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General-Purpose Solution for Timepix3 –Katherine Readout

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The contribution shows possibilities of the readout for Timepix3 (Ethernet Embedded Readout Interface for Timepix3 –called Katherine) for a wide range of applications. The architecture and features of the system are described in detail. The stress is laid on the usage of more readouts in a telescope configuration, where more Timepix3 sensors are operated and their time-dependent functions are synchronized. The fully radiation hardened solution for Timepix3 is also presented. Authors demonstrate and discuss the utilization of the device in ATLAS experiment.

Summary

The Katherine readout device is new embedded readout device using Gigabit Ethernet interface for Timepix3 pixel detectors (the latest generation of Medipix family). The device can manage one Timepix3 sensor and process all functions of the sensor as a high hit-rate, a time resolution (1.56ns), event data-driven mode etc. Used interface –Gigabit Ethernet –makes it possible to communicate (up to about 15Mhit/s) with back-end DAQ systems for long distance. That is an important benefit in comparison with USB-based readout devices used very frequently in Medipix/Timepix detectors domain. In the contribution, the main features of device are mentioned in detail –such as the implemented bias high voltage source (range ±300V), automatic data sending via SSH, automatic compensation of ToA values (columns with shifted clock) etc. The readout device is equipped with a dual-core ARM A9 processor with the high computational power which is, in conjunction with the FPGA device, good platform for wide range of tasks where the need for extended features of the readout, according to requirements, is important.

The contribution summarizes also measurements accomplished with Katherine readout in the past. The results of equalization, energetic (ToT) calibration and time-walk corrections performed by the readout are mentioned. The significant emphasis will be placed on the usage of more readout devices in telescope configuration. For this purpose, the authors also use Time-to-Digital Convertor (TDC) device with time resolution of 13 ps for very accurate measurements of clock phase differences in sensors. The individual sensors with the readout can be far each other several meters. The concept of this measurement chain was tested at the SPS facilities at CERN in a 120 GeV/c pion beam and synchronization accuracy of ˜0.8 ns was achieved.

The most important feature of the Katherine readout is its optimization for a long cabling. It is absolutely profitable when a user needs a long distance between sensor and readout electronics –typically for measurements in higher radiation field. The special extending option modules and chipboard for Timepix3 were designed for this purpose. Using that the fully radiation hardened measurement setup/chain can be built. The system setup was tested with 20m long cabling with no communication speed reduction (640Mbs speed used), and 100m long cabling with reduction to 80Mbs (per output data line). The contribution also presents the first real application using this solution –the system has been already installed in ATLAS cavern. The sensor's position is 80m away from the readout device placed in USA15 rack room. The maximal hit rate is 5Mhit/s; however authors plan to make minor upgrade of the system and get approximately 10Mhit/s. Clock data recovery technique is used for all Timepix3 output data, this avoid the worries about length matching of data cables. Data taken and obtained knowledge (e.g. dependence of cables quality) will be the subject of the discussion as well. Another important point of the system is the price. The whole system can be considered as low-cost

system.

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