Grant Number: DE-SC0005290
PI: Craig Levin, Stanford University

Final Report: New Strategies for 0.5 mm Resolution, High Sensitivity, Multi-Radionuclide Imaging

A test system was developed to enable efficient testing of CZT detector crystals, including properties such as CZT module impedance and leakage current (Fig. 1). Experiments were performed to evaluate the performance of CZT detector module (where each module contains two crystals) and compare it with the performance of a single CZT crystal. Potential design weaknesses were identified and resolved. CZT crystals were assembled with associated readout circuits.

A prototype chassis that housed the CZT detectors as well as readout electronics were designed, fabricated, and assembled. High and low voltage power supplies, signal generators, and cooling devices were acquired and implemented in the prototype system.

A readout circuit board was designed and fabricated for front-end data acquisition that significantly reduced cross-talk between signals (Fig. 2). The detector system's backplane bus was also developed and its functionality was demonstrated to aggregate data from the photon detectors and send them to a computer over Ethernet. In parallel, software was developed to complete the data acquisition chain. The software was continuously improved to parse the data acquired from the CZT detectors, apply error correction and calibration, extract useful imaging data, and output files that can be used for data analysis.

A sub-system of two detector panels was assembled (Fig. 3). System-level characterization studies, including optimizing the trigger threshold for the analog to digital converter (ADC) of each channel, were performed. ^{68}Ge and ^{137}Cs radioactive isotopes were used to characterize the anode energy resolution of all channels in the system. The mean measured global 511 keV photopeak energy resolution over 240 anode channels was found to be 8.03 ± 0.96% full width at half maximum (FWHM) (Fig. 4). The Ge-68 point source was imaged and it was shown that the system was able to resolve the point source moving within one millimeter.

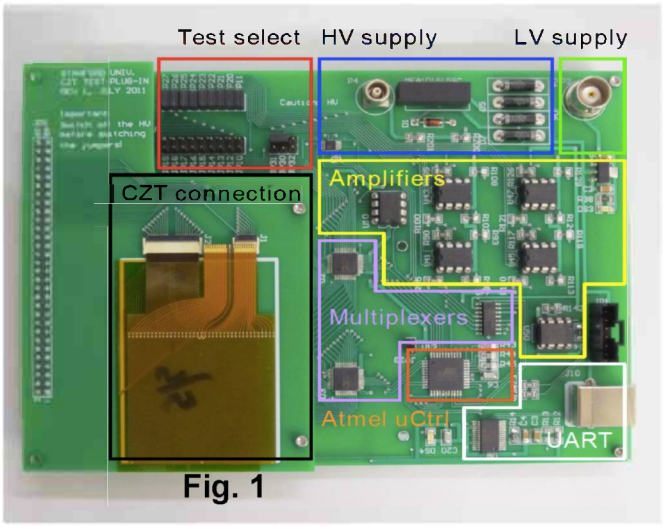
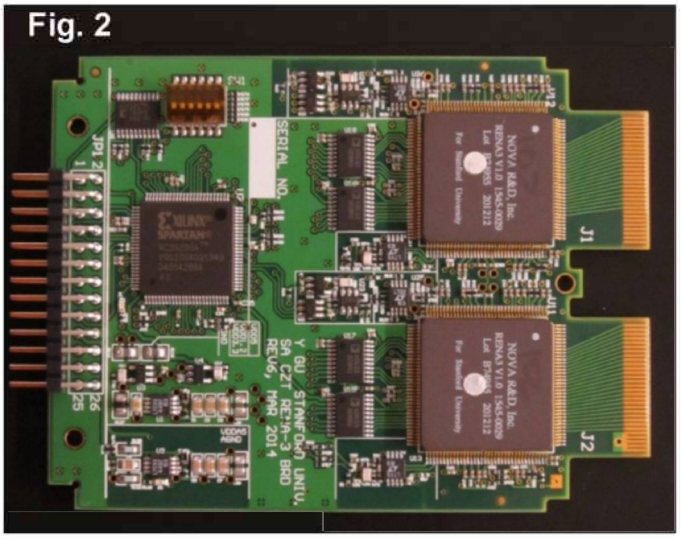
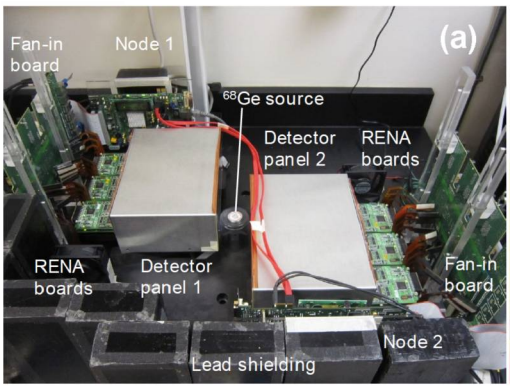


Fig. 1





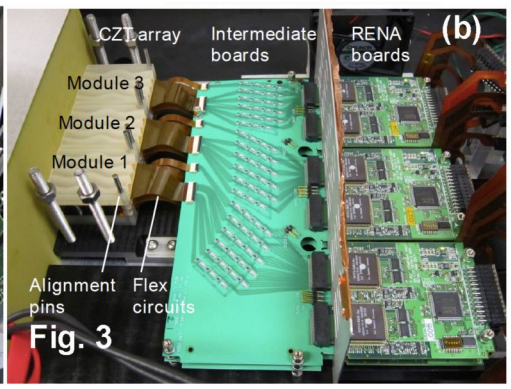


Fig. 3