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Laser and Photodiode Environmental Evaluation for the Versatile Link Project

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We summarize the results obtained in a series of radiation tests of candidate laser and photodiode components for use in the Versatile Transceiver (VTRx), the front-end component of the Versatile Link. We have carried out radiation testing at a full spectrum of sources (neutrons, pions, gammas) and can now compare the results and show that the spectrum of components that meet the radiation tolerance requirements is rather large. In addition, devices have been operated in a high magnetic field to qualify them for use in (HL-) LHC detectors.

Summary

The Versatile Link project aims to produce a bi-directional optical data transmission system for the transmission of readout and control data to- and from the upgraded detectors to be operated in successive upgrades of the LHC. The proposed link will transmit digital data at a serial line rate of 4.8 Gb/s to match the rate of the associated GBT serializer/deserializer chipset project. The front-end components will have to operate in the radiation environment of the detector front-ends, where the Versatile Link project distinguishes two tolerance classes: the Calorimeter class where radiation levels up to 10 kGy ionizing dose and 5 x 10ˆ14 n/cmˆ2 20 MeV neutrons are expected; and the Tracker class where radiation levels up to 500 kGy ionizing dose and 6 x 10ˆ15 n/cmˆ2 20 MeV neutrons are expected.
In order to qualify components we have carried out a number of irradiation tests at different radiation sources covering the full spectrum of the radiation field of (HL-) LHC. We will summarize the results of testing at gamma, neutron, and pion sources and put them into the context of the overall link performance margins. This will allow us to demonstrate that an optical link where the front-end has been irradiated will continue to function according to the specifications. For the transmitter side of the link we will show that the increase in laser threshold current and forward voltage coupled with a decrease in slope efficiency can all be compensated using the adjustable laser bias and modulation currents of the driver ASIC. On the receiver side we will demonstrate that the decrease in responsivity and increase in leakage current have been properly accounted for in the link optical power budget calculation, thus ensuring that the link will continue to operate with irradiated components.
The other important environmental factor that must be considered for optical link component qualification is the strong magnetic field that will be encountered when the link is installed. This field can reach 4 T in the case of installation in the CMS detector. We have operated lasers in increasing magnetic fields in order to verify that no candidate components show degradation in their static and dynamic operating characteristics. Detailed results of these tests will be shown.
A production of 10-15 thousand links is foreseen to meet the needs of early adopters of the Versatile Link. The extensive testing carried out to date has formed the basis of the test procedures that will be used to radiation-qualify sample components that will be supplied in the framework of procurement of these link components. We will outline the test procedure and test limits that will be used in the coming years during this production cycle.

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