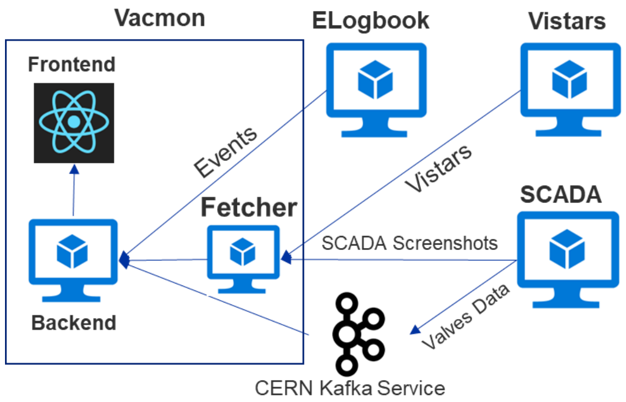
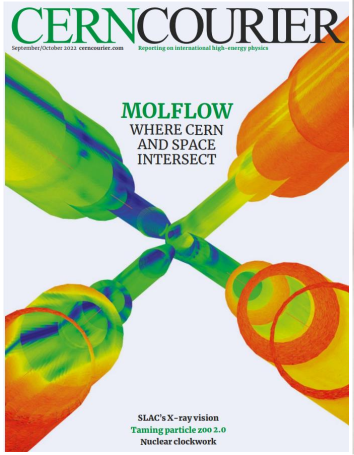
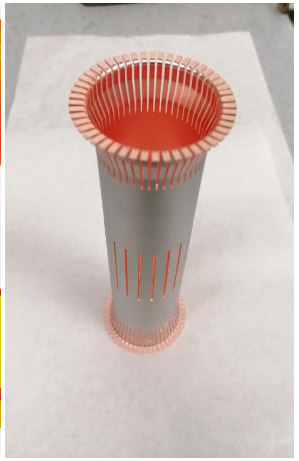
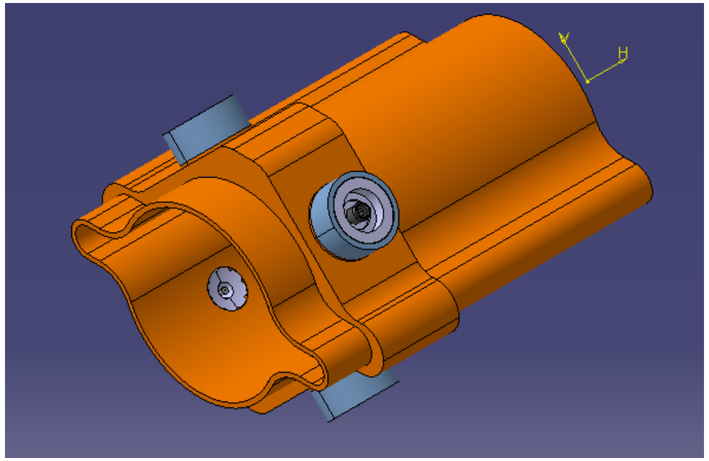
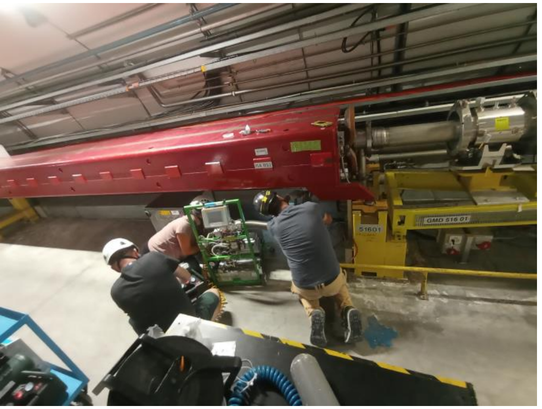
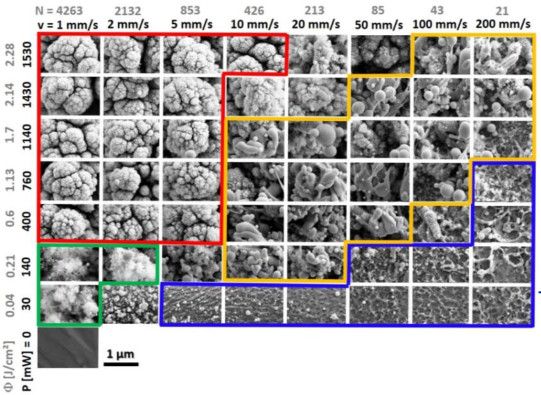


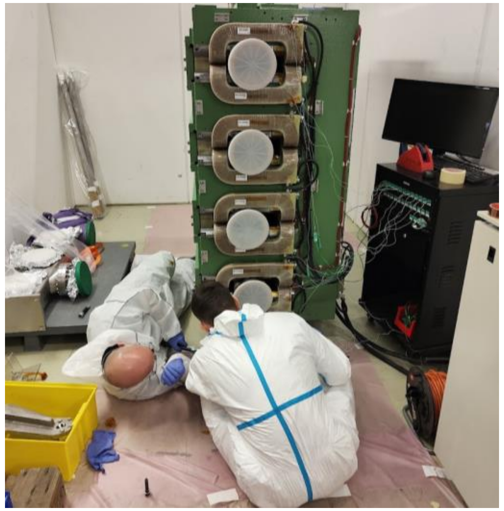


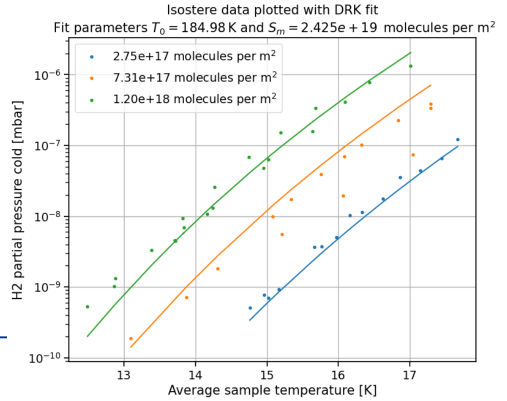










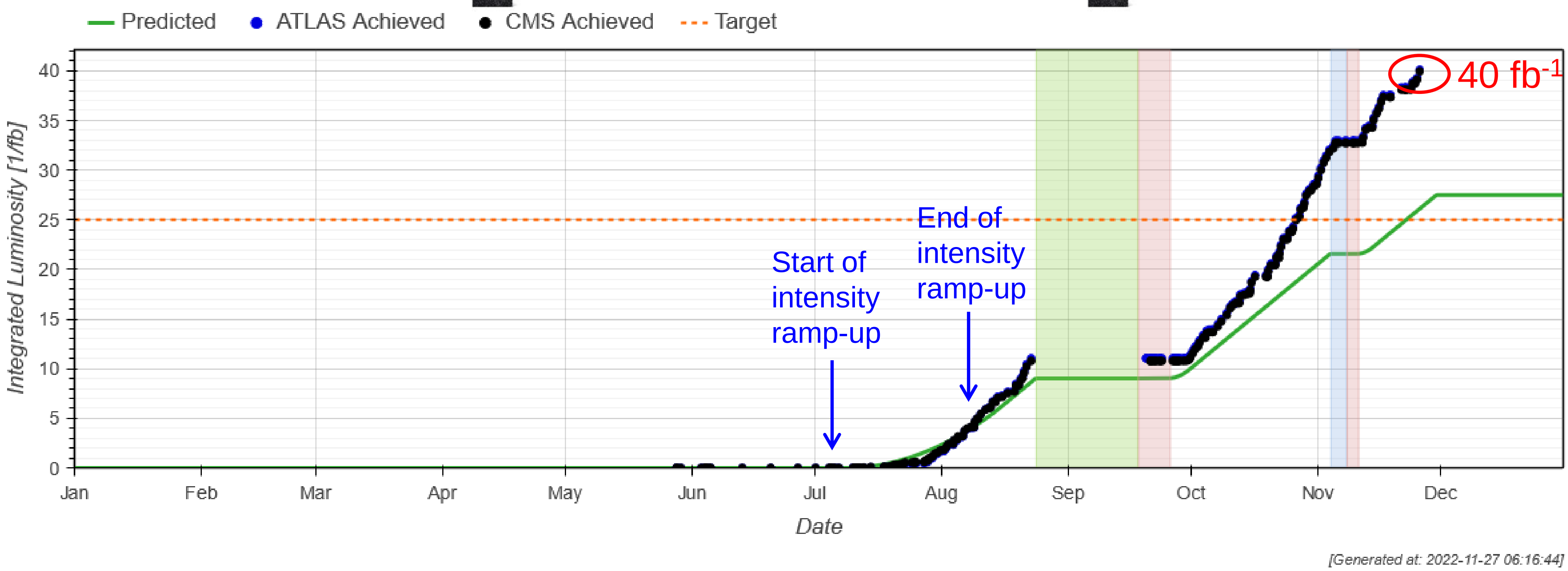


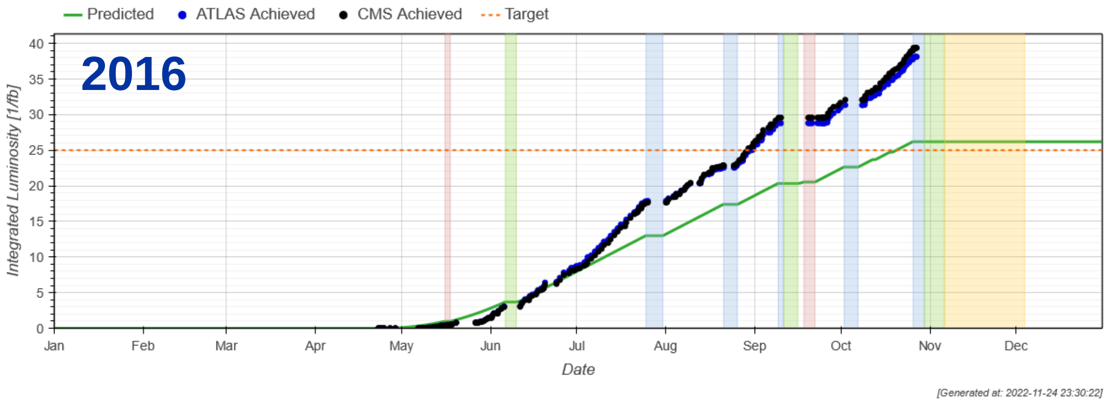
Technology Department

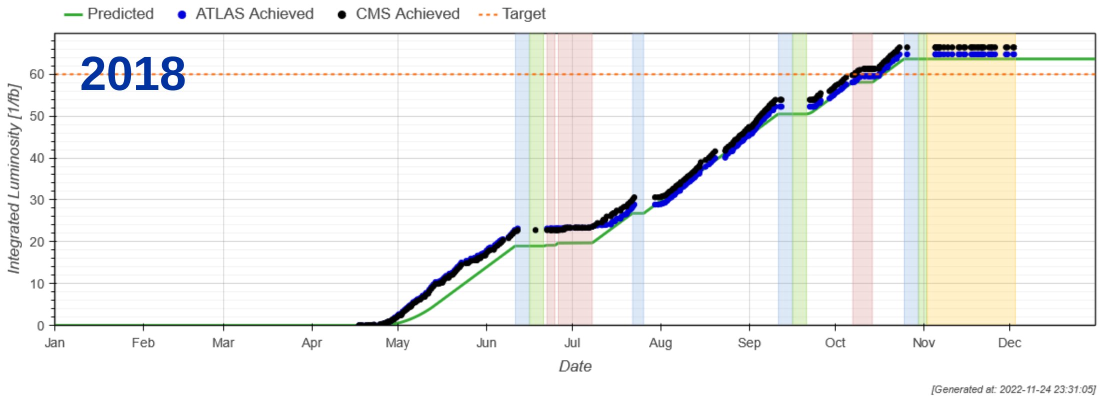
Vacuum, Surfaces and Coatings Group
2022’s General Meeting

Paolo Chiggiato
Group Leader

Outstanding results in 2022

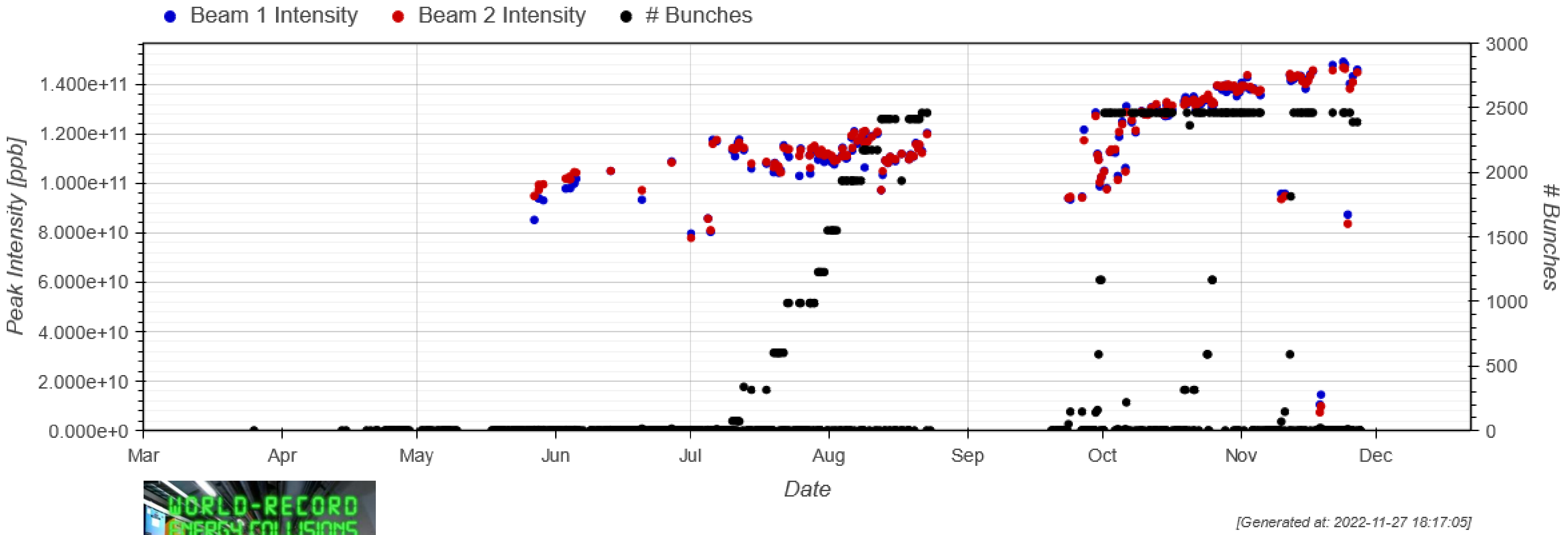






Outstanding results in 2022

Approached **1.5×10^{11} ppb** at start of stable beams. Reached **record stored beam energy** of almost **400 MJ**



Fast switching from proton to ions and ions to protons (two days).

Outstanding results in 2022

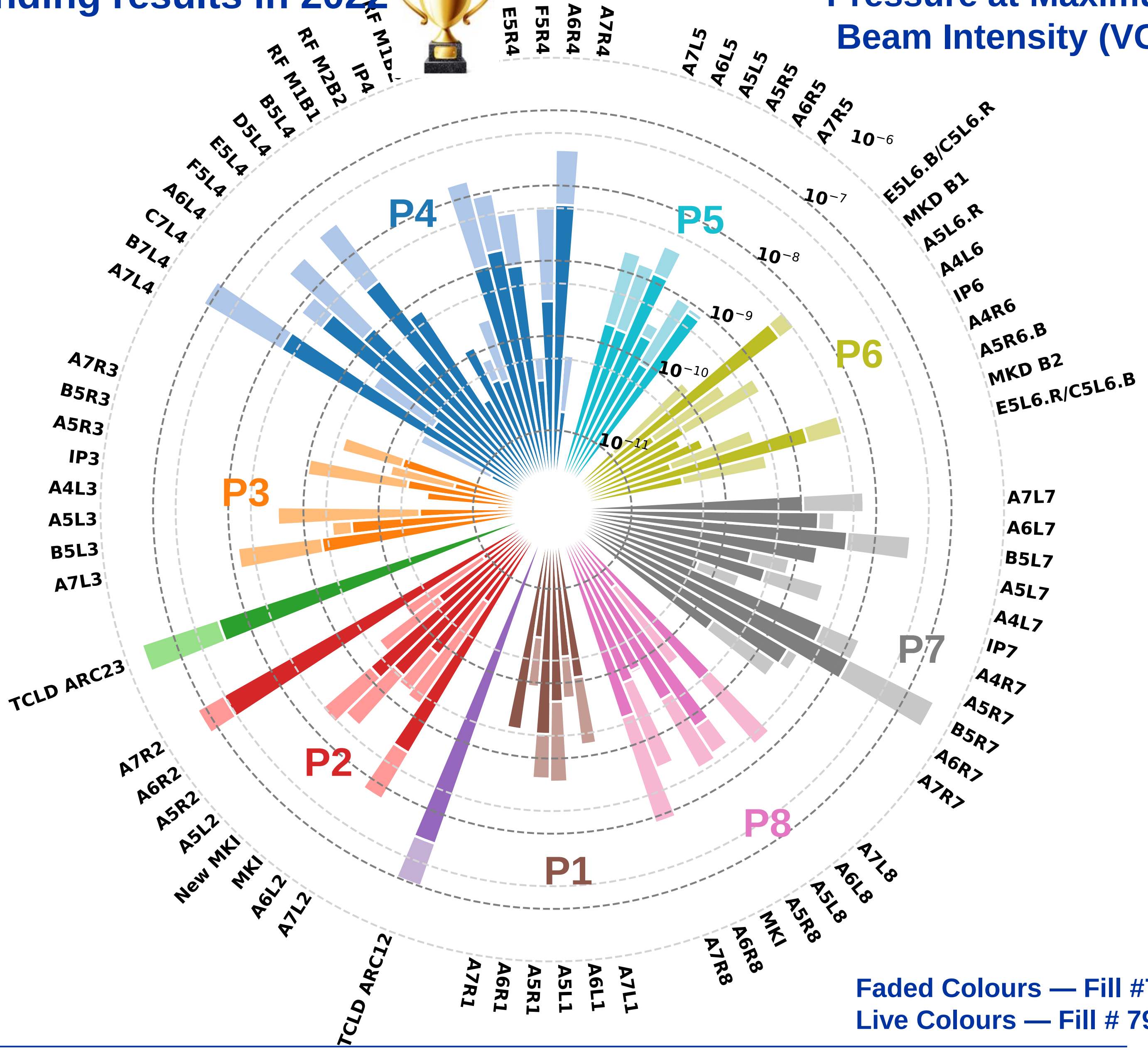
LHC SCRUBBING RUN
Baked Sectors Overview

Conditioning effect visible in all room temperature sectors

Pressure measurements scattered through 3 orders of magnitude:

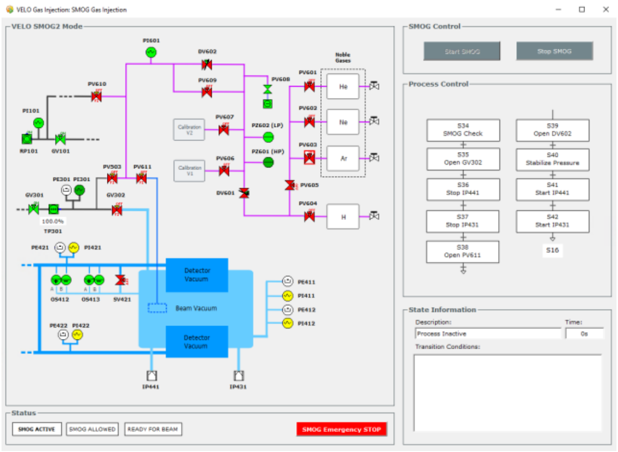
- Vacuum sector history dependence
- Different systems, sector lengths, effective pumping speeds

Pressure at Maximum Beam Intensity (VGI)

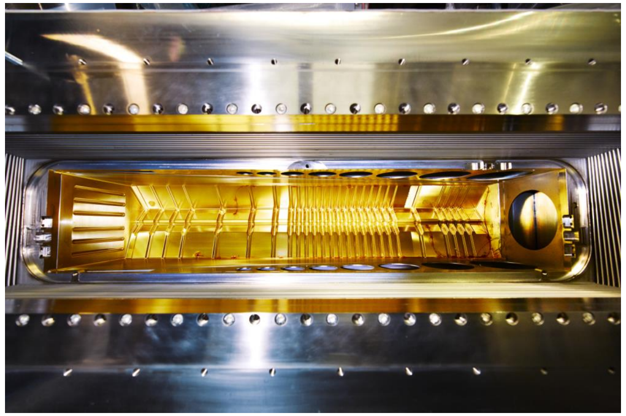


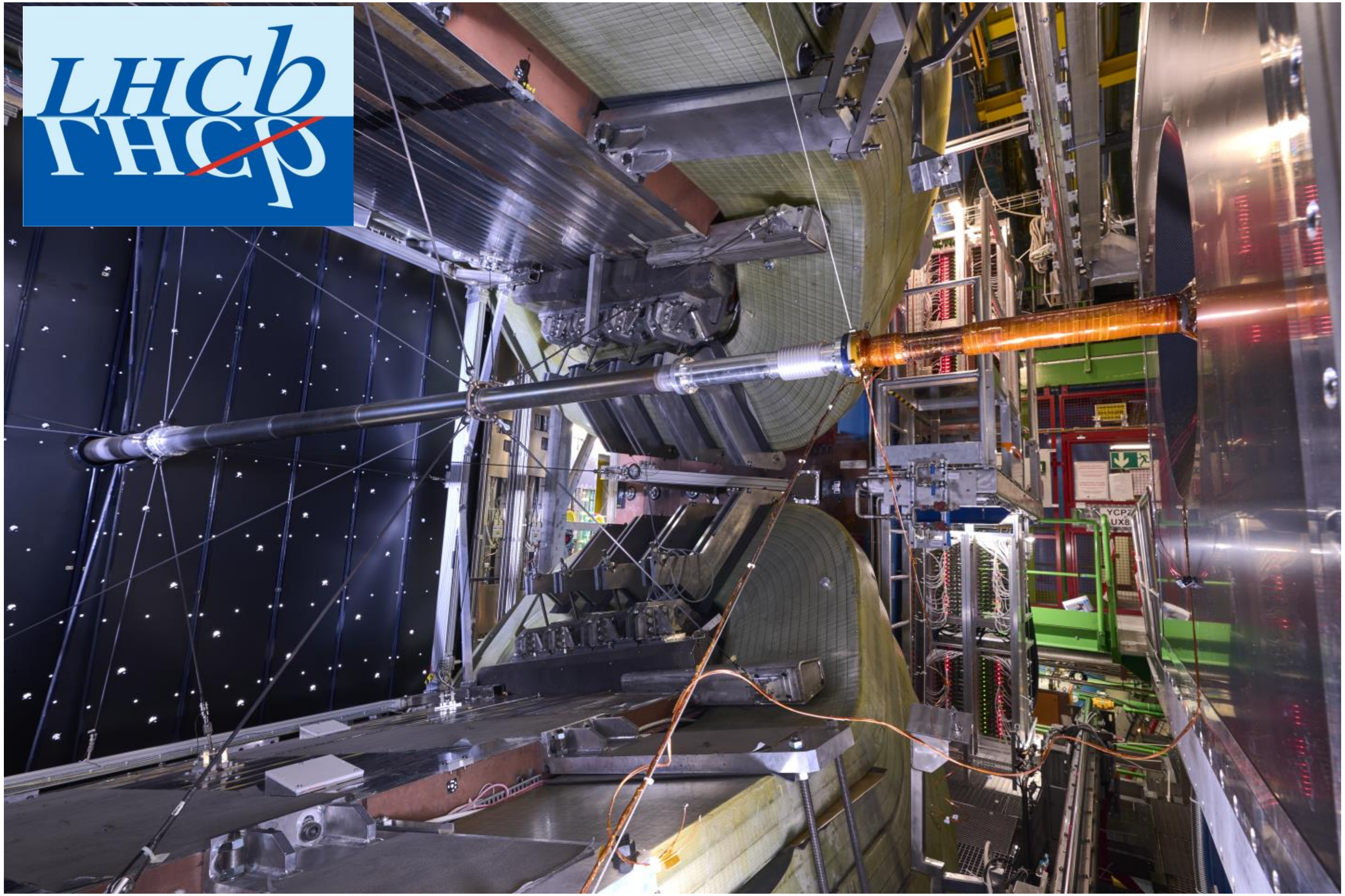
Faded Colours — Fill #779
Live Colours — Fill # 7956

Outstanding results in 2022



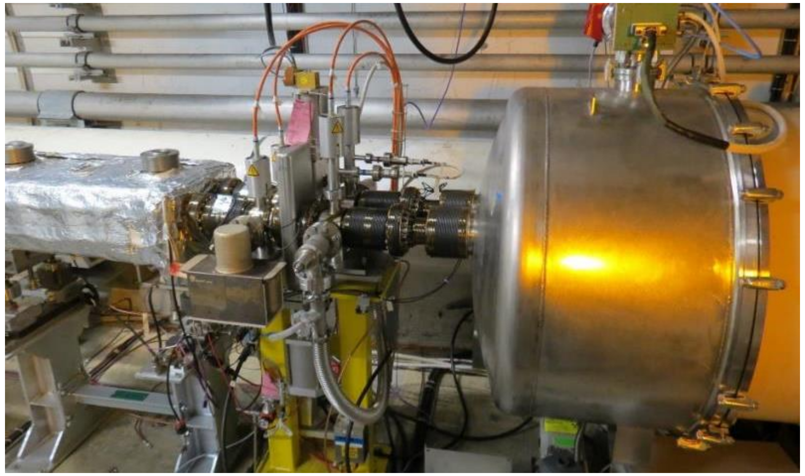
Three TE-VSC sections involved (BVO, ICM, SCC) in the **upgrade of the VELO and SMOG-2**: now perfectly working with beams.





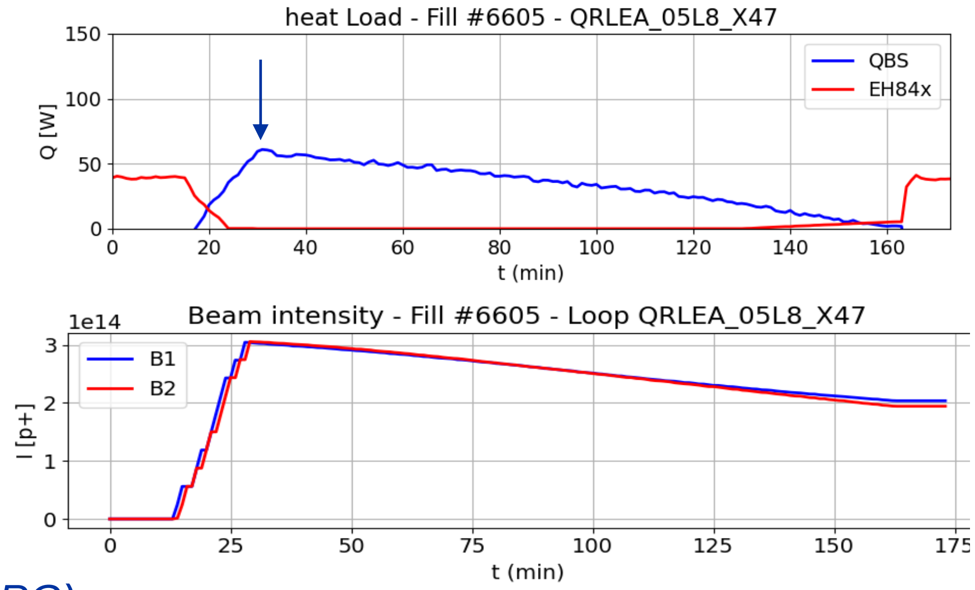
🏆 Outstanding results in 2022 🏆

In-situ **carbon coated** beam screen in **Q5L8** standalone magnet:
no measurable heat load.

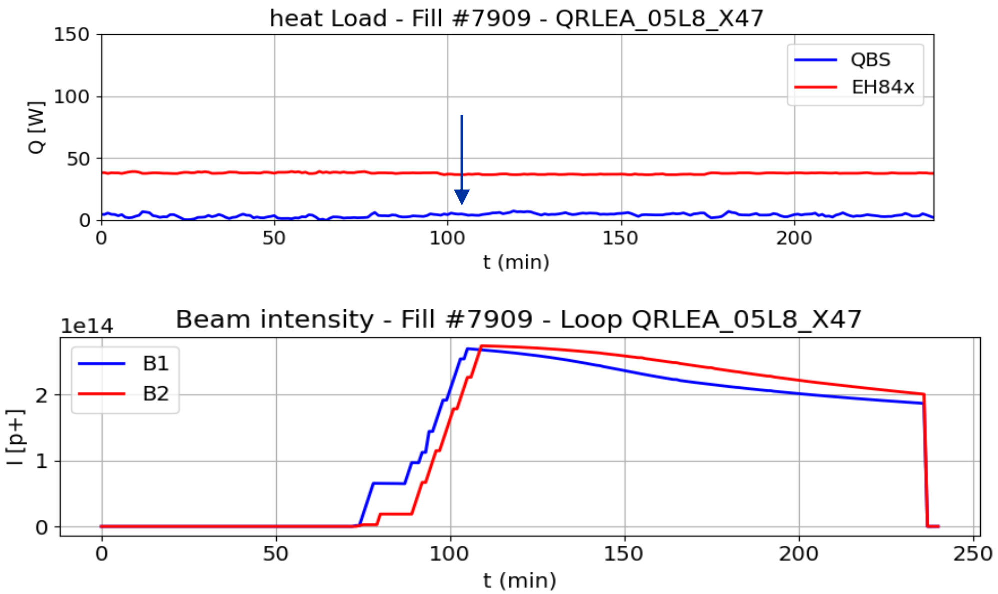


Run 2

Heat load [W]



Run 3



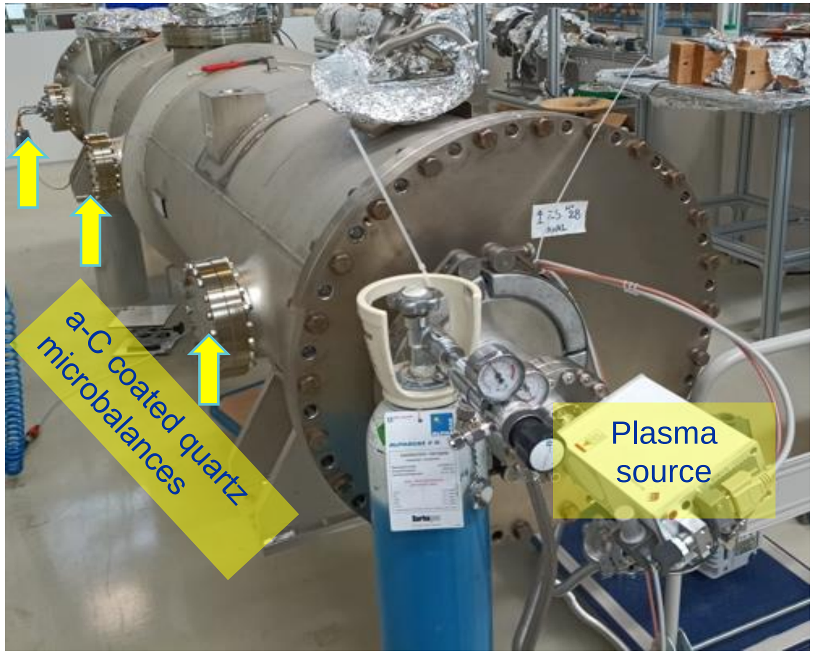
B. Bradu (TE-CRG)

Plasma cleaning of radioactive vacuum equipment

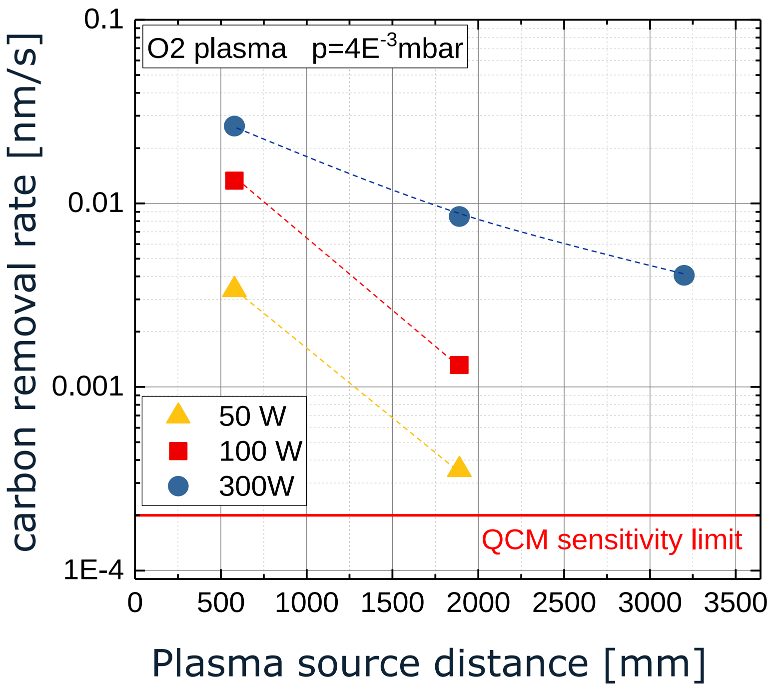
Outstanding results in 2022

Aim: replace a wet degreasing with a plasma cleaning for **activated** parts; avoid liquid retention in complex shapes (avoid complex treatment of activated fluids).

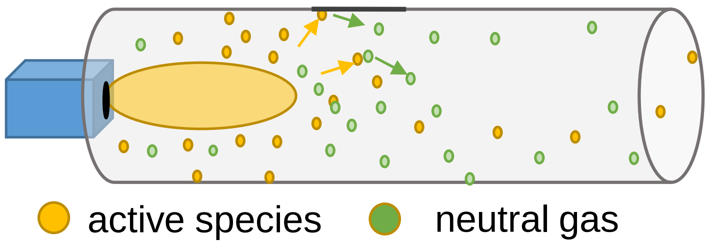
-O_2 plasma to oxidise hydrocarbons to CO_2

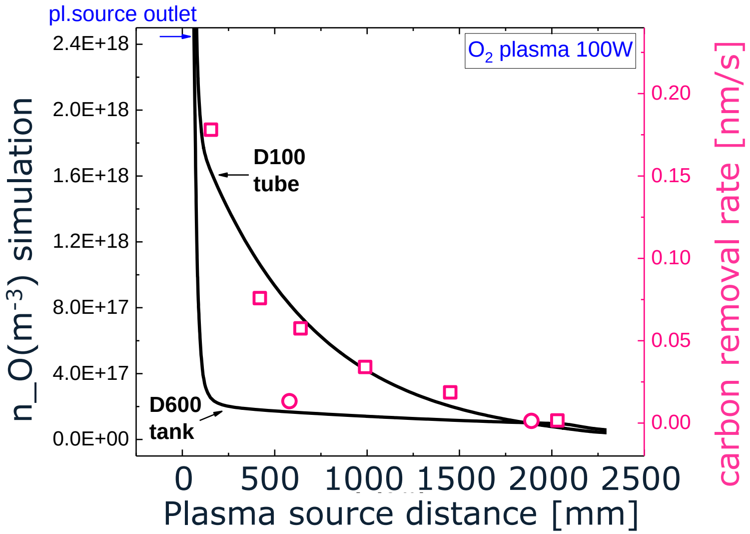


ZS tank D=600mm L=3500mm



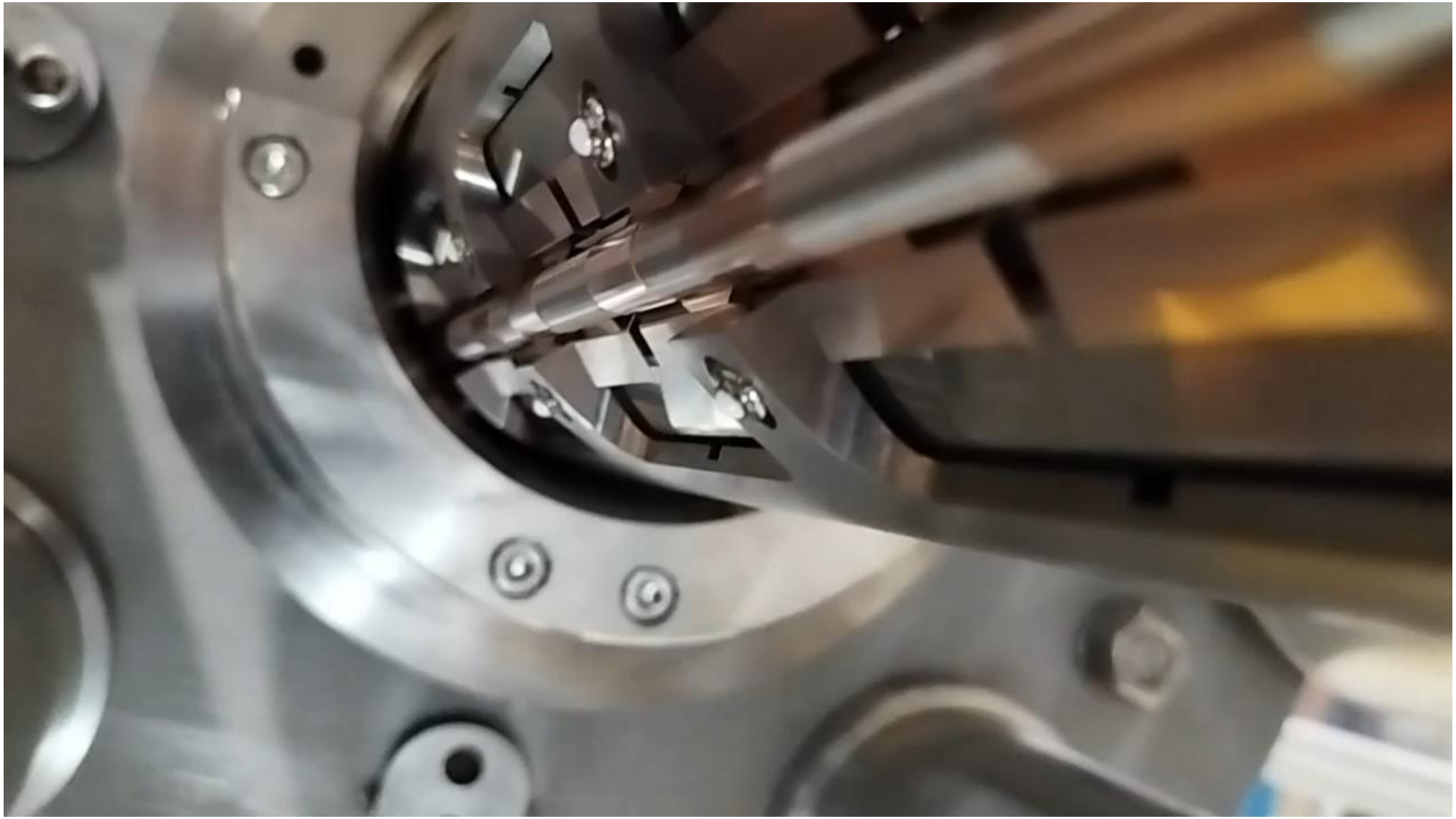
Simulation: plasma species generation, surface and gas collisions, transport of active species





First real PSB tank cleaned successfully

Outstanding results in 2022



A milestone:
HL-LHC beam-screen dummy inserted in a real magnet.

Installation of New Titanium LHC Dump Windows

Outstanding results in 2022

-Double windows design:

- A Ti window in sandwich between 2 C/C disks. (vacuum side).
- A second robust window downstream (vacuum/atm).

- **First use of SMA coupling in accelerators.** Implementation of a DN25 Steel-Titanium joint for LHC dump window

SCADA Performance Study

Outstanding results in 2022

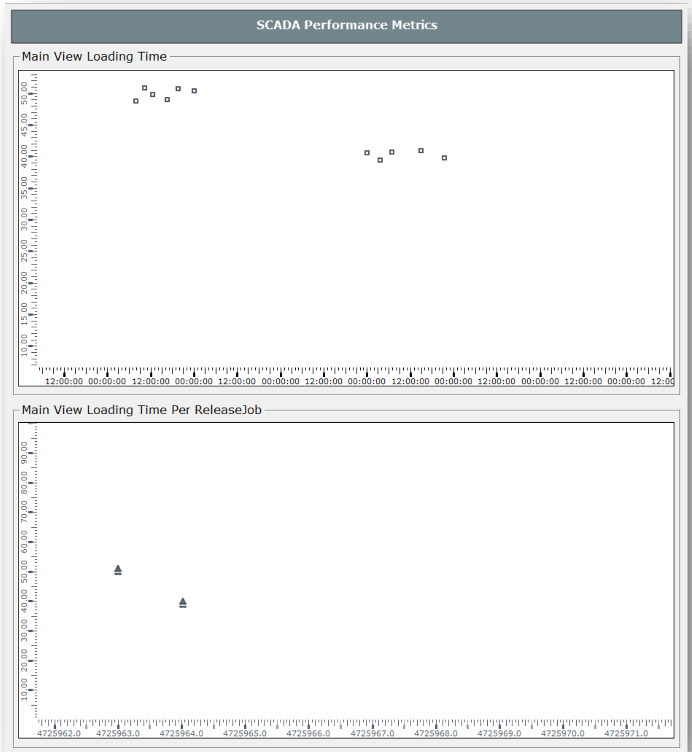
Gather performance metrics of the system

Refactor problematic components

Analysis of the current environment

Identify sources of poor performance

Gather new performance metrics of the system



Performance Measuring Panel

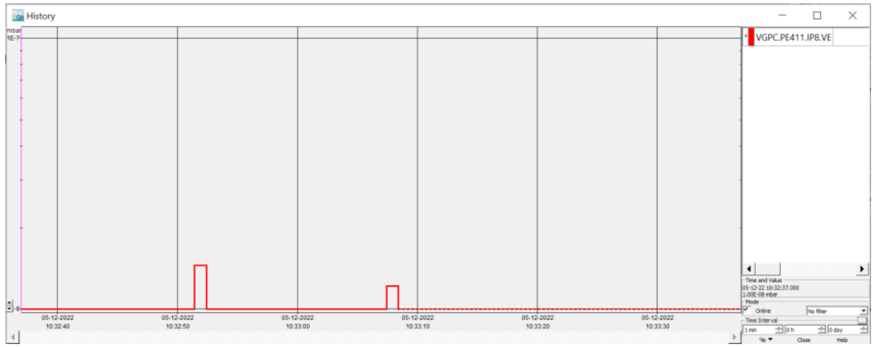
- Several algorithms modified to increase the performance of the vacuum SCADA
- LHC's Main View loading time is expected to improve ± 10 seconds compared to the previous baseline after the LHC SCADA update
- Startup performance will further improve after the deployment of the new Unified Mobile System to about 50% of current time
- New metrics gathering system will allow to monitor the performance evolution on upcoming SCADA releases

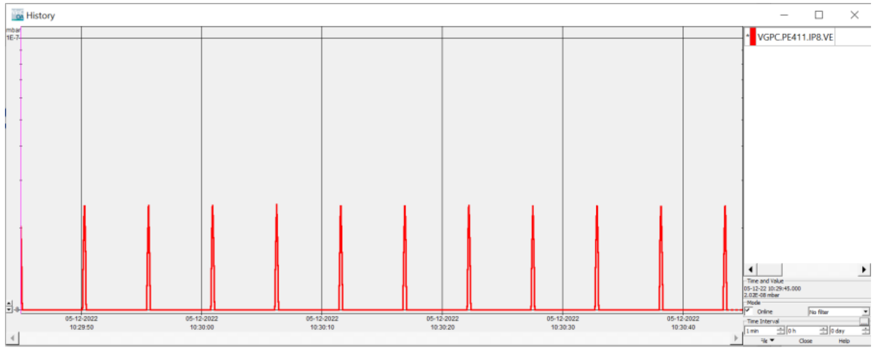
TSPP for Vacuum Framework

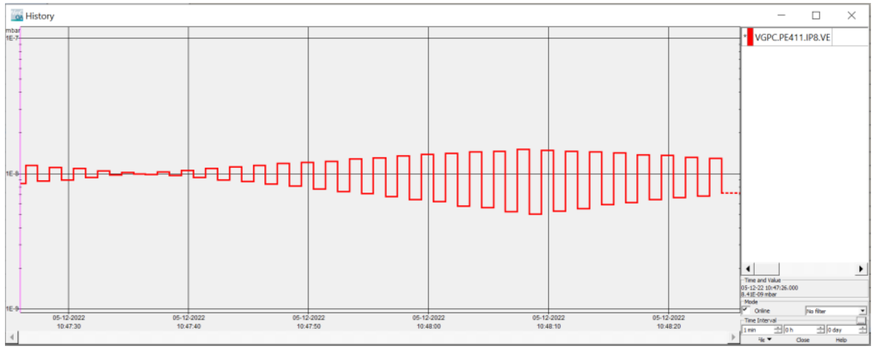
Outstanding results in 2022

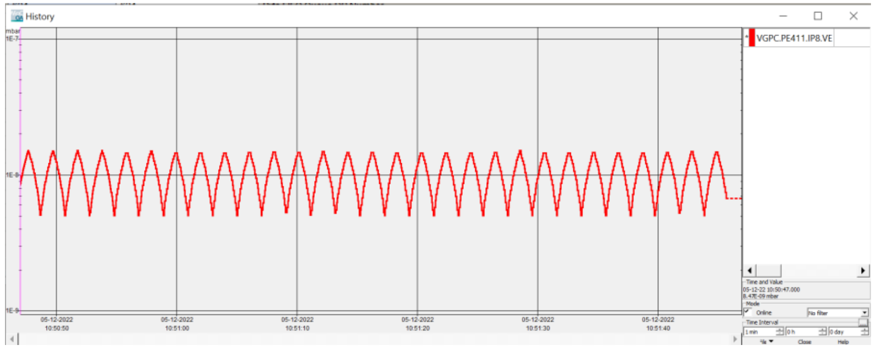
Implementation of TSPP for Vacuum Framework (“UNICOS-style” Data Acquisition)

- **Time Stamped Push Protocol**: vast improvement in Time and Value resolution of acquired data
- No more lost data (pressure spikes, fast interlocks, momentary glitches, etc)
- Start of **deployment during 2023**







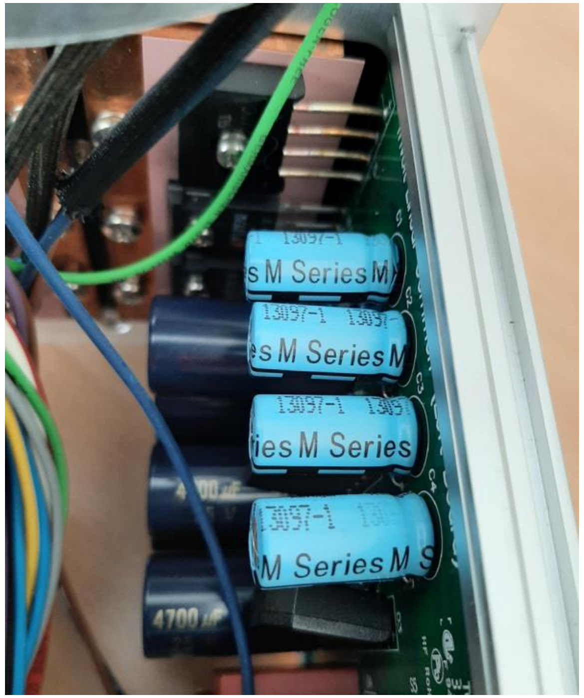


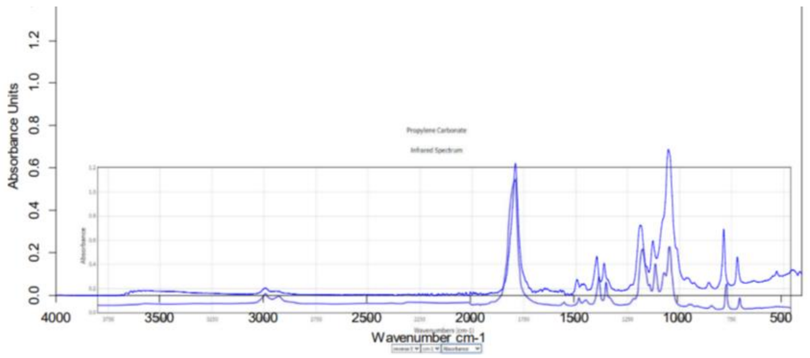
Polling at 1s
Pressure peaks every 5 seconds (**top**), ramp up/down every second (**bottom**)

With TSPP
Same signals, now properly acquired

Outstanding results in 2022

Determination of the problem that caused the failure of four DQLPR001 power supplies: EDMS 2779930





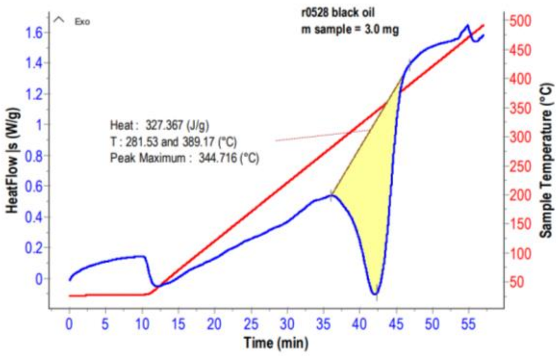


Figure 15. DSC thermogram of the black oily liquid 30—500 °C at 10 °C/min

‘It seems highly probable that the PSU’s failure was caused by the **PowerStor® Aerogel capacitors** damaging their PCBs. It can also be assumed that the **release of the solvent and ammonium salts** was a factor that, together with slightly elevated operating temperature, caused the **decomposition of the PU cable**.’

MolFow+ extension

Outstanding results in 2022

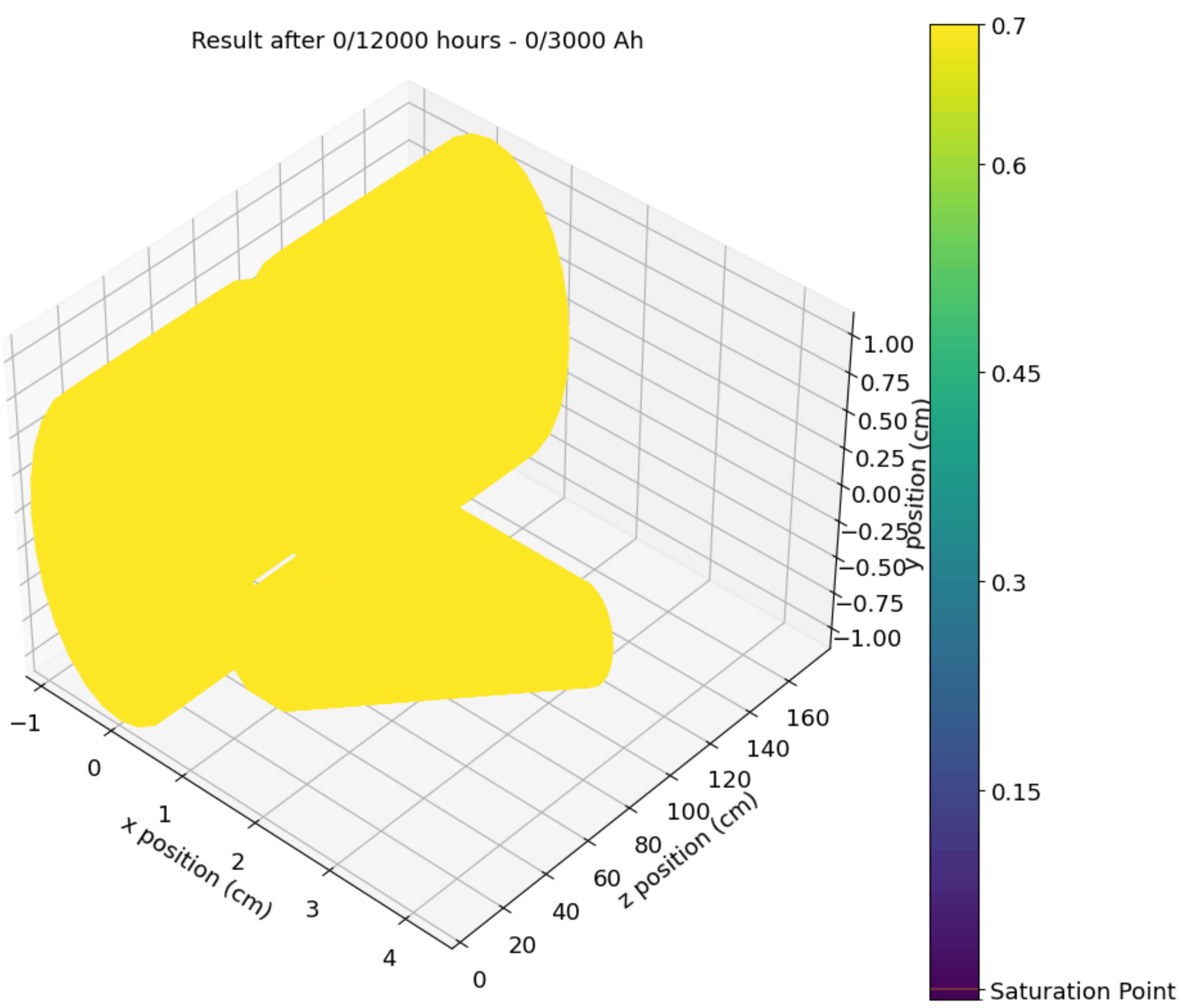
Time dependent simulat pipes

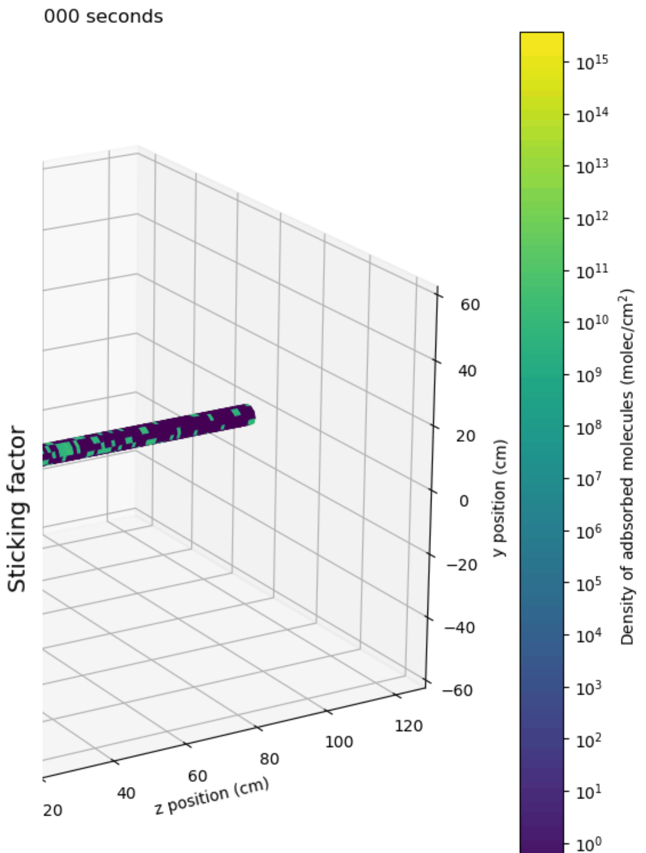
Vacuum chamber conditioni (VacuumCOST)

Python code for iterative Mo resolution.

Allow time-dependent simul conditioning and NEG satur

https://gitlab.cern.ch/phenrik





into NEG-coated tube. density of adsorbed d facets are saturated.

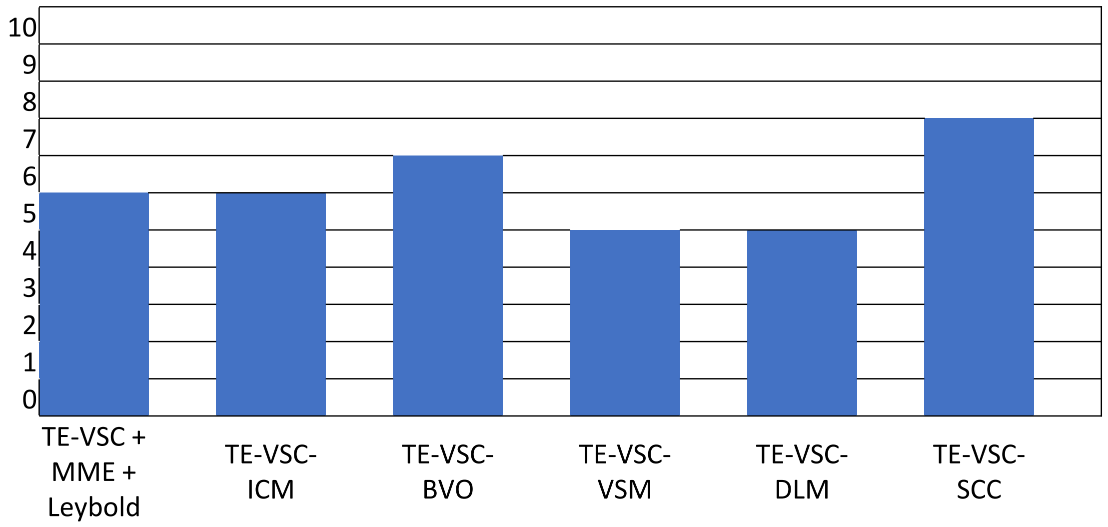
Outstanding results in 2022

TE-VSC Seminars

31 seminar talks in 24 group meeting, including Leybold’s day and two **joint MME-VSC seminars.**

Good collaboration and support from the whole VSC group; excellent way to **share information**.

Number of Seminars during 2022




December 2022

- 15 Dec TE-VSC Plenary NEW
- 13 Dec HL-LHC yearly update
- 06 Dec Gas propagation in cryogenic tubes // New Sector Valve Control Unit

November 2022

- 29 Nov Leybold Users day at CERN
- 23 Nov Joint TE-VSC and EN-MME Seminar on LISA - 23 November 2022
- 15 Nov Production of a-C coatings for new HL-LHC beam screens // Advances on Nb3Sn HiPIMS coatings for SRF cavities
- 09 Nov Joint Seminar TE-VSC and EN-MME on 9 November 2022
- 01 Nov Laser surface treatment setup and development

October 2022

- 25 Oct Scrubbing run results
- 18 Oct Degassing and Ultimate vacuum of gauges // Thin self-supported carbon films
- 04 Oct New Profibus and 4G mobile equipment connectivity (HW & PLC) // New passivation recipes for copper

September 2022

- 20 Sept FCC-ee vacuum chamber development // Renovation of the HPWR control system
- 13 Sept simulations for chemical/electrochemical surface treatments // FCC-ee and hh prototyping

July 2022

- 19 Jul NEG Embrittlement studies // Vacuum vs Polymers

June 2022

TE-VSC and EN-MME main actors in **beampipes for next-generation gravitational waves detectors. Now approved!**

Outstanding results in 2022

ADDENDUM NO. 1
KR5427/TE
TO
FRAMEWORK COLLABORATION AGREEMENT
KN 4657/DG

BETWEEN: THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH ("CERN"), an Intergovernmental Organization having its seat at Geneva, Switzerland,

AND: THE ITALIAN NATIONAL INSTITUTE FOR NUCLEAR PHYSICS ("INFN"), established in Rome, Italy,

AND THE DUTCH NATIONAL INSTITUTE FOR SUBATOMIC PHYSICS ("Nikhef"), established in Amsterdam, The Netherlands,

Hereinafter each individually referred to as a "Party" and collectively as the "Parties",

CONSIDERING THAT:

Framework Collaboration Agreement KN4657/DG (the "Agreement") concluded between the Parties defines the framework applicable to collaboration between them in domains of mutual interest.

Article 2.1 of the Agreement provides that the scope, each Party's contributions, and all other details of each specific project shall be set out in Addendum to the Agreement.

The Parties have identified the collaborative project set out below, which shall be covered by the provisions of this Addendum No. 1 (the "Addendum"),

AGREE AS FOLLOWS:

Article 1
Purpose

1.1 Under the terms of this Addendum, the Parties shall collaborate in the development of the vacuum systems of the arms of the Einstein Telescope ("ET") (the "Project"). The Project is outlined in Annex 1.

1.2 The Parties shall use the results and resources of their collaboration for non-military purposes only. INFN and Nikhef shall ensure compliance with this obligation by the ET Consortium members.

1.3 This Addendum shall be subject to the provisions of the Agreement, it being understood that in case of divergence the provisions of this Addendum shall prevail.

Article 2
Duration of the Project

Subject to the continued validity of the Agreement, the Project shall begin upon signature by the last Party to sign and shall be completed after 36 months.

Done in the English language and signed by the authorized representatives of the Parties.

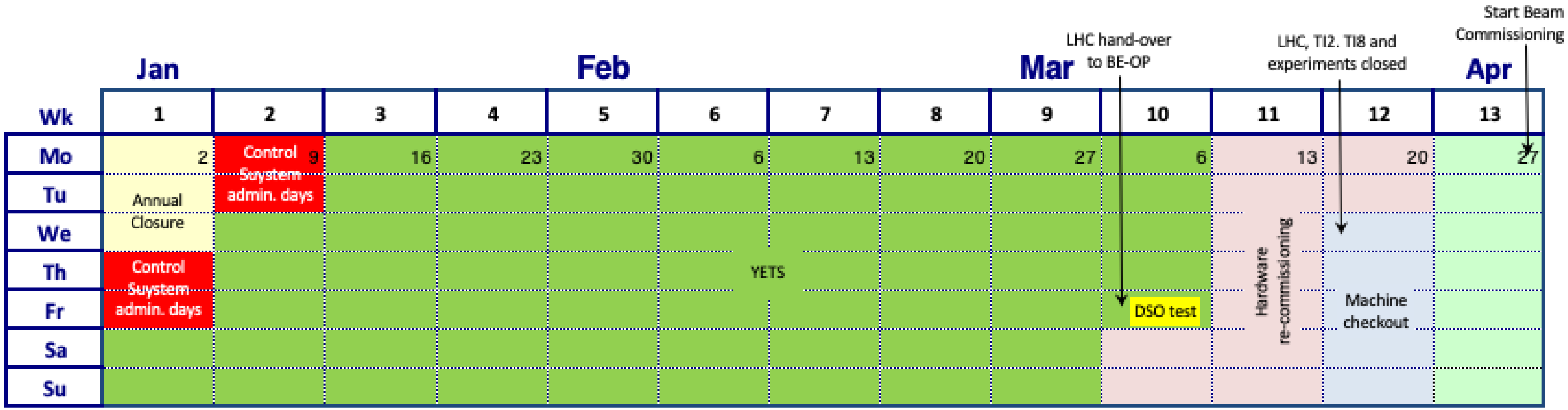
The European Organization for Nuclear Research (CERN)	The European Organization for Nuclear Research (CERN)
Mike Lamont Director for Accelerators and Technology	Jose Miguel Jimenez Head of Technology Department
Signed on 7/7/2022	Signed on 8/7/2022
Christopher Hartley Head of Industry, Procurement and Knowledge Transfer Department	Cristina Lara Deputy Head of Procurement Service
Signed on 11/7/2022	Signed on 9/7/2022
The Dutch National Institute for Subatomic Physics ("Nikhef")	**The Italian National Institute for Nuclear Physics ("INFN")**
Stan Bentvelsen Nikhef Director	Antonio Zoccoli INFN President
Signed on 19/7/2022	Signed on 26/7/2022

LHC operation in 2023

- **2023 Final draft schedule:**
  - *YETS'23-'24: 4 weeks extension and 6 weeks anticipation as a result of the energy crisis*
  - *5 weeks Pb ions run, includes p-p reference run - partial compensation for no Pb ions in 2022*
  - *217 days YETS to YETS:*
    - *Start beam commissioning 27 March 2024*
    - *End of run 30 October 2023*

Rende Steerenberg LMC 30-11

2023 – Q1



Post-YETS’22-23 commissioning as initially foreseen – not impact by change of YETS

Control system administration days in wk1 and wk2

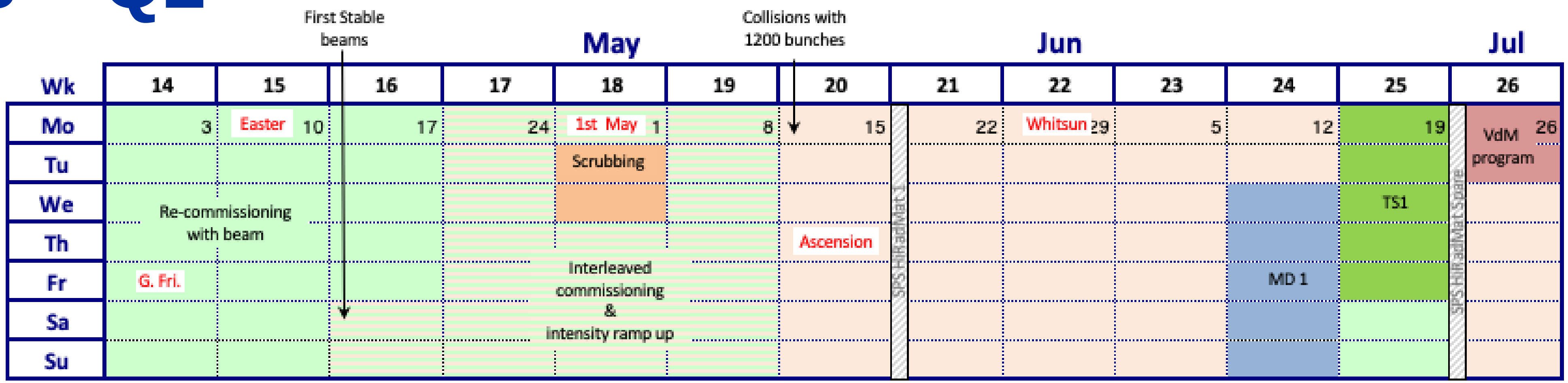
LHC hand-over to OP & DSO test 10 March

Hardware re-commissioning and machine cold check out wk11 and wk12

Beam commissioning starts 27 March

Rende Steerenberg LMC 30-11

2023 – Q2



Beam commissioning & intensity ramp-up wk14 – wk19

- *First stable beams* ***22 April***
- *2 day e-cloud scrubbing run*

Start of physics with 1200 bunches 15 May

SPS HiRadMat#1 added as indication in wk22

MD1 block (5 days) in wk24

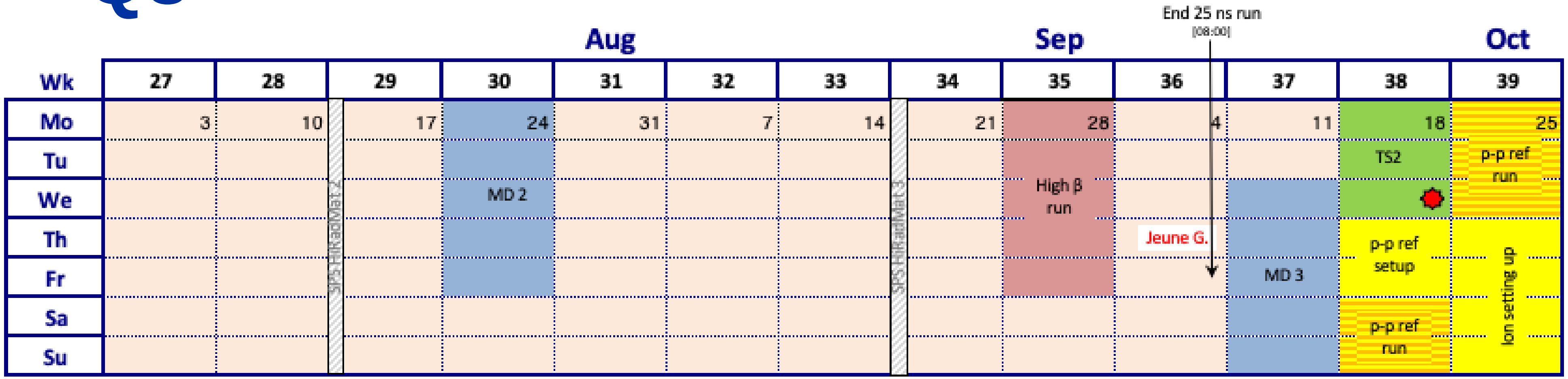
Technical stop & technical stop recovery wk25

Van de Meer run week 26 followed by return to normal p+ physics

- *This week is also a spare week for SPS HiRadMat*

Rende Steerenberg LMC 30-11

2023 – Q3



Good period of hopefully stable p+ running and lumi production

SPS HiRadMat runs added as indication in wk29 and wk34

MD2 block (5 days) in wk30

High beta run in wk35 is a place holder – the actual dates may change depending on the needs

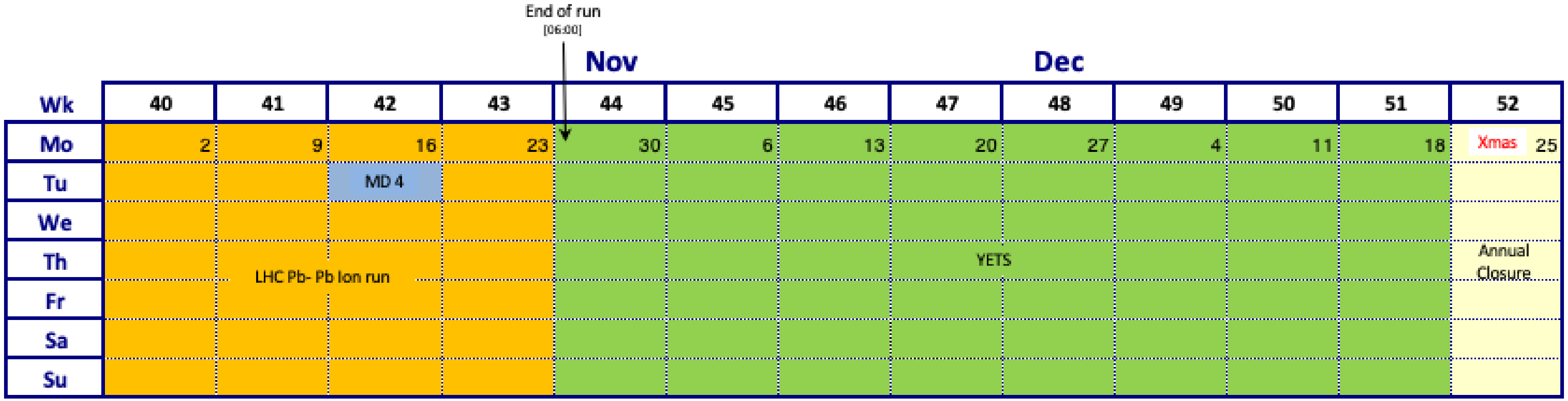
MD3 block (5 days) in wk37

Wk 38 until end of the 2023 run Pb ion run period

- *3-day technical stop for experiment to move in ZDCs – no major activities expected in the LHC machine – quick restart*
- *p-p reference run and its setting-up*
- *Pb ion setting-up*

Rende Steerenberg LMC 30-11

2023 – Q4



Wk40 – Wk43 Pb-Pb ion run

24 hours MD slot on 17 October

End of 2023 run on Monday 30 October @ 06:00

SAFETY

Safety (status on 1st Dec 2022)

11 incidents
reported in TE-VSC (info from **DSO**)

Eyes	Head	Back	Hand	Fall	Driving or bike riding	Electrical	Radioactivity, contamination	Other
	1		2		5	1		2

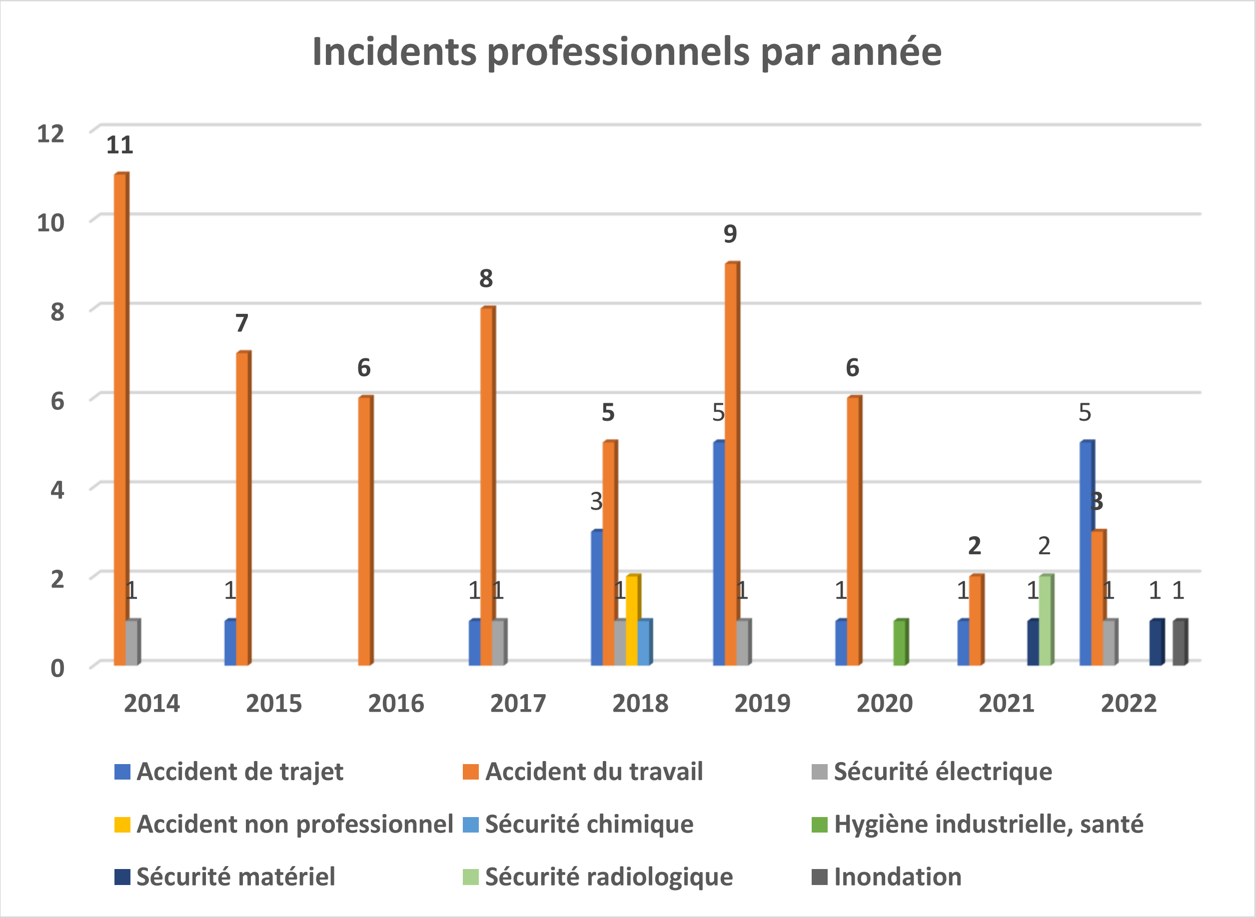
Loss of working days:
0 MPE, **0** for MPA+MPAt, **0** for ENTC

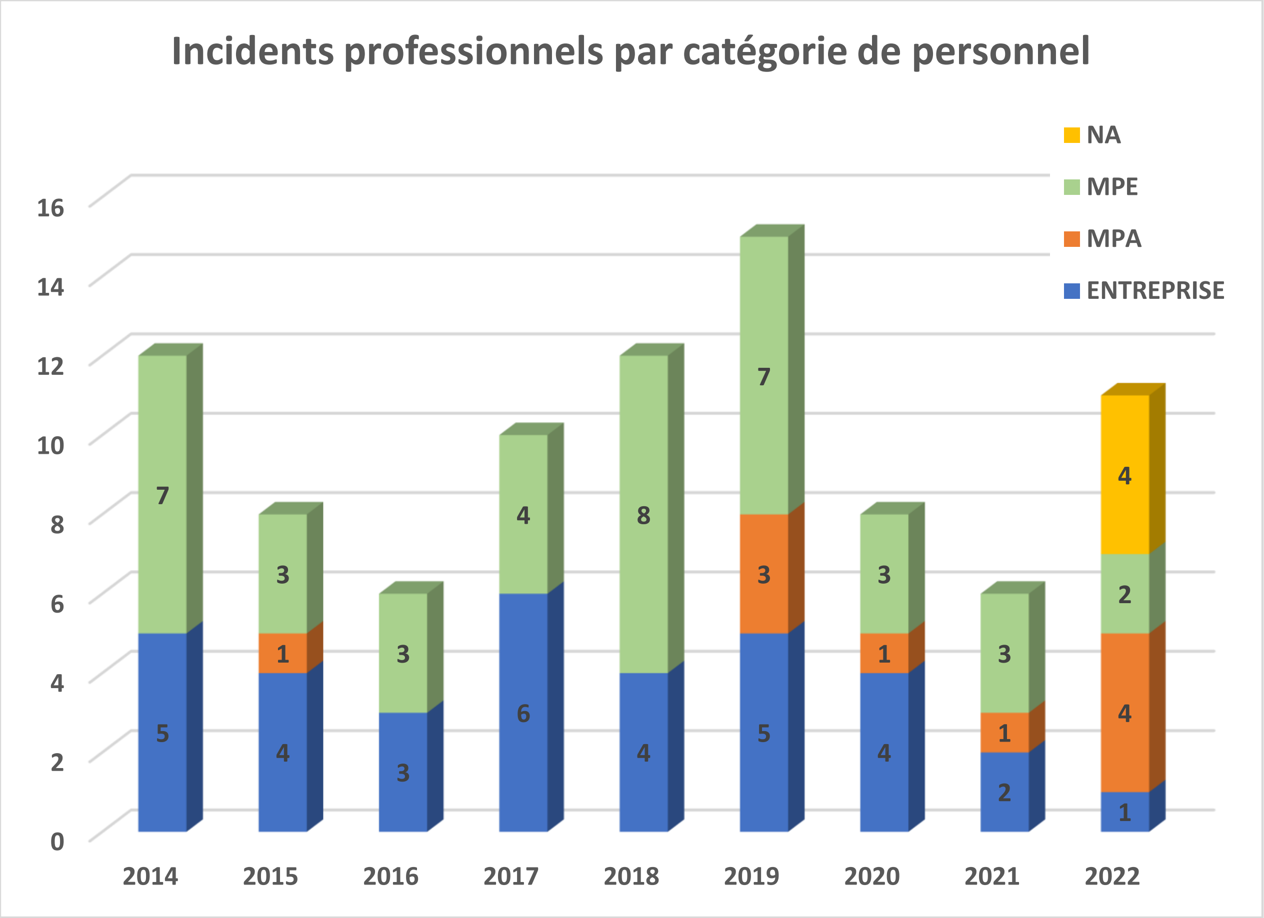
Accident (status on 6th Dec 2022)

Date	Incident de sécurité	Groupe	Statut	Catégorie	Bâtiment	Description	Type d'incident de sécurité	Siège des lésions	Elément matériel	Jours d'arrêt
17 janv. 22	Accident évité de justesse	VSC	Titulaire (STAF)	MPE	3126 (LHC Pt1 - UX15)	Légères décharges ressenties lors de l'installation du beam pipe depuis une petite nacelle une place	Sécurité électrique	Pas de lésions	Electricité	
7 févr. 22	Accident évité de justesse	VSC	Attaché(e) de projet (PJAS)	MPA	Hors CERN	Chute à vélo après avoir perdu l'équilibre lorsqu'une sangle de son sac à dos s'est prise dans les rayons	Sécurité routière	Pas de lésions	Véhicules	
8 févr. 22	Accident évité de justesse	VSC	Attaché(e) de projet (PJAS)	MPA	Hors CERN	Chute à vélo après avoir perdu l'équilibre en heurtant une bordure de trottoir	Sécurité routière	Pas de lésions	Véhicules	
14 févr. 22	Accident				548	Accrochage d'un rétroviseur avec un autre véhicule lors du pasage dans le tunnel	Sécurité routière			
11 avr. 22	Accident évité de justesse				376	Morceaux saillants touchant les mains et les avant-bras de l'opérateur suite à la rupture en plusieurs parties de la protection en plastique sur un tour, en la manipulant après un usinage	Sécurité matériel	Pas de lésions	Machines / Machines-outil fixes	
2 mai 22	Situation dangereuse				814 (SPS, sous BA1)	Etincelles de fumée au niveau d'un cable électrique endommagé recouvert d'eau	Inondation			
16 mai 22	Accident professionnel	VSC	Employé(e) d'entreprise contractante du CERN (ENTC)	ENTREPRISE	3191 (hall SMI2)	Heurt de la tête contre une bride de cryostat en se relevant	Accident du travail	Tête	Heurt au poste de travail, faux-mouvement	0
11 août 22	Accident professionnel	VSC	Attaché(e) de projet (PJAS)	MPA	376	Coupure index main droite avec une pièce métallique tranchante	Accident du travail	Mains	Objets en cours de manipulation/manutention manuelle	0
2 sept. 22	Accident professionnel	VSC	Titulaire (STAF)	MPE	Hors CERN	Douleur à l'épaule et égratignures sur la jambe en chutant au sol après avoir été percuté par un véhiucle alors qu'il était arrêté à un feu rouge avec son scooter	Accident de trajet	Localisations multiples	Véhicules	0
27 sept. 22	Accident évité de justesse	VSC	Etudiant(e) en doctorat (DOCT)	MPA	CERN	Signalement d'un véhicule entrant dans un rond-point sans tenir compte de la présence d'un cycliste	Sécurité routière	Pas de lésions	Véhicules	

info from **DSO**

Evolution of the number of incidents since 2014





Check your training courses

- **lms.cern.ch**

and access right :

- ADaMS (from CERN directory, Applications)

In case of doubts or problems, please contact GL or **Bernard Henrist**, **our Safety Link Person (SLP)**.

Departmental officers (2022)

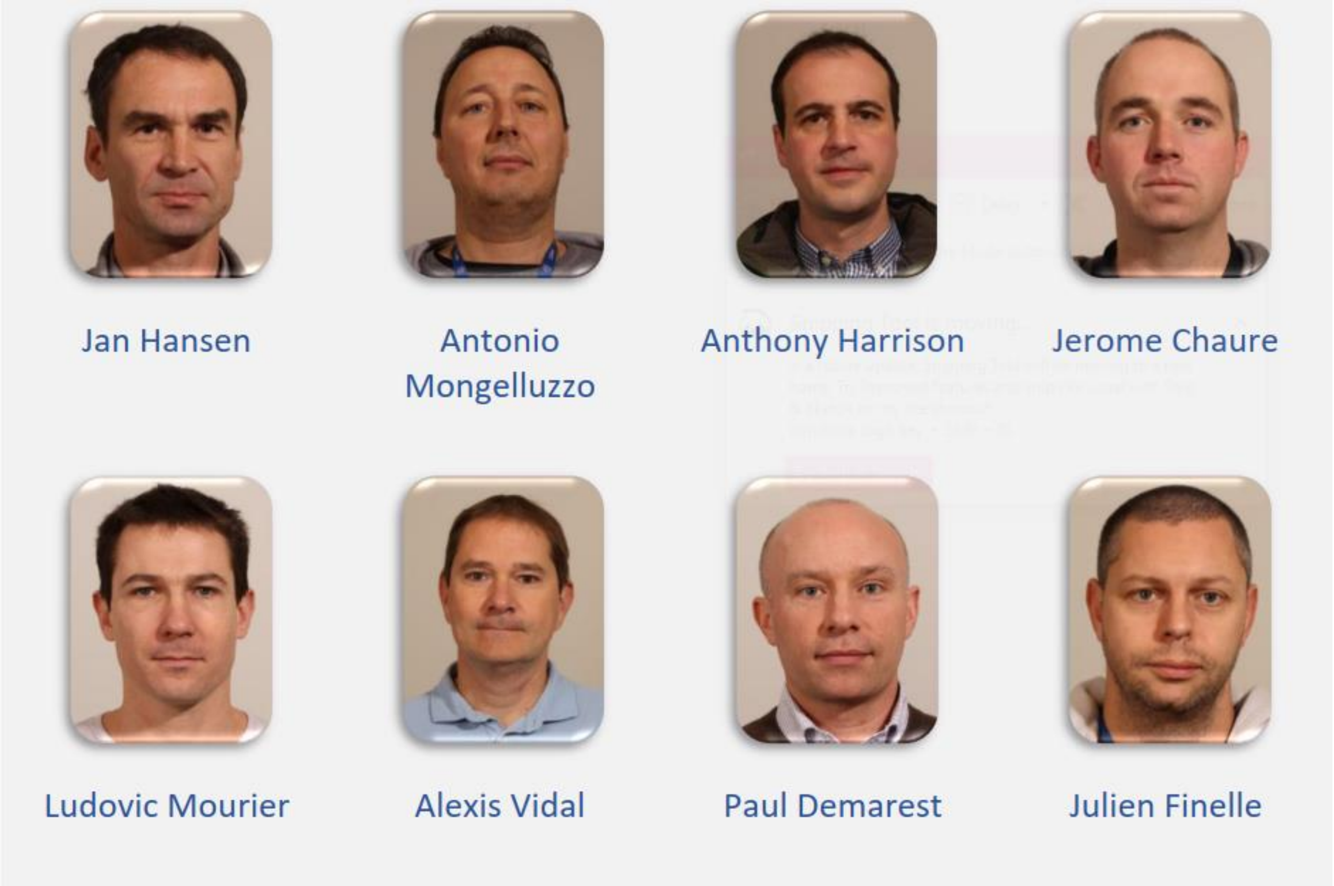
					
Delphine Letant-Delrieux	Alexis Vidal	Olivier Pirotte	David Jaillet (Dept. EN)	Bruce Marsh (Dept. EN)	Leonel M. A. Ferreira
DSO Deputy RSO	Radiation SO Deputy DSO	Cryogenic SO	Flammable Gas SO	Laser SO	A&T sector Chemical SO
162473	164502	164252	167151	162552	163612

Staff members with safety roles

Radiation Safety Support Officer RSSO

GENERAL SAFETY INSTRUCTION GSI-SO-8

RSSO are nominated by the group leader



Staff members with safety roles

Territorial Safety Officer TSO

GENERAL SAFETY INSTRUCTION GSI-SO-2

TSO are nominated by the department head


Alexis Vidal — SMA-18


Serge Forel — 118, 676


Benoit Teissandier — 10-1


Jerome Gilles Chaure — 112, 142


Paul Richard Demarest — 169


Wilhelmus Vollenberg — 101


Jose De La Gama Serrano — 368


Antoinio Mongelluzzo — 375-1, ISR Ring

Deputy Territorial Safety Officer DTSO

GENERAL SAFETY INSTRUCTION GSI-SO-2

DTSO are nominated by the department head

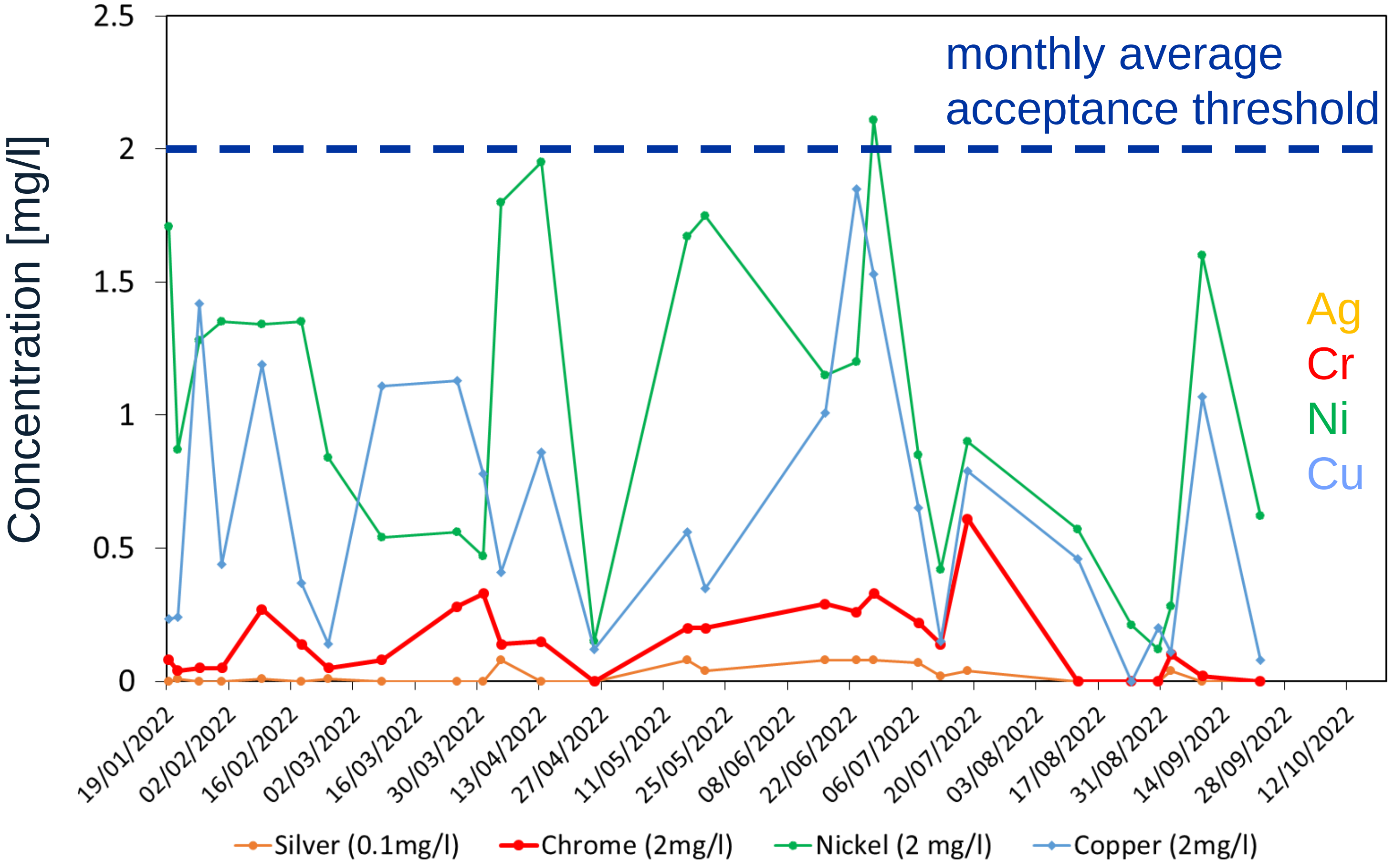

Colette Charvet — 10-1


Bernard Henrist — 142, SMA-18


Benoit Tessandier — 101

Waste-water treatment plant

Regular treatment and monitoring of the released effluent measured by ICP-OES at the Chemistry Lab.



TE-VSC group structure

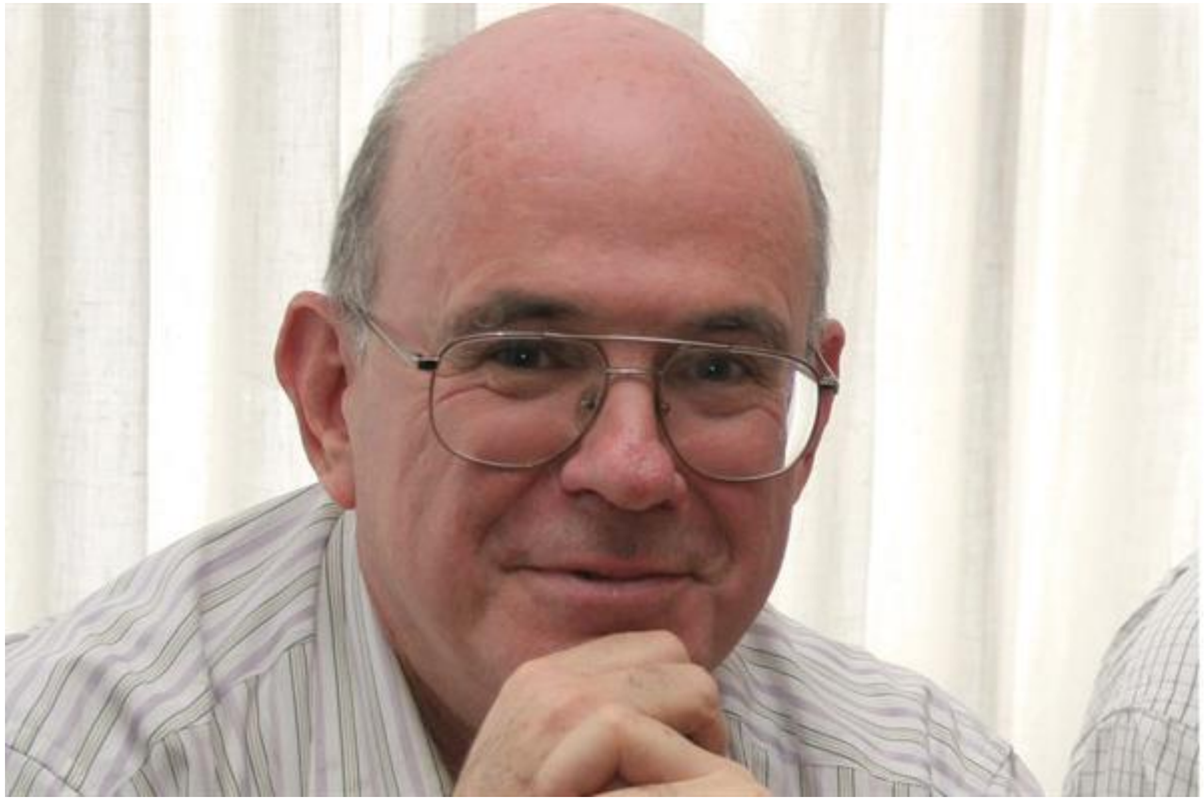
Dec 2022

- Staff: 72
- Fellows: 27
- MPA: 25, including 3 COAS
- ➔ **Total: 124**

Associates for the purpose of international collaboration (MPAc);
Associates for the purpose of exchange of scientists (MPAx);
Associates for the purpose of training (MPAt).

Our director general and new president of CERN Council

Director-General of CERN, **Fabiola Gianotti**

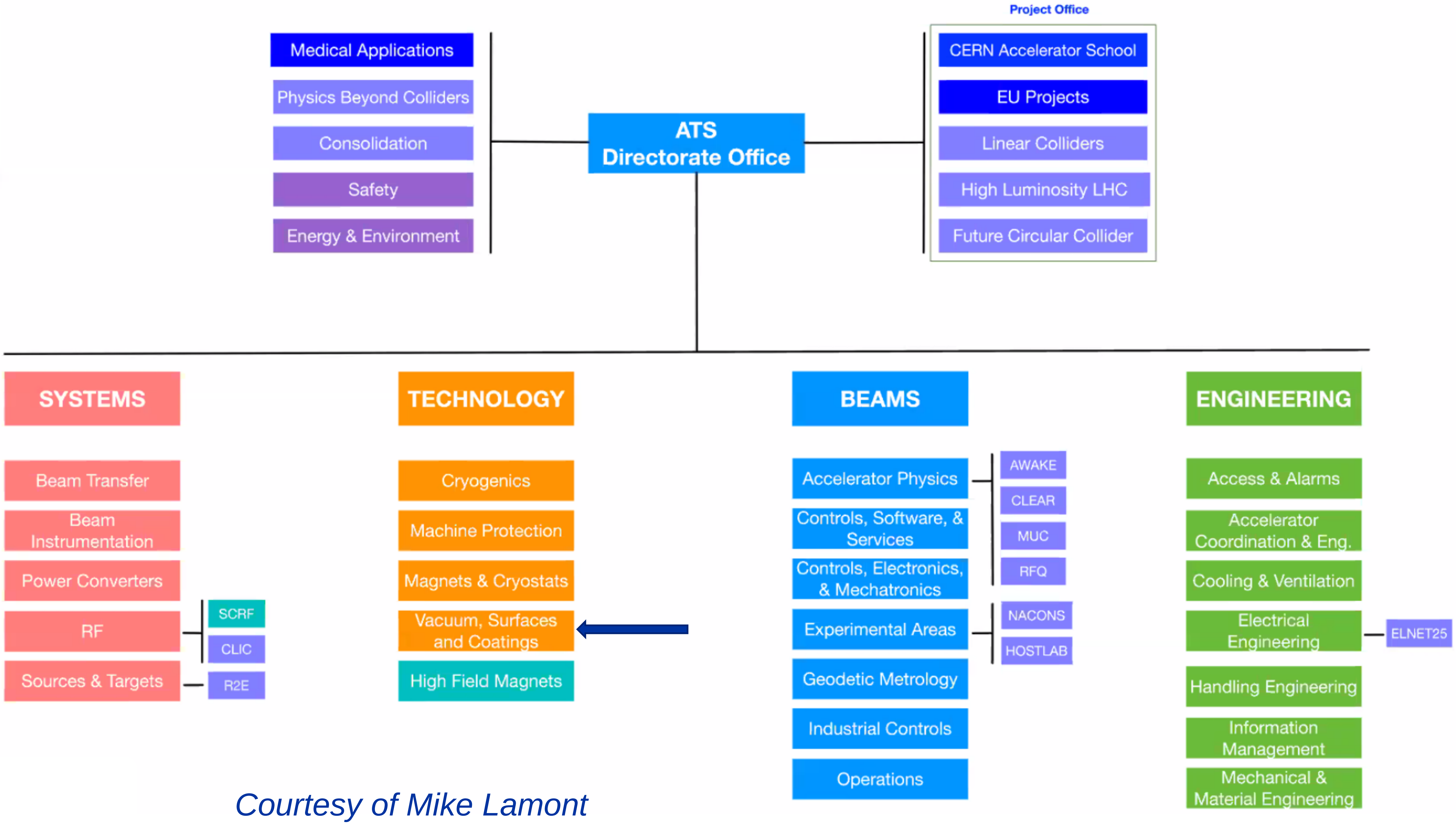


President of the CERN Council, **Eliezer Rabinovici**

Our management

Our A&T director
Mike Lamont

Our TE Department Head
José Miguel Jimenez



Courtesy of Mike Lamont

TE-VSC
Vacuum, Surfaces & Coatings

GL : Paolo CHIGGIATO

DGL : Paul CRUIKSHANK

TE-VSC-BVO
Beam Vacuum Operation

Giuseppe BREGLIOZZI

- Didier CALEGARI
- Gregory CATTENOZ
- Jerome Gilles CHAURE
- Paul Richard DESMAREST
- Jose Antonio FERREIRA SOMOZA
- Julien FINELLE
- Jan HANSEN
- Anthony HARRISON
- Jarmo KORTESMAA
- Guillermo MERINO FERNANDEZ
- Alice Ingrid MICHET
- Karl John OWENS
- Eric PAGE
- Chiara PASQUINO
- Josef SESTAK
- Alexandre SINTUREL
- Nicolas THAUS
- Cesar VAZQUEZ PELAEZ
- Ivo WEVERS
- Nicolas ZELKO
- Alexis BITAUD
- Kristoffer HENNELI
- Rowan Cape HILL-JAMES
- Tomas RASKA
- Orlando SANTOS
- Xavier Michel SAX
- Alessio GALLORO
- Isabel LOPEZ CUEVAS
- Vasco Miguel NASCIMENTO MARTINS
- Tomas PEREIRA NAVE HENRIQUES DA SILVA
- Carlo SCARCIA
- Paulina CZAPKOWICZ
- Panagiota NAZLIDOU

TE-VSC-DLM
Design, Logistic & Methods

Cedric GARION

- Christian DUCLOS
- Nicolaas KOS
- Hendrik KOS
- Willemjan MAAN
- Marco MORRONE
- Jaime PEREZ ESPINOS
- Herve RAMBEAU
- Fabrice SANTANGELO
- Alexis VIDAL
- Ilana HAVLIKOVA
- Marcel KNOCH
- Maria SEREMETI
- Samuel James RORISON
- Fabrizio NICCOLI
- Rita PEREZ MARTINEZ
- Livia Carmen COMAN
- Valentina GIOVINCO
- Frederik RASMUSSEN

TE-VSC-GLO
Group Leader's Office

Paolo CHIGGIATO

- Paul CRUIKSHANK
- Paulo GOMES

TE-VSC-ICM
Interlocks, Controls & Monitoring

Gregory PIGNY

- Benjamin BAYLISS
- Nikolaos CHATZIGEORGIOU
- Jose DE LA GAMA SERRANO
- Rodrigo FERREIRA
- Abel GUTIERREZ
- Iker LOBATO SOLA
- Andre ROCHA
- Lampros ZYGAROPOULOS
- Joao Diogo FRANCISCO REBELO
- Joanna STANISZEWSKA
- Sara GONVALVES SOARES
- Mustafa KHALIL
- Daniil TEPLITSKI

TE-VSC-SCC
Surface, Chemistry & Coatings

Mauro Taborelli

- Colette CHARVET
- Pedro COSTA PINTO
- Yorick Maxence DELAUP
- Florent FESQUET
- Spyridon FIOTAKIS
- Serge FOREL
- Paul GARRITTY
- Bernard HENRIST
- Marcel HIMMERLICH
- Leonel MARQUES ANTUNES FERREIRA
- Pierre MAURIN
- Antonio MONGELLUZZO
- Ludovic MOURIER
- Holger NEUPERT
- Valentine PETIT
- Guillaume Jonathan ROSAZ
- Alban SUBLET
- Benoit TEISSANDIER
- Daria TERNOVA
- Marc THIEBERT
- Louise VIEZZI
- Wilhelmus VOLLENBERG
- Tom David AGULHON
- Stewart LEITH
- Stefano SAROGLIA
- Matthew WATKINS
- Fabian MANKE
- Martino RIMOLDI
- Maria Carmen GIORDANO
- Amroise GUILLARD
- Ana Karen REASCOS PORTILLA
- Carolina AMOEDO
- Gloria BELLINI
- Elena Annelie BEZ
- Carlota PEREIRA CARLOS
- Nicolas SOUCHET
- Eva STRANELOVA

TE-VSC-VSM
Vacuum Studies & Measurements

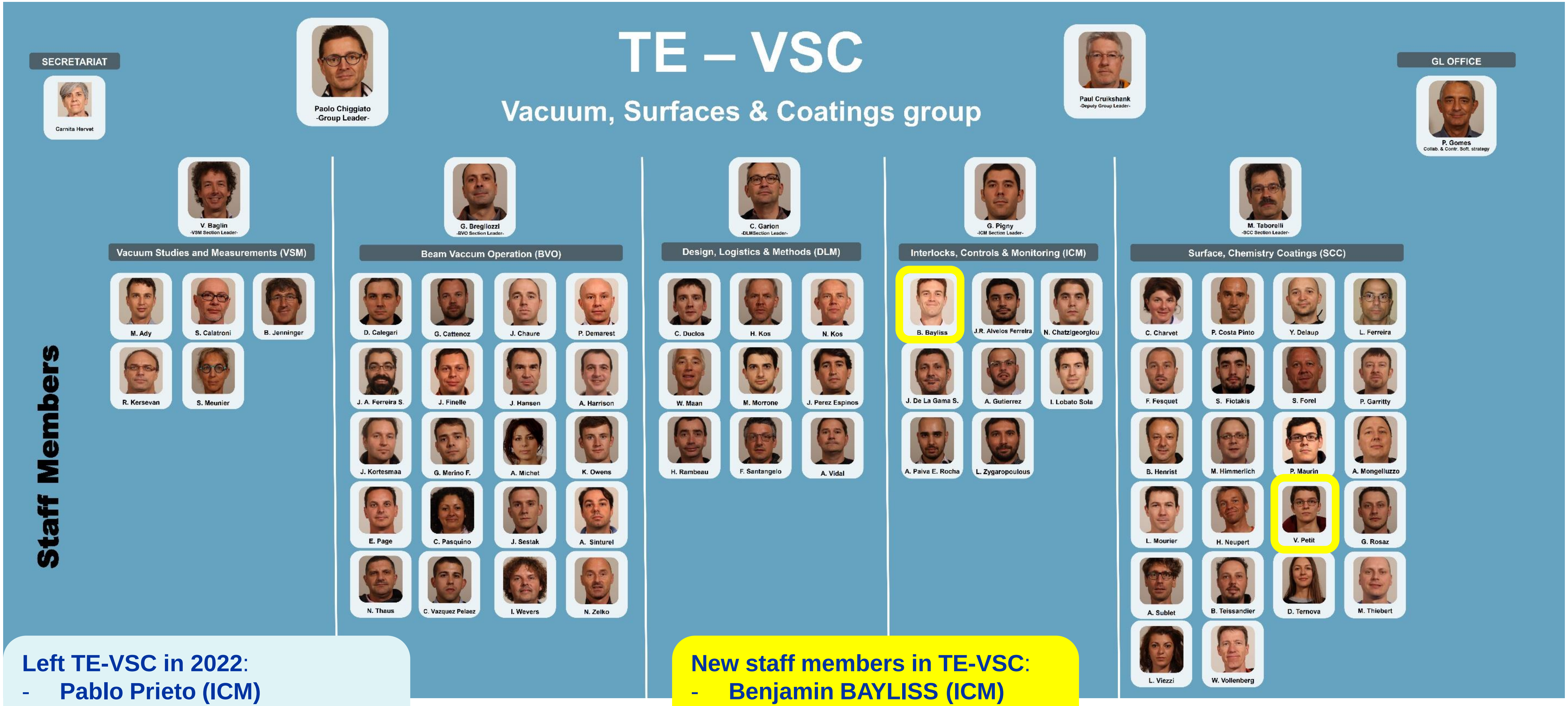
Vincent BAGLIN

- Marton ADY
- Sergio CALATRONI
- Berthold JENNINGER
- Roberto KERSEVAN
- Sophie MEUNIER
- Eino Johannes TIIRINEN
- Patrick KRKOTIC
- Anke STOELTZEL
- Joana REPOLHO CORREIA
- James David HOOPER
- Cristina CASTRO SEQUEIRO
- Peter Lindquist HENRIKSEN
- Quentin DUONG
- Catarina SERAFIM

Key:
- **Staff Member**
- **Fellow**
- **Associate**
- **Temporary Labour**
- **Student**

CERN

72 Staff members

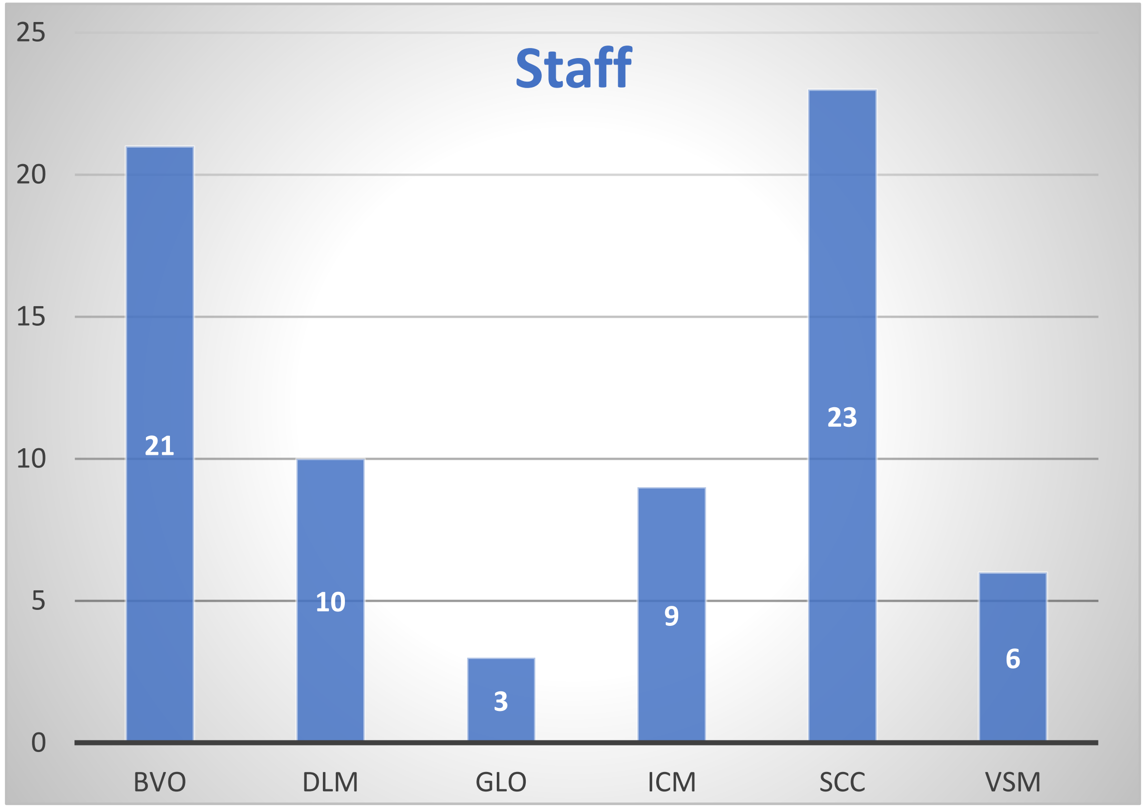


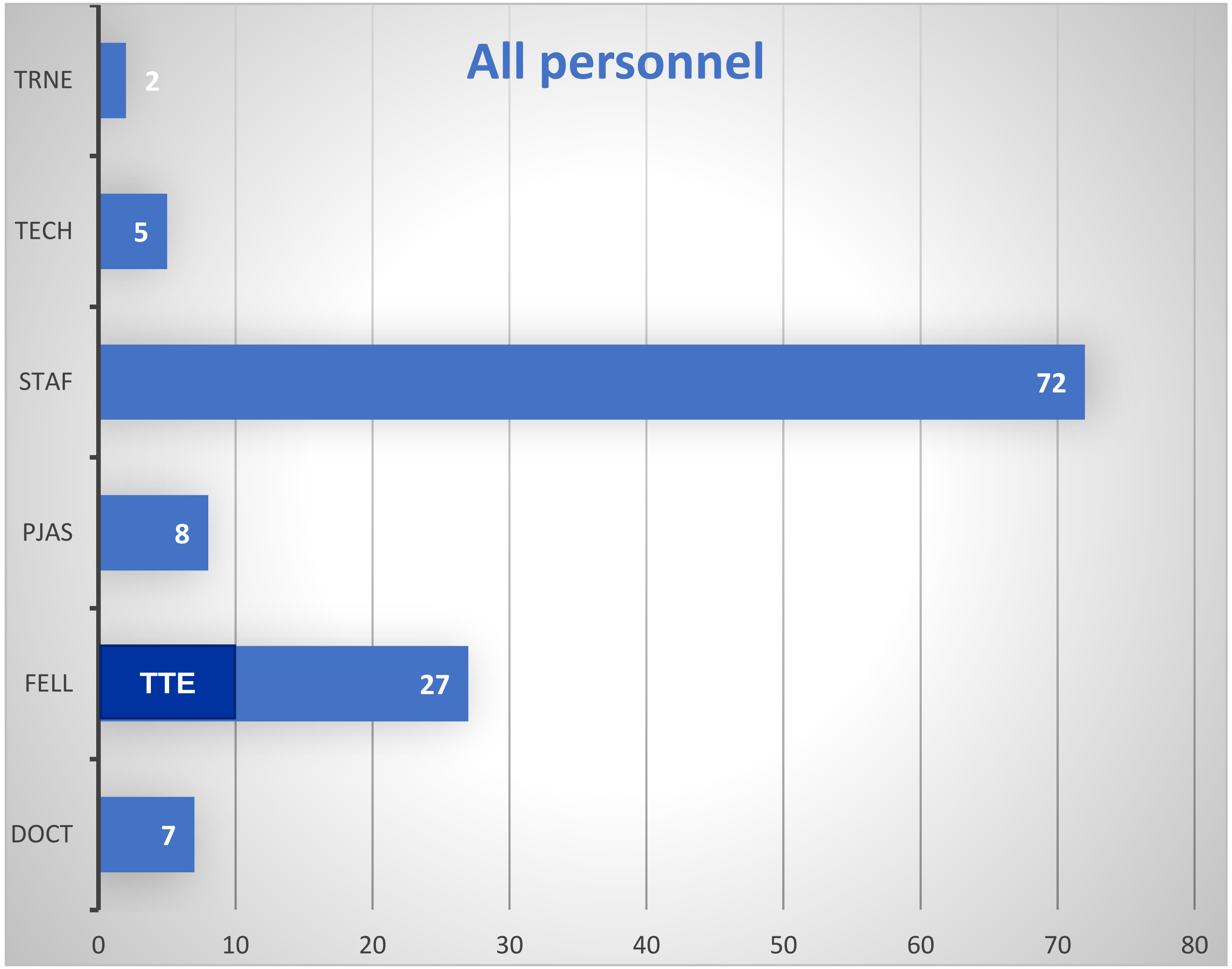
Left TE-VSC in 2022:
- Pablo Prieto (ICM)
- Patrick Lepeule (BVO)
- Claude Collomb Patton (BVO)

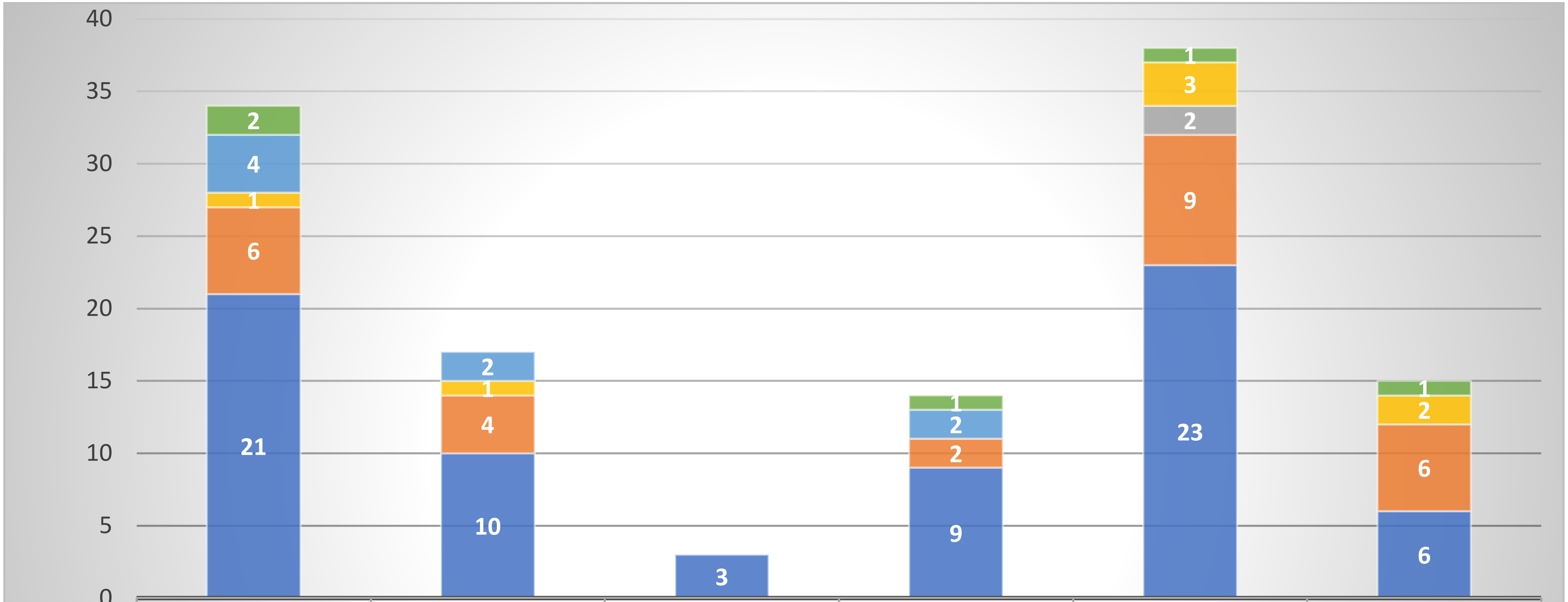
New staff members in TE-VSC:
- Benjamin BAYLISS (ICM)
- Valentine PETIT (SCC)

Dec 2022

Structure of the TE-VSC group



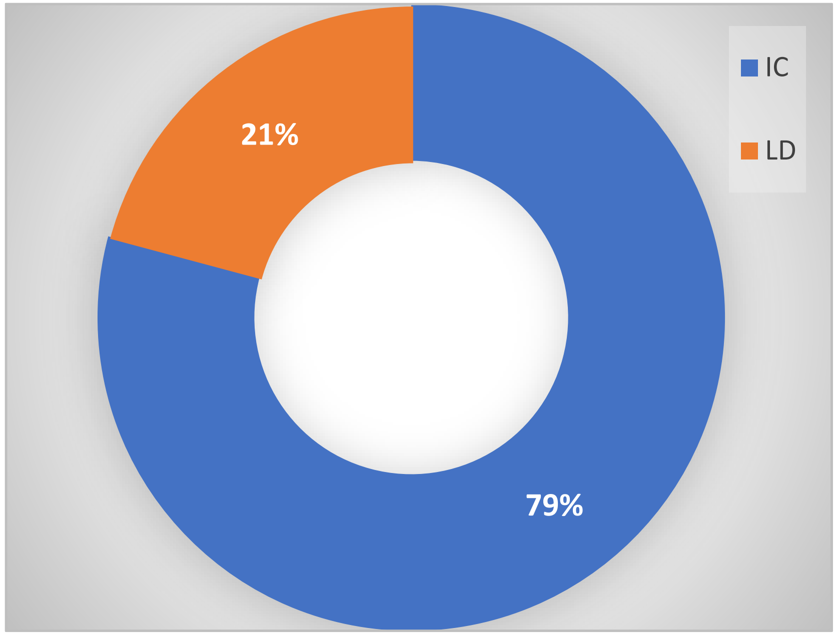


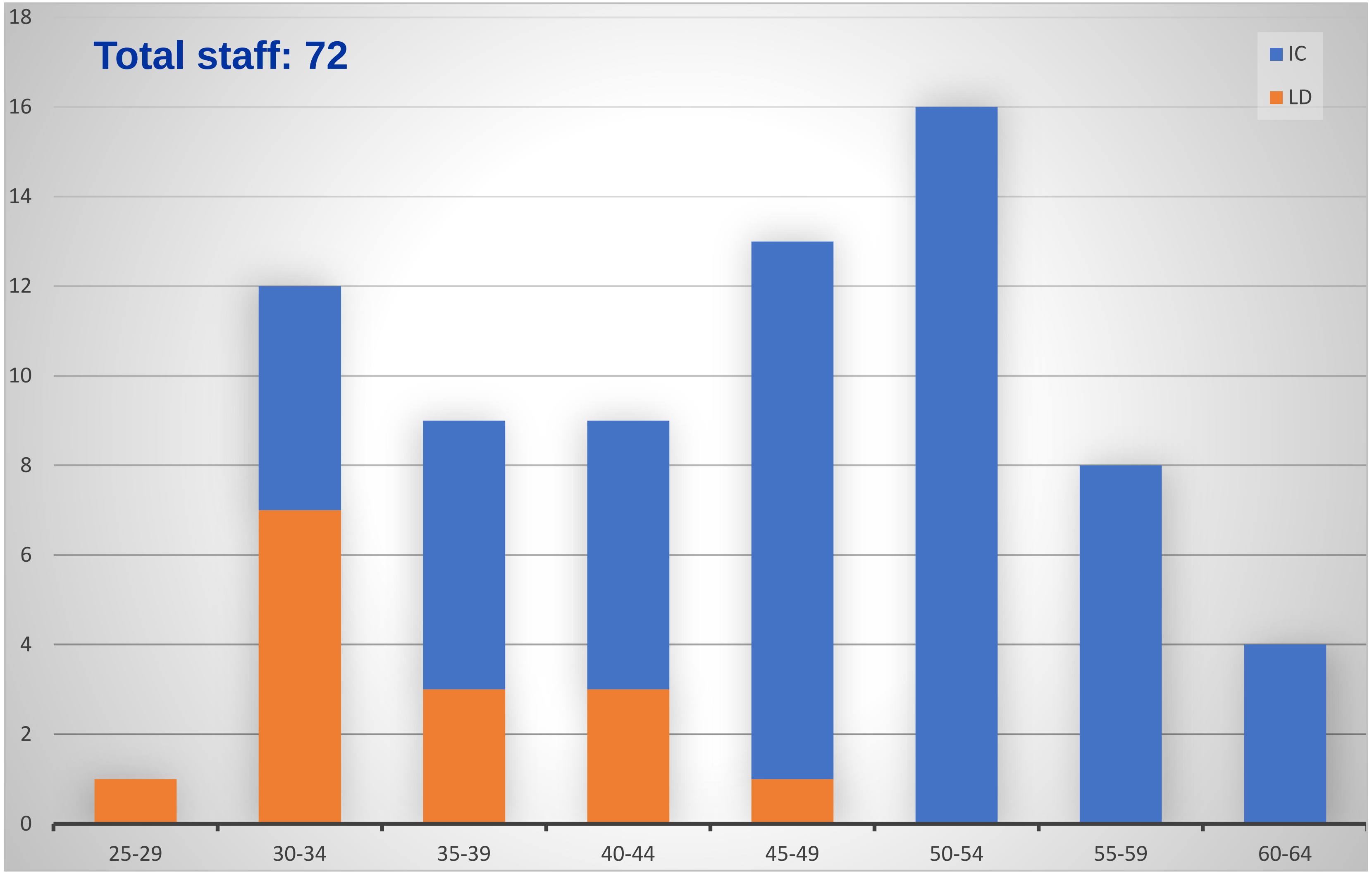


	BVO	DLM	GLO	ICM	SCC	VSM
TECH	2			1	1	1
PJAS	4	2		2		
DOCT	1	1			3	2
TRNE					2	
FELL	6	4		2	9	6
STAF	21	10	3	9	23	6

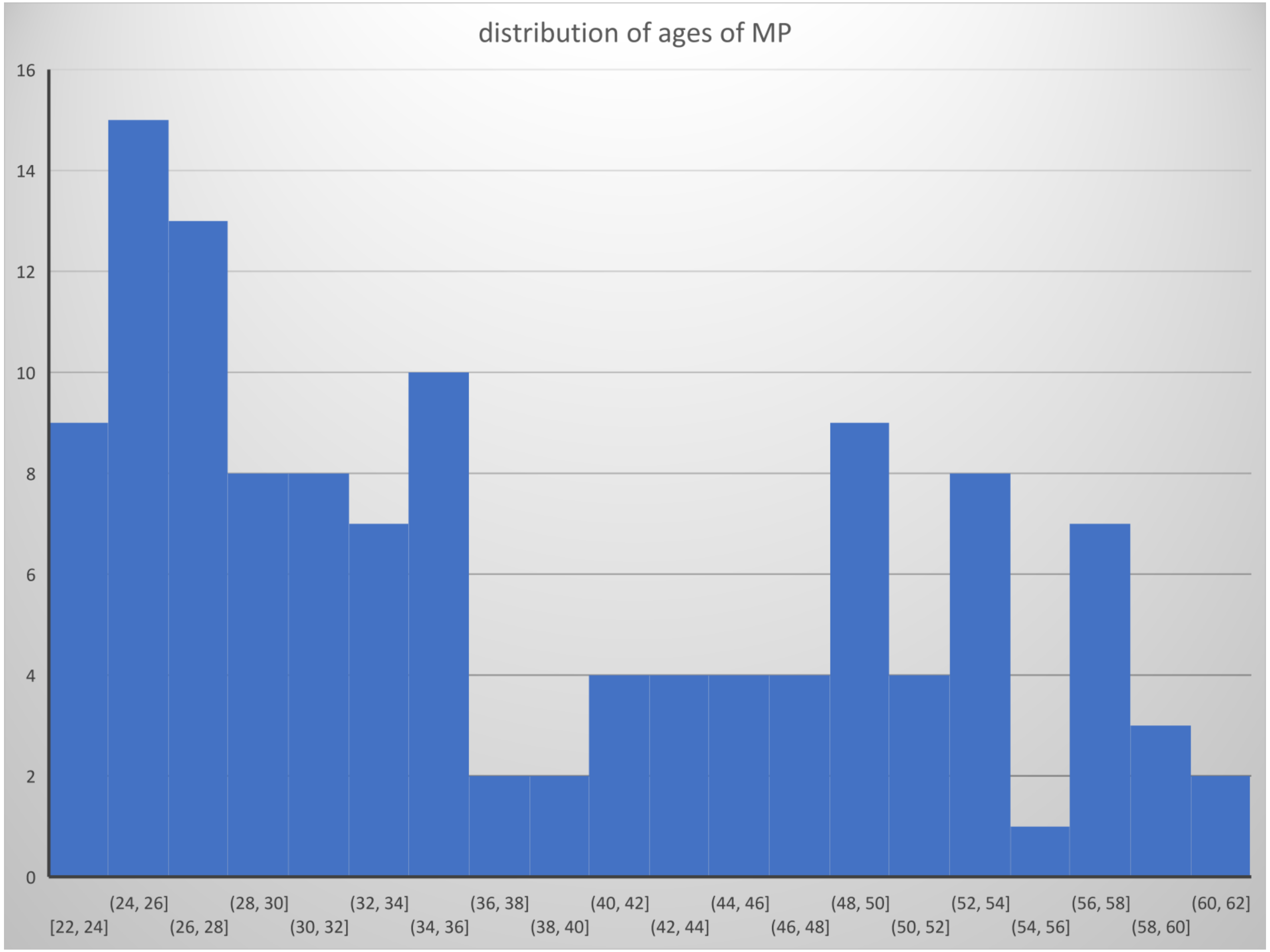
Age of staff members in Dec 2022

Average age: **45.5**
was 42 in 2014





Age of all MP in Dec 2022

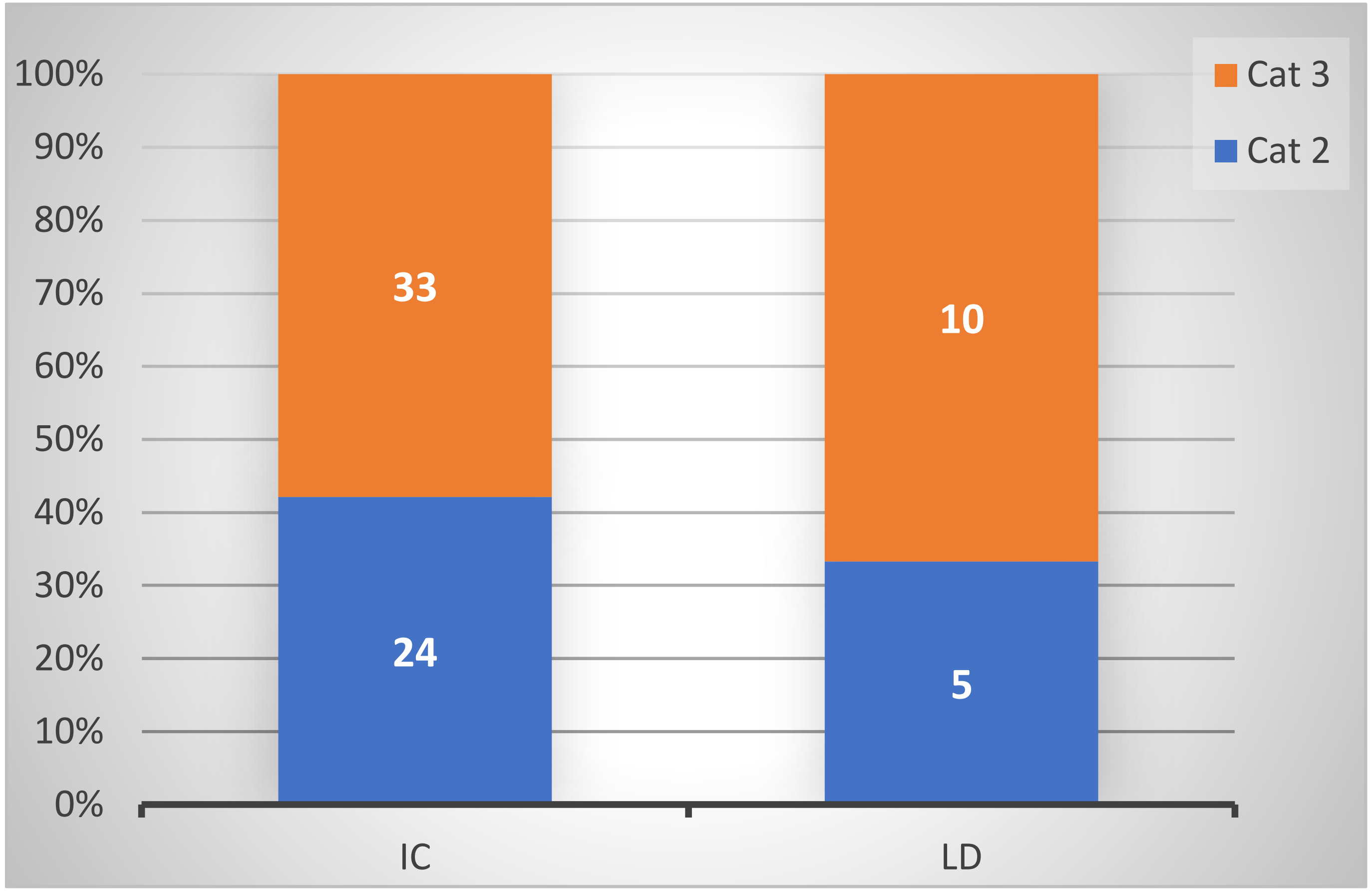


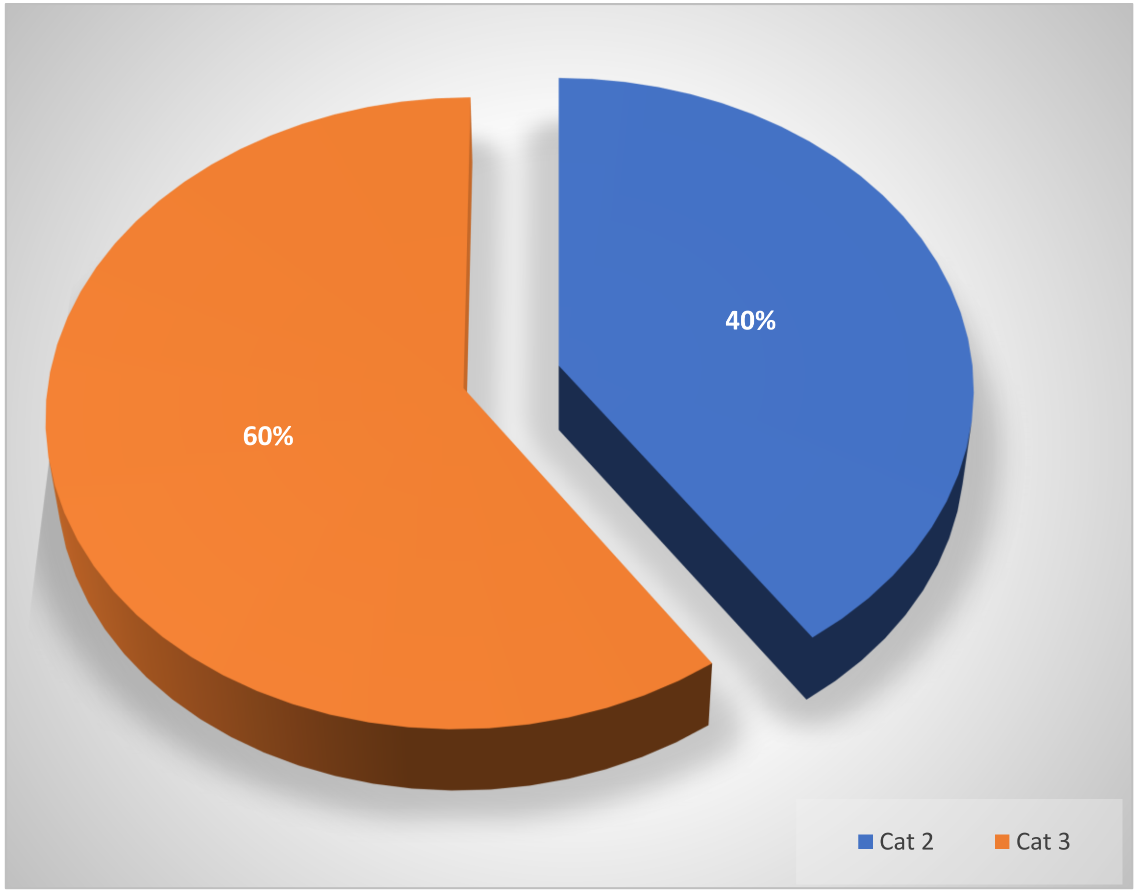
Average age: **38.1**

Category of staff members in Dec 2022

Staff indefinite contract (IC): 57

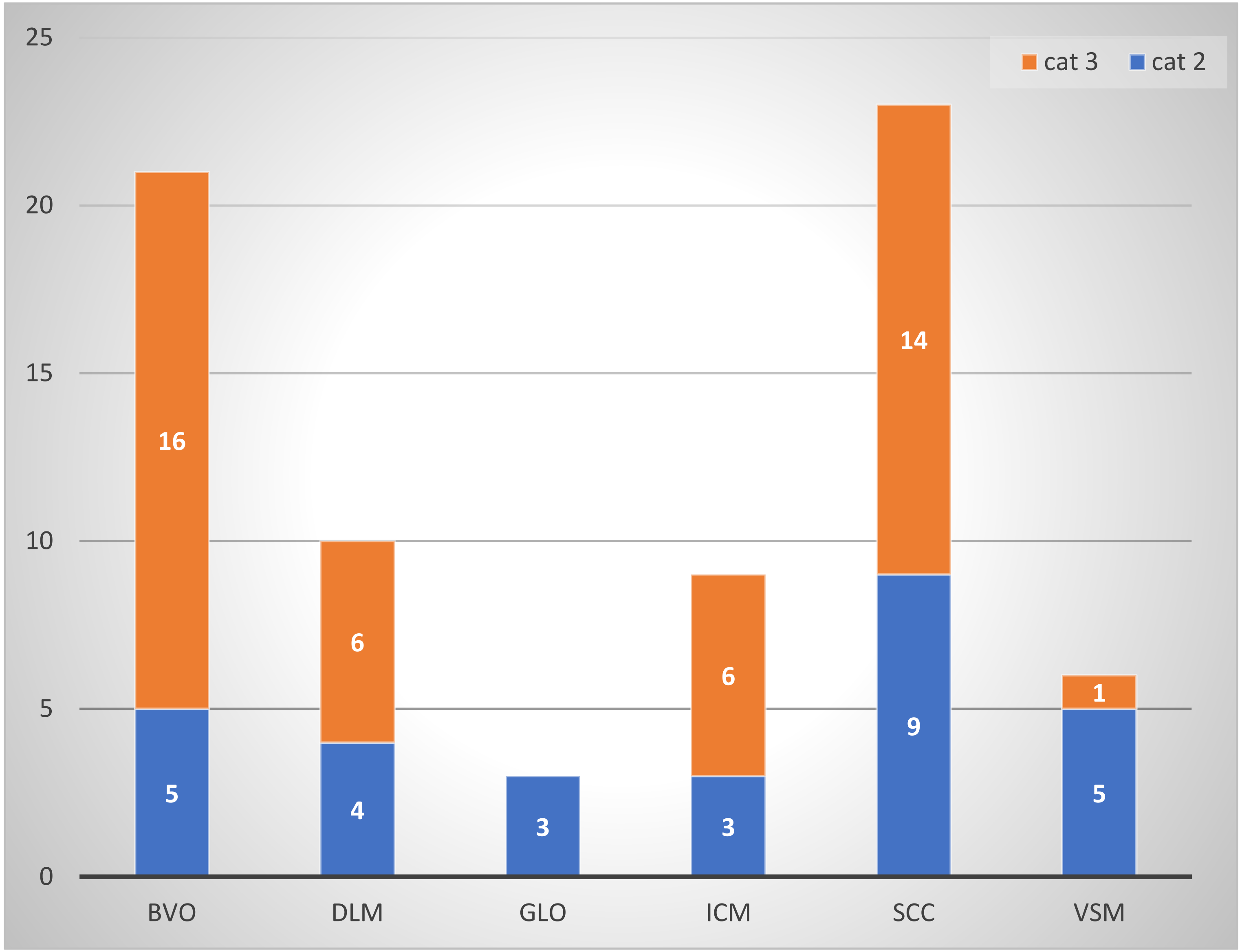
Staff limited duration (LD): 15



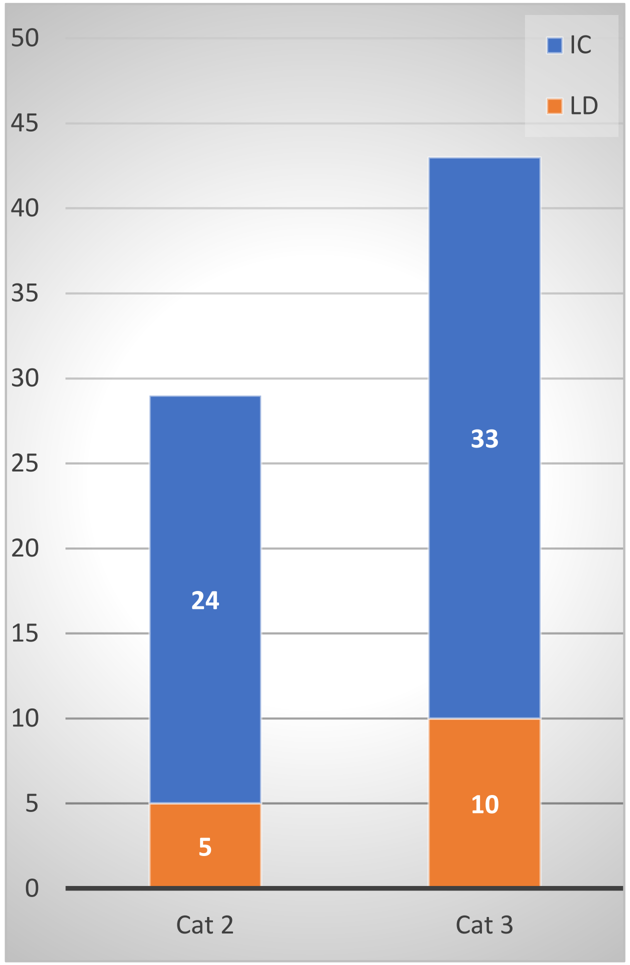


Cat 2: Scientific work
Cat 3: Technical work

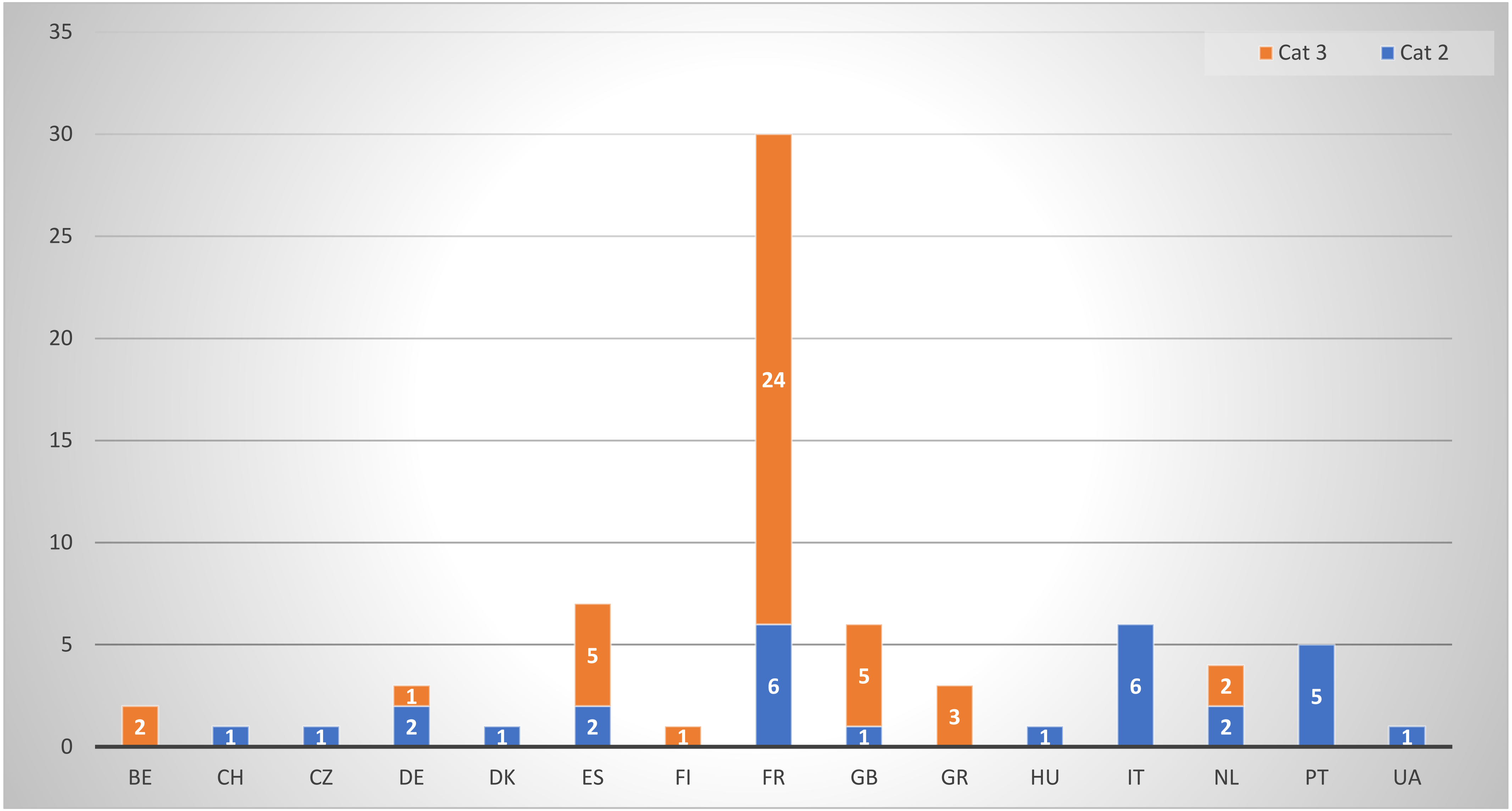
Category of staff members in Dec 2022

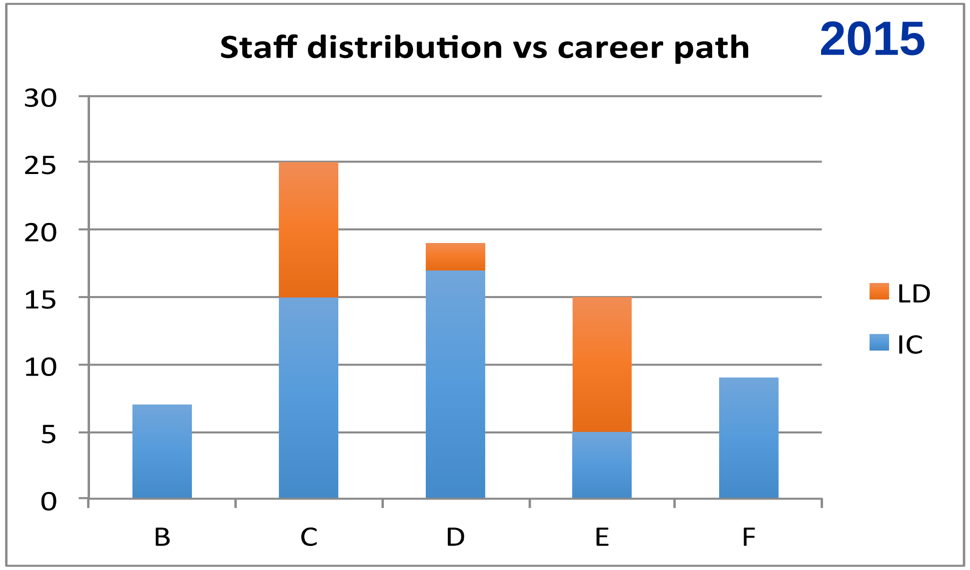


Staff indefinite contract (IC): 57
Staff limited duration (LD): 15

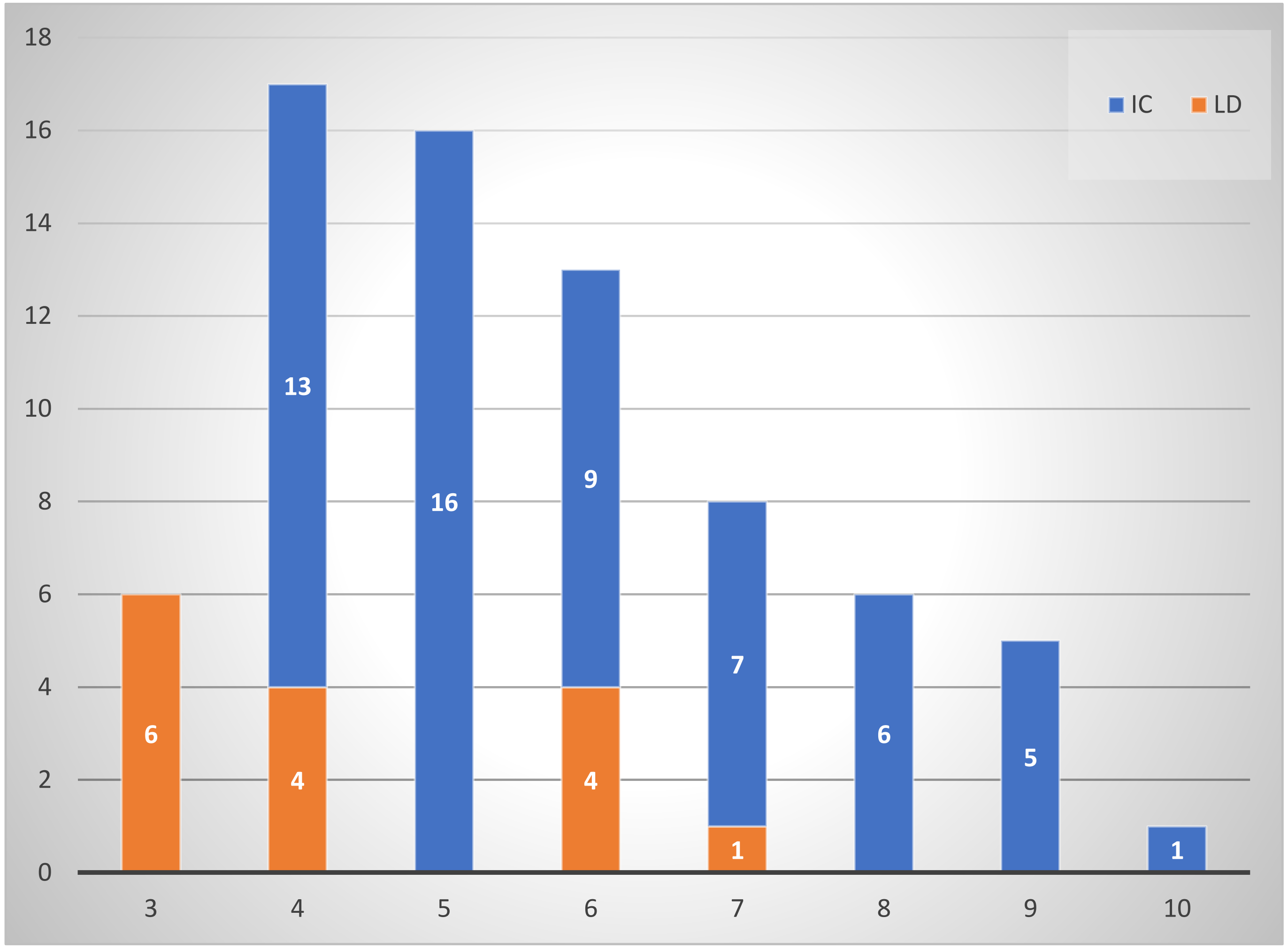


A 15-country group, with a significant French composition in Dec 2022





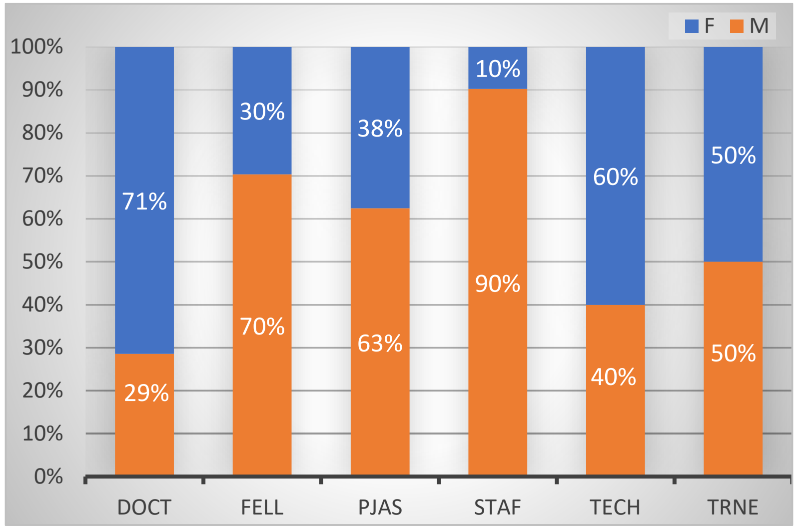
Grades of staff members in Dec 2022



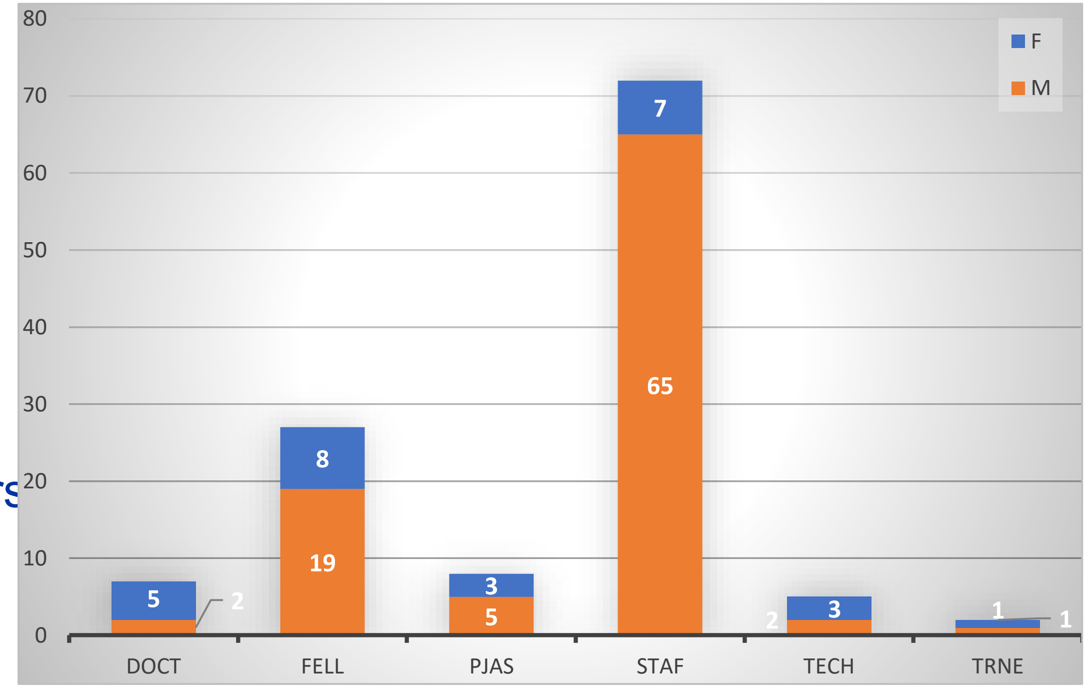
Staff indefinite contract (IC): 57
Staff limited duration (LD): 15

Gender repartition in TE-VSC in Dec 2022

Maestro delle storie del pane, Portrait of a man and a woman, New York



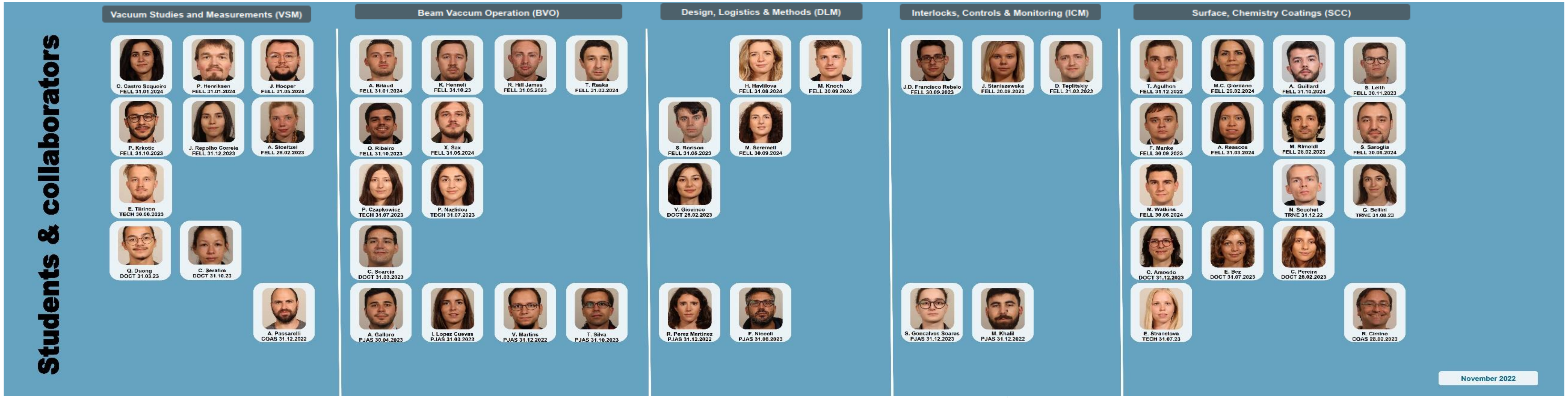
Average F / tot : **22%**

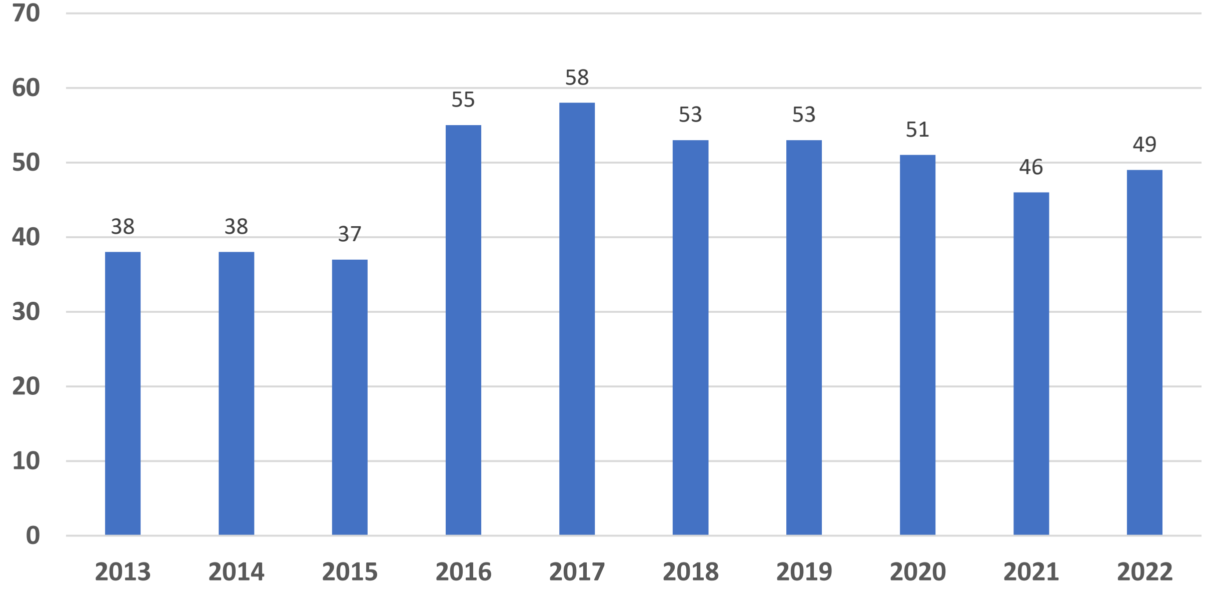


In USA in the 2017-2018 academic year, women represented **about 21%** of the bachelor's degree holders in the fields of engineering and computer/information sciences.

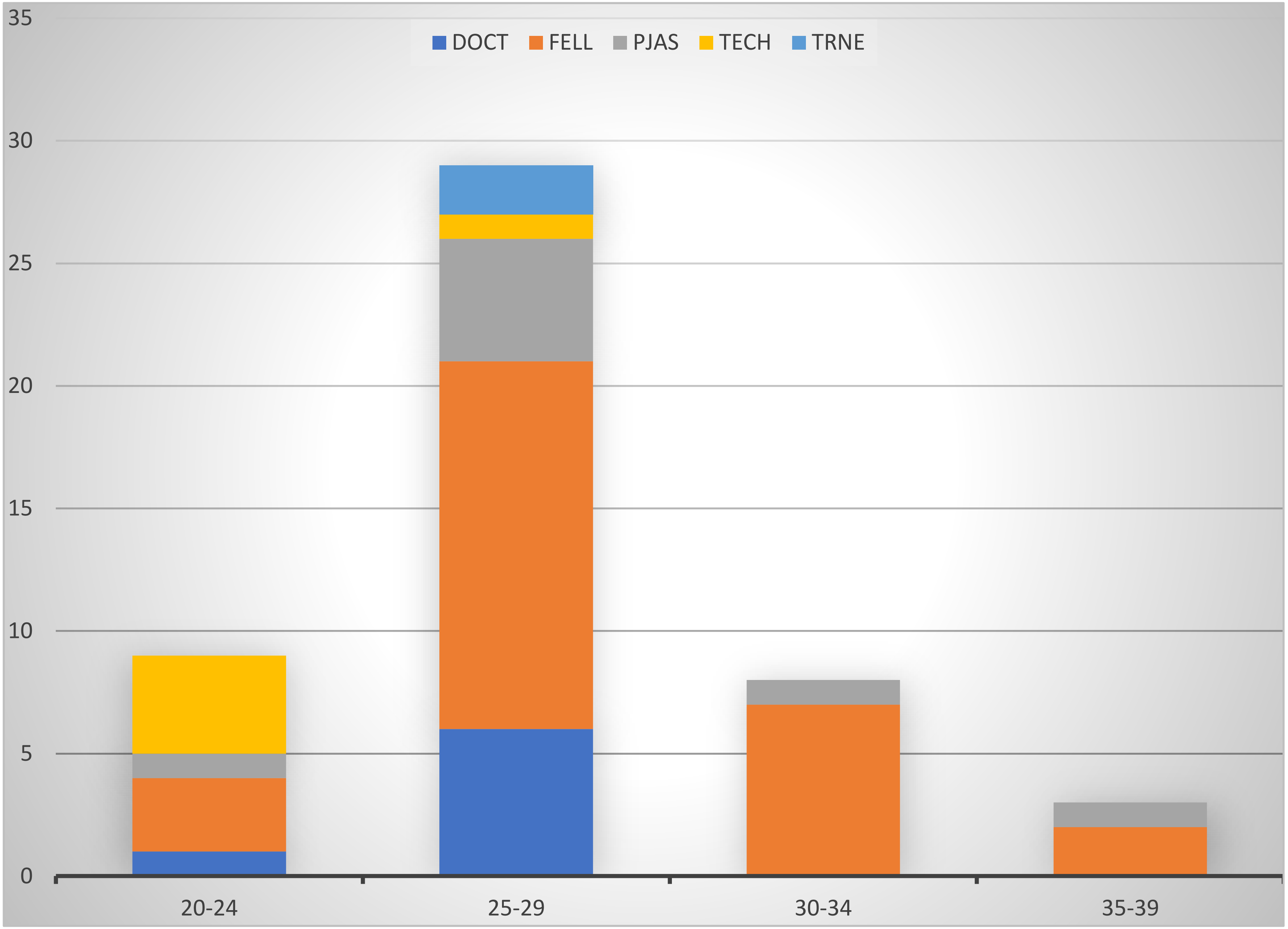
Source: SWE, Society of Women Engineers

Student, fellows and collaborators in Nov 2022





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)**



Age of non-staff members

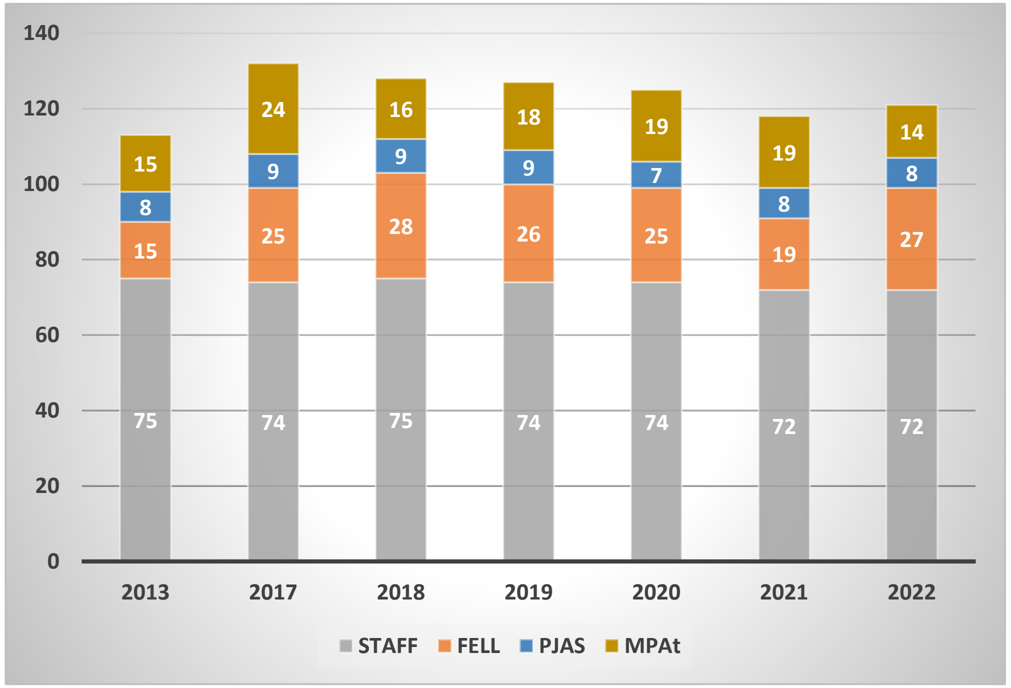
Total: 49 (exc. COAS)

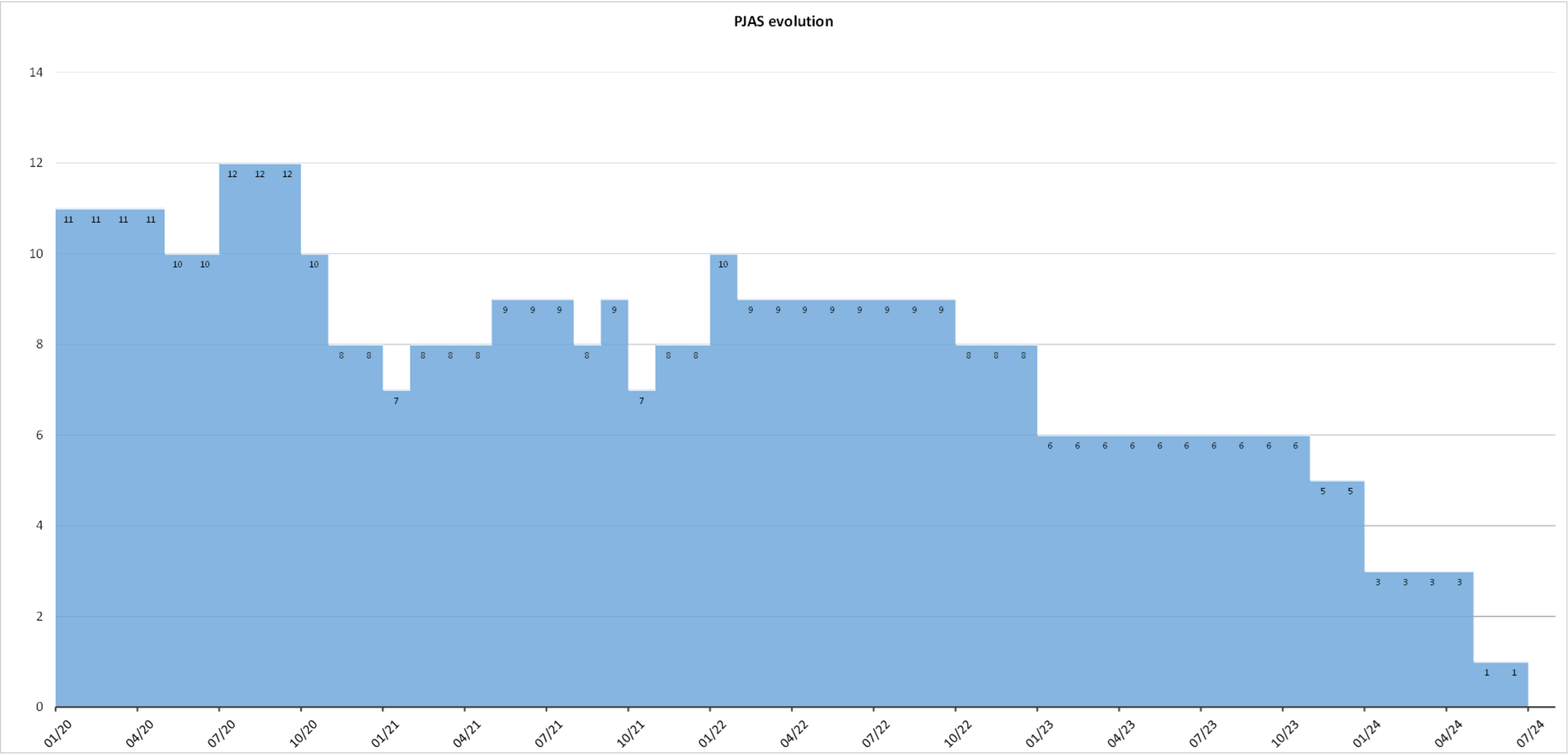
Average age: 27.3

Evolution in 9 years

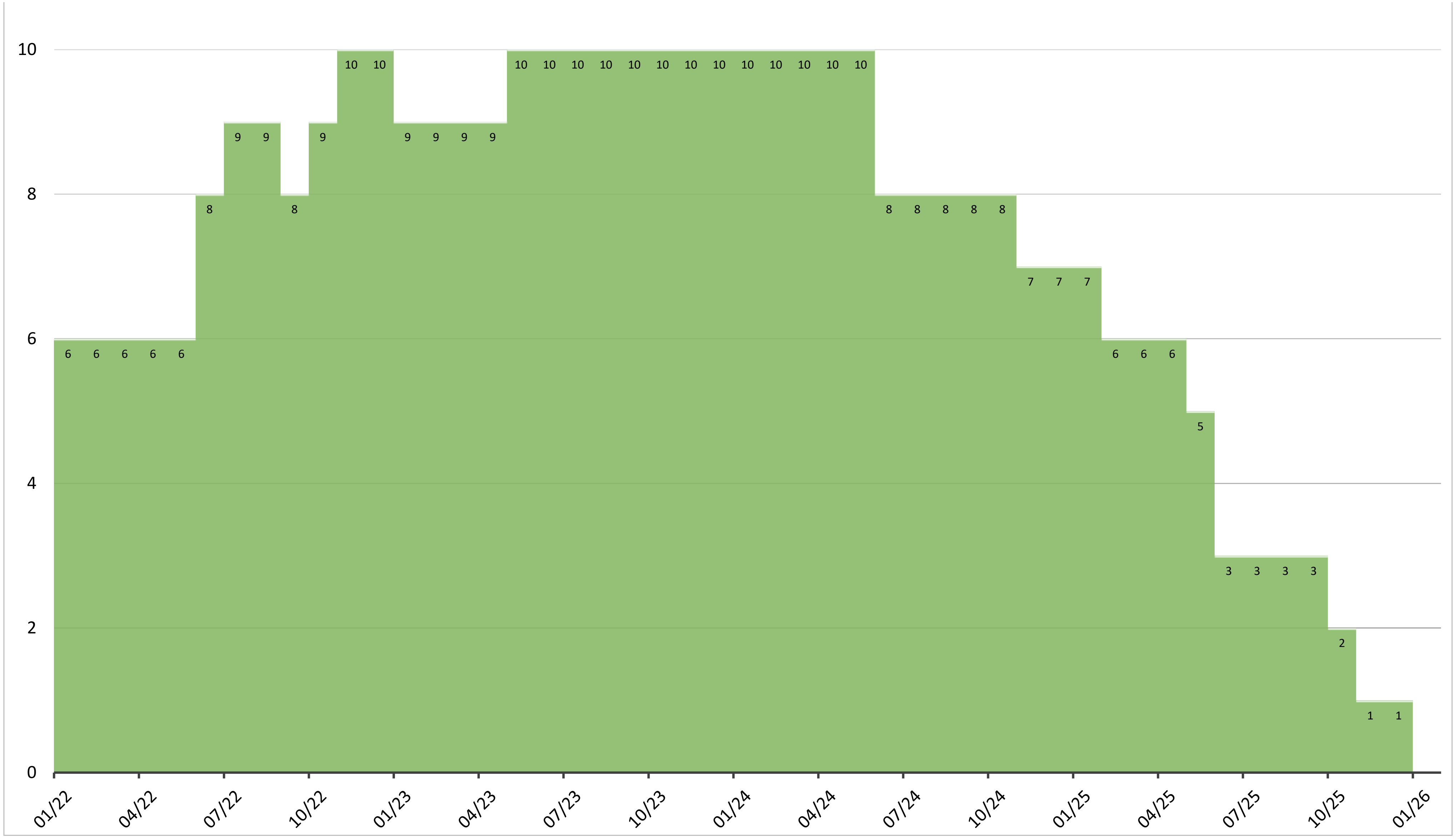
COAS excluded

Status	2013	2017	2018	2019	2020	2021	2022
STAFF	**75**	**74**	**75**	**74**	**74**	**72**	**72**
TECH-ADMIN	9	15	6	8	5	5	5
DOCT	2	5	5	5	6	7	7
FELL GET-DGP-EU	13 (6 GET)	17 (14 GET)	19 (13 GET)	17 (11 GET)	17 (9 GET)	13 (6 GET)	17 (11 GET)
FELL TTE-TTS	2	8	9	9	8	6	10
SASS	1	0	0	0	0	0	0
PJAS	8	9	9	9	7	8	8
VIA, ADI, Trainee	3	4	5	5	8	7	2
TOTAL	***75+38 113***	***74+58 132***	***75+53 128***	***74+55 129***	***74+51 125***	***72+46 118***	***72+49 121***




PJAS evolution
14
12
10
8
6
4
2
0
11 11 11 11 10 10 12 12 12 10 8 8 7 8 8 8 9 9 9 8 9 7 8 8 10 9 9 9 9 9 9 9 9 8 8 8 6 6 6 6 6 6 6 6 6 6 5 5 3 3 3 3 1 1
01/20 04/20 07/20 10/20 01/21 04/21 07/21 10/21 01/22 04/22 07/22 10/22 01/23 04/23 07/23 10/23 01/24 04/24 07/24

Fellows TTE evolution



PhD students

DOCT: 7 at CERN in Dec 2022

1. Valentina GIOVINCO: **Shape memory alloys** for UHV bi-material connections
2. Elena BEZ: **Laser surface treatments** for accelerator applications
3. Catarina SERAFIM: Materials for **RFQ of LINAC4**, hydrogen implantation and blistering
4. Carlo SCARCIA: Materials for vacuum systems of next-generation **gravitational wave telescopes**
5. Carolina AMOEDO: Discharge **plasma source** design and characterisation
6. Carlota CARLOS : Development of high performance thin film **coatings for SRF cavities**
7. Quentin DUONG : Electron cloud interaction with laser treated beam tube at the **vacuum pilot sector**

Changes in the TE-VSC group structure

New Section: Insulation and Injectors Vacuum Operation (**IVO)**

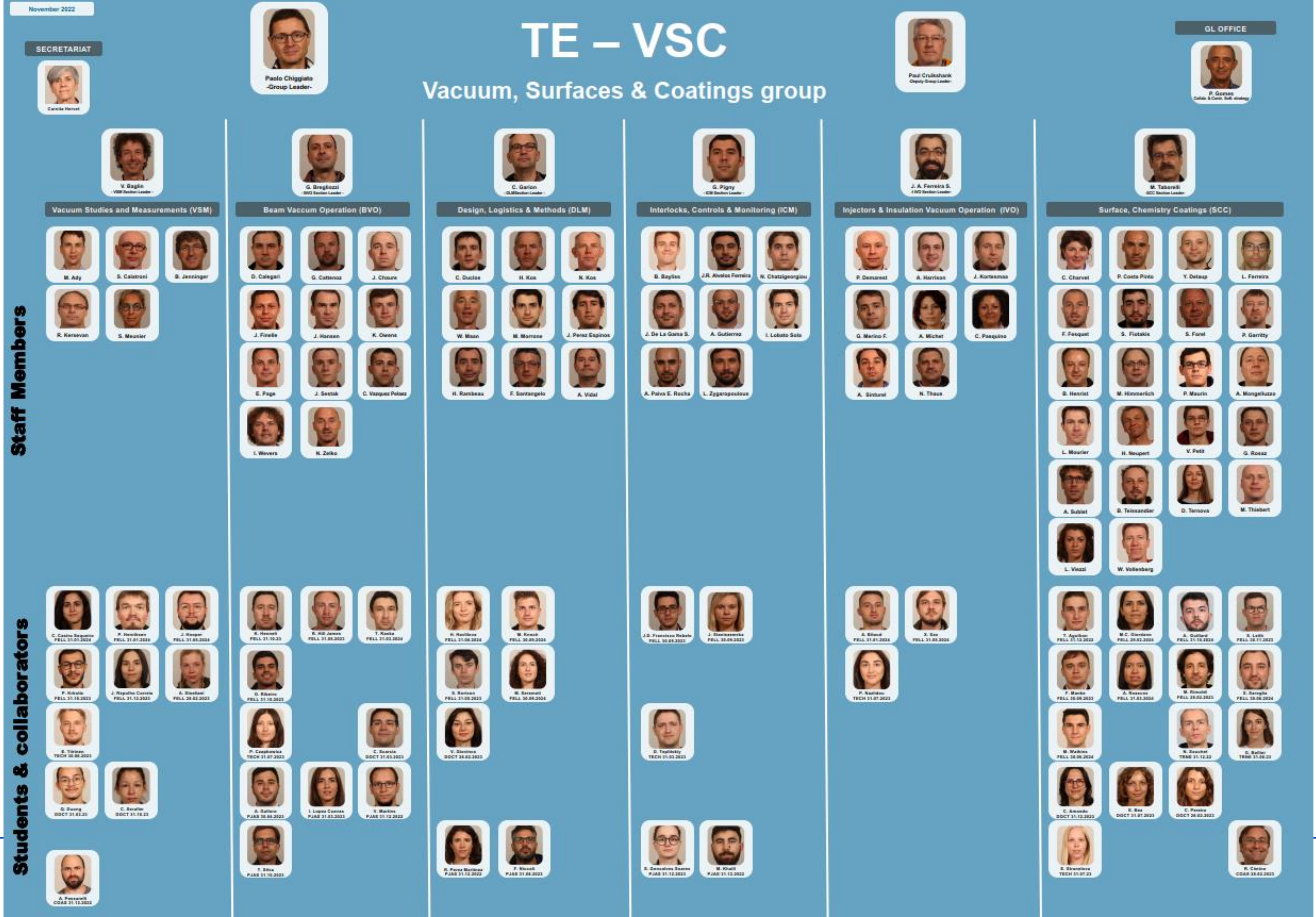
Name	First Name	Status Code	Supervisor Name
SAX	Xavier Michel	FELL	FERREIRA SOMOZA, Jose Antonio Dr.
BITAUD	Alexis	FELL	PASQUINO, Chiara Ms.
NAZLIDOU	Panagiota	TECH	FERREIRA SOMOZA, Jose Antonio Dr.
DEMAREST	Paul Richard	STAF	FERREIRA SOMOZA, Jose Antonio Dr.
KORTESMAA	Jarmo	STAF	PASQUINO, Chiara Ms.
THAUS	Nicolas Claude	STAF	FERREIRA SOMOZA, Jose Antonio Dr.
HARRISON	Anthony	STAF	PASQUINO, Chiara Ms.
FERREIRA SOMOZA	Jose Antonio	STAF	~~BREGLIOZZI, Giuseppe Dr.~~ Paolo
SINTUREL	Alexandre Xavier	STAF	FERREIRA SOMOZA, Jose Antonio Dr.
PASQUINO	Chiara	STAF	~~BREGLIOZZI, Giuseppe Dr.~~ Jose
MICHET	Alice Ingrid	STAF	FERREIRA SOMOZA, Jose Antonio Dr.
MERINO FERNANDEZ	Guillermo	STAF	FERREIRA SOMOZA, Jose Antonio Dr.

Changes in the TE-VSC group structure

LHC Beam Vacuum Operation
BVO

Name	First Name	Organic Unit	Status Code	Professional Category	Supervisor Name	New Section
SCARCIA	Carlo	TE-VSC-BVO	DOCT	2	BREGLIOZZI, Giuseppe Dr.	no
CZAPKOWICZ	Paulina Gabriela	TE-VSC-BVO	TECH	2	WEVERS, Ivo Mr.	no
REIS E RIBEIRO SANTOS	Orlando Miguel	TE-VSC-BVO	FELL	2	BREGLIOZZI, Giuseppe Dr.	no
HENNELI	Kristoffer	TE-VSC-BVO	FELL	3	BREGLIOZZI, Giuseppe Dr.	no
RASKA	Tomas	TE-VSC-BVO	FELL	2	SESTAK, Josef Mr.	no
HILL-JAMES	Rowan Cape	TE-VSC-BVO	FELL	3	BREGLIOZZI, Giuseppe Dr.	no
LOPEZ CUEVAS	Isabel	TE-VSC-BVO	PJAS	2	BREGLIOZZI, Giuseppe Dr.	no
NASCIMENTO MARTINS	Vasco Miguel	TE-VSC-BVO	PJAS	2	SESTAK, Josef Mr.	no
GALLORO	Alessio	TE-VSC-BVO	PJAS	2	BREGLIOZZI, Giuseppe Dr.	no
PEREIRA NAVE HENRIQUES DA SILVA	Tomas	TE-VSC-BVO	PJAS	2	BREGLIOZZI, Giuseppe Dr.	no
HANSEN	Jan Helge	TE-VSC-BVO	STAF	2	BREGLIOZZI, Giuseppe Dr.	no
WEVERS	Ivo	TE-VSC-BVO	STAF	3	BREGLIOZZI, Giuseppe Dr.	no
ZELKO	Nicolas	TE-VSC-BVO	STAF	3	BREGLIOZZI, Giuseppe Dr.	no
PAGE	Eric	TE-VSC-BVO	STAF	3	BREGLIOZZI, Giuseppe Dr.	no
CALEGARI	Didier	TE-VSC-BVO	STAF	3	SESTAK, Josef Mr.	no
BREGLIOZZI	Giuseppe	TE-VSC-BVO	STAF	2	CHIGGIATO, Paolo Mr.	no
CHAURE	Jerome Gilles	TE-VSC-BVO	STAF	3	SESTAK, Josef Mr.	no
CATTENOZ	Gregory	TE-VSC-BVO	STAF	3	BREGLIOZZI, Giuseppe Dr.	no
FINELLE	Julien	TE-VSC-BVO	STAF	3	BREGLIOZZI, Giuseppe Dr.	no
SESTAK	Josef	TE-VSC-BVO	STAF	2	BREGLIOZZI, Giuseppe Dr.	no
VAZQUEZ PELAEZ	Cesar	TE-VSC-BVO	STAF	3	BREGLIOZZI, Giuseppe Dr.	no
OWENS	Karl John	TE-VSC-BVO	STAF	3	BREGLIOZZI, Giuseppe Dr.	no

From 01-2023


November 2022
TE – VSC
Vacuum, Surfaces & Coatings group
SECRETARIAT
Paolo Chiggiato
-Group Leader-
Paul Cruikshank
GL OFFICE
Vacuum Studies and Measurements (VSM)
Beam Vaccum Operation (BVO)
Design, Logistics & Methods (DLM)
Interlocks, Controls & Monitoring (ICM)
Injectors & Insulation Vacuum Operation (IVO)
Surface, Chemistry Coatings (SCC)
Staff Members
Students & collaborators

Roles in TE-VSC

The roles and participation in CERN's official meetings are reported in:

https://edms.cern.ch/document/2566636/2

CERN | Memorandum

Date	:	December 8th, 2022
To	:	TE-VSC staff members
Copy to	:	José Miguel Jimenez
From	:	Paolo Chiggiato
Objective	:	Roles in TE-VSC and participation in official meetings from 01-2023

New post in 2023

Abel Grimmer, Spring

Posts	Planned contract start
Technical eng. in chemistry	Q3-Q4

CCRB slots in 2022

Posts	VSC candidates	Results
Mechanical technician	Christian Duclos	✓

Budget in 2022

Budget

OP budget and commitments (CET extraction 08-12):

Payment budget: **4.126 MCHF**

Charged to budget code on **recurrent** budget: **2.979** MCHF

Commitment (incl. pipeline) on operation (**recurrent**) : **4.091 MCHF**

(Transitory code for IS and FSU, XPS and NEG pumps DR excluded)

PRJ+CONS budget and commitments (CET extraction 08-12):

Payment budget: **7.61 MCHF**

Charged to budget code on **non-recurrent** budget: **6.164 MCHF**

Most important lines of expenditure:

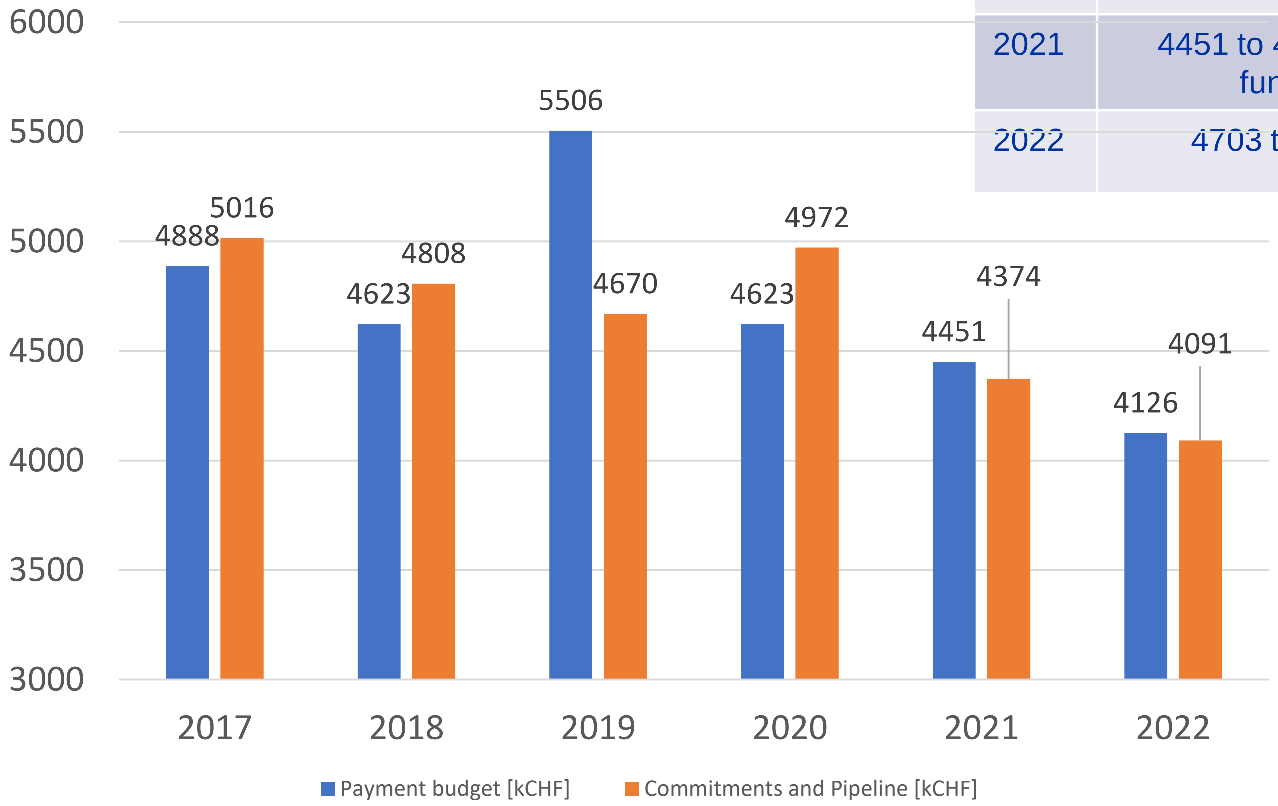
- Blanket contracts
- Industrial support
- EN-MME services
- CERN store

2022 Budget

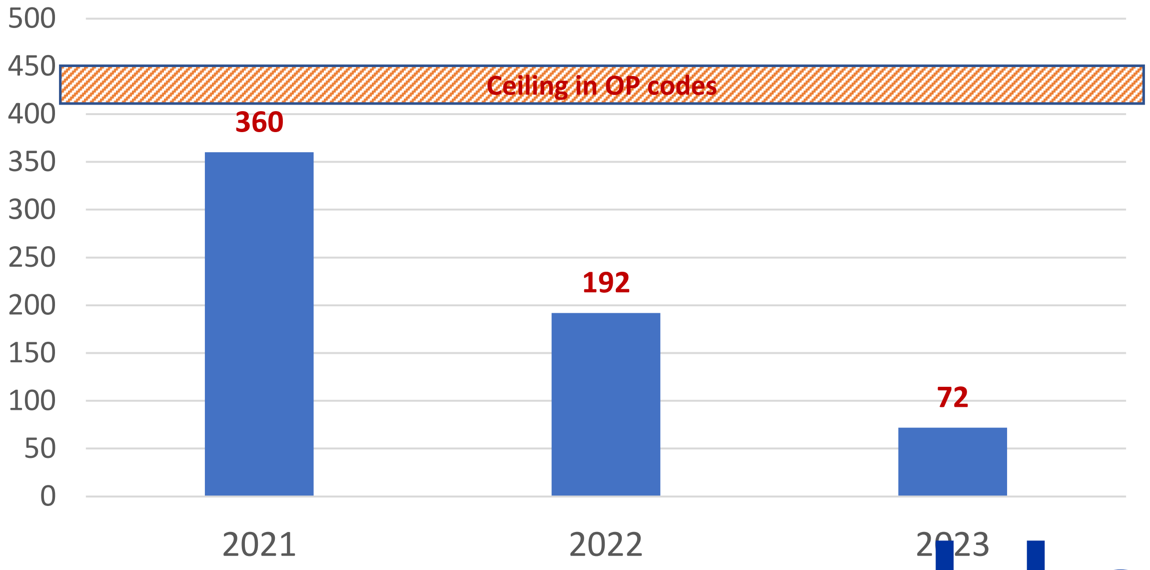
Operational budget evolution

Jan Gossaert, Portrait of a Merchant, 1530
National Gallery of Art, Washington DC

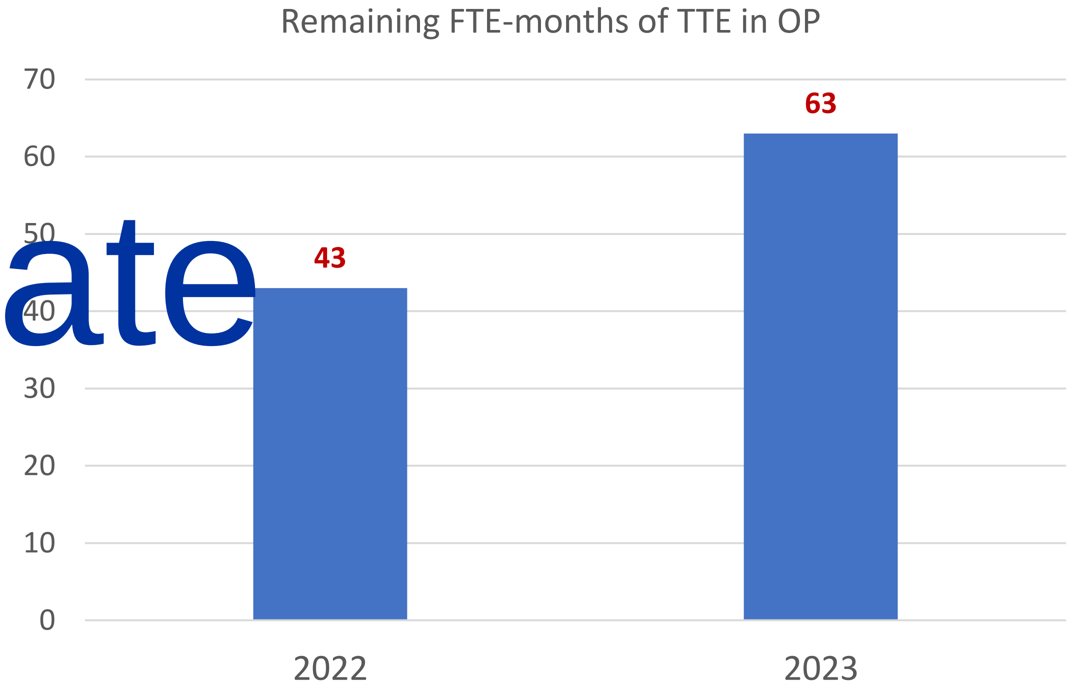
Year	Payment budget [kCHF]	Commitments and Pipeline [kCHF]
2017	4888 to 4798 in Dec	5016
2018	4623 to 4453 in Dec	4808
2019	5506 to 4596 in Dec	4670
2020	4623 to 4621 in Dec	4972
2021	4451 to 4551 (DG funds)	4374
2022	4703 to 4126	4091



Costs of Fellows TTE

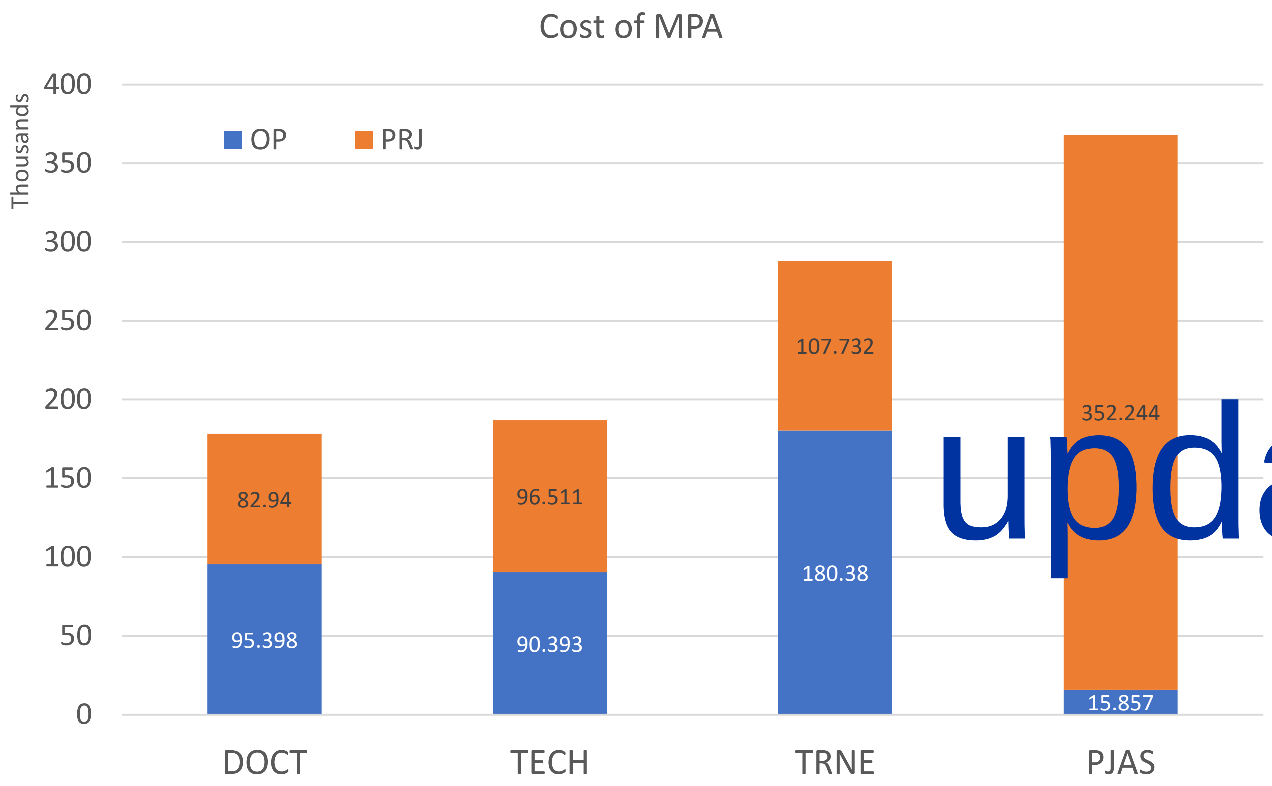


Update



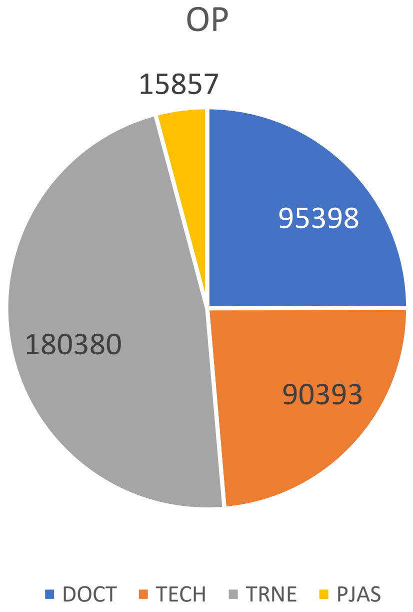
Cost of MPA in 2021

Status on 12.12.2021 (reference CET using ‘Account’, incl. pipeline)



update

Total cost in OP: **382 kCHF**
Ceiling: **400 kCHF**



Industrial support & FSU contracts

VSC coordinator of the IS contract: Jaime Perez Espinos
FSU and IS contract supervision and FSU coordinator: Nico Kos

Contracts close to retendering.

Status on 12.12.2022 (reference JMT+CET)

Contract	No. of jobs	Total (kCHF)
S175 (AL4030)*	364 (*CERN-wide: 900*)	455 (*CERN-wide: 1028*)
S144 – Cabling, bakeout and mechanical design	208	381
S145 – Machining, assembly, testing, logistics and mechanical design	144	422
Total	716	1258

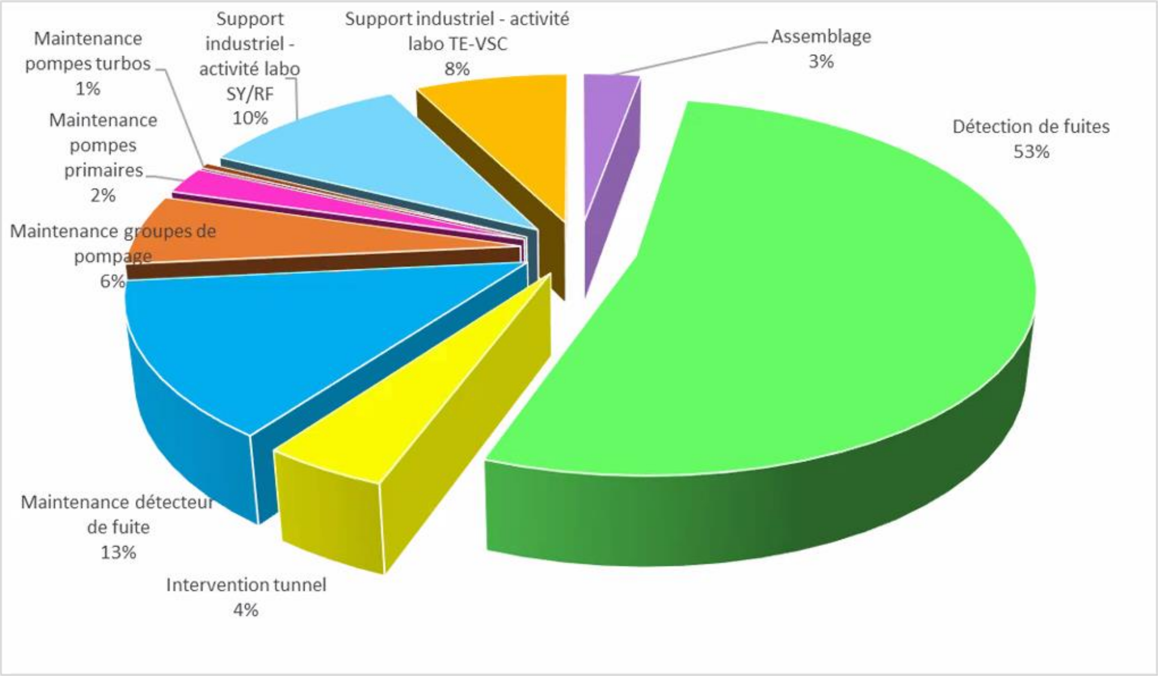
*This includes the cost of jobs, as well as supervision, QA and logistics.

Industrial support: new contract in 2023

Vue générale des activités du consortium

- Nombre total de lignes SP : 900

Moyenne H/ligne	12,7
Maintenance	6,8
Détection de fuite	10,5
Support indus	24,3
Intervention tunnel	35,3



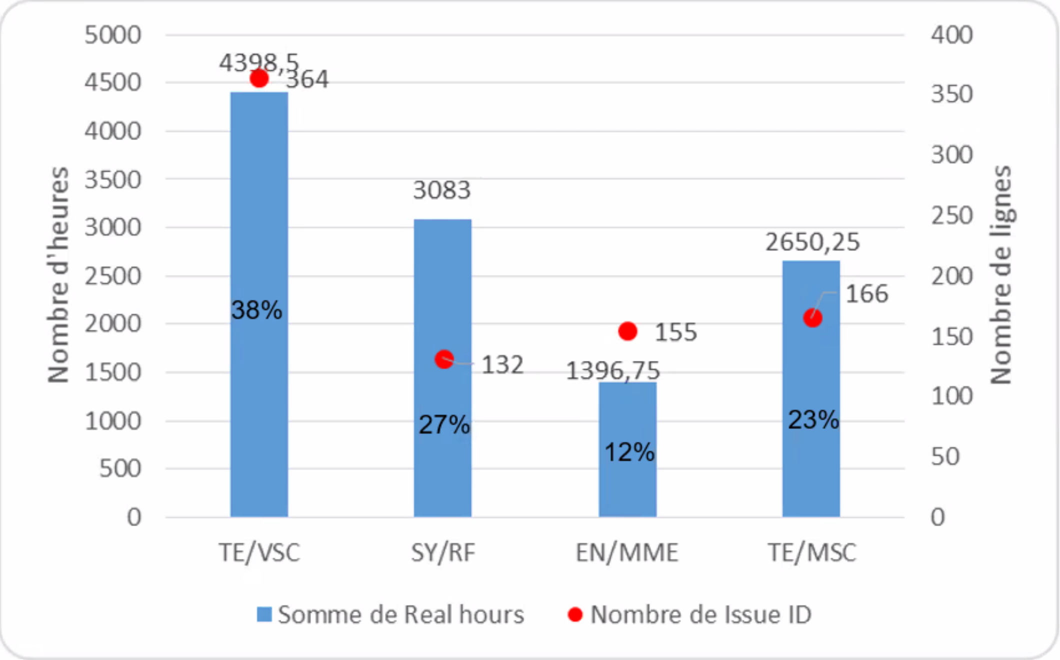
12/12/2022 *Réunion annuelle 2022* *4*

Courtesy of AL-4030

Industrial support: new contract in 2023

Répartition des activités sur le CERN

4 Principaux demandeurs

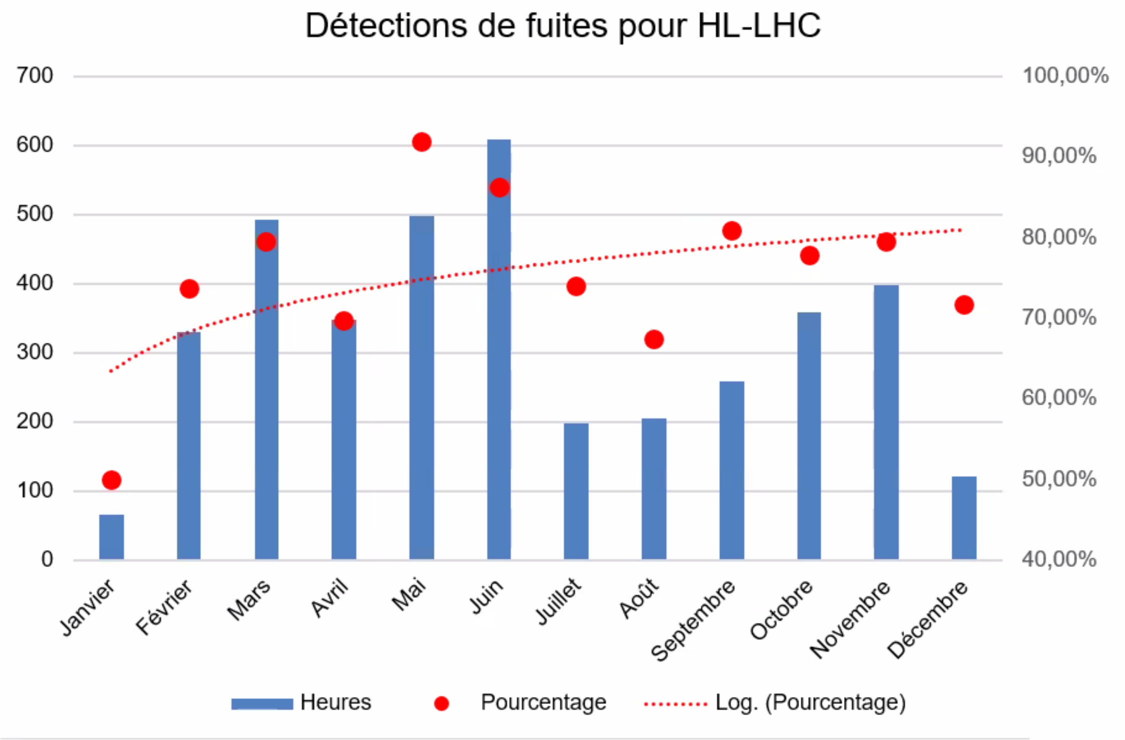


- 2022 : Toujours les mêmes principaux demandeurs,
- 2021 vs 2022 : Modification importante de la répartition des différents demandeurs.

12/12/2022 *Réunion annuelle 2022* Courtesy of AL-4030 *5*

Industrial support: new contract in 2023

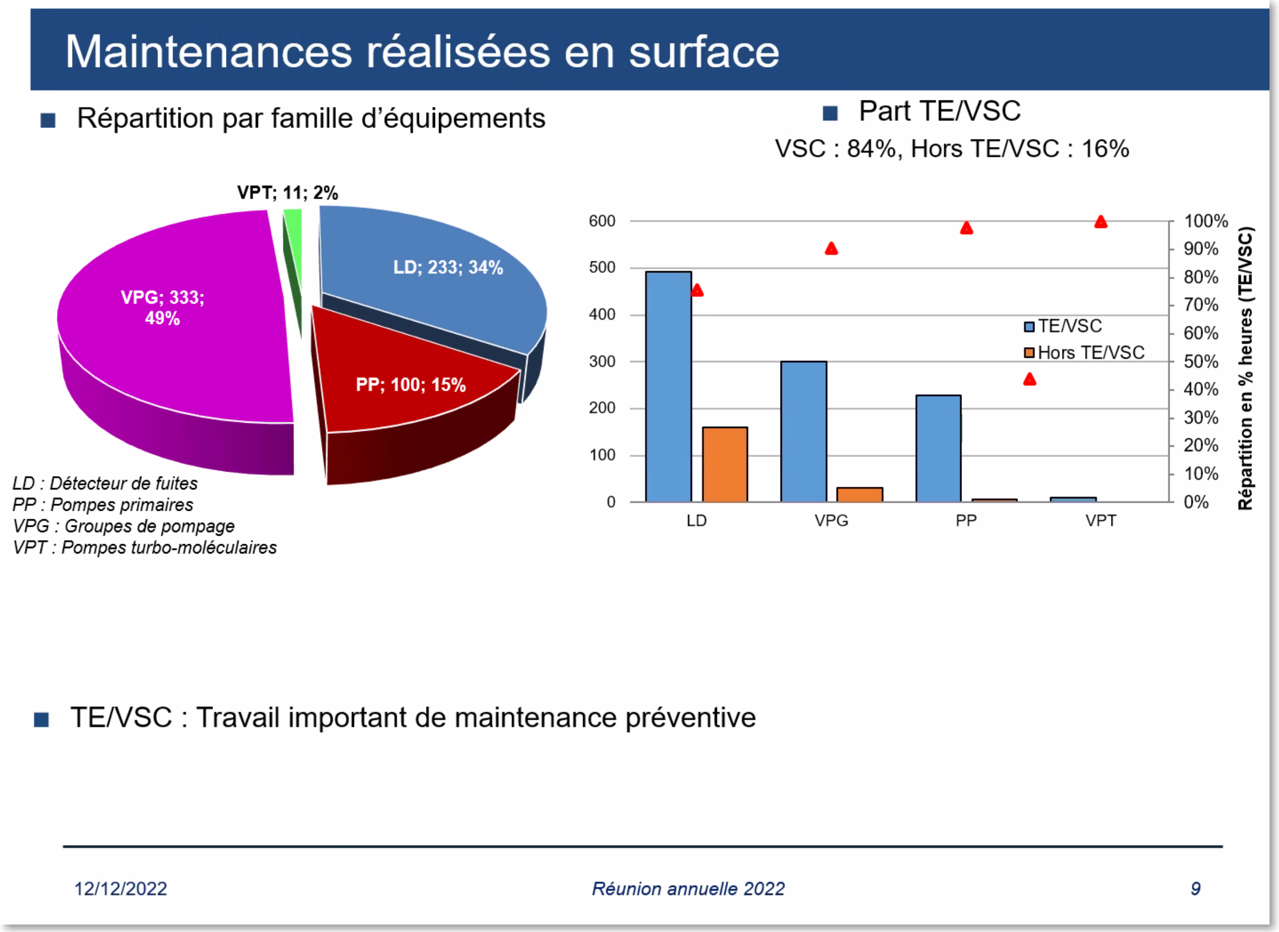
Activités : Détection de fuites



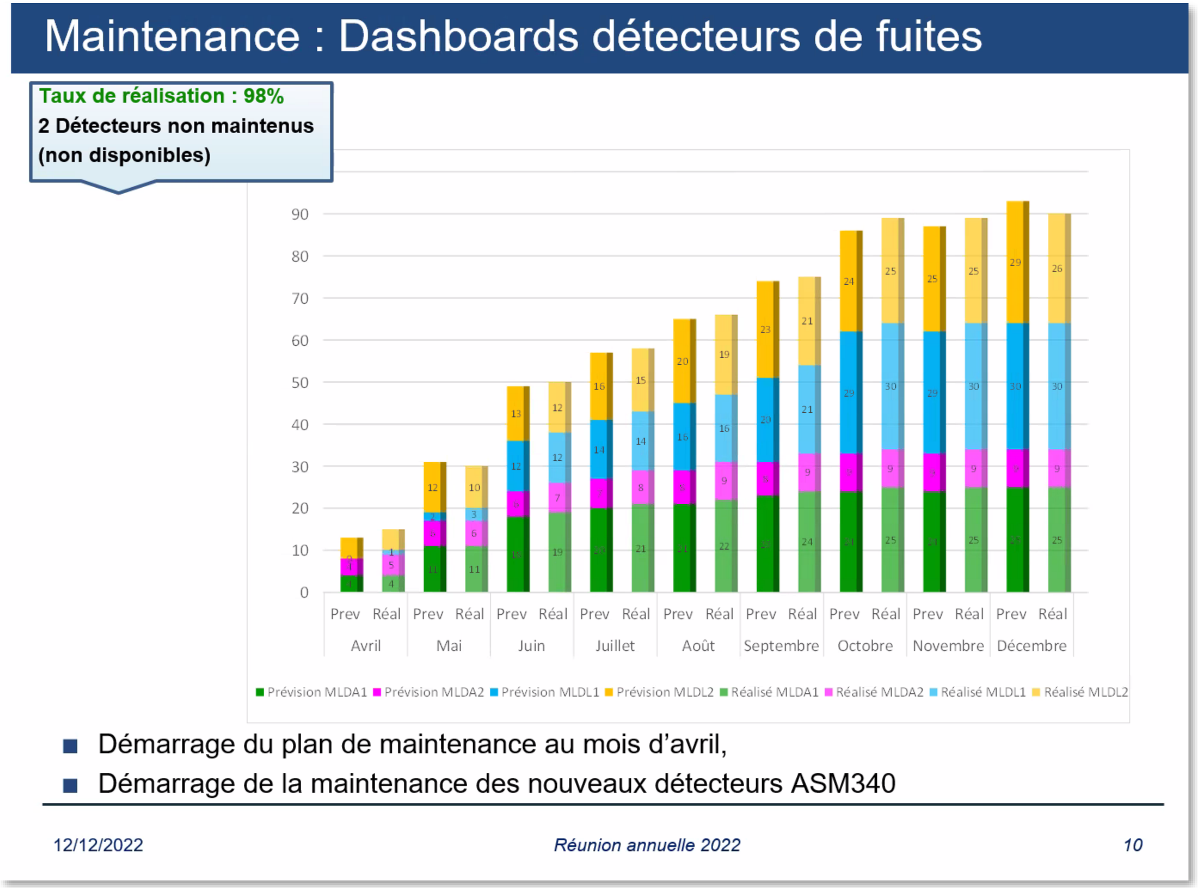
- HL-LHC grand demandeur de test d'étanchéité
- Activités également sur l'ensemble des accélérateurs et projets.

12/12/2022 *Réunion annuelle 2022* *6*

Courtesy of AL-4030



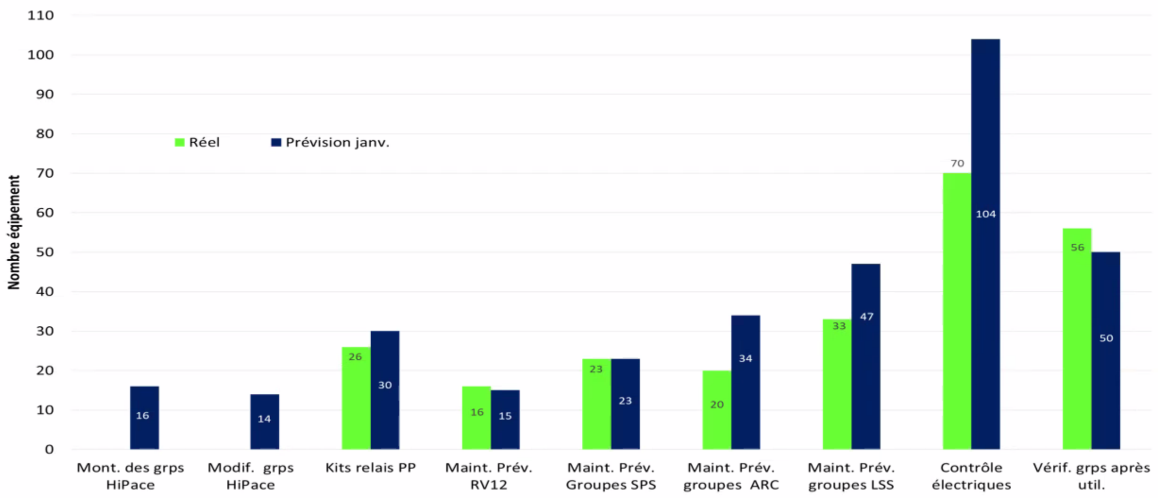
Industrial support: new contract in 2023



Courtesy of AL-4030

Industrial support: new contract in 2023

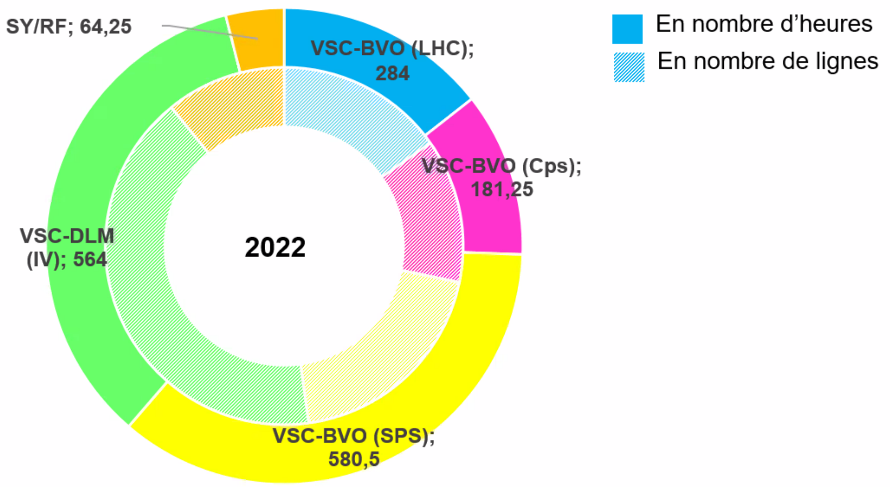
Maintenance des équipements Vide faisceau par année calendair



* Exclusion du matériel partiellement démonté

- Modification des groupes HiPace 80 :
  - Toujours en stand by (pompes primaires pas encore livrées par le fournisseur),

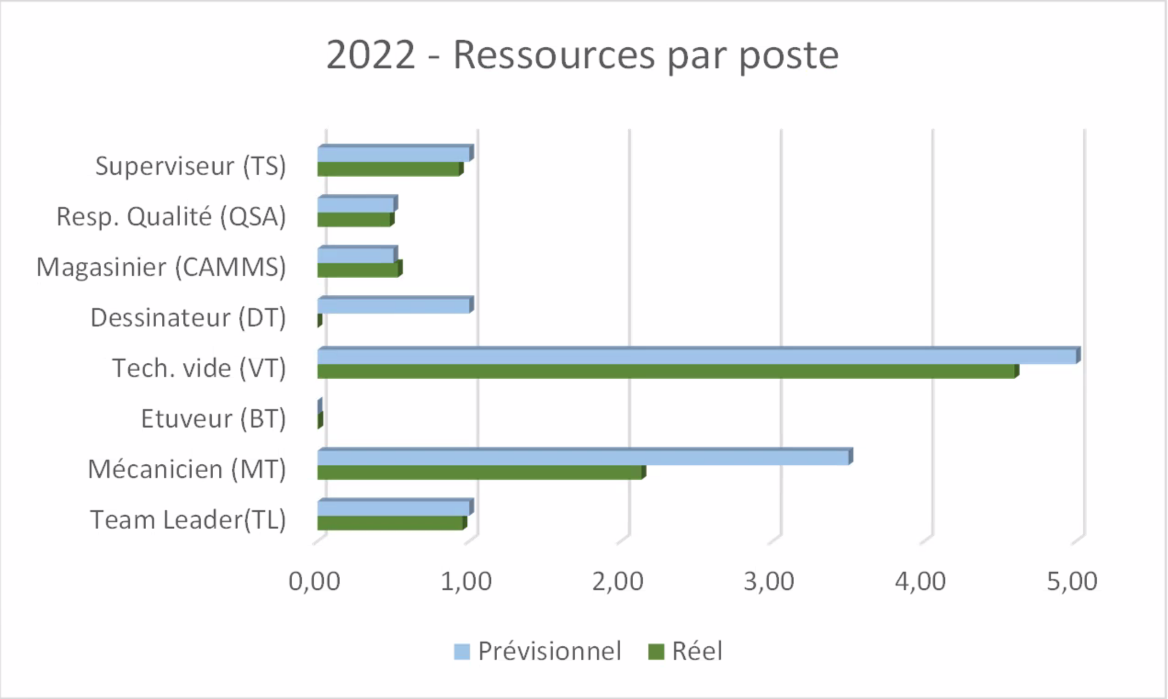
Interventions tunnel



- Répartition des interventions tunnel :
  - Interventions spécifiques vide isolation
  - Consolidation des groupes de pompage vide isolation
  - Consolidation du SPS
  - Intervention Cps
  - Intervention secteur cavité RF

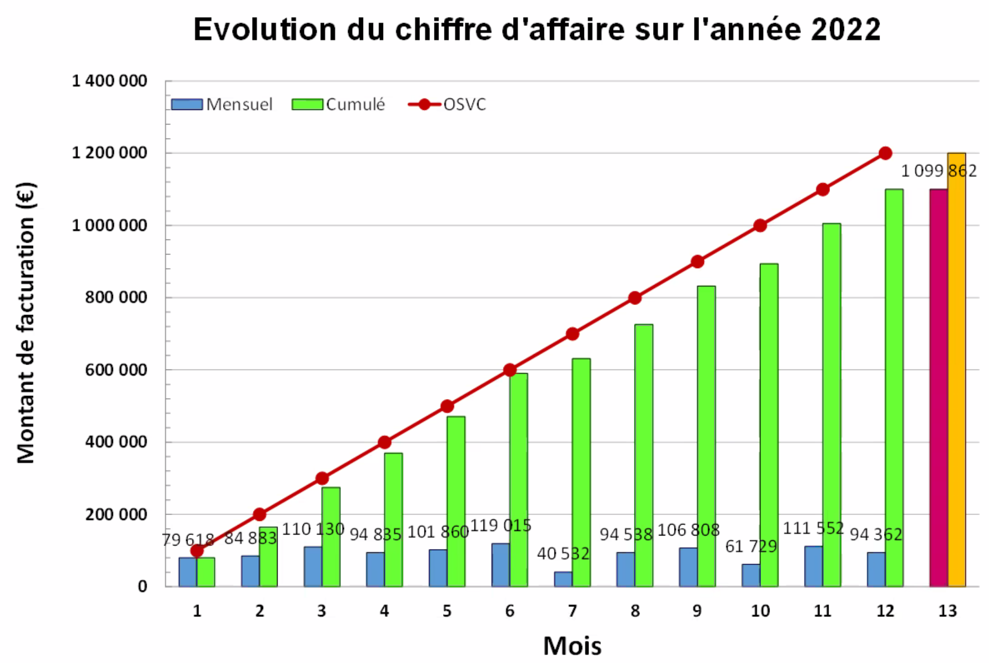
Courtesy of AL-4030

Suivi des ressources exprimé en hommes



Industrial support: new contract in 2023

Etat de la facturation



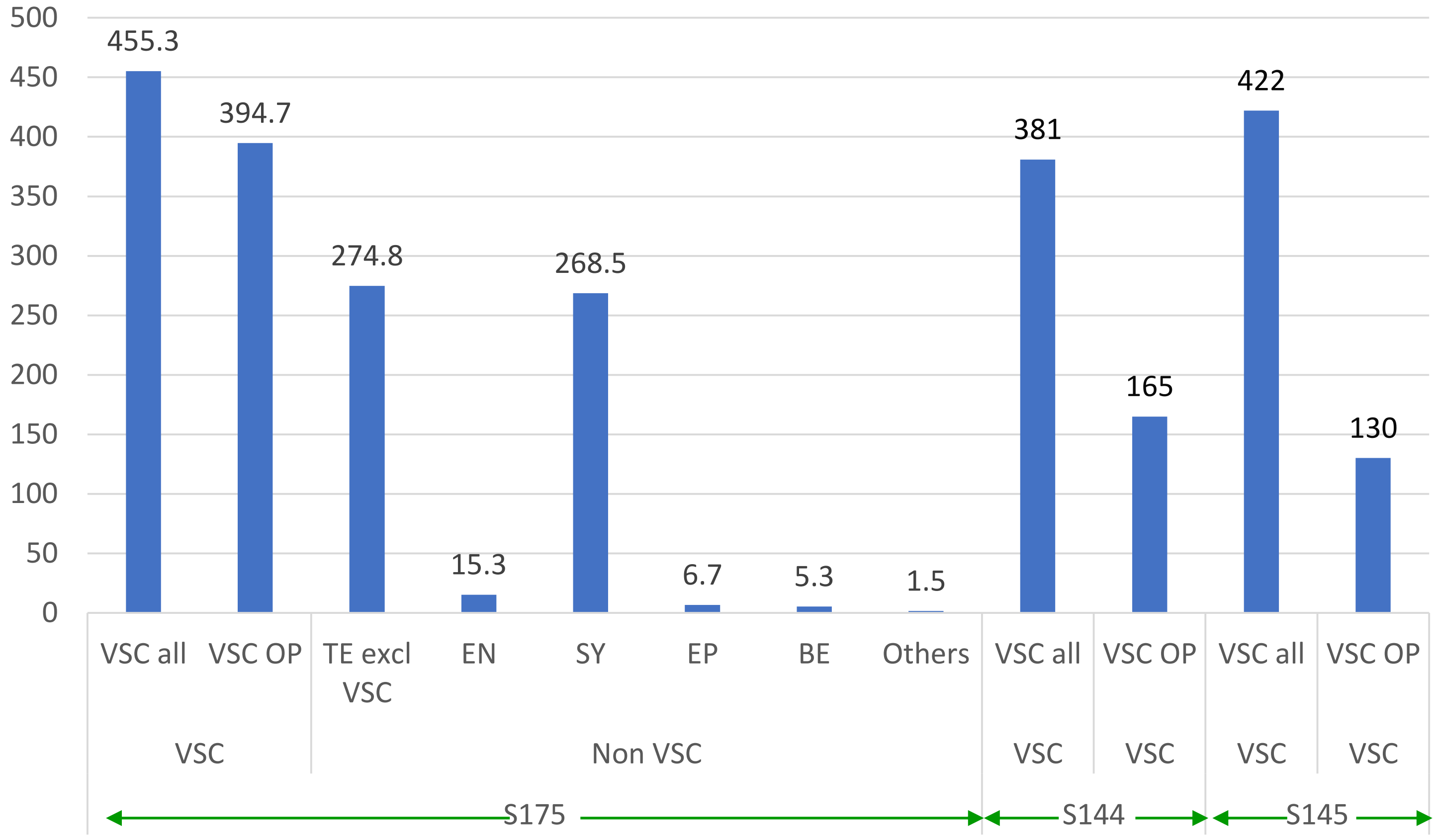
- Budget maîtrisé : Respect de la cible maximale validée à l'été 2021
- Méthodologie de facturation du petit matériel à définir

Courtesy of AL-4030

Industrial support

For the IS contracts, we have two limits in 2022-23:

- Max in **OP** in the period 2022-2026: **737 kCHF**.
- Max **contract envelop** in 2022-2023: **1350 kCHF.**



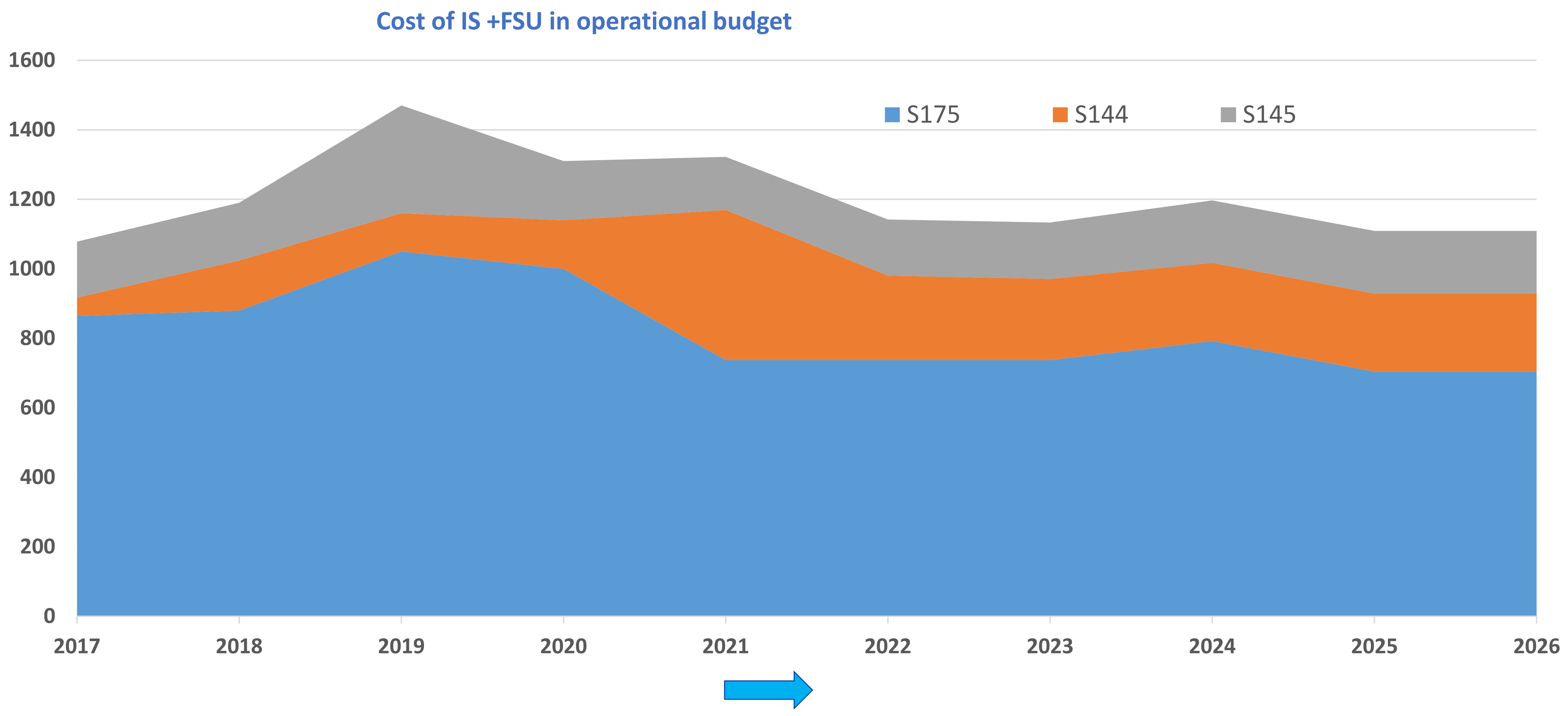
Total annual commitment of S175 in 2022 (all groups) = 1028 kCHF

TE-VSC only annual commitment in 2022 in OP = **395** kCHF

In VSC:

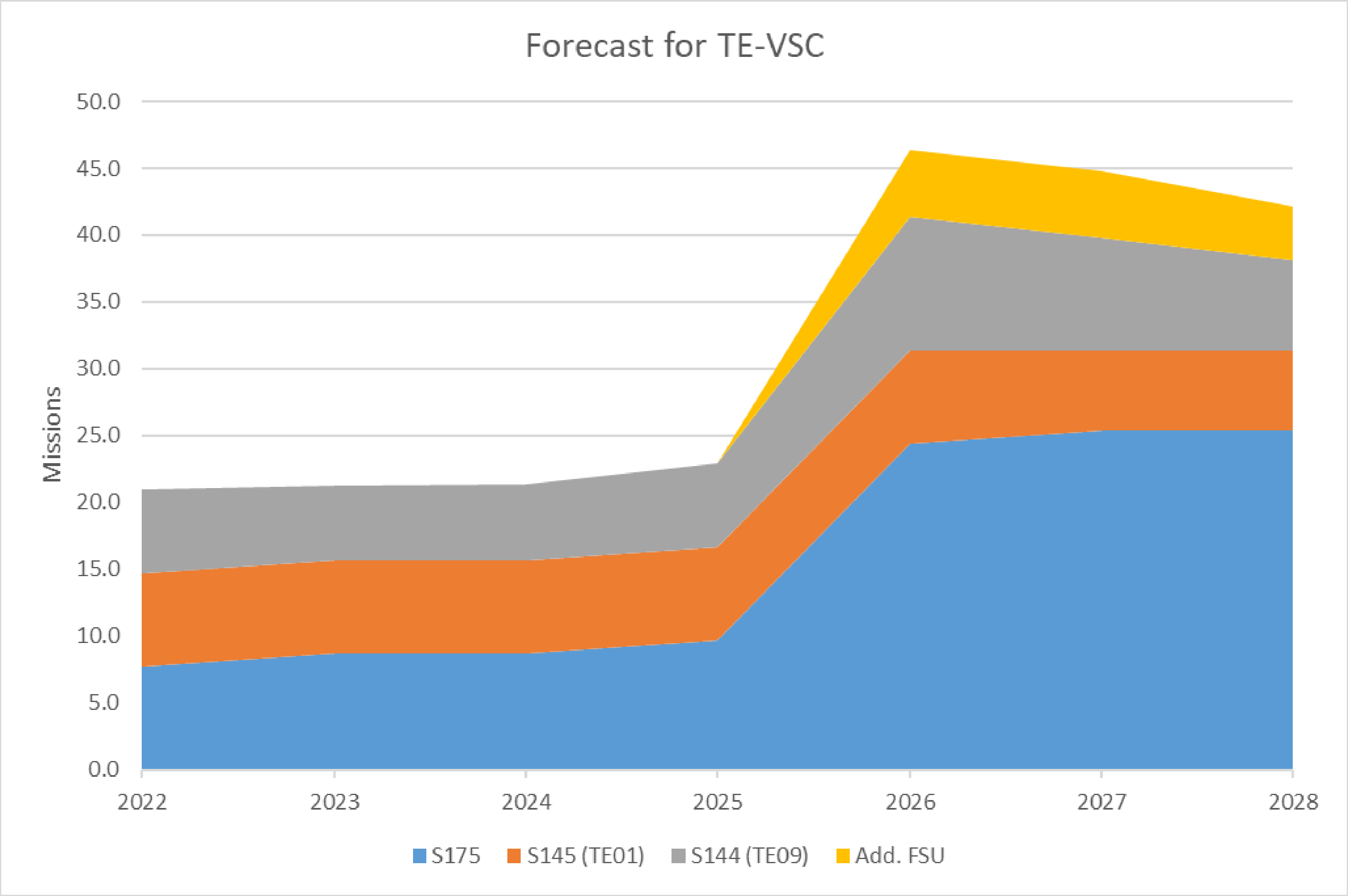
Contract	OP part
S175	87%
S144	43%
S145	31%

Forecast in OP: IS and FSU contracts



Ceiling for OP

Forecast IS and FSU for TE-VSC



- Current IS support contract will end on 30 June 2023.
- Current FSU contract will end on 31 March 2024.

Procedure for request for industrial support since 01-2015

2022 Budget

Identified need for industrial support and submit via dedicated SharePoint

Jaime, in his absence to Paul, verifies compatibility with our planning

Is the request compatible with our strategy and regular maintenance?

Yes → OK

No → Possible arbitration of GL

Direct request won’t be considered by our contractors.

Blanket contracts

TE-VSC Blanket contracts

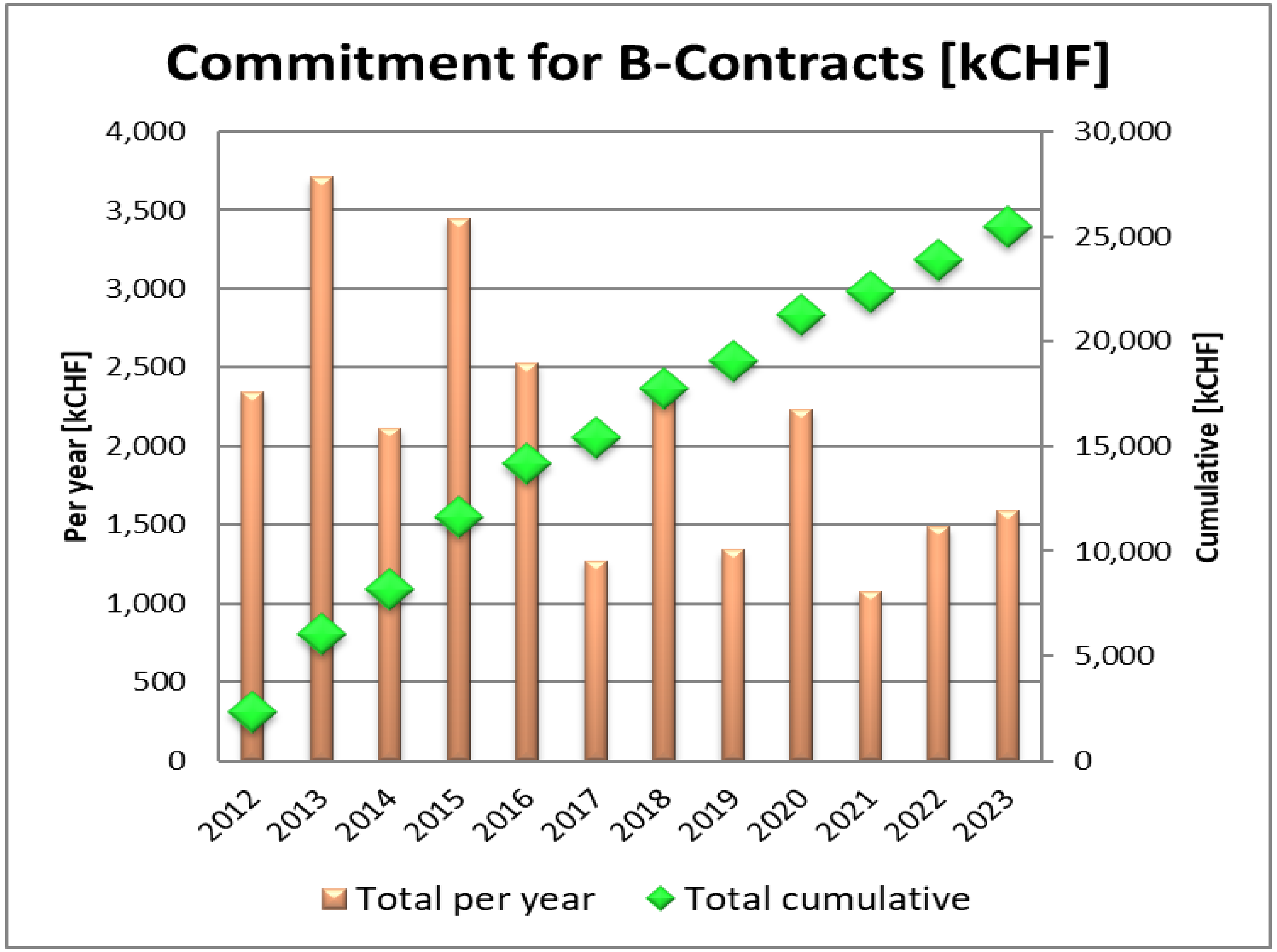
At present 8 blanket contracts running:

1. Supply of UHV all-metal valves with and without RF-contacts [3.758 MCHF]
2. Supply of Turbo-Molecular Vacuum Pump Packages [4.939 MCHF]
3. Supply of UHV right angle valves [1.153 MCHF]
4. Sputter ion pumps [3.5 MCHF]
5. Supply on non-evaporable getter pumps [2.184 MCHF]
6. Helium leak detectors [0.351 MCHF]
7. Overhaul of residual gas analysers [0.992 MCHF]
8. Dry pumps (High water vapour capacity) [0.75 MCHF]

2 New Blanket contracts being put in place:

- SMA rings [200 KCHF] → B1715 (not in CET yet)
- Dry primary pumps [550 KCHF] → Market Survey ongoing

Thanks Chiara for ensuring the contracts supervision



Status on 05.12.2022

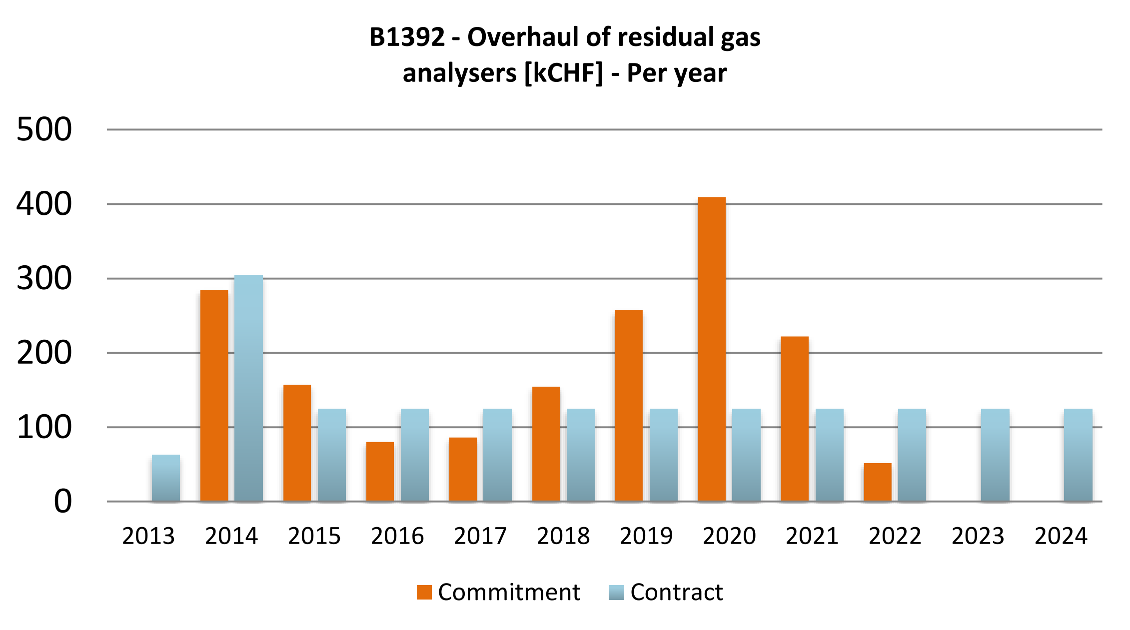
B CONTRACTS OVERALL STATUS

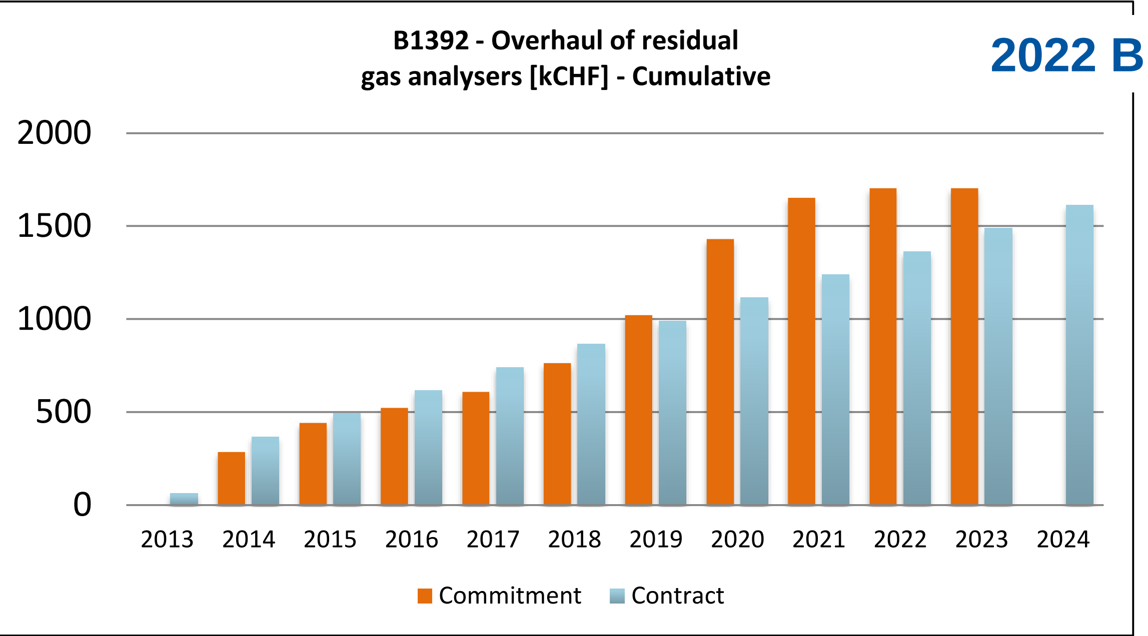
	Description	Company	Start Date	End Date	Extension End Date
B1501	Metal gate valves	VAT	01.01.2017	31.12.2021	31.12.2024
B1502	UHV right angle valves	VAT	01.01.2017	31.12.2021	31.12.2024
B1510	Dry pumps	Swiss Vac Tech	01.03.2017	28.02.2022	28.02.2024
B1520	Turbo pumps	Pfeiffer	01.01.2018	31.12.2022	31.12.2024
B1457	Non Evaporable Getter Pumps	SAES	15.01.2016	14.01.2022	14.01.2023
B1646	Sputter Ion Pumps	Agilent	16.10.2020	15.10.2025	
B1589	Helium Leak Detectors	Pfeiffer	01.01.2019	31.12.2024	
B1392	Overhaul of Residual Gas Analysers	Pfeiffer	20.02.2014	31.12.2024	

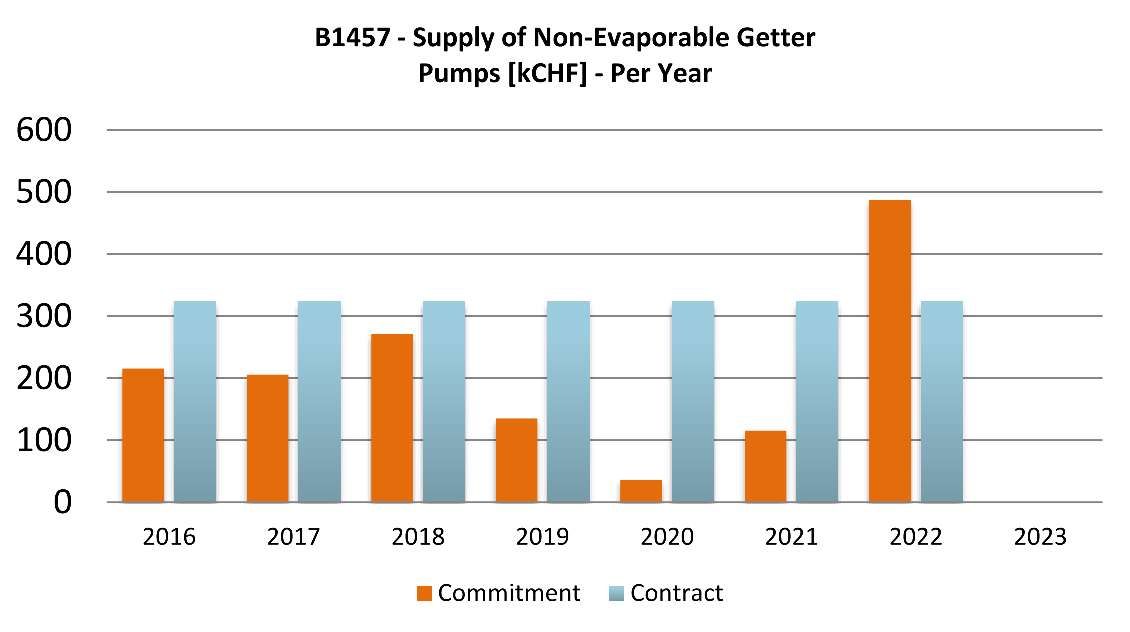
➡ Strategy under discussion with VAT

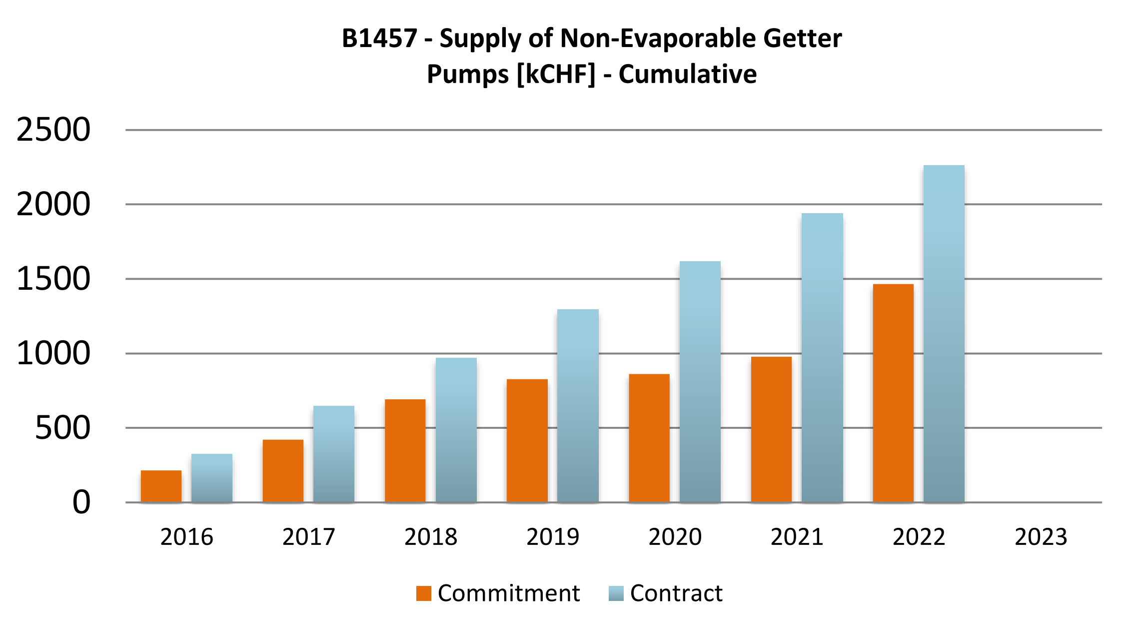
➡ Extension asked, a new B contract will be needed to be put in place in the coming year

2022 Budget

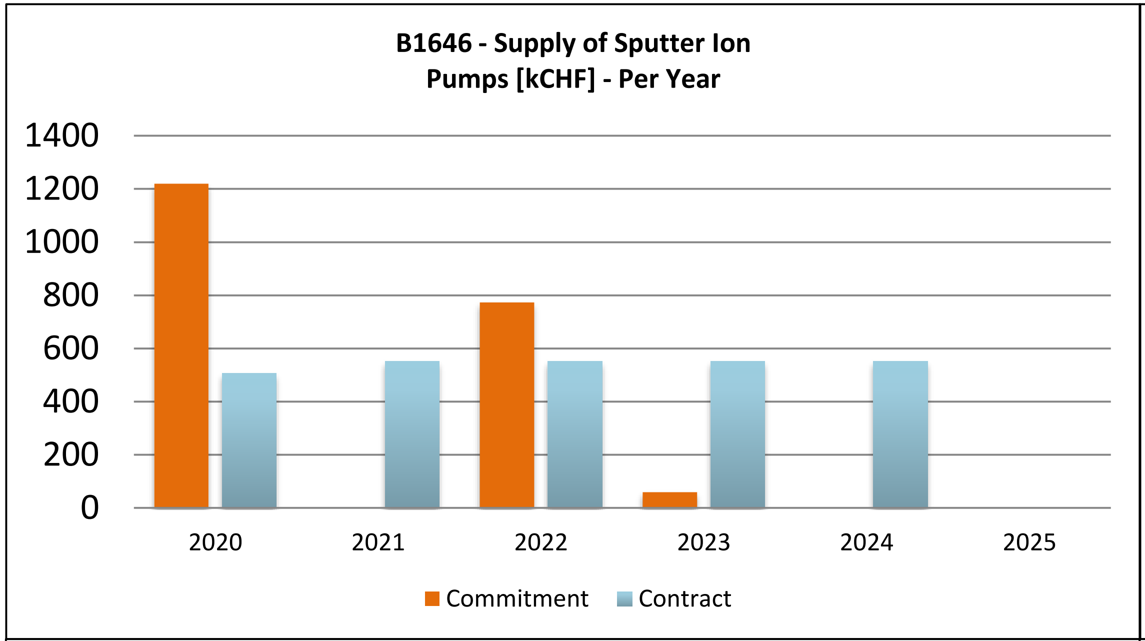

B1392 - Overhaul of residual gas analysers [kCHF] - Per year
500
400
300
200
100
0
2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Commitment
Contract


B1392 - Overhaul of residual gas analysers [kCHF] - Cumulative
2000
1500
1000
500
0
2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024
Commitment
Contract

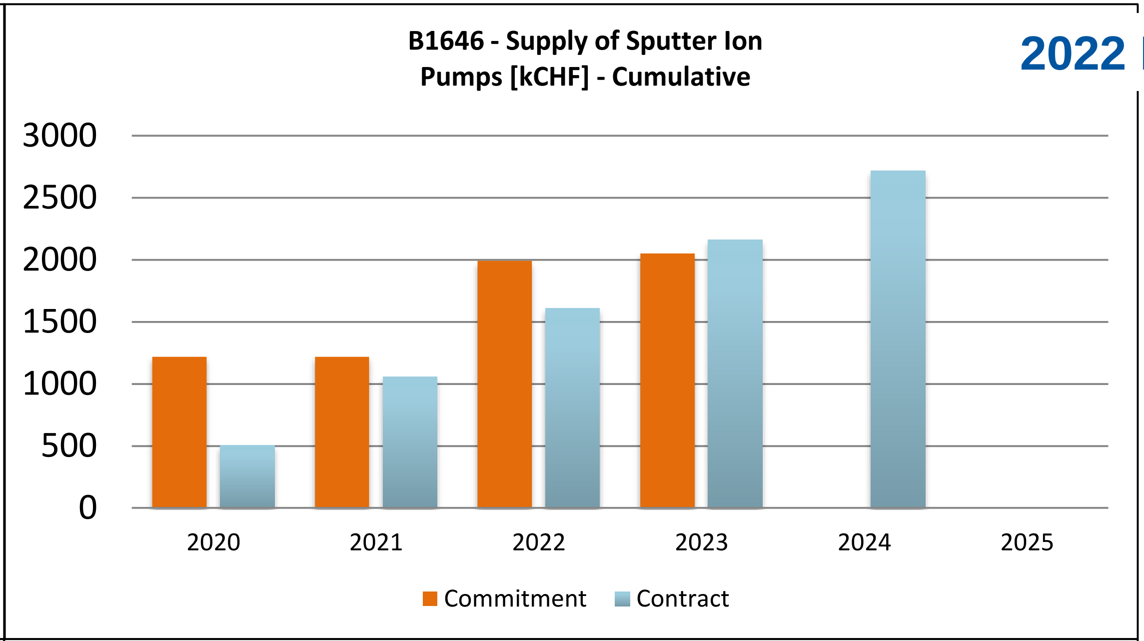

B1457 - Supply of Non-Evaporable Getter Pumps [kCHF] - Per Year
600
500
400
300
200
100
0
2016 2017 2018 2019 2020 2021 2022 2023
Commitment
Contract


B1457 - Supply of Non-Evaporable Getter Pumps [kCHF] - Cumulative
2500
2000
1500
1000
500
0
2016 2017 2018 2019 2020 2021 2022 2023
Commitment
Contract

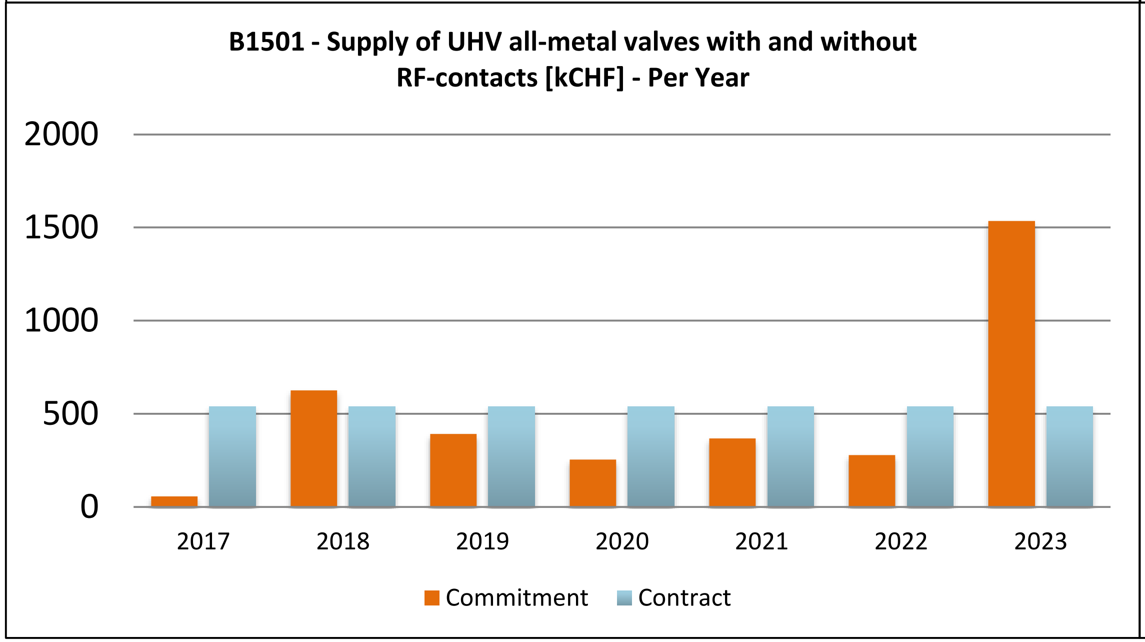
2022 Budget



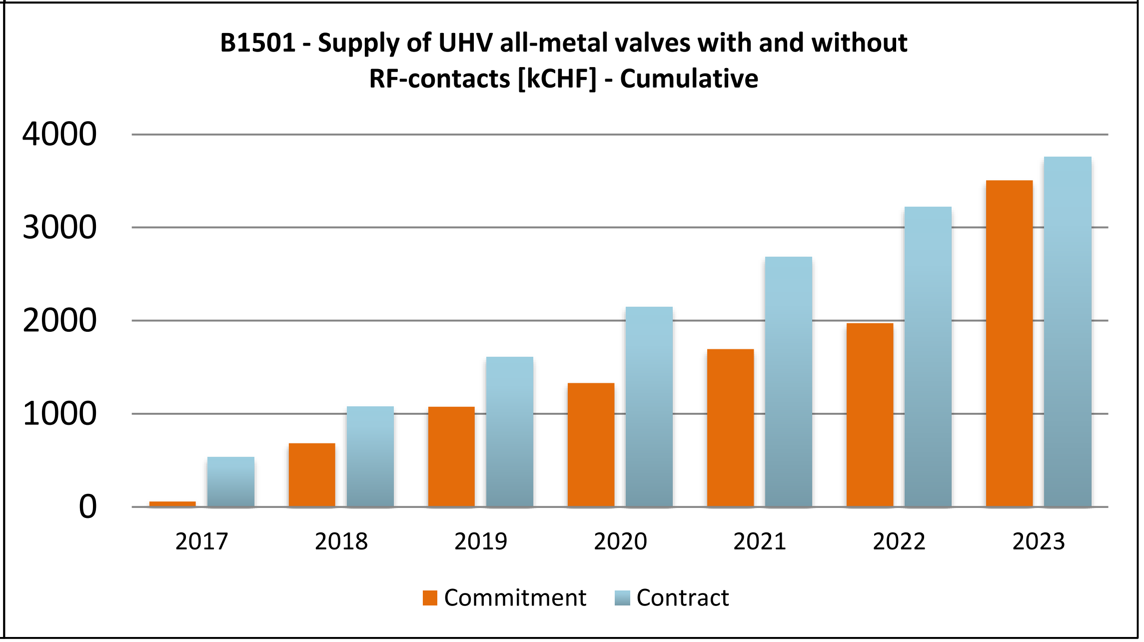
B1646 - Supply of Sputter Ion Pumps [kCHF] - Per Year
1400
1200
1000
800
600
400
200
0
2020
2021
2022
2023
2024
2025
Commitment
Contract



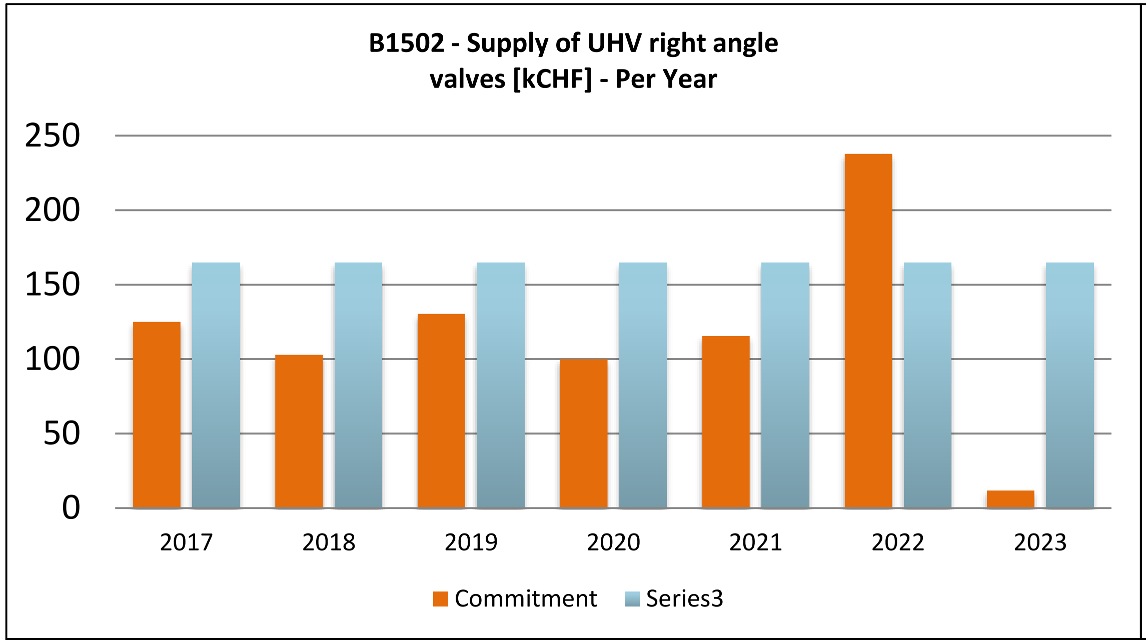
B1646 - Supply of Sputter Ion Pumps [kCHF] - Cumulative
3000
2500
2000
1500
1000
500
0
2020
2021
2022
2023
2024
2025
Commitment
Contract

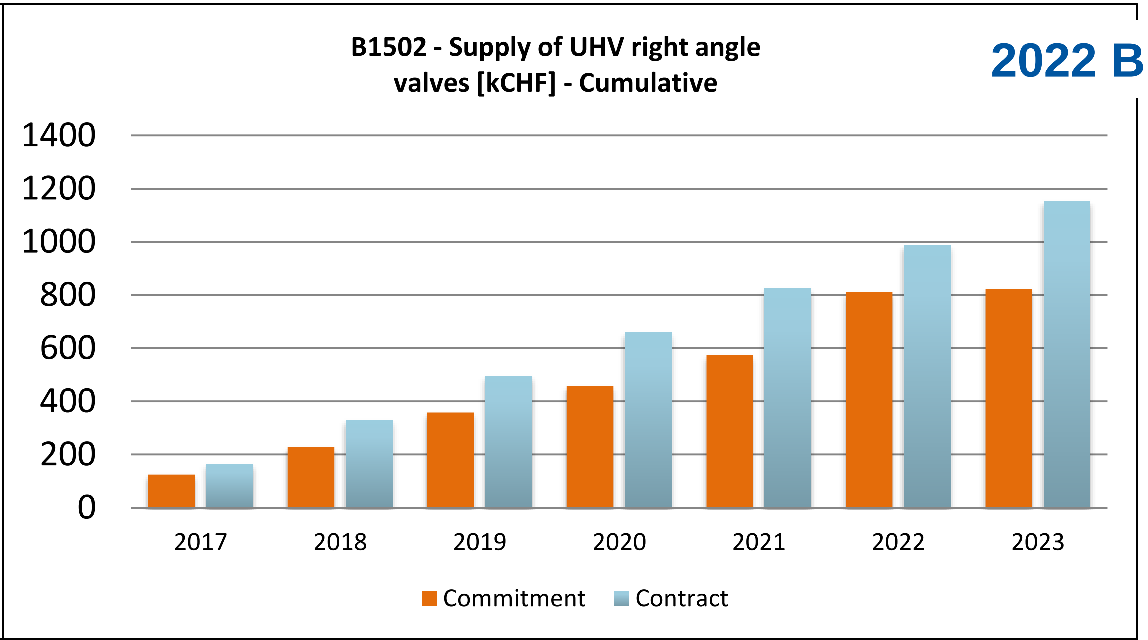


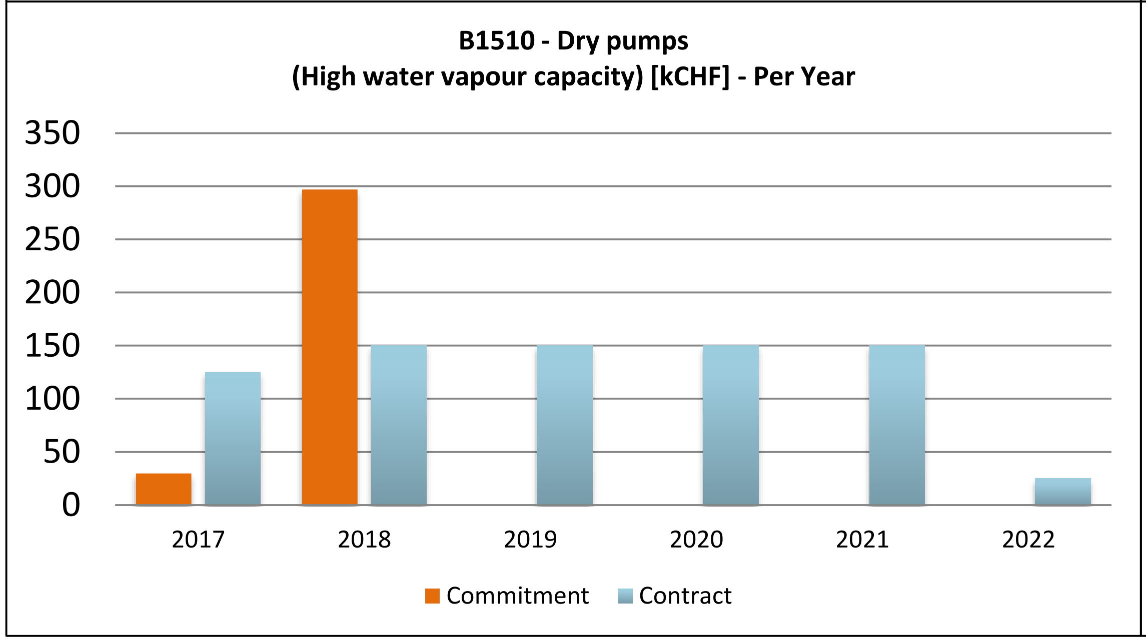
B1501 - Supply of UHV all-metal valves with and without RF-contacts [kCHF] - Per Year
2000
1500
1000
500
0
2017
2018
2019
2020
2021
2022
2023
Commitment
Contract

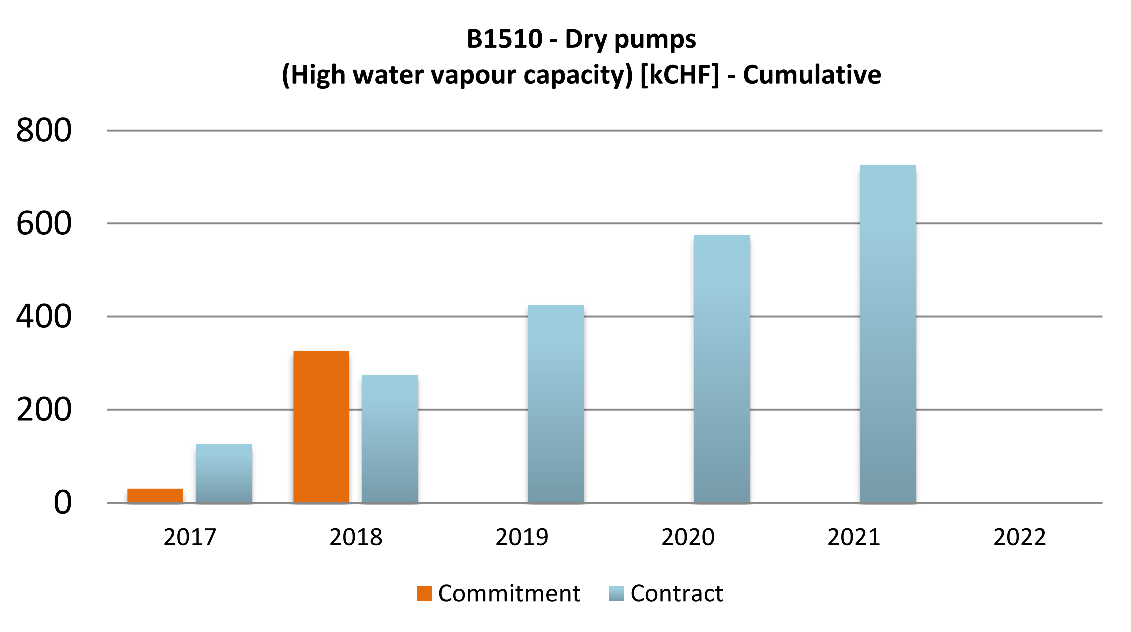


B1501 - Supply of UHV all-metal valves with and without RF-contacts [kCHF] - Cumulative
4000
3000
2000
1000
0
2017
2018
2019
2020
2021
2022
2023
Commitment
Contract

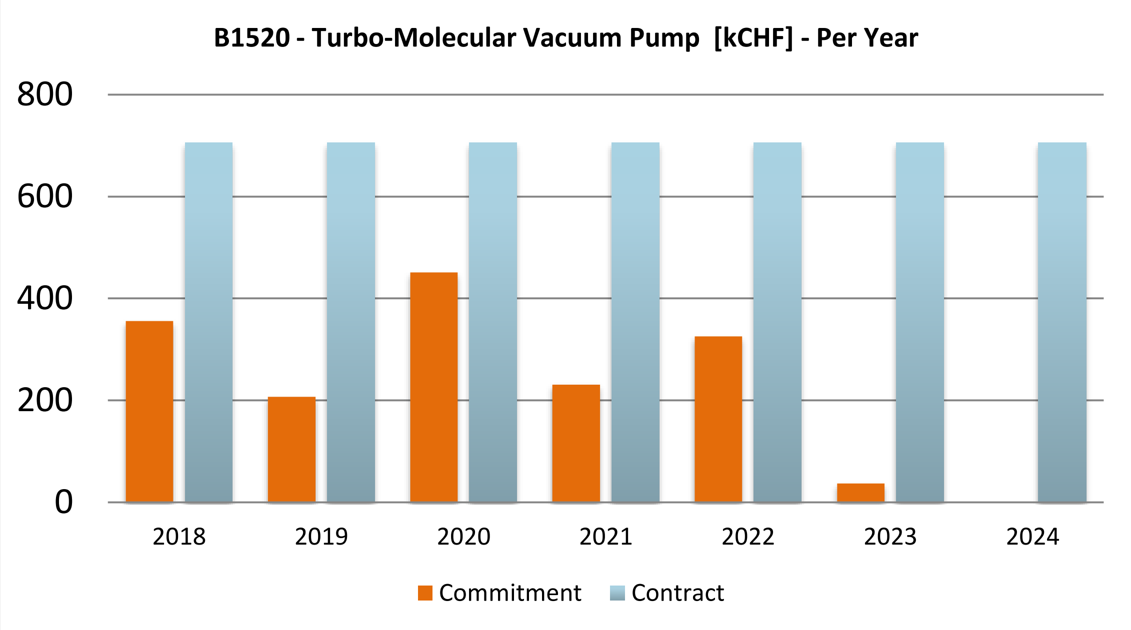

B1502 - Supply of UHV right angle valves [kCHF] - Per Year
250
200
150
100
50
0
2017
2018
2019
2020
2021
2022
2023
Commitment
Series3

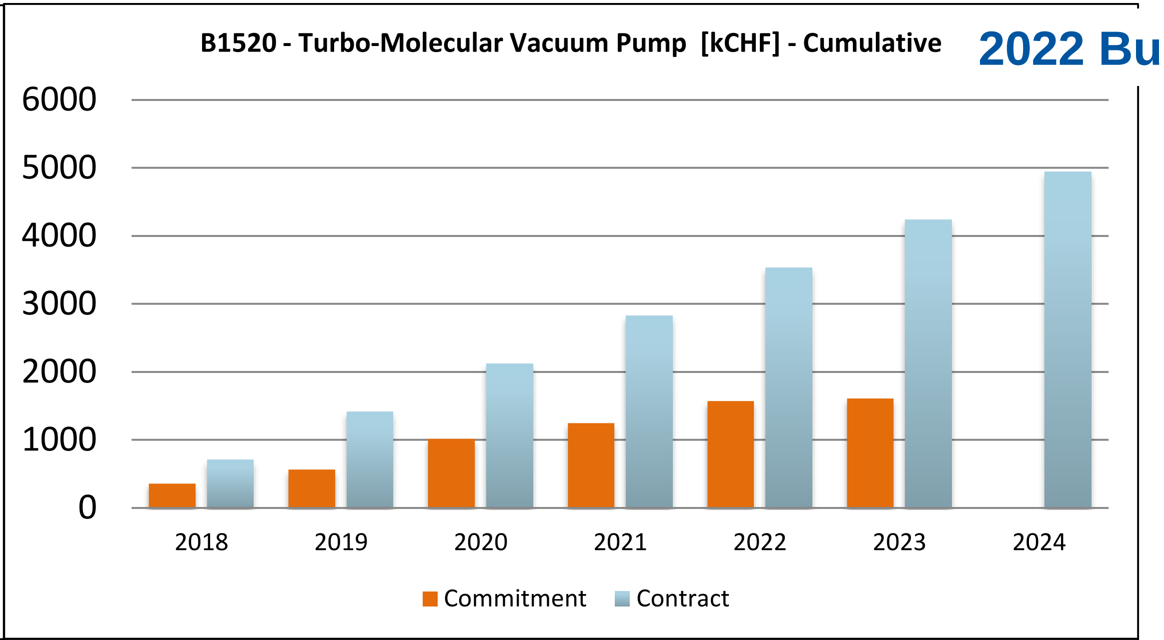

B1502 - Supply of UHV right angle valves [kCHF] - Cumulative
1400
1200
1000
800
600
400
200
0
2017
2018
2019
2020
2021
2022
2023
Commitment
Contract

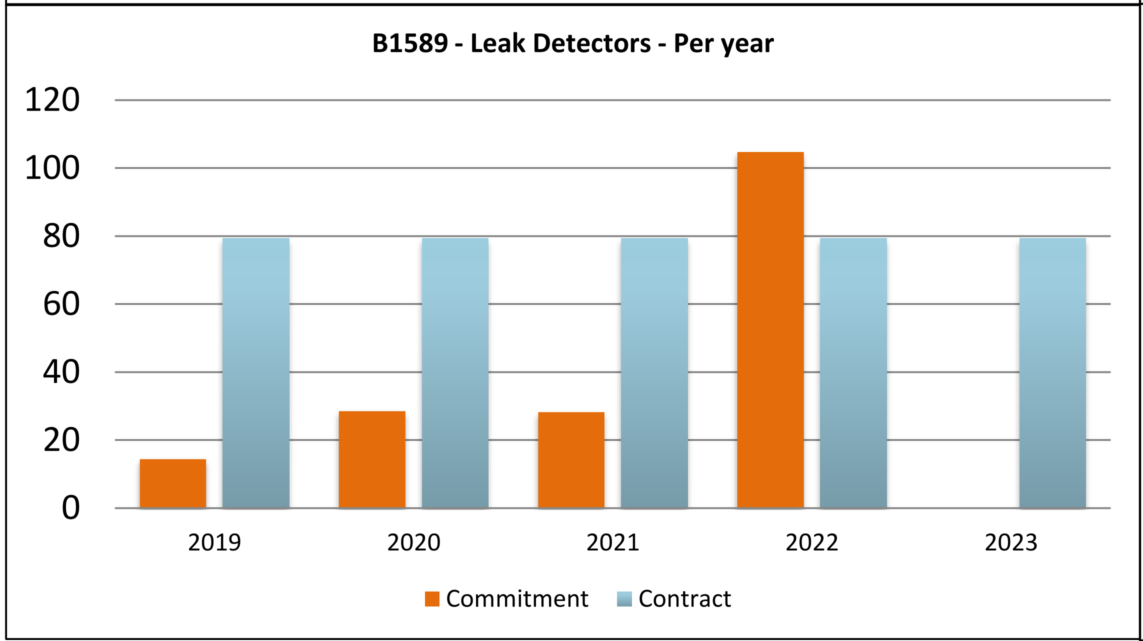

B1510 - Dry pumps (High water vapour capacity) [kCHF] - Per Year
350
300
250
200
150
100
50
0
2017
2018
2019
2020
2021
2022
Commitment
Contract

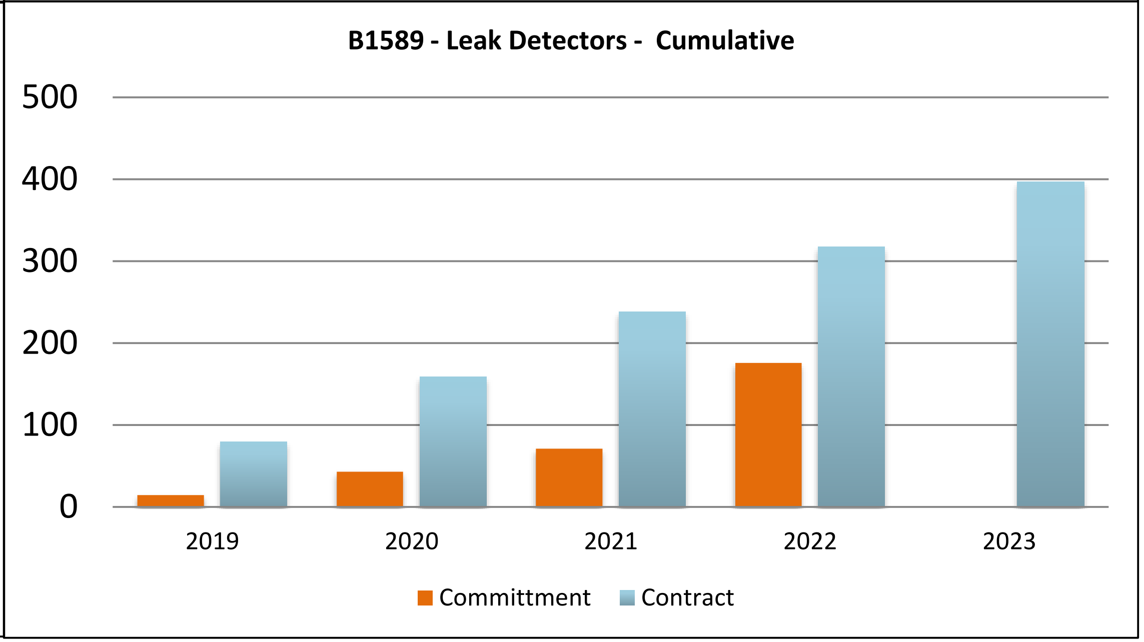

B1510 - Dry pumps (High water vapour capacity) [kCHF] - Cumulative
800
600
400
200
0
2017
2018
2019
2020
2021
2022
Commitment
Contract

2022 Budget

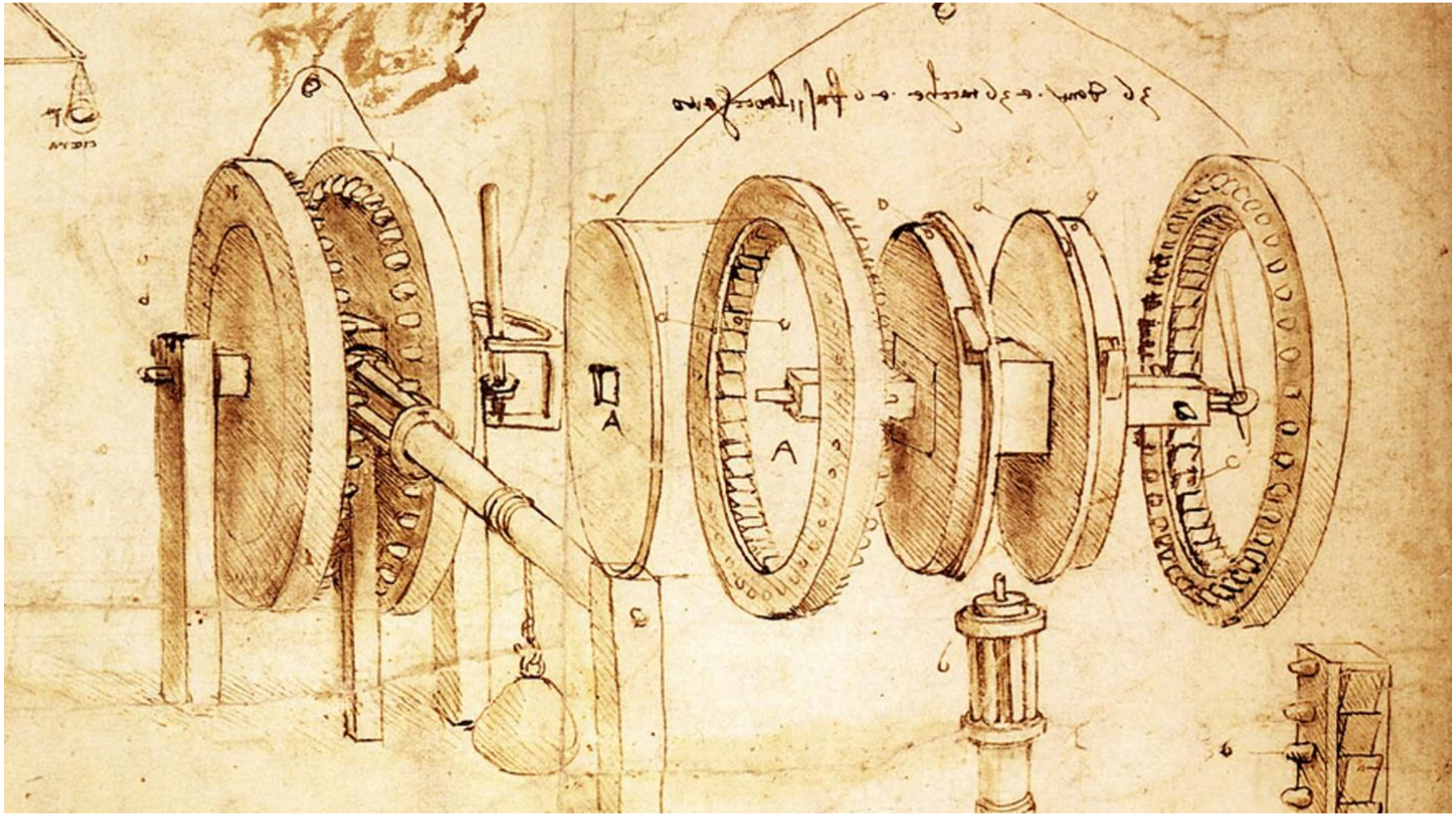

B1520 - Turbo-Molecular Vacuum Pump [kCHF] - Per Year
800
600
400
200
0
2018
2019
2020
2021
2022
2023
2024
Commitment
Contract


B1520 - Turbo-Molecular Vacuum Pump [kCHF] - Cumulative
6000
5000
4000
3000
2000
1000
0
2018
2019
2020
2021
2022
2023
2024
Commitment
Contract


B1589 - Leak Detectors - Per year
120
100
80
60
40
20
0
2019
2020
2021
2022
2023
Commitment
Contract


B1589 - Leak Detectors - Cumulative
500
400
300
200
100
0
2019
2020
2021
2022
2023
Committment
Contract

Consolidation



Leonardo da Vinci, *Codex Atlanticus*, Biblioteca Ambrosiana, Milan, Italy

TE-VSC Accelerator CONS in 2022

In addition to the operation budget, VSC submits funding requests for CONSOLIDATION of the existing accelerator complex.

CONS criteria = Safety conformance; Ensuring accelerator availability; End-of-life replacement; Spares; Equipment obsolescence; Achieving nominal performance.

LHC program - 1 consolidation packages

99712	VSC Prj: Acc Cons - LHC Turbo mobile pumping vacuum - P1
99716	VSC Prj: Acc Cons - LHC beam vacuum
99727	VSC Prj: Acc Cons - LHC Insulation Vacuum
99763	VSC Prj: Acc Cons - LHC bake out
99764	VSC Prj: Acc Cons - LHC Beam Vacuum instrumentation
99776	VSC Prj: Acc Cons - LHC Electron Cloud
99804	VSC Prj: Acc Cons - LHC MKB dilution kickers - Turbos
99810	VSC Prj: Acc Cons-Replacement BV mobile pumping groups-arcs
99829	VSC Prj: Cons X-ray Photoemission Spectroscope (XPS)
99893	VSC Prj: LS2 Consolidation of Vacuum Controls
99710	VSC Prj: Acc Cons - LHC Spares - Ins. vacuum turbos
99820	VSC Prj: Acc Cons - LHC spares - MBX chambers
99822	VSC Prj: Acc Cons - LHC spares - RT magnet chambers

Two new consolidations programs proposed in 2022:
1. SPS Transfer Line Vacuum system consolidation : 862 kCHF
2. SPS Ring and Transfer Lines Valve consolidation : 560 kCHF

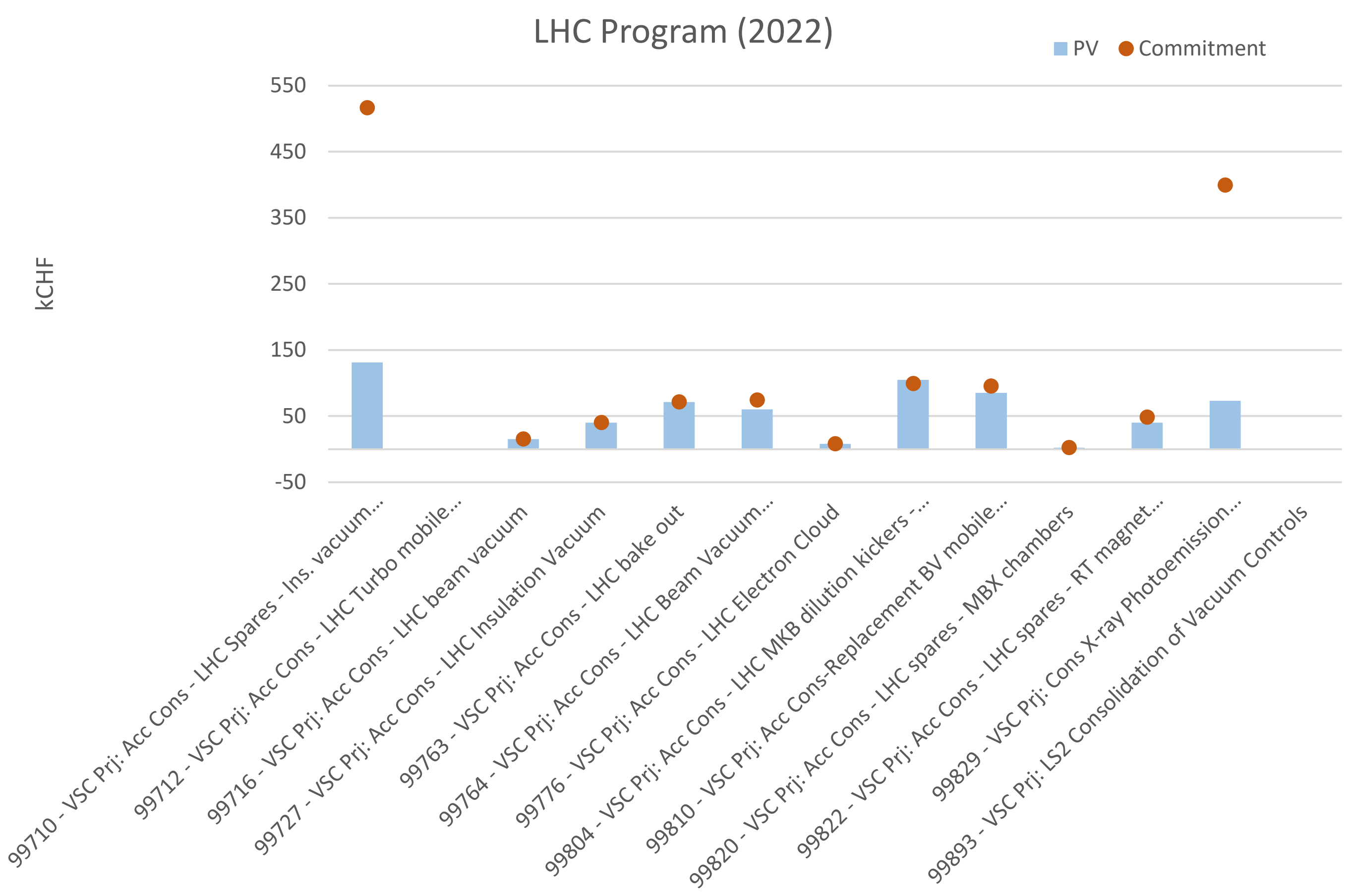
Other programs - 10 consolidation packages (NA cons not included)

99741	VSC Prj: Acc Cons - PS
99824	VSC Prj: Isolde pumps & front-end consolidation
99827	VSC Prj: Acc Cons - consolidation of PS controls
99830	VSC Prj: Acc Cons - PS fixed pumping
99831	VSC Prj: Acc Cons - PS magnet consolidation
99828	VSC Prj: Acc Cons - consolidation of SPS controls
99840	VSC Prj: Acc Cons - SPS ion pumps
99841	VSC Prj: Acc Cons - SPS spares
99842	VSC Prj: SPS cons - Pumping Groups cons - inj & ext zone
62722	VSC Prj: Acc Cons - SPS & TD2

Approved in 2022:
Consolidation of LHC Turbo mobile pumping groups and pump out valves (insulation vacuum) (718 kCHF).

TE-VSC Accelerator CONS in 2022

TE-VSC **LHC** consolidation budget (Status on 9.12.2022)

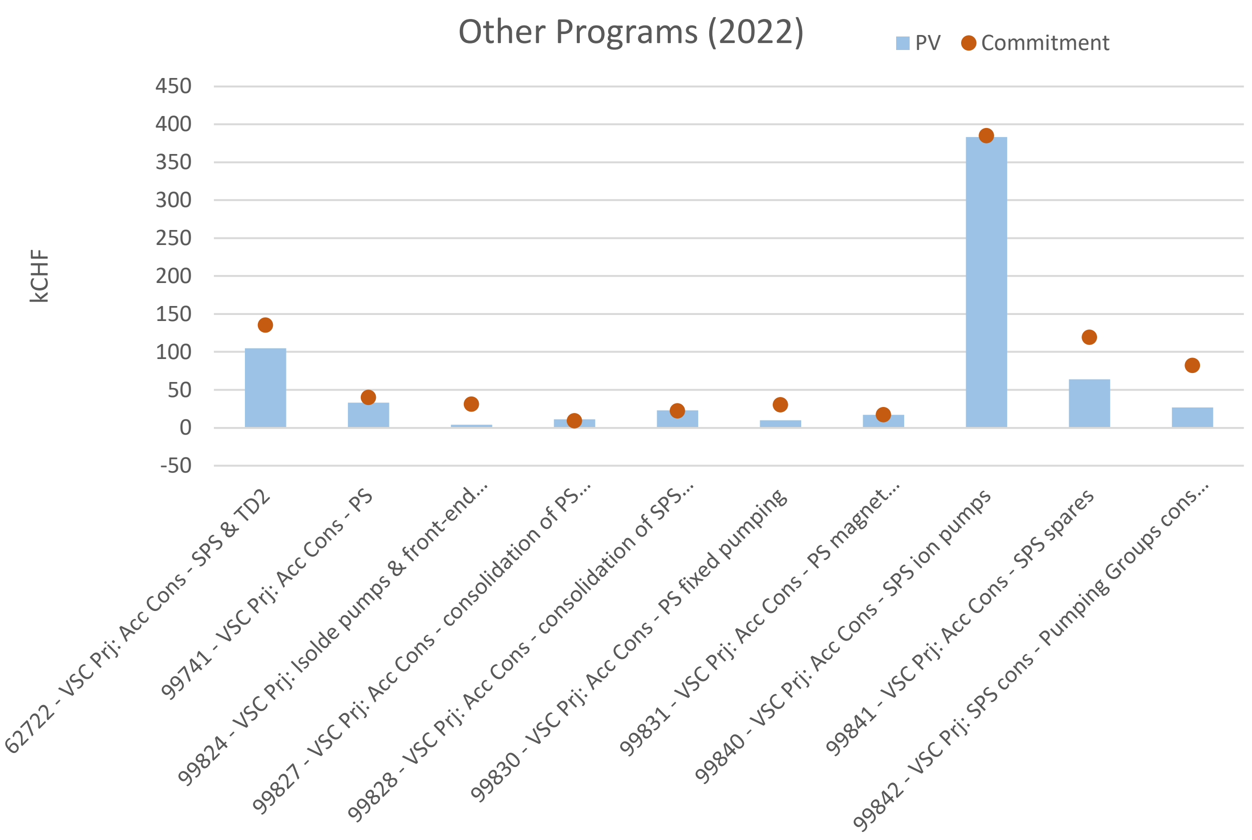


- **Total planned value: 630 kCHF**
- **Total commitment: 1367 kCHF**
- **Delays of big deliveries pushed the budget to 2023**

- Over several years, VSC has **consistently achieved** its CONS goals.
- As we compete with many Groups for limited CONS funds, **our continued efforts & results provide a solid basis** for further approval of essential VSC needs.
- In the future the focus should be put on matching the planned value with the charged budget ➔ Advance your orders!!

TE-VSC Accelerator CONS in 2022

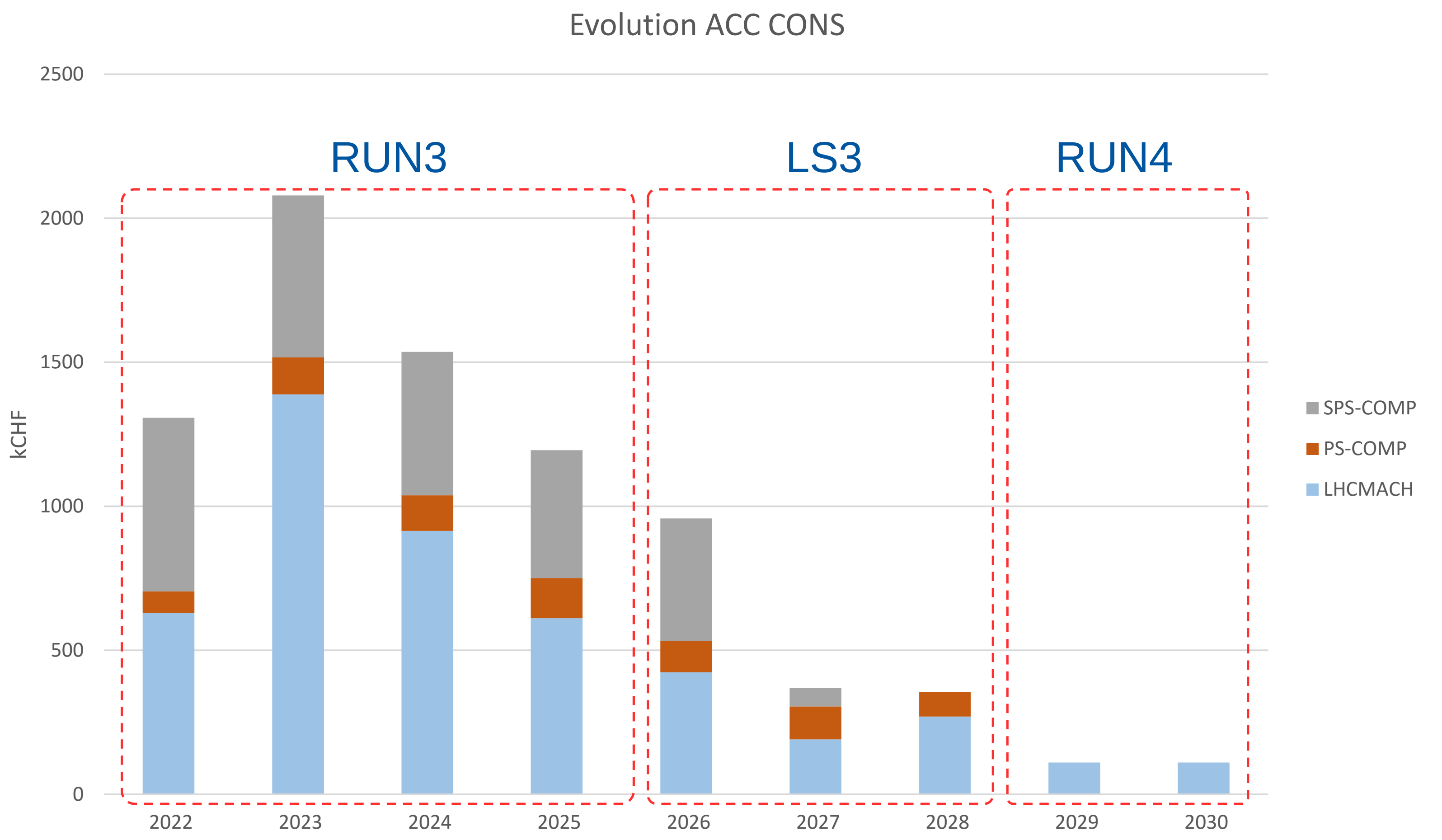
TE-VSC **other consolidation** budgets (Status on 9.12.2022)



- **Total planned value: 677 kCHF**
- **Total commitment: 877 kCHF**

TE-VSC Accelerator CONS in 2022

Status on 9.12.2022 (APT)



Total amount of 8.9 MCHF

LHC – 4.6 MCHF

PS – 0.8 MCHF

SPS – 2.6 MCHF

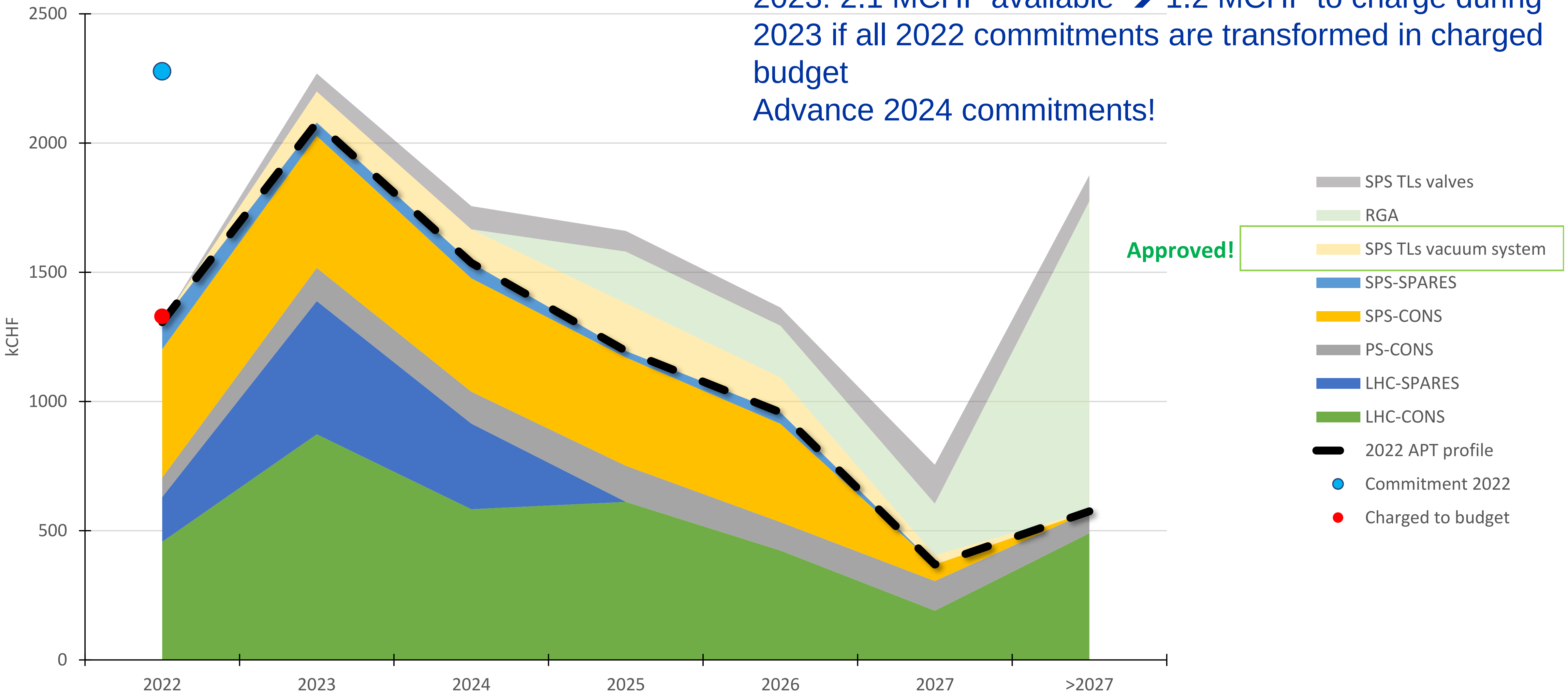
PROJ: SPS-CONS, PS-CONS, ADCONS, LHC-SPARES, LHC-CONS, NA-CONS, EA-CONS, SPS-SPARES, PS-SPARES

New requests at Consolidation Day (October 2022) - summary

New request #	Short description	Material [kCHF]	M2P [KCHF]	Time frame	Priority
VSC-1	SPS Transfer Line Vacuum systems consolidation Consolidation of ion pumps (reusing VPIAL from LEP), gauges, spare chambers and windows.	862	FSU: 0.6 Y's G/S: 0 Y's	2023-2027	1
VSC-2	SPS Ring and Transfer Lines Vacuum valve consolidation Consolidation of valve pneumatics (irradiation), old venting valves and VVRs in sectors 6001, 440 and 2002	560	FSU: 0.3 Y's G/S: 0 Y's	2023-2028	2

Proposed spending profile

0.9 MCHF already committed for 2023!
2023: 2.1 MCHF available ➔ 1.2 MCHF to charge during 2023 if all 2022 commitments are transformed in charged budget
Advance 2024 commitments!



HiLumi
HL-LHC PROJECT

Purpose of HL-LHC

At present, **HL-LHC is the most important CERN's project**. Its objective is an **annual** LHC integrated luminosity of **250 fb^{-1} in ATLAS and CMS** for 12 years of operation.

To achieve this ambitious goal:

- The LHC **injector chain** will be **upgraded**:
  - Bunch population from 1.15 to 2.2×10^{11}.
  - Emittance reduction from 3.4 to 2.0 μm at the SPS extraction.

- The beam optics in **IP1 and IP5** will be **improved**:
  - β^* reduction from 0.55 to 0.15 m.
  - Bunch rotation by crab cavities.

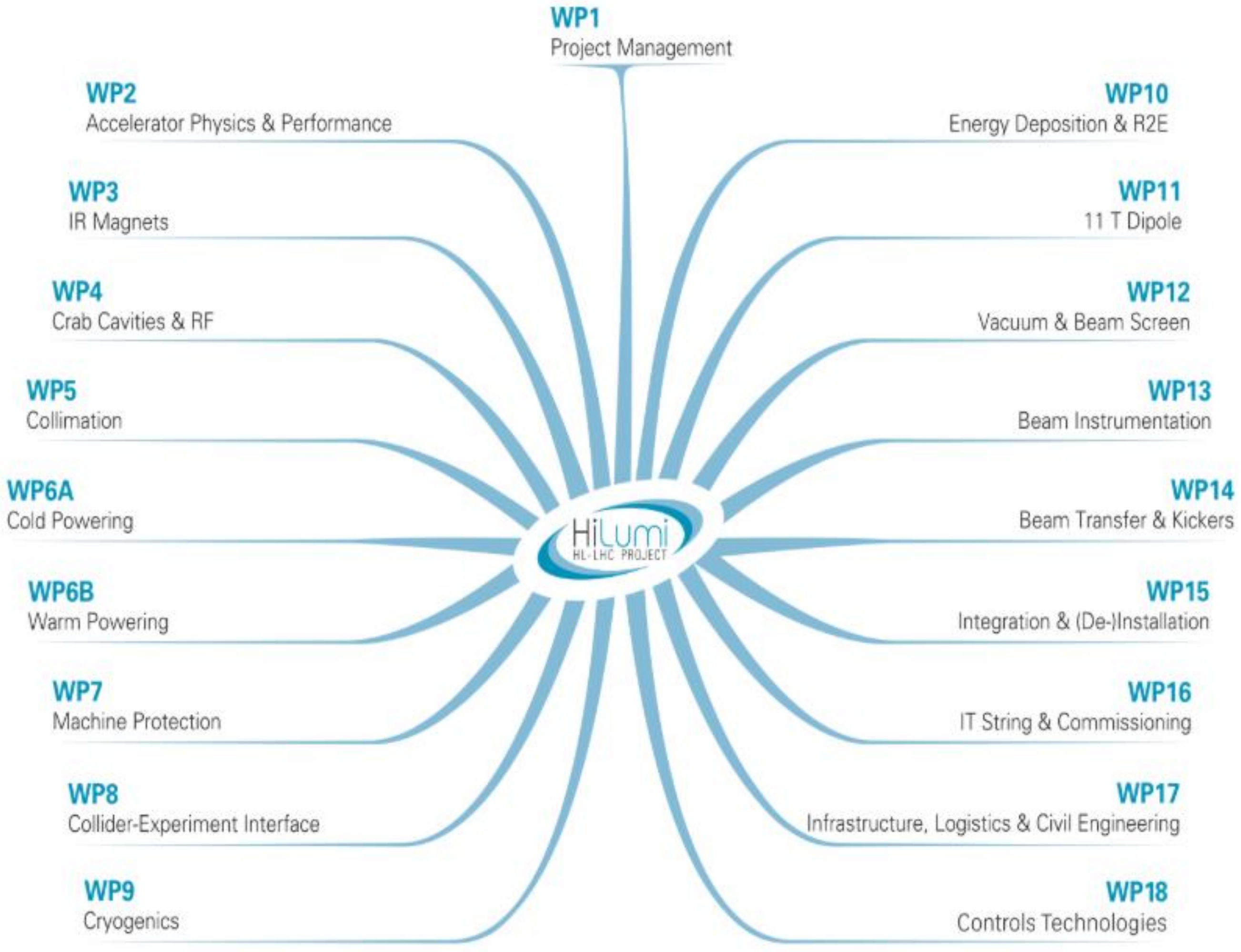
The new parameters coupled together imply, among other modifications, **larger aperture insertion magnets** (triplet magnets, D1, D2 and Q4, Q5 magnets) in P1 and P5.

The insertion magnets of P2 (ALICE) and P8 (LHCb) are not replaced nor modified.

HL-LHC in TE-VSC

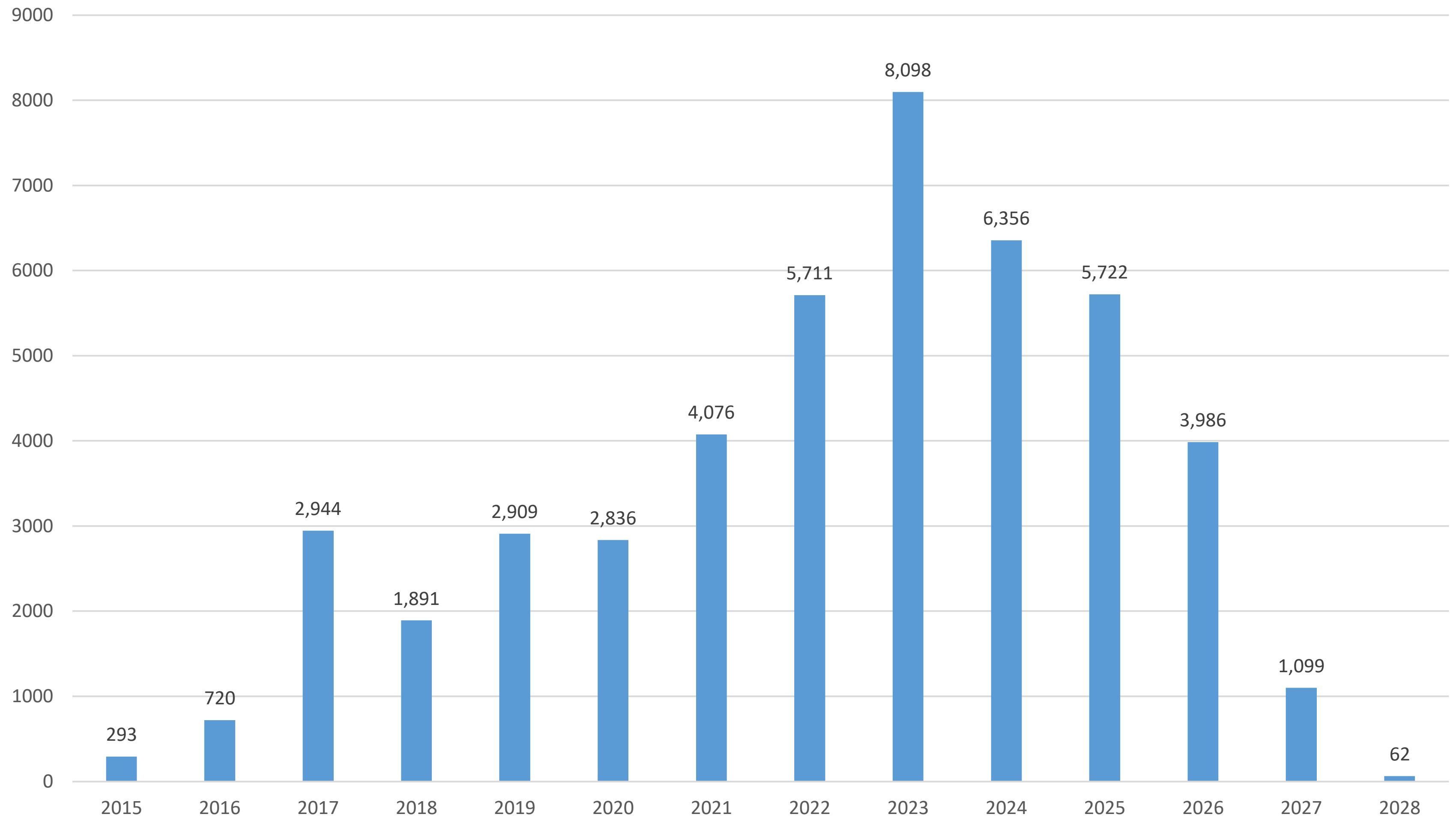
2022 Budget

Vincent Baglin & Giuseppe Bregliozzi: TE-VSC link and deputy link persons for the HL-LHC project



HL-LHC is divided into 19 Work Packages.

TE-VSC HL-LHC (all VSC)



Crosstab Report

Report extracted on 08-Dec-2022 18:38

Rows:
WBS from 0 to 1

Columns:
Time from 0 to 0

Time:
All

Category of Accounts:
Materials (all) kCHF

Filters:

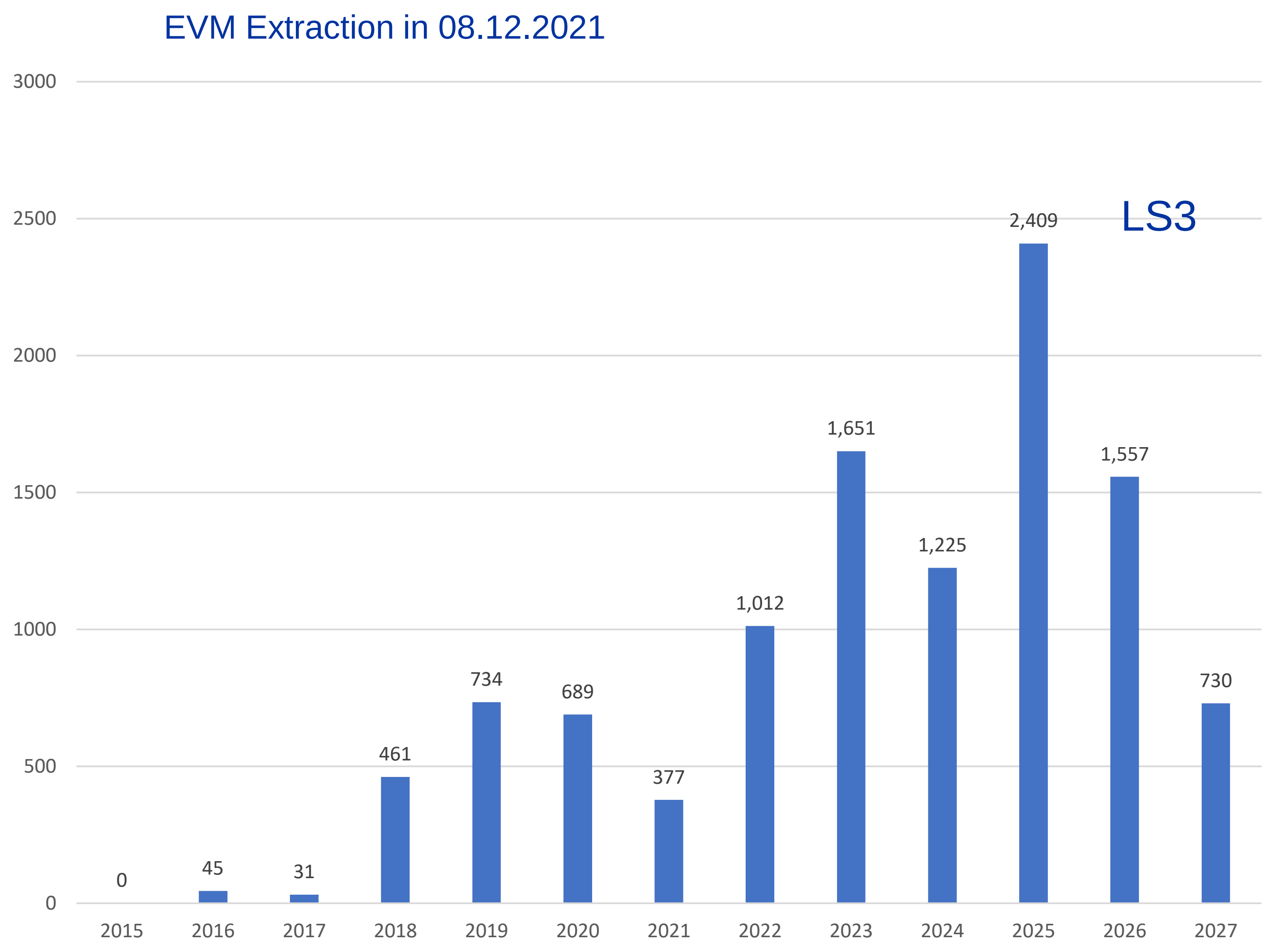
Org (Res)	TE-VSC
Wbs	CERN-PPA
Project (Res)	HL
Workunit	
Status	PL, AC, CO

Show:

A	APT
	Totals
	Use Trend (All) for EVM projects

TE-VSC HL-LHC CONS (all VSC)

2022 Budget



HL-LHC CONS

Total amount of 10.9 MCHF

Main activities:

- LS2 : BS and LSS
- RUN3 and LS3: LSS

Crosstab Report

Report extracted on 08-Dec-2022 18:44

Rows:
WBS from 0 to 1

Columns:
Time from 0 to 0

Time:
All

Category of Accounts:
Materials (all) kCHF

Filters:

Org (Res)	TE-VSC
Wbs	CERN-PPA
Project (Res)	HL-C
Workunit Status	PL, AC, CO

Show:

A	APT
	Totals
	Use Trend (All) for EVM projects

What's the difference between ACC-CONS & HL-CONS ?

2022 Budget

TE-VSC submits funding requests for ACCelerator CONSolidation (ACC-CONS):

- Criteria: Safety conformance; availability; end-of-life replacement; spares; obsolescence; achieving nominal performance.
- Vision of the needs for all operational accelerators for at least the next 5 years.

To upgrade LHC to HL-LHC, some costs are taken outside of HL project and grouped as HL CONSolidation. So for TE-VSC we have 'HL-LHC WP12' & 'HL-LHC WP12 CONS', where the latter includes:

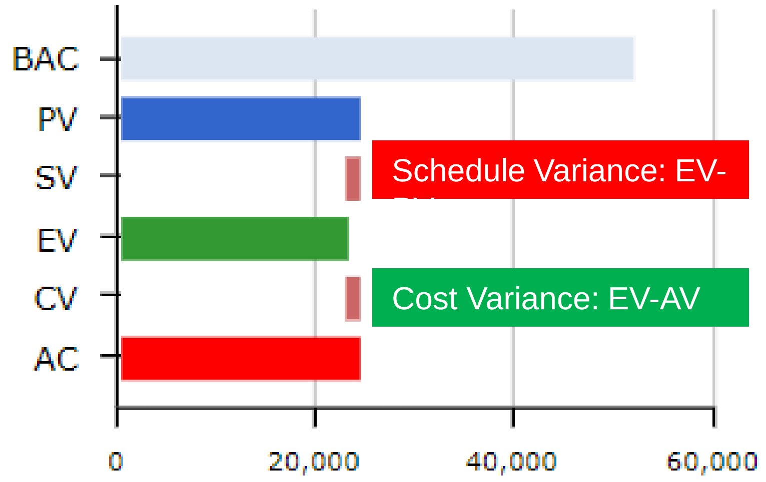
- Manpower to demount & remount existing vac equipment - eg due to civil engineering at IP1 & IP5 or equipment relocation,
- R2E infrastructure changes due to higher radiation doses – eg control rack displacements, cable routings,
- R2E infrastructure changes due to pressure measurement issues – eg VPI re-cabling at LSS3 collimators,
- Replacement of equipment that doesn't have the required capacity for HL needs – eg new PLC masters & slaves,
- Increase of beam vacuum instrumentation all around the ring for adequate monitoring during the HL era,
- Replacement of mobile equipment in readiness for heavy use during HL installation in LS3 – eg RGA & magic box,
- HL spares – eg vacuum chambers, interconnections, instrumentation.

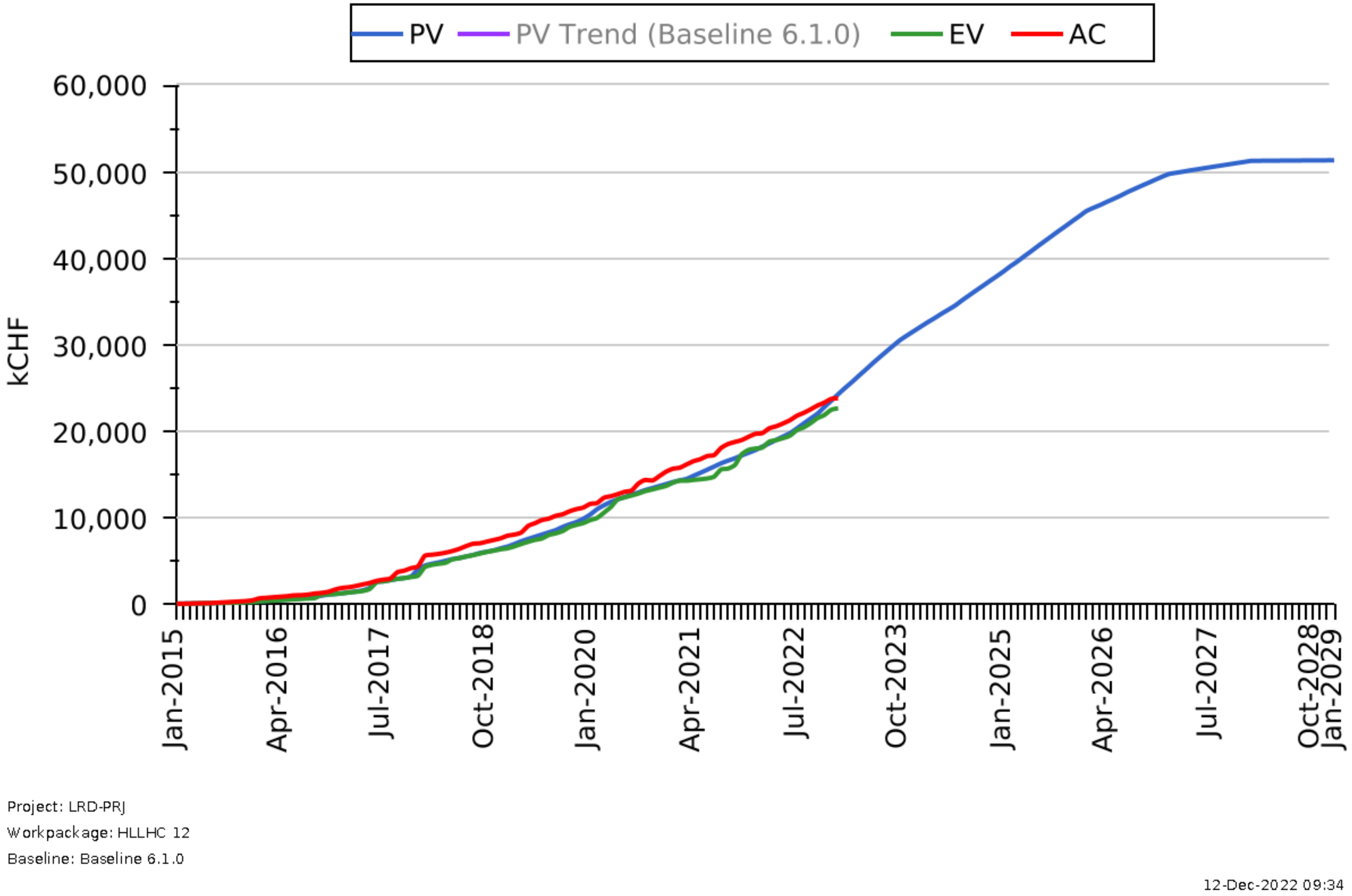
Presently ACC-CONS and HL-CONS are separately managed within Accelerator & Technology Sector (ATS).

- On 7th Nov '18, TE-VSC were asked to review all the approved & pending activities,
- Goals: defend existing approved activities, identify possible cost savings, check which activities can be postponed & the impact, check & remove any double-counting, motivate the (financial) approval of pending items, submit new requests as required.
- Outcome: Some inconsistencies in the categorization of some ACC-CONS, HL-LHC & HL-LHC-CONS workunits. Several significant VSC cost savings were identified, allowing the approval of pending VSC requests.

Status on 12 Dec 2022 (EVM, baseline 6.1.0)

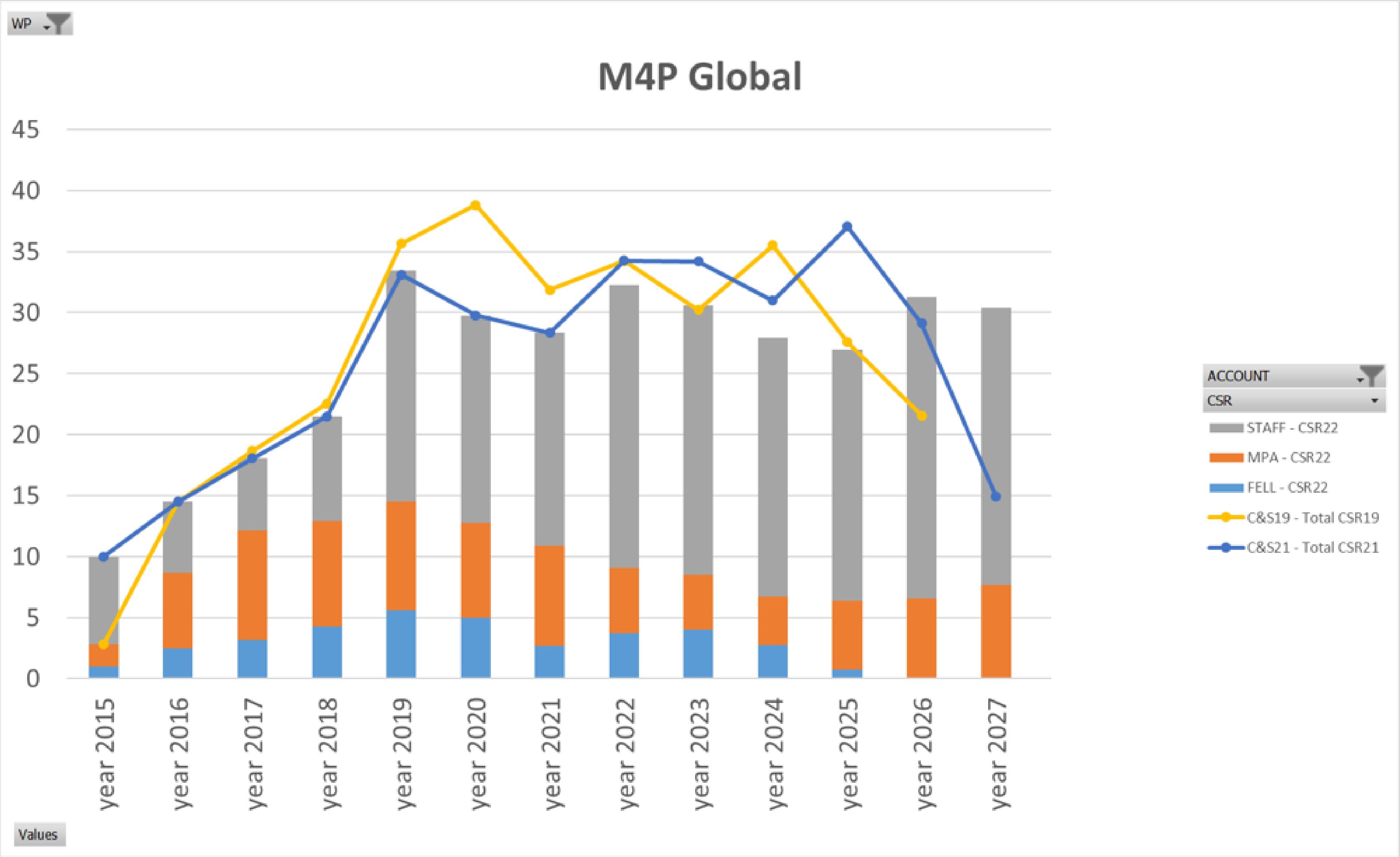
kCHF			
PV	**EV**	**AC**	**BAC**
23782	**22612**	**23763**	51304





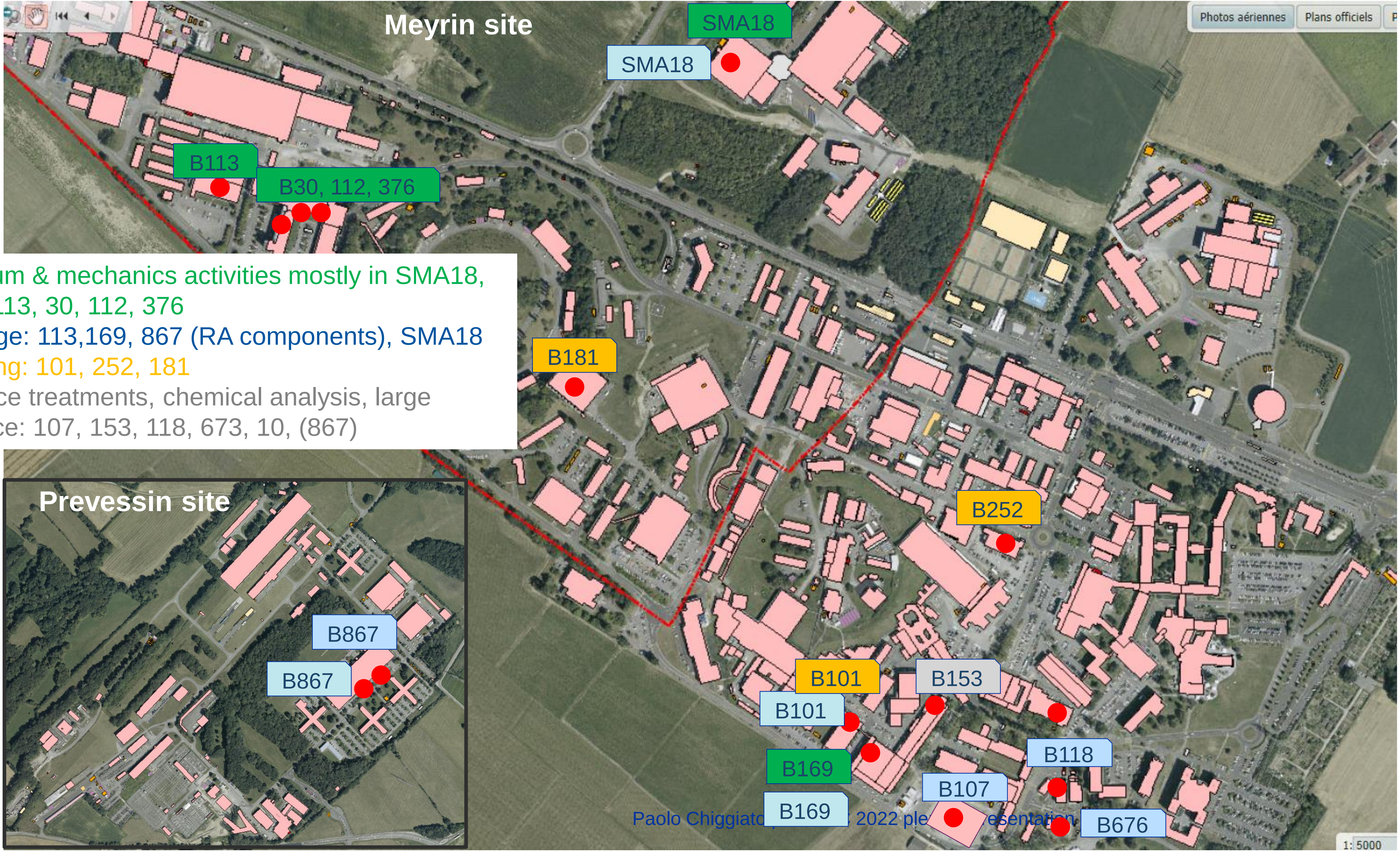
PV: Planned Value
EV: Earned Value (i.e. the value of completed work expressed in terms of budget assigned to that work)
AC: Actual Cost (i.e. the costs actually incurred and recorded in accomplishing the work performed)
BAC: Budget At Completion

HL-LHC WP12 personnel plan



HL-LHC: Cost and Schedule Review 2022

Space management and strategy



Vacuum & mechanics activities mostly in SMA18, 101, 113, 30, 112, 376

Storage: 113,169, 867 (RA components), SMA18

Coating: 101, 252, 181

Surface treatments, chemical analysis, large furnace: 107, 153, 118, 673, 10, (867)

Restructuring of the welding workshop (b. 376)

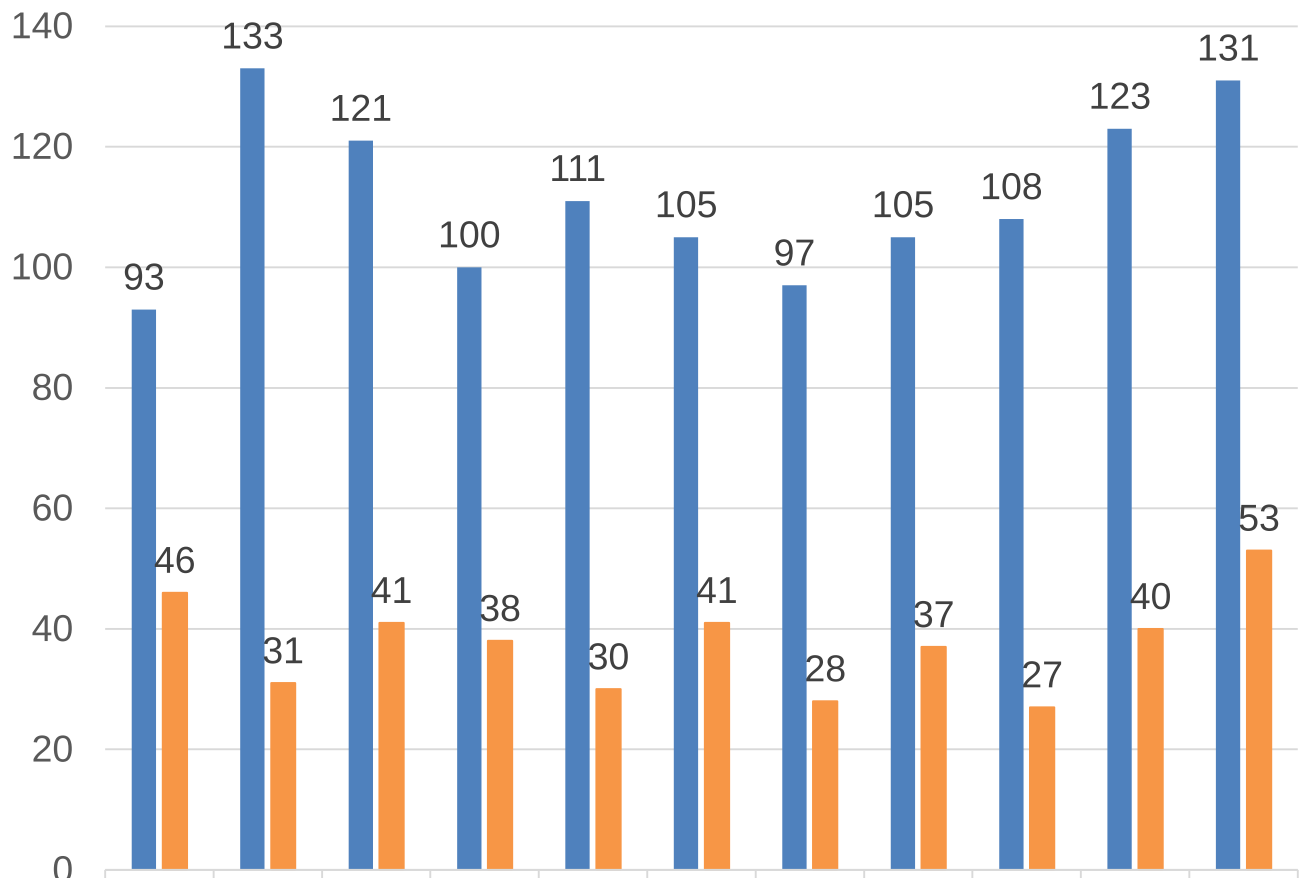
TE-VSC's services

W. Kandinsky, *Farbstudie Quadrate*, 1913

TE-VSC services: 2022 summary updated on November 30th

Service	Number of jobs (all included)	Income [kCHF]
Surface treatment	1729	416
Surface treatment for ext. institutes	3	24
Chemical analysis	41	42
Thin film deposition	38	50
Large furnace	6	6
Total	1817	538

Surface treatments: 1639 jobs (status on 30.11.2022)

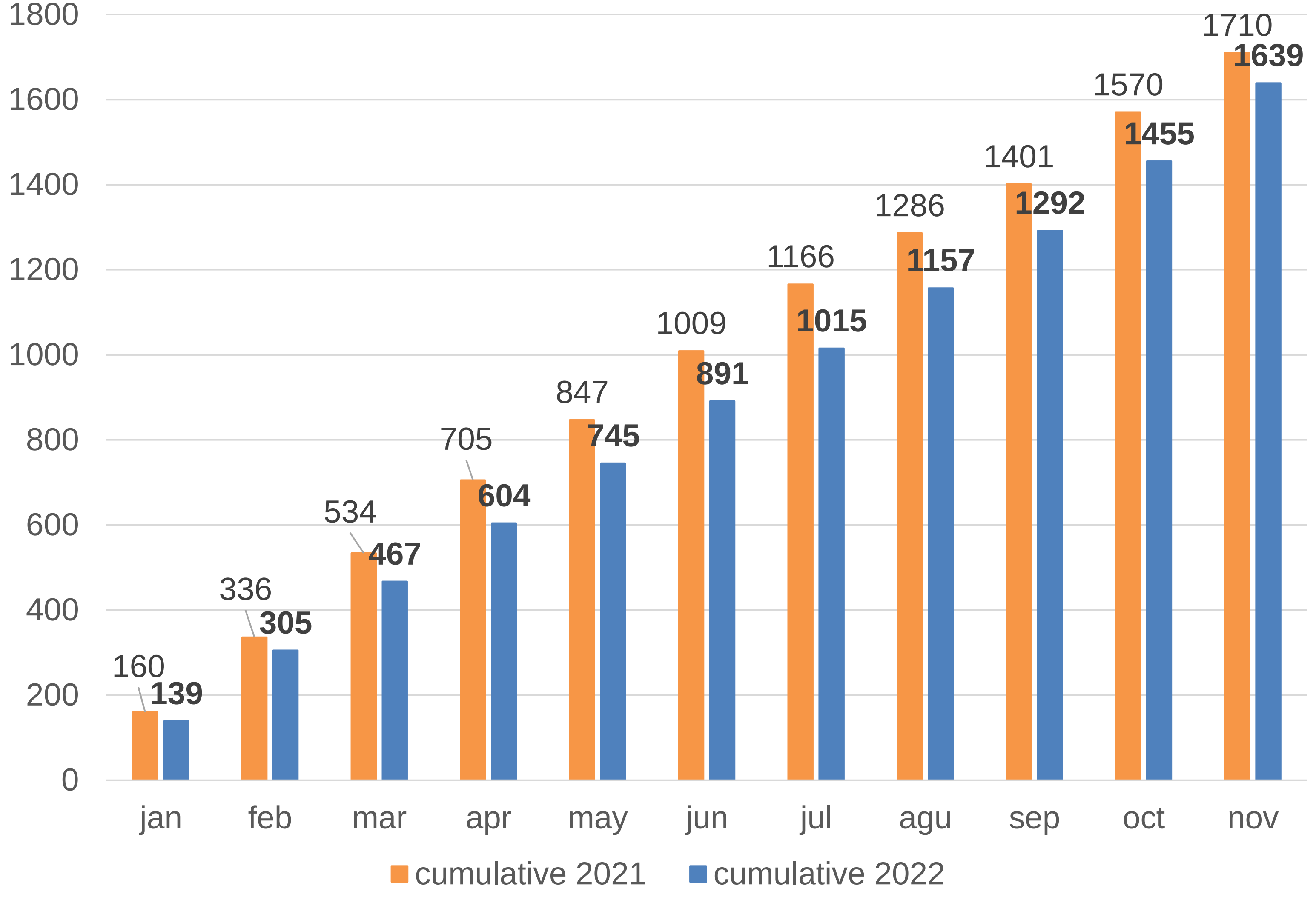


	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov
Jobs facturable	93	133	121	100	111	105	97	105	108	123	131
Jobs no facturable	46	31	41	38	30	41	28	37	27	40	53

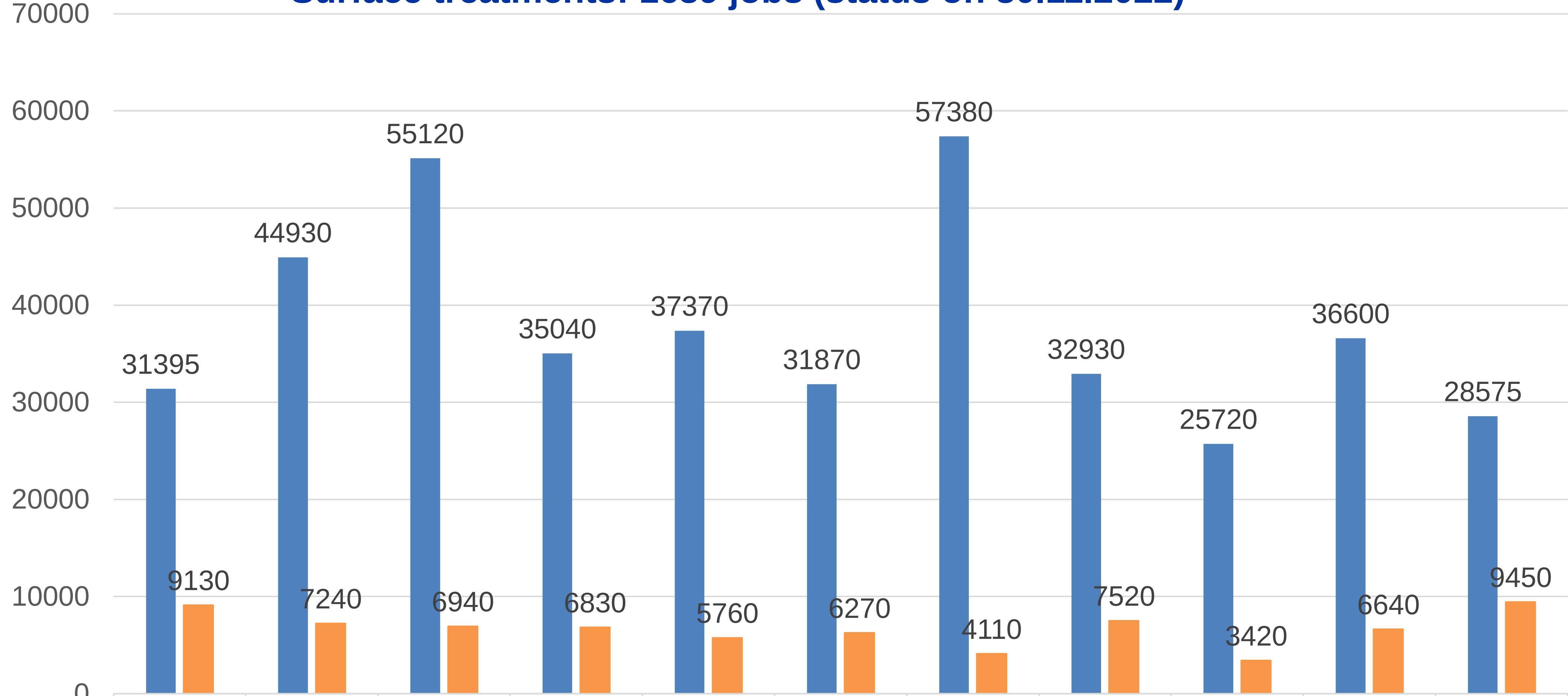
Invoiced jobs: **1227**
Non-invoiced jobs: **412**

Last year the total number was 1710.

Surface treatments: 1639 jobs (status on 30.11.2022)

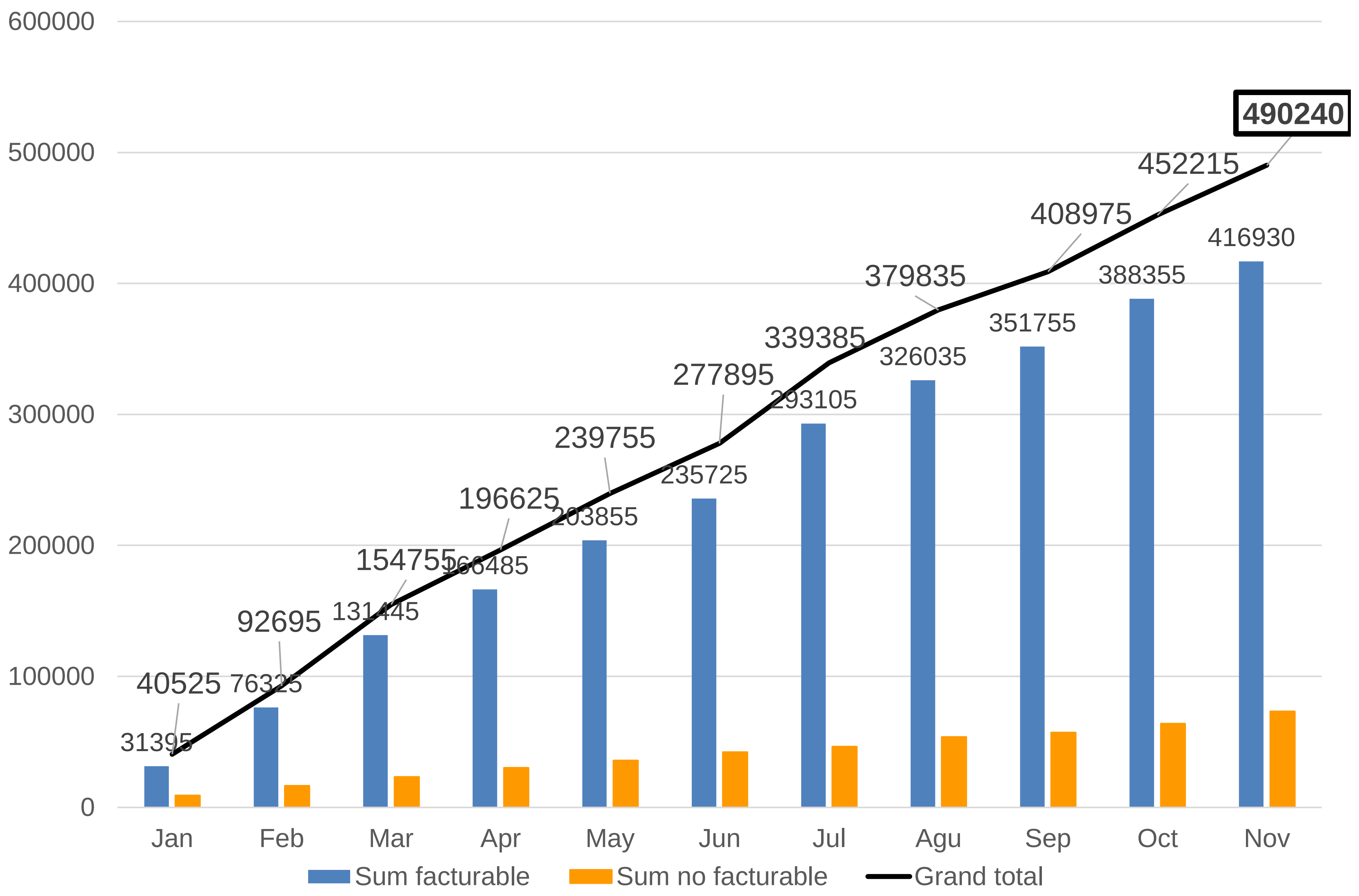


Surface treatments: 1639 jobs (status on 30.11.2022)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Agu	Sep	Oct	Nov
Sum facturable	31395	44930	55120	35040	37370	31870	57380	32930	25720	36600	28575
Sum no facturable	9130	7240	6940	6830	5760	6270	4110	7520	3420	6640	9450

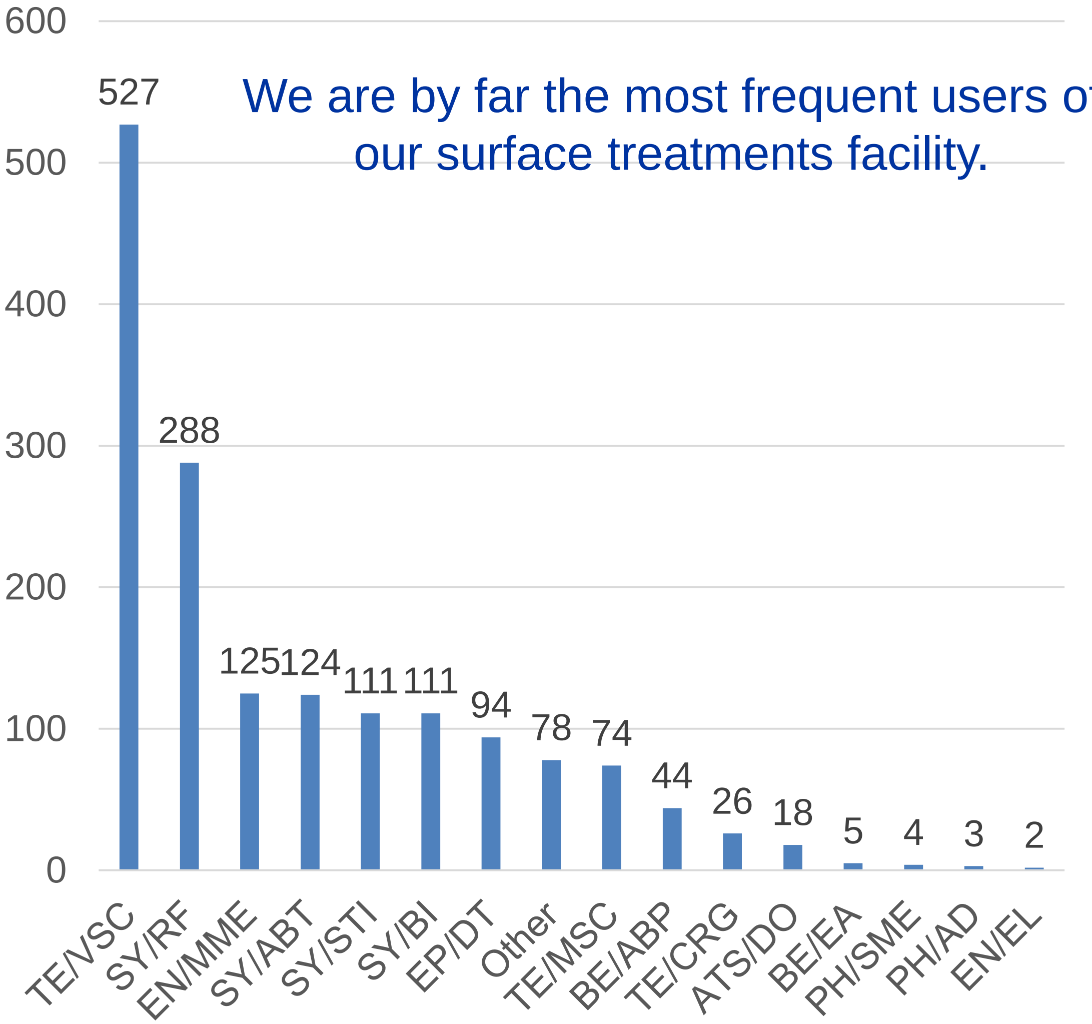
Surface treatments: 1639 jobs (status on 30.11.2022)



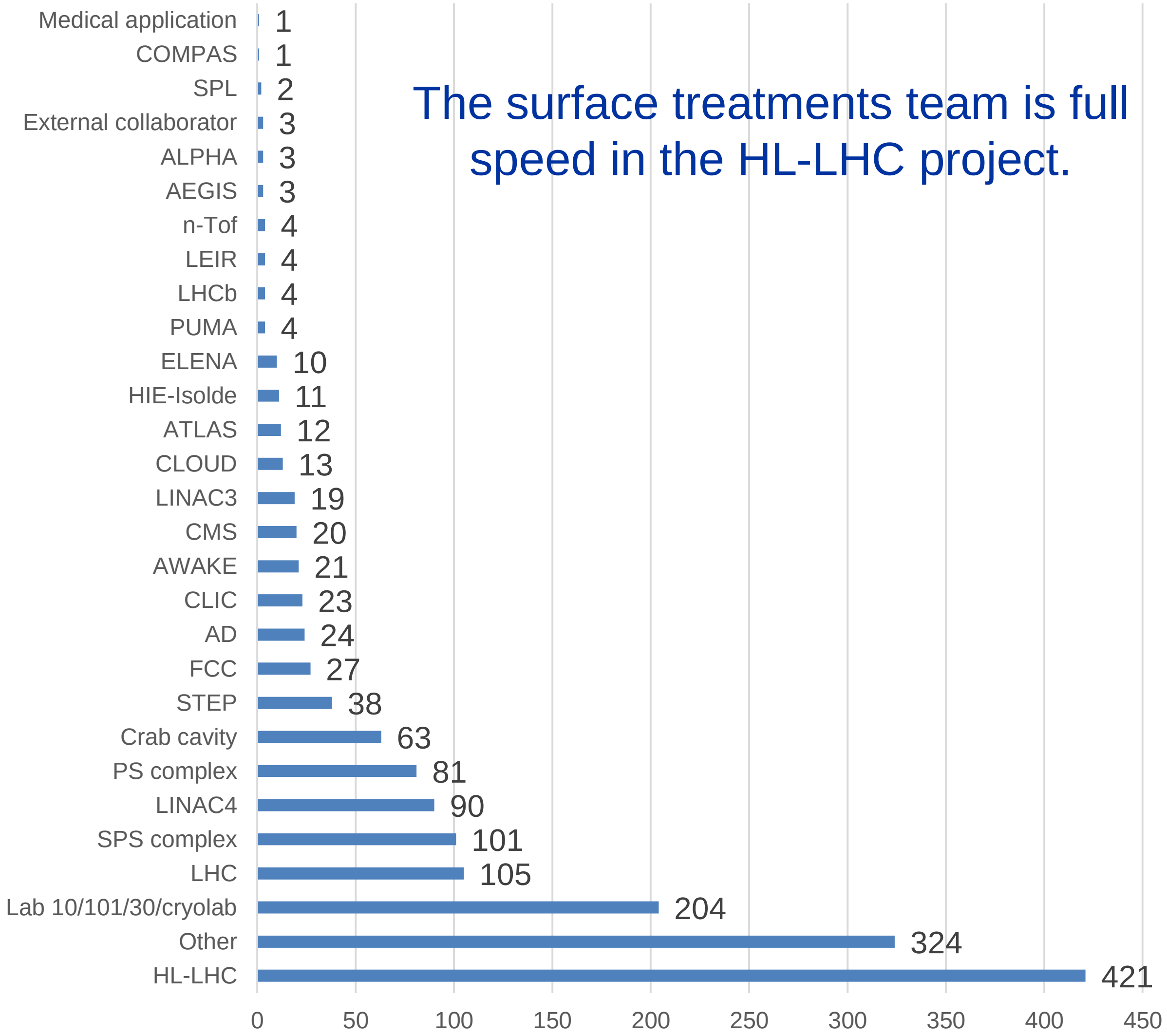
Total revenue expected at the end of the year: ≈ 440 kCHF

Last year: 410 kCHF

Surface treatments: 1639 jobs (status on 30.11.2022)

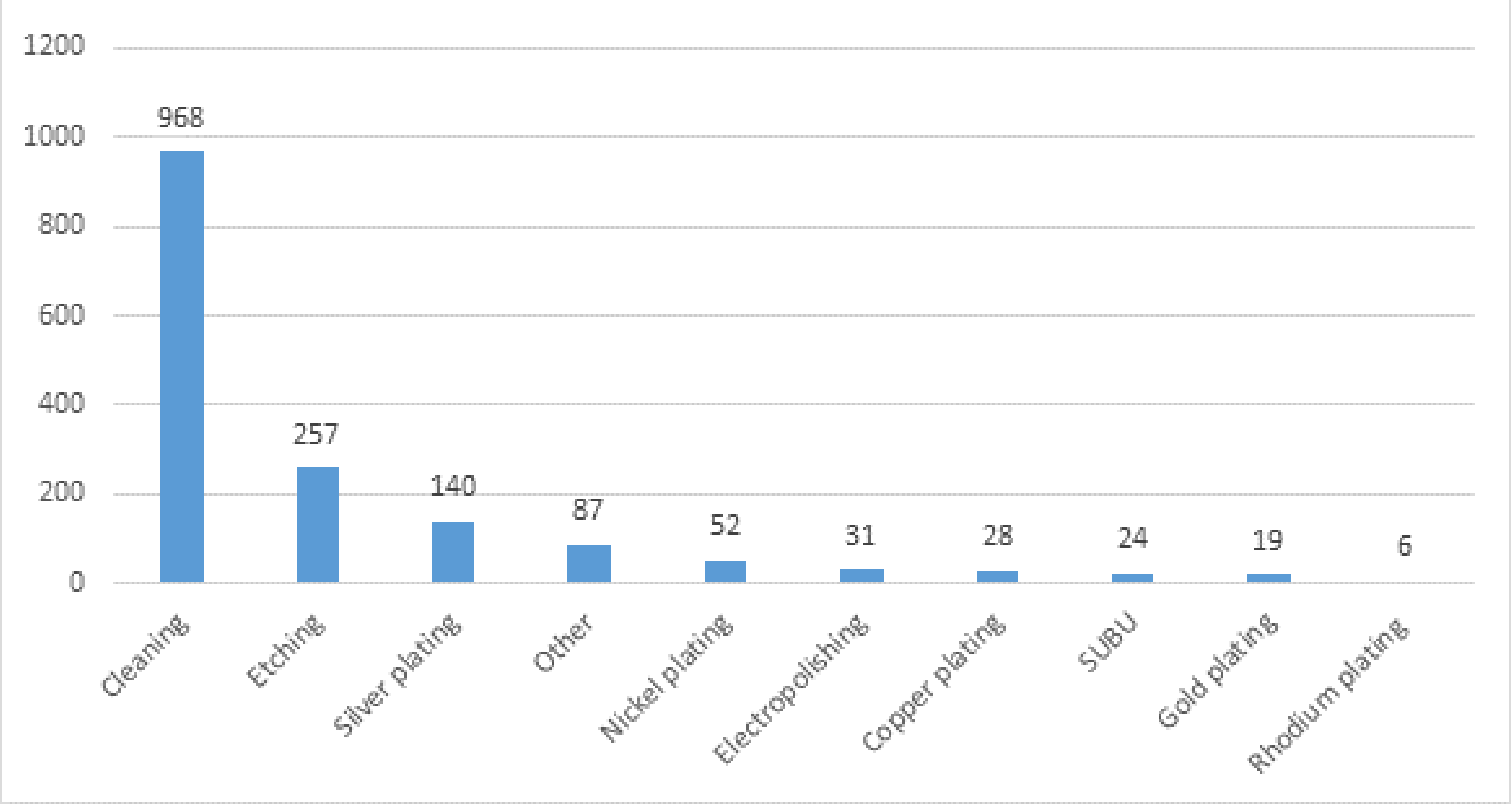


We are by far the most frequent users of our surface treatments facility.

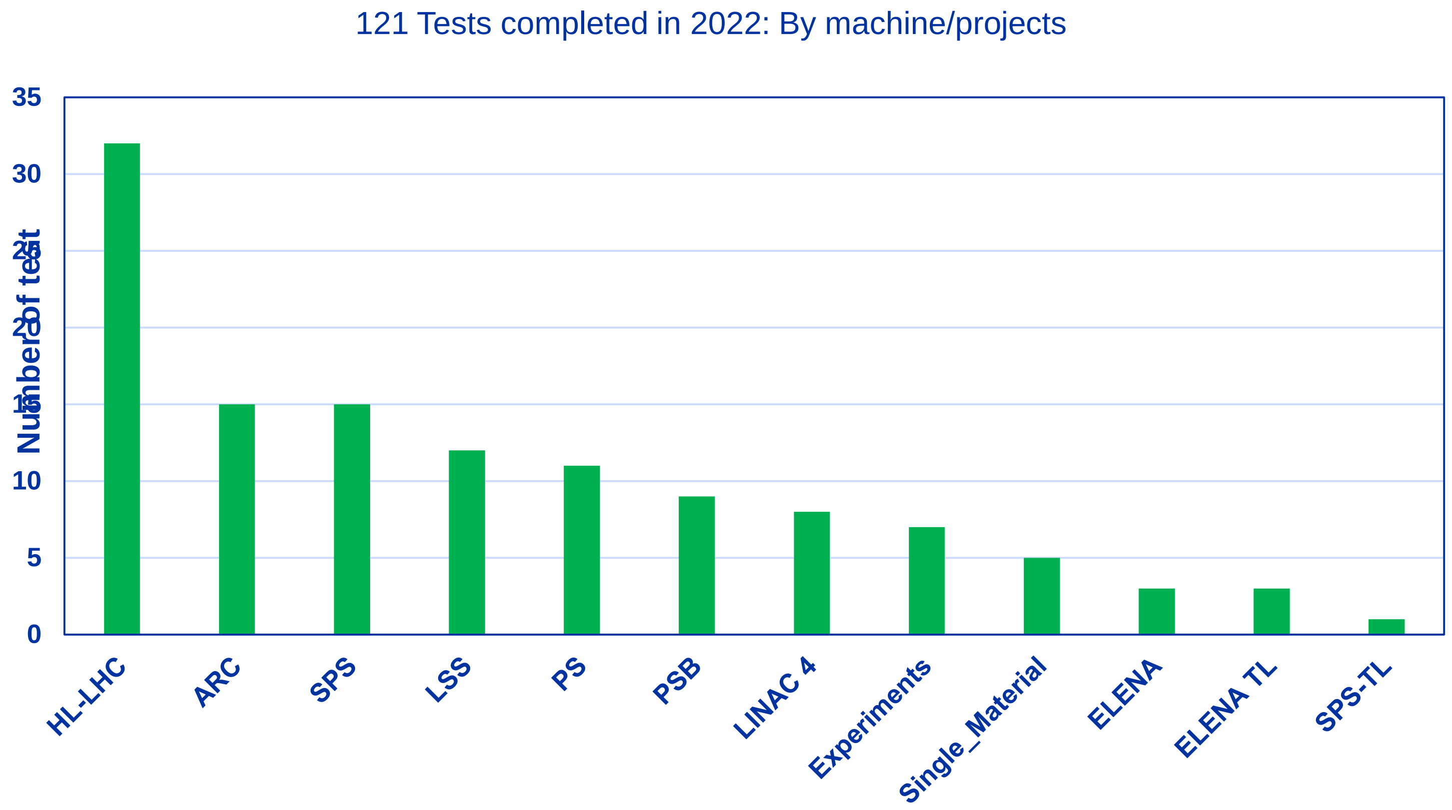


The surface treatments team is full speed in the HL-LHC project.

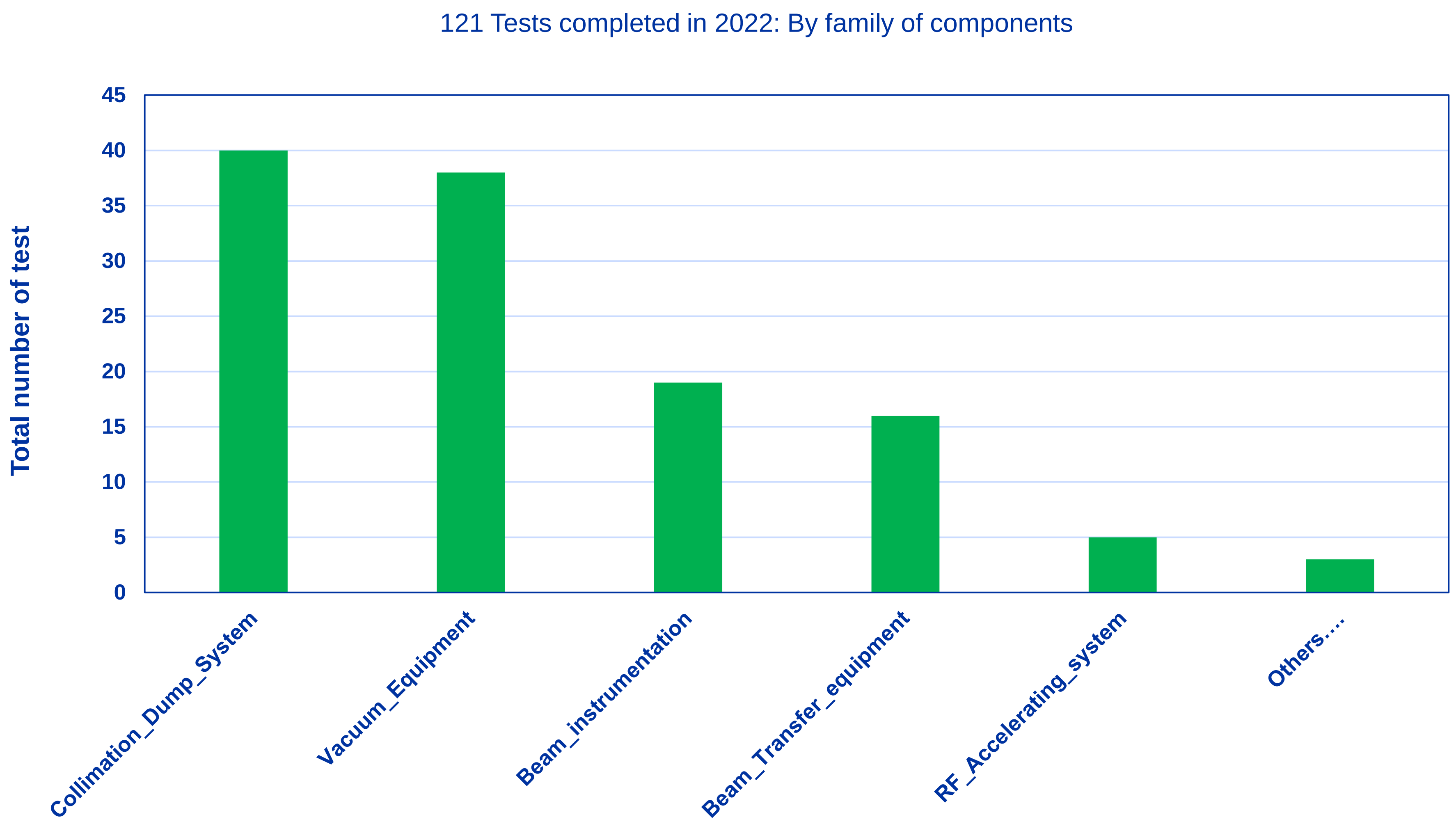
Surface treatments: 1639 jobs (status on 30.11.2022)



Acceptance tests: 121 tests (status 01.12.2022)

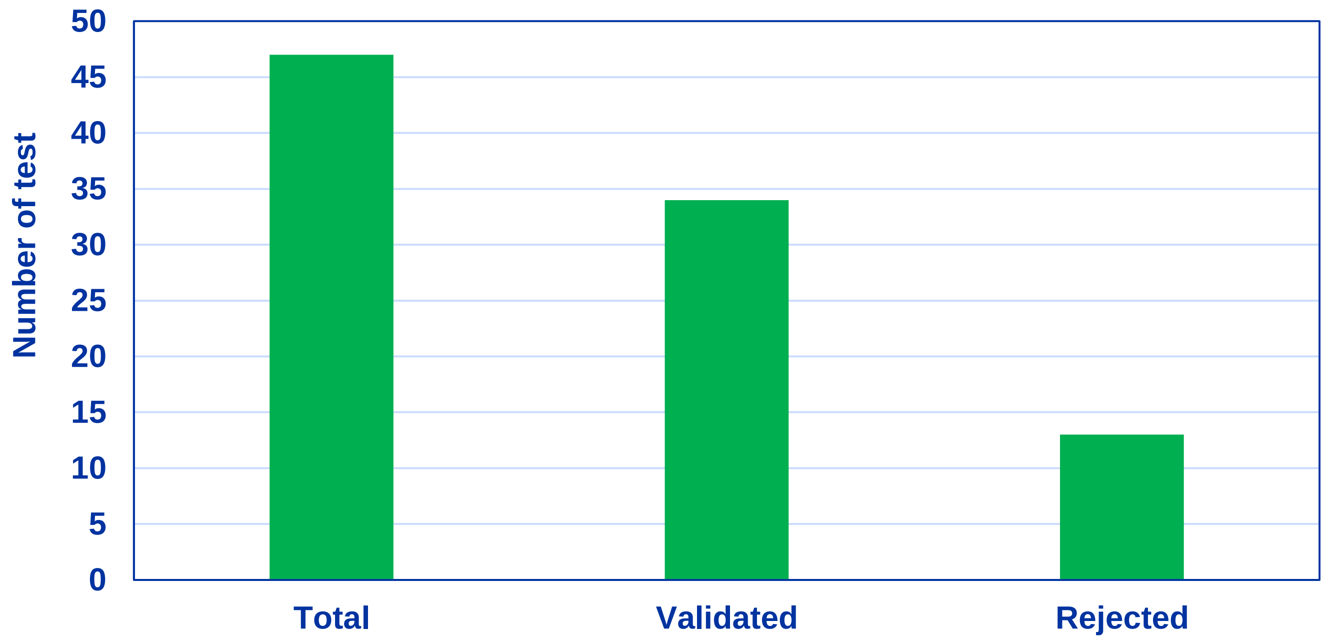


Acceptance tests: 121 tests (status 01.12.2022)



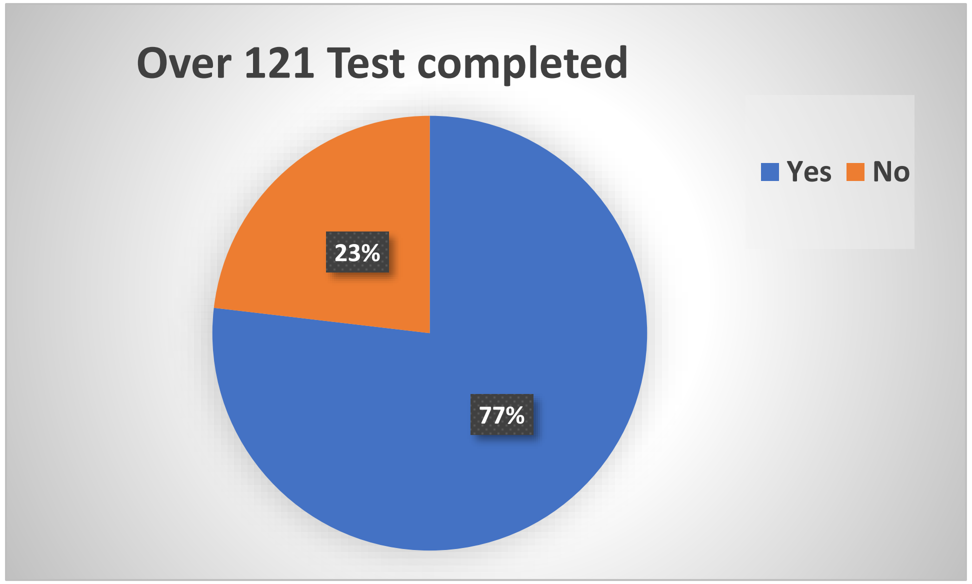
Acceptance tests: 121 tests (status 01.12.2022)

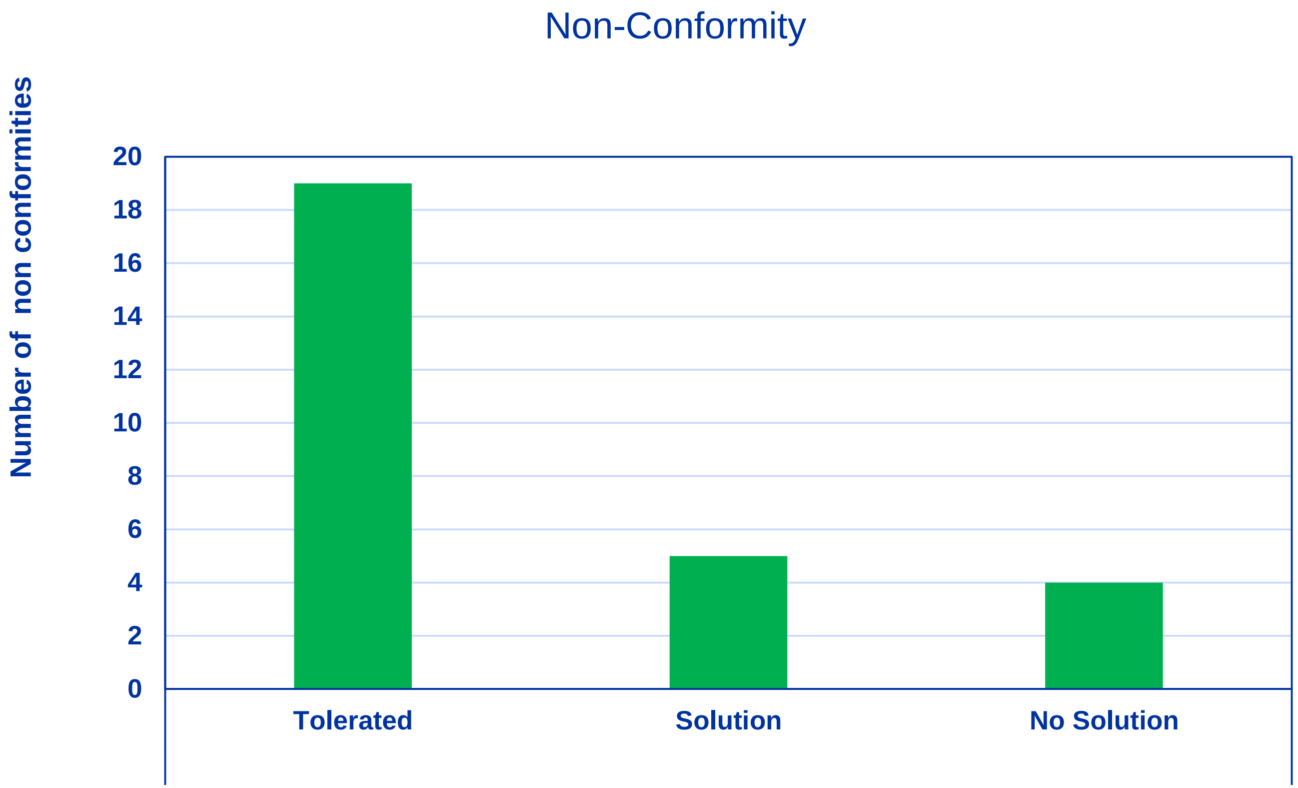
Special tests for SY-BI
47 full assembly pre-validation: old radiation stock



Acceptance tests: 121 tests (status 01.12.2022)

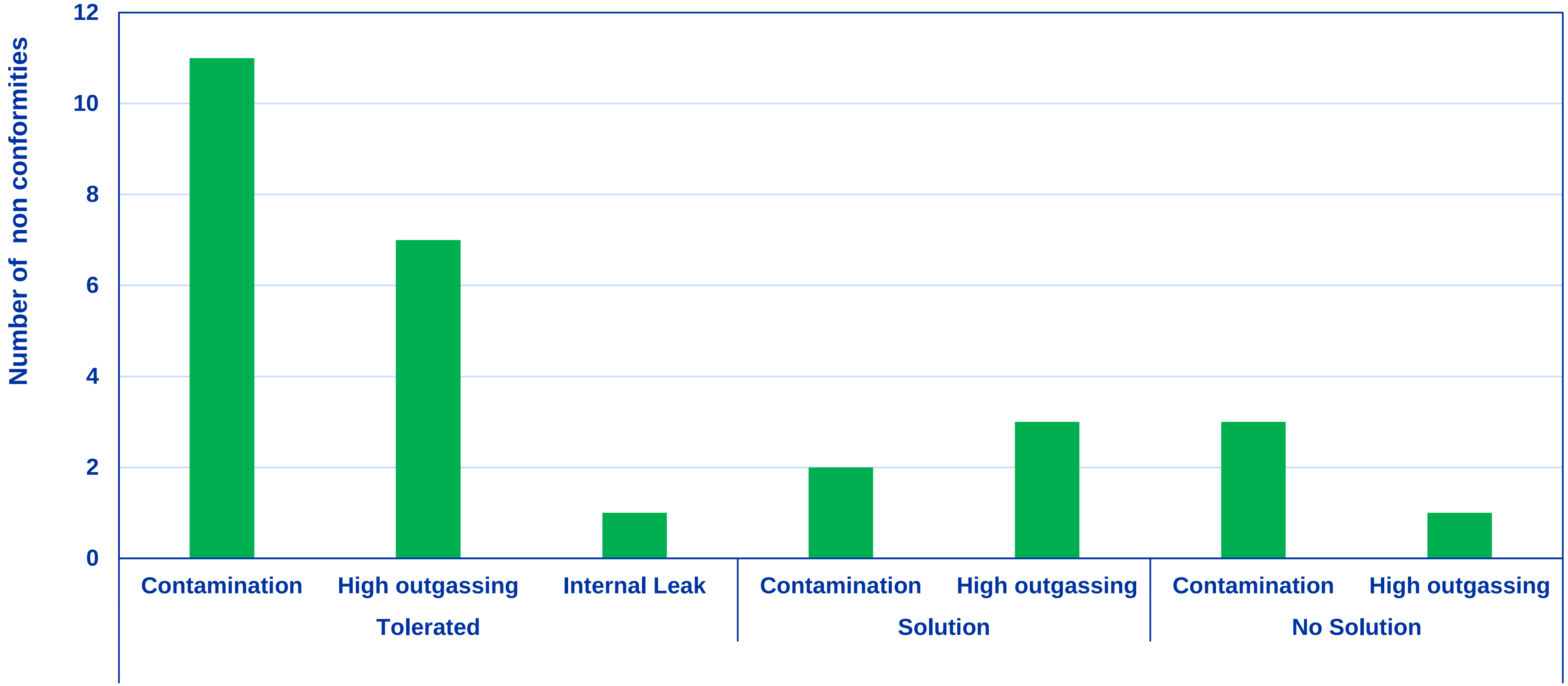
Non-conformities





Acceptance tests: 121 tests (status 01.12.2022)

Non-conformities



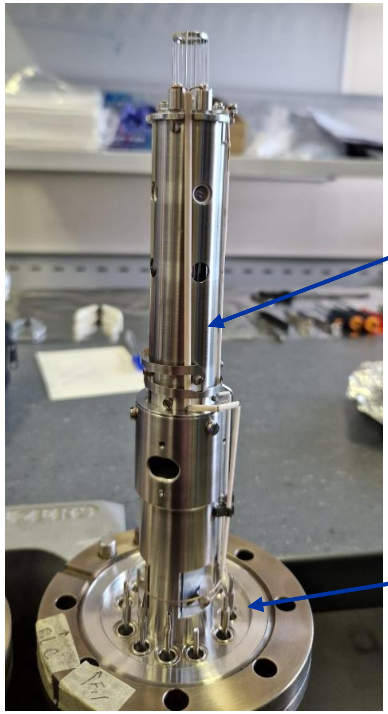
A selection of remarkable activities in 2022

Internal and CERN-wide services

Vacuum measurement service: Instrumentation laboratory

Repair & construction

- Complete set of insulating wire & connectors built by CERN

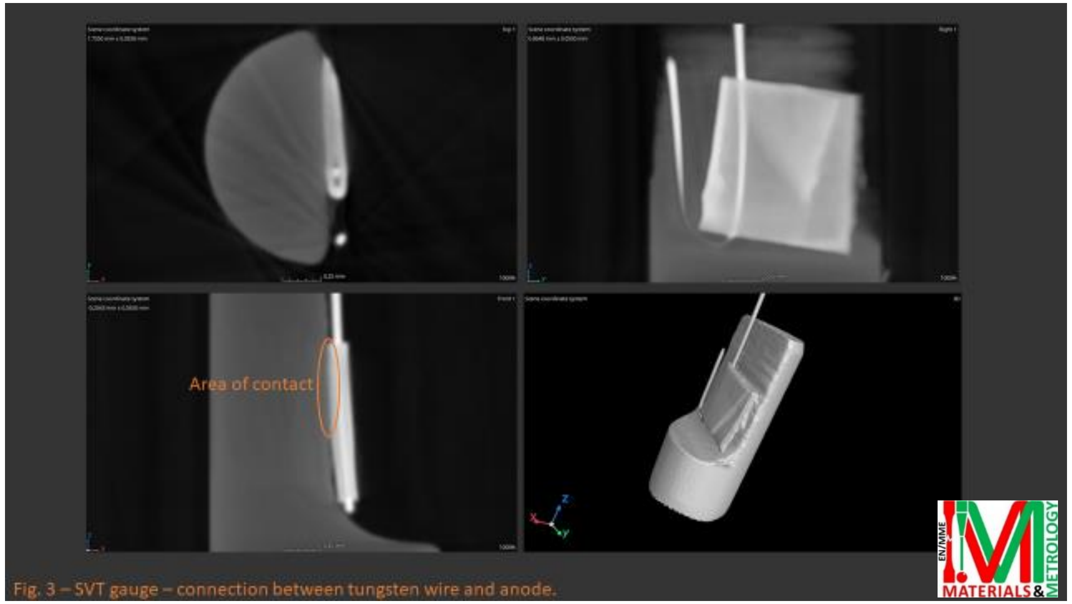


Insulating wires

Connectors

• Gauge design

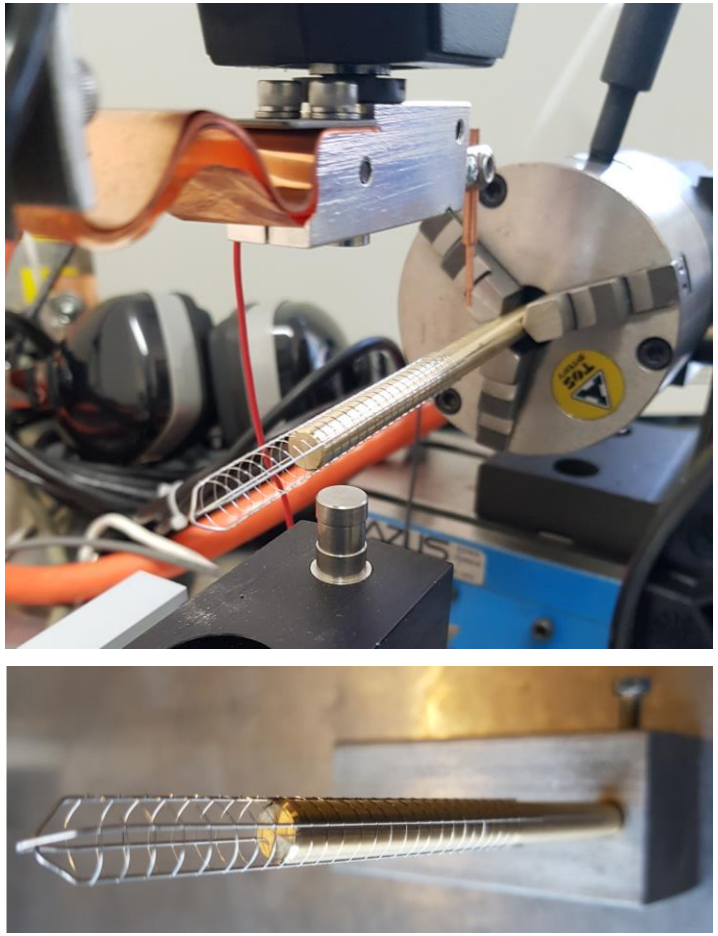
- Study of the SVT 305 collector assembly



- **In collaboration with DLM and EN-MME**

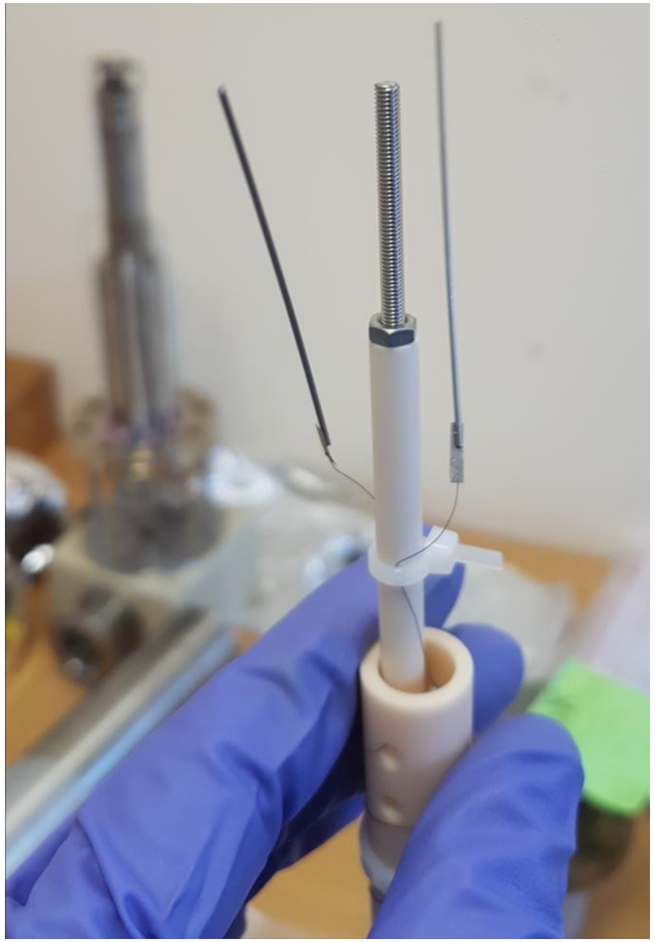
Vacuum measurement service: Instrumentation laboratory

Instrumentation manufacturing



Grid for coating : SMOG

Power supply gas analyzer

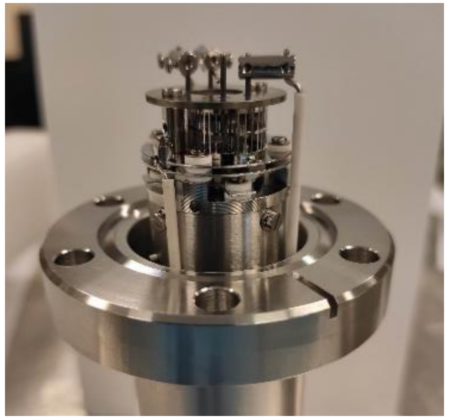


ESD BIG welding filament

Vacuum measurement service: Instrumentation laboratory

Vacuum and functional tests

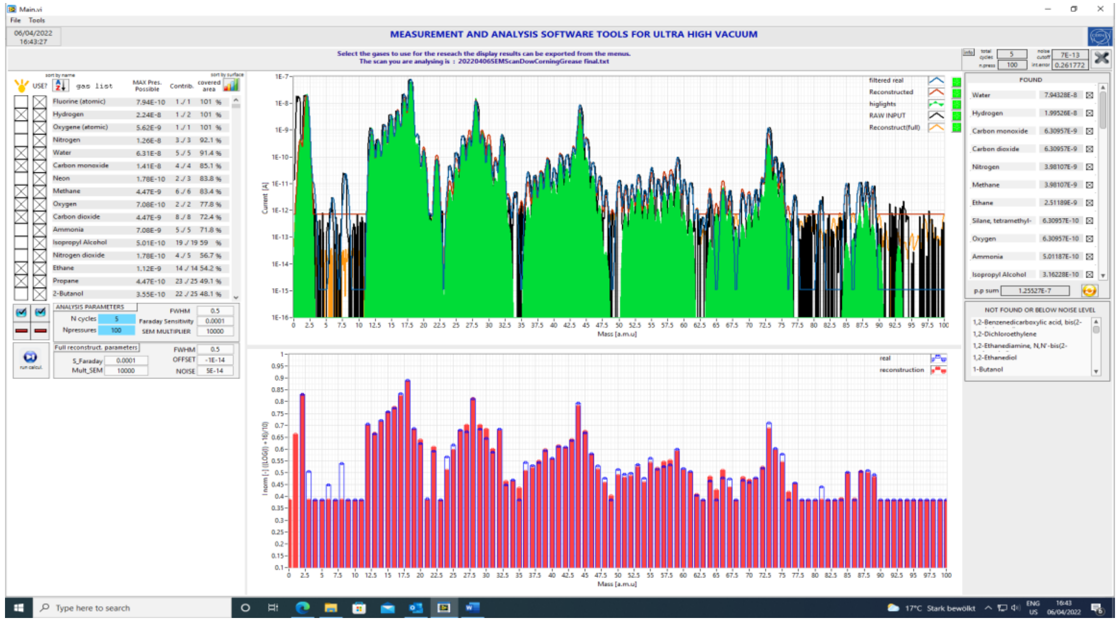
- 9 repairs/mainteance
- 36 acceptance tests
- New RGAs evaluation



MKS Microvision 2 with degassed ion source

• MAST software evaluation

- Dow corning grease recognition



- Next step: filling of database

Vacuum measurement service: Instrumentation laboratory

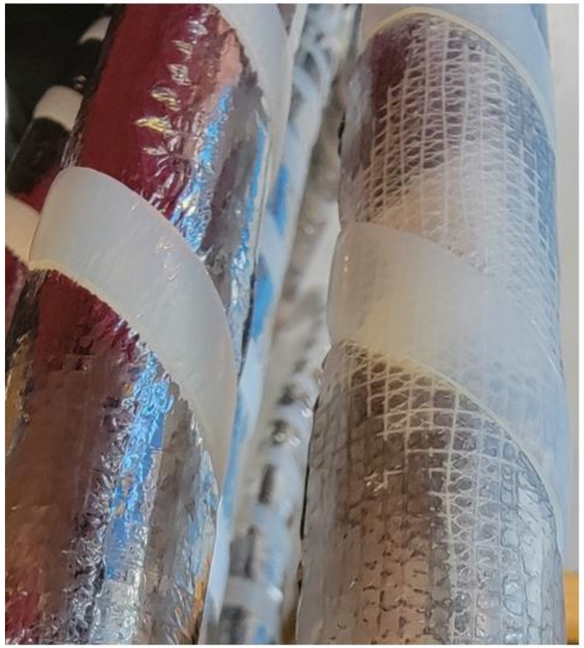
Mass spectrum analysis

Based on iterative deconvolution and machine learning

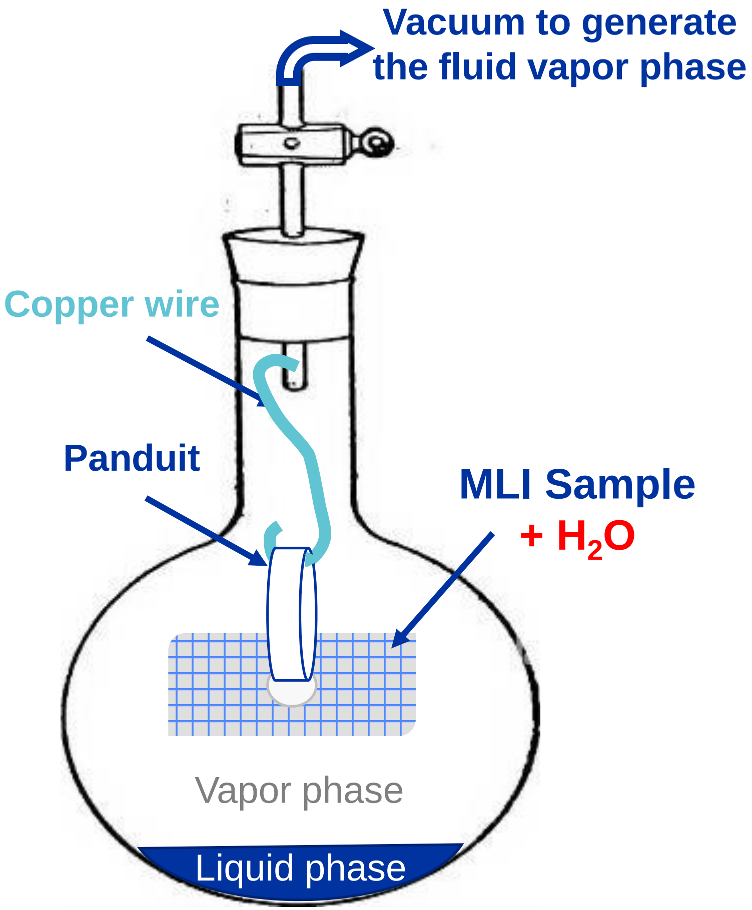
- Web interface developed in collaboration with IDAL, under test

Chemistry Laboratory
Corrosion issue of aluminium on MLI (LHCb SciFi cooling plant)

MLI corrosion after Novec 649 leak



Courtesy : S. Jakobsen



strong corrosion in contact with Novec 649 + water (acid production)

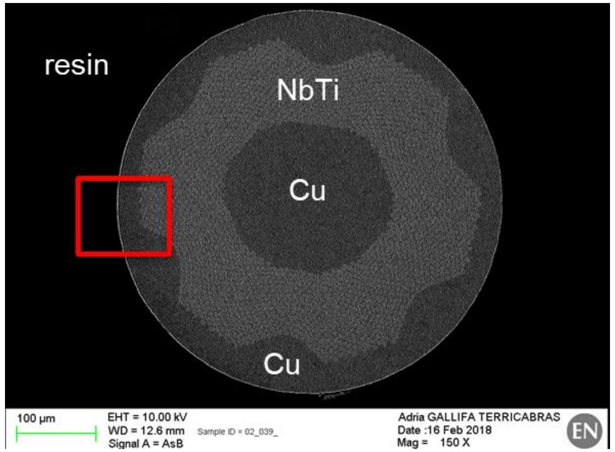
<u>On going :</u> Polymer and metal compatibility tests with different cooling fluids *(Novec 649, NOVEC 7100 and C_6F_{14})*

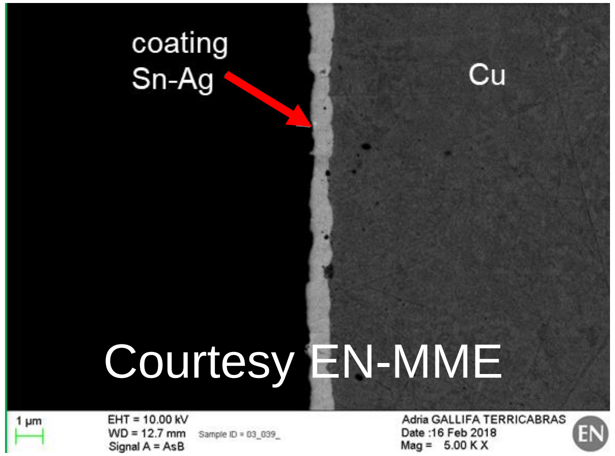
Chemistry Laboratory
Characterization of SnAg layer on Nb-Ti superconducting wires

HL-LHC production of SnAg coating:

- electroplating specifications:
  - ✓ Composition SnAg 5%wt.
  - ✓ Thickness: 0,5 mm

Rutherford cable coated with SnAg





ICP-OES analysis of SnAg coating: Composition and thickness

- Since 2019: qualification of companies (IT4703) ~100 analysis
- Now: **quality control** of the production

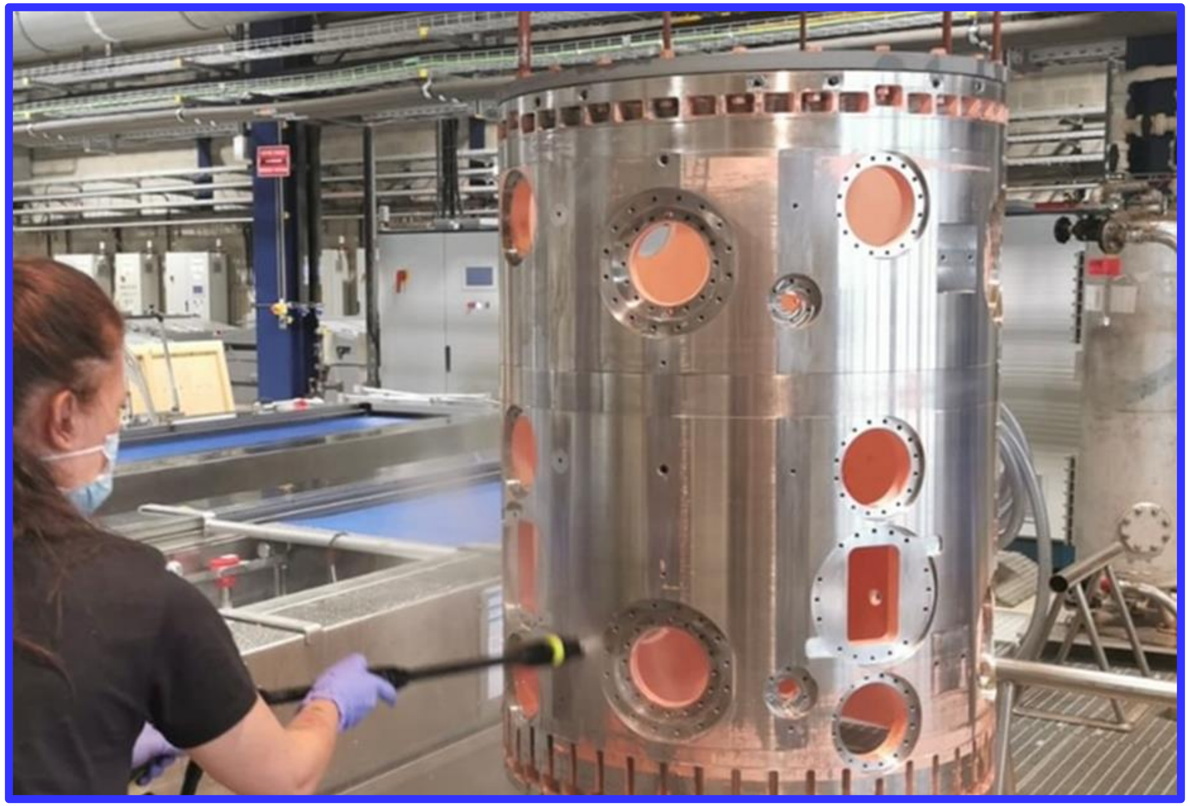
  ~ 50 analysis planned for December 2022

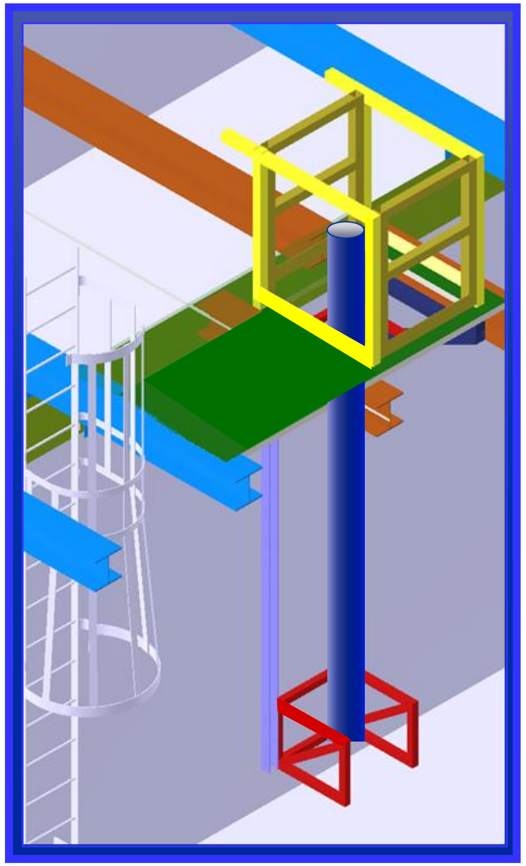
Acidic solution etching of SnAg coating

ICP-OES (Agilent 5110)

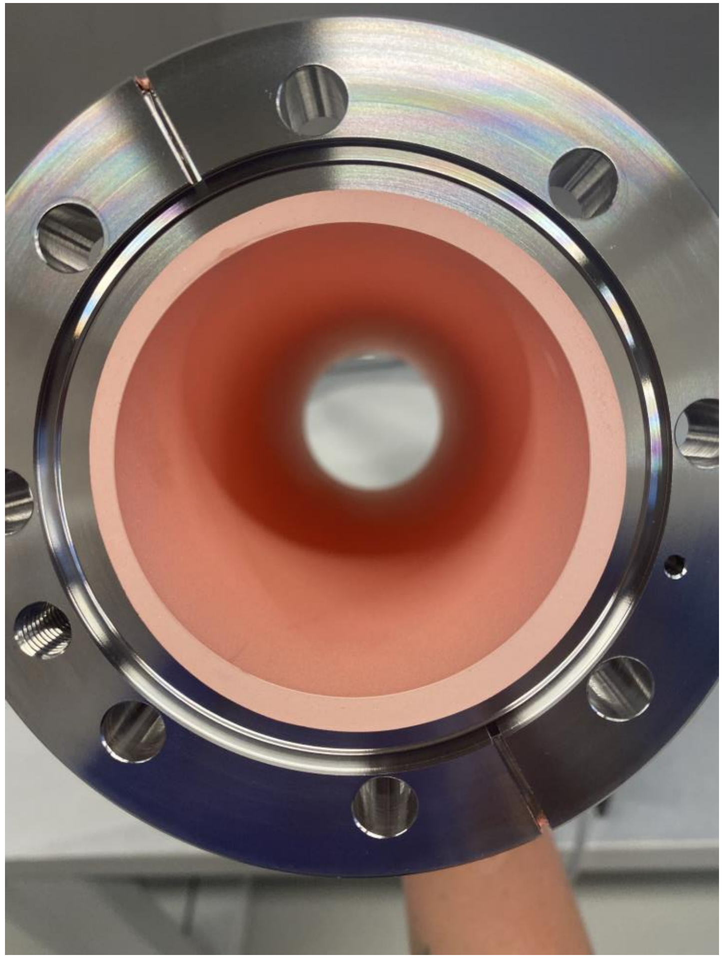
Surface finishing
Wet surface treatments: copper plating of large components

- Finished the plating of a series of 5 RFQ tanks for SPES accelerator at INFN Legnaro
- Developing a new facility for plating by fluid circulationat at bdg 107 **for long chambers** (up to 5m) to get more flexibility for CERN vacuum chambers production

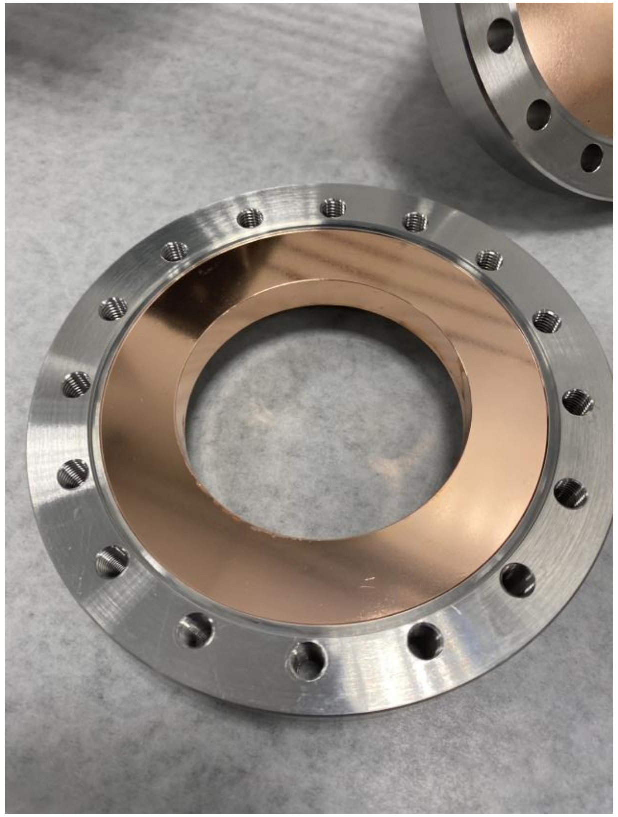




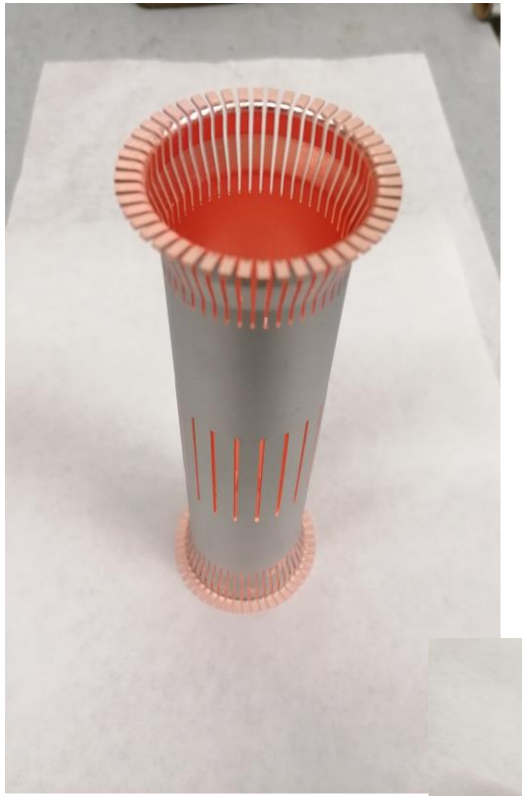
Surface finishing



Cu plated tube for CRAB coupler



Copper plated flange
before Nb coating



RF contacts
inner CRAB line
(copper plating
on stainless
steel)

Surface finishing

Gold and copper plating steps of LHC BPMs

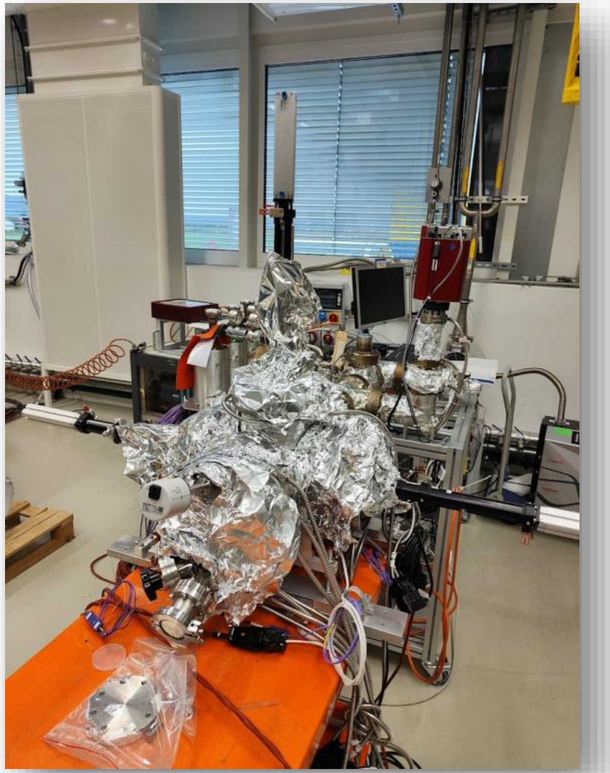
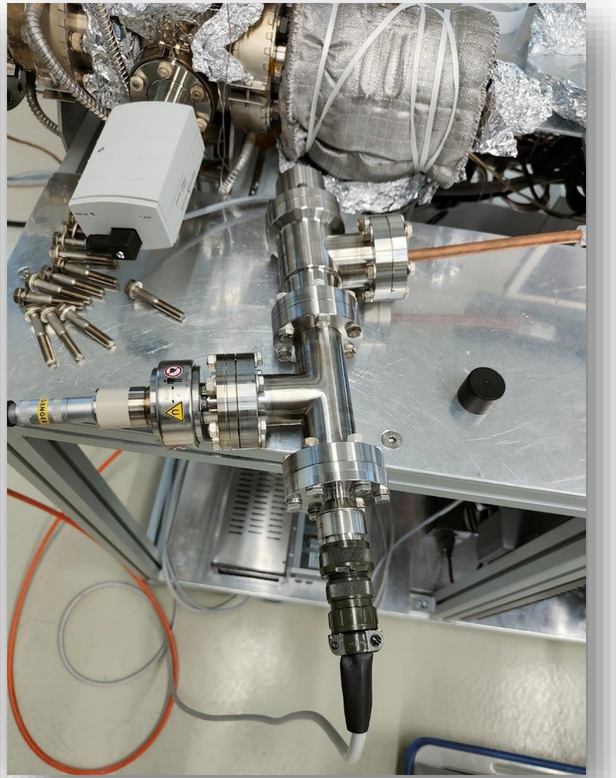
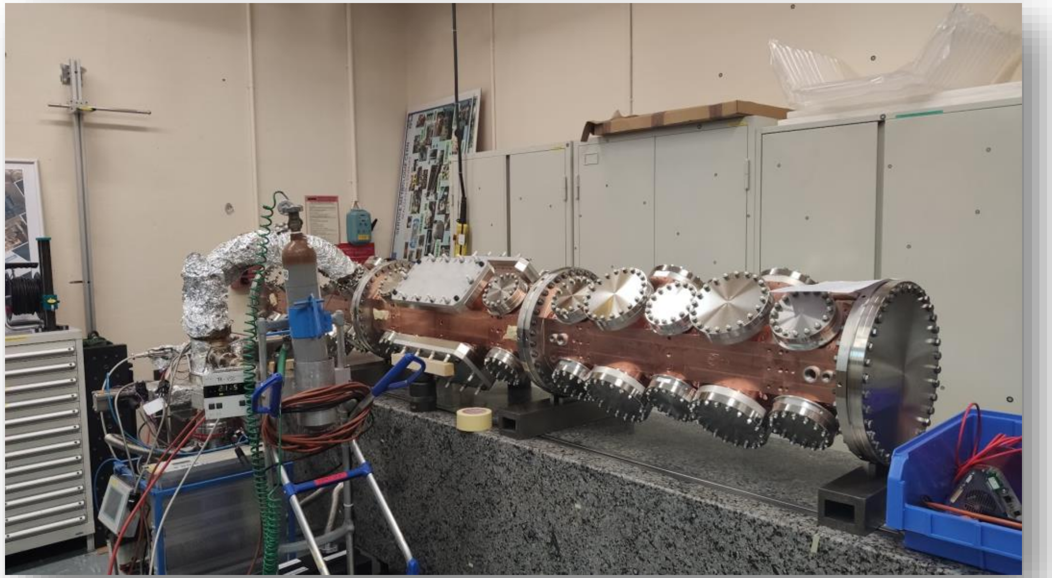
Surface finishing

Gold plating of Kovar edge of the glass assembly for the FLOTUS experiment (CLOUD)

Surface finishing
Wet surface treatments: special copper plating...on polymers

-Application: Mock-up of HOM couplers for PERLE. For low power RF testing and design validation
-with EN-MME, TE-MSC polymer lab, EP-DT
-3D printing in Accura polymer + 30 um copper (inside) plating on a pre-layer of chemical carbon based conuductor (commercial)
-complex configuration of electrodes to get a good thickness distribution

Acceptance tests
Lab 101

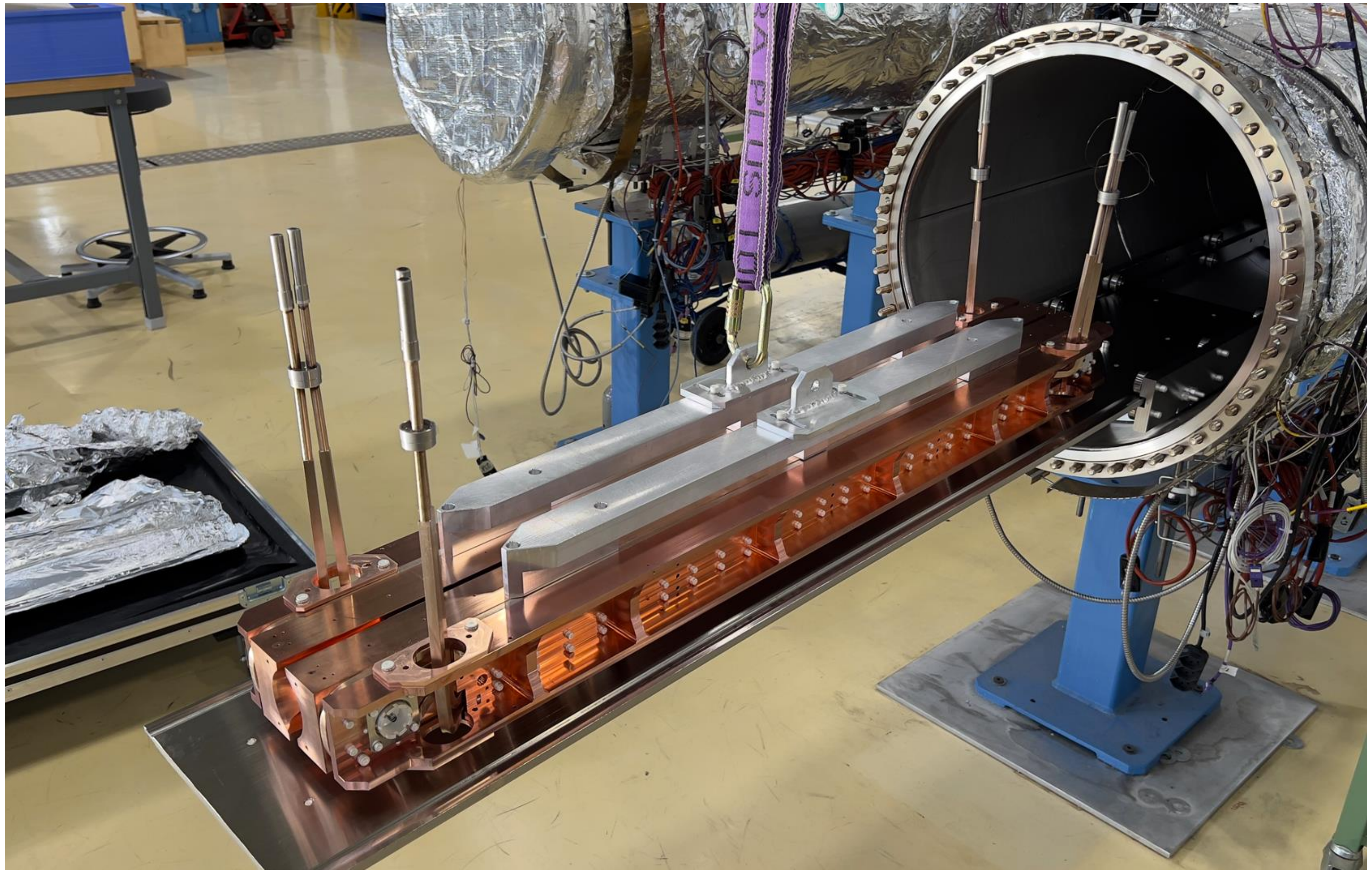

Acceptance tests:
Material validation for prototype double beam collimator for HL-LHC

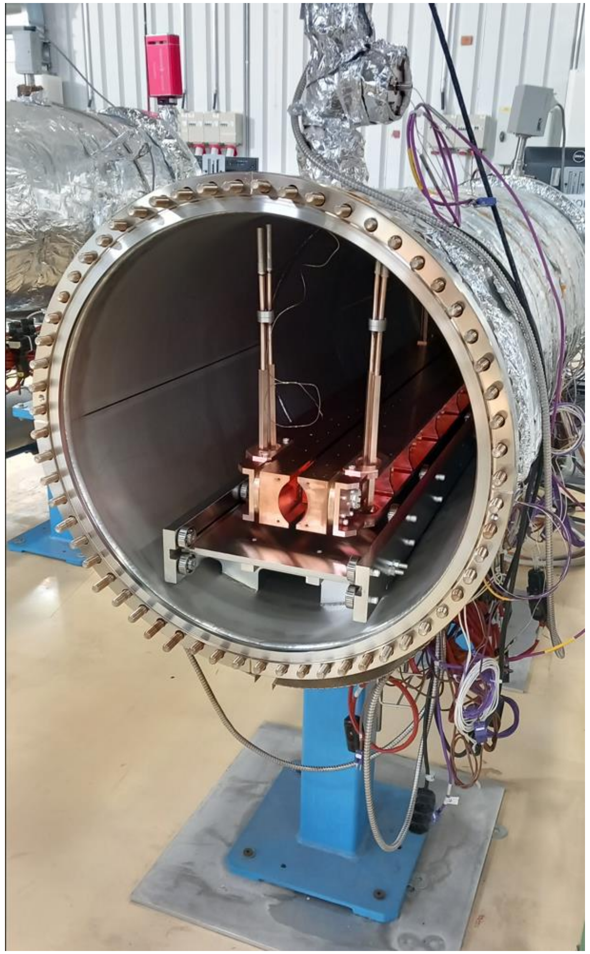
CuCD jaw blocks for TCTPXH

Hydroformed belows

Acceptance tests: sub-assemblies validation for prototype double beam collimator for HL-LHC

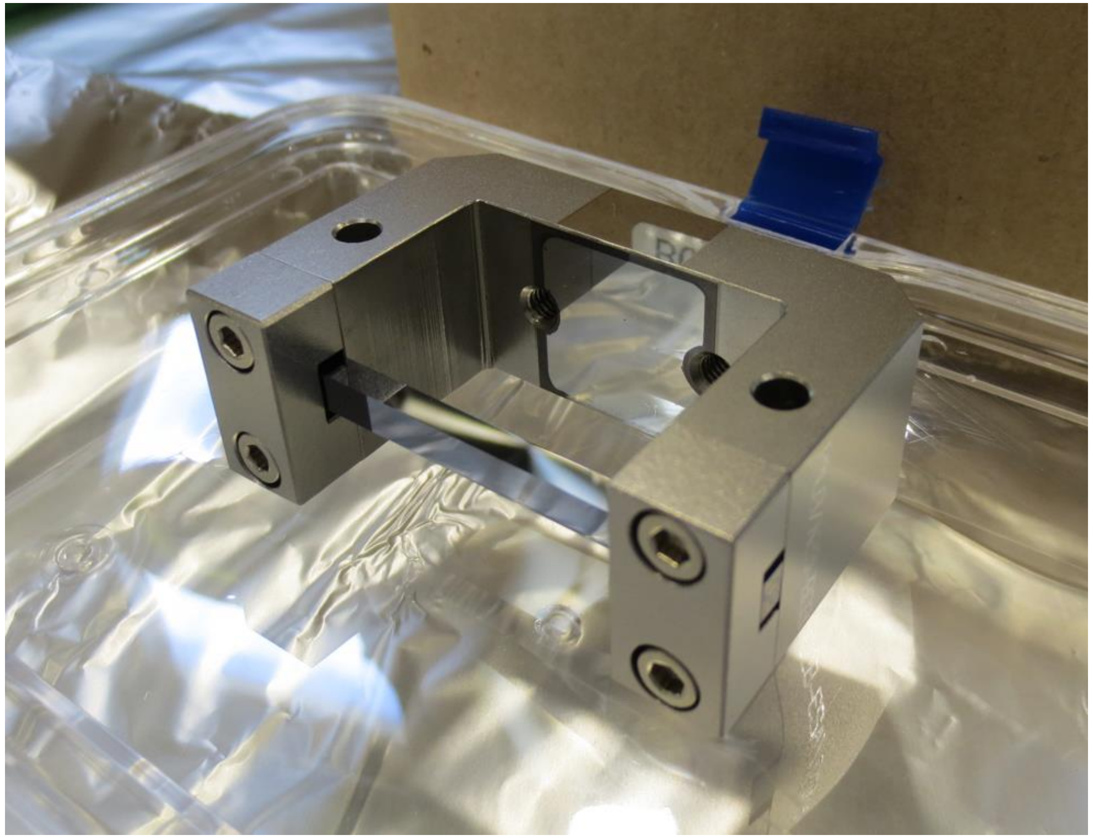
TCLPX jaws





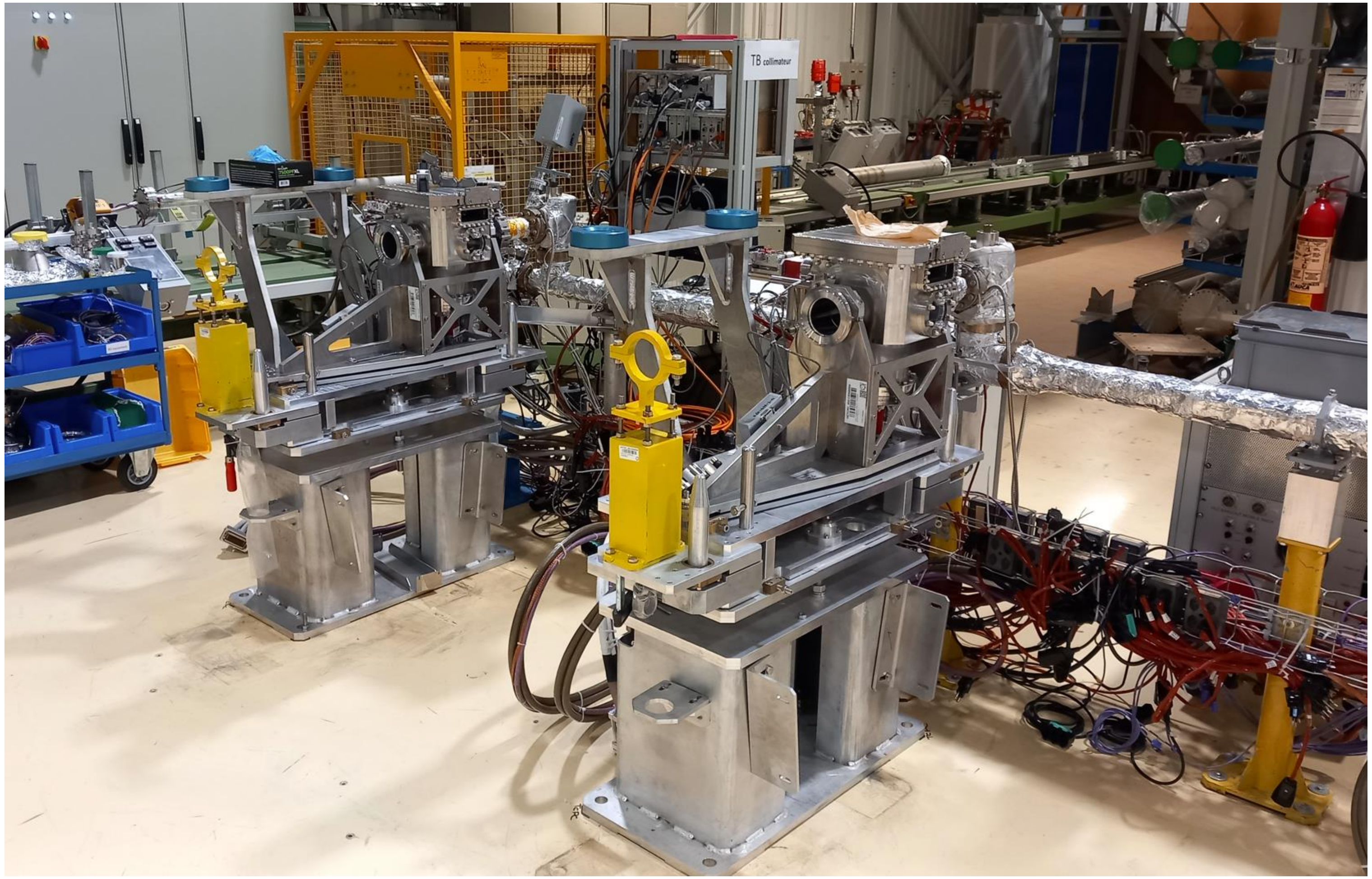
Acceptance tests:
Sub-assembly UHV validation for TCPC collimator at YETS 22-23

Crystal inside holder

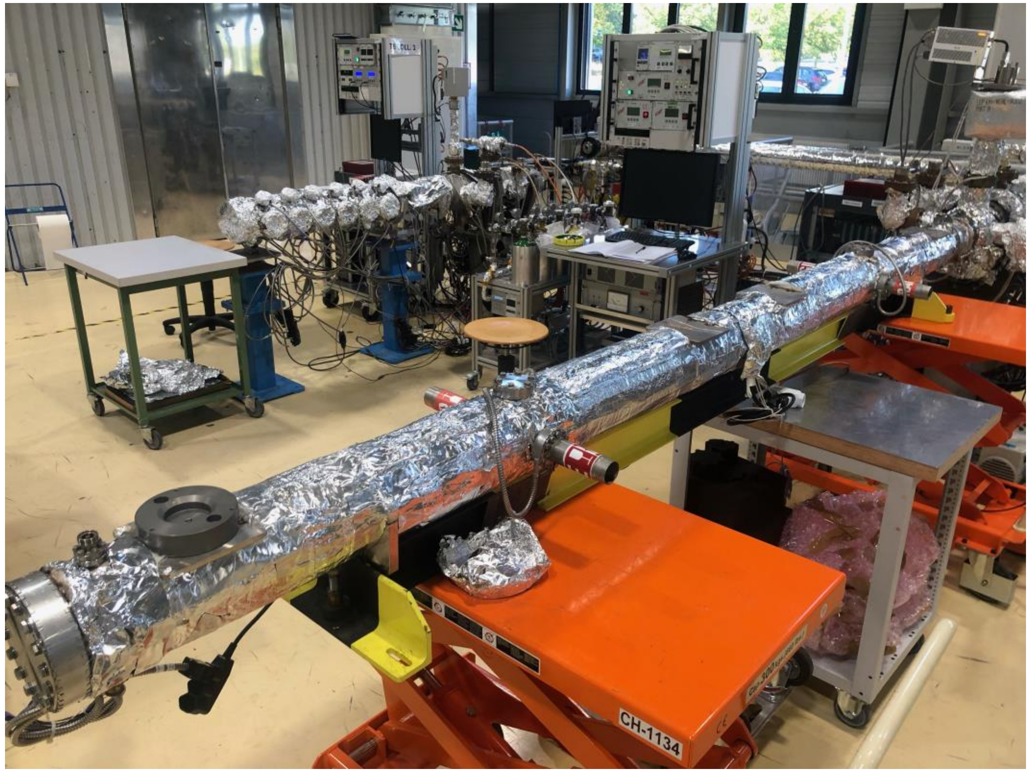


Edge welded bellows for motorisation

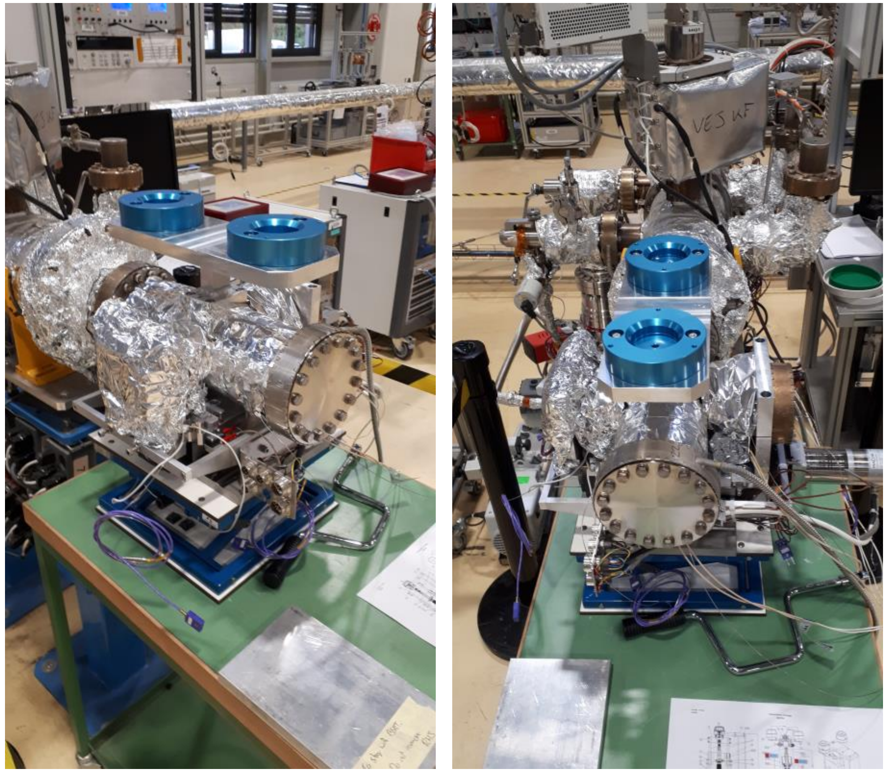
Acceptance tests:
Final vacuum acceptance test of TCPC collimators



Bakeout:
Example of activities

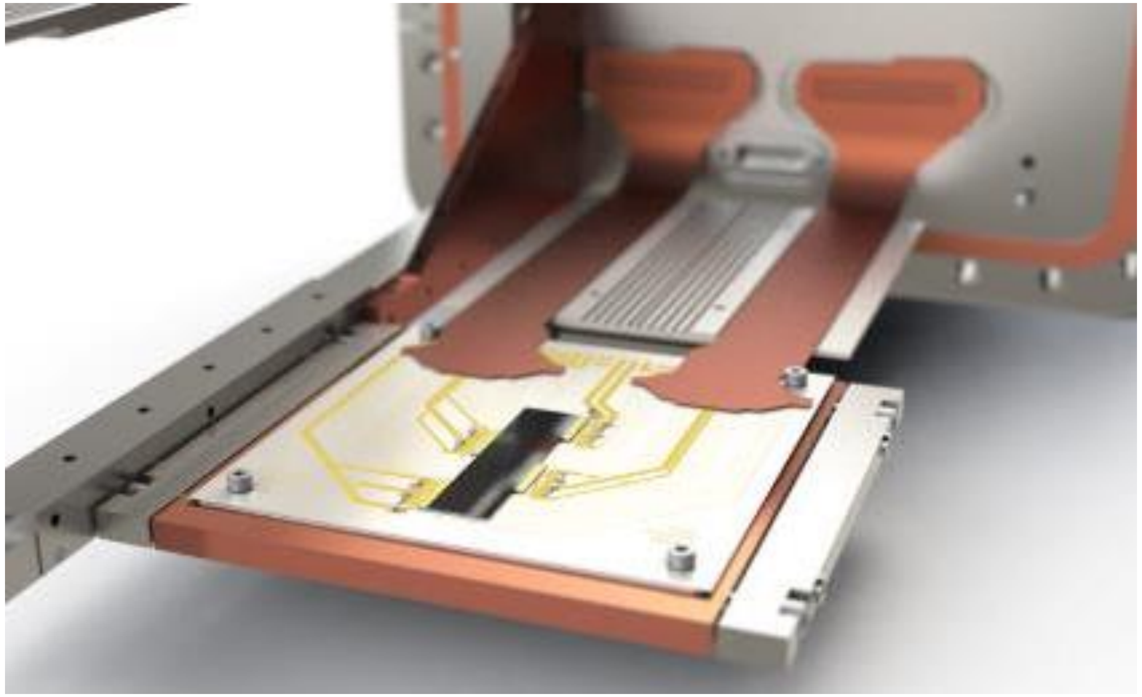


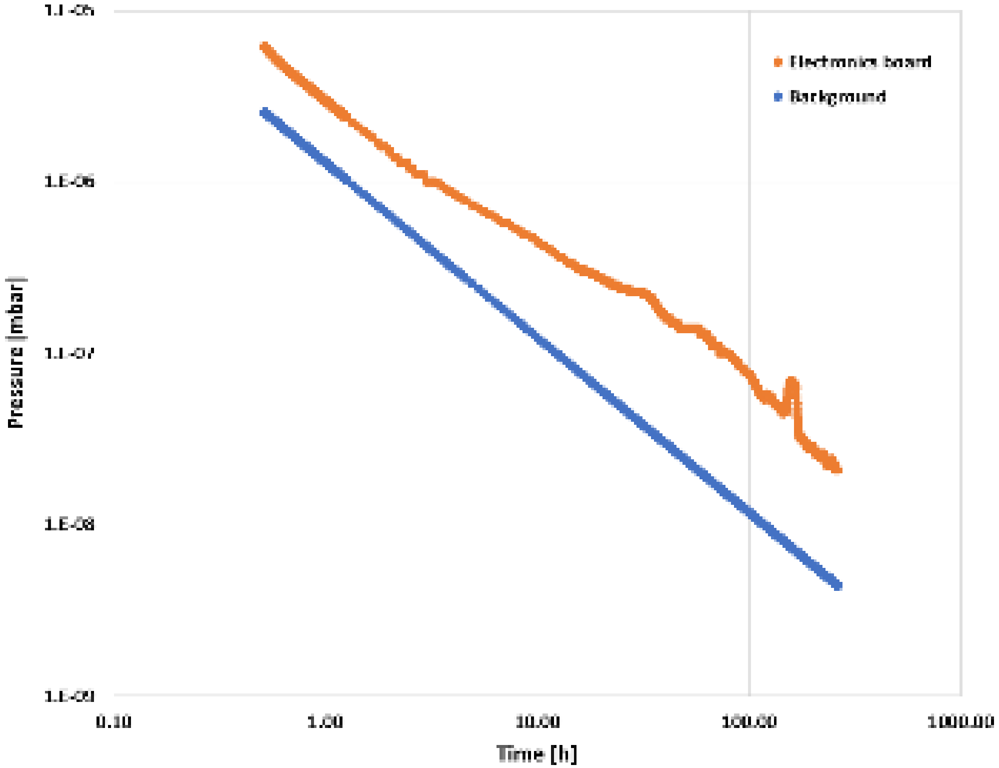
ADT Transverse Kicker Bake-out Installation – B.113



BSRTMB Bake-out Installation – B.113

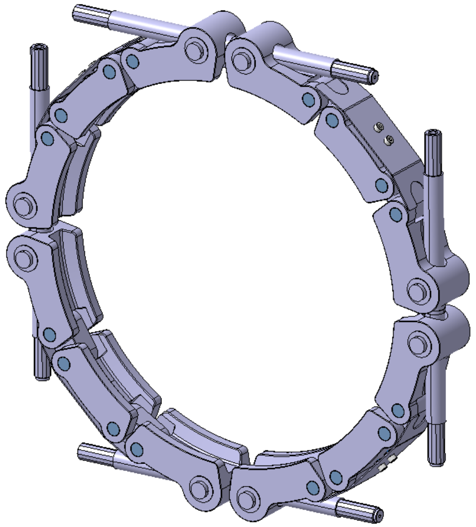
Outgassing measurements:
Polymeric LCP for BGI

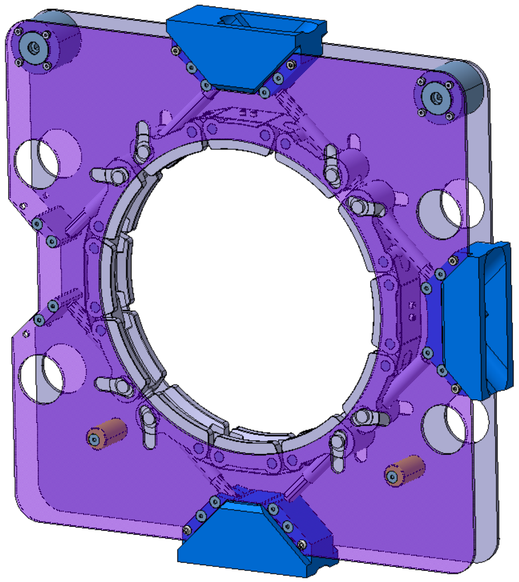




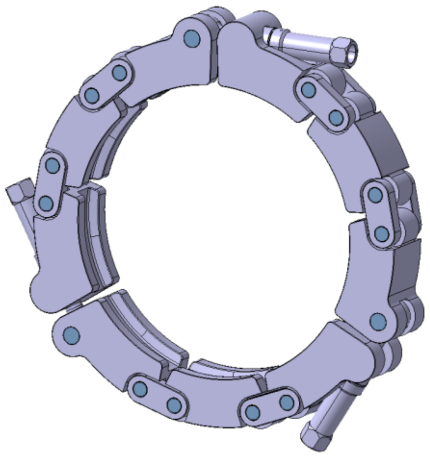
Mechanical design:
QCF CHAIN CLAMP

3D models

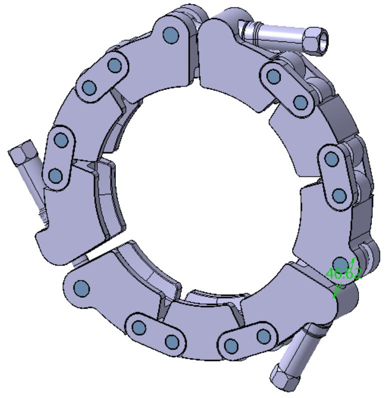




DN300



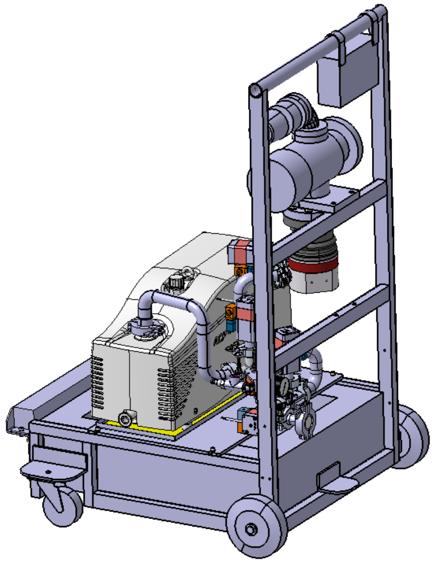
DN250



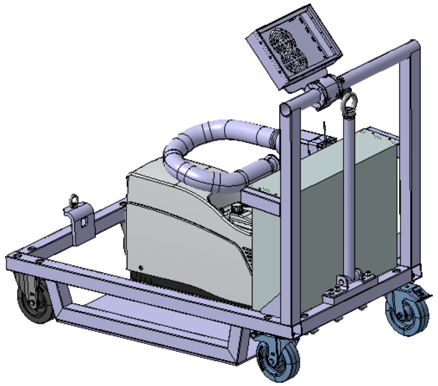
DN200

Mechanical design:
Trolley for operation

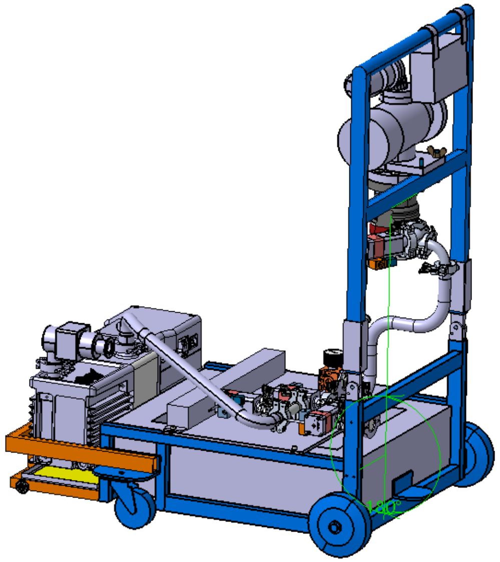
3D models and manufacturing



JOB 1012

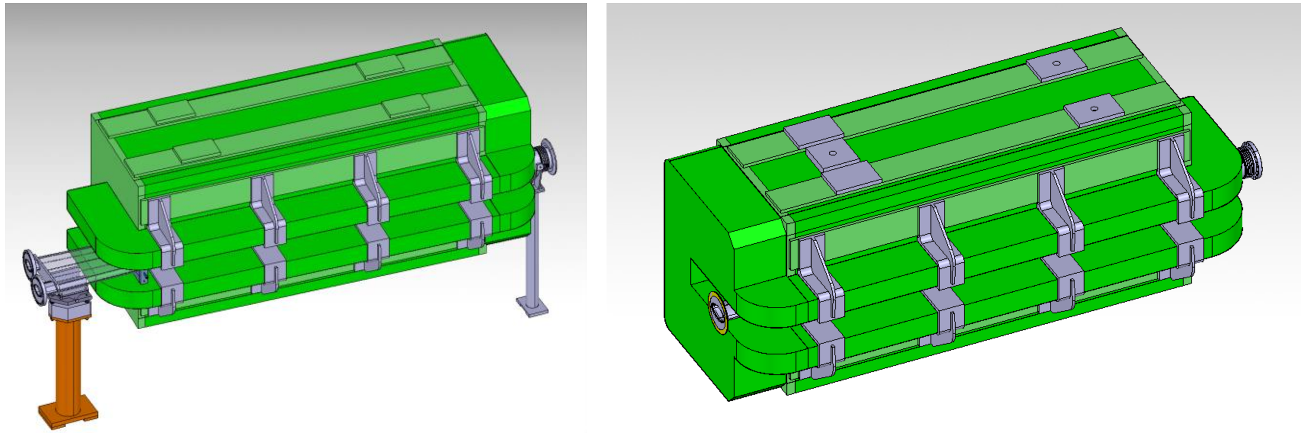


JOB 983

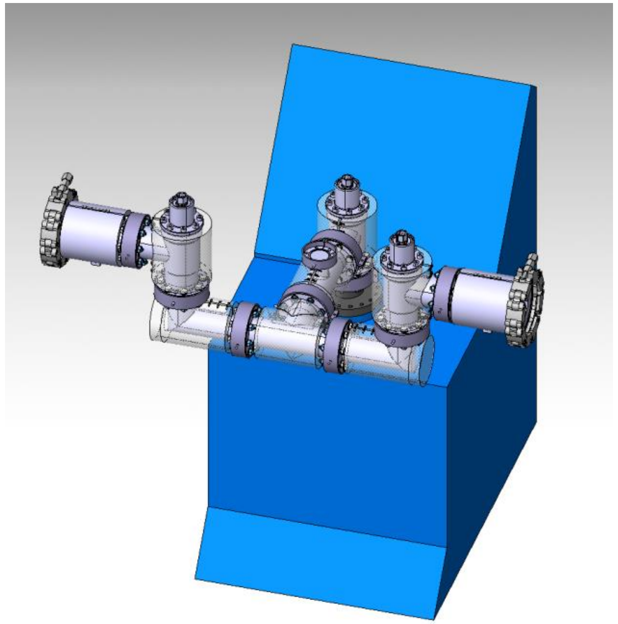


JOB 1020

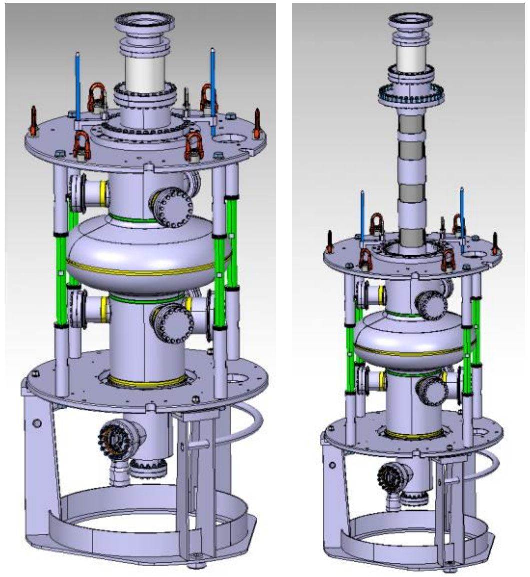
Mechanical design
Examples



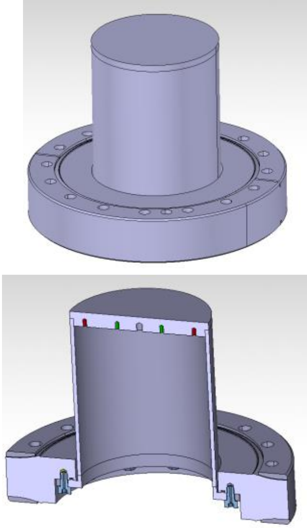
Consolidation of vacuum chambers BHZ378 and BHZ377 in TT2 (F16) beam line



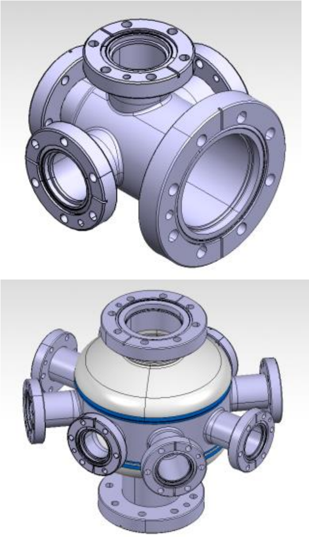
Design of autoregulated bake-out jacket for UHV test collimation at LS3 (HL)



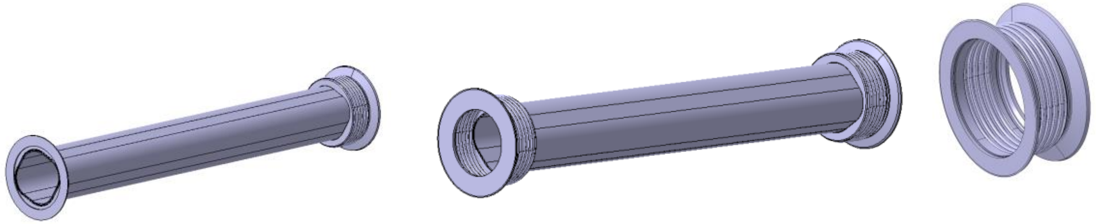
New Plasma support system



Dismountable QPR sample + flange drawing

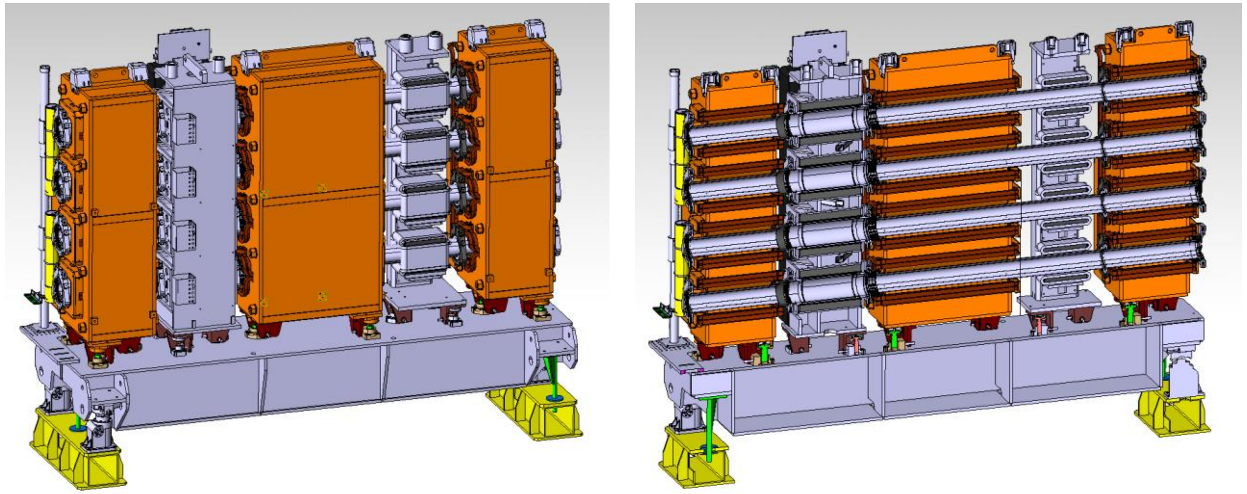


Vacuum chambers for ion gun setup

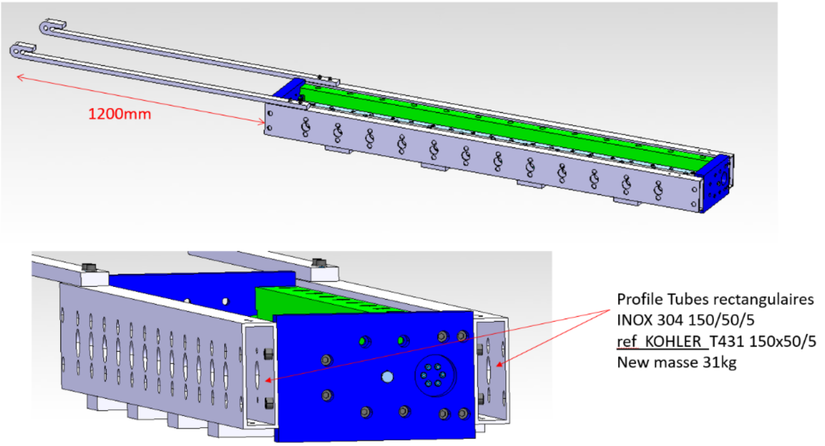


PSBooster

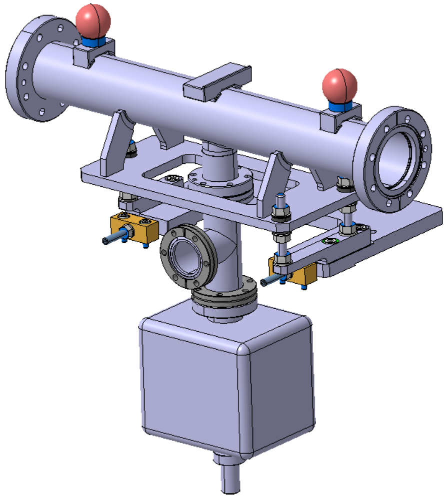
Mechanical design
Examples

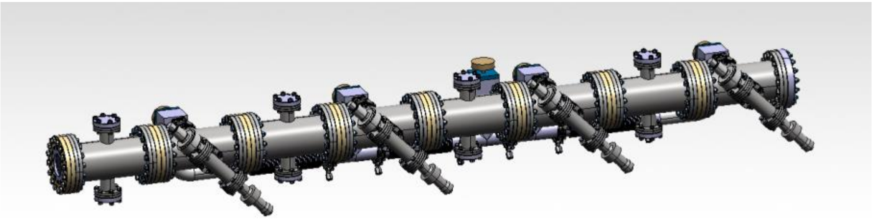


Chamber cut + flanges for PS magnet leak

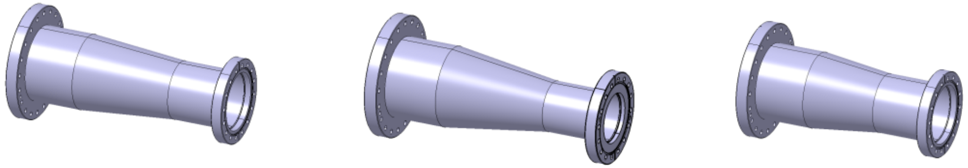


Cadre machining of the stiffener 2M

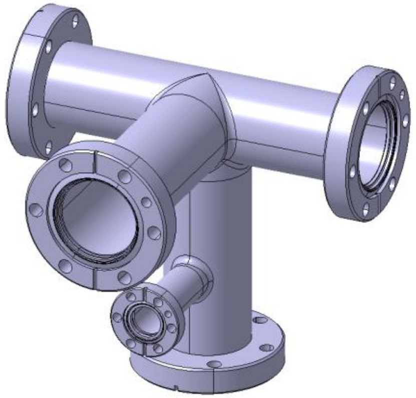




HRM SMAUG experiment



Design of 2 vacuum transitions (VCT) and one vacuum chamber (VCD)



New VCPMC for Magic boxes

Accelerator operation

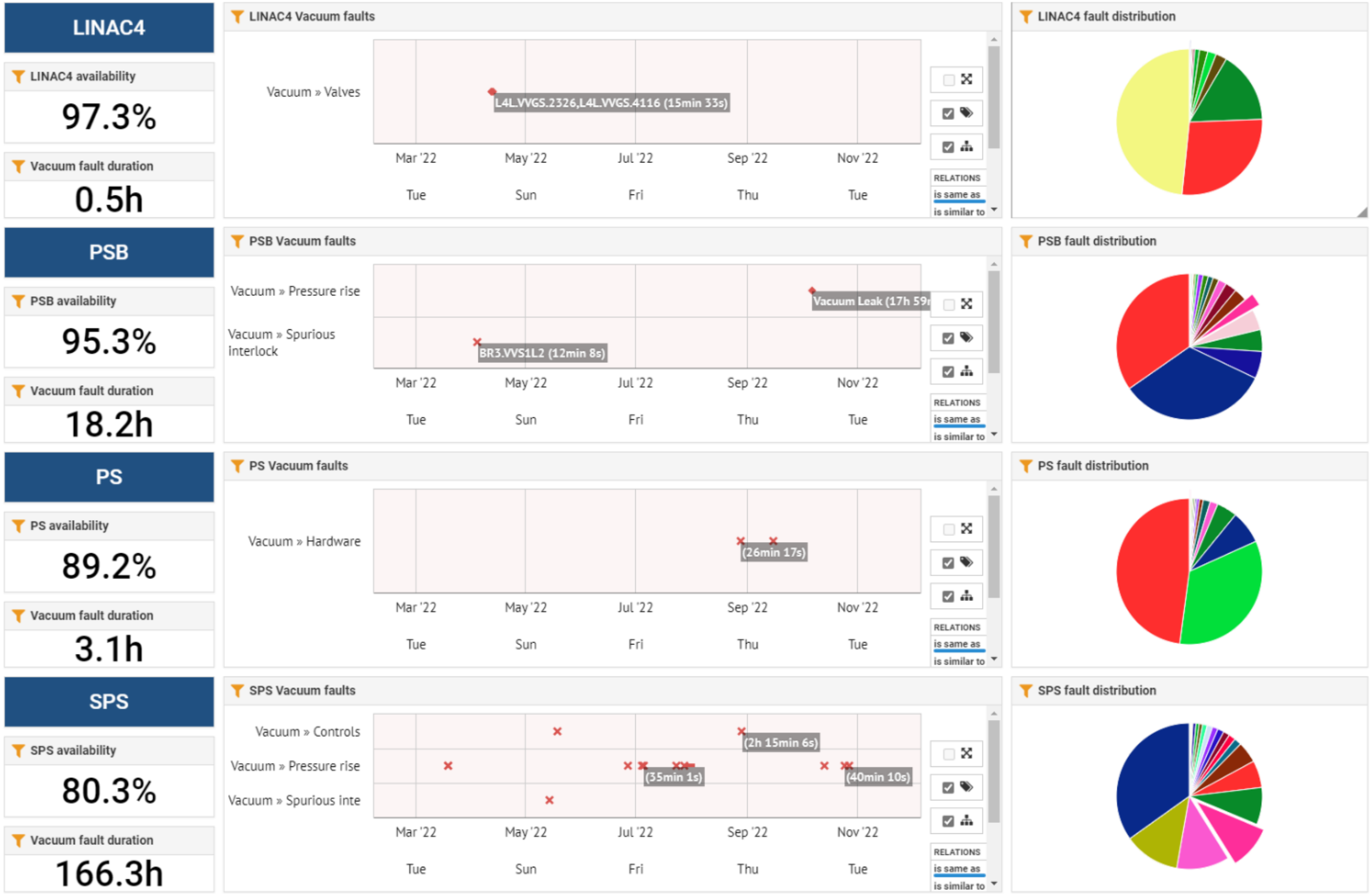
Injectors and experimental areas

LHC injectors 2022 performance

Excellent availability, but still some faults:

- LINAC4: Valves closed due to RF spark (child of another fault)
- PSB: Leak due to faulty RF bypass (spark)
- PS: One solenoid valve burnt in TT2 sector valve
- SPS: TBIU beam strike and BA5 collar mechanical failure

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



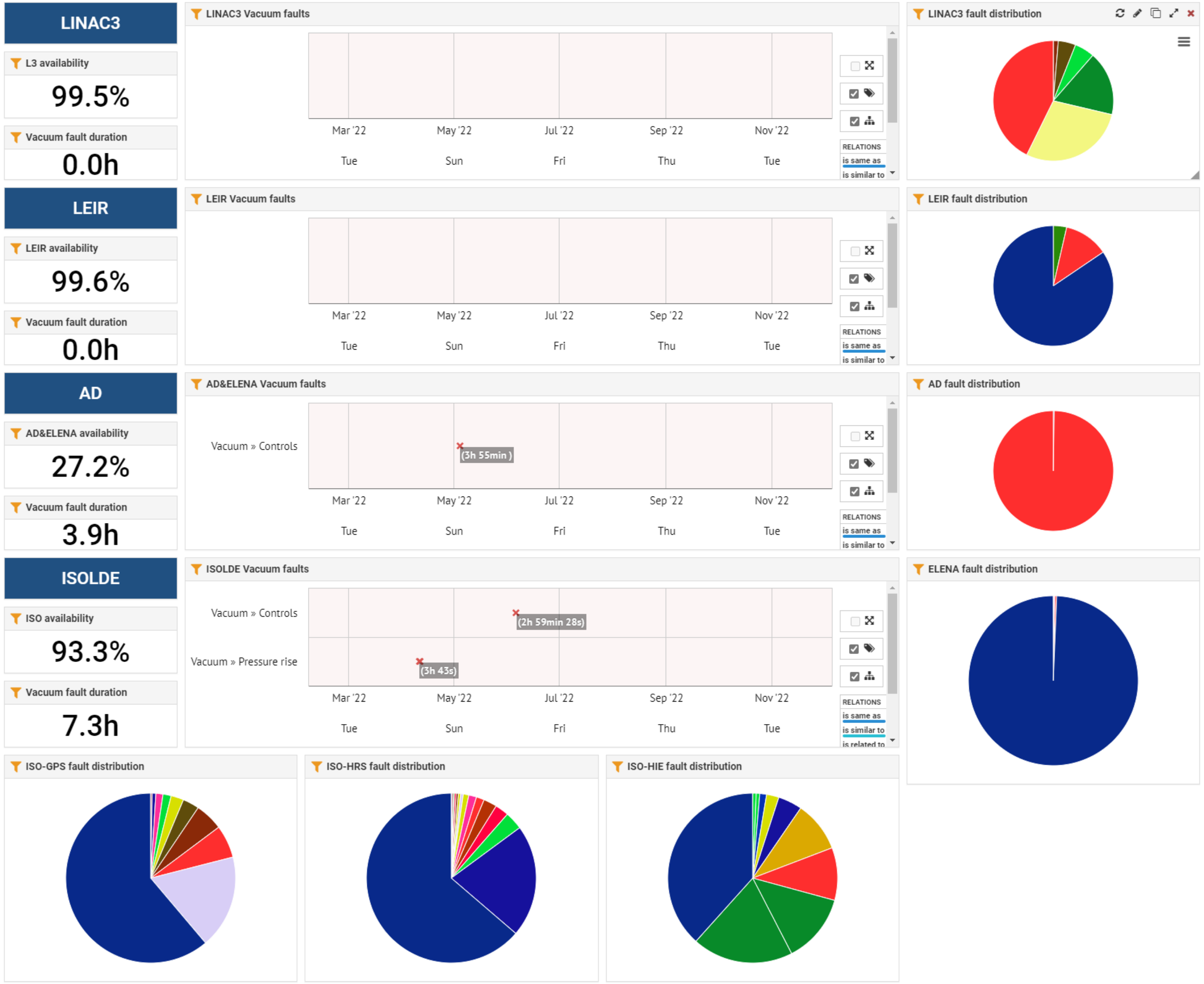
LHC injectors 2022 performance

Excellent availability, but still some faults:

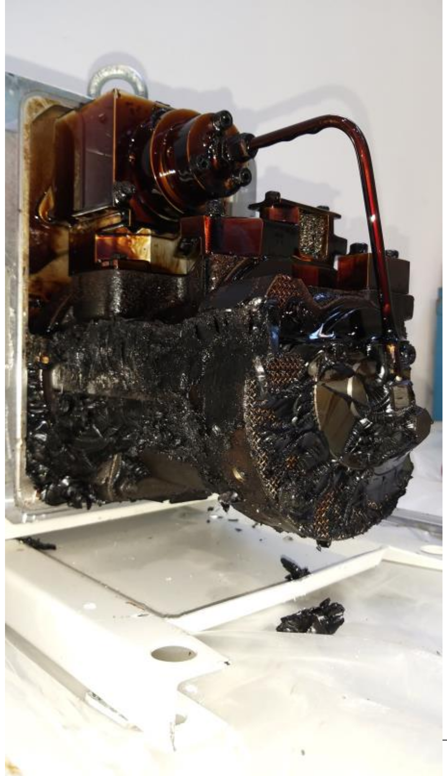
- ❑ AD/ELENA: Failure PLC communication module
- ❑ ISOLDE: Failure TPG controller. Target leak (no VSC origin)

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

PUMA received beam for first time!

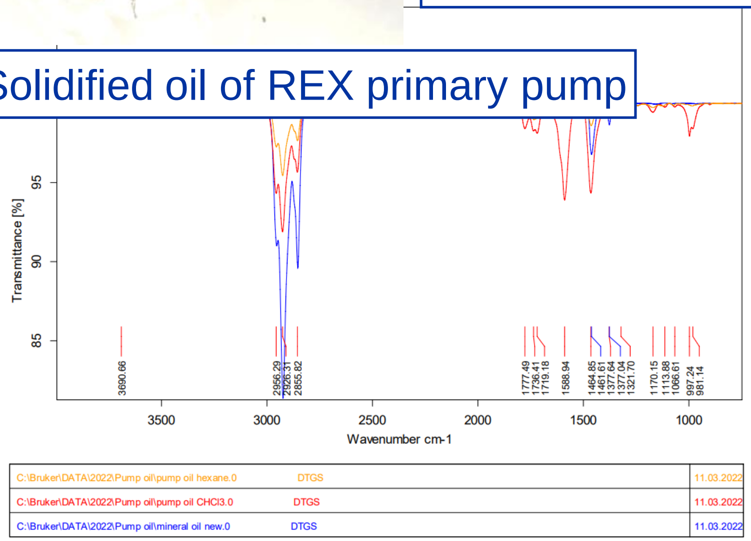


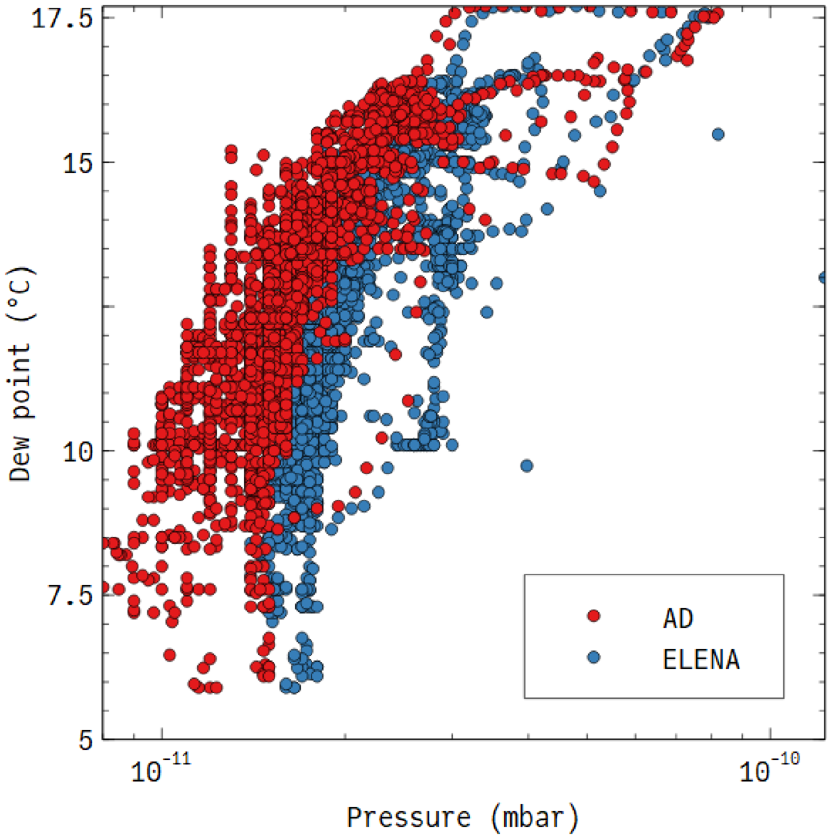
Injectors and EA: Some issues



YETS: water leak brazing BSW in PSB

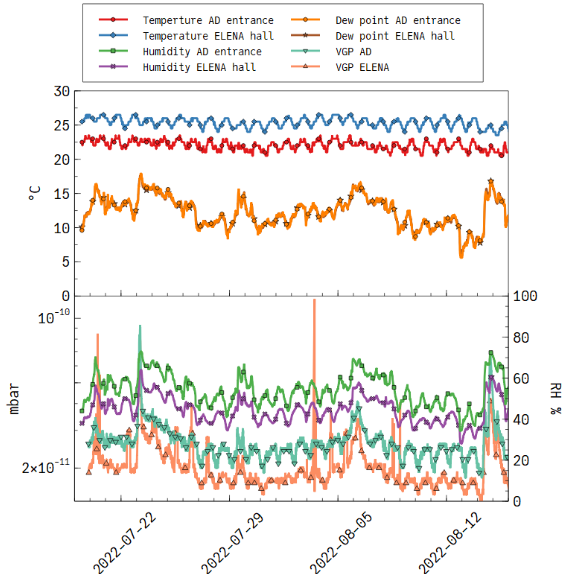
Solidified oil of REX primary pump



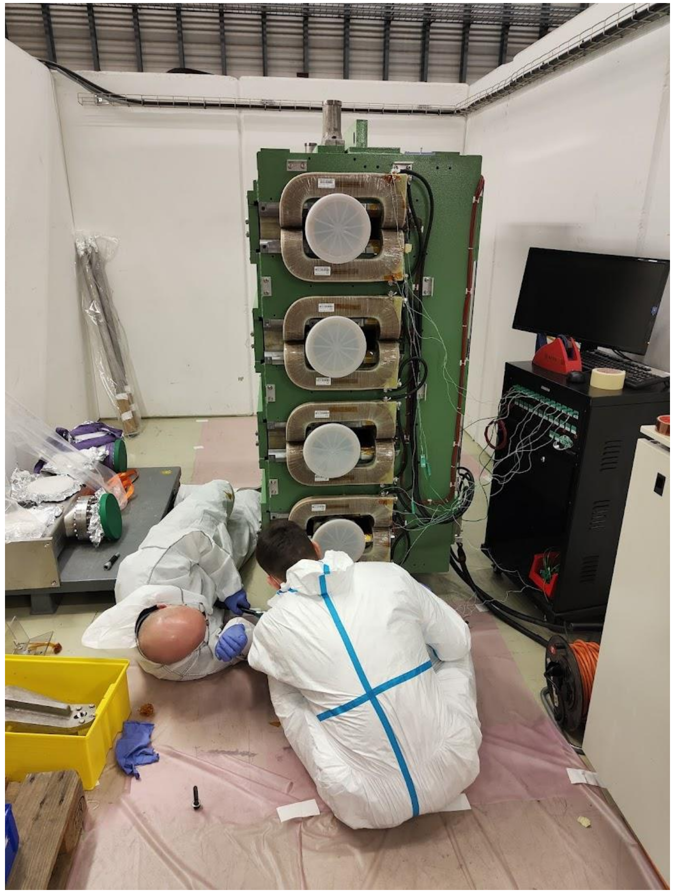


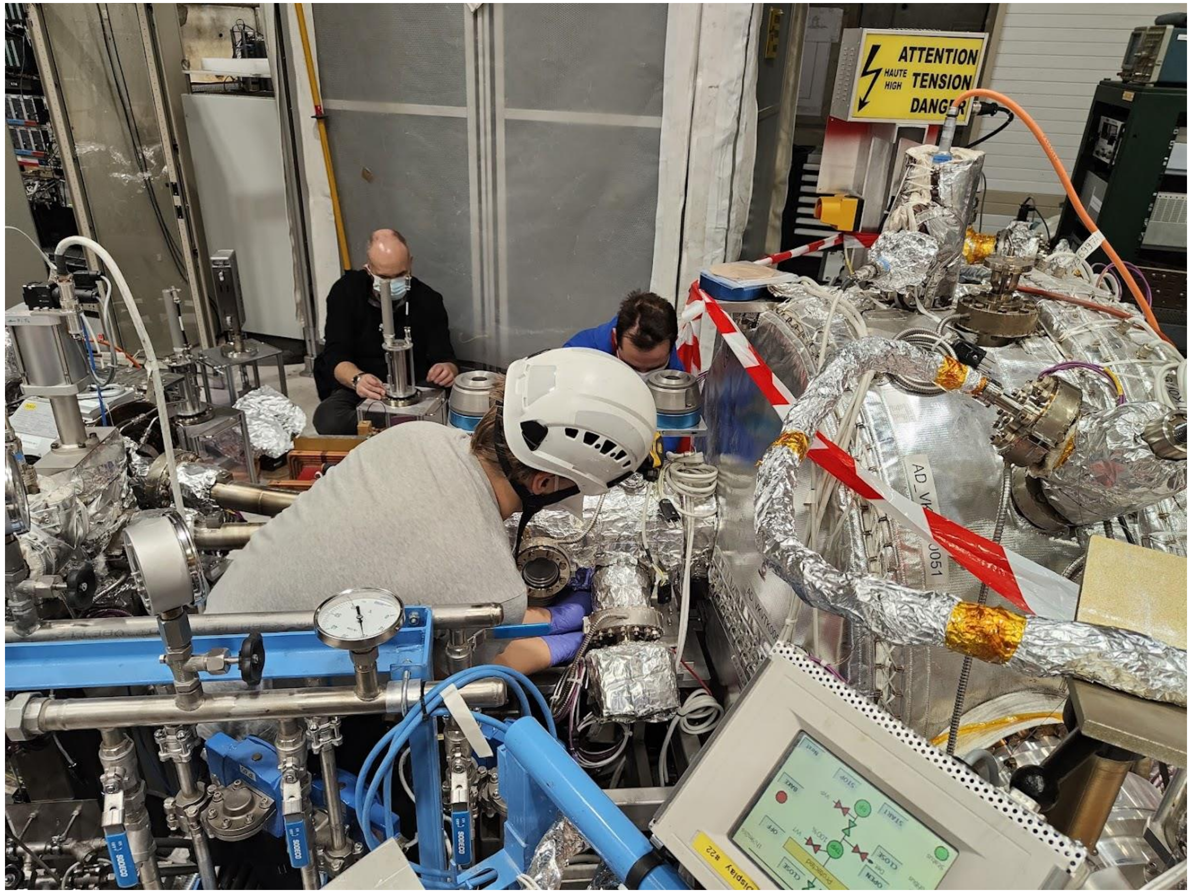
ELENA: Leakage current of penning gauges due to humidity

Spark PSB seal (faulty RF bypass)



Interventions in PS complex





Linac4 Controls upgrade

New pumping groups control

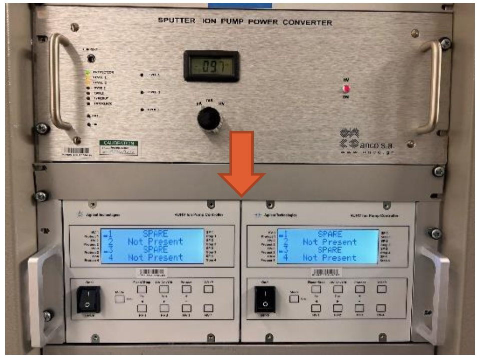
- Test, Installation and commissioning of 14 VPG controls
- Power network modification
- VacBD and SCADA update

Homogenization of Interlock system

- Replacement the LHC logic interlock by cPS logic
- New cabling for interlocks sources

VPI control upgrade

- Replacement of old VPI controllers for new Agilent
- New Profibus network
- Test and commissioning



De-cabling and cabling

BA1
Cables identification

HV lock-out

VPI controllers in local during de-cabling campaign

LINAC3 and LEIR
Unscheduled campaign

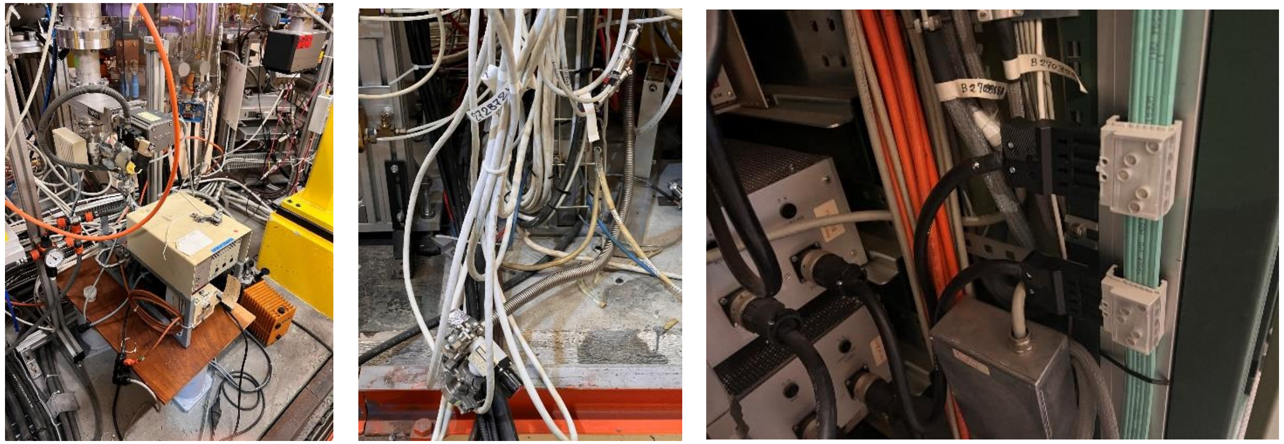
New 3 Phase distribution

VPI controllers in local during de-cabling campaign

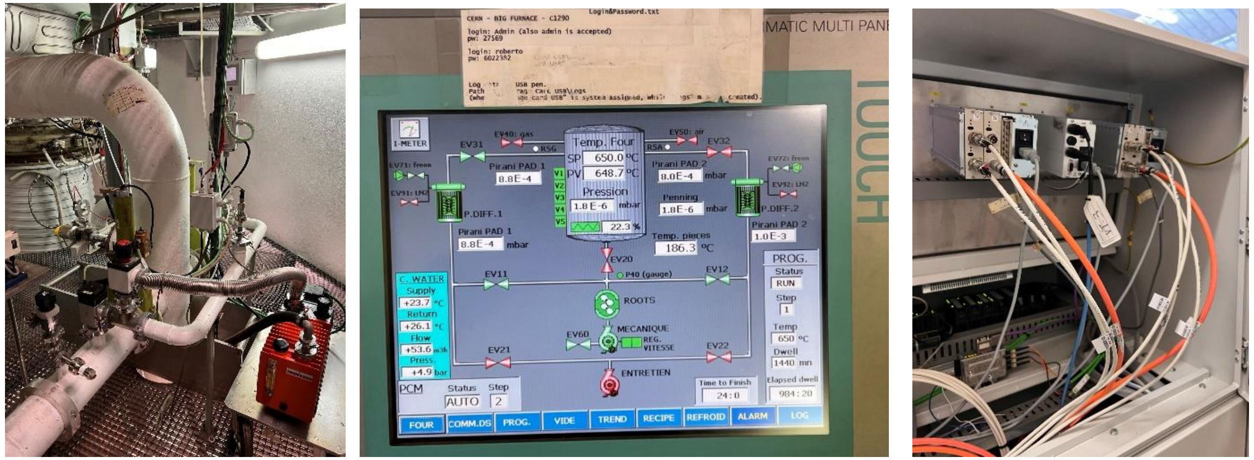
Grand Four
New cabling due to gauge measurement issues

Test and commissioning

Electro beam test stand
Cabling for a VPS and a Valve, test and commissioning



Linac3 de-cabling and 3Phase



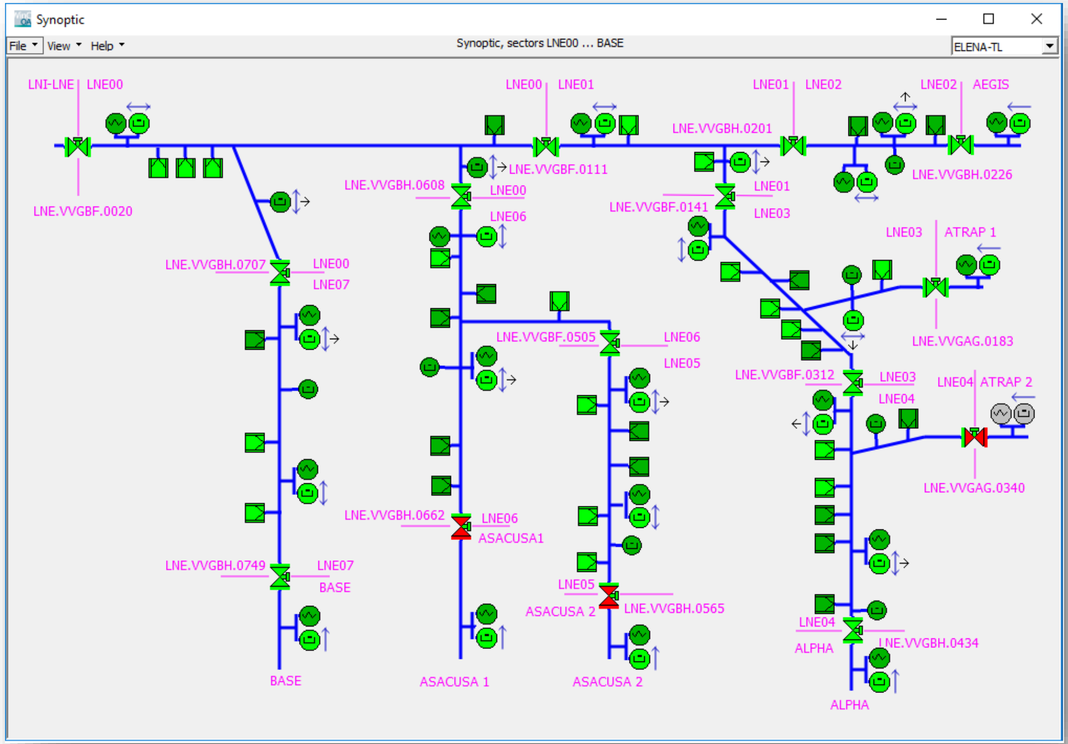
Grand Four

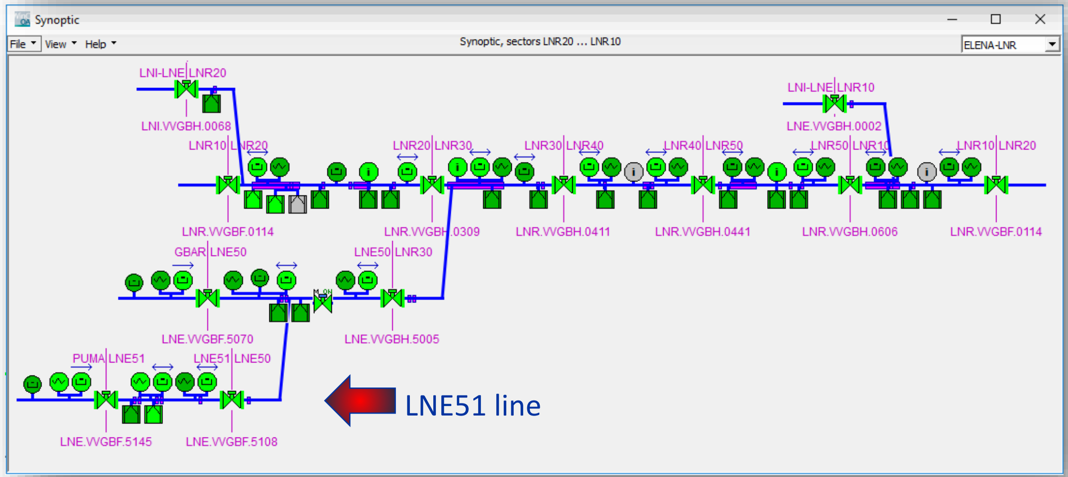
AD area

ELENA

- 8 working experiments
- New WIC interlocks installed and tested
- LNE51 (**PUMA**) line commissioned
  - Local controls rack and cabling provided to operate the vacuum line of the PUMA experiment

Local vacuum controls rack

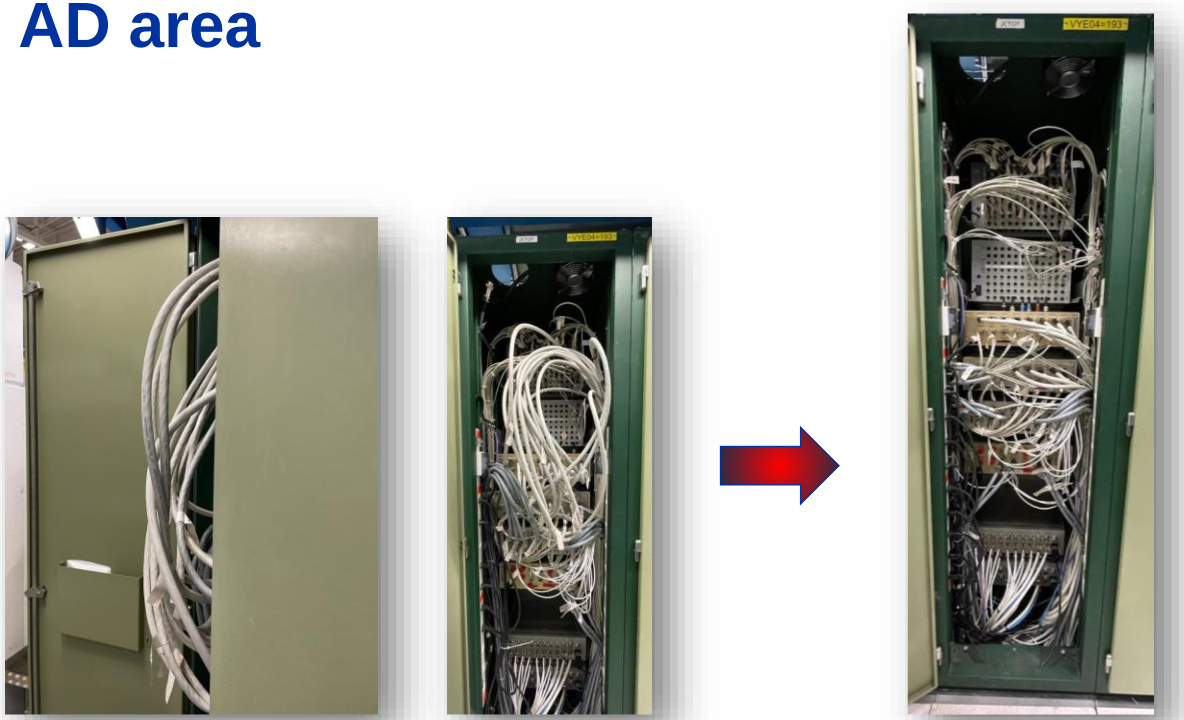




AD area

AD/ELENA

- Racks cabling re-routing
- UPS powered racks
- IP3/2 compliant racks/crates

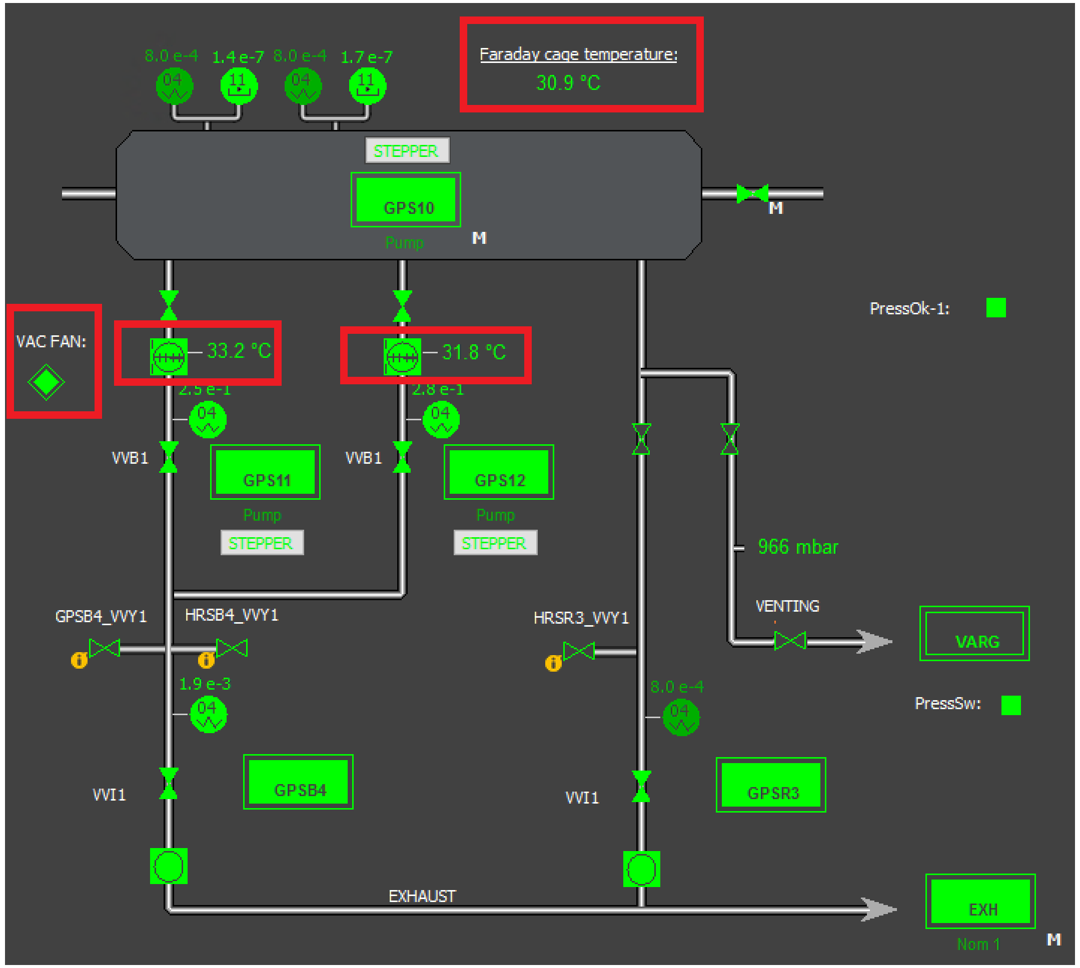


Rack cabling re-routing, door can be closed now

UPS powered racks

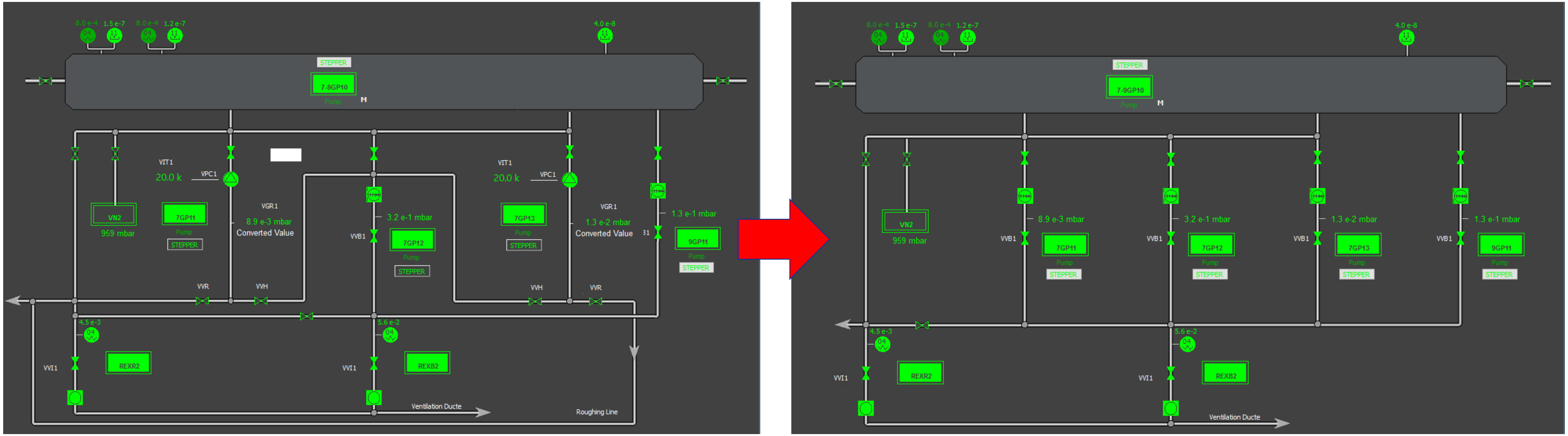
IP2/3 compliant racks – Plexiglass covers to see the PLCs

ISOLDE complex



- New **temperature measurement** for faraday cage and turbo-pumps in front-ends **HRS & GPS**
- New **fans and control system** to cool down the turbo-pumps in front-ends HRS & GPS

ISOLDE complex

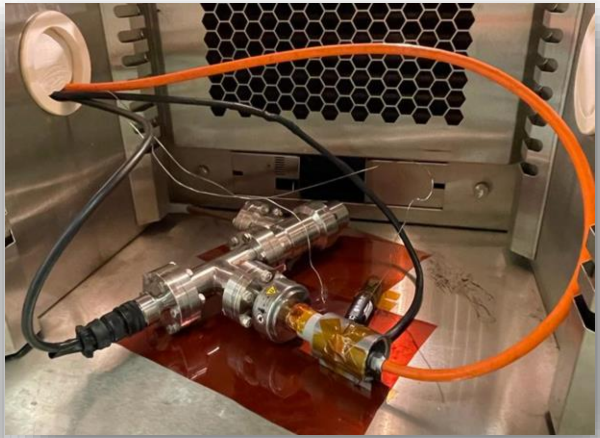


- Replacement of **3x cryo-pumps by 3x turbo-molecular pumps** in RFQ and 7-9GAP sector of REX-ISOLDE

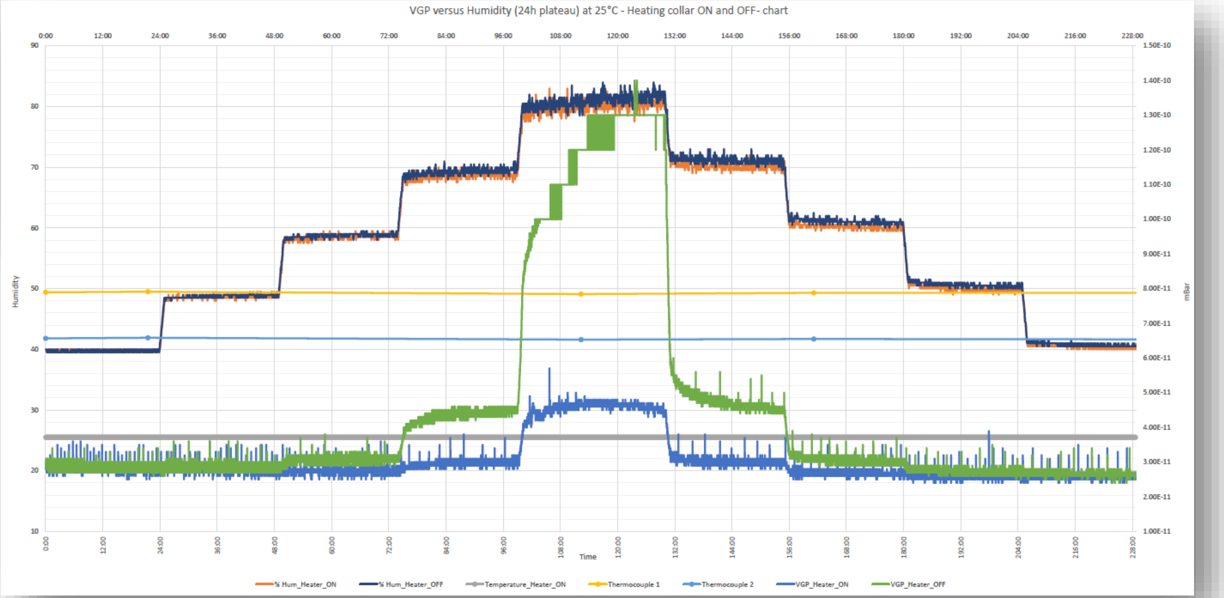
Climatic Chamber Tests

EXCAL machine tests for temperature and humidity effect on Penning gauge measurement

EXCAL climatic machine



Penning setup



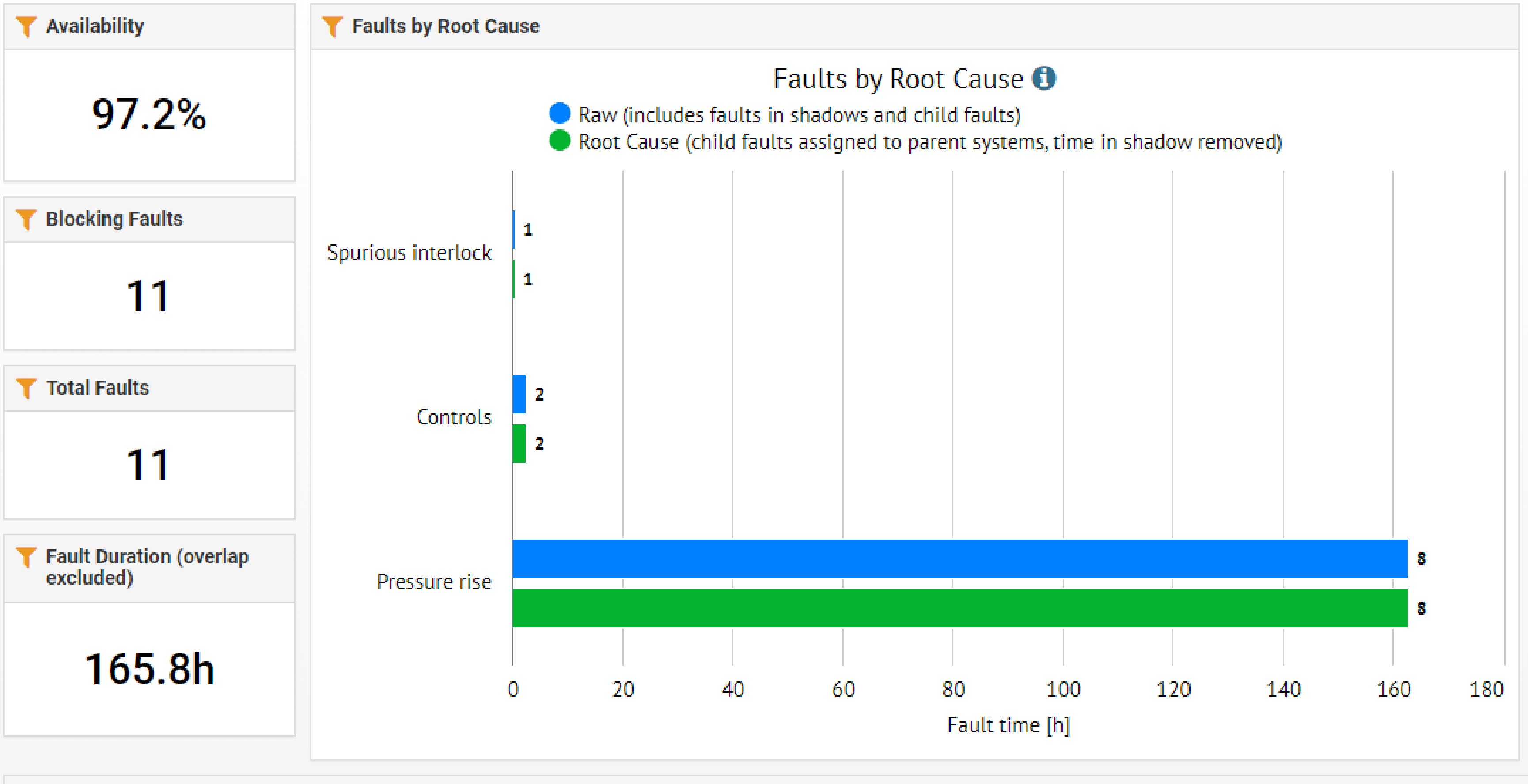
Temperature and humidity effects on VGP readout

SPS Operation

Excellent availability all along the year!

Main vacuum faults

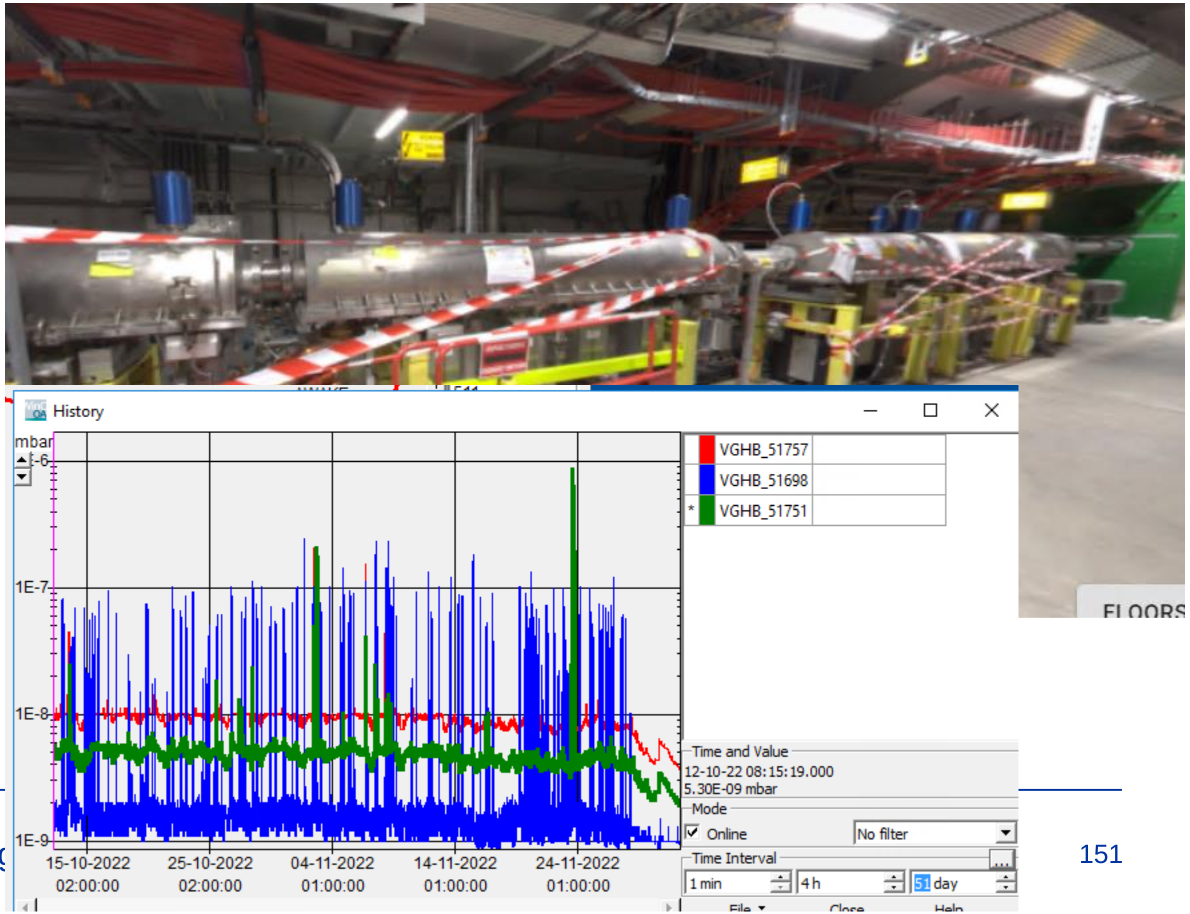
- T2 TBIU beam strike: **140h** of downtime (high radiation area no direct access). No impact to the SPS and LHC operation
- BA5: Collar failure with 5 sectors vented. Just **19 h** to restart physic.
- BA2 Failure of 2 interlock cards (**2 h** of downtime).



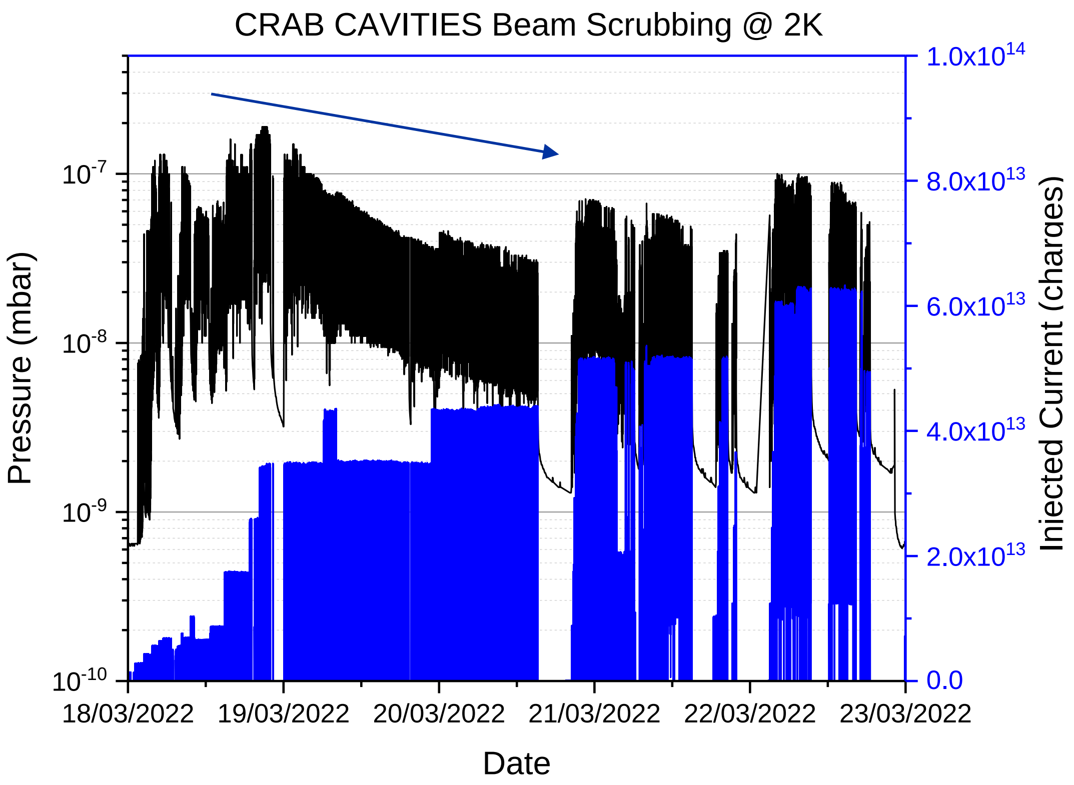
SPS High Intensity vacuum limitations

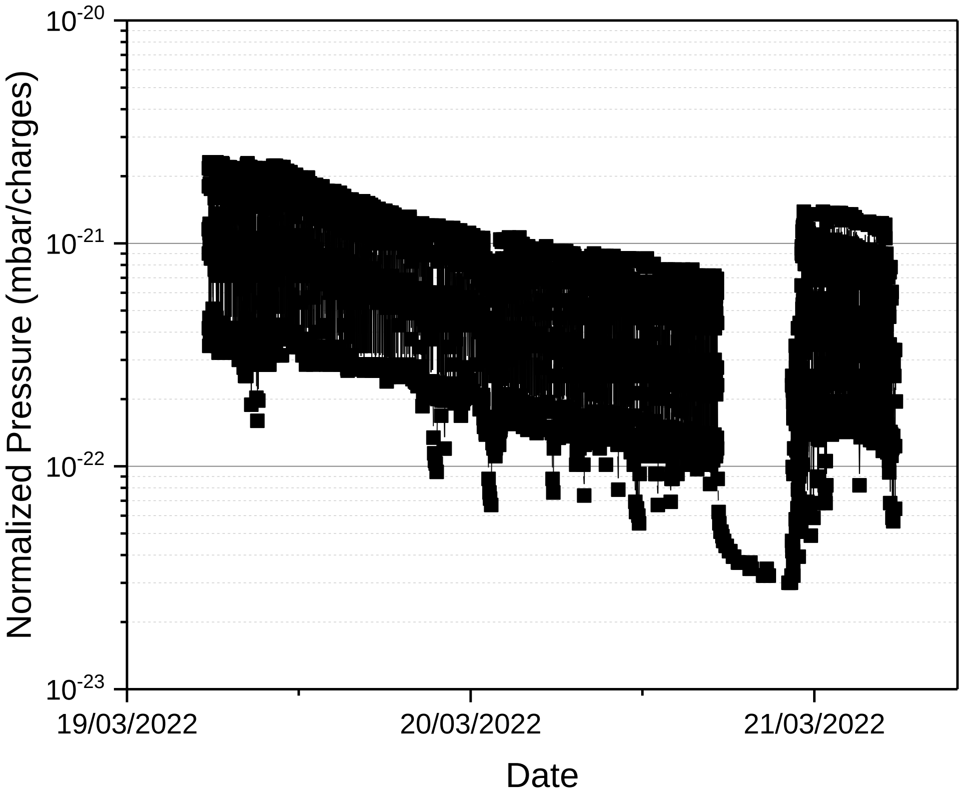
8b4e & batch spacing: sparks upstream the **800MHz cavity** depending on batch spacing→ **limiting beam delivery to LHC next year**. Endoscopy foreseen in YETS.

Dumping Kickers: MKDV/H **spurious sparks at LHC-25ns high intensities**. No action during YETS on VSC side.



SPS CRAB Cavities 2022 Operations

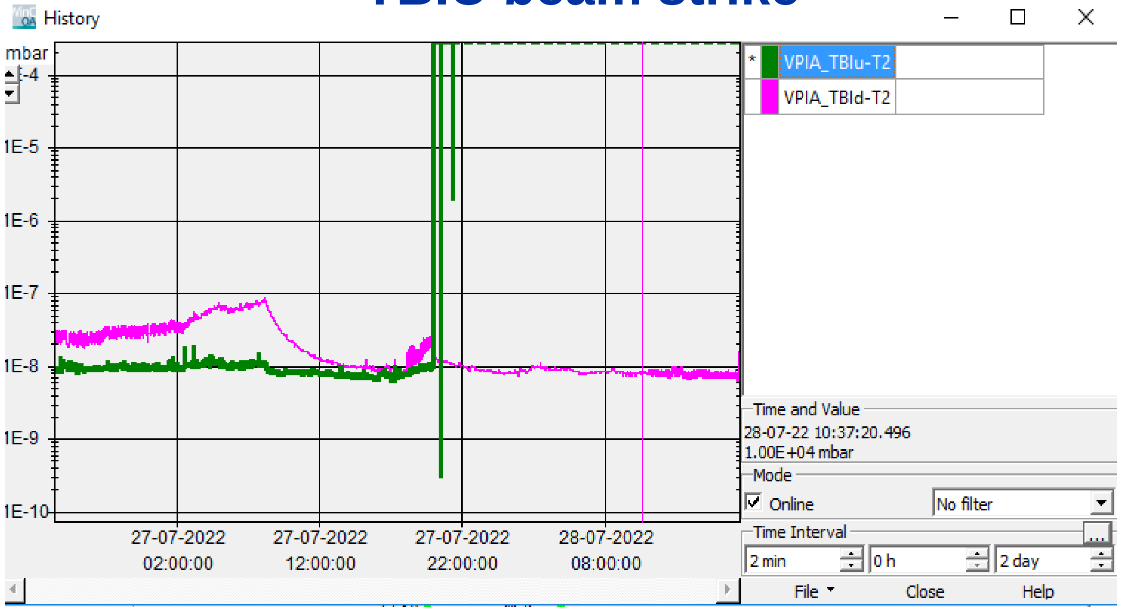




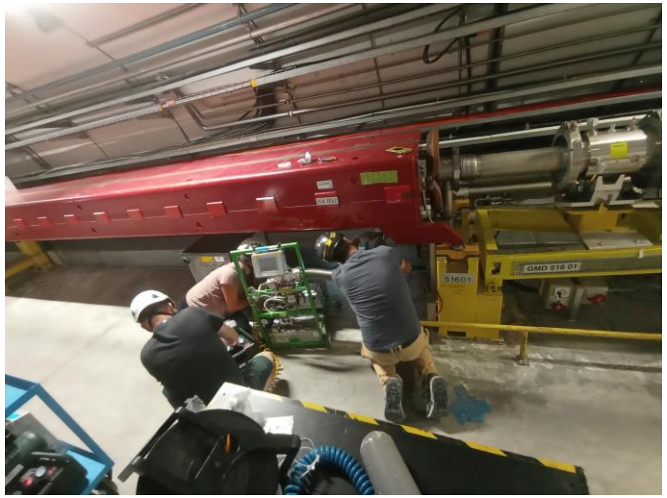
- For the first time the crab cavities have been scrubbed at 2K with high intensity beam (LHC-25nd at 450GeV, 1,6*10^11 ppb);
- Minor heat load deposited on the cavities;
- Slower conditioning than expected wrt SEY and ESD experimental data.

SPS: issues during 2022 run

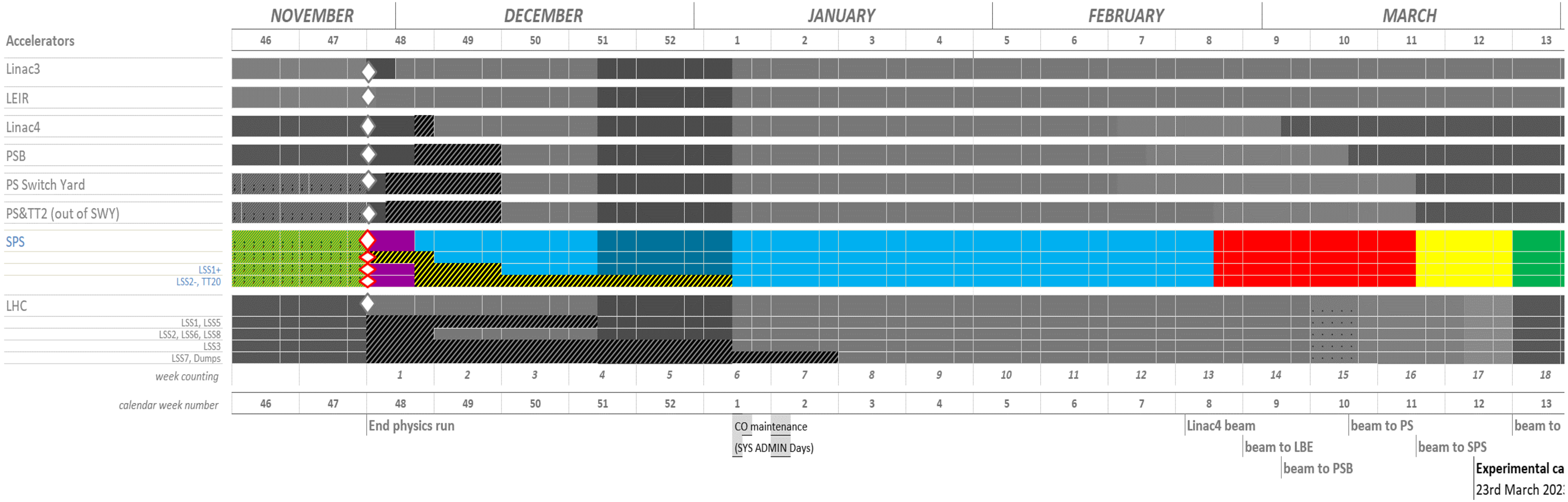
TBIU beam strike



Collar failure in BA5 → 5 sectors vented



SPS YETS 22/23 Activities

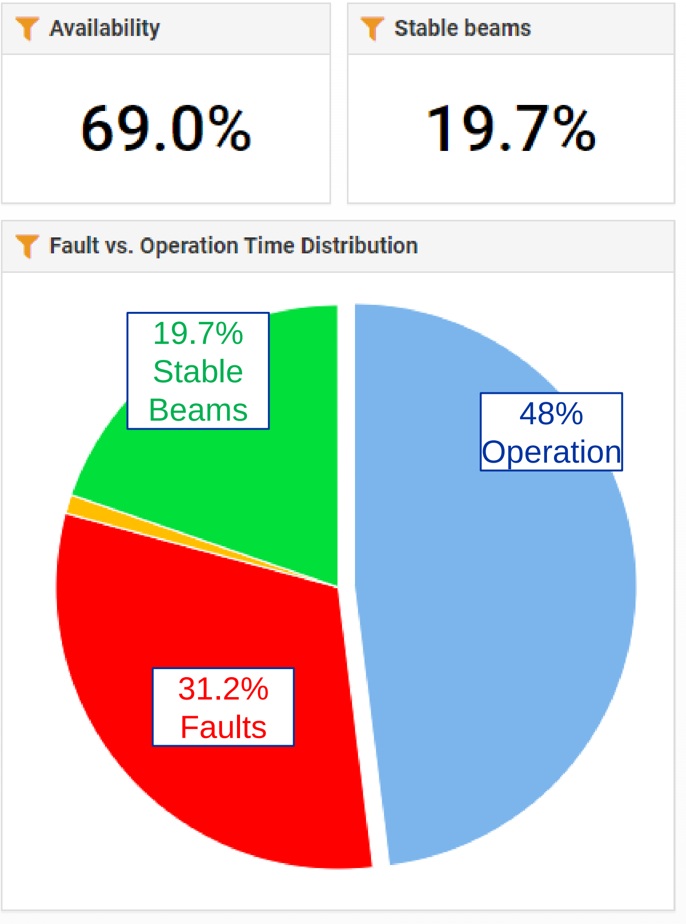


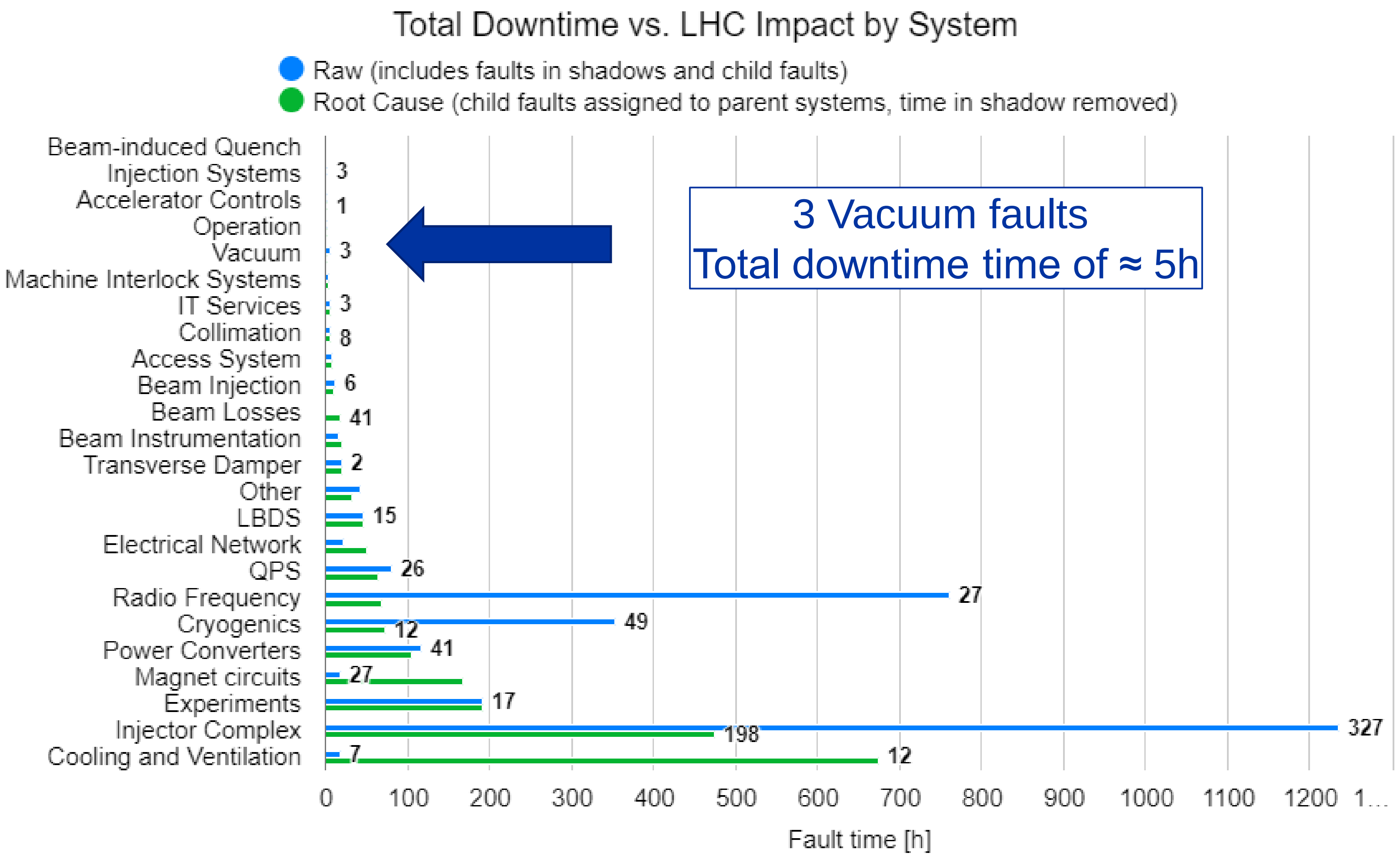
YETS schedule for the SPS, with the following main activities:

- MKE4 sectorization;
- MPKIV exchange (current intensity limitation in the SPS);
- 800MHZ endoscopy, 300MHz Cavity 5 leak detection;
- T4 reconfiguration in TDC2;
- Ion pumps consolidation, magnet campaign, aperture restrictions investigations, wire scanner exchange.

LHC operation

LHC Operation

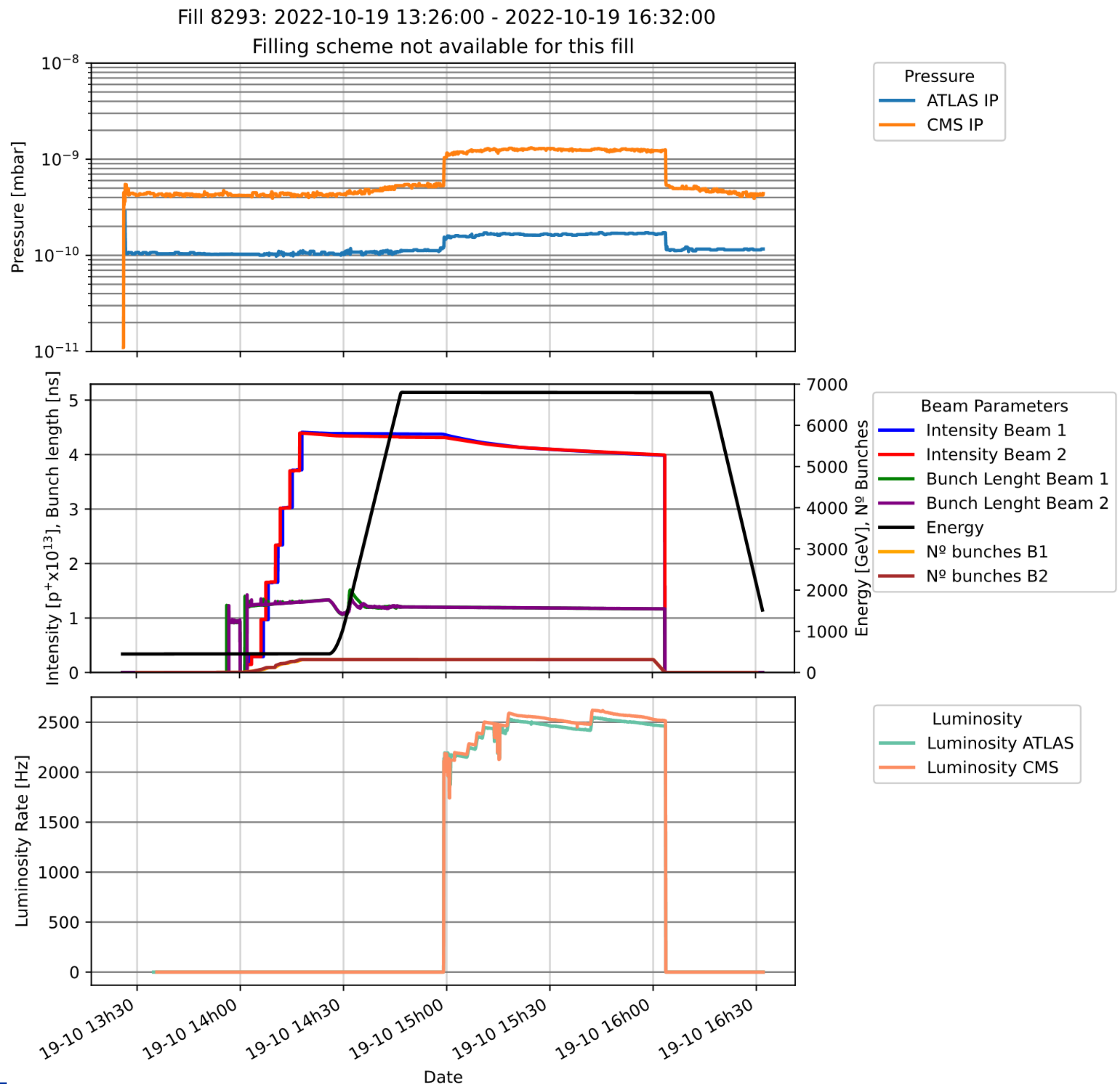




3 Vacuum faults
Total downtime time of ≈ 5h

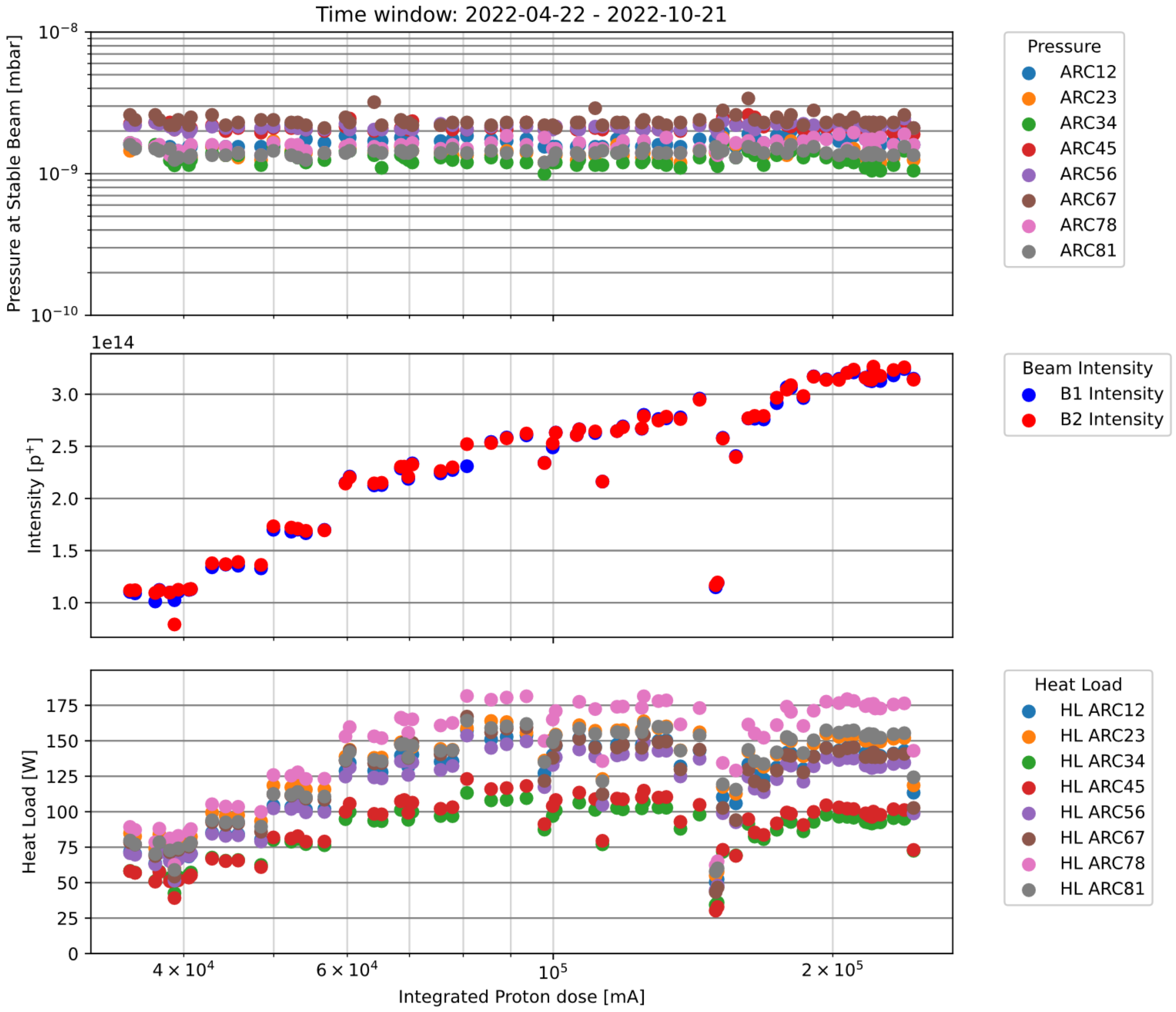
LHC Operation
Short-term analysis

- Works with **time windows** and a **range of fills**
- **Large choice of variable types**:
    - Pressure
    - Temperature
    - Heat Load
    - Beam Parameters
    - More are added on a regular basis!
- **Plot fully customisable**
    - X axis
    - Y axis
    - Logarithmic scale
    - Beam intensity and Energy filters
    - Gauges organisation
    - Legends, colours, etc…



LHC OPERATION
Long-term analysis

- Works with a **time window**, a **range of fills**
- **Possibility to choose the instant we are interested in**:
  - Maximum intensity, stable beam, static pressure, etc…
  - Any other requirement is also possible
- **As before, large choice of variable types**
  - Allows beam vacuum performance analysis with beam parameters, heat loads, temperature, etc…
- **Plot fully customisable**
  - The same as before + trend lines



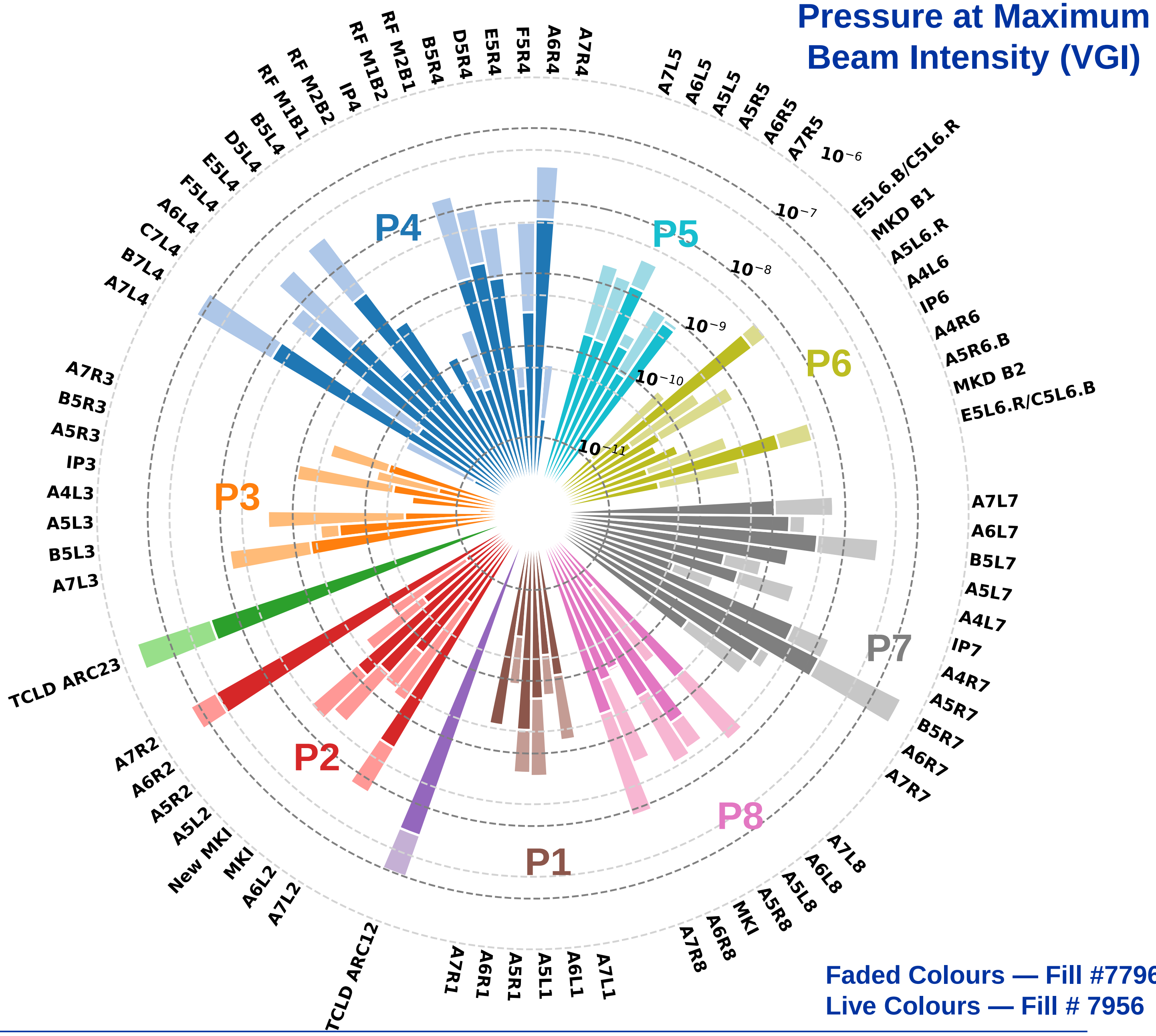
Pressure values at stable beam

LHC SCRUBBING RUN
Baked Sectors Overview

Conditioning effect visible in all room temperature sectors

Pressure measurements scattered through 3 orders of magnitude:

- Vacuum sector history dependence
- Different systems, sector lengths, effective pumping speeds

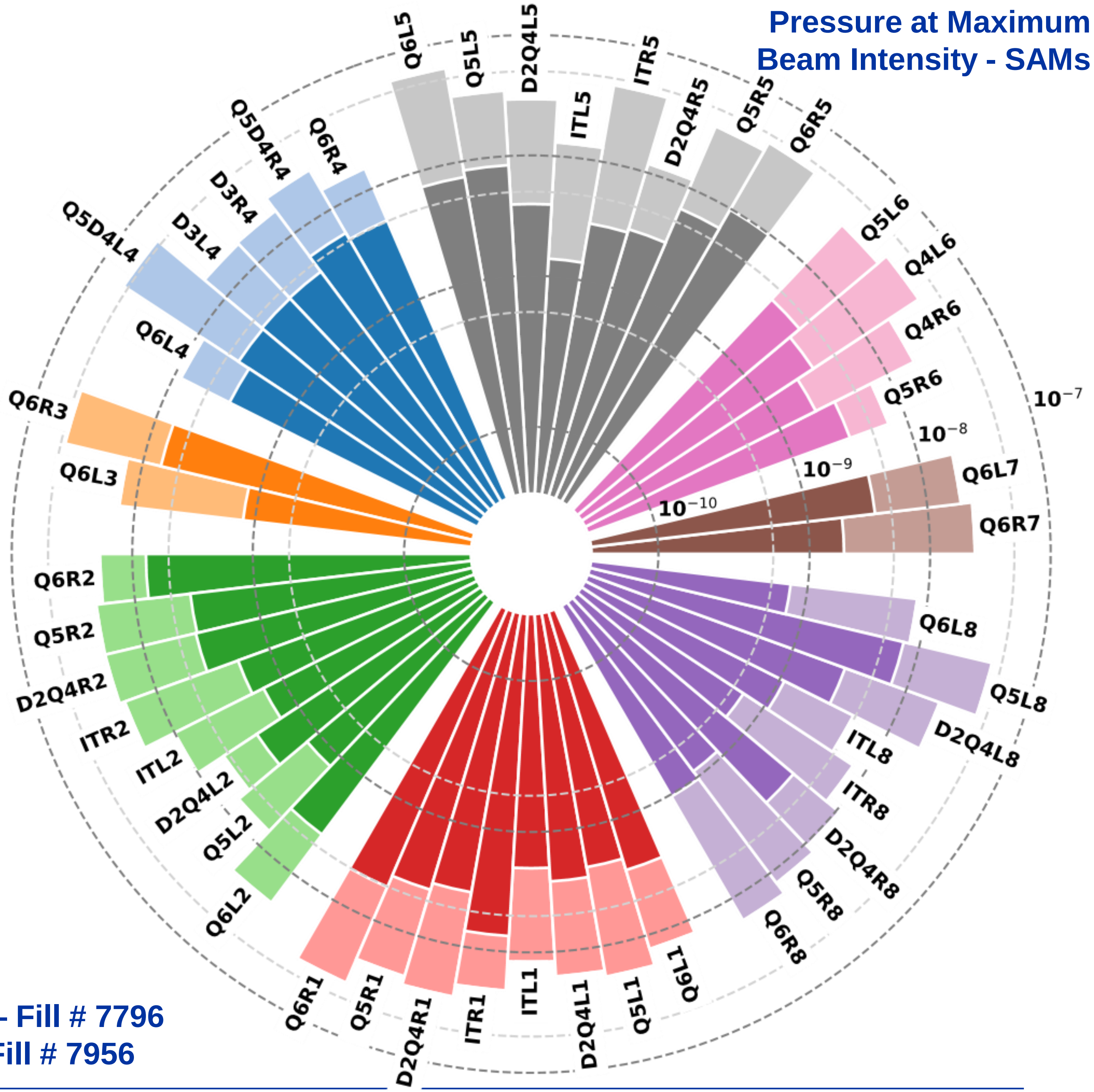


LHC SCRUBBING RUN
Unbaked Sectors

Conditioning effect clearly visible in all SAMs

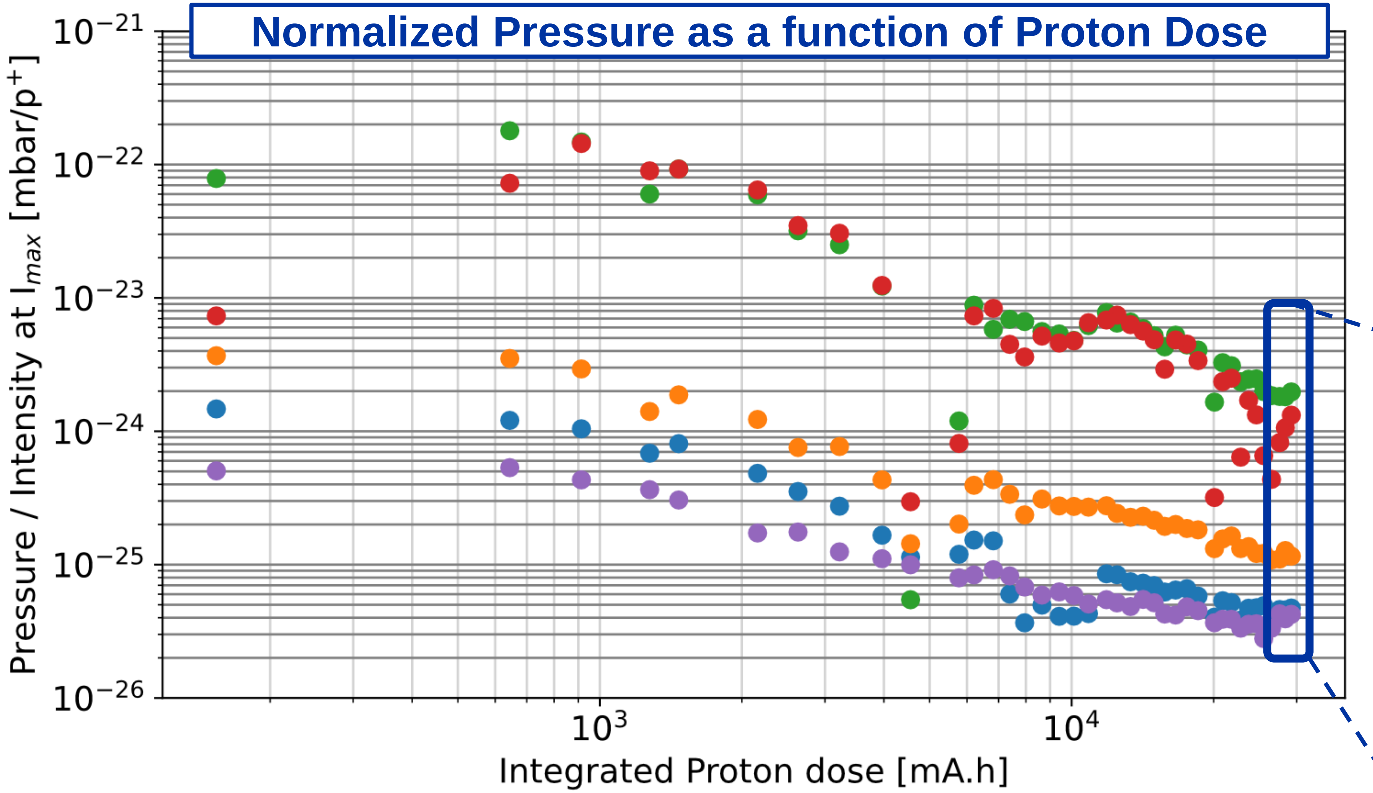
- All SAMs were vented in LS2 with ultra-pure Neon
- Pressure measurement at room temperature after the cold-warm transition
- ≃1 order of magnitude decrease in pressure at maximum intensity (10^{-8} mbar ⇒ 10^{-9} mbar)

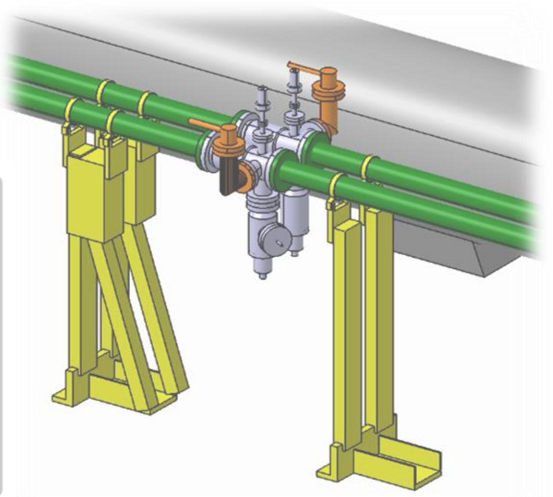
Pressure at Maximum Beam Intensity - SAMs

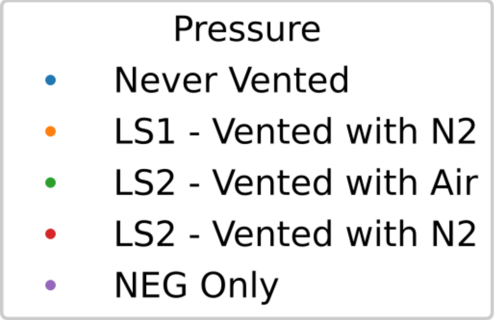


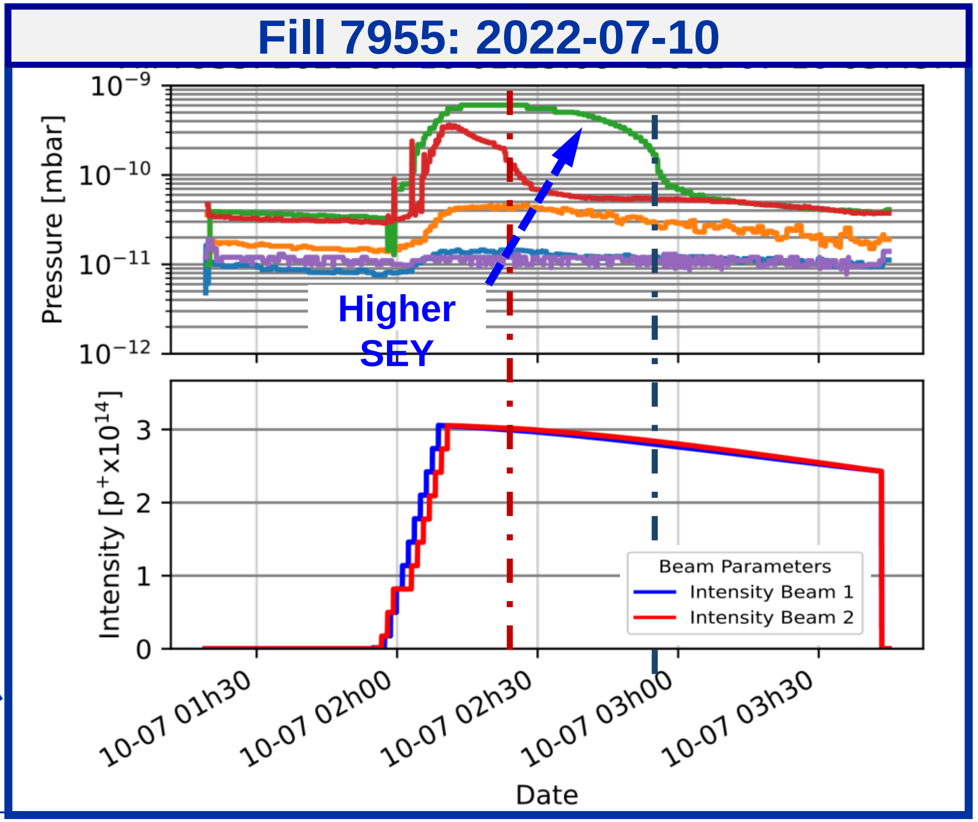
Faded Colours — Fill # 7796
Live Colours — Fill # 7956

LHC SCRUBBING RUN
History Dependence in Baked Sectors







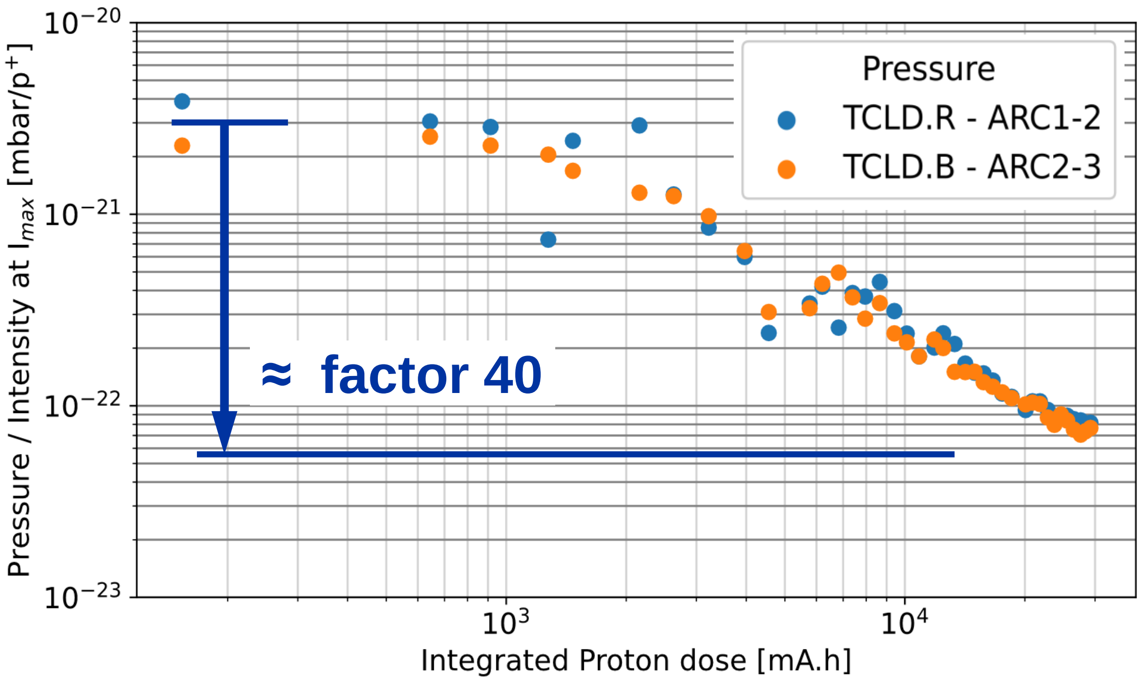


Vacuum performance analysis must consider sector history:

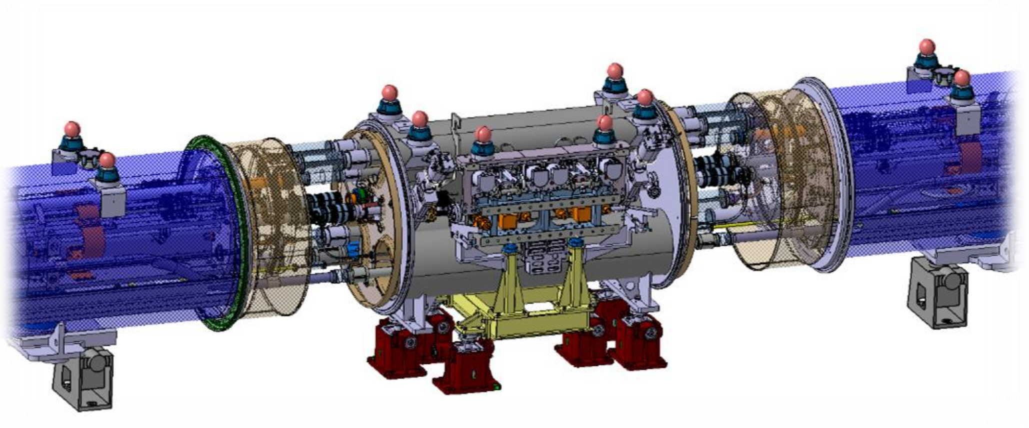
- Pressure measurements spanning 2 orders of magnitude.
- Differences between LS1 and sectors that were never vented are still seen.
- In some locations we are at the multipacting threshold for this intensity/energy.

LHC SCRUBBING RUN
TCLD Collimators

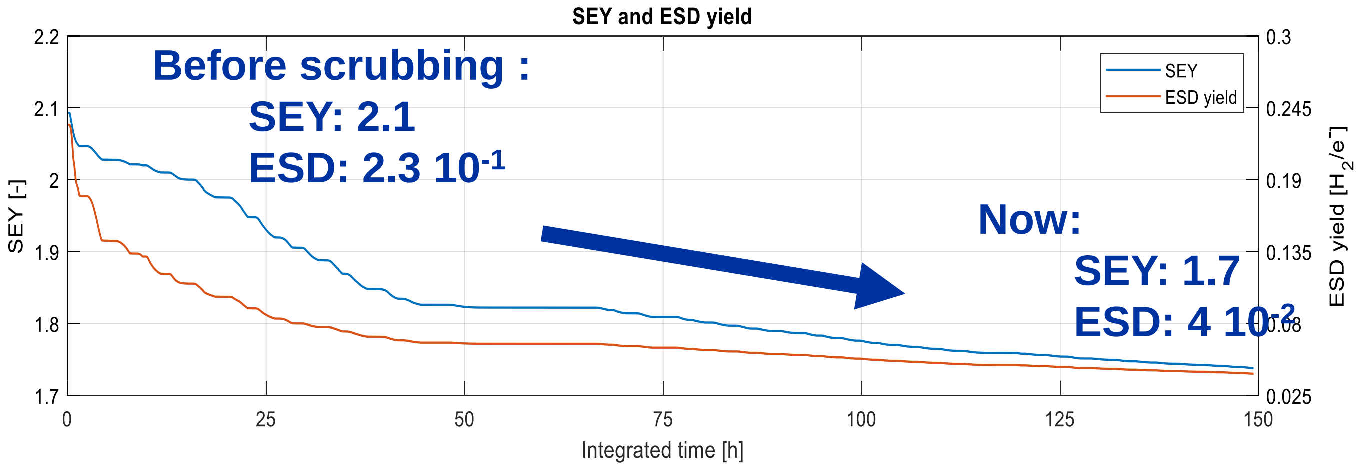
First room temperature sector in LHC ARCs



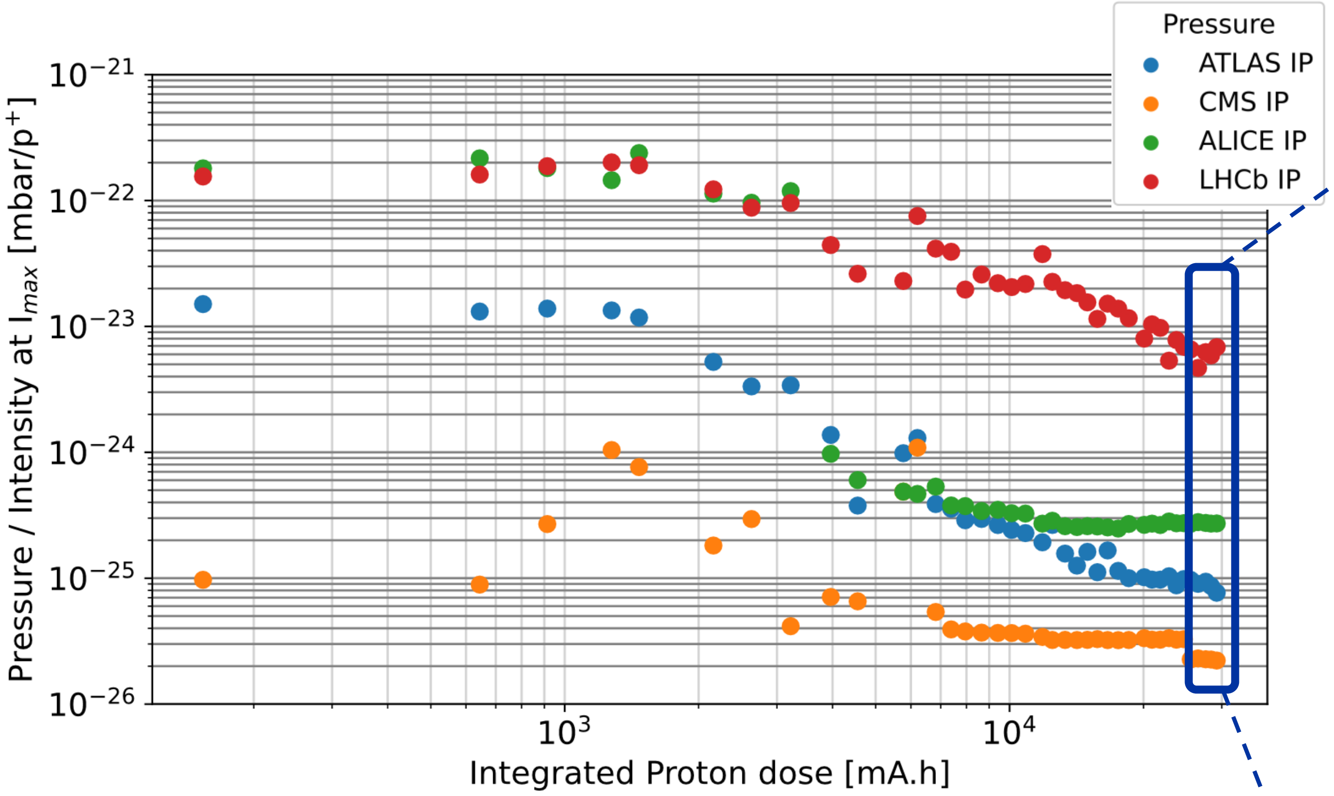
Factor 20 decrease of pressure at maximum intensity, down to low 10^{-8} mbar.

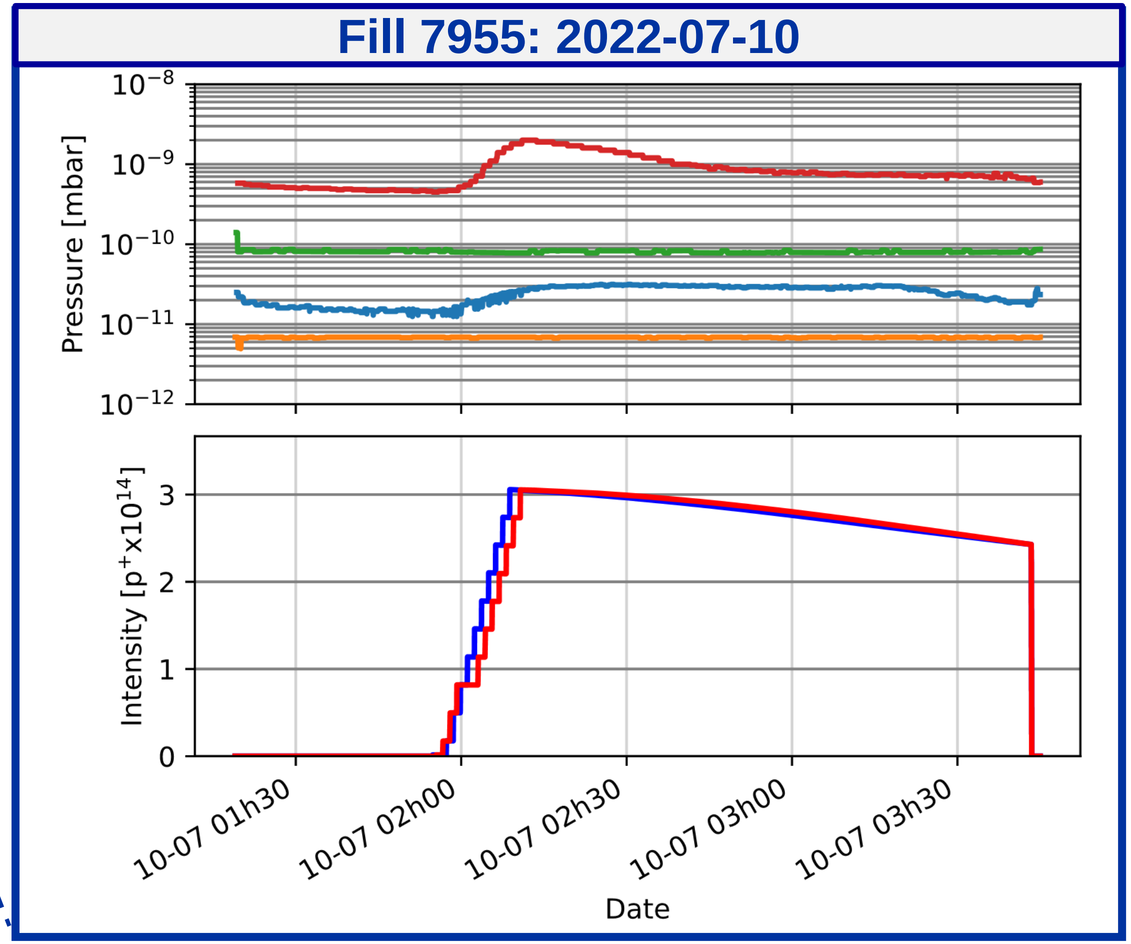


- **Completely un-scrubbed surface: known initial surface state**
- **Possible to estimate ESD and SEY from:**
  - Experimental conditioning curves.
  - TCLD pressure evolution



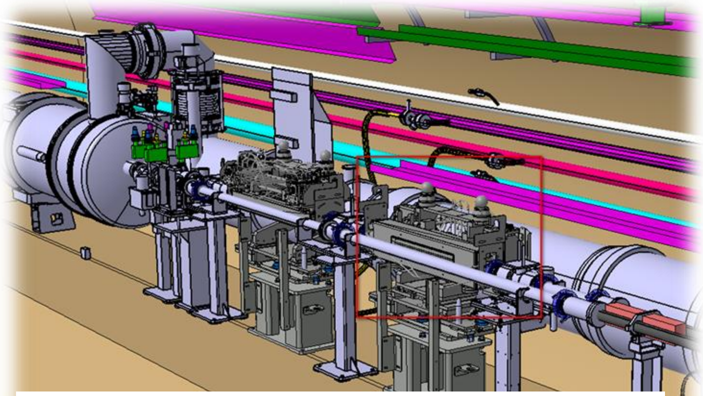
LHC SCRUBBING RUN
Experimental Areas





- **Conditioning observed in ATLAS and LHCb**
- **In CMS and ALICE:**
  - No visible multipacting if the solenoid is ON
  - Pressure readings affected by magnetic fields

LHC YETS 22-23: Overview of Activities



Leak found on a TCTPV edge welded bellow (A4L8.X)

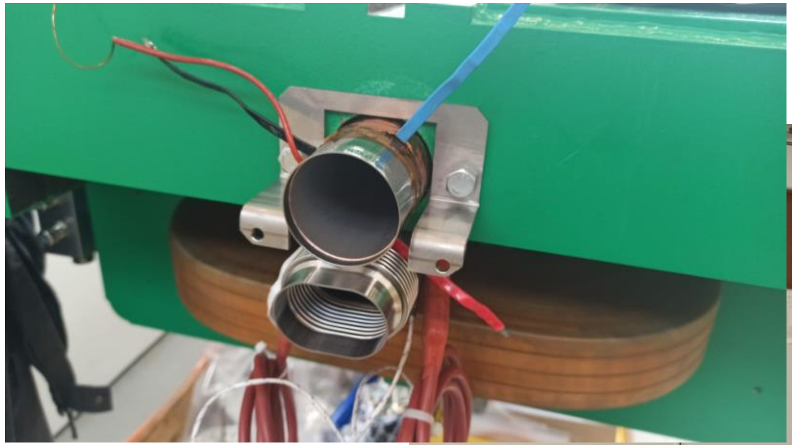
MKB Consolidation

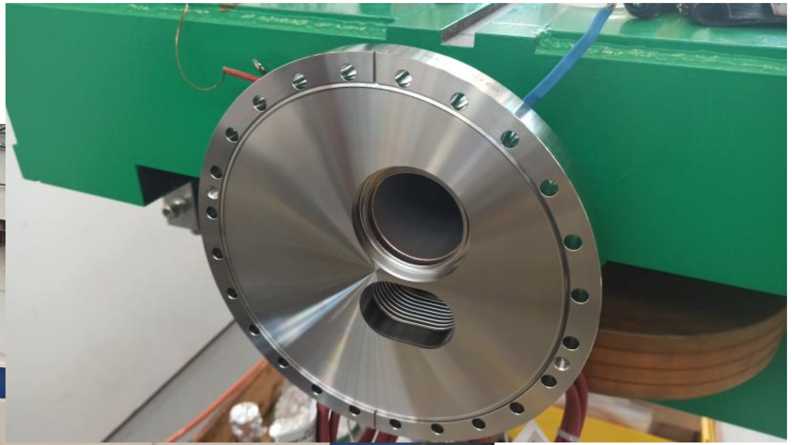
Where	Sector	Activity	NEG activation
LSS6	MKB	Upgrade with NEG cartridges	N
LSS4	E5R4.B	BWS Maintenance	Y
	E5R4.R	BSRTM mirror exchange	Y
	E5L4.R	Pressure spikes (tbc)	Y
	C5L4.B	BGC installation	N
LSS7	A4L7.B	TCPCH.A4L7.B1 Exchange	Y
	A5R7.R	TCPCH.A5R7.B2 Exchange	Y
	A4R7.R	Sector valve exchange	Y
LSS8	E5R8.R-B	MKI Cool Installation	Y
	G5R8.R-B	MKI Cool Installation	Y
	A4L8.C	Leak on a TCTPV	Y
-	-	Sector valve consolidation in high radiation area	N

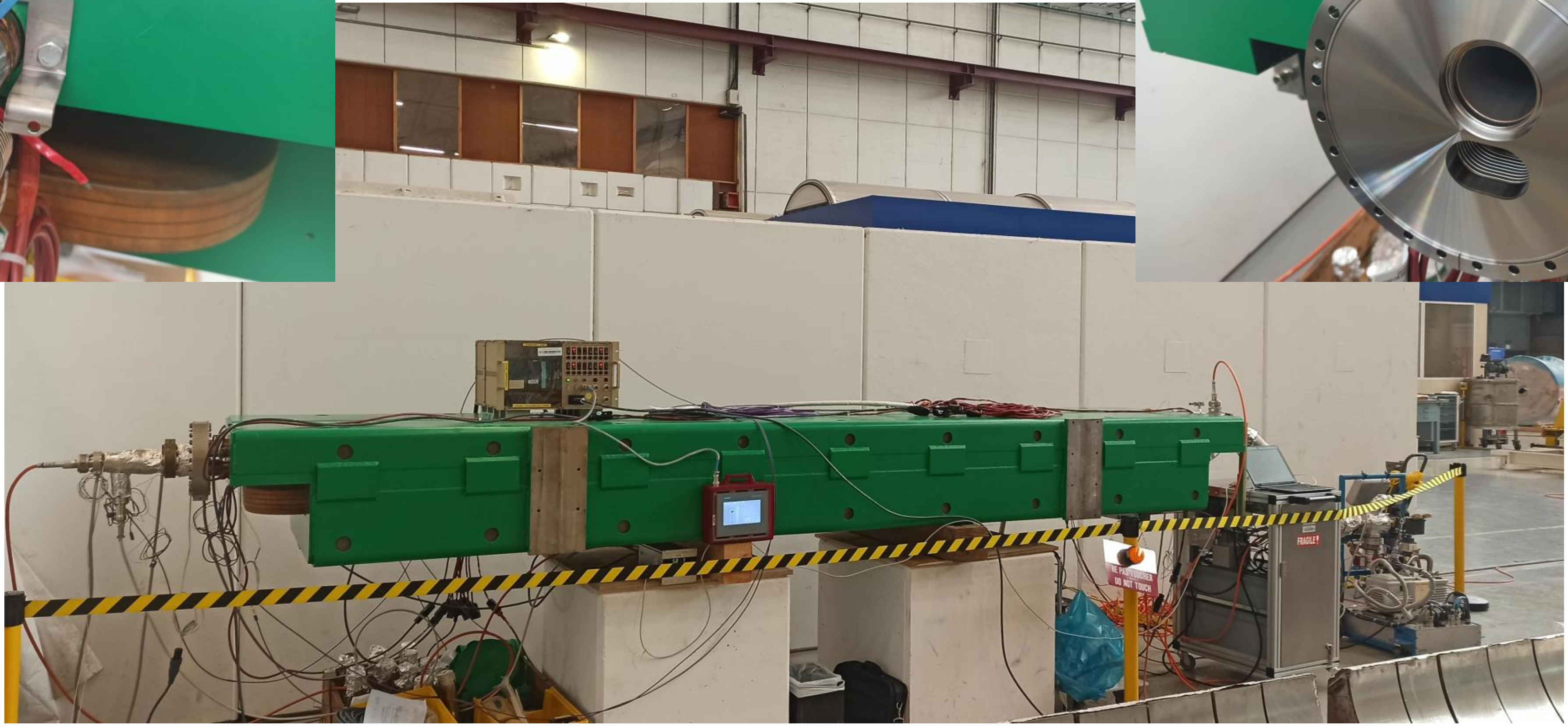
Resistive Magnets consolidation

10 over 15 MSD spare magnets (LSS6 Ejection dump septum) equipped

with racetrack and circular chambers







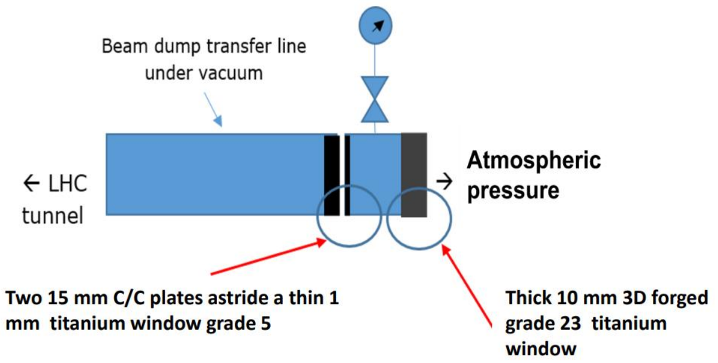
Installation of New Titanium LHC Dump Windows

-Double windows design:
- A Ti window in sandwich between 2 C/C disks. (vacuum side).
- A second robust window downstream (vacuum/atm).

- First use of SMA coupling in accelerators. Implementation of a DN25 Steel-Titanium joint for LHC dump window

Installation of New Titanium LHC Dump Windows

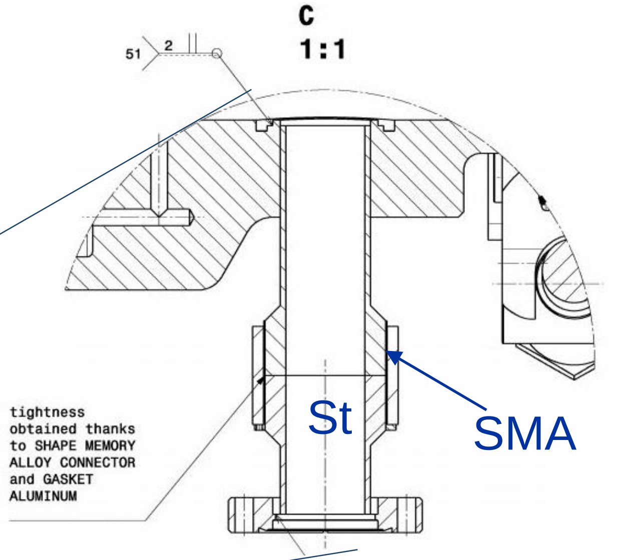
Implementation of a DN25 Steel-Titanium joint for LHC dump window

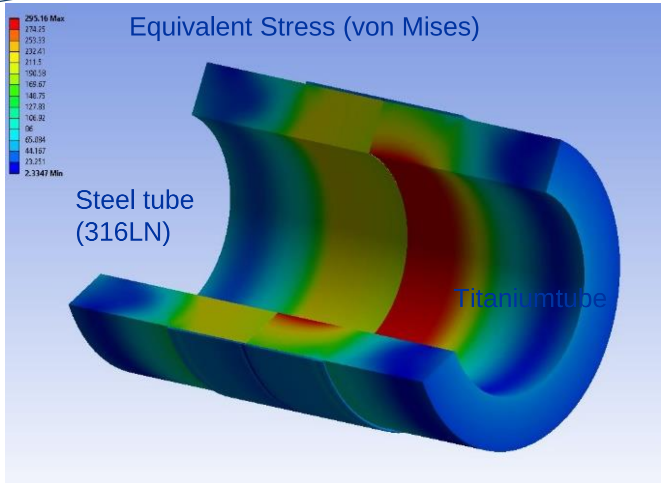


SMA joint (Ti-St transition)

Conflat St flange (to connect pump/gages)

Ti window

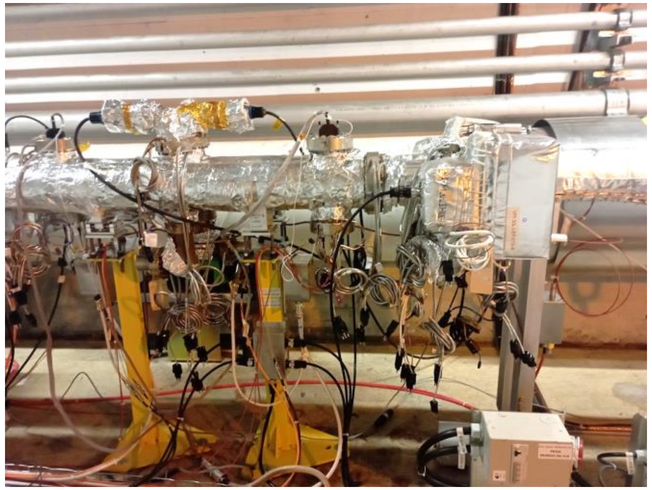


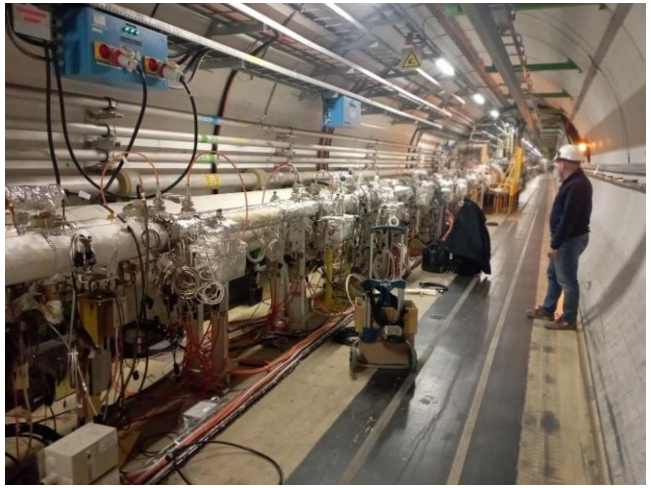


TCPC Crystal Goniometer installation in LSS7

LHC YETS 21/22 - Vacuum Pilot Sector NEG consolidation

- **Controls:**
  - Procurement & production
  - Cables & interconnection boxes production
- **SCADA integration:**
  - Vacuum Database
  - Manual modification of SCADA
- **Installation:**
  - Rack installation
  - Tunnel installation
  - Hardware tests & commissioning

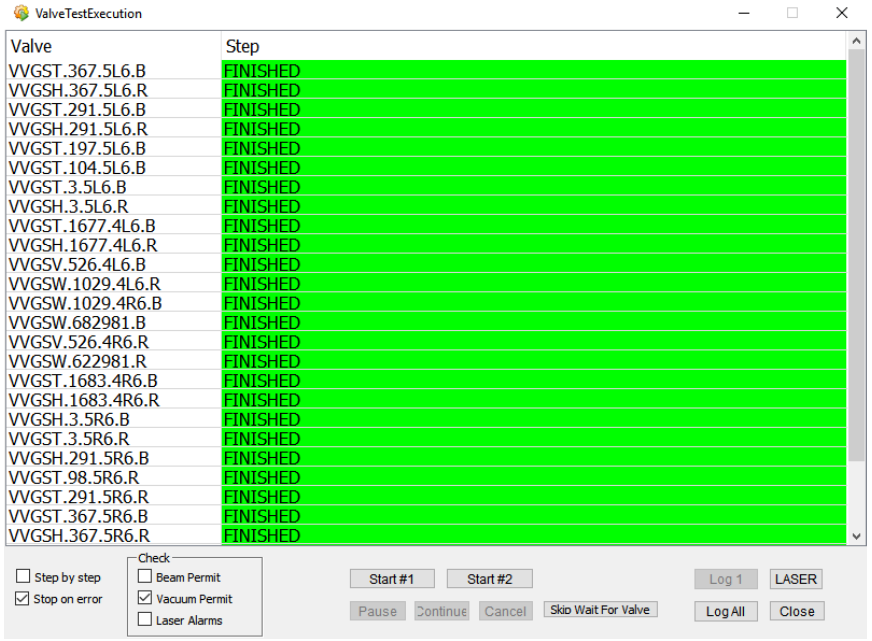




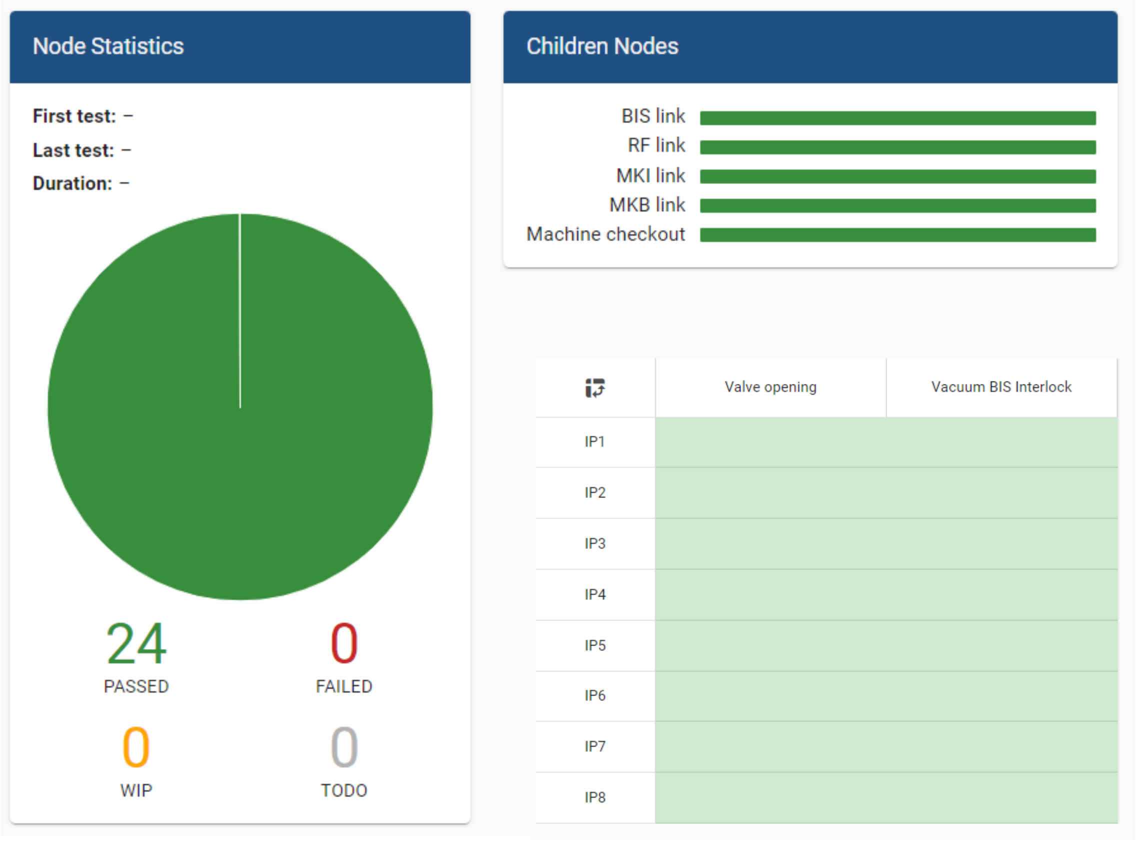
LHC YETS 21/22 - LHC Machine Checkout

Automatic test script of Vacuum Sector Valves & interlocks

- Reduces significantly the time to verify interlocks integrity
- Detection of interlock cabling and setting issues
- Number of equipment tested
  - Interlock Valves: ~300
  - Vacuum Gauges: ~680
  - Vacuum Pumps: ~820



MPP Vacuum tests and LHC checkout tracking with OP



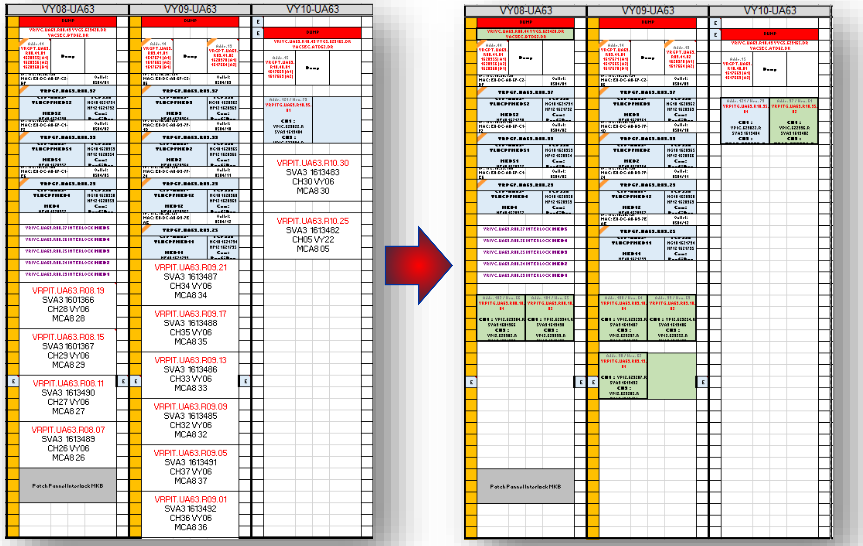
LHC YETS 22/23 – P6 Controls Consolidation

Consolidation of Ion Pump Controllers

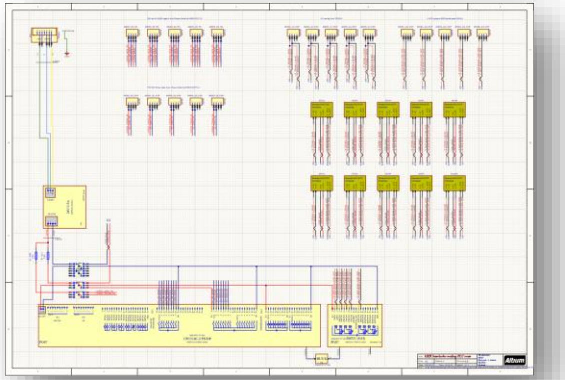
- Racks and PLC/SCADA documentation
- Cabling and material preparation
- Consolidation during YETS 22/23

MKB fast interlocks acquisition PLC

- Electrical schematic design
- Production of crates and cabling
- Installation during YETS 22/23



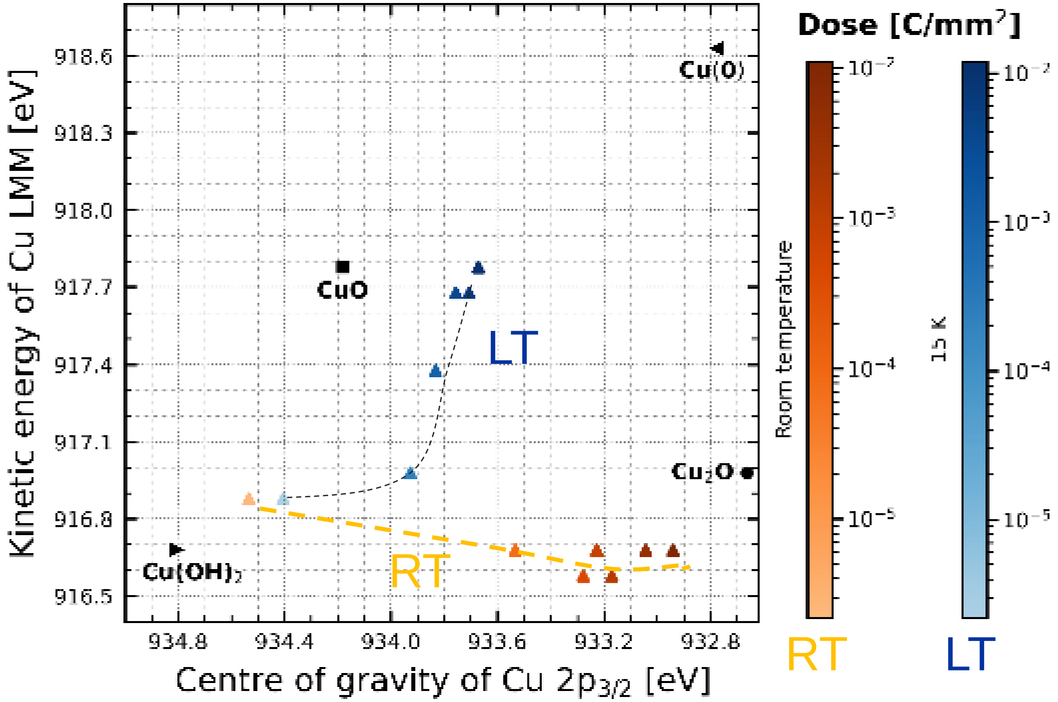
UA63 MKB racks distribution



MKB fast acquisition interlocks reading PLC crates

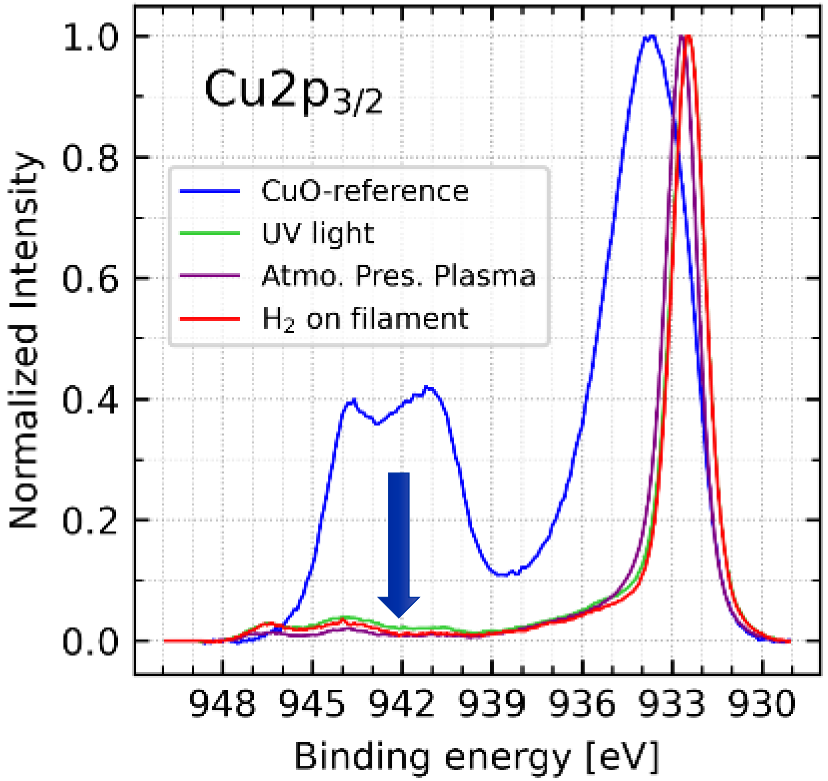
LHC beam-screen surface evolution (Heat Load Task Force)

Measure XPS and irradiation at 15K of sample exposed to humidity ($Cu(OH)_2$)



Plausible path to **explain CuO presence**

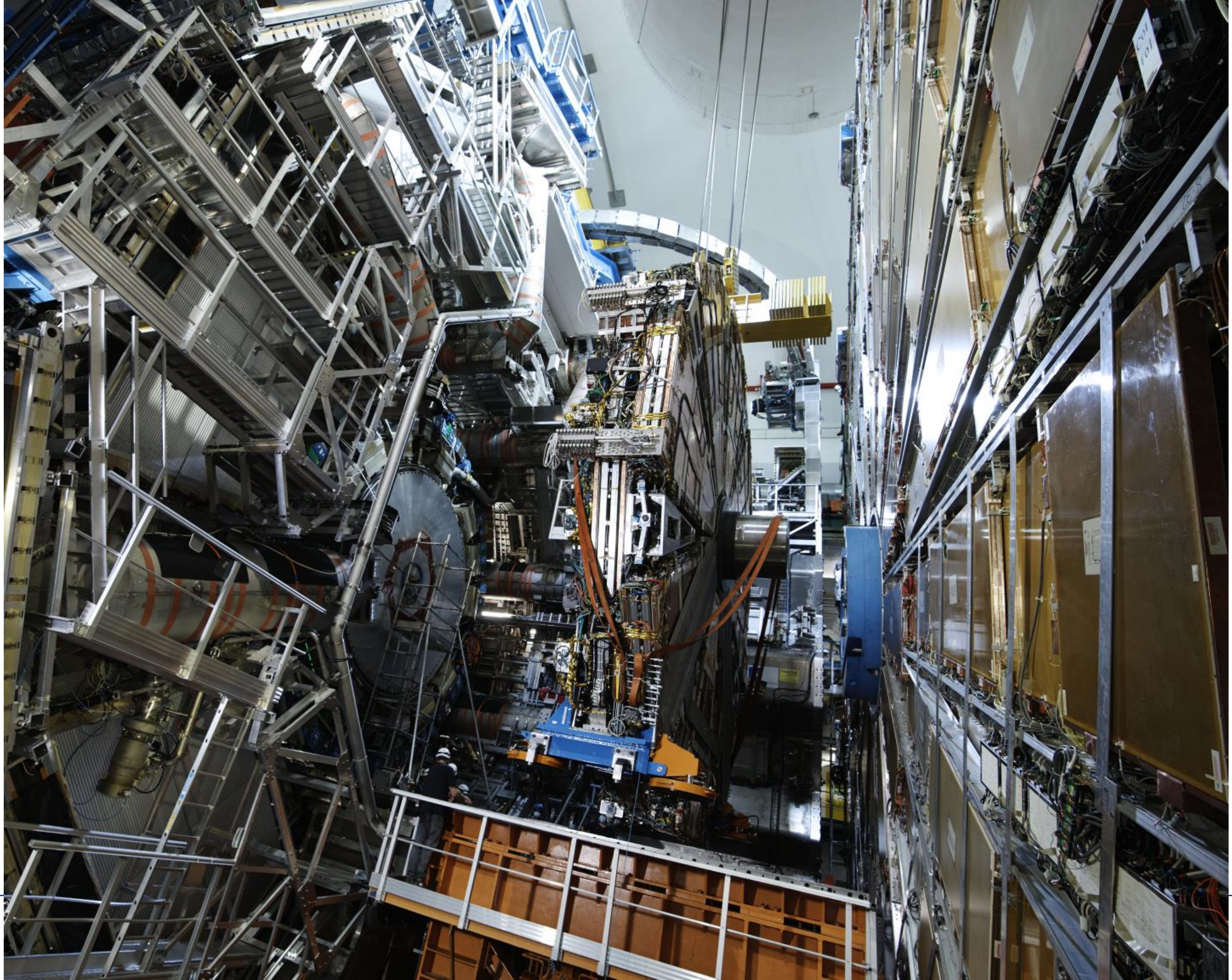
Working to get rid of CuO… various principles work



Integration in-situ with limits of treatment time, temperature, gas safety reliability etc.…going **towards plasma based system** progress.

LHC Experiments

ATLAS EXPERIMENT



ATLAS experimental beam vacuum IP1.X

New Small Wheel – side C (nSW-C) installed by end of 2021

- TE-VSC removed the vacuum layout for the LHC special run (2021) in ≈ 3 days.
- Installation of the operational layout by January 2022.

Installation of the VT and VJ aluminum chambers

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ATLAS experimental beam vacuum IP1.X

Bake-out & NEG activation of the IP1.X performed by February 2022.

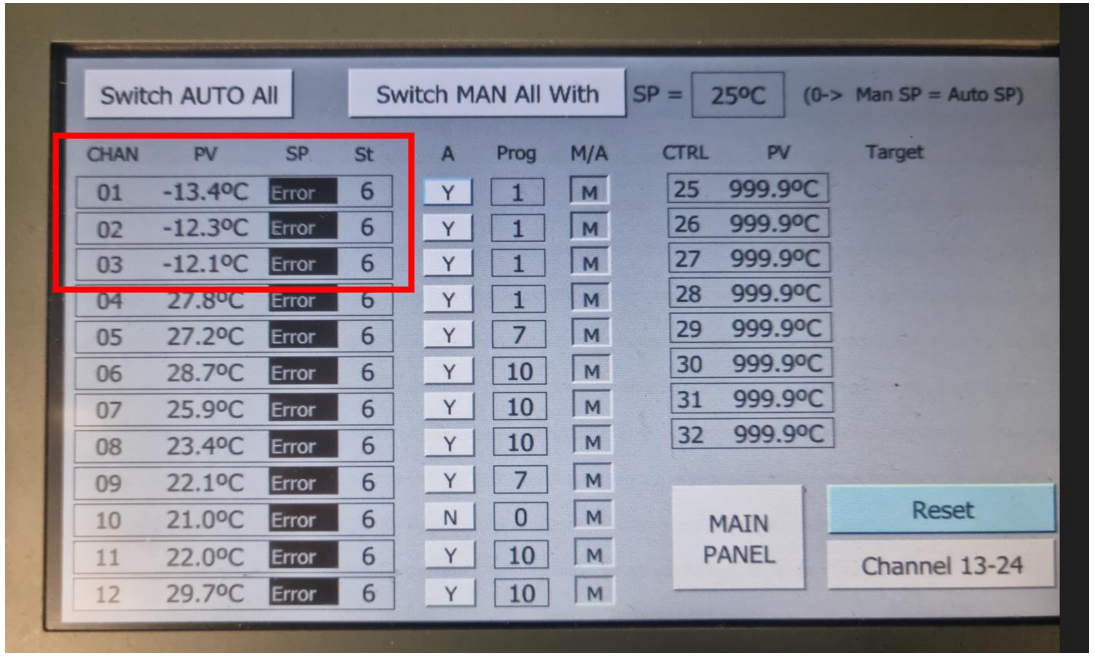
ATLAS tracker stays in place (including pixel detector).

- Complex DSS protection matrix put in place by ATLAS.
- **8 days process** (ATLAS running non-stop shifts).

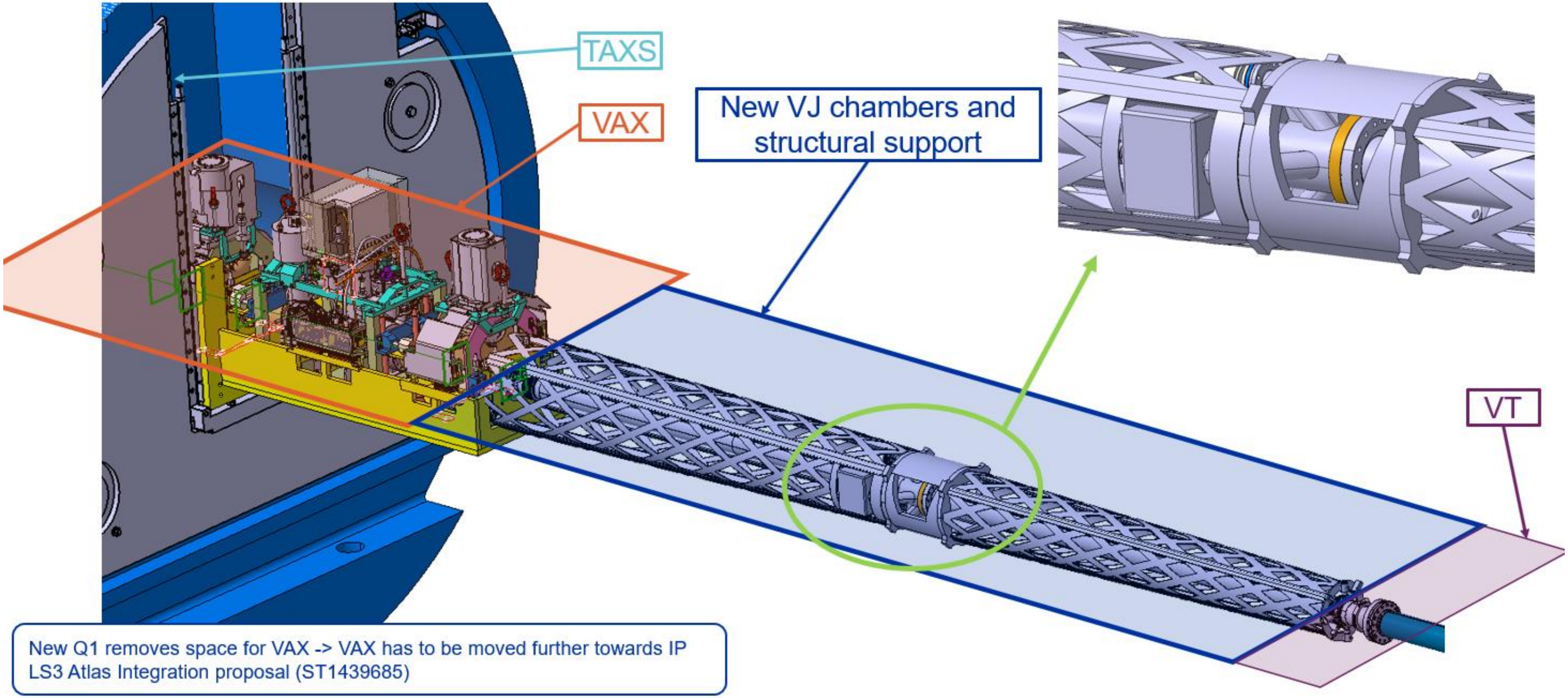
18 m of IP1.X under active cooling

We are basically baking a fridge without melting the ice-cream inside ☺

Overheating may cause permanent damage of the tracker.



ATLAS experimental beam vacuum IP1.X



New Q1 removes space for VAX -> VAX has to be moved further towards IP
LS3 Atlas Integration proposal (ST1439685)

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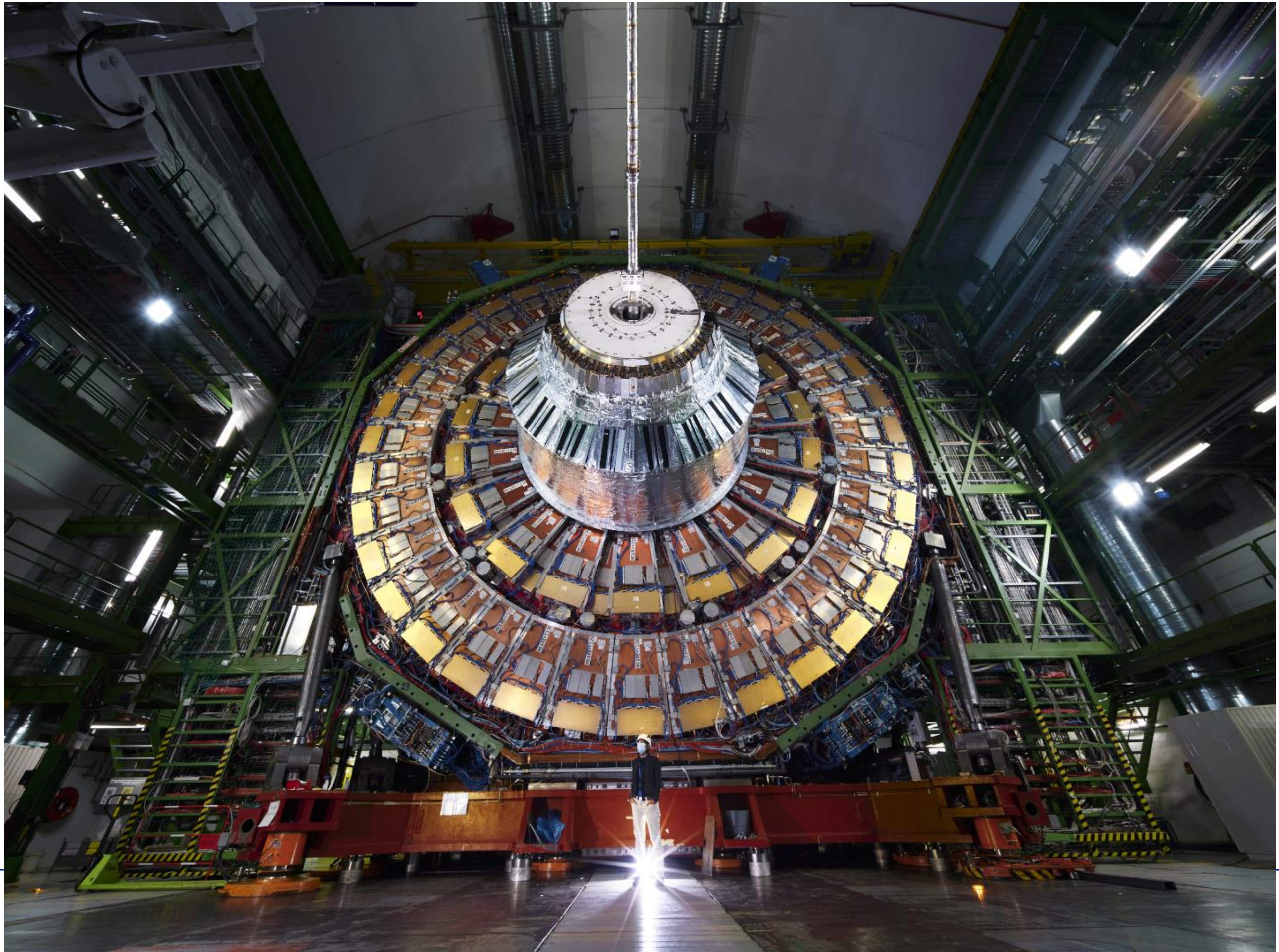
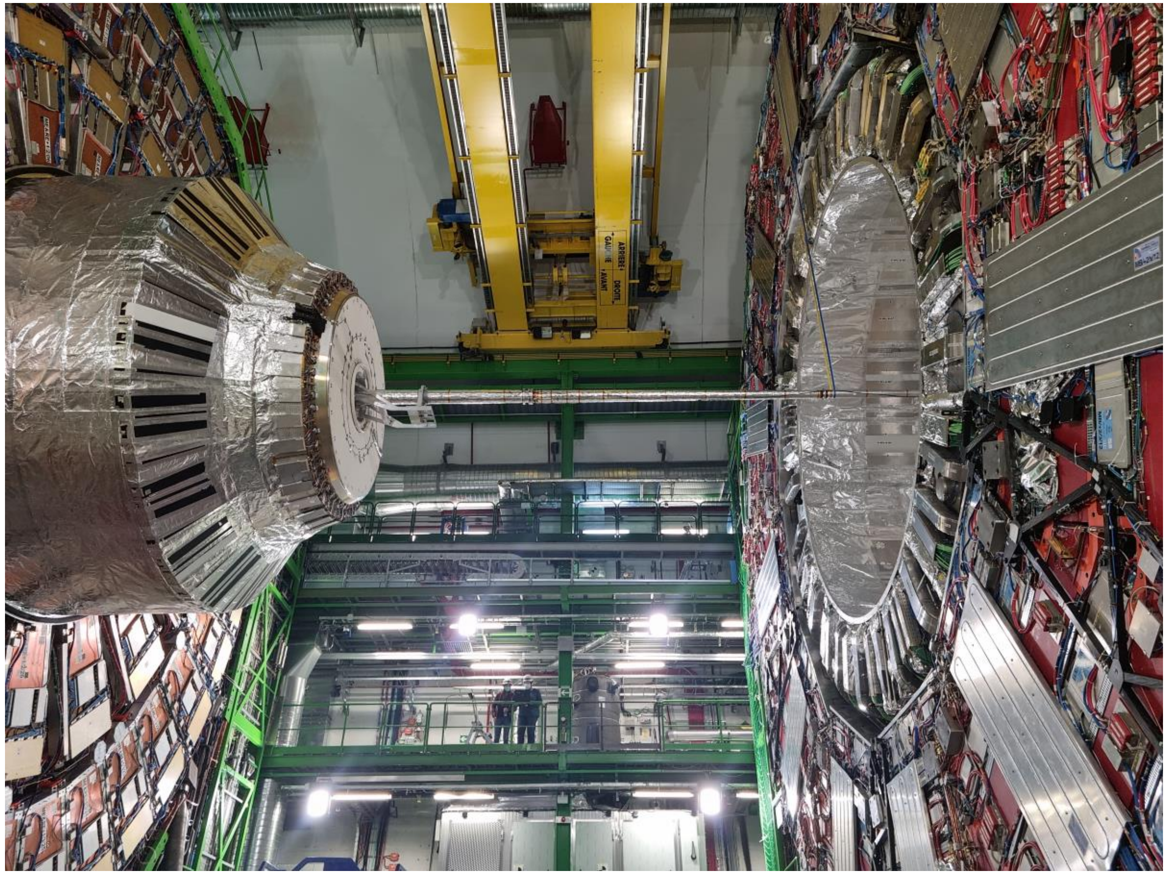
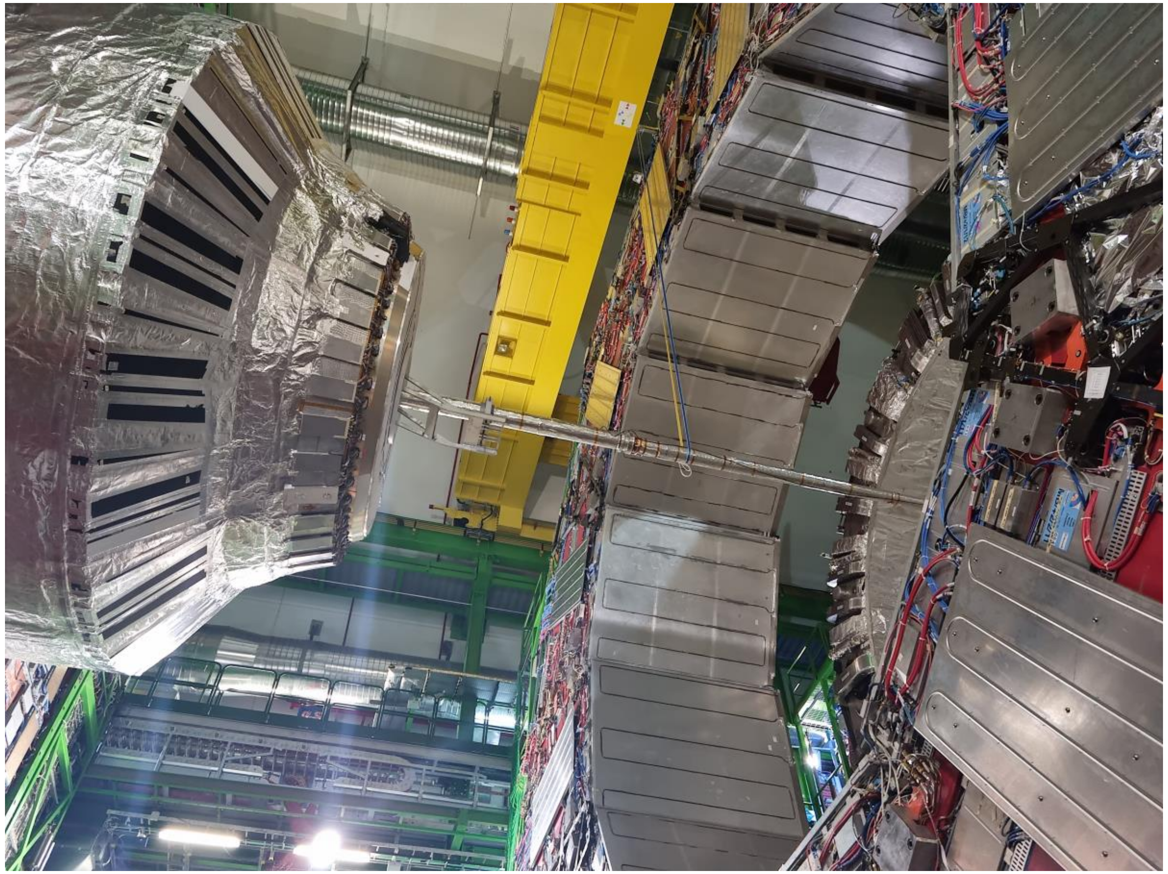


CMS experimental beam vacuum IP5.X

IP5.X vacuum sector recommissioned (installation, bake-out & NEG activation) by May 2021.

CMS required special opening to investigate post-SR2021 observations by beginning 2022.



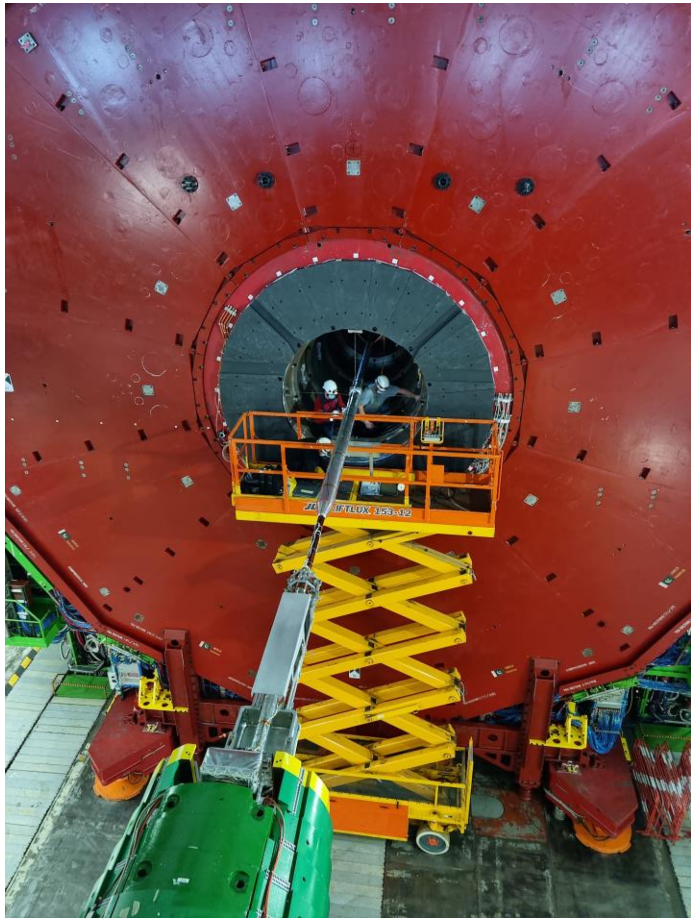


Opening of the YB+2 central segment during LS2

CMS experimental beam vacuum IP5.X

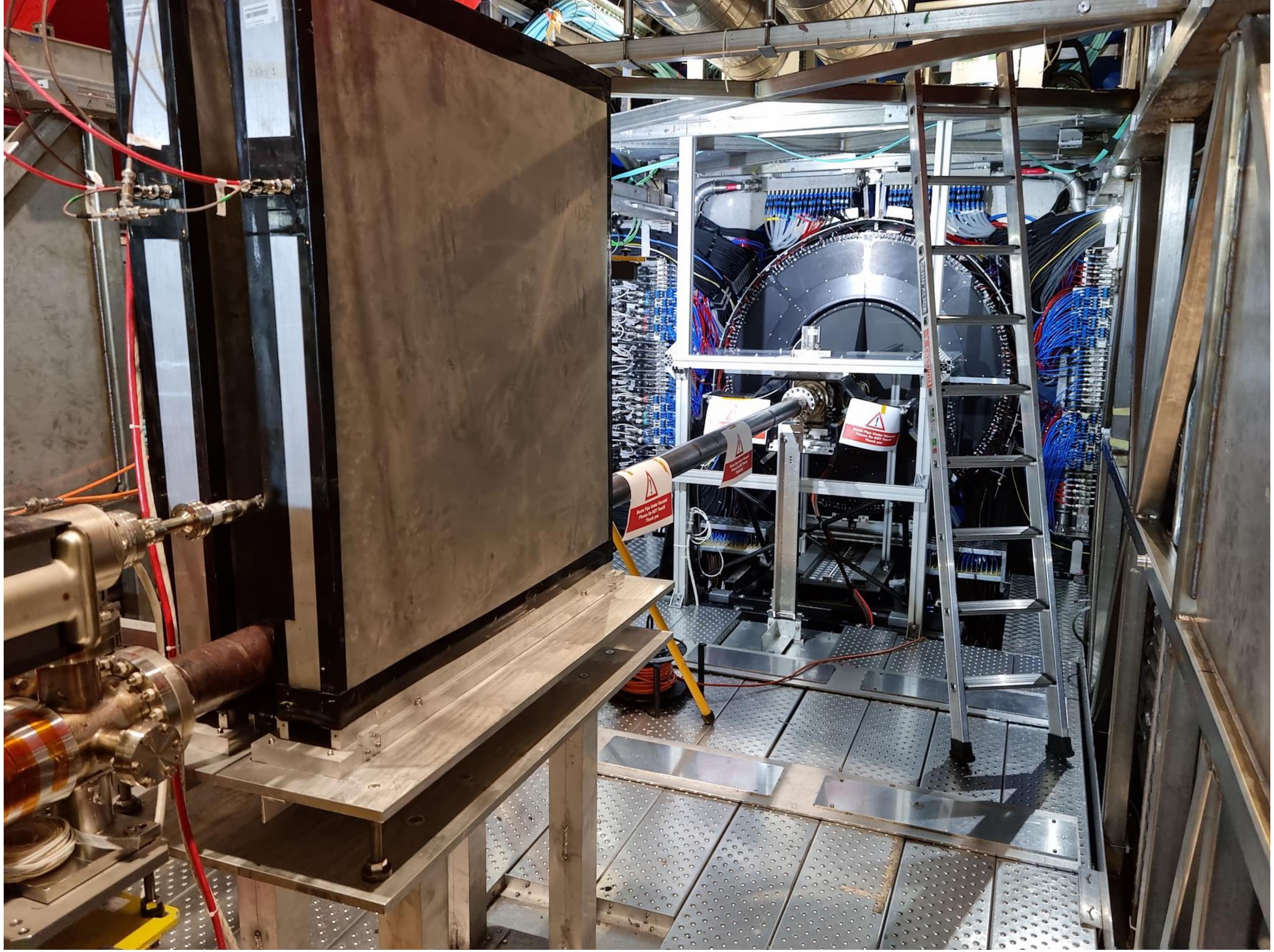
Experiment reclosed for Run 2022 by March 2022.

Standard heavy involvement of TE-VSC team on site.



Final alignments prior the Run 3

ALICE



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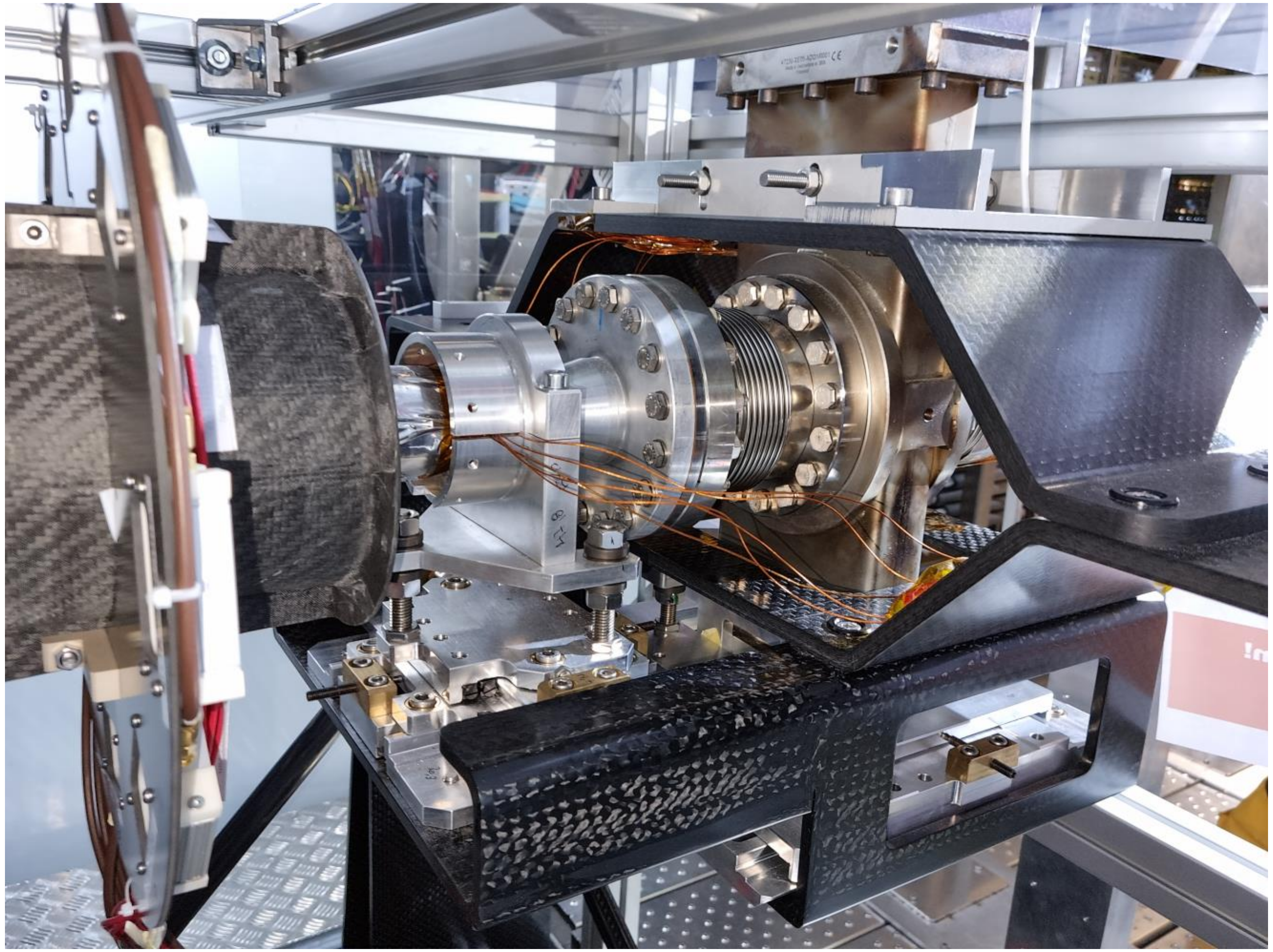
ALICE experimental beam vacuum IP2.X

Mechanical support for additional activities with central region (new tracker tested during the special run 2022).



Central chamber upstream of the IP2 – carbon “trampoline” zone

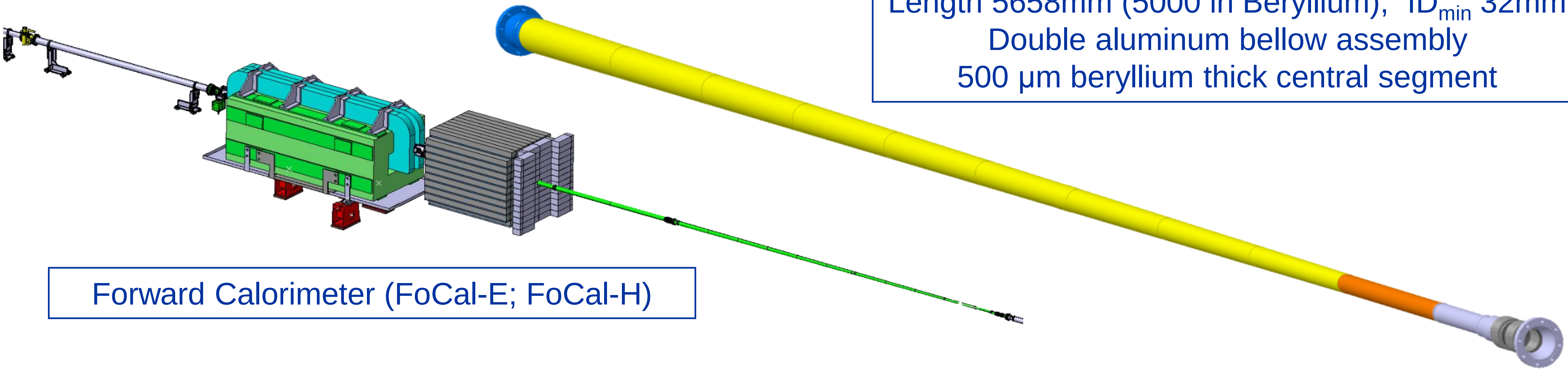
182

ALICE experimental beam vacuum IP2.X

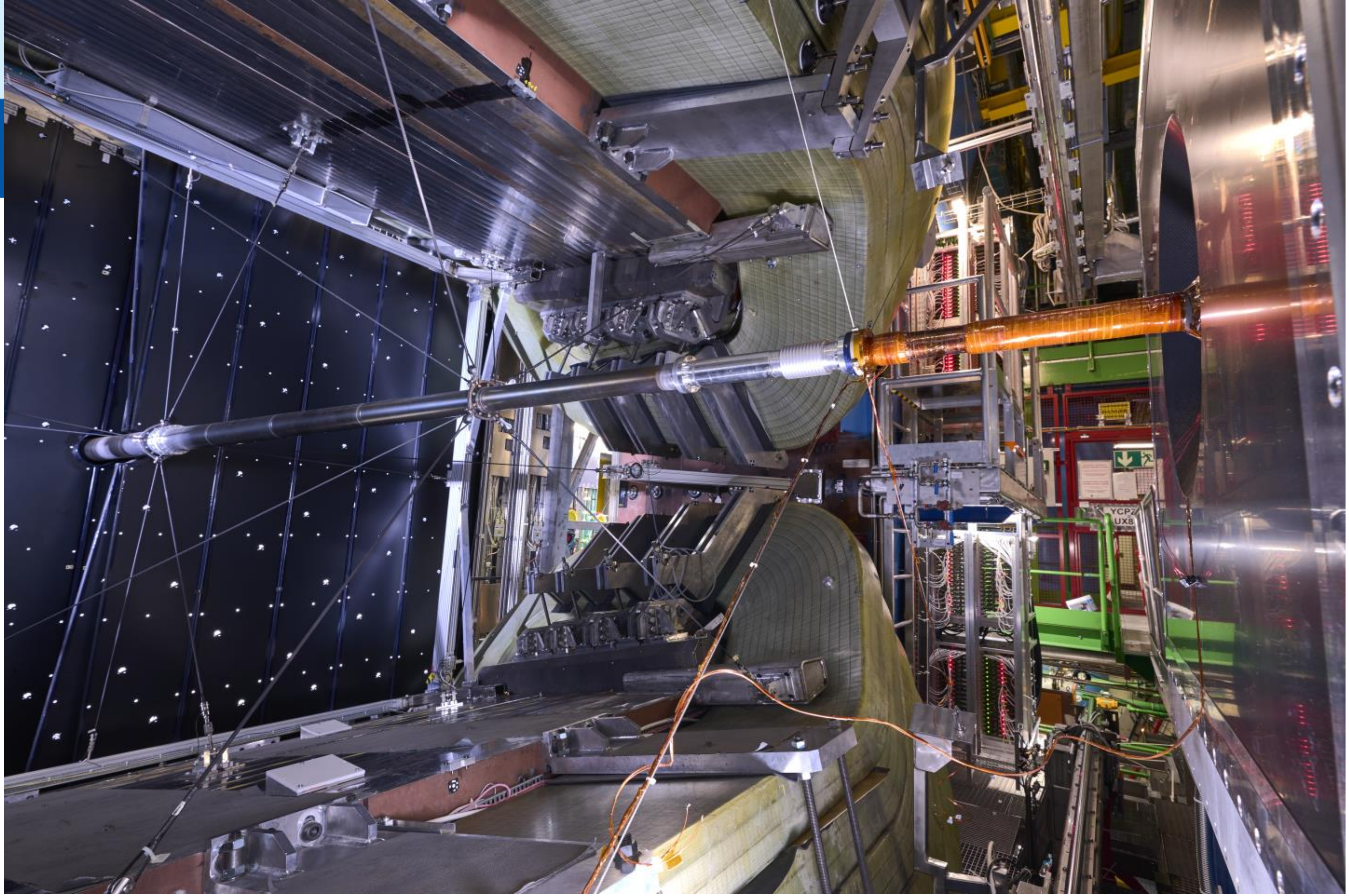
- New central beryllium chamber, new FoCal (Forward calorimeter) chamber.
- Main changes in vacuum layout of IP2.X (merge with upstream sector).

The most complex beryllium chamber we ever build

Length 5658mm (5000 in Beryllium), ID_{min} 32mm
Double aluminum bellow assembly
500 µm beryllium thick central segment



Forward Calorimeter (FoCal-E; FoCal-H)



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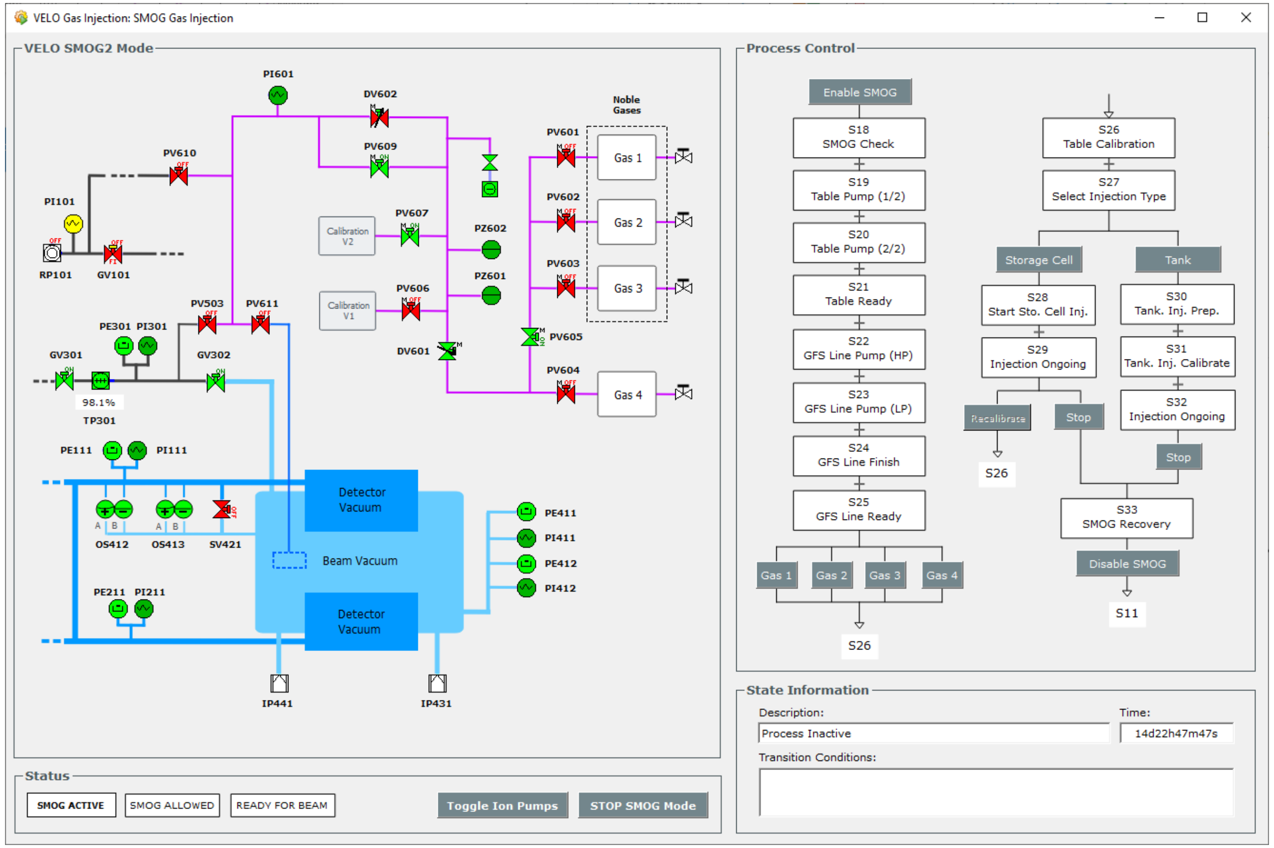
LHCb VELO & SMOG2 Control System



Implementation and deployment of SMOG2 Control System (integrated into VELO)

Extensively validated and calibrated during 2022

Several modification requests after one year of tests

Injection control to be transferred to LHCb during 2023

LHCb experimental beam vacuum IP8.X

VELO detector (C – side) installed 02-2022.

VELO detector (A – side) installed 05-2022 (from Ne venting to pump-down <24h).

Installation of the VELO A-side

186

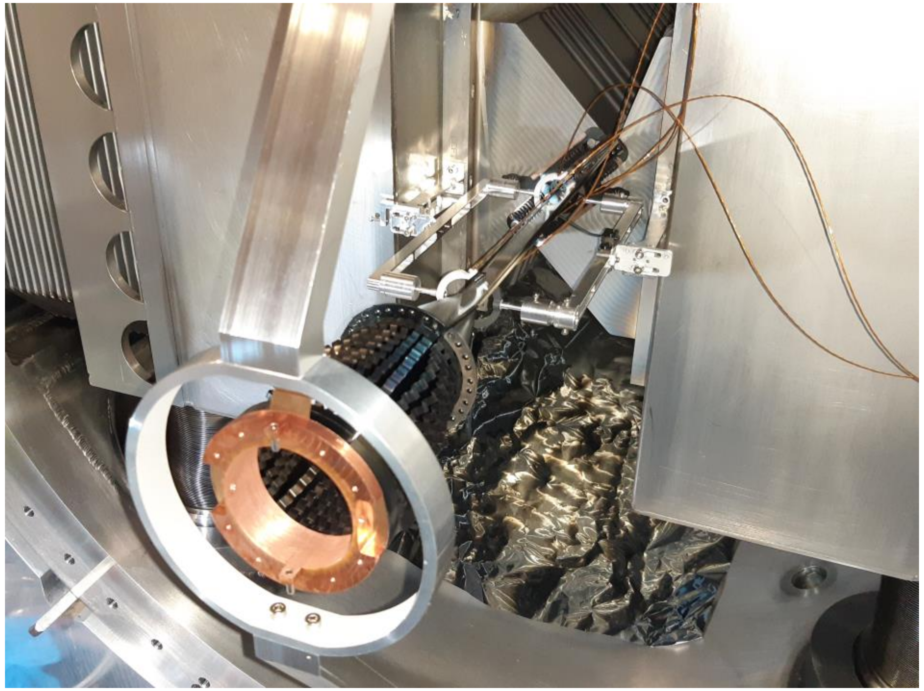
LHCb experimental beam vacuum IP8.X

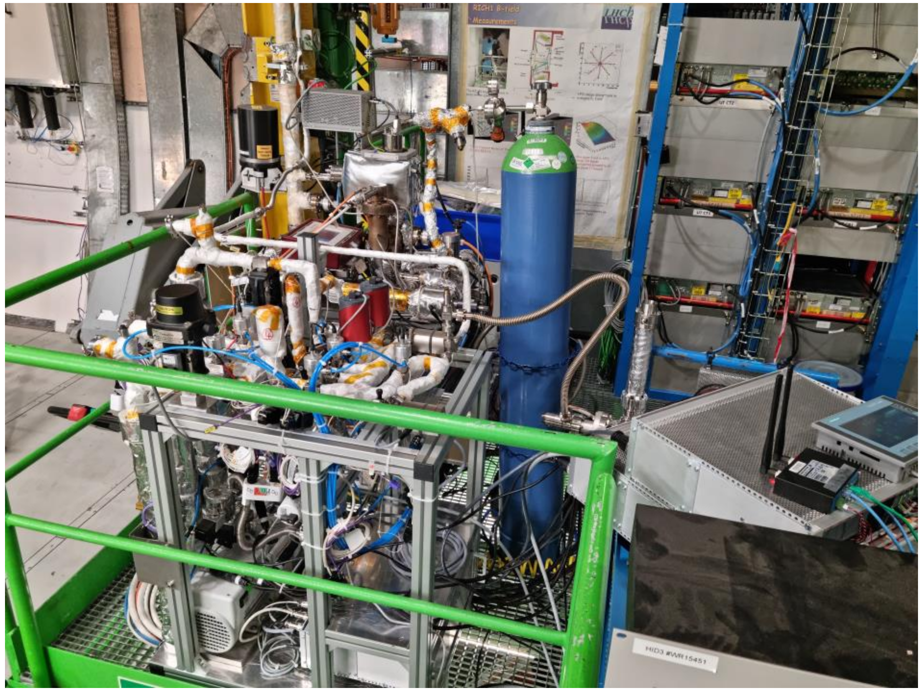
SMOG & GFS system installed in March 2022.

- *SMOG – System for measuring overlap with gas; GFS – Gas Feeding System (SMOG injection platform)*

System allows injection of 4 different gases (He, Ne, Ar, H_2).

Two injection modes (VELO vessel – SMOG 1, Storage cell – SMOG 2).



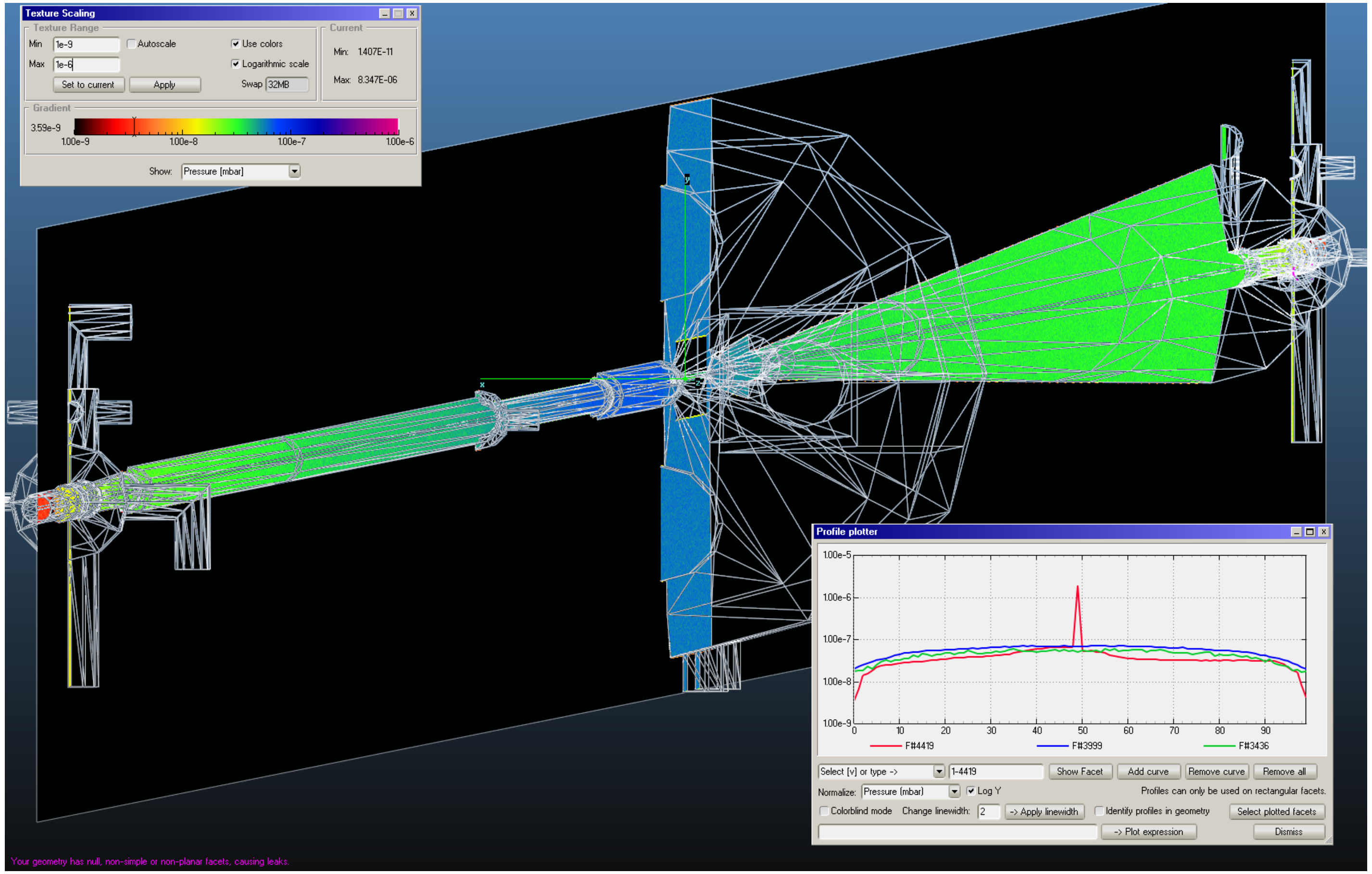


SMOG2 storage cell, Gas Feeding System (UX85 table)

LHCb experimental beam vacuum IP8.X

Intensive testing performed during 2022 (SMOG 1-2, different gases).

Injection without beam; with beam – VELO open; with beam VELO closed.

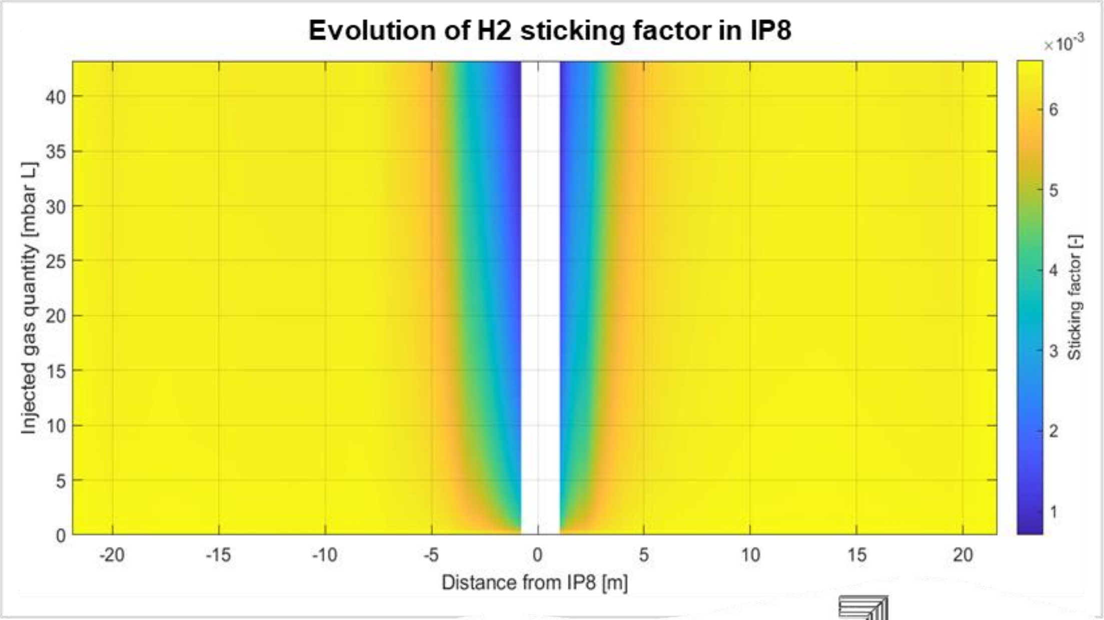


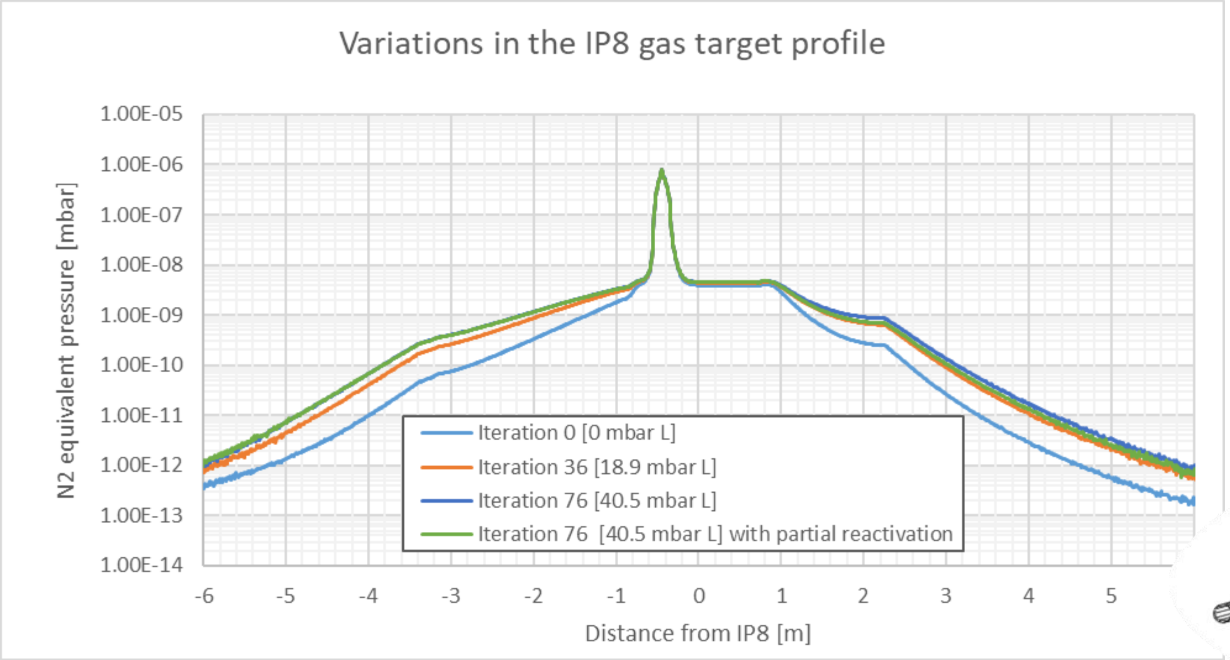
Molflow simulation of SMOG2 injection

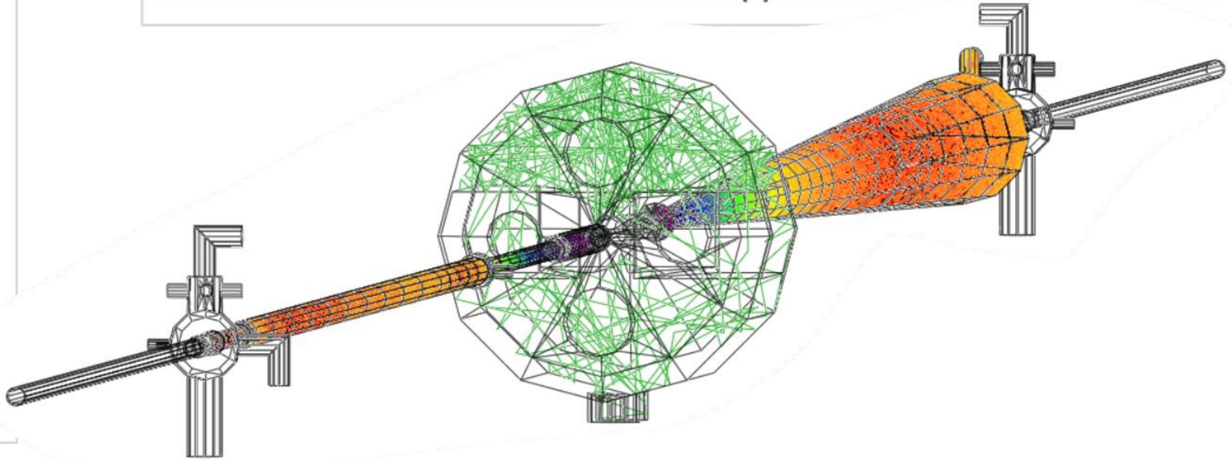
LHCb experimental beam vacuum IP8.X

Hydrogen injection simulations for SMOG2

- Iterative simulations made using the Molflow+ CLI interface.
- Calculation of the progressive degradation of the sticking factor of the NEG coating during hydrogen injection.



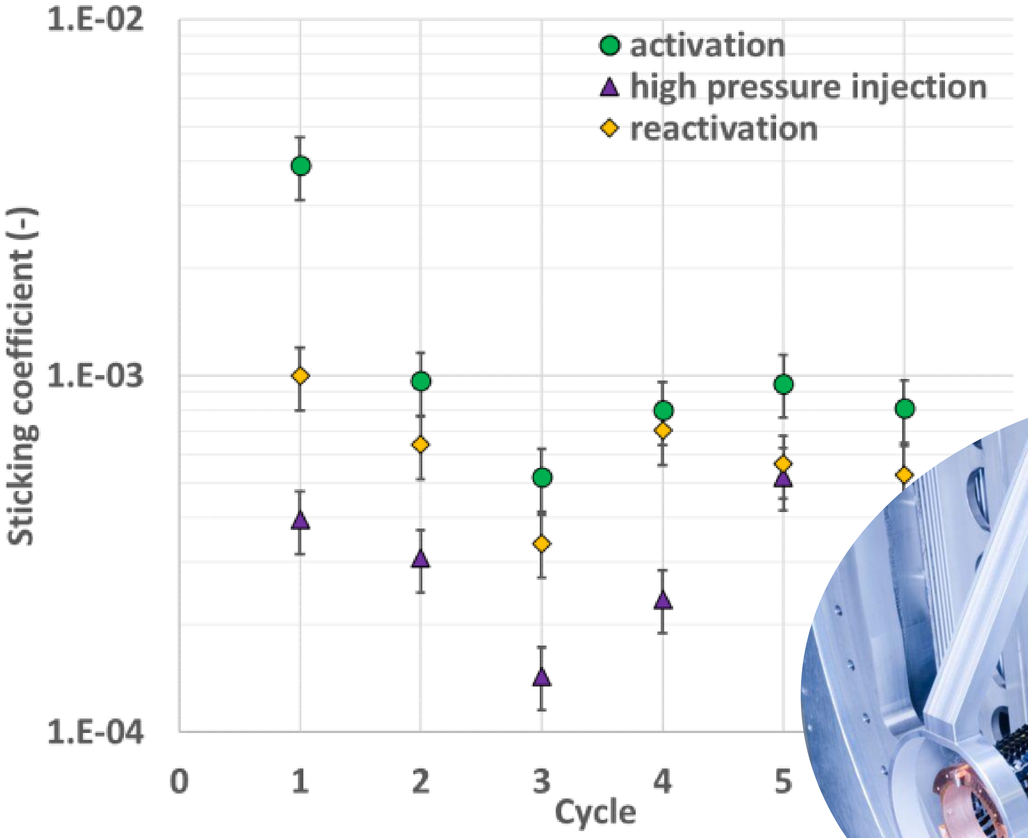


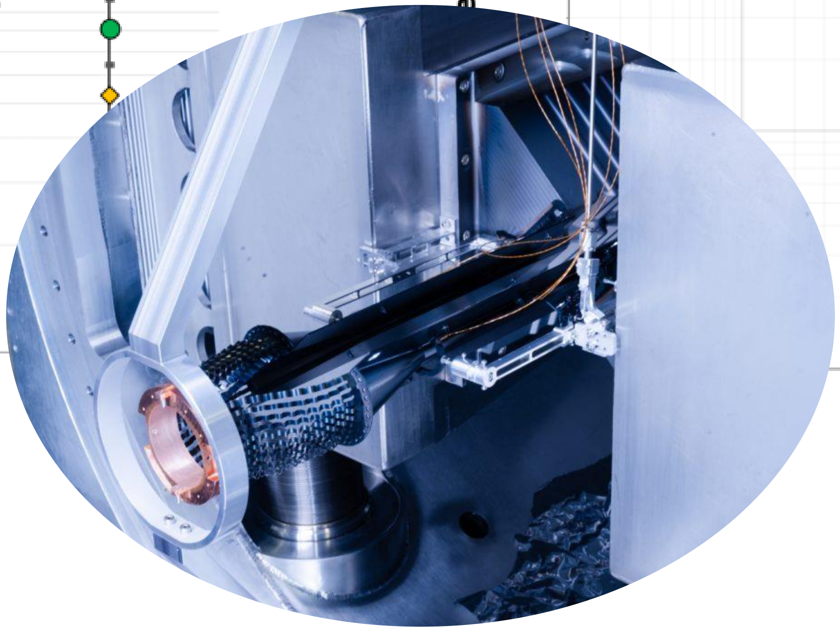


LHCb experimental beam vacuum IP8.X

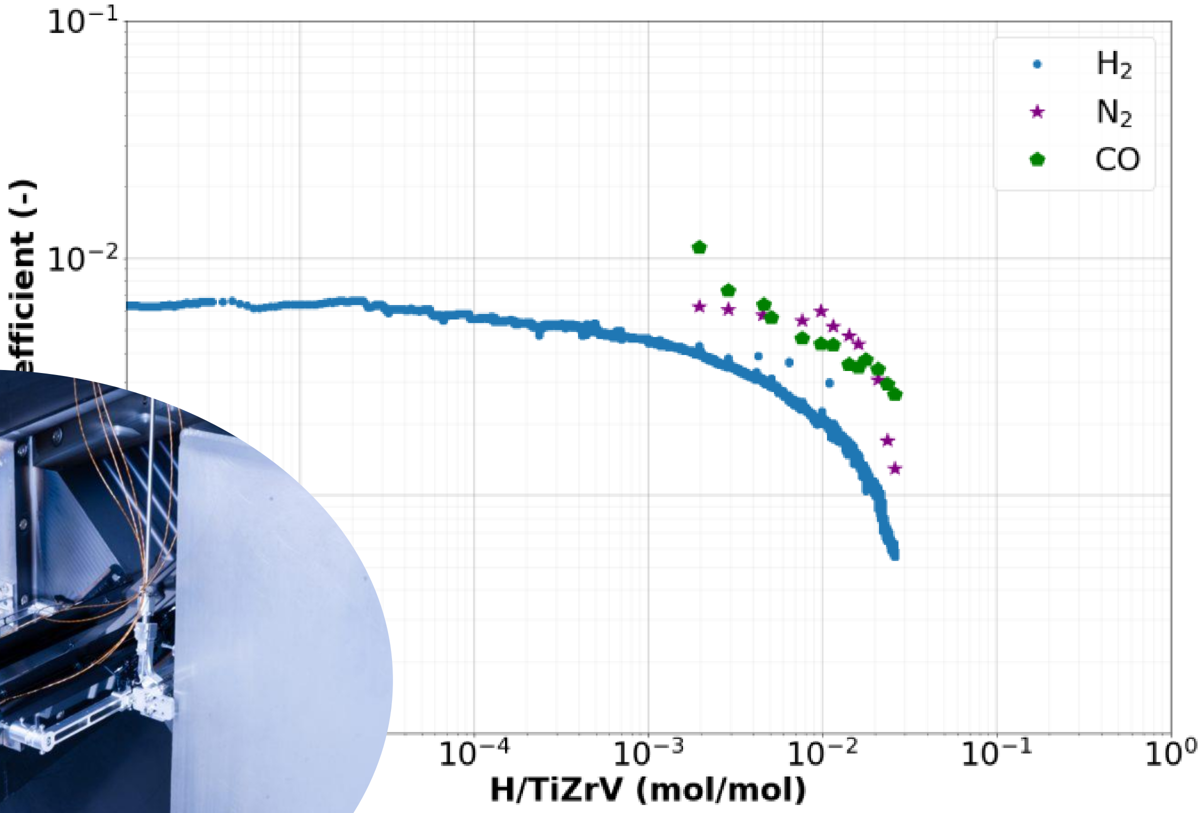
NEG embrittlement studies for SMOG II

High pressure experiment





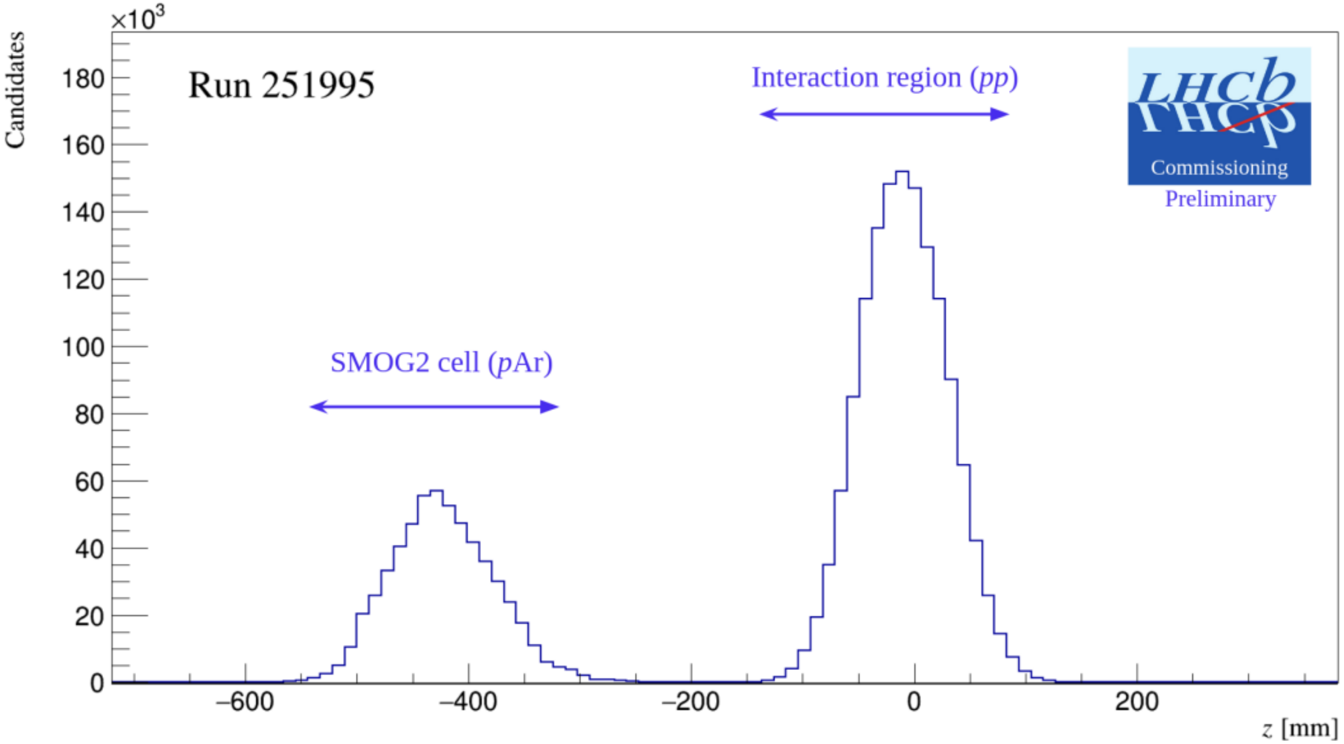
Low pressure experiment

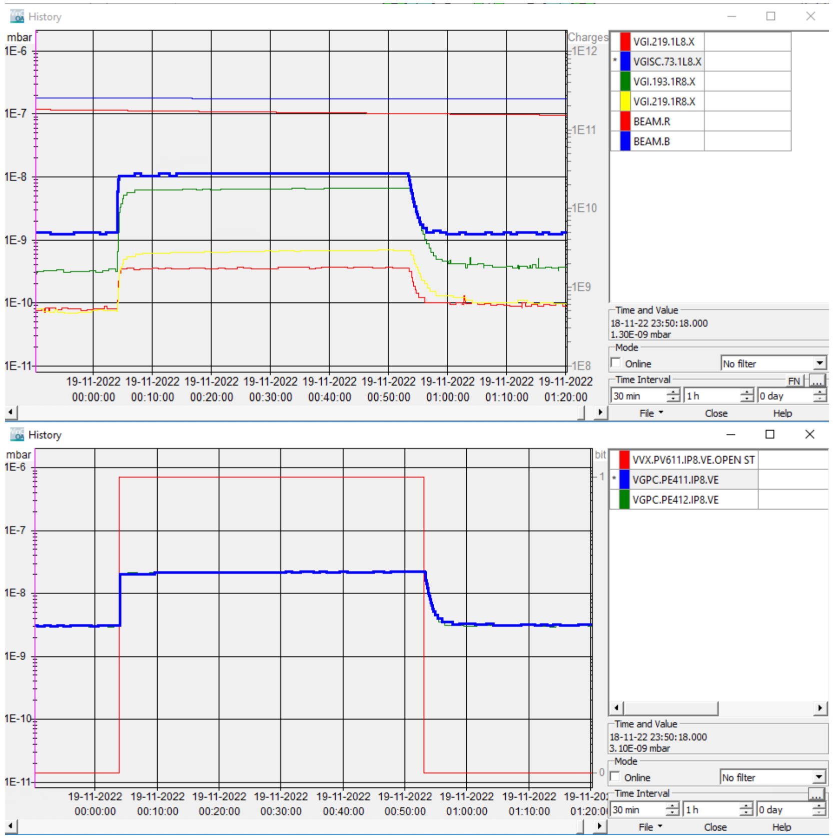


LHCb experimental beam vacuum IP8.X

TE-VSC Support to the LHCb during 2022

Injections in both SMOG 1 & 2 regimes for VdM Scans (for all experiments)





LHCb is the world first experiment taking data simultaneously in beam/beam & beam/gas regime

The second interaction point provided by TE-VSC ☺

SMOG2 Argon injection as seen by VELO and Machine

HL-LHC: some remarkable results

Layout DB and 3D layout

Finalize data changes after LS2 and for YETS 2021-22

Finalize the HL-LHC v1.6 layout and continue studies in v1.7 for LSS 5R

Work in progress for LS3 de-installation and re-installation for LHC-LSS 1 and 5

VCBQQDDA.D4R5.X IP 95.804	VCBQQDDA.252.4R...	13425.2456 13431.1456	5.9	S B	22.207 U 0 A	0 V 0 C	0 0
VAMCAGAI.4R5.X IP 101.704	VAMCAGAI.283.4R...	13431.1456 13431.5456	0.4	S B	28.107 U 0 A	0 V 0 C	0 0
VMBQQDDG.C4R5.X IP 101.704	VMBQQDDG.283.4...	13431.1456 13431.5456	0.4	S B	0 U 0 A	0 V 0 C	0 0
VPIB.C4R5.X IP 101.829	VPIB.282.4R5.X	13431.2706 13431.2706	0	S B	0.125 U 0 A	0 V 0 C	0 0
VAZAE.4R5.X IP 101.829	VAZAE.282.4R5.X	13431.2706 13431.2706	0	S B	0.125 U 0 A	0 V 0 C	0 0
VGIA.C4R5.X IP 101.829	VGIA.282.4R5.X	13431.2706 13431.2706	0	S B	0 U 0 A	0 V 0 C	0 0
VCBQQDDA.E4R5.X IP 102.104	VCBQQDDA.315.4R...	13431.5456 13437.4456	5.9	S B	28.507 U 0 A	0 V 0 C	0 0

VAMCAGAI.4R5.X ID 56775021

Vacuum - Assembly - Module - Circular - Circular - VMBQQDDG400 with -,VGI,-,VPI

H > S56 > LSSR5 > 4R5

Type

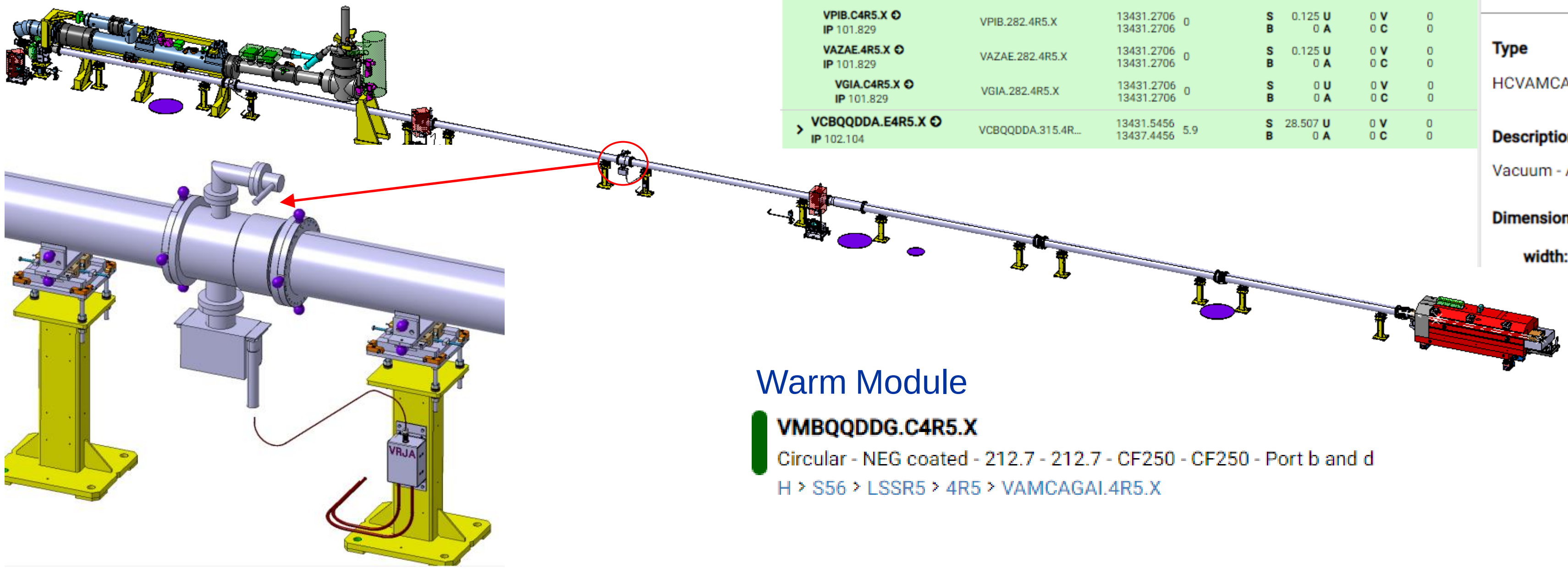
HCVAMCAGAI001 ID 56772096 Vacuum Assembly Module

Description

Vacuum - Assembly - Module - Circular - Circular - VMBQQDDG400 with -,VGI,-,VPI

Dimensions

width: 0.4



Warm Module

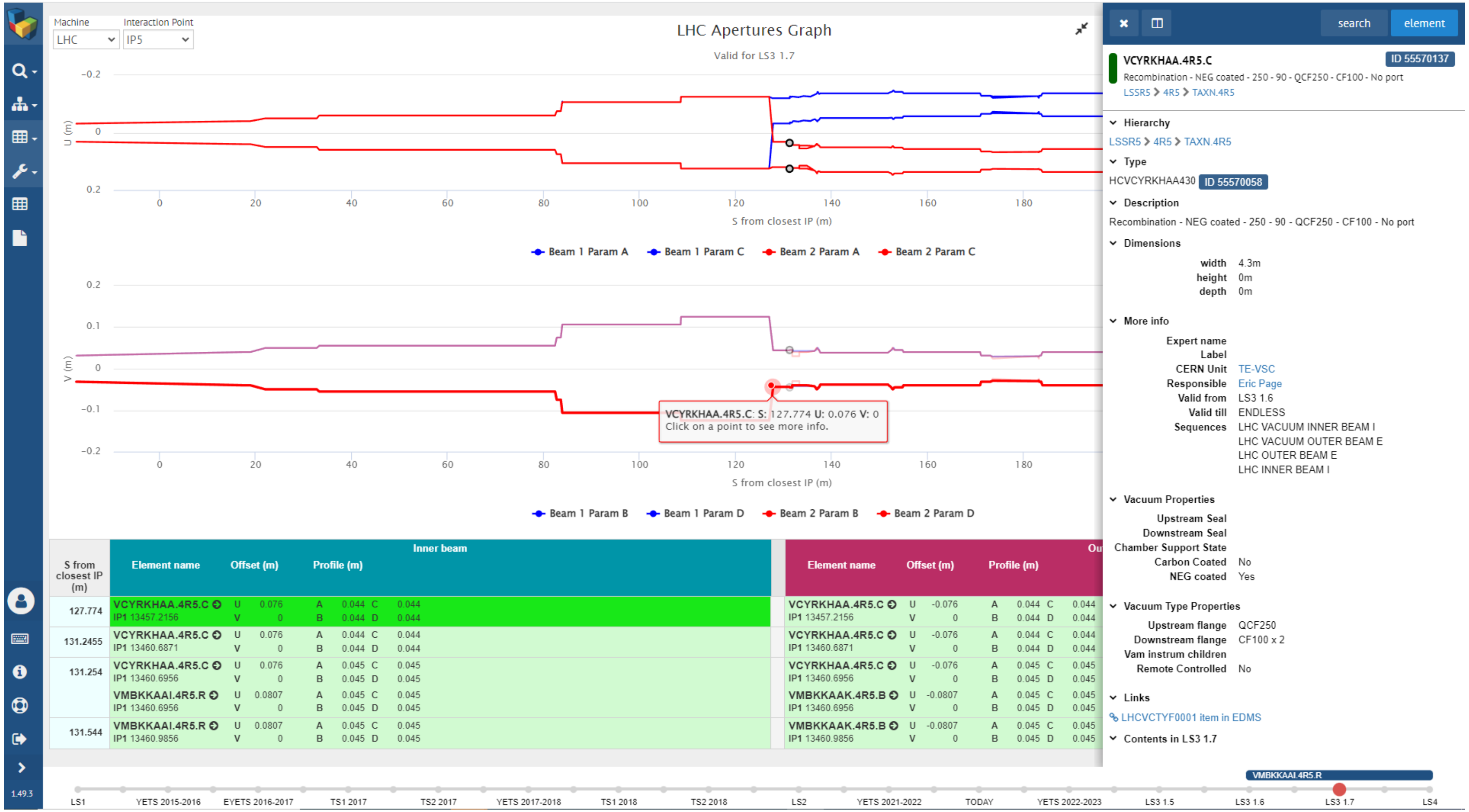
VMBQQDDG.C4R5.X

Circular - NEG coated - 212.7 - 212.7 - CF250 - CF250 - Port b and d

H > S56 > LSSR5 > 4R5 > VAMCAGAI.4R5.X

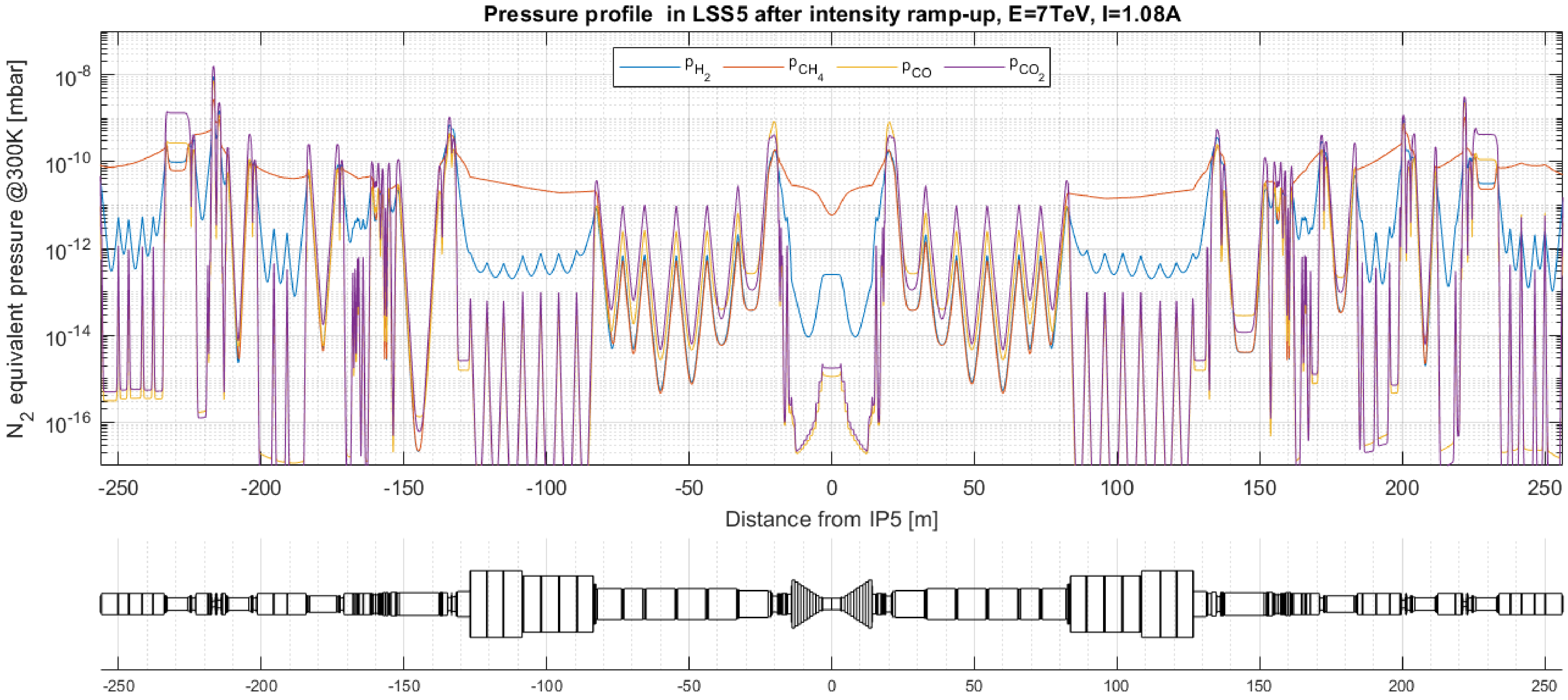
Layout DB and 3D layout

Layout DB data are used by the optics to check the aperture for the future: LSS 5R for LS3



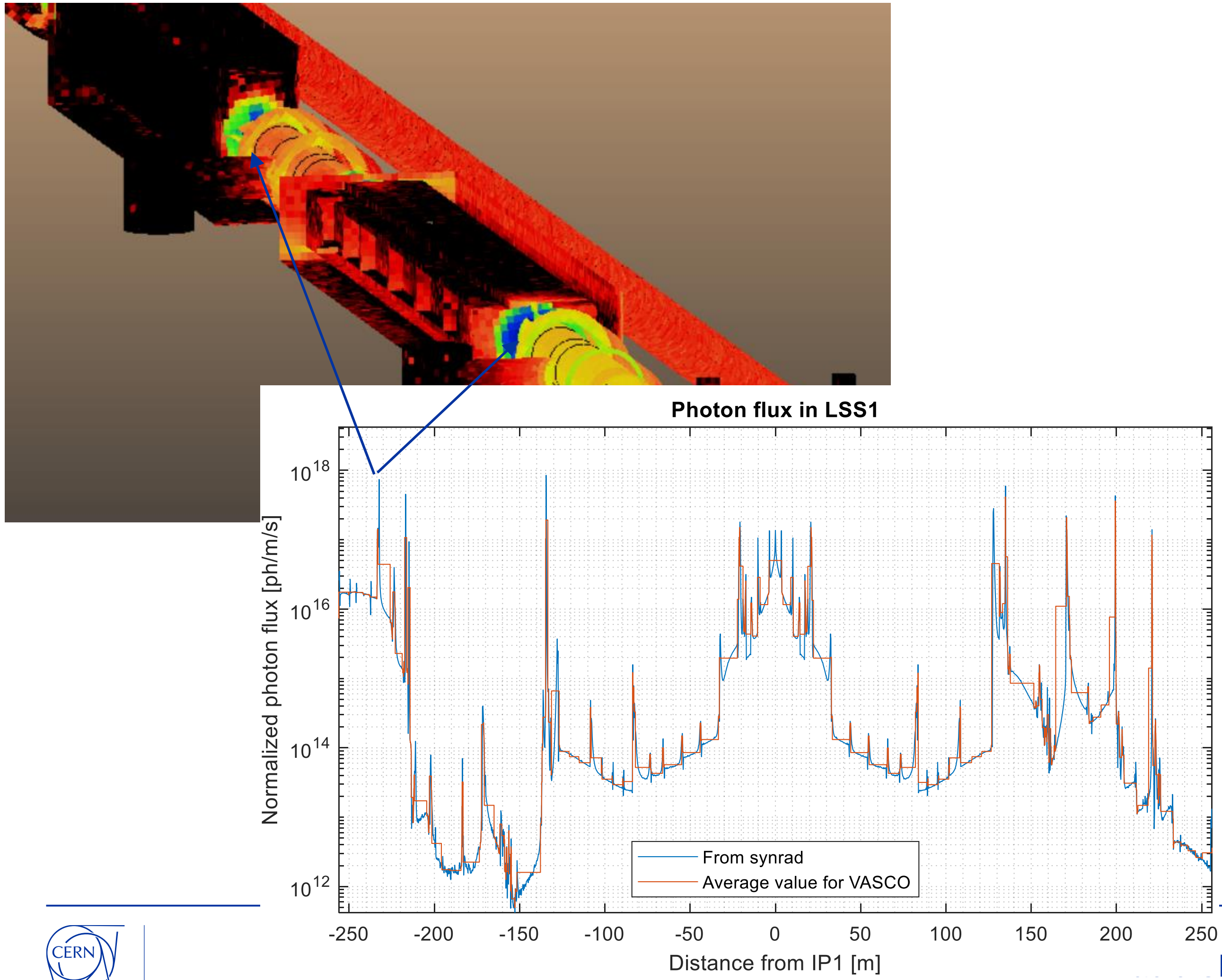
Pressure profile of LSS1 and LSS5 of HL-LHC

- Simulation of the pressure in the LSS1 and LSS5 with the new HL-LHC layout
- Different scenarios simulated, from the machine startup to the end of the Run 4
- Similar profiles in both LSS, with small differences at the IP due to the different apertures

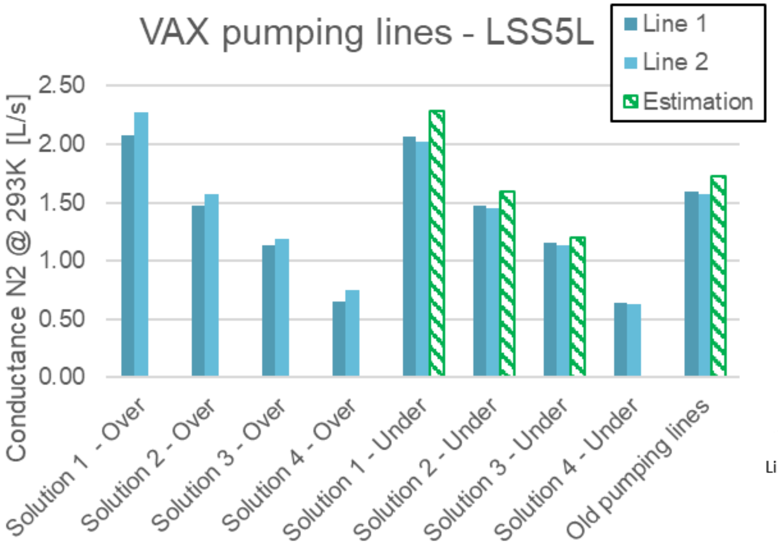


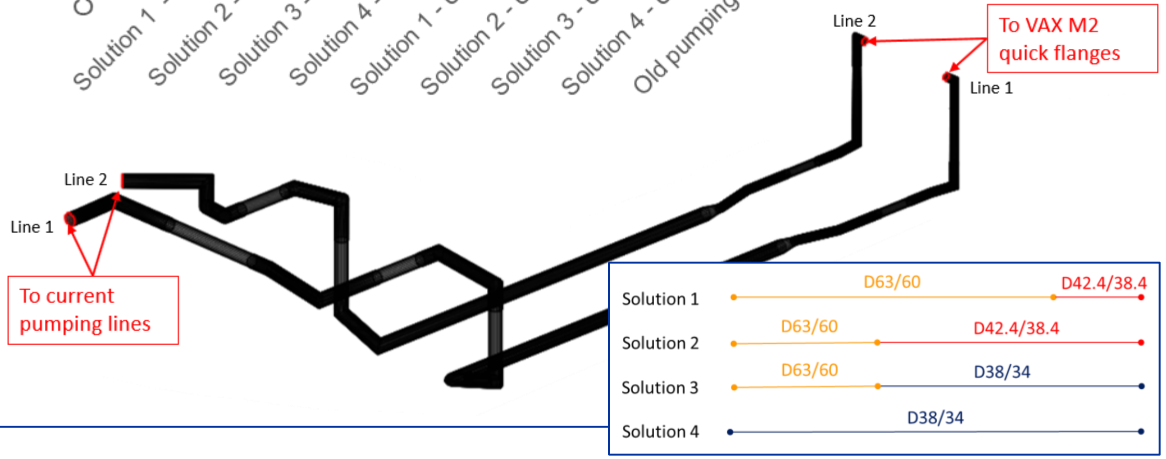
Other vacuum simulations for LSS1 and LSS5

- LSS1 and LSS5 SR simulations
  - Include actual PSD gas load in vacuum simulations



- Support to the routing of the pumping lines of the VAX
  - Guarantee adequate pumping speed of the IP sector

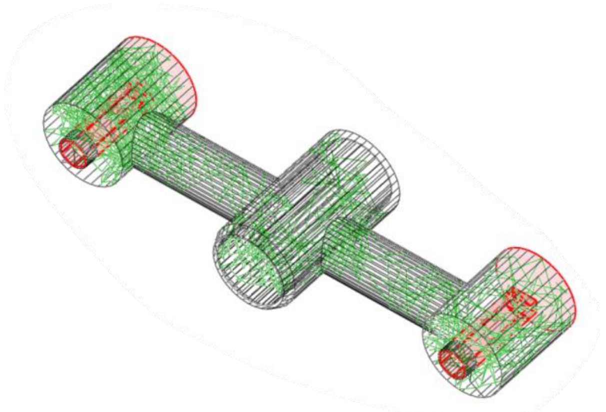


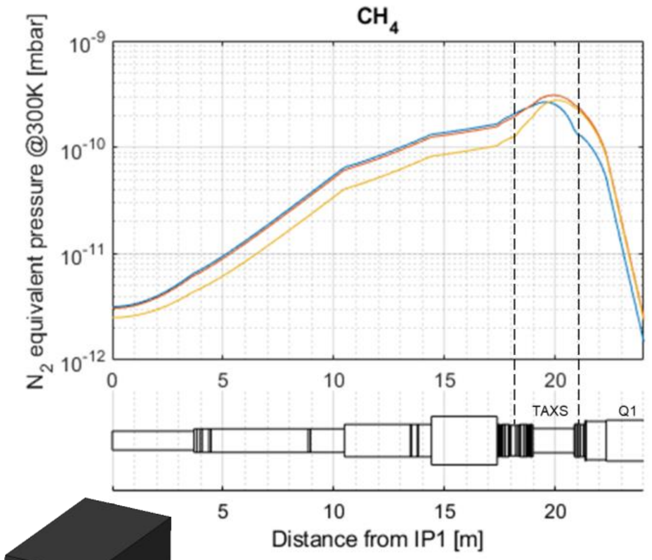


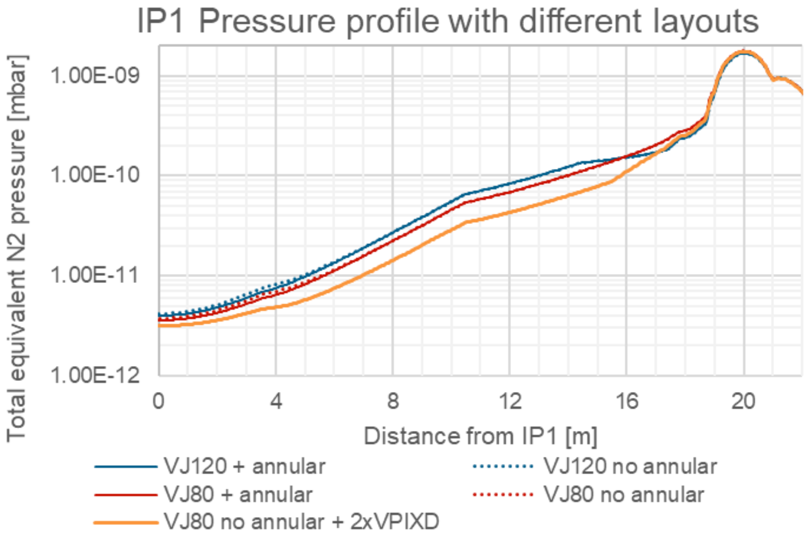
Other vacuum simulations for LSS1 and LSS5

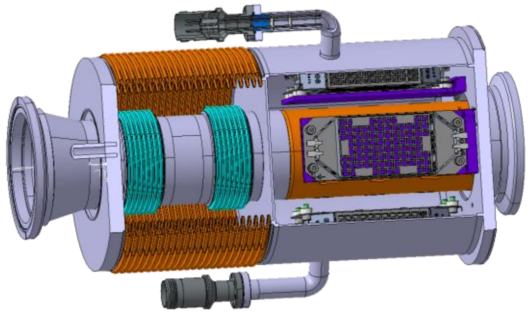
- Optimization of the VAX-TAXS area
  - Improve reliability, performance and access to the area

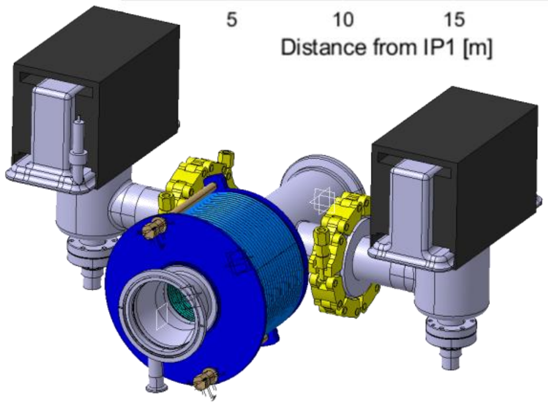
- Support to the ATLAS vacuum system upgrade
  - Assess the effects of the experimental vacuum upgrade

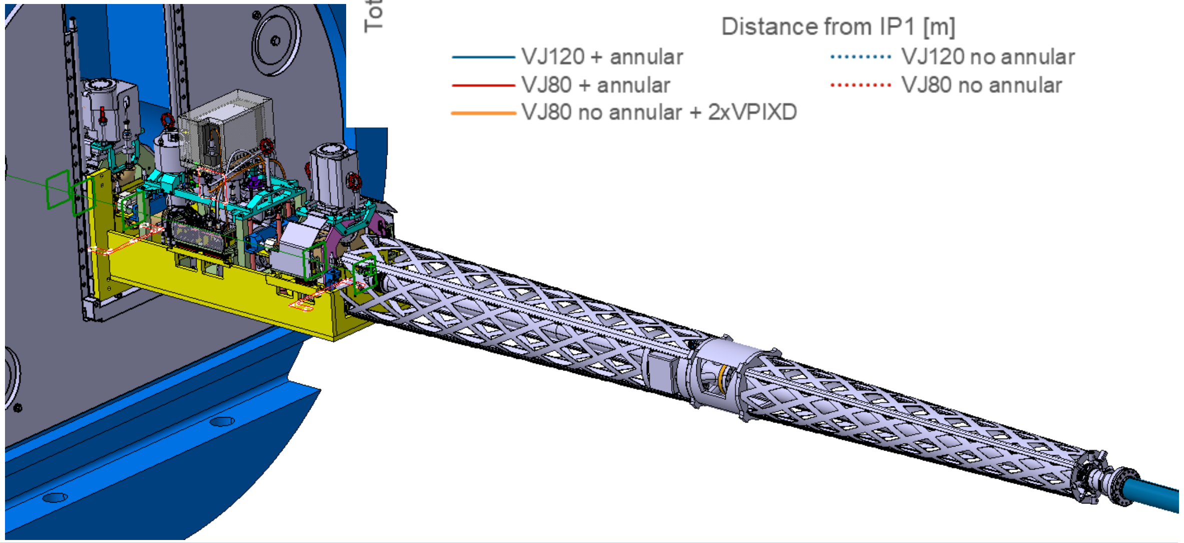






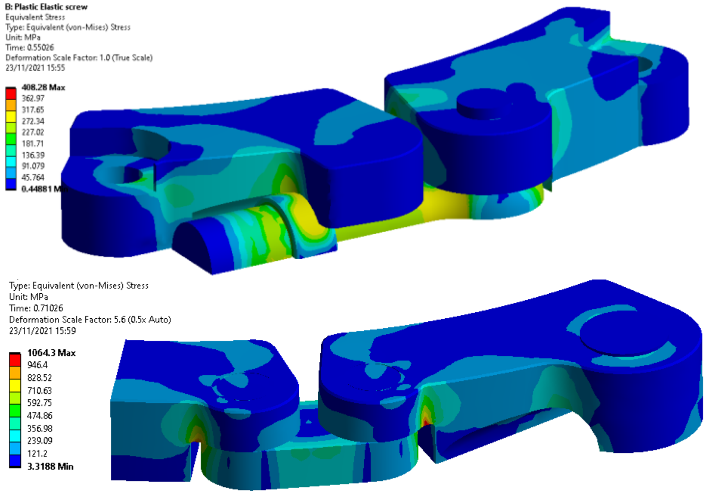


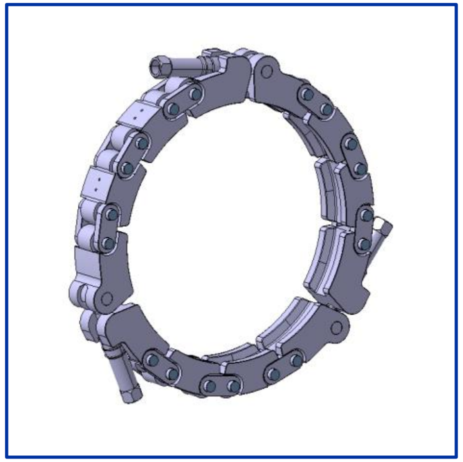


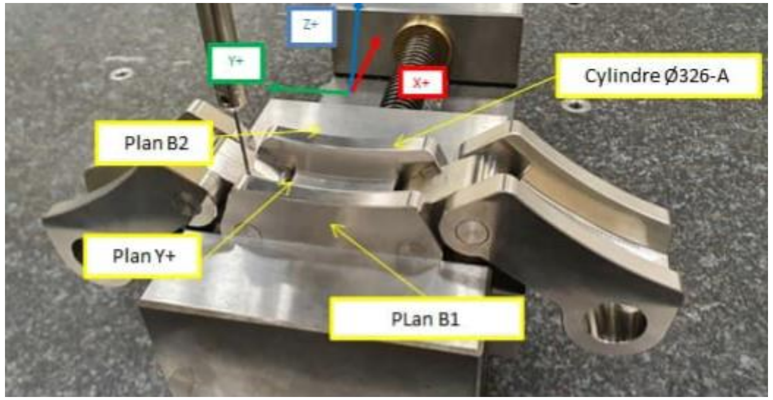


ANSYS simulations and metrology of QCF chain clamps

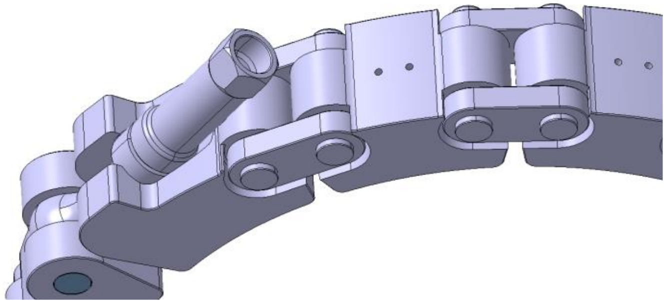
Stress/Strain analysis of different QCF chain clamp designs using FEM

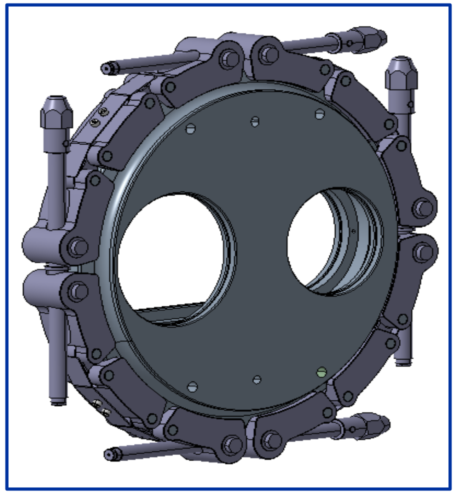




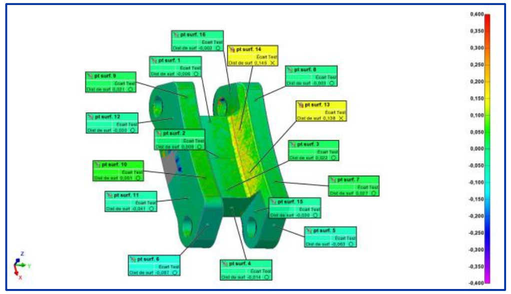


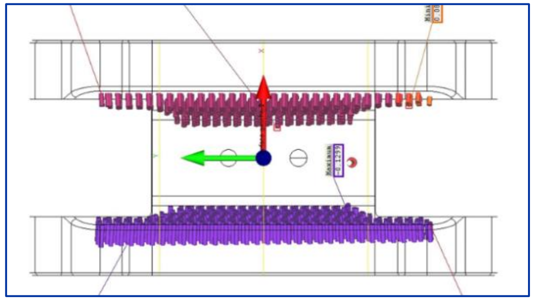
Design proposal for manual chain assembly for ISO standard chain.



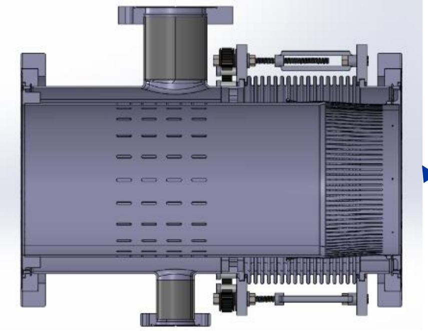


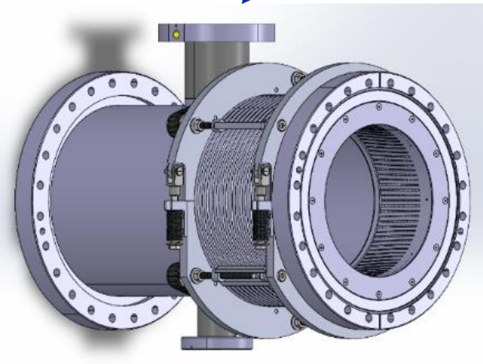
3D scan of chain parts to verify tolerances

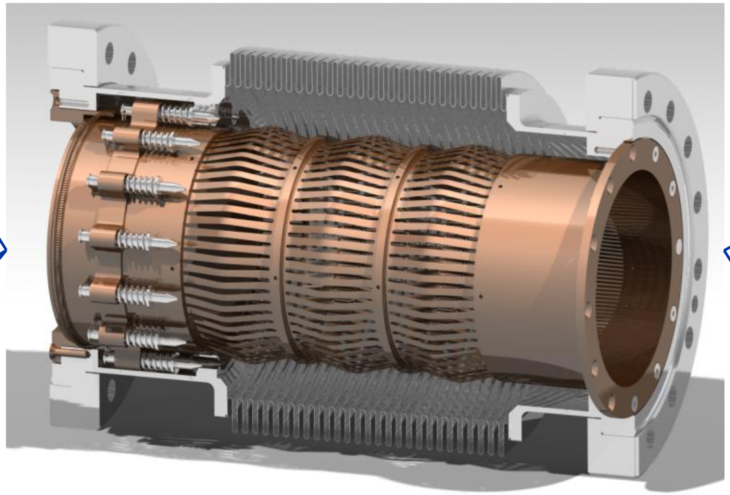




DRF assembly tooling







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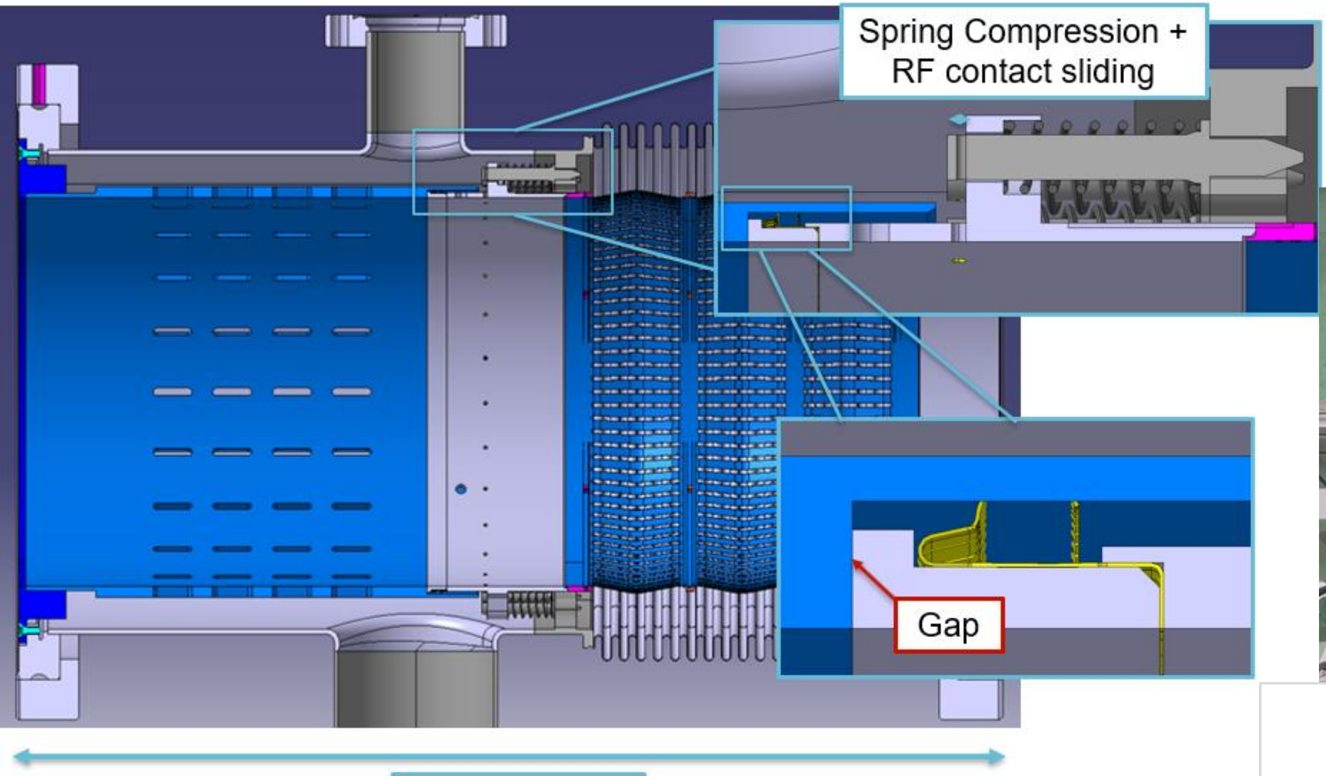
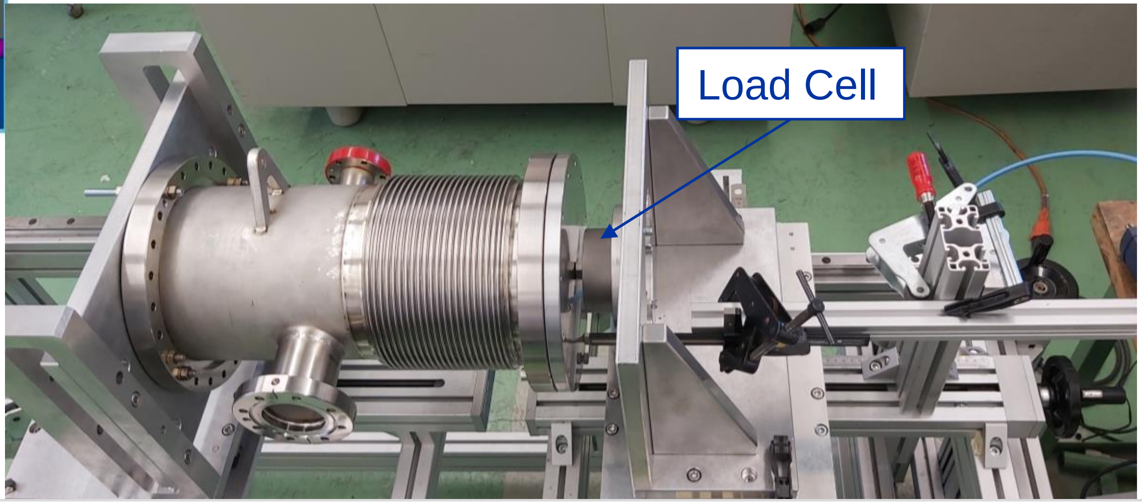
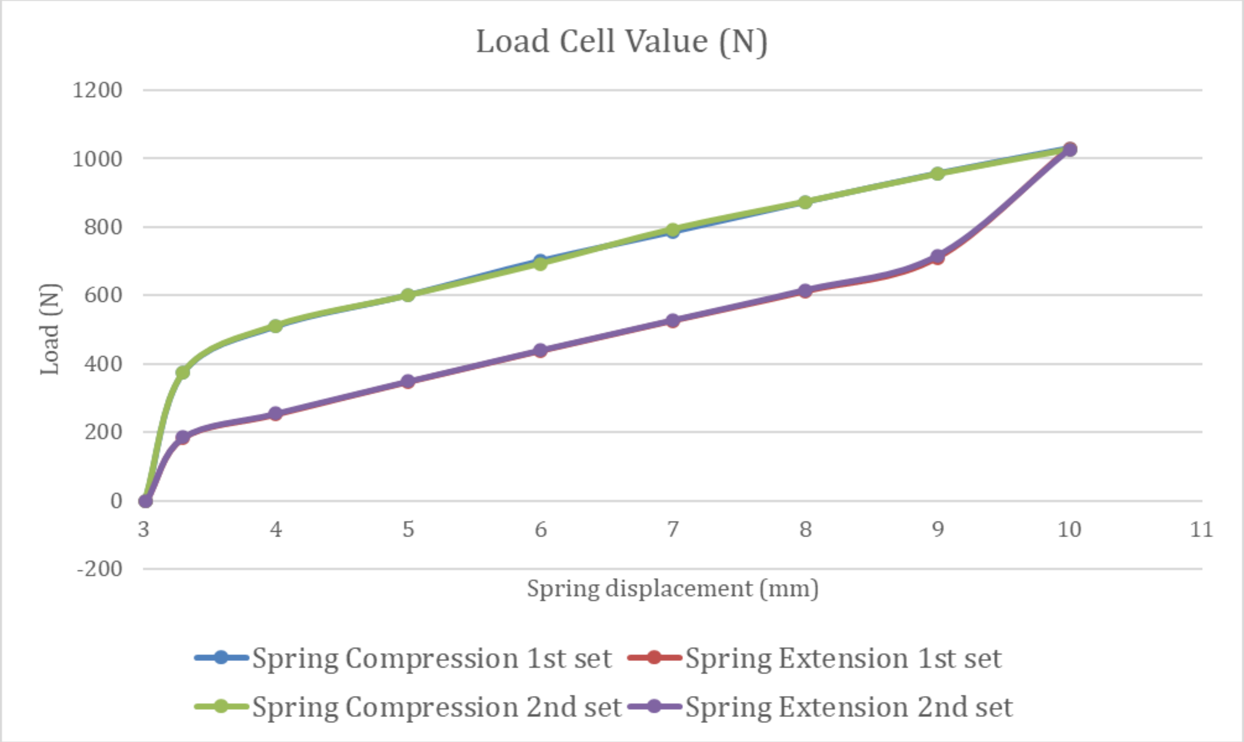
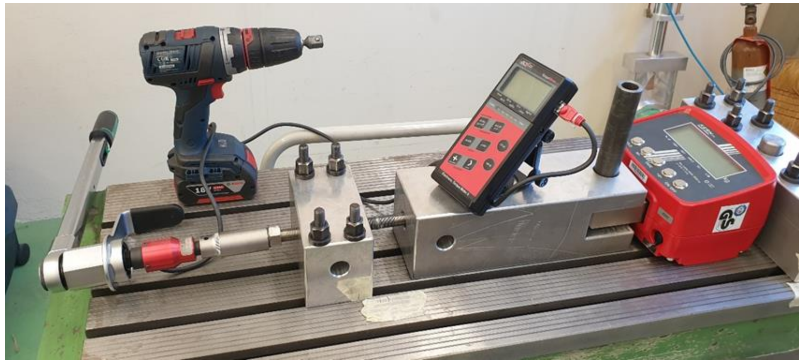
Deformable RF Fingers DN150 Assembly Test



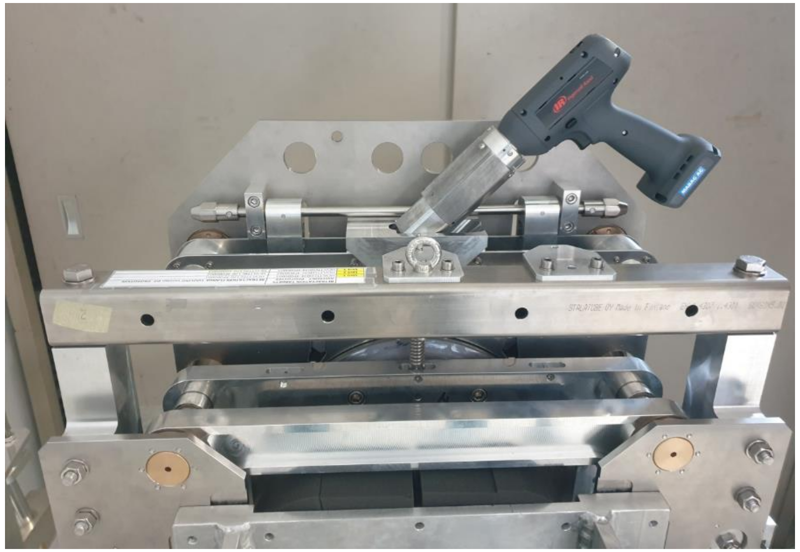




Tooling and QCF chain clamp validation

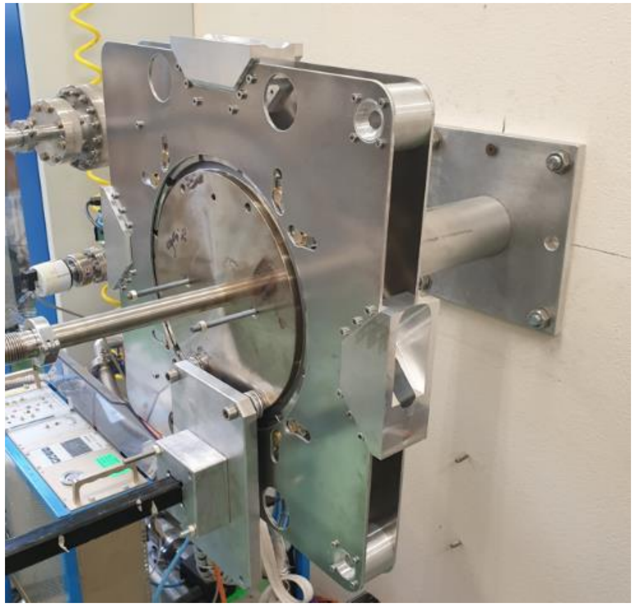


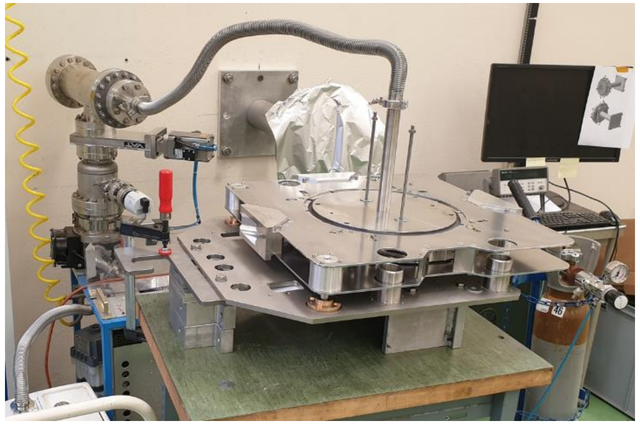
Torque Multiplier Test



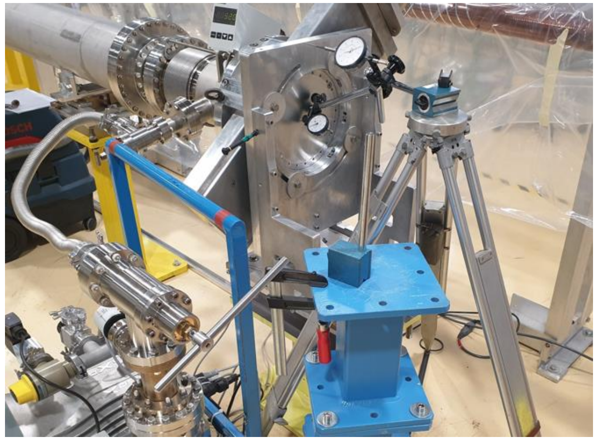
Tightening tool

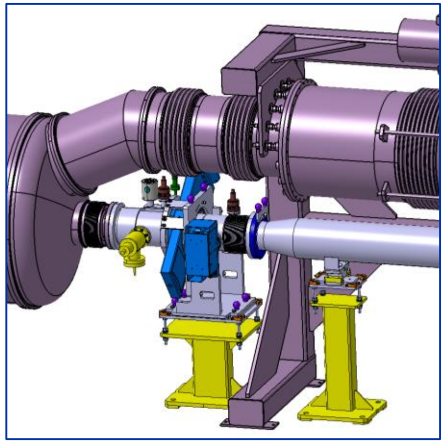
Seal and chain installation test

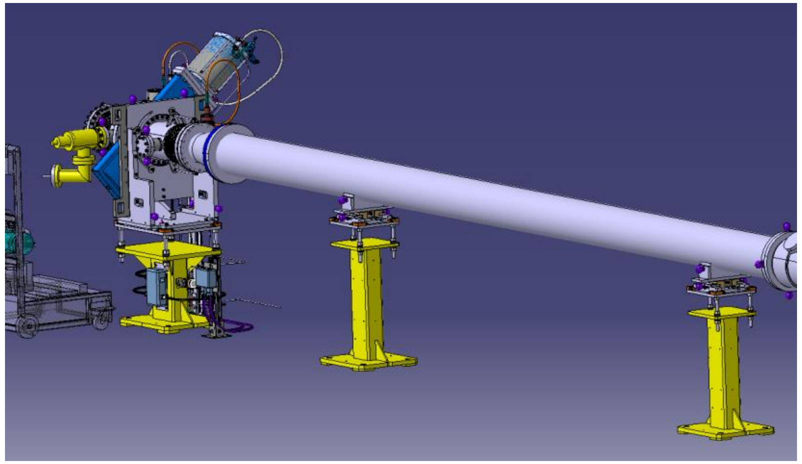




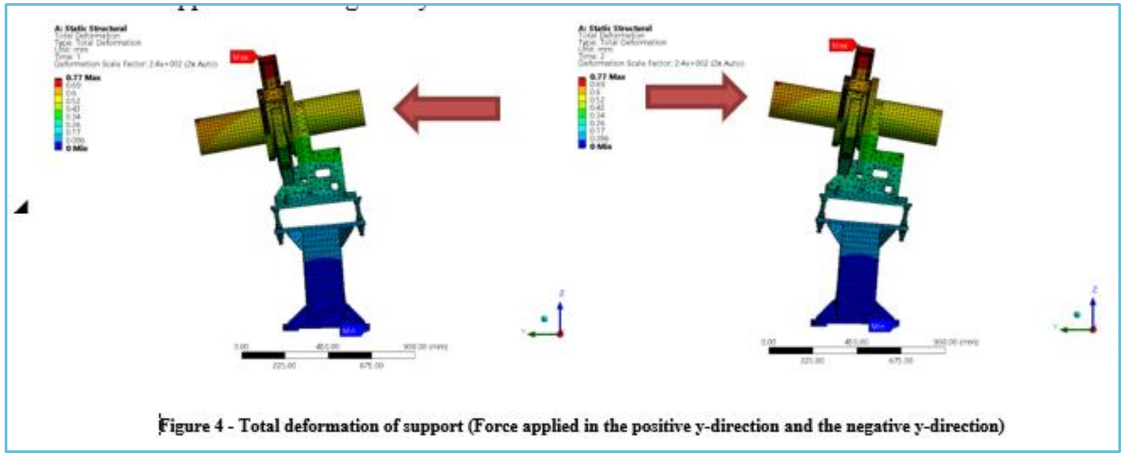
Design and testing of new vacuum support for HL-LHC







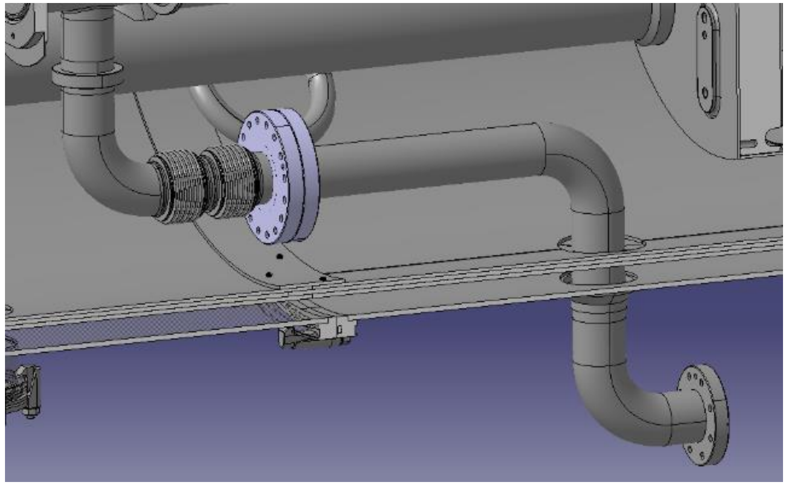
HL-LHC criteria: All vacuum supports shall be designed to have atmospheric pressure on one side and vacuum on the other.

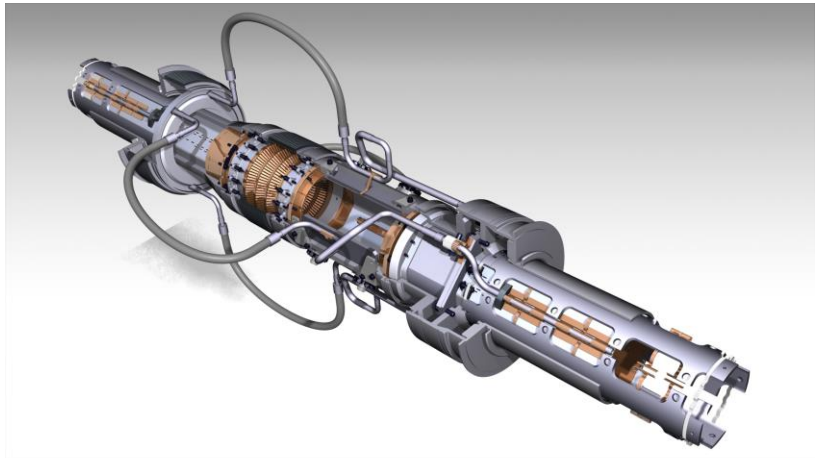


ANSYS simulation: total deformation of support

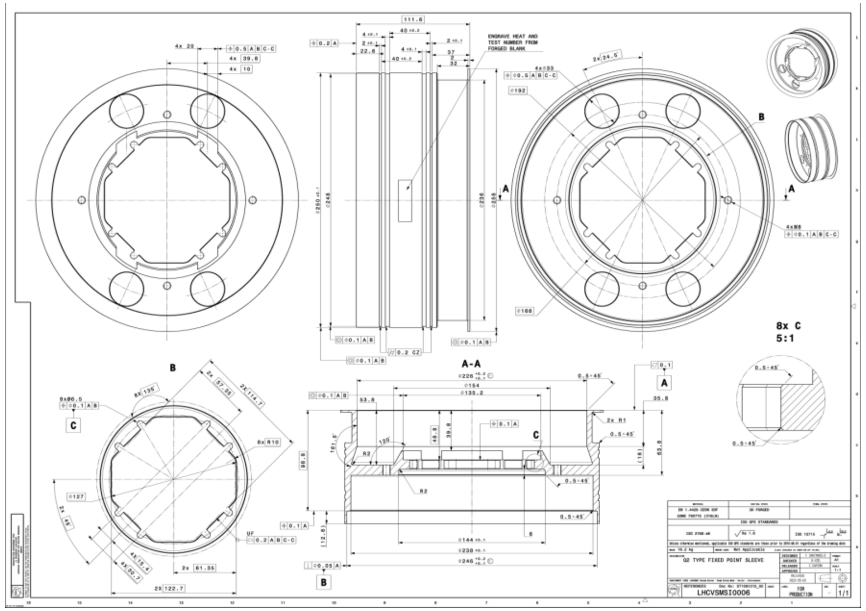
Deformation testing of vacuum supports in B113

HL-LHC cold vacuum system development

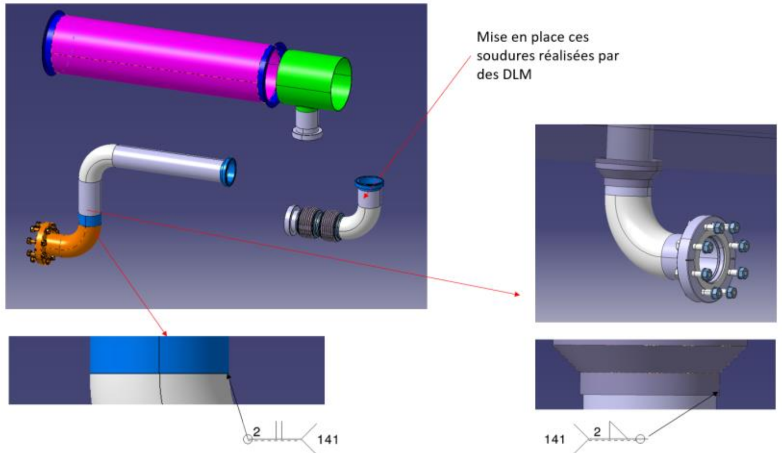




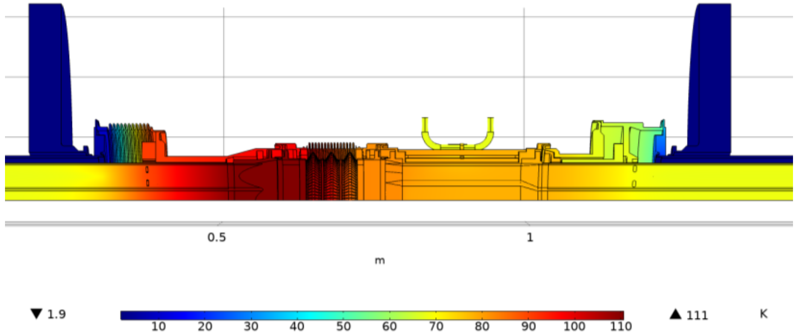
3D update of the interconnections



Drawings for fabrication of the interconnection components

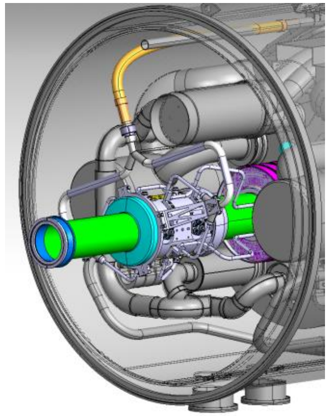


3D update of the triplet pumping line

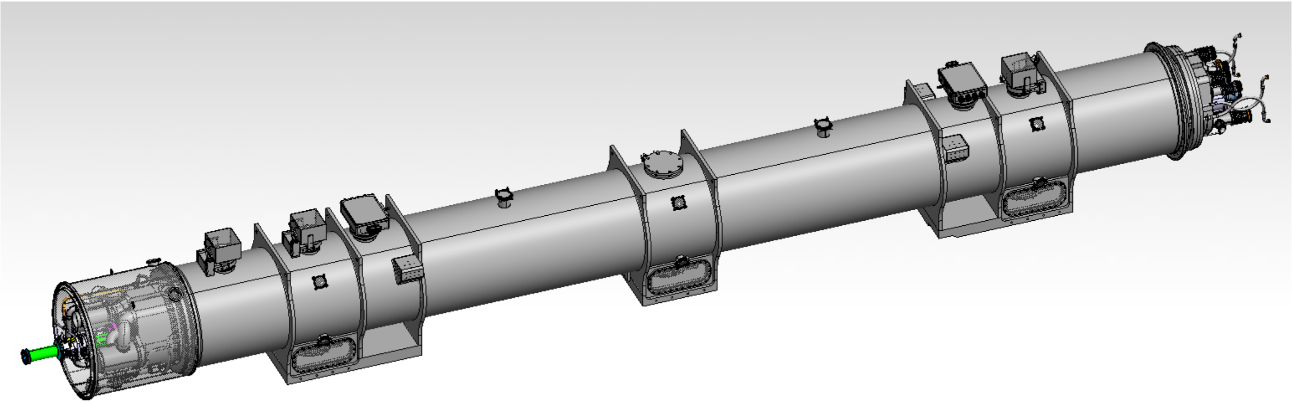


Update of thermal simulations

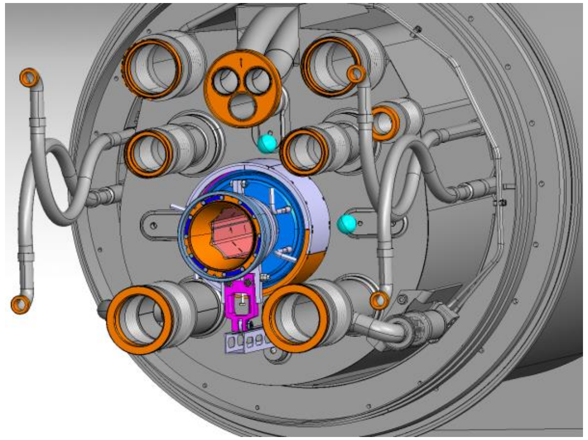
HL-LHC cold vacuum system development



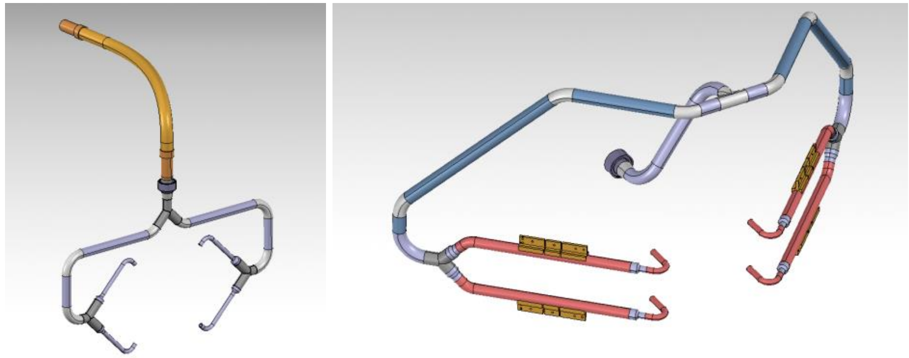
Integration of the cold/warm transition



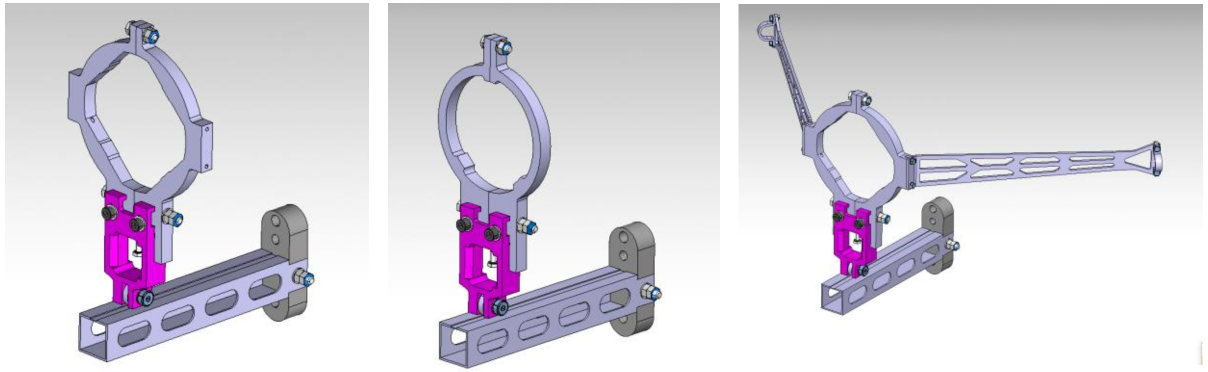
Integration of the beam vacuum line in the cryomagnet



Integration of the mobile point support



Inlet/outlet of the helium beam screen cooling circuit

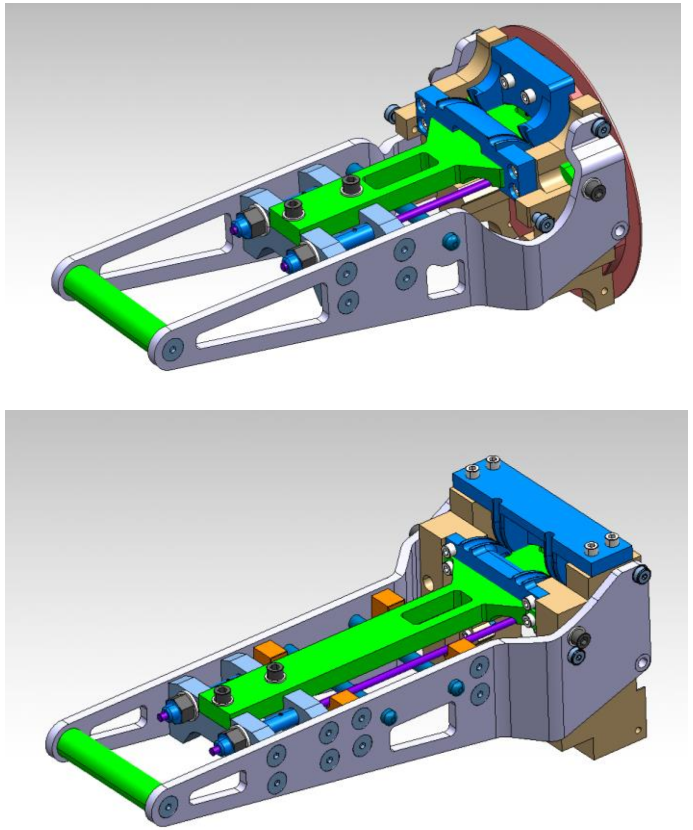


Supports of the beam screen mobile point

HL-LHC cold vacuum system development

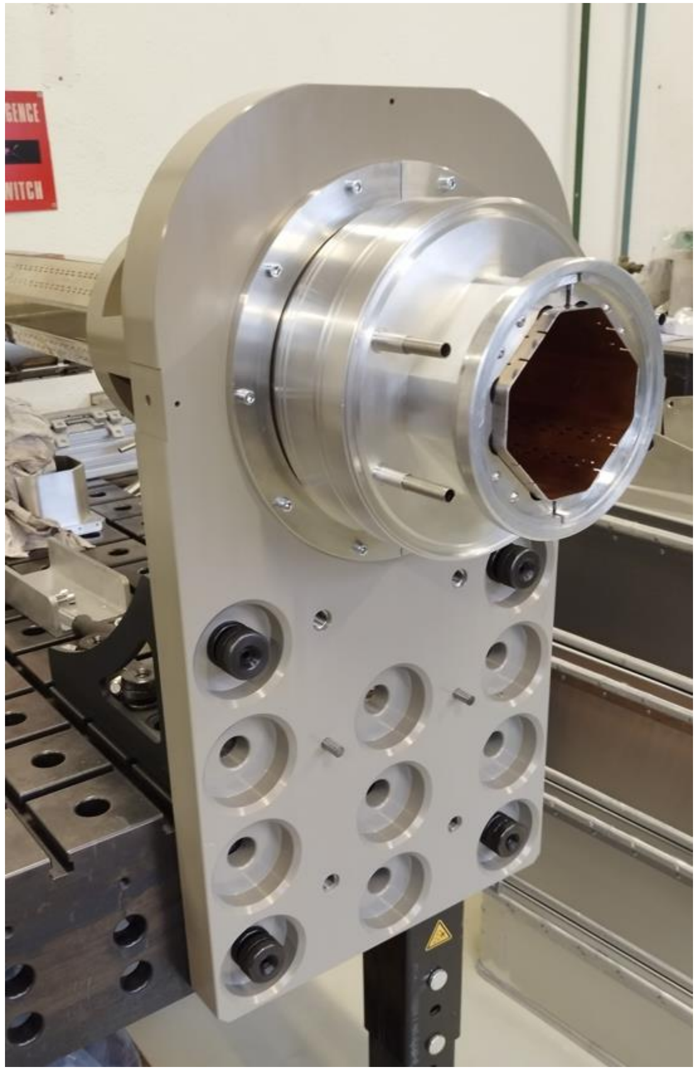
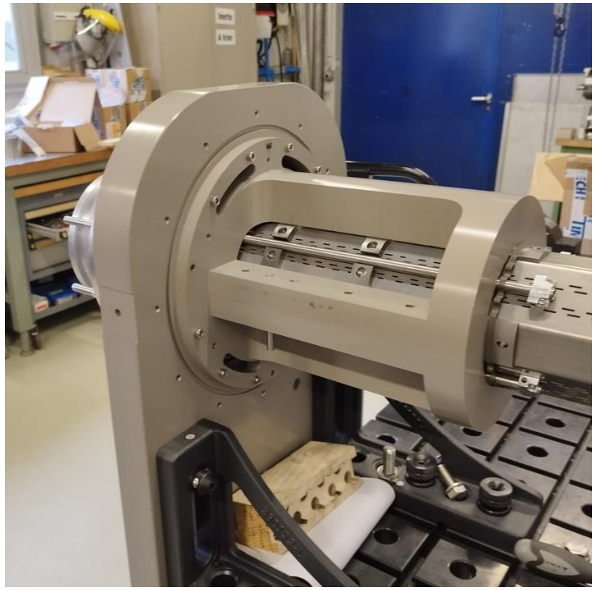
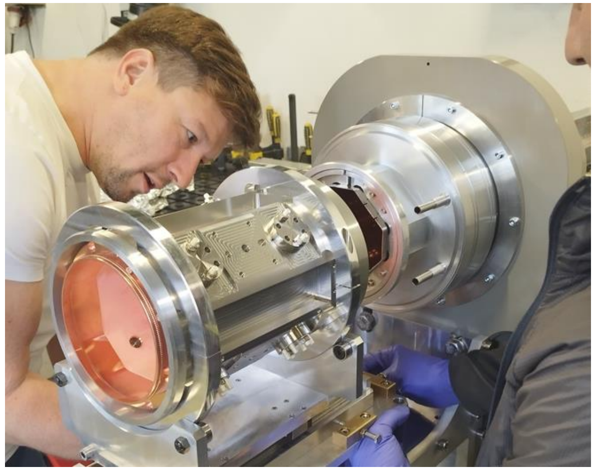
Cooling tube bending machine for D2

Model of the D2 exit tubes



Cooling tube bending machine for Q1

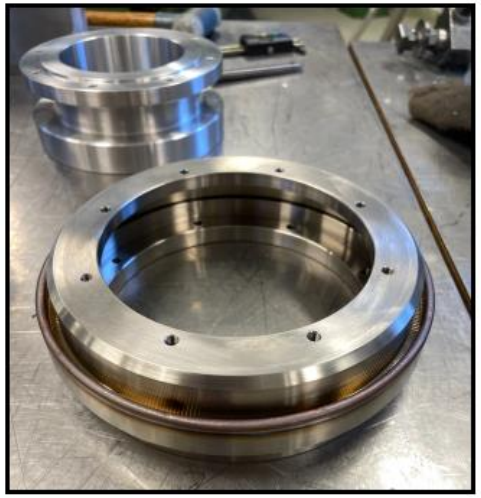
HL-LHC cold vacuum system development

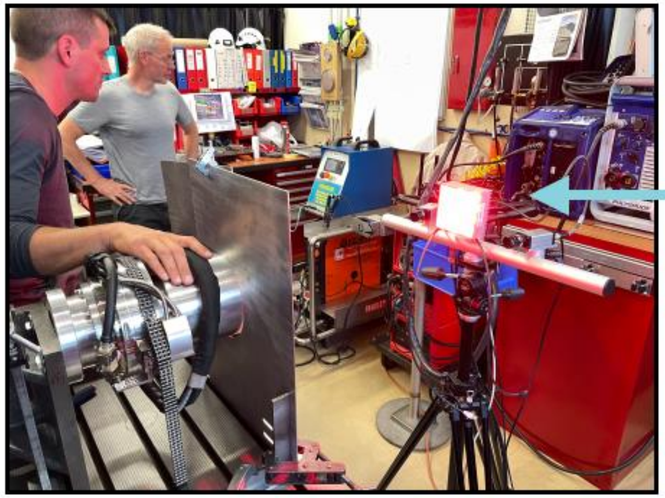




Fixed point pre-assembly mock-up and BPM assembly test

Model of the beam screen for cold leak/pressure test

HL-LHC cold vacuum system development



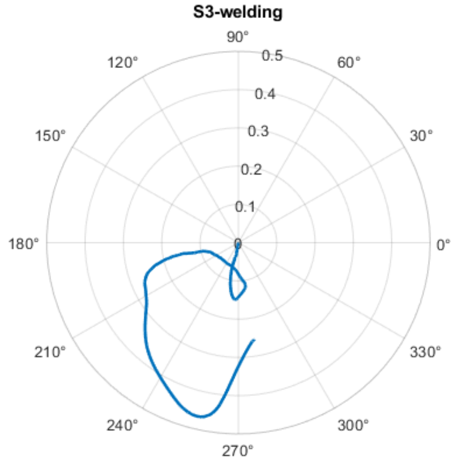


Digital Image Correlation

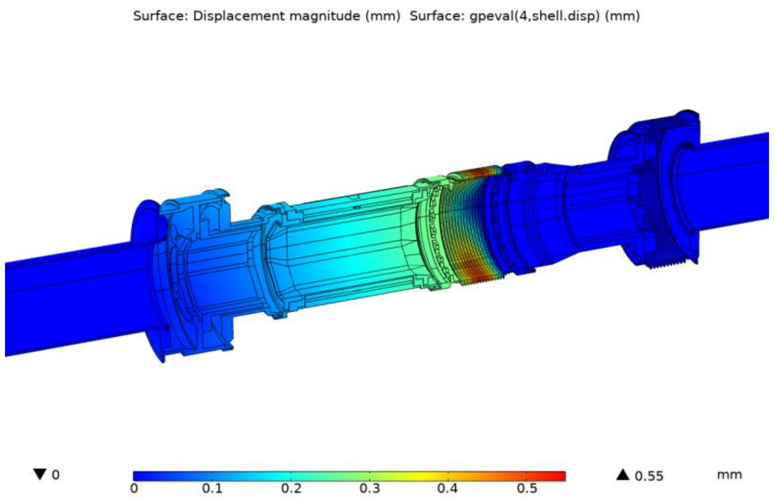
Orbital welding head

Stochastic painting

Preliminary tests of welding induced deformation

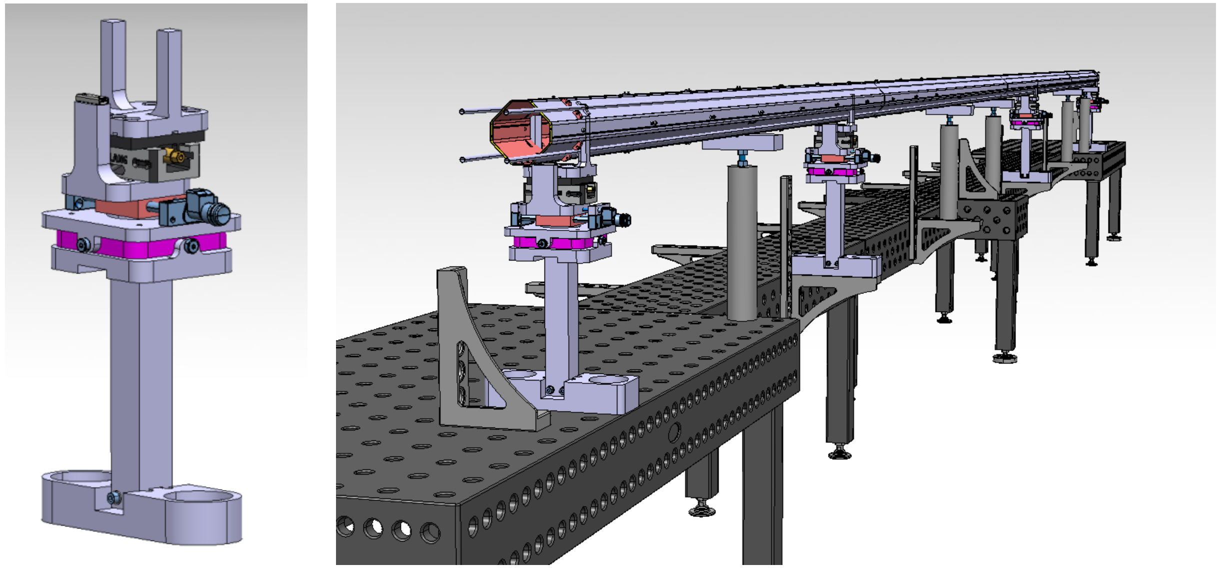


Preliminary results of deformation after welding



Deformation due to gravity

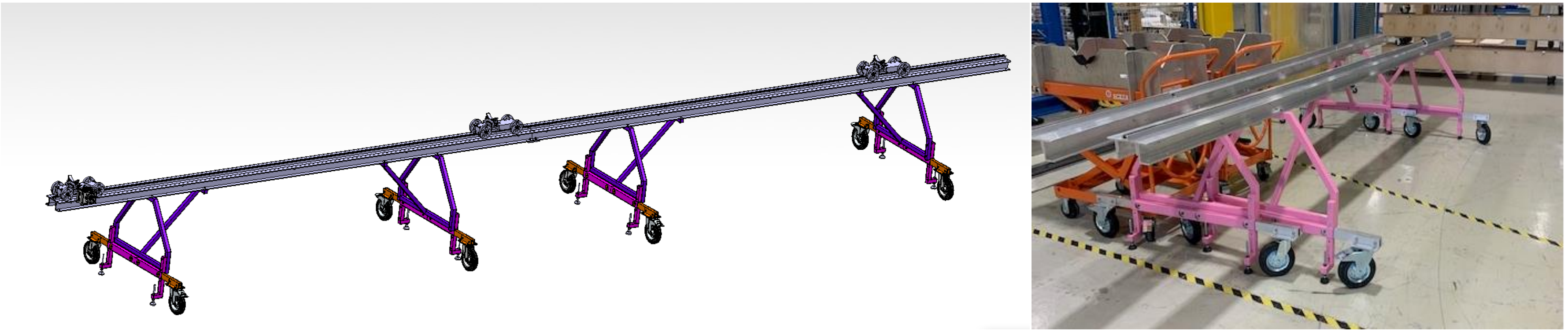
HL-LHC cold vacuum system development



Update of the metrology bench

Model and fabrication of the supports

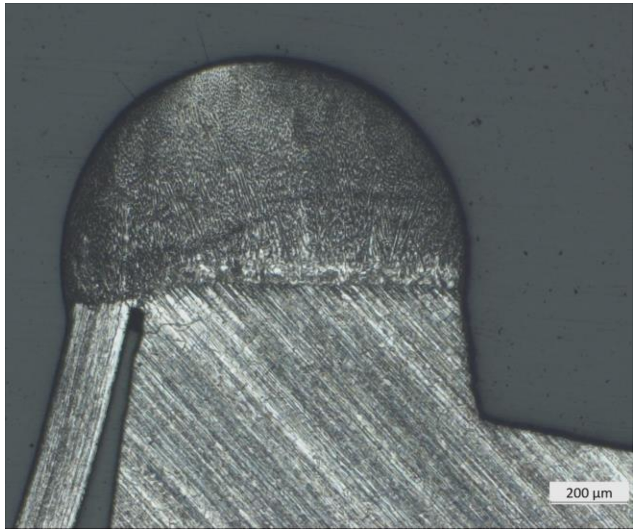
Model and fabrication of the adjustable movable supports



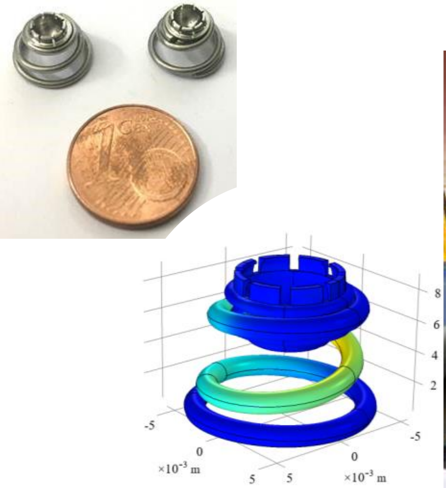
Model and fabrication of the insertion bench

HL-LHC cold vacuum system procurement

Reception of machined parts for the interconnections

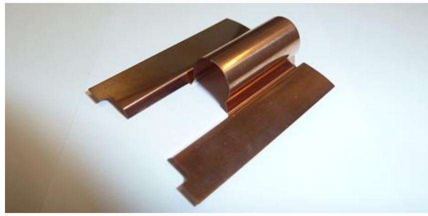


Bellows supplier qualification



Analysis of as-built Ti springs

Rework of Ti compression rings



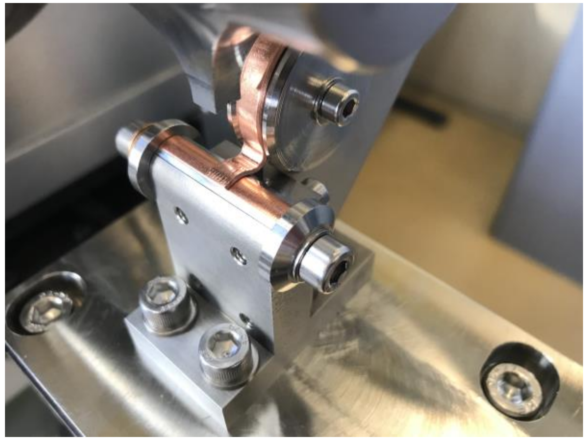
Completion of pumping slot shields

Reception of tungsten absorbers

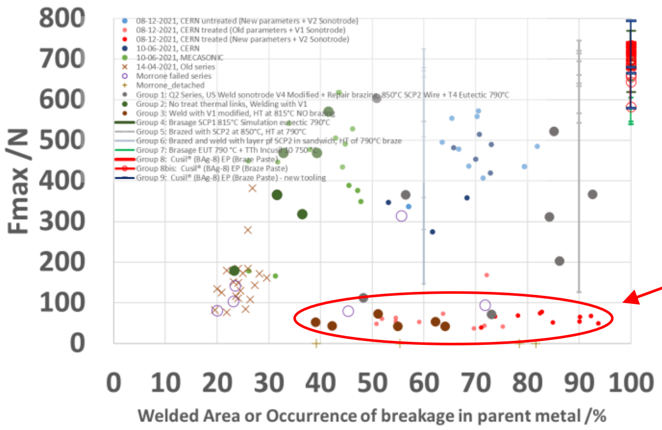
Leak test tooling for series bellows

HL-LHC cold vacuum system procurement

Thermal link production: change from ultrasound welding to brazing



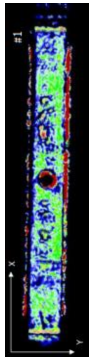
Ultrasound welding

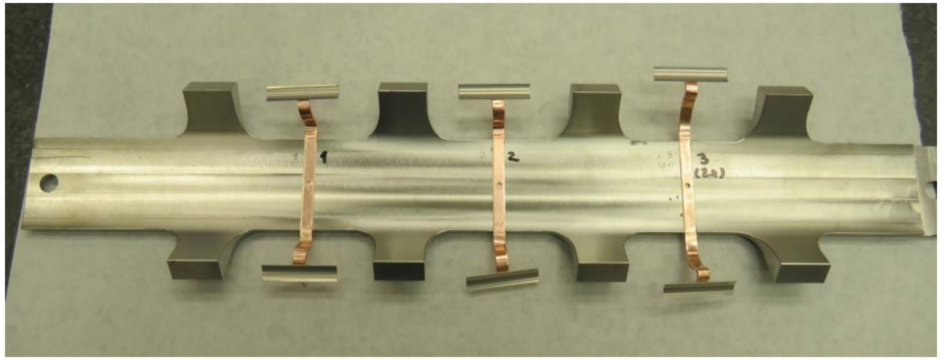


Ultrasound weld after thermal cycle

Comparison of ultrasound welding and brazing

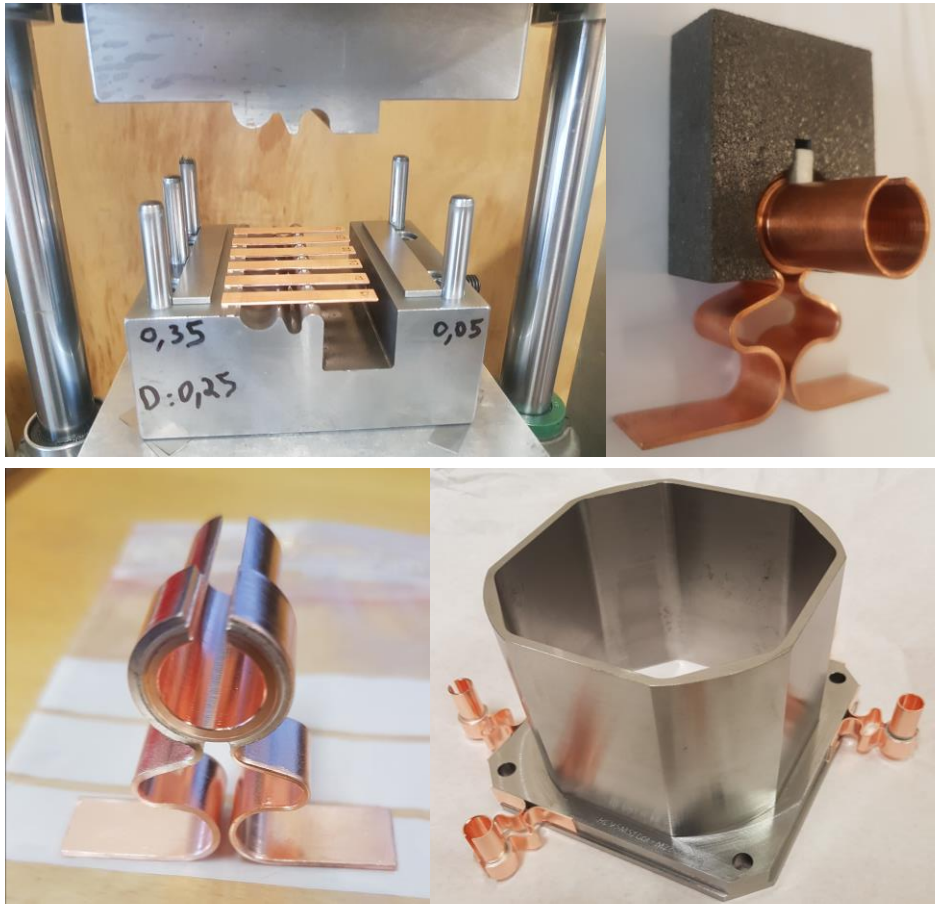
Thermal link brazing on the tungsten absorbers



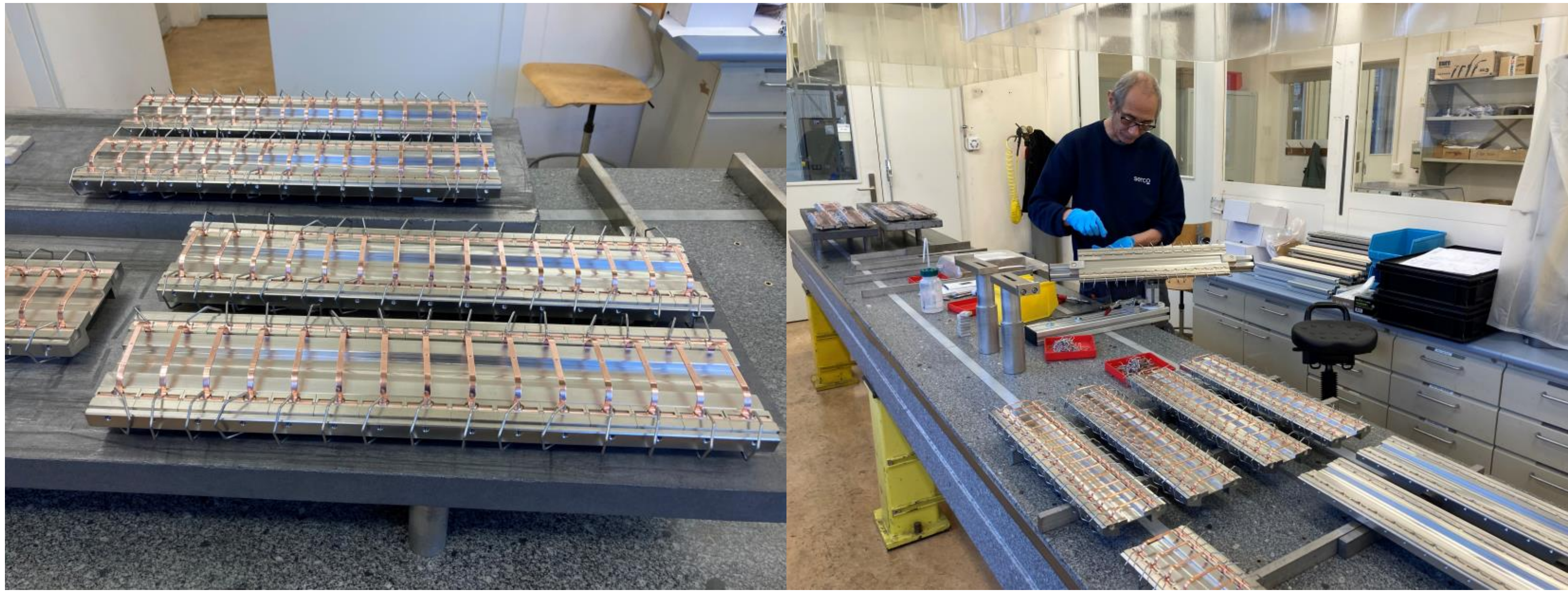


Assessment of brazing quality for different process configurations

HL-LHC cold vacuum system manufacturing



Production of thermal links for the interconnection absorbers



Production of thermal links for the beam screen absorbers

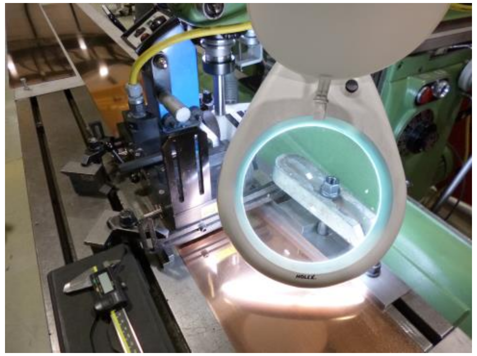
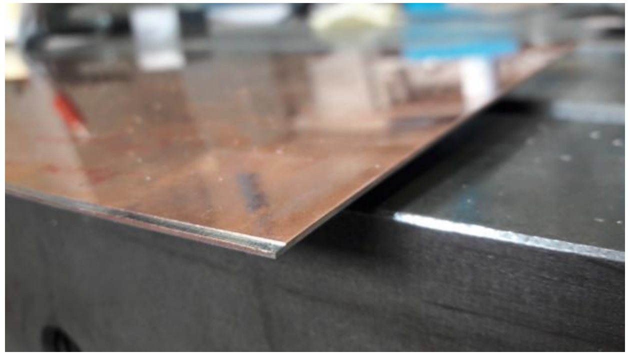
HL-LHC cold vacuum system manufacturing

Beam Screen Tube Manufacturing

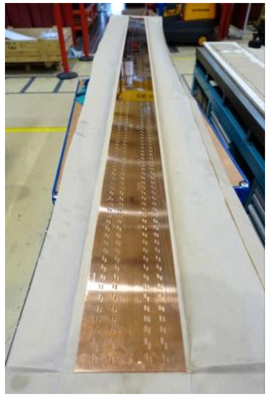
Series production of the beam screen tubes:


Levelling of the sheets in industry, completed

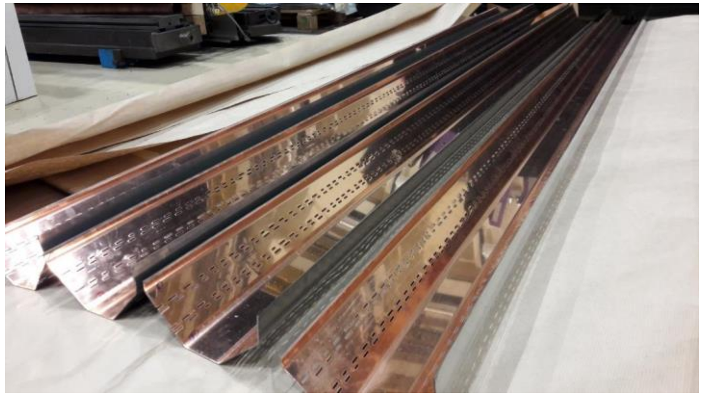
Machining to width and length, completed

Copper removal at the edges, completed

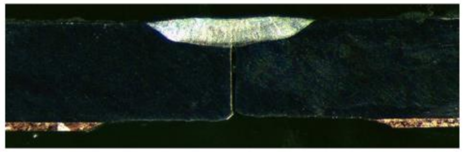


Punching of the strips in industry, completed

Forming of the half shells, completed

Micro-TIG tack welding, completed

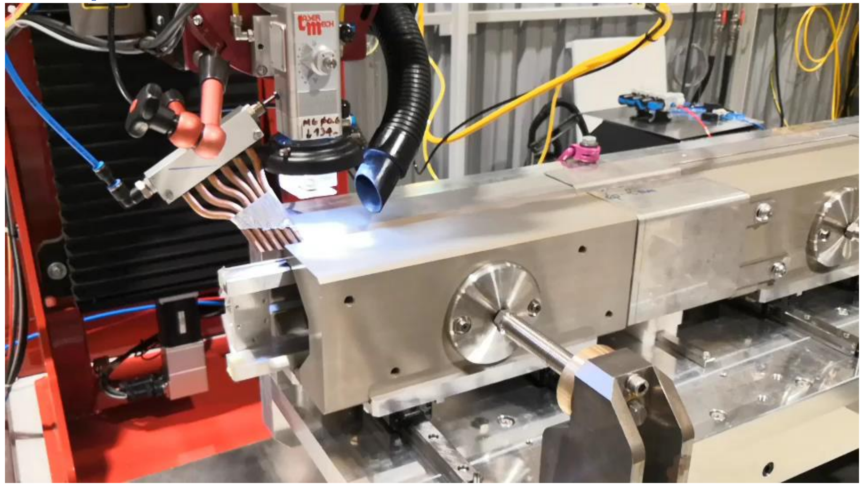


Micro-TIG tack welding

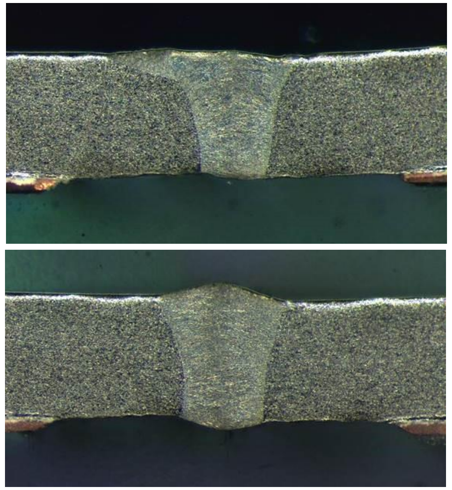
HL-LHC cold vacuum system manufacturing

Beam Screen Tube Manufacturing

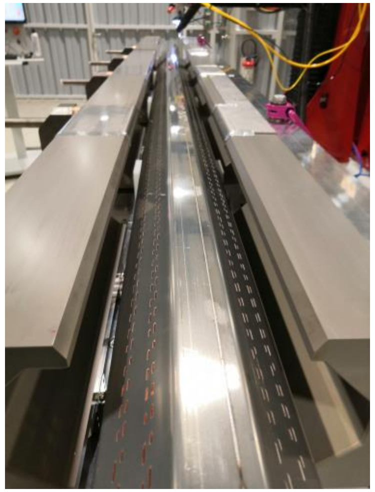
Series production of the beam screen tubes:



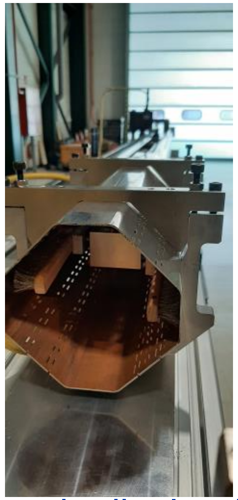
Longitudinal welding, ongoing



Metallography for butt weld qualification

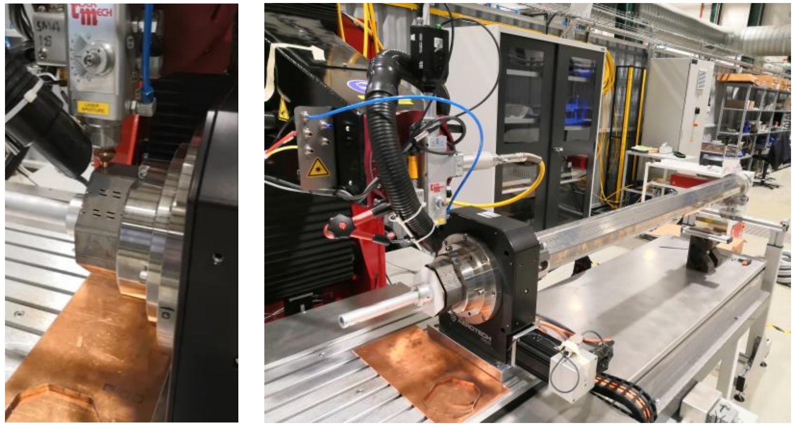


Longitudinal welding tooling



Longitudinal weld brushing

Calibration of the beam screen segments



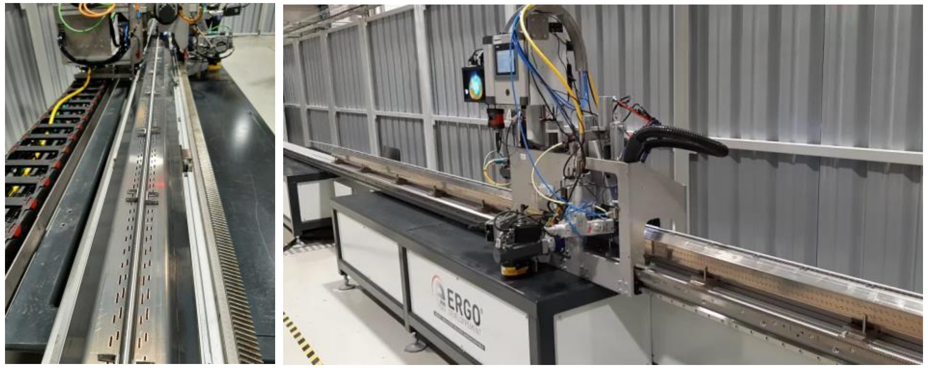
Cutting to length of the beam screen segments

Butt welding of the beam screen segments

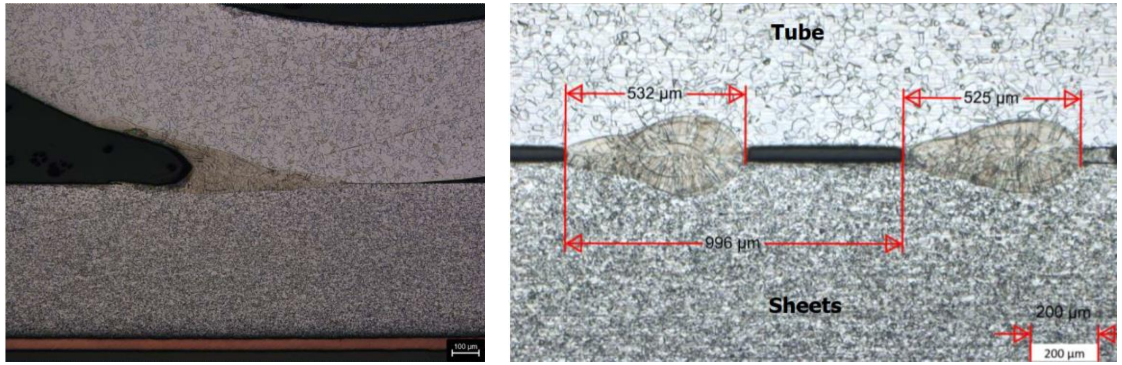
HL-LHC cold vacuum system manufacturing

Beam Screen Pre-Assembly Manufacturing

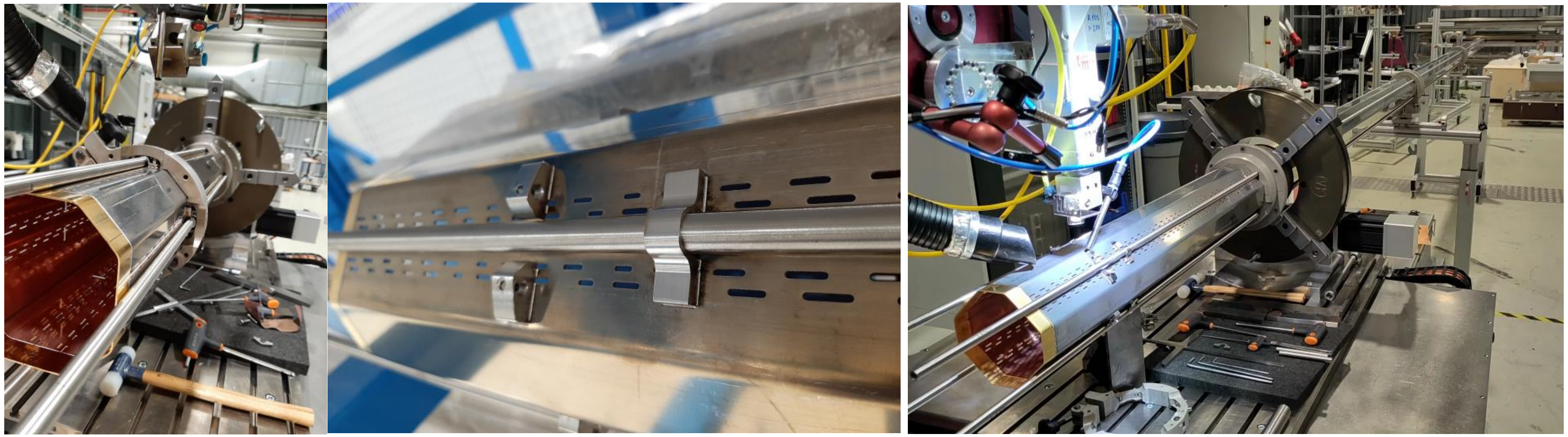
Preseries production of the beam screen pre-assemblies:



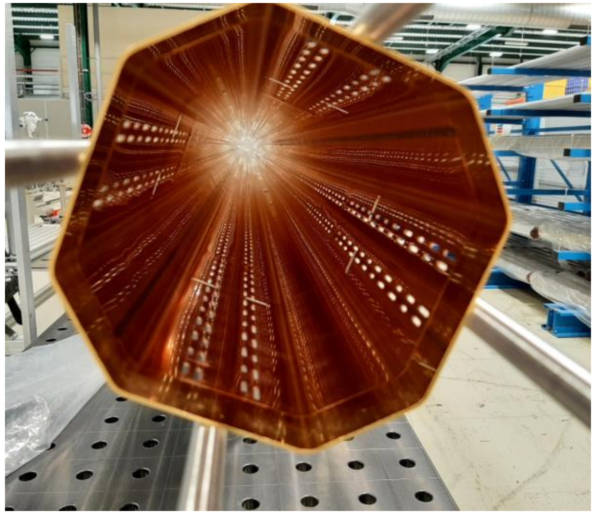
Laser welding bench for the cooling tube welding, completed



Metallography for the cooling tube weld qualification



Welding of the contact rings, cooling tube supports and fixed points, completed



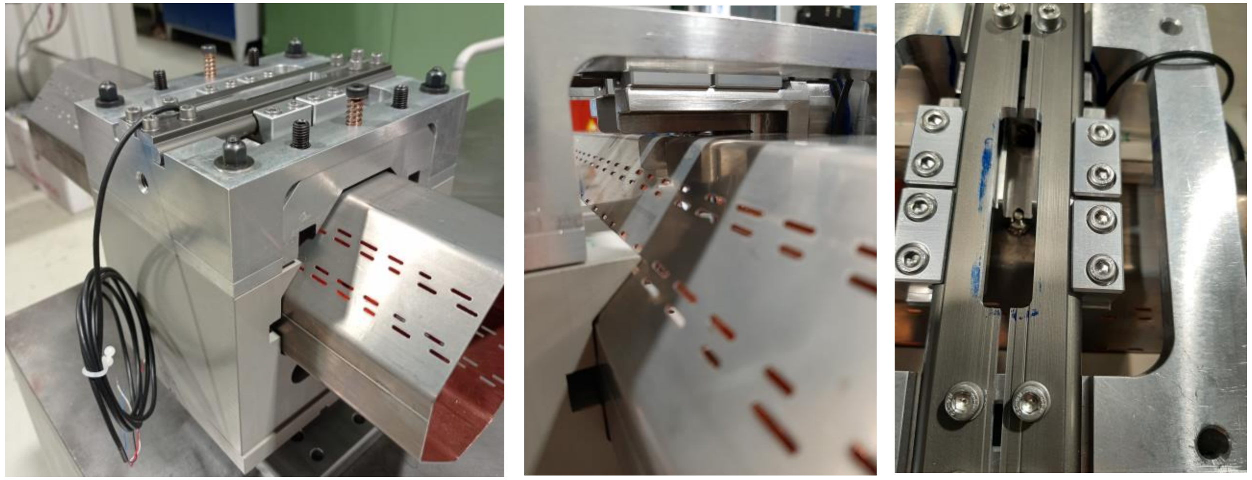
Pre-series completed

HL-LHC cold vacuum system manufacturing

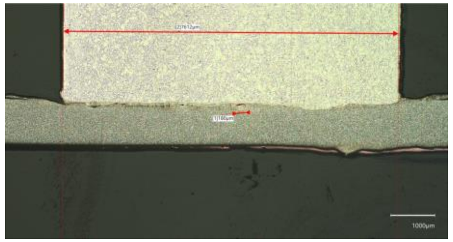
Beam Screen Pre-Assembly Manufacturing

Completion of the dedicated bench for the stud welding of the absorber pin supports

Stud welding on Q2 pre-series



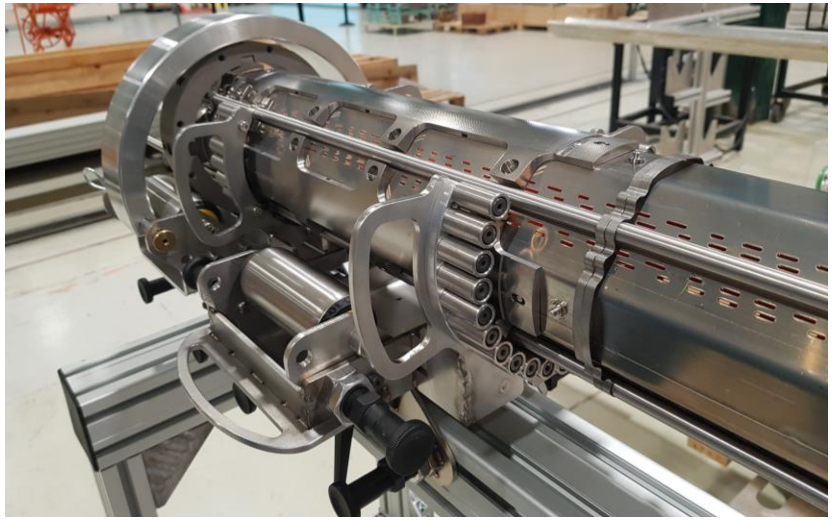
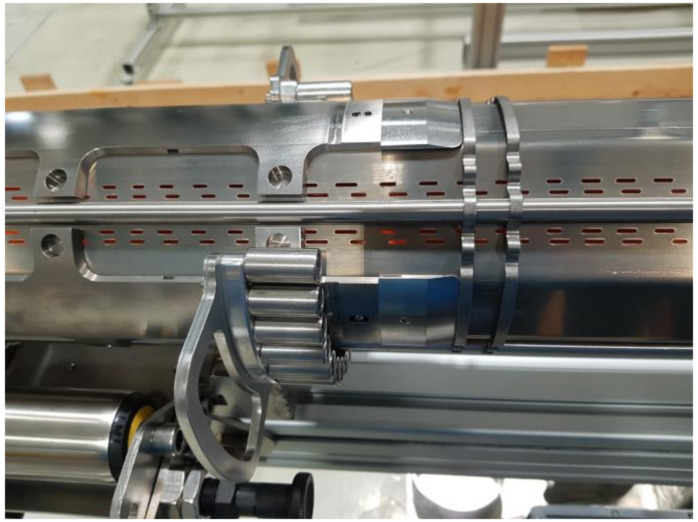
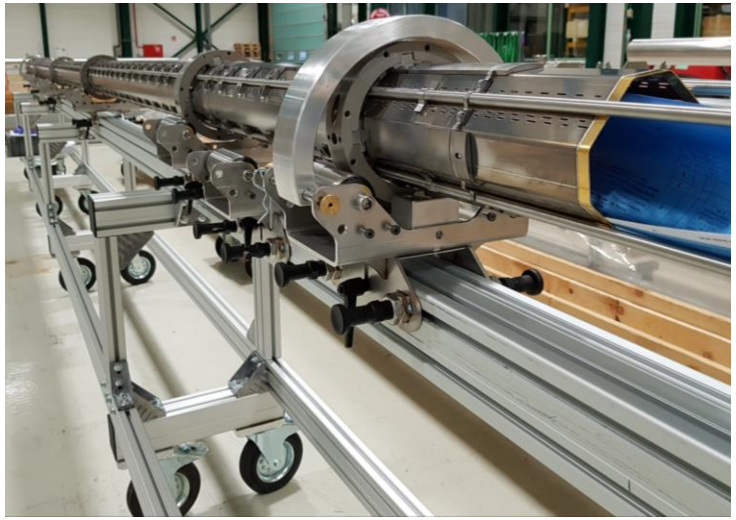
Tooling for stud welding quality check



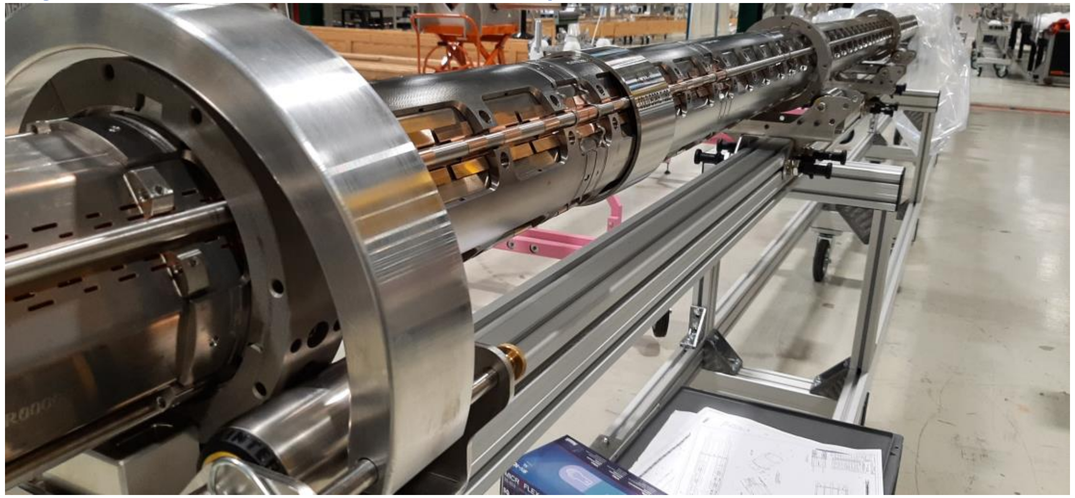
Metallography for stud weld qualification

HL-LHC cold vacuum system manufacturing

Dummy Beam Screen Assembly

Preparation of the bench and tooling for the beam screen assembly



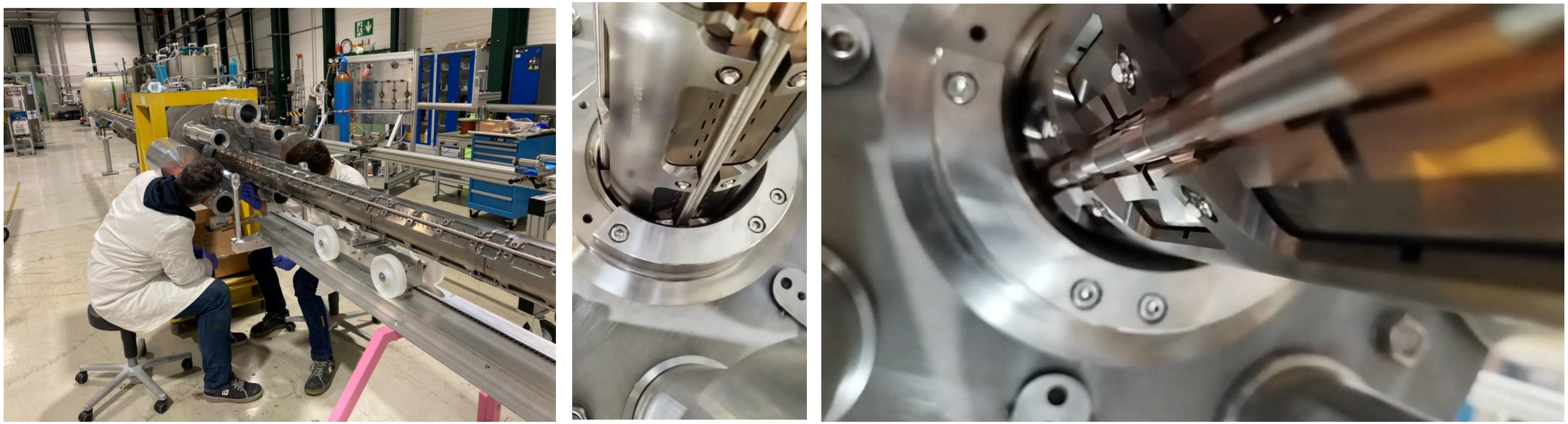
Dummy beam screen assembly

HL-LHC cold vacuum system integration

Dummy Beam Screen Insertion

Preparation of the springs with ceramic balls

Transfer from the assembly to the insertion bench

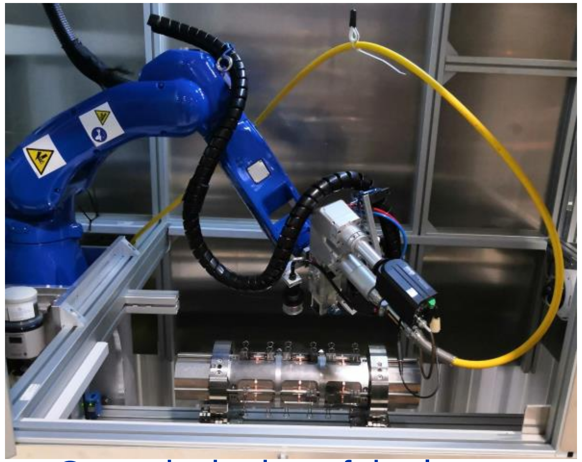


Insertion of the dummy beam screen in the interconnection mock-up

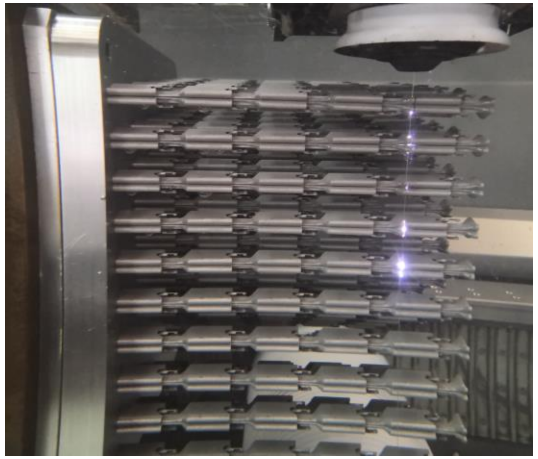
HL-LHC cold vacuum system integration

Beam Screen Assembly

Bench for the thermal link welding on the cooling tubes:



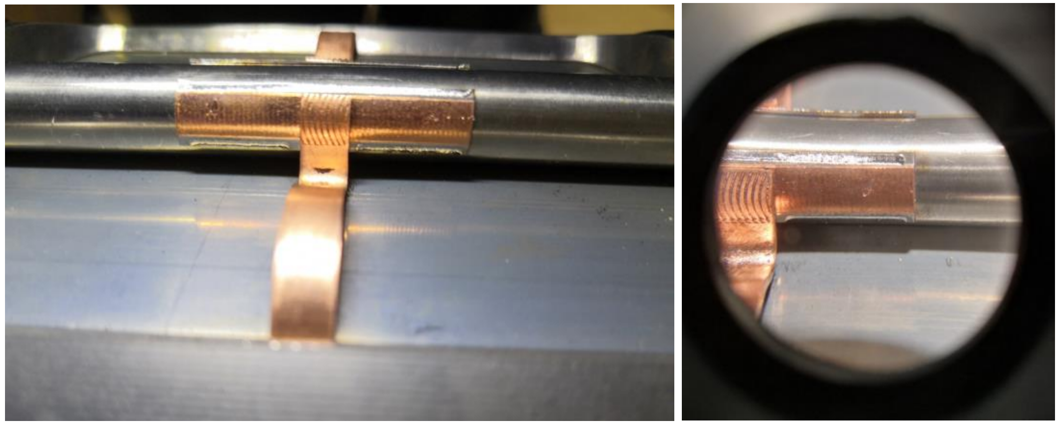
Commissioning pf the laser welding robot



Clamp manufacturing

Beam screen assembly before laser weld

Commissioning of the laser bench with welding robot



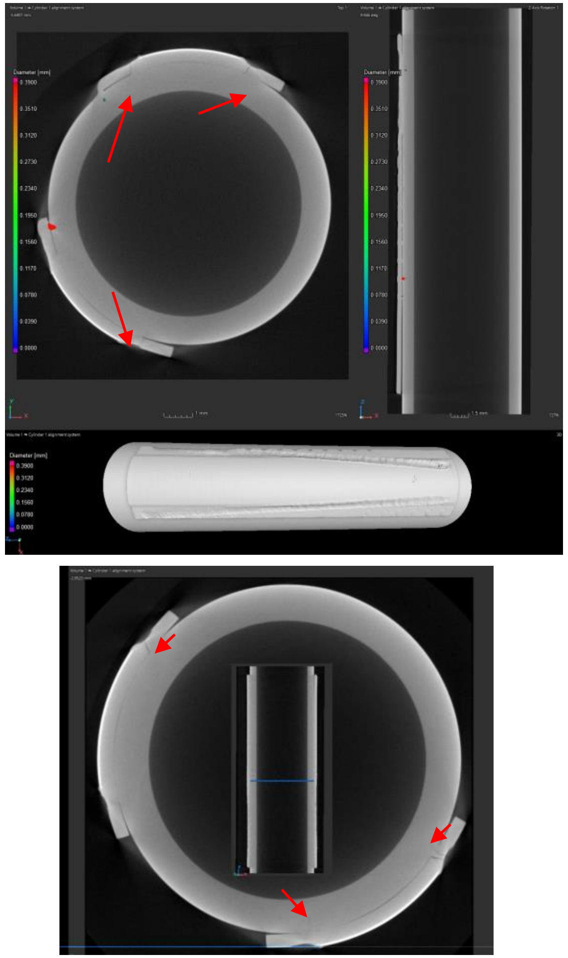
Welds between the cooling tube and the interface plate

Metallography for the thermal link weld qualification

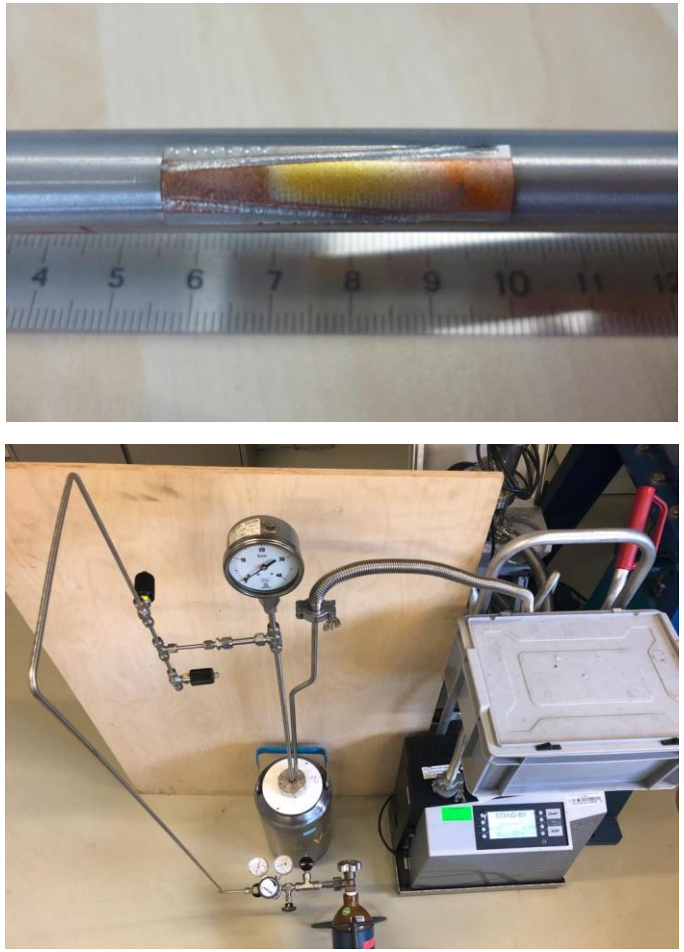
HL-LHC cold vacuum system integration

Beam Screen Assembly

Assessment of a potential non-conformity for the thermal link welding on the cooling tubes:



Tomography of interface plate weld with defects done on purpose

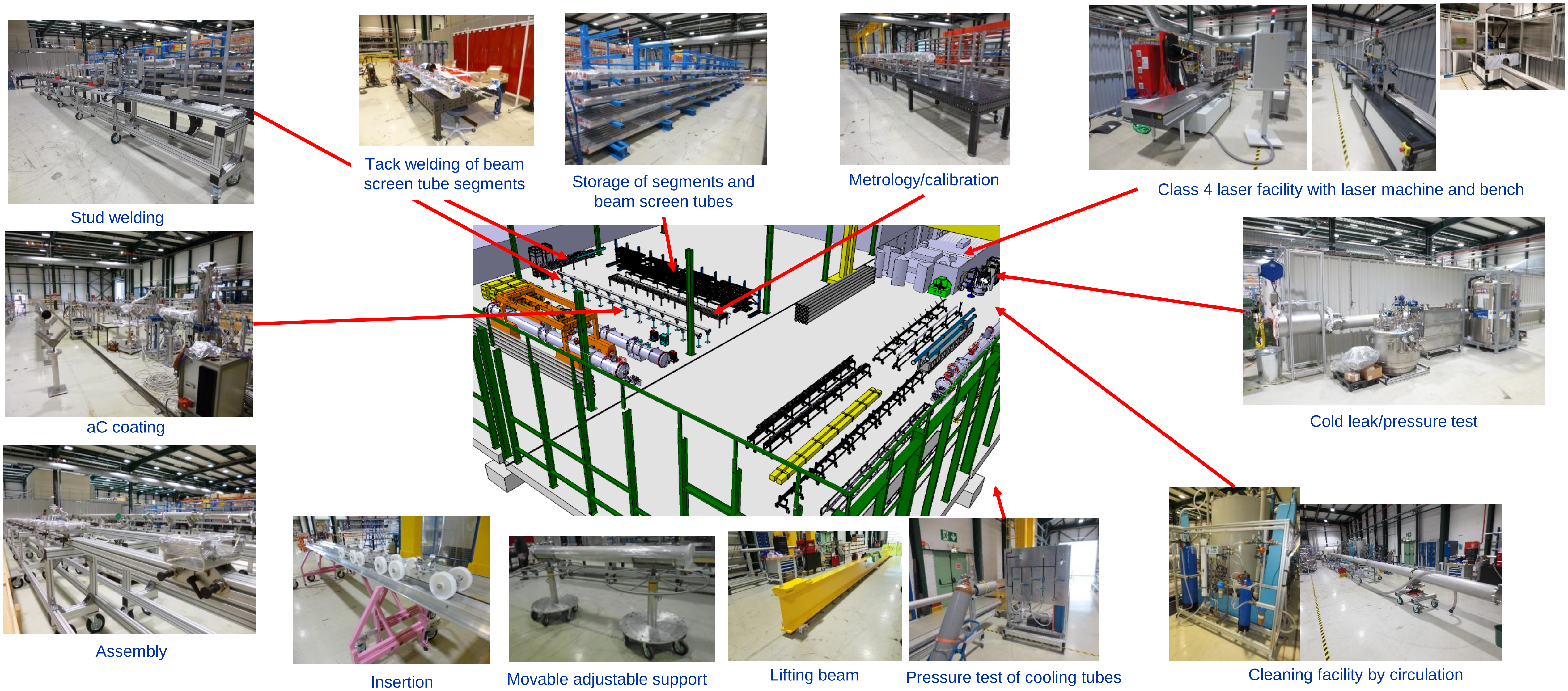


Sample and pressure cycling test set-up

Pressure cycling at room temperature and 77K (3000 + 3000 cycles without sign of leak)

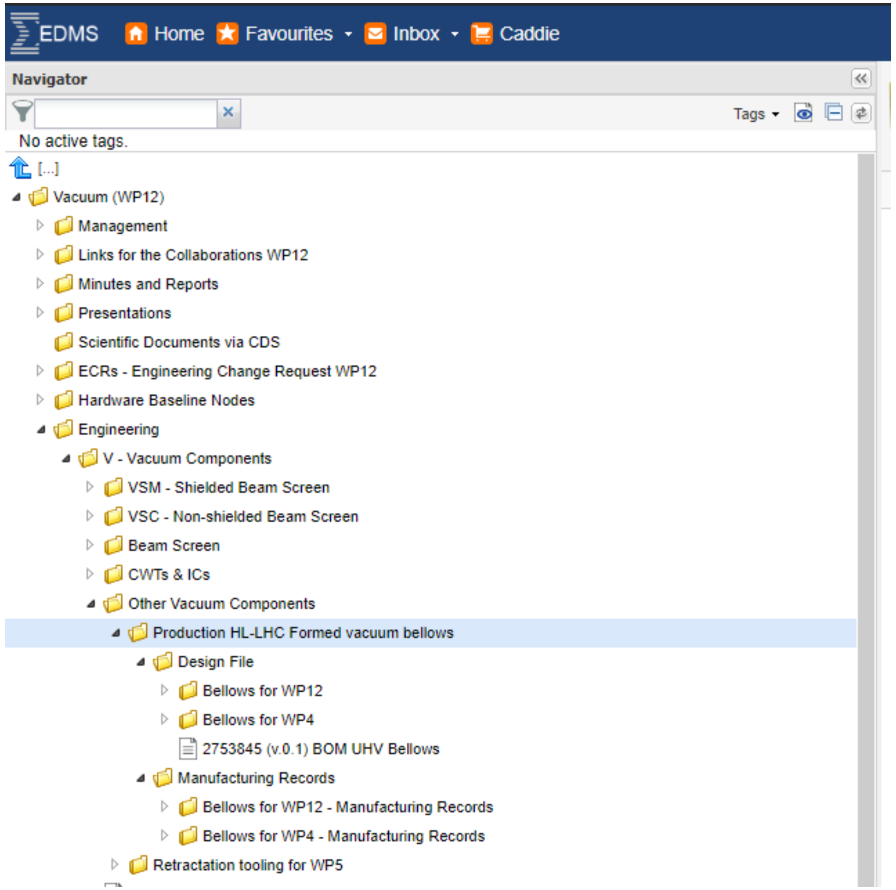
HL-LHC cold vacuum system integration

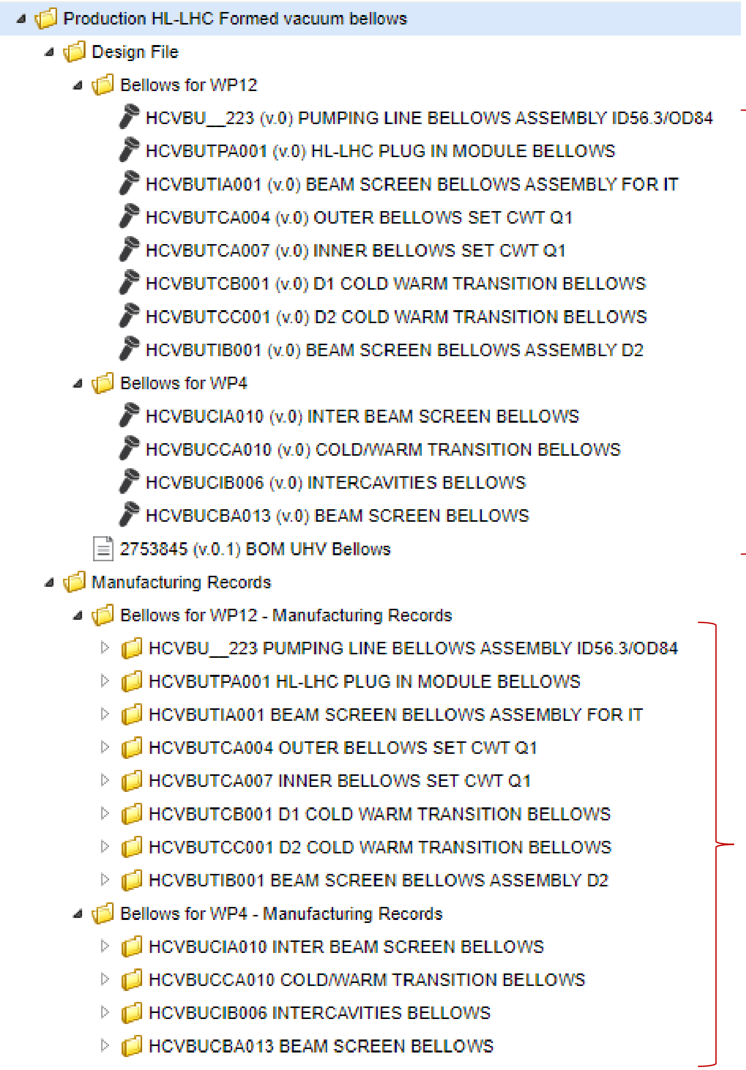
Beam Screen Facility



HL-LHC cold vacuum system quality assurance

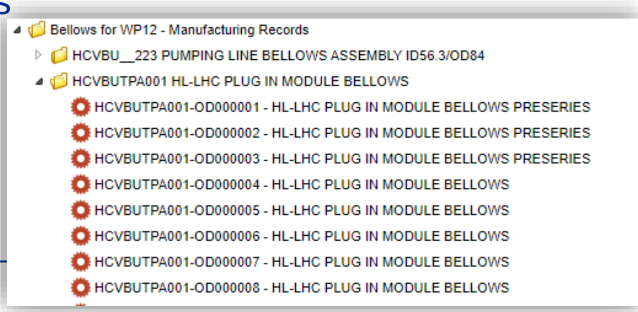
WP12-WP4 UHV Bellows MTF Structure





Items

Assets



HL-LHC cold vacuum system quality assurance

Beam Screens EDMS-MTF Structure

- Vacuum (WP12)
  - Management
  - Links for the Collaborations WP12
  - Minutes and Reports
  - Presentations
  - Scientific Documents via CDS
  - ECRs - Engineering Change Request WP12
  - Hardware Baseline Nodes
  - Engineering
  - Fabrication, Assembly and Verification
    - V - Vacuum Components
      - VSM - Shielded Beam Screen
        - Manufacturing procedures
        - Inspection & test procedures
        - Qualifications
        - Manufacturing records
          - Beam Screens
            - Beam Screen Assembly Before Insertion
            - Beam Screen Tubes
            - Beam Screen segments
            - Beam Screen segments w/o slots
          - Tungsten Shielding and Extremities/Interconnections
          - Beam Screens Cooling Tubes
          - Co-laminated Strips for BS
          - Pumping Slot Shield
          - HCVS___002-X1000001 - HL-LHC Beam Screen cooling tube Ø10
          - HCVS___002-X1000002 - HL-LHC Beam Screen cooling tube Ø10
          - HCVSMSC001-F2000001 - HL-LHC Cold Bore Type Q1/Q3
          - HCVSMSC001-F2000002 - HL-LHC Cold Bore Type Q1/Q3
          - HCVSMSC001-F2000003 - HL-LHC Cold Bore Type Q1/Q3
          - HCVSMSC001-F2000004 - HL-LHC Cold Bore Type Q1/Q3
          - HCVSMSC001-F2000005 - HL-LHC Cold Bore Type Q1/Q3
          - HCVSMSC001-F2000006 - HL-LHC Cold Bore Type Q1/Q3
          - HCVSMSC001-F2000007 - HL-LHC Cold Bore Type Q1/Q3
          - HCVSMSC001-F2000008 - HL-LHC Cold Bore Type Q1/Q3

Tungsten Absorbers

- MTF

Equipment Identifier: **HCVSMSL002-MZ000455**
Other Identifier: None
Description: **TUNGSTEN SHIELDING [6mm]**

Main | Made of | Equipment data | Manufacturing | Operation | Documents | History | Map

Actions : Add extra step

Workflow Diagram

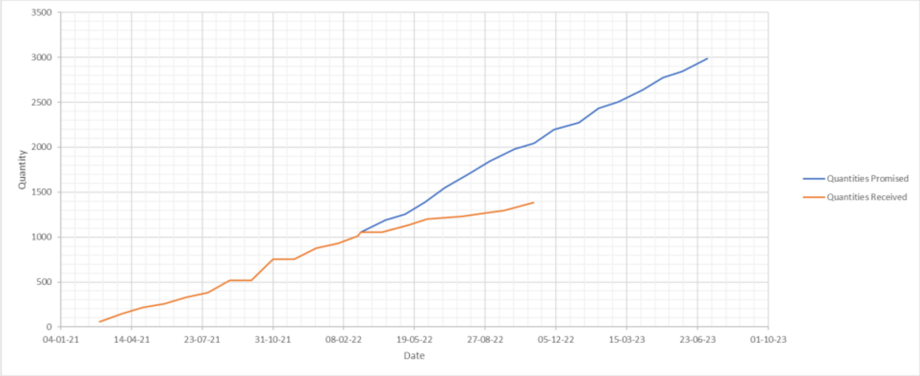
No workflow diagram is defined for this equipment

Workflow Steps — Last Repeated

Step	R/E	Other name	Description	Status	Result	NC
10		()	Certificate of Conformity	Done	Ok	
20		()	Cleaning at CERN (*)	Done	Ok	
30		()	Vacuum testing	Done	Ok	

- Delivery

Quantity delivered by 12/2022: 1383 parts



In work: Interconnections EDMS/MTF Structure
BOM -> Done

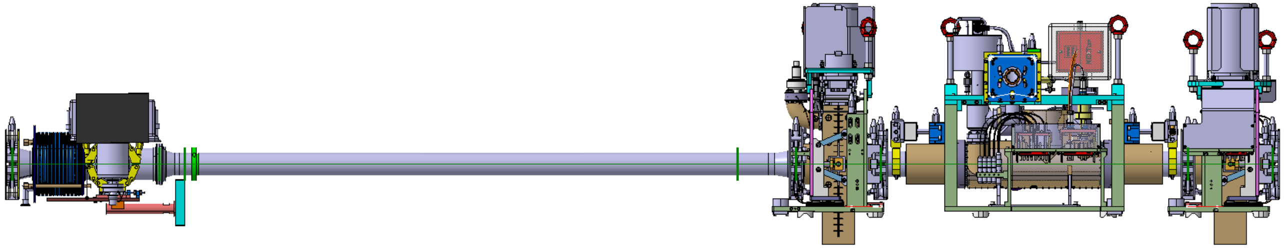
HL-LHC VAX area design

ATLAS and CMS layouts

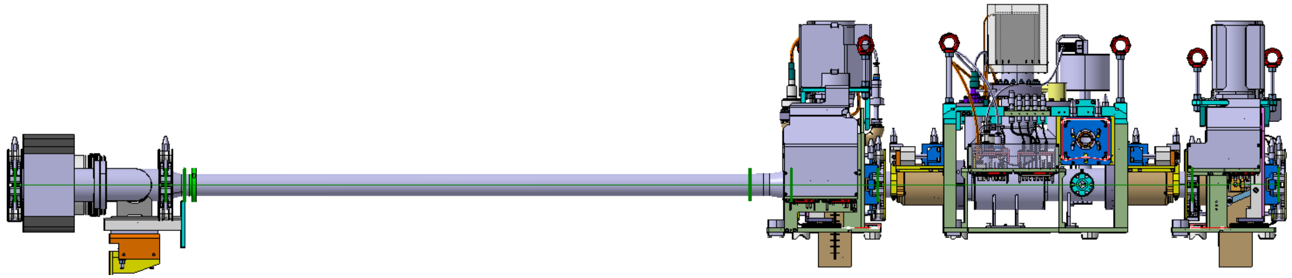
Q1 side

Modules 1+2+3

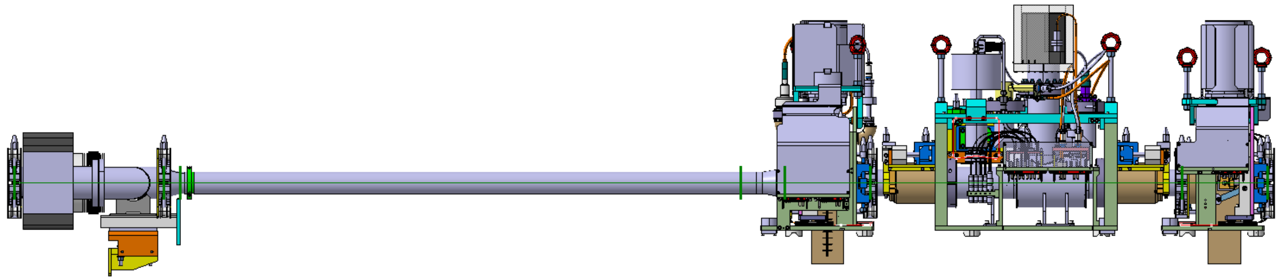
Layout LSS5R
Layout LSS5L



Layout LSS1R



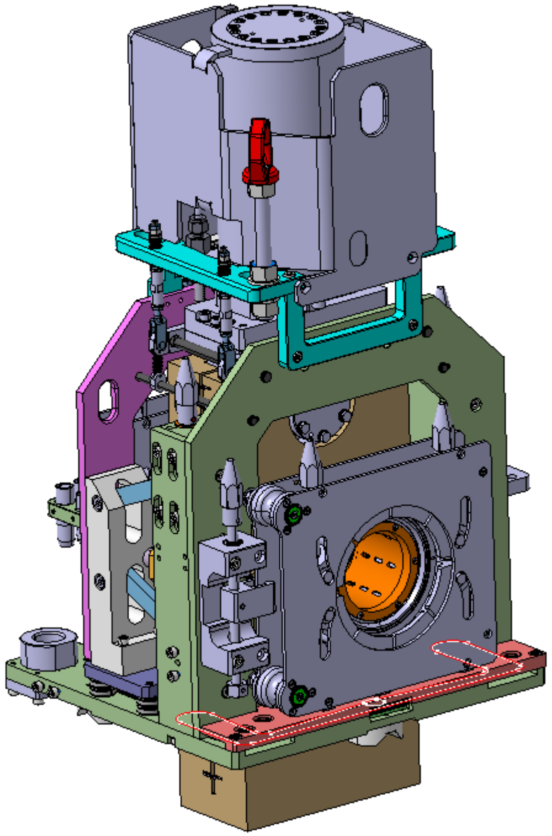
Layout LSS1L



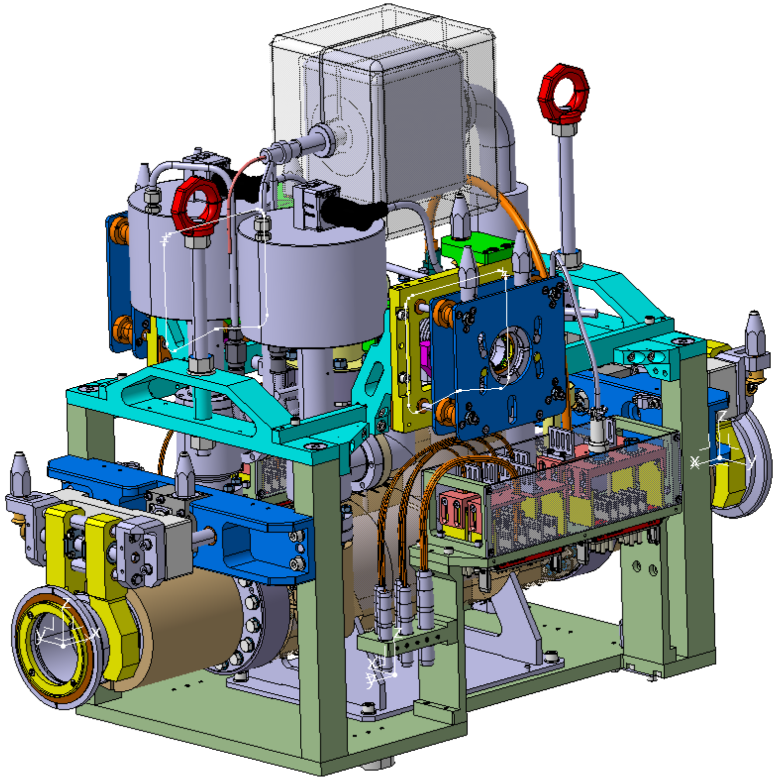
HL-LHC VAX area design

Module design

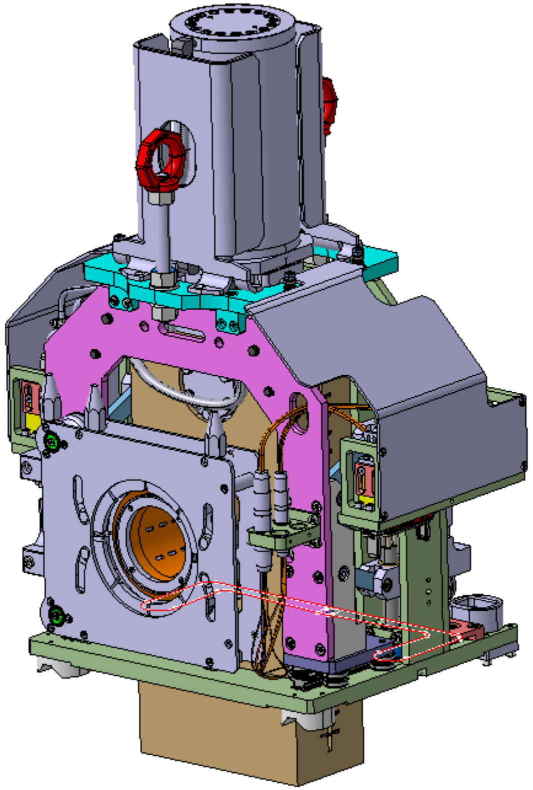
Module 1



Module 2

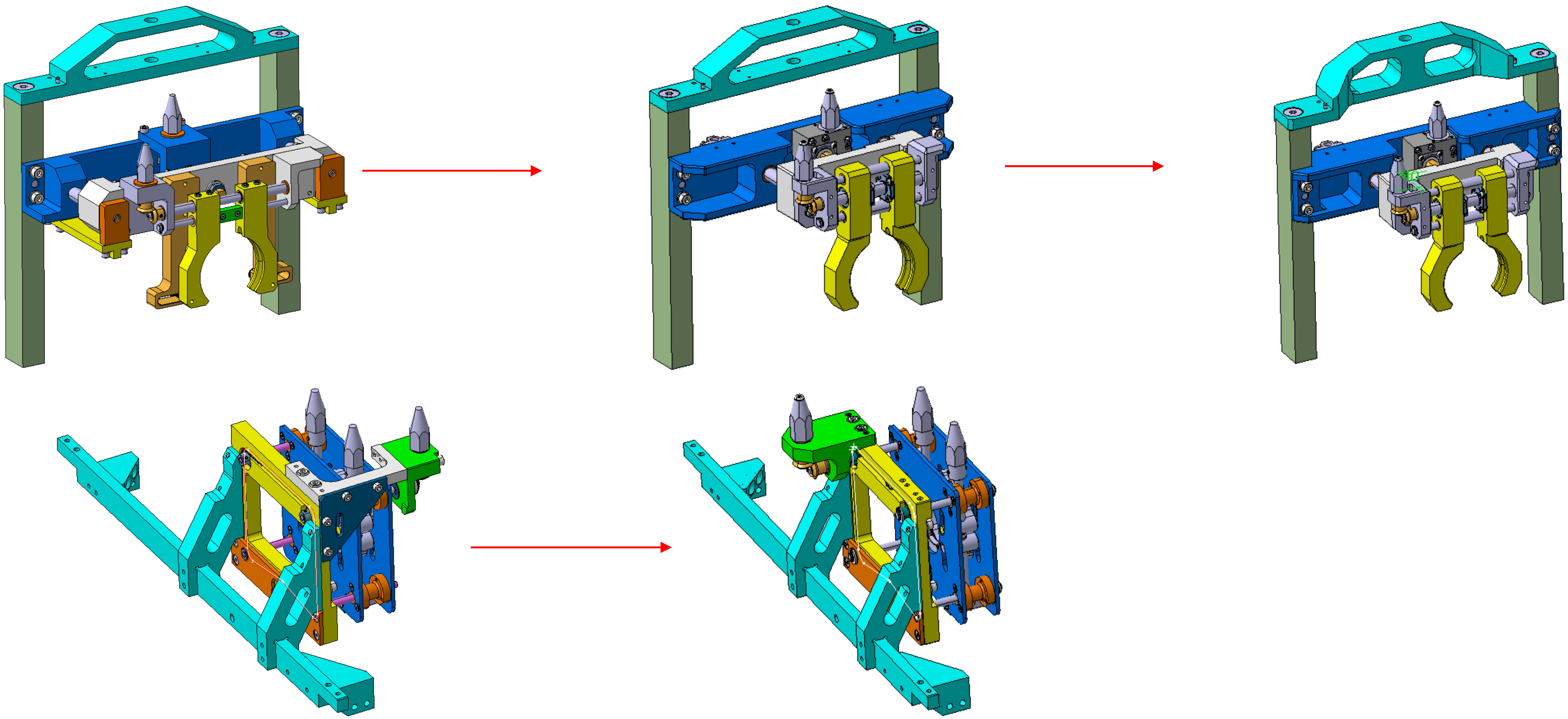


Module 3



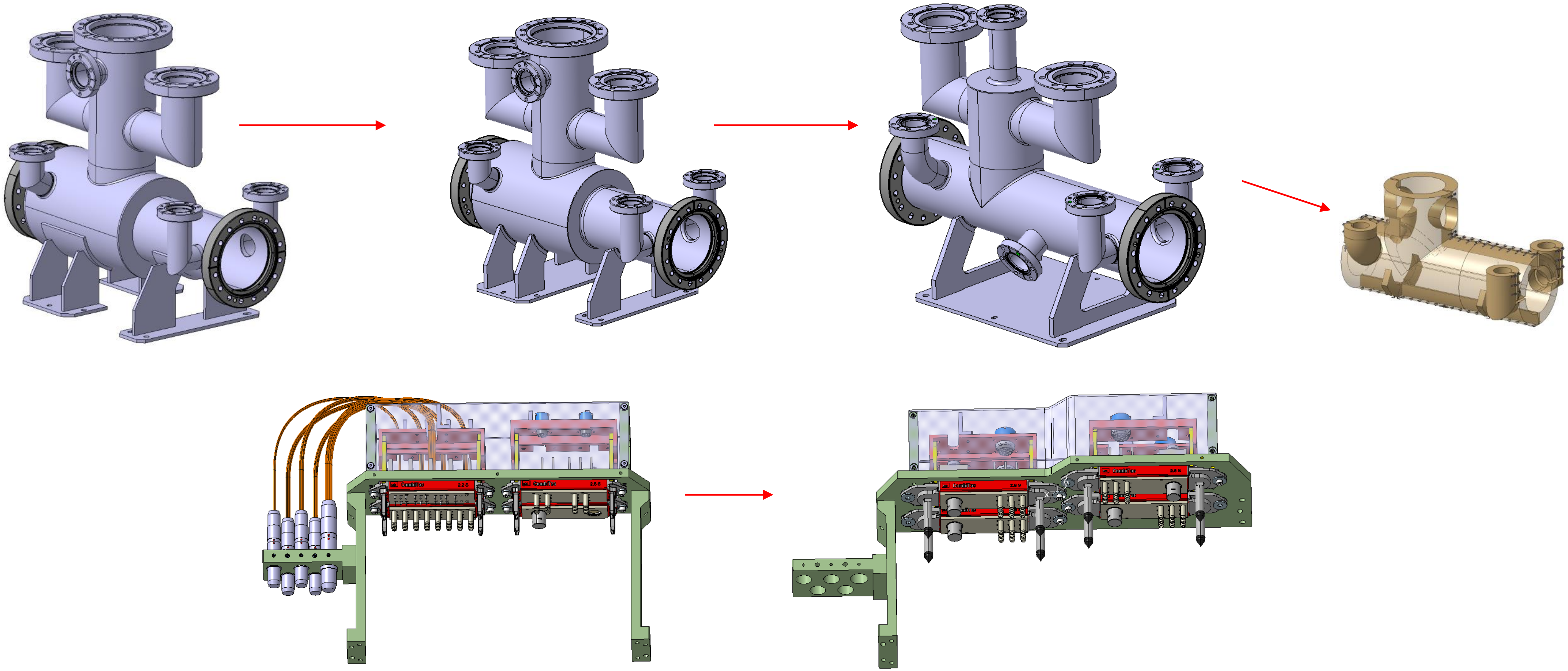
HL-LHC VAX area design

Simplification and update of technical design



HL-LHC VAX area design

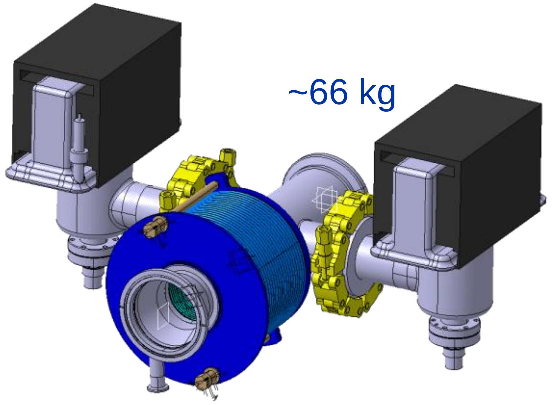
Simplification and update of technical design



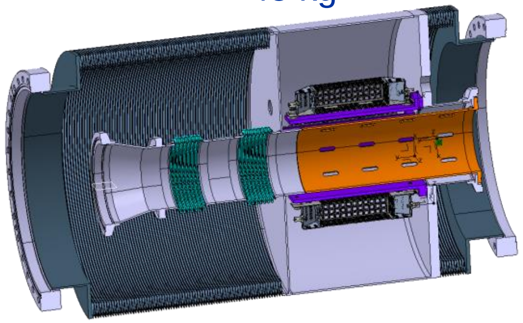
HL-LHC VAX area design

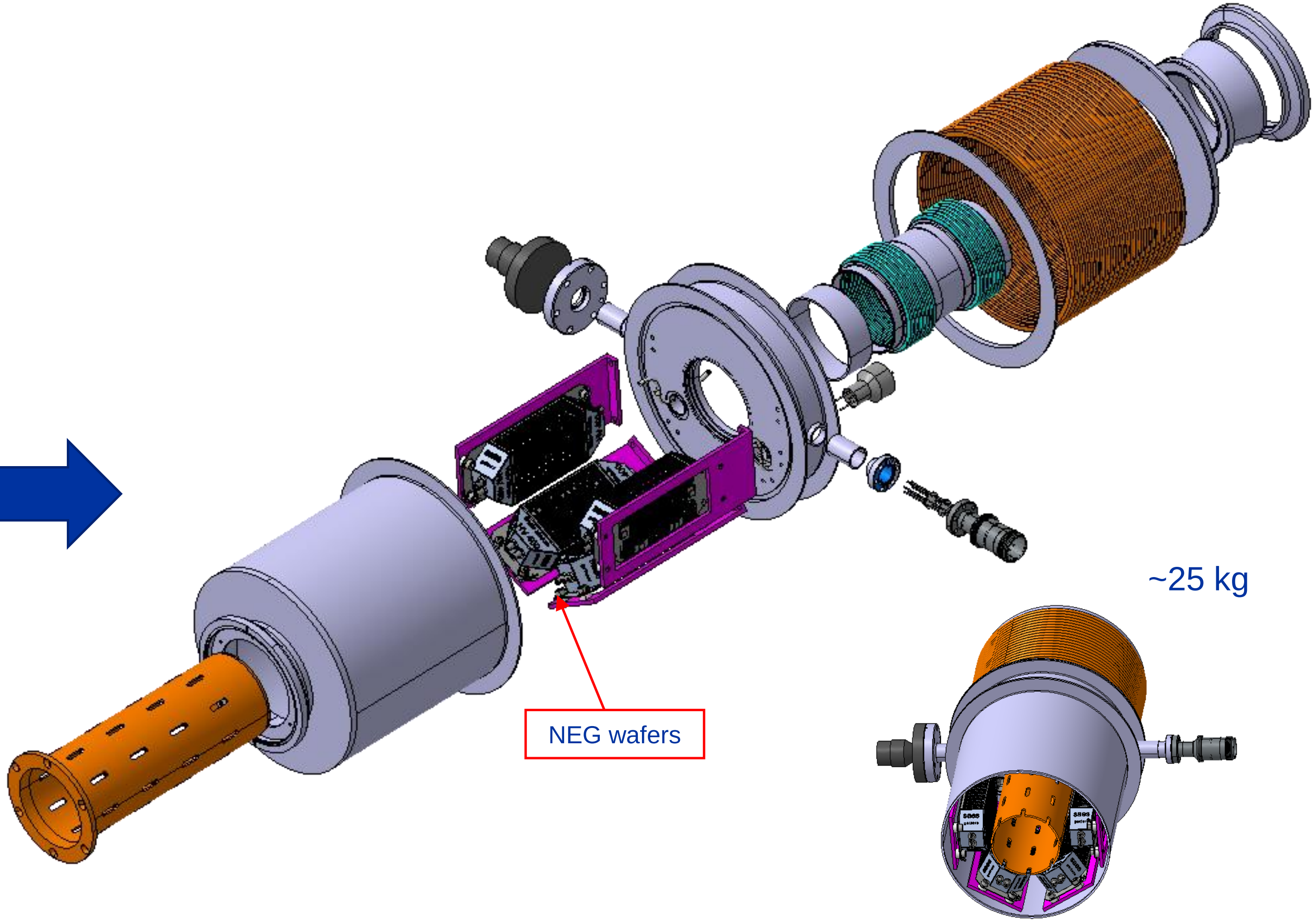
Simplification and update of technical design

~66 kg



~45 kg

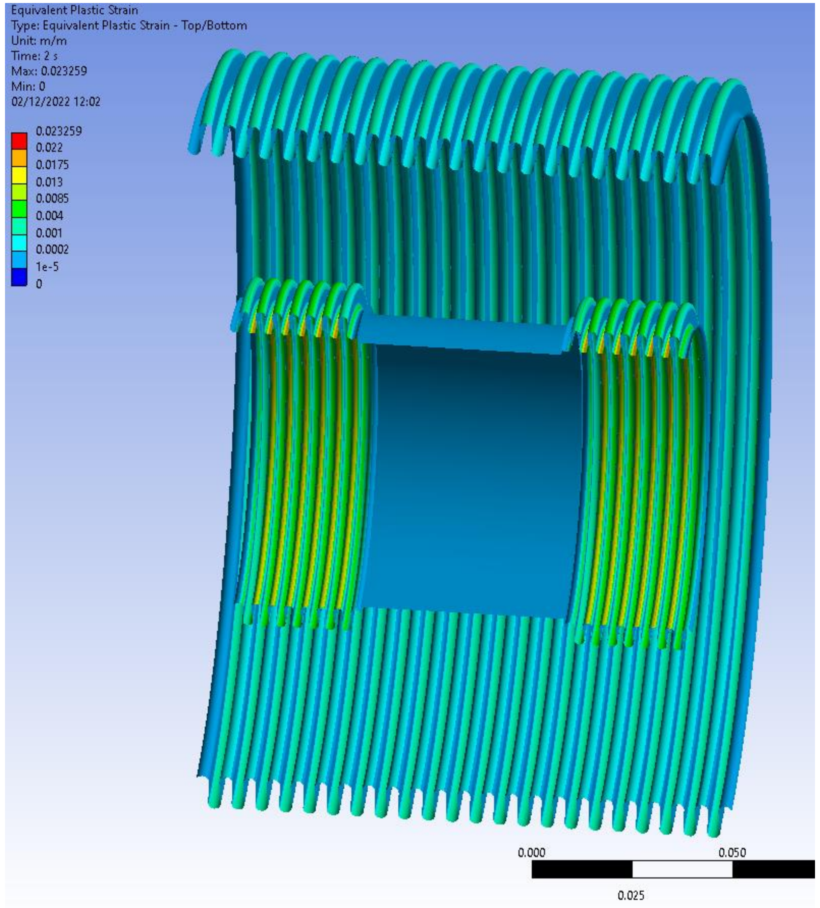


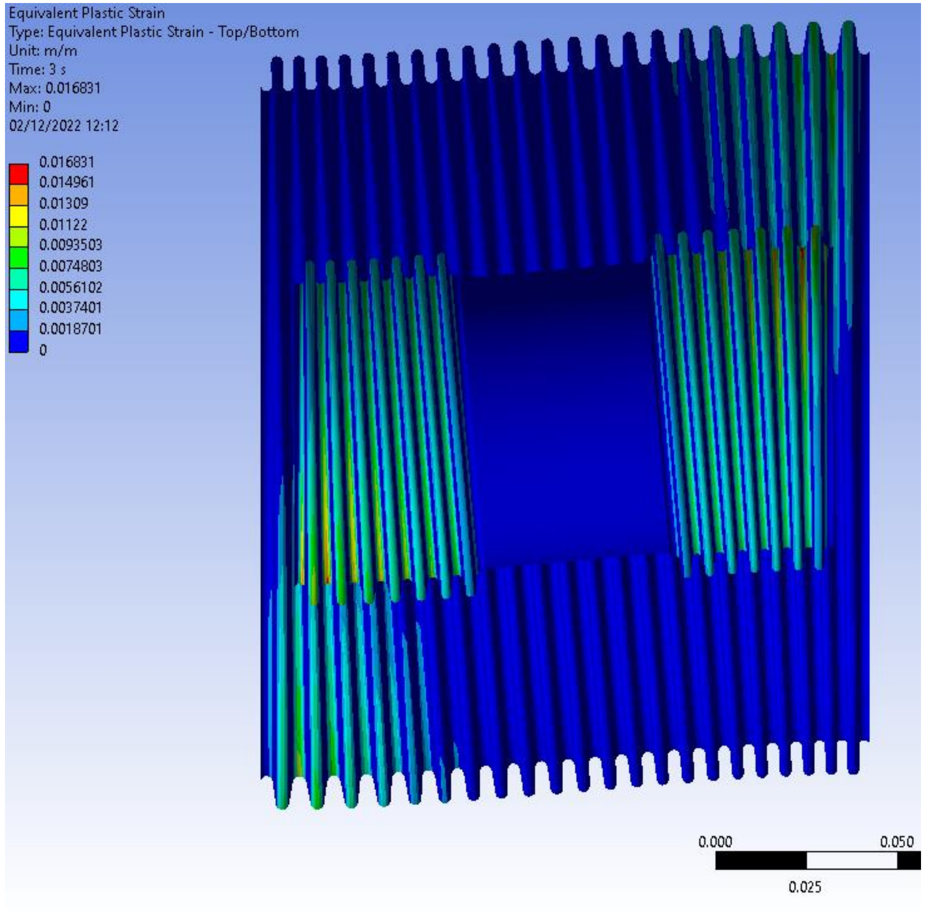


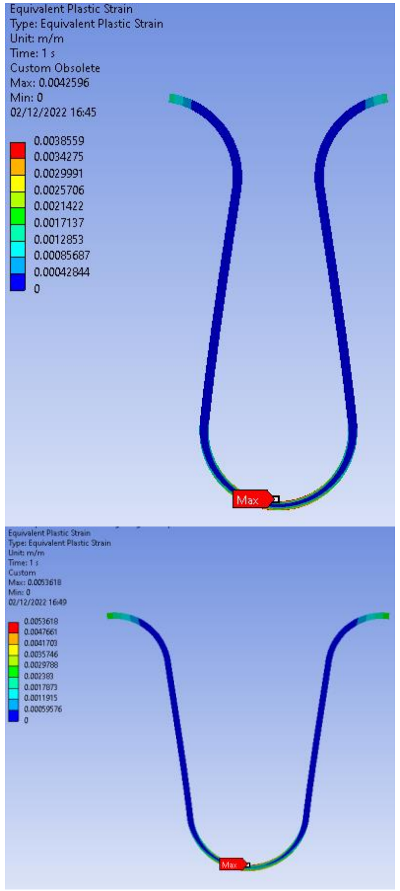
Q1 – TAXS module: evolutions 2022. Use of NEG SAES wafers. Integration details under discussion

HL-LHC VAX area design

Compensation system study



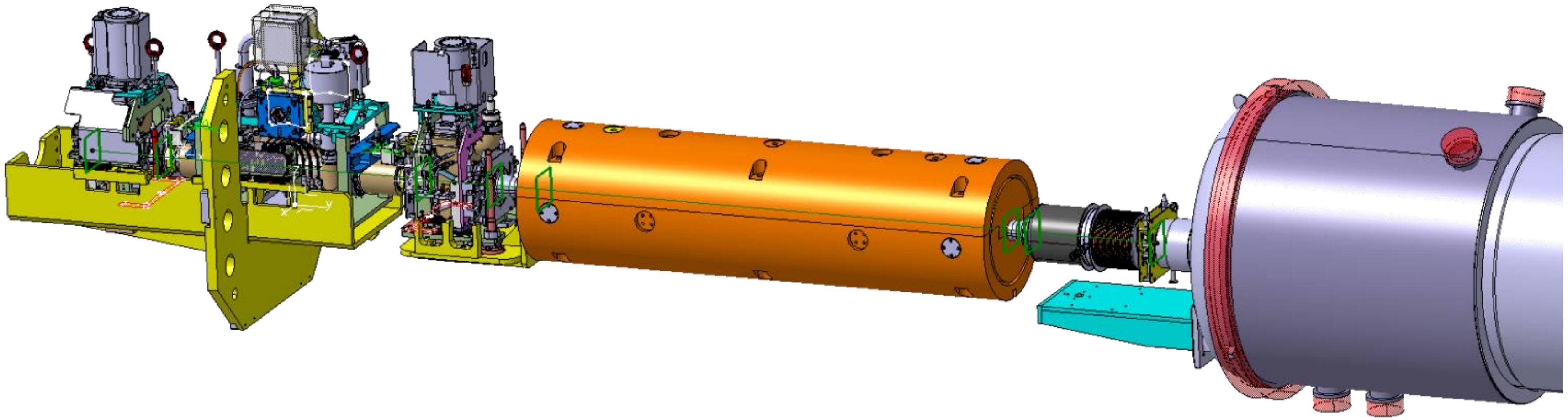


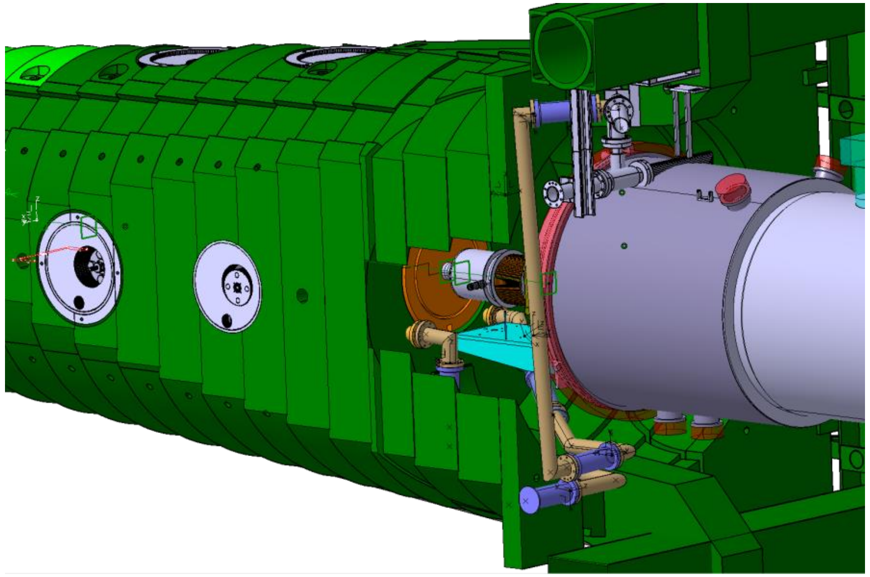


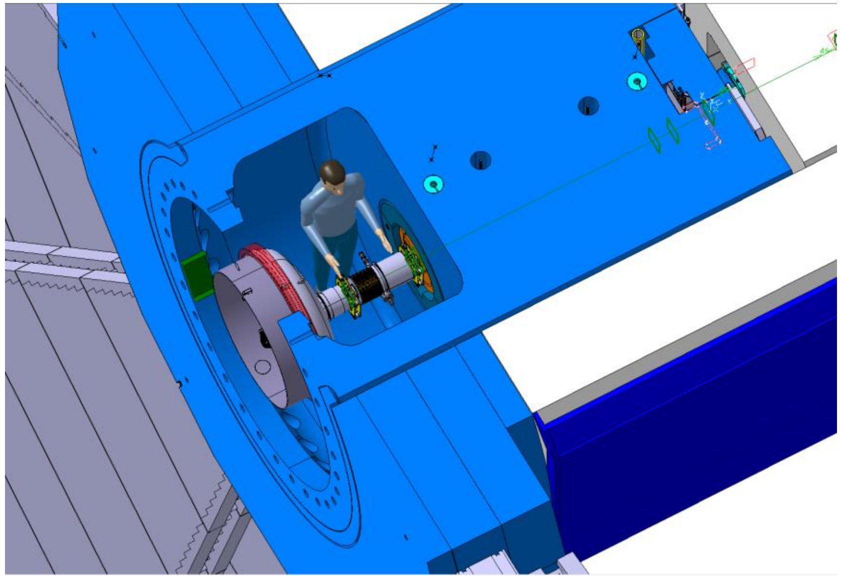
FEM analysis UEJ bellow and Q1-TAXS double bellow system.

HL-LHC VAX area design

Integration study





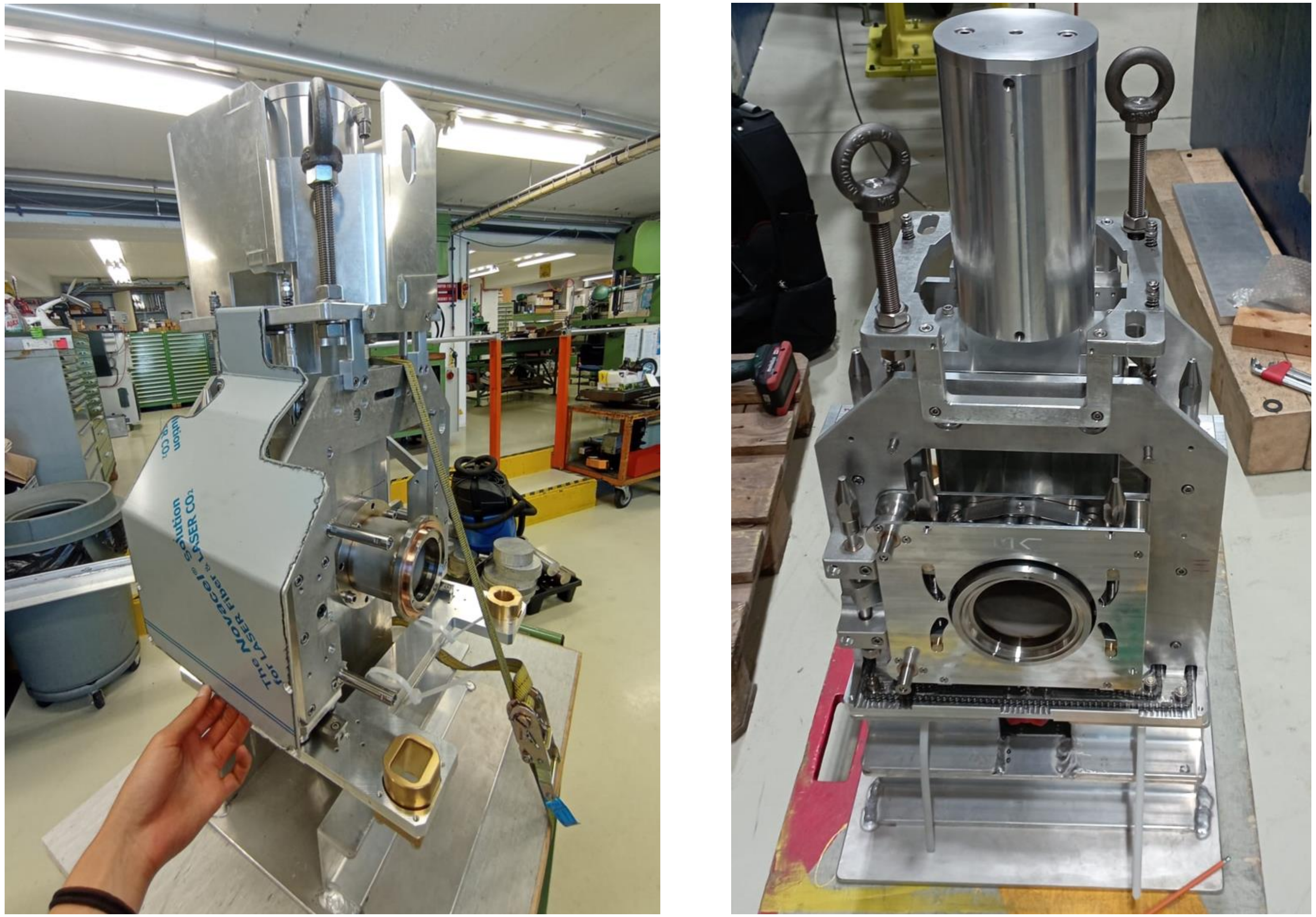


Integration of new Q1-TAXS model

HL-LHC VAX area design

Module prototyping

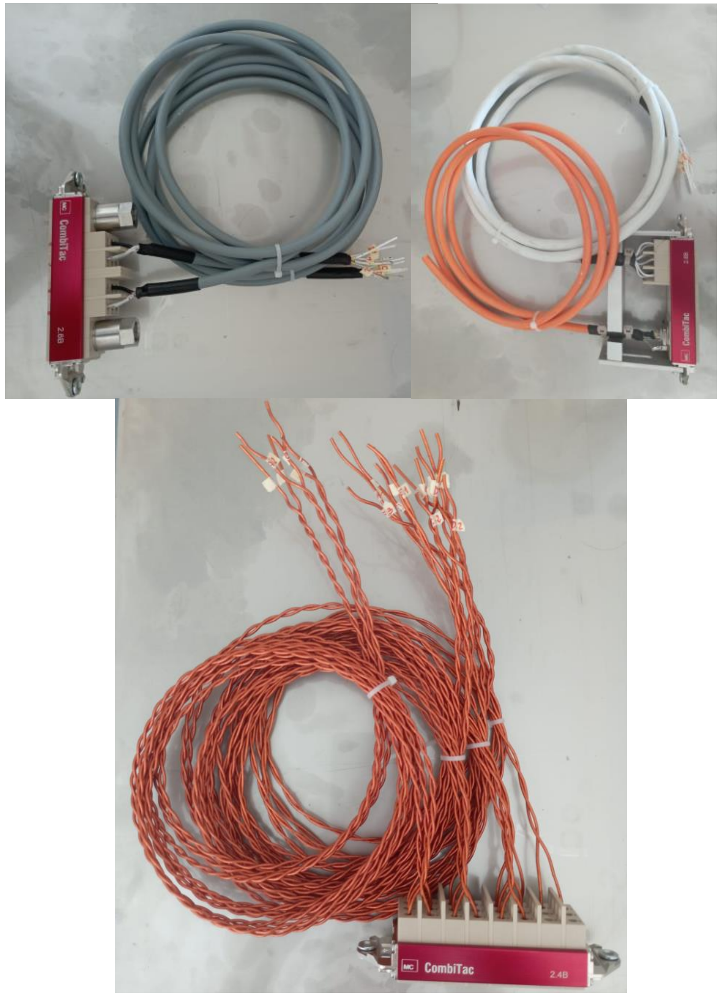
Reception and assembly of vacuum parts for final proto M1 and M3

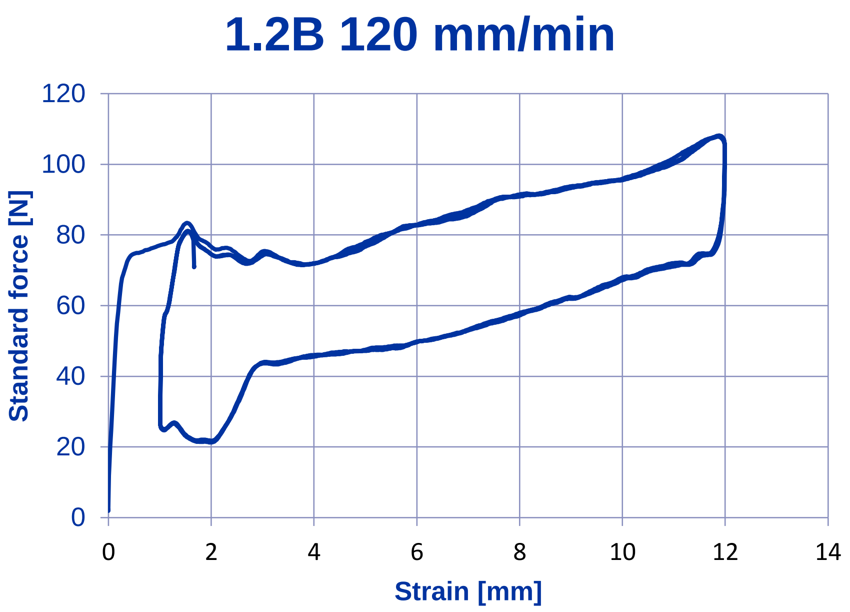


Assembly of M1 proto – final version. New valve supporting system.

HL-LHC VAX area design

Module prototyping





Cabling of female staublis (VAX support), installation of support tooling and measuring the force needed for connection of the pneumatic lines

HL-LHC VAX area design

Integration tests

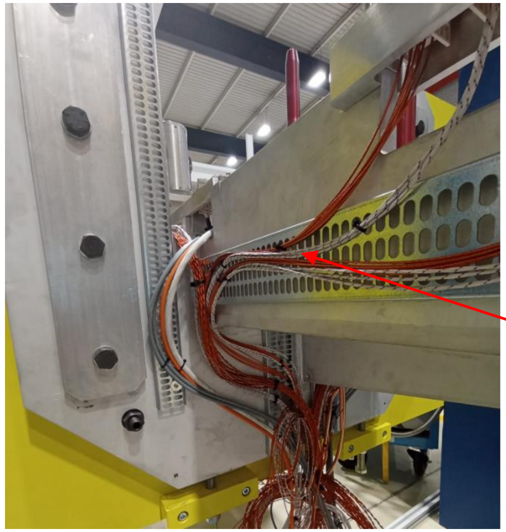
Tests mock-up in Prevessin site

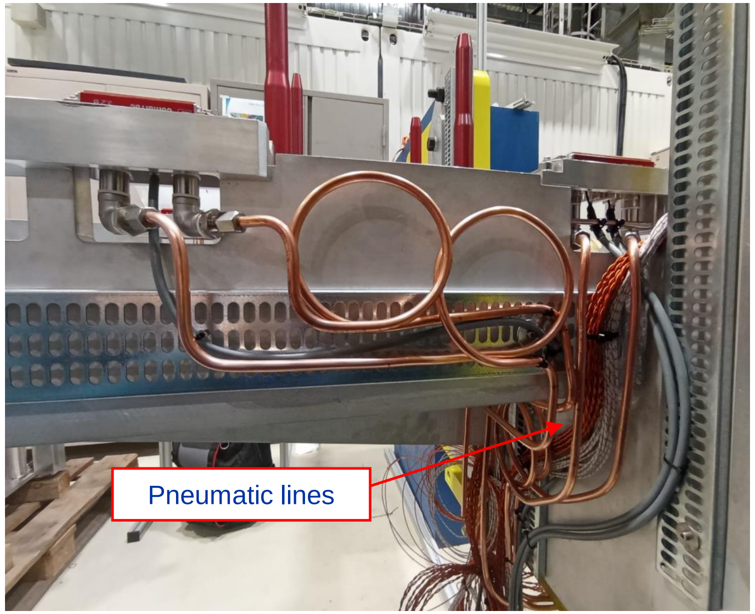
Temporary integration of pumping lines in mock-up. Adjustable system.

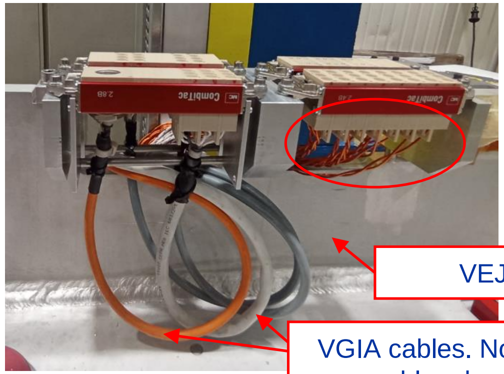
HL-LHC VAX area design

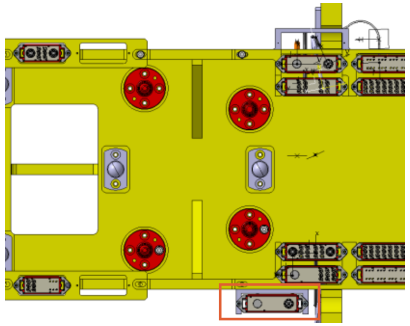
Integration tests

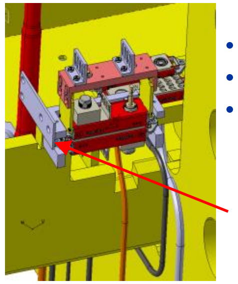
First tests of cables routing on support, for VAX modules 2 & 3, CMS









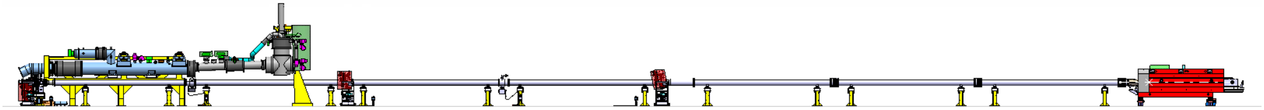


- Studies ongoing.
- New position for Penning cable.
- Symmetric solution for VGIA may be necessary.

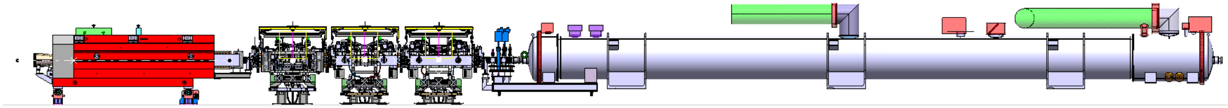
HL-LHC warm vacuum system

3D models of the vacuum layouts

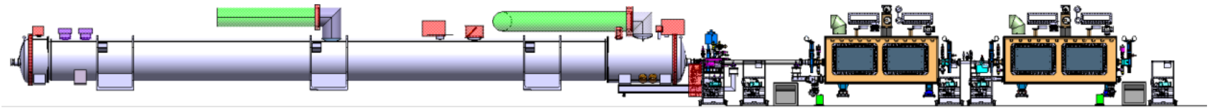
D1 / TAXN



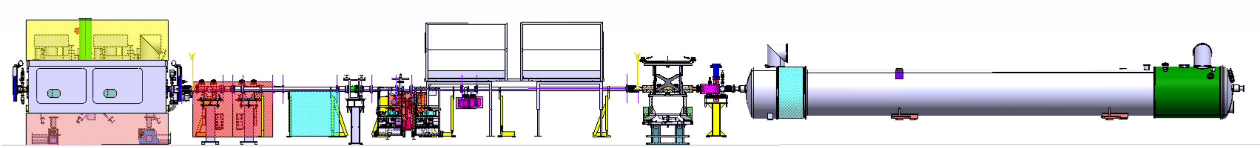
TAXN / D2



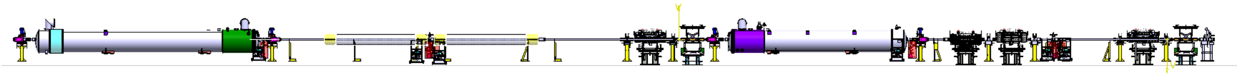
D2 / CRAB



CRAB / Q4



Q4 / Q6

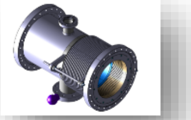


HL-LHC warm vacuum system

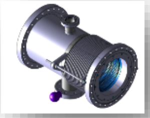
Design of the warm modules

Ø150

Ø150 VMBNNCCL

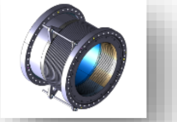


Ø150 VMDNNCCL

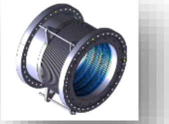


Ø250

Ø250 VMBRREEA

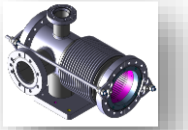


Ø250 VMERREEA

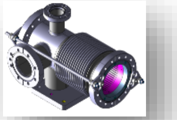


Ø90

Ø90 VMBLKAAI

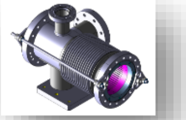


Ø90 VMBLKAAK



Ø90 VMBKKAAI

Ø90 VMBKKAAK



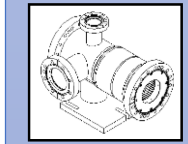
Ø63 DRF

Ø63 VMDFFAAI DRF

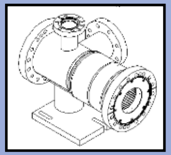
Ø63 VMDFFAAK DRF

Ø63 RF

LHCVMABC0002

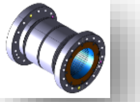


LHCVMABD0001



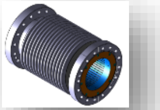
Ø90/80 RF

Ø90/80 VMBKIAAA200



Ø80 LRM

Ø80 VMVIIAAA



Ø80/63 LRM

Ø80/63 VMVIFAAA

DOUBLE MODULE Ø80/63

Ø80/63 double VMQIFFAN

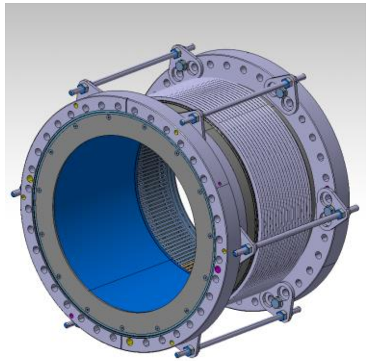
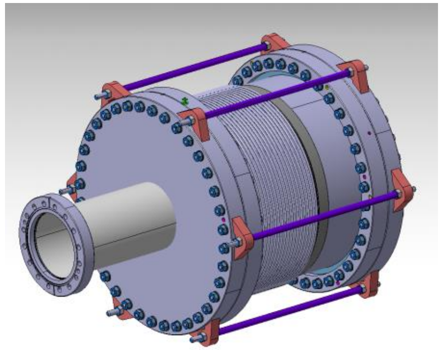
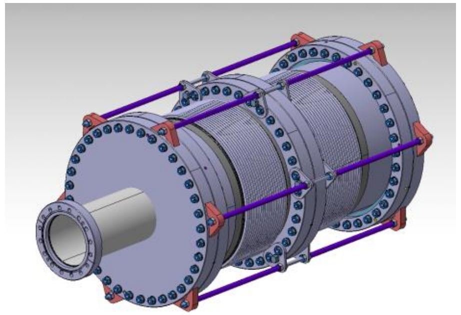
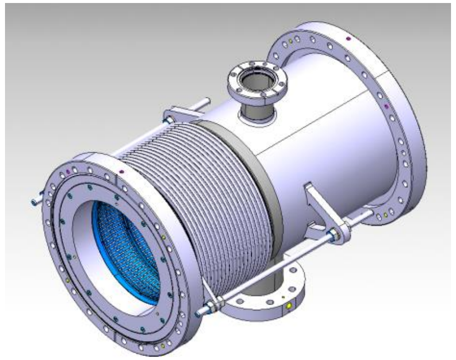
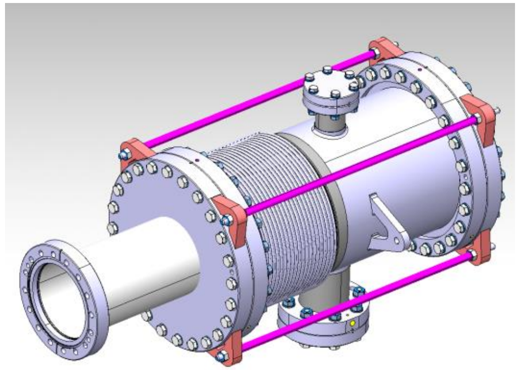
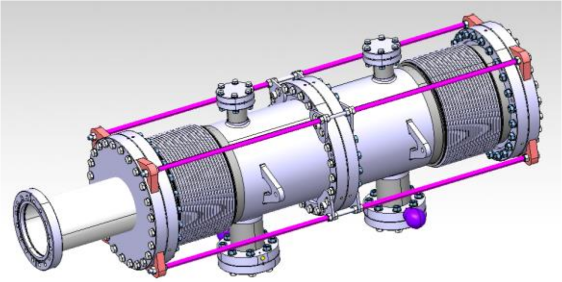
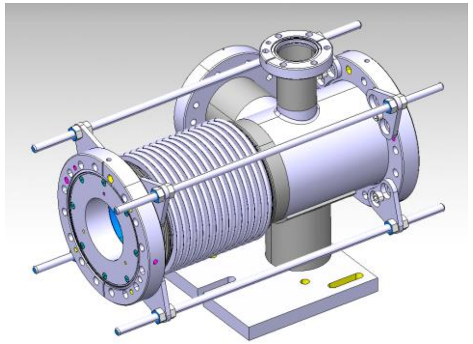
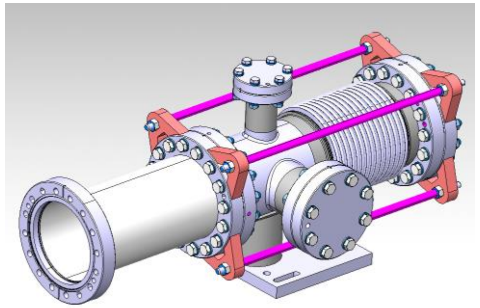
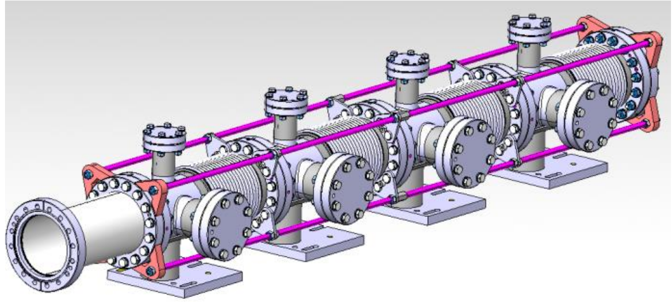
Ø63 LRM

Ø63 VMVFFAAI LRM

Ø63 VMVFFAAK LRM

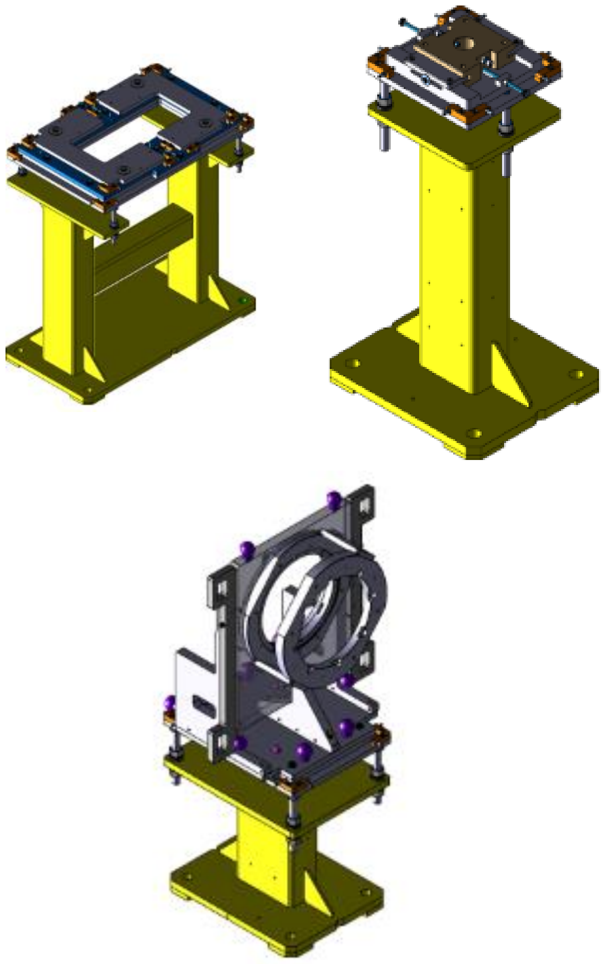
HL-LHC warm vacuum system

Design of the warm module supports for storage

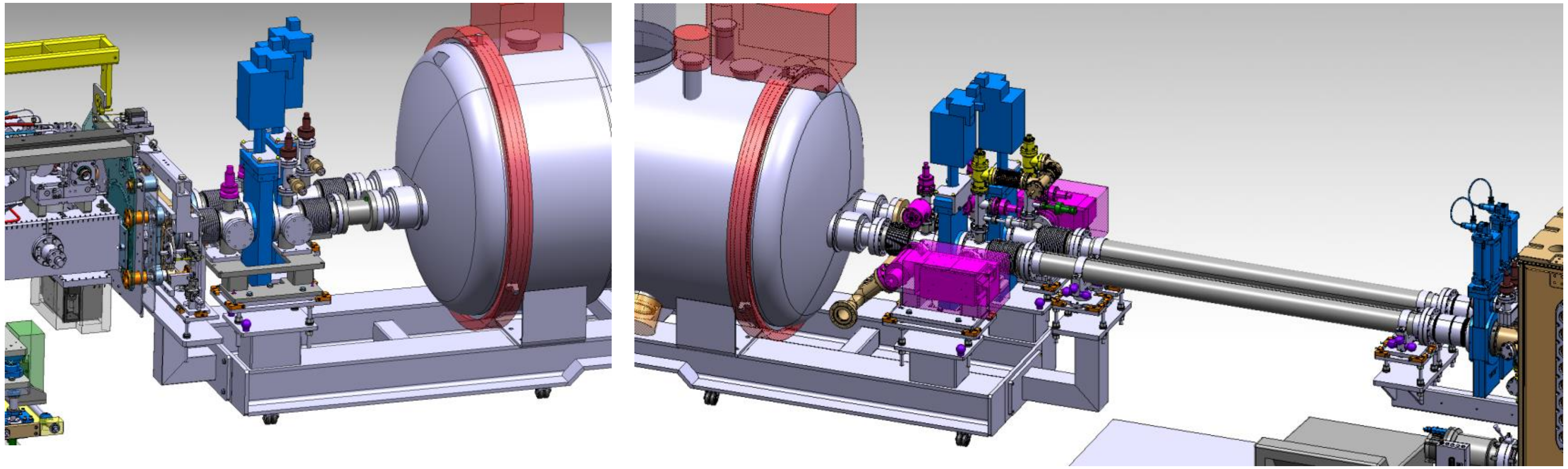










HL-LHC warm vacuum system

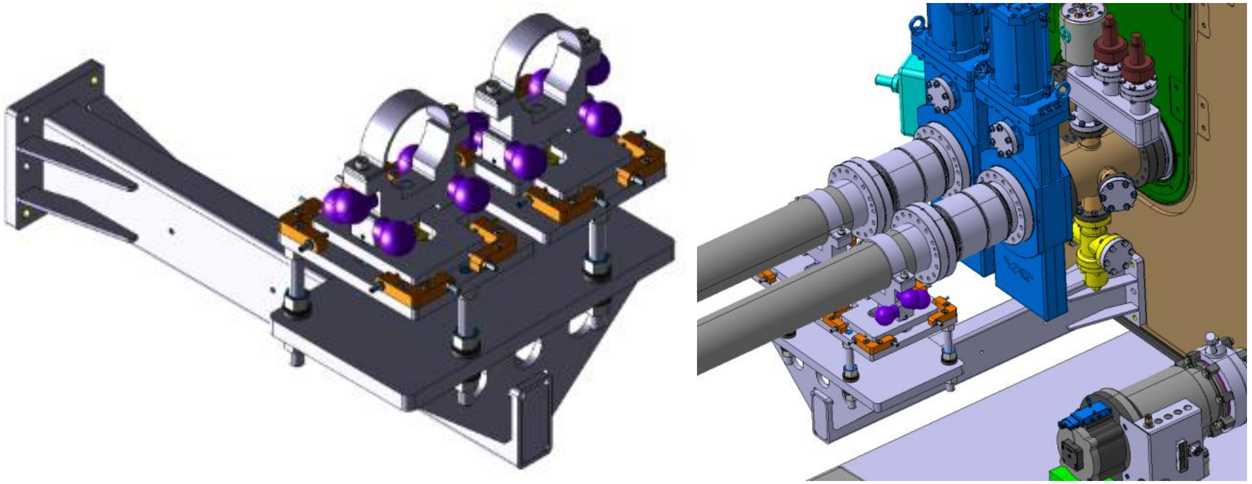
Design of the supports



Vacuum chamber supports



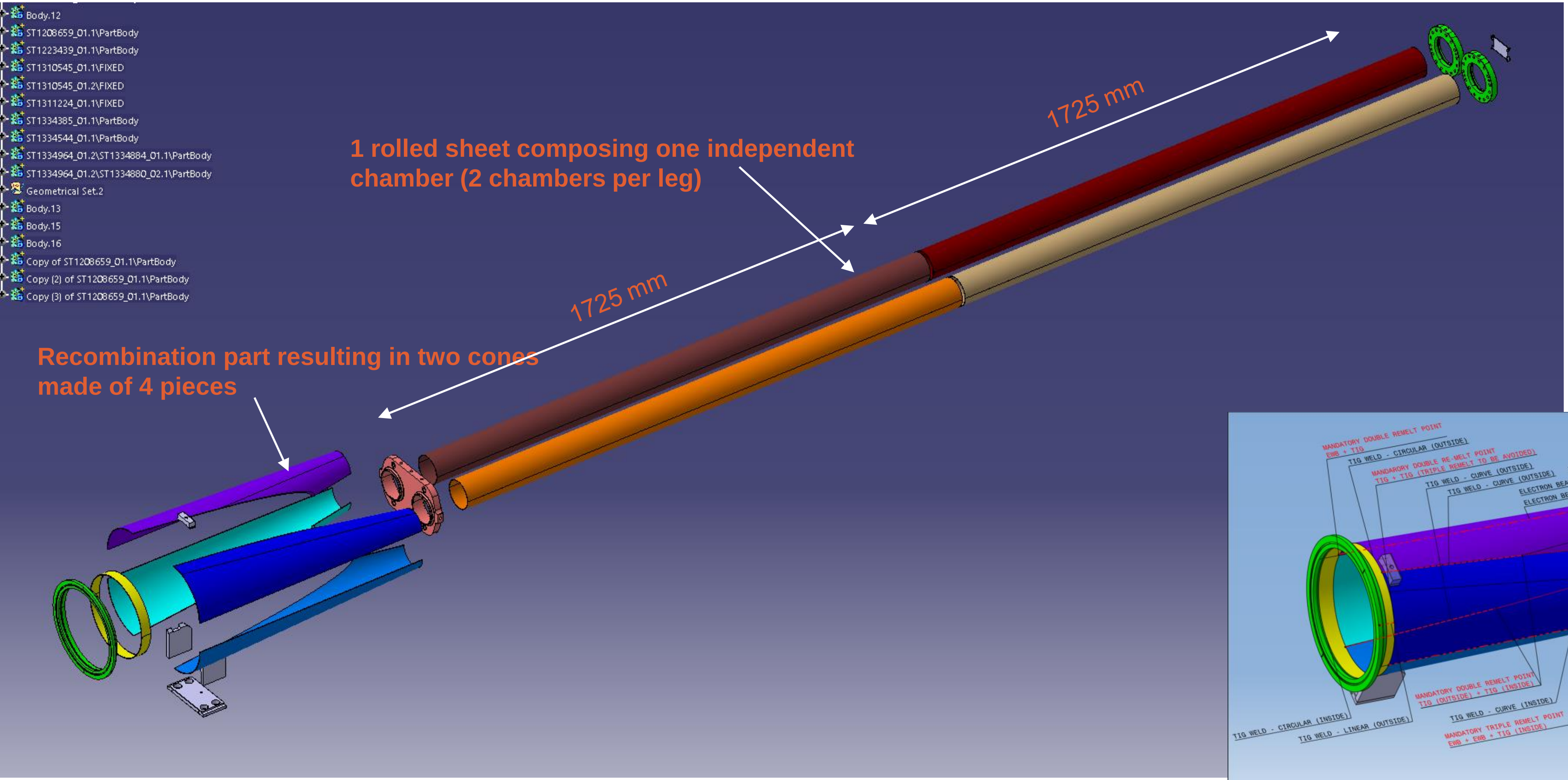
Valve module supports for D2



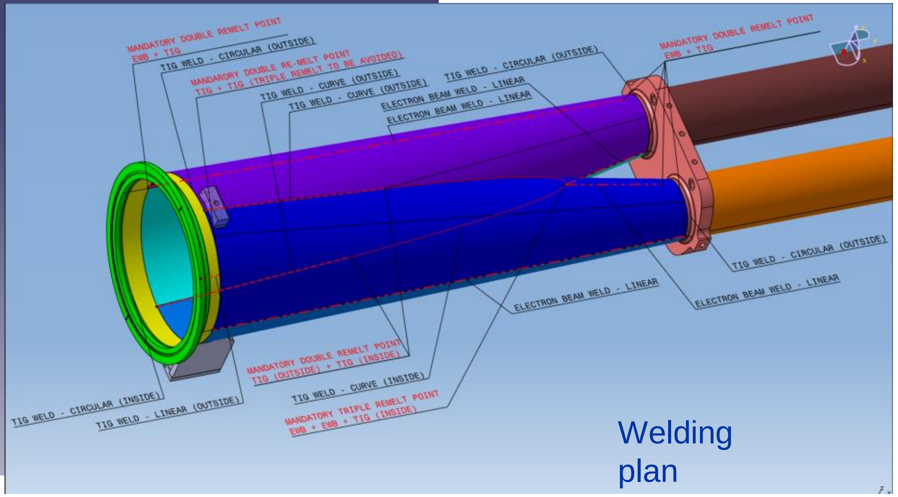
Valve module supports for the crab cavities

HL-LHC warm vacuum system

Recombination chamber

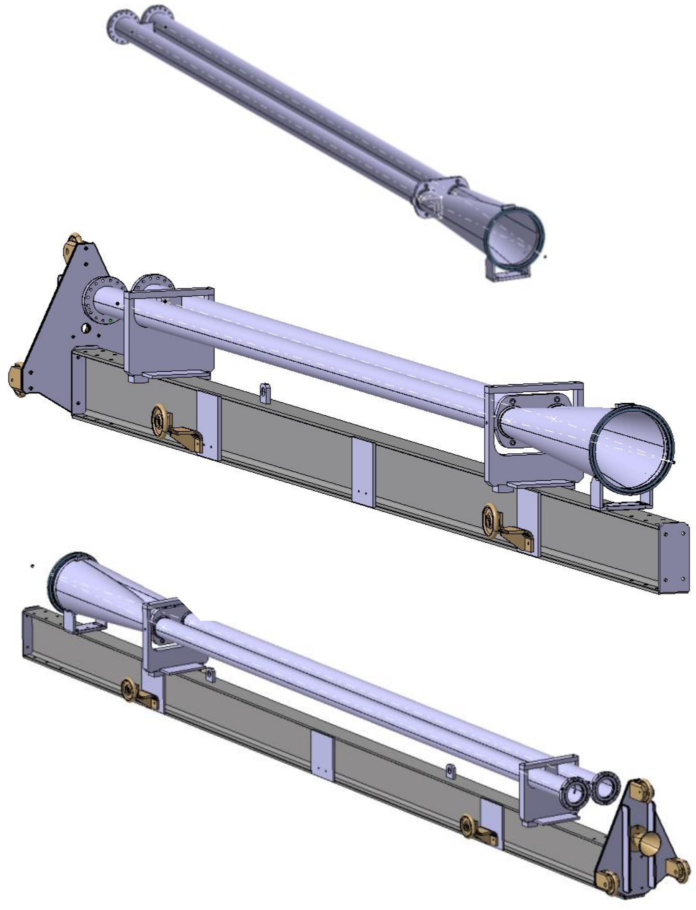


Production plan definition + welding plan

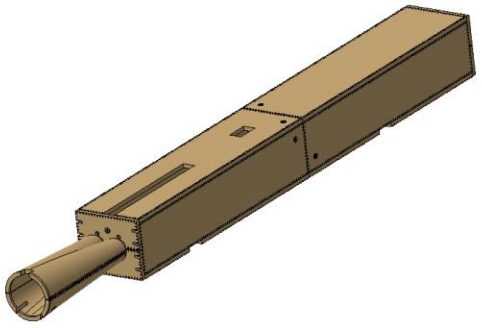


HL-LHC warm vacuum system

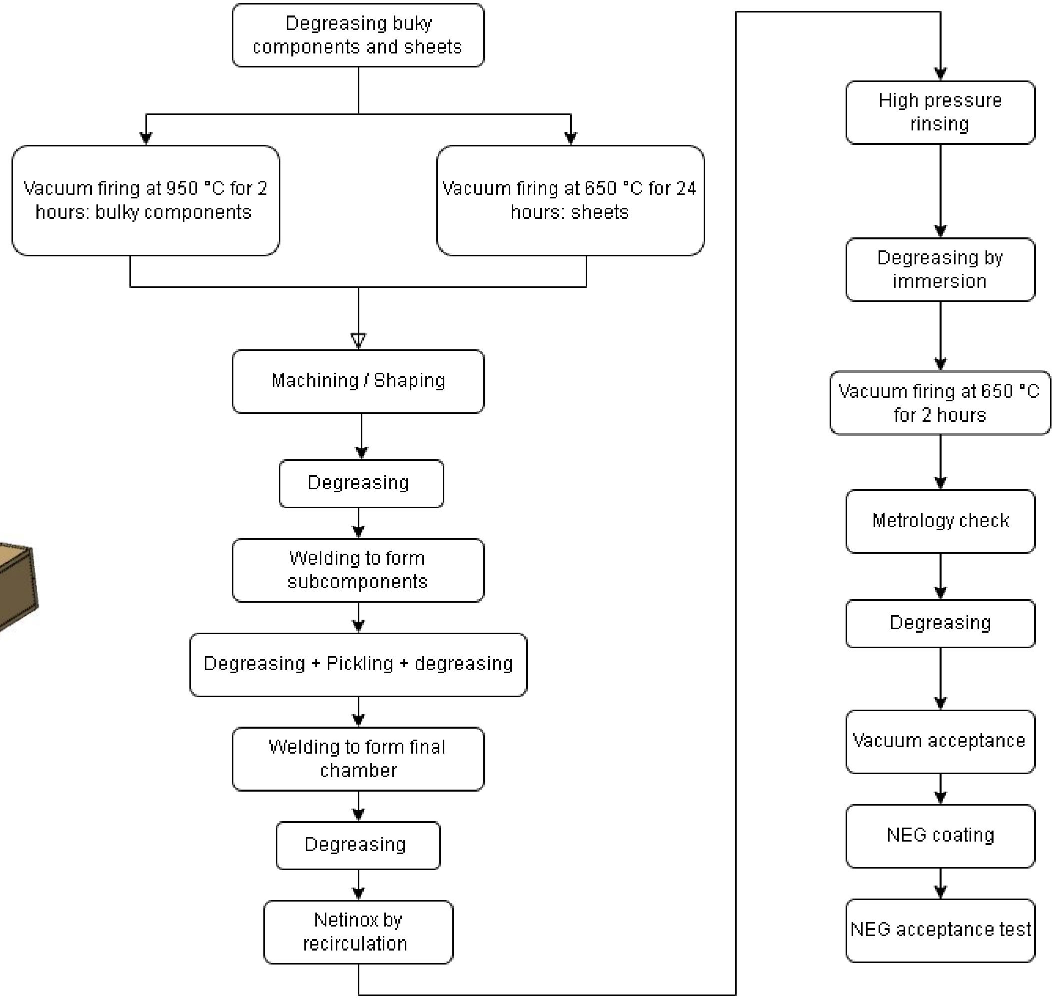
Recombination chamber



Supporting beam for NEG coating, cleaning, handling and storing.



Heating jacket



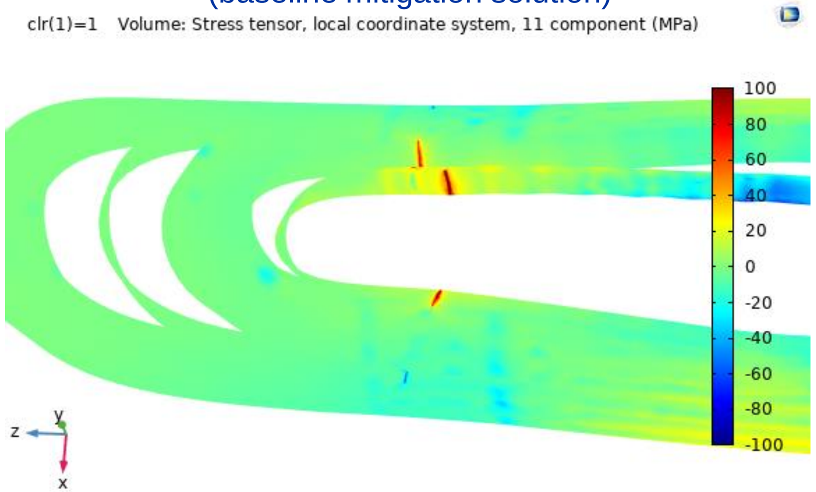
Processing steps for the recombination chamber

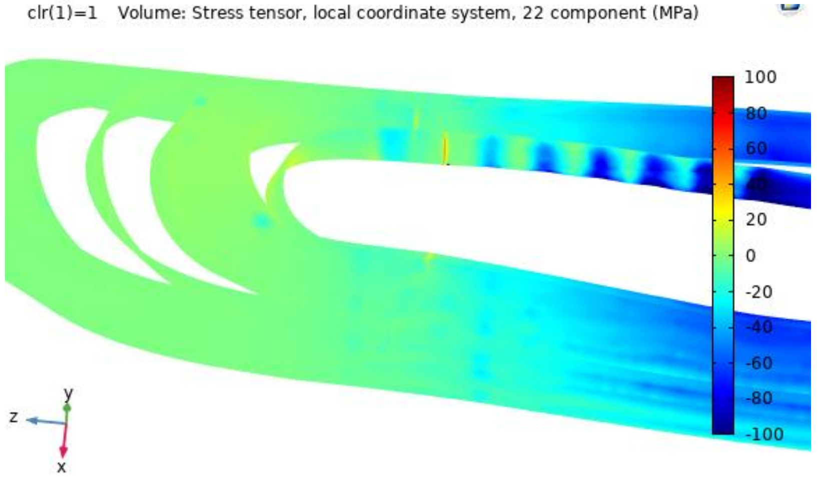
11 T magnet

Shimming schemes tested in the 11 T model

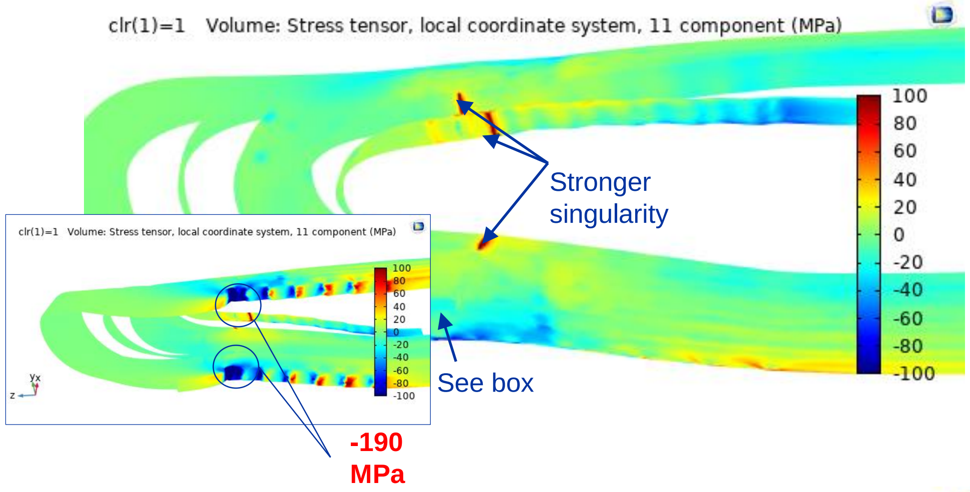
Collaring phase
-outer layer-

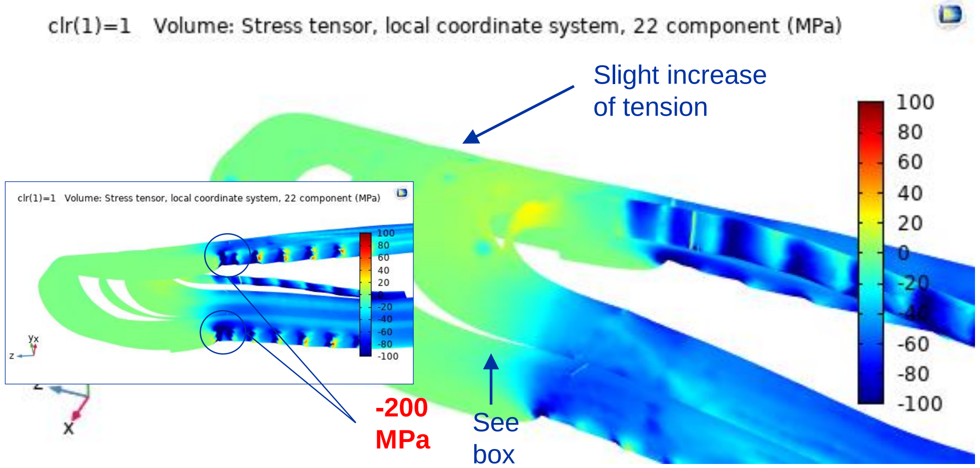
pole shimming
(baseline mitigation solution)





pole shimming
(FUJI_1)



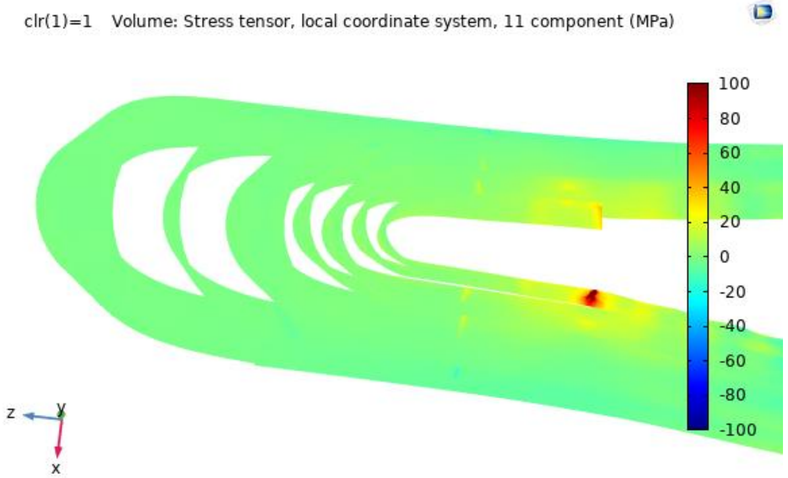


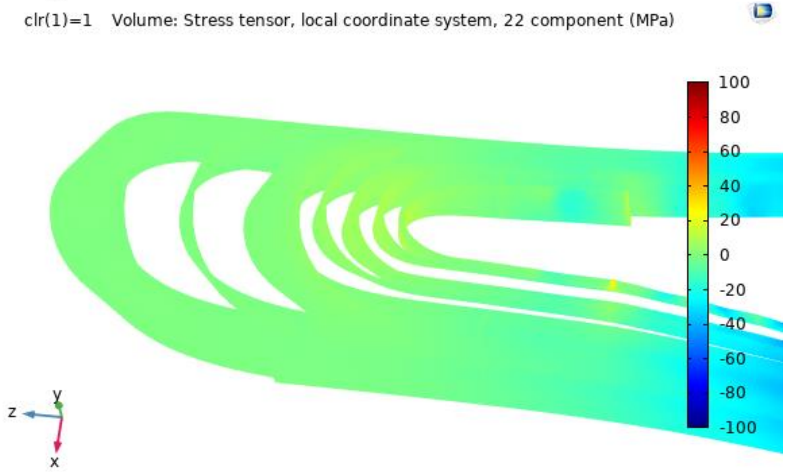
11 T magnet

Shimming schemes tested in the 11 T model

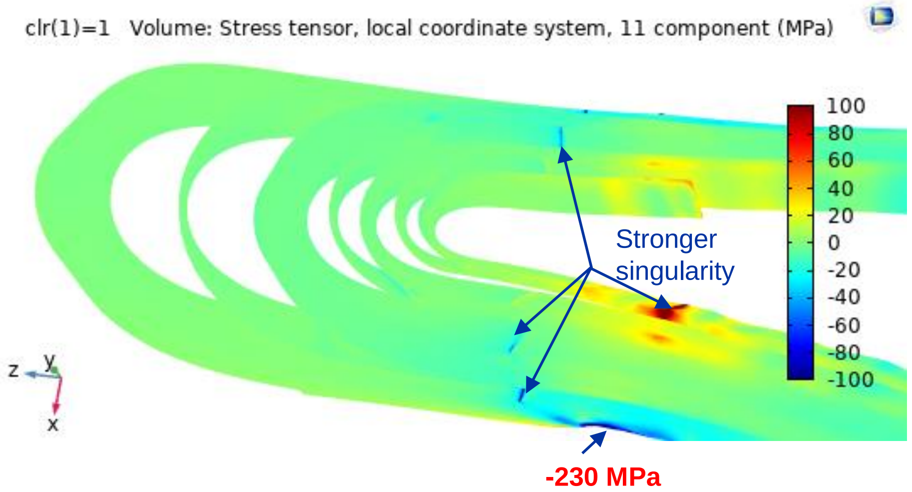
Collaring phase
-inner layer-

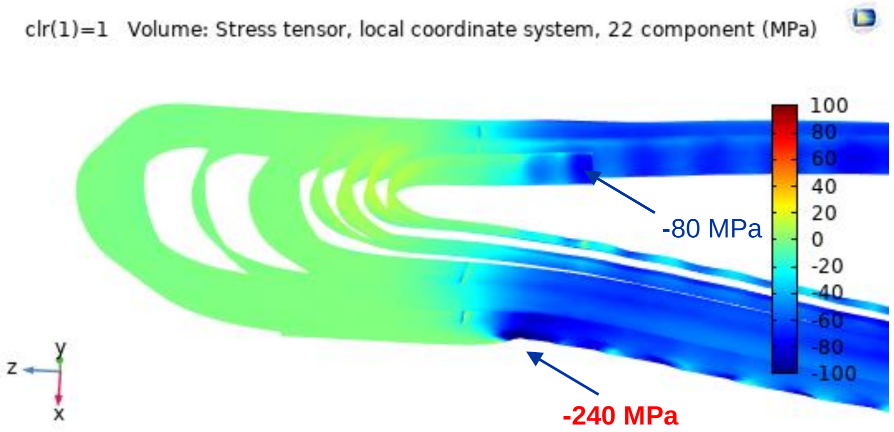
pole shimming
(baseline mitigation solution)





pole shimming
(FUJI_1)

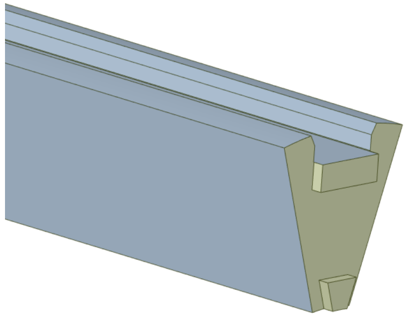


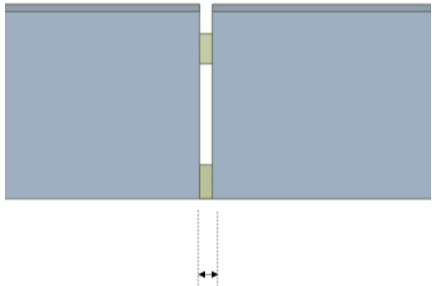


11 T magnet

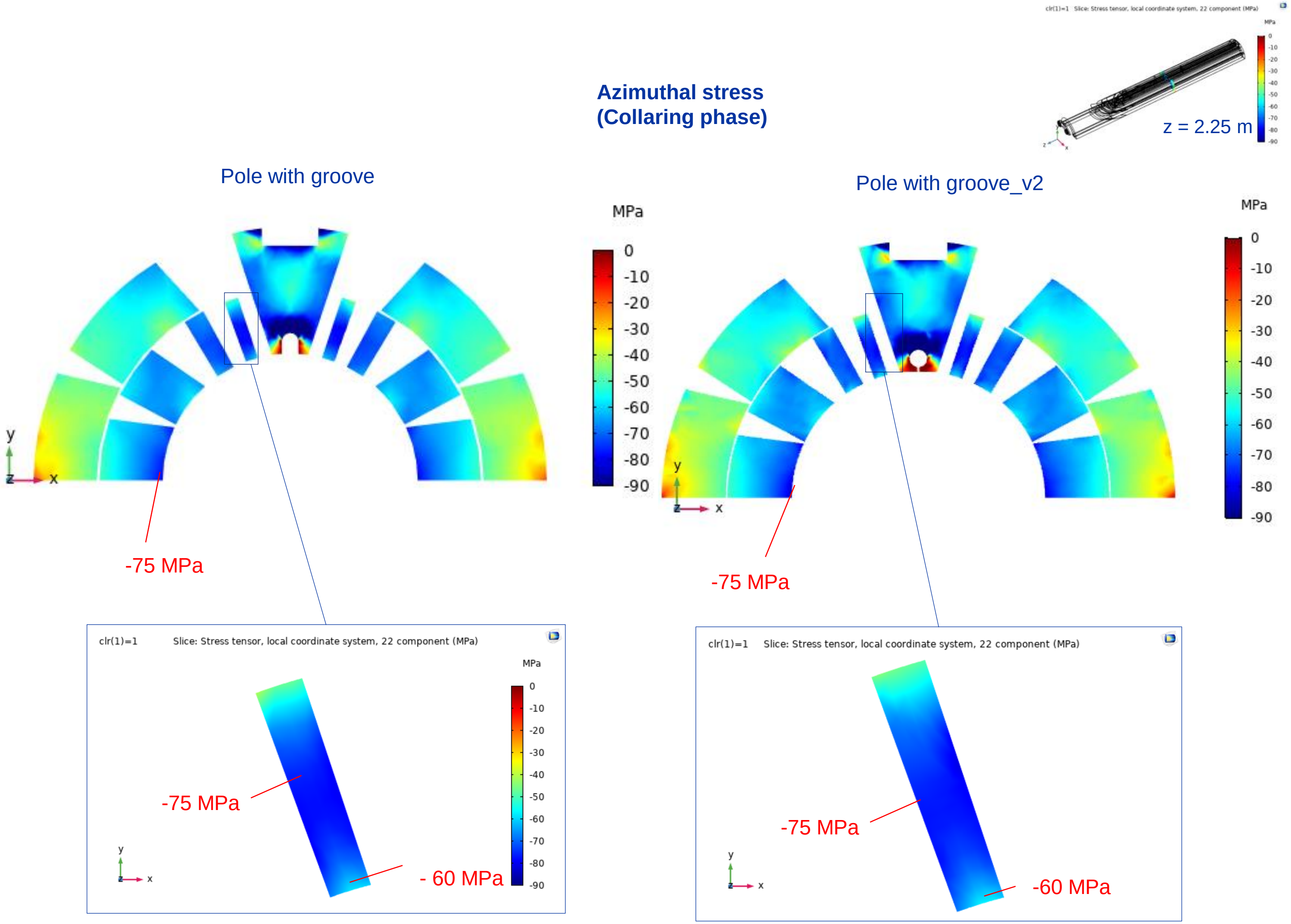
Instrumentation impact on the magnet

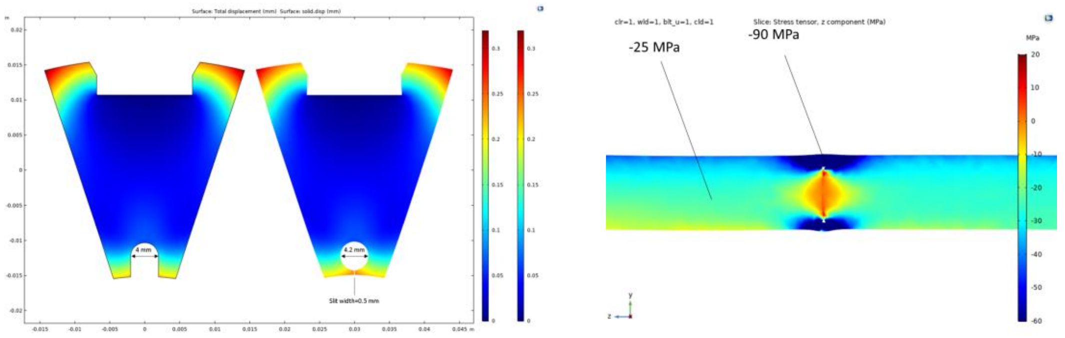
Determination of an equivalent pole to accommodate the instrumentation for the testing campaign





Slit for instrumentation: 2 mm (baseline)

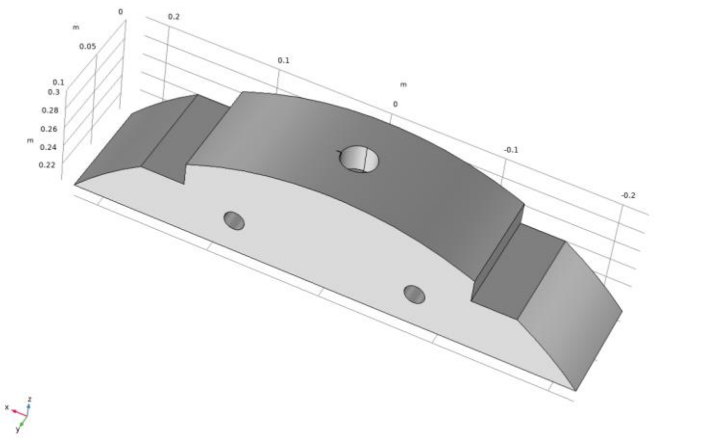


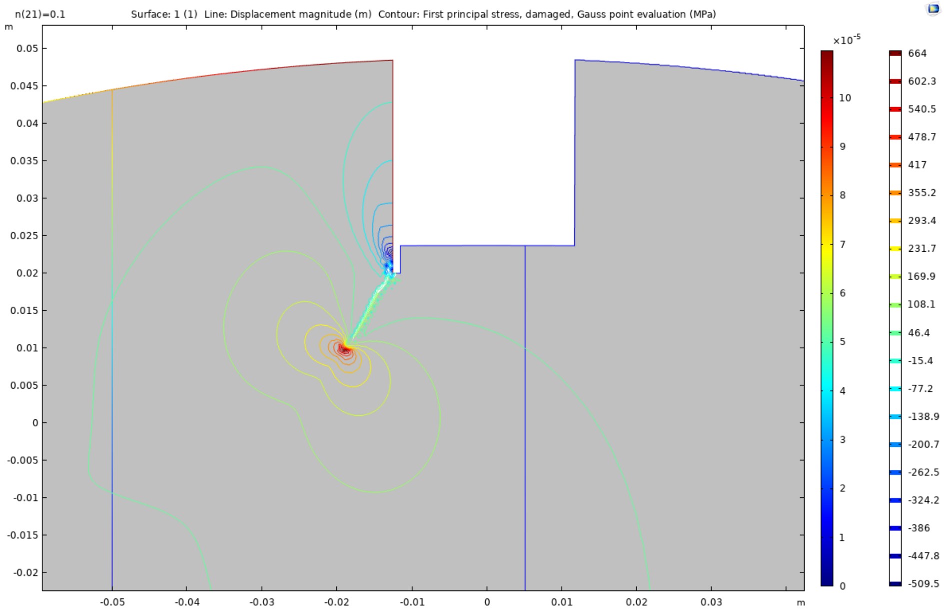


MQXF magnet

Fracture mechanics

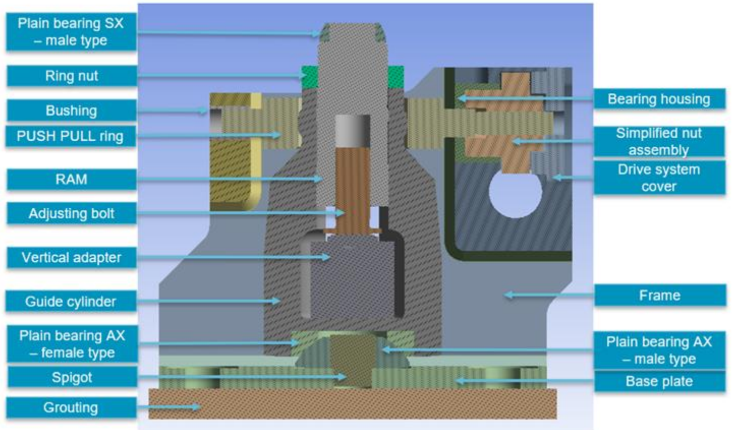
Fracture mechanics analysis on the fixed point of MQXF. Crack phase field based on damage model.



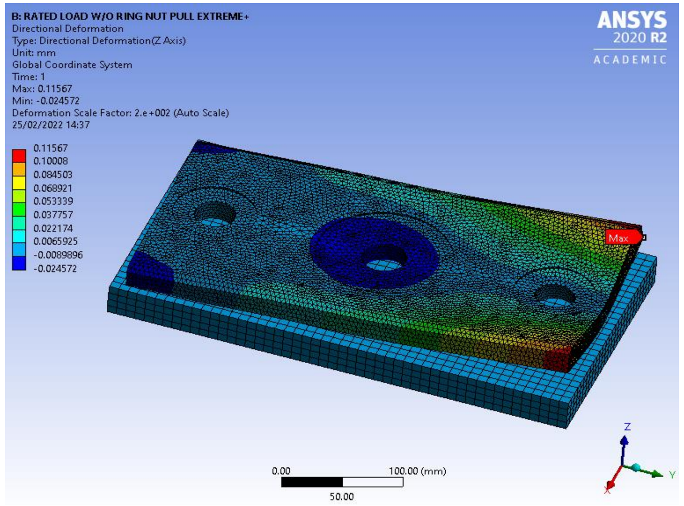


HL-LHC jacks

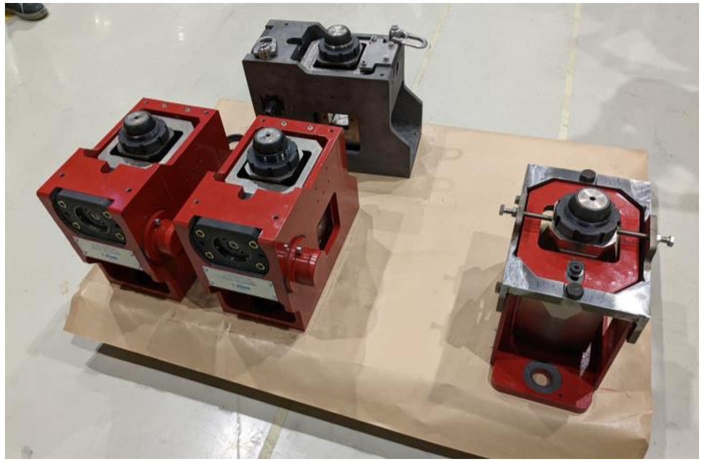
Mechanical design and procurement of pre-series



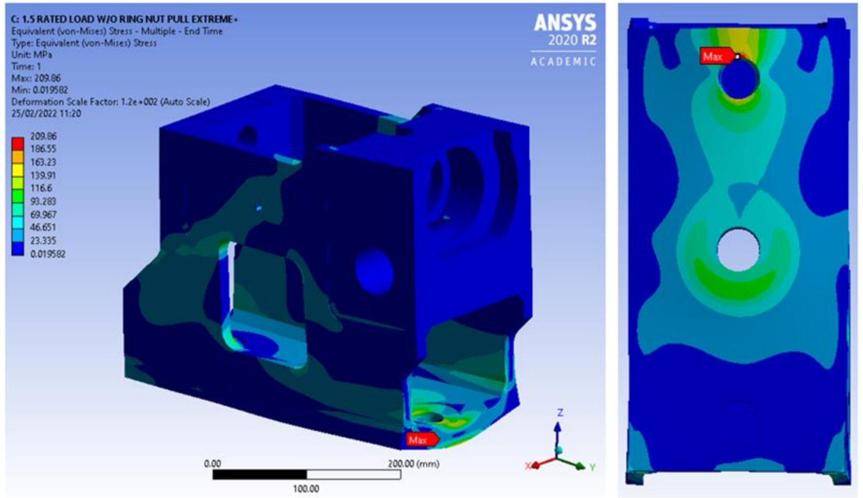
Cross-section of HL-LHC jack 3D model for FEA



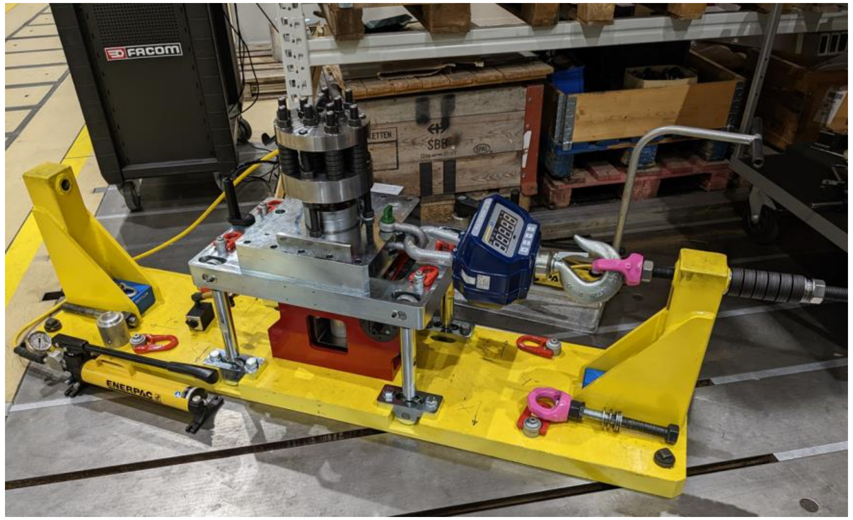
Deflection of HL-LHC jack base plate wrt ground (concrete)



Pre-series of HL-LHC jacks for IT String



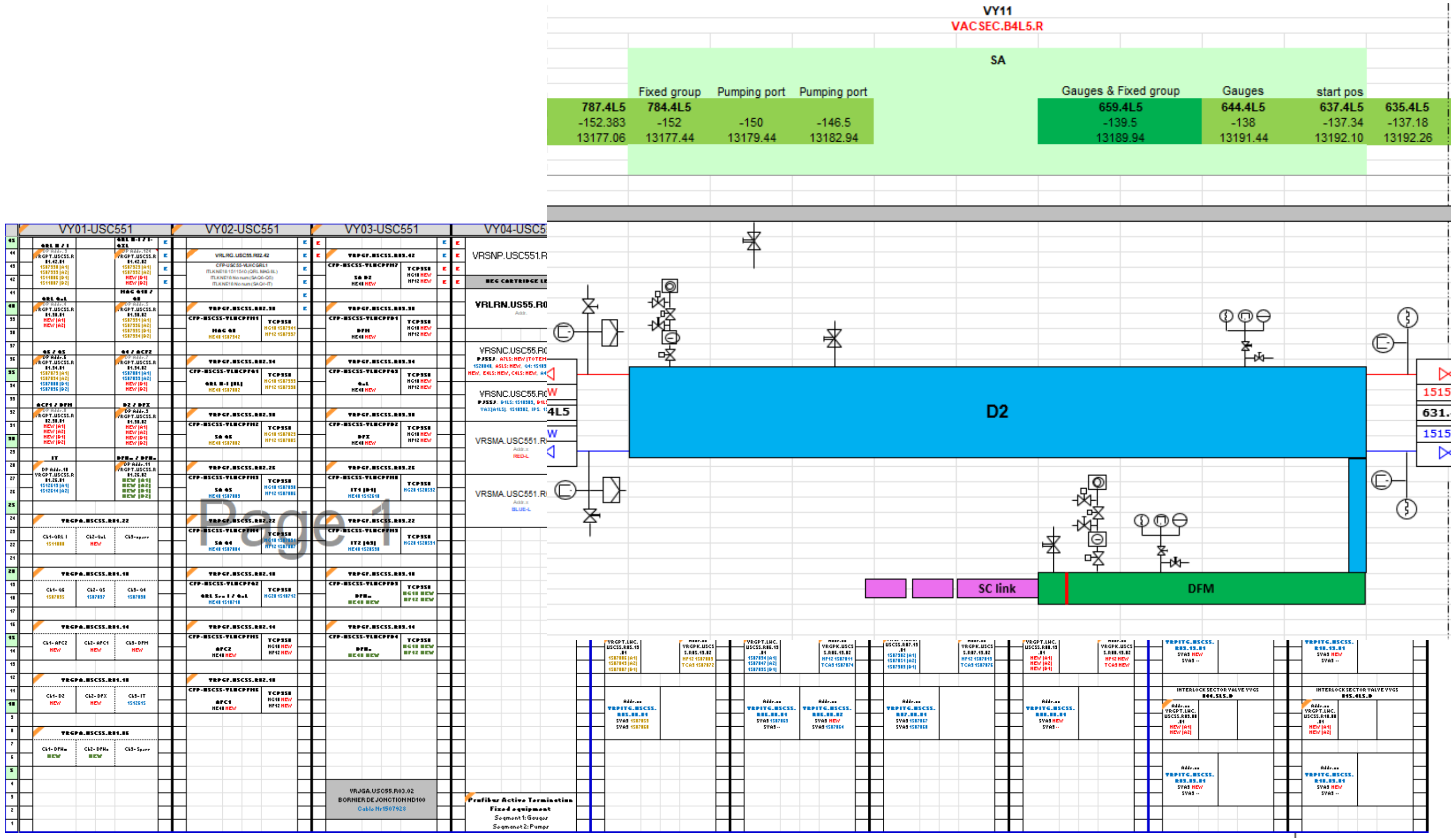
Von-Mises stress of HL-LHC jack frame at 1.5 rated load

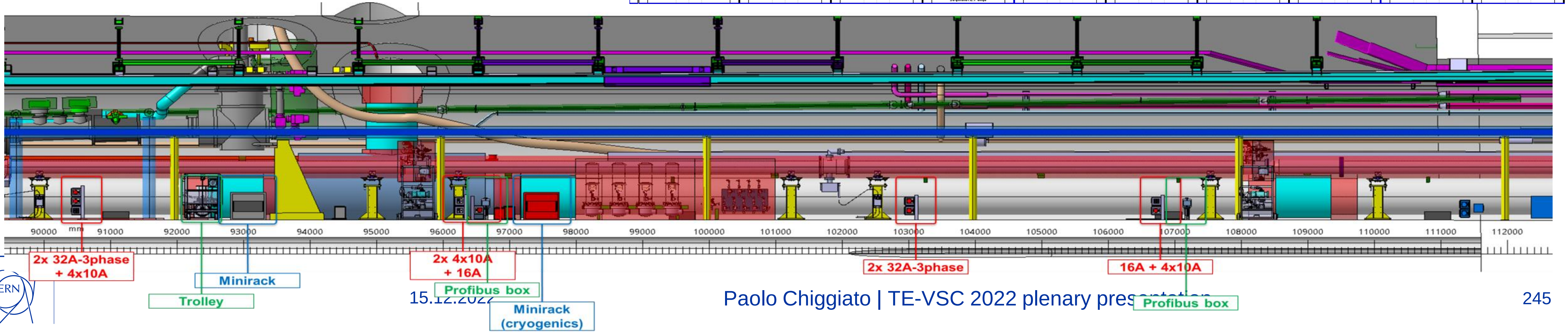


Acceptance test tool for HL-LHC jacks (prepared to apply >26 Tn of vertical load and >4 Tn of lateral load)

HL-LHC WP12 Vacuum Controls – LSS1 and LSS5 documentation

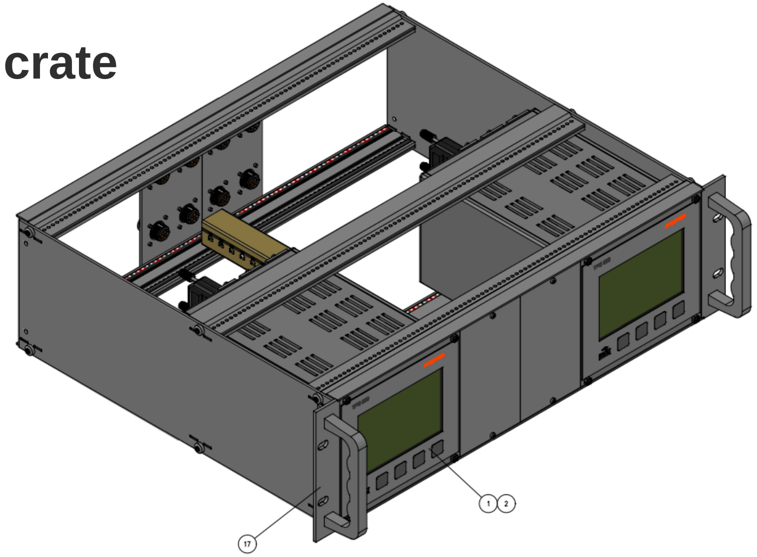
- Work units with deliverables and spending profiles
- Racks and machine layout updated for optics v1.6
- Cable requests for P1 & P5
- Integration of power and mini-racks for P5R



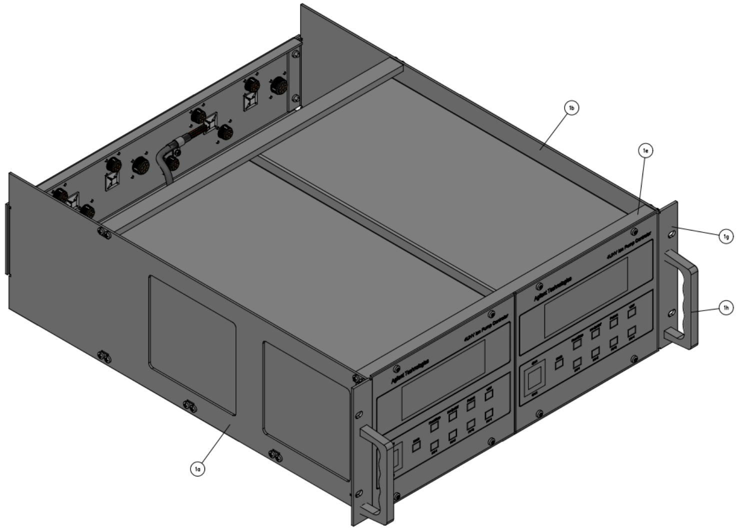


HL-LHC WP12 Vacuum Controls – Integration of equipment in EDA

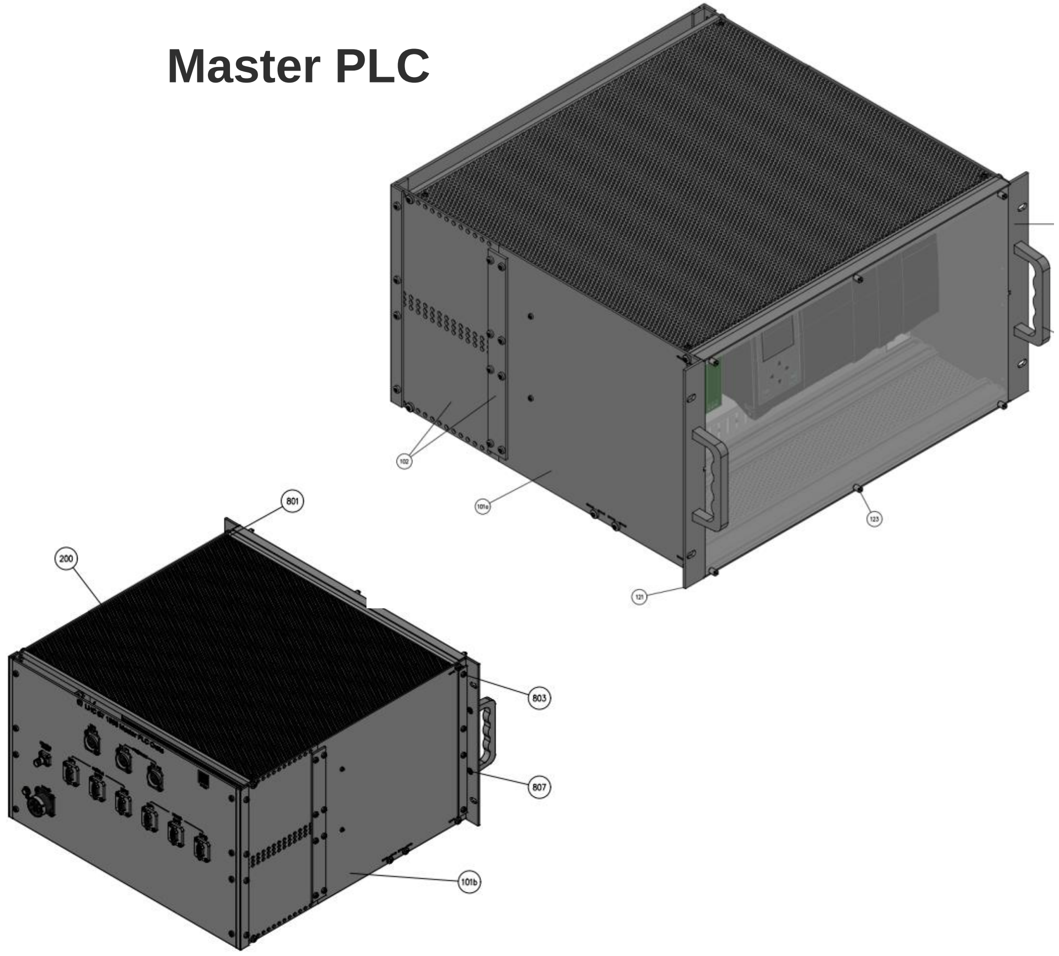
TPG crate



Agilent crate

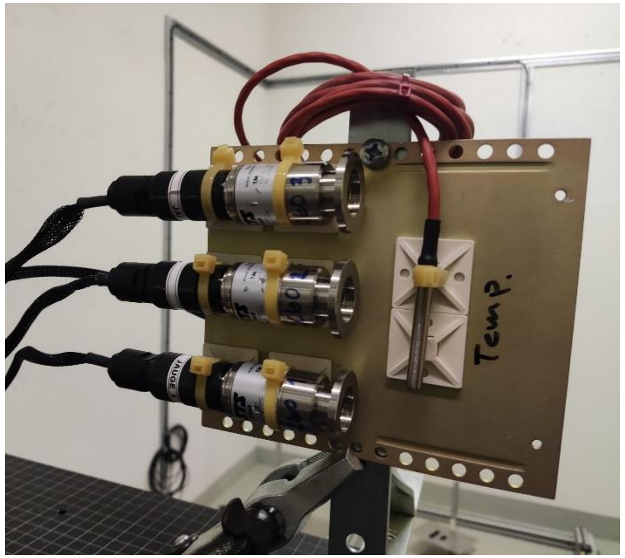


Master PLC



HL-LHC WP12 Vacuum Controls – R2E

- 3 designs qualified at CHARM
- Starting production of x400 power supplies for LS3
- Penning design partially accepted (LOG stage requires further analysis)
- Good results from the STS Piezo gauge up to 60 kGy (gamma)



HL-LHC WP12 Vacuum Controls - production

- **Number of equipment produced:**
  - 120 Agilent crates & 35 controllers
  - 80 VPI local boxes
  - 60 TPG crates
  - 100 Profibus cards
  - 32 VPGF local crates (DS)
  - 140 R2E crates
  - Master PLC crates
- **Equipment prepared and stored ready for LS3 deployment**

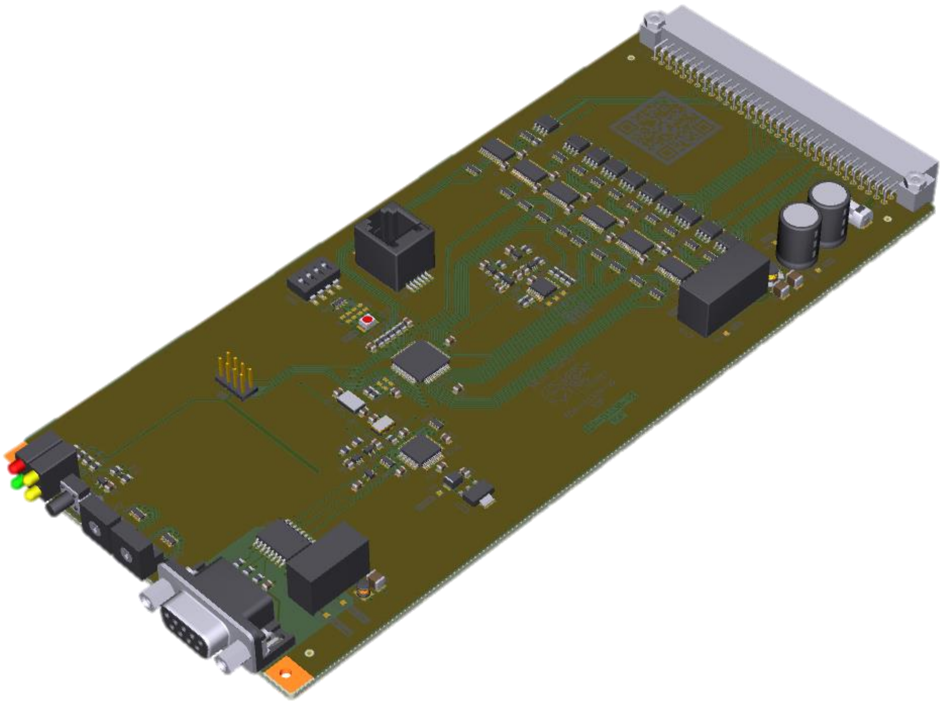
HL-LHC productions
R2E crates

HL-LHC productions
TPG crates

HL-LHC WP12 - New electronics for Sector Valve Control

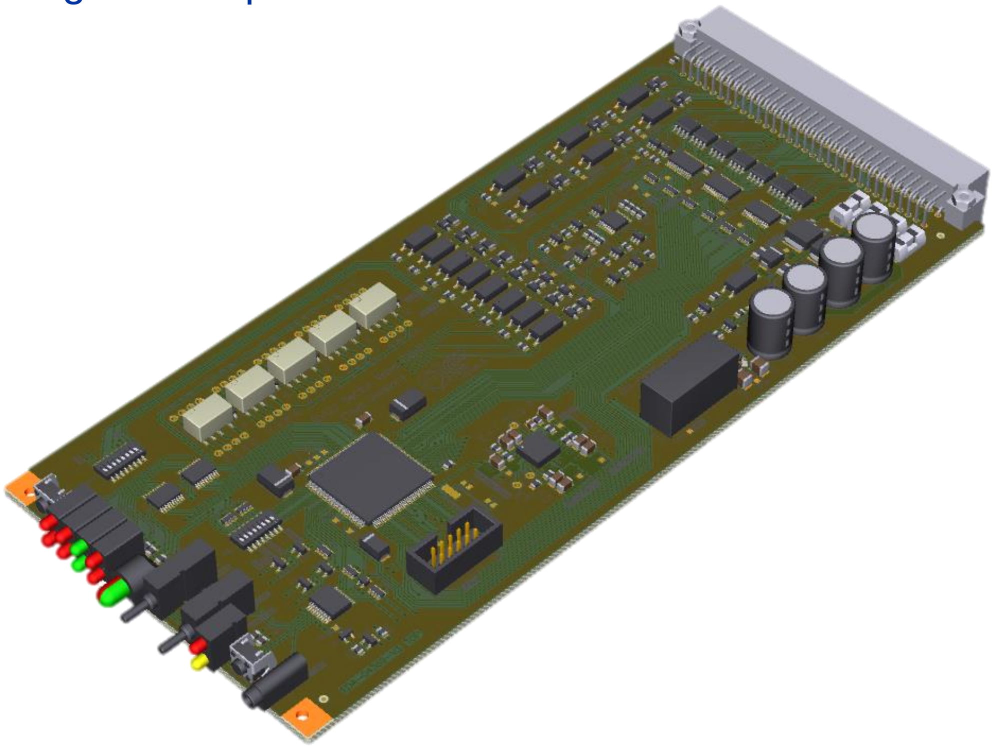
New Profibus DP Interface Card

- Based on Microcontroller and ASIC
- New SPI differential lines communication
- Improved surge and overvoltage protection
- C code Firmware update



New Sector Valve Control Card

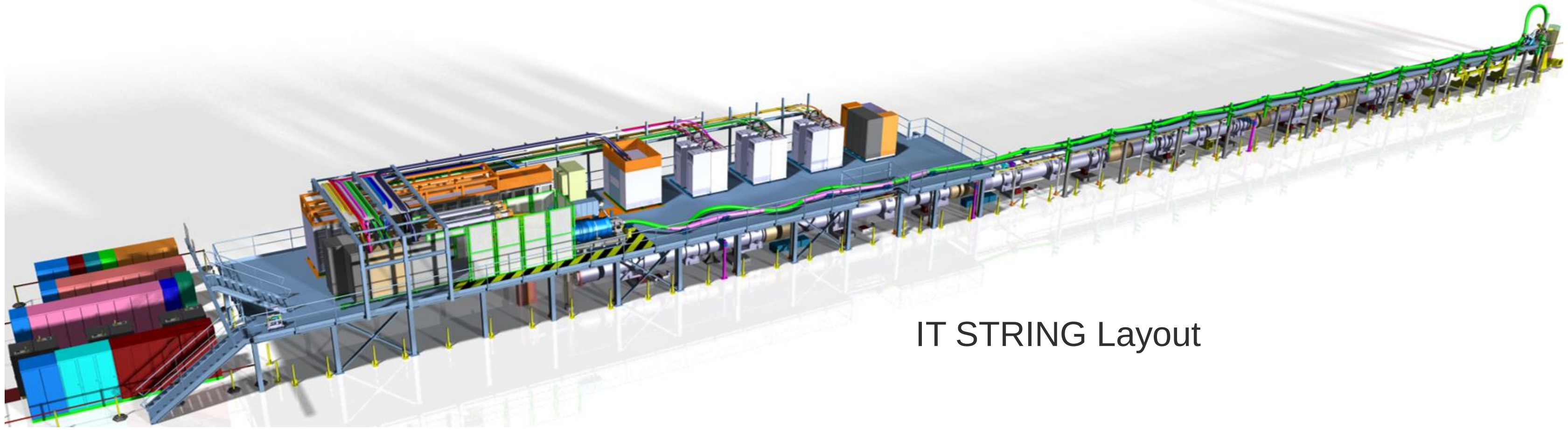
- Based on FPGA
- New SPI differential lines communication
- Improved surge and overvoltage protection
- New VHDL Gateware and logic description
- Long life components



HL-LHC WP16 Vacuum Controls - IT STRING

- **Procurement & production**
  - Designed at CERN
  - Manufactured at CERN & external companies
  - ➢ All controllers are ready & tested

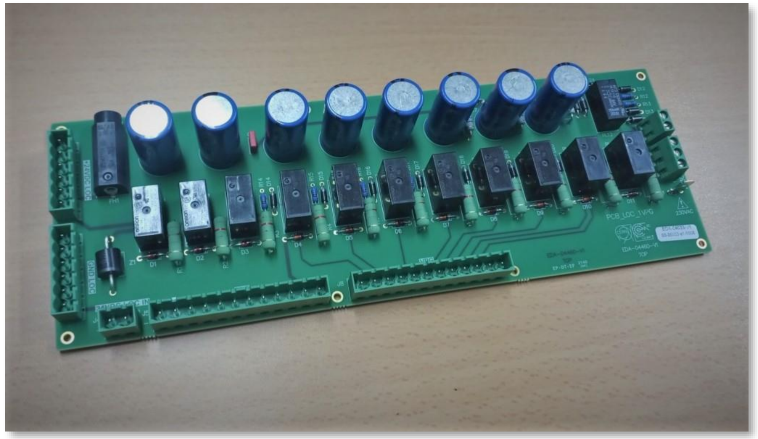
- **Requests**
  - Rack requests
  - Cabling requests
  - Powering requests
  - Ethernet sockets requests
  - ➢ Installations completed

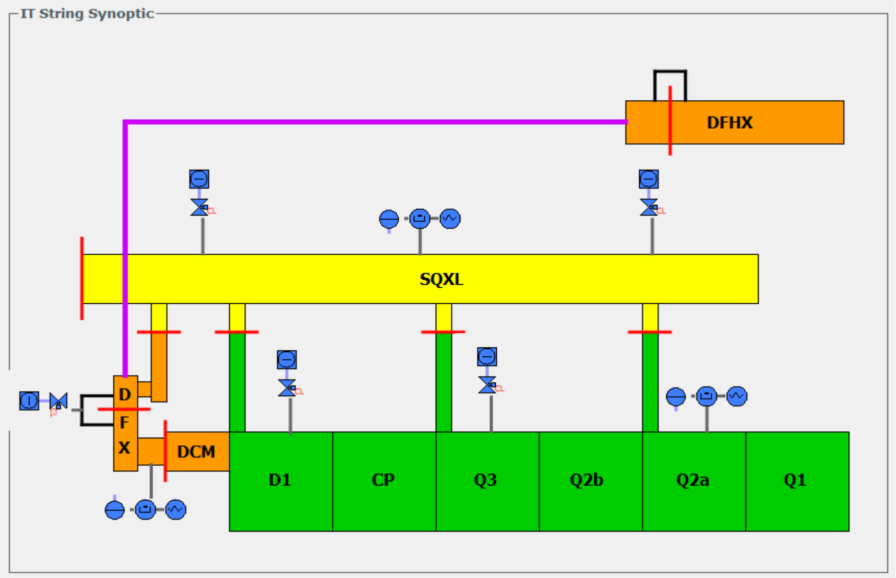


IT STRING Layout

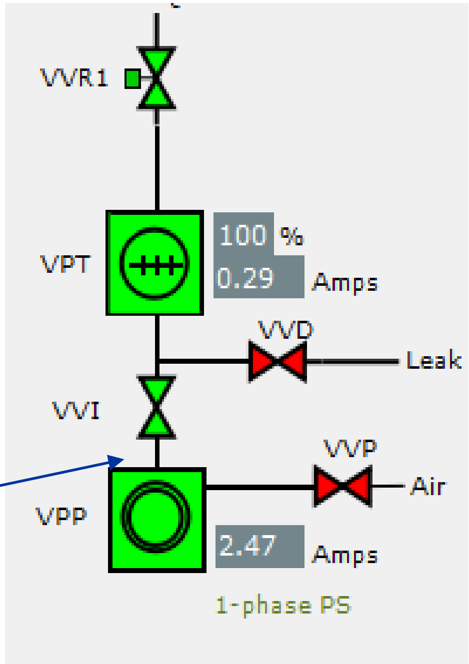
HL-LHC WP16 Vacuum Controls - IT STRING

- **Developments**
  - New PCB for the VPGF local crate
  - Pumping group safety feature: HW pressure switch
  - Vacuum data base & SCADA synoptic





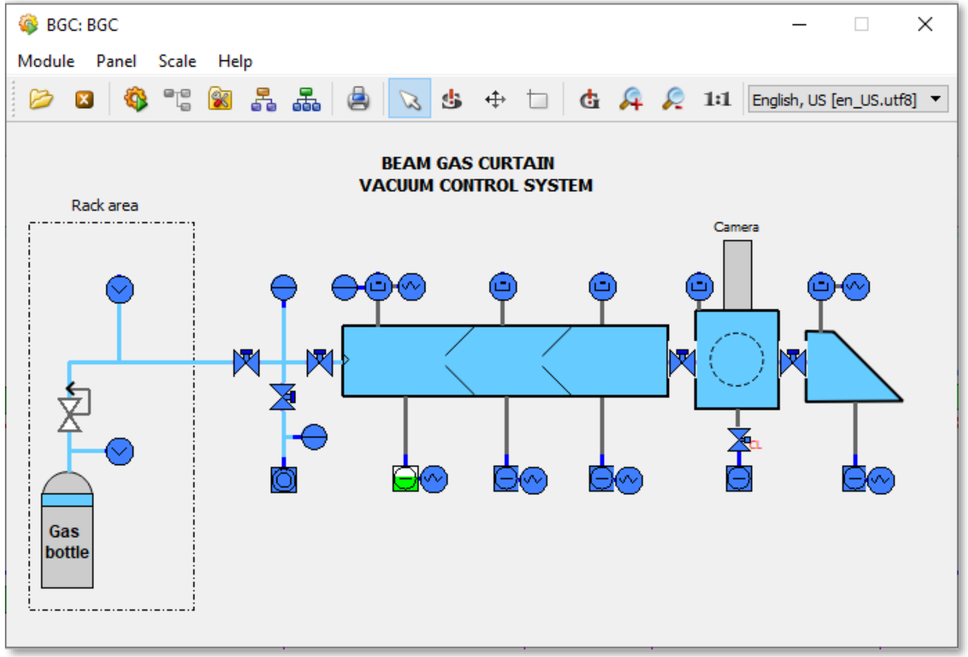
New SCADA Application for IT string



HL-LHC WP5.3 Vacuum Controls - Beam Gas Curtain (BGC)

- **Developments**
  - Study of control system
  - Design BGC PLC controller
  - Controllers procurement & production
  - Vacuum data base & SCADA synoptic
- **Requests**
  - Cabling & power requests
  - Ethernet sockets
- **Documentation**
  - Technical specifications document

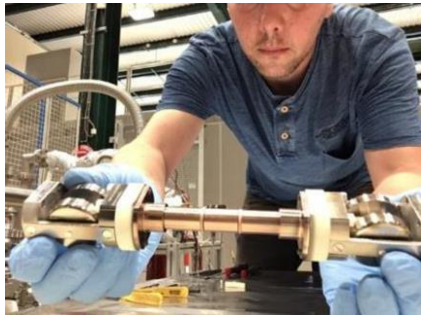
BGC PLC controller



New Synoptic integrated in LHC SCADA

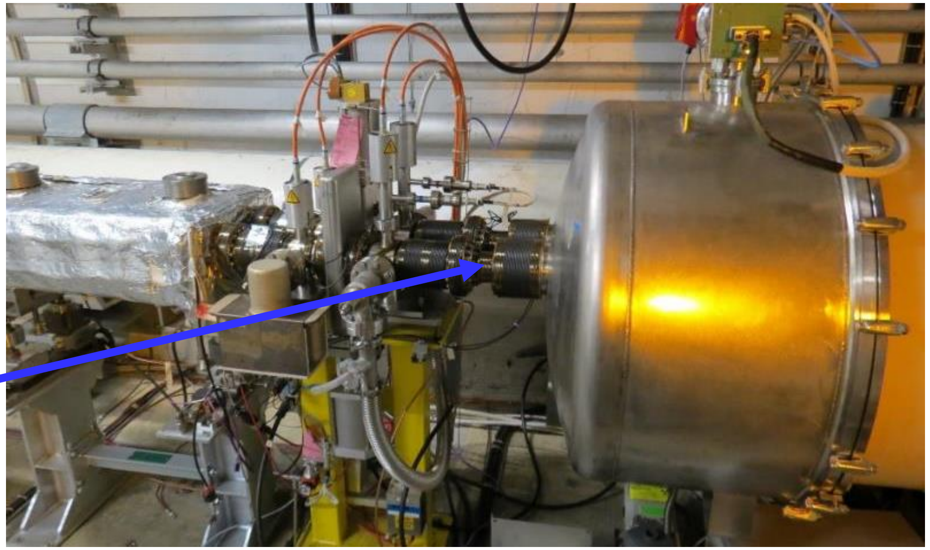
Results from the a-C in-situ coated standalone of LHC

Coated only Q5L8 during LS2, to suppress e-cloud related heat load (the other standalones are equipped with cryosorbers: gas release during coating spoils the SEY performance)

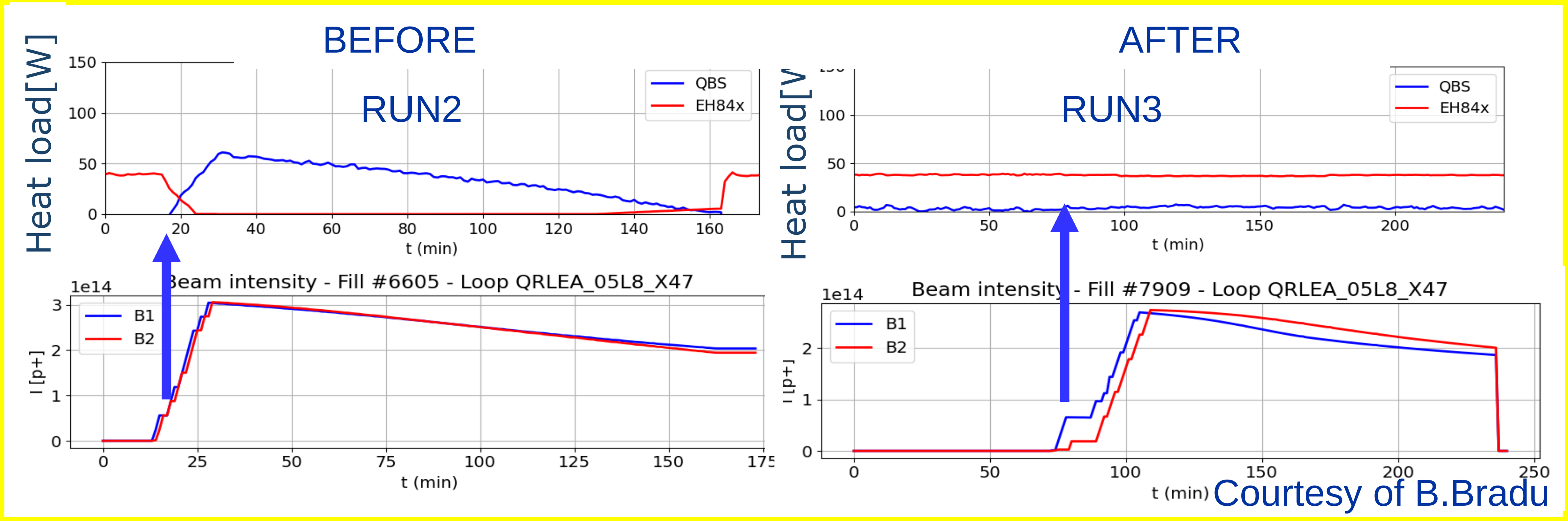


etching train

coating train

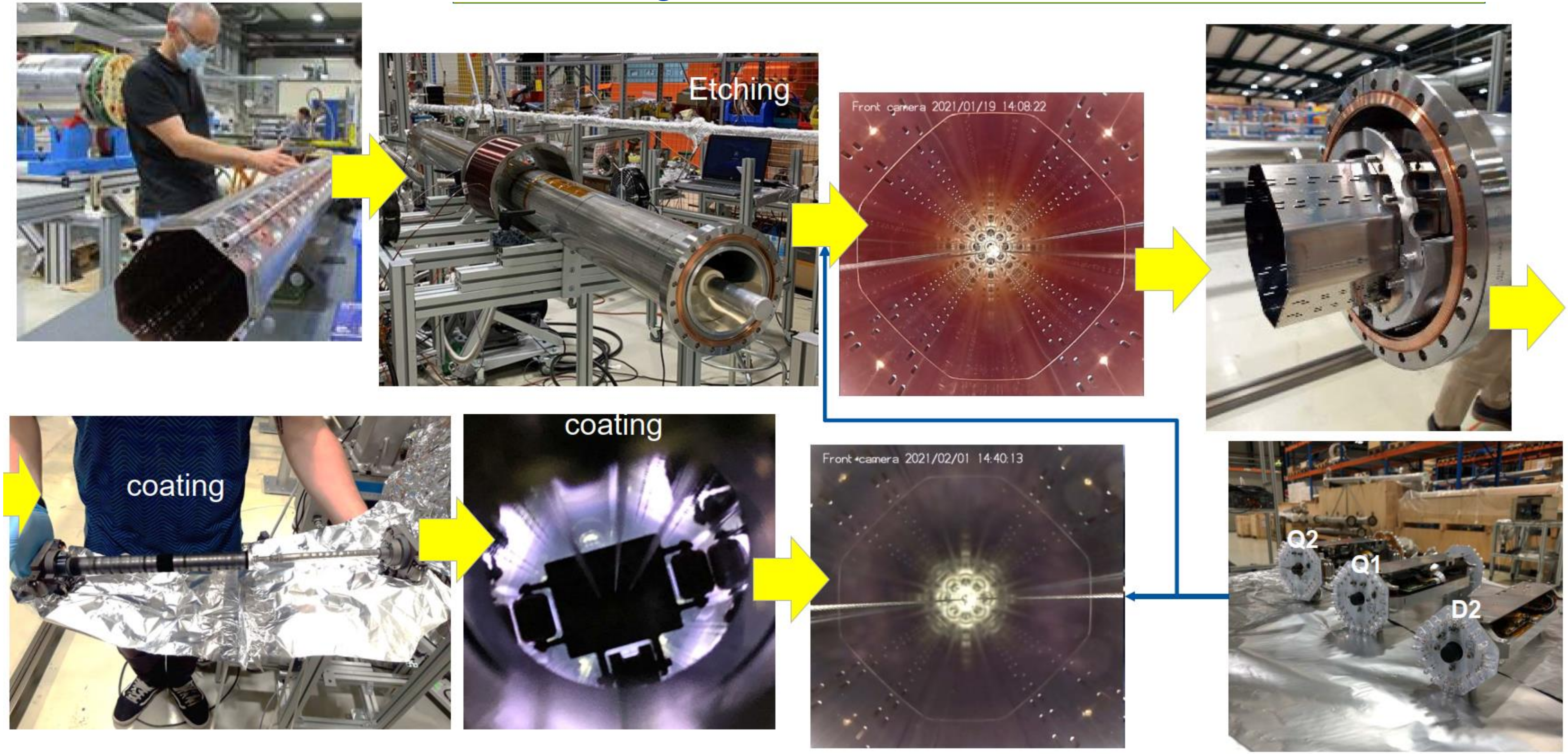


The result:

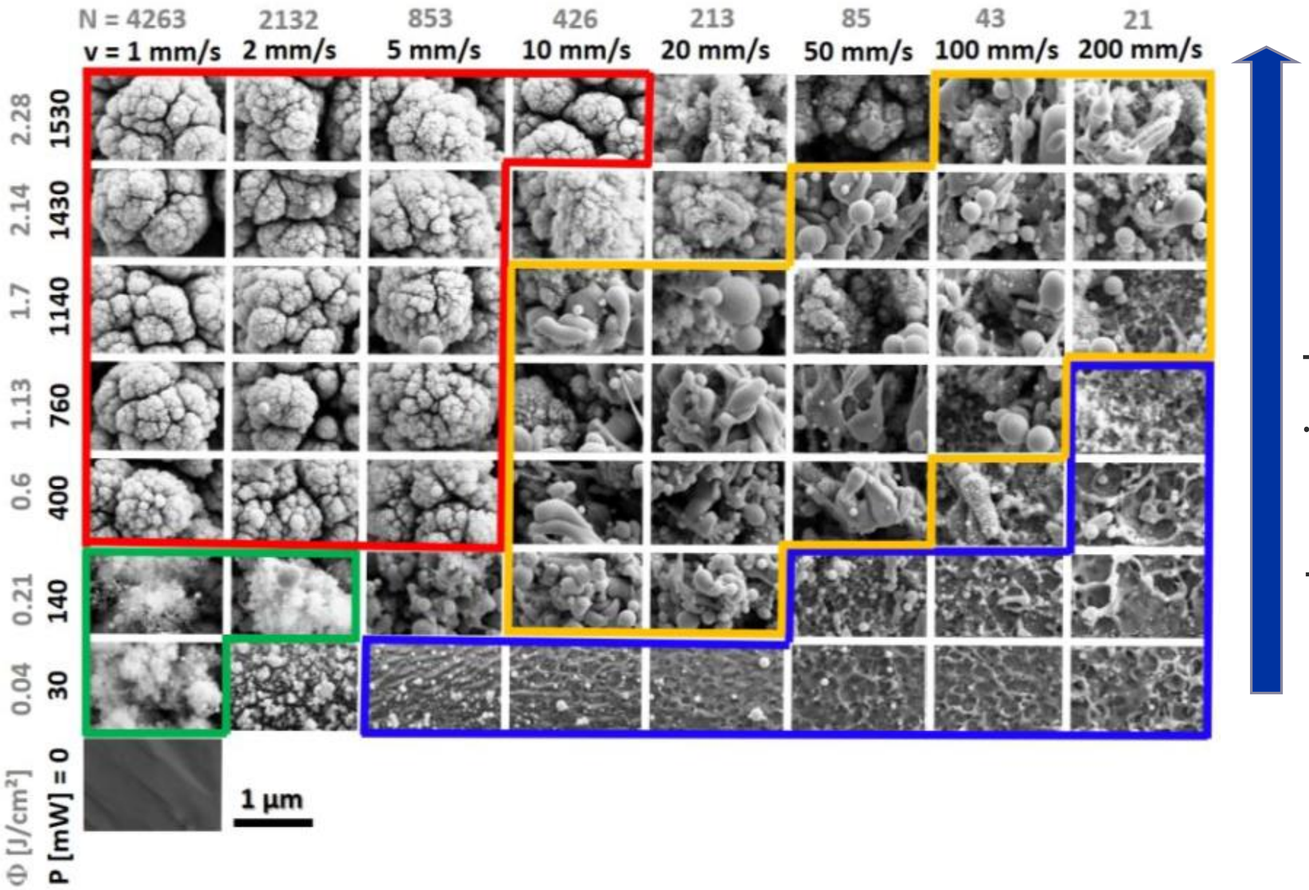


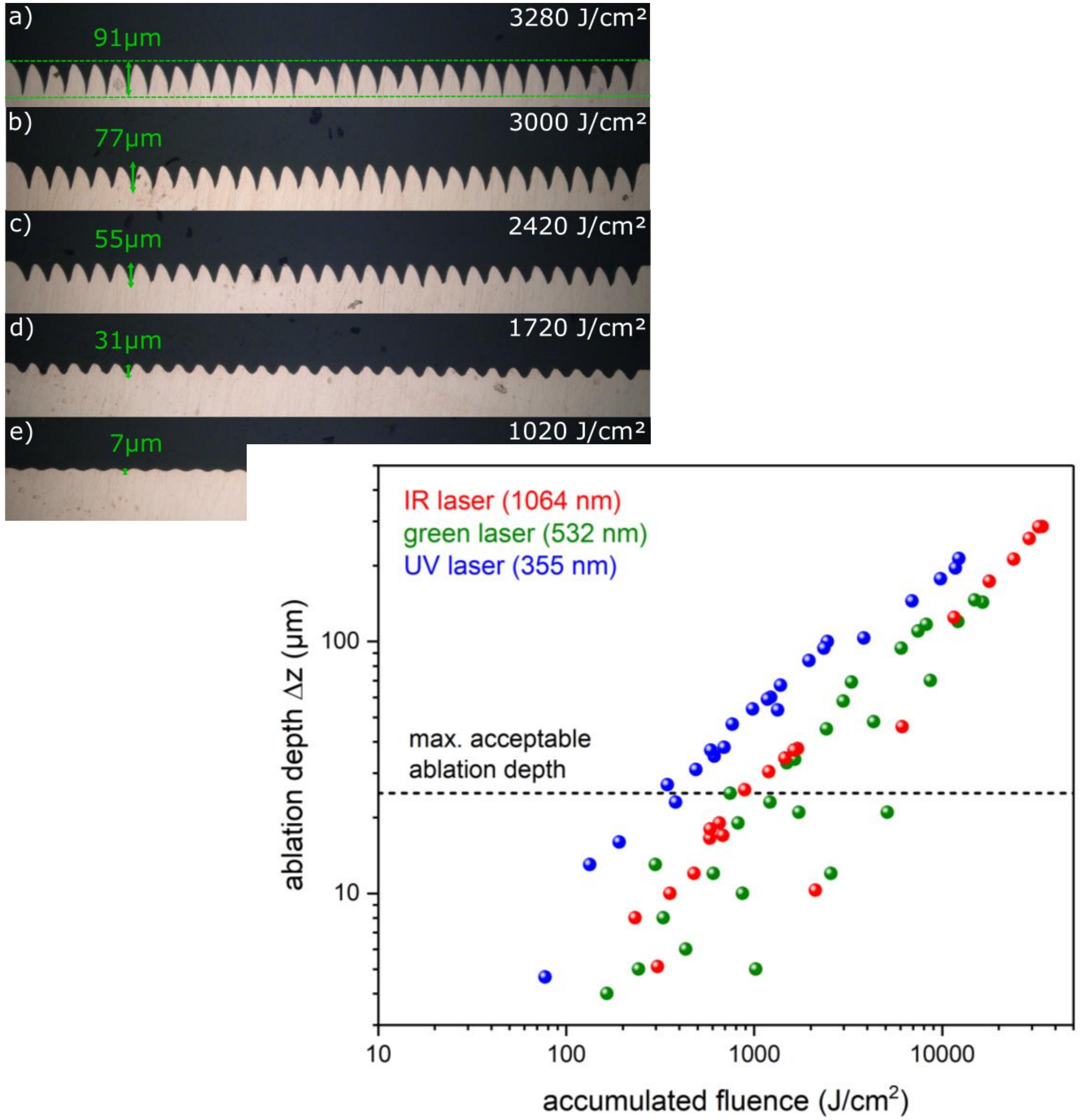
Courtesy of B.Bradu

Thin film coating: a-C on HL-LHC beam screens in IP 1 and 5



Laser Surface Structuring to reduce SEY in HL-LHC vacuum components

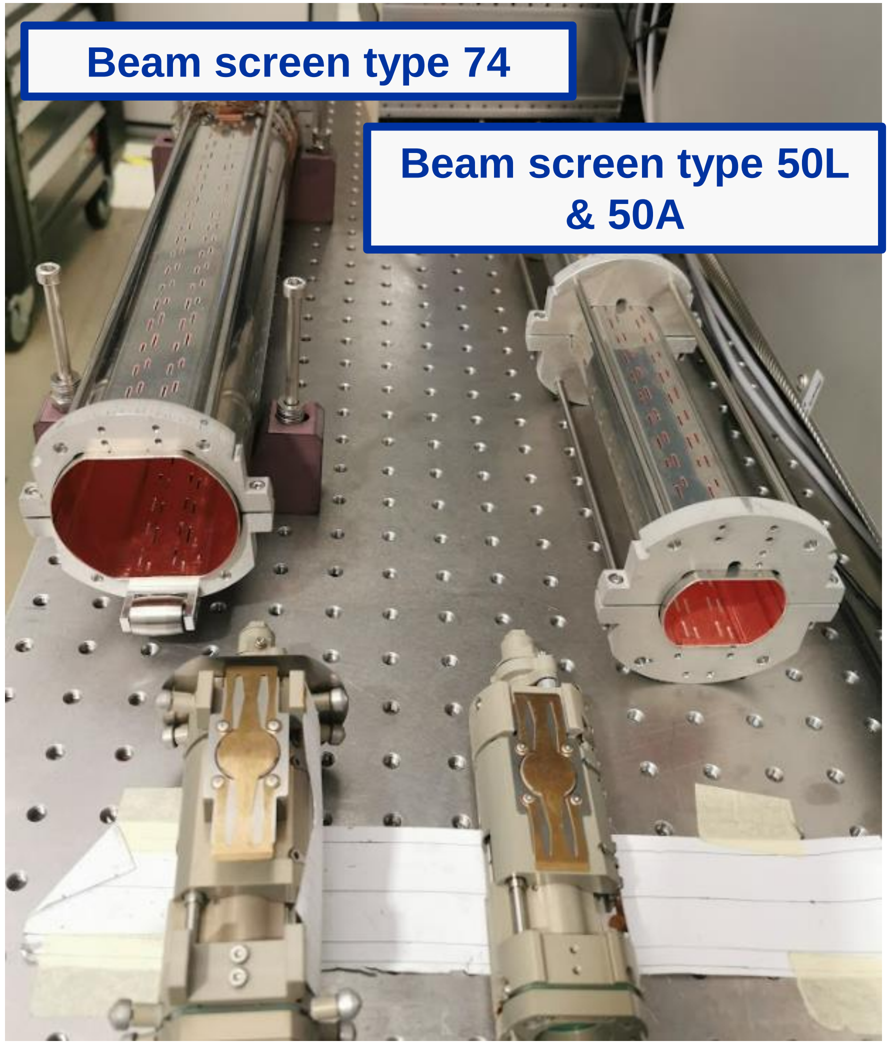




Higher power and slower scanning speed :

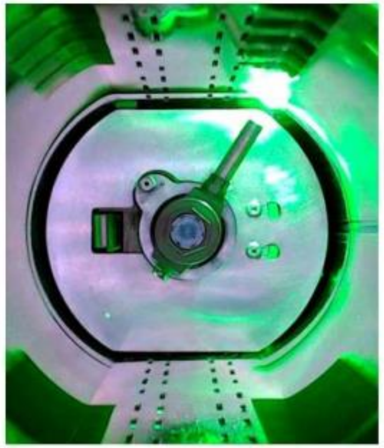
- More material removal
- Deeper trenches
- Lower SEY….but more particles

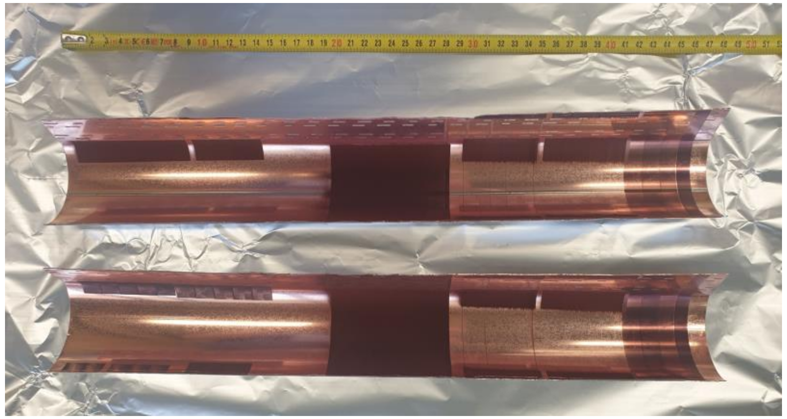
Laser Surface Structuring to reduce SEY in HL-LHC vacuum components

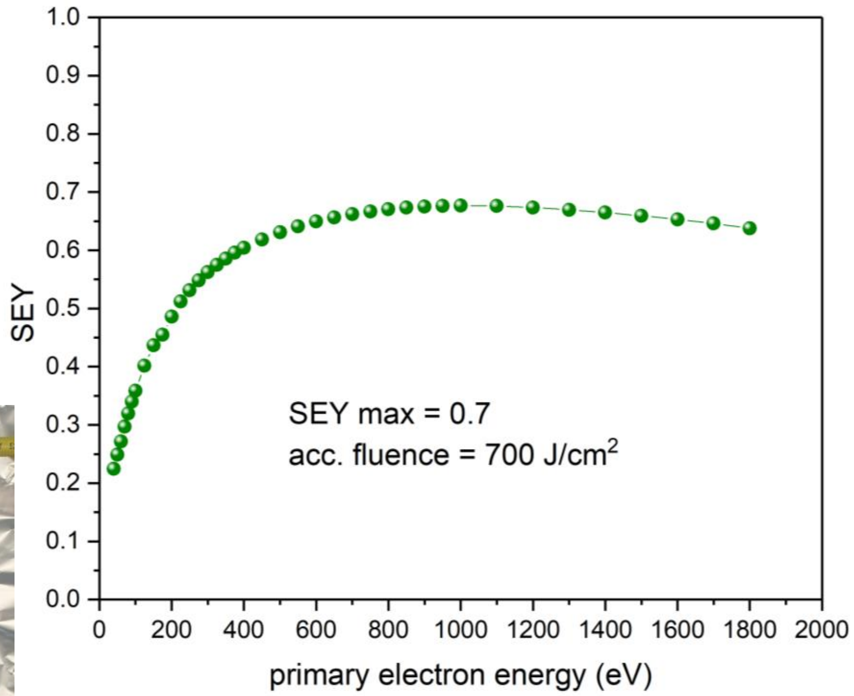


-possible application in LS3 for beamscreens of Q5 of IP1 and IP5, to be treated on surface, to mitigate e-cloud -collaboration UK2 HL-LHC, IOM Leipzig, Uni Naples

-integration and particle mitigation in progress

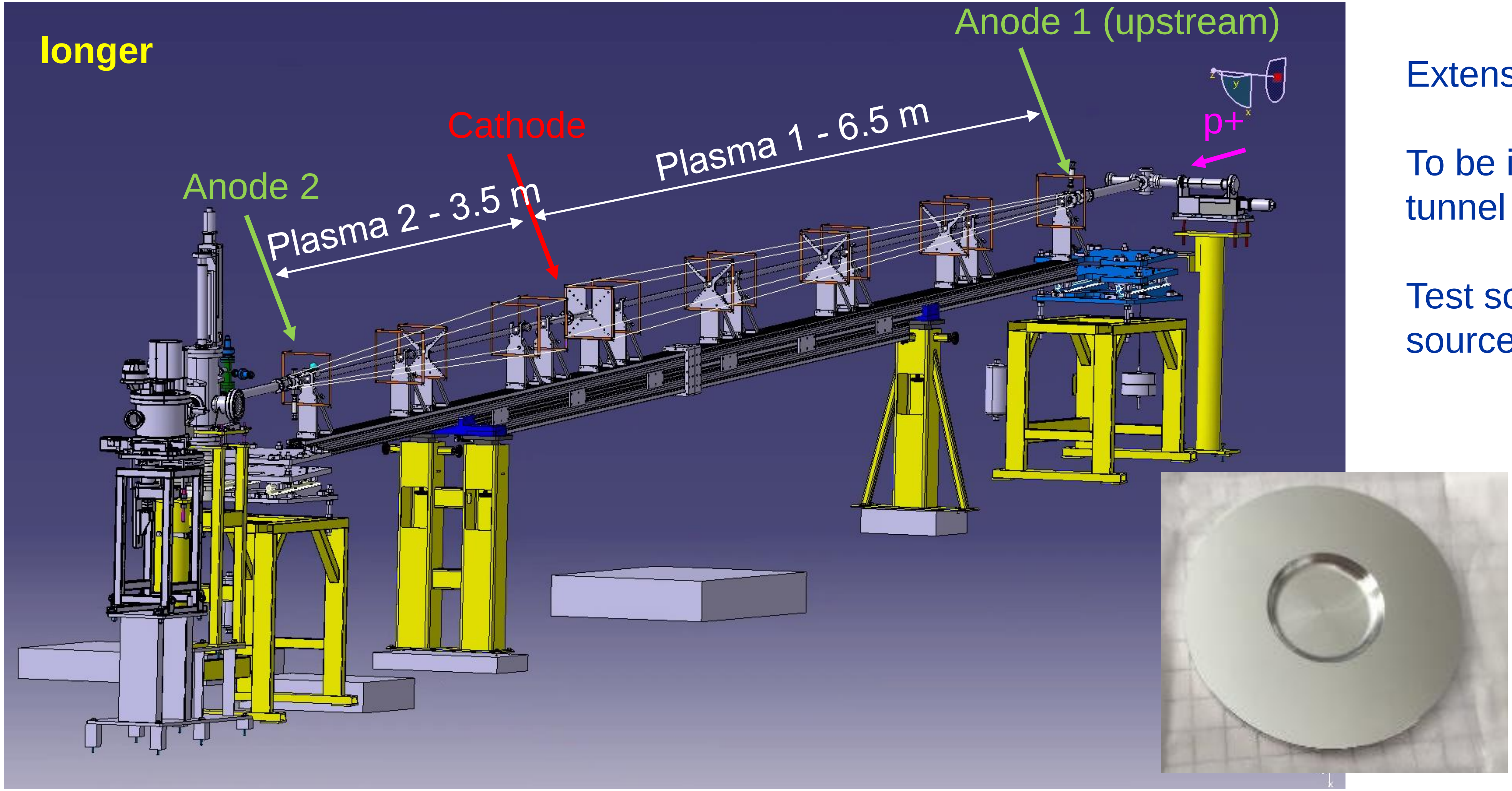






Other projects and studies

Future acceleration techniques: 10 m plasma source for AWAKE tunnel



Extension to 10 m

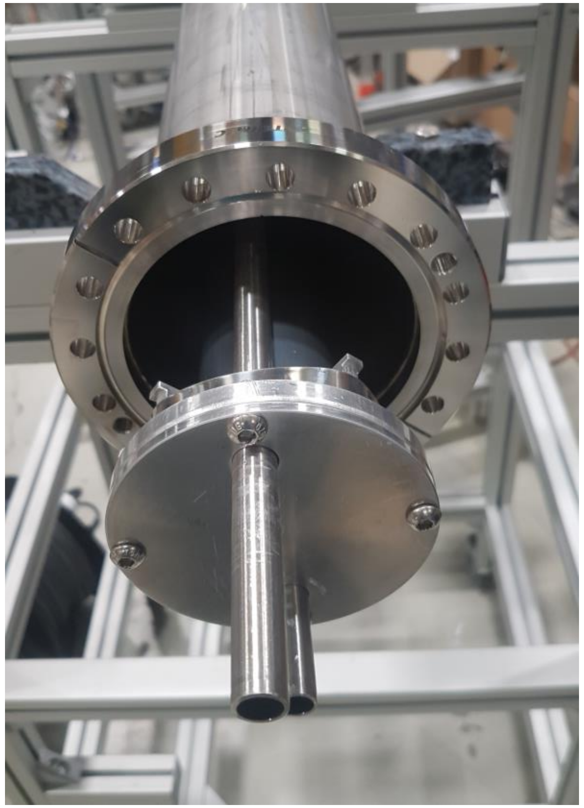
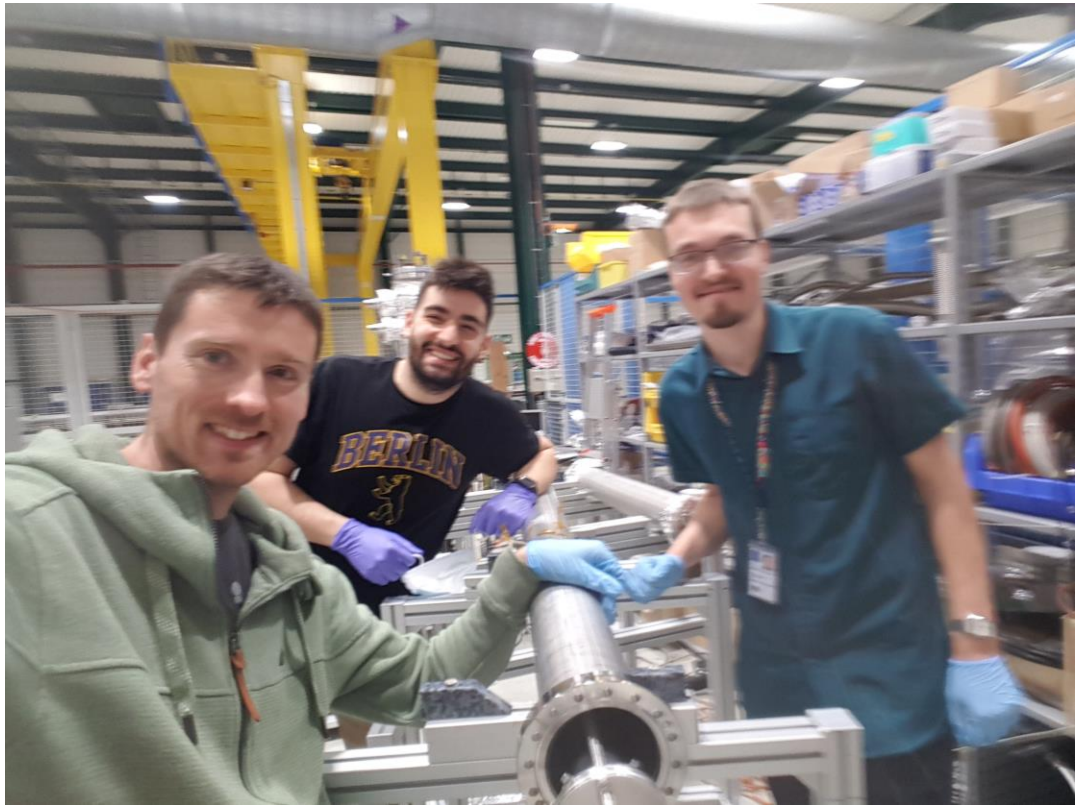
To be inserted in AWAKE tunnel in spring 2023

Test scalability: 2 plasma sources in series

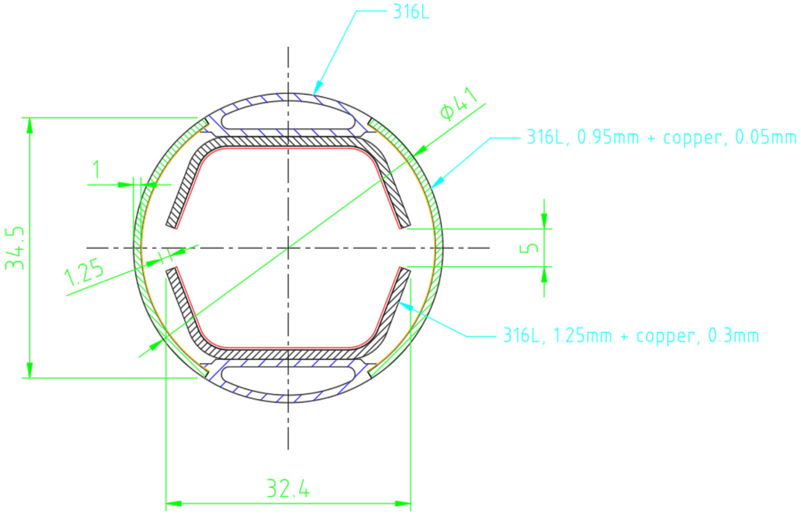
Gasket-like aluminium vacuum window (200 μm thick)

FCC-hh vacuum system

FCC-hh prototyping

Carbon coating of prototypes sent to KARA



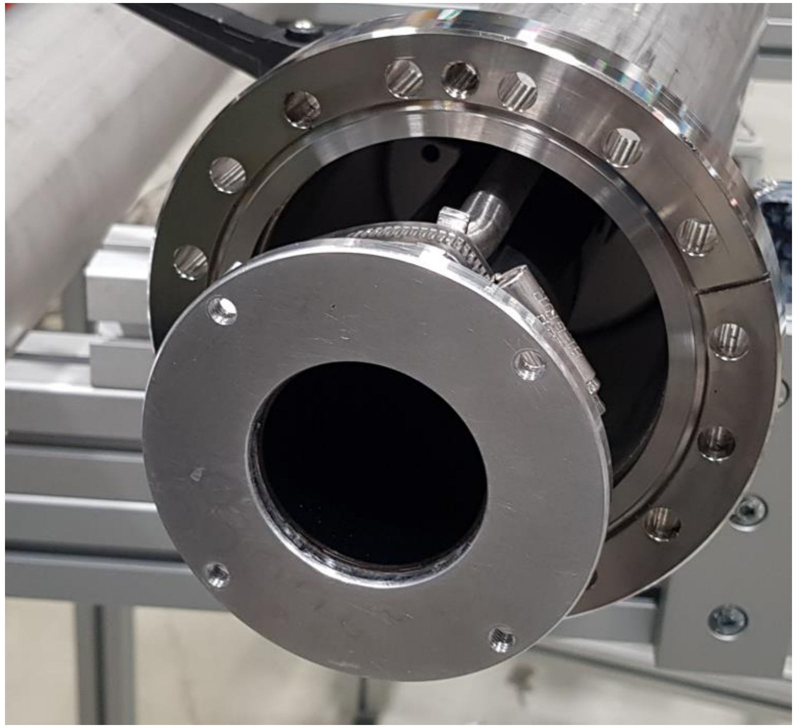
Sample design for impedance tests

FCC-hh BESTEX studies at KARA

3 FCC-hh beam screen prototypes ready to be measured (Cu, Cu sawtooth, a-C coated).

Measurements to be started in 2023. First (preparatory) visit to KIT in January.

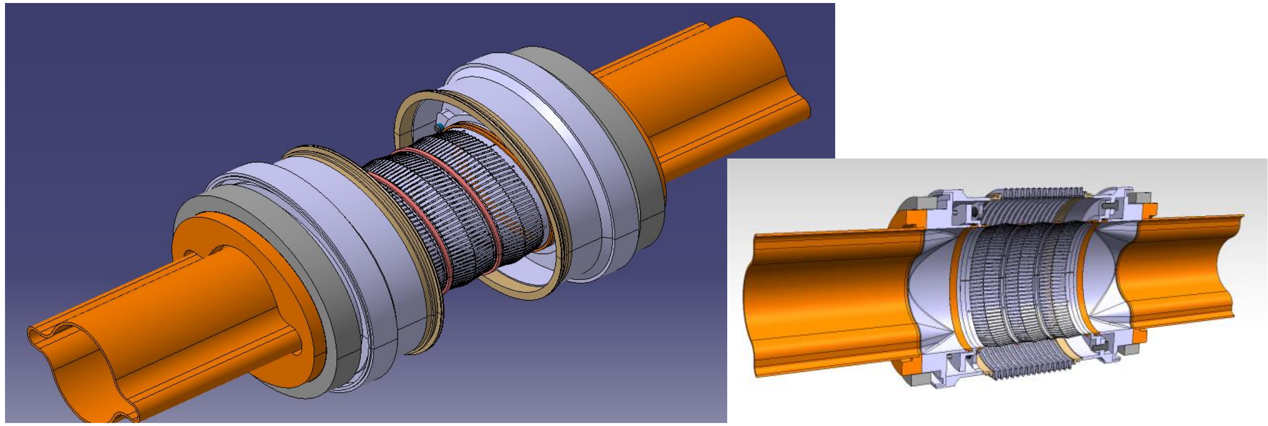
Also work ongoing for measuring FCC-ee beam pipe in BESTEX.



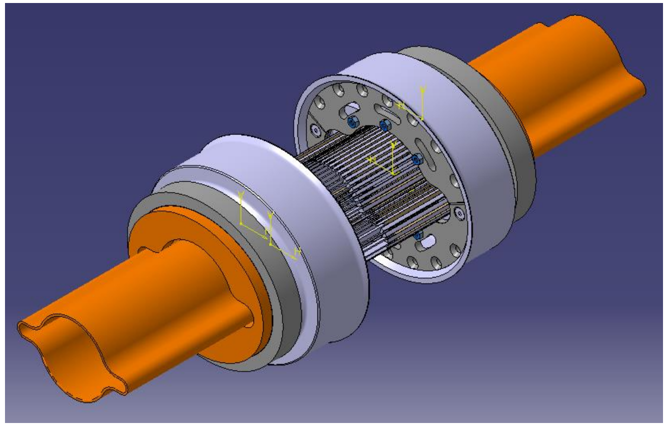
FCC-ee vacuum system

FCC-ee design

Interconnection design:



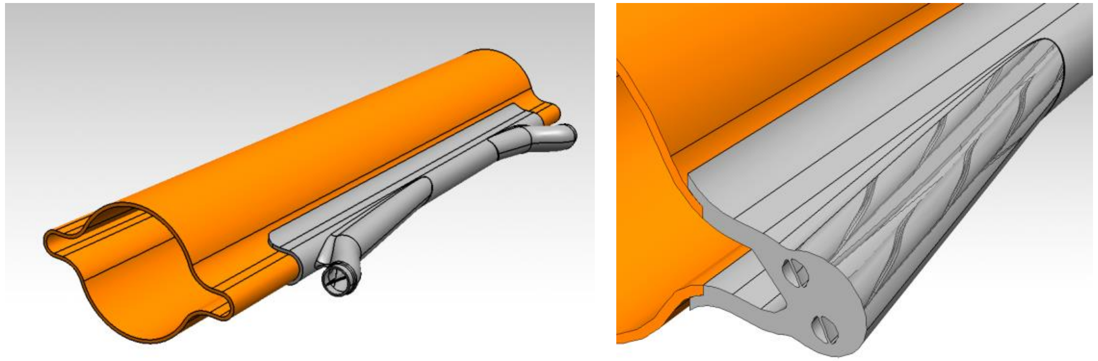
DRF Contact Bridge type

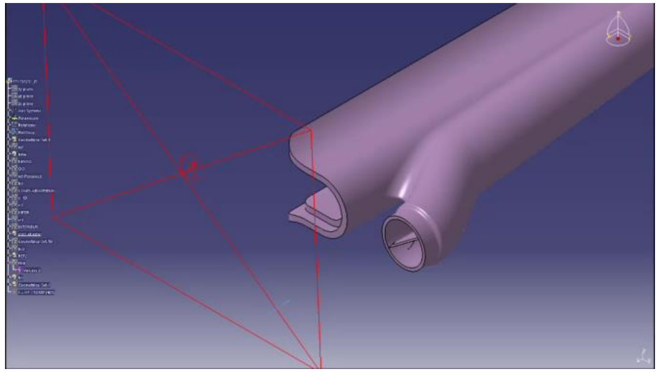


Comb-type

Two designs presented for the interconnection undergoing impedance modelling.

Synchrotron radiation absorber design:



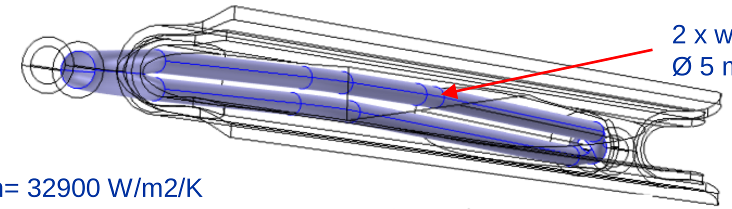


3D model with twisted tape to increase heat transfer coefficient

FCC-ee vacuum system

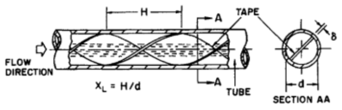
FCC-ee design

Thermal analysis on the absorber

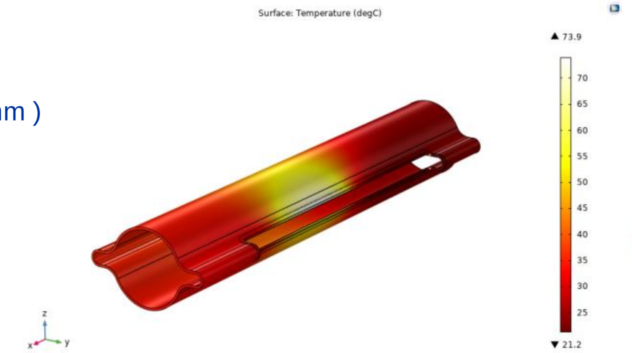


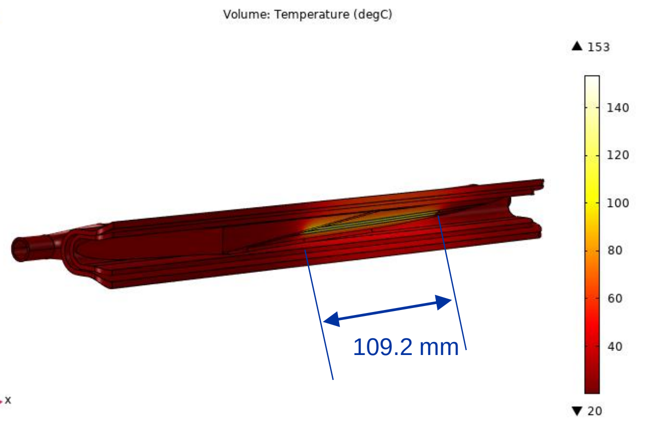
2 x water channel:
Ø 5 mm (INLET Ø 8 mm)

h= 32900 W/m2/K
(**Turbulent flow**)

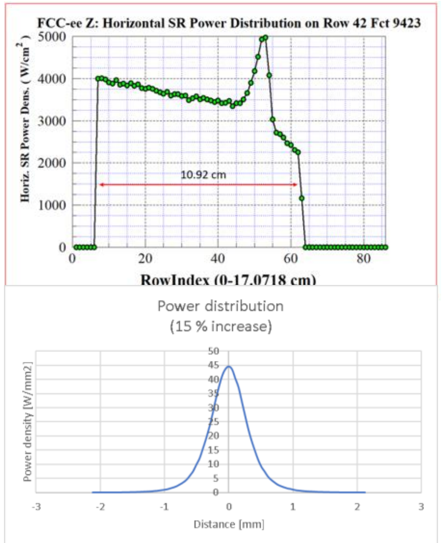


Assessment of the heat transfer coefficient

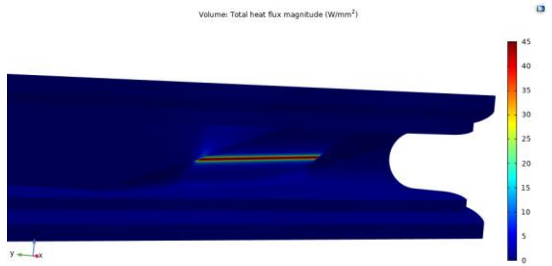




Temperature fields in the chamber and in the absorber

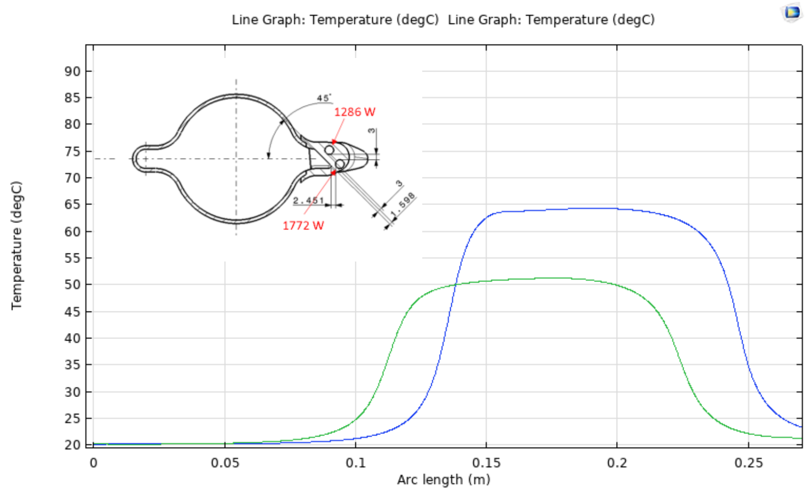


Integrated power is ~ 3 kW over 109.2 mm.



Gaussian distribution for the applied thermal power

Model of the heat deposition

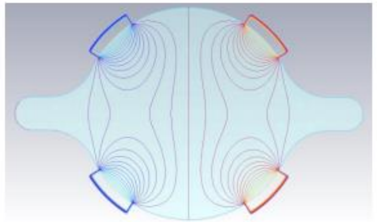


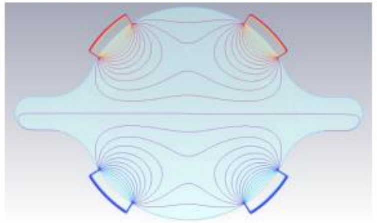
Temperature on the cooling tube wall

FCC-ee vacuum system

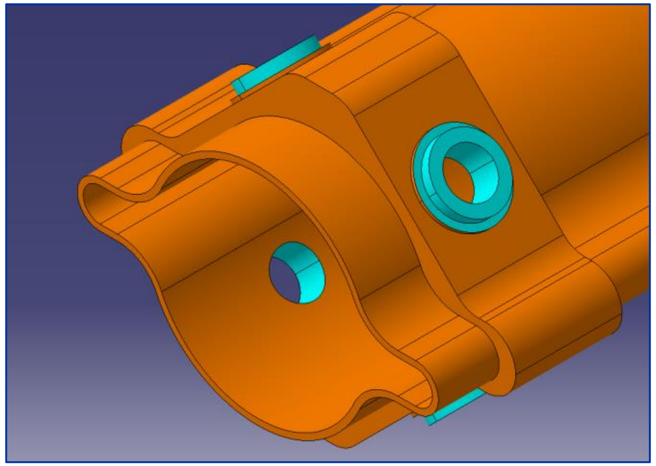
FCC-ee design: SMA applications

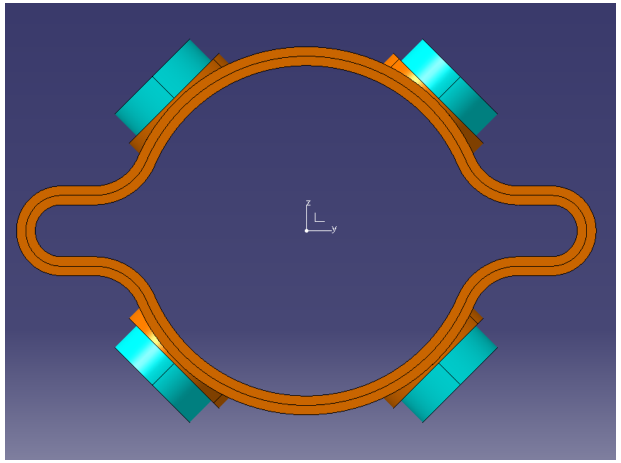
BPM Design Updated


BPM position behaviour: horizontal

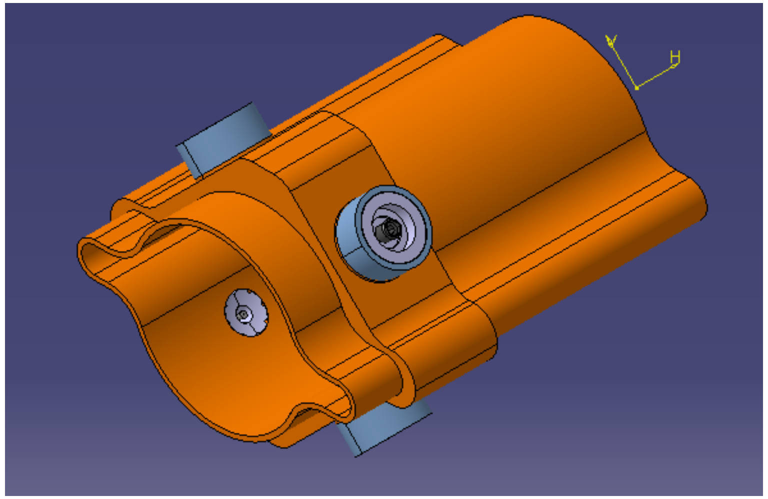

BPM position behaviour: vertical

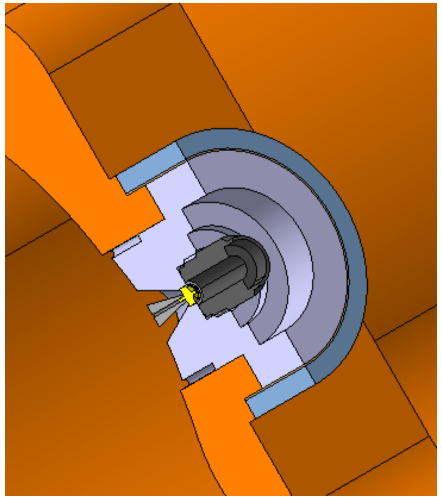
Current analysis from BPM R&D team on optimal locations for BPM pick-ups

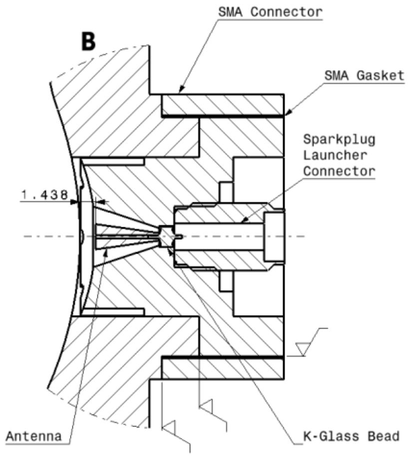




Copper additive manufacturing using cold-spray: Blue area are machined to support SMA couplers and pick-up devices





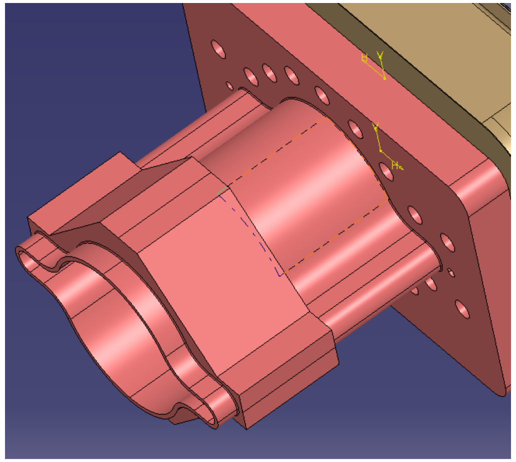


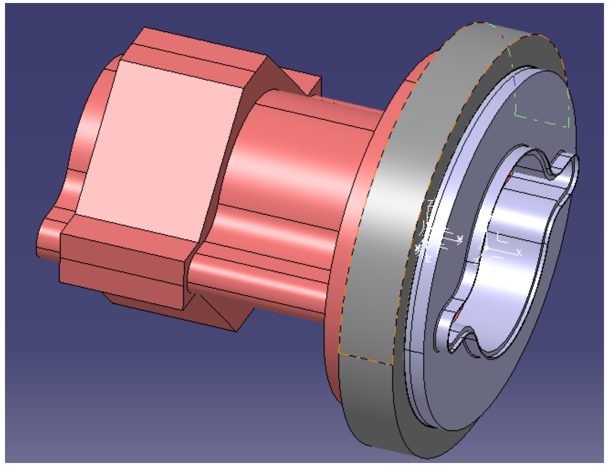
Design update of the FCC-ee BPM block on the vacuum chamber, incorporating the proposed equipment (BPM design given CERN/SY/BI for illustration)

FCC vacuum system

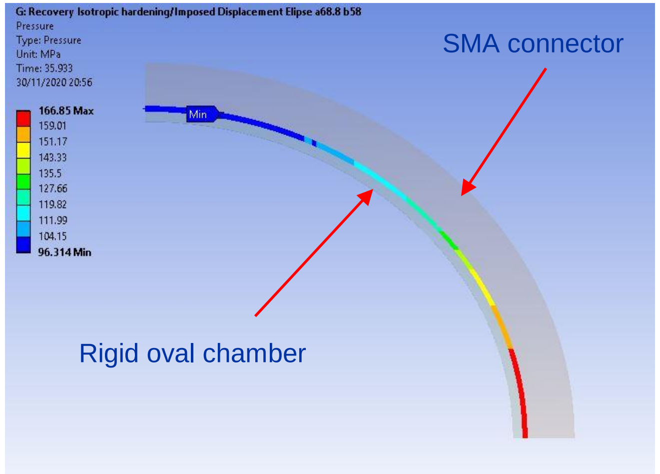
FCC-ee design: SMA applications

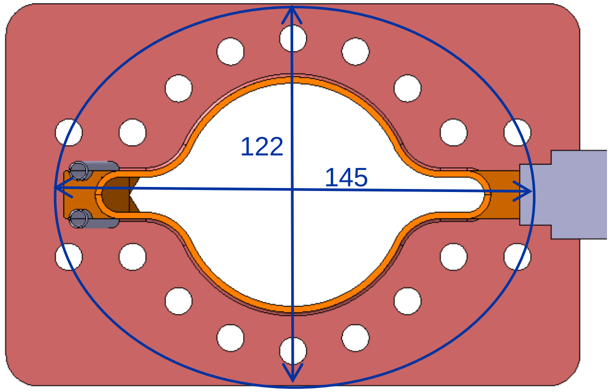
Oval-shaped connectors for FCC-ee chamber



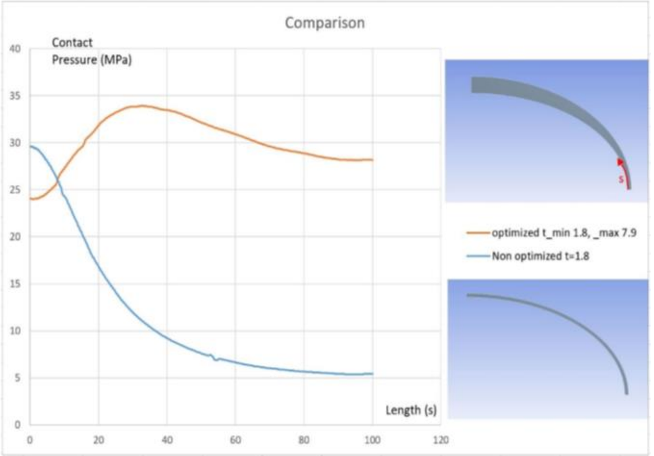


Replacement of bolted flanges by SMA connectors

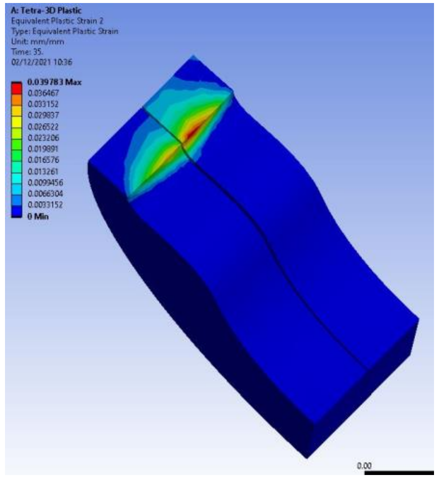




Elliptic profile for SMA connector compatibility



Simulations of contact pressure

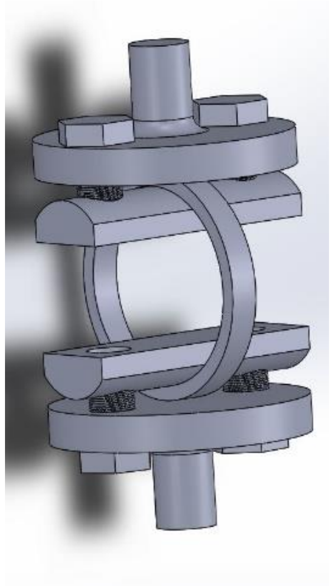


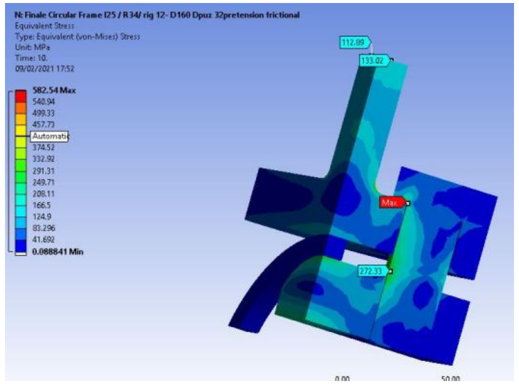
Preliminary analytical calculations and FE simulations

FCC-ee vacuum system

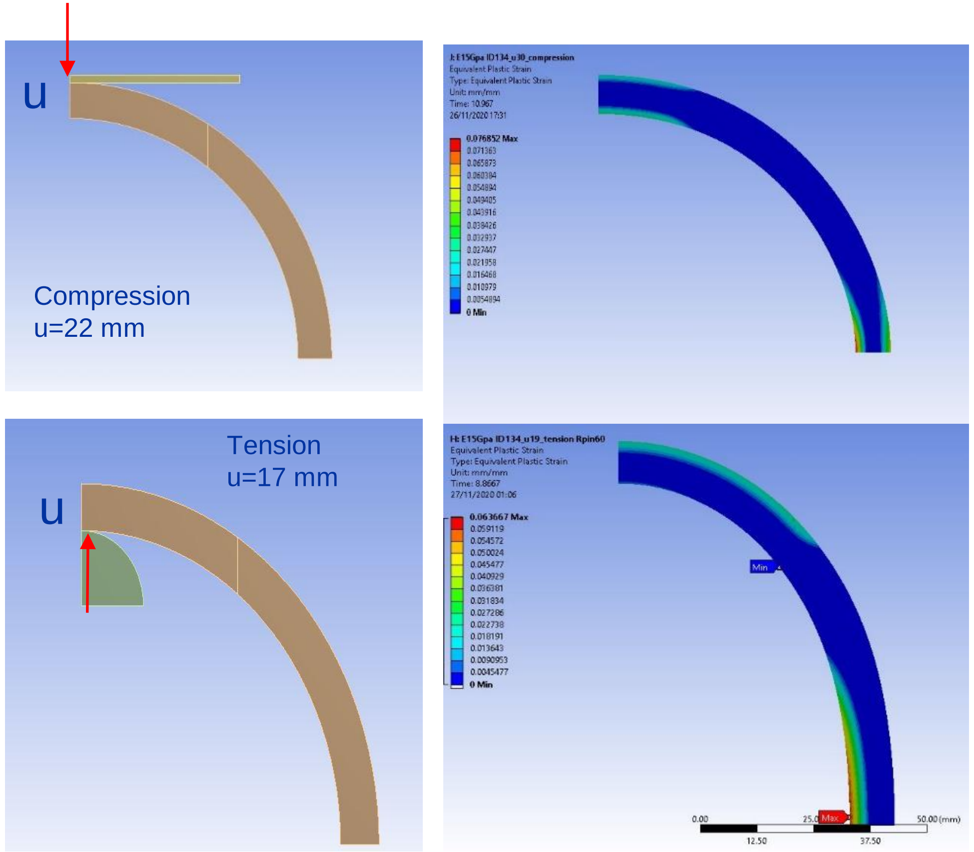
FCC-ee design: SMA applications

Training setup for oval-shaped connectors





Training set-up

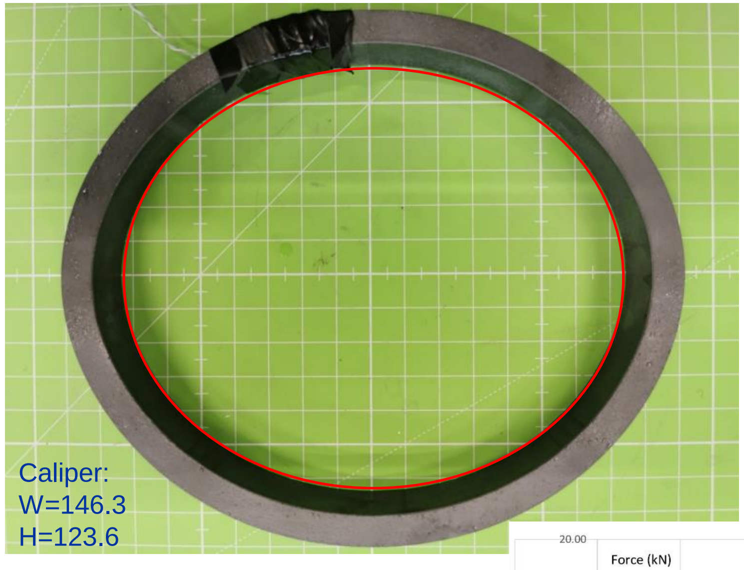


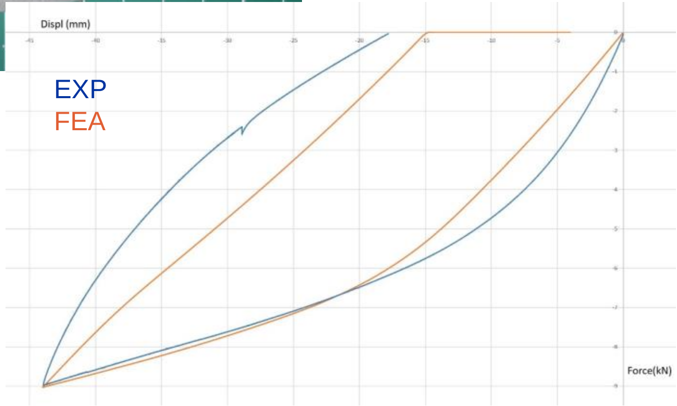
Training parameters optimization based on simulations

FCC-ee vacuum system

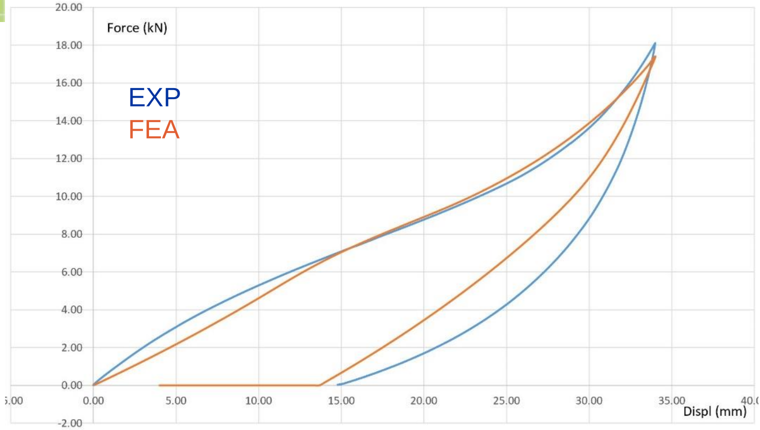
FCC-ee design: SMA applications

Training setup for oval-shaped connectors





Ring 1- Compression



Ring 2- Tension

Future tests: Recovery stress test (contact pressure measurements) and leak-tightness tests

FCC-ee vacuum system

FCC-ee prototyping

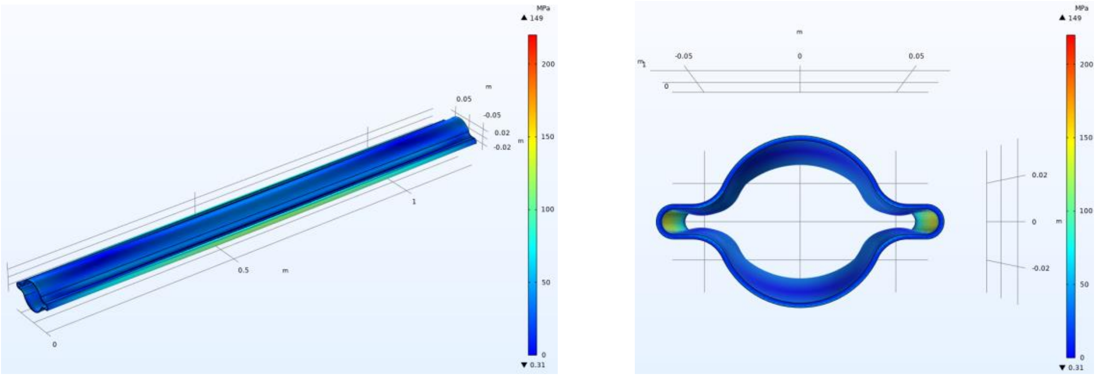
FCC-ee Vacuum Chamber Prototypes

Prototype vacuum chambers delivered.

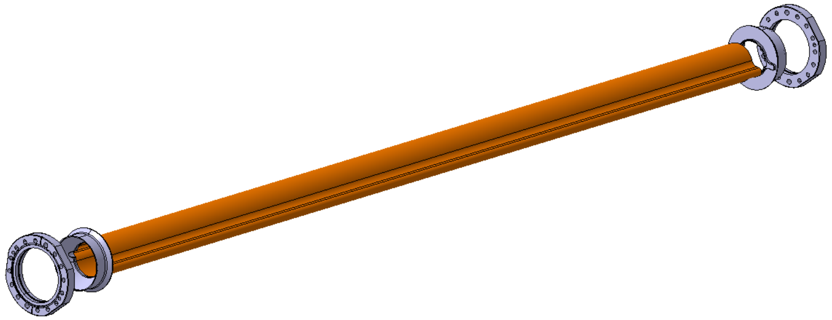
Cold extruded chamber in C10200, 2 mm uniform thickness

First plans for use are:

- Metallography
- Metrology analysis (create 3D image of 5m length to compare against baseline design)
- NEG Coating
- **Integration to magnet system**

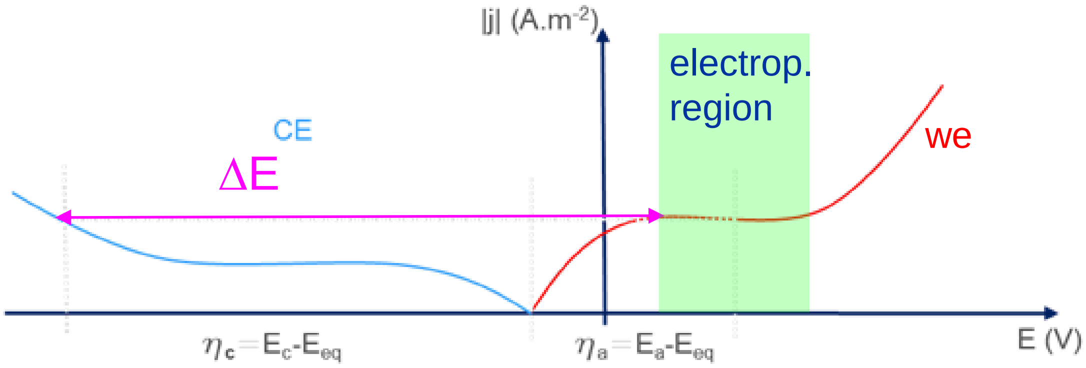


Stress field in the prototype chamber under vacuum



Preliminary study for integration in KARA

FCC-ee SC-RF cavities: electropolishing optimisation



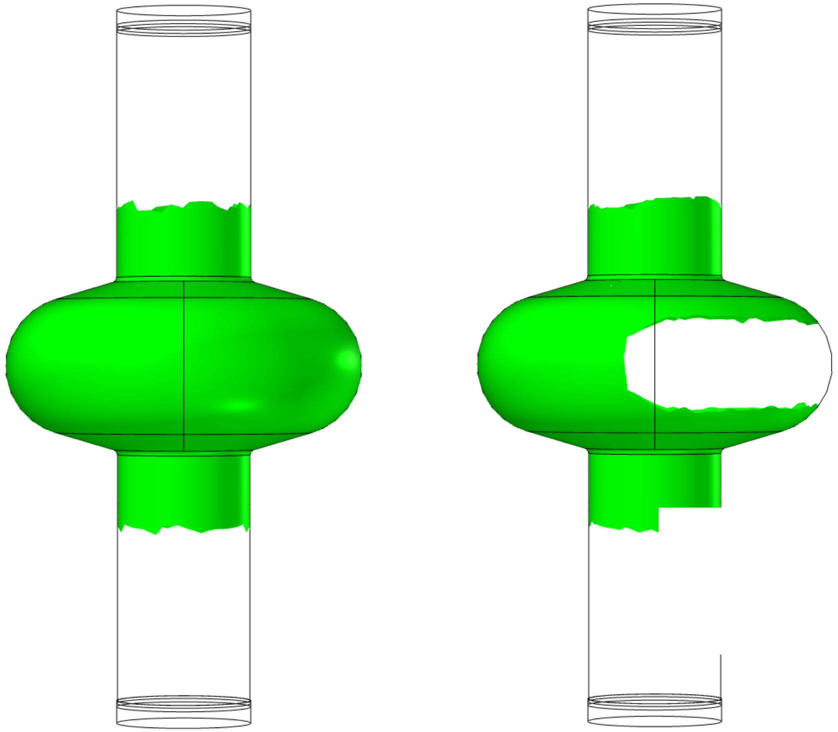
ΔE=U-IR(bath, cables…)

j= f(U,

- j, Current density
- **U, Overall applied tension**
- **T_b, Bath temperature**
- **τ, fluid dynamics**
- Sc/Sa, **Cathode geometry** & Cathodic/Anodic surface rati
- σ_l, Bath conductivity
- [b], Bath composition

1.3GHz
Mass flow rate: 30 L/min
T_b: 15 °C
0.5 rotations per minute
U: 7.4 V

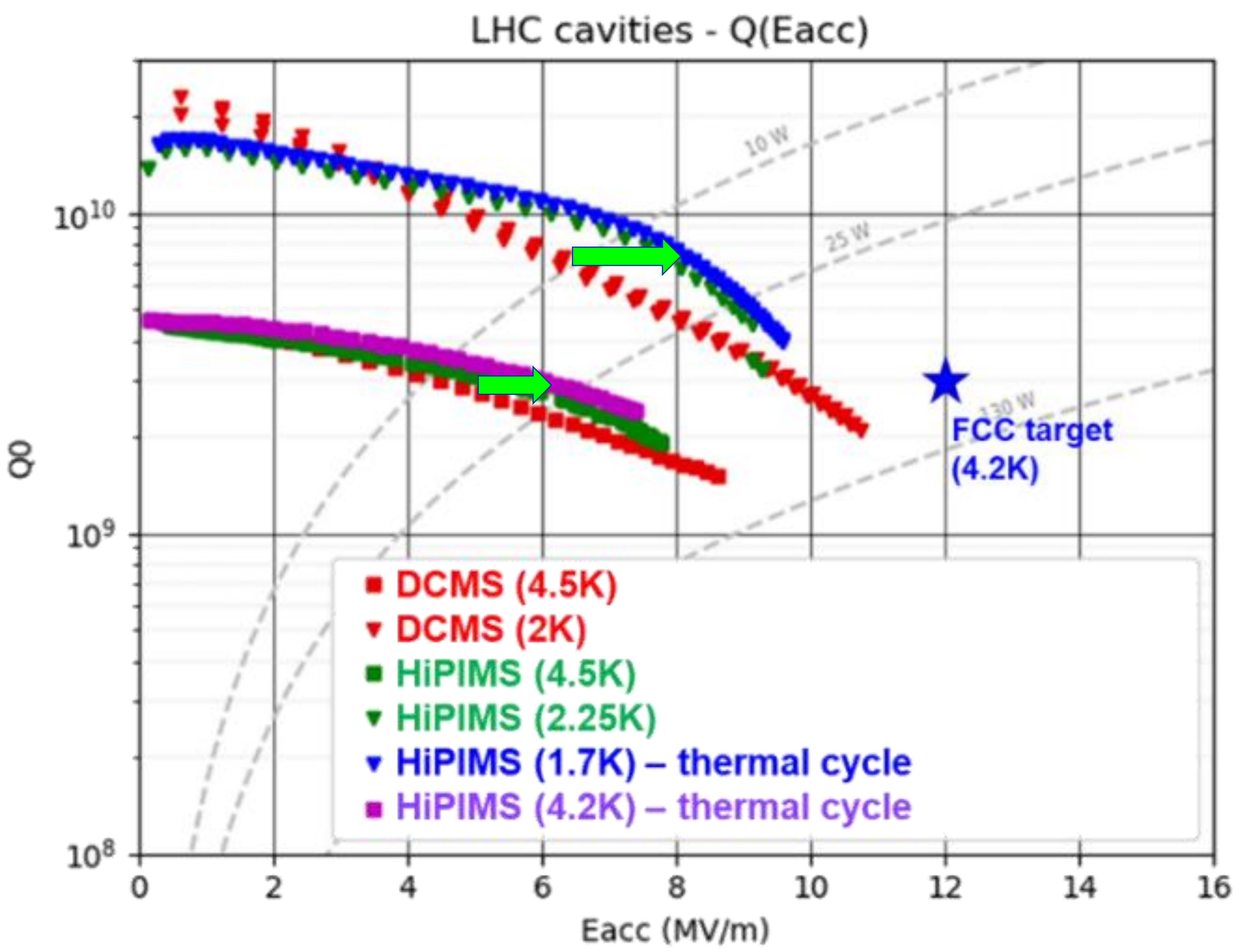
$j = f(\eta_a)$ $\quad$ $j = f(\eta_a, \tau)$



Electropolished area

1.3 GHz

FCC-ee SC-RF cavities: coating optimisation



From DC magnetron sputtering to **HIPIMS***:

- first LHC-like cavity (400MHz)

-more compact coatings, improve the quality factor Q for the cavity (R_{res} ~ 18 nOhms, Target: <10nOhms)

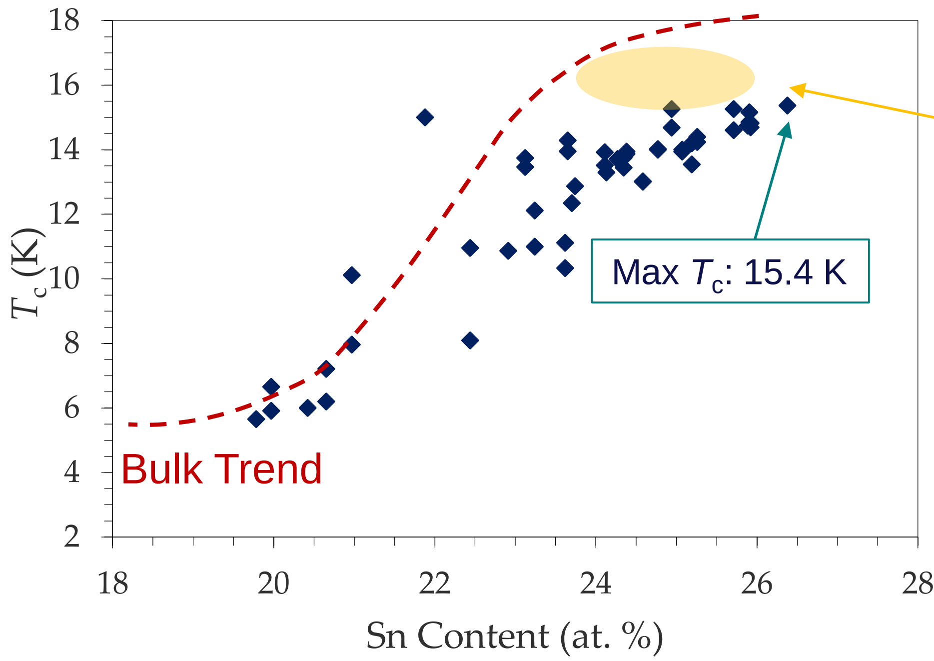
NB: on small 1.3GHz the electropolishing+ HIPIMS proved a surface resistance below 5nOhms!

*HIPIMS: HIgh Power Impulse Magnetron Sputtering

FCC-ee SC-RF cavities: coating optimisation (Nb_3Sn)

Reacted **During** Coating

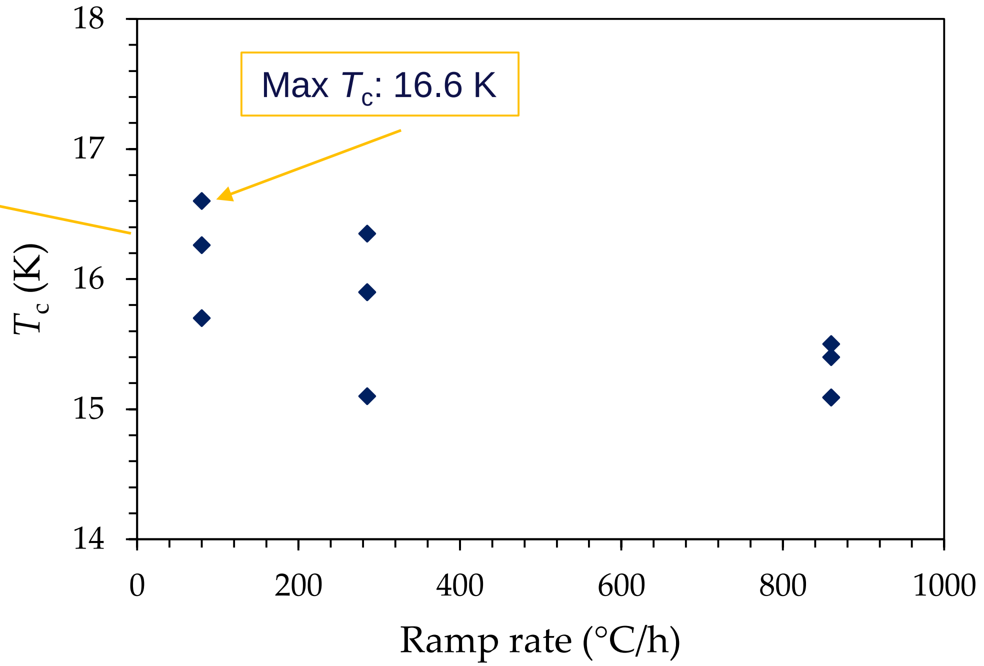
coating temperatures	500 - 750°C
further annealing (in-situ)	24 - 72 h



- Majority of coatings completed this way
- Large parametrical space investigated
- Cu diffusion issue

Reacted **After** Coating (Post-coating annealed)

annealing temperatures 450 - 750°C (1 - 24 hrs)
annealing vacuum much better than in situ

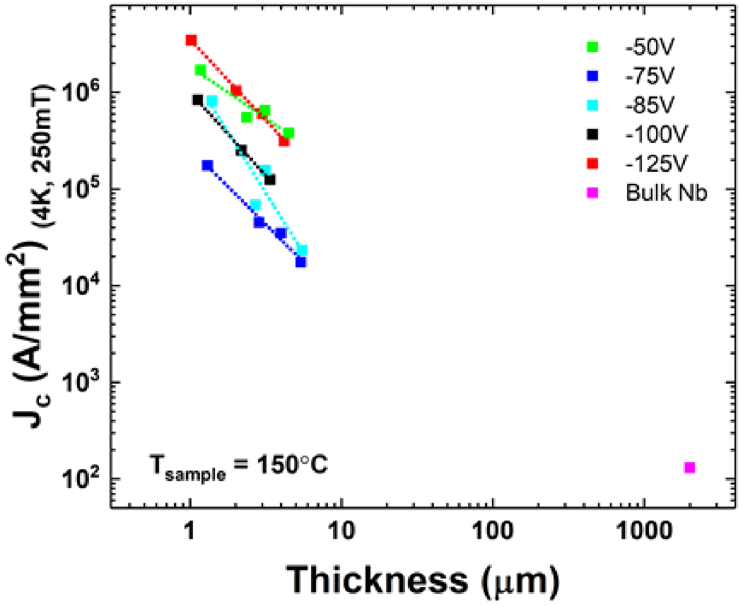


- Reduced Cu diffusion
- Ramp rate dependency
- Improved T_c consistency with Sn enriched target

FCC-ee SC-RF cavities: coating optimisation

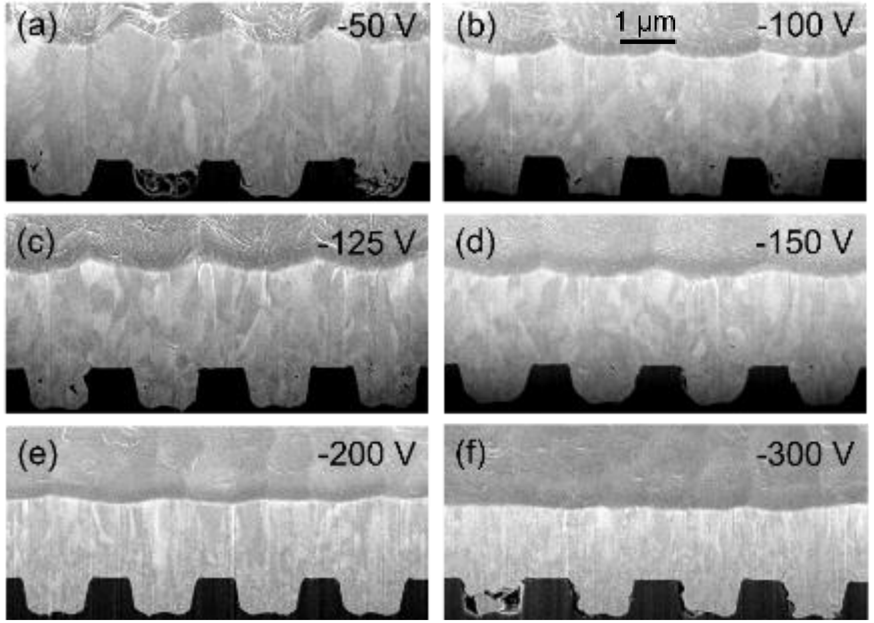
1. Understand relationship between microstructure and RF properties

J_c = metric of crystalline quality
Low J_c = low RF dissipation
Increase maximum gradient



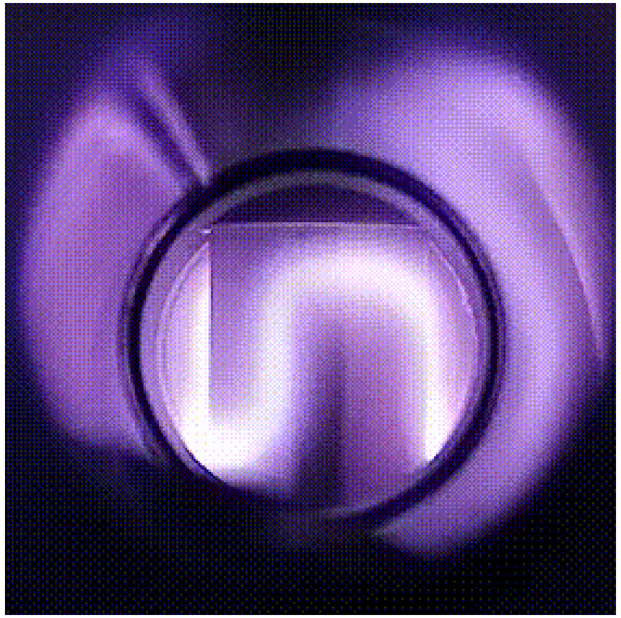
2. Relax requirements on surface treatments

"erase" the substrate by planarization effect

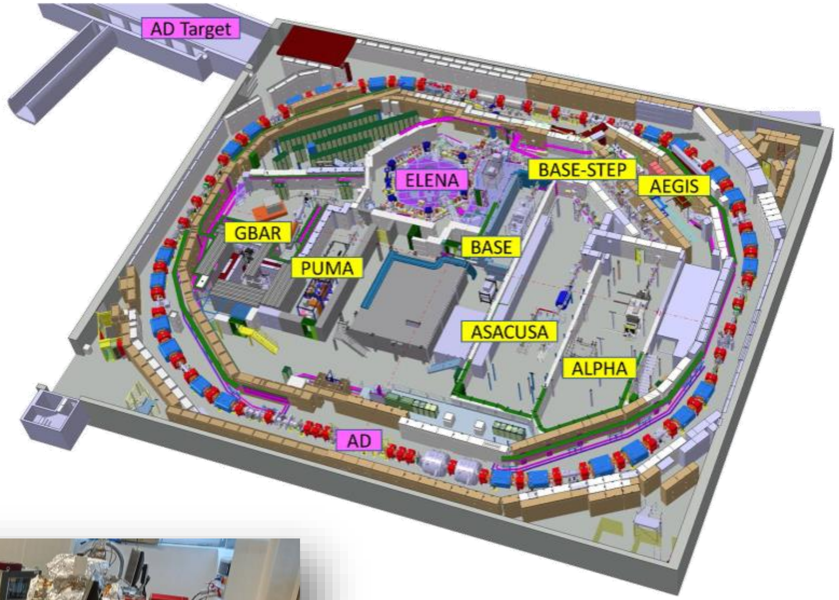


3. Reduce costs

Improve target utilization by shaping the plasma source



PUMA

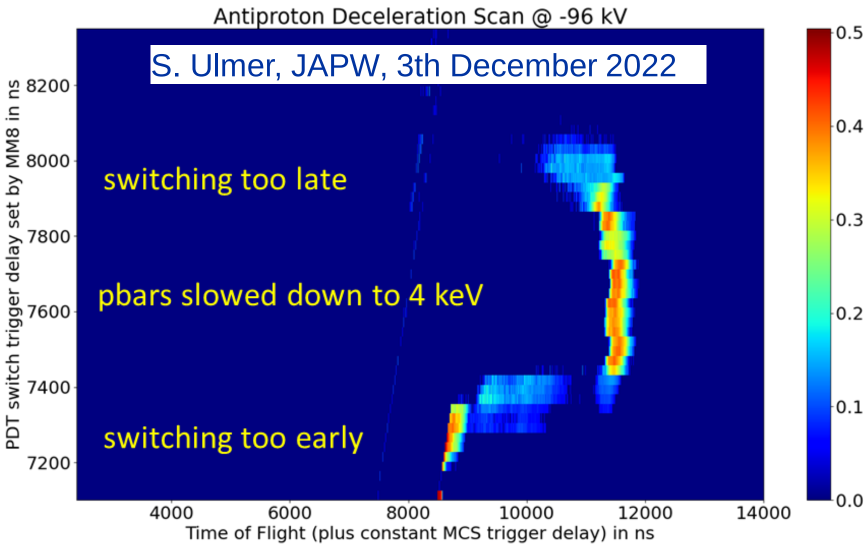


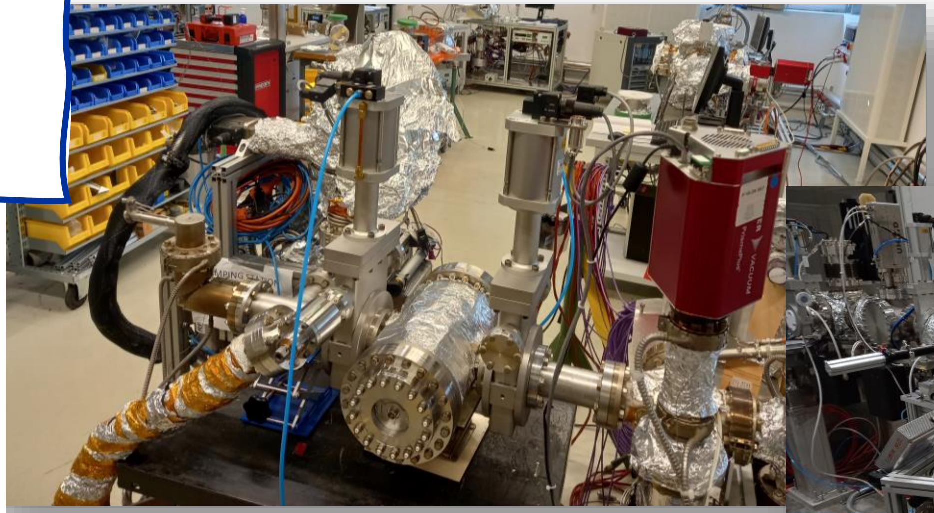
Deceleration of antiprotons from 100 to 4 keV

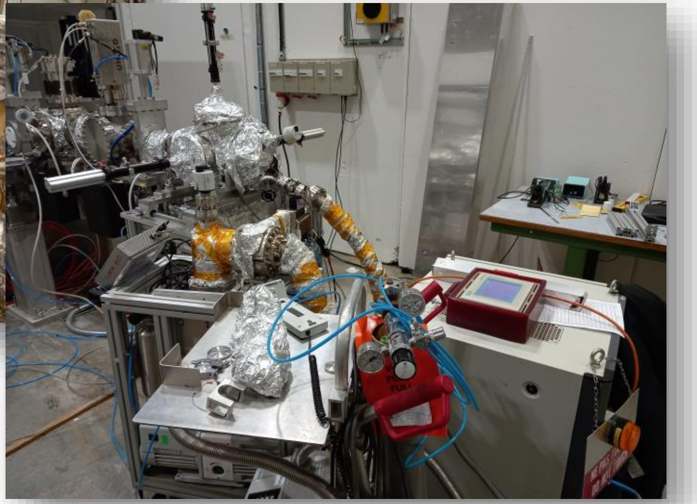
Design of ISOLDE beam line ongoing

<u>Objectives 2023:</u>

- First trapping of antiprotons
- First attempt to transport antiprotons

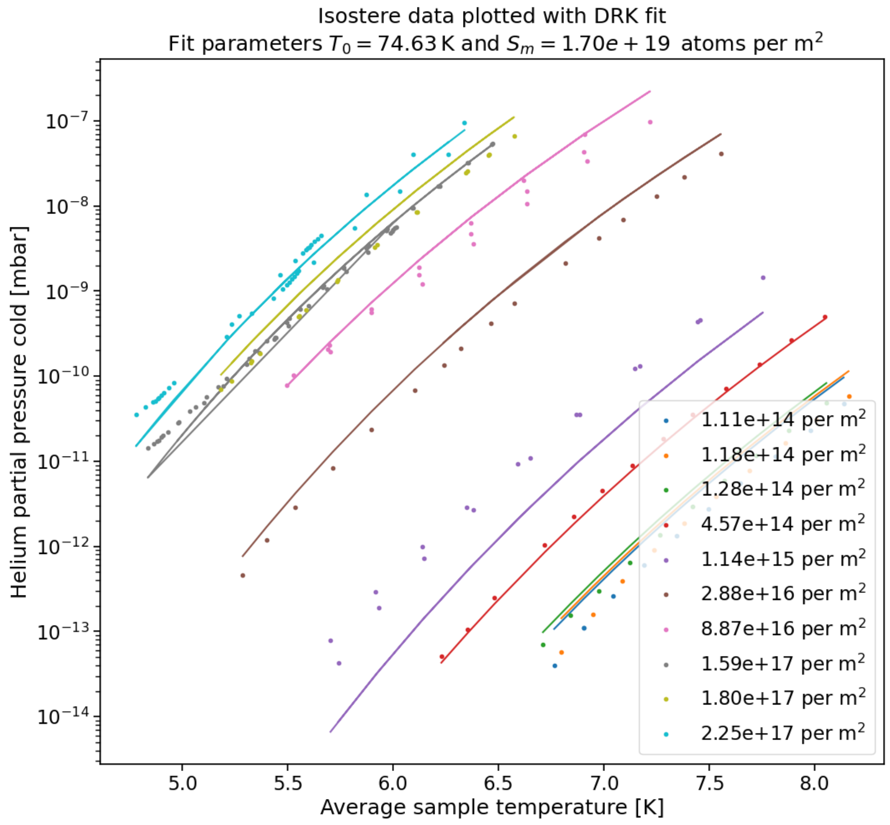




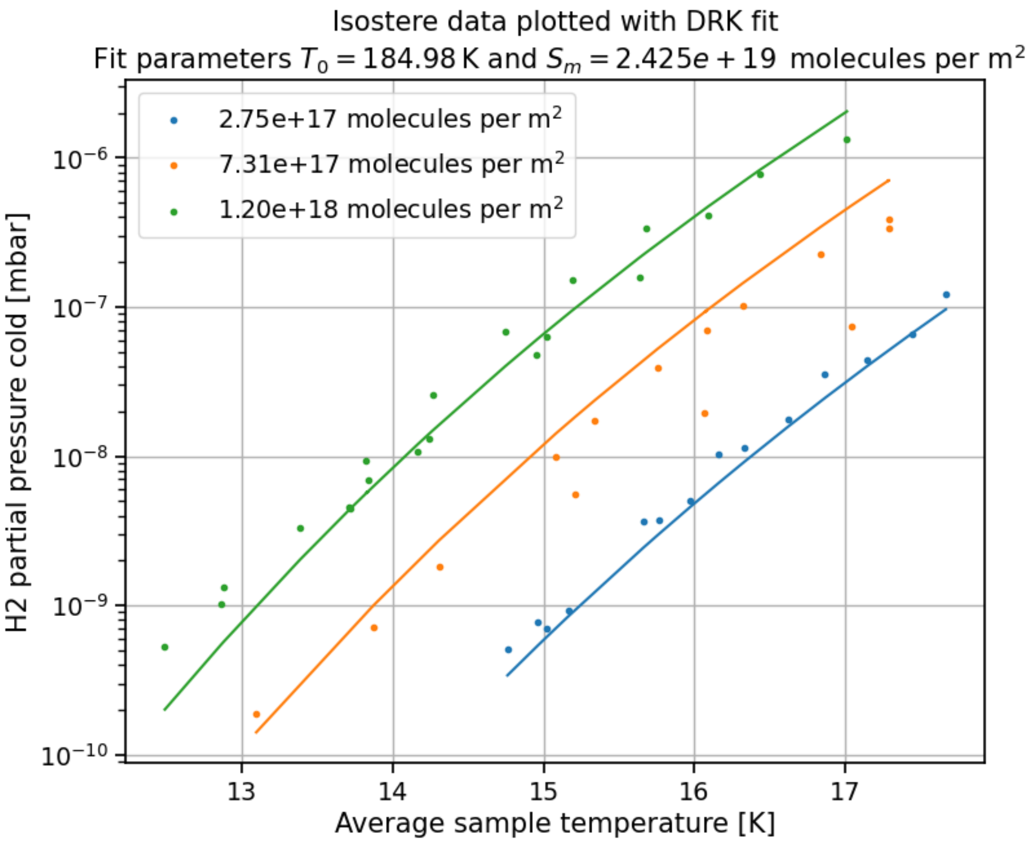


PUMA: H_2 and He isosteres in the 5-20 K range on Cu

Helium



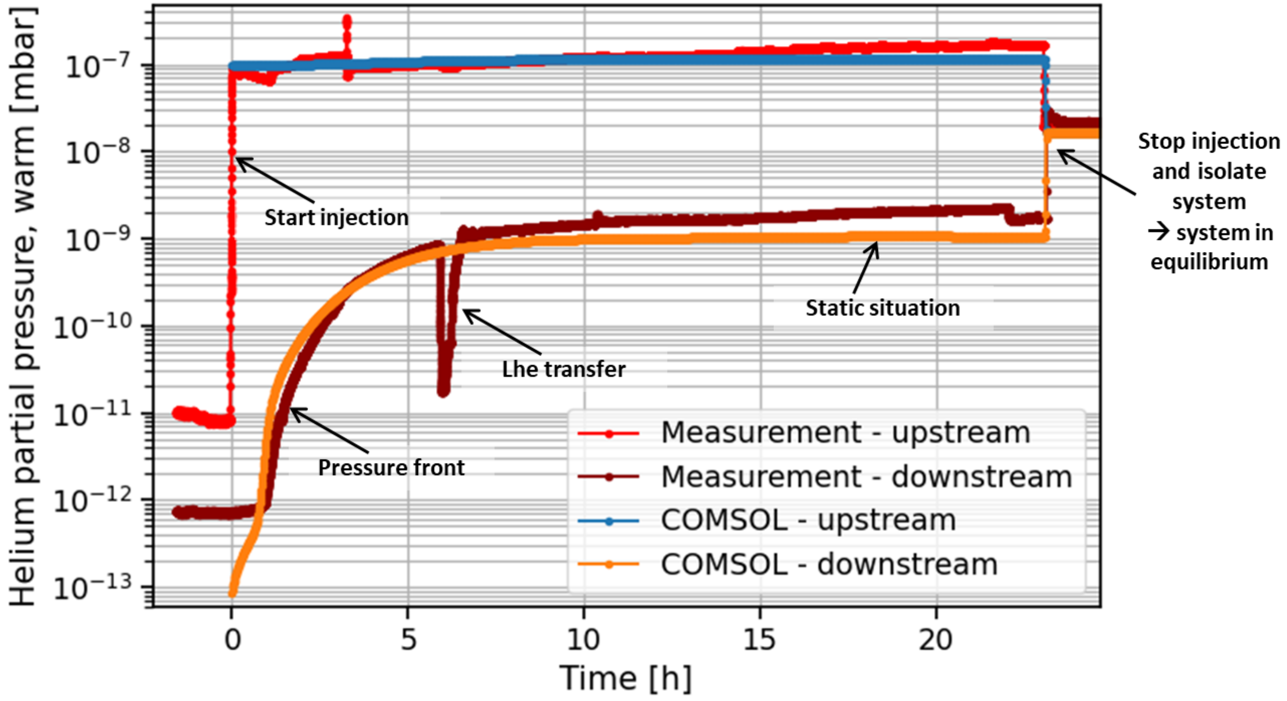
Hydrogen



PUMA: Pressure wave propagation on Cu at cryogenic temperature

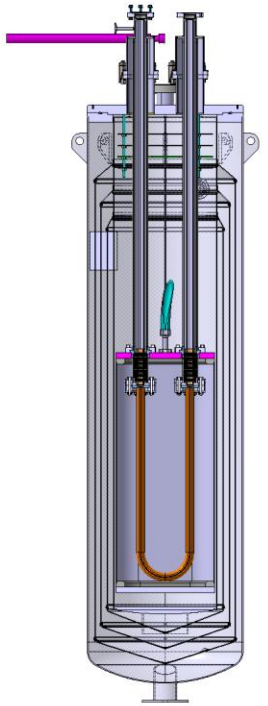
He propagation at 6 K

Simulation in agreement with experimental data



At 5-10 K

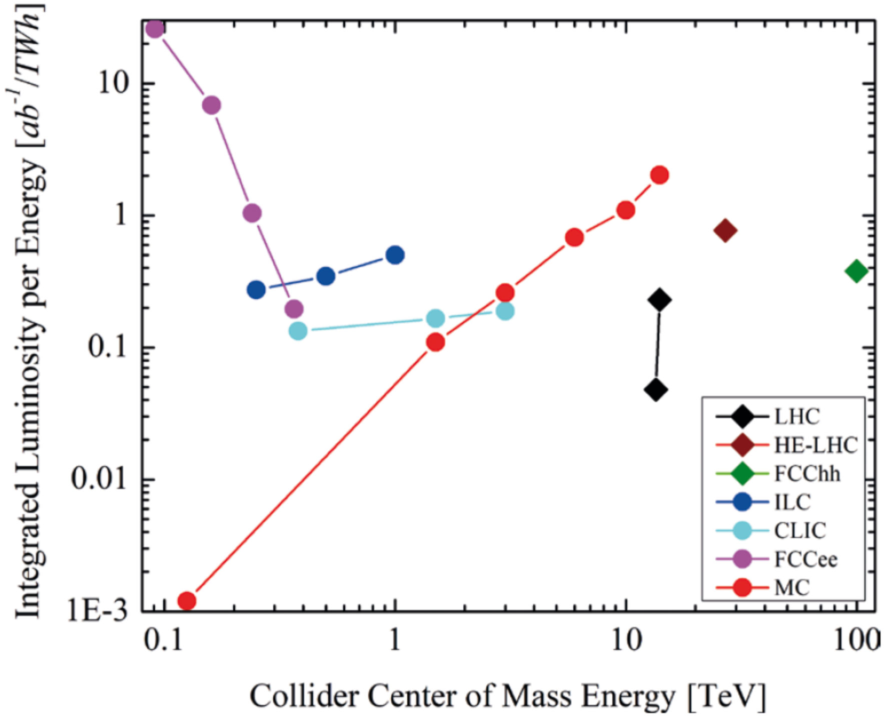
- New cryostat in construction
- a-C surface to slow down the pressure wave



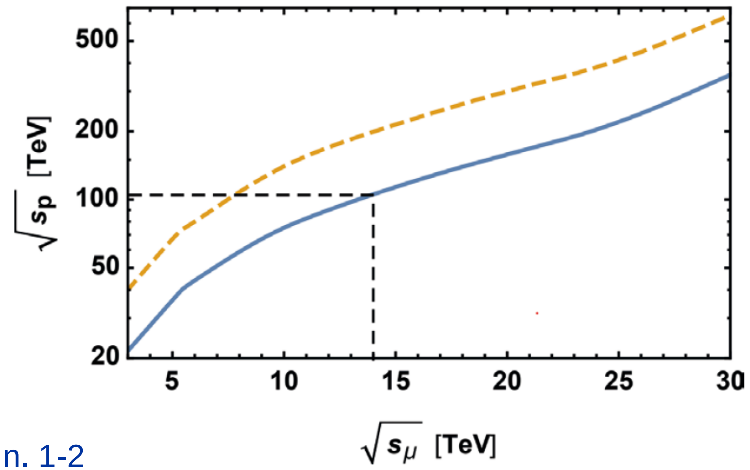
Muon collider

Muons are elementary particles, over **200 times heavier than the electrons**, that therefore emit much **less synchrotron radiation** than the electrons and positrons.

Muon Colliders are the **ideal accelerators to reach multi-TeV center-of-mass energies**, otherwise forbidden in conventional e+ e– linear colliders because of the cost



- Operating a Muon Collider at high energy is convenient with respect to other accelerators.
- No sub-constituents: the full energy can be exploited in the interaction. 14 TeV center of mass muon collisions are equivalent to 100 TeV p-p collisions.



F. Zimmermann, V. Shiltev, https://arxiv.org/pdf/2003.09084.pdf // Nuovo Saggiatore, anno 37, n. 1-2

Muon collider

Building muon colliders is **very challenging**.

Muons decay with a **lifetime of 2.2 $\cdot 10^{-6}$ s if at rest**, while in a machine with a centre-of-mass energy of 3 TeV each beam has an energy of 1.5 TeV and the muons have a longer lifetime, **3.1$\cdot 10^{-2}$ s**. In this very short time, the produced muons have to be accelerated and transferred in the collider to make them interact, possibly several times.

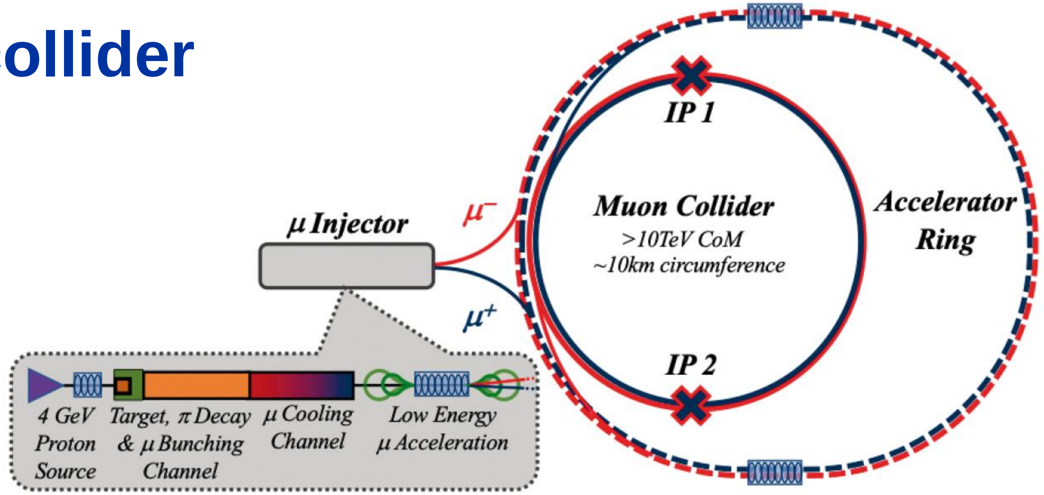
Three stages are needed: muons have to be **produced**, **accelerated** and finally **brought to collision.**

Muons are produced as tertiary particles by decay of pions created with an intense, **typically several MW**, **proton beam interacting with a heavy material target**.

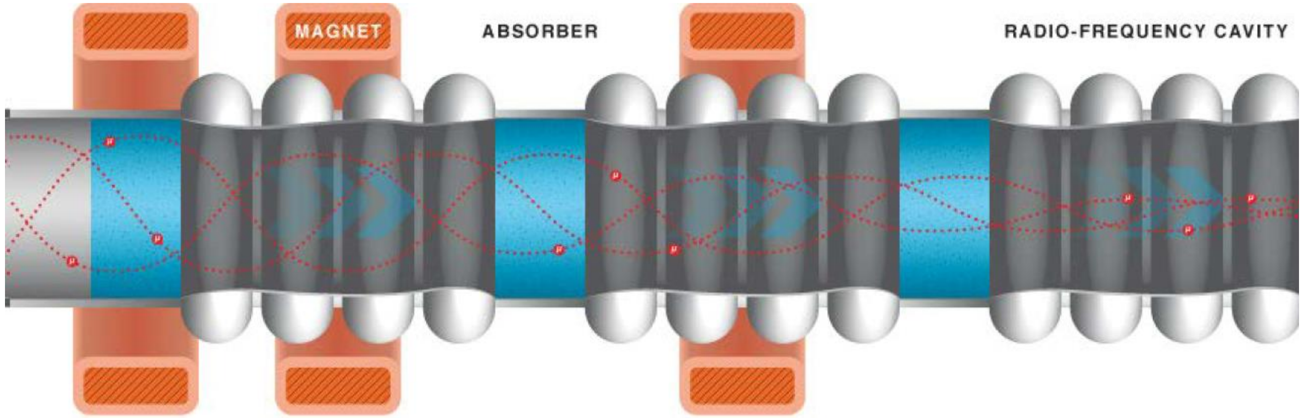
The muon beam is **produced with low energy** and hence a limited lifetime.
It has **very large transverse and longitudinal emittances**.
It needs **to be cooled** by approximately five orders of magnitude in the six-dimensional (6D) transverse and longitudinal phase space.

The beam has to be **accelerated rapidly** to avoid excessive muon decay.

Muon collider



A **solenoidal cooling** channel was proposed and cooling of muons was demonstrated by using both **liquid hydrogen and lithium hydride absorbers**



Ionization cooling is achieved by reducing the beam momentum through ionization energy loss in absorbers and **replenishing the momentum loss only in the longitudinal direction** through radio frequency (RF) cavities.

Muon collider

An impressive list of problem to solve, including **radiological hazard**.

The muon decay

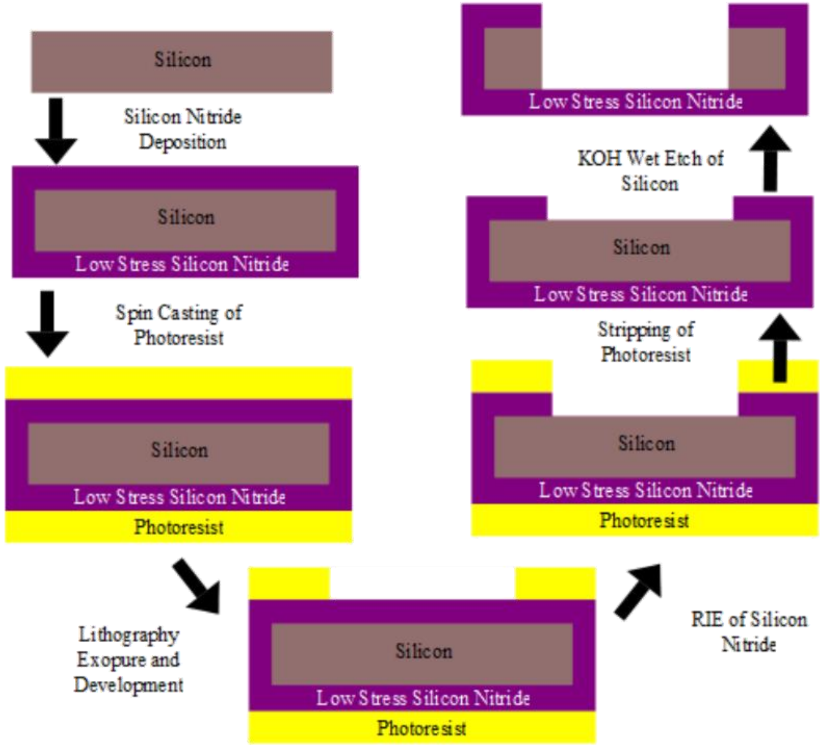
$$\mu^- \rightarrow e^- \bar{\nu}_e \nu_\mu$$

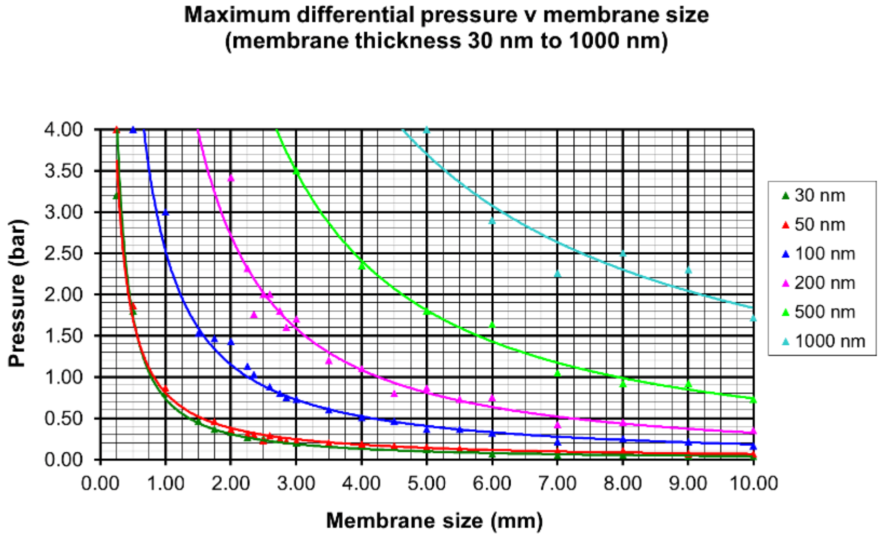
and its charge conjugate are the major source of background in a Muon Collider. The decay neutrinos coming from muon decays do not affect the detector design due to the low interaction cross section, but the secondary radiation, hadrons, muons and electrons **produced by the neutrino** interaction with the earth could constitute a problem.

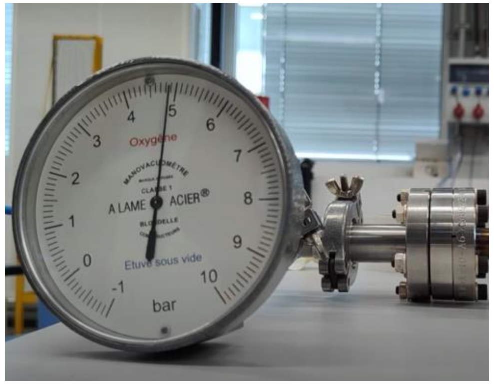
TE-VSC participate in the study. Our task is to contribute to the feasibility study of ionisation cooling investigating very thin beam window separating vacuum from liquid hydrogen.

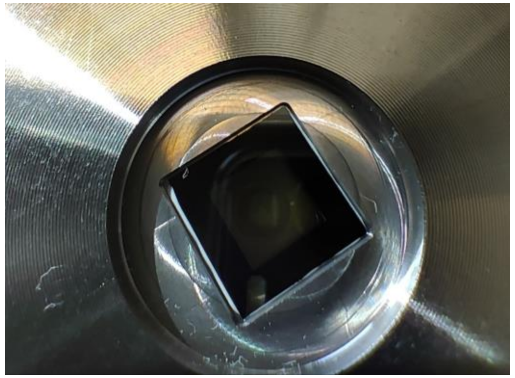
Muon collider

H_2 Absorber	Length	Max P (bar)	Max T (K)	P assuming power deposited in $3\times\sigma_{RMS}$ (bar)	K assuming power deposited in $3\times\sigma_{RMS}$ (K)
RT@1bar	124 m	1.3	373	1.04	303
RT@4bar	31 m	5.2	373	4.18	303
20.3K@1bar vapor	8 m	7.5	140	1.8	34
26.1K@4bar vapor	2.1 m	29.2	143	7	40
20.3K@1bar liquid	15 cm	833	128	125	35





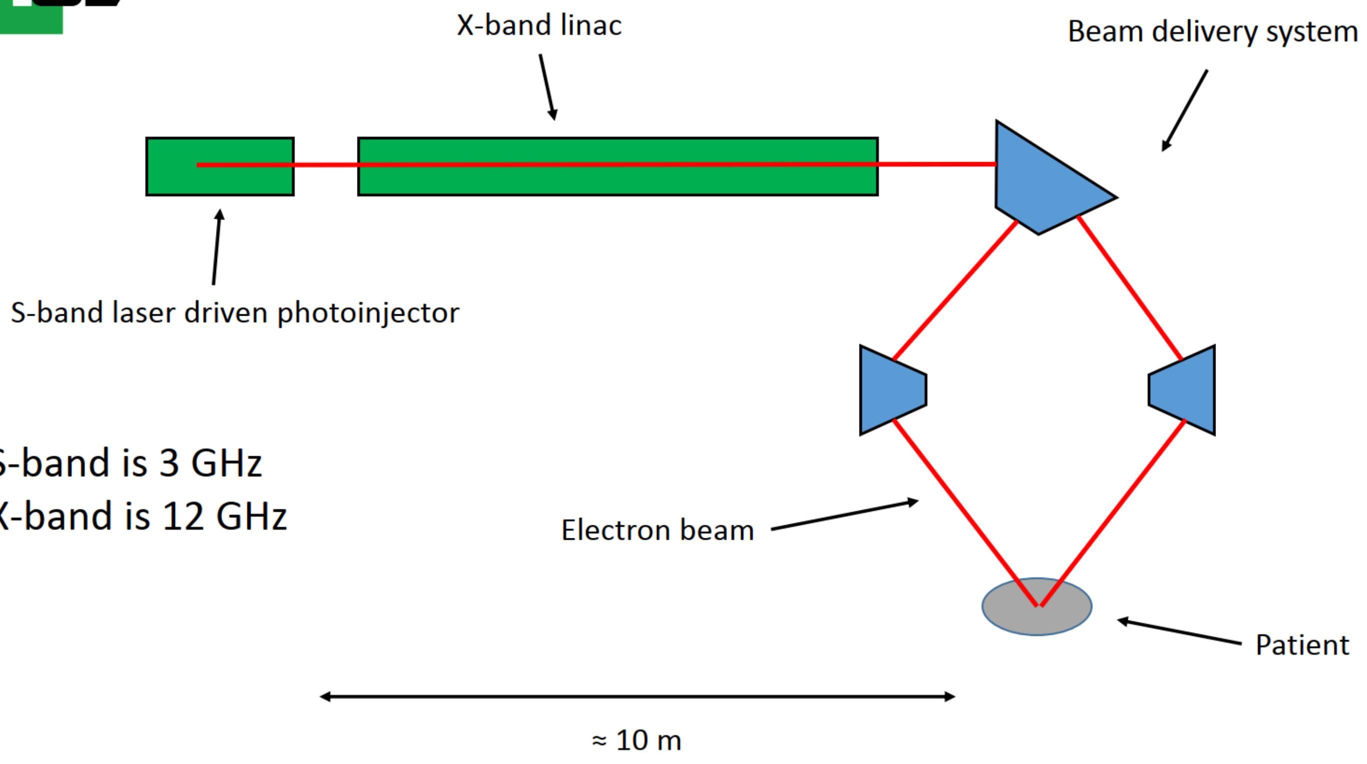




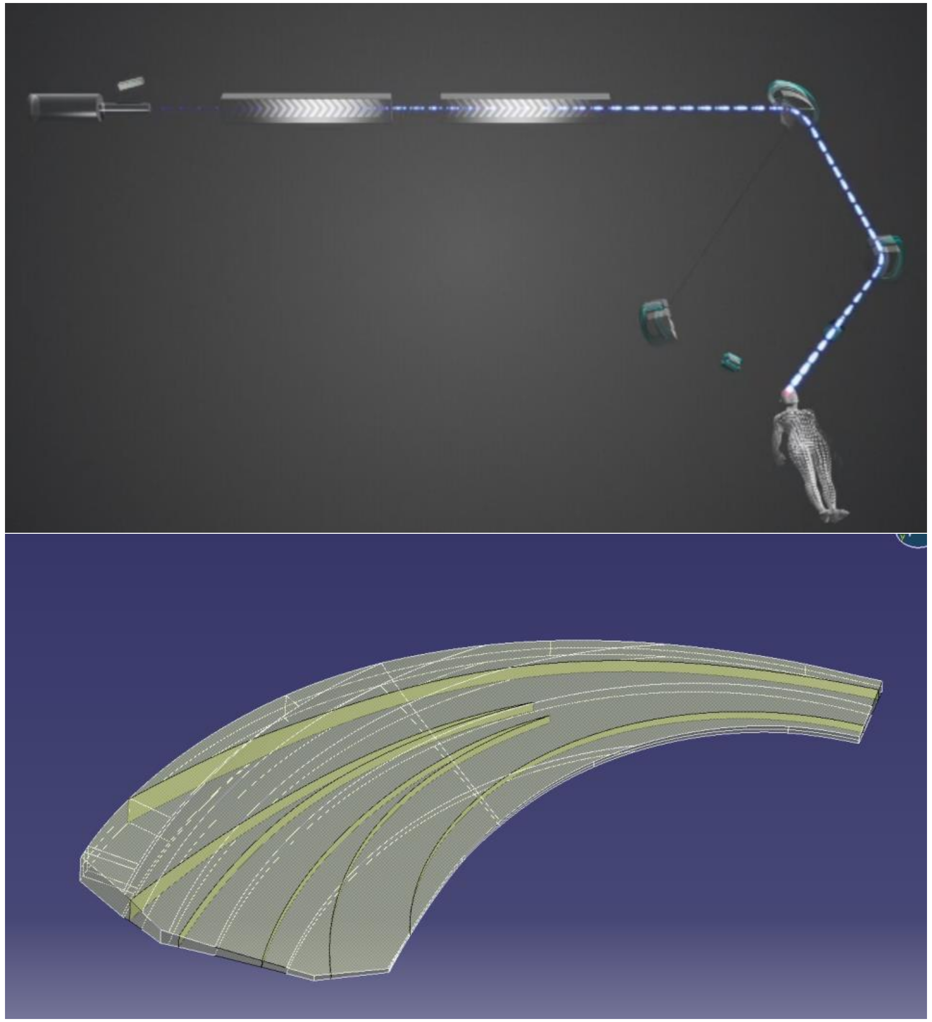
1 µm 6×6mm Si_2N_3 window → ≈5 bar pressure

DEFT: Deep Electron FLASH Therapy

CHUV



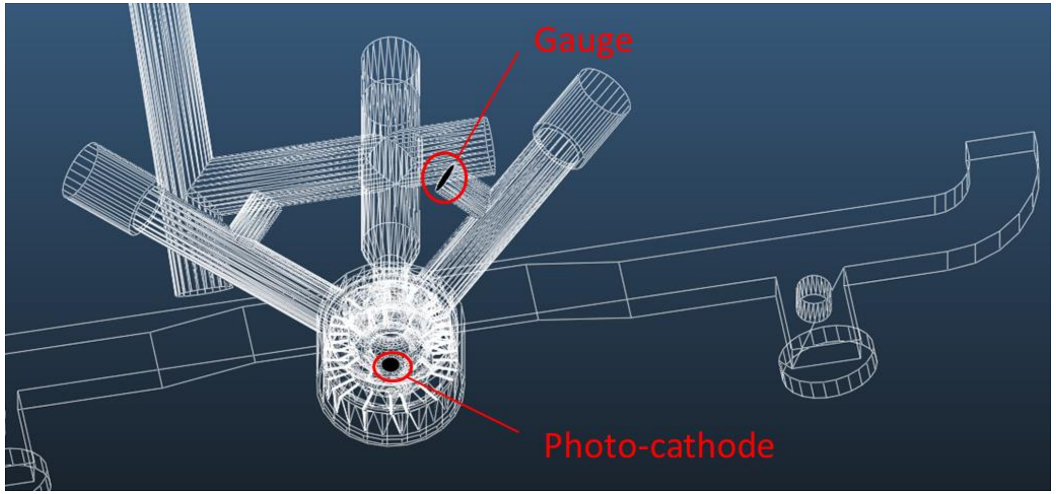
S-band is 3 GHz
X-band is 12 GHz

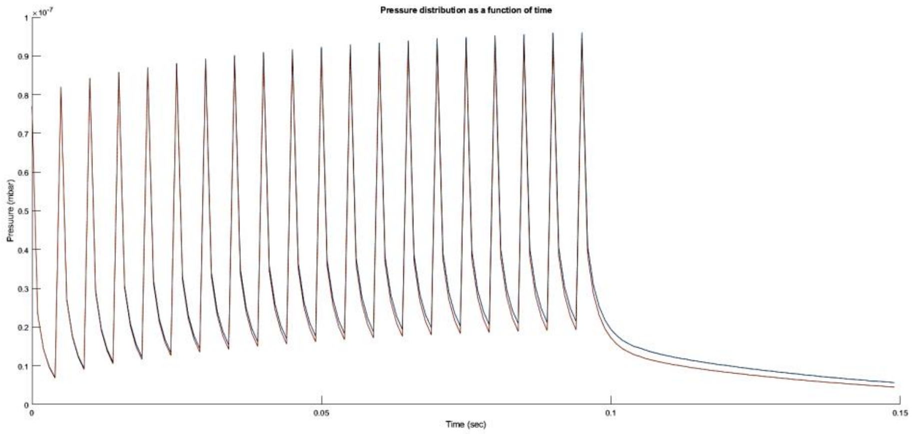


Design of the FLASH therapy vacuum chamber placed in a bending magnet.

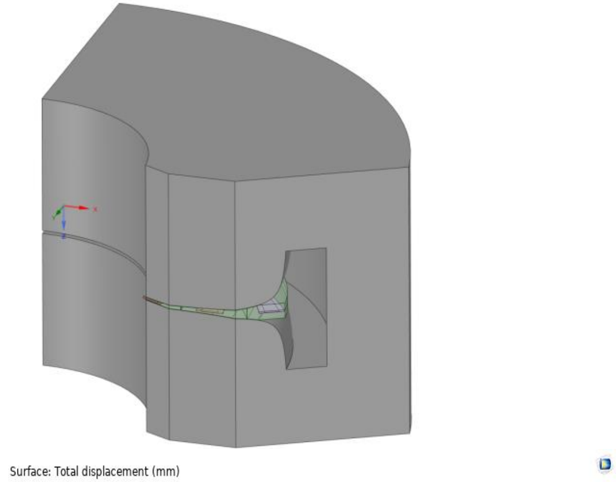
DEFT: Deep Electron FLASH Therapy

Time dependent pressure profile in the photo-cathode area

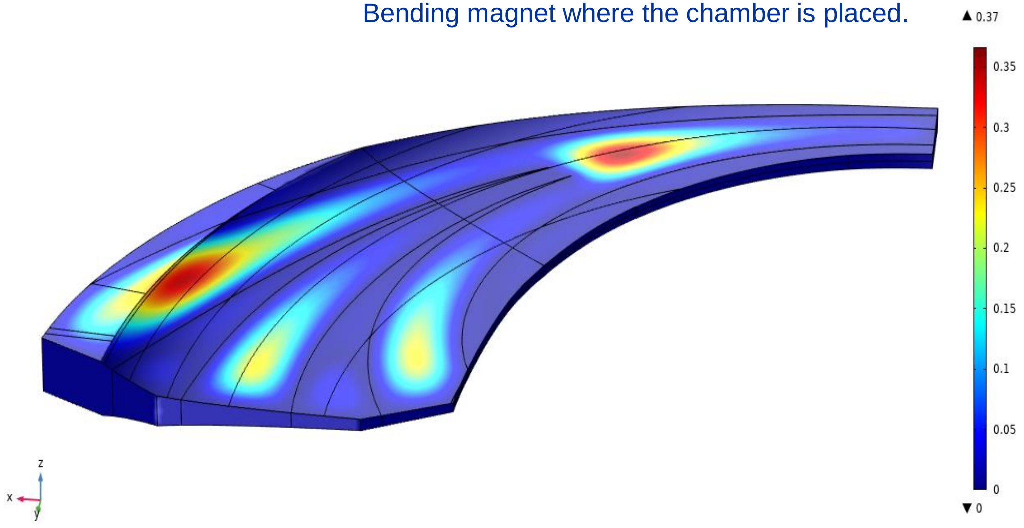




Design of the FLASH therapy vacuum chamber placed in a bending magnet.

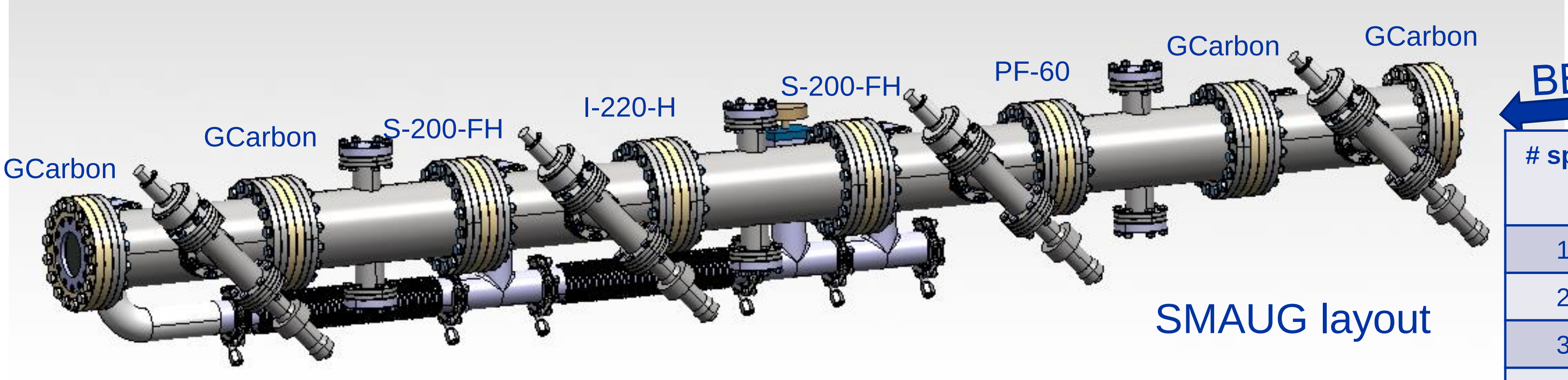


Bending magnet where the chamber is placed.



Displacement map of the vacuum chamber due to external pressure. Load factor : 38.

HiRadMat – SMAUG vacuum window experiment



SMAUG layout

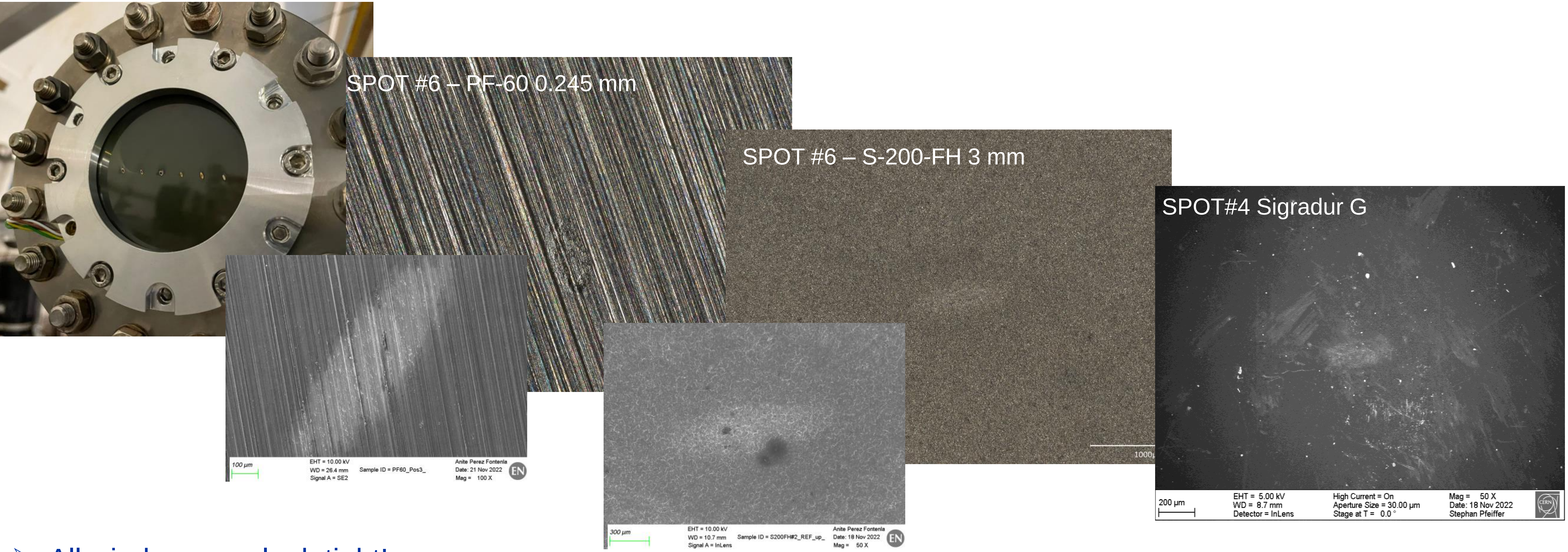
# spot	Beam size	Intensity	# shots at 288 bunches
1	0.5	$1.6*10^{+11}$	5
2	0.5	$1.6*10^{+11}$	50
3	0.35	$1.2*10^{+11}$	5
4	0.35	$1.2*10^{+11}$	50
5	0.35	$1.6*10^{+11}$	5
6	0.35	$1.6*10^{+11}$	50

Assembly in BA7

Transport to TNC

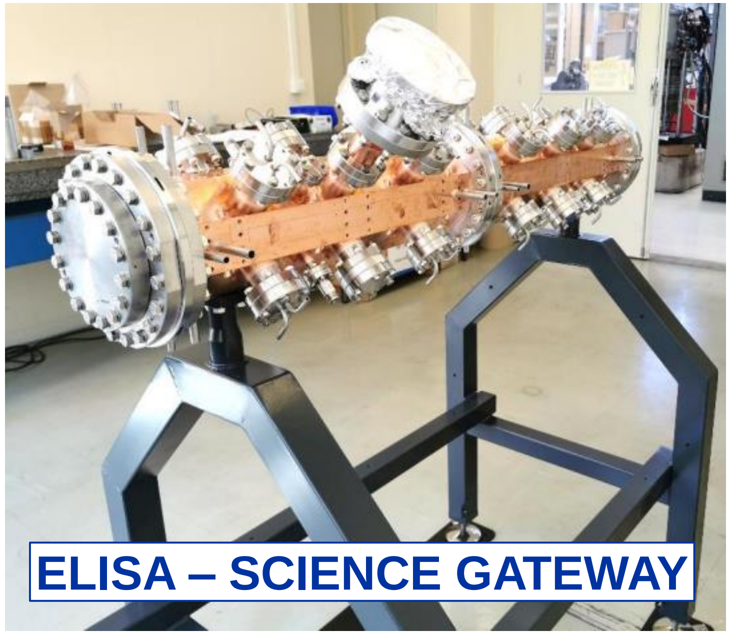
CCC – SMAUG run!

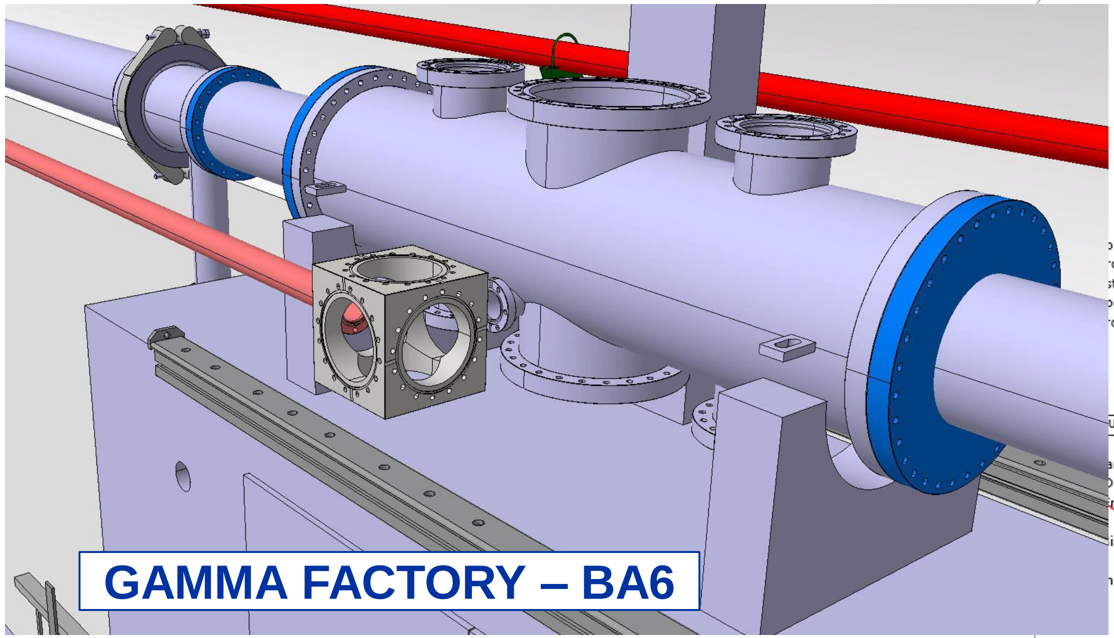
HiRadMat – SMAUG vacuum window experiment

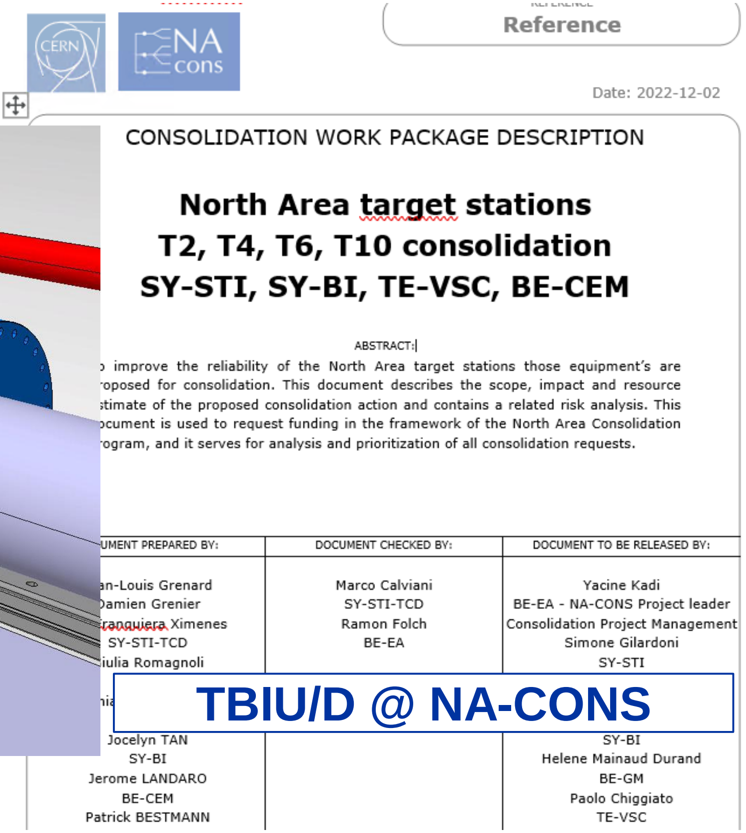


- All windows are leak tight!
- Optical microscopy: clear marks of point 2-4-6 on G-carbon and Be alloyed sample; clear marks of point 4 and 6 on PF-60.
- The Facility limit in terms of brightness is moved from 0.5*10^13 p+/mm2 to 1.8*10^14 p+/mm2 (beyond LIU);
- A new layout is under study within the HRM upgrade working group.

Other projects: ELISA, CNAO gantry, gamma factory,…


ELISA – SCIENCE GATEWAY


GAMMA FACTORY – BA6


Reference

Date: 2022-12-02

CONSOLIDATION WORK PACKAGE DESCRIPTION

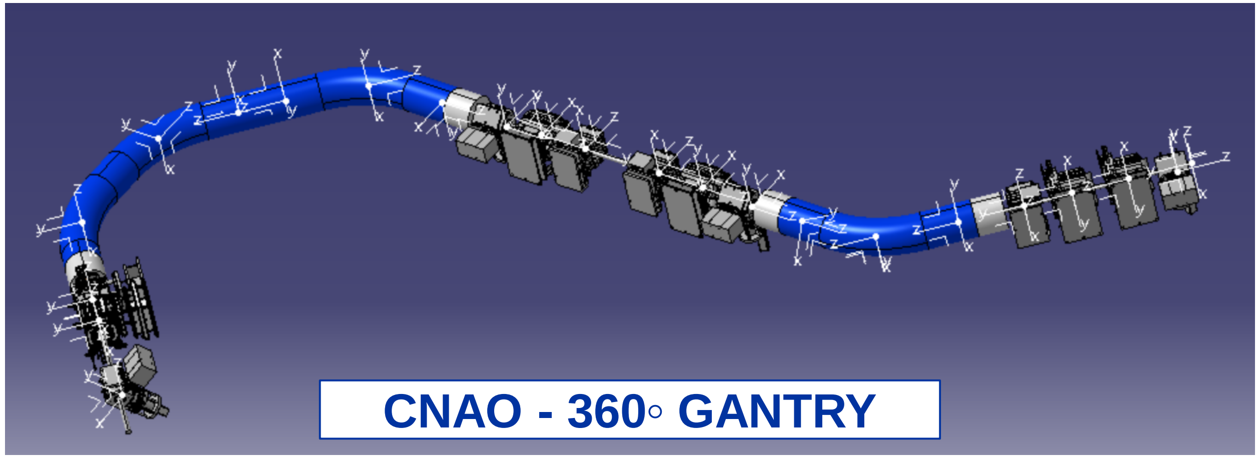
North Area target stations
T2, T4, T6, T10 consolidation
SY-STI, SY-BI, TE-VSC, BE-CEM

ABSTRACT:

› improve the reliability of the North Area target stations those equipment's are ›roposed for consolidation. This document describes the scope, impact and resource ›stimate of the proposed consolidation action and contains a related risk analysis. This ›ocument is used to request funding in the framework of the North Area Consolidation ›rogram, and it serves for analysis and prioritization of all consolidation requests.

›UMENT PREPARED BY:	DOCUMENT CHECKED BY:	DOCUMENT TO BE RELEASED BY:
›an-Louis Grenard ›amien Grenier ›ranquiera Ximenes SY-STI-TCD ›iulia Romagnoli ›ni… Jocelyn TAN SY-BI Jerome LANDARO BE-CEM Patrick BESTMANN	Marco Calviani SY-STI-TCD Ramon Folch BE-EA	Yacine Kadi BE-EA - NA-CONS Project leader Consolidation Project Management Simone Gilardoni SY-STI … SY-BI Helene Mainaud Durand BE-GM Paolo Chiggiato TE-VSC

TBIU/D @ NA-CONS


CNAO - 360◦ GANTRY

284

Next generation of GWD: Einstein Telescope

ADDENDUM NO. 1
KR5427/TE
TO
FRAMEWORK COLLABORATION AGREEMENT
KN 4657/DG

BETWEEN: THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH ("CERN"), an Intergovernmental Organization having its seat at Geneva, Switzerland,

AND: THE ITALIAN NATIONAL INSTITUTE FOR NUCLEAR PHYSICS ("INFN"), established in Rome, Italy,

AND THE DUTCH NATIONAL INSTITUTE FOR SUBATOMIC PHYSICS ("Nikhef"), established in Amsterdam, The Netherlands,

Hereinafter each individually referred to as a "Party" and collectively as the "Parties",

CONSIDERING THAT:

Framework Collaboration Agreement KN4657/DG (the "Agreement") concluded between the Parties defines the framework applicable to collaboration between them in domains of mutual interest.

Article 2.1 of the Agreement provides that the scope, each Party's contributions, and all other details of each specific project shall be set out in Addendum to the Agreement.

The Parties have identified the collaborative project set out below, which shall be covered by the provisions of this Addendum No. 1 (the "Addendum"),

AGREE AS FOLLOWS:

Article 1
Purpose

1.1 Under the terms of this Addendum, the Parties shall collaborate in the development of the vacuum systems of the arms of the Einstein Telescope ("ET") (the "Project"). The Project is outlined in Annex 1.

1.2 The Parties shall use the results and resources of their collaboration for non-military purposes only. INFN and Nikhef shall ensure compliance with this obligation by the ET Consortium members.

1.3 This Addendum shall be subject to the provisions of the Agreement, it being understood that in case of divergence the provisions of this Addendum shall prevail.

Article 2
Duration of the Project

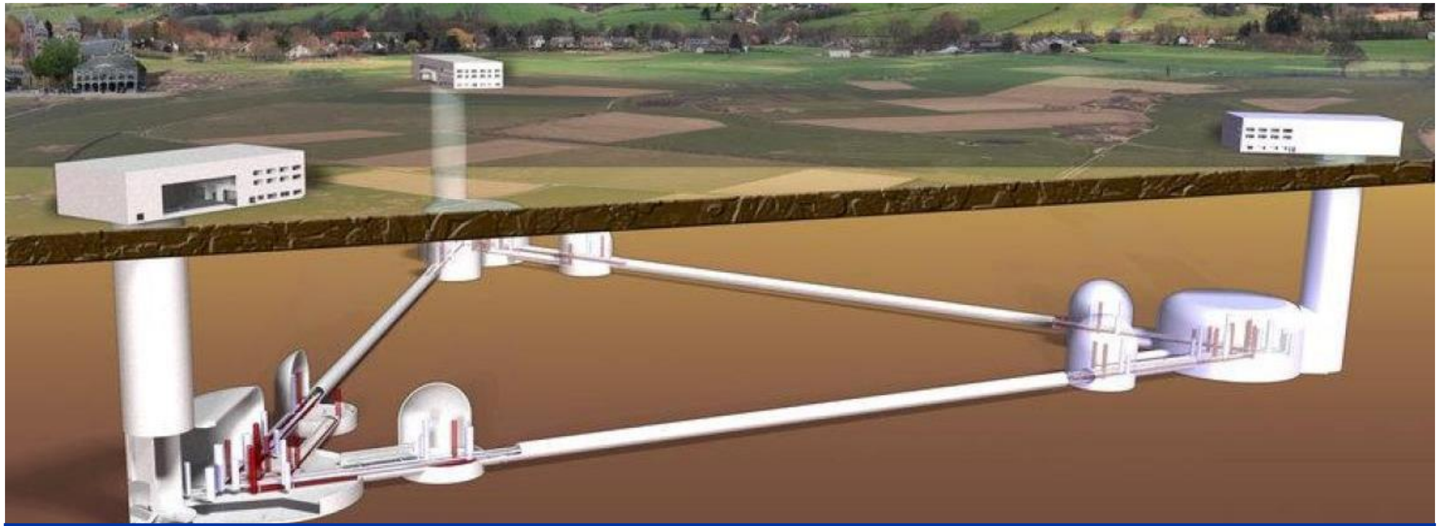
Subject to the continued validity of the Agreement, the Project shall begin upon signature by the last Party to sign and shall be completed after 36 months.

Done in the English language and signed by the authorized representatives of the Parties.

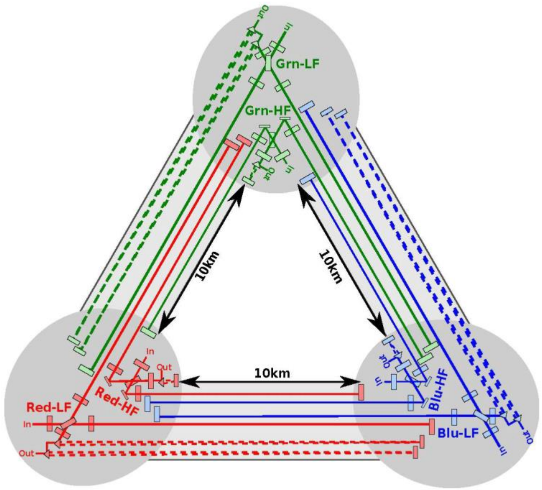
The European Organization for Nuclear Research (CERN)	The European Organization for Nuclear Research (CERN)
Mike Lamont	[signature]
Mike Lamont Director for Accelerators and Technology	Jose Miguel Jimenez Head of Technology Department
Signed on 7/7/2022	Signed on 8/7/2022
Christopher Hartley	*Cristina Lara*
Christopher Hartley Head of Industry, Procurement and Knowledge Transfer Department	Cristina Lara Deputy Head of Procurement Service
Signed on 11/7/2022	Signed on 9/7/2022

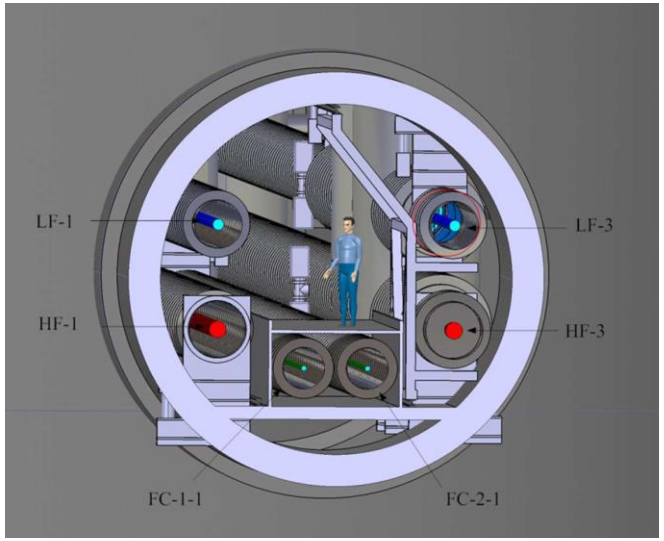
The Dutch National Institute for Subatomic Physics ("Nikhef")	The Italian National Institute for Nuclear Physics ("INFN")
[signature]	*Dr. Antonio Zoccoli*
Stan Bentvelsen Nikhef Director	Antonio Zoccoli INFN President
Signed on 19/7/2022	Signed on 26/7/2022

Next generation of GWD: Einstein Telescope



Items	Requirements
Pipe diameter	1.2 m (tbd)
Total length	≈120 km
Hydrogen partial pressure	order of 10^{-10} mbar
Water vapour partial pressure	< $5x10^{-11}$ mbar
Hydrocarbon partial pressures	< 10^{-14} mbar
Lifetime	50 years





WP1: engineering

Design and engineering of the vacuum chamber

WP2: production

Choice of materials and manufacturing technology

WP3: treatments

Choice of post-manufacturing treatments

WP4: transport

Handling and logistics

WP5: installation

Installation procedure and interface with other systems

WP6: vacuum

Choice of vacuum pumps and valves

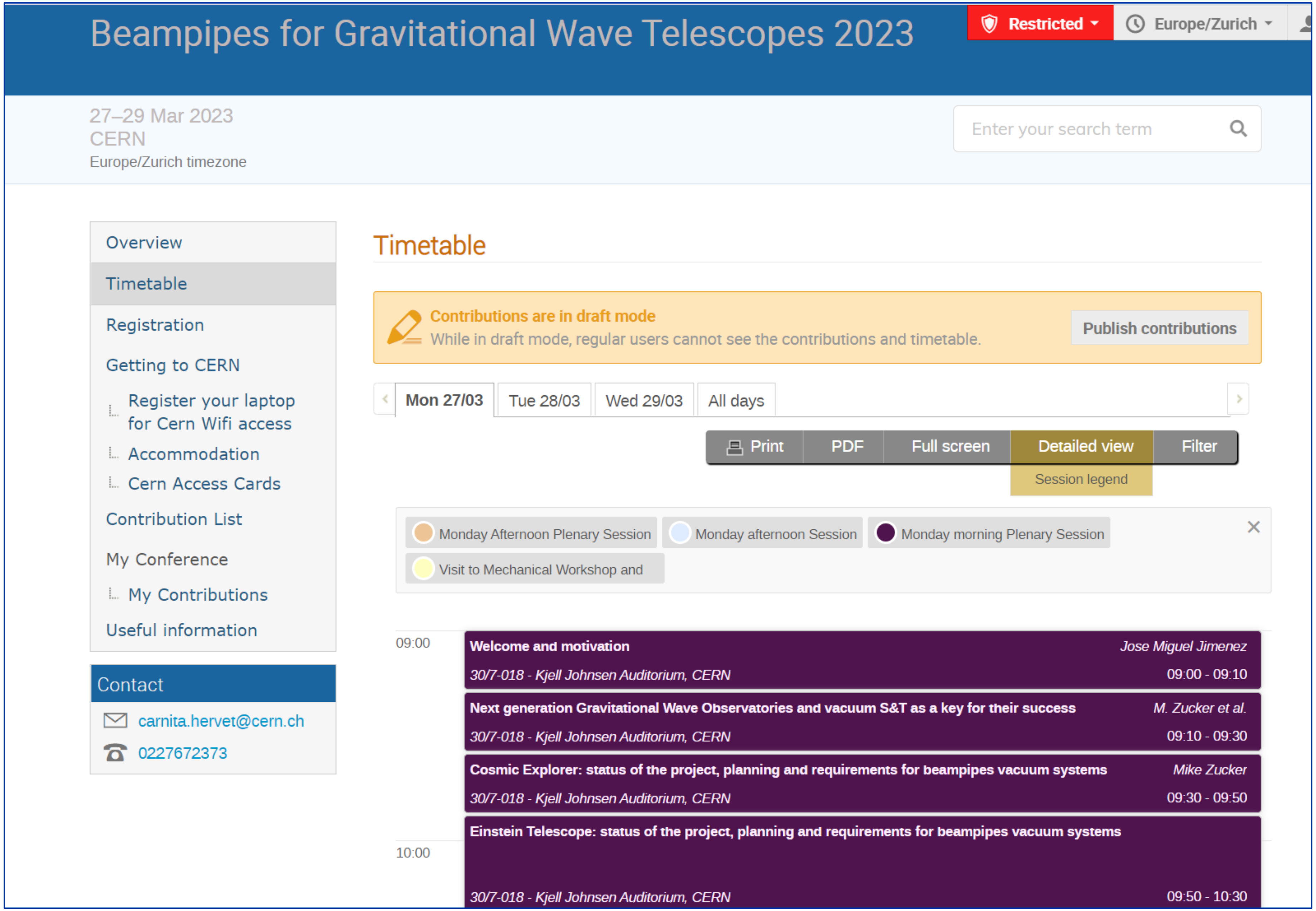
Work-Breakdown Structure

WP7: prototyping

Installation and test of a pilot sector

WP8: coordination

Coordination of the different work packages and contribution of collaborators


Beampipes for Gravitational Wave Telescopes 2023
Restricted
Europe/Zurich
27–29 Mar 2023
CERN
Europe/Zurich timezone
Enter your search term
Overview
Timetable
Registration
Getting to CERN
Register your laptop for Cern Wifi access
Accommodation
Cern Access Cards
Contribution List
My Conference
My Contributions
Useful information
Contact
carnita.hervet@cern.ch
0227672373
Timetable
Contributions are in draft mode
While in draft mode, regular users cannot see the contributions and timetable.
Publish contributions
Mon 27/03
Tue 28/03
Wed 29/03
All days
Print
PDF
Full screen
Detailed view
Filter
Session legend
Monday Afternoon Plenary Session
Monday afternoon Session
Monday morning Plenary Session
Visit to Mechanical Workshop and
09:00
Welcome and motivation
Jose Miguel Jimenez
30/7-018 - Kjell Johnsen Auditorium, CERN
09:00 - 09:10
Next generation Gravitational Wave Observatories and vacuum S&T as a key for their success
M. Zucker et al.
30/7-018 - Kjell Johnsen Auditorium, CERN
09:10 - 09:30
Cosmic Explorer: status of the project, planning and requirements for beampipes vacuum systems
Mike Zucker
30/7-018 - Kjell Johnsen Auditorium, CERN
09:30 - 09:50
Einstein Telescope: status of the project, planning and requirements for beampipes vacuum systems
10:00
30/7-018 - Kjell Johnsen Auditorium, CERN
09:50 - 10:30

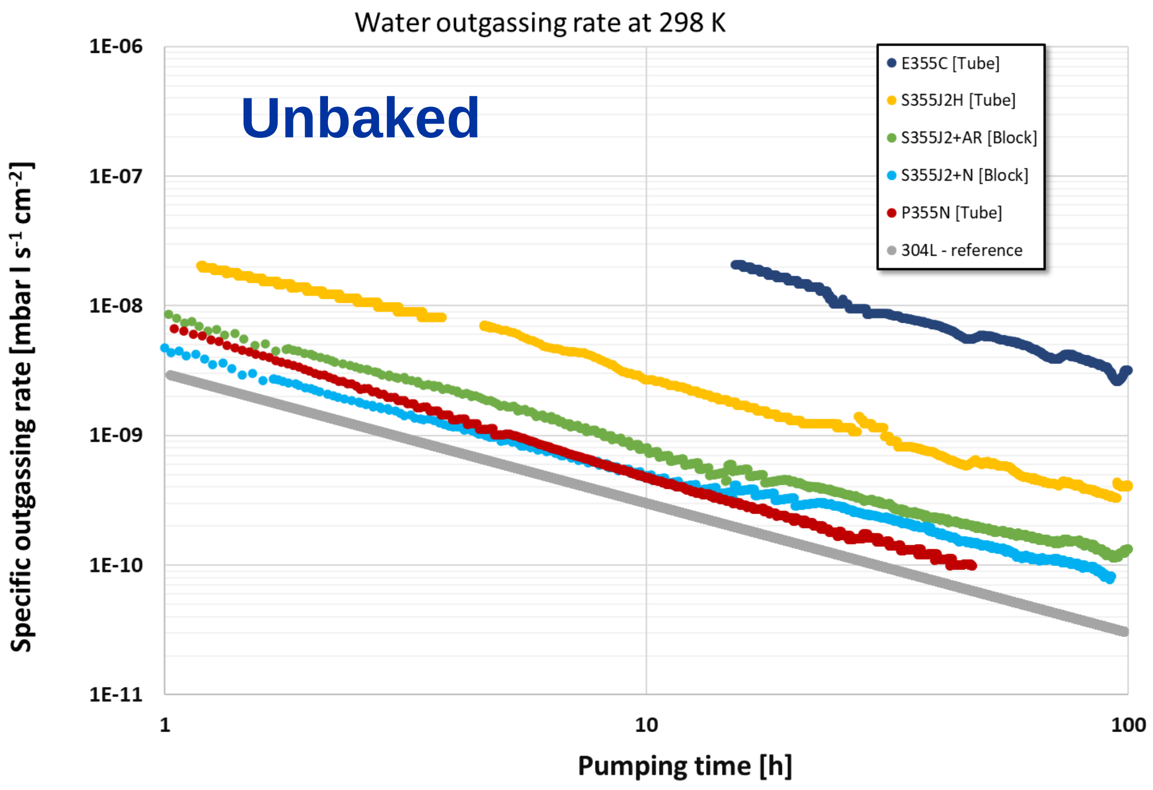
Next generation GWD: Einstein Telescope

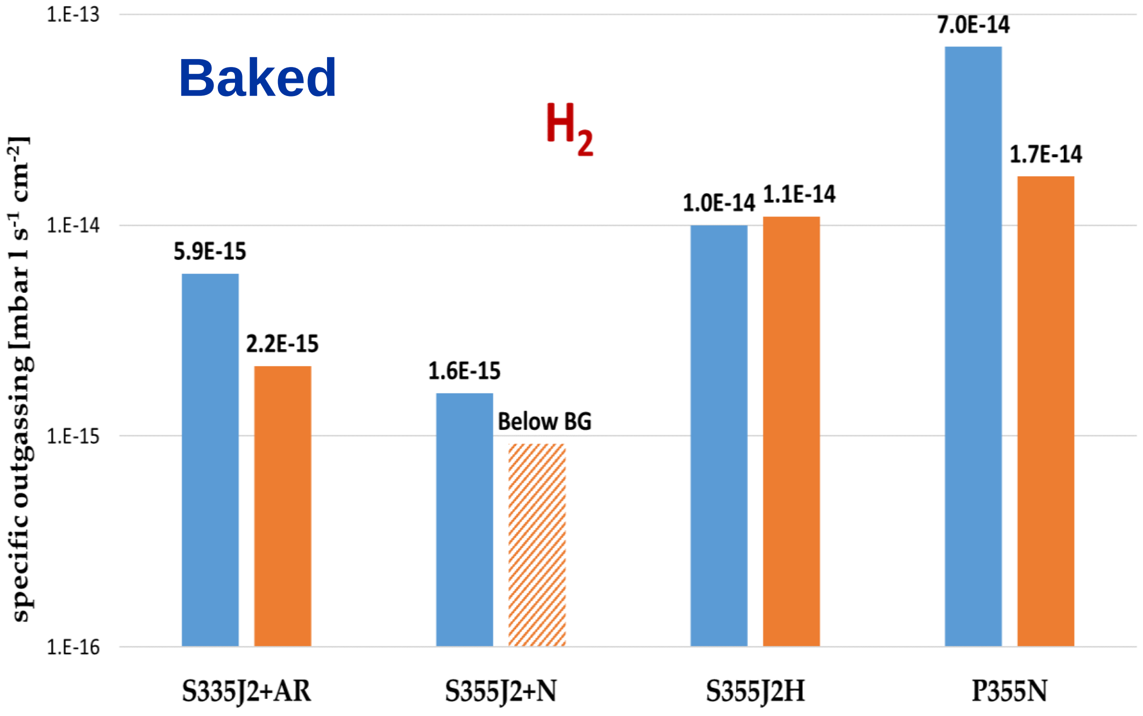
- **TT1 tunnel:**
  - Advantages: almost constant environmental conditions, synergy with alignment team.
  - Disadvantage: difficult access and transport (feasibility to be done), no ventilation in the tunnel.

Next generation GWD: Einstein Telescope

Mild Steel as possible alternative to stainless steel

Extended study of the outgassing properties of mild steel to replace austenitic stainless steels





Next generation GWD: Einstein Telescope

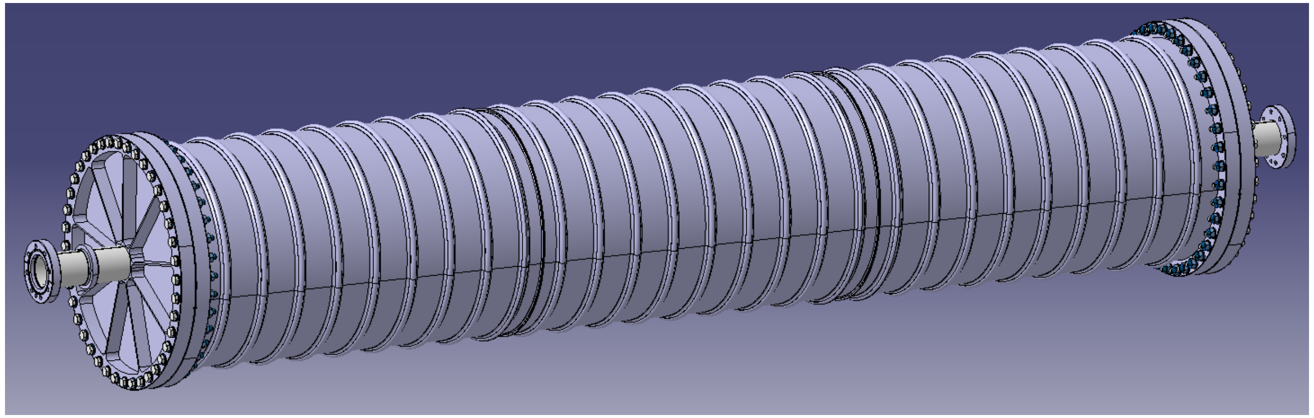
Interferometer vacuum chamber for Einstein Telescope

Pre-prototype chamber:

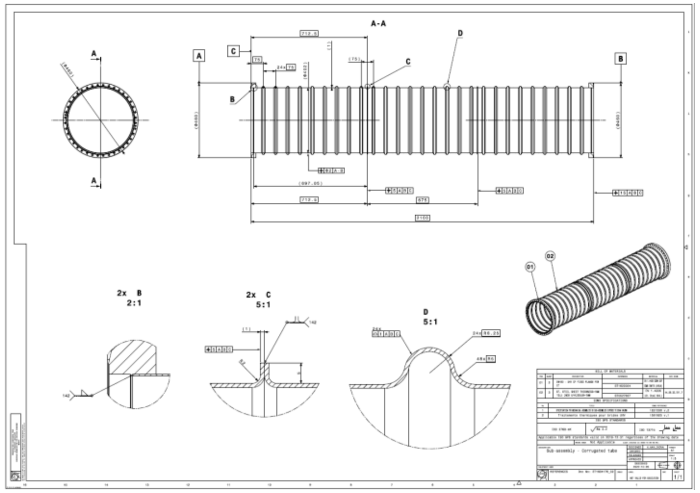
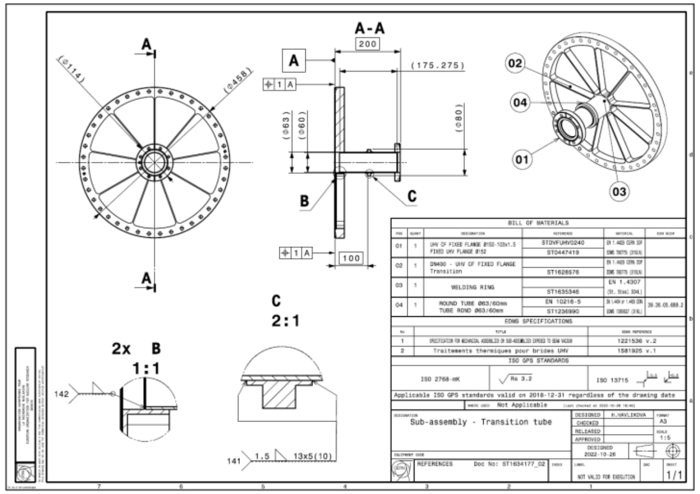
Reduced 2.1-m long, 400-mm diameter corrugated vacuum chamber, thickness 1.0mm

3 different types of material:

- 304L -> production launched December/January
- Ferritic stainless steel
- Mild steel



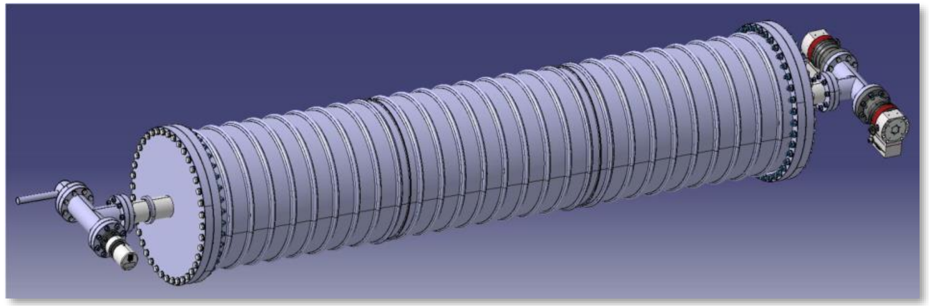

Vacuum chamber design and prototype

2D drawings

Next generation GWD: Einstein Telescope

Study of low temperature bakeout efficiency

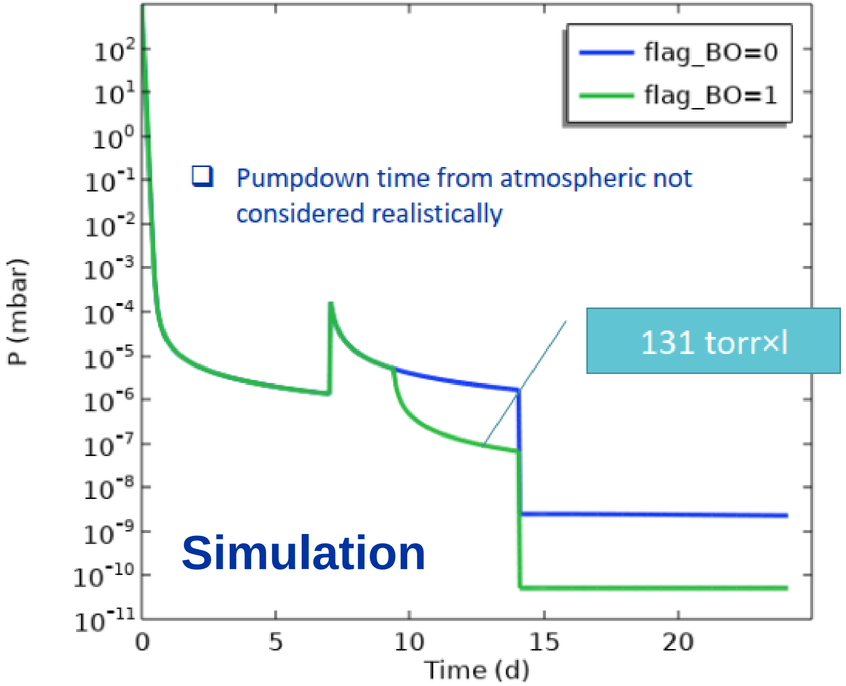


3 x DN400 – 2m long corrugated chambers

Structural mild steel

304L + VF

AISI430

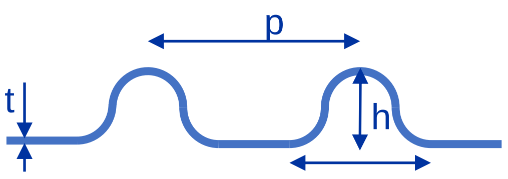


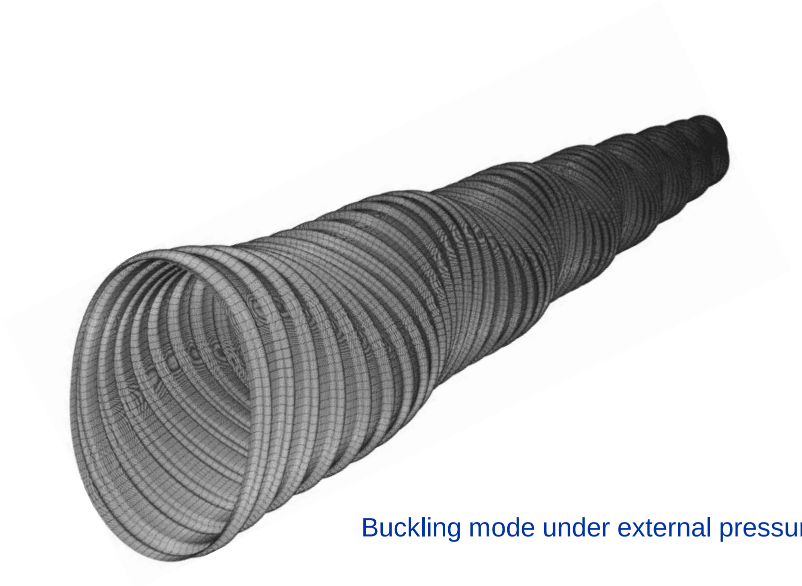
- 1 turbo pump every 2 km (the curves shown are at 1 km, so L/2)
- D = 1.2 m
- Isotherm parameter from mild steel binding energy measurement.
- Distribution of NEG pumps every 100 m (CapaciTorr HV2100).
- $Q_{H2} = 1\times10^{-13}$ [$mbar\cdot l\cdot s^{-1}\cdot cm^{-2}$]
- The cycle was thought as follow:
  - Pump-down for 7 day
  - Bake-out for 7 days

Next generation GWD: Einstein Telescope

Interferometer vacuum chamber for Einstein Telescope

Mechanical concept: **thin-walled corrugated tube in stainless steel**





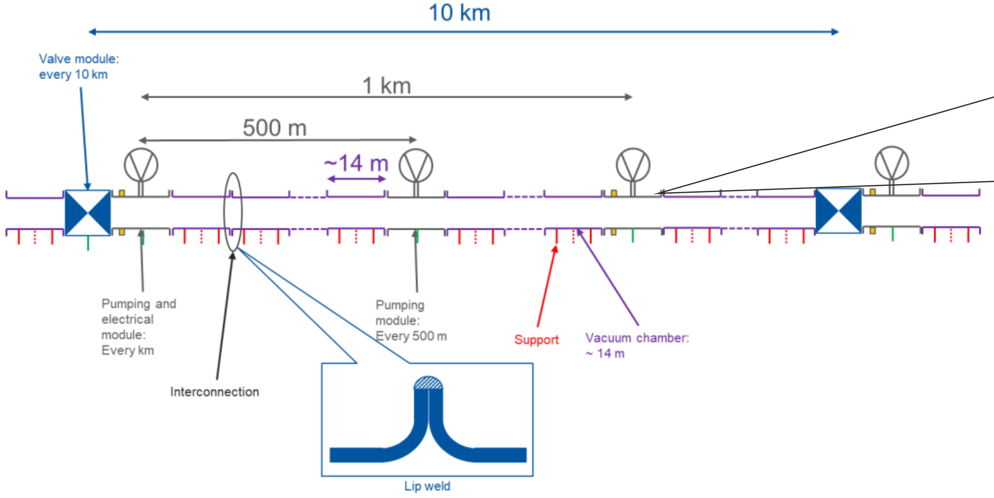
Buckling mode under external pressure

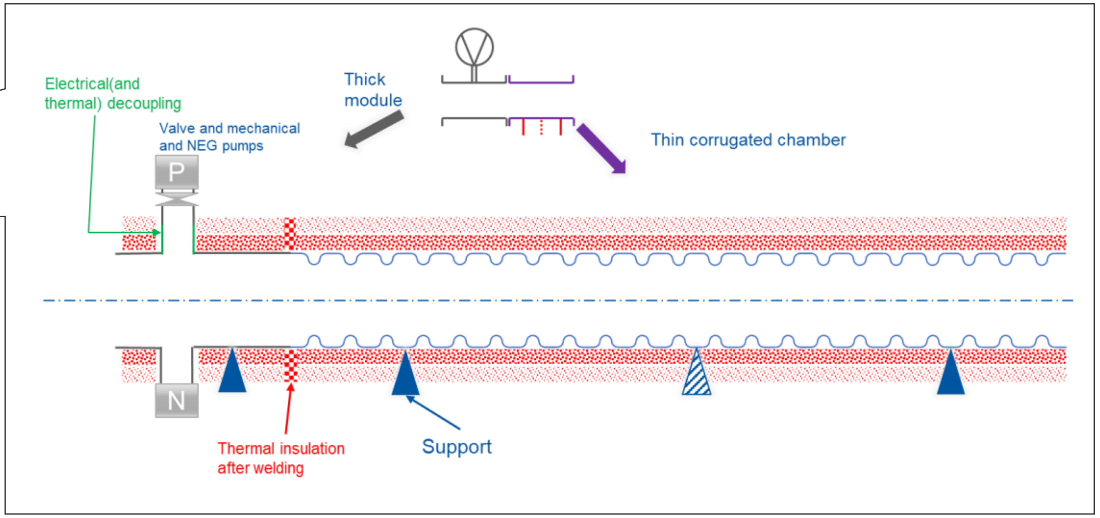
- Withstand external pressure:
  For steels, a thickness of around 1.3 mm is enough to ensure the mechanical stability of the ~ ϕ1.1 m vacuum chamber.
- No need of compensation bellows.
- Light structure: ~ 50 kg/m (without thermal insulation).
  The chamber can be supported either from the roof or the floor.
- “Easy” bake out of the structure.
- Reduced material amount and therefore cost.

Next generation GWD: Einstein Telescope

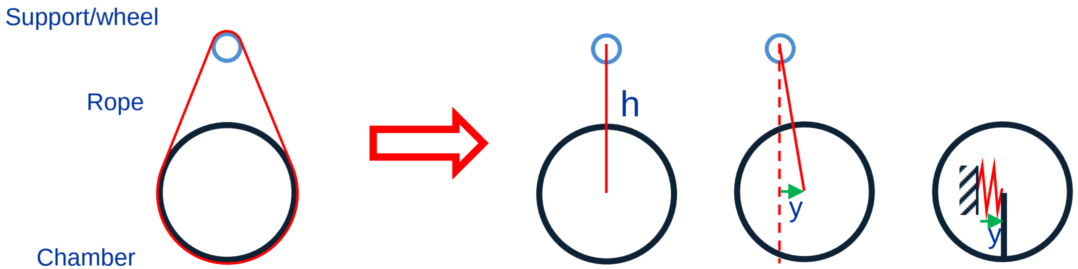
Interferometer vacuum chamber for Einstein Telescope

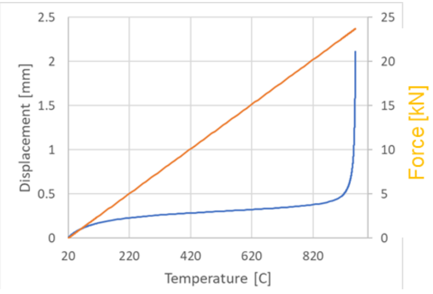
Vacuum system layout proposal:



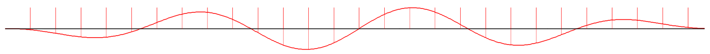


Soft supporting system: stability analysis under compressive force





Non linear analysis

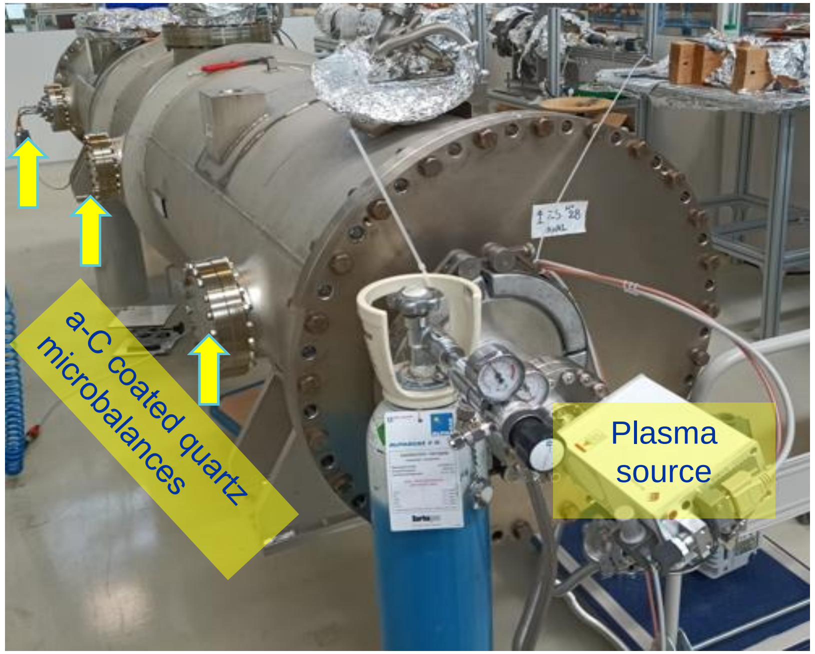


Linear and non-linear global buckling analysis

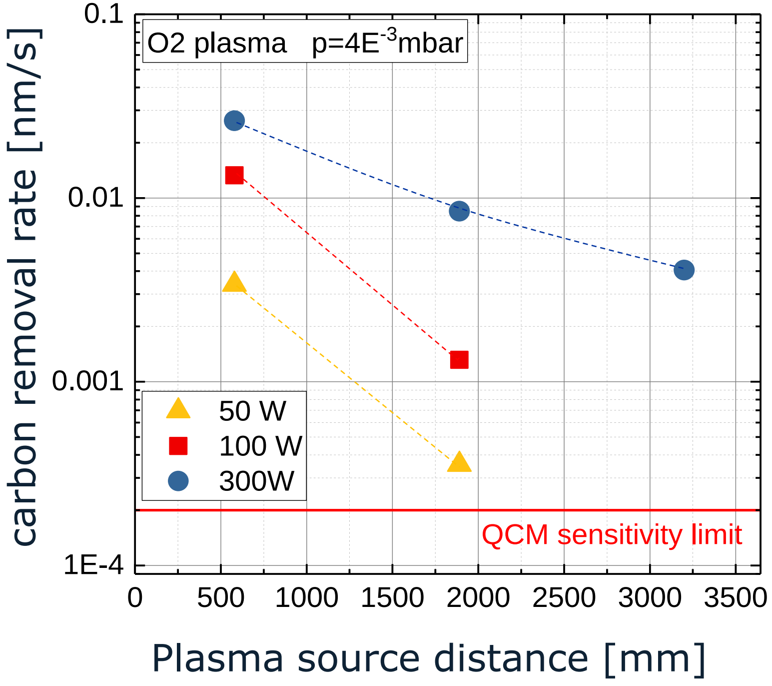
Plasma cleaning of radioactive vacuum equipment

Aim: replace a wet degreasing with a plasma degreasing for **activated** parts; avoid liquid retention in complex shapes (avoid complex treatment of activated fluids)

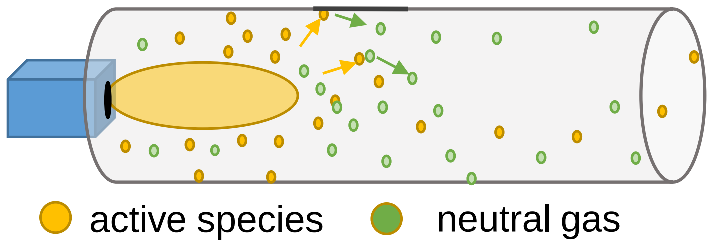
-**O_2 plasma** to oxidise hydrocarbons to CO_2

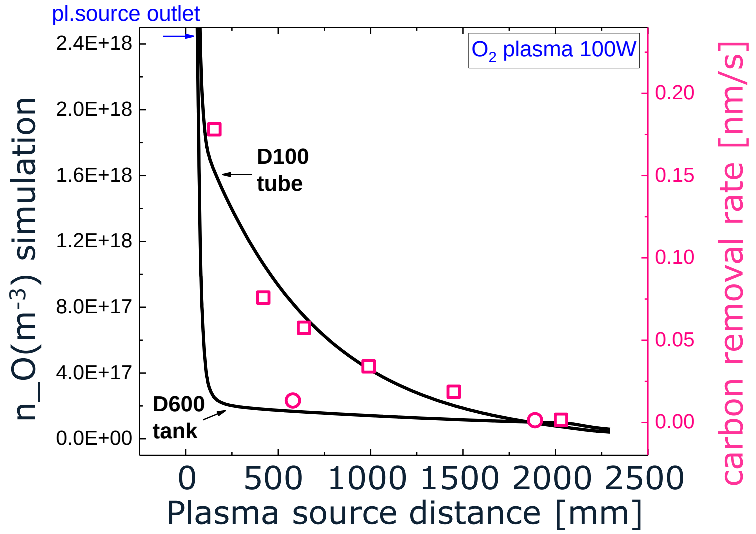


ZS tank D=600mm L=3500mm



Simulation: plasma species generation, surface and gas collisions, transport of active species





First real PSB tank cleaned successfully

Developments

Shape Memory Alloy Rings for Tight connections

FE modelling of SMA: implementation of a new constitutive model in ANSYS

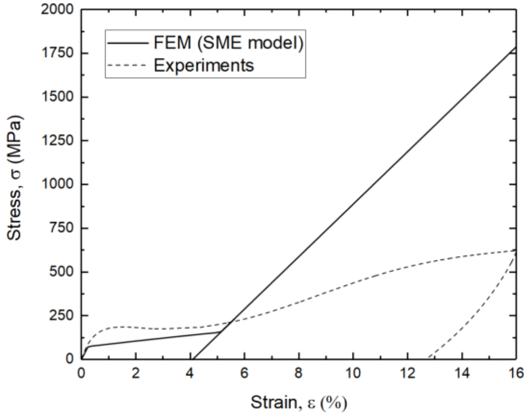
- Additional features: plasticity and Two-Way SME
- Ability to simulate coupling/uncoupling process
- Suitable for complex system geometries
- Possible results: transformation/plasticity strain components
- High solution accuracy
- Subroutine (USERMAT) code: FORTRAN77

Microsoft Visual Studio Professional 2017

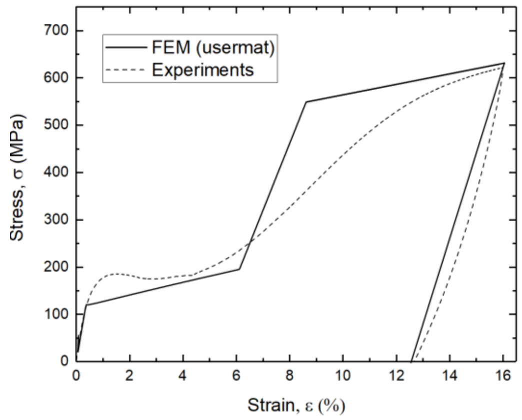
Ansys 2022 R1 Engineering What's Ahead.

Intel® oneAPI Toolkits Release 2022.2.0

Thermo-mechanical pre-strain ε_{tot}=15% (T=-65°C)

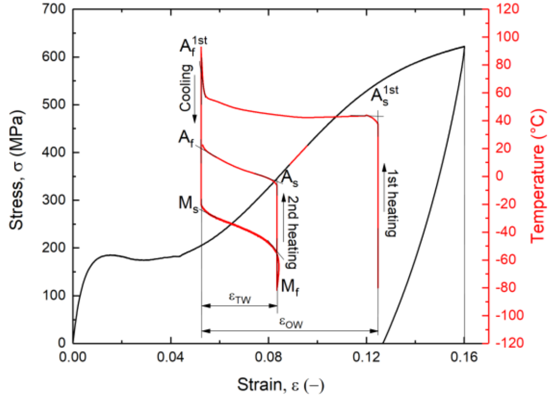


no usermat

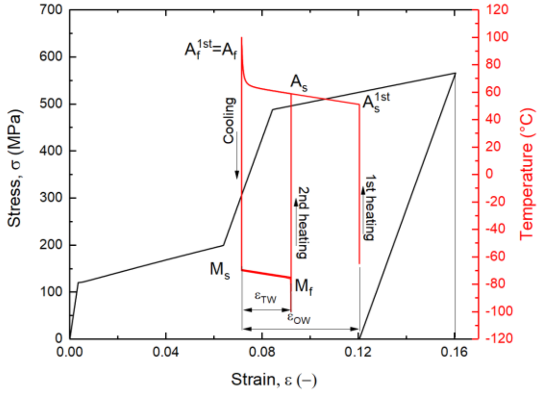


usermat

Pre-strain (ε_{tot}=28.8%) + free thermal cycles



Experimental measurements



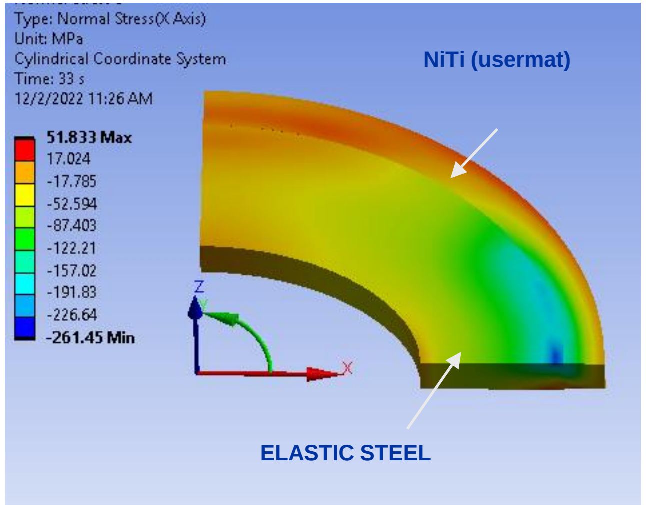
Predicted numerical results

Shape Memory Alloy Rings for Tight connections

FE modelling of SMA: implementation of a new constitutive model in ANSYS

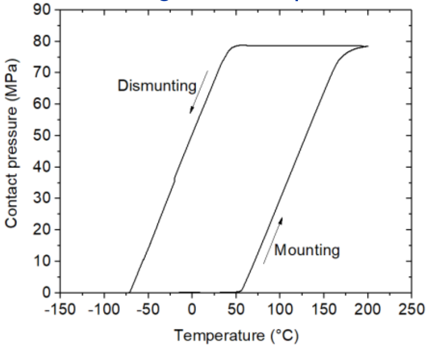
OVAL COUPLERS

Radial stress at T_{max}=200°C

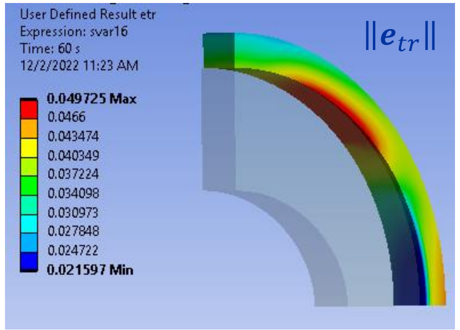


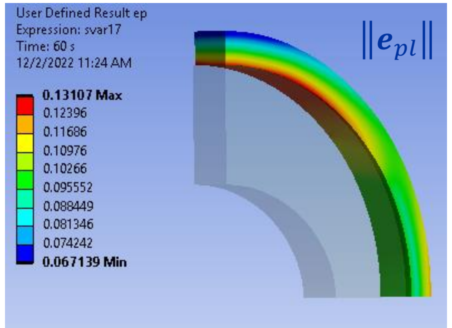
- Pipe-pipe and pipe-coupler contact: FRICTIONAL
- Max pre-strain: ε_{tot}=15%
- Initial pipe-coupler gap: 0.15mm

Average contact pressure



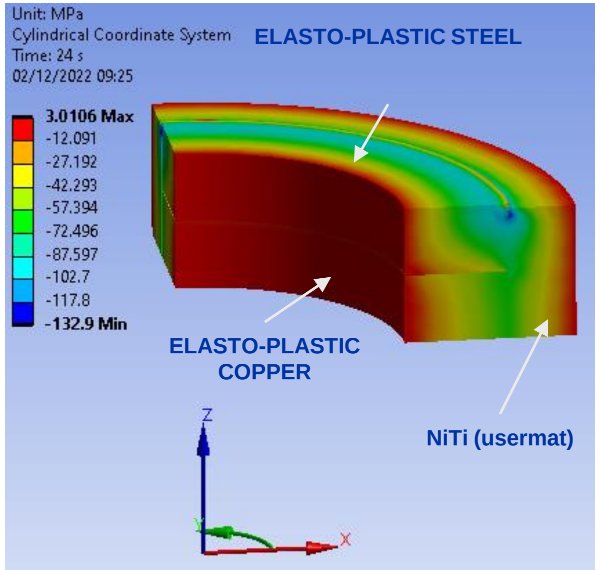
Norm of transformation and plastic strain tensors at T_{max}=200°C



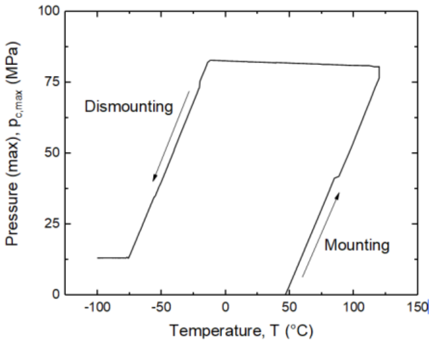


BI-MATERIAL CONNECTION

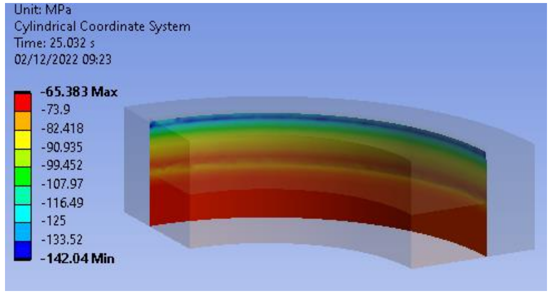
Radial stress at T_{max}=120°C



Average contact pressure



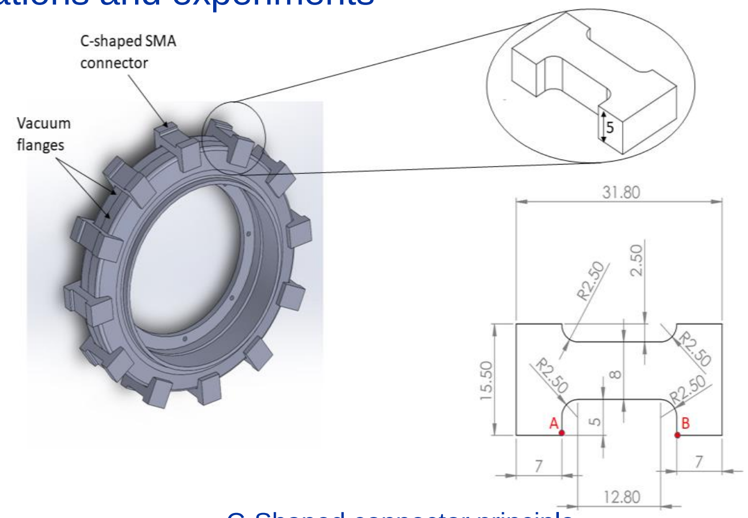
Pipes-SMA contact pressure at T_{max}=120°C



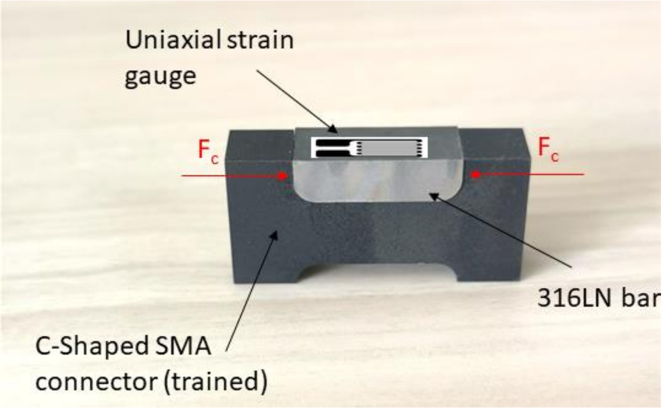
Shape Memory Alloy Rings for Tight connections

C-Shaped connectors for conical CF flanges

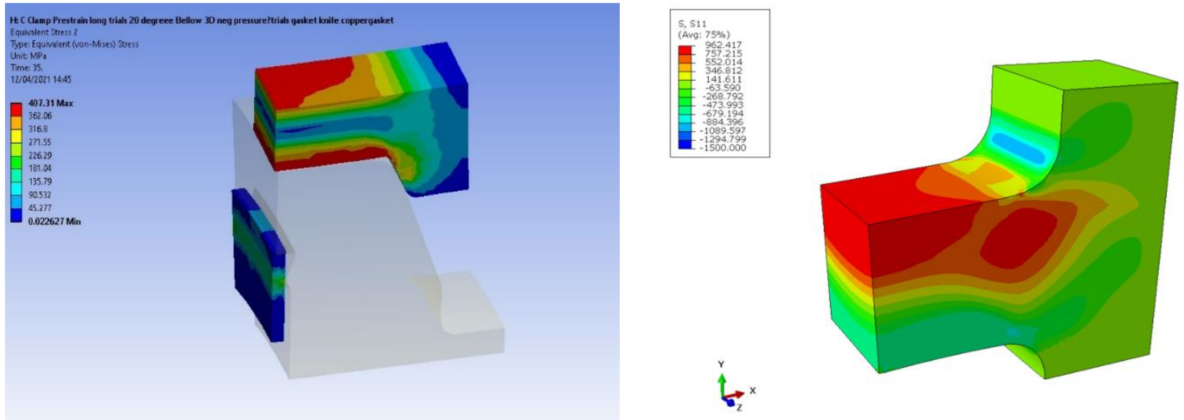
Simulations and experiments



C-Shaped connector principle

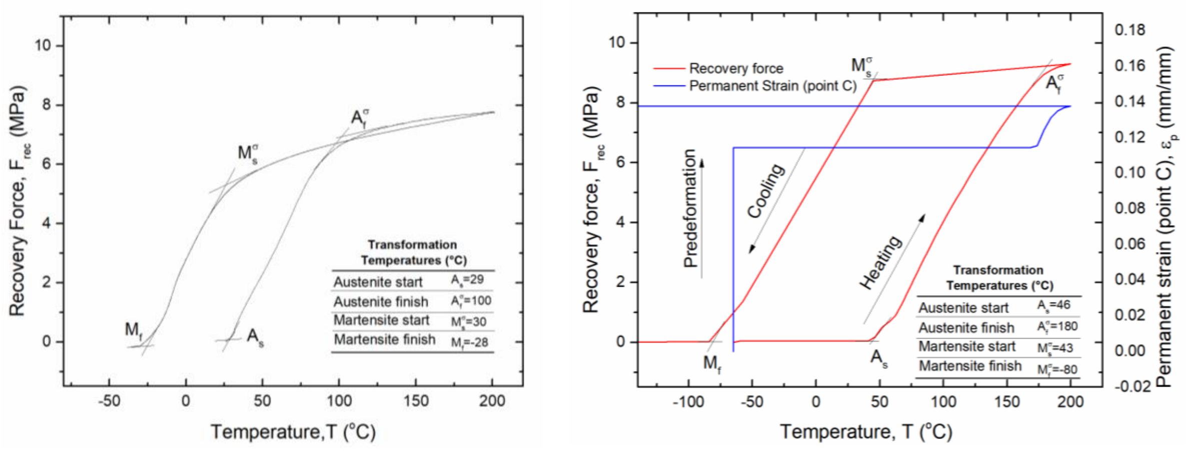


Instrumented C-shaped connector



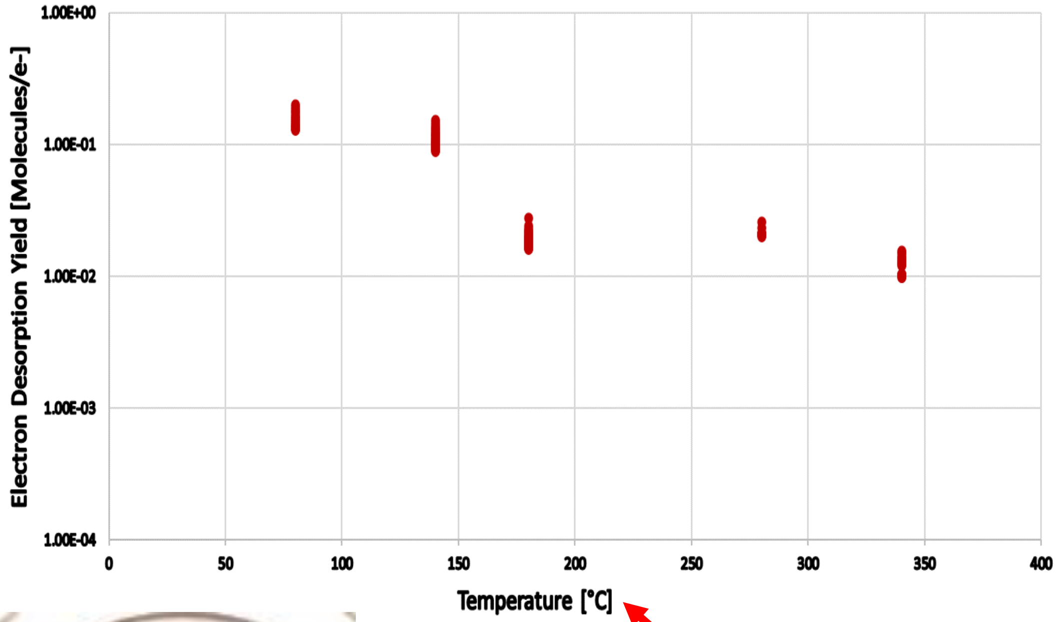
DN100 3D simulations

- Elastic-plastic copper gasket
- Elastic flange



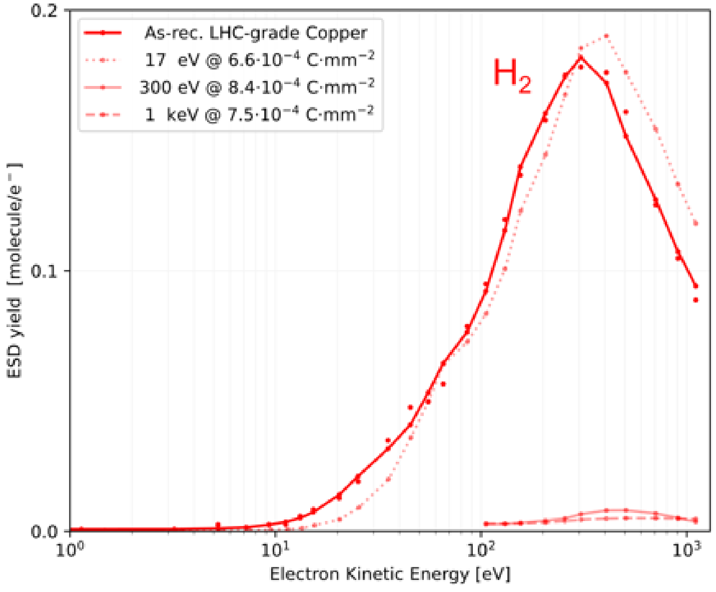
Measured and simulated recovery force

ESD characterization of materials for UHV

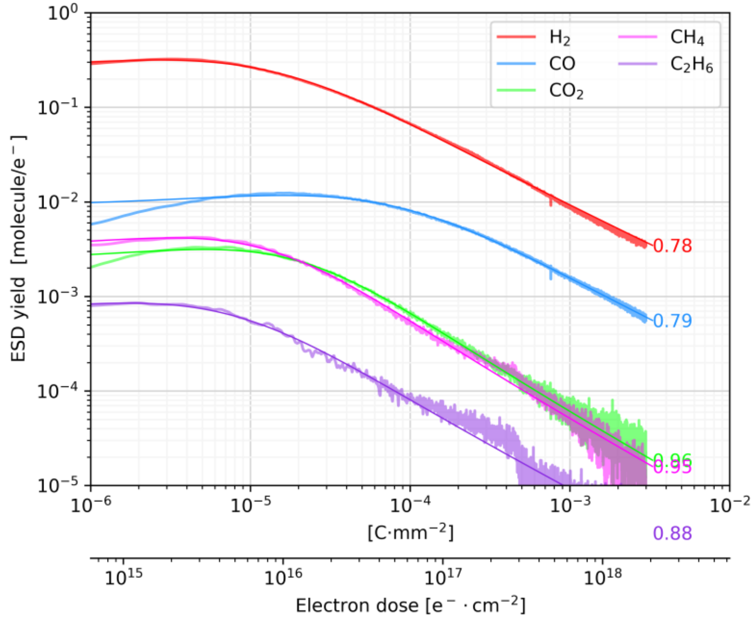


Sample temperature measurement

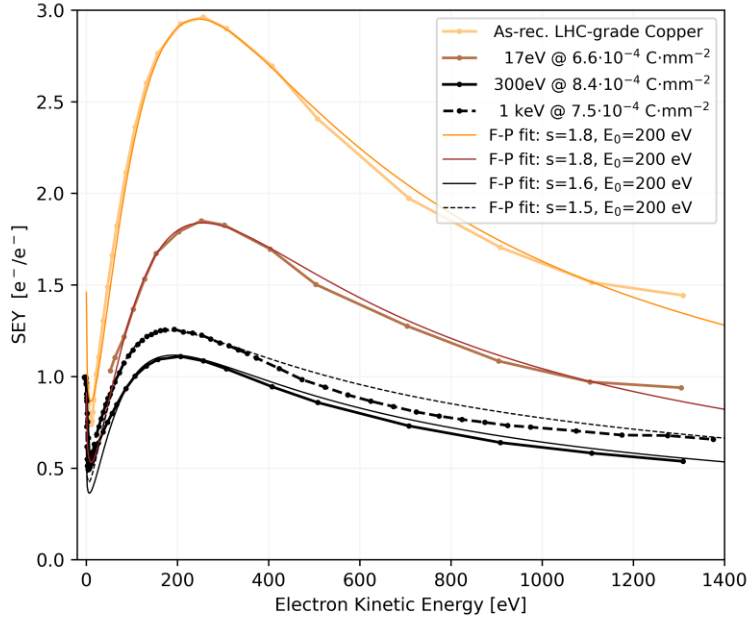
ESD and SEY of LHC Cu BS characterisation at 15 K



ESD vs primary energy



ESD conditioning at 300 eV

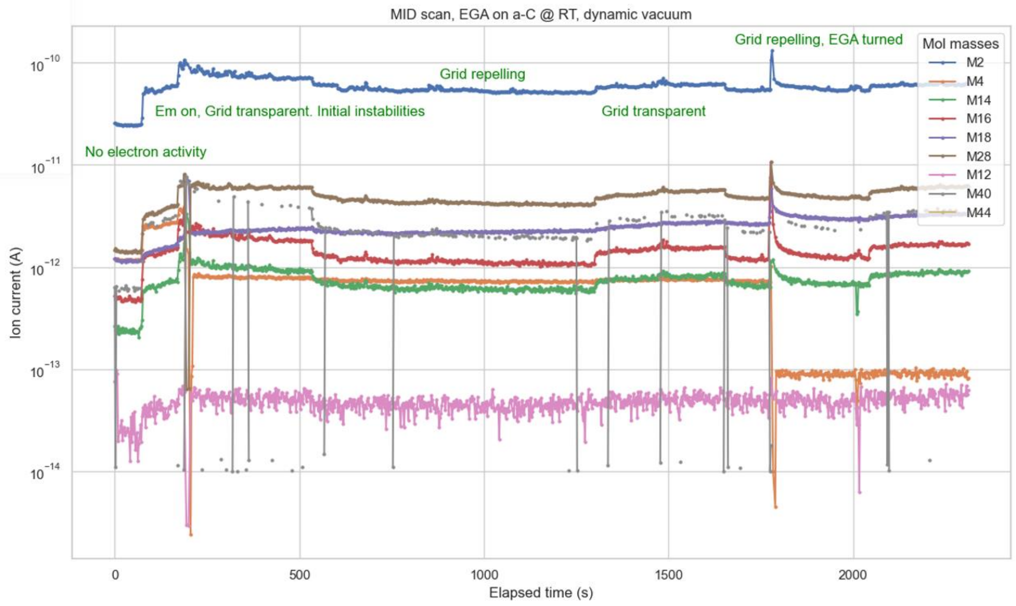


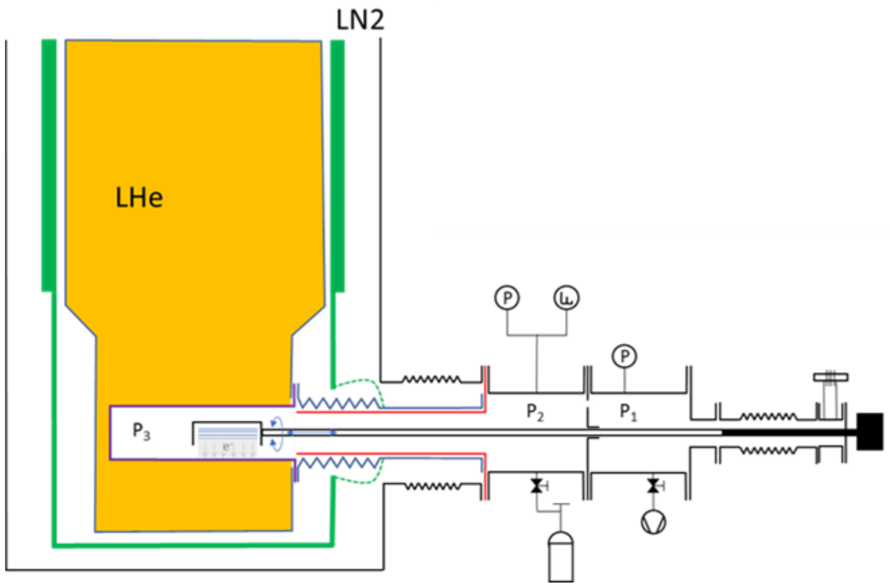
SEY conditioning at 0.3 and 1 keV

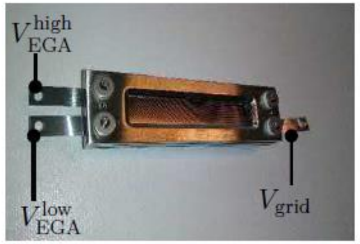
ESD of a-C at 4.2 K in a closed geometry

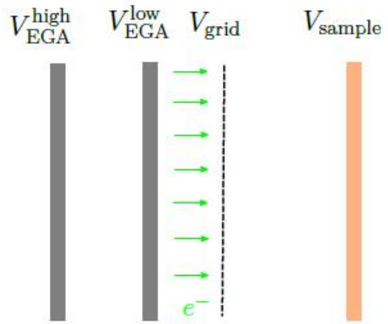
a-C surface irradiated at 500 eV

- Room temperature: η = 0.15 molecule/electron
- H_2 dominated







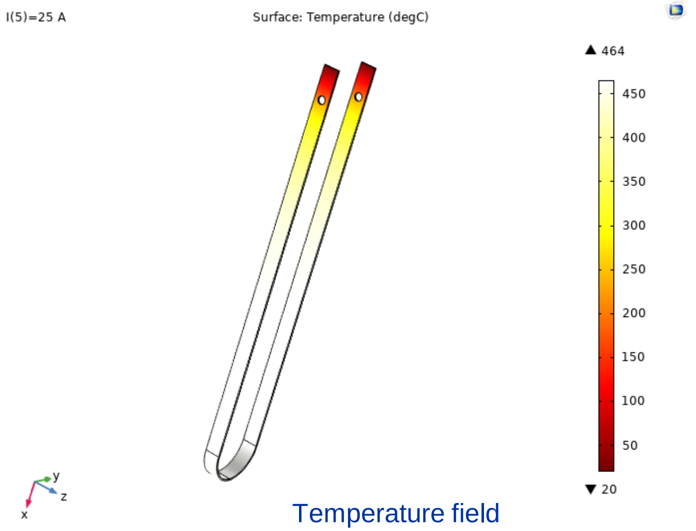


- 4.2 K: η < 0.05

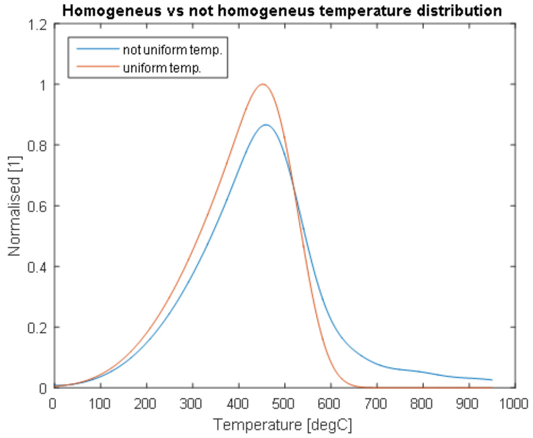
TDS

Thermal and diffusion analysis

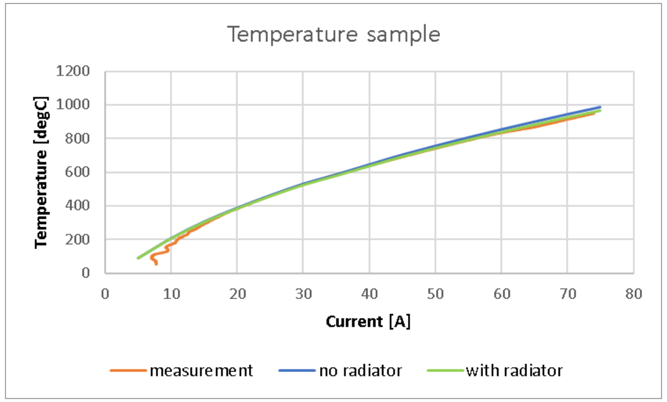
Thermal simulation on TDS samples (radiation + conduction) to better estimate the outgassing rate.



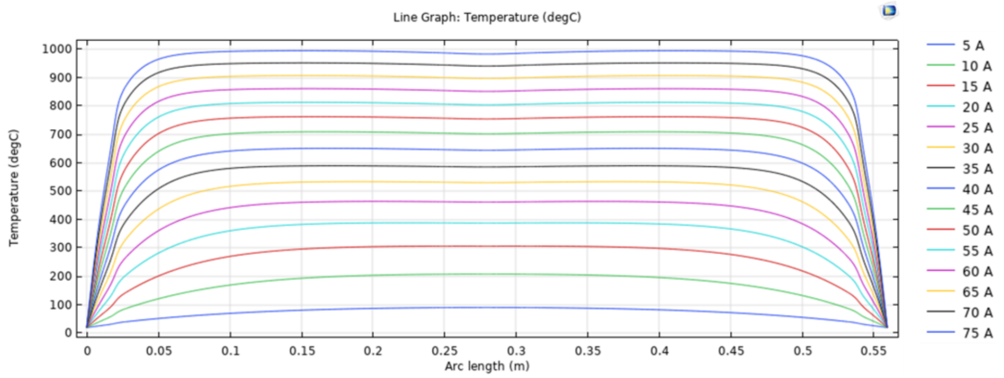
Temperature field



Outgassing rate (normalised) vs temperature between uniform temperature and the simulated one considering the thermocouple wires.

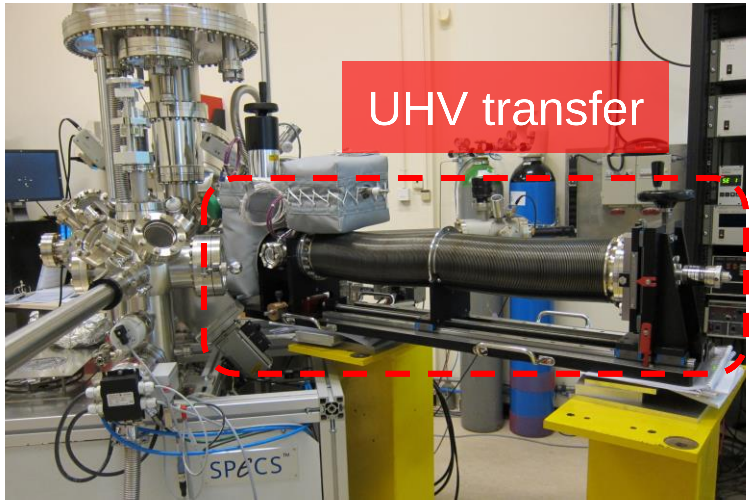


Temperature comparison



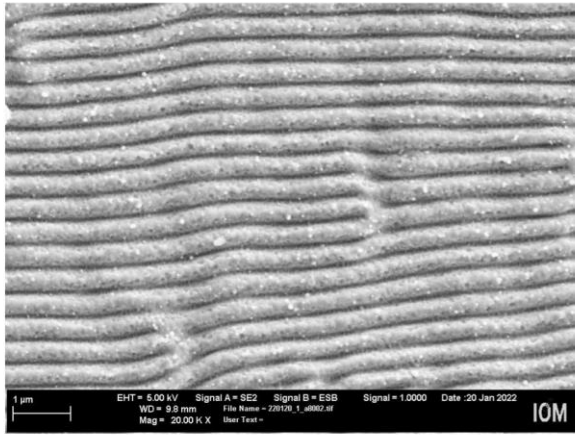
Temperature uniformity

Surface analysis: surface characterization of photocathodes

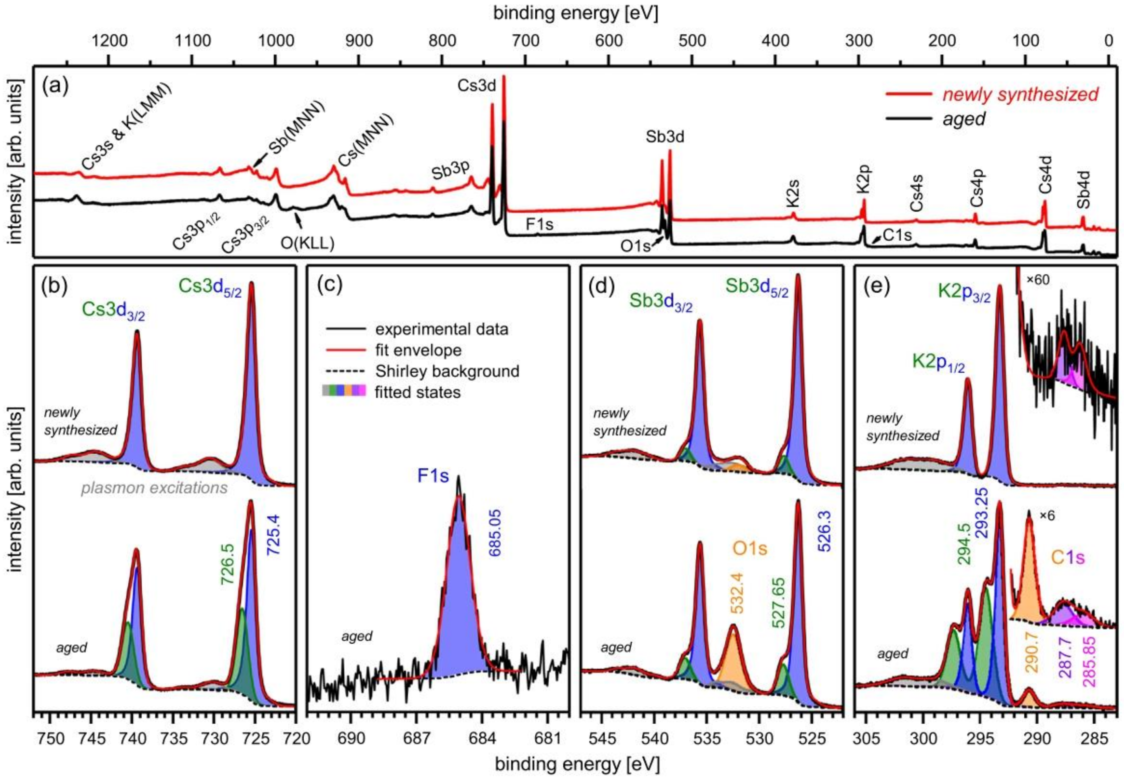


- ✓ Vacuum transfer systems for sensitive and reactive photocathodes to avoid surface oxidation and adsorption of ambient species (with SY-STI-LP)
- ✓ CsKSb film-like cathodes and Cu nanostructured cathodes for

→ **Surface composition analysis, aging effects**

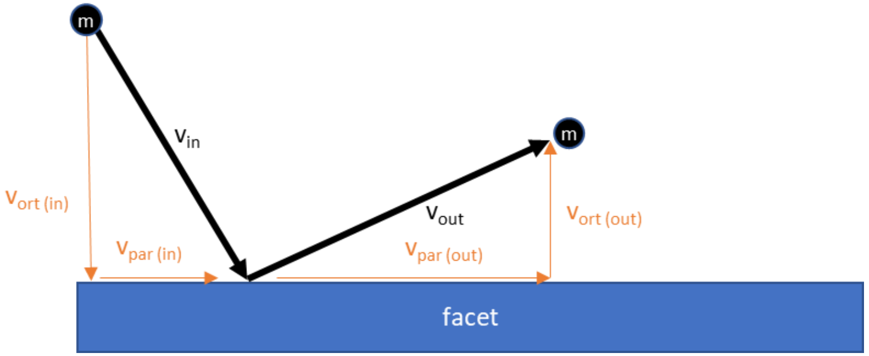


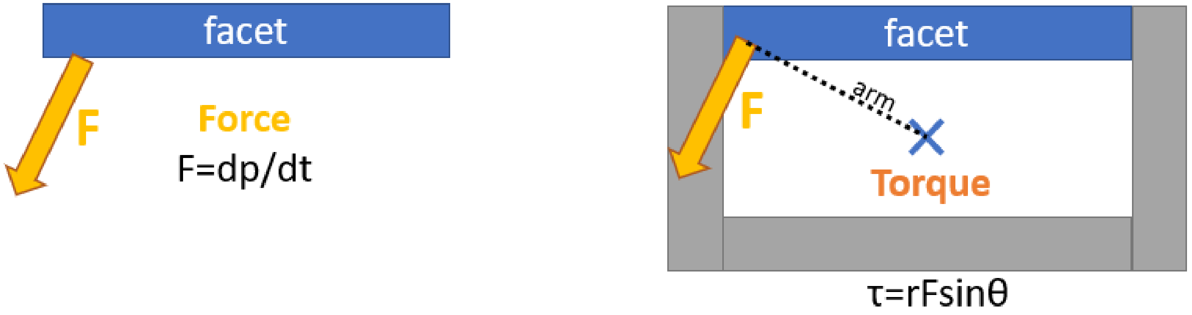
H. Panuganti et al., Nucl. Inst. Meth. Phys. Res. A 986 (2021) 164724



MolFow+ extension

Extending MolFlow+ with microscopic force and torque calculations





LISA Pathfinder

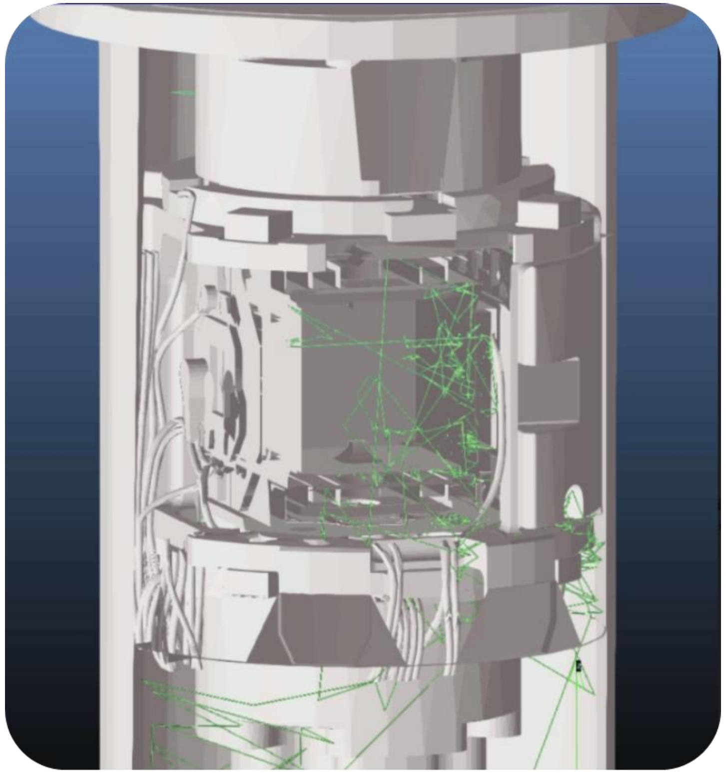


Image: Lorenzo Sala, ESA

MolFow+ extension

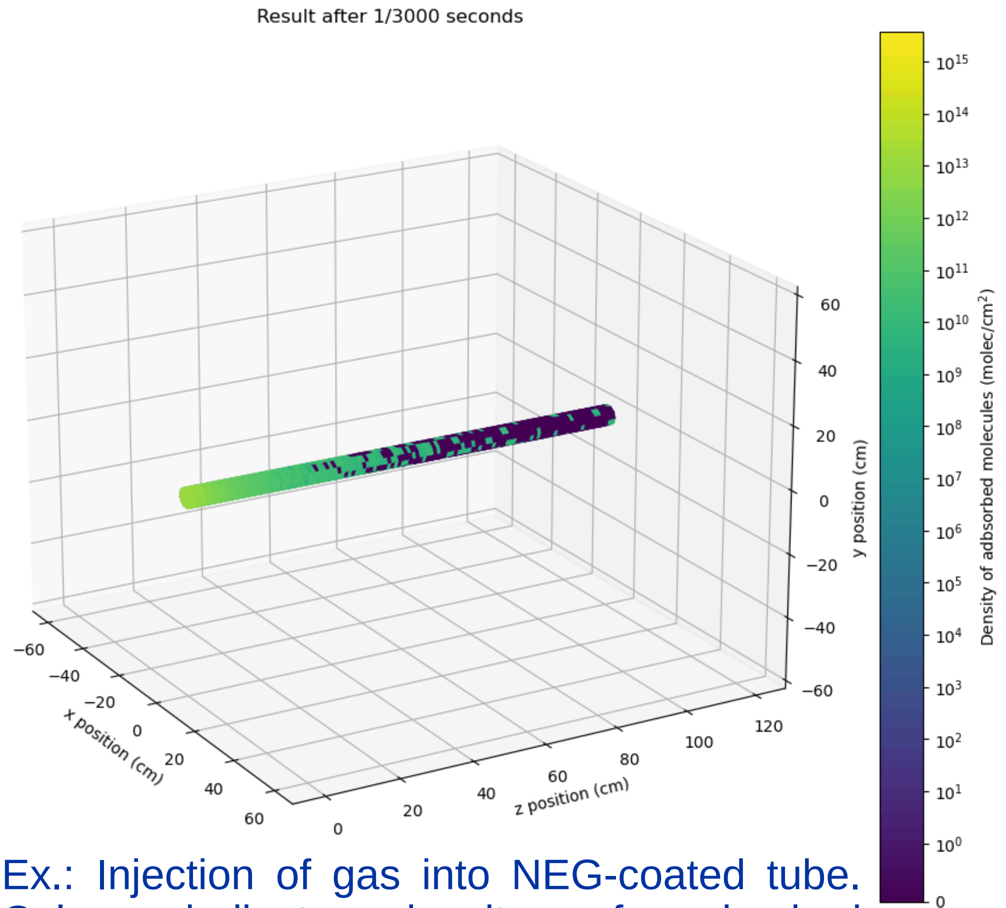
Time dependent simulations of pressure in NEG pipes

Vacuum chamber conditioning and saturation simulation tool (VacuumCOST)

Python code for iterative Molflow simulations of high temporal resolution.

Allow time-dependent simulation of vacuum chamber conditioning and NEG saturation.

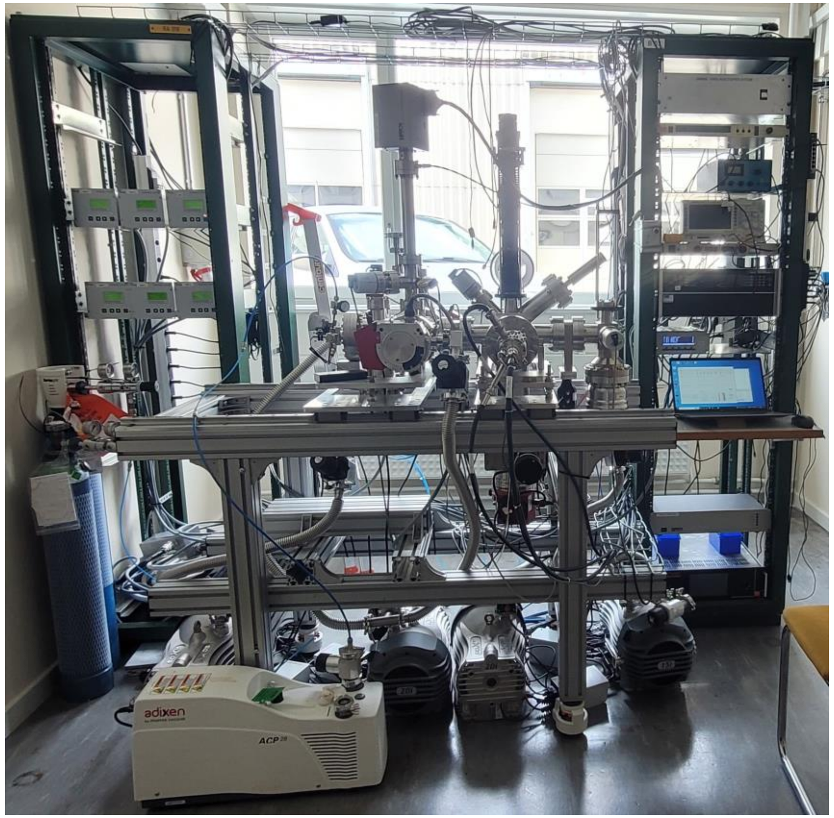
https://gitlab.cern.ch/phenriks/vacuumcost



Ex.: Injection of gas into NEG-coated tube. Colors indicate density of adsorbed molecules. Red-edged facets are saturated.

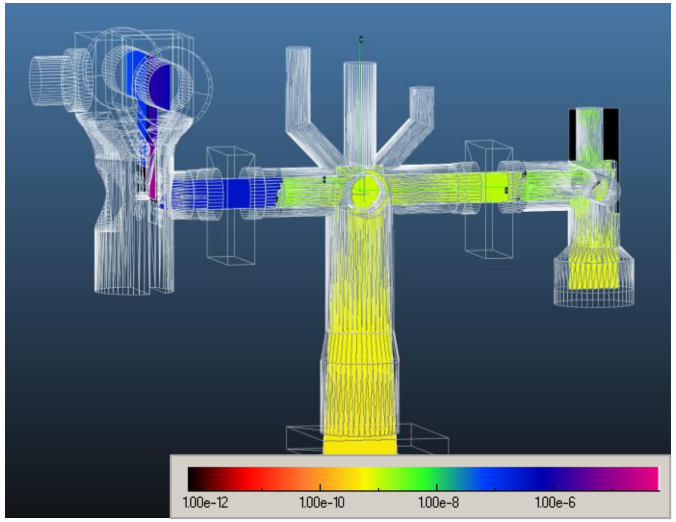
BGC phase II for LHC and phase III for Hollow e^- lens

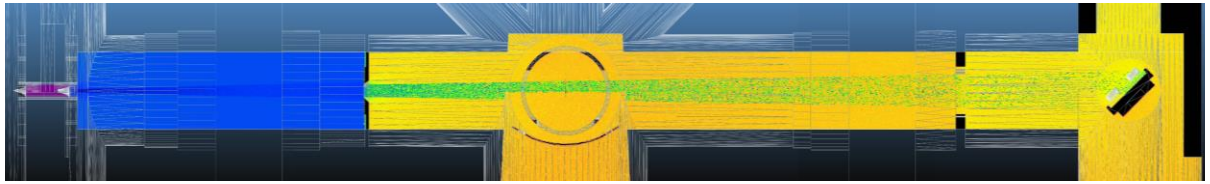
BGC ph.II Vacuum studies



Vacuum tests of BGC at B8 laboratory

- ## BGC ph. III Simulations

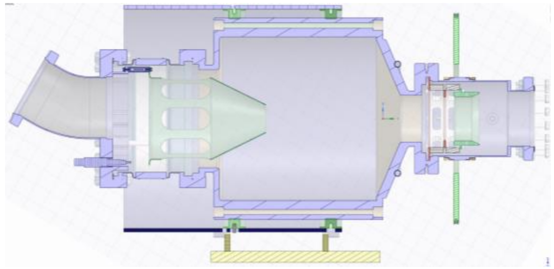




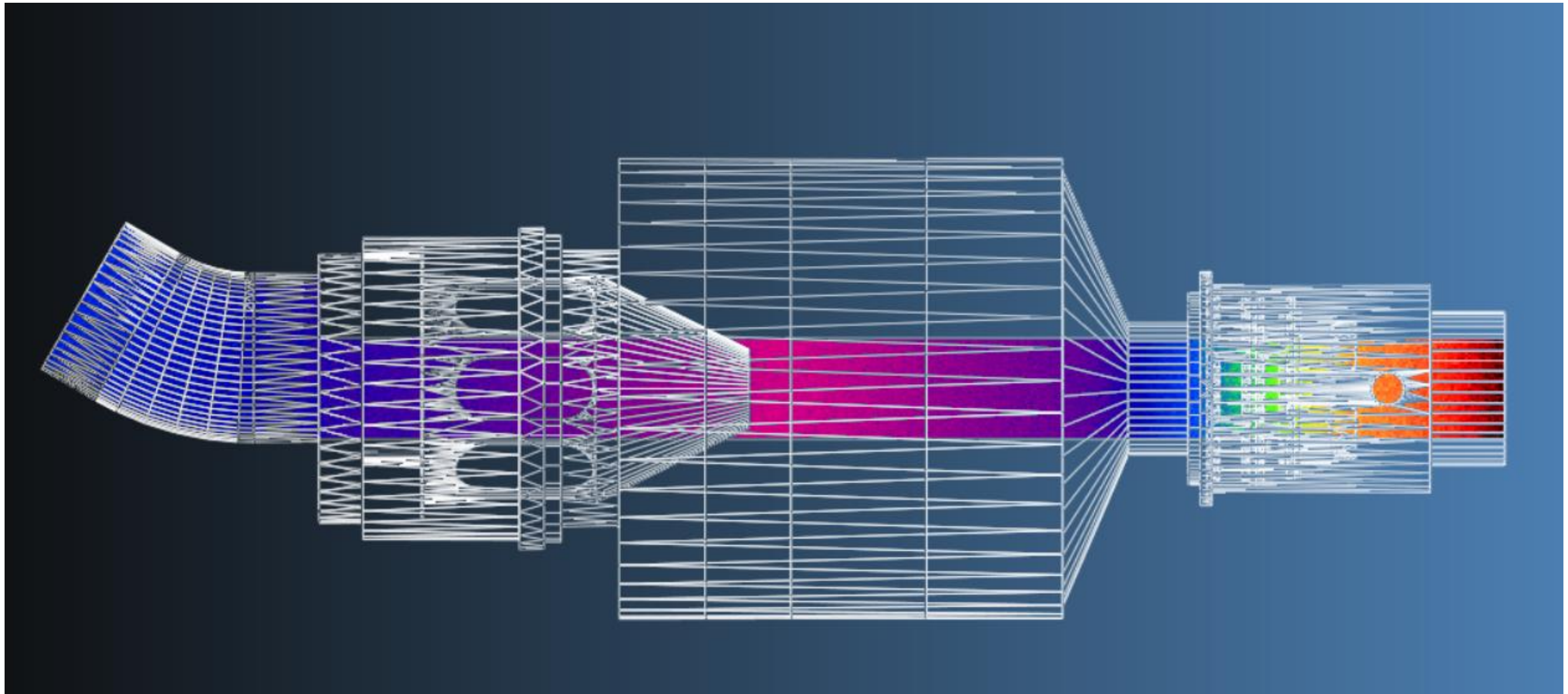
Pressure in vessel & particle density due to gas jet

Hollow Electron Lens collector vacuum simulations

Pressure at the HEL collector due to ESD and thermal outgassing produced by the flux of electrons impacting on the surface of this chamber



Section view of the original CAD model



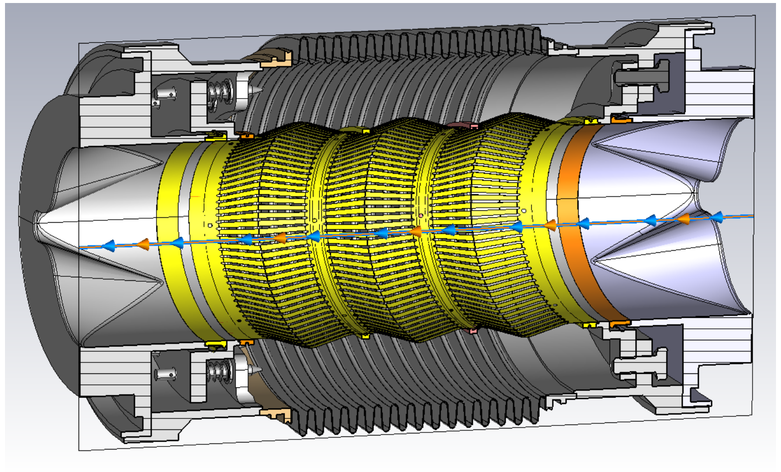
Pressure along the collector

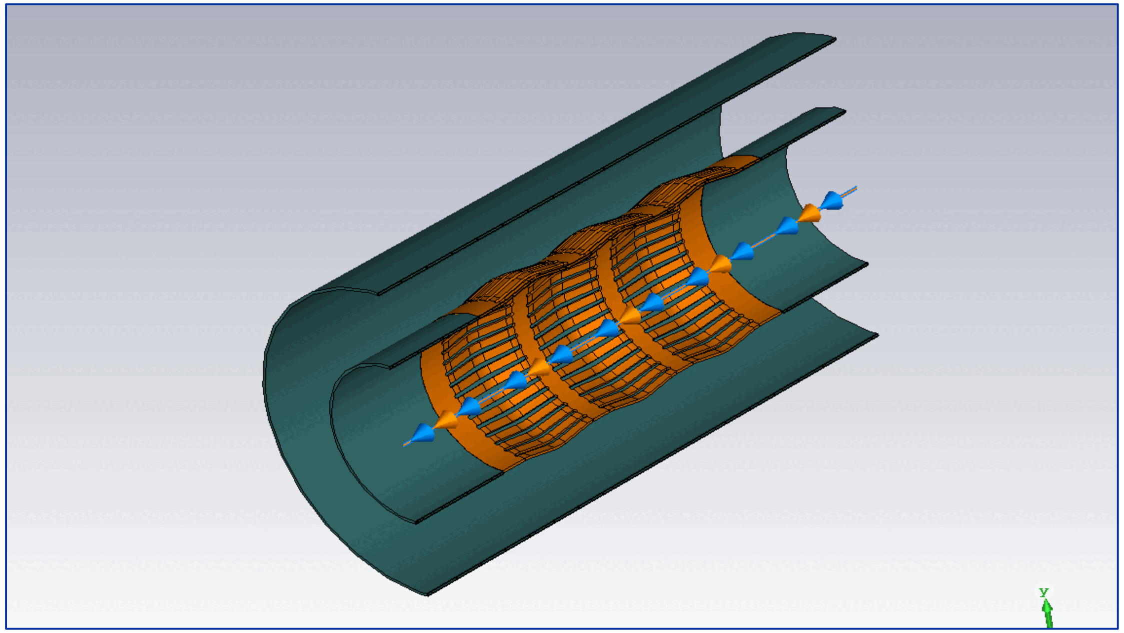
Beam impedance of deformable RF bridge

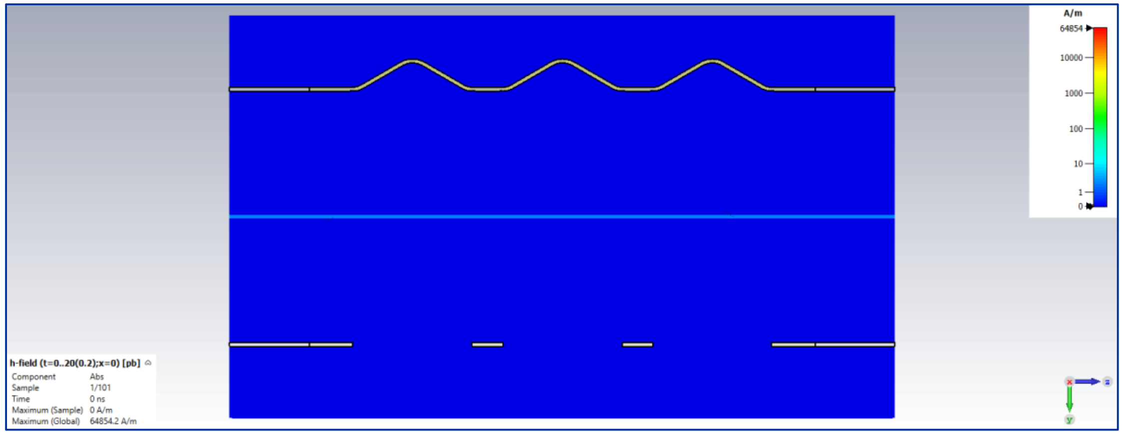
3 types of warm modules in HL-LHC

- Ø63, Ø150, Ø250

Determination of the longitudinal and transverse beam impedance

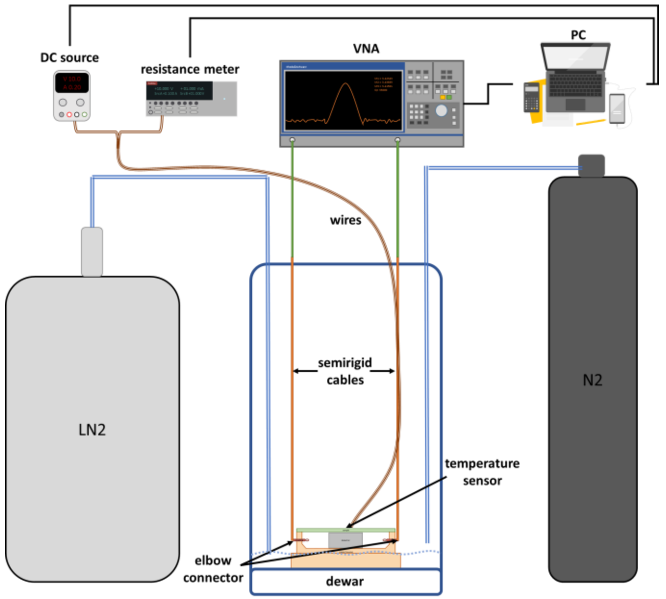


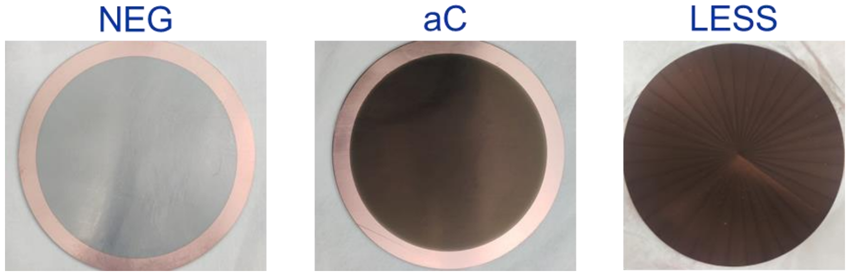


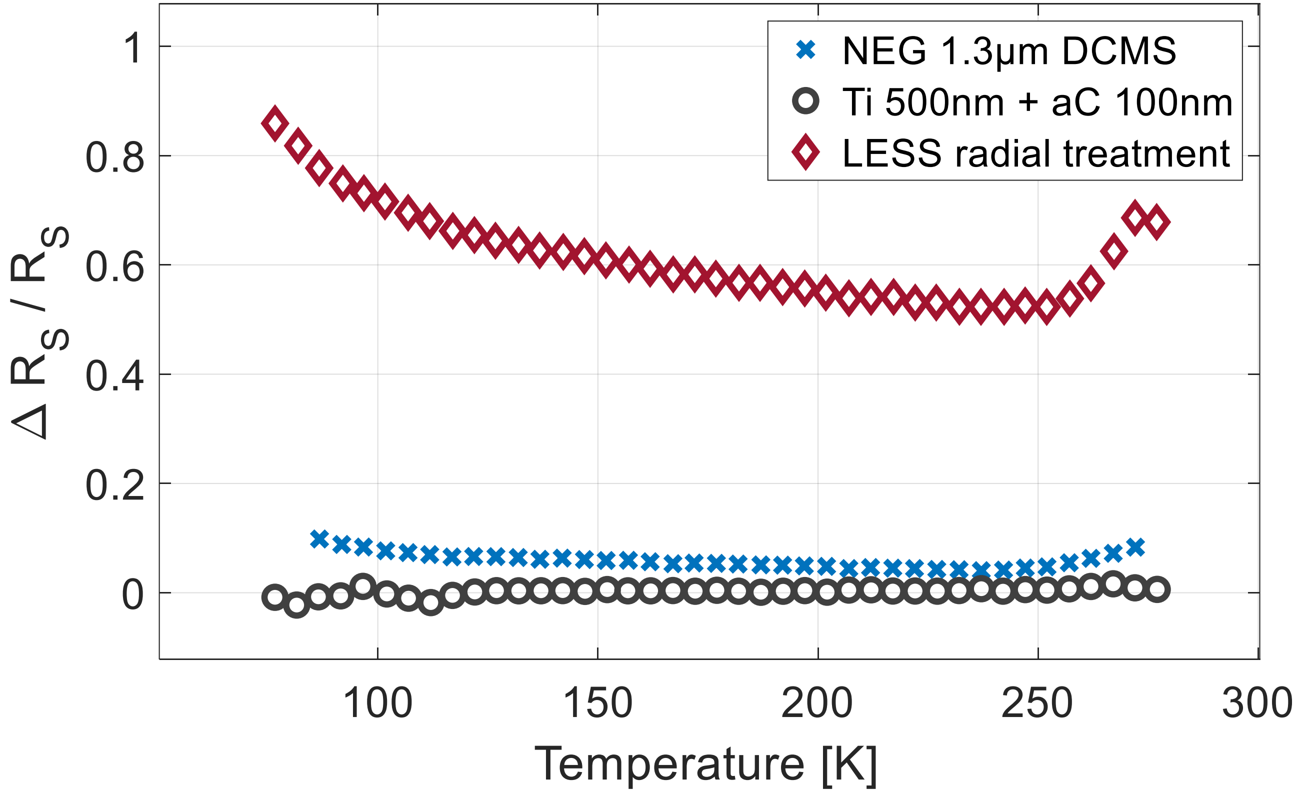


Surface impedance as a function of temperature

Coatings and treatments caracterisation



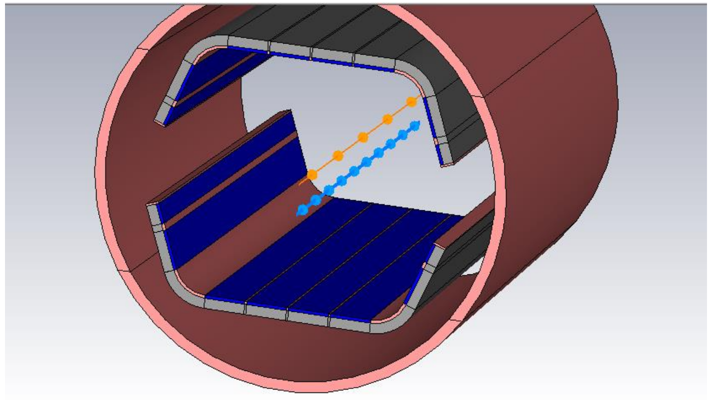


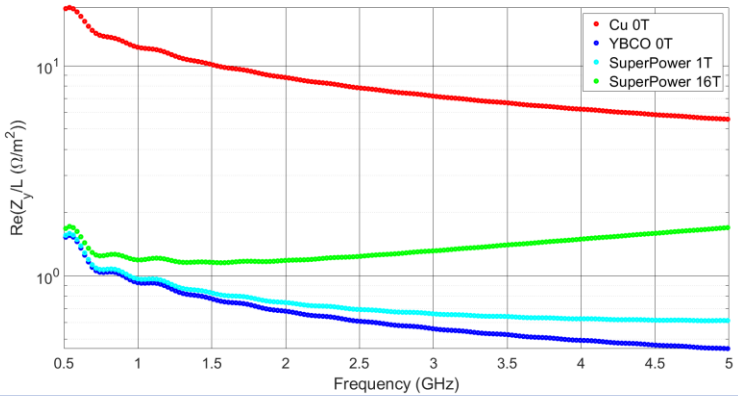


HTS applications for future accelerators

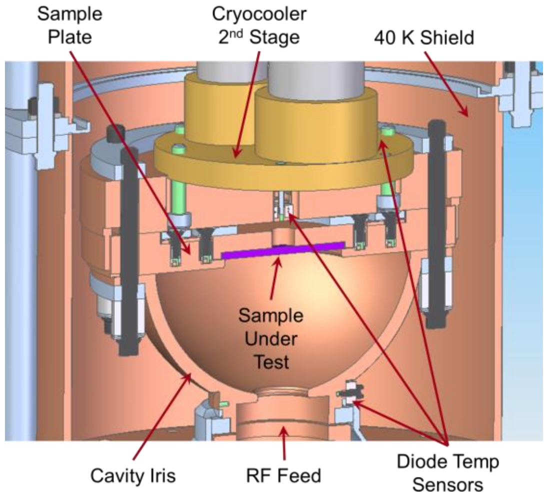
Beam screens

- Factor 10 reduction in surface impedance

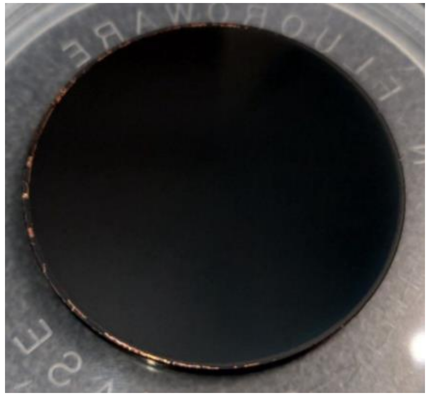




- ## RF cavities
  - High power test facility at SLAC

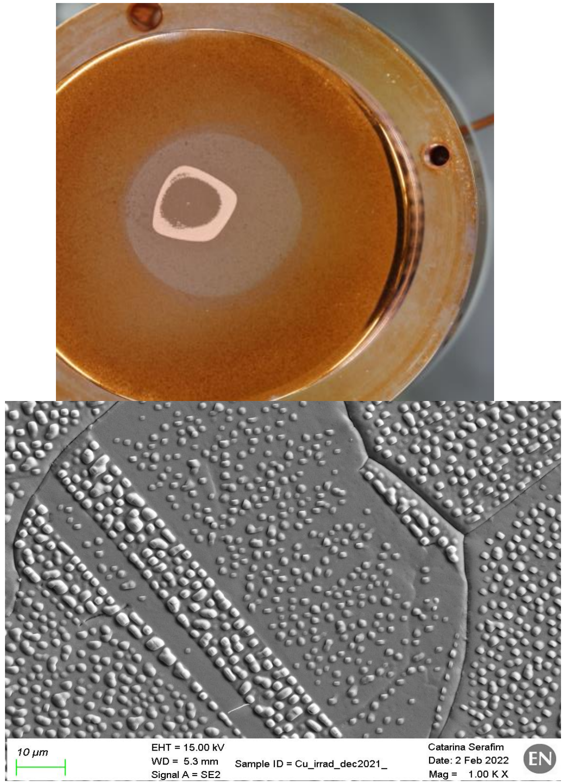


YBCO deposition on Copper



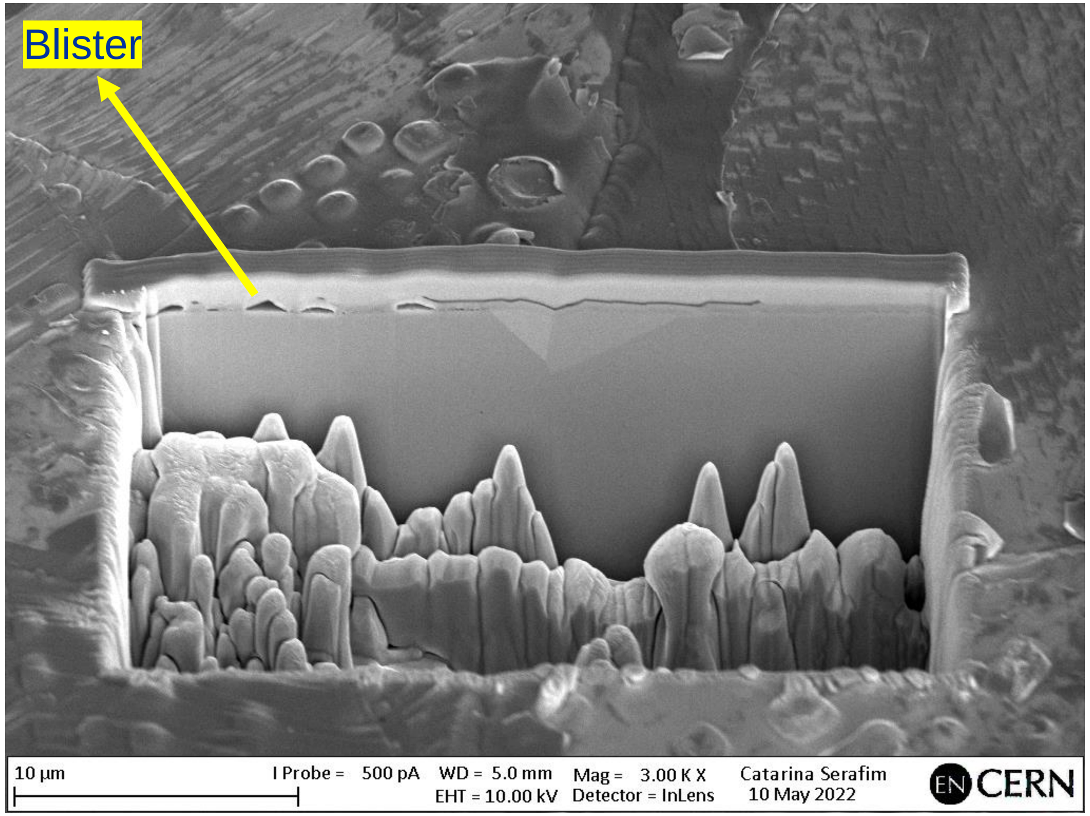
RFQ-Linac 4 irradiation campaign

The blistering effect does not affect the conditioning field but is a function of the grain orientation.



Cu OFE

Material	Emax (MV/m)	Irrad.	Blistering
Cu OFE	80	Yes	Yes
	83	Yes	
	80	No	x
TiAl6V4	110	No	No
	95	Yes	x

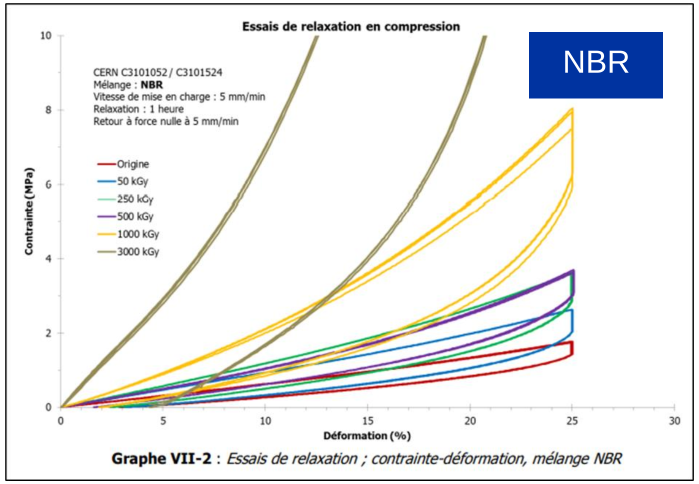


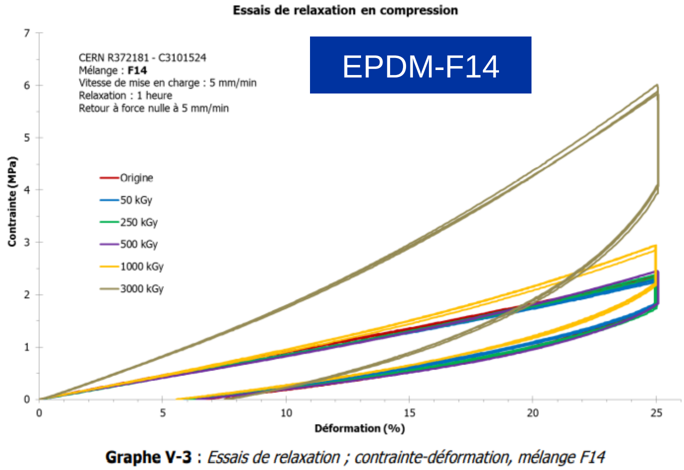
Cu-OFE and TiAl6V4 are so far best materials in reaching a stable field.

Radiation hard O’rings

New O’ring formulation:

- Development by LRCCP of a new formulations for high irradiation environment
- Characterisation tests, in particular after irradiation, with LRCCP of two new formulations and comparison with LHC O’rings.





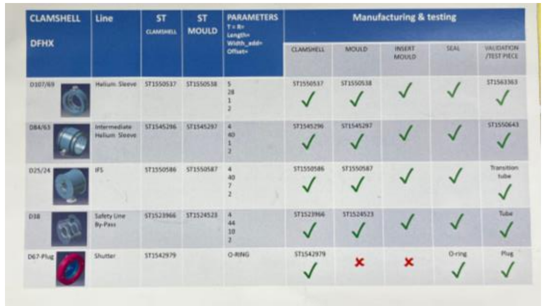
Influence of radiation doses on tensile/relaxation curves for selected and LHC formulations

Summary of leak tests for EPDM-F14 for 25% compression:

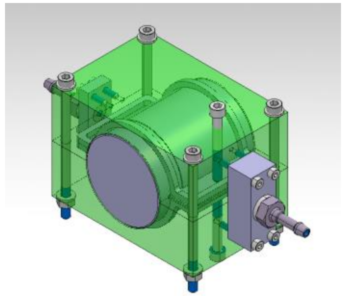
- Irradiation up to ≤1 MGy (at γ): leak tight assembly at any condition
- Irradiation up to 2 and 3 MGy (at γ): leak tight assembly as received; leak tight assembly when O-ring is irradiated without compression and mounted for vacuum sealing; leaky assembly when O-ring is irradiated at compressed status and re-assembled at the same compression ratio
- Irradiation up to 5 MGy (at γ): leaky assembly as received; leak tight assembly when O-ring is irradiated without compression and mounted for vacuum sealing; leaky assembly when O-ring is irradiated at compressed status and re-assembled at the same compression ratio

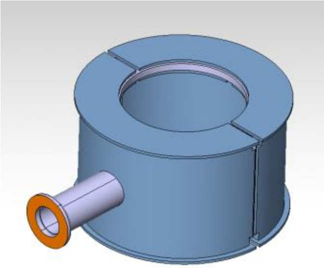
Irradiation campaign of elastomer seals

Clamshell for leak detection



CLAMSHELL DFHX	Line	ST CLAMSHELL	ST MOULD	PARAMETERS T = R= Length= Width_add= Offset=	Manufacturing & testing				
					CLAMSHELL	MOULD	INSERT MOULD	SEAL	VALIDATION /TEST PIECE
D107/69	Helium Sleeve	ST1550537	ST1550538	5 28 1 2	ST1550537 ✓	ST1550538 ✓	✓	✓	ST1563363 ✓
D84/63	Intermediate Helium Sleeve	ST1545296	ST1545297	4 40 1 2	ST1545296 ✓	ST1545297 ✓	✓	✓	ST1550643 ✓
D25/24	IFS	ST1550586	ST1550587	4 40 7 2	ST1550586 ✓	ST1550587 ✓	✓	✓	Transition tube ✓
D38	Safety Line By-Pass	ST1523966	ST1524523	4 44 10 2	ST1523966 ✓	ST1524523 ✓	✓	✓	Tube ✓
D67-Plug	Shutter	ST1542979		O-RING	ST1542979 ✓	×	×	O-ring ✓	Plug ✓





Clamshell and fabrication tooling design

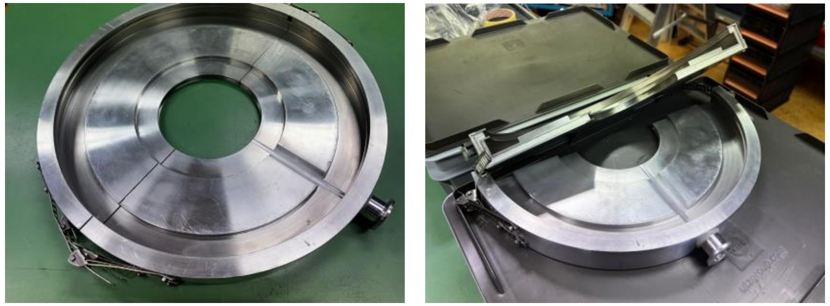
Clamshell redesign

Clamshell prototype

Clamping methods

Different seals and sealing manufacturing method

Clamshell tests

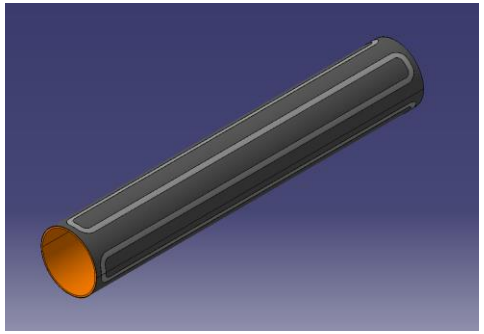


Aluminum clamshell with glued vacuum connection

Radiation hard bakeout system

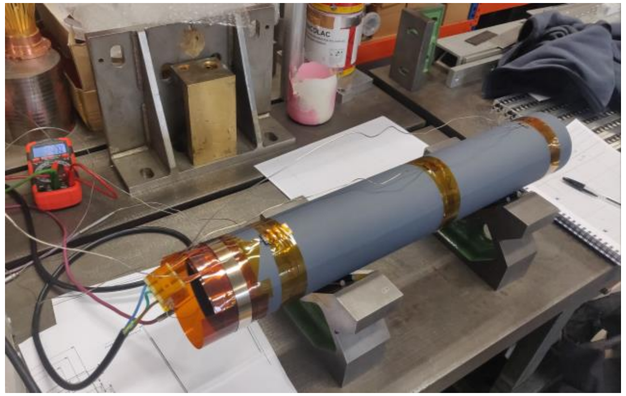
Heating track deposited by cold-Spray

Thermal simulations:

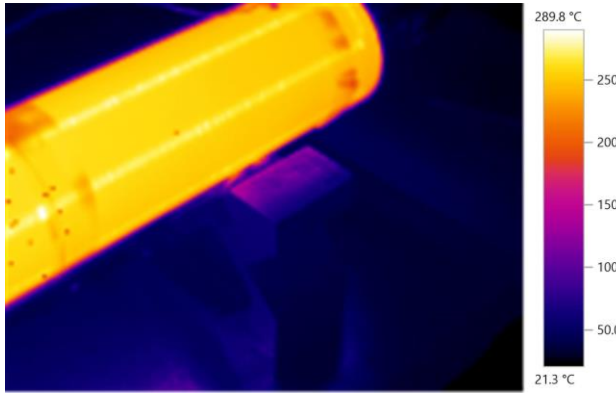


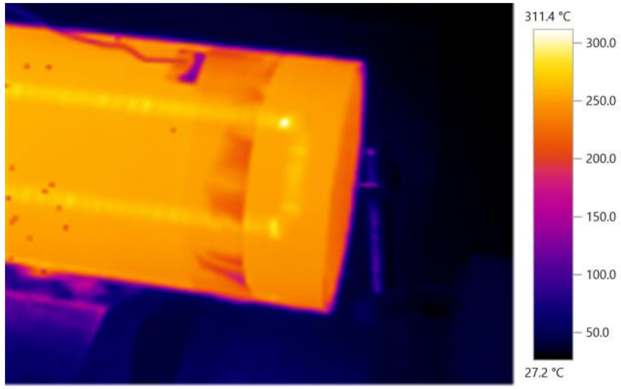
From 2021, design of prototype

Bake-Out prototype successfully tested:

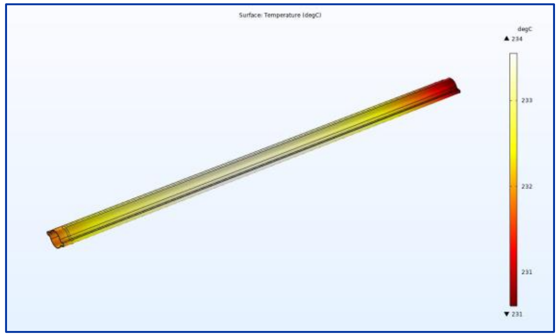


Bake-out setup in workshop





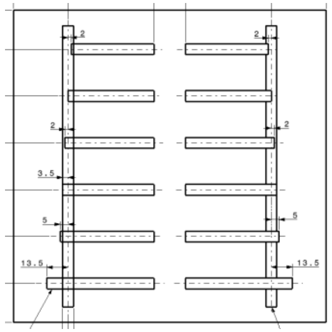
Thermal camera examination



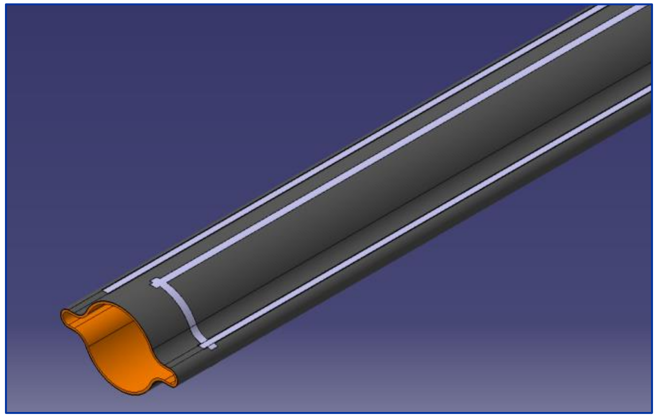
Heat Transfer simulations of the lattice track.

Temperature homogeneity within tolerance.

Materials can achieve bake-out of 250°C.



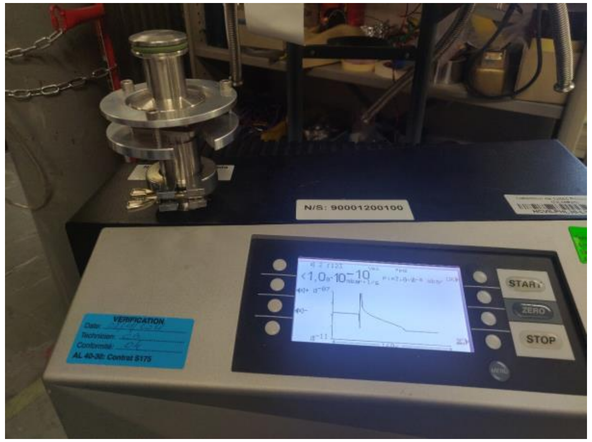
Testing ideal track parameters to update above design.



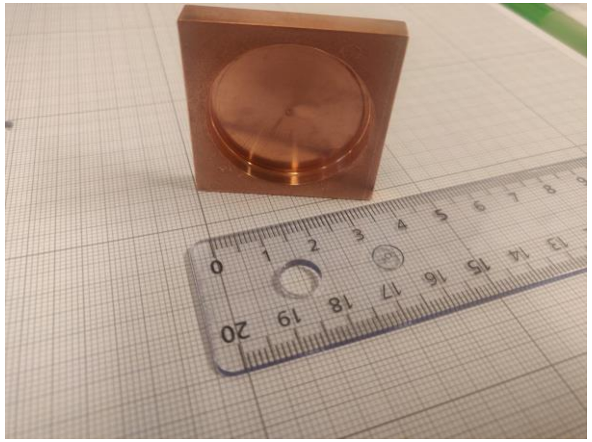
Further work required to perfect bake-out track and cold-spray parameters. New ‘lattice’ track proposed

Additive manufacturing by cold spray

Cold-Spray UHV Validation

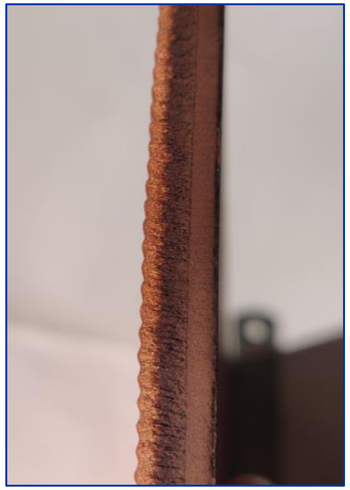


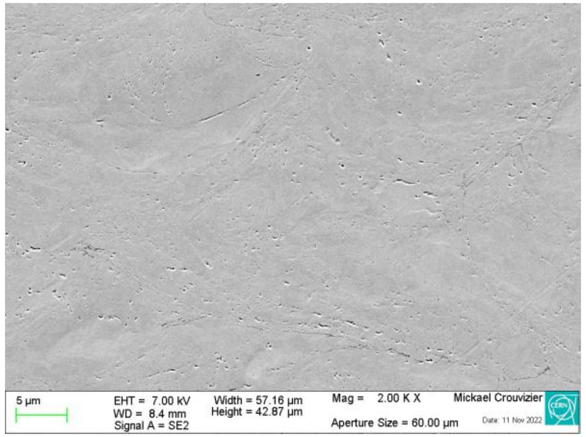
Helium leak testing. Tool developed to test:
- Deposit + Substrate
- Deposit only
- Interface



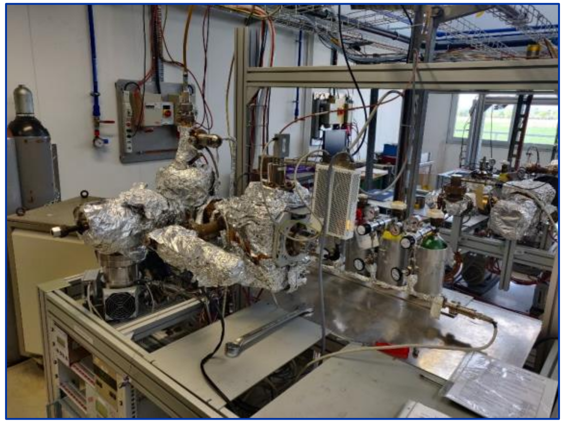
Pure Cu and Cu + Al2O3 combinations successfully tested
Decreasing thickness of Deposit to find limit of leak tightness capability. Pure Cu is better

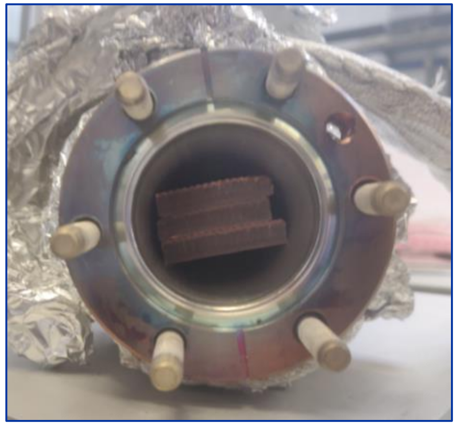
All samples subjected to thermal shock testing





Metallography examinations
- Alumina particles are homogeneously distributed
- Interfaces are free from imperfections (cavities, cracks, lack of adhesion)





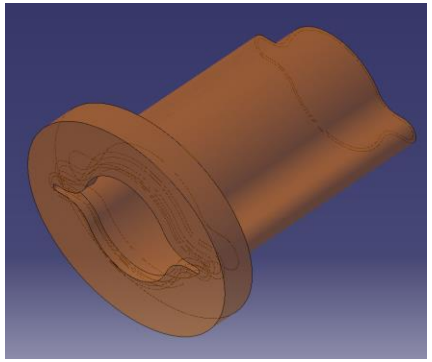
Outgassing campaign on-going in Bld.101

Additive manufacturing by SLM

Leak tightness tests of copper samples made with green laser.

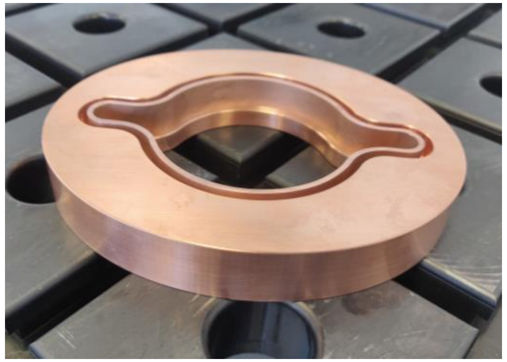
Friction stir welding of copper flange

Phase 1: 6 Flanges + short chamber profiles for destructive testing to determine optimal weld parameters and refine any design issues with flange and/or chamber.



Oval Flange designed to fit vacuum chamber with FSW manufacturing process in mind.

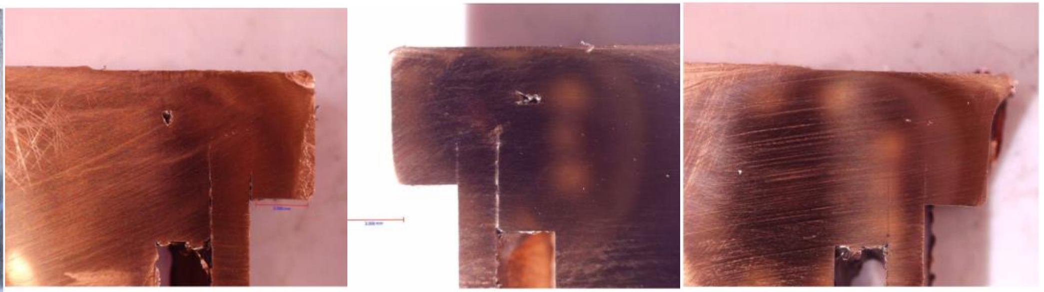
Short chamber profile made by wire-cutting (Erosion Discharge Machining)



Short chamber profile inserted into flange for Phase 1 welding tests

Results from Phase 1 of Friction Stir Weld (FSW) Tests:

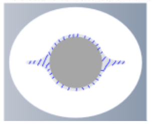
- Good shoulder print on part surface.
- Small internal porosities (maximum size = 0,9 mm) into some (likely coming from the clearance between tube and flange)
- No residual bond between flange and tube
- On cross section 3, we see copper pushed away on the internal side of the flange



Cross-section 1 *Cross-section 2* *Cross-section 3*

Macroscopic inspection

- Good shoulder print on part surface
- No visible porosity in surface
- Excessive penetration in the end of the weld (tool collapse, too hot)



Possible flange modification for future iterations

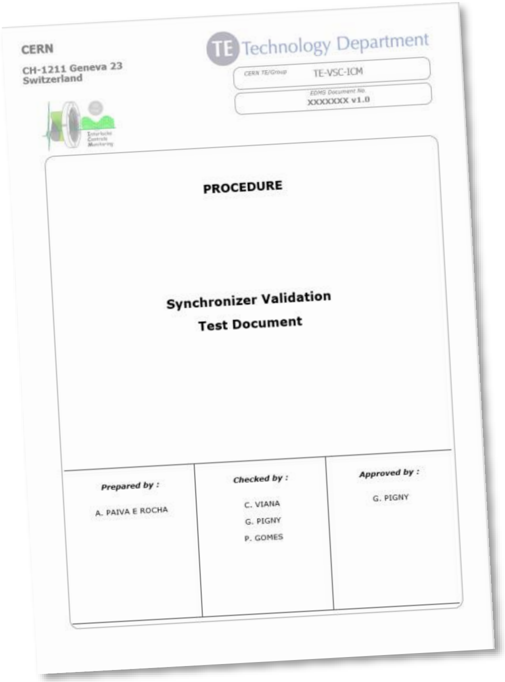
Phase 2:
Longer chambers, 150mm inserted into flanges.
15 assemblies will be welded using newly-determined weld parameters for UHV validation and other testing at CERN.

SCADA development

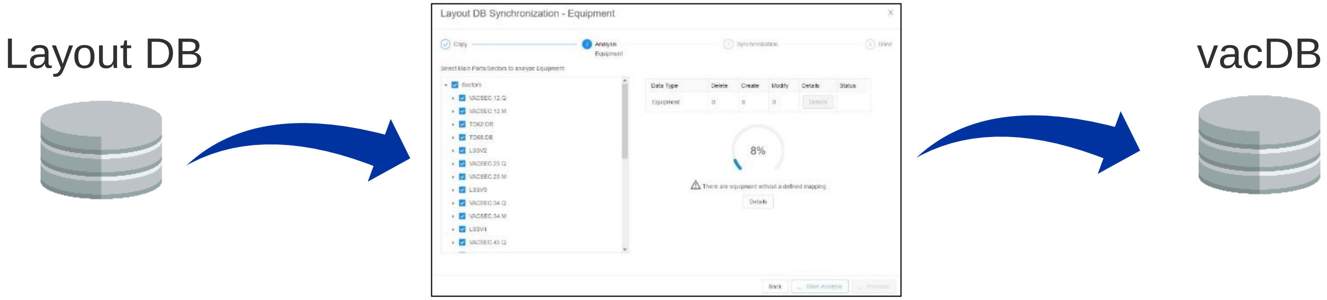
vacCC Synchronizer – Tool for Layout and vacDB synchronization

vacCC Synchronizer – Validated and used to perform the final LHC synchronization before RUN3

- Human-assisted tool to aid the update of vacDB with new LayoutDB data (equipment, sectors, mainparts)
- New version allows:
  - Partial synchronizations (per sector/mainpart) as opposed to the entire machine
  - Synchronization with different LayoutDB versions – allowing us to work in advance for HI-LUMI



vacCC Synchronizer

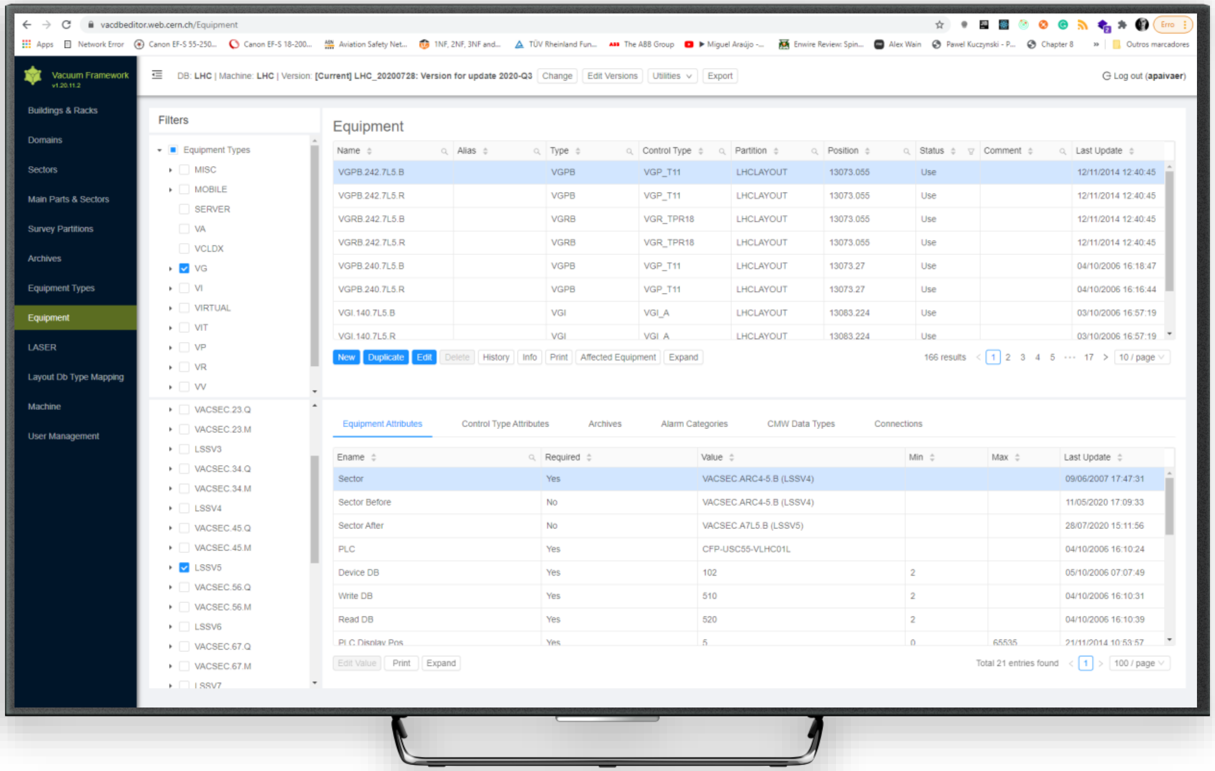


- New LayoutDB error detection mechanisms implemented – errors are now detected in the layoutDB before they are imported into vacDB:
  - Missing attributes (Sector, Sector Before, Sector After)
  - Position Mismatch (DCUM and Sector don't match)
  - Overlapped sectors
  - Sector loss of continuity
  - Control type mismatch (types in LayoutDB and vacDB don't match)

Validation:

- ~ 100 page test document
- Synchronizer fully validated in production environment
- vacDB LHC production database synchronized

Vacuum Controls Configurator Machine



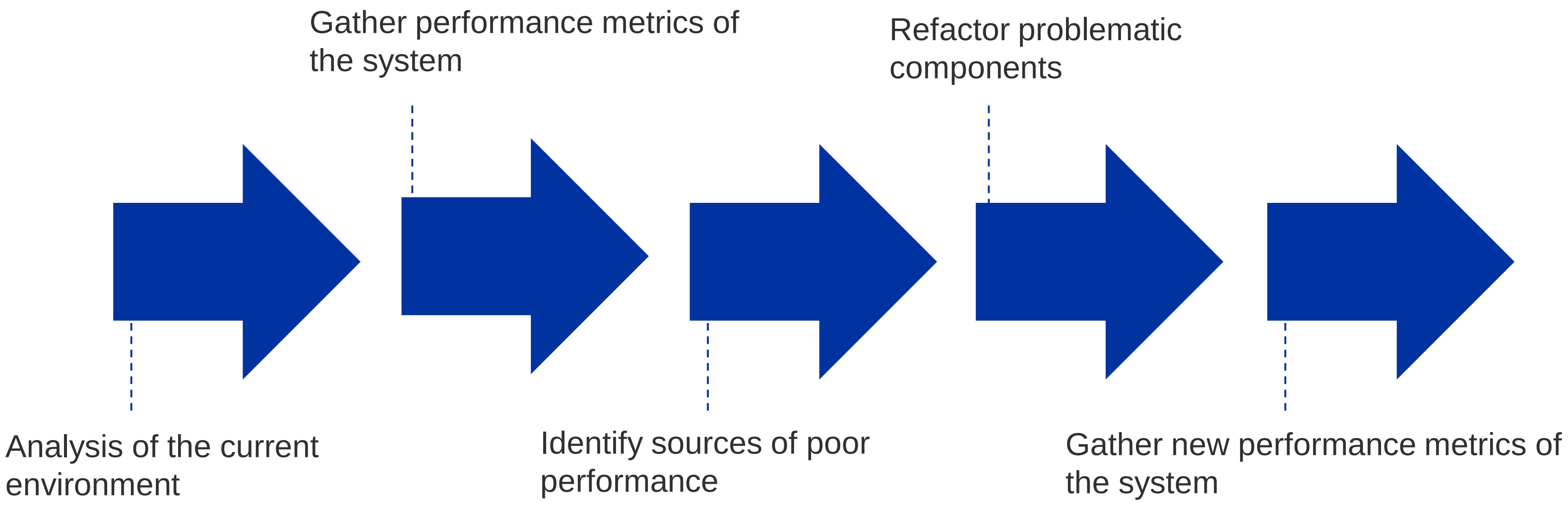
vacCC Machine upgraded to use the new versions:

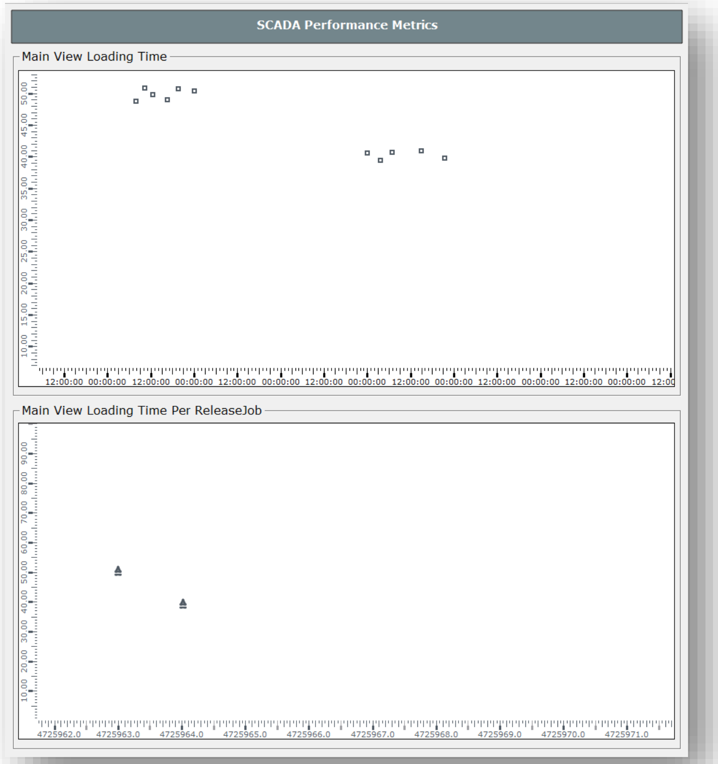
- Backend updated to Spring 2.7
- User Interface upgraded to React 17 and AntD 5

Updating software:

- Avoiding software obsolescence
- Keeping up to date with security patches

SCADA Performance Study



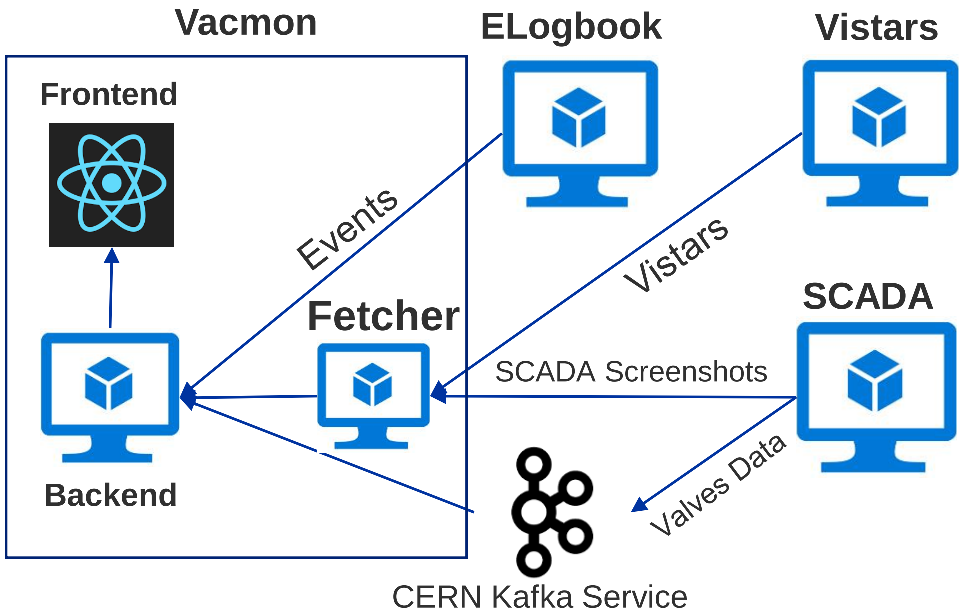


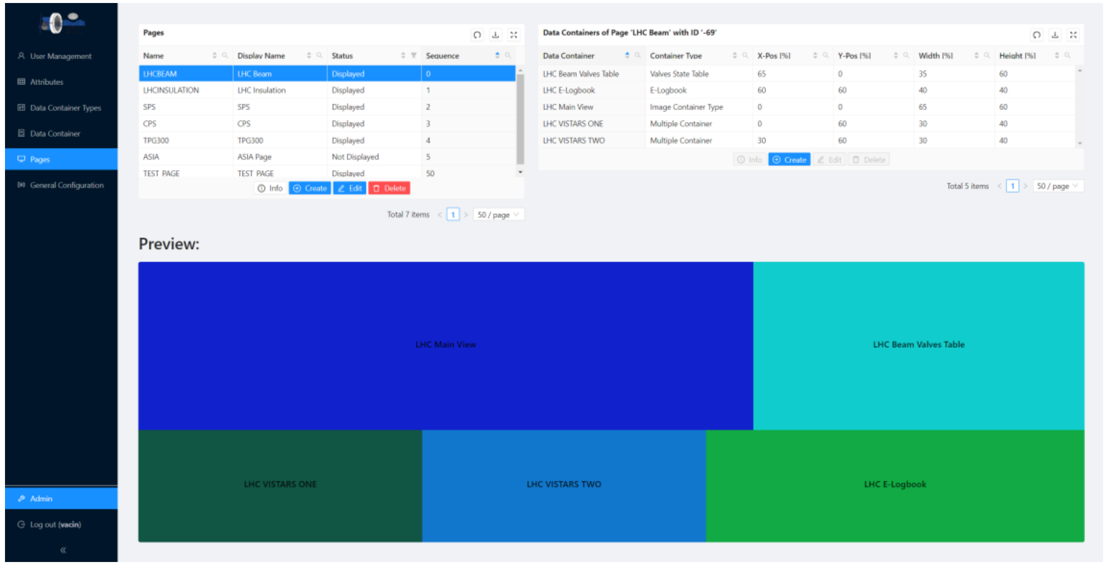
Performance Measuring Panel

- Several algorithms modified to increase the performance of the vacuum SCADA
- LHC's Main View loading time is expected to improve ± 10 seconds compared to the previous baseline after the LHC SCADA update
- Startup performance will further improve after the deployment of the new Unified Mobile System to about 50% of current time
- New metrics gathering system will allow to monitor the performance evolution on upcoming SCADA releases

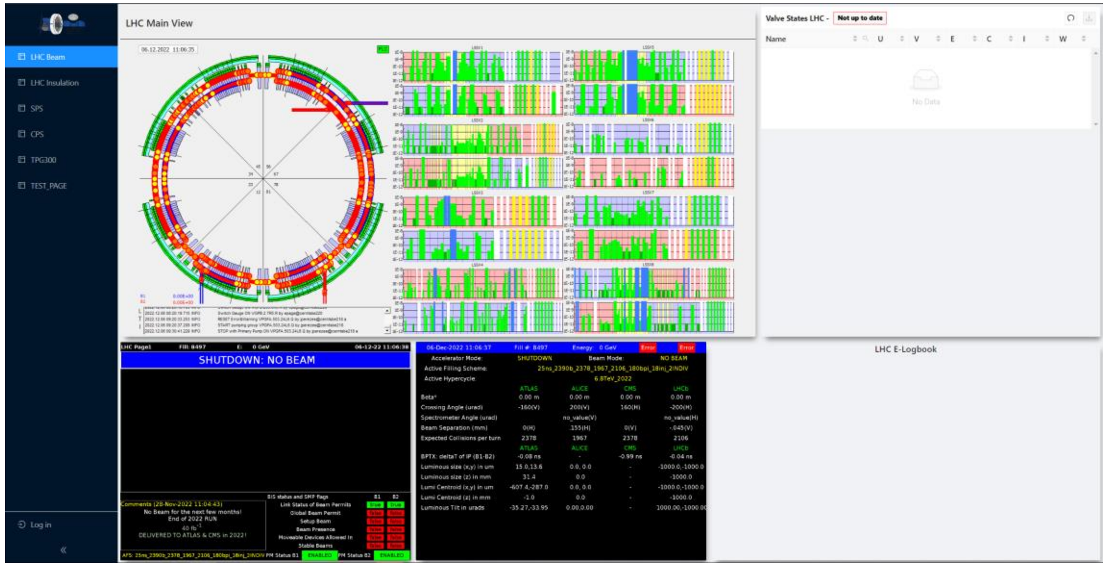
Vacmon

- New version under development
- Web pages with resume information from vacuum SCADA applications
- Fully configurable – new **templating mechanism** allows pages to be created online
- Data containers developed:
    - Real-time streaming the current state of Valves
    - Real-time Elogbook events
    - Vistar Images
    - SCADA Screenshots
    - Images
- **To be released Q1 2023**





Templating a Page



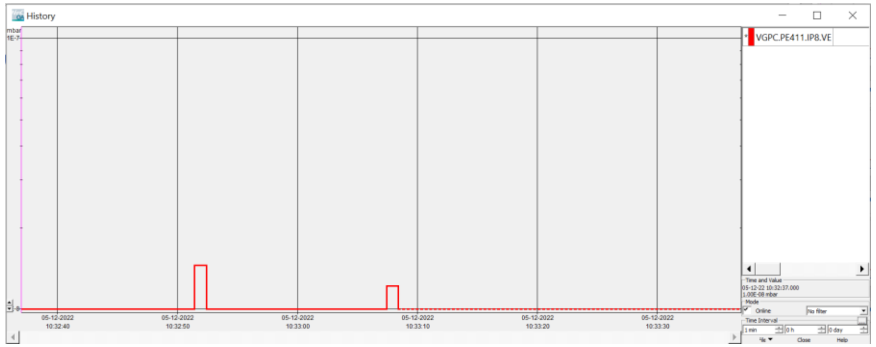
Rendered templated Page

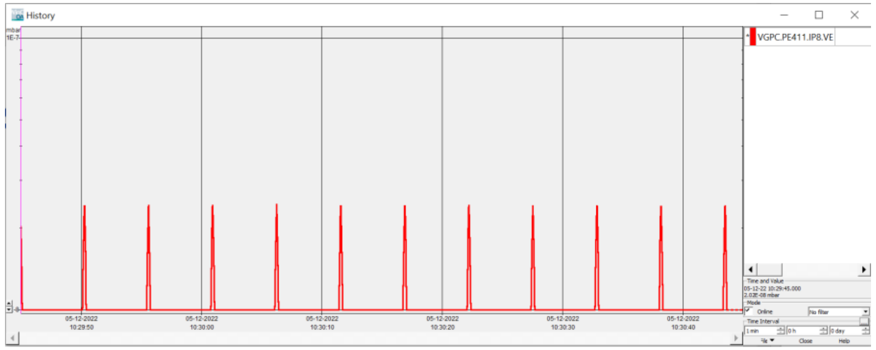
PLC and ELECTRONICS DEVELOPMENT

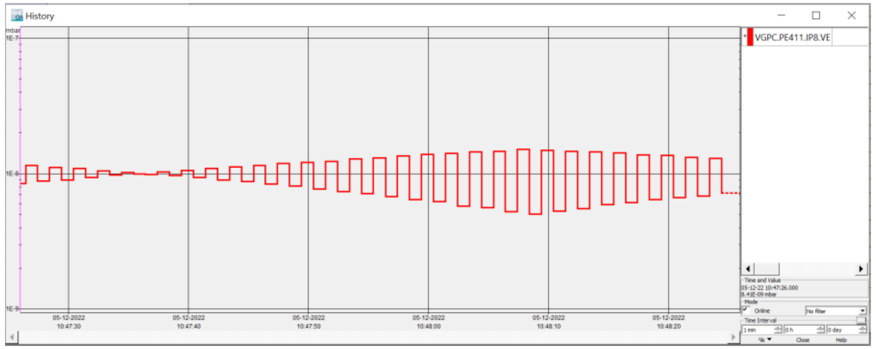
TSPP for Vacuum Framework

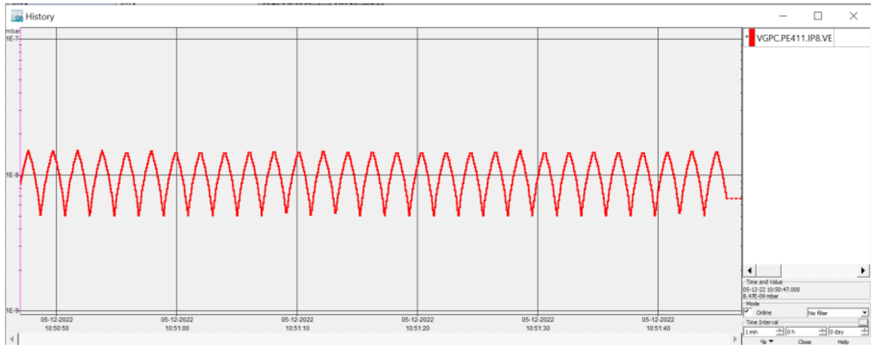
Implementation of TSPP for Vacuum Framework ("UNICOS-style" Data Acquisition)

- Time Stamped Push Protocol: vast improvement in Time and Value resolution of acquired data
- No more lost data (pressure spikes, fast interlocks, momentary glitches, etc)
- Start of deployment during 2023









Polling at 1s
Pressure peaks every 5 seconds (**top**), ramp up/down every second (**bottom**)

With TSPP
Same signals, now properly acquired

Consolidation of Mobile Systems

New router for 4G renovation of Mobile Systems selected and validated

Connectivity tests on the surface and tunnels

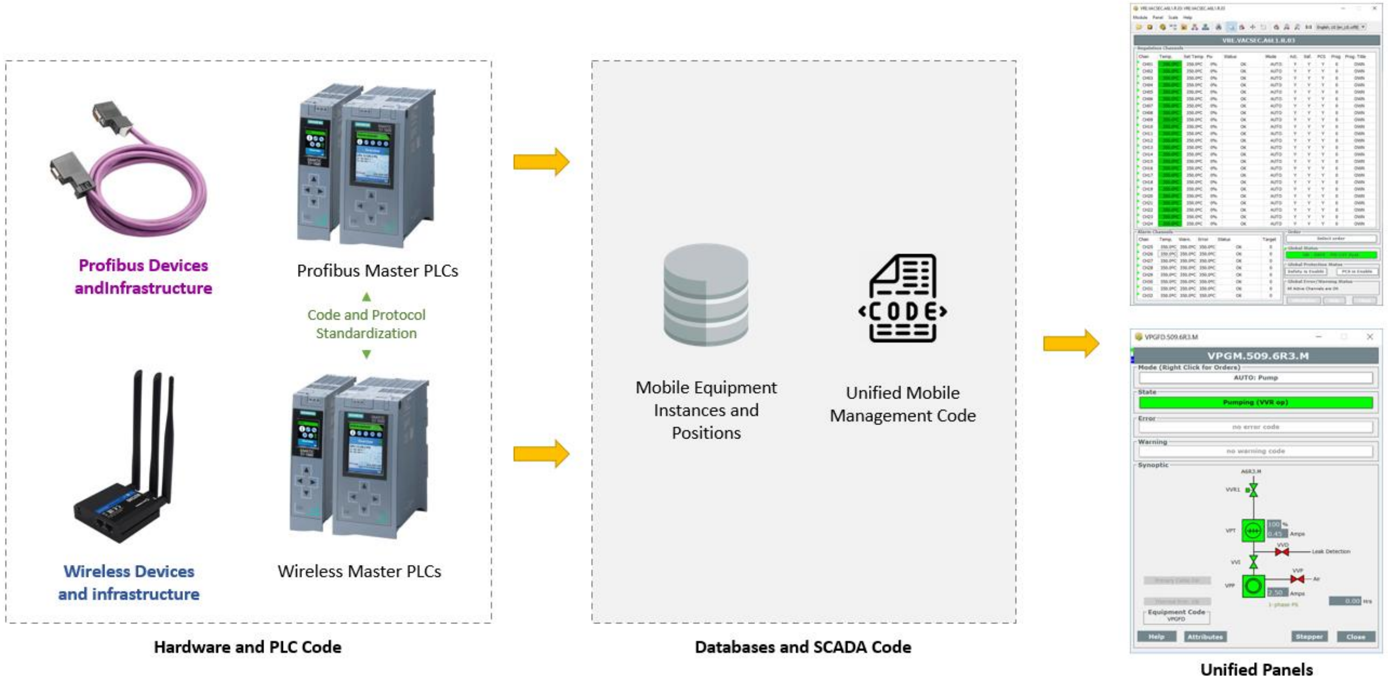
Vibration tests in QART Lab

Large-volume orders in late 2022 / early 2023

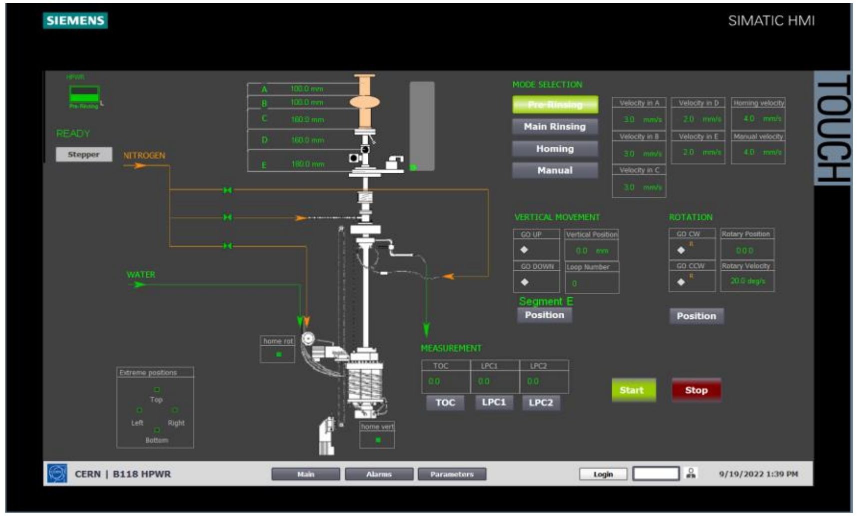
Consolidation planned for 2023 (VPGs + Bakeout)

Merging of Wireless and Profibus

- Works continues to merge the 4G and Profibus systems for Profibus Mobile Integration
- PLC implementation of new Profibus Protocol is **complete**
- SCADA / exporter implementation is **ongoing** (planned 2023)



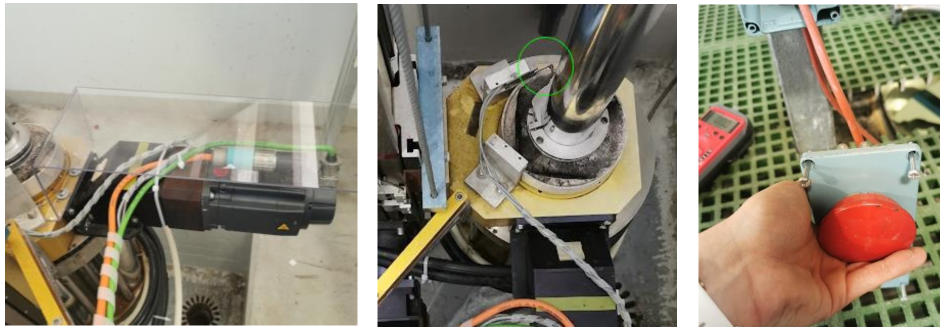
Renovation of High-Pressure Water Rinsing Facility



Intuitive Touch Panel

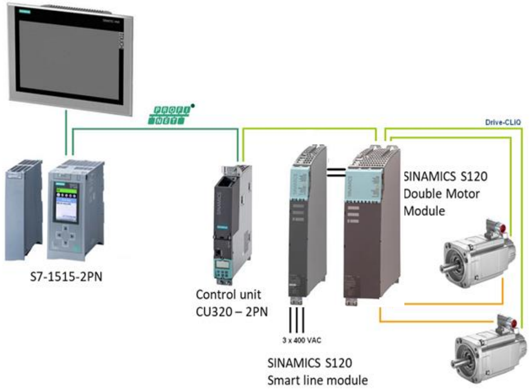
New, reliable and flexible Control System

- Uses up-to-date technology that we can maintain for the expected lifetime of the machine
- A lot of added functionality
- New safety features
- Properly documented



Safety interlocks integrated into the Control System

Rinsing Quality Control



Modern Control Architecture

TPG500 & Profibus diagnostic

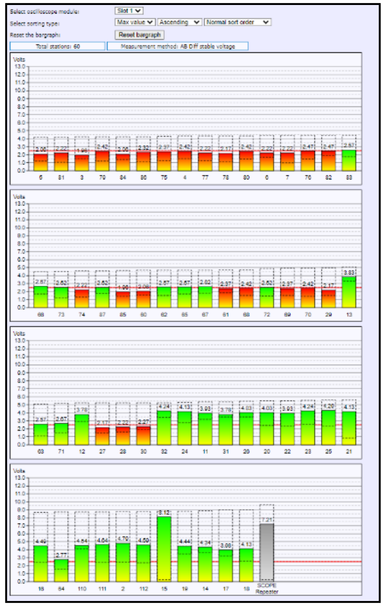
TPG500

- Validation of new Profibus firmware v2.11
- Sixteen units installed in production (13x SPS, 2x MEDICIS, 1x LEIR)

PROFIBUS

- Combricks diagnostic tool evaluation
- One unit installed in BA2
- One unit installed in Lab
- Company visit

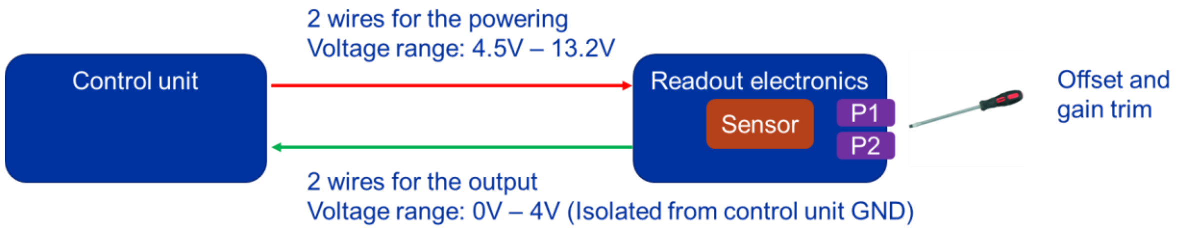
TPG500s installed in BA6



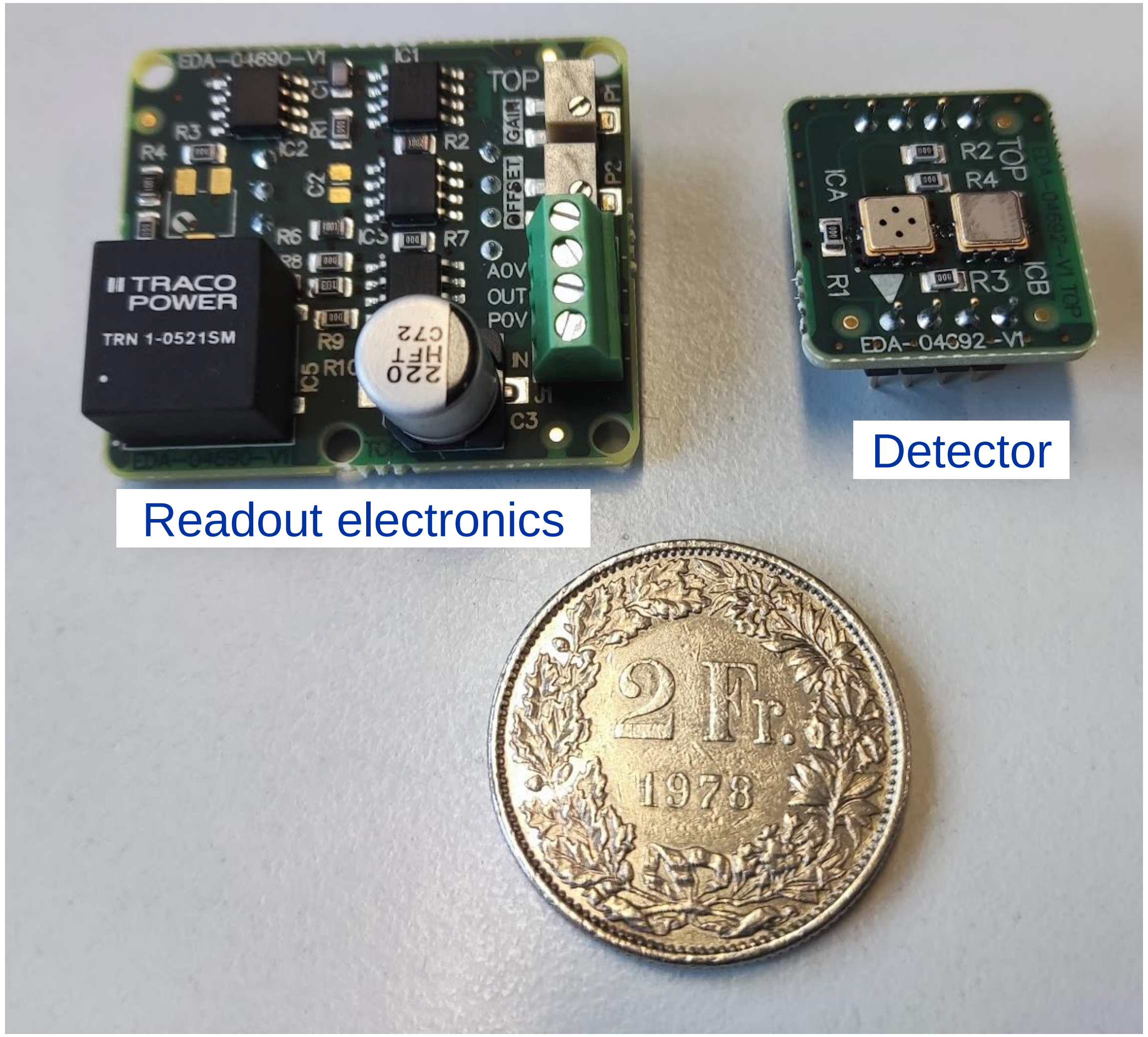
ComBricks in BA2 Profibus network

MEMS low-cost Helium detector electronics

- **MEMS thermal conductivity sensor**
  - First demonstration prototype fully functional
  - Very small size: 37mm x 29mm x 25mm



- **Foreseen upgrades for second prototype**
  - Further size reduction
  - Battery powered
  - Wireless (LoRa)
  - Radiation tolerant



In period with **limited visibility**, we have to **reinforce and acquire new competences**.

Technological competences are key aspects of our flexibility and ability to join new studies and projects

However, **our credibility comes from our services and operational daily work**. Only if we ensure excellent services/operation, we can see **optimistically into the future**.

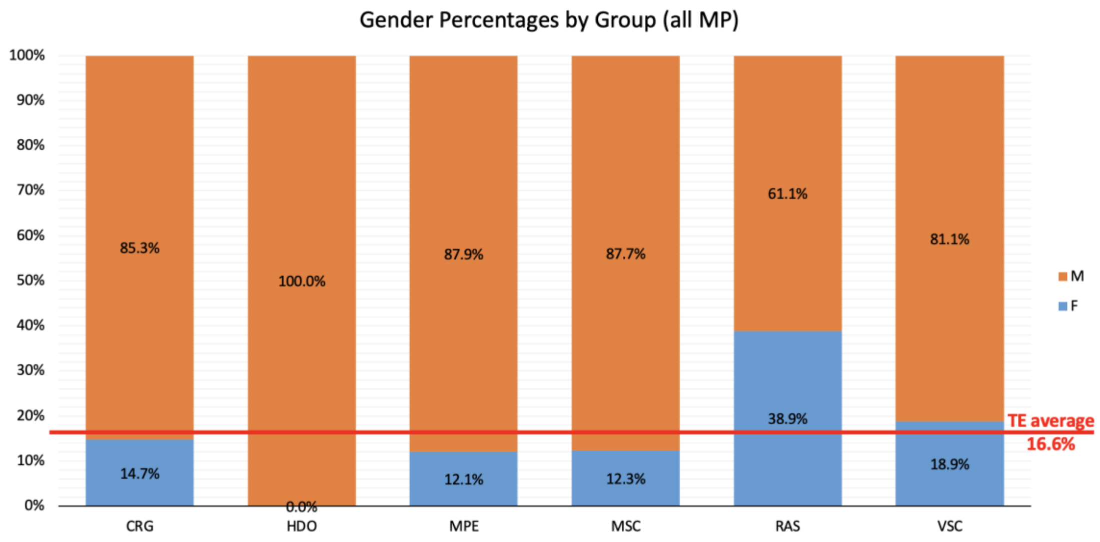
25 x 25 Diversity & Inclusion Programme

[TE Focal Points : Caroline Fabre, Holger Neupert, Paulo Gomes]

Analysed and summarised the answers from a sample of ˜45 TE members. Examples of comments:

- colleagues are strongly against positive discrimination at recruitment and advancement
- there are not enough interesting candidates applying (already before looking into nationality or gender)
- action is needed upstream of HR long list, e.g. the advertisements for open positions
- Dept. should provide more visible, accessible and digested data analytics; and more communication on dept. vision

Analysed the TE personnel statistics on nationality and gender



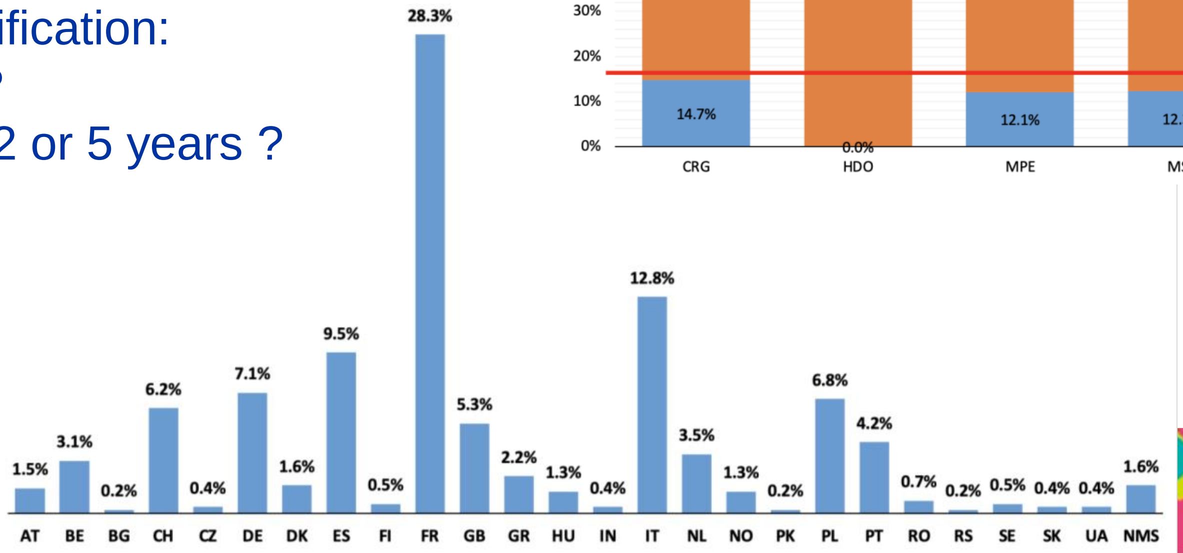
Elaborated a set of actions for the "Department Finess Plan"

Presented to & approved by HD and TEMB (22/09/2022) [EDMS 2775176]

Moved from 3 Dep. Focal Points to 1 D&I Officer [Paulo Gomes]

Current Discussion on DIO mandate modification:

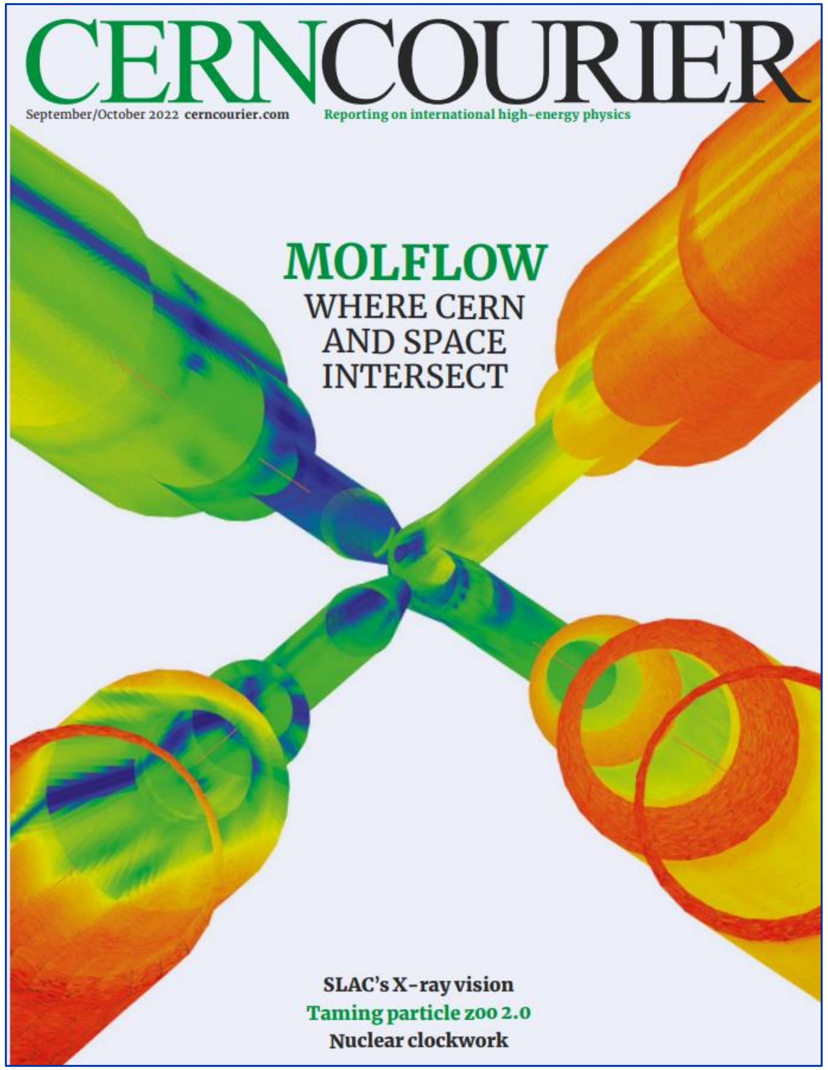
- monthly meetings instead of 3 / year ?
- extend duration of the mandate up to 2 or 5 years ?
- include policy recommendations ?

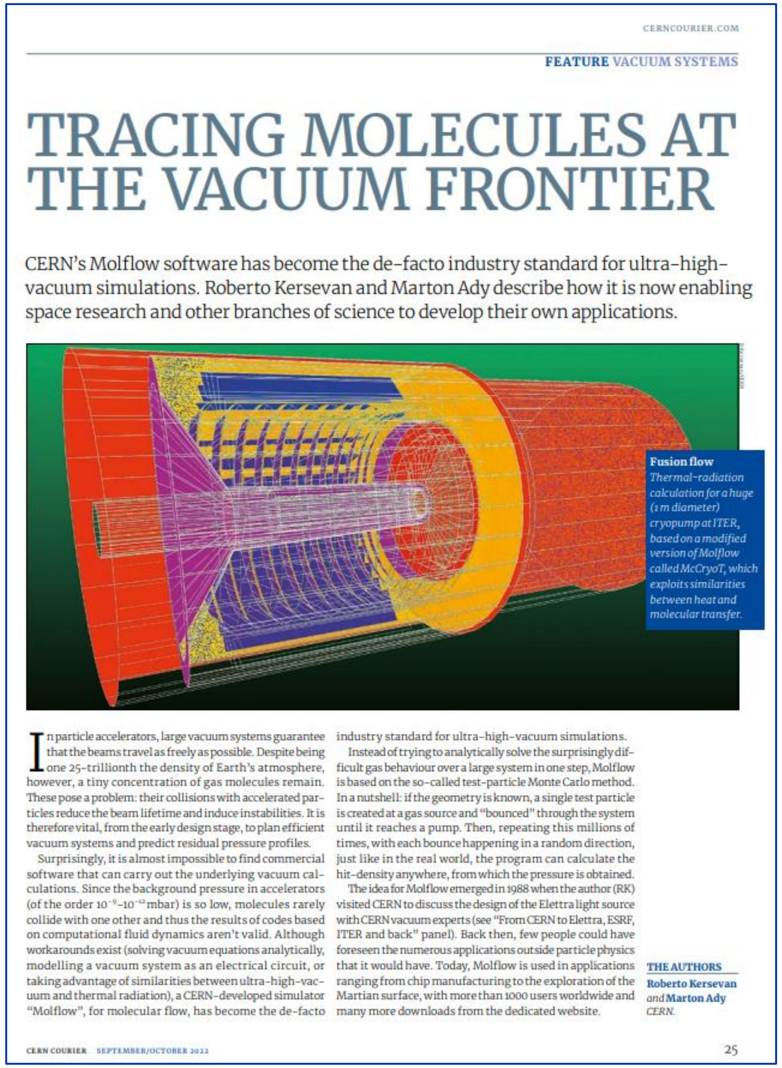


Merci à vous tous!

Publications 2022

CERN COURIER Sep/Oct’22 Edition





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FEATURE VACUUM SYSTEMS

TRACING MOLECULES AT THE VACUUM FRONTIER

CERN’s Molflow software has become the de-facto industry standard for ultra-high-vacuum simulations. Roberto Kersevan and Marton Ady describe how it is now enabling space research and other branches of science to develop their own applications.

Fusion flow *Thermal-radiation calculation for a huge (1 m diameter) cryopump at ITER, based on a modified version of Molflow called McCryoT, which exploits similarities between heat and molecular transfer.*

In particle accelerators, large vacuum systems guarantee that the beams travel as freely as possible. Despite being one 25-trillionth the density of Earth’s atmosphere, however, a tiny concentration of gas molecules remain. These pose a problem: their collisions with accelerated particles reduce the beam lifetime and induce instabilities. It is therefore vital, from the early design stage, to plan efficient vacuum systems and predict residual pressure profiles.

Surprisingly, it is almost impossible to find commercial software that can carry out the underlying vacuum calculations. Since the background pressure in accelerators (of the order 10^{-9}–10^{-12} mbar) is so low, molecules rarely collide with one other and thus the results of codes based on computational fluid dynamics aren’t valid. Although workarounds exist (solving vacuum equations analytically, modelling a vacuum system as an electrical circuit, or taking advantage of similarities between ultra-high-vacuum and thermal radiation), a CERN-developed simulator “Molflow”, for molecular flow, has become the de-facto industry standard for ultra-high-vacuum simulations.

Instead of trying to analytically solve the surprisingly difficult gas behaviour over a large system in one step, Molflow is based on the so-called test-particle Monte Carlo method. In a nutshell: if the geometry is known, a single test particle is created at a gas source and “bounced” through the system until it reaches a pump. Then, repeating this millions of times, with each bounce happening in a random direction, just like in the real world, the program can calculate the hit-density anywhere, from which the pressure is obtained.

The idea for Molflow emerged in 1988 when the author (RK) visited CERN to discuss the design of the Elettra light source with CERN vacuum experts (see “From CERN to Elettra, ESRF, ITER and back” panel). Back then, few people could have foreseen the numerous applications outside particle physics that it would have. Today, Molflow is used in applications ranging from chip manufacturing to the exploration of the Martian surface, with more than 1000 users worldwide and many more downloads from the dedicated website.

THE AUTHORS
Roberto Kersevan *and* Marton Ady *CERN.*

CERN COURIER SEPTEMBER/OCTOBER 2022 25

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