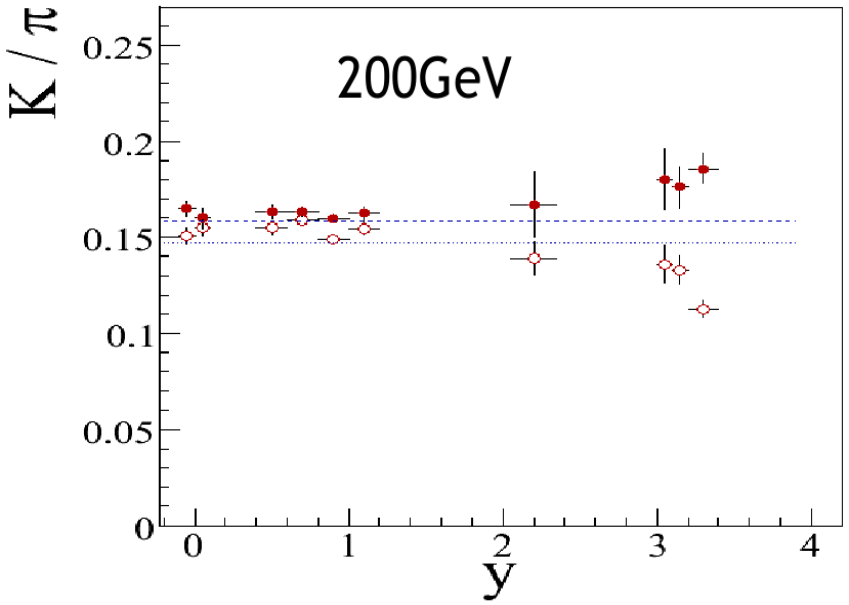
Rapidity density distributions for identified particles in 0-5% central Au+Au collisions at e.c.m. = 200 A GeV

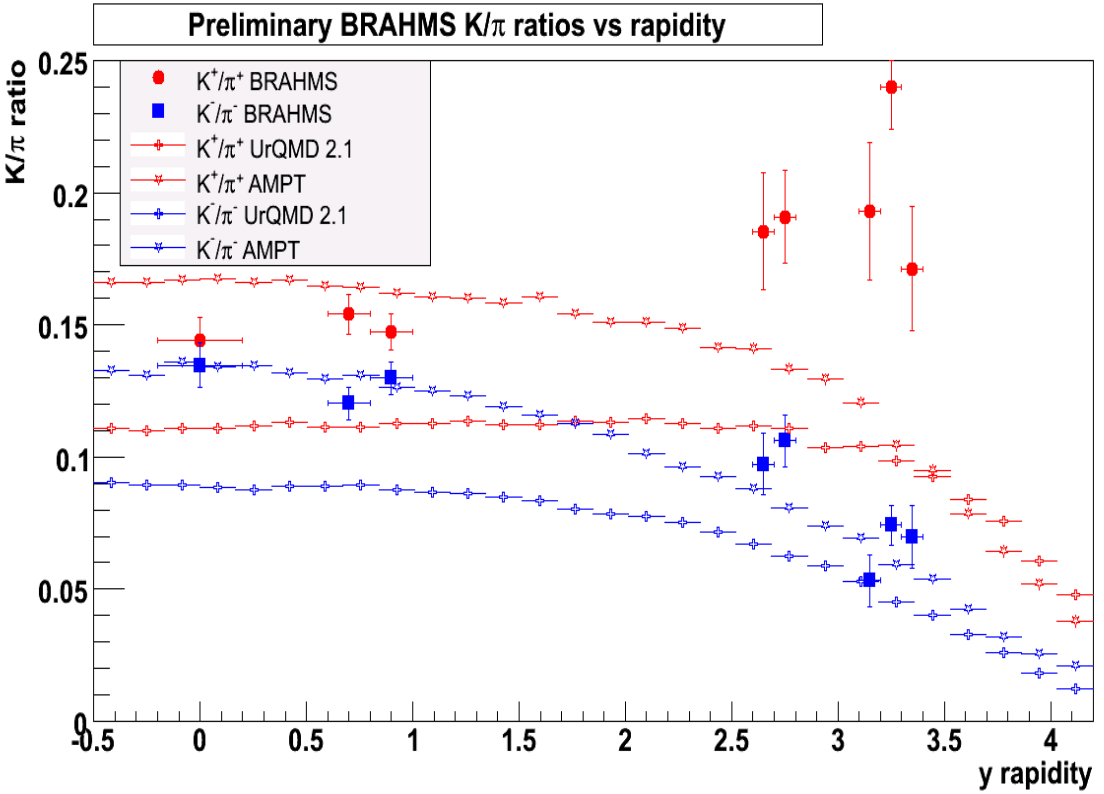
I.G.Bearden et al., nucl-ex/0403050

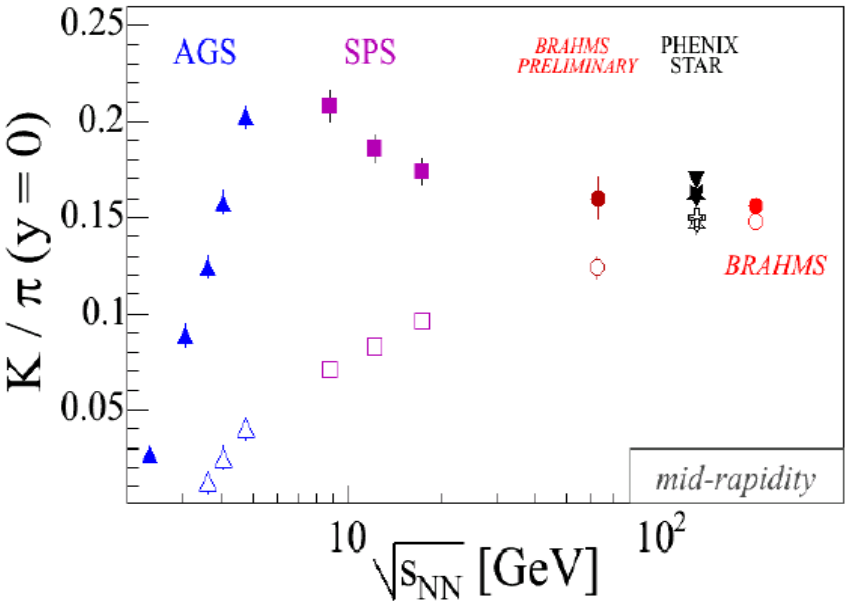


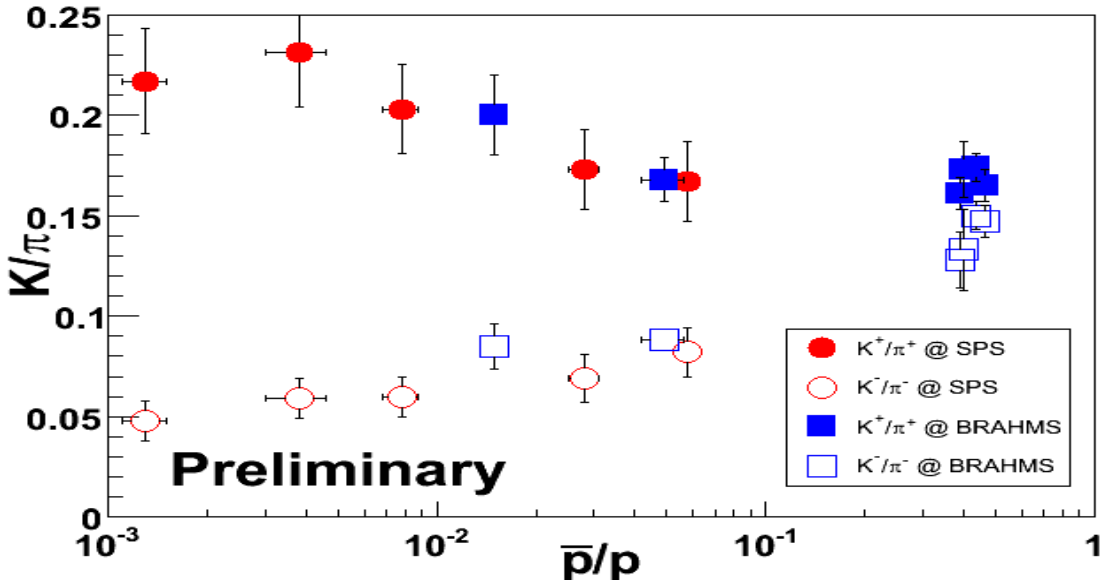
PRELIMINARY rapidity density distributions for identified particles in 0-10% central Au+Au collisions at e.c.m. = 62.4 A GeV

K/π ratios as a signal for a new state of matter



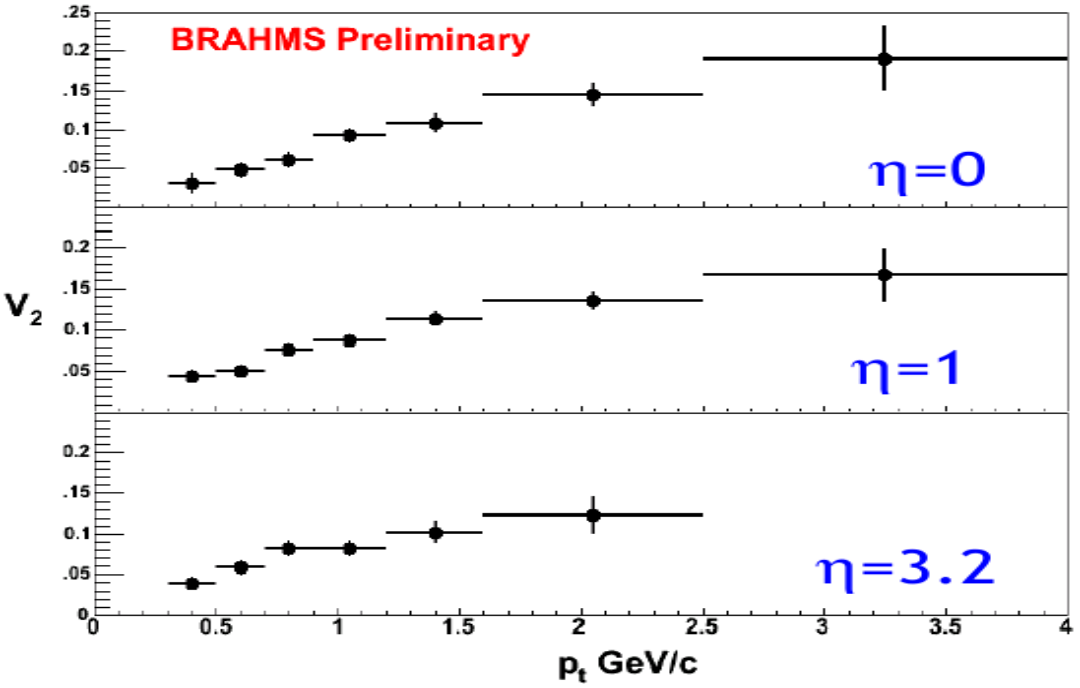




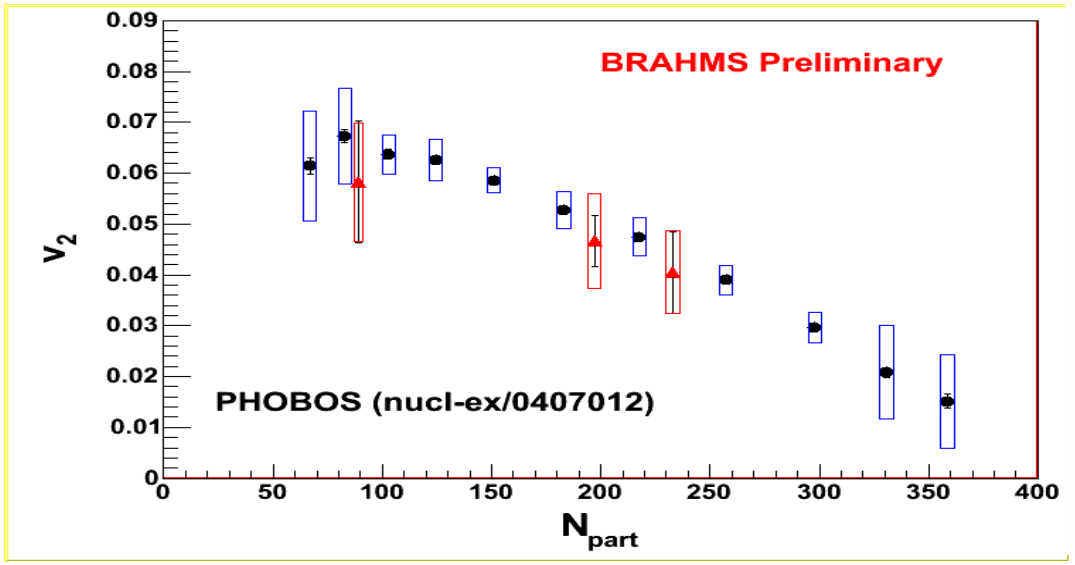


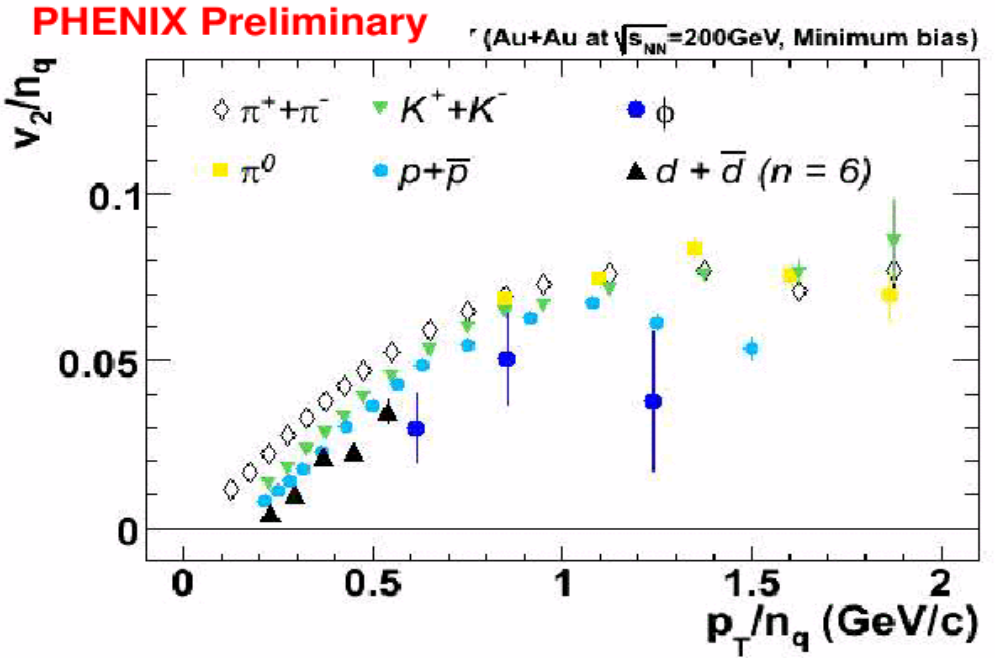
I.G.Bearden et al., nucl-ex/0403050

Elliptic flow (v2)



<-- No v2(pt) rapidity dependence





The elliptic flow parameter (momentum anisotropy) increases for peripheral collisions.

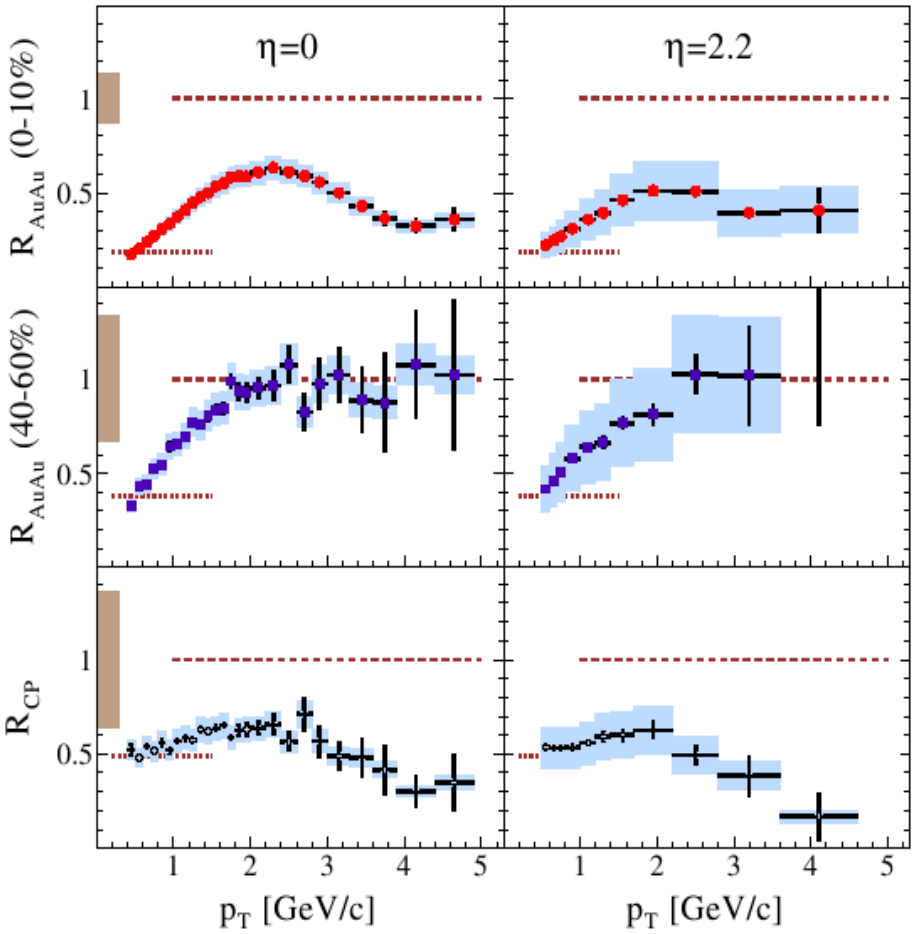
Flow happens at partonic level !

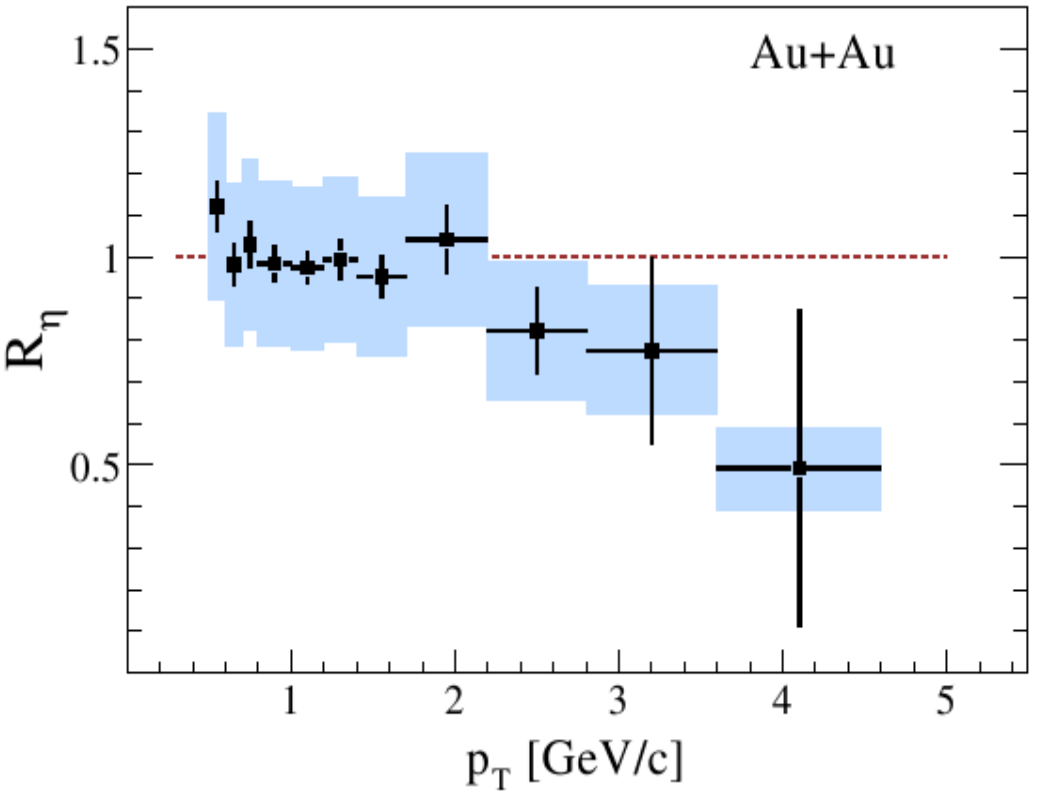
High pt suppresion & jet quenching

- Particles with high pt (~above 2GeV/c) are primarly produced in hard scattering processes in the early stage of the collision.
- In the p+p experiments hard scattered partons fragment into jets of hadrons.
- In A+A collisions they traverse the created medium --> probe the dense and hot stage. In the case of a very dense medium (e.g. QGP) we expect to see a suppression of these jets.
- Experimentally we measure an observable called nuclear modification factor

$$R_{AA} = \frac{d^2 N^{AA} / dp_t d\eta}{\langle N_{bin} \rangle d^2 N^{NN} / dp_t d\eta}$$

High pt suppresion





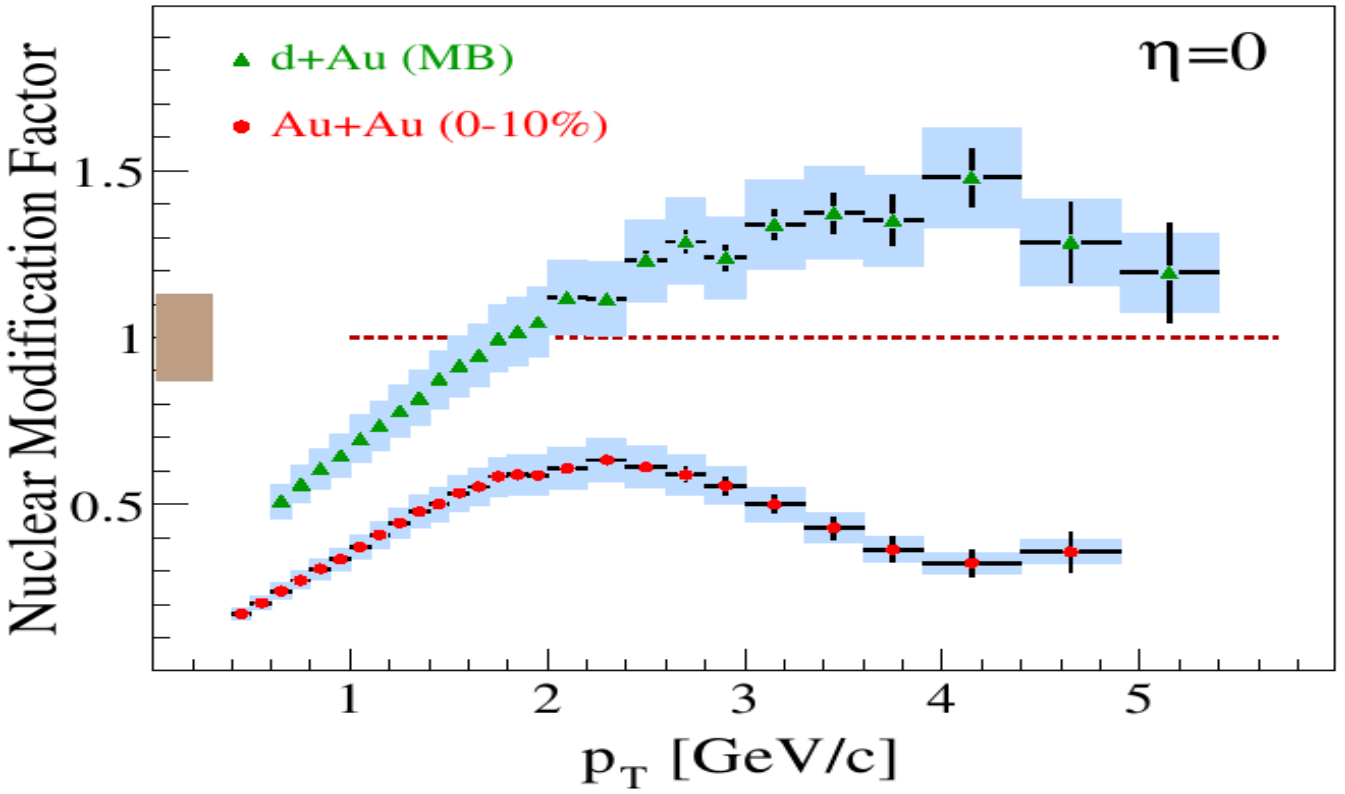
$$R_{cp} = R_{AA}(central)/R_{AA}(peripheral)$$

$$R_{\eta} = R_{cp}(\eta=0)/R_{cp}(\eta=2.2)$$

The suppresion is higher in central collisions. At higher rapidities, the suppresion persist and is even more important.

I.Arsene et al., PRL 91, 072305 (2003)

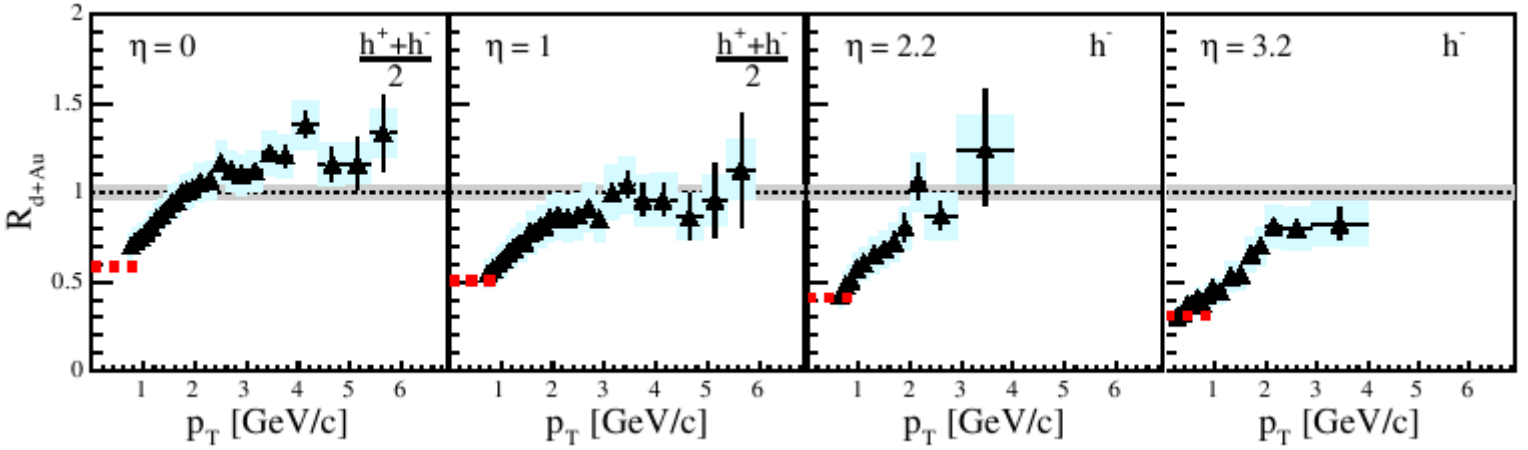
High pt suppresion



There is no high pt suppresion in d+Au collisions at mid-rapidity,

BUT...

at forward rapidities, there is high pt suppresion.



<== CGC ?

I.Arsene et al., PRL 91, 072305 (2003)

I.Arsene et al., nucl-ex/0403005

Summary

- The energy loss measurements show that a very big part of the beam kinetic energy is removed from the beam in central Au+Au collision and is available for particle production.
- The particle multiplicities that are observed at RHIC indicate that the energy density associated with particle production in the initial stages of the collisions largely exceeds the energy density of hadrons.
- The K/π ratios show a behaviour that is correlated with the net-baryonic densities and this behaviour appears to be independent of the c.m. energy of the collision. This phenomena it is important for the understanding of the strange quark-antiquark production and for its dynamics during the collision and it looks like it is not very well understood by the theoretical models.
- The observation of a strong elliptic flow at RHIC suggests that the system is strongly collective as must be the case for an equilibrated system.
- The suppresion of high pt jets at mid-rapidity seen at RHIC is an important signal which evidences the interaction of particles originating from parton scatterings with the high energy density medium created in the collisions.
- The suppresion of high pt particles seen at forward rapidities in A+A collisions is a novel and unexpected effect and may be related to a new collective partonic state that describe nuclei at small x --> CGC.

Thank you !