AB004. Doses-distribution measurement for boron neutron capture therapy in a water phantom using a scintillator detector

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Background: Particle radiotherapy is the most common type of cancer treatment, as can be performed by an external source such as accelerators or an internal source by radioisotopes. Compared to conventional radiation therapy (photons or electrons), boron neutron capture therapy (BNCT) method is considered effective and successful in treating intractable cancers such as melanoma and glioma brain tumors. BNCT treatment planning includes determining the directions and fluxes of neutron and gamma radiation and analyzing the ratio of the radiation dose distribution and boron distribution in the patient's body in order to ensure efficacy and safety treatment for all patients and operators. Therefore, characterization of the neutron beam becomes an urgent task. In this work, the boron dose and gamma radiation dose in a water phantom were measured using a small-sized neutron detector for two neutron beam shaping assemblies at the Virginia Innovative Traineeships in Accelerators (VITA) accelerator facility and compared with the simulation results using the Nursing and Midwifery Council (NMC) code.

Methods: In this study, we used a neutron source developed at Budker Institute of Nuclear Physics and two neutron beam shaping assembly, one with a magnesium fluoride moderator and one with a Plexiglas moderator. The distribution of boron dose and gamma-ray dose within a water phantom is measured using a detector with three different sensors (a sensor with a plastic scintillator enriched with boron, a sensor with a simple plastic scintillator, and a sensor with a non-scintillator).

Results: The spatial distribution of the boron dose and the gamma-ray dose was measured in a water phantom, in a phantom similar to placing mice, and in air for a number of proton energies using a compact neutron detector with polystyrene scintillations. It has been established that the use of a magnesium fluoride moderator provides a greater ratio of boron dose to the sum of other doses and a greater depth of therapy, the use of a Plexiglas moderator provides a greater dose rate. Magnesium fluoride moderator should be used for patient therapy, Plexiglas moderator can be used for pet therapy and for testing new boron delivery drugs. It has been shown that the addition of plexiglass reflectors during irradiation of cell cultures and mice improves the dose rate and the quality of the neutron beam.

Conclusions: The BNCT method is promising in the treatment of intractable tumors such as brain tumors and melanoma. For this purpose, a compact accelerator-based neutron source has been developed at the Budker Institute of Nuclear Physics in Novosibirsk, Russia and a dosimeter made of a plastic scintillator enriched with boron for measure the spatial distribution of the boron dose and the gamma-ray dose.

Keywords: Radiation therapy; dose; plastic scintillator; beam shaping assembly; boron neutron capture therapy (BNCT)

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The approval of ethical statement is not required, because the research did not include human experiments or experiments on cells or animals. Doses were only measured in a phantom of water equivalent to the human body and in air.

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