Depth position measurement ability of SGT's planar strip Ge detector

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The SGT (Strip Germanium Telescope) detector was developed about 20 years ago to realize the Doppler shift correction of gamma rays emitted from nuclides in flight.[1)] SGT has a planar strip Ge detector at the front face that has position sensitivity in the direction along the accelerator beam axis, and it can detect photoelectric interaction or Compton scattering of incident gamma rays. The Compton scattered gamma rays are detected by the large volume coaxial Ge detector placed behind. Thus, SGT can detect the emission angle of gamma rays to perform Doppler shift correction, assuming that the emission point is the target center position.

To increase the detection efficiency with a single SGT detector, one effective approach is to place the detector as close as possible to the target. This is an advantage of using semiconductor radiation detectors that can have fine pixelation. However, simply pixelating the surface of the semiconductor detector can cause angular uncertainty of the gamma-ray emission direction because of the thickness of the planar Ge detector. Thus, we investigated the depth position measurement ability of the SGT's planar Ge detector that can determine where in the thickness of the planar Ge crystal the gamma-ray interaction occurred.

In the measurement experiment, we connected the output signal of the SGT detector to the data acquisition (DAQ) system of the GREI[2)] detector. The diagram of the connection is shown in Fig. 1. Owing to the modification in the previous works of the SGT's planar Ge detector that enabled both anode and cathode signals to be obtained, we were able to utilize the timing method implemented in the GREI DAQ system to determine the depth position. In the depth measurement experiment, we placed a lead collimator with a 3-mm-diameter hole to limit the depth position of the incident gamma rays emitted from the ^{152}Eu gamma-ray source as shown in the top-left of Fig. 3. From the acquired data, we selected events in which only one of the strips had a valid signal and the time difference between the anode and the cathode of the planar strip Ge detector was calculated to deduce the depth position.

Figure 2 shows the gamma-ray energy spectra obtained in the experiment. Owing to the good energy resolution of the SGT detectors, we were able to obtain sharp peaks for each intrinsic gamma ray and FWHM

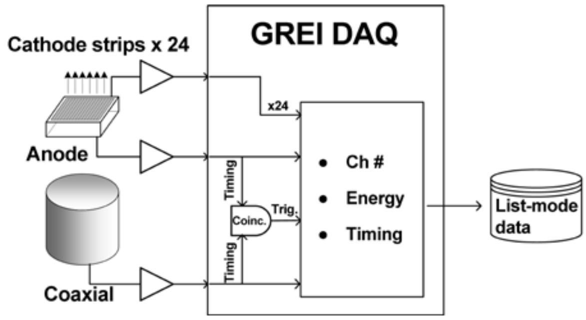

Fig. 1. Connection of the SGT detector to the GREI DAQ system. Coincidence measurements between strip and coaxial Ge detectors were performed and the list-mode data were collected.

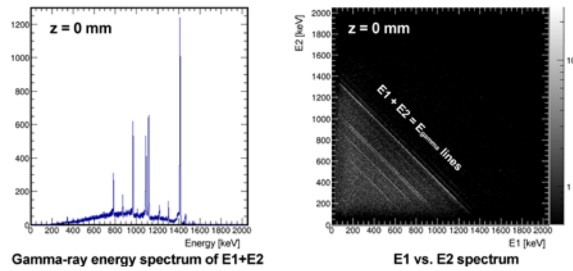

Fig. 2. Gamma-ray energy spectra obtained in the experiment. Only single strip hit data were used for the data analysis.

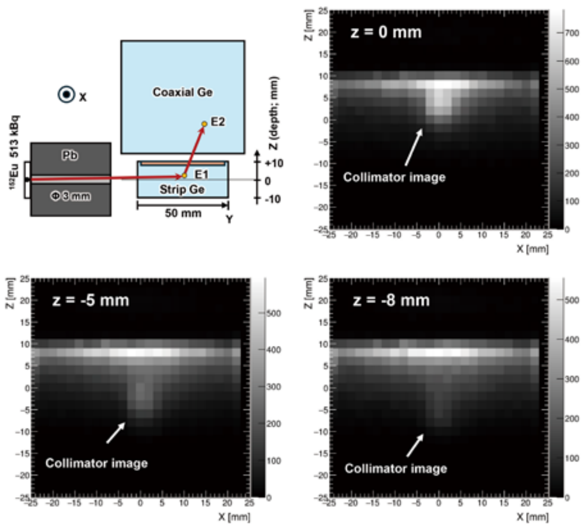

Fig. 3. Result of the depth position determination. The top-left shows the setup. The strips run parallel to the Y axis on the surface facing towards the coaxial Ge. The collimator Z position was changed for each measurement.

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DOI:10.34448/RIKEN.APR.58-073

energy resolution of 4.7 keV for 1408 keV gamma ray that is better than that of previous report.[1)]

The result of the derivation of the depth position is shown in Fig. 3. We were certainly able to obtain the response of the collimator hole image depending on the collimator position. However, there appeared an artifact that has a structure of z = constant, which indicates that there are a significant number of synchronized timing signals between anode and cathode strips, probably caused by the crosstalk previously reported. We need to further investigate the signal pulse shapes to identify the cause of the artifact and perform more sophisticated analysis to apply the depth measurement method to practical experiments.

References
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