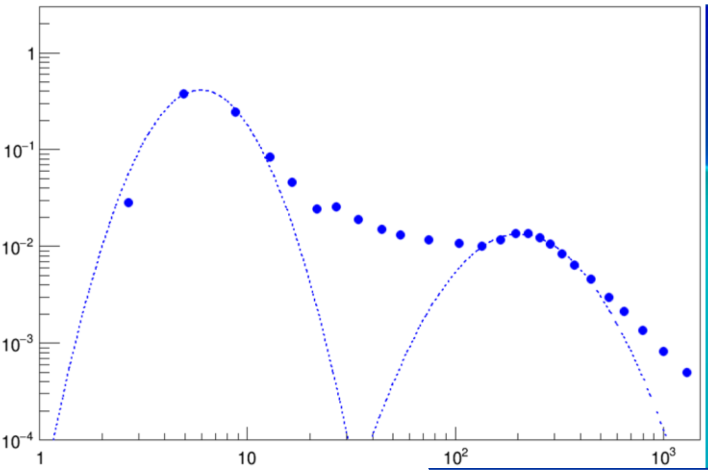
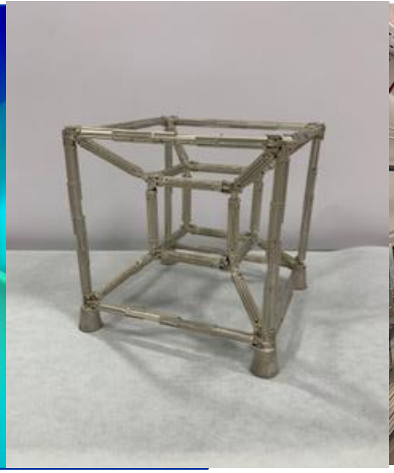
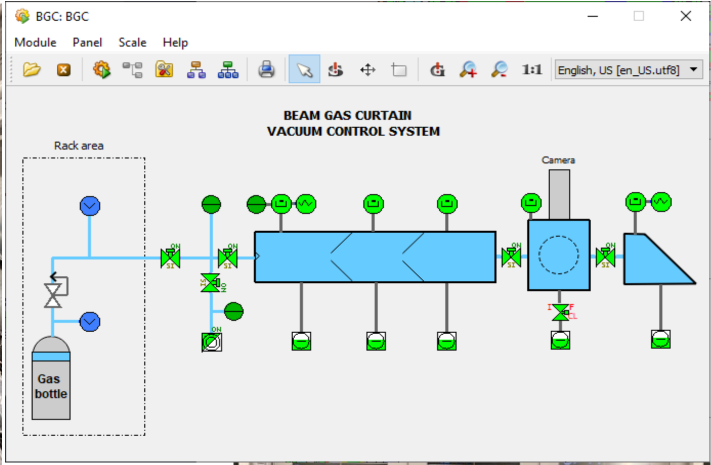
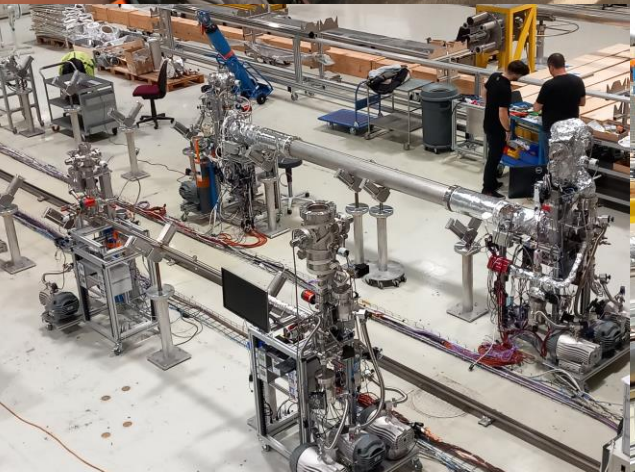
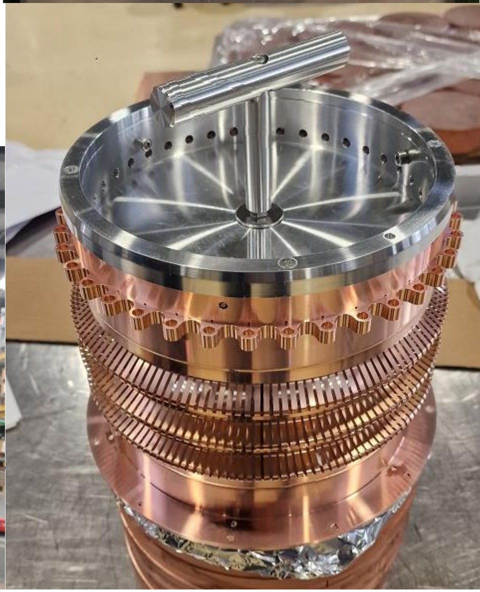




TE-VSC general meeting 2023

1. VSC's **structure**: changes and new posts.
2. **Operation** in 2023 and **schedule** for 2024.
3. **Three additional projects** in 2024.

This presentation encompasses merely a **small fraction of the topics** I aim to address.

A comprehensive overview can be downloaded from January 2024 onwards.

For **technical reports and advancement**, please refer to our series of **seminars**

https://indico.cern.ch/category/16375/

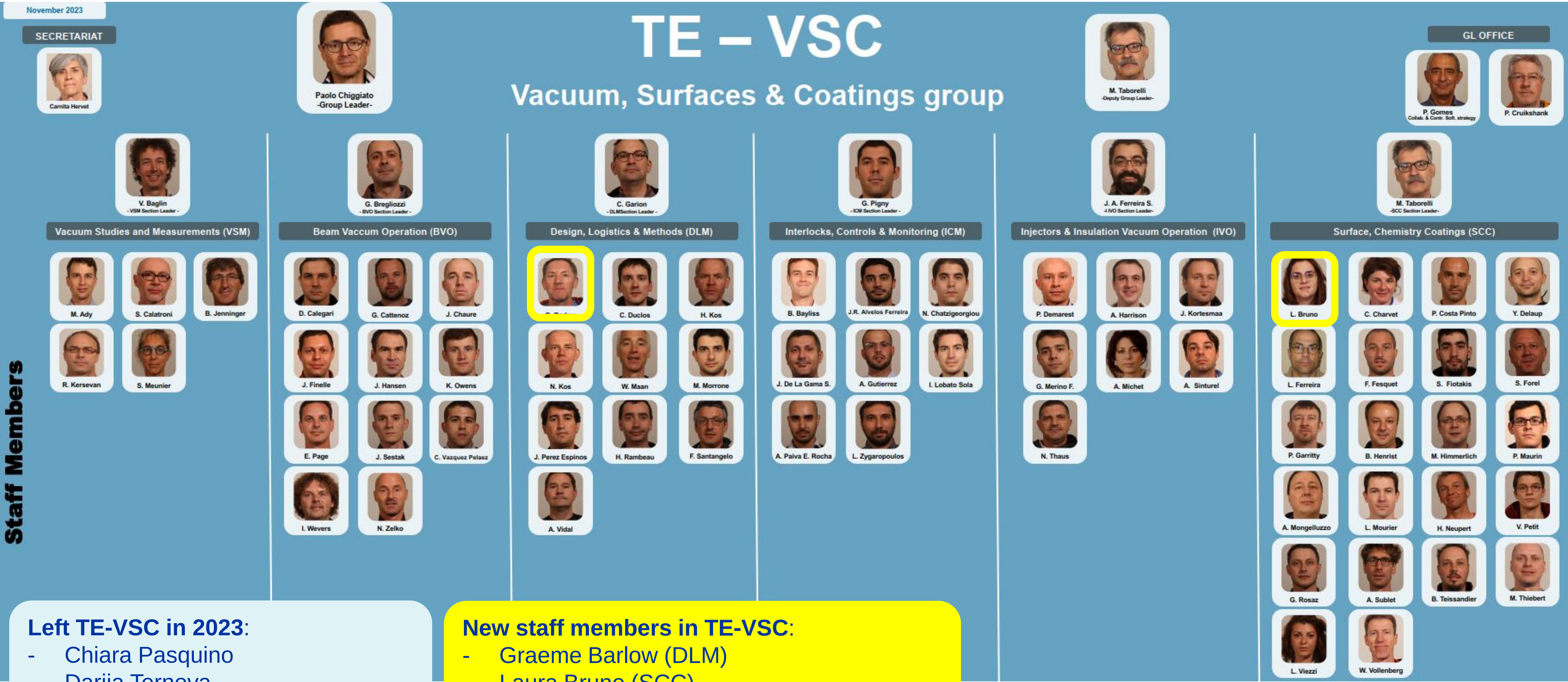
HL-LHC will be comprehensively treated in the next seminar (V. Baglin)

Group structure

Bruegel the elder, source Wikipedia

Staff Members in Dec 2023

71(+1) Staff members

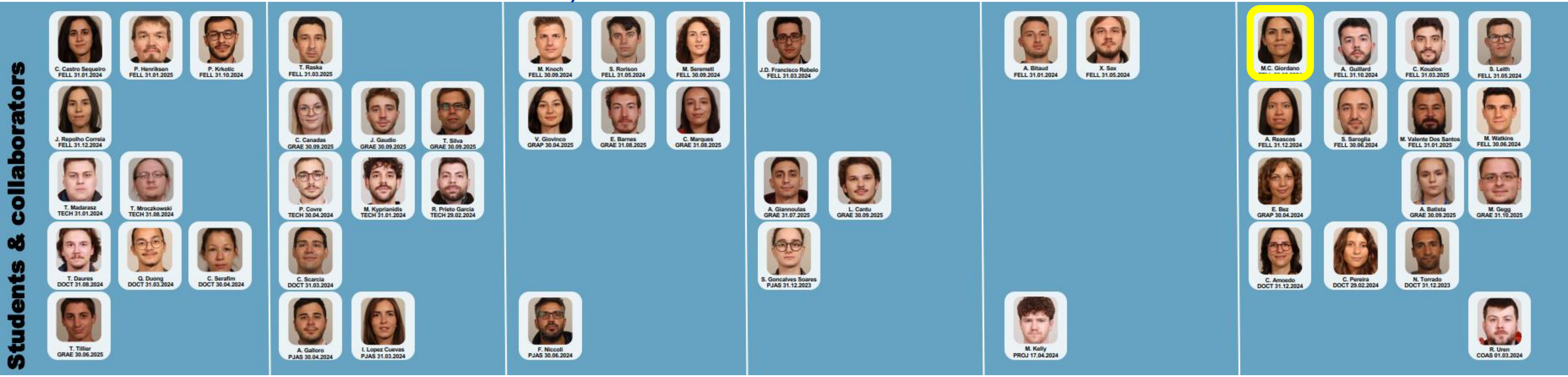


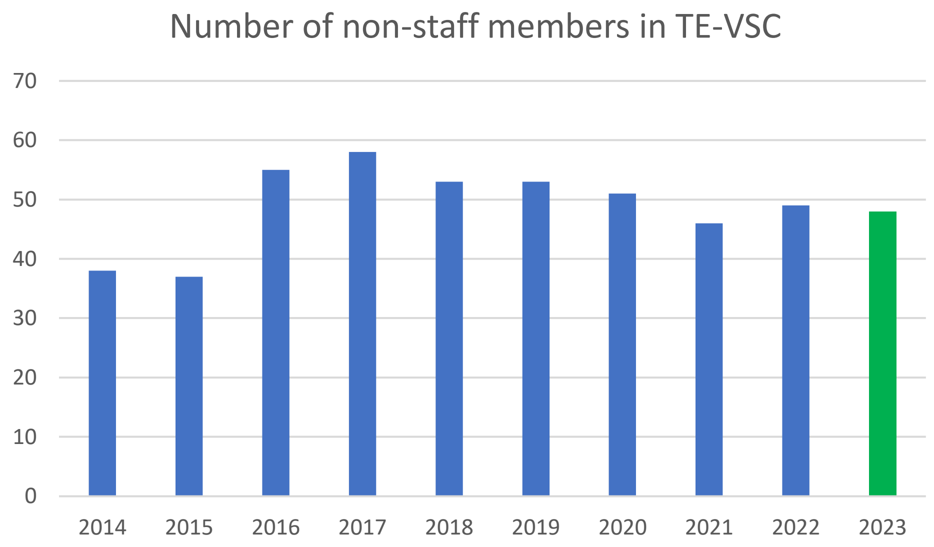
Left TE-VSC in 2023:
- Chiara Pasquino
- Dariia Ternova
- Paul Cruikshank

New staff members in TE-VSC:
- Graeme Barlow (DLM)
- Laura Bruno (SCC)
- Maria Carmen Giordano (IVO) from 2024

No planned change in structure in 2024-2025

Student, fellows and collaborators in Dec 2023





12-2023: **48** **(exc. COAS)**
12-2022: **49** **(exc. COAS)**
12-2021: **46** **(exc. COAS)**
11-2020: **51** **(exc. COAS)**
11-2019: **53** **(exc. COAS)**
11-2018: **53** **(exc. COAS)**
12-2017: **58** **(exc. COAS)**
12-2016: **55** **(exc. COAS)**
12-2015**: 37** **(exc. COAS)**
12-2014**: 38** **(7 COAS)**

New posts in 2024

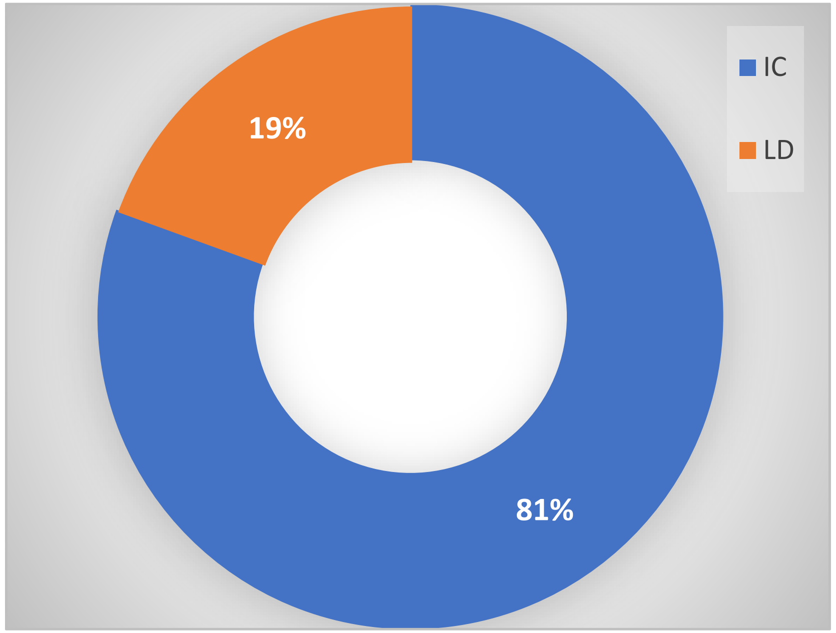
Abel Grimmer, Spring, source Wikipedia

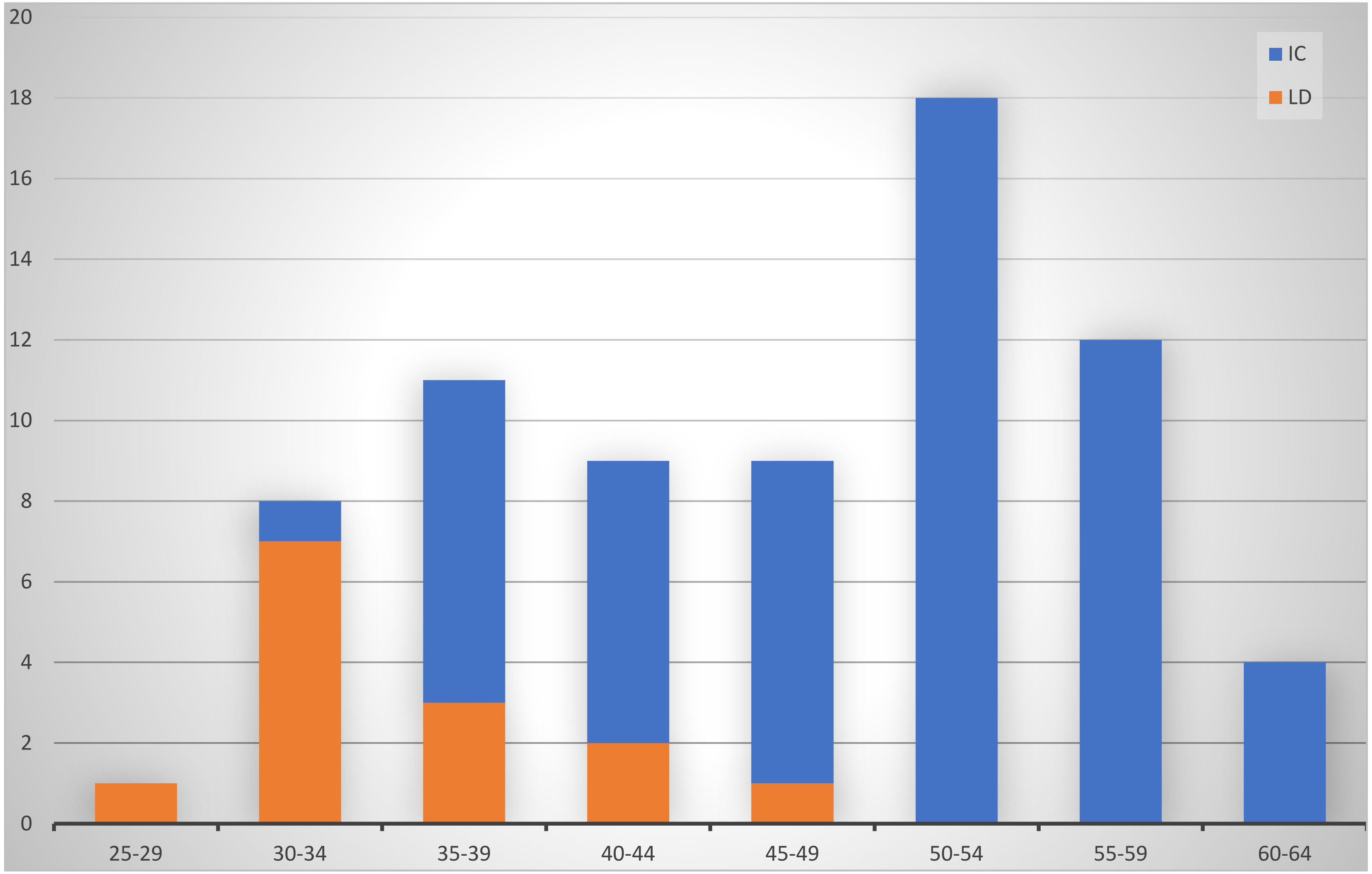
Last day of work at CERN for **Berthold:** June 30, 2024.

Posts	Planned contract start	
Vacuum Technician (IVO)	Q2-Q3	Approved
Material Science Technician (surface treatments, SCC)	Q1	
Vacuum Technical Engineer (VSM or DLM)	Q4	
Vacuum Operation Engineer (BVO)	*Q1-2025*	*Requested*
Control Software Engineer (ICM)	*2025*	
Vacuum Technician (4 years, IVO)	*2025*	

Age of staff members in Dec 2023

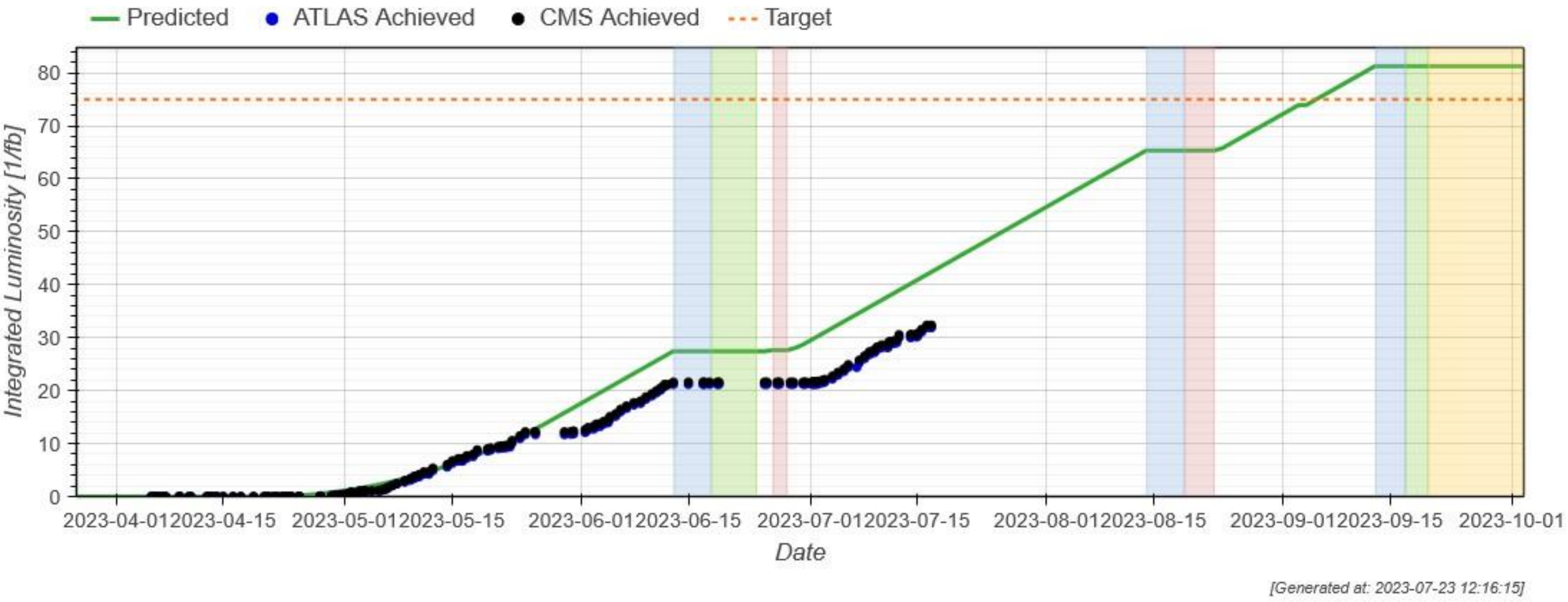
Total staff: 72 Average age: **46.6**





LHC operation in 2023

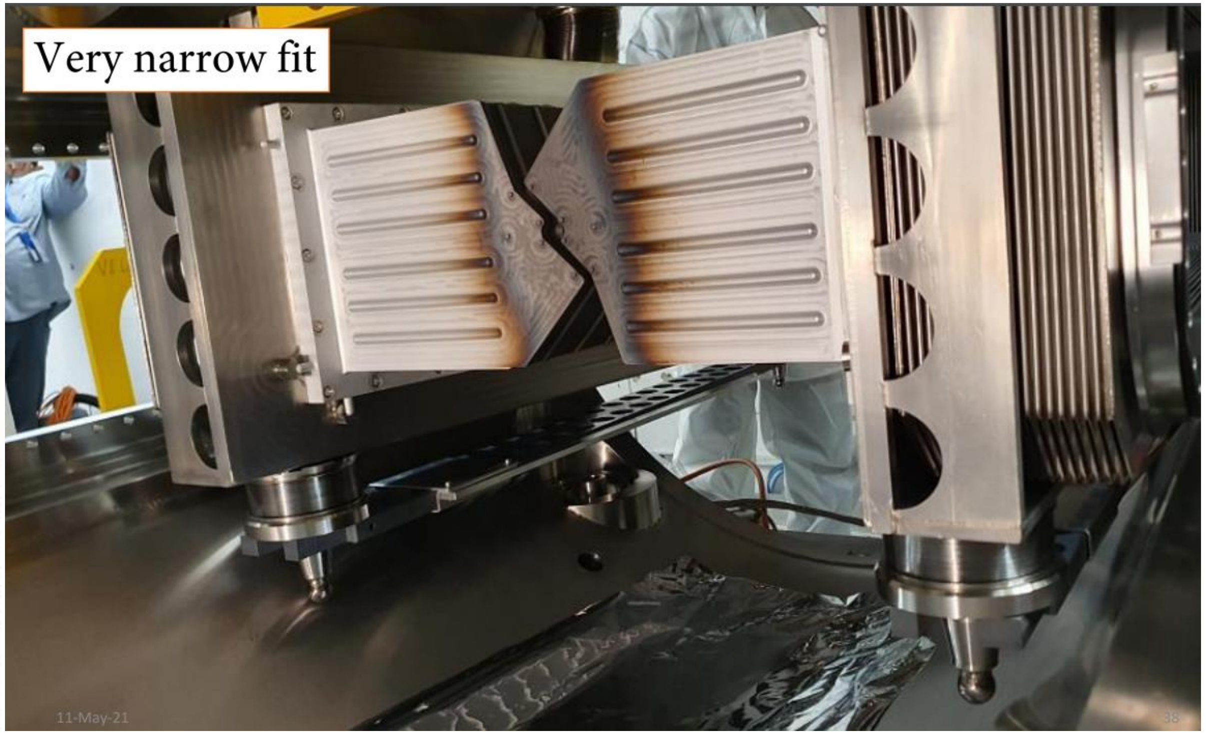
LHC operation in 2023



BE-OP-LHC team

January 2023: LHCb VeLo RF BOX

Credit: M Kraan (Nikhef)



Credit: Freek Sanders (Nikhef)

Context

‘An **incident in January 2023** led to an over pressurization of the VELO Detector Volume and subsequent **deformation of the RF Foils.**

The cause of the over pressurization was an unlikely **conjugation of unusual situations**, planning shortcomings and miscommunication between different teams.

Ultimately, though, the **deformation was not prevented because the existing safety system failed to act due to a hardware failure**. This failure, in turn, affected the control system, which further compounded the issue.

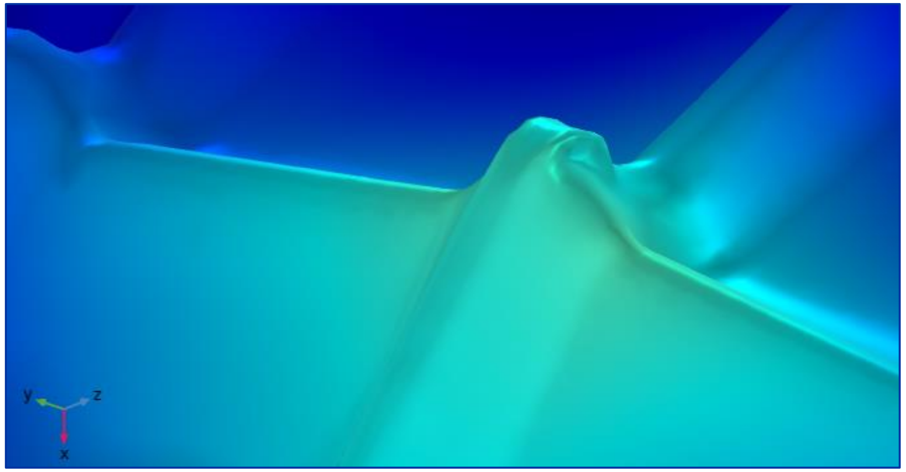
A **temporary replacement for the safety system electronics** was quickly implemented and installed, but the decision was taken to **entirely redesign the VELO Safety System during 2023** and replace it prior to the installation of the new RF foils.

Additional steps were taken during 2023 regarding **mechanical redesign** of the vacuum system and redefinition of certain procedures.’

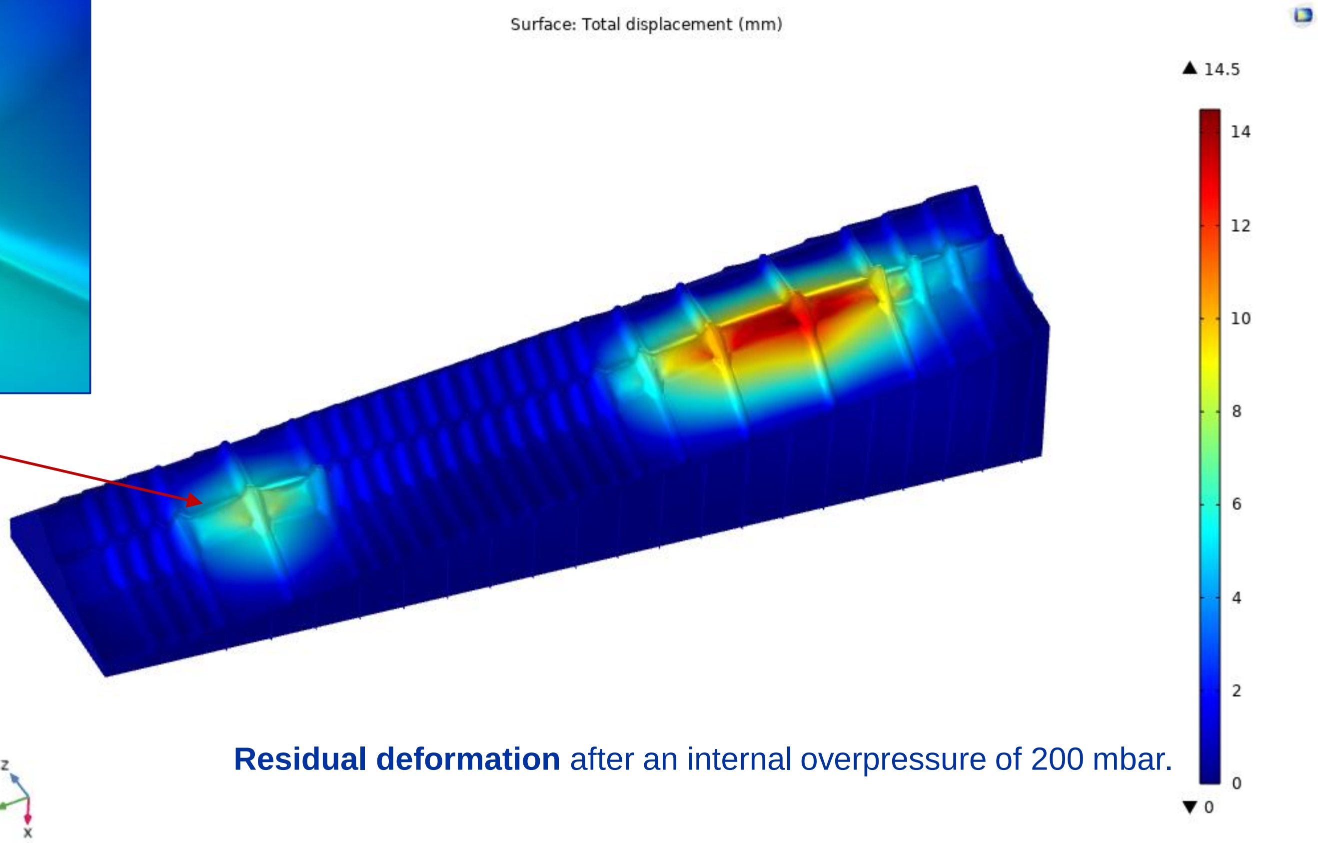
Rodrigo Ferreira & Josef Sestak: LMC November 22nd, 2023

Simulation of elastic-plastic behaviour of the RF box

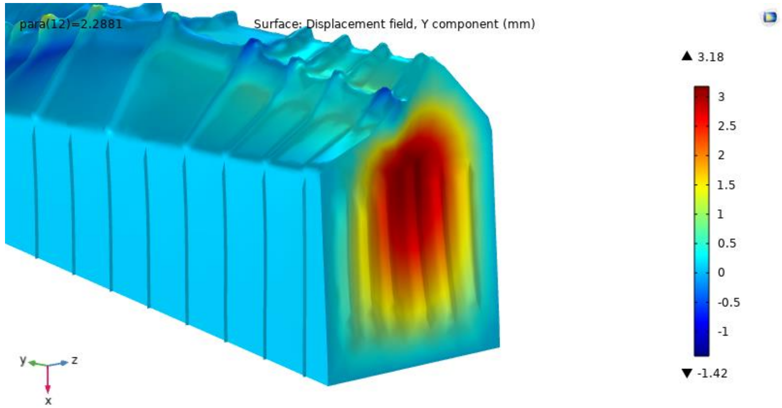
Mechanical analysis of the VeLo RF box with non-linear elastic-plastic model



Local buckling occurring at 100 mbar



Residual deformation after an internal overpressure of 200 mbar.



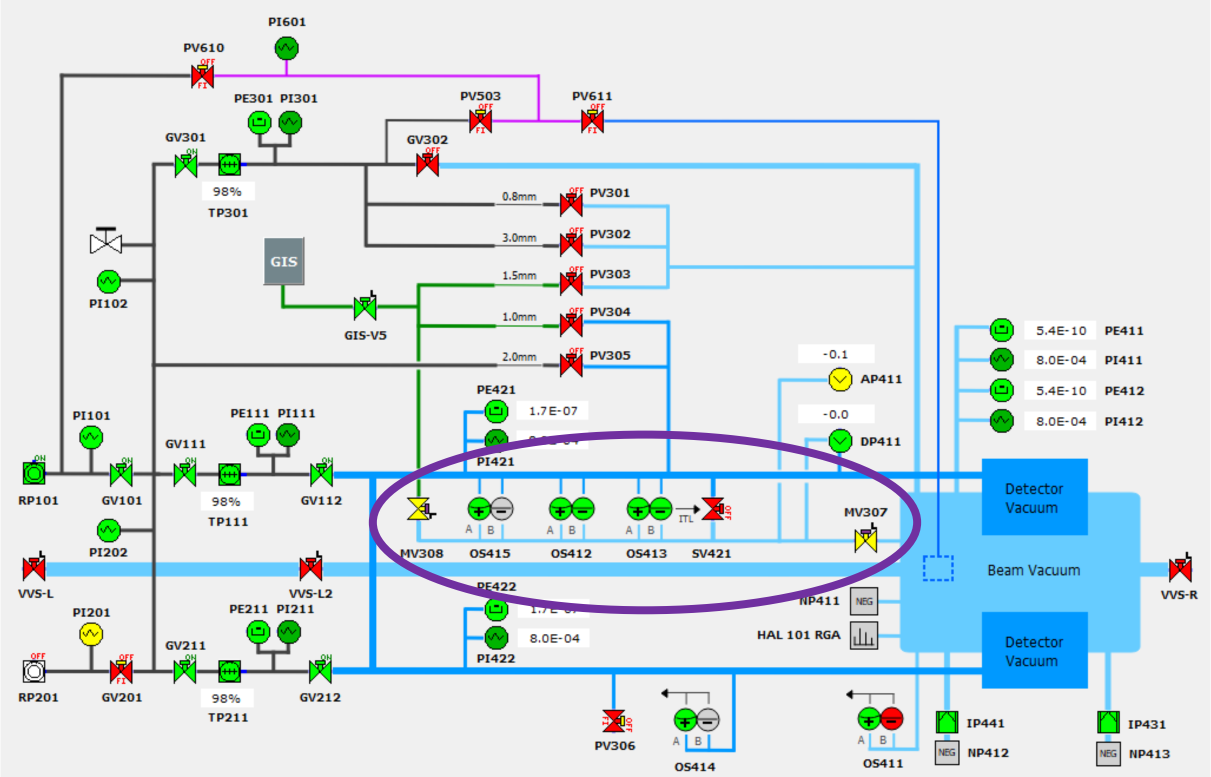
Instability for an external overpressure of ~56 mbar. **Back-buckling** phenomena studied in detail.

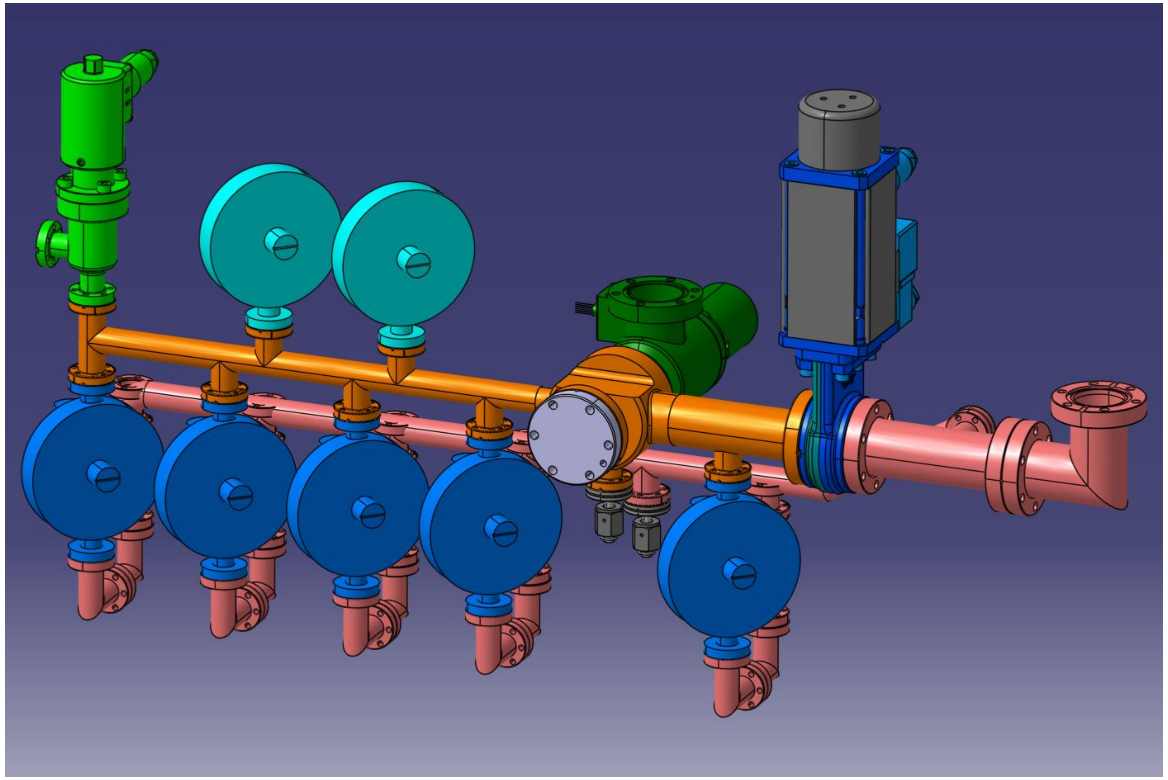
Report: Mechanical deformations of the velo RF box due to 200 mbar EDMS: 2820818

VeLo – New vacuum safety system

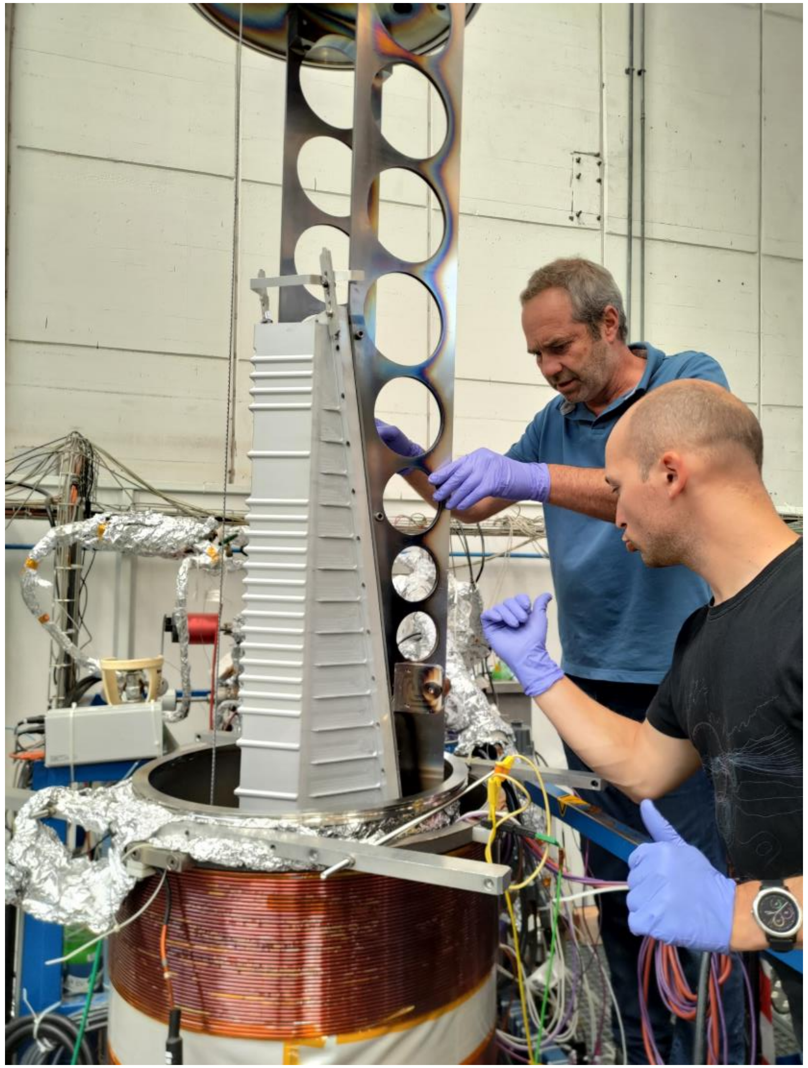
New measurement assembly

Enable to plan and enforce a procedure to **perform regular proof-tests of the Safety System**, as mandated by the IEC 61511 standard, without posing significant risks to the vacuum system and the RF foils.

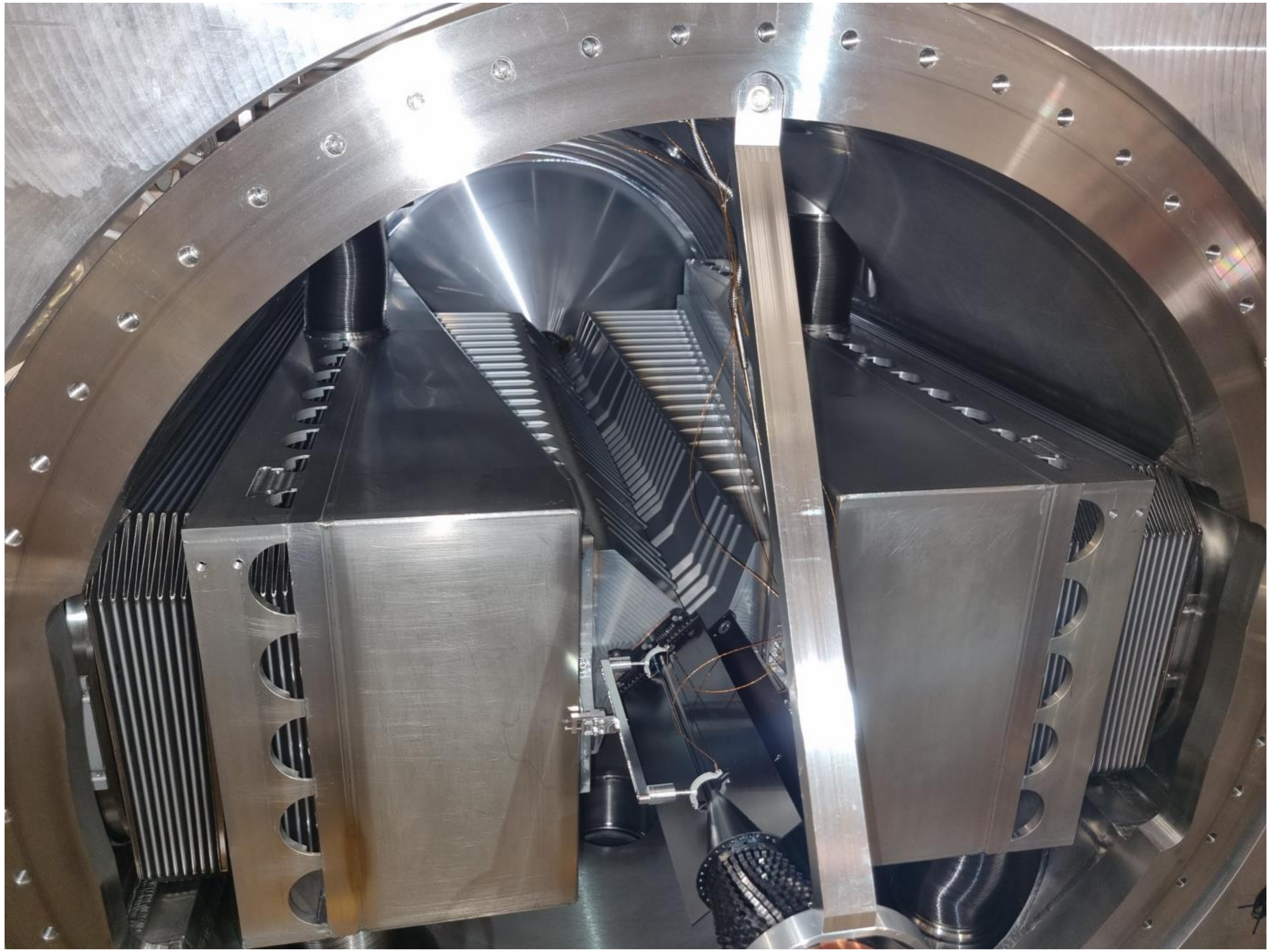




New VeLo RF box: NEG coating

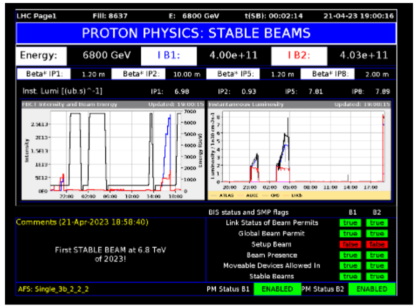


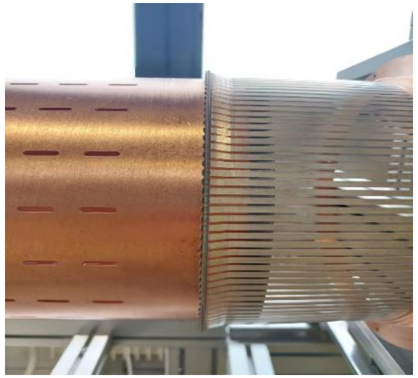
VeLo RF foils exchange intervention



18.03.2023
Crystal collimator Non-Conformity appeared during testing

21.04.2023
1st stable beam (3bx3b)



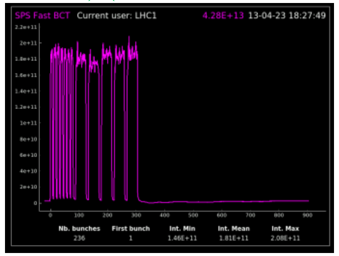


24.05.2023
RF finger module Vacuum spikes caused by beam induced arcing/heating

p run

March | April | May | June | July | August | September | October

02.04.2023
RF Rupture discs following IP4 SVC trip



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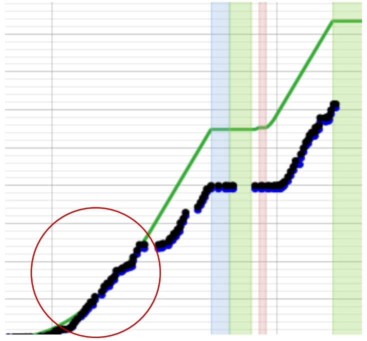
1st collisions with 2374 b (mixed scheme to minimize HL)

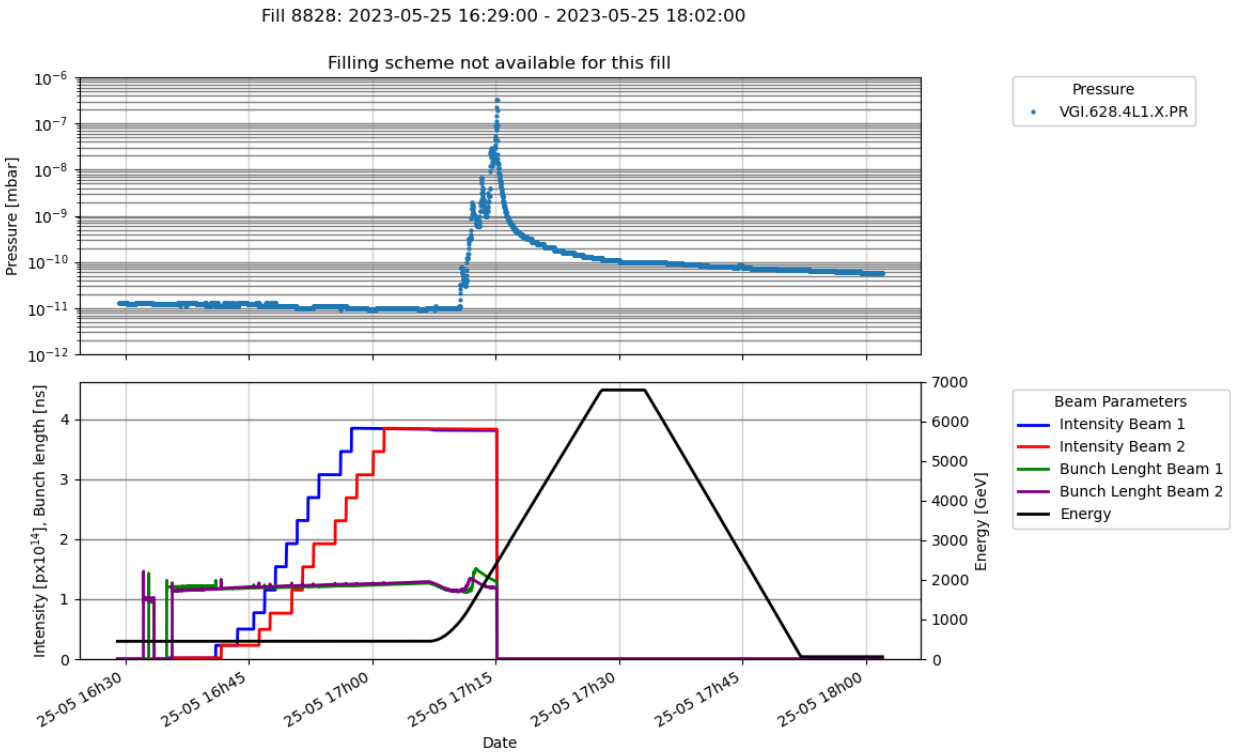
12 fb-1 in ~1month

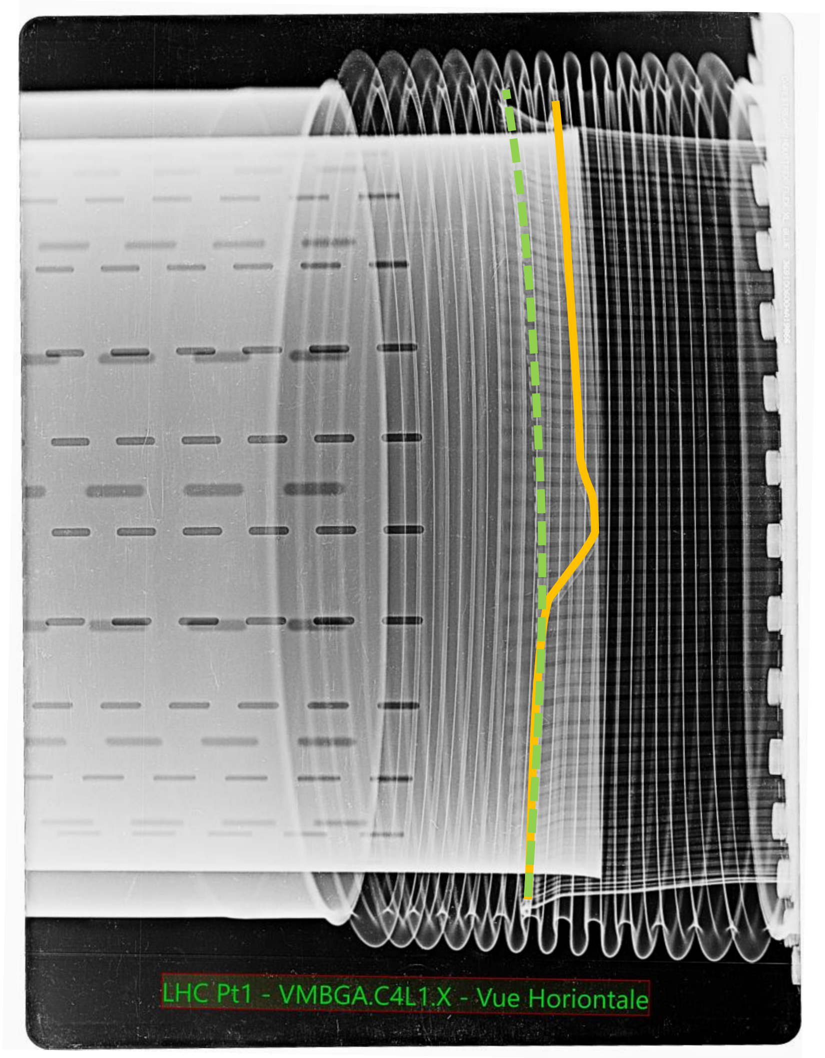


Matteo Solfaroli (BE-OP-LHC); presented at the JAP 2023

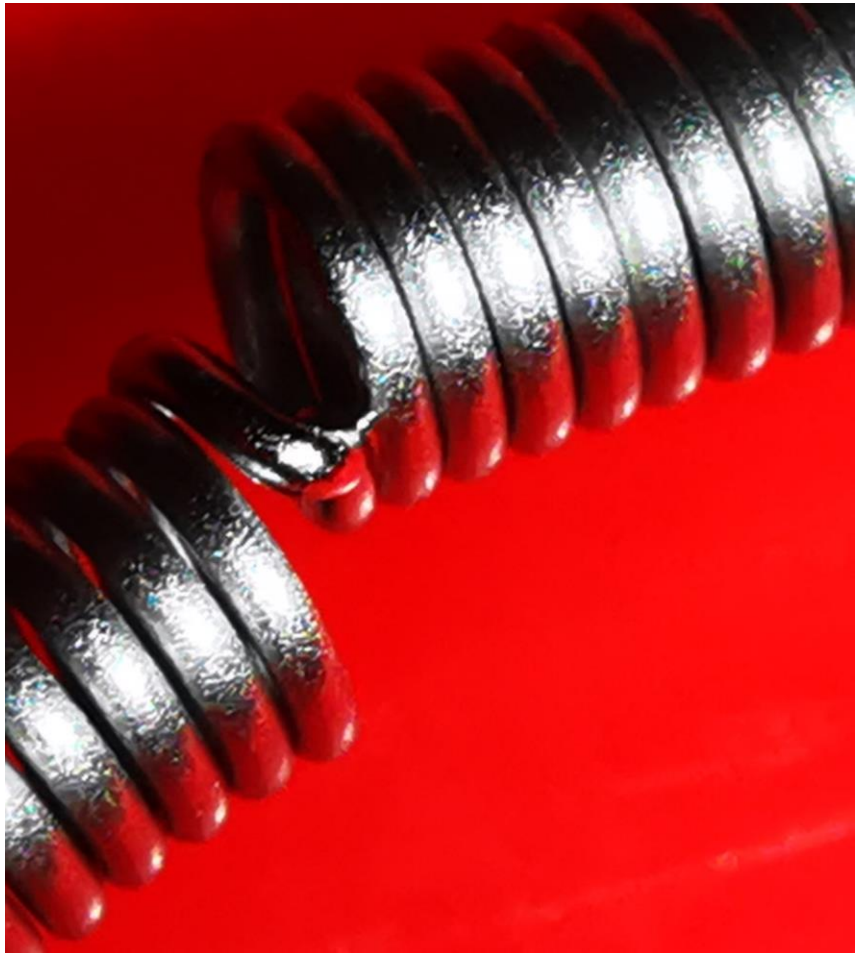
RF-finger fault

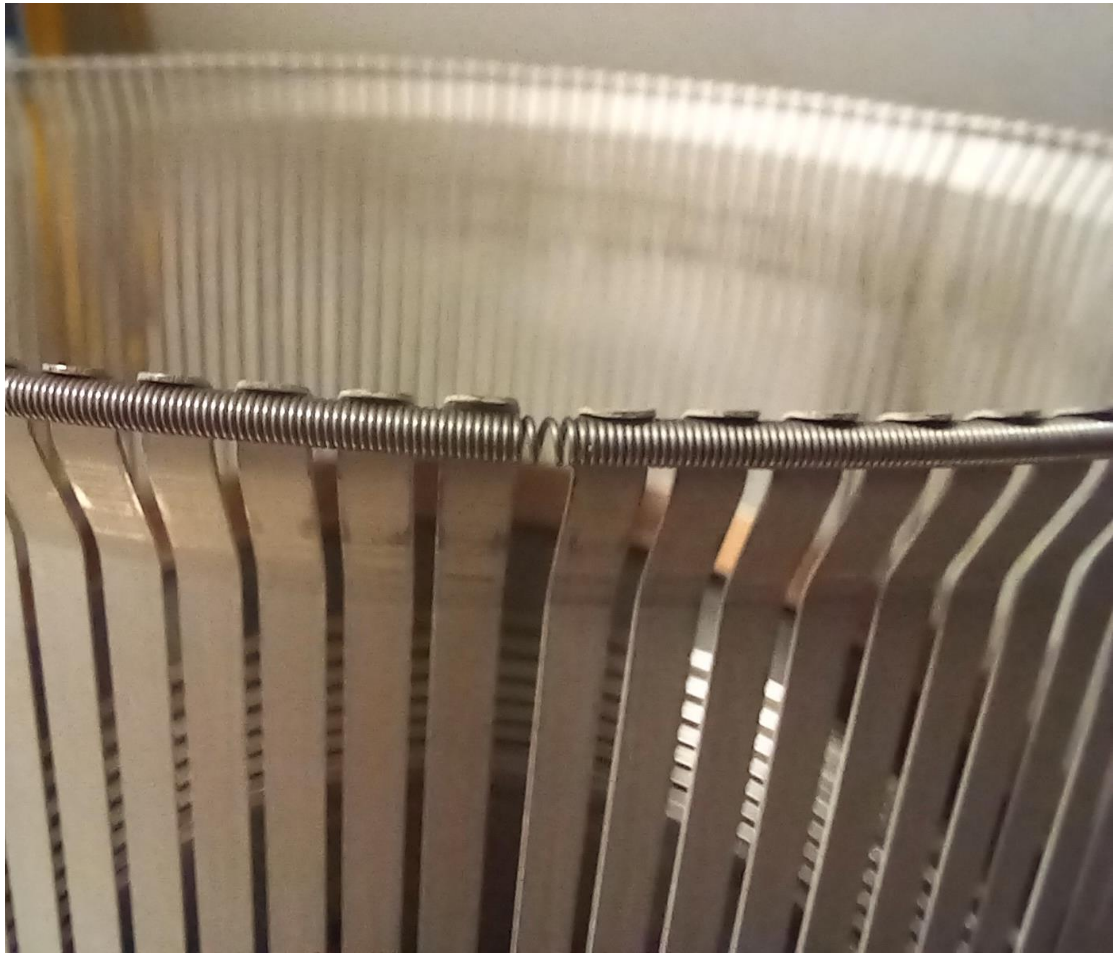
May 25-26, 2023: **Pressure spikes** within the vacuum sector **A4L1** during the fill ID 8828 (**1.63 · 10^{11} p/b – 2358 bunches**) lead to a **beam dump due to losses**.





RF-finger faults: analysis of the problem



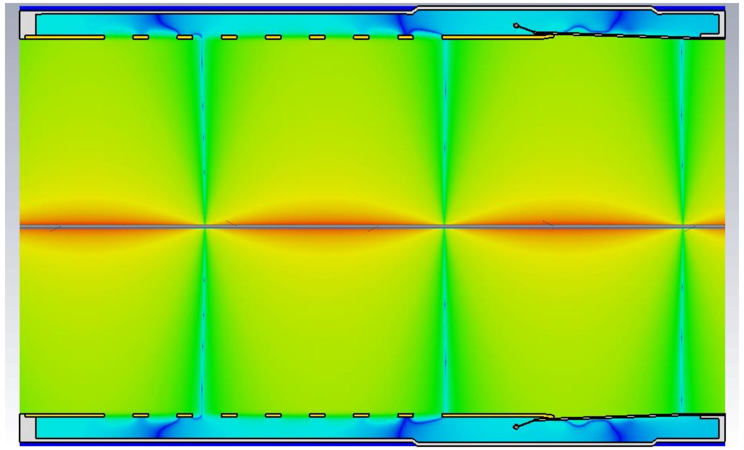


RF finger faults: analysis of the problem

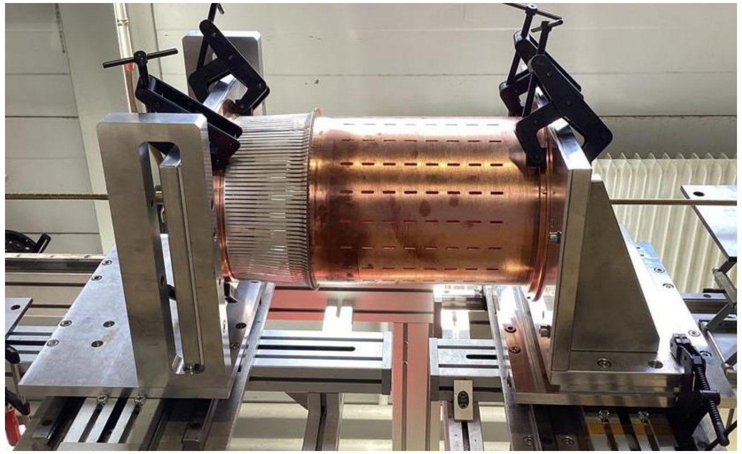
Taskforce ABP & VSC

Anomalous heating of a stainless-steel spring

Heated spring



EM field leakage outside the RF fingers



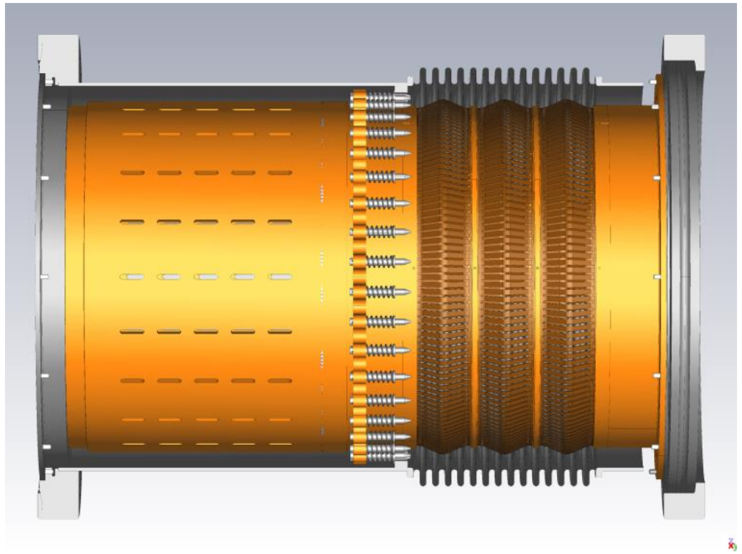
Impedance measurement test bench

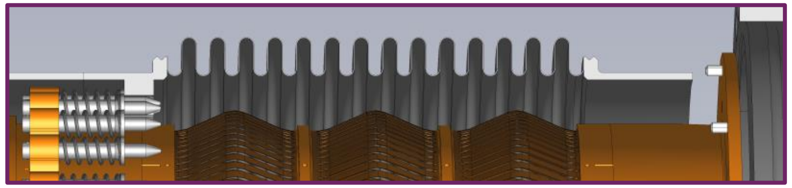
- Important progress in simulation and measurement.
- Development and testing of consolidation strategies

RF-finger fault: Mitigation strategy

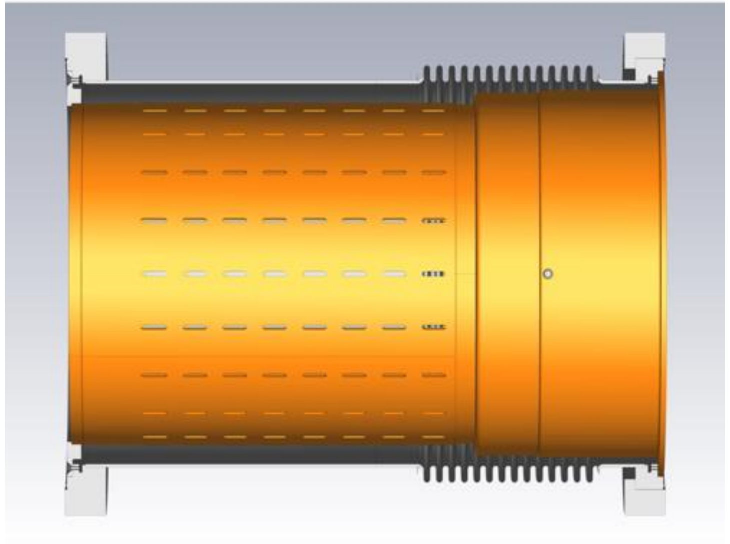
Replace the current 71 modules in the **ID212.7** RF contact **with newly designed modules** wherever it is possible to implement such a substitution.

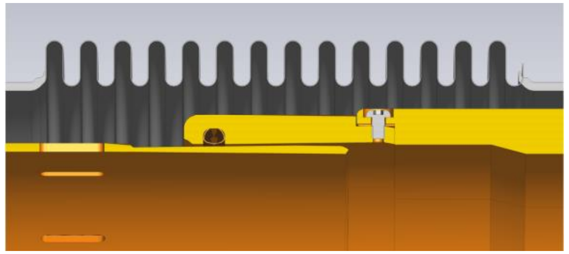
Deformable RF Finger



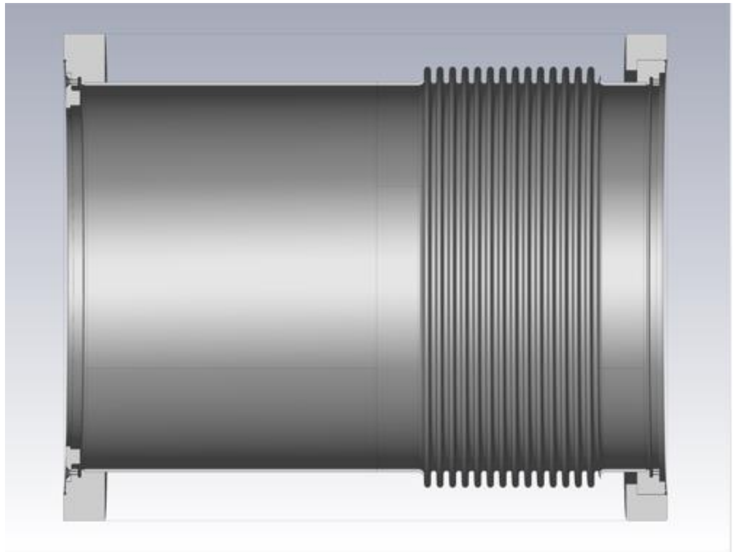


Retrofitted ID 212.7





Unshielded Bellows



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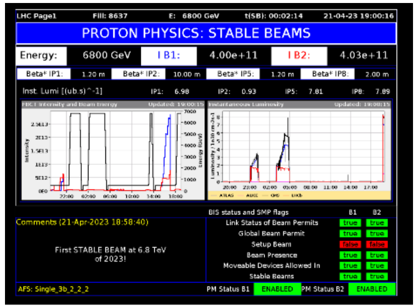
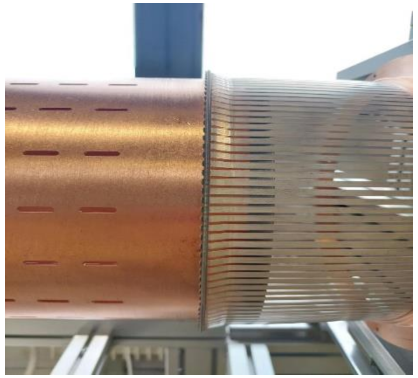
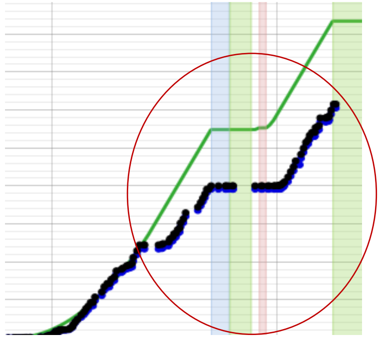




24.05.2023
RF finger module Vacuum spikes caused by beam induced arcing/heating

20 fb-1 in ~1.5month

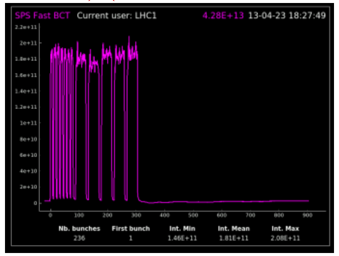


p run

IT.L8 fault

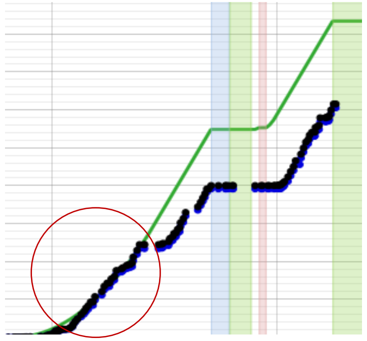
March	April	May	June	July	August	September	October

02.04.2023
RF Rupture discs following IP4 SVC trip



12.05.2023
1^{st} collisions with 2374 b (mixed scheme to minimize HL)

12 fb-1 in ~1month



17.07.2023
Power glitch, magnet quench, and leaking bellow in IT.L8

Matteo Solfaroli (BE-OP-LHC); presented at the JAP 2023

LHC Inner Triplet in L8

Edward Henry Potthast, A Holiday, Art Institute Chicago

Paul Cruikshank, A charismatic leader at CERN

18.03.2023
Crystal collimator
Non-Conformity appeared during testing

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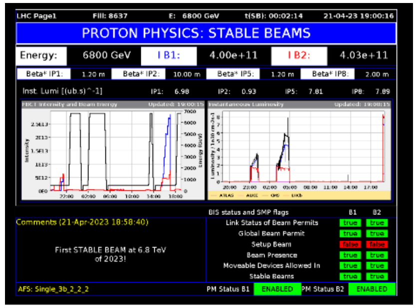

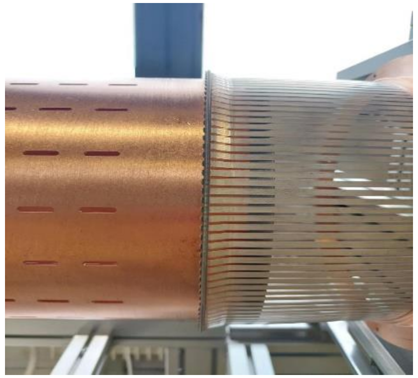

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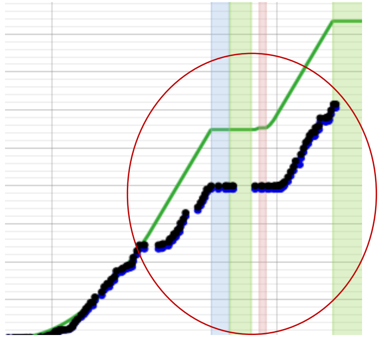
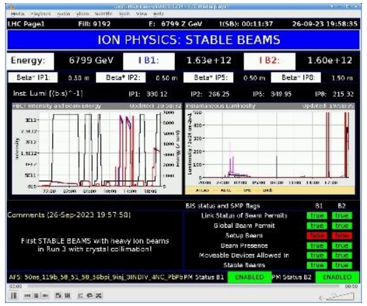


31.08.2023 (B)
08.09.2023 (A)
2 vacuum leaks on IP8-TDIS
Preventing p+ operation, but Pb ion possible



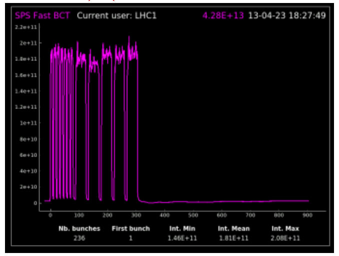
26.09.2023: 1st stable Pb ion beam of 2023

High Beta + recommissioning

p run | IT.L8 fault | IONS run

March | April | May | June | July | August | September | October

02.04.2023
RF Rupture discs following IP4 SVC trip



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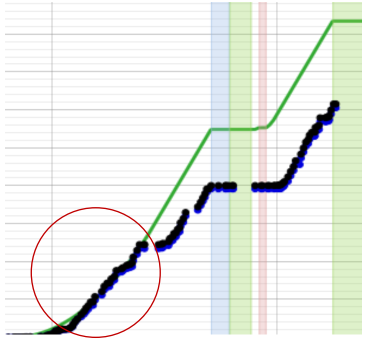

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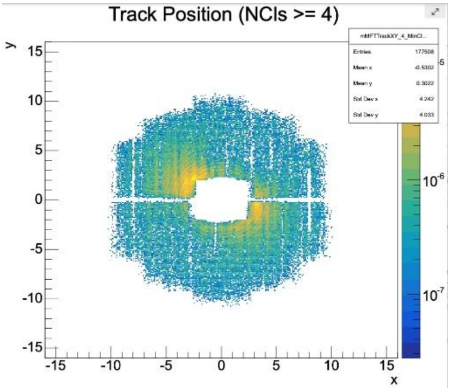
Power glitch, magnet quench, and leaking bellow in IT.L8

2.16 nb^{-1} to ALICE



Matteo Solfaroli (BE-OP-LHC); presented at the JAP 2023

Injector chain and experimental areas: operation in 2023

Source Wikipedia, C. Monet: Impression, soleil levant; Musée Marmottan Monet

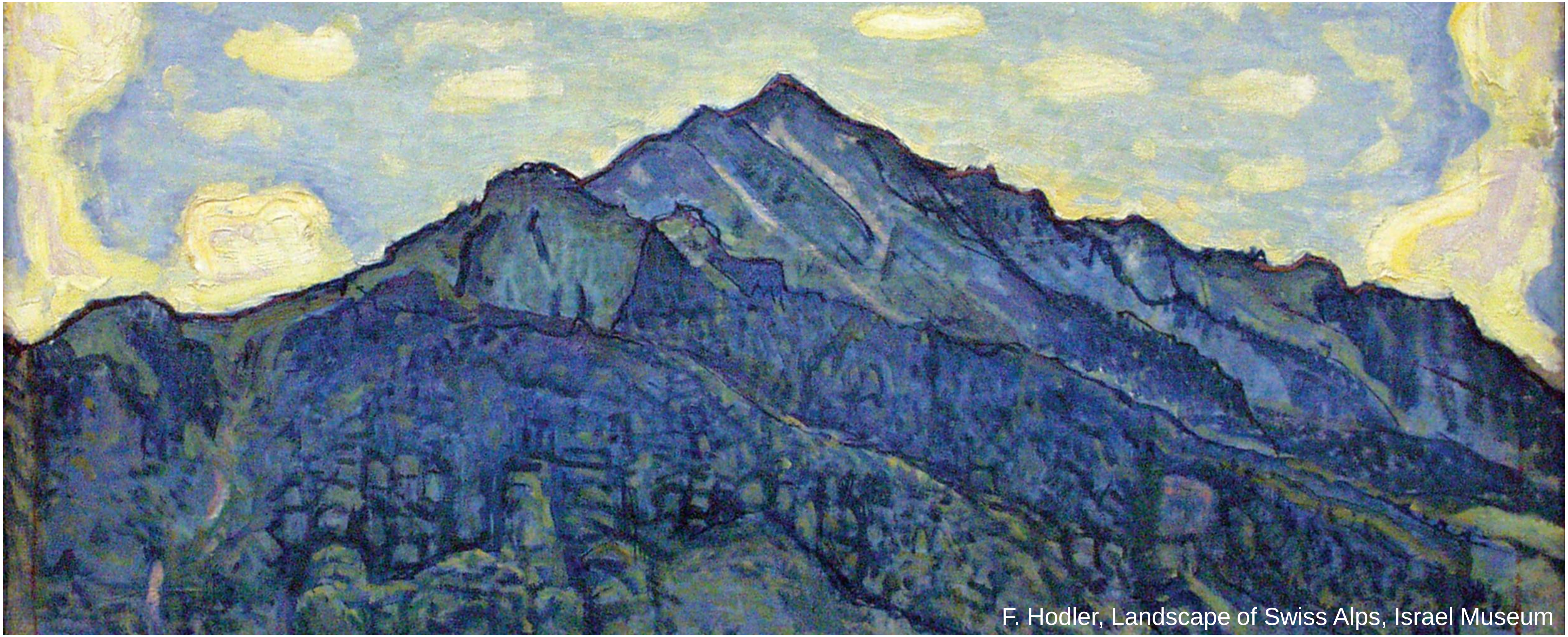
LHC injectors vacuum performance in 2023

Excellent availability, as usual:

- LINAC4: Less than 30 min VSC downtime.
- PSB: No downtime
- PS: Downtime dominated by RF bypass failure that opened a leak (no VSC responsibility)
- SPS: Better year. Failures dominated by vacuum interlocks. Pressure rise dominated by beam related phenomena.

No systematic failure. Most of the failures linked to non VSC origin

Operation schedule in 2024



F. Hodler, Landscape of Swiss Alps, Israel Museum

LHC in 2024

Moved to 2025

Research Board decision

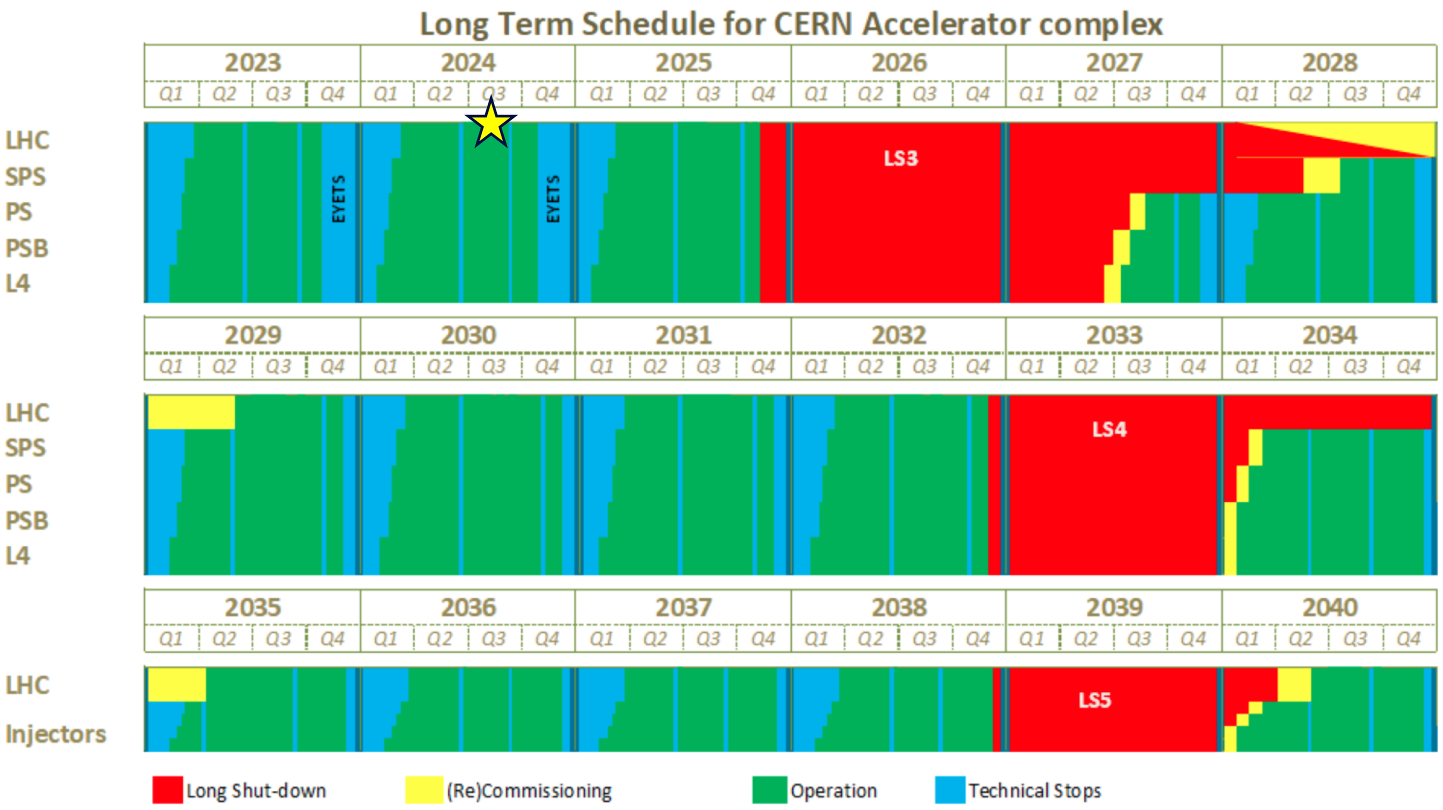
- **Physics in LHC** restarts in week 17.
- **PbPb run:** 2.5-3 weeks in 2024 and 2025 run
- **Oxygen** run after TS#1 in 2025

Rende Steerenberg: LMC, 22 Nov 2023

Long-term schedule update

- **LS3 readiness review in Q3 2024**
- 30 months for SPS i.e. NA CONS

- Progressive commissioning of LHC:
  - First sectors recommissioning, i.e. leak tests after pressure test, in January 2028 (2-3 & 3-4)
  - First sectors cooldown in March 2028 (2-3 & 3-4)



Under approval: https://edms.cern.ch/document/2311633/2.1

Rende Steerenberg: LMC, 22 Nov 2023

Three projects:

- In-house assembly of beryllium beampipes
- Beam-screen treatment in LHC
- SA18


Caravaggio, The cheater of cards, Princeton

In-house assembly of beryllium beampipes

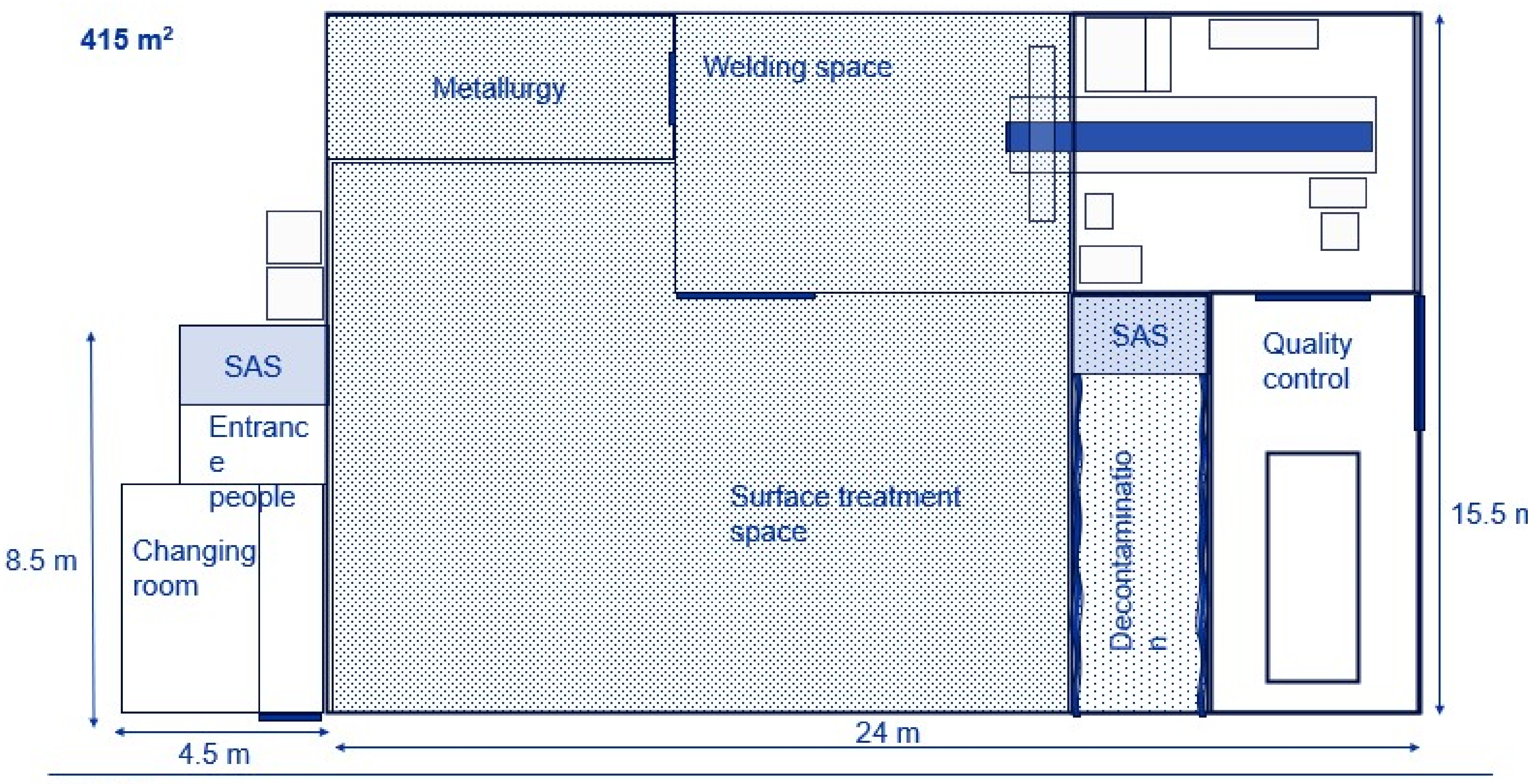
CERN has always relied on an **external supplier to produce beryllium** experimental vacuum **chambers**.

However, in 2023, our supplier declared its intention to **discontinue the assembly** of these pivotal vacuum chambers.

Subsequently, during the past summer, a proposal was made to **establish a new assembly facility at CERN**, thereby bringing the fabrication process in-house. This program has now been **approved by the Director-General**.

In-house assembly of beryllium beampipes

A new workshop



Preliminary, Courtesy of Isabel Bejar Alonso

Beam-screen treatment in LHC

The objective of the Beam Screen Treatment (**BST**) project is to **reduce the cryogenic heat load of the LHC** by implementing an in-situ chemical modification of the beam screen surfaces.

The project will unfold in three distinct phases:

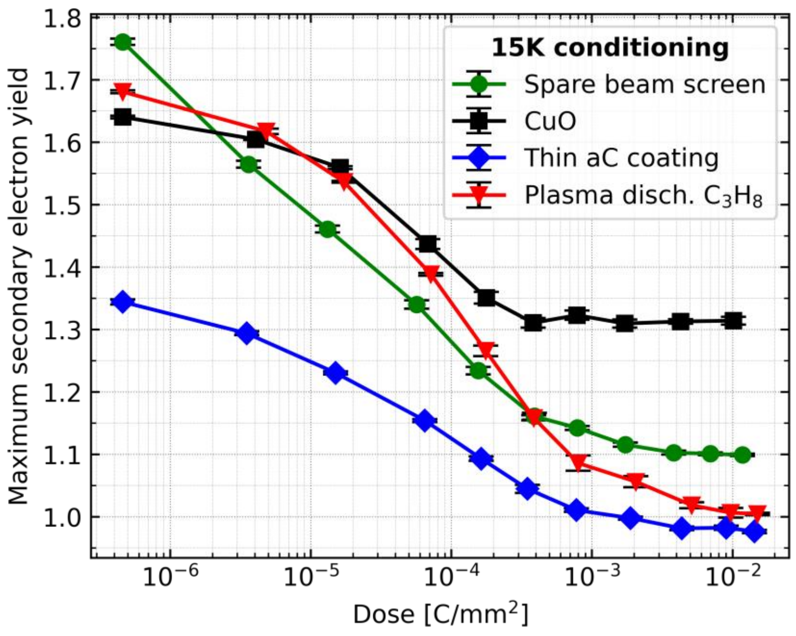
- Selecting the most **suitable method**.
- Applying this method within a **mock-up** of half-cell.
- **Integrating** the chosen method into the LHC during the **LS3 period**.

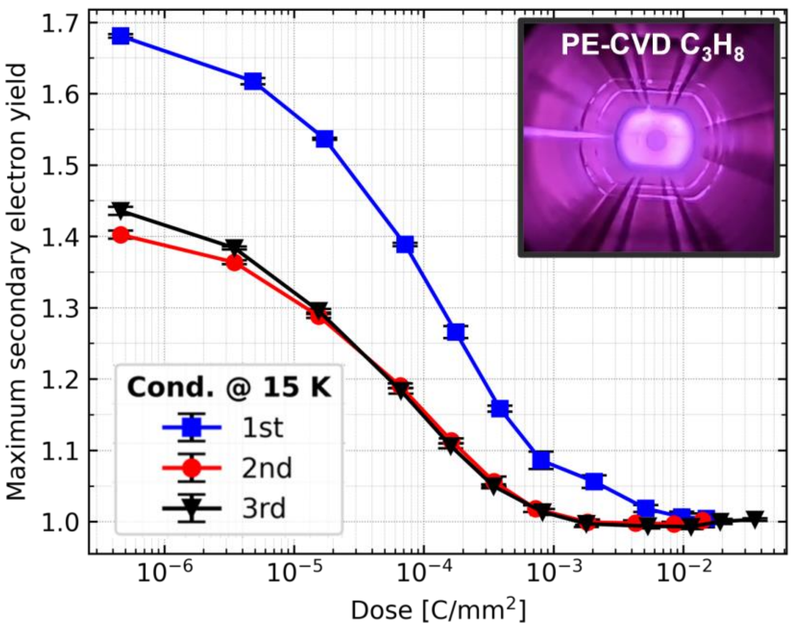
Over the course of the long shutdown period spanning 400 weekdays, there is a potential to treat up to **100 half-cells** for a cost of **4 MCHF**, which includes material, IS and M-to-P for graduate programmes.

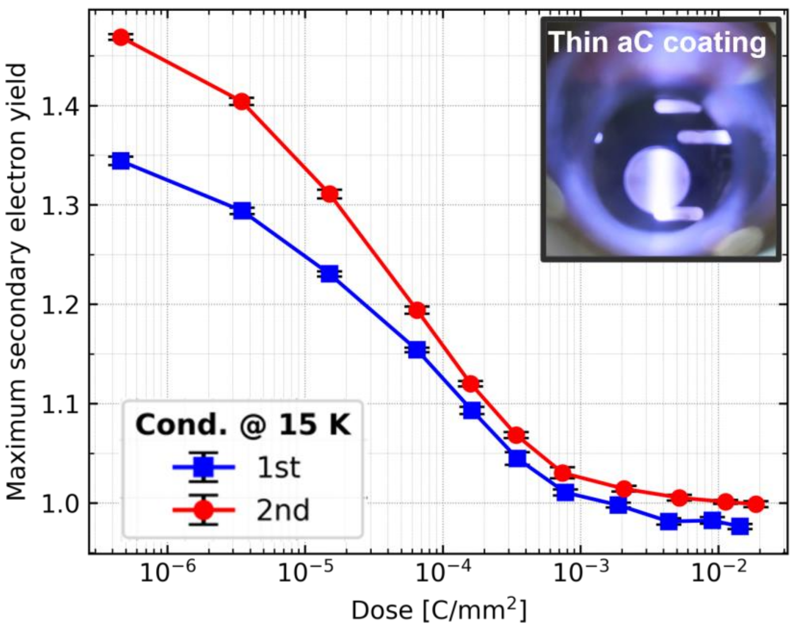
The project necessitates the contribution of approximately **100 person-months** of both cat-2 and cat-3 staff members.

Beam-screen treatment in LHC

Development of coatings to reduce LHC beam-screen heat loads after a restricted period of beam conditioning in the LHC arcs.



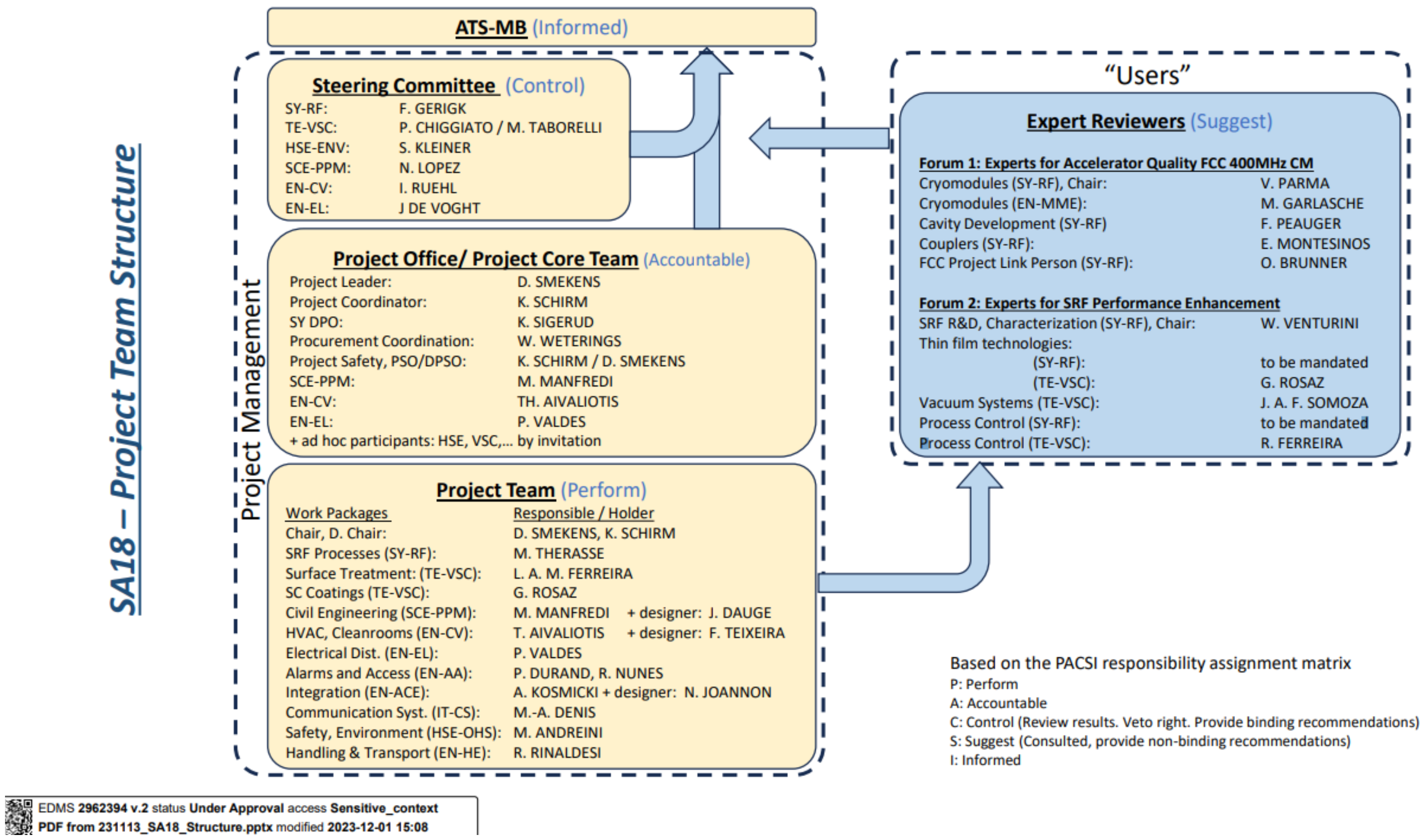




SEY ≤ 1 after 15K conditioning validated for PE-CVD coating in C_3H_8 and thin aC coating by PVD

SEY = 1 still reached after several cycles of 15K conditioning ↔ air exposure

New building for superconducting RF cavities: SA18



SA18 – Project Team Structure

Project Management

ATS-MB (Informed)

Steering Committee (Control)

SY-RF:	F. GERIGK
TE-VSC:	P. CHIGGIATO / M. TABORELLI
HSE-ENV:	S. KLEINER
SCE-PPM:	N. LOPEZ
EN-CV:	I. RUEHL
EN-EL:	J DE VOGHT

Project Office/ Project Core Team (Accountable)

Project Leader:	D. SMEKENS
Project Coordinator:	K. SCHIRM
SY DPO:	K. SIGERUD
Procurement Coordination:	W. WETERINGS
Project Safety, PSO/DPSO:	K. SCHIRM / D. SMEKENS
SCE-PPM:	M. MANFREDI
EN-CV:	TH. AIVALIOTIS
EN-EL:	P. VALDES
+ ad hoc participants: HSE, VSC,...	by invitation

Project Team (Perform)

Work Packages	Responsible / Holder
Chair, D. Chair:	D. SMEKENS, K. SCHIRM
SRF Processes (SY-RF):	M. THERASSE
Surface Treatment: (TE-VSC):	L. A. M. FERREIRA
SC Coatings (TE-VSC):	G. ROSAZ
Civil Engineering (SCE-PPM):	M. MANFREDI + designer: J. DAUGE
HVAC, Cleanrooms (EN-CV):	T. AIVALIOTIS + designer: F. TEIXEIRA
Electrical Dist. (EN-EL):	P. VALDES
Alarms and Access (EN-AA):	P. DURAND, R. NUNES
Integration (EN-ACE):	A. KOSMICKI + designer: N. JOANNON
Communication Syst. (IT-CS):	M.-A. DENIS
Safety, Environment (HSE-OHS):	M. ANDREINI
Handling & Transport (EN-HE):	R. RINALDESI

"Users"

Expert Reviewers (Suggest)

Forum 1: Experts for Accelerator Quality FCC 400MHz CM

Cryomodules (SY-RF), Chair:	V. PARMA
Cryomodules (EN-MME):	M. GARLASCHE
Cavity Development (SY-RF)	F. PEAUGER
Couplers (SY-RF):	E. MONTESINOS
FCC Project Link Person (SY-RF):	O. BRUNNER

Forum 2: Experts for SRF Performance Enhancement

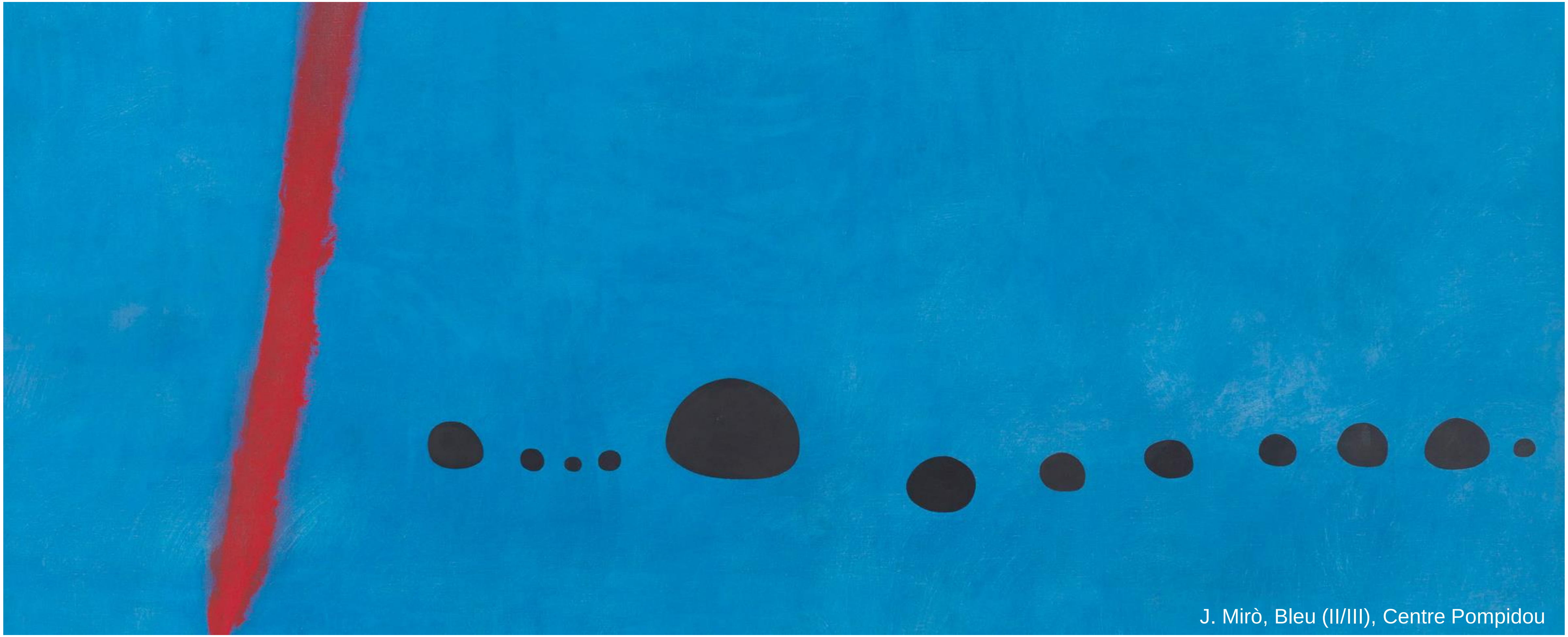
SRF R&D, Characterization (SY-RF), Chair:	W. VENTURINI
Thin film technologies:	
(SY-RF):	to be mandated
(TE-VSC):	G. ROSAZ
Vacuum Systems (TE-VSC):	J. A. F. SOMOZA
Process Control (SY-RF):	to be mandated
Process Control (TE-VSC):	R. FERREIRA

Based on the PACSI responsibility assignment matrix
P: Perform
A: Accountable
C: Control (Review results. Veto right. Provide binding recommendations)
S: Suggest (Consulted, provide non-binding recommendations)
I: Informed

EDMS 2962394 v.2 status Under Approval access Sensitive_context
PDF from 231113_SA18_Structure.pptx modified 2023-12-01 15:08

In approval phase, D. Smekens

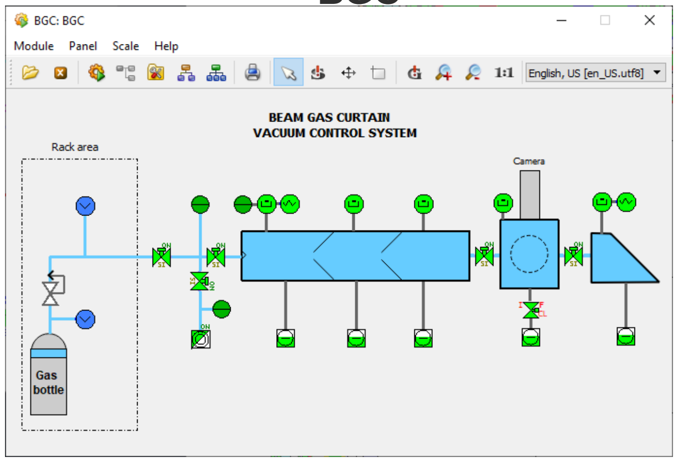
One last sentence



J. Mirò, Bleu (II/III), Centre Pompidou

SCADA Applications

BGC



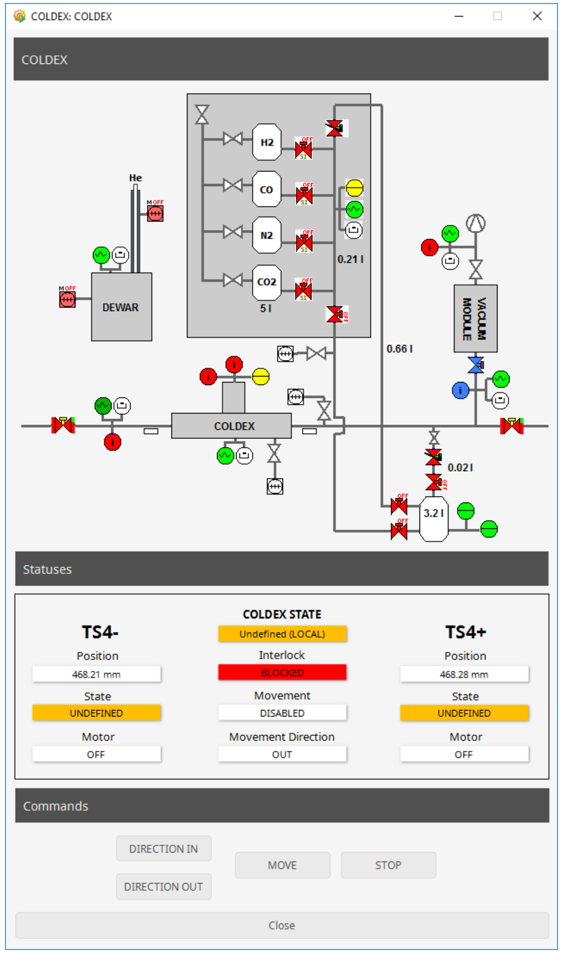
Critical equipment with gas injection in the beam vacuum and permanent TM pumping.

SCADA integrated into the general LHC frame.

Three new types of pumping groups.

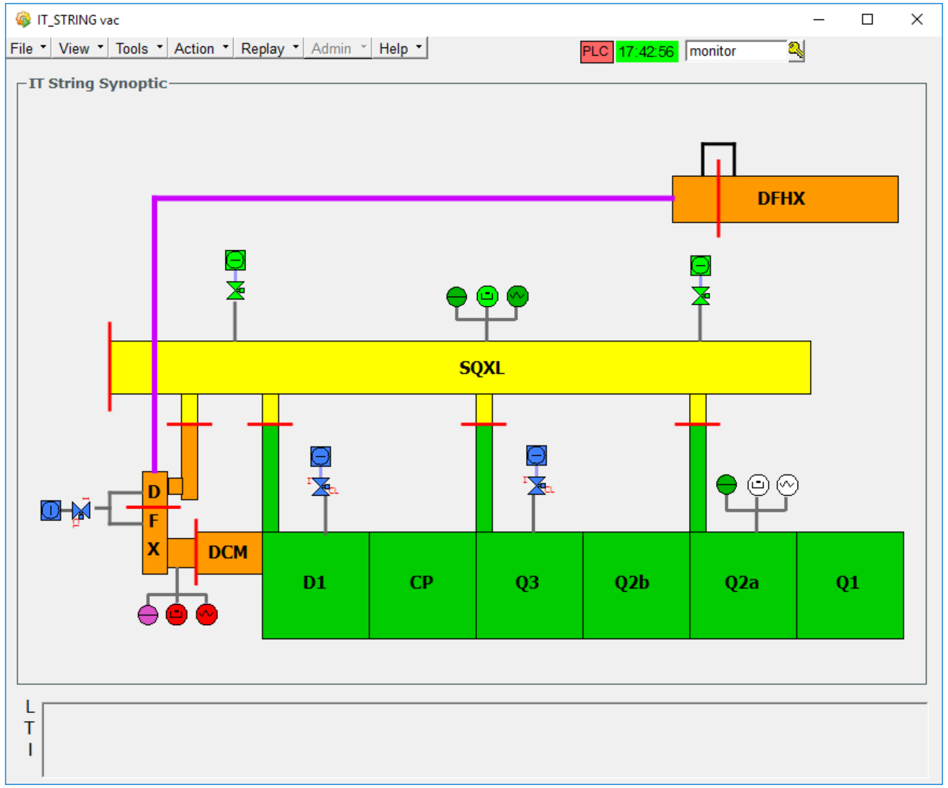
Now operational.

New Coldex



Refurbished applications after changes in the hardware. Motorized system.

IT String

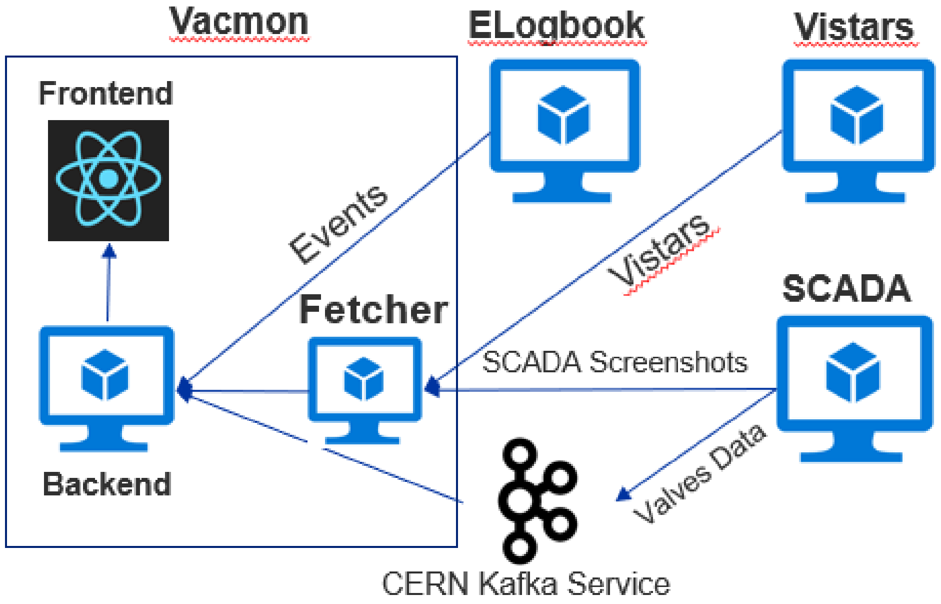


Inner Triplet magnet string for HL-LHC in SM18

Vacmon

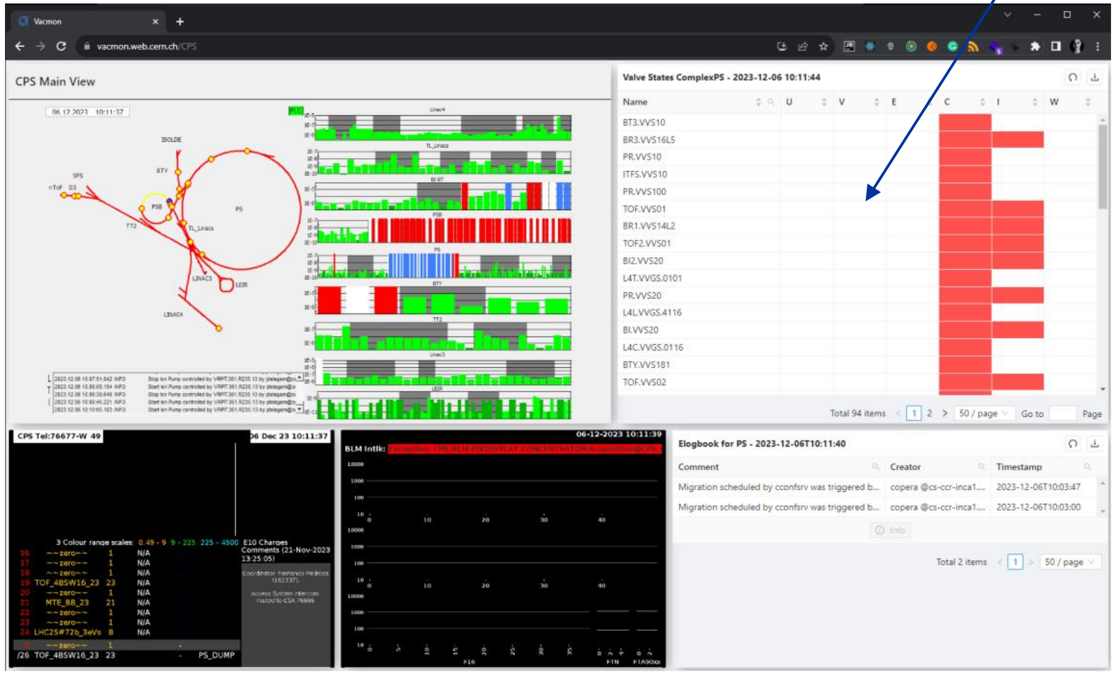
New vacmon is fully operational:

- Templating mechanism
- Vistars
- Sector valves
- Integration with elogbook
- TPG300 daily snapshot w/ change notifications

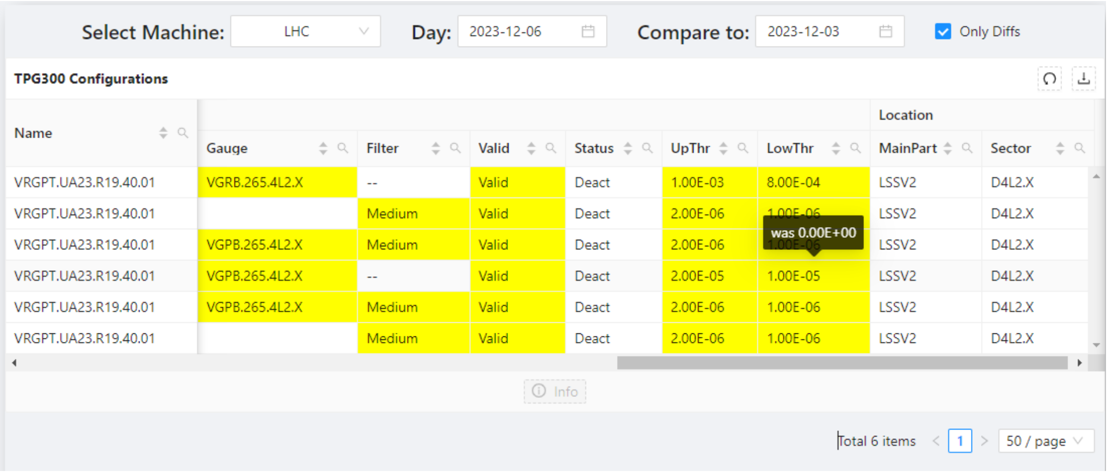


Vacmon

Status of sector valves



TPG300 Daily Snapshots



Select Machine: LHC Day: 2023-12-06 Compare to: 2023-12-03 Only Diffs

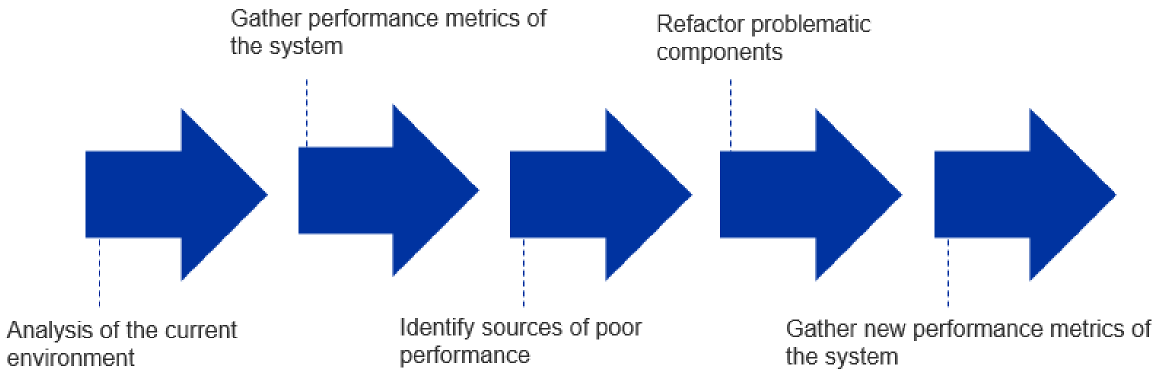
TPG300 Configurations

Name	Gauge	Filter	Valid	Status	UpThr	LowThr	Location: MainPart	Location: Sector
VRGPT.UA23.R19.40.01	VGRB.265.4L2.X	--	Valid	Deact	1.00E-03	8.00E-04	LSSV2	D4L2.X
VRGPT.UA23.R19.40.01		Medium	Valid	Deact	2.00E-06	1.00E-06	LSSV2	D4L2.X
VRGPT.UA23.R19.40.01	VGPB.265.4L2.X	Medium	Valid	Deact	2.00E-06	1.00E-06 (was 0.00E+00)	LSSV2	D4L2.X
VRGPT.UA23.R19.40.01	VGPB.265.4L2.X	--	Valid	Deact	2.00E-05	1.00E-05	LSSV2	D4L2.X
VRGPT.UA23.R19.40.01	VGPB.265.4L2.X	Medium	Valid	Deact	2.00E-06	1.00E-06	LSSV2	D4L2.X
VRGPT.UA23.R19.40.01		Medium	Valid	Deact	2.00E-06	1.00E-06	LSSV2	D4L2.X

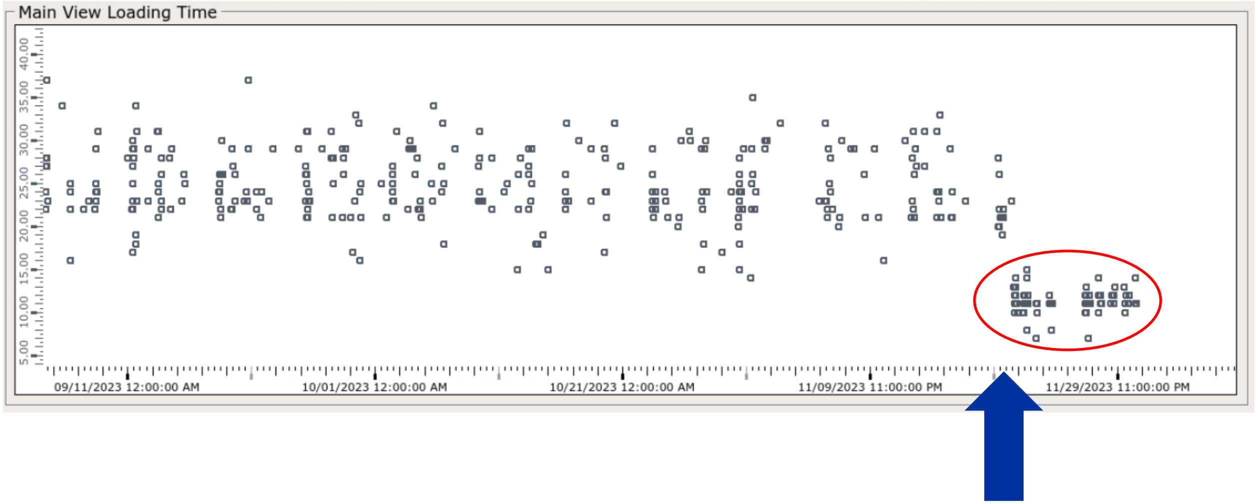
Total 6 items 1 50 / page

SCADA Performance Improvements

- **Several algorithms improved** to increase the performance of the vacuum SCADA
- **Deployment of the Unified Mobiles System** resulted in a **52% improvement** in LHC SCADA application performance.



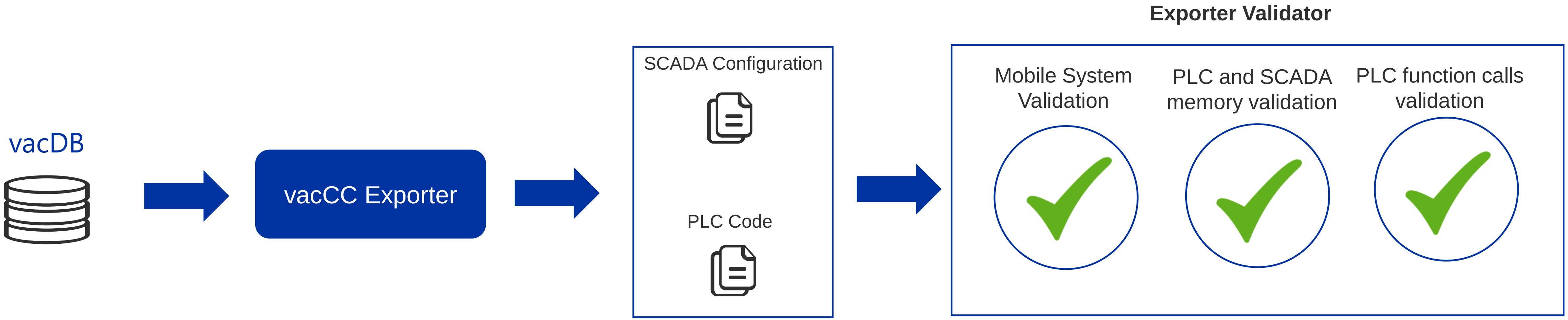
SCADA loading time



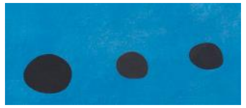
Last LHC upgrade
21st of November

VacCC Exporter Validator

- Tool used **to run multiple parallel tests** to validate files produced during an export, ensuring their accuracy and integrity.
- Current tests include:
  - Legacy or Unified Mobiles System validation
  - PLC and SCADA memory validation
  - PLC function calls validation
- Integrated with vaccumProductionExports Gitlab CI/CD pipelines to automatically validate export files pushed to the repository
- **Adaptable to accommodate additional tests in the future** as the need for further testing arises

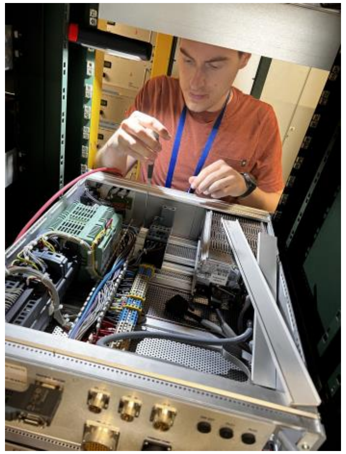


VacCC : Vacuum Controls Configurator

Some pictures 

P2 Agilent consolidation

Agilent’s test procedure



ITL VPG troubleshooting

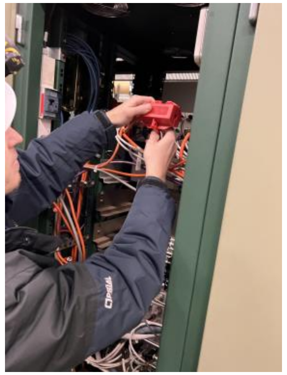
Sector valves consolidation

Test for SVCU crate consumption

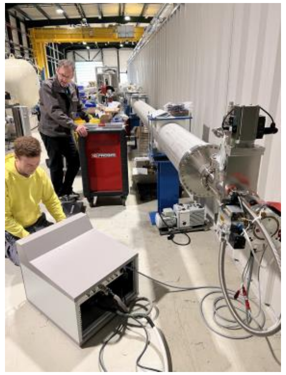
VELO TPG300 troubleshooting

SPS valve troubleshooting

Profibus Support BVO

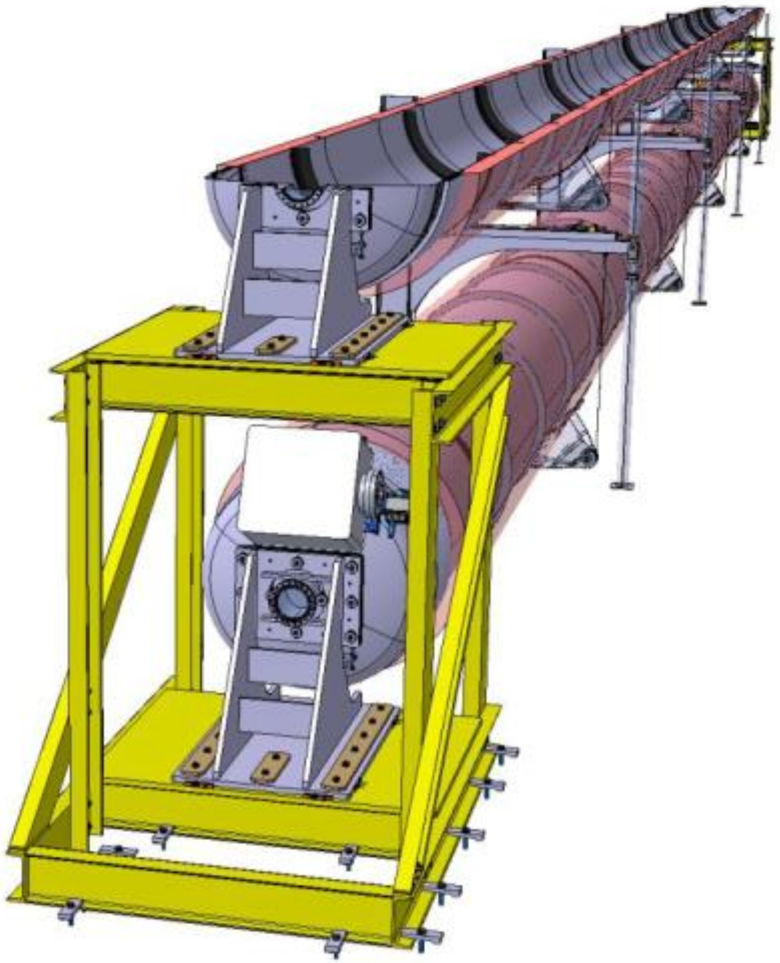


De-cabling lockout



VPG for Beam screen TB

Einstein Telescope's Beampipe



Beampipes for Gravitational Wave Telescopes 2023

Beampipe know-how for GW observatories

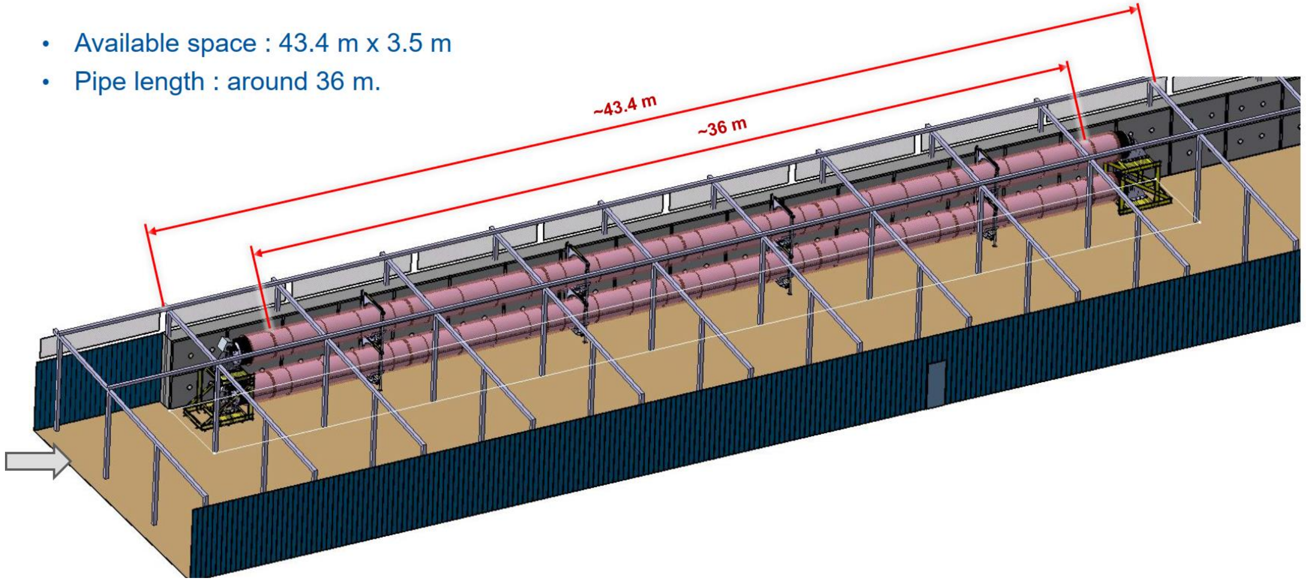
The direct detection of gravitational waves (GWs) in 2015 opened a new window to the universe, allowing researchers to study the cosmos by merging data from multiple sources. There are currently four gravitational wave telescopes (GWTs) in operation: LIGO at two sites in the US, Virgo in Italy, KAGRA in Japan and GEO600 in Germany. Discussions are ongoing to establish an additional site in India. The detection of GWs is based on Michelson laser interferometry with Fabry–Perot cavities, which reveals the expansion and contraction of space at the level of ten-thousandths of the size of an atomic nucleus, i.e. 10^{-19} m. Despite the extremely low strain that needs to be detected, an average of one GW is measured per week of measurement by studying and minimising all possible noise sources, including seismic vibration and residual gas scattering. The latter is reduced

Beam me up *The participants of the March workshop that was dedicated to vacuum technologies for beampipes of next-generation gravitational-wave telescopes.*

solutions were adopted, then the vacuum pipe system would amount to half the estimated cost of the CE and almost one-third of the ET, with underground civil engineering the dominant amount. Reducing the cost of vacuum systems requires the development of different technical approaches with respect to previous-generation facilities. Developing cheaper technologies is also a key subject

vacuum systems provided a starting point for the presentations of ongoing developments. To conduct an effective cost analysis and reduction, the entire process must be taken into account – including raw-material production and treatment, manufacturing, surface treatment, logistics, installation and commissioning in the tunnel. Additionally, the interfaces with the experimental areas and other services

- Available space : 43.4 m x 3.5 m
- Pipe length : around 36 m.



Caravaggio, Bacco adolescente, Galleria degli Uffizi

Merci à vous tous!