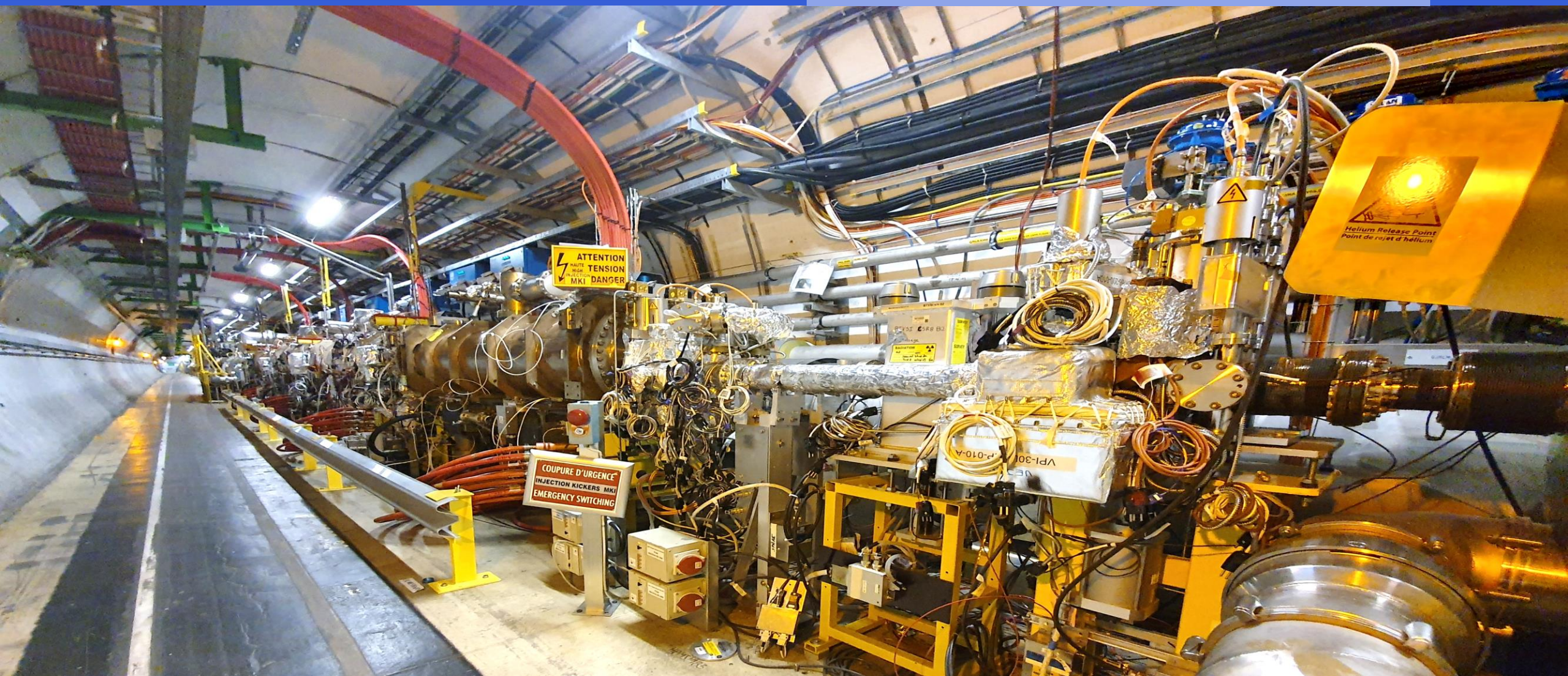




LS2 2015-2020 Coordination

LS2 Status of the accelerator



- **Introduction to the Long Shutdown 2 (LS2)**
- **Safety Coordination**
- **Achievements up to COVID-19 Safe mode**
- **Restarting CERN activities after Safe mode**
- **Schedules & Milestones**



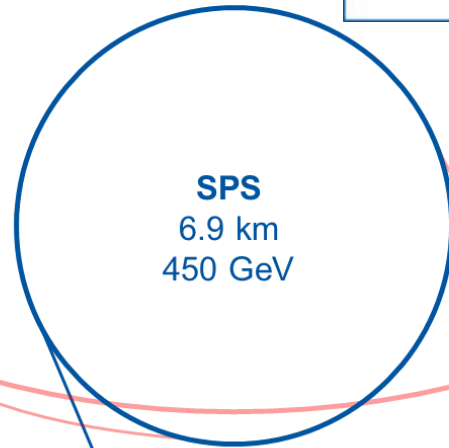
LS2 Scope – LIU main activities

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**



LHC Injectors Upgrade



SPS
6.9 km
450 GeV

PSB
157 m
1.4 GeV

PS
628 m
26 GeV

Linac 4
160 MeV

Linac 2
50 MeV

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



Linac 4, has been built to take over.

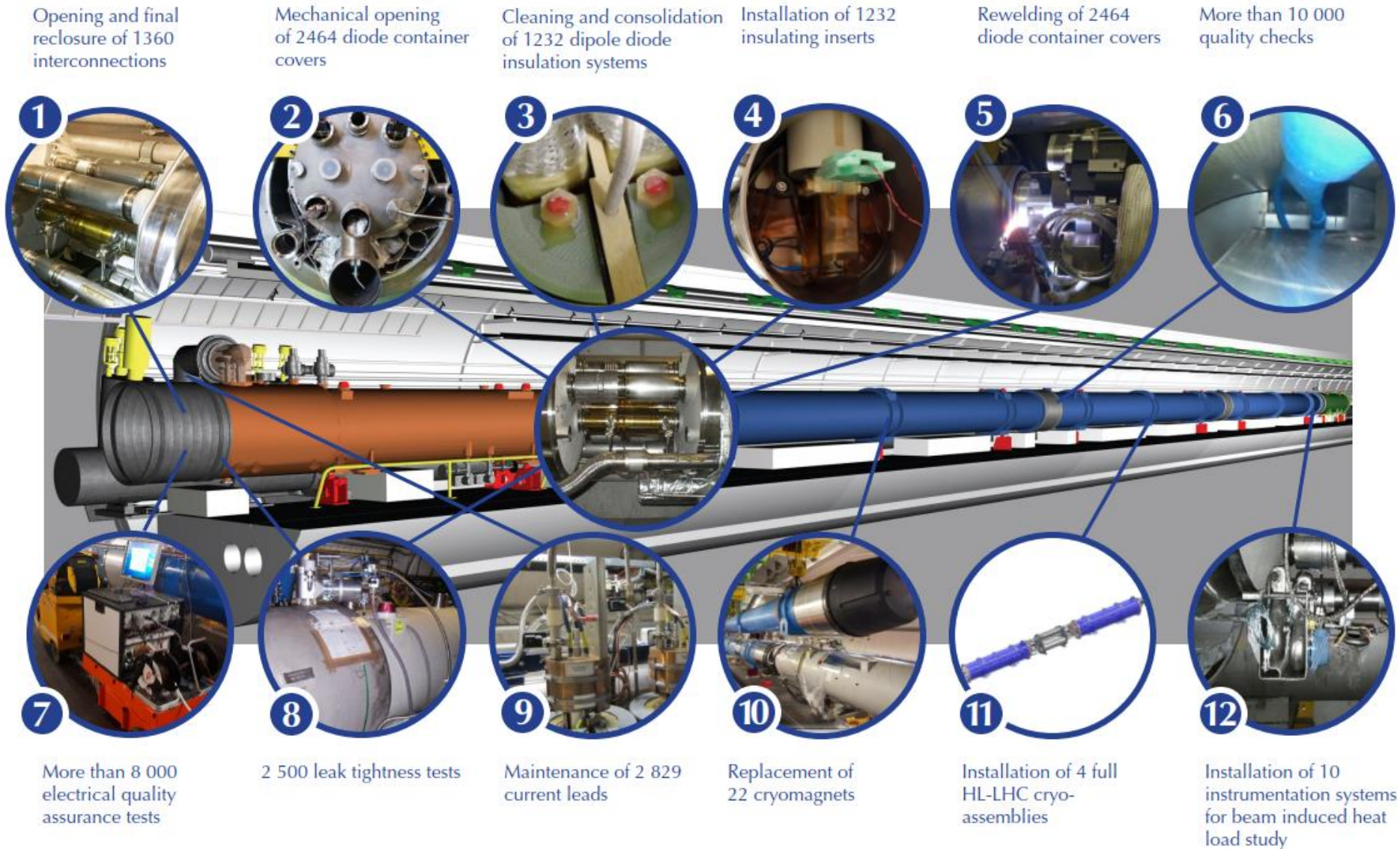
- Higher energy **160 MeV**
- Acceleration of **H⁻ ions** (charge exchange H⁻→p⁺ in the PSB)

Construction **completed in 2017**

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



LS2 Scope – LHC main activities



Safety Coordination



Barriers @ SPS-BA3



Access restriction @ SPS-BA2



Flashing lights & signs to warn during tests @ PS Switch Yard



Electrical lock-out @ PS Booster

Safety – LS2 Accidents

Facility	Total	Minor	With days of absence	Total days
PS	8	5	3	36
SPS	19	8	11	282
LHC inc. LEX	28	21	7	69
Surface	24	11	13	158
Total	79	45	34	545

LS1 Accidents

Facility	Total	Minor	With days of absence	Total days**
PS	2	1	1	6
SPS	7	6	1	3
LHC	30	20	10	93
Surface	50	34	16	151
Experiments*	6	3	3	20
Total	95	64	31	273

- 3.7 Million Hours worked
- 64 minor accidents (no absence)
- 31 accidents with total 273 days absence

Frequency rate : 8.4
Severity rate : 0.07

Frequency Rate = Number Accidents (with absence) per Million Hours worked
Severity Rate = Number of days Absence per 1,000 Hours worked

LHC Long Shutdown 1 (LS1) Status and Outlook
F. Bordry
12th December 2014

HL-LHC and LIU Cost and Schedule Review
November'19

	LS2*	LS1	Industrie**		
			Fabrication de machines et equipement	Entreposage, auxiliaire de transport	Travaux de Construction
Frequency	9.7	8.4	16.3	32.3	42.3
Severity	0.14	0.07	0.8	2.3	2.9

Frequency Rate:

Accidents with absence per million hours worked

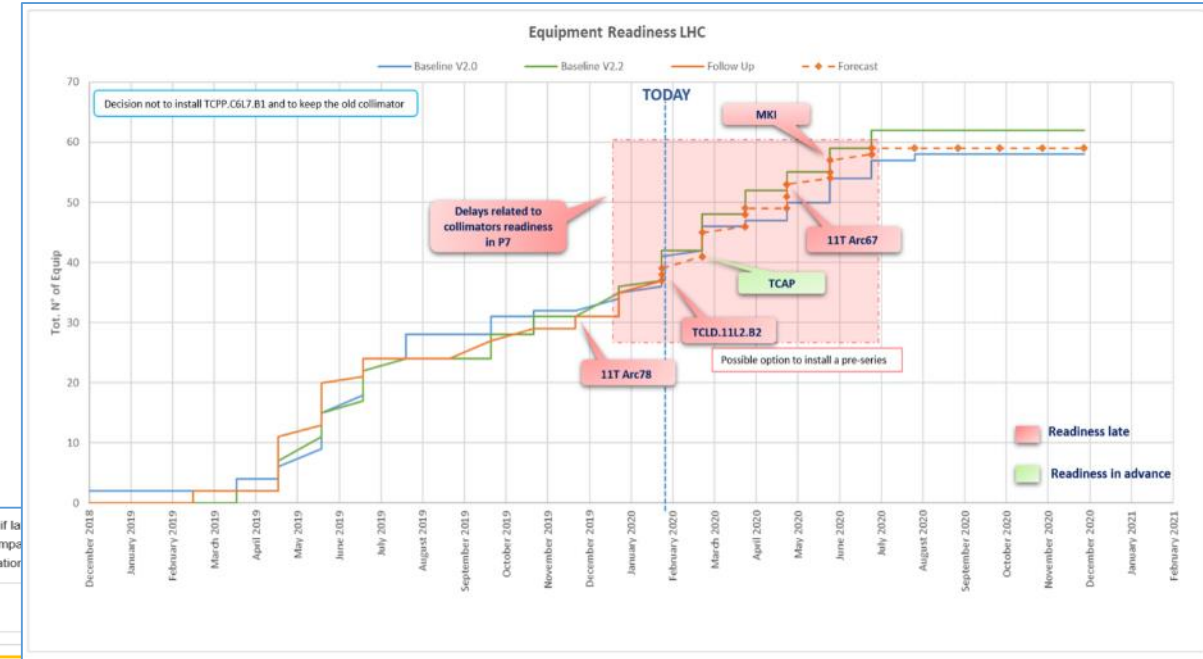
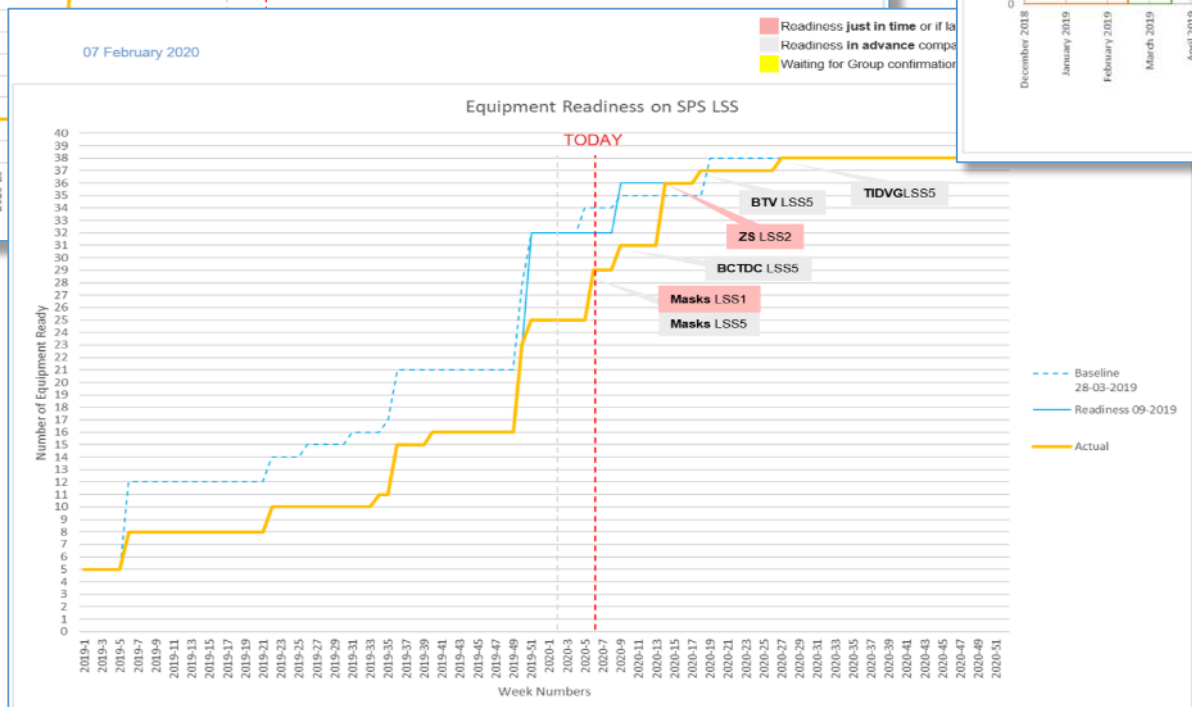
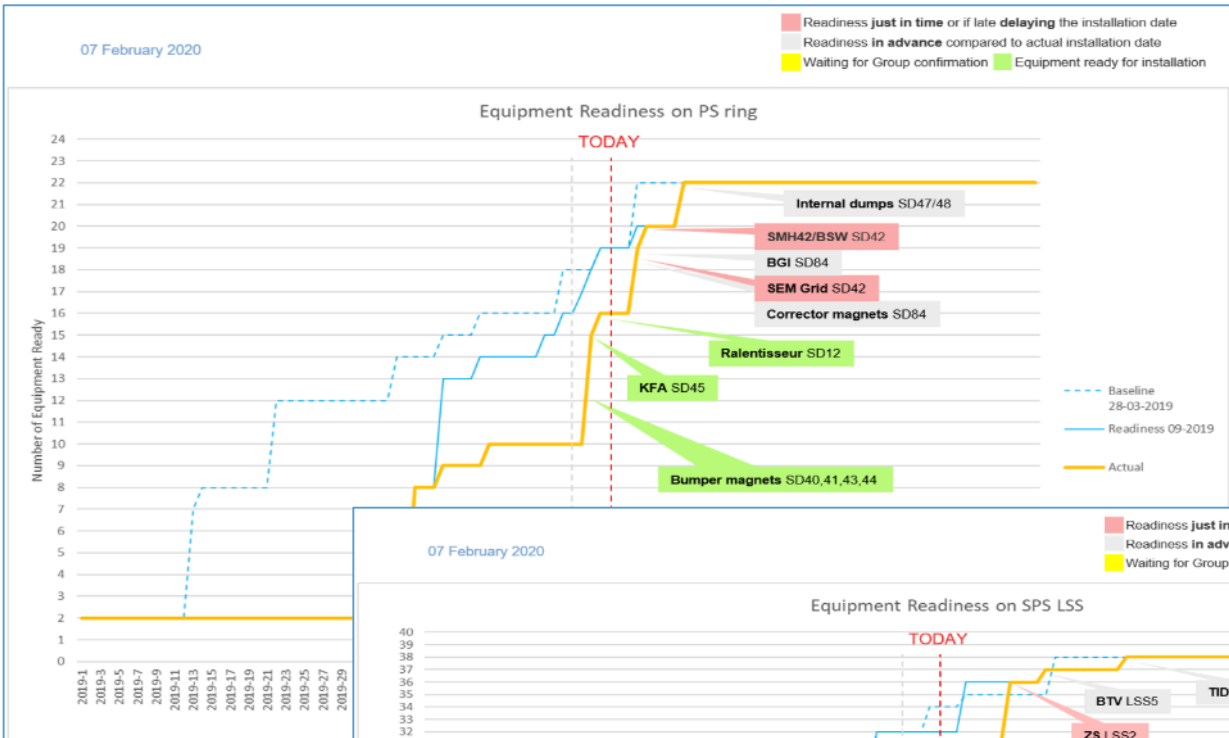
Severity Rate:

Days of absence per thousand hours worked

- * Data incl. February 2020 included, 1500 workers
- ** Source: France, Caisse nat'le d'assurance des travailleurs salaries, 2017

February 2020

Equipment readiness, Schedules & Milestones



LS2 Dashboard

<https://acc-dashboard.web.cern.ch/ls2>
 (CERN Single Sign On required)

PSB Update



New Wire Scanners



New RF Finemet Cavities

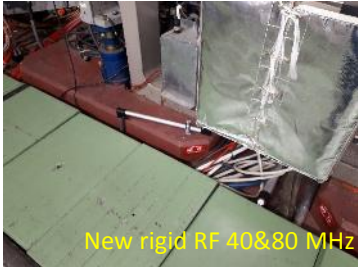


New extraction line bending magnets



New PS Booster injection system

- Most of the LS2 activities are on track or in advance
- Galleries cleaning completed
- Individual Systems tests (ISTs) will start soon for some specific equipment in the ring



New rigid RF 40&80 MHz lines



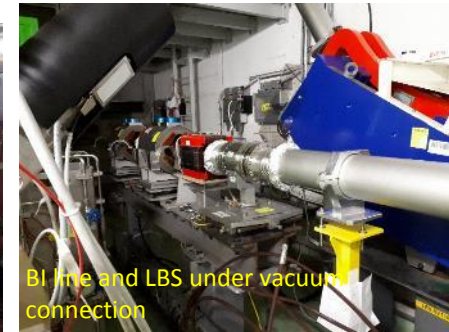
New WIC system



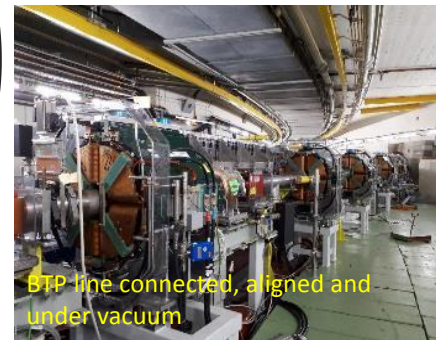
SMH16 back to the machine



BI line and LBS under vacuum connection

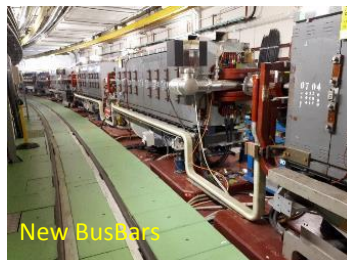
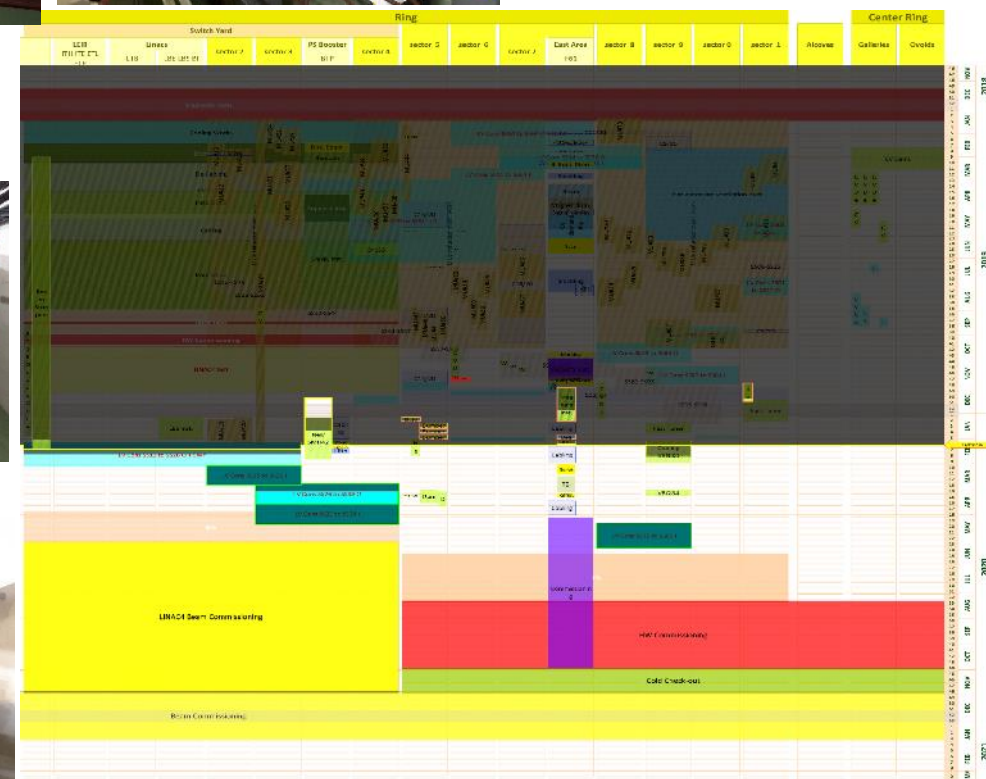


New Bumpers



Last MU back to the machine

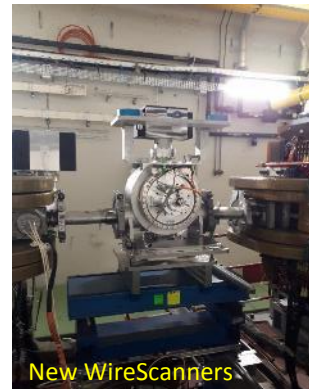
PS Ring and PS SwitchYard



New BusBars



New RF10MHz cooling



New WireScanners



New F16 Beam Stoppers

SPS Update



CE works in ECX5 complete on time.



LSS1 Re-installation



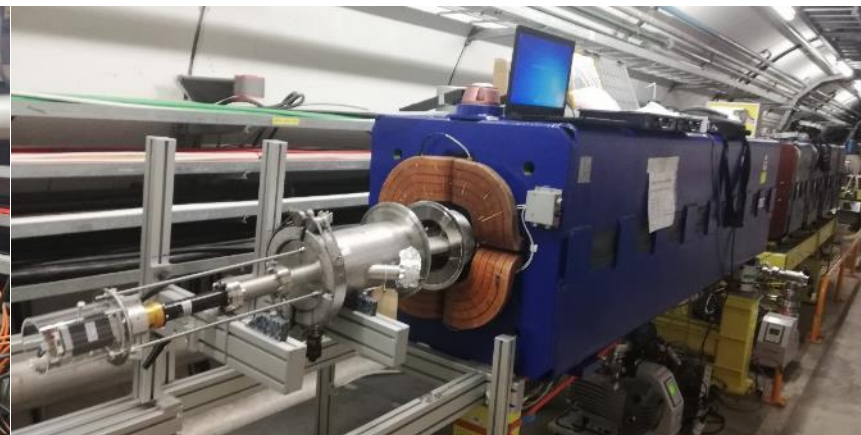
New PPS BA1



WP2, 3 & 4 installed in LSS5



Re-installation of magnets and RF cavities in LSS3



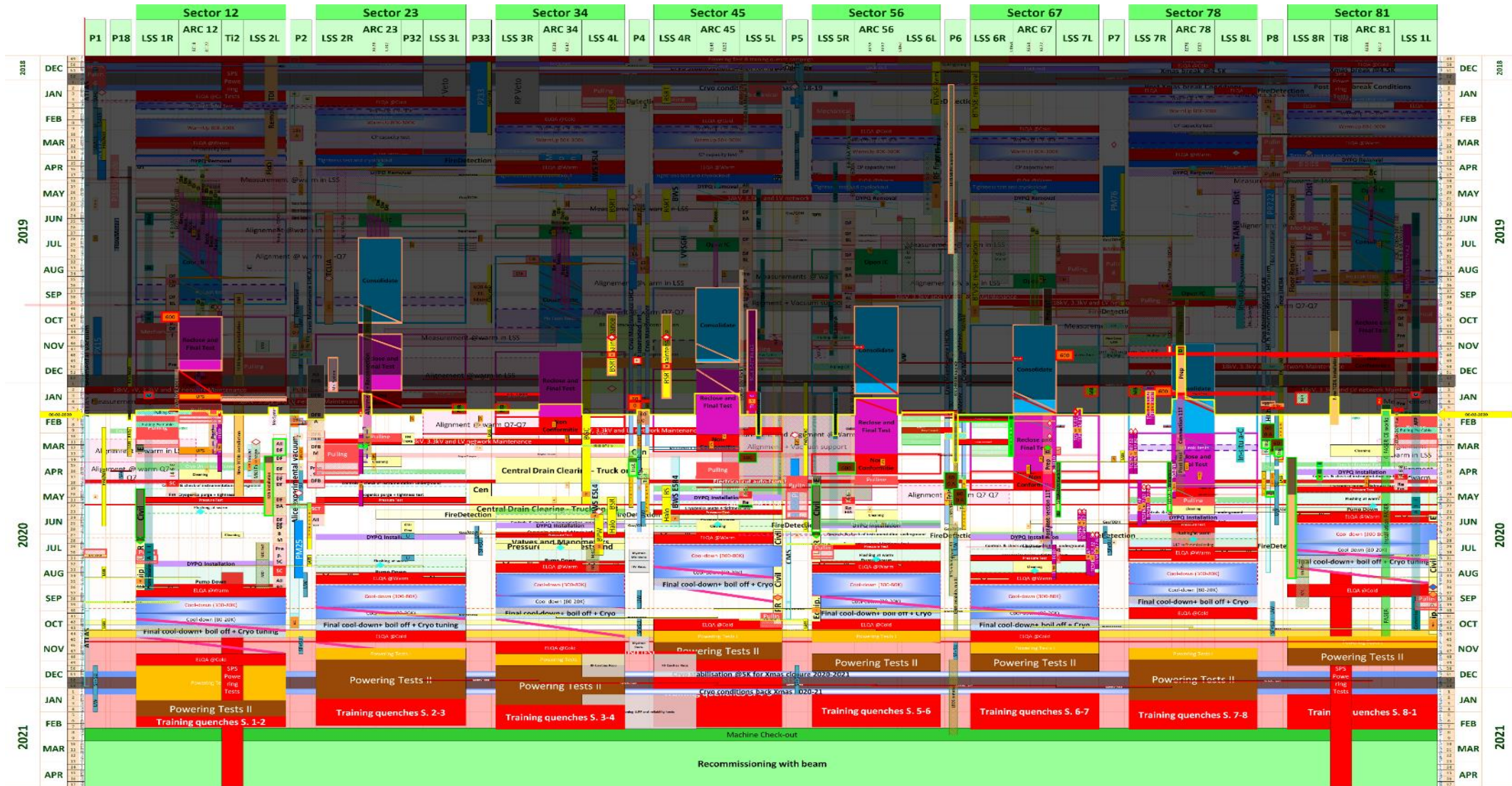
aC coating about to start its final sector

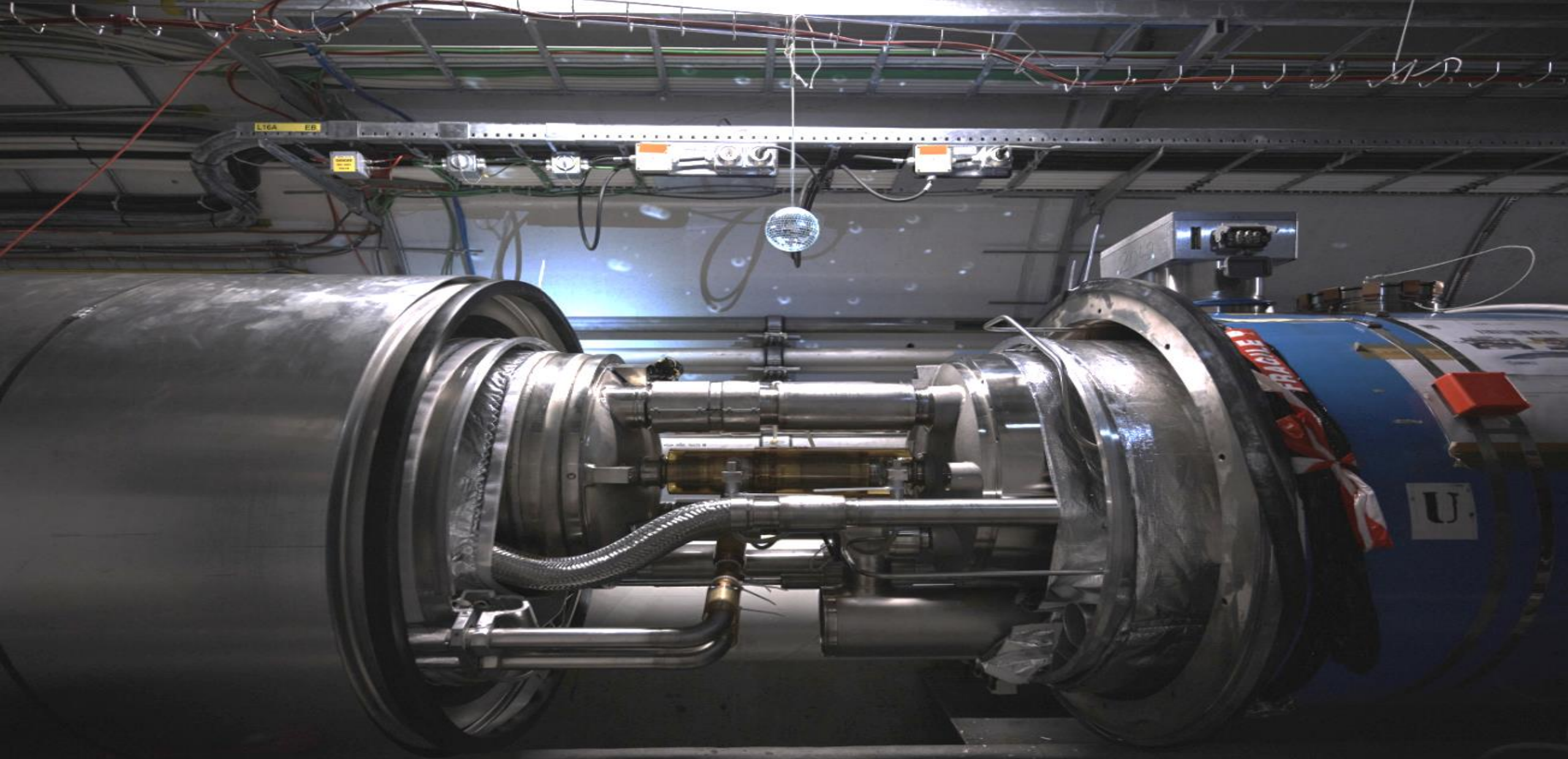


WP1 installed in LSS6+

LHC Update

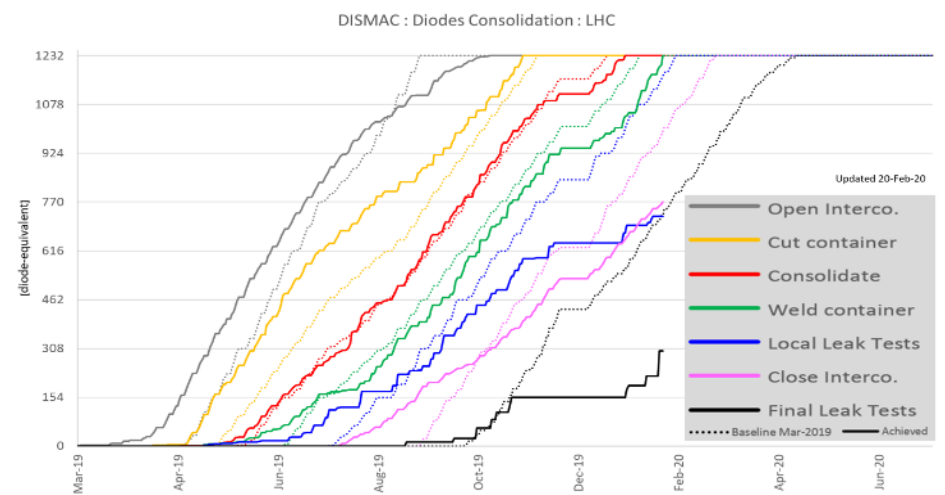
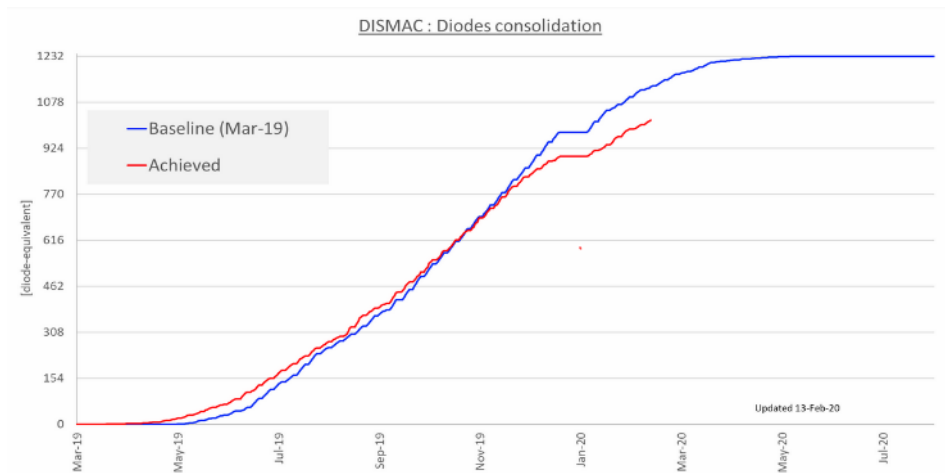
Status 7th February 2020 wrt baseline 2.4





20th February 2020: Last Diode box consolidation (insulation + welds)

DISMAC



- Sector 8-1 all works done
- Diodes electrical insulation consolidation fully completed
- DISMAC progression shows a small delay according to the baseline

LS2 - DISMAC PROJECT CWIC&CWICQC team

16th April 2019: First diode-box cover opening QBBL13R8 sector 8-1

27th November 2019: Last diode-box cover opening QBBLA12L8 sector 7-8

27th November 2019: Last interconnection cutting QBBLA12L8 sector 7-8

2464 covers opened

FINISH!

Pakistan Atomic Energy Commission, AltéAd, DEKRA

LS2 - DISMAC PROJECT DISCO-QC team

25th March 2019: First training session on the mock-up

23th April 2019: First Visual inspection after opening in sector 8-1

30th January 2020: Last quality check performed in sector 7-8

End of quality control campaign!

LS2 - DISMAC PROJECT Last diode consolidation 28.01.2020

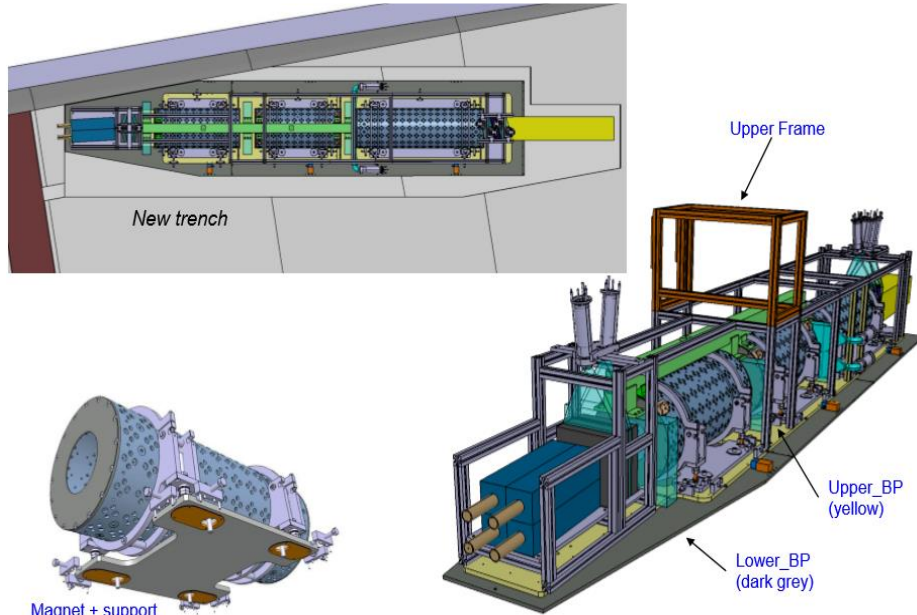
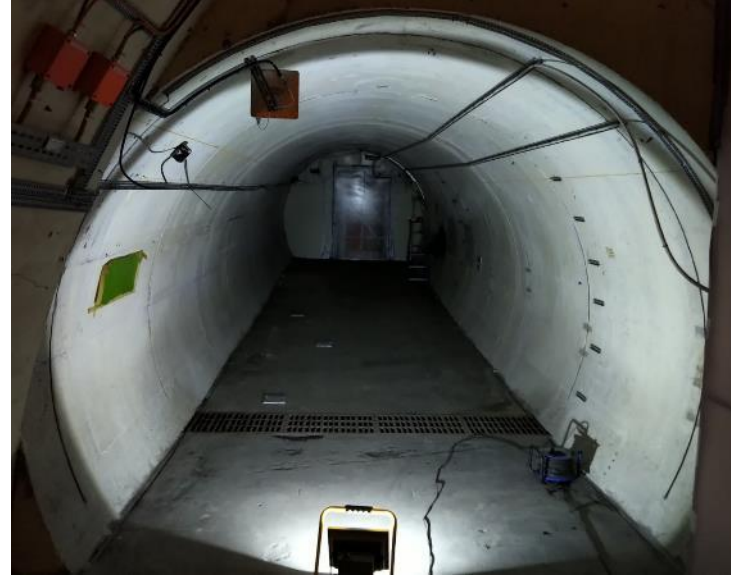
LS2 - DISMAC PROJECT CWIC & CWICQC team

20th February 2020: Last Interconnection weld QBBL9L8 sector 7-8

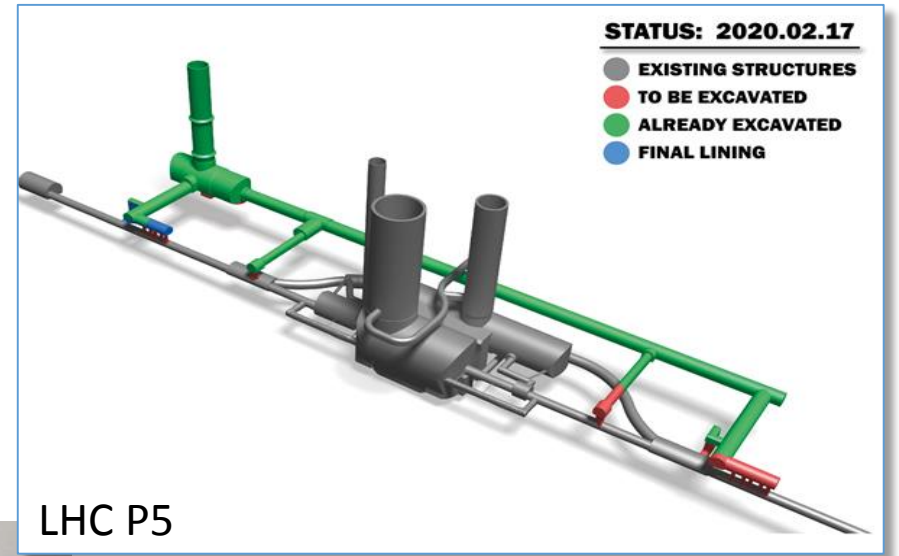
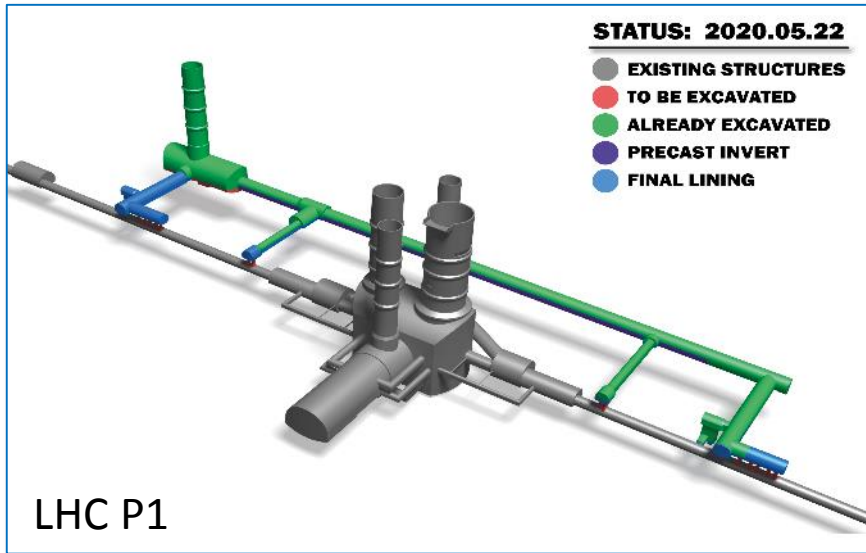
2464 welds

AltéAd, DEKRA

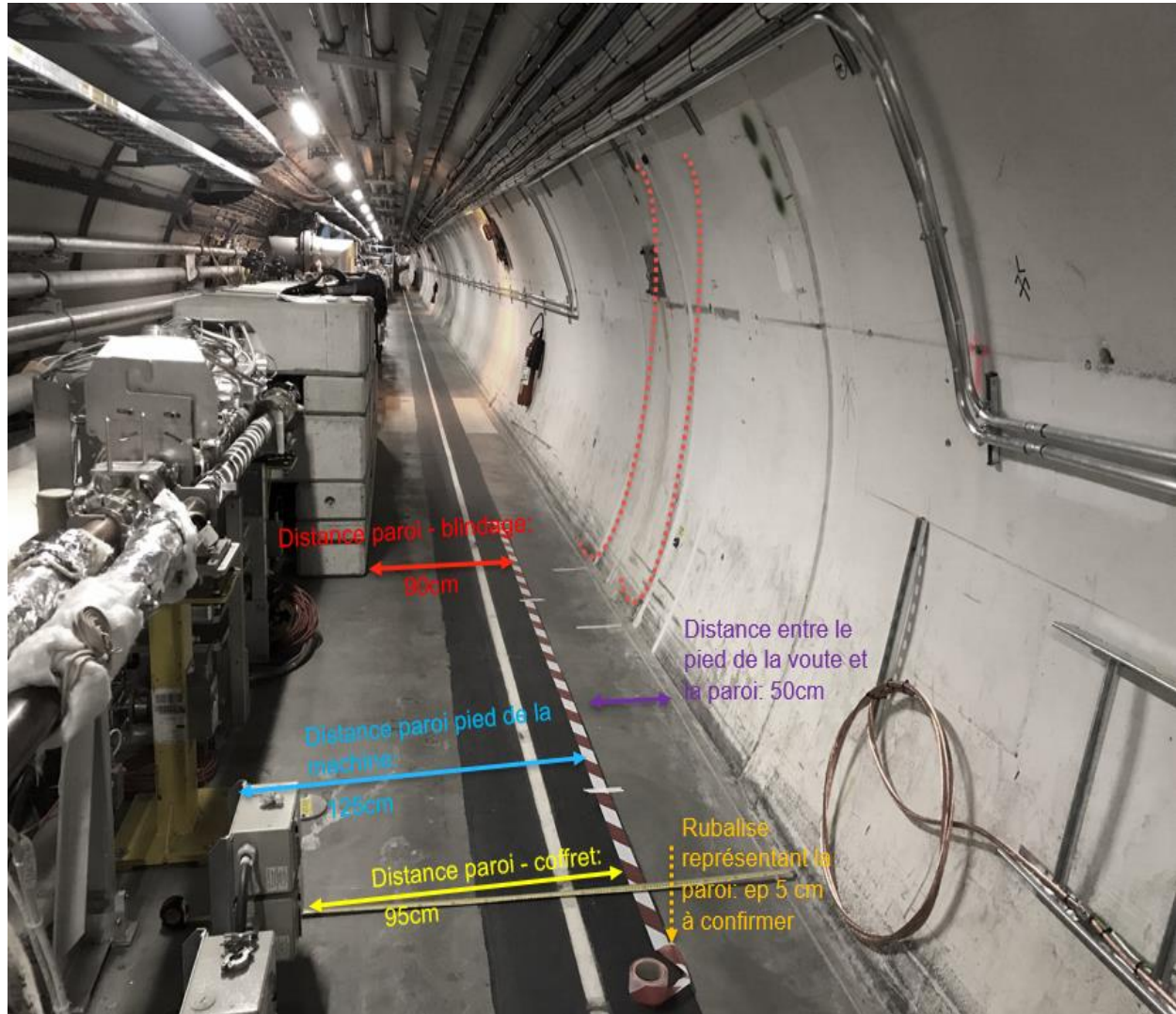
FASER



HL-LHC civil engineering



HL-LHC civil engineering



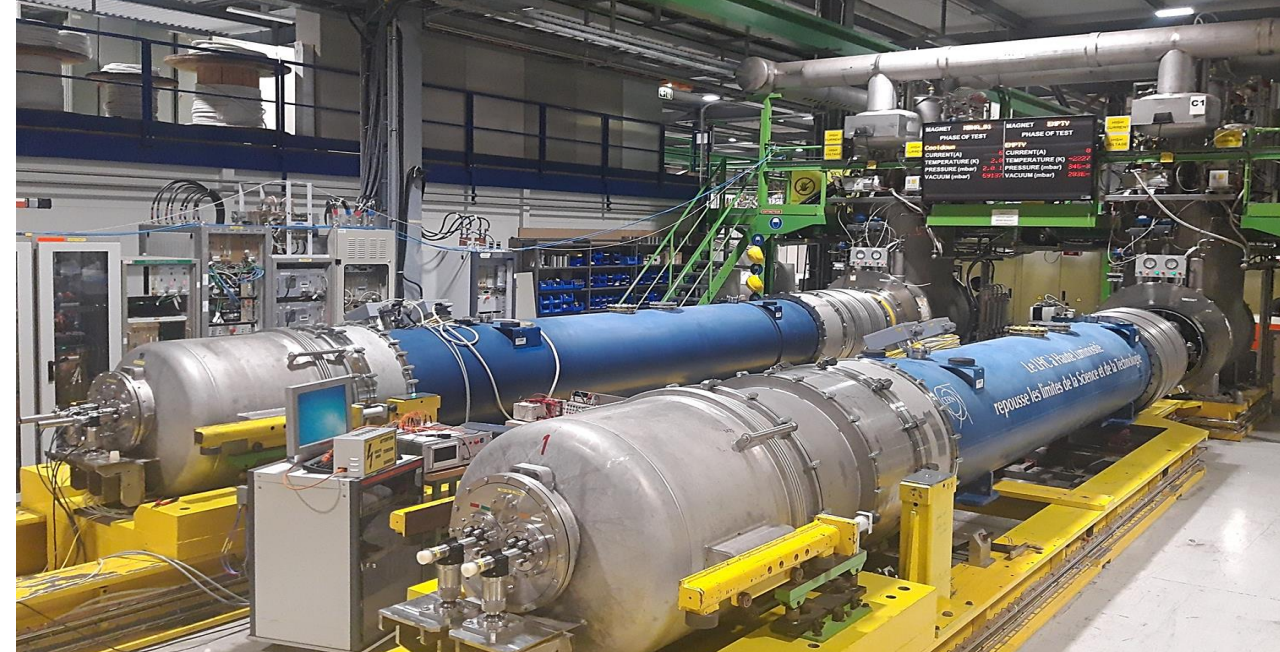


S1 successfully qualified

MBHA002 (S3) – cold mass in dis-assembly (orbital cut) for repair (Bdg. 180)



S3 preparing for coil replacement



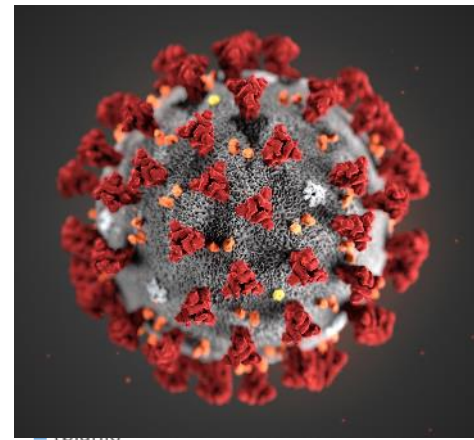
S2 & S4 @ SM18, cool down, being tested



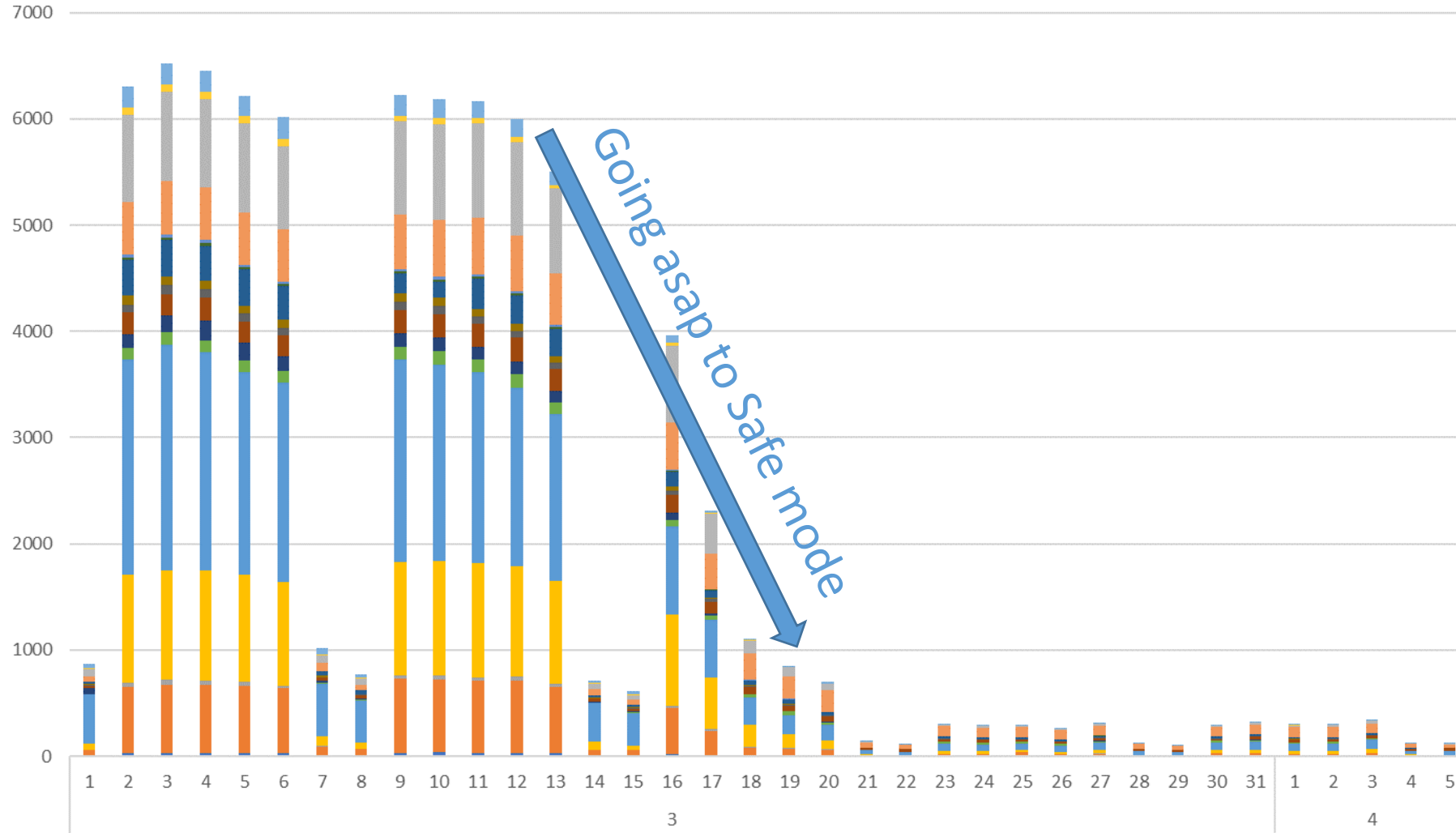
S5 in construction in LMF

CERN going to Safe mode

Number of individuals seen on CERN site per day by Department

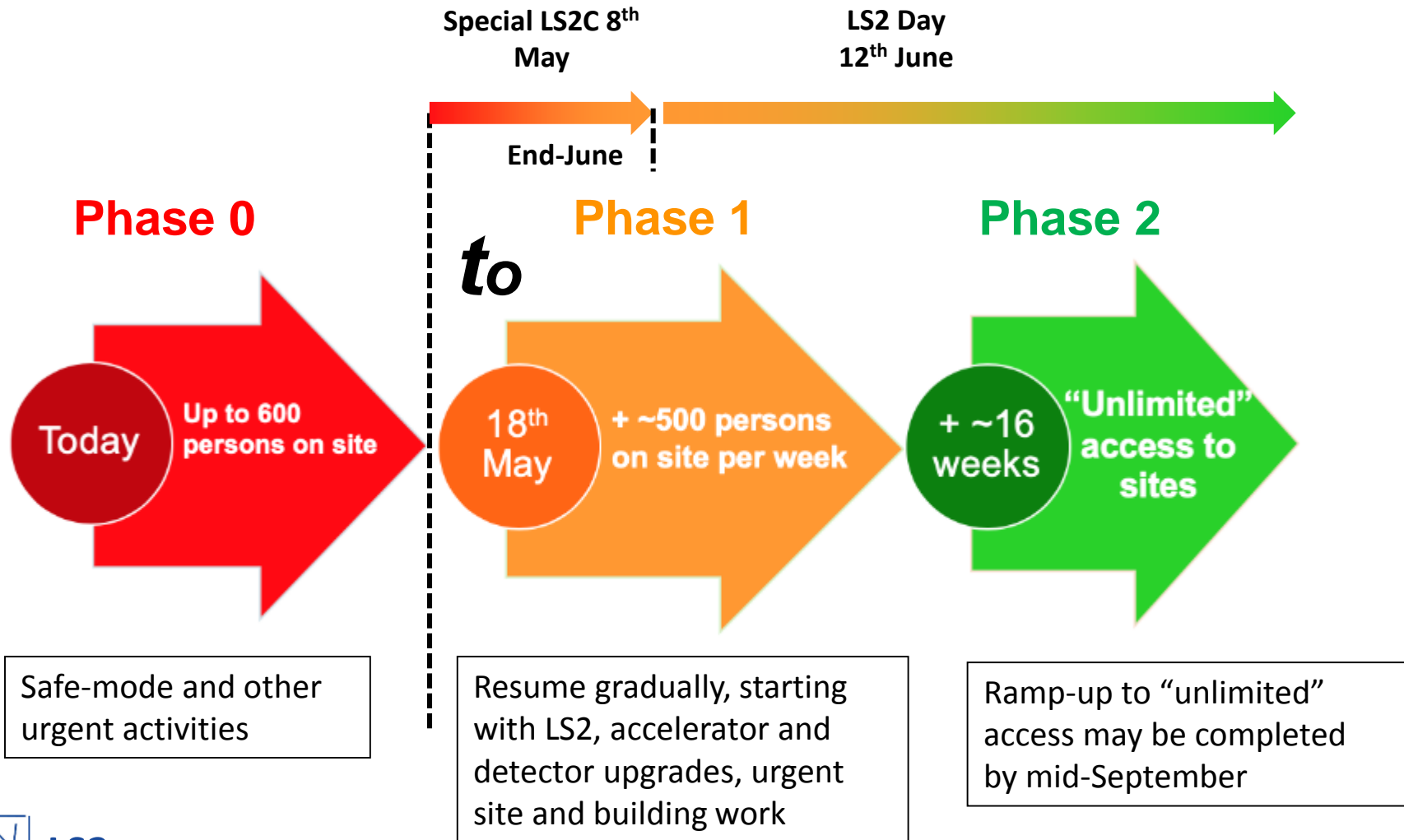


- TH
- TE
- SMB
- RCS
- PF
- IT
- IR
- IPT
- HSE
- HR
- FAP
- EP
- EN
- DG
- BE
- ATS



LS2 Ramping-up as of Phase 1 (or after t_0)

A gradual and cautious re-start plan



- ❑ Number of people on sites includes CERN's personnel as well as contractors.
- ❑ Personnel involved in LS2, accelerator and detector upgrades, urgent site and building work will come back to site gradually as of 18 May.
- ❑ The rest of personnel will come back gradually as of 2nd week of June.
- ❑ Personnel will be called back by supervisors.

Activities before t_0

- 68 x BE department with 53 with interpersonal distancing
 - ABP (4), BI (11), CO (5), OP(1), RF (29), ICS (18)
- 28 x EN department, all with full distancing
 - CV (8), EA (4), EL (5), HE (3), MME (4), SMM (4)
- 129 x TE department with 80 with interpersonal distancing.
 - ABT (12), CRG (9), EPC (15), MPE (4), MSC (45), VSC (44) **included DISMAC (14), HL-LHC (22)**

	On-site AM		On-site PM	
	Staff CERN [FTE]	Staff Contractor [FTE]	Staff CERN [FTE]	Staff Contractor [FTE]
L3	3		1	
L4	8	2	5	
PSB	25	19	8	8
PS	29	17	12	3
SPS	29	16	11	9
LHC	29	15	25	13
EXP	25	13	15	10
HL-LHC	46	29	43	28
INFRAS	21	16	19	14
SUPPORT	2	1	3	2
Grand Total	217	128	142	87

36% Injectors/LIU

14% LHC

11% Host Lab

25% HL-LHC

14% Dept Infras

Beams Department

P1	On-site AM		On-site PM		Number of people to be added to existing CERN access list
	Staff CERN [FTE]	Staff Contractor [FTE]	Staff CERN [FTE]	Staff Contractor [FTE]	
BE-ABP	4		4		4
BE-BI	11	11	11	11	11
BE-CO	5	5	5	5	5
BE-OP	1	1	1	1	1
BE-RF	27	1	26	1	29
BE-ICS	14	18	14	18	17
Grand Total	62	36	61	36	67

Engineering Department

	On-site AM		On-site PM		Number of people to be added to existing CERN access list
	Staff CERN [FTE]	Staff Contractor [FTE]	Staff CERN [FTE]	Staff Contractor [FTE]	
EN-CV	10	10	10	10	10
EN-EA	6	2	2	2	6
EN-EL	11	11	11	11	11
EN-HE	1	3	2	4	4
EN-MME	6		6		6
EN-SMM	8	4	8	4	9
Grand Total	42	30	39	31	46

Technology Department

P1	On-site AM		On-site PM		Number of people to be added to existing CERN access list
	Staff CERN [FTE]	Staff Contractor [FTE]	Staff CERN [FTE]	Staff Contractor [FTE]	
ABT	12	10	11	10	12
TE-CRG	7	7	7	7	7
TE-EPC	15	9			
TE-MPE	4		1		4
TE-MSC	75	65	40	33	49
TE-VSC	42	4	24	3	42
Grand Total	155	95	83	53	114

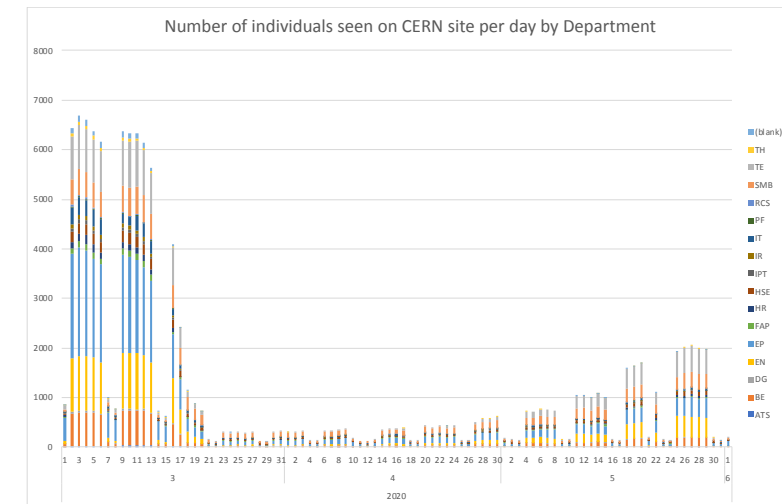
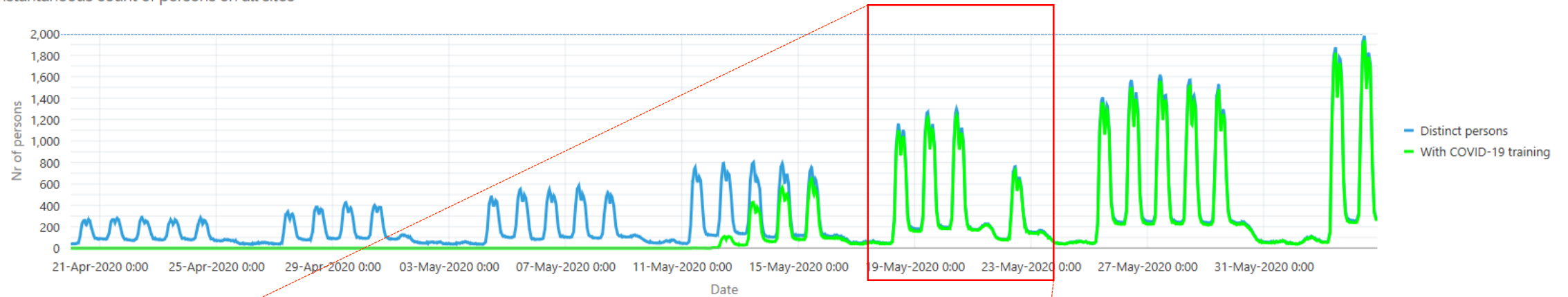
Monitoring the flow of Persons on Sites during Phase 1

COVID-19 Dashboard

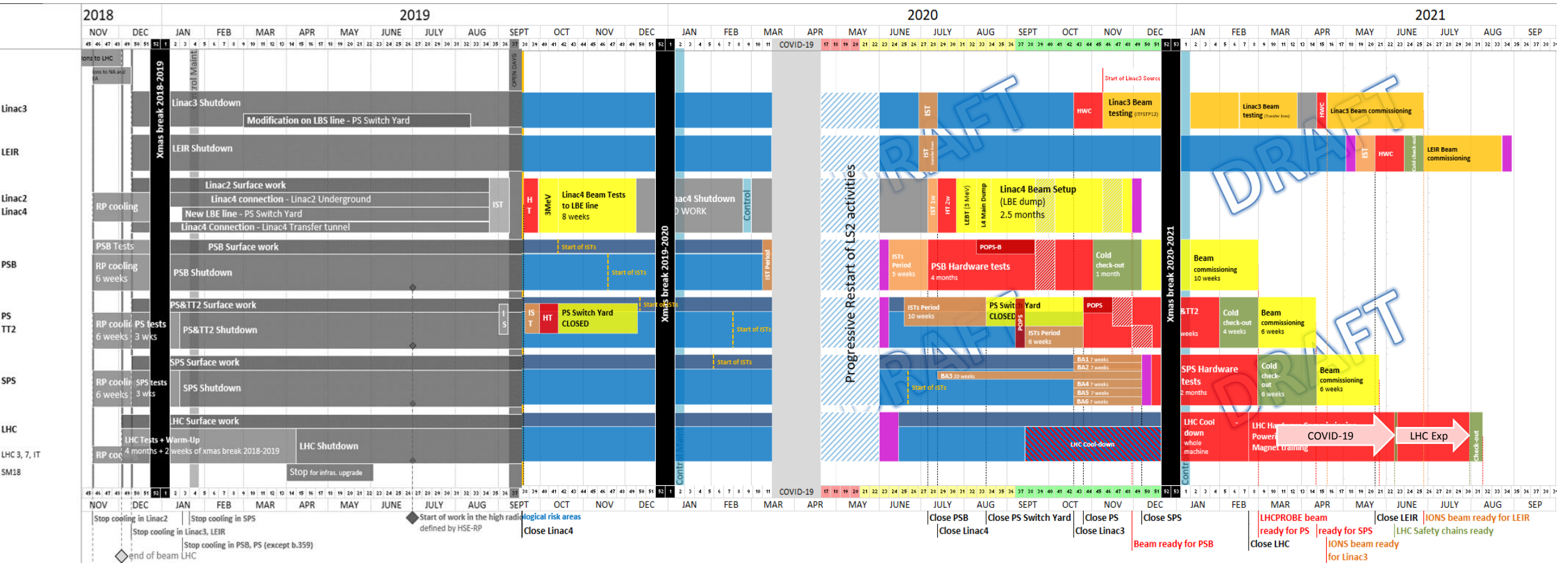
Start date

End date

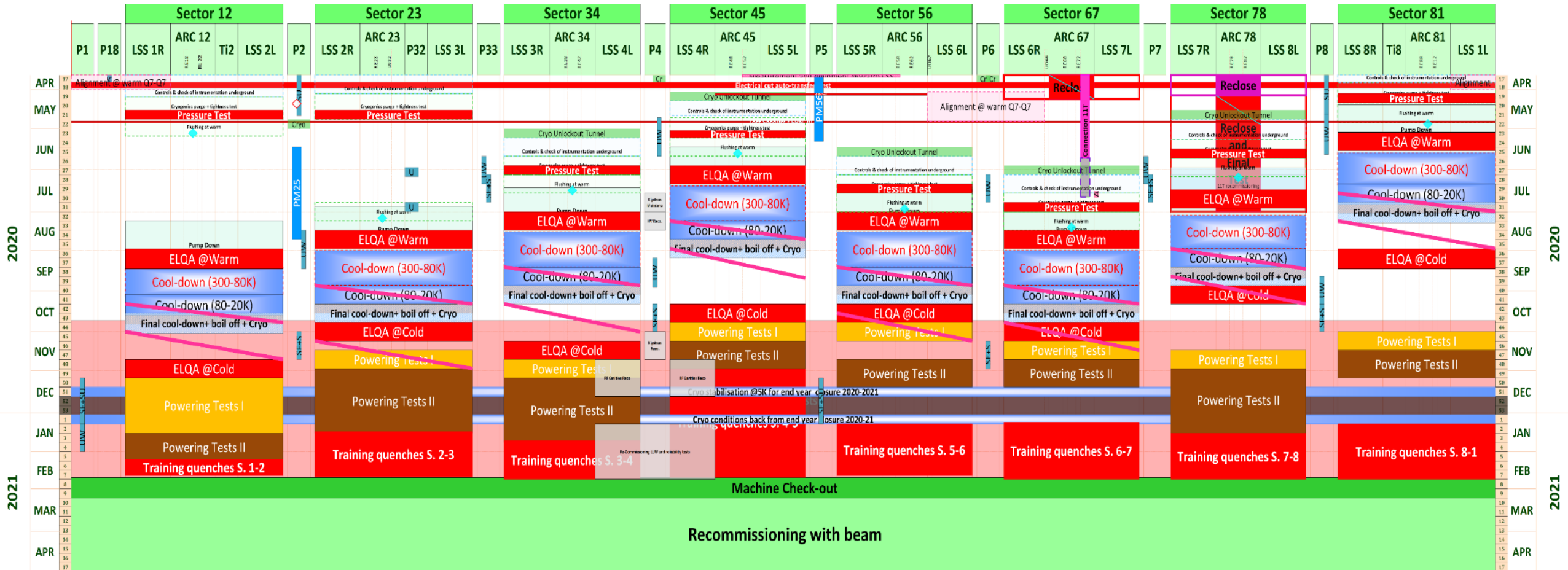
Instantaneous count of persons on all sites



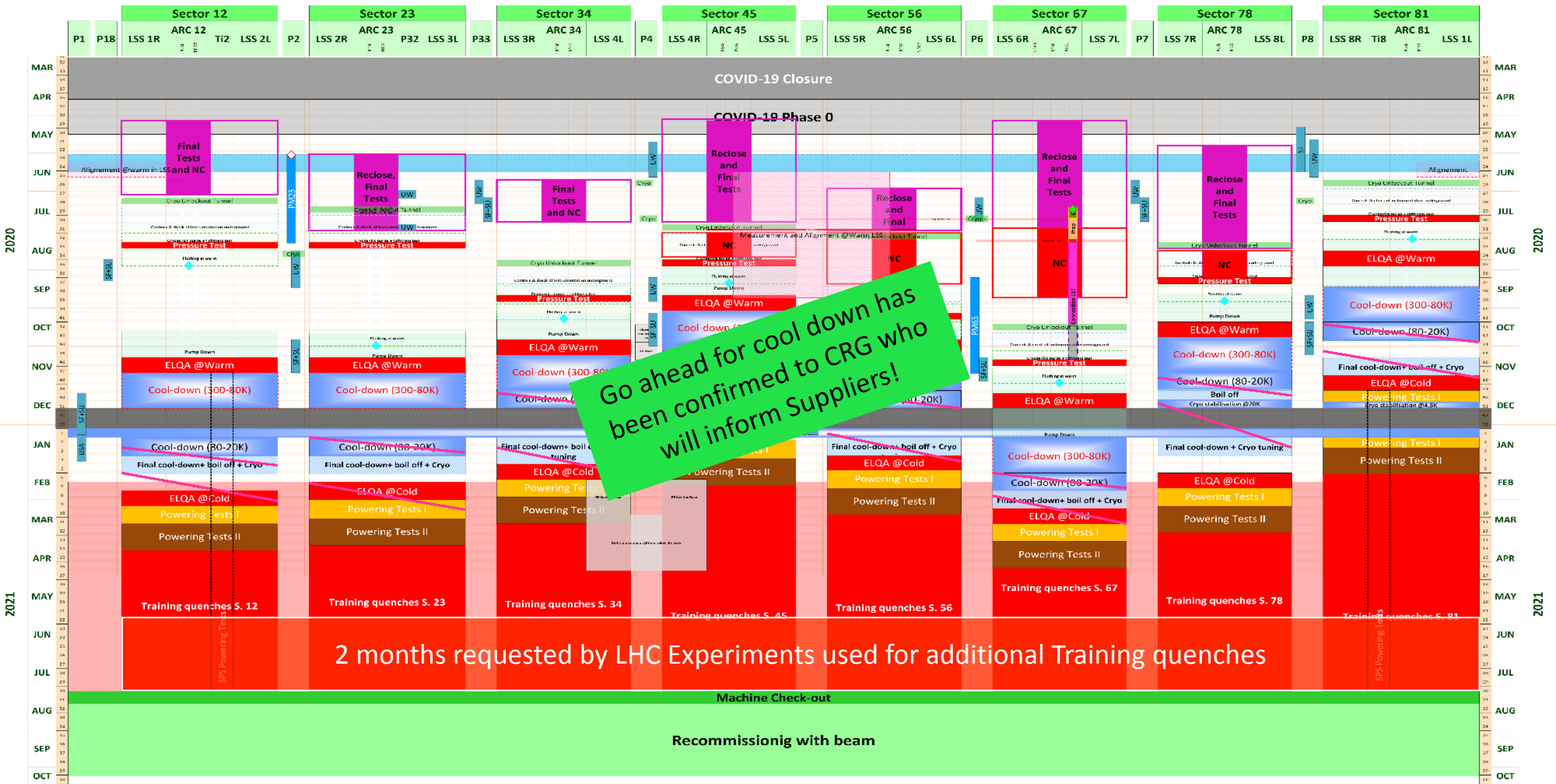
LS2 Master Schedule *INWORK* [EDMS ACC-PM-MS-0002 v.2.6](#)



LHC LS2 Baseline V2.3 FRAME [LHC-PM-MS-0018 v.2.3](#)



LHC LS2 Baseline V2.4 FRAME *INWORK* [LHC-PM-MS-0018 v.2.4](#)



2 months requested by LHC Experiments used for additional Training quenches

Closing remarks

Injectors & LHC were on schedule...

- ✓ Few components on the critical path were followed closely.
- ✓ No showstopper identified, full span of activities and resources.
- ✓ Two additional months requested by LHC Experiments to be used for additional magnet training to see potential for operation @ higher energy.

CERN went on Safe mode due to COVID-19 mid-March

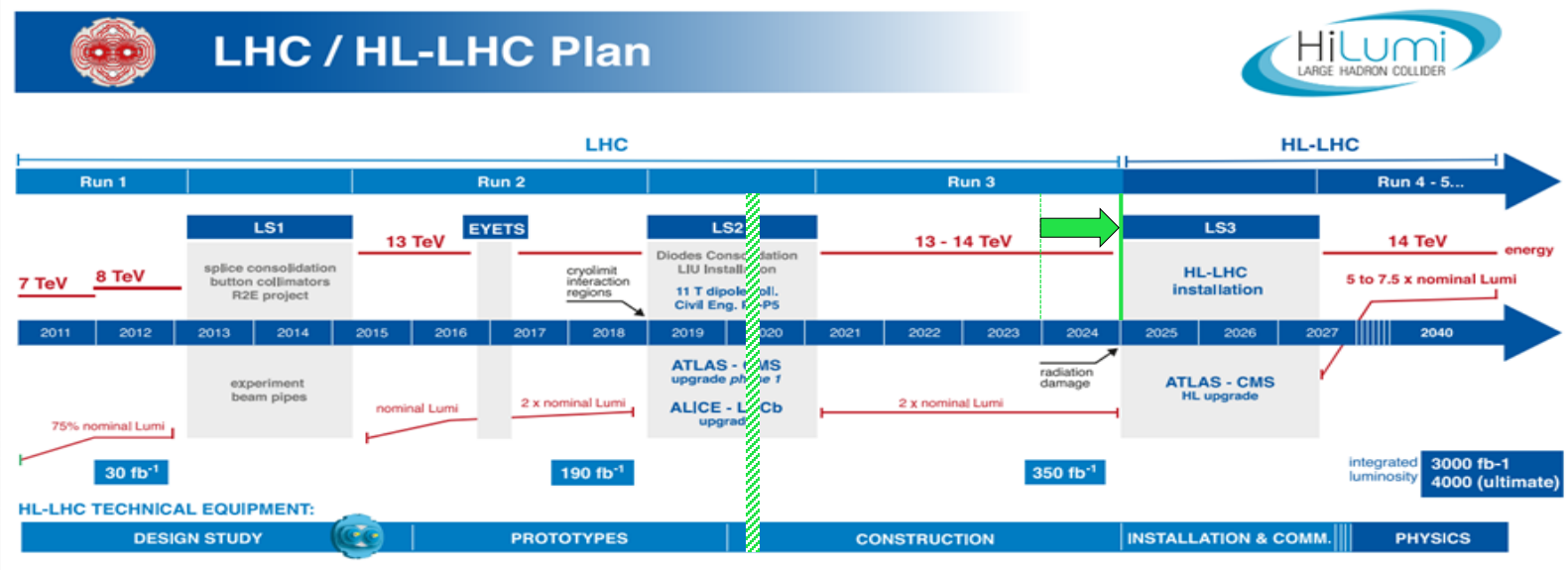
- ✓ **All equipment & infrastructures put on Safe mode within 2 weeks!**

Closing remarks

LS2: the main driver of CERN Ramping-up

- ✓ Phase 0_{till mid-May}: used to implement COVID-19 Safety measures, adapt procedures, tools and schedules.
 - Successful with intensive field coordination and safety follow-up (tunnel and surface).
- ✓ Phase 1_{since mid-May}: LS2 activities restarting according to new schedules.
 - ~3 months impact of COVID-19 Safe mode → No snow-ball effect.
 - LN₂ and LHe start deliveries mid-July'20 → LHC cool down to start mid-September'20.
- ✓ Beams in Injectors by Spring'21 and in LHC by end-Summer'21

- **Special LS2 Committee (8th May)**
 - **Prioritization review of Phase 1 re-start up to end-June.**
- **LHC accelerator and Experiments meeting (8th June)**
 - **LS2 & Experiments status and Run 3.**
- **LS2 Day (12th June)**
 - **Consolidate the LHC Experiments timeline and LS2 Master schedules.**
 - **Update on resources availabilities including Support's group and General Services for entire LS2.**
- **LHC Performance Workshop "Chamonix", 28th Sept to 1st Oct**
 - **Review and optimize the LS2 schedule and the Run 3.**





Warm thanks to:

- ✓ All Contributors to this presentation
- ✓ LS2C Representatives for their help in the LS2 preparation and follow-up

Congratulation to:

- ✓ CERN Teams and Collaborators from Institutes and Universities
- ✓ Industrial Support Teams

Keep going!

...and my warm thanks to the LS2 Team ☺



LS2

Coordination