

#### §4. The Proposal for Gamma-ray Imaging Detector

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We have been developing a radiation detector system which can obtain gamma-ray imaging data of far-off radiation source, for example deposited radionuclide on wall surface or induced radioactivity of materials, in nuclear facilities. The system can identify distribution and intensity of radiation source, and it can visualize remote existing source with visible scene.

There are three types of gamma ray imaging detectors under development or practical use before the present study. The first type is radiation detector with collimator. That is limited opening view, solid angle using collimator made from lead or tungsten. Then, sensor with collimator is scanned to obtain the wide angle of gamma ray imaging. The second one is the system like as radiography, mask pattern is placed between radiation source and detector. Then distribution of radiation source is estimated from the detected shade pattern. And the third one is a Compton camera. The gamma ray detected by the first stage detector is traced with the second part detector, obtaining scattering direction and energy. The device with collimator has short point that is small detection efficiency because of limited solid angle. Compton camera requires complicated and precise signal processing system.

In this study we propose a gamma ray imaging detector, which has high efficiency and without collimator. This equipment has different concept from the former three types detectors. Large area

scintillator is applied as detection unit in the present instrument. The system use the characteristic that the sensitivity of large area scintillator is depend to incident angle of gamma ray. Since it does not use collimator and install large volume scintillator, the detection efficiency is given very larger order than the other former gamma ray imaging detector. Additionally, this does not need complex signal processing system.

The detection efficiency of scintillator is determined by amount of incident fluence and absorption about gamma ray. The amount of incident fluence to scintillator becomes maximum on vertical incident, minimum on parallel incident. In this situation, when absorption coefficient is enough large, largeness of efficiency is roughly determined by the amount of incident fluence.

We calculated sensitivities between gamma ray incident angles, where the scintillator size is fixed  $50\text{cm} \times 50\text{cm} \times 5\text{cm}$ , and absorption coefficient is varied. In the case of NaI(Tl), incident energy of gamma-ray, 0.1, 0.3, 0.6, 2.3 MeV is correspond to absorption coefficient, 514, 29, 14, 9, respectively. Figure 1 shows the result. These values are normalized to vertical incident which is 1.57 radian. Different sensitivity between incident angles increase, when absorption coefficient increases.

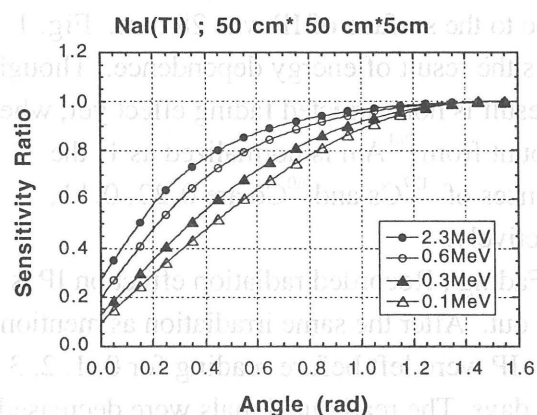


Fig. 1. Sensitivities in various incident angles.