SG6131 Basic Measurements: γ Spectroscopy and System Linearity

Related Experiment
SG6113
SG6114
ED3163

Ordering Options

Equipment	
Code	**Description**
WSP5700XAAAA	SP5700 – EasyPET
WDT5720AXAAA	DT5720A - 2 Ch. 12 bit 250 MS/s Digitizer: 1.25MS/ch, C4, SE
WDT5770AXAAA	DT5770 – Digital MCA - 1 LVPS ±12V/100mA ±24V/50mA

Purpose of the experiment

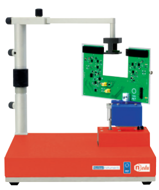
Gamma spectroscopy studies by using a gamma radioactive sources and by analysing the signals produced by the interaction of the gamma with one of the scintillating crystals of the system.

Fundamentals

The EasyPET detector system is composed of two Silicon Photomultipliers (SiPM) coupled to scintillating crystals. The EasyPET operation principle is simple: the two small detector cells, each composed of a small scintillator crystal coupled to a silicon photomultiplier (SiPM), develop a signal when they detect a photon emitted by the source. In order to perform the gamma spectroscopy measurements using one of the two detector systems, it is important underline that the detector is characterized by a noise component, caused by spurious events occurring randomly and independently from the illumination field. This noise, called Dark Count Rate (DCR), depends mainly on the sensor technology and on the operating temperature, with a rate from 100kHz up to several MHz per mm^2 at 25 °C. The DCR decreases with the lowering of the temperature (about a factor 2 of DCR reduction every 8°C). In addition, the operating voltage has an impact on the DCR since it's connected to the electric field and as a consequence to the active volume of the sensor and to the triggering probability of the charge carrier. This noise component affects the resolution of a generic gamma spectrum composed of system noise peak, Compton distribution and Photo-peak.

Equipment

SP5700 - EasyPET

Model	SP5700	DT5720A		DT5770
Description	EasyPET	Desktop Digitizer 250MS/s		Desktop Multi-Channel Analyzer
			OR	

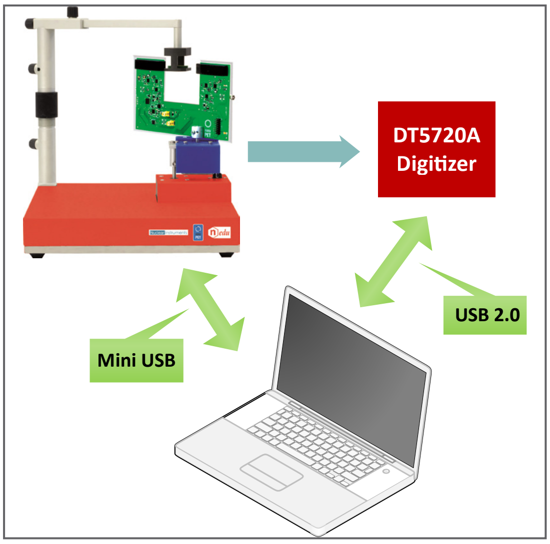
The First X-ray, 1895.
The discovery of a new and mysterious form of radiation in the late 19th century led to a revolution in medical imaging.

At the end of the 19th century, while studying the effects of passing an electrical current through gases at low pressure, German physicist Wilhelm Röntgen accidentally discovered X-rays—highly energetic electromagnetic radiation capable of penetrating most solid objects. His discovery transformed medicine almost overnight. Within a year, the first radiology department opened in a Glasgow hospital, and the department head produced the first pictures of a kidney stone and a penny lodged in a child's throat. Shortly after, an American physiologist used X-rays to trace food making its way through the digestive system. The public also embraced the new technology—even carnival barkers touted the wondrous rays that allowed viewing of one's own skeleton. At the close of 1895, Röntgen published his observations and mailed his colleagues a photograph of the bones of his wife's hand, showing her wedding ring on her fourth finger.

http://www.the-scientist.com/?articles.view/articleNo/30693/title/The-First-X-ray--1895/

Requirements

^{22}Na Radioactive source (recommended: 1/2 inch disc, 10 μCi)



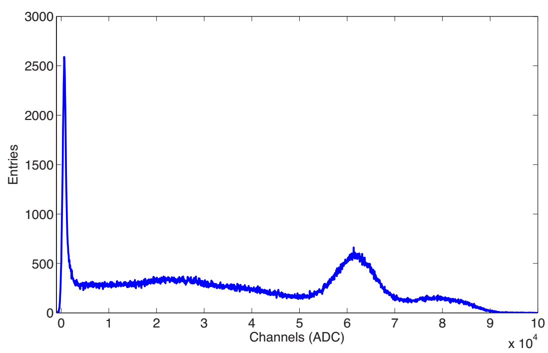
Experimental setup block diagram.

Carrying out the experiment

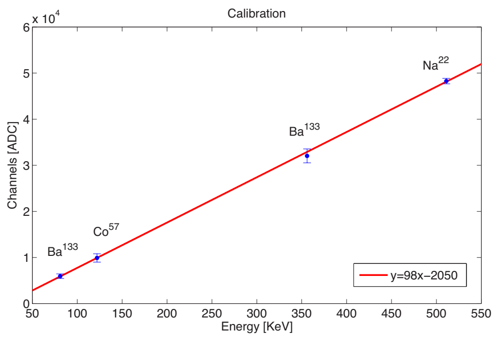
Mount the arm of the source holder on the column fixed to the system base, fix the U-shaped board to the top stepper motor and connect the flat cable to the U-shaped board and to the control unit. Connect to PC and power ON the system. Choose one detection system and connect its analog output to channel input of the DT5720A and use the digital output as digitizer “trigger IN” and choose the threshold in mV of the signal output. Place the radioactive source as close as possible to the detector chosen and acquire the energy spectrum thanks to a digitizer that perform charge integration by processing the signals exceeding a fixed threshold. Repeat the measurements with several gamma radioactive source in order to study the linearity system.

Results

The γ spectrum shows the Compton continuum, related to the continuum of energies released by the Compton scattered electrons, and the Photo-Peak, the full-energy peak corresponding to the photoelectric absorption of the incident gamma. The peak around zero represents the system noise. The conversion between the channels number and the energy can be performed by a calibration. The system linearity is checked by using several radioactive sources. If the response of the system is linear, the output signals are directly proportional to the incident gamma energies.



Energy spectrum of ^{22}Na source.



Energy Calibration.