C.1.3 Muons Detection

SG6211A

Difficulty	Execution Time	Data Analysis	Radioactive Sources
		NO	YES

Dedicated kit	
Description	pp.
SP5600D Educational Beta Kit	182 179

Requirements

No other tools are needed.

Equipment

SP5600D - Educational Beta Kit

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

Cosmic rays detection by using a system composed of a plastic scintillating tile directly coupled to a Silicon Photomultiplier detector.

See the Application

Fundamentals

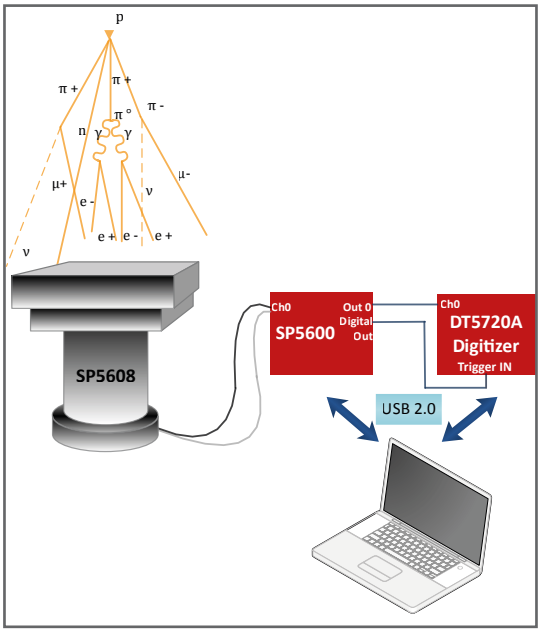
The muons, produced by the decay of pions and kaons generated by the hadronic interaction of the primary cosmic rays with atmospheric nuclei, are the most cosmic rays at sea level.

Cosmic muons are charged particles, produced high in the atmosphere (typically 15 km) with highest penetration capability in matter. Their mass (~ 200 times the electron mass), the absence of strong interactions and their long lifetime ($\tau \sim 2{,}2 \times 10^{-6}$ s), allow muons to cross the atmosphere and reach the Earth's surface.

The muon average energy at sea level is around 4 GeV.

Carrying out the experiment

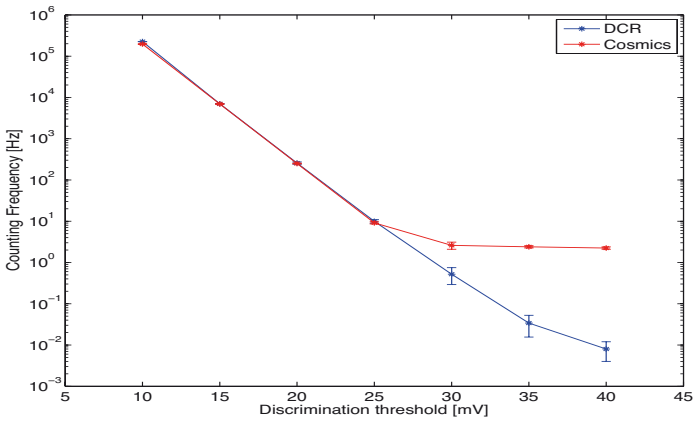
Open the SP5608 and remove the plastic scintillating tile. Close the SP5608 and connect its power cable and its MCX cable to one channel of the SP5600. Connect the two outputs of the chosen channel to DT5720A: the analog output to the channel 0 and the digital output to “trigger IN“ of the digitizer. Use the default software values or optimize the parameters to evaluate the noise contribution of the sensor, called Dark Count Rate (DCR). Measure the DCR as a function of the discrimination threshold in mV. Because of the DCR, the system has to be made sensitive to the cosmic ray flux relying on the acquisition time of the sensor signal. Switch off the power supply, open the SP5608 top, spread the optical grease on the SiPM and insert the scintillating tile. Close the support top, switch ON the power supply and restore the previous configuration parameters. Measure the counting rate scanning the values of the threshold.



Experimental setup block diagram.

Results

The cut-off threshold has a key role in the cosmic ray detection and it shall be set to reduce the random coincidence rate below the Hertz level and measure the cosmic rate.



Signal frequency as a function of discriminator threshold. The red line represents the cosmic contribution, the black one the noise.

This experiment is also possible with the following kits

B SP5600AN
Educational kits
PREMIUM

see p. 179

D SP5620CH
Cosmic Hunter

see p. 182