"Search for BSM physics at TeV scale by exploring the transverse polarization of electrons emitted in neutron decay – the BRAND project"

Nuclear and neutron beta decay have played a crucial role in the development of the weak interaction theory. The empirical foundations of the electroweak standard model (SM) are directly linked to the experiments performed with the nuclear and neutron beta decay. Nevertheless, despite the great success of the SM, many open questions remain such as the origin of parity violation, the hierarchy of fermion masses, the number of particle generations, the mechanism of CP violation, the worrying large number of parameters of the theory, etc. Presently, many large-scale research projects both at high-energy and at the precision frontier are focused on searches for deviations from the SM assumptions as possible indications of new physics.

The basic goal of the proposed project is the construction of the apparatus and carrying out of the first phase of data taking in an innovative experiment measuring simultaneously as many as 11 correlation coefficients in the decay of polarized free neutrons. Five from them (*H, L, S, U, V*) would be measured for the first time. The ultimate goal of the project (third phase) is the determination of the correlation coefficients *H, L, N, R, S, U* and *V* with the accuracy of about 5×10^{-4}, and providing complementary and competitive information respectively to "classical" neutron decay experiments (correlation coefficients *a, b, A, B, D*) and to ongoing and planned high-energy experiments (like e.g. CMS at LHC) searching for not existing in the Standard Model but theoretically possible scalar and tensor couplings. This information is contained in the transverse polarization of electrons emitted in beta decay, in particular in the neutron beta decay. Choice of the neutron comes from the fact that in contrast to nuclear transitions, the measured neutron quantities are not dependent on the nuclear structure so that the weak interaction parameters extracted from these quantities are not affected by theoretical uncertainty. The analysis performed in the framework of the effective field theory (EFT) shows that the proposed method is sensitive to hypothetical processes that could appear in the weak interaction at the energy scale of 5 TeV and higher.

The BRAND experiment is split into three phases. In each of them, the basic goal is to reduce the floor of incontrollable systematic effects by a factor of 2. **The current application covers exclusively the first phase devoted to construction and characterization of the apparatus. However, already at this stage, the never attempted before correlation coefficients *H, L, S, U* and *V* will be deduced with the statistical precision of 0.02 and with systematical uncertainty of 0.002.**

The BRAND project will be implemented on the worldwide strongest cold neutron beam line PF1b at the Institute Laue-Langevin in Grenoble and the first two phases of data taking will be carried out there. Beyond of that, it is planned that the ultimate phase will be realized at the European Spallation Source in Lund (presently under construction). The BRAND polarimeter will be designed and completely constructed in laboratories of the Institute of Physics of the Jagiellonian University and in the Institute of Nuclear Physics Polish Academy of Sciences with the help of external companies. The apparatus will enable to reconstruct the decay kinematics and evaluation of all available correlation coefficients including the "classical" ones (*a, A, B, D*). This feature is especially attractive as it gives opportunity to compare with the results of other independent measurements that used different methods.