Charmonium production at LHC beams in a fixed target mode.

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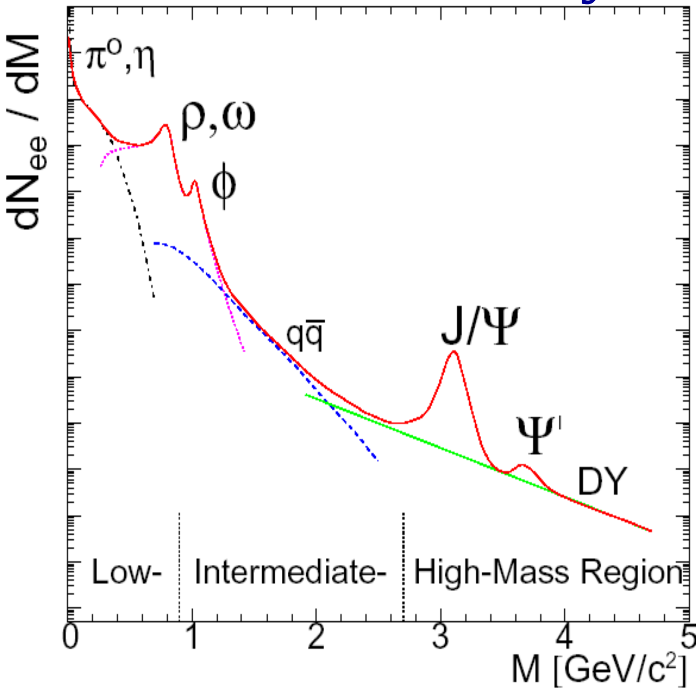
INR RAS, Moscow

1. Physical motivaion.
2. Experimental situation.
3. Fixed target suggestion.
3. Summary.

Charmonium

- 1974 г.: discovery of J/ψ, 1986 г.: Matsui & Satz:



colour screening in deconfined matter
→ J/ψ suppression
→ possible signature of QGP formation

Experimental and theoretical investigations
→ situation is more complicated

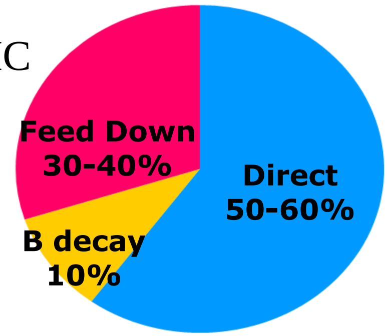
cold nuclear matter (CNM)/initil states.

- **“normal” nuclear suppression**
- **(anti)shadowing**
- **saturation, color glass condensate**

suppression via comovers
feed down from χ_c, ψ’
sequential screening (first : χ_c, ψ’, J/ψ only well above T_c)

regeneration via statistical hadronization or charm coalescence

CDF-LHC
Low pt



J/ψ production from *B*-hadron

Important for “large” charm yield, i.e. RHIC and LHC

Fixed-target data (SPS, FNAL, HERA)

AA collisions
SU, PbPb, InIn

NA38
S-U 200 GeV/nucleon, $0<y_{cm}<1$, $\sqrt{s}=19.4$ GeV

NA50
Pb-Pb 158 GeV/nucleon, $0<y_{cm}<1$, $\sqrt{s}=17.3$ GeV

NA60
In-In 158 GeV/nucleon, $0<y_{cm}<1$, $\sqrt{s}=17.3$ GeV

pA collisions

HERA-B
p-Cu,(Ti),W 920 GeV, $-0.34<x_F<0.14$, $\sqrt{s}=41.6$ GeV

E866
p-Be, Fe, W 800 GeV, $-0.10<x_F<0.93$, $\sqrt{s}=38.8$ GeV

NA50
p-Be,Al,Cu,Ag,W,Pb 400/450 GeV, $-0.1<x_F<0.1$, $\sqrt{s}=27.4/29.1$ GeV

NA51
p-p, d 450 GeV, $-0.1<x_F<0.1$, $\sqrt{s}=29.1$ GeV

NA3, NA38
p-p,Pt, Cu,U 200 GeV, $0<x_F<0.6$, $\sqrt{s}=19.4$ GeV

NA60
p-Be,Al,Cu,In,W,Pb,U 158/400 GeV, $-0.1<x_F<0.35$, $\sqrt{s}=17.3/27.4$ GeV

Colliders (RHIC,LHC)

AA collisions

RHIC CuCu, AuAu $\sqrt{s}$ =39, 62, 130 GeV, 200 GeV
LHC PbPb $\sqrt{s}$ = 2.76 TeV (max 5.5 TeV)

pA collisions

RHIC pp, dAu $\sqrt{s}$ = 130, 200 GeV
LHC pp $\sqrt{s}$ = 2.76, 7, 8 TeV (max 14TeV)
pPb $\sqrt{s}$ = 5.02 TeV

Fixed-target (at LHC) — energy between SPS and RHIC

was suggested in 2005 and then in 2009 at CERN Workshop "New opportunities at CERN".

AA collisions

Pb-Pb 2750 GeV/nucleon, $\sqrt{s}$ = 71.8 GeV

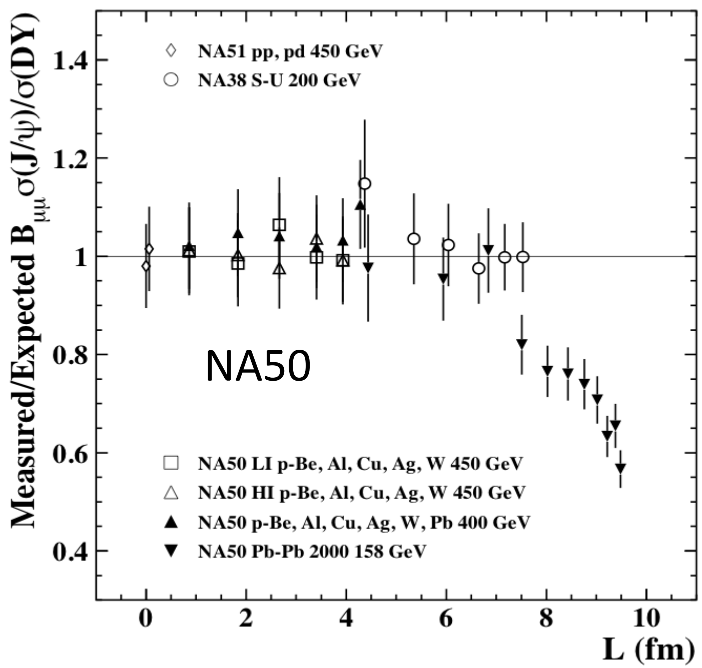
pA collisions

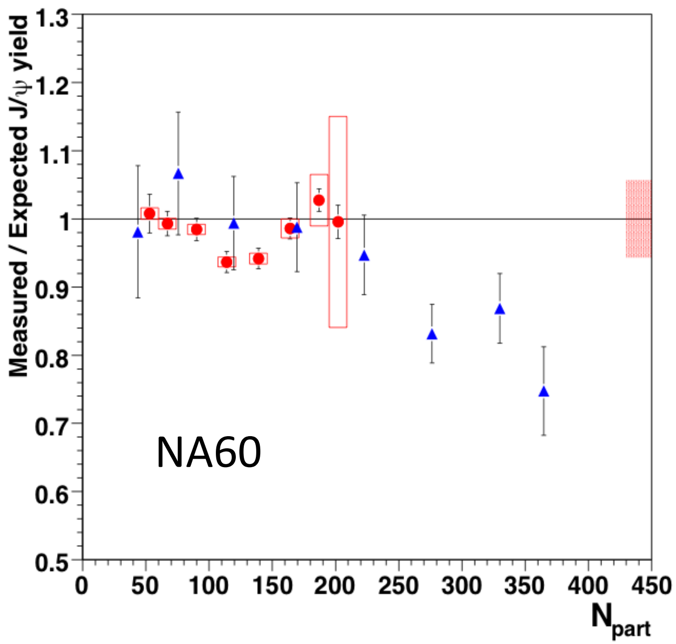
p-A 7000 GeV , $\sqrt{s}$ = 114.6 GeV
(5000 GeV, $\sqrt{s}$ = 96.9 GeV)

J/ψ suppression at SPS

NA50

NA60





Suppression (~40%);

ψ' suppression is measured

σ_{abs} **depends on energy ;**

Suppression (~20-30%);

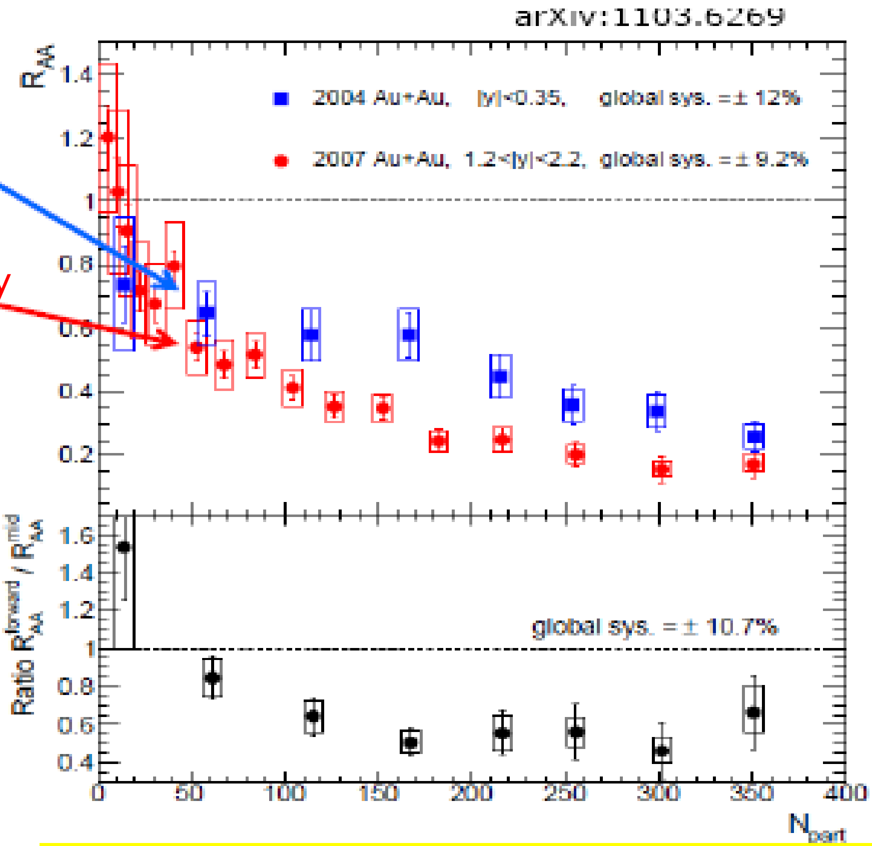
$\sigma_{abs}^{J/\psi}$ (158 GeV) = 7.6 ± 0.7 ± 0.6 mb

$\sigma_{abs}^{J/\psi}$ (400 GeV) = 4.3 ± 0.8 ± 0.6 mb

B. Alessandro et al. (NA50), EPJC39 (2005) 335

R. Arnaldi et al. (NA60), Nucl. Phys. A (2009) 345

J/ψ suppression at PHENIX, RHIC



Suppression (~40-80%);
Larger suppression at forward rapidity

$$R_{AA}(p_T) = \frac{d^2N^{AA}/dp_T d\eta}{T_{AA} d^2\sigma^{NN}/dp_T d\eta}$$

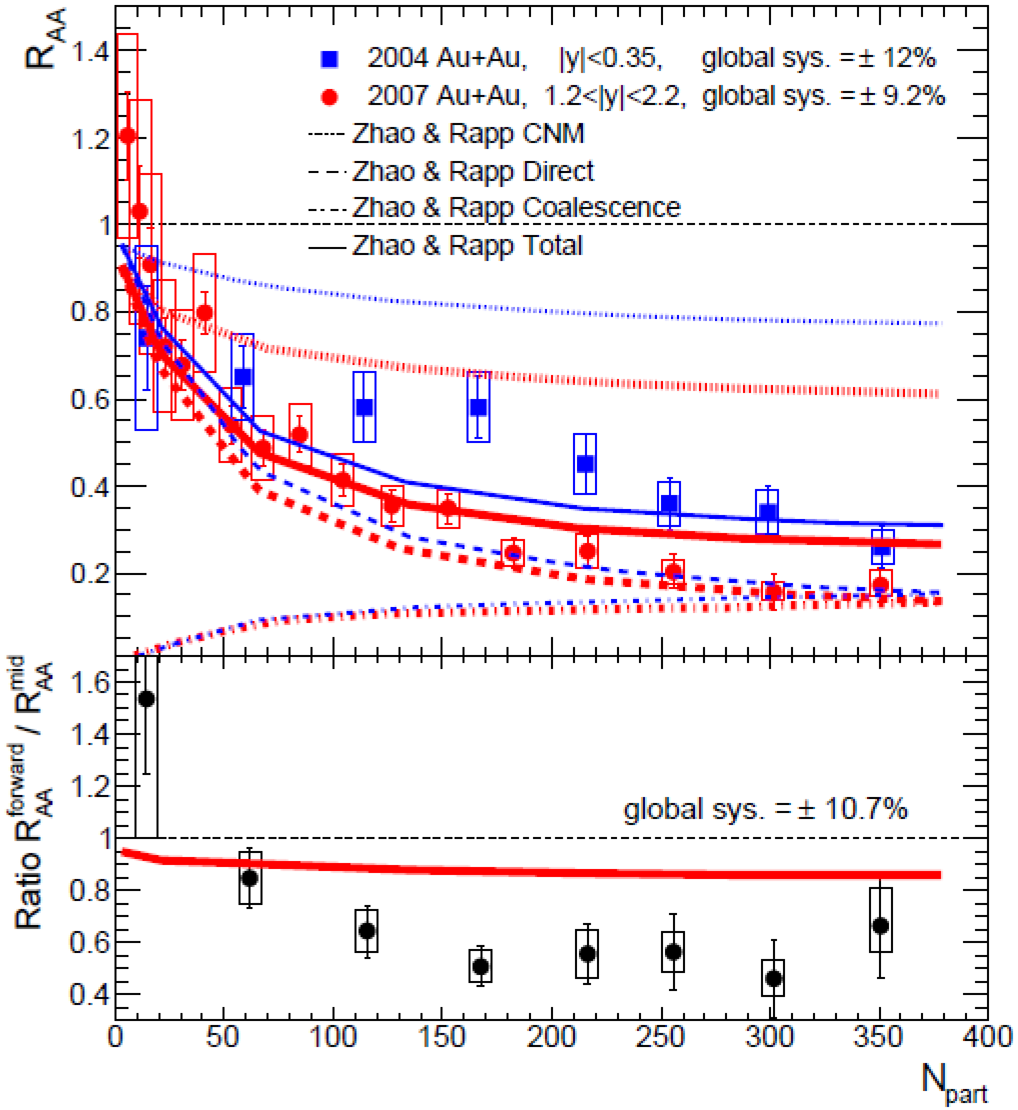
N-N cross section

$\langle N_{binary}\rangle/\sigma_{inel}^{p+p}$

A.Adare et al. (PHENIX), PRC84 (2011) 054912

J/ψ suppression at PHENIX, RHIC

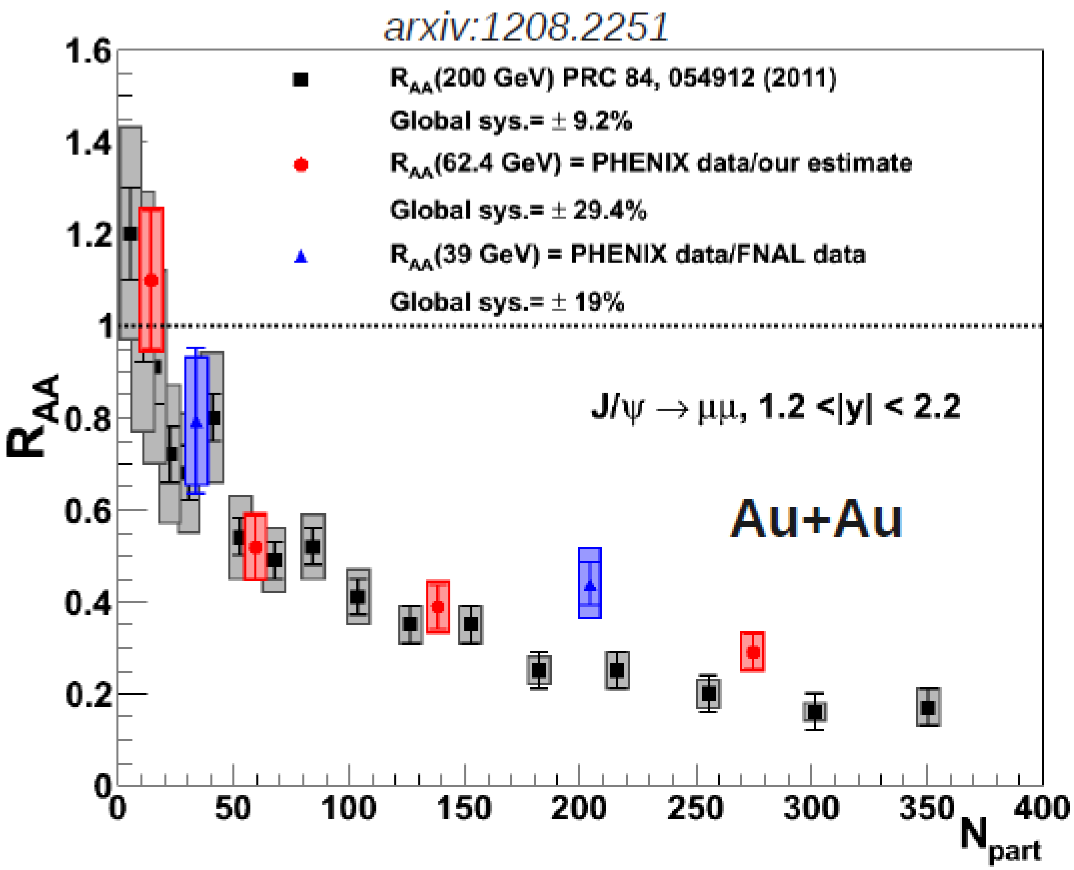
Theoretical models for Au-Au



Models could describe main features but no quantitative agreement.

Is regeneration important?

J/ψ suppression at PHENIX, RHIC(+low energy)



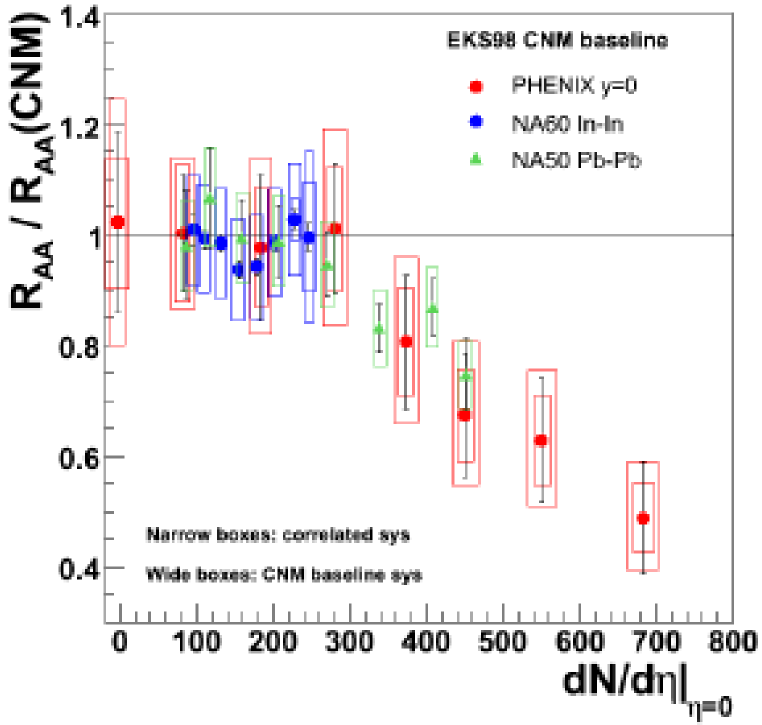
Suppression approximately the same.

No *pp*- data at 62.4 and 39 GeV – large systematic errors

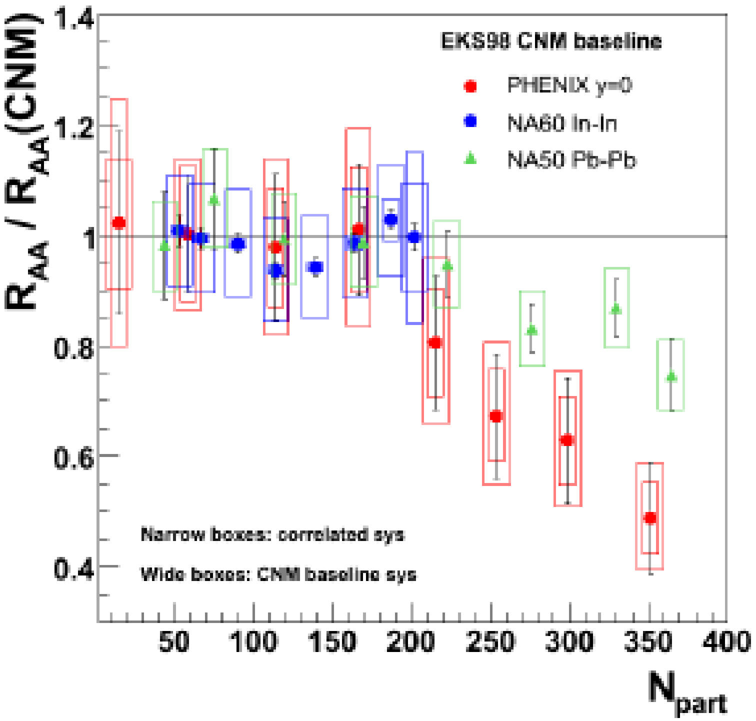
D McGlinchey - QM2012

Comparison of SPS and RHIC data at mid rapidity

R_{AA} as a function of multiplicity (~ε)



R_{AA} as a function of N_{part}



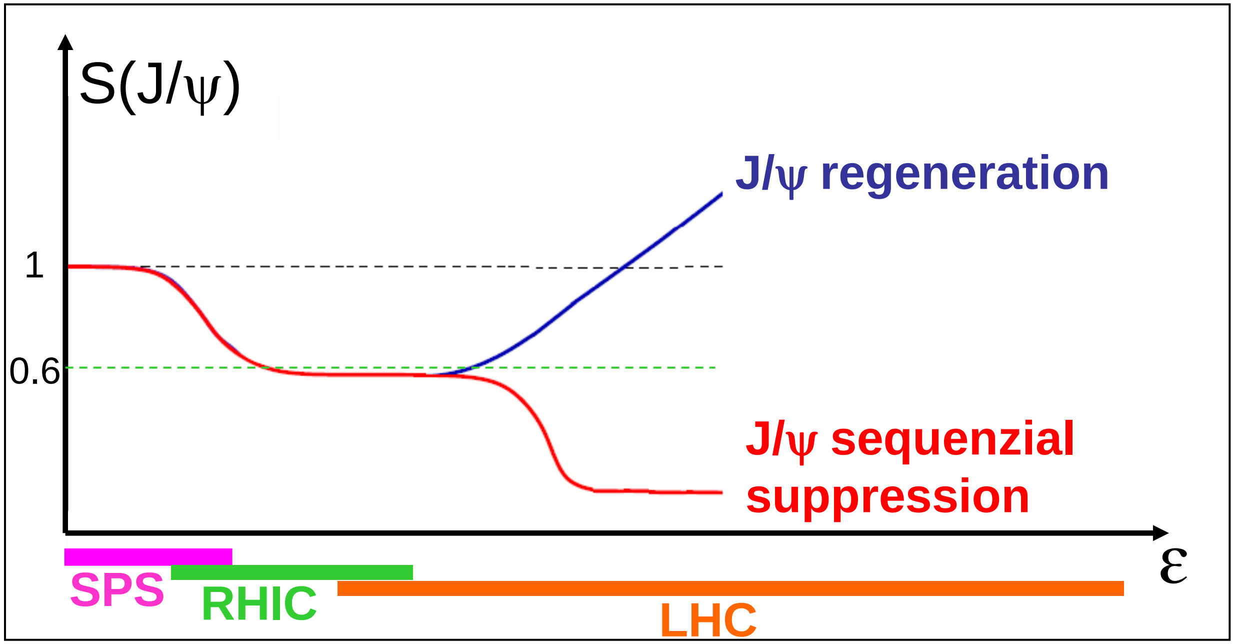
Which dependence to choose?

With NA60 data (σ_{abs} depends on energy) suppression of charmonium production at PHENIX larger that at NA50

N.Brambilla et al. , EPJ C71 (2011) 1534

J/ψ production in heavy ions collisions

At LHC energy ? Suppression or/and regeneration ?



Bottomonium production at LHC

State	$J/\psi(1S)$	$\chi_c(1P)$	$\psi'(2S)$	$\Upsilon(1S)$	$\chi_b(1P)$	$\Upsilon(2S)$	$\chi_b(2P)$	$\Upsilon(3S)$
T_d/T_c	2.10	1.16	1.12	≥ 4.0	1.76	1.60	1.19	1.17

Charmonium production at LHC: ALICE, ATLAS, CMS and LHCb .

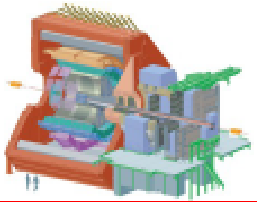
ALICE

$J/\psi \rightarrow \mu^+\mu^-$ $2.5<y<4$

$J/\psi \rightarrow e^+e^-$ $|y|<0.9$

p_T coverage down to p_T~0

(up tp now only inclusive J/ψ results)

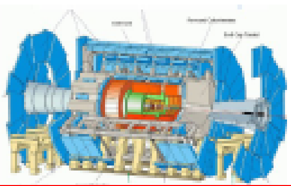


ATLAS

$J/\psi \rightarrow \mu^+\mu^-$ $|y|<2.4$

$p_{T\mu}>3$GeV, $|\eta_\mu|<2.5$ → p_T $J/\psi>6.5$GeV/c

(separation between B and prompt J/ψ)

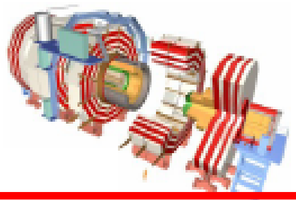


CMS

$J/\psi \rightarrow \mu^+\mu^-$ $|y|<2.4$

p_T coverage depending on the y region

(separation between B and prompt J/ψ)



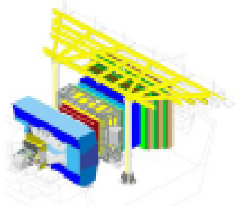
LHCb

$J/\psi \rightarrow \mu^+\mu^-$ $2.5<y<4$

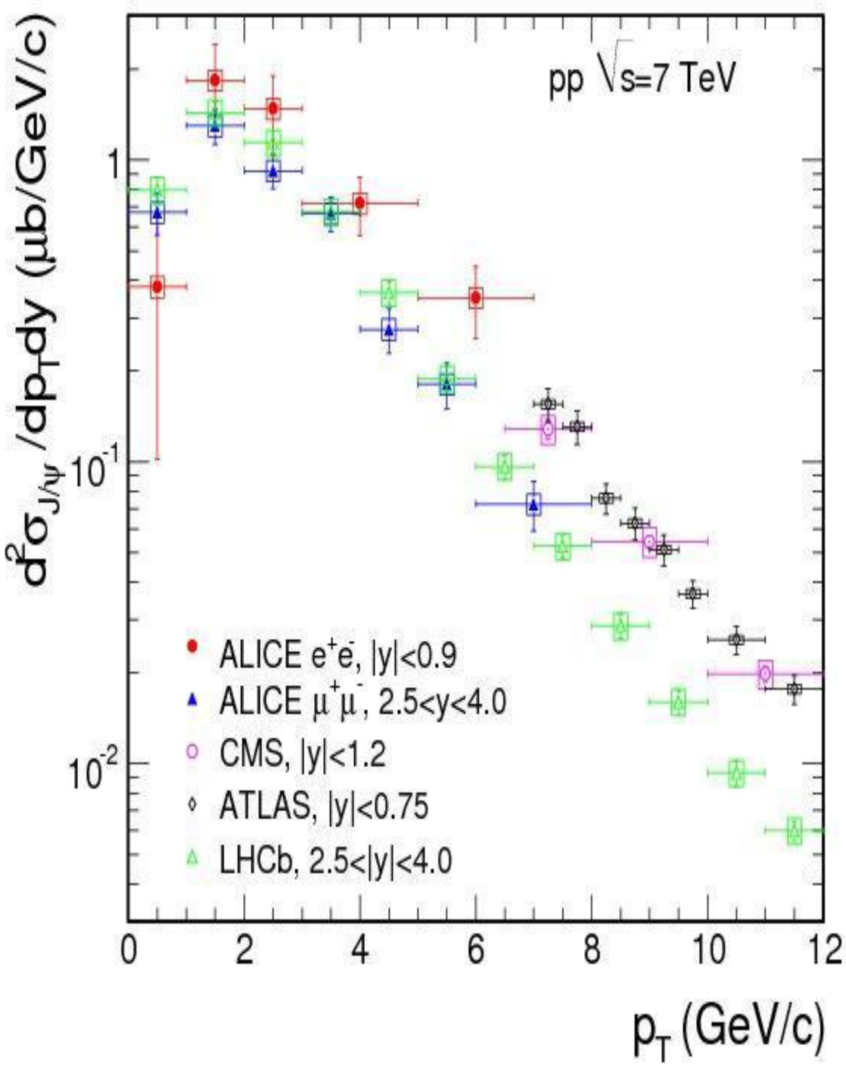
p_T coverage down to p_T~0

(separation between B and prompt J/ψ)

(no heavy ion physics program)



Charmonium production in *pp*- collisions at LHC: ALICE, CMS, ATLAS and LHCb .



Good agreement of experimental data of ALICE, CMS and ATLAS for mid-rapidity

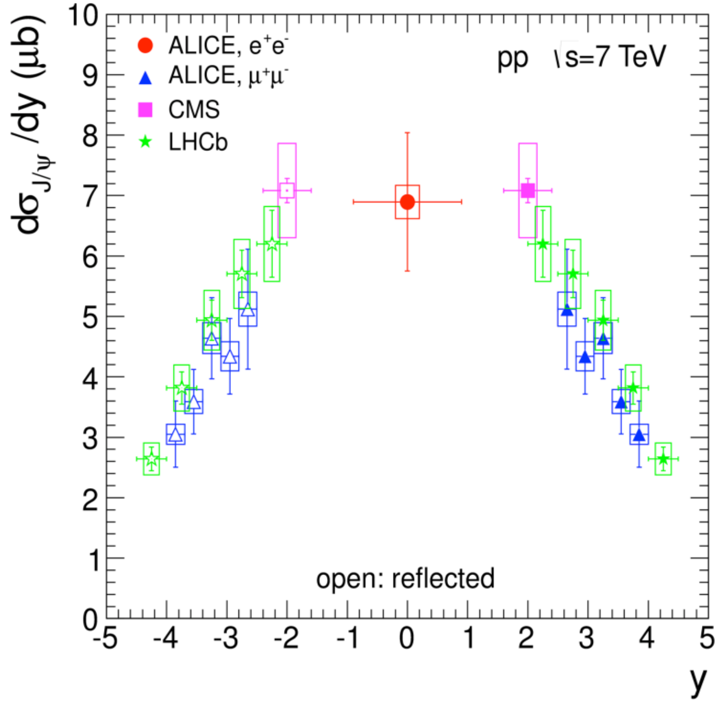
and ALICE and LHCb for forward-rapidity

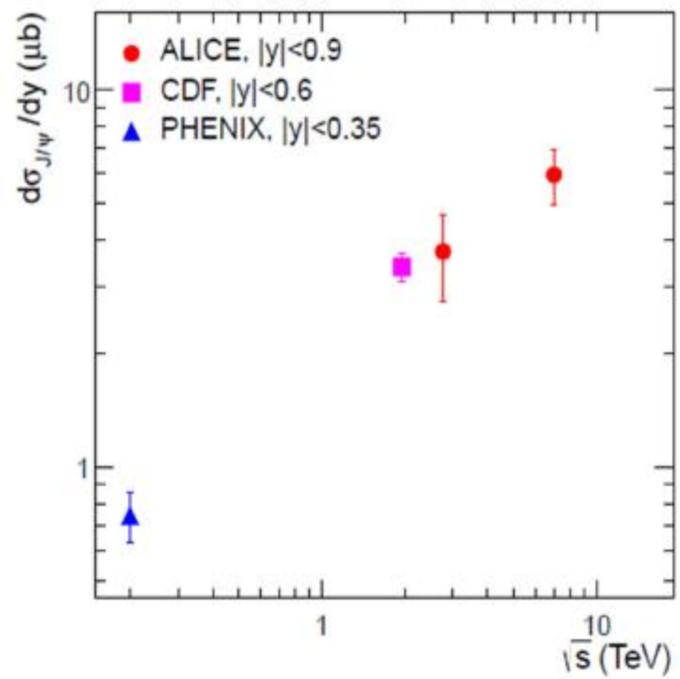
Transverse momentum distribution- dependence on rapidity range.

CMS: Eur. Phys. J. **C71**, 1575 (2011).
ATLAS: Nucl. Phys. **B850**, 387 (2011).
LHCb: Eur. Phys. J. **C71**, 1645 (2011).

ALICE: Phys. Lett. B704 (2011) 442

J/ψ production in *pp*-collisions and dependence on rapidity and energy



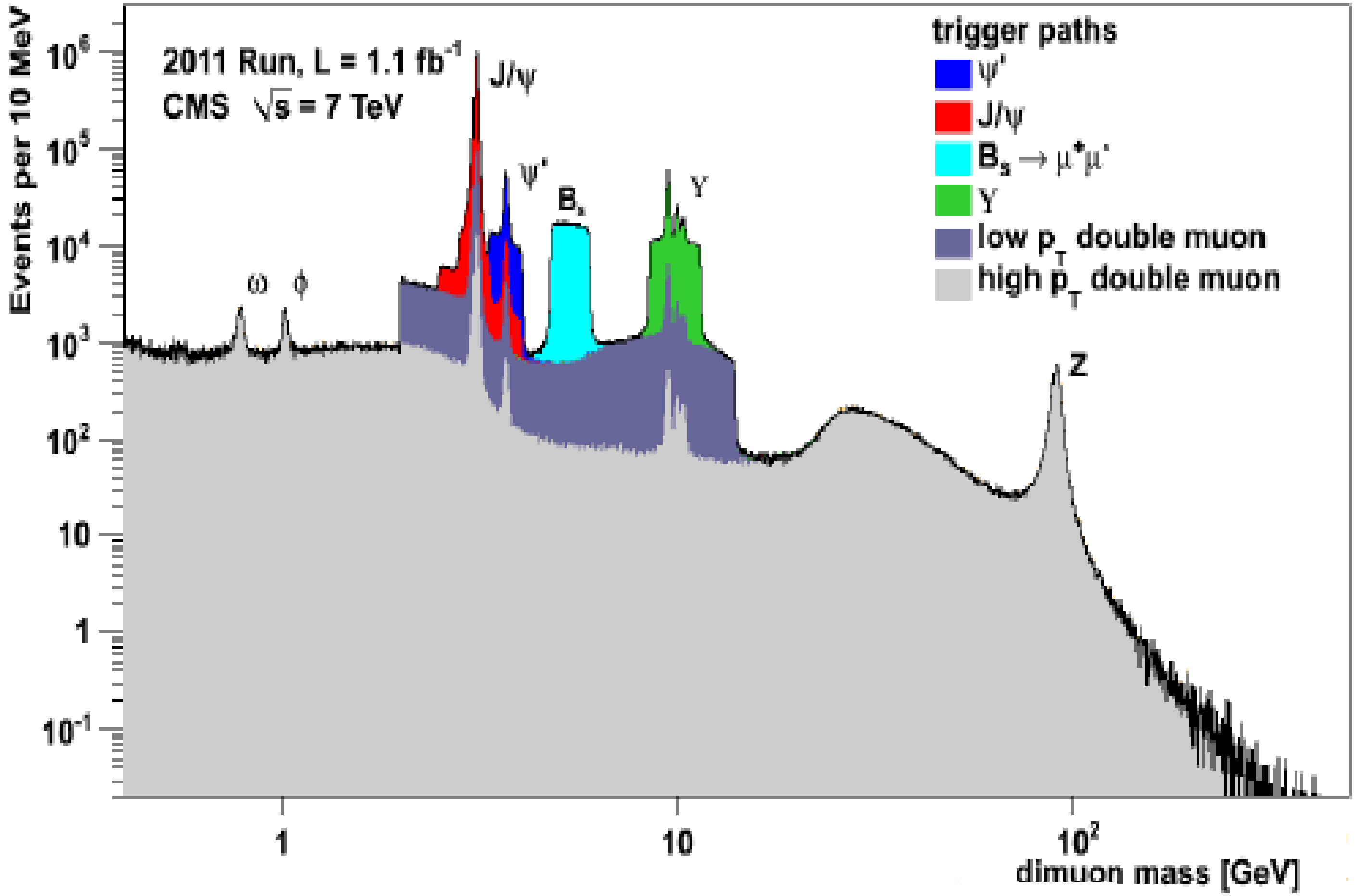


Good agreement of experimental data at ALICE and LHCb for forward-rapidity

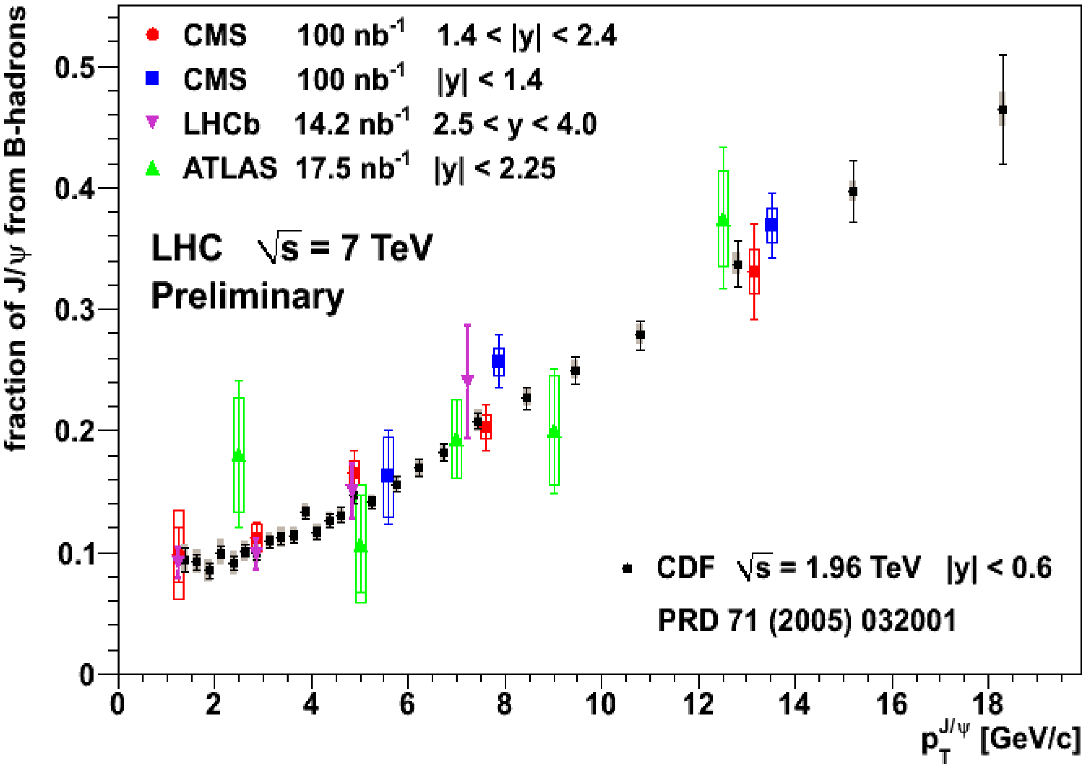
CMS: Eur. Phys. J. **C71**, 1575 (2011).
ATLAS: Nucl. Phys. **B850**, 387 (2011).
LHCb: Eur. Phys. J. **C71**, 1645 (2011).

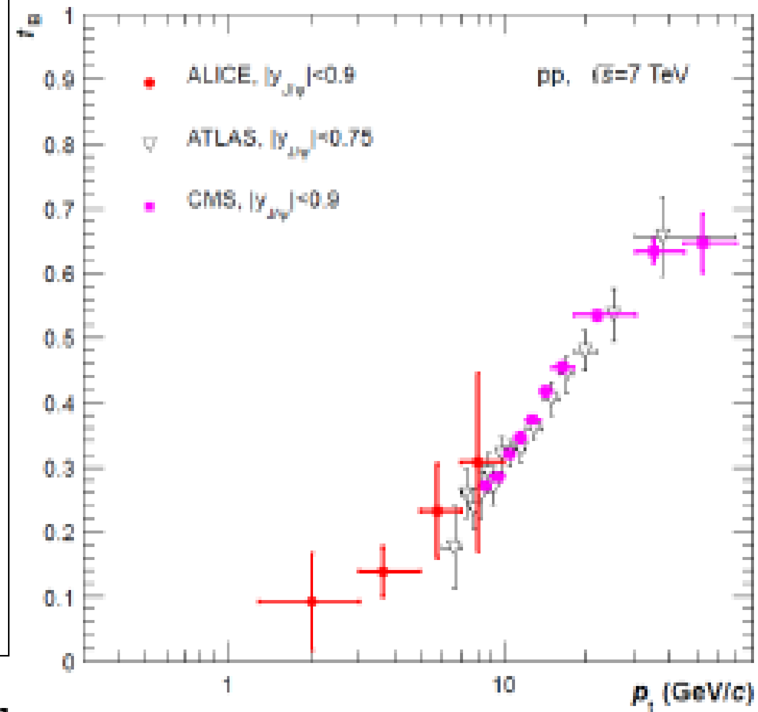
ALICE: Phys. Lett. B718 (2012) 295

Dimuons spectra at CMS in *pp* at $\sqrt{s}$ = 7 TeV



B_s is now seen by CMS, ATLAS and LHCb





ATLAS: Nucl.Phys/B **850**, 387 (2011).

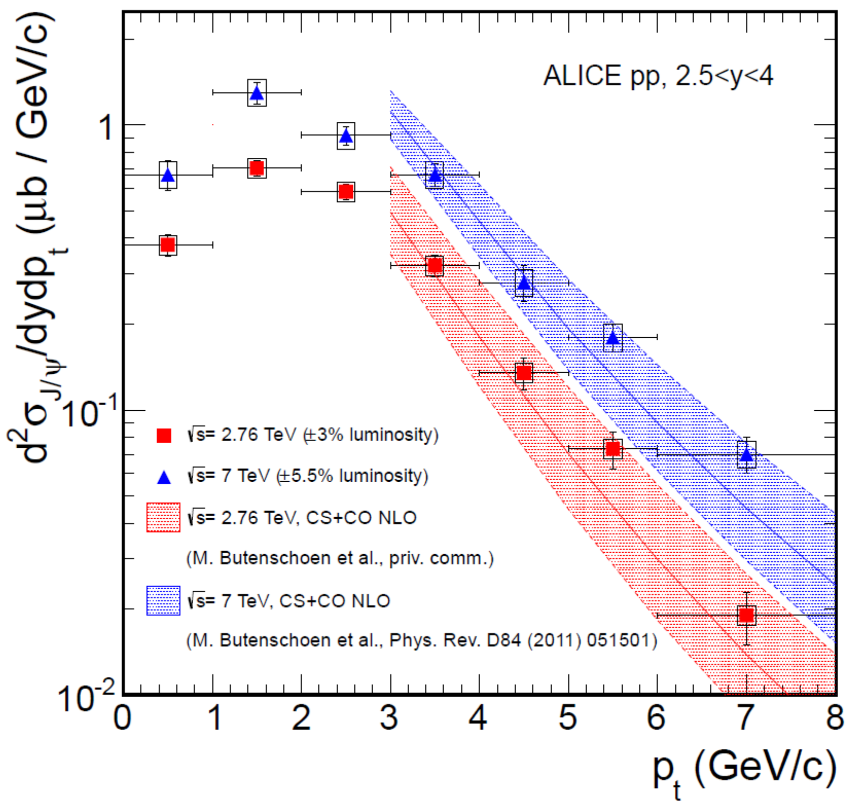
CMS: JHEP **2**, 011 (2012).

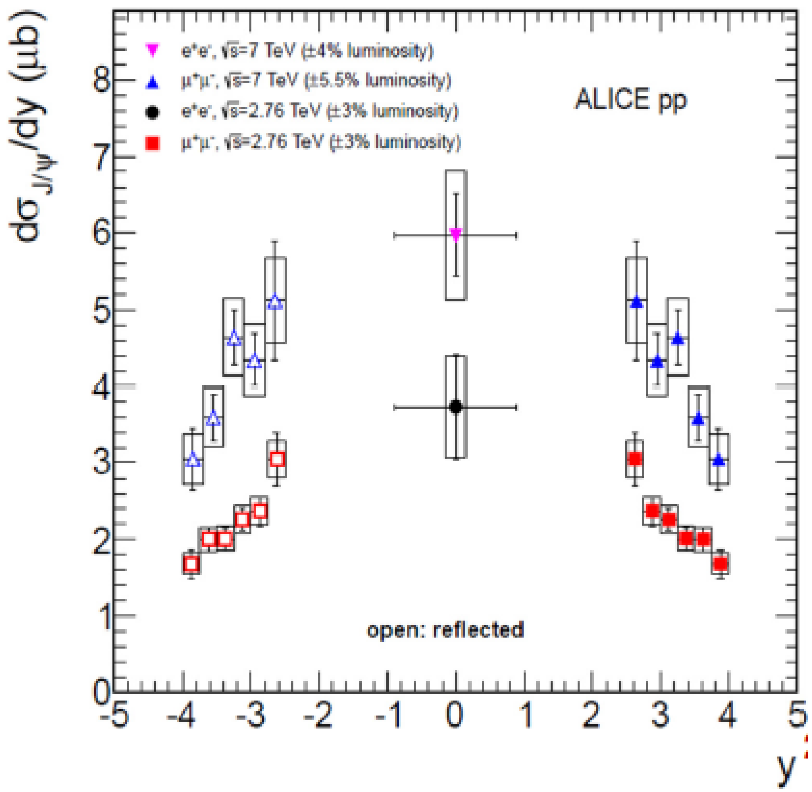
ALICE: JHEP **11**, 065 (2012).

The fraction of J/ψ from B-hadrons decay depends on pt

and consists ~10% for pt ~1.5 GeV/c.

J/ψ production in ALICE in *pp*-collisions and dependence on pt and rapidity



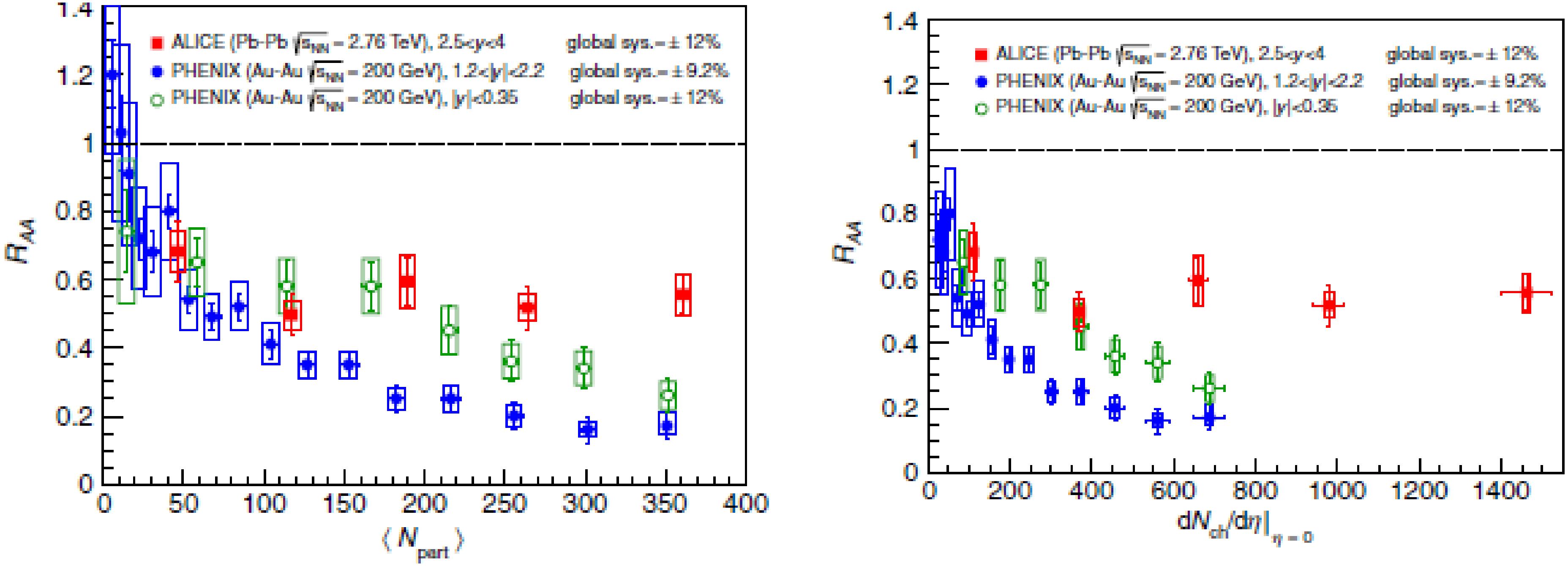


Results in agreement with NLO NRQCD calculations.

pp data at 2.76 TeV – reference for PbPb at 2.76 TeV.

ALICE: Phys. Lett. B718 (2012) 295

R_{AA} vs number of participant and multiplicity. Comparison of ALICE and PHENIX data.



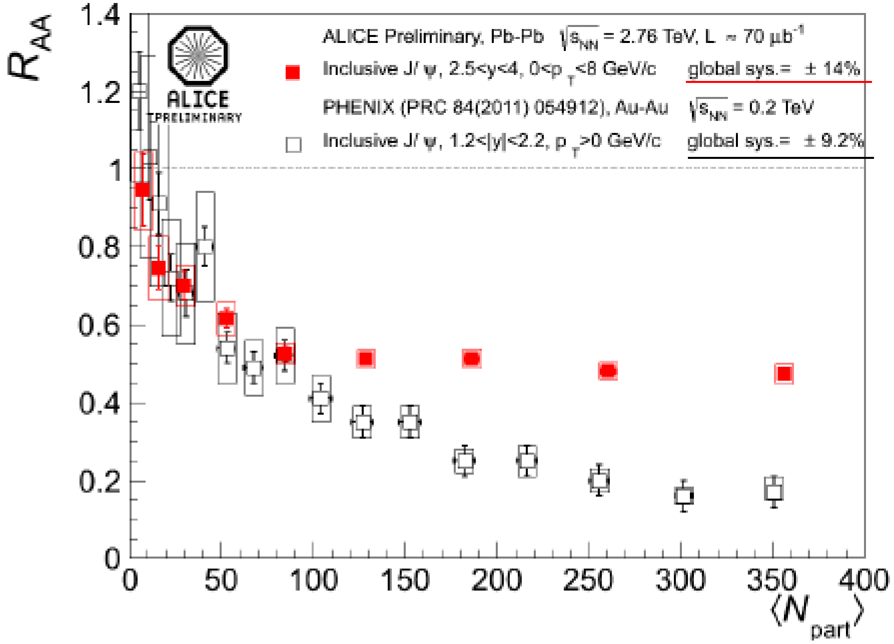
Suppression for forward rapidity at ALICE lower than at PHENIX.

No significant centrality dependence.

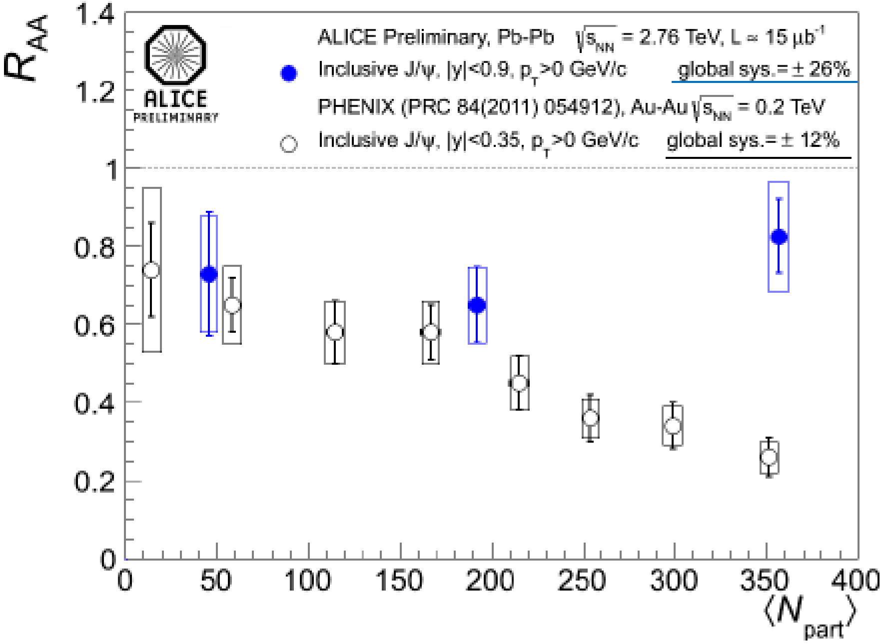
Phys.Rev.Lett.109,072301(2012)

R_{AA} vs number of participant for different rapidity regions. Comparison of ALICE and PHENIX data.

Forward rapidity

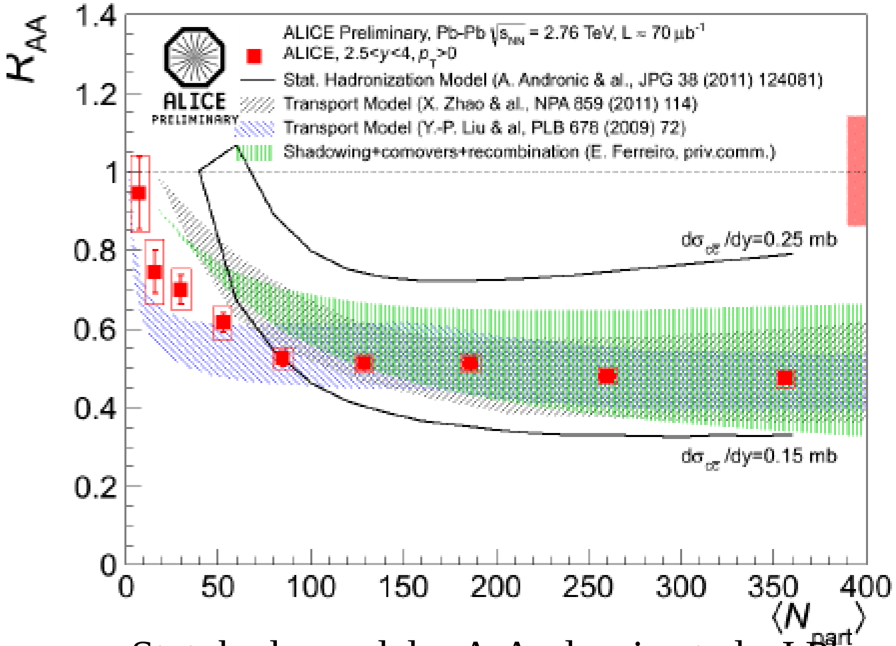


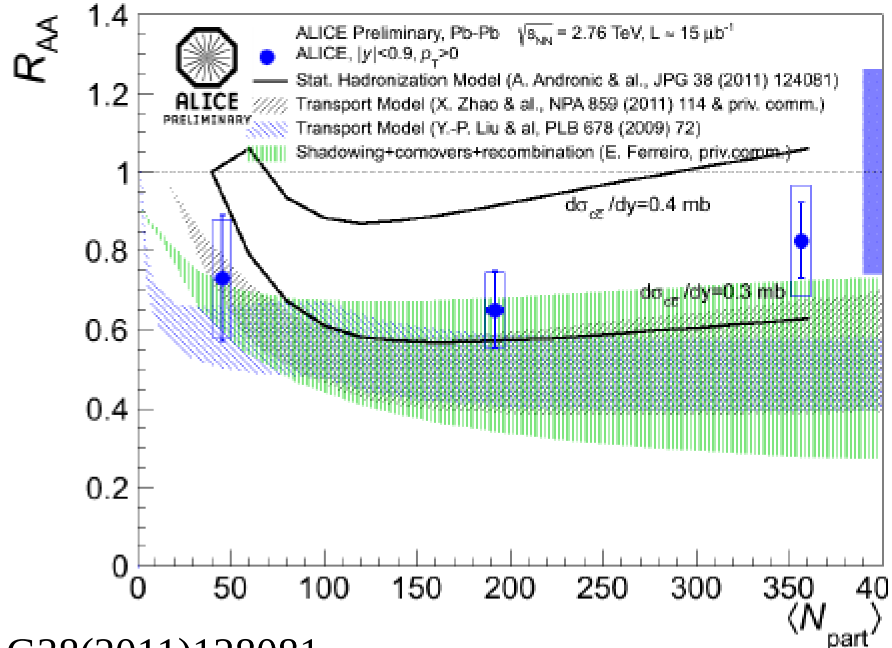
Mid- rapidity



Smaller suppression with respect to RHIC, compatible with J/ψ regeneration model

Comparison with the statistical hadronization model and transport models.

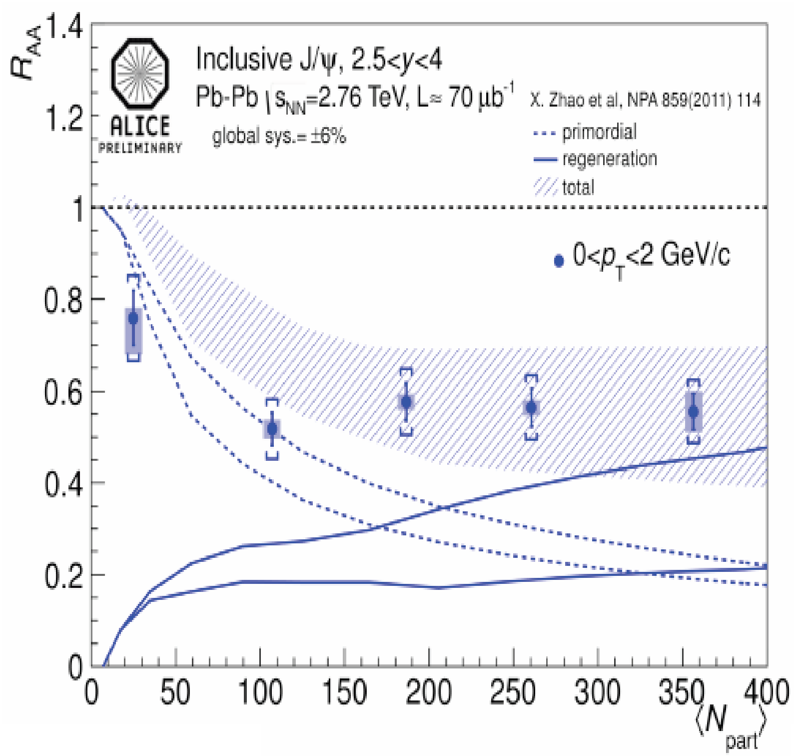


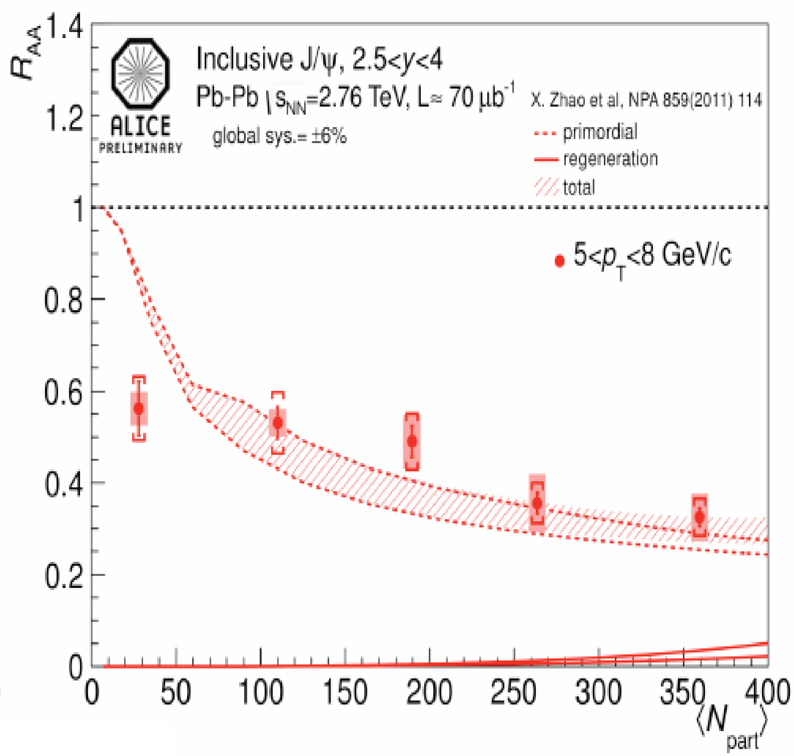


Stat. hadr. model – A.Andronic et al., J.Phys.G38(2011)128081
Transport models- X.Zhao and R.Rapp, N.Phys.A859(2011)114,
Y.Liu et al.,P.Lett.B678(2009)72
Shadowing+comovers+recomb.- Capella et al., E.Phys.G C58(2008)437 and
E.Ferreiro,priv.comm.

Models with all J/ψ produced at hadronization or models including large fraction (>50% in central collisions) of J/ψ produced from recombinations can describe results.

R_{AA} ALICE for forward rapidity vs centrality for different ranges of transverse momentum. Comparison with models of X.Zhao and Y.P.Liu



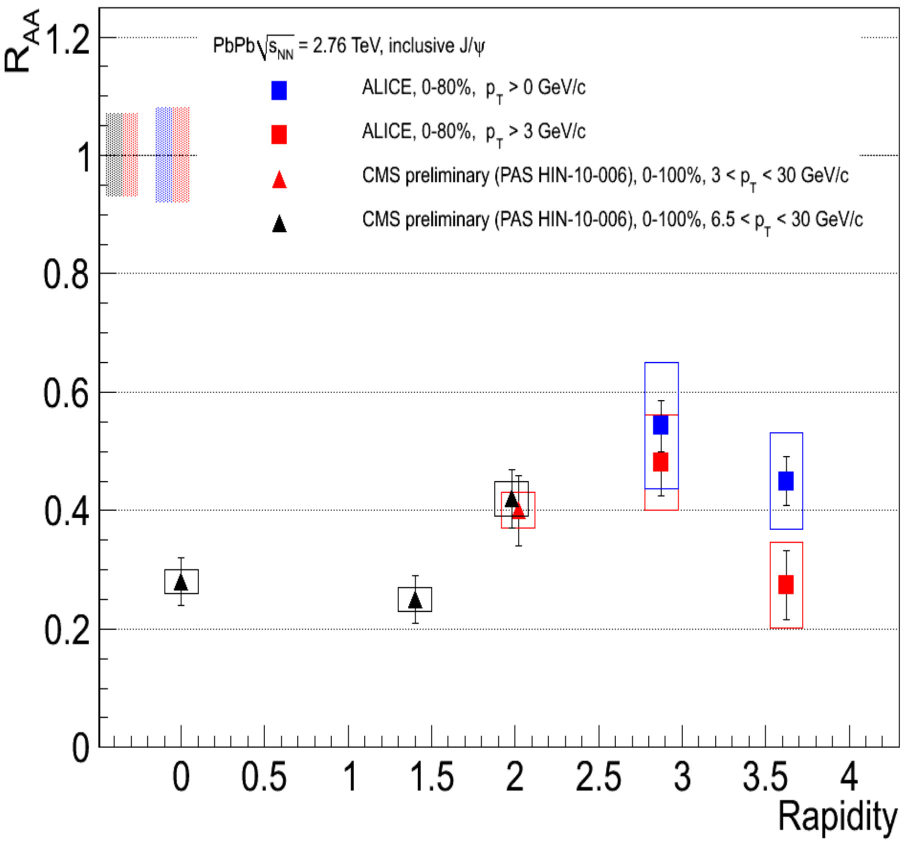


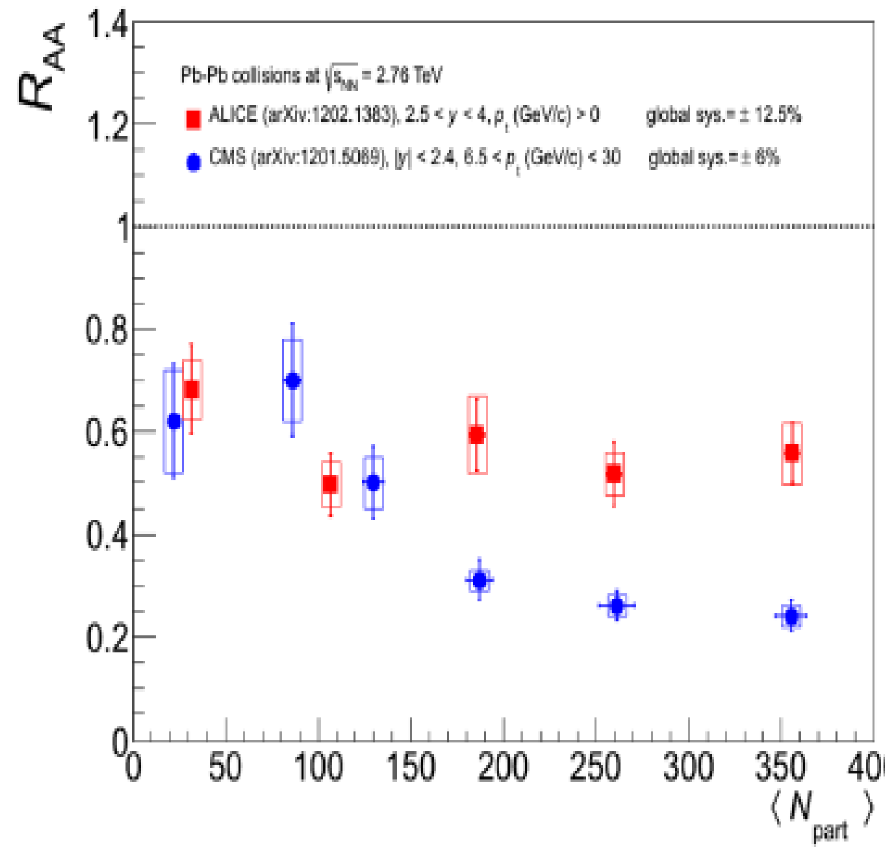
At low transverse momentum ~50% J/ψ are produced with regeneration.

At high transverse momentum contribution of regeneration is negligible.

X.Zhao and R.Rapp, Nucl. Phys. A859(2011) 114
Y.Liu, Z. Qiu, N. Xu and P. Zhuang, Phys. Lett. B678(2009) 72

R_{AA} vs rapidity and comparison of ALICE and CMS data





At large rapidity suppression is higher for p_T >3 GeV/c

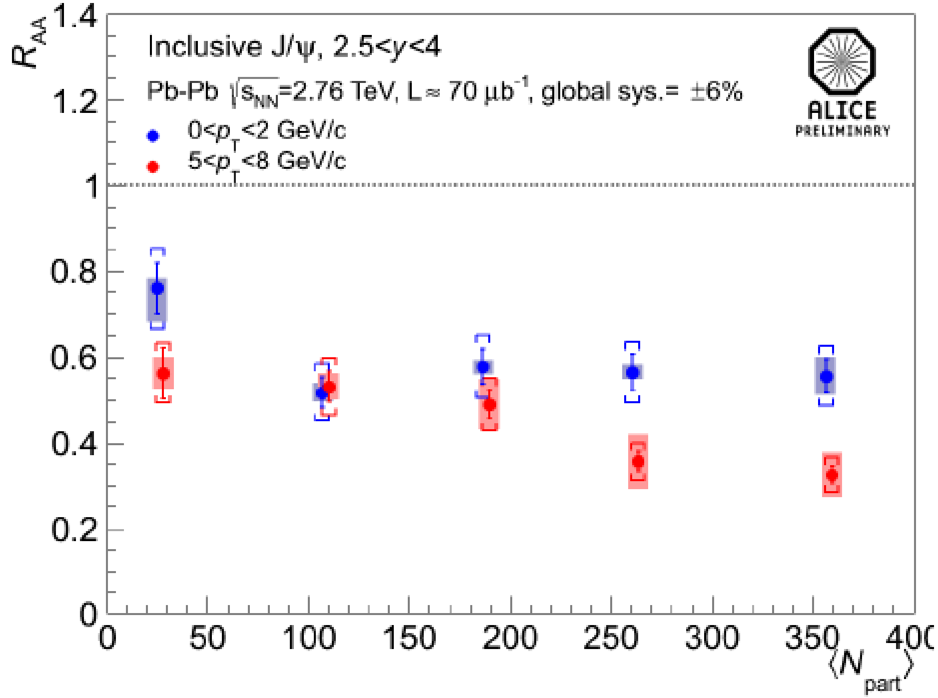
Suppression at ALICE for 2.5<y<4 lower, than at CMS for |y|<2.4 and p_T >6.5 GeV/c.

S. Chatrchyan (CMS) ,JHEP 05(2012) 063

arXiv:1202.1383

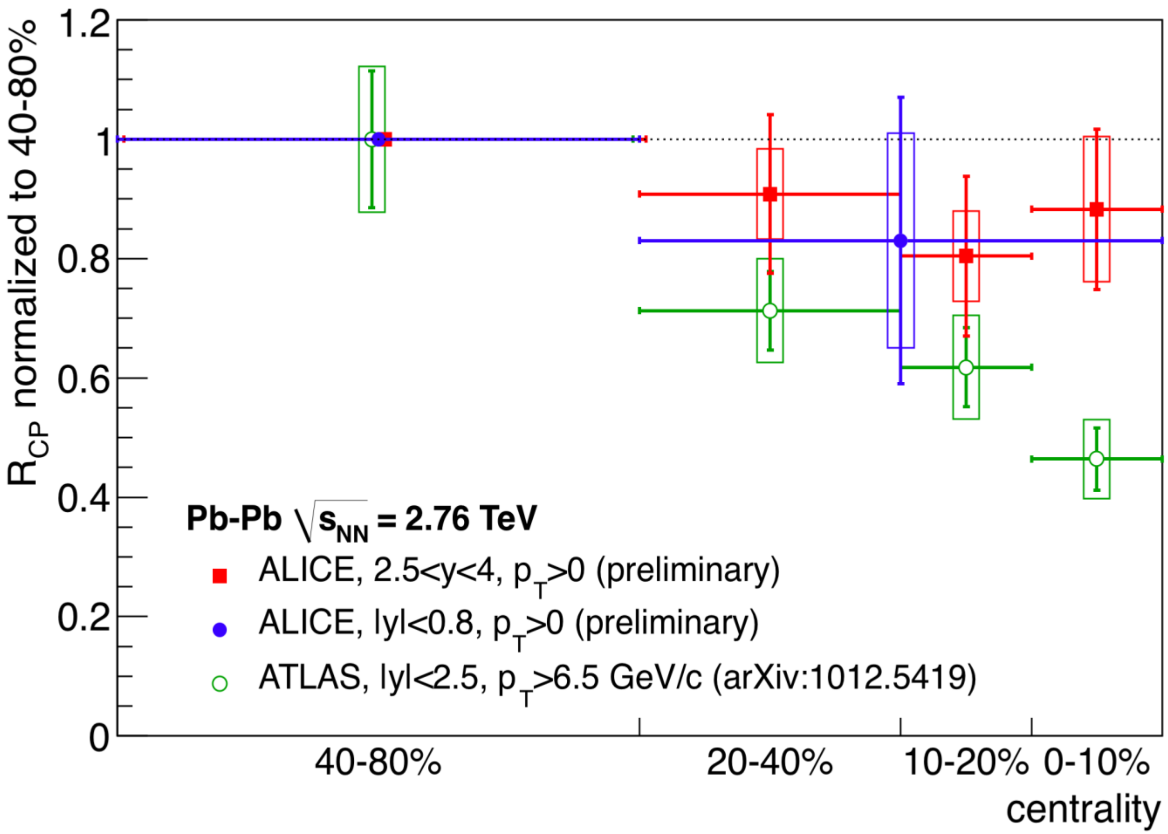
Cold nuclear effects in p-Pb collisions need to be evaluated

ALICE inclusive R_{AA} at low and high transverse momentum.



Suppression is higher for higher transverse momentum.

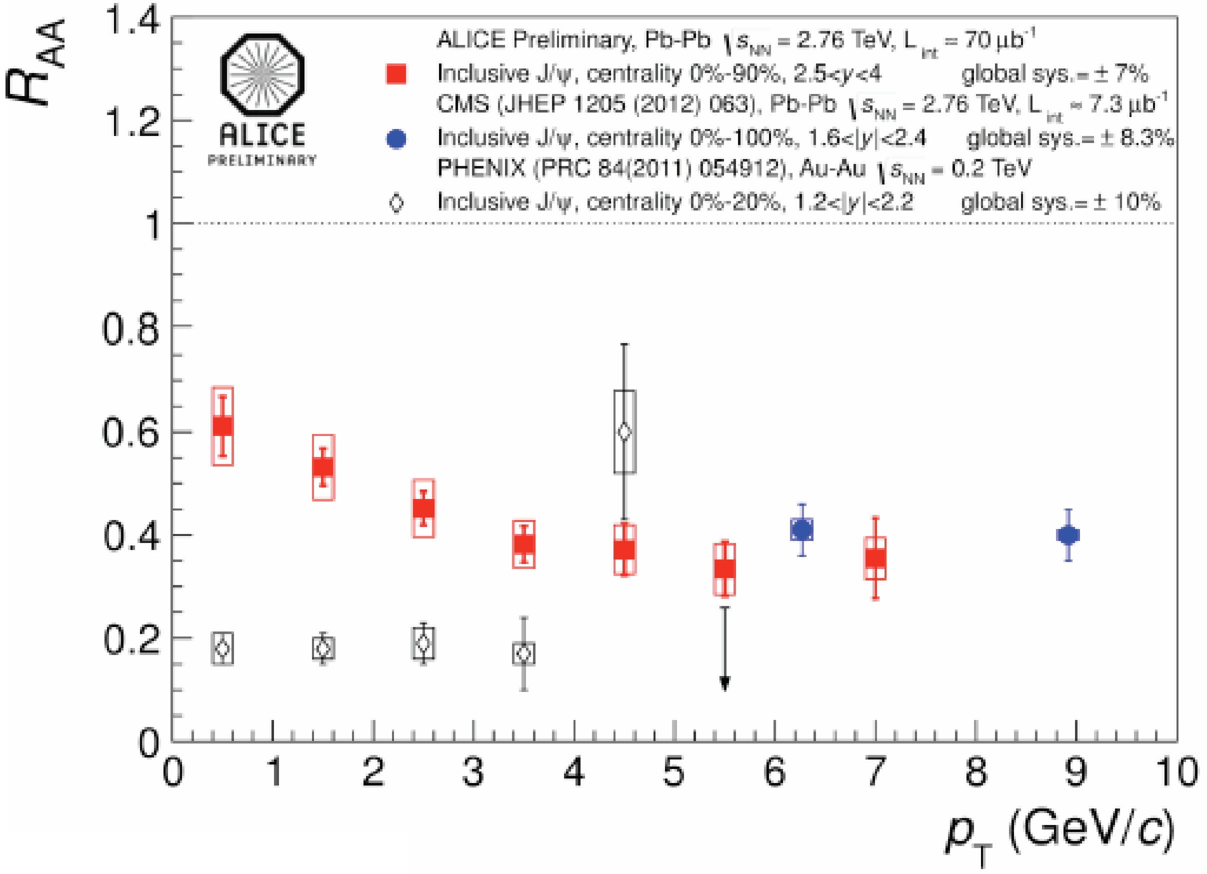
R_{CP} as a function of centrality. Comparison ALICE and ATLAS data.



Suppression at ALICE for 2.5<y<4 lower, than at ATLAS for |y|<2.5 and p_T >6.5 GeV/c.

P. Pillot (ALICE), QM2011
G. Aad et a l. (ATLAS), PLB697 (2011) 294

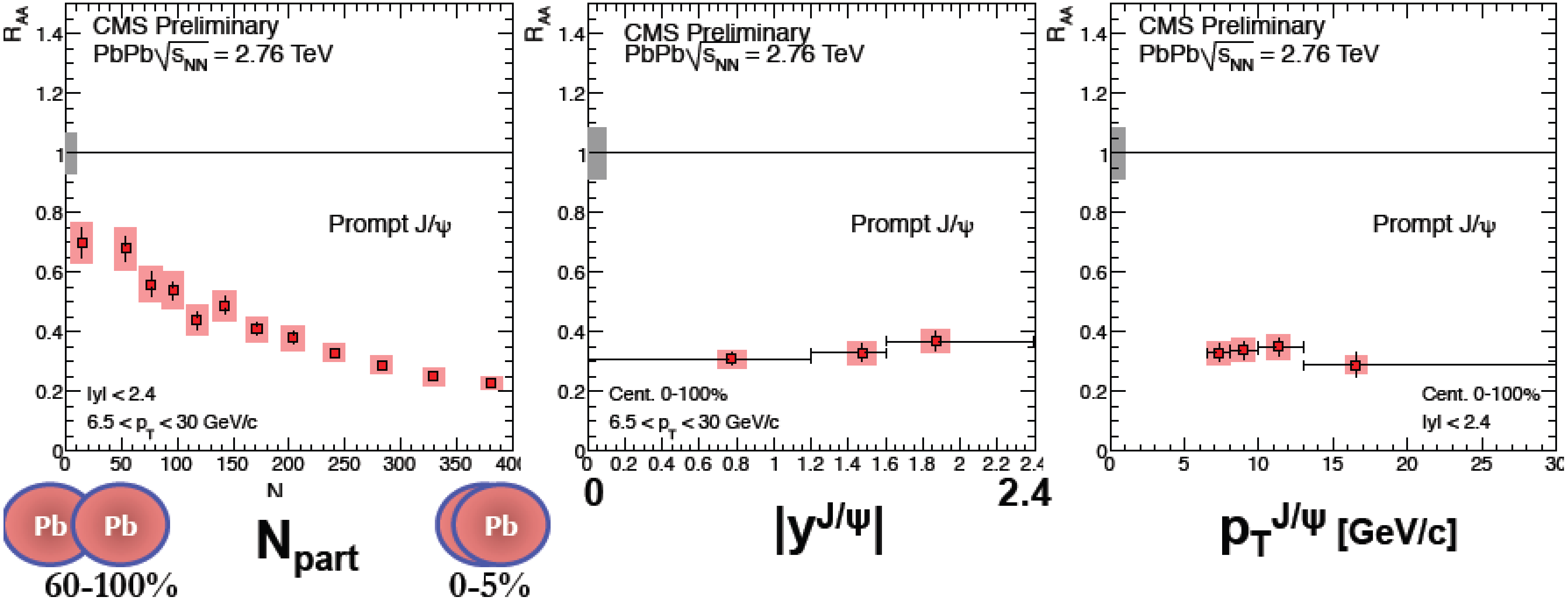
R_{AA} for forward rapidity vs transverse momentum. Comparison ALICE, CMS and PHENIX data.



At LHC suppression is stronger for higher transverse momentum. At low transverse momentum suppression is lower than at RHIC.

R_{AA} data at CMS.
Prompt J/ψ.

|y|<2.4 and p_T >6.5 GeV/c.

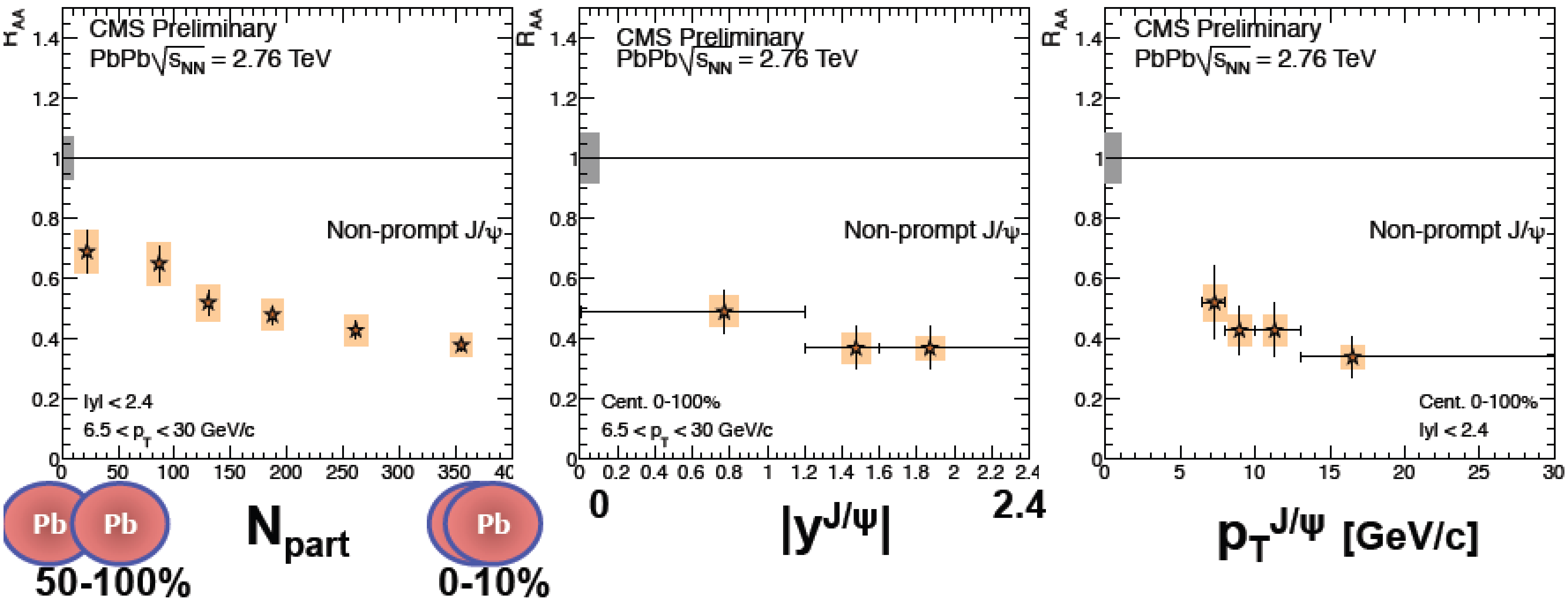


Suppression is growing with centrality (up ~80%) .

Week dependence on rapidity and transverse momentum.

CMS-PAS HIN-12-014

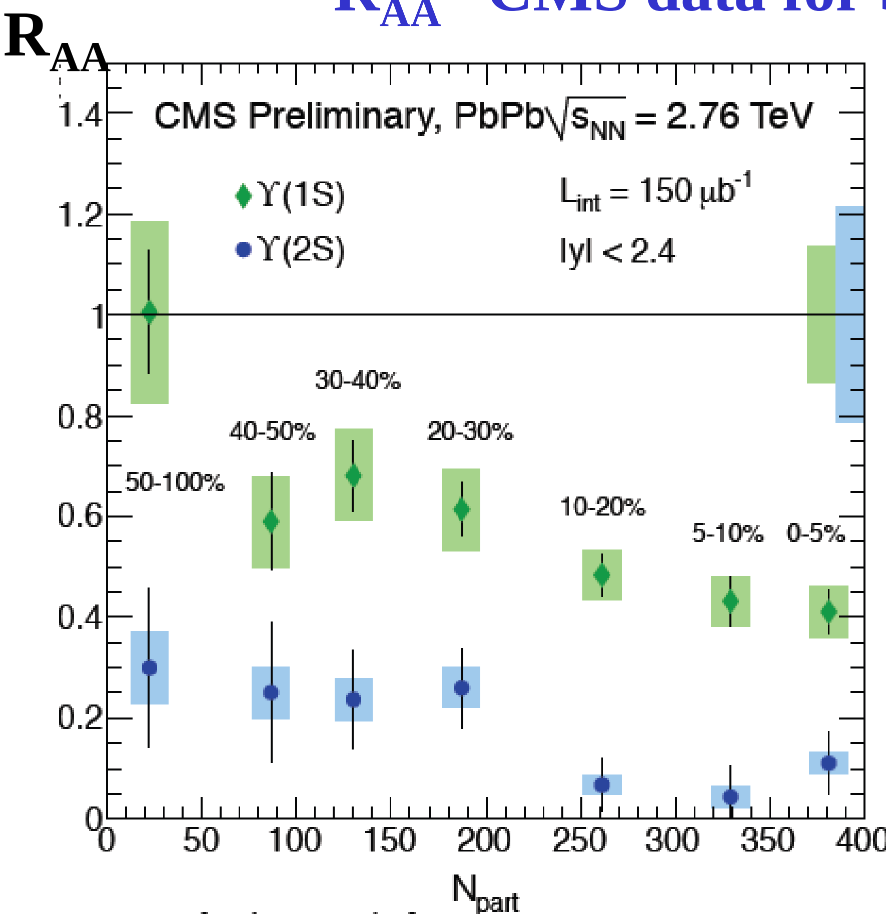
R_{AA} data at CMS.
Non-prompt J/ψ. |y|<2.4 and p_T >6.5 GeV/c.



Week suppression growing with centrality (from ~30% to ~60%). Indication on lower suppression for mid-rapidity and low transverse momentum.

CMS-PAS HIN-12-014

R_{AA} CMS data for bottomonium

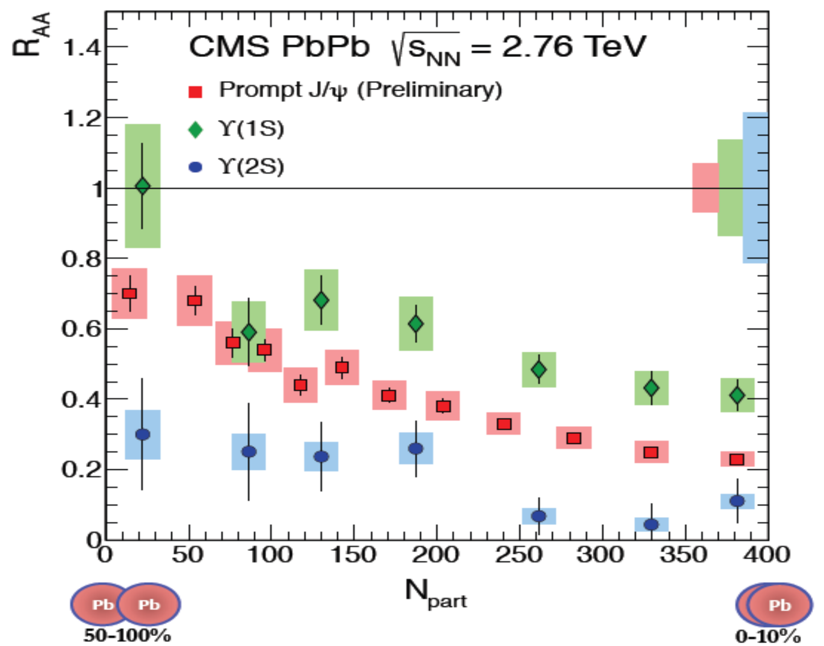


For all centrality

- ϒ(1S): 0.56±0.08±0.07
- ϒ(2S): 0.12±0.04±0.02
- ϒ(3S): <0.10 at 95% CL

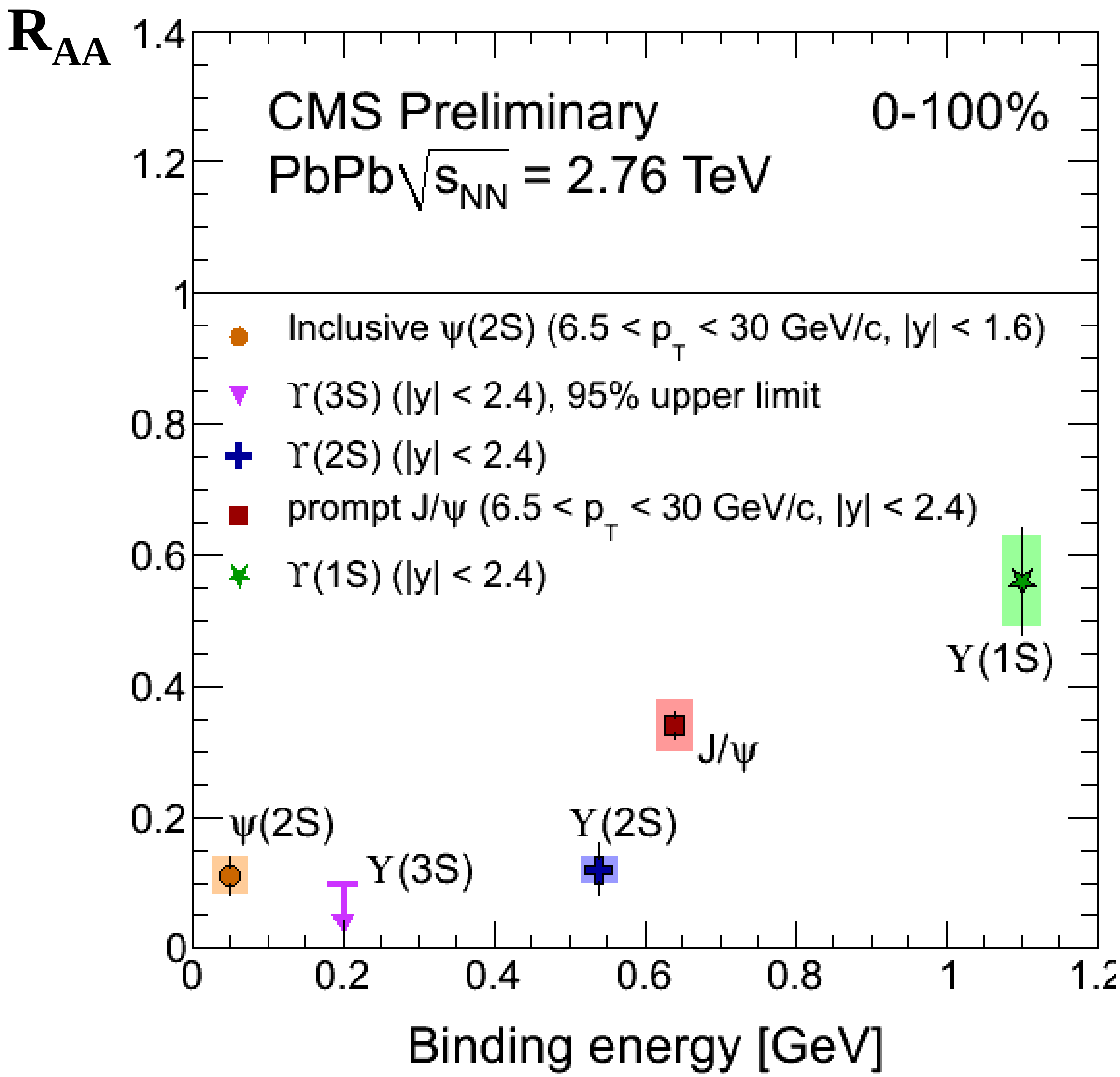
$$R_{AA}^{\Upsilon(3S)} < R_{AA}^{\Upsilon(2S)} < R_{AA}^{\Upsilon(1S)}$$

Comparison of J/ψ and bottomonium



arXiv: 1208.2826

R_{AA} CMS data



arXiv: 1208.2826
CMS-PAS HIN-12-007
CMS-PAS HIN-12-014

Less suppression for states with higher binding energy.

Summary

2010 -2011.

At LHC in *p-p* and Pb-Pb collisions:

- **measured suppression of charmonium and bottomonium states production.**
- **the importance of regeneration process for charmonium production was shown, and feed-down contribution from B ~ 10% at pt~1.5 GeV/c.**

2012.

Measuring of *p-p* at 2.76, 7 and 8 TeV.

Test measuring *p*-Pb collisions.

2013.

Measuring *p*-Pb collisions at 5.02 TeV. (CNM effects).

Our suggestion to measure charmonium production at LHC with fixed targets for lower energy with high statistic to clarify the mechanism of production.

A.B.Kurepin, N.S.Topilskaya, M.B.Golubeva

Charmonium production in fixed-target experiments
with SPS and LHC beams at CERN.

Phys.Atom.Nucl.74:446-452, 2011,
Yad.Fiz.74:467-473, 2011.

No theoretical model that could reproduce all data.

Fixed target experiment at LHC for charmonium production at the energy range between SPS and RHIC in p-A and A-A collisions with planning proton beam at T=7 TeV ($\sqrt{s}$ = 114.6 GeV) and Pb beam at 2.75 TeV ($\sqrt{s}$ = 71.8 GeV) is possibility to clarify the mechanism of charmonium production, to separate two possibilities:

i): hard production and suppression in QGP and/or hadronic dissociation or

ii): hard production and secondary statistical production with recombination, since the probability of recombination decrease with decreasing energy of collision in thermal model.

In the frame of AliRoot fast simulation we calculated the geometrical acceptances for the J/ψ production at LHC (ALICE for testing) and RHIC and at known fixed target experiments.

In the same framework we calculated geometrical acceptances for fixed target experiment at LHC for charmonium production at the energy range between SPS and RHIC in p-A and A-A collisions with planning proton beam at T=7 TeV ($\sqrt{s}$ = 114.6 GeV) and Pb beam at 2.75 TeV ($\sqrt{s}$ = 71.8 GeV).

Then - luminosity and counting rate estimation and comparison.

Geometrical acceptances for J/ψ at ALICE

Pb-Pb, √s=5.5 TeV

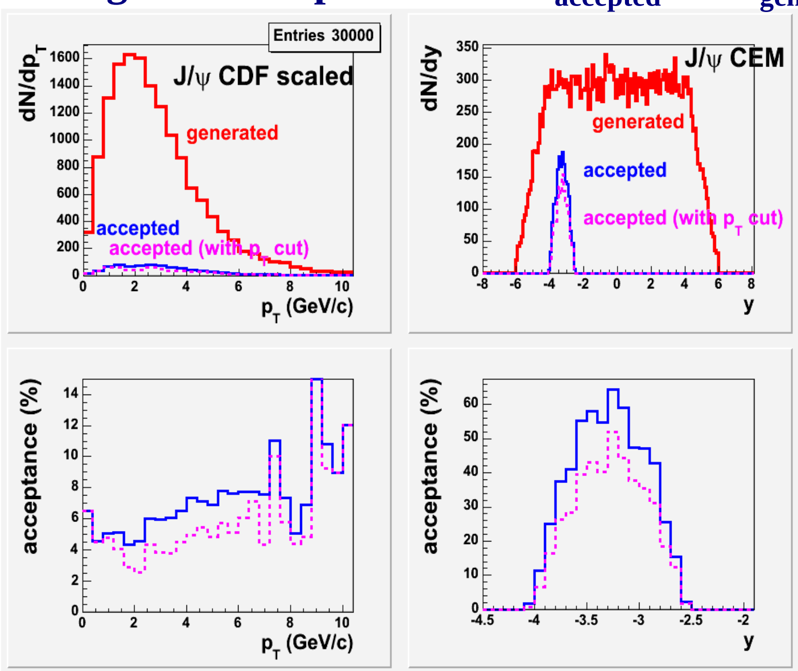
J/ψ are generated using CEM y-spectra and CDF scaled p_T-spectra and including shadowing for Pb-Pb.

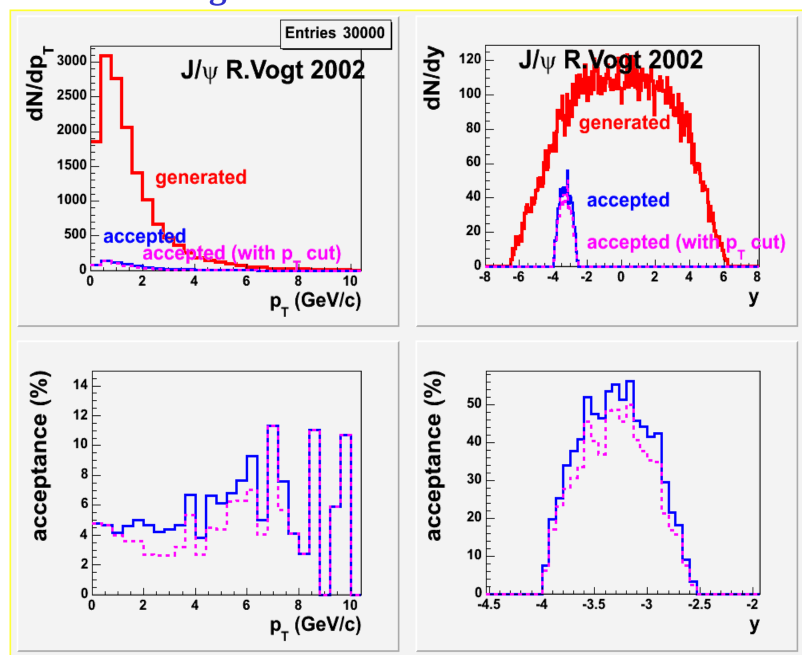
pp, √s=14 TeV

J/ψ are generated according R.Vogt 2002 approximation for p_T -spectra and y - distribution.

I_{acc} = Integrated acceptance = $N_{accepted}/N^{total}_{generated}$

$N_{gen}(J/\psi)=30000$





I_{acc}= 5.76%-w/o p_T cut
4.26%- with cut p_T >1 GeV/c

I_{acc}= 4.71%-w/o p_T cut
4.01%- with cut p_T >1 GeV/c

Fixed target experiment

Pb-Pb, T=2750 GeV, √s=71.8 GeV.

J/ψ are generated at z=0 and outside of ITS at z=+50 cm.

J/ψ are generated using p_T-spectra with HERA and PHENIX form, consistent with COM model, but parameters are energy scaled:
$dN/dp_T \sim p_T[1+(35\pi \cdot p_T/256 \cdot \langle p_T \rangle)^2]^{-6}$ with $\langle p_T \rangle = 1.4$, and using y-spectra as Gaussian with mean value $y_{cm}=0$ and $\sigma=1.1$

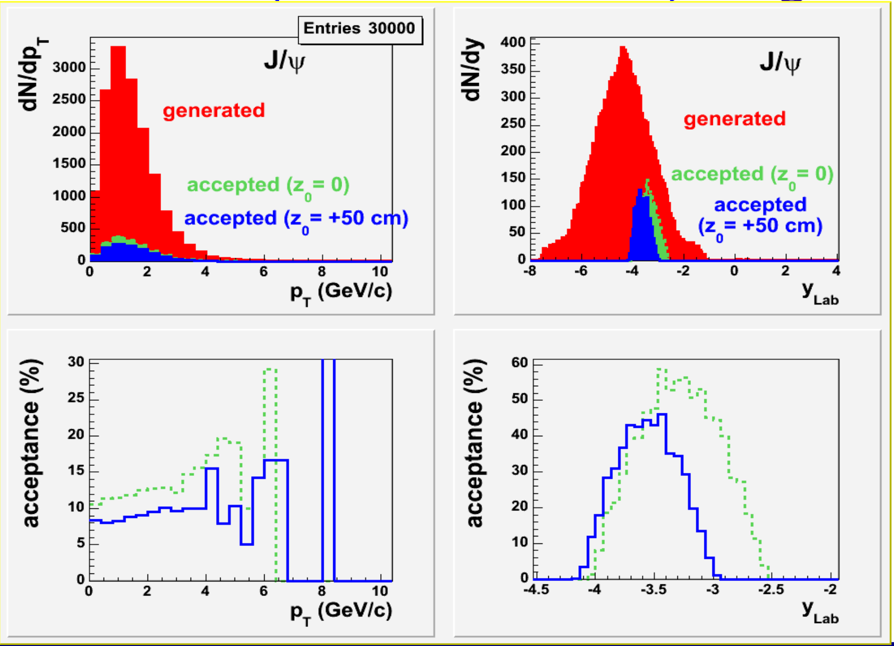
J/ψ are accepted in the rapidity range $-2.5<\eta<-4.0$ ($-2.98<\eta<-4.14$), and each of 2 muons in the degree range $171^0<\theta<178^0$ ($174.2^0<\theta<178.2^0$) for generation J/ψ at z=0 (z=+50 cm).

z=0

I_{acc} = 12.0%

z=+50 cm

I_{acc} = 8.79%

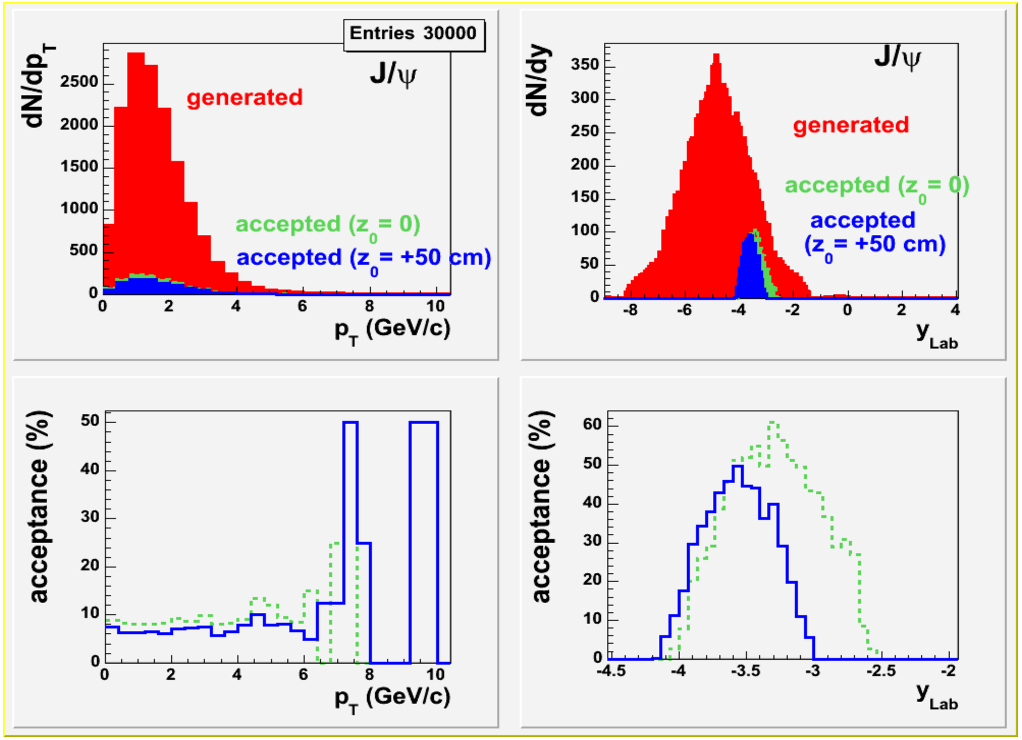


Fixed target experiment

pA, T=7000 GeV, √s=114.6 GeV.

J/ψ are generated at z=0 and outside ITS at z=+50 cm.

J/ψ are generated using p_T-spectra with the same parametrization with energy scaled parameter: $dN/dp_T \sim p_T[1+(35\pi \cdot p_T/256 \cdot \langle p_T \rangle)^2]^{-6}$ where $\langle p_T \rangle = 1.6$, and using y-spectra as Gaussian with mean value $y_{cm}=0$ and $\sigma=1.25$.



z=0

I_{acc} = 8.54%

z=+50 cm

I_{acc} = 5.98%

Geometrical acceptances

System pPb_{fixed}

pt cut	√s (TeV)	z = 0	z = +50 cm	z = -50 cm
no cut	0.1146	8.54	5.98	5.07
pt > 1 GeV/c	0.1146	6.77	4.89	4.11
no cut	0.0718	12.0	7.97	7.44
pt > 1 GeV/c	0.0718	9.79	6.62	6.20
η range		-4.0 ↔ - 2.5	-4.09↔ -2.97	-3.76 ↔ -2.5

As it was already used for the experiment on collider with a fixed target at HERA-B K.Ehret, Nucl. Instr. Meth. A 446 (2000) 190, the target in the form of thin ribbon could be placed around the main orbit of LHC. The life time of the beam is determined by the beam-beam and beam-gas interactions. Therefore after some time the particles will leave the main orbit and interact with the target ribbon. So for fixed target measurements only halo of the beam will be used. Therefore no deterioration of the main beam will be introduced. The experiments at different interaction points will not feel any presence of the fixed target.

Luminocity, cross sections($x_F>0$) , counting rates

System	$\sqrt{s}$ (TeV)	σ_{nn} (μb)	$\sigma_{pA}=\sigma_{nn}\cdot A^{0.92}$ (μb)	I (%)	$I\cdot B\cdot\sigma_{pA}$ (μb)	L ($cm^{-2}s^{-1}$)	Rate ($hour^{-1}$)
pp	14	32.9	32.9	4.7	0.091	$5\cdot10^{30}$	1635
pp_{RHIC}	0.200	2.7	2.7	3.59	0.0057	$2\cdot10^{31}$	410
pPb_{fixed}	0.1146	0.65	88.2	5.98	0.310	$1\cdot10^{29}$(*)	112
pPb_{fixed}	0.0718	0.55	74.6	7.97	0.349	$1\cdot10^{29}$	126
pPb_{NA50}	0.0274	0.19	25.8	14.0	0.212	$7\cdot10^{29}$	535
$PbPb_{fixed}$	0.0718	0.55	11970	7.97	47.9	$2.2\cdot10^{27}$(**)	378

(*) pPb_{fixed}, 500 μ wire, $3.2\cdot10^{11}$ protons/60 min

(**) $PbPb_{fixed}$, 500 μ wire, $6.8\cdot10^{8}$ ions/60 min

Conclusions

1. The integrated geometrical acceptances for charmonium measurement by dimuon spectrometer of ALICE are 5.76% for $\sqrt{s}$=5.5 TeV Pb-Pb and 4.71% for $\sqrt{s}$=14 TeV pp collisions.
2. For fixed target charmonium measurement in 2.5<y<4 range the geometrical acceptances are of the same order and even larger: 7.97% for $\sqrt{s}$=71.8 GeV Pb-Pb and 5.98% for $\sqrt{s}$=114.6 GeV pA at z=+50 cm. The acceptances are compatible with the acceptances from other experiments.
3. The measurement in energy range for fixed target experiment between SPS and RHIC with high statistics gives important additional information for charmonium production.

Comparison with AFTER

AFTER has advantages:

- Offers a wide physical program.
- Possibility to use different targets with high thickness – higher luminosity (20 times more for 1 cm target vs 500 μm)
- Possibility to use 1 meter-long liquid H_2 and D_2 targets: extremely high luminosity ~20 fb^{-1} yr^{-1} -compatible to LHC. But – high cost.

Fixed target experiment with the target in the form of thin ribbon:

- Only after beam tuning with the aid of rotation system-put in the working position
- Used only halo of the beam (and may be used as extra collimator)
- May be placed at existing experimental installation (for example, LHCb?)
- Possibility to measure charmonium production with rather high statistics on different targets in pA and PbA. First step to AFTER?

Backup

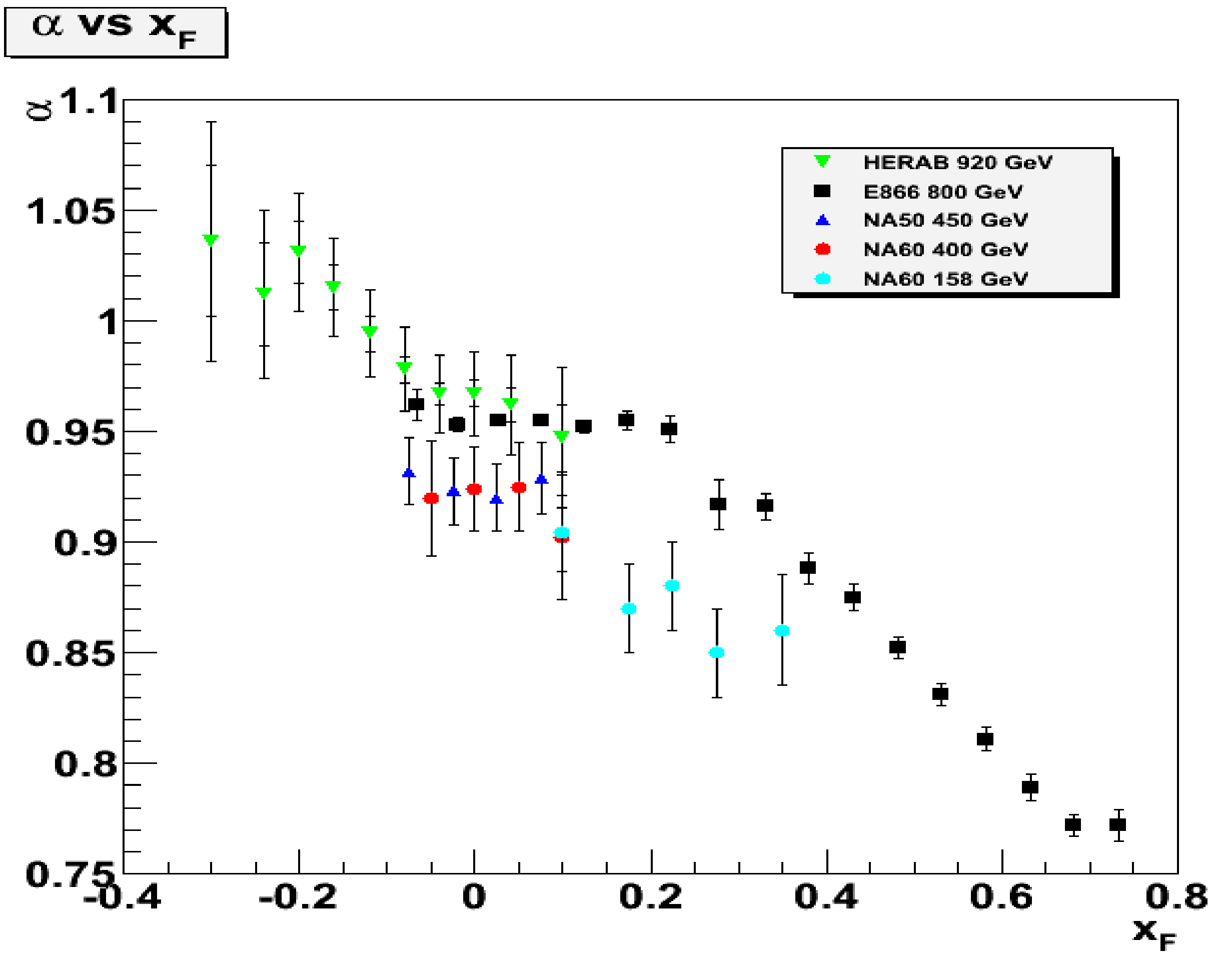
The luminosity estimate is shown in the Table . This number we obtain from the LHC proton parameters for the Commissioning Version 3(*)

http://bruening.home.cern.ch/bruening/lcc/WWWpages/commissioning_parameter.htm

We get proton loss of $3.2\cdot10^{11}$ during first hour ($0.9\cdot10^{8}$ p/s) and luminosity about $1.5\cdot10^{29}$ $cm^{-2}\,s^{-1}$ for 500 micron lead ribbon.
Mean luminosity ~ $1\cdot10^{29}$ $cm^{-2}\,s^{-1}$ ($0.1\mu b^{-1}\,s^{-1}$). Integrated $\int L dt$ = 1 $pb^{-1}\,yr^{-1}$.

For loss 10^{9} p/s , mean luminosity ~ $1\cdot10^{30}$ $cm^{-2}\,s^{-1}$ ($1\mu b^{-1}\,s^{-1}$).
$\int L dt$ = 10 $pb^{-1}\,yr^{-1}$). Yr (p)= 10^{7} s.

For lead beam the loss is $6.8\cdot10^{9}$ ions/ hour , and luminosity about $3.2\cdot10^{27}$ $cm^{-2}\,s^{-1}$ for 500 micron lead ribbon.
Mean L ~$2.2\cdot10^{27}$ $cm^{-2}\,s^{-1}$ (2.2 $mb^{-1}\,s^{-1}$). $\int L dt$ = 2.2 $nb^{-1}\,yr^{-1}$. Yr (Pb) = 10^{6} s.



Using $\sigma_{pA=}\sigma_{pp} A^{\alpha}$ ➡

α (158 GeV) = 0.882 ± 0.009 ± 0.008
α (400 GeV) = 0.927 ± 0.013 ± 0.009

R. Arnaldi et al. (NA60), Nucl. Phys. A (2009) 345

Luminosities

- Expected proton flux $\Phi_{beam} = 5 \times 10^8\ p^+ s^{-1}$
- Instantaneous Luminosity:

$$\mathscr{L} = \Phi_{beam} \times N_{target} = N_{beam} \times (\rho \times \ell \times \mathcal{N}_A)/A$$

[ℓ: target thickness (for instance 1cm)]

- Integrated luminosity: $\int dt \mathscr{L}$ over 10^7 s for p^+ and 10^6 for Pb

[the so-called LHC years]

Target	ρ (g.cm^{-3})	A	$\mathscr{L}$ (μb^{-1}.s^{-1})	$\int \mathscr{L}$ (pb^{-1}.yr^{-1})
Sol. H_2	0.09	1	**26**	**260**
Liq. H_2	0.07	1	**20**	**200**
Liq. D_2	0.16	2	**24**	**240**
Be	1.85	9	**62**	**620**
Cu	8.96	64	**42**	**420**
W	19.1	185	**31**	**310**
Pb	11.35	207	**16**	**160**

Luminosities

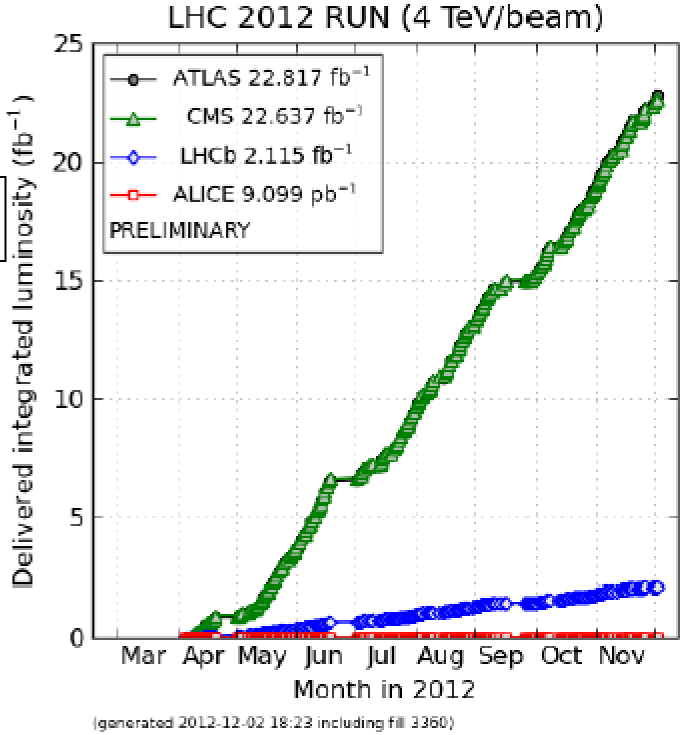
- 1 meter-long liquid H_2 & D_2 targets can be used (see NA51, ...)
- This gives: $\mathcal{L}_{H_2/D_2} \simeq 20\ \mathrm{fb}^{-1} y^{-1}$
- Recycling the LHC beam loss, one gets

a luminosity comparable to the LHC itself !

- PHENIX lumi in their decadal plan
  - Run14pp 12 pb^{-1} @ $\sqrt{s_{NN}} = 200$ GeV
  - Run14dAu 0.15 pb^{-1} @ $\sqrt{s_{NN}} = 200$ GeV
- AFTER vs PHENIX@RHIC:

  3 orders of magnitude larger
- Lumi for Pb runs in the backup slides

  (roughly 10 times that planned for the LHC)



Luminosities

- Instantaneous Luminosity:

$$\mathscr{L} = \Phi_{beam} \times N_{target} = N_{beam} \times (\rho \times \ell \times \mathscr{N}_A)/A$$

$$\Phi_{beam} = 2 \times 10^5 \text{ Pb s}^{-1}, \quad \ell = 1 \text{ cm (target thickness)}$$

- Integrated luminosity $\int dt \mathscr{L} = \mathscr{L} \times 10^6$ s for Pb
- Expected luminosities with 2×10^5Pb s^{-1} extracted (1cm-long target)

Target	ρ (g.cm^{-3})	A	$\mathcal{L}$ (mb^{-1}.s^{-1})=$\int\mathcal{L}$ (nb^{-1}.yr^{-1})
Sol. H_2	0.09	1	11
Liq. H_2	0.07	1	8
Liq. D_2	0.16	2	10
Be	1.85	9	25
Cu	8.96	64	17
W	19.1	185	13
Pb	11.35	207	7

- Planned lumi for PHENIX Run15AuAu 2.8 nb^{-1} (0.13 nb^{-1} at 62 GeV)
- Nominal LHC lumi for PbPb 0.5 nb^{-1}

A few figures on the (extracted) proton beam

- Beam loss: $10^9\ p^+ s^{-1}$
- Extracted intensity: $5 \times 10^8\ p^+ s^{-1}$ (1/2 the beam loss) E. Uggerhøj, U.I Uggerhøj, NIM B 234 (2005) 31
- Number of p^+: 2808 bunches of $1.15 \times 10^{11} p^+ = 3.2 \times 10^{14} p^+$
- Revolution frequency: Each bunch passes the extraction point at a rate of 3.10^5 km.s^{-1}/27 km $\simeq$ 11 kHz
- Extracted "mini" bunches:
  - the crystal sees 2808×11000 s$^{-1} \simeq 3.10^7$ bunches s^{-1}
  - one extracts $5.10^8/3.10^7 \simeq 16 p^+$ from each bunch at each pass
  - Provided that the probability of interaction with the target is below 5%, no pile-up...
- Extraction over a 10h fill:
  - $5 \times 10^8 p^+ \times 3600$ s h$^{-1} \times 10$ h $= 1.8 \times 10^{13} p^+$ fill^{-1}
  - This means $1.8 \times 10^{13}/3.2 \times 10^{14} \simeq$ 5.6% of the p^+ in the beam

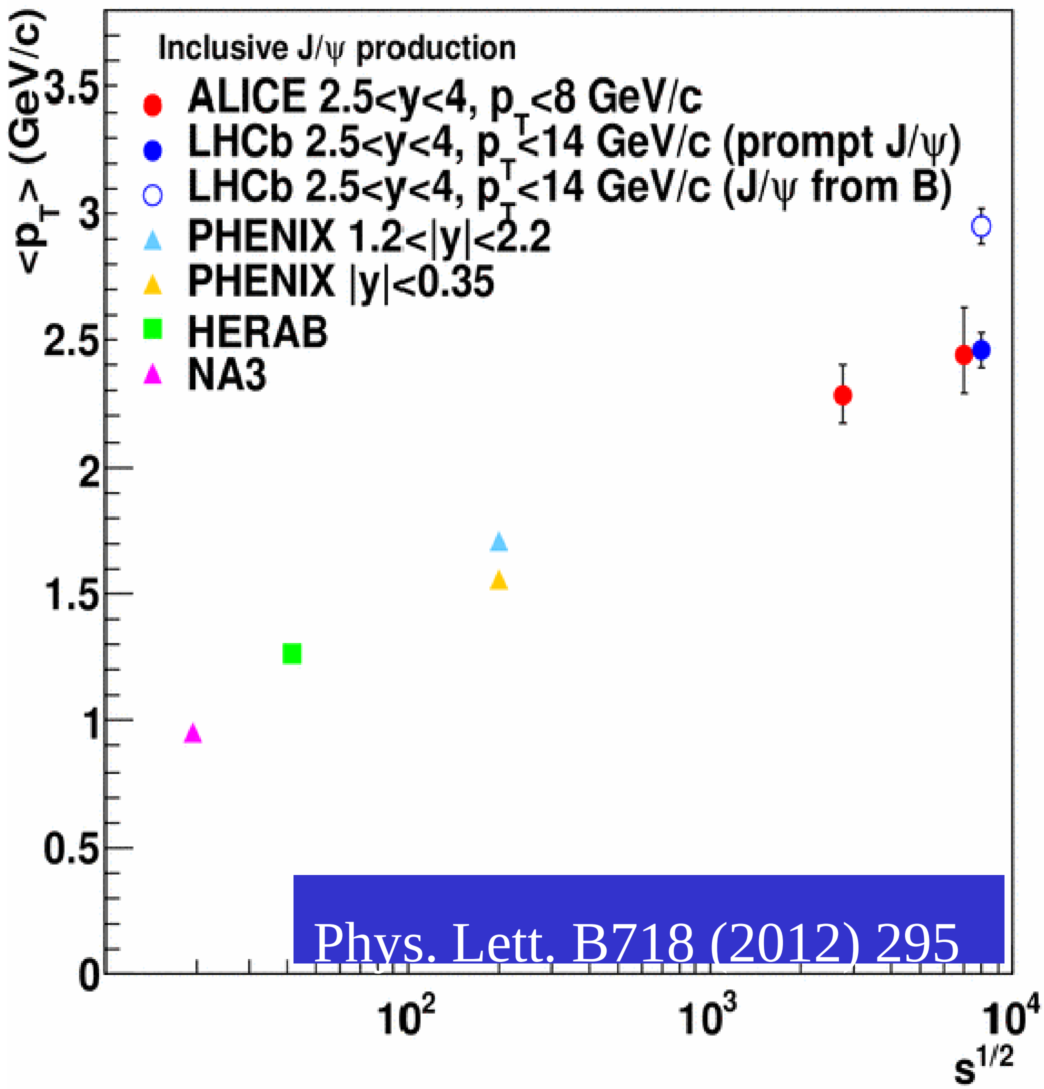
  These protons are lost anyway !
- similar figures for the Pb-beam extraction

AFTER: also an heavy-flavour observatory in *PbA*

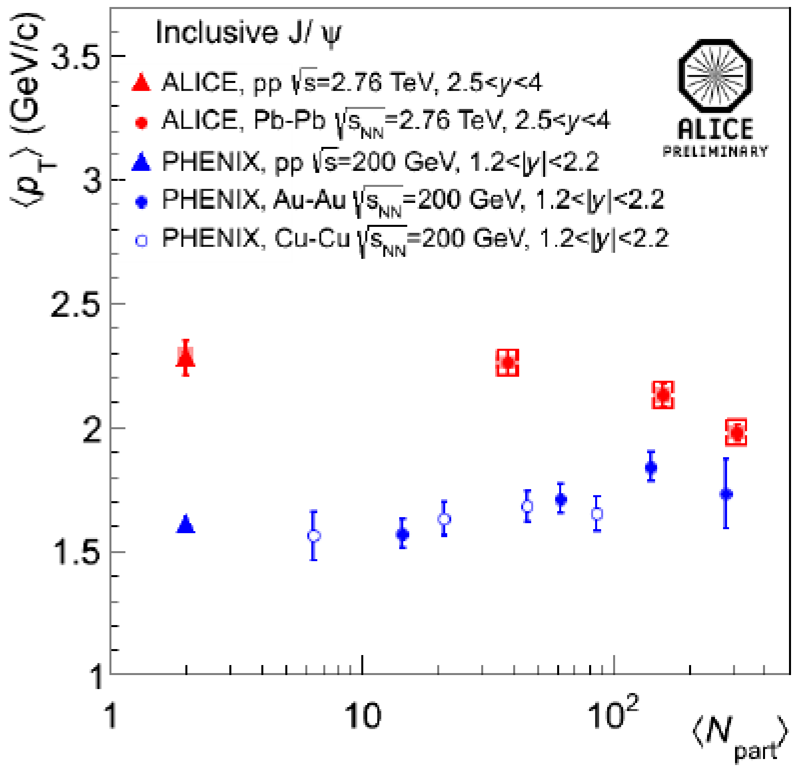
- Luminosities and yields with the extracted 2.76 TeV Pb beam ($\sqrt{s_{NN}} = 72$ GeV)

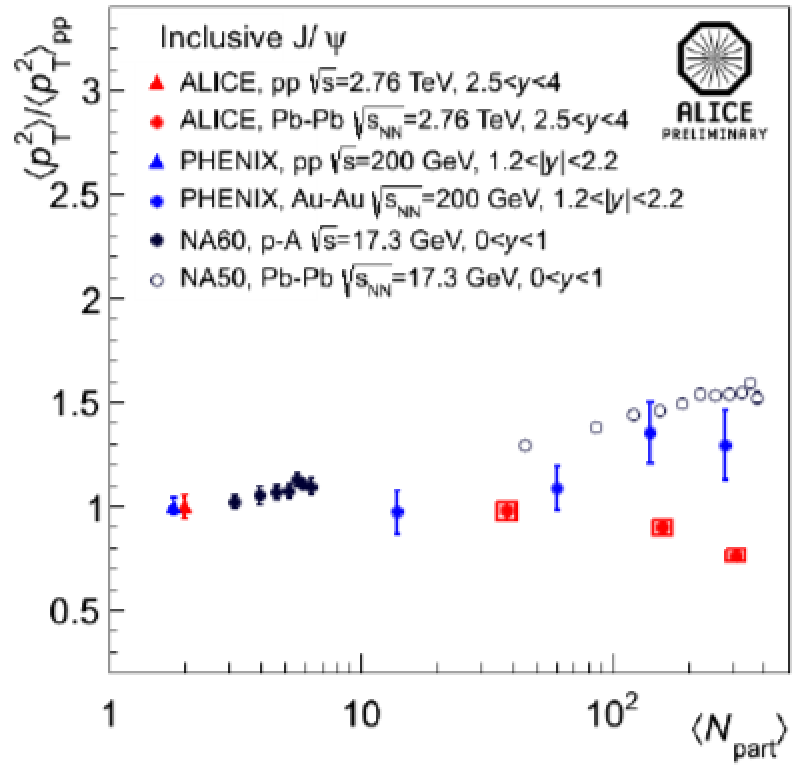
Target	A.B	$\int \mathcal{L}$ (nb^{-1}.yr^{-1})	N(J/Ψ) yr^{-1} $= AB\mathcal{L}\mathcal{B}\sigma_\psi$	N(ϒ) yr^{-1} $=AB\mathcal{L}\mathcal{B}\sigma_\Upsilon$
1 m Liq. H_2	207.1	800	3.4 10^6	6.9 10^3
1cm Be	207.9	25	9.1 10^5	1.9 10^3
1cm Cu	207.64	17	4.3 10^6	0.9 10^3
1cm W	207.185	13	9.7 10^6	1.9 10^4
1cm Pb	207.207	7	5.7 10^6	1.1 10^4
LHC PbPb 5.5 TeV	207.207	0.5	7.3 10^6	3.6 10^4
RHIC AuAu 200GeV	198.198	2.8	4.4 10^6	1.1 10^4
RHIC AuAu 62GeV	198.198	0.13	4.0 10^4	61

Mean transverse momentum of J/ψ vs energy in *pp*



ALICE inclusive J/ψ mean $\langle p_T \rangle$ and $\langle p_T^2 \rangle$ in comparison with SPS and RHIC data.

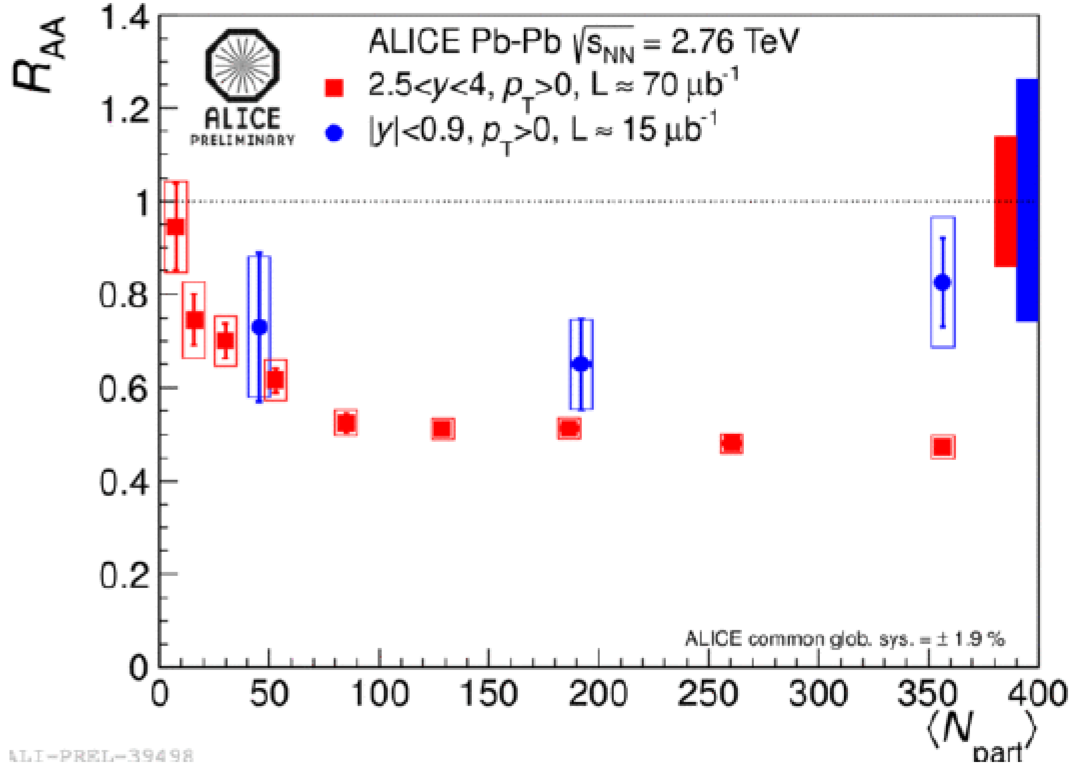




Behavior at ALICE is different from obtained at lower energies at SPS and RHIC where increase of the mean transverse momentum and the mean square transverse momentum with centrality was obtained.

E.Scomparin, QM12

ALICE inclusive R_{AA} at forward and central rapidities.



Large uncertainty on the mid-rapidity *pp*- reference.
Different behaivior?