Υ production in dAu collisions at RHIC

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University of Mons

Quarkonium Working Group Workshop
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In collaboration with E. G. Ferreiro, F. Fleuret, J. P. Lansberg and A. Rakotozafindrabe

Outline

Introduction and motivations

- Extend to Υ the study of CNM effects (shadowing + absorption) on production of quarkonia

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- Comparison of three differents shadowing parametrisations

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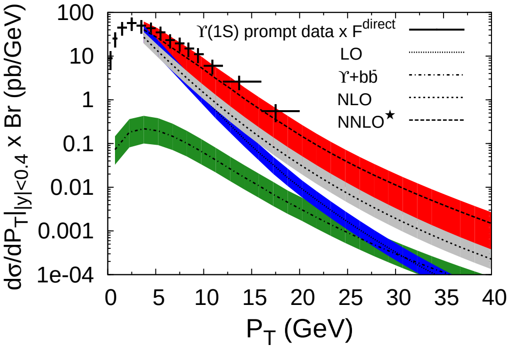
- Glauber Monte Carlo model to simulate dAu and AuAu collisions at RHIC
- Two main production schemes ($2 \rightarrow 1$, $2 \rightarrow 2$)
- Comparison of three differents shadowing parametrisations
- Three absorption cross sections

Experimental situation

P. Artoisenet, J. Campbell, J.P. Lansberg, F. Maltoni, Phys. Rev. Lett. 101, 152001 (2008).
D. Acosta et al. (CDF collaboration), Phys. Rev. Lett 88, 161802 (2002).

Results at 1.8 TeV



- CSM describes well the data at NNLO*

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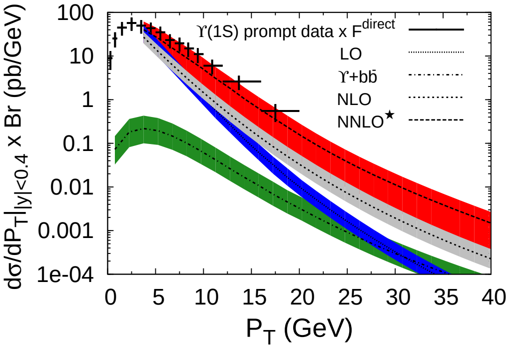
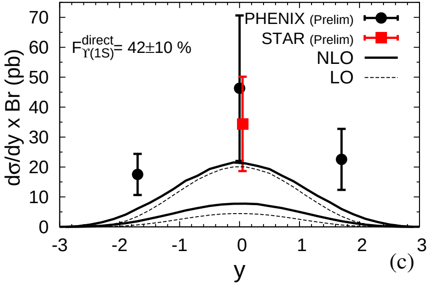


- CSM describes well the data at NNLO*
- However LO CSM is sufficient to describe low pT data

Experimental situation

S. J. Brodsky and J. P. Lansberg, Phys. Rev. D81, 014004 (2010).
P. Djawotho et al., J. Phys. G34, s947 (2007); T. Ullrich (private communication) (STAR)
C.L. da Silva, Nucl. Phys. A830, 227c (2009); L.L. Levy, Nucl. Phys. A830, 353c (2009); W. Xie et al., J. Phys. A774, 693 (2006) (PHENIX)

Results at 200 GeV



- Upper dashed line, $m_b = 4.5$ GeV, $\mu_R = M_T$, $\mu_F = 2M_T$
- Lower dashed line, $m_b = 5.0$ GeV, $\mu_R = 2M_T$, $\mu_F = M_T$

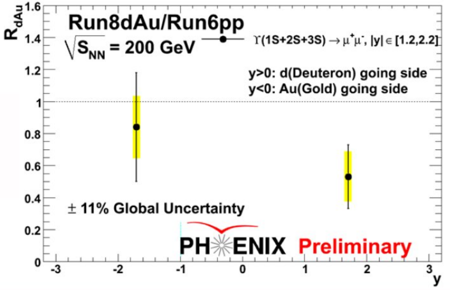
We take the parameters of the upper curve in the following.

Experimental situation

H. Liua and the STAR collaboration, Nucl. Phys. A830, 235c (2009)
H. Pereira Da Costa for the PHENIX collaboration, talk at the rencontres de Moriond, March 15, 2010

3 data points :

- $-2.2 < y < -1.2$: PHENIX - $R_{dAu} = 0.84 \pm 0.34$ (stat.) $\pm$ 0.28 (sys.)
- $1.2 < y < 2.2$: PHENIX - $R_{dAu} = 0.53 \pm 0.20$ (stat.) $\pm$ 0.16 (sys.)



- $|y| < 0.5$: STAR - $R_{dAu} = 0.98 \pm 0.32$ (stat.) $\pm$ 0.28 (sys.)

On the kinematics of Υ production

If $\mathcal{F}_g^A(x, \vec{r}, z, \mu_f)$ gives the distribution of a gluon of mom. fract. x at a position $\vec{r}, z$ in a nucleus A, the differential cross-section reads:

$$\frac{d\sigma_{AB}}{dy\, dP_T\, d\vec{b}} =$$

$\boxed{\mathbf{2} \longrightarrow \mathbf{1} \text{ kinematics with intrinsic } p_T}$ | $\boxed{\mathbf{2} \longrightarrow \mathbf{2} \text{ kinematics with extrinsic } p_T}$

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$\boxed{\mathbf{2} \rightarrow \mathbf{1} \text{ kinematics with intrinsic } p_T}$	$\boxed{\mathbf{2} \rightarrow \mathbf{2} \text{ kinematics with extrinsic } p_T}$
$\int d\vec{r}_A\, dz_A\, dz_B$	$\int dx_1\, dx_2 \int d\vec{r}_A dz_A dz_B$
$\times\ \mathcal{F}_g^A(x_1^0, \vec{r}_A, z_A, \mu_f)\mathcal{F}_g^B(x_2^0, \vec{r}_B, z_B, \mu_f)$	$\times\ \mathcal{F}_g^A(x_1, \vec{r}_A, z_A, \mu_f)\mathcal{F}_g^B(x_2, \vec{r}_B, z_B, \mu_f)$
$\times\ \sigma_{gg}^{\text{Intr.}}(x_1^0, x_2^0)$	$\times\ 2\hat{s} P_T \frac{d\sigma_{gg\to\Upsilon+g}}{d\hat{t}} \delta(\hat{s} - \hat{t} - \hat{u} - M^2)$
$\times\ S_A(\vec{r}_A, z_A)\, S_B(\vec{r}_B, z_B)$	$\times\ S_A(\vec{r}, z_A) S_B(\vec{r}_B, z_B)$

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$$\frac{d\sigma_{AB}}{dy\, dP_T\, d\vec{b}} =$$

2 → 1 kinematics with intrinsic p_T

$$\int d\vec{r}_A\, dz_A\, dz_B$$
$$\times\ \mathcal{F}_g^A(x_1^0, \vec{r}_A, z_A, \mu_f)\mathcal{F}_g^B(x_2^0, \vec{r}_B, z_B, \mu_f)$$
$$\times\ \sigma_{gg}^{\text{Intr.}}(x_1^0, x_2^0)$$
$$\times\ S_A(\vec{r}_A, z_A)\, S_B(\vec{r}_B, z_B)$$

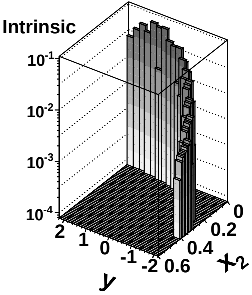
$$\boxed{x_{1,2} = \frac{m_T}{\sqrt{s_{NN}}} \exp(\pm y) \equiv x_{1,2}^0(y, P_T)}$$

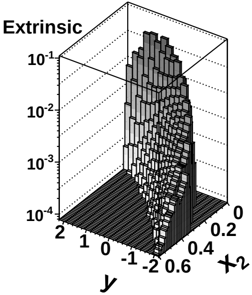
2 → 2 kinematics with extrinsic p_T

$$\int dx_1\, dx_2 \int d\vec{r}_A dz_A dz_B$$
$$\times\ \mathcal{F}_g^A(x_1, \vec{r}_A, z_A, \mu_f)\mathcal{F}_g^B(x_2, \vec{r}_B, z_B, \mu_f)$$
$$\times\ 2\hat{s}P_T \frac{d\sigma_{gg\to\Upsilon+g}}{d\hat{t}} \delta(\hat{s} - \hat{t} - \hat{u} - M^2)$$
$$\times\ S_A(\vec{r}, z_A) S_B(\vec{r}_B, z_B)$$

$$\boxed{\delta(..) \to x_2 = \frac{x_1 m_T \sqrt{s_{NN}} e^{-y} - M^2}{\sqrt{s_{NN}}(\sqrt{s_{NN}} x_1 - m_T e^{y})}}$$

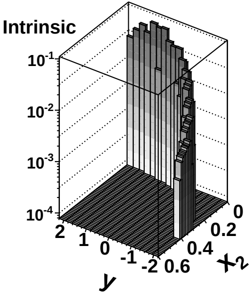
On the kinematics of Υ production

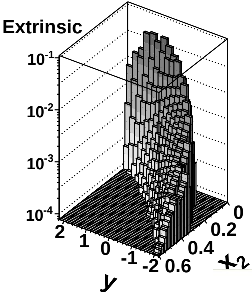




For a given couple (y, p_T), x_2 is larger in the extrinsic scheme

On the kinematics of Υ production





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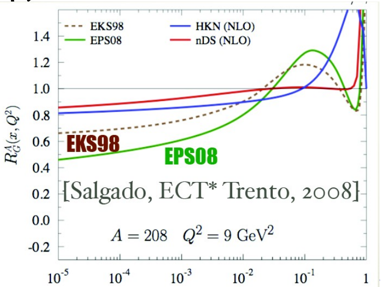
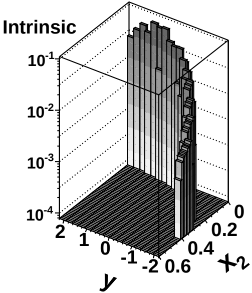
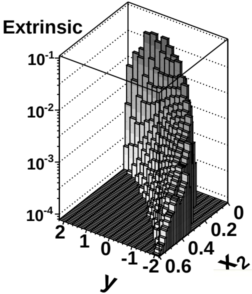
Antishadowing peak at $\sim 10^{-1}$



On the kinematics of Υ production





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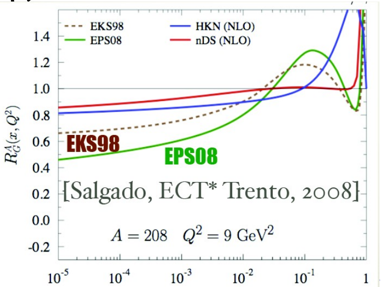
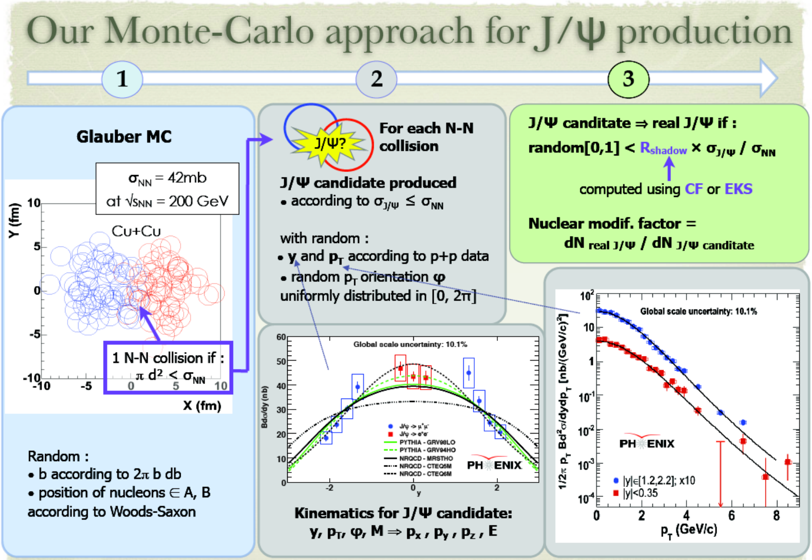
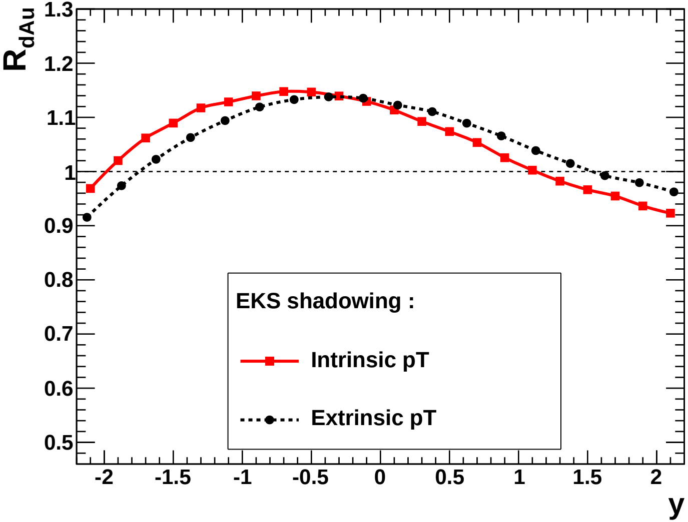


We expect different shadowing effects in both cases.

The Glauber Monte Carlo (for Υ here)

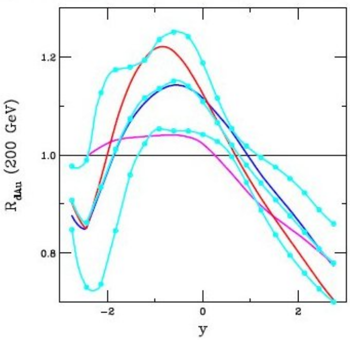


Results for dAu collisions for Υ



Results for dAu collisions for Υ

R. Vogt, talk at Joint CATHIE-TECHQM Meeting, BNL, December 14-18, 2009



EKS98 (blue), nDSG (magenta), EPS08 (red), EPS09 (cyan)

- One has to be careful about binning effect (usually decrease the modifications)
- Interesting to see the difference between $2->1$ (as done by R. Vogt) and $2->2$ (kinematics for LO CSM)

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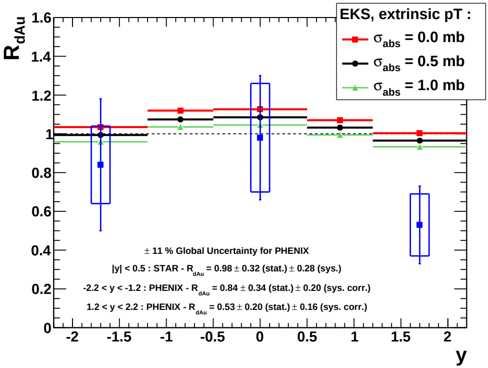

- backward: ok within uncertainties;
- central: reasonable job - $R_{dAu} > 1$ (for any σ_{abs});
- forward: clearly too high (for any σ_{abs});

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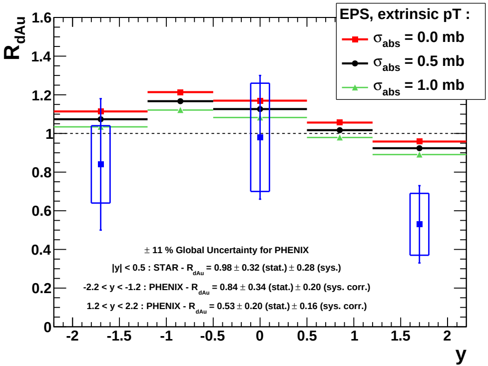

- backward: slightly too high (but ok within uncertainties);
- central: reasonable job - $R_{dAu} > 1$ (for any σ_{abs});
- forward: clearly too high (for any σ_{abs}), though 'better' than EKS;

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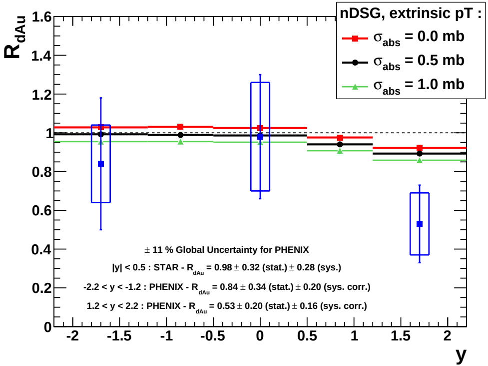

- backward: ok within uncertainties;
- central: reasonable job - R_{dAu} 1;
- forward : clearly too high (for any σ_{abs}), though 'better' than EKS and EPS;

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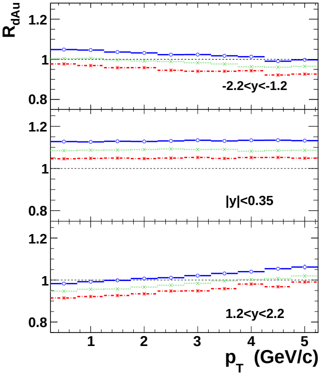

EKS

The extrinsic scheme enables to predict the pT dependence, which is non trivial

- In blue, $\sigma_{abs} = 0.0$ mb
- In green, $\sigma_{abs} = 0.5$ mb
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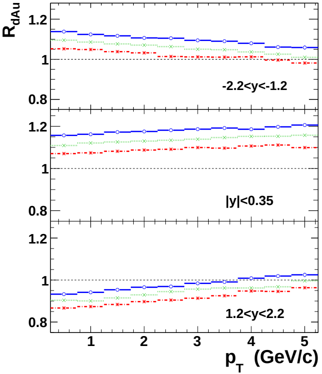

EPS

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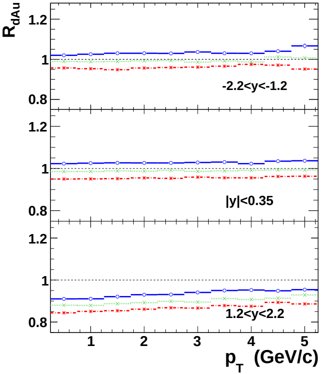

nDSg

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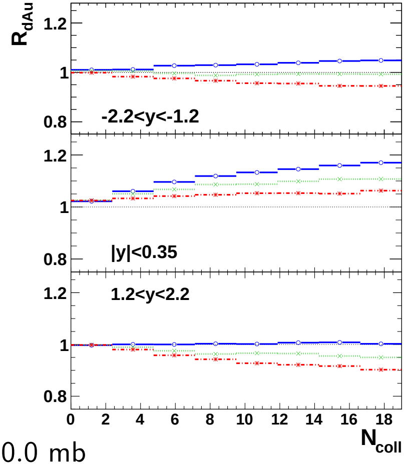

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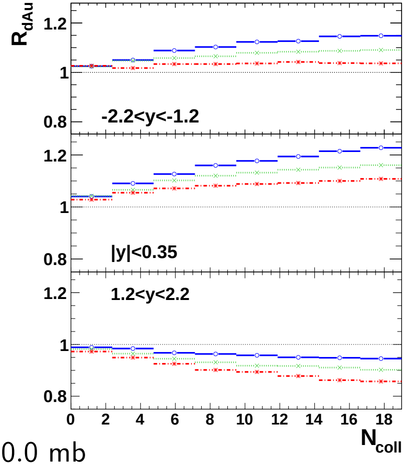

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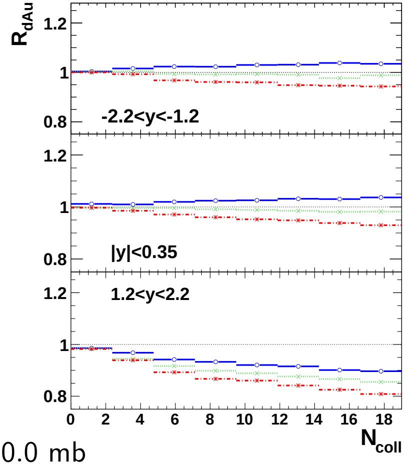

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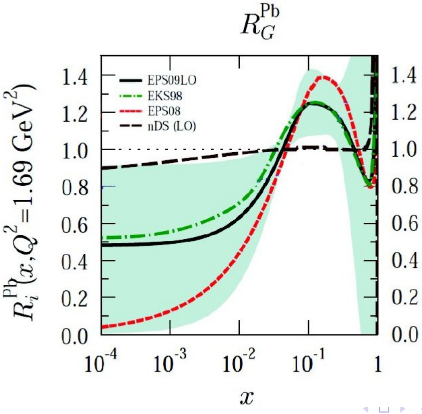
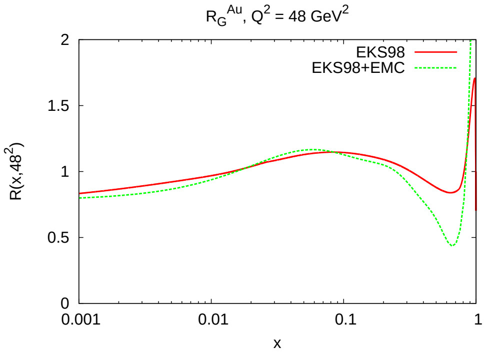
EMC effect for gluons

- Tension between the theory and the PHENIX point in the backward region
- The backward region correspond to the EMC region ($x > 0.1$)
- EMC effect basically unknown for the gluon



EMC effect for gluons

- Let us try to increase the suppression of $g(x)$ in the EMC region
- Keeping momentum conservation : $\int xg(x)\, dx = Cst$



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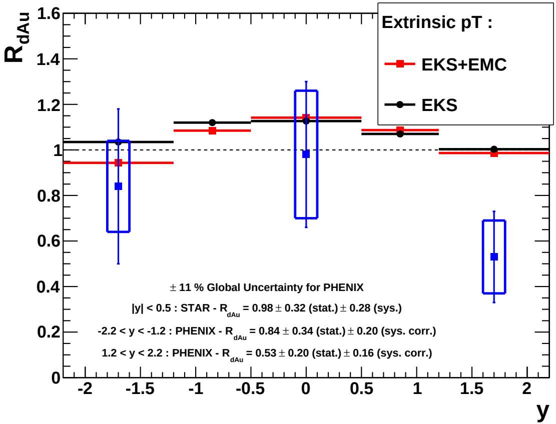

Works better for backward region

Conclusions and perspectives

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- Backward region dominated by EMC effect
- Energy loss seems to be needed to reproduce the data at forward y
- Within the commonly accepted σ_{abs}, one should expect an excess of Υ
- ... unless there is no antishadowing (see nDSg)