Heavy Flavor Production in High Energy Nuclear Collisions

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Outline

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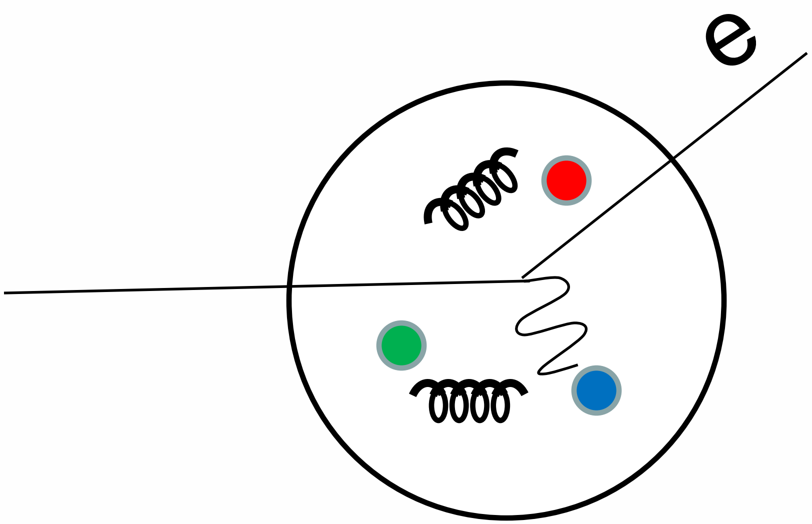
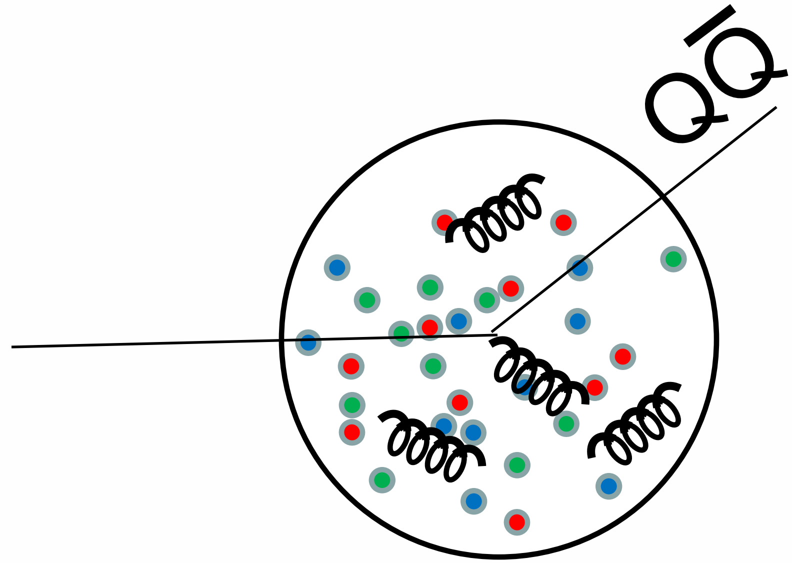
- Transport Approach
- Numerical Results
- Summary

Background

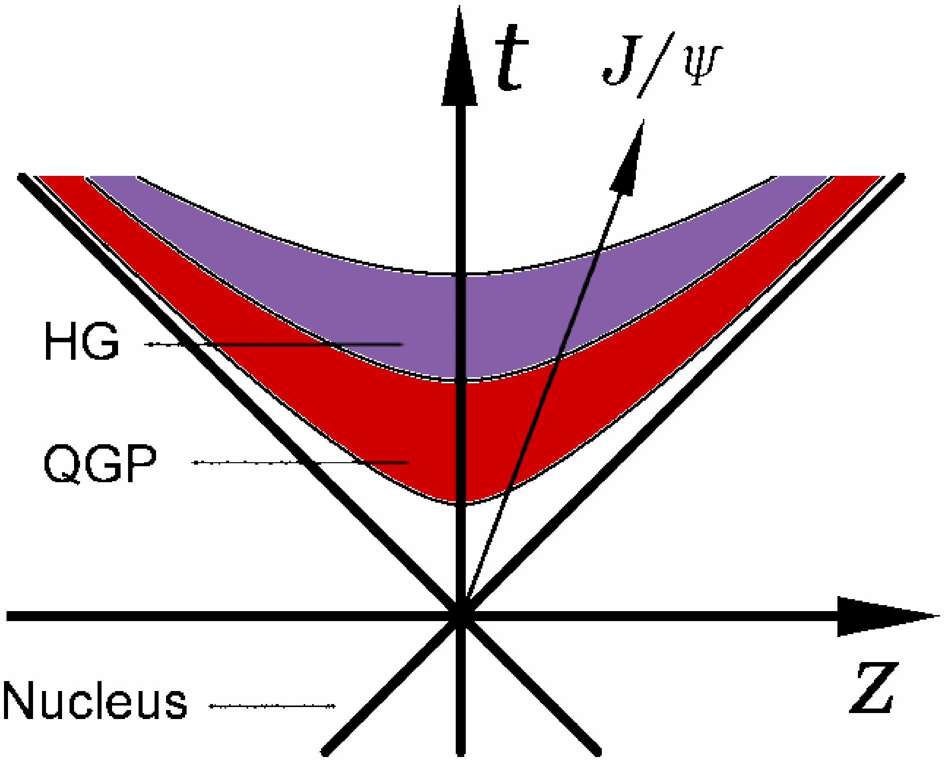


JLab

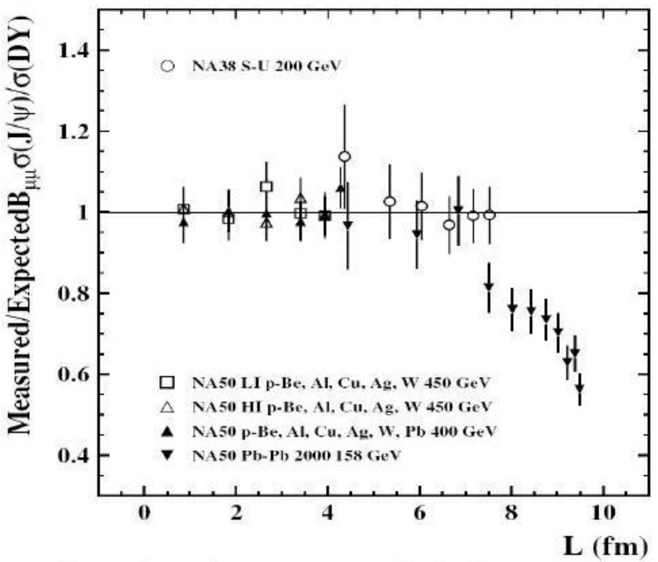


SPS, RHIC, LHC…

Heavy ion collisions



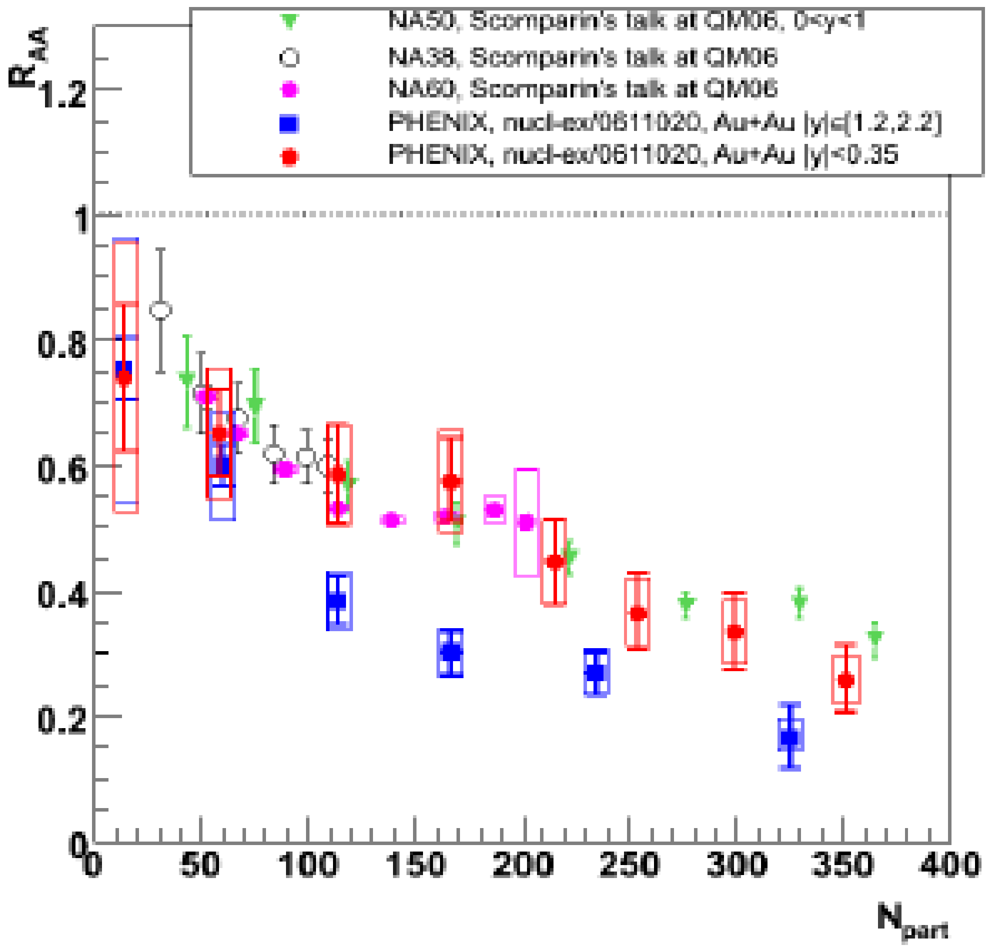
$$R_{AA} = \frac{N^{AA}_{J/\psi}}{N_{coll} N^{pp}_{J/\psi}}$$



(Matsui, and Satz, 1986)

(NA50, 1996)

RHIC Puzzles



$$R_{AA} = \frac{N^{AA}_{J/\psi}}{N_{coll} N^{pp}_{J/\psi}}$$

SPS $\sqrt{s} = 17.3$ A GeV

RHIC $\sqrt{s} = 200$ A GeV

Transport approach

$$f = f_\Psi(\vec{p}, \vec{x})$$

$$\partial_t f + \vec{v}_t \cdot \nabla_t f + v_z \partial_z f = -\alpha f + \beta$$

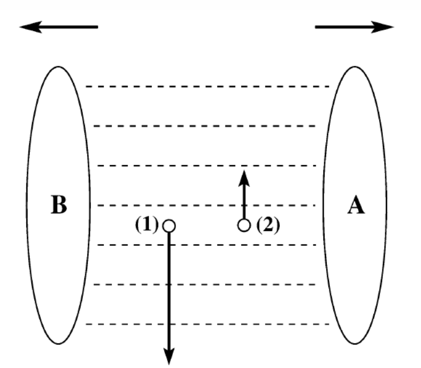
Time evolution

Leakage effect

Longitudinal streaming

Dissociation

Thermal regeneration

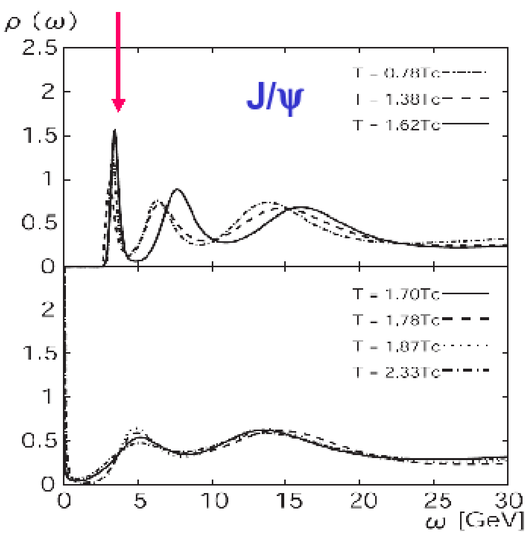


Leakage Effect

(J. Hüfner, P. Zhuang, 2003)

The dynamical terms

$$\partial_t f + \vec{v}_t \cdot \nabla_t f + v_z \partial_z f = -\alpha f + \beta$$



(Asakawa, Hatsuda, QM2006, lep-lat/0808034)

$$J/\psi + g \rightarrow c + \bar{c}$$

$$\sigma_g(\omega) = A_0 \cdot \frac{(\omega/\epsilon_\psi - 1)^{3/2}}{(\omega/\epsilon_\psi)^5}$$

$$\epsilon_\psi = \text{const, for } T_c < T < T_d,$$

$$\alpha_\Psi(\mathbf{p}_t, \mathbf{x}_t, \tau|\mathbf{b}) = \frac{1}{2E_\Psi}\int \frac{d^3\mathbf{p}_g}{(2\pi)^3 2E_g} W_{g\Psi}^{c\bar{c}}(s) f_g(\mathbf{p}_g, \mathbf{x}_t, \tau) \times \Theta(T - T_c) / \Theta(T_d - T),$$

β is related to α by detailed balance.

2+1D ideal hydrodynamics of the medium

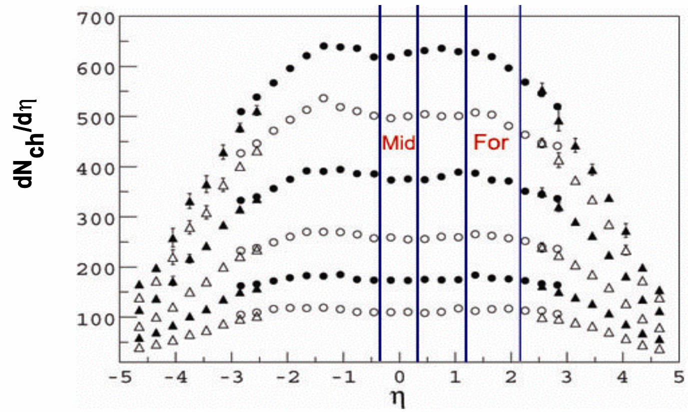
2D Hydrodynamics at y=0

$$\begin{cases} \partial_\tau E + \nabla \cdot \vec{M} = -\frac{E+p}{\tau}, \\ \partial_\tau M_x + \nabla \cdot (M_x \vec{v}) = -\frac{M_x}{\tau} - \partial_x p, \\ \partial_\tau M_y + \nabla \cdot (M_y \vec{v}) = -\frac{M_y}{\tau} - \partial_y p, \\ \partial_\tau R + \nabla \cdot (R \vec{v}) = -\frac{R}{\tau}. \end{cases}$$

where

$$\begin{aligned} E &= (\epsilon + p)\gamma^2 - p, \\ \vec{M} &= (\epsilon + p)\gamma^2 \vec{v}, \\ R &= \gamma n. \end{aligned}$$

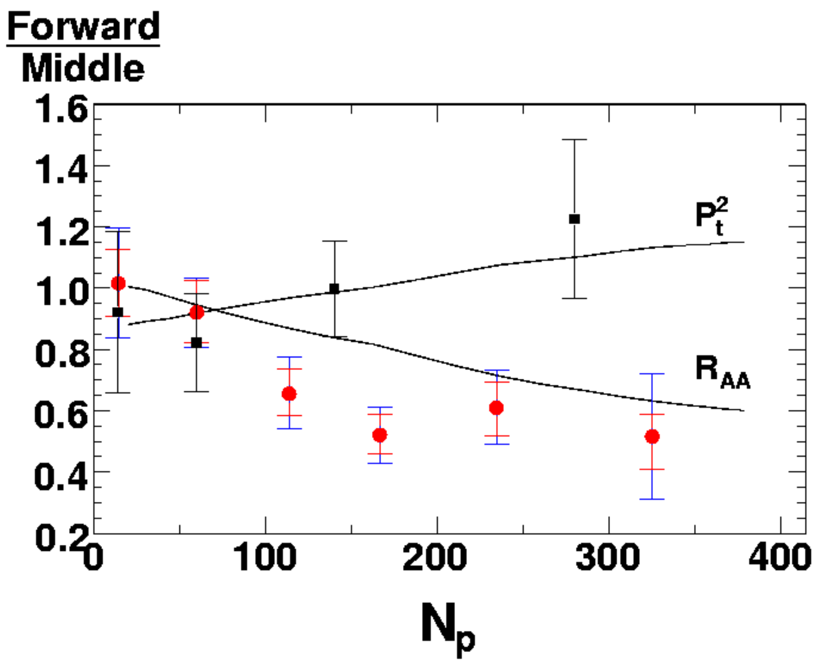
with EoS.

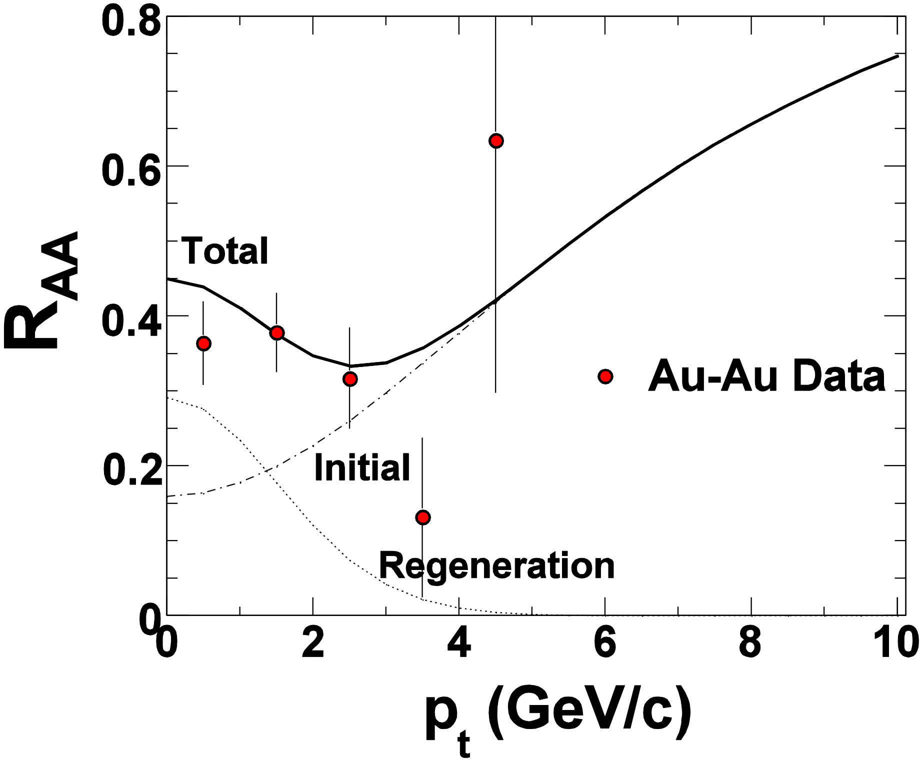


Boost Invariance
(BRAHMS, PRL, 88, 2002)

Quantities at different rapidity are related by a boost.

J/psi production at RHIC

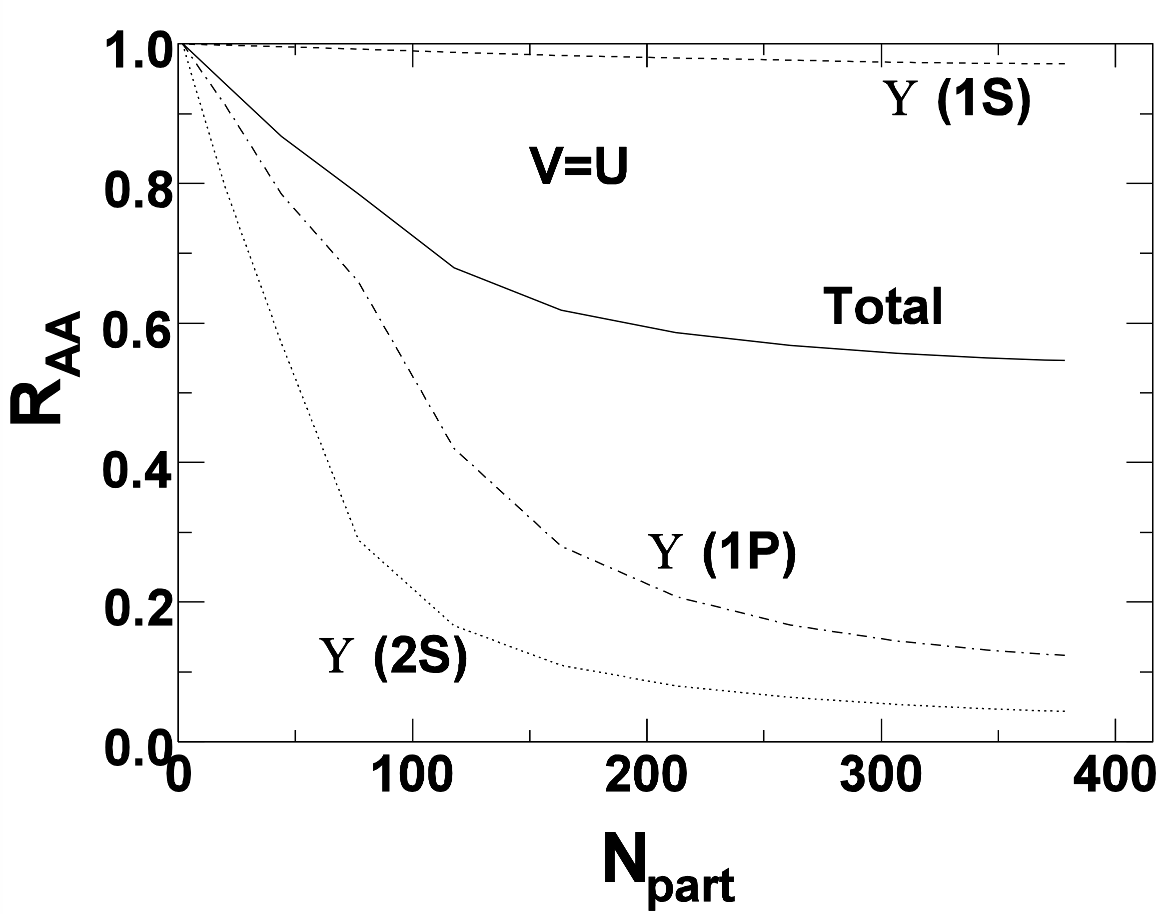




(Liu, Qu, Xu, Zhuang, 2009, 2010)

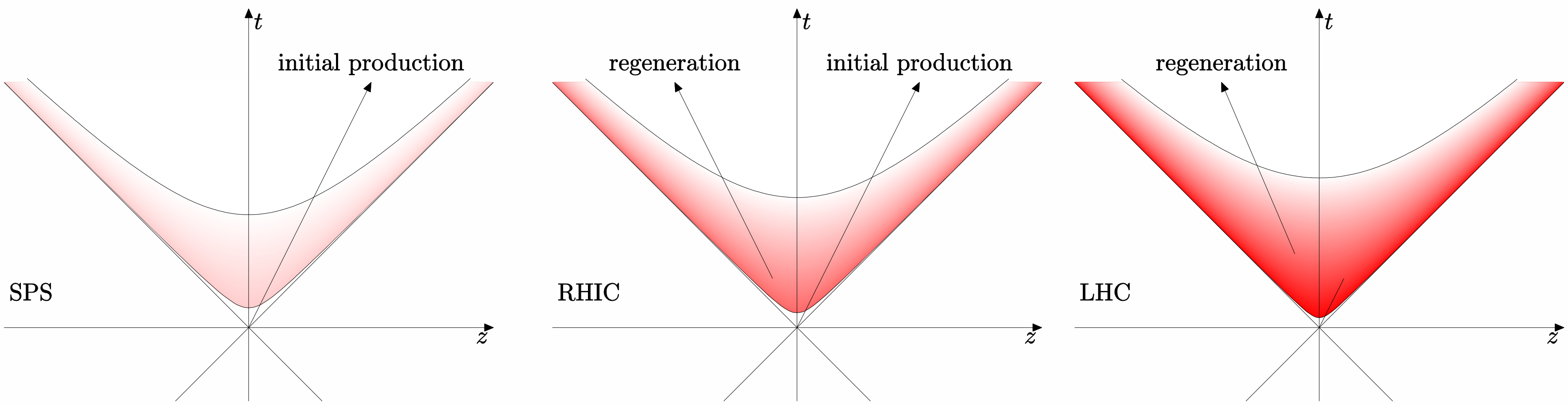
(Data from PHENIX)

Upsilon suppression at RHIC



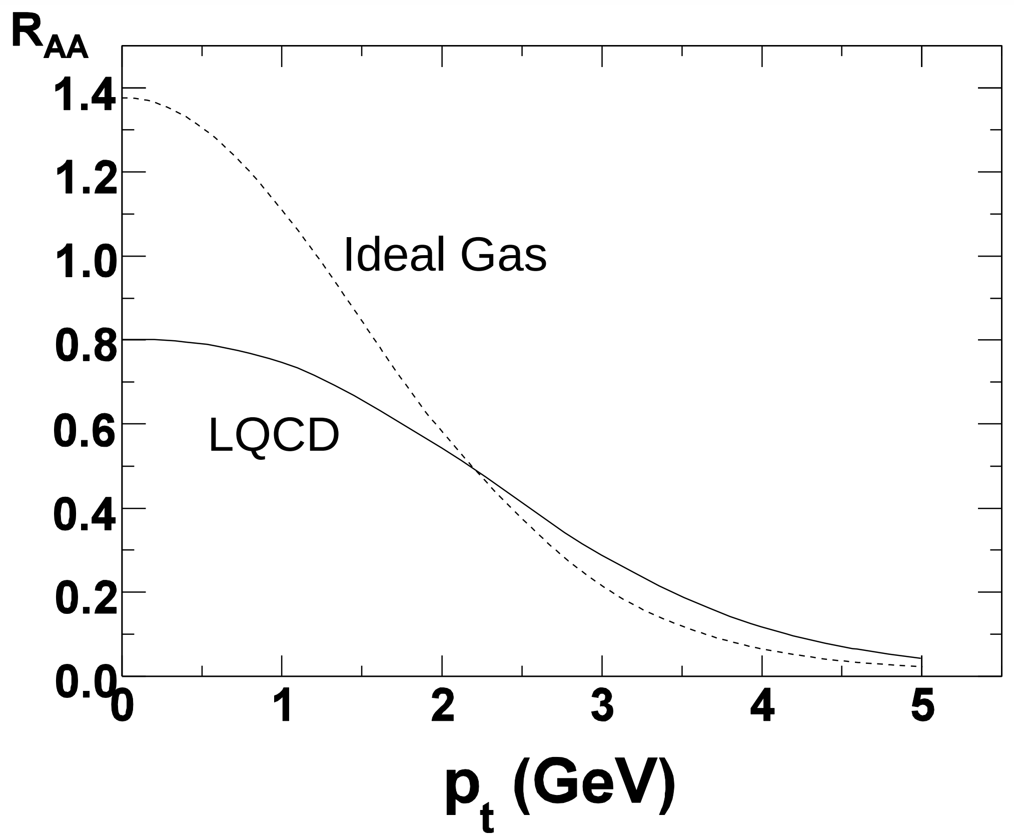
Minimium Bias Value 0.62 agrees with the preliminary data(<0.64) from Phenix

Energy dependence



(Sats, 1986) (Thews, 2001)

EoS dependence of J/psi production at LHC



Summary

- Experimental data can be described by the transport approach qualitatively.

- Quarkonium production at LHC are expected to tell more.