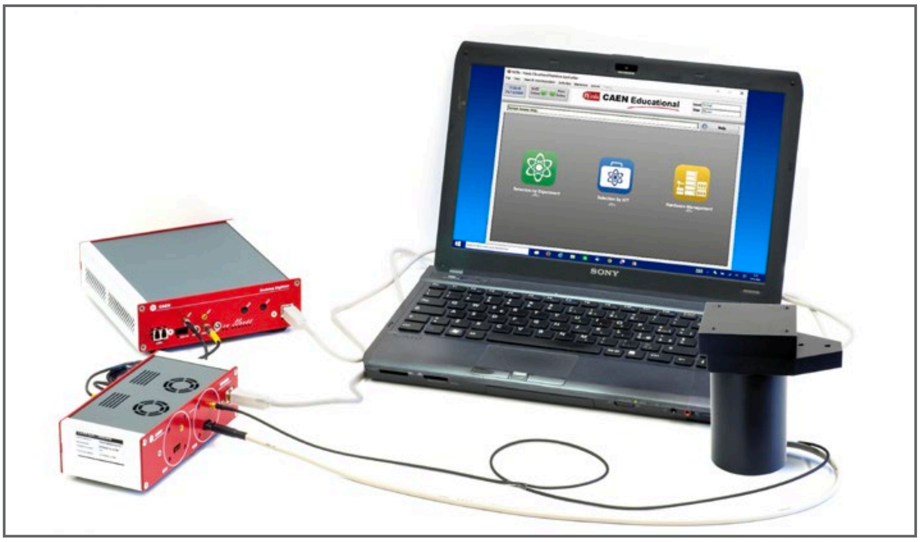
# C.1.2 Muons Detection

**SG6211**




### Ordering Options

| Equipment A | |
|---|---|
| **Code** | **Description** |
| WK5600XDAAAA | SP5600D - Educational Beta Kit |
| *or the all inclusive Premium Version* | |
| WK5600XANAAA | SP5600AN - Educational Kit - Premium Version |

| Equipment B | |
|---|---|
| **Code** | **Description** |
| WK5620CHAAAA | SP5620CH - Cosmic Hunter |

## Purpose of the experiment

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

## 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.

## Equipment

SP5600D - Educational Beta Kit

| Model | SP5600 | SP5608 | DT5720A |
|---|---|---|---|
| Description | Power Supply and Amplification Unit  | Scintillating tile coupled to SiPM  | Desktop Digitizer 250 MS/s  |
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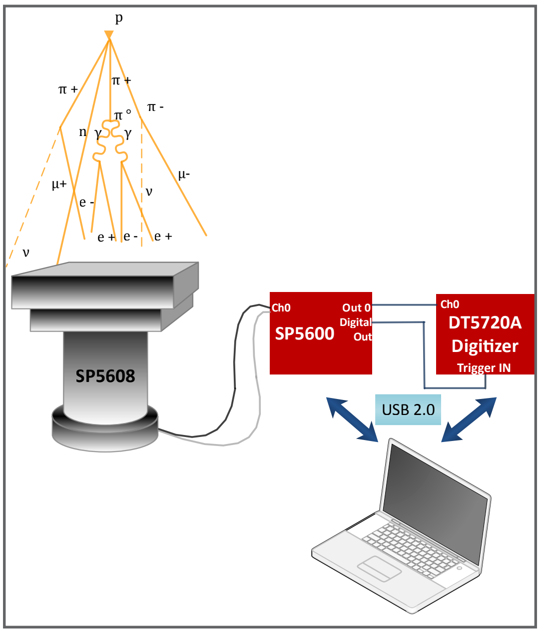
## Requirements

No other tools are needed.

**1932, physics "annus mirabilis": the positron**

1932 was an extraordinary year for nuclear physics: J. Chadwick discovered the neutron, C. D. Anderson identified the positron and the first artificial disintegration was realised with a particle accelerator by J. Cockcroft and E. Walton. These 3 discoveries transformed nuclear physics by providing basis on which any new research could be led. The neutron allowed the discovery of artificial radioactivity by Joliot - Curie in 1934 and later the discovery of nuclear fission by O. Hahn, F. Strassman and L. Meitner. The positron brought new concepts about cosmic radiation and drew the way to the discovery of new particles. Artificial disintegration paved the way to the ever-bigger machines. It was the beginning of the era of breaking nuclei. 1932 deserves its title of "annus mirabilis" of physics. This article presents the quick evolution of ideas, concepts in nuclear physics in the thirties. (A.C.)

*https://inis.iaea.org/search/search.aspx?orig_q=RN:30014612*



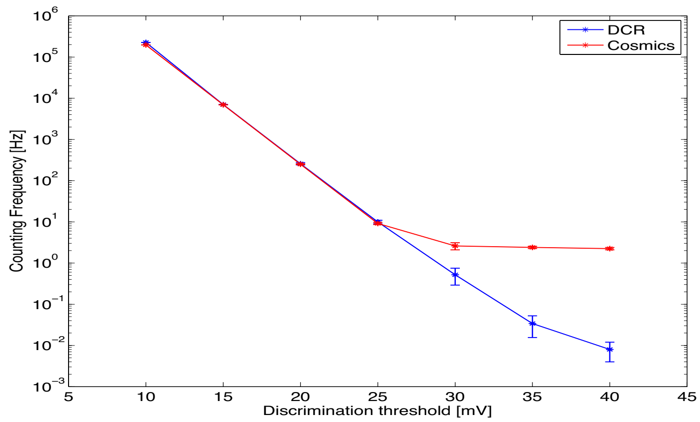

Experimental setup block diagram.

## 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.

## 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.