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Energy Response of Imaging Plate to photons from 10 to 60 keV

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Introduction

An imaging plate (IP) is a two dimensional integrating radiation detector developed as a substitute for medical X-ray film. IP is used for many opportunities, such as X-ray examination in medical field, X-ray inspection in industrial fields, research fields and others. Due to its sensitivity and its 2-dimentional characteristics, IP is also expected to work as a personal dosimeter.

One of the important characteristics of IP is that the sensitivity to photons differs according to exposed photon energies, especially in low energy regions below few hundred keV [1]. Therefore, the energy response of IP to low energy photons is necessary to realize accurate dose estimation. Several experiments have already been performed to investigate the energy response of IP to photons. However, these experiments to low energy photons were performed by using X-ray generators and filters such as copper, led, tin or cadmium combined together, which can only generate photon with wide distribution of energy.

For the purpose of accurate dose estimation, it is a must to obtain energy response of IP to low energy photons using mono-energetic X-rays. By using synchrotron radiation in Photon Factory at the High Energy Accelerator Research Organization, whose energy dispersion could be minimized up to nearly 1 %, we could obtain the accurate energy response of IP.

Experiment

In the experiment, IPs were exposed to photons monochromized by double crystals, whose energies were 10, 20, 37, 40, 50 and 60 keV. These experiments were carried out by using commercially available IP, BAS-MS (Fuji film Co.) The system of the experiment is described in Figure 1. Photon beam monochromized by double crystals was scattered at 90 degrees direction using a carbon target. Photon beams were then uniformalized using 5 mm collimator then exposed to IPs. IPs were cut into 5 cm square to meet the size of the equipment. At each energy, a germanium detector was used to investigate the energy spectrum of the irradiated photons. An ionization chamber was used to estimate the number of photons which hit the IP in the exposure. The number of photons ranged about 4,000 to 10,000 per mm^2 in each exposure. The IP output was read out 24 hours after exposure, using BAS-1800 (Fujifilm Co.)

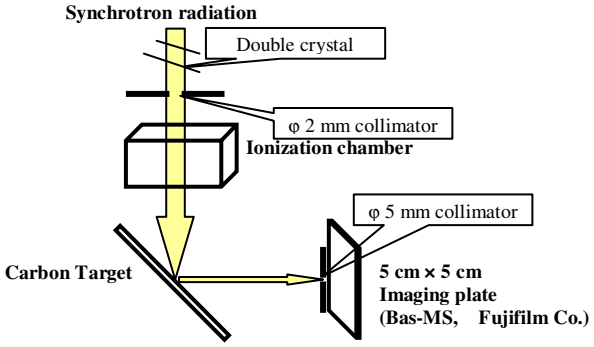

Figure 1. Experimental setup

Results and Discussion

Relationships between photon energy and the IP output are shown in Figure 2. IP shows highest output to photons near 20 keV (0.005 PSL/photon). Energy response falling drastically at 37 keV describes that there is absorption of photons near the energy. Also, energy response plateaued below 20 keV suggests that low energy photons were absorbed by surface layer on top of phosphor layer.

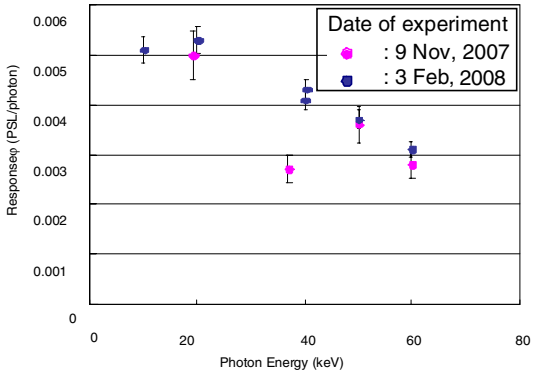

Figure 2. Energy response curve of the Imaging Plate

Conclusion

Energy responses of IP to several energy photons were obtained. The data suggests that IP's energy sensitivity to low energy photons is strongly influenced both by X-ray absorption properties of $BaFBr:Eu^{2+}$ phosphor layer, and existence of surface layer (polyethylene terephthalate) above the phosphor layer.

Reference

[1] A. Yamadera et al., Radioisotopes 42 (1993) 676.

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