There are over 300 different natural isotopes in nature on Earth. In addition, over 3000 radioactive isotopes can be man-made using particle accelerators and nuclear reactors. All these isotopes are the subject of the nuclear physics research. The purpose of these studies is to learn about the laws governing interactions of protons and neutrons. Even though since the discovery of the radioactivity in 1911 more than 100 years have passed, many secrets are still hidden in atomic nuclei.

Some of the thousands of known isotopes create particularly favourable conditions to check and extend specific aspects of our knowledge of the structure of nuclear matter. Most of the existing heavy atomic nuclei contain significantly more neutrons than protons. In the project described here, we will deal with unusual nuclei which contain similar numbers of nucleons of both types. Particularly favourable conditions occur in such systems for the observation of special interactions between protons and neutrons which are not visible in other areas of the chart of nuclides.

Among the tested nuclei there will be nuclides with proton and neutron numbers neutrons near 28 or 50. These numbers in nuclear physics belong to the so-called magic numbers. Atomic nuclei containing magic numbers of nuclides (separately counting protons and neutrons) are particularly strongly bound. Neighbouring nuclei (containing similar numbers of nuclides) can be described as systems consisting of magic core and several additional nucleons. Comparison of properties of such nuclei established in experiments with theoretical predictions allows for a very precise verification of model assumptions — information about fundamental processes occurring in matter can be obtained. The core nucleus containing exactly 50 neutrons and 50 neutrons is called ^{100}Sn (tin 100). This is the heaviest existing doubly magic nucleus containing equal numbers of protons and neutrons.

In the experiments, selected atomic nuclei will be accelerated to velocities of about 10% of speed of light. Such projectiles will hit especially prepared thin layers of material, called targets. New nuclei will be created as a result of the interaction of the projectile with the target. They will be highly excited (will have excess energy) and they will gradually change their excitation state, until they reach the state of the minimal energy (the ground state). Electromagnetic radiation of high energy (gamma rays) will be emitted as result of this deexcitation. The measurements of the emitted radiation will make it possible to study properties of the nuclei.

We will use complex systems of detectors to register the γ radiation. So-called germanium detectors will give most precise information on the properties of the registered gamma quanta. Detectors of charged particles and neutrons will be used to select exotic, but most interesting products of the reactions.

The properties of the studied states will lead to a better understanding of processes for creating heavy elements in stars under the so-called rp process and will help to explain the amount (abundance) of various elements found in nature.

We will analyse data collected during the experiments performed in leading European laboratories: the GANIL laboratory in Caen, France and the LNL laboratory in Legnaro, Italy. In addition, or rather — first of all, the most modern European system of neutron detectors will be installed and used in the Heavy Ion Laboratory in Warsaw.