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The VTRx+, an Optical Link Module for Data Transmission at HL-LHC

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Optical data transmission will remain a key enabling technology for the upgrading detectors at HL-LHC. In particular the inner tracking detectors will require low-mass, radiation tolerant optical transmit- and receive modules for tight integration in the detector front-ends. We describe the development of such a module, giving details of the design, functional and environmental performance and showing the feasibility of achieving small size, low-mass, and low-power operation.

Summary

During the phase II upgrades of the ATLAS and CMS experiments at the Large Hadron Collider (LHC) several detectors will be replaced to improve their physics performance. In particular, these upgrades aim to replace the innermost detectors that are exposed to the harshest radiation environments. To cope with the increasing data volume and the higher trigger rate, high-speed optical links will be deployed in large quantities as part of the upgrade programme. The tight space constraints and the high channel count of the on-detector electronics will require to develop a low-profile (20mm x 10mm x 2.5mm target), multi-channel front-end component. During their expected lifetime these components will have to withstand the on-detector radiation levels (1MGy total dose, 1x10ˆ15 n/cm2 and 1x10ˆ15 hadrons/cm2 total fluence) and they have to operate over a wide temperature range (-35 ℃ to +60 ℃). The Versatile Link PLUS (VL+) project is developing custom front-end modules that fulfil these requirements. The front-end module (VTRx+) will be based on radiation-hard laser diode driver (LDD) and transimpedance amplifier (TIA) ASICs, and commercial VCSEL and PIN photodiode (PD) components. The initial project phase of demonstrating the feasibility of the VTRx+ design has now been completed. Components have been evaluated and shown to meet the required performance targets during both functional and environmental testing. We will show an overview of the static and dynamic performance of VCSELs and PDs operating over the full required temperature range. These tests allow us to select devices that perform best for further investigation. Radiation testing has also been carried out for candidate VCSELs and PDs and the results will be shown, along with the impact of the observed degradation on system performance and margins.

The module design is being carried out in two parallel paths: the first being to carry out a full-custom design based on commercially-available optical coupling blocks; the second to carry out minimal customisation of an existing commercially-available module. The former path allows us to learn about the difficulties of the design and inform the requirements of the second path. We will outline the various procedures put in place to enable the parallel developments to be carried out in a robust commercial framework with the clear path to volume production. The measured performance of the various module types will also be reported.

Finally, we will give an overview of the work being done to integrate the modules in various user systems, highlighting the challenges brought to the overall common design by different use-cases. This will be accompanied by the overall project timeline leading up to production starting in 2019 so as to be aligned with the production and assembly timescales of the HL-LHC experiments.

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