Transverse and Longitudinal Dynamics at RHIC

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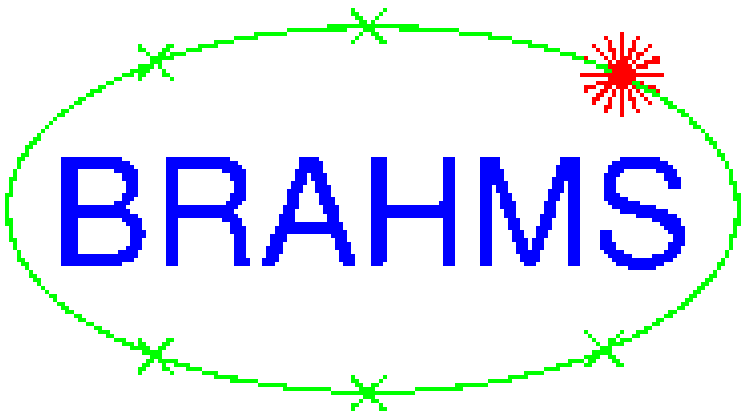

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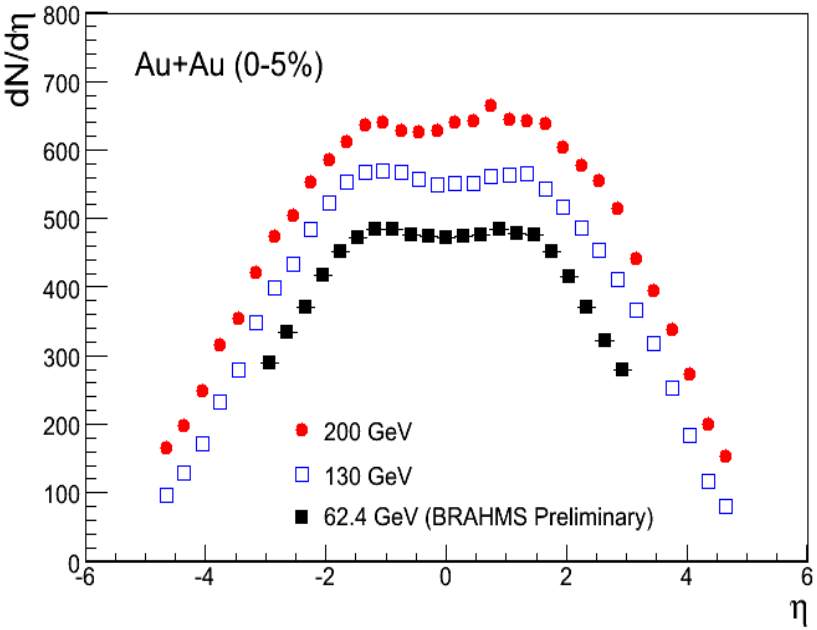
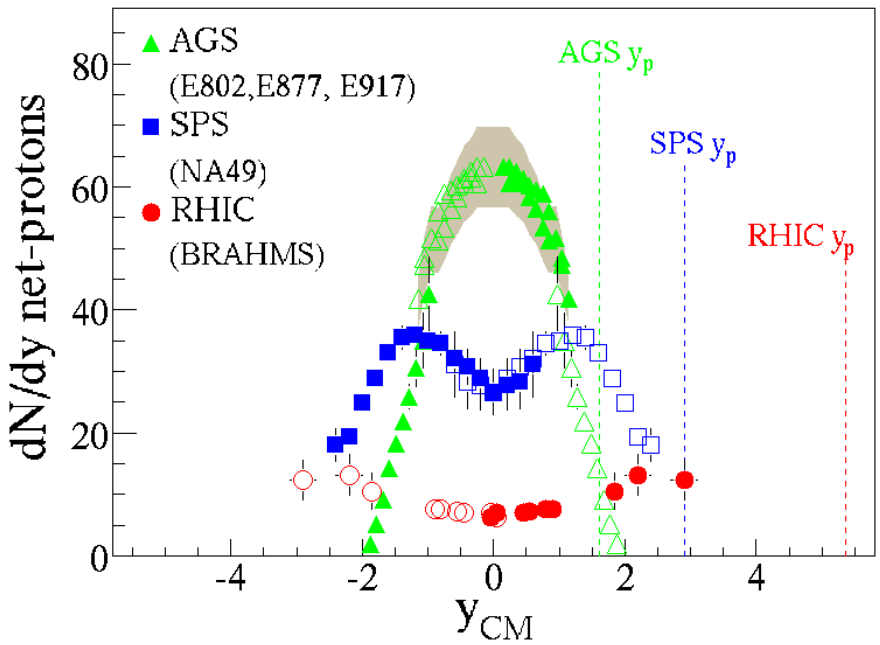
Outline

- General (bulk) characteristics of nucleus-nucleus reactions.
- Nuclear effects at mid- and forward rapidity (R_{AA} and p/π)
- Elliptic Flow
- Testing pQCD at large rapidities in p+p
- Summary.

Particle production and energy loss





Energy density: Bjorken 1983

$e_{BJ} = 3/2 \times (\langle E_t \rangle / \pi R^2 \tau_0)\, dN_{ch}/d\eta$

assuming formation time t_0=1fm/c:

>5.0 GeV/fm^3 for AuAu @ 200 GeV

>4.4 GeV/fm^3 for AuAu @ 130 GeV

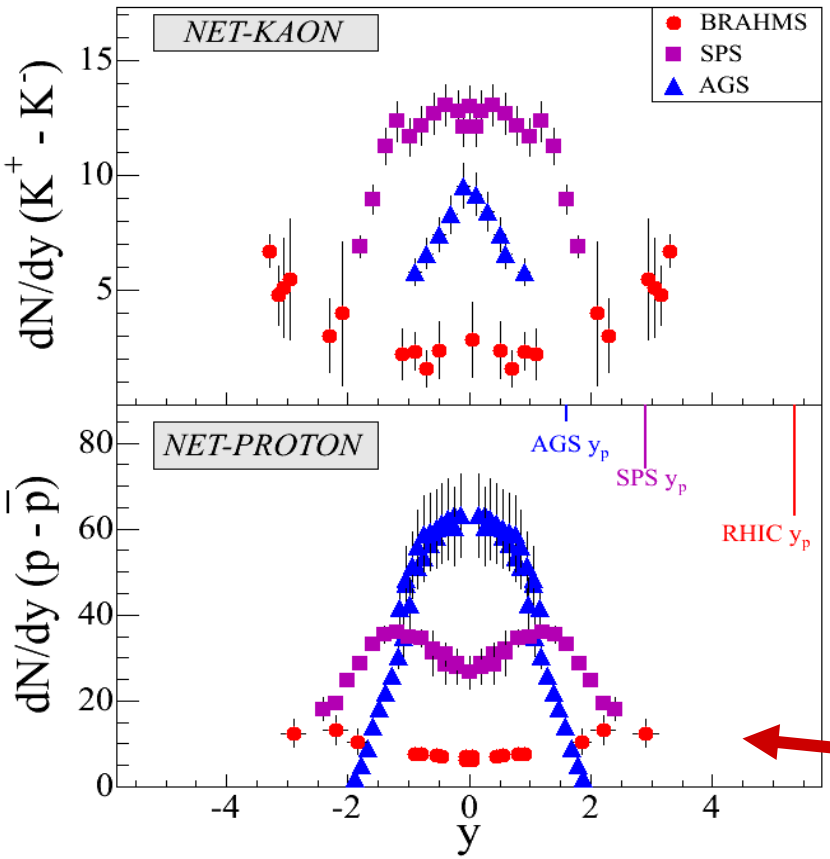
>3.7 GeV/fm^3 for AuAu @ 62.4 GeV

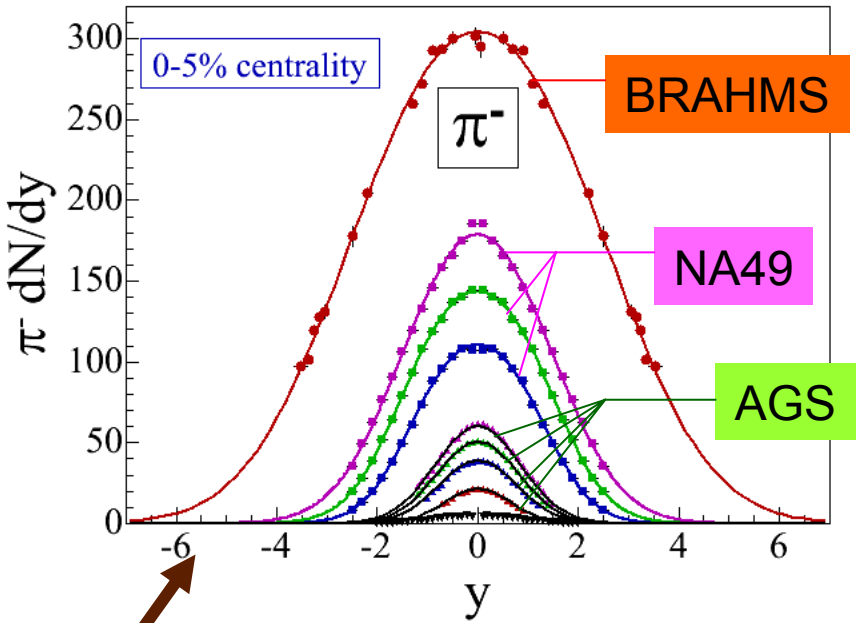
$$\int_{-y_p}^{y_p} \langle m_T \rangle_y \frac{dN_{(B-\bar{B})}}{dy} \cosh y \, dy$$

Total ΔE=25.7±2.1TeV

72GeV per participant

Primary versus produced matter





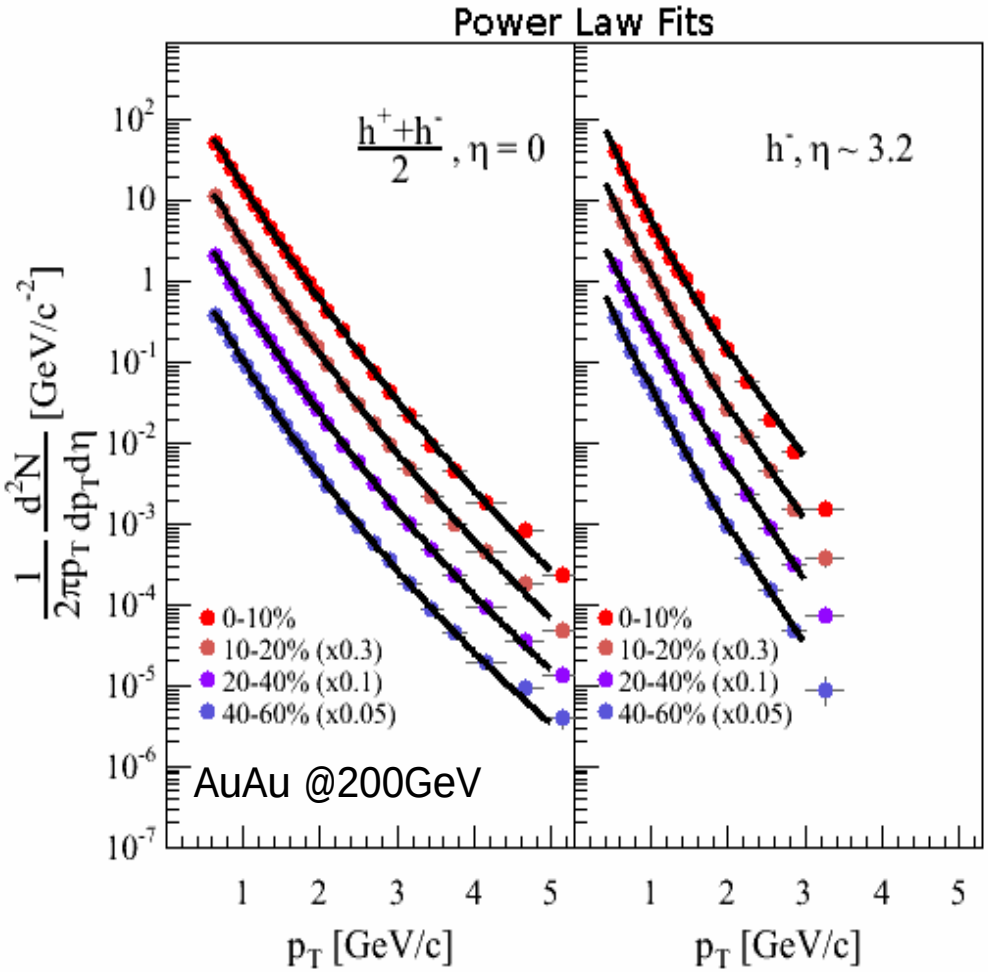
At 200GeV

created matter is picked at y=0

primary matter is concentrated around y≈3 (δy≈2.0)

- longitudinal net-kaon evolution similar as net-proton in |y|< 3 at RHIC (AuAu @ 200 GeV)
- strong "association": net-kaon / net-lambda /net-proton?

Nuclear effects



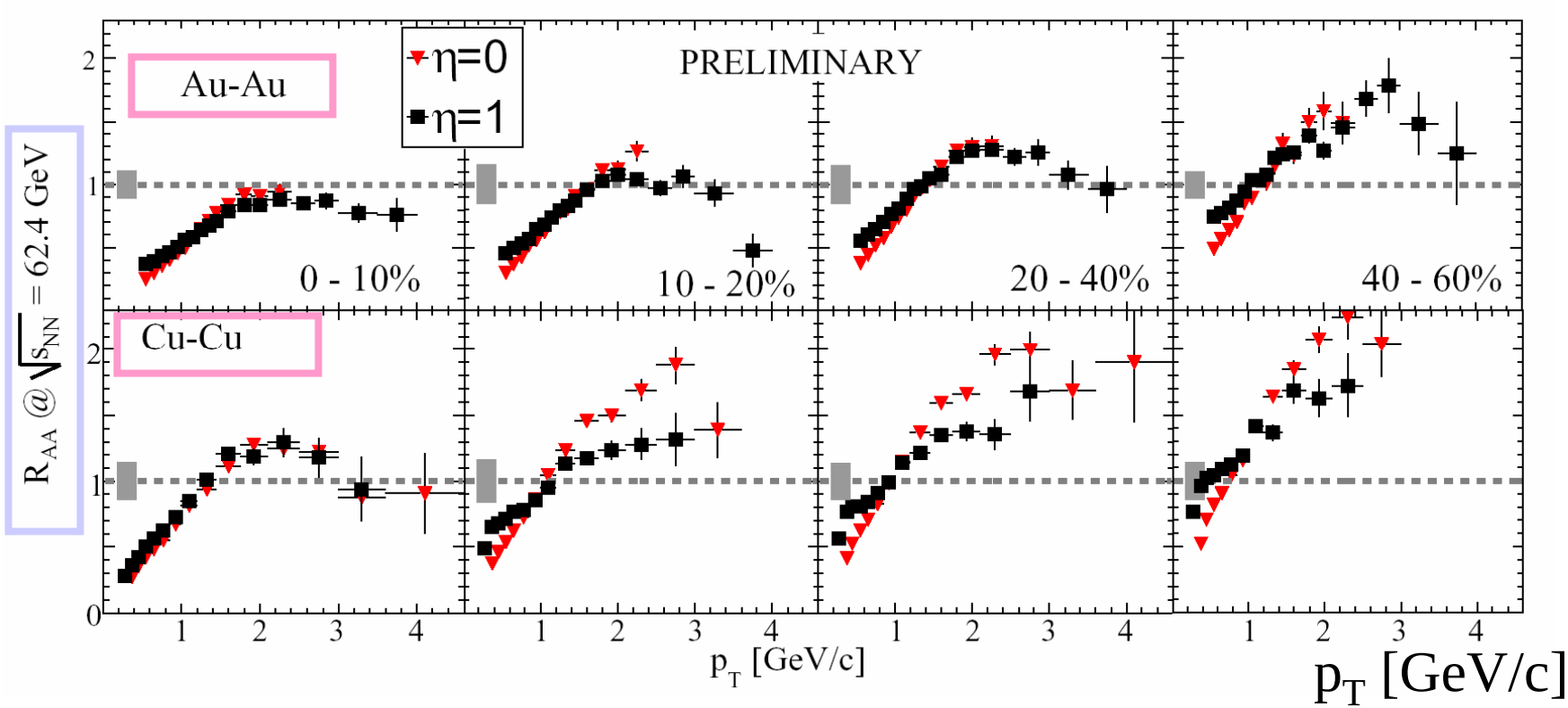
Nuclear Modification Factor

$$R_{AA} = \frac{\text{Yield(AA)}}{N_{COLL}(AA) \times \text{Yield(NN)}}$$

Scaled N+N reference

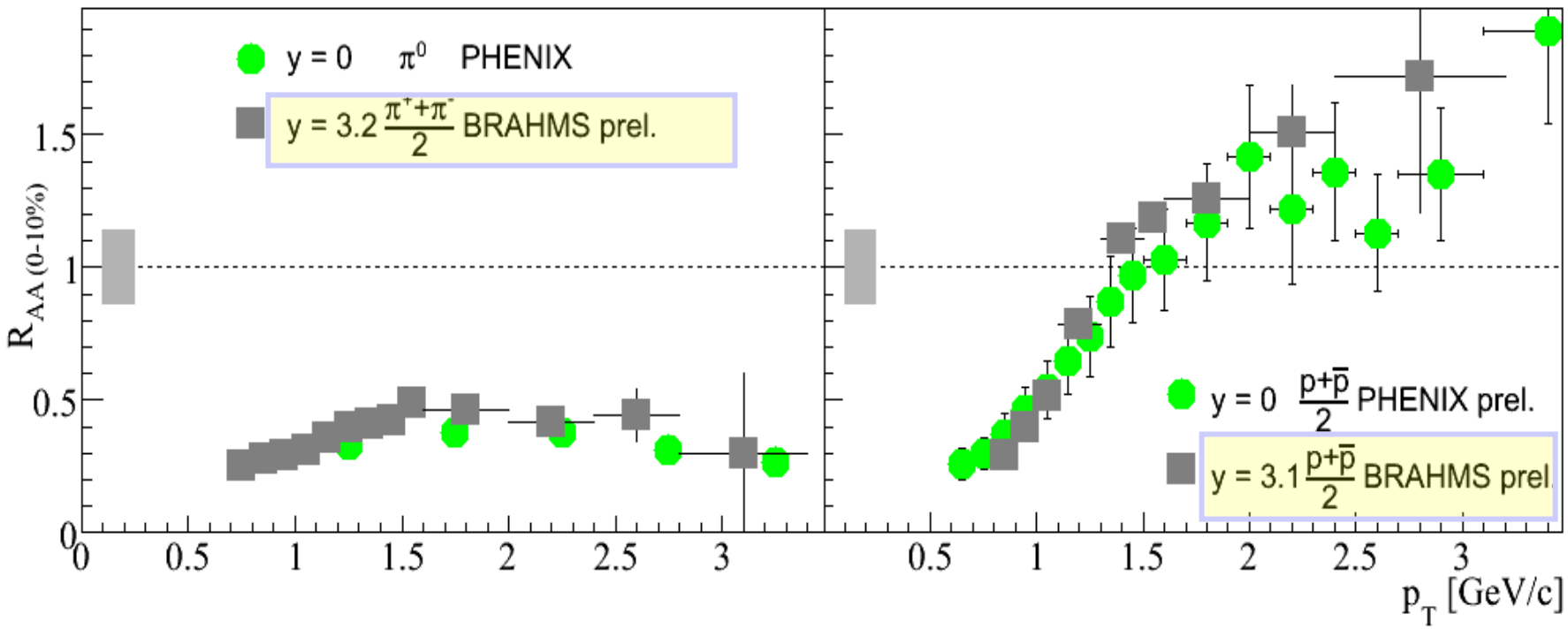
R_{AA}<1 ↔ Suppression relative to scaled NN reference

Energy and system dependent nuclear modification factors at h~0 and 1



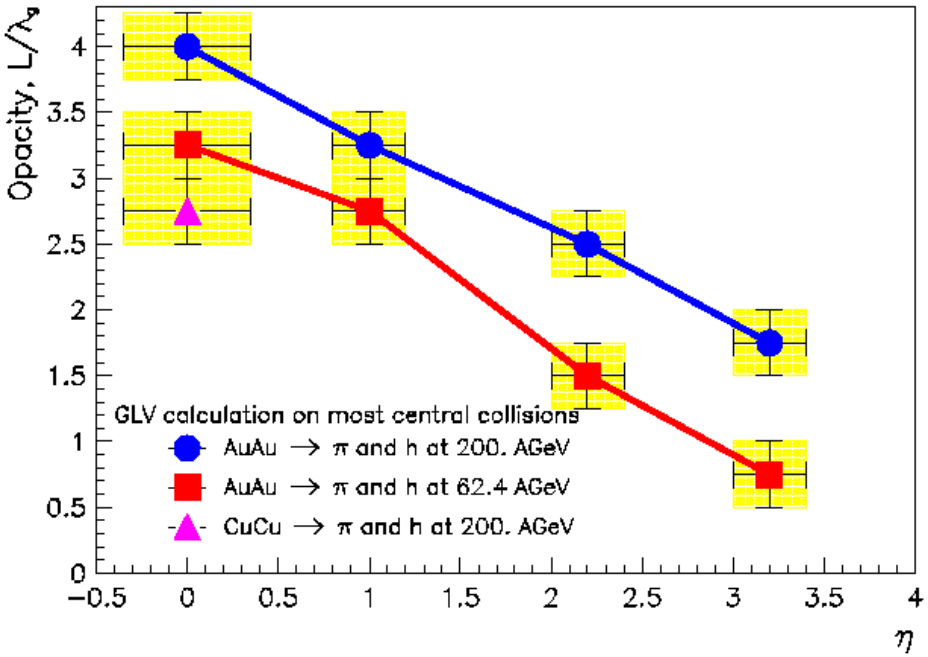
- R_{AuAu} (200 GeV) < R_{AuAu}(63 GeV) < R_{CuCu}(63 GeV) for charged hadrons
- p+p at 63 GeV is ISR Data (NPB100), RHIC-Run6 will provide better reference

$R_{AuAu}(y=0) \sim R_{AuAu}(y\sim3)$ for central Au+Au at $\sqrt{s}$ = 200 GeV

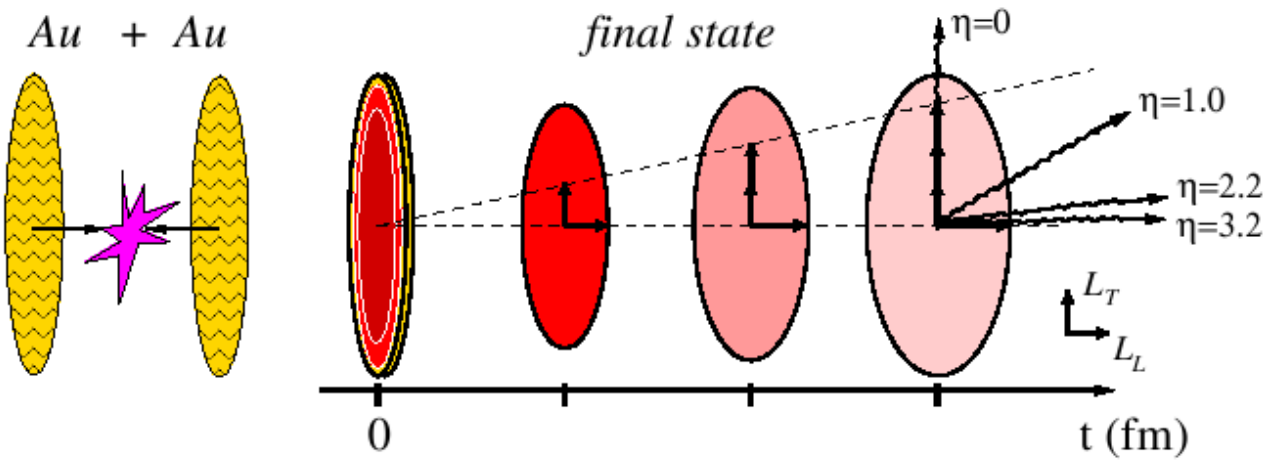


- R_{AuAu} (y=0) ~ R_{AuAu}(y~3) for pions and protons: accidental?
- Rapidity dependent interplay of Medium effect + Hydro + baryon transport

Interpretation of suppression at forward y



- G. G. Barnafoldi et al. Eur. Phys. J. C49 (2007)333
- pQCD + GLV fit to $R_{AA} \rightarrow L/\lambda$
- assuming λ=1fm
- L~4/1.5fm at mid/forward rapidity



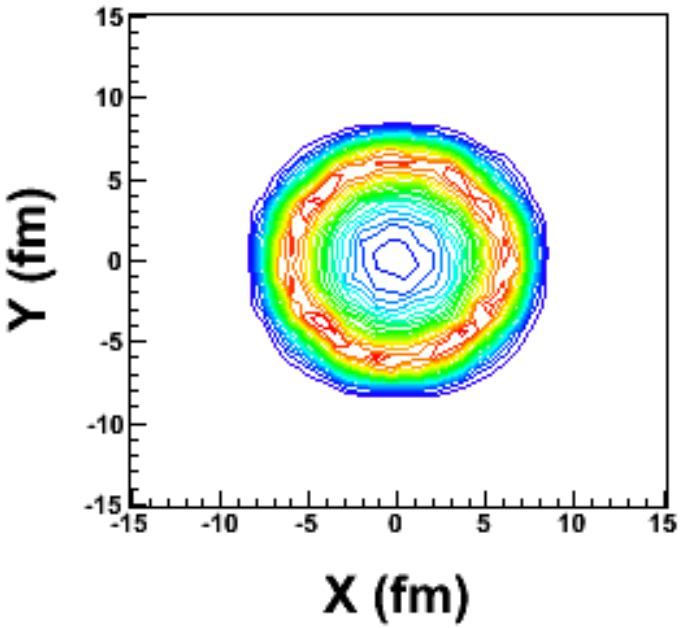
Strong energy absorption model - static 2D source.

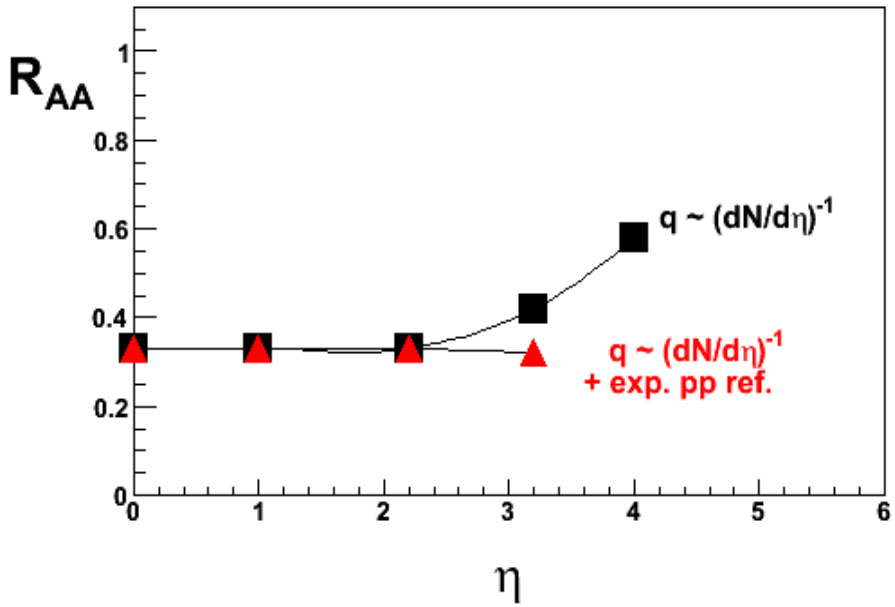
(Insprired by A.Dainese (Eur.Phys.J C33,495) and A.Dainese , C.Loizides and G.Paic (hep-ph/0406201))

- Parton spectrum using pp reference spectrum
- Parton energy loss dE ~ **q**.L**2
- **q** adjusted to give observed R_{AA} at h~1.

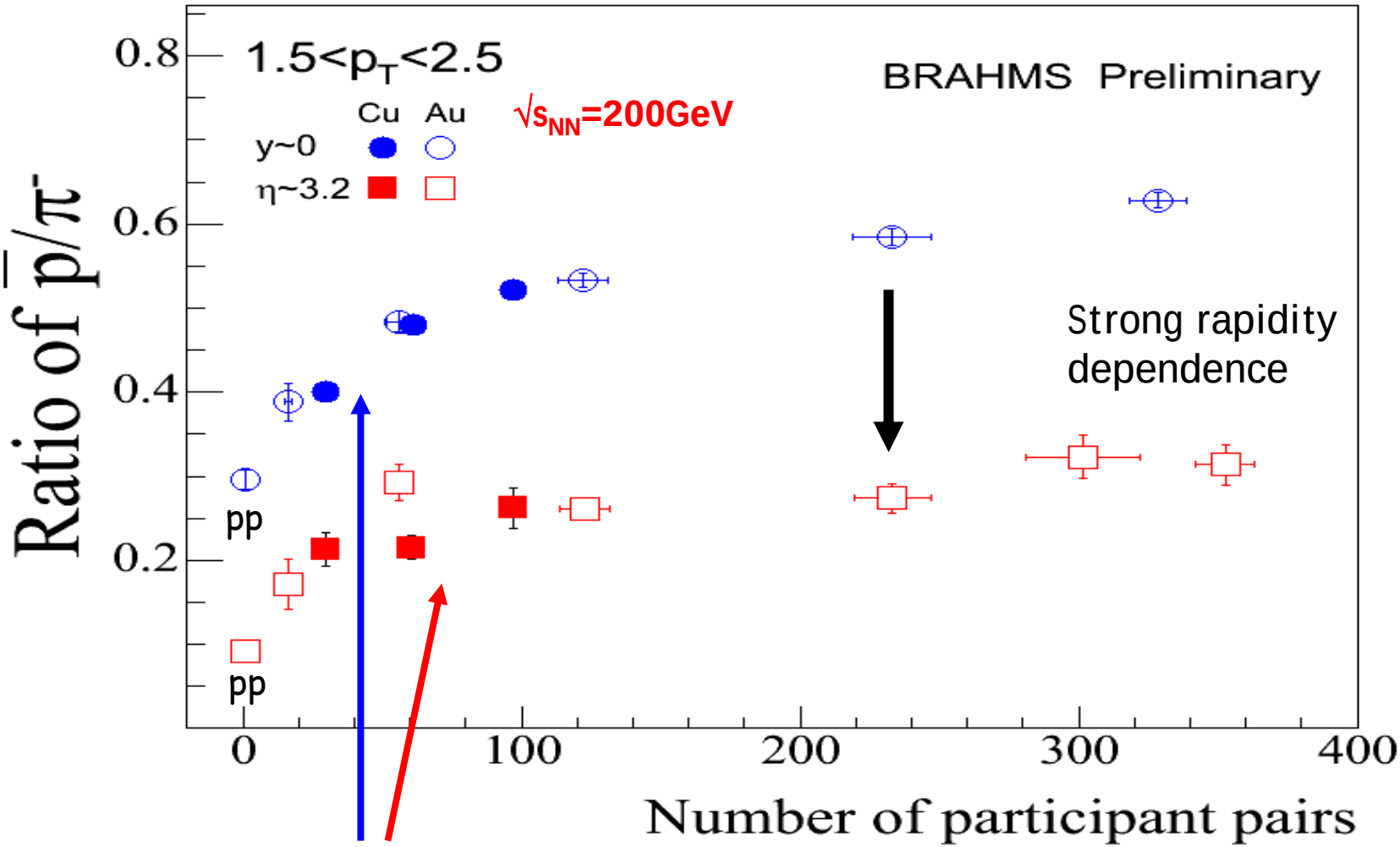
The change in dN/dη will result in slowly rising R_{AA} .

The modification of reference pp spectrum causes the R_{AA} to be approximately constant as function of η .





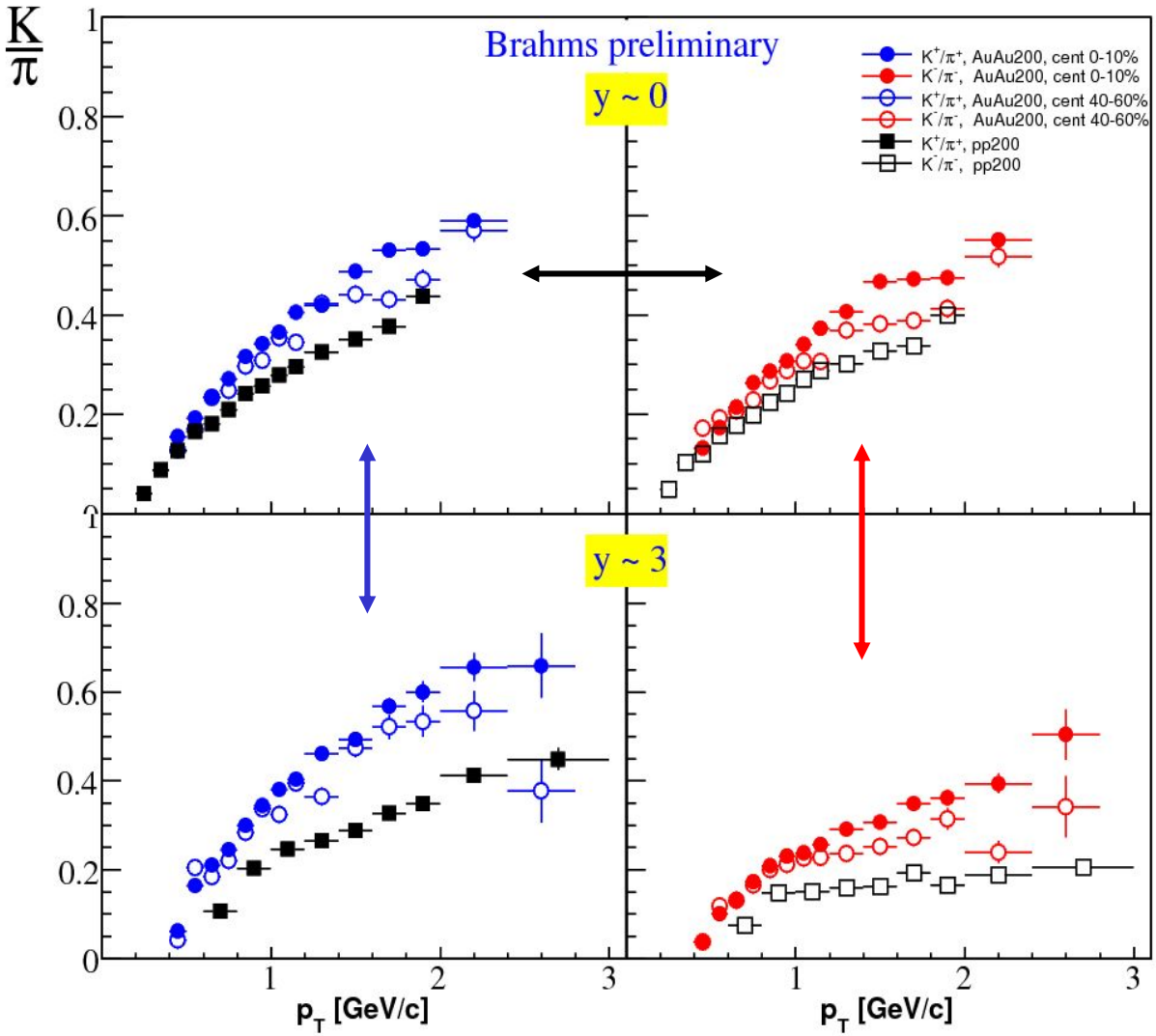
pbar / π^- scaling with N_{part}



CuCu data consistent with AuAu for the same N_{part}

K/π ratios at y~1 and y~3, Au+Au @200GeV

K^+/π^+ K^-/π^-



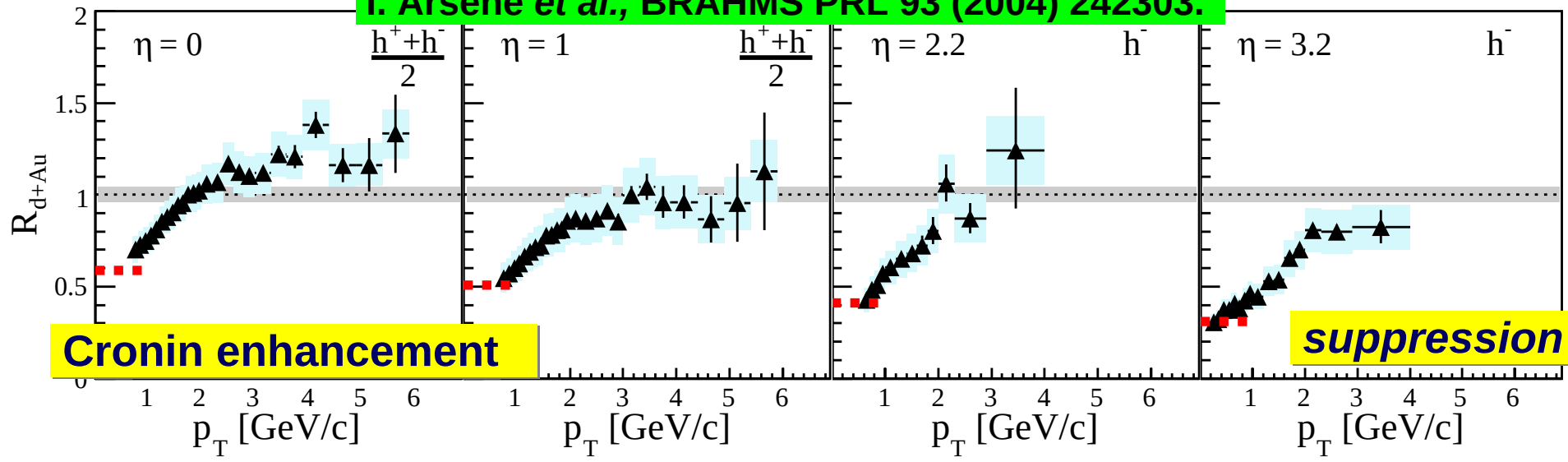
At y~0 negative and positive ratios behave similar

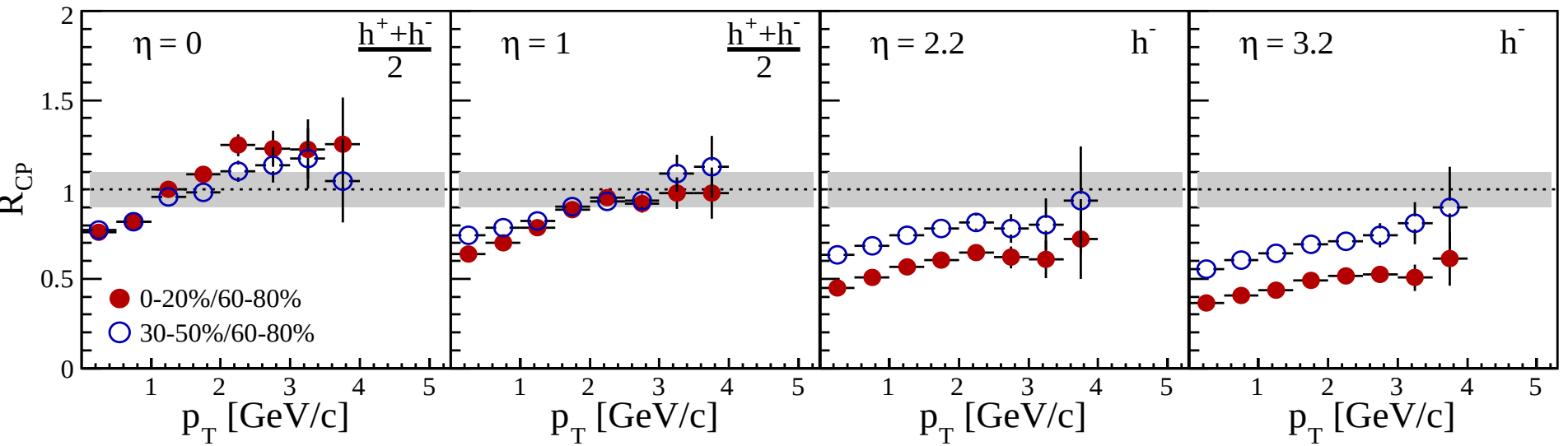
K^-/π^- decreases by factor of 2/3 when going from y~0 to y~3, however, enhancement over p+p increases. In accord to pbar/π^-

K^+/π^+ at y~0 is similar that at y~3, however, enhancement over p+p increases

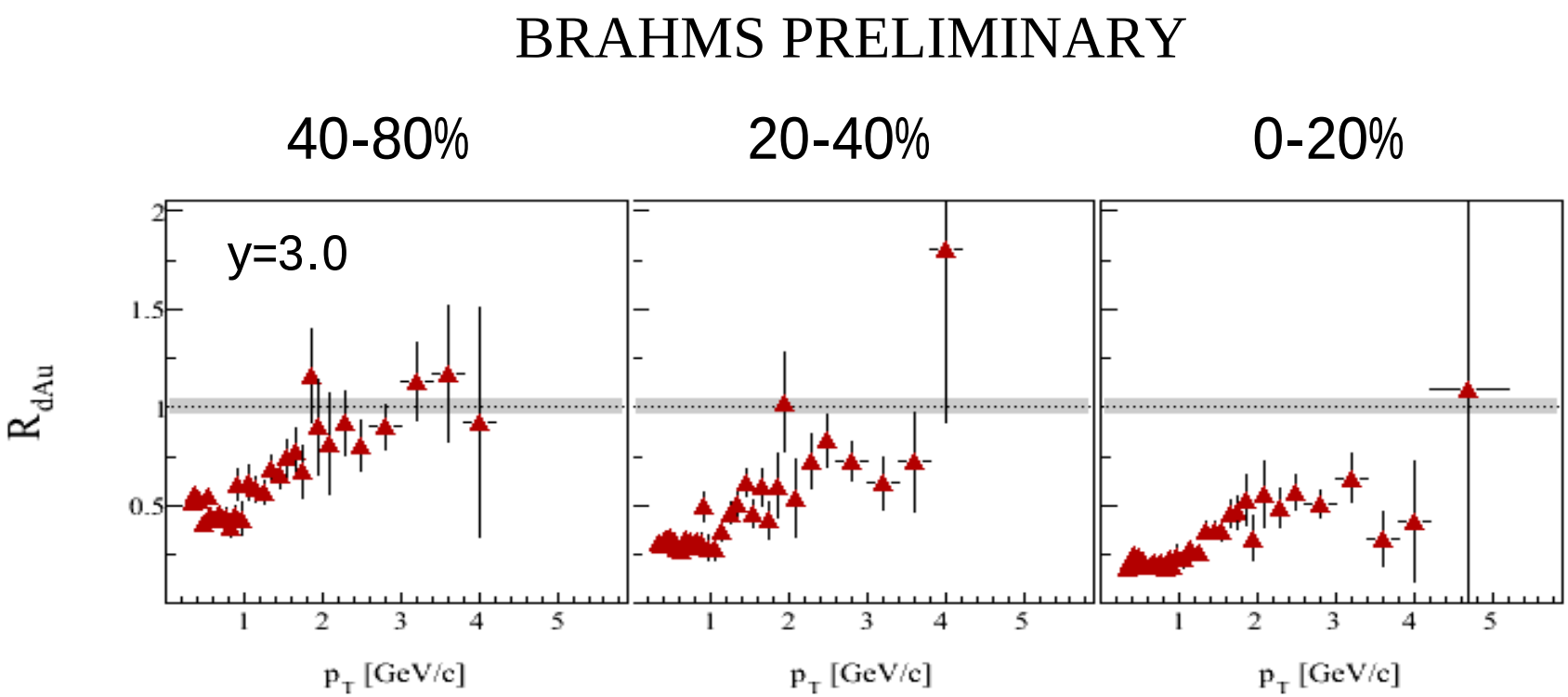
Examine d+Au at all rapidities

I. Arsene *et al.*, BRAHMS PRL 93 (2004) 242303.



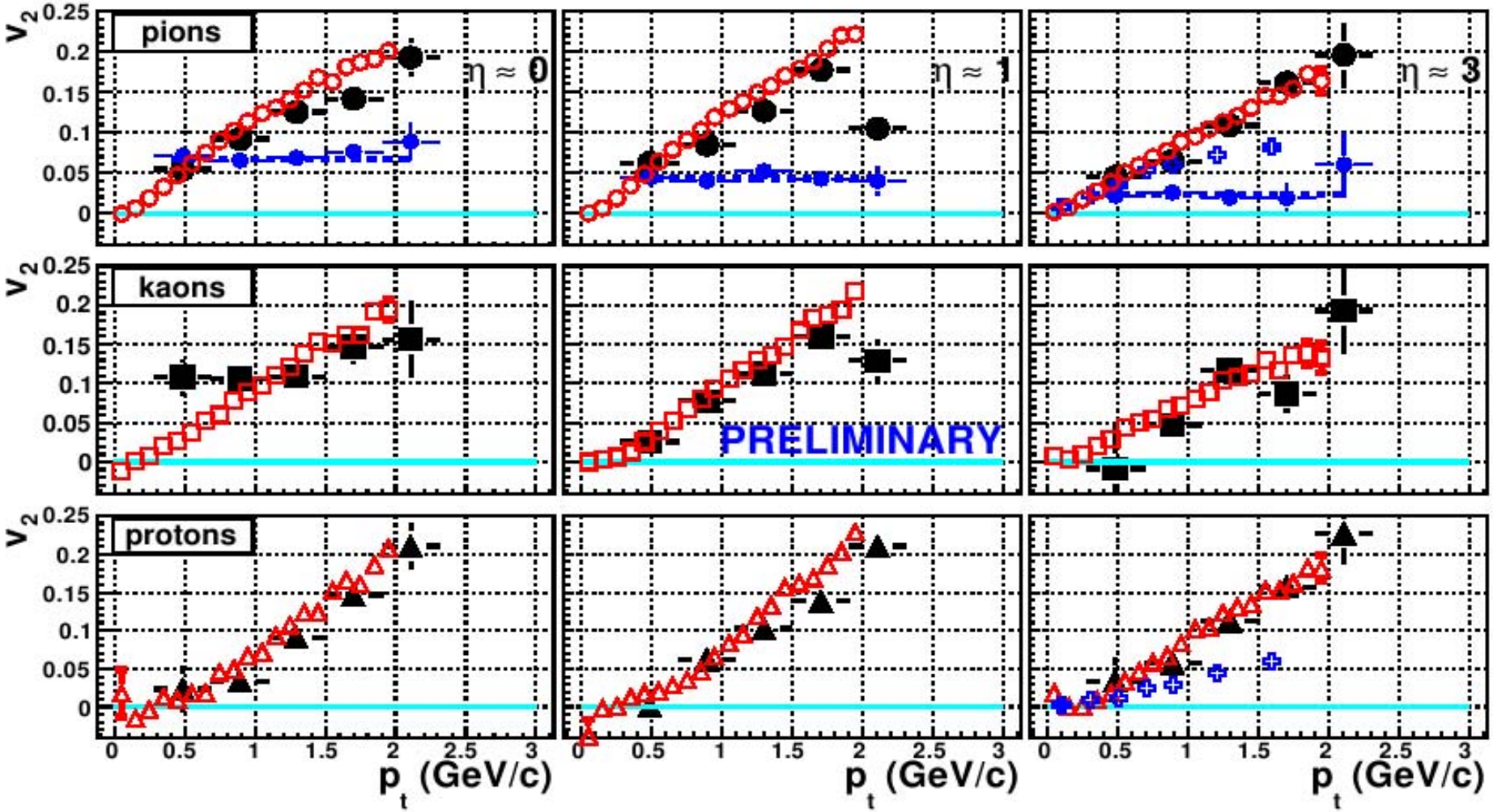


R_{dAu} centrality dependence for π^+



At y~3 R_{dAu} for π^+ reflects stronger suppression for more central collisions – same trend as for h^-

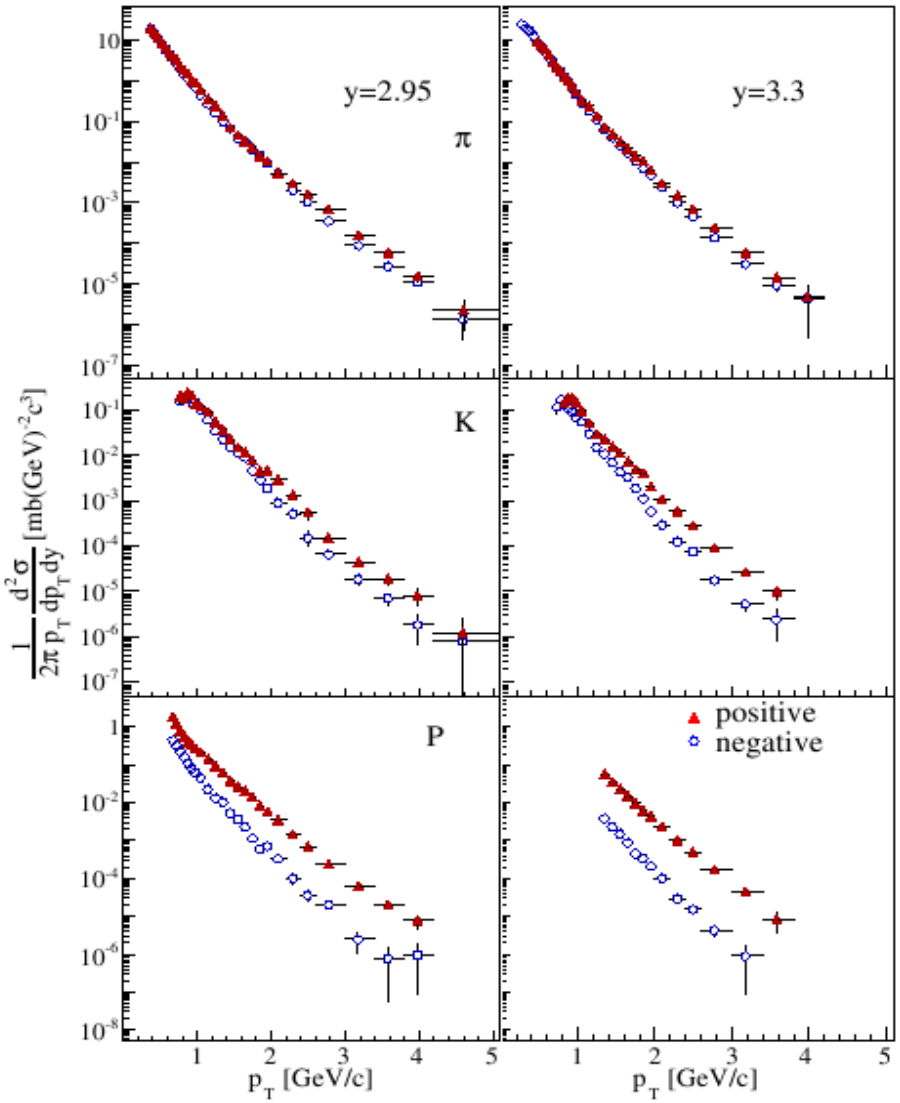
Differential flow at forward rapidity

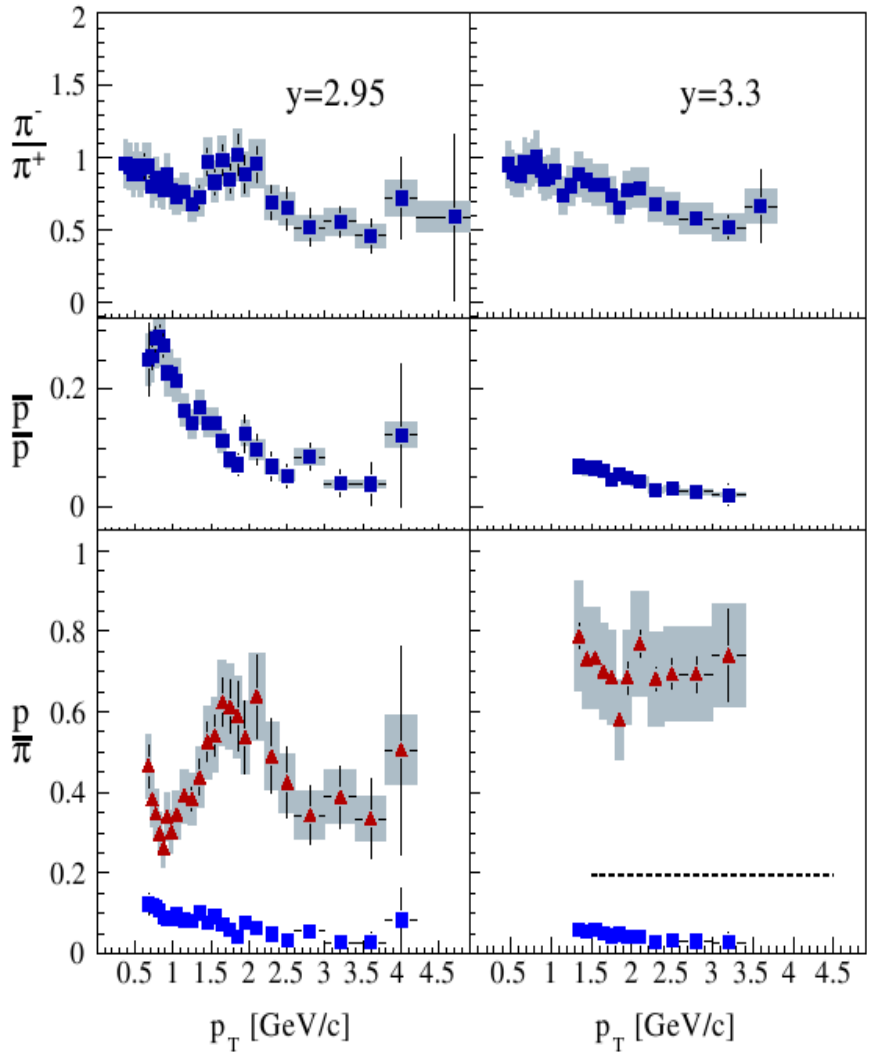


Hydro calculations (red symbols) by T. Hirano

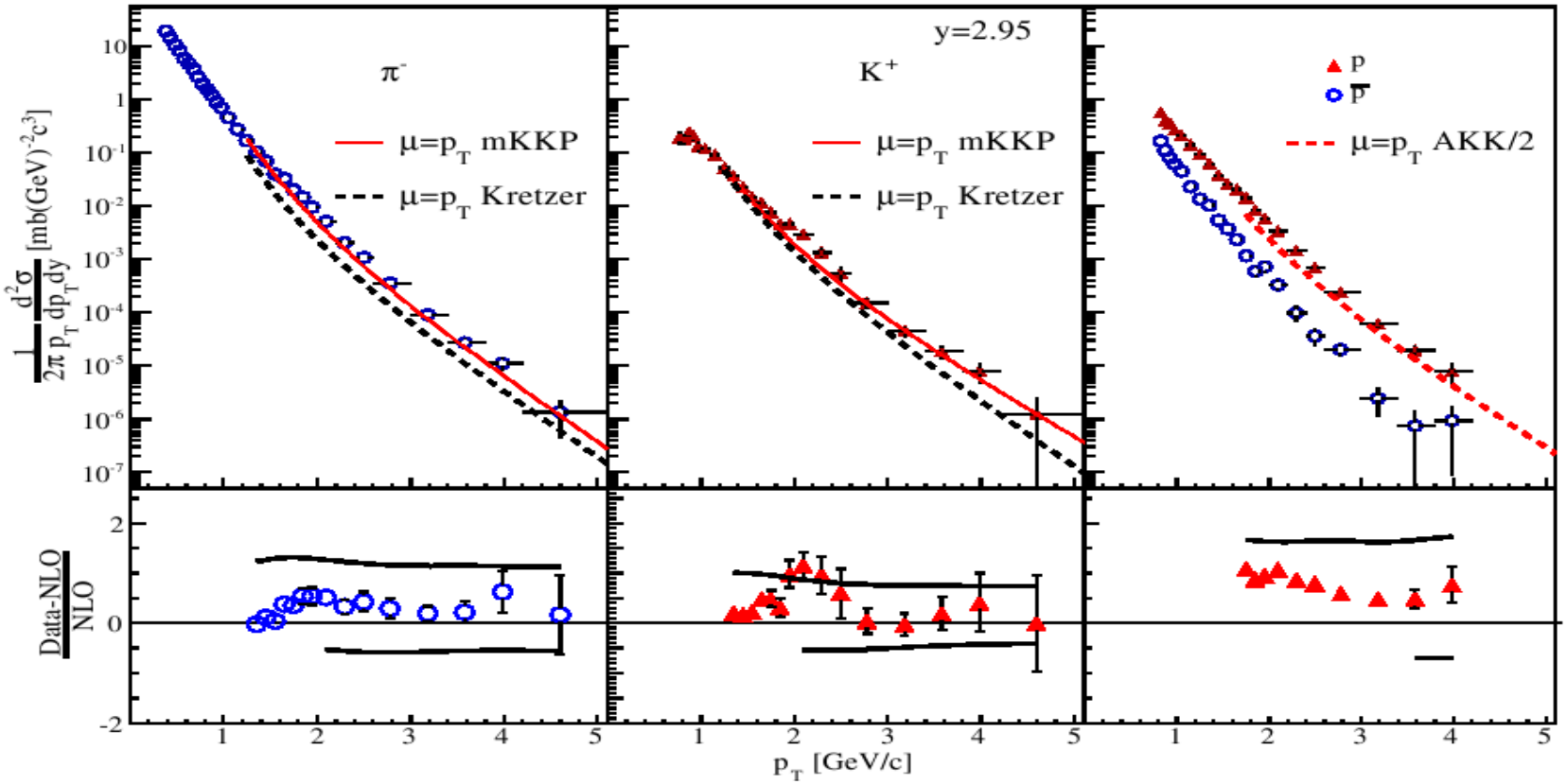
p+p at 200GeV – examine pQCD at large y

PRL 98 (2007) 252001





Large y: pQCD versus data



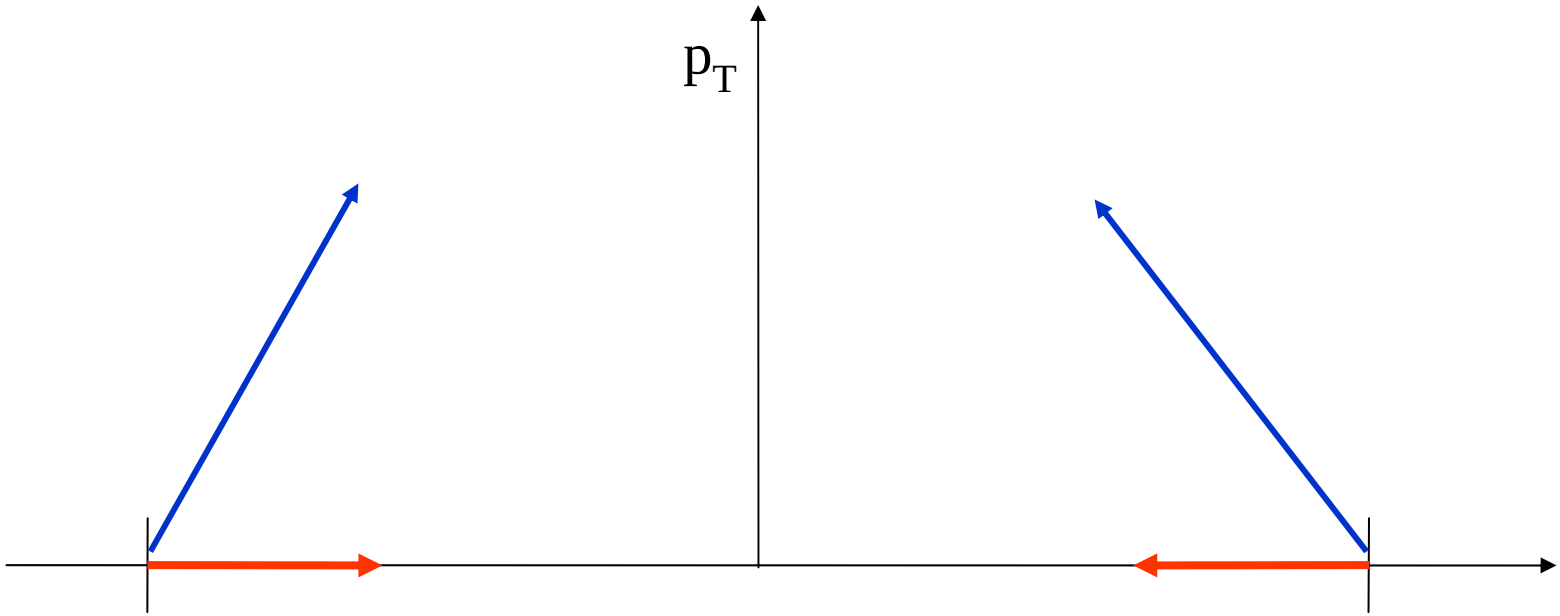
$\mu=\mu_F=\mu_R=p_T$. CTEQ6 parton distribution functions.

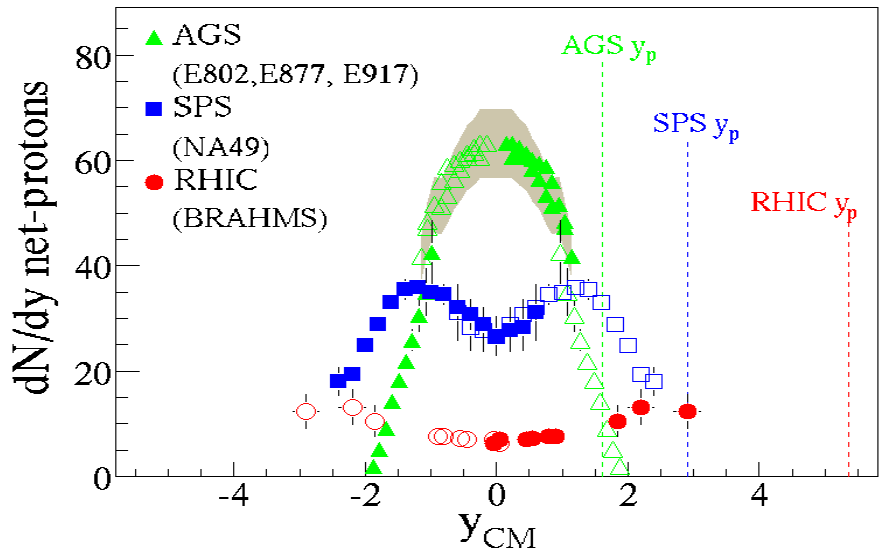
KKP modified to obtain FFs for specific charges: $D^{\pi+}_u = (1+z)D^{\pi0}_u$; $D^{\pi-}_u = (1-z)D^{\pi0}_u$

AKK reproduce STAR p+pbar at y~0, at large y gluons contribute in > 80%

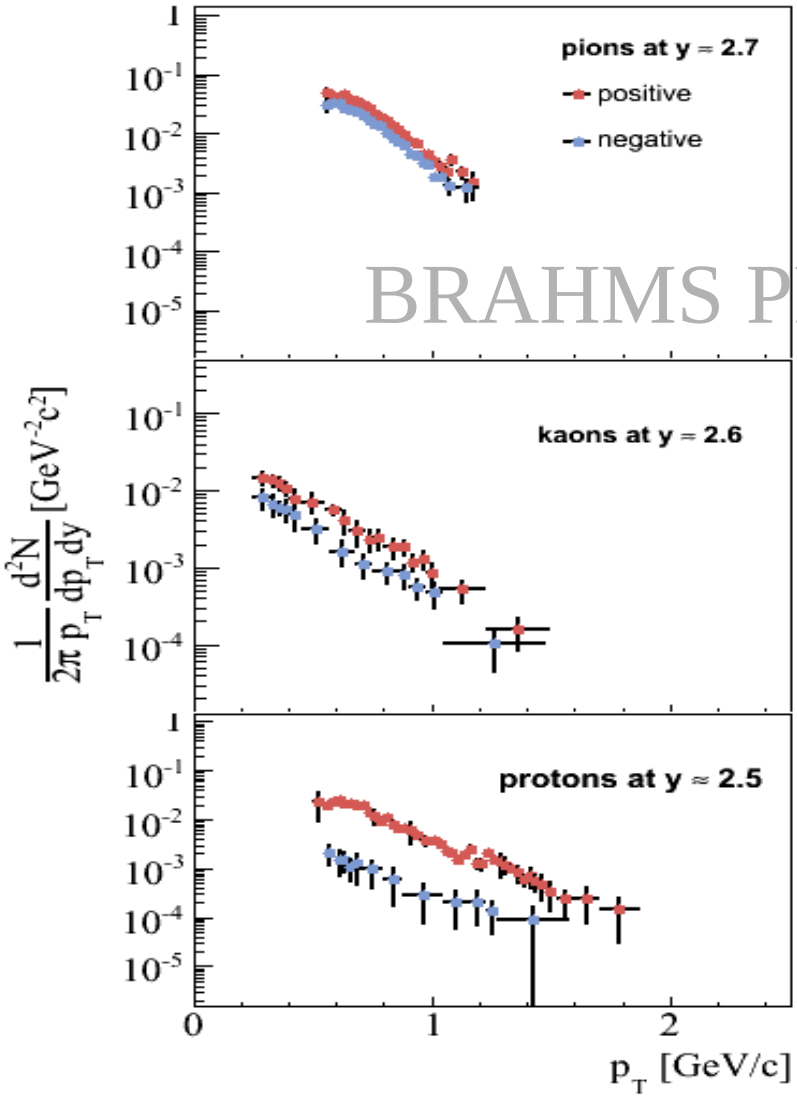
KKP under predict p+pbar by factor of 10.

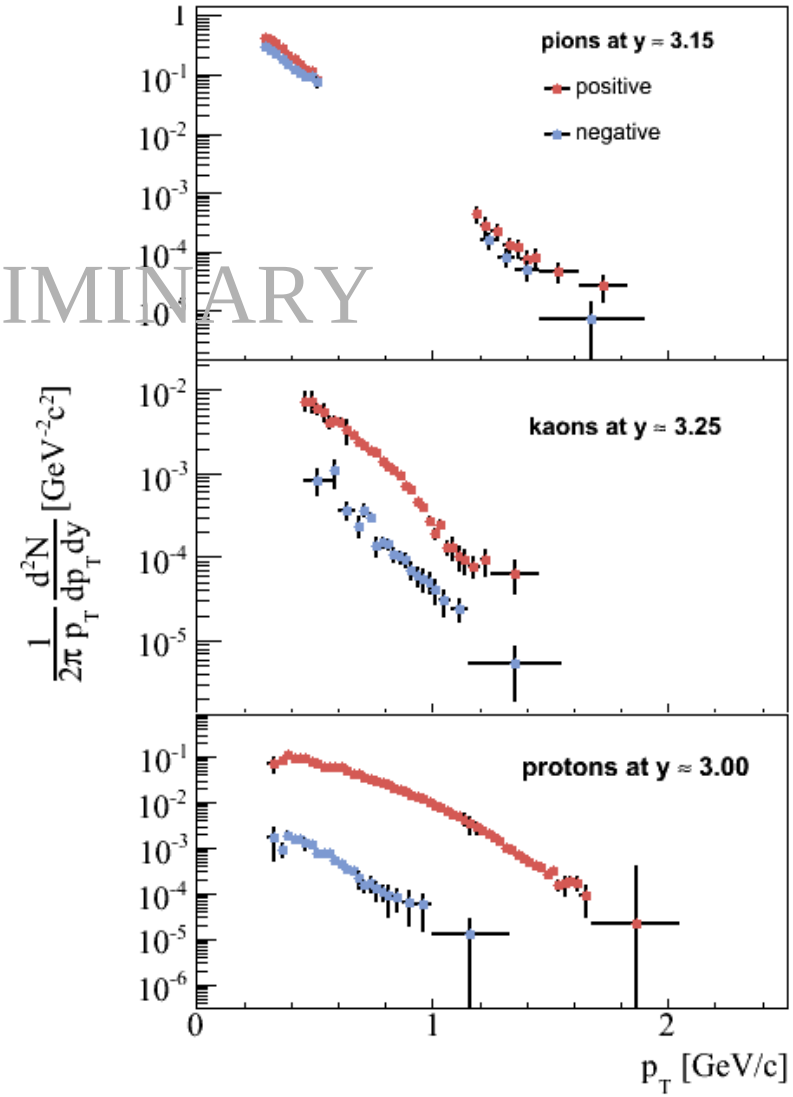
Does baryon number transport extend to high p_T?





p+p @ 62GeV results





Summary for A+A

• K/p reflects stronger enhancement at forward rapidity as compared to mid-rapidity.

• K^-/π^- drops when going form mid to forward rapidity whereas K^+/π^+ shows weak dependency on rapidity

• R_{dAu} for π^+ decreases with increasing centrality and for 0-20% centrality reaches value of ~0.5 ($3 < p_T < 4$)

Summary for p+p

- At 200 GeV pbar/p is below 0.1 at high p_T (~4GeV/c) and y~3.

- This strong asymmetry in p and pbar production can not be described by known FFs.

- Explanation of data require new mechanism that will be able to transport baryon number to high p_T (recombination soft-shower?)

- At the same y but lower energy (62GeV) the effect is stronger by an order of magnitude (both for kaons and protons)

The BRAHMS Collaboration

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