

Accelerator Status during LS2

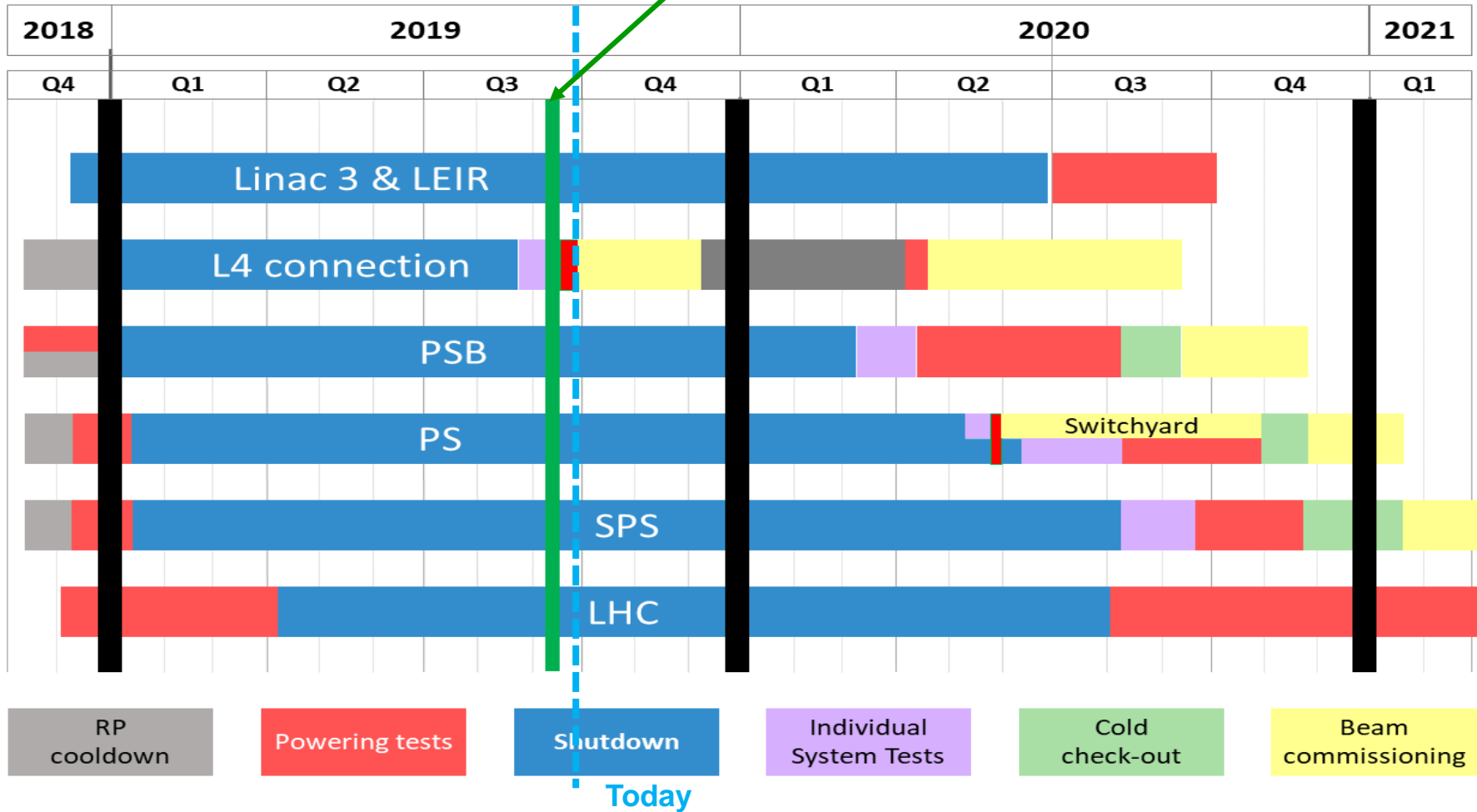
RRB

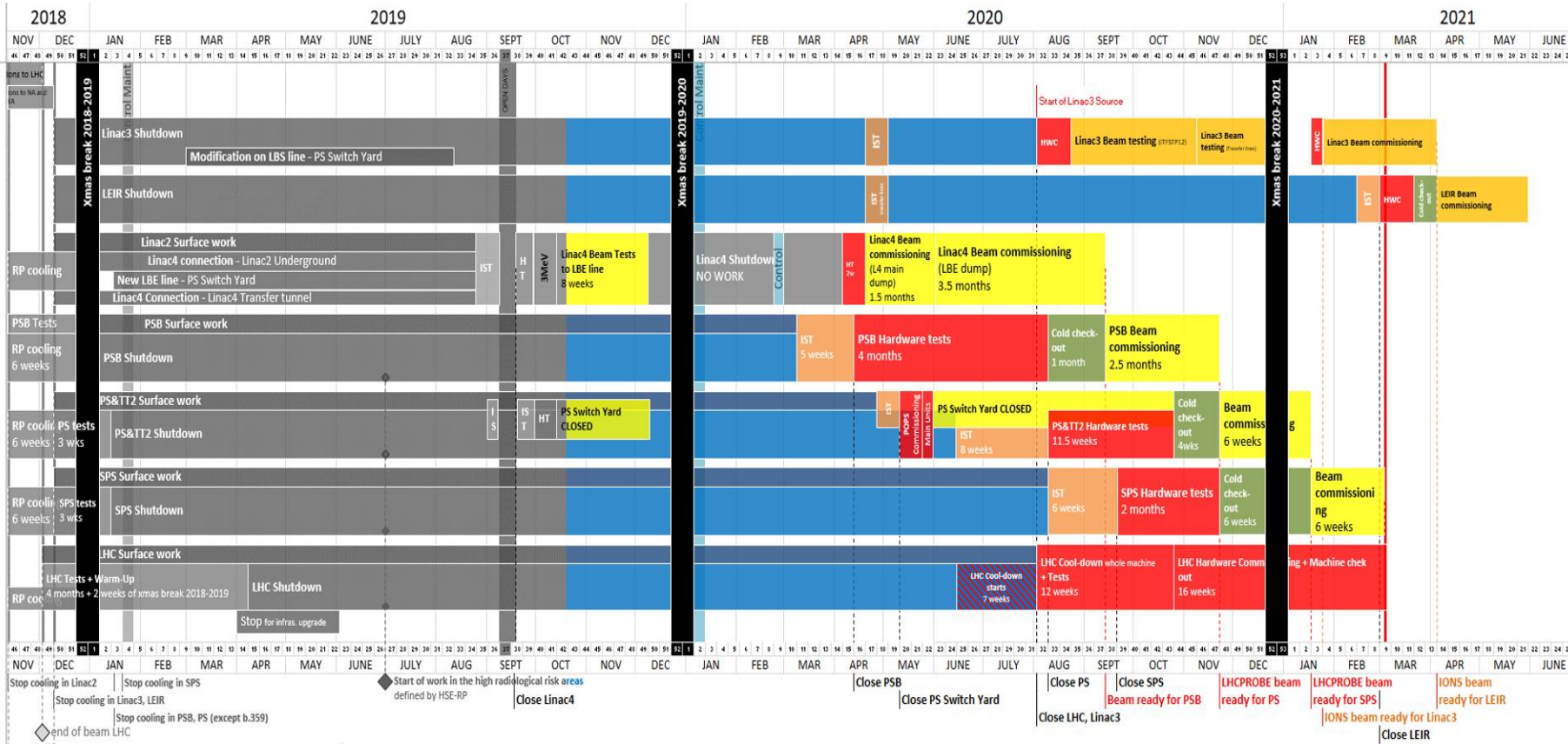
Frédéric Bordry

28th October 2019



LS2 schedule





Safety First



Quality second



Schedule third

LS2: LIU installation



LHC Injectors Upgrade

SPS upgrade

- **Main RF system upgrade** (new solid state power plants – 2 x 1.6 MW)
- **Impedance mitigation** to improve beam stability
- More robust **beam dump and protection devices**



SPS
6.9 km
450 GeV

PSB upgrade

- **H⁻ charge exchange injection** at 160 MeV → improved beam brightness (weaker space charge forces)
- **Energy : 1.4 GeV → 2 GeV**
 - New main power supply
 - New RF systems



PSB
157 m
1.4 GeV

PS
628 m
26 GeV

Linac 4
160 MeV

Linac 2
50 MeV

Linac 4, has been built to take over.

- Higher energy **160 MeV**
- Acceleration of **H⁻ ions** (charge exchange H⁻→p⁺ in the PSB)

Construction **completed in 2017**

- Extensively tested in 2017-2018
- Ongoing **work in LS2 to connect it to the rest of the chain**





Opening and final reclosure of 1360 interconnections

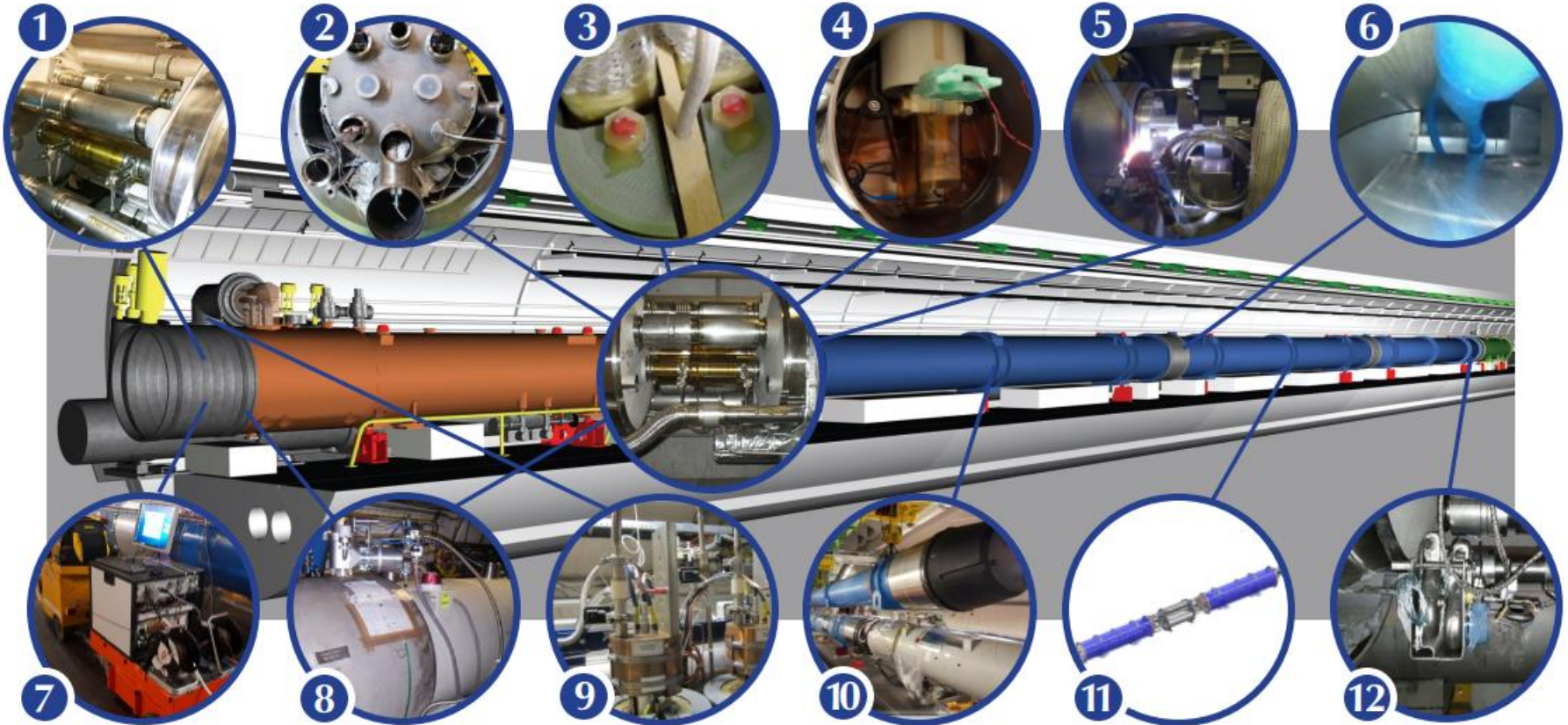
Mechanical opening of 2464 diode container covers

Cleaning and consolidation of 1232 dipole diode insulation systems

Installation of 1232 insulating inserts

Rewelding of 2464 diode container covers

More than 10 000 quality checks



More than 8 000 electrical quality assurance tests

2 500 leak tightness tests

Maintenance of 2 829 current leads

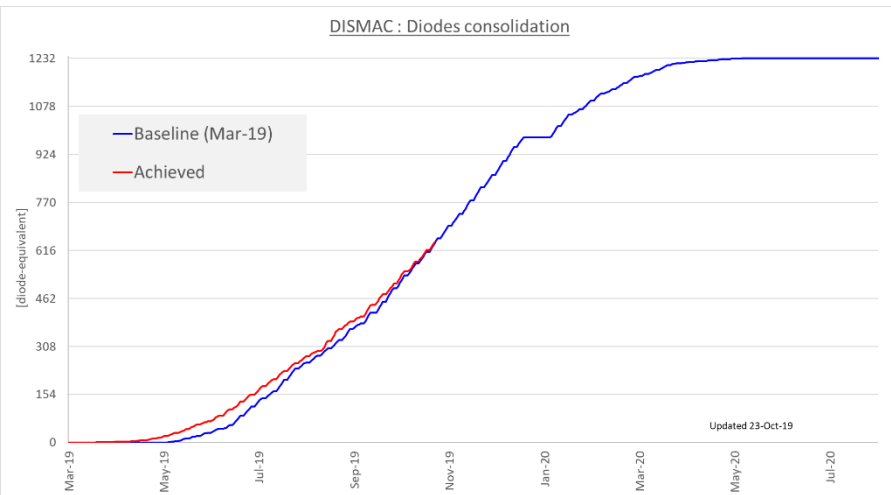
Replacement of 22 cryomagnets

Installation of 4 full HL-LHC cryo-assemblies

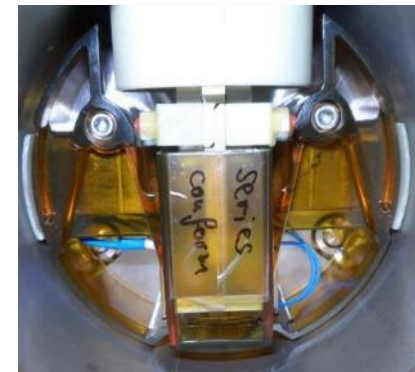
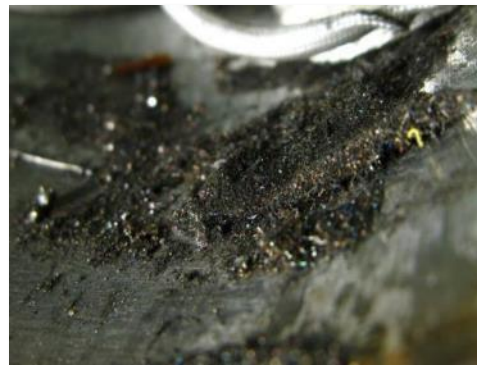
Installation of 10 instrumentation systems for beam induced heat load study

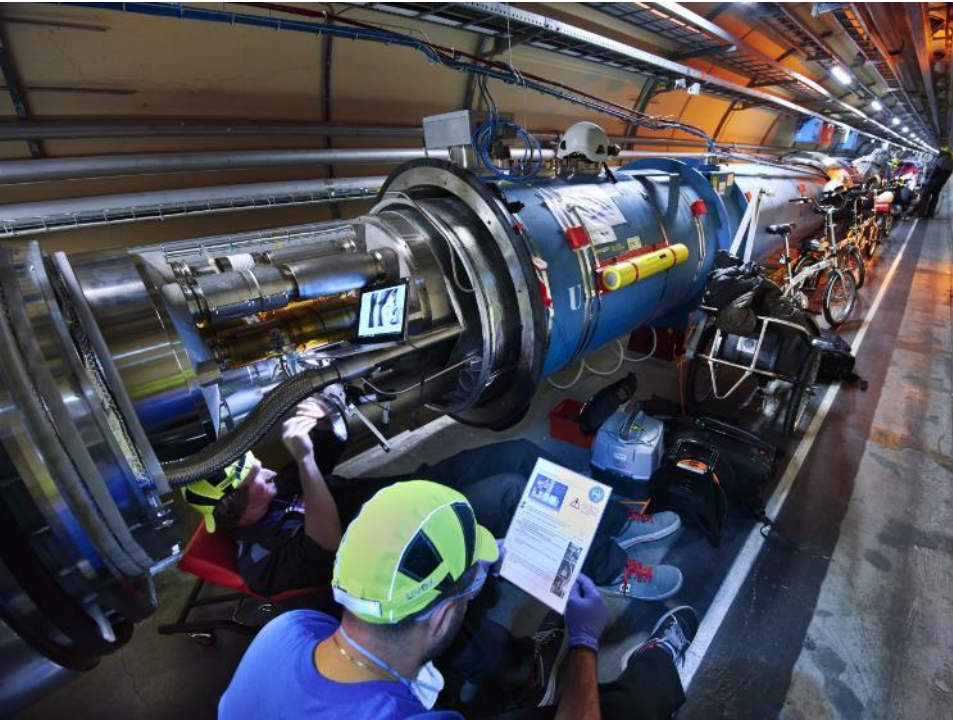
DISMAC project status: diode consolidation

- 1st diode consolidated on 3rd May 2019 (about 1 month ahead of schedule)



- Cleaning is complete in > 4 sectors
- The insulation plates and the inserts are installed in > 3 sectors





LHC: cryo-magnet consolidation



S 3-4
x 1 dipole exchange
x 3
Quadrupoles
exchange

S 4-5
x 1 dipole exchange

Total x26

- 19 Dipoles exchange
- 3 Quadrupoles exchange
- 2 Dipoles removal for 2x11T full assembly installation
- 2 CC removal for 2x CC full assembly installation

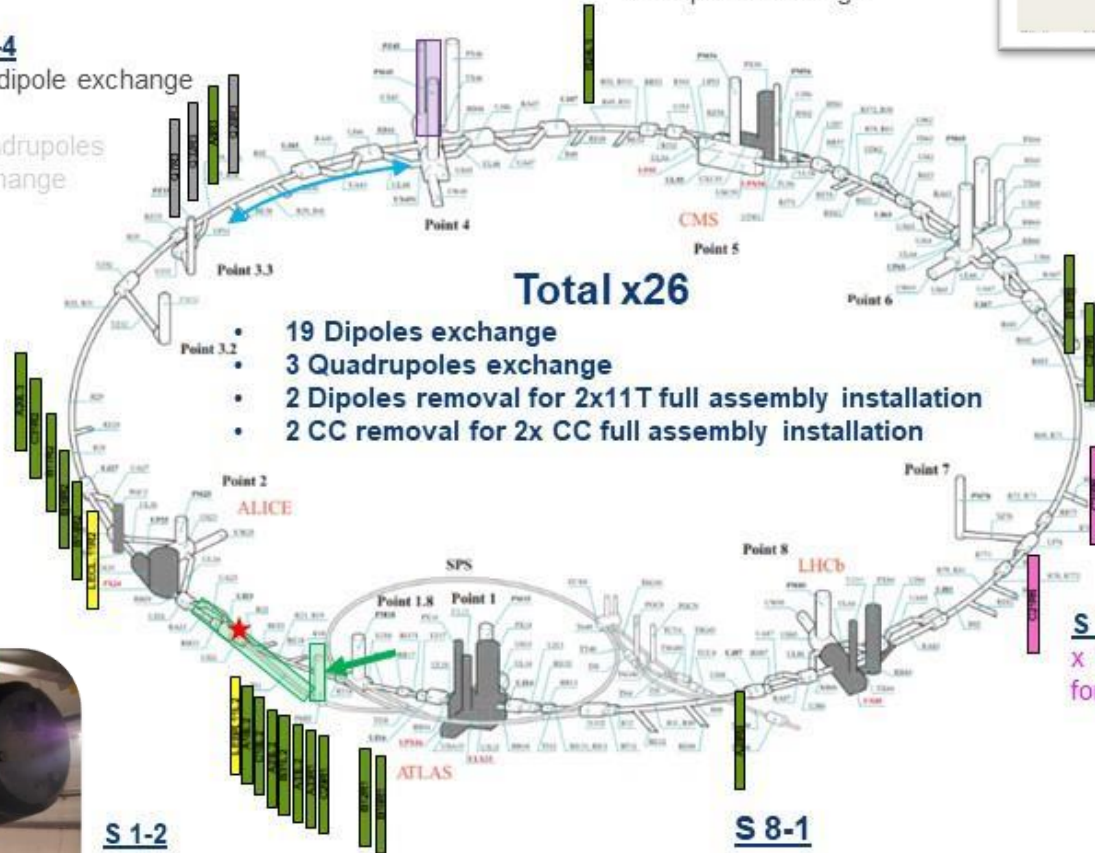
S 2-3
x 5 dipoles exchange
x 1 LECL11R2 removal
for cryo assembly
installation

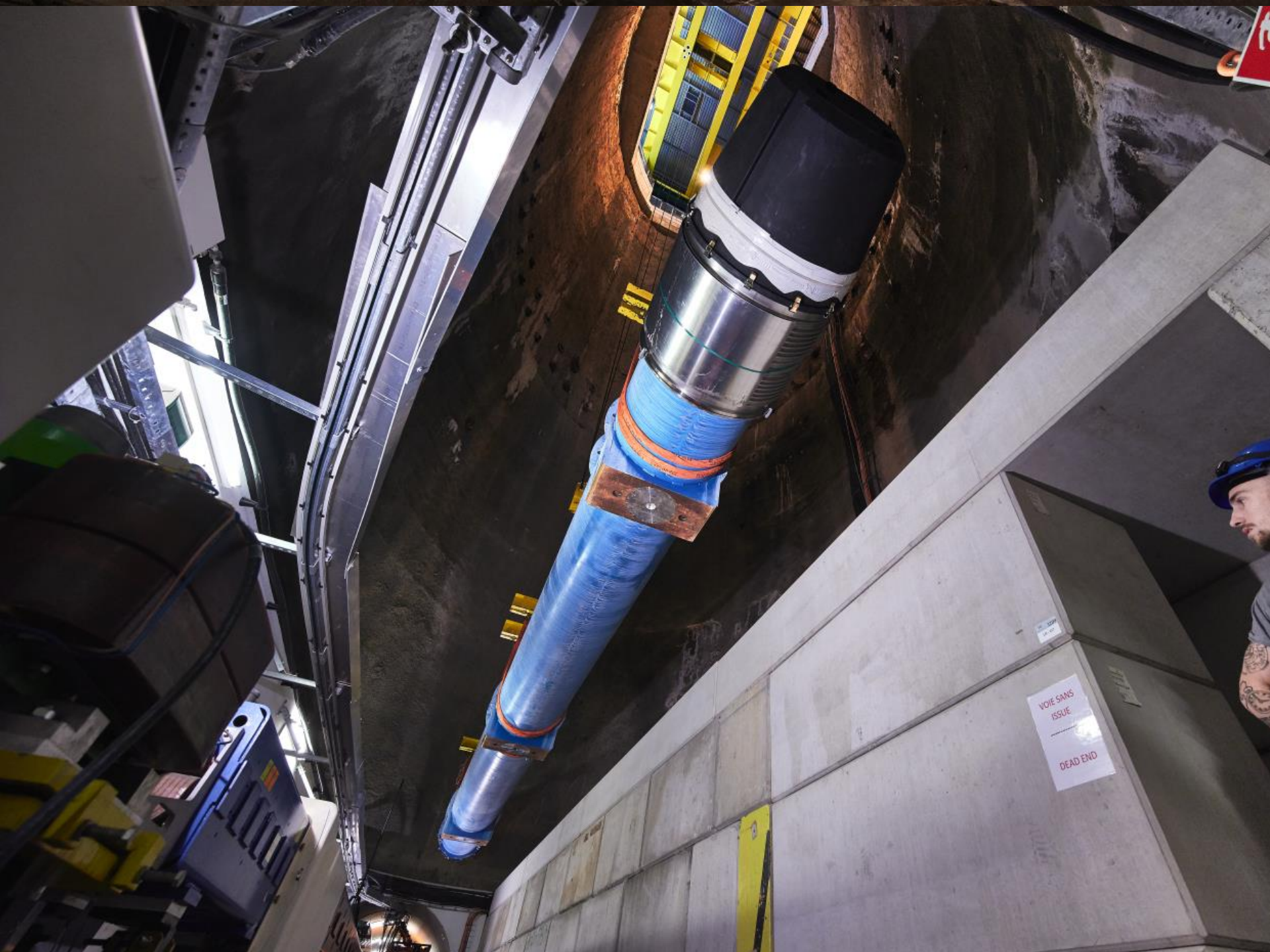
S 6-7
x 1 dipole removal for
11T installation

S 7-8
x 1 dipole removal
for 11T installation

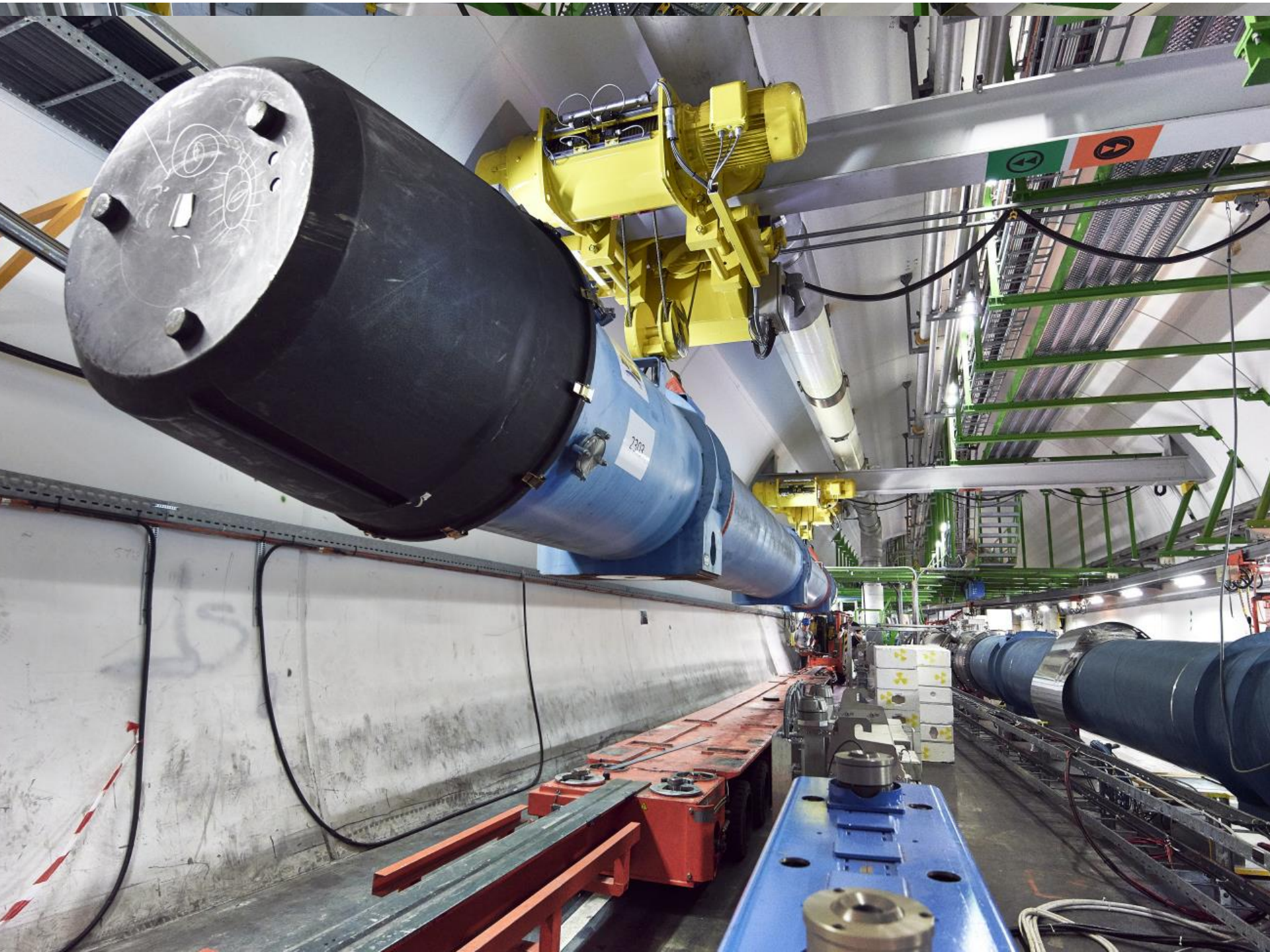
S 1-2
x 9 dipoles exchange
x 1 LEBR11L2 removal for
cryo assembly installation

S 8-1
x 1 dipole exchange

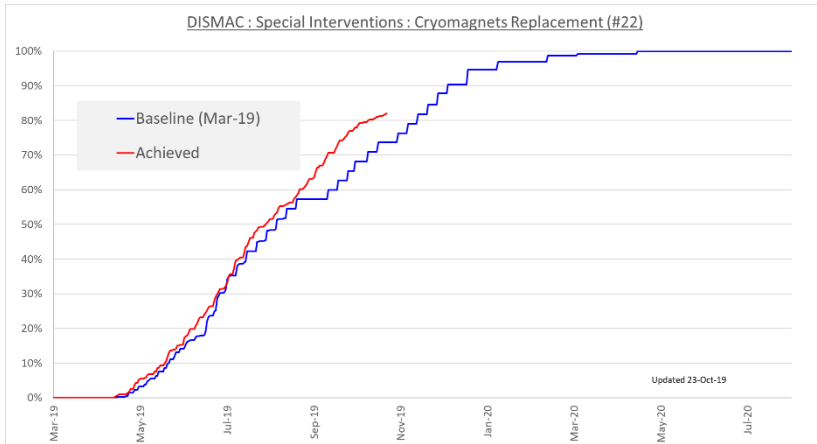




NOISE SHIMS
ISSUE
DEAD END



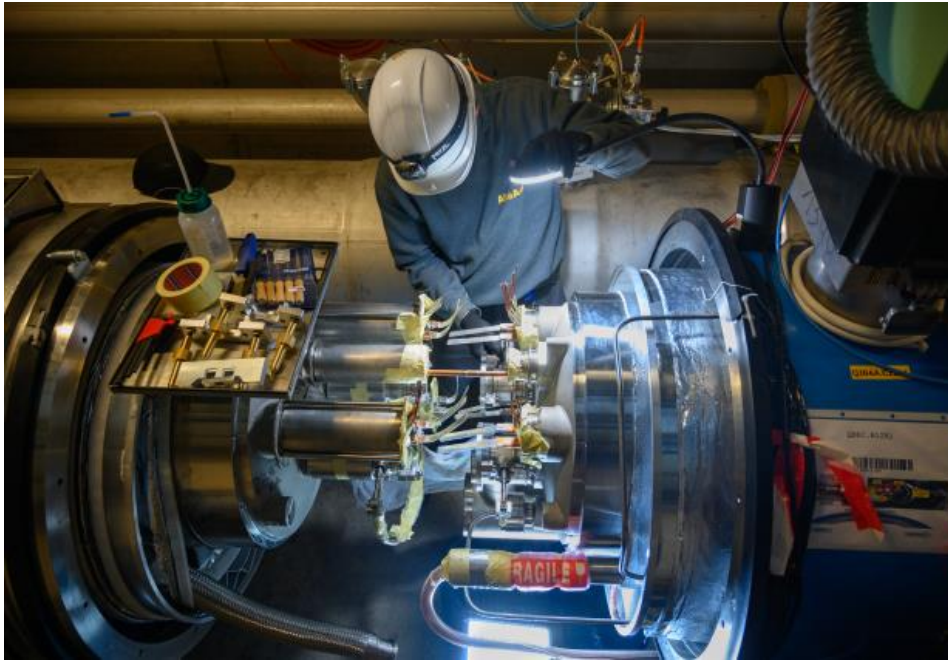
LHC: cryo-magnet replacement



19 cryodipoles & 3 SSS

- All cryomagnets (not including HL-LHC WP11 assemblies nor 16L2) have been disconnected, removed and reinstalled;
- The reconnection of the first cryodipole in sector 8-1 (A26R8) is completed except the leak tests that are being performed.
The others magnets reinstalled are being reconnected.

16L2, CC@P2: will be connected in the coming days



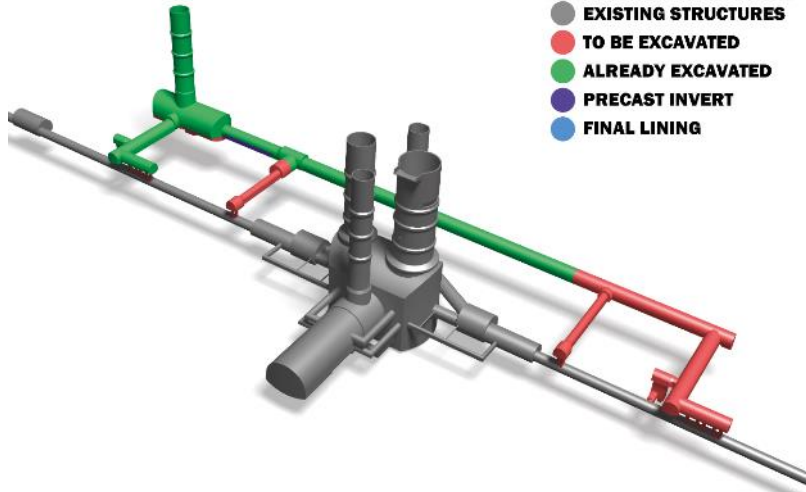
HL-LHC civil engineering status

Excavation progress at Point 1

Overall excavation \approx 67%

STATUS: 2019.10.11

- EXISTING STRUCTURES
- TO BE EXCAVATED
- ALREADY EXCAVATED
- PRECAST INVERT
- FINAL LINING



Excavation Progress:

UR15: \approx 221m of 300m

UA17: \approx 70m of 70m

UPR17: \approx 14m of 29m

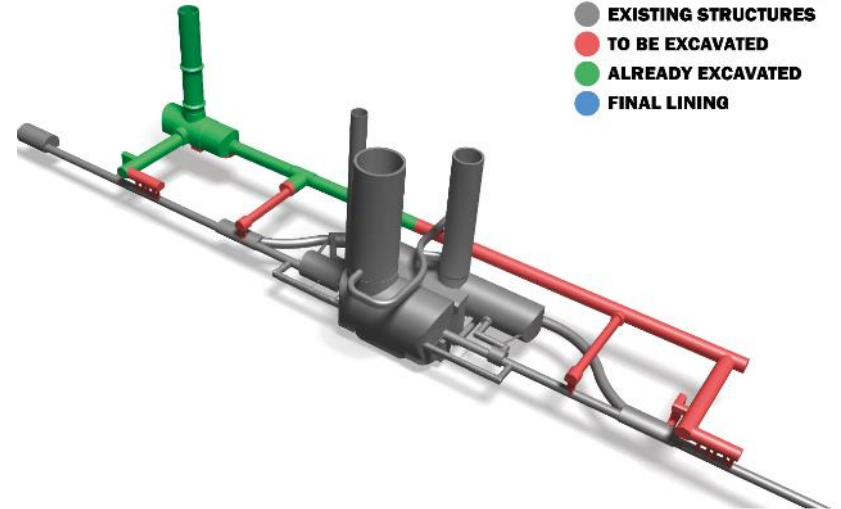
UL17: \approx 5m of 50m

Excavation progress at Point 5

Overall excavation \approx 60%

STATUS: 2019.10.11

- EXISTING STRUCTURES
- TO BE EXCAVATED
- ALREADY EXCAVATED
- FINAL LINING



Excavation Progress:

UR55: \approx 126m of 300m

UA57: \approx 50m of 70m

UPR57: \approx 22m of 29m

UL57: \approx 13m of 50m



US/UW17 cavern
(view towards UR15 gallery)



UR15 gallery excavation



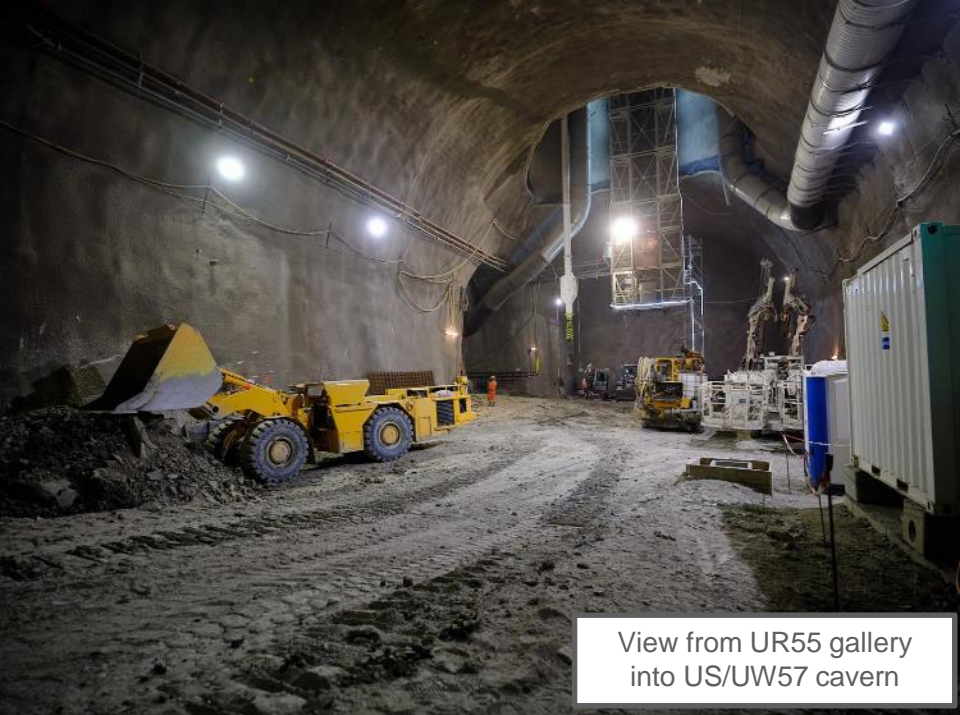
UA17 gallery excavation



UR15 precast invert installation



US/UW57 cavern with entrance to UR55 and UA57 galleries



View from UR55 gallery into US/UW57 cavern

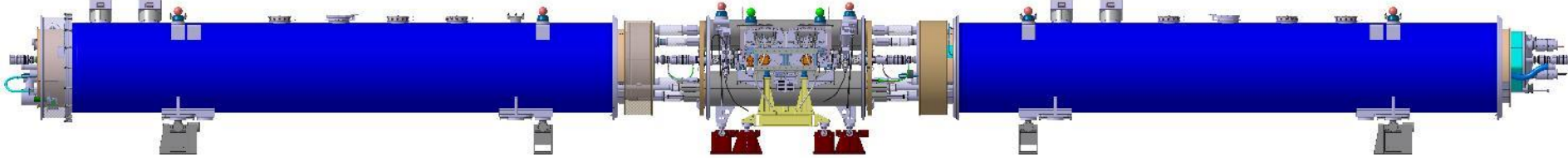


HL-LHC : 11 T magnets

LBH_A (11T)

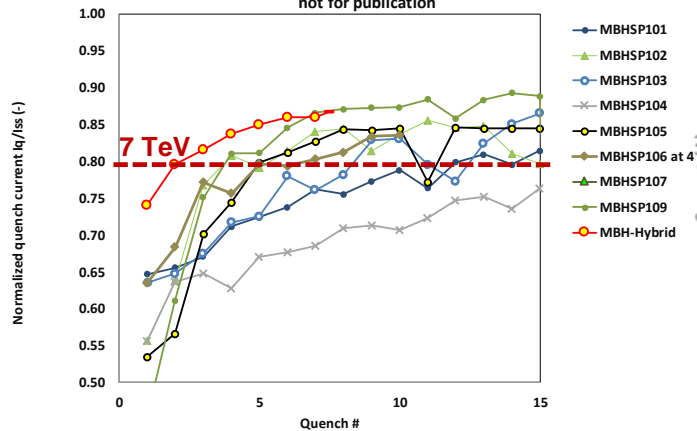
By-pass cryostat with collimator

LBH_B (11T)

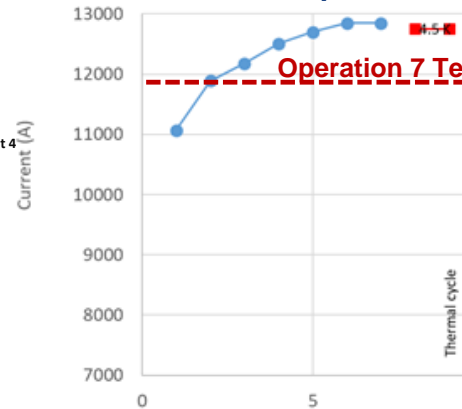


Complete 11.2 T cryo-assembly replacing a 15 m 8.3 T LHC dipole

Quick training comparison - MBH models to MBH-hybrid
not for publication



5.5m prot



Event number

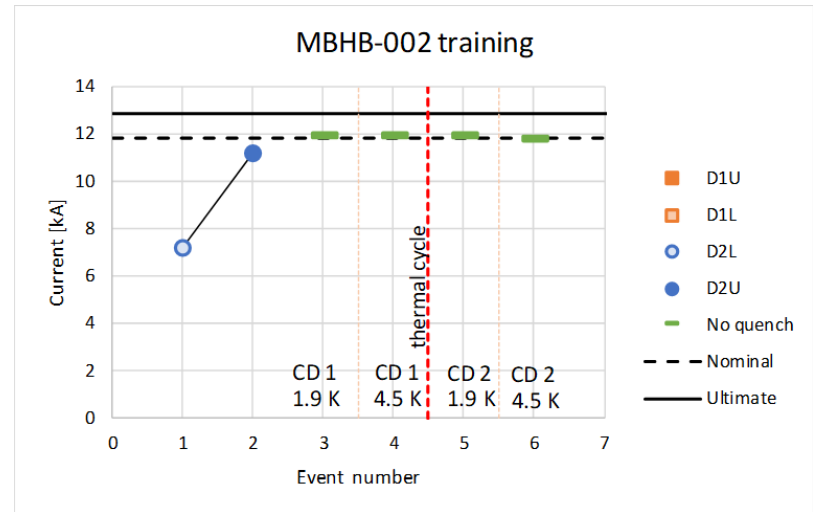
Hybrid (long proto): Excellent! But strong permanent degradation after thermal cycle.
New thermal gradient control should be implemented.

HL-LHC : 11 T magnets

MBH-002: first out of four 11 T dipoles.



**Quench performance:
good for installation in LS2**

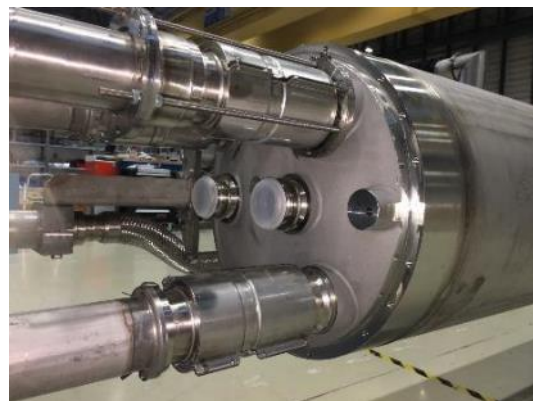
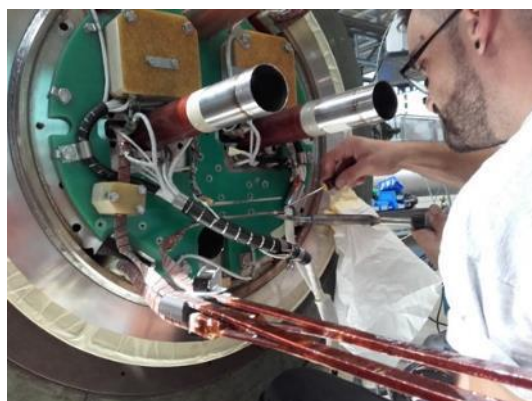
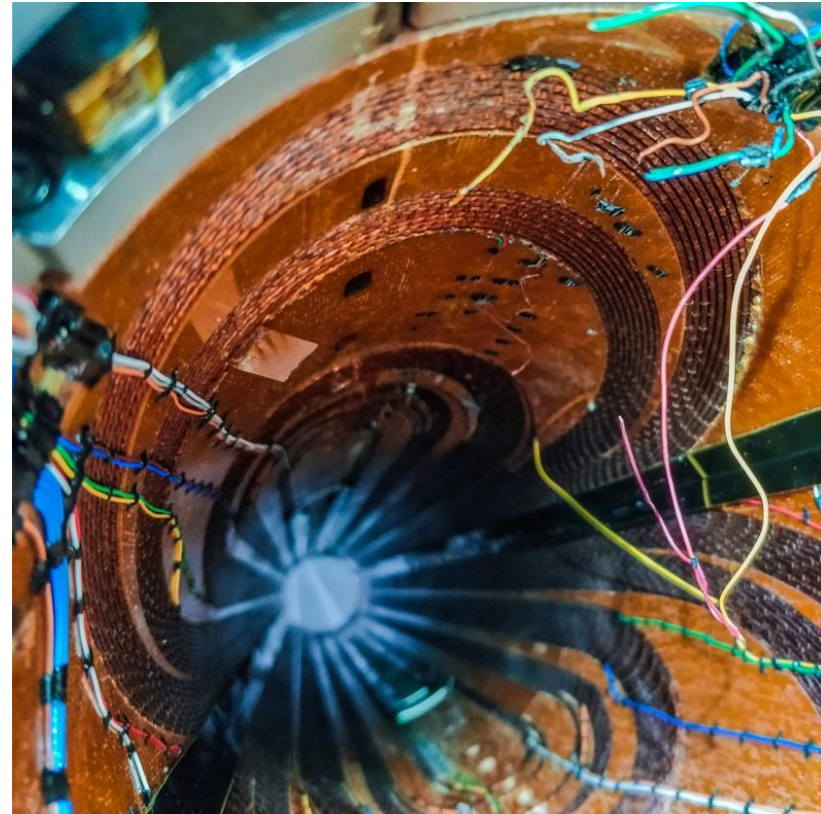


Coils after impregnation



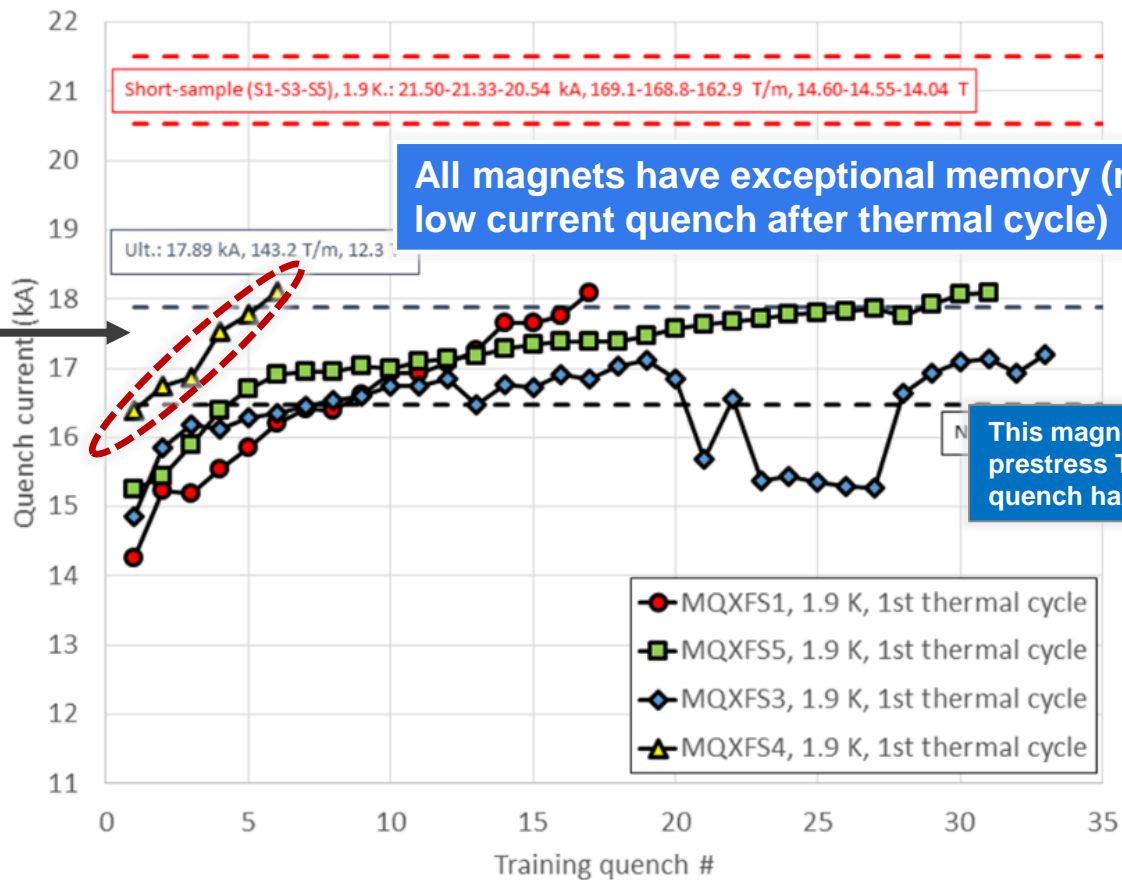
Magnet on test bench @ SM18 (July 2019)

11 T in full swing production: LS2 installation in 2020!
Great care given the stress sensitivity of Nb_3Sn

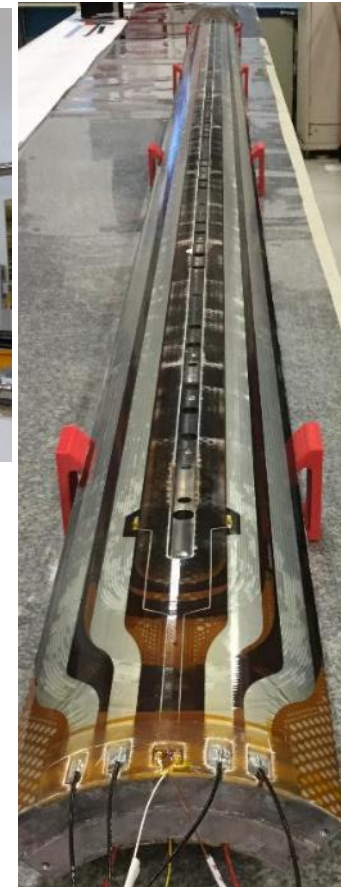
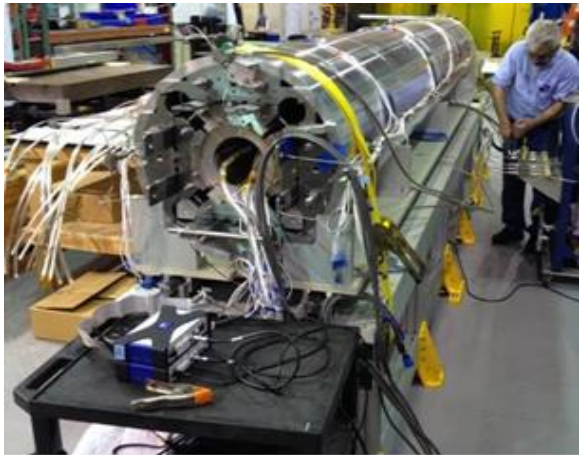


Further results IT quadrupoles on short models

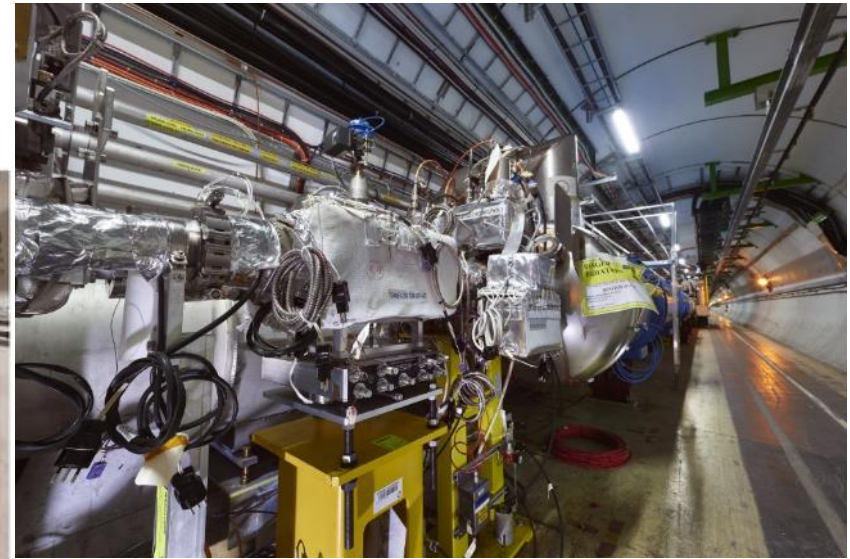
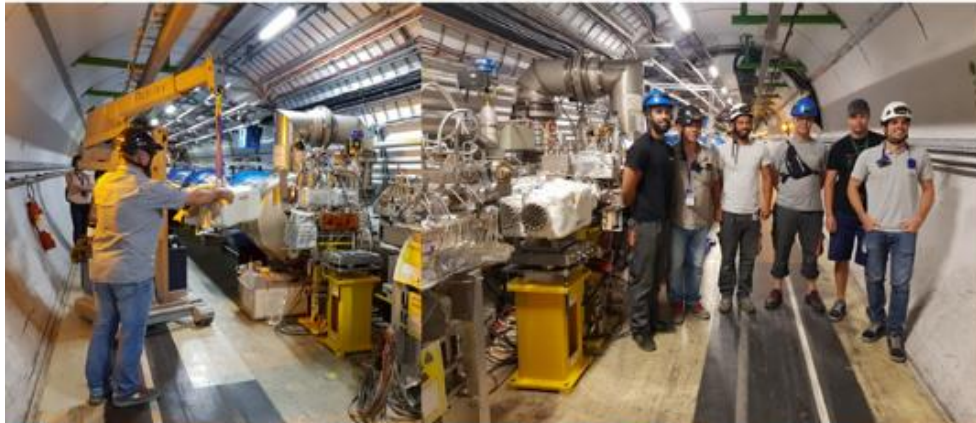
**Best HF magnet ever tested in terms of behaviour (not max field)
Final conductor, final prestress procedure**



Construction of the 1st and 2nd long (7.2 m) IT quad at CERN



HL-LHC : 1st equipment installed in LHC tunnel



Inspection to the first HL-LHC installed in LHC!

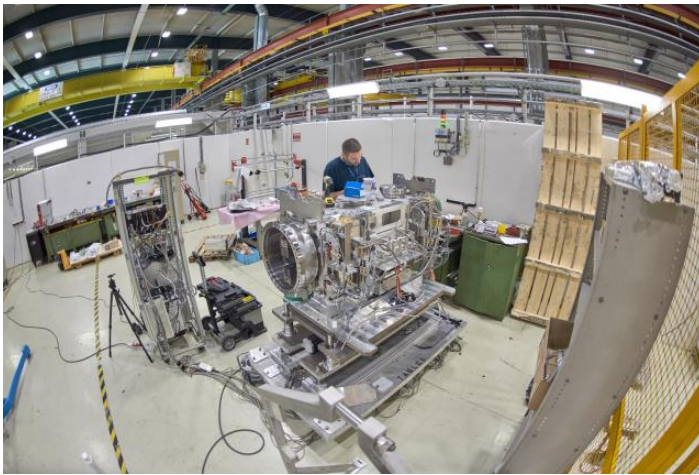
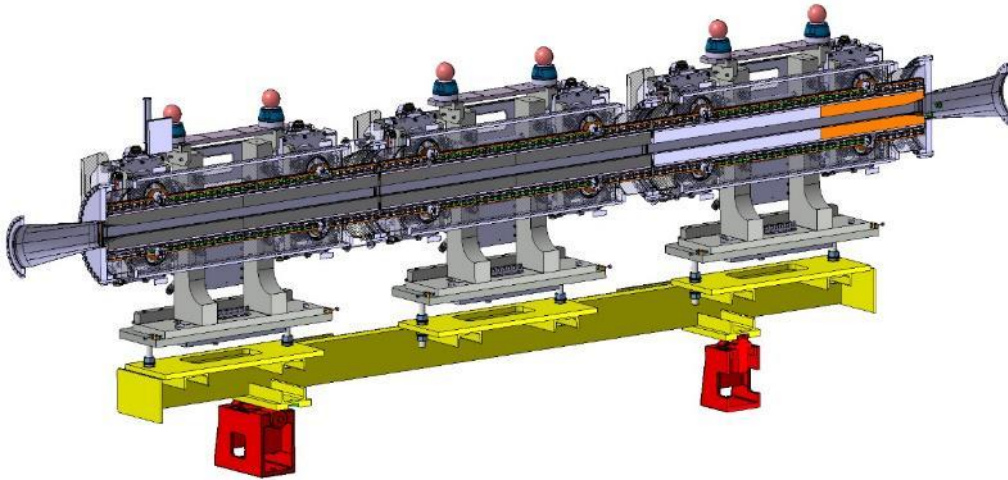


New TANB installed in LHC-IR8

HL-LHC : equipment for LS2

New injection protection absorber (TDIS: Target Dump Injection Segmented)

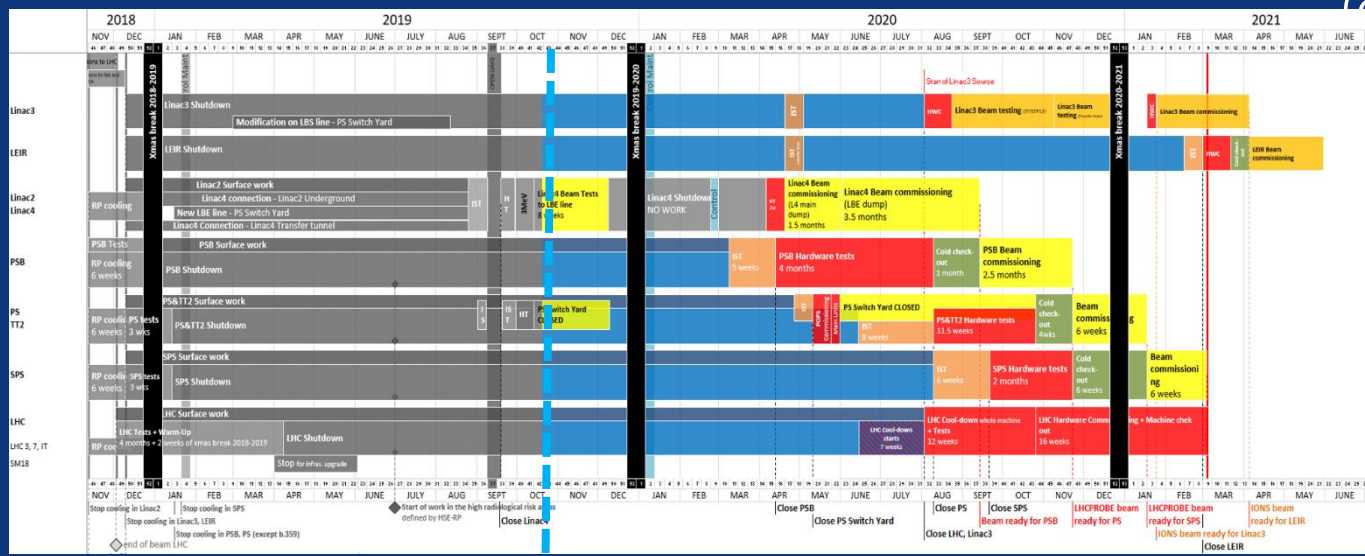
Necessary to inject LIU beam into LHC



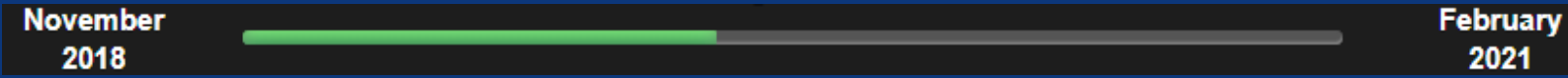


www.cern.ch

LS2
So far,
so good !



Today



KEEP CALM AND KEEP GOING