

Microdosimetric Characteristics of the JINR Phasotron Therapeutic Proton Beam

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The study presents and discusses the results of measurements of the contribution of particles with various LET values and their effect on the dosimetric and microdosimetric characteristics of a proton beam with the energy of 171 MeV at various depths of the beam penetration into the substance.

Proton therapy treatments are based on a proton RBE (relative biological effectiveness) relative to high-energy photons of 1.1. The use of this generic, spatially invariant RBE within tumors and normal tissues disregards the evidence that proton RBE varies with linear energy transfer (LET), physiological and biological factors, and clinical endpoint [1].

When using proton beams in radiation therapy, it is necessary to take into account the increase in the relative biological efficiency (RBE) during deceleration of the beam in biological tissue and an increase in the ionization density of protons with a decrease in the residual energy. In addition, when the proton beam passes through the substance, secondary particles with high linear energy transfer values are formed, which also increase the RBE.

The contribution of particles with high LET values to the dose of clinical proton beams was experimentally studied using a MiniPIX TPX3 camera in this experiment. MiniPIX TPX3 camera is a miniaturized and low power radiation detection camera with the state of art Timepix3 chip. The Timepix3 is the CERN's latest pixel detector chip that records position, energy and time for every detected quantum or particle of ionizing radiation [2].

In this study, based on the results of measurements of the LET spectra, the integral dosimetric and microdosimetric characteristics of the beam were determined - absorbed, equivalent and biological doses, as well as the radiation quality factor and the relative biological efficiency of the therapeutic proton beam from the JINR Phasotron.

1. H. Paganetti. Relative biological effectiveness (RBE) values for proton beam therapy. Variations as a function of biological endpoint, dose, and linear energy transfer. Phys. Med. Biol. 59 (2014) R419–R472
2. MiniPIX TPX3 Miniaturized Spectral Imaging Camera. Advacam <https://advacam.com/camera/minipix-tpx3>

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