P-94

基礎科学

Plastic Scintillator Response and its Properties for Radioactive Sources Dosimetry

■ はじめに

Plastic scintillator is a simple material in which a primary fluorescent emitter, called a fluor, is suspended in a solid polymer matrix. Plastic scintillator (PLS) shows desired characteristic in dosimetry; tissue-equivalence due to their closely atomic components (Z), compared to other inorganic scintillator such as NaI. This is a desirable characteristic for measuring radiation dose, either for radiation monitoring or as a personal dosimeter and it is relatively energy independent. In a clinical setting, plastic scintillator (PLS) detector had been proposed to measure soft tissue dose (rate) directly without requiring any conversion/correction factors that normally used for other common detectors. Many studies had been carried out for plastic scintillator dosimetry for high-energy applications (MeV). However, availability research of PLS dosimetry in a laboratory setting (scintillator coupled with PM-tube) for assessing gamma dose rates is not entirely satisfactory.

■ 活動内容

Compton scattering of radionuclides gamma rays with energies from 3 MeV to a few hundred keV produces scattered radiation with energies of 140-220 keV for scattering angles between 120^0 and 180^0. Thus, it is important to evaluate low-energy applications (<0.2 MeV) of plastic scintillator for assessing gamma dose rates.

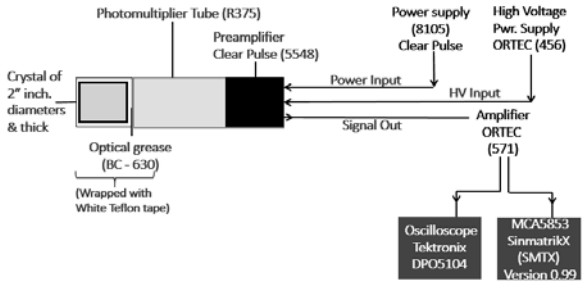
Measurements were made using spectrometry equipment, as shown in Fig. The gamma-ray source Cs-137 (662 keV) or other reference source was placed 10cm away in front of the plastic scintillator. The size of the circular cylinder of plastic scintillators was 50.8mm in diameter and in 50.8 mm depth. The plastic scintillator was covered with 3 layers of white Teflon tape reflector. The plastic scintillator was directly attached to a photomultiplier tube with optical grease. Then the plastic scintillator and the photomultiplier tube (Hamamatsu R375) were wrapped with aluminum sheet. The electric signal from the photomultiplier was amplified by an amplifier (ORTEC 456) and acquired with a multichannel analyzer (SinmatrikX: MCA/5853 Version 0.99).

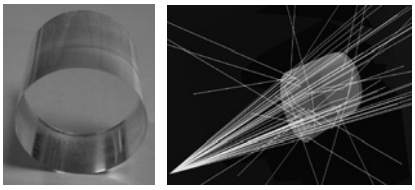
As a starting point, the measured and calculated absorbed dose rate of middle energy region (200 to 800 keV) were determined by direct summation of energy deposition throughout the volume of the detector (MeV/g). Monte Carlo methods for electron and photon transport (EGS5 code) were used to simulate the response of a 2”×2” plastic scintillator detector using a point 4π isotropic source. The percentage of differences between measured and calculated absorbed dose rates are less than 10%; for Backscatter field 190 keV (6%), Cs-137 (5%) and Mn-54 (3%).

The result showed that the detector system can be used to measure the absorbed dose above 200 keV and the absorbed energy spectra. However the detector system was not able for absorbed dose measurement at ~120 keV photon field (gamma/X-ray) due to ‘unreasonable’ actual measured energy spectra of plastic scintillator.

■ 関連情報等(特許関係、施設)

The measurements were done at the radiation calibration facility, KEK, Japan.





Above figure showing the block diagram of electronics used in the experiment. Below is the actual plastic scintillator photo.

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■キーワード: (1) Plastic scintillator
(2) Gamma dose rates
(3) Low-energy applications