DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

Standard Model

The Standard Model (SM) is a theory, which describes fundamental constituents of matter and interactions between them. We distinguish two types of elementary particles. First of them are fermions, which build up the matter. Among them are leptons (there are 6 fermions in SM for example. Electron) and quarks (there are 6 quarks in SM) , which build up hadrons (for example proton, neutron). They can not be directly observed as the interactions between them do not allow them to be free. Each particle has its antiparticle. When they meet together, they annihilate and produce energy, which can be used to create new particles. The second type of particles are bosons, which are responsible for interactions. They are exchanged between interacting fermions. We can distinguish three kinds of interactions:

1. Electromagnetic interaction (intermediate boson is massless photon)
2. Weak interaction (intermediate bosons are massive W^+, W^- and Z bosons)
3. Strong interaction (intermediate bosons are massless gluons)

The Standard Model does not describe gravitational interaction. The last constituent of this model is Higgs boson, which was discovered in LHC (Large Hadron Collider) in 2013. It is a particle, which give the mass to fermions and W^+, W^- and Z bosons. Despite finding the last missing element of this theory, one can still observe potential discrepancy between Standard Model and experimental measurements. Extension of the Standard Model is necessary. Since it does not explain baryogenesis and what is dark matter and dark energy. For these reasons, there exist many theories, which by adding new elements, are trying to explain these issues for example Supersymmetric Model.

How to search physics beyond the Standard Model?

One of the possibilities of seeking confirmation of new theories is continuous increasing of the energy of accelerators. It allows for search of new heavier particles. Other, complementary to LHC, methods are based on precise measurements, which allow for searching for discrepancy between measured quantities and theoretical predictions. One of them is the anomalous magnetic moment of the muon $(g-2)_\mu$, where relatively big discrepancy, between theoretical predictions and experiments is observed. Yet, the experimental precision and the precision of theoretical calculations is not good enough to be sure the observed difference is caused by effects coming from the physics beyond the Standard Model. To answer this question one has to increase the precision of the measurements and calculations. The Monte Carlo generators, which simulate physical processes are used to analyze of the data. The error of the simulations has impact on the experimental error, so it is important that the precision of the simulations is better than the achieved in the experiments. Increasing of the precision can be obtained by including effects of so called radiative corrections. These effect are call radiative corrections. New effects connected with new particles can be observed through these corrections, because their masses and couplings can be different from the Standard Model predictions. Testing the extensions of the Standard Model involve not only the data obtained by LHC but also precise determination of $(g-2)_\mu$. Precisely, the complementing of the data collected by LHC with measurements of anomalous magnetic moment of the muon allows for finding better restrictions of parameters of new models.

The objective of this project is to calculate radiative corrections for the process of annihilation of electron-positron to hadrons (process $e^+ e^- \to$ hadrons), which have never been done before. These corrections will be implemented in Monte Carlo event generator Phokhara, which currently is used by all existing experiments. These generator will help experimental collaborations for more precise measurements of the process $e^+ e^- \to$ hadrons. Accurate measurement of this reaction is important for precise determination of anomalous magnetic moment of the muon, which helps in searching of physics beyond the Standard Model.