Contribution ID: **236**   Type: **Oral presentation**

Commissioning and performance of the common readout system for the Belle II experiment

Thursday, June 9, 2016 1:35 PM (20 minutes)

The Belle II experiment, aiming to search for physics beyond the standard model by precision measurement, is scheduled to start in 2017. The target luminosity of SuperKEKB, an asymmetric electron–positron collider, is 8×10^{35} cm^{-2} s^{-1} and the Level-1 trigger rate is estimated to reach as much as 30 kHz. The readout system of the Belle II experiment is supposed to receive a large amount of data from different front-end electronics of several sub detectors, process and send the data downstream before the event-rate reduction is performed by the high level trigger system. We have developed the common readout system for all sub detectors except for the innermost pixel detector, which consists of COmmon Pipelined Platform for. Electronics Readout (COPPER) boards and readout PC servers. A COPPER board equips with receiver daughter cards, called as High Speed Link Board (HSLB) which provide common interface with front-end electronics employing a home brew protocol called as "Belle2link" based on Rocket I/O and optical fibers. The COPPER board also has a PCI mezzanine processor card, which equipped with 1.6 GHz Atom CPU to format data and send them downstream via Gigabit Ethernet. The data are further processed by readout PCs, which perform the check of data corruption, data reduction by merging redundant information and partial event-building before sending the data to the full event-builder and high-level trigger PC farm. To check the performance of the readout system, we did a stress test using dummy data produced by FPGA on HSLB boards. We estimated the event size of each sub-detector with the help of Monte Carlo simulation and produced data flow, whose throughput is expected to be same as when the accelerator reaches its target luminosity. In this test, it was achieved that the target event rate of 30 kHz from each detector can be handled by the readout system. In addition to that, we performed commissioning of the readout system by using Electromagnetic CaLorimeter (ECL) and Central Drift Chamber (CDC) for the Belle II experiment in their cosmic ray tests. Although the even rate was lower than that of the actual Belle II experiment, the basic functionality of the readout system worked well with real data from the detectors.

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Session Classification: RTA 2

Track Classification: Real Time System Architectures and Intelligent Signal Processing