NEUTRON AND PHOTON SKYSHINE FROM ELECTRON SYNCHROTRON

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The neutron and photon skyshine has been measured to estimate the dose level of the surrounding environment. The electron was accelerated up to 650 MeV and the monitor currents were about 80 mA in the ring. The ring is 11.6 m in diameter and 1.25 m high and is surrounded with the concrete whose thickness is 1 m on side wall and 0.5 m on ceiling as shown in fig. 1. In order to get the distribution of the skyshine source intensity, the dose measurements were carried out around the outer surface of concrete. It gave us the following results,

	On ceiling	On side wall
Neutron	20 - 30 mrem/hr	1 - 5 mrem/hr
Photon	50 - 100 mrem/hr	5 - 10 mrem/hr

excluding several localized leakage places. This revealed that the skyshine effect due to the leakage radiation from the synchrotron ceiling mainly contributes to the environmental radiation dose.

In the skyshine experiment, the measurements were performed in two directions, that is, in the INS area and in the vast field, as seen in fig. 2. The big BF_3 counter of 14.7 cm x 207 cm was also used with 6.5 cm polyethylene moderator to investigate the profile of long-distance neutron propagation. Figure 3 shows the neutron dose distribution in the field, D(r) as a function of the distance from the center of the synchrotron ring r. From fig. 3, it is found that

1) the absolute value of neutron dose is larger in the INS area than in the vast field at the same r point, due to the influence of buildings,
2) the neutron attenuation through air increases with decreasing the neutron energy and the neutron spectrum becomes harder with the distance r,
3) D(r) can be approximated as $D(r) = D_0 r^{-n}$ ($n \approx 2.7$) and the value of $n \approx 2.7$ is very close to 2.6 for the case of FM cyclotron.

Figure 4 shows the neutron energy spectra on the synchrotron ceiling and at r = 110 m in the INS area. The neutron spectrum in the field is much softer than the source neutron spectrum. Figure 5 shows the photon pulse height spectra at several field points. It is remarkable that the photon spectrum has a broad peak around 5 MeV which may be considered to be due to capture γ rays from concrete and earth.

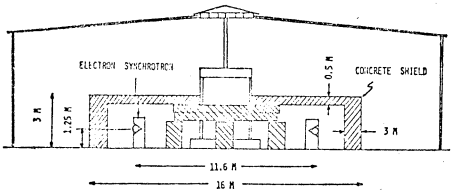

Fig.1. Cross Sectional View of Electron Synchrotron and Concrete Shield

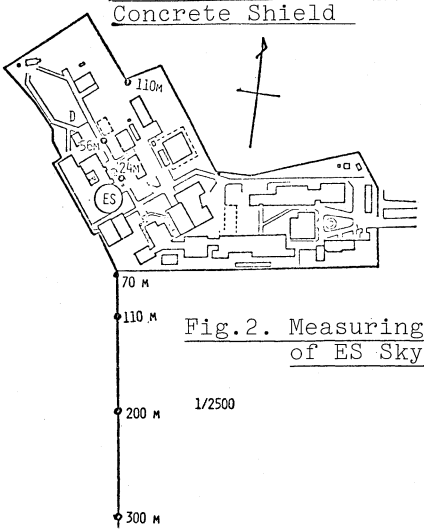

Fig.2. Measuring Points of ES Skyshine

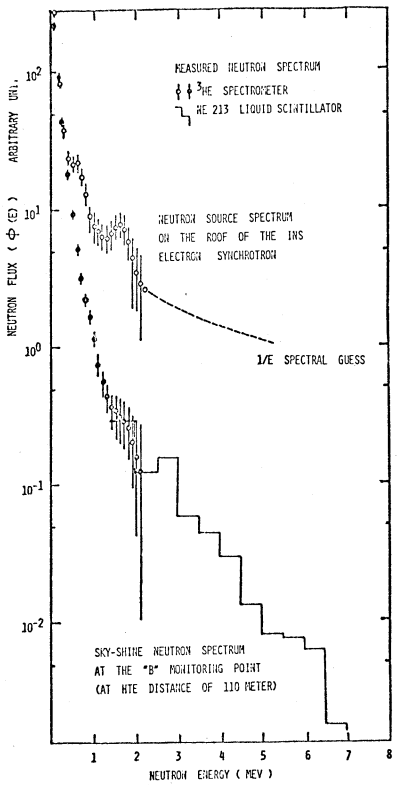

Fig.4. ES Skyshine Neutron Spectrum

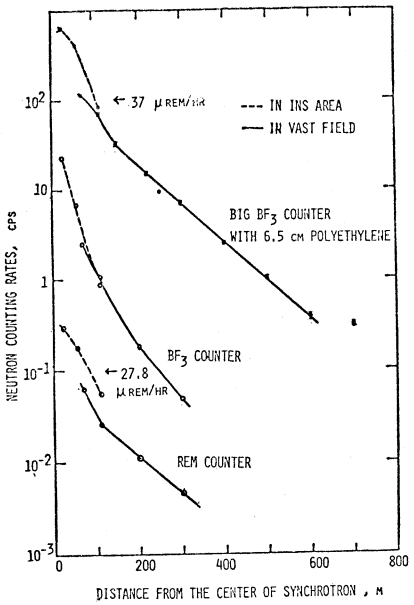

Fig.3. Neutron Propagation from Electron Synchrotron

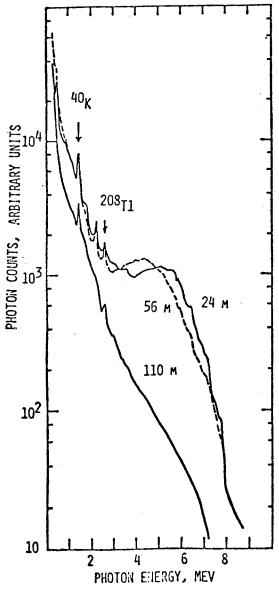

Fig.5. Photon Pulse Hight Spectra at Several r Points in the INS Area