Υ Production in p+p and Pb+Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV.

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1. Introduction

The heavy ion collisions are performed to study the interaction of matter at extreme temperatures and densities where it is expected to be in the form of Quark Gluon Plasma (QGP), a state where color degrees of freedom are dominant. One of the expected signal of this phase is the suppression of quarkonium states [1], both from the charmonium (J/ψ, ψ', χ_c, etc.) and bottomonium families (Υ(1S, 2S, 3S), χ_b, etc) due to the color screening produced by the surrounding light quarks and gluons. The suppression is predicted to occur above a critical tempara-ture T$_c$, sequentially, in order of the binding energy. Since the Υ(1S) is the strongest bound state among all quarkonia, it is expected to be the last to melt in the QGP. Examples of dissociation temperatures are given in reference [2] and are < 1 Tc, 1.2 Tc, and more than 2 Tc for the Υ(3S), Υ(2S) and Υ(1S) respectively.

2. 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), in coincidence with a bunch crossing identified by the Beam Pick-up Timing Experiment detectors. A sample of 55 million minimum bias (MB) events passed these plus offline filters corresponding to an integrated luminosity of $\mathbf{L}_{int}$ = 7.28 μb^{-1}. (assuming an inelastic PbPb cross section of σ_{PbPb} = 7.65 barn). Tracks in the muon detectors are matched to the tracks in tracker to obtain global muons used in the analysis. The measurements reported here are based on (di)muon events triggered by the Level-1 (L1) and High Level Trigger (HLT) processor farm. Simulated events were used to tune the muon selection criteria, to check the agreement with data, and to compute the acceptance and efficiencies corrections.

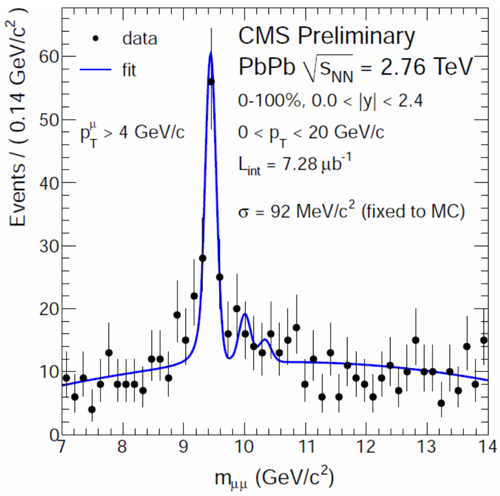

FIG. 1: Invariant mass spectrum of $\mu^+\mu^-$ pairs.

3. Analysis and results

The Υ(1S) yield is extracted via an extended unbinned maximum likelihood fit to the $\mu^+\mu^-$ invariant-mass spectrum [3]. The three Υ(1S), Υ(2S) and Υ(3S) states are fitted simultaneously with three Crystal Ball (CB) functions. The parameters describing the radiative tail are fixed to the MC PbPb Υ(1S)

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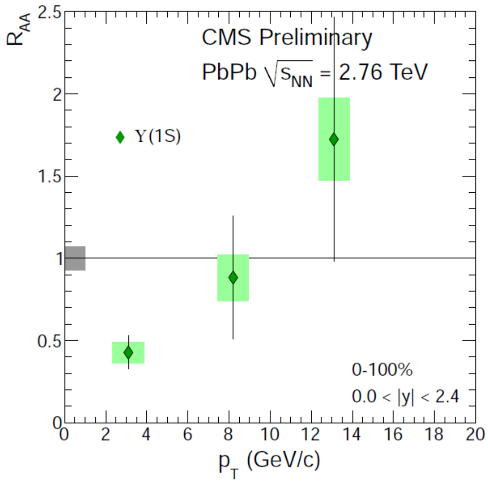

FIG. 2: The nuclear modification factor as a function of p_T for Υ(1S).

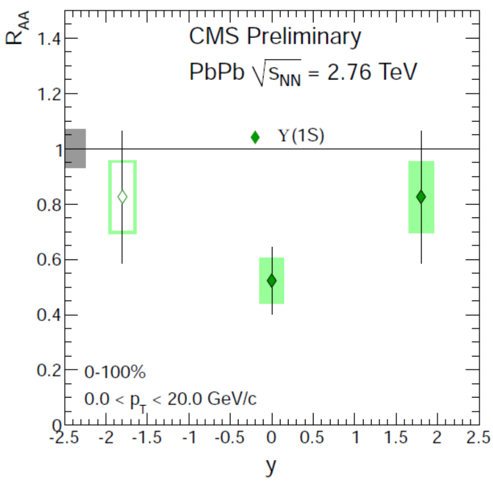

FIG. 3: The nuclear modification factor as a function of rapidity for Υ(1S).

shape. In addition, the Υ(1S) resolution is fixed to the MC value 92 MeV/c^2, The width of the Υ(2S) and Υ(3S) states are fixed to the Υ(1S) width scaled by their respective mass ratios. The mass of the Υ(1S) is a free parameter in the fit, to accommodate the uncertainties in the momentum scale calibration. The number of free parameters is reduced by fixing the mass difference between Υ(3S), Υ(2S) and Υ(1S) to the world average value. A second-order polynomial is chosen to describe the background in the mass range 7-14 GeV/c^2. The fit to the dimuon invariant mass spectrum in PbPb in the Υ region is shown in Fig. 1. The mean value is $m_0 = 9.441 \pm 0.024$ GeV/c^2. From this fit, before accounting for acceptance and efficiencies, the Υ(1S) raw yield measured is 86 ± 12.

A pp run at $\sqrt{s}$ = 2.76 TeV was delivered by the LHC in March 2011. The luminosity CMS recorded was 225 nb $^{-1}$. For probes that follow binary scaling, the integrated luminosity of the pp sample is comparable to the one of the PbPb sample. Same analysis procedure is used for pp data and Υ yield is extracted. Both PbPb and pp yield is corrected for acceptance and efficiency corrections, obtained from simulation. R_{AA} is defiend as ratio of yield in PbPb collisions to pp collisions scaled by number of binary collisions. The Υ(1S) R_{AA} is studied as a function of p_T, rapidity and centrality. Fig.2 shows R_{AA} as a function of p_T . A suppression by a factor 2.3 is observed for low p_T which seems to disappear for pT > 6.5 GeV/c. Fig.3 shows R_{AA} as a function of rapidity. The rapidity dependence indicates a slightly smaller suppression at forward rapidity. In conclusion, Υ(1s) is suppressed at low p_T that seems to disappear for p_T higher than 6.5 GeV/c. The suppression is slighly more in central rapidity in comparison to forward rapidity.

References

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[3] CMS Collaboration, "Indications of Suppression of Excited Υ States in Pb-Pb Collisions at $\sqrt{s}_{NN}$ = 2.76 TeV" PRL **107**, 052302 (2011).