Experimental Examination of Real-time Gamma-ray Spectrum / Dose Monitor

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Abstract

Radiation has become an integral part of current medical treatment. However, in the medical field, treatment of patients is the first priority, meaning there may be a tendency that radiation exposure of medical staffs is not so focused on. In the authors' laboratory, development of a portable monitor is underway that can measure the energy spectrum and dose of γ-rays simultaneously in real time for medical use. We believe that this spectrometer could enhance awareness of the exposure dose of the medical staffs. As a result, it would lead to finally reduce exposure dose at the medical field. So far, we developed a prototype spectrometer and confirmed its basic properties using standard gamma sources. In addition, it was found by the measurement in a fuel storage room of the authors' laboratory, where a large number of gamma rays are mixed, reconstruction of the gamma ray energy spectrum and the dose estimation can simultaneously be carried out in real time in a relatively strong radiation field. Meanwhile, in this monitor a scintillation detector of CsI (Tl) crystal (2.6×2.6×2.6 cm^3) combined with a Multi-Pixel Photon Counter (MPPC) was adopted in order to reduce the size and weight. To realize real-time measurement of gamma-ray energy spectrum, we employed the sequential Bayesian estimation method to convert measured pulse height spectrum to energy spectrum.

In this study, it was examined by experiments whether dose and energy spectrum can be estimated simultaneously in real time using the present prototype monitor in the background gamma-ray field, which thought to be the weakest radiation field. This means that it is possible from the experimental results to examine whether the size of the CsI (Tl) crystal currently used is appropriate.

As a result of the series experiments, it was found that dose estimation did not converge if setting α as a constant in the sequential Bayesian estimation method (so-called α method) normally used for gamma-ray energy spectrum reconstruction, because the background field is very weak, i.e., the counting rate becomes small. To overcome this difficulty, the α value was set changing continuously according to the count number. The exposure dose was thus able to be estimated in real time. However, with regard to real-time measurement of energy spectrum, the counting rate may still be so small that

the estimation accuracy was low and should be improved.

In the next step. we will find out the lower limit dose value at which the energy spectrum can be estimated in real time with the current crystal size. Also, we will confirm the feasibility in a field stronger than the fuel storage room (~2μSv/hr). Based on these results, we will finally complete the commercial base gamma-ray spectrum / dose monitor.