

Reg. No: 2015/18/M/ST2/00523; Principal Investigator: prof. dr hab. czł. koresp. PAN Marek Lesław Pfützner

Atomic nuclei are very complicated quantum objects, consisting of two types of particles: protons and neutrons. Because of very complex nature of interactions between these constituents, atomic nuclei have very rich structure and exhibit a very broad spectrum of properties. Obtaining the full understanding of nuclear phenomena represents a huge challenge of the fundamental significance for physics. This significance can be illustrated by two examples. The first is related to the fact that the atomic nucleus can be treated as a laboratory of fundamental interactions, which can provide basic information on the structure of matter. The second example is the deep connection between nuclear physics and astrophysics. Learning the ways of nucleosynthesis, or discovering the structure and evolution of stars, would not be possible without understanding the nuclear processes.

One of the most important branches of contemporary nuclear physics is the investigation of the nuclear systems which have a disturbed balance between the numbers of protons and neutrons. These are the nuclei far from stability, and we call them exotic. The studies of exotic nuclei allow us to learn better the nature of nuclear interactions, the limits of the nuclear chart, and to test models of synthesis of chemical elements in explosive astrophysical environments. Investigations of exotic nuclei are very difficult and require special, advanced installations to produce them. One of the leading centers worldwide in which very exotic nuclei are produced is CERN-ISOLDE near Geneva. In this laboratory, powerful accelerators which are used to study elementary particles (like the recently discovered Higgs boson) are also employed to produce short-lived, very exotic nuclei. ISOLDE is equipped with a series of modern, state-of-the-art scientific instruments providing unique opportunities to investigate such nuclei, for example by accelerating them to induce nuclear reactions (radioactive beams). The ISOLDE laboratory is managed by an international collaboration ISOLDE formed by scientists from 14 countries.

Polish physicists participate in experiments at ISOLDE exceptionally or due to hospitality of foreign groups. One of the main goal of the present project is the inclusion of Poland as a full member of the ISOLDE collaboration and launching various scientific programs realized by groups of Polish nuclear scientists. The full membership will allow them to conduct their own projects independently, will provide an influence on the scientific policy of the collaboration and on the functioning and development of the laboratory. In addition, it will facilitate running master and doctoral projects on the highest international level.

In order to realize this goal, five Polish scientific institutions formed a consortium Polska@ISOLDE which acts as a group applicant of this project. Each of the partners has its own, long-term research plan for the ISOLDE laboratory. The tasks of the project represent the first steps of these plans. They involve performing various experiments at the front-line of contemporary low-energy nuclear physics. They include studies of radioactive decays of exotic nuclei, measurements of the basic properties of excited states of such nuclei, and investigations of reactions induced by them. In the course of the project next experiments will be planned as a continuation and extension of the original scientific goals. The planned tasks concern topics in which Polish groups already have significant expertise. The possibility to run these tasks at ISOLDE will help to efficiently exploit and to increase our research potential and to strengthen our rank within the international community.