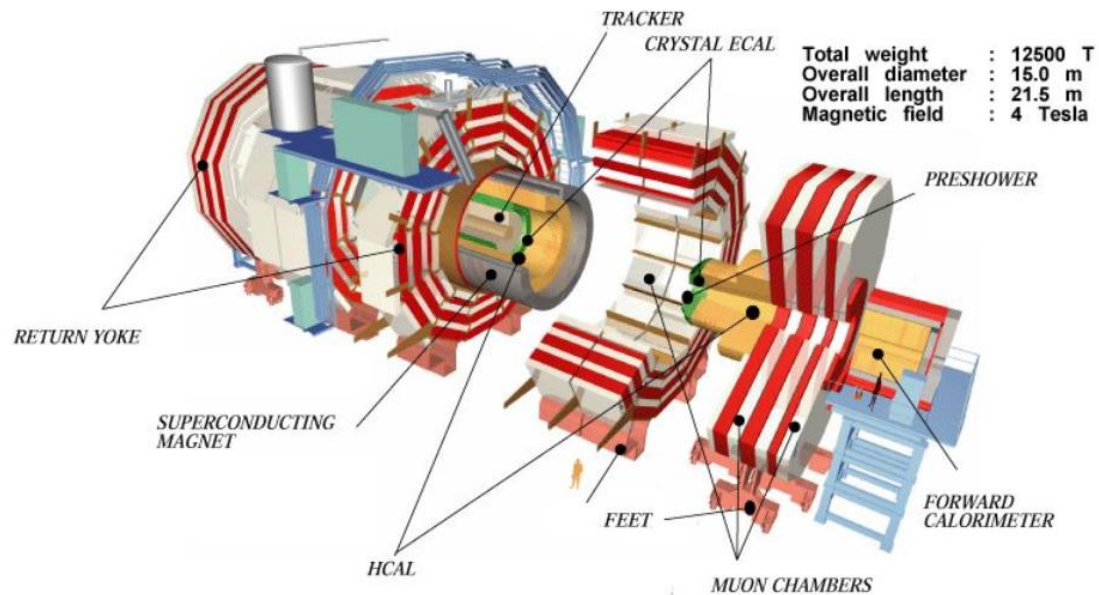



DT Group Meeting, 22 June 2017

DT contributions to CMS



Contributions summarized in a CMS & DT workpackage



EP-DT
Detector Technologies

EDMS Nb. 1735465
Created: 7 Nov 2016
Modified: 19 June 2017

WORKPACKAGE

Collaboration Agreement between the CMS Experiment & EP-DT group for the period 2017-2021

This workpackage agreement describes the support by the EP-DT group to the CMS experiment, including TOTEM and CTPPS, from 2017 to 2021 (end of LS2). It describes the DT involvement (deliverables and allocated DT resources) in projects related to the development and construction of new detectors, maintenance and operation responsibilities, and availability of DT services for the experiments. Where possible, plans to contribute to LS3 detector upgrades are also included.

<https://edms.cern.ch/document/1735465/1>

| Prepared by: | Checked by: | Approval list: |
|------------------------|--|---|
| P. Tropea A. Onnela | P. Petagna D. Abbaneo [CMS Tracker Upgrade Project Leader] J. Varela [CTPPS Project Manager] | M. Krammer [EP Department Head] F. Hahn [EP DDH] C. Decosse [EP DPO] B. Schmidt [EP-DT Group Leader] A. Catinaccio [EP-DT DGL] M. Moll [EP-DT DGL] T. Camporesi [CMS Team Leader] A. Ball [CMS Technical Coordinator] J. Baecheler [TOTEM Technical Coord] A. Charkiewicz [CMS Resource Coord] |

Distribution List:

EP-DT group

Workpackage for years 2017-2021 currently under approval (EDMS 1735465)

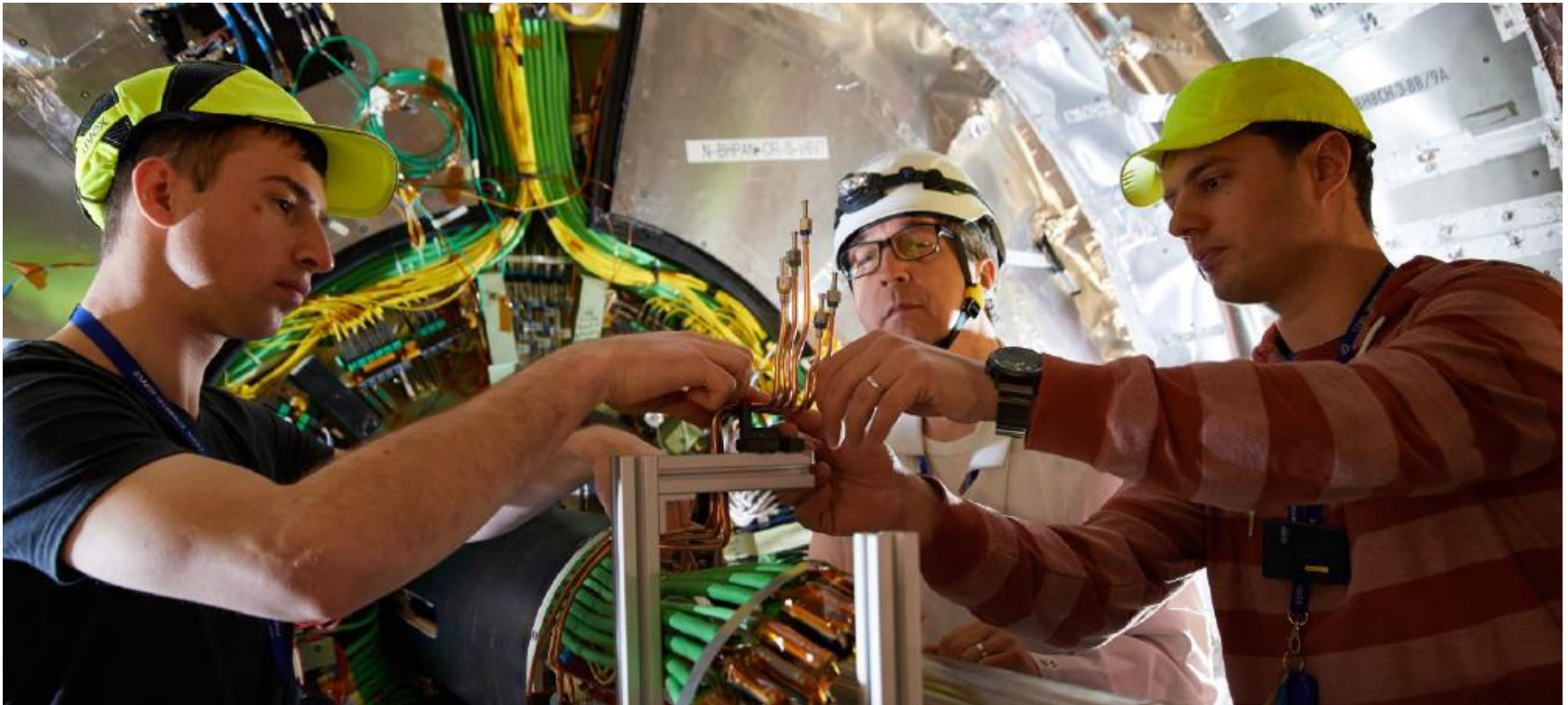
Includes:

- Maintenance & operation support
 - Gas systems
 - Detector cooling
 - Magnet controls
 - Sub-detectors (Tracker, ECAL, BRIL) *
 - Totem *
- Detector projects
 - Phase-2 upgrade of the Tracker *
 - Upgrade of the Endcap Calorimeter *
- DT services and infrastructure

* Covered in this presentation.
Others in corresponding 'service' talks.

Tracker Phase 1 upgrade: New Pixel detector

- Installed in Year-End Technical Stop 2016-2017
- DT contributions in: CO₂ cooling plants and pipework, integration design, removal of the old pixel detector & installation of the new one.
 - Jérôme Daguin, Paola Tropea, Paolo Petagna & DT cooling team, Antti Onnela, Rob Loos

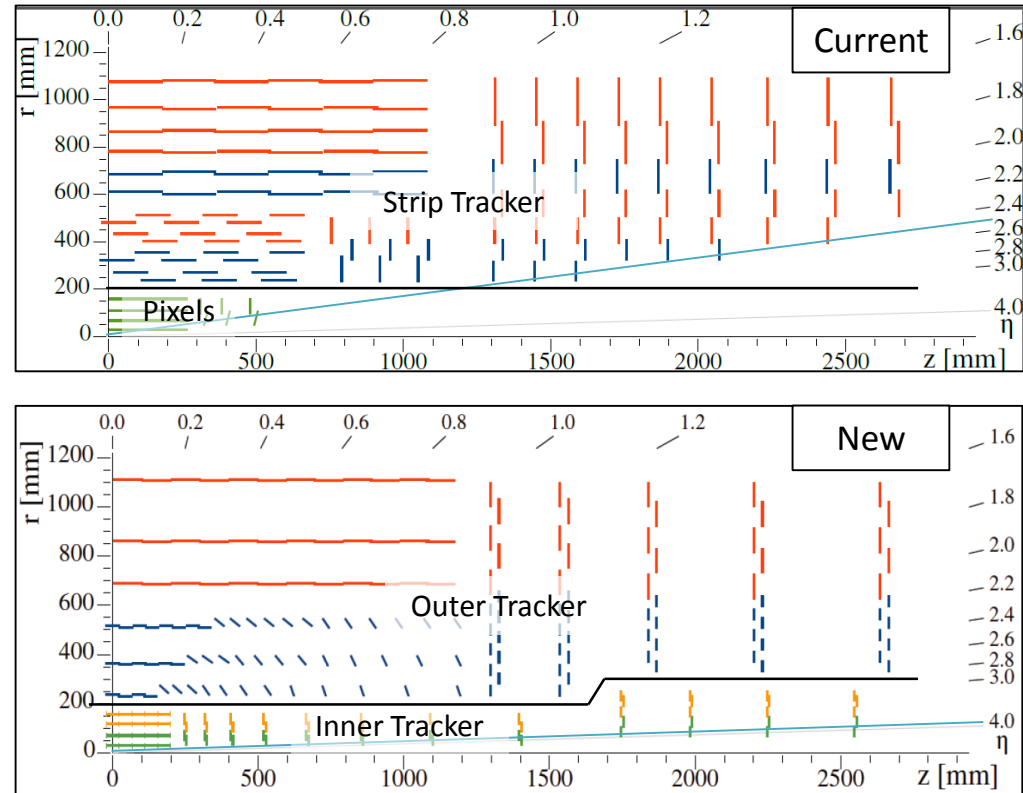
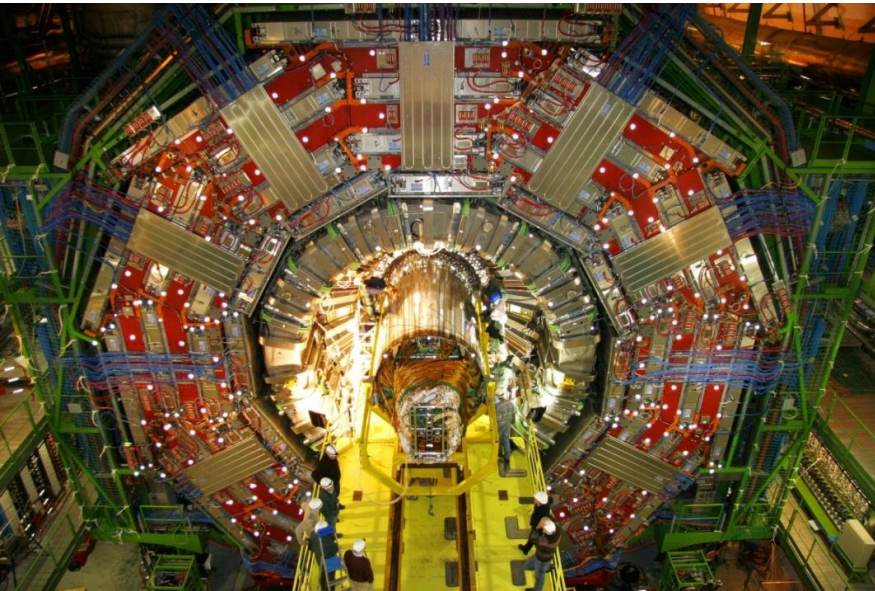


Tracker Phase 1 upgrade: New Pixel detector

Complex intervention in a short time-window (year-end stop)
Successful thanks to a lot of preparation work since several years.
Example here from Karol Rapacz, one of the main contributors.



Phase 2 Upgrade: New Tracker



Installation in LS3, 2025-2026

Acceptance up to $|\eta| \sim 4$ (currently 2.5)

Inner Tracker

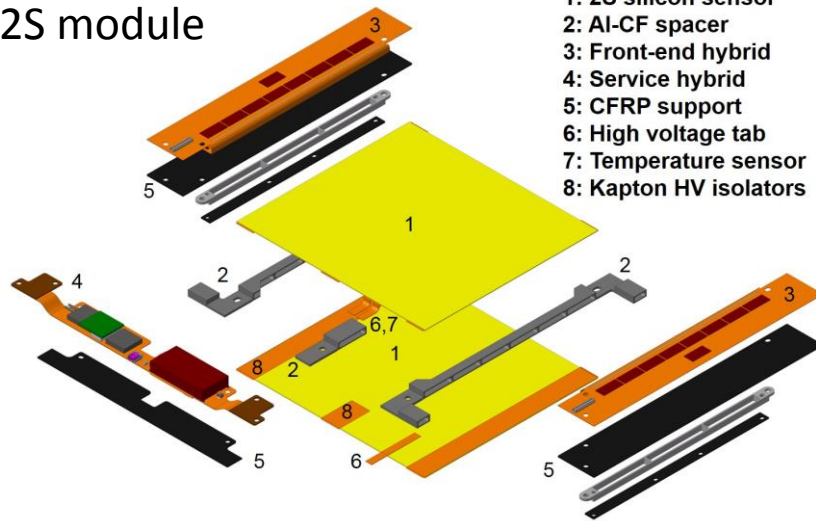
- Sensor area 4.9 m^2 , 2×10^9 pixels

Outer Tracker

- Sensor area 192 m^2 , 42×10^6 strips + 170×10^6 macro-pixels
- Innovative solutions with central contributions by DT:
Double-sensor modules: **strip + strip (2S)** and macro-**pixel + strip (PS)**
Tilted geometry in inner barrel

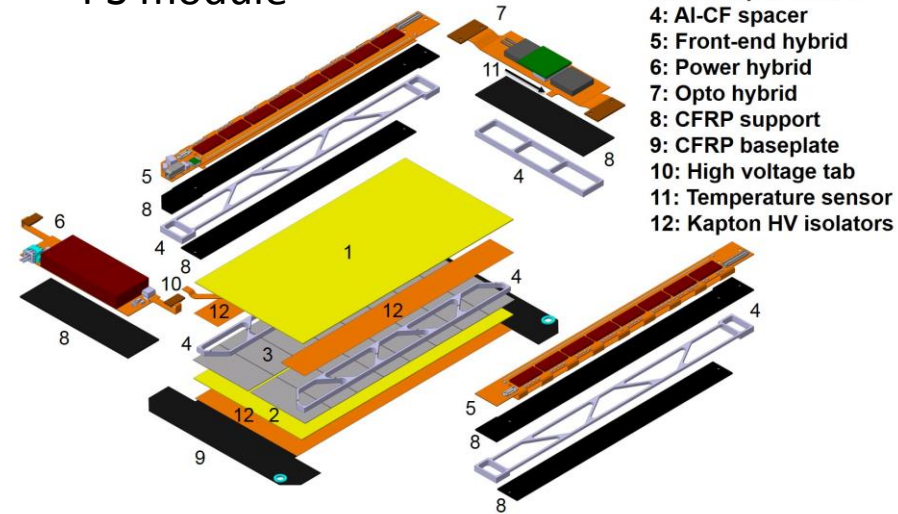
Tracker upgrade: Module development

2S module

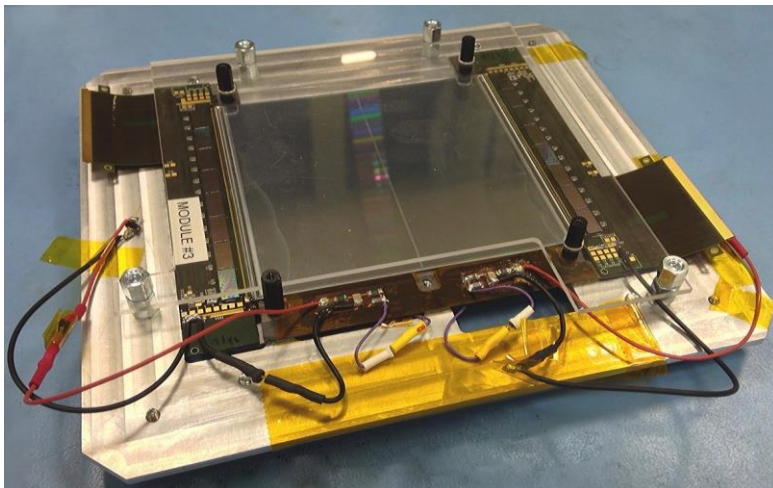


- 1: 2S silicon sensor
- 2: Al-CF spacer
- 3: Front-end hybrid
- 4: Service hybrid
- 5: CFRP support
- 6: High voltage tab
- 7: Temperature sensor
- 8: Kapton HV isolators

PS module



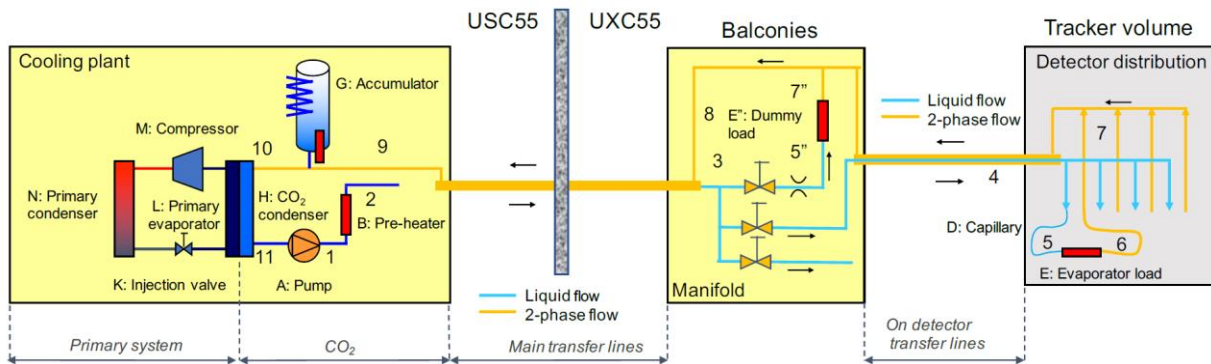
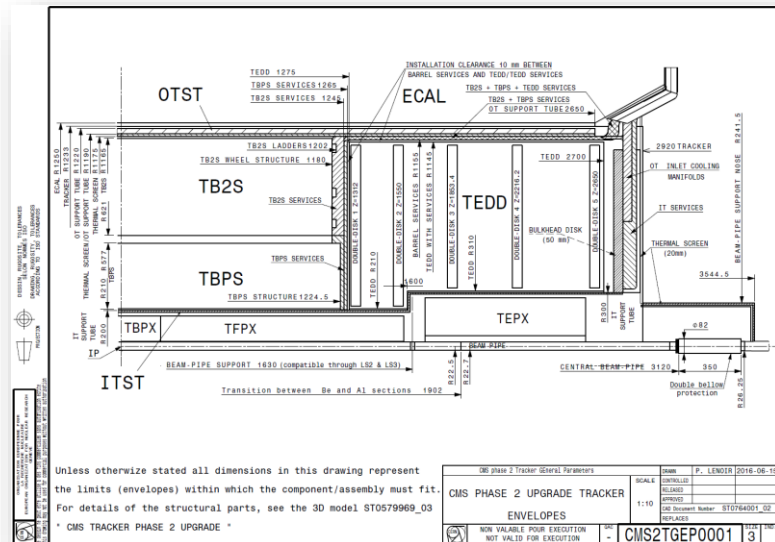
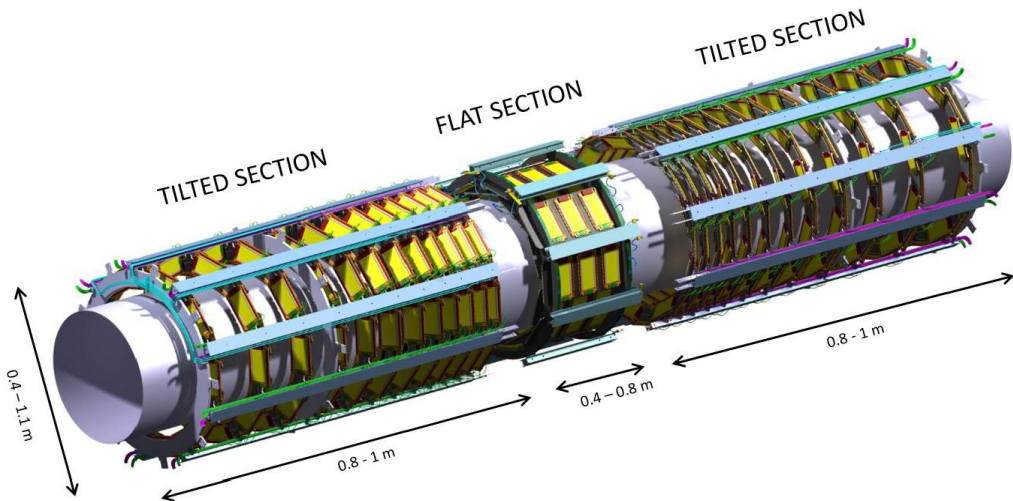
- 1: PS-s sensor
- 2: PS-p sensor
- 3: Macro-pixel ASICs
- 4: Al-CF spacer
- 5: Front-end hybrid
- 6: Power hybrid
- 7: Opto hybrid
- 8: CFRP support
- 9: CFRP baseplate
- 10: High voltage tab
- 11: Temperature sensor
- 12: Kapton HV isolators



DT contributions:

Alan Honma (module working group coordinator),
 Julien Bonnaud, Ian McGill, Florentina Manolescu,
 Vassilis Samothrakis (CMS-paid tech. student).
All part-time (10% - 60%) except V. Samothrakis.

Tracker upgrade: Mechanics, cooling, integration

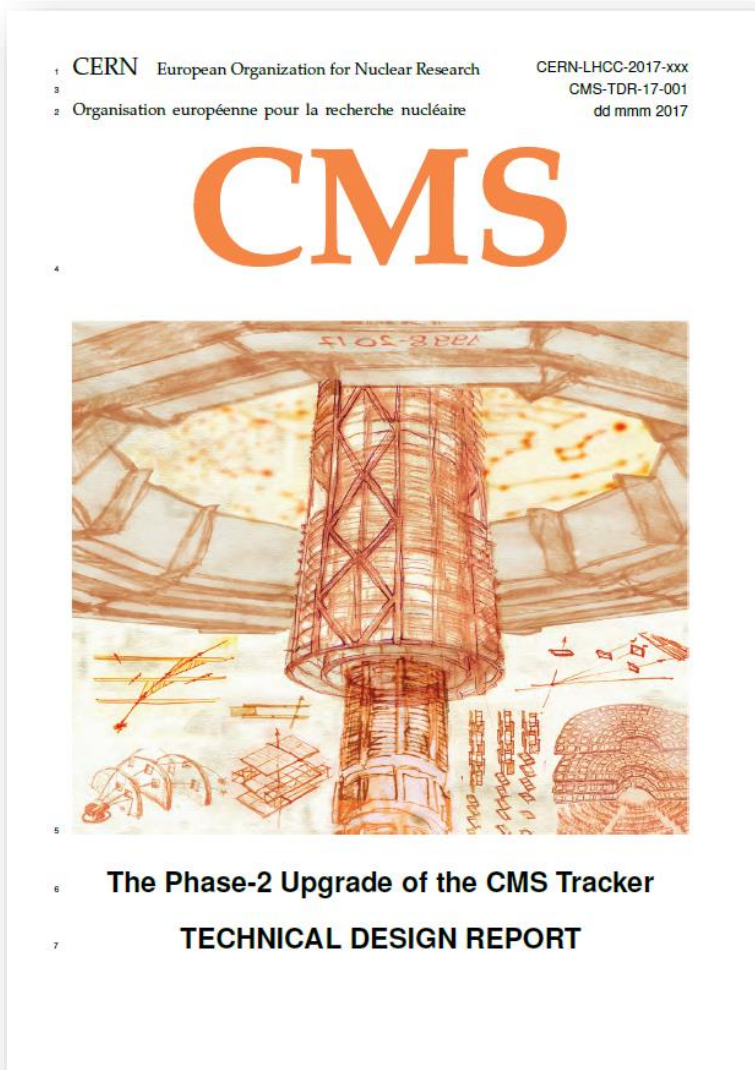


DT contributions:

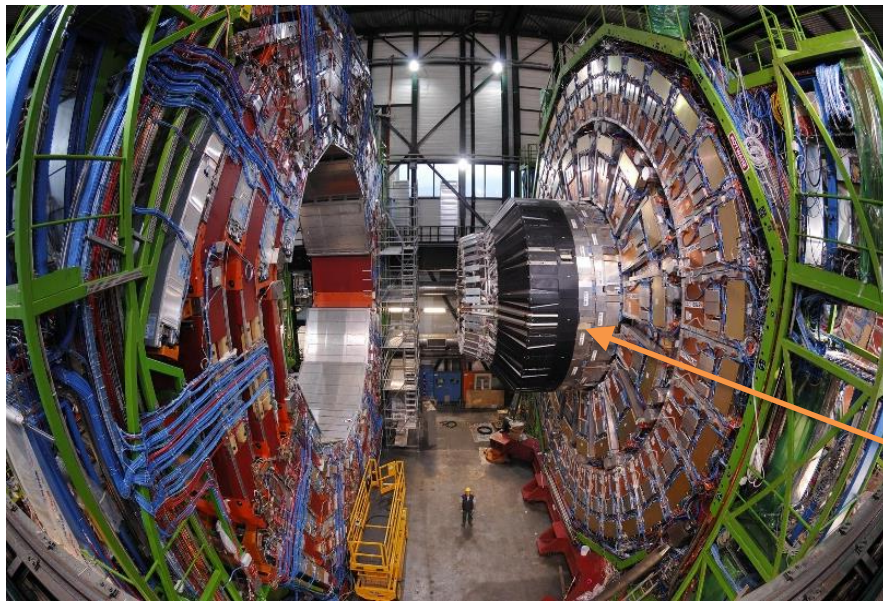
Antti Onnela (mechanics working group coordinator), Kamil Cichy (fellow in CMS quota), Philippe Lenoir, Luc Kottelat, Francisco Perez, Jerome Bendotti, Maurice Vergain, Rob Loos, Paola Tropea, Paolo Petagna & DT Cooling Team.

All part-time (10-50%) except K. Cichy.

Year 2017: Tracker TDR & Towards future



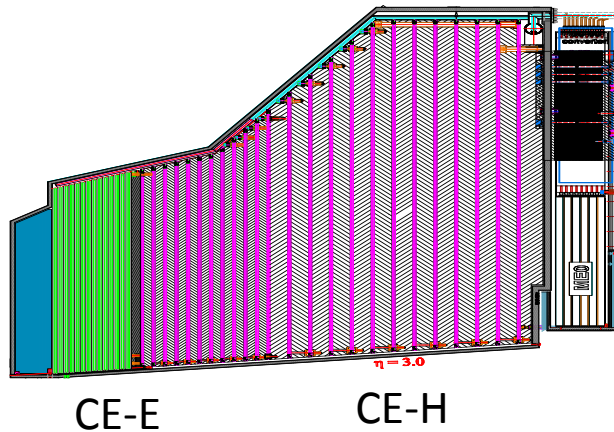
- Tracker TDR published very soon.
 - Description of the detector
 - Resources and planning
- Within 2017 need to define DT role for 2018 onwards.
- Many work opportunities for DT, the exact roles and responsibilities to be taken will depend on:
 - Available resources.
 - Task sharing within CMS collaboration.



Endcap calorimeter upgrade: High-Granularity Calorimeter “HGCal”

Replaces current End-cap Preshower, ECAL and HCAL.

TDR in the end of 2017.



Electromagnetic calorimeter (CE-E):

Si, Cu & CuW & Pb abs., 28 layers, $25 X_0$, $\sim 1.3\lambda$

Hadronic calorimeter (CE-H):

Si & scintillator, steel abs., 24 layers, $\sim 8.5\lambda$

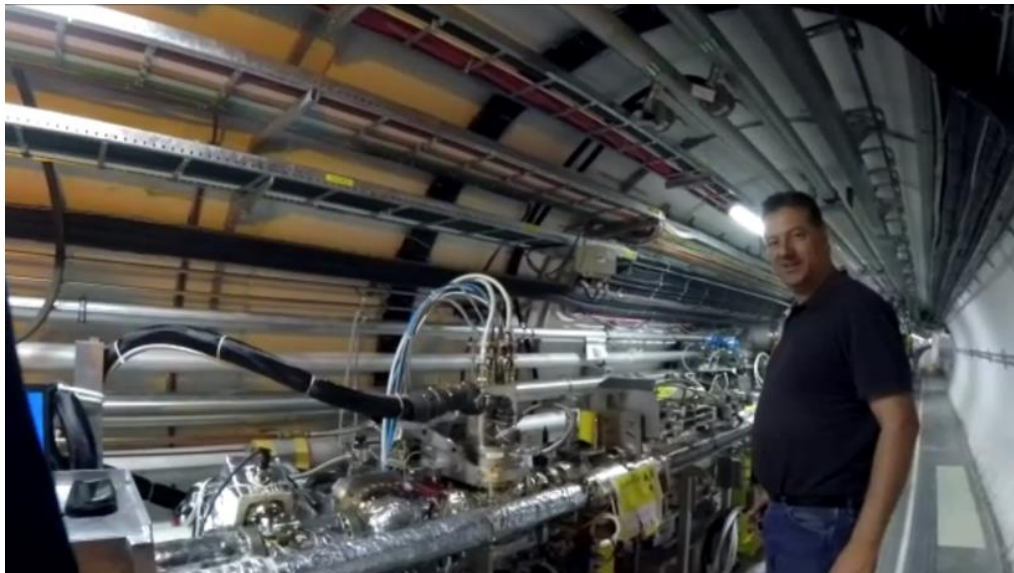
HGCal's active Elements:

- Hexagonal modules based on Silicon sensors in CE-E and high-radiation regions of CE-H
- Scintillating tiles with SiPM readout in low-radiation regions of CE-H

Key Parameters:

- Full system maintained at -30°C
- $\sim 600\text{m}^2$ of silicon sensors
- $\sim 500\text{m}^2$ of scintillators
- 6M Si channels, 0.5 or 1 cm^2 cell size

TOTEM



DT contributions:
Control engineering and maintenance support for sensor exchange and detector movements by [Xavier Pons](#), [Sylvain Ravat](#), [Luc Kottelat](#), [Jérôme Noël](#)



Summary and outlook

- DT contributes to CMS in several key areas.
 - Summarised in a Workpackage currently under approval.
- CMS requests DT for significant contributions in the upgrade projects (in particular Tracker and HGCal) from now until completion in ~2026.
 - Available tasks are in good match with DT competencies.
 - Current DT manpower allocation for these projects is fairly limited: 3.6 FTE + work by the DT cooling team.
- Detailed Workpackages to be made for the DT role in the CMS upgrades. For the Tracker such Workpackage is to be made in 2017.
 - The key questions to be answered:
 - What are the DT resources needed / made available during that period?
 - What long-term engagements can and should the DT group take?