Contribution ID: **32** Type: **Poster**

In-situ Radiation Damage Studies of VCSELs and p-i-n diodes in the ATLAS SemiConductor Tracker

Tuesday 18 September 2018 18:20 (15 minutes)

This talk will present the results of in-situ measurements of radiaton damage for the on-detector optoelectronics for the ATLAS SemiConductor Tracker. The results come from proton-proton collisions in LHC during operation in 2016 and 2017. Both p-i-n diodes and VCSELs will be presented and compared to expectations from beam tests of identical devices before the start of LHC operation. The VCSELs show clear evidence for radiation damage, as expected qualitatively from earlier studies. However the p-i-n diodes do show significant radiation damage. There is strong evidence for an unexpected rate-dependent effect for the p-i-n diodes.

Summary

Optical links are used for the readout and control of the SemiConductor Tracker (SCT). The on-detector data links are based on Vertical Cavity Surface Emitting Lasers (VCSELs)
and the control links use silicon p-i-n diodes. The results of the in-situ radiation damage for both the on-detector p-i-n diodes and VCSELs used in the ATLAS SCT optical links show that these links should survive the radiation damage from the full LHC run. The results are compared with predictions based on previous test beam studies of VCSELs from the production wafer; it was found that the level of radiation damage is significantly higher than predicted.
The change in responsivity of the p-i-n diodes is monitored by regular readings of the photocurrents. The on-detector p-i-n diodes, operated at a reverse bias voltage significantly higher than the depletion voltage, showed clear evidence of radiation damage to the responsivity but no significant increase in depletion voltage, compatible with expectation from test beam studies.
One hypothesis for the decrease in responsivity despite the fact that devices were operated over-depleted is that the charge trapping causes the rapid loss of the slow diffusion signal with radiation damage. This hypothesis can be tested by comparing the response to fast signals as opposed to the slow DC signal measured by the photocurrents. The fast signal response is studied using threshold scans of the laser light sending the optical signals to the on-detector p-i-n diodes.
Additionally, the decrease in responsivity observed in-situ for the p-i-n diodes is significantly smaller than that observed in previous test beam studies. This suggests some rate dependence or annealing effect. However, the physical cause of any rate dependence in these devices is not currently understood.

Authors: POWNALL, Gavin (University of Oxford (GB), DESY (DE)); WEIDBERG, Anthony (University of Oxford (GB)); LIU, Jesse (University of Oxford)

Presenter: POWNALL, Gavin (University of Oxford (GB), DESY (DE))

Session Classification: Posters

Track Classification: Optoelectronics and Links