In this test we investigated the radiation tolerance of a few such devices in two tests: one where devices were exposed to 20 MeV neutrons and another where 24 GeV protons were used.

The upgrade from LHC to HL-LHC will increase the luminosity of the LHC by a factor of 5-10. This imposes even more stringent requirements on the optoelectronic components used in the front-ends of the data transmission links.

The effect of radiation on a phase-shifting Mach-Zehnder-Interferometer (MZI) modulator and a Germanium on Silicon (Ge-on-Si) photodiode was investigated here. Because neither of these devices were attached to an optical fibre the change in leakage current of the devices was used as a measure of the effect of radiation on these devices.

Silicon Photonics is a new technology approach to using light to transfer data at high speeds and with low power over an optical fibre rather than using electrical signals over copper cable. A silicon photonics optical link that could generate, modulate, process and detect light signals would be of interest to HEP applications because of its small size, high speed, and low power. This is a new technology whose radiation response is not known, therefore as a first test of their suitability for HEP applications we looked at the effect of radiation on some Si-based optoelectronic components.

The leakage current of both the Ge-on-Si photodiodes and the MZI modulators increased post-irradiation. Below we compare the neutron radiation induced increase in leakage current of a Ge-on-Si photodiode to an InGaAs photodiode that was irradiated at the same time. Also shown are before and after reverse I-V curves of two different modulators from the same test chip which was irradiated with 24 GeV protons.

CONCLUSIONS AND FUTURE WORK

InGaAs VCSSEL and CWDM VCSELs were irradiated with 20 MeV neutrons to total fluence levels of 7.1e15 n/cm^2 and 4.6e15 n/cm^2 respectively (tracker qualification level for front-end components for HL-LHC applications is 4x15 20 MeV n/cm^2). The results of the test show that both devices behave in a manner similar to other candidates for HL-LHC optical links and are therefore potentially suitable for use in future applications. The effect of radiation on the reverse I-V characteristics of Si-based optoelectronic components was also tested using the 20 MeV neutron source and a 24 GeV proton source and showed that the leakage current of Ge-on-Si photodiodes and Silicon-On-Insulator (SOI) MZI modulators increases after exposure to radiation.

This has been a first test of the effect of radiation on these silicon-based devices, in the next year we plan on irradiating pigtailed SOI MZI modulators in order to measure the effect of radiation on the modulation efficiency of these devices. We are also working on simulating these modulating structures using TCAD tools to model the effect of radiation on such structures.

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ABSTRACT

In this test we investigated the radiation tolerance of a few such devices in two tests: one where devices were exposed to 20 MeV neutrons and another where 24 GeV protons were used.

The upgrade from LHC to HL-LHC will increase the luminosity of the LHC by a factor of 5-10. This imposes even more stringent requirements on the optoelectronic components used in the front-ends of the data transmission links (binary radiation, higher data rates). Components with lower power consumption, higher speeds, and smaller sizes are being considered for the next generation of optical links.

Motivation and context

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