PROCEEDINGS OF SCIENCE

Charmonium production in pPb and PbPb collisions with the CMS detector

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The nuclear modification factors of the ground and excited states of J/ψ were measured via dimuon channels in pPb and PbPb collisions at 5.02 TeV. The analysis was performed as functions of collision centrality, rapidity, and transverse momentum. The results are discussed in the framework of the modified nuclear parton distribution function (for pPb) and the interaction of charmonia with dense partonic matter.

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[†]A footnote may follow.

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1. Introduction

Charmonia are produced in the early stage of collision and experience medium. Due to this characteristics charmonia are promising probe for studying the properties of the de-confined medium created in ultra-relativistic heavy-ion collisions, the quark-gluon plasma (QGP). CMS has measured charmonium observables in lead-lead (PbPb), proton-proton (pp), and proton-lead (pPb) collision systems at a centre-of-mass energy per nucleon pair of $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV. Measurement of charmonium production at PbPb collisions compared to pp collisions enables to understand the energy of QGP by suppression. On the other hand, the measurement of charmonium production in pPb collisions enables to investigate the so-called "cold nuclear matter" (CNM) effects, which provide new information to examine quantitatively the genuine hot-medium effects in PbPb collisions. The nuclear modification factor (R_{AA}) of the ground (J/ψ) and excited (ψ(2s)) charmonium states, reconstructed via their decays to $\mu^+\mu^-$, were studied as function of meson rapidity (y) and transverse momentum (p_{T}), and event centrality (N_{part}).

2. Signal extraction

Charmonia were measured via dimuon decay channel. The invariant mass spectrum of $\mu^+\mu^-$ pairs was modeled by the sum of a Crystal Ball (CB) function and a Gaussian function for the Charmonia signal, and by an exponential function for the underlying continuum background. Unlike ψ(2s), J/ψ mass spectrum is mixture of prompt and non-prompt (decay from B meson) component. In order to separate prompt and non-prompt, pseudo-proper decay length, $l_{\mathrm{J}/\psi} = L_{xyz}\, m_{\mathrm{J}/\psi}/p_{\mathrm{T}}$, was used. L_{xyz} is the distance between the primary and secondary vertices in the laboratory frame. The invariant-mass spectrum and the $l_{\mathrm{J}/\psi}$ distribution of $\mu^+\mu^-$ pairs were fitted sequentially in an extended unbinned maximum-likelihood fit.

3. Results

3.1 pPb collisions

Figure 1 shows nuclear modification factor of prompt J/ψ. The nuclear modification factors as function of p_{T} are higher than 1 at the mid and backward region (Pb going side) while only most forward region (p going side) is suppressed. This suppression at forward describes shadowing effect of nuclear parton distribution functions. Proton experience modification of parton distribution in the heavy-ion at the high energy collision [1].

Figure 2 shows nuclear modification factor of prompt J/ψ and ψ (2S) as function of rapidity. In this measurement strong suppression of ψ (2S) is observed at the most backward region and nuclear modification factor of ψ (2S) is smaller than that of J/ψ while the nuclear modification factors are similar at the forward region. This suppression in the backward region indicates the final state effect beyond Cold Nuclear Matter (CNM) effect.

3.2 PbPb collisions

Previously CMS has measured nuclear modification factor of J/ψ at 2.76 TeV. 5.02 TeV results as function of p_{T} and rapidity are compared with previous results and no significant difference is

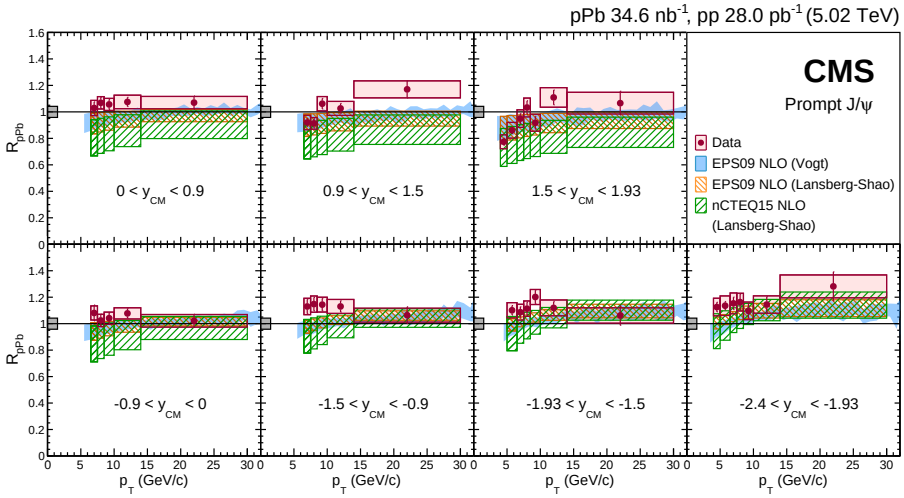

Figure 1: The nuclear modification factor of prompt J/ψ meson as a function of p_{T} in various rapidity regions. Top plots are forward region (p going side) and bottom plots are backward region (Pb going side). Results are compared with various theories.

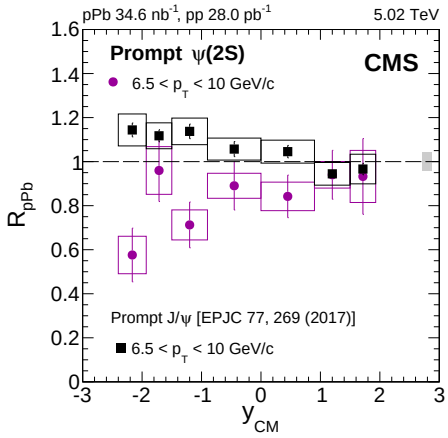

Figure 2: The nuclear modification factor of prompt J/ψ and ψ (2S) as function of rapidity. Black square is prompt J/ψ, magenta circle is ψ (2S). Both mesons are in the p_{T} range from 6.5 to 10 GeV/c. Plus rapidity correspond to forward region (p going side) and minus rapidity correspond to backward region (Pb going side).

observed from the collision energy difference. Figure 3 shows prompt J/ψ nuclear modification factor as function of event centrality. Large number of particles involved in collision is central collision while low number of particles is peripheral collision. At the lower p_{T} for the central events less suppression is observed and also at the low p_{T} in the forward region ($1.8 < |y| < 2.4$) less suppression is observed. From this less suppression hint of regeneration process is expected. ψ (2S) also has measured in the 5.02 TeV PbPb collision. ψ (2S) is more strongly suppressed than J/ψ in the all p_{T}, centrality regions and there is no strong p_{T} dependence.

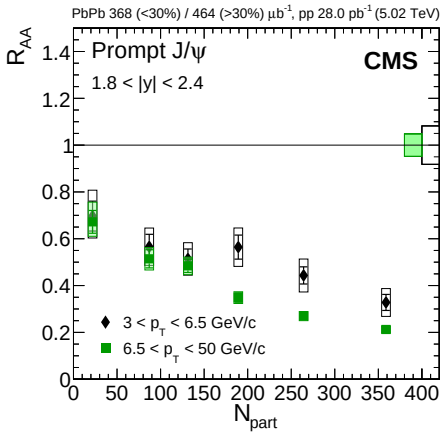

Figure 3: The nuclear modification factor of prompt J/ψ as function of number of participants. Low N_{part} correspond to peripheral collision and high N_{part} correspond to central collision. Black diamond is low p_{T} ($3 < p_{\mathrm{T}} < 6.5$ GeV/c), green square is high p_{T} ($6.5 < p_{\mathrm{T}} < 50$ GeV/c).

4. Summary

CMS collected data in the pp, PbPb, pPb collision system at the $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV. With these data prompt J/ψ and ψ (2S) mesons are measured as function of p_{T}, rapidity, event centrality. From the pPb collision result CNM effect has observed at the forward region and beyond CNM effect observed at backward region. No significant collision energy dependence has observed from the comparison with different energy of PbPb collisions. The low suppression at low p_{T} especially in the central collision shows hint of the regeneration.

References

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