論 文 の 内 容 の 要 旨

論文題目　Design of Quantitative Radioactivity Imaging Systems With Gamma Camera Technique
(ガンマカメラを用いた定量的放射能イメージングシステムの設計)

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The gamma ray emitting radioisotopes are injected intentionally, as for diagnosis in medical imaging, or dispersed accidently, as release from the nuclear reactors after the accident. In former case, 3D image is preferred for the high sensitivity, whereas, 2D image is obtained in the latter case. Quantitative gamma ray imaging can explain the radiotracer concentration present in region of interest (ROI) in a much better way as compare to conventional gamma ray imaging for quantitative PET as well as new drug development. Hence, we considered both 2D and 3D case and used the existing instruments to move towards quantitative images for the medical applications as well as for the environmental radioactivity monitoring. As a first case, EGS5 simulations are performed by discretizing the complex geometries of radiation sources into simple ones for initial guess, verification of results, and laboratory experiments. Finally, these simple geometries were used to reconstruct the realistic radiation sources.

Gamma ray imaging is widely used in many applications of medical imaging for diagnosis purposes. The non-invasive diagnosis imaging procedures involve injection of radiotracer and measuring its concentration in the body through gamma sensitive detection systems like SPECT/PET. The PET, an important tool with potential of quantitative imaging, is seldom used for quantitative measurements due to the requirement of blood sampling which is incompatible with clinical applications. Using various advantages and tremendous efforts for the development of small animal PET imaging systems, we used LuAG-APD based small animal PET system, developed at our laboratory, for the non-invasive

measurement of radiotracer concentration in blood to avoid the manual blood sampling problems and hence, exploit the full potential of quantitative PET. Sensitivity and spatial resolution are the two important parameters to obtain a quantitative image of fore arm. As for the clinical applications, the most important parameter is measurement time which is determined from the sensitivity of the tomograph. Thus, we considered the sensitivity as a factor of prime importance in this study. EGS5 simulations results using realistic geometry of four segmented LuAG-APD detector modules are presented. We are hopeful that this tomograph with eight detector modules has the potential to image fore arm artery within reasonable measurement time interval.

Gamma camera was primarily proposed for medical applications; however, it is also used for environmental radiation monitoring. Tungsten pinhole collimator CdTe gamma camera is proposed to be used for the monitoring of radioisotopes dispersed in environment especially after the accident. We intend to design the systems for the aerial monitoring, fast and for vast area monitoring, as well as for the detailed ground monitoring especially damaged systems of nuclear reactors, based on the lesson learnt from the accidents. The accurate, fast and remote monitoring of released activity is expected to be helpful for authorities in decision making like evacuation, effectiveness of actions taken to countermeasure the accident, and specify the areas to be decontaminated.

Finally, accurate detection of radioactivity ensures the safe use of radioisotopes. We are hopeful that this work will contribute to help to exploit the full potential of quantitative PET through patient and staff comfort as well as safe and economical use of nuclear energy.