[Objective of the project]
One of the, so called, high energy "Great Experiments" that are currently operating at the LHC (Large Hadron Collider) is LHCb (Large Hadron Collider beauty). This experiment, in contrary to its other counterparts such ATLAS or CMC, is searching for New Physics phenomena in indirect manner by careful studies of rare decays of beauty and charm mesons.

The purpose of this project is related to the life cycle of a typical HEP (High Energy Physics) experiment - firstly physicists make a project the detector, which is fundamental ingredient of the experimental work, next there is a construction and comissioning step after that the data can be taken. At this very moment the next cycle begins which is the modernisation of the current detector and expansion of the physics mission of the experiment. The upgrade of the current detector is ongoing, this step is necessary to operate the LHCb spectrometer beyond 2019 where the first upgrade campaign of the large detectors is foreseen. The submitted proposal contains a list of software tasks that are necessary for operation of the tracking detectors of the upgraded LHCb detector as well as description of proposed contribution to testing of the future devices able to perform precise charge particles tracking. Such devices could be used in next generation HEP experiments or in various applied fields such as imaging for the medicine. It should be stressed that joining the upgrade effort of the LHCb detector by the Krakow group at this time is absolutely necessary to allow further collaboration and access to the data collected by the modernised spectrometer. Also, participation in the upgrade process will secure the continuation of leading role of the group from AGH in the LHCb Collaboration.

[Research plan]
The tasks assigned to the AGH group can be divided into two general categories - design and implementation of the software necessary for operation and running the modernised LHCb experiment and participation in test beam experiments that are vital for testing new silicon sensors design dedicated for the future HEP experiments or possible spin-offs such medical applications. It should be stressed that the software that we are going to supply is absolutely vital for correct operation of the modernised LHCb experiment.

The description of the intended research that will be carried out is described in the following text. Firstly we will be working on a brand new package for ionising radiation interaction with silicon simulation. This is absolutely critical part for simulated track reconstruction procedure of the modernised spectrometer. Generic software platform for emulation, calibration and monitoring of the silicon tracking pixel detector VELO II (VELO - Vertex Locator - is the vertex detector of the LHCb experiment) is another example of vital contribution of the Krakow group to the detector upgrade. Without such software it would not be possible to take collision data with the VELO II detector. Finally, participation in test beam experiments is both necessary and regardes as very prestigous by the LHCb Collaboration. Such test beams are critical part of the upgrade process where new devices can be tested in realistic environment, i.e., with particle beam, readout electronics and DAQ system (Data Acquisition System). Such test beam experiments are invaluable for introducing master and PhD students into the world of partilce physics and teach them the team work.

[Motivation]
Each "Great Experiment" that operates at LHC machine uses a complicated detection system to collect data that are subsequent exploited to perform physics analysis. LHCb spectrometer comprises of a large number of sub-detectors (such as the VELO) which must be supervised and operated by highly trained experts. In a sense, each such sub-detector may be regarded as small experiment within LHCb. Each group that belongs to the LHCb Collaboration should paricipate in running the detector. Members of the AGH group are regarded as experts in silicon response simulation, emulation of the readout electronics, calibration and monitoring of the silicon based detectors. The AGH group, for many years, take part in preparation and running of various test beams. Continuation of this activity for the upgrade project should be treated as a natural step that allow to maintain our leading position in the experiment and give a chance to even further expand the knowledge acumulated by the group. At the same time participation in such studies are required in order to secure our further membership in the LHCb Collaboration and access to the data collected by the upgraded detector.

This set of activities - related to the detector - is complementary to the other tasks related to the physics analyses which are not included in this proposal. This complementary work is very desirable for development of master and PhD students which are given opportunity to work at the best particle physics laboratory in the world, interact and collaborate with large teams of sciencists. The can learn and design high quality and robust software and take part in designing ang testing the latest types of semiconductor devices used for particle detection. Such experience give them also opportunity to pursue cariers outside the field of particle physics which also should be noted here.