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Advances in neutron source modeling for BNCT applications

The production of neutron beams with optimal energy and angular distributions is crucial for Boron Neutron Capture Therapy (BNCT). While the 7Li(p,n) reaction is well established, the 9Be(p,xn) reaction is characterized by scarce data and inaccurate descriptions. We developed a model for the beryllium reaction that incorporates two dominant channels: (p,n), supported by experimental data, and (p,p'n), for which we introduced a data-driven parametrization to accurately describe double differential neutron yields. To enhance the production, we also proposed a bilayer beryllium–lithium target, validated through in-silico dosimetry with an anthropomorphic phantom. These models were implemented in a new Geant4 class to enable angle–energy correlated particle sources, extending the standard capabilities of the code. Finally, we explored epithermal neutron sources without Beam Shaping Assembly, identifying a methodological concern in a recent study on 45Sc. Collectively, these contributions strengthen the BNCT source design and provide foundations for more reliable clinical translation.

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