# Performance of the CMS Electromagnetic Calorimeter data acquisition system at LHC Run 2

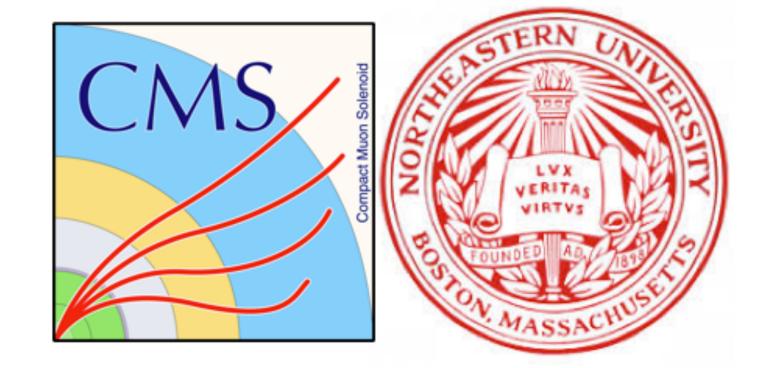
**Trigger** Data

## Tanvi Wamorkar, on behalf of the CMS collaboration Northeastern University

VFE card

Clock & Control

E card



## PM2018 (14th Pisa Meeting on Advanced Detectors)

- ECAL Trigger and DAQ hardware system is divided in two parts:
  - On-detector: responsible for signal digitization and trigger primitives production
  - Off-detector: finalization of trigger primitive calculation & readout of full granularity data
- Trigger tower (TT): group of 25 adjacent crystals, basic detector unit
- Off-detector electronics is made of 54 identical modules: FED's (Front End Driver)
- Every FED is made of Trigger concentrator card (TCC) + Clock & Control System (CCS) + Data concentrator card (DCC)

**Front end → Off-detector trigger boards → Control path → DAQ path** 

Trigger path (Front end)

Clock & Control chip (CCU)

Front end electronics is the first step of trigger

<u>Trigger path (Off-detector Trigger boards)</u>

• TCC boards elaborate TP's to extract

#### **Control Path**

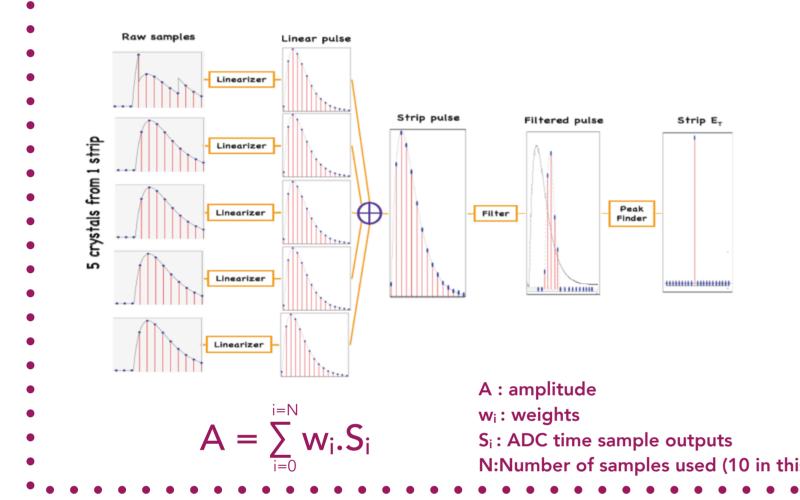
TCDS (Trigger control & distribution system)

- & DAQ path
- TT → Front End (FE): Shapes, amplifies, digitizes
- signals from photodetectors & generates
- trigger primitives
- FE cards send trigger primitive information to
- the off-detector electronics

Lead-Tungstate crystals

Gain Pre-Amplifier chip (MGPA)

AD41240 ADC



- interesting events & send potential triggers to L1 trigger (first stage of the central DAQ system)
- sends accepted triggers & control commands (Start, Stop, Reset...) to CCS boards From here, signals are distributed to the rest of ECAL DAQ system

Clock, L1A

TTC signals (L1A)

TTS signals

Trigger Primitives

Trigger

Primitives

TCC

\* \*

L1A signal

Synchronized trigge

Trigger towers flags

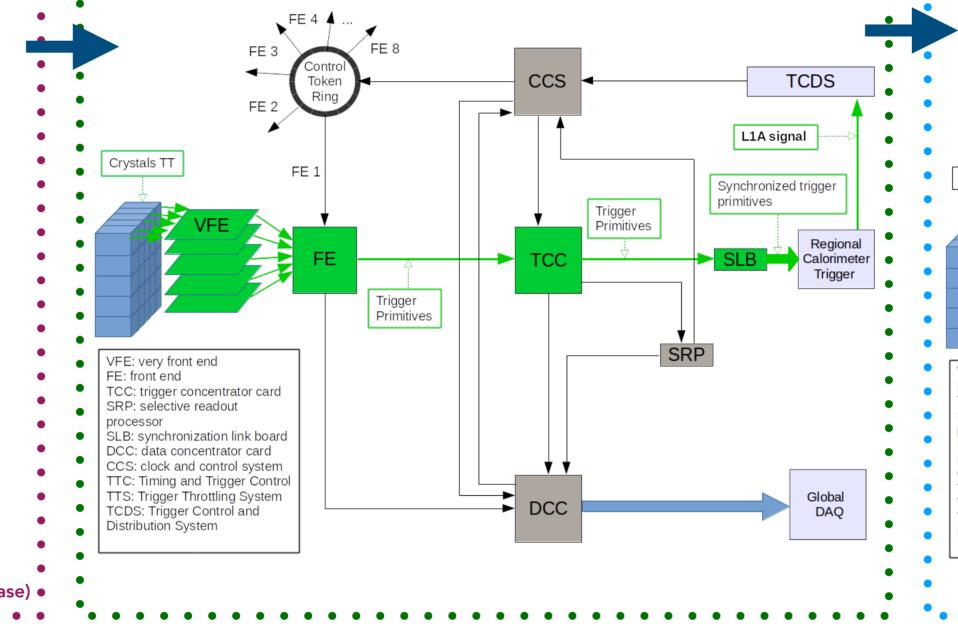
Global

primitives

SLB

Selective Readout flags

Event fragment



**ECAL Online Software** 

Responsible for configuration, operation &

monitoring of ECAL Trigger & DAQ system

building blocks of the ECAL DAQ software

(FM) @ top level

Hierarchical organization - Function Managers

ECAL supervisor & electronic supervisors are the

DAQ path

- Additional information is added to the event
- package of the signal acquired by DCC
- boards
- Event fragments are sent to central DAQ
- system

FE 2

FE

Crystals T

FE: very front end

RP: selective readout

C: trigger concentrator card

CC: data concentrator card

S: clock and control system

TC: Timing and Trigger Control

TS: Trigger Throttling System

TCDS: Trigger Control and

Distribution System

FE config.

Clock, L1A

Trigger Primitives

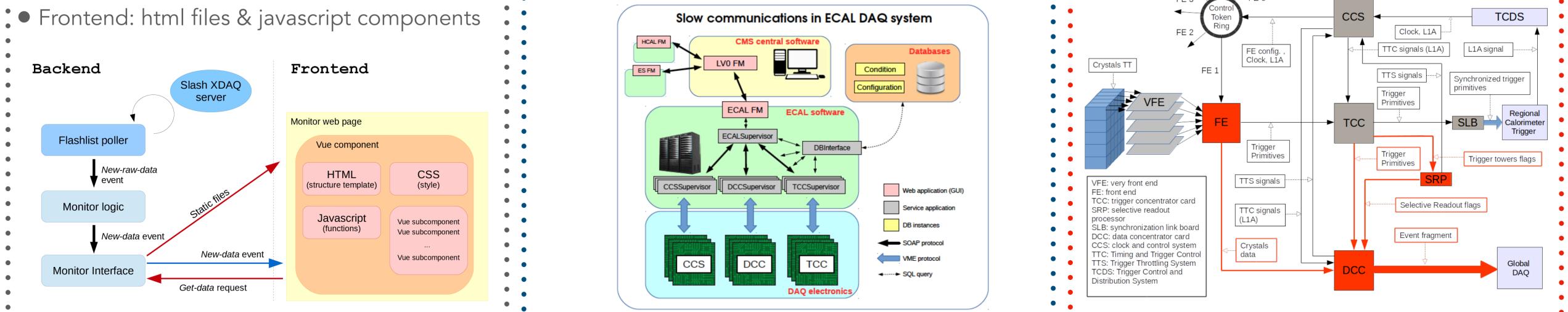
TTS signals

TTC signals (L1A)

Crystals data

## ECAL Monitoring Tools

- ecalView: web application to monitor online
- status of ECAL and Preshower
- Acquires monitoring data from supervisor
  - applications & elaborates it into useful
- information for ECAL shifters
- Backend: node.js modules



### ECAL DAQ performance and automatic recovery procedures

• In comparison to the luminosity delivered by CMS, ECAL DAQ and Preshower DAQ were responsible for 3% and 0.9%, respectively, of the lost luminosity

- in 2017. This improvement over 7% and 6% lost luminosity due to ECAL and Preshower DAQ in 2016 is a result of the different automatic recovery
- procedures, some of which are:
- Integrity and link errors (noisy patterns in occupancy) in CCS for ECAL and Preshower
- DCC errors when CMS clock is unstable (particularly for Preshower)
- ECAL and Preshower stuck during Single Event Upset (SEU) in the front-end electronics
- For 2018: auto-recovery procedures being improved for ECAL DAQ to maintain excellent performance!