Contribution ID: **72** Type: **Oral**

The Drift Tube Track Finder Muon Trigger at the CMS Experiment

Tuesday, 26 September 2006 11:45 (25 minutes)

The Compact Muon Solenoid (CMS) is a general purpose experiment designed to study proton-proton collisions at the Large Hadron Collider (LHC). At the LHC, proton beams will cross each other at a rate of 40 MHz, producing in average 20 p-p interactions. The CMS L1 Trigger must select interesting collisions at a rate smaller than 100 kHz. The Drift Tube Track Finder (DTTF) implements the CMS DT L1 Regional Muon Trigger. The DTTF motivation and design, its electronic implementation and the production status will be presented. Tools for configuration, data acquisition, and monitoring will be described. Performance at Beam Tests and at the 2006 Cosmic Challenge will be discussed. Finally, recent results on expected rates for single muon and dimuon triggers, and prospects for operation at the first year of the LHC will be reviewed.

Summary

At the Large Hadron Collider (LHC), muons of large transverse momenta are expected to play a crucial role in the physics under study. The Compact Muon Solenoid (CMS) is a general purpose experiment designed to study proton-proton collisions at the LHC. At the LHC, proton beams will cross each other at a rate of 40 MHz, producing in average 20 p-p interactions. The CMS L1 Trigger must select interesting collisions at a rate smaller than 100 kHz. In this report we describe the Drift Tube Track Finder (DTTF) Muon Trigger.

CMS will combine three different technologies for precise muon detection and efficient triggering: drift tube (DT) chambers in the barrel region ($|\eta| < 1.2$), cathode strip chambers (CSC) in the forward region ($0.8 < |\eta| < 2.4$), and resistive plate chambers (RPC) in both regions ($|\eta| < 2.1$). The DT muon chambers are located in the gaps of the barrel iron yoke. The yoke is organized in five wheels along the detector axis. Each wheel is divided in twelve 30^o sectors in azimuth, and four concentric stations in the radial direction: MB1, MB2, MB3, MB4. In every station in a sector, one DT muon chamber contains twelve layers of drift cells organized in two $r - \phi$ superlayers and one $r - z$ superlayer (except the MB4 chambers that do not contain $r - z$ superlayer).

The information delivered by the DT muon chambers is processed by the DT L1 Muon Trigger, which is divided into a DT Local Trigger and a DT Regional Trigger. Hits in the DT muon chambers are first organized in segments and assigned a beam crossing by the DT Local Trigger, and delivered to the DT Regional Trigger.

The DTTF system implements the DT Regional Trigger. The task of the Drift Tube Track Finder Trigger is to reconstruct full muon tracks originating at the interaction point, and to assign them physical parameters.

The DTTF Trigger is physically realized using a sophisticated electronic system. The DTTF logical segmentation replicates the CMS barrel detector geometrical structure. The system is organized in twelve modules stored in six crates. Each module processes the information that originated in a 30^o wedge of the barrel detector. One module is formed by eight boards: six Phi Track Finder (PHTF) sector processors (one PHTF for wheels ±1 and ±2, and two PHTF boards for wheel 0), one Eta Track Finder (ETTF), and one Wedge Sorter. Two modules share the same crate and the same VME Controller, Timing, and Data Link boards. A 7th crate contains the Trigger Timing and Control system, the Barrel Sorter, and the interface to the CMS DAQ system.

The Phi Track Finder sector processors (PHTF) reconstruct muon tracks in the $r-\phi$ plane. The PHTF track finding algorithm is implemented in three logical steps: (i) Extrapolation, (ii) Track Assembling, and (iii) Parameter Assignment (transverse momentum, position in ϕ, electric charge, and quality).

In every 30^o wedge, the Eta Track Finder (ETTF) reconstructs the muon trajectory in the $r-z$ plane. The ETTF uses a pattern matching procedure which is implemented in three logical steps. First, patterns of $r-z$ segments are recognized among a predefined set (η-patterns). Second, η-patterns are matched to PHTF tracks. Finally, if the pattern matching step was successful, the PHTF track is assigned a fine value of η. If no η-pattern could be matched, a rough η value is assigned.

The DT Sorters select the four highest rank DTTF muons in the barrel detector and, after a clean-up procedure, forward them to the Global Muon Trigger.

The DTTF system is realized in Field Programmable Logic Array (FPGA) technology, and is largely programmable. Its optimal exploitation requires the setting-up of logic and lookup tables, that can even be tuned to the physics that is to be explored. All DTTF functional elements were specified using VHDL behavioral code. In addition, real-time software to operate, test and monitor the system has been produced.

The final design of the DTTF boards was decided after an extensive prototyping phase. The PHTF and ETTF final designs concentrate almost all the track-finding functionalities in a big Altera Stratrix FPGA. By March 2006, all electronic boards for the DTTF system had been produced. Quality Control of the produced boards has almost finished.

In October 2004 the behavior of parts of the DTTF were studied under realistic experimental conditions at the CERN Test Beam. The results were excellent. More complex tests of the DTTF system will take place before the LHC era. In 2006 the integrated CMS Trigger will be tested with cosmic muons at the Magnet Test/Cosmic Challenge. Production, installation, and commissioning of the DTTF trigger will happen in 2006 and beginning of 2007, to be ready for the first LHC collisions in April 2007.

Author: FERNANDEZ DE TROCONIZ, Jorge (Universidad Autonoma de Madrid)

Presenter: FERNANDEZ DE TROCONIZ, Jorge (Universidad Autonoma de Madrid)

Session Classification: Parallel Session B1-Trigger session 1