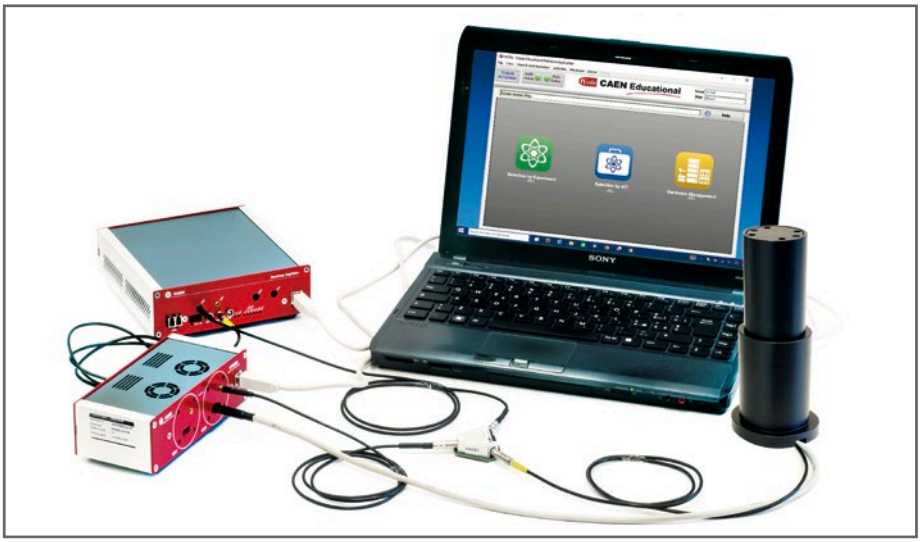
B.1.6 γ-Radiation Absorption

SG6116



Purpose of the experiment

The main goal of the experiment is the measurement of the γ radiation attenuation coefficient for different materials and different energies.

Fundamentals

The attenuation of a γ radiation flux passing through matter is described by the exponential law

$$I(x)=I_0 * e^{-\mu x}$$

where I0 is the incident photon flux and I(x) measures the flux of γ rays emerging from a layer x of material without having interacted. The coefficient μ depends on the material properties (atomic number, density) and on the energy of the impinging photon.

The student is guided towards the development of complementary measurement techniques based on counting and on the analysis of the spectrum, performing the experiment for different materials (including PMMA, a water equivalent solid state organic material used in medical dosimetry).

Equipment

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
					
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Requirements

Gamma Radioactive Source

Ordering Options

Equipment A	
Code	Description
WK5600XCAAAA	SP5600C - Educational Gamma Kit
or the all inclusive Premium Version	
WK5600XANAAA	SP5600AN - Educational Kit - Premium Version

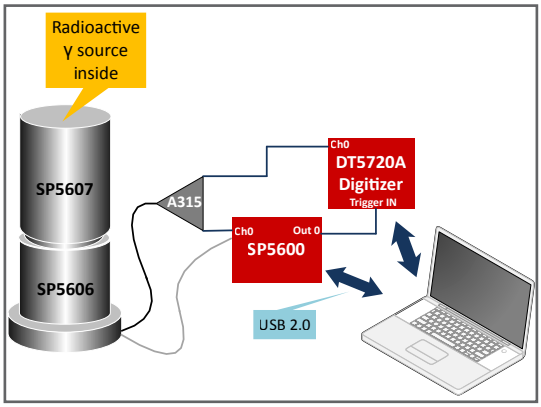
Equipment B	
Code	Description
WK5640XAAAAA	SP5640 - GammaEDU

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

The Higgs Boson

On 4 July 2012, the ATLAS and CMS experiments at CERN's Large Hadron Collider announced they had each observed a new particle in the mass region around 126 GeV. This particle is consistent with the Higgs boson predicted by the Standard Model. The Higgs boson, as proposed within the Standard Model, is the simplest manifestation of the Brout-Englert-Higgs mechanism. Other types of Higgs bosons are predicted by other theories that go beyond the Standard Model. On 8 October 2013 the Nobel prize in physics was awarded jointly to François Englert and Peter Higgs "for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider."

http://home.cern/topics/higgs-boson



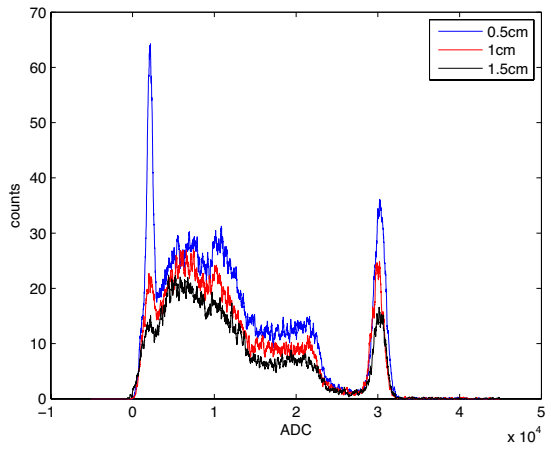
Experimental setup block diagram.

Carrying out the experiment

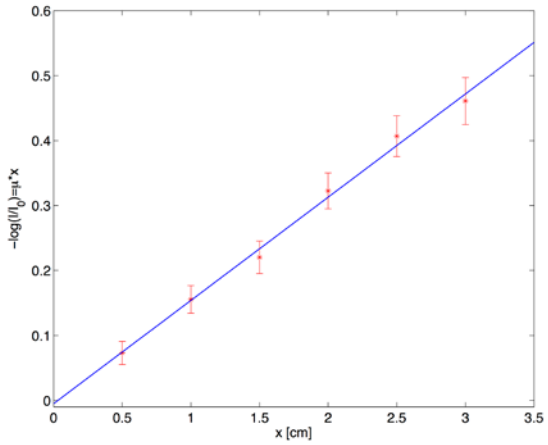
The scintillator crystal shall be coupled to the SiPM in the SP5607, through a thin layer of index matching grease to maximize the light collection. In order to avoid saturation, the output of the SiPM is divided using the A315 splitter: one branch is connected to the DT5720A and will be digitized. The 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 the SP5609 absorption tool shall be mounted. The experiment can be performed for every absorber thickness in counting mode and analysing the spectrum, measuring the events in the photo-peak for a constant predefined time interval.

Results

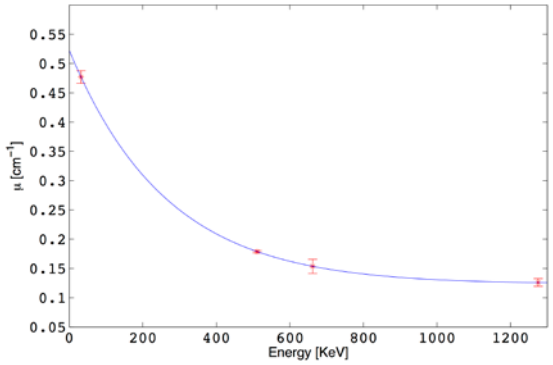
Exemplary results are shown below, reporting the variation of the events in the photopeak for different absorber thickness, a plot verifying the exponential absorption law and the dependence of the absorption coefficient on the energy.



Gamma spectra acquired with different absorber thicknesses.



Linear dependence of logarithmic intensity of gamma rays as a function of penetration thickness.



Gamma attenuation coefficient as a function of energy.