## DESCRIPTION FOR THE GENERAL PUBLIC

Particle physics provides a description of elementary matter building blocks and their fundamental interactions, so it belongs to basic research. It has witnessed a lot of quantitative progress in the last decades: a common description of three fundamental forces of nature (electromagnetic, strong and weak) acting between quark and leptons, which constitute the elementary building blocks of matter. This description, labelled as "the Standard Model" (SM) allows to predict the behaviour of matter at subatomic scales with the precision reaching sometimes to over a dozen decimal numbers. Thus the Standard Model describes very precisely features of the physical world starting e.g. from electric phenomena in our smartphone, through the properties of atoms and nuclei, reaching interactions of quarks and leptons in the hot early Universe. This successes of the SM is now crowned with the discovery of the Higgs boson at CERN's LHC collider in 2012. The Higgs particle is responsible for giving masses to quarks, leptons, and heavy carriers of the weak interactions. The SM exhibits a limited range of applicability. It is expected that it will be extended and/or absorbed by a more general description of physics reality. This extension named as "New Physics" is crudely described by a very broad class of theoretical models. Many of them predict the existence of new particles with new properties. Some models of New Physics assume that fundamental objects are not pointlike or that we exist in a space with more than three dimensions. Each of these theories aims at the elimination of at least some problems of the SM. The biggest enigma of modern cosmology is that matter described in the framework of the Standard Model contributes to only 5% of the mass of the Universe. The SM also cannot provide an explanation how in the primordial Universe the surplus of matter over antimatter was created and does not solve the puzzle why fundamental building blocks of matter occur in three sets, exhibiting similar properties and differing in mass. The ultimate answer to the above problems of modem particle physics can be delivered only by experimental studies. It is expected that an important role will be played by experiments at electron-positron colliders. These accelerators, thanks to cleaner final states and higher precision of the measurements than in proton colliders (like LHC) can provide information about small deviations of certain carefully chosen observables from the values predicted within the Standard Model. These small deviations require from researches not only a substantial effort in improving experimental precision, but also very high precision of theoretical calculations and realistic computer modelling of the collisions.

**The main aim of the project** is to study theoretical and experimental uncertainties in determining observables sensitive to the presence of the New Physics in the planned electron-positron colliders, where they could be measured up to a factor 10-100 more precisely than in the past. This kind of colliders are planned in Europe in CERN and also in China and Japan. Their main task will be to search for signals of New Physics as deviations of the very precisely measured experimental data from theoretical predictions of the SM. The precise experimental data will be useless unless the theoretical precision (uncertainty) of the SM calculations is comparable to that of the data! The precision evaluation and improvements of the SM calculations in the research of the project will be done for (1) muon pair production near the Z peak with the aim of deducing the strength of the electromagnetic coupling at distances 100 times smaller than the size of proton (2) discovery of a new “sterile” neutrino as a tiny effect in the decay of the Z boson accompanied with energetic photons (3) discovery of forbidden transitions between electron, muon, and tau leptons in the decays of Z bosons and tau leptons. Each of these measurements may shed light on New Physics beyond the SM. Studies of the project aim to prove that the usefulness of such measurements in future electron colliders is not inhibited by insufficient knowledge of the SM predictions. All new results of the research will be published in scientific journals. Most of them will also enter into the Conceptual Design Report of the Circular Future Collider (FCC), to be completed in CERN in the year 2019, the year of the decision about the construction of the next collider at CERN.