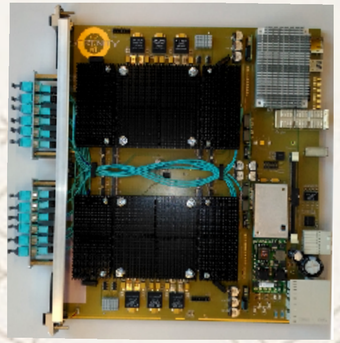
CMS Operations and Upgrades



What we do

Detector operations

Electromagnetic Calorimeter (ECAL) + Silicon Tracker

Upgrades

leading roles in ECAL, Tracker, Trigger Phase-2 upgrades

Trigger operations

key roles and expertise in Level-1 and HLT

Computing

RAL Tier-1 and Tier 2 (LHC data grid)

Physics Analysis

with Theory colleagues (NExT institute)

Design → Construction → Operations → Exploitation → Upgrades

Our team


Manny


Tom


Claire


Ian

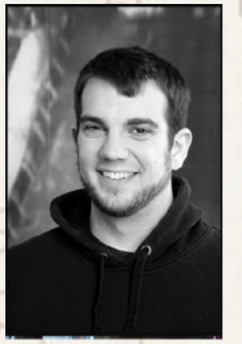

Kostas


Kristian


Chris


David


Sam


Thomas


Thomas

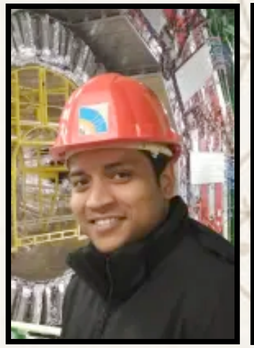

Jacob


Katy


Alison


Kate


Souad


A.R.


Dharmender


Jakub


Mehrnoosh


Stefano


Sasha


Elena


Shankha


Harri


Dave


Dave


Ken

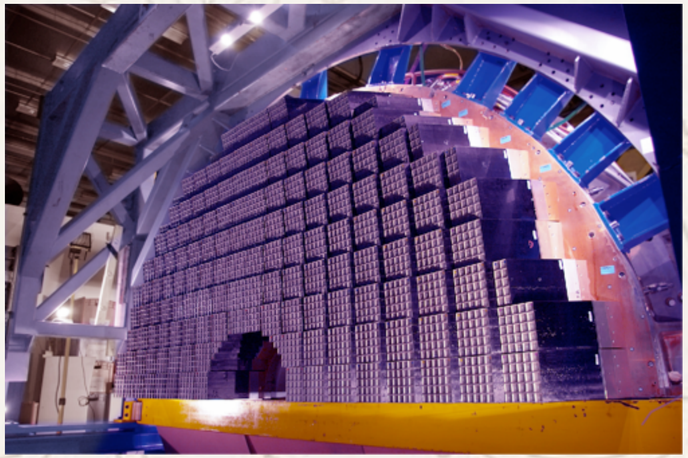

Bob

Our expertise - ECAL

Concept

Design and testing

Construction



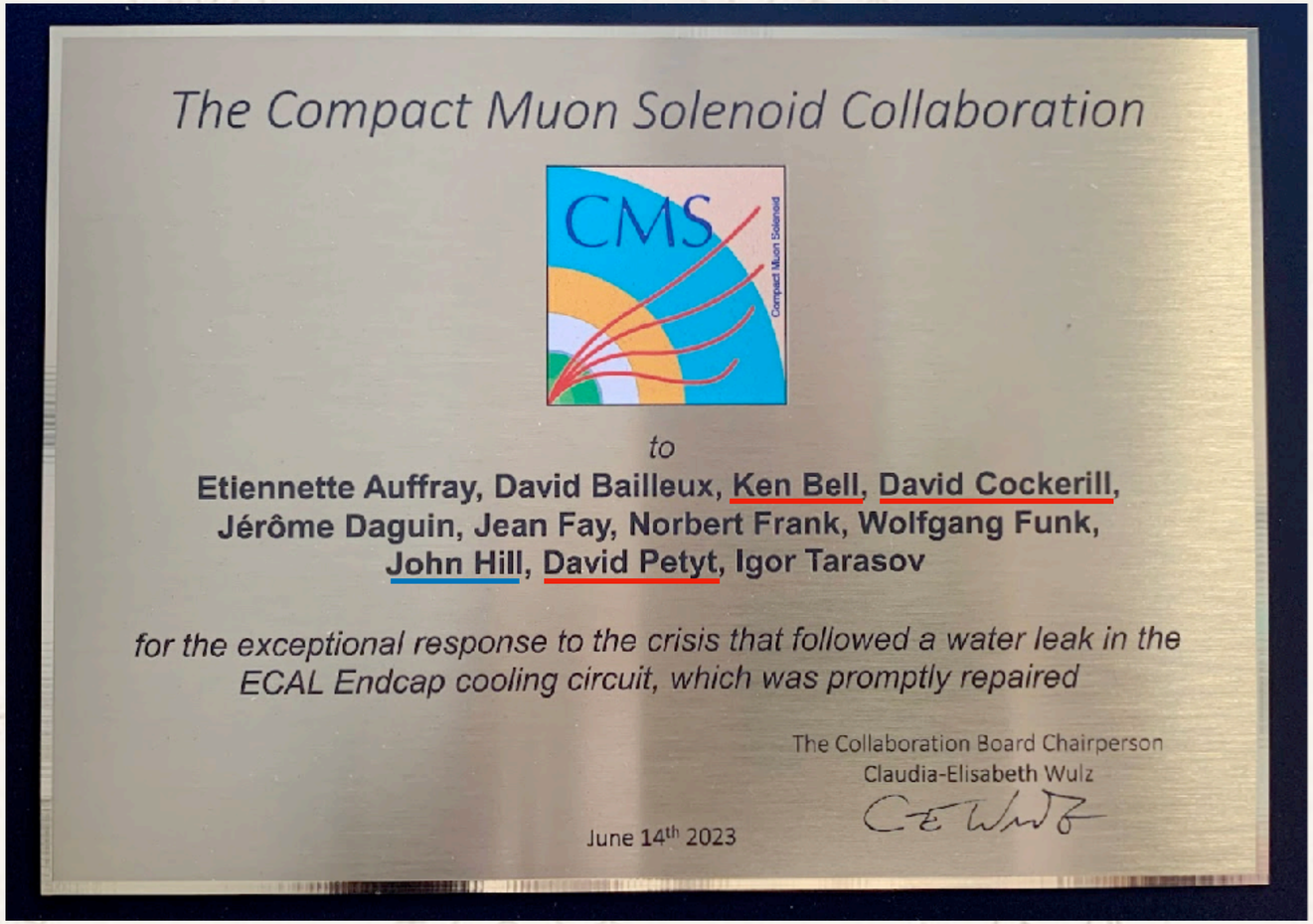
Installation

Operation

Upgrades

Leading experts in CMS for ECAL trigger, detector calibration and performance, offline software including GPU expertise, electron/photon reconstruction. Design/build/operation of ECAL Endcaps. Trigger firmware expertise

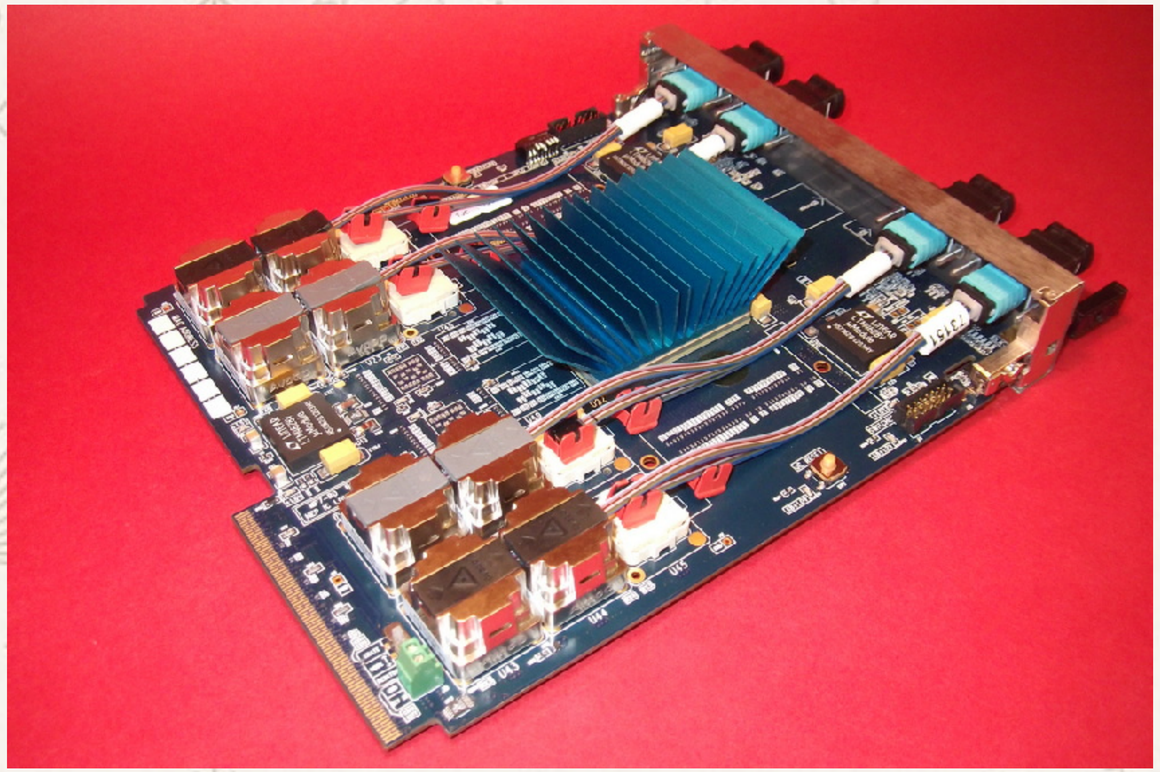
Our expertise - ECAL



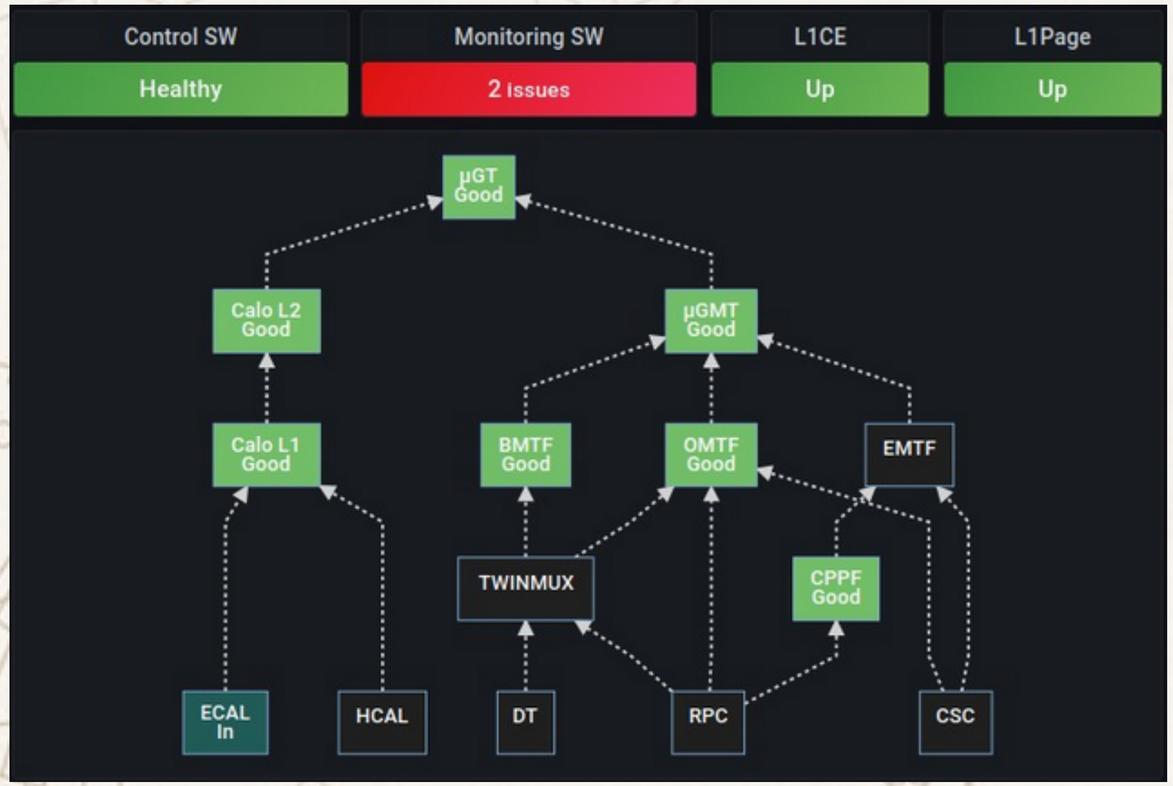
https://cms.cern/news/problems-and-solutions-ecal-leak-story

Solving serious problems - with long-standing and unique expertise from RAL PPD and RAL TD

Our expertise - Trigger operations



CMS Calorimeter Trigger Processor board, with Virtex®-7 FPGA

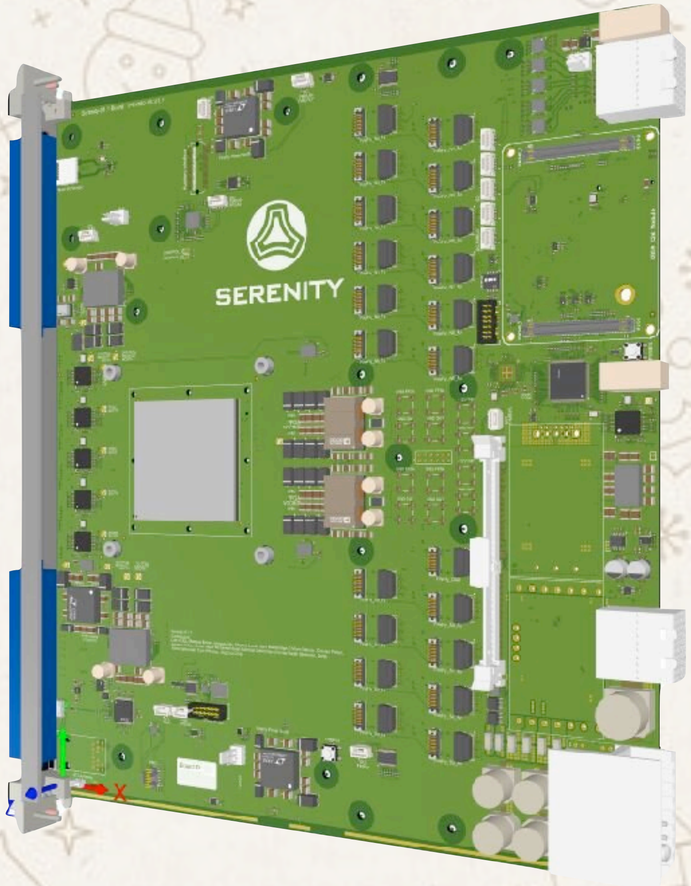


CMS Trigger Monitoring Software

Extensive hardware, firmware and software expertise. Developed and support CMS Level-1 hardware-based Calorimeter trigger and the online software that controls and monitors the status of the trigger boards

Leading CMS expertise in CMS software-based High-Level Trigger, particularly in electron/photon reconstruction. Pioneering efforts in the use of GPUs. Expertise in web-based monitoring tools and anomaly detection

Our expertise - Trigger upgrade



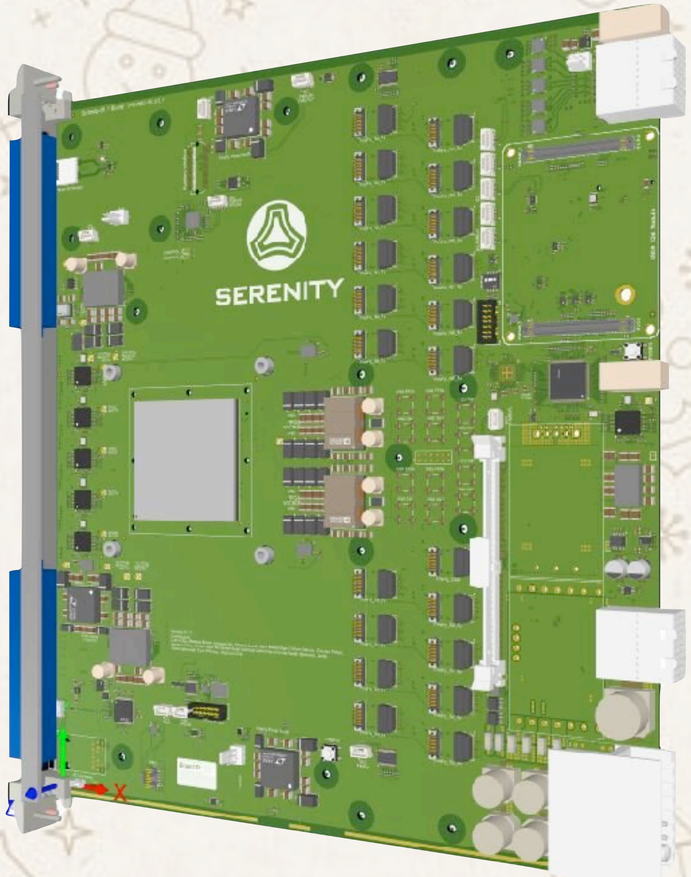
Trigger upgrade built around a common hardware platform - Serenity

Forms the backbone of the Tracker upgrade, and the High Granularity Calorimeter (replacing ECAL endcaps)

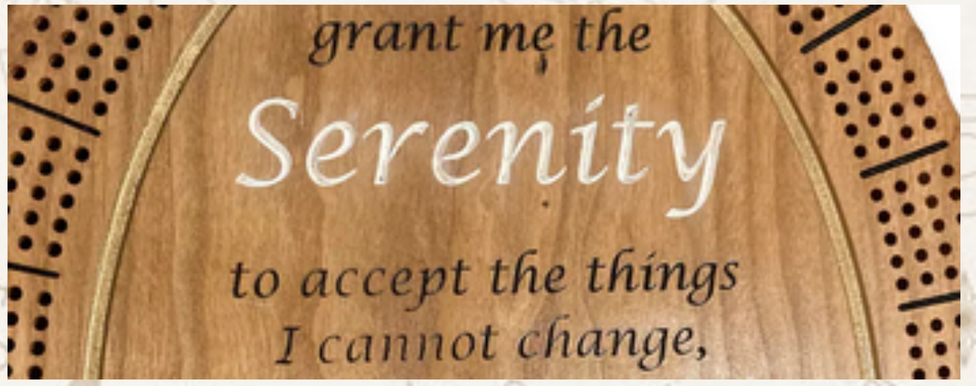
Leveraging our extensive expertise in hardware and software, algorithm development and FPGA programming

Cross-experiment initiatives (IPBus, collaboration with ATLAS/TD). Expertise helped to develop DAQ for DUNE

Our expertise - Trigger upgrade



Serenity board



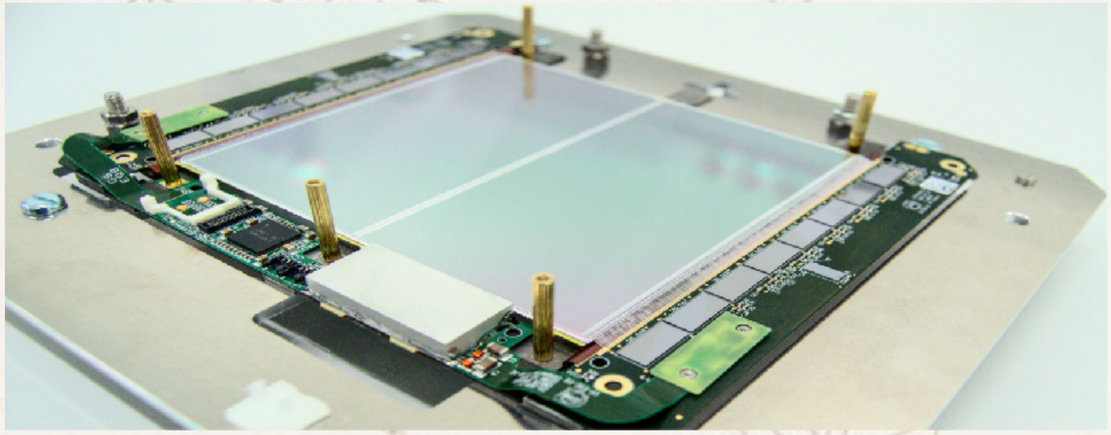
dealing with difficult collaborators?

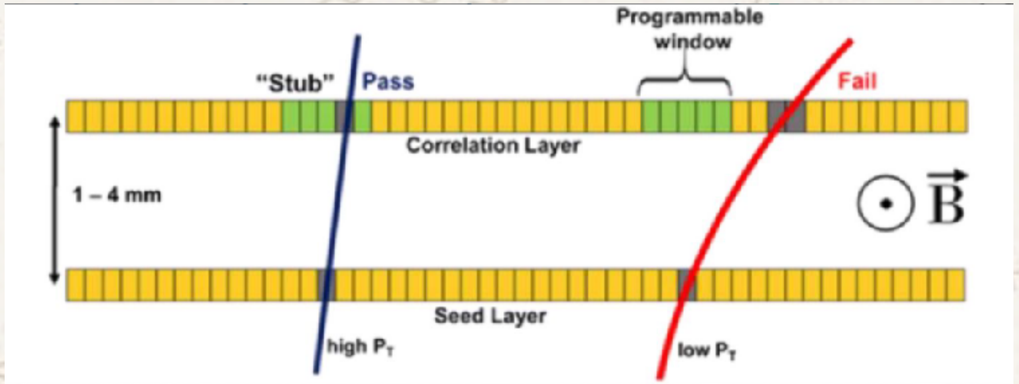
Significant RAL-led effort to develop test systems and software to control and monitor board functions and test board-to board communications

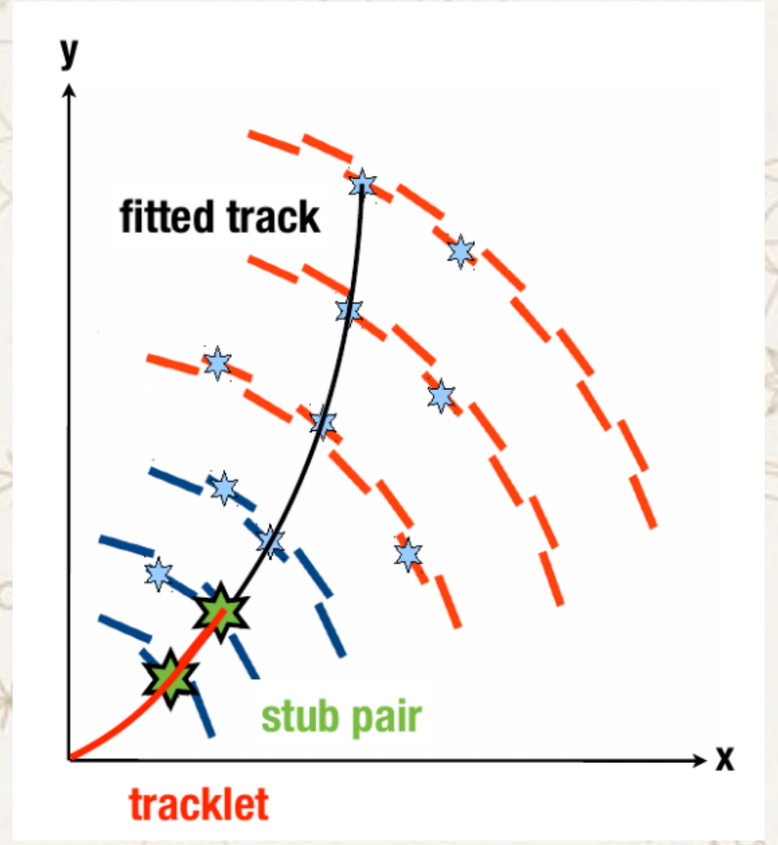
Developing firmware algorithms (e.g. vertexing) to be deployed on Level-1 trigger processor boards

Serenity board

Our expertise - Tracker Upgrade



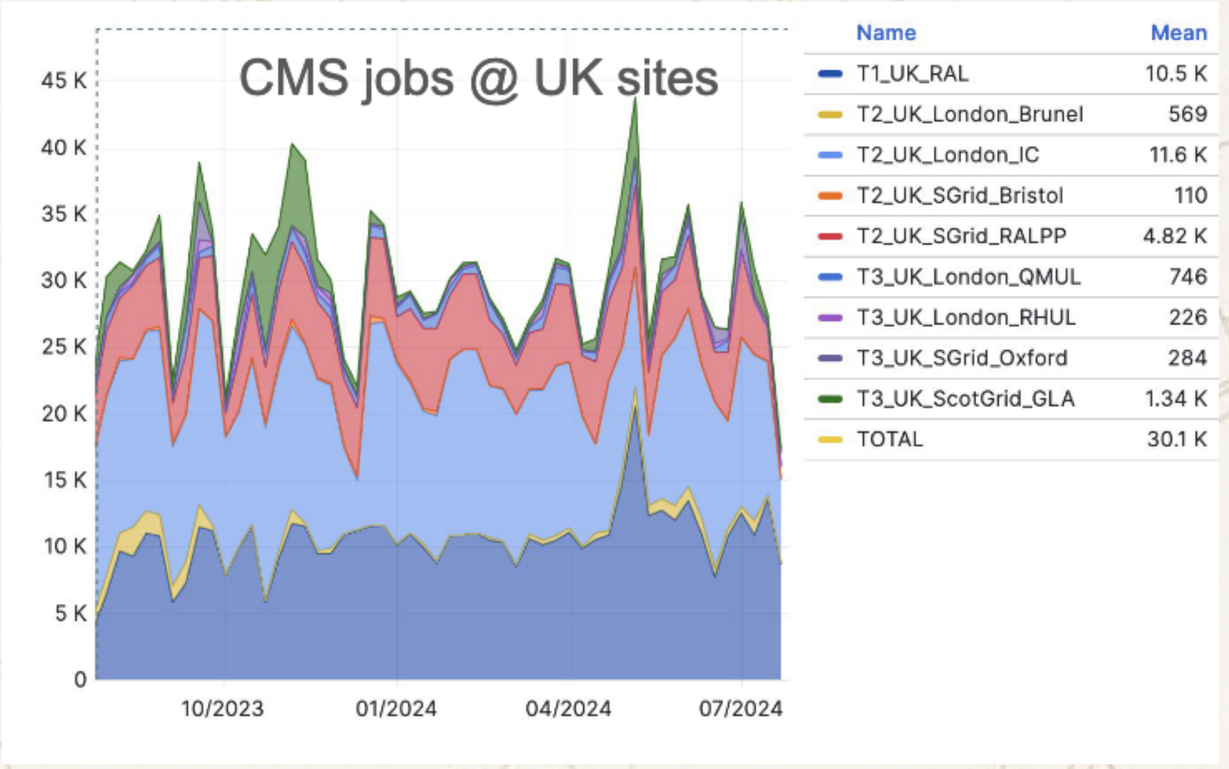




Hardware track trigger - a substantial upgrade to CMS triggering capability for the Phase-2 upgrade

Leveraging our tracker and particularly our firmware expertise to develop algorithms and associated software to perform track-finding and track fitting functions in FPGA boards. About to publish a paper on a full implementation in firmware of a track reconstruction algorithm.

Our expertise - Computing



Manage RAL Tier-1 and Tier 2 data grid sites, maintaining key collaboration computing resource, and deploying improvements to improve efficiency of the service.

Leading “data challenges” to simulate the huge increases in data volumes for the Phase-2 upgrade of CMS

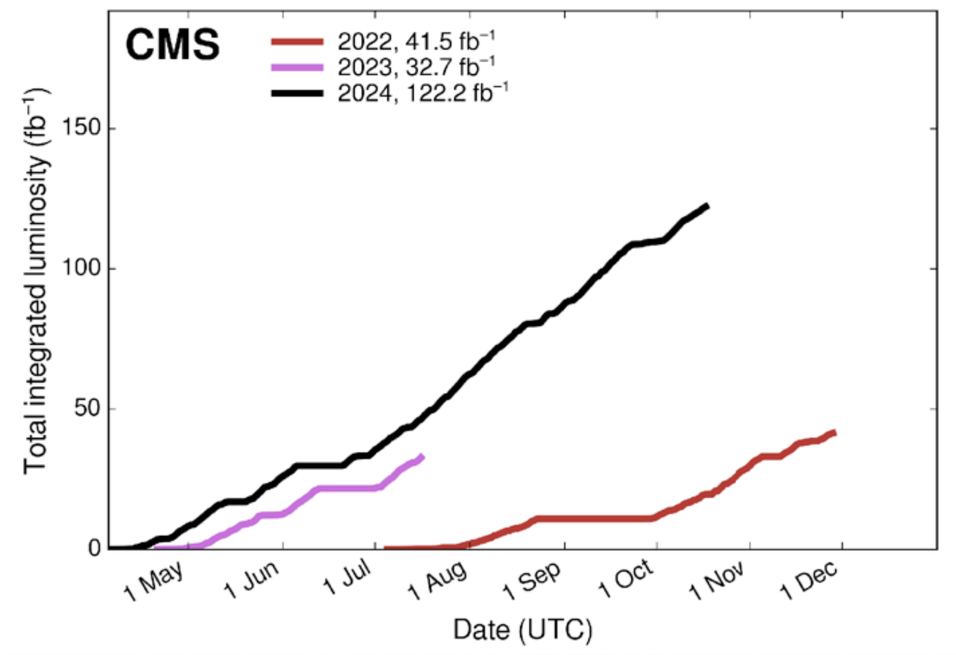
Strong participation in SWIFT-HEP initiative - exploring use of accelerators (FPGAs/GPUs) and ML/AI on FPGAs

Our expertise - Physics

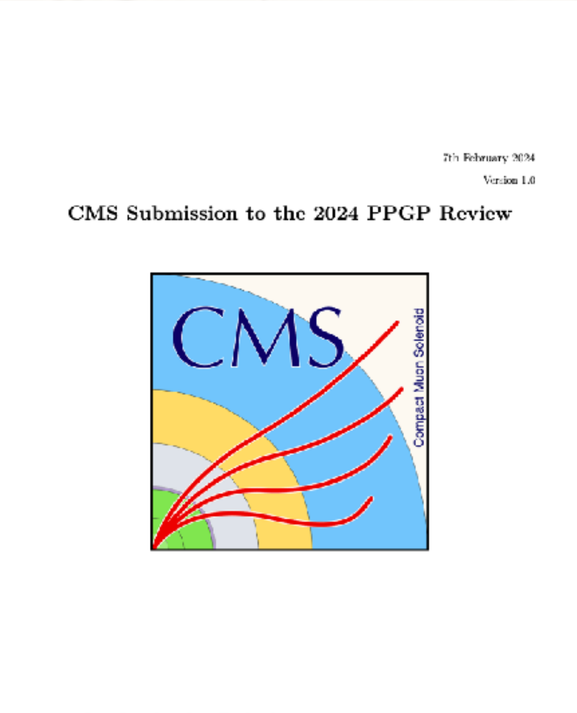
Led physics analysis in CMS since the start of data taking - focused on beyond the standard model signatures (leveraging expertise in electron/photon and jet reconstruction)

Strong links with particle theorists and phenomenologists, guiding our physics analysis activities - founding and leading member of NeXT institute (bringing together experimentalists and theorists)

Our successes



CMS integrated luminosity (2022-24)



7th February 2024

Version 1.0

CMS Submission to the 2024 PPGP Review

CMS

Compact Muon Solenoid

CMS Phase 2 Upgrade Project

Case for Support

University of Bristol: E. Clement, J. Goldstein, S. Paramesvaran
Brunel University London: A. Khan
Imperial College: C. Bowes, P. Dauncey, C. Ilie, M. Pesaresi, A. Tapper*
STFC-PPD: K. Harder, D. Petyt, K. Richards , I. Tomalin, C.H. Shepherd-Themistocleous, T. Williams
*Principal Investigator, †Project Manager

Submitted on behalf of the UK CMS Collaboration

January 19, 2024

University of BRISTOL

Brunel University London

Imperial College London

Science and Technology Facilities Council

Huge data volumes in 2024

Physics analyses: working to exploit Run 3 data

Efficient detector operations (ECAL, tracker, trigger)

improved calibration procedures and monitoring tools (increased automation, multi-run harvesting, anomaly detection)

Submitted two important project reviews in 2024:

Operations grant request will allow us to maintain our leading contributions to detector operations and physics analysis

Upgrade grant request - builds on our excellent progress to date and covers the period of installation and commissioning of the new detectors

Resolutions for the New Year

new years resolution:

RAL CMS

Support detector operations - maximise performance of ageing detector

Fully exploit the rich stream of Run 3 CMS data for Physics - with strong theory involvement

Progress with the Phase-2 upgrades - important year with many key items entering full production

Develop new ideas - both for future physics analyses and new detector capabilities

Dear Santa…

1. **Encourage Physics analyses within PPD**
   (maintain and strengthen existing activities)

2. **Better capitalise on our newly developed technologies/expertise**
   (find ways to ensure our expertise in high-speed f/w and electronics can be used in other research contexts - needs funding/personpower beyond project-allocated effort)

3. **More informative webpages across STFC**
   (make it easier to find out what other departments are doing, and the relevant contacts)

4. **Streamline methods to access TD time to explore new ideas**
   (recent LiquidO example shows what can be achieved if sufficient resources are available)

5. **Create RAL Lab Fellowships**
   (other labs have these - why not us? Explore new ideas/improve collaboration within the dept)

6. **Strengthen Research office**
   (office is a good initiative, but need to ensure it has enough resources to be maximally effective)

7. **Strengthen lab facilities**
   (not necessarily for CMS, new initiatives like LiquidO will need lab space/resources/equipment)

p.s. Mince pie and sherry are under the tree…

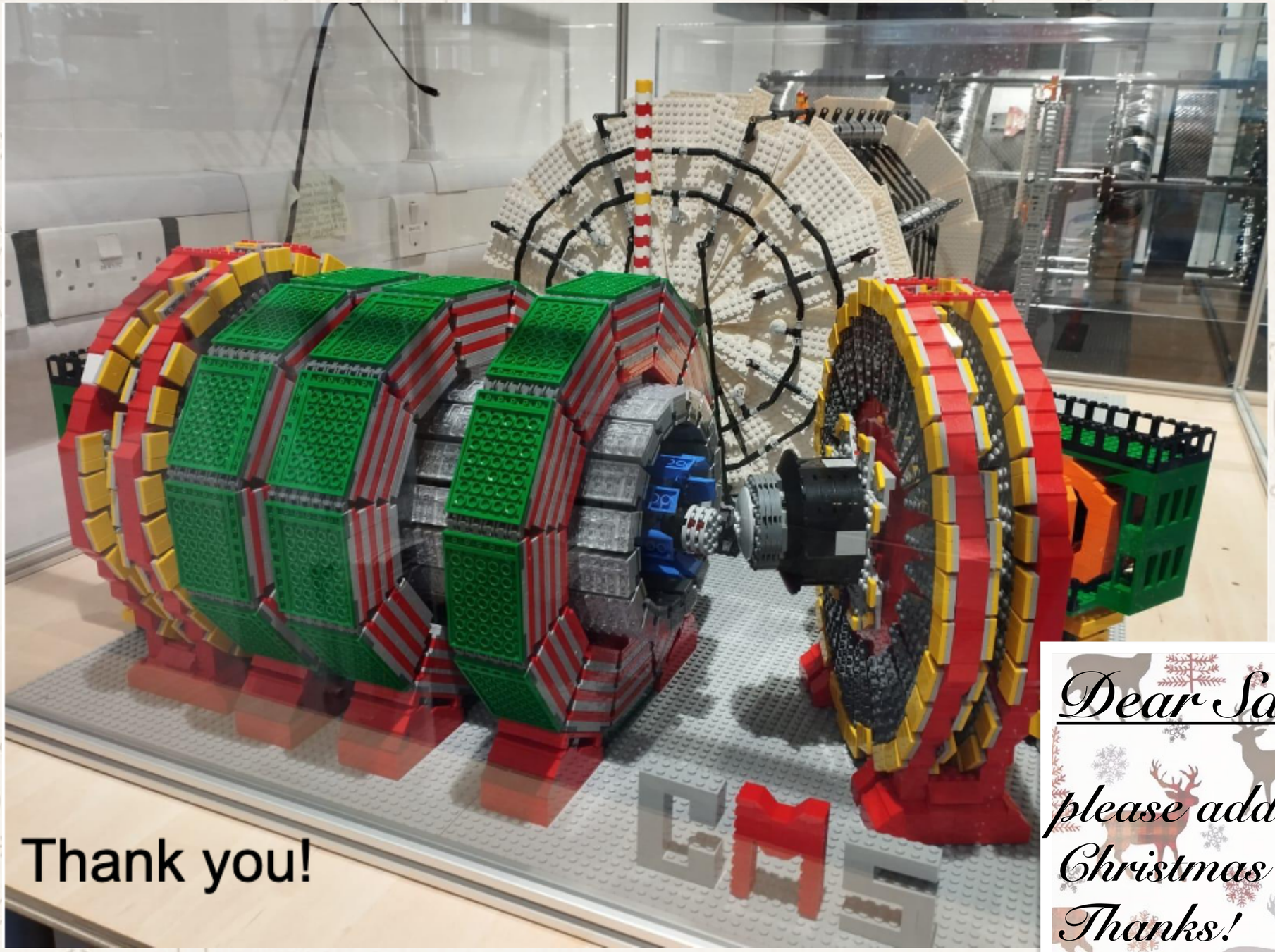


photo from Katy Ellis CMS UK talk

Dear Santa

please add this to my Christmas stocking.

Thanks!