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Irradiation tests on InP based Mach Zehnder Modulators

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Particle detectors in High Energy Physics experiments, contain various types circuits and demand data rates of multiple Gbps per chip and several Tbps for the whole detector. Optical transmission by external modulation of a continuous wave laser is a possible solution to tackle the problem of high data rates.In this paper, we investigate the radiation hardness performance of InP-based Mach-Zehnder modulators. The modulator circuit is irradiated with a 24 GeV/c proton beam at CERN up to various fluences. Also, a design of an optical integrated circuit using the Generic Integration platform is presented.

Summary

Particle detector circuits are complex and demand high speed serial links to send enormous amounts of data to a computer farm. This demand for bandwidth is ever increasing as experiments progress to higher luminosities. Detector circuits demand serial data rates in multiple Gbps per chip and several Tbps for the whole detector. Copper co-axial cables combined with CMOS technologies are seen reaching their limits at data rates of 10 Gbps for a couple of meters of cable. Optical transmission is a possible solution to tackle the problem of high data rates.

The detector circuits have to operate in a high radiation environment [1,2]. Particles passing through the circuits causes trapping of charges at interfaces, damages to crystal structure etc giving rise to performance issues. State of the art techniques include reading out the data on electrical links for the first couple of meters and optical conversion of the electrical signals, by directly modulating a Laser diode. The computer farm, located about hundred meters away from the high radiation environment has photo-detectors to read the optical data. The radiation levels are orders of magnitude lower at the computer farm. With data rates going high, the relatively short distance electrical connections are becoming a significant challenge. Optical conversion of the data is desired as close to the detector as possible. Lasers cannot be modulated directly in this extreme environment as performance of Lasers degrade significantly already at less severe radiation environments [2]. External modulation of a continuous wave laser beam is an alternative solution worth considering, since it doesn't involve active light emitting devices in the high radiation environment. Such modulator devices could be placed in high radiation environments, with photo-detectors and the lasers placed in a far away low radiation environment.

An Application Specific Photonic Integrated Circuit (ASPIC) comprising of modulators, arrayed waveguide gratings etc needs to be designed and studied w.r.t irradiation performance. This work focuses on one such irradiation study on an existing modulator circuit [3]. Also, an optical integrated circuit design with components like modulators, arrayed waveguide gratings and semiconductor optical amplifiers will be presented. The design is based on the generic integration platform. The design is aimed at more understanding of radiation performance of passive optical circuits.

References :

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