The scientific aim of this project is the experimental confirmation of the existence of mesic-nucleus: a new kind of nuclear matter consisting of nucleons and mesons. Nucleons are components of atomic nucleus while mesons are particles composed of quark and anti-quark (matter and antimatter). A mesic nucleus would be a system of nucleus and meson bound via *strong* interaction. Analogously as electron and nucleus form a system bound via *electromagnetic* interaction, and Earth and Moon form a system bound via *gravitational* force.

The existence of such mesic matter was postulated thirty years ago, however, untill now it has not been confirmed experimentally. Such system may be created for example in the deuteron-deuteron or proton-deuteron fusions. Fusion of protons and deuterons is one of the basic nuclear processes which leads to the synthesis of helium inside the Sun (Helium element is named after helios, the Greak word for Sun). At large energies, such process may lead to the production of the helium nucleus associated with the η meson. The η meson is the best candidate for the creation of the mesic nucleus because it interacts with nucleons stronger than other mesons. In addition the η meson is electrically neutral, therefore if the η-mesic helium was discovered it cannot be formed by the *electromagnetic* interaction and hence we can be sure that it is bound by the *strong* forces, since *gravitational* and *weak* force are by many orders of magnitude too small to bind such tiny objects.

It is interesting to note that ^{3}He is larger and interacts more strongly with the η meson than ^{4}He, though ^{4}He comprises more nucleons than ^{3}He. This indicates that it is more probable that the η meson can form a mesic nucleus with ^{3}He than with ^{4}He. Therefore, it is worth searching for the η-^{3}He bound state.

Our research group has developed a method which can lead to the discovery of the η-^{3}He bound state. In 2014 we performed measurements using a proton beam from the COSY synchrotron and the WASA detector installed in the Research Center Juelich in Germany. Based on the new data, for the first time, we will be able to verify new hypotheses: e.g disintegration of the η-^{3}He bound state via decay of the η meson while it is still "orbiting" around the nucleus. The main advantage of the used experimental setup is a possibility of continuous changing of beam energy and simultaneous registration of all particles taking part in the reaction. Moreover, we have collected significantly higher statistics in comparison to previous experiments. The existence of the bound system should manifest itself as an increase of the number of events in the energy range corresponding to its production – for the energy lower than the sum of η meson and helium masses.

The search for new kind of nuclear matter is a very exciting experimental challenge. The confirmation of the existence of a mesic nucleus would be interesting on its own account, and in addition it would allow for a better understanding of the structure of mesons and their interactions with nucleons.