Master 2 training - (Feb. - May 2022)

Measurement of inclusive quarkonium production in p–Pb collisions at $\sqrt{s_{NN}} = 8.16$ TeV with ALICE

Laboratoire : Laboratoire de Physique de Clermont-Ferrand (Université Clermont Auvergne - CNRS/IN2P3)

Supervisors : P. Crochet (crochet@clermont.in2p3.fr) and X. Lopez (lopez@clermont.in2p3.fr)

The study in detail of the properties of the quark–gluon plasma (QGP) in heavy-ion collisions is one of the main goals of A Large Ion Collider Experiment (ALICE) [1] at the Large Hadron Collider (LHC).

Quarkonia are bound states of either a charm and anti-charm quark pair (charmonia, e.g. J/ψ, χ_c and ψ(2S)) or a bottom and anti-bottom quark pair (bottomonia, e.g. Υ(1S), Υ(2S), χ_b and Υ(3S)). They are sensitive probes of color deconfinement via quantum chromodynamics Debye screening [2] as they are produced in initial parton-parton interactions and experience the full medium evolution. Quarkonia suppression due to the QGP must be disentangled from that due to cold nuclear matter (CNM) effects, such as nuclear modification of the parton distribution functions [3] as well as parton energy loss [4]. These effects were studied with bottomonium production in p–A collisions by ALICE [5] and reported that Υ(1S) yields are slightly lower than the binary-scaled yields extrapolated from pp collisions in the p-going forward direction.

This research training aims first to learn how to reconstruct quarkonia decaying into two muons in the ALICE muon spectrometer with p–Pb data at $\sqrt{s_{\rm NN}} = 8.16$ TeV. Quarkonia signal extraction as well as the estimation of the associated systematic uncertainties will complete this first part. In a second step, a preliminary bottomonium production cross section will be estimated by means of a realistic simulation of the detector. This, compared to the corresponding cross section in pp collisions will allow to discuss the importance of CNM effects. Finally, the new software developed in ALICE for the analysis of the LHC Run 3 data will be implemented and operated.

The work will be developed by using C++ programmable language under the ALICE software (AliRoot [6]). A good knowledge of C ++ is required and knowledge of Root is an advantage.

References

[1] K. Aamodt *et al.* (ALICE), *JINST* **3** (2008) S08002.

[2] T. Matsui and H. Satz, *Phys. Lett.* **B178** (1986) 416–422.

[3] D. de Florian, R. Sassot, P. Zurita, and M. Stratmann, *Phys. Rev.* **D85** (2012) 074028, arXiv:1112.6324 [hep-ph].

[4] M. Hirai, S. Kumano, and T. H. Nagai, *Phys. Rev.* **C76** (2007) 065207, arXiv:0709.3038 [hep-ph].

[5] B. B. Abelev *et al.* (ALICE), *Phys. Lett.* **B740** (2015) 105–117, arXiv:1410.2234 [nucl-ex].

[6] http://aliweb.cern.ch/Offline/AliRoot/Manual.html