Contribution ID: **92** Type: **Oral**

STUDY OF RADIATION HARDNESS OF PIN AND VCSEL ARRAYS

Thursday, 24 September 2009 10:10 (25 minutes)

We study the radiation hardness of 850 nm PIN/VCSEL arrays for possible deployment in the detector optical readouts for the LHC luminosity upgrades. In 2008, we irradiated two devices from several vendors to the radiation doses expected for the ATLAS silicon trackers. This leads to the identification of the best arrays from two vendors for possible deployment in a new ATLAS pixel-detector for the first phase of the luminosity upgrade. In 2009, we will irradiate a large sample of these arrays, together with some new devices available, to verify the radiation hardness. We will present the results from the irradiations.

Summary

Optical links deploying VCSELs and PINs are used for the data transmission in the major detectors at the Large Hadron Collider (LHC) at CERN (Geneva). The LHC will be upgraded in two phases, resulting in ten times higher luminosity. The detectors are expected to be exposed to a similar increase in radiation. In the past years, we have studied the radiation hardness of VCSEL and PIN from several vendors using 24 GeV/c protons at CERN up to a fluence of 2.6 x 10^15 p/cm^2. The GaAs VCSEL arrays were fabricated by four vendors, Optowell, Advanced Optical Components (two varieties, 5.0 and 10 Gb/s), and ULM Photonics (two varieties, 5 and 10 Gb/s). The GaAs PIN arrays were also fabricated by the same vendors but there was only one variety from each vendor. In addition, we also irradiated the GaAs (one variety) and silicon (two varieties) PIN devices from Hamamatsu. For the VCSEL arrays, we monitored the optical power as a function of dosage and observed significant decrease in the optical power with radiation. We periodically moved the devices out of the proton beam and passed high currents through the arrays for annealing. However, the time available for the annealing was limited during the irradiation period and the devices were returned to the laboratory for an extended annealing. Overall, we found that the AOC arrays were the most radiation hard. For the PIN diodes, we monitored the responsivity as a function of dosage and observed that the responsivity decreased with radiation. In general, the silicon devices had lower data bandwidth but were more radiation hard than the GaAs devices as expected. The degradation in the responsivities was smallest in the Hamamatsu devices, followed by the Optowell arrays. The above study was based on a small sample (typically two devices for each variety). We plan to repeat the irradiation this August with a much larger sample (20 devices for each variety) for possible application in the new pixel detector for the first phase of the LHC upgrades. The candidate devices are AOC (10 Gb/s) VCSEL array and Optowell PIN array. We will not study the Hamamatsu devices because we cannot acquire bare arrays for custom packaging. In addition, we will irradiate new devices available. The results from the studies will be presented.

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Session Classification: Parallel Session B5 - Optoelectronics and Links

Track Classification: Optoelectronics and Links