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A New High-Speed Optical Transceiver For Data Transmission at the LHC Experiments

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We report on the development of a new commercial off-the-shelf optical transceiver as a candidate for the transmission of data from the detector to the counting room for experiments at the Large Hadron Collider (LHC). The device is manufactured by Molex using CMOS integrated silicon photonics developed by Luxtera. A transceiver contains four RX and four TX channels operating at 10 Gbps each, and is packaged in a QSFP+ format. The approach features superb manufacturing costs, power consumption, scalability, and reliability. We present performance measurements, radiation tolerance measurements, and plans for deployment in the ATLAS experiment at the LHC.

Summary

We report on the development of novel commercially-available optical transceivers as a candidate technology for high-speed data transmissions from the ATLAS detector at the LHC to the counting room. These devices are manufactured by Molex using CMOS-integrated silicon photonics developed by Luxtera, a groundbreaking platform for building high-speed optical interconnects. A candidate transceiver is required to be radiation-tolerant, highly-reliable, cost-effective, with low bit-error-rate (BER), and with low power consumption. The proposed device satisfies all the requirements even after exposure to ionizing radiation.

Entire functionality of a transceiver is implemented in a single chip containing four RX and four TX channels operating at 10 Gbps each. Optical devices and transistors are constructed side-by-side monolithically in the silicon. The optical chip is directly coupled single-mode optical fibers packaged into a ribbon cable. The single-mode fibers can be operated at higher speeds if that is needed in the future. Modulation in the TX channels is done by Mach-Zehnder interferometers fed by a single continuously-running laser. This design enables cost-effective manufacturing and high reliability of the device.

The radiation tests have been performed using gamma-rays from Co60, neutrons, and energetic protons. Results of the tests demonstrate that the product is a promising solution for radiation-intense environments such as at the ATLAS experiment at CERN. During the tests we have monitored characteristics of the device such as BER, temperature, consumed power.

We plan to deploy these devices for transmissions of data from the Tile (hadronic) calorimeter of the ATLAS detector to the counting room in about 2022. Before that they will be tested in the demonstrator project. The transceivers can also be utilized for other sub-systems of the ATLAS detector.

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