Study on an accelerator based epithermal neutron source for a preliminary study of BNCT: Monte-carlo approach

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Boron Neutron Capture Therapy(BNCT) is a cancer treatment method using a high neutron capture cross section of slow neutron and boron. Recently, accelerator based BNCT is being actively studied because of the continuous development of accelerator engineering and the need for cancer treatment methods using high LET radiation. The accelerator-based neutron source is relatively small size compared to nuclear reactors, and the cost of construction is smaller than that of nuclear reactors, so it is advantageous for use in such as hospitals and research institutes. In general, the energy of neutron produced by accelerator was controlled through BSA because generated neutron's energy is not suitable to be used for neutron capture therapy.

In this study, a study on the production of epithermal neutrons using the cyclotron accelerator was performed using Monte Carlo simulation.

Be target was assumed to generate neutrons using Be(p,n)B reaction. The generation of neutrons was confirmed using a target, and based on this result, a device that can reduce the energy of neutrons, Beam Shape Assembly (BSA), was designed. BSA is a device that adjusts the energy of neutrons generated from the target and it is generally composed of parts such as fast-neutron filter, moderator, thermal neutron filter, gamma filter, and reflector. In this study, materials such as Fe, Al, MgF2, Cd, Bi, and Graphite were used for each component, and neutrons with various characteristics were generated through the specification change of components.MCNP (v6.2) was used as a Monte-Carlo simulation tool, and F4 tally was used to calculate the flux and energy spectrum of neutrons.

Various types of neutron energy could be obtained through the change of the BSA parts. It was confirmed that the generated neutron has a relatively low flux, high fast-neutron and gamma-dose compared to the IAEA recommendation because of low specification of accelerator.

Generated neutron source could be sufficiently applied in physical and boron-compound evaluation experiments with epithermal-neutron before full-scale BNCT.It aims to optimize BSA in the future. Based on this design, we are aiming for actual production, and it will be used for various physical experiments using ion chambers and bonner-sphere after production.