System Design and Prototyping for the CMS Level-1 Calorimeter Trigger at the High-Luminosity LHC

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Posters@LHCC, CERN, Geneva (Switzerland), 27 November 2023

1

CALORIMETER TRIGGER ARCHITECTURE

High Luminosity LHC

Main highlights:

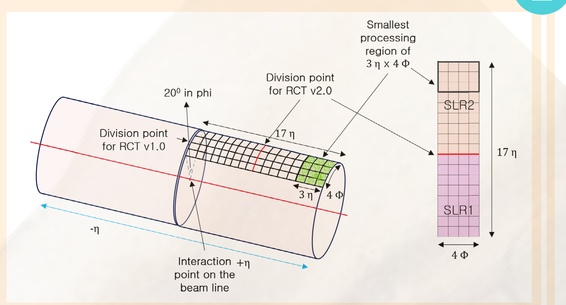
- Usage of large FPGAs
- Usage of high speed (~25 gbps) optical links
- Flexible, modular and scalable algorithms
- The key calo trigger objects are: photons, electrons, energy sums, jets, and hadronically decaying taus

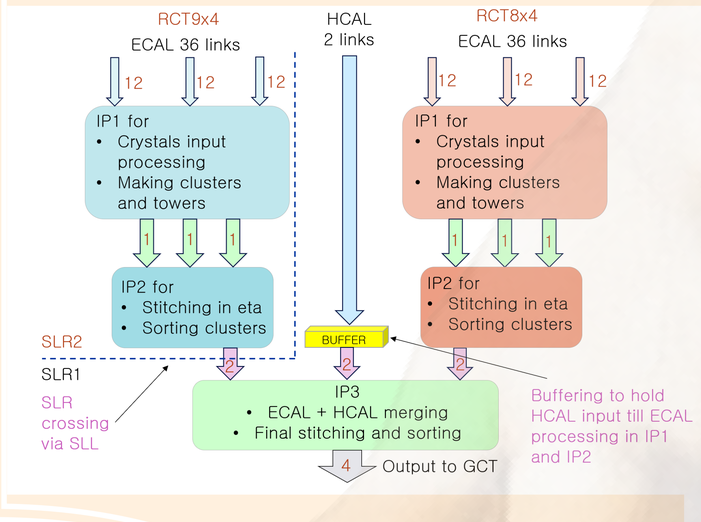
2

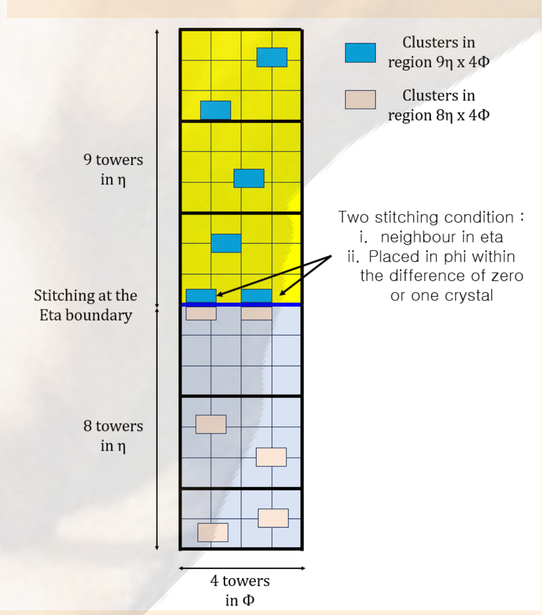
REGIONAL CALORIMETER TRIGGER

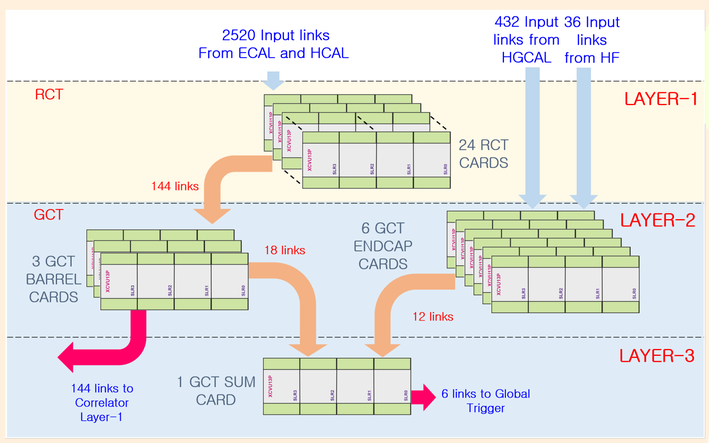
RCT

- Processing barrel ECAL and HCAL
- Implemented in three intellectual property (IP)
- Create electron/photon clusters and towers

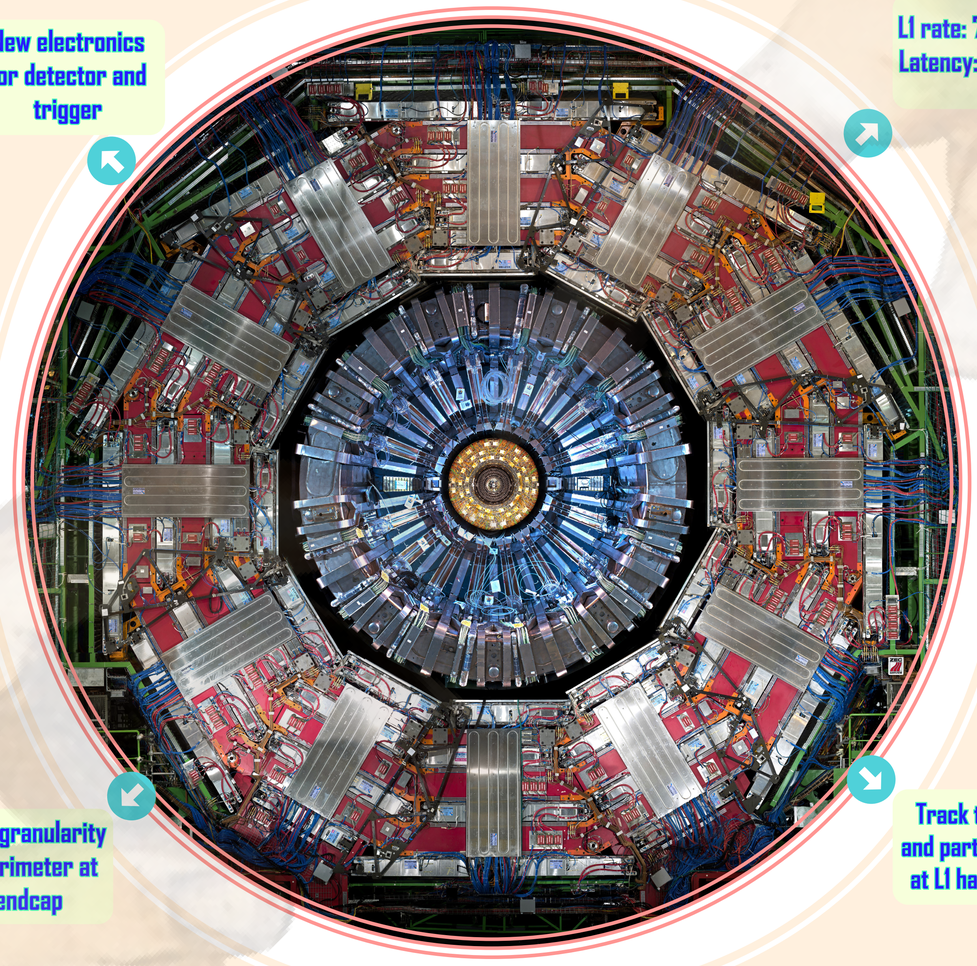




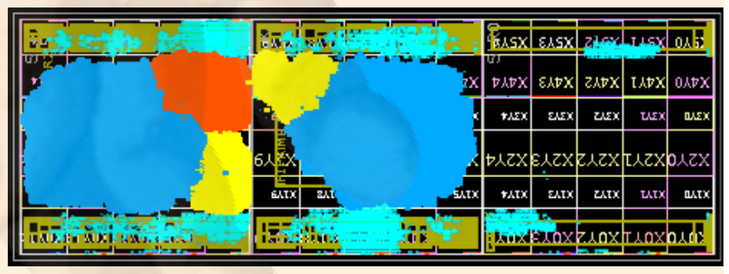




New electronics for detector and trigger

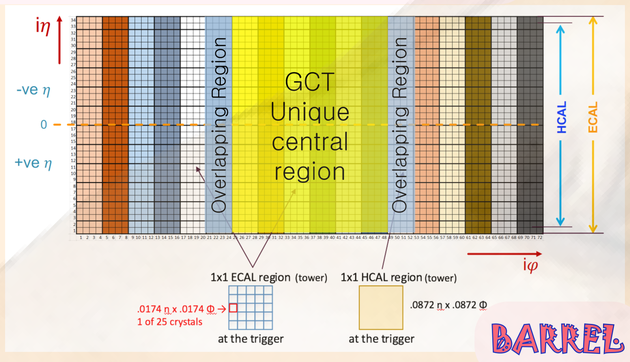


L1 rate: 750 KHz
Latency: 12.5 μS



3

GLOBAL CALORIMETER TRIGGER



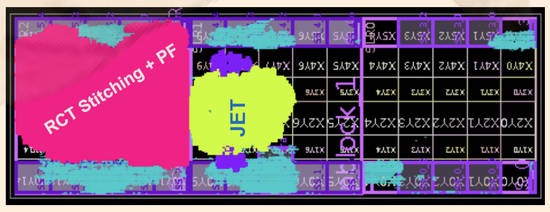
High granularity calorimeter at endcap

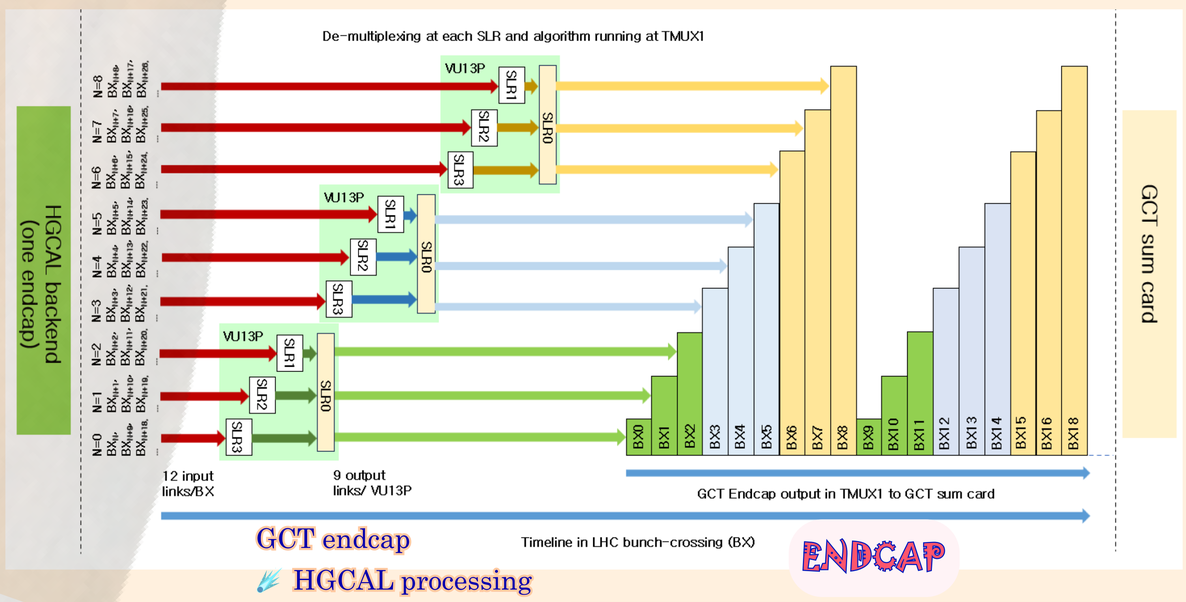
Track trigger and particle flow at L1 hardware

BARREL

GCT barrel

- 12 unique RCT $(17\eta \times 4\phi)$ + 4 neighbours cards
- RCT stitching
- PF clustering
- Jets





ENDCAP

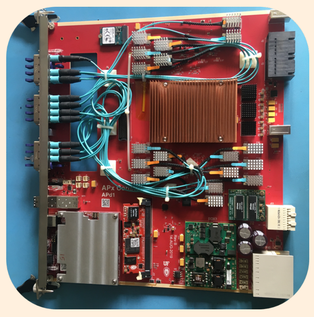
GCT endcap

- HGCAL processing
- Demultiplexing and jet creation

4

CALORIMETER TRIGGER PROTOTYPING

- Prototyping the complete chain of Phase-2 calorimeter trigger.
- Connecting 4 APD1 at UW lab
- 3 Layers
- Cards aligned and tested successfully with one bunch-crossing of input.



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REFERENCE

The Phase-2 Upgrade of the CMS Level-1 Trigger. Technical Report CERN-LHCC-2020-004. CMS-TDR-021, CERN, Geneva, Apr 2020. URL http://cds.cern.ch/record/2714892.

ACKNOWLEDGEMENT

Piyush Kumar and Bhawna Gomber acknowledge the support from IOE, University of Hyderabad, through Grant Number UOH-IOE-RC2-21-006. Piyush Kumar acknowledges the support from the University of Wisconsin, Madison, at CERN for a year.