



**CERN**  
CH1211 Geneva 23  
Switzerland

EDMS NO. <b>3170223</b>	REV. <b>1.0</b>	VALIDITY <b>approved</b>
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REFERENCE <b>C.Santos EN/MME</b>
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Date: 27.09.2024

**NDT Report**  
**Ultrasonic Testing by immersion**  
**WP4 HL-LHC Crab Cavities cryomodules**  
**project – AUP Collaboration**  
**Dressed bulk Nb RF Crab Cavities**  
**B20-BHT006**  
**B20-SHT004**

TEST PERFORMED BY:  M. FAVREL EN/MME/MM EN ISO 9712 - level 2 Card n° B02-029333	DOCUMENT PREPARED BY:  M.FAVREL EN/MME/MM EN ISO 9712 - level 2 Card n° B02-029333	DOCUMENT APPROVED BY:  G. Arnau Izquierdo EN/MME/MM EN ISO 9712 level 2 Card n° B02-020101
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## General Information

<b>Client</b>	C.Santos – EN/MME
<b>Job number</b>	
<b>Project</b>	WP4 HL-LHC Crab Cavities cryomodules project – AUP Collaboration
<b>Sub project</b>	Dressed bulk Nb RF Crab Cavities

## Pieces Description

<b>Designation, diameter, number</b>	B20-BHT006 B20-SHT004
<b>Type, materials</b>	Stainless steel 316LN Tube/Titanium Tube
<b>Estimated Ra</b>	< 1.6 $\mu\text{m}$

## Standards & Specifications

<b>CERN Specification</b>	EDMS 1389669, Paragraphe 4.2.6.4 and Table 13											
<b>Acceptance criteria</b>	<p>4.2.6.4 <i>Brazed joints: procedure and acceptance criteria for ultrasonic inspection</i></p> <p>The following requirements are valid for qualification tests and for tests during production. For non-destructive tests, semiautomatic or automatic immersion equipment able to record C-scans shall be used. The probe shall be of frequency <math>\geq 5</math> MHz and shall be focused or have a transducer size <math>\leq 5</math> mm. Where possible, the joint shall be scanned from the inner side of the tube. The scan shall cover an area exceeding at least 5 mm the nominal joint length.</p> <p>The reference amplitude shall be set from the tube thickness back wall echo measured outside the joint. Sizing of discontinuities shall be performed following a probe movement technique (ISO 16827) where the assessment level will be equal to the reference amplitude minus 6 dB. The record of the C-scan shall be included in the test report.</p> <p style="text-align: center;"><b>Table 13: Acceptance levels for ultrasonic inspection</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th rowspan="2">DESCRIPTION</th> <th colspan="2">STANDARDS</th> </tr> <tr> <th>AMERICAN</th> <th>EUROPEAN</th> </tr> </thead> <tbody> <tr> <td>Vacuum Brazing</td> <td colspan="2">           The inspection shall be performed conforming to the general principles set in ISO 16810 or EN 4050-1 and EN 4050-2.           <ul style="list-style-type: none"> <li>Combinations of discontinuities: the total projected area of the discontinuities shall be <math>\leq 20</math> % of the joint projected area (according to the Quality Level B of ISO 18279)</li> <li>Potential leaking channels: any continuous line crossing the joint shall be free of discontinuities over a length <math>\geq 20</math> % of the nominal length of the joint.</li> <li>For other defects, quality Level B of ISO 18279</li> </ul> </td> </tr> <tr> <td>Qualifications of NDT personnel</td> <td>Recommended Practice N<sub>o</sub> SNT-TC-1A Level II</td> <td>EN ISO 9712 Level II</td> </tr> </tbody> </table>	DESCRIPTION	STANDARDS		AMERICAN	EUROPEAN	Vacuum Brazing	The inspection shall be performed conforming to the general principles set in ISO 16810 or EN 4050-1 and EN 4050-2. <ul style="list-style-type: none"> <li>Combinations of discontinuities: the total projected area of the discontinuities shall be <math>\leq 20</math> % of the joint projected area (according to the Quality Level B of ISO 18279)</li> <li>Potential leaking channels: any continuous line crossing the joint shall be free of discontinuities over a length <math>\geq 20</math> % of the nominal length of the joint.</li> <li>For other defects, quality Level B of ISO 18279</li> </ul>		Qualifications of NDT personnel	Recommended Practice N <sub>o</sub> SNT-TC-1A Level II	EN ISO 9712 Level II
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## Testing Results

For all parts:

- the total projected area of the discontinuities is  $\leq 20$  % of the joint projected area (brazing wire groove excluded)
- any continuous line crossing the joint is free of discontinuities over a length  $\geq 20$  % of the nominal length of the joint (brazing wire groove excluded)

**all parts Are Acceptable**

See more details in the next pages.



## Testing Conditions

<b>Date of Testing</b>	27.09.2024
<b>EQUIPMENT</b>	
<b>Flaw Detector</b>	Triton 1000
<b>Probe</b>	TECHNISONIC IPU-1002-HR : SN-19453 Single crystal focused – 10 MHz – diameter 0.25 inch – 0.5 inch focalized
<b>Couplant</b>	Water
<b>EXAMINATION</b>	
<b>Scanning method</b>	Immersion scanning with 15 mm water height, using a mirror
<b>Scanning coverage</b>	Scan U lines with 0.2mm resolution, on 360° Incrementation Z of 0.2mm
<b>Sound entry surface</b>	Titanium first



Scanning setup

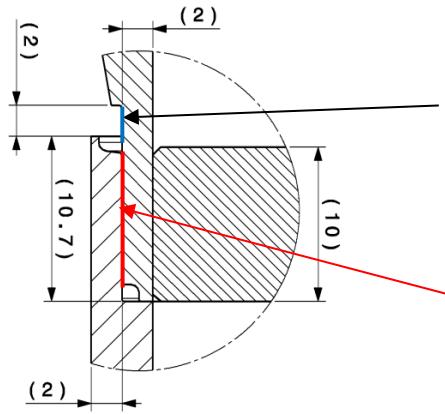


### CALIBRATION

**Gain Level** 43 dB

**Distance calibration** Velocity = 6100 m/s

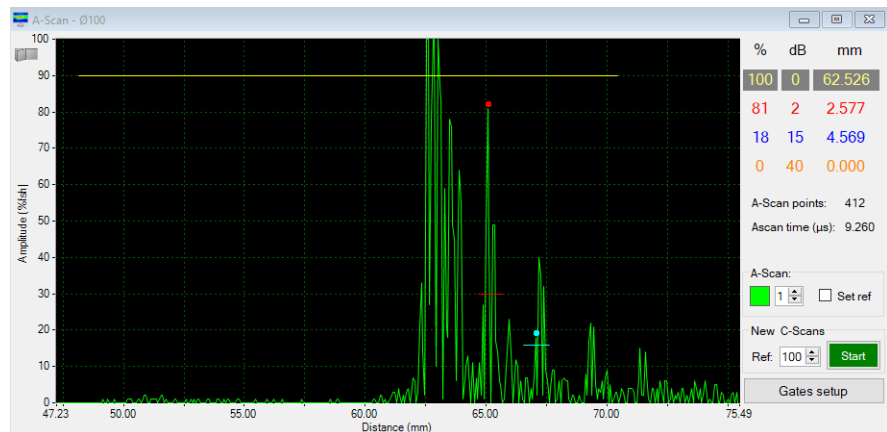
#### Test sensitivity calibration



Titanium sleeve without brazing, used as reference.  
The Gain level is defined to have this interface echo at amplitude of 80% Screen Height. Recording level is 40% Screen Height (i.e. -6dB)

Brazed interface

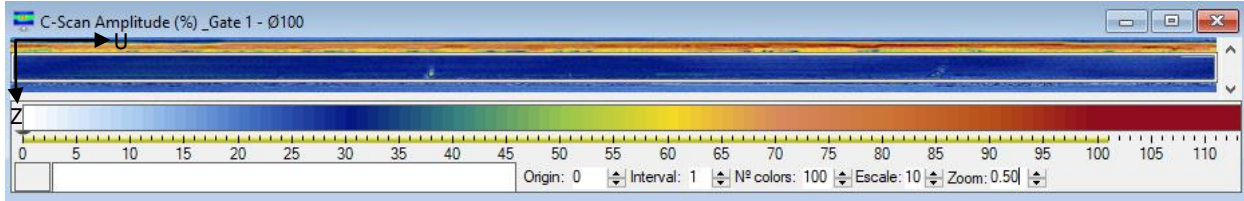
#### A-Scan of brazed interface





**C-SCAN RESULTS – amplitude of brazed interface**

B20-BHT006



B20-SHT004

