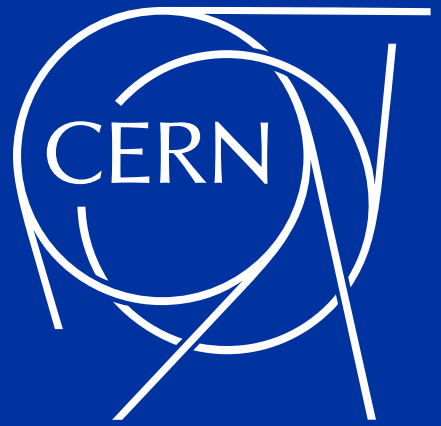

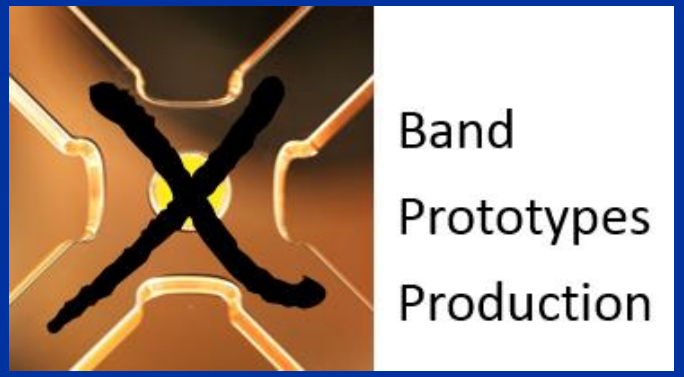

Smartcell structure development

Pedro Morales Sanchez

14/12/2021

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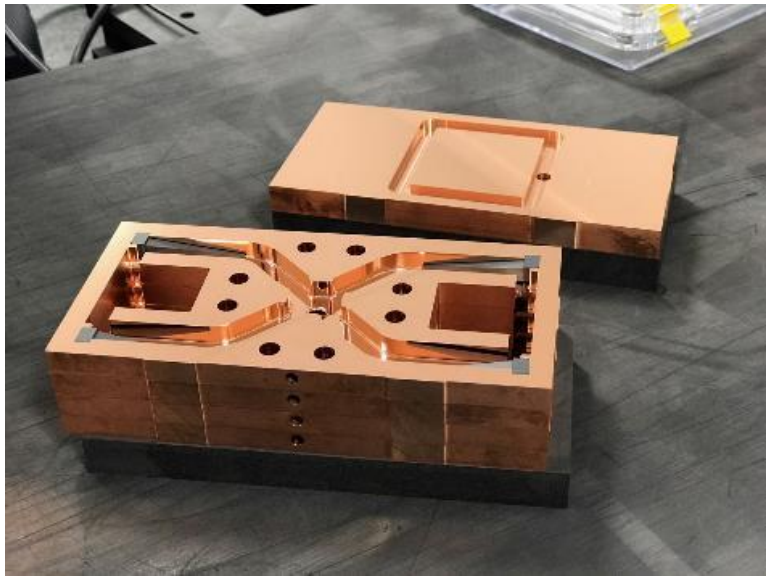
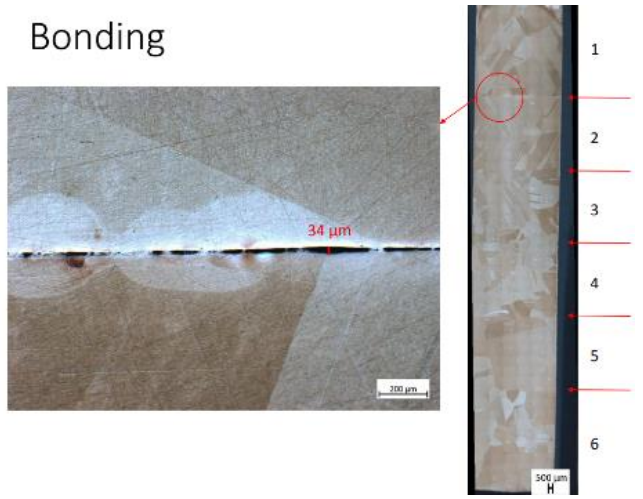
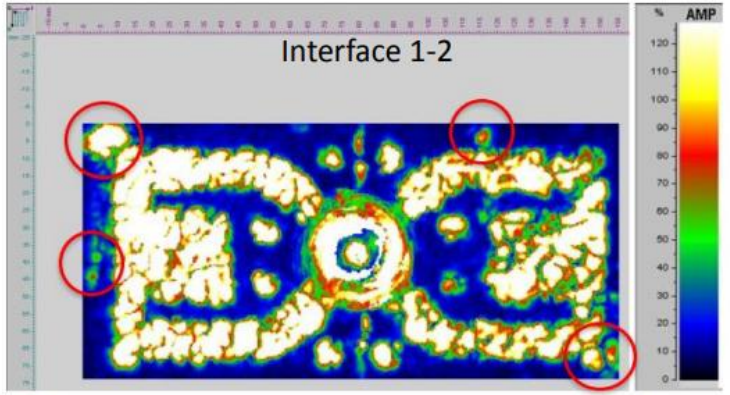
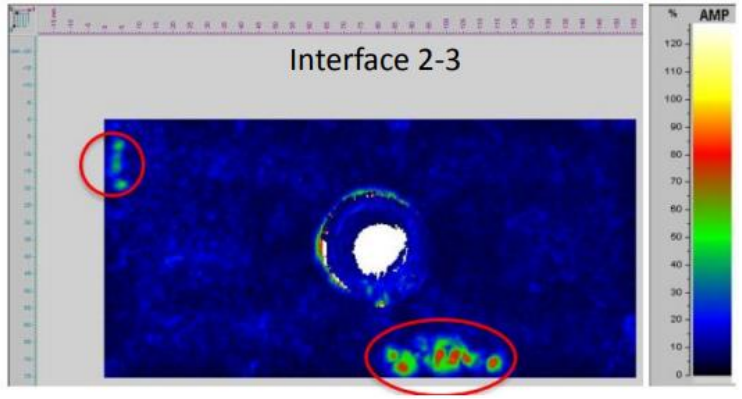
- ❑ Summary
- ❑ Brazing/Bonding test
- ❑ Smartcell Structure development

Brief summary







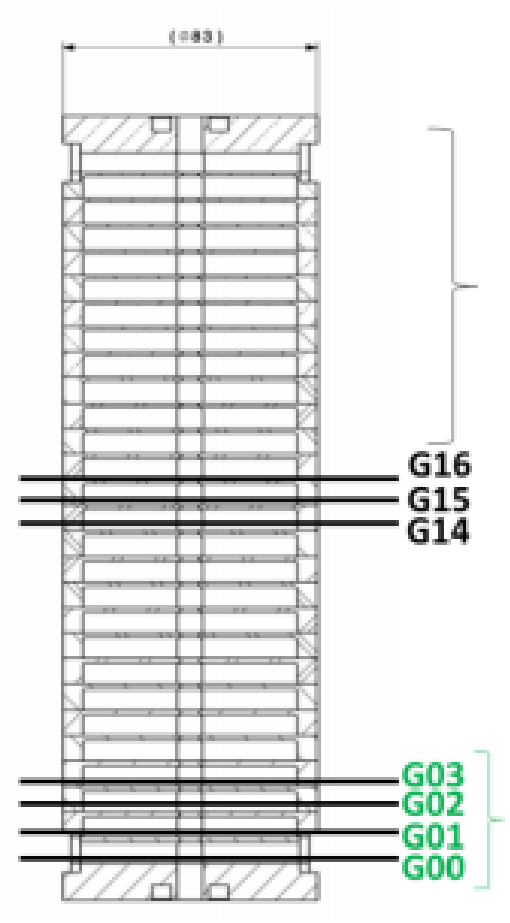


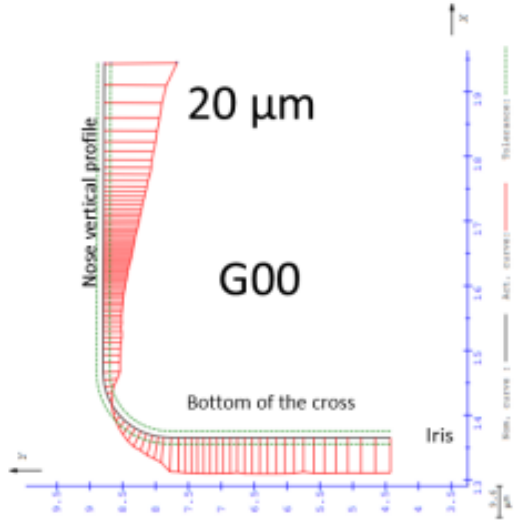
The first approach to this structure in 2018.
One mock-up to test it.

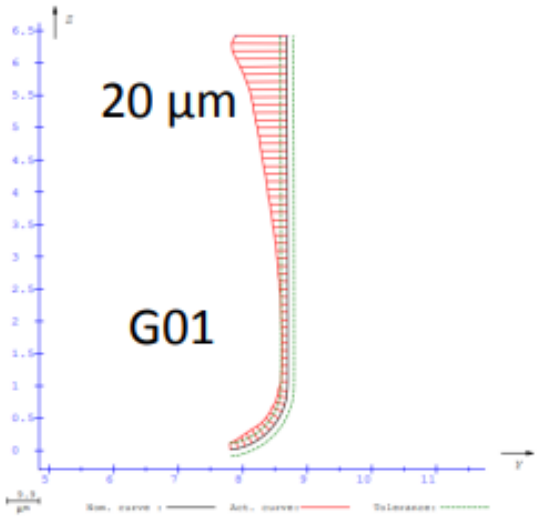
Parts were ok but the leak test failed.
The SC pieces were slightly bigger than the discs.

CLIC Module Fabrication Working Group (27 October 2020) · Indico (cern.ch)

Brief summary







We have seen deformation effects in the structure due to bonding cycles and weight during them.

Joel Sauza
X-band production meeting 19.06.2019 (11 September 2019) · Indico (cern.ch)

Bibliography research

VAC AERO INTERNATIONAL INC.

vacaero.com

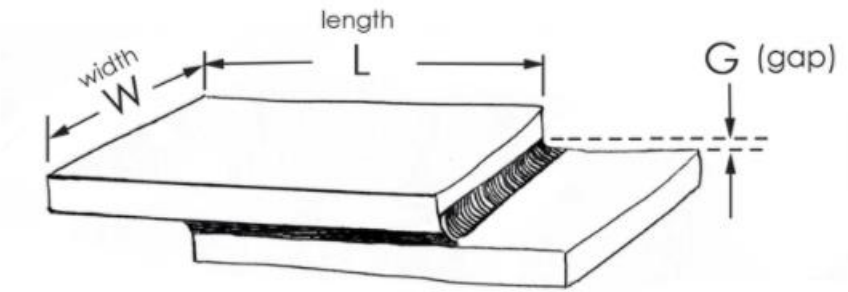
Blog

Essential Criteria for Brazing: Item 4c – Brazing filler metal (BFM) – How much should be used? (Link)

Quantity of BFM to put into braze joint (Rule of thumb):

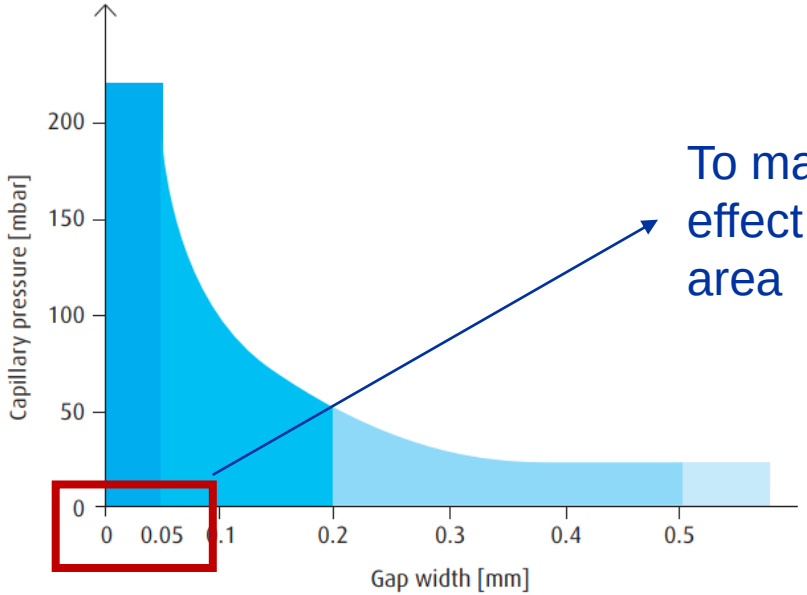
1.5 times the volume of the gap between faying surfaces!

Fig. 2 This Rule of thumb applies to the amount of LIQUID filler metal that is needed to properly fill a joint being brazed.



V (volume of joint) = W x L x G

Amt of LIQUID BFM needed = V x 150%



To maximize the capillarity effect we need to be in this area

Linde presentation. Link

Two key factors extracted from this:

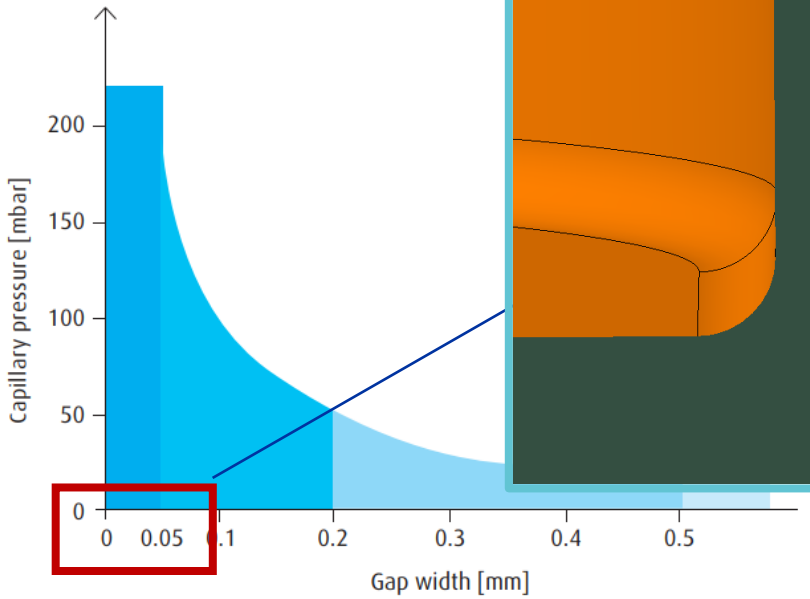
- 1.5 ratio

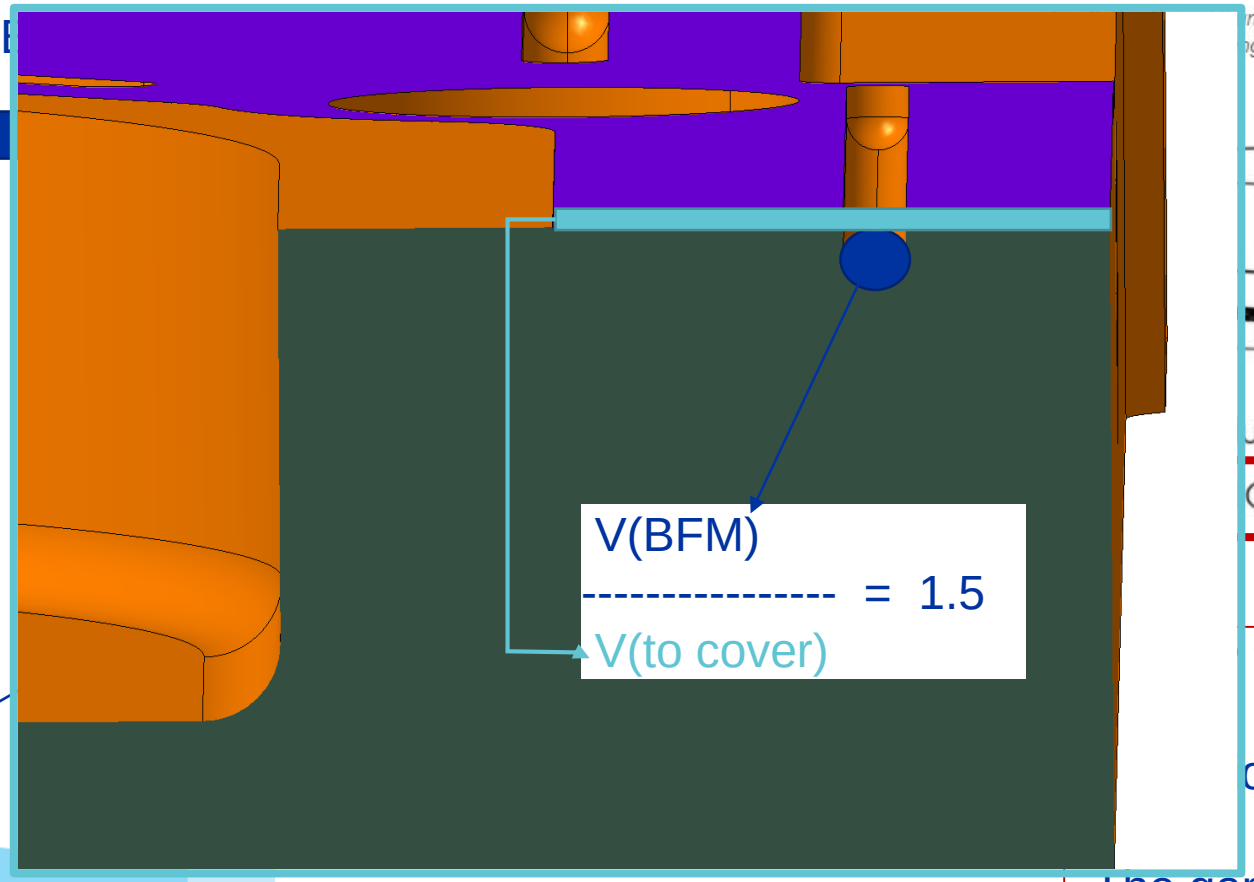
- The gap width must be from 0 to 0.05mm

Bibliography research

VAC AERO INTERNATIONAL INC.

vacaero.com



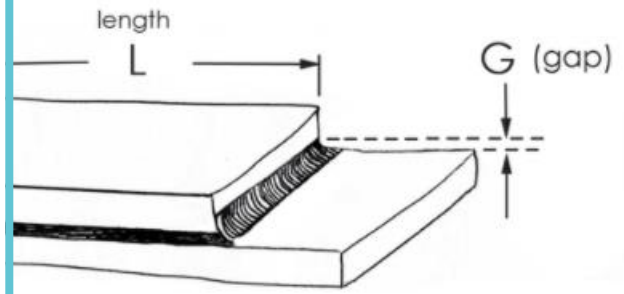


Linde presentation. Link

Quantity of BFM to put into braze joint (Rule of thumb):

1.5 times the volume of the gap between faying surfaces!

...mb applies to the amount of LIQUID filler metal that is needed to ...g brazed.



...ume of joint) = W x L x G

...QUID BFM needed = V x 150%

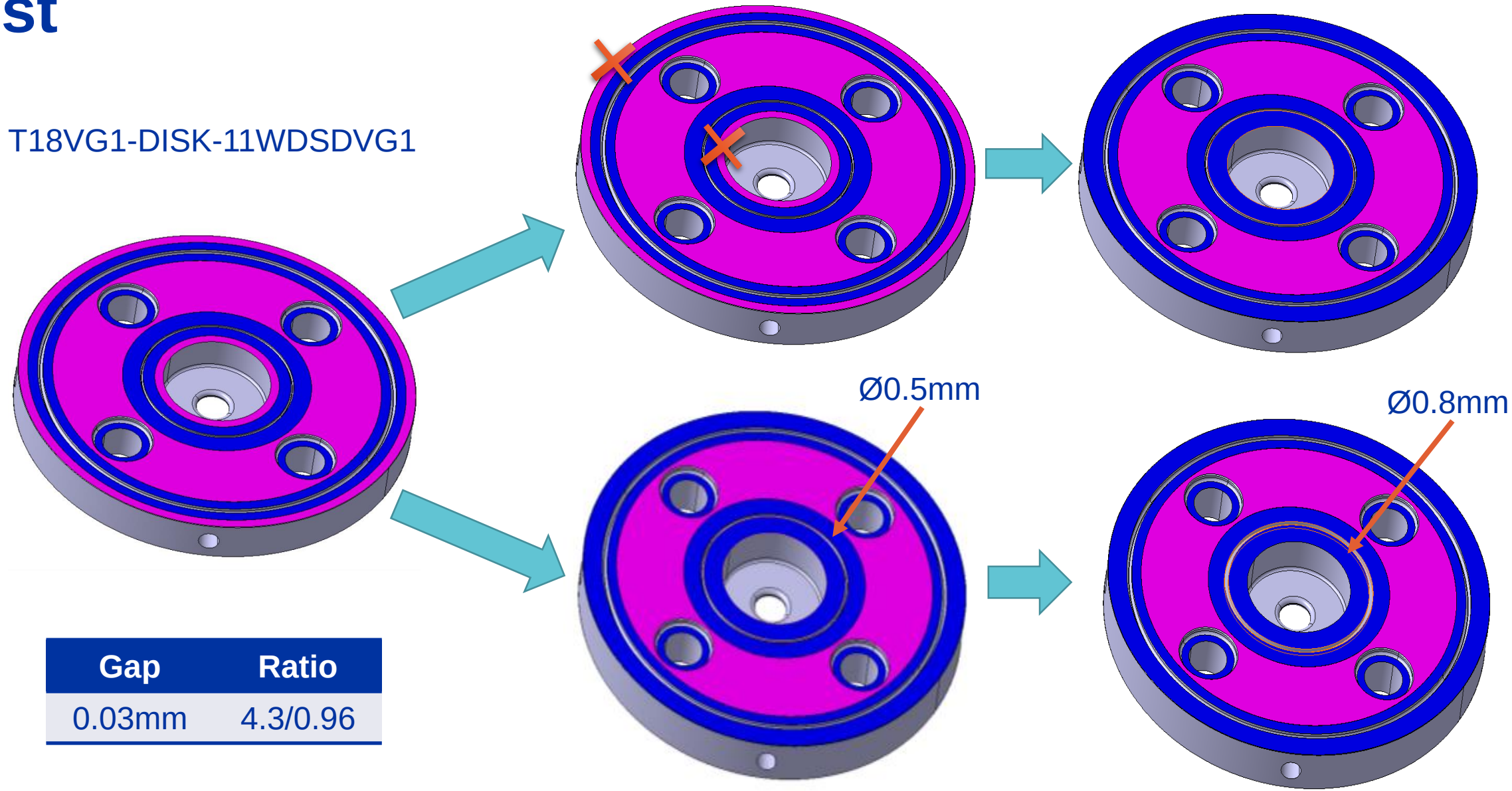
... factors extracted from this:

...o

- The gap width must be from 0 to 0.05mm

Test

T18VG1-DISK-11WDSDVG1



Gap	Ratio
0.03mm	4.3/0.96

Programed tests

- Different materials / temperatures / ratios / companies

No.	Discs	Disc Number Holding BFM	Disc Number Not Holding BFM	Material	(*) orientation Temperature	(*) orientation Time	Atmosphe	Outer ring Fil. Diam	Outer ring Ratio	Inner ring Fil. Diam	Inner ring Ratio	Oven	Weight (Kg)
1	1,2	8/7	8/8	AuCu50	1030		H2 dry	1	4.36	0.5	0.96	Bodycote	9.91
2	3,4	8/9	8/10	AuCu50	1030		H2 dry	0.7	2.13	0.5	0.96	Bodycote	1
3	5,6 Machined	8/2	8/11	AuCu50	1030		H2 dry	0.7	2.13	0.5	0.812	Bodycote	1
4	7,8	8/12	8/13	Palcusil5	810		Vacuum	1	4.36	0.5	0.96	CERN	1
5	9,10	8/16	8/17	Palcusil5	810		Vacuum	0.7	2.13	0.5	0.96	CERN	9.91
6	11,12 Machined	8/1	8/15	Palcusil5	810		Vacuum	0.7	2.13	0.5	0.812	CERN	1
7	13,14 Machined	8/3	8/14	Palcusil5	810		Vacuum	0.7	2	0.7	1.9	CERN	9.91
8	15,16	8/19	8/20	AuCu50	1030		H2 dry	1	4.36	0.5	0.96	CERN	9.91
9	17,18	8/18	8/22	AuCu50	1030		H2 dry	0.7	2.13	0.5	0.96	CERN	1
10	19,20 Machined	8/5	8/21	AuCu50	1030		H2 dry	0.7	2	0.7	1.9	CERN	1
11	21,22	8/25	8/24	Pallabraze 840	834		Vacuum	1	4.36	0.5	0.96	CERN	1
12	23,24	8/26	-	Pallabraze 840	834		Vacuum	0.7	2.13	0.5	0.96	CERN	1
13	25,26 Machined	8/4	8/23	Pallabraze 840	834		Vacuum	0.7	2	0.7	1.9	CERN	9.91
14	27,28												

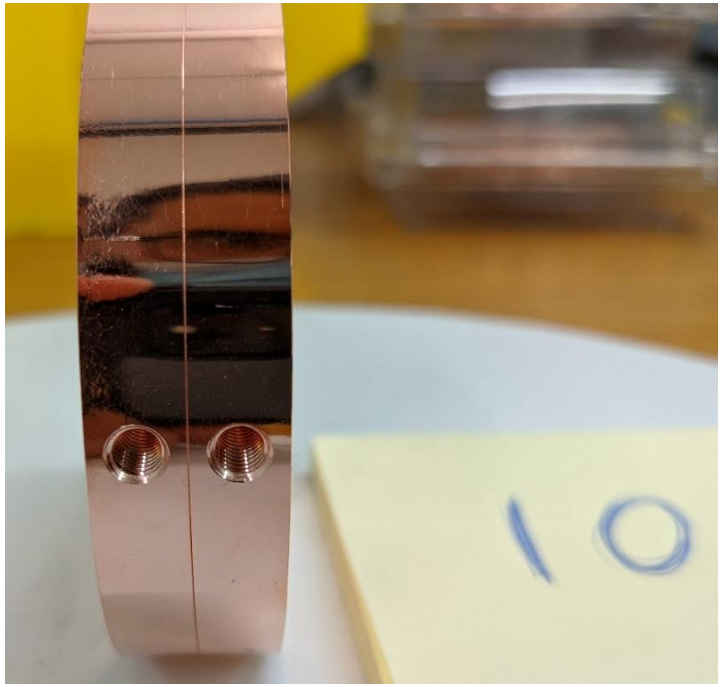
Thanks to Bodycote and Fritz Motschmann for their collaborative approach to this project.

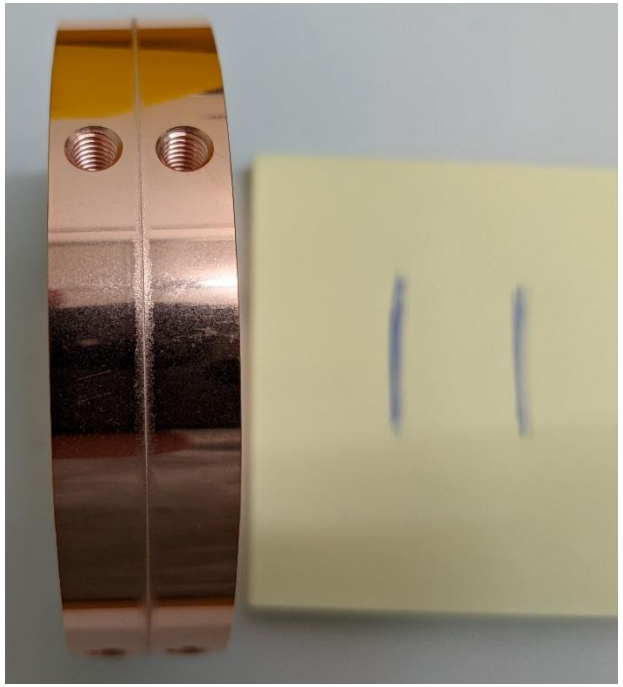
Visual inspection

No overflow

Diffusion

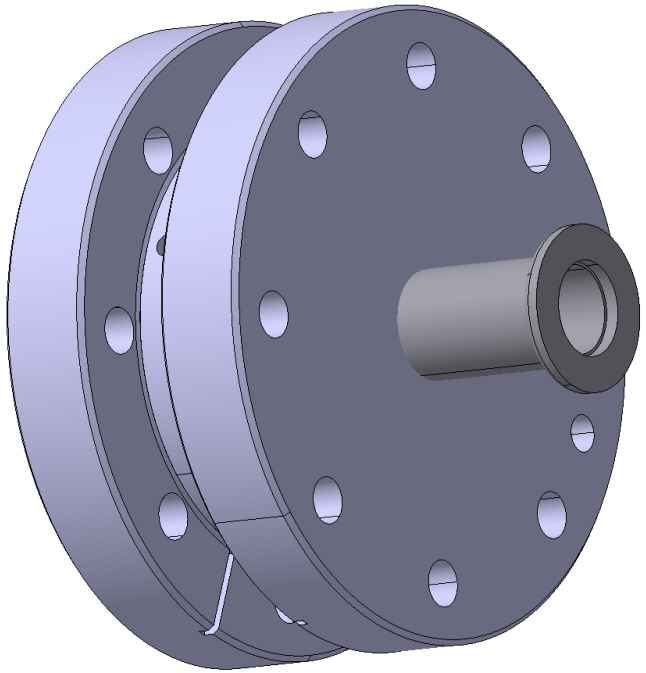
No remarkable problem

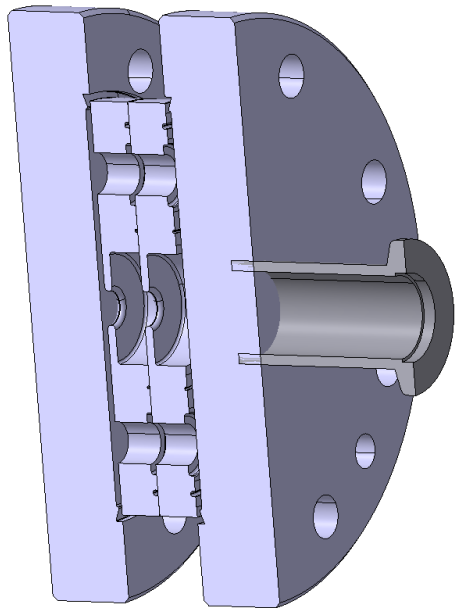




Leak test

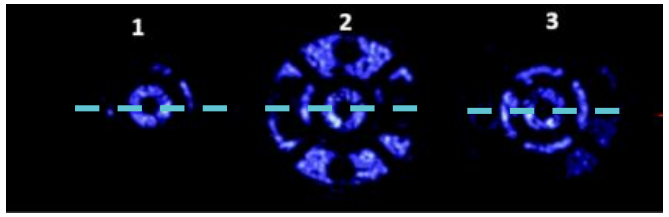
Leak test OK of all parts after brazing cycle





Ultrasounds analysis

H_2 dry/ AuCu50/ Bodycote



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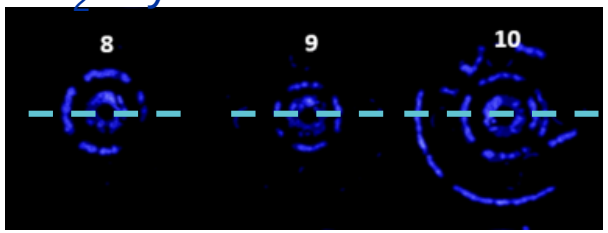
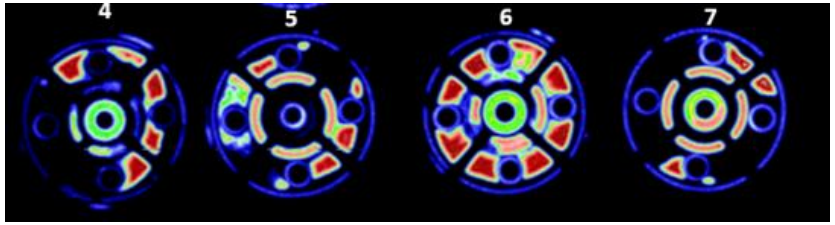
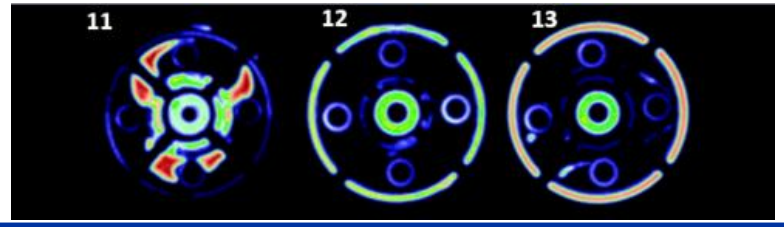


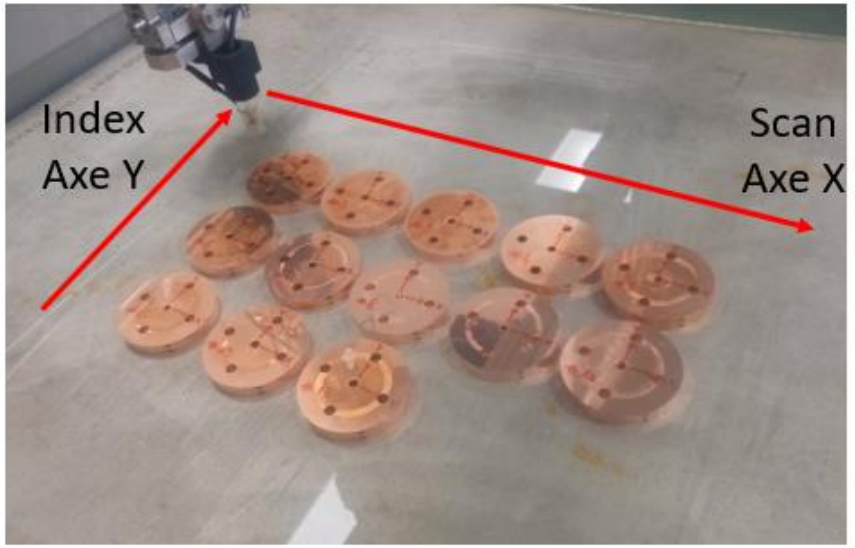
Vacuum/ Palcusil-5/ CERN



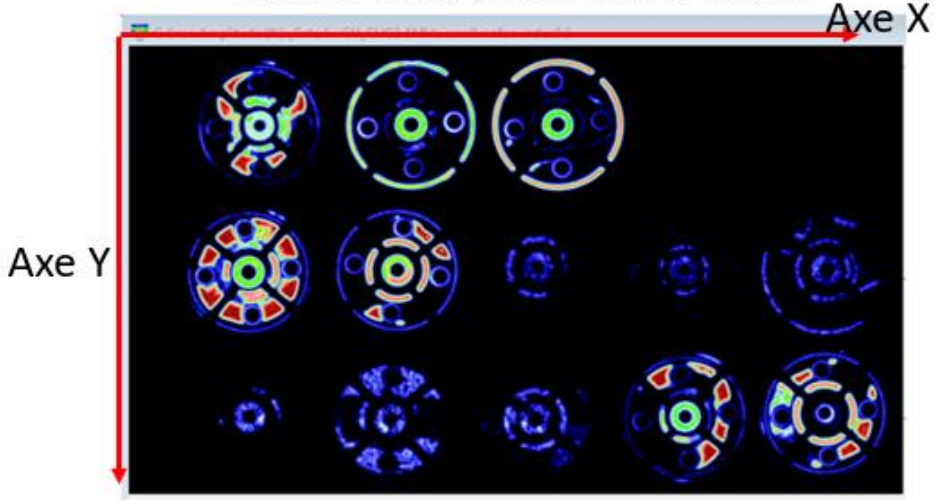
Vacuum/ Palabraze-840/ CERN



PIECES IN IMMERSION TANK



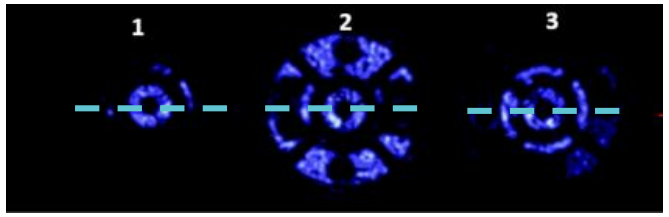
PIECES VISUALISATION C-SCAN



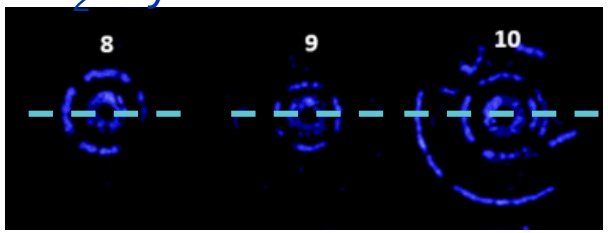
Brazing tests (15 September 2021) · Indico (cern.ch)

Ultrasounds analysis

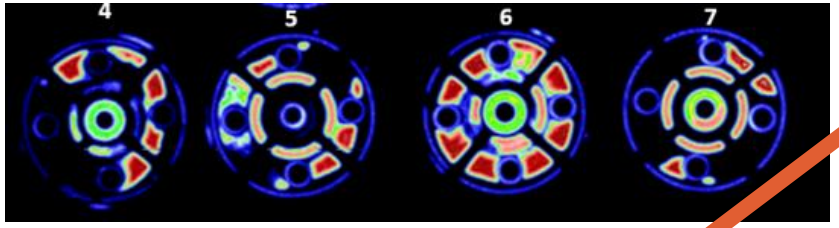
H_2 dry/ AuCu50/ Bodycote



H_2 dry / AuCu50/ CERN

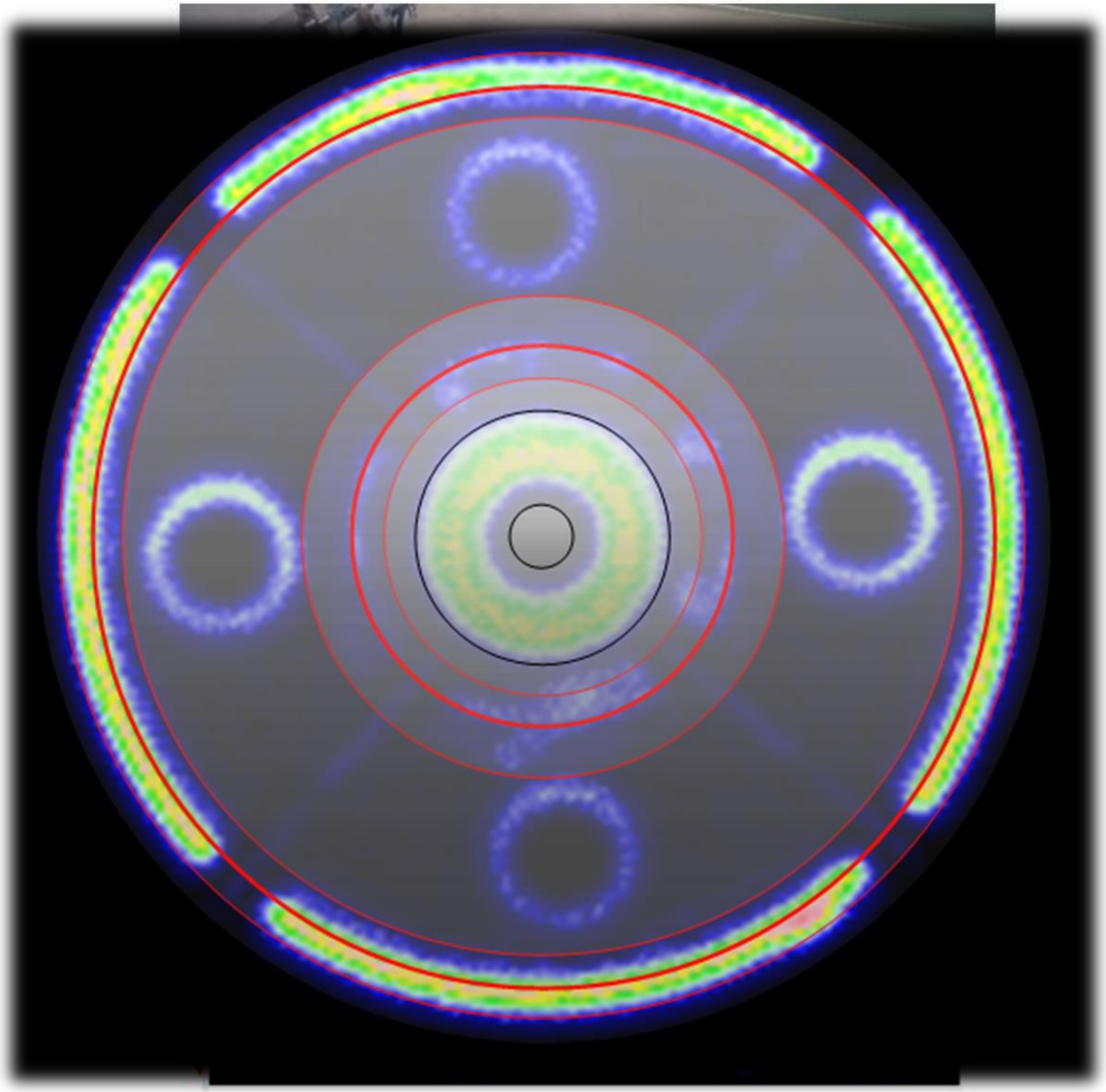


Vacuum/ Palcusil-5/ CERN



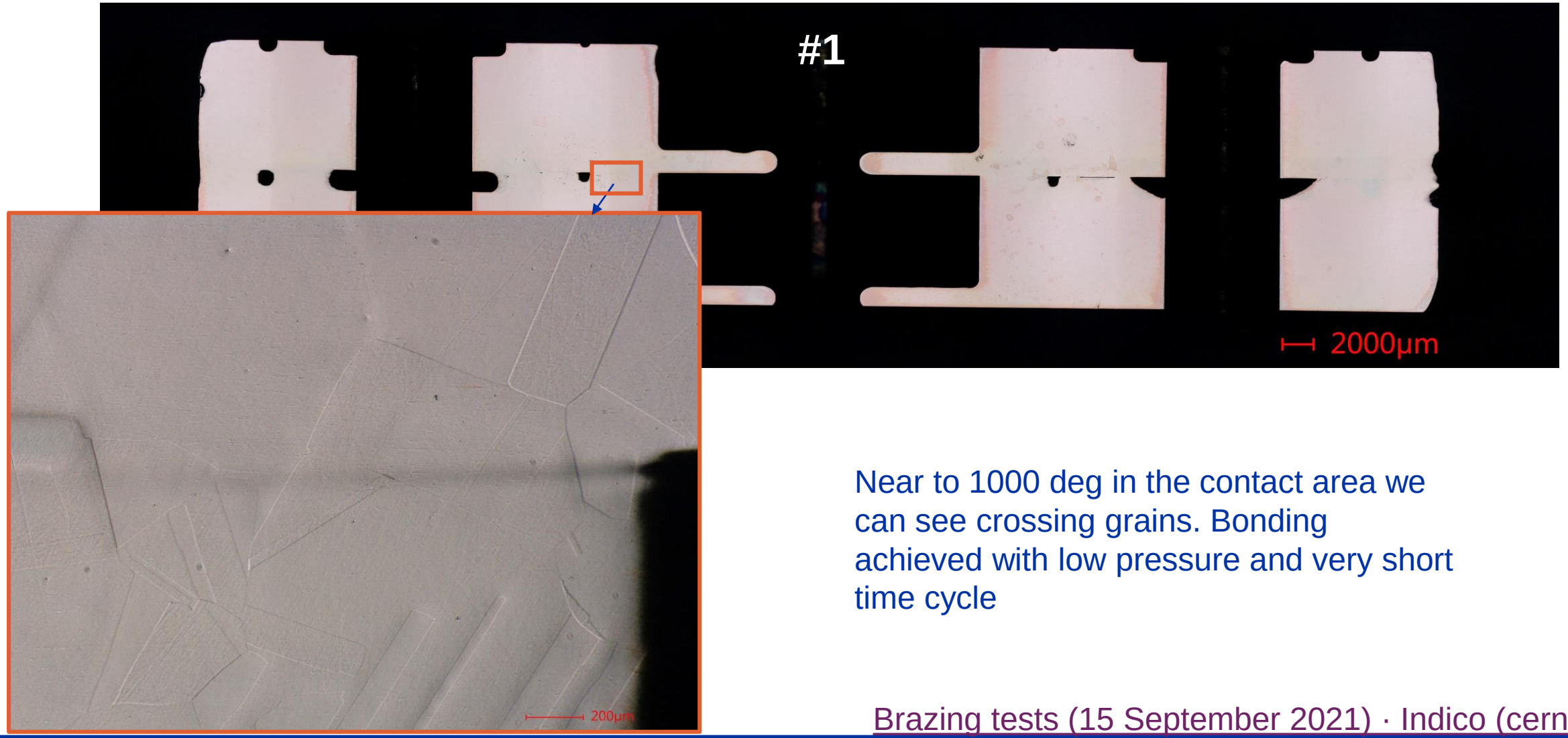
Vacuum/ Palabraze-840/ CERN

PIECES IN IMMERSION TANK



Brazing tests (15 September 2021) · Indico (cern.ch)

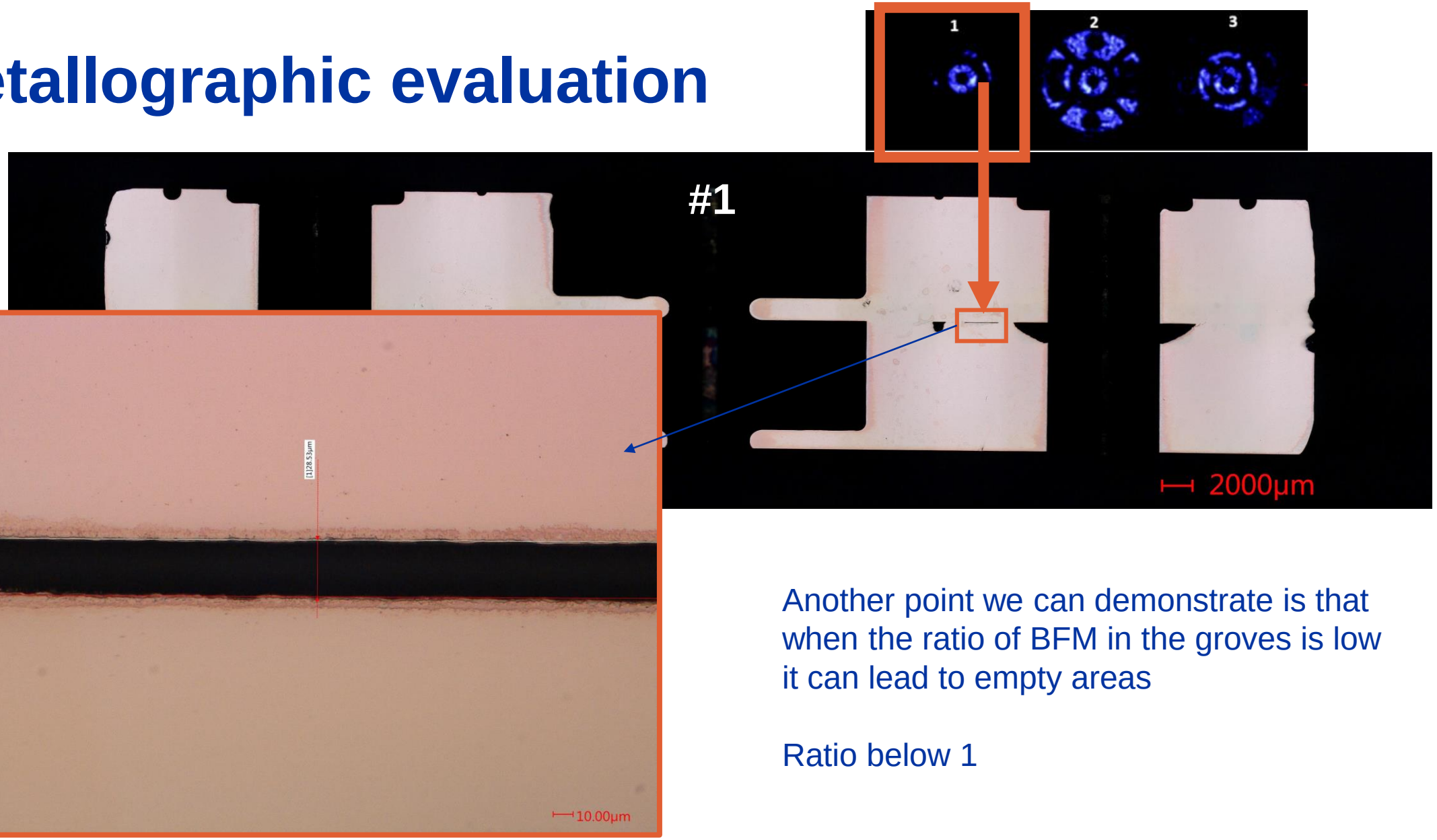
Metallographic evaluation



Near to 1000 deg in the contact area we can see crossing grains. Bonding achieved with low pressure and very short time cycle

Brazing tests (15 September 2021) · Indico (cern.ch)

Metallographic evaluation

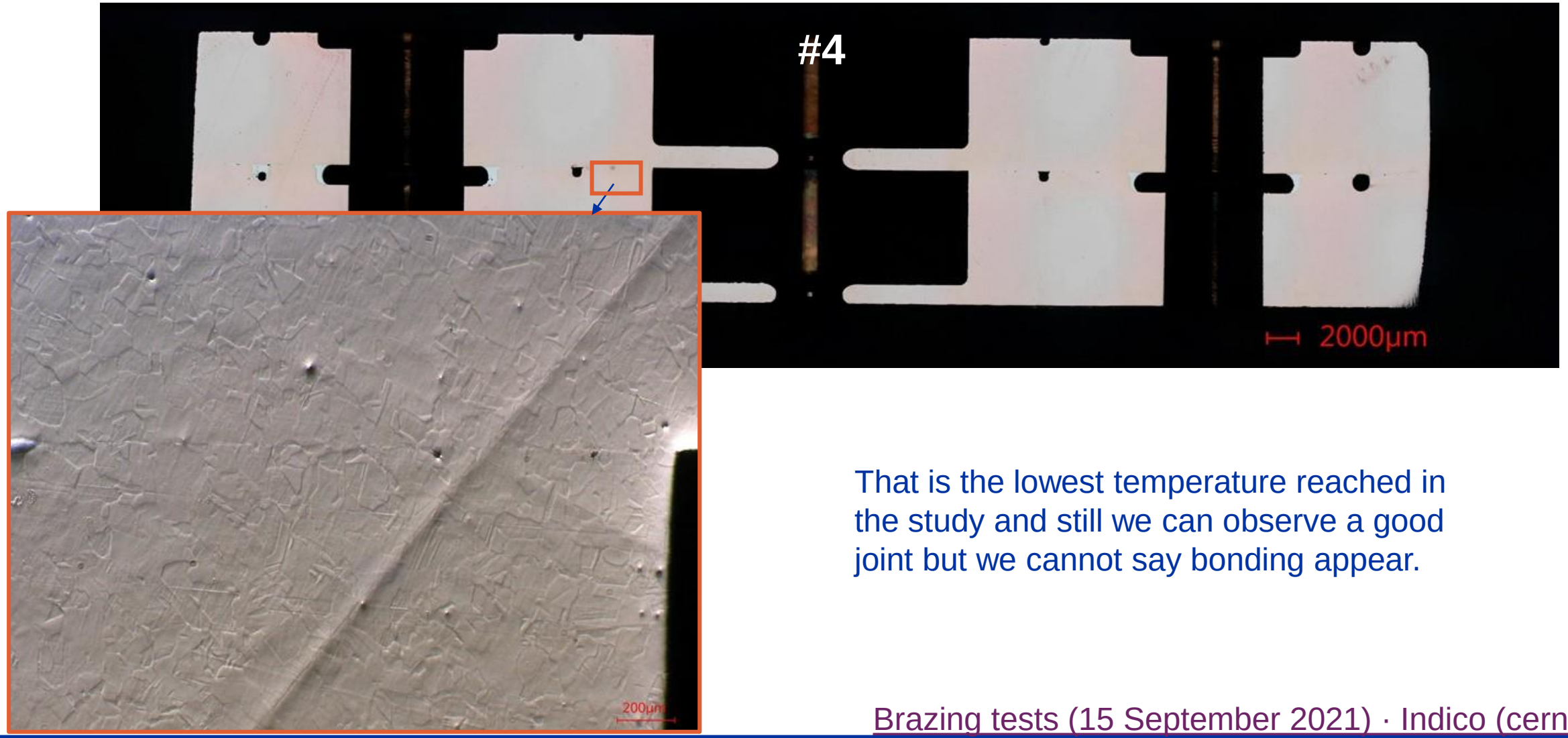


Another point we can demonstrate is that when the ratio of BFM in the groves is low it can lead to empty areas

Ratio below 1

Brazing tests (15 September 2021) · Indico (cern.ch)

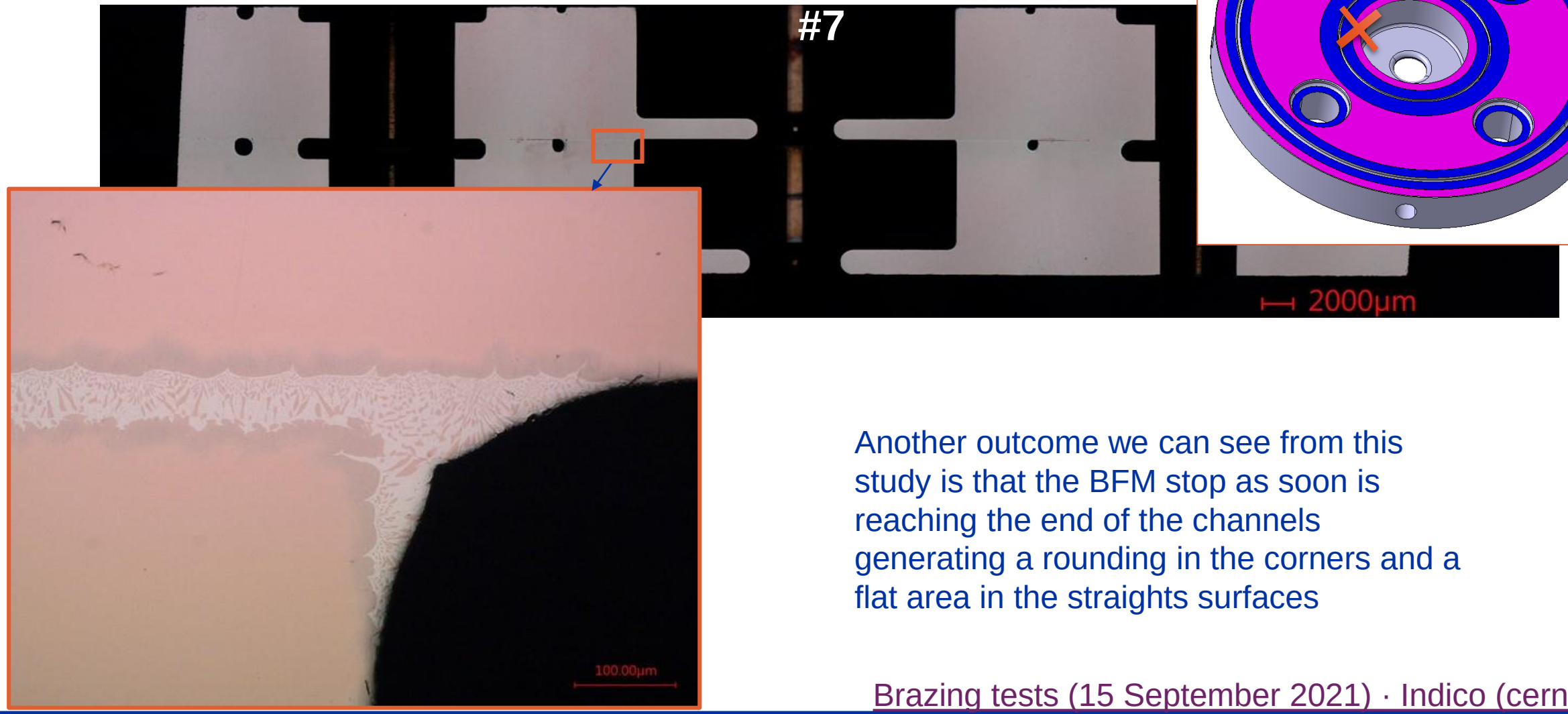
Metallographic evaluation



That is the lowest temperature reached in the study and still we can observe a good joint but we cannot say bonding appear.

Brazing tests (15 September 2021) · Indico (cern.ch)

Metallographic evaluation

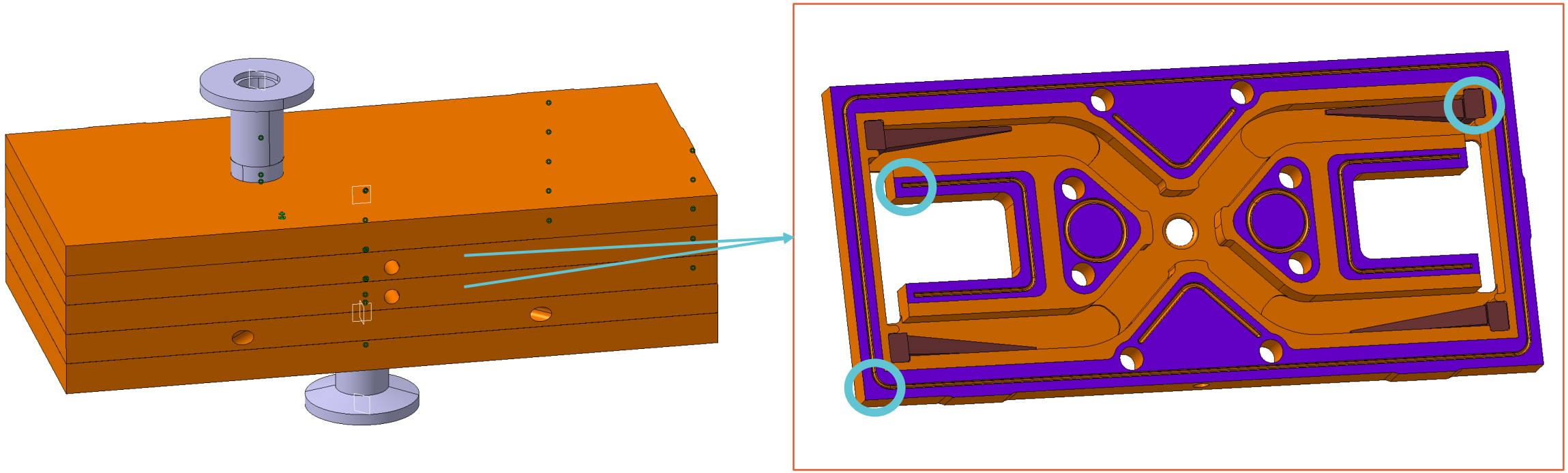


Another outcome we can see from this study is that the BFM stop as soon is reaching the end of the channels generating a rounding in the corners and a flat area in the straights surfaces

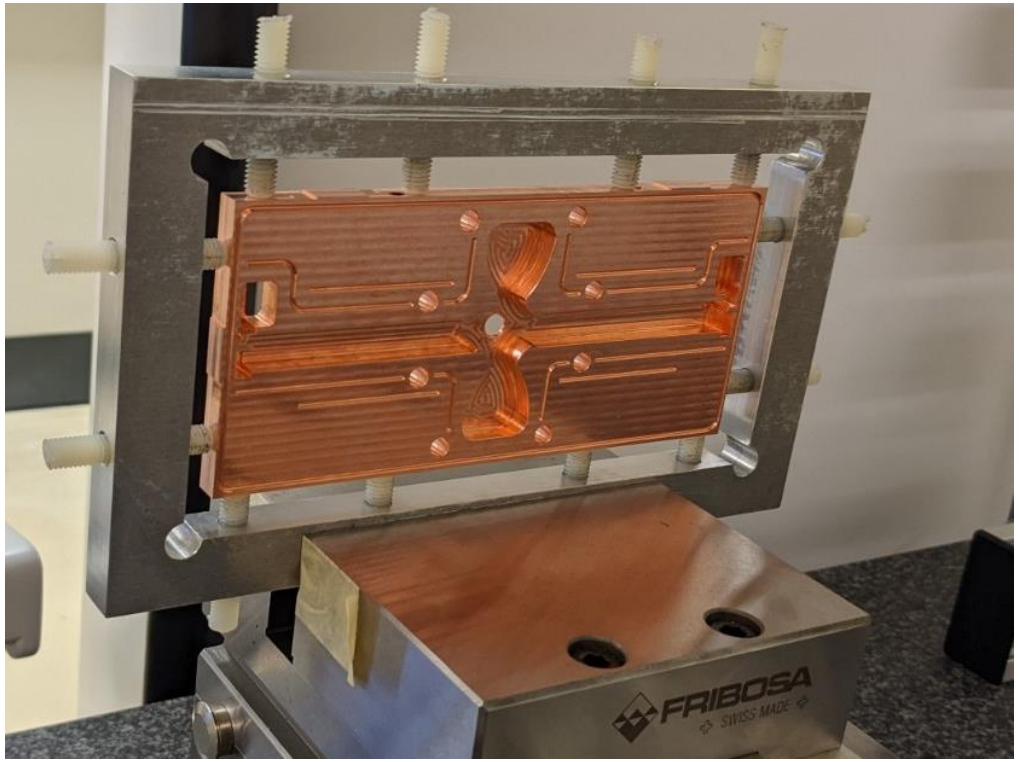
Brazing tests (15 September 2021) · Indico (cern.ch)

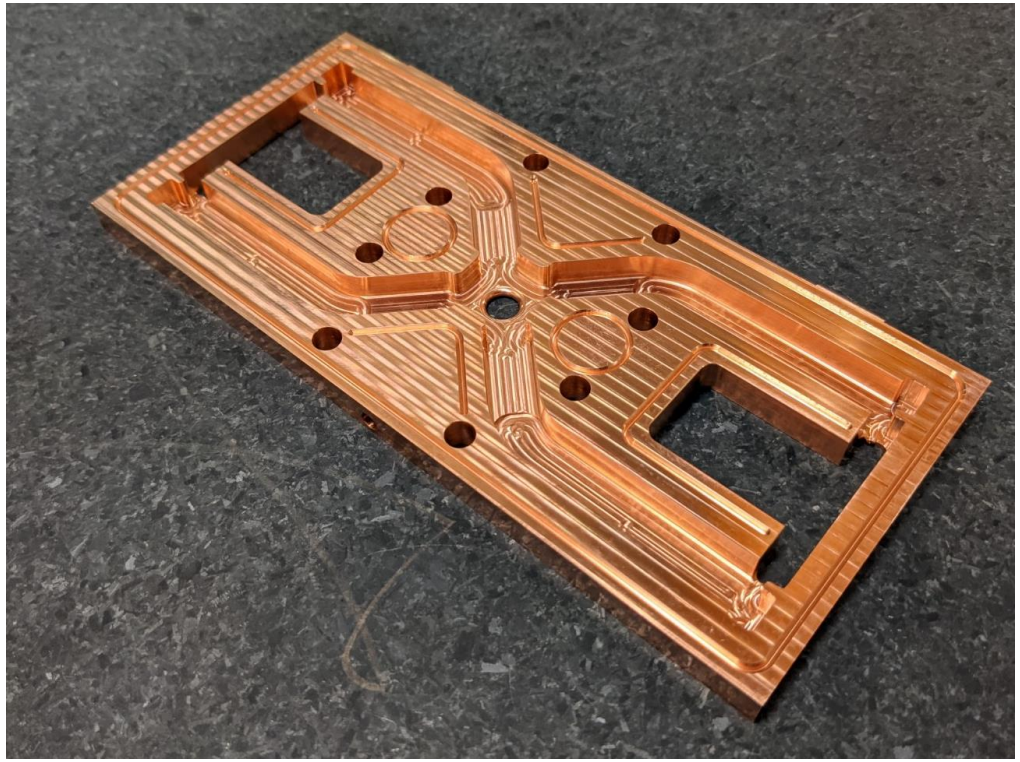
Smartcell prototype

With all the outcomes from this study, next step is to build a prototype for checking we are going in the right direction (or not). The prototype has been ordered at CERN to be manufactured completely at CERN



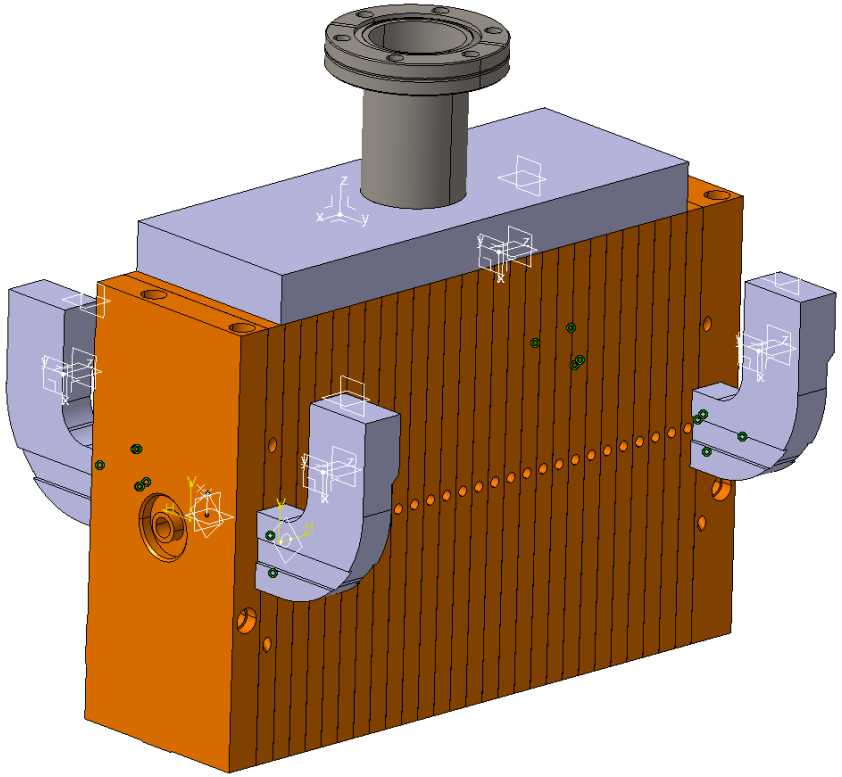
Smartcell prototype

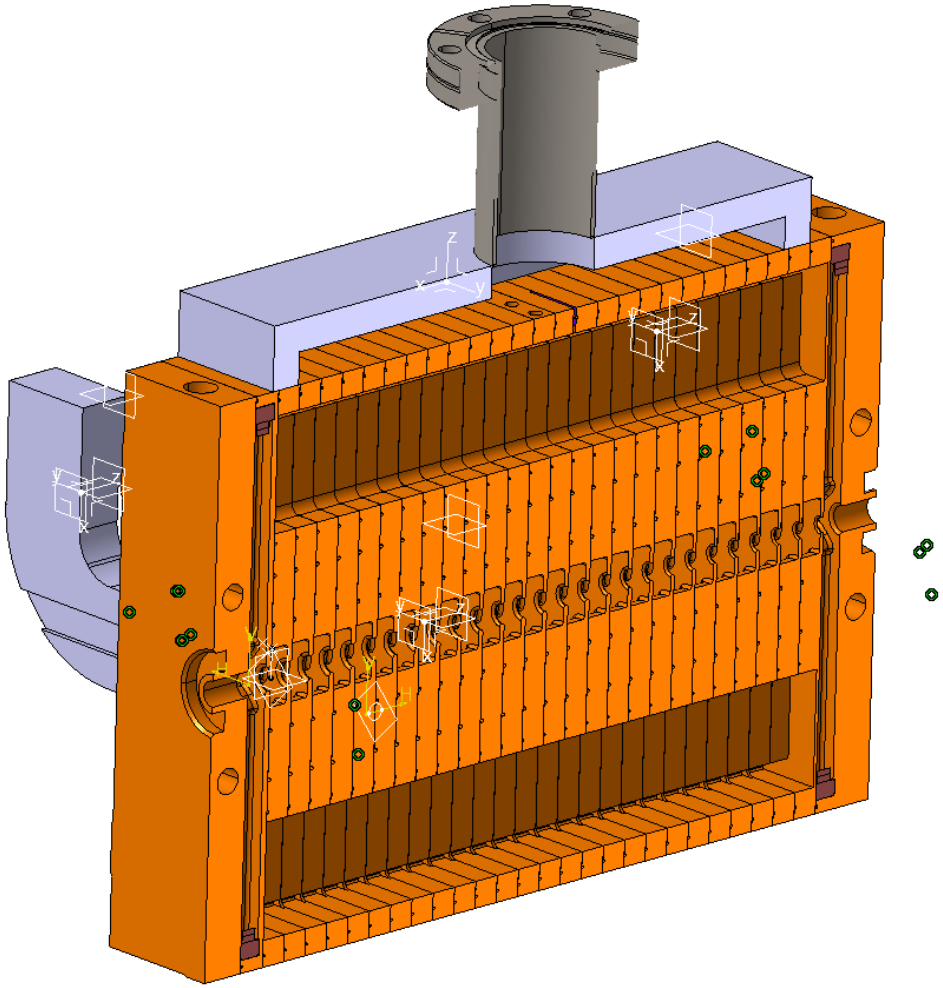




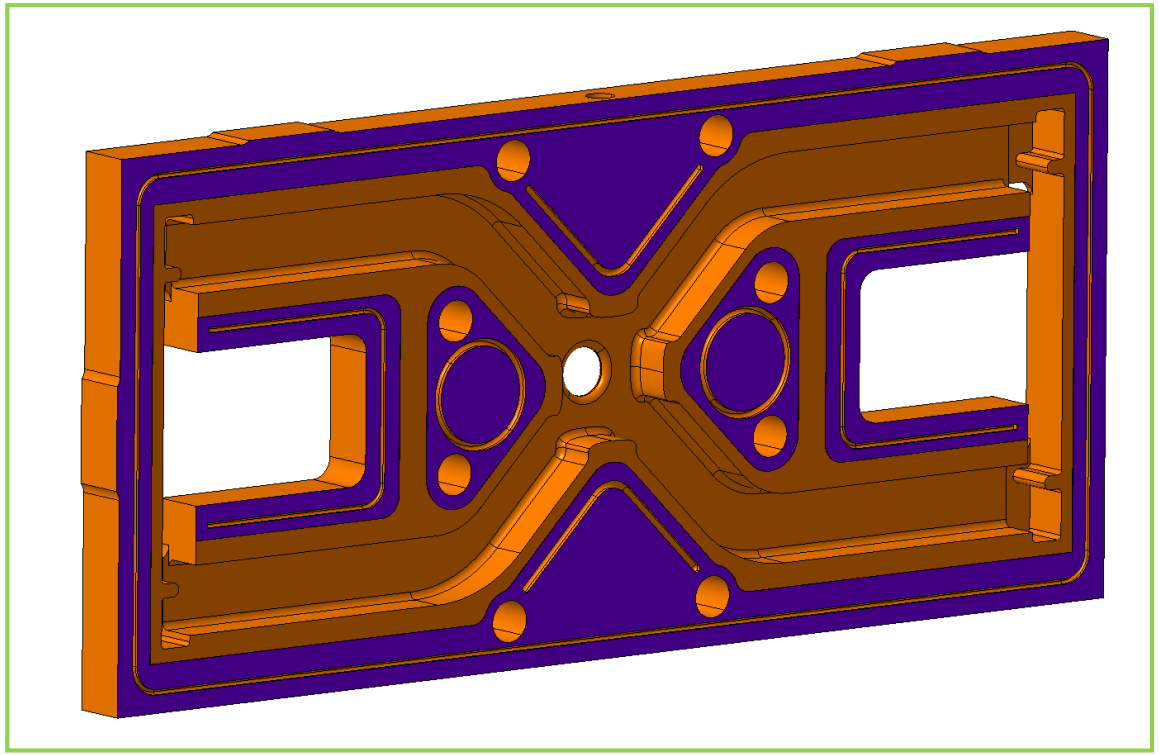
The material used for the prototype is Cu OFE laminated

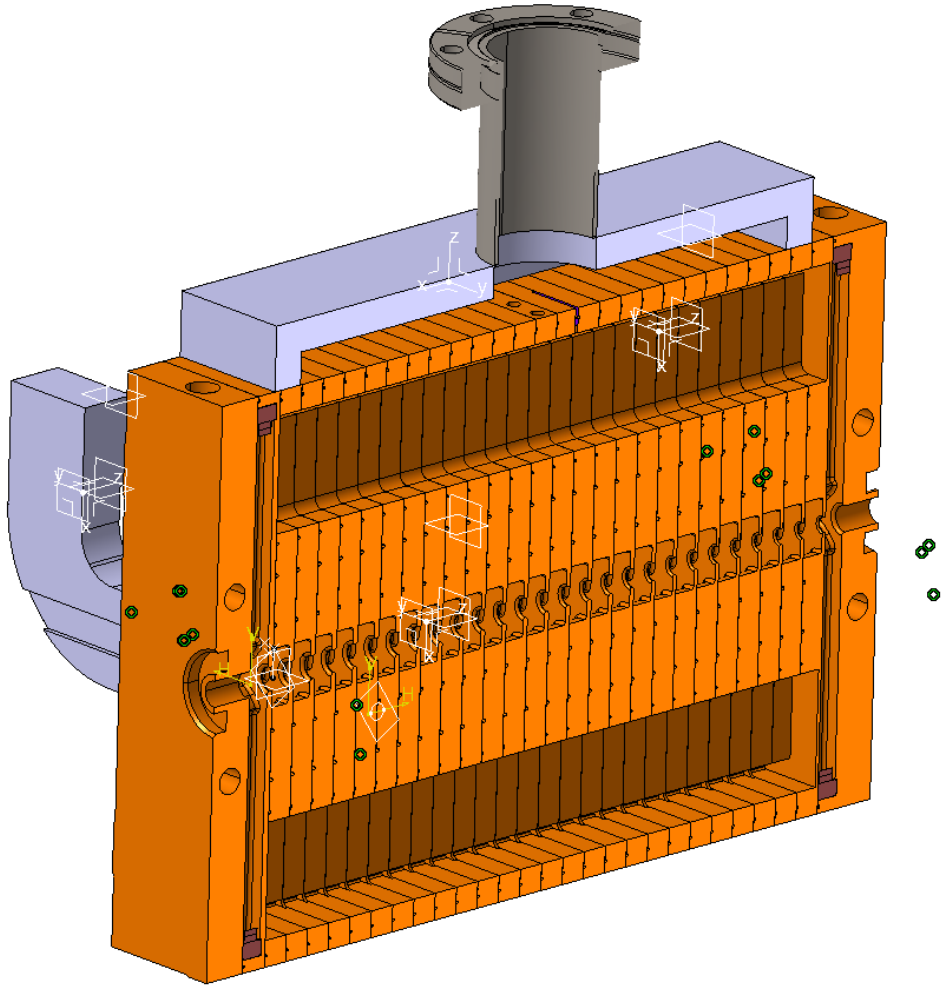
Smartcell structure



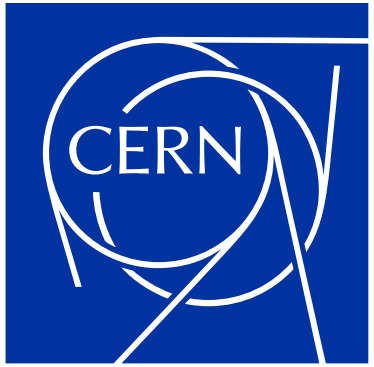


Smartcell structure





Thanks for your attention.
Questions??



Thanks to Nuria Catalan, Anastasiya Magazinik, Joel Sauza, Fritz Motschmann, Bodycote, Serge Lebet and all participants from materials, especially Anite Pérez and Enrique Rodriguez