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HANDBOOK OF EXPERIMENTS

SG6111A γ-Spectroscopy

Detecting γ-Radiation

Nuclear Physics and Radioactivity

EDUCATIONAL KIT

SP5600C

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Detecting γ-Radiation

Categories: CAEN Experiments, Nuclear Physics and Radioactivity | Tags: Gamma radiation, Nuclear Physics, γ Spectroscopy

Difficult	Execution Time	Data Analysis	Radioactive Sources
		No	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: SG6111C, SG6111E – 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

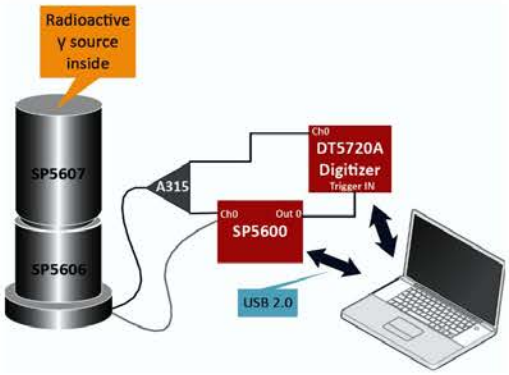
Purpose of the experiment

Gamma radioactivity detection by using a system composed of a scintillating crystal coupled to a photon detector.

Fundamentals

Gamma rays interact with matter by three processes: Compton Scattering, Photoelectric Effect and Pair Production (whenever the energy exceeds the 1.022 MeV threshold corresponding to the e^+e^- rest mass). The cross section of each process depends on the energy of the γ-ray. The Compton Effect is the inelastic scattering between the incoming photon and an atomic electron. In the Photoelectric Effect, the incident γ-ray transfers all of its energy to a bound electron which acquires a kinetic energy equal to the incoming γ-energy decreased by the binding energy. These processes convert, totally or partially, the γ-ray energy into kinetic energy of electrons (or positrons, in case of pair production). The interaction of the charged particles with the atomic and molecular systems of the medium results in excited states whose decay, possibly mediated, leads to light in the visible or UV region, eventually detected by the light sensor. A wide range of scintillator products is available today, differing for the light yield, the material properties, the time characteristics of the scintillation light and, last but not least, cost. The choice of the scintillator is essentially dependent on the specific targeted application.

Carrying out the experiment

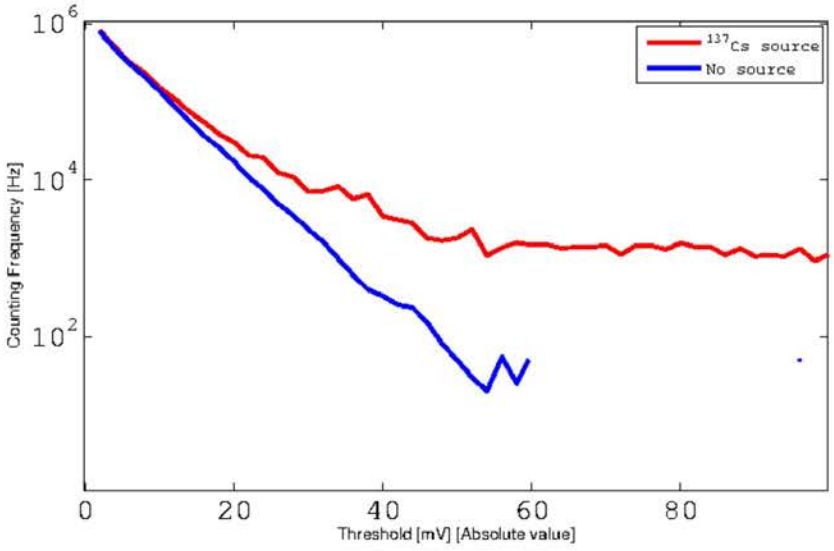


Experimental setup block diagram.

The selected 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 or simply counting the pulses induced by the detected γ-ray.

Results

The student may get acquainted with the presence of radioactivity with a simple preliminary measurement, namely comparing the counting frequency as a function of the discriminator threshold with/without the source. Presuming the source, essentially in contact to the crystal, to be point like with respect to the crystal surface, and assuming its activity is known, the student may estimate for every threshold value the detection efficiency and the signal over noise ratio, building up an efficiency-purity plot. Exemplary results obtained with a ^{137}Cs source are shown. Moving away the source from the crystal, the law governing the variation of the flux can also be investigated.



Sensor output frequencies as a function of the threshold in mV, with and without ^{137}Cs source

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