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Microcontroller based data acquisition system for silicon photomultiplier detectors.

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Silicon photomultipliers are robust, low power detectors for low light levels. This, along with the low bias voltages and their relatively low cost makes them a good candidate for portable scintillation detectors. A data acquisition system based around a microcontroller has been developed for such a detector with a small number of data channels. Different powering and data recording or reporting options have been investigated for a range of possible operational scenarios such as laboratory based cosmic ray measurements, high altitude cosmic ray measurements and portable radiation detection.

Summary

Silicon photomultipliers are light detectors with high quantum efficiency able to detect low light levels. Since they are robust, require low bias voltages (compared to other photomultipliers), require low power and are relatively inexpensive (again, compared to other photomultipliers) they are good candidates for portable scintillation detectors.

Microcontrollers can be used to a design portable, low cost and versatile data acquisition for silicon photomultiplier based detectors. A DAQ system using mbed microcontrollers, which are based on ARM Cortex-M processors, has been developed. The system can count the number of events where the photomultiplier detects a signal above a programmable threshold. The system can acquire data from a small number of photomultiplier channels, with the ability to do coincidence detection between channels. The cost of the DAQ system should be lower than the cost of a silicon photomultiplier detector.

A number of different data recording or reporting options are being investigated, including serial data transfer over USB, serial/I2C/SPI communication with other devices, communication over ethernet and data storage on SD memory. Different powering options are also being investigated, including power over USB, power over ethernet and battery power.

This DAQ system should therefore allow versatile, portable scintillation detectors that are fairly inexpensive. Such detectors could have a number of uses such as laboratory or school based cosmic ray experiments, high altitude cosmic ray experiments, portable radiation detectors or prototype scintillation detectors for large scale experiments.

This system has been designed with high altitude cosmic ray measurements as a main goal. Weather balloons and helium can be used to launch low mass payloads into the upper atmosphere for a few hundred pounds. This cost puts such activities within the budgetary reach of undergraduate or even school experiments. This DAQ system has been designed with the goal of providing a low mass, inexpensive cosmic ray detector that could be launched under a helium filled weather balloon. A detector using one or two silicon photomultipliers and this DAQ system should make it possible to measure the cosmic ray flux up to altitudes of 30km at a cost of approximately £500.

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