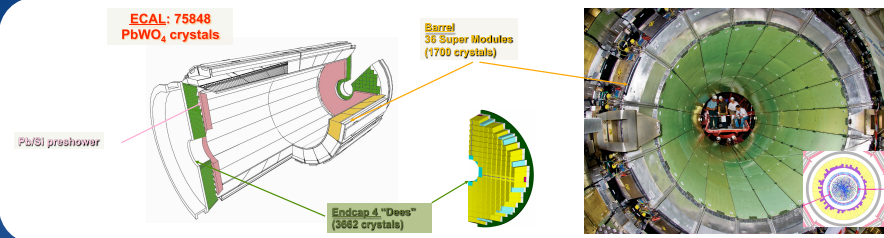




# CMS Level 1 Electron and Photon Trigger

## Commissioning and performance on 7 TeV data

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On behalf of the CMS Collaboration



**CMS Electromagnetic Calorimeter (ECAL):** optimized for reconstructing photons and electrons with energy relevant for the search of the intermediate mass Higgs boson. Nearly 76000 scintillating PbWO<sub>4</sub> crystals organized in a compact and hermetic structure.

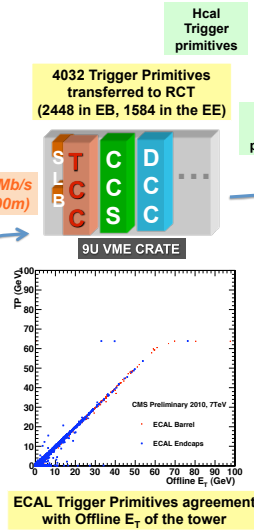
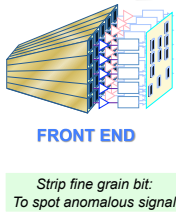
The first level (hardware) electron and photon trigger (or L1 EG) uses information from the ECAL Barrel (EB) and Endcap (EE) crystals only. Preshower information is added at the second level (online processing).

### Algorithm

The transverse energies of the crystals in each trigger tower are summed into trigger primitives, in the Front End boards (3072 total) and sent to the TCC boards (108 total) for further processing.

They are then combined to form Isolated or Non-Isolated EM objects: the L1 Electron and Photon Trigger Candidates.

@ 40 MHz, 800 Mb/s optical fibers (90m)



- EG1
- EG2
- EG5
- EG8
- EG10
- EG12
- EG15
- EG20

The Regional Calorimeter Trigger creates Level 1 EG Trigger Candidates, based on the Trigger Primitive information.

**L1 Candidate:**  
- sum of two adjacent Trigger Primitives  
- labeled "isolated" or "non-isolated", depending on the energy in the neighbor ECAL and HCAL towers.

**Per RCT region:**  
- 4 highest isolated L1 EG Candidates  
- 4 highest non-iso L1 EG Candidates  
- 4 highest central, forward, L1  $\tau$  Jet Candidates

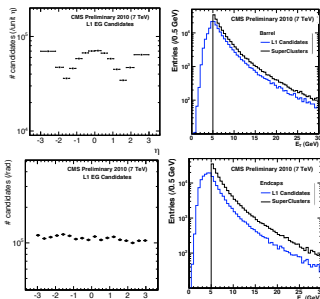
The Global Calorimeter Trigger:  
- receives L1 candidates from all regions  
- transmits the 4 highest E<sub>T</sub>, ones to the Global Trigger.

**Global Trigger:**  
- 4 isolated L1 EG Candidates  
- 4 non-iso L1 EG Candidates  
- 4 central, forward, L1  $\tau$  jet Candidates

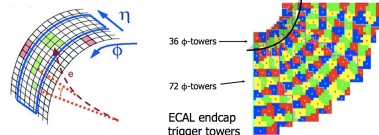
The Global Trigger:  
- receives L1 candidates from all GCT's  
- makes the final Level 1 Trigger Decision.  
- contains different E/Gamma trigger paths, with different E<sub>T</sub> thresholds (in GeV) on L1 E/Gamma candidates, and potential prescales.

EG5 (L1 candidate above 5 GeV) is the path currently used (with no prescale) for Physics Analyses.

### Commissioning



Distribution of L1 EG candidates matched to Superclusters (E<sub>T</sub> > 5 GeV)  
Left:  $\eta, \phi$  - Right: E<sub>T</sub> (Barrel, Endcaps)  
Unbiased selection based on muon triggers.



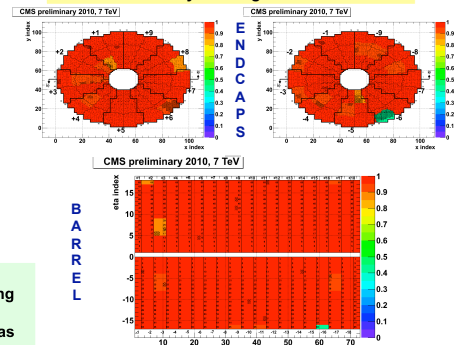
- L1 EG algorithm = 2 tower sum
- Supercluster is generally spread over many towers, especially in endcaps.

#### Measurement of the E/Gamma trigger performance from first data

- Superclusters (offline ECAL objects) are compared here to their corresponding L1 trigger online object: the L1 candidate.
- For efficiency studies, an event selection unbiased from E/Gamma triggers has been developed, on which all superclusters or electrons can be considered. This selection is based on ZeroBias events, and activity in the ECAL.

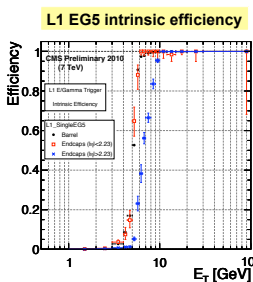
Apr10-July10: 7 TeV collisions

### L1 EG5 plateau efficiency map on superclusters by RCT region



Very good efficiency overall (~100%). Inefficiency regions correspond to masks (shown by hatches) at detector level or at regional trigger level. The most extended masks are only temporary.

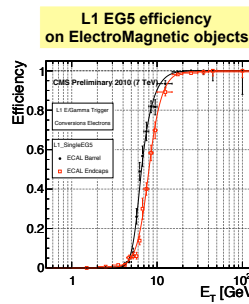
### Performance



To estimate the intrinsic efficiency, considered superclusters are required to have a topology comparable to L1 candidates: they must be spread on no more than 2 Trigger Towers, and reconstructed in the right bunch crossing.

**Intrinsic Efficiency:** Given an ECAL SuperCluster with a topology comparable to the one of a L1 EG candidate, we measure its probability to create a L1 EG candidate which fired L1 EG5.

E/Gamma Trigger operated as expected.



To estimate the efficiency on ElectroMagnetic objects, a selection of electrons from conversions has been chosen. With more statistics, a selection of prompt electrons will be possible, using Tag & Probe methods.

**Efficiency on Electrons from Conversions:** Given an Electron Candidate, after loose ID and isolation, and conversion selection, we measure its probability to create a L1 EG candidate which fired L1 EG5.

E/Gamma Trigger operated as expected.

### Conclusion

The Level 1 Electron and Photon Trigger has proved its excellent performance during these first months of collisions at 7 TeV and allowed the whole CMS collaboration to select interesting physics events like  $Z \rightarrow ee, W \rightarrow e\nu$ . It is ready for the upcoming higher luminosity and more interesting events.

One of the first  $Z \rightarrow ee$  events Selected by the Electron and Photon Trigger

