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Recent Results on the Performance of the CMS Tracker Readout System

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The CMS Silicon Tracker is comprised of a complicated set of hardware and software components that have been thoroughly tested at CERN before final integration of the Tracker. A vertical slice of the full readout chain has been operated under near-final conditions. In the absence of the tracker front-end modules, simulated events have been created within the FED and used to test the readout reliability and efficiency of the final DAQ. The data are sent over the final SLink 64 bit links to the final FRL modules at rates in excess of 200 MBytes/s per FED depending on setup and conditions. The current tracker DAQ is fully based on the CMS communication and acquisition tool called XDAQ. This paper discusses setup and results of a vertical slice of the full Tracker final readout system. Simulated data is created with varying hit occupancy (1-20%) and trigger rates (<200KHz) and the resulting behaviour of the system is recorded. Data illustrating the performance of the system and data readout is presented.

Summary

The CMS Silicon Tracker will produce large amounts of data, which must be read out by the Front End Drivers (FEDs), which are 9U 400mm VME64x cards that process the raw data from a subset of 192 APV25 silicon readout ASICs, equivalent to 0.2% of the tracker. After multiplexing and streaming, the data from the tracker are routed via analogue optical links to the FEDs. 96 optical channels are then digitised to 10bit precision at 40MHz and processed in large FPGAs, before being collated into events and sent to the CMS DAQ via either VME or the SLINK-64 protocol.

Under final running conditions the SLINK-64 protocol must be used to enable a data throughput of up to 200 Mbytes/s per FED. It is clear therefore that such a system must be well tested before the final system is assembled at Point 5 on the LHC ring, so that the final operation of the system is certified. However, during the testing and assembly stages in 2006 there are not enough Tracker front-end modules available in order to drive a large enough number of FEDS to make a true vertical slice test. Nominally a vertical slice would consist of 1 whole crate of FRLs, which corresponds to two whole crates of FEDs ˜ 32 in total. Therefore another method of testing the readout system without the need for the detector modules is required. This is achieved by creating Pseudo-Random fake events within the front-end modules of the FEDs themselves, which are injected directly into the FED exactly where the optical data samples would arrive from the final system.

In order to qualify the hardware readout system and operation of the DAQ, this system was set up in building 904 on the CERN Prevessin site. This system is capable of creating variable event occupancies in the front end of the FED, without the need for the actual detector modules to create the event frames from the APV25 front-end readout chips. The "fake events"which are created in the FED have the capability to be set to operate at any occupancy between 0 and 100% and also include a pseudo random adjustment to the pedestals of the fake APV frames, in order to simulate the random nature of the hits in the front-end silicon detector modules.

The main purpose of this test is to qualify the functionality of the entire trigger and readout chain from the LTC –TTCci –TTCex –TTCoc –APVE –FMM –FRL –FED –Transition Card - Slink Sender Card and DAQ software. Operating the system under various conditions by varying the trigger rate and data throughput (occupancy). In doing so one can investigate the limiting factors of the system to gain a better understanding of how the final tracker will perform.

The results of this test have shown that the system is stable for periods of time

over many hours when running at 150KHz Poisson distributed triggers, the back pressure from the APVE and FED, via the FMM, works perfectly to throttle the trigger rate down to a sustained rate of 72Khz when operating the FED at 5% occupancy. At lower occupancies, 2-3%, more representative of nominal data taking conditions in the final Tracker, the system runs without interruption at trigger rates around 100 KHz sustained. A number of other scenarios have also been tested and will be presented in the paper, and if time permits, some nominal testing of the same system with real detector modules will also be included.

Primary author: FULCHER, Jonathan (Imperial College)

Presenter: FULCHER, Jonathan (Imperial College)

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