DATA ACQUISITION AND ANALYSIS FOR THE SEGMENTED GERMANIUM DETECTOR TEST STAND

K.L. Miller, C. Campbell[a], T. Glasmacher, W.F. Mueller, E. Strahler

In order to achieve good energy resolution with the new segmented germanium detector array [1], the position of photon interactions must be precisely measured. The 32-fold electronic segmentation of each germanium crystal (Fig. 1) allows the interaction point to be localized to within one centimeter. The germanium crystal must be kept at liquid nitrogen temperatures, so determination of the position of each segment within the detector cryostat is necessary in order to measure the photon interaction positions with respect to the target.

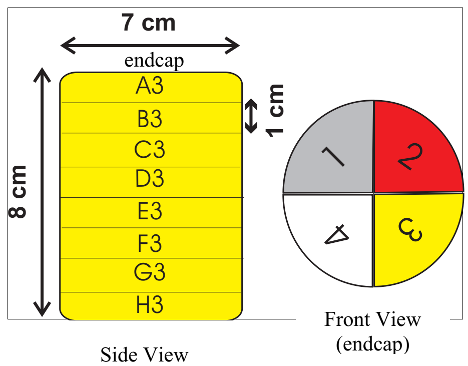

Figure 1: Electronic segmentation of the germanium crystal.

The detector manufacturer, Eurisys Mesures, specifies the position of the crystal in the cryostat to within two millimeters. A difference in position of one millimeter in the laboratory frame corresponds to a difference in center-of-mass energy of about 10 keV, so more accurate measurements of the position of the crystal segments is necessary. A test stand has been developed to automatically determine the segment positions [2]. This test stand moves a ^{57}Co source over the surface of the cryostat while monitoring the response of the detector. The data is then analyzed to determine the center of mass of each of the thirty-two segments.

Two positions must be specified for the center of mass of each segment: The linear position with respect to the endcap of the cryostat, and the angular position with respect to the zero-degree position of the source. The detector must be leveled and centered with respect to the movement axes of the source in order for the positions to be determined accurately. The detector is mounted on a base with four adjustable feet (Fig. 2), allowing the leveling and centering process to be completed manually.

Once the detector has been centered, the data acquisition process is controlled by LabVIEW programming. First, the position of the endcap of the detector is measured using a PicoDot convergent laser sensor. Next, the source moves to a specified number of linear and circular positions. At each position, data for 40,000 events is acquired. Signals from the detector s central contact and outer segments are passed through a series of electronics prior to digitization by two 16-channel ADCs. The electronics and LabVIEW program both require a trigger, which is provided by the central contact. The central contact registers a signal when any of the outer segments registers an interaction. When the source is positioned over the center of one segment, we require 1,000 events in the photopeak. As the trigger could be activated by any of the 32 segments, an average of 40,000 total events are required to produce 1,000 photopeak events in any one segment.

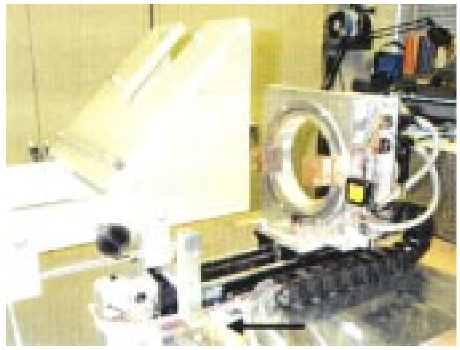

Figure 2
Photograph of the test stand. The solid arrow indicates one adjustable leg.

Signals from the individual segments are passed to MSU Quad Shapers, and then to an ASCOM 48-Channel NIM Stretcher module. The time required by the LabVIEW program to process one event is long compared to the time between events in the electronics. The stretcher receives a gate from the electronics, senses the peak voltages from the Quad Shapers, and holds the peak until the LabVIEW program sends a reset signal. The result of the data acquisition process is one binary file per position, containing the uncalibrated linear and angular position of the source, and the data for 40,000 events in thirty-two segments.

After the LabVIEW program has completed and all of the raw data has been acquired, the data must be analyzed to determine the center of mass positions of each segment. Data analysis is performed in UNIX, using Tcl, C and Physica programming. First, the raw data files for each source position are reduced to a form that can be plotted. A C program is used to byte-swap and histogram the raw data. A histogram is produced for each segment at each position. The range of channels corresponding to the ^{57}Co peak is identified, and for each histogram the peak within that range is identified. The number of counts in a specified number of channels surrounding the peak is summed, and the resulting number of counts for each segment is written to a secondary file, along with the linear and circular position of the source. A Tcl file concatenates these result files (one for each position) into one result file. A C program is used to reorganize the single result file so that all linear positions for a single circular position, and vice versa, are grouped together. This allows the results to be graphed more easily in Physica.

Physica will be used to plot and fit the histogrammed data. For each linear position, number of counts as a function of angular position is plotted. All thirty-two segments will be plotted on the same graph, and each segment will show a peak where the response of the detector to the source is highest. The linear and angular position of the peaks is the center of mass position of the segment. The curves for each segment will be fitted to determine the position of the peak, which is given in steps. These positions will then be calibrated to reflect real positions: in millimeters from the endcap for linear positions, and milliradians from the zero-degree position of the source. Preliminary data for one linear position, fixed in the C segments, is shown in Figure 3. The four C segments are plotted together, and the peak for each segment is visible. The linear and angular center-of-mass positions will finally be combined with the positions of the detectors with respect to the target, which are measured for each experimental setup.

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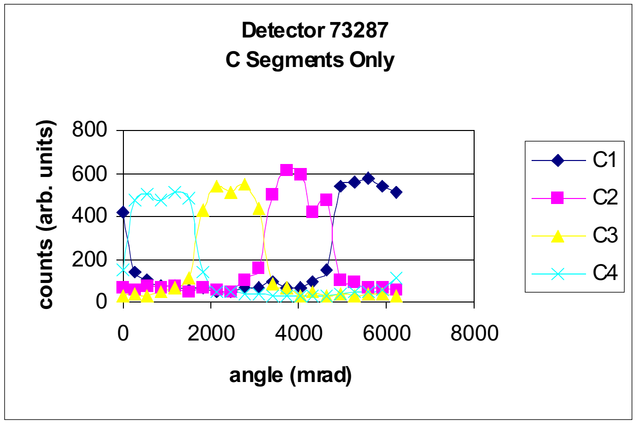

Figure 3: Graph of counts vs. angle for one fixed linear position.
Shown is the response of the C segments for detector 73287.

a. Western Kentucky University, Bowling Green, KY 42102

References

1. W.F. Mueller, T. Glasmacher, D. Gutknecht, G. Hackman, P.G. Hansen, Z. Hu, K.L. Miller, P. Quirin, Thirty-Two-Fold Segmented Germanium Detectors to Identify γ-Rays from Intermediate-Energy Exotic Beams, submitted to Nuclear Instruments and Methods, 2000.

2. K. Miller, L. Morris, T. Glasmacher, Germanium Detector Test Stand, NSCL Annual Report, 1998.