



## Industrial & CERN DQW status

N. Valverde on behalf of HL-LHC WP4, EN-MME & SY-RF-SRF

12<sup>th</sup> HL-LHC Collaboration Meeting, Uppsala, 21.09.2022



# DQW Jacketed Cavities Contract

- Contract signed on March 2018 with the company Research Instruments (RI) to provide:

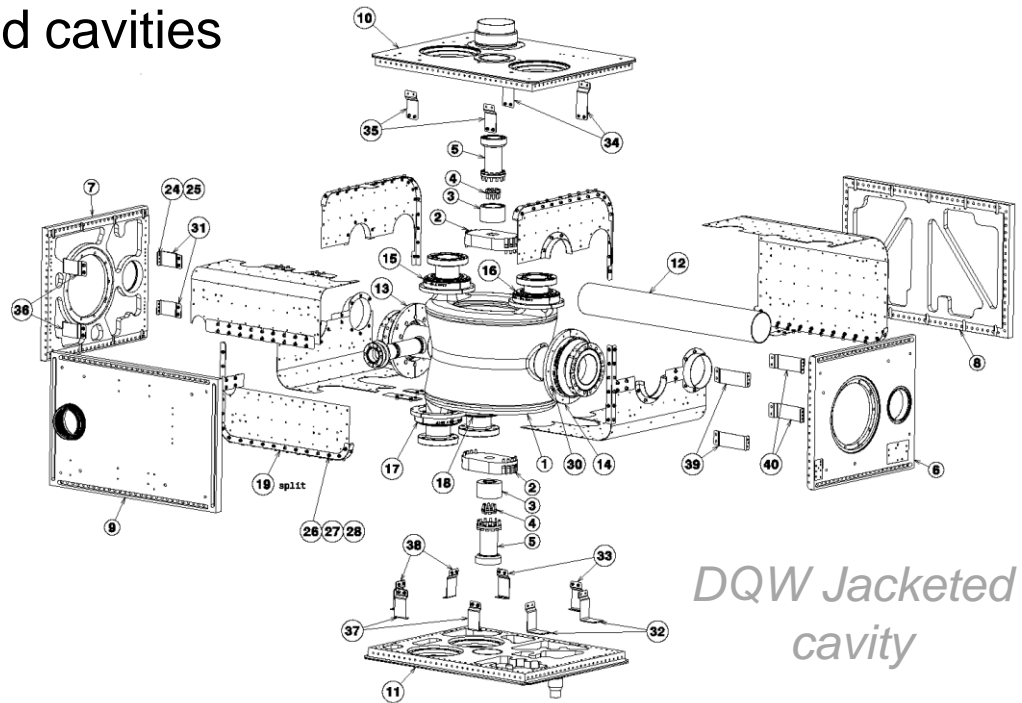
- 1 preseries Jacketed cavity

After qualification of preseries Jacketed cavity by CERN (cold RF test):

- 10 series Jacketed cavities



*DQW Bare cavity*

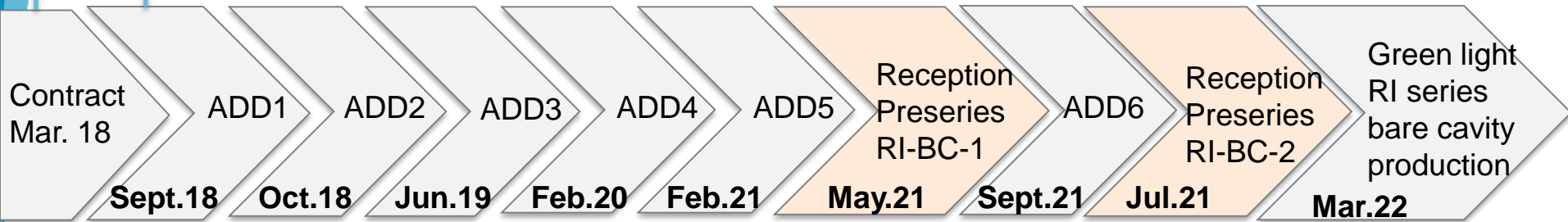


*DQW Jacketed cavity*

# RI Contract Timeline

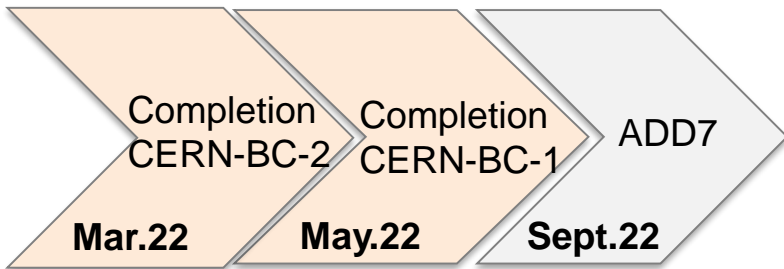
1 preseries + option of 10 series JC

2 preseries + option of 9 series JC



2 preseries + option of 6 series JC

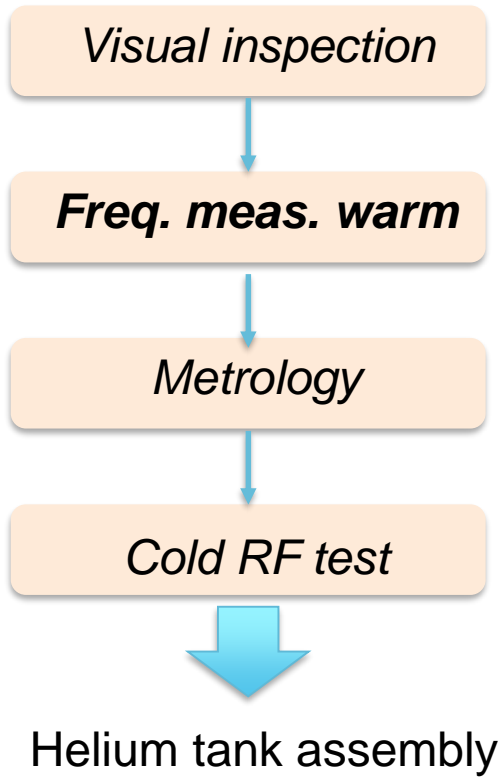
*Fabrication at CERN of 2 JC*



ADD: Addendum to the contract

# Reception RI Preseries Bare Cavities

- RI cavities arrived to CERN ready for cold RF test.
  - BCP (150-200  $\mu\text{m}$ ), heat treatment (650C<sup>0</sup>@24h), HPR and clean room assembly done by RI



	RI-DQW1	RI-DQW2	Target*
Freq. (warm, atm. press)	400.71	400.59	400.53 $\pm$ 0.1 MHz
	+ 80kHz	OK	

\* Estimated target freq. assuming freq. deviation during helium will be the same as for CERN prototypes



# Reception RI Preseries Bare Cavities

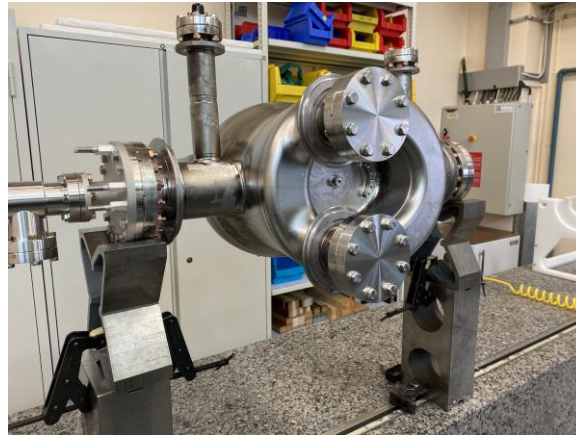
*Visual inspection*

*Freq. meas. warm*

**Metrology**

*Cold RF test*

Helium tank assembly



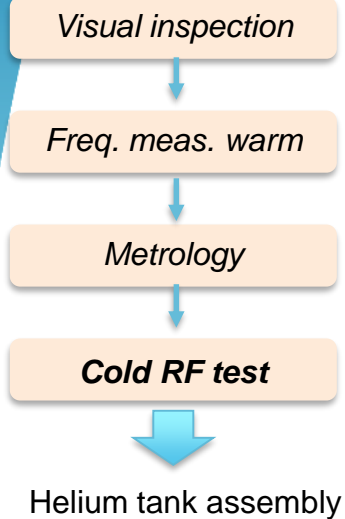
Final metrology by portable metrology 3D scan complemented with CMM, thanks to MME/MM

Metrology has been accepted for both preseries



# Reception RI Preseries Bare Cavities

*See talk K. Turaj*



- Cold RF test of RI preseries BC 1:
  - 1st Cold RF test did not reach specification.
  - HPR and clean room assembly at CERN. 2nd Cold RF test did not reach specification.
  - Light BCP (thanks to TE-VSC), HPR and clean room assembly at CERN. 3<sup>rd</sup> cold RF test with successful results.
- Cold RF test of RI preseries BC 2:
  - Cold RF test with successful results.



Both cavities went back to RI for helium tank assembly

# Documentary structure RI preseries BC

Documentary structure of the contract (EDMS) in place and actively used by the supplier. Full traceability of documents and versions.

Many interactions with the supplier to achieve the quality level requested by the technical specification (EDMS 1803555).

The screenshot displays the EDMS (Electronic Document Management System) interface. The top navigation bar includes 'EDMS', 'Home', 'Favourites', 'Inbox', and 'Caddie'. The left sidebar shows a 'Navigator' with a tree view of the document structure. The main area shows a folder named 'CERN-0000185872 MIP and Procedures' with 'Public access'. Below this, there are tabs for 'Info' and 'More info'. The 'More info' tab is active, showing a table of documents with columns for '#', 'Id', 'Title', 'Files', 'Status', 'Created on', and 'Author'. The table lists various documents related to manufacturing and inspection plans, BCP procedures, chemical surface treatments, HPWR procedures, heat treatment, brazing, helium leak tests, ultrasonic testing, and grinding of niobium.

#	Id	Title	Files	Status	Created on	Author
70	1887287 v.7	Manufacturing and Inspection Plan Pre-s...	2	Released	2020-05-15	RESEARCH INSTRU
13C	1887289 v.6	BCP Procedure	1	Released	2019-03-05	RESEARCH INSTRU
19C	2050479 v.6	Chemical Surface Treatment of Niobium ...	1	Released	2019-12-18	RESEARCH INSTRU
22C	1887290 v.3	HPWR procedure	2	Released	2019-08-09	RESEARCH INSTRU
26C	1887291 v.4	Heat Treatment Procedure	1	Released	2019-02-25	RESEARCH INSTRU
32C	2041072 v.6	Brazing procedure	1	Released	2019-07-09	RESEARCH INSTRU
35C	2050505 v.3	Helium leak test procedure	3	Released	2019-09-27	NURIA VALVERDE AL
38C	2067217 v.3	Ultrasonic Testing Procedure	1	Released	2019-01-24	RESEARCH INSTRU
42C	2082966 v.4	Cleaning procedure for SS, Cu and Ti	1	Released	2019-05-14	NURIA VALVERDE AL
45C	2113095 v.3	Grinding of Niobium procedure	1	Released	2019-03-21	RESEARCH INSTRU
49C	2257799 v.4	RF measurement and trimming procedure	1	Released	2021-06-03	ANKE CLEVER
53C	2268021 v.4	Manufacturing and Inspection Plan Pre-s...	1	Released	2020-03-16	NURIA VALVERDE AL
55C	2375144 v.2	Venting procedure	1	Released	2020-10-27	Research Instrument
56C	2375168 v.1	Report Templates related to surface treat...	44	In Work	2020-05-12	Research Instrument
57C	2393441 v.1	Report templates related to bare cavity fa...	1	In Work	2020-07-04	NURIA VALVERDE AL
60C	2712912 v.3	Manufacturing and inspection plan - Series	1	Released	2022-07-18	RESEARCH INSTRU

# Follow-up of fabrication, RI preseries BC

RI's MIP was implemented in MTF and they upload directly the fabrication reports. 252 steps for bare cavity fabrication. >200 documents per bare cavity to be reviewed.

**Equipment Identifier:** HCACFCA001-RN000001  
**Other Identifier:** 4094-P111520-01  
**Description:** DQW Bare Cavity (Variant #1)

Main   Made of   Equipment data   <b>Manufacturing</b>   Operation   Non-conformities   Documents   History   Map						
Actions: Add extra step						
<b>Workflow Diagram</b>						
No workflow diagram is defined for this equipment						
<b>Workflow Steps</b>						
Step	IR/E	Other name	Description	Status	Result	NC
5	()		Traceability of mats (*)	Done	Ok	
10	()		Reception Material from CERN (*)	Done	Ok	
15	()		Related MIP (*)	Accepted	Ok	
20	()		P110937-2.2.2.5 -4094_US_01 -US thck before shaping (*)	Accepted	Ok	
25	()		P110937-2.2.2.6 -4094_VC_01 -VT before shaping (*)	Accepted	Ok	
30	()		P110937-2.2.2.10 -4094_US_02 -US thck after shaping	Accepted	Ok	
35	()		P110937-2.2.2.11 -4094_VC_02 -VT after shaping (*)	Done	Ok	
40	()		P111520-2.2.3.5 -4094_US_03 -US thck before shaping (*)	Accepted	Ok	
45	()		P111520-2.2.3.6 -4094_VC_03 -VT before shaping (*)	Accepted	Ok	
50	()		P111520-2.2.3.9 -4094_US_04 -US thck after shaping (*)	Accepted	Ok	
55	()		P111520-2.2.3.10 -4094_VC_04 -VT after shaping (*)	Done	Ok	
60	()		P111523-2.2.4.5 -4094_US_05 -US thck before shaping (*)	Accepted	Ok	
65	()		P111523-2.2.4.6 -4094_VC_05 -VT before shaping (*)	Accepted	Ok	
70	()		P111523-2.2.4.11 -4094_US_06 -US thck before shaping (*)	Accepted	Ok	
75	()		P111523-2.2.4.12 -4094_VC_06 -VT after shaping (*)	Accepted	Ok	
80	()		P110942-2.2.5.11 -4094_EB_01 -VT before welding (*)	Accepted	Ok	
85	()		P110942-2.2.5.13 -4094_EB_02 -VT after welding (*)	Accepted	Ok	
90	()		P110942-2.2.5.16 -4094_EB_03 -VT after welding (*)	Done	Ok	
95	()		P110942-2.2.5.17 --RT after welding (*)	Accepted	Ok	
100	()		P110942-2.2.5.21 -4094_US_07 -UT thck before shaping (*)	Done	Ok	
105	()		P110942-2.2.5.22 -4094_VC_07 -VT before shaping (*)	Done	Ok	
110	()		P110942-2.2.5.24 -4094_US_08 -UT thck after shaping (*)	Done	Ok	
115	()		P110942-2.2.5.25 -4094_VC_08 -VT after shaping (*)	Done	Ok	
120	()		P111300-2.2.6.11 -4094_EB_04-VT before welding (*)	Accepted	Ok	
125	()		P111300-2.2.6.13 -4094_EB_05-VT after welding (*)	Accepted	Ok	
130	()		P111300-2.2.6.16 -4094_EB_06-VT after welding (*)	Accepted	Ok	
135	()		P111300-2.2.6.17 --RT after welding (*)	Accepted	Ok	
140	()		P111022-2.2.7.11 -4094_EB_07-VT before welding (*)	Accepted	Ok	
145	()		P111022-2.2.7.13 -4094_EB_08-VT after welding (*)	Accepted	Ok	
150	()		P111022-2.2.7.16 -4094_EB_09-VT after welding (*)	Accepted	Ok	
155	()		P111022-2.2.7.17 --RT after welding (*)	Done	Ok	



# RI Preseries Jacketed Cavities

- Drawings, MIP and fabrication procedures are released.
- Welding qualifications are expected by November.
- Material and special subcomponents (i.e bellows) were ordered.
- Machining of subcomponents started.
- Cold Magnetic shield provided by UK collaboration already at RI.
- Preseries jacketed cavities (x2) will arrive to CERN Q1-2023.

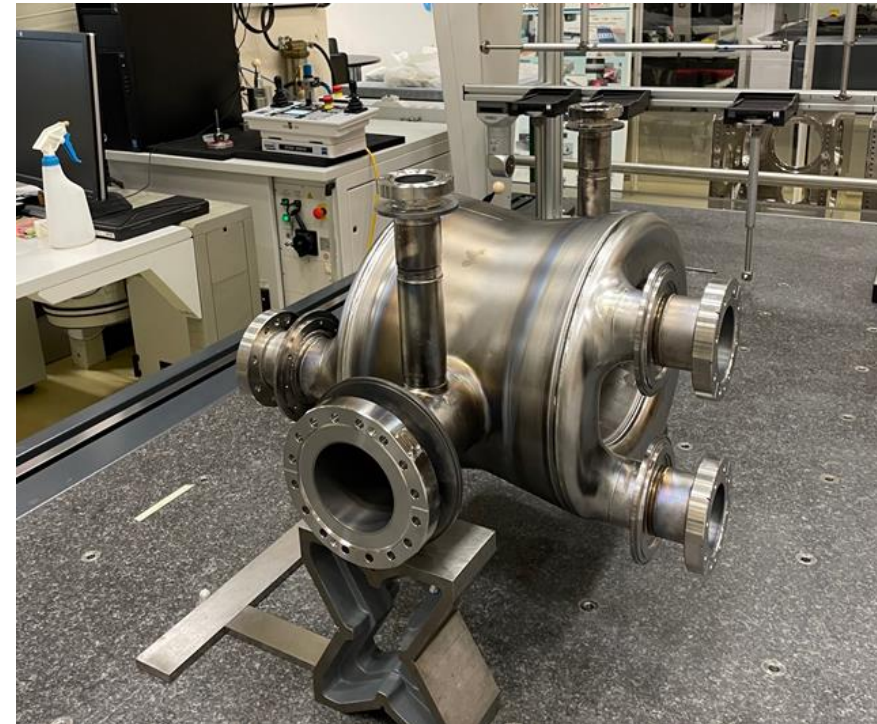
# RI Series Bare Cavities

- Improvements from preseries were implemented in drawings and fabrication procedures.
- Fabrication started and RI is progressing well.
- Series bare cavities (x6) will arrive CERN between May and December 2023,(one cavity every 6 weeks).
- Incoming inspection including cold RF test at CERN (SM18) of each bare cavity in 2 months is needed to keep the planning.



# CERN DQW Series Bare Cavities

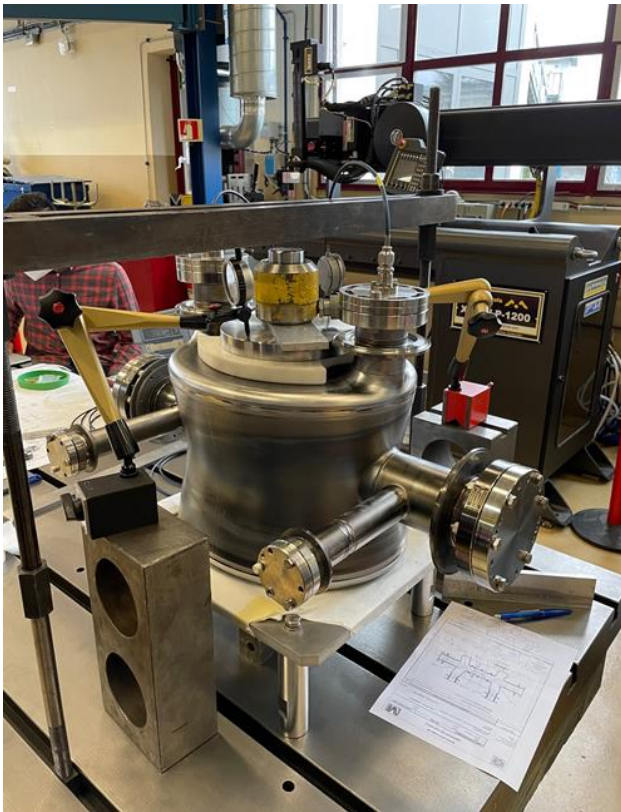
- Managed as a “standard priority” job within CERN main workshop activities :14 months to 1st cavity assembled, +2 month for 2nd cavity.
- Full traceability of materials, fabrication steps and QA/QC according to HL-LHC quality standards.





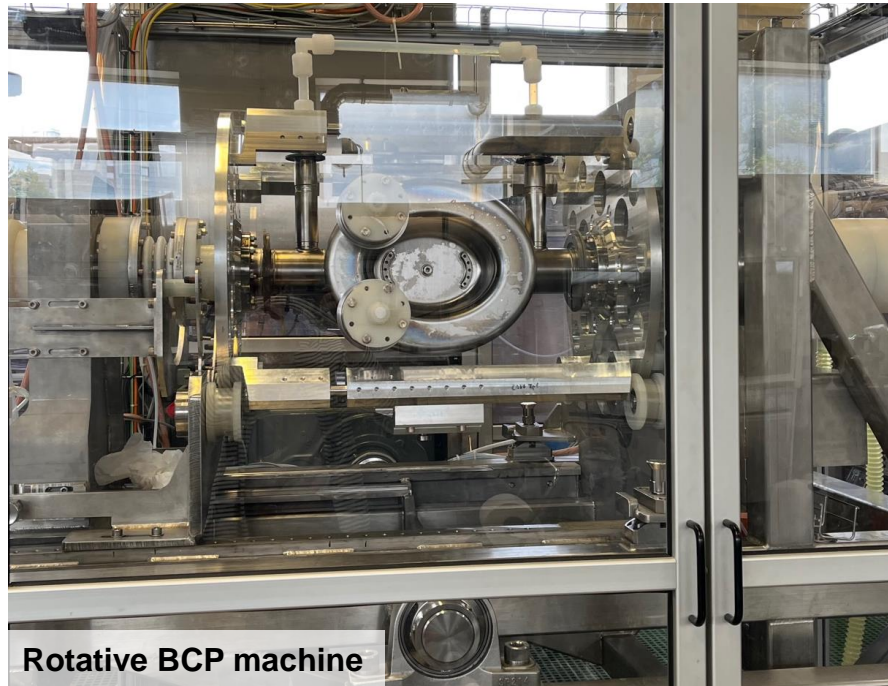
# CERN DQW Series Bare Cavities

- Frequency shift due to final welds required alternative tuning, which degraded position of the cavities' ports.
- Corrective actions already implemented (custom tank helium adaptive rings) with frequency checks during jacketing.



# CERN DQW Series Bare Cavities

- Cavity processing:
  - BCP (150-200  $\mu\text{m}$ ) at CERN.
  - HT at RI.
  - HPR, Clean room assembly, and cold RF test at CERN (SM18).
- Cold RF test **See talk K. Turaj**
  - CERN DQW-2, excellent results  $\longrightarrow$  Helium tank assembly started
  - CERN DQW-1, high field emission at low voltage. Cavity submitted to additional light BCP and will be re-tested next week

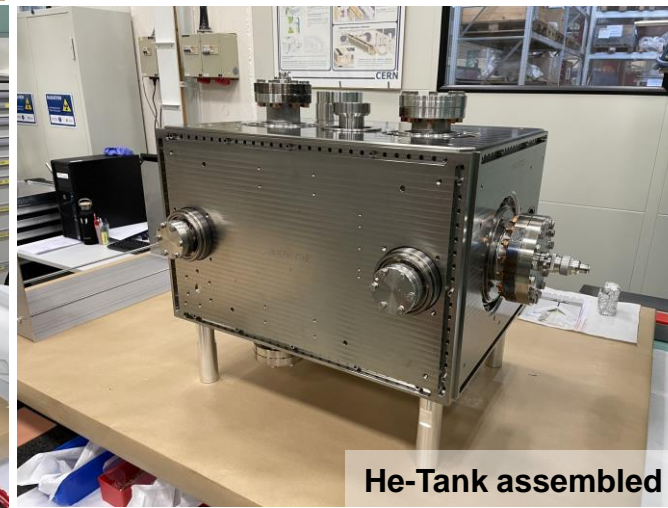
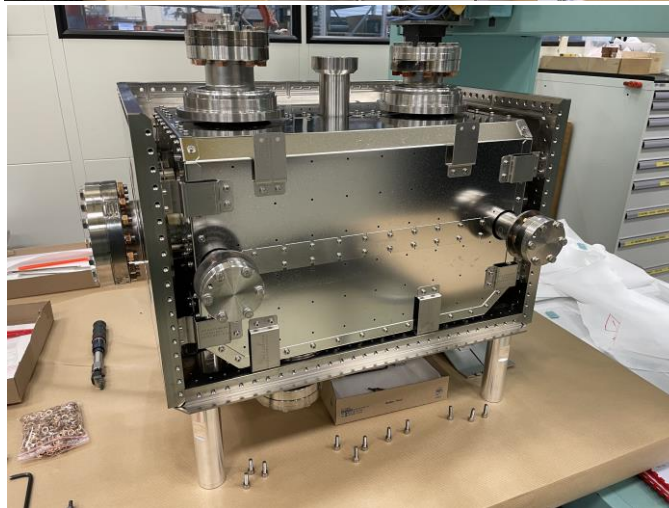
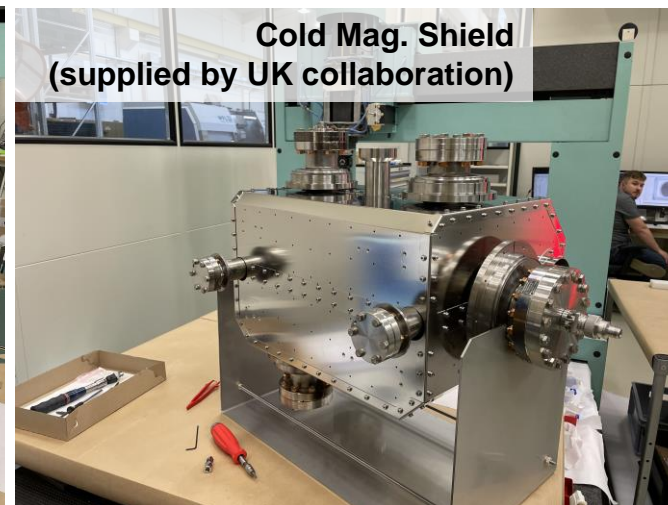
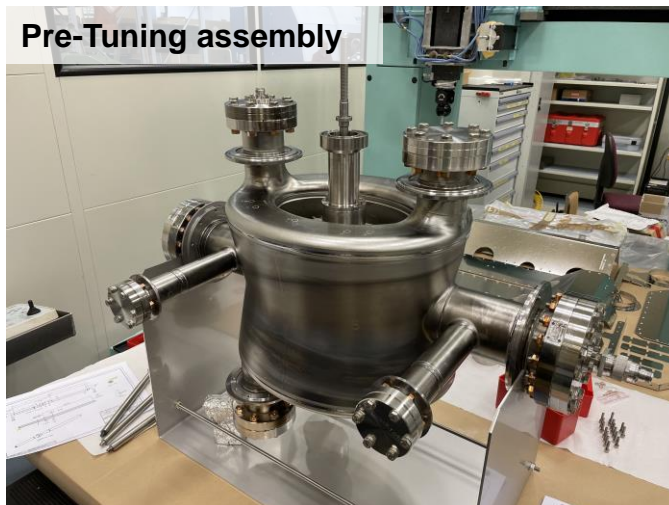


Rotative BCP machine



# CERN DQW Jacketed Cavities

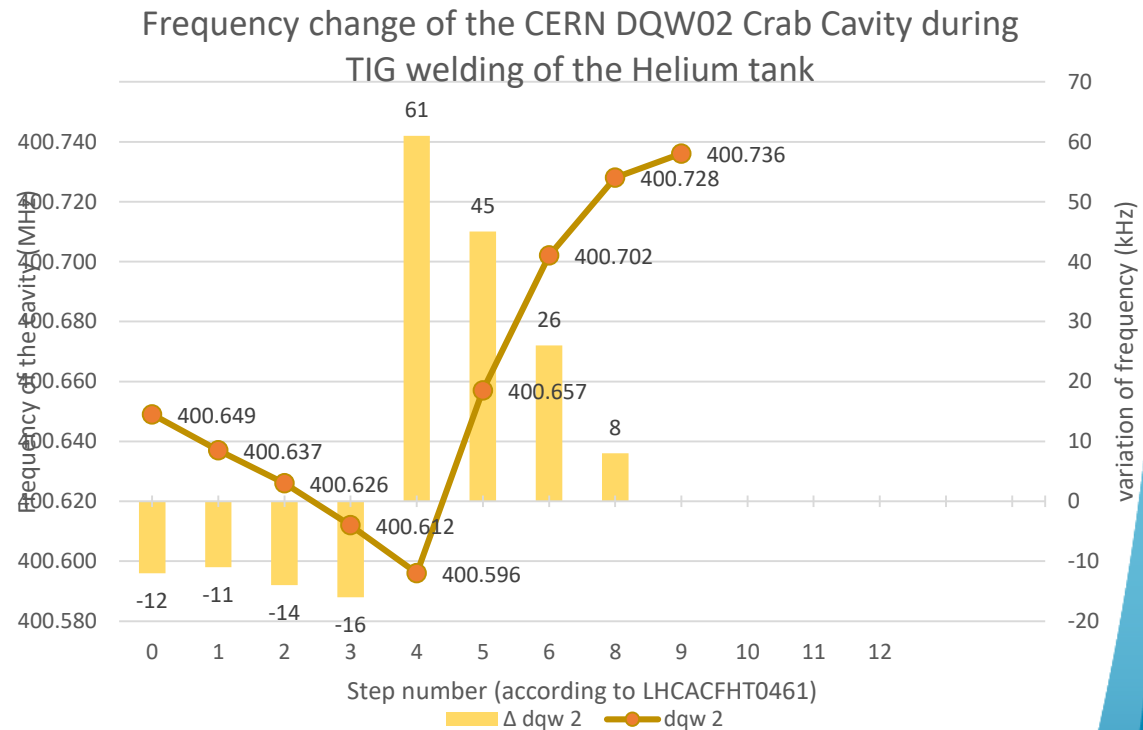
- CERN DQW JC-2
  - Cold MS + Helium tank assembly (bolted). TIG welding in glove box ongoing
  - Next steps: leak checks and pressure tests, final metrology/fiducialization



# CERN DQW Jacketed Cavities

CERN DQW JC-2: Frequency measurements during helium tank assembly. So far, frequency shifts are similar to SPS DQW cavities.

TIG welding He-Tank



# Conclusions

- **RI preseries** bare cavities were delivered to CERN and met the requirements.
- Helium tank assembly of **RI preseries** cavities is on going:
  - Main documents were released.
  - Machining of singles components started.
  - Orders of subcomponents were done.
  - Welding qualifications (WPQRs) ongoing.
- Expected delay for **RI preseries** jacketed cavities: Q1 2023
- Manufacturing documentation for **RI series** bare cavities were released and fabrication is progressing well.
- Expected delivery for **RI series** bare cavities (x6): from Q2 to Q4 2023 (one cavity every 6 weeks).
- Two CERN **series** cavities were fabricated to ease RI planning and keep the planning with UK collaboration.