Over the last few decades of experimental studies of exotic nuclei an impressive progress has been made substantially expanding our knowledge on nuclear properties. Among the most fundamental ones are half-life and radioactive decay modes of the nucleus. The most common forms of decay have been traditionally classified as alpha, beta, and gamma radiation. However, other more rare decay modes might occur when approaching the exotic species, including the emission of protons or neutrons. Definitely, the detection of radioactivity by Becquerel and soon after first radioactive elements – polonium and radium discovered by Curie laid the foundations for new scientific discipline expanded studies of subatomic world. Subsequent milestones have been done by Rutherford and Villard thanks to their work concerning α, β and γ-rays. Together with the experiment goes the significant progress of the theoretical approaches with capacity to explain observed phenomena. This has contributed to the development of new field – quantum mechanics. Indeed, the description of the α-decay process by Gamow required entry “tunneling effect” while β-decay mechanism proposed by Fermi based on the quantum field theory.

Continued progress of the new experimental methods allows populating very exotic nuclei on the neutron-rich and neutron-deficient sides of nuclear landscape, thereby, opens the new perspective for the nuclear radioactivity studies. In 1969, the first observation of a proton from the high–spin long lived state in the neutron-deficient ^{53}Co isotope confirmed the existence of proton radioactivity as a new mode of the nuclear decay that was predicted by theory ten years earlier by Goldansky. The missing puzzle in this picture is neutron radioactivity that has never been observed in the experiment. This decay mode is also foreseen by theory as described by Peker et al. in 1971. For the search for neutron radioactivity, nuclei lying in the yet unexplored region of doubly magic ^{78}Ni offer favorable conditions. The difficulty of accessing the nuclei of interest, since they lie in the very neutron-rich region of the nuclear chart, poses experimental obstacle. Currently applied experimental methods provide information only about one or two low-lying states, which are located well below the neutron binding energy. In many instances, no levels are known. In order to search for the neutron radioactivity we propose to populate neutron-rich species around ^{78}Ni in fission of a heavy target induced by neutrons.

The Institut Laue-Langevin (ILL) in Grenoble (France) is an ideal facility to perform such measurement. The highest neutron flux in the world was delivered from the ILL reactor and can be collimated providing thermal-neutrons beam with a flux of $10^8/(s*cm^2)$. The neutrons hitting the target leading to the fission reaction. During this "mini-explosions" were produced atomic nuclei from the exotic regions of the nuclear chart. Then, the nuclei emitted portions of energy called gamma quanta that give us information about their structure. The production of nuclei of interest will be possible by applying the unique conditions in the experiments, which will be carried out by using state-of-the-art equipment available at ILL. If the new nuclear process, neutron radioactivity, is observed, the next big step for our understanding the nuclear properties will be made. This goal requires an up-to-date experimental approach as well as some new development. The data will be analyzed by using the complex coincidence techniques. If successful, the present study will provide an important scientific and technical output giving strong impulse to further progress in nuclear physics.