

# **FCC R&D WP5 Cavity Fabrication Status May 2017**

**M. Karppinen on behalf of the project team**

# Objective

Development of new cavity fabrication methods suitable for production of large series of SC cavities based on thin film and bulk Nb-technologies

# WP 5: Scope

WU 5.1 Copper and Niobium sheet supply  
C. Abajo Clemente CERN:

WU 5.2 Fabrication of seamless cavities  
M. Karppinen CERN, V. Palmieri LNL

WU 5.3 High velocity forming of SC RF structures  
C. Abajo Clemente CERN, TBD BMAX

WU 5.4 Fabrication of 1.3 GHz seamless cavities  
W. Venturini CERN, V. Palmieri LNL

WU 5.5 Fabrication of 800 MHz 5-cell Nb-cavity  
K. Schirm CERN, R. Rimmer JLAB

# WU 5.1: Cu- and Nb-sheet Supply & Material Characterization Pre- and Post-forming

- Specification, characterisation, handling, and supply of copper and niobium sheets for cavity forming development:
  - **Task 1:** Collection of technical specifications for the sheet metal to be used for cavity forming studies;
  - **Task 2:** Procurement of Cu- and Nb-sheets;
  - **Task 3:** Processing of the sheets including the heat treatments, chemical processing, and cutting to required size;
  - **Task 4:** Material characterisation at appropriate stages ranging from material reception to samples extracted from formed cavities;
  - **Task 5:** Quality assurance related to the sheet metal supply to ensure the conformance with the technical specification and the traceability.

# WU 5.1: Status

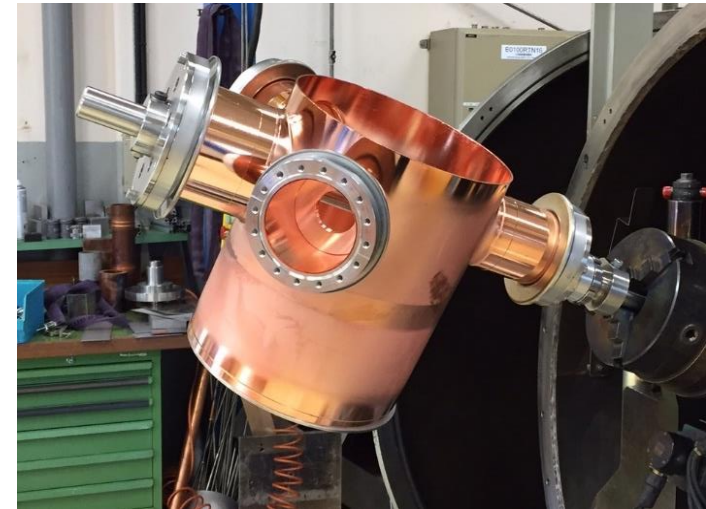
- OFE-copper supply
  - Handling of sheets to avoid scratches
  - Supply of >1000 mm wide sheets challenging
- Annealing:
  - Annealing at CERN or in industry
  - Improved tooling being manufactured
- Characterisation:
  - Samples from EHF half-cells analysed, additional tests underway
  - Samples from spun half-cells analysed, shortly from spun and machined cells

# WU 5.2: Fabrication of Seamless Cavities

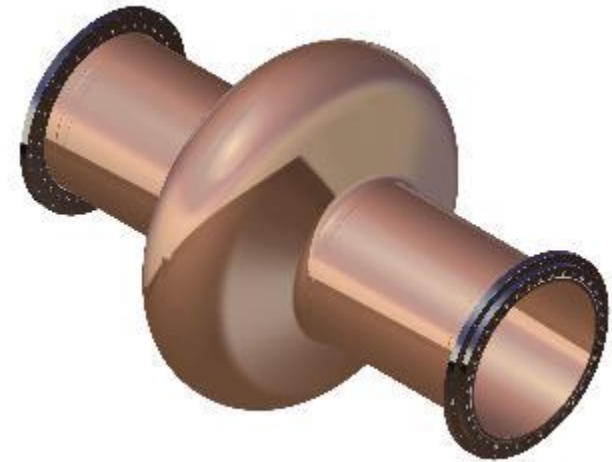
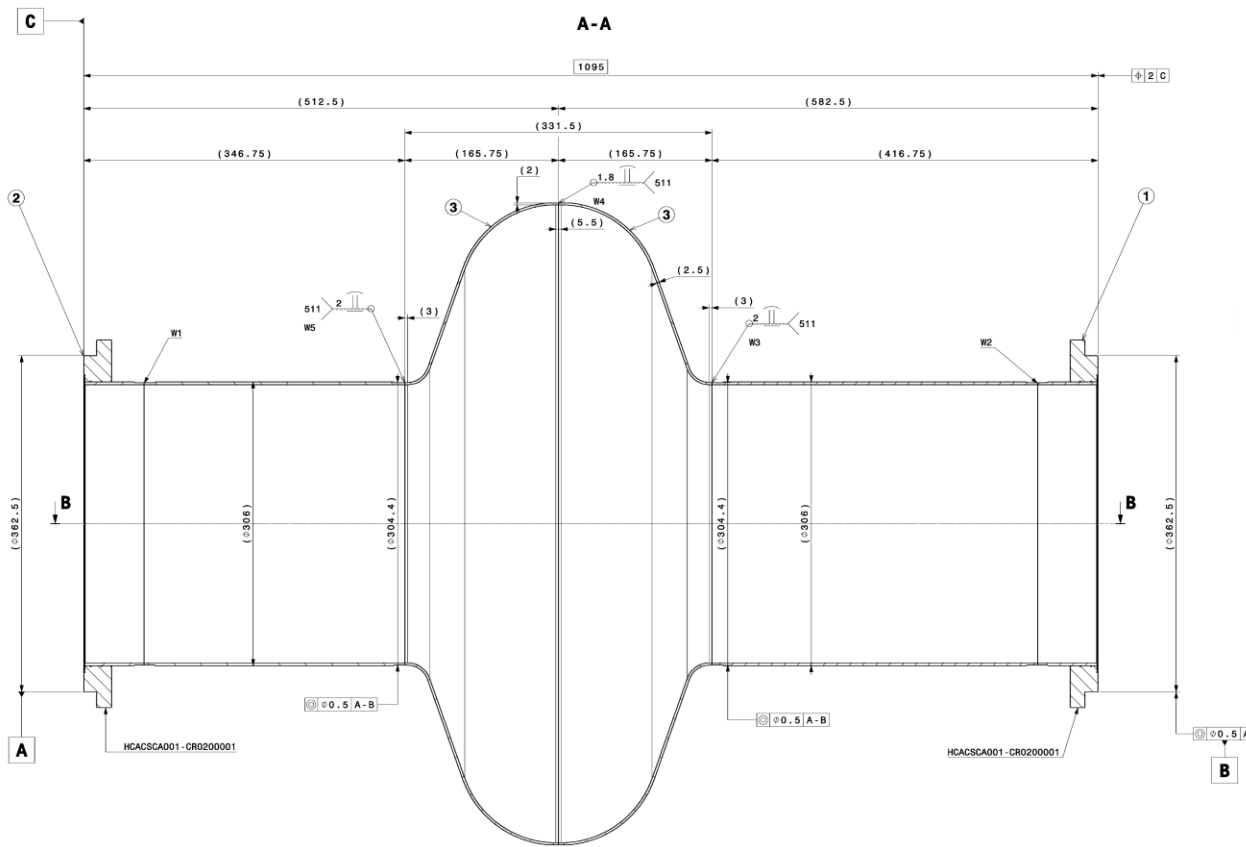
- Objective:
  - Development and validation of seamless cavity forming technology by spinning for multi-cell 800 MHz and mono-cell 400 MHz Cu-cavities
- **Task 1:** Manufacturing drawings
- **Task 2:** Fabrication of cut-off tubes
- **Task 3:** Fabrication of 400 MHz mono-cell cavity
- **Task 4:** Fabrication of 800 MHz mono-cell cavity
- **Task 5:** Fabrication of 800 MHz 2-cell cavity
- *Task 6: Fabrication of 800 MHz Nb cavity (Option)*

# WU 5.2: Status

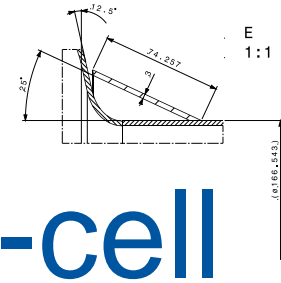
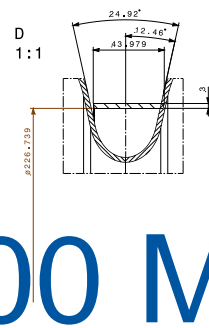
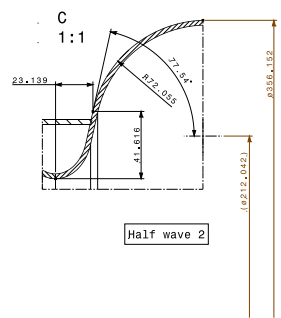
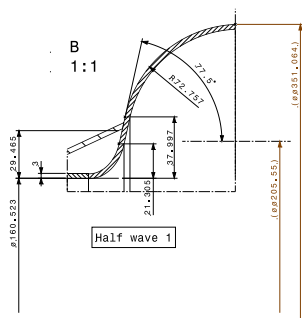
- **Task 1: Manufacturing drawings**
  - 400 MHz complete
  - 800 MHz complete
- **Task 2: Fabrication of cut-off tubes**
  - Seamless tubes being investigated
- **Task 3: Fabrication of 400 MHz mono-cell cavity**
  - Material supply challenging ( $\varnothing 1300$  mm sheets)
  - Spinning tooling in fabrication
  - First forming trials using AI expected in June



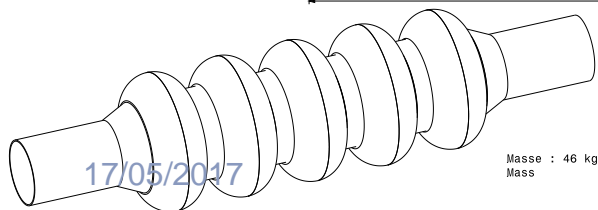
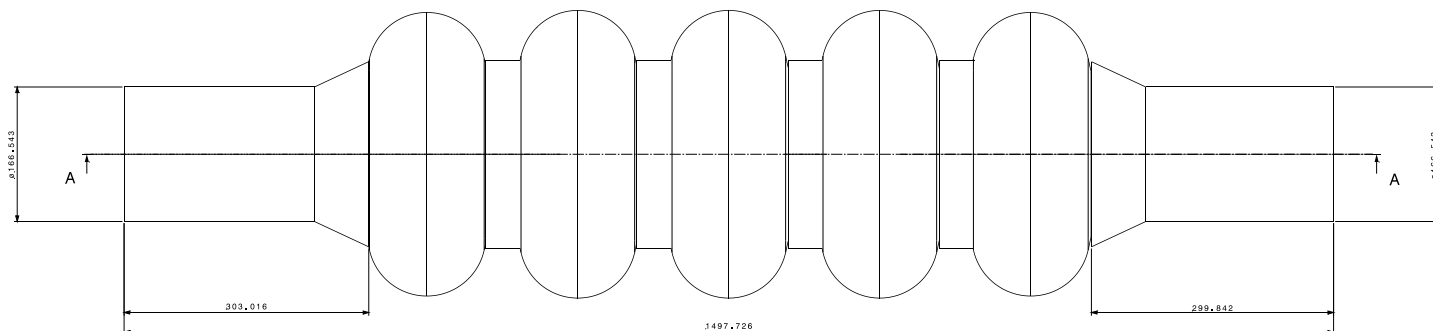
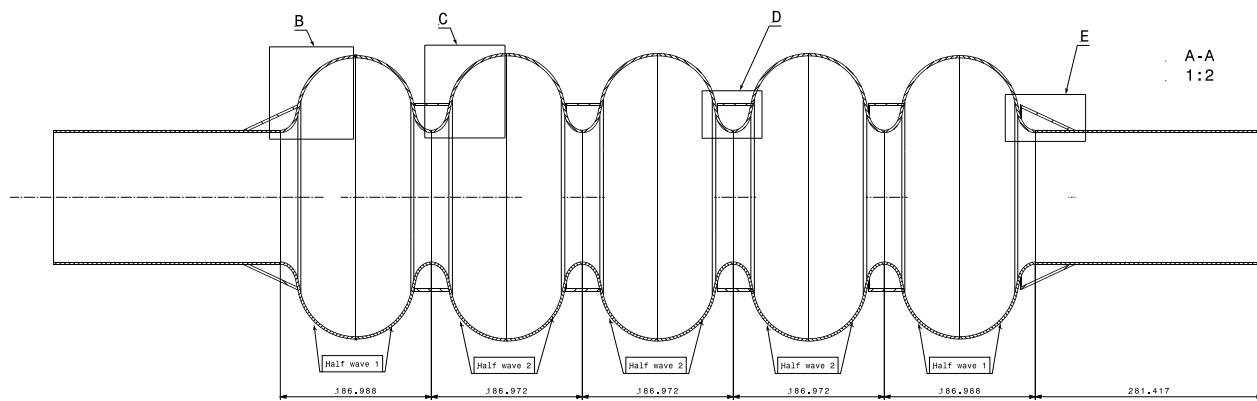
# Simplified LHC 400 MHz Practice Cavity







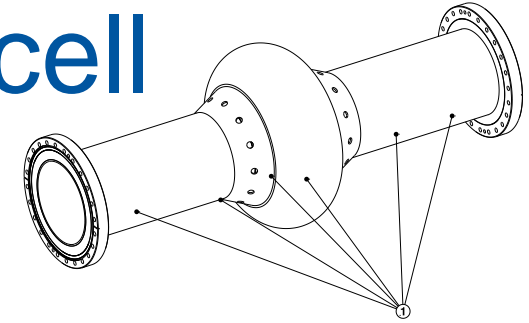
# 800 MHz 5-cell



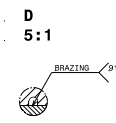
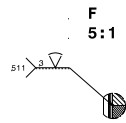
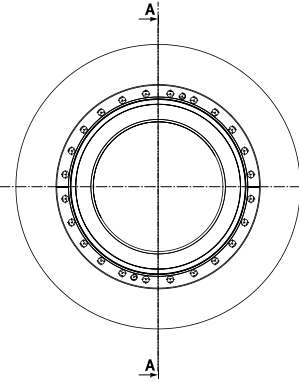
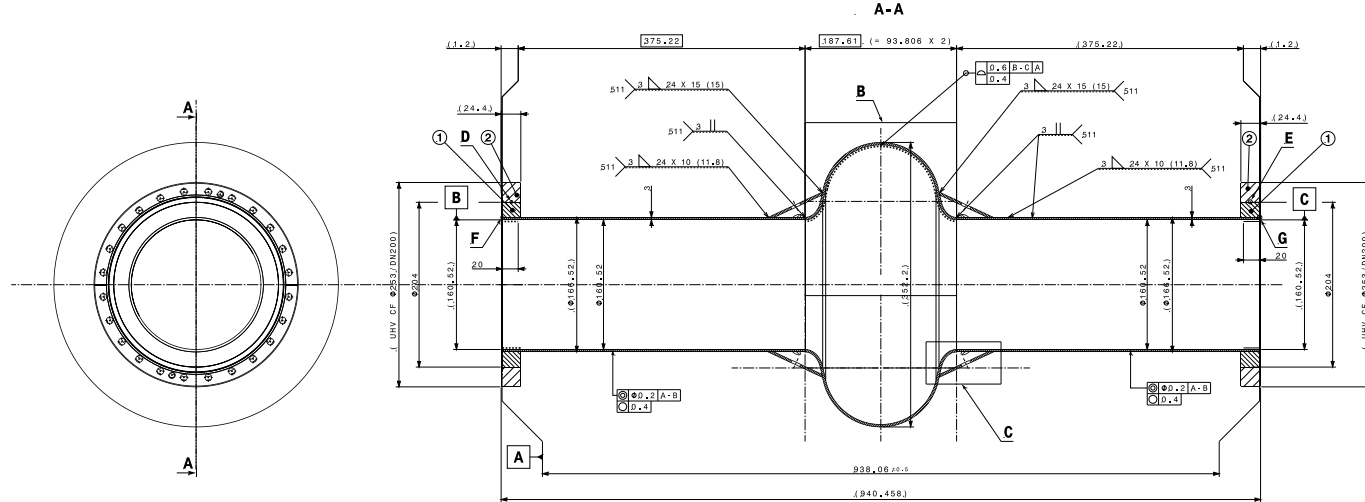
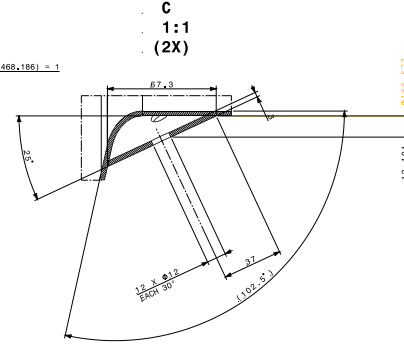
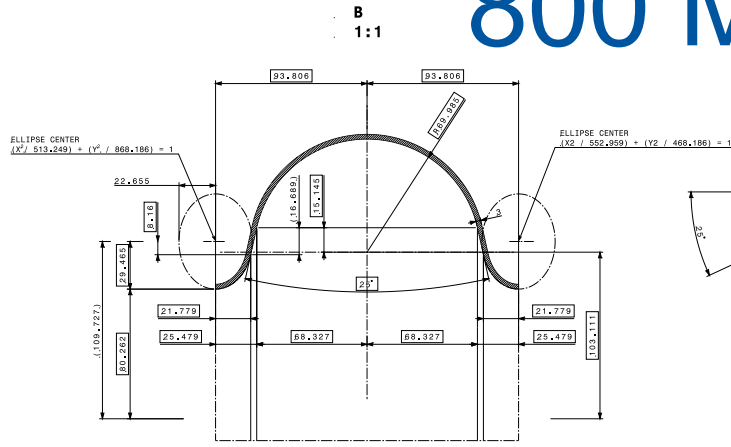
M. Karppinen CERN BE-RF-SRF

DESIGNER	DATE	REVISION	NO.	DATE
APPROVED	DATE	REVISION	NO.	DATE
DESIGNER	DATE	REVISION	NO.	DATE
APPROVED	DATE	REVISION	NO.	DATE
CAVITY FCC NiB-COATED COPPER VACUUM VESSEL CAVITE FCC NiB-COATED COPPER ENCEINTE A VIDE				
ISO 2708-EN-4 √F733 (✓) ISO 15715 15-05-15-00				
FOR VALUABLE FOR EXECUTION NOT VALID FOR EXECUTION				

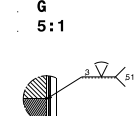
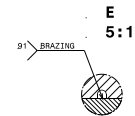
# 800 MHz Mono-cell



Mass: 29,9 Kg



ROOM TEMPERATURE DIMENSIONS  
 WELD MUST NOT BE GRIND OR FINISHED BY MECHANICAL ABRASION WITH 100% PENETRATION  
 A LEAK RATE MORE THAN  $10^{-6}$  PA.m<sup>3</sup>.s<sup>-1</sup> ( $10^{-7}$  mbar. (s<sup>-1</sup>)) IS UNACCEPTABLE  
 CHEMISTRY REMOVAL LESS THAN 20 µm  
 COATING:



17/05/2017

MILITARY STANDARD 150 WPS FOR WELDS ARE THOSE IN FORCE UNTIL 2016, OR OF REGARDLESS OF THE DRAWING DATE

REV	NO	DESCRIPTION	DATE	BY	CHKD
2	1	ISSUED			
1	1	ISSUED			

150 2788-nk	150 13715	150 13715
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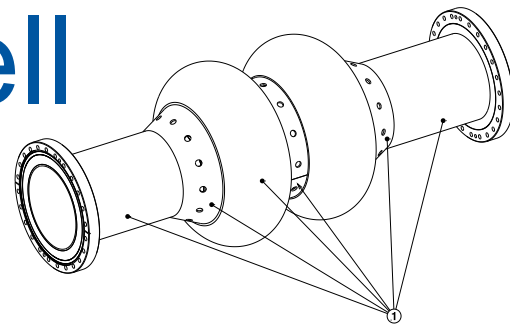
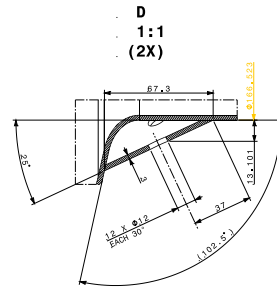
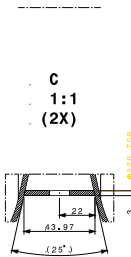
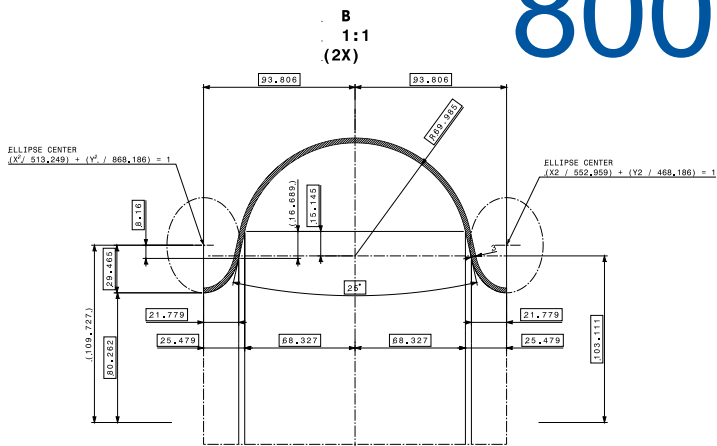
  

150 2788-nk	150 13715	150 13715
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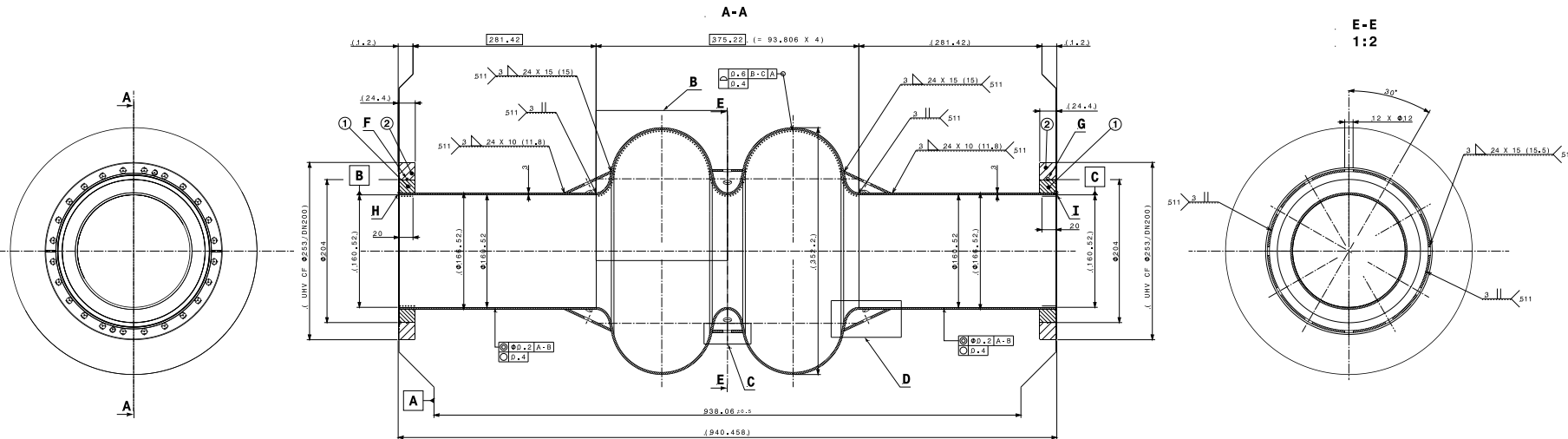
  

150 2788-nk	150 13715	150 13715
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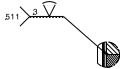
# 800 MHz 2-cell



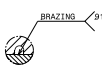
Mass: 682.9 Kg



H  
5:1



F  
5:1



ROOM TEMPERATURE DIMENSIONS

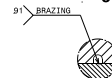
WELD MUST NOT BE GRIND OR FINISHED BY MECHANICAL ABRASION WITH 100% PENETRATION

A LEAK RATE MORE THAN  $10^{-7}$  PA·m<sup>3</sup>/s<sup>2</sup> ( $10^{-9}$  mbar·l/s<sup>2</sup>) IS UNACCEPTABLE

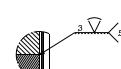
CHEMISTRY REMOVAL LESS THAN 20 µm

COATING:

G  
5:1



I  
5:1



17/05/2017

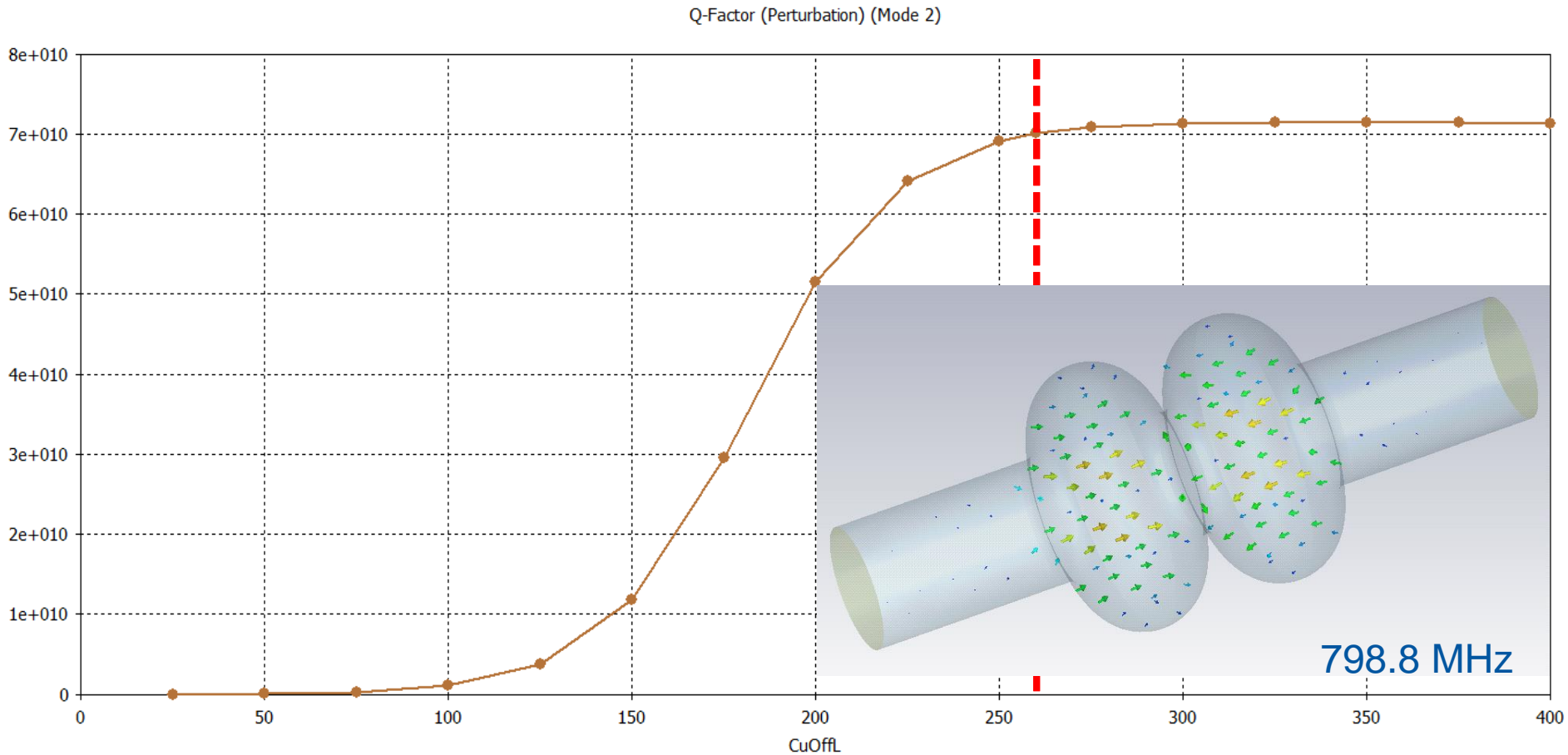
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REV	DATE	DESCRIPTION	DESIGNER	DRAWN	CHECKED	APPROVED
1	17/05/2017	INITIAL DESIGN				
2	17/05/2017	REVISION				

PROJECT	350 2708-4K	REV	1	DATE	17/05/2017
PROCESS	VACUUM (✓)	DATE	17/05/2017	REV	1
ITEM	350 2708-4K	REV	1	DATE	17/05/2017
DESCRIPTION	Cavity with 2 Cells - assembly 800 MHz CAVITY - FCC PROJECT				
DESIGNER	PIPA	DATE	17/05/2017	REV	1
CHECKED	PIPA	DATE	17/05/2017	REV	1
APPROVED	PIPA	DATE	17/05/2017	REV	1

FOR VALUABLE FEEDBACK  
DO NOT HESITATE TO CONTACT US

# Cut-off length 260 mm



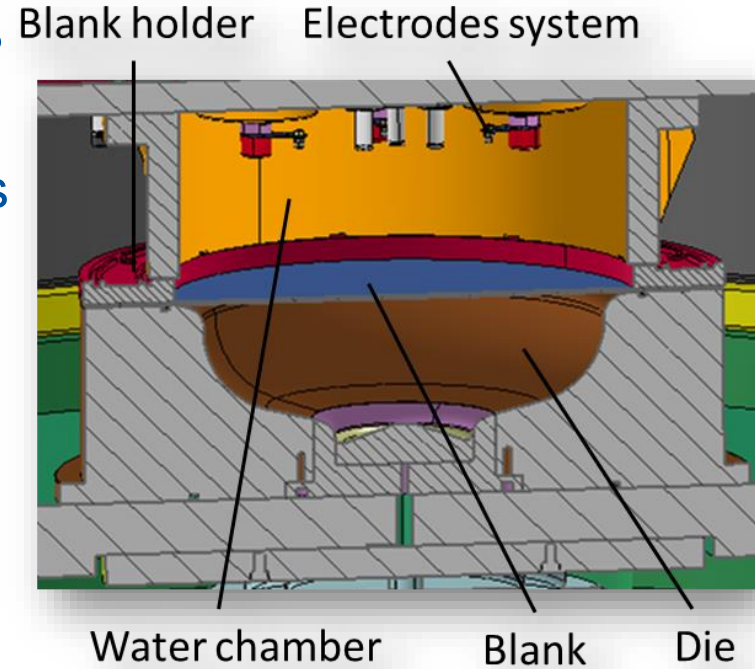
# WU 5.3 High Velocity Forming of SC RF-Structures

- Objectives:
  - Thorough understanding of the EHF process applied to elliptical niobium cavities (Cu for technical development)
  - Characterisation and modelling of Cu and Nb for EHF;
  - Option: Production of a Nb functional structure.
- **Task 1:** Manufacturing drawings
- **Task 2:** Forming of 800MHz Cu half-cells
- **Task 3:** Fabrication of cut-off tubes
- **Task 4:** Fabrication of 800 MHz Cu-cavity from half-cells
- **Task 5:** Feasibility study of of seamless Nb 800 MHz cells by Numerical modelling

# WU 5.3 Status

## Task 2: Forming of 800MHz half-cells

- Drawings available.
  - 704 MHz 3 x Cu and 2 x Nb half cells produced
    - Cu dimensionally acceptable
    - Nb half-cells require further development.
    - Halted since Mid-2016.
  - Forming tool for 800 MHz half cells launched



## WU 5.4 Fabrication of 1.3 GHz seamless cavities

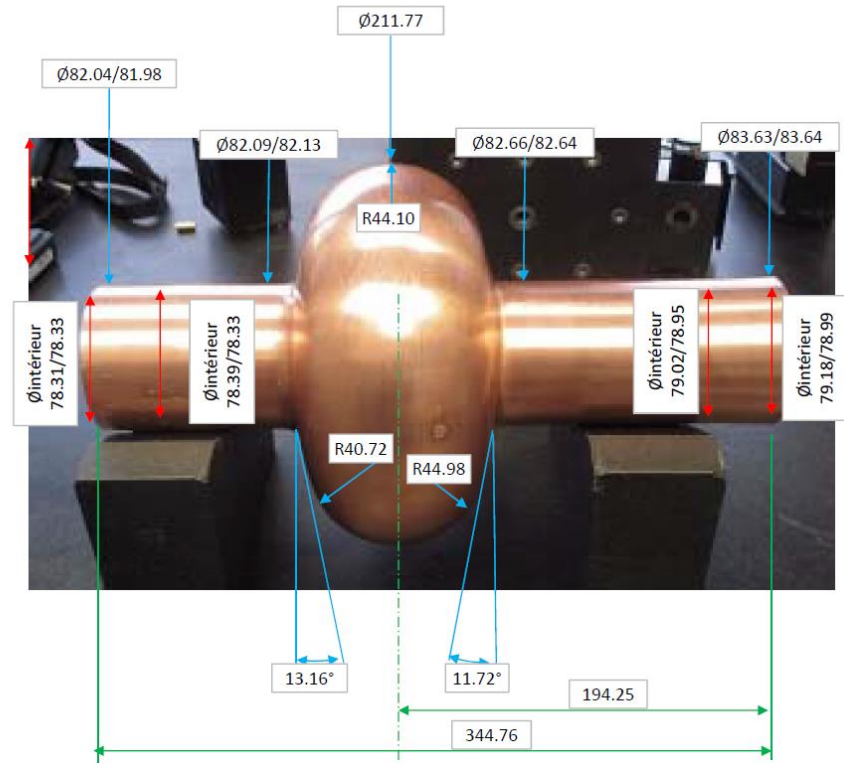
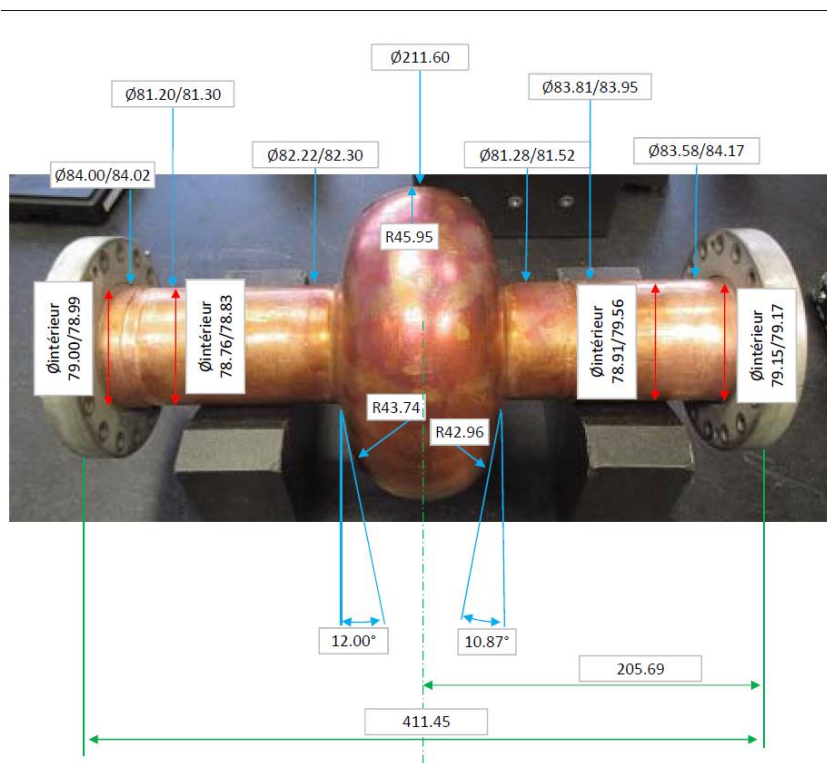
- Objectives:
  - New 1.3 GHz substrates for coating studies within **WP3**
  - Clones of spun cavities used for R&D in the 1990's
- Status:
  - 10 x seamless Cu cavity cells ordered in Feb-16 were delivered by LNL in Dec-16
  - Dimensional inspection in progress
  - Cut-offs for 4 cavities in stock
- Plans:
  - Cavity assembly, chemical processing, coatings
  - RF-tests..



Courtesy of W. Venturini CERN BE-RF-SRF



# First impression on metrology



Courtesy of W. Venturini CERN BE-RF-SRF

# WU 5.4 Fabrication of 800 MHz 5-cell Nb cavity

- Objectives:
  - Single cell & 5-cell (simplified cut-offs)
  - To use as reference cavities
- Status (March-17):
  - Tooling in production
  - Nb in stock
- Plans:
  - Trial cells to validate the form
  - Fabrication of Nb cavities
  - Full processing and testing at JLAB
  - Re-testing at CERN