In our current understanding of fundamental interactions, processes involving elementary particles are described by quantum field theory (QFT). Scattering amplitudes are one of the most crucial objects in QFT since they are the connection between the theoretical predictions and the experimental measurements performed at the particle colliders, for example at the Large Hadron Collider (LHC) near Geneva. Scattering amplitudes are basic ingredients used to determine the probabilities of different scattering processes occurring at the particle colliders. In order to have a thorough understanding of particle physics, it is necessary to develop efficient methods of calculating scattering amplitudes at an exquisitely precise level.

The present project focuses on the pure gluonic sector of Quantum Chromodynamics (QCD) which contributes significantly to collisions taking place at LHC. QCD is the theoretical framework for describing the strong interactions (one of the four fundamental forces in nature) and gluons are particles that mediate the strong interactions. These can, however, interact with each other, unlike photons of Quantum Electrodynamics, because they carry the so-called *color* charge responsible for the strong interactions. Scattering amplitudes for such interactions can be divided into two essential classes: tree-level amplitudes that correspond to the classical limit of the theory and loop amplitudes that account for virtual quantum excitations and constitute the higher order corrections. The traditional method of computing scattering amplitude is the well known Feynman diagram technique in which the amplitude is given by the sum of all contributing diagrams one can draw using the basic building blocks of the theory, that is the most elementary ways the particles can interact. For gluonic interactions this methodology becomes inefficient even at tree level because the building blocks are so small that there are enormous number of diagrams which makes this technique cumbersome. However the end results often turns out to be unexpectedly simple (single term expressions in certain cases) implying that there is some hidden structure or symmetry. The simplicity of the end results, which was not evident from the Feynman technique, sparked the development of a wide range of techniques for calculating scattering amplitudes, making this a very active and fascinating field of research. In addition to being effective, these new techniques offer unique insights into the structure of theory, while having different viewpoints and origin.

Over the past couple of decades, a number of different techniques have been developed ranging from geometry based technique to analytic methods. Quite recently, we have offered a new formulation of the theory for interactions of gluons by introducing a new set of ”building blocks” that allow for efficient calculations of tree-level scattering amplitudes. Such building blocks, called vertices, are collected in a function called Lagrangian, that in general should contain all information needed to calculate observables.

The objective of the project is to develop quantum corrections to this new Lagrangian, so that it is possible to calculate not only tree-level amplitudes, but also loop amplitudes. It turns out, that there are some purely quantum contributions missing in the Lagrangian. For example, there are amplitudes that vanish at tree level, but are non-zero at loop level, and these cannot be build from the vertices in the classical Lagrangian. The objective of the project is therefore to supplement this new classical Lagrangian with the missing terms that contribute at loop level. Successful implementation of the project will provide a new alternative efficient way of calculating scattering amplitudes at loop level, fully formulated in terms of the Lagrangian.