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Silicon Photomultiplier Module Tester*

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Abstract

Our plan is to create a flexible tester device, which can test multiple SiPM arrays and SiPM + LYSO crystals modules simultenaously. Many kind of tester machine are present nowadays, all of them lacks of precision and/or speed and usually measuring only one sensor at a time. Using these devices to test an array is time consuming, slow, it can take a day for only one array. An array consists of 16 SiPMs which are read by high speed ADCs. For transferring this much of data from the ADCs to a computer, the FPGAs are the only cost effective and viable solutions. Our SiPM tester can measure both IV curve of the sensor and single photon spectrum. These devices on one array must have a very similar breakdown voltage to work precisely together, at the end of production further inspections and measurements needed, because the data provided by the manufacturer has a high offset error. An IV measurement usually consists of hundreds of voltage points to measure on and can be done in a few seconds, while the single photon spectrum method generates thousands of hundred gigabytes of data, the ADCs acquire millions of points in a second and stores the values on 10bits. To overcome and handle this data stream, a highly integrated electronics with appropriate softwares needed. This huge amount of data sent to a PC where it is analyzed. According to the amount of the data, the device is connected to a PC through PCI Express (PCIe), which is a high speed, high bandwidth protocol, the same way as the GPUs. A database from the acquired and analysed data is stored, can be reached by other researchers also. The database of thousands SiPM measurements will help to finetune backwords the analysis itself. The module tester uses radioactive sources to validate the gluing of the crytal and the SiPMs. The signal created by the decay gammas is read out with a full bandwidth of order of 100Gbps, triggered

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and analysed real time. The results in the database together with the results of the SiPM tests will help at the detector assembly centers (INFN Milan, INFN Rome, CalTech Los Angeles). The raw data is also stored alongside the results of our analysis for both of the measurement modes. Most of the paramateres can be calculated, like breakdown voltage, gain, etc, and can be verified using the database, even with temperature compensation for more precise analysis. The device will be used for testing all of the SiPM sensor for the MIP Timing Detector at CERN. [1] Hundreds of thousands of SiPMs and tens of thousand modules will be tested with much higher precision in much less time than with other consumer electronics and devices. Selecting the right arrays for a project is very easy using the database.

References

[1] J. N. Butler, T. Tabarelli de Fatis: *A MIP Timing Detector for the CMS Phase-2 Upgrade* (2019).