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Level-3 Calorimeter Resolutions Available for the Level-1 and Level-2 CDF Triggers.

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As the Tevatron luminosity increases more sophisticated selections are required to be efficient in selecting rare events from a very huge background.
To cope with this problem, CDF has pushed the level 3 calorimeter algorithm resolutions up to Level 2 and, when possible, even at Level 1, increasing efficiency and, at the same time, keeping under control the rates.
This strategy increases the purity of the Level 2 and Level 1 samples, produces free-bandwidth that allows to reduce the thresholds. The global effect is an increase of the signal efficiency on important Tevatron Standard Model Higgs search channels (H -> WW, HZ, HW).

The L2 upgrade improves the cluster finding algorithm, the resolution of the Missing Transverse Energy (MET) and the SUM Transverse Energy (SUMET) calculations. The same Level 2 MET and SUMET improved resolution has been made available to the Level 1 system, exploiting the same hardware used for the Level 2 upgrade.

The upgrade is based on the Pulsar board [1], a general purpose VME board developed at CDF and already used for upgrading both the Level 2 tracking and the Level 2 global decision crate [2]. The Level 2 upgrade has been designed, built, tested and commissioned in six monthes. It was accepted as the default system for CDF in August 2007.

The same Level 2 hardware can be used in such a way to provide the Level 1 colorimeter system of the same MET, SUMET resolution provided to Level 2.
While in the upgraded Level 2 system the algorithms are executed in a commercial CPU within the typical Level 2 processing timing of 20 us, in the upgraded Level 1 system, MET and SUMET are calculated by powerful FPGAs[3] within 5 us. The Level 1 upgrade is currently ongoing and in commissioning phase.

We describe the CDF Level 2, Level 1 calorimeter upgrades, the architecture and the trigger performances, with particular emphasis on a new calorimeter MET_JET-based trigger performances used for CDF Higgs search.

Summary

At Level 2 an array of 23 Pulsars organized into 3 different levels, merge all the calorimeter trigger towers inside a CPU where the Level 2 reconstruction is executed.
The Pulsar boards receive data, over 288 LVDS cables, well before the Level 1 accept decision. The events are synchronized with the Level 1 decision inside the 18 first level Pulsars, so that only events accepted at Level 1 are allowed to go ahead along the Pulsar tree. The FPGA occupancy due to the Level 2 computation is very low
, so that we could easily implement the MET and SUMET calculation exploiting the extra FPGA logic. This calculation is executed at the full Level 1 input rate.
A partial computation is executed on each first level Pulsar board and finally sent to a single
extra Level 1 Pulsar that refines the final MET and SUMET values, compares to the trigger threshold and sends the decision to the global Level 1 logic.

Bibliography

[1]http://hep.uchicago.edu/~thliu/projects/Pulsar

[2] K. Anikeec et al. IEEE Trans. on Nucl. Sci., Vol. 53, No 2, 2006 pp. 653-658.

[3]ALTERA Pub, APEX 20K Programmable Logic Device Family, Data Sheet v.5.1, (2004).

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