

Scintillation Detector for Gamma Spectroscopy

Anh Than
Department of Electrical and
Computer Engineering
Oklahoma State University
Stillwater, Oklahoma
anh.than@okstate.edu

Conor Henry
Department of Electrical and
Computer Engineering
Oklahoma State University
Stillwater, Oklahoma
conor.henry@okstate.edu

Haley Welch
Department of Electrical and
Computer Engineering
Oklahoma State University
Stillwater, Oklahoma
haley.welch10@okstate.edu

Stephen Ivancic
Department of Electrical and
Computer Engineering
Oklahoma State University
Stillwater, Oklahoma
stephen.ivancic@okstate.edu

Abstract (Stephen Ivancic)— This project is documentation of a scintillation radiation detector for gamma spectroscopy. Gamma radiation causes a scintillator crystal to illuminate, which is captured and converted to an electrical signal. The detector works by measuring electrical pulses from the output of a photomultiplier tube (PMT). The amplitude of these pulses is proportional to the energy of the radiation. By creating a histogram with x-axis of energy and y axis of “# of counts” the energy spectrum of the radiation can identified and analyzed.

Keywords—scintillation, radiation, multi-channel analyzer, photomultiplier

I. INTRODUCTION (STEPHEN IVANCIC)

This paper will show the design process for creating a scintillation radiation detector for gamma spectroscopy. A scintillator is a material which fluoresces when excited by a gamma photon. The intensity of this visible flash of light is proportional to the energy of the photon, which allows for analysis of the energy spectrum of radiation sources. This is in contrast to a geiger counter, which can only show intensity in counts per second. The visible light emitted by the scintillator is fed into a photomultiplier by physically attaching the scintillator to the cathode end of the PMT (Photomultiplier Tube). The PMT is powered by high voltage, slightly more than 1kV, but requires very little current, less than one millamp. Output pulses from the PMT are then amplified and fed into an MCA (Multi Channel Analyzer). This MCA device consists of a peak-and-hold circuit and ADC, which holds the very fast peaks at their maximum and records the values. A microprocessor is used to record and display these maximum peak values. A histogram graph of amplitudes vs. number of counts is shown on the display, which shows the energy spectrum of the radiation source. The specifications of this project state that the authors should have an instrument in a box with labelled switches or other controls and neat wiring inside. Due to the typically high price of scintillators and PMTs, the budget of \$300 is a notable constraint. Devices which are used for laboratory or security work can often cost anywhere from \$750-\$10000 or more. Applications of this device include gamma spectroscopy, which is used in nuclear

science, astrophysics data, medical analysis, and educational topics such as nuclear physics.

II. PRELIMINARY DESIGN

A. Project Disambiguation (ALL)

This section will clearly define which authors were responsible for the separate parts of the project. It should be noted that there was significant overlap between hardware worked on by Stephen Ivancic and Conor Henry and software worked on by Anh Than and Haley Welch. Specific sections will be denoted here and will follow for the rest of the report.

Stephen Ivancic was responsible for the scintillator, which entails choosing and testing multiple scintillators for accuracy and compatibility with the PMT. Stephen was also responsible for powering any and all devices within the project. This includes the main power input and any power conversion needed for internal electronics.

Conor Henry was responsible for the PMT, which entails choosing the correct PMT and socket to couple with the scintillator. Conor was also responsible for putting the housing together on the PMT and the housing for the all the electronic components, such as power supplies, display, and MCA.

Anh Than was responsible for the analog-to-digital-converter and the software, i.e., user interface. The user interface displayed the counts per seconds of detected photons, a histogram of the counts versus energy levels, and the spectrum of detected gamma photon energies. Anh also assisted Haley with the MCA.

Haley Welch was responsible for the program calculations and calibration and helping Anh Than with the user interface. Haley was also responsible for the MCA.

Scintillation Spectroscopy Of Gamma Volume 1

Raffaela Di Napoli



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