TE
Accelerator Technology Departement

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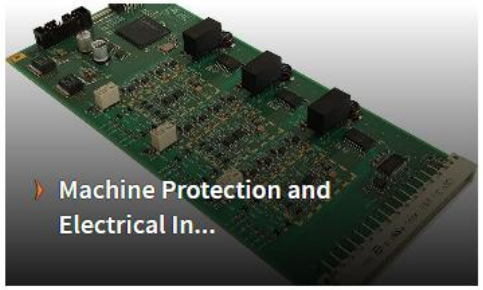
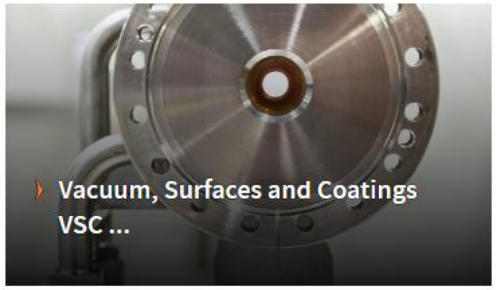
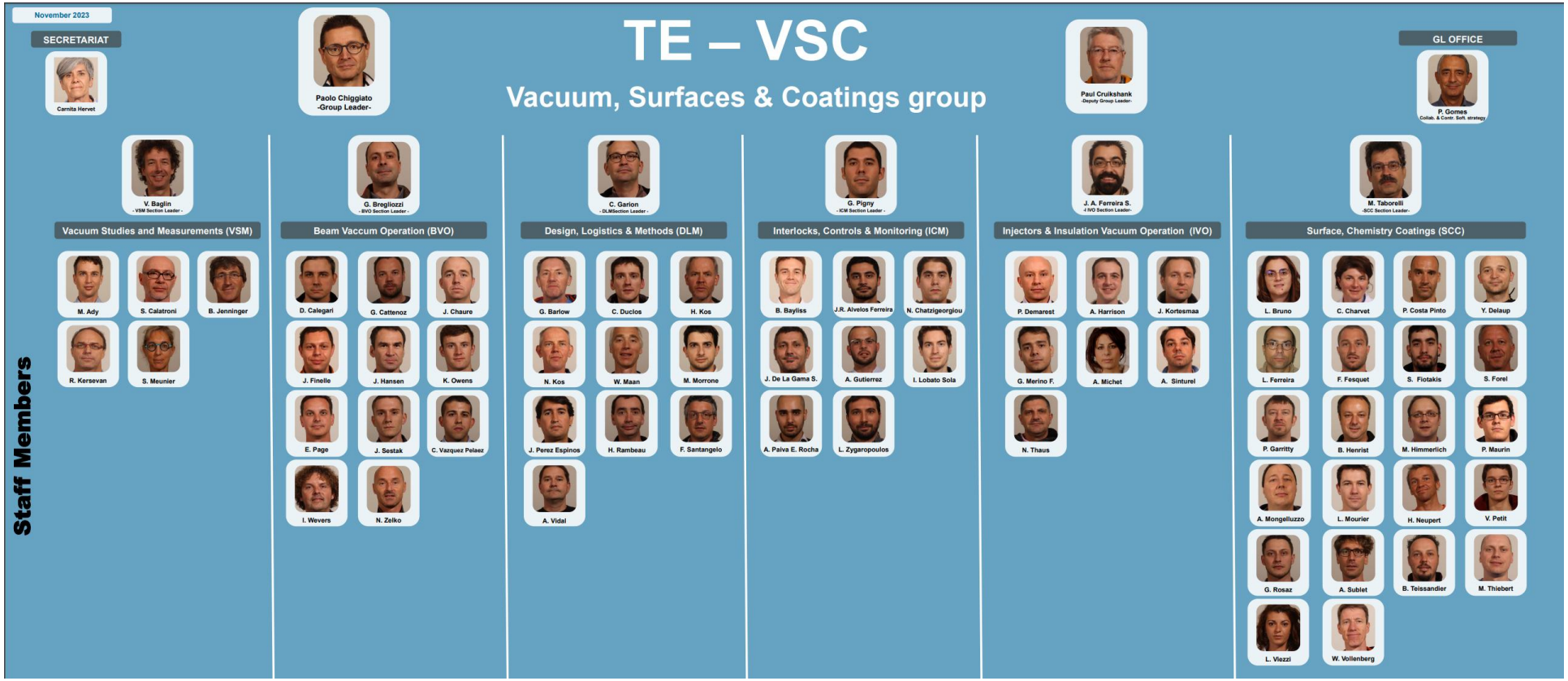
TE-CRG	TE-HDO	TE-MPE	TE-MSC	TE-RAS	TE-VSC
Cryogenics	Head Of Department's Office	Machine Protection & Electrical Integrity	Magnets, Superconductors and Cryostats	Resources, Apprentices & Safety	Vacuum, Surfaces & Coatings
GL: Dimitri DELIKARIS DGL: Johan BREMER	GL: Jose Miguel JIMENEZ	GL: Jan UYTHOVEN DGL: Daniel WOLLMANN	GL: Attilio MILANESE DGL: Amalia BALLARINO	GL: Valeria PEREZ REALE DGL: Germana RIDDONE	GL: Paolo CHIGGIATO DGL: Mauro TABORELLI






November 2023
TE – VSC
Vacuum, Surfaces & Coatings group
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Paolo Chiggiato
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Paul Cruikshank
-Deputy Group Leader-
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B. Jenninger
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M. Taborelli
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Y. Delaup
L. Ferreira
F. Fesquet
S. Fiotakis
S. Forel
P. Garritty
B. Henrist
M. Himmerlich
P. Maurin
A. Mongelluzzo
L. Mourier
H. Neupert
V. Petit
G. Rosaz
A. Sublet
B. Teissandier
M. Thiebert
L. Viezzi
W. Vollenberg

Vacuum, Surfaces and Coatings Group

Design, construction, operation, maintenance and upgrade of high & ultra-high vacuum systems for Accelerators and Detectors.

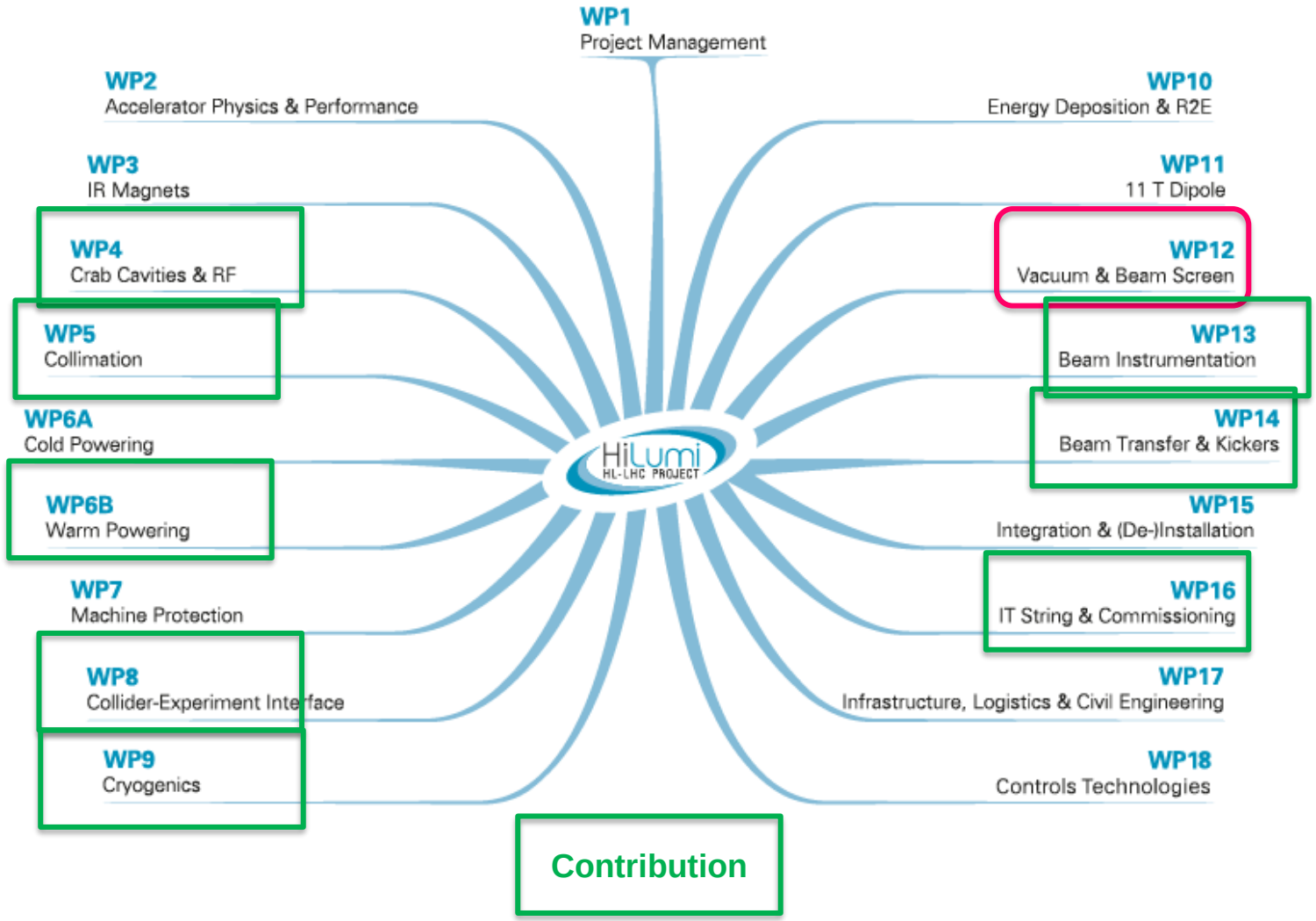
- Expertise and support on thin-walled vacuum chambers, windows and bellows compensation systems
- Expertise in vacuum sealing and leak-tightness technology
- Expertise in dynamic vacuum phenomena
- Management of the industrial support contract for vacuum work in accelerators
- Expertise in vacuum control systems, vacuum interlocks and monitoring tools

Coatings, surfaces treatments, surface and chemical analysis for Accelerators and Detectors. Expertise and support in the fields of:

- Coatings, electroplating and surface cleaning techniques
- UHV characterization and of material and surfaces
- Degassing analysis and treatments

Organisation

https://espace.cern.ch/HiLumi/default.aspx



WP12 Contribution
Vacuum preparations for collaborations

G.Bregliozzi & F.Silvagni

Contribution from B.Henrist, P.C.Pinto. S.Fiotakis

Outline

Plug-in modules:

- Status of production, vacuum acceptance test, assembly, and shipping preparation.

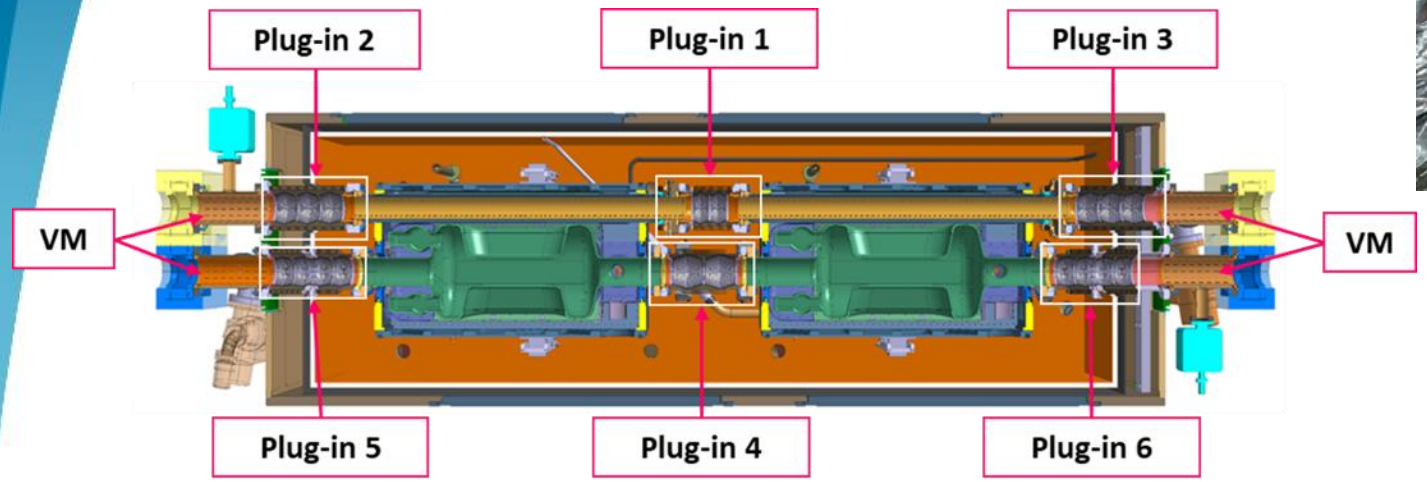
Beam screen & Cold Bore:

- Plasma cleaning, a-C coating, vacuum acceptance test, insertion procedure.

Extremity vacuum chambers & Ancillaries:

- Status of production, vacuum acceptance test, assembly.

Plug in modules



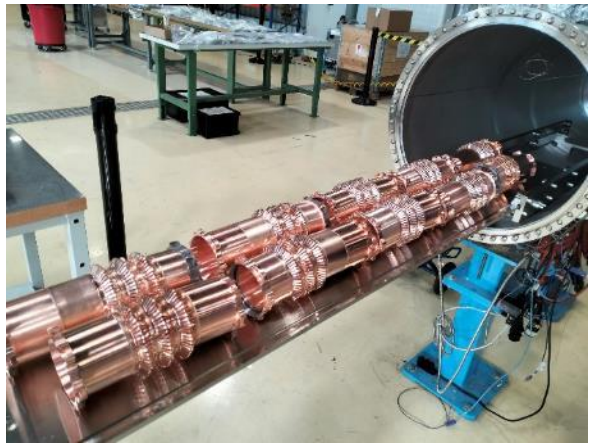
Item	Needed	Spare	Produced	Fully assembled	Comments
PIMs	60	6	28	19	All bellows delivered, PIMs manufacturing on going
DRF inserts	60	6	30	19	Welding and assembly of remaining DRF will start in Q1-2025

PIMs assembly status

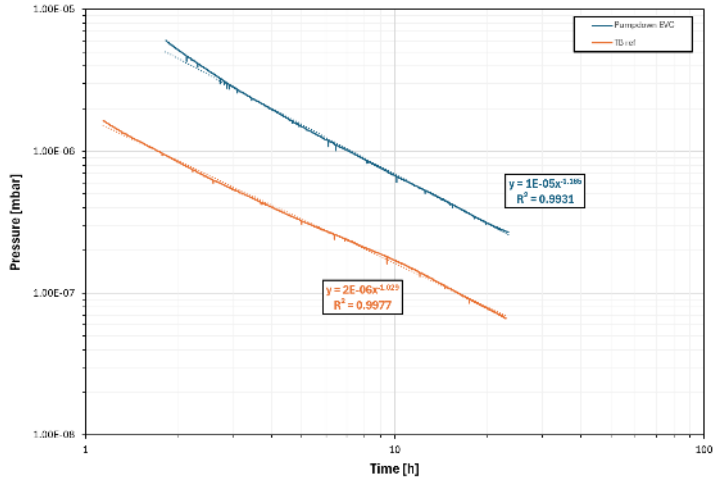
CRAB	DESTINATION	PIMs ASSEMBLED	TO BE ASSEMBLED
RFD	SPS (prototype)	6	-
RFD	CANADA 1st	3	3
DQW	UK 1st	6	-
DQW	CERN	4	2

- PIMs assembly for 2 cryomodules completed (first cryomodule UK and SPS prototype).
- PIMs assembly for 2 cryomodules on going (first cryomodule Canada and DQW CERN).
- PIMs for remaining 7 cryomodules to be assembled.

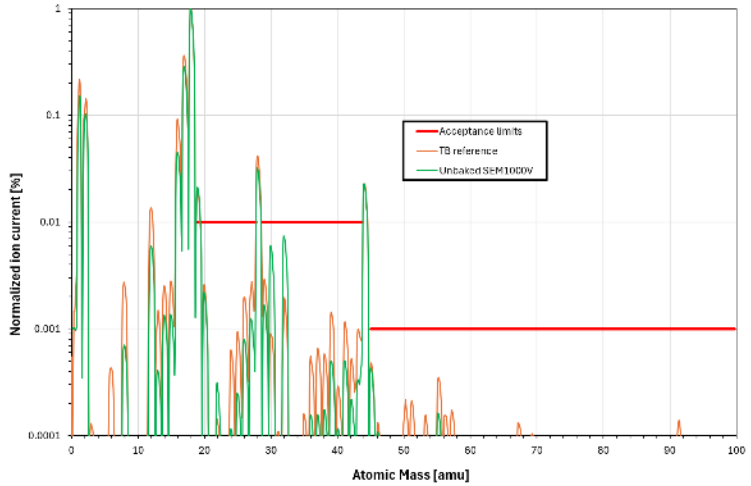
PIMs: DRF inserts vacuum acceptance test



Pump down curve with 1/t behavior typical of clean metallic material



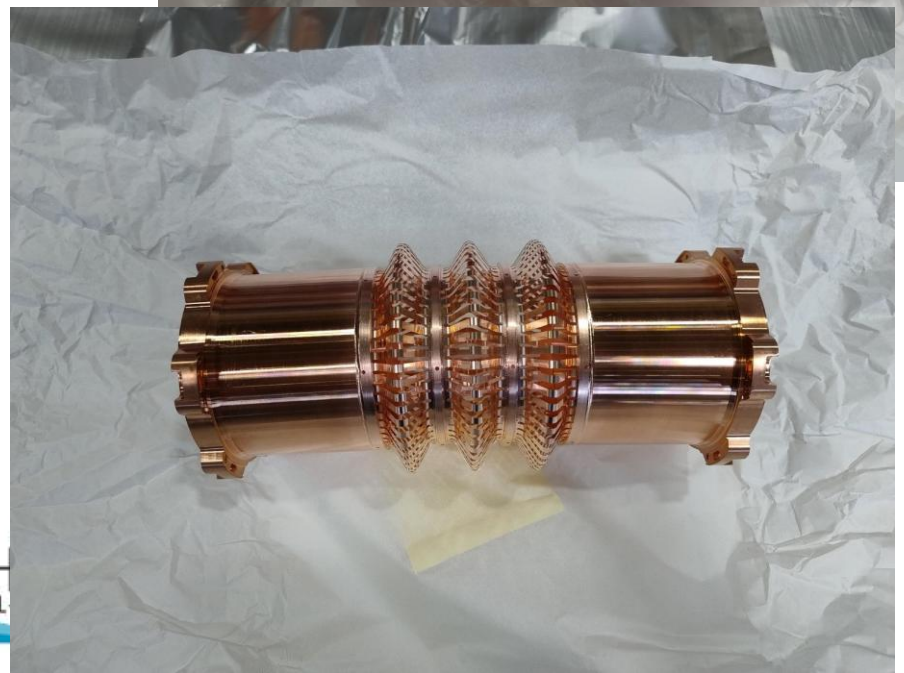
RGA analysis normalised to H_2O peak: Unbaked vacuum acceptance tests

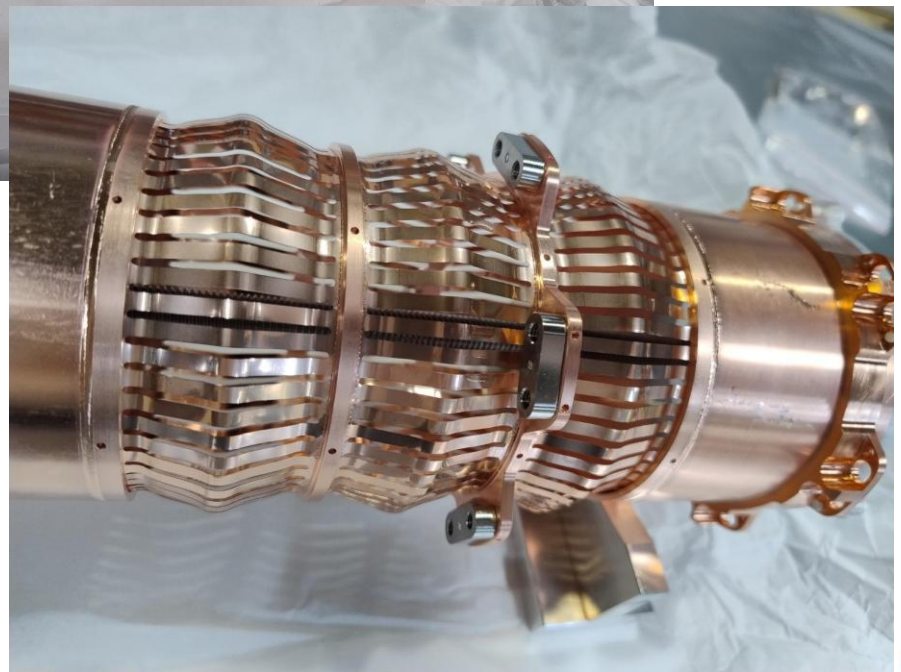


Vacuum Acceptance Test on DRF inserts after standard CERN cleaning procedure for UHV application.

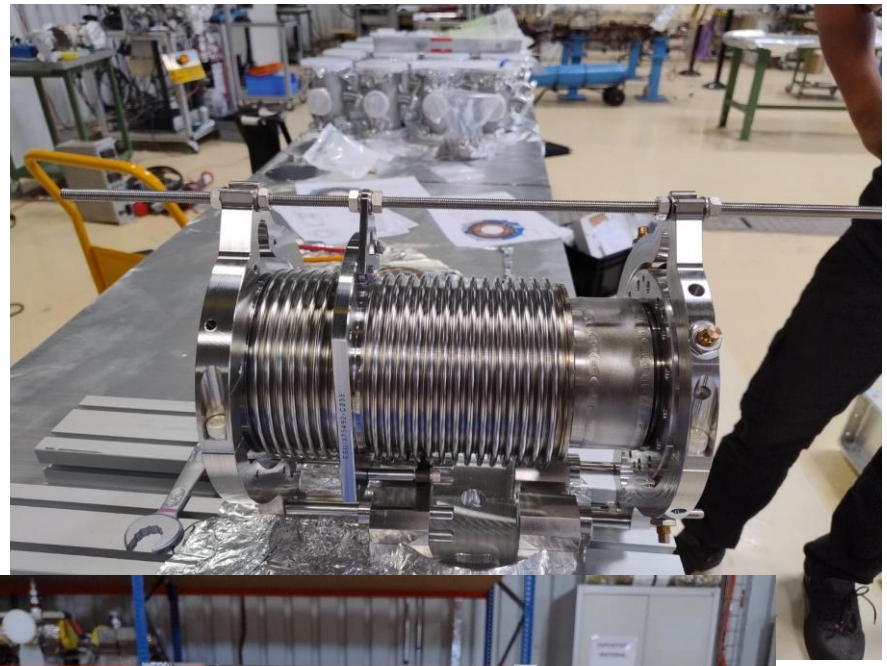
PLUG IN MODULES ASSEMBLY

1. Prepare the DRF insert and equipe it with thermalization clamps

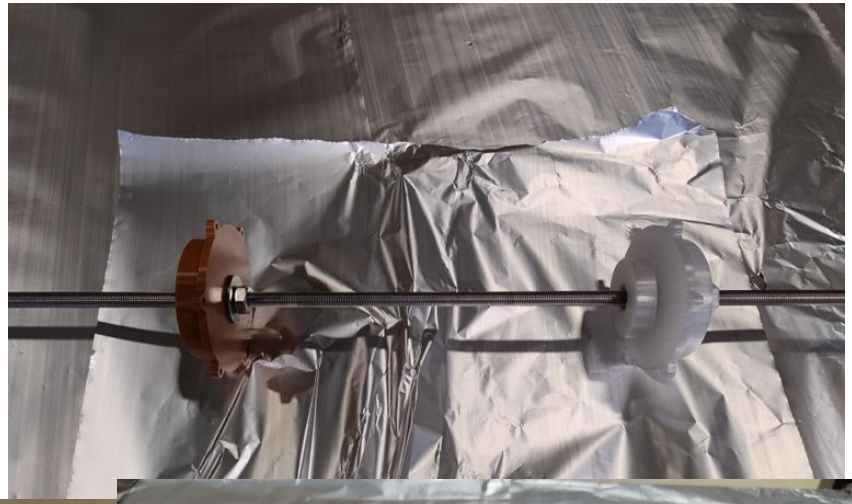


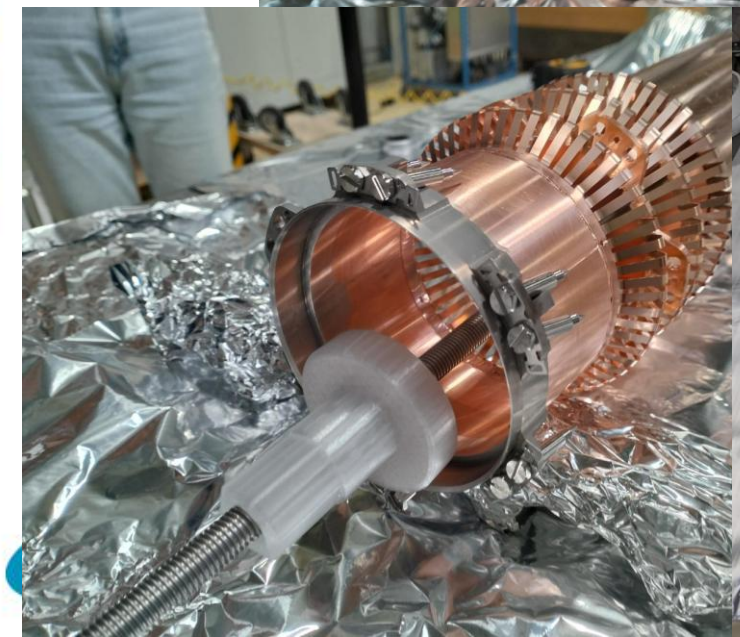


2. Prepare the bellow and fix it to the assembly tooling

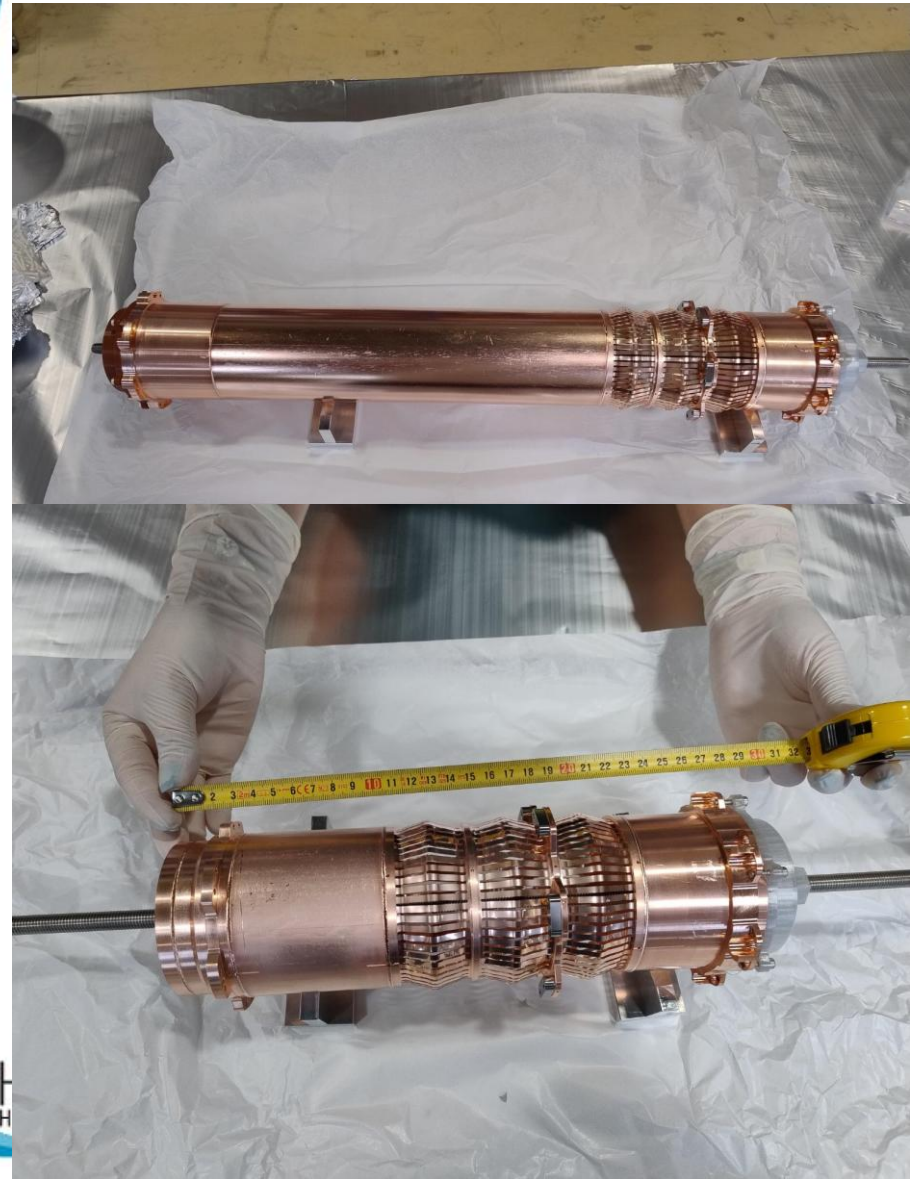


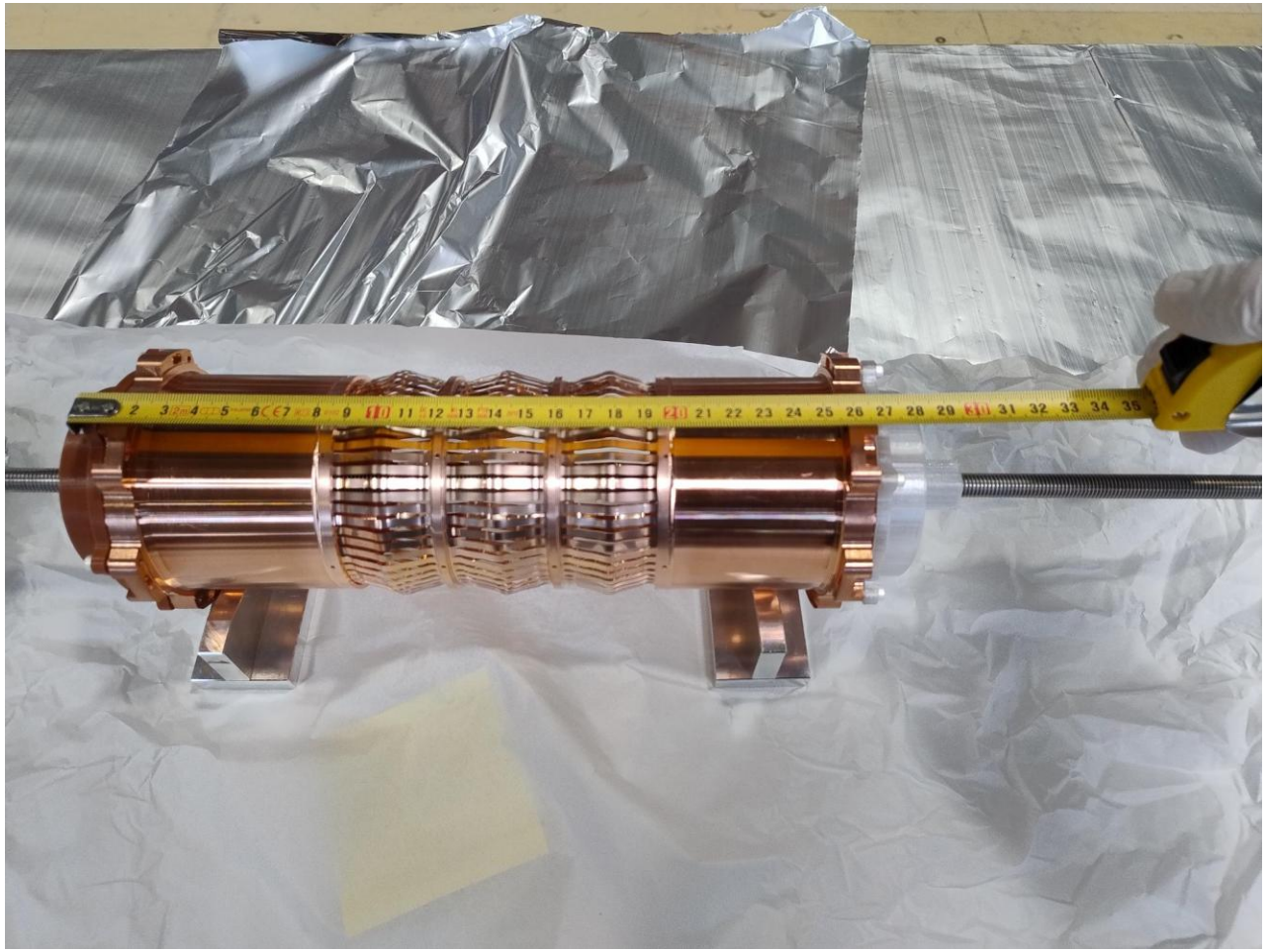
3. Connect the extension tooling to the DRF insert





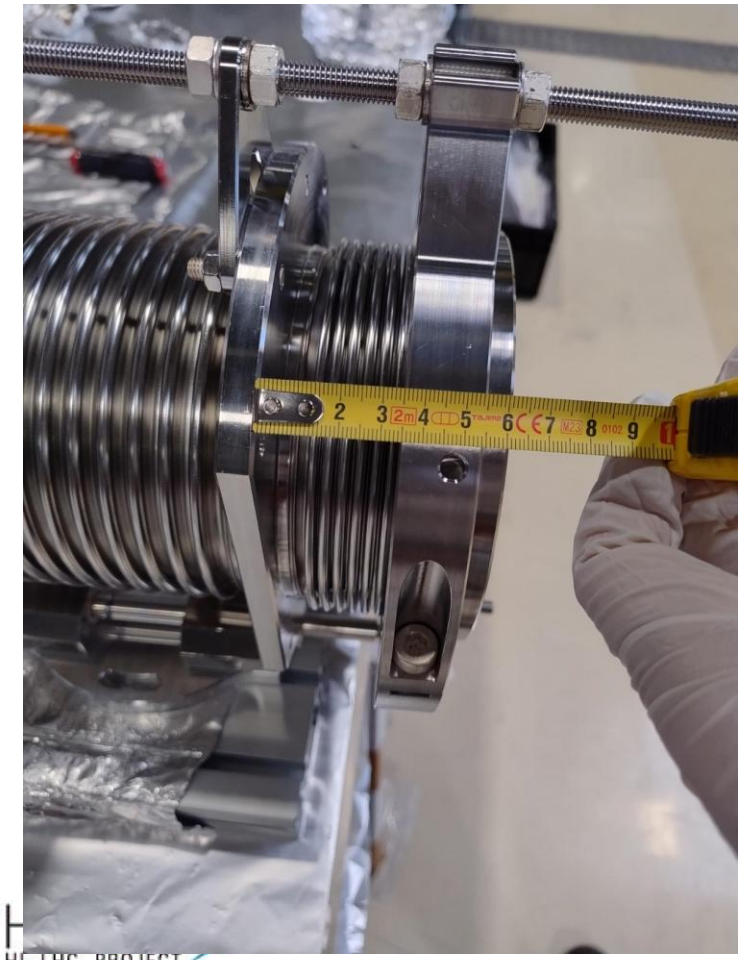
4. Extend the DRF insert

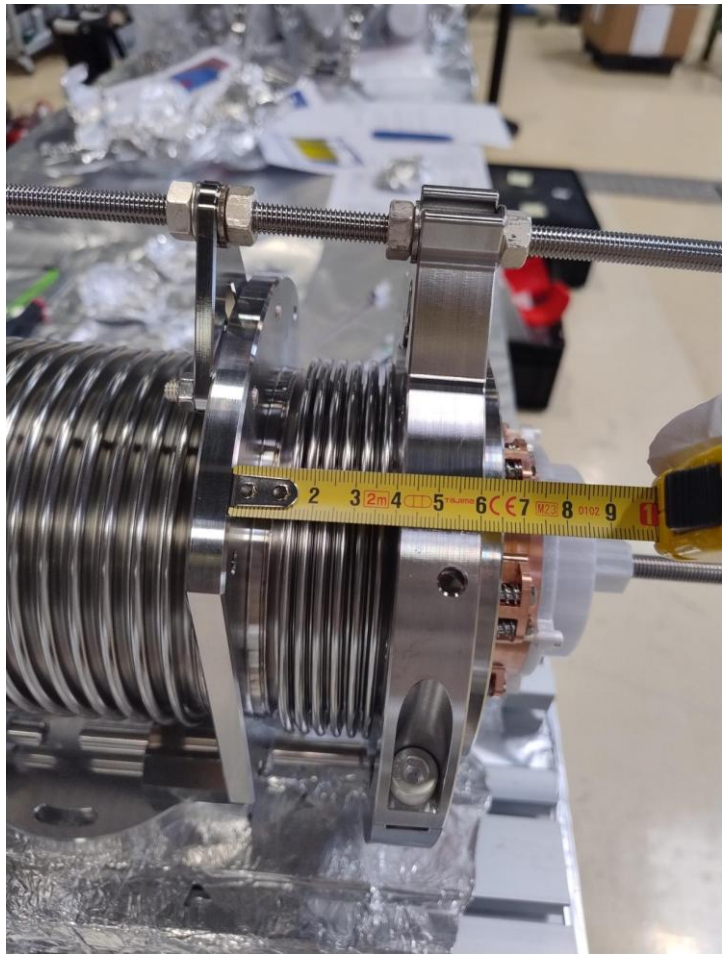


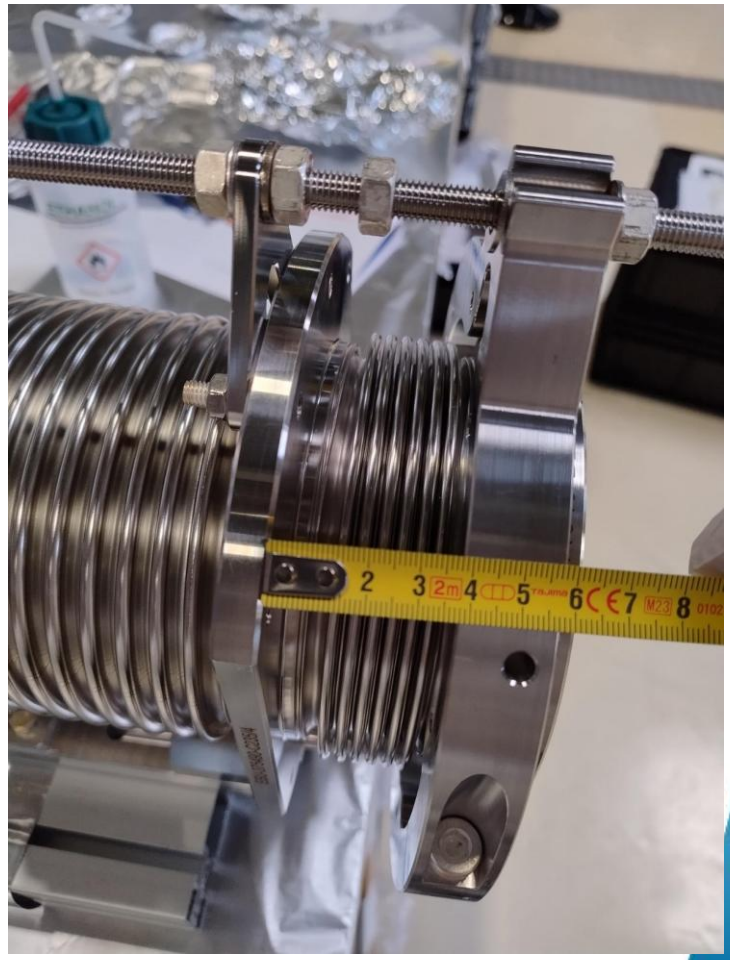


5. Put the M4x20 screws inside with washer, but just in position

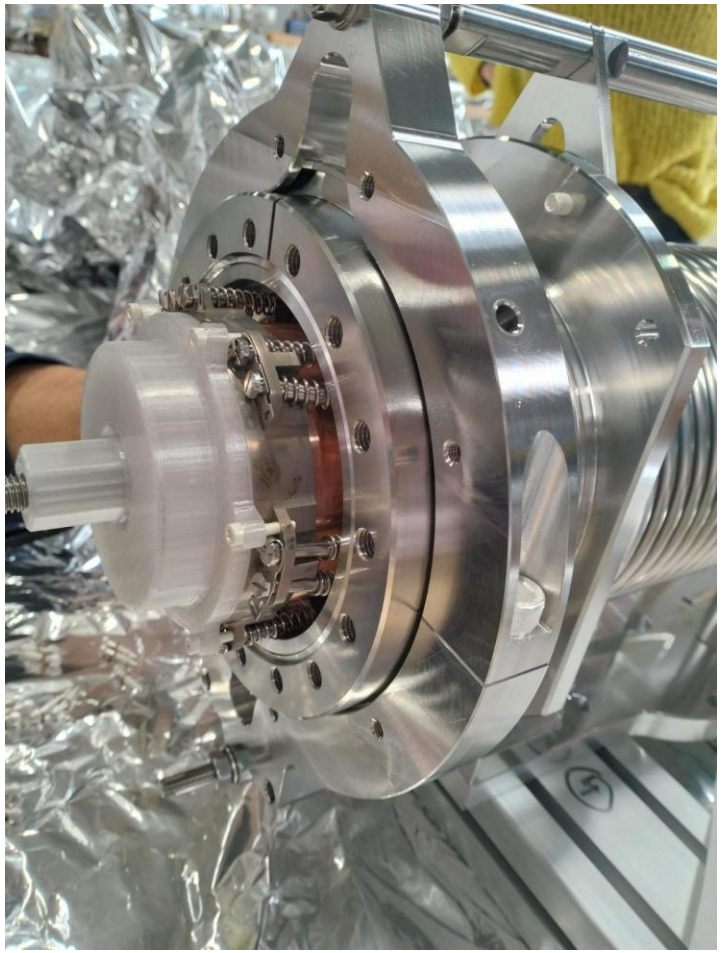
6. Compress the small bellow and for BS line extend the big one



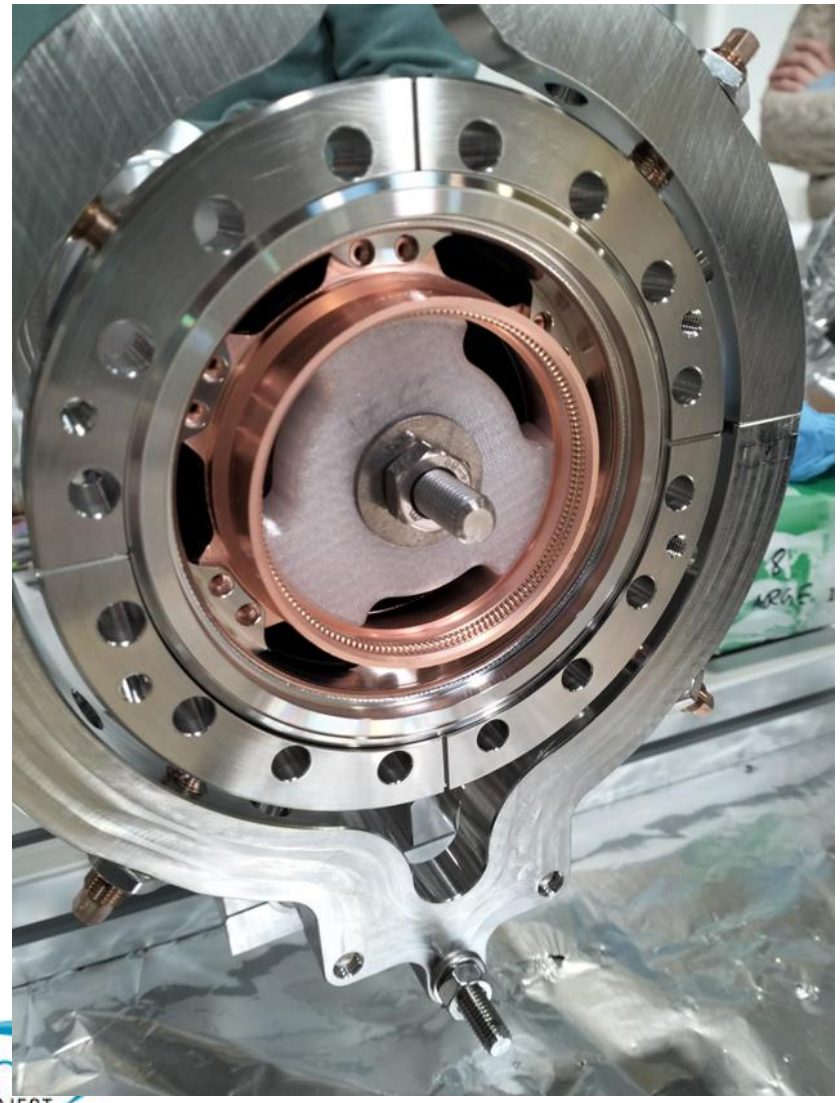


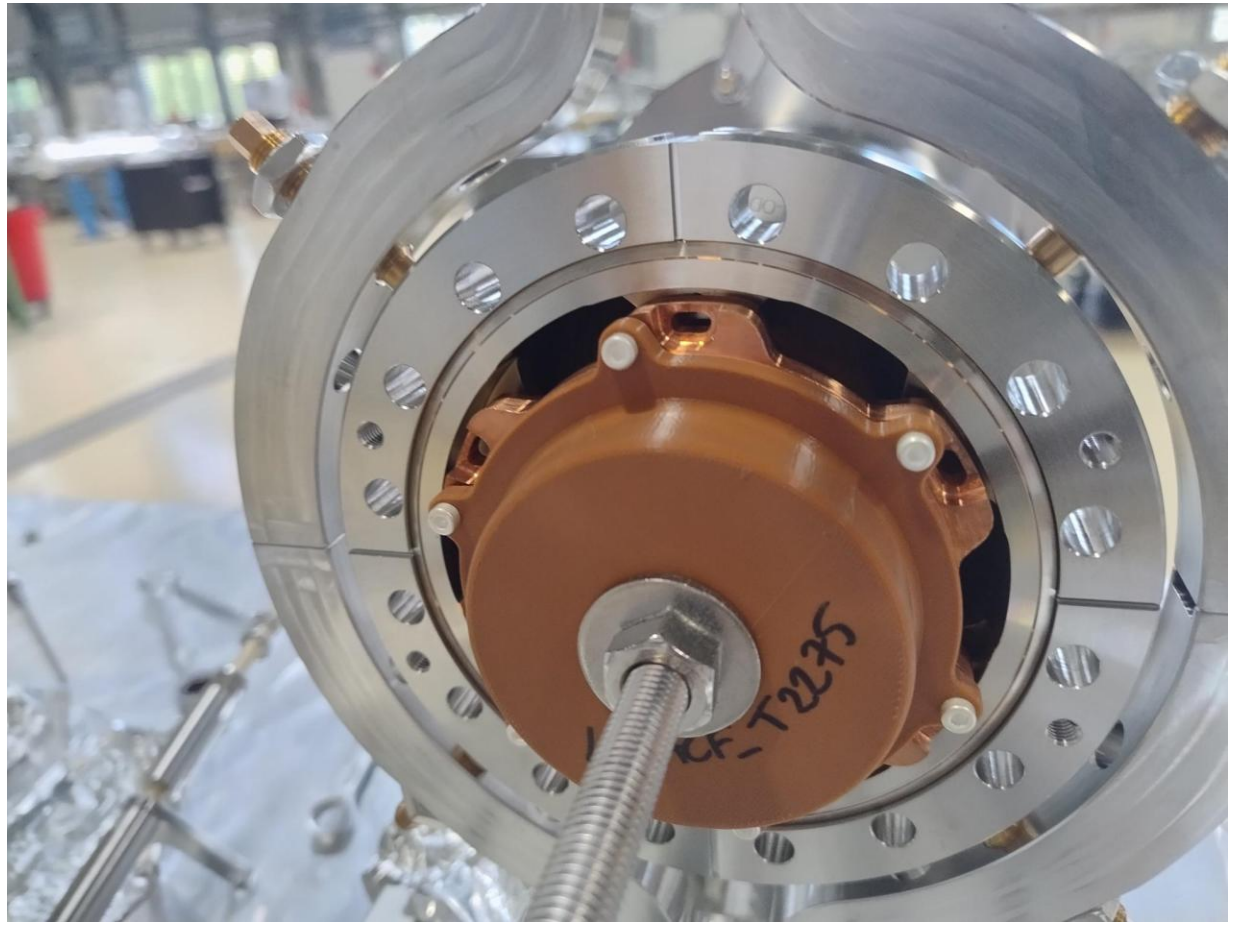


7. Proceed with the insertion and ensure the insert is in the right position

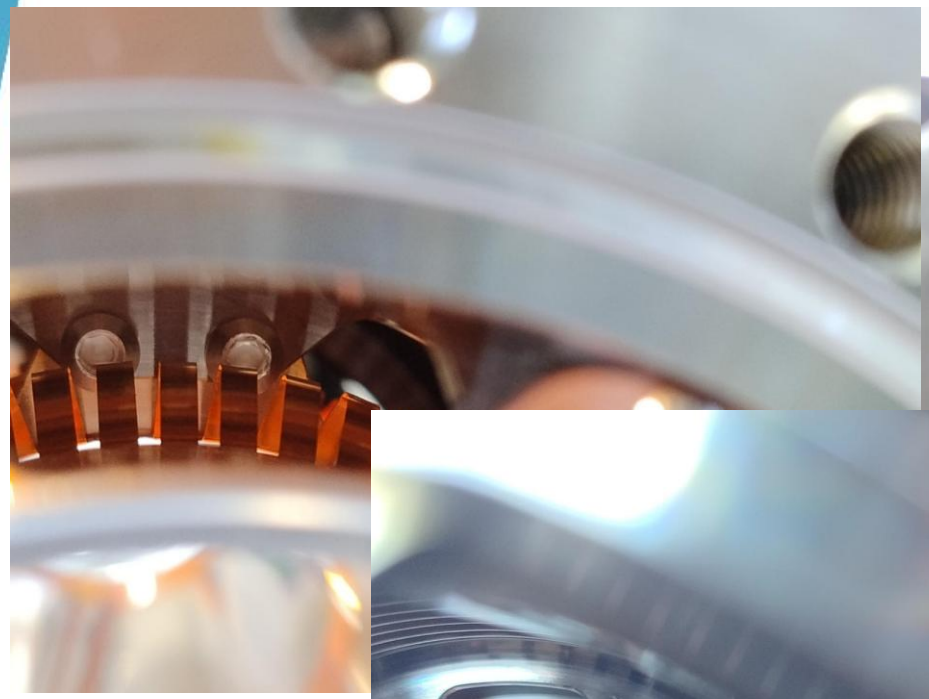


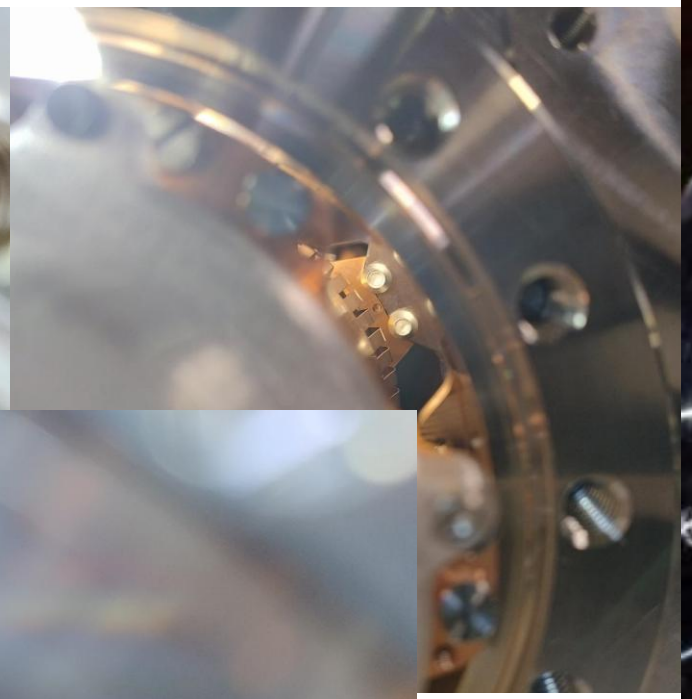
8. Ensure the DRF is in the right position on both sides and all the holes are perfectly aligned

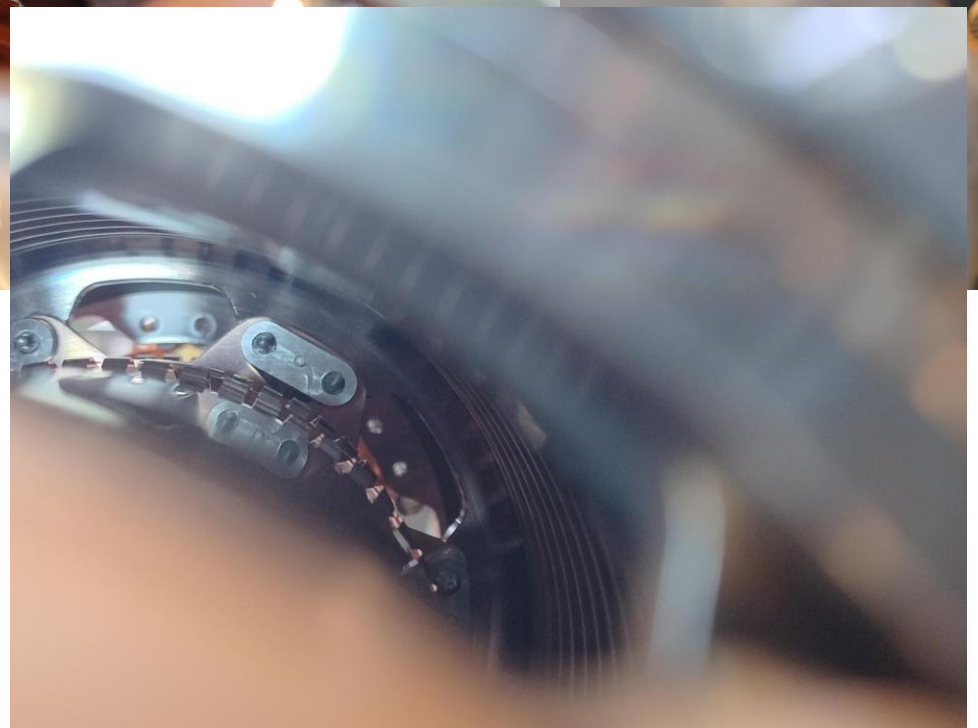


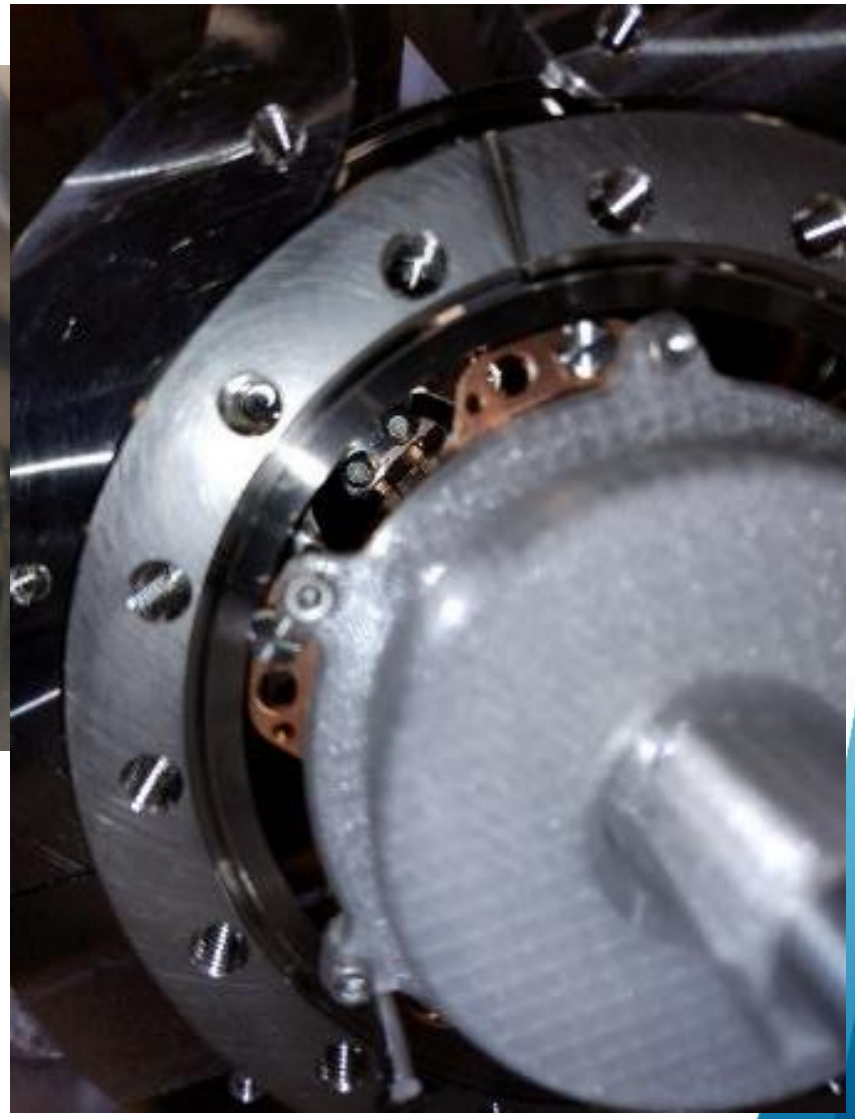


9. Fix the DRF to the bellow screwing the M4x20 screws inside

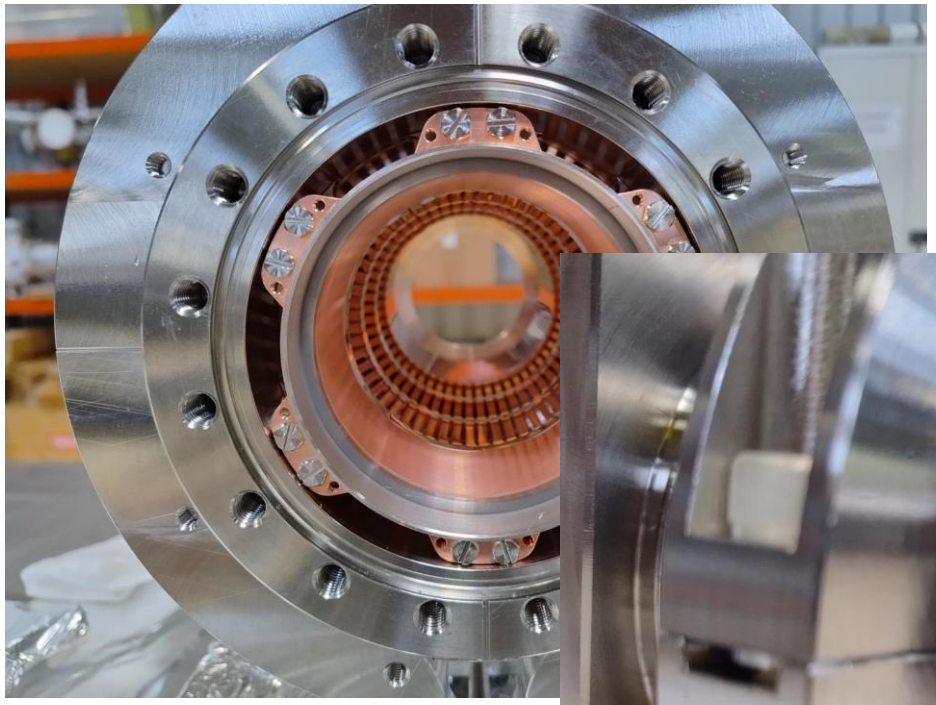


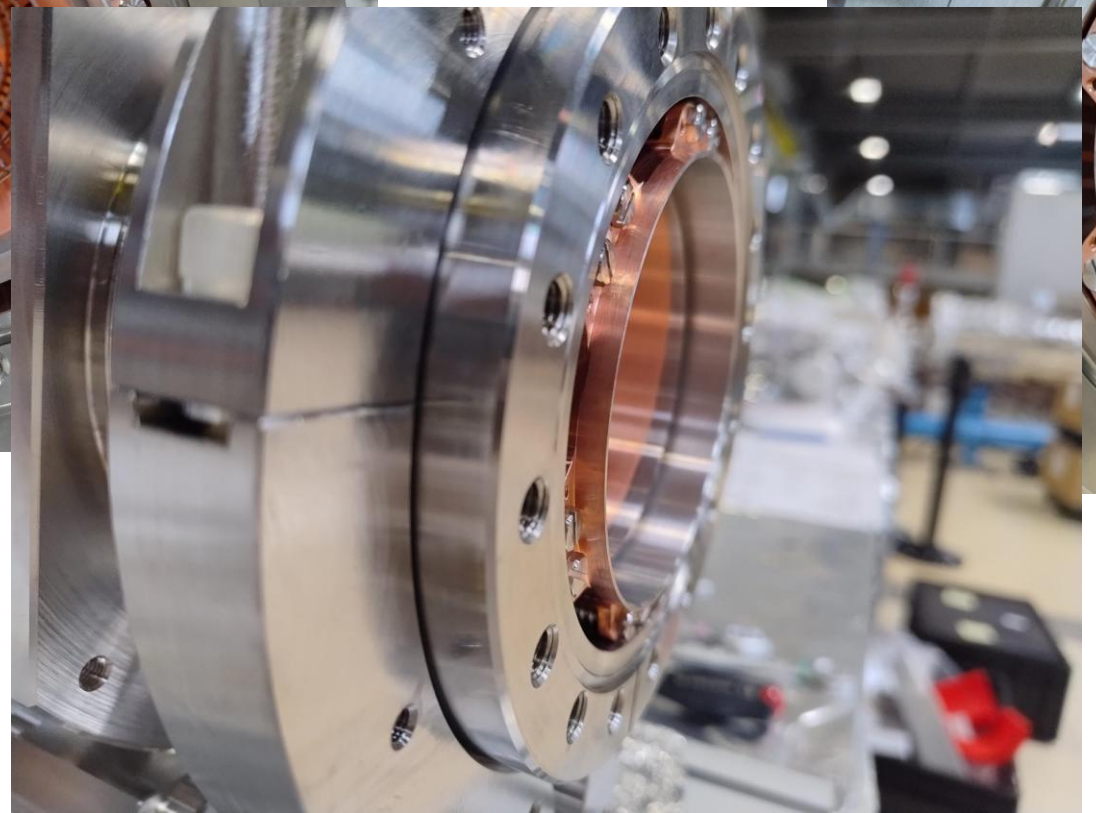


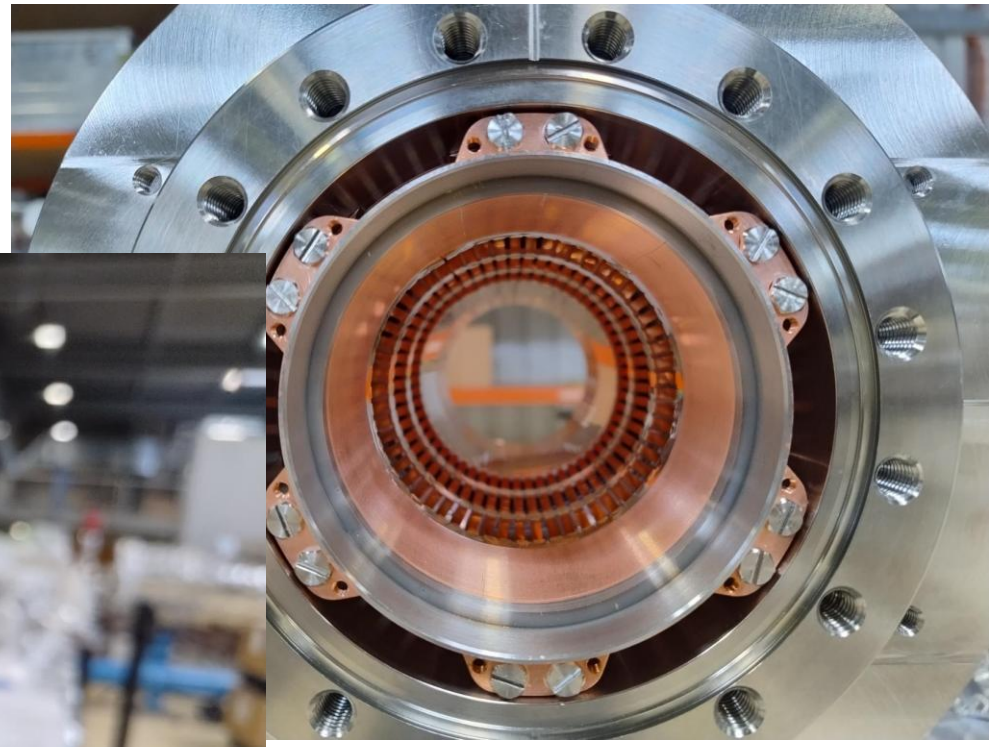


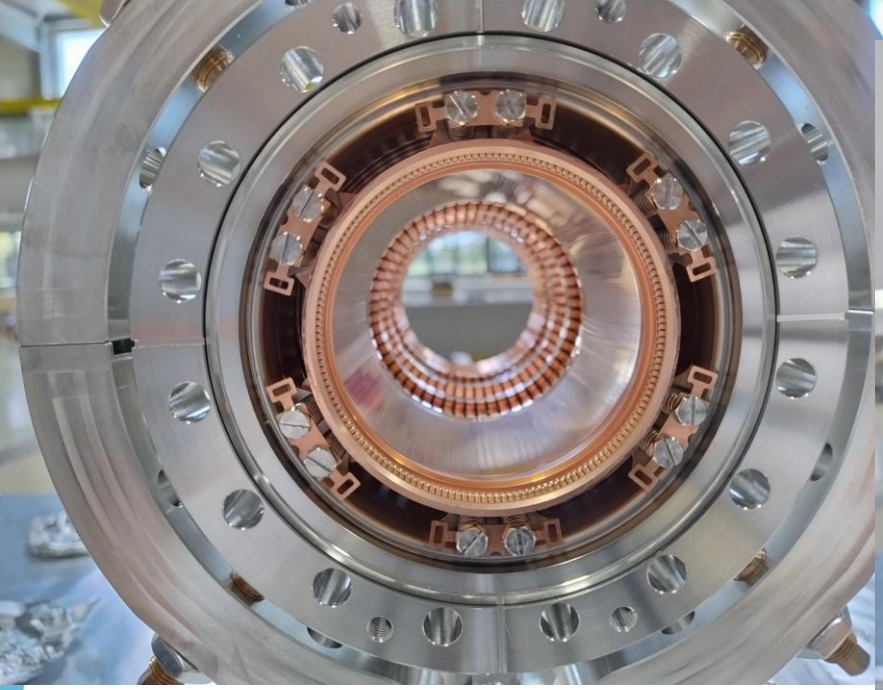


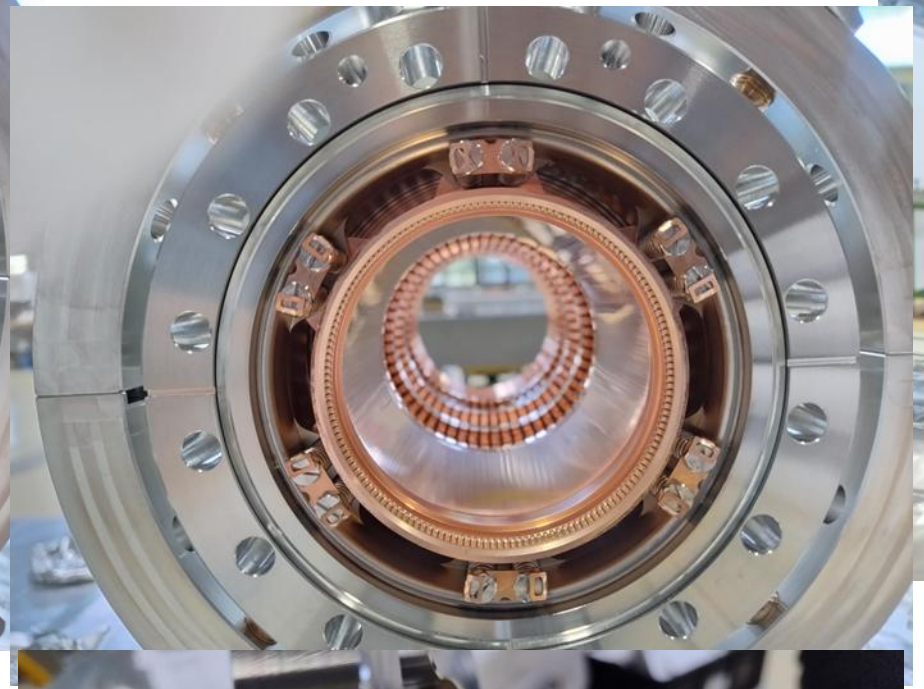
10. Uncompress/compress the bellows and remove the extending tooling. Finally fix the insert to the bellow on both sides

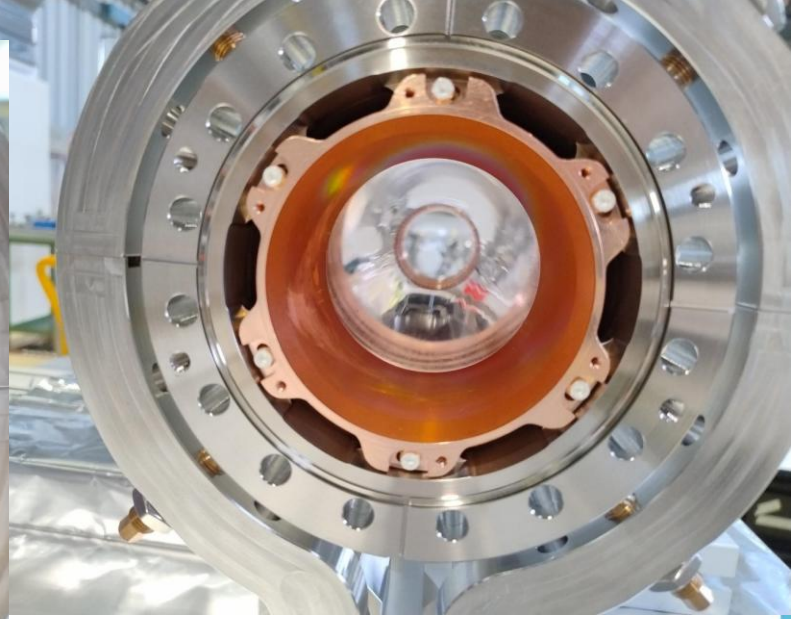


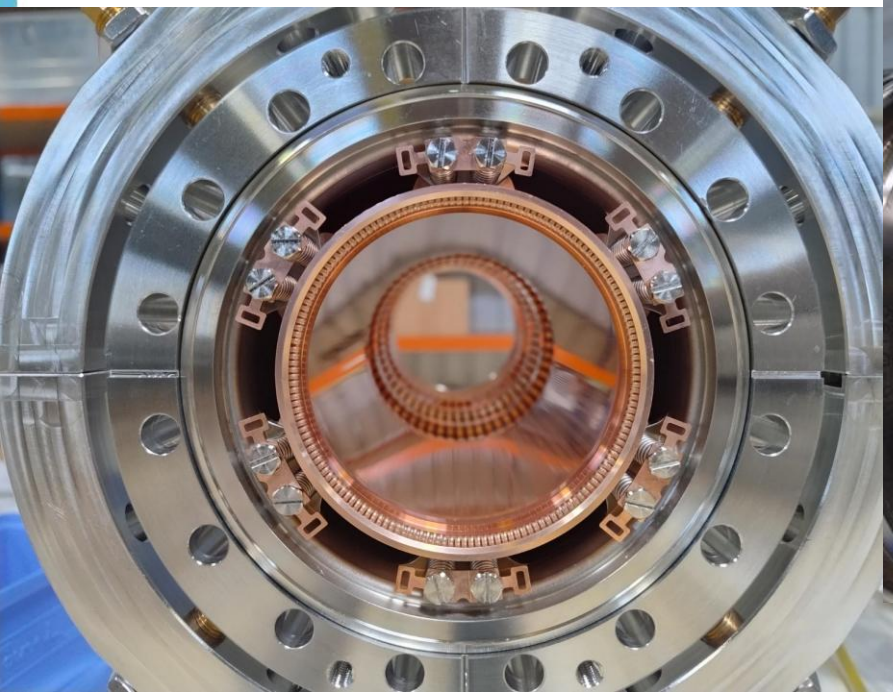


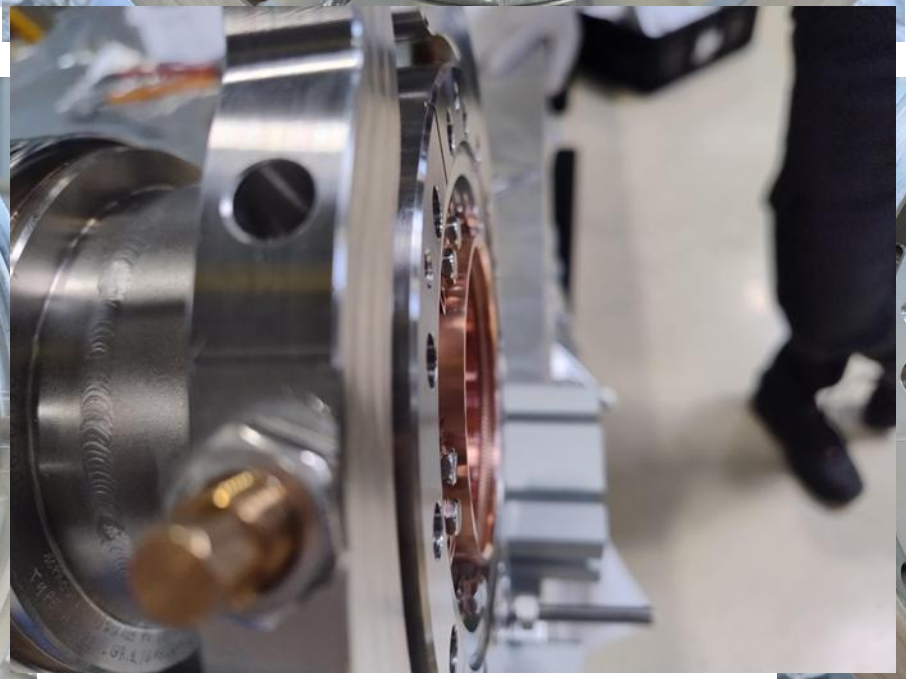


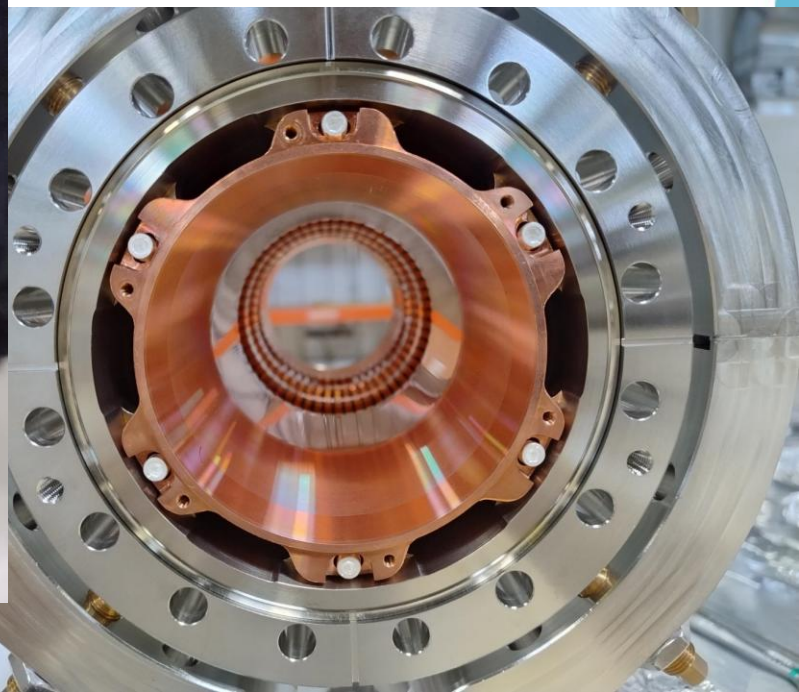








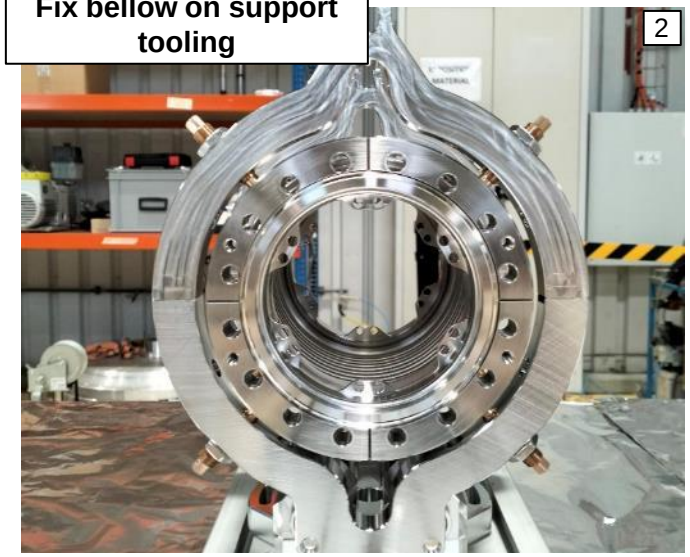




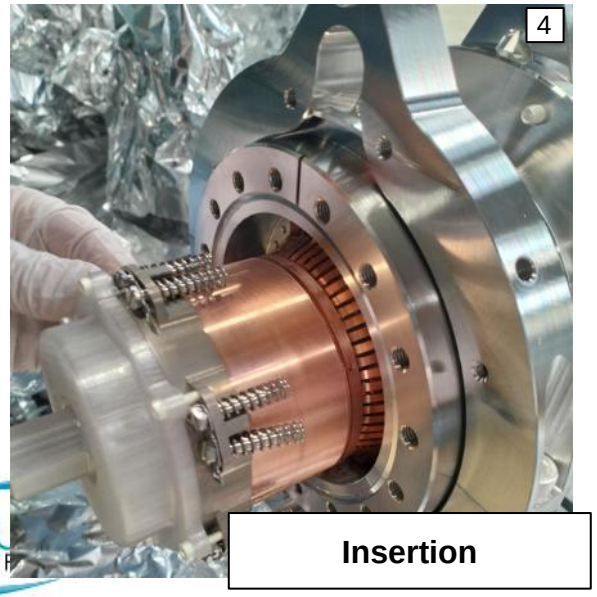
PIMs assembly an example

Extend DRF insert, using fix and mobile tooling

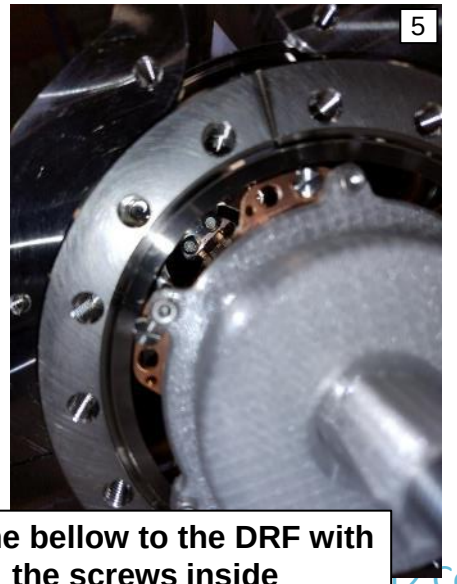
Fix bellow on support tooling



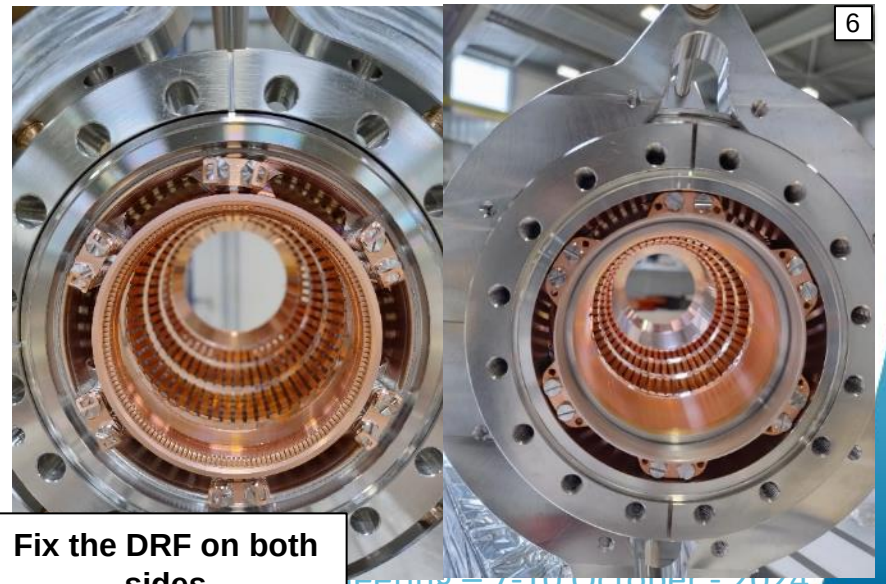
Put M4x20 screws inside



Insertion



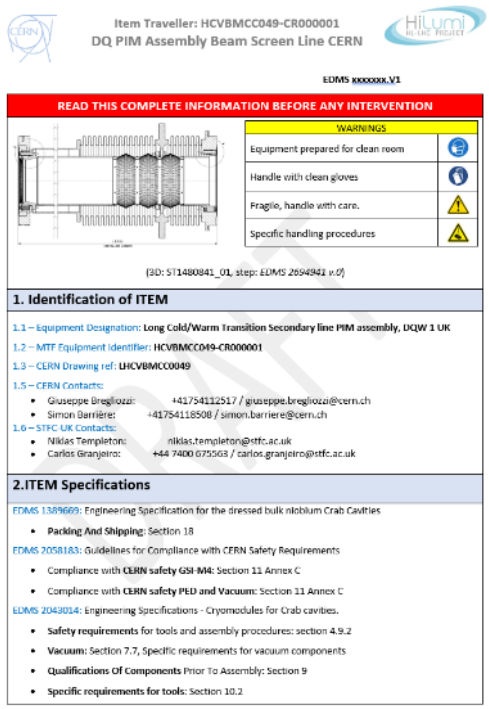
Fix the bellow to the DRF with the screws inside



Fix the DRF on both sides

Final Status & Transport

Assembled PIMs are shipped to UK and Canada in Al boxes with foam. PIM bellows are protected by Al foil, bubble wrap plastic and st. steel sheet.
All PIMs Traveler available in EDMS


Item Traveller: HCVBMCC049-CR000001
DQ PIM Assembly Beam Screen Line CERN

EDMS xxxxxxx_V1

READ THIS COMPLETE INFORMATION BEFORE ANY INTERVENTION

WARNINGS
- Equipment prepared for clean room
- Handle with clean gloves
- Fragile, handle with care.
- Specific handling procedures

(3D: ST1480841_01, step: EDMS 2694941 v.0)

1. Identification of ITEM

1.1 – Equipment Designation: **Long Cold/Warm Transition Secondary line PIM assembly, DQW 1 UK**
1.2 – MTF Equipment Identifier: **HCVBMCC049-CR000001**
1.3 – CERN Drawing ref: **LHCVBMCC0049**
1.5 – CERN Contacts:
- Giuseppe Bregliozzi: +41754112517 / giuseppe.bregliozzi@cern.ch
- Simon Barriere: +41754118508 / simon.barriere@cern.ch

1.6 – STFC UK Contacts:
- Niklas Templeton: niklas.templeton@stfc.ac.uk
- Carlos Granjeiro: +44 7400 075563 / carlos.granjeiro@stfc.ac.uk

2.ITEM Specifications

EDMS 1389669: Engineering Specification for the dressed bulk niobium Crab Cavities
- **Packing And Shipping**: Section 18

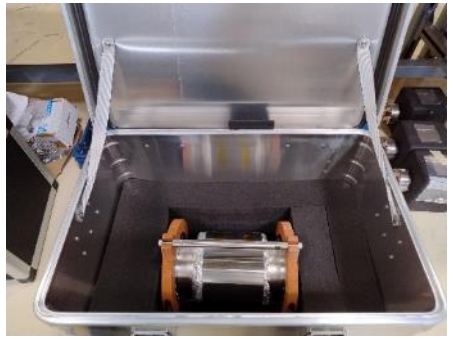
EDMS 2058183: Guidelines for Compliance with CERN Safety Requirements
- Compliance with **CERN safety GSI-M4**: Section 11 Annex C
- Compliance with **CERN safety PED and Vacuum**: Section 11 Annex C

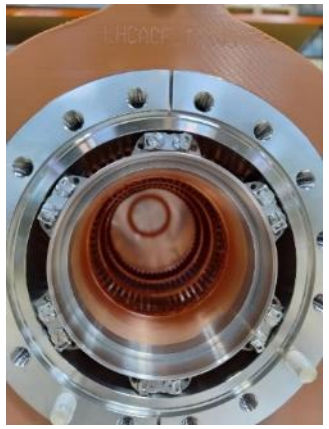
EDMS 2043014: Engineering Specifications - Cryomodules for Crab cavities.
- **Safety requirements** for tools and assembly procedures: section 4.9.2
- **Vacuum**: Section 7.7, Specific requirements for vacuum components
- **Qualifications Of Components** Prior To Assembly: Section 9
- **Specific requirements for tools**: Section 10.2

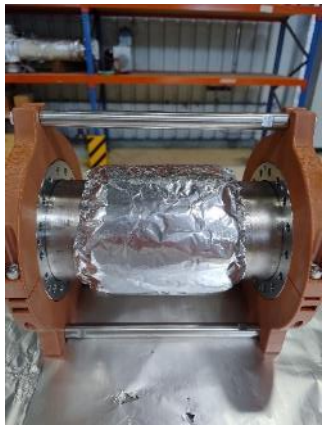
1

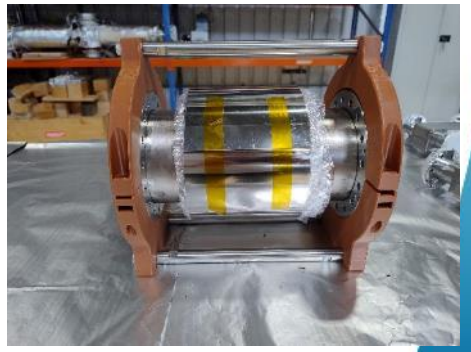
Cryomodule	EDMS number	Cavity
UK 1	**3132909**	DQW
Canada 1	**3132914**	RFD

PIMs Assembled ready for installation: 27%



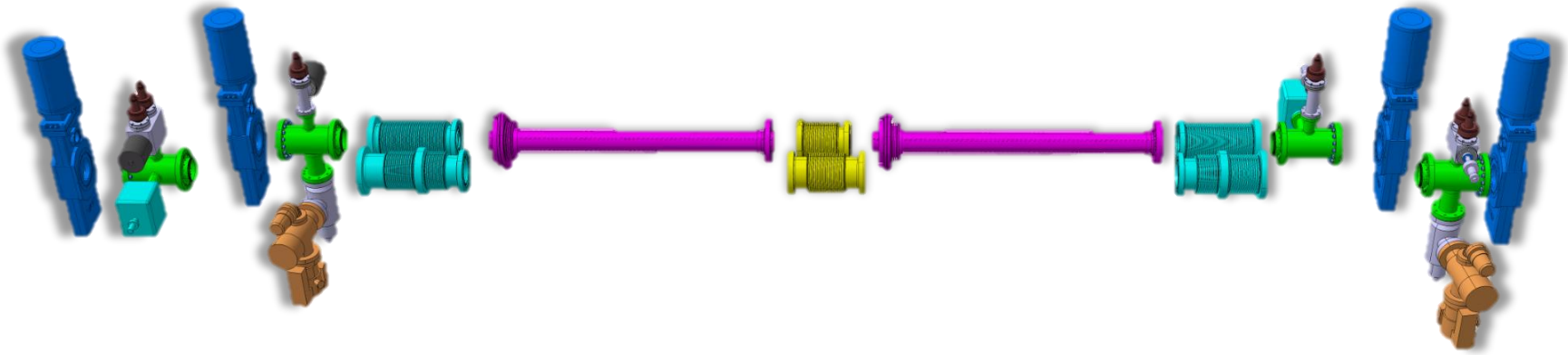


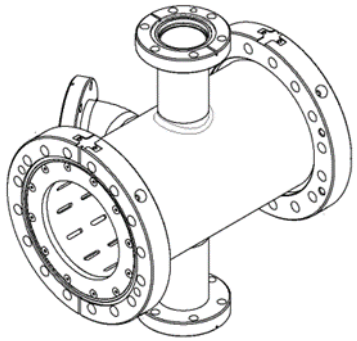


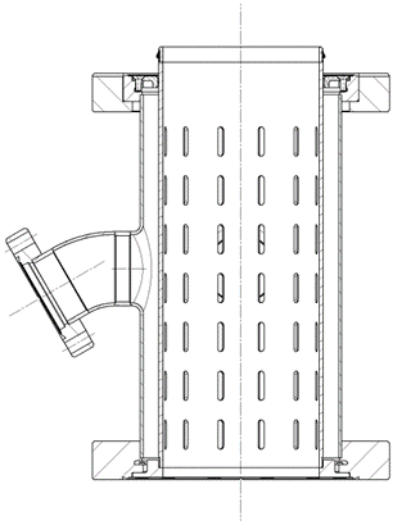


Extremity vacuum chambers (EVC)

Extremity vacuum chambers are assembly with instrumentation and connect each the sector valve with the crab cryomodule





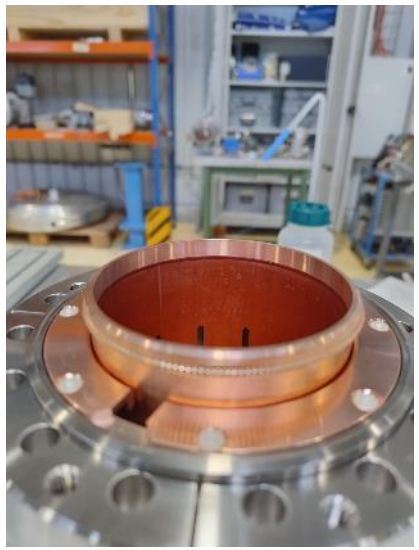


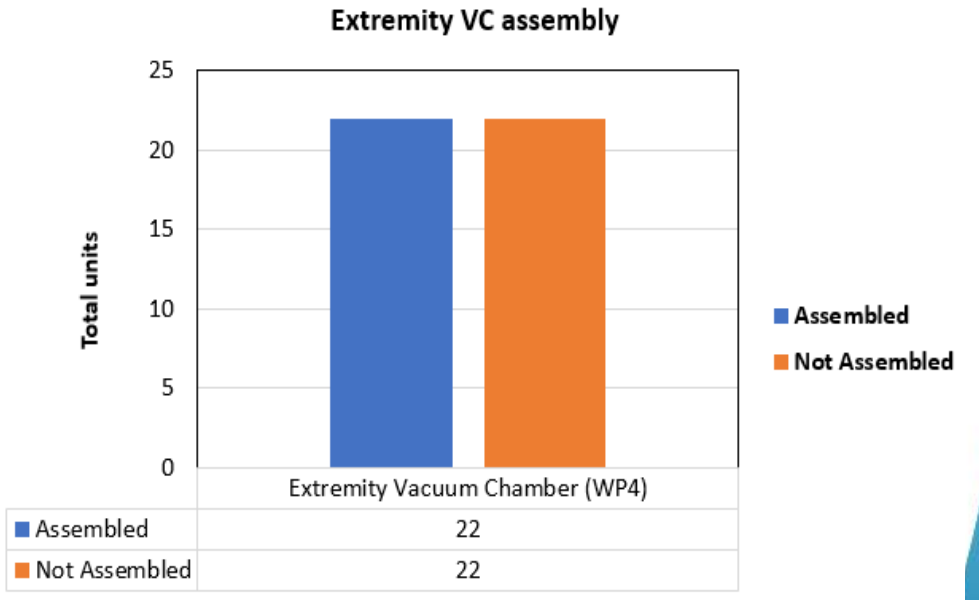
Item	Needed	Spare	Produced	Comments
Ext. Vac. Ch	40	4	44	8 shipped for cryomodule assembly (RFD prototype and DQW 1 UK)

EVC: production status: Completed

Extremity VC have been fully produced (RF inserts and st.steel chamber), assembly is on going.

Component	Asset	Total	% assembled
Extremity vacuum chamber for instrumentation	HCVMACAA_T001	44	50%



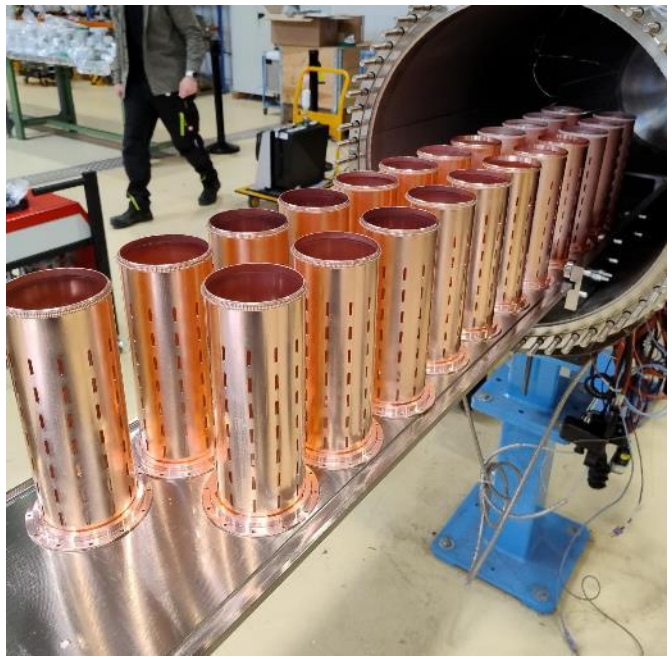


EVC: vacuum acceptance test

Three vacuum acceptance test have been performed:

- Acceptance test RF shield
- Acceptance test vacuum chambers
- Leak test vacuum chambers and ancillaries

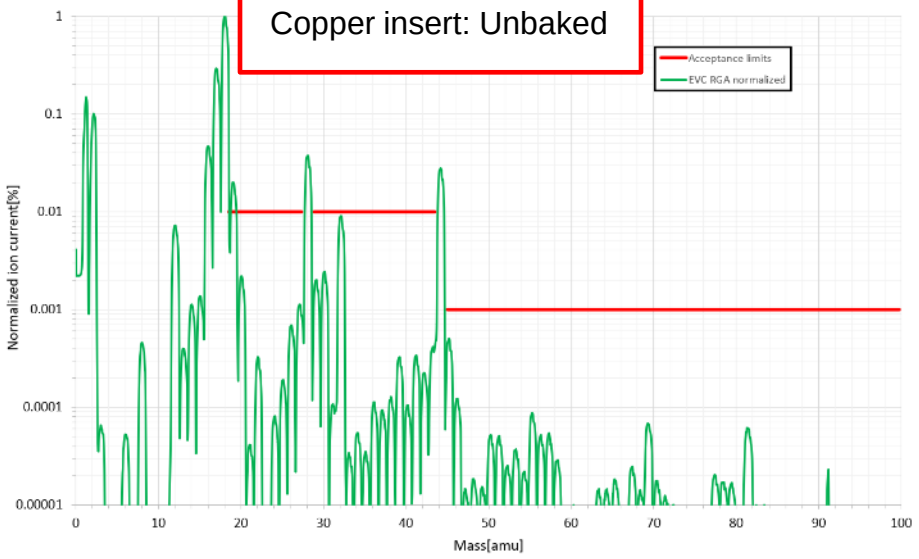
Reports attached to asset code **HCVMACAA_T001**



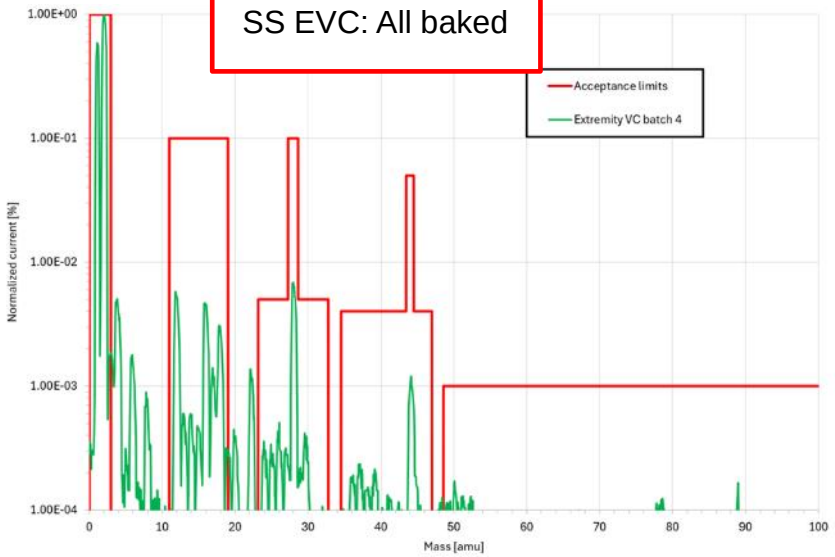
EVC: vacuum acceptance test

Item	Total Qty	Completely tested
Extremity VC	38	18
DRF shield	38	38

Copper insert: Unbaked



SS EVC: All baked



Particle counting of copper inserts

Sara Domingo Gomez

SY-RF-SRF

1 2024

Introduction

- It was received two copper inserts (LHCVBMCC0018 and LHCVSR__3500001) with oxidation traces on the surface.
- It was performed a rinsing procedure and particle counting test to check cleanroom compatibility.
- The particle counting test was performed again after three days, during this time both pieces were kept in cleanroom under laminar flow, to check the evolution of the oxide of the components.

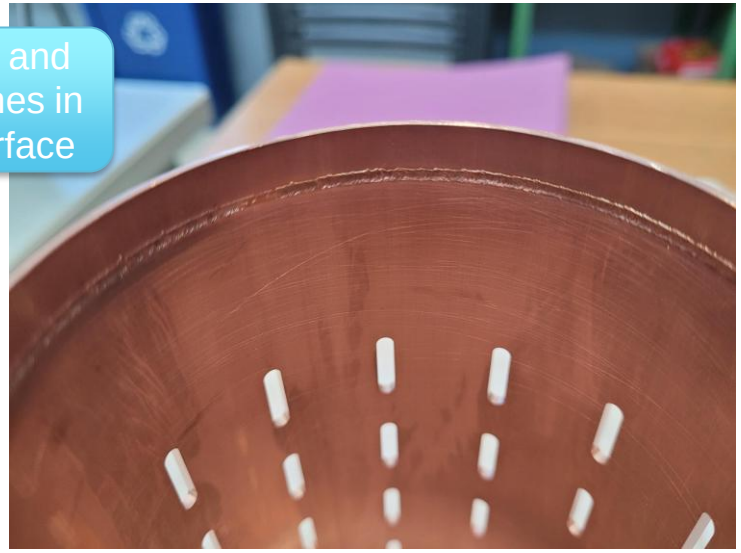
Preparation procedure

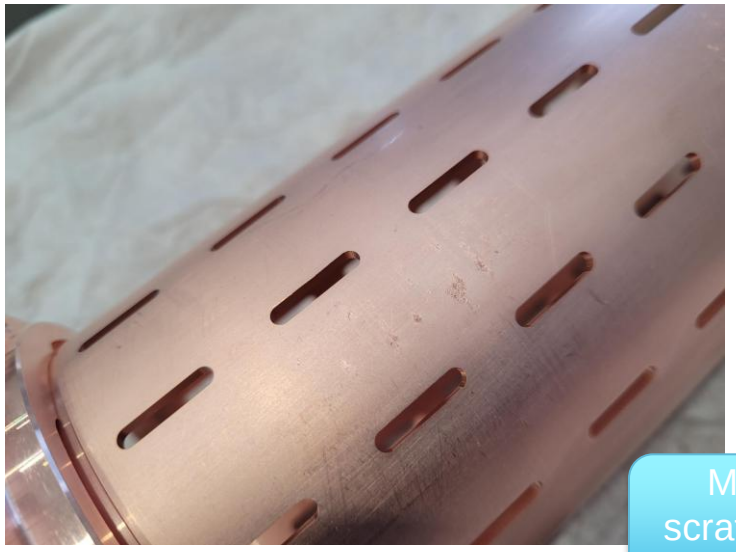
- Test place: Building 252
- Cleanroom: ISO 4
- Operators: G.Pechaud
- The rinsing of pieces in Bldg. 252 is carried out according to the established procedures. For detailed steps and guidelines, refer to the document: Low Pressure Water Rinsing (LPR) in Air (EDMS 2825568)

1. Clean all the pieces using clean room tissues soaked in isopropyl alcohol 70%
2. Transfer the pieces into the cleanroom ISO Class 4
3. Rinse the pieces with Ultra-Pure water (5 bars)
4. Rinse with Ethyl Alcohol 99%
5. Dry with nitrogen gun
6. Keep under laminar flow until dry (Approximately 3 hours)
7. Blow and particle count
8. Keep under laminar flow for 3 days
9. Blow and particle count

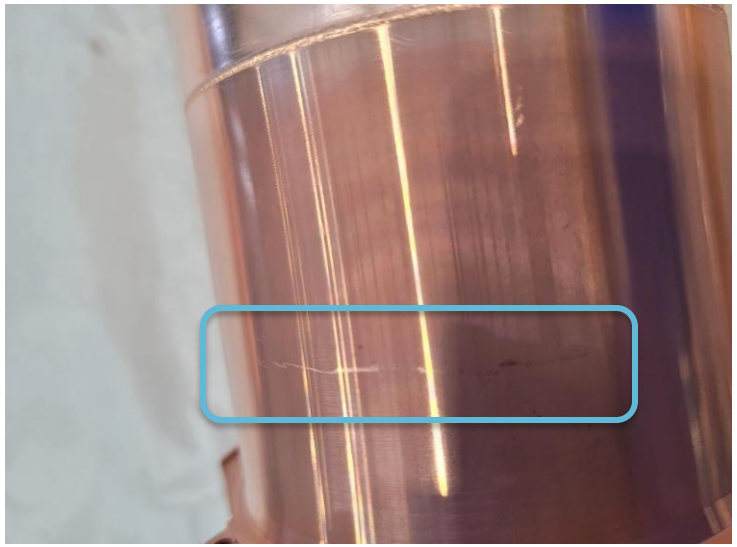
Pictures before rinsing

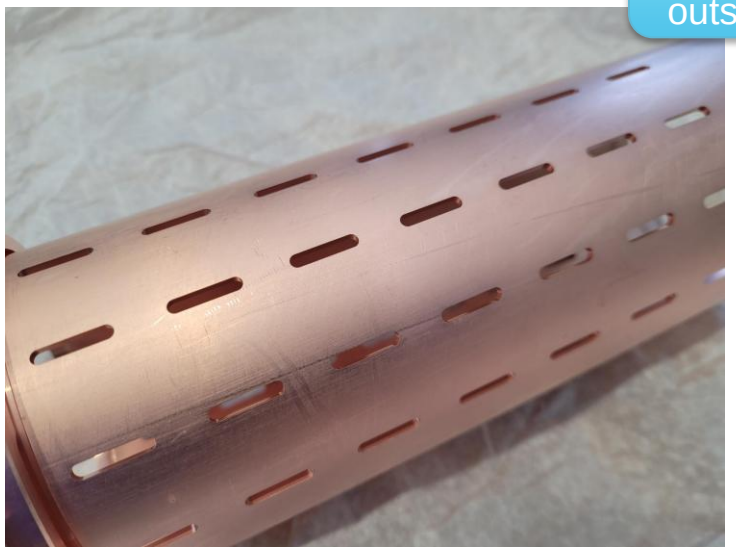
Marks and scratches in RF surface





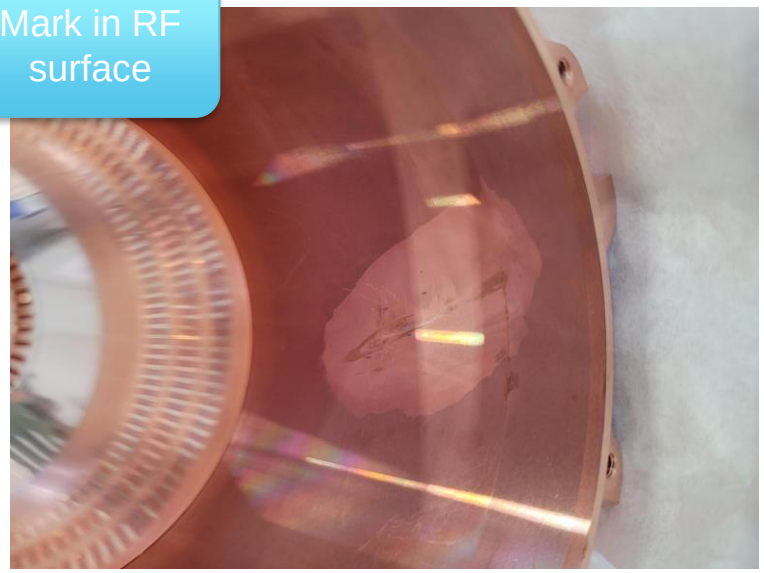
Marks and scratches in the outside surface





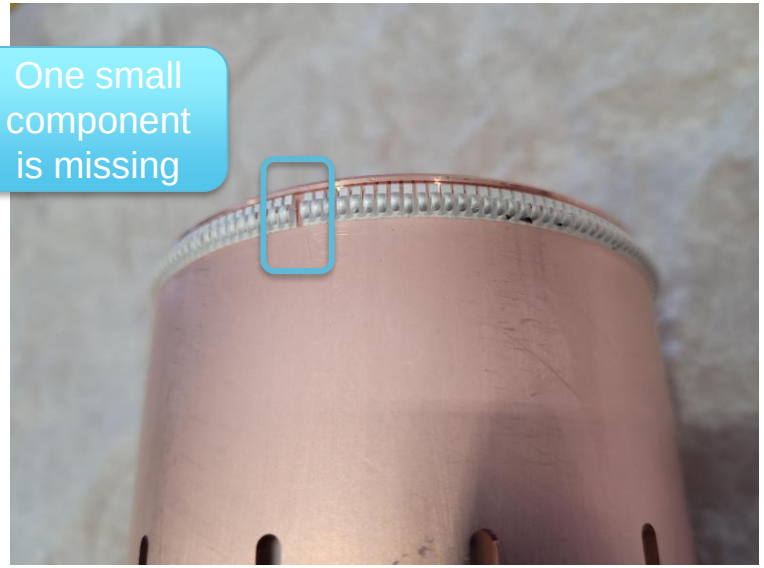
Pictures before rinsing

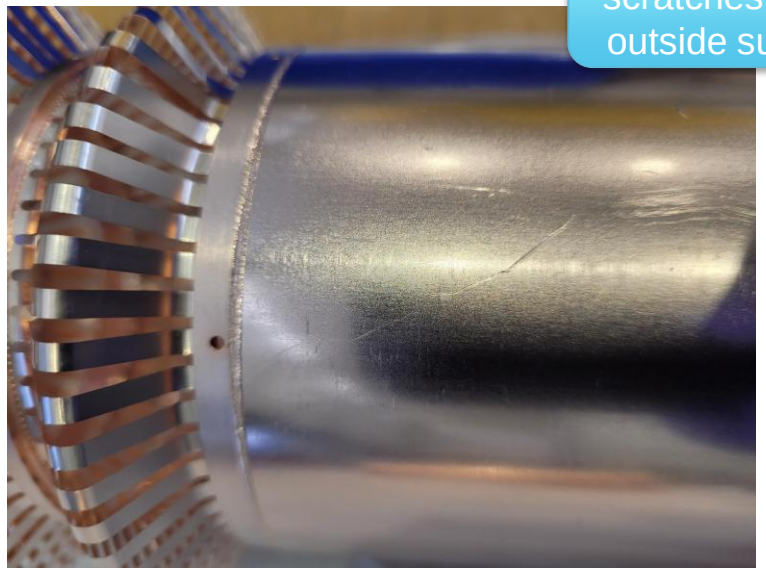
Mark in RF surface



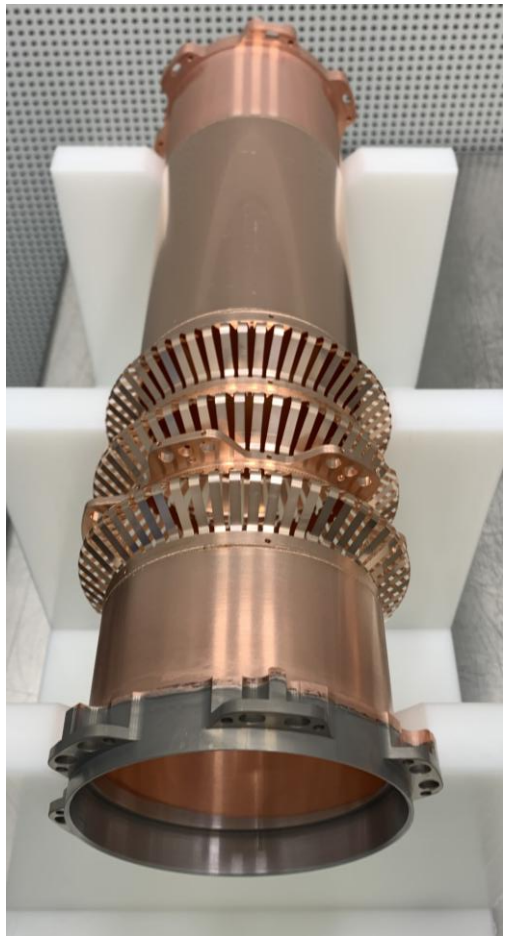
Marks and scratches in the outside surface

One small component is missing



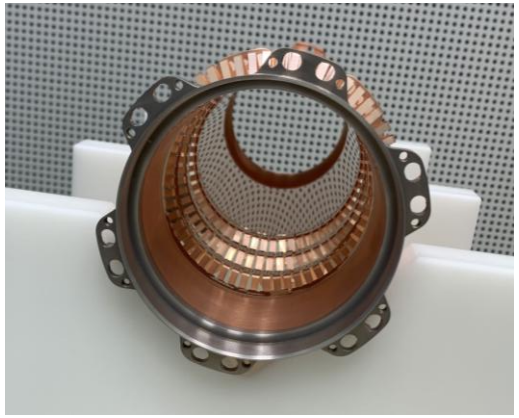


Pictures after rinsing



LHCVBMCC0018

LHCVSR__3500001



1st Particle counting (10/12/2024)

Test place: Bldg. 252

Particle counter: SOLAIR 3200

Cleanroom: New daldrop ISO 4

Operators: G. Pechaud

Piece	ISO
LHCVSR__3500001	1
LHCVBMCC0018	1

Size of particles [µm]	Number of particles found (LHCVSR__3500001)	Number of particles found (LHCVBMCC0018)
0.3	0	0
0.5	0	0
1.0	0	0
5.0	0	0

All samples comply with the ISO standards for cleanrooms (ISO 14644-1)

2nd Particle counting (13/12/2024)

Test place: Bldg. 252

Particle counter: SOLAIR 3200

Cleanroom: New daldrop ISO 4

Operators: G. Pechaud

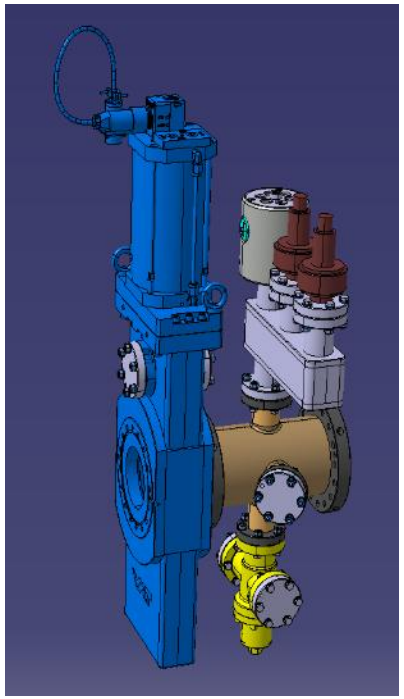
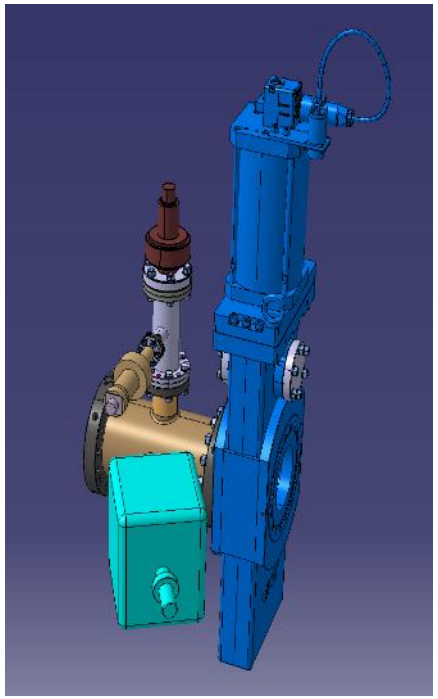
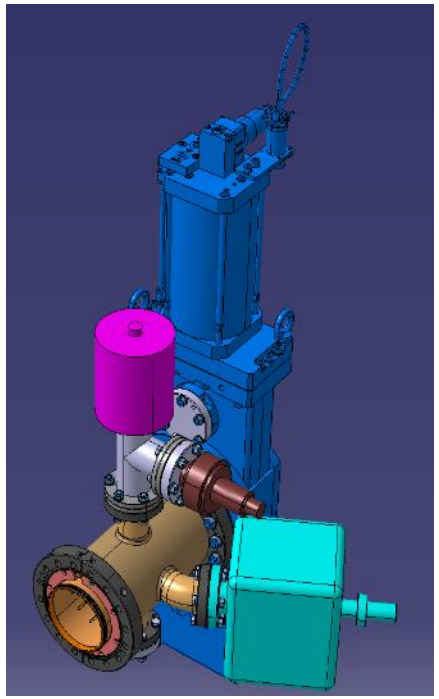
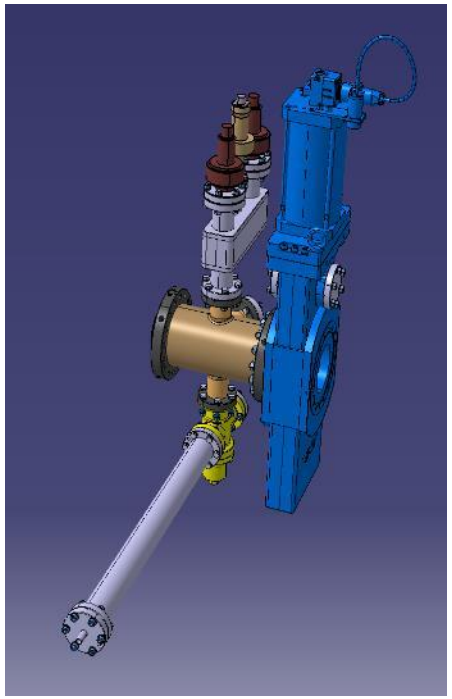
Piece	ISO
LHCVSR__3500001	1
LHCVBMCC0018	1

Size of particles [µm]	Number of particles found (LHCVSR__3500001)	Number of particles found (LHCVBMCC0018)
0.3	0	0
0.5	0	0
1.0	0	0
5.0	0	0

All samples comply with the ISO standards for cleanrooms (ISO 14644-1)

EVC: Ancillaries

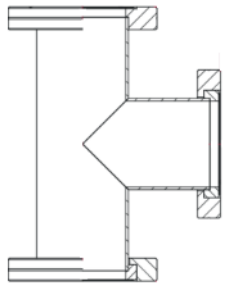
The assembly of the extremity vacuum chamber includes ancillaries and instrumentation

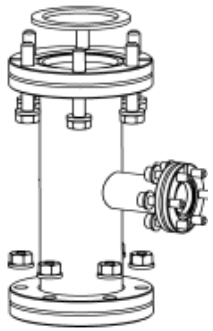





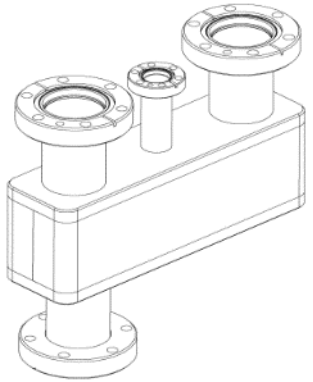
EVC: Ancillaries status

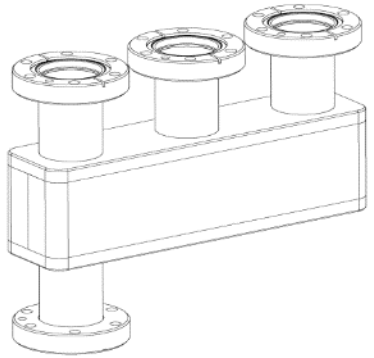
The assembly of the extremity vacuum chamber includes ancillaries and instrumentation. In-house contribution:

Component	Reference	Needed	Spare	In stock
Vacuum Gauge Manifold (1)	LHCVTFGC0001	**11**	**2**	**19**
Vacuum Gauge Manifold (2)	LHCVTFGA0001	**11**	**2**	**19**
VTD- Tee rot. Flange DN40-16CF	Pfeiffer Vac. 420RTR040-16	**10**	**1**	**15**
VTD-Tee rot flange DN40CF	Pfeiffer Vac. 420RTS040	**10**	**1**	**15**







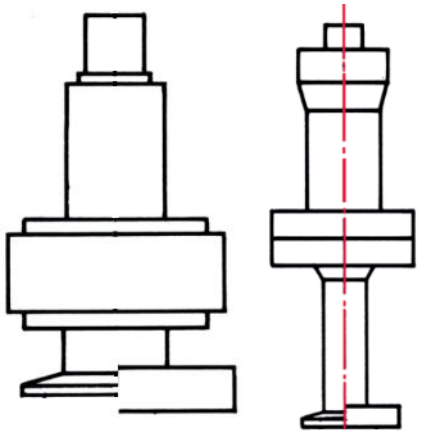


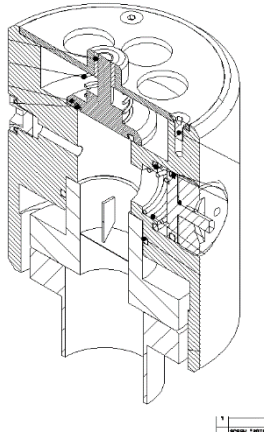
EVC: Ancillaries status

In-kind contribution:

Component	Reference	Needed	Spare	Purchased by CERN
Sector valve VVGSC DN80	VAT 47238-XE74-ANV1	**40**	**4**	**40/40**
VGPB- Cold cathode gauge	Pfeiffer Vac. IKR070 (PTR20 502)	**60**	**6**	**36/60***
Non return valve (with rupture disk)	LHCVV___0040	**20**	**2**	**20/20**
VGRB Pirani gauge DN16 CF-F	Pfeiffer TR018 (PT R15 011)	**20**	**2**	**12/20***
VVFMD003- Angle valve T shape	VAT: 54132-GE02_AAY1	**20**	**2**	**2/20***
Ion pump	Sputter Ion – plus starcell 20	**20**	**2**	**12/20***

* UK-STFC purchased those equipment on his own





Fasteners supplied by CERN

Concerning vacuum and RF equipment fasteners are supplied by CERN

The order related to the fasteners has been partially delivered, but some items have a delay due to the supplier: they will be delivered on week 48.

Ag coating is done at CERN.

The global cost of the fasteners is around 3.5K CHF per cryomodule.

SCEM/ Reference	Description	Total 1 cryomodule + spares
18.60.57.100.9	Metal seal UHV DN100-80.6 Ag coated	5
47.78.15.116.5	Plain washer 8x16 UHV flanges	550
47.33.51.311.8	Goujon UHV flange M8x30 Ag coated	200
47.43.78.108.4	Hex nut M8 UHV flange	200
18.60.57.035.1	Metal seal UHV DN40-36.8 Ag coated	13
47.78.15.112.9	Plain washer 6x12 UHV flange	400
47.33.51.258.6	Goujon UHV flange M6x20 Ag coated	80
47.43.78.106.6 Ag coated	Hex nut M6 UHV flange Ag coated	172
47.43.78.106.6	Hex nut M6 UHV flange	100
47.62.83.014.6	Hex screw M6x35 UHV flange	150
18.60.56.035.2	Metal seal UHV flange DN40-36.8	28
18.60.56.016.1	Metal seal UHV DN16-16.2	3
47.78.15.109.1	Plain washer 4x9 UHV	30
47.62.71.904.4	Hex screw M4x20 UHV Flange	20
47.43.78.104.8	Hex nut M4 UHV flange	20
47.33.51.262.0	Goujon UHV flange M6x35	20
47.33.51.317.2	Goujon UHV flange M8x60	70
47.43.78.108.4 Ag coated	Hex Nut M8 Ag coated	210
47.62.83.122.3	Hex screw M8x55 UHV flange	20
47.43.78.110.0	Hexagon Nut M10 for UHV Flange	100
47.62.83.112.5	Hex Hd Screw M8x30 UHV Flange	100
47.62.83.118.9	Hex screw UHV flange M8x45	100
LHCACFCA0662	METAL SEALS	5
LHCACFCA0659	METAL SEALS	5
LHCACFCA0648	METAL SEALS	5
LHCACFMC0031	METAL SEALS FPC	3
LHCACFCA0663	METAL SEALS	5

Final transport

EVC and Ancillaries are shipped to the UK and Canada in boxes with foam. EVCs are shipped in two per box, ancillaries are shipped with two foam, depending on the beamline, but in the same box. Like PIMs also the EVC come with a traveler.

Summary

Plug-in modules:

- Under production and assembly.
- First PIMs shipped to collaboration.

Beam screen production & a-C coating: **Completed**

Cold Bore Plasma Cleaning:

- Procedure prepared.
- Possibility to see the system next week in CERN

Extremity vacuum chambers & Ancillaries:

- Production finalized, vacuum acceptance tests, leak test and assembly ongoing.

SPSV vs PIM RGA comparison

Stuart Wilde & Oliver Poynton

ASTeC Vacuum Solutions Group

20 Aug '24

Conclusion

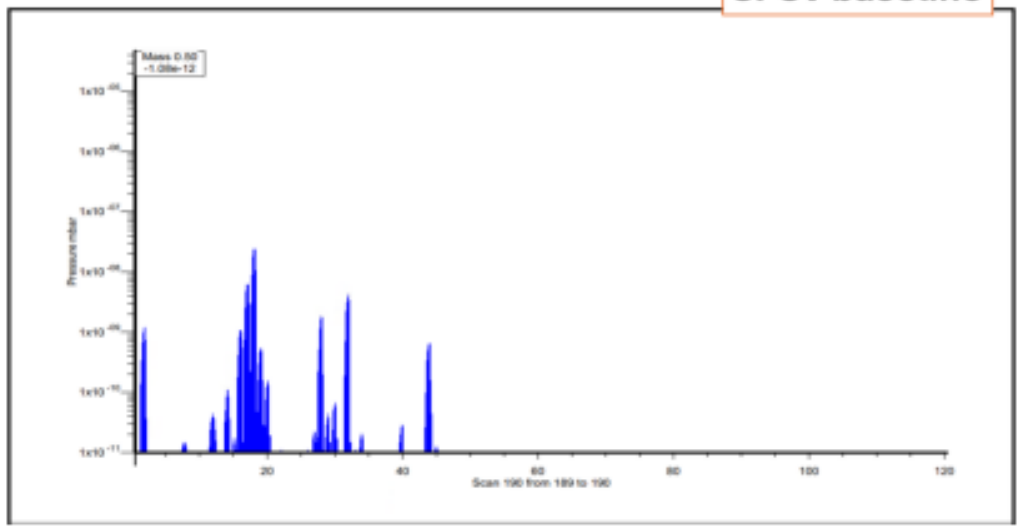
The scans show that any residual gasses are present in both measurements and are therefore not indicative of a leak on the PIMS.

The cart is thoroughly leak tested before each test and there was no leak present.

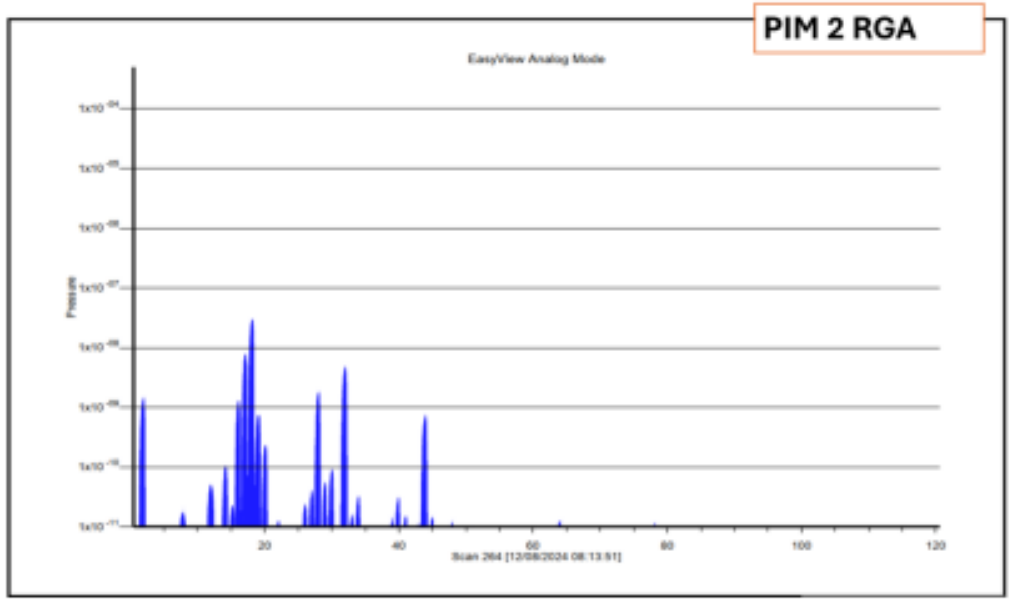
We originally thought there may be a virtual leak on this pumping system, for the same reasons described by Marco, but could not find any further evidence of this.

However, this type of background is consistent with our other unbaked systems that use similar RGA analysers and may be an artifact of the device.

SPSV baseline



PIM 2 RGA



Chemical treatment for Cu-OFE @ CERN

- Surface Treatments:

DEGREASING (15 min)
- 10 - 20 g/l NGL Cleaning Technology 17.40 spec. ALU III
- 45 - 55 °C
- Ultrasonic agitation

ELECTROPOLISHING (60 µm)
- 55 % vol. phosphoric acid
- 45 % vol. ethanol
- 1 µm/min etching rate

PASSIVATION (~30 s)
- 70 - 80 g/l chromic acid
- 3 ml/l sulphuric acid
- Room temperature
- 1 µm/min etching rate

SUBU (chemical polishing) (10 µm)
- 5 g/l sulfamic acid
- 1 g/l ammonium citrate
- 5 % vol. hydrogen peroxide
- 5 % vol. n-butanol
- 70 - 50 °C
- 0.5 µm/min etching rate