Contribution ID: **945** Type: **Oral**

Very Cold Neutron Source Based on Nanodiamond Reflector

Tuesday 12 October 2021 16:45 (15 minutes)

Neutrons can be an instrument or object in many fields of research. Major efforts all over the world are devoted to increasing the range of useful neutrons towards smaller energies. However, the progress in the field is limited by the severe decrease of the flux of available slow neutrons, as well as the efficiency of the delivery of such neutrons to experimental installations. The properties of neutron reflectors cause this dramatic decrease of slow neutron flux. Independently of the choice of materials, their evident common feature is that they are composed of atoms separated by distances of ~0.1 nm. As soon as the neutron wavelength reaches this value, neutrons penetrate through the reflector and are lost. This is equally relevant for nuclear research reactors, neutron spallation sources, compact accelerator-driven neutron sources, and others. In this context, neutron reflectors play a key role because they improve the performance of neutron sources and delivery systems in an economical and efficient way.

For slow neutrons, powders of detonation nanodiamond provide exceptionally good reflecting performance due to the combination of enhanced coherent scattering and low neutron absorption. This work reflects the current state of research of the nanodiamond reflectors for very cold neutrons. We will describe the application of a nanostructured reflector for the directional extraction of neutrons, as well as the experimental results and calculations. The concept of a low-energy neutron source based on such a reflector will be discussed. We will present the efficiency estimation for the developing prototype of a very cold neutron source.

This research is funded by grants RFFI-18-29-19039, CREMLINplus (grant agreement 871072), and the JINR grant for young scientists №21-402-06.

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Session Classification: Nuclear Physics

Track Classification: Experimental Nuclear Physics