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SYNCHRONIZATION OF THE CMS CATHODE STRIP CHAMBERS

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The synchronization of the trigger and data acquisition systems for the Cathode Strip Chambers (CSCs) in the Compact Muon Solenoid (CMS) detector at CERN is described. To date, asynchronous cosmic ray data have been used to define the protocol and to refine timing algorithms, allowing synchronization to be realized within and between chambers. From this baseline, final synchronization of the CSCs will be readily achieved using data taken with the synchronous beam structure of the Large Hadron Collider. Details regarding the definition, procedures, validation, and performance of the synchronization of the CSCs will be presented.

Summary

The synchronization of the trigger and data acquisition (DAQ) systems for the Cathode Strip Chambers (CSCs) in the Compact Muon Solenoid (CMS) detector at CERN is described. To date, asynchronous cosmic ray data have been used to define the protocol and to refine timing algorithms, allowing synchronization to be realized within and between chambers. From this baseline, final synchronization of the CSCs will be readily achieved using data taken with the synchronous beam structure of the Large Hadron Collider (LHC).

The CSCs comprise 468 chambers covering the full azimuth, divided into 4 stations on each endcap of the CMS magnet, interleaved between the magnet yokes to detect muons produced at polar angles between 1<|eta|<2.4. The chambers contain 6 layers, with radial cathode strips to measure the muons'azimuthal position and bend from the magnetic field in this region, and anode wires to measure their polar angle. The trigger electronics are custom-designed, using FPGAs to process information in boards located on the chamber, and in VME crates both on the periphery of the magnet yokes and in the counting house. The electronics were designed to process events at the LHC bunch crossing rate of 40MHz, to be highly configurable, and to recover quickly from single-event upsets which will occur in the high radiation environment. Inaccessibility to the electronics during collisions requires that remote communication protocol be used to set timing parameters and to monitor trigger performance.

Anode wire signals are used primarily to determine the timing of the event. Cathode strip signals are processed by comparator ASICs to specify the muon's location within a layer to a precision of ½-strip. The strip-positions from all layers are compared with patterns to pick muons with large momenta. A coincidence between the cathode and anode information is required for the trigger candidate to pass to the next step. Up to 2 trigger candidates per chamber are sent, of which 3 are chosen within a trigger sector to be sent on for further processing. These trigger primitive candidates are passed via optical fibers to a Sector Processor, which combines information from different stations through LookUp Tables in order to pick the most desirable candidate muons and measure their momenta. The CSC trigger candidate is handed to higher levels of the CMS trigger system to be chosen or discarded as a "L1Accept"event. A robust procedure to carefully synchronize the steps in a system of this magnitude and complexity is necessary.

Further requirements are imposed by the CSC DAQ system. In order not to choke the CMS DAQ with mostly empty data, the CSC DAQ was designed to send data from a chamber only when that chamber has created a trigger. The coincidence of a trigger coming from the CSCs together with the receipt of the L1Accept signal in the DAQ boards imposes further constraints to the synchronization of the system.

Details on the definition, procedures, validation, and performance of the synchronization of the CSC trigger and DAQ paths will be presented.

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