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HANDBOOK OF EXPERIMENTS

SG6123A β-Spectroscopy

β-Radiation: Transmission through Matter

Nuclear Physics and Radioactivity

EDUCATIONAL KIT

SP5600D

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β-Radiation: Transmission through Matter

Categories: CAEN Experiments, Nuclear Physics and Radioactivity | Tags: Nuclear Physics, Radiation Absorption, β Spectroscopy

Difficult	Execution Time	Data Analysis	Radioactive Sources
		Yes	Yes

Hardware setup

This experiment guide is referred to the **SP5600D** educational kit.

Equipment: SP5600D – Educational Beta Kit

Model	SP5600	DT5720A	SP5608	Additional Tool
Description	Power Supply and Amplification Unit	Desktop Digitizer 250 MS/s	Scintillating tile	β Radioactive source

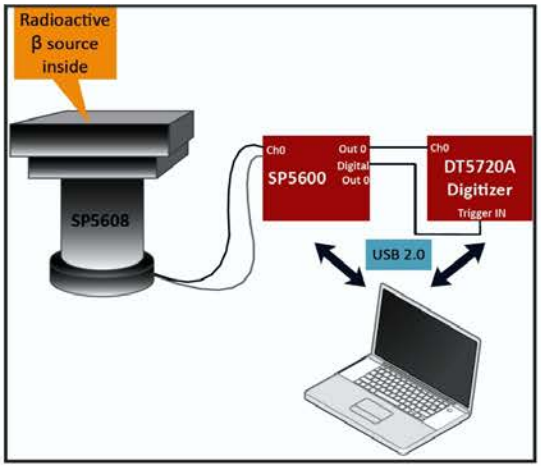
Purpose of the experiment

Attenuation measurement of the intensity of β radioactive source as a function of the absorber thickness by using two absorber materials: aluminium and paper sheets.

Fundamentals

β-particle is a charged particle that interacts with matter in several ways depending on its initial energy: ionization process, Bremsstrahlung process, Cherenkov and Transition radiation. When β-radiation crosses a matter thickness, it releases completely or part of its energy due to collisions with absorber atoms; this phenomenon depends on the initial β-energy and on the crossed material density. β-particles are less massive than alpha particles and only carry a charge of 1e; consequently, β-particles can appreciably penetrate many potential shielding materials although their penetrating capacity is considerably lower compared with γ-rays. These different radiation behaviours are essential for those attempting to shield locations from gamma radiation, either for sensitive experiments or for the safety of humans. The transmission of β-particles is frequently calculated in the same fashion as that of gamma rays, where the mass attenuation coefficient is defined by the slope of the exponential function. Due to the fact that the β-particles with lower energies are less penetrating hence they are completely absorbed at smaller values of thickness, the initial decrease of the absorption curve is too rapid to be fit by exponential function. This approximation is verified only in a particular region of the transmission curve: a minimal absorber thickness so that the β counting are very well separated from the “background level”.

Carrying out the experiment



Experimental setup block diagram.

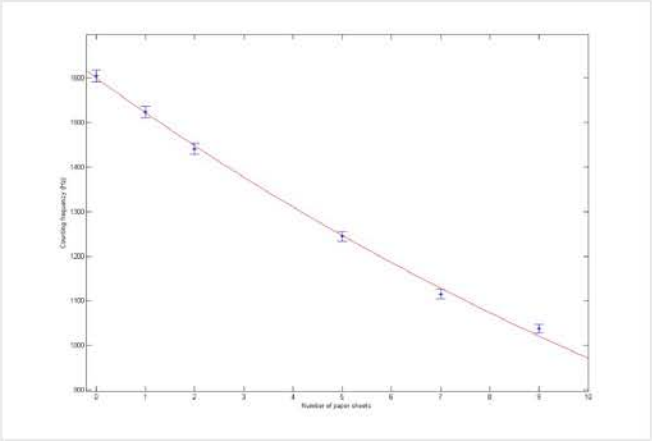
Insert the beta source support in the SP5608 and connect power and MCX cables to one channel of the SP5600. Connect the two channel outputs to DT5720A: the analog output to the channel 0 and the digital output to “trigger IN“ of the digitizer. Use the default software values or optimize the parameters to evaluate the contribution not coming from the β source and choose the discrimination threshold in mV. After that, switch off the power supply, open the SP5608 top and place the β source on the plastic support and close the support top. Switch ON the power supply and measure the counting rate. Repeat the measurement by adding layers of the same absorber and later change the absorber type.

Results

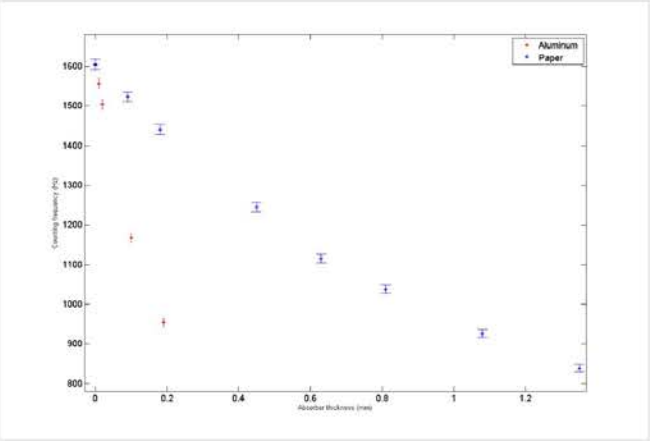
By using different absorber thicknesses, the near-exponential decreasing of β-radiation intensity *I* as a function of the absorber thickness *x*, is verified. This behaviour does not have a fundamental basis like gamma rays attenuation, but it is very well described by:

$$I = I_0 \cdot \mathrm{e}^{-nx}$$

where *n* is the absorption coefficient. This coefficient correlates the endpoint energy of β source for a particular absorbing material. From absorption curves of β-particles, the absorption coefficients and ranges of β particles in aluminium and in paper sheets can be determined.



Essential behaviour of the transmitted counting rate of ^{90}Sr source with respect to number of paper sheets.



Behaviour of the transmitted counting rate of ^{90}Sr source as a function of different absorbing materials.

HEADQUARTERS

CAEN S.p.A.

Via Vetraia 11
55049 - Viareggio
Italy

Phone +39 0584 388 398
Fax +39 0584 388 959
info@caen.it
www.caen.it



WORLDWIDE

CAEN GmbH

Brunnenweg 9
64331 Weiterstadt
Germany
Phone +49 212 254 40 77
Fax +49 212 254 40 79
info@caen-de.com
www.caen-de.com

CAEN Technologies, Inc.

1 Edgewater Street - Suite 101
Staten Island, NY 10305
USA
Phone: +1 (718) 981-0401
Fax: +1 (718) 556-9185
info@caentechnologies.com
www.caentechnologies.com

CAENspa INDIA Private Limited

B205, BLDG42, B Wing,
Azad Nagar Sangam CHS,
Mhada Layout, Azad Nagar, Andheri (W)
Mumbai, Mumbai City,
Maharashtra, India, 400053
info@caen-india.in
www.caen-india.in

CAENsn SAS

Gare du Nord Business Centre 14,
Rue De Dunkerque
75010 Paris
France
info@caen-sn.fr
www.caen-sn.fr