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Investigations of the Gamma and Neutron Radiation Produced by High Energy Electrons at Interaction with the Model of the Head of Siemens Primus LINAC Medical Accelerator

The use of high-energy particles in the treatment of cancer patients is growing rapidly every year. The result of burning pathogenic cells can be used to judge the effectiveness of tumor destruction, i.e. the effectiveness of the therapeutic beam. At the same time, patients experience a decrease in comfort after the procedures and relapses occur.

There may be different reasons for this, but we must be sure that there is no non-targeted irradiation of the patient "from head to toe" among the reasons. There are no published experimental data anywhere on the produced side flows of gamma quanta and especially on fast neutrons at medical accelerators such as LINACs. As is known, gamma quanta and neutrons are neutral particles, and therefore have high penetrating ability. In addition, the sources of neutrons and gamma quanta are isotropic, i.e. they fly out in different directions with the same probability.

As a result, the patient is exposed to whole-body irradiation in addition to the therapeutic beam. The treatment mode uses high radiation intensity, which leads to a correspondingly high density of secondary isotropic radiation. This is especially noticeable at the point of interaction of electrons with the heavy target and the primary collimator. It is not possible to measure this radiation at the places of application and production of LINAC due to the poor geometry and pulsed nature of the radiation.

We performed full-scale experiments to determine the yield of neutrons and gamma quanta from a heavy target with acceptable loads for the measuring device. The LINAC-200 electron accelerator was selected as the electron-producing facility (simulating the LINAC medical accelerator), and a certified spectrometer-dosimeter of the SDMF-1206SN type (registration number in the Russian State Register of Measuring Instruments # 90065023) was used as the measuring device. The main sources of gamma quanta and fast neutrons are the equalizing filter, the heavy target with a holder, the secondary collimator/jaws (if present), and the primary collimator. The sources are arranged in ascending order of the yield of secondary particles. The 15MV Siemens Primus model described earlier [1] was taken as the sample LINAC head.

1. Mohammadi, N., Miri-Hakimabad, H., Rafat-Motavlli, L. et al. Neutron spectrometry and determination of neutron contamination around the 15 MV Siemens Primus LINAC. J Radioanal Nucl Chem 304, 1001–1008 (2015). https://doi.org/10.1007/s10967-015-3944-5

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