Progress in the development and application of the accelerator based neutron source VITA

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The accelerator based neutron source VITA [1] is a facility that includes an electrostatic tandem accelerator of charged particles of an original design (Vacuum Insulated Tandem Accelerator) for obtaining stationary beam of protons or deuterons with an energy of 0.1 MeV to 2.3 MeV with current up to 10 mA, a thin lithium target for generating neutrons and set of neutron beam shaping assemblies. The facility produces neutron beams in a wide range of energies: from cold to fast. The facility is used to develop BNCT, including the treatment of domestic cats and dogs, testing new boron delivery drugs, and the development of dosimetry tools and methods. We have opened the era of lithium neutron capture therapy [2], which brings a new quality – 100% delivery of the dose to tumor cells. Considerable attention is paid to obtaining fundamental knowledge: measuring the yield of particles and the cross-section of nuclear reactions. The facility is used for radiation testing of semiconductor photomultipliers, Hall sensors, boron carbide and steel samples for the ITER, optical cables for the CERN, ^{55}Fe and ^{57}Co isotopes production, etc. [3]. The use of a thin lithium target makes the neutron source extremely bright, which can be used to obtain a beam of cold neutrons and, using a sextupole magnet, repeat the Stern-Gerlach experiment and give it a correct description [4]. The next step could be the creation of a neutron-electron collider for the first time to directly study the neutron.

Two neutron sources VITA-II made for oncology clinics. The first source was delivered to Xiamen, China, and has been used for several years to conduct clinical trials of BNCT, which allowed China to become the second country in the world, after Japan, to master the new method of treating malignant tumors. The second source has been delivered to an oncology center in Moscow, Russia, where clinical trials will soon begin, making Russia the fifth country in the world to master the new method of treating malignant tumors.

Experience gained from operating slightly different neutron sources has allowed the development of a third version VITA-III, which is distinguished by the use of a more compact gas stripper and the use of pre-decelaration instead of pre-acceleration of the injected ion beam [5]. This will make it possible to obtain a parallel beam of protons and eliminate the need for a high-voltage platform, an isolating transformer, and a set of focusing lenses.

The facility height can be significantly reduced by placing the high-voltage power supply within the upper vacuum part of the feedthrough insulator, eliminating its lower gas part. This solution, featuring a symmetrical cascaded Cockcroft-Walton generator with a 500 kV output, is being developed for the high-power compact fast neutron source VITAmin.

The report will describe the facility and present the results of the studies, which are of great importance for the development of BNCT.

This work was supported by the Russian Science Foundation [grant number 26-12-00020].

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