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Tools for Discovery

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HANDBOOK OF EXPERIMENTS

SG6113A γ-Spectroscopy

γ-Spectrum and Energy Resolution

Nuclear Physics and Radioactivity

EDUCATIONAL KIT

SP5600C

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γ-Spectrum and Energy Resolution

Categories: CAEN Experiments, Nuclear Physics and Radioactivity | Tags: Energy Resolution, Nuclear Physics, γ Spectroscopy

Difficult	Execution Time	Data Analysis	Radioactive Sources
		Yes	Yes

Hardware setup

This experiment guide is referred to the **SP5600C** educational kit. If you don't have this kit, choose your own from the following list to visualize the related experiment guide: SG6113C, SG6113E – Educational Kit

Equipment: SP5600C – Educational Gamma Kit

Model	SP5600	DT5720A	A315	SP5606	SP5607	Additional Tool
Description	Power Supply and Amplification Unit	Desktop Digitizer 250 MS/s	Splitter	Mini Spectrometer	Absorption Tool	Gamma Radioactive Source

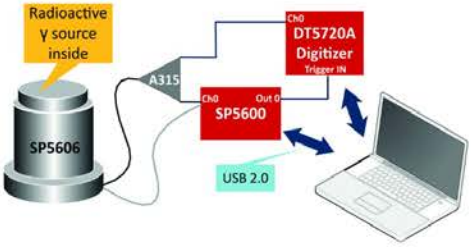
Purpose of the experiment

Analysis of the spectrum of the deposited energy by a γ ray in a detector discloses the essence of the interaction of high energy photons with matter and allows to learn by doing the detector related effects.

Fundamentals

For γ-energy less than 2MeV, the interaction with matter is dominated by Compton scattering and Photo-absorption. The analysis of the Compton continuum of the deposited energy and of the photo-peak conveys information on the characteristics of the decaying isotope as well as the effects due to the system noise, the detected photon statistics, the stochastic terms in the detector and the intrinsic resolution of the scintillator. The experiment presumes to use ^{137}Cs with its decays detected by a CsI crystal coupled to a Silicon Photomultiplier. The ^{137}Cs source is particularly interesting due to its low energy X ray line at 32 keV and the high energy gamma emission at 662 keV. The former is relevant to optimize the lower detection limit of the system; the latter is a standard to evaluate the energy resolution. The use of the 2 lines and the analysis of the Compton spectrum characteristics allow to perform a rough measurement of the linearity with a single isotope.

Carrying out the experiment



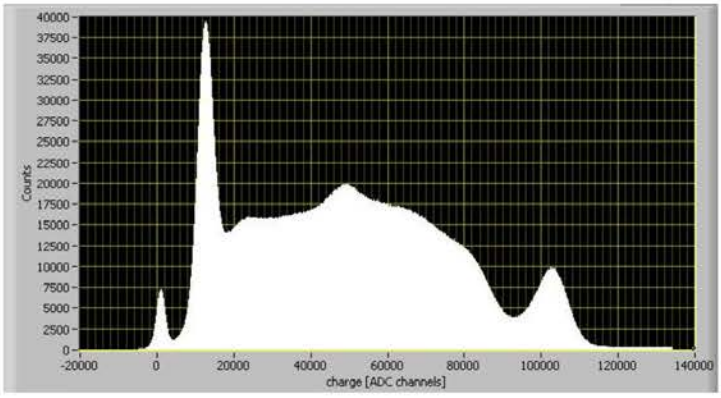
Block diagram of the experimental setup that makes use of the "Educational Gamma Kit"

The CsI 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 properly set and the radioactive source is properly positioned, the spectrum can be recorded.

Results

The figure shows a typical gamma spectrum, recorded with a very low energy threshold. The left over from the system noise is clearly visible, as well as the low energy line at 32 keV and the photopeak. For this specific spectrum, the energy resolution on the 662 keV peak corresponds to:

$$\text{Energy Resolution} = \left(\text{FWHM}_{peak} / \mu_{peak} \right) \times 100 \sim 10$$



^{137}Cs spectrum

Where: FWHM_{peak} = full width at half maximum of the peak and μ_{peak} = channel number of the peak centroid.

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