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Reliability Tests of the SFP+ Transceivers and the TGC Readout Board for the ATLAS Experiment at HL-LHC

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Results are presented for reliability tests of the SFP+ transceivers and the readout board of Thin Gap Chambers (TGC) for the ATLAS experiment at HL-LHC. The radiation tolerance was evaluated for the SFP+ transceivers from Broadcom and FS and the TGC frontend board with gamma ray irradiation up to O(100) Gy at the Cobalt-60 facility of Nagoya University. An accelerated aging test was also performed for the SFP+ transceivers with the Kintex-7 evaluation board integrated in the temperature chamber.

Summary (500 words)

Results are presented for reliability tests of the SFP+ transceivers and the readout board of Thin Gap Chambers (TGC) for the ATLAS experiment at HL-LHC. The radiation tolerance of the electronics components used in the detector area is crucial for the electronics systems at the HL-LHC experiments. The total ionizing dose estimated for the on-detector electronics of TGC is 14 Gy for an integrated luminosity of 4000 fbˆ-1. In addition, the installed electronics is required to be operational until the end of the experiment around 2040.

In this work, the radiation tolerance was evaluated for the SFP+ transceivers from Broadcom and FS and the TGC readout board with gamma ray irradiation up to O(100) Gy at the Cobalt-60 facility of Nagoya University. The irradiated SFP+ transceivers are AFBR-710SMZ (Broadcom) and SFP-10GSR-85 (FS). A dedicated electronics board was prepared to supply power to the SFP+ transceivers during the gamma ray irradiation. The performances of the SFP+ transceivers were tested by measuring the light intensity from the transmitter and the bit error ratio (BER) during the loopback data transfer. The light intensity was measured using Photom MiNi 211B from Graytechnos. The BER was measured using the integrated bit error ratio tester from AMD with the KC705 evaluation kit. The transfer rates employed for the BER measurements were 1.0, 2.56, 8.0, and 10.24 Gbps. A reference clock of 160 MHz was used for all the transfer rates. For the TGC readout board, a board from mass production was irradiated and the functionalities were fully checked with a quality check system developed with the use of the Zynq SoC device.

In addition to the aforementioned radiation tolerance studies, an accelerated aging test was performed for the SFP+ transceivers. The SFP+ transceivers were mounted on the KC705 evaluation board and integrated in the temperature chamber. The loopback was operated and BER was monitored with the ambient temperature set to 60 degrees, which is >30 degrees higher than the location at the actual experiment. Assuming an acceleration factor of eight, the test was performed for a period equivalent to O(1) year of operation at the actual experiment and the loopback worked fine.

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