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Modeling of Cf-252 and PuBe Neutron Sources by Monte Carlo Method in Order to Develop Innovative BNCT Therapy

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Abstract : Currently, boron-neutron therapy is carried out mainly with the use of a neutron beam generated in research nuclear reactors. This fact limits the possibility of realization of a BNCT in centers distant from the above-mentioned reactors. Moreover, the number of active nuclear reactors in operation in the world is decreasing due to the limited lifetime of their operation and the lack of new installations. Therefore, the possibilities of carrying out boron-neutron therapy based on the neutron beam from the experimental reactor are shrinking. However, the use of nuclear power reactors for BNCT purposes is impossible due to the infrastructure not intended for radiotherapy. Therefore, a serious challenge is to find ways to perform boron-neutron therapy based on neutrons generated outside the research nuclear reactor. This work meets this challenge. Its goal is to develop a BNCT technique based on commonly available neutron sources such as Cf-252 and PuBe, which will enable the above-mentioned therapy in medical centers unrelated to nuclear research reactors. Advances in the field of neutron source fabrication make it possible to achieve strong neutron fluxes. The current stage of research focuses on the development of virtual models of the above-mentioned sources using the Monte Carlo simulation method. In this study, the GEANT4 tool was used, including the model for simulating neutron-matter interactions - High Precision Neutron. Models of neutron sources were developed on the basis of experimental verification based on the activation detectors method with the use of indium foil and the cadmium differentiation method allowing to separate the indium activation contribution from thermal and resonance neutrons. Due to the large number of factors affecting the result of the verification experiment, the 10% discrepancy between the simulation and experiment results was accepted.

Keywords : BNCT, virtual models, neutron sources, monte carlo, GEANT4, neutron activation detectors, gamma spectroscopy
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