CMS CALORIMETER TRIGGER CIRCUITS

W. H. Smith, S. Dasu, M. Jaworski, J. Lackey, D. Panescu,W. Temple
University of Wisconsin

1. INTRODUCTION

The CMS level 1 trigger decision is based in part upon local information from the level 1 calorimeter trigger about the presence of objects such as photons, electrons, and jets, as well as global sums of E_t and missing E_t (to find neutrinos). Each of the objects, such as electrons, muons and jets, are required to pass a series of p_t or E_t thresholds, which are used in making the Level 1 Trigger Decision.

The electron/photon trigger is based on the recognition of a large and isolated energy deposit in the electromagnetic calorimeter by asking for a small hadronic energy deposited in the HCAL in the cluster region. There are different thresholds for inclusive electrons/photons, dileptons, and for very high E_t electrons. The isolation cuts are relaxed and finally eliminated for triggers with increasing E_t thresholds.

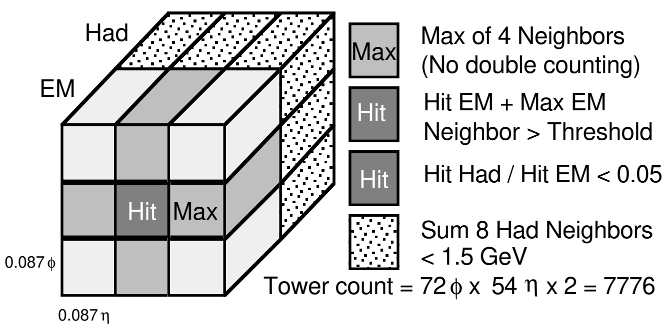

Figure 1. Level 1 Electron Trigger Algorithm.

As shown in Figure 1, the algorithm implemented in the hardware design involves two separate cuts on the longitudinal and transverse isolation of the ECAL energy deposit. The first cut involves the hit tower HCAL to ECAL energy ratio, $H/E < 0.05$. A second cut requires a cut on a sum of HCAL transverse energies in the nearest eight towers surrounding the hit tower, $H1 < 2.0$ GeV. In order to reduce the number of bits of information exchanged between electronics cards we limit the dynamic range of neighboring tower HCAL information to 2 bits. Neighboring ECAL energies are sent as 6 bits. Overflows of both the 8-bit scale for ECAL and central HCAL towers, and the 2-bit scale for neighboring HCAL towers are treated as maxima.

The jet triggers are based on sums of 0.35 x 0.35 eta-phi regions using a dynamic range that covers energies up to about 250 GeV. Jet triggers with lower thresholds will be used in combination with electron/photon, muon and other jet triggers.

Neutrino identification consists of calculating the event missing E_t vector and testing it against a threshold. The calorimeter trigger calculates both sums of E_t and missing E_t. The transverse energy vector components are calculated from the 8-bit compressed-scale digitized HCAL and ECAL pulse heights converted to a linear scale with a 10-bit dynamic range, and multiplied by entries in lookup tables containing the tower angular coordinates. The HCAL and ECAL sums are combined into single tower sums. The tower sums over threshold are routed through the digital summing networks. The E_t trigger is not used as a standalone trigger, but only in combination with other triggers. When pre-scaled by factors of 1000 or more for E_t above 100 GeV, it is also used to check trigger efficiency and measure the E_t spectrum.

2. CALORIMETER REGIONAL TRIGGER CRATES

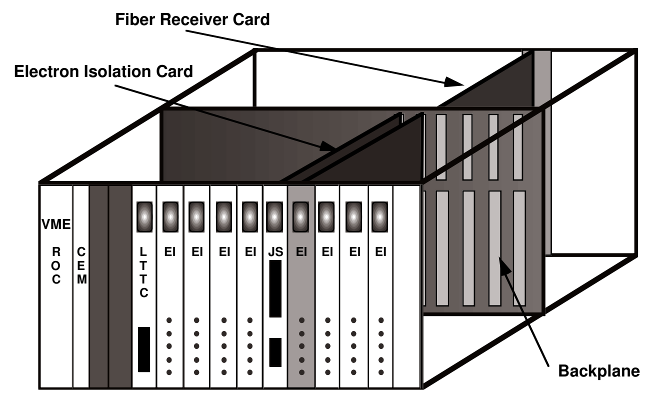

Figure 2. Schematic view of a typical Calorimeter Level 1 Regional crate.

The crate, shown schematically in Figure 2, has a height of 9U and a depth approximately of 700mm[1] . The backplane is completely custom with a full 9U height. The top 3U is reserved for a 32 bit VME interface. The remaining 6U is used for the high speed data paths between individual cards. The front section of the crate is designed to accommodate 280mm deep cards, leaving the major portion of the volume for 400mm deep rear mounted cards.

The majority of cards in the Calorimeter Level 1 Regional Processor Crates, encompassing three custom board designs, are dedicated to receiving and processing data from the

[1] J. Lackey et al., CMS Calorimeter Level 1 Trigger Conceptual Design, CMS TN/94-284 (1994).