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The Sector Collector of the CMS DT Trigger System: Installation and Performance

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Drift Tubes chambers are used for muon detection in the central region of the CMS experiment at LHC. Custom electronics is used for reconstructing muon track segments and for triggering the CMS readout. The trigger Sector Collector modules collect muon segments identified by the on-chamber devices, synchronize the data received from different chambers and convert from LVDS to Optical for transmission to the off-detector electronics. Installation and integration tests were developed for tuning both firmware and hardware of the Sector Collector system: results will be reviewed. The system performance during CMS data taking with cosmic rays and LHC beam (if available) will be discussed.

Summary

The CMS experiment at LHC is equipped in the central region with Drift Tubes chambers, providing muon detection. The DT chmbers are also used by the CMS trigger system in order to reconstruct track segments and measure transverse muon momentum. Electronics for local trigger data generation is installed on the chambers, while track finding algorithms are implemented on off-detector devices.

The trigger Sector Collector (SC), installed in racks placed on the towers surrounding the experiment, acts as link between on-detector processors and the off-detector ones. The SC collects reconstructed segments from the DT chambers of a 30 degrees azimuthal sector of the detector, performing reduction and synchronization of the data. The trigger segments are transmitted to the track finding devices through optical fibers.

The SC modules consist of several units: a VME 9U motherboard, hosting a board controller; four mezzanine cards, receiving data from the four chambers in a sector via 8-to-1 LVDS links on copper cables; a fifth mezzanine card, hosting serializers (GOL chips at 1.6 Gbit/s) and optical drivers; an optical receiver card, placed in the counting room, whose main task is to deserialize high-speed transmitted data and inject them in the track finding devices. Spy features on the SC modules allow trigger data flow to be monitored by injecting part of them into the DAQ stream, so providing us a useful tool for system monitoring and diagnostic.

Several custom processing units have been implemented on FPGA devices using VHDL programming. Flash-based FPGAs have been used for the electronics installed in the tower rack, where the environment is expected to be highly radiative during LHC operation.

All electronics has been tested before installation, with a custom test jig, mimicking the whole data transmission path, from on-chamber devices to counting room modules. Then, after installation and integration in the CMS trigger and data acquisition systems, the SC became part of the CMS trigger facility for providing cosmic muon triggers for the commissioning of the CMS sub-detectors.

A technical trigger based on coincidences on muon detected on each DT chamber has been developed. It provides triggers on cosmic muons used for electronics synchronization (adjust timing of data coming from different sectors) as well as for data taking of CMS sub-detectors during the beam stop periods.

The technical trigger provides us a flexible tool to be used still for synchronization studies with the very first LHC beam when, for instance, a trigger rate of about 500 Hz is expected for luminosity of 10ˆ31 cm-2 s-1 .

In parallel, complete and reliable control software was developed, taking advantages from the facilities already implemented in the overall CMS-trigger framework. It is designed for handling a multi-crate environment with fully parallel access and maximal flexibility. Databases are used for retrieving both software and board configurations as well as for recording on-line monitoring information.

Long periods of data-taking led us to design powerful and easy-to-use diagnostic tools such as summaries of the hardware status and plots showing the trend of the temperatures, as monitored by sensors hosted in the electronic modules.

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