Contribution ID: **19** Type: **Oral**

Radiation-Hard Optical Link for the ATLAS Pixel Detector

Tuesday 13 September 2005 14:40 (25 minutes)

We have developed a radiation-hard optical link for the ATLAS pixel detector at the LHC at CERN. The driver and receiver chips are implemented in 0.25 micron CMOS technology using enclosed layout transistors and guard rings for increased radiation hardness. The former drives the Vertical Cavity Surface Emitting Laser (VCSEL) diode to transmit 80 Mbit/s data from the detector. The latter decodes the Bi-Phase Marked signal received optically by a PIN diode to recover the control data and 40 MHz clock. The chips and optical devices are mounted on a hybrid circuit board, opto-board. We present the experience from the production of the opto-boards together with results from the the irradiation studies with 24 GeV protons up to a total dose of 32 Mrad. In addition, we will present some results from the simulation of the upgrade versions of the chips operating at Gbit/s for the SuperLHC.

Summary

The ATLAS pixel detector consists of two barrel layers and two forward and backward disks which provide at least two space point measurements.
The low voltage differential signal (LVDS) from the pixel detector is converted by the VCSEL Driver Chip (VDC) into a single-ended signal appropriate to drive a Vertical Cavity Surface Emitting Laser (VCSEL).
The resulting optical signal is transmitted to the Readout Device (ROD)via a fibre.
The 40 MHz beam crossing clock from the ROD, bi-phase mark encoded with command signals to control the pixel detector, is transmitted via a fibre to a PIN diode.
This signal is decoded using a Digital Opto-Receiver Integrated Circuit (DORIC).
The PIN and VCSEL are packaged in the so-called opto-packs for connecting to the chips and fibers.

We implement the VDC and DORIC circuits in standard deep submicron (0.25 micron) CMOS technology. Employing enclosed layout transistors and guard rings, this technology promises to be very radiation hard.
After five prototype runs, the chips meet the ATLAS specifications,including the radiation hardness requirements.

The chips together with the optical devices are mounted on a hybrid circuit board, opto-board. The board uses BeO as the substrate for heat management. We are currently producing the 300 opto-boards needed for the pixel detector. The micro-soldering of the leads of the opto-packs is a particular challenge and we will present this along with other production experience.

In June 2004, we irradiated the production opto-boards with 24 GeV protons at CERN up to a dosage of 32 Mrad. We observed no significant degradation of chips and the VCSEL still produces quite adequate power after the irradiation. The results indicate that the optical link meets the radiation hardness requirements for the ATLAS pixel detector.

We are also in the process of converting the VDC and DORIC to operate at Gbit/s with 0.13 micron technology for the Super-LHC. Some preliminary results from the conversions will be presented.

In summary, we have developed an opto-link that meets all the requirements for operation in the ATLAS pixel optical link. The link is expected to be sufficiently radiation hard for ten years of operation at the LHC. We are also in the process of converting the chips to operate at much higher speed for the Super-LHC.

Authors: GAN, KK (Department of Physics, The Ohio state University); Mr JACKSON, Paul Douglas (Department of Physics, The Ohio state University)

Co-authors: ROGGENBUCK, A (Fachbereich Physik, Universitaet Siegen); RAHIMI, Amir (Department of Physics, The Ohio state University); RUSH, Chuck (Department of Physics, The Ohio state University); KAGAN, Harris (Department of Physics, The Ohio state University); ARMS, Kregg (Department of Physics, The Ohio state University); HOLDER, M (Fachbereich Physik, Universitaet Siegen); JOHNSON, Mark (Department of Physics, The Ohio state University); ZOELLER, Michael (Department of Physics, The Ohio state University); ZIOLKOWSKI, Michal (Fachbereich Physik, Universitaet Siegen); BUCHHOLZ, P (Fachbereich Physik, Universitaet Siegen); SCHADE, P (Fachbereich Physik, Universitaet Siegen); KASS, Richard (Department of Physics, The Ohio state University); TER-ANTONIAN, Rouben (Department of Physics, The Ohio state University); SMITH, Shane (Department of Physics, The Ohio state University)

Presenter: Mr JACKSON, Paul Douglas (Department of Physics, The Ohio state University)

Session Classification: Parallel session B2