High P_T Hadron Spectra at Large Rapidity

Quark Matter 2004
Oakland – January 11-17

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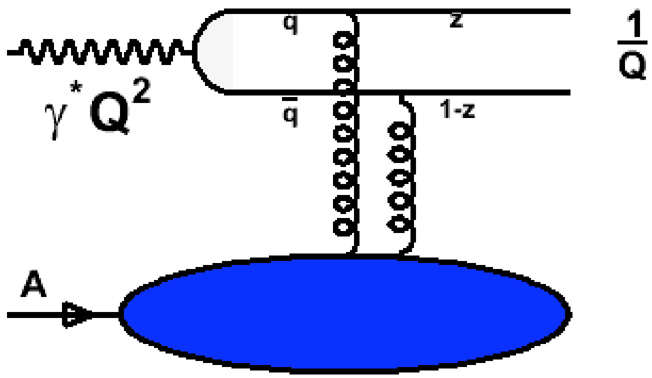
for the **BRAHMS** collaboration

Physics Department

BROOKHAVEN NATIONAL LABORATORY

QM2004 13-Jan Oakland CA.

Motivation



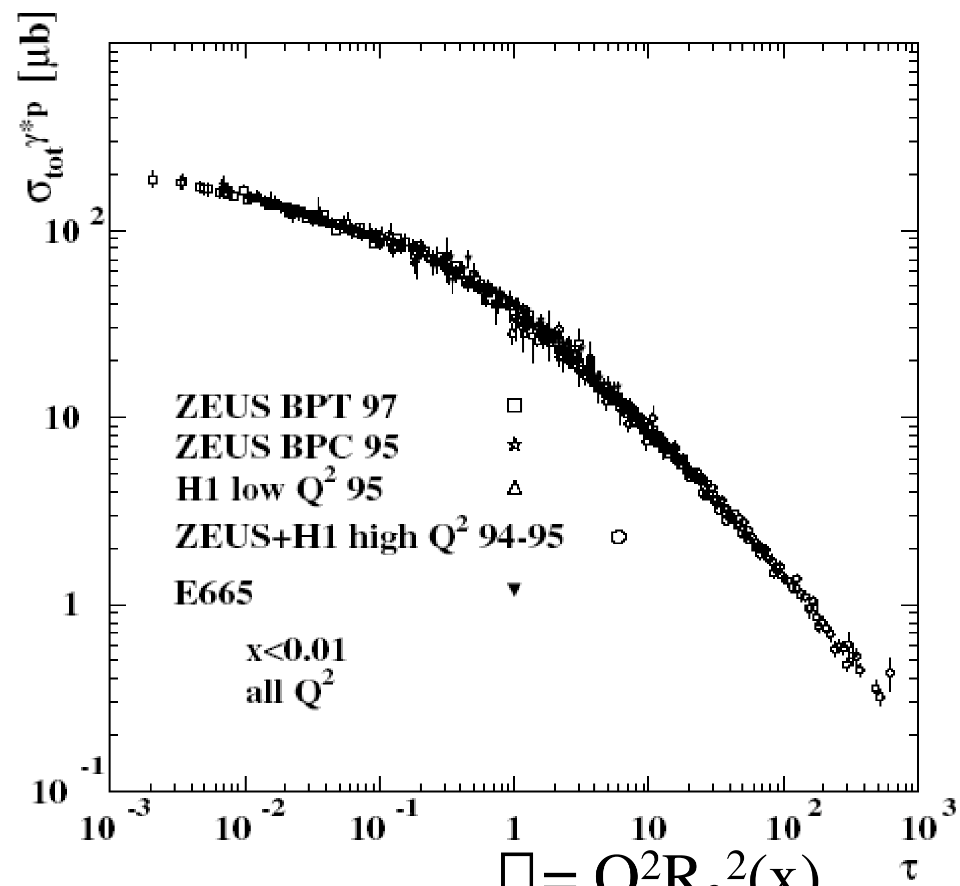
Transverse "size" of the dipole ~ 1/Q

"Geometric Scaling" at HERA
(**K. Golec-Biernat PRL 86 2001**)

R_0 "saturation radius" ~x□

defines a scale: for values of Q^2 such that for $1/Q \geq R_0$

the cross section becomes a constant.



□= $Q^2R_0{}^2(x)$

Motivation cont.

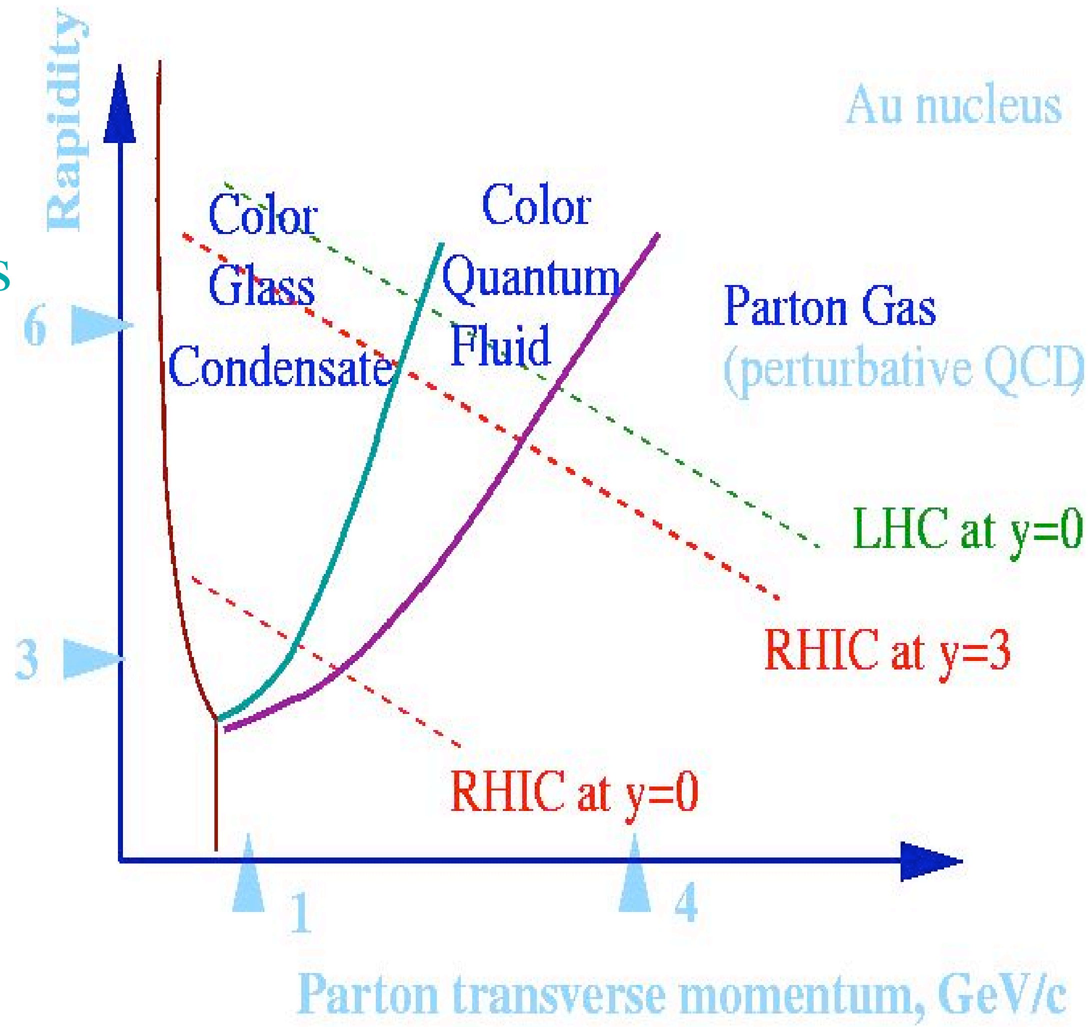
Further theoretical work postulates the existence of a new regime: the Color Glass Condensate.

Use of nuclei with large A facilitates the study of saturation:

$Q^2_s \sim A^{1/3}/x^{\lambda}$

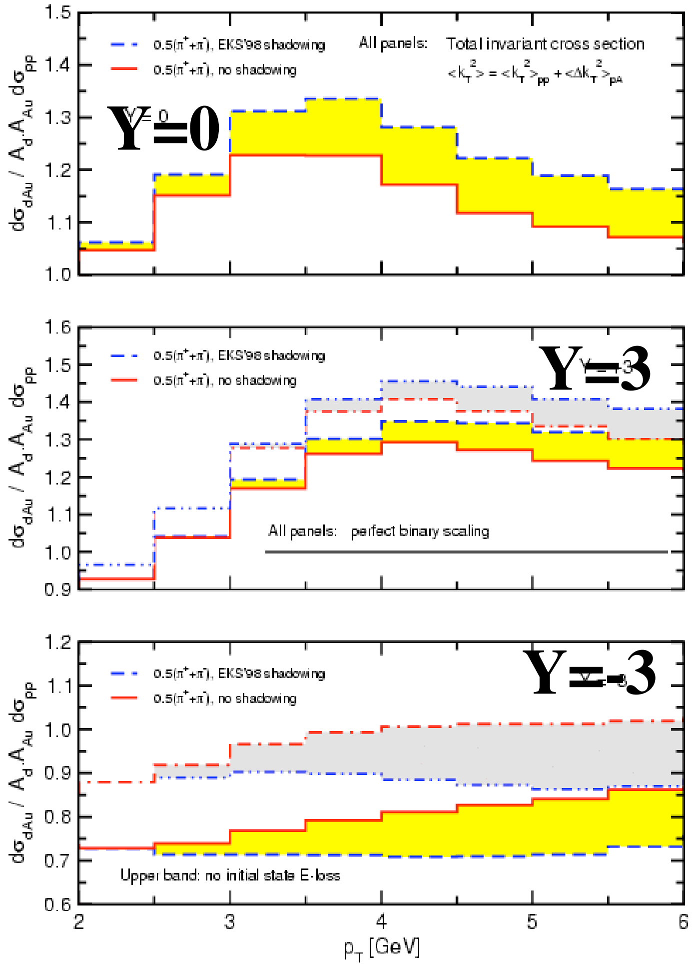
$x_2 = (m_T/\sqrt{s}\ )\ e^{-y}$

Measurements at large rapidities in p-A systems "probe" small x of A:



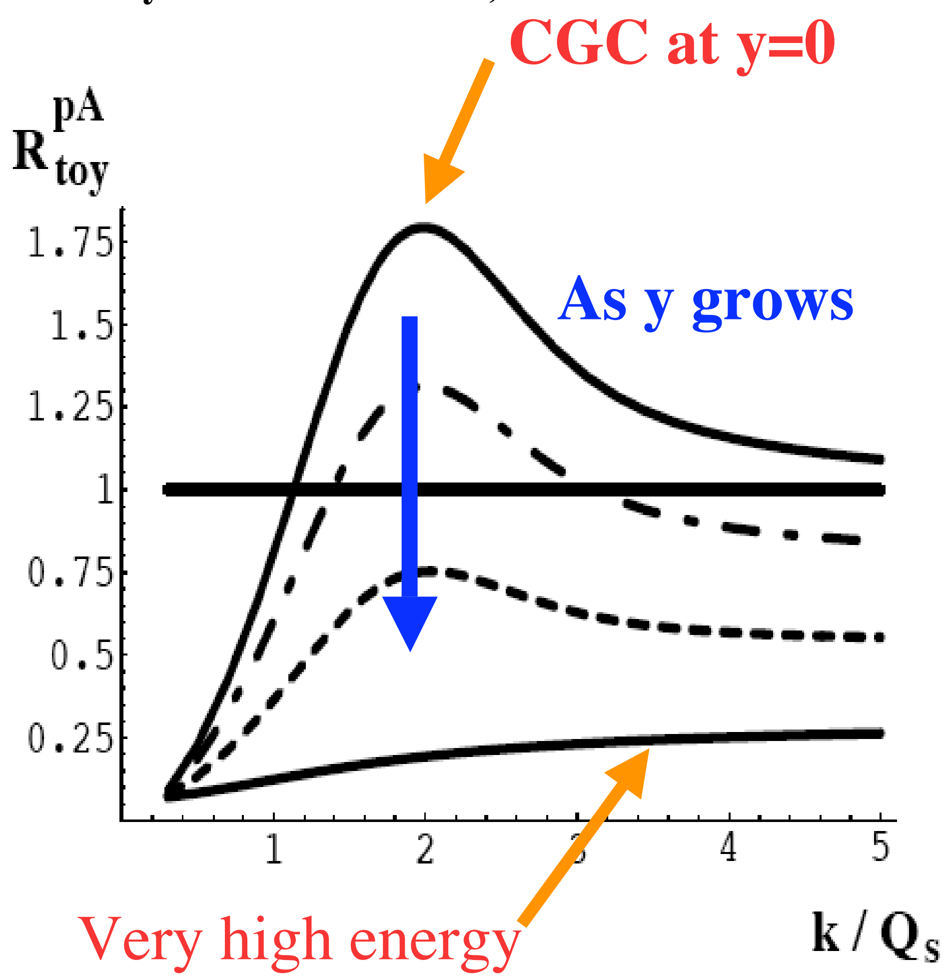
Predictions from theory

I. Vitev nucl-th/0302002 v2

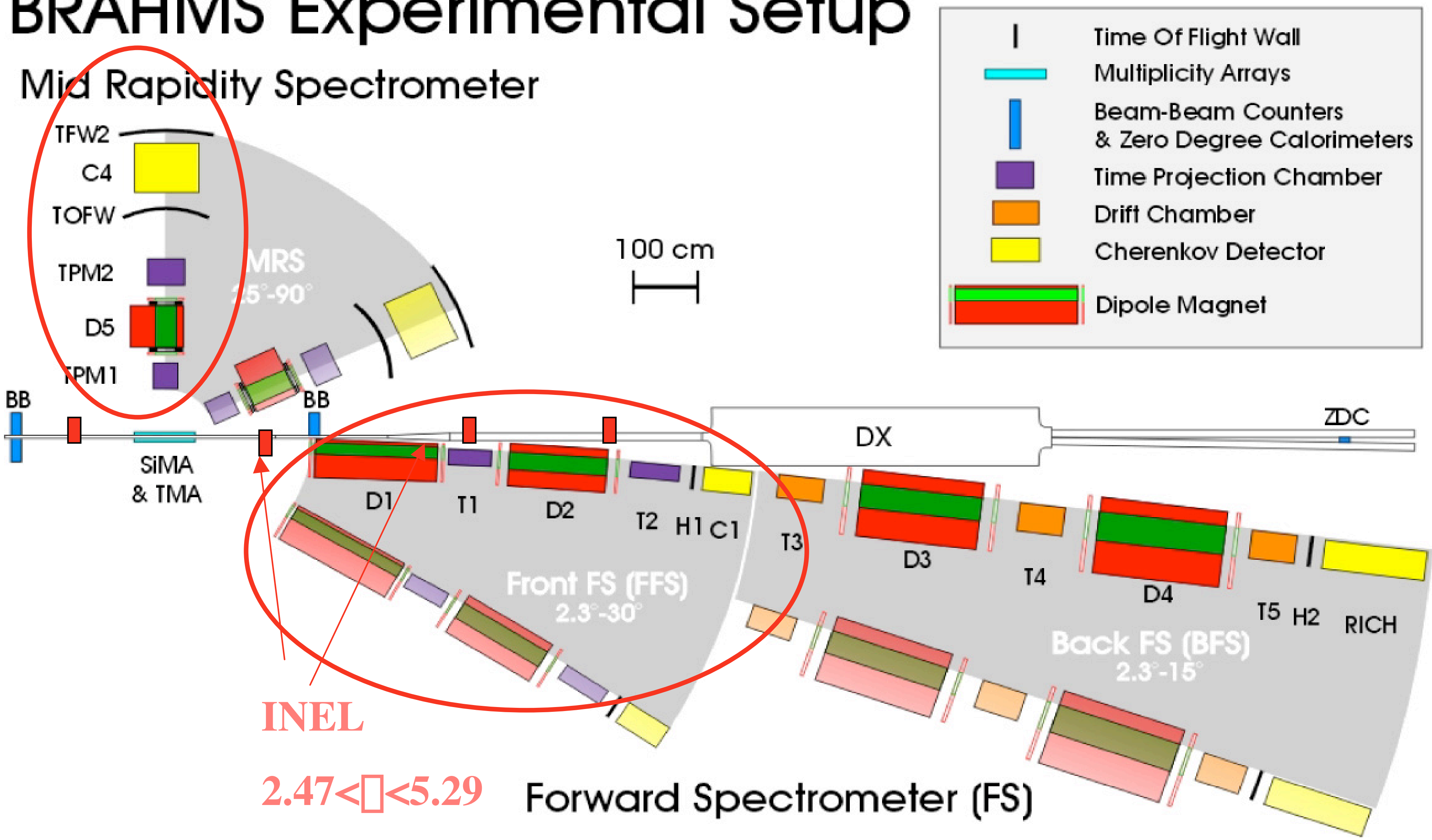


D. Kharzeev et al.

Phys.Rev.D68:094013,2003

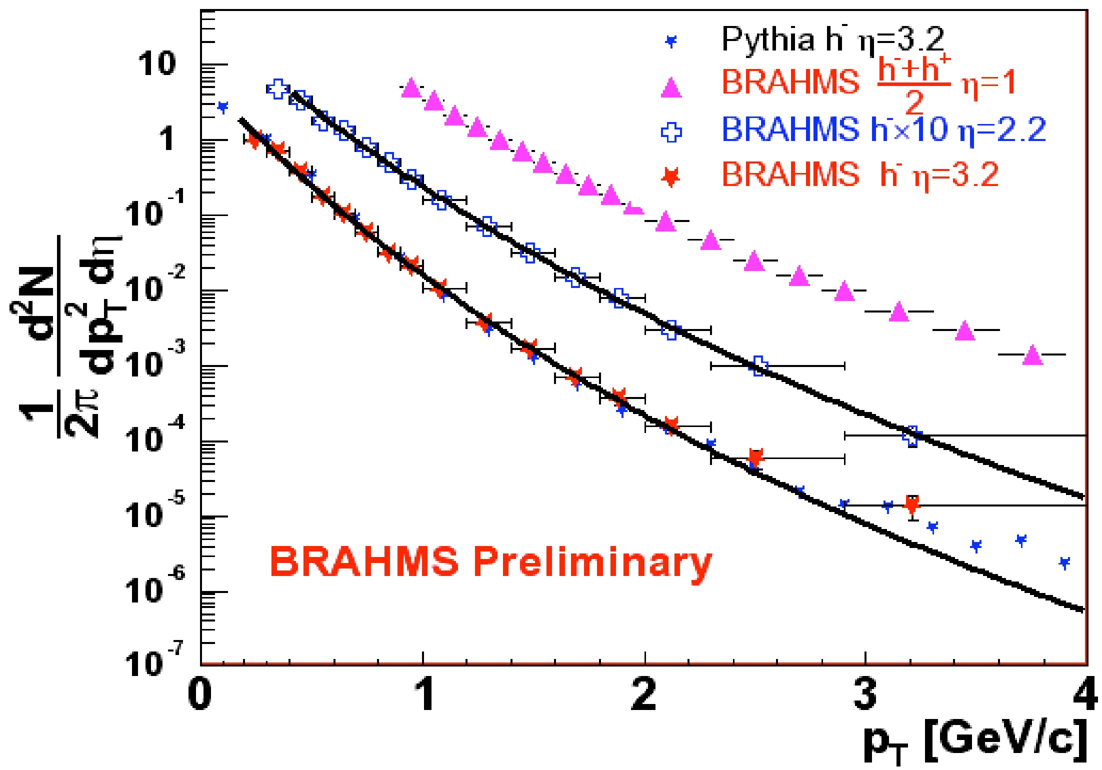


BRAHMS Experimental Setup



The data at forward rapidities was collected with FFS at 4° (η ~3) and 12° (η~2)

Spectra from p-p collisions



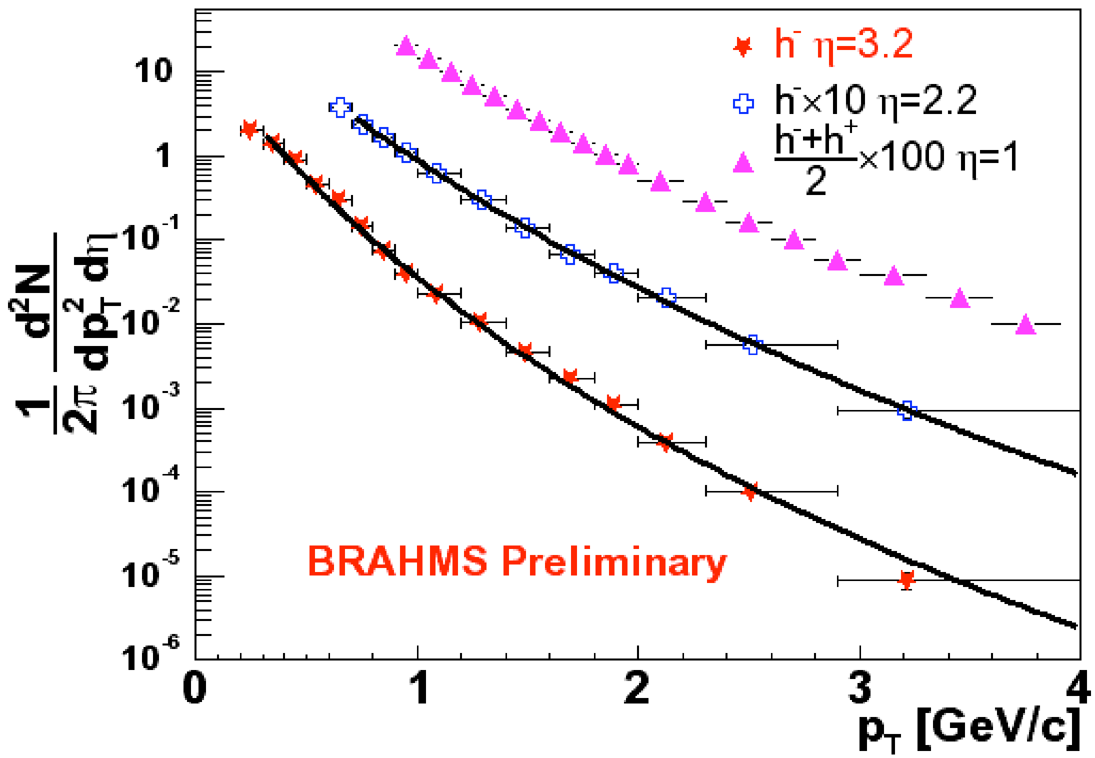
All spectra shown on this presentation have been corrected for acceptance and tracking efficiencies.

Fits to power law.

Pythia run with our trigger cond. and momentum resolution

Minimum biased (80%±3% of NSD p-p cross section)

Spectra from d-Au collisions



Minimum biased events corresponding to 91%±3% of the d-Au inelastic cross section.

Nuclear modification factor R_{dAu}

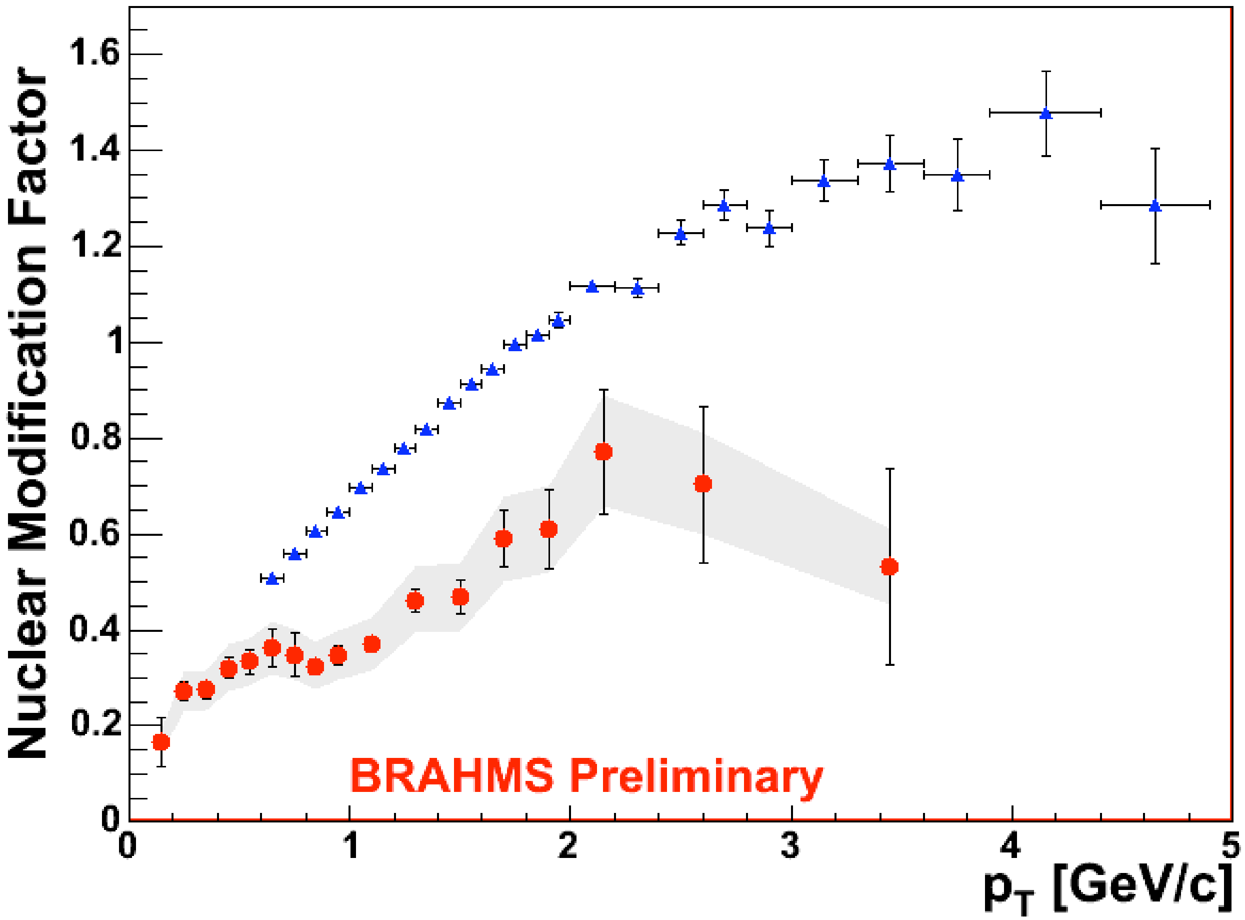
The behavior of the many-body systems we study (A-A or d-A) can be "calibrated" with a "simple system" like p-p .

Borrowing from "Cronin effect" studies, we compare particle production in d-A to the scaled production in p-p:

$$R_{dAu} = (d^2N_{dAu}/dp_T d\eta) / (N_{coll}\, d^2N_{pp}/dp_T d\eta)$$

With N_{coll} being the estimated number of binary collisions as d "goes through" the Au nuclei.

R_{dAu} at different rapidities



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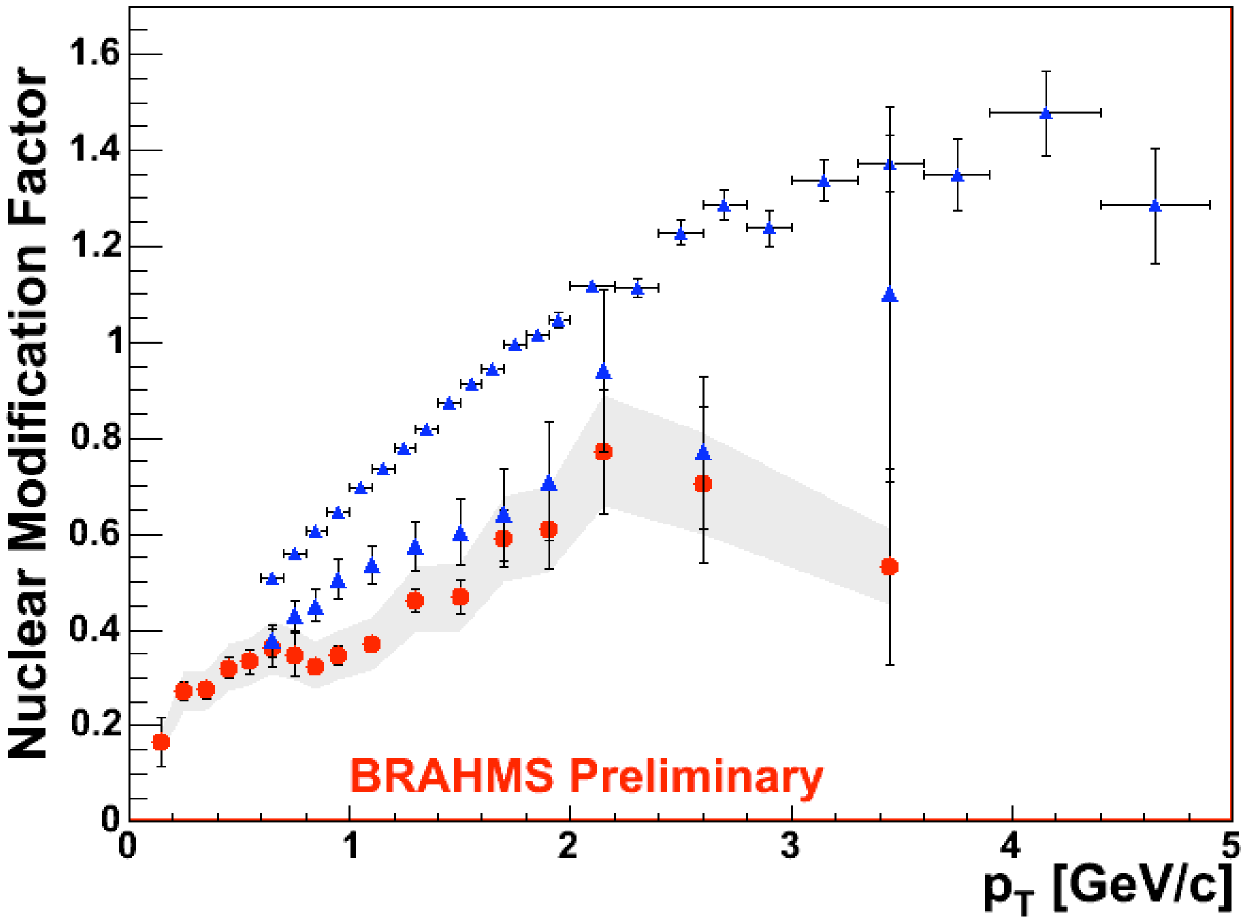
The values for []=0 were published in:

PRL 91 072305 (2003)

All ratios extracted from minimum biased data samples

R_{dAu} at different rapidities



Number of binary collisions in minimum biased events is estimated:

N_{coll} = 7.2±0.3

Statistical errors dominant over the systematic ones at □=2 and 3

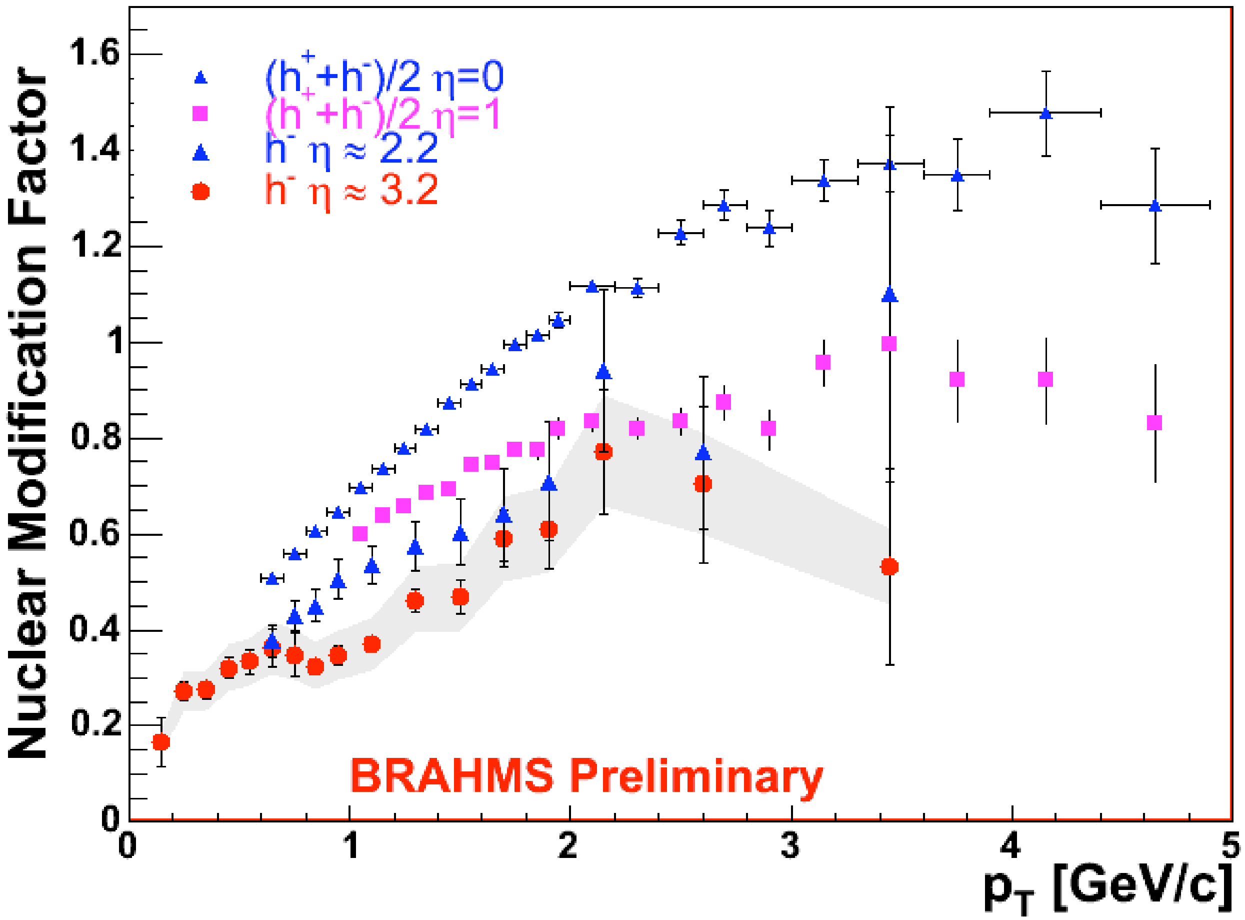
Systematic error (not shown) ~15%

The values for □=0 were published in:

PRL 91 072305 (2003)

All ratios extracted from minimum biased data samples

R_{dAu} at different rapidities



All ratios extracted from minimum biased data samples

Number of binary collisions in minimum biased events is estimated:

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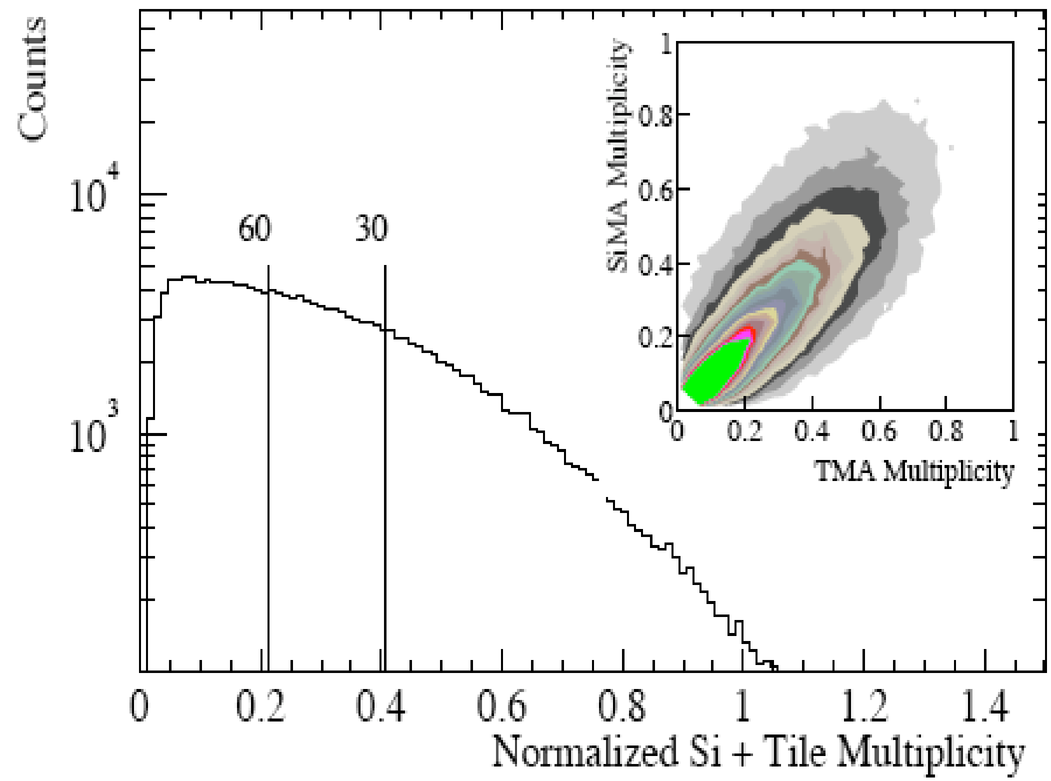
Centrality dependence

To reach further understanding of the effects seen in the ratio **R_{dAu}** as function of rapidity, we studied the **centrality dependence** of particle yields.

We infer centrality from the measured charged particle multiplicity in -2<□<2



R_{cp} definition

We select three data samples:

"Central": centrality 0-20%

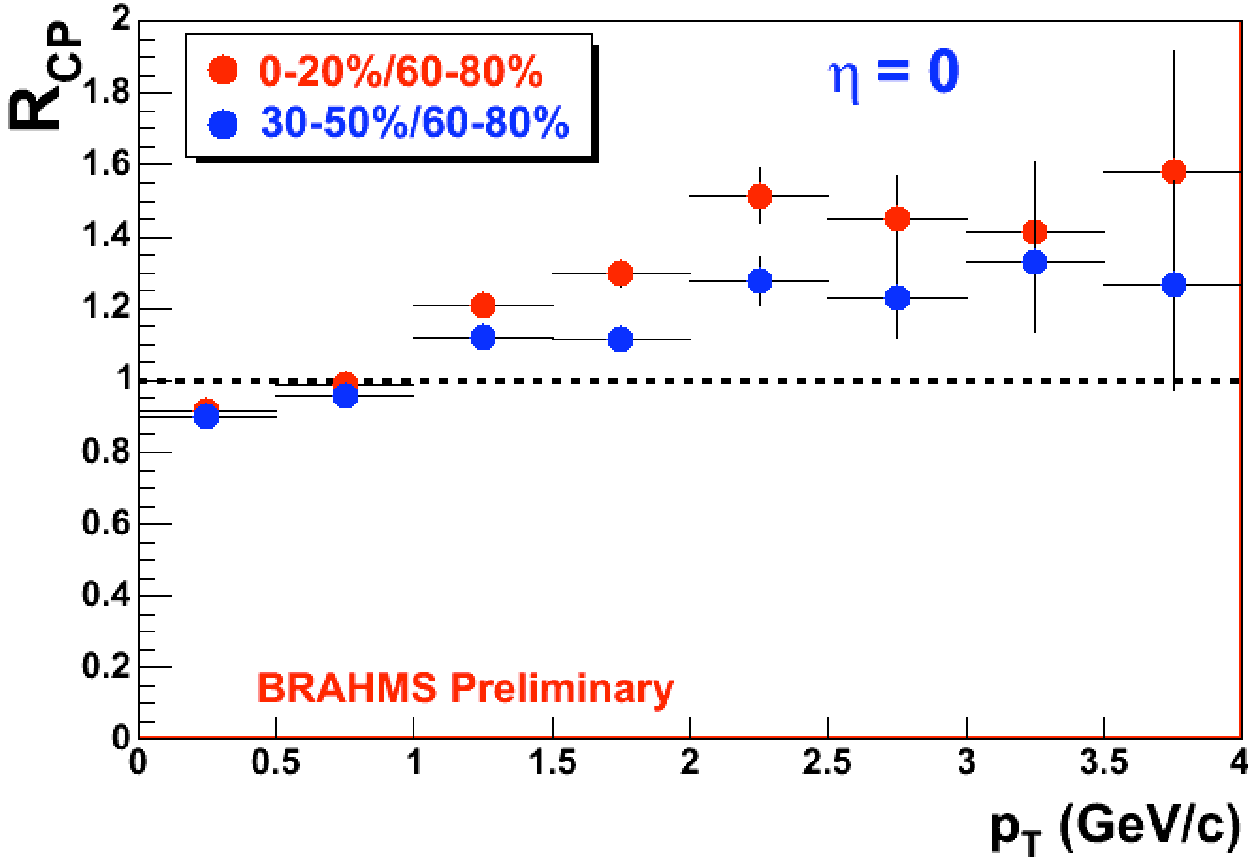
"Semi-central": centrality 30-50%

"Peripheral": centrality 60-80%

Then we calculate the ratios Central/Peripheral and Semi-central/Peripheral as function of p_T at different rapidities.

Many corrections and systematics cancel out.

Centrality dependence

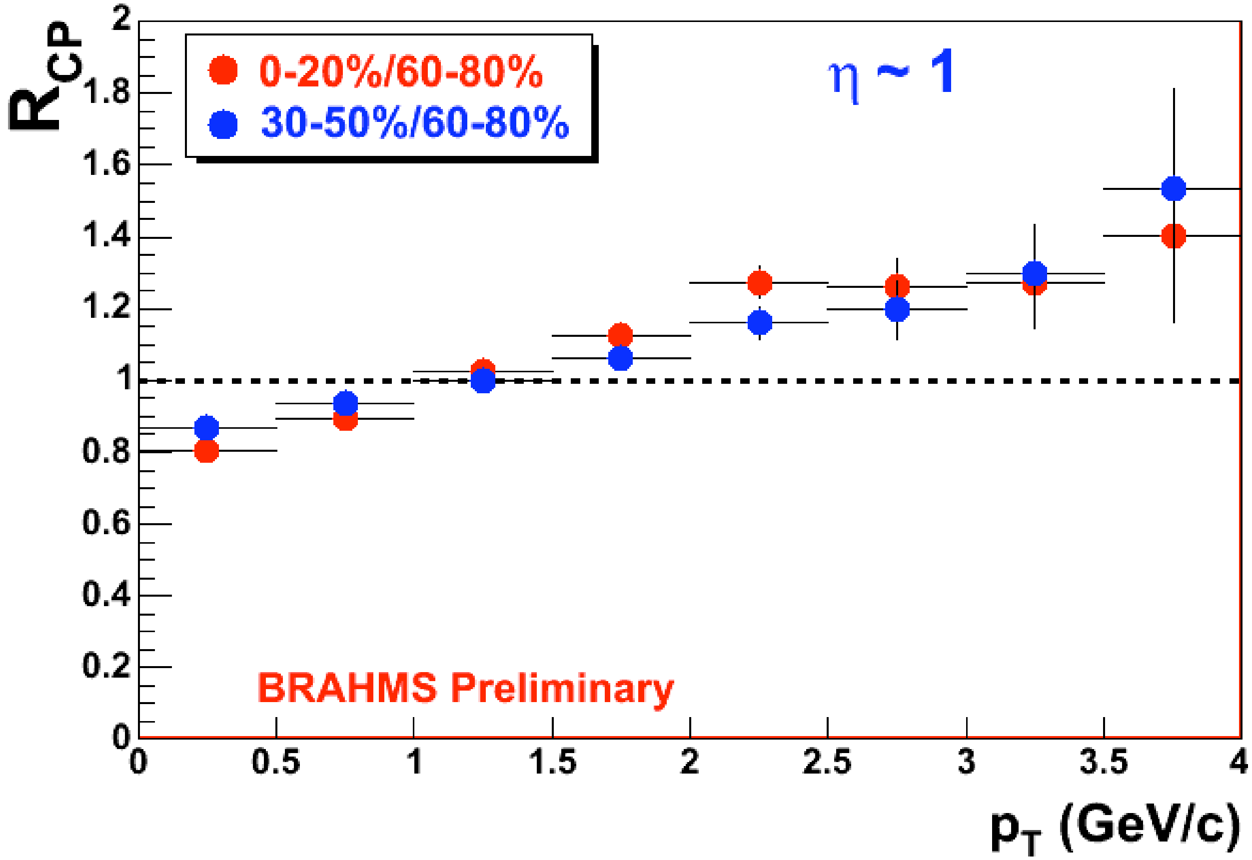


All numerators and denominator are scaled by the appropriate estimated number of binary collisions (HIJING + BRAHMS GEANT)

The ratios are corrected for trigger inefficiency.

All other corrections (acceptance, tracking efficiency..) cancel out.

Centrality dependence



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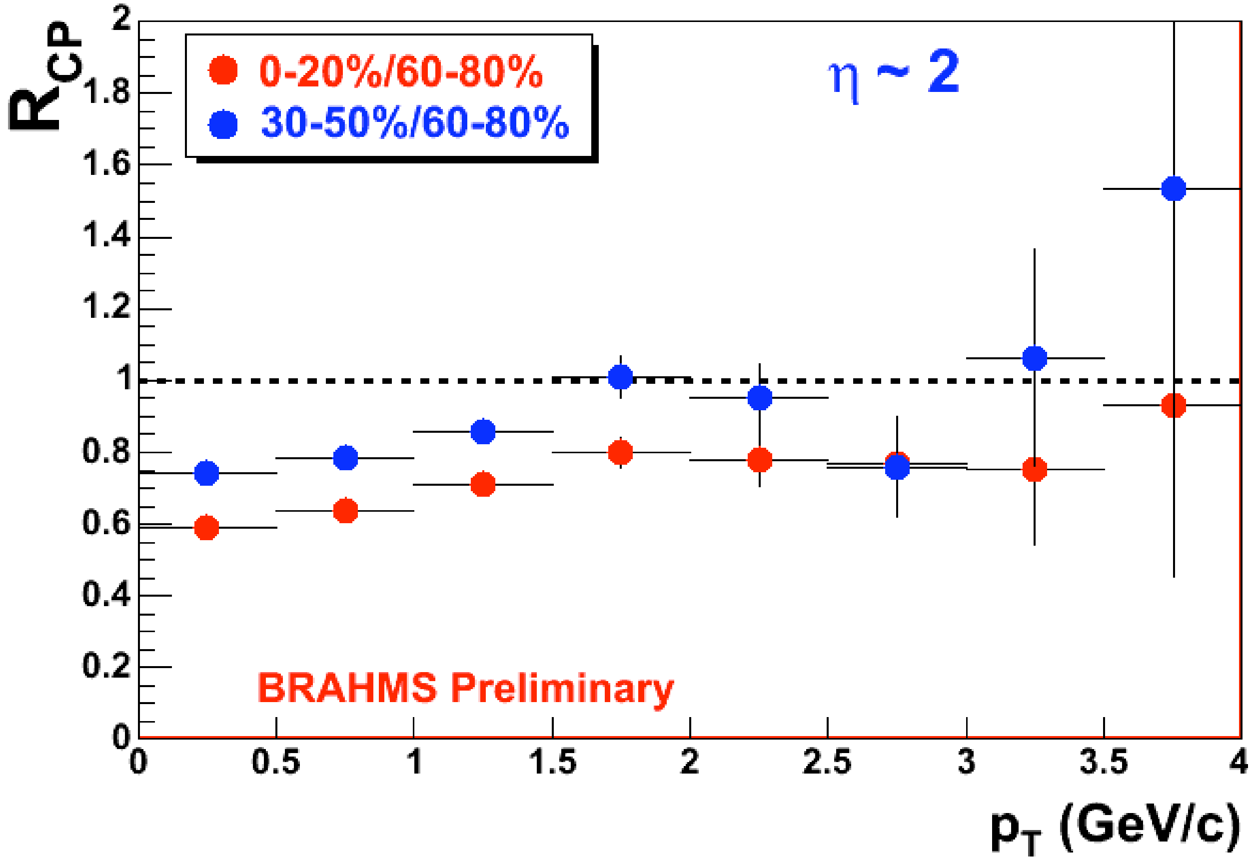

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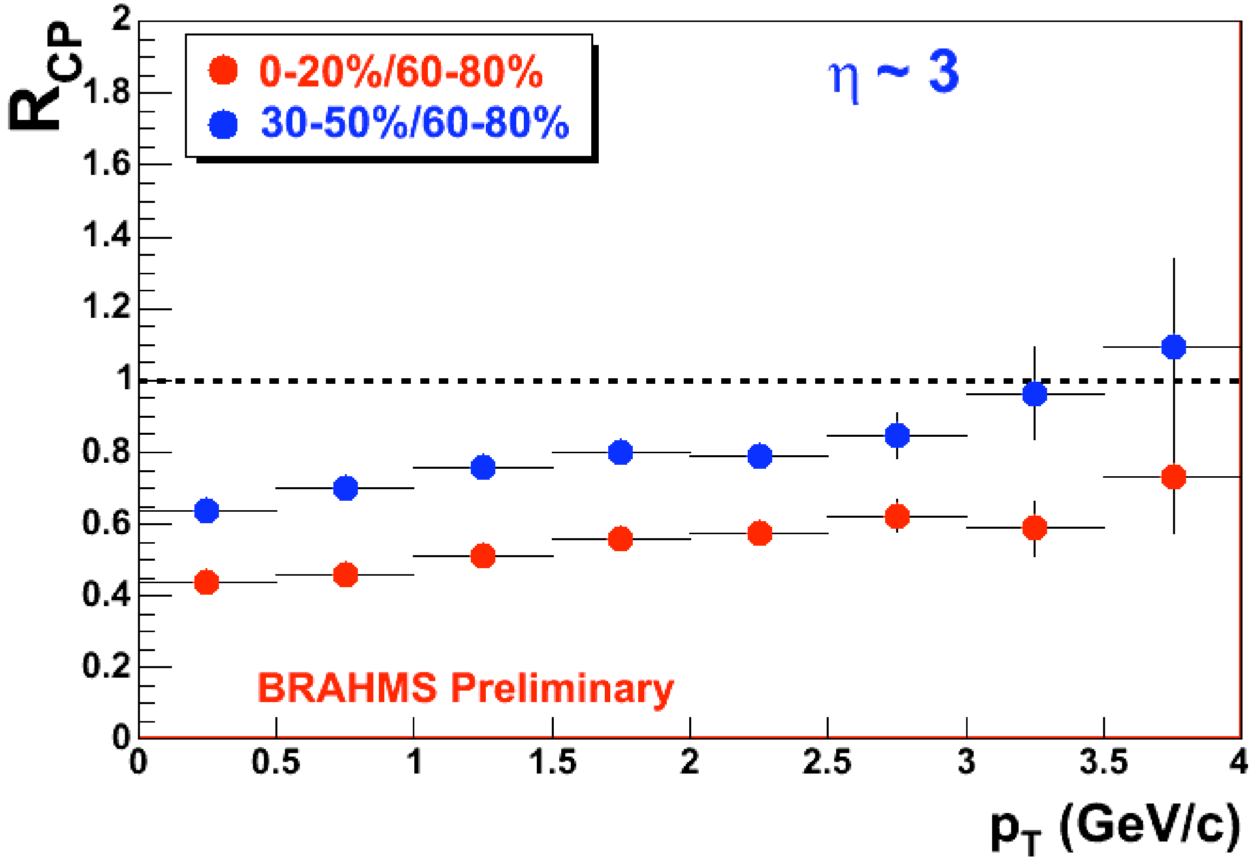

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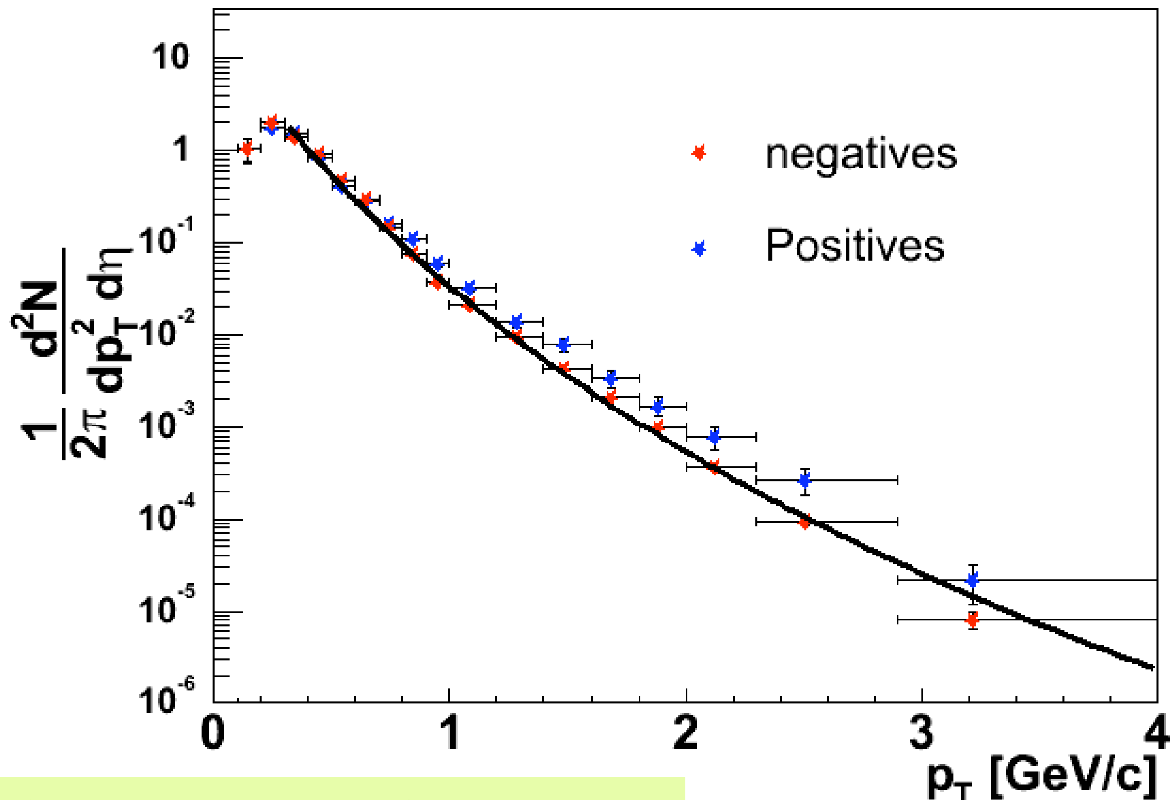
Discussion

BRAHMS has measured a clear modification of the Cronin peak as we detect charged particles at pseudo-rapidities ranging from 0 to 3.

We also found that particle yields at all values of p_T are more suppressed in central events at high rapidity.

Both results are consistent with a description of the Au wave function **evolving in ln(1/x)** (rapidity) into a saturated non-linear medium.

Positive and negative hadrons from d-Au at η~3



The results at η~3 have been attributed to **beam fragmentation** as the dominant process for η>3.

RIKEN High P_T Physics at RHIC Dec 2-6, 2003

Valence quarks fragment by "string breaking" with a 1/x "wee" parton distribution. The ratio of particle yields:

$(dN^{dAu}/d\eta)/(dN^{pp}/d\eta)$ drops from a maximum at $-\eta_{Au}$ to a minimum on the deuteron fragmentation side following a triangular distribution.

"$h^+ > h^-$ clear evidence of Valence quark fragmentation "

M. Gyulassy BNL 12.4.03

Summary and outlook

- **Compared to previous results at □=0, we have measured considerably smaller values of R_{dAu} at pseudo-rapidities 1, 2.2 and 3.2**

- **Yields of charged particles per binary collision are reduced in data samples of higher centrality.**

- We will put "final touches" to the present analysis and submit it for publication.

- We continue the analysis of Run III data with the full complement of our detectors. That analysis will reveal details of the "suppression" for different particles species (see Z. Yin's presentation this afternoon)

- Looby the RHIC community for additional d-Au running.

BRAHMS collaboration

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Brookhaven, Strasbourg, Krakov, Johns Hopkins, NYU, Niels Bohr.

Texas A&M, Bergen, Bucharest, Kansas, Oslo