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REFERENCE
LHC-Y-EC-0021

LHC

Date: 2018-06-06

ENGINEERING CHANGE REQUEST

LHC Safety System Modifications Due To HL-LHC During LS2

BRIEF DESCRIPTION OF THE PROPOSED CHANGE(S):

The new HL-LHC caverns will be connected to the LHC tunnel during LS2 via emergency exit galleries UPR. During the run 3 the UPR galleries need to be closed off from the HL-LHC galleries with end-of-zone doors supervised by the LASS. In addition, ODH detection, automatic fire detection, evacuation/BIW system, red telephones, RAMSES radiation monitoring, and Technical Network connectivity need to be installed.

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DOCUMENT SENT FOR INFORMATION TO:

LMC members, LSC members, ATS groups leaders.

SUMMARY OF THE ACTIONS TO BE UNDERTAKEN:

- Include the new access doors in the UPRs and UAs galleries into the LASS and LACS.
- Install ODH detection, automatic fire detection, evacuation/BIW system, and red telephones.
- Install a Ramses monitoring station outside of each interlocked zone in the new HL-LHC galleries and
- Install Technical Network connectivity in UPRs and UAs.

Note: When approved, an Engineering Change Request becomes an Engineering Change Order.

1. EXISTING SITUATION AND INTRODUCTION

The new caverns for HL-LHC at Point 1 and Point 5 will be dug during LS2. During the installation of the HL-LHC equipment, an emergency exit towards the LHC is needed in case of a fire or other hazard blocking exit via the principal HL-LHC pit.

2. REASON FOR THE CHANGE

The new HL-LHC caverns will be connected to the LHC tunnel during LS2 via emergency exit galleries UPR. During the run 3 the UPR galleries need to be closed off from the HL-LHC galleries with end-of-zone doors supervised by LASS [1]. In addition, ODH detection, automatic fire detection, evacuation/BIW system, red telephones, RAMSES radiation monitoring and Technical Network connectivity need to be installed.

3. DETAILED DESCRIPTION

3.1 MODIFICATION SCOPE FOR ACCESS SYSTEM

- New sectors: UPR13, UPR17, UPR53, UPR57.
- New end-of-zone doors: YCPZ01=UA13, YCPZ01=UA17, YCPZ01=UA53, YCPZ01=UA57.
- New sector doors: YCPS01=UPR13, YCPS01=UPR17, YCPS01=UPR53, YCPS01=UPR57.
- New ventilation doors: YCPV01=UA13, YCPV01=UPR13, YCPV01=UA17, YCPV01=UPR17, YCPV01=UA53, YCPV01=UPR53, YCPV01=UA57, YCPV01=UPR57.
- New patrol boxes: YZBPA01=UPR13, YZBPA02=UPR13, YZBPB01=UA13, YZBPA01=UPR17, YZBPA02=UPR17, YZBPB01=UA17, YZBPA01=UPR53, YZBPA02=UPR53, YZBPB01=UA53, YZBPA01=UPR57, YZBPA02=UPR57, YZBPB01=UA57.
- New racks (installation by CERN, connection boards by Mobility/Actemium):
  - YYACS09=SD1 and YYACS10=SD1 at PM15.
  - YYACS09=SD5 and YYACS10=SD5 at PM56.
  - YYACS06=UJ561 and YYACS07=UJ561 at UJ56 (optional – subject to a more accurate space estimate of the current racks).
- Cabling (DIC RQF0871690):
  - 16 cables NE48 from PM15 to US15. This number includes cabling needed for the works during LS3 as well.
  - 2 cables NE26 from US152 to UA13.
  - 3 cables NE26 from US152 to UPR13.
  - 1 cable BJ5SJ from US152 to UPR13.
  - 2 cable NE26 from US152 to UA17.
  - 3 cables NE26 from US152 to UPR17.
  - 1 cable BJ5SJ from US152 to UPR17.
  - 16 cables NE48 from PM56 to UJ56. This number includes cabling needed for the works during LS3 as well.
  - 2 cables NE26 from UJ561 to UA53.

  - 3 cables NE26 from UJ561 to UPR53.
  - 1 cable BJ5SJ from US152 to UPR53.
  - 2 cables NE26 from UJ561 to UA57.
  - 3 cables NE26 from UJ561 to UPR57.
  - 1 cable BJ5SJ from US152 to UPR57.
- New junction boxes at: UA13, UPR13, UA17, UPR17, UA53, UPR53, UA57, UPR57.
- Pull local cabling to the door contacts from the junction box.
- Modify the LASS safety program to include the new sectors, doors and patrol boxes.
- Add UA/UPR galleries to LASS sectorization and patrol documentation of points 1 and 5.

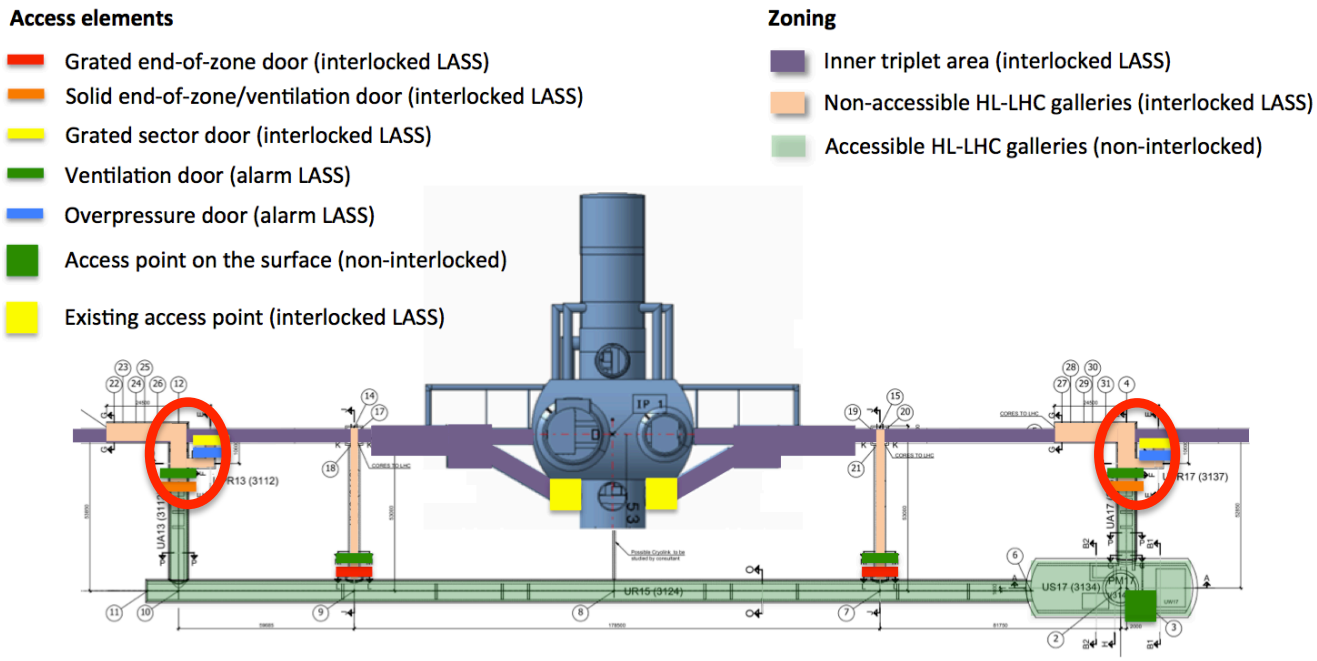

Figure 1 — Access element modifications for HL-LHC at Point 1. The circled areas (UA/UPR) are to be installed during LS2 and the rest (UL, LHC tunnel) during LS3 (a separate ECR). Similar modifications are foreseen in Point 5.

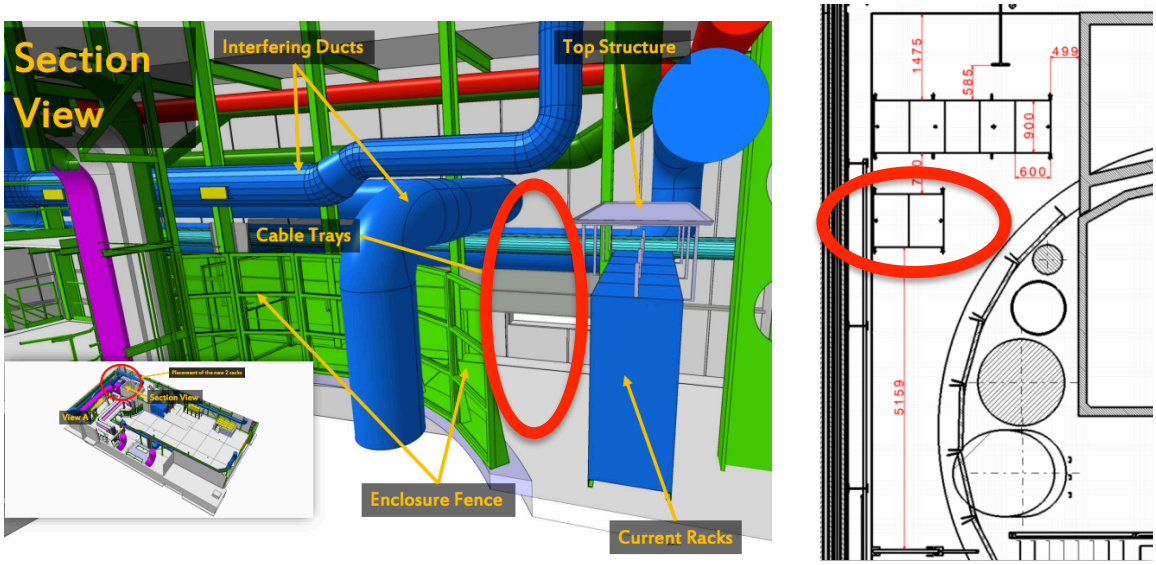

Figure 2 — Integration model view of the the new racks YYACS09=SD1 and YYACS10=SD1 at SD1.

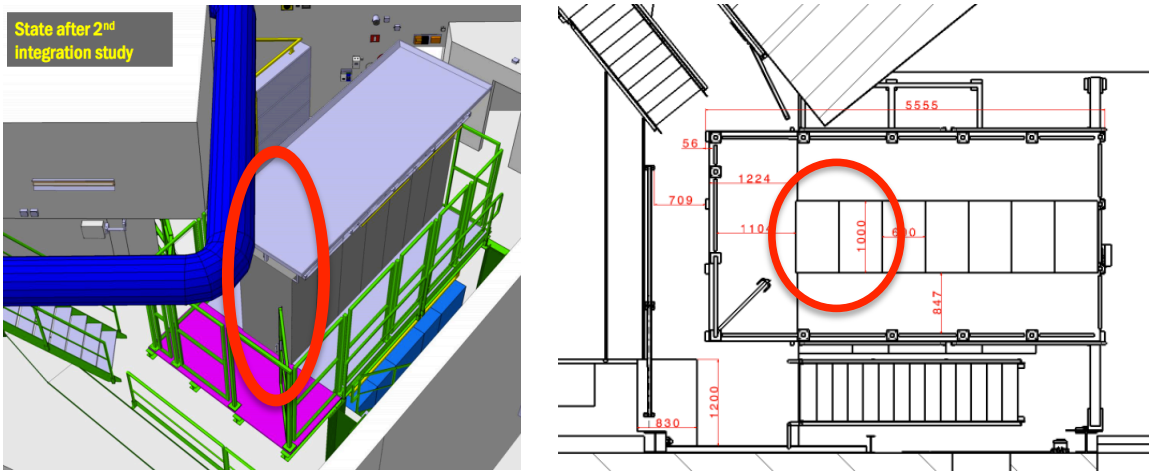

Figure 3 — Integration model view of the new racks YYACS09=SD5, YYACS10=SD5 at SD5 on top of the current LHC access point PM56.

Figure 4 — LHC grated sector door (left) and solid end-of-zone / ventilation door (right).

Figure 5 — Sector door opening buttons and patrol box (left) and junction box (right).

3.2 MODIFICATION SCOPE FOR THE OXYGEN DEFICIENCY HAZARDS (ODH) DETECTION

- 1 ODH detector in UA13, UA17, UA53, UA57.
- 2 ODH detectors in UPR13, UPR17, UPR53, UPR57.
- Cabling for each individual ODH detector from service areas of Point 1.
- 1 ODH flash signal in UA13, UA17, UA53, UA57.
- 3 ODH flash signals (one at top, one at middle, one at bottom) in UPR13, UPR17, UPR53, UPR57.
- Cabling for each individual ODH detector from service areas of Point 5.

Figure 6 — ODH detector (left) and flashing light (right).

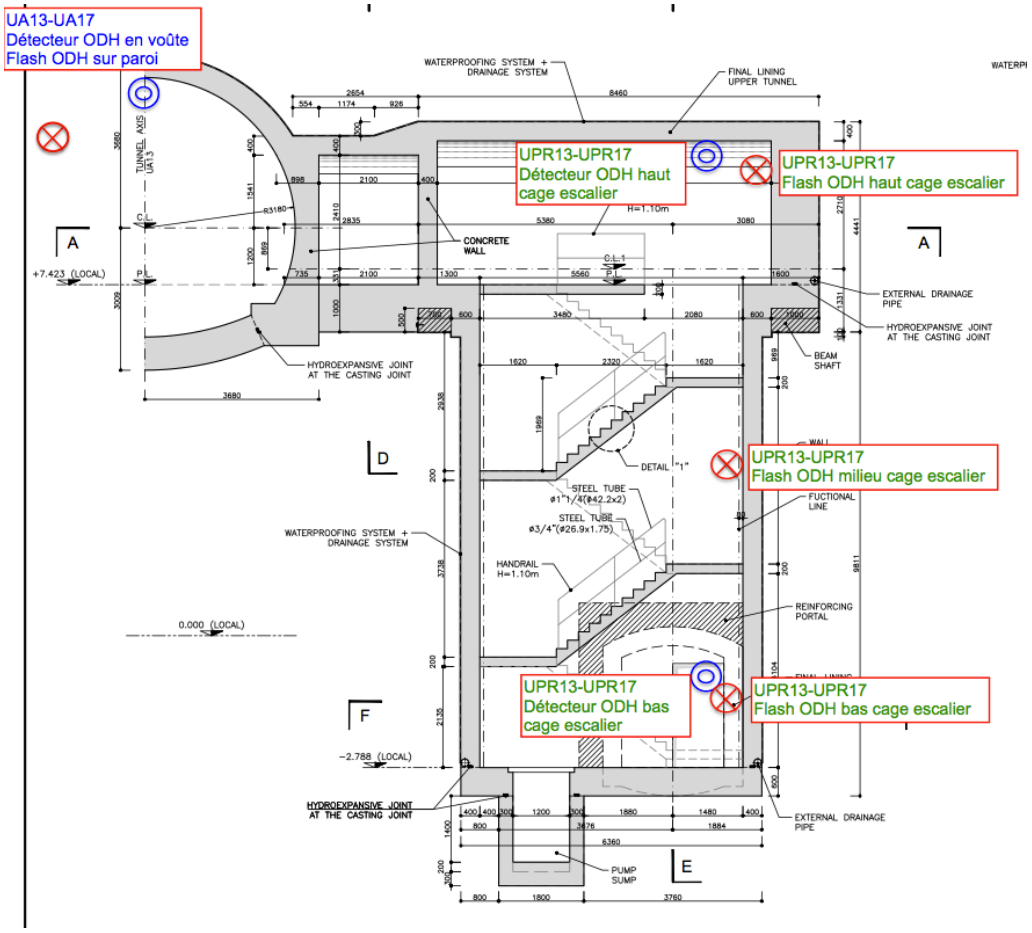

Figure 7 — Approximate positions of ODH detectors and flashes in UA17 and UPR17 (similar positions in other UAs and UPRs).

3.3 MODIFICATION SCOPE FOR AUTOMATIC FIRE DETECTION (AFD)

For Automatic Fire Detection, two different technologies exist: air sampling tubes and point detectors. The selection between these technologies depends mainly on the expected radiation environment of the installation area. Air sampling tubers are resistant to radiation and are used, e.g., in the LHC tunnel and experimental areas, whereas point detectors will deteriorate with high radiation exposure. Fire detection in the UA overpressure sas is to be carried out with point detectors, elsewhere with air sampling tubes:

- 2 fire detection tubes to UA13/UPR13 from sampling units in service areas of P1.
- 2 fire detection tubes to UA17/UPR17 from sampling units in service areas of P1.
- 2 new sampling units in service areas of P1 (1 unit / 2 tubes).
- 2 fire detection tubes to UA53/UPR53 from sampling units in service areas of P5.
- 2 fire detection tubes to UA57/UPR57 from sampling units in service areas of P5.
- 2 new sampling units in service areas of P5 (1 unit / 2 tubes).
- 4 point-detectors, one in each UA overpressure sas. Cabling is to be pulled from the service areas.

Figure 8 — AFD air sampling smoke detectors (left) and a point detector (right).

3.4 MODIFICATION SCOPE FOR EVACUATION SYSTEM AND BIW

- 2 sirens for evacuation signal and BIW inside every UPR (UPR13, UPR17, UPR53, UPR57), one at the top of stairs, one at the bottom
- 2 evacuation buttons (break-glass device) in each UPR (UPR13, UPR17, UPR53, UPR57), one at the top of stairs, one at the bottom.
- Standard signalisation of evacuation routes to be installed by HSE / TSOs.

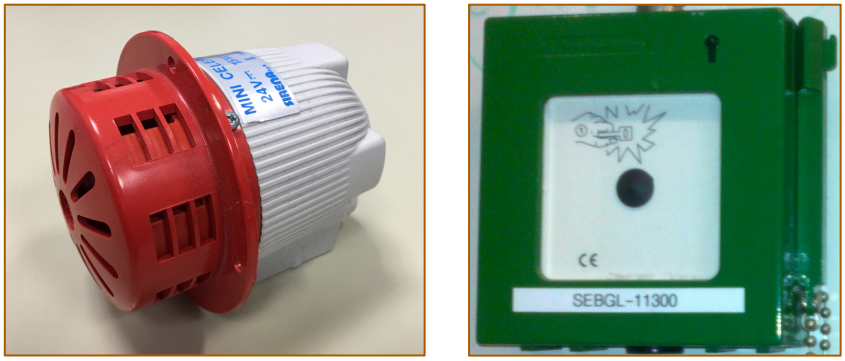

Figure 9 — Evacuation/BIW siren (left) and evacuation button, i.e., break-glass device (right).

3.5 MODIFICATION SCOPE FOR RED TELEPHONES

- 2 red telephones in each UPR (UPR13, UPR17, UPR53, UPR57), one at top of stairs, one at the bottom.
- Cabling for red telephones in each UPR from the service areas of P1 and P5 (one cable per two phones).

Figure 10 — Red telephone.

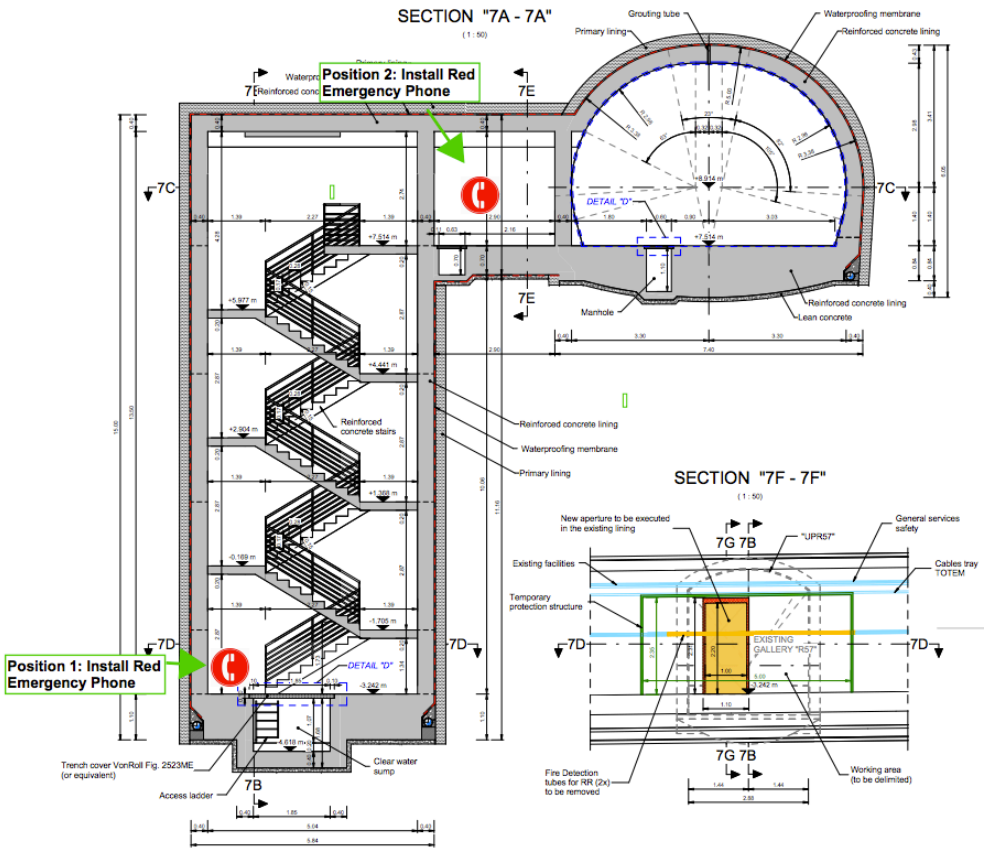

Figure 11 — Approximate positions of red telephones in UA57 and UPR57 (positions in other UAs and UPRs are similar).

3.6 MODIFICATION SCOPE FOR CERN SAFETY ALARM MONITORING (CSAM)

Some of the equipment to be installed in the UPRs will be connected to the currently existing CSAM installation at P1 and P5 for safe delivery of level-3 alarms:

- The red telephones.
- Equipment by CV: pumps, ventilators.

No extension of the current CSAM service on sites 1 and 5 is currently foreseen as the existing capacity should be sufficient. The following SAREP-connection boxes for the physical connection to CSAM are available:

SAREP UNITS AVAILABLE FOR EACH UPR			
UPR	**SAFETY ZONE**	**SAREP**	**LOCATION**
13	01	0001	Underground
17	01	0001	Underground
		0044	Surface
53	05	0025	Underground
57	05	0025	Underground

3.7 MODIFICATION SCOPE FOR RAMSES RADIATION MONITORING

- 1 RAMSES "Crome" radiation monitor and one signalling flash light outside of the interlocked zone of each UA gallery (UA13, UA17, UA53, UA57).
- 1 uninterruptible power unit on the interlocked side of each UA gallery.

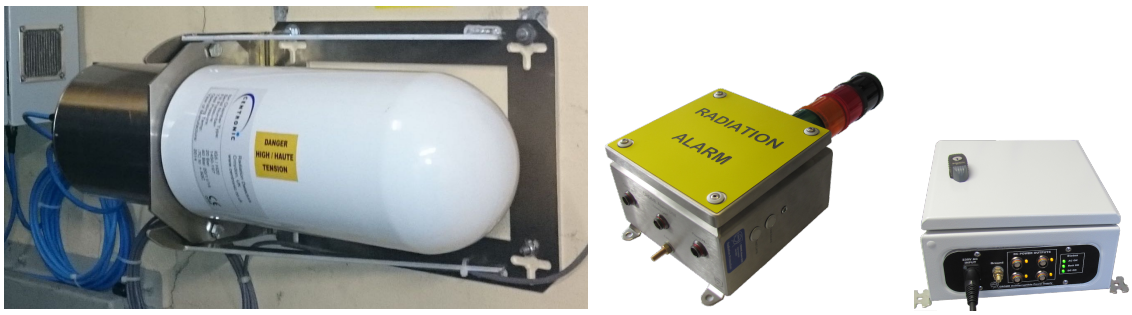

Figure 12 — "Crome" radiation monitor (left), flashing light (middle) and power unit (right).

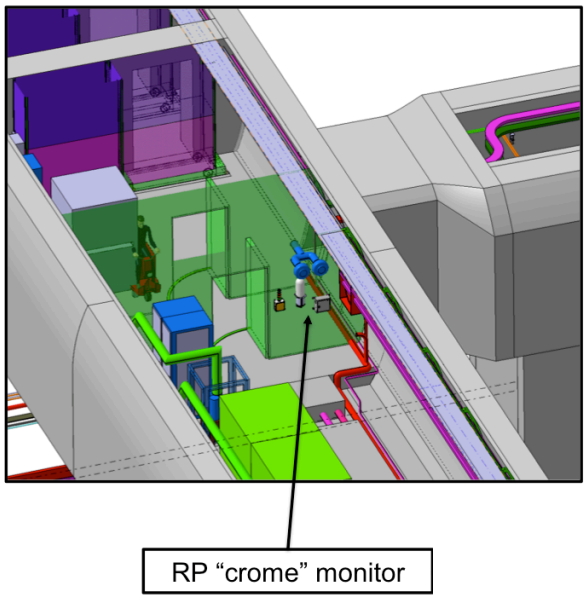

Figure 13 — Integration model view of the positioning of the “Crome” radiation monitor and the flash unit outside of the interlocked area in the UA gallery in the final configuration.

3.8 MODIFICATION SCOPE FOR EMERGENCY LIGHTING AND AUG

Emergency lighting is to be installed to the UPRs.

AUG is to be installed in the UPR.

3.9 MODIFICATION SCOPE FOR FIREFIGHTING EQUIPMENT

In the final configuration after LS3 there will be RIA/STORZ installed for fighting fire. However, after LS2 these equipment will not yet be available.

The Fire Brigade will position an electrical 2-seat tractor and a fire intervention trailer equipped with a CAFS (Compressed Air Foam System), spare SCBA (Self-Contained Breathing Apparatus), hose loads, forcible entry tools and extinguishers into the interlocked part of the UA.

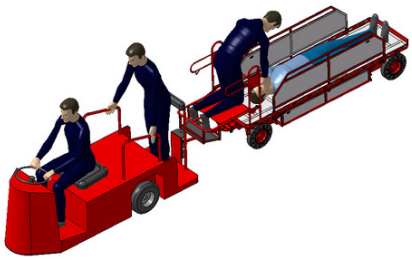

Figure 14 — The tractor with CAFS, spare SCBA, and other equipment (left). The tractor being used to transport an unwell person.

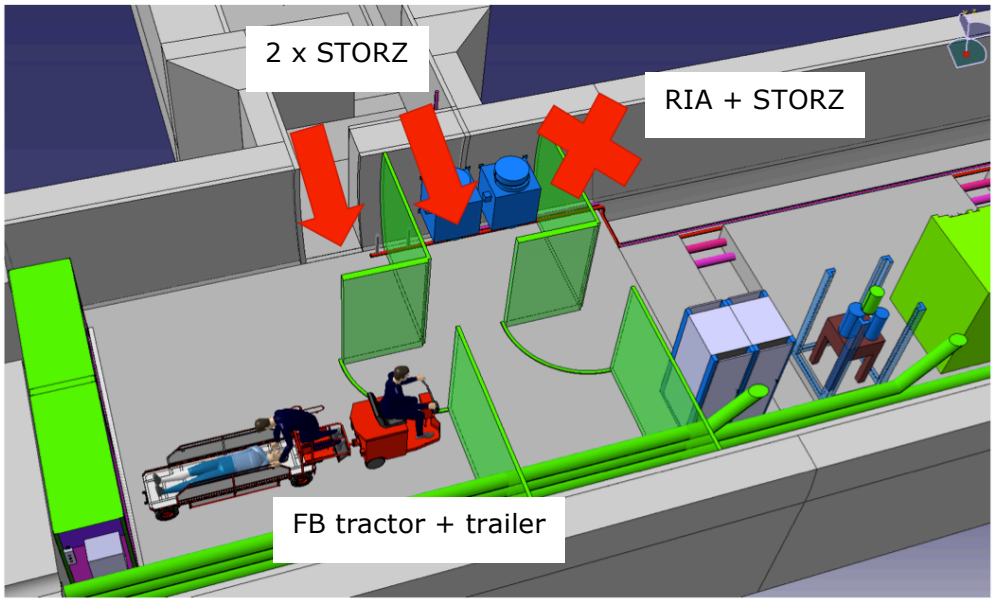

Figure 15 — Positions of the Fire Brigade tractor and trailer (after LS2) as well as the STORZ and RIA/STORZ equipment (after LS3) in the UA.

3.10 MODIFICATION SCOPE FOR DOORS AND SHIELDING

Overpressure door: 60 mbar overpressure for MCI He.

Fire doors: 90 min fire resistance.

Mobile shielding at the top of UA.

Chicane at the bottom of UPR.

3.11 MODIFICATION SCOPE FOR CV EQUIPMENT

Overpressure sas: 25 Pa

Sump pumps.

3.12 MODIFICATION SCOPE FOR NETWORKING

An IT starpoint will be installed in each UPR to provide Technical Network connectivity to systems that require it. Of the safety systems, only RAMSES monitoring will be connected to the Technical Network. The list of equipment to be installed is:

- IT starpoint rack on the top level of each UPR.
- Fiber-optic cabling from the closest IT starpoint in the service areas of P1 and P5.
- Network sockets and local cabling from the starpoint rack to each socket: 6 sockets in each UA, 2 sockets at the top of each UPR and 4 sockets at the bottom of each UPR.

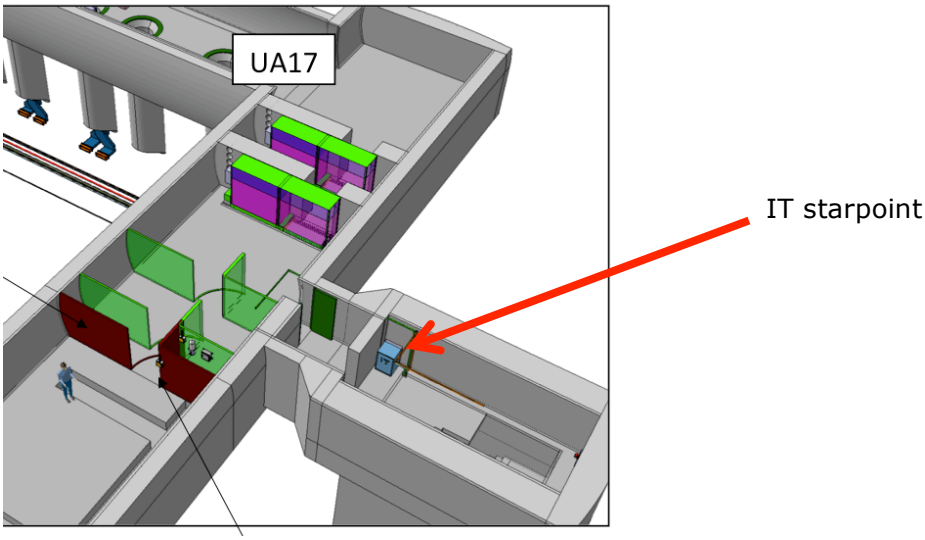

Figure 16 — Integration model view of the location of the IT starpoint rack in the UPR17.

3.13 PREREQUISITES

- The LHC has to be in general access mode and the LASS not solicited.
- UPR caverns are finalized by HL-LHC WP17.1.
- Access and ventilation doors are installed by HL-LHC WP17.10.

3.14 INTEGRATION

The corresponding integration models are in SmarTeam:

- Point 1 UPR/UA: ST0866270_01
- Point 5 UPR/UA: ST0874341_01
- Point 1 SD1 access racks: ST0808543_01
- Point 5 SD5 access racks: ST0806300_01

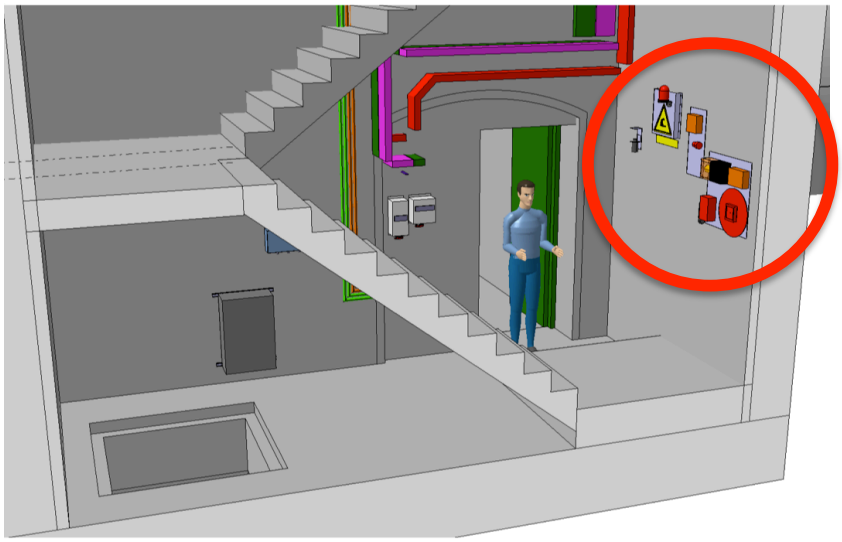

Figure 17 — Integration model view of the locations of ODH detector, flashing light, red telephone, evacuation break-glass device and siren, as well as AUG at the bottom of a UPR (courtesy of XXX).

3.15 PLAN

This activity is covered by PLAN entry 11105.

4. IMPACT ON OTHER ITEMS

4.1 IMPACT ON ITEMS/SYSTEMS

LACS	Functional tests of the new equipment.
LASS	Functional tests of the new equipment.
ODH	Functional tests of the new equipment.
Fire detection	Functional tests of the new equipment.
Red telephones	Functional tests of the new equipment.
Radiation monitoring	Functional tests of the new equipment.

4.2 IMPACT ON UTILITIES AND SERVICES

Raw water:	-
Demineralized water:	-
Compressed air:	-
Electricity, cable pulling (power, signal, optical fibres…):	Signal cabling from LASS / ODH / fire detection / evacuation / red telephone racks at US15 and USC55, respectively. Optical fibres for IT starpoint racks at UPRs.
DEC/DIC:	The DIC references are: RQF0871690 (Access system P1 and P5) RQF0970069 (Access system racks P1 and P5) RQF0812531 (ODH detection P1) RQF0812538 (ODH detection P5) RQF0857847 (Fire detection / evacuation / BIW P1) RQF0857856 (Fire detection / evacuation / BIW P5) RQF0943508 (Red telephones UPR13) RQF0943514 (Red telephones UPR17) RQF0940810 (Red telephones UPR53) RQF0940815 (Red telephones UPR57) The DIF is under discussion: To be defined by IT for the starpoint installation.
Racks (name and location):	2 new access racks at P1: YYACS09=SD1, YYACS10=SD1 4 new access racks at P5: YYACS09=SD5, YYACS10=SD5 YYACS06=UJ561, YYACS07=UJ561 (optional) 4 new IT starpoint racks at the top of each UPR (1 in each).

Vacuum (bake outs, sectorisation…):	-
Special transport/ handling:	-
Temporary storage of conventional/radioactive components:	-
Alignment and positioning:	-
Scaffolding:	-
Controls:	-
GSM/WIFI networks:	-
Cryogenics:	-
Contractor(s):	Cegelec, Semer (Access system), Securiton (Fire detection / evacuation / BIW)
Surface building(s):	-
Others:	Civil engineering: Require SMB-SE to modify existing structures.

5. IMPACT ON COST, SCHEDULE AND PERFORMANCE

5.1 IMPACT ON COST

Detailed breakdown of the change cost:	There's no cost to LHC consolidation budget. Estimated cost to HL-LHC project is: Access system installation: 149 000 EUR Access system cabling: 174 000 CHF ODH detection (cabling included): 74 000 CHF Fire detection / evacuation / BIW (cabling included): 149 000 CHF Red telephones (cabling included): 20 000 CHF Radiation monitoring: 170 000 CHF IT Networking: 79 000 CHF
Budget code:	91060: HL-LHC WP17.4 – LASS:EIS –a-f-m- for LHC run (Access system) 91069: HL-LHC WP17.4 – ODH detection 91066: HL-LHC WP17.4 – Fire detection, automatic protection & evacuation 91068: HL-LHC WP17.4 – CSAM & red telephones 91185: HL-LHC WP17.4 – Radiation monitoring 47446: HL-LHC WP17.5 – Networking

5.2 IMPACT ON SCHEDULE

Proposed installation schedule:	LS2

Proposed test schedule (if applicable):	LS2
Estimated duration:	1 month for installation per UPR according to current HL-LHC planning.
Urgency:	High
Flexibility of scheduling:	Rigid. Very tight installation window at the end of LS2.

5.3 IMPACT ON PERFORMANCE

Mechanical aperture:	N/A
Impedance:	N/A
Optics/MADX	N/A
Electron cloud (NEG coating, solenoid…)	N/A
Insulation (enamelled flange, grounding…)	N/A
Vacuum performance:	N/A
Others:	

6. IMPACT ON OPERATIONAL SAFETY

6.1 ÉLÉMENT(S) IMPORTANT(S) DE SECURITÉ

Requirement	Yes	No	Comments
EIS-Access	x		New EIS-a in the new HL-LHC UPR/UA galleries.
EIS-Beam		x	
EIS-Machine		x	

6.2 OTHER OPERATIONAL SAFETY ASPECTS

Have new hazards been created or changed?	No
Could the change affect existing risk control measures?	Modification of LHC patrol routes.
What risk controls have to be put in place?	-

Safety documentation to update after the modification	LASS / LACS documentation, operator and patrol documentation. Engineering safety documentation for ventilation doors [3]. Instructions for TI operator in case of loss of overpressuration of the sas in the UA.
Define the need for training or information after the change	LHC operator and patroller training.

7. WORKSITE SAFETY

7.1 ORGANISATION

Requirement	Yes	No	Comments
IMPACT – VIC:	x		
Operational radiation protection (surveys, DIMR…):		x	
Radioactive storage of material:		x	
Radioactive waste:		x	
Non-radioactive waste:		x	
Fire risk/permit (IS41) (welding, grinding…):		x	
Alarms deactivation/activation (IS37):	x		Possible during installation of new alarm equipment.
Others:		x	

7.2 REGULATORY TESTS

Requirement	Yes	No	Responsible Group	Comments
Pressure/leak tests:		x		
Electrical tests:		x		
Others:	x		BE-ICS, DSO	Validation tests of installed equipment. DSO tests.

7.3 PARTICULAR RISKS

Requirement	Yes	No	Comments
Hazardous substances (chemicals, gas, asbestos…):		x	

Work at height:		x	
Confined space working:		x	
Noise:		x	
Cryogenic risks:		x	
Industrial X-ray (*tirs radio*):		x	
Ionizing radiation risks (radioactive components):		x	
Others:		x	

8. FOLLOW-UP OF ACTIONS BY THE TECHNICAL COORDINATION

Action	Done	Date	Comments
Carry out site activities:			
Carry out tests:			
Update layout drawings:			
Update equipment drawings:			
Update layout database:			
Update naming database:			
Update optics (MADX)			
Update procedures for maintenance and operations			
Update Safety File according to EDMS document 1177755:			
Others:			

9. REFERENCES

[1] G. Apollinari et al., "High-Luminosity Large Hadron Collider (HL-LHC) : Technical Design Report", CERN-2017-0007-M, Chapters WP17.4 and 17.5. CDS: http://cds.cern.ch/record/2284929
[2] Xxx
[3] S. Weisz, "Doors in the LHC Underground Areas: Principle for Control and Release of Helium in Case of Accident", LHC-SQ-EY-0001, EDMS: 1346139 v.1.0