SG6114 System Calibration: Linearity and Resolution



Purpose of the experiment

Recording and comparing the γ energy spectra of several radioactive sources is the main goal of the experiment. The photo-peaks are used to calibrate the response of the system and to measure the energy resolution.

Fundamentals

Linearity and energy resolution are the main figures of merit of a spectrometric system. In the proposed experiment, based on a scintillating crystal coupled to a Silicon Photomultipliers, deviations in the linearity may be due to the sensor or the front-end electronics saturation. The student is guided through the analysis of the response curve using a series of isotopes up to the MeV energy by a ⁶⁰Co source and to disentangle the different effects. At the same time, the energy resolution of the system is measured by the width of the photo-peaks and the results compared to what is expected by the fluctuations in the number of detected scintillation photons, the system noise, the sensor stochastic effects, the intrinsic resolution of the scintillator.

This is following an initial activity on the optimization of the operating parameters by an analysis of the photo-peak position and the resolution for a single isotope.

The experiment can be performed by using to different set-ups:

EQUIPMENT A

SP5600C - Educational Gamma Kit



Related Experiment	
SG6131	
ED3163	
Ordering Options	
Equipment A	
Code	Description
WK5600XCAAAA	SP5600C - Educational Gamma Kit
or the all inclusive Premium Version	
WK5600XANAAA	SP5600AN - Educational Kit - Premium Version
Equipment B	
Code	Description
WK5600XEMUAA	SP5600EMU - Emulation Kit

The kit instrumentation provides the CAEN digitizer DT5720A.This device is part of a complete family of digitizers in this form factor that consists of several models differing in sampling frequency. resolution, number of channel, memory size and other parameter. In parallel with the hardware development, CAEN have made a big effort in developing algorithms for the Digital Pulse Processing (DPP); you can install a DPP algorithm on the FPGA of the digitizer (firmware upgrade), run it on-line and implement new acquisition methods that go beyond the simple waveform recording. A digitizer with DPP becomes a new instrument that represents a fully digital replacement of most traditional modules such as Multi and Single Channel Analyzers, QDCs, TDCs, Discriminators and many others. CAEN digitizers are widely diffused in

major physics experiments Worldwide. www.caen.it



Requirements

Gamma Radioactive Source 🚱



Carrying out the experiment

The scintillator crystal shall be coupled to the SiPM in the SP5607, through a thin layer of index matching grease to maximize the light collection. In order to avoid saturation, the output of the SiPM is divided using the A315 splitter: one branch is connected to the DT5720A and will be digitized. The other branch will be amplified by the SP5600 module, generating the trigger for the integration signal by the on-board leading edge discriminator. The discriminator threshold shall be defined looking at the spectrum and evaluating the dark count rate. Once this is set and the radioactive source is properly positioned, the spectrum can be recorded.

Block diagram of the experimental setup that makes use of the "Educational Gamma Kit"





SP5600EMU - Emulation Kit



Requirements

Gamma Radioactive Source is not needed



Carrying out the experiment

Carrying out the experiment: To perform the experiment connect the DT4800 output to the input channel of the MCA DT5770 and use the DT4800 GP0 as digitizer "trigger IN". The DT4800 Control Software Interface allows to emulate signals from a real energy spectrum linked to different radioactive sources with variable activity.

Results

By fitting the photo-peaks with a Gaussian curve, the system linearity as a function of energy is verified. The peak widths is determining the energy resolution. At more advanced level, the interpretation of the results accounting for the system properties may be



performed.



Energy Calibration

Energy dependence of the system resolution



Block diagram of the experimental setup that makes use of the



"Emulation Kit"

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