Thesis abstract Andrea Tavira Garcia

"Single and double charm production in pp collisions at $\sqrt{s}$ = 13.6 TeV with ALICE"

The ALICE experiment at the Large Hadron Collider (LHC) is dedicated to the study of the Quark-Gluon Plasma (QGP), a state of matter in which quarks and gluons, the fundamental constituents of nuclear matter, are deconfined. Quantum Chromodynamics (QCD) predicts a phase transition from ordinary nuclear matter to the QGP at an energy density of approximately 1-2 GeV/fm^3 and a temperature of around 200 MeV. It is believed that the Universe underwent such a phase a few microseconds after the Big Bang. Ultra-relativistic heavy-ion collisions provide a unique opportunity to recreate in the laboratory the extreme conditions necessary to form the QGP. The resulting medium behaves as a quasi-perfect liquid composed of strongly coupled partons.

Among the key observables used to probe the QGP are hard probes, which originate in the early stages of the collision and traverse the entire medium, thereby offering insight into its evolution. This thesis focuses on measuring fundamental perturbative QCD (pQCD) processes, which serve as a reference for interpreting results from Pb--Pb collisions. All D-meson candidates used in this thesis are selected using Machine Learning techniques and using Run 3 data from the ALICE experiment. This dataset is significantly larger and includes more comprehensive sub-detector information compared to previous runs.

The thesis explores beauty-hadron production in ultra-relativistic hadronic collisions, which is a fundamental test of pQCD and hadronisation models. One approach to studying beauty quarks involves measuring non-prompt D mesons, which originate from the decays of B hadrons. The fraction of non-prompt D^0 mesons is measured in pp collisions at $\sqrt{s}$ = 13.6 TeV. The preliminary results of the non-prompt D^0 fraction are compared to theoretical predictions, which do not fully reproduce the experimental data.

The impact of multiple parton interactions (MPI) on the production of double D^0 mesons, composed of a charm and a light quark, is also investigated. MPIs are one possible explanation for the existence of QGP-like signatures that have been found in high-multiplicity proton-proton and proton-nucleus collisions. These signatures include an enhancement of the strange hadron production with multiplicity and the existence of non-zero azimuthal anisotropy coefficients. Our analysis includes the study and comparison of the production of two like-sign D^0 mesons (mainly produced via MPIs) and two opposite-sign D^0 mesons (mainly produced in a single parton-parton collision). The integrated and transverse-momentum-differential cross sections of the double D^0 mesons are measured for the first time in ALICE, and the ratio of like-sign to opposite-sign D^0 mesons is calculated.

In addition, the thesis presents preliminary studies on the muon tracking efficiency in the muon chambers for the Pb--Pb data collected in 2023. These studies are essential for understanding the performance of the muon chambers in Run 3 and for ensuring the accuracy of the measurements involving muons in heavy-ion collisions.