TRAPP — FACILITY FOR PROTON THERAPY OF CANCER

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The facility is based on a 300 MeV proton synchrotron with two operation modes.

The «tomography» mode serves for making a density map of a patient in the tumour plane by proton tomography.

The «irradiation» mode allows a proton irradiation of targets of any size located in an arbitrary site of the human body.

In the first variant a patient is sitting in an armchair with a vertical axis of rotation. An extracted beam can scan in a horizontal plane. For the «tomography» mode slow extraction of the beam is used. The integrated density of the patient in a given direction is determined from the energies at the body input and output. The time planned for one tomogram is 3—5 minutes. In the «irradiation» mode both the Bragg peak and punch-through can be used. In both operation modes the proton energy is varied by the variation of the synchrotron energy. Use of tomograms allows the computer control of the irradiation process.

Brief Description of the Main Synchrotron Systems

An injector consisting of a high-voltage rectifier, a proton source and an accelerating tube is located in a SF_6 filled barrel with 500 mm diameter and 1800 mm length. 750 mm of this length are occupied by a cascade rectifier, 300 mm — by arc proton source with pulsed filling of hydrogen and 750 mm by a ceramic accelerating tube.

The beam transfer channel to a ring contains four magnets with common d. c. power supply. Four ion pumps provide a necessary pressure difference between the injector and synchrotron. The channel is equipped with four secondary emission grid profile monitors.

The magnetic system of the ring consists of 16 *C*-type zero-gradient dipoles grouped into four quadrants. The magnets of one quadrant are installed on one rigid platform and have a common excitation coil. A free 100 mm straight section in the middle of the quadrant doubles the number of the focusing edges resulting in the decrease of the variation of the vertical beam size.

The elements of beam correction, acceleration, injection and extraction systems are mounted in four 750 mm straight sections between the quadrants. In a small quadrant section four pick-ups for orbit observation are installed.

The all-welded vacuum chamber of the synchrotron is made of nonmagnetic stainless steel. To obtain high vacuum the vacuum chamber can be heated up to 200°C without disassembling the main magnets. Heating is performed by the electric current passing trough the vacuum chamber. The ring vacuum system is pumped out by 5 ion pumps.

The RF system consists of an untuned, ferrite loaded cavity and a broadband amplifier. The peak voltage at the accelerating gap is 200 V. A frequency varies from 0.8 to 16 MHz. RF power is less then 100 W.

«Slow» proton extraction from the synchrotron is performed by scattering of the internal target. Here an electrostatic septum with an electric field up to 200 kV/cm is used. The calculated efficiency exceeds 50%.