HU-1: Development of a collimator built-in type dose distribution shifter for boron neutron capture therapy to superficial tumour

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The Kansai BNCT Medical Center has a cyclotron based epithermal neutron source for clinical BNCT. The system accelerates a proton to an energy of 30 MeV which strikes a beryllium target producing high energy epithermal neutrons preferable for treatment of deep-seated tumours. While, clinical studies in the past have shown BNCT to be highly effective for malignant melanoma of the skin, to apply BNCT for superficial lesions using this system, it is necessary to shift the thermal neutron distribution so that the maximum dose occurs near the surface. One method is to utilise a bolus material (like conventional radiotherapy) to provide a build-up effect. However, there are a few difficulties with the use of bolus for BNCT, such as difficulty in placing the bolus over the treatment area due to the unique patient set up and the potential radioactivity of the bolus causing unwanted exposure to the patient. To overcome these issues, a dose distribution shifter (DDS) to fit inside the collimator opening was investigated. The PHITS Monte Carlo simulation was performed to determine the optimum moderator material and thickness. A polyethylene type material with a thickness of 2 cm was found to be the most optimum combination. Compared with the original neutron beam, the shifter increased the thermal neutron flux at the skin surface by approximately 4 times the measured and simulated central axis depth distribution and off axis distribution of the thermal neutron flux was found to be in good agreement with the simulated result. The irradiation time was reduced by approximately 15% with the DDS system. This system would not only reduce the treatment time but may also reduce the patient set up time due to the simple mechanism of placing the DDS into the collimator opening. With the system being interchangeable, it allows the user to freely adjust the condition to suit each individual patient treatment plan. Currently, the placement of the DDS into the collimator opening is a manual task, however, an automated exchanged system would be ideal from a safety perspective but also to speed up the set-up time even more.