Beamtime Results of the MVD Prototype DAQ Network*

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Recently, the MVD Prototype has been developed at the IKF in Frankfurt. The module contains one quarter of the first MVD station featuring 4 thinned MIMOSA-26AHR sensors on CVD support. The prototype has been tested at the CERN SPS accelerator in 2012.

The CBM Micro Vertex Detector (MVD) is based on Monolithic Active Pixel Sensors (MAPS). In order to prove its suitability for upcoming experiments, the MVD-Prototype has been developed and tested during a beamtime at the CERN SPS accelerator with high energetic pion beams of varying intensity. The prototype (Device Under Test, DUT) features four MIMOSA-26AHR MAPS sensors thinned down to 50 μm and glued back-to-back on the 200 μm thick CVD diamond support. It features therefore doublesided MAPS sensors with excellent heat conductivity, material budget and non-ionizing radiation hardness. The test setup intended to demonstrate tracking capabilities of the MVD. Therefore the DUT was placed between four reference detector planes (see Fig. 1, left) containing MIMOSA-26AHR sensors as well.

The sensors are operated via JTAG which is implemented on a central controller board called MVD Acquisition and Interaction Node (MAIN). The MAIN board is capable of controlling three independent JTAG chains with up to 6 MIMOSA sensors (tested). In total 12 sensors are used in the setup, 4 per chain. Specialized Front-End Electronics (FEEs), designed to sustain large radiation doses, were used to operate the sensors. Sensors are connected via short Flexprint Cables (FPCs) to the FEEs and the FEEs are all connected with RJ45 cables over patch panels either to the MAIN board or the Readout Controllers (ROCs) (see Fig. 1). The ROCs are responsible for the actual acquisition of data. Each ROC can process 4 sensors in parallel. Sensor data is checked online for errors and a status report containing all the errorbits is written with the data. For the implementation of the MAIN board and the ROCs a TRBv2 board [1] with a general purpose addon is used. Data is encoded using TrbNet [1] as a network protocol and transmitted via optical links.

One single MIMOSA-26AHR chip can produce up to 20 MB/s data at full occupancy. It can theoretically detect up to 342 particles per event at an event rate of 8,68 kHz and under the asumption that each hit activates an area of 3×3 pixels. However, the datarate throughout the beamtime was very low. Even after achieving maximum beam intensity of 33 kHz, the entire setup featuring 10 active sensors produced 25,1 MB/s on average, half of which was noise. Peak sensor occupancy was at 75 particles per event. After putting four sensors manually into saturation mode, the peak readout rate of 98 - 99 MB/s could be achieved. Under overload, the network synchronizes all frames by stopping the data buffers. New data is discarded until all buffers can take another event. Then, the data acquisition continues in a synchronous manner without errors. All sensors are synchronized within 10 ns due to a common clock and simultaneous *start* signal provided by the MAIN board.

All power supplies, FPGAs and sensors have been controlled and monitored actively. An automated PERL script acquired data from 244 TrbNet registers and stored them in a local ASCII file for error analysis. Throughout the beamtime, no errors have been observed. The system was running very stable at all times. Merely two FEE boards had to be replaced due to mechanical damage. In future, a new ROC based on TRBv3 will be implemented in order to support CBMNET and higher readout rates for the final MVD.

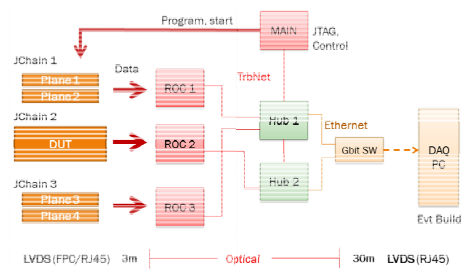

Figure 1: The prototype readout network

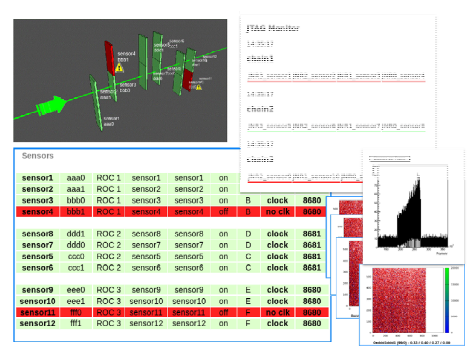

Figure 2: Beamtime DAQ monitoring tools

References

[1] J. Michel, "Development and Implementation of a New Trigger and Data Acquisition System for the HADES Detector", PhD Thesis, University Frankfurt, 2012.

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