The Standard Model (SM) of particle physics is the fundamental theory describing all known elementary particles and interactions between them. Almost all the SM predictions are already confirmed experimentally. In 2012, the last missing constituent of the SM, the so-called *Higgs boson*, was discovered. The confirmation of the existence of this particle, predicted already in the sixties, completed our picture of physics on the tiniest of scales. This milestone in our understanding of the Universe was achieved by the ATLAS and CMS experiments, operating at the Large Hadron Collider (LHC) at CERN, near Geneva. The LHC is the largest accelerator facility in the world; it allows to accelerate protons to speeds very close to the speed of light. As described by Einstein's mass-energy equivalence principle, $E = mc^2$, huge energies of colliding protons allow producing new massive particles. The ATLAS and CMS detectors at the LHC have been built using the most advance technologies to measure such states, giving a unique input to our knowledge of particle physics.

Despite SM predictions being confirmed with high accuracy, there are many indications that it is not the ultimate "theory of everything". The most convincing arguments come from cosmological observations. For instance, the SM cannot explain the origin of the so-called *dark matter*, or the observed excess of the matter over antimatter in the Universe. For those and several other reasons, physicists try to *extend* the fundamental theory by adding new particles and interactions to those currently known.

Unfortunately, during many years of research at the LHC, not a single particle nor any effect beyond the SM (BSM) have been observed, although many promising theories predict the existence of particles with masses in the energy range of the LHC. This may be caused by the characteristic of the interactions between protons (and, more precisely, their components, quarks and gluons), producing an overwhelming number of particles uninteresting from the scientific point of view, making the distinction between new and SM particles extremely difficult. On the other hand, the new particles might not interact directly with the proton components, and therefore, they could be produced rarely.

To take full advantage of the Higgs boson discovery, the particle physics community agreed on the necessity of further studies of its properties. This could be achieved by building a new huge machine, colliding electrons with their antiparticles, positrons. Such a worldwide successor of the LHC would offer a complementary approach allowing not only for very precise measurements of known particles but also for new particle searches. In such experiments, with leptons being sensitive to electromagnetic and weak interactions only, one could observe particles and processes undetectable at the LHC. Four Higgs Factory projects are currently being considered: Future Circular Collider (to be built at CERN), Circular Electron-Positron Collider (China), International Linear Collider (Japan) and Compact Linear Collider (CERN). Despite technical differences in their design, each of those colliders would give a significant contribution to our knowledge of particle physics. Nevertheless, all these projects are still under development. One of the issues that should be addressed is realistic simulation of exotic processes which could be potentially observed at the future colliders.

As long as future colliders are not ready for data taking, each analysis of their performance has to rely on simulations. First, one has to generate large pseudo-data sets: simulated event samples reflecting our knowledge about possible interactions between colliding particles. For example, in an $\mathrm{e}^+\mathrm{e}^-$ collision, a pair of muons can be produced. At this stage, it is essential to estimate how often such a process can occur and what is the muons kinematics. This information should be processed to reflect experimental effects, e.g. measurement accuracy. Only then, reliable analysis of future machine discovery reach can be performed. Even though the procedure is well-established, both the event generation and the detector simulation require further improvements.

In the project, we would like to address issues connected with the reliable simulation of physical phenomena. First, we want to focus on processes involving photons. According to theoretical predictions, some important phenomena can be initiated by photons emitted from incoming electrons and positrons. If the photons have low energies, additional corrections need to be taken into account and the simulation can take a long time. To avoid this problem, the Equivalent Photon Approximation, the theoretical concept allowing to hide the real origin of photons, can be used. The idea was already presented almost one hundred years ago but a specific implementation to energies of future $\mathrm{e}^+\mathrm{e}^-$ colliders is still missing. We want to fill the void and incorporate the proper description to Whizard, one of the most popular event generators.

The second part of the project will concern the simulation and reconstruction of exotic processes. In light of no BSM particle observation, scientists came up with the concept of Feebly Interacting Massive Particles (FIMPs). The majority of standard searches assume that the BSM particles decay immediately and we can rely on measuring the tracks and energies left in detector by the products of these decays. On the contrary, the FIMPs could travel large distances in the detector before a decay and the observed tracks would not originate from the electron-positron collision point, as in a "typical" case. However, the standard algorithms, used to recreate the tracks and their origin, were not initially designed for such events. In this project, we want to address such issues (and other possible, caused by the exotic processes) by testing and improving the existing algorithms.