



European Organization for Nuclear Research

LHC-LS2 BEAM VACUUM CONTROLS

Pablo Prieto



01

INITIATION & CONCEPTION

1.1 WHERE IT ALL BEGAN

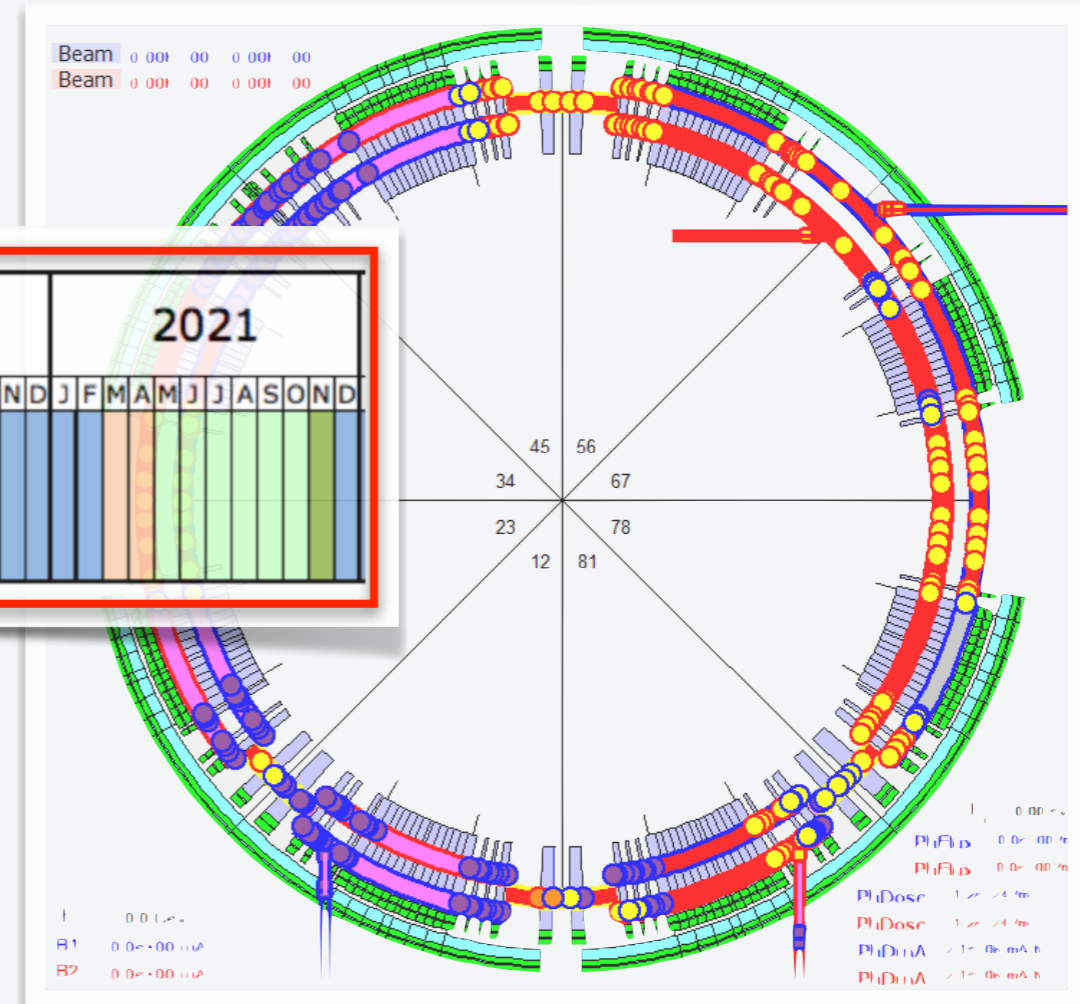
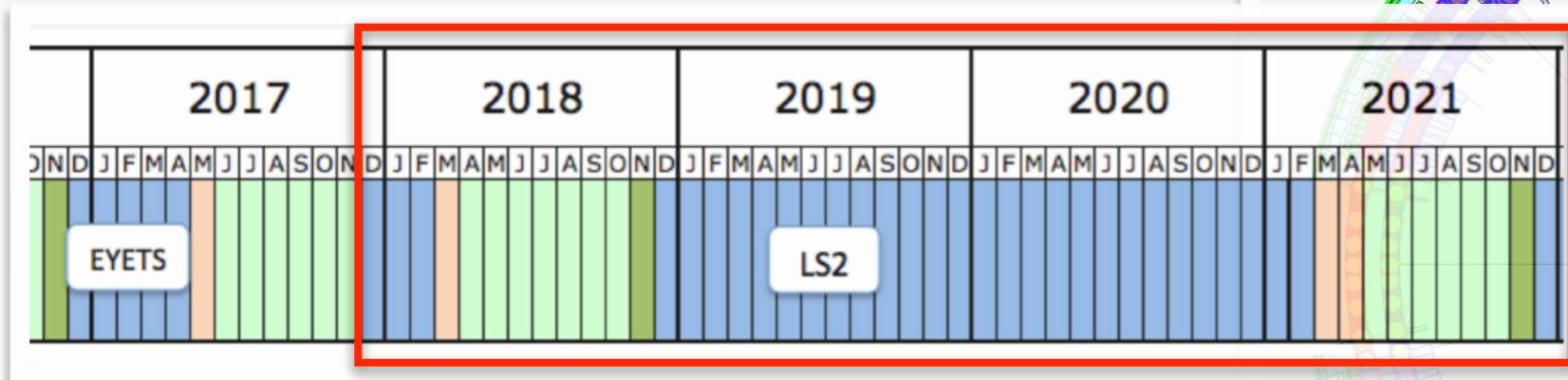
Three Years Ago...

Rewind almost **three years ago**: beginning of **2018**

LHC's Run 2 taking place, control system running and in **full operation**

Before getting started, defined necessary **objectives to be accomplished**

According to **LHC's MTP Plan**



1.2 STAKEHOLDERS MEETINGS


ECR Technical Specifications

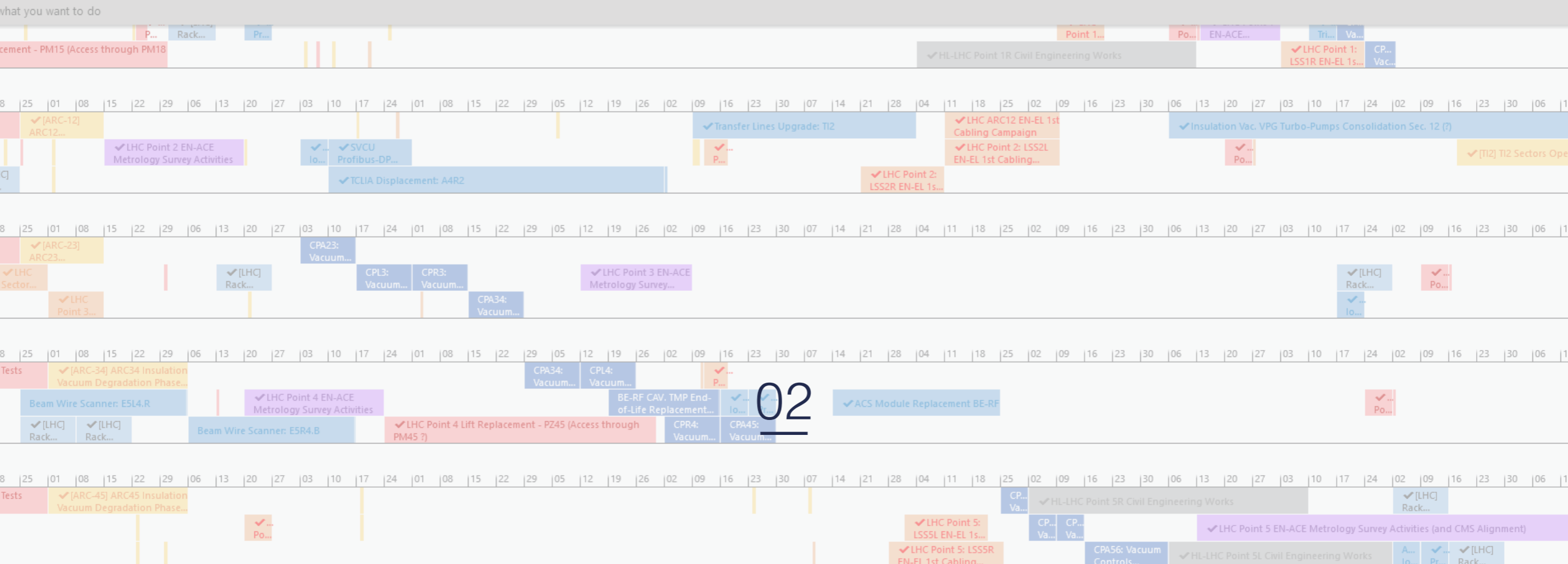
Meetings with **different groups** and **stakeholders**

Retrieving **maximum** amount of **information**

In order to align our **vacuum controls** actions

With predefined **technical specifications** (ECR)

CERN CH-1211 Geneva 23 Switzerland	EDMS NO. 1967305	REV. 1.0	VALIDITY RELEASED
 LHC	REFERENCE LHC-VC2-EC-0001		
Date: 2019-07-17			
ENGINEERING CHANGE REQUEST			
UPGRADE of the LHC Vacuum Sectors A1L2.X, IP2.X and A1R2.X within the LS2 ALICE Experiment Upgrade			
<small>BRIEF DESCRIPTION OF THE PROPOSED CHANGE(S):</small>			
<p>This ECR summarizes the vacuum layout upgrade of ALICE experiment vacuum during the LS2. Concerned vacuum sectors are A1L2.X, IP2.X and A1R2.X located between Q1L2 and Q1R2, mostly in the ALICE experimental cavern UX25.</p>			



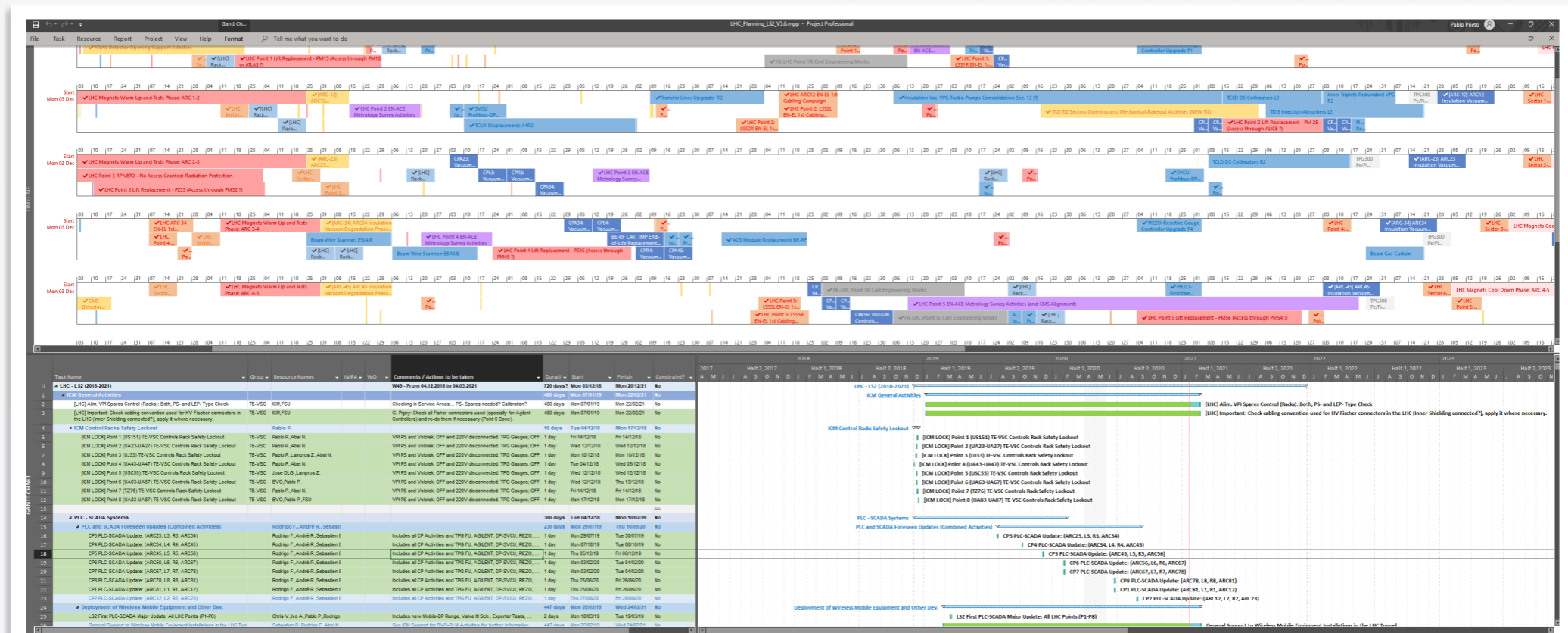
PLANNING & PREPARATION

Names	IMPA	WO	Comments / Actions to be taken	Durati	Start	Finish	Constraint?	2018												2019					2020									
								2017					Half 2, 2017					Half 1, 2018					Half 2, 2018					Half 1, 2019					Half 2, 2019	
			W49 - From 04.12.2018 to 04.03.2021	720 days?	Mon 03/12/18	Mon 20/12/21	No	LHC - LS2 (2018-2021)																										
				480 days	Mon 07/01/19	Mon 22/02/21	No	ICM General Activities																										
			Checking in Service Areas... PS- Spares needed? Calibration?	480 days	Mon 07/01/19	Mon 22/02/21	No																											
			G. Pigny: Check all Fisher connectors used (specially for Agilent Controllers) and re-do them if necessary (Point 6 Done).	480 days	Mon 07/01/19	Mon 22/02/21	No																											
				10 days	Tue 04/12/18	Mon 17/12/18	No	ICM Control Racks Safety Lockout																										
del N.			VPI PS and Volotek; OFF and 220V disconnected. TPG Gauges; OFF.	1 day	Fri 14/12/18	Fri 14/12/18	No	[ICM LOCK] Point 1 (US151) TE-VSC Controls Rack Safety Lockout																										
del N.			VPI PS and Volotek; OFF and 220V disconnected. TPG Gauges; OFF.	1 day	Wed 12/12/18	Wed 12/12/18	No	[ICM LOCK] Point 2 (UA23-UA27) TE-VSC Controls Rack Safety Lockout																										
mpros Z., Abel N.			VPI PS and Volotek; OFF and 220V disconnected. TPG Gauges; OFF.	1 day	Mon 10/12/18	Mon 10/12/18	No	[ICM LOCK] Point 3 (UJ33) TE-VSC Controls Rack Safety Lockout																										
del N.			VPI PS and Volotek; OFF and 220V disconnected. TPG Gauges; OFF.	1 day	Tue 04/12/18	Wed 05/12/18	No	[ICM LOCK] Point 4 (UA43-UA47) TE-VSC Controls Rack Safety Lockout																										
Lampros Z.			VPI PS and Volotek; OFF and 220V disconnected. TPG Gauges; OFF.	1 day	Wed 12/12/18	Wed 12/12/18	No	[ICM LOCK] Point 5 (USC55) TE-VSC Controls Rack Safety Lockout																										
P.			VPI PS and Volotek; OFF and 220V disconnected. TPG Gauges; OFF.	1 day	Wed 12/12/18	Thu 13/12/18	No	[ICM LOCK] Point 6 (UA63-UA67) TE-VSC Controls Rack Safety Lockout																										
del N.			VPI PS and Volotek; OFF and 220V disconnected. TPG Gauges; OFF.	1 day	Fri 14/12/18	Fri 14/12/18	No	[ICM LOCK] Point 7 (TZ76) TE-VSC Controls Rack Safety Lockout																										
P.,FSU			VPI PS and Volotek; OFF and 220V disconnected. TPG Gauges; OFF.	1 day	Mon 17/12/18	Mon 17/12/18	No	[ICM LOCK] Point 8 (UA83-UA87) TE-VSC Controls Rack Safety Lockout																										
				300 days	Tue 04/12/18	Mon 10/02/20	No	PLC - SCADA Systems																										
.,André R.,Sebasti				230 days	Mon 29/07/19	Thu 10/09/20	No	PLC and SCADA Foreseen Updates (Combined Activities)																										
André R.,Sebastien F			Includes all CP Activities and TPG FU, AGILENT, DP-SVCU, PIEZO, ...	1 day	Mon 29/07/19	Tue 30/07/19	No	CP3 PLC-SCADA Update: [ARC23, L3, R3]																										
André R.,Sebastien F			Includes all CP Activities and TPG FU, AGILENT, DP-SVCU, PIEZO, ...	1 day	Mon 07/10/19	Tue 08/10/19	No	CP4 PLC-SCADA Update: [AR]																										
André R.,Sebastien F			Includes all CP Activities and TPG FU, AGILENT, DP-SVCU, PIEZO, ...	1 day	Thu 05/12/19	Fri 06/12/19	No	CP5 PLC-SCADA Upd																										
André R.,Sebastien F			Includes all CP Activities and TPG FU, AGILENT, DP-SVCU, PIEZO, ...	1 day	Mon 03/02/20	Tue 04/02/20	No	CP6 PLC-SC																										
André R.,Sebastien F			Includes all CP Activities and TPG FU, AGILENT, DP-SVCU, PIEZO, ...	1 day	Mon 03/02/20	Tue 04/02/20	No	CP7 PLC-SC																										
André R.,Sebastien F			Includes all CP Activities and TPG FU, AGILENT, DP-SVCU, PIEZO, ...	1 day	Thu 25/06/20	Fri 26/06/20	No																											
André R.,Sebastien F			Includes all CP Activities and TPG FU, AGILENT, DP-SVCU, PIEZO, ...	1 day	Thu 25/06/20	Fri 26/06/20	No																											
André R.,Sebastien F			Includes all CP Activities and TPG FU, AGILENT, DP-SVCU, PIEZO, ...	1 day	Thu 27/08/20	Fri 28/08/20	No																											
				447 days	Mon 25/02/19	Wed 24/02/21	No	Deployment of Wireless Mobile Equipment and Other Dev.																										
A.,Pablo P.,Rodrigo			Includes new Mobile-DP Range, Valve I/I Sch., Exporter Tests, ...	2 days	Mon 18/03/19	Tue 19/03/19	No	LS2 First PLC-SCADA Major Update: All LHC Points (P1-P8)																										
R. Rodrign F. Abel N			See ICM Support for RVO-DI M Activities for further information	447 days	Mon 25/02/19	Wed 24/02/21	No																											

2.1 LS2 PROJECT PLAN

Project Baseline and Critical Path

First LS2 project plan (MS Project) with initial baseline
Containing all known constraints and potential co-activities
Plus, tasks and actions needed to reach objectives set
Due to vast amount of activities, critical path was set
Defining the project's roadmap and dependencies



2.1 LS2 PROJECT PLAN

WBS and Agile Methodology

Work **B**reakdown **S**tructure (WBS) approach

Led to **more manageable** work and **increased efficiency**

Main **summary tasks** and activities into **smaller sub-tasks**

Structuring work into **pre-defined** and **recurrent processes**

Agile: two-week sprints with daily scheduled activities and biweekly sprint review

Activity Description	Responsible	Mon	Tue	Wed	Thu	Fri
HL-LHC + LS2 Proj. (Instrument. + HL-LHC/LS2 Projects)	Pablo/Abel N.	BWS-BGC Reconn. + ICM Tests (AN+FSU)			TDIS-TI8 Reconn. + ICM Tests (AN+FSU)	BWS-BGC Reconn. + ICM Tests (AN+FSU)
Mobile Equipm. Connect. (NEG Activation + BO)	Pablo/Abel N.		TI2-A6L2 BO Support (PP+AN+BVO)			
BVO-ICM Common Activities (See PPT Slides)	Pablo/Abel N.	LSS4L? (AN+FSU)	LSS8 Urgent Gauge Actions (PP+AN+FSU)	LSS8 Urgent Gauge Actions (PP+AN)	LSS8R? (AN+FSU)	LSS4L-R? (AN+FSU)
ICM Racks Cons. (P-DP Network Cons., SVCU-DP)	Pablo/FSU/Abel N.	BWS-BGC Reconn. + Tests (AN+FSU)		TE Elec. Safety (FSU)	TE Elec. Safety (FSU)	TE Elec. Safety (FSU)
ICM PLC HW Config.+Vac-DB (BV + Update)	Pablo/Gregory					
ICM LHC Coordination (IMPACTs, Constraints, Planning, ...)	Pablo	LHC Urgent Gauges Actions + Prep. (PP)	LHC Urgent Gauges Simulators + Tests (PP)		LSS Meeting + Sprint Review (PP+BVO)	LHC Urgent Gauges Actions Follow-up (PP)
ICM LHC Infrastruct. + Services (Cabling, Power, IT Sockets)	Pablo/Lampros	LSS2 EN-EL ALICE + TCLD R2 Queries (PP)		TI8 Local TPG Config. + Check Outlets (PP)		

2.2 RESOURCES MANAGEMENT

Allocation and Access-Dose Management

- Allocating **resources** and **manpower** to match actions
- Balance between **number of people** and **type of activities**
- Dealing with paperwork** to grant access and track doses
- Including **IMPACTs**, **DIMR-RWP** and **WDP** creation

IMPACT Search for Activities, Clusters, DIMRs, VCs, Lockouts, Fire Permits, ISPs, Work Order Plannings...

My Open Activities (23) Pending My Approval (0)

ACTIVITY / SAFETY PROCEDURES	STATUS	FACILITY	START DATE	END DATE	PARTICIPANTS	COLL. DOSE
122400 - [LHC] US505: Vacuum Controls Activities	Late	LHC Machine	10-Dec-2018	09-Jan-2021	0 / 0	
122489 - [LHC] UA43-UM47: Vacuum Controls Activities	Late	LHC Machine	10-Dec-2018	09-Jan-2021	0 / 0	
122488 - [LHC] US52: Vacuum Controls Activities	Late	LHC Machine	10-Dec-2018	09-Jan-2021	0 / 0	
122482 - [LHC] UA22-UM27: Vacuum Controls Activities	Late	LHC Machine	10-Dec-2018	09-Jan-2021	0 / 0	
122486 - [LHC] US151: Vacuum Controls Activities	Late	LHC Machine	10-Dec-2018	09-Jan-2021	0 / 0	
122484 - [LHC] L557: Vacuum Controls Activities DIMR: 7865416/1	Late	LHC Machine	14-Oct-2019	25-Dec-2020	0 / 0	102 / 150 person.uSv
122482 - [LHC] L552: Vacuum Controls Activities DIMR: 7865806/1	Late	LHC Machine	10-Dec-2018	09-Jan-2021	0 / 0	91 / 150 person.uSv
122481 - [LHC] L591: Vacuum Controls Activities	Late	LHC Machine	10-Dec-2018	09-Jan-2021	0 / 0	
122480 - [LHC] L592: Vacuum Controls Activities	Late	LHC Machine	10-Dec-2018	09-Jan-2021	0 / 0	
122479 - [LHC] L592: Vacuum Controls Activities	Late	LHC Machine	10-Dec-2018	04-Jan-2021	0 / 0	
122478 - [LHC] L591: Vacuum Controls Activities	Late	LHC Machine	10-Dec-2018	04-Jan-2021	0 / 0	

Inconsistencies (1)

SEVERITY	DESCRIPTION	CREATION DATE	ACTIVITY	ACTIVITY STATUS
WARNING	The Activity 122478 is in status Late and a Change Request is waiting for approval to put it back in progress. @	03-Jan-2021	122478 [LHC] L591: Vacuum Controls Activities	Late

Activity 122484 - [LHC] L557: Vacuum Controls Activities

Owner: PEDRO PABLO PROIETO DOMINGUEZ

Main Facility: LHC Machine

PSO/Experiment PSO: ALDOES VIDAL

RPO: CHRIS TORRE THORPEL

RSSO/RPE: ALDOES VIDAL

Bypass DIMR Level 1 approval: Yes

PCR Notification: N/A

Risk Analysis Assessment: N/A

Work Period: 14-Oct-2019 until 25-Dec-2020

Work Dose Manning: Manage Optimization Attachments

Other Attachments: Manage Other Attachments

Calculated totals for DIMR (all RP Assessments)

Max. estimated airborne contamination:	0.05	CA
Max. estimated surface contamination:	1	CS
Max. estimated dose rate:	20	µSv/h
Highest average estimated dose rate:	10	µSv/h
Estimated collective dose:	120	person.uSv
Max. Estimated individual dose:	50	µSv

ALARA Level: Level 1

Force ALARA Level: Use calculated ALARA Level

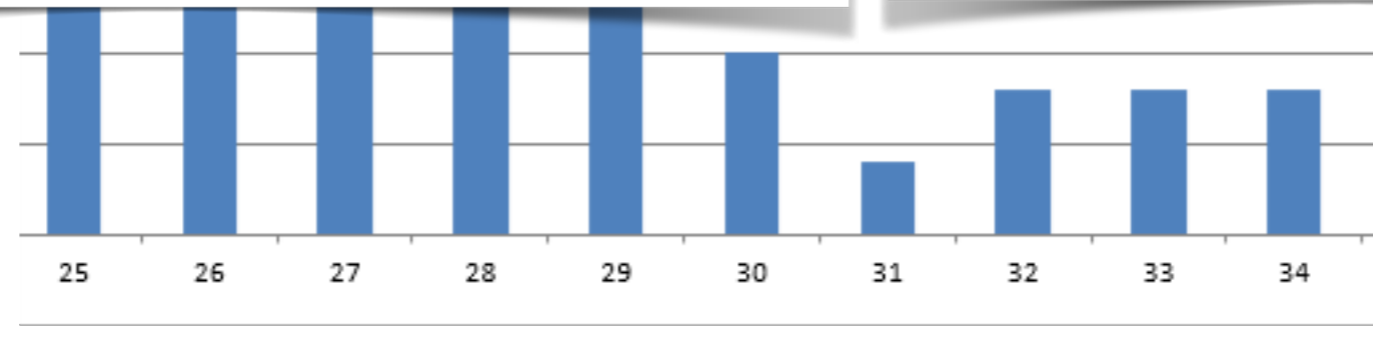
Radiation Protection Assessment for activity 122484 - [LHC] L557: Vacuum Controls Activities

RSSO / RPE:	ALDOES VIDAL
RP presence required:	Not required
Facility:	LHC Machine
Locations:	L557 RIGHT L557 LEFT
General Job Code:	MAINTENANCE

Operational boundary mandatory: Yes

Highest Area Classification: Controlled - Limited Stay

Average estimated dose rate:	10	µSv/h
Total collective working time:	60	person.h
Max. individual working time:	32	h
Estimated Collective Dose:	120	person.uSv



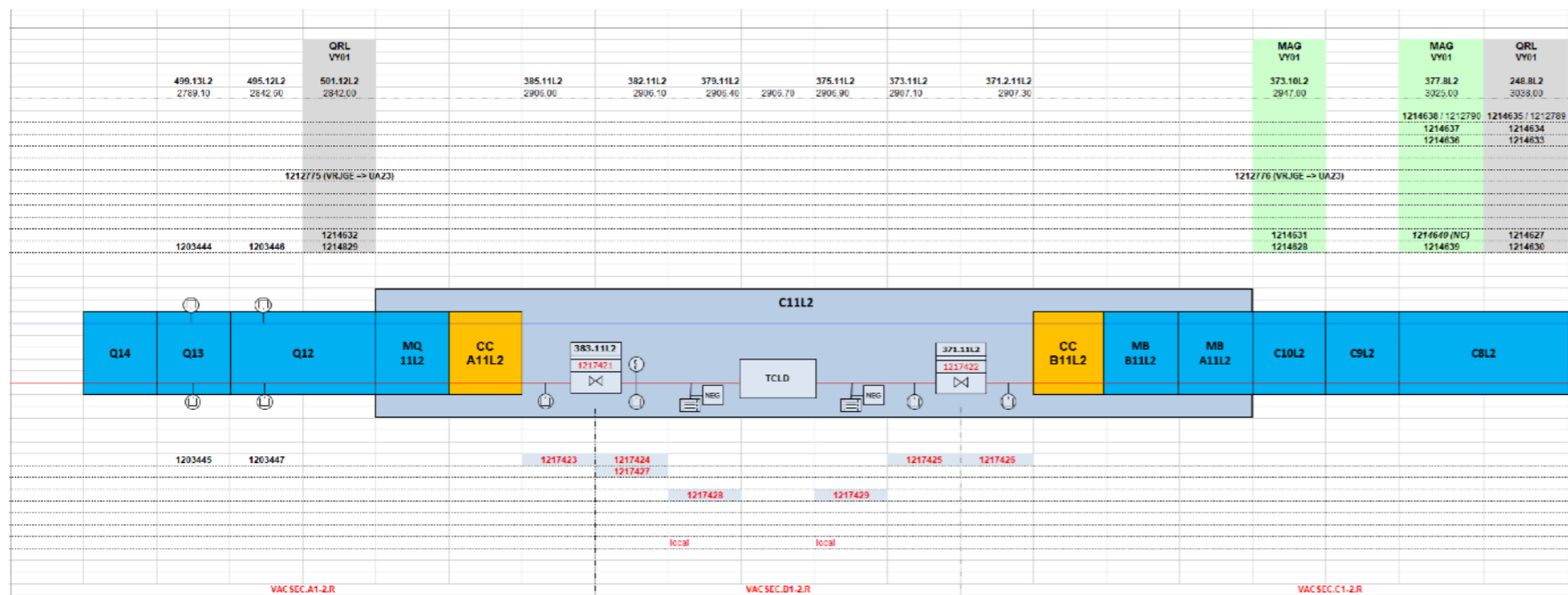
2.3 TECHNICAL DOCUMENTATION

Machine and Racks Layout

Focus on design, modification and update of **technical documentation**

Predefining **guidelines** to follow, overview of **end-result Machine and racks layout**, interlock schematics, etc.

Exact amount of **controllers and crates needed**



VY10-UA23	
E	
E	T12
X	CIBUS
X	VRIBB.UA23.R10.39 (VR_BIC) Beam 1 (T12) (1-4)
X	VRVCL.UA23.R10.35 T12 Addr. 90 NF12 1217500-1222878-1222879
	BEAM1
X	VRVCL.UA23.R10.29 Addr. 91 NF12 1211583-1211584-1211585-1211586- 1211587-1217493-1217497-1217495
X	VRVCL.UA23.R10.24 Addr. 92 NF12 1217493-1217491-1217489-217487- 11217486-1211588-1211589-CONT
	BEAM2
X	VRVCL.UA23.R10.19 Addr. 93 NF12 1217421-1217422-1211596- 1211597-1211598-1211599-1211600- 1217533
X	VRVCL.UA23.R10.14 Addr. 94 NF12 1217498-1217496-1217494-1217492- 1217490-1217488-1217534-1211601
X	VRVCL.UA23.R10.09 Addr. 95 NF12 1211602-CONT-CONT-CONT- CONT-CONT-CONT-CONT
	BORNIER DE JONCTION AVEC UA27 NE48 1215236

2.4 MATERIAL PROCUREMENT

Budgeting and Management

Material procurement was our first priority during 2018

Budgeting and **estimating** needs to respect given timeframe

Anticipating **potential delays**: call for tenders, procurement justifications, logistics issues, etc.

1

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

FOR APPROVAL	CLARIFICATION REQUEST	JUSTIFICATION
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Memorandum linked to **DAI 7513369**

1 THE AIM OF THE PROJECT

The main motivation for this request is to urgently order the assembly of 18x new VPG (Vacuum Pumping Groups) control-crates with their corresponding material procurement and budget allocation in view of the upcoming needs for the LHC's vacuum controls and its related projects during the Long Shutdown 2 (LS2).

2 SUPPLIER SELECTION

2

series where a flawless service from their side allowed us to resolve minor upcoming issues within schedule.

Bearing in mind the urgency and sensitivity of the concerned equipment, as well as the unfortunate short-notice and circumstances, we ultimately consider this option as the most suitable one in terms of efficiency and convenience. Furthermore, the price enquiry obtained from them is within the competitive price range of the main tender and leaves no doubt, as to why this is the best alternative solution to choose.

SERVICIO TECNICO 24 HORAS
TEL. 902 10 17 81

INGENIERÍA ELECTROTÉCNICA Y SISTEMAS DE AUTOMATIZACIÓN
INGESA BARRACHINA

PRESUPUESTO

CLIENTE	EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH	Cód.Cliente	10.082
Dirección	CH-1211 GENEVE 23	Número	18 / 239
Local		Fecha	15/10/18
Localidad	GENEVE		
Descripción	18x ASSEMBLING VGPF_LHC		

Detalle de los trabajos	Cant.	PVP	Importe
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2.4 MATERIAL PROCUREMENT

Logistics and Manufacturing

- More than 650 kCHF in new components and controllers
- Also manufacturing and assembly of electronic crates
- Procurement of new MKB-BGC vacuum pumping groups
- Pre-order, packaging, external shipment and reception

Equipment Type	Length [m]	No. #	Unit Price [CHF]	Total Price [CHF]	Total [CHF]
VPG					85,800
VPGF [PLC_2VPG_US] PLC crate "New_VPGF_LHC"	6	2,800	15,800		
VPGF [LOC_1VPG_RS] Local Crate	6	1,500	9,000		Mini-Racks?
Primary Pump Powering Crate	0	1,000	0		
Turbo Controller (TCP350)	6	10,000	60,000		Ordered by BVO
VVGS					5,900
VVGS Card	4	300	1,200		
VVGS Crate (SVCU)	1	3,000	3,000		
MUX Card	1	200			
Interlock Crate IMS12	1	1,000	1,000		
Multiplexer [CPS]	0	1,000	0		
VPI					5,323
Agilent 2UHV Controller (2x200W)	0	5,323	0		
Agilent 4UHV Controller (4x80W)	1	5,323	5,323		
VPI Local Box + Cable [VRJIA]	0	400	0		
Profibus Connectors	0	69	0		
TPG (Penning/Piran)					31,871
Profibus Card	8	745	5,950		
Gauge Card Pe/Pi (10e-11)	16	1,018	16,288		
TPG300 Controller	8	868	6,944		
Crate (2x Controllers)	4	500	2,000		
Profibus Connectors	14	49	679		
VGI					0
VGC1000	0	4,100	0		
Transformer + Local Cable	0	181	0		
Crate (2x Controllers)	0	200	0		
Profibus Connectors	0	69	0		
PLC					0
PLC Master	0	11,000	0		
EN/EL [HW + Manpower]					19,800
Power Outlets	0	230	0		
Inter-Racks (Interlocks)	5	10	18	900	
UM43	30	25	18	13,500	
LSS4	30	10	18	5,400	
Total HW to buy [CHF]					148,194
Total HW bought [CHF]					0
KCM Manpower (from Dec'18 to May'21 = 2.5 years)					78,250
FSU		27,500			
Staff (Grade 3-4)		50,750			
Grand total [CHF]					226,444

SIEMENS

Cart - 7394372
15.08.2018

Contact Information

Pablo Prieto
p.pablo.prieto@cern.ch
+41 75 411 7203

Delivery address

CERN
route de Meyrin
1211 Genève 23
Switzerland

Order Data

Account number 570680
Customer order number 7394372
Internal Order Reference //
Receiver

Currency EUR
Requested delivery date 20.08.2018
Last Amended Date 15.08.2018

Item	Article ID	Quantity Qty. Unit	Price Per Item	Customer Price	Price Unit	Line price
1	6ES7214-1AG0-0XB0 SIMATIC S7-1200, CPU 1214C, compact CPU, DC/DC/DC, onboard I/O: 14 DI 24 V DC; 10 DO 24 V DC; 2 AI 0-10 V DC, Power supply: DC 20.4-28.8V DC, Program/data memory 100 KB	18	346.10 EUR	Discount 1 256.11 EUR 26.00 %	1	4609.98 EUR
	Price Group 212 Export control codes AL/N / ECCN:EAR99H Country of origin CN EAN-Nr. 4047623402787 Commodity code 85371091 Weight (kg) 0.412 Requested delivery date 20.08.2018					
2	6ES7221-1BH31-0XB0 SIMATIC S7-1200, Digital input SM 1221, 16 DI, 24 V DC, Sink/Source	18	158.60 EUR	Discount 1 117.36 EUR 26.00 %	1	2112.48 EUR
	Price Group 212 Export control codes AL/N / ECCN:EAR99H Country of origin CN EAN-Nr. 6940408101920					

2.5 INFRASTRUCTURE REQUESTS

Cabling Campaigns and Ethernet Sockets

In parallel, management of **major infrastructure requests**

Cable pulling campaigns (DIC): signal and power cables

More than **200 vacuum signal cables** pulled during LS2

And more than **20 new power cables** to feed new vacuum pumping groups

7		CERN EN/EL																PAGE :
DIC		DEMANDE D'INSTALLATION DE CABLES														DATE D'EMISSION : 13/02/2019	VERSION :	Réservé EN-EL
DEMANDEUR : P. PRIETO / G. PIGNY		DESCRIPTION : DIC LS2														FIN TRAVAUX DEMANDE :		RECU LE :
TEL :		DEPARTEMENT : TE														CODE BUDGETAIRE : 99150		No. DT :
GSM : 167203 / 169526		GROUPE : VSC														ID PLAN : 10012		AFFAIRE :
COMMENTAIRES : Nouvelles installations NEG pour les collimateurs TCSPM du LSS7. (Rev. 3)																CODE ETUDE :		OE :
7		CERN EN/EL																PAGE :
DIC		DEMANDE D'INSTALLATION DE CABLES														DATE D'EMISSION : 22/05/2018	VERSION :	Réservé EN-EL
DEMANDEUR : G. PIGNY / P. PRIETO		DESCRIPTION : DIC LS2														FIN TRAVAUX DEMANDE :		RECU LE :
TEL :		DEPARTEMENT : TE														CODE BUDGETAIRE : 64062		No. DT :
GSM : 169526 / 167203		GROUPE : VSC														ID PLAN : 10834		AFFAIRE :
COMMENTAIRES : DIC Beam Gas Curtain based on v3.0 Layout (BE-BI, G. Schneider)																CODE ETUDE :		OE :
No. Cable	No	TYPE	RE-	FONCTION DU CABLE	ORIGINE				DESTINATION				LON-					
(par EN-EL)		CABLE	SEAU		OUVRAG	Position Fonction.	ELEMENT	POSV POSH	CONNECT	CONVN	OUVRAG	Position Fonction.	ELEMENT	POSV POSH	CONNECT	CONVN	GUEUR	
6	1	NF12		SECTOR VALVE	UA43	VY18=UA43	VRVCL.UA43.R18.14		12BPMB	56	RB44	9956	VVGS.411.5L4.B		12BPFB	56	(+2m)	Int. Chamber
7	2	NF12		SECTOR VALVE	UA43	VY18=UA43	VRVCL.UA43.R18.14		12BPMB	56	RB44	9956	VVGS.411.5L4.B		12BPFB	56	(+2m)	Int. Chamber
	3	NF12		SECTOR VALVE	UA43	VY18=UA43	VRVCL.UA43.R18.14		12BPMB	56	RB44	9956	VVGS.411.5L4.B		12BPFB	56	(+2m)	Int. Chamber
9	PH3SJ	NEG PUMP		R74	19925 ?	VRJNA.759.4L7.B			12BPMB	VPN01	R74	19918	VPNCA.759.4L7.B		4APFAS	VPN02	(+2m)	
10	PH3SJ	NEG PUMP		R74	19925 ?	VRJNA.739.4L7.B			12BPMB	VPN01	R74	19920	VPNCA.739.4L7.B		4APFAS	VPN02	(+2m)	
1714241B ?	11	PH3SJ	NEG PUMP	R74	20010 ?	VRJNA.60.4L7.B			12BPMB	VPN01	R74	19988	VPNCA.60.4L7.B		4APFAS	VPN02	(+2m)	
1714242B ?	12	PH3SJ	NEG PUMP	R74	20010 ?	VRJNA.40.4L7.B			12BPMB	VPN01	R74	19990	VPNCA.40.4L7.B		4APFAS	VPN02	(+2m)	

2.5 INFRASTRUCTURE REQUESTS

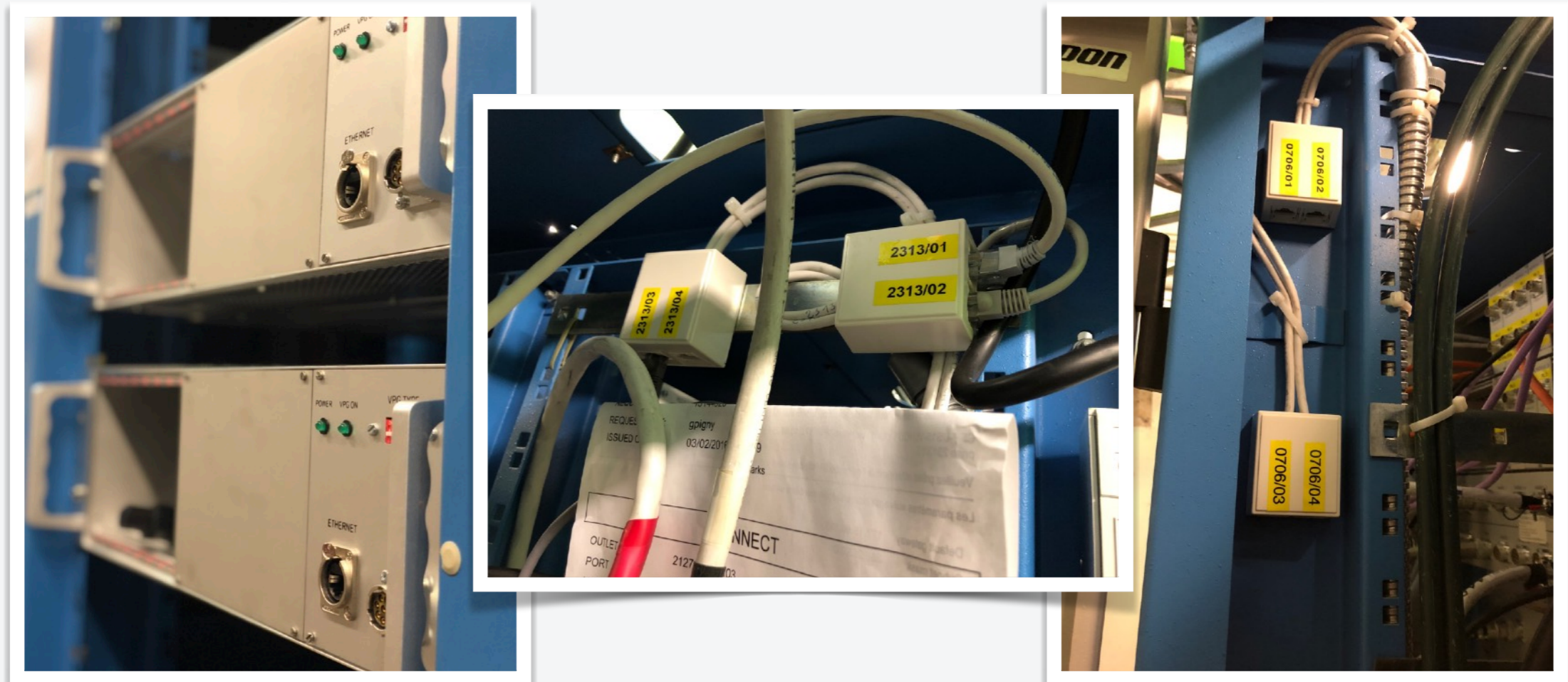
Cabling Campaigns and Ethernet Sockets

Ethernet **sockets installations** requested (SNOW Tickets)

Essential for the operation and control of new **controls equipment**

More than **130 new ethernet sockets** installed all around the LHC

Remote access and control of new vacuum pumping groups



2.6 PLC HW-ARCHITECTURE

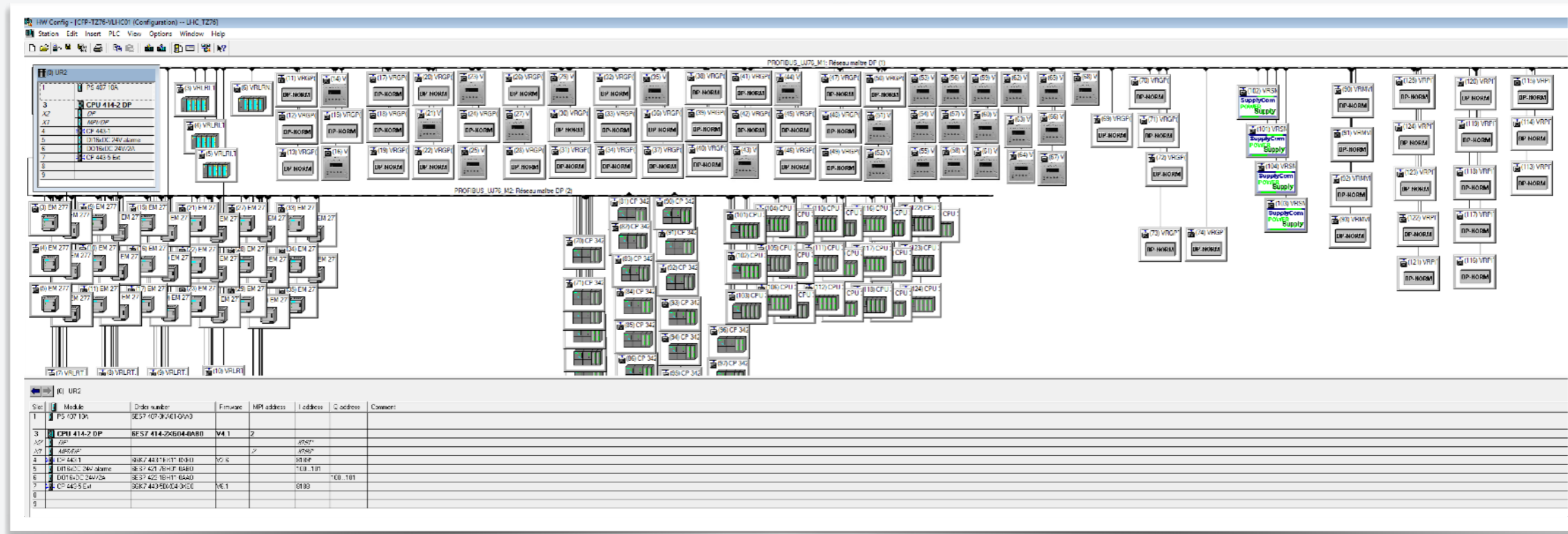
Re-design, Parametrisation and Configuration

Major **PLC hardware-architecture** re-design

Configuration and **parametrisation** of new controllers

Re-imagined due to **saturation of existing DP networks**

New redundant PLC installation in P7-TZ76 service area



2.7 VACUUM DATABASE & SCADA

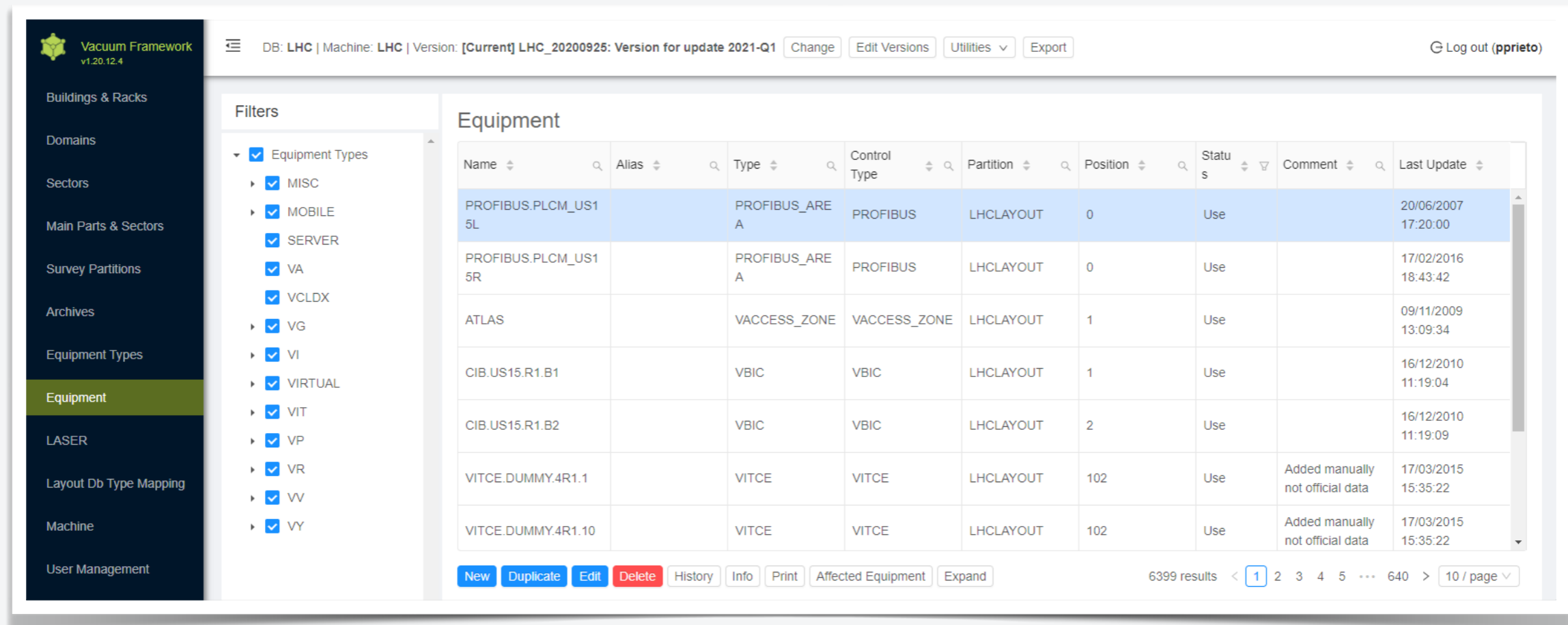
LS2 Controllers Addition and Configuration

Internal vacuum controls **system-database** (VacDB)

LHC VacDB instances well-prepared in advance

Addition and configuration of **new LS2 controllers** and **corresponding connections**

Large amount of information, **use of dedicated templates**



The screenshot displays the Vacuum Framework web interface. The top navigation bar includes the logo, version information (v1.20.12.4), and user information (DB: LHC | Machine: LHC | Version: [Current] LHC_20200925: Version for update 2021-Q1). The left sidebar contains a menu with categories like Buildings & Racks, Domains, Sectors, Main Parts & Sectors, Survey Partitions, Archives, Equipment Types, Equipment (highlighted), LASER, Layout Db Type Mapping, Machine, and User Management.

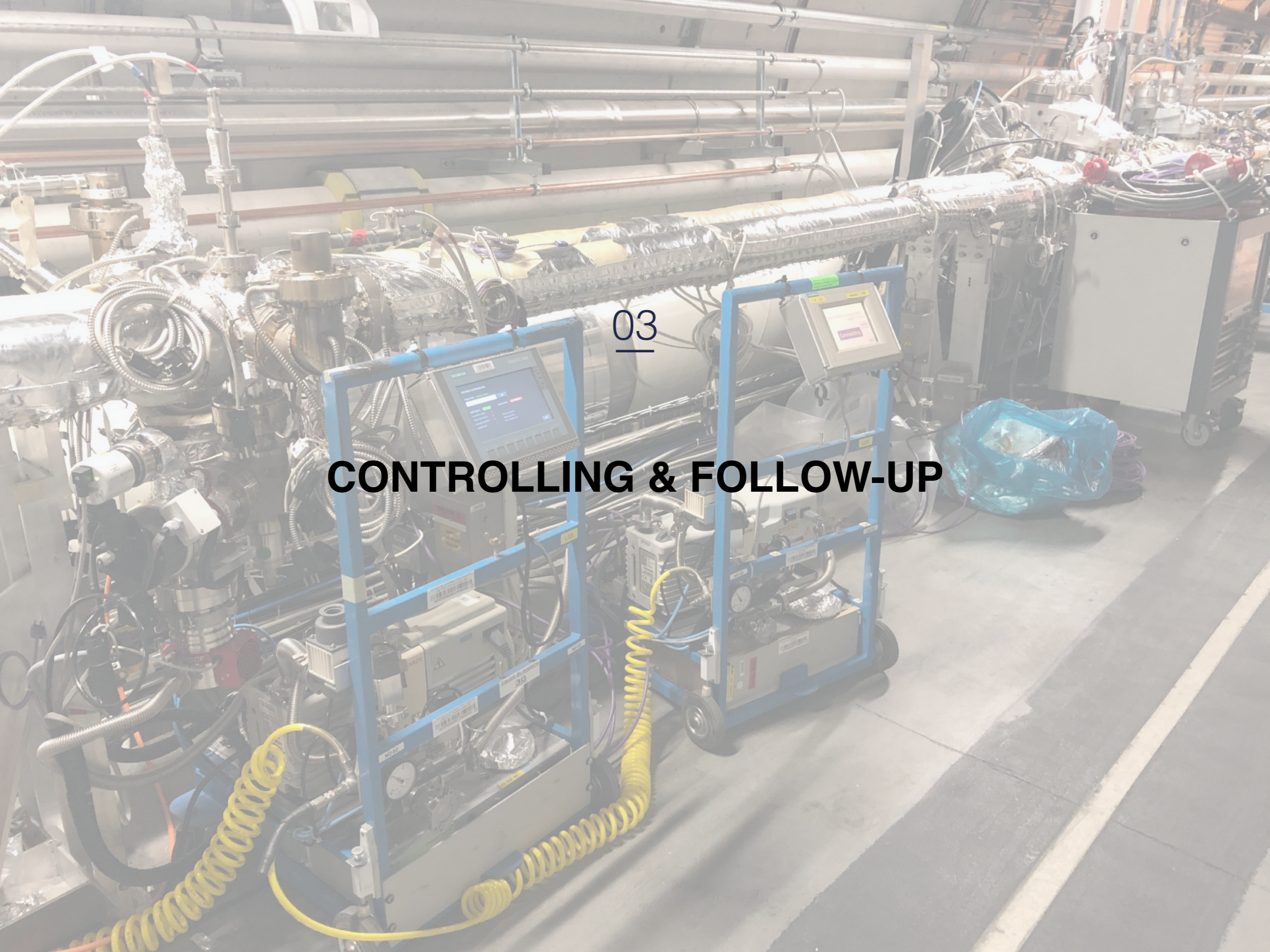
The main content area shows a table of equipment with the following columns: Name, Alias, Type, Control Type, Partition, Position, Status, Comment, and Last Update. The table contains several rows of equipment data, including PROFIBUS.PLCM_US1 5L, PROFIBUS.PLCM_US1 5R, ATLAS, CIB.US15.R1.B1, CIB.US15.R1.B2, VITCE.DUMMY.4R1.1, and VITCE.DUMMY.4R1.10.

Name	Alias	Type	Control Type	Partition	Position	Status	Comment	Last Update
PROFIBUS.PLCM_US1 5L		PROFIBUS_ARE A	PROFIBUS	LHCLAYOUT	0	Use		20/06/2007 17:20:00
PROFIBUS.PLCM_US1 5R		PROFIBUS_ARE A	PROFIBUS	LHCLAYOUT	0	Use		17/02/2016 18:43:42
ATLAS		VACCESS_ZONE	VACCESS_ZONE	LHCLAYOUT	1	Use		09/11/2009 13:09:34
CIB.US15.R1.B1		VBIC	VBIC	LHCLAYOUT	1	Use		16/12/2010 11:19:04
CIB.US15.R1.B2		VBIC	VBIC	LHCLAYOUT	2	Use		16/12/2010 11:19:09
VITCE.DUMMY.4R1.1		VITCE	VITCE	LHCLAYOUT	102	Use	Added manually not official data	17/03/2015 15:35:22
VITCE.DUMMY.4R1.10		VITCE	VITCE	LHCLAYOUT	102	Use	Added manually not official data	17/03/2015 15:35:22

The bottom of the interface shows a pagination bar with 6399 results and a page number of 1. There are also buttons for New, Duplicate, Edit, Delete, History, Info, Print, Affected Equipment, and Expand.

03

CONTROLLING & FOLLOW-UP



3.1 FACING THE UNEXPECTED

The Pandemic Situation and its Impact

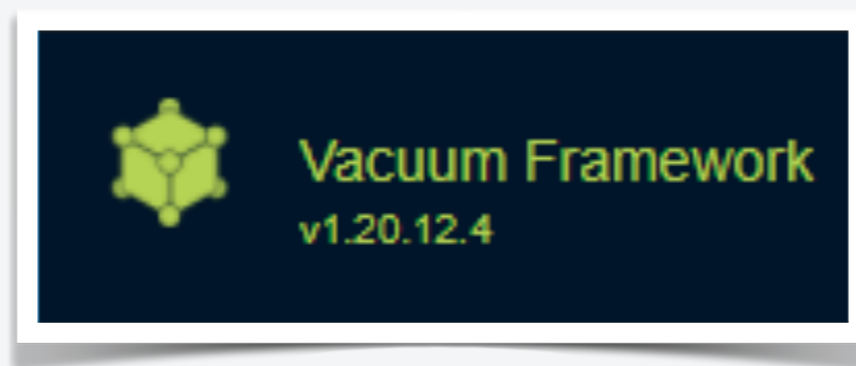
A pressing issue: the **coronavirus pandemic**

Best wishes go to the victims and their families

What did the **pandemic situation** meant for us?

Vac-DB **updating** and **synchronising** during first lockdown

Vast majority of **new LS2 equipment added**



3.2 GRADUAL RESTART

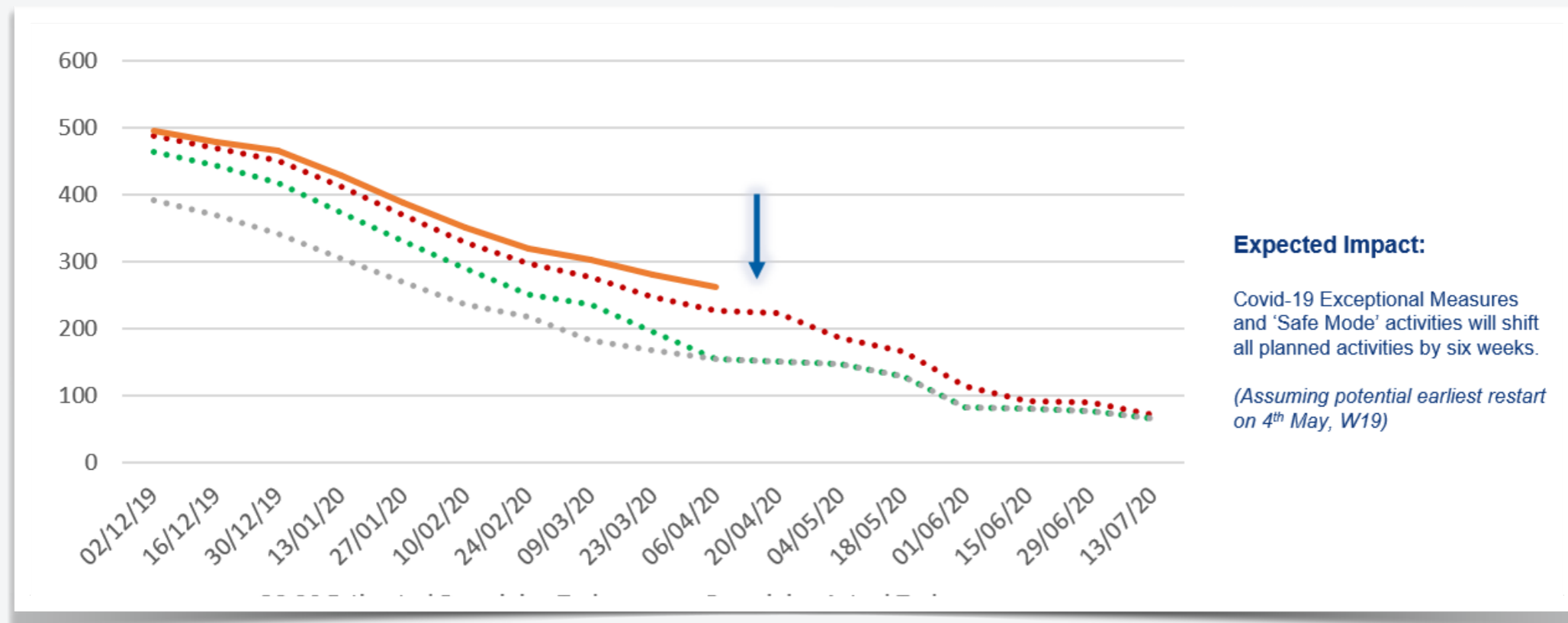
Flexibility and Adjustments

Gradual **restart of machine activities**: well-placed

Advanced with majority of works, **no big delays nor cancellations**

Already completed the **core activities of our controls' consolidation**

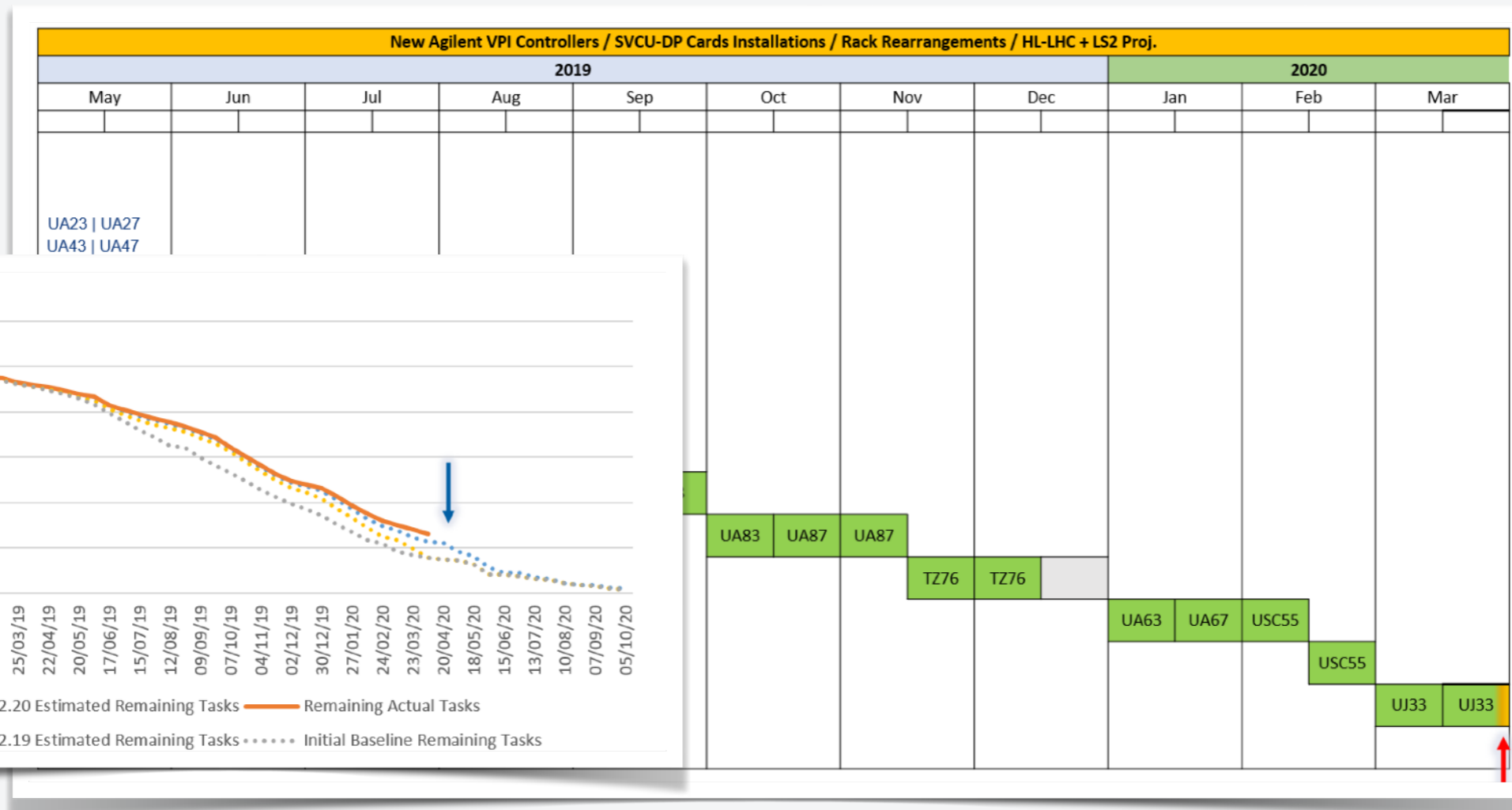
Adjusted initial baseline to the unexpected and dealt reasonably well with **the new situation**



3.3 PROJECT TOOLS

Burn-down Chart and Timeline Report

Project Tools: **Burn-down Charts** and **Timeline Reports**
 Periodically updating the **Project's Plan** (MS Project)
 Successfully managed the **follow-up of the activities**



04

EXECUTION & INSTALLATION



4.1 HL-LHC: TCLD-11T

Target Collimation Long Dispersion

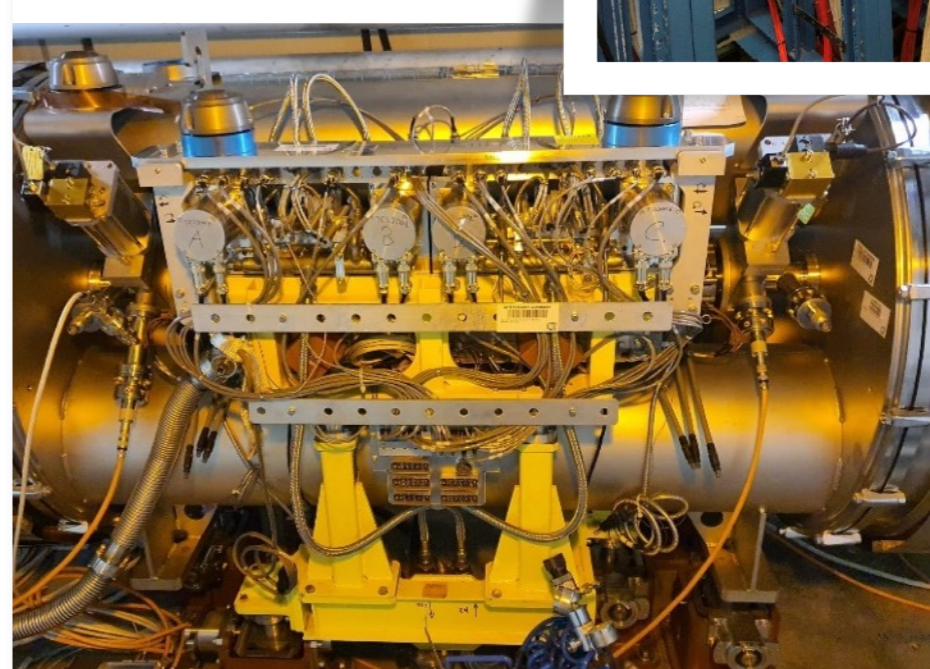
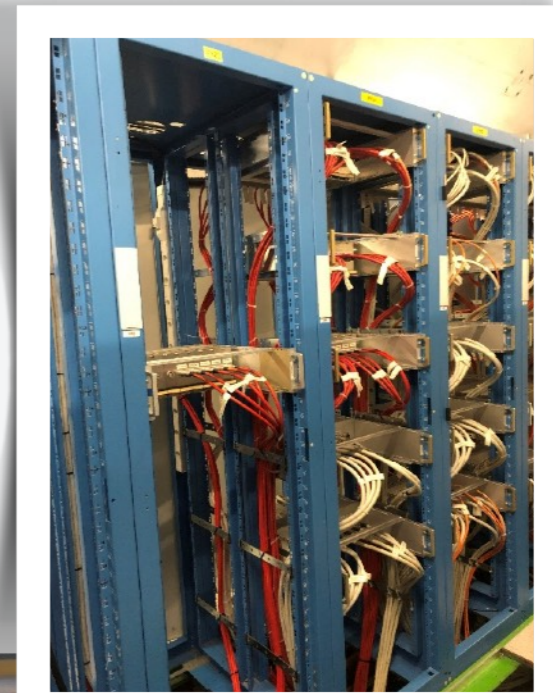
Limited space around the equipment

Challenging installation and hardware connections

ARCs **interlock system** and **logic re-design**

Integration of **new sectorisations** in existing architecture

Specific interlock solutions to cable and configure TZ76 racks and UJ76 patch-panels



4.2 HL-LHC: TDIS

Target Dump Injection Segmented

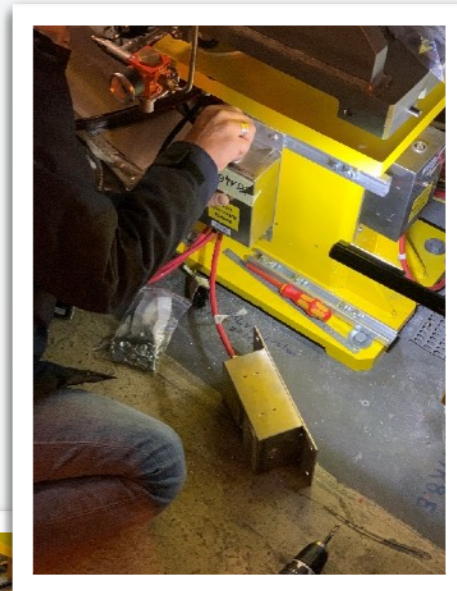
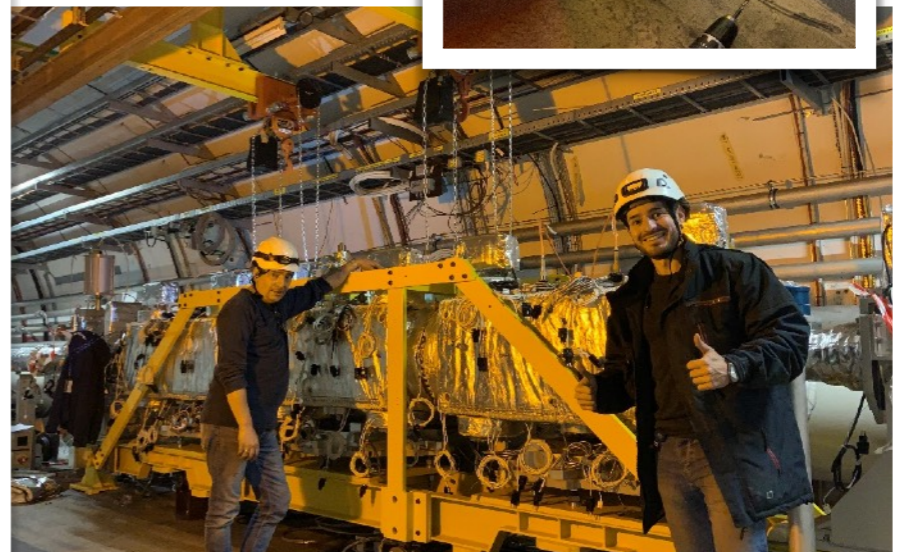
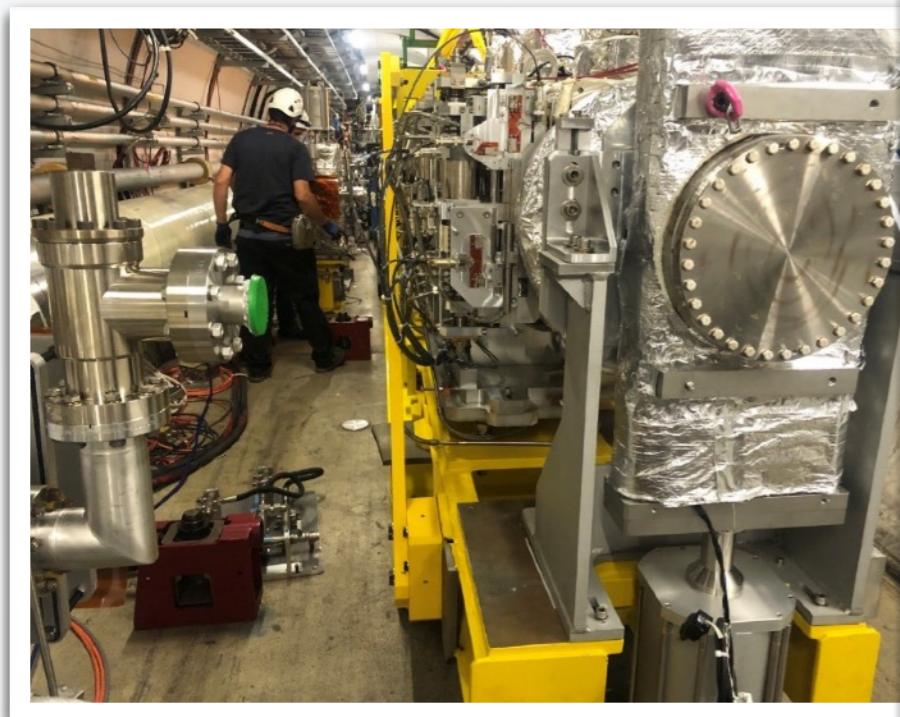
Integration changes from old TDI to new TDIS configuration

New sectorisations with reduced adjacent sectors

Ion pump **HV boxes recabling in series** per tank

Reduced accessibility under tanks and difficulties to reconnect instruments

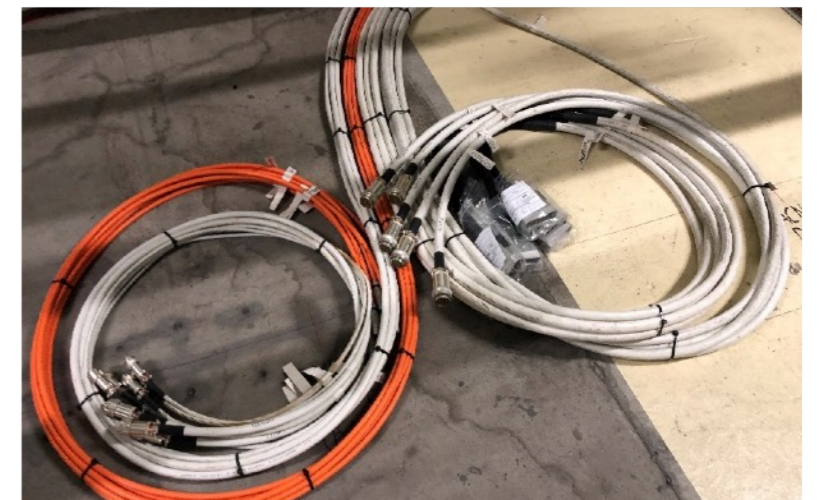
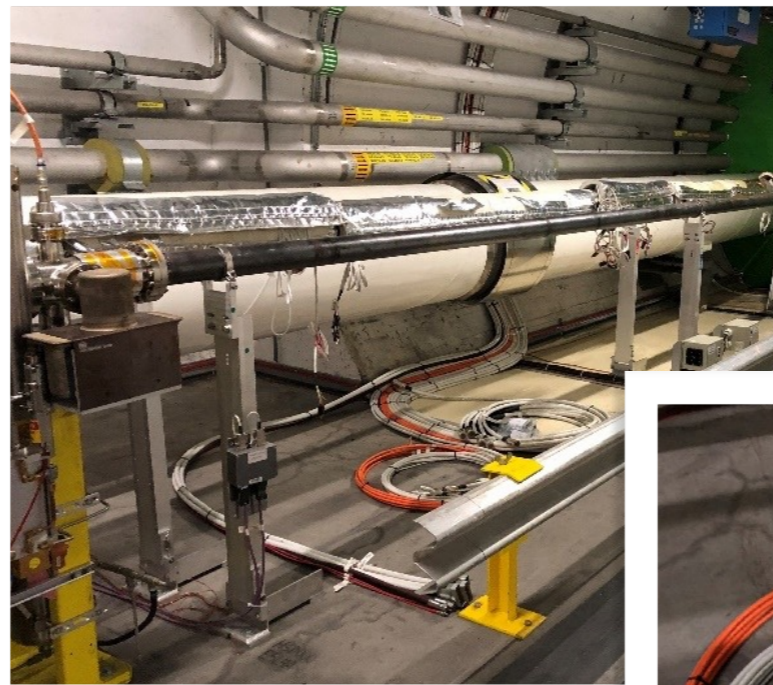
Sector **valve cards shifting** and valve crates reconfiguration



4.3 BI: BWS & BGC

Beam Wire Scanner and Beam Gas Curtain

Cross-collaborations between TE-VSC and BE-BI
New BWS-BGC sectorisations performed
Displacement and re-cabling of ion pumps
Relocation of Beam Gas Ionisation (BGI) system



4.4 RF: ACS CAVITIES

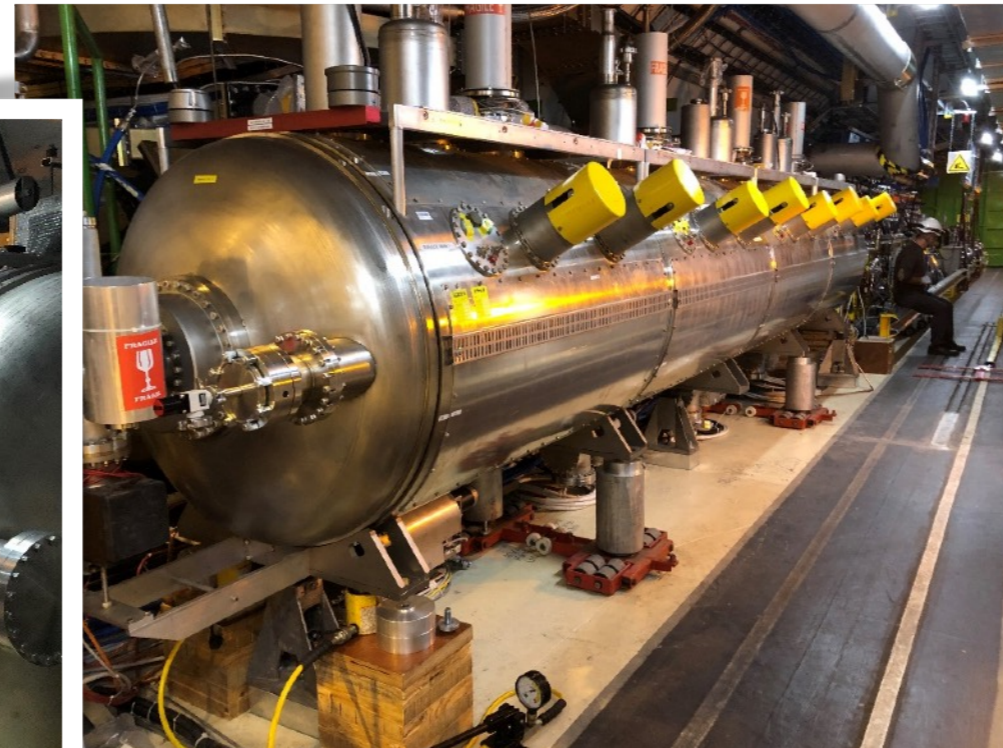
Radio-Frequency ACS Modules

ACS Module Replacement: 'Asia' left its place to 'America'

Disconnection and reconnection of both cavities

Intensive clean-up of the emplacement and vicinity

Clearing the way for the **new cavity to be installed**



4.5 ABT: MKB INTERVENTIONS

Calibration Campaign and Fine-Tuning

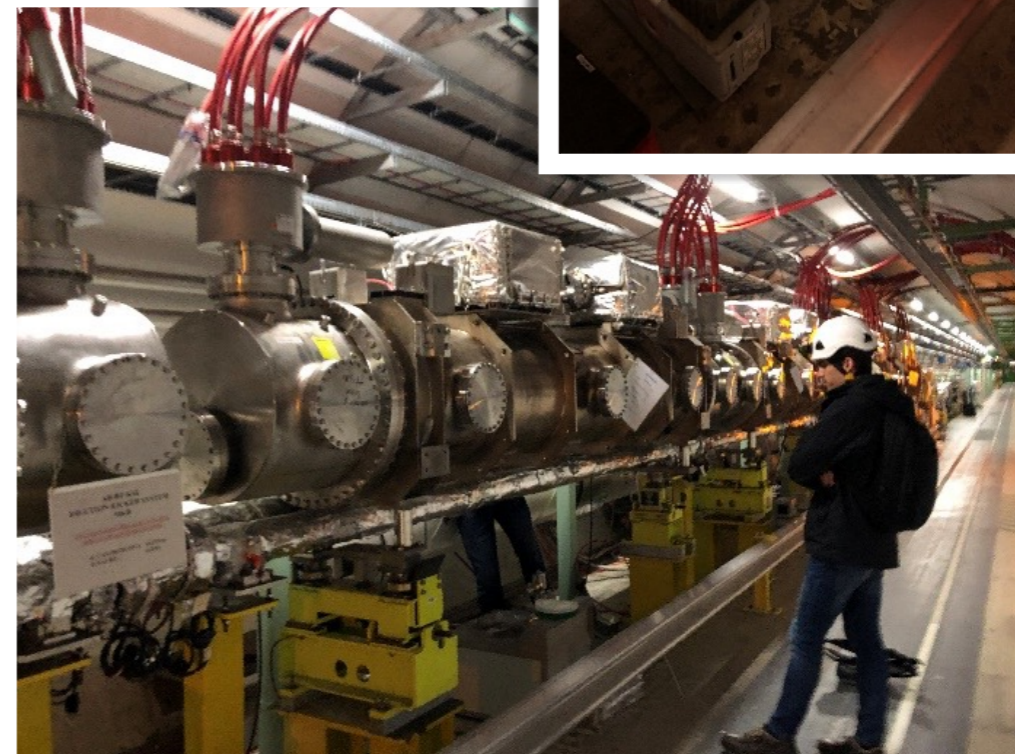
Recurrent interventions on existing **MKB systems**

Performed exhaustive **ion pump calibration**

Power supplies **fine-tuning** at TE-ABT's request

Vacuum digital alarms to stop and protect their equipment

New **redundant pumping groups**, with full consolidation



4.6 STI: TCPPM & TCSPM

Target Collimators Primary and Secondary Pickup Metallic

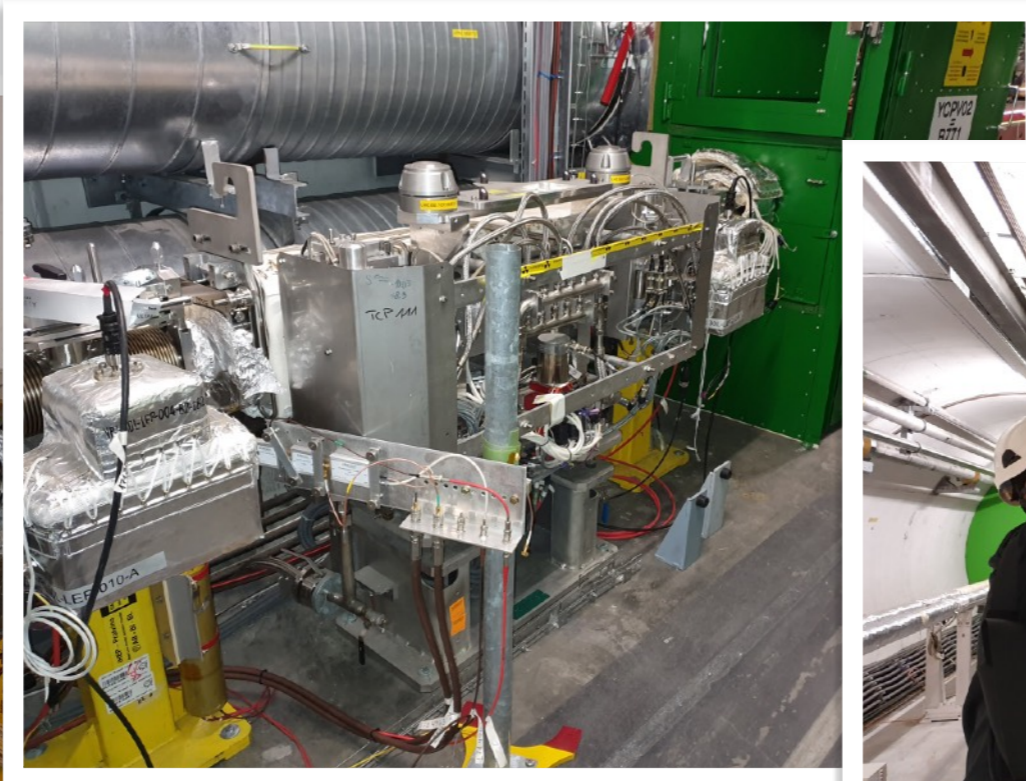
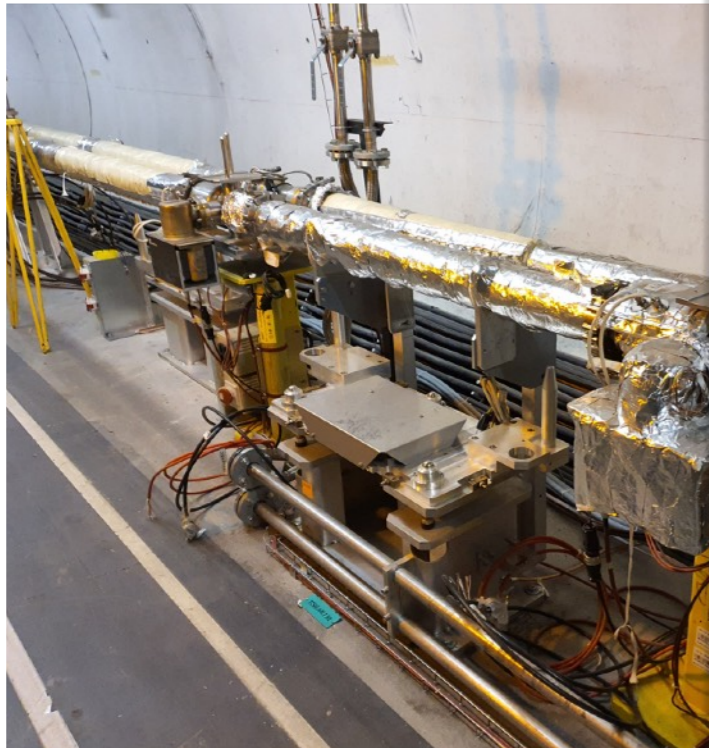
Series of **Target Collimators** interacting with beam

NEG cartridges at both ends of the collimators to 'activate' such collimators

How it affects: **full review of NEG configuration** in the LSS

Power consumptions calculations and needs

Cabling and adding **new VRJNA junction boxes**



4.7 TI2-TI8: TRANSFER LINES

HV Cables Pulling and HSE-PIRL Interventions

TI2 and TI8, one of the biggest challenges to face

Around **100m of HV cables** hand-pulled by our team

Guidance from our **HSE colleagues** with specific safety equipment: **PIRL ladders**

Purpose: adapt existing **cable layout** and **arrangement** to new Transfer Lines layouts (TED sectorisations)



4.8 EXP: LHC EXPERIMENTS

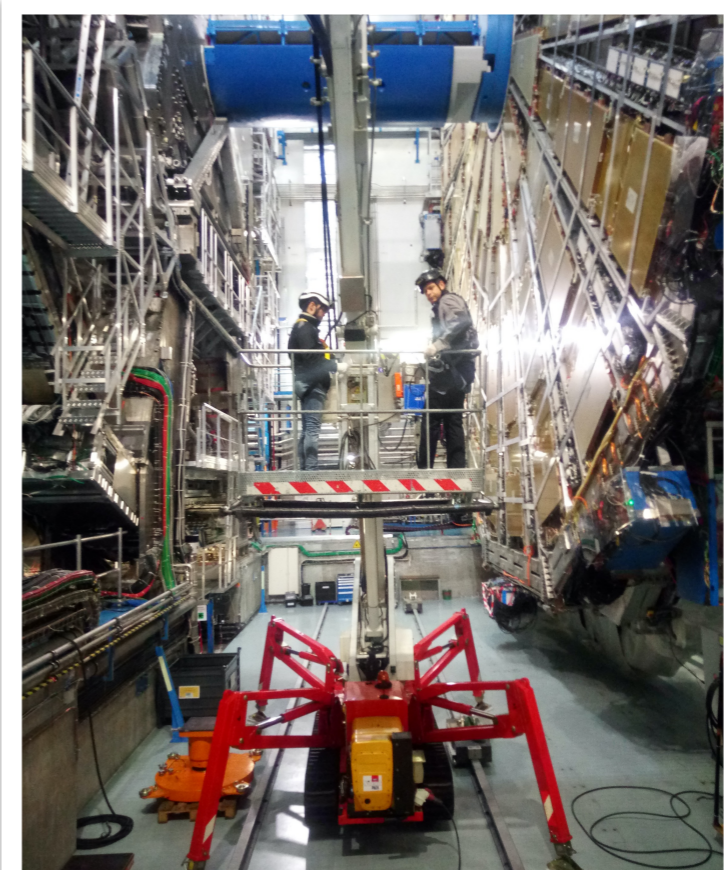
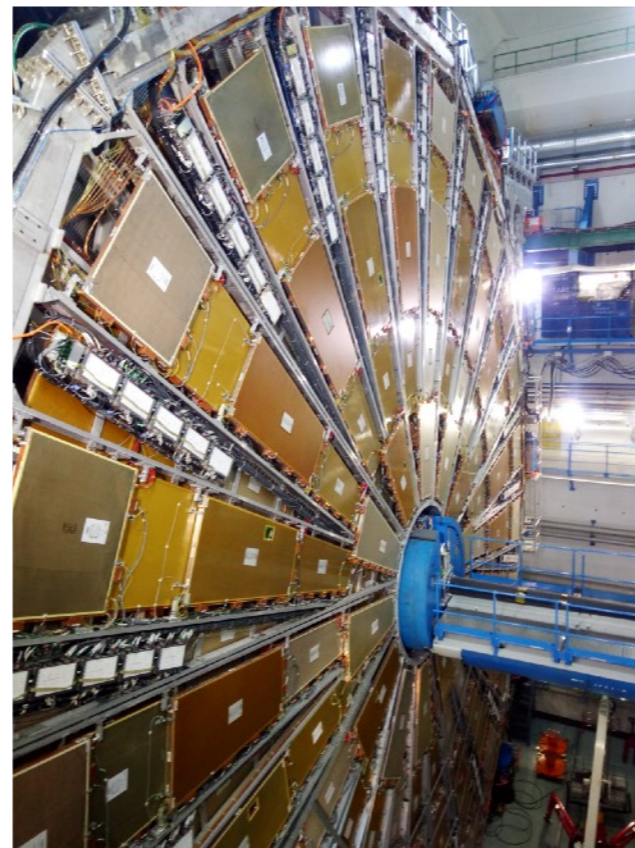
ATLAS A-C and VC1AP Chambers

LHC's Experiments: some major interventions

Dis- and re-connecting **sensitive vacuum instrumentation** at heights in **ATLAS' A and C sides**

Dismantling and conditioning ATLAS experiment's 'heart'

VC1AP Inner vacuum chambers de-cabling with bake-out colleagues



4.8 EXP: LHC EXPERIMENTS

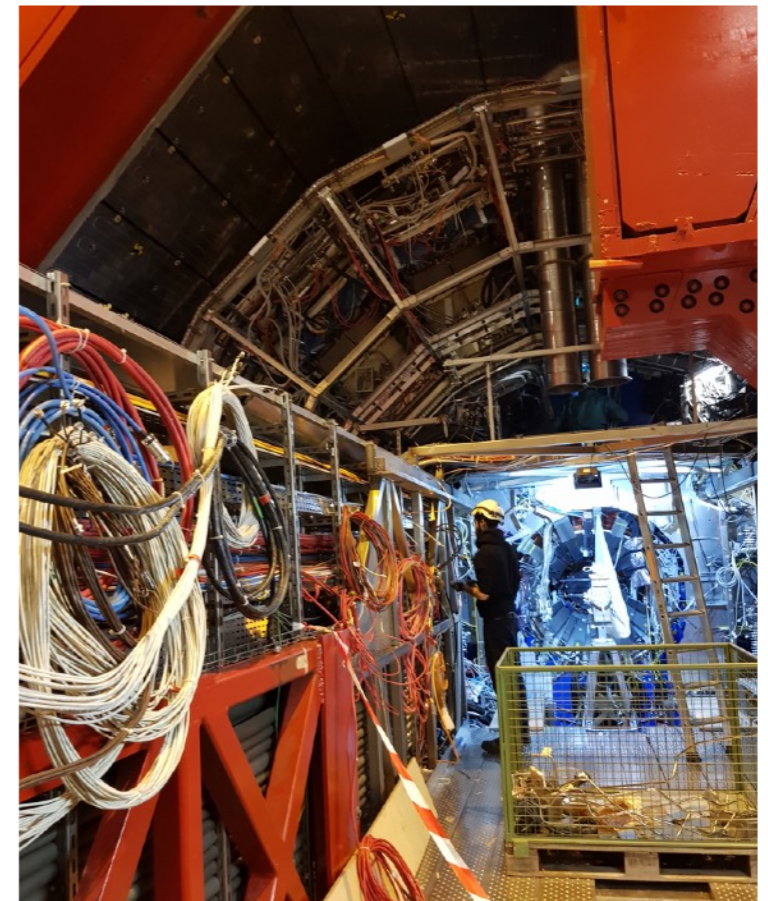
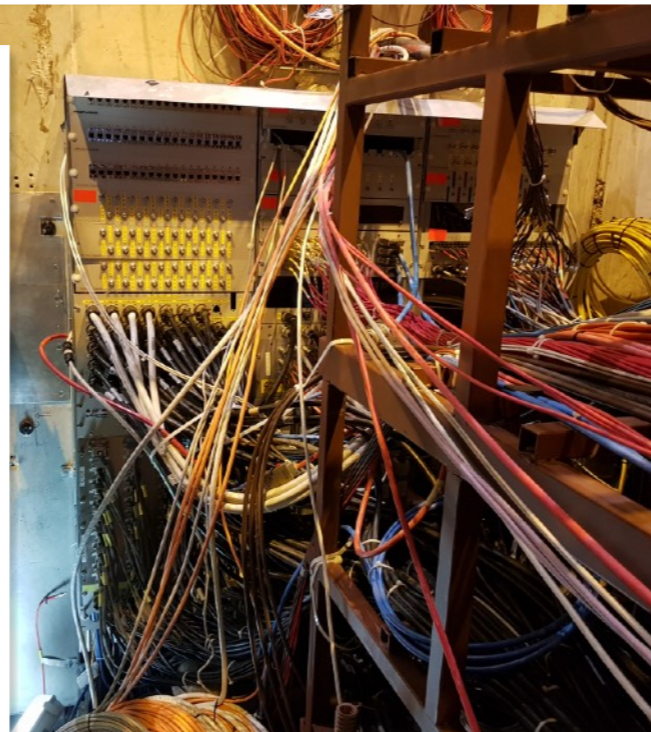
ALICE RB24 Core Disassembling

Moving into **ALICE's core** in RB24 Mini-frame's Platform

Disconnection, re-routing and **disassembling** of existing control cables and infrastructure

Tidying up and **keeping safe** existing control cables

While ALICE **underwent major upgrades** in this area



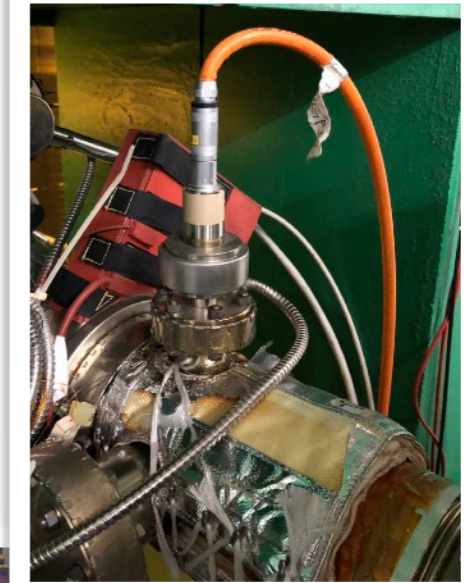
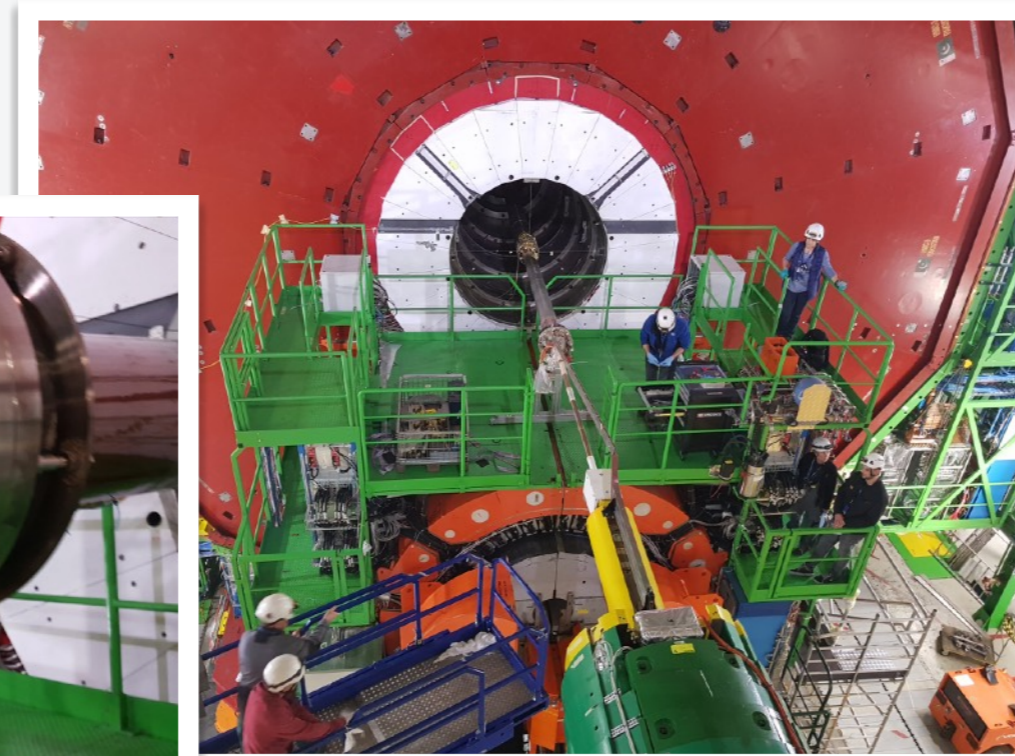
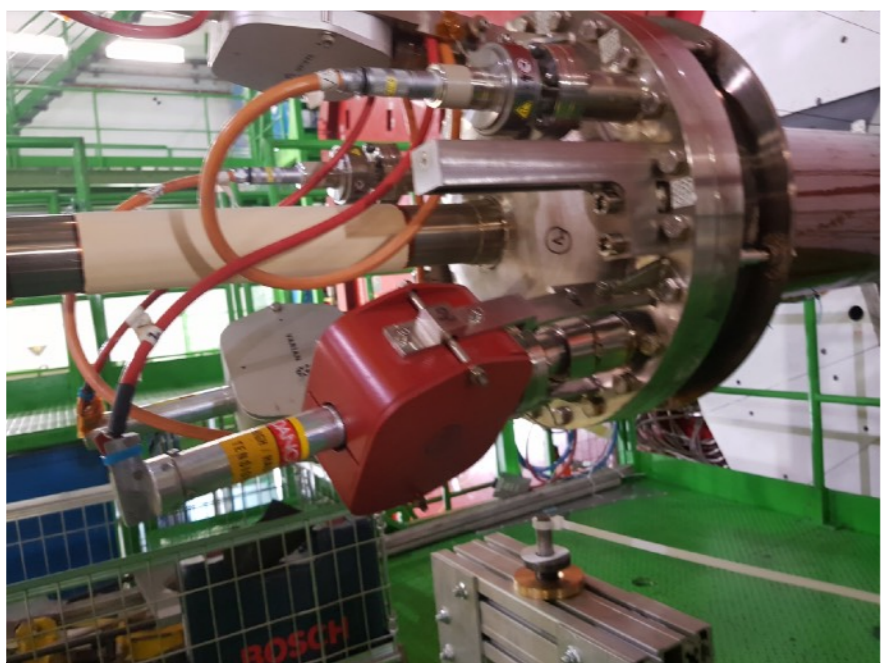
4.8 EXP: LHC EXPERIMENTS

CMS Z+/- Interventions and LHCb-VELO Upstream

CMS Z+ and Z- sides, controls equipment manipulation and opening activities

Bake-out and Gas-injection controls support provided

LHCb just a **new Upstream Valve**, **VELO** Experiment controls already presented



4.9 ICM: LHC RACKS CONSOLIDATION

Mechanical Re-arrangement and Connectors Modification

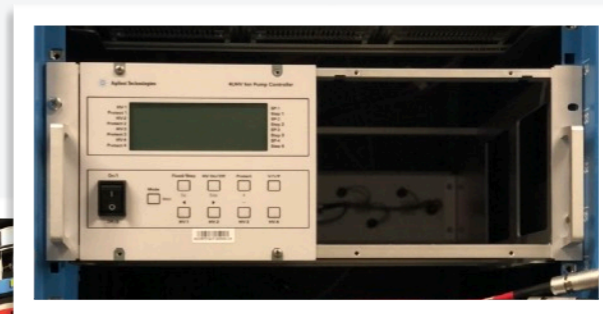
Execution of a **massive rack consolidation** in parallel with already mentioned projects and activities

Mechanical re-arrangement of more than **160** vacuum racks

More than **200** new **ion pump controllers** installed

More than **800** **connectors modified** (400 Burndy-7 and 400 HV-Fischer connectors)

Old LEP-power supplies replaced by **more robust** and **versatile** Agilent VPI controllers (2x200W)



4.9 ICM: LHC RACKS CONSOLIDATION

Network Consolidation, Electrical Safety and Power Redistribution

Racks DP-network consolidation, integrating all new LS2 controllers

New DP interface card for sector valves with dedicated network segments (replacing I/O solution)

Applied **protective actions** to comply with **TE's electrical safety guidelines** (IP2x and IP3x)

Performed a **power redistribution** aiming to reduce the **impact of power cuts** and interruptions



4.10 TE-VSC: SUPPORT-ASSISTANCE

Mechanical Activities, Bake-Out and NEG Activations

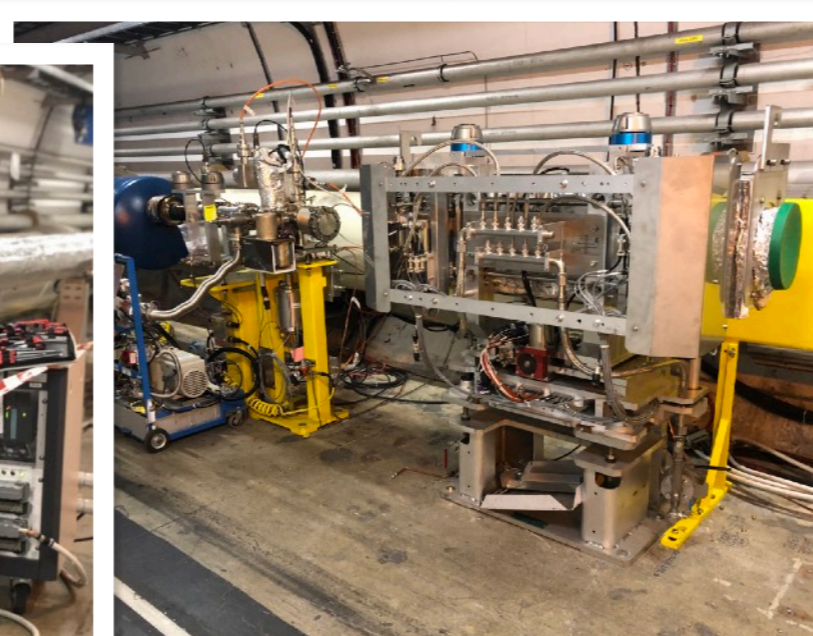
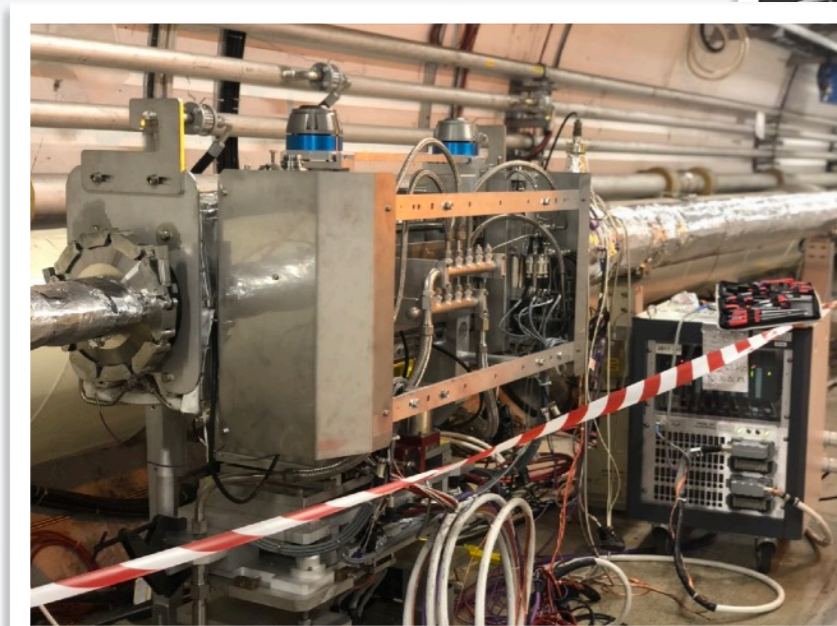
Continuous support to our VSC group, specifically to BVO

TCLIA and TANB displacements, or MKI exchanges

Providing service to LHC 'clients' and CERN as a whole

Performing numerous **Bake-out and NEG activation activities**

Collaborative effort on **instrumentation checks and mobile equipment connections**



4.10 TE-VSC: SUPPORT-ASSISTANCE

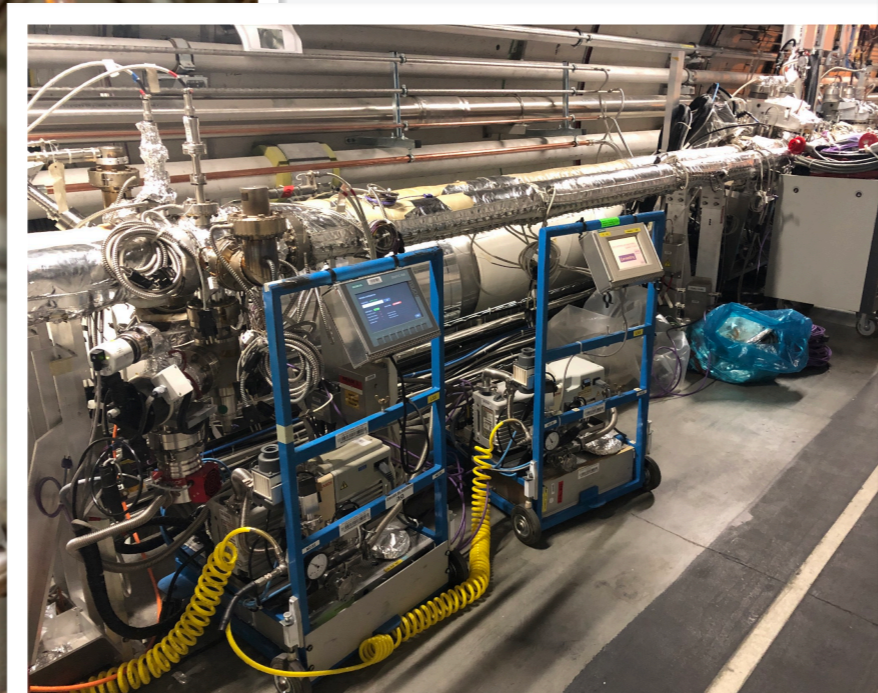
3G and Profibus-DP Mobile Connections

Huge manpower in mounting and dismantling of connections

With **both 3G-Wireless** and **Profibus-DP** elements

More than **10km of Profibus-VE2L cable-pulling** in cumulative distance

Rough idea of dimension of these temporary installations





05

CLOSING & CHECK-OUT

5.1 QA ASSET MANAGEMENT

Scanning-Labeling Campaign and CMMS DB Consolidation

Still few tasks on the pipeline and soon fully completed
Including LS2-end **asset management QA campaign**
Hardware level with **scanning** and **labelling** actions
Consolidation of CMMS database and interface (InforEAM)

Work Order	Description
23167537	VGR.505.31R1.R/B
23167544	PLC Profibus Cable to Thermocouples
23175377	Calibration & Reparation VOLOTEK (53 VGCs)
23167695	[PLC] Prepare spare crates for urgent intervention
23167781	Profibus connection C4R8.C
23167790	TPG300 test and storage
23168273	Réaménagement du stockage SPARES ICM LHC au SM18
23205591	mise à jours programme touchpanels rack etuvage
23205604	mise à jours programme carte PLC rack etuvage
23205650	[BAKEOUT] VREMB update with software VREM2v1.3

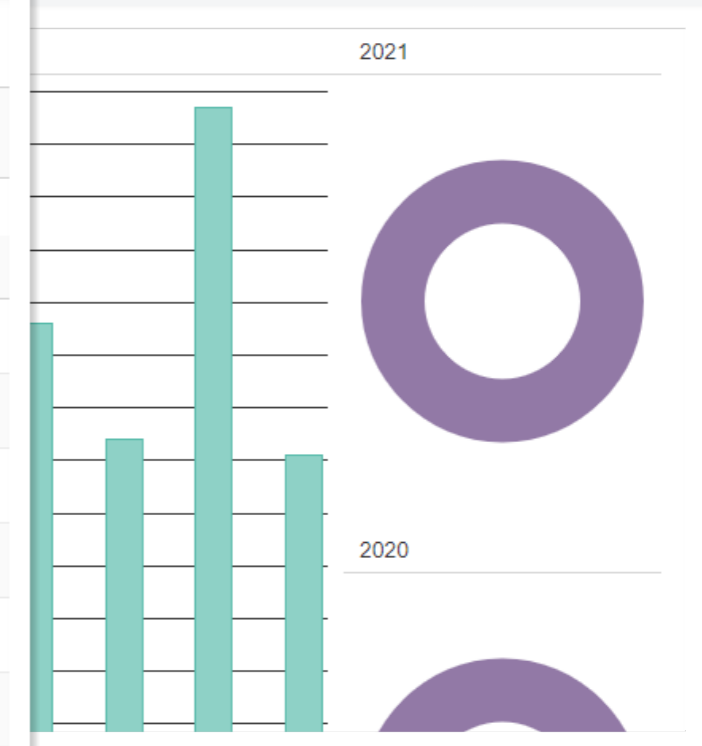
EAM Store Kiosk

[CHANGE STORE](#) [BACK](#)

Datasy: All Records [SHOW FILTERS](#)

SELECT ALL UNSELECT ALL

Choose	Part	Description	Class
<input type="checkbox"/>	HCVRJIB001	Junction-box or Patch-Panel crate / plate - For Ionique pump - VPI Junction-box,	V01
<input type="checkbox"/>	HCVRPCTA01	Pump controller - Crate - for Turbo moleculaire controller - DUAL TM PU ACT crate	V01
<input type="checkbox"/>	HCVRPCTA01	Pump controller - Crate - for Turbo moleculaire controller - DUAL TM PU ACT crate	V01
<input type="checkbox"/>	HCVRPCTA01	Pump controller - Crate - for Turbo moleculaire controller - DUAL TM PU ACT crate	V01
<input type="checkbox"/>	HCVRPCTA01	Pump controller - Crate - for Turbo moleculaire controller - DUAL TM PU ACT crate	V01
<input type="checkbox"/>	HCVRPCTA01	Pump controller - Crate - for Turbo moleculaire controller - DUAL TM PU ACT crate	V01
<input type="checkbox"/>	HCVRPCTA01	Pump controller - Crate - for Turbo moleculaire controller - DUAL TM PU ACT crate	V01
<input type="checkbox"/>	HCVRPCTA01	Pump controller - Crate - for Turbo moleculaire controller - DUAL TM PU ACT crate	V01



5.2 COMMISSIONING PHASE

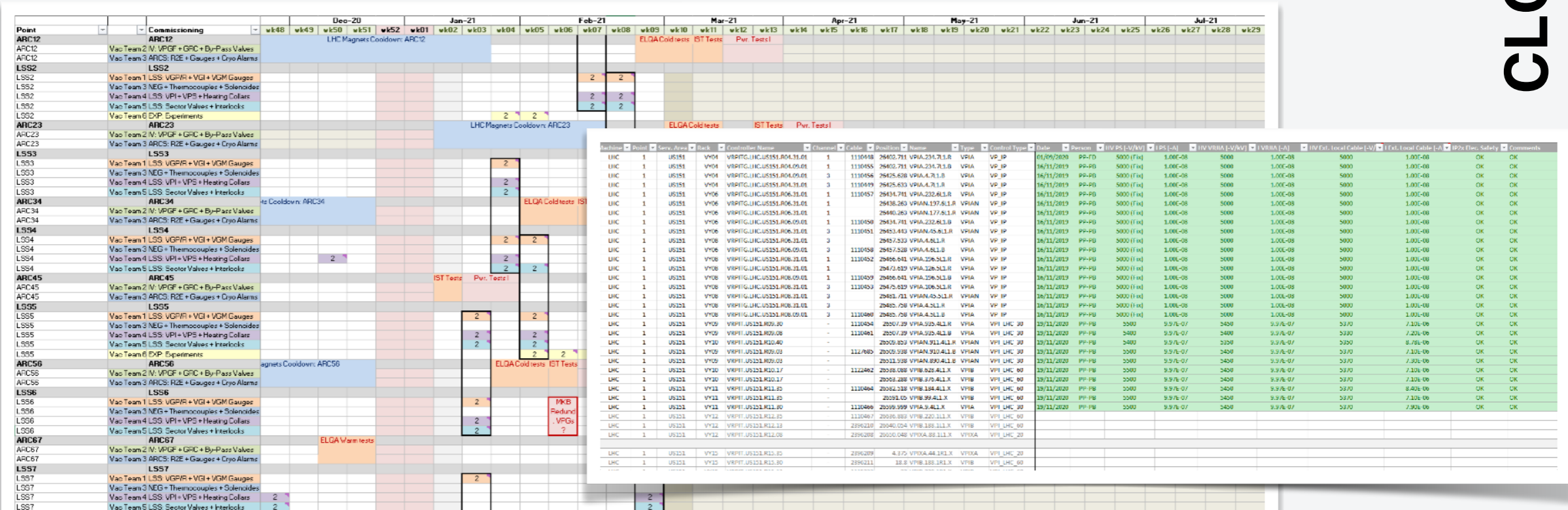
BVO Non-Conformities and Final Tests

Final tour of the machine, to solve BVO non-conformities

Extensive commissioning phase currently on-going

Final tests and checks: ion-pumps, gauges, sector valves, interlocks, etc.

Access constraints: Cool-Down 300°K-20°K, ELQA-IST Tests, Powering Tests I (adapt activities to schedule)



5.3 DELIVERY OF THE PROJECT

The Final Countdown

Fruitful completion of this project, not an overnight success

Vast amount of effort and work by a small group of people

What really happens behind the scenes, to have a great controls system at our disposal


Fireworks will only begin, when after almost four years...

LHC machine is finally '**checked-out**', valves wide-opened

First pilot beams circulate again in the world's largest particle accelerator: **the LHC**

“The best is yet to come...”





CERN

THANK YOU

Pablo Prieto