At recent years linear accelerators (Linacs) have been considered as a favorable facility for BNCT application due to compactness, easy handling, adjustable flux, no radioactive waste, and less shielding requirements. Although photoneutron production isn't an efficient way to produce enough neutron for BNCT, but it would be possible using linac with high average beam current. ILU-14, the industrial and powerful electron accelerator, can produce 10 MeV electrons in average current of 10 mA. Melting down may be cause due to impinging of such focusing beam on photon target because the temperature of target will be increased more than melting point even in first moments of irradiation. A solutions proposed in this work are using of scanning beam instead of focusing beam and designing a heat removal system. At first step with focusing beam, targets with disc and cylindrical geometry have been designed for photon converter and photoneutron target, and according to the scanning beam, their dimensions and geometries have been changed.

Different materials in various geometries with reasonable size, cost and availability have been studied for an optimized neutron target for ILU-14 in order to use for BNCT. All optimization calculations for targets have been performed by Monte Carlo MCNPX2.6 code.

According to the results, tungsten strip with 54 cm in length, 2 cm in width, and 0.15 cm in thickness has been introduced as the photon target, and D_2O in cylindrical form with 26 cm in radius and 16 cm in thickness has been selected as the photoneutron target. A water cooling system has been proposed to reduce the temperature of the target (around 14°C). Heat transfer evaluations in neutron target (consist of photon and photoneutron targets) have been performed by ANSYS software. The results show that this combined target can produce epithermal neutron flux about 1.24×10^8 ($n.s^{-1}.cm^{-2}$) at therapeutic window which can be appropriate for BNCT.

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Modification of the argon stripping target of the tandem accelerator

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For development of the accelerating concept of neutron capture therapy, the tandem accelerator with vacuum insulation is proposed and developed. In the tandem accelerator negative hydrogen ions are accelerated by the positive potential of the high-voltage electrode, converted into protons in the stripping target inside the electrode, and then protons are accelerated again by the same potential. Stripping target is made as a tube 16 mm in diameter and 400 mm long with the supply of the stripping gas (argon) in the middle. When studying the dependence of beam stripping on the argon pressure we have found an effect that can be explained by the appearance of the additional flow of positively charged ions of the stripping gas in accelerating channels. The interaction of the injected ion beam with the gas in the stripping target leads to ionization of the argon and to appearance of a low-ionized plasma with a positive potential. Under the influence of this potential part of positive argon ions comes out of the stripping target, enters into the acceleration channel where it is accelerated. This effect causes an additional load of power source, deterioration of the high-voltage strength in the vacuum gap and limiting of the proton beam current. Suppression of the ion flux of the stripping gas is proposed using a transverse magnetic field applied in the region between the stripping target and the apertures in the high-voltage electrode. The paper presents the results of measurements of the ion beam current at the output of the accelerator depending on the argon pressure. Also the scanning electron microscope observations of the diaphragm surface modified by accelerated argon ions, and the results of direct measurements of the specially installed argon ion current detector are presented. The paper presents and discusses the project of modified gas stripping target. The idea of the target modification is the following. Inside the high-voltage electrode just behind inlet aperture it is proposed to apply 1 T transverse magnetic field using two-pole permanent magnets. In this field a parallel shift of the injected beam of negative hydrogen ions is performed. Similar magnets at the exit of the stripping target return proton beam back to the axis of accelerator channel. In this geometry not only significant suppression of ion penetration of the stripping gas into the accelerating channel can be achieved, but also a significant improvement of vacuum conditions in the accelerating channel and reduction of the ultraviolet radiation from the plasma in the stripping target. It is enough to shift the stripping target to a distance greater than the aperture (20 mm) in the high-voltage electrode and to implement a differential gas pumping. The paper presents results of trajectory calculation of the injected ion beam, evaluation of its emittance increase because of the magnetic field penetration into the stripping tube and selection of the optimal solution. The geometry of the magnetic system and the system of differential gas pumping using turbomolecular pump installed inside the high-voltage electrode are presented. The work plan for the stripping target modification and increasing the proton beam current is discussed.

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A new concept of a Vacuum Insulation Tandem Accelerator

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Tandem accelerator with vacuum insulation has been proposed and developed in Budker Institute of Nuclear Physics. Negative hydrogen ions are accelerated by the positive 1 MV potential of the high-voltage electrode, converted into protons in the gas stripping target inside the electrode, and then protons are accelerated again by the same potential. Potential for high voltage and intermediate electrodes are supplied from the sectioned rectifier of electron accelerator ELV produced by the Institute for a long time, through sectioned feedthrough insulator with a resistive divider. In this work, we propose a radical improvement of the accelerator concept. It is proposed to abandon the separate placement of the accelerator and the power supply and connecting them through the feedthrough insulator. It is proposed to locate the source of high voltage inside the accelerator insulator, high voltage and intermediate electrodes mounted on it. This will reduce the facility height from 7 to 3 m and make it really compact and attractive for placing in a clinic. This will also significantly increase the stability of the accelerator, because the potential for intermediate electrodes can be fed directly from the relevant sections of the rectifier. The paper presents and discusses technical solution for making compact sectioned rectifier, scheme of its placement inside the insulator, and the benefits of this proposal.