Contribution ID: **35** Type: **Poster**

Radiation tests for Slow Control ALICE TOF systems

Wednesday, 27 September 2006 16:20 (25 minutes)

The read-out modules of the ALICE Time-of-flight (TOF) system will be hosted in custom VME crates near the apparatus in a moderately hostile environment.
Commercially available options to provide remote VME connection to the crate have been considered to provide slow control functionalities.

The main slow control channel will be implemented through an optical link based on the commercial cards A2818/V2718 from CAEN for front-end electronics configuration and monitoring purposes.
An additional ethernet link to an ARM CPU running Linux will be available.

Radiation tolerance test results for the critical components corresponding to the abovementioned choices will be presented, as well as estimates of the minimum time between failure while taking data.

The results presented here can be used to estimate upset rates for specific applications of commercially available VME controller cards and Single Board Computer like the CAEN V2718 and A1500.

Summary

The ALICE Time-of-flight (TOF) system will be a large area (140 m2) detector made OF Multigap Resistive Plate Chambers (MRPC) installed in the barrel region. The read-out modules will be hosted in custom VME crates near the apparatus in A moderately hostile environment (1.2 Gy expected in 10 years of operation). Data collected will be sent to the central DAQ through the custom optical link developed within the ALICE collaboration (ALICE DDL).

The choice VME bus as the backbone to house the readout electronics ALLOWS for commercial options to provide remote VME connection to the crate and to provide slow control functionalities.
The design of the slow control system to access the VME bus while taking data has been thoroughly investigated with respect to radiation tolerance issues.

The main slow control channel will be implemented through an optical link based on the commercial cards A2818/V2718 from CAEN for front-end electronics configuration and monitoring purposes. An additional ethernet link to an ARM CPU (which will be mainly responsible for firmware upgrade), running Linux, will be available.

Radiation tolerance test results for the critical components, corresponding to the above mentioned choices, will be presented. We used, at the CRC Louvain facility, a proton beam OF 60 MeV energy. We irradiated all devices under tests with a total dose of 10 Krad. No latchups have been observed for all the components tested.

The components tested include: optical transceiver HFBR-5911L (from Agilent) coupled to two different SerDes: Pericom HDMP-1636 and Agilent PI90SD1636A.
The total cross sections of the optical link for SEU were measured : 1.9E-9 cm2 and 3.3E-9 cm2 respectively, allowing to select the more radiation tolerant SerDes for the final card. FOR all errors observed the communication was quickly re-established after a simple reset (managed by the Linux driver on the receiving PC).

The ARM processor was originally foreseen to handle firmware upgrade for TDC cards through a custom bus on the VME backplane and not to be operated while taking data and under irradiation.

Due to the fact that we measured for the ARM processor AT91RM9200 from Atmel a device cross section equal to 1.0E-9 cm2 for operating system failures, we plan to use now the card also as a backup slow control link.

For both slow control solutions we actually obtained an estimate of minimum time between failure while in data taking, which is around 20 hours for the whole TOF detector, where 72 slow control optical links will be deployed.

We then tested, for the final card, also the FPGA normally used by CAEN for the V2718 (Altera Cyclone, which has built-in CRC error monitoring for configuration bits) and different memory chips, to be used to stage data during data collection. The result for the Cyclone (cross section 9.0E-9 cm2/device) is very similar to a previous result obtained for an Altera Stratix, when normalized to the configuration bits.

Besides the specific technical solutions adopted in the final VME ALICE card (Data Readout Module, which will host other LHC specific chips, like the TTCrx), the results presented here can be used to estimate upset rates for specific applications of commercially available VME controller cards and Single Board Computer like the CAEN V2718 and A1500.

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Session Classification: Poster sessions