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Evaluation report PhD thesis Vít Kučera

The PhD work of Vít Kučera presents an experimental analysis of data collected by the CERN ALICE collaboration in lead-lead (Pb-Pb) collisions at center-of-mass energies $\sqrt{s_{NN}}$ = 2.76 TeV. The work focuses on the study of the production of strange hadrons inside jets, as a means to understand the mechanisms of parton energy loss (also known as « jet quenching ») and parton hadronization in the Quark Gluon Plasma (QGP) formed in these collisions. The main result of the PhD work of the candidate is the measurement of the transverse momentum (p_T) spectra of Λ baryons and K^0_s mesons produced inside charged jets reconstructed using charged-particle tracks with the anti-k_T algorithm. He finds the interesting result that the ratio of production of strange baryons (Λ) compared to strange mesons (K^0_s) inside jets in PbPb collisions ressembles that measured for inclusive strange hadrons in proton-proton (p-p) collisions. This result is clearly at variance with the strong Λ/K^0_s enhancement, with respect to p-p, observed in inclusive production in PbPb collisions, and points to the important fact that the final hadronization of high-p_T partons into (strange) baryons and mesons is not seemingly affected by the QGP. The result is truly innovative and interesting –in particular, it sheds new light into our understanding of two competing mechanisms for hadron production inside the QGP: parton fragmentation versus parton coalescence. The analysis seems robust, and the thesis is appropriately written.

The thesis is organized as follows. Chapter 1 outlines the basic concepts of the thesis including: the theory of the strong interaction, the study of the QGP in heavy-ion collisions, the production of jets (including jet reconstruction and the phenomenon of jet quenching), and the different hadronization mechanisms (parton fragmentation and parton coalescence) in the QGP. Chapter 2 describes the ALICE experiment, its main detectors and performances, as well as the reconstruction of primary and secondary vertices and full tracks, and the determinaton of the PbPb reaction centrality. Chapter 3 presents the hardware service task carried out by the PhD candidate consisting in the characterization tests for determining the performance of prototypes of the ALPIDE chips designed for the upgrade of the tracking detectors of the experiment. In Chapter 4, he describes the data analysis including reconstruction of the strange particles (Λ, K^0_s), reconstruction of jets, association of particles with jets, application of corrections to the spectra, and evaluation of the associated systematic uncertainties. The results of the analysis are presented in Chapter 5 where the final spectra of neutral strange particles in jets and associated baryon-to-meson (Λ/K^0_s) ratios are presented, described, interpreted and compared with results of other related analyses. Finally, the conclusion summarizes the whole analysis and its main findings.

The data analysis presented in this thesis, as well as the hardware work with prototypes of the ALPIDE chips for the upgrade of the tracking detectors of the ALICE experiment, are interesting, timely and innovative. The reconstruction algorithms used in the work are based on state-of-the-art tools, and the final results obtained are important for the clarification of the mechanisms of parton hadronization (and associated high-p_T meson and baryon formation) in the QGP. The results of this PhD provide interesting and novel insights for our understanding of the physics of the collective behaviour of systems interacting via the strong force, described by the theory of Quantum Chromodynamics, as studied with heavy-collisions at the CERN LHC.

In my opinion, the work presented by Vít Kučera makes good contributions to justify the award of the joint-doctorate of the Strasbourg University and Charles University (Prague). I thereby declare my favourable opinion for the public defence of this PhD study.

With my best wishes,

Dr David d'Enterria
Senior research physicist (Cat. I)

Geneva (Switzerland), 20 October 2016