

# CMS ECAL Endcaps - Overview & UK Activities

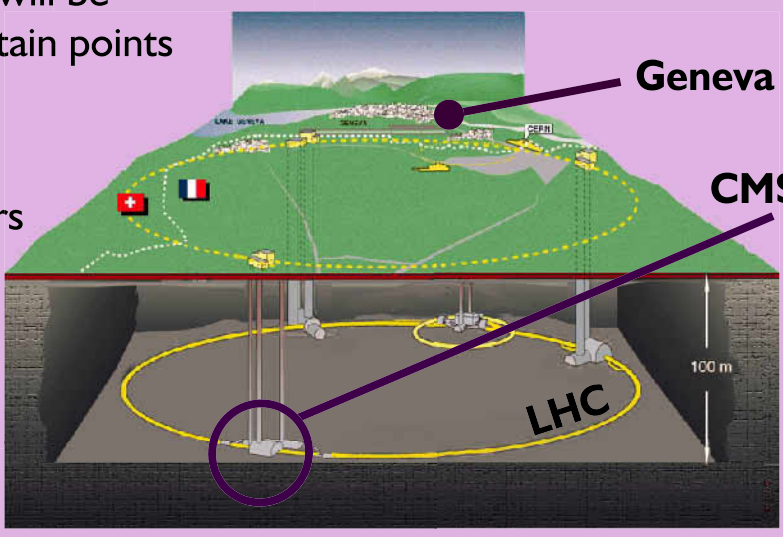
## So what is CMS ECAL?

CMS is a particle detector for the Large Hadron Collider (LHC). It will provide us with a better understanding of matter than ever before. The ECAL is part of the CMS detector.

LHC is the new flagship experiment being built at the CERN, the European Organization for Nuclear Research near Geneva.

High energy particles will be smashed together at certain points around a 17-mile-long acceleration ring.

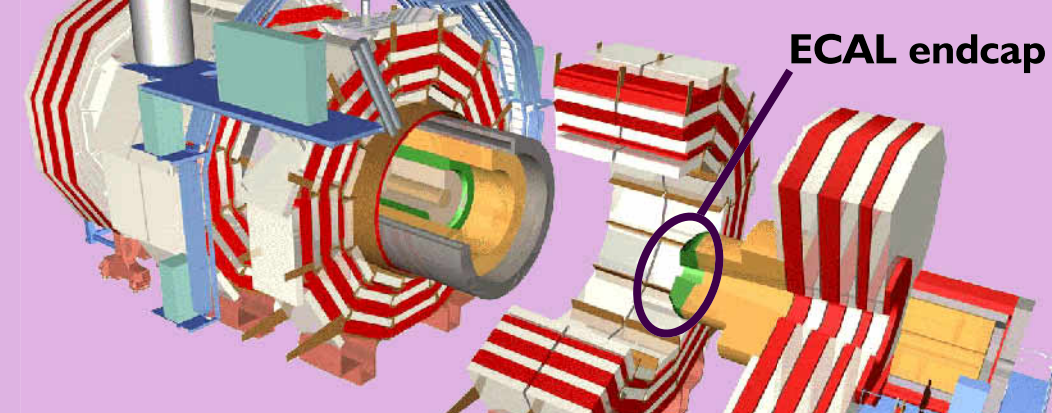
At these points, detectors are built, to identify the fundamental particles thrown out by the collisions.



### Compact?

The Compact Muon Solenoid, or CMS, is one of the detectors. 15m high, 26m long and weighing 12,500 tons, most people would not consider it to be "compact", but its innovative design makes it much smaller than its sister experiment, ATLAS.

### The Compact Muon Solenoid



The Electromagnetic Calorimeter (ECAL) is the layer of CMS designed to measure the energy and direction of photons and electrons. It is comprised of the Barrel and two Endcaps.

### What's it all for?

The main goals of the experiment are:  
 - understand what happened just after "Big Bang"  
 - discover and examine the Higgs boson, the "origin of mass"  
 - to look for evidence of supersymmetry  
 - study aspects of heavy ion collisions

As well as furthering our understanding of the world (and universe) around us, there are many technology spin-offs.

### UK Involvement

Over 36 countries and 160 institutions are involved in LHC. The UK contributes a significant amount, and the UK is involved, partly or wholly, on nearly all the items illustrated.

## Lead Tungstate crystals

Dense material stops photons and electrons, giving off scintillation light.



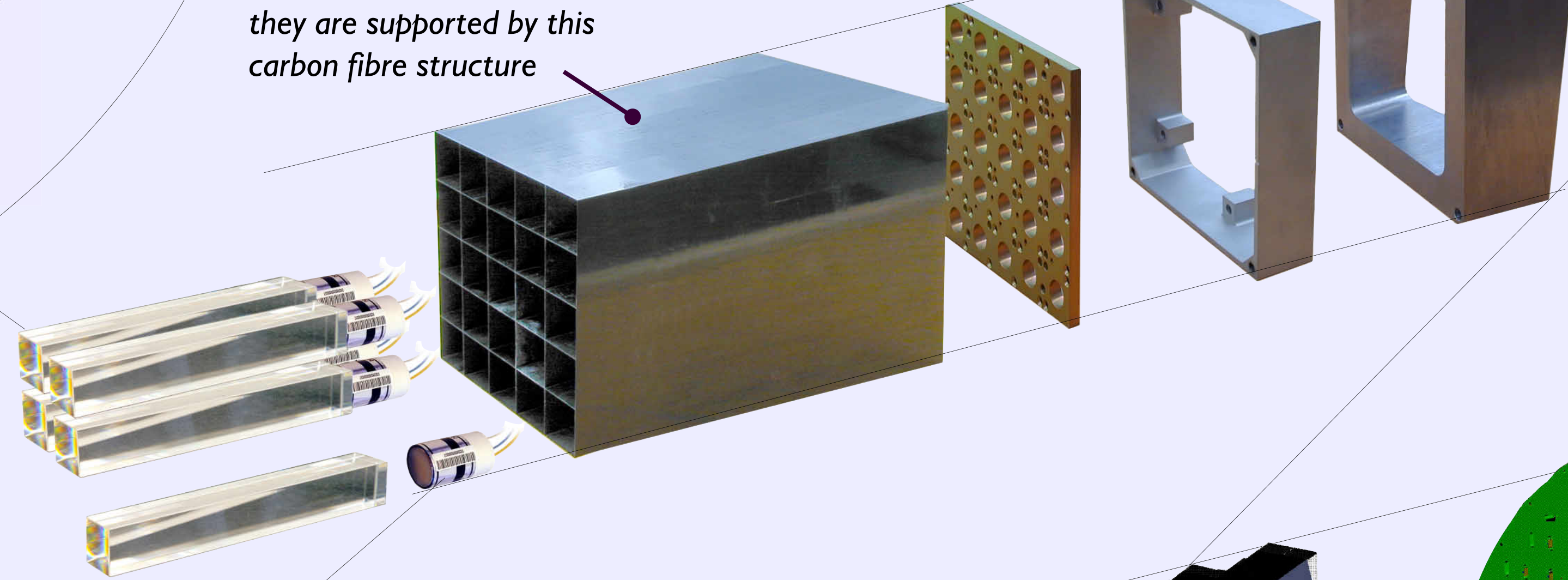
Lead tungstate (PbWO4) is a new type of scintillator  
 - high density  
 - short radiation length  
 - small molière radius

## Supercrystal

25 Crystals and VPTs per supercrystal

### Alveolar

The crystals are fragile so they are supported by this carbon fibre structure



### Positional spacer

Points the supercrystal in the correct direction. Unique to each supercrystal

## Vacuum Phototriodes (VPTs)

Detect scintillation light from the crystals

### Faceplate / Photocathode at 0V

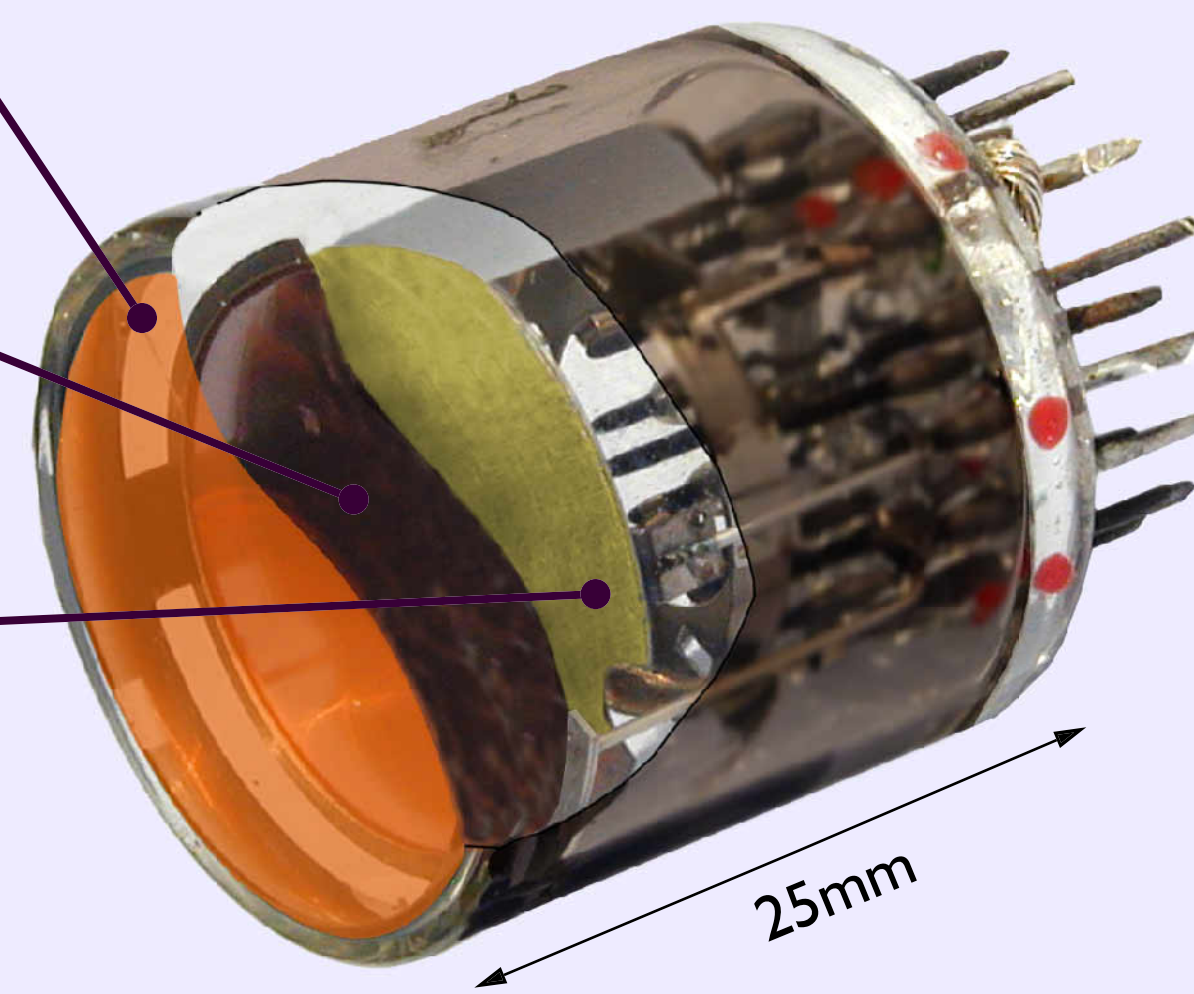
Coating on faceplate converts photons from crystal to electrons

### Grid / Anode at 800V

50% of the electrons pass through the grid and hit the dynode

### Dynode at 600V

Electrons that hit the dynode cause more electrons to be expelled from the dynode



25mm

### Environmental Shield

Provides thermal insulation

### Supercrystals

138 supercrystals per Dee

### Backplate

Machined from single block of aluminium

### Electronics

Radiation-hard VFE & FE cards

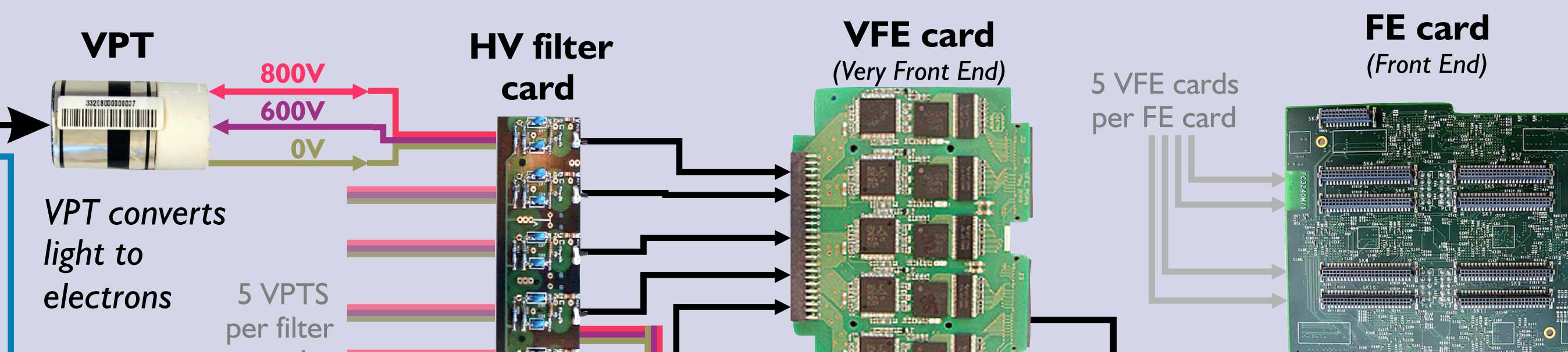
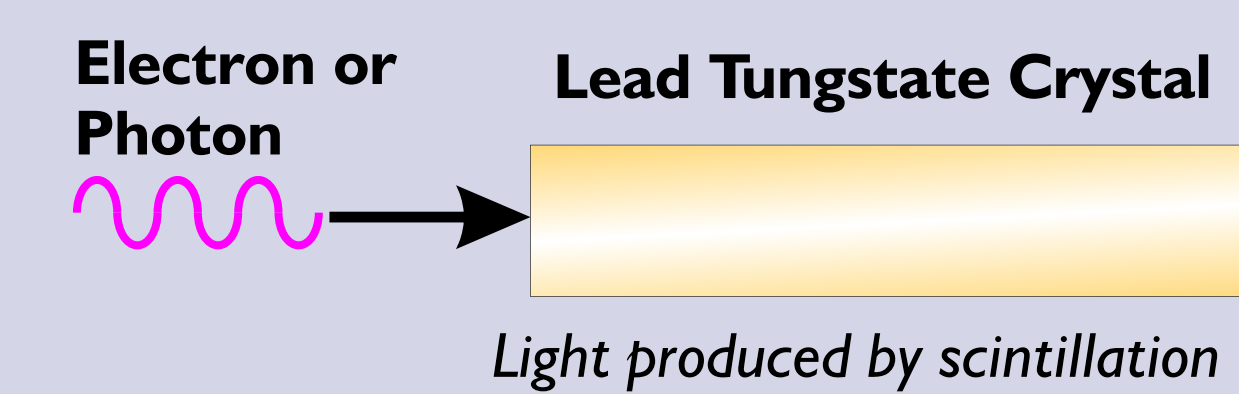
### Assembled Dee

### EE patch panel on Ring Flange

### Service ducts (HCAL endcap behind)

### Magnet yoke and muon chambers

## Readout Chain



- Jargon Buster**
- ADC: Analogue-to-Digital Converter
  - ASIC: Application-Specific Integrated Circuit - a custom-designed microchip
  - CCLRC: Council for the Central Laboratory of the Research Councils - governing body of government funded, non-university physics research organisations, including Rutherford Appleton Laboratory
  - CERN: Centre Européen pour Recherche Nucléaire - European Organization for Nuclear Research, near Geneva
  - CMS: Compact Muon Solenoid - a detector at LHC
  - DAQ: Data Acquisition - the process of getting information from sensors into a PC or chip
  - Dee: One half of an endcap (its shaped like a 'D')
  - ECAL: Electromagnetic CALorimeter - the part of CMS designed to measure the energy of electromagnetic waves and electrons
  - EE: ECAL Endcap
  - FE: Front End (card) - see Readout Chain diagram
  - FENIX: Front End New intermediate data eXtractor - the custom readout ASIC on the FE card
  - GOH: GOL Opto-Hybrid
  - GOL: Gigabit Optical Link
  - Hadron: particle containing quarks or antiquarks, including protons, neutrons and mesons
  - HCAL: Hadronic CALorimeter - the part of CMS designed to measure the energy of hadrons
  - HF: Hadronic Forward calorimeter - a special HCAL very near the beam
  - HV: High Voltage
  - LHC: Large Hadron Collider - CERN's new flagship proton-proton collider
  - LVR: Low-Voltage Regulation
  - MGPA: Multi-Gain Pre-Amplifier - a custom built pre-amplifier for the VPTs
  - PSU: Power Supply Unit
  - Trigger: A "flag" used to indicate to the data capture system that an interesting event has been seen
  - VFE: Very Front End (card) - see Readout Chain diagram
  - VPT: Vacuum PhotoTriode

### Endcap

### EE Patch Panel (Service ducts)

### Counting Room

### Optical links

Trigger info

"Retrieve data" call

Data

### TCC

Trigger Concentrator Card

### RCT

Regional Calorimeter Trigger

### GCT

Global Calorimeter Trigger

### GT

Global Trigger

### TTC

Timing, Trigger & Command system

### DCC

Data Concentrator Card

### Other ECAL DCCs

(Tracker, HF, HCAL,  $\mu$ -chambers)

### Main HV Distrib'n Unit

10 Local dist. units per main unit

### HV Control

8 HV PSUs in total (one per quadrant)

### Optical Fibre Switch

### Calibration Laser

To 200 crystals from each level 1 sphere

### Fanout sphere Level 1

To 9 level 1 spheres per level 2 sphere

### Fanout sphere Level 2

To 80 level 2 spheres in barrel & endcaps

### CERN main site

Tier 0 processing

### Worldwide

Tier 1 centre

Tier 1 centre

Tier 1 centre

Tier 1 centre

Tier 1 centre

Tier 1 centre

Tier 1 centre

Tier 1 centre

Tier 1 centre

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Around Eight Tier 1 centres in UK, Italy, USA, etc.

