GERMANIUM DETECTOR TEST STAND

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The array of high purity germanium detectors currently under development at the NSCL [1] will consist of eighteen segmented germanium detectors. Each germanium crystal will have its outer contacts electronically divided into thirty-two segments. The test stand is designed to automatically determine the position of each segment and the position of the crystal within the cryostat.

Positions of photon reactions with the germanium crystal must be known to within a few millimeters. Such a resolution will be achieved by using germanium detectors with the outer contacts electronically segmented into eight one cm wide disks. Each disk will be further subdivided into four quadrants. To determine the position of the emitted photon with respect to the beam axis in an experimental setup, three positions must be known: the detector position with respect to the target, the position of the germanium crystal in the detector, and the position of each segment on the crystal. The crystal must be kept at liquid nitrogen temperatures while data is taken, and the position of the crystal within the cryostat may change with temperature due to the thermal expansion of the cooling rod. The test stand will determine the necessary positions while the crystal is kept cold inside the cryostat.

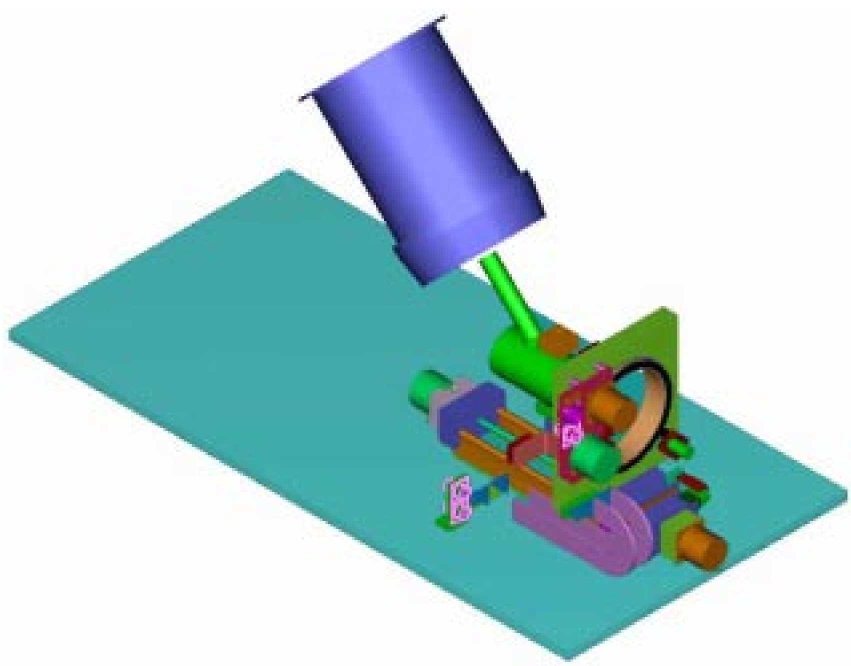

Fig. 1 Germanium detector test stand.

In order to measure the positions of the crystal segments and crystal itself, it was decided to scan a source of low energy photons around the cryostat, and read out the response of the thirty-two detector channels. The test stand apparatus will allow the x-ray source to move 360 degrees around the stationary cryostat, and approximately fifteen inches linearly. The data read out from the detector at each position of the source will be analyzed to determine the position of the crystal within the cryostat, and the location of the center of each crystal segment. Use of a x-ray source as the source of photons provides several advantages. Compton scattering is eliminated and only full-energy peaks are read from the detector. In addition, the typical interaction depth is close to the surface of the crystal, allowing us to map out the position of the outer contacts. For future tests, a higher energy source such as ^{60}Co may be used.

Before any position information about the detector crystal is measured, the detector cryostat must first be aligned with the axes of motion of the test stand. There are two motion axes, one linear and one rotary. A PicoDot convergent laser sensor (PD45VP6C100) is mounted onto the test stand frame to align the front edge of the detector cryostat with the source collimator hole. A dial indicator will then align the detector cryostat with the axis of rotation of the source.

After the detector is aligned, the x-ray source will be scanned around the area of the cryostat. The motion of the source is driven by two Slo-Syn M063-LE09 synchronous/stepping motors, one on each motion axis. In order to better control the position of the source, each axis also has a BEI Model L25 incremental optical encoder. The direction of motion and number of steps to be moved are sent from the computer to the stepper motors, while the encoder is read out by the computer to ensure that the correct position has been attained. Also mounted on the test stand frame to aid in motion control are four mechanical switches and one optical switch, which act as limit and home switches for the two axes.

The stepper motors must be controlled remotely, for which a National Instruments pcStep four axis control board is used. The pcStep board cannot interface directly with the stepper motor, however, so a Slo-Syn MD7 translator/drive is used to translate the computer signals to step and direction inputs for the stepper motors. A 16-channel 12 bit National Instruments PC-MIO-16E-4 ADC board is used for data acquisition.

All programming for the test stand was done in the graphical programming language LabVIEW, which makes use of VIs (virtual instruments) in its programs. A set of ValueMotion VIs had been created by National Instruments. A LabVIEW program was created that used the ValueMotion VIs and data acquisition VIs to control the motion of the source around the detector, and the readout of the detector response to the x-rays. The position of the 10 linear segments and the four quadrants both must be measured. First, the source is fixed in one circular position and incrementally moved down the length of the detector cryostat. At each position, the response of the detector is read out and stored. After several circular positions, the source is fixed in one linear position and incrementally moved around the circumference of the cryostat. Still to be programmed will be the analysis of the position and voltage data to give the positions of the segments within the crystal, and the position of the crystal within the cryostat.

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References

[1] T. Glasmacher, P.G. Hansen, V. Maddalena, P. Mantica, D.J. Morrissey, M. Thoennessen, and A. Wagner, “Design of an Array of Germanium Detectors for Experiments with Fast Radioactive Beams,” NSCL Annual Report, 1997.