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THE HISTORY OF GAMMA-RAY SPECTROSCOPY FOR ISOTOPE IDENTIFICATION, J. MCQUAID

Blog Post

Introduction

Gamma rays were first discovered and studied in 1900 by a French chemist, Paul Villard, while observing radiation from radium. However, the fist quantitative analysis of gamma radiation is credited to Rutherford and Andrade in 1914. This earliest technique was accomplished by diffraction spectroscopy using a rock-salt crystal.

Crystal diffraction is regarded as an important and pioneering effort in the analysis of gamma-ray energy but falls short of a means to accurately quantify and identify various radionuclides. Therefore, we must wait several decades later to see achievements leading to what we know as gamma spectroscopy.

Gamma-ray Spectroscopy

A spectrometer system for radionuclide analysis is composed of a photon detector and associated electronics (e.g., amplifier and pulse shaping) including a means of sorting various energy events and recording/displaying the data. These events are sorted to produce a spectrum (histogram) displaying intensity (of events) as a function of photon energy.

The advent of the sodium-iodide scintillator [1] in 1948 and other detectors to follow became useful for spectroscopy. The photon detector and the Multichannel Pulse-Height Analyzer (MCA) [2] become the primary tools needed to produce a pulse-height spectrum of one or more radionuclides. It is first necessary to derive a digital number that is proportional to the amplitude of the analog pulse. This is performed in an Analog-to-Digital Converter (ADC) which is a key part of the MCA. A number of linear and fast ADCs have been developed over the years (e.g., Wilkinson) [3]. One of the first MCAs was developed by Fred Goulding in the 1950s, at the Atomic Energy of Canada, Chalk River facility. This MCA was called a “Kicksorter” and boasted excellent linearity and 100 channels. Goulding later worked at the Lawrence Berkeley Lab (1959) 1 and brought some of the early nuclear counting technology to Berkeley and Livermore Labs. Through later years a number of advances in MCAs have been impressive with 16K channel analyzers being common. Improvements in nuclear detectors has brought improved energy resolution creating advancements in nuclear science. In the early 1960s germanium (Ge) detectors were being developed with excellent energy resolution. This work has continued with emphasis on high purity and larger ingots. Since these detectors are cooled to liquid nitrogen temperatures advancements in room temperature detectors have been necessary for small, portable instruments called Radioisotope Identification Devices (RIIDs). With newer high-resolution

scintillators [1], RIIDs have become excellent tools for Homeland Security and many other applications requiring spectroscopic identification of radioisotopes.

Berkeley Nucleonics Corporation (BNC) has been a leader in providing RIIDs for over two decades. BNC has implemented a number of techniques to enhance the accuracy, speed and sensitivity needed to quickly identify radioisotopes. One of these techniques is called Quadratic Compression Conversion (QCC). QCC is a digital conversion transform used to obtain excellent characterization of spectral peaks. This allows sensitivity beyond conventional spectroscopy by spreading out tightly spaced low energy peaks and enhancing high energy peaks for faster and easier search of energy lines across the spectrum. This is especially important for quick indication of highly enriched weapons grade material. QCC is now incorporated in our new SAM 940+ RIID. This light-weight, hand-held RIID uses some of the newest high-resolution detectors and the capability of auto updates of new software. Please contact BNC for detailed information.

1 BNC was a spin-off from Goulding's group in 1963

References

[1] *The History of Scintillation Detectors for Gamma Spectroscopy*, BNC web site

[2] G. Knoll, *Radiation Detection and Measurement*, Second Edition, **656**

[3] G. Knoll, *Radiation Detection and Measurement*, Second Edition, **662**