DAQ system in RHICf experiment

H. Menjo,[*1,*2] Q. Zhou,[*2,*3] K. Sato[*2,*3] for the RHICf collaboration

The data acquisition (DAQ) system of the RHICf experiment[1], which measures very forward neutral particles at RHIC, was set up in 2016, and it has been readied for data acquisition in an operation scheduled for June 2017[2]. The RHICf uses one of the LHCf detectors[3], which has 2 independent calorimeter towers composed of tungsten plates, 16 layers of GSO scintillators and 4 X-Y hodoscopes of GSO bar bundles. Figure 1 shows the schematic of the detector. The RHICf detector is located 18 m away from the STAR interaction point, which is immediately in the front of the STAR zero-degree calorimeter (ZDC). The RHICf DAQ uses read-out electronics, power supplies, and also the trigger system of the LHCf experiment. These are installed in a rack located in the STAR experimental cabin to avoid the effect of high radiation near the detector. The PMT analog signals from the sampling layers are transmitted from the detector to the rack via coaxial cables, and they are distributed over two analog-to-digital conversion (ADC) modules, CAEN V965, for charge measurement and two discriminator modules, CAEN V814B, for the trigger system via analog fanout modules. The AD conversion of signals from MAPMTs connected to the 480 GSO bars is performed in a radiation-hard front-end circuit located inside the detector. A VME board receives the digital data and stores it. The total data size per event is about 2.7 KB.

The trigger logic was designed for detecting events with electromagnetic and hadronic showers induced by incident photons and neutrons. A trigger is issued when any three successive layers have an energy deposit over a certain threshold. This type of trigger is called as a shower trigger. The logic was implemented on a field-programable gate array (FPGA) board with inputs from the discriminator boards. It was originally designed for the LHCf DAQ and optimized for the RHICf DAQ to work under the beam configuration of RHIC. Assuming discriminator threshold of 30 MeV energy-deposit equivalent signals, we estimated the trigger efficiencies of 100% for photons with energies over 30 GeV and about 70% for neutrons with energies over 50 GeV. In addition to the shower trigger, another trigger mode, the so-called π^0 trigger, was implemented. We note that π^0 particles generated in p-p collisions decay to photon pairs immediately. A π^0 trigger is issued when both the towers detect electromagnetic showers upon the condition that shower triggers are initiated in the first seven layers of each tower. The expected shower trigger rate is 18 kHz while the π^0 trigger rate is only about 60 Hz.[4] To enrich recoded π^0 trigger events within the readout rate of 1 kHz, the shower trigger rate is pre-scaled down to 0.8 kHz.

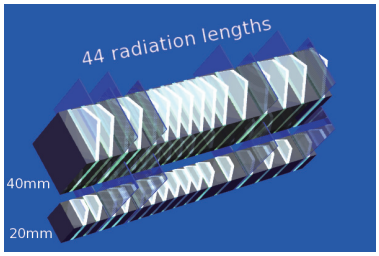

Fig. 1. Schematic view of the RHICf detector.

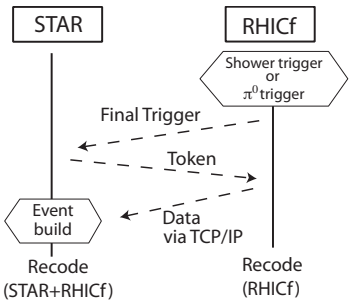

Fig. 2. Common-DAQ scheme of STAR and RHICf.

A common operation with the STAR experiment is performed. The RHICf final trigger signals are sent to the STAR trigger system to trigger the STAR DAQ. In the common operation, the RHICf works as a sub-detector of STAR. Figure 2 illustrates this common-DAQ scheme. STAR issues an event ID token for each triggered event and distributes it to all sub-detectors. The RHICf receives the token and sends RHICf data together with token via the network. The STAR DAQ combines all data from the sub-detectors and dumps it into a disk. This common operation increases the physics potential of the RHICf experiment, for example, the energy resolution for neutrons is improved upon combining the RHICf and STAR-ZDC data.[5]

*1 Graduate School of Science, Nagoya University
*2 RIKEN Nishina Center
*3 Institute for Space-Earth Environmental Research, Nagoya University

References
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