Radiation Exposure Due to Synchrotron Radiation within Beamline Experimental Hutch

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1. Introduction

Measurement was carried out to get the exposure distributions within a hutch due to linearly polarized synchrotron radiation white beam originated from the BL-14C of KEK. The data were analyzed with a beamline shielding design code STAC-8[1] and a Monte Carlo simulation code EGS4[2].

2. Experimental and Calculational Methods

Figure 1 gives the arrangement of the experimental setup, installed in the experimental hutch with sizes of 4.5m long, 4.5m wide and 4.0m high. The virtual five planes parallel to the X-Y plane were considered, on which LiF TLD were set on the concentric circles of various radial length. In order to simulate a configuration of optical elements, the mono-crystal Si disk of 152.4mm in diameter and 23mm in thickness was introduced as photon scatterers in two ways. One is set perpendicular to the X-Z plane with inclination of 30° against the X-axis, defined as Si(X) geometry and another one is perpendicular to the Y-Z plane with inclination of 60° against the Y axis, defined as Si(Y) geometry. One more case of no photon scatterer was also employed.

The exposure distribution in case of no Si scatterer was calculated with the EGS4 code. The calculational configuration consists of semi-infinite slabs of various materials (one slab for Be, one for Al and 12 for air). Rectangular photon beam is incident normal to the berilium slab surface. In case of Si scatterer, however, the STAC-8 code was used to obtain the photon energy spectrum of the synchrotron radiation ranging from 1 to 500 keV and also the exposure distribution due to scattered photons.

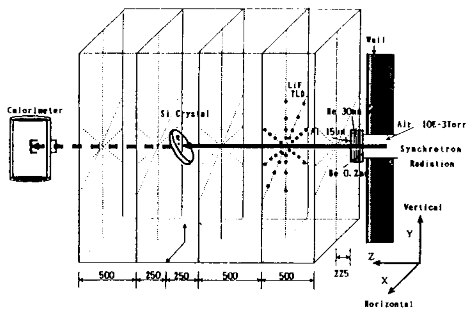

Fig.1 Arrangement of the experimental setup.

3. Results

In case of no scatterer, the exposure distributions show apparent effect of the photon polarization, giving an asymmetric angular distribution. Being averaged over azimuthal angle, however, they can be approximated by the power of radius R.

Figure 2 gives the exposure distribution along the X-axis (horizontal axis) at the azimuthal angle of 90° just behind the Si scatterer. The figure shows that the distribution for the Si(Y) geometry is lower than that for the case of no scatterer and that the exposure decreases rapidly with decrease of radius R because of shadow effect. The STAC-8 calculation shows close agreement with the measurement for the Si(Y) geometry, in the region of larger R, where the geometry is simple and besides no shadow effect is there.

Figure 3 shows the exposure distribution along the Y-axis (vertical axis) at 0° behind the Si scatterer. The features you easily notice are that the distributions for the Si(X) and Si(Y) geometries are nearly equal at the region of larger R and that the STAC-8 calculation agrees well with the exposure distribution for the Si(Y) geometry.

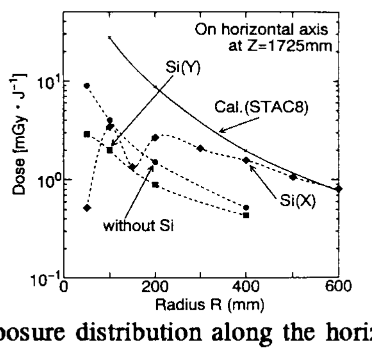

Fig.2 Exposure distribution along the horizontal axis behind the Si scatterer.

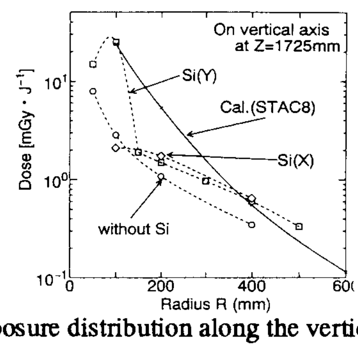

Fig.3 Exposure distribution along the vertical axis behind the Si scatterer.

References

[1] Y.Asano and N.Sasamoto, Radiat. Phys. Chem. Vol.44 133 (1994).

[2] W.R.Nelson et al., "The EGS4 Code System", SLAC-265 (1985).