

Technical Coordination, BRIL, and Run/DPG Coordination

CMS Technical Coordination: Wolfram Zeuner (CERN) - Paola Tropea (CERN)

CMS Run Coordination : Gaëlle Boudoul (IP2I Lyon) - Gianni Masetti (INFN-Bologna)

CMS Run Coordination/DPG Coordination: Andrea Massironi (INFN-Milano Bicocca)

CMS BRIL Project Management: Anne Dabrowski (CERN), David Stickland (Princeton University),
Gabriella Pasztor (Eotvos Lorand University)

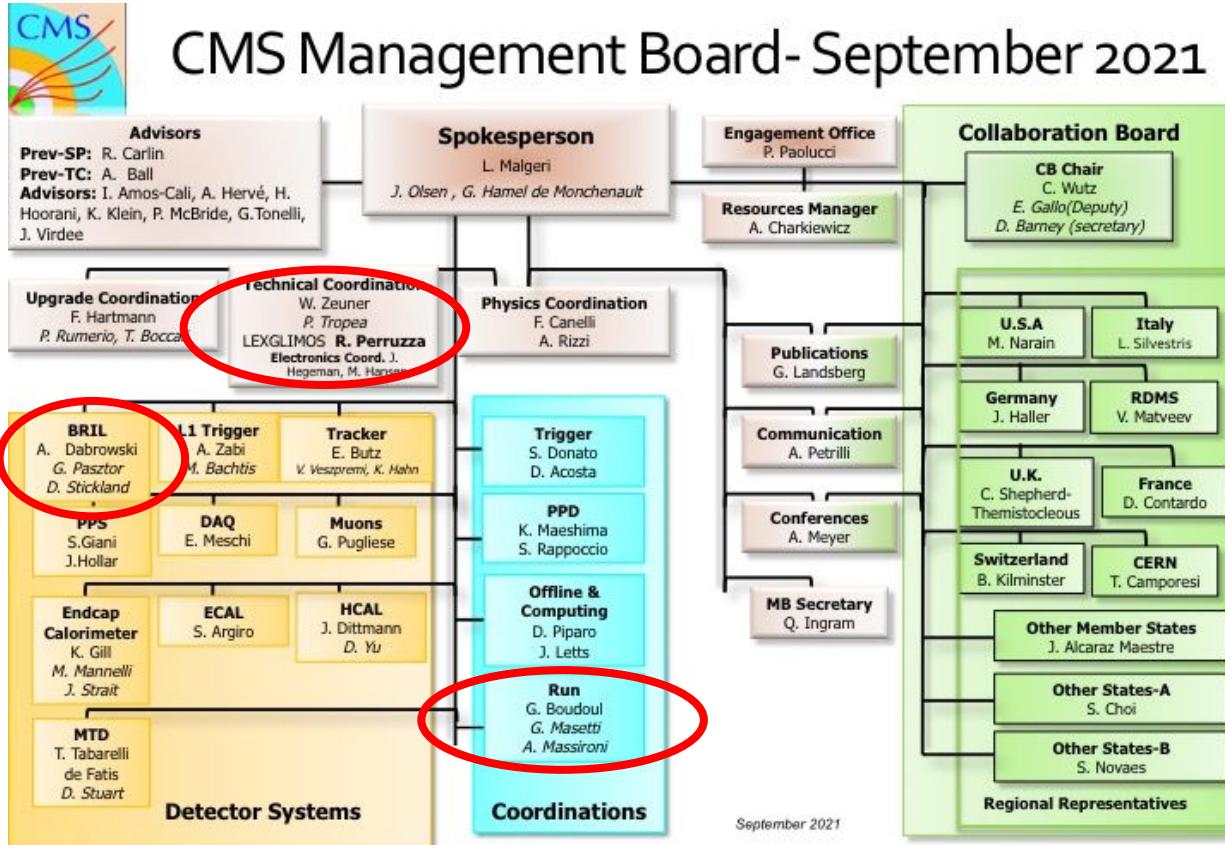
Speaker: Andrea Massironi

CMS 12th Induction course

20-22 September 2021

<https://indico.cern.ch/event/1050796>

CMS management board – September 2021



So you know our faces ...

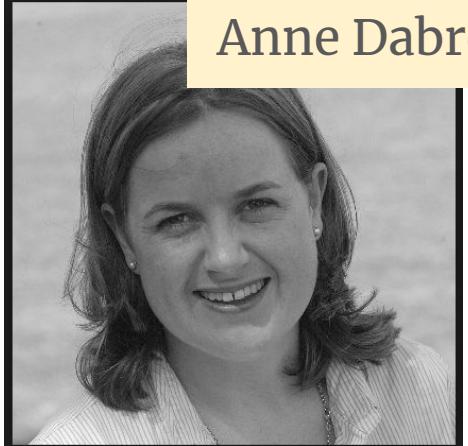
Technical coordination



Wolfram Zeuner

Paola Tropea

So you know our faces ...



Anne Dabrowski

Bril project managers



Gabriella Pasztor



David Stickland

Run coordination



Andrea Massironi



Gianni Masetti



Gaëlle Boudoul

Technical Coordination



1



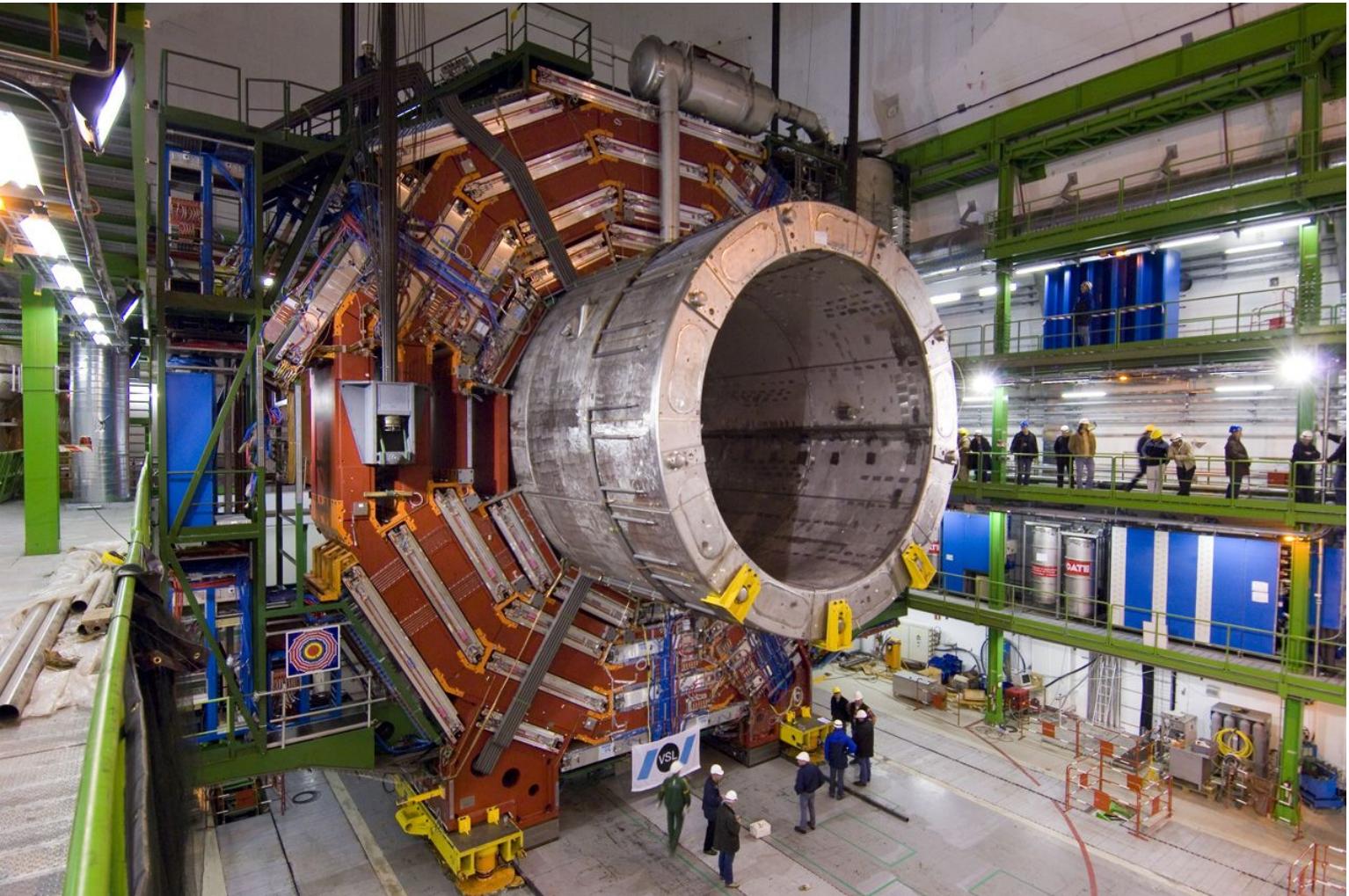
In the beginning

Technical Coordination was the art of transforming this ...

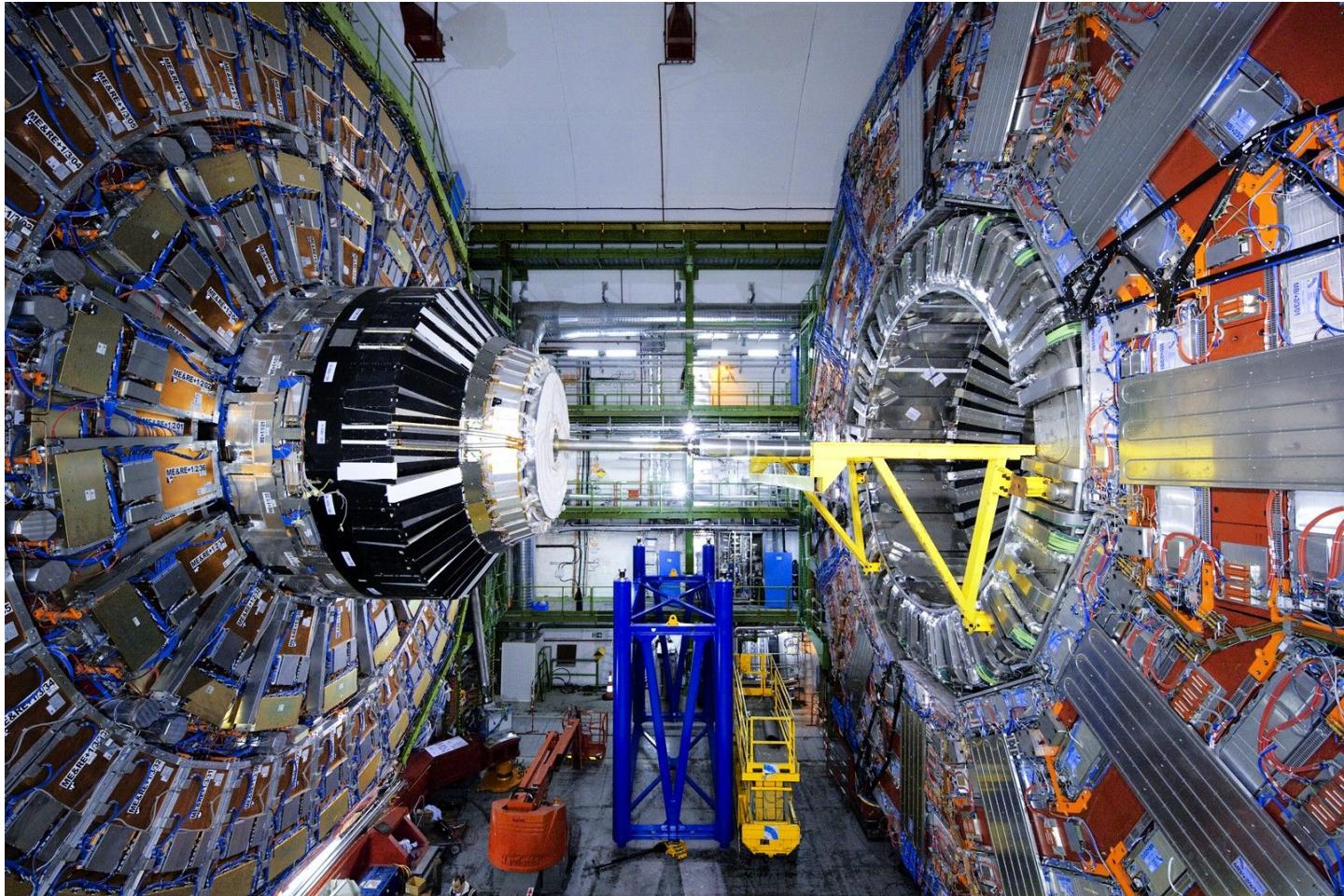


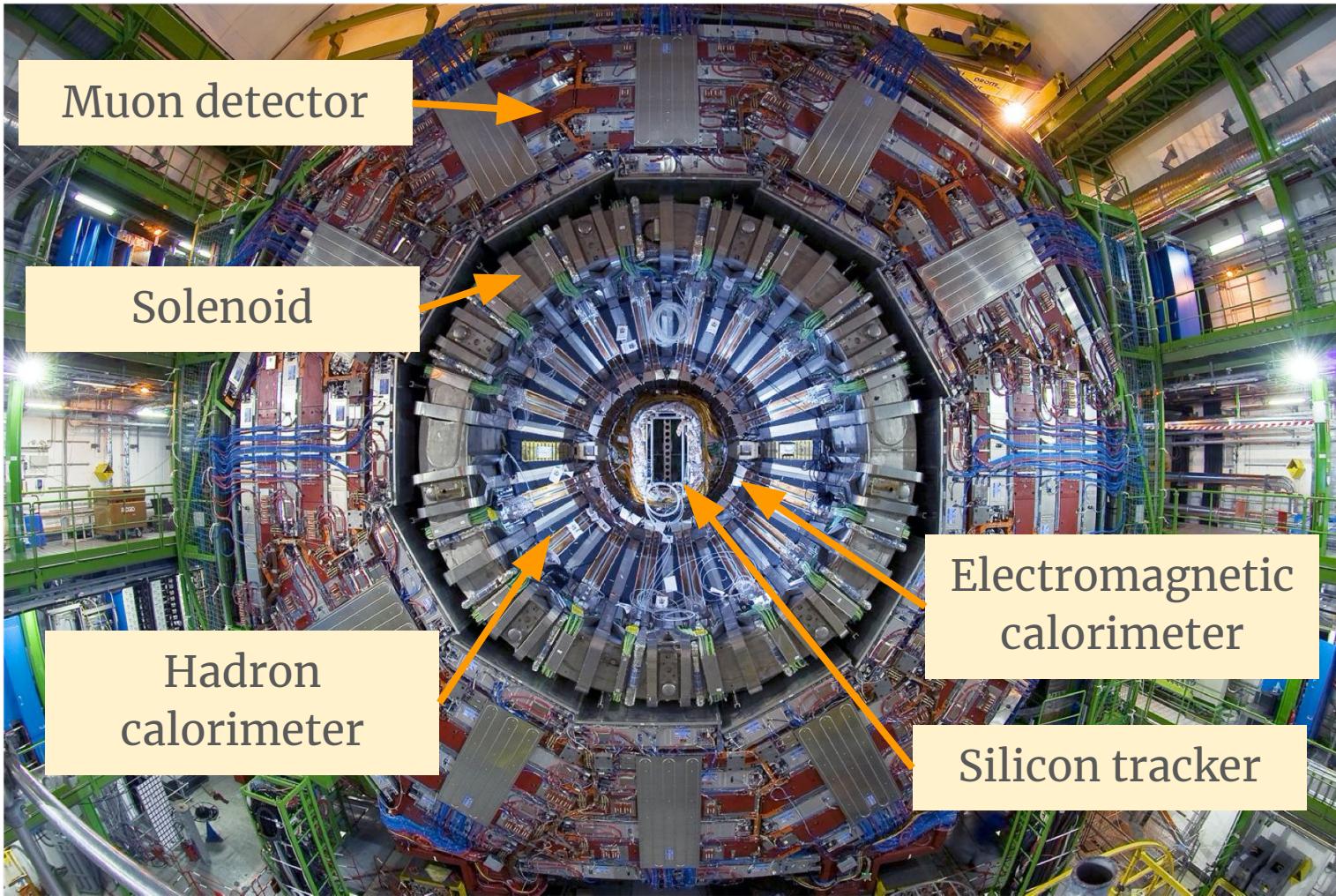
...in an hangar on surface and then moved 100 m underground !





... into that:





Technical coordination: what about now?

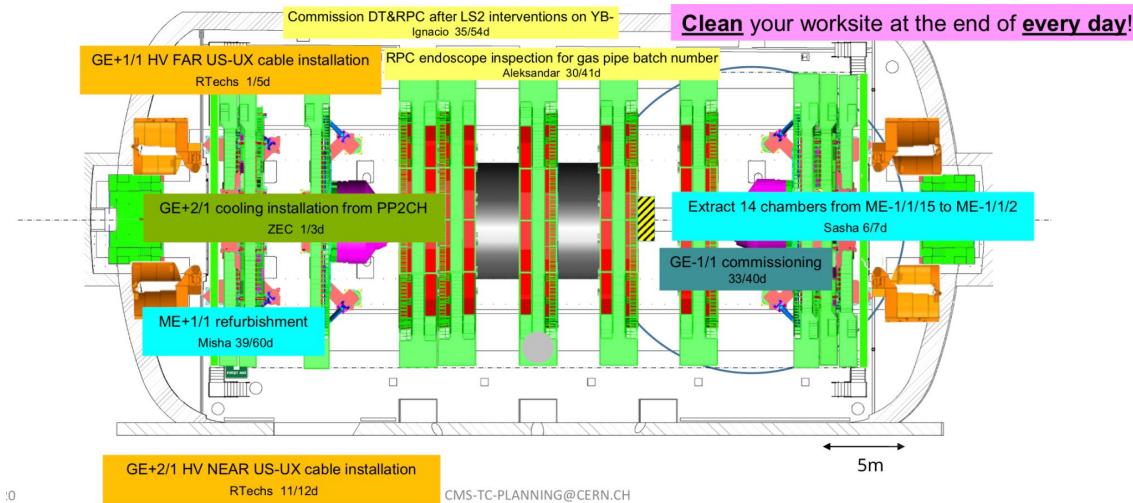
- CMS is a very **complicated technical object**
- There are a lot of interfaces and interdependencies to be considered...
- Continuously, and especially during breaks in LHC operation, CMS performs:
 - Upgrades
 - Maintenance
- Moreover, this must all be done **safely** (see Roberto's talk)
 - Gas, High Voltage, cryogenics, strong magnetic fields, radioactive sources, activated material, lasers, ...
- The **coordination of all these activities** is done by the team of “Technical Coordination”

Upgrade projects ...

- Technical coordination is involved in all CMS upgrade projects
 - Compatibility with the existing detector has to be ensured
 - Compatibility with the LHC accelerator has to be ensured
 - Performance of the entire detector has to be kept at a high level
 - Integration of new components needs to be worked out, involving engineering in various fields (cooling, electrical, mechanical, ...)
 - Availability & readiness of infrastructure for new systems must be ensured
- Installation of upgrades typically occurs during Long Shutdowns (**LS**), Year-End Technical Stops (**YETS**) and Extended Year-End Technical Stops (**EYETS**)
 - Long Shutdowns typically last ~2 years
 - Year-End Technical Stops typically last ~ 3 months

Planning

- Technical Coordination needs to plan all these activities carefully
 - On a long-time scale – but being flexible in case of unforeseen issues
 - On a day by day basis
- Daily meetings during Shutdowns and Technical Stops
- Technical Coordination, together with the Spokesperson and in agreement with the Collaboration Board, prioritizes the various tasks



Other tasks

- Organization of **engineering design, production, monitoring and pre-installation reviews**
 - Experts internal + external are invited to review projects before a major production is started
 - Minimize risk for a project to fail or to incur unexpected cost to completion
 - Ensure compatibility with the rest of CMS
 - Ensure required performance of the apparatus
- Interface between **CERN service groups & CMS**
 - E.g.: cooling & ventilation, electrical power, gas services, space management and buildings, HSE

Beam Radiation, Instrumentation, and Luminosity (a.k.a. BRIL)

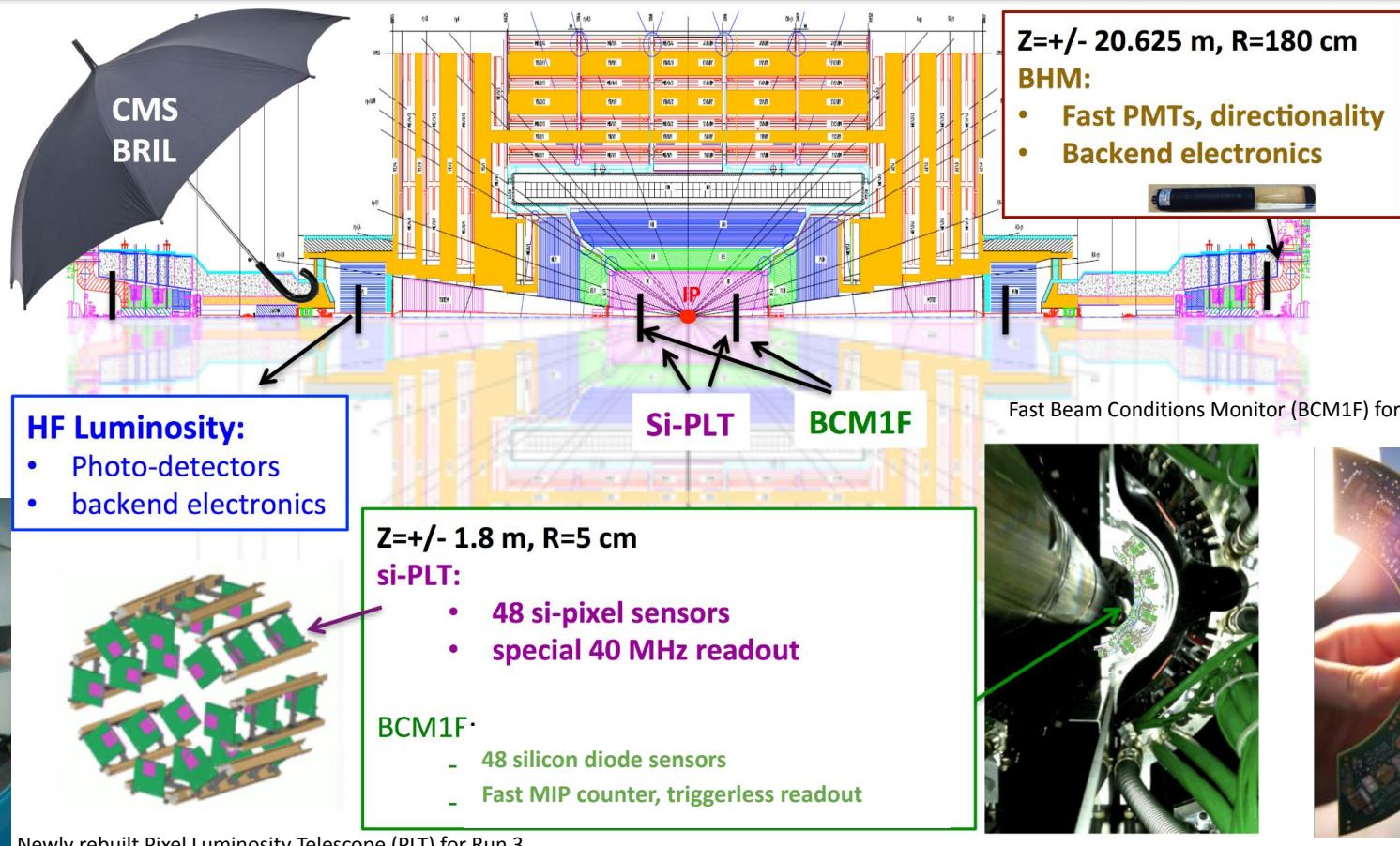


2



The detector(s)

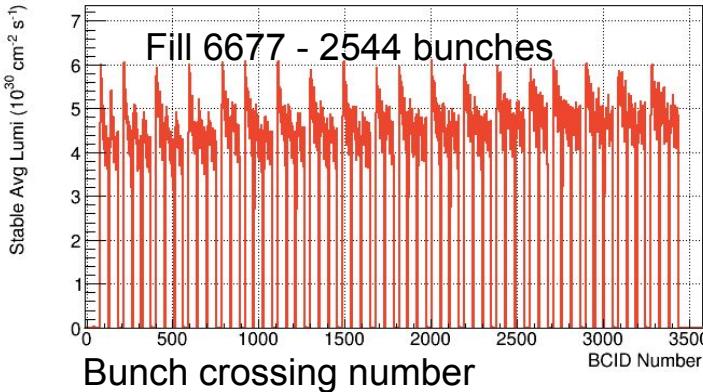
Beam Halo Monitor (BHM)



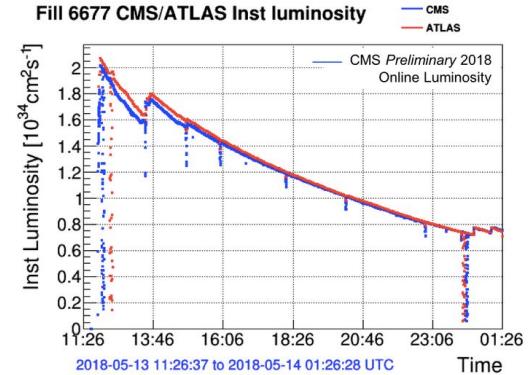
Newly rebuilt Pixel Luminosity Telescope (PLT) for Run 3

Luminosity Measurement

- **Online Instantaneous Luminosity** used for machine performance and monitoring
 - Absolute precision 3% or better, bunch-by-bunch, highly sensitive to relative changes used for lumi levelling
 - Pile Up (PU) distribution
 - Beam monitoring
 - <<1 % stability fill-to-fill
 - Well understood linearity & bunch by bunch corrections in trains



Run 2- pp bunches
separated by 25 ns,
 $\sqrt{s}=13 \text{ TeV}$



Luminosity Measurement for Physics Analyses

- Luminosity key ingredient in analyses: $N_{\text{data}} = \sigma * \text{Luminosity}$
 - Cross section measurement: $\sigma = N_{\text{data}} / \text{Luminosity}$
 - Want to get involved? cms-dpg-conveners-bril@cern.ch & cms-pog-conveners-lum@cern.ch
- <https://cms.cern.ch/iCMS/analysisadmin/cadilines?awg=LUM>

Calibration and evaluation of systematics errors:

• Normalisation

- Absolute scale vdm method
- complemented by the luminous-region evolution & beam imaging scans
- Special measurement done in collaboration with LHC & other experiments

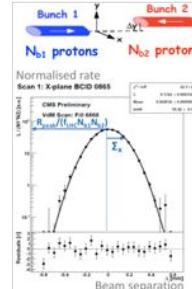
• Integration

- Evaluation of **linearity** over four orders of magnitude in luminosity
 - BX dependent corrections, in-time and out-of-time pileup
- **Stability** throughout the year → redundancy between luminometers

- Public documentation available for all preliminary Run2 calibration results ([link](#))

• Uncertainties:

- 2.3 - 2.5% for pp@13 TeV in single year
- 1.7% for pp@13 TeV <PU>>3 in 2017
- 2.3% for pp@5.02 TeV in 2016
- 3.5% for pA@8.16 TeV in 2016
- 2018 dominant systematics due to x-y correlation: study ongoing to measure the bias, after correction expect improved uncertainty
- 2015/2016 luminosity paper in internal review: expect significant improvement



	Systematic	Correction (%)	Uncertainty (%)
Normalization	Length scale	-0.8	0.2
	Orbit drift	0.2	0.1
	x-y nonfactorization	0.0	2.0
	Beam-beam deflection	1.5	0.2
	Dynamic- β^*	-0.5	0.2
	Beam current calibration	2.3	0.2
	Ghosts and satellites	0.4	0.1
	Scan to scan variation	—	0.3
	Arclength variation	—	0.1
	Cross-detector consistency	—	0.5
Integration	Background subtraction	0 to 0.8	0.1
	Afterglow (HFOC)	0 to 4	0.1±0.4
	Cross-detector stability	—	0.6
	Linearity	—	1.1
	CMS downtime	—	<0.1
Total			2.5

CMS-PAS-LUM-18-002

BRIL Hardware Work LS2

- Complete rebuild of the Pixel Luminosity Telescope (PLT)
 - Due to radiation damage in the sensors and other components during Run 2, the PLT has been successfully being rebuilt and installed with new components for Run 3
 - A second copy is being built in case quick replacements during Run 3 are needed
- Newcomers welcome for construction or operation
- Learn about pixel detectors
- Get involved in assembly, testing, and commissioning
- EPR credits. Email cms-BRIL-PM@cern.ch

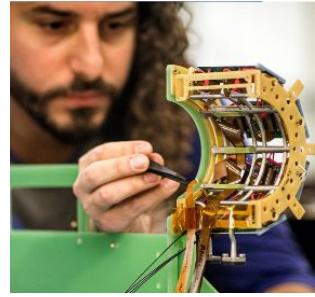


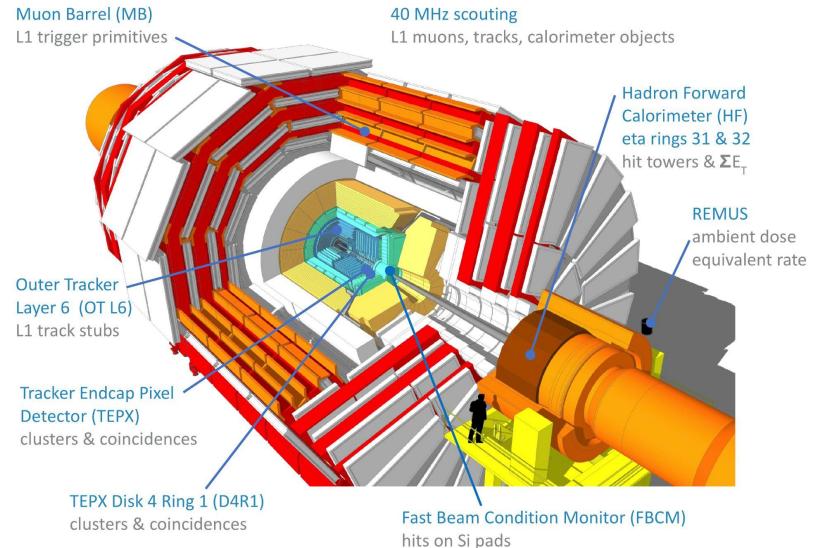
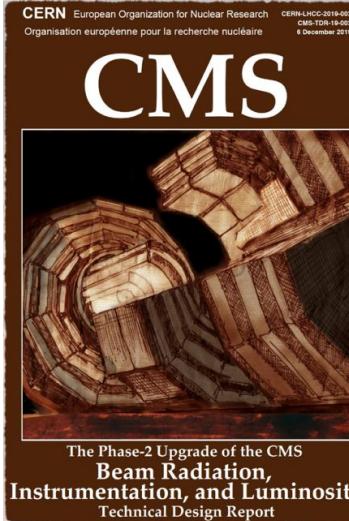
Fig. 7: PLT telescope with visible sensors (left) and front view of a PLT quadrant (right)



Fig. 8: Spare port card (top) and fully assembled PLT optohybrid-motherboard (bottom)

BRIL Phase II Upgrade

- Many R&D activities ongoing for BRIL Phase 2 Upgrade
- Strategy is to exploit as much as possible existing CMS subsystems to provide precision luminosity
 - Inner Tracker Pixel Extension (TEPX, triggered with dedicated luminosity triggers), including TEPX-Disk4Ring1 (TEPX-D4R1) as a dedicated luminometer (triggered with dedicated luminosity triggers)
 - Outer Tracker Stubs (synchronous 40 MHz)
 - HF (synchronous 40 MHz), DT (synchronous 40 MHz), trigger scouting (asynchronous 40 MHz)
- But also build precision luminosity detector
 - Fast Beam Conditions Monitor (FBCM)
- Conceptual Design Report published 2020:
 - The Phase-2 Upgrade of the CMS Beam Radiation, Instrumentation, and Luminosity Detectors: Conceptual Design
 - <http://cds.cern.ch/record/002706512?ln=en>
- Technical Design Report, Recently approved by LHCC Sept. 2021:
 - The Phase-2 Upgrade of the CMS Beam Radiation, Instrumentation, and Luminosity: Technical Design Report
 - <https://cds.cern.ch/record/2759074?ln=de>



Run Coordination



3



Run Coordination “job description”

- Make sure the CMS experiment operates effectively to achieve physics objectives and to maintain detector performance
- To make this happen, Run Coordination must:
 - Interface with CMS management
 - How does CMS want to run?
 - Interface with LHC
 - Understanding what kind of conditions we expect to have
 - Setting up special runs (low luminosity runs, p+p reference runs for Heavy Ions, “Splash” events, ...)
 - Coordinate operations
 - E.g., establish shift crew procedures for physics data collection
 - Coordinate commissioning
 - E.g., “Global runs” with DAQ, Trigger, and sub-detectors
 - Coordinate Detector Performance Groups
 - Next page
 - Organize central shifts
 - Next next page ...

Run Coord. deputy: DPG Coordination

- Coordination of the **Detector Performance Groups (DPG)**
 - Detector performance groups take care of fundamental tasks, which directly relate to the physics performance of the detector:
 - **Prompt feedback and Data Quality monitoring** of collected data
 - **Simulation** of the detector response and its performance
 - Development, maintenance and optimization of first steps of **reconstruction** ('local reconstruction' (from bits to hits...))
 - **Validation** of related **software** changes
 - Definition of optimal workflows for **alignment and calibration**
- DPG coordination organizes **common tasks** and facilitates flow of info among DPGs and others (like **PPD/trigger/computing/offline/POGs**) both for offline and during data-taking
 - PPD: Physics Performance and Datasets
 - POG: Physics Objects Groups

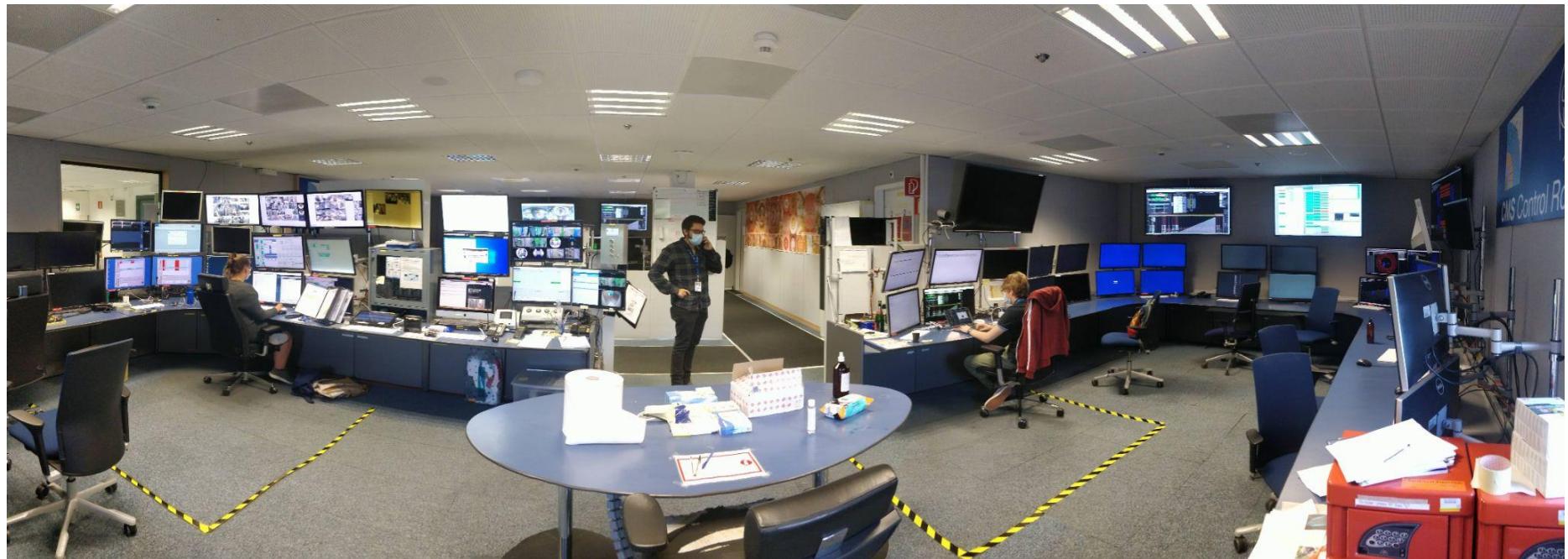
Approval of detector performance plots

- Every plot shown in public needs prior **approval** in the collaboration
 - Plots related to the Detector Performance are approved in several steps:
 - Inside the related **DPG**
 - By **DPG-/Run-coordination** in a public meeting
 - By the CMS community in the **General meeting** on Thursday
 - This procedure guarantees the quality of the plots according to some guidelines, the consistency of the results with other publications and tries to ensure the correctness of the shown material
 - Procedure documented here: <https://twiki.cern.ch/twiki/bin/view/CMS/Internal/DPSnotePreparation>
 - Approved plots can be found in public twikis: <https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResults>
 - And corresponding notes in iCMS: <http://cms.cern.ch/iCMS/jsp/iCMS.jsp?block=publications&mode=single>



<https://cmsdpgplots.web.cern.ch/>

Operations in P5



Tomorrow begins today



- Shutdown/Technical stop
- Protons physics
- Ions
- Commissioning with beam
- Hardware commissioning/magnet training

Last updated: June 2021

A typical LHC year during operation (2018)

- **Quarter #1:** Technical Stop (winter shutdown), closing machine, first beams
- **Quarter #2:** Recommissioning with beams, intensity ramp up, Physics and special runs
- **Quarter #3:** Physics runs
- **Quarter #4:** Physics (pp) + Heavy Ion program, Winter Shutdown



LHC during shutdown

- **No BEAM**

- Major activities for LHC are:
 - Consolidation of the bypass diode boxes (cleaning & insulation)
 - Prevention of short circuits from metallic debris
 - Replacement of ~20 magnets with non-conformities
 - Maintenance and consolidation of many machine elements (cryogenics, collimators, beam instrumentation, RF, ...)
 - Preparing new era at ~14 TeV !

LHC Page1		Fill: 7495	E: 0 Z GeV	30-01-19 11:17:08
SHUTDOWN: NO BEAM				
-21 11:22:46				
Comments (25-Jan-2019 09:21:50)				
LS2		BIS status and SMP flags	B1	B2
		Link Status of Beam Permits	false	false
		Global Beam Permit	false	false
		Setup Beam	false	false
		Beam Presence	false	false
		Moveable Devices Allowed In	false	false
		Stable Beams	false	false
AFS: 75_150ns_733Pb_733_702_468_42bp1_20inj		PM Status B1	ENABLED	PM Status B2
				ENABLED
Comments (30-Aug-2021 10:28:01)		BIS status and SMP flags	B1	B2
W35 magnet training in S81		Link Status of Beam Permits	false	false
BLM radiation source tests in S67 and S78 – no access to tunnel areas.		Global Beam Permit	false	false
		Setup Beam	true	true
		Beam Presence	false	false
		Moveable Devices Allowed In	false	false
		Stable Beams	false	false
AFS: Multi_7b_7_0_0_lowE_highBeta_2		PM Status B1	ENABLED	PM Status B2
				ENABLED

<https://op-webtools.web.cern.ch/vistar/vistars.php>

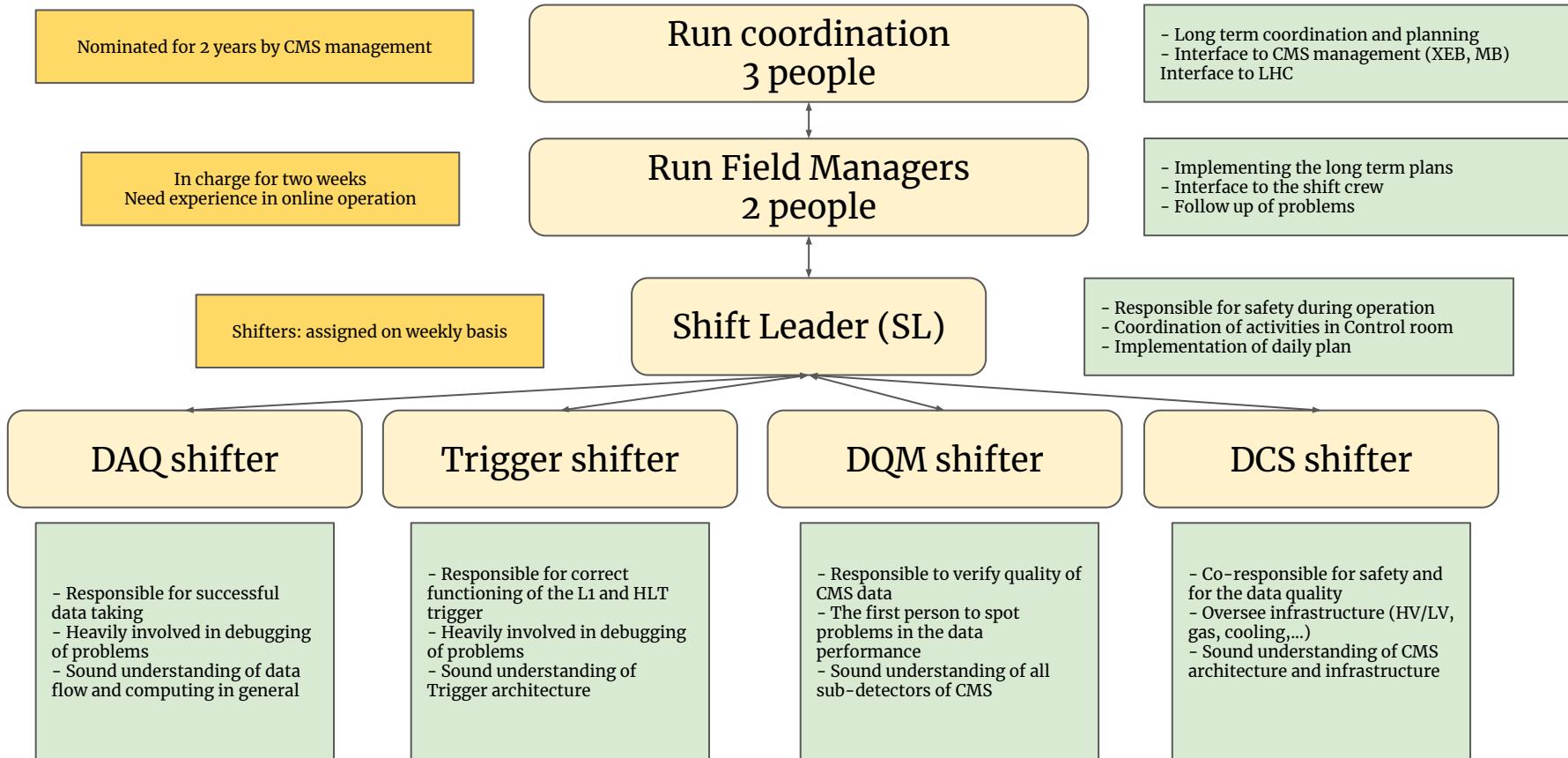
Run Coordination daily meetings

- Standard LHC operation
 - Daily **8h30 LHC planning meeting**. Participants include:
 - Injector experts ('cause if injectors ain't working, LHC ain't working either)
 - LHC experts (operations, cryogenics, RF, beam instrumentation, ...)
 - LHC Program Coordinators (Coordinate use of "Physics" beamtime)
 - Experiment Run & Technical Coordinators CMS, ATLAS, LHCb, ALICE, ...)
 - Great place to learn the latest rumors
- **Daily 9h30 at point 5.** Coordination meeting w/CMS operations teams
 - What are the LHC plans?
 - What happened in CMS over the past 24 hours?
 - What do I want to do with my subsystem in the next 24 hours? And how is that going to affect others?
 - Make the **plan of the day**, based on the LHC plans, what happened yesterday, the priority/impact of subsystem requests...

CMS operations team

- Run Field Managers (RFM) and Offline Run Managers (ORM)
- Detector experts On-Call (DOC)
 - One for each subsystem + coordination area
 - 17 DOCs report at each daily run meeting
- Operations managers
 - Couple for each subsystem
 - <https://twiki.cern.ch/twiki/bin/view/CMS/OnlineWBCContactListDetails1>
- Subsystem experts
 - DAQ, DCS, Trigger, hardware, firmware, software...
- Point-5 shift crew
 - Shift Leader (SL), Trigger, Detector Controls System (DCS, aka Technical Shifter, TS), Data Acquisition (DAQ), Data Quality Monitor (DQM)
- It takes a village to operate this detector!
- Newcomers welcome!

CMS operation at P5

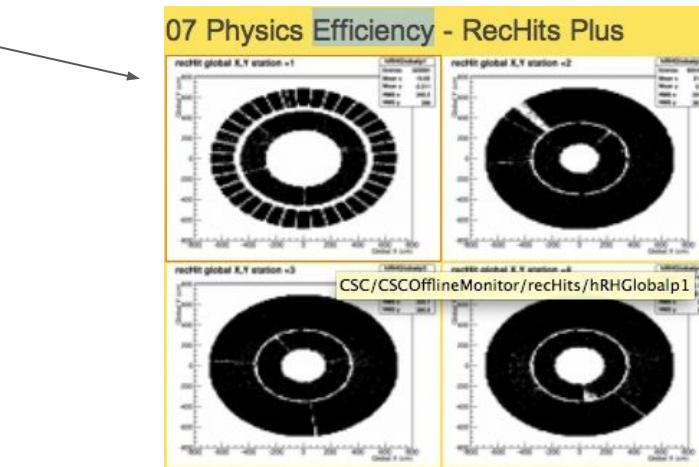
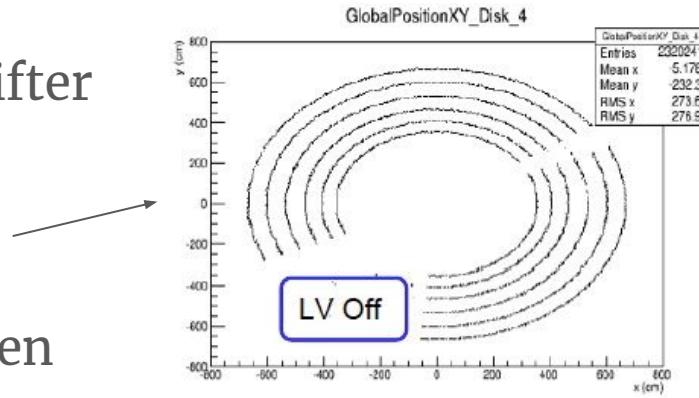


Shifts in CMS

- CMS shifters are the main stakeholders for **successful data taking**
 - They “run the show” in CMS
 - They are the first to spot problems
 - Their efficiency is directly correlated to the **data taking efficiency** of the experiment.
- Shifters in CMS get extensive **training**
 - Need a thorough knowledge of the experiment to act correctly in normal operation or in case of problems
- Doing shifts is **useful** for your **physics analysis**
 - You know where your data comes from
 - You know what can go wrong
 - You will be able to better understand the problems you will see in the data
- Last but not least... shifting is **FUN**: It is cool to run the show in one of the most complex experiments of the world!!!

Example: DQM shift

- Reference **plots** available to the shifter for comparison
- RPC hits in Disk 4: the “holes” indicate regions where the Low Voltage for the electronics have been off
- CSC hits maps in 4 disks on the positive side: Holes indicate problematic zones and are easily visible by the shifter in these hit-maps



Shifts in CMS during Long Shutdown

- If LHC is not operating and CMS is not taking global runs
 - the minimal shift crew is needed at point 5 for safety (first!), to support detector commissioning and work crews
 - Minimal = **Shift Leader** and **Technical Shifter**
- If LHC is not operating BUT CMS is taking **global runs**
 - the full shift crew is needed to ensure optimal operation of the CMS experiments

2021: commissioning year

- Keep new equipment powered on Services and shifts
- **Global commissioning with cosmics**: Milestones that define the Global Runs
- The Technical Coordination (TC) schedule for LS2 is full **maintaining and upgrading** the CMS detector
 - We must maintain close communication with our Technical Coordination colleagues
- Commissioning of the current detector to make sure it will collect high quality data after LS2
- Series of **MidWeek of Global Runs (MWGRs)** every 1-2 months for the first part of the year
- 1 month of continuous data taking with cosmic during the summer (without magnetic field), Cosmic RUn at ZERo Tesla (**CRUZET**)
- 2 weeks of **beam test** (with collisions!) at the end of October
 - Review and maintain the 2018 CMS operational
 - Review the systems performance
 - Commissioning of new detectors/systems/software during the long shutdown
 - Calibration and alignment of the detector

CMS Control Room: 2020–2021

- In June 2020 CMS Control Room was made compliant with current COVID 19 rules and constraints (surface sanitisation, restriction in the number of people, distance)
 - Shift Leader and DCS shifter in control room
 - DAQ, Trigger and DQM shifter from remote



CRUZET: Shifters + DOCs ☆

269 1 CRUZET 2021: Shifters and DOCs

yes

 Simone Bologna 11:05 PM
I will relay the message
Wait I can hear you but you can not hear me

K Kirill Ivanov 3:26 AM
Hi all, I'm not happy with the current status of F3 Mon: last line of lumisection rows is olive instead of green for a while
Image Posted at 2021-08-11 04:20 pm

Other DAQ tools seem to show no problem currently
Is the situation with the other stuff is OK ?

 Simone Bologna 3:34 AM
What does that colour mean? When did it turn olive?
Stuff looks normal here

K Kirill Ivanov 3:34 AM
Well, it should be all green, and olive means that something is not ideal, but it is hard to say what exactly since other tools do not show problems..
It is happening since about LS 1050 (about hour and half, I did not notice it earlier and checked several times trying to understand it)
In RunControl Level 0 Automator I have these:
2021-08-11 02:44:36 CEST: L0: 0.00 TrigID EvtID Auto Fix Soft Error Done TX_HV_DONtrue
PZL_HV_CDRtrue LHC_RAMPINGfalse PHYSICS_DECLAREDtrue
2021-08-11 02:44:36 CEST: L0: 0.00 TrigID EvtID Auto Fix Soft Error Done TX_HV_DONtrue

Write to CRUZET: Shifters + DOCs

Interested in more info ?

- It is cool to run one of the most complex experiments of the world!
- Do not hesitate to ask the **Run Coordinators** (cms-run-coordinator@cern.ch) in case you want to have more detailed information about shifts
- If you are a CMS member and local resident: please contact us
 - Anyone living close to CERN will be welcome to participate to the operation at P5 !
 - Giving few hours of your time, even if you are not familiar with detector operation, could help CMS to be fully operational for Run3
 - Please contact Run Coordination: cms-sldcs-shiftsupport@cern.ch
- Living outside CERN area? You are welcome to also contribute in remote operation!
- Please contact the relative organizers: cms.daq.admin@cern.ch , cms.trigger.admin@cern.ch , cms-dqmshift-admin@cern.ch
- Shift information
 - <https://twiki.cern.ch/twiki/bin/view/CMS/CentralShifts2021>
- CMS online workbook: links to pages relevant for online operation
 - <https://twiki.cern.ch/twiki/bin/viewauth/CMS/OnlineWB>
- **Entry point to various online services** like the online logbook, shift-lists, overviews for DAQ, DCS, DSS status and others
 - <http://cmsonline.cern.ch/>

Thank you for your attention Welcome to CMS!!

