STATUS AND FUTURE PROSPECT OF NUCLEAR MEDICINE AND HADRON THERAPY IN NORTH-WEST REGION OF RUSSIA

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Abstract

Since 1975, a Center of Stereotaxic Proton Therapy (CSPT) is operating at Petersburg Nuclear Physics Institute (PNPI) exploiting a 1000 MeV proton beam from the PNPI synchro-cyclotron. The center is specialized on treatment of some brain diseases, such as pituitary adenomas and arteriovenous malformations. Small scattering of the 1000 MeV proton beam in the tissue in combination with the irradiation rotation technique provide high ratio of the radiation doze in the irradiation zone to that at the head surface. The functioning of CSPT is performed in close cooperation with the Russian Scientific Center of Radiology and Surgical Technology (RSCRST). At present, 1352 patients have been treated in this center. This method of high energy proton therapy, being unique in the world practice, is distinguished by high safety of the irradiation process and high medical efficiency. However, its application is limited so far to several brain diseases.

In addition to the existing CSPT center, a project of the universal center of proton therapy with the proton beam energy variable in the range 80-230 MeV is under realization at PNPI-RSCRST. This center should provide the North-West region of Russia a possibility to treat a wide spectrum of oncological diseases. The center is created on the basis of two proton accelerators: a high current cyclotron C-80 (energy 80 MeV, current 100 mkA) and a fast cycling proton synchrotron S-230 with variable energy from 120 MeV to 230 MeV. The cyclotron C-80 is used as the injector to the synchrotron S-230. In addition, a proton beam extracted from C-80 will be used for eyes therapy (high precision 80 MeV beam with low intensity), while the high intensity (100 mkA) 80 MeV proton beam will be used for production of radioisotopes for nuclear medicine.

The proton synchrotron S-230 was designed at G.N. Budker Nuclear Physics Institute of SB RAS. Its repetition rate is 1 Hz with a possibility for a 10 % modulation of the energy of the extracted beam at the rate of 10 Hz. The irradiation stand will be equipped with the GANTRY system. As the result, the four-dimension irradiation will be provided via variation of the beam in X,Y,Z, and time, that, in particular, makes possible synchronization of the beam stop position with the position of the organs moving in course of irradiation.

The cyclotron C-80 will provide production of a variety of radioisotopes for medical applications. In particular, production of the ^{82}Sr–^{82}Rb generators could allow to use the positron-emission tomography (PET) in the medical centers which has no special cyclotrons for production of the PET emitters.

PNPI can also produce radioisotopes in nuclear reactors. This line becomes especially promising after startup of the high flux reactor PIK at PNPI. The plans include production of super clean short-lived isotopes without “hot chemistry” using the on-line mass separator which selects the desired isotopes directly from the target placed in the neutron channel of the reactor.

At present, the North-West region has already some experience in production and application of the radioisotopes in medical practice. In particular, the isotopes ^{99}Mo and ^{125}I, produced at PNPI at the existing nuclear reactor WWR-M, are supplied to the Radium Institute in St. Petersburg for production of various radiopharm preparations. Also, the isotope ^{18}F is produced at RSCRST for a PET operating in this center.