Transverse momentum dependence of J/Ψ shadowing effects in $\sqrt{s_{NN}}$=200 GeV d+Au collisions at RHIC (and its consequences in Au+Au)

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INTRINSIC AND EXTRINSIC P_T EFFECTS ON J/Ψ SHADOWING

This work, on behalf of

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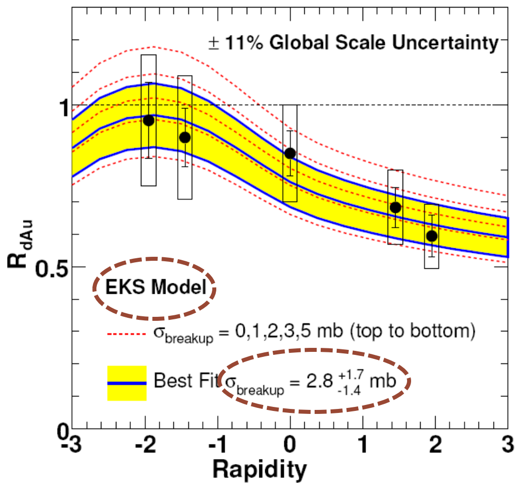
Work in progress…

Introduction

- Shadowing and d+Au PHENIX data

200 GeV/c PHENIX d+Au data
Phys. Rev. C 77, 024912 (2008)

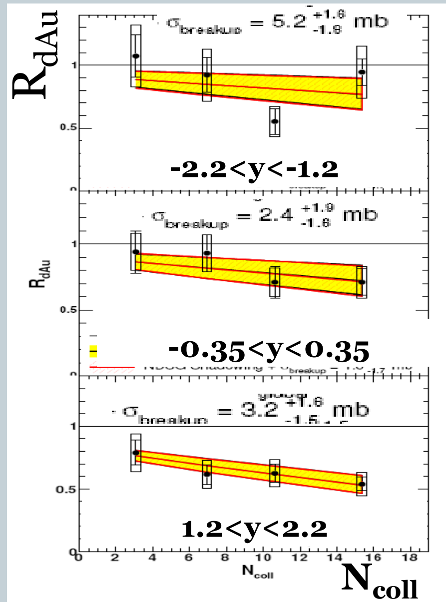


Shadowing modelisation from R.Vogt, Phys.Rev. C71 (2005) 054902
Assuming p_T=0

$$x_1 = \frac{M}{\sqrt{s}} e^{y}$$

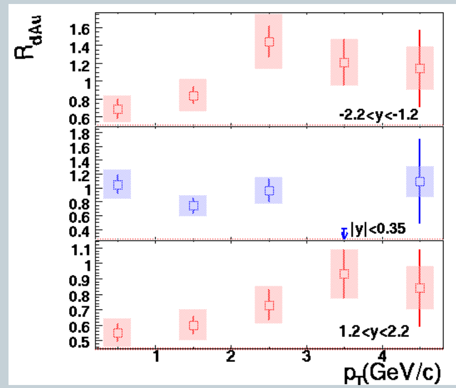
$$x_2 = \frac{M}{\sqrt{s}} e^{-y}$$

$$Q^2 = M^2$$



2 remarks:

- Need at least 2 different $\sigma_{breakup}$ to fit R_{dAu}.vs.N_{coll}
- No prediction for R_{dAu}.vs.p_T



$$R_{dAu} = \frac{dN^{J/\Psi}_{dAu}}{\langle N_{coll} \rangle dN^{J/\Psi}_{pp}}$$

Nuclear modification factor

- Goal of this work: introduce J/Ψ p_T in shadowing computation
  - In this talk, we'll consider EKS98 shadowing only
  - Investigating two mechanisms
    - g+g → J/Ψ ➔ « intrinsic » scheme: the p_T of the J/Ψ comes from initial partons
      - Can be parametrized using the data
    - g+g → J/Ψ+g ➔ « extrinsic » scheme: the p_T of the J/Ψ is balanced by the outgoing gluon
      - Need a model to be described

This work

Glauber modelisation of CNM effects

See arXiv:0801.4949 for more details

- An event generator to produce J/Ψ samples
  - Based on a glauber Monte Carlo
  - Use J/Ψ production models (or data) to get (J/Ψ) y, p_T, x_1, x_2, Q^2
  - Using EKS98, modify the J/Ψ cross section according to:

$$\sigma_{AB}^{J/\Psi} = R_{shadow}^{A}\left(x_1, Q^2, b\right) \times R_{shadow}^{B}\left(x_2, Q^2, b\right) \times \left\langle N_{coll} \right\rangle \sigma_{pp}^{J/\Psi}$$

  - Compare with data using:

$$R_{AB} = \frac{dN_{AB}^{J/\Psi}}{\left\langle N_{coll} \right\rangle dN_{pp}^{J/\Psi}}$$

  - **Use « intrinsic » (g+g→J/Ψ) and « extrinsic » (g+g → J/Ψ+g) schemes as inputs to get J/Ψ kinematics information**

« intrinsic » J/Ψ production

g+g → J/Ψ

y, p_T, x_1, x_2, Q^2 can be determined with data : using PHENIX p+p data
Phys. Rev. Lett. **98**, 232002 (2007)

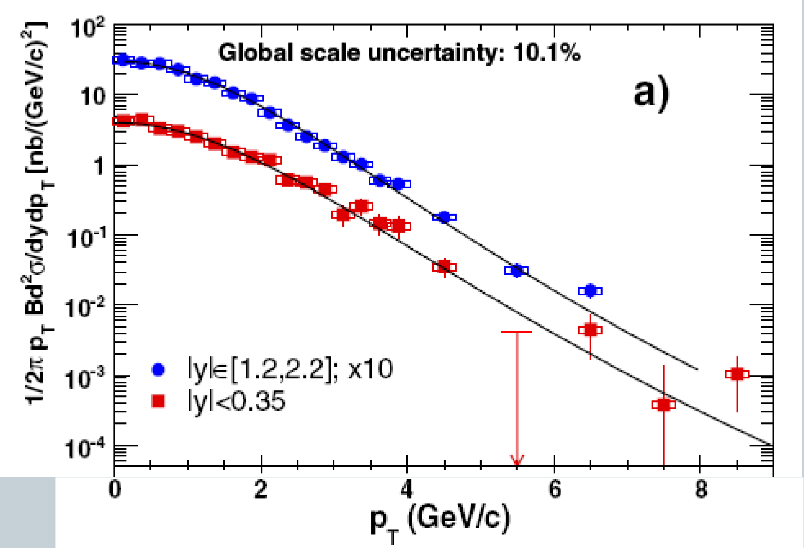
- kinematics:
  - y, p_T randomly picked on the data
  - Then, compute kinematics as input of shadowing factors $R_{shadow}(x_{1,2}, Q^2, b)$

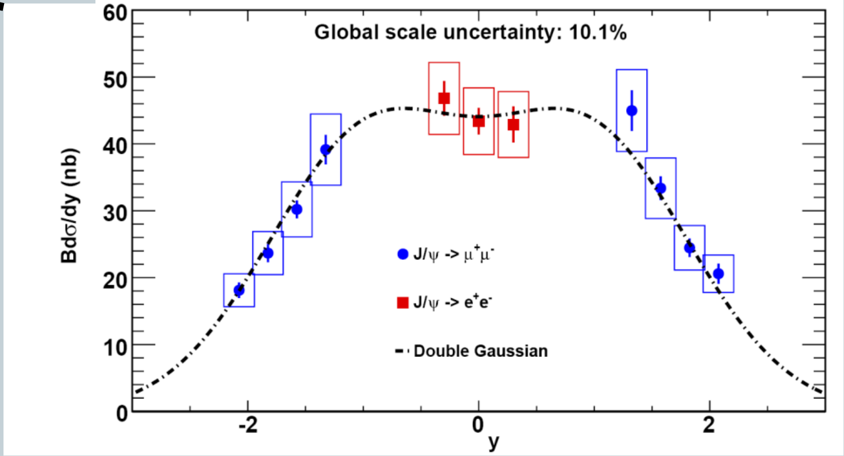
$$M_T^2 = M^2 + p_T^2$$

$$x_1 = \frac{M_T}{\sqrt{s}} e^{y}$$

$$x_2 = \frac{M_T}{\sqrt{s}} e^{-y}$$

$$Q^2 = M_T^2$$



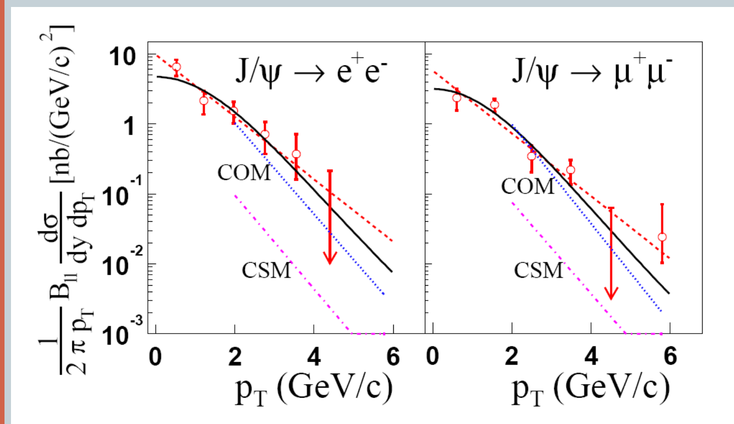


« extrinsinc » J/Ψ production

$g+g \rightarrow J/\Psi+g$

Color singlet and color octet calculations compared with PHENIX run 3 (200 GeV/c) p+p data :

PHENIX, Phys. Rev. Lett 92, 051802 (2004).



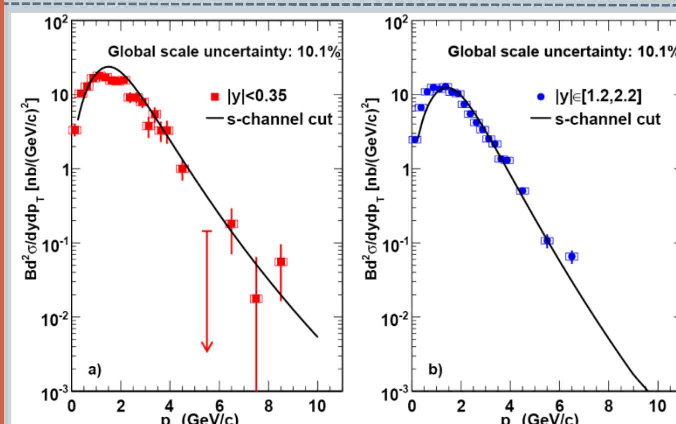
Good description for p_T > 2 GeV/c

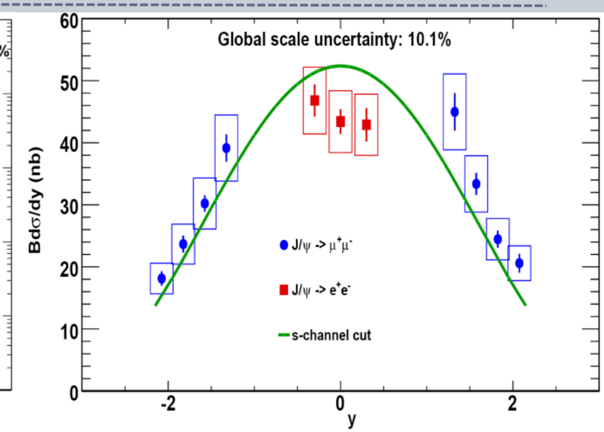
No description below 2 GeV/c

S-channel cut mechanism (extension of the color singlet model) compared with PHENIX run 5 (200 GeV/c) p+p data:

Haberzettl and Lansberg, Phys. Rev. Lett. 100, 032006 (2008).

➔ Use s-channel cut model in the following





Model provides y, p_T, x_1; get $x_2 = \frac{x_1 M_T \sqrt{s} e^{-y} - M^2}{\sqrt{s}\left(\sqrt{s} x_2 - M_T e^{-y}\right)}$ and $Q^2 = M^2 + p_T^2$

d+Au Rapidity dependence

intrinsic.vs.extrinsic

Intrinsic (g+g → J/Ψ)

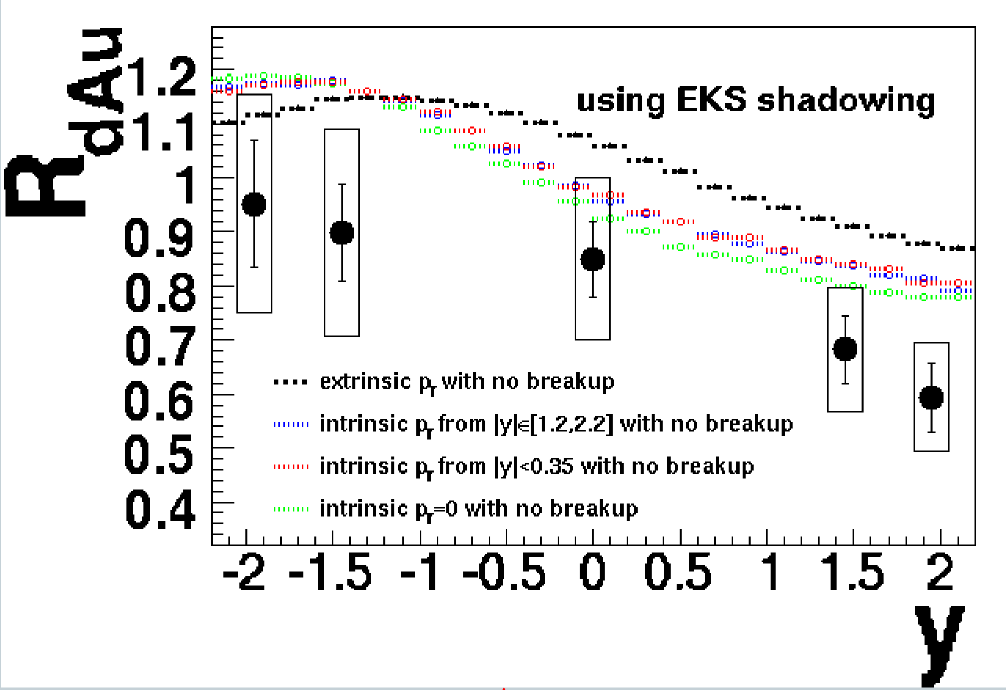
• Small difference when adding p_T. In p+p: <pT> < 2 GeV/c

$$x_{1,2} = \frac{M_T}{\sqrt{s}} e^{\pm y} \sim \frac{M}{\sqrt{s}} e^{\pm y}$$

• No significant difference between p_T from central and forward rapidity

Extrinsic (g+g → J/Ψ + g)

significant difference between intrinsic and extrinsic scheme : more antishadowing at mid rapidity ; less shadowing at forward rapidity.



No breakup cross section used for this plot

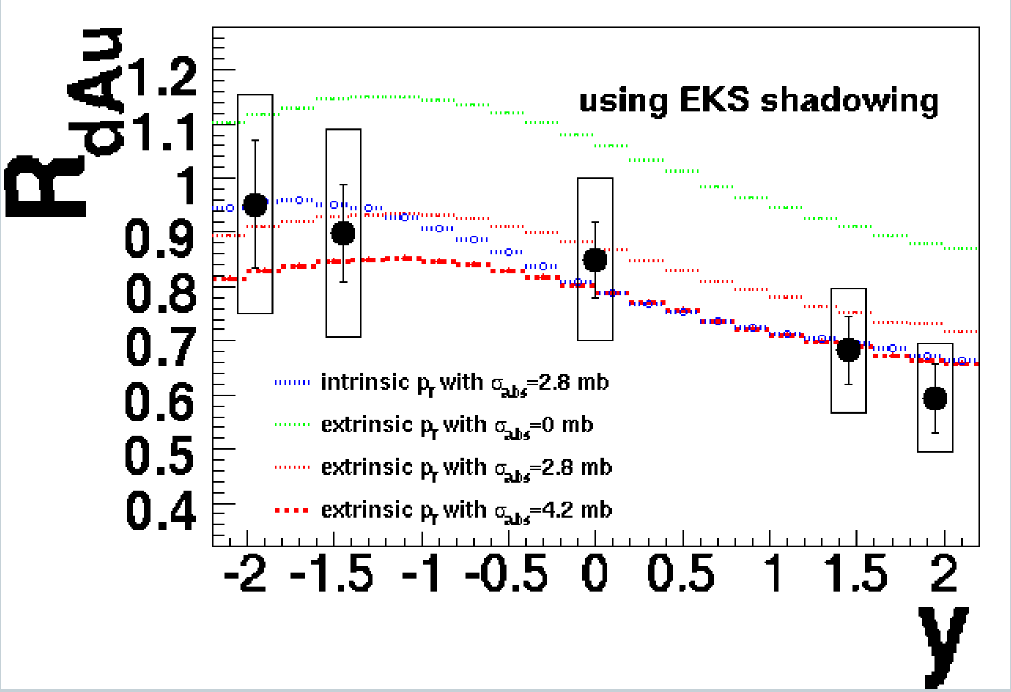
d+Au Rapidity dependence

breakup (absorption) cross section

Nuclear absorption added

- **Intrinsic scheme:**
  - following PHENIX PRC 77, 024912 (2008), best match is obtained with **$\sigma_{breakup} = \sigma_{abs}$ = 2.8 mb**

- **Extrinsic scheme:**
  - $\sigma_{breakup}$ = 2.8 mb is not enough for extrinsic scheme to match data
  - Try **$\sigma_{breakup}$ = 4.2 mb** as measured by NA50. ➔ good match
  - to be done: determining best $\sigma_{breakup}$ using χ^2 minimization



d+Au Centrality dependence

intrinsic .vs. extrinsic (w/ absorption)

R_{dAu} .vs. N_{coll}

Backward rapidity : ➔

Intrinsic + $\sigma_{breakup}$=2.8 mb fails to reproduce the data (better with $\sigma_{breakup}$=5.2mb)

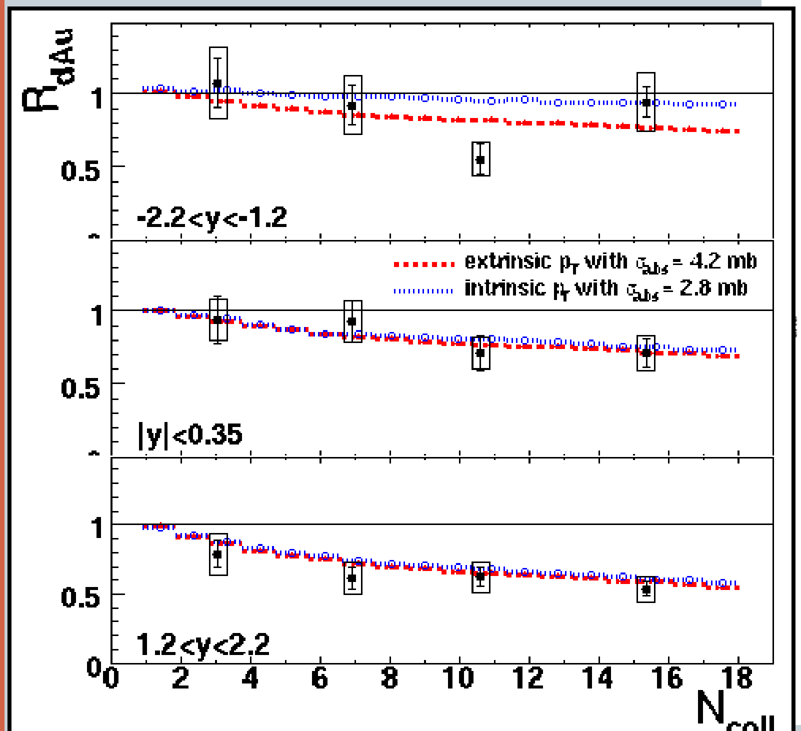
Extrinsic + $\sigma_{breakup}$ = 4.2 mb reproduces the data

Mid rapidity: ➔

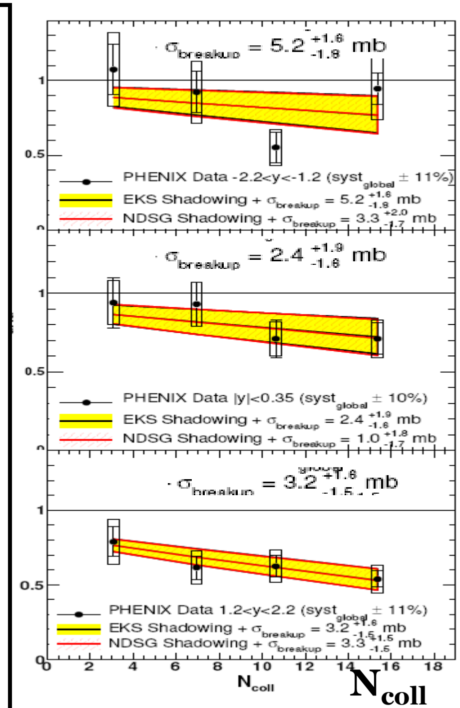
Both scenarios have the same behavior. Good match

Forward rapidity: ➔

Both scenarios have the same behavior. Good match



PHENIX Phys. Rev. C 77, 024912 (2008)



« extrinsic » shows a fair agreement with the data using the same $\sigma_{breakup}$ = 4.2 mb for all rapidities

d+Au Transverse momentum dependence

intrinsic .vs. extrinsic (w/ absorption)

R_{dAu} .vs. p_T

1. *Backward rapidity:* Same behavior for both scenarios ; difficult to conclude about the slope

   →

2. *Mid rapidity:* Same behavior for both scenarios and match the data

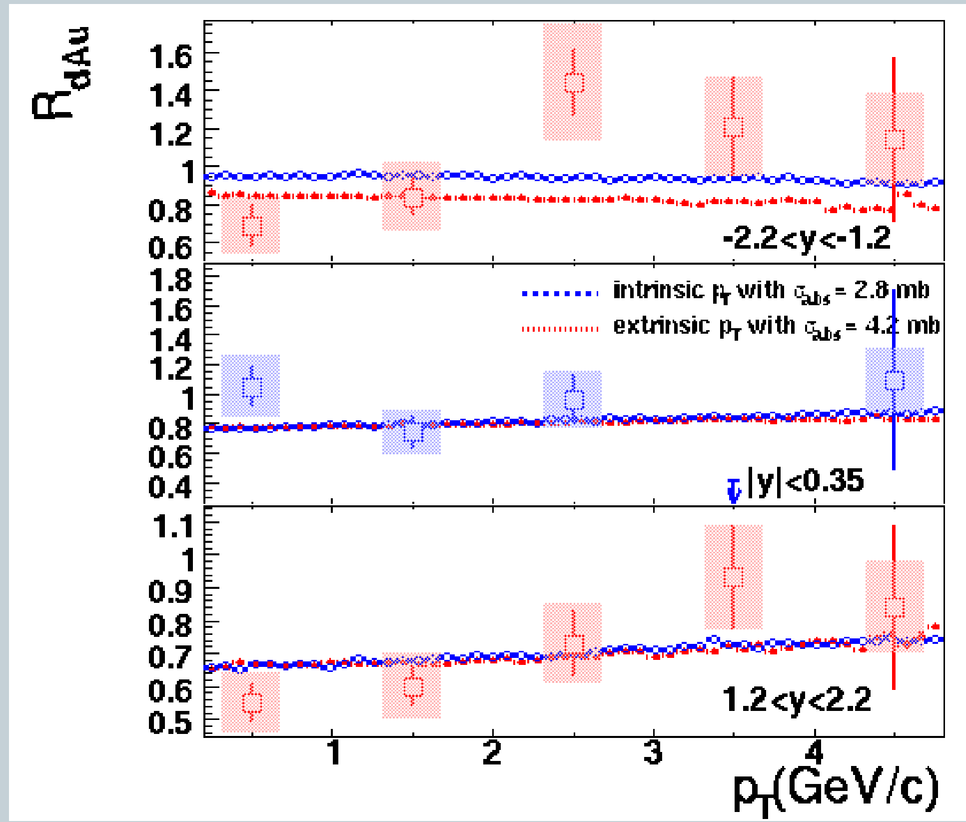
   →

3. *Forward rapidity:* Both scenarios have the same behavior ; slopes seem smaller than in the data

   →

→ *p_T broadening ?*

→ *Cronin effect ?*



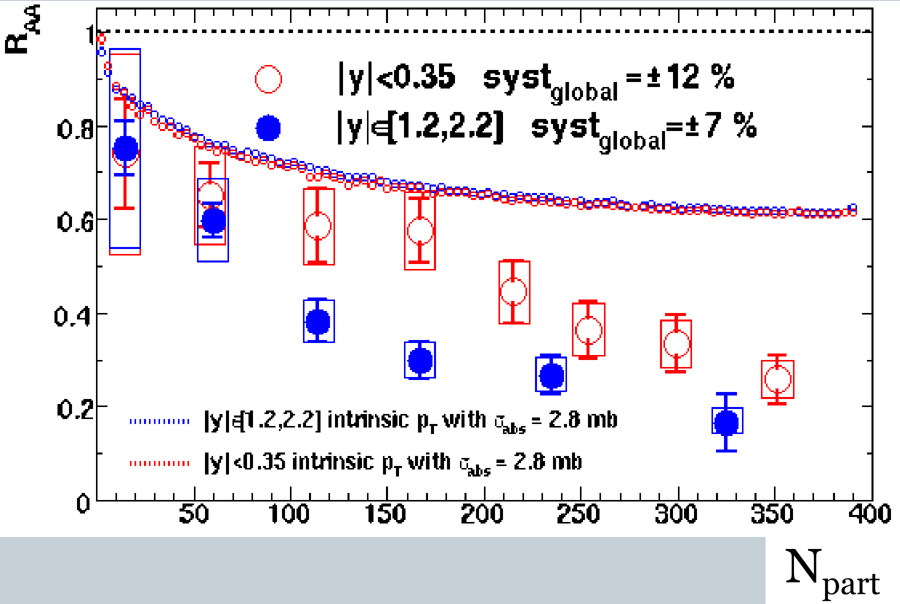
Difficult to conclude
Need more precise data

Au+Au centrality dependence

intrinsic .vs. extrinsic (w/ absorption)

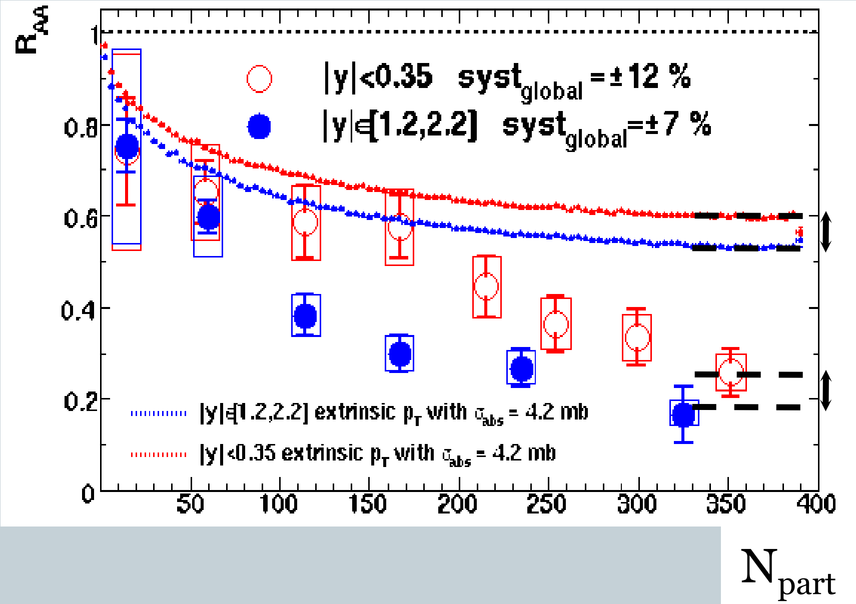
Intrinsic

- Same CNM suppression at forward and central rapidity. More « additionnal » suppression observed at forward than at mid rapidity



Extrinsic

- More CNM suppression at forward than at central rapidity. Seems to be consistent with the behavior observed in most central data. R_{AA}/CNM to be done…

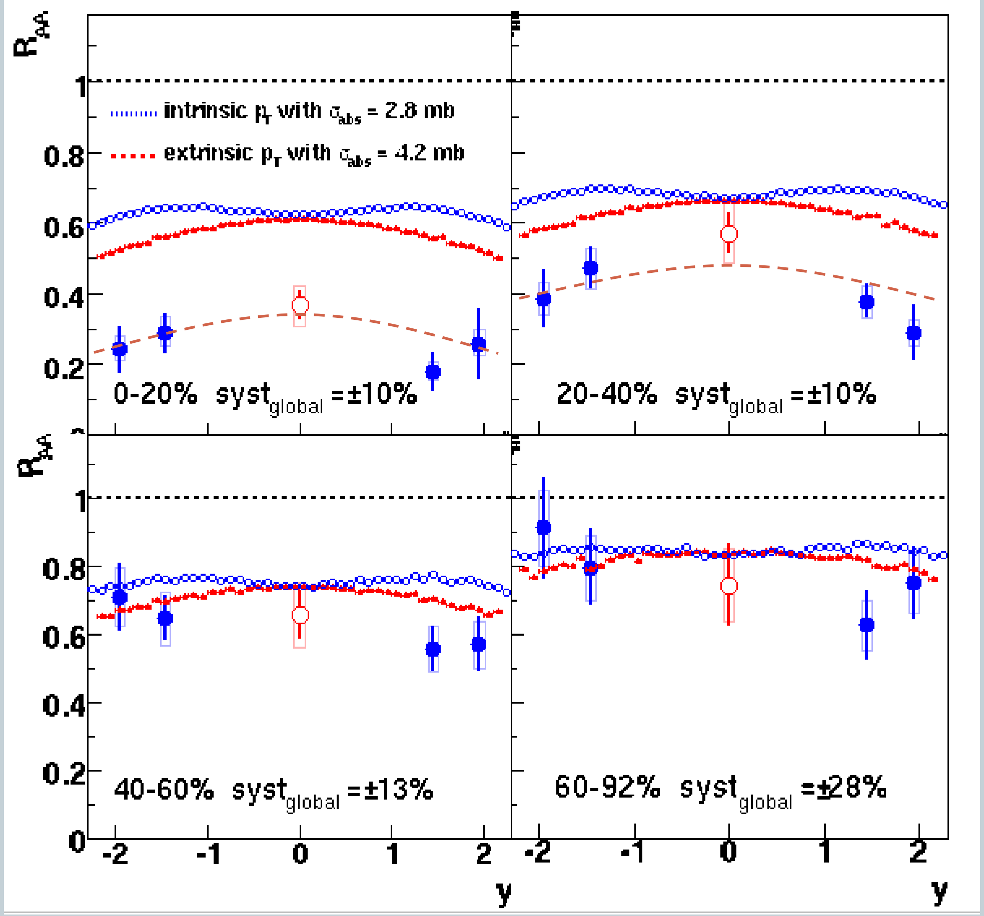


Au+Au rapidity dependence

intrinsic .vs. extrinsic (w/ absorption)

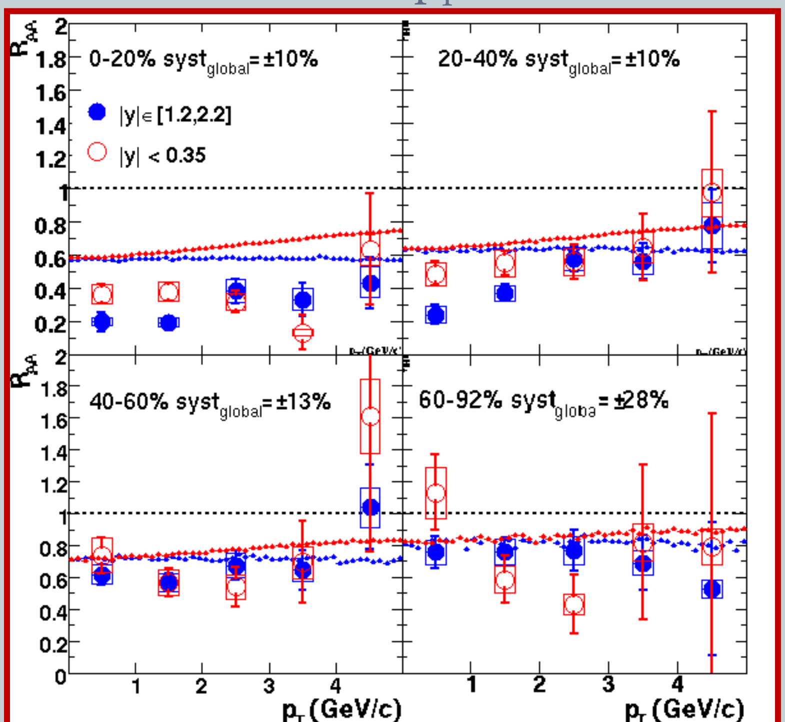
- **Intrinsic**
  - Shape of CNM effects ~flat for all centrality bins ➔ *suppression due to HDM effects is larger at forward rapidity than at central rapidity.*

- **Extrinsic**
  - Shape of CNM effects is changing with centrality and follows the data ➔ *suppression due to HDM effects is ~flat for all centrality bins.*



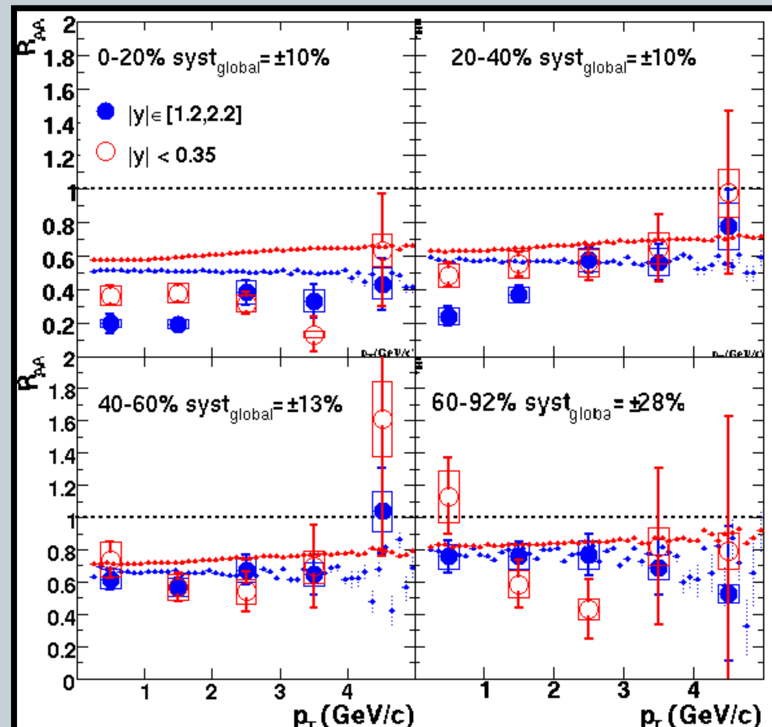
Au+Au transverse momentum dependence

- No major difference between intrinsic and extrinsic
  - Both models seem to reproduce fairly well the slopes of |y|<0.35 data at any centrality
  - Both models fail to reproduce the slopes of |y| ∈ [1.2,2.2] data for central events ➔ larger slope in the data (Cronin effect ?)
  - Will look at <p_T^2>…



Intrinsic

Extrinsic



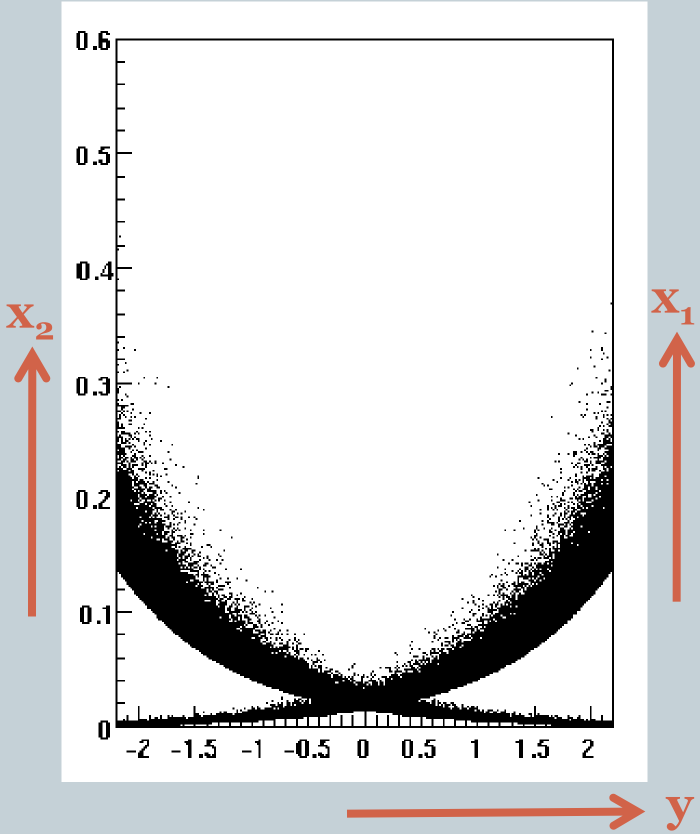
Conclusion

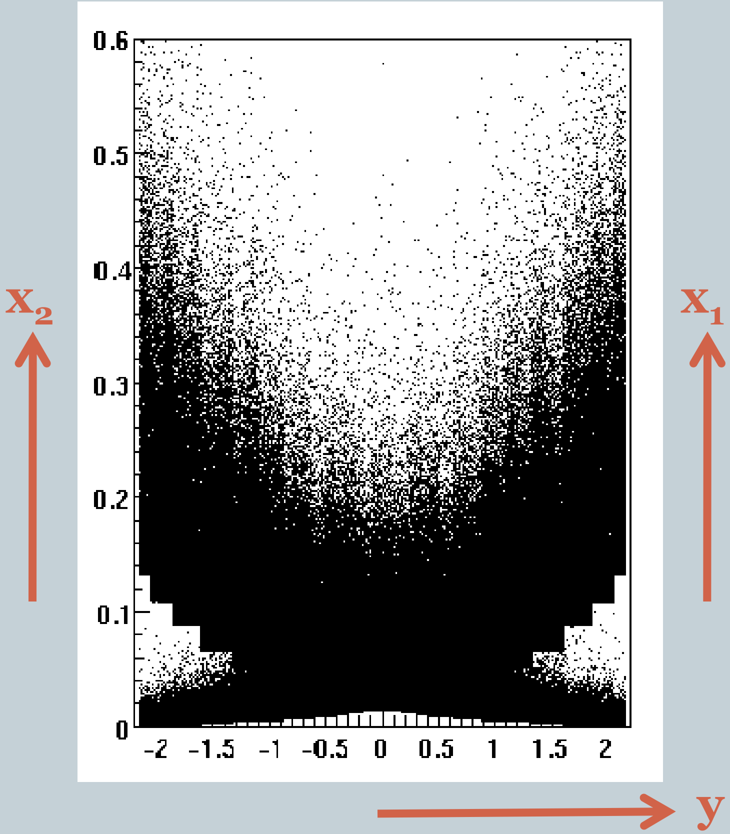
- We have investigated effects of « intrinsic » (g+g → J/Ψ) and « extrinsic » (g+g → J/Ψ+g) p_T schemes on shadowing (using EKS98)
- Observe significant differences in the shadowing effects when using the two schemes ➔ it is important to understand J/Ψ production in p+p collisions
- These differences affect the conclusion we can make when studying HDM effects in Au+Au collisions
  - The difference between $R_{AuAu}^{forward}$ / $R_{AuAu}^{central}$ can be partly due to CNM effects
  - The R_{AuAu}.vs.y shape can be partly due to CNM effects
- Transverse momentum studies give additionnal information
  - R_{AuAu}.vs.pT shape is fairly well reproduced by CNM effects at mid-rapidity
  - R_{AuAu}.vs.pT slope is smaller for CNM effects than for the data at forward rapidity
- More precise d+Au data are needed to better constraint the models ➔ new d+Au data have been recorded this year (run 8) ➔ 30 times more data…

Backup slide

$x_{1,2}$.vs.y

intrinsic | **extrinsic**

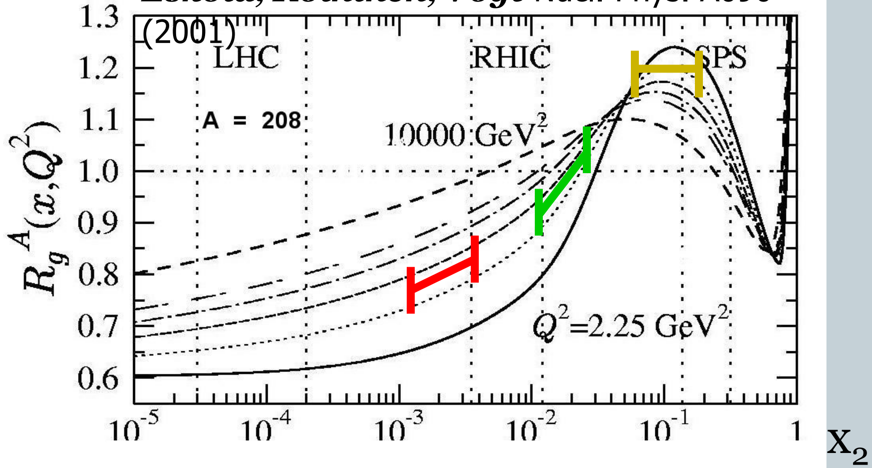




Backup slide

EKS98

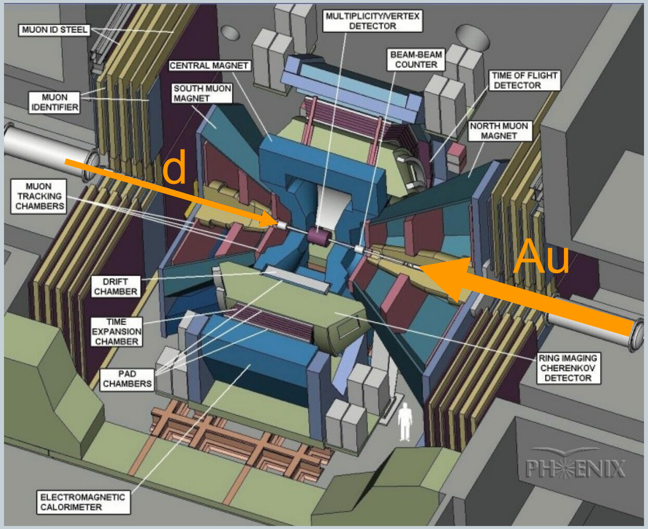
Eskola, Kolhinen, Vogt Nucl. Phys. A696 (2001)



PHENIX μ, North **PHENIX μ, SOUTH**

PHENIX e

South **Central** **North**



rapidity y