Modified Collimator for Neutron Therapy Applications: Enhancing Narrow Beam Detection of Fast Neutrons

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In clinical practice, it is often necessary to concentrate neutrons emitted by a target in 4π space into a mono-directional beam. This process is crucial for increasing the particle flux density and optimizing the beam shape and cross-sectional area, while minimizing neutron absorption in structural elements. A collimator can be used to change the beam shape, significantly narrowing it and achieving optimal results. This paper presents simulation works using the MCNP5 code to investigate the feasibility of applying a narrow beam of fast neutrons, measuring 2 cm or less, in radiotherapy. The simulations were performed on the original design of an 8.5×8.5 cm^2 collimator for treatment, located in the cyclotron laboratory of Tomsk Polytechnic University. The results show that the neutron energy spectrum remains nearly unchanged in the fast region, while the neutron flux increases by approximately 11% when using the collimator with a 2 cm aperture. The spatial distribution of fast neutrons is significantly narrower at a distance of 10 cm from the aperture compared to the original design of 8.5×8.5 cm^2. The narrower and more intense neutron beam reduces damage to healthy tissue and decreases the treatment time, making the procedure more comfortable for the patient. Narrow beams offer the potential to make neutron beam radiotherapy safer and more accurate for the treatment of small and irregularly shaped tumors.