Suppression of charmonia states present in Pb+Pb compared to pp collisions at 5.02 TeV with the ATLAS detector

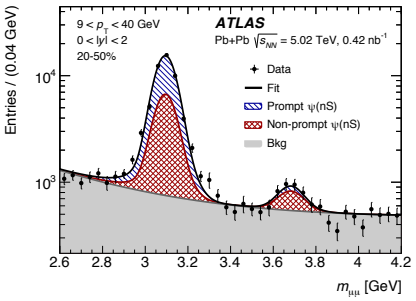
Sebastián Tapia for the ATLAS collaboration

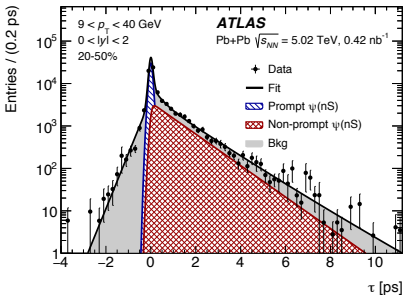
Universidad Técnica Federico Santa María, Valparaíso, Chile

The suppression of heavy charmonia states in relativistic heavy-ion collisions is a phenomenon related to the formation of the Quark Gluon Plasma. This new state of matter can be produced in interactions of heavy ions at high energy. A full assessment of the charmonium production requires a detailed study of the effects present in Pb+Pb compared to pp collisions. A more detailed description of these results may be found in arXiv:1805.04077.

Data analysis

This analysis uses data from Pb+Pb and pp collisions at a nucleon-nucleon centre-of-mass energy of 5.02 TeV recorded by ATLAS in 2015. The measurement is done in the dimuon decay channel, selecting muons with $p_T > 4$ GeV and $|\eta| < 2.4$. Charmonium candidates are required to have opposite charge, $p_T > 9$ GeV, $|y| < 2$ and $2.6 < m_{\mu\mu} < 4.2$ GeV. The pseudo-proper decay time, $\tau = L_{XY} * m_{\mu\mu}/p_T$, is used to distinguish between prompt and non-prompt charmonium production. The yields are extracted with a 2D fit to the invariant mass and pseudo-proper decay time distributions corrected for muon trigger and reconstruction efficiencies, and J/ψ acceptance.





Observable

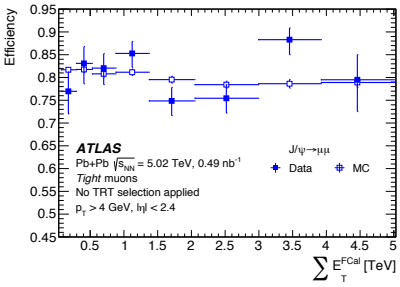
The suppression of charmonium states is quantified by the nuclear modification factor, R_{AA}, which is defined for a given centrality class as:

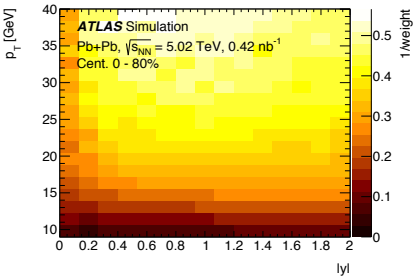
$$R_{\mathrm{AA}} = \frac{N_{\mathrm{AA}}}{\langle T_{\mathrm{AA}} \rangle \cdot \sigma_{pp}}$$

where the N_{AA} is the per-event yield measured in Pb+Pb collisions, $\langle T_{AA} \rangle$ is the mean nuclear thickness function and σ_{pp} is the cross section for the production of the corresponding charmonium states in *pp* collisions at the same energy.

ATLAS performance

The acceptance of a ψ(nS) decaying into *μμ* was obtained from MC simulation and is defined as the probability that both muons fall within the fiducial volume $p_T > 4$ GeV, $|y| < 2.4$. Trigger and reconstruction efficiencies are calculated using the tag-and-probe method. The muon reconstruction efficiency was found to have a non-negligible dependence on the centrality of the collisions.

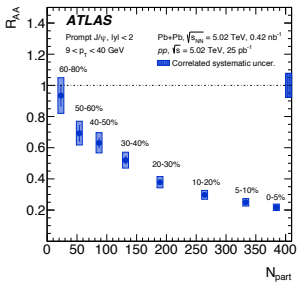


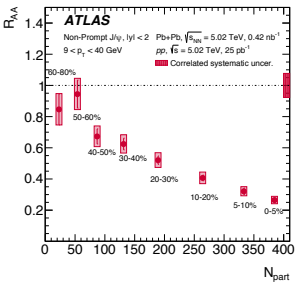


Results

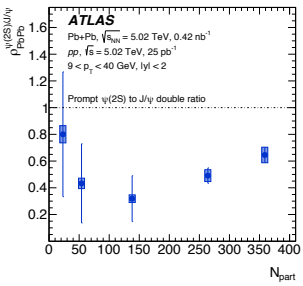
Charmonia states are found to be strongly suppressed; ψ(2S) is more strongly suppressed than J/ψ. Prompt J/ψ R_{AA} increases with p_T in a way that is similar in shape and magnitude to that which is observed for charged particles and D-mesons. It is not clear if the enhancement is due to energy loss effects or a transition between color screening and color transparency.
The non-prompt ψ(2S) to J/ψ R_{AA} ratio is consistent with unity, suggesting both particles originate from b-quarks hadronising outside of the medium. The prompt ψ(2S) to J/ψ RAA ratio shows an enhancement in central collisions, supporting the idea of ψ(2S) being readily produced by regeneration.

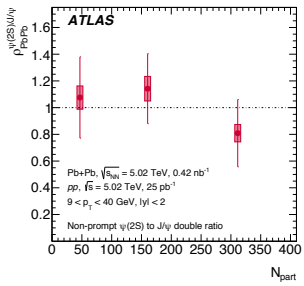
J/ψ R_{AA} as a function of centrality



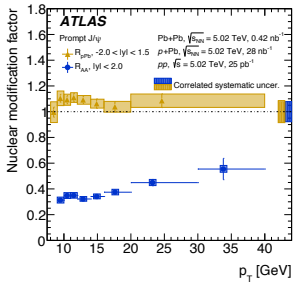


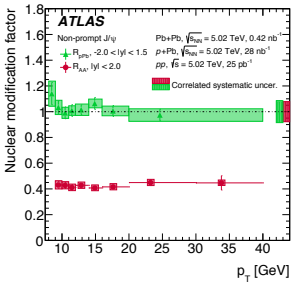
ψ(2S) to J/ψ R_{AA} as a function of centrality





A clean window for hot matter studies





High p_T universality, screening or energy loss?