Contribution ID: **15** Type: **Oral**

Installation and Commissioning of the On-Detector Electronics for the CMS Electromagnetic Crystal Calorimeter

Tuesday 26 September 2006 14:40 (25 minutes)

The CMS electromagnetic calorimeter is composed of 76,000 PbWO_4 scintillating crystals. The scintillating light is captured by photo-detectors, amplified and digitized. The conversion is performed inside the detector volume and data are transported through optical fibers to the off-detector electronics.
About 25,000 Printed Circuit Boards of 5 different types and 5,500 Gigabit-Optical-Links and fibers should be installed and tested. The integration of electronics, cooling system, mechanical supports, low and high voltage distribution, synchronization and controls are discussed.
Each step of the assembly sequence is followed by extensive test and quality control.
Installation, commissioning strategy and the achieved system performance results are presented.

Summary

A high performance and homogeneous calorimeter based on lead tungstate crystals is an essential part of the CMS experiment.
The CMS electromagnetic barrel calorimeter is composed of scintillating crystals grouped in 36 super-modules of 1700 crystals each. The scintillating light from a crystal is detected by two avalanche photo-diodes (APDs).
The signal amplification and digitization, including the formation of Trigger Tower sums on each group of 25 crystals, is performed inside the detector volume and transported through high speed links (optical fibers) to the counting room. Lower speed links are used to transport timing and control information to and from the detector. This scheme requires a large quantity of radiation hard electronics installed on the detector. The electronics must be highly reliable since it will not be accessible during data taking.
The basic block of the electronics is a Trigger Tower made of 5x5 crystals. It contains 1 Motherboard, 5 Very-Front-End (VFE) boards, 1 Front-End (FE) board, 1 Low Voltage Regulator (LVR) board and 2 Gigabit Optical Hybrid (GOH).
The Motherboard is connected to the avalanche photo-detectors by flexible kapton ribbons and distributes the bias voltage to the APDs and the LV to the VFEs. The LVRB contains three Detector Control Units to monitor input and output voltages and cards temperature. The VFE consists of five identical readout channels, each one consisting of a gain preamplifier (MGPA), a 12-bit 40MS/s 4-channels Analog to Digital Converter and a buffer. It receives and distributes also the 40 MHz clock. The FE board contains the trigger-primitives generation, the digital pipeline and the primary event buffers together with the clock, control links and slow control for configuration. The GOH boards house a data serializer, a laser driver chip (GOL) and a laser diode with an attached fiber pigtail.
Each super-module contains about 552 PCBs (340 VFE, 68 FE, 68 LVRB, 68 MB and 8 token-ring link-boards), 138 Gigabit Optical Links, 17 LV distributors and 12 distributed fiber patch-panels. Each PCB element arrives fully qualified and labeled with bar codes. A total amount of about 4.6 kW of heat has to be removed by the cooling system in order to keep the crystal temperature within the specified tolerance of +-0.1 K.
The installation and commissioning of the 37 (36 + 1 spare) barrel super-modules shall be completed by early spring 2007.

To cope with the construction schedule we have prepared three completely independent assembly stands. Each one consists of a support stand, a cooling unit, a HV and LV system, a readout system for single trigger towers, a database and shared services as the detector control system and the laser. Some extra stands with partial assembly components are also available.
After a super-module arrives in the electronics integration area it is installed in a frame and connected to services. Then the integration sequence proceed in steps, by installing:
1. Motherboards.
2. Cooling system.
3. Trigger Tower electronics (VFE, FE, LVDB).
4. Token-rings including TRLB.
5. GOH, optical fibers and fiber patch-panels.
6. LV distribution, cables and patch panels.
7. Commissioning: one week operation and test of the completed super-module using the standard CMS DAQ and control systems.
At each step the installed components and their locations are registered into a database.
Installation sequence is optimized but still each phase covers the previously installed items, so a full validation of each step is necessary. Extensive testing is part of each installation step to evaluate the full functionality and performance. A pulsed laser is available to test the full chain from crystal to optical fibers outputs (from light-to-light). Internal test pulses are used to test and calibrate the electronics.
The test strategy and procedure during the installation is described and results of the system performance achieved are presented.

Primary author: BIINO, Cristina (INFN - sezione di Torino)

Presenter: BIINO, Cristina (INFN - sezione di Torino)

Session Classification: Parallel Session A2-Readout, commissioning and integration 2