Fundamental constituents of matter can interact with each other in a variety of ways. Four fundamental interactions have been identified so far: electromagnetic, weak, strong and gravitational. There exist a quantum theory for the former three interactions known as the Standard Model, whose predictions have been verified by a great amount of various experiments. Nevertheless, there are many indications that the Standard Model is only an effective theory valid only at sufficiently small energies. One of them is that it does not provide quantum description of gravitational interactions which is described, at classical level, by Einstein's General Relativity. It is expected that quantum gravitational phenomena appear around the Planck mass of about 10^{19} GeV. The Standard Model has also several phenomenological problems including the lack in its particle spectrum of dark matter candidate that would be responsible for a quarter of the total energy of the Universe or incapability of explaining why there are different amounts of matter and antimatter in the Universe. These drawbacks of the Standard Model motivate a lot of physicist to construct its extensions.

There exist many models that solve most of the problems of the Standard Model but none of them has been confirmed by experiment. Moreover, there are many examples of models solving most problems of the Standard Model without implying significant deviations from predictions of the Standard Model at sufficiently small energies to be observed in experiments in foreseeable future. However, there is one exceptional problem of the Standard Model solution to which requires existence of new particles with masses not far above the scale of the electroweak symmetry breaking of order 100 GeV, i.e. the scale above which electromagnetic and weak interactions are unified. This problem is caused by the presence in the Standard Model spectrum a particle with spin 0 - the Higgs boson which was recently discovered at experiments performed at the LHC accelerator located at CERN near Geneva. From the theoretical point of view typical mass of the Higgs boson is of the order of the Planck mass of 10^{19} GeV, while the measured Higgs mass is about 125 GeV. Avoiding this great disparity requires appropriate extension of the Standard Model with new particles whose mass does not exceed much the scale of the electroweak symmetry breaking.

In spite of the intensive LHC searches particles responsible for smallness of the Higgs mass as compared to the Planck mass have not been found. However, it does not imply that such particles do not exist. It is perfectly viable possibility that they have not been properly searched for. The latter interpretation of the LHC results seems quite plausible given the high level of complexity of the LHC experiment, in which millions of proton collisions occur every second, and one has to know what to look for in order to find it. In other words, a theoretical framework is indispensable to interpret the experimental data. Since experimental searches for signatures of proposed models aiming to explain the large hierarchy between the Higgs mass and the Planck mass haven't lead to discovery of new phenomena it is necessary to construct alternative models whose experimental signatures differ from those that have been proposed previously. The main objective of this project is to build such alternative models and identify the best methods to confirm them experimentally. This is particularly important now when the LHC enters the next phase of operation and future search strategies for new particles are under discussion.