Physics of elementary particles describes a behavior of tiny, invisible particles, quarks and leptons, which are called fermions and particles responsible for the interactions, called bosons. There is also a Higgs boson, which takes part in a process of giving mass to particles. The LHCb is the detector placed in the Large Hadron Collider (LHC) which is dedicated to search for particles containing beauty and charm quarks. The aim of this project is to analyse decay of beauty meson B^0 to kaon (K^+), pion (π^-), muon (μ^- - the heavier counterpart of the electron) and antimuon (μ^+). Presented analysis will be based on the data collected by the LHCb experiment in 2016, 2017 and 2018 where protons collided with each other at the center of mass energy of 13 TeV (teraelectronovolts).

The main reason for carrying such a research is the fact that the Standard Model of elementary particle physics is not a final theory. It does not describe gravity and does not provide any information about so-called dark matter. It also does not explain why in the Universe is much more matter than antimatter. According to the theory of the Big Bang matter and antimatter should be produced equally. Many analyses that have been performed have shown that the Standard Model predictions do not always overlap with experimental results. Some anomalies have appeared in the rare decays of beauty mesons B^0 which are not present in ordinary matter, however they can be produced in very energetic particle collisions. This meson is made of quark-antiquark pair (up quark and b antiquark). It is an unstable particle, which means it decays very rapidly and this decay can proceed on very various ways. In one of the scenarios B^0 decays to K^{*0} (down quark and strange antiquark pair, which decays to kaon and pion) and muon-antimuon pair. Last analysis of this decay, carried out by the researchers from the LHCb experiment, has shown some deviations from the SM expectations. That means that broader research of this decay may contribute to the discovery of New Physics Beyond the Standard Model (BSM). Similar anomalies were also observed for almost identical decay of charged B^+ meson. Scientists discovered also so-called lepton universality violation effect. The SM treats all charged leptons (electrons, muons and tau leptons) equally, they differ in masses only. However analysis of the $B^+ \to K^+\ell^+\ell^-$ decay, where ℓ can be electron or muon have shown that electron final state are more frequent than final state with muons. The question is, what is the cause of those anomalies? According to some propositions new, unknown particles like Z' boson or leptoquarks could be responsible for observed measurements discrepancies.

Presented analysis of the $B^0 \to K^+\pi^-\mu^+\mu^-$ decay will be focused on the higher invariant mass range of $K\pi$ system (1430 MeV/c^2), in comparison to most of other analyses which are concentrated on the 892 MeV/c^2 $K\pi$ invariant mass. The first stage of the analysis will be proper division of data sample, because the signal candidates are also accompanied by background events such as those with misidentified particles. After the signal extraction it will be possible to determine the number of signal events which is necessary for branching fraction calculation, which is the ratio of the number of searched decays to the number of all B^0 decays. It will be calculated as a function of invariant mass squared of a muon pair (q^2). The angular analysis of final state particles, which is a study of how particles propagate in a detector, can tell a lot about the B^0 decay. Except for decay angles, decay is described by a number of measurable quantities (observables), which can be compared to the SM predictions. Quantities of those observables could be modified by the presence of new, unknown particles. With data collected in years 2016-2018 it is expected that measurement precision will increase with respect to the previous analysis. Owing to the continuous improvement of the LHC accelerator and to sequential increase of the amount of data, analyses of the corresponding decay will be much more precise, and it grant a better verification of various hypothesis. From 2018 to early 2022(planned) the LHC was shut down in order to perform a broad modernization of the whole accelerator and all experiments within it, before the start of the third operation stage (Run3). Due to this improvements LHCb experiment will be able to increase the amount of collected data as well as the data precision. There is a plan to build bigger accelerators in the future, such as the FCC (Future Circular Collider), where collision energies would be up to 100 TeV. There is a possibility that such a high collision energy could allow to the direct observation of BSM particles, which now present LHC cannot detect due to their high mass. We are living in a very interesting times, where new discoveries are at our fingertips, and after this achievement our perspective of the world will not be the same again.