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on behalf of the ALICE Collaboration

J/ψ production measurements in pp and PbPb collisions in the ALICE experiment at the LHC

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Outline

Motivations for J/ψ studies

The ALICE experiment and its performance in detecting quarkonia

Results in pp collisions at 7 TeV and 2.76 TeV

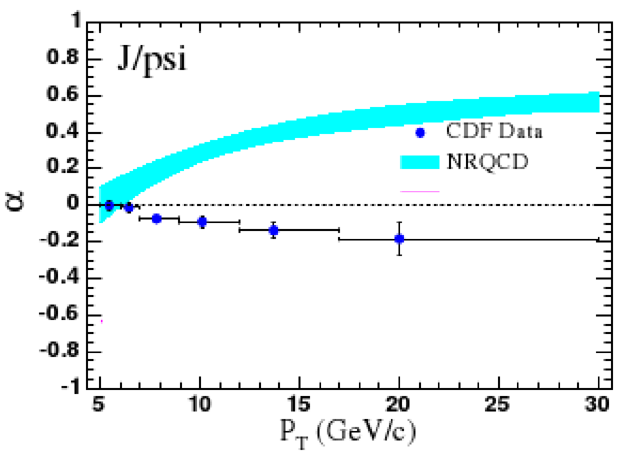
Results in PbPb collisions at 2.76 TeV

Conclusions

Motivations for J/ψ in pp

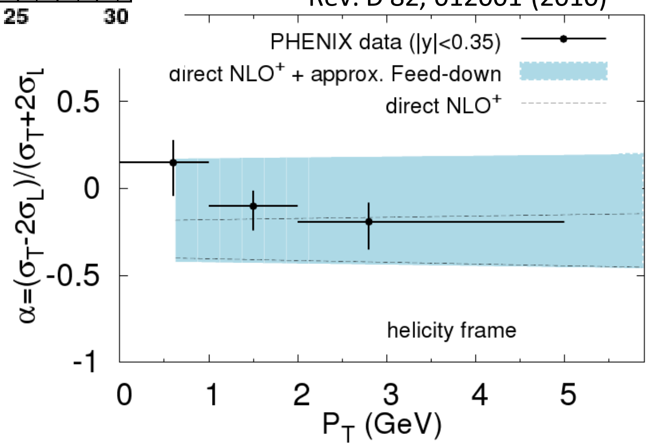
Need to understand production mechanism. Several models:

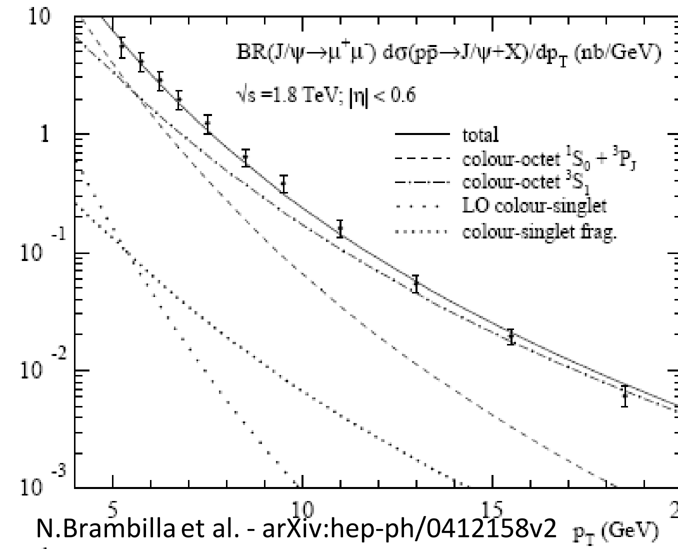
- **CEM:** phenomenological;
- **CSM LO:** bad x-sect. reproduction (ruled out in the '90s);
- **COM:** good x-sect. reprod. for all quarkonia, bad polarization prediction;
- **CSM NLO:** x-sect. better than LO, better polar. prediction



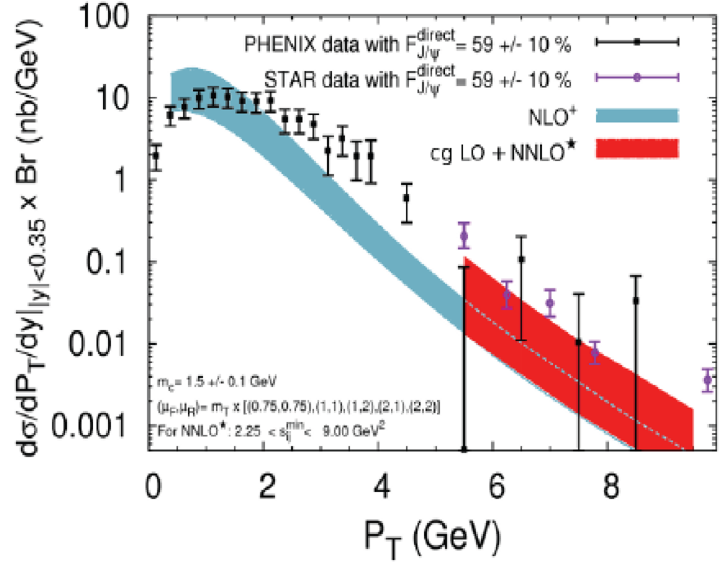
A. Abulencia et al., The CDF Collaboration, Phys. Rev. Lett. 99, 132001 (2007)

Phenix Collaboration, Phys. Rev. D 82, 012001 (2010)





N.Brambilla et al. - arXiv:hep-ph/0412158v2

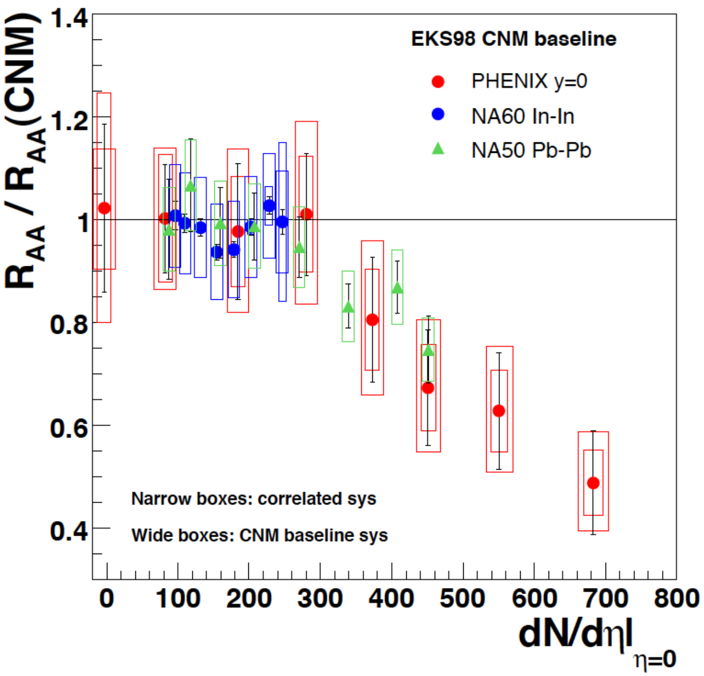


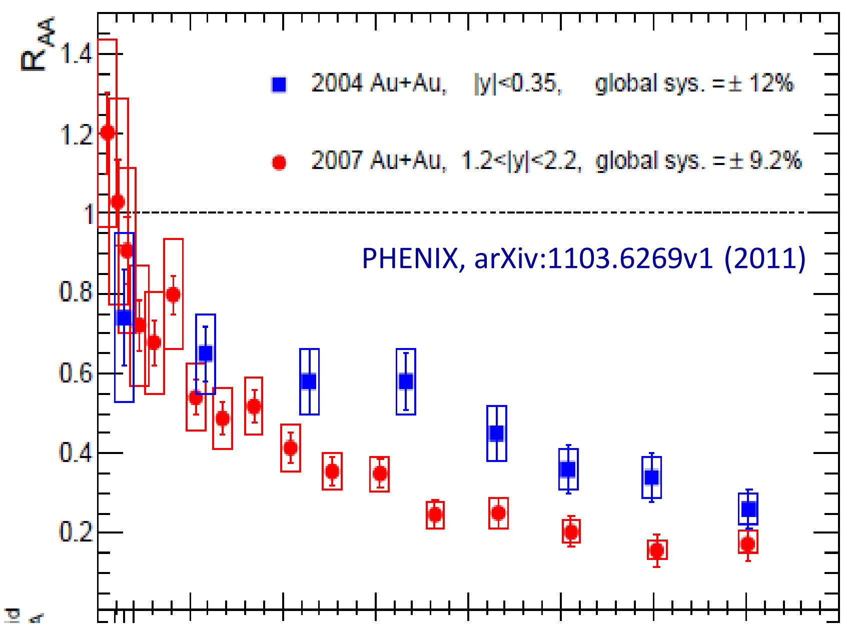
J.P.Lansberg - arXiv:1003.4319

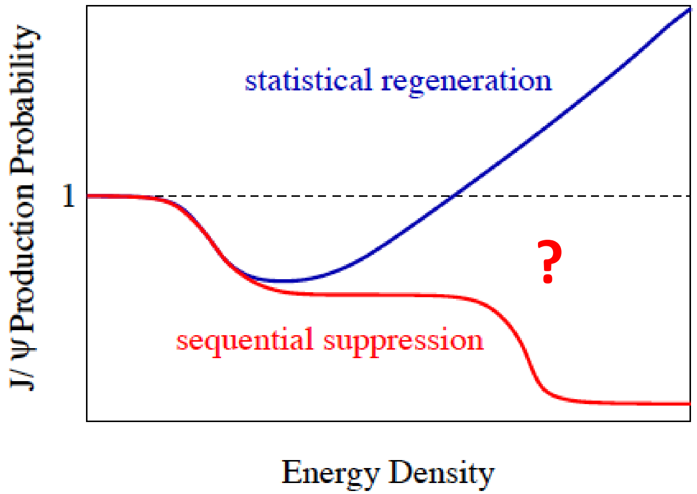
Quarkonium suppression proposed as a probe of deconfinement. Observed suppression in central collisions at SPS and RICH (above cold nuclear matter effects)

Many issues as:

- Suppression at PHENIX not larger than at SPS (regeneration? Interesting to study at higher energies)
- PHENIX finds larger suppression at forward rapidity → interesting to study the forward region at LHC







ALICE detector and performance

The ALICE experiment

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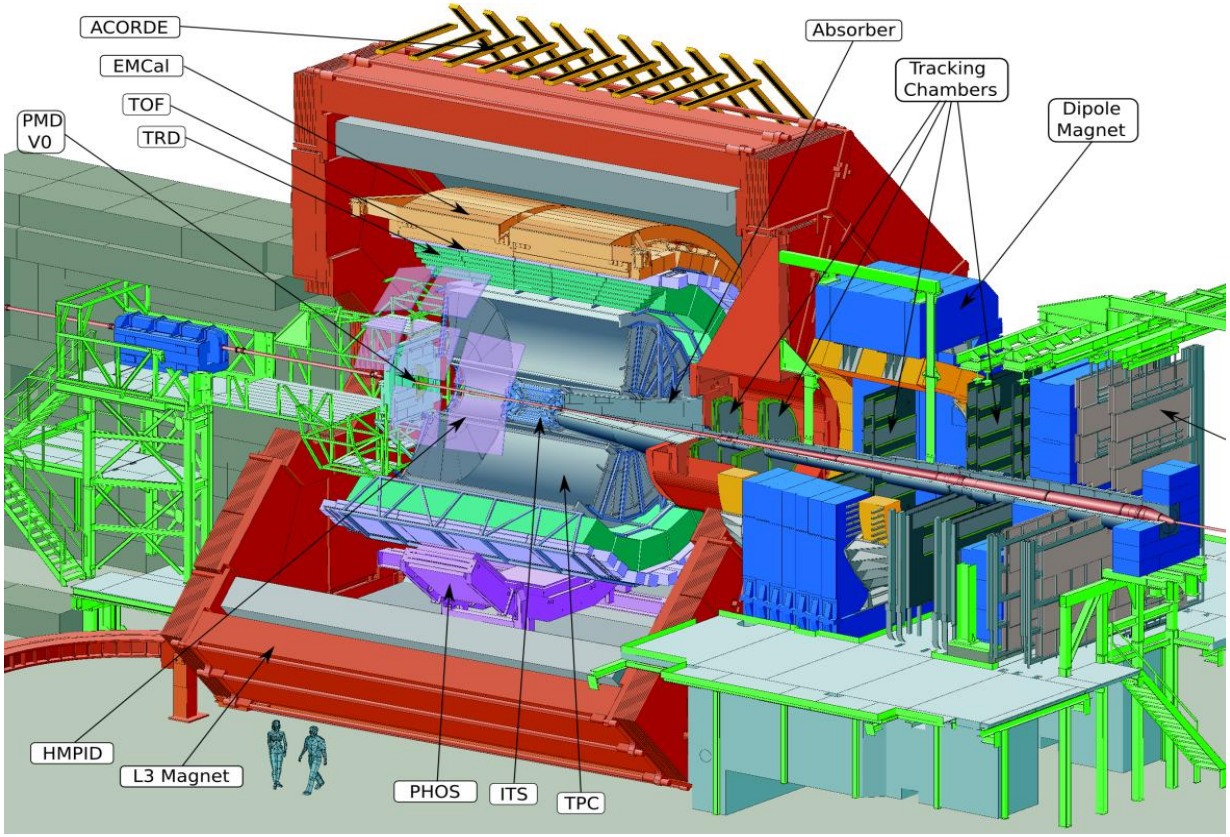
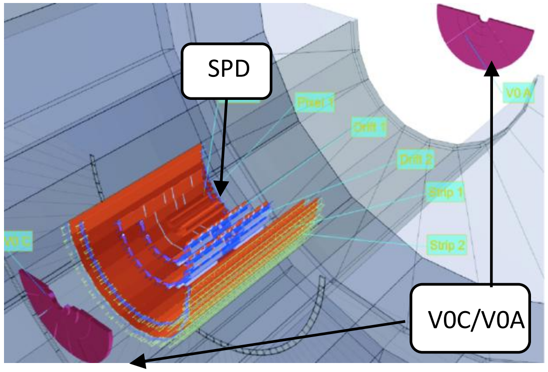
EPS HEP 2011
Grenoble - 21/07/11



ALICE studies J/ψ production down to p_T=0 both at mid-rapidity (**|y|<0.9**) in the di-electron channel and at forward rapidity (**2.5<y<4**) in the di-muon channel



Inner Tracking System (ITS), 6 layers:
- 2 pixel layers (SPD)
- 2 drift layers (SDD)
- 2 strip layers (SSD)

Time Projection Chamber (TPC): main tracking detector, used for PID via specific energy loss

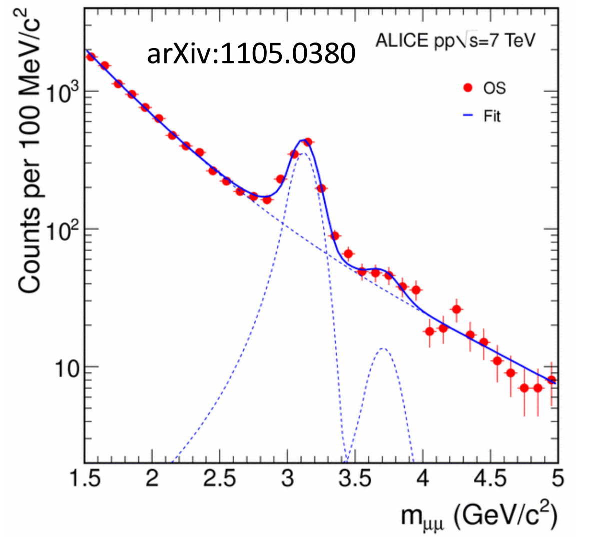
V0: scintillator arrays at forward and backward rapidities – used for MB trigger (with SPD) and for centrality determination

Muon Spectrometer:
- Front absorber
- 5 tracking stations
- Dipole magnet
- Iron wall
- 2 trigger stations

$J/\psi \rightarrow \mu^+\mu^-$ and $\rightarrow e^+e^-$ in ALICE (pp)

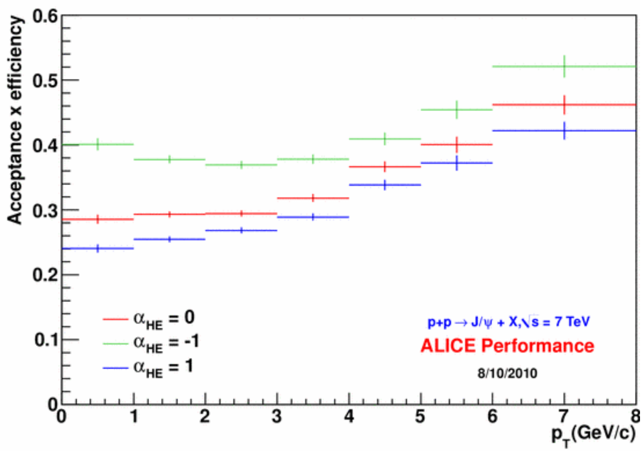
ALICE took data in pp runs at 7 (arXiv:1105.0380) and 2.76 TeV.
Integrated luminosity corresponding to the results that will be shown:

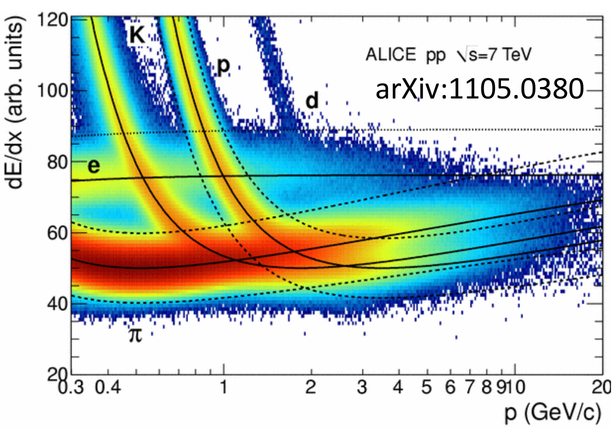
	$J/\psi \rightarrow \mu^+\mu^-$	$J/\psi \rightarrow e^+e^-$
$\sqrt{s}$ = 7 TeV	15.6 nb^{-1}	3.9 nb^{-1}
$\sqrt{s}$ = 2.76 TeV	20.2 nb^{-1}	1.1 nb^{-1}

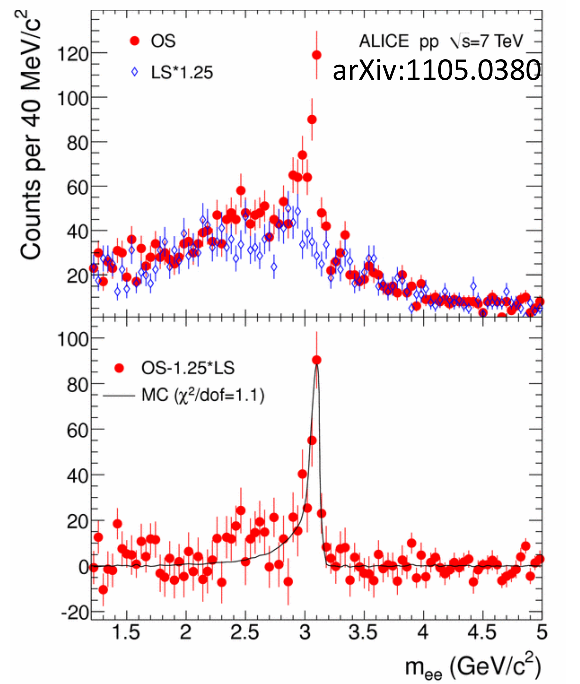


2 peculiarities of ALICE:

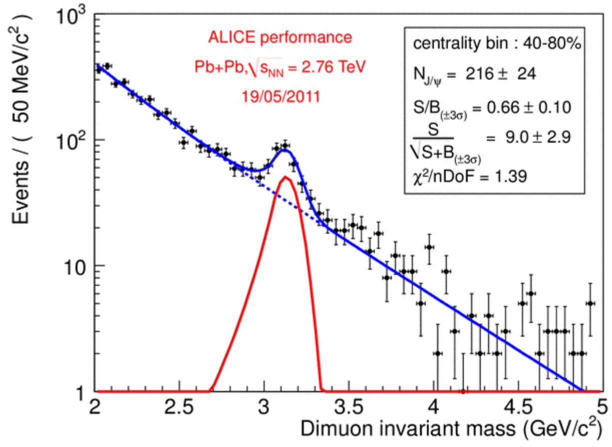
1. In the Forward spectrometer the acceptance is slowly dependent on p_T and, as in the e^+e^- channel, goes down to p_T=0
2. In central barrel PID performed with the TPC (in the future also TRD and EMCAL): ±3σ inclusion cut for electrons, ±3.5σ(3σ) exclusion cuts for pions (protons).

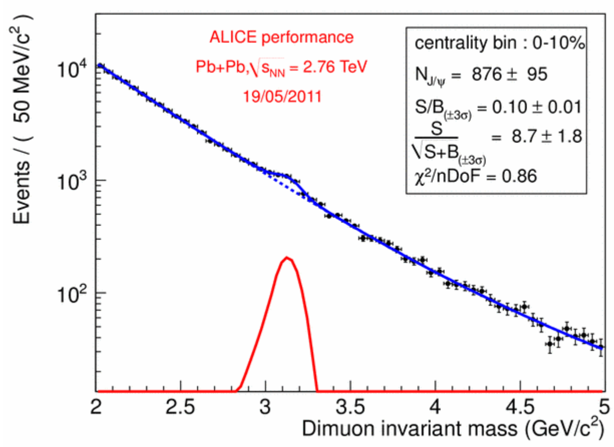


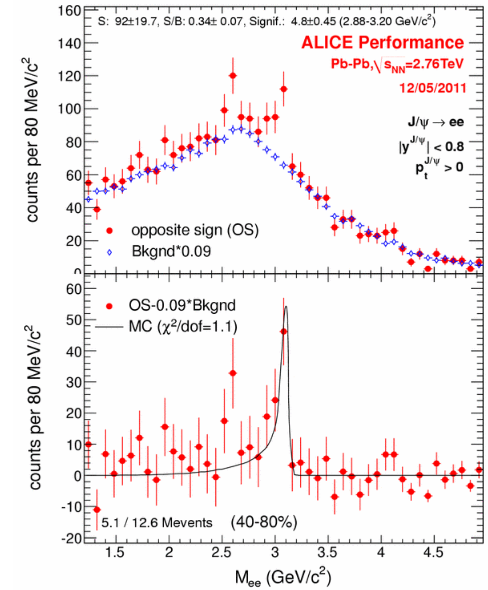




$J/\psi \rightarrow \mu^+\mu^-$ and $\rightarrow e^+e^-$ in ALICE (PbPb)

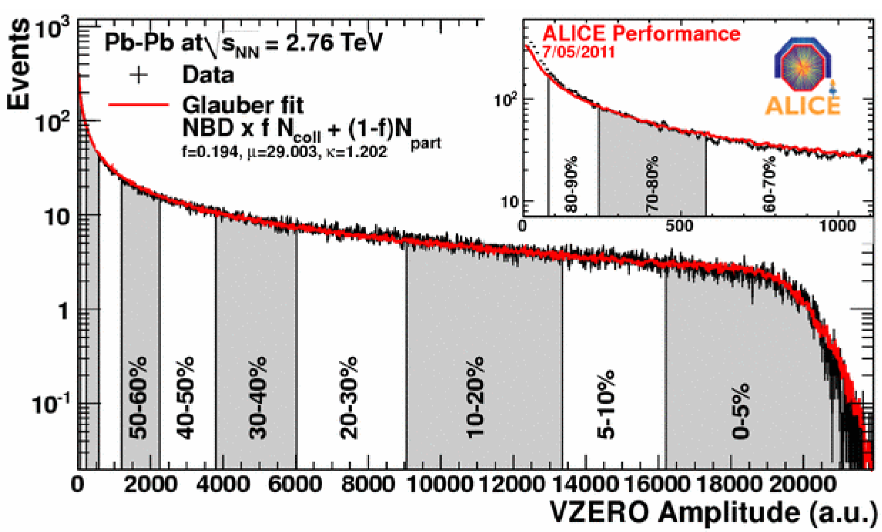






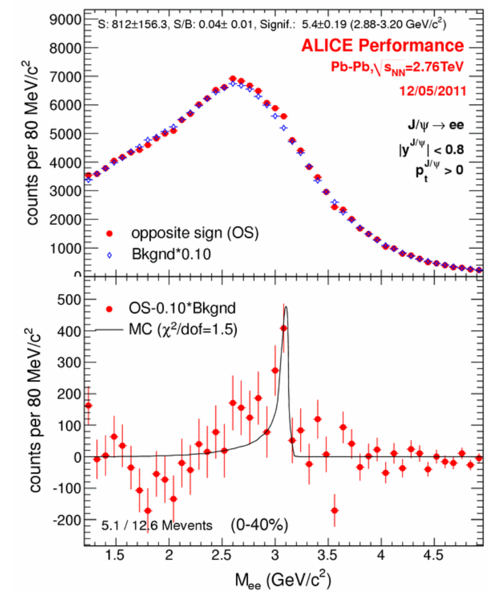
Data were taken at 2.76 TeV in both channels - total luminosity of 2.7 μb^{-1}

To estimate centrality: V0 amplitude fitted with glauber model



Four centrality classes chosen for muons:
[0,10]% [10,20]%
[20,40]% [40,80]%

Only two for electrons:
[0,40]% [40,80]%



Results: pp collisions at 7 TeV & 2.76 TeV

pp at √s=7TeV & 2.76TeV: cross-section

Integrated inclusive J/ψ production cross sections:

7 TeV (arXiv:1105.0380):

$\sigma(2.5<y<4) = 6{,}31 \pm 0.25(stat) \pm 0.8(syst) + 0.95(\lambda_{CS}=+1) - 1.96(\lambda_{CS}=-1)\ \mu b$

$\sigma(|y|<0.9) = 10{,}7 \pm 1.2(stat) \pm 1.7(syst) + 1.6(\lambda_{HE}=+1) - 2.3(\lambda_{HE}=-1)\ \mu b$

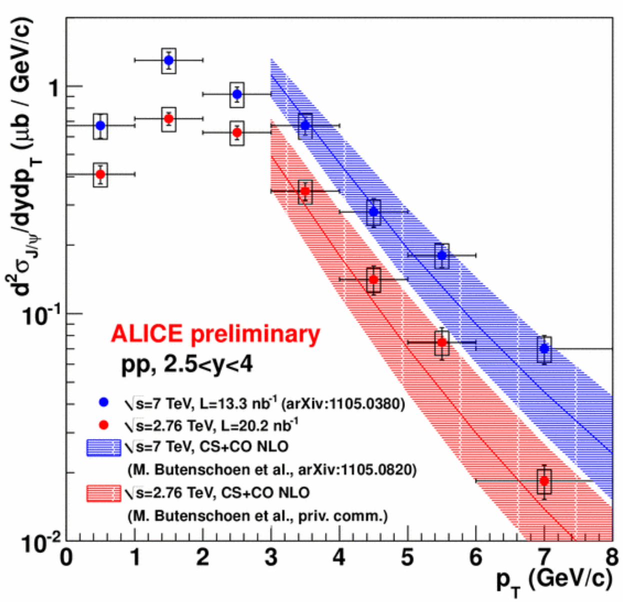
2.76 TeV:

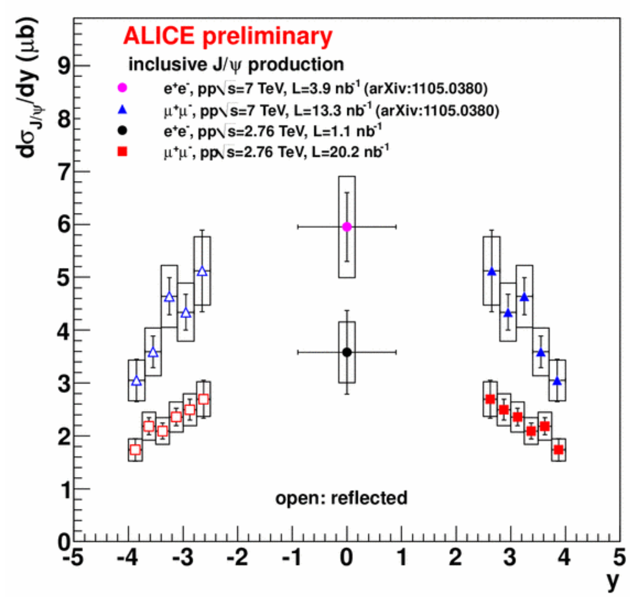
$\sigma(2.5<y<4) = 3{,}46 \pm 0.13(stat) \pm 0.32(syst) \pm 0.28(lumi) + 0.55(\lambda_{CS}=+1) - 1.11(\lambda_{CS}=-1)\ \mu b$

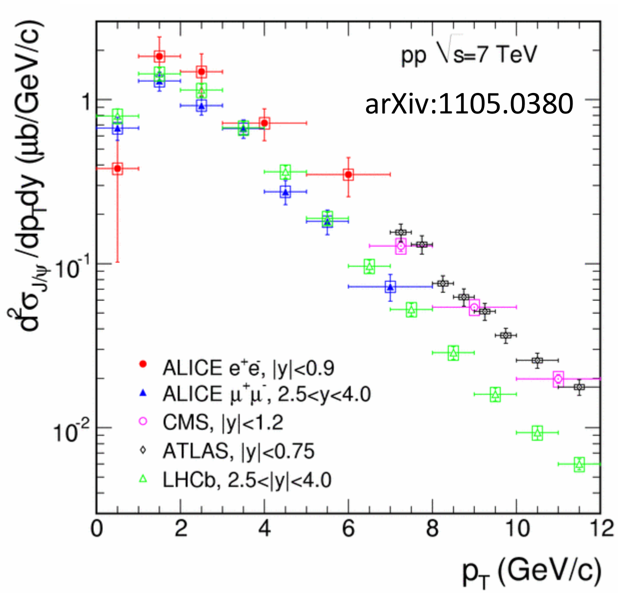
$\sigma(|y|<0.9) = 6{,}44 \pm 1.42(stat) \pm 0.88(syst) \pm 0.52(syst) + 0.64(\lambda_{HE}=+1) - 1.42(\lambda_{HE}=-1)\ \mu b$

At forward rapidity the $d^2\sigma/dydp_T$ was extracted at both the energies → well reproduced by NRQCD calculations at NLO

Comparison at 7 TeV with other LHC experiments: fair agreement both at forward rapidity (with LHCb) and at mid rapidity, where ALICE is complementary to ATLAS and CMS

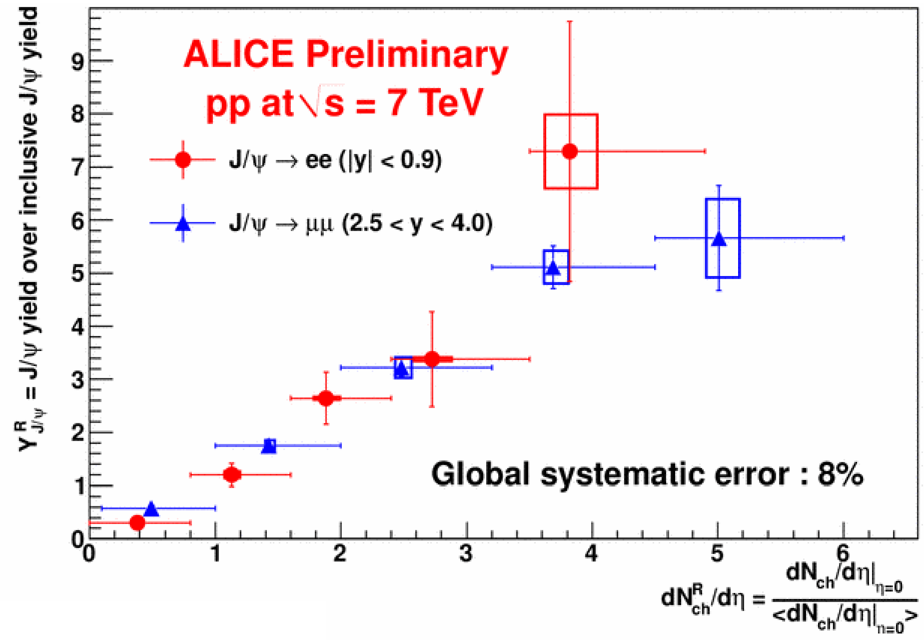


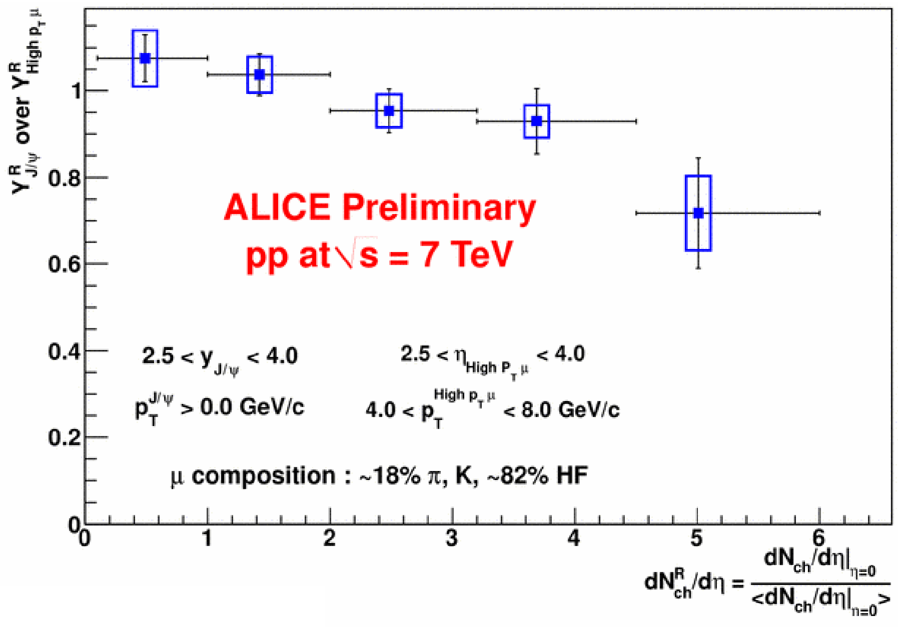




J/ψ production VS multiplicity at √s=7TeV

J/ψ yield as a function of the charged particle multiplicity studied at central and forward rapidities.
Linear increase observed





The J/ψ yield exhibits a weaker increase with $dN_{ch}/d\eta$ than the high p_T muons (>80% of which are coming from heavy flavors). Different mechanisms can explain this observation such as kinematical effects, modification of the p_T distribution, modification of the bottom to charm ratio, etc..

STILL WORK FOR THE INTERPRETATION

Results: PbPb collisions at 2.76 TeV

R_{AA} VS centrality

R_{AA} calculated only in the forward region:

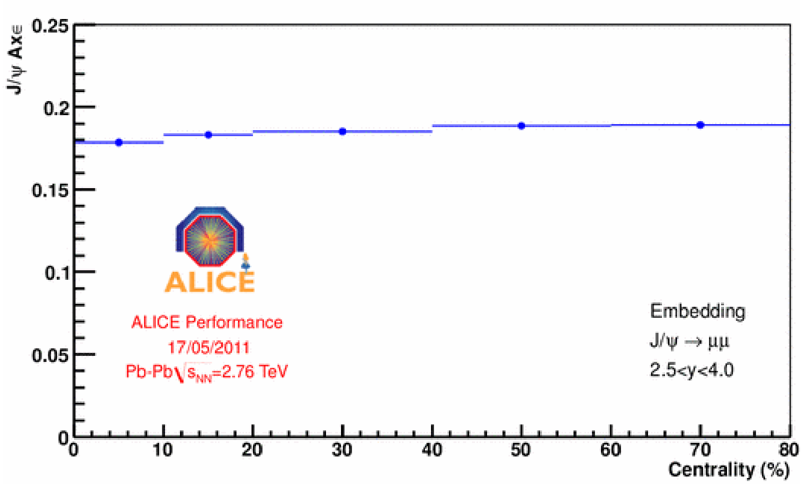
$$R^i_{AA} = \frac{Y^i_{J/\psi}}{\langle T^i_{AA} \rangle \cdot \sigma^{inclu}_{J/\psi}(2.76\,TeV)}$$

Raw yields were corrected for acc×eff:

$$Y^i_{J/\psi} = \frac{N^i_{J/\psi}}{B.R. \cdot Acc \times Eff \cdot N^i_{MB}}$$

- p_T and y inputs taken from interpolation based on real data (F. Bossu *et al.*, arXiv:1103.2394)
- shadowing from EKS98 calculations (K.J.Eskola *et al.*, Eur. Phys. J. C9, 61, 1999)
- less than 2% dependence of tracking efficiency on the centrality

Normalization to the inclusive cross-section measured in pp at 2.76 TeV



Systematics dominated by signal extraction (up to 19% in the most central bin) and by the uncertainty on the pp inclusive cross-section measurement (13%)

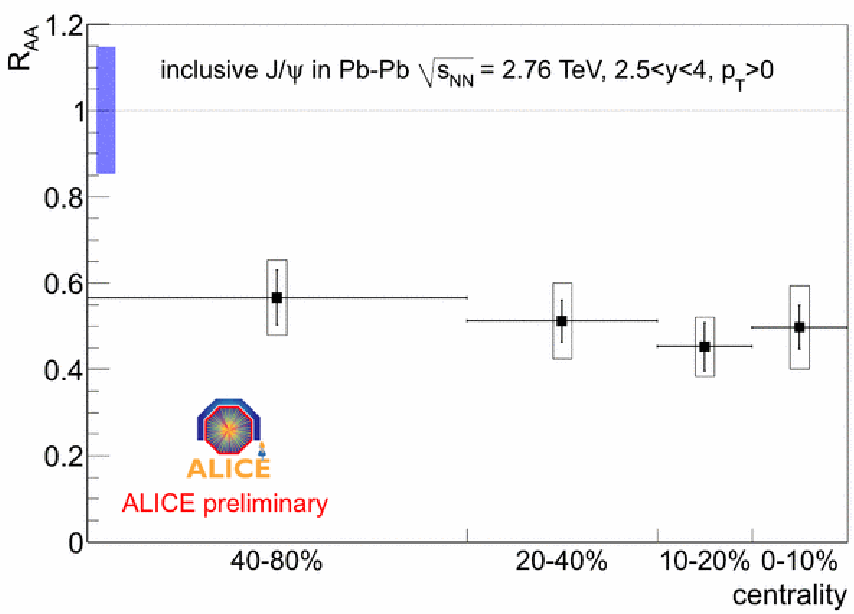
R_{AA} VS centrality: results (I)

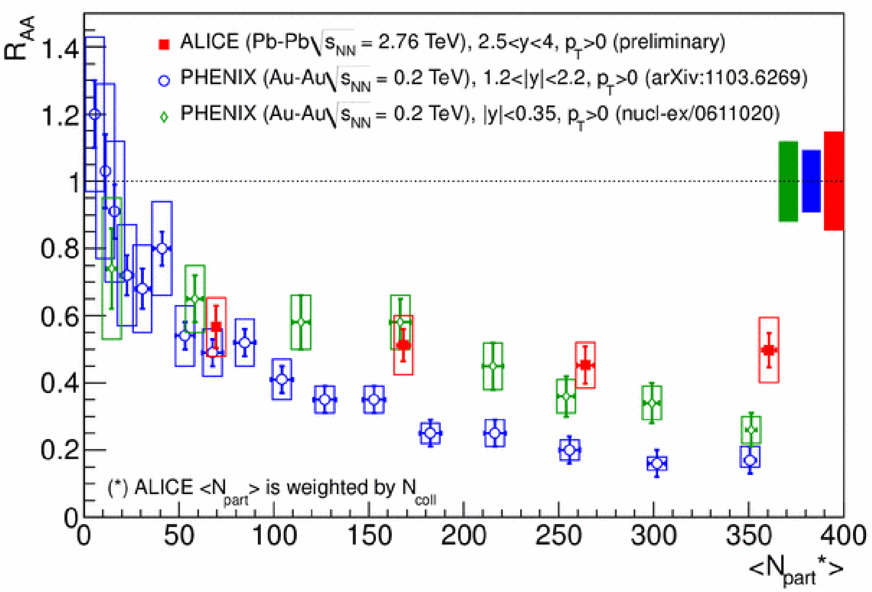
The inclusive J/ψ R_{AA} integrated over all the centralities is measured to be:

$R_{AA}^{0\text{-}80\%} = 0.49 \pm 0.03(stat) \pm 0.11(syst)$

The dependence of R_{AA} on centrality not strong
note that the most peripheral class includes semi-central events!!

The comparison with the results obtained by PHENIX at forward rapidity (1.2<|y|<2.2) shows
less suppression at LHC then at RHIC: hint for regeneration?
Better agreement with PHENIX data at mid-rapidity, but not at very high N_{part}



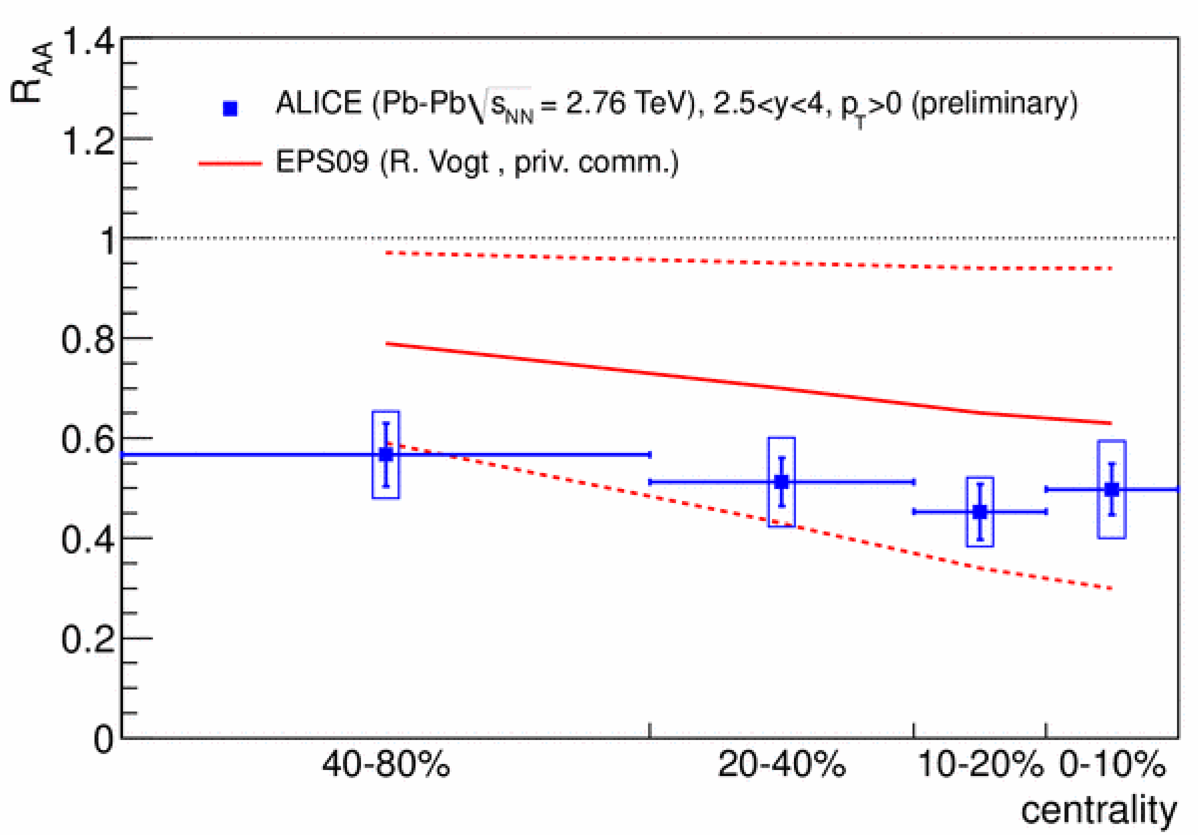


R_{AA} VS centrality: results (II)

We can compare the R_{AA} to pure shadowing predictions

K.J.Eskola *et al.*, JHEP 0904:065, 2009

R. Vogt, Phys.Rev.C81:044903, 2010



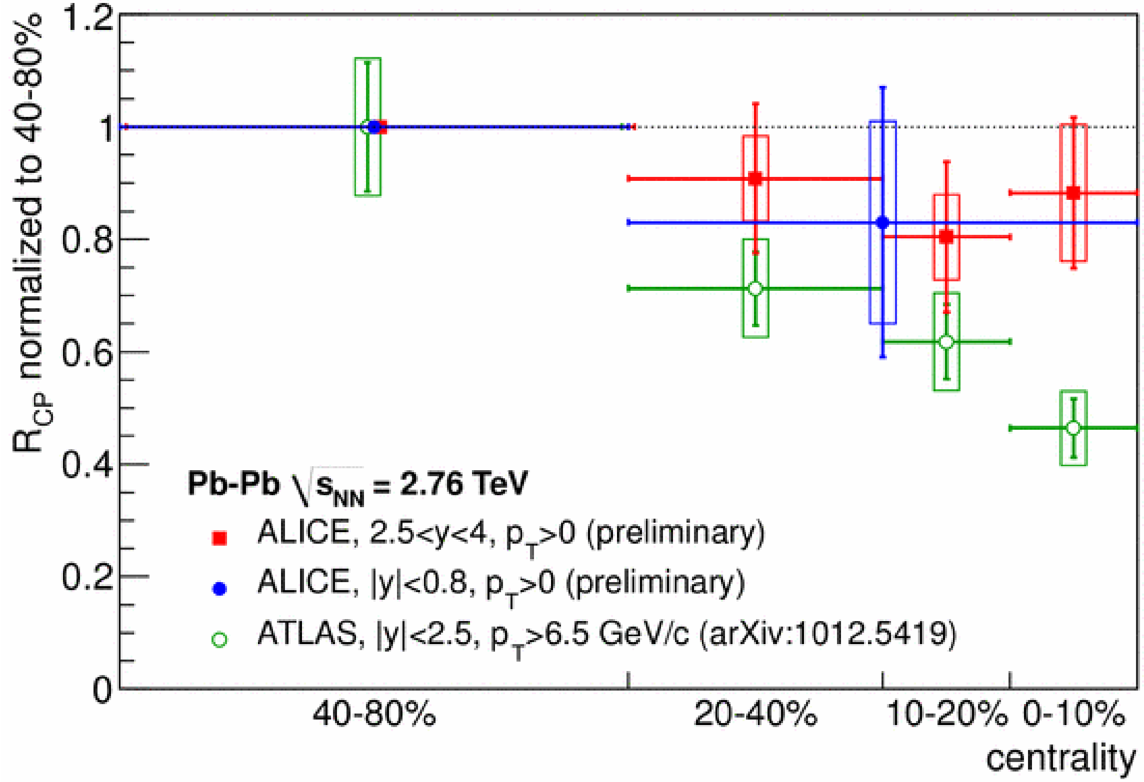
Uncertainties on the shadowing predictions are very high: need of pA data at LHC for addressing cold nuclear matter issues

PbPb at √s=2.76TeV : R_{CP}

R_{CP} computed in both forward and central rapidity regions: allows to compare with ATLAS result.

Ratio normalized to the 40-80% bin

Error bars: statistical uncertainties
Empty boxes: centrality dependent systematic uncertainties



The R_{CP} extracted in ALICE at forward rapidity is not in agreement with the one extracted by ATLAS at mid-rapidity, especially in central collisions

Higher suppression at higher p_T? Or at central rapidities? Or both?

The mid-rapidity result in ALICE has too large errors to allow a comparison

Conclusions

ALICE has been studying inclusive J/ψ production in a large rapidity region extending from -0.9 to 4 and down to p_T=0

The inclusive production cross-sections in pp collisions at 7 TeV and at 2.76 TeV , as well as the p_T and y differential cross sections, are in nice agreement with what found by the other LHC experiments both at forward rapidity and at mid-rapidity

The measured $d^2\sigma/dp_Tdy$ is in good agreement with NRQCD NLO predictions at both the energies

The inclusive J/ψ yield shows a linear increase as a function of $dN_{ch}/d\eta$

In PbPb at 2.76 TeV the R_{AA} factor was measured at forward rapidity as a function of the centrality.
Comparison with the PHENIX $\rightarrow$ less suppression at LHC with respect to RICH in central collisions.
The interpretaion of this result will be simpler when pA data at the same energy will be taken

The R_{CP} was also measured. The factor is larger with respect to what ATLAS measures at mid-rapidity, possibly reflecting some kinematical dependence of the factor itself