Abstract:
The Dapnia contribution to the PHENIX experiment focuses on the study of the J/Ψ production in heavy ions collisions via its decay into a $\mu^+ \mu^-$ at forward rapidity. The first results on J/Ψ production in Au+Au collisions at a center of mass energy of 200 GeV per nucleon-nucleon collision has been measured in 2004 and published in 2006. Additional measurements in p+p and Cu+Cu collisions have also been performed in 2005.

Introduction
The PHENIX experiment is located on the Relativistic Heavy Ion Collider (RHIC) at the Brookhaven National Laboratory (BNL). It aims to identify and study the possible formation of a quark-gluon plasma in heavy nuclei collisions at a nucleon-nucleon center of mass energy $\sqrt{(s_{NN})}$=200 GeV. Many probes are studied using the PHENIX spectrometer to achieve this goal and notably the production of the J/Ψ resonance which is a heavy quarkonia constituted of a charm anti-charm quark pair. The suppression of the J/Ψ production with growing energy density of the medium was long considered as a promising proof of the formation of the quark gluon plasma, because of the inability of the charm quark pairs to form a bound state if the colour density of the surrounding medium is large enough to screen the strong interaction between these two quarks [1]. A suppression of the J/Ψ production was already observed at a lower energy by the NA50 experiment at the SPS [2,3], and for several models that describe these results a larger suppression is expected when increasing the nuclei beam energy.

SPHN contribution to the PHENIX experiment
Our group joined the collaboration at the end of 2000 together with several groups from the IN2P3 inside the PHENIX-France collaboration. Its hardware contribution was to finance 25% the electronics of the PHENIX muon arms, dedicated to the measurement of muons at forward rapidity and notably the production of J/Ψ via its decay into a muon pair.

Starting from 2003 the group took the responsibility of the reconstruction and analysis software of the PHENIX muon arms. This software was entirely redesigned from 2002 to 2003 to better suit the requirements of a Au+Au run in 2004 for which the number of tracks per events and thus the constraints in terms of reconstruction time and efficiency were larger than for the previous data taking periods. The transition between the old and new reconstruction software occurred on behalf of the whole collaboration for the Run4 Au+Au analysis, during which our group played a leading role in measuring the J/Ψ production at forward rapidity. The first preliminary results have been presented in the 2005 Quark-Matter international conference at Budapest and the final results have been published in July 2006 [4], together with new high statistics J/Ψ measurements in p+p collisions [5] which are used as a reference. Additional and complementary results obtained in Cu+Cu collisions are presently being finalized and expected to be published in 2007.

J/Ψ results
The nuclear modification factor R_{AA} is the ratio between the J/Ψ production cross-section in nuclei-nuclei (A+A) collisions and its production in p+p collisions, normalized by the number of nucleon-nucleon collisions N_{col} equivalent to one A+A collision for a given impact parameter. In absence of any nuclear effect this ratio is equal to one. Figure 1 shows the J/Ψ nuclear modification as a function of the number of participating nucleons N_{part} in Au+Au collisions. For peripheral collisions (small number of participants) R_{AA} is close to one and the J/Ψ production mechanism are essentially the same as in p+p collision. When N_{part} increases, the ratio becomes smaller than 1. This is the first time that a suppression of the J/Ψ production is observed at such an energy. This suppression is larger than what could be expected from cold nuclear effects, as extrapolated from

earlier d+Au measurements [6,7,8], which means that additional suppression mechanisms come into play, such as color screening due to the formation of a quark-gluon plasma. Whether this scenario is able to reproduce the measurement or if additional (or competing) mechanisms such as charm quarks recombination are needed is still unclear and needs further theoretical work. Figures 2 and 3 show the J/Ψ nuclear modification factor as a function of its transverse momentum and rapidity for four centrality bins. These measurements also represent important constraints to the various theoretical models that aim to describe the medium produced in ultra relativistic heavy ion collisions.

Perspectives

Starting from 2007 the group also took the responsibility of the simulation software for the whole spectrometer (as opposed to the muon arms only). This consists in providing the proper simulations needed to estimate the detector acceptance and efficiency as well as the physical and combinatorial background specific to the various analysis performed by the collaboration, such as high transverse momentum particle correlations, light and heavy particle elliptic flow measurements, single muons and single electrons productions (related to open charm production). The 2007 data taking period will consist again of Au+Au collisions with an expected luminosity four times larger than in 2004. This will result in more accurate results, a better control of the systematic errors and possibly new measurements such as the J/Ψ elliptic flow. More data will also be taken using d+Au collisions to have a better control on cold nuclear matter effects that need to be subtracted from the suppression observed in heavy ion collisions. This should occur in 2008 or 2009. Finally, PHENIX plans several detector and electronics upgrades to cope with the RHIC luminosity upgrade foreseen in 2010. So far no contribution from the DAPNIA to these upgrades was envisaged.

References

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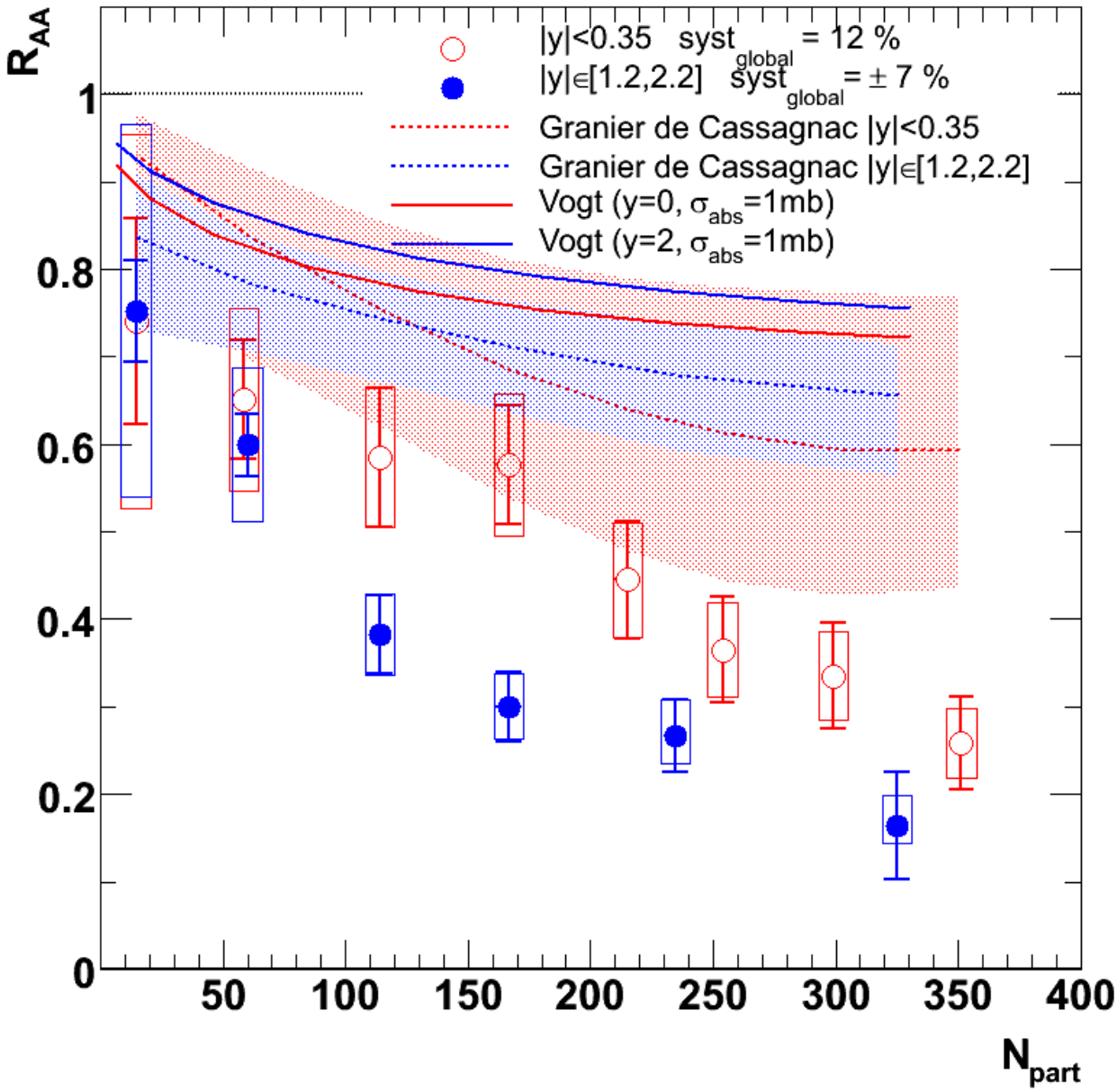

Figure 1 : J/Ψ nuclear modification factor R_{AA} as a function of the number of participant (N_{part}) in Au+Au collisions at $\sqrt{(s_{NN})}$ = 200 GeV. Red (blue) symbols are for mid (forward) rapidity J/Ψ. Lines are expected R_{AA} based on cold nuclear matter effects only, extrapolated from J/Ψ production cross-section in d+Au collisions.

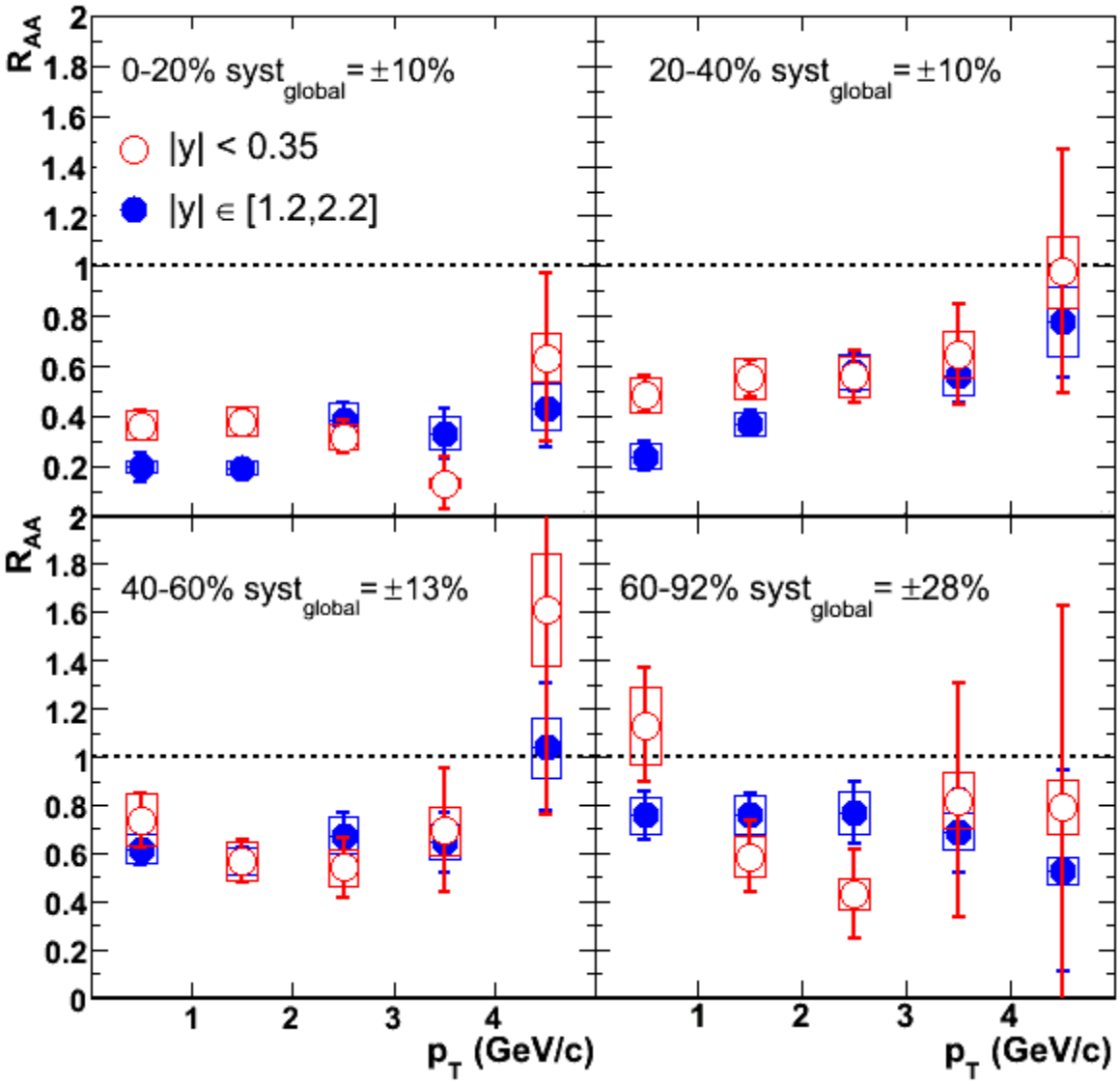

Figure 2 : J/Ψ nuclear modification factor as a function of the J/Ψ transverse momentum for four centrality bins in Au+Au collisions at $\sqrt{(s_{NN})}$ = 200 GeV. Red (blue) symbols are for mid (forward) rapidity J/Ψ.

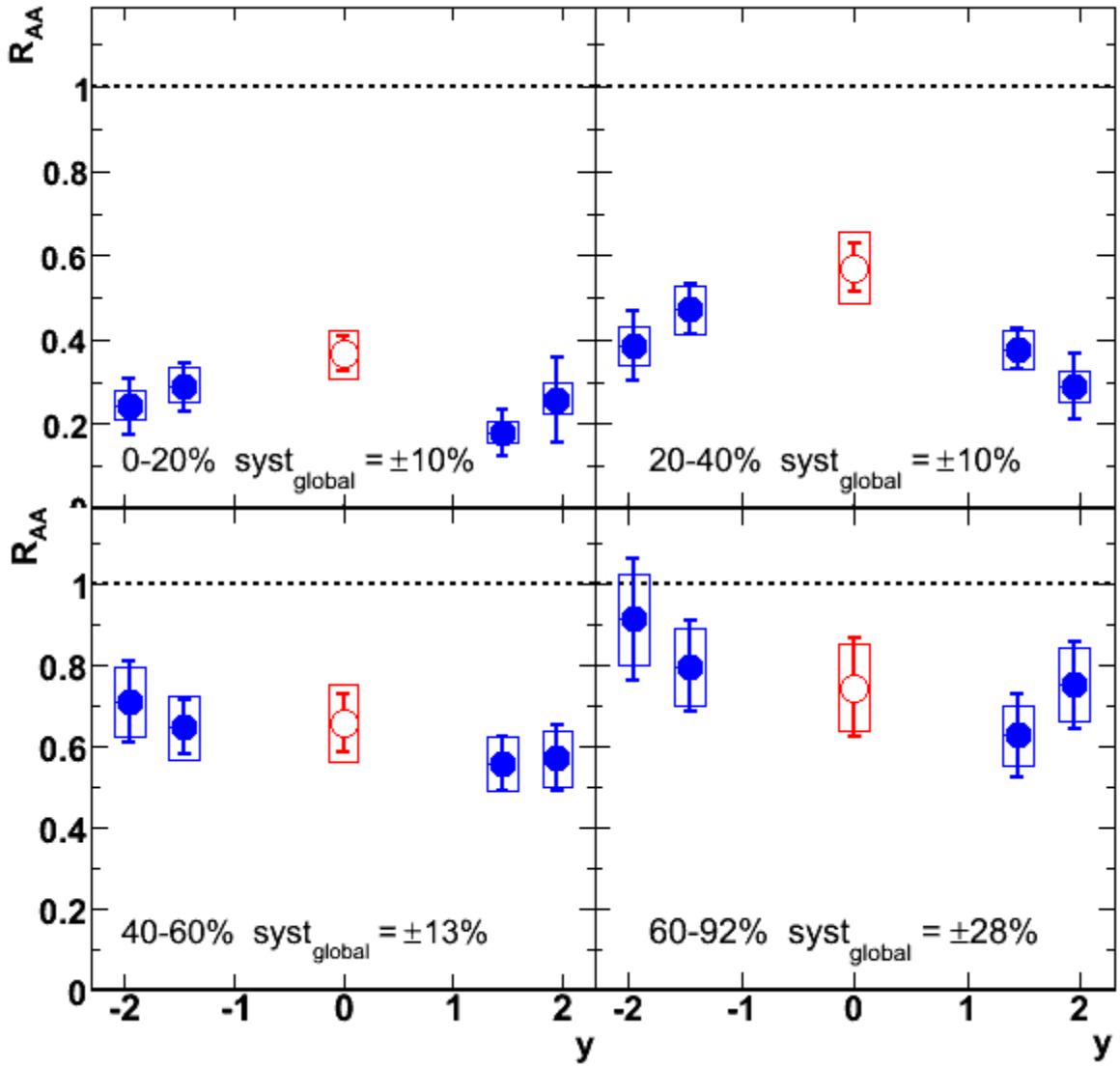

Figure 3 : J/Ψ nuclear modification factor as a function of the J/Ψ rapidity for four centrality bins in Au+Au collisions at $\sqrt{(s_{NN})}$ = 200 GeV. Red (blue) symbols are for mid (forward) rapidity J/Ψ.