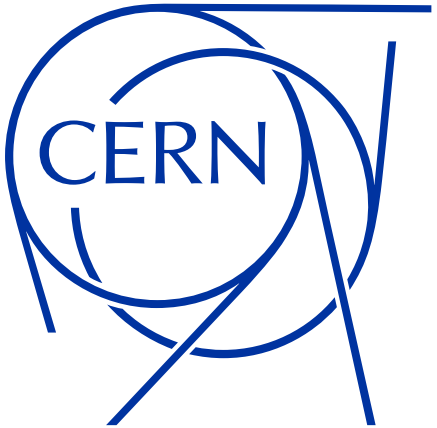


LS3

Readiness Review

EDMS 3170211

TE-MSC Activities for the LHC

Sandrine Le Naour

2024-12-10 – TE-MSC meeting

LS3 activities for MSC in the LHC

MSC activities and contribution during LS3

MSC activities in Arc and DS

Consolidation activities in the LHC

- **Change of cryomagnets (quench heater circuit issue) :**
  MQ.11R8, MB.A18L1, MQ.14L3, MB.C28L6 (NCR 2570229, NCR 2579551, NCR 2868367, NCR 3091387)
- **Diode blowholes issue** (NCR 2707278)
  42 diodes to open in all sectors but S23, S56
- **Connection cryostat inspection**
  LEJL.5L6 & LEBL.11R4 (NCR 2571503, NCR 2550143)
- **Current leads maintenance**
- **Known and unknown NC**

HL-LHC activities for WP3 :

- **Change of cryo-magnets** (cold mass with MS corrector magnet) **:**
  Q10R1, Q10L1, Q10R5, Q10L5

BST activities see G. Rosaz presentation

- **Opening and closure of the interconnection**
- **V line cutting and PIM flange cutting on magnet side** if necessary

MSC activities and contribution during LS3

MSC activities in Arc and DS

Consolidation activities in the LHC

- **Change of cryomagnets (quench heater circuit issue) :**
  MQ.11R8, MB.A18L1, MQ.14L3, MB.C28L6 (NCR 2570229, NCR 2579551, NCR 2868367, NCR 3091387)
- **Diode blowholes issue** (NCR 2707278)
  42 diodes to open in all sectors but S23, S56
- **Connection cryostat inspection**
  LEJL.5L6 & LEBL.11R4 (NCR 2571503, NCR 2550143)
- **Current leads maintenance**
- **Known and unknown NC**

HL-LHC activities for WP3 :

- **Change of cryo-magnets** (cold mass with MS corrector magnet) **:**
  Q10R1, Q10L1, Q10R5, Q10L5

BST activities see G. Rosaz presentation

- **Opening and closure of the interconnection**
- **V line cutting and PIM flange cutting on magnet side** if necessary

MSC activities in LSS (MS & IT)

Consolidation activities in the LHC

- **Seal maintenance on normal conductor magnets**
- **Bellows consolidation in IT in point 2 & 8**
  Exchange of wedge welded bellows by hydroformed bellows where it is possible

HL-LHC activities in IT 2 & 8 for WP12/ WP14

- **Installation of D1 mask**
- **aC coating of beam line**
  Opening / Closure of IT interconnection and PIM cutting

HL-LHC activities in Pt 1 & 5 for WP3/ WP9 / WP15

- **Disconnection of Inner Triplet (IT)**
- **Disconnection and connection of magnets in MS : Q5,Q4 (-D2)**
- **Connection of WP3 magnets and interlinks**
- **Splicing work on the DSL, and QRL/QXL jumper plug cutting**

HL-LHC activities in Pt 1 & 5 for WP6a : Cold Powering systems

HL-LHC activities in Pt 4

Replacement of BGI magnets (NC magnets)

Inner Triplet disconnection in point 1&5

Three months after the beginning of LS3, the inner triplet magnets Q1, Q2, Q3 and D1 must be dismantled.

A DIMR has been defined, requiring intervention of several equipment owners from different groups. The collective dose will be collected by B. Di Girolamo by the end of the year.

Group 1 Criteria: EDMS 1751123

'**hard**' limits used to determine the minimum ALARA Level

Individual dose equi.	Level I	100 µSv	Level II	1 mSv	Level III
Collective dose equi.		500 µSv		5 mSv	

Group 2 Criteria:

base of a radiological risk assessment

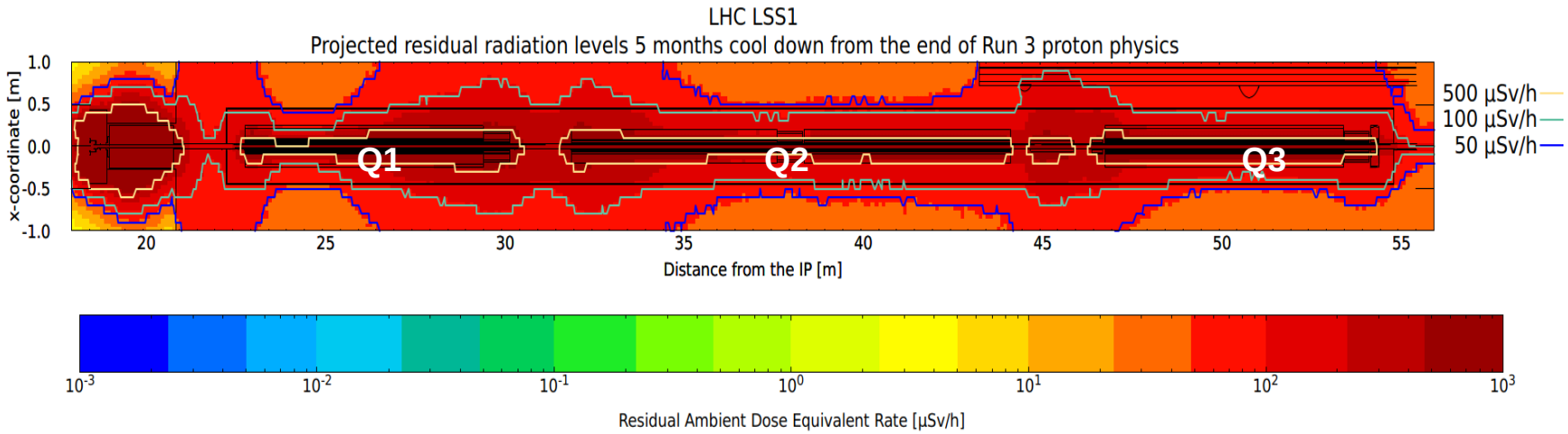
Ambient dose equivalent rate	Level I	50 µSv/hr	Level II	2 mSv/hr	Level III
Airborne activity in CA		5 CA		200 CA	
Surface contamination in CS		10 CS		100 CS	

Note: 1 mSv = 100 mrem

For the disconnection of the IT magnets managed by TE-MSC, a first estimation of exposure time and dose received has been performed mixing fast and proper disconnection of cryogenics lines.
This activity reaches the ALARA 3 level : 20 mSv < Coll. Dose < 5 mSv. The tooling development /preparation and the sorting of the equipment (waste or spare) is the key to reduce the exposure time.

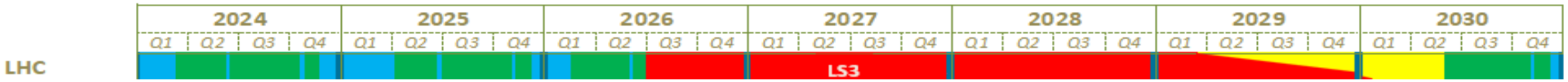
D1 disconnection is very fast : ~1h per side

For the SAM (Stand Alone Magnet), the residual ambient dose rate is two orders of magnitude lower with respect to IT interconnection.



Preliminary Schedule

TE-MSC schedule



All TE-MSC activities are in the master schedule and three main phases appears

Phase 1 : Q4 2026 ~2 ½ months long after the first cryo lockout:	• IT, D1 & MS disconnection in point 1&5 • Preparatory work for BST (12 IC) : IC opening and PIM cutting • Removal of the two Q10 of point 1	Very dense period
Phase 2 : Q1 2027→ Q3 2028 ~1 3/4 year *In case of LS3 extension only phase 2 will benefit of the extension*	• Preparatory work for BST/aC coating (Arc - IT) • PIM flanges cutting on mag side if needed (Criteria to be defined) • Removal of two Q10 of Point 5 • Magnet exchange (QH issue) • IT 2 & 8 - bellows consolidation • IT R2 & L8 - D1 mask • Diode blowholes • QXL/QRL jumper plug and DSL splices • Non-Conformity revealed during phase 1 and 2 • Q4,5,10 connection if possible	Very varied period
Phase 3 : Q4 2028 → Q2 2029 ~ 9 months	• WP3 magnet connections • Q4,5,10 connection if not done	Very dense period

Coordination

TE LS3 LHC coordination activity

RP | Safety | Planning | QA | Budget

Logistics:
- Space
- Radioactive spares

⟺ **HL-LHC coordination activity**

Activities

BLM/BPM – (SY/BI)
~250 IC + 4 LSS (1,2,5,8)

CWIC – (EN/MME)
Cutting : 42 diode pots
Welding : PIMS (~320 Arc + all IT) + 42 diodes + M Lines of Mag Exchange + WP3 PIM

OPCLIC – (TE/MSC)
~250 IC + 4 LSS

CLEM – (TE/MSC)
DFBs + all SSS

CRIN – (TE/CRG)
Mag exchange + NC

COPIM – (TE/VSC)
~320 (Arc + IT 2&8) PIMS

Arc BST – (TE/VSC)
100-120 ½ cells coating

IT 2&8 aC coating – (TE/VSC)

SIT – (TE/MSC)
IT 1 & 5 disconnection
IT 2 & 8 bellow consolidation
IT R2 & L8 D1 mask
320 PIM cutting
PIM flange cutting if needed
8 Magnet exchange in arc
8 Magnet exchange in MS
42 Diode blowholes
WP3 magnets connection
QRL/QXL plug + DSL splices
Other consolidation & NC

NCM activities :
D1 disconnection
BGI magnets

Quality Control

Arc & IT BST QC – (TE/VSC)
100-120 ½ cells coating + IT 2&8 beam lines

CWICQC – (EN/MME)
~320 PIMS +16 Magnet Exchange + 42 diodes + IT2&8 PIMS & bellows + WP3 magnet connection

ICIT + SPQC – (TE-VSC/MSC)
~ 250 IC + splices QC (Mag. Exchange + WP3)

LTIC – (TE/VSC)
~250 IC + Magnet exchange + diodes + WP3

LTBL – (TE/VSC)
RF ball + beam line pumping (all sectors)

ELQA – (TE/MPE)
Magnet exchange + diodes (110 IC) + 4 LSS

BLM : Beam Loss Monitor
BPM : Beam Position Monitor
IC : InterConnection
CWIC : Cutting and Welding in IC
OPCLIC : OPening and CLosure of IC
CLEM : Current LEad Maintenance
CRIN : CRyo INstrumentation
COPIM : COnditioning of PIMs
Arc BST : Beam Screen Treatment
IT 2&8 aC Coating
SIT : Special Intervention Team

QC: Quality Control
ICIT : InterConnection Inspection Team
SPQC : SPlice Quality Control
LTIC : Leak Test on InterConnection
LTBL : Leak Test of Beam Line
ELQA : Electrical Quality Assurance

Resources

TE-MSC resources

OPCLIC : OPening and CLosure of IC
CLEM : Current LEad Maintenance
SIT : Special Intervention Team
ICIT : InterConnection Inspection Team
SPQC : SPlice Quality Control

For superconducting magnet activities, TE-MSC will be organised in four teams : **SIT, OPCLIC, CLEM** and **ICIT/SPQC**.

For each team, the size and the profile of interveners have been determined.

- For OPCLIC and ICIT, 15 % of the arc interconnections will be opened (~ 250 IC) + interconnections in 4 LSS (1,2,5,8)
- For CLEM and SIT, the team size will be equivalent of the ones of LS1/LS2.

As in the previous long shutdowns, SIT team will count ~75% of MSC resources (staff + FSU) and ~25% of newcomers (temp contract). The team will evolve along the different phases of activities.

At the opposite, for OPCLIC , only 15% of the team will come from MSC resources.

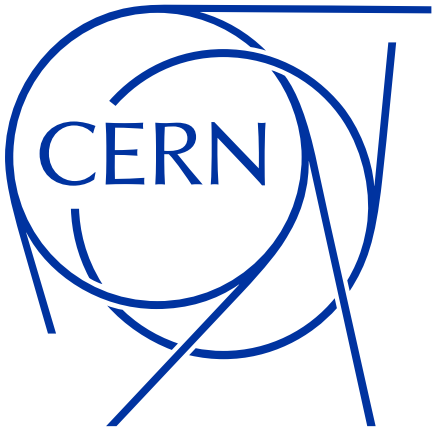
In 2026, a part of TE-MSC resources will be detached from magnet activities at surface to tunnel activities, although the cold mass production is not over. For the phase 3 (WP3 magnet connection), more resources will be available.

Depending on the planning and the progress of WP3 activities, 6 to 8 persons should come from outside of MSC personnel.

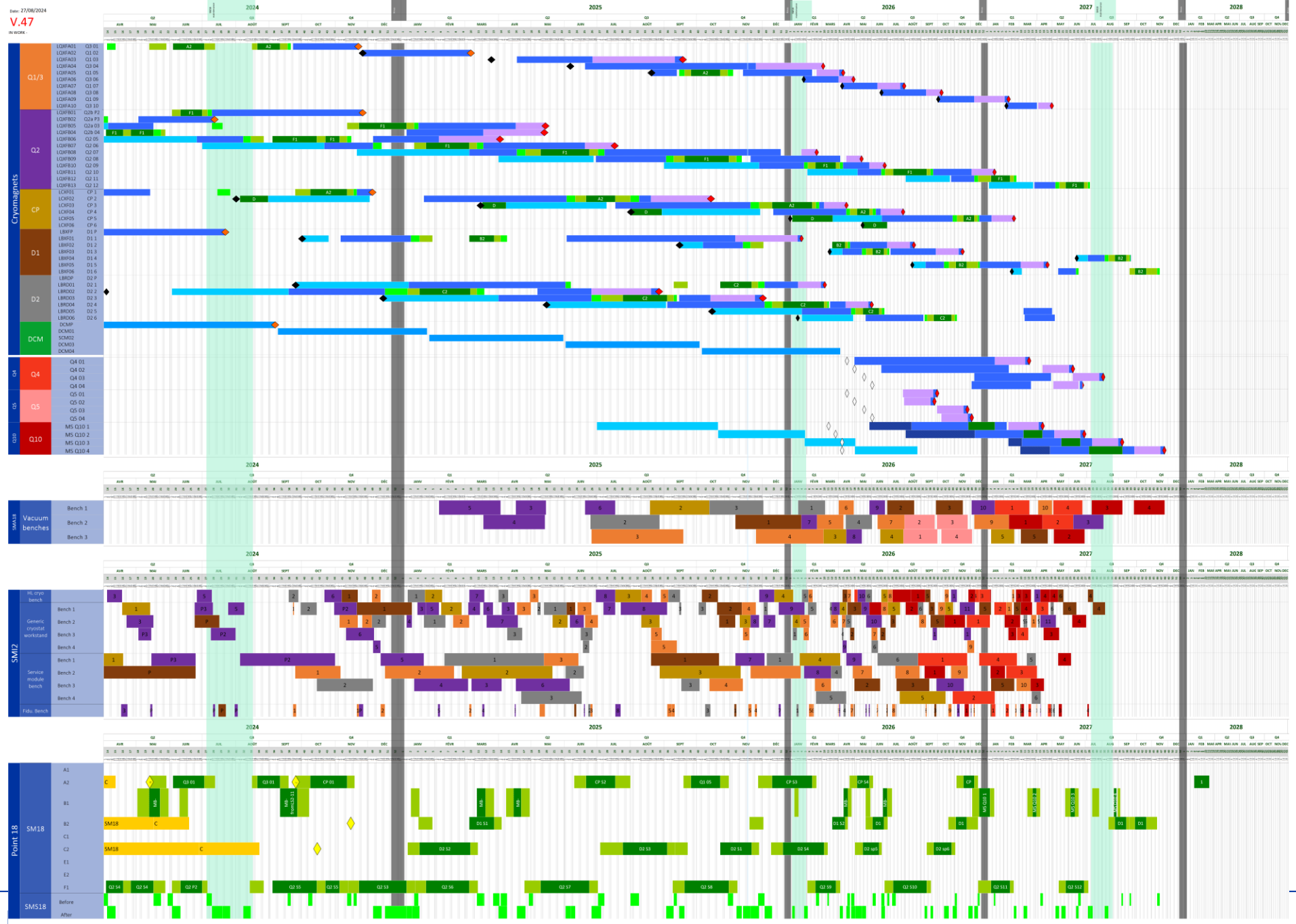
In case of a start of LS3 in 2026 (July/Oct), the WP3 cold mass production will be closer to the end.
For that aspect, a latest start of LS3 is an advantage (more time for preparation and training).

Summary

- The list of TE-MSC activities (HL-HLC project and consolidation project) for LS3 has been presented and they are all approved and validated in PLAN tool.
- Most of them were already performed in the previous long shutdown (procedures known). Only activities around the inner triplets are new and the study will start on Oct 2024.
- Dismantling of the inner triplet of points 1 & 5 brings to an ALARA 3 level.
- The TE-MSC activities and aC-coating activities (Arc and IT) will benefit of a close coordination plan to assure safety and quality assurance. A new tool of coordination based on e-MIP program will be adapted.
- TE-MSC resources size and profile has been defined. Six to eight persons could not come from TE-MSC resources.
- A delay or an extension of LS3 translates in a better availability on TE-MSC resources.


CERN

EDMS link


Date: 27/08/2024
V.47
IN WORK -
2024
2025
2026
2027
2028
Cryomagnets
Q1/3
Q2
CP
D1
D2
DCM
Q4
Q5
Q10
Vacuum benches
Bench 1
Bench 2
Bench 3
SM2
HL cryo bench
Generic cryostat workstand
Service module bench
Fidu. Bench
Point 18
SM18
SMS18
Before
After
Magnets
Q1/3 CP
Q2 D1 D2
Building 180
Cold mass assembly
Cold mass disassembly
Building SM2
Cryostating
Decryostating
Point 18
Preparation in SMS18
SM18 - warm test
SM18 - cold test
Shuffling module
Parts delivery
Assembly in SM2
Commissionning
Assembly in SM18
Milestones
Delivery to CERN
Ready for the String
Test proto ready
Test bench ready
Vacuum activities
Vacuum activities

Cryo-magnets readiness

Exchange of cryo-magnets due to quench heater circuit issues : MQ.11R8, MB.A18L1, MQ.14L3, MB.C28L6

3 out of 4 cryo-magnets are ready.
The issue of the Q14L3 appeared in May 2024 . A SSS cold mass is available but needs to be prepared, cryostated and cold tested before LS3. TE-VSC will insert beam screens and BPMs. All these activities are planned in 2025.

If other need of magnet exchanged, please consider the time preparation of the spare magnet !

WP3 magnet readiness : see WP3 planning (link).

Exchange of Q10 in points 1 and 5 : New optics layout with a MS in Q10 (MQML+MCBC → MQML+MSCB)

MQML and MSCB magnets are being tested individually, before the cold masses assembly.
Vacuum vessels for Q10 are not available, the ones from Q10 in the LHC will be reused. Cryostating, cold testing and beam screens installation will be done during LS3.

Q4, Q5 modification for HL-LHC : LQY, LQM

Q4L1 and Q4R5 will be swapped, as well as Q4R1 and Q4L5. The new layout requires new service modules and modified beam screens (aC coated and, in some cases, rotated). For Q5, the service module remains the same.

All modifications will be done during LS3.