



HL-LHC LS3 Planning in LSS1 and LSS5 and EN-EL activities

WP15 and EN-EL meeting
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HL-LHC WP15.2 (Installation) and 15.3 (De-Installation)

The Problem

- In C&SR'19, WP15 presented the first version of the LS3 Installation Planning for LSS1 and LSS5 ([EDMS 2254475](#)).
 - The LS3 duration according to the planning presented in 2019 was **4 years** (*resulted from putting together the first inputs from WPs/Groups on how much time they would need and possible parallelisms between the 4 IP sides*)
 - We also said that we see possibilities to go down to **3 years** (*with some more aggressive assumptions, unilaterally defined by WP15 at that moment*).
- **CERN management** asked the HL-LHC Project to develop a planning fitting in **2.5 years (30 months)** that is the nominal LS3 duration as of today, of course listing next to the planning what it will mean in terms of **resources**.
- As such, WP15 is asked to present in the **TCC Day (5-November-2020)** a **possibly 2.5 years** planning for the LS3.
- We have been working in the last months with all WPs/CERN Groups mainly impacting the **critical path**. Several activities have been better optimized wrt C&SR'19 (*e.g.: machine de-installation, civil engineering works, CRG installation/commissioning, magnets installation, commissioning sequence etc. – see slide 4*).
- The activities of **EN-EL** (Electrical distribution and Cabling) are activities on which an **optimization has not yet been completed** to (try to) fit in the LS3 nominal duration (*we worked a lot with EN-EL on study cohabitation of activities but not on possible approach for increased resources/shifts*).

(DISCLAIMER: in this presentation we only discuss EL activities on the LS3 critical path, i.e. activities whose duration translate directly on LS3 total duration; as such, this does not cover Optical Fibers activities and some of the interventions of EPM/FC teams in non-critical phases.)

“Very basic recall” of LS3 sequence in LSS1-LSS5

In blue the phases with big participation of EN-EL

1. Warm-up of the machine
2. De-installation of existing LHC machine from IP center up to Q6 (excluding Q6)
3. Preparation for civil engineering works (including de-cabling campaign and general services removal)
4. Civil engineering works (6 vertical cores per IP side connecting new HL-LHC galleries to the LHC tunnel, and other minor works in the tunnel)
5. Re-installation of general services
6. Installation of new cryogenic lines
7. 1st Cabling works (in multiple/parallel or not phases)
8. Installation of new HL-LHC machine (beamline elements)
9. 2nd (completion) of cabling works
10. Cool-down and commissioning sequence

Significant reduction has been achieved with various teams

Activity		Duration			agreed upon?
		C&SR 2019	August-2020	Delta	
Warm-up and associated activities		14w	12w	2w	yes
De-installation	one IP	11w	8w	3w	yes
	all IPs	20w	13w	7w	yes
De-cabling and services preparation for cores works		16w	12w	4w	yes
Cores and other civil engineering works	one IP	16w	8w	8w	yes
	all IPs	24w	14w	10w	yes
Re-establish services after cores		15w	15w	0	no, EL asks for far larger installation times. Work in progress with EL.
QXL/QRL Installation and system tests	1st IP	12w	12w	0	yes
	2nd IP	9w	12w	-3w	yes (CRG now requires full system test of both points)
Magnet installation	1st IP side	23w	17w	6w	yes
	Remaining IP sides	19w	13w	6w	yes
	all IPs	42w	25w	17w	yes
New Cabling	alone time	37w	37w	0	no, EL asks for far larger installation times. We would need to reduce cabling time to about 20W+10W to stay in 31 months. Work in progress with EL.
	parallel with magnets	14w	14w	0	
VSC installation	one IP	9w	9w	0	TBC (depends on number of parallel work fronts vs available resources)
	all IPs	14w	14w	0	
Cool-down sequence		26w	22w	4w	TBC (depends on independent cool down of arc vs LSS). Today this gain looks far fetched after initial work of dedicated WG

Note: weeks shall not be summed up because they are not all on the critical paths

Recall of EN-EL Activities in LSS1-LSS5 during LS3

- Electrical distribution (by N. Dos Santos, details in [EDMS 1896607](#))
 1. De-installation:
 - Removal and disconnection of all machine power boxes and associated cabling (before machine removal)
 - Identify, pull and connect temporary cabling for RRs and sectors >C6 (to assure continuity of services during cores works)
 - Dismantle EN-EL PW equipment (AUG, PW panels, lights, boxes)
 - Remove powering cables (done by FC)
 - Dismantle cable trays and supports (in the area of the cores and where the present cable tray layout is not compatible with the future machine)
 - Displace safety cables around UA-UL cores area.
 2. Re-installation:
 - Install supports and cable trays in the future layout
 - Install EN-EL PW equipment (AUG, PW panels, lights, boxes)
 - Re-install, pull and connect powering cables
 - Remove temporary cabling; displace back safety cables.
 - Tests and commissioning
 3. New machine installation:
 - Install new power boxes and new cabling for new machine needs
- Considered resources up to now: 1 team per IP side, 1 shift of 8h/day, 5 days/week.

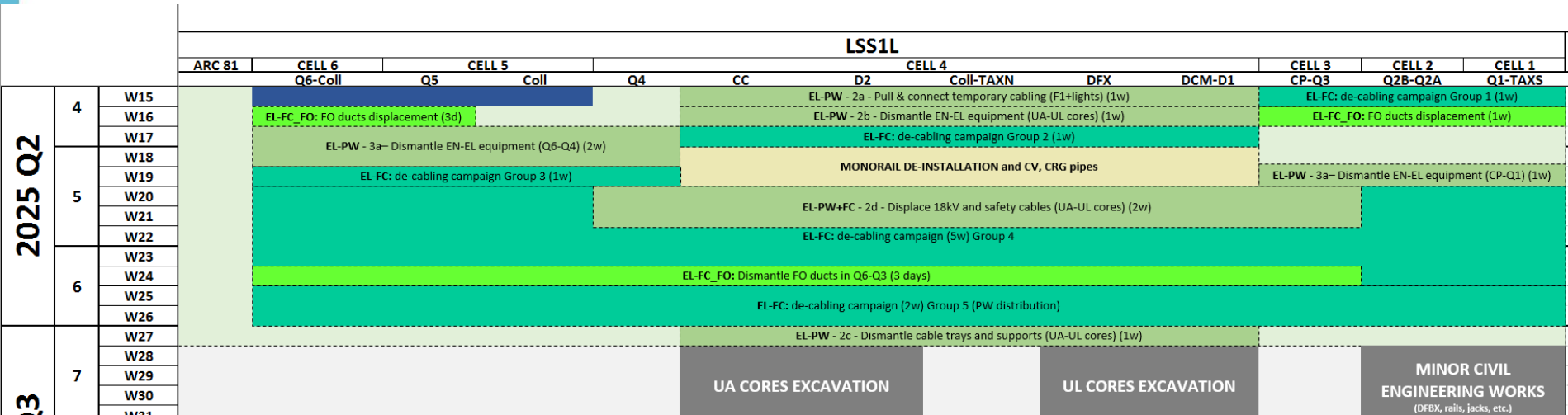
Recall of EN-EL Activities in LSS1-LSS5 during LS3

- Control/Signal (by D. De Luca, details in [Indico 942518](#))
 1. De-installation:
 - de-cabling of **all cables (control/signal and powering)** in machine cable trays before cores activities because (1) cable trays interfering with cores; (2) obsolete cables must be removed to make space for new HL cabling.
 - displace safety cables around UA-UL cores area.
 2. Re-installation: displace back safety cables
 3. Installation: cabling for new HL-LHC machine
 - from existing LHC galleries in center of IP1/5 to the LSS (including those cables traversing the area affected by HL-LHC)
 - from new HL-LHC galleries to the LSS (via UA/UL cores)

- Considered resources up to now: 1 team per IP side, 1 shift of 8h/day, 5 days/week.

Phase 1: De-cabling

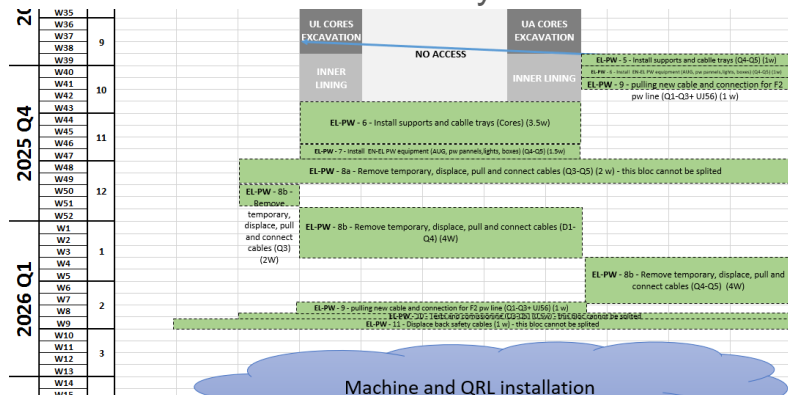
- The inputs provided by D. De Luca, N. Dos Santos and J. Blanc were included properly in the planning in terms of duration, co-habitation and parallelism of activities.
- However, we are talking about ~3 months in which EN-EL teams will be alone in the tunnel, so, would it be possible to consider an optimization of this phase in order to be faster?



Phase 2: Re-installation of services

- We have parallelized as much as possible EL activities with Civil engineering works to reduce critical path occupancy. But we still have a major mismatch between available slots and the durations estimated by N. Dos Santos to carry out the needed works as known today.

2025 Q3	W28	MINOR CIVIL ENGINEERING WORKS (including) (2w)	UL CORES EXCAVATION	UA CORES EXCAVATION	ACCESS POLICY DURING CORES WORKS IS UNDER REVISION
7	W29				
8	W30				
8	W31				
8	W32	EL-PW - 3a - Re-install supports, cable trays (D2-D7) (2w)	INNER LINING	INNER LINING	EL-PW - 3b - Demount cable trays (D4-D8) (2w)
8	W33	EL-PW - 5a - Re-install supports, cable trays, lights & ducts, boxes FX for new layout (D2-D7) (2w)			EL-PW - 5a - Re-install supports, cable trays, lights & ducts, boxes FX for new layout (D4-D8) (2w)
8	W34				
8	W35	EL-PW - 3b - Connecting lights & distribution boxes, cables, tests and commissioning (EPG2) (2w)			EL-PW - 3b - Connecting lights & ducts boxes cables, tests and commissioning (D4-D8) (2w)
8	W36				
8	W37	EL-PW - 3b - Connecting lights & distribution boxes, cables, tests and commissioning (EPG2) (2w)			EL-PW - 3b - Connecting lights & ducts boxes cables, tests and commissioning (D4-D8) (2w)
8	W38	EL-PW - 3b - Connecting lights & distribution boxes, cables, tests and commissioning (EPG2) (2w)			EL-PW - 3b - Connecting lights & ducts boxes cables, tests and commissioning (D4-D8) (2w)
8	W39	EL-PW - 3b - Connecting lights & distribution boxes, cables, tests and commissioning (EPG2) (2w)			EL-PW - 3b - Connecting lights & ducts boxes cables, tests and commissioning (D4-D8) (2w)
8	W40	EL-PW - 3b - Connecting lights & distribution boxes, cables, tests and commissioning (EPG2) (2w)			EL-PW - 3b - Connecting lights & ducts boxes cables, tests and commissioning (D4-D8) (2w)
			SURVEY: Marking equipment position (beamline, jacks, cryogenic line and pumps, etc.)		



- Under the current working assumptions, **19.5 weeks** are needed for EL activities after Civil Engineering and before the new machine can be installed.
- Given that, also in this phase there are only EN-EL activities, we ask EL management what other actions or strategic decisions can be taken in order to fit in the time provided by CERN management.
 - Whether it is worth the “price to pay” versus the “time gain” will be determined by CERN management. Remember our mandate: To develop a planning fitting in **2.5 years** (the official LS3 duration), listing next to the planning what this would means in terms of extra resources.

Phase 3: Cabling

- The times estimated by FC team are coming from:
 - Existing cables to be re-installed:
 - based on traversing cables from GESMAR extraction of 2018 → this is a very rough approximate, **we will provide very soon (next week) a detailed list of these cables;**
 - New HL-LHC cables (*2019 pre-DIC exercise*)
 - We were able to collect recently some missing inputs from 2019 (e.g: CRG)
 - We asked the major players in terms of cabling volume (e.g.: MPE, Survey) to revise their pre-DIC to provide a better, more accurate and updated view on their cabling needs. **This should arrive end of September.**
 - However, we believe the present cabling BoQ being used for planning inputs is, within a reasonable error margin, **representative of the correct volume.**
 - As such we should carry out the “planning optimization” regardless of the refinement going on.
- Under present working assumptions (1 shift) the time requested for cabling installation is as follows, values per IP side:
 - 7 weeks for re-installation of existing cables
 - 24 weeks from HL-LHC galleries to the LHC tunnel or existing LHC galleries
 - 20 weeks from existing LHC galleries to LHC tunnel or within LHC tunnel.
 - Total: **51 weeks per IP side.**

Phase 3: Cabling – possible optimizations

- Parallelism with Machine installation by dividing the cabling campaigns in locations (*inputs from Davide De Luca*):
 - Cables in UA cores: **14w**
 - Cables in UL cores + Cables from LHC galleries: **33w**
 - **Total: 47w** (less 4w than before because final connector mounting is assumed in co-habitation with other installation tasks)
- Today we have in the planning in-work the following available times:
 - UA cores available (but not towards the IP): **8w**
 - Everything available (minor or no co-activities): **15w**
 - **Total: 23w**
- **Therefore we ask EL management what other actions or strategical decisions can be taken in order to fit in the time provided by CERN management.**

Conclusions/next steps

- We need to know:
 - Can we assume a reduction in de-cabling activities (to gain time for your other activities) by changing work conditions?
 - Can we estimate a reduction in the re-installation activities (electrical distribution) and cabling activities (control and signal cabling) ? The inputs provided are just too long to fit in LS3 baseline duration?
 - If YES, by how much? Budget evaluation for the resources needed for this optimization will follow...
 - If NOT, we will input the times provided stating these are the best estimates provided by EL group and optimization was deemed unfeasible at this stage.
- Technical works are still being carried out to provide better inputs for planning estimates:
 - Cable trays integration in the LHC tunnel is under discussion because the volume available in existing cable trays is not enough for future HL-LHC cable volume.
 - New and revised/more accurate pre-DICs will be confirmed very soon, together with a more accurate list of existing cables to be re-installed (we would like to “freeze” for the moment at that stage the process and then leave EN-EL with the revision of estimation).
- Either way, to be keep in mind that this planning will surely evolve significantly in the years to come.