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Time synchronization and DAQ for electromagnetic calorimeter of MPD experiment at NICA

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Time synchronization and data acquisition systems are designed for the Electromagnetic Calorimeter (ECAL) of Multi Purpose Detector at NICA collider. The DAQ system comprises 43,000 readout channels with waveform digitizers and with pulse reconstruction algorithms signal magnitude and time of arrival are found.

Clock distribution and time tag synchronization are performed with White Rabbit technology. It is an extension to Ethernet and provides sub-nanosecond accuracy and picoseconds precision for distributed system. MPD timing network topology is tree with Grand-Master at root connected to GPS receiver, two levels of distribution switches, control boards and finally endpoints in readout boards. All readout boards have same notion of frequency and time and digitize detector signals synchronously. Low jitter ADC sampling clocks are derived from tunable local crystal oscillators controlled by FPGA on readout boards.

Control boards perform hardware data merging per-event and deliver data stream to DAQ computer farm by 10 Gbit/s Ethernet links. TCP/IP is run on FPGA and include endpoint discovery and automatic configuration protocols.

Readout electronics will be installed on ECAL modules inside MPD and is designed to operate in magnetic field. 672 FPGA readout boards have 10 kW total power dissipation and liquid cooling system is designed.

Prototype system has been running at BM@N detector in 2018 at Nuclotron extracted beam and ECAL test setups are operational now.

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