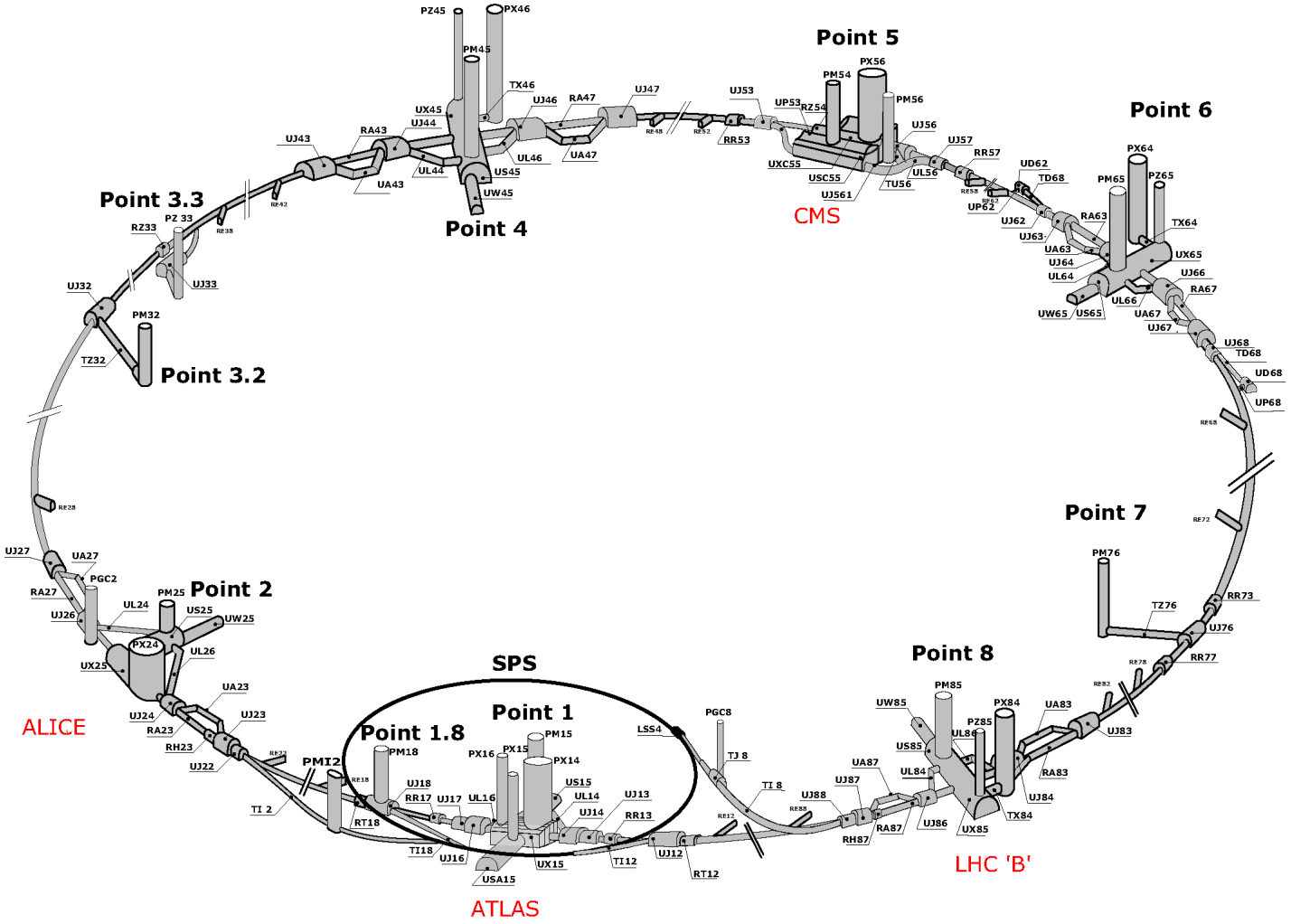
REDESIGN AND UPGRADE OF THE LHC ACCESS CONTROL SYSTEM

Large Hadron Collider (LHC)

- 7+7 TeV proton-proton collider
- Injection from the SPS at 450 GeV
- Full fill per beam 3.23×10^{14} protons (2808 bunches)
- 1232 superconducting main dipoles and 392 quadrupoles at 1.9 K with superfluid-He cooling by 120 metric tons of helium
- Main tunnel of 26.7 km circumference, ~100 m underground
- 4 large experiments at interaction points (ATLAS, ALICE, CMS, LHCb)
- 6 small experiments (LHCf, FASER, SND, TOTEM, MilliQAN, MoEDAL)
- 8 main and 2 minor sites, 26 vertical shafts (including 2 new HL-LHC shafts not shown)
- Commissioned in 2008



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LHC Access Control System (LACS)

- Manages personnel and material access to the underground areas:
  - Identification (RFID badge)
  - Authorization (granted to specific areas, mandatory trainings, work authorization)
  - Authentication (biometric iris-scan)
- 36 access points
- 43 Personnel Access Devices (PAD)
- 29 Material Access Devices (MAD)

LHC Access Safety System (LASS)

- Protects personnel from the hazards by the beam (radiation) and He-release (asphyxiation, cryogenic hazards)
- “If beam, no persons. If persons, no beam”
- Access modes: General, Restricted, Closed
- Comprehensive interlock system with two separate and diverse safety chains, PLC and cabled

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Motivation for the Upgrade

- Old LACS software and hardware at end-of-life – availability of support and spares limited
- Monolithic design: hard to carry out modifications to the subsystems without side-effects
- Upgrade only possible during long LHC shutdowns – not feasible to postpone
- MAD replacement required at 4 sites to match lift dimensions
- Synergy advantages coupled with simultaneous LASS modifications

LASS Consolidation and Modifications

- Reliability and availability improvements
- Sectorization modifications (new PZ65 access point, MilliQAN experiment)
- New HL-LHC emergency exit sectors
- Small safety improvements on all sites

System Design

- New access control software and hardware
- New simplified operator interface
- Full automation upgrade: 49 access point racks, 18 sector door racks, 2 central control racks
- Subsystems: central control, door control, access control, access points, video surveillance, interphones, biometry, MAD detection
- Main design principle: minimal integration between subsystems for maximum flexibility in O&M and upgrades

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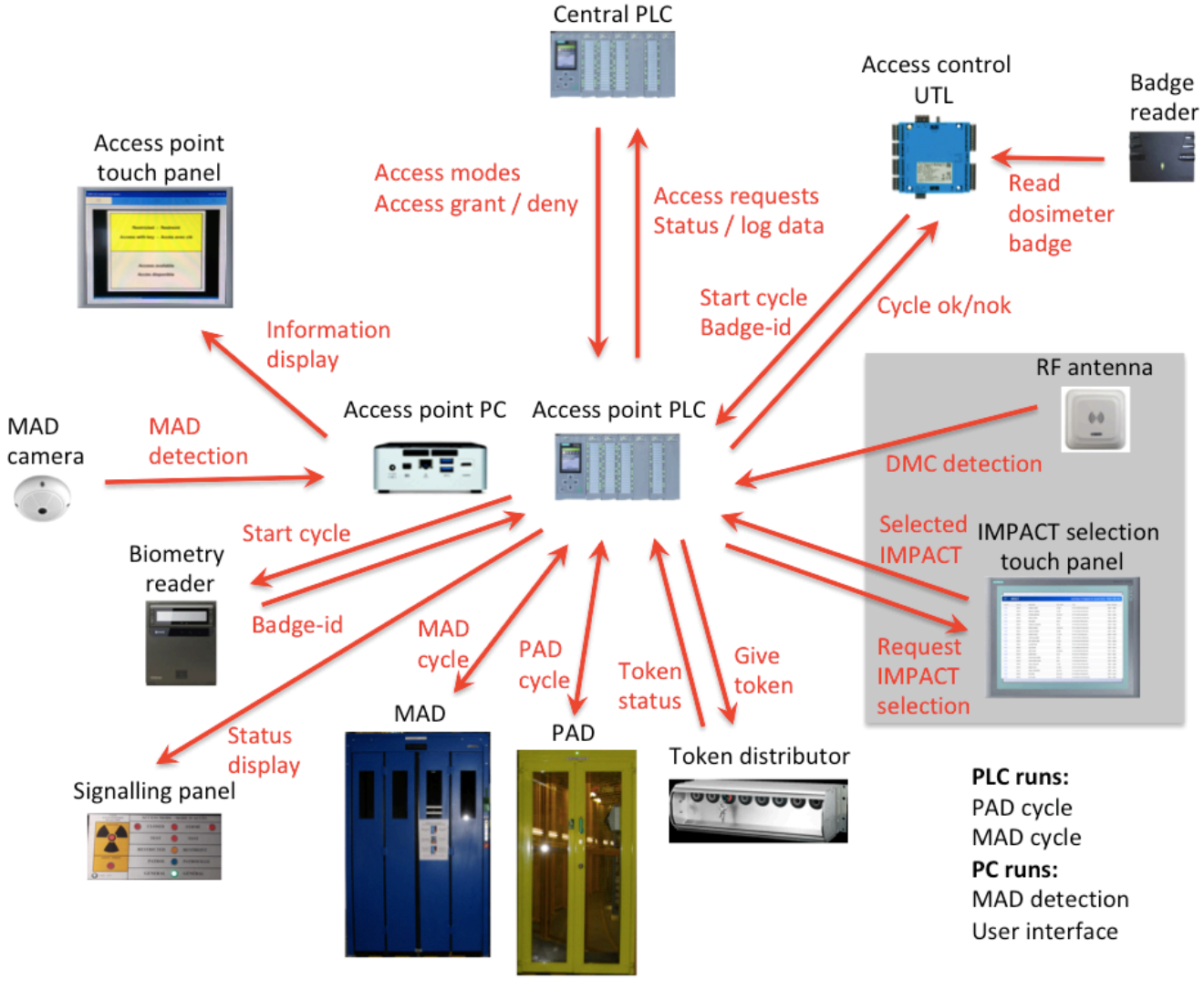
Access Point Automation

- Most functionality controlled by a Siemens 1500 series access point PLC :
  - Connected to the central PLC
  - PAD and MAD operational cycles
  - Safety token distributors (in Restricted access mode) – safety inputs to LASS
  - Interface to Local Control Unit (UTL) for access control (person identification) connected to its own server
  - Biometric authentication by an IrisID iCAM 7000 iris reader
  - A future reservation for an active dosimeter reader (DMC) interface
- Access point touch panel / PC for user interface functionality and information display
- MAD personnel detection algorithm runs in the local access point PC



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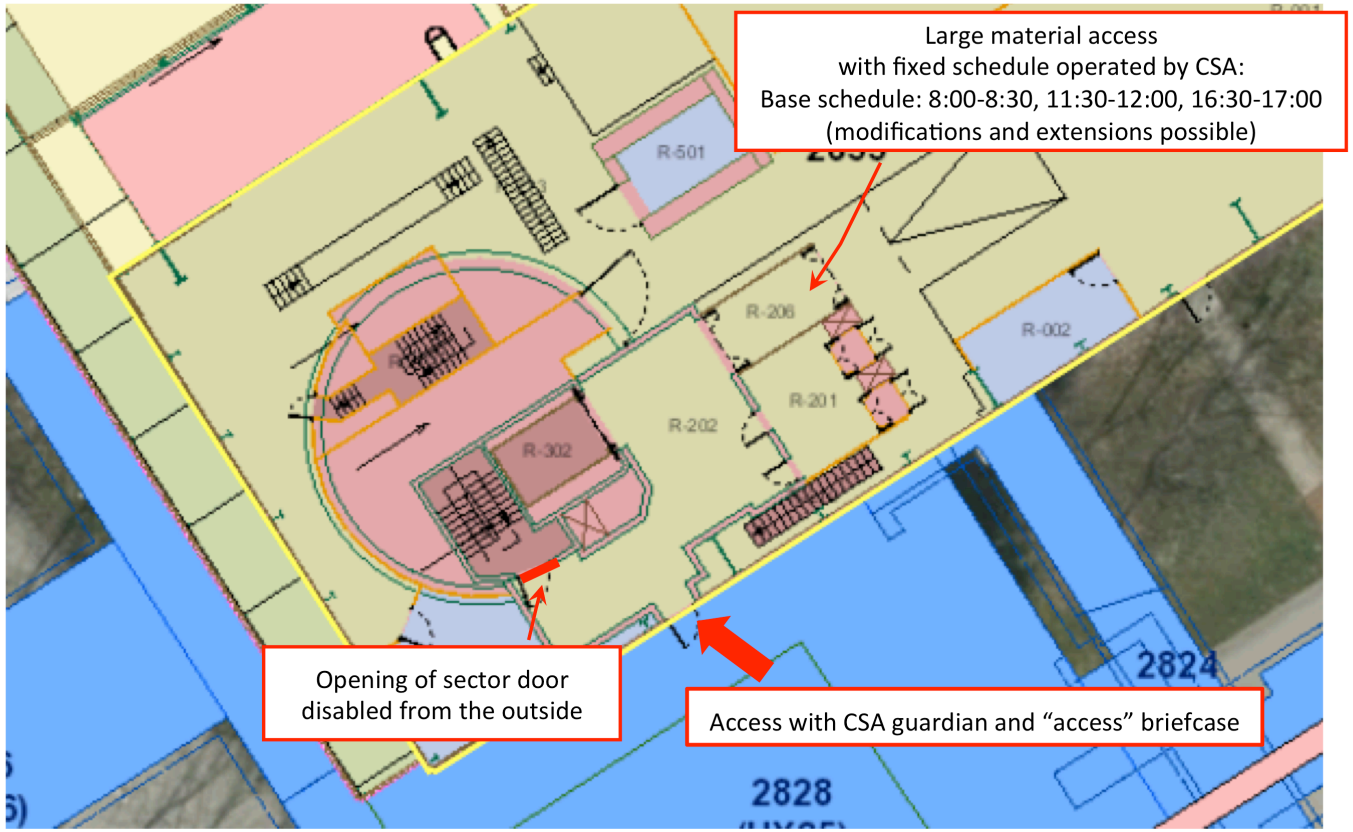
REDESIGN AND UPGRADE OF THE LHC ACCESS CONTROL SYSTEM

Project Planning and Execution

- Design and preparation 2015-2016
- Detailed specification 2017
- Prototyping 2018 – a full system prototype in the LHC access system off-line test bench
- Execution planning 2018
  - Close collaboration with LHC coordination to fix installation slot for each site
  - A widely distributed compensatory measures plan for all the stakeholders
  - Obligation to maintain access control even when an access point dismantled
  - Old and new systems coexisted during project
- Pilot installation of the new PZ65 access point in 2018 – debug installation procedure
- Upgrade of experiment non-interlocked access points early 2019 – team training
- Main installation project 2019-2020 + a COVID-19-induced extension to 2021

YCA01=PM85
(Weeks 02-04 – 2020)



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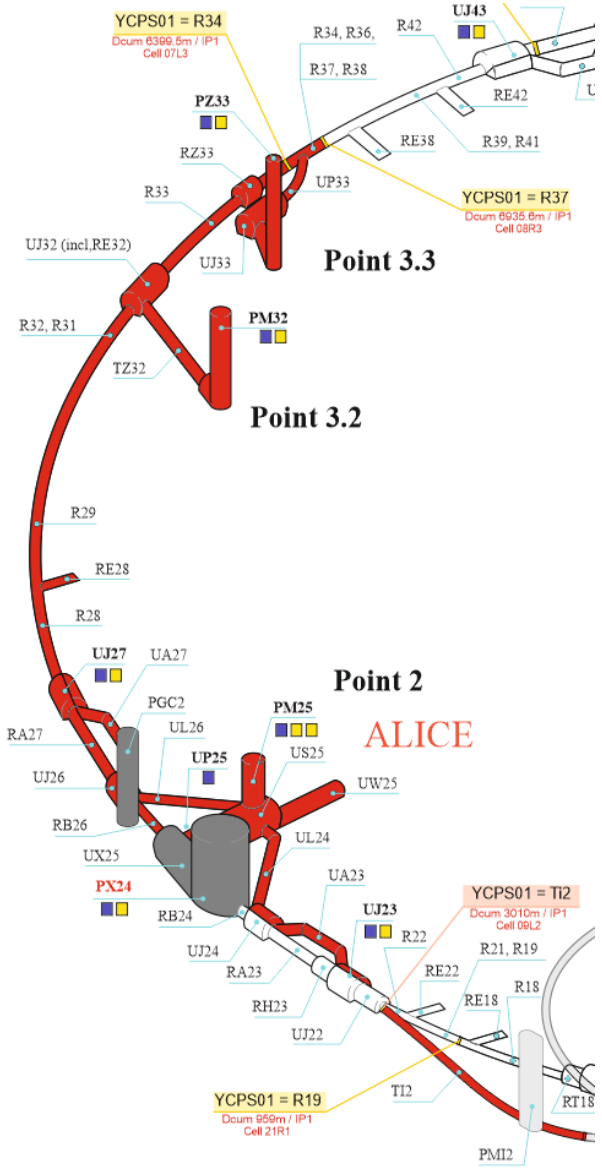
REDESIGN AND UPGRADE OF THE LHC ACCESS CONTROL SYSTEM

Verification and Validation

- Rigorous regime of testing all newly installed and modified equipment
  1. Cabling and point-to-point functionality – Contractor
  2. Local automation and signal transmission – Contractor
  3. Site-wide functional verification – CERN team
  4. Local functional validation – DSO
  5. Global functional verification – CERN team
  6. Global functional validation – DSO
- All safety elements validated by CERN Departmental Safety Officers (DSO)
- Access and safety system tests are disruptive – even local verification tests can block several sites
- Tests started in January 2020 and everything except the global tests (steps 5 and 6) have been completed

Conclusions

- The upgrade project went very smoothly: Thanks to all the stakeholders!
- Early planning and adaptability is essential
- For testing, simulation of missing elements essential, and the capability should be built-in from the start



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