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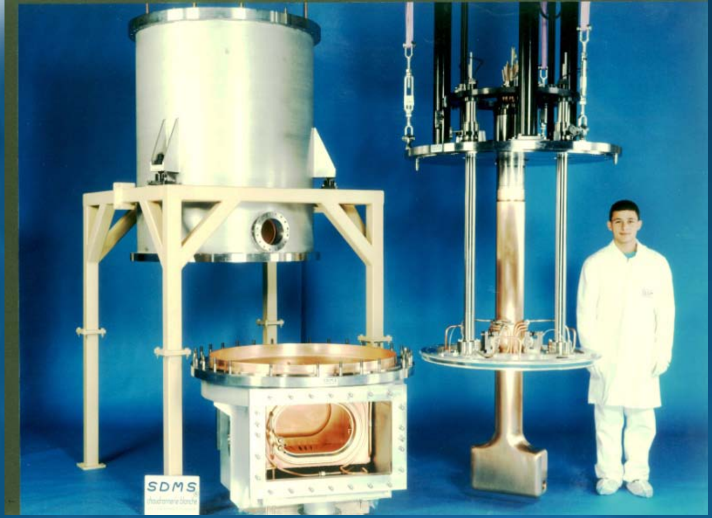
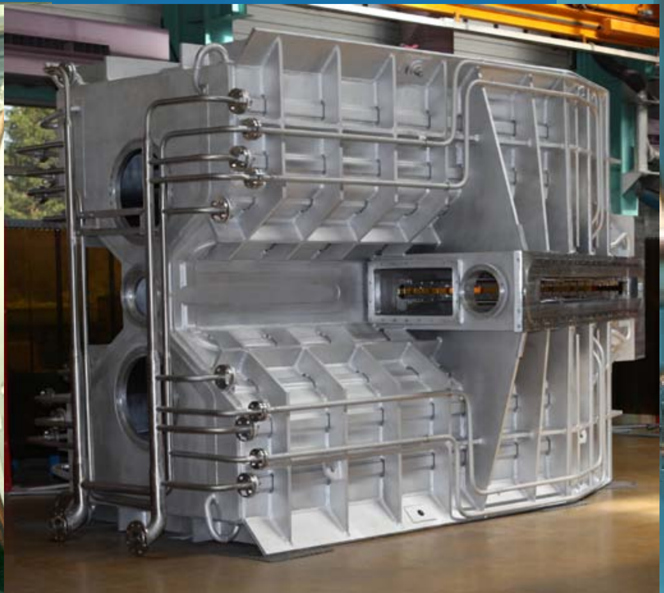


RF Cavities Manufacturing Techniques I

CAS 2010 June 16, Ebeltoft Denmark
Pierre Maccioni, SDMS Technologies
38160 St Romans, France



The main aims of this presentation are:

- To unveil and list the **under jacent basic and quite simple concepts** ruling the **NC RF Cavities** construction techniques

- To show and describe now a days **Standard Technologies mastered by Industry** for manufacturing **NC RF Cavities**

- To illustrate the talk with **several typical examples** based on **SDMS experience**

Who is SDMS Technologies ? A few numbers:

- 1 High Technology French SME Company

- For highly demanding customers… when Technology matters !

- 2 Plants locations:

- **St Romans:** 130 p. (30 engineers and managers) 20 M€/year
- **Manosque :** 90 p. (20 engineers and managers) 10 M€/year

- 3 Fields of Activities:

- Energy, Research, Defence&Space

- 4 Technologies Poles:

- Nuclear, Vacuum, Cryogenics, Mecatronics

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Our Clean Workshops

NC RF Cavities made by Industry (Ideal Case)

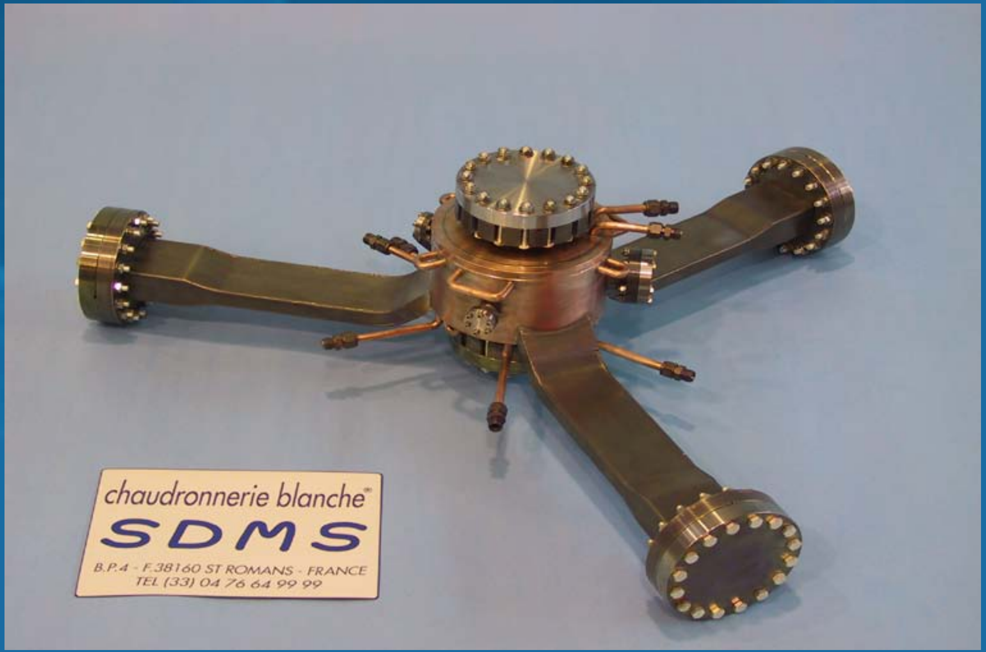
1 - Design

2 – Materials

3 – Forming Techniques

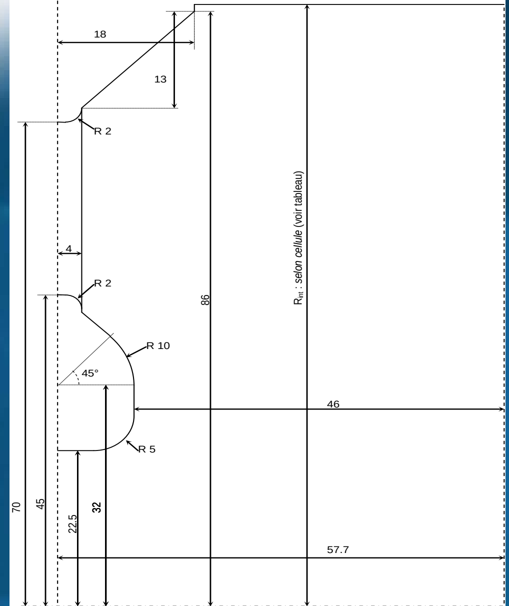
4 – Cleaning Techniques

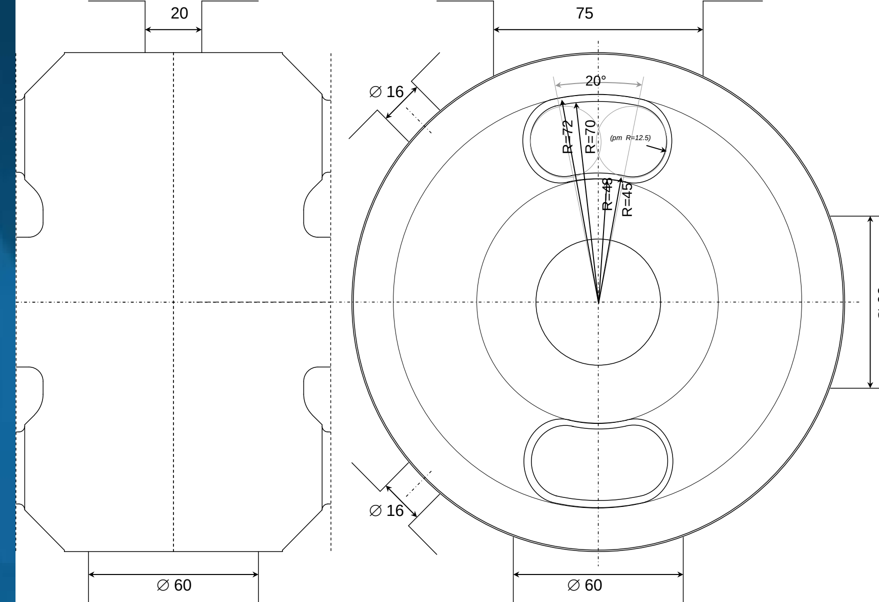
5 – Joining Techniques



6 – ND Control Techniques, RF and Vacuum Conditionning

7 – New ESRF Cu Cavity: Comparison between 2 Manufacturing Routes



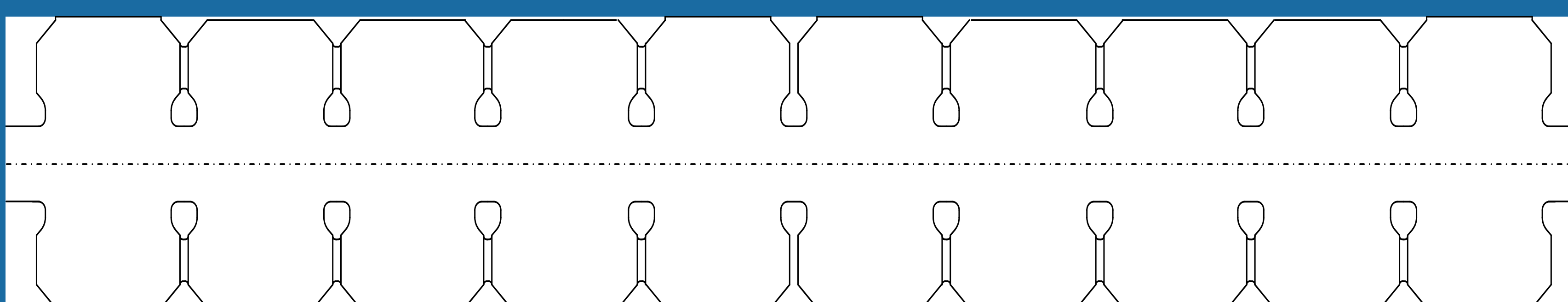


BASIC DESIGN (made by the Customer)

- General Design (needs of the Research Center… dreams of the Physicist !!)

  - Global shapes, mandatory dimensions, RF parameters…

  - Conditions in use, thermo mechanical requirements, vacuum…



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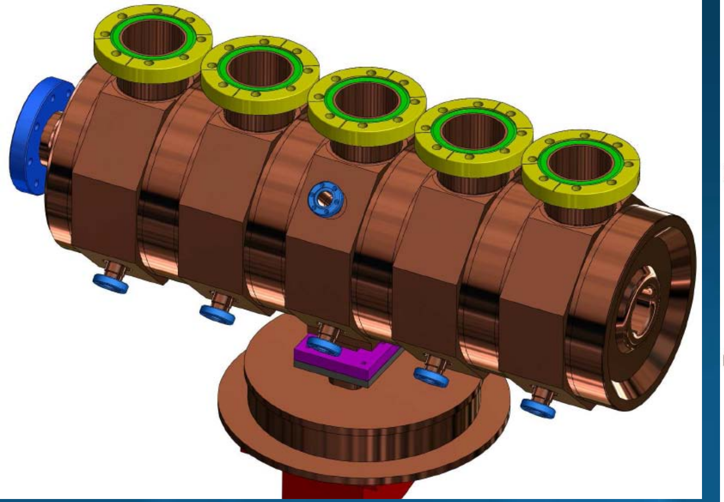
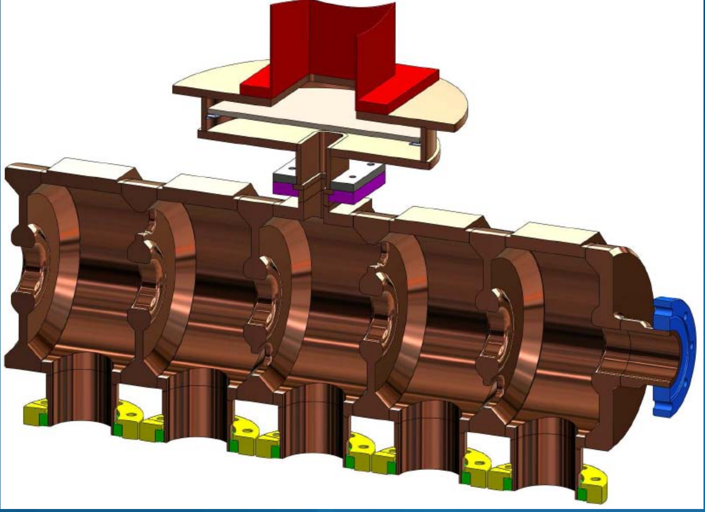
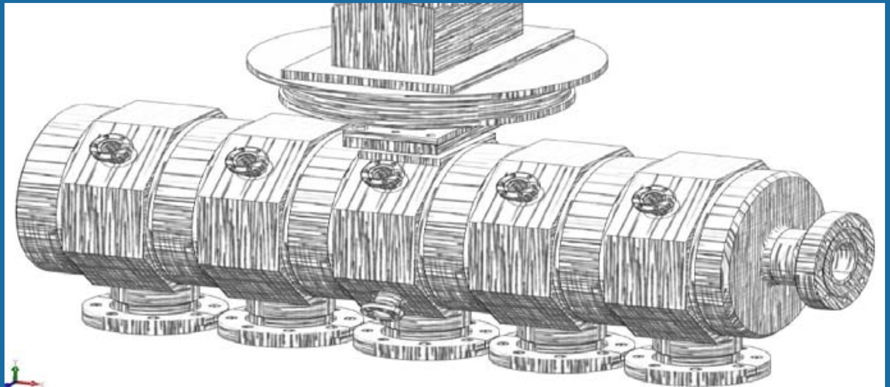
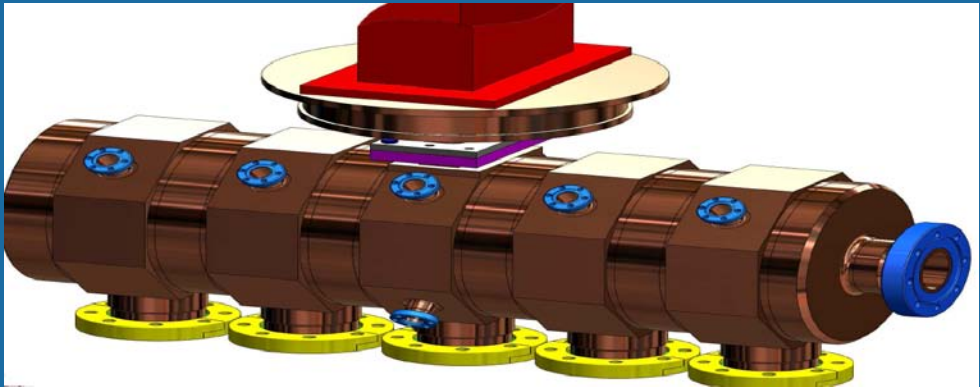




ENGINEERING DESIGN (made by the Industry)

- Precise Design (imperatives of Industry… from dreams to reality)
    - Detailed Design: Mechanics, Cooling systems, Interfaces…
    - Manufacturing Design: Processes choices, Toolings, Fabrication route…





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« IDEAL » MATERIALS FOR NC RF CAVITIES

Important « Physical » Properties

	Electrical Conductivity	Thermal Conductivity	Mechanical Stiffness	Secondary Emission Coefficient
- <u>OFHC COPPER</u>	Very Good $5.8\ 10^{9}\ (\Omega.m)^{-1}$	Very Good 400 W/m/K	Poor $1.2\ 10^{10}$ daN/m²	Good
- <u>COPPER ON STEEL</u>	Good $5.0\ 10^{9}\ (\Omega.m)^{-1}$	Poor 20 W/m/K	Very Good $2.1\ 10^{10}$ daN/m²	Good
- <u>PURE ALUMINUM</u>	Good $3.7\ 10^{9}\ (\Omega.m)^{-1}$	Good 220 W/m/K	Bad $0.7\ 10^{10}$ daN/m²	Bad

« IDEAL » MATERIALS FOR NC RF CAVITIES

Important « Engineering » Properties

	Availability Cost	Machinability Formability	Weldability Brazability	Vacuum Outgasing Rate
- <u>OFHC COPPER</u>	Expensive 40 €/Kg	Good	Good	Good 1.5 10^{-11} mbar.l/s/cm²
- <u>COPPER ON STEEL</u>	Cheap 4 €/Kg	Good	Very Good	Bad 1.5 10^{-10} mbar.l/s/cm²
- <u>PURE ALUMINUM</u>	Rather cheap 10 €/Kg	Good	Bad	Good 1.5 10^{-11} mbar.l/s/cm²

FORMING TECHNOLOGIES FOR NC RF CAVITIES

	Cost	Toolings	Accuracy	Surface Quality
MACHINING / ED STRIKING	Cheap	None	High (+/- 2 µm)	Very Good (<0.1 µm)
ROLLING / FOLDING	Cheap	Few	Good (+/- 0.5 mm)	Good (<2 µm)
FORGING / MATRICING	Expensive	Heavy	Rough (+/- 10 mm)	Damaged Crust
SPINNING / FLUOTURNING	Cheap	Shapes	Good (+/- 0.2 mm)	Good (<4 µm)
DEEP DRAWING / PRESSING	Cheap	Dies	Good (+/- 0.2 mm)	Good (<4 µm)
HYDROFORMING	Expensive	Multi Dies	Good (+/- 0.2 mm)	Orange Peel
ELECTROFORMING	Expensive	Lost Mould	Good (+/- 0.2 mm)	Etching Pits
EXPLOSING	Cheap	Shapes	Good (+/- 0.2 mm)	Damaged Crust

A combination of several techniques can be used for one given cavity, according to the concerned part

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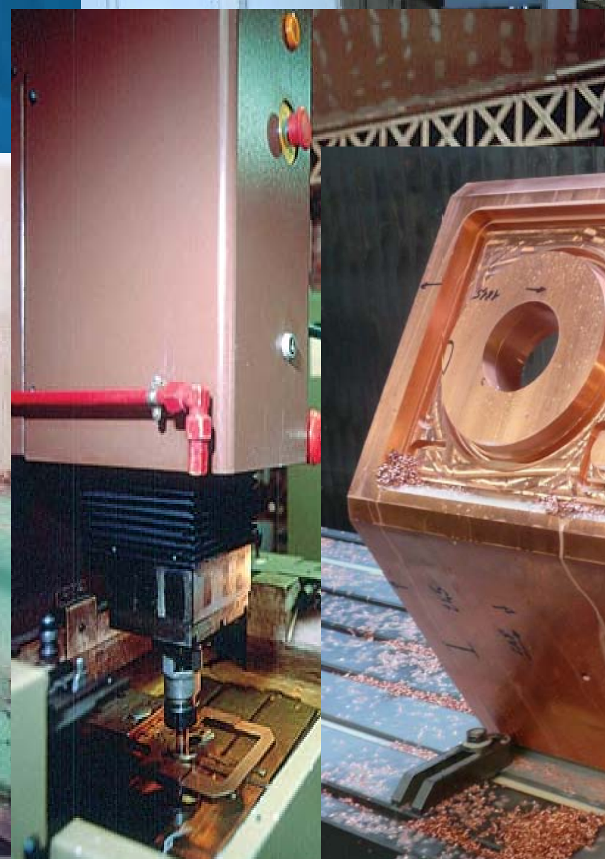
MACHINING ED STRIKING



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ROLLING
FOLDING

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FORGING MATRICING

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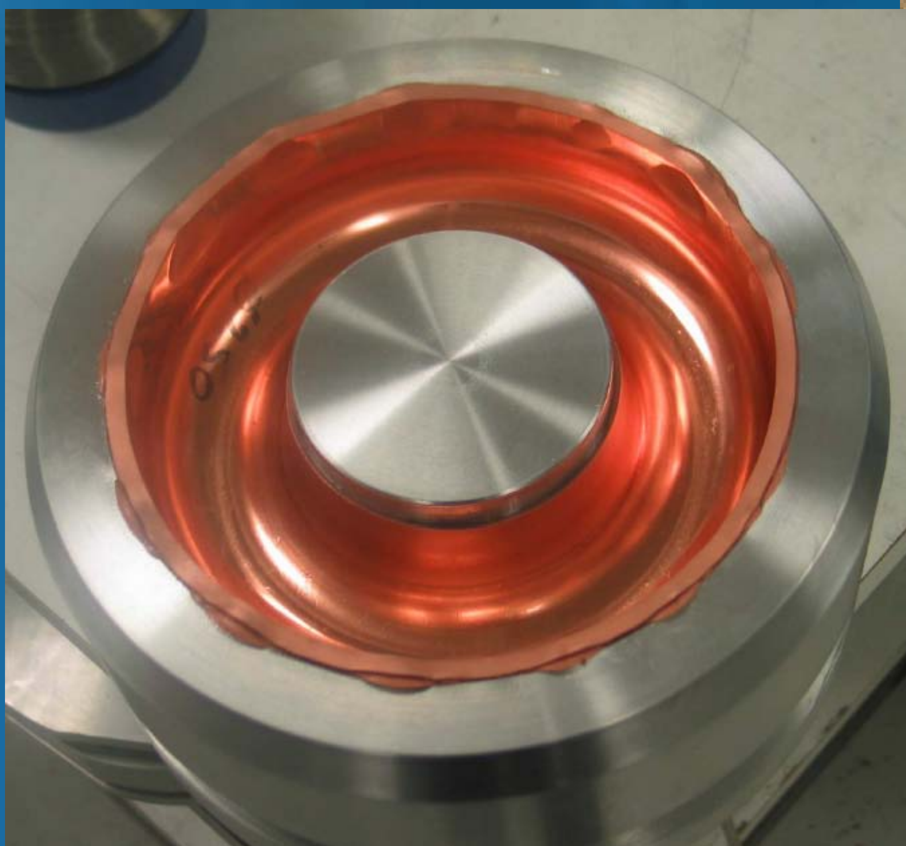
DEEP DRAWING PRESSING



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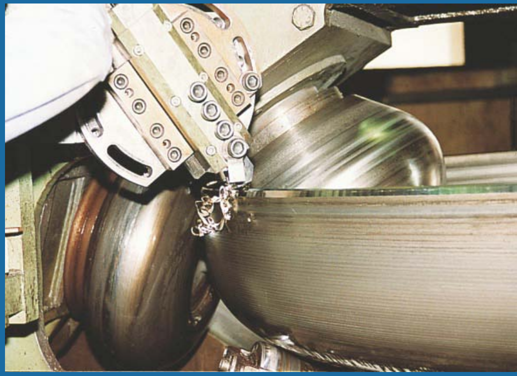
SPINNING
FLUOTURNING



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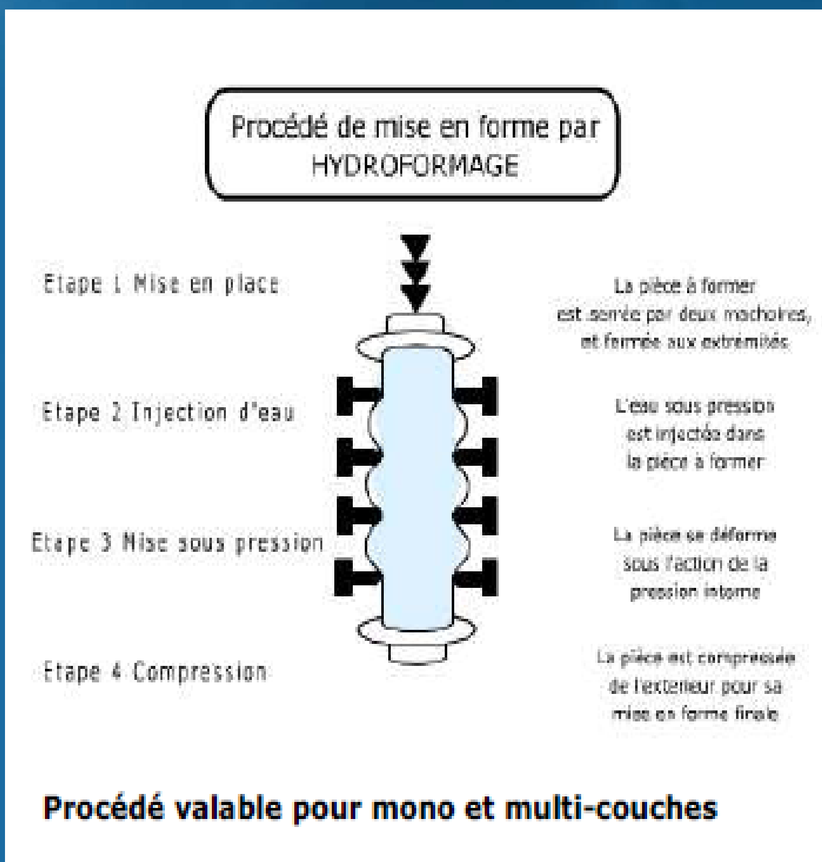
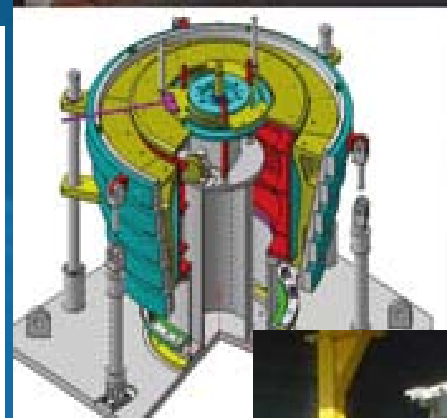
HYDROFORMING





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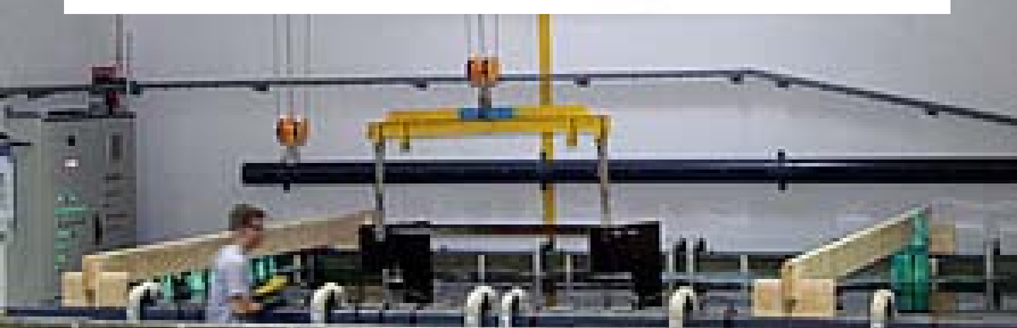
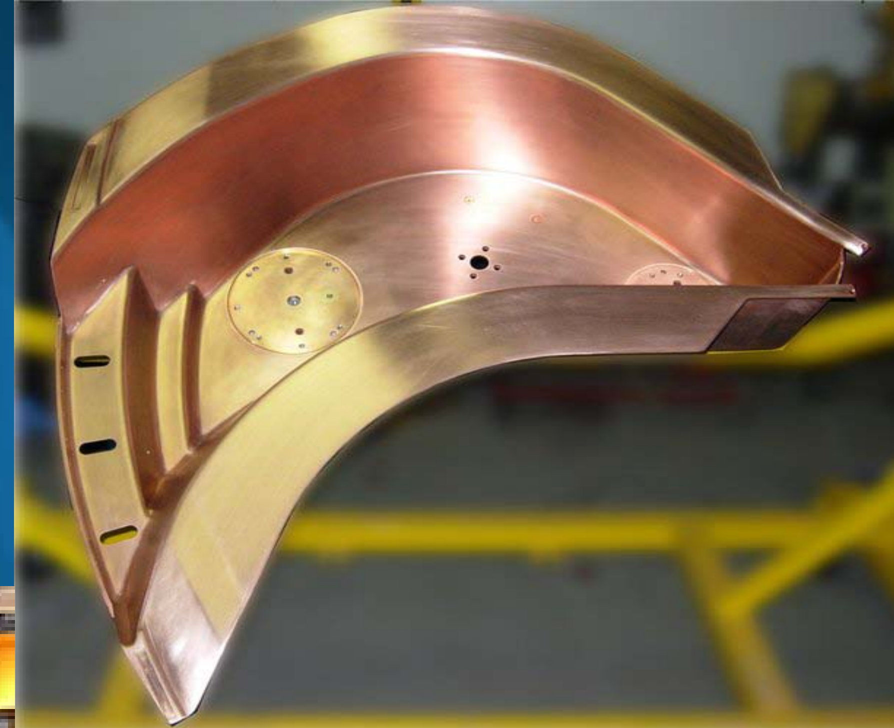
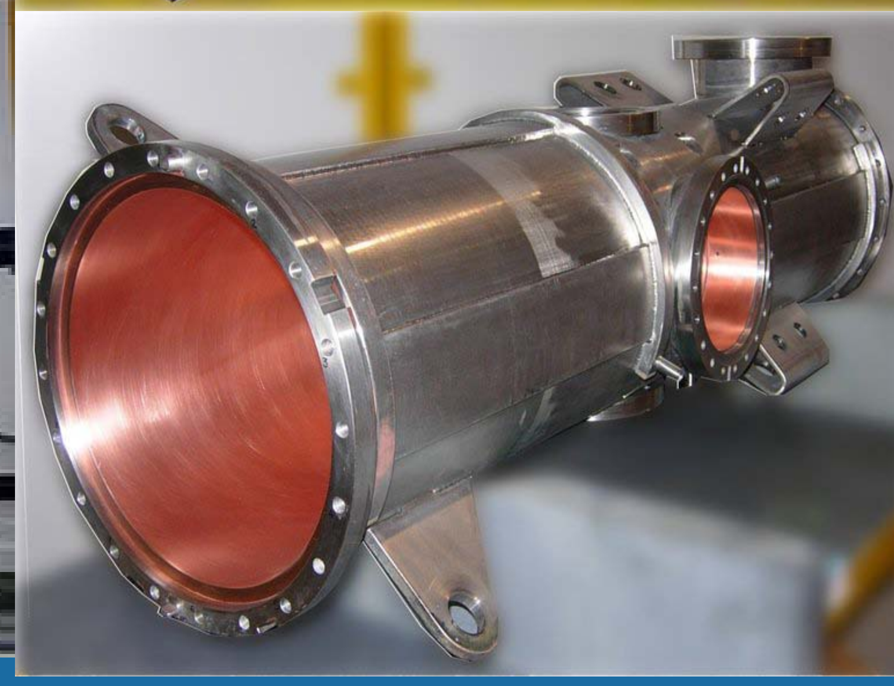
ELECTROFORMING
ELECTROPLATING







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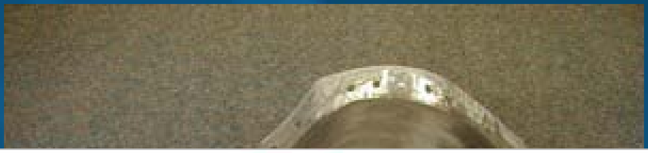
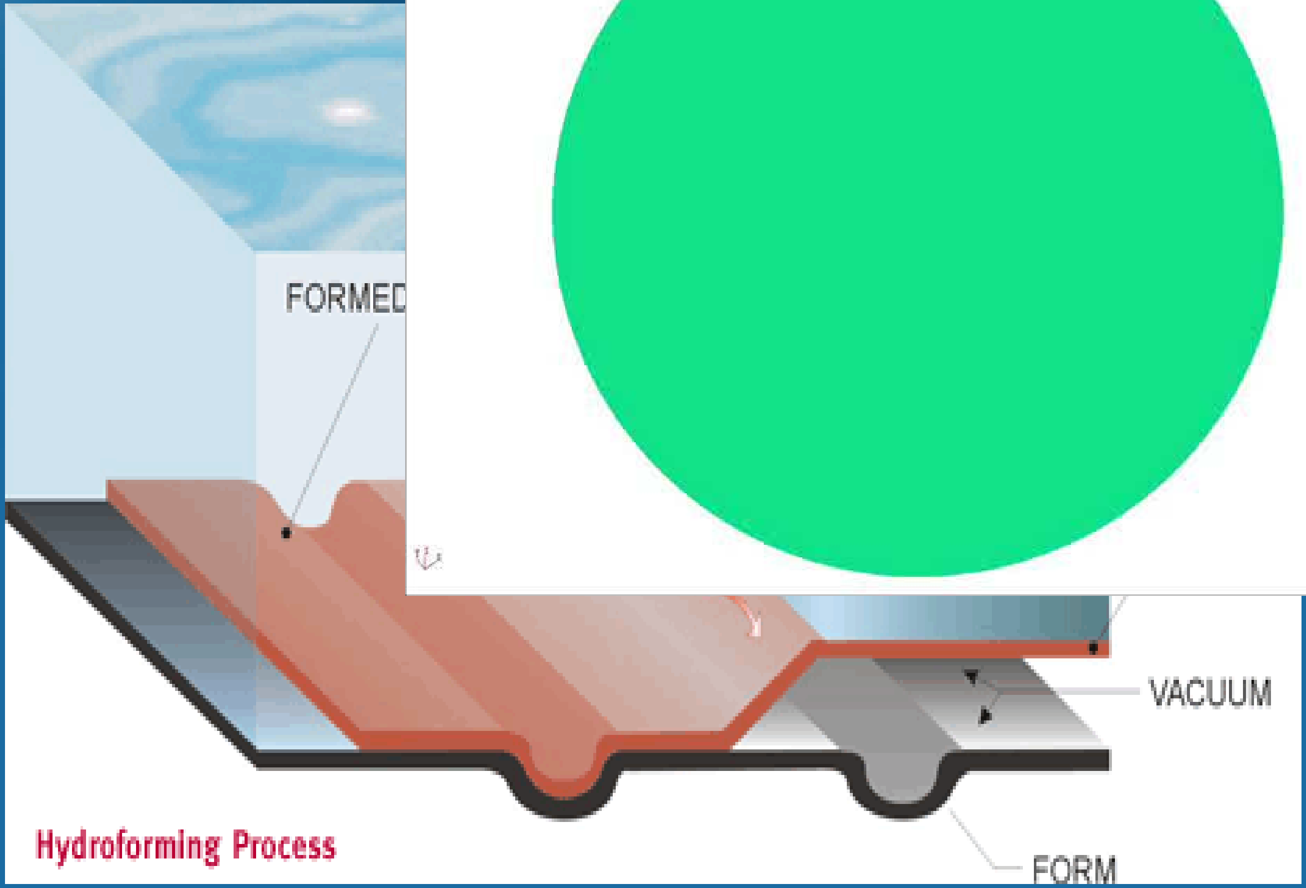
EXPLOS





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CLEANING TECHNOLOGIES FOR NC RF CAVITIES

DEGREASING

Hot Solvant Vapours + Alkaline Detergent + US

ETCHING

Acid Desoxydation + Etching (A or B) + Passivation

CHEMICAL POLISHING

Acid + Alcool + Hydrogene Peroxyde Mixture

ELECTROPOLISHING

Acid + Alcool + Current Density

PURE WATER RINSING

ETHANOL DRYING

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JOINING TECHNOLOGIES FOR NC RF CAVITIES

VACUUM BRAZING

DIFFUSION BONDING

SOLDERING

TIG/MIG WELDING

ELECTRON BEAM WELDING

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VACUUM BRAZING

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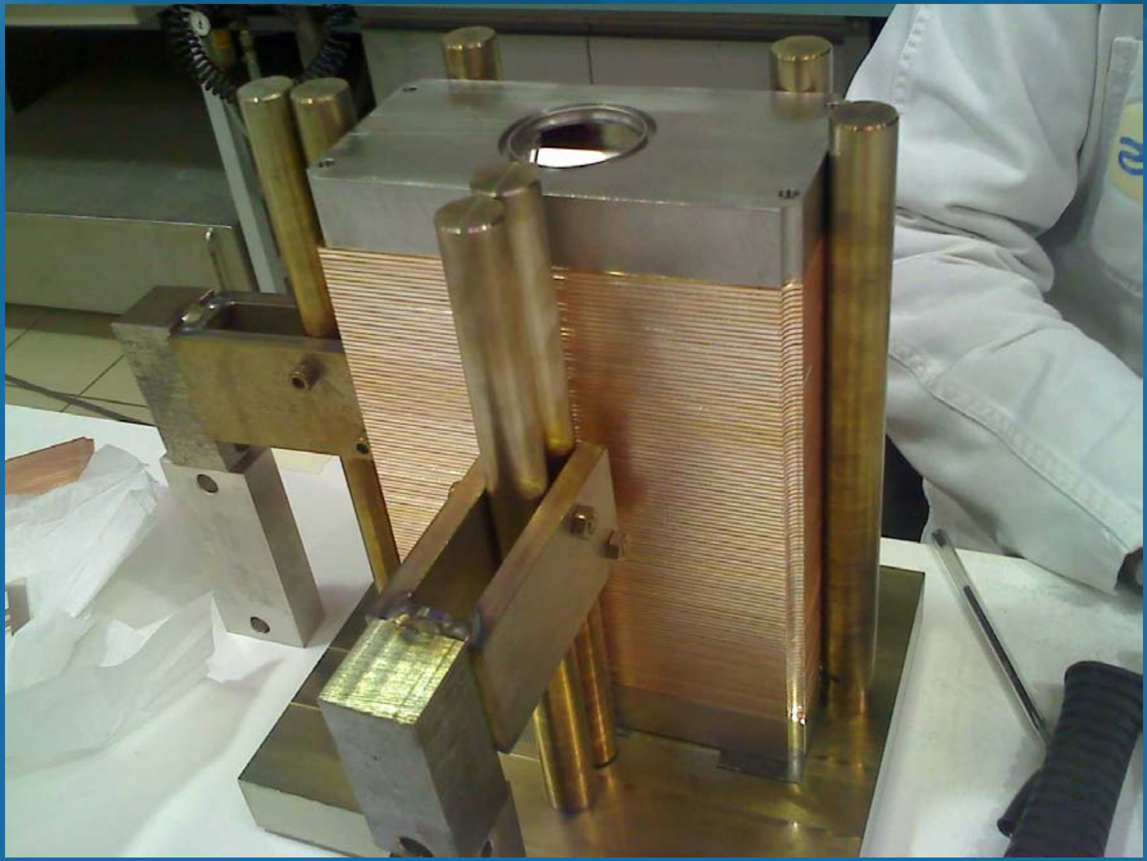
DIFFUSION BONDING



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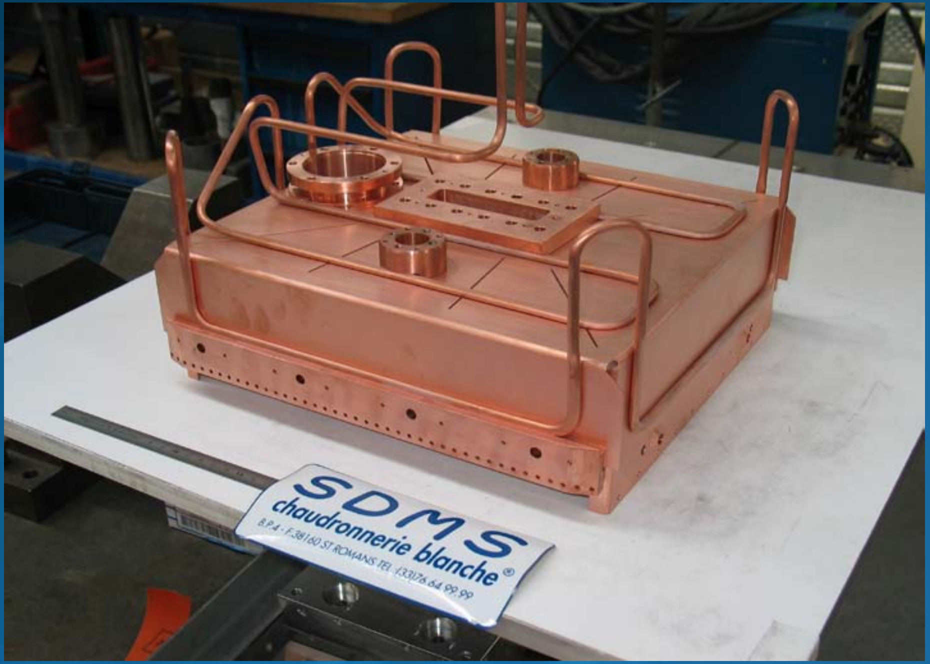
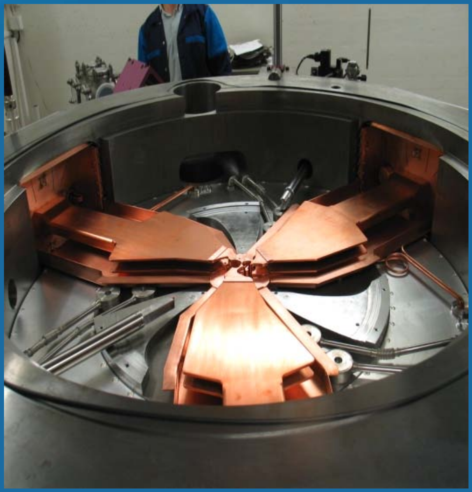
SOLDERING





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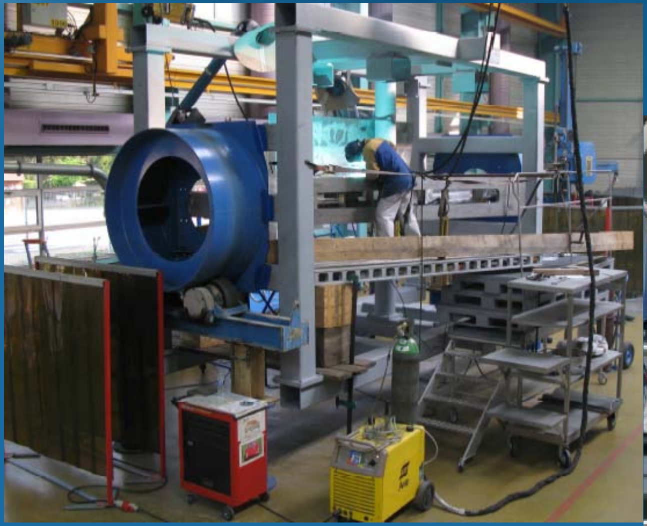
TIG/MIG WELDING



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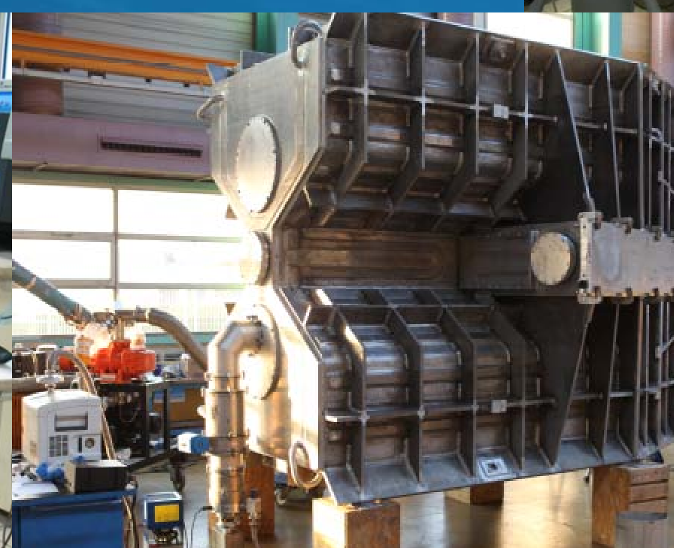
ELECTRON BEAM WELDING

ND TESTING TECHNOLOGIES FOR NC RF CAVITIES

- 3D CONTROLS
- HELIUM LEAK TESTS
- RF TESTS AND ADJUSTMENTS
- VACUUM CONDITIONNING



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PSI 56 MHz pure Al Cavity

Al TIG, MIG, and EB Welded

PSI 65 MHz pure Cu Cavity

Cu TIG and EB Welded

SS/Cu Brazed and Soldered

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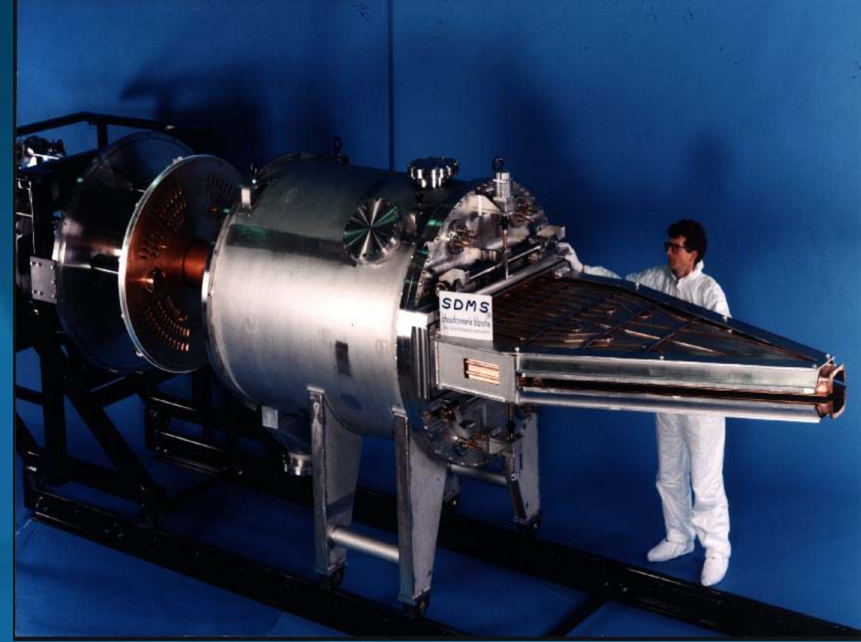
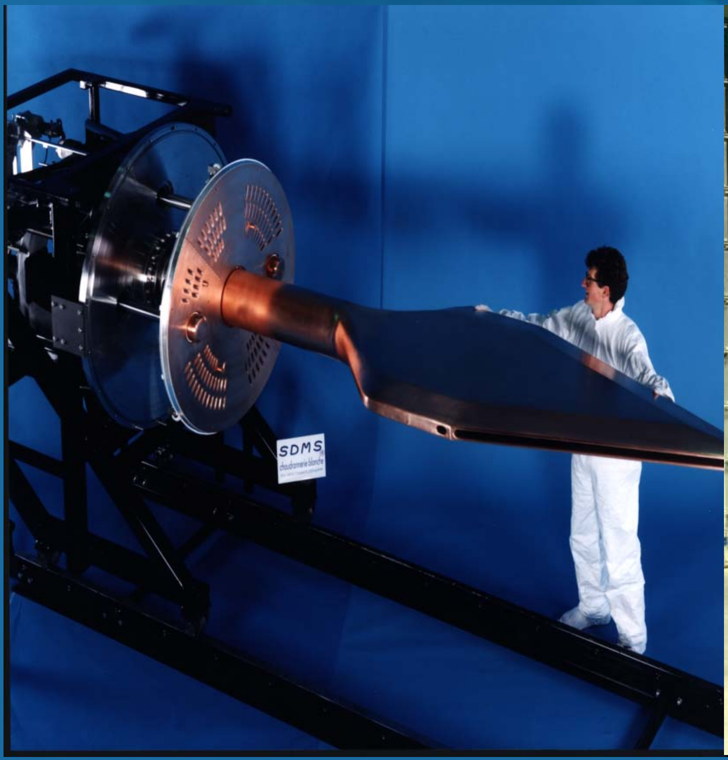
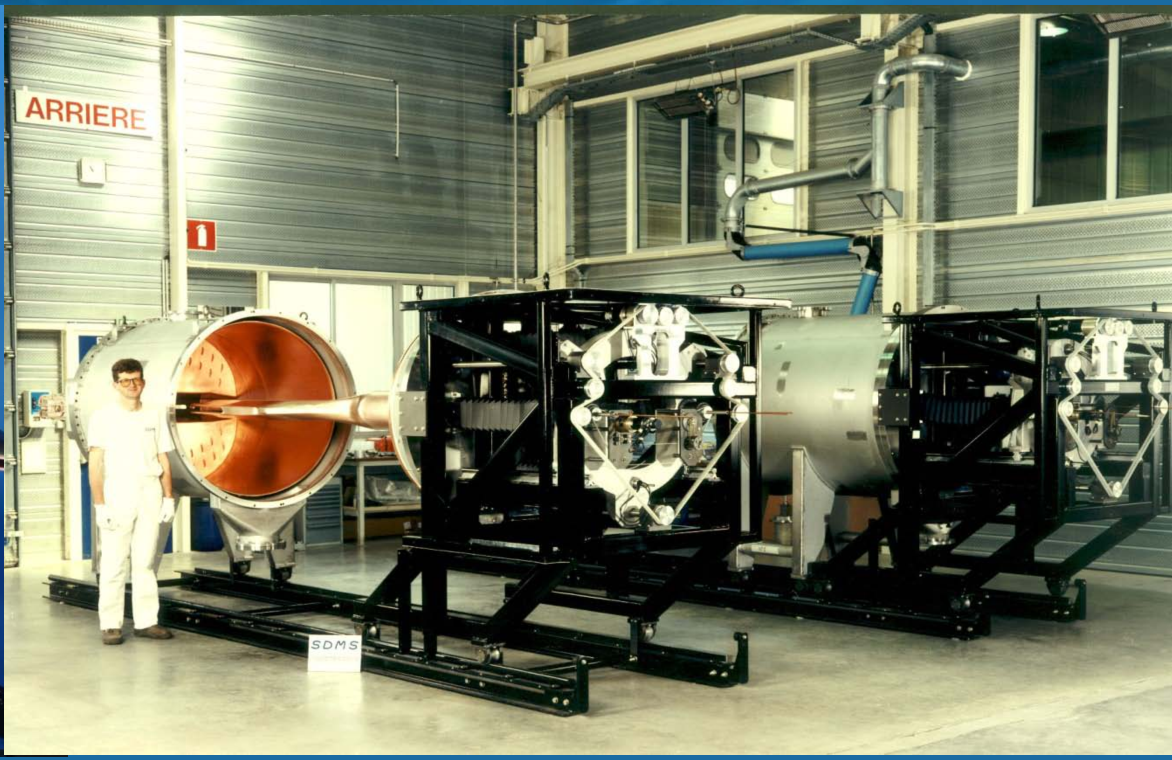
GANIL 9 to 15 MHz Cu and SS CAVITIES
Cu EB Welded and Brazed
SS TIG Welded
Cu Plated on SS







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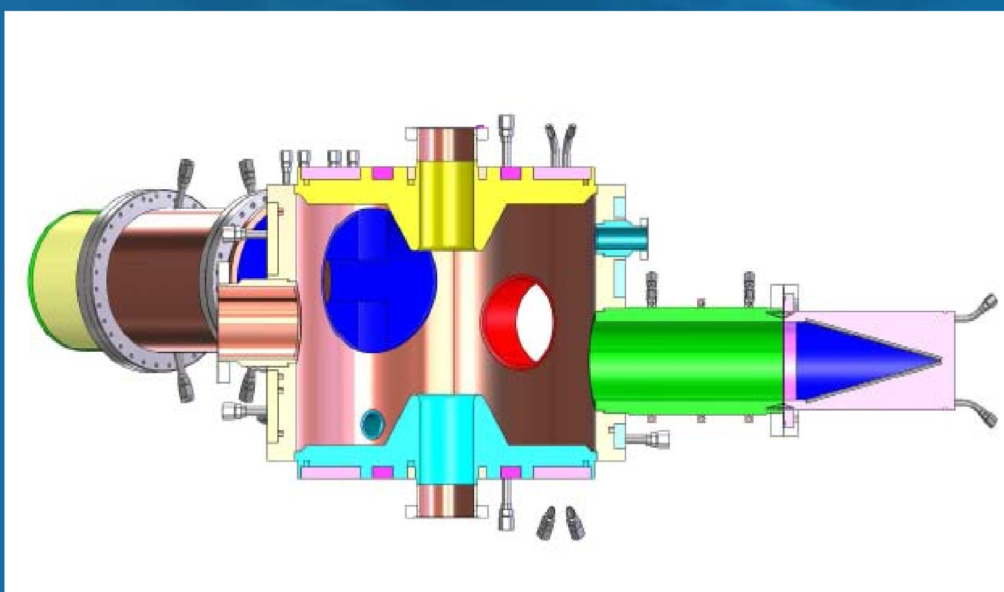
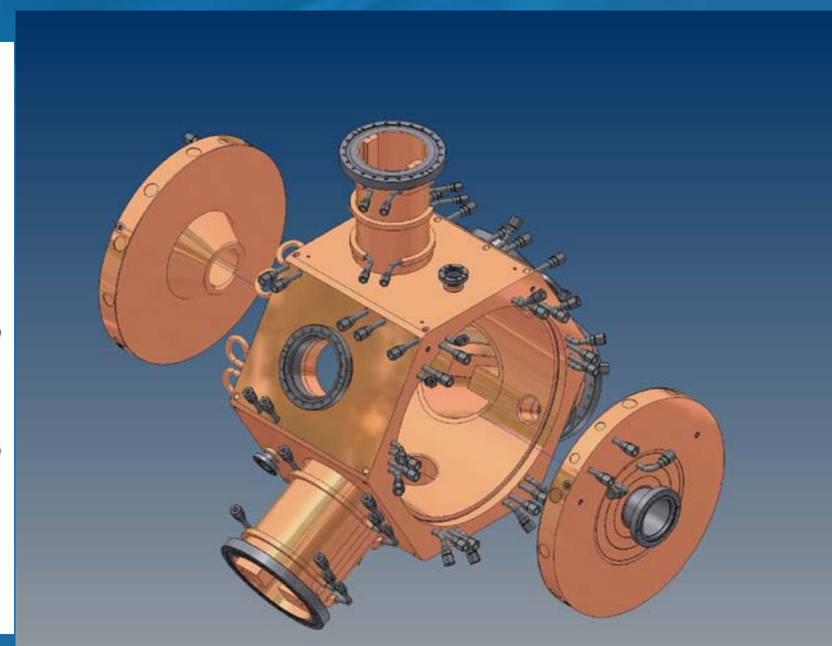
THE NEW ESRF Cu CAVITY: RF Design by the Lab

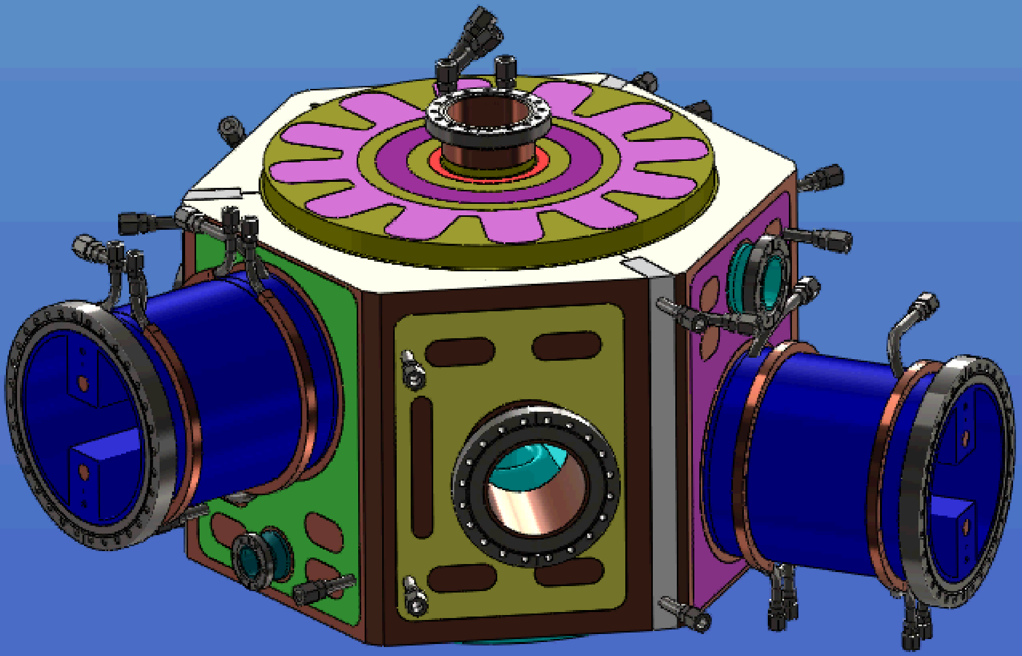
A NICE COMPARISON OF 2 MANUFACTURING ROUTES
A FAIR COMPETITION BETWEEN 2 SKILLED SUPPLIERS



EB Welded Concept (SDMS)



Vacuum Brazed Concept (RI)



Thanks to SDMS Industrial partners for photos credit:

BONITEMPO (Spinning), COURBIS (Deep Drawing),CORIMA (Electroforming), BRILLAT (Rolling), OMG (Machining), HYDROPRESS (Hydroforming), CARLIER (Forging), EXPLOFORM (Explosing)

THANK YOU FOR YOUR KIND ATTENTION…!