

Graphite calorimetry for absorbed dose measurements in heavy-ion beams

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In order to sophisticate the radiotherapy, high accuracy knowledge of the absorbed dose delivered to the patient is essential. The main methods of absolute dosimetry are indicated as follows: (a) Dosimetry by ion chamber, (b) Fricke dosimetry and (c) Calorimetry. The calorimetry is most direct method of dosimetry due to direct measurement of energy deposit in principle and no requirement of information of radiation fields for the calibration. Many countries tend to adopt the calorimetry to determine the standard absorbed dose to water and become to be capable of deciding the absorbed dose in precision of about 0.6 % for photon and electron beams. Despite the recent progress of particle therapy, the parameters such as w-value and stopping power ratio for ionization chambers in the particles is not obtained accurately. Therefore, that causes uncertainty in determination of the absolute dose. For this reason, we developed a graphite calorimeter to obtain high precision absorbed dose and reduce the uncertainty for various beams. When the absorbed dose of 1 Gy is irradiated to the sensitive volume, the temperature rise is about 1.4 milliKelvins. The performance require the resolution of plus or minus 7 micro Kelvins to measure it in precision of plus or minus 0.5 %. The stability within several micro Kelvins per minute is necessary to obtain measurable background. The miniature glass bead thermistors were embedded in the sensitive volume to perform active control of temperature. The resistance change of these thermistors is approximately 0.68 Ohms and 488 micro Ohms at temperature rise of 1.4 milliKelvins and 1 micro Kelvins from 20 degrees, respectively. The temperature-measuring thermistor is connected to a Wheatstone bridge and the resistance change is measured by lock-in amplifier and nanovoltmeter. Simulations and experiments have been performed for photon and various heavy-ion beams.