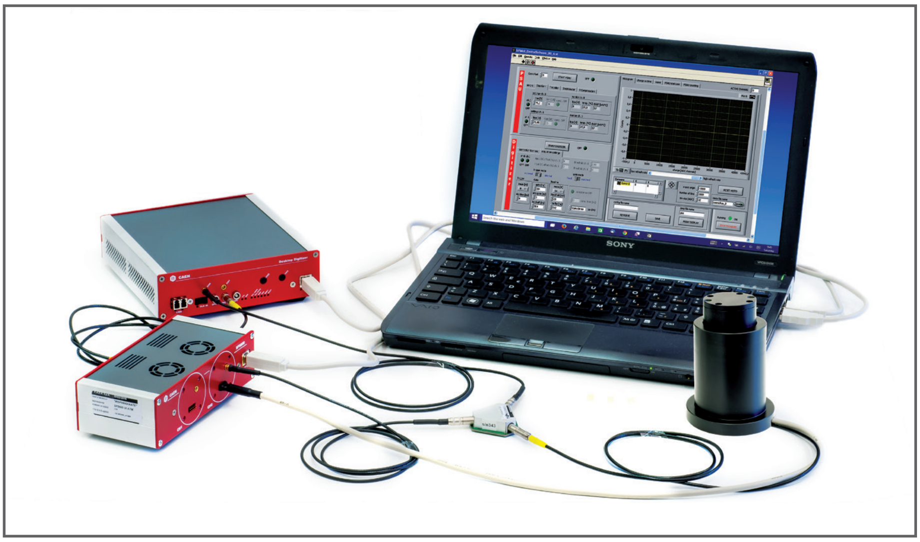
SG6113 Energy Resolution



Purpose of the experiment

The 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 30 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.

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

Related Experiment
SG6131
ED3163

Ordering Options

Equipment A

Code	Description
WK5600XCAAAA	SP5600C - Educational Gamma Kit

or the all inclusive Premium Version

Code	Description
WK5600XANAAA	SP5600AN - Educational Kit - Premium Version

Equipment B

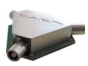
Code	Description
WK5600XEMUAA	SP5600EMU - Emulation Kit

ATLAS is one of two general-purpose detectors at the Large Hadron Collider (LHC). It investigates a wide range of physics, from the search for the Higgs boson to extra dimensions and particles that could make up dark matter. Although it has the same scientific goals as the CMS experiment, it uses different technical solutions and a different magnet-system design. Beams of particles from the LHC collide at the centre of the ATLAS detector making collision debris in the form of new particles, which fly out from the collision point in all directions. Six different detecting subsystems arranged in layers around the collision point record the paths, momentum, and energy of the particles, allowing them to be individually identified. A huge magnet system bends the paths of charged particles so that their momenta can be measured. Also this experiment makes use of the CAEN instrumentations.

http://home.cern/about/experiments/atlas

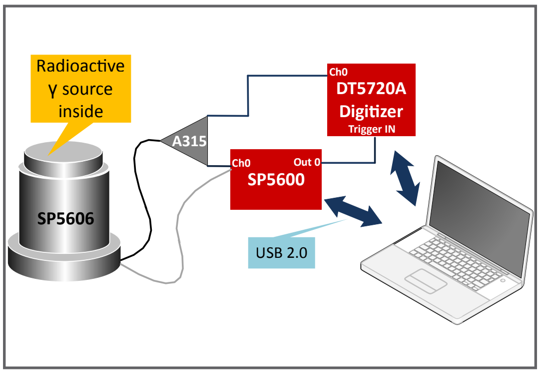
EQUIPMENT A

SP5600C - Educational Gamma Kit

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

Requirements

Gamma Radioactive Source

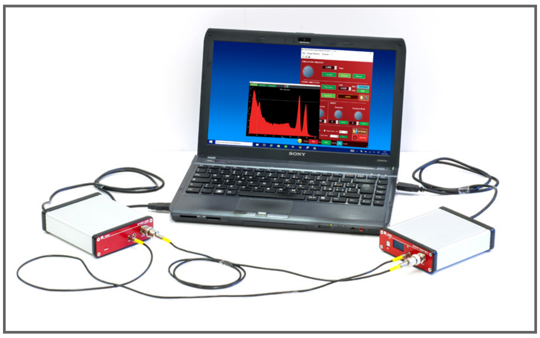


Block diagram of the experimental setup that makes use of the "Educational Gamma Kit" .

Carrying out the experiment

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.

EQUIPMENT B

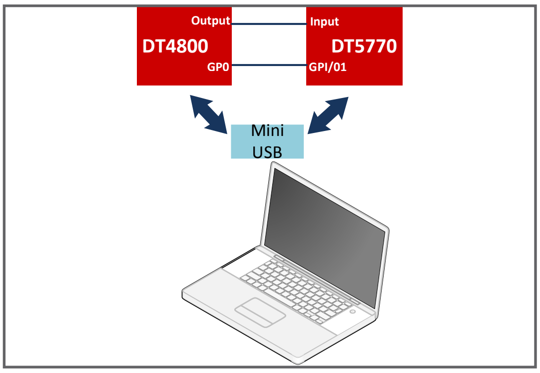


SP5600EMU - Emulation Kit

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

Requirements

Gamma Radioactive Source is not needed



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

Carrying out the experiment

To perform the experiment connect the DT4800 output to input 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 a radioactive source with variable activity.

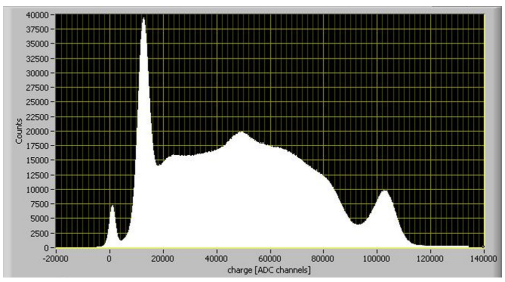
Results

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 30 keV and the photopeak. For this specific spectrum, the energy resolution on the 662 keV peak corresponds to

$$\text{Energy Resolution} = \frac{\text{FWHM}_{\text{peak}}}{\mu_{\text{peak}}} * 100 \sim 10\%$$

$FWHM_{peak}$ = full width at half maximum of the peak

μ_{peak}= channel number of the peak centroid.



^{137}Cs spectrum.