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Radiation Tolerant Source Interface Unit for the ALICE Experiment

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The ALICE Detector Data Link (DDL) is a high-speed optical link designed to interface the readout electronics of ALICE sub-detectors to the DAQ computers. The Source Interface Unit (SIU) of the DDL will operate in radiation environment. Tests showed that configuration loss of the ALTERA APEX II FPGA device used earlier on the DDL SIU card is only marginally acceptable. We developed a new version of the SIU card using ACTEL ProASIC+ device based on flash memory technology. The new SIU card has been extensively tested using neutron and proton irradiation. In this paper we present the SIU card and describe the results of irradiation measurements.

Summary

The ALICE Detector Data Link (DDL) is a high-speed, duplex, point-to-point optical link designed to interface the readout electronics of all the ALICE detectors to the DAQ computers in a standard way. The DDL consists of the Source Interface Unit (SIU), an optical cable up to 300 meters, and the Destination Interface Unit (DIU). The DDL provides enough bandwidth to transfer data from the detectors at 200 MB/s. The SIU will be attached to the Front-end Electronics, hence it will be exposed to the radiation caused by the interacting particles. According to the latest simulations, the highest radiation level for the SIU card is expected at the inner radius of the TPC detector, where the total ionizing dose is 1.3 krad and the 1 MeV equivalent neutron fluence is 1.47 × 10ˆ11 neutrons/cm2 for 10 years of operation. The hardware consists of three main, and several auxiliary components. The full-duplex optical transceiver makes the conversion between the optical serial data and the high-speed differential electrical data. The electrical transceiver performs data conversion serial-to-parallel and parallel-to-serial. The DDL protocol and additional logic functions are implemented in a programmable logic device (FPGA). The components of the SIU card have been extensively tested. The results show that the TID effects have little impact on the components used. The single event effects (SEE), however, can provoke two different types of error. High-energy particles may change the content of the registers or the user memory therefore increases the single-bit-error rate. According to the measurements, this error rate increase is negligible compared to the bit-error rate always present during optical transmission. In addition, the particles may as well alter the content of the configuration memory cells of the SRAM-based FPGA device used on the prototype cards. This type of error may cause functional interrupt at a rate, which is only marginally acceptable.
We developed a new version of the SIU card using alternative logic device, namely the ACTEL ProASIC+ device family based on flash memory technology. We carried out two series of tests to investigate the configuration loss in radiations environment. The first series of measurements was carried out in TSL, (Uppsala, Sweden) using protons at energy of 150 MeV and 180 MeV. The 2nd series of measurements was done at ATOMKI (Debrecen, Hungary) using thick target p+Be neutrons with spectrum extending up to En=14 MeV. The methods and results of the measurements are shown in this paper.

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