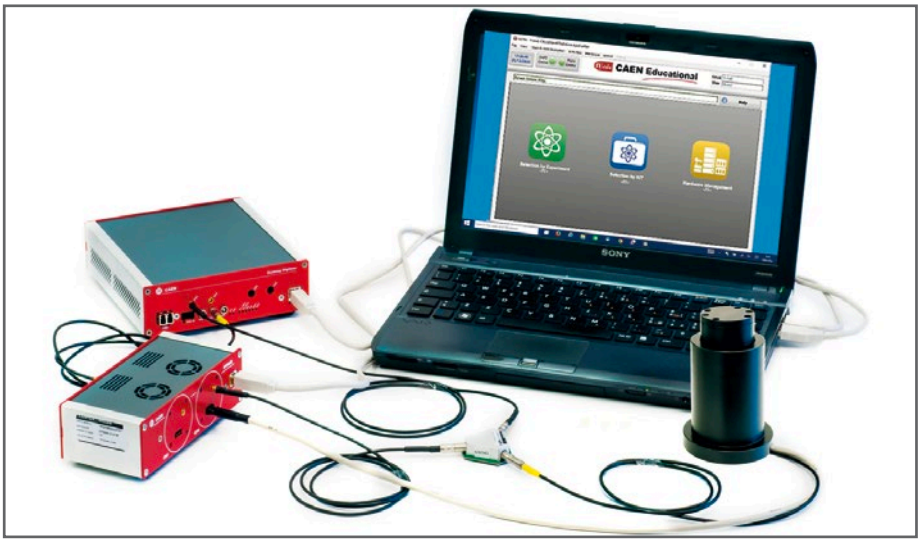
B.1.7 SG6117 Photonuclear cross-section / Compton Scattering cross-section



Purpose of the experiment

Determination of the ratio of the effective cross-sections due to Compton and Photoelectric effects as a function of photons energy.

Fundamentals

In the energy range up to 2MeV, gamma rays interact with matter by two processes:

- Photoelectric Effect, dominant at energy less than 100 KeV. In this process the photon energy is completely transferred to atomic electron bounded
  $\gamma + atom \rightarrow ion + e^-$
- Compton Scattering, linked to the elastic collision between electrons and photons and relevant at 1MeV energy level
  $\gamma + e^- \rightarrow \gamma' + e^{-'}$

The predominant mode of interaction depends on the energy of the incident photons and the atomic number of the material with which they are interacting. From the acquired γ-spectrum, it is possible to estimate the fraction of events due to Compton scattering and those caused by the photoelectric. The ratio of the event fractions is used to determine the ratio of the two effective cross-sections that depends on the detector size.
The experiment can be performed by using to different set-ups:

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**
WK5640XAAAAA	SP5640 - GammaEDU

Equipment C	
Code	**Description**
WK5630ENAAAA	SP5630EN - Environmental Kit
or the Kit Plus	
WK5630XENAAA	SP5630ENP - Environmental Kit Plus

Equipment D	
Code	**Description**
WK5600XEMUAA	SP5600EMU - Emulation Kit

EQUIPMENT A

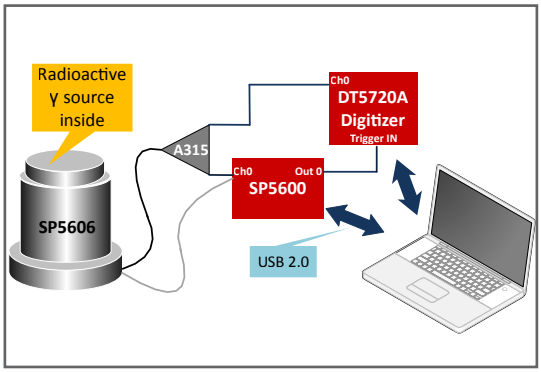
SP5600C - Educational Gamma Kit

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

Scintillating crystals can be organic or inorganic. Their different features make them adapted to particular applications. Organic single crystal scintillators (Anthracene, Stilbene) are aromatic hydrocarbon compounds which contain benzene ring structures composed of carbon and hydrogen atoms.
ca/~phys352/lect19.pdf

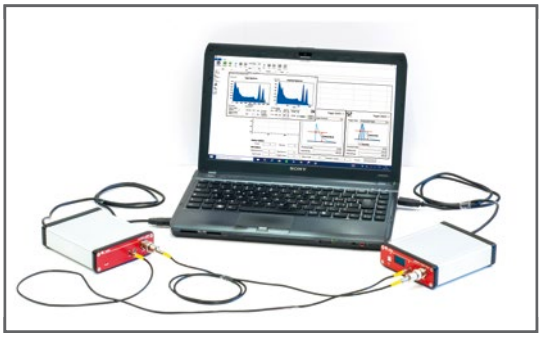


Block diagram of the experimental setup that makes use of the "Educational Gamma Kit" .

Carrying out the experiment

Spread the optical grease on the open face of the scintillating crystal, insert this crystal side in the SP5607 spectrometer. Connect the power cable to the SP5600 module and connect the other cable of the spectrometer to the splitter A315. Connect the two split outputs to SP5600 channel 0 and DT5720A channel 0. Use the SP5600 digital output as DT5720A "trigger IN". Use the default software values or optimize the parameters to choose the discriminator cut-off threshold in mV. Switch off the power supply, open the spectrometer and insert the radioactive gamma source to acquire the first spectrum. After that, switch off the power supply, open the spectrometer, change the radioactive gamma source and repeat the measurement.

EQUIPMENT D

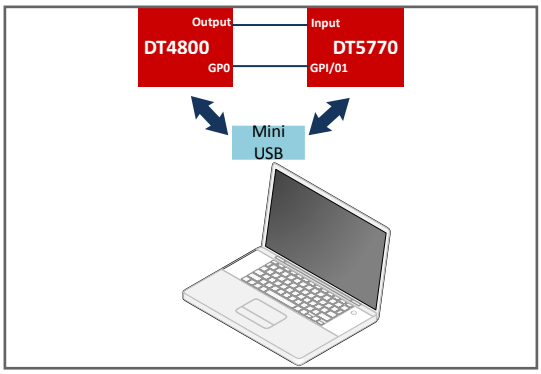


SP5600EMU - Emulation Kit

Model	DT4800	DT5770
Description	Digital Detector Emulator	Desktop Multi-Channel Analyzer
		
	p. 149	p. 149

Requirements

Gamma Radioactive Source is not needed.



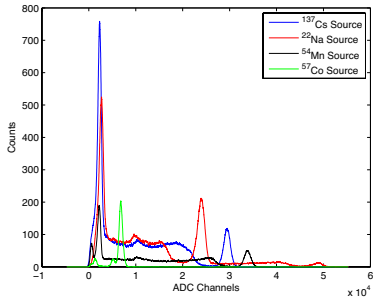
Block diagram of the experimental setup that makes use of the "Emulation Kit" .

Carrying out the experiment

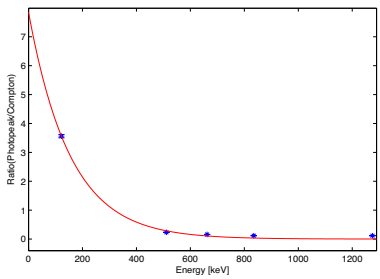
To perform the experiment connect the DT4800 output to the input channel of the MCA DT5770 and use the DT4800 GP0 as digitizer "trigger IN". The DT4800 Control Software Interface allows to emulate signals from real energy spectra of several gamma radioactive source.

Results

By using several radioactive sources or spectra simulated by DT4800, the energy dependence of the ratio between the cross-sections of two phenomena can be examined, by verifying that the Photoelectric Effect cross section decreases with increasing energy compared to the Compton Scattering cross section for the used detector size.



Spectra of radioactive sources used to estimate the ratio of Photonuclear and scattering Compton cross sections.



Behaviour of the ratio between Photo-Peak and Compton contributions as a function of energy.