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Dosimetric planning of radiation treatment of bio-objects and materials

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Today more than 70 countries of the world have industrial centres of radiation sterilization of food products and medical devices [1]. Compared to classical approaches, radiation sterilisation has a number of advantages: ionising radiations suppress microorganisms more effectively, the temperature of products does not change during processing, and they can be processed immediately in the package (which excludes the possibility of re-contamination). Today, when planning radiation treatment, all attention is focused on the integral released dose [2, 3], while recent studies [4 - 6] show that the efficiency of radiation treatment also depends on the nature of its distribution over the volume of the object.

The integral absorbed dose is unambiguously determined by the amount of delivered radiation and can be easily measured in practice (e.g., using dosimetric films or alanine dosimetry). The nature of the volume distribution of absorbed dose depends on several factors, including the type of radiation, the shape of the object and the energy spectrum of the beam. In order to take all these factors into account when planning radiation treatment, computer modelling is used [7]. And if the type of radiation and the shape of the treated object are reliably known, the exact energy spectrum of the beam is unknown and difficult to measure in practice. Replacing the exact spectrum by the "effective energy" can lead to an error of up to 20% in the estimation of processing uniformity.

In this paper, we propose a method for recovering the energy spectrum of an electron accelerator beam from the experimentally measured depth distribution of the dose produced by the beam. To implement the algorithm, the depth distributions of absorbed dose in various reference materials under irradiation with monoenergetic beams of accelerated electrons with energies from 100 keV to 20 MeV with a step of 100 keV are pre-calculated using the Geant4 software code [8, 9]. Experimental verification of the algorithm was carried out on the Varian TrueBeam medical electron accelerator in the radiosurgery and radiotherapy department with a day hospital at the Burdenko Neurosurgery Centre, operating in the 6 MeV and 9 MeV modes. The depth dose distributions in aluminium, water and polymer RW3 Slab Phantom were measured. The spectra reconstructed from the measured distributions showed agreement with each other, the discrepancy was not more than 5%.

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Section

Applications of nuclear methods in science, technology, medicine and radioecology

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