Efficiency of High-Purity Germanium Detectors

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For my 395 Research Project I investigated the efficiencies of the high-purity germanium (HPGe) detectors used in the Clover Array setup at the High-Intensity Gamma-Ray Source (HIγS) at Triangle Universities Nuclear Laboratory (TUNL). These detectors, which are used in experiments of nuclear resonance fluorescence (NRF), capture and record the energy of gamma-ray decays attributed to transitions of a nucleus to various excited states. My project consisted of working with both experimental and simulated data sets, and comparing the two in order to find both the efficiency of each detector and its dead layer, or the percentage of the detector that has become desensitized following decades of use and radiation exposure. Ensuring that the simulated efficiency values align with our experimental findings allows my group to accurately predict experimental results at higher energy values (3-15 MeV) that radioactive sources alone cannot reach. Working with the spectra from a 152 Europium source measurement, I analyzed experimental data sets through the use of the *HDTV – Nuclear Spectrum Analysis* program, which allowed me to energy calibrate, background subtract, and measure the count rate per energy level of each spectra. 152Eu is ideal for a source measurement, as its lower energy peaks, intensities, and activity are well known. Using the simulation program *Geant4*, I was able to create a realistic simulation of a 152Eu source measurement, and compare experimental and simulated efficiency values. Through the use of least-squared/Chi^2 fitting, each dead-layer was optimized and updated into my simulation to return the efficiency value for each detector. Special thanks to Dr. Robert Janssens for sponsoring my research, and Dr. Udo Friman-Gayer for helping me with this project.