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Intelligent FPGA based Event Builder and Data Acquisition System for the COMPASS experiment.

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High reliability and compactness are key features of the Data Acquisition system for the COMPASS experiment at CERN's SPS. The system was commissioned in 2015 for the Drell-Yan physics run, when the physics program required a reduced COMPASS spectrometer configuration. For 2016 run the system will be employed in full scale with on spill data rate of 1.5 GB/s and a sustained rate of 500 MB/s.

The DAQ has a hybrid FPGA-software architecture, where the event building task is performed by FPGAs, while the software is responsible for overall system control, user interfaces, configuration and monitoring.

The event builder consists of nine DHx FPGA cards. The DHx card complies with the AMC ATCA standard, equipped with 4GB of DDR3 memory and 16 high speed links. The event builder receives data from front-end electronics via about 100 optical serial interfaces, buffers data in local memories, combines event fragments into complete events, and then distributes them to eight Readout Engine computers via FPGA PCIe cards. The FPGA cards, including the PCIe cards, are orchestrated by the Trigger Control System. The event builder is designed to provide continuous, uninterruptible data flow. The measures, which were taken to achieve it, are following: handling of wrong data format or missing data, throttling of too high data rate, automatic resynchronization of problematic front-end modules. Status information and diagnostics about detected problems are accessible via a dedicated Ethernet network using IPbus protocol. The DDR memories are divided into multiple, independent, oversized FIFO buffers or memory blocks. They eliminate a random nature of event intervals and event size fluctuations. The data flow and event building processes are self-synchronized. Actually an internal event builder performance is limited by a throughput of the DDR3 memory of 3GB/s. Overall system performance is 1.6 GB/s, limited by the bandwidth of eight serial interfaces between the event builder and the readout engine computers.

The DAQ software provides a set of tools for configuration, run control, monitoring and visualization. The information is stored in MySQL data base and can be retrieved using elaborated search engine of the Message Browser. The Run Control GUI together with the configuration GUI provide intuitive interface for shift crew. The architecture and performance of IFDAQ will be discussed.

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