§9. Study on Radiation Measurement Using Imaging Plate in Photon-neutron Mixed Field

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When using an imaging plate for dosimetry, there still remains a problem that fundamental characteristics of imaging plate have not been investigated sufficiently. Energy response of imaging plate for low energy photons is one of these important characteristics. Several reports have discussed on this energy dependence, but most of these lack in either theoretical analysis or experimental verification.

The purpose of this report is to precisely evaluate the energy response of imaging plate to photons of its energy around a few tens of keV, both by measurement and by computer simulation.

Experiment was performed in synchrotron facility named Photon Factory at High Energy research Accelerator Center (KEK). Monochromatic light produced from synchrotron orbit light was used as photon source. Fig.1 shows the geometrical setup of the experiment. White X-rays emitted from storage ring was monochromized using silicon double crystal, then exposed to imaging plates (BAS-MS, cut into 5 cm square) after φ 5mm collimator. Half width of source spectrum at each energy was approximately 1 %. At each energy, imaging plates were exposed to the source beam for 10 minutes and the output of imaging plate was read out 15 minutes after exposure. This exposure was repeated 3 times at each energy. 900 to 9000 photon / mm^2 photons were exposed to imaging plate in each exposure.

Computer simulation was performed using monte-carlo code EGS5 (Electron Gamma Shower Ver.5). Energy absorption of photon in phosphor layer, which is radiation sensitive layer of imaging plate, was calculated for each photon energy. However, response of imaging plate is considered to vary depending on depth in phosphor layer where radiation energy was absorbed. This comes from the supposition that output light emitted from certain depth of the phosphor layer will be attenuated by the material above when reading imaging plate. Thus the deeper the radiation is absorbed, the weaker the output would be. Here, phosphor layer was divided into several layers (Fig.2) for analysis and absorption energy in each layers were calculated. By weighting absorption energy in each layer according to its depth, response of imaging plate was estimated.

Fig. 3 shows the energy response of the imaging plate obtained by experiment and by monte-carlo simulation. Value of the simulation result is normalized by the experimental results at 40 keV. Result of experiment and simulation correspond to each other with accuracy of 3 %. Discontinuity of its response near 13, 34 and 37 keV comes from K-absorption of bromine (13.3 keV) and barium (32.2 keV, 36.4 keV) which are components of phosphor layer.

In this research, energy response of imaging plate to low energy photons was obtained. In order to use imaging plate for dose estimation in photon-neutron mixed field, it is also important to discuss this kind of precise characteristics.

In addition to developing radiation separation techniques, we will continue to perform this kind of fundamental characteristics experiments.

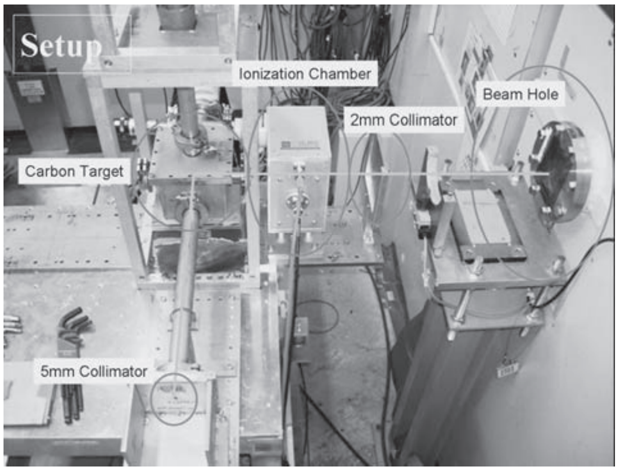

Fig. 1 Experimental setup

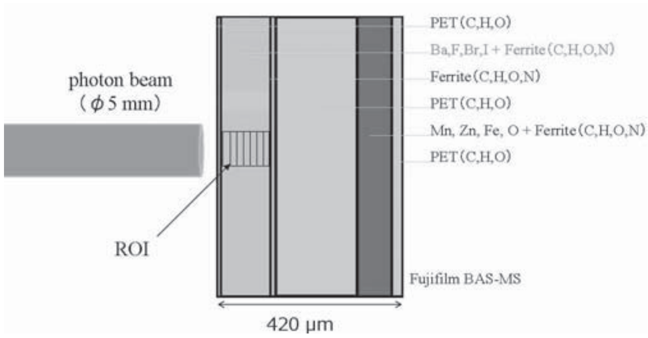

Fig. 2 Geometry of calculation

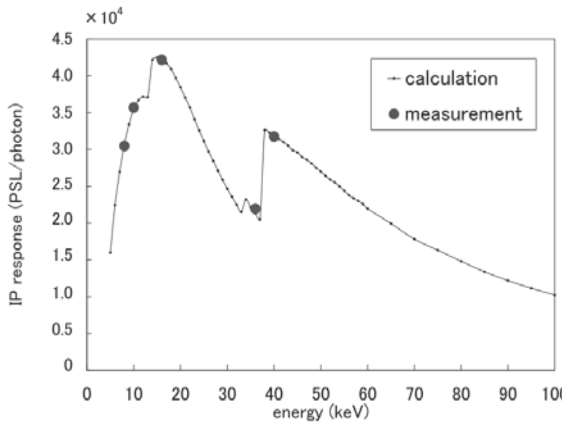

Fig. 3 Energy dependent response of imaging plate obtained by calculation and measurement.