Development of Shielding Design Code for Synchrotron Radiation Beamline[1]

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1. Introduction

PHOTON code[2] has been utilized for shielding calculations for beamlines of some synchrotron radiation facilities involving the ESRF. For making the beamline shielding calculation for the SPring-8, we developed a new shielding code STAC-8 on the basis of the PHOTON code, by overcoming some shortcomings involved in the code. Flow chart of the code is given in Fig.1.

2. Characteristics of the Code

The code starts its calculation with determining the synchrotron radiation spectrum. Secondary, calculations are made for photon attenuation and heat load in optical elements, and finally doses outsides the shield wall are obtained considering angular dependent scattering cross sections and K-fluorescence radiation. The distinctive features of the code are:

(1) adding the undulator source calculation;
(2) taking account of angular dependent coherent and incoherent scattering cross sections and photon polarization effect;
(3) introducing buildup factors for shielding calculations; and
(4) incorporating calculations of 10mm, 3 mm, 0.07 mm depth doseequivalent or absorbed dose.

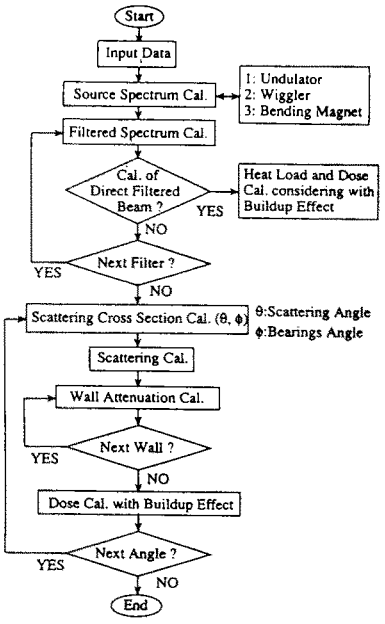

Fig.1 Flow diagram of STAC8

3. Preliminary Shielding Calculation

We carried out preliminary shielding calculations for the typical beamlines (bending magnet, undulator and wiggler) of the SPring-8. As an example of the results, Fig. 2 shows the angular dependence of dose equivalent outside the shield wall for a wiggler radiation. Here the angle is measured from the moving direction of the incident beam. As apparently seen from the figure, the dose distribution outside the shield wall depends strongly on photon scattering angle, forming its peak around the angle of 40° to 50° The peak can be formed by the combined effects of angular differential scattering cross section and variation with angle of slant length of the shield wall.

4. Validity Verification of STAC-8

In order to verify its validity, the calculation of the benchmark problem using STAC-8 was compared with the Monte Carlo calculation using an electro-magnetic cascade simulation code EGS4[3]. Excellent agreement between the two calculations was confirmed except for the region of small scattering angle, where STAC-8 calculation overestimates the EGS4 one by a factor of two or slitely more.

From the above result it is concluded that using STAC-8 we can carry out shielding design calculations for the beamline easily and quickly with satisfactory accuracy.

References

[1] Y.Asano and N.Sasamoto, Radiat. Phys. Chem. Vol.44 133 (1994).
[2] D.Chapman, "PHOTON; A User's Manual", BNL 40822 (1988).
[3] W.R.Nelson et al., "The EGS4 Code System", SLAC-265 (1985).

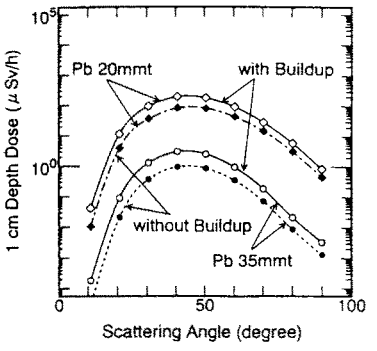

Fig.2 Calculated dose outside the beamline shield as a function of scattering angle.