J/ψ Production in Pb+Pb Collisions at $\sqrt{s}_{NN}$ = 2.76 TeV

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Introduction

High energy heavy ion collisions create extreme energy density where matter is in the form of Quark Gluon Plasma(QGP), a phase in which color degrees of freedom play role. The J/ψ in heavy-ion collisions was suggested to be a promising probe as the deconfined medium should screen the two quarks leading to a suppression of its production. It has been studied at different energies and with different collision systems without yet giving a fully understood global picture [1, 2]. Measuring the charmonium production at the LHC energies in PbPb collisions will help constrain predictions, in particular those with a large recombination probability for prompt J/ψs.

Data Selection

The analysis is based on a data sample recorded by the CMS detector in pp and PbPb collisions at $\sqrt{s}_{NN}$ = 2.76 TeV. Hadronic PbPb collisions were selected using information from the two Beam Scintillator Counters and Forward Hadronic calorimeters (HF). After filtering, a sample of 55 million minimum bias (MB) events was collected. Assuming an inelastic PbPb cross section of σ_{PbPb} = 7.65 barn, this sample corresponds to an integrated luminosity of L_{int} = 7.28 μb^{-1}. The pp luminosity recorded in CMS was 225 nb^{-1}.

Different variables to select good quality global muons have been studied in Monte-Carlo generated PbPb events. The transverse (longitudinal) impact parameter from the measured vertex is required to be less than 3(15) cm. Tracks are kept only if they have 11 hits or more in the silicon tracker and the χ^2 per degree of freedom of the global (tracker) track is required to be lower than 20 (4). The probability of the two tracks to belong to a common vertex is requested to be better than 1%, removing background arising from B-meson semileptonic decays.

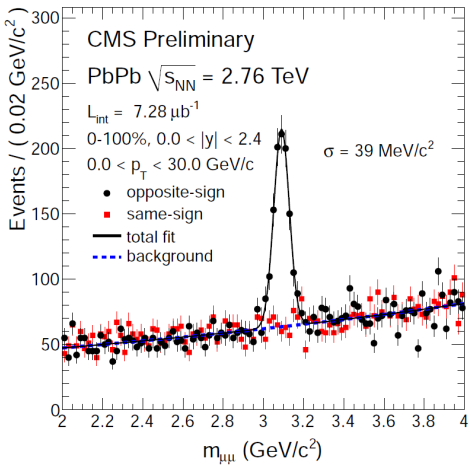

FIG. 1: Invariant mass spectrum of $\mu^+\mu^-$ pairs

J/ψ analysis

The invariant mass spectrum of $\mu^+\mu^-$ pairs with p_T < 30 GeV/c, after applying the single muon quality cuts is shown in Figure 1; as black circles for all $\mu^+\mu^-$ pairs. The curve is an unbinned maximum log-likelihood fit with sum of a Crystal Ball and a Guassian function with common mean and width for the signal, and an exponential for the background. The number of inclusive J/ψ obtained is 734±54.

The pp quarkonia measurement at 2.76 TeV serves as a reference to quantify the quarkonium production in the hot medium created in PbPb collisions. The offline selection and extraction of quarkonium signal in pp is same as in PbPb analysis. The nuclear modificatoin factor is defined as

$$R_{AA} = \frac{N_{PbPb}}{N_{pp}} \frac{1}{<N_{coll}>}$$

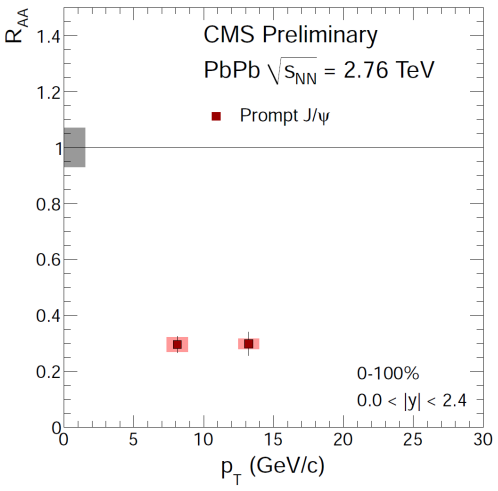

FIG. 2: R_{AA} as a function of p_T

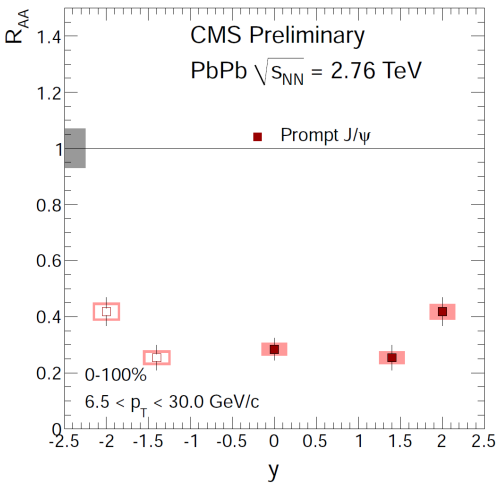

FIG. 3: R_{AA} as a function of rapidity

N_{PbPb} and N_{pp} are the measured prompt J/ψs in PbPb and pp collision respectively. $<N_{coll}>$ is average number of binary collisions. Figures 2 and 3 present the R_{AA} of prompt J/ψ as function of p_T and rapidity respectively. A suppression of J/ψ by a factor of ∼3 with respect to pp is observed and does not exhibit a p_T dependence in the measured p_T range, while there is an indication of less suppression in the most forward bin.

In Figure 4, the prompt J/ψ R_{AA} results of CMS in the p_T range $6.5 \leq p_T < 30.0$ GeV/c are compared to inclusive PHENIX results [2] from AuAu at 0.2 TeV, measured in the p_T range $0.0 \leq p_T < 5.0$ GeV/c and in two rapidity regions: with electrons in $|y| < 0.35$ and with muons in the forward region, $1.2 < |y| < 2.2$. N_{part} is function of number of participant nucleons. The suppression pattern is similar, despite the difference in the colliding energy and very different J/ψ kinematics.

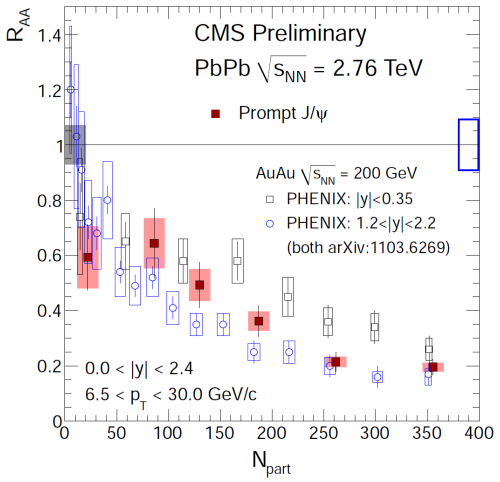

FIG. 4: R_{AA} as a function of N_{part}

Conclusion

This paper presents the measurements of the prompt J/ψ via its decay into $\mu^+\mu^-$ pairs in PbPb and pp collisions at $\sqrt{s} = 2.76$ TeV. With respect to pp, $R_{AA} = 0.20 \pm 0.03$(stat) $\pm$ 0.01(syst) has been measured in the 10% most central collisions and $R_{AA} = 0.59 \pm 0.12$(stat) $\pm$ 0.10(syst) in the 50-100% centrality bin. In most central collision bin, prompt J/ψ is the most suppressed.

References

[1] NA60 Collaboration, Phys. Rev. Lett. **99** (2007) 132302.

[2] PHENIX Collaboration, arXiv:nucl-ex/1103.6269.