Nuclear Modification Factors at BRAHMS

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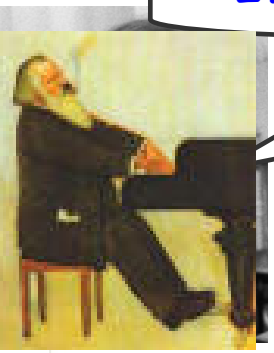
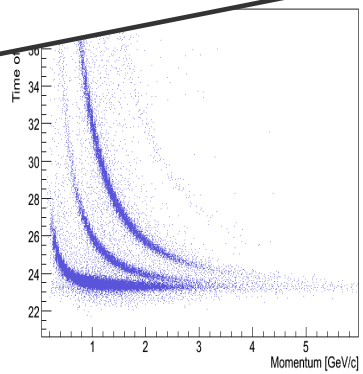
For the BRAHMS Collaboration

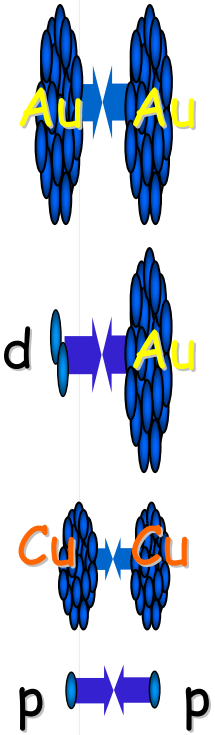
Outline

- BRAHMS experiment
- ✓ Nuclear Modification Factor
  - rapidity, system, energy dependence
  - dAu, AuAu, CuCu at 200, 62.4 GeV
- Summary

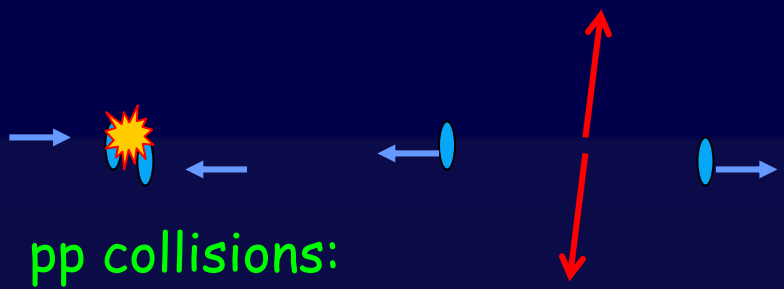
It's the Broad RAnge Hadron Magnetic Spectrometers!



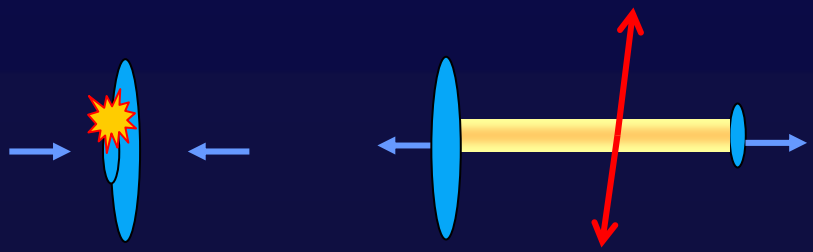




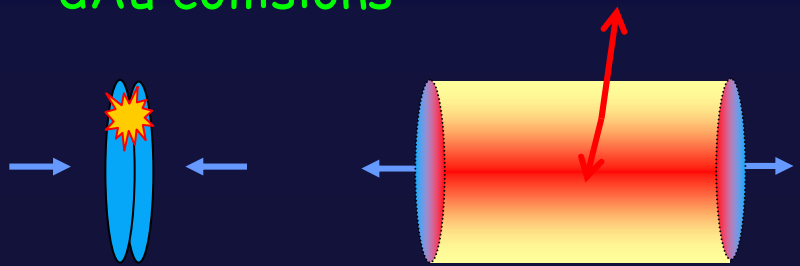
BRAHMS studies the properties of the produced medium as a function of rapidity…



pp collisions:
we need this as reference



dAu collisions



AuAu & CuCu collisions

- At the RHIC energies, hard scattering processes at high-p_T become important.
- Partons are expected to loose energy in the dense matter
- Different rapidities provide different densities of the medium : study nuclear modification in AA, dA with respect to pp via N_{coll} scaling to learn about QCD dynamics
- "Dialing" initial condition channel
- Rapidity dependent high p_T suppression factors : provide information on dynamical medium effect

Nuclear Modification Factor

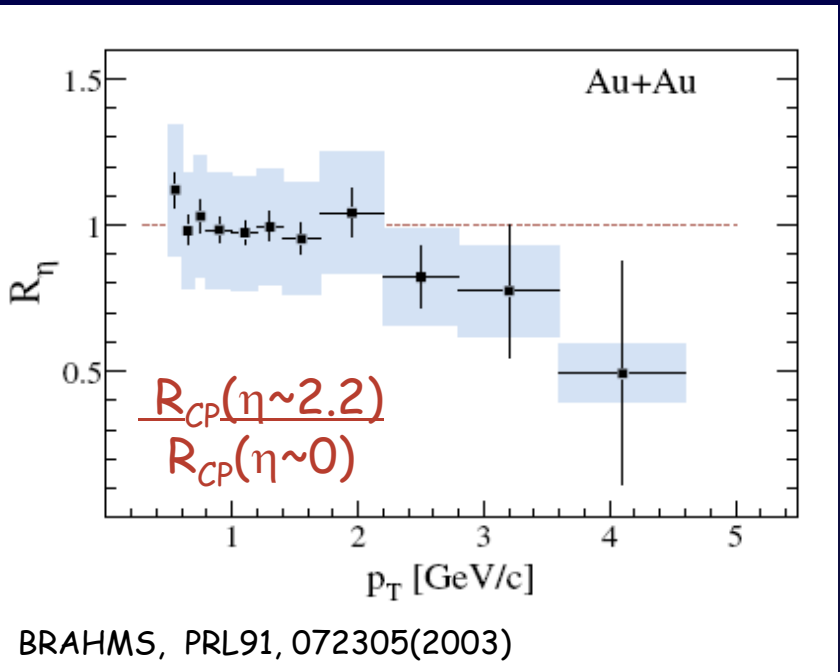
- quantify the nuclear effects

$$R_{AA} = \frac{\text{yield in AA/number of equivalent pp collisions}}{\text{yield in pp}}$$

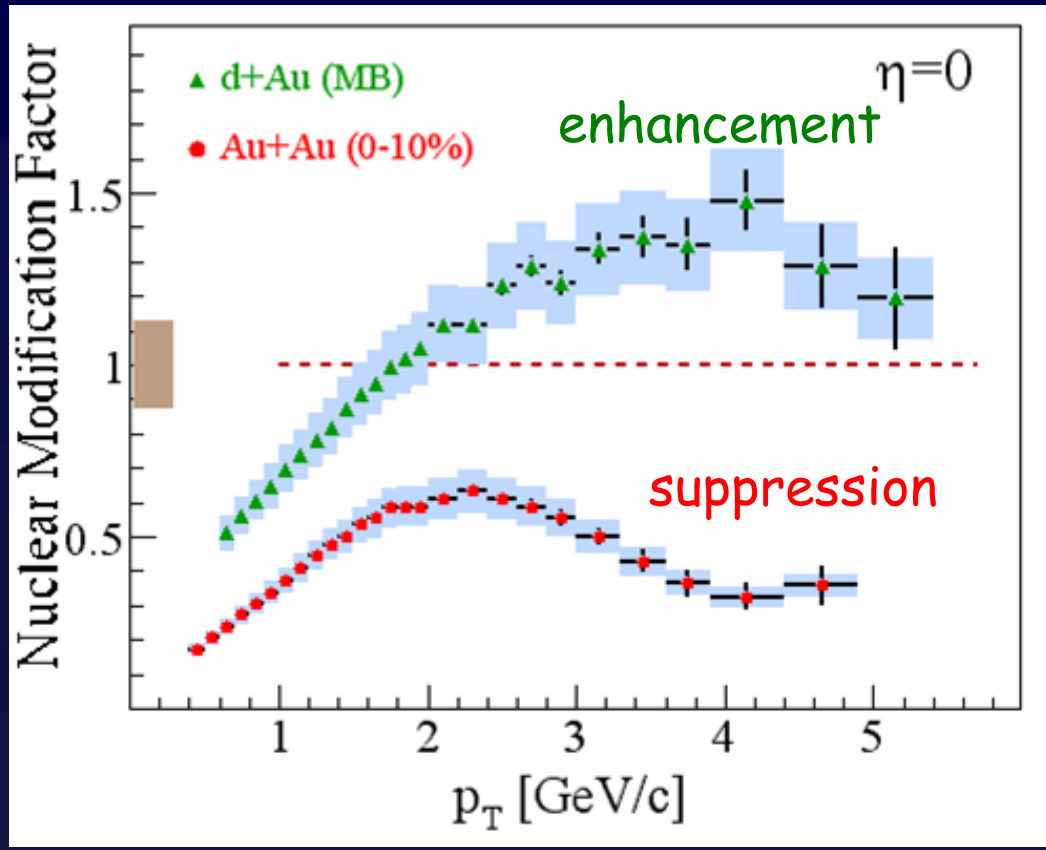
$$= \frac{1}{\langle n_{coll} \rangle} \frac{d^2N_{AB}/dy\,dp_T}{d^2N_{pp}/dy\,dp_T} = \frac{1}{\sigma_{pp} \langle T_{AB} \rangle} \frac{d^2N_{AB}/dy\,dp_T}{d^2N_{pp}/dy\,dp_T}$$

$$R_{cp} = \frac{\text{yield in central events/}\langle N_{coll} \rangle_{cent}}{\text{yield in peripheral events/}\langle N_{coll} \rangle_{peripheral}}$$

R_{dAu}, R_{AuAu} at η=0, η~2.2



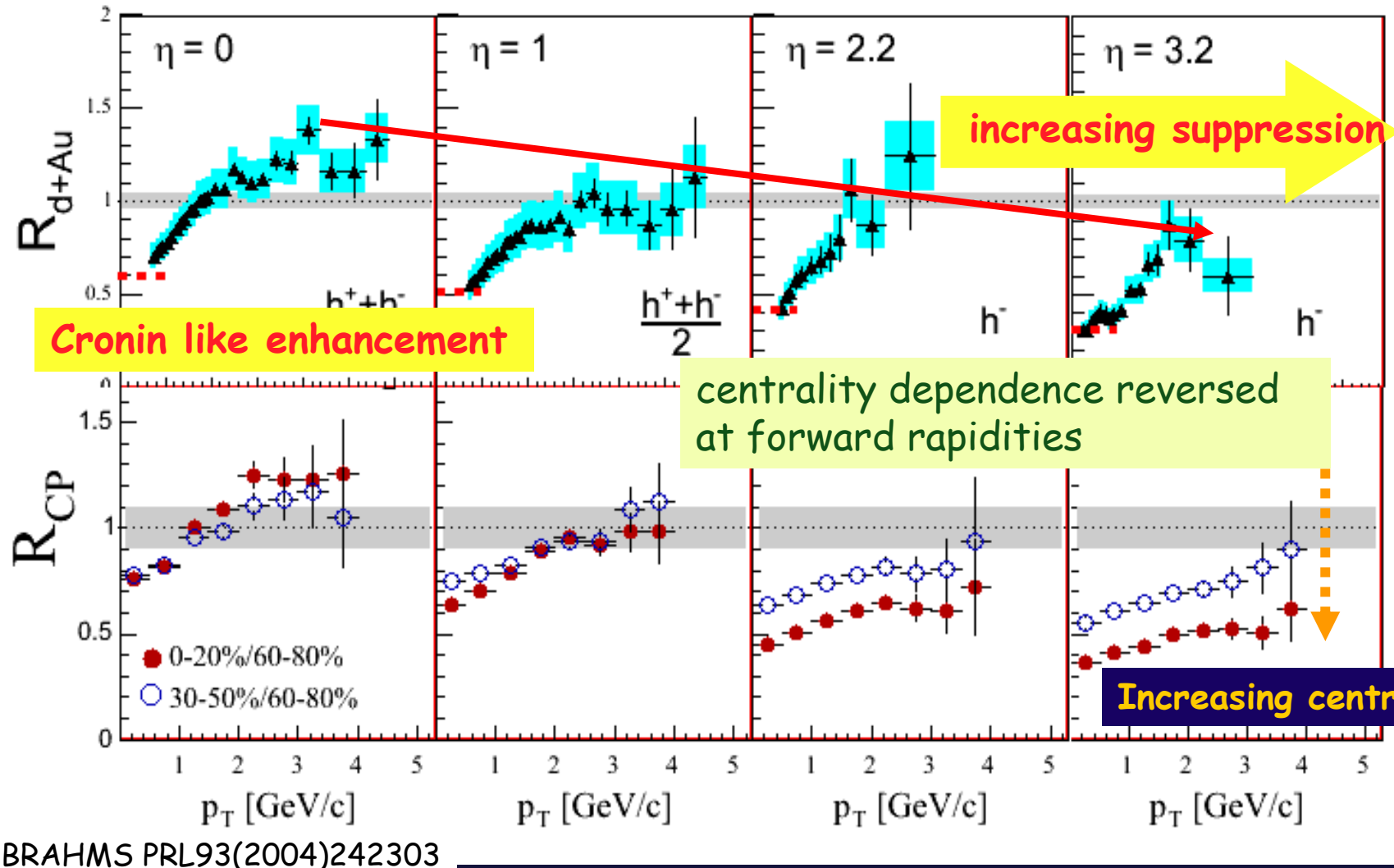
BRAHMS, PRL91, 072305(2003)



Nuclear Modification at higher rapidity

- Longitudinally extended source?
- And/or Initial state effect enhancing?

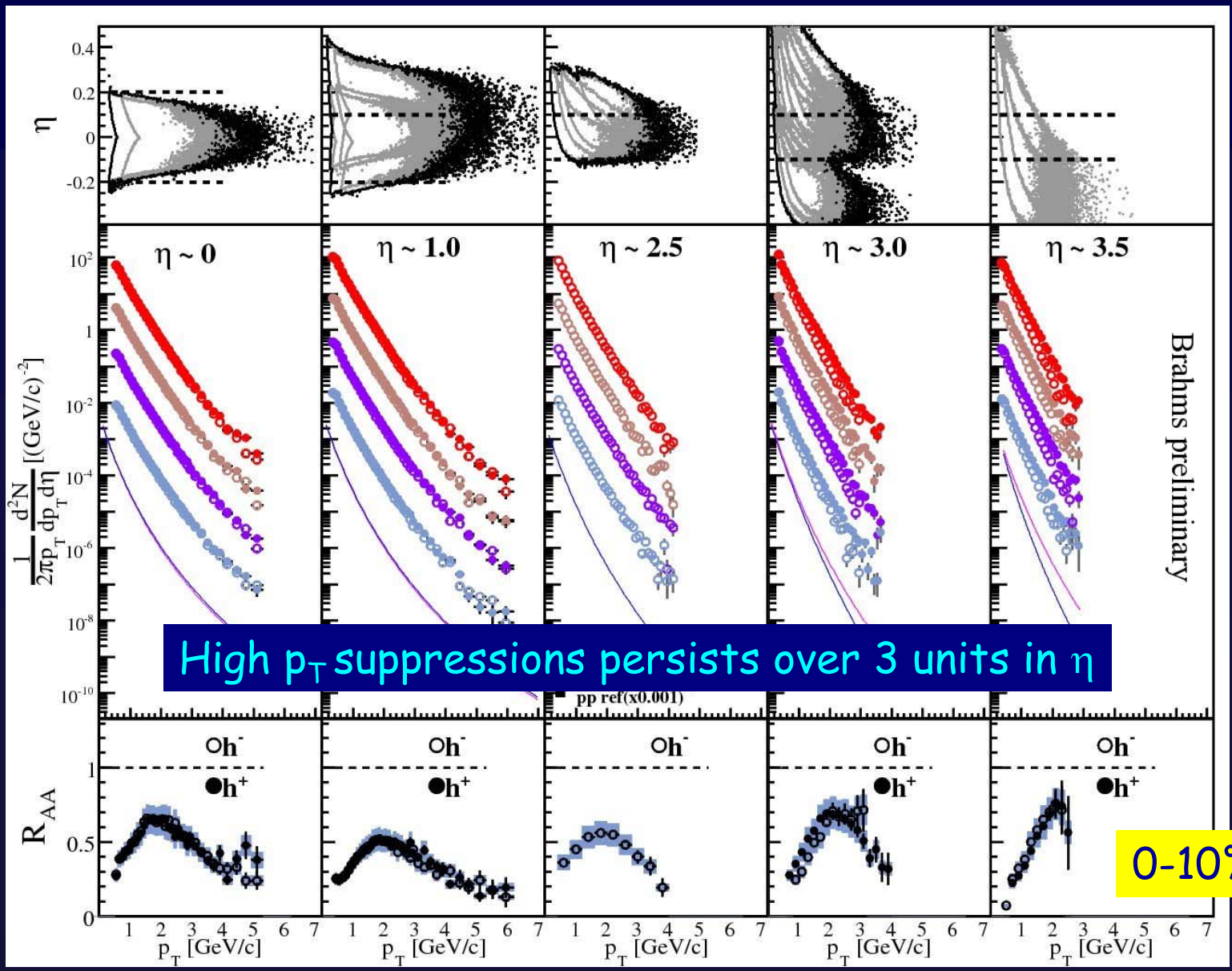
dAu results as a function of η & centrality



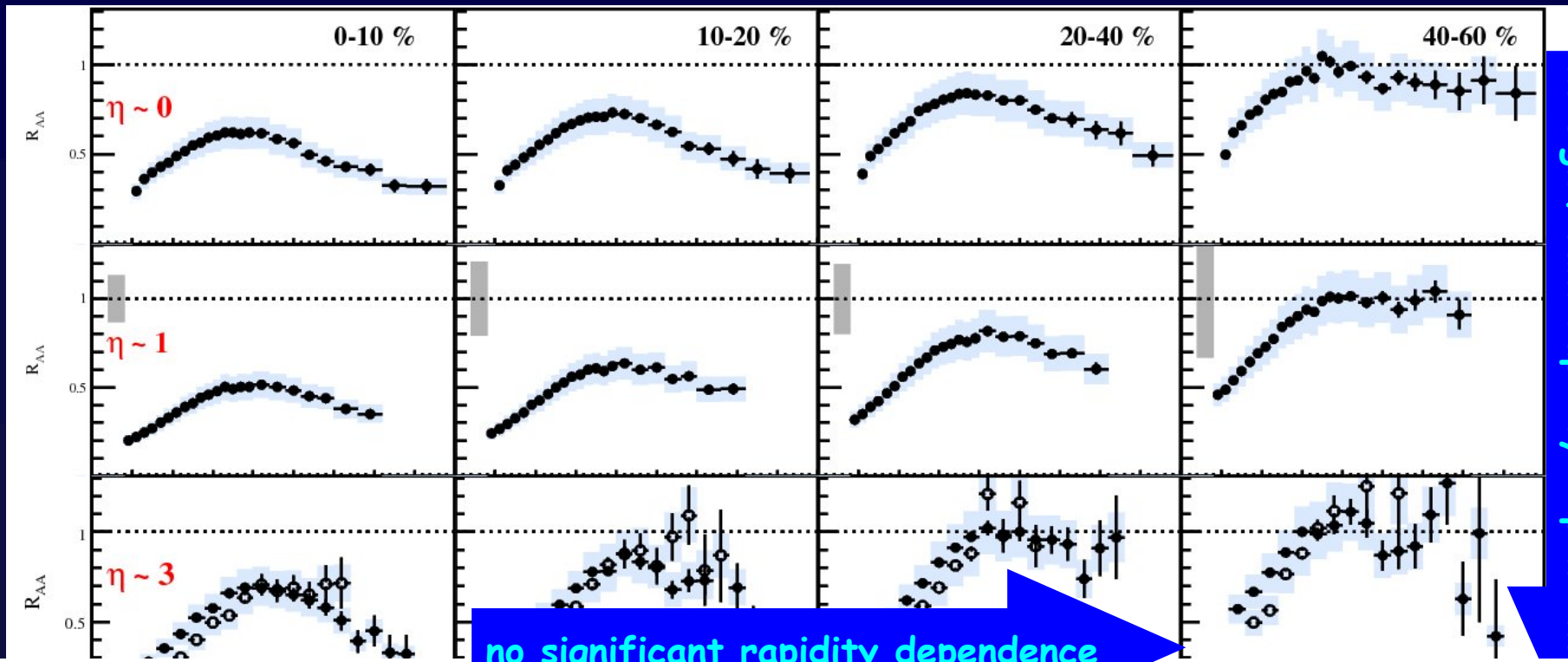
BRAHMS PRL93(2004)242303

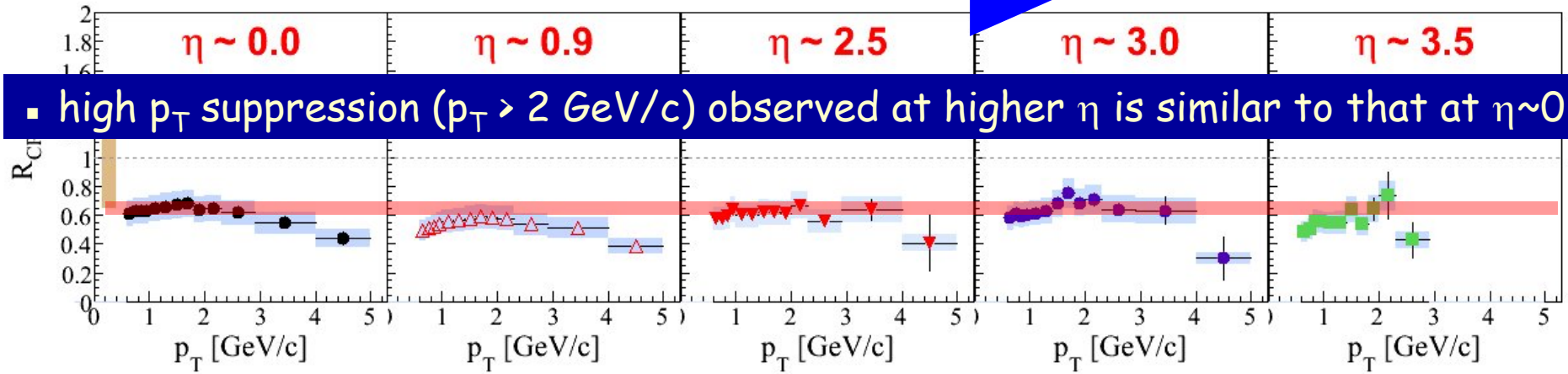
The data are described by CGC models [PLB599(2004) 23], and have given rise to other interpretations and additional measurements. [Phys. Rev. C71 (2005) 024902]

Rapidity dep. R_{AuAu} : $h^{\pm}$ at 200 GeV



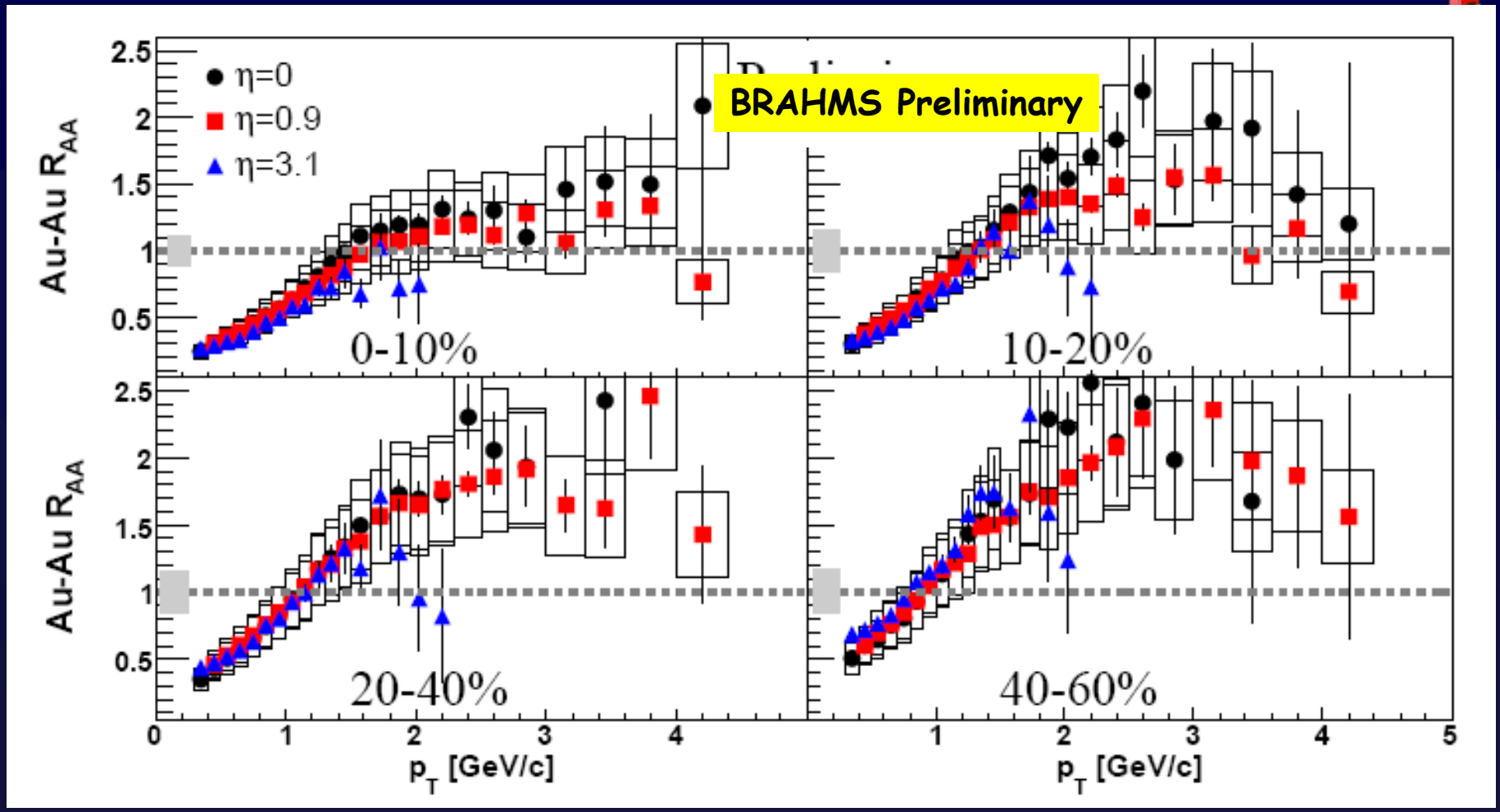
Centrality dependence of R_{AuAu} & R_{CP}





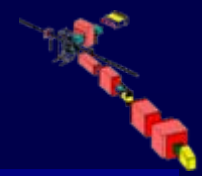
- high p_T suppression (p_T > 2 GeV/c) observed at higher η is similar to that at η~0

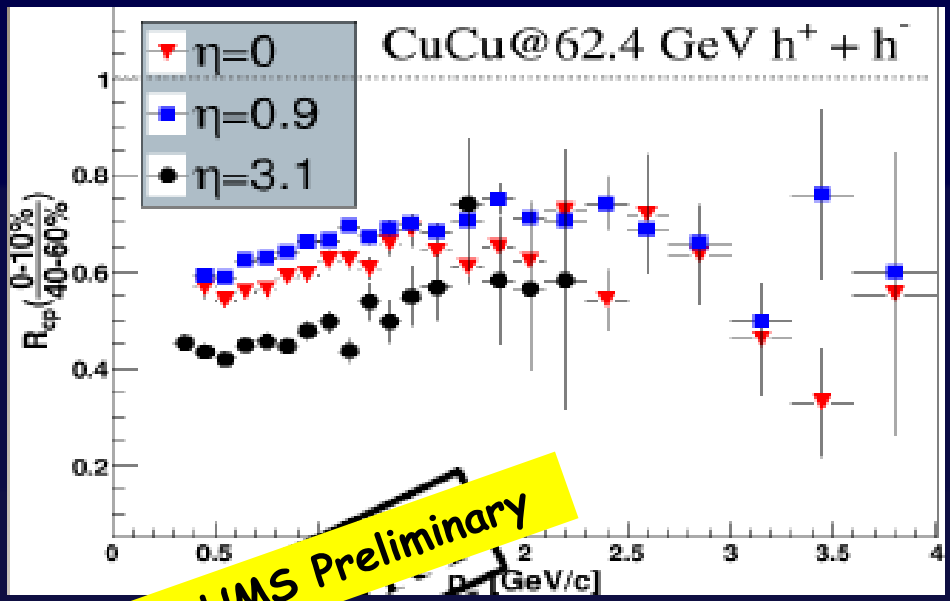
R_{AuAu} of hadron at 62.4 GeV

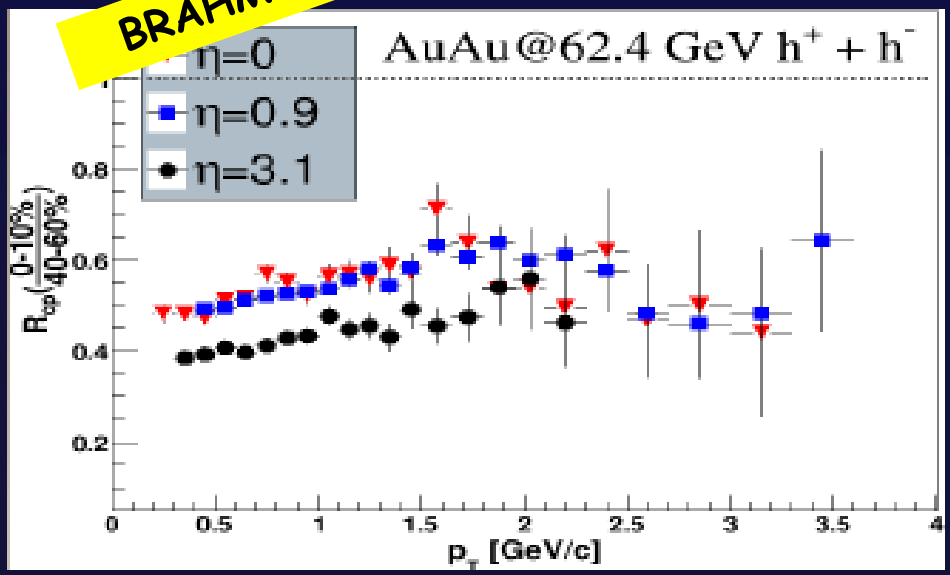


- R_{AuAu}(62.4GeV) > R_{AuAu}(200 GeV) at p_T > 2GeV/c & no rapidity dependence
- more peripheral, less suppression : depends on geometry of system?
- consistent with weak effects of a dense medium and a return of Cronin type enhancements

R_{CP}, R_{CuCu} of hadron at 62.4 GeV

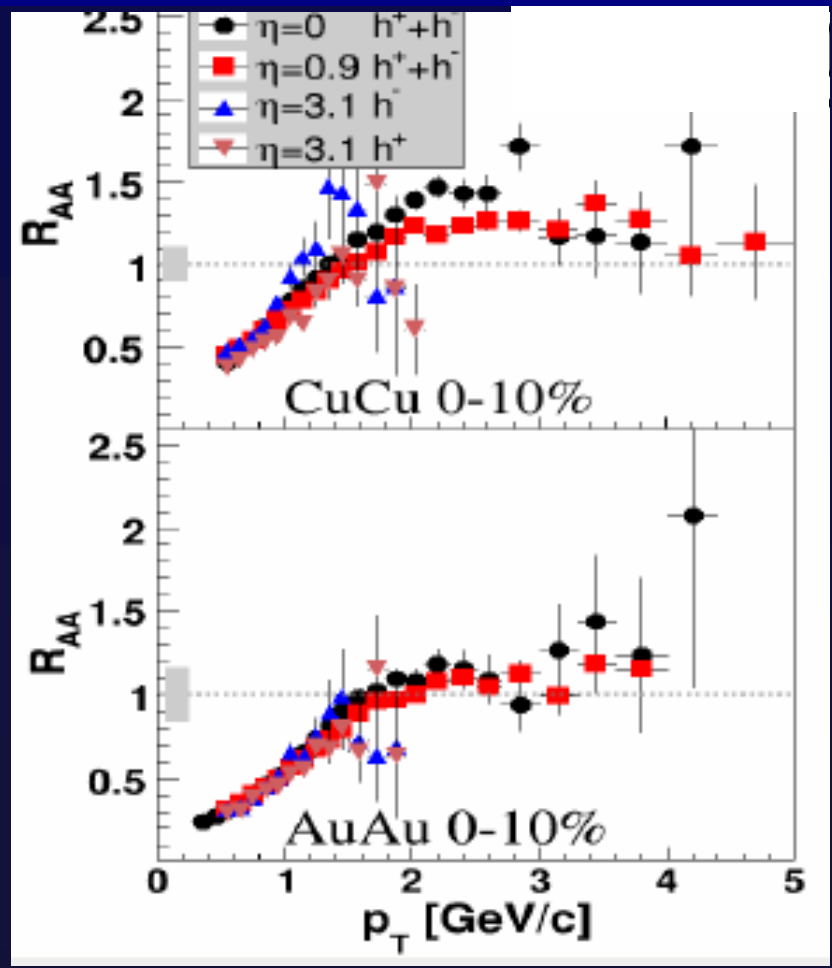






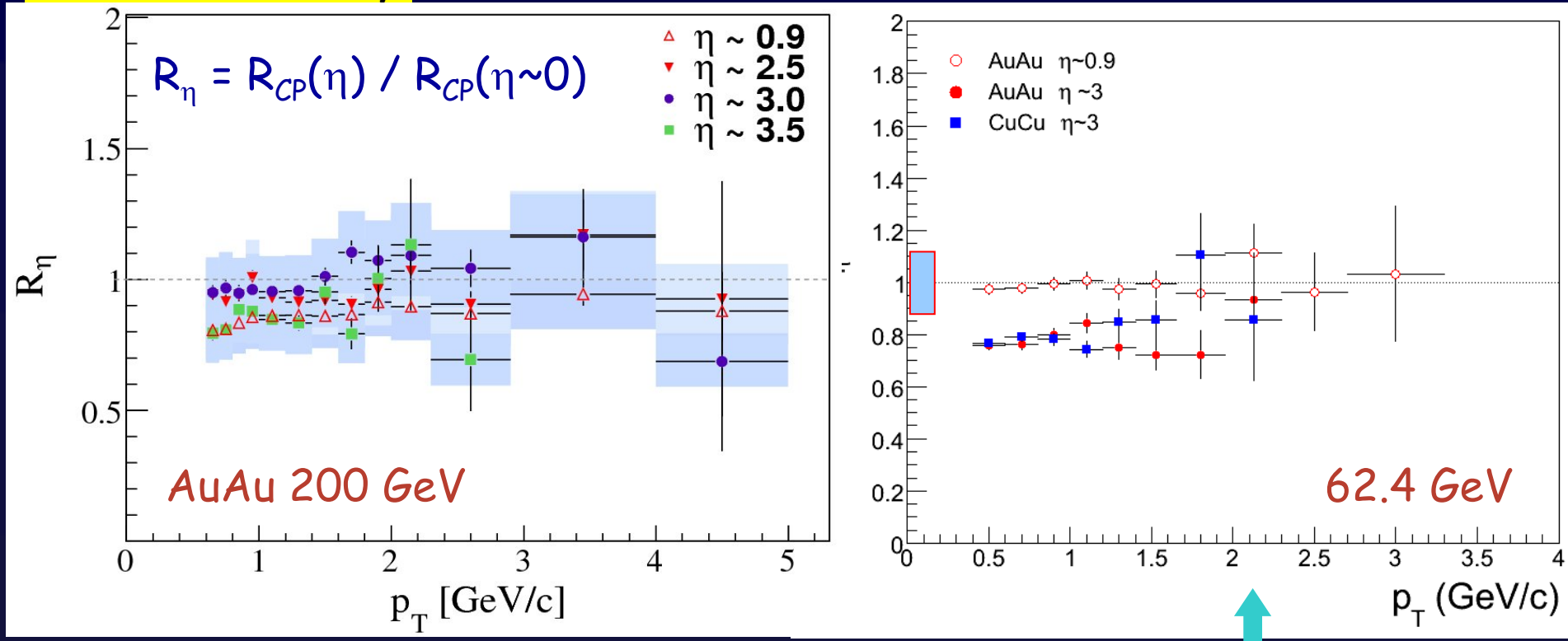
BRAHMS Preliminary

- no p_T dependence
- no dependence on system size
- no rapidity dependence



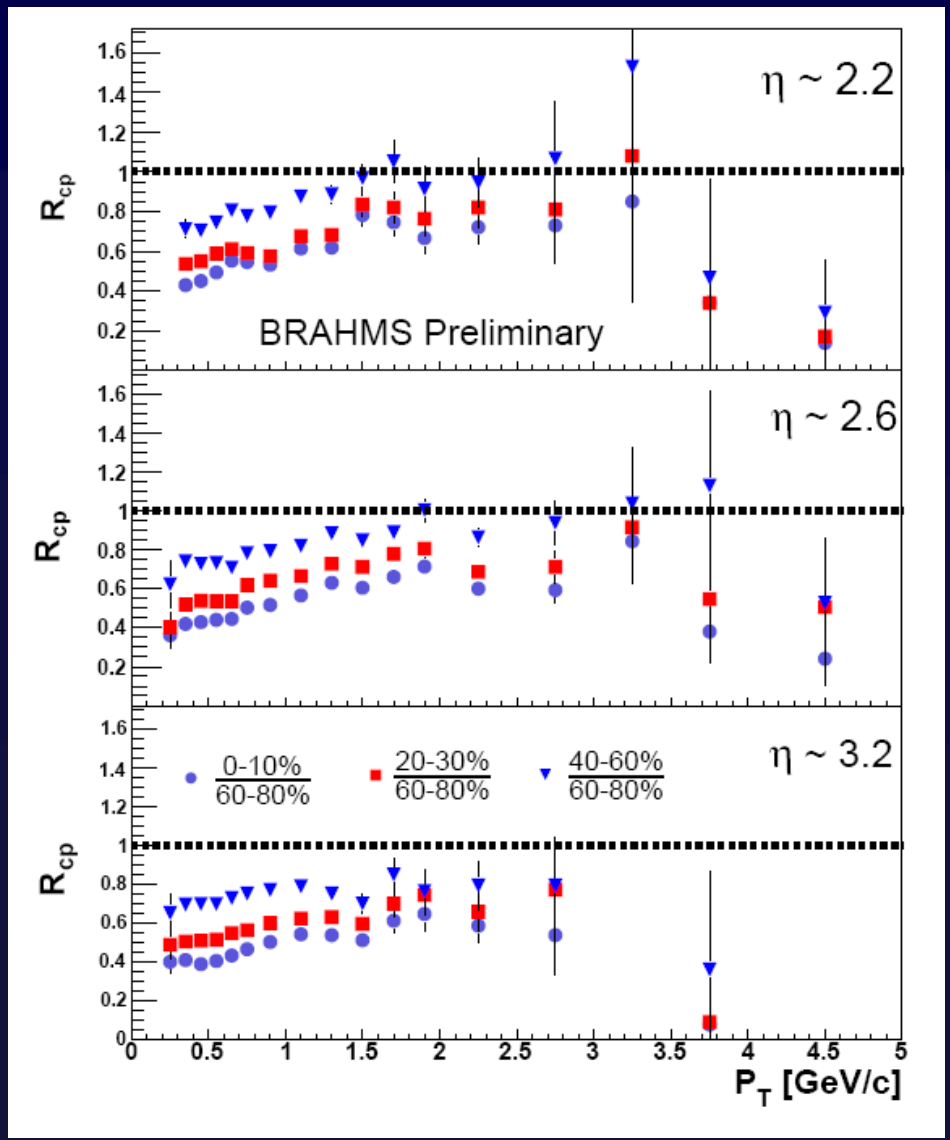
R_η from R_{CP} at 200, 62.4 GeV

BRAHMS Preliminary



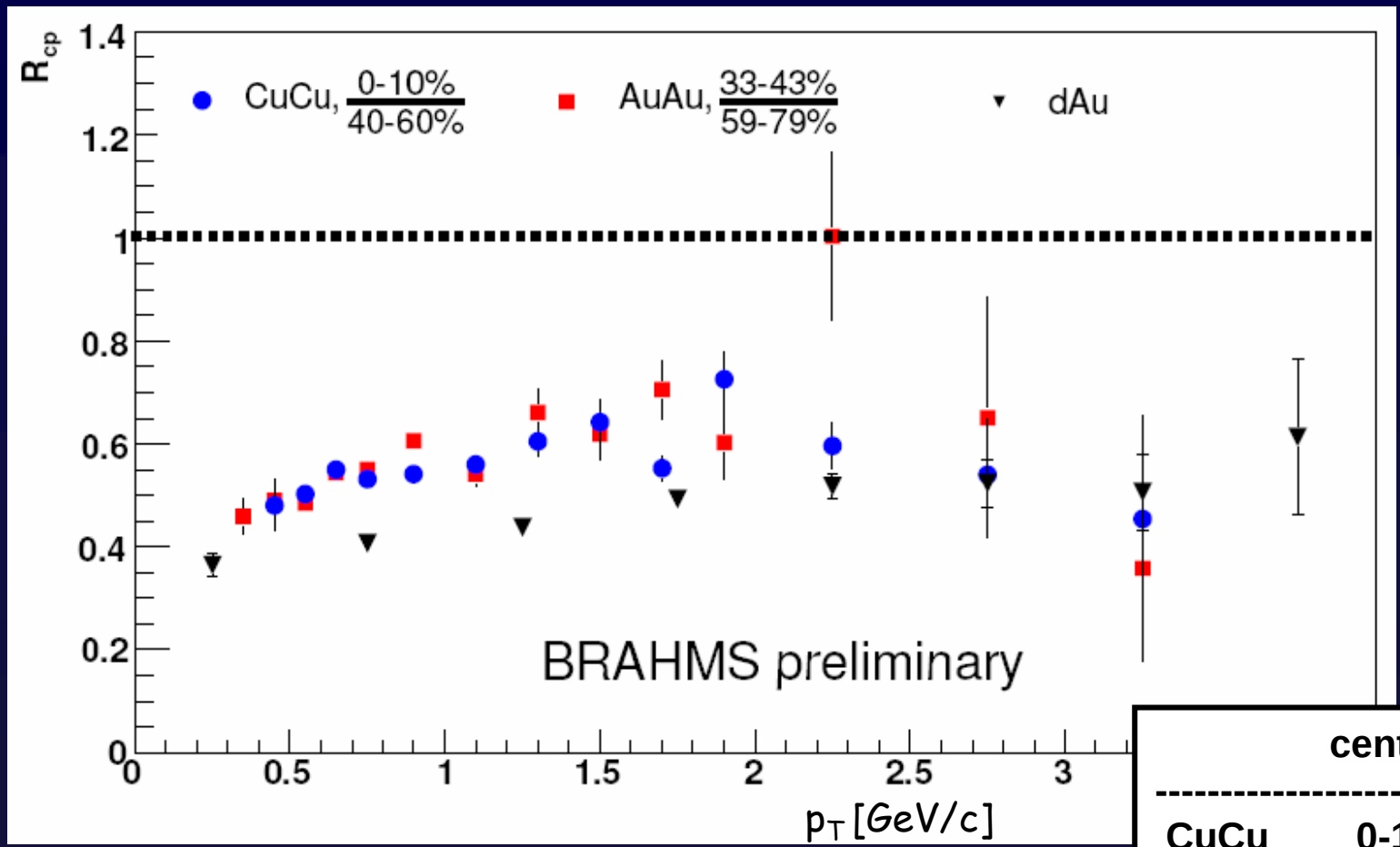
- R(η~3) < R(η~0.9) at low energy

R_{CP} at CuCu 200 GeV



- more suppression as the collisions become more central
- little dependence on η
- similar effect as seen AuAu

R_{CP} : dependency on system size at 200 GeV

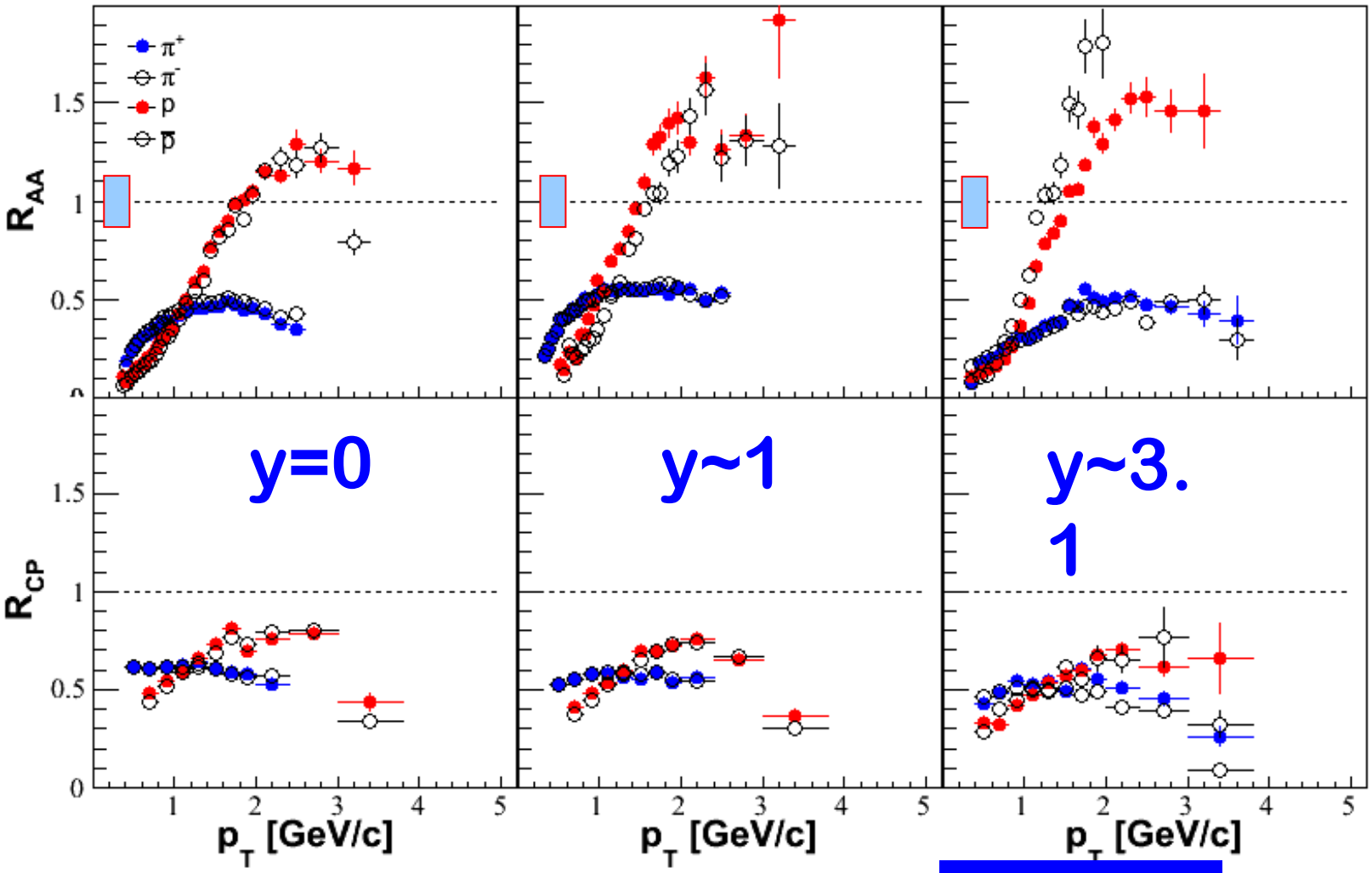


	centrality	N_{part}
CuCu	0-10%	96.8
	40-60%	17.2
AuAu	33-43%	96.3
	59-79%	15.7
dAu	0-20%	14.6
	60-80%	4.8

- Forward central CuCu looks like forward peripheral AuAu
- R_{CP} depends on N_{part}

R_{AuAu}, $R_{CP}(\pi, p)$ at 200GeV

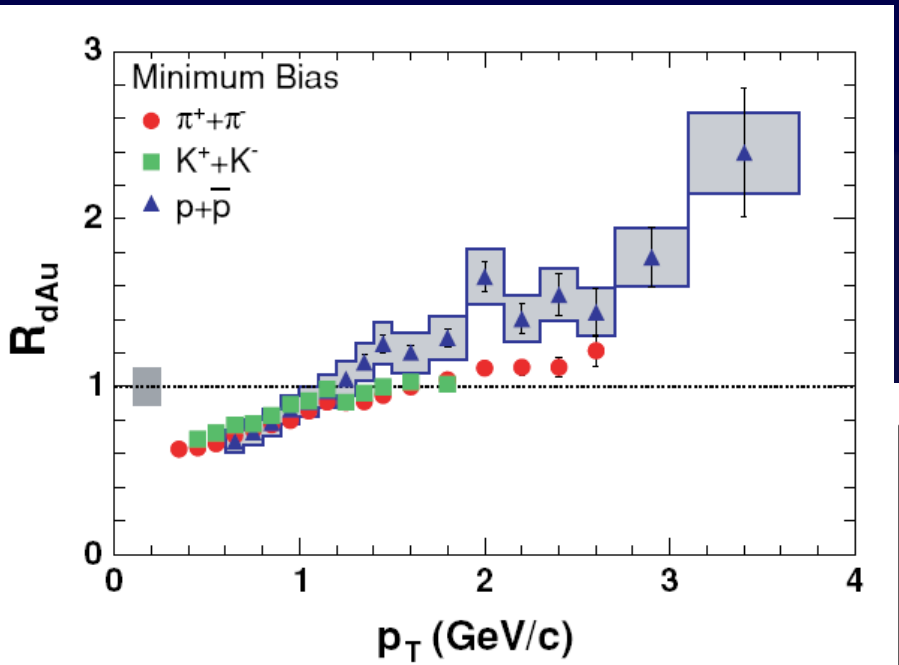
Suppression for pions



BRAHMS Preliminary

R_{AuAu}: $\pi < p$

R_{dAu} at Forward rapidity



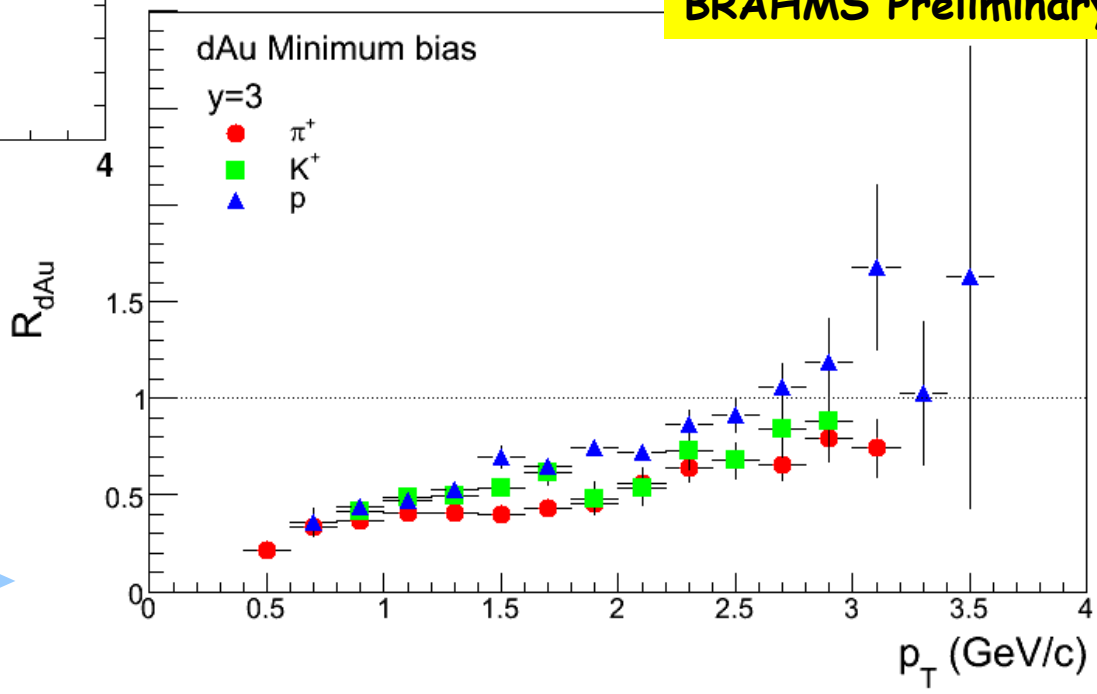
PHENIX PRC74, 024904(2006)

more suppressed at forward

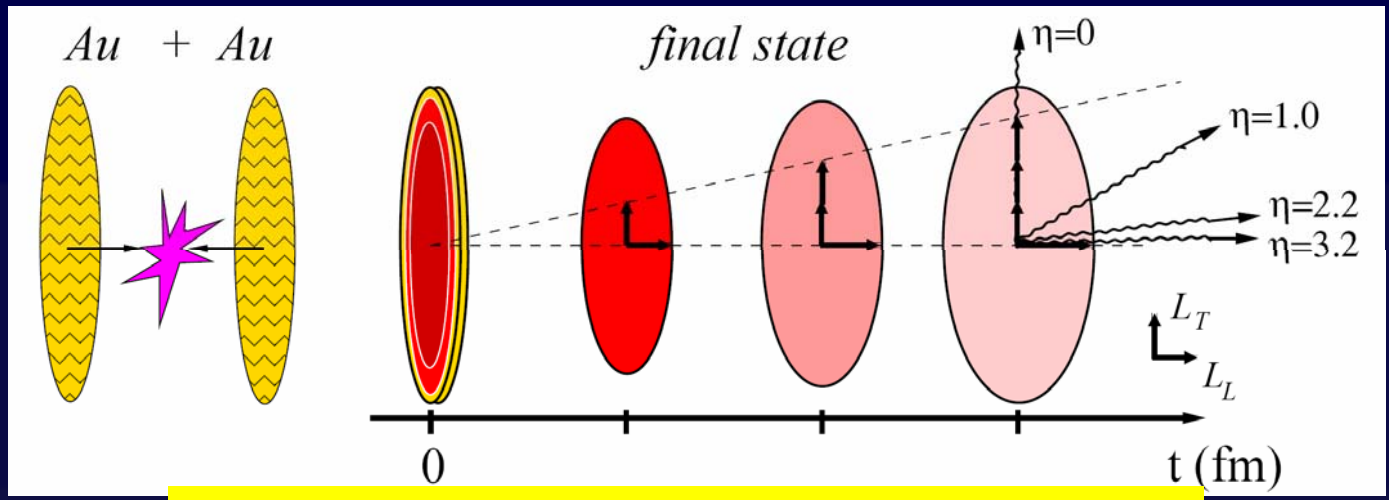
baryons : enhancement

R_{dAu}(p) suppression up to 2.5 GeV/c

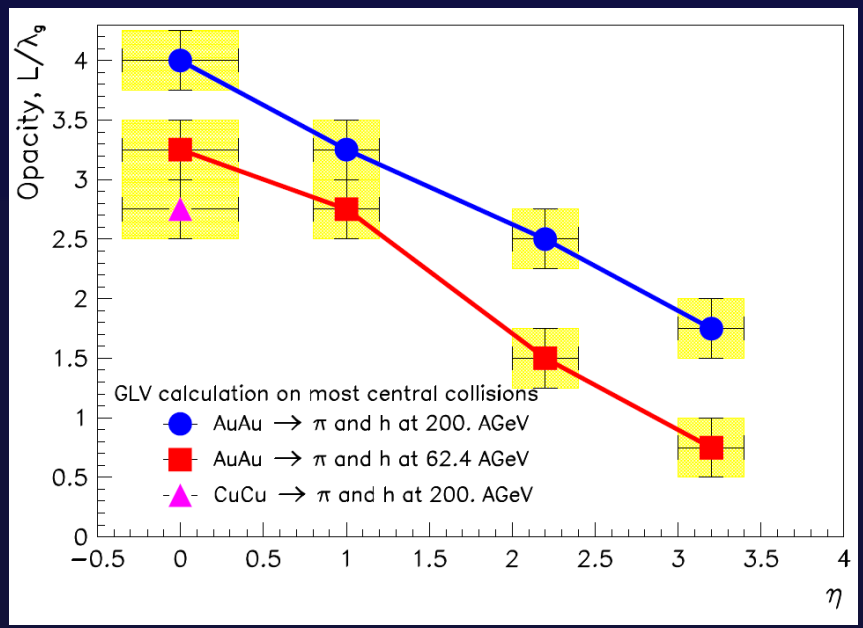
BRAHMS Preliminary



Forward Tomography: Dynamics + Geometry



G. Barnaföldi, Lévai, Papp, Fai: nucl-ph/0609023



- Shadowing + MS + Energy Loss
- "Extracted" opacity indicates longitudinally traveling partons see less colored field
- Not a prediction : Assuming rapidity independent suppression factor

L/λ : mean value of jet scattering

Summary

Nuclear Modification Factors at BRAHMS show

- suppression at forward rapidity, too : R_{AA}, R_{dAu}
- no significant rapidity dependence : R_{AA}

✓ Non-hadronic energy loss through the medium in |y|<3:

- centrality dependence (the geometry of the system) : R_{AA}, R_{dAu}
- energy dependence, quantitatively : R_{AA}
- more suppression for mesons than baryons : R_{AuAu}, R_{dAu}

✓ Forward suppression indicates that there most likely is some interplay between initial state (e.g. shadowing) and final state (suppression in the thin slice of deconfined matter, energy loss) effects.

✓ needs more theoretical/experimental understanding on dynamics of particle suppression/production at RHIC

The BRAHMS Collaboration

I. Arsene[9,11], I.G. Bearden[6], D. Beavis[1], S.Bekele[10], C. Besliu[9], B. Budick[5], H. Bøggild[6], C. Chasman[1], C. H. Christensen[6], P. Christiansen[6], R.Clarke[9], R.Debbe[1], J. J. Gaardhøje[6], K. Hagel[7], H. Ito[1], A. Jipa[9], J. I. Jordre[8], F. Jundt[2], E.B.Johnson[10], J.I.Jordre[8], C.Jørgensen[6], R. Karabowicz[3], E. J. Kim[10], T.M.Larsen[6], J. H. Lee[1], Y. K.Lee[4], S.Lindal[11], G. Løvhøjden[2], Z. Majka[3], M. Murray[10], J. Natowitz[7], B.S.Nielsen[6], D.Ouerdane[6], R.Planeta[3], F. Rami[2], C.Ristea[6], O.Ristea[9], D. Röhrich[8], B. H. Samset[11], S. J. Sanders[10], R.A.Sheetz[1], P. Staszel[3], T.S. Tveter[11], F.Videbæk[1], R. Wada[7], H.Yang[8], Z. Yin[8], and I. S. Zgura[9]

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