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Review Report on Master's Thesis of

Jakub Kubát

entitled

„Reconstruction of Strange Hadrons in Collisions of Nuclei at RHIC"

The study of the properties of matter at extreme temperatures and densities is of great importance for a more accurate interpretation of quantum chromodynamics, as well as for understanding the evolution of the universe immediately after its creation, and the behavior of stars at the final stage of their evolution. This became possible with the construction of accelerator facilities such as CERN (Switzerland) and RHIC (USA) and the future facility FAIR (Germany). Experiments with heavy ions such as ALICE (CERN), STAR (RHIC) and CBM (FAIR) make it possible to investigate these properties in detail in laboratory.

This study imposes huge demands on both the detectors and the algorithms for processing experimental data. For a detailed investigation of nuclear collision processes at relativistic energies, the detectors must operate at high loads and the algorithms must process the data with maximum speed and high efficiency.

The physics under study is often hidden in the properties of short-lived particles that do not even reach the detection systems. In this case, they have to be reconstructed by their decay products, which are already in the detector acceptance and can be registered and their trajectories reconstructed. To solve the problem of search and reconstruction of short-lived particles, the KF Particle Finder package of algorithms was developed. Its advantage is the reconstruction of short-lived particles in the same form as their decay products. This allows all particles to be naturally combined into long decay chains. In addition, the use of the Kalman filter provides mathematically correct estimation of both particle parameters and accuracy of

these parameters. The package is also adapted for operation on modern parallel computer architectures, which makes it fast.

In the master's thesis of Mr. Kubát KF Particle Finder package is used to reconstruct strange hadrons produced in the collisions of heavy ions in the STAR experiment on the accelerator facility RHIC (BNL, USA).

The thesis consists of 7 chapters. The first chapter gives a brief introduction to the problem, as well as sets goals and gives an overview of the content of the chapters. In the second chapter, the basics of quantum chromodynamics (QCD) and the experimental features of quark-gluon plasma (QGP) detection are given and the QCD phase diagram and the STAR Beam Energy Scan (BES) program are discussed. The third chapter is devoted to the RHIC accelerator facility as well as a detailed description of the STAR experiment detector system and the features of online processing in the High Level Trigger (HLT). Chapter four discusses the principles of reconstruction of short-lived particles with the KF Particle Finder package. Chapter five summarizes the features of Multivariate Analysis and Boosted Decision Tree, which are used for further analysis. Chapter 6 deals with the reconstruction of strange hadrons with the KF Particle Finder. The search for Λ at the collision energies of gold nuclei of 27 GeV with express and standard data production and 14.6 GeV with express data production only is discussed. In the second case, the detector was improved to iTPC, which increased the detector's acceptance with respect to low momentum particles. Much attention is also paid here to determining the reconstruction efficiency of strange hadrons. The chapter briefly analyzes data obtained in a fixed target mode at 3.9 GeV and processed in the express stream on the HLT cluster. Such analysis of physics obtained in both collider and fixed target modes became possible due to the universal approach provided by the KF Particle Finder package. The seventh chapter summarizes the work done.

The master's thesis of Mr. Kubát is well structured and written in clear language with sufficient amount of details. The work can be read easily and with interest. The study of reconstruction of strange baryons on the example of Λ shows a high level of understanding of the underlying physics, the STAR detector setup, as well as a very solid knowledge of the KF Particle Finder package and other data processing and analysis tools. Essentially, the use of the KF Particle Finder made it possible to reconstruct Λ down to very low transverse momenta, which was previously impossible with standard approaches. It is also important to note that the work on calculating the efficiency of strange hadrons is complicated and time consuming, requiring understanding of all stages of processing both simulated and real data. I should also note that working with data online with incomplete calibration requires great care and attention during analysis.

Finally, I evaluate the master's thesis of Mr. Kubát with the grade A (excellent).

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