Contribution ID: **121** Type: **oral**

Upgrade of the ATLAS Thin Gap Chambers Electronics for HL-LHC

Thursday, 25 May 2017 09:00 (18 minutes)

The High-Luminosity LHC (HL-LHC) is planned to start the operation in 2026 with an instantaneous luminosity of 7.5 x 10ˆ34 cm-2s-1. To cope with the event rate higher than that of LHC, the trigger and readout electronics of ATLAS Thin Gap Chamber will need to be replaced. An advanced first-level trigger with fast tracking will be implemented with the transfer of all hit data from the frontend to the backend boards. Studies with the data taken by ATLAS indicate that the advanced trigger could reduce the event rate by 30% for a single muon trigger with a transverse momentum threshold of 15 GeV while maintaining similar efficiency. First prototype of the frontend board has been developed with full functions required for HL-LHC including the data transfer of 256 channels with a 16 Gbps bandwidth and the control of the discriminator threshold. The data transfer has been demonstrated with charged particle beam at the CERN SPS beam facility. The control of the discriminator threshold has also been demonstrated, and a perfect linearity between the set and the measured values was obtained. We will present the overall design of the new trigger and readout electronics as well as the demonstration of the frontend board prototype.

Summary

The High-Luminosity LHC (HL-LHC) is planned to start the operation in 2026 with an instantaneous luminosity of 7.5 x 1034 cm-2s-1. To cope with the event rate higher than that of LHC, the trigger and readout system of ATLAS will be upgraded based on the first-level trigger with a higher rate of 1 MHz and a longer latency of 6 us. The change in the trigger and readout system requires the replacement of the electronics for the Thin Gap Chamber (TGC), which plays a primary role for the first-level muon trigger in the endcap regions. The new design assumes the transfer of all hit data from the frontend to the backend boards, where only selected data are transferred in the current system. The current coincidence-based trigger will be upgraded by a tracking-based trigger to improve the transverse momentum resolution at the first-level trigger.

We have developed the first prototype frontend board of the TGC for the HL-LHC, which has a transceiver to send all hit data of 256 channels with a 16 Gbps bandwidth based on the optical transceivers. The data transfer was tested with pseudorandom numbers, and the bit error rate was less than 8.9 x 10-15. The prototype includes the controller of the threshold voltage for the discriminator, which is also essential for the TGC frontend board. Linear relation between the set and the measured voltages was obtained in a range from -300 mV to 300 mV, which covers the operation range of the current system (from -250 mV to 250 mV). The prototype has been mounted on the spare TGCs for ATLAS, and the data transfer has been demonstrated with the charged particle beam at the CERN SPS beam facility. The single-hit efficiency in the bulk region of the chamber was obtained to be ˜99%, which indicates that the data transfer works without problems. The investigation of the radiation tolerance for the elements on the prototype, e.g FPGA, is the next major step. R&D is also ongoing for the backend board. Segment reconstruction with a software-based minimum chi-square method showed a potential of the TGC to provide the segment angle resolution of 3.5 mrad. As a result, the rate for a single muon trigger with a transverse momentum threshold of 15 GeV may be reduced by 30%. The algorithm of the segment reconstruction suited for the implementation in the hardware is under study.

Primary authors: BINI, Cesare (Sapienza Università and INFN Roma); KAWAGUCHI, Tomomi (Nagoya University)

Presenter: KAWAGUCHI, Tomomi (Nagoya University)

Session Classification: R2-Gaseous detectors(3)

Track Classification: Gaseous detectors