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The DØ Run II Trigger System

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The DØ trigger system has been upgraded for Run II at the Tevatron. I present the current status of the DØ trigger.

Keywords: Trigger; Hadron Collider; Tevatron; Dzero.

1. Introduction

The DØ detector at the Fermilab Tevatron was upgraded for Run II[1,2]. This upgrade included improvements to the trigger system in order to be able to handle the increased Tevatron luminosity and higher bunch crossing rates compared to Run I.

The DØ Run II trigger is a highly flexible system to select events to be written to tape from an initial interaction rate of about 2.5 MHz. This is done in a three-tier pipelined, buffered system. The first tier (level 1) processes fast detector pick-off signals in a hardware/firmware based system to reduce the event rate to about 1. 5kHz. The second tier (level 2) uses information from level 1 and forms simple Physics objects to reduce the rate to about 850 Hz. The third tier (level 3) uses full detector readout and event reconstruction on a filter farm to reduce the rate to 20-30 Hz. The DØ trigger menu contains a wide variety of triggers. While the emphasis is on triggering on generic lepton and jet final states, there are also trigger terms for specific final state signatures.

In this document we describe the DØ trigger system as it was implemented and is currently operating in Run II.

2. Level 1 and Level 2 Trigger System

The first two levels of the trigger system reduce the event rate from the initial interaction rate of about 2.5 MHz to a rate of below 850 Hz that allows for a full

*On behalf of the DØ collaboration.

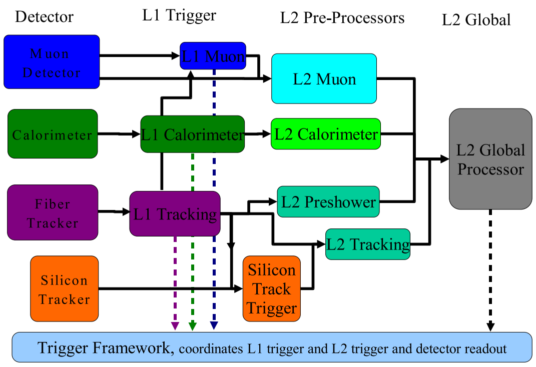

Fig. 1. A schematic illustration of DØ Trigger level 1 and level 2 systems.

readout of the DØ detector. In order to accomplish this, the first two levels are coupled together tightly through a system that coordinates the trigger decisions and distributes trigger information to the various sub-detectors. This "trigger framework" handles the information from the level 1 muon, calorimeter, and tracking sub-systems as well as the level 2 trigger system. It forms global level 1 and level 2 trigger decisions which are sent out to all detector systems to coordinate event transfers from front-end buffers to level 1 buffers and to the level 3 system.

A diagram of the level 1 and level 2 trigger configuration is shown in Fig. 1. At level 1, the individual sub-systems are mostly independent, except for the ability to match muons to central tracks. At level 2, sub-detector specific objects are reconstructed in separate pre-processors. The level 2 global processor then reads these objects from the pre-processors and combines them to form Physics objects. It furthermore computes event-wide variables such as the total transverse energy H_T and event correlations such as ϕ separation between objects.

The level 1 and level 2 trigger systems allow for up to 128 individual triggers to be programmed. If any of these triggers passes, the event is read out and sent to level 3. Each individual trigger may itself contain several different conditions. All conditions must be fulfilled in order for this trigger to pass. This flexible configuration has enabled the design of Physics trigger menus suited well for the instantaneous luminosities produced by the Tevatron to date. During the Tevatron start-up, the focus of the trigger menu was on simple calorimeter-based objects (electrons and jets) and on muons reconstructed using the muon detector. As the instantaneous luminosity increased over time, track requirements, more complex objects, and event-wide variables were added.

3. Level 3 Trigger System

The entire DØ detector is read out for events passing level 1 and level 2. This includes reading out all of the detector elements as well as the trigger level 1 and

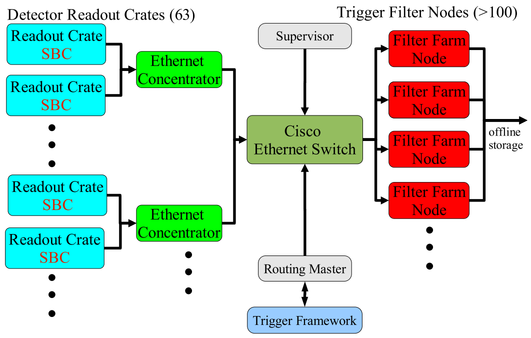

Fig. 2. A schematic illustration of DØ Trigger level 3 system.

level 2 systems themselves. Fig. 2 shows an overview of the level 3 system.

The hit and pulseheight information from each detector readout crate is collected in single-board-computers (SBC), which send this information to a node on the filter farm through a commercial Ethernet switch. The flow of information from the readout crates to the filter nodes is controlled by the routing master. The trigger programming is loaded onto the filter nodes by the supervisor node. The routing and filter node programming occurs over the same Ethernet links that are used in the data transfer.

Each event is fully reconstructed at level 3 with algorithms that are similar to those used in the offline event reconstruction. This allows the level 3 system to accomplish a large rejection factor of 20 that is required to limit the output rate to less than 50 Hz.

The flexibility of the trigger programming is expanded further at level 3. There are 256 individual trigger bits available at level 3, each coupled to one of the level 1/level 2 triggers. Each can be programmed to filter on combinations of simple objects such as electrons, muons, or jets, as well as event-wide variables and correlations. Level 3 also provides the ability to select b-tagged jets based on tracking and silicon detector information.

4. Conclusions

The DØ Run II trigger system is working well, selecting events for offline processing with high efficiency for many different Physics signal processes. Full advantage has been taken of the flexibility of the system as the Tevatron instantaneous luminosity has increased.

References

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2. S. Abachi et al., The DØ Upgrade: The Detector and Its Physics, Fermilab Pub-96-357-E (1996).