The aim of the project is to measure the quantum spin correlation function for a pair of relativistic particles with mass. The results will be compared to the predictions of relativistic quantum mechanics and will be the first attempt to verify this theory in the domain of spin correlations.

The phenomenon of quantum entanglement takes place when several seemingly separate and noninteracting physical objects in fact constitute one quantum system, whose state has to be described collectively – there exist no separate states of the constituent subsystems. This phenomenon is observed also in systems in which two objects are separated from each other by such a distance, that according to special theory of relativity there is no interaction between them. Entangled states of two particles can be created as a result of their interactions. Møller scattering (scattering of two electrons) studied in our experiment is an example.

The results of measurements carried out on the components of the entangled system are not independent but exhibit correlations. The so–called correlation function is a measure of quantum entanglement suitable for experimental investigation. In case of spin correlations the experiment comes down to measuring spin projections on chosen directions in space. As the spin projection can take only two values (+ or −), the correlation function is determined by four probabilities of spin projections of an electron pair (++, −−, +−, −+).

The measurement of the correlation function will be carried out on a pair of electrons originating from Møller scattering. Polarized electron beam will be scattered off electrons of a stationary (unpolarized) target. The spin projections of each of the electrons will be measured by means of Mott polarimetry. The method is based on the asymmetry in scattering of polarized electrons off atomic nuclei.

Since this measurement will be the first such project in the world, a dedicated experimental setup had to be developed. A double Mott polarimeter was designed for the exclusive purpose of this experiment. It will consist of two Mott polarimeters, one for each of the two electrons originating from Møller scattering, in which both spin projections will be measured simultaneously.

The experiment will be carried out at Institut für Kernphysik, Technische Universität Darmstadt, Germany. It will use a polarized 3 MeV electron beam provided by S-DALINAC electron accelerator.

The motivation of these studies is twofold. Firstly, the project will have a pioneering character, as in all of the experiments performed until now the energy of the particles was insufficient to observe relativistic effects. Secondly, the theoretical calculations revealed unexpected dependence of the studied quantities on energy, which has not yet been verified. This way our project will make an outstanding contribution to relativistic quantum mechanics.