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Modular Trigger Processing, The GCT Muon and Quiet Bit System

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The CMS Global Calorimeter Trigger system's HCAL Muon and Quiet bit function is being implemented with a novel processing architecture. This architecture utilizes micro TCA, a modern modular communications standard based on high speed serial links, to implement a processing matrix. This matrix is configurable in both logical functionality and data flow, allowing far greater flexibility than current trigger processing systems. In addition, the modular nature of this architecture allows flexibility in scale unmatched by traditional approaches. The Muon and Quiet bit system consists of two major components, a custom micro TCA backplane and processing module based. These components are based on Xilinx Virtex5 and Mindspeed crosspoint switch devices, bringing together state of the art FPGA based processing and Telcom switching technologies.

Summary

A secondary function of the CMS Global Calorimeter Trigger system (GCT) is to provide reordered HCAL Muon and Quiet bit data to the Global Trigger. This function is being implemented utilizing a multi-gigabit switched serial mesh based processing topology. It represents an evolution of the current GCT architecture, taking advantage of the lessons learned implementing the optical data transmission and concentration between the Regional Calorimeter Trigger racks and the GCT. This topology is realizable in the micro TCA communications equipment standard, with a custom (though spec compliant) backplane.

Traditional detector triggering systems have always been large hardware designs that pushed the state of the art in both speed and density. Due to their optimization for throughput, they have tended to be fully custom one-off systems, complex and difficult to modify, and generally lacking in clean internal interfaces.

A more desirable architecture would support fine grained modularity, and be based on a suitably flexible commercial standard, while supporting the extreme data rates required of current trigger systems. Recent advancements in FPGA and data switching technology, as well as the emergence of the Advanced Telecommunications Architecture, have made it practical to consider a modular, commercial standards based architecture for future triggering systems.

The GCT HCAL Muon and Quiet bit functionality entails the reorganization of the data as collected by the 18 Regional Calorimeter Trigger crates, and transfer to the Global Trigger (GT). In addition, the serial encoding of the data needs to be changed to provide compatibility with the GT. While computationally fairly straightforward, the number of channels (18, 1.6Gbit in, 24, 1.2Gbit out) is significant. This communication intensive design is a good fit for an initial implementation of a micro TCA based modular processing system.

The design is based on two main modules, a custom micro TCA backplane and a processing module. The custom backplane is an intelligent micro TCA implementation embedding hub functionality in the backplane. This allows the inclusion of large crosspoint switches (Mindspeed M21161), creating a high performance data routing fabric. A large FPGA (Xilinx V5LX110T) forms the basis of the processing modules, which receive and reformat the data.

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