Measurement of dose distribution in water phantom using twin small ionization chambers for Boron Neutron Capture Therapy

Yuya Kumagai[1], Takushi Takata[2], Keita Okazaki[1], Akinori Sasaki[1], Kiyotaka Akabori[3], Yoshinori Sakurai[2], Hiroki Tanaka[2]

[1] *Kyoto University, Engineering, Kyoto, Japan*

[2] *Institute for Integrated Radiation and Nuclear Science, Kyoto University, Osaka, Japan*

[3] *Sumitomo Heavy Industries, Ltd., Tokyo, Japan*

E-mail: kumagai.yuya.37n@st.kyoto-u.ac.jp

Introduction: At Kyoto University, Institute for Integrated Radiation and Nuclear Science (KURNS), clinical trials for recurrent brain tumors and head and neck tumors have been performed using Cyclotron-Based Epi-thermal Neutron Source (C-BENS). Thermo luminescent dosimeters (TLDs) in which BeO powder are sealed in quartz glass has been used as a method of confirming the gamma ray dose in a water phantom. As these specially manufactured TLDs may not be commercially available in the future, alternative methods of measuring gamma ray dose are desired.

Measurement of gamma ray dose with an ionization chamber is effective to simplify quality assurance. Normally, neutron and gamma ray doses are measured by twin ionization chambers, however the volume is as large as 2 cm^3, which may disturb the neutron and gamma ray field. In this study, we aim to establish the measurement methods of the dose distribution of gamma rays in water phantom using two small ionization chambers that can overcome the disturbance of neutron and gamma ray field.

Materials and methods: A graphite wall ionization chamber flowing carbon dioxide with low sensitivity to neutrons was used for the measurement of the gamma ray dose. A tissue equivalent ionization chamber flowing tissue equivalent gas was used for the measurement of neutron dose and subtracting the contribution of neutrons in a graphite wall chamber. The sensitive volume of each ionization chamber was 0.1 cm^3. In order to calibrate the dose for these two ionization chambers, the Co-60 gamma ray source was used. The correlation between the amount of charge measured by each ionization chamber and the gamma ray dose was determined.

An ionization chamber was set in a water phantom and epithermal neutron beam with a collimator size of 12 cm in diameter was irradiated using C-BENS. The charge amount was measured by an electrometer at each depth. The dose of each ionization chamber was determined using a calibration line. Furthermore, the gamma ray dose was evaluated.

Results: The measured dose rates of gamma rays at the 7.5, 17.5, 37.5, 55.0, and 95.0 mm depths were 3.3, 3.7, 3.4, 2.9 and 1.4 Gy/hr, respectively. When comparing the distribution of the measured values with the calculation results by MCNPX, the measurement results showed good agreement with the errors of 10% or less. The measured data was also consistent with the results of TLDs within the errors.

Conclusion: In this study, two small ionization chambers were used to measure the gamma ray dose in a water phantom. It was confirmed that twin small ionization chambers were able to be applied to simple quality assurance of the accelerator BNCT.