



# 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 tests, assembly, and shipping preparation.

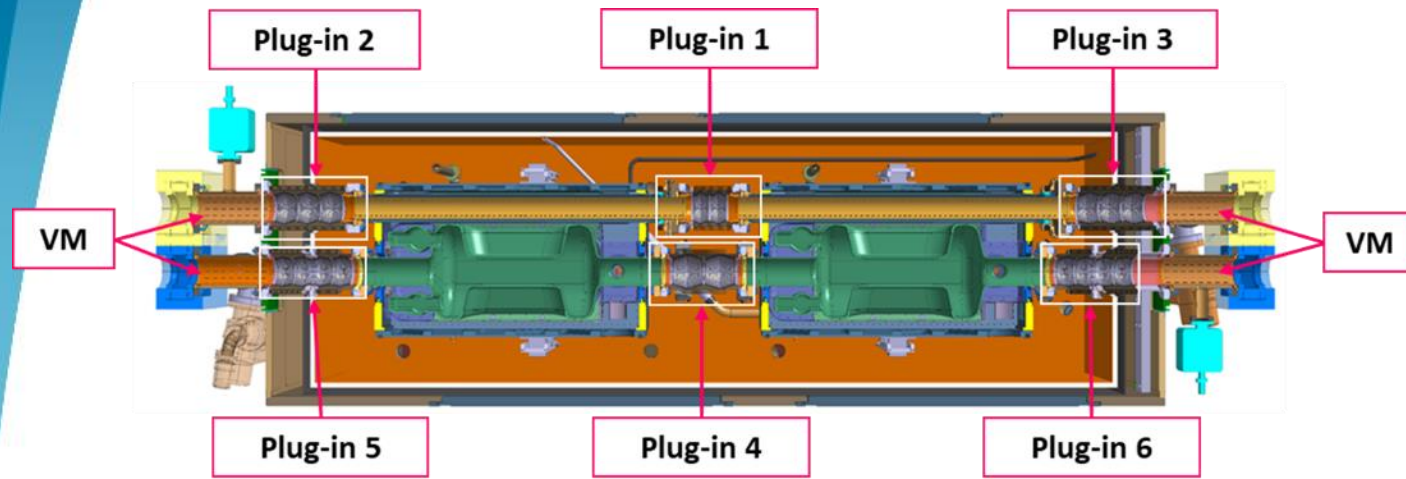
## Beam screen & Cold Bore:

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

## Extremity vacuum chambers & Ancillaries:

- Status of production, vacuum acceptance tests, 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

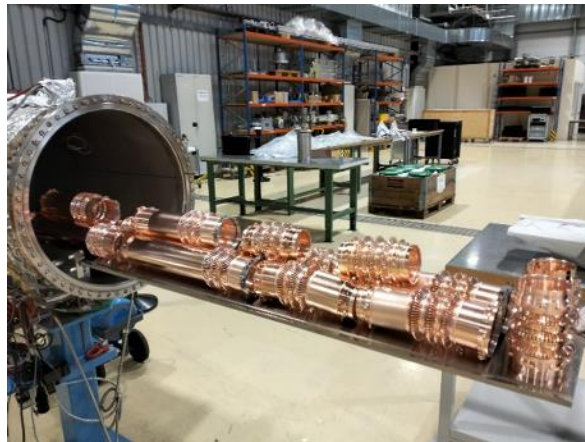
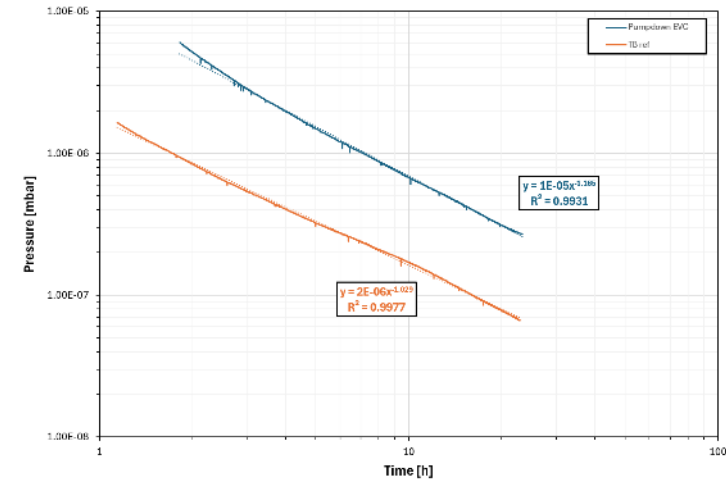
CRAB	DESTINATION	PIMs ASSEMBLED	TO BE ASSEMBLED
RFD	SPS (prototype)	6	-
RFD	CANADA 1st	3	3
DQW	UK 1st	6	-
DQW	CERN	4	2

- PIMs assembly for 2 cryomodules completed (first cryomodule UK and SPS prototype).
- PIMs assembly for 2 cryomodules ongoing ( first cryomodule Canada and DQW CERN) waiting for feedback on cleaning capability from Canada.
- PIMs for the remaining 7 cryomodules to be assembled.

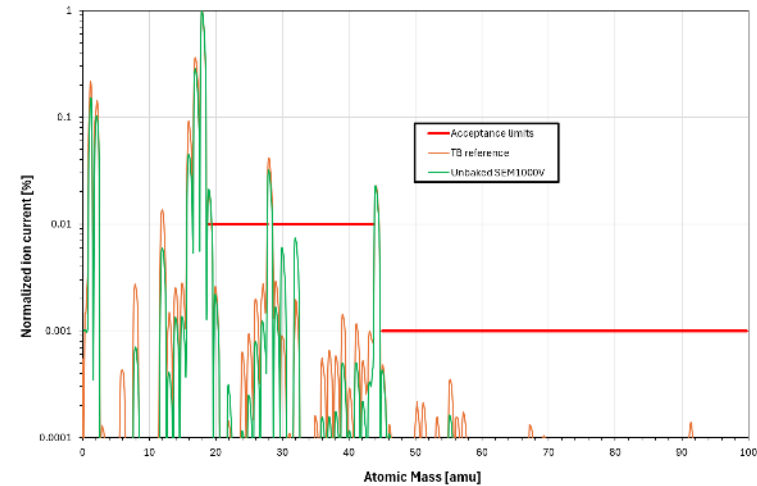
# PIMs: DRF inserts vacuum acceptance test



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



RGA analysis normalised to H<sub>2</sub>O peak: Unbaked vacuum acceptance tests



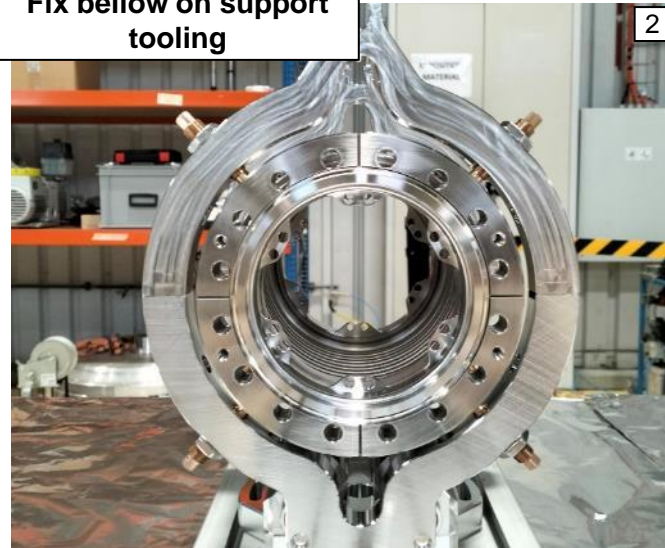
Vacuum Acceptance Test on DRF inserts after standard CERN cleaning procedure for UHV application.

# PIMs assembly an example

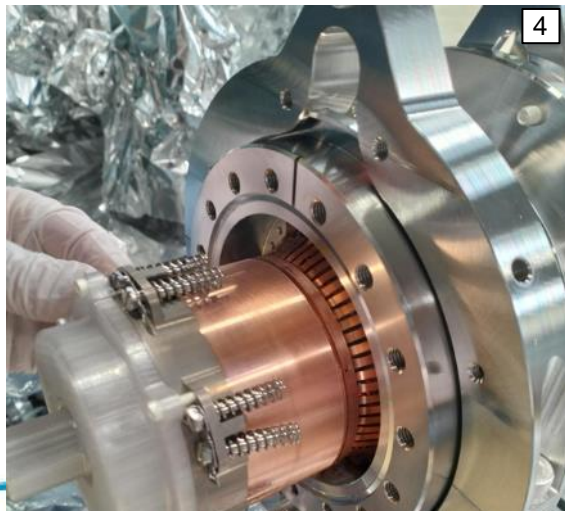
Extend DRF insert, using fix and mobile tooling



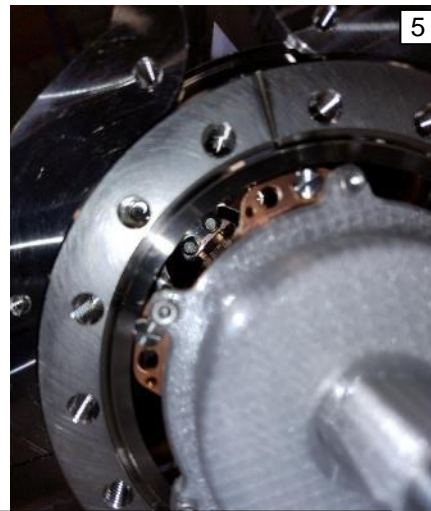
Fix bellow on support tooling



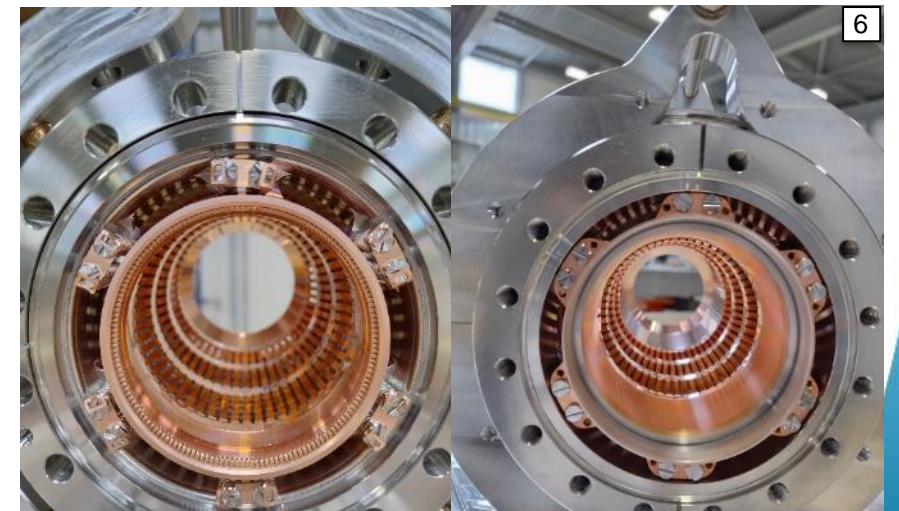
Put M4x20 screws inside



Insertion



Fix the bellow to the DRF with the screws inside



Fix the DRF on both sides

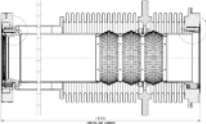
# Final Status & Transport

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 xxxxxxxx.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	⚠️

[ID: 511480941\_01, step: EDMS 2694942 v.0]

**1. Identification of ITEM**

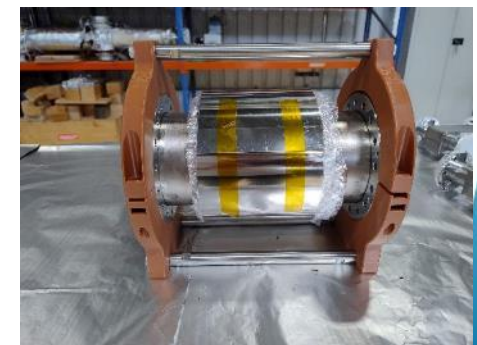
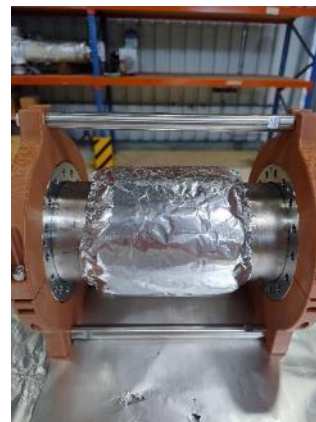
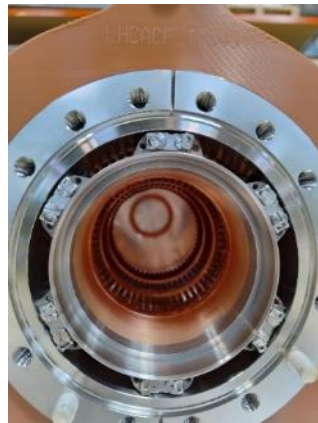
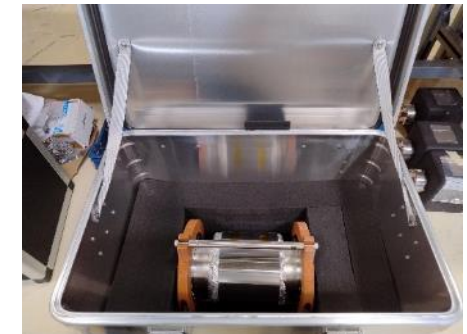
1.1 – Equipment Designation: Long Cold/Warm Transition Secondary line PIM assembly, DQW 1 UK  
 1.2 – MTF Equipment Identifier: HCVBMCC049-CR000001  
 1.3 – CERN Drawing ref: LHCVBMC0049  
 1.5 – CERN Contacts:  
 • Giuseppe Bregliozzi: +41754112517 / giuseppe.bregliozzi@cern.ch  
 • Simon Barrière: +41754118508 / simon.barriere@cern.ch  
 1.6 – STFC UK Contacts:  
 • Niklas Templeton: niklas.templeton@stfc.ac.uk  
 • Carlos Granjero: +44 7400 675503 / carlos.granjero@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 PLD and Vacuum: Section 11 Annex C  
 EDMS 2042014: 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

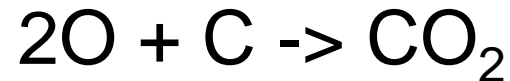
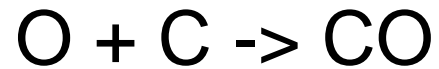
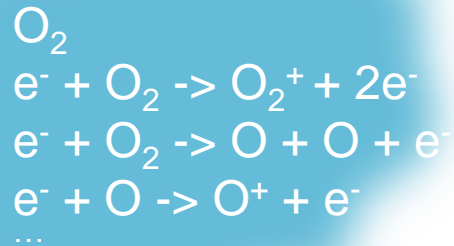
Cryomodule	EDMS number	Cavity
UK 1	3132909	DQW
Canada 1	3132914	RFD

**PIMs Assembled ready for installation: 27%**

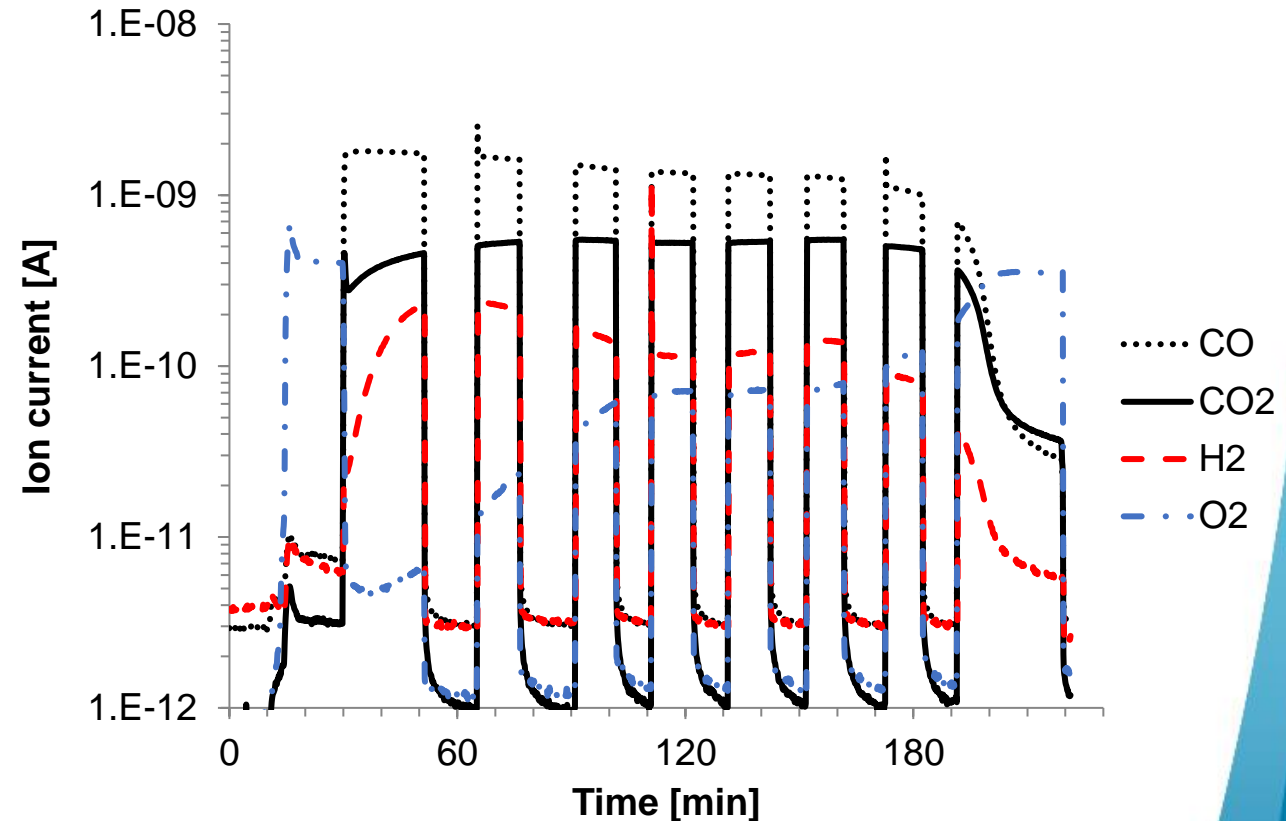


# Plasma Cleaning: How?

Oxygen plasma to remove carbon and hydrocarbon contaminations, but not dust (inorganic).



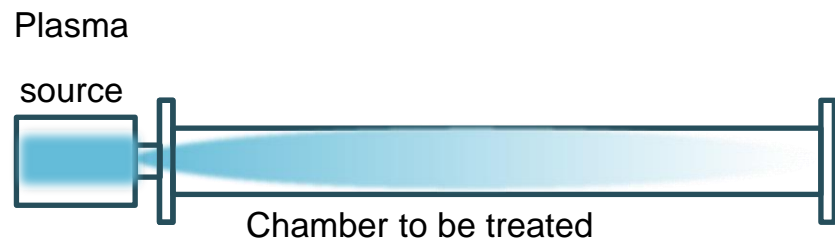
Volatiles -> pumped by the vacuum system



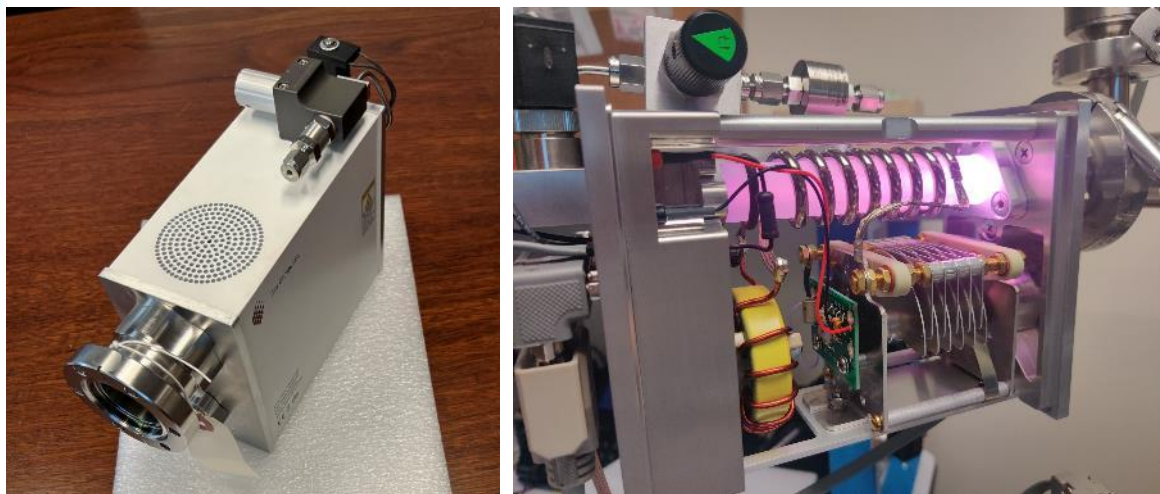


# Plasma Cleaning: How?

## Remote plasma source



- ✓ Low energy ions (<100 eV)
- ✓ Simplicity
- × High inhomogeneous plasma distribution
- × Lower efficiency

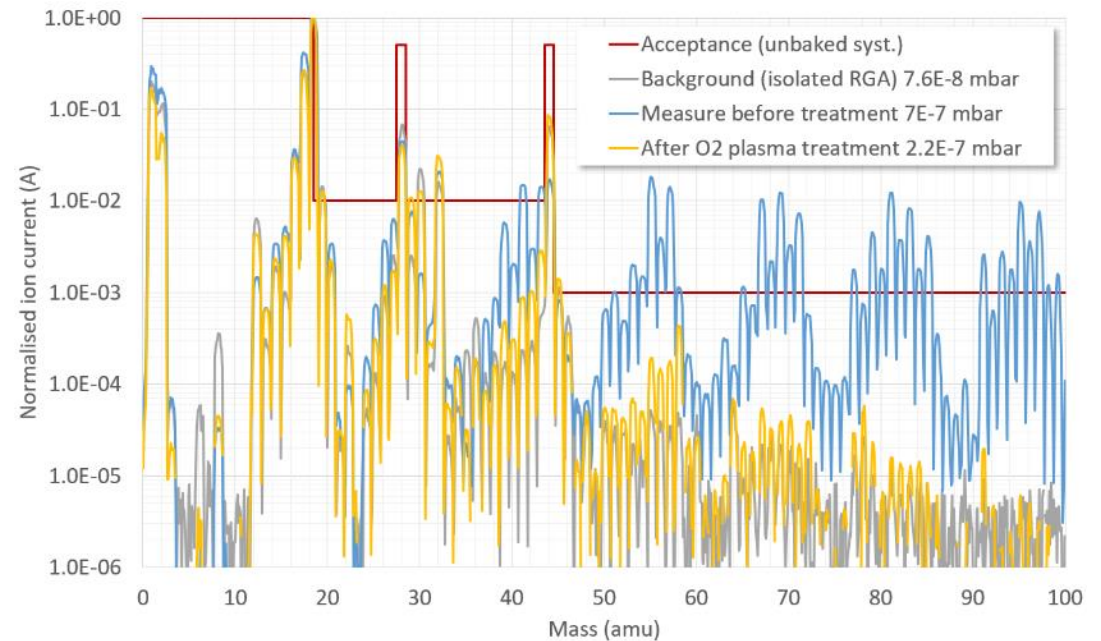
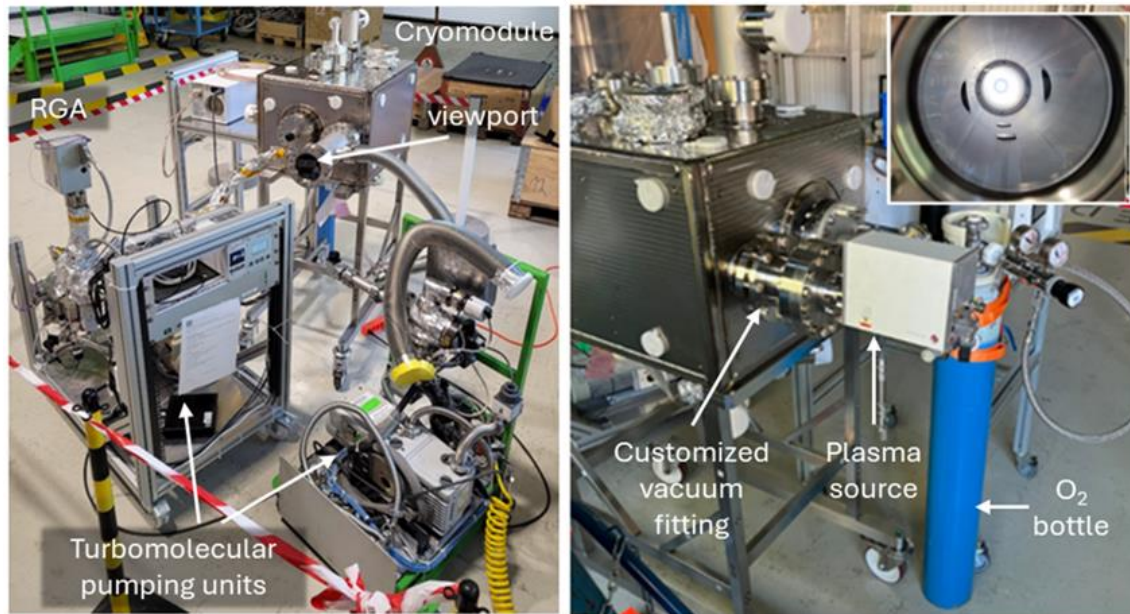


GV10 Asher from Ibss Inc. (13 MHz, 25 ~ 300 W, from  $3 \times 10^{-3}$  ~  $10^{-1}$  mbar)

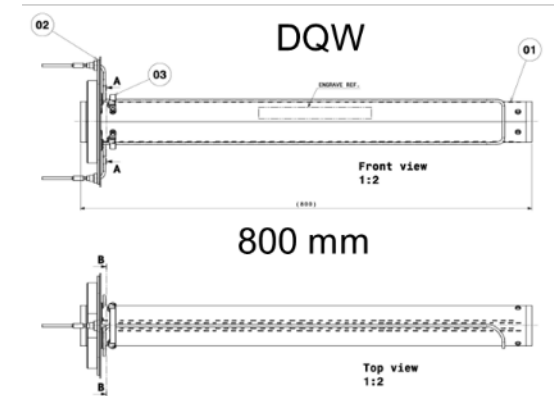
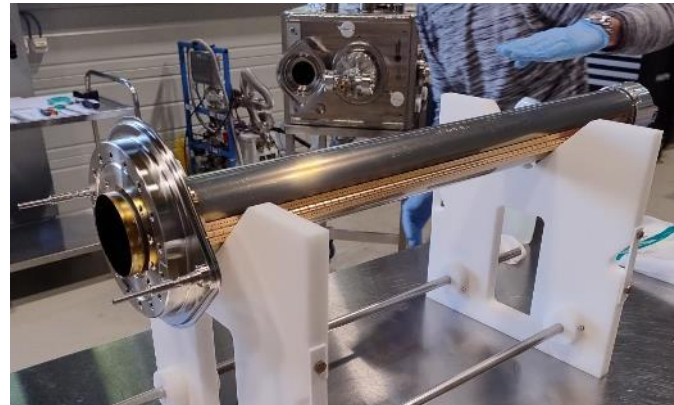
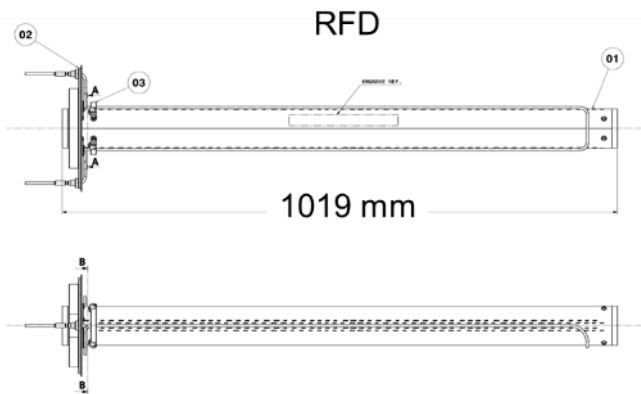


# Cold bore cleaning by oxygen plasma etching

- Generation of a plasma in an external source then injected in the cold bore.
- The lower energy of the ions ( $< 100$  eV) produced generating the plasma inside the cold bore doesn't cause sputtering of the cold bore surface.
- The cleaning effect is seen by comparing the spectra before and after cleaning. (the cold bore was dirty)
- Procedure in **EDMS n° 3126461 v.2**



# Beam screen: production status and a-C coating: **Completed**

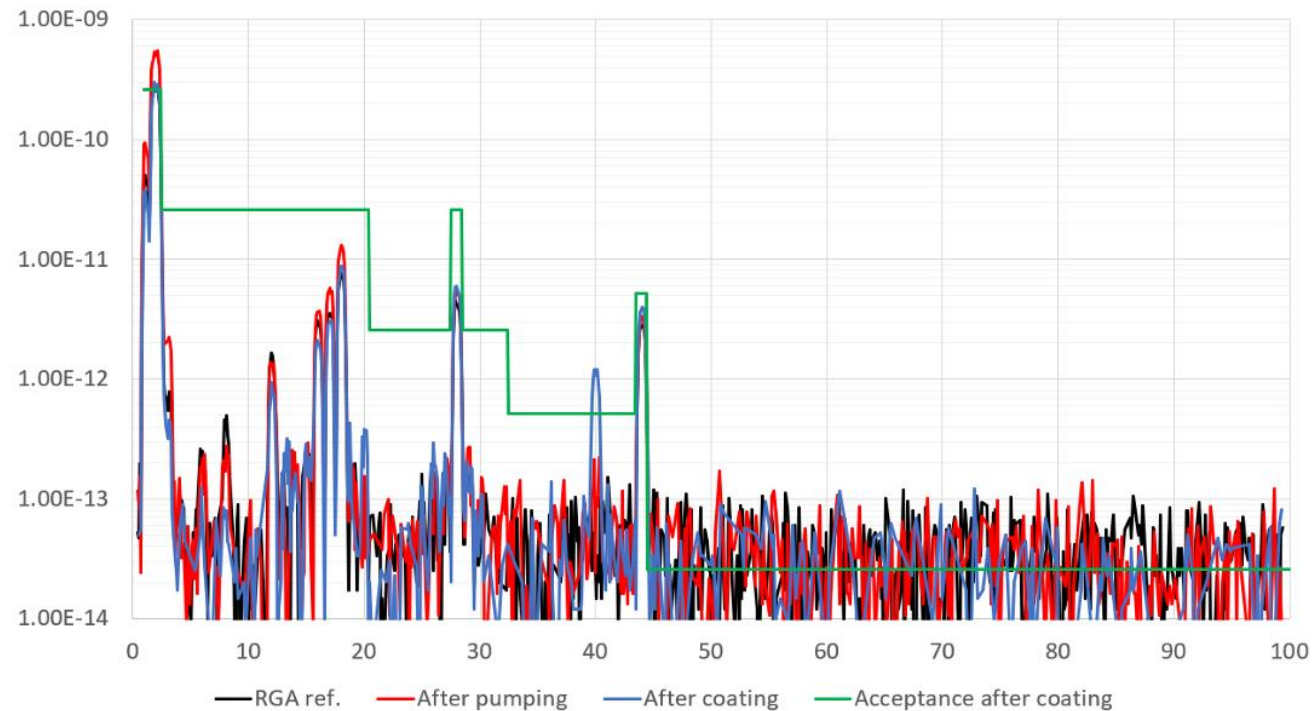
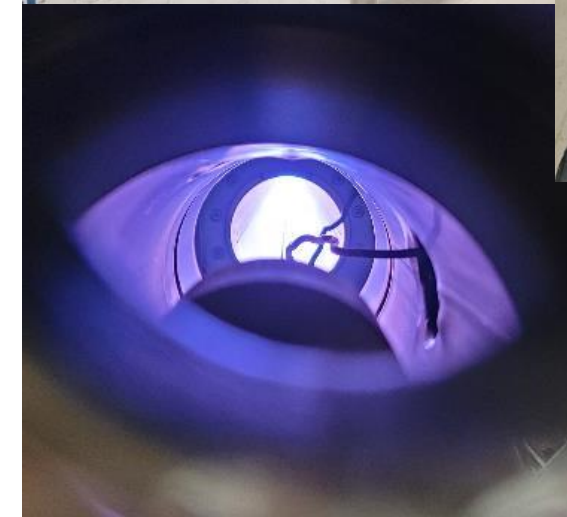
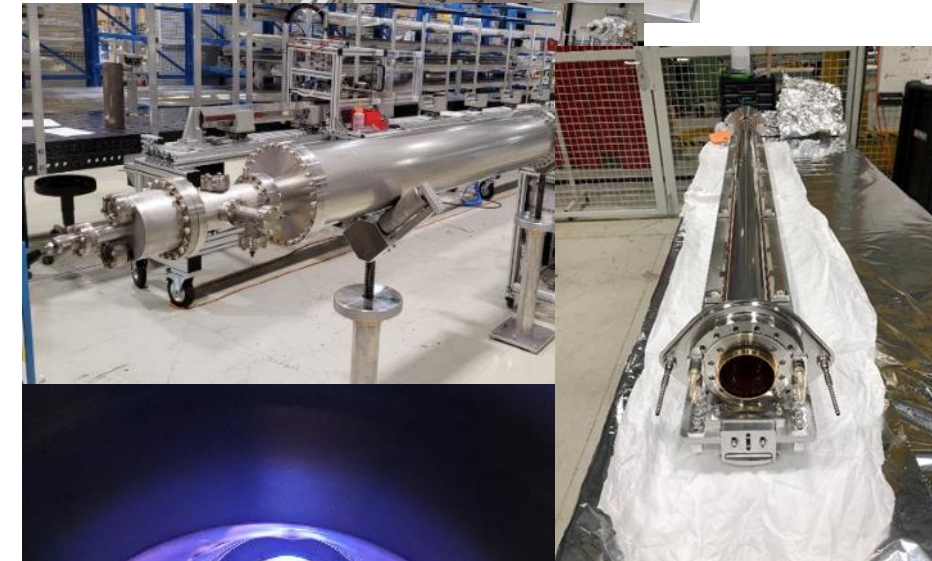
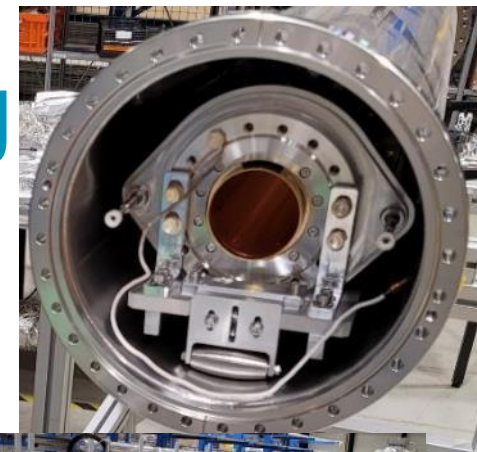


Component	Qty CERN (SPS&D QW)	Qty Canada	Qty UK	Qty Spare	Asset	aC coated
RFD Circular beam screen + cooling tubes + end connections VSSC	2	10	-	3	HCVSSCA001	12
DQW Circular beam screen + cooling tubes + end connections VSSC	2	-	8	5	HCVSSCA031	10

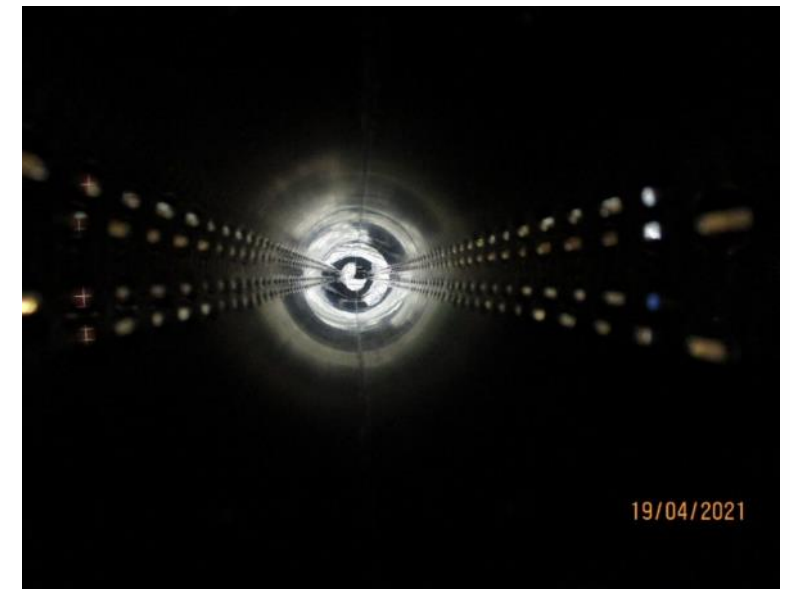
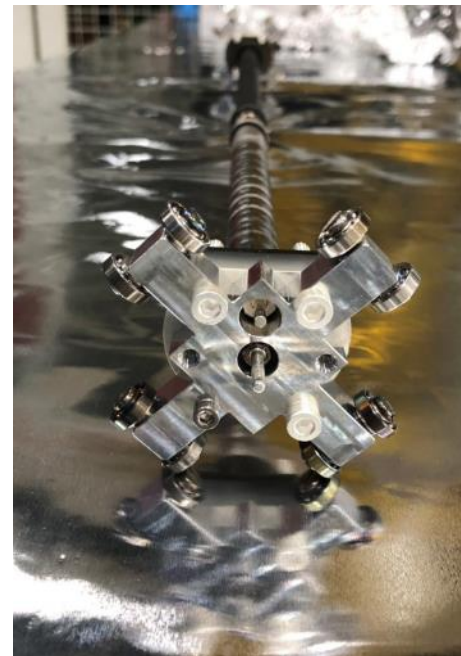
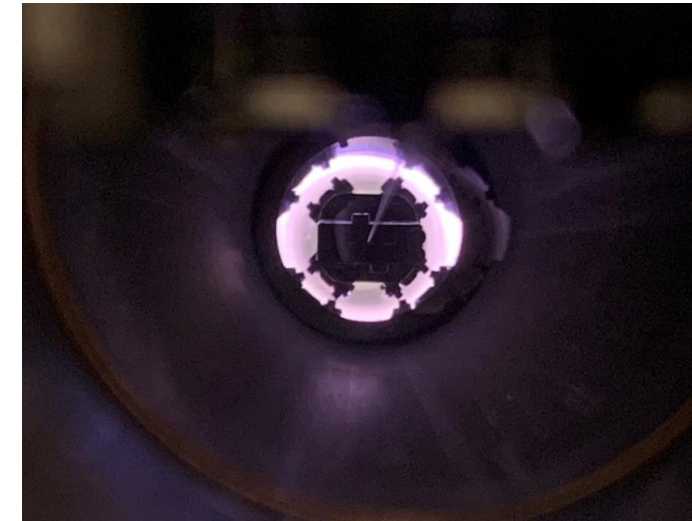
# Beam screen: aC coating

## a-C coating procedure on EDMS n° 3036208.

- Argon plasma cleaning, surface preparation before coating
- a-C coating
- Final RGA performed after every coating, reports available in EDMS folder: CERN-0000249963



Amorphous carbon coating in the beam screens for the circulating beam in the cryomodules for the CRAB cavities: production completed | High Luminosity LHC Project (cern.ch)

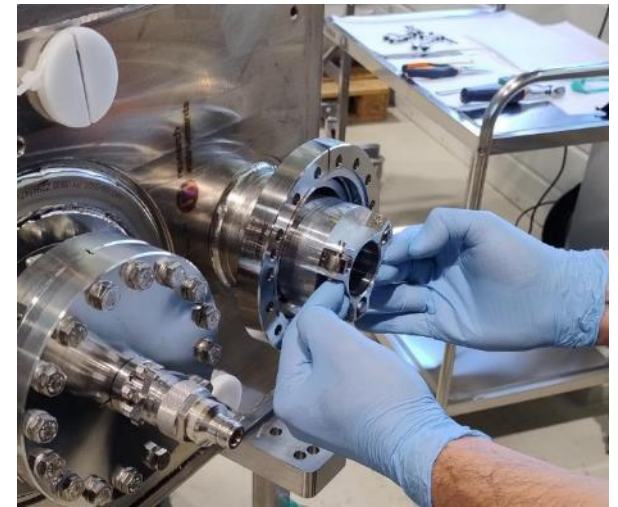
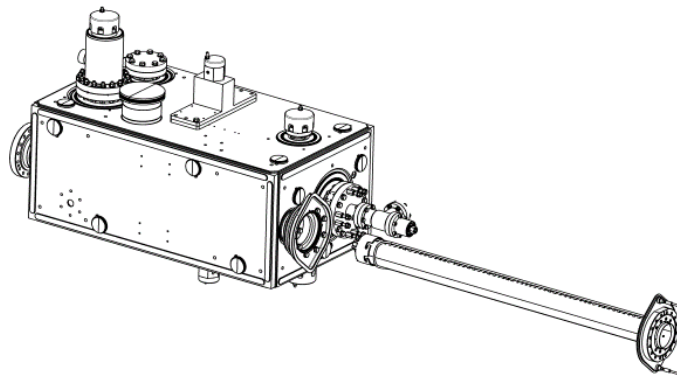


# Beam screen: insertion in the cold bore

Procedure available in EDMS: 3129282 v.1.

The insertion is done essentially in 2 steps:

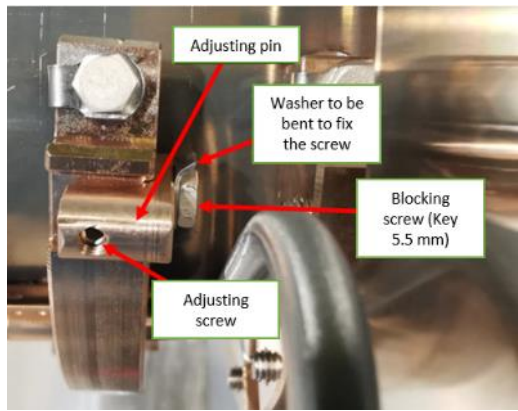
- Centre the beam screen on the diamond flange side by regulating its adjustable rings.
- Centre the beam screen on the other side installing two half-moon rings.



# Beam screen: insertion in the cold bore

## Centering the diamond flange:

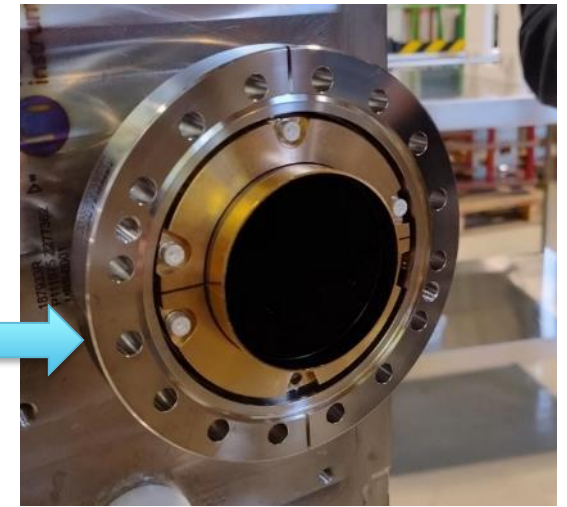
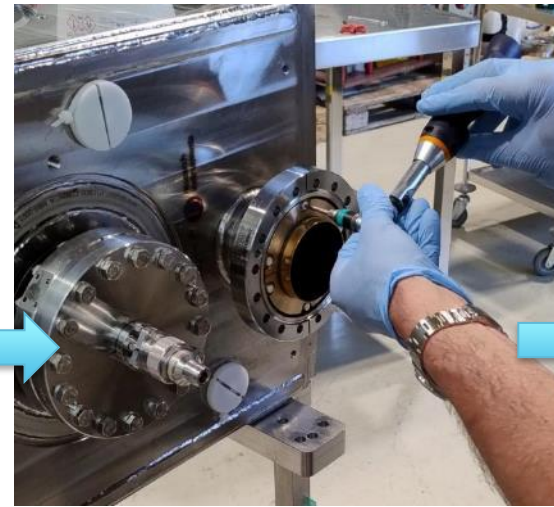
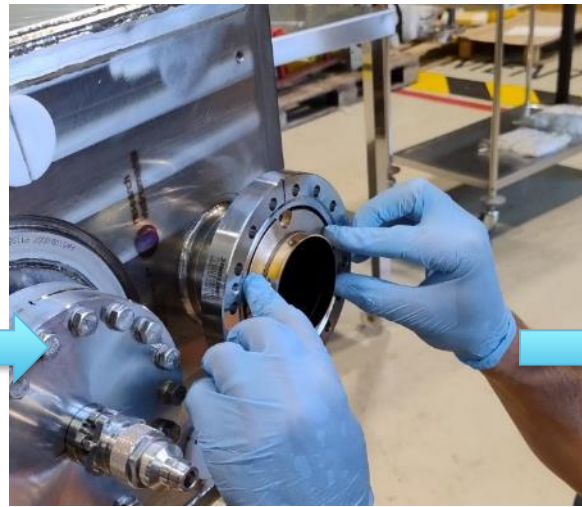
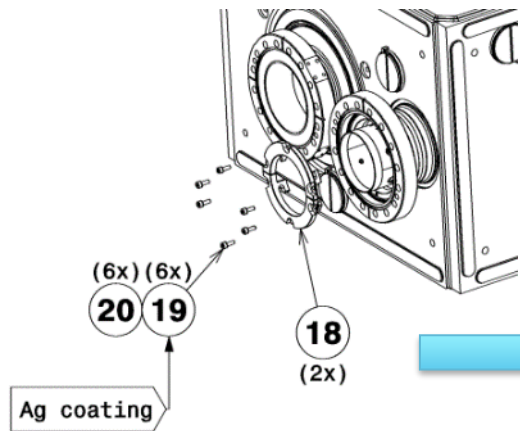
- Remove the beam screen from the transport box and place it on the V support.
- Tight/Untight the adjusting pins and try to insert the beam screen, then repeat regulating the adjustable pins till the diamond flange is completely in contact and the beam screen can't move anymore.



# Beam screen: insertion in the cold bore

Centering the beam screen on the other flange:

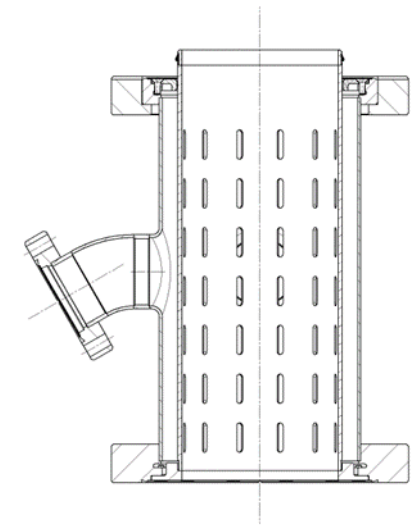
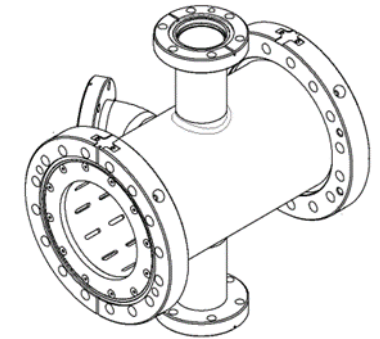
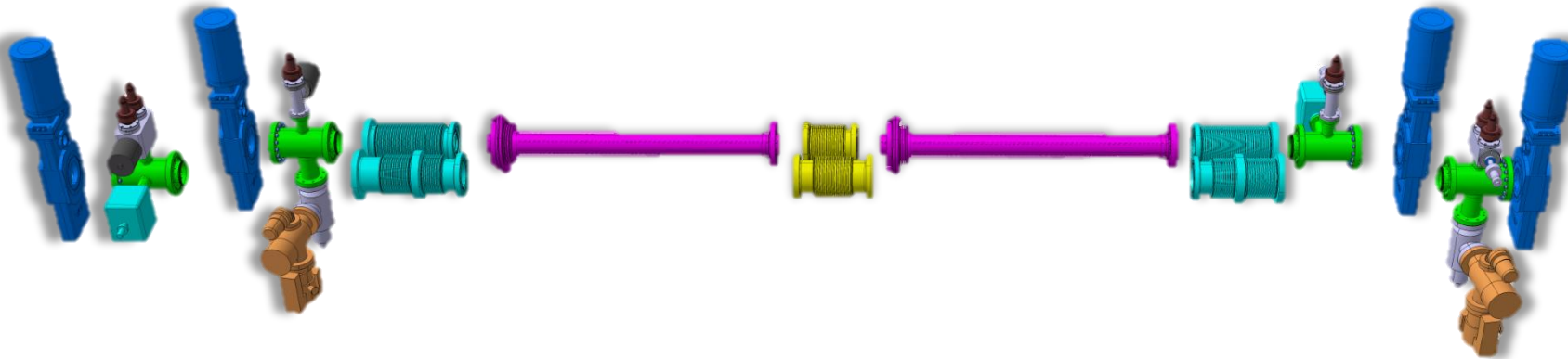
- Insert the half-moon rings'
- Fix them with a maximum torque of 1.5Nm





# Extremity vacuum chambers (EVC)

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

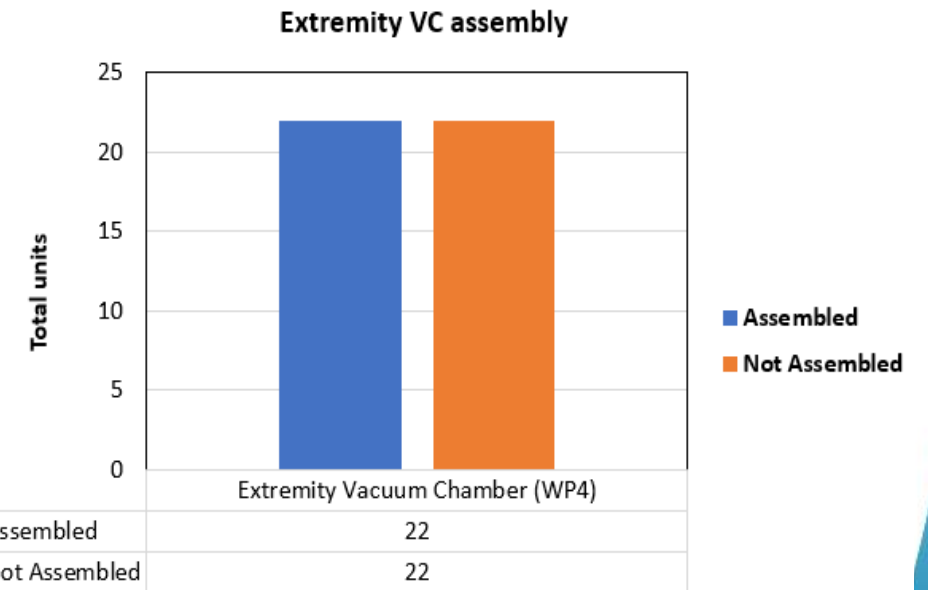
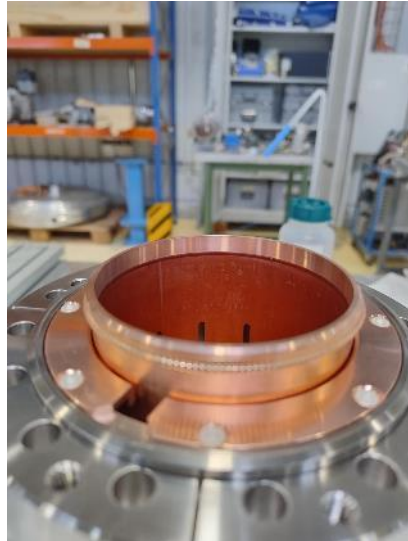


Item	Needed	Spare	Produced	Comments
Ext. Vac. Ch	40	4	44	8 shipped for cryomodule assembly (RFD prototype and DQW 1 UK)

# 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%

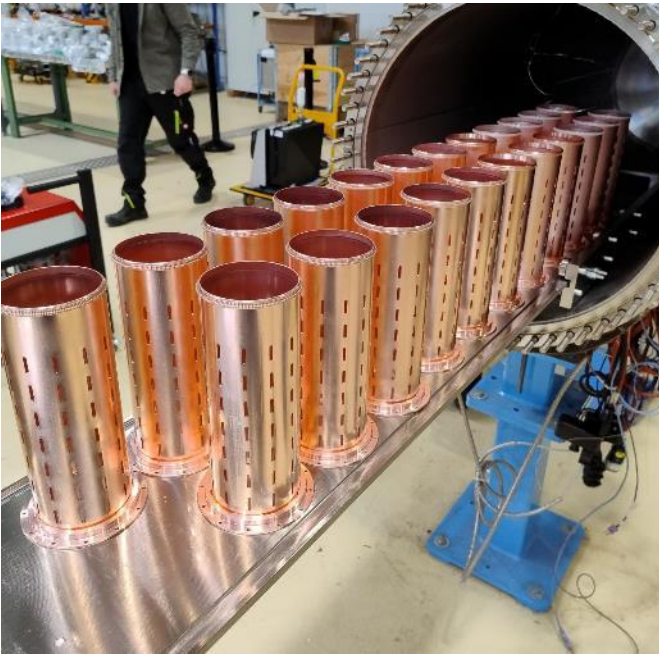


# EVC: vacuum acceptance test

Three vacuum acceptance test have been performed:

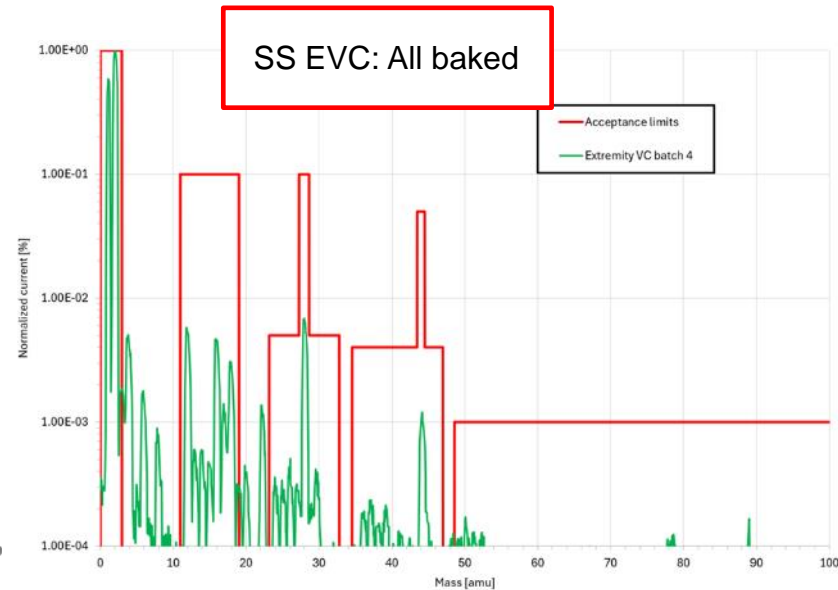
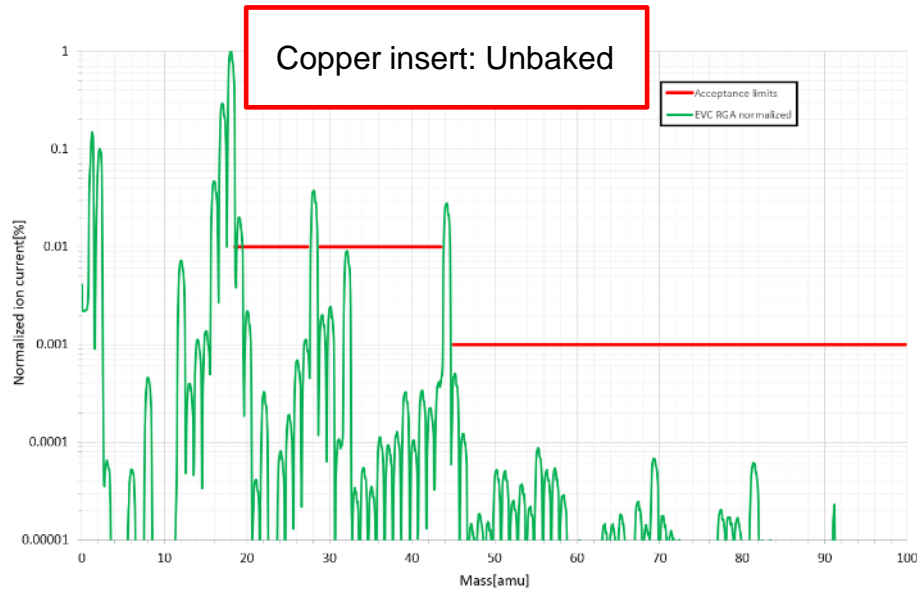
- Acceptance test RF shield
- Acceptance test vacuum chambers
- Leak test vacuum chambers and ancillaries

Reports attached to asset code **HCVMACAA\_T001**



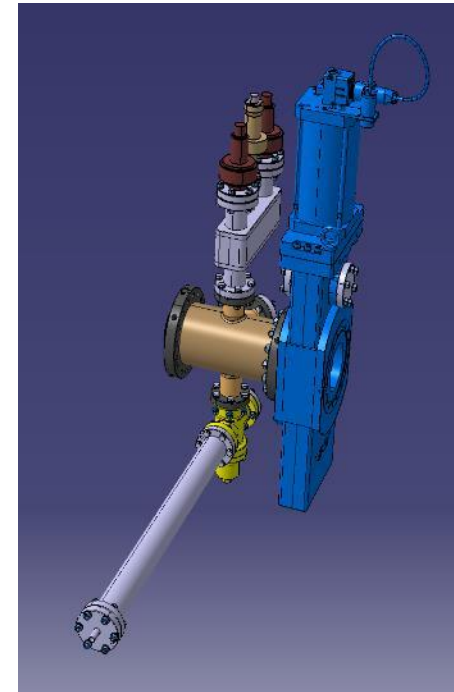
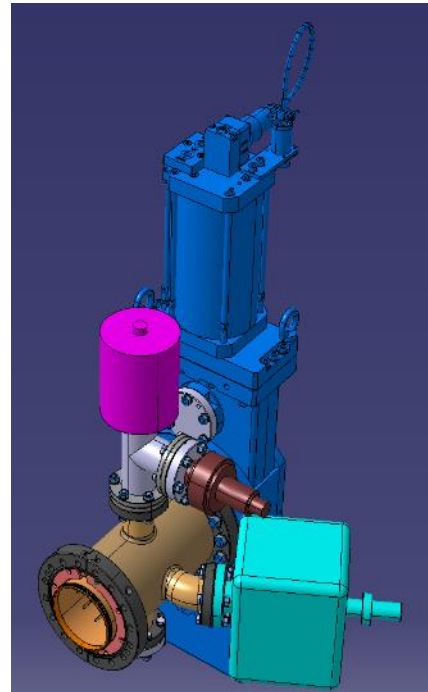
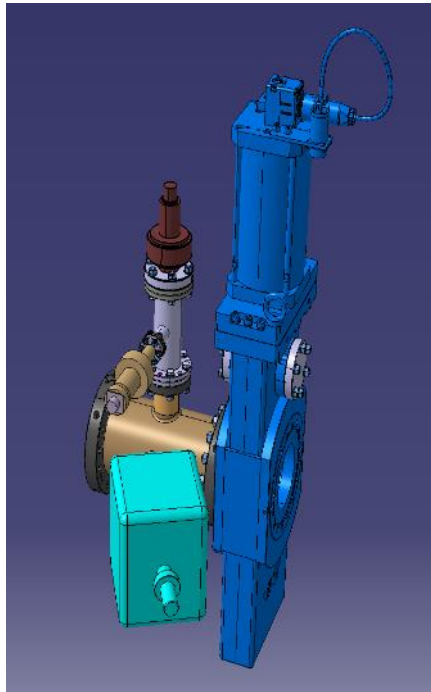
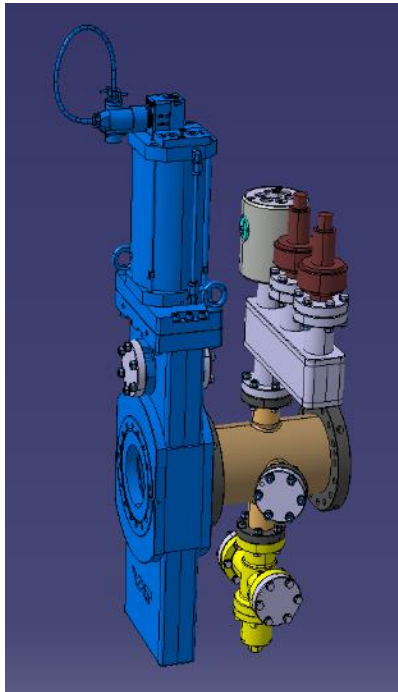
# EVC: vacuum acceptance test

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



# EVC: Ancillaries

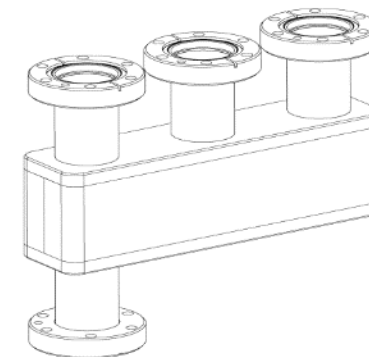
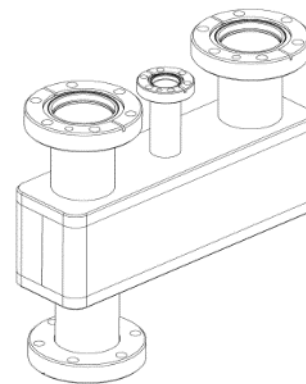
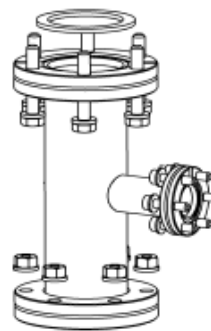
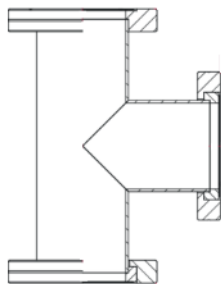
The assembly of the extremity vacuum chamber includes ancillaries and instrumentation



# 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

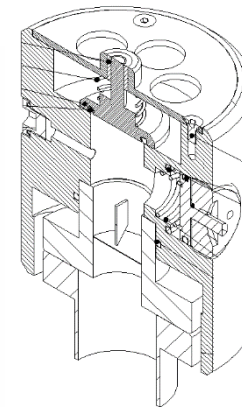
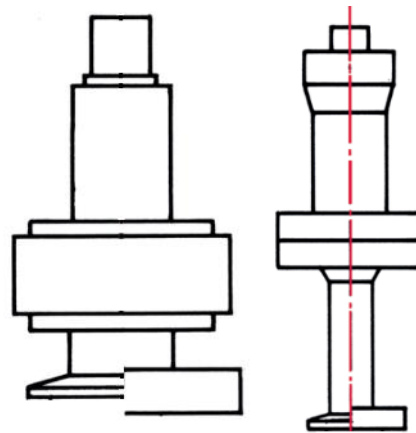


# EVC: Ancillaries status

In-kind contribution:

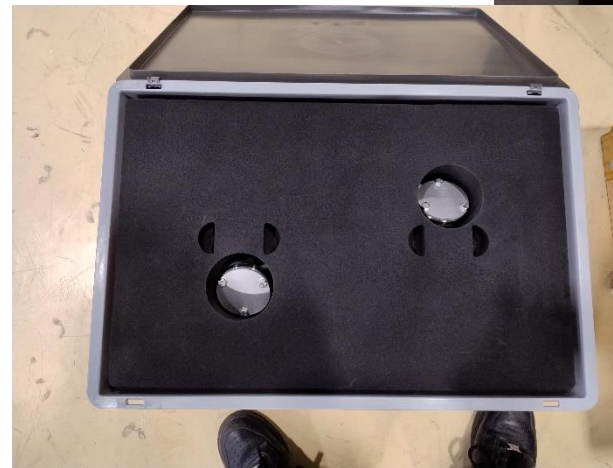
Component	Reference	Needed	Spare	Purchased by CERN
Sector valve VVGSC DN80	VAT 47238-XE74-ANV1	40	4	40/40
VGPB- Cold cathode gauge	Pfeiffer Vac. IKR070 (PTR20 502)	60	6	36/60*
Non return valve (with rupture disk)	LHCVV__0040	20	2	20/20
VGRB Pirani gauge DN16 CF-F	Pfeiffer TR018 (PT R15 011)	20	2	12/20*
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



# 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.