MEASUREMENT OF STRAY NEUTRON SPECTRA FROM 8 GEV PS AT HIGH ENERGY PHYS. LAB.

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1. Introduction

Around high energy accelerators, the largest contribution to total dose comes from neutrons in the energy interval from 0.1 to 30 MeV. Organic scintillators were used to measure neutron spectra and spectra from 1 to 60 MeV were determined. There were two components, cascade neutrons and evaporation neutrons. Gamma ray spectra were also measured using the same organic scintillators.

2. Measurements

Liquid scintillators NE-213, 3 inches in diameter and 3 inches long, were used as spectrometers. RCA 8575 and 56 AVP photomultiplier were used. Neutrons and gamma-rays spectra were measured by using of two kinds of the pulse shape discrimination technique, zero-crossover method and rise-time to pulse height conversion method[1]. Degree of the n-γ discriminations were fairly good for both methods in the neutron energy range from 1 to 60 MeV, i.e. 200 : 1 dynamic range, in the burst neutron field up to about a few mrem/h.

3. Unfolled spectra of neutrons and gamma-rays

Response functions of the NE-213 scintillators to neutrons and gamma-rays were calculated by Monte Carlo method. Because of wall and end effects and also of the statistical errors, unfolded neutron spectra were of greater uncertainties above 50 MeV. The differential method was used to obtain neutron spectra. Two examples of the obtained neutron spectra are shown in Fig.1, the one is for the radiation field on the shield surface above the internal target and the other above the injection point from the booster to the main PS. It is seen from the figure that the former due to stray neutrons through the concrete shield of 5.5 m is a typical 1/E spectrum, and the latter due to neutrons through the earth shield of 5.5 m is much softer. Photon spectra obtained on the shield surface above the internal target were shown in Fig.2. The unfolding code FERDO[2] was used in the analysis. Gamma-rays due to H and Si in the concrete are seen. Energy spectrum of the recoil protons is shown in Fig.3. Wall and end effects are seen at about 100 MeV.

4. Results

The neutron spectrum on the shield above the internal target (rectangular to the beam direction) was the 1/E spectrum. But for the beam directions cascade neutrons are more dominant. Cascade neutrons are hardly seen on the earth shield above injection point from the booster to the main ring where the most of the lost beam are 500 MeV protons. For gamma-rays, dominant are capture gamma-rays, but their contributions to the total dose are small.

References:
1). S. Kinbara, et al., Nucl. Instr. Methods, 70, 137 (1969).
2). W.R. Burrus and V.V. Verbinshi, ANS-SD-2, 148 (1964).

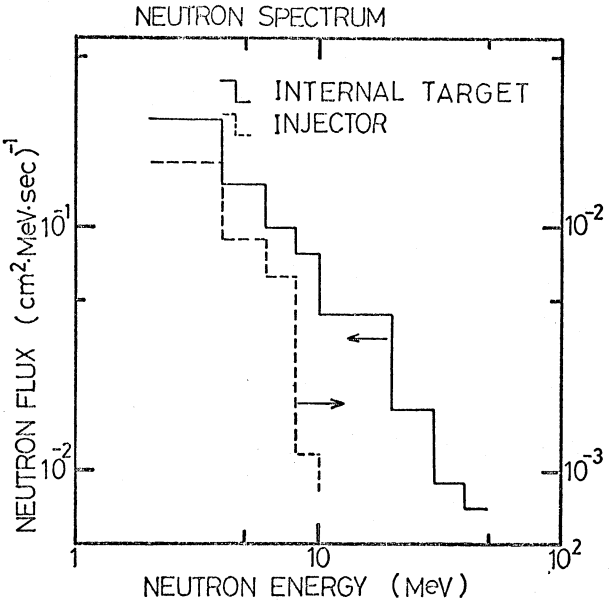

Fig. 1

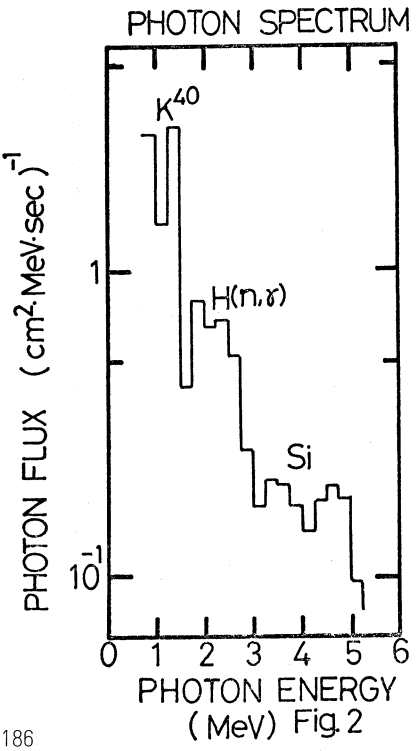

Fig. 2

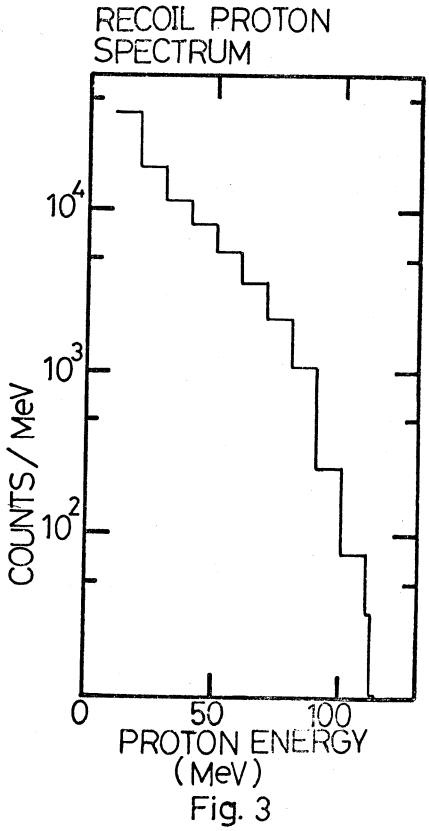

Fig. 3