**Review on the project**

**“Design and development of the tagged neutron method for determining the elemental structure of matter and studying nuclear reactions”.**

The presented project is continuation of the work successfully implemented in recent years by a team of several research groups from different laboratories and institutes in the framework of the basic theme of the Nuclear Physics Division of the Frank Laboratory ofNeutron Physics.The formed team has experience in development and application of the experimental equipment in applied and fundamental problems.The methodical highlight of the project in the implementation of the goals is the tagged neutron method (TNM). The use of TNM for practical purposes, including for non-destructive elemental analysis, requires expansion and refinement of a databank on14-MeV neutronnuclearinteractioncrosssections and thegamma spectra typical for them in the detectors used for the analysis.The use of 18 new BGO detectors has significantly improved the opportunities of the setup in conducting experiments in order to obtain new data on cross sections and angular correlations.It is planned to use gamma-detectors with high energy resolution for precision determination of gamma-ray yields in reactions with fast neutrons, as well as the use of more efficient and fast neutron detectors. The use of a 14-MeV neutron source, advanced detectors and electronics will provide much better conditions for measuring small cross sections and angular correlations that have been achieved at this stage of the project.

The advantages of the present project are achieved by using a neutron generator with a built-in multi-channel alpha detector, which fixes the direction of neutron emission, and a multi-detector system of the “daisy-flower” (romashka) type, both in the gamma-quanta and neutron registration mode and with high efficiency.Digitization of detector signals provides separation of the registration of neutrons and gamma quanta. The TNM in combination with the detectors of the “romashka” typeallowsto carry out measurements of cross sections under low background conditions.

The following experimental research on the interactions of nuclei with the neutrons with an energy of 14.1MeVwill be carried outwithin the framework of the project:

* Measurement of angular correlations of gamma-quanta and secondary neutrons in the reaction of inelastic neutron scattering.
* Development and creation of theoretical models describing the angular correlations of gamma-quanta and secondary neutrons in inelastic scattering.
* Investigation of the (n, 2n) reaction in the interaction of nuclei with the neutrons with an energy of 14.1 MeV.
* Measurement of gamma-ray yields for various samples emitted in the interaction of the neutrons with an energy of 14.1 MeV. Creating a database for gamma-transitions.
* Development of a diamond search technique in kimberlite ores using the tagged neutron method.
* Research on the Martian soil model.

In addition to the applied significance of the data obtained on cross sections and gamma-spectra, these data are important in a purely scientific aspect.Since the characteristics of the reactions are of interest in building models of the processes of the Universe development, data on the structure of low levels of light nuclei are necessary.Despite the significant bank of such data, research on the reactions can detect levels that are not visible in other methods.

Measuring in coincidence the two neutrons formed in the reactions and determining their energy, it is also possible to determine the energy of the excited level of the residual nucleus by the missing mass. The study of reactions for medium and heavy nuclei, including split ones,remains relevant.

Thus, we see that the setup is used and can be effectively used to obtain various new experimental data of applied and fundamental significance. The proposed improvements for it will enhance the ability of measuring small cross sections. The proposal of test studies of the soil model of the planet Marsis of particular interest, in the international program for studying the surface of which FLNP has been involved in recent years, as well as the creation of theoretical models describing the angular correlations in the inelastic scattering reaction.

The authors of the project reasonably propose an extension of the detector arsenal (gamma-detectors with precision energy resolution, position-sensitive neutron detectors), and improvement in electronics. The requested funds for the project implementation for the next three years are reasonable.

I propose to approve the project.

Project evaluation:

A. - Scientific, methodical or technical significance (scale 0-10 points): 8 points;

B. - Competitiveness (scale 5 points): 5 points;

C. - Probability of the Project implementation (scale 0-1): 1 point;

D. - Compliance of resources with the significance of the Project (scale 0-1): 1 point;

E. - Authors’ qualification and staffing (scale of 0-5 points): 5 points;

F. - Sum of points (scale 0-20): 18 points.

Advisor to the FLNP Director, Ph.D. A.B. Popov