6 - 33 Design of a Portable Multi Parameter Cosmic Ray Detector

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We have designed and developed one small, low power consumption, portable and fully functional secondary charged particle detector. This detector consists of sensitive detection body, photomultiplier tube, high voltage power supply module, signal conditioning and data processing circuit, and can work at outdoor powered by a solar battery or vehicle power supply when monitoring the cosmic ray flux at different areas via a network for a long time, and make records of environmental parameters, such as air temperature, humidity and air pressure in these areas as large data sample. This large data sample shall be used in a further study of the correlation between cosmic rays and climate change [1], biodiversity and genetic variations of animals and plants.

1. Key technologies of system design

As shown in Fig. 1, there are four channels for the flux counting of secondary charged particles while the dead time is less than 10 ns, and a function of efficiency correcting is also developed; FPGA based TDC technology is used to measure the signal leading edge time differences and pulse width with a range of 6 μs and a time resolution of 100 ps; Adopt high precision AD/DA for high voltage power supply monitoring accurately to ensure the power output stability better than 0.5%. An over-voltage or current protection is developed as well; Parameters of environmental temperature and humidity, air pressure, altitude, GPS position and UTC time are collected stored and transmitted through network. Several data acquisition units could be cascaded through a 60 MB/S data and control bus working as a data acquisition system with a great number of measurement channels.

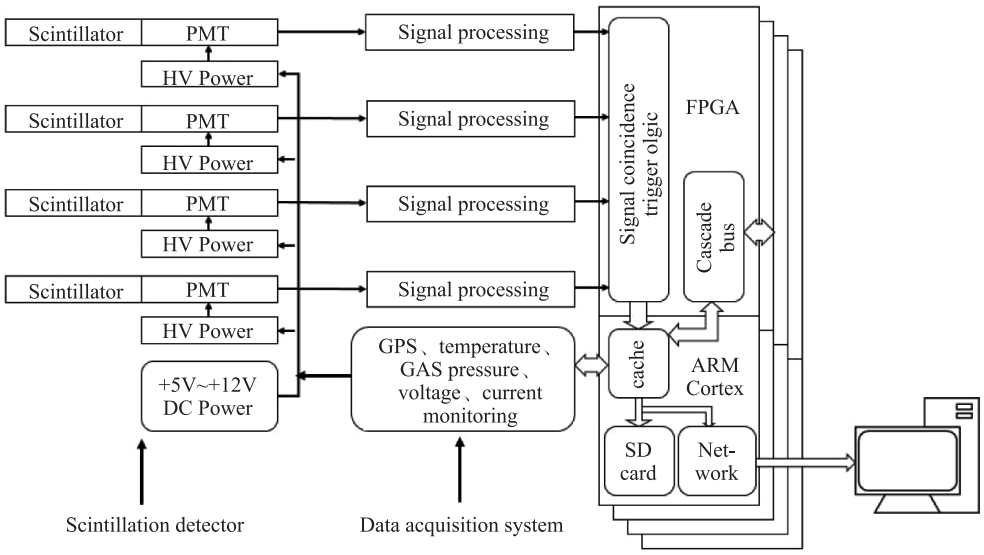

Fig. 1 Block diagram of system design.

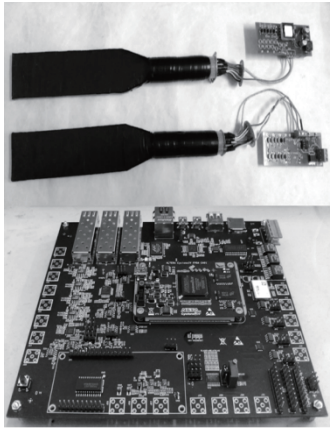

Fig. 2 A prototype of detector circuit.

2. A prototype of cosmic ray detector

As shown in Fig. 2, a small cosmic ray detector with the function of cosmic ray demonstration has been developed in lab, which is mainly used to measure and display the sub rays in real time, and to monitor and record the secondary cosmic ray flux at different angles in a long time scale. The detection efficiency of the detector is 93.1%, and the detection efficiency of the two detectors is up to 86.6%. In addition, the zenith angle distribution measurement result of the secondary cosmic rays in the urban area of Lanzhou city is well satisfied with $I\ (\theta) = I_{\mathrm{H}} + I_0 \cos\theta$ empirical formula[2,3], in which the angle dependent parameter $\alpha = 2.42 \pm 0.52$.