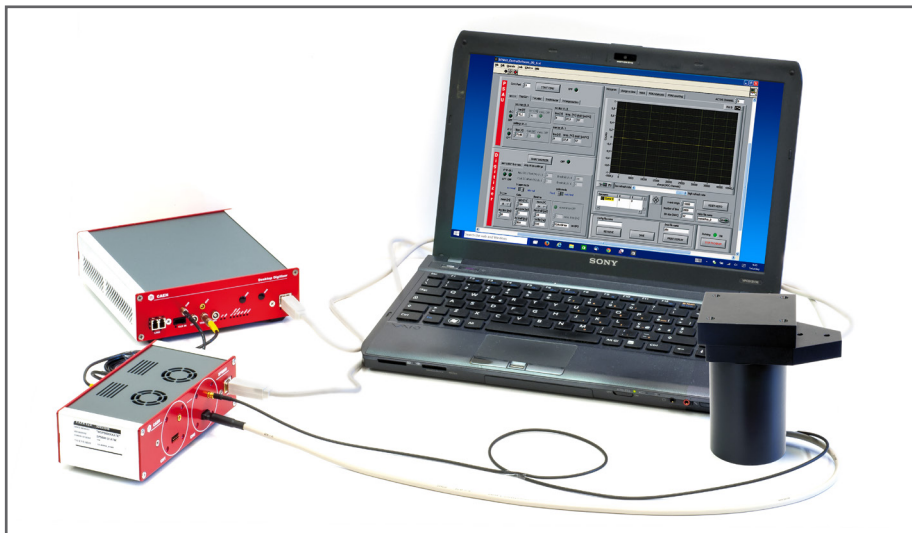


SG6122 β Spectroscopy



Purpose of the experiment

After gamma spectrometry, the student is introduced to the measurement and interpretation of β spectra, using a plastic scintillator tile.

Fundamentals

There are three different beta decays:

β^- decay (electron emission): $n \rightarrow p + e^- + \nu$

β^+ decay (positron emission): $p \rightarrow n + e^+ + \nu$

Electron capture (EC): $p + e^- \rightarrow n + \nu$

Where p identifies the proton, n the neutron and ν the weakly interacting neutrino. Because of the three body kinematics and the energy associated to the neutrino, the β spectrum is continuum up to a maximum energy depending on the isotope under study (and the neutrino mass).

Equipment

SP5600D - Educational Beta Kit

Model	SP5600	SP5608	DT5720A
Description	Power Supply and Amplification Unit	Scintillating tile	Desktop Digitizer 250MS/s
			

Requirements

Beta Radioactive Source 

Ordering Options

Equipment	
Code	Description
WK5600XDAAAA	SP5600D - Educational Beta Kit

or the all inclusive Premium Version

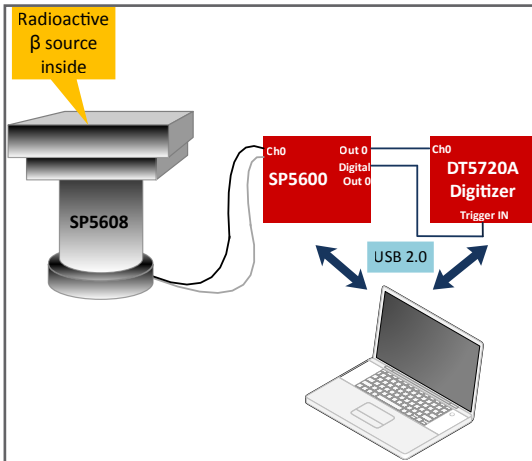
WK5600XANAAA	SP5600AN - Educational Beta Kit - Premium Version
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In the first decade of the 20th century, physicists believed that the β particles emitted in radioactive decay were monoenergetic and that such monoenergetic electrons would be absorbed exponentially in passing through matter. Conversely, they also believed that if electrons followed an exponential absorption law then they were monoenergetic. William Wilson showed conclusively that this view was wrong. After Wilson's work, physicists changed the experimental technique they used to investigate the phenomena. Instead of using absorption to measure the decay energy, they now used magnetic spectroscopy with various detectors as their standard method. Although Wilson's work changed the entire practice of the field and showed that the accepted view on electron absorption was wrong, references to it soon disappeared. Perhaps more surprisingly, after 1912 Wilson himself no longer published work on β particles and disappeared from the physics literature completely. The reasons for this also will be discussed.

<http://phys.colorado.edu/sites/default/files/williamwilsonandbetarays.pdf>





Experimental setup block diagram.

Carrying out the experiment

Connect the power and the MCX cables of the SP5608 tile 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 beta source and choose the discrimination threshold in mV. After that, switch off the power supply, open the SP5608 top and place the beta source on the scintillating tile. close the support top, switch ON the power supply and acquire the beta spectrum.

Results

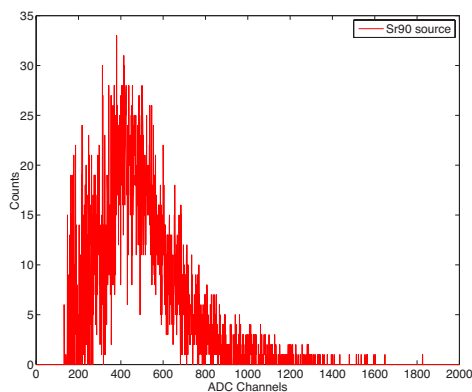
Measurement and interpretation of β spectra introduce the student into the field of special relativity and weak interactions of radioactive decays. Observation of the beta spectrum is very important to understand the theory of beta decay. Historically, experimental beta-ray spectra introduced enormous problems in the interpretation of beta decay due to the ostensible violation of the energy conservation. The introduction of neutrinos explaining the continuous beta-ray spectra solved not the problem conservation of energy, momentum and lepton number.

As first approach to beta spectroscopy, it is interesting to determine the maximum energy available in the decay process and to verify that the most probable energy value E_{avg} can be expressed as:

$$E_{avg} \cong 1/3 * E_{max}$$

By using several β -sources, different energy values E_{avg} can be estimated, each one corresponds to the total energy released in the specified β decay.

An example of ^{90}Sr spectrum is shown in the figure. For a most complete analysis on beta spectrum, other application notes are recommended.

Experimental beta spectrum of ^{90}Sr radioactive source.