

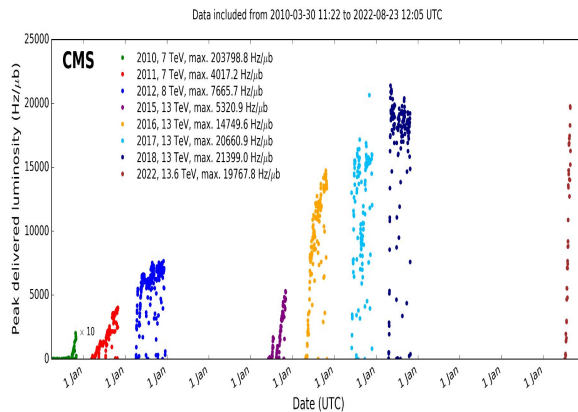
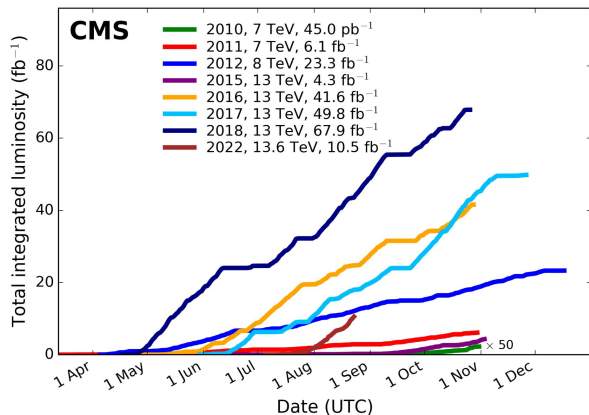
CMS

C. F. Bedoya

on behalf of CIEMAT's CMS group

Madrid, September 19th, 2022

After 3 years of Long Shutdown 2, LHC Run 3 has restarted in 2022



- Achieving peak luminosities (~40 pile-up)
- RF problem in September (~1 month stop)
- CMS behaviour is excellent: Data taking efficiency very high

Important responsibilities (Level 1s) along the years:

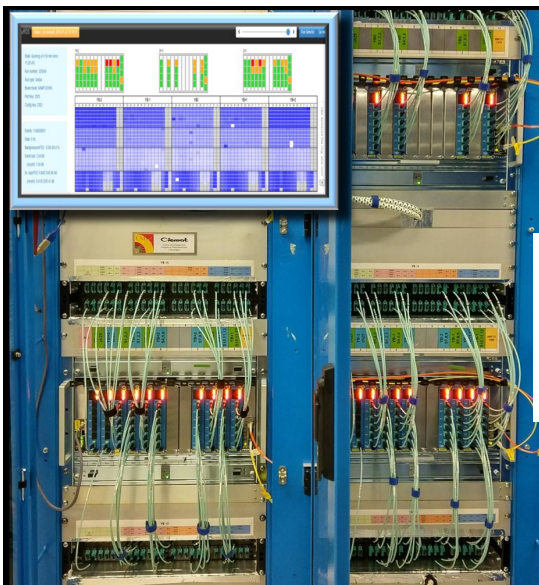
- CMS PHYSICS COORDINATOR
- CMS RUN COORDINATOR (twice)
- MUON SYSTEM MANAGER
- TRIGGER COORDINATOR
- DT PROJECT MANAGER (twice)

and many Level 2s

DT detector and L1 trigger providing excellent performance:

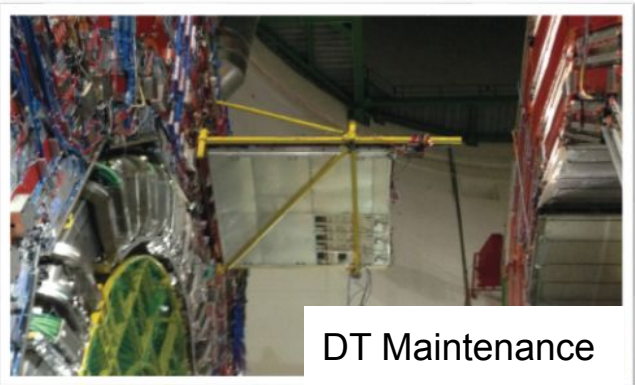
- synchronization is good
- backgrounds have been reduced more than a factor 2 in the outer chambers (no longer the hottest region)

CIEMAT in Run 2 and LS2



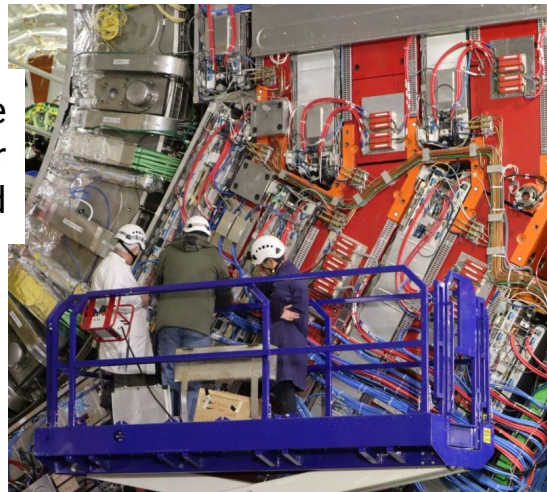
DTs READOUT
upgrade to
 μ TCA

Muon Barrel radiation
shielding against
neutron background



DT Maintenance

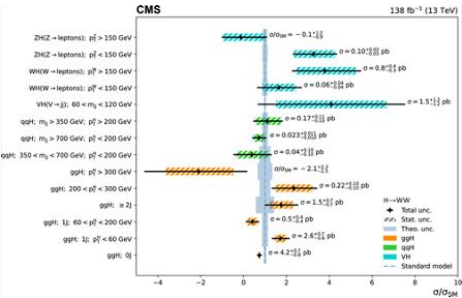
DT Phase2 Slice
Test demonstrator
installed



PHYSICS in Run 3

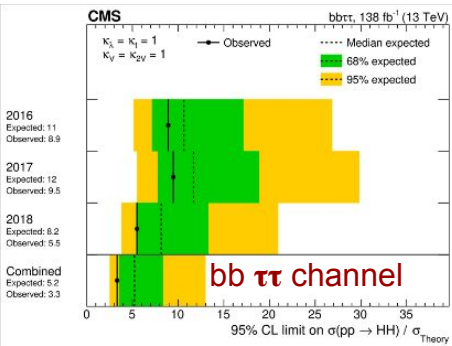
Building on the expertise achieved in Run 2

Higgs properties (H->WW)



Cross sections, searches for heavy Higgses, anomalous couplings

Searches for HH production

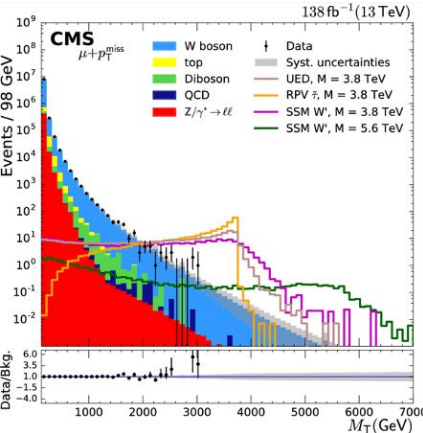
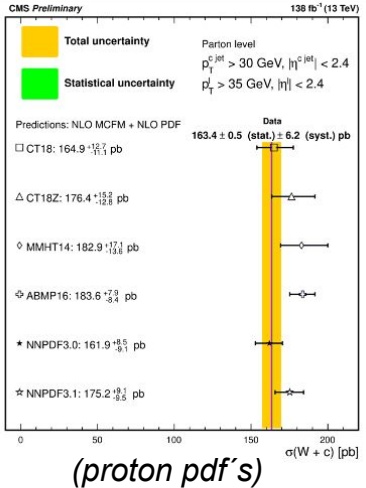


Run 3: new triggers

+ Exotic Higgs decays (LFV- $\mu\tau$, $e\tau$)

Run 3: new final states

Vector bosons (W/Z) and heavy flavour jets



BSM Searches

High mass resonances decaying into high momentum leptons ($\ell\nu$) - Multiple interpretations

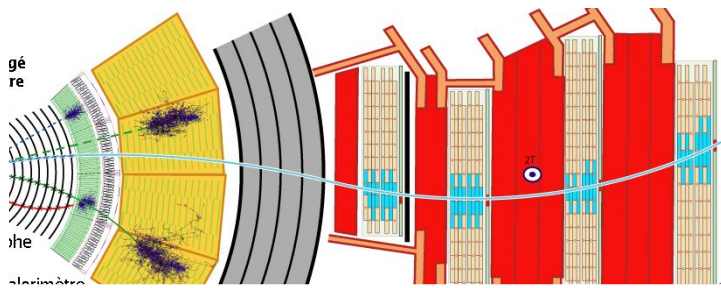
Run 3: Extension to Z'

+ Physics objects studies

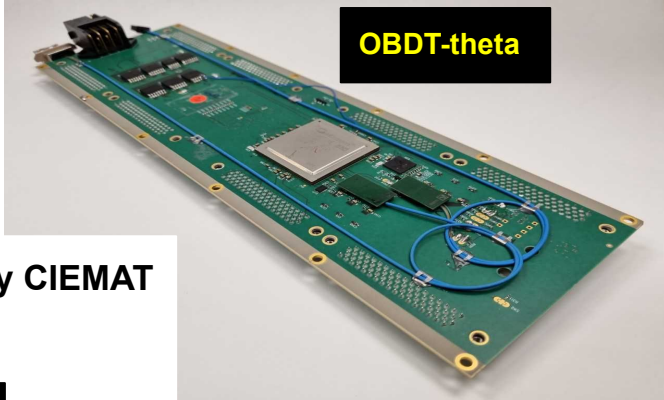
- muon (high momentum muons) reconstruction and id.
- b(c)-tagging algorithms

+ Physics studies for future facilities (ECFA) in collaboration with dedicated project

CIEMAT Contribution to CMS UPGRADE: Scope and Achievements



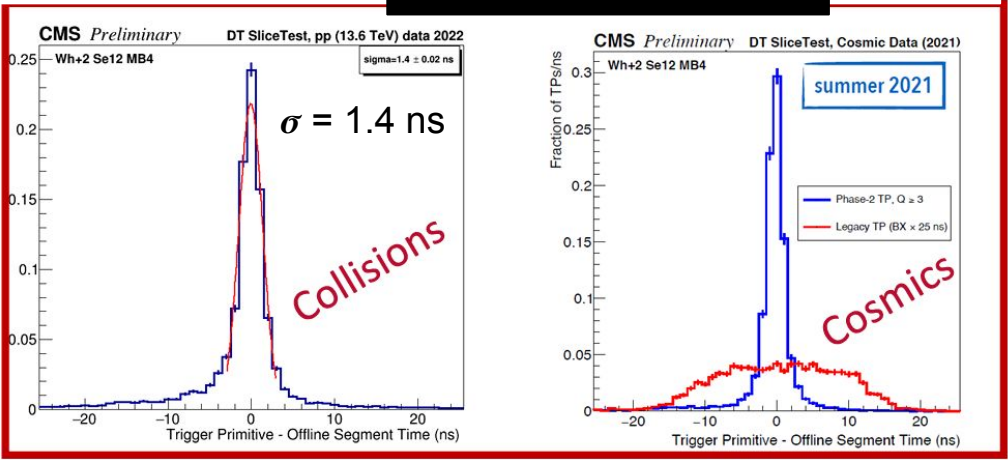
Building new on-detector electronics for Muons Drift Tubes



New trigger primitive generation algorithm lead by CIEMAT in collaboration with UAM+Oviedo:

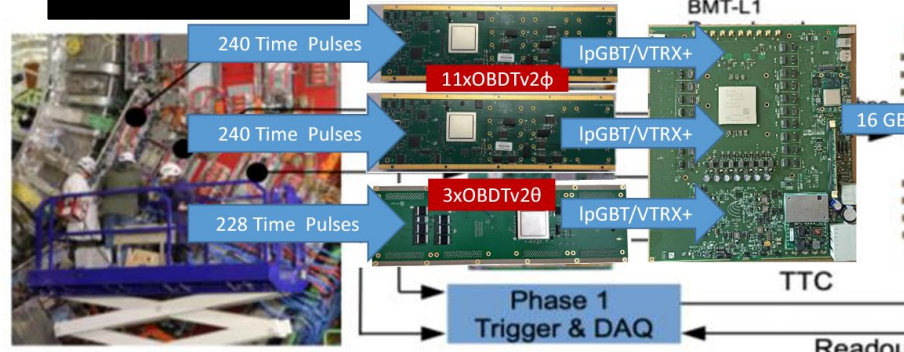
- achieves offline resolution (backend trigger firmware)

Analytical Method Algorithm



Slice Test at CMS

Trigger backend



CIEMAT Contribution to CMS HL-LHC Upgrade: Core Resources

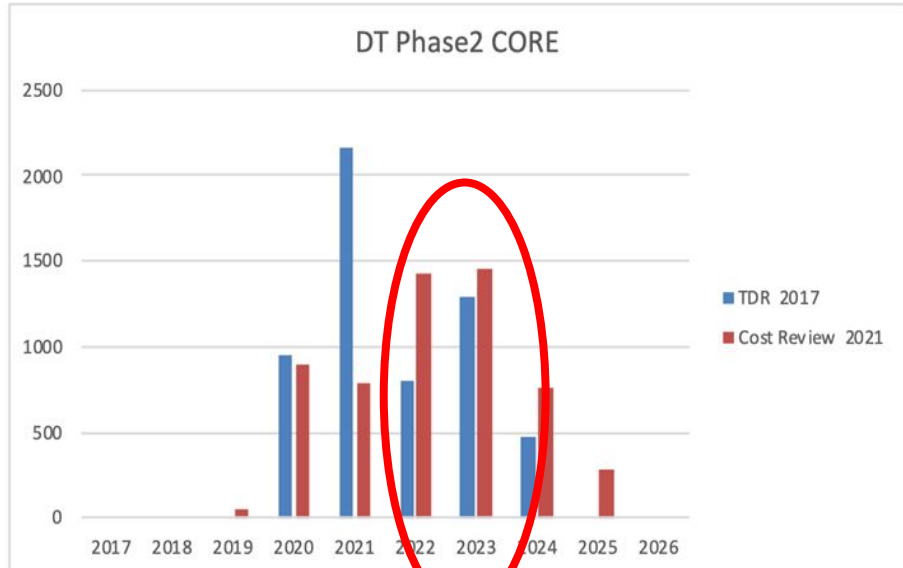
CIEMAT's contribution to CMS Phase 2 core (Muon CERN-MOU- 2019-008, Trigger CERN-MOU- 2020-319):

- 1500 kCHF for Drift Tubes (25%, consistent with DT weight since construction) (1430 kCHF Ciemat, 70 kCHF Oviedo)
- 140 kCHF for Trigger (100 kCHF CIEMAT, 40 kCHF Oviedo).

Note that spanish weight in the CMS Upgrade (1%, ~2.7 MCHF) is << than our current weight (3% of the signatures, which would correspond to ~8.25 MCHF)

- FPA 2017 Core 400 kCHF recognized by CMS
- FPA 2020 Core not in the project. Sent from European Funds to CERN (Annex I):
 - 700 keuros DT (676 kCHF today)
 - 127 keuros Trigger (122 kCHF today)
 - 250 keuros personnel (Ciemat, UO, IFCA)
- **Remains: FPA 2023 Core ~400 kCHF (to be requested next year)**

!?
KCHF

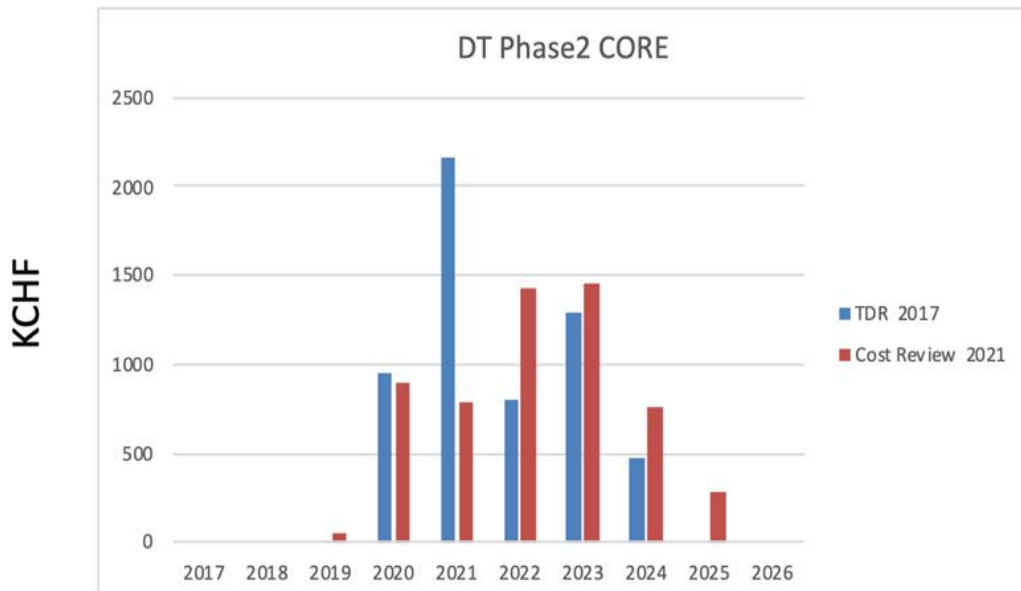


CIEMAT Contribution to CMS HL-LHC Upgrade: Common Fund

- CMS Common Fund: limited to 25 MCHF
- Spain common Fund: 3% => 779 kCHF
- CIEMAT approx 50% => 389 kCHF
- Covered so far: 266 kCHF

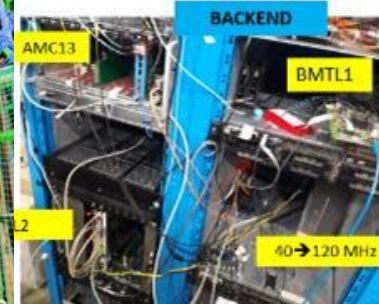
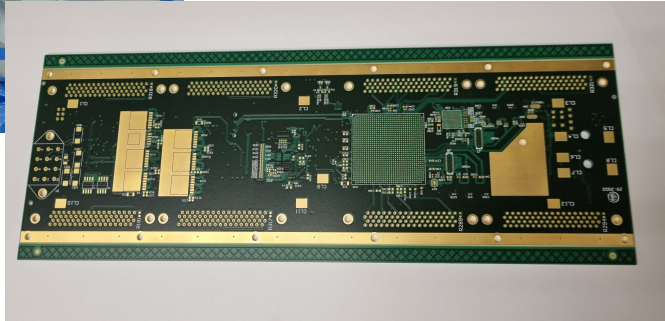
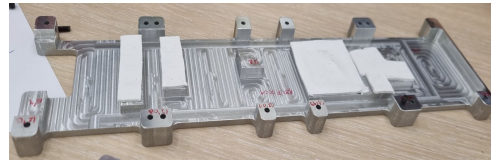
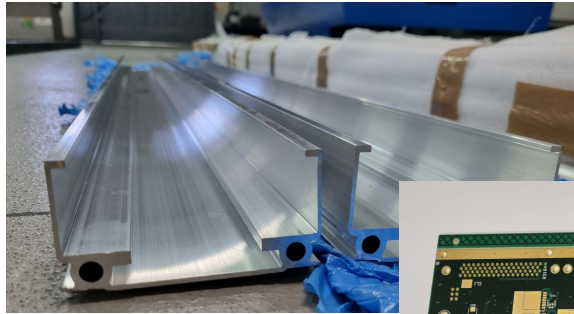
- FPA 2017: 176 kCHF Common Fund paid
- FPA 2020: 90 kCHF Common Fund being paid
- **FPA 2023: ~123 kCHF Common Fund to be requested**

However, note that CMS is planning to increase the CF request



CMS HL-LHC UPGRADES (CMS PHASE 2)

- LHC delay granted one extra year
- DT ESR passed last June 2022
- We are entering into production for the on-detector system
- Purchasing is getting difficult: increased costs and delays (52 weeks for electronic components). We have to make purchases now!
- In parallel approaching relevant milestone: L1 trigger ESR next spring
 - Testing backend prototype and increased integration activity with collaborators at CERN

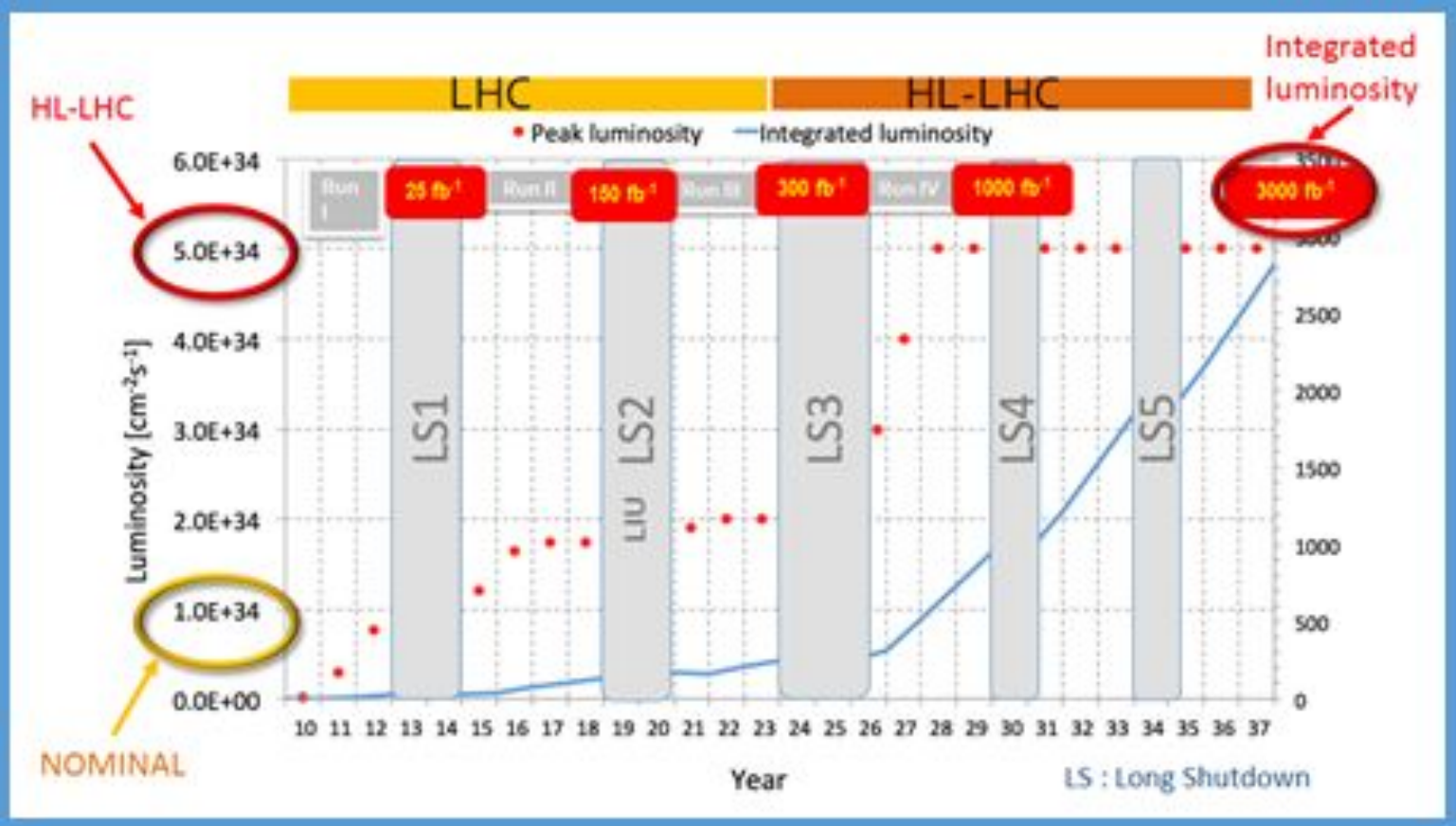


SUMMARY

- CMS Upgrade at Ciemat is progressing very satisfactorily
 - Prototypes have shown very good behaviour
 - Performance of new algorithms are excellent
- Worries exist for entering into production phase with uncertain funding
- FPA2023 is needed for backend production but will come late for on-detector electronics
- Gap between projects not covered by extension was a very important problem (loss of contracts of personnel)

- Costs increases are appearing in many places (luckily not in our part so far: increase of electronics is being compensated with decrease of optics costs). But it will impact:
 - Common Funds (expecting an important increase ~10%)
- Situation with Russia is very worrisome.
 - Help requested from HGCAL project.
 - Plus important lack of funds to be distributed (HGCAL but also M&OA)

CMS HL-LHC UPGRADES (CMS PHASE 2)

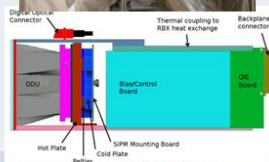


CMS IN RUN 2

New Pixel (2016/2017)



HCAL FORWARD and ENDCAP SiPM+5Gbps readout



L1 TRIGGER upgrade to μ TCA



DTs READOUT upgrade to μ TCA



Installation fourth Layer of RPCs in the endcap RE4/2 and RE4/3



ME4/2 and ME1/1 unganging



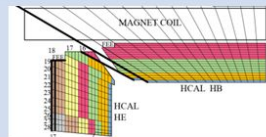
CMS - LS2 UPGRADES FOR RUN 3

New beam pipe, Tracker cooling, CMS opening system and other preparations for HL-LHC

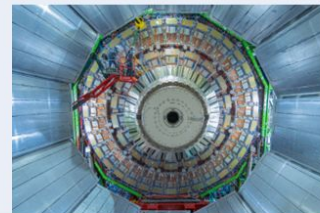
Pixel replaced barrel layer 1



HCAL BARREL SiPM+5Gbps Readout



GE1/1: 144 GEM chambers Installed in the forward region



Muon Barrel radiation shielding against neutron background



CSC front end electronics for HL-LHC trigger rates



(x)DCFEb



ME1/1 OTMB mezzanine

