A.1.3 Temperature Effects on SiPM Properties

SG6013

Ordering Options

Equipment	
Code	**Description**
WK5600XEAAAA	SP5600E - Educational Photon Kit
or the all inclusive Premium Version	
WK5600XANAA	SP5600AN - Educational Kit - Premium Version

Purpose of the experiment

Gain, noise and photon detection efficiency (at fixed bias voltage) are affected by temperature. The student is driven through the measurement of the dependence of these critical figures.

Fundamentals

The gain in a SiPM biased at fixed voltage changes with temperature since the breakdown voltage V_{br} does it. Gain stabilization is a must and can be pursued tracking the V_{br} changes and adjusting the bias voltage accordingly. The rate of variation depends on the sensor, through the material properties. Noise depends on the thermal generation of charge carriers, so a significant dependence is expected as well.

The NA62 is an experiment at CERN with the aim to measure the very rare kaon decay $K^+ \rightarrow \pi^+ \nu \bar{\nu}$. Carried on at CERN SPS the experiment aims to collect about 80 $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ events at the SM prediction with a signal to background ratio of 10:1 in two years of data taking. In particular, the experiment makes also use of the Silicon Photomultipliers technology due to the properties similar to conventional photomultipliers but withstanding to high magnetic fields. CERN awarded CAEN with a contract for the design and production of the High Voltage power supply system for photomultiplier tubes for the NA62 Large Angle photon Veto (LAV), Muon Veto detectors (MUV), Differential Cherenkov counter (CEDAR) and the Calorimeter REAdout Module (CREAM) for the NA62 high resolution Liquid Krypton Calorimeter (LKr).

http://na62.web.cern.ch/NA62/

Equipment

SP5600E - Educational Photon Kit

Model	SP5600	DT5720A	SP5601	SP5650C
Description	Power Supply and Amplification Unit	Desktop Digitizer 250 MS/s	LED Driver	Sensor Holder for SP5600 with SiPM
				
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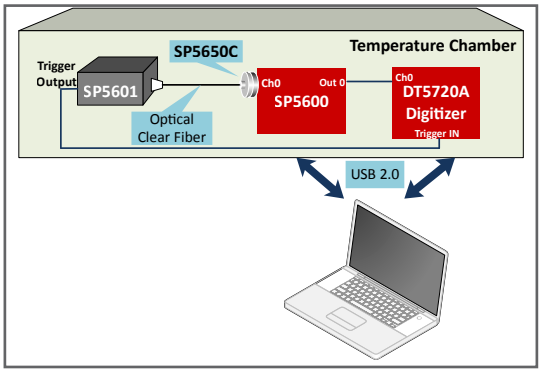
Requirements

A temperature controlled box/room is essential.



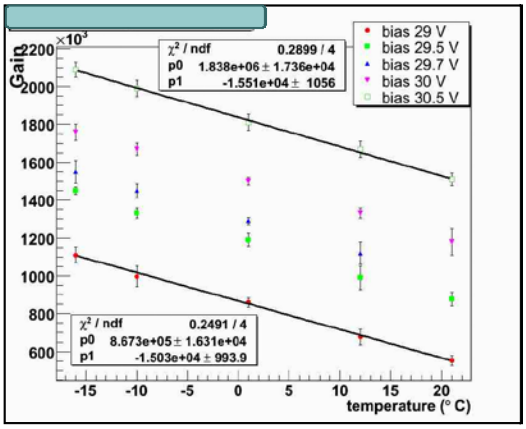
Experimental setup block diagram.

Carrying out the experiment

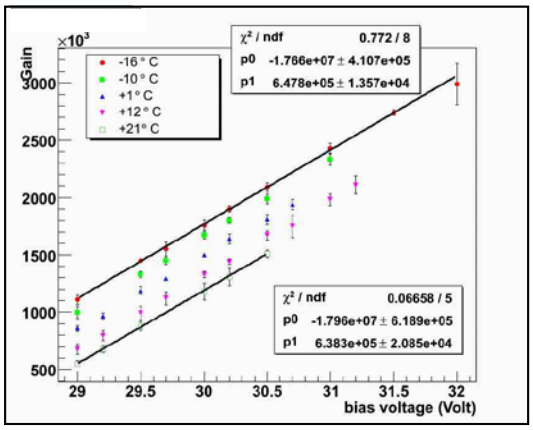
In a temperature controlled box, mount one of the sensors (SP5650C) on the SP5600 and connect the analog output to the input of the DT5720A digitizer. Optically couple the LED and the sensor via the optical fiber, after having used the index matching grease on the tips. Set the internal trigger mode on the P5601 and connect its trigger output on the DT5720A trigger IN. Connect via USB the modules to the PC and power ON the devices. Through the LabView graphical user interface (GUI), properly synchronize the signal integration and, for every temperature & voltage value, record the photon spectrum and measure directly the Dark Count and the Optical Cross talk.

Results

Figures show the dependence of the gain upon temperature at various voltages and the voltage dependence at various temperatures. By the two set of results, the temperature coefficient of the sensor, i.e. the variation of the breakdown voltage with temperature, can be measured



SiPM gain as a function of temperature, at different bias voltage values.



SiPM gain as a function of the bias voltage, at different temperature values.