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A Compact Neutron Generator Based on D-D or D-T Fusion for BNCT*

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Abstract

Various different neutron generator systems have been made and are under testing at the Plasma and Ion Source Technology Group in Lawrence Berkeley National Laboratory. The neutron production is based on the D-D or D-T reaction. The deuterium or tritium ions are produced from plasma using either a 2 MHz or 13.56 MHz radio frequency (RF) discharge. RF-discharge yields high fraction of atomic species in the beam which enables higher neutron output. The beam is accelerated to energy of 80 keV or higher. The ion beam then impinges on a titanium coated copper or aluminum target where either the 2.4 MeV D-D or 14 MeV D-T neutrons are generated by fusion reaction. These neutrons are then moderated to thermal or epithermal neutrons for various applications.

The earlier theoretical studies of the applicability of the fusion based neutron generators for BNCT have shown that the ideal epithermal neutron source for brain tumor treatments can be created with the optimal beam-shaping assembly. With the optimal moderator and reflector configuration, the absorbed tumor dose comparable to other accelerator based neutron source doses can be achieved with a treatment time of ~45 minutes. Near the center of the brain an optimized D-T neutron source produces more than 65% higher tumor dose than the clinically used reactor spectrum at BMRR. Because of the small size of the neutron tube, two beams could easily be used in parallel to reduce the treatment time. In addition to beam diameter, the beam energy can be determined by the depth of the tumor to be treated. The sealed D-T neutron generator would be ideal for hospital operation.

Currently developed second-generation neutron tube is co-axial unlike the proto-type multicusp neutron tube where the accelerator column was axial. The dimensions of the neutron generator are approximately 25 cm in diameter and 40 cm in height. The cylindrical geometry allows larger target area which enables higher neutron yields and better cooling. This new target design has been implemented, which would allow higher power operation. Testing of this new tube design has been started and the results will be presented.

Keywords

Neutron Generator, Accelerator, D-D Neutron Source, D-T Neutron Source

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