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The Calorimeter Control Card Unit

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The project of the LHCb upgrade foresees a replacement of the whole acquisition system of the detector to allow a full readout at 40 MHz. The development of a new control board, called the 3CU for the electromagnetic and hadronic calorimeters was proposed. This board receives commands from the main LHCb control system and sends them through the backplane to the front-end boards. Each calorimeter crate is equipped with one unique 3CU plugged in the central slot which also provides the clock, slow controls, and Fast Control command to all the boards inside the same crate.

Summary

LHCb, one of the four particle physics experiments at the Large Hadron Collider at CERN (Geneva), is aiming at studying CP violation and rare decays using B-hadrons. Its results contribute to complete the understanding of quark flavor physics in the framework of the Standard Model, and may reveal sign of the physics beyond the Standard Model. The LHCb experiment started data taking in 2009 and an upgrade of the detector is planned for 2019.
For the purpose of the LHCb upgrade, it is foreseen to replace the electronics of the calorimeter. The calorimeter front-end crate is a standard 9U VME-like frame. Inside each crate, 16 front-end boards and a single control board (in the central position of the crate) are plugged. The calorimeter new acquisition system will be controlled by the so called 3CU board. It is responsible for sending and processing the information received though optical fibres from the main LHCb system to the front-end boards.

The S-ODIN system receives directly the clock from the RF-system of the LHC via an LHC Interface card located on the S-ODIN card. The S-ODIN card distributes the clock and the Fast Control commands to the SOL40 and TELL40 board, and the SOL40 board distribute the Clock and the Fast Control command to the 3CU board.
The main role of the 3CU is to receive the GBT frame through the optical link and to extract the information which is needed by the FEBs inside a same crate: the 40 MHz clock, the Time Fast Control (TFC) commands and Experiment Control System (ECS).

The various parts of the board are:
- A Versatile Link Transceiver / Receiver (VTRx), for the reception and transmission to the SOL40 board.
- A radiation tolerant chip that can be used to implement multipurpose high speed (3.2-4.48 Gb/s user bandwidth) bidirectional optical links (GBTX).
- GBT-SCA ASIC, part of the GBT chip-set, to distribute control and monitoring signals to the on-detector front-end electronics and perform monitoring operation of detector environmental parameters.
- A Microsemi FPGA (IGLOO2 family) who is in charge of the processing on the 3CU.

First the 3CU receives the clock and the TFC commands through the optical transmitter (VTRx) and decoding inside the GBTX. After processing (inside IGLOO2), the board transmits through the 3U backplane these signals to all the FEB inside the same crate. The FEB are protected by delatchers which detect any current increase that could be due for example, to a Single Event Latchup (SEL). The 3CU board is in charge to monitor the delaching status of all FEBs inside the same crate.

The greater part of the 3CU components have been tested in proton and heavy ions beams in order to test the radiation tolerance of the board and its immunity to accumulated dose and single event latch-up effects. The

FPGA are ACTEL flash technology component and cope the radiation level expected. A mitigation technique (triple voting) will be implemented in the firmware of the FPGAs to prevent single event upsets.

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