# CMS Level 1 Trigger Software Release Validation

## The Trigger

At the full design luminosity of the LHC, beam crossings occur in the CMS detector at a rate of 40 million per second (40MHz). Approximately 25 interactions occur with each beam crossing giving 10<sup>9</sup> events occurring in the CMS detector every second.

This input rate of  $10^9$  interactions per second must be reduced by a factor of at least  $10^7$  to 100 Hz, the maximum rate that can be archived by the on-line computer farm.

To extract interesting physics from all interactions for storage and further analysis, we require a fast and precise electronic system called **The Trigger**.



The trigger is divided into two levels:

- Level 1 (L1) Trigger
- High Level Trigger (HLT)

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To analyse CMS data, we use a specific software framework for CMS called CMSSW framework.

To prepare the L1 Trigger to be ready for real data taking when CMS is operational, the events are generated by Monte Carlo process and the trigger is emulated onto the framework.

I work on the Level 1 Trigger Software Release Validation. The purpose of the release validation is to provide information on the verification of the validity and performance status of the trigger software. The L1 Trigger will look for electrons, muon, jets, and missing transverse energy.

To see how good L1 Trigger is, we plots distributions of some quantities such as

- efficiency
- resolution
- correlation between L1 trigger data and the MC data
- of
- Transverse Energy  $(E_T)$
- η (pseudo rapidity)
- φ (azimuthal angle)

for

- isolated  $e/\gamma$ , and non-isolated  $e/\gamma$
- central jet, forward jet, and tau jet
- muon
- MET

## Work Flow



## L1 Validation Plots: isolated electrons



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## L1 Validation Plots: central jets



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## Some Improvement in The New release of CMSSW

#### CMSSW\_3\_1\_0\_pre6

#### CMSSW\_3\_1\_0\_pre10











## **GCT Validation**

## **Global Calorimeter Trigger (GCT) Validation**



#### **GCT validation**

Plot correlation of  $\eta$ ,  $\phi$ , and  $E_T$  between input and output of the GCT

## $e/\gamma$ and $E_T$ Sum



#### **An RCT Region**

#### e/γ

For EM, we just compare isolated and non-isolated EM outputs of the RCT to those of the GCT.

 $\eta$ ,  $\phi$ , and ET of the EM candidates are identified by  $\eta$ ,  $\phi$ , and E<sub>T</sub> of the RCT regions

#### E<sub>T</sub> Sum

The  $E_T$ -sum input to the GCT is summation of  $E_T$  of all RCT regions.

Jet



#### **Jets**

The jets are characterized by the transverse energy  $E_T$  in 3x3 calorimeter regions. The summation spans 12x12 trigger towers. The jets are labelled by  $(\eta, \varphi)$  indexes of the central calorimeter region.

## GCT Validation: $\eta$ , $\phi$ , and $E_T$ plots for $e/\gamma$



## GCT Validation: $\eta$ , $\phi$ , and $E_T$ plots for jets



## **GCT Validation:** E<sub>T</sub> sum plot



## Conclusion

We have a tool to validate L1 Trigger software.We have a tool to validate the GCT software.

Thank you for your attention!