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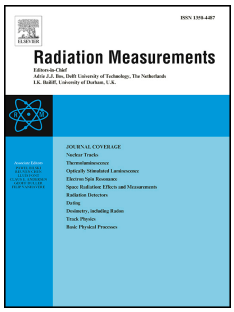

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Neutron spectral fluence and dose distribution inside a NYLON 6 phantom irradiated with pencil beam of high energy protons

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Abstract

Monte Carlo (MC) simulations using the MCNPX™ code supported by measurements were exploited for detailed characterization of secondary neutrons generated by high energy protons during pencil beam proton therapy. The study focused on the estimation of the distribution of secondary neutron points of origin, their average initial energy, and the distribution of absorbed dose and equivalent dose from neutrons and photons inside the NYLON 6 phantom (diameter of 25.5 cm, length of 31.0 cm) irradiated with a proton beam with the energies of 100, 150 and 200 MeV. Validation of the MC model and the used methods was done by comparison of calculated responses of the extended-range Bonner Sphere Spectrometer at several positions outside the phantom with the measured ones. The results show that high energy neutrons predominate in the direction of the proton beam and more neutrons are generated by higher energy protons. The MC simulations also demonstrated that the majority of high energy neutrons is generated at the beginning of the proton trajectory in the phantom and the neutron yield and neutron initial average energy decrease with increasing depth. Therefore, attention should be paid not only to the tissues behind the irradiated volume, but also to the preceding ones. However, the neutron spectral fluence in the vicinity of the treated tissue can only be determined by calculation, mainly due to the dimensions of the neutron spectroscopic instrumentation.