CERN Xband Acc. structure update

CLIC miniweek 2023

Pedro Morales Sánchez

12/12/2023

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- **SmartCell CLIC-G Structure**
  - Structure design
  - Brazing mock-up
  - HOM damping load

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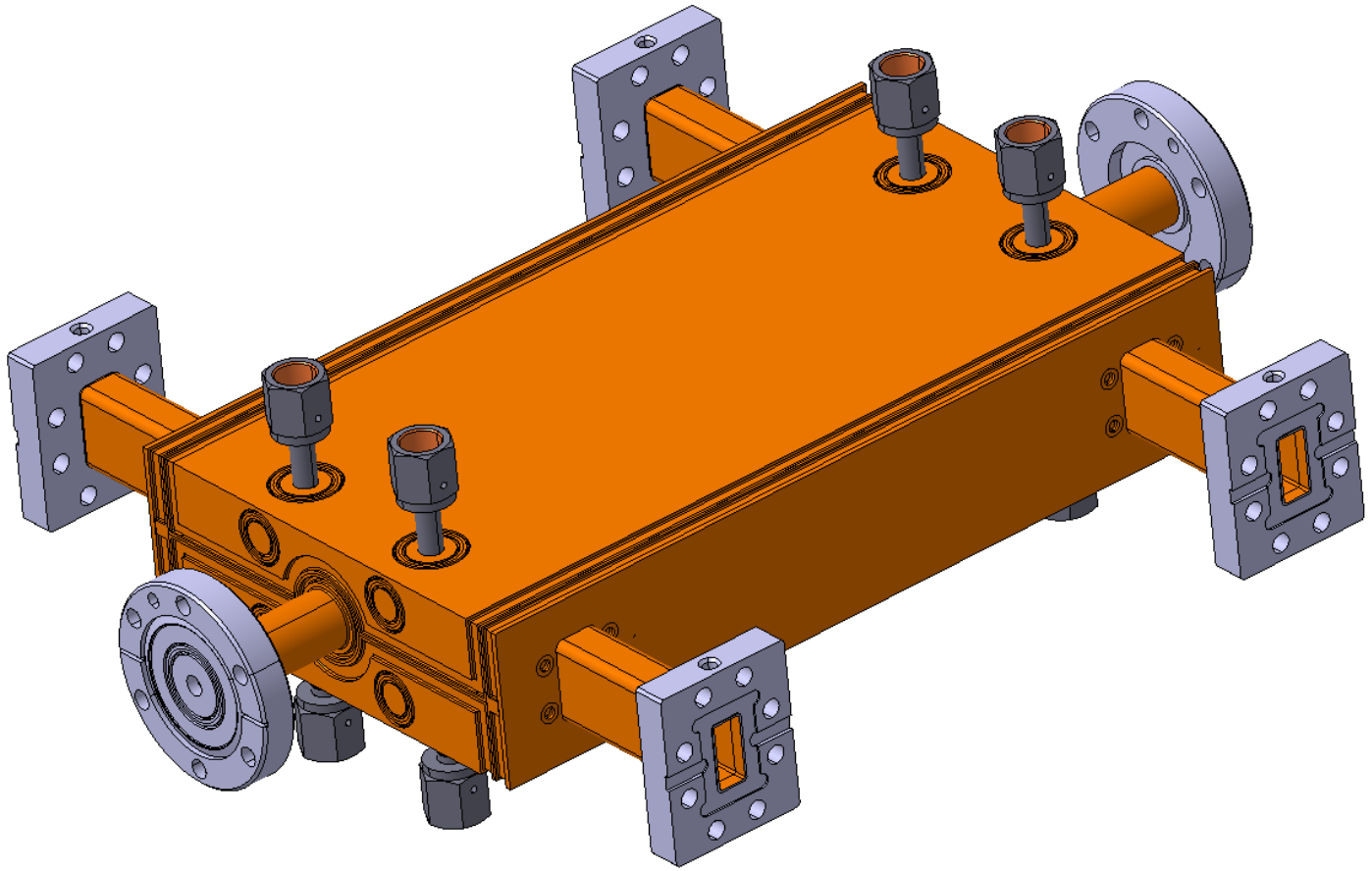
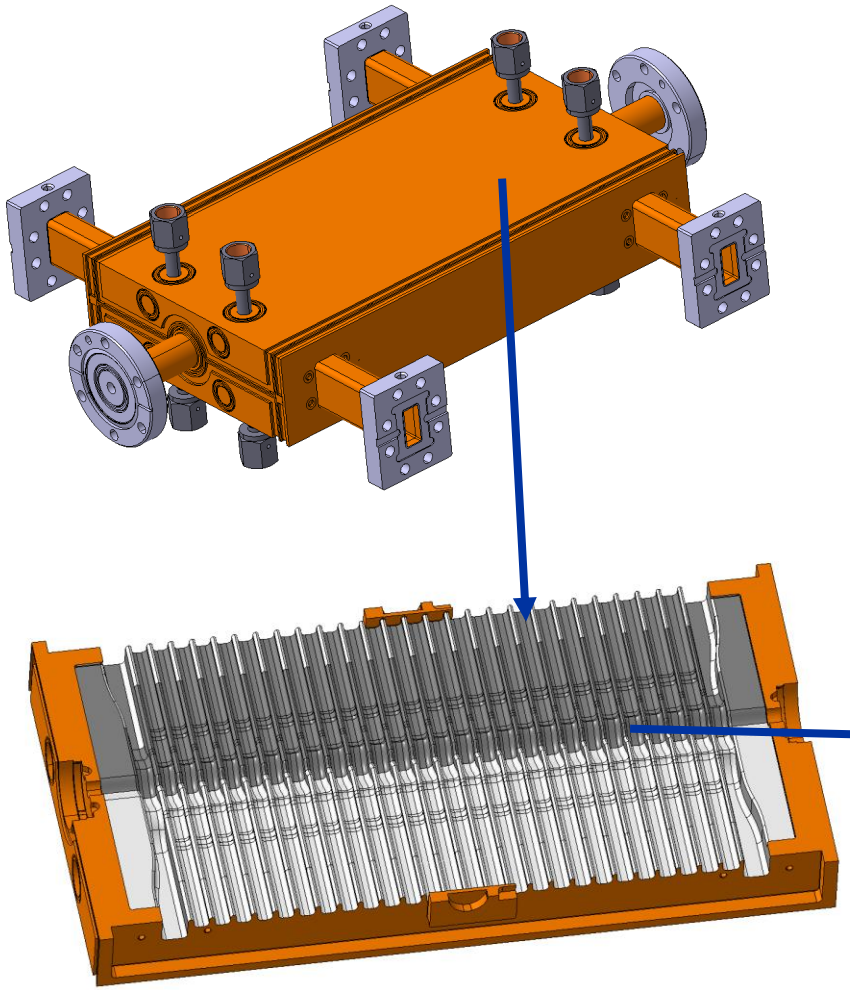
Halves TD26 structure - Short sum-up



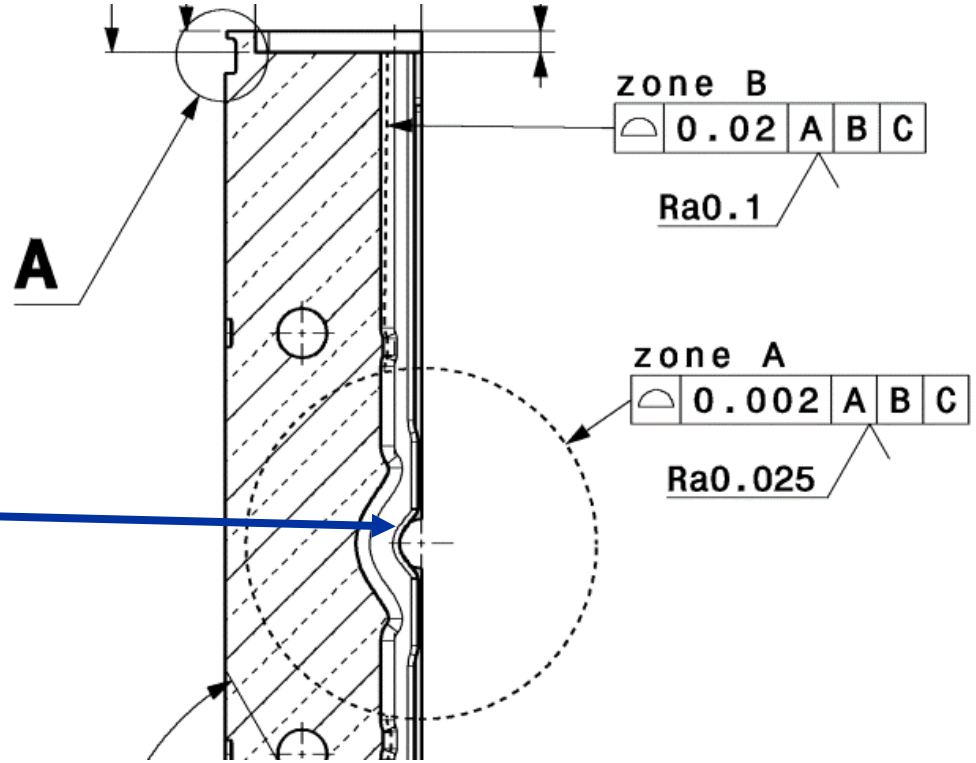
The main advantage of this halves accelerating machine is that it is made of **hard copper** which is better for the conditioning of the structure.
Apart from that, it has fewer parts to handle.

Designed by Anastasiya Magazinik CLIACTD260018

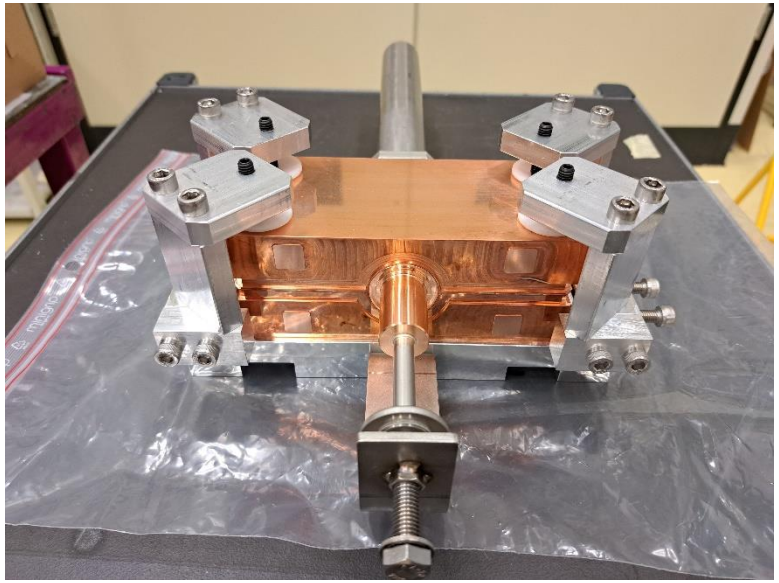
Halves TD26 structure - Short sum-up



We are trying to achieve a cutting-edge Ultra Precision machining to get tolerances on the range of 1-2um on the iris area with 25nm in roughness.



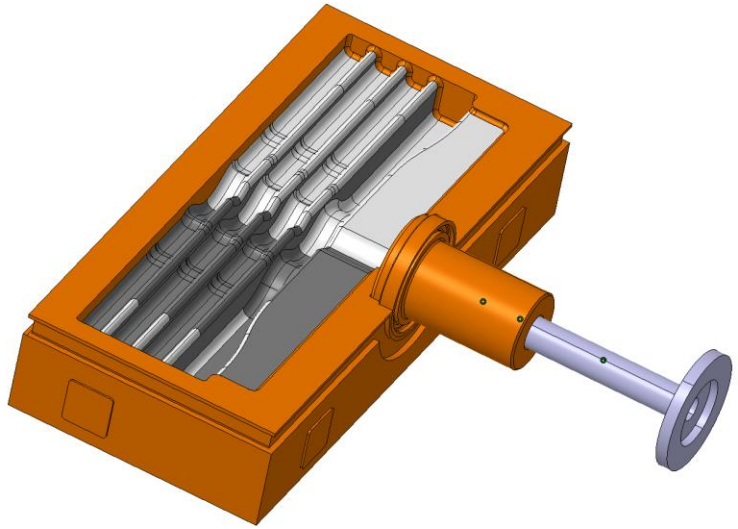
Halves TD26 structure - Short sum-up



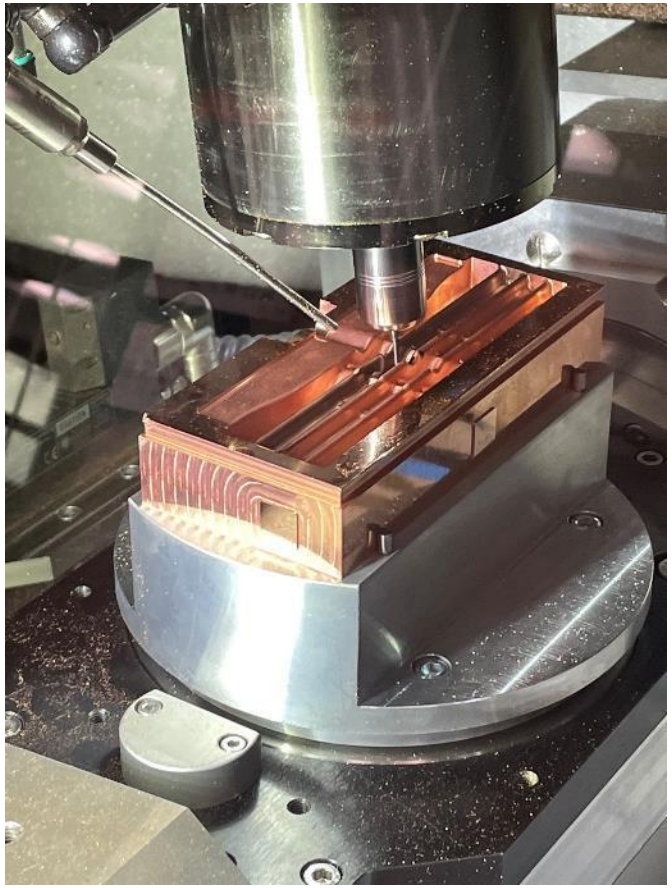
- Reduced dimension mock-up to test the feasibility of those tolerances by milling.
- Also, we want to test the welding/assembly techniques for the final tolerances.

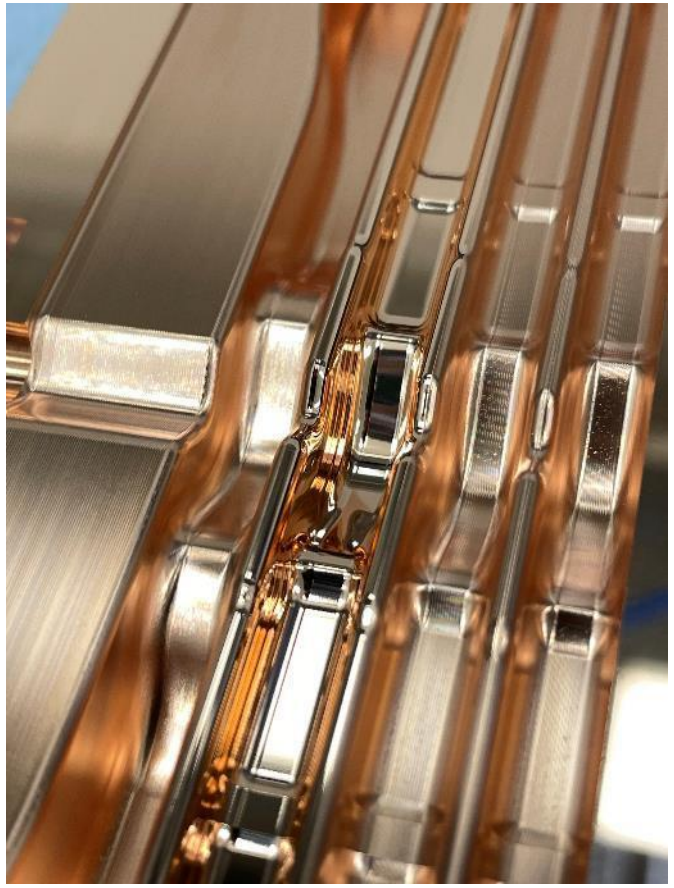
The part is significantly shorter than the final TD26 with only 3 out of 26 cells.

It gives us a lot of information on the machining strategy and if we need to focus on changing/re-think any area of the final design.



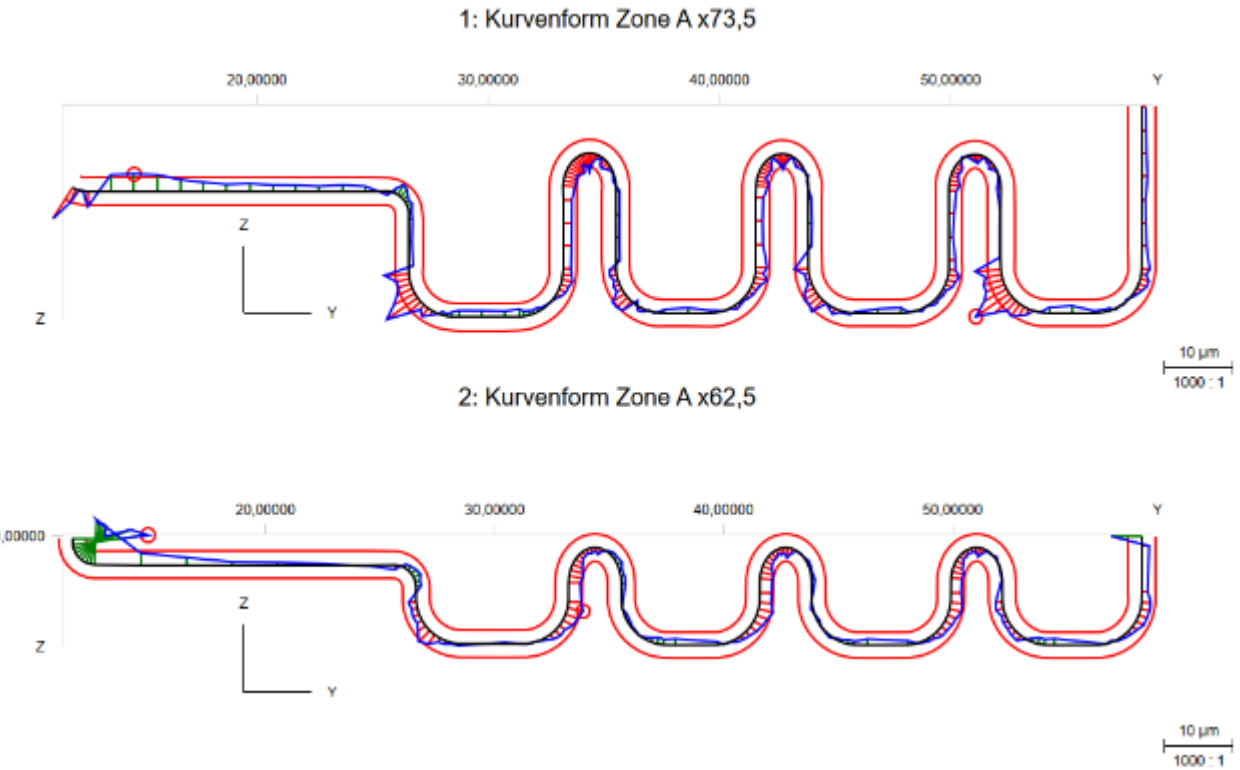
Halves TD26 structure – Diamond machining



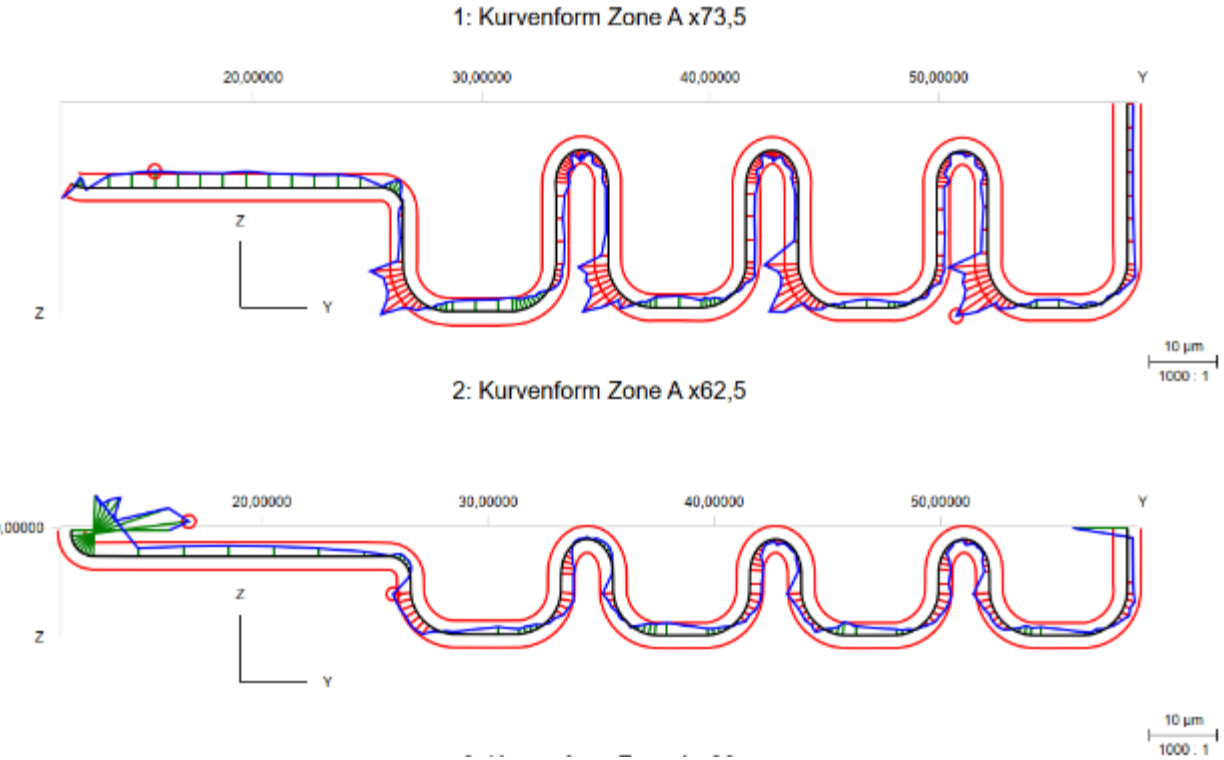


Halves TD26 structure – Repeatability

T3



T4

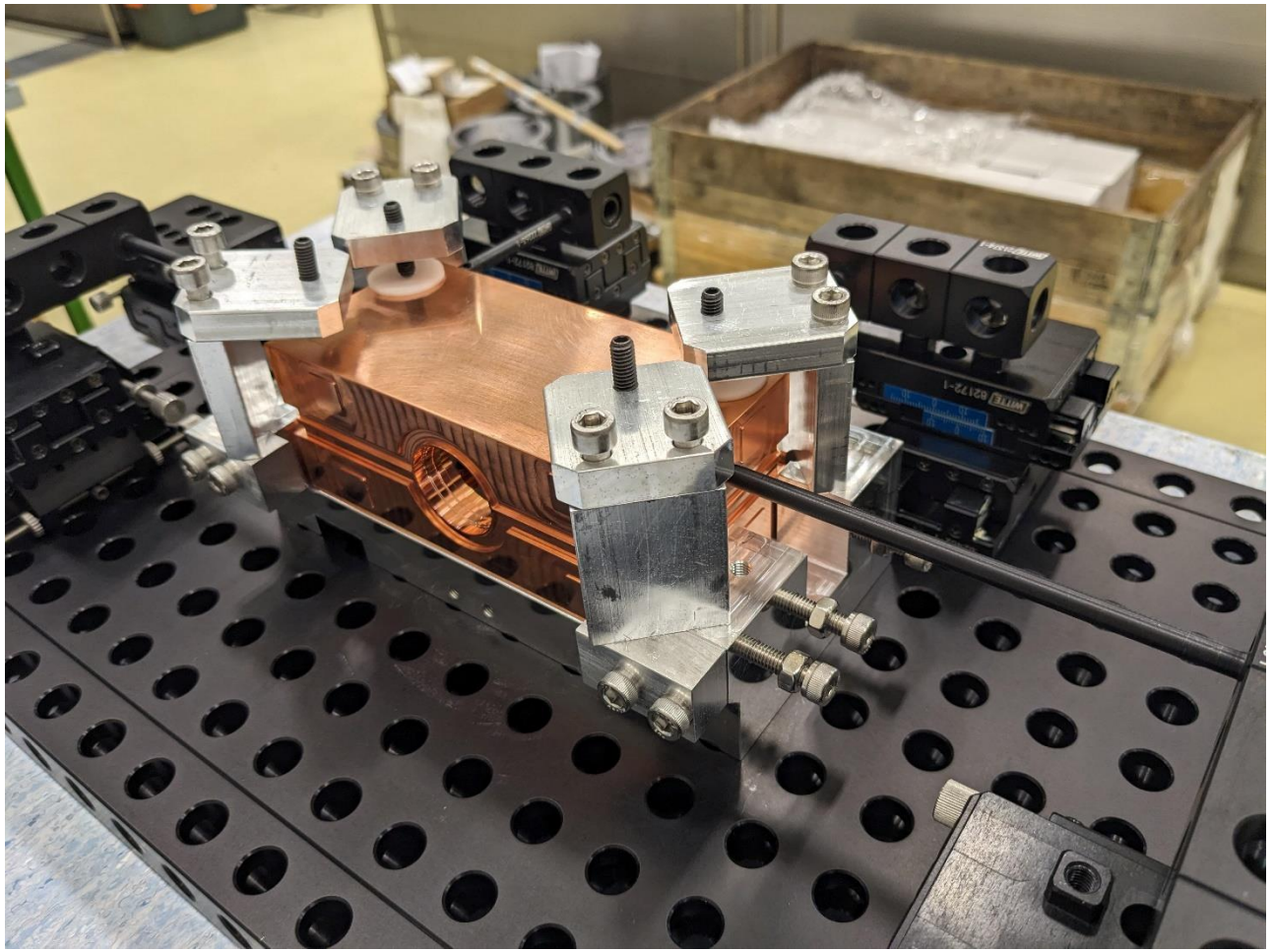


Halves TD26 structure - Assembly

For the assembly, a special tooling was designed with two main purposes:

One is to hold everything in place during the assembly process. The second is to be able to adjust everything with easy access for different welding iterations.

Alignment check before EBW: 3um



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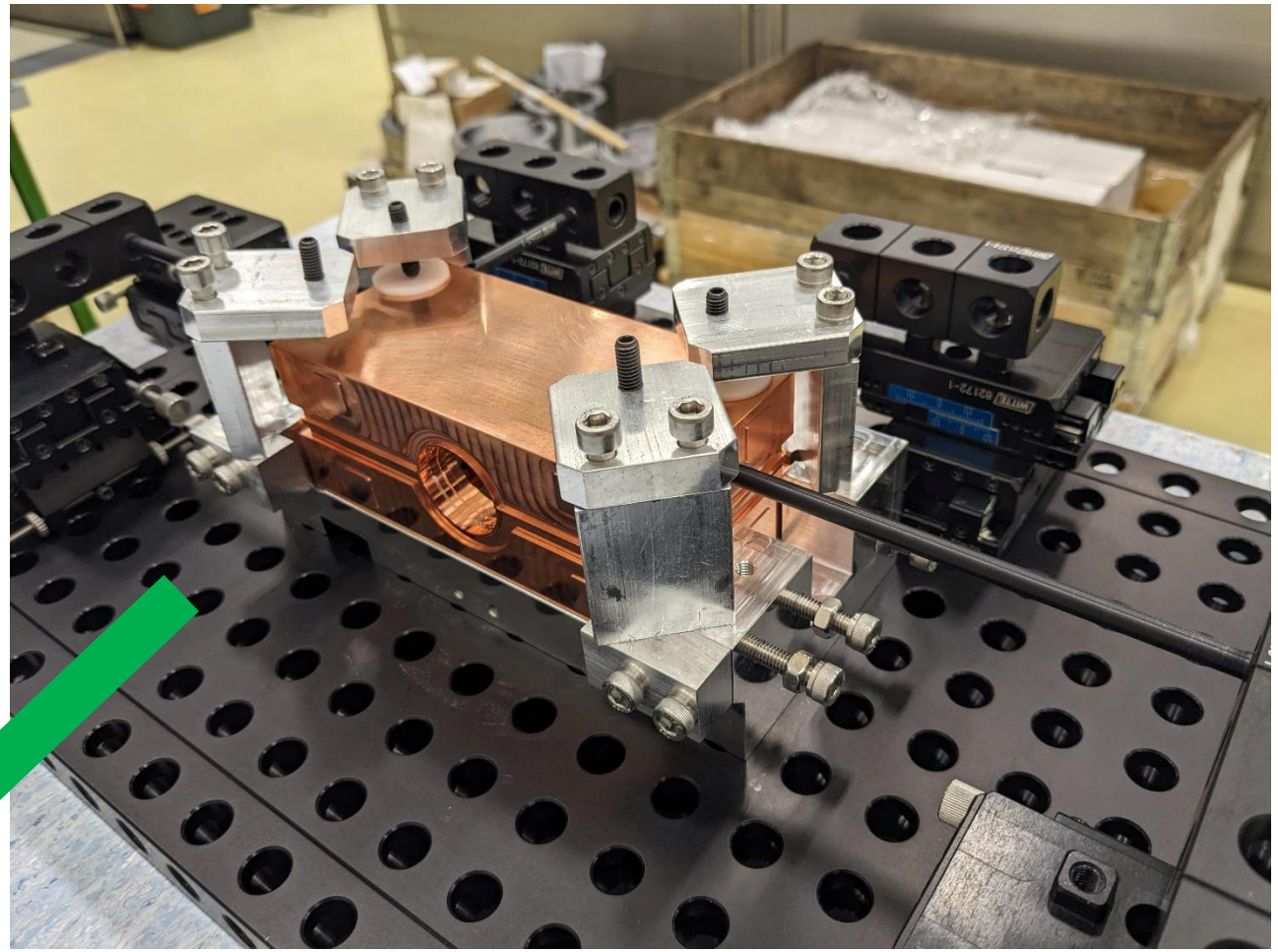
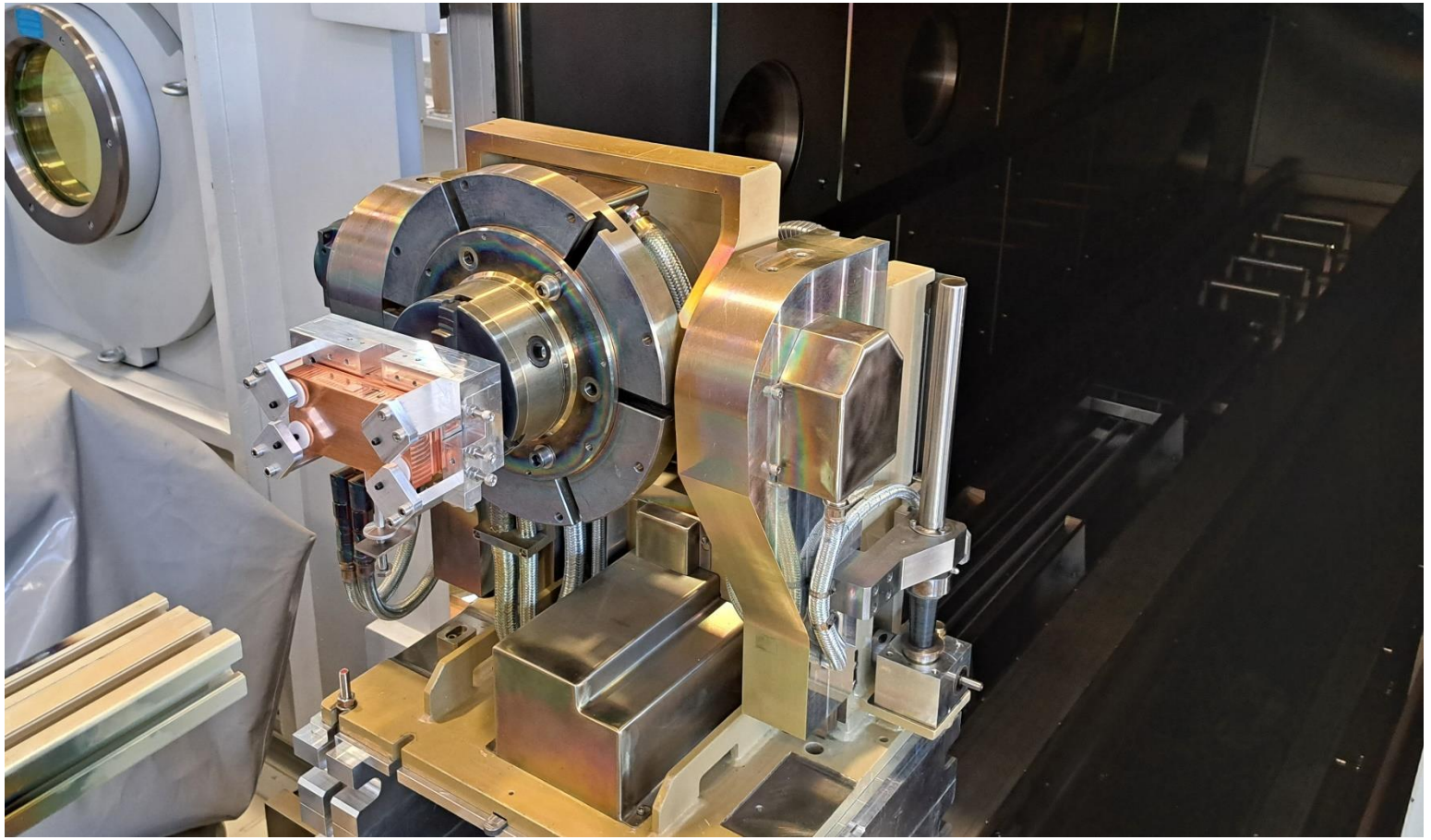


Halves TD26 structure - Assembly

Welding procedure:

Leak proof after welding OK



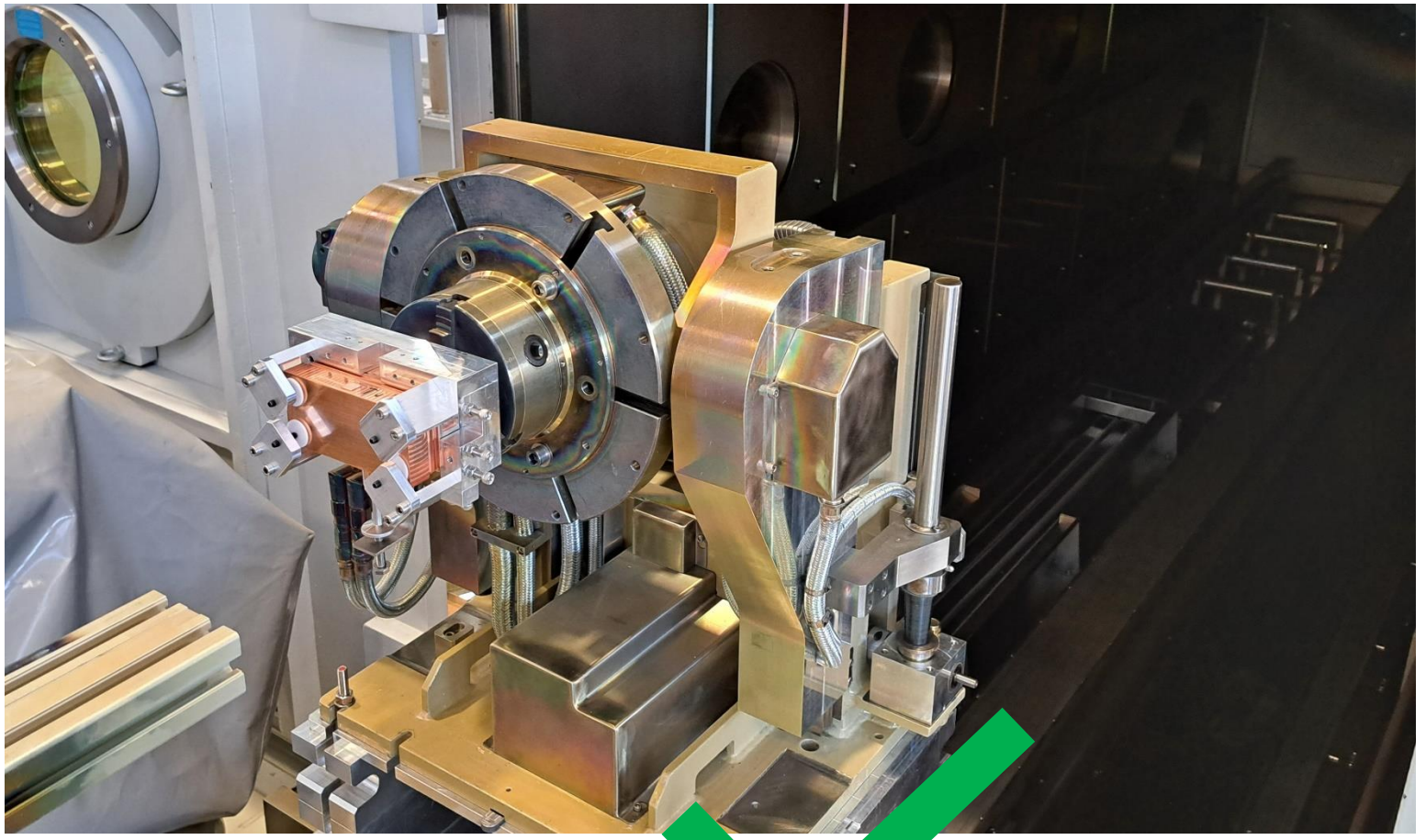
Thanks, Sergio Gonzalez for the tests and pictures

Alignment check after EBW: 4.5um

Halves TD26 structure - Assembly

Welding procedure:

Leak proof after welding OK



Th[illegible]s, Serg[illegible]onzalez for the tests and pictures

Alignment check after EBW: 4.5um

Halves TD26 structure – Lessons learnt

- The machining of this small mock-up has been a great exercise to test the capabilities of the industry on this kind of complex machining.
- With the current state of the art in UP-Machining a larger structure will require some attention and maybe some re-design since the parts will be heavier and longer.
- There is a risk intrinsic to machining such a large part. If you make a mistake with one part, you loose half of the structure.
- From the point of view of the assembly process, the method has been validated and could be implemented in a longer structure.

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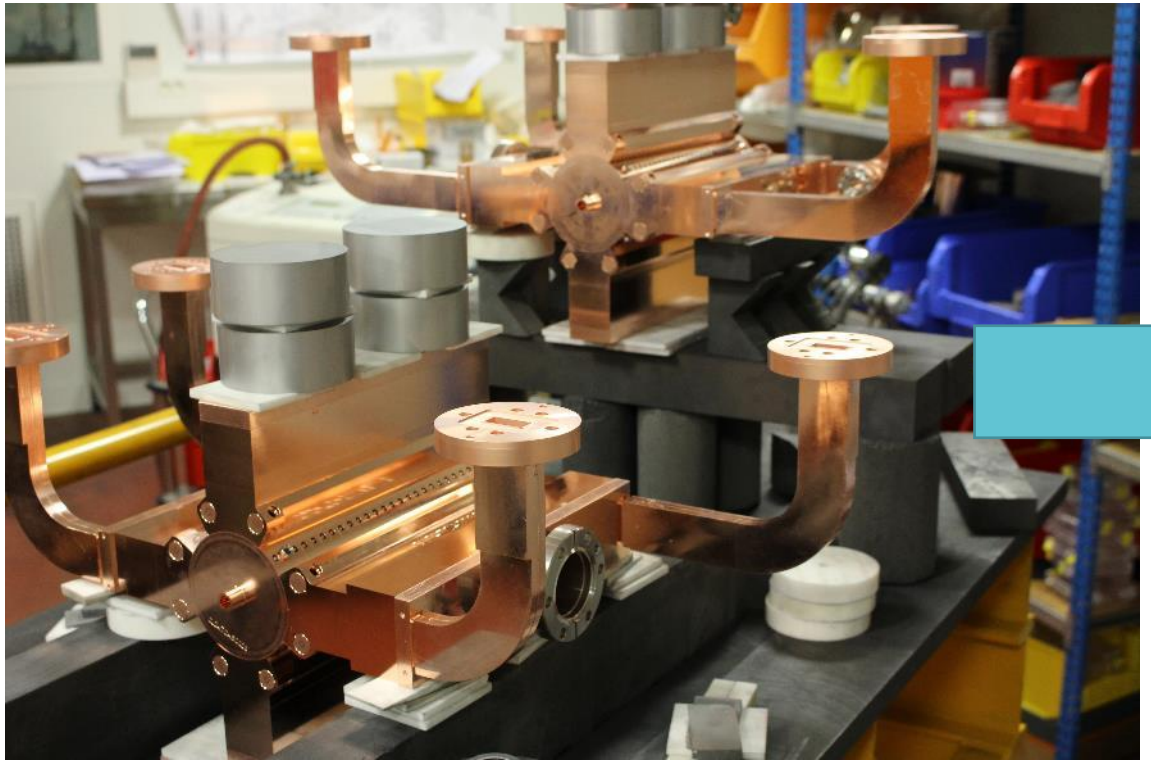
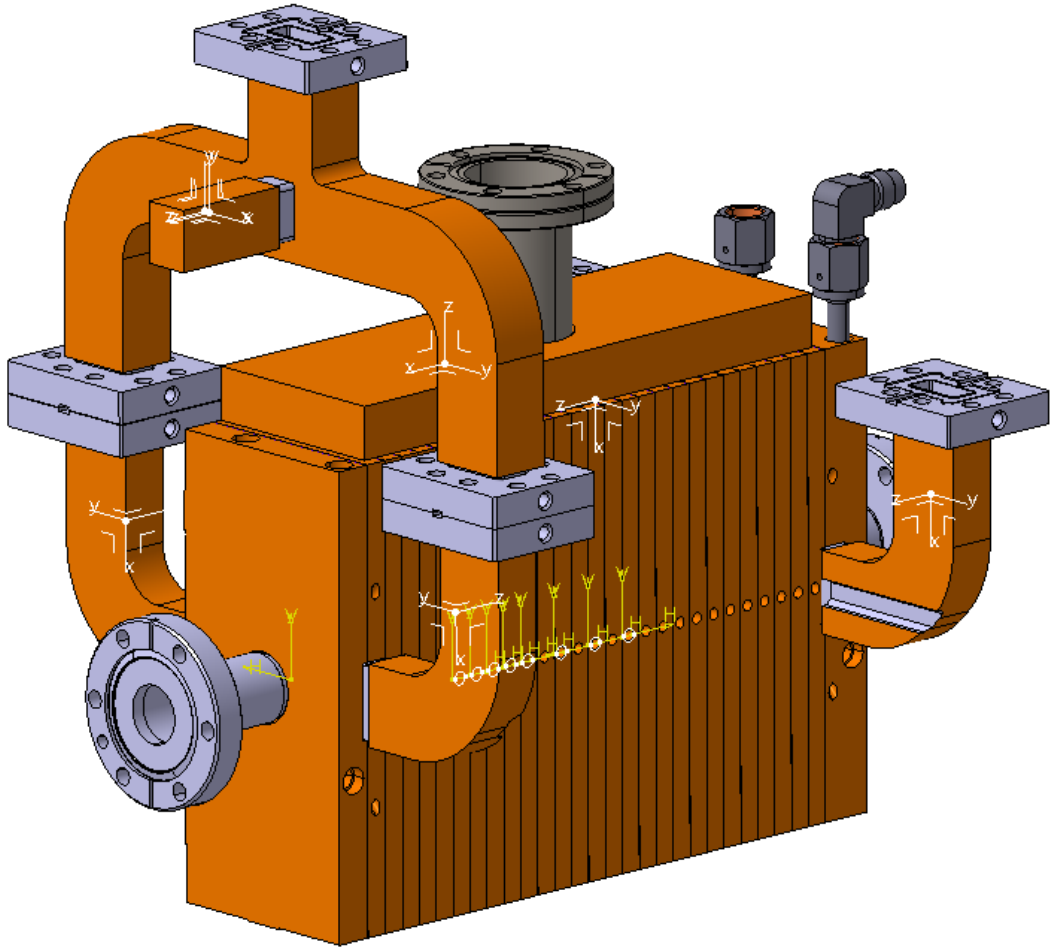
  - HOM damping load

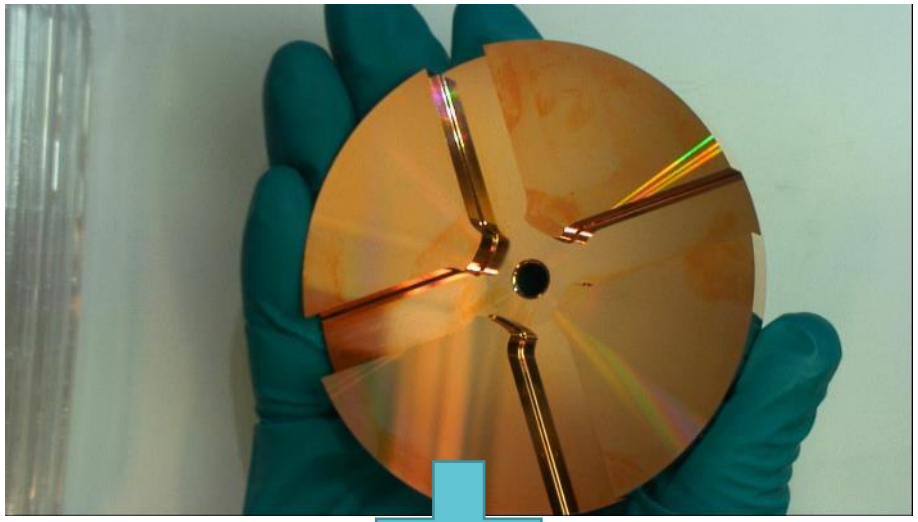
Smartcell - Structure design





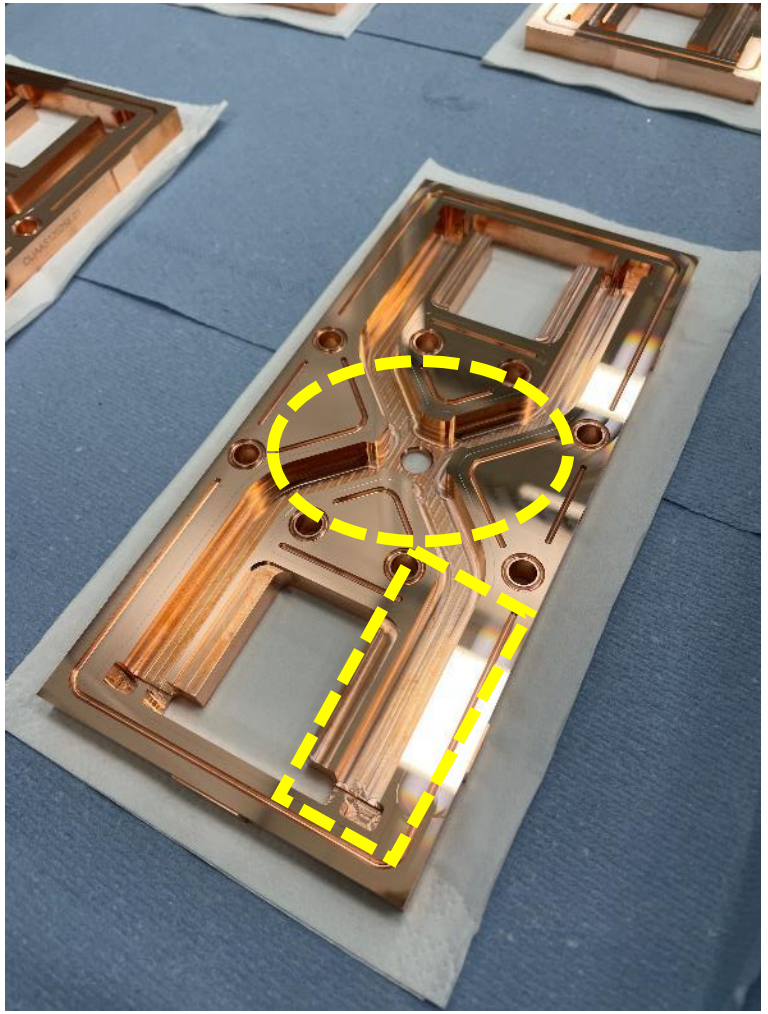
Prior to this new design, many steps for the full structure

Structure design

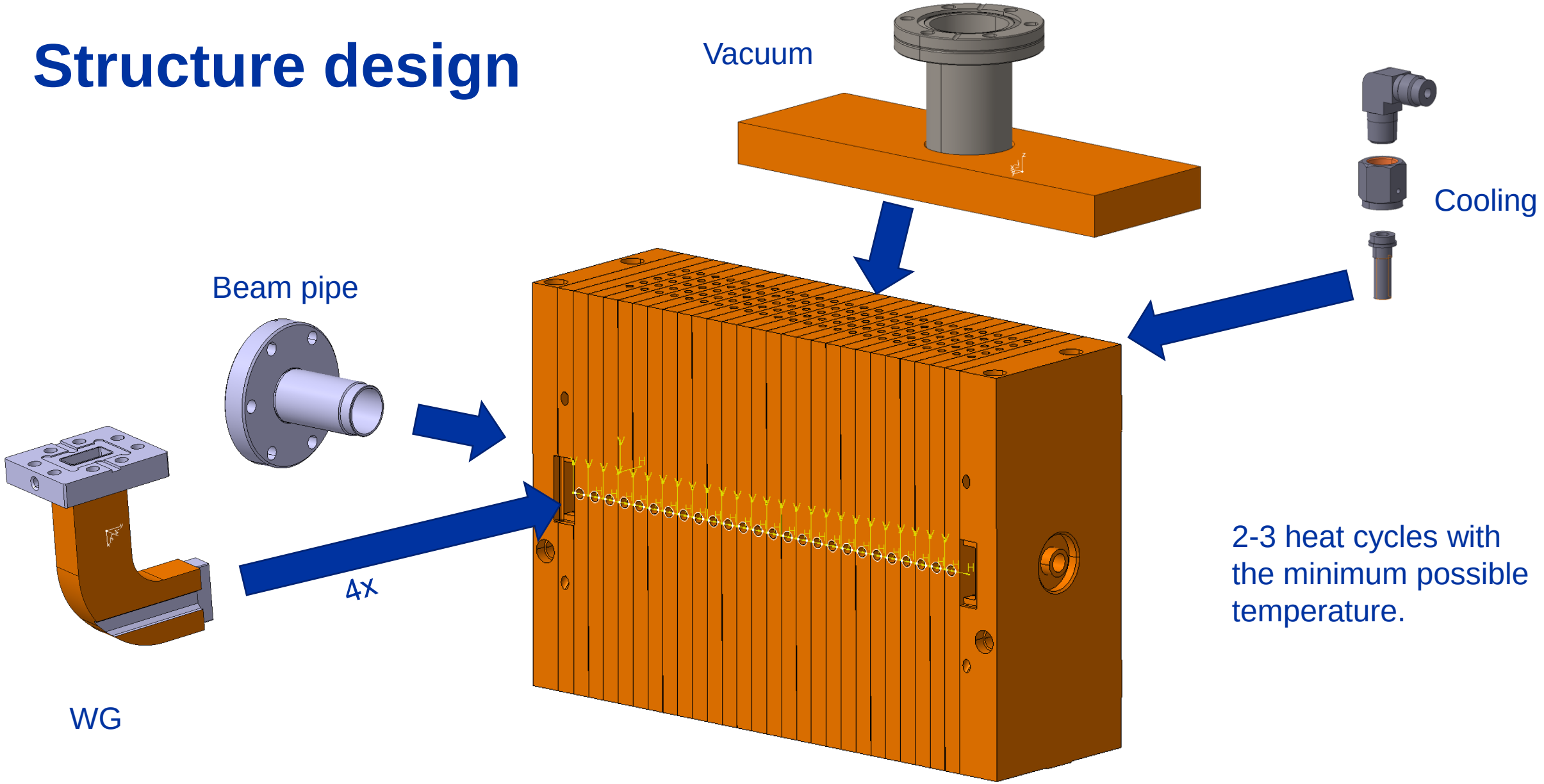


There are two main reasons for this redesign. The transition from bonding to bonding + brazing and avoiding many parts and steps to get the full structure

The new design integrates the RF area, cooling circuits, HOM loads and part of the vacuum system in one part

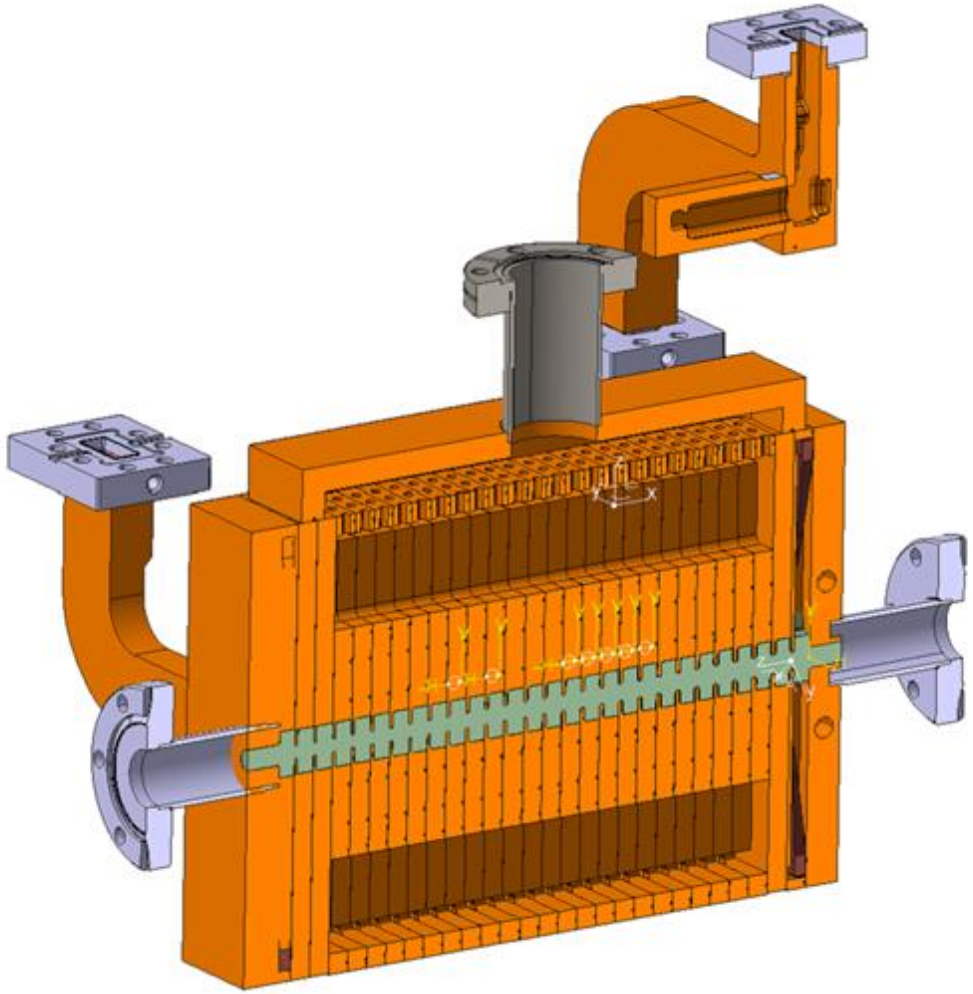


Structure design

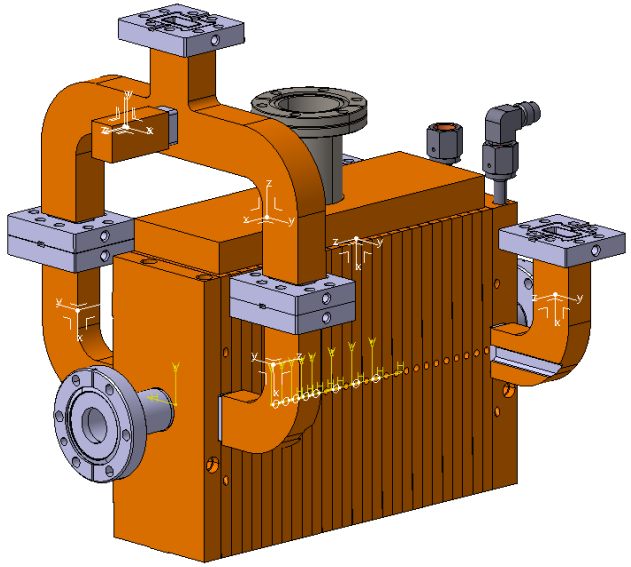


2-3 heat cycles with the minimum possible temperature.

Structure design



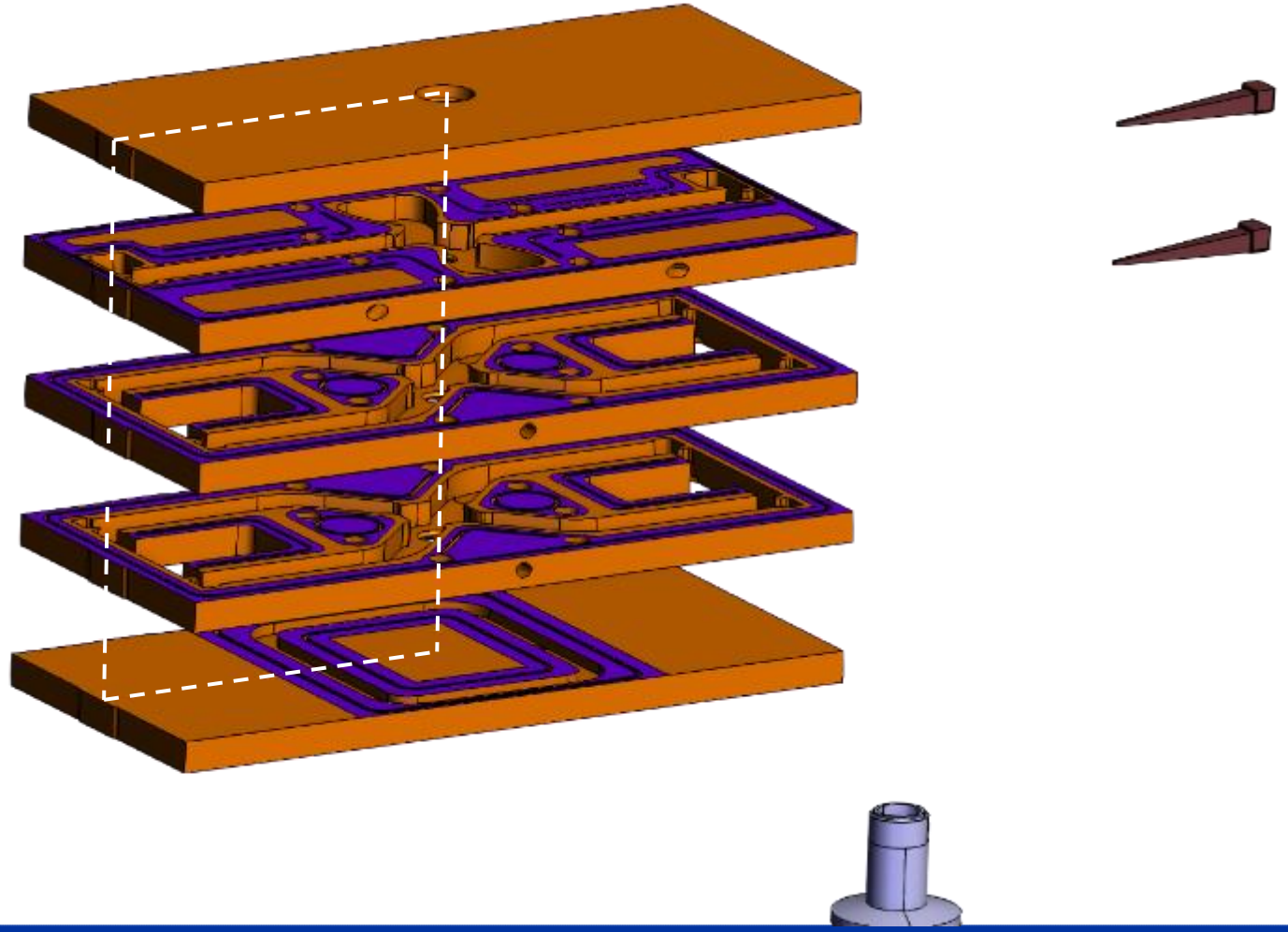
- The design of the RF area and peripherals are finished.
- Some areas on the interfaces and assembly procedures are still pending validation after mock-up brazing test



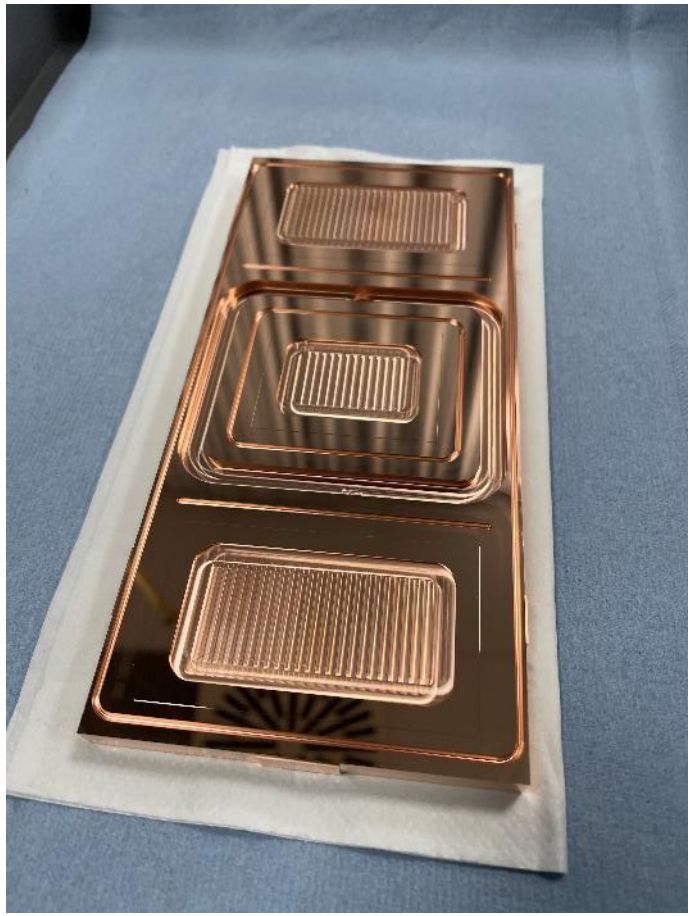
Brazing Mock-up

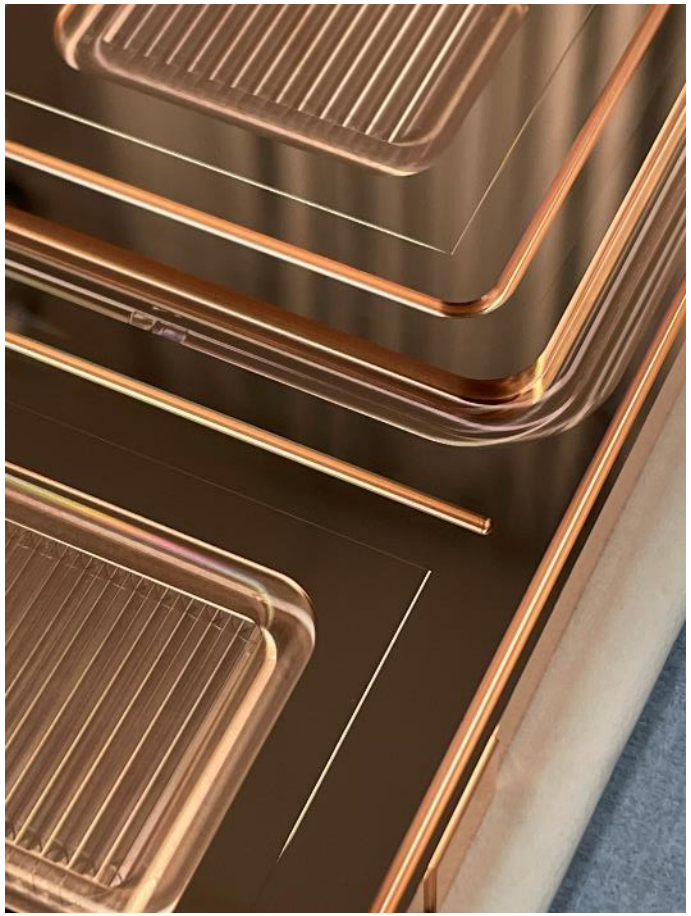
Previous to this, we already did a mock-up, using precision machining.
More details about it at this previous meeting: https://indi.to/zB6GH

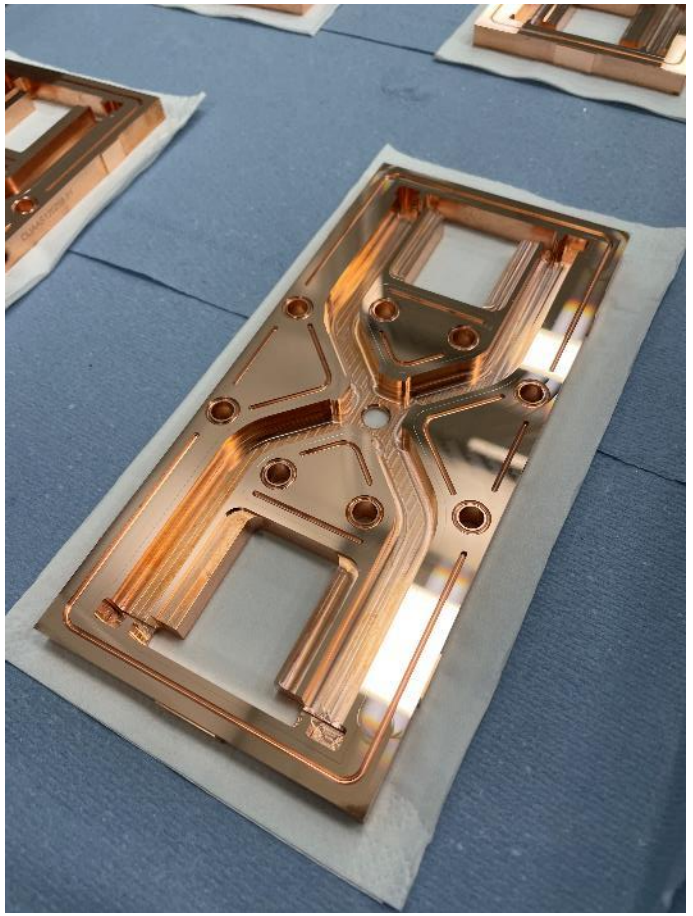
This mock-up was produced by UP-Machining. With this production we aim to check the bonding starting at a very low temperature cycle, the layout of the brazing channels and the overall feasibility of the whole part.



Brazing Mock-up





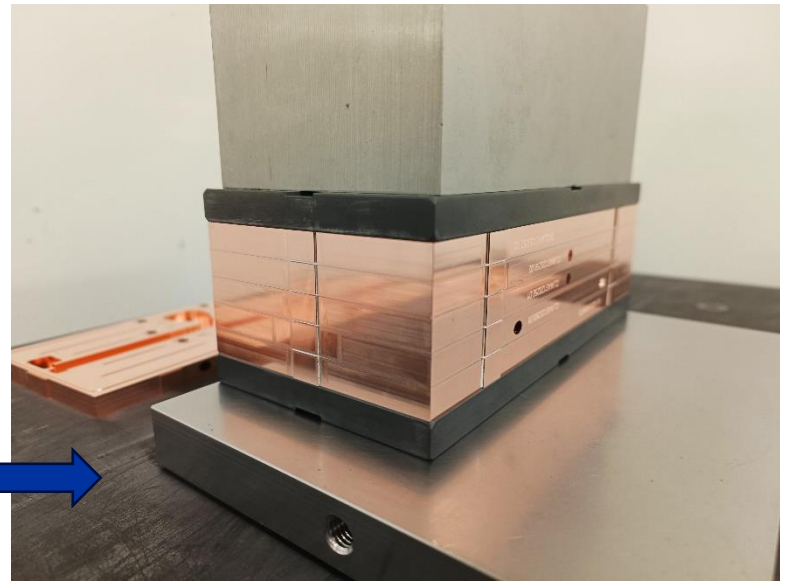


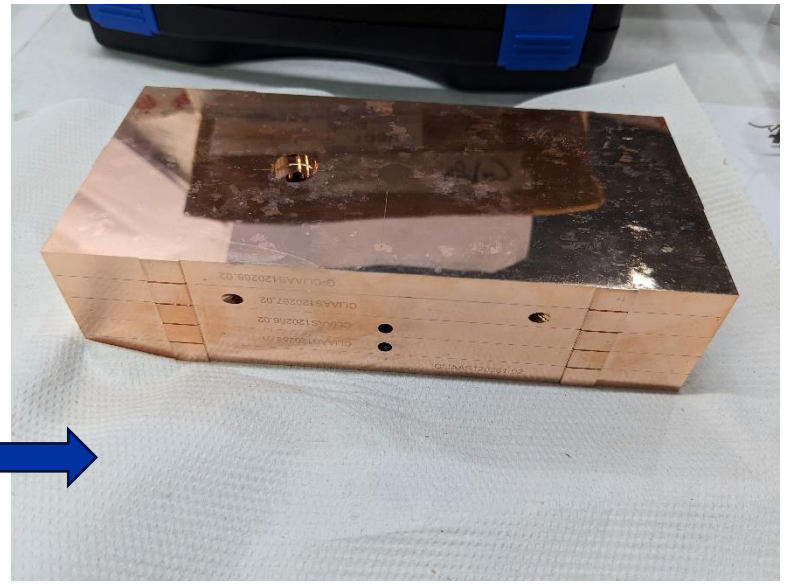
- Pre-machining done at CERN by MME, metrology OK.
- All cells with UP-Machining at external company.

Brazing Mock-up

4 different Brazing tests

- Silver base
  - In-house
  - External
- Gold base
  - In-house
  - External



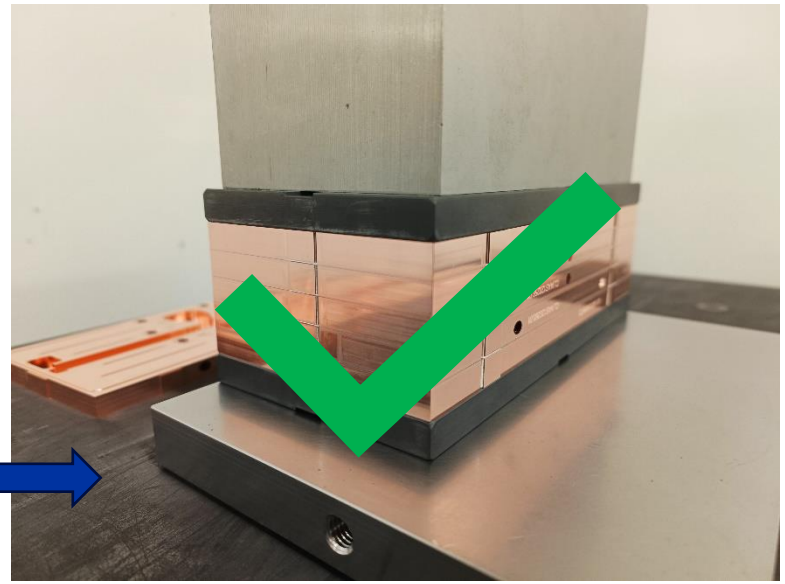


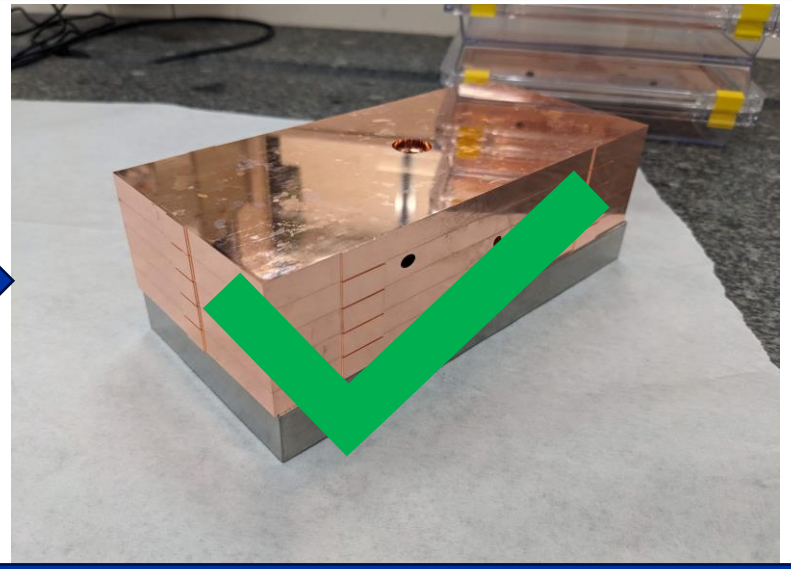
Brazing Mock-up

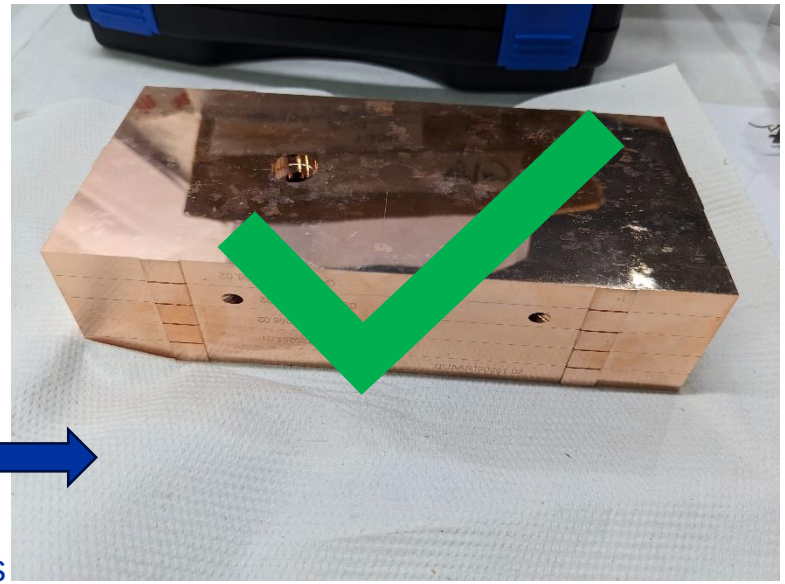
Leak check

4 different Brazing tests

- Silver base
  - In-house
  - External
- Gold base
  - In-house
  - External







Thanks, Sergio Gonzalez for the tests and pictures

Brazing Mock-up

Alignment

4 different tests

- Silver base
  - In-house → 
    Pads covered in BFM
  - External →

Alignment (um)	Before brazing	After brazing
Pad 1	3	5
Pad 2	1	-
Pad 3	2	5

- Gold base
  - In-house →

Alignment (um)	Before brazing	After brazing
Pad 1	4	15
Pad 2	2	18
Pad 3	1	14

  - External →

Alignment (um)	Before brazing	After brazing
Pad 1	4	9
Pad 2	3	5
Pad 3	3	7

Brazing Mock-up

Alignment

4 different tests

- Silver base
  - In-house → 
    Pads covered in BFM
  - External →

Alignment (um)	Before brazing	After brazing
Pad 1	3	5
Pad 2	1	-
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Pad 1	4	15
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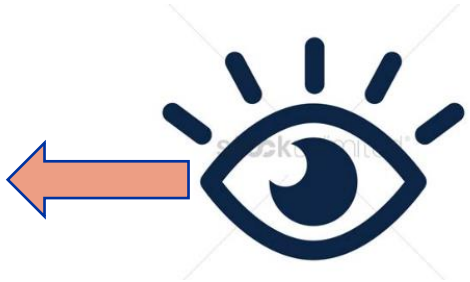
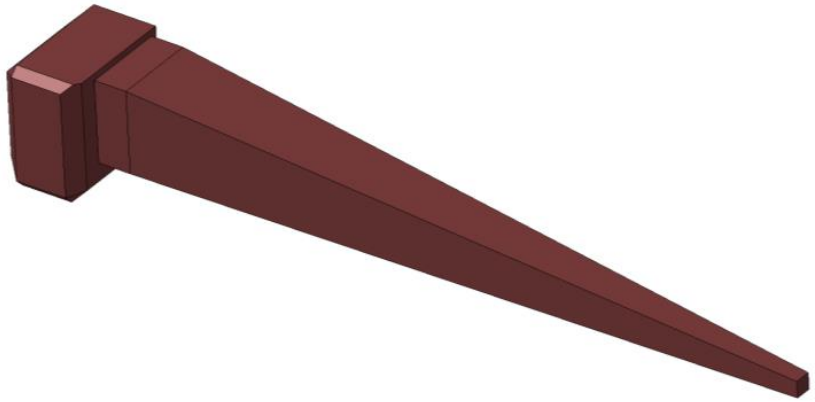


  - External →

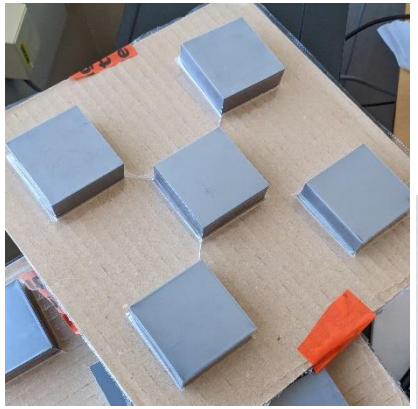
Alignment (um)	Before brazing	After brazing
Pad 1	4	9
Pad 2	3	5
Pad 3	3	7

HOM damping load



"Material for the loads should be whithin these ranges: have ε' in the range of 11-14 and tanδ > 0.15"

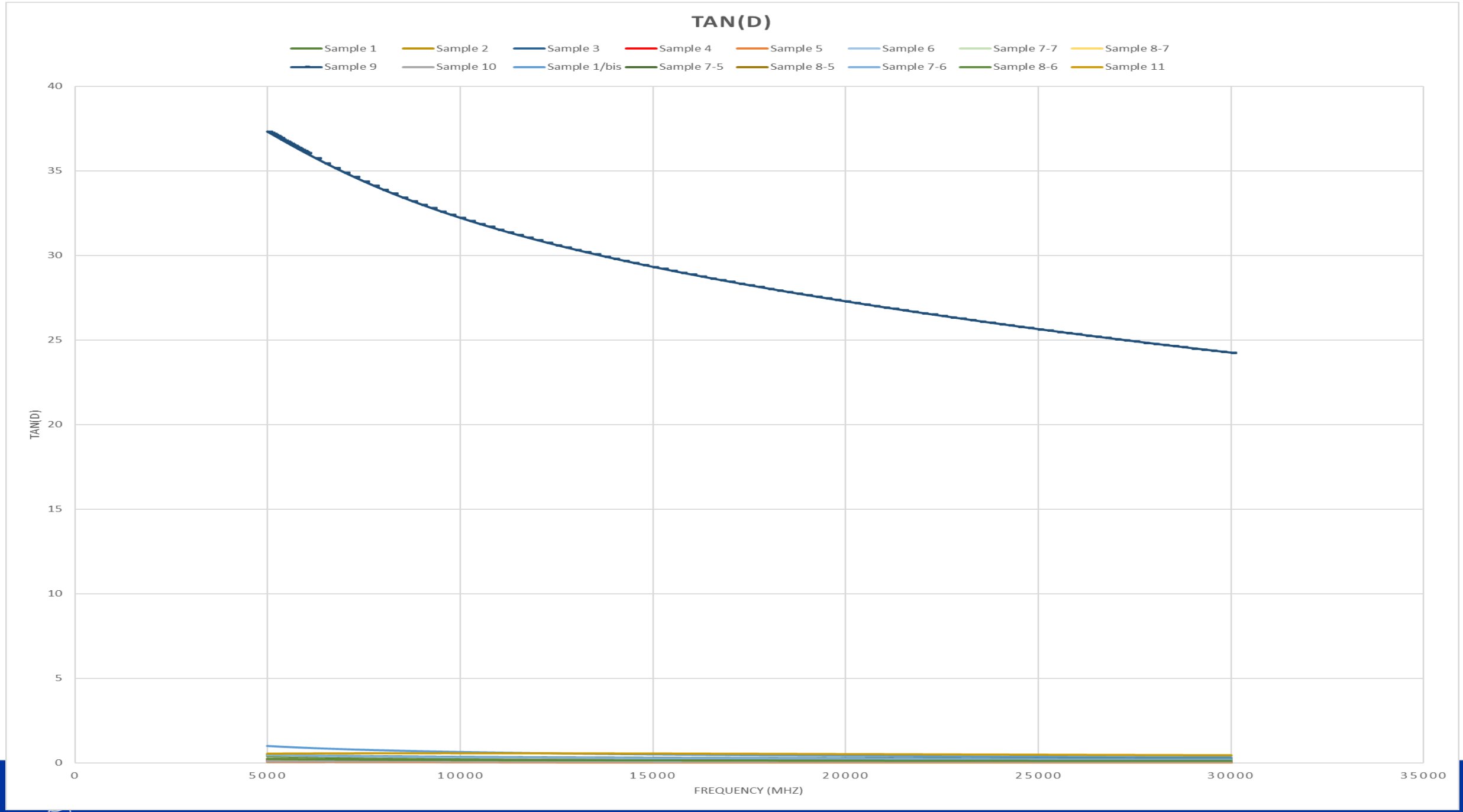
Reference

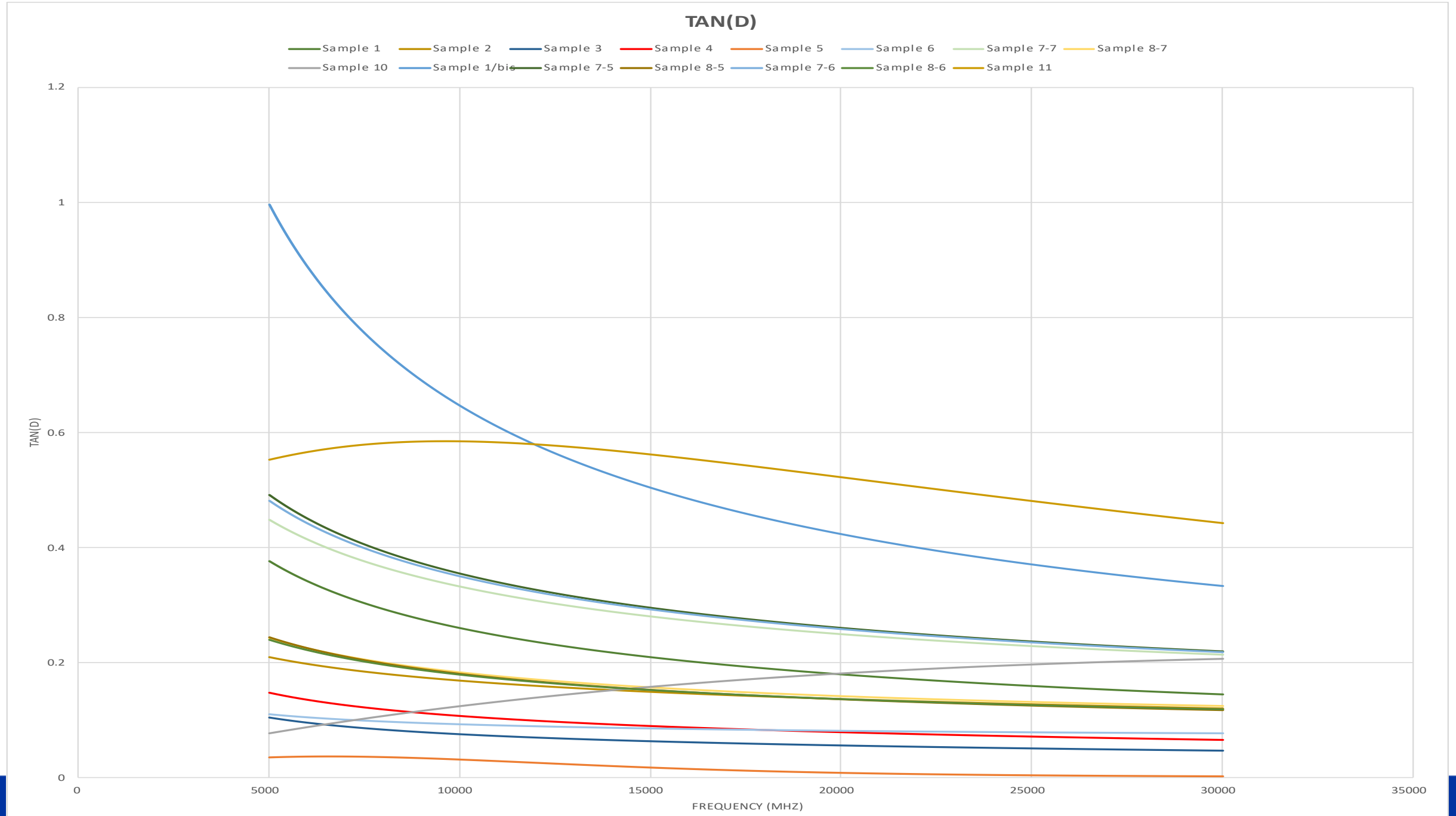


DAK-TL2

A campaign with 7 different suppliers was launched, considering their proposal for this use.

The measurements were subcontracted to an external company but finally after verifying that the values could fluctuate from batch to batch on this material. CERN decided to acquire the machine they are using, to check the material upon reception by ourselves.


TAN(D)
Sample 1
Sample 2
Sample 3
Sample 4
Sample 5
Sample 6
Sample 7-7
Sample 8-7
Sample 9
Sample 10
Sample 1/bis
Sample 7-5
Sample 8-5
Sample 7-6
Sample 8-6
Sample 11
40
35
30
25
20
15
10
5
0
TAN(D)
0
5000
10000
15000
20000
25000
30000
35000
FREQUENCY (MHZ)


TAN(D)
Sample 1
Sample 2
Sample 3
Sample 4
Sample 5
Sample 6
Sample 7-7
Sample 8-7
Sample 10
Sample 1/bis
Sample 7-5
Sample 8-5
Sample 7-6
Sample 8-6
Sample 11
1.2
1
0.8
0.6
0.4
0.2
0
TAN(D)
0
5000
10000
15000
20000
25000
30000
35000
FREQUENCY (MHZ)

HOM damping load

Still tuning it to get accurate measurements and make a proper installation.

After measuring the samples, another company contacted us to participate in the study of the material characterization. Good news to have this feedback and interest from companies.

Thanks to Paz Alonso for making it works

Conclusions

- Halves need to be reviewed with the industry to find a solution for such a long part by milling procedure but ready to launch the full prototype. Good feedback from all stakeholders.
- Smartcell is closing the mock-up and study phase and preparing the ground to launch the first prototype by next year.
  - All the tooling was working properly and some of them were even better than expected.
  - We will need to pay attention to the transportation of the structure to the furnace.
  - Another focus point is to check the final surface on the HOMs after the heat cycles.

2024 Outlook

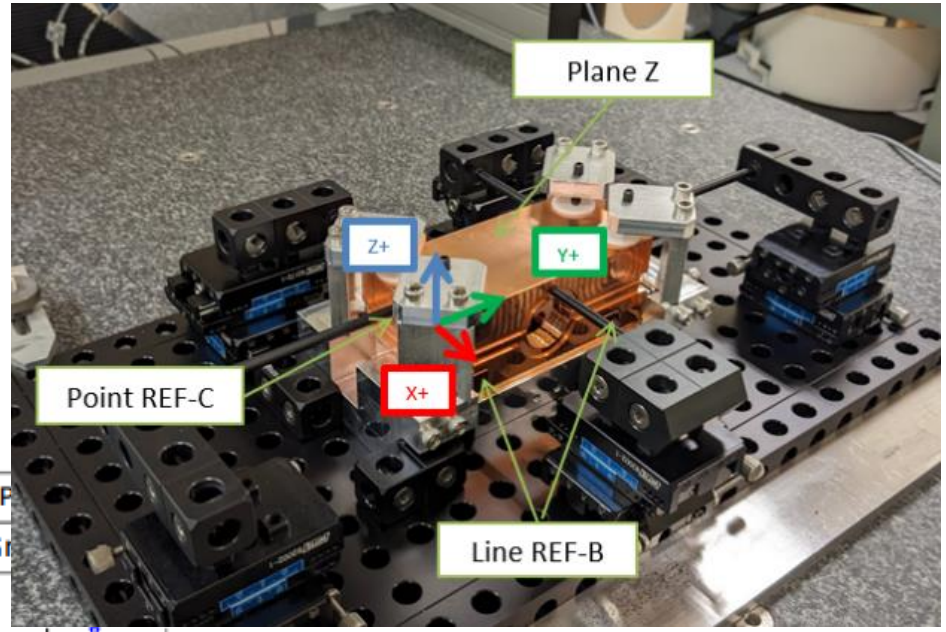
- Fully analyze all data obtained from the mock-up phase (Ultrasounds and microscopy)
- Two prototypes should be ready using brazing technology for next year. They will be tested with 380GeV Klystron-based

Band
Prototypes
Production

Thank you for your attention and do not hesitate to ask any question.

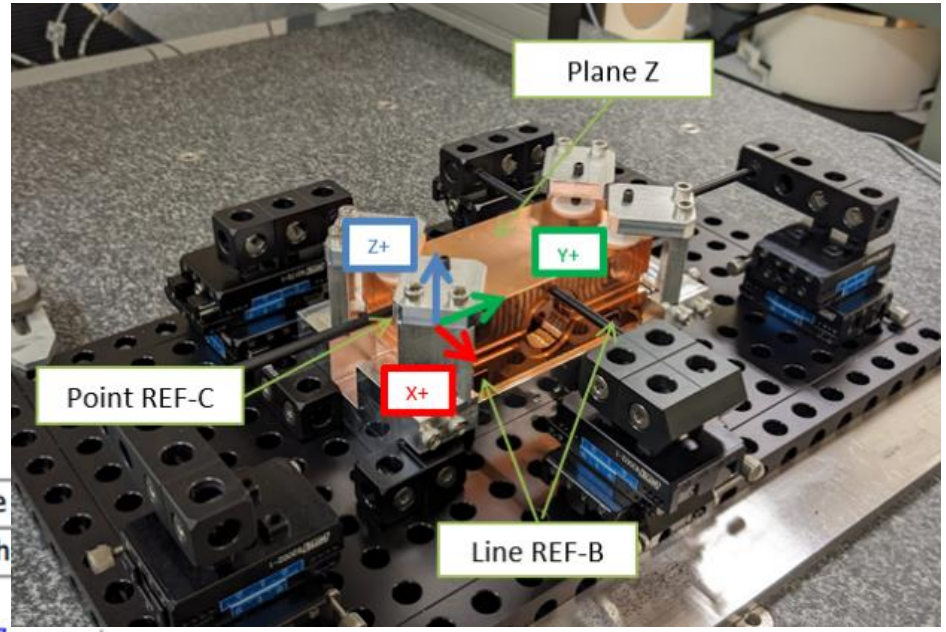
Thanks to Nuria Catalan Laseras and all the team for the help on the presentation and the pictures.

Halves – Metrology before



Date: 28-Sep-23, 14:33:14			EBW_test_assembly				P
Text	Eval.	Measured	Nominal	Upp.Tol.	Low.Tol.	Dev.	Gr
E3_PNT1_DB			POI				
	X	0.0020	0.0000	0.0050	-0.0050	0.0020	
E3_PNT2_DB			POI				
	X	0.0025	0.0000	0.0050	-0.0050	0.0025	
E3_PNT3_DB			POI				
	X	0.0000	0.0000	0.0050	-0.0050	0.0000	
E3_PNT4_DB			POI				
	X	0.0000	0.0000	0.0050	-0.0050	0.0000	
E3_PNT1_DC			POI				
	Y	0.0029	0.0000	0.0050	-0.0050	0.0029	
E3_PNT2_DC			POI				
	Y	0.0000	0.0000	0.0050	-0.0050	0.0000	

Halves – Metrology after



Date: 05-Oct-23, 11:33:42			EBW_test_assembly				Page
Text	Eval.	Measured	Nominal	Upp.Tol.	Low.Tol.	Dev.	Graph
E3_PNT1_DB			POI				
	X	0.0006	0.0000	0.0050	-0.0050	0.0006	
E3_PNT2_DB			POI				
	X	0.0017	0.0000	0.0050	-0.0050	0.0017	
E3_PNT3_DB			POI				
	X	0.0000	0.0000	0.0050	-0.0050	0.0000	
E3_PNT4_DB			POI				
	X	0.0000	0.0000	0.0050	-0.0050	0.0000	
E3_PNT1_DC			POI				
	Y	0.0046	0.0000	0.0050	-0.0050	0.0046	
E3_PNT2_DC			POI				
	Y	0.0000	0.0000	0.0050	-0.0050	0.0000	

HOM Loads advantages

Symmetric part