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Development of the Cold Neutron Beam Shaping Assembly for the Accelerator-based Neutron Source VITA

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A promising method for treating malignant tumors - boron neutron capture therapy (BNCT) is being actively developed at the Budker Institute of Nuclear Physics. This method is based on the absorption of neutrons by boron-10 preliminarily accumulated in the tumor. The cross-section of the neutron capture of boron-10 increases with the neutron energy decrease. Nowadays, the most optimal neutron energy for BNCT is the energy of the epithermal range (1-30 keV). Neutrons with this energy effectively penetrate 4 cm into human tissues. Neutron delivery to a deeper distance will allow to increase localization of a therapeutic dose in a tumor, exclude impact on healthy cells of a patient and increase BNCT efficiency both in case of deep lying malignant tumors and those on the surface. Neutrons with energies of the order of 10-4 eV (cold neutrons) have distinct wave properties that allow transporting them via flexible neutron guides. To realize this idea, it is necessary to produce cold neutrons. This work was devoted to the production of cold neutrons at the accelerator-based neutron source VITA.

The paper describes the developed cold neutron Beam shaping assembly (BSA). The modeling of the neutrons passage through the proposed BSA was performed by Geant4 software. The modeling corresponds to the experiments geometry. The series of experiments aimed at investigation of the moderating properties of the selected materials - plexiglas, water, and heavy water - are conducted. The initial neutron beam with an average energy of 30 keV and an intensity of 21012 n/s was obtained at the accelerator-based neutron source by the 7Li(p,n)7Be threshold reaction. The energy of the incident proton beam on the lithium target was 2.1 MeV. Thus, a multilevel moderating system consisting of heavy and ordinary water at room temperature and 73 K is tested as a moderator. After passing through the system, neutrons were registered with a neutron detector, based on plastic polystyrene scintillators enriched with boron (IHEP, Protvino).

The possibility of generation of cold neutrons at the accelerator-based neutron source at the Budker Institute of Nuclear Physics has been demonstrated.

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Young scientist paper:

Yes

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THE CONTROL SYSTEM OF NOVOSIBIRSK FREE ELECTRON LASER FACILITY AND USERS STATIONS

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