Contribution ID: **53** Type: **Oral**

High Speed Radiation Tolerant Optical Links based on Coarse Wavelength Division Multiplexing

Thursday 22 September 2022 16:15 (20 minutes)

The upgrade of CERN's accelerator complex requires improved beam instrumentation systems that will generate an increased volume of data to be transferred from the radiation areas to the back-end. A solution that increases the throughput of already deployed fibers consists in implementing the coarse wavelength division multiplexing (CWDM) technique where independent optical carriers at properly spaced wavelengths are multiplexed into a single fiber. In this paper we describe the CWDM Link project, which scope is to realize a high speed radiation tolerant optical link based on four CWDM channels, and we investigate the radiation resistance of commercial CWDM components.

Summary (500 words)

The upgrade of CERN's accelerator complex requires the consolidation of all monitoring systems, with a consequent increase in the data volume that need to be transferred to the back-end. Deploying new fibers to cope with this increase may either be not convenient or not possible at all, so a solution is to investigate optical communication techniques increasing the throughput S of the fibers already installed. An interesting technique is called coarse wavelength division multiplexing (CWDM) where N optical carriers at specific wavelengths, defined by the ITU standard G.694.2, are independently modulated at the desired data-rate R and multiplexed on the same fiber. The throughput of the fiber becomes then proportional to the number of optical carriers: $S=N\cdot R$.

The scope of CERN's CWDM Link project is to realize a radiation tolerant optical link based on CWDM with an uplink of S=40 Gbps. To achieve such throughput four transceivers emitting at wavelengths λ= 1271,1291,1311, and 1331 nm are independently modulated in the front-end at a data-rate D=10 Gbps and are multiplexed on a single optical fiber by a 4-channel CWDM multiplexer. The front-end devices (transceivers and multiplexers) are installed in a radiation environment where during their lifetime they will have to withstand a total ionising dose (TID) of 10 kGy and a particle fluence equivalent to 5·1014 20MeV neutrons/cm2. These levels are high enough to require that the radiation tolerance of all front-end components needs to be qualified. For the back end, standard commercial devices are used and radiation qualification is not necessary.

The front-end transceivers are minimally customized, based on previous knowledge, to guarantee their radiation resistance. The transmitter optical sub-assemblies (TOSA) of choice for this project consists of a set of distributed feedback edge-emitting laser diodes (LD), emitting at the different CWDM wavelengths, assembled inside a metallic coaxial package. The laser light is focused on the core of the optical fiber through a glass ball lens. The LD is particularly sensitive to displacement damage caused by particle irradiation, while the attenuation of the focusing lens may increase with TID. Several commercial CWDM TOSAs have been identified through separate market surveys in 2018 and 2021. A neutron and gamma irradiation test for the 2018 set have been performed and the results have been analysed. The neutron and gamma irradiation test for the 2021 set is scheduled for May 2022. The CWDM MUX under evaluation can be realized using two different technologies, the thin-film technology (TF) and the planar lightwave circuit (PLC). For both technologies exposure to radiation causes an increased attenuation but a gamma ray irradiation test is sufficient to qualify their radiation tolerance. An initial test for the TF MUX have been performed, more are scheduled for both technologies in June 2022. The results of these radiation tests will be reported.

A proof of concept for the CWDM link have been realized by producing 16 CWDM transceivers prototypes.

A full CWDM Link has been assembled and experimentally characterized, and the results will be shown to meet the required specifications.

Primary author: MARCON, Leonardo (CERN)

Co-authors: SCARCELLA, Carmelo (CERN); DETRAZ, Stephane (CERN); LALOVIC, Milana (University of Belgrade (RS)); OLANTERA, Lauri (CERN); PROUSALIDI, Thenia (National Technical Univ. of Athens (GR)); SANDVEN, Ulrik (CERN); SIGAUD, Christophe (CERN); SOOS, Csaba (CERN); TROSKA, Jan (CERN)

Presenter: MARCON, Leonardo (CERN)

Session Classification: Optoelectronics and Links

Track Classification: Optoelectronics and Links