Υ Production in 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.

Measurements of the Υ(1S) absolute suppression [3] and the relative suppression of Υ(2S)+Υ(3S) to Υ(1S) were recently reported by CMS experiment for integrated luminosity 7.28 μb^{-1} [2]. In this paper, an update of these measurements is reported, utilizing 150 μb^{-1} of PbPb data and 231 nb^{-1} of pp data, collected in 2011 by CMS at $\sqrt{s_{NN}}$=2.76 TeV. This larger PbPb dataset together with the good momentum resolution of the CMS detector allow for separating the Υ excited states in the heavy-ion environment and exploring centrality dependence of their production.

2. Data Selection

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 1.13 Billion minimum bias (MB) events passed these as well as offline filters corresponding to an integrated luminosity of $\mathbf{L}_{int}$ = 150.0 μb^{-1}.

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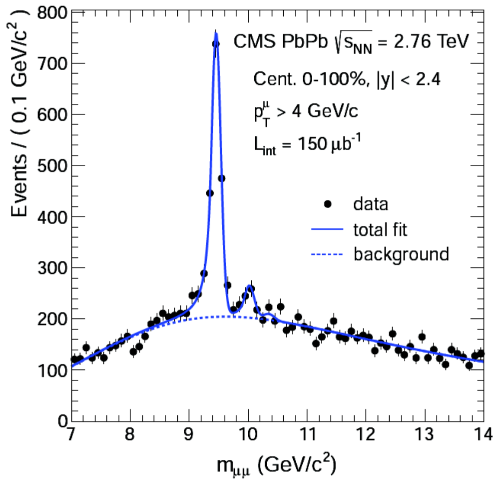

FIG. 1: Invariant mass spectrum of $\mu^+\mu^-$ pairs.

(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 efficiency corrections.

3. Analysis and results

The Υ(1S) yield is extracted via an extended unbinned maximum likelihood fit to the $\mu^+\mu^-$ invariant-mass spectrum [2]. The three Υ(1S), Υ(2S) and Υ(3S) states are fitted simultaneously with three Crystal Ball (CB) functions. The mass, yield and resolution of the Υ(1S) is a free parameter in the fit, to accommodate the uncertainties in the momen-

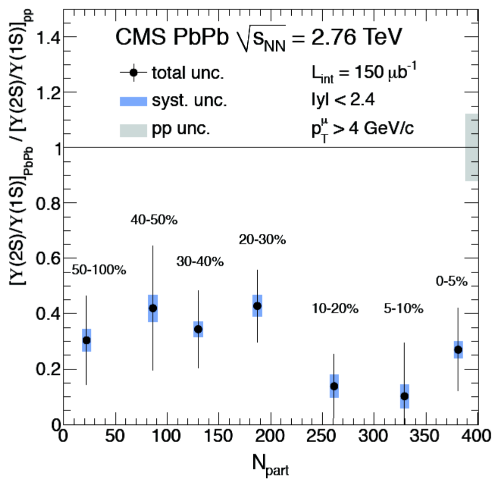

FIG. 2: Double Ratio of Υ states as a function of centrality of collision.

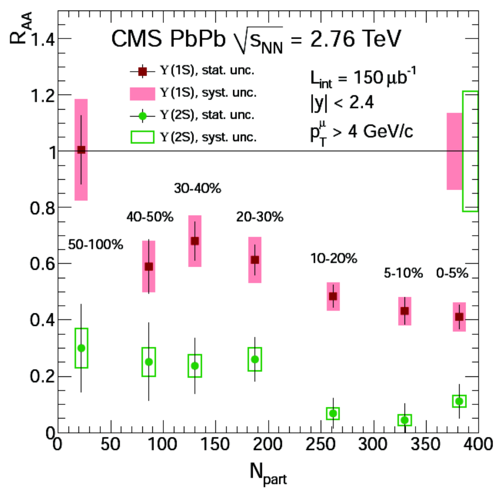

FIG. 3: The nuclear modification factor of $\Upsilon(1S)$ and $\Upsilon(2S)$ as a function of centrality of collision.

tum 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. The width of the Υ(2S) and Υ(3S) states are fixed to the Υ(1S) width scaled by their respective mass ratios. The background model for the pp dataset consists of a second-order polynomial, while the PbPb dataset, with higher statistical precision, calls for a more detailed background model. The $p_T > 4$ GeV/c muon selection threshold induces a sculpting of the background in the 7-14 GeV/c^2 mass fitting range, where the exponential-like shape is distorted toward the lower mass end of the spectrum. To accommodate this, the employed PbPb background model consists of an exponential function multiplied by an error function. The fit to the dimuon invariant mass spectrum in PbPb in the Υ region is shown in Fig. 1. The ratio of the $\Upsilon(nS)/\Upsilon(1S)$ ratios in PbPb and pp benfits from an almost complete cancellation of possible acceptance or efficiency differences among the reconstructed resonances. The double ratios, shown in 2, are expected to be compatible with unity in the absence of suppression of the excited states relative to the Υ(1S) state. The measured values are, instead, considerably smaller than unity. The significance of the observed suppression exceeds five standard deviations. The suppression of the individual Υ states and its dependence on the collision centrality are measured, through the nuclear modification factor calculated from the raw Υ(nS) yields observed in PbPb and pp, and correcting for the ratio of combined trigger and reconstruction efficiencies. As shown in Fig. 3 nuclear modification factor have moderate dependence on centrality for the Υ(1S) and Υ(2S) states, with a more pronounced suppression observed for the more central collisions.

References

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[3] CMS Collaboration "Suppression of non-prompt J/ψ, prompt J/ψ, and Υ(1S) in PbPb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV" JHEP **1205**, 063 (2012)