The referee's report on theme "**Investigations of neutron nuclei interactions and properties of the neutron" and proposal for its extension** reported by E. Lychagin

Since the JINR Directorate decided to extend the scientific topics only within the current seven years, this PAC meeting considers the extension of this topic for another year, that is, until the end of 2023.

This theme includes three projects: TANGRA, ENGRIN and Modernization of EG-5. The results obtained in the previous two years are presented. Part of the planned work was not carried out for objective reasons, however, the results obtained are quite convincing and interesting from a scientific point of view. The subjects of the works are traditionally diverse and contain fundamental, methodological and applied research. Of interest are the results obtained in all reported areas, including the study of nuclear reactions caused by neutrons, the study of quantum mechanical phenomena with ultracold and cold neutrons; as always, the works using various nuclear physics methods for the problems of ecology, materials science, archeology, art science, medicine, etc. are impressive. The status of operation and development of the IREN facility is presented.

The plans of the laboratory for the year 2023 are a logical development of ongoing work, they are understandable and justified. There is no doubt about the ability of the team to continue to obtain high-level scientific results, to develop the instrumental and methodological base, and also to maintain the equally high and successful publication activity. All of these components are recognized and welcomed by the world's neutron science community, as well as those active in related fields. It should be noted the succession of scientific activity and the active training of young specialists.

The idea of temporal focusing of the neutron beam is interesting. A possible application is to obtain the peak (rather than average as usual) neutron density outside a pulsed neutron source. This possibility of a huge increase in the extracted neutron density is of particular interest for neutron sources such as the JINR source, both existing and planned. The source of ultracold neutrons of record density, built on the basis of this method, is doubly interesting for JINR, where ultracold neutrons were once discovered. I recommend looking at an alternative way of practical implementation of neutron focusing in time, as well as neutron moderation, which will soon be published in PEPAN Letters. The efficiency of these methods is high and they can be implemented practically.

Of great scientific and practical interest are works on the study and improvement of nano-diamond reflectors of slow neutrons. Significant progress has been made in these works in recent years. To do this, the parameters of small samples were measured and the characteristics of the reflector were numerically modeled using these experimental results. An experiment is being prepared in which slow neutrons will be stored in the cavity of a macroscopically large nano-diamond reflector and, as a result, the parameters of the reflector will be measured directly. Subject to experimental confirmation of the high probability of neutron reflection, I recommend using the nano-diamond reflector method to develop the ultracold neutron source mentioned above.

I recommend considering the possibility of a more active participation of the laboratory in the development of methods, technical solutions and the experimental base of the new JINR neutron source.

I fully support the proposed extension of the topic “Investigations of neutron nuclei interactions and properties of the neutron” for 2023 and wish the laboratory staff success in its implementation.

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Prof. Valery Nesvizhevsky, Institut Max von Laue – Paul Langevin, Grenoble, France