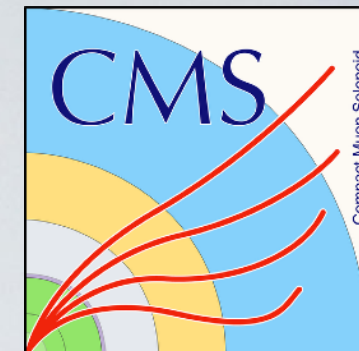




LABORATÓRIO DE INSTRUMENTAÇÃO  
E FÍSICA EXPERIMENTAL DE PARTÍCULAS  
*partículas e tecnologia*

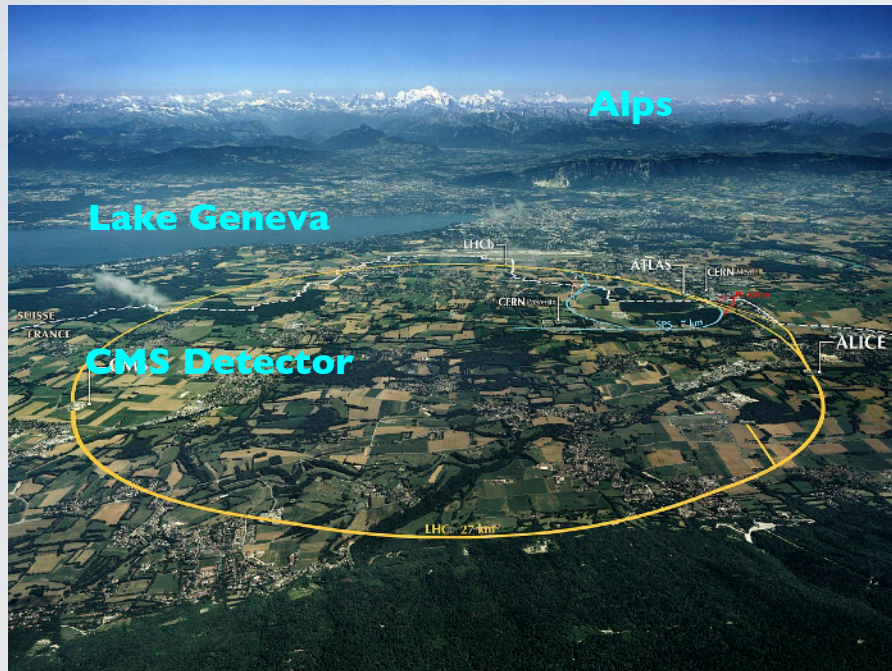


# *CMS DAY AT IST*

*REPORT FROM CERN*

Jonathan Hollar (LIP)

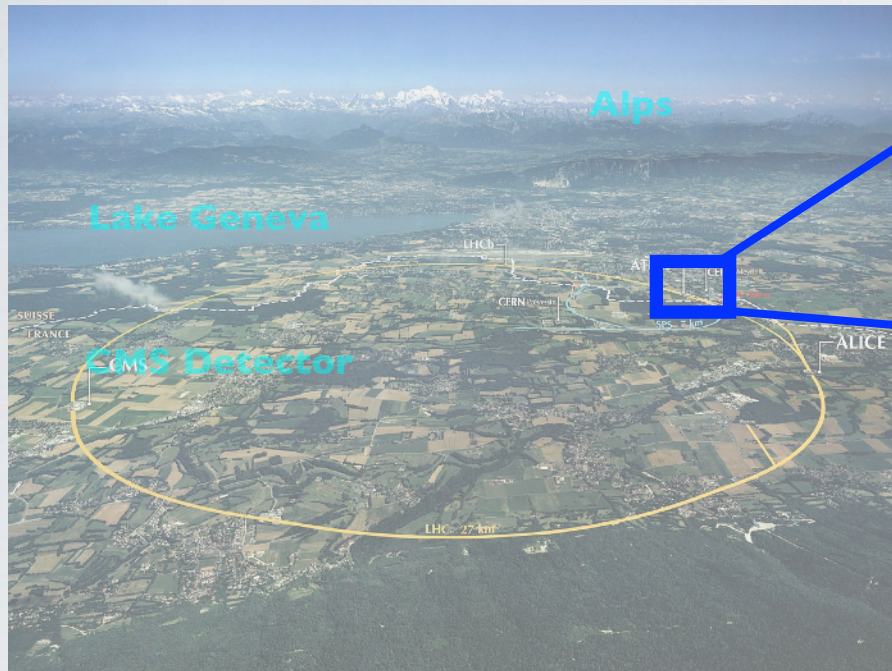
# REPORT FROM CERN



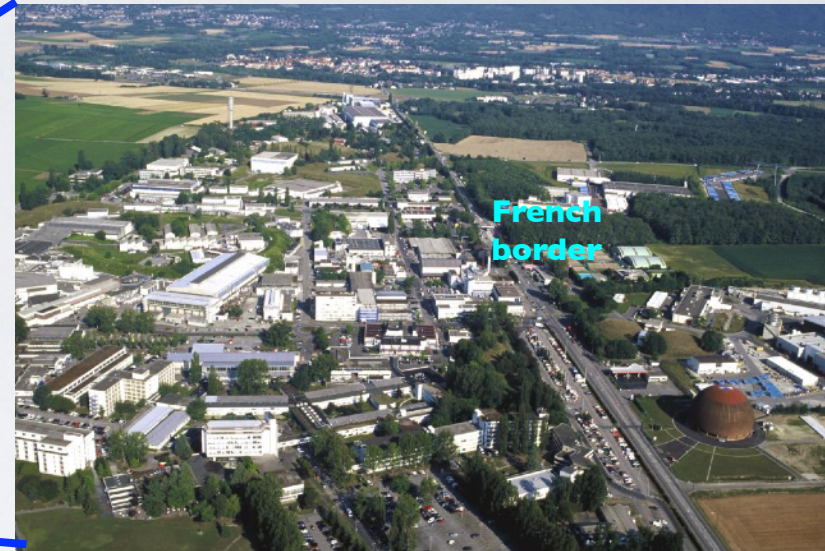
**The LHC  
accelerator ring**



# REPORT FROM CERN



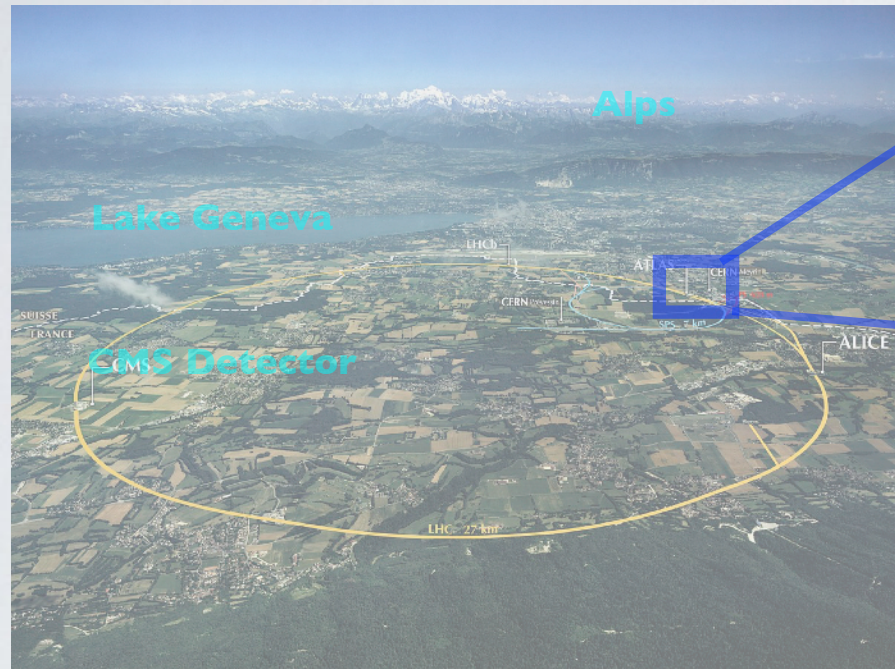
**The LHC  
accelerator ring**



**Main CERN site  
(Meyrin, CH)**



# REPORT FROM CERN



**The LHC  
accelerator ring**



**Main CERN site  
(Meyrin, CH)**



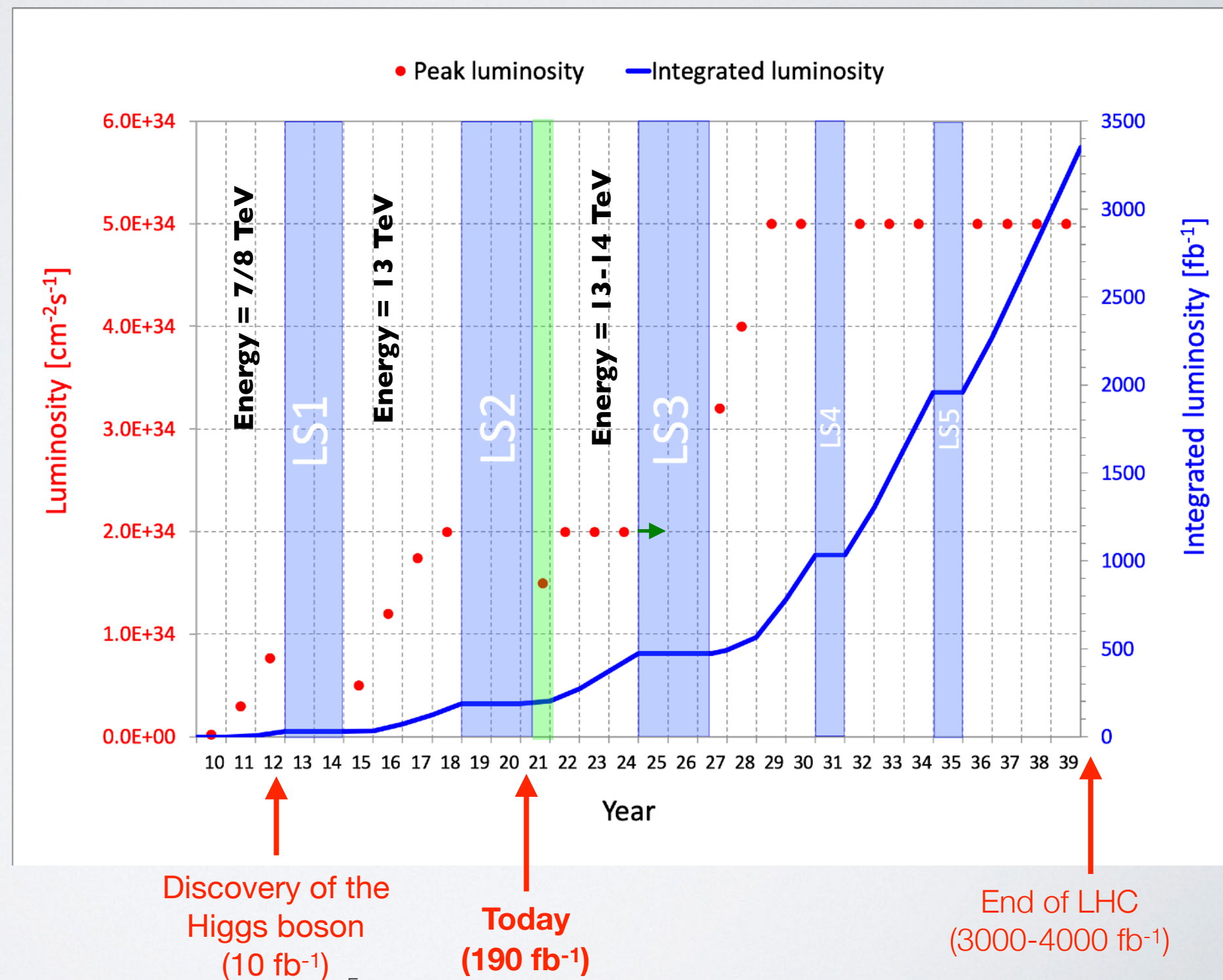
**LIP-CMS electronics lab, bldg. 20  
(not currently radioactive!)**



# THE LHC TIMELINE

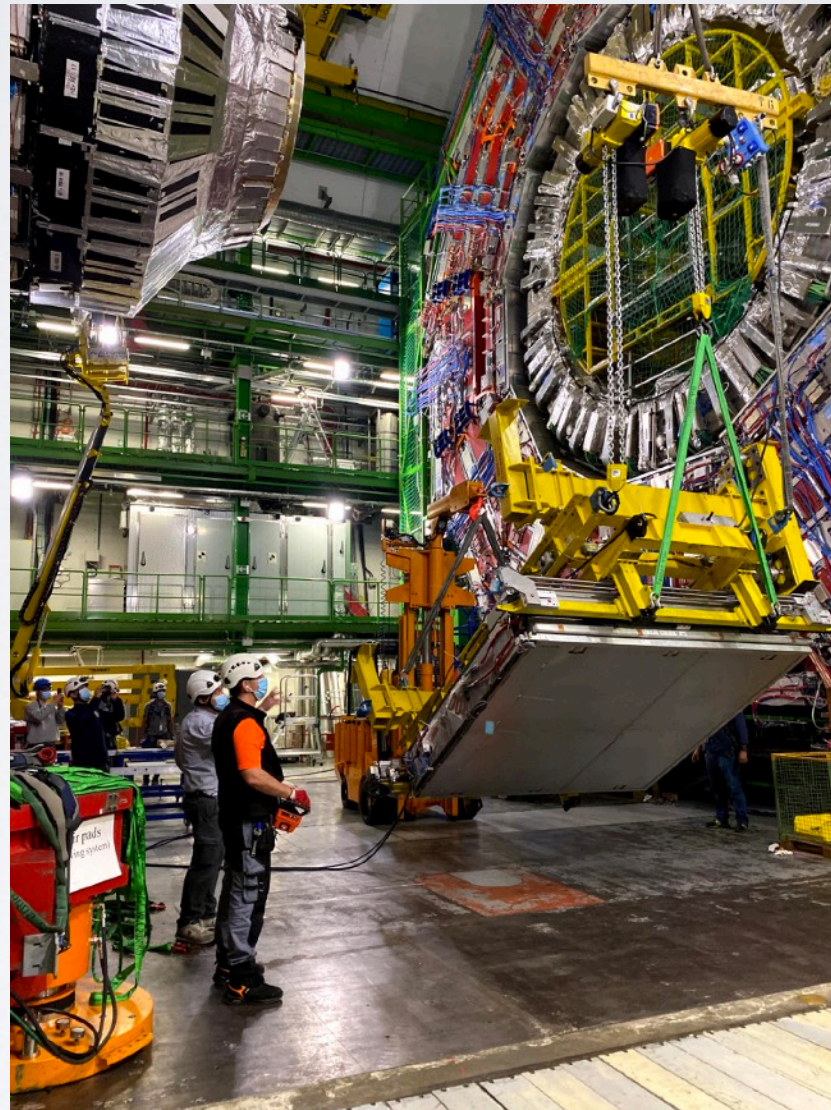
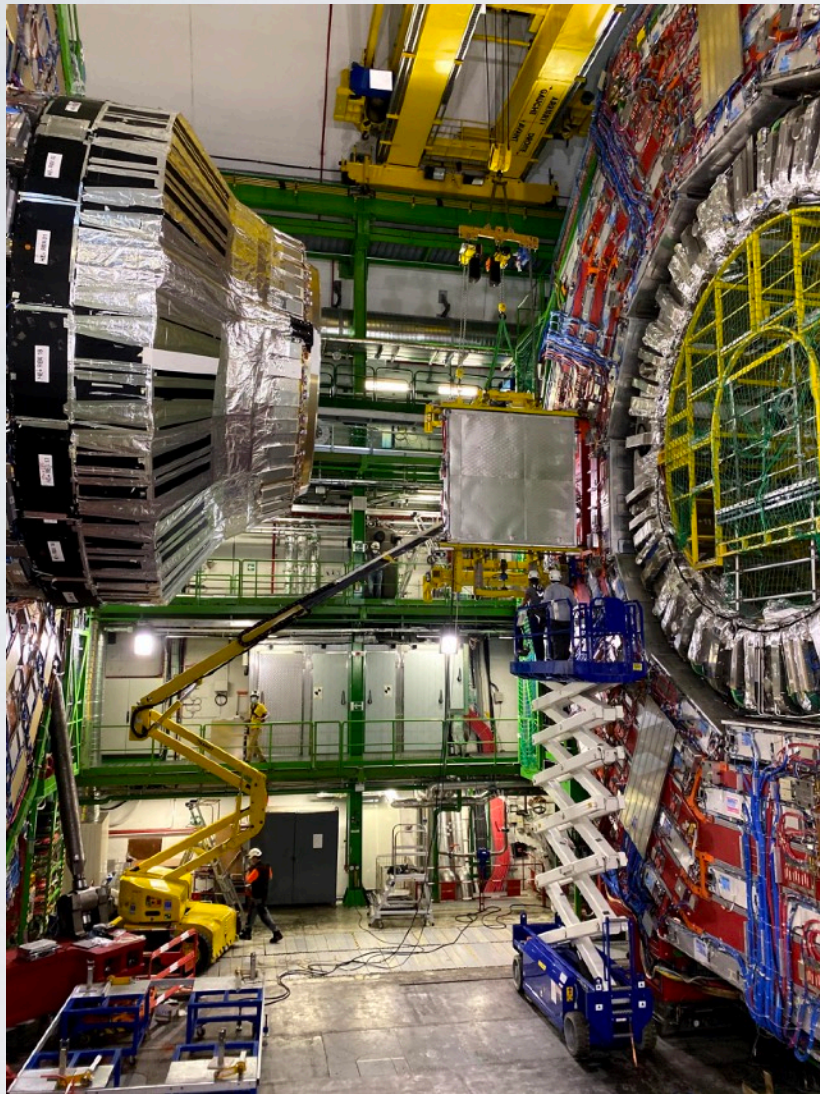


- **LHC completed it's 2nd physics run in 2018, with  $>150\text{fb}^{-1}$  of proton-proton data delivered**
- $>10$  quadrillion proton-proton collisions
- + heavy ion collisions
- **Now in “Long Shutdown 2” until 2021-2022**





# WHAT HAPPENS DURING A “LONG SHUTDOWN” AT CERN?



CMS detector in “open” configuration to allow access for repairs and improvements

- **The LHC will restart collisions for Run 3 in 2022**
- **Both the LHC accelerator and CMS detector are undergoing many repairs and improvements to prepare**
  - The LHC will try to increase the collision energy from 13 TeV to 14 TeV
- **CMS must be ready to take data before the first collisions of Run 3**

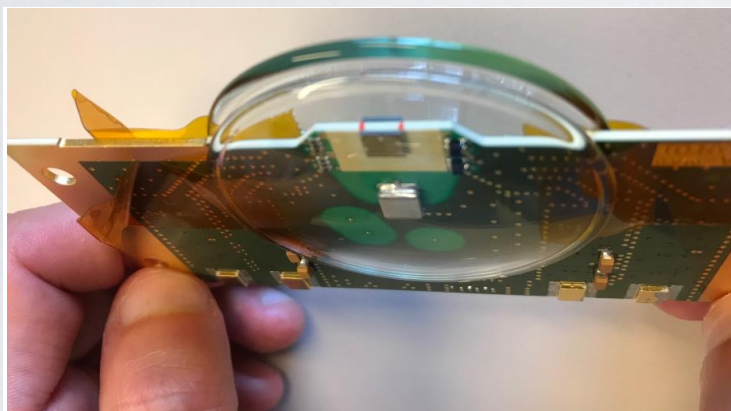


# PREPARING FOR RUN 3 IN CMS: FROM SMALL...



- **Replacement and improvements to electronics ongoing for many detector systems - examples:**

- Refurbishing boards and optical components/cables for electromagnetic calorimeter, now taking test runs with cosmic rays ([long time LIP-CMS leadership in electronics](#))



New hybrid board  
for PPS timing detectors



New time->digital converter  
cards for PPS (LIP-CMS design)

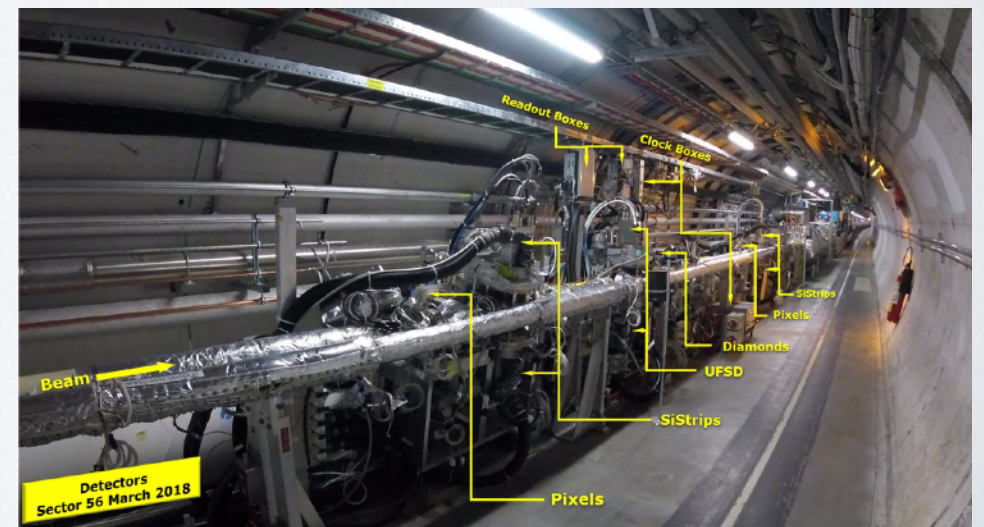
- Replacement of front-end timing electronics for PPS forward proton detector ([long time LIP-CMS involvement](#))

- Plus all of the important “invisible” work of improving firmware, software, data acquisition, calibrations ([LIP-CMS contributions in all of these](#))...



# ...TO LARGE

- Larger-scale mechanical/infrastructure work also ongoing for many detector subsystems in CMS
- Refurbishment of old and addition of new muon chambers →
- Replacement of beam-pipe
- Replacement of inner layer of the silicon pixel tracker
- Reconfiguration of Roman Pots for PPS forward proton detectors →





# AND BEYOND RUN 3: THE HL-LHC



- **From 2027, the LHC accelerator will reconfigured into the “HL-LHC” (High Luminosity LHC)**
  - Rate of collisions will increase by a factor of 2-3
  - By the end of operations, will provide ~20x more data than currently available
- **Large civil engineering work is already ongoing at CERN in preparation**
  - New underground caverns, new buildings, new cryogenic facilities...





# AND BEYOND RUN 3: CMS



## CMS HL-LHC upgrade

Technical proposal CERN-LHCC-2015-010 <https://cds.cern.ch/record/2020886>  
Scope Document CERN-LHCC-2015-019 <https://cds.cern.ch/record/2055167>

**L1-Trigger/HLT/DAQ**  
<https://cds.cern.ch/record/2283192>  
<https://cds.cern.ch/record/2283193>

- Tracks in L1-Trigger at 40 MHz
- PFlow-like selection 750 kHz output
- HLT output 7.5 kHz

**Calorimeter Endcap**  
<https://cds.cern.ch/record/2293646>

- 3D showers and precise timing
- Si, Scint+SiPM in Pb/W-SS

**Tracker** <https://cds.cern.ch/record/2272264>

- Si-Strip and Pixels increased granularity
- Design for tracking in L1-Trigger
- Extended coverage to  $\eta \approx 3.8$

**Barrel Calorimeters**  
<https://cds.cern.ch/record/2283187>

- ECAL crystal granularity readout at 40 MHz with precise timing for e/ $\gamma$  at 30 GeV
- ECAL and HCAL new Back-End boards

**Muon systems**  
<https://cds.cern.ch/record/2283189>

- DT & CSC new FE/BE readout
- RPC back-end electronics
- New GEM/RPC  $1.6 < \eta < 2.4$
- Extended coverage to  $\eta \approx 3$

**Beam Radiation Instr. and Luminosity, and Common Systems and Infrastructure**  
<https://cds.cern.ch/record/002706512>

**MIP Timing Detector**  
<https://cds.cern.ch/record/2296612>

Precision timing with:

- Barrel layer: Crystals + SiPMs
- Endcap layer: Low Gain Avalanche Diodes

**New paradigms (design/technology) for an HEP experiment to fully exploit HL-LHC luminosity**

03/08/20 CMS highlights ICHEP 2020 28

- In addition to the accelerator, the CMS detector will undergo a major upgrade to cope with new conditions and allow new physics measurements
- Large effort by the LIP-CMS group(details in talk by J. Varela)



# SUMMARY



- **In spite of Covid, many activities are ongoing in parallel at CERN**
  - Physics analysis of the CMS data already recorded in LHC Run 2 from 2010-2018 (see talk by Michele Gallinaro)
  - Preparations for the LHC Run 3 restart in 1.5 years
  - Development of upgrades for the HL-LHC program covering the next 20 years (see talk by Joao Varela)
- **The LIP-CMS group is heavily involved in all of these areas**