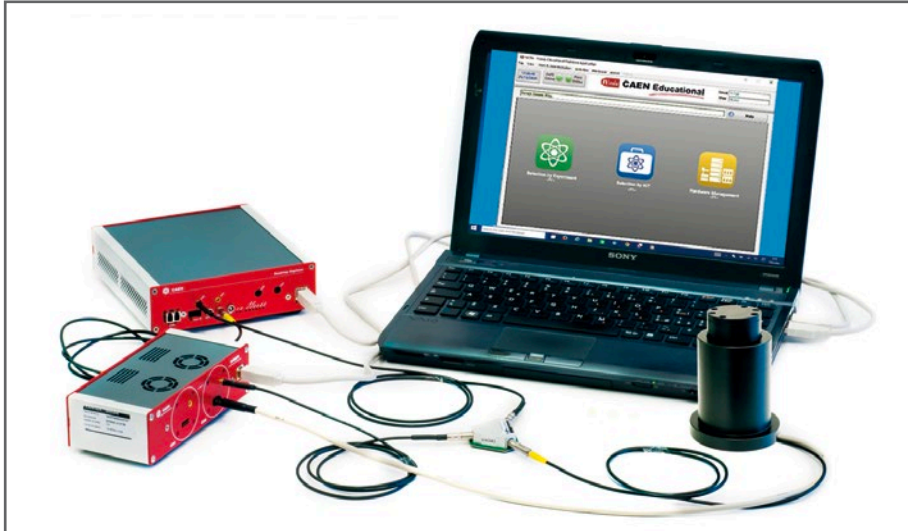


# B.1.4 System Calibration: Linearity and Resolution

SG6114



## Purpose of the experiment

Recording and comparing the  $\gamma$  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  $^{60}\text{Co}$  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

Model	SP5600	SP5606	A315	DT5720A	SP5607
Description	Power Supply and Amplification Unit	Mini-Spectrometer	Splitter	Desktop Digitizer 250 MS/s	Absorption tool
	p. 145	p. 147	p. 147	p. 145	p. 148

## Requirements

Gamma Radioactive Source

### Related Experiment

B.3.1

D.3

### Ordering Options

#### Equipment A

Code	Description
WK5600XCAAAA	SP5600C - Educational Gamma Kit

or the all inclusive Premium Version

WK5600XANAAA	SP5600AN - Educational Kit - Premium Version
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#### Equipment B

Code	Description
WK5640XAAAAA	SP5640 - GammaEDU

#### Equipment C

Code	Description
WK5630ENAAAA	SP5630EN - Environmental Kit

or the Kit Plus

WK5630XENAAA	SP5630ENP - Environmental Kit Plus
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#### Equipment D

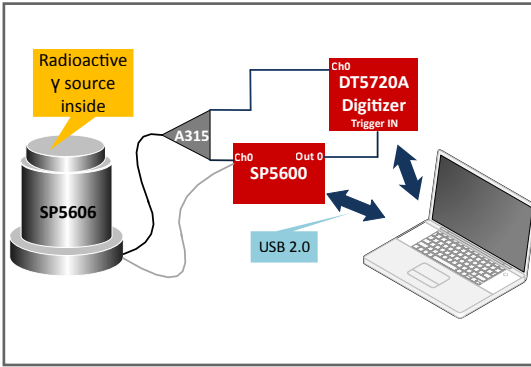
Code	Description
WK5600XEMUAA	SP5600EMU - Emulation Kit



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.

[www.caen.it](http://www.caen.it)



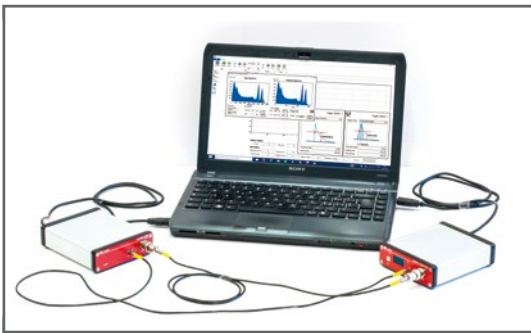


Block diagram of the experimental setup that makes use of the "Educational Gamma Kit" .

### 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.

## EQUIPMENT D



### SP5600EMU - Emulation Kit

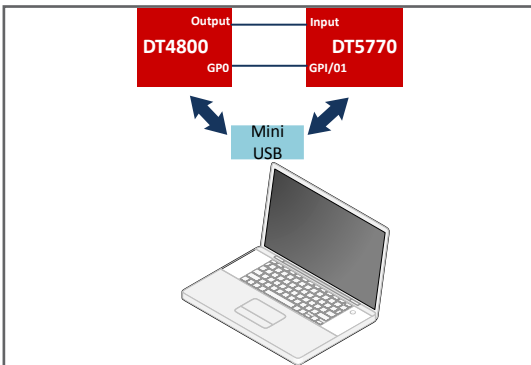
Model	DT4800	DT5770
Description	Digital Detector Emulator	Desktop Multi-Channel Analyzer
		

p. 149

p. 149

### Requirements

Gamma Radioactive Source is not needed.



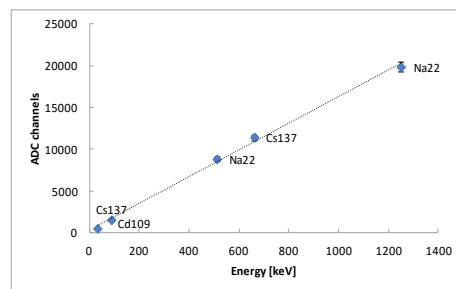
Block diagram of the experimental setup that makes use of the "Emulation Kit" .

### Carrying out the experiment

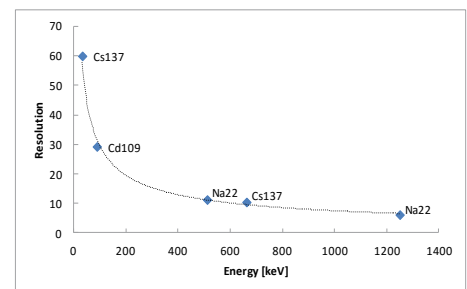
Carrying out the experiment: To perform the experiment connect the DT4800 output to the input channel of the MCA DT5770 and use the DT4800 GPI as digitizer "trigger IN". The DT4800 Control Software Interface allows to emulate signals from a real energy spectrum linked to different radioactive sources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