Upsilon Production in Pb-Pb Collisions at Forward Rapidity with ALICE at the LHC

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1. Introduction

The ALICE apparatus at the LHC was designed and built to perform dedicated studies of the Quark-Gluon Plasma (QGP), a strongly interacting QCD matter of deconfined state, expected to be created in high energy heavy-ion collisions. In such collisions heavy flavours are produced at the very early stage of the interaction in the initial hard scattering processes and hence can be used to characterize the hot and dense medium [1]. In particular the sequential suppression of quarkonia (charmonia and bottomonia) family was proposed as a thermometer of the deconfined medium [2]. In ALICE, the $\Upsilon(1S)$ meson can be measured in its dimuon decay channel at forward rapidity ($2.5 < y < 4.0$). In this talk, results on the $\Upsilon(1S)$ nuclear modification factor (R_{AA}) in Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 2.76 TeV will be discussed and will be compared to the measurement at midrapidity by CMS and to theoretical predictions. Bottomonium production in Pb–Pb collisions is shown for the first time in the forward rapidity region at the LHC.

2. Data and Event Selection

A data sample of integrated luminosity of $L_{int} = 69.2\ \mu\mathrm{b}^{-1}$ have been collected. The minimum bias (MB) trigger is defined as the coincidence of a signal in both the VZERO-A and the VZERO-C detectors synchronized with the passage of two colliding lead bunches. This MB trigger provides high trigger efficiency (> 95%) for hadronic interactions. In order to ensure a fully efficient MB trigger, the data sample previously described corresponds to the centrality class 0% − 90%.

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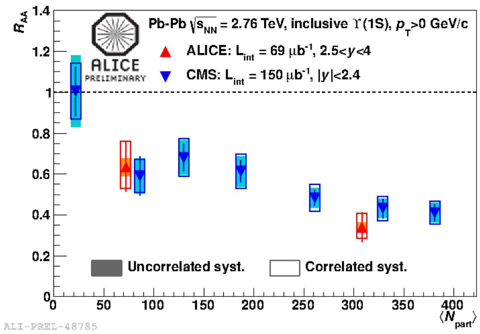

FIG. 1: R_{AA} as a function of $\langle N_{\mathrm{part}}\rangle$ for $\Upsilon(1S)$ as measured by ALICE and CMS.

3. Results

The suppression of quarkonia can be quantified by measuring the nuclear modification factor R_{AA}, which is the ratio of production in nucleon-nucleon collisions to the production in proton-proton collisions scaled by the number of binary collisions.

$$R_{\mathrm{AA}} = \frac{N_{\mathrm{AA}}^{\Upsilon(1S)}}{\langle N_{\mathrm{coll}}\rangle_{\mathrm{AA}} \times N_{\mathrm{pp}}^{\Upsilon(1S)}} \quad (1)$$

The measurement of the nuclear modification factor of the inclusive $\Upsilon(1S)$ production has been performed in the $2.5 < y < 4$ rapidity range, down to $p_{\mathrm{T}} = 0$ and in the 0% − 90% centrality class by the ALICE Collaboration in Pb-Pb collisions at $\sqrt{s_{\mathrm{NN}}} = 2.76$ TeV. The integrated R_{AA} value is $0.439 \pm 0.065(stat.) \pm$

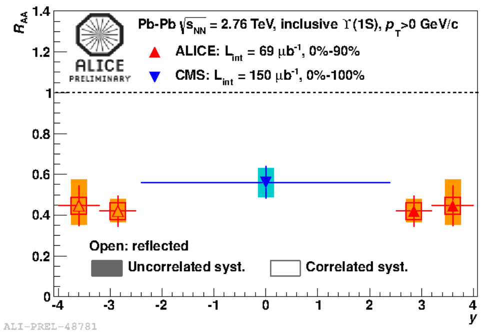

FIG. 2: R_{AA} as a function of y for $\Upsilon(1S)$ as measured by ALICE and CMS.

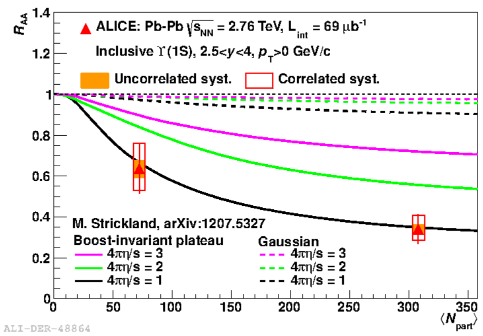

FIG. 3: ALICE R_{AA} as a function of $\langle N_{\rm part}\rangle$ for $\Upsilon(1S)$ compared with Strickland model [3].

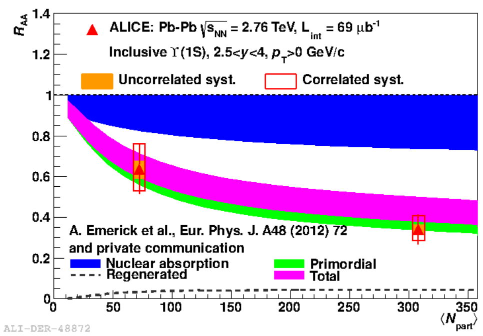

FIG. 4: ALICE R_{AA} as a function of $\langle N_{\rm part}\rangle$ for $\Upsilon(1S)$ compared with Emerick et al. model [4].

$0.028(syst.)^{+0.092}_{-0.076}(glob.)$ and implies a significant suppression of inclusive $\Upsilon(1S)$. Two centrality ranges were studied and a stronger suppression in more central collisions has been observed (FIG. 1). In addition, two rapidity ranges were considered and no significant dependence of the suppression with rapidity was observed (FIG. 2). The $\Upsilon(1S)$ $R_{\rm AA}$ as a function of both rapidity and centrality was found to be comparable with that observed for the J/ψ measured by ALICE in the same kinematic range. The interpretation of this observation is not straightforward due to the different amount of feed down from higher mass states and to the presence of a recombination contribution for the J/ψ. The $\Upsilon(1S)$ $R_{\rm AA}$ was also compared to CMS results for the kinematic range $|y| < 2.4$. A similar behaviour can be observed both as a function of centrality and rapidity. This measurement suggests a rather small rapidity dependence of the inclusive $\Upsilon(1S)$ suppression over the present range accessed by the two experiments. In addition, theoretical predictions [3] based on a plasma description by means of an anisotropic hydrodynamic formalism and including a suppression component for rather weakly bounded bottomonia were found to reasonably describe the data (FIG. 3). Another model [4] taking into account a suppression and a small regeneration component for strongly bound bottomonia in an ideal fireball also provides a good prediction of the centrality dependence observed for inclusive $\Upsilon(1S)$ (FIG. 4).

Acknowledgments

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References

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