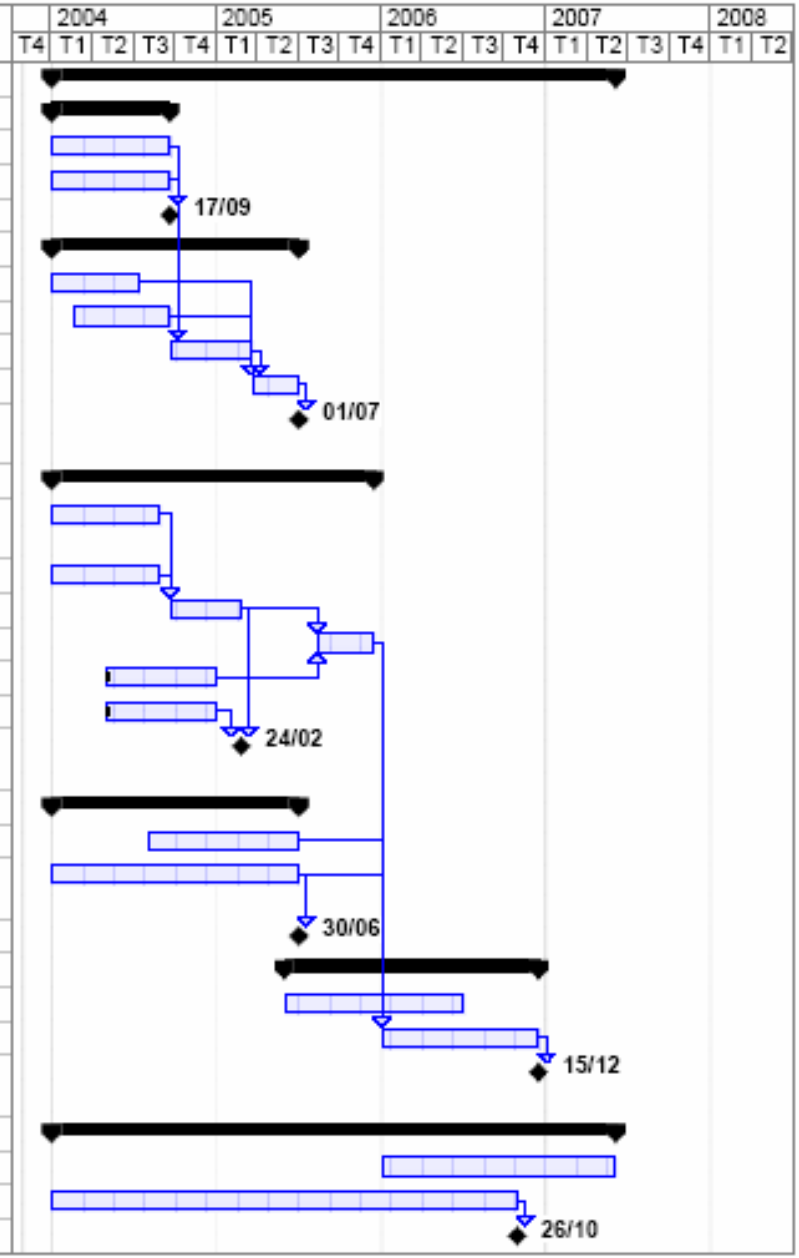
3.2 Seamless by Hydroforming

W. Singer

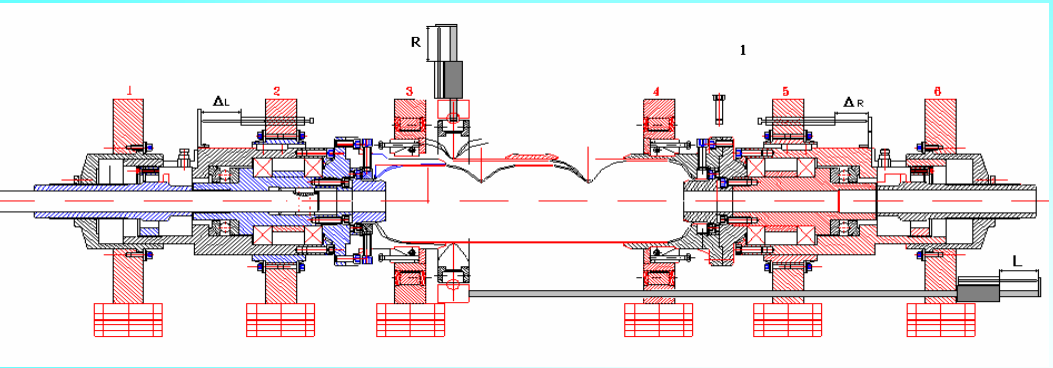
- Necking device
- Hydroforming machine
- Seamless Nb tubes
- NbCu clad cavities

Task Name	Milestones, Deliverables
Seamless by hydro forming	
Design hydro forming machine	
Drawings of the matrices	
Drawings of the support system	
MS Drawings matrix & support finished	**Design Report**
Construction of hydro forming machine	
Hydraulic for machine	
Software for the machine	
Machine fabrication	
Commissioning of the machine	
MS hydro forming machine ready	**Hydro-forming machine**
Construction of tube necking machine	
Drawings of the support system and turning mechanism	
Drawings of the necking mechanism	
Fabrication of the tube necking machine	
Commissioning of the machine	
MS Necking machine ready	
Software for the tube necking machine	
MS Construction tube necking machine finished	**Necking machine**
Development of seamless tubes for 9-cell cavities	
Material and fabrication of bulk Nb test tubes	
Material and fabrication of bimetallic NbCu test tubes	
MS seamless tubes ready	
Development of tube necking	
Computer simulation of the necking	
Experiments on tube necking at iris	
MS Tube necking machine operational	**Necking Machine ready**
Hydro forming of seamless cavities	
Computer simulation of the hydro forming	
Hydro forming of bulk Nb 9-cell cavities	
MS Hydro formed 9-cell cavities ready	

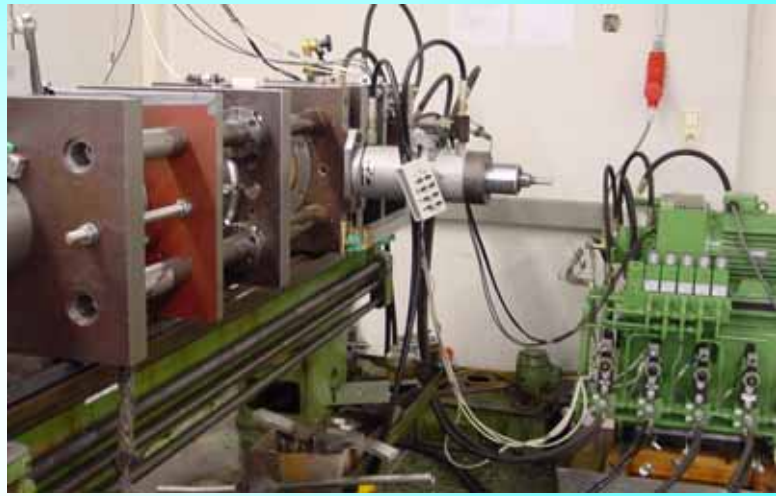


We are in time in all positions

Necking machine



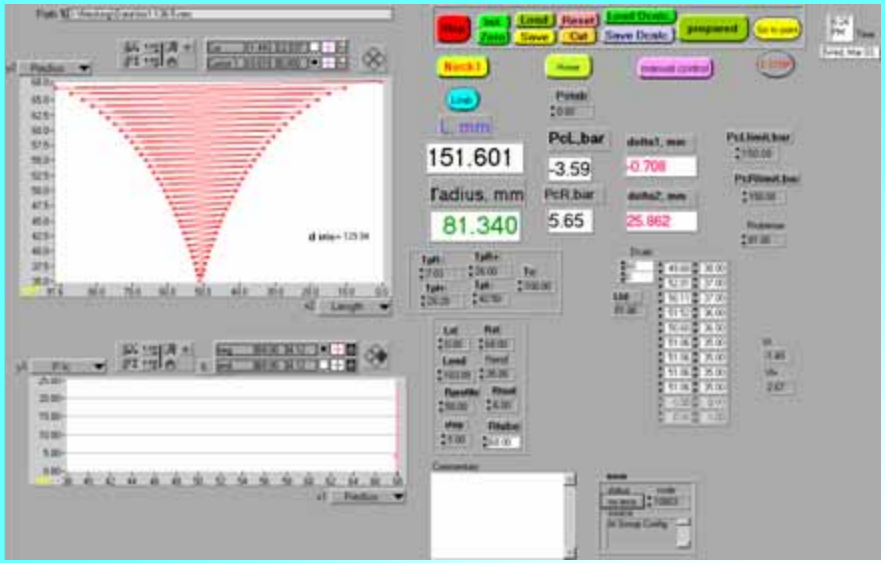
Principle of tube diameter reduction in the iris area



Reduction mechanism.

DESY Necking machine: new PC controlled necking procedure

Tubes after reduction in the iris areas



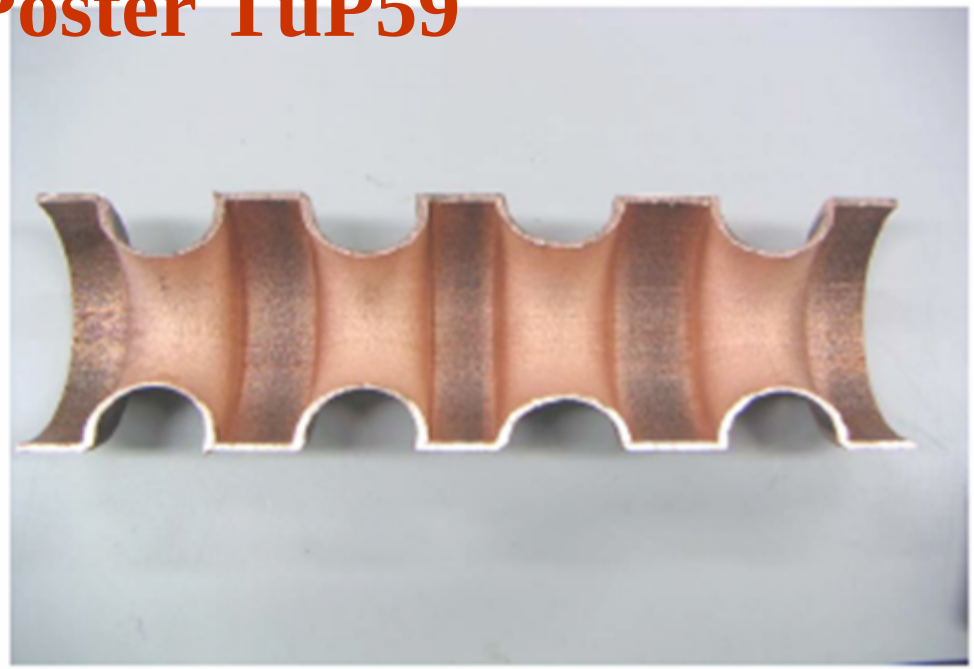
Front panel of the software for necking - machine

PC control allows reproducibly repeat the forming parameters

KEK necking activity

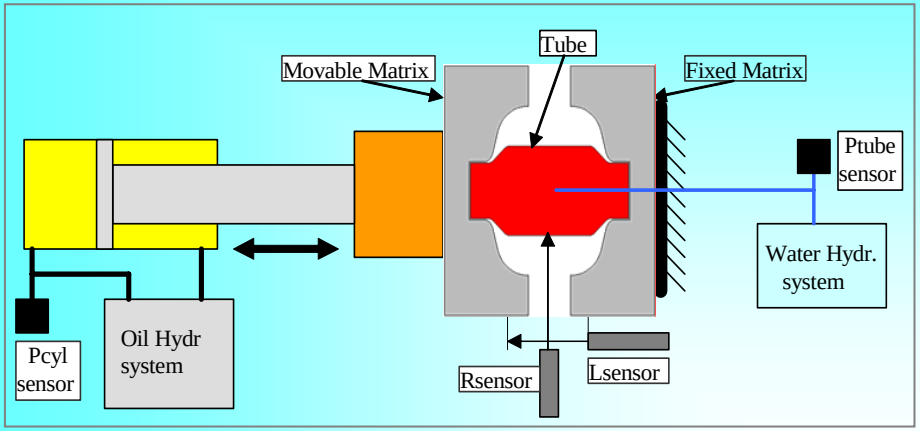
Successful necking test on June 20-24th in Shimizu Co.

SRF2005 Poster TuP59

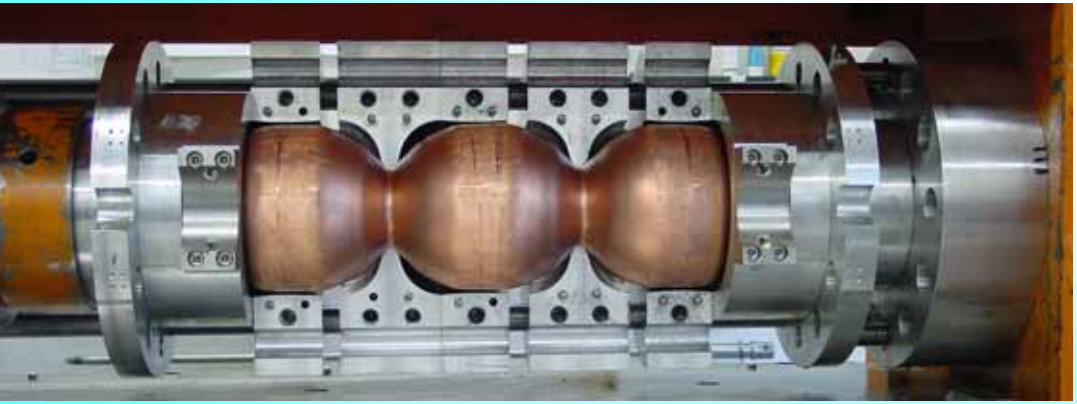


Necking 100phai, 3mm thick copper tube to 50phai

Hydroforming machine

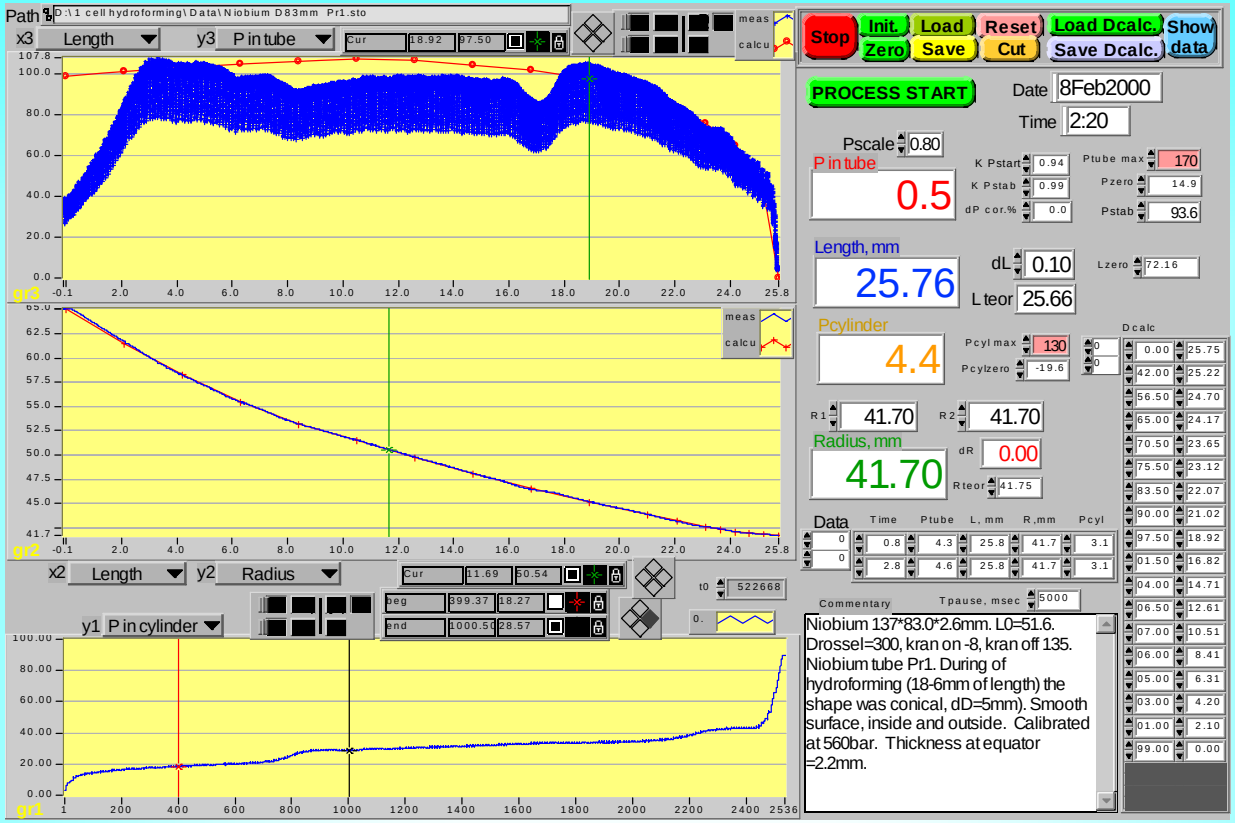


Principle of hydroforming



DESY hydroforming machine

Hydroforming machine was provided with new moulds for fabrication of multi cells.



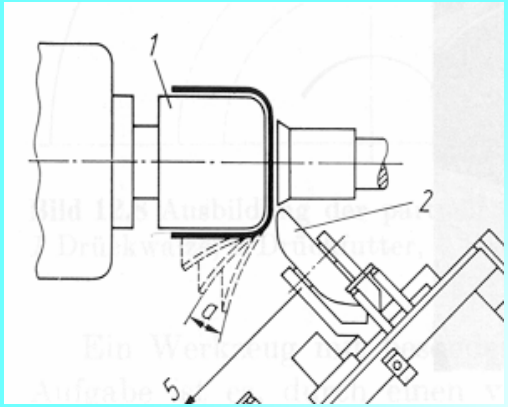
Front panel of the software for hydroforming - machine

A new software for multicell fabrication is developed. The system allows the hydraulic expansion in stepwise as well as in continuous regime.

Hydroforming of cells can be done or as three cells simultaneously or cell by cell

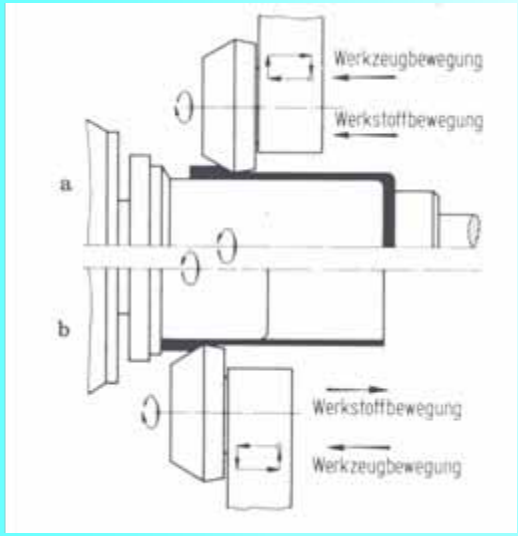
Rather uniform wall thickness distribution is achievable

Seamless bulk Nb tubes



Pot with thick wall by spinning

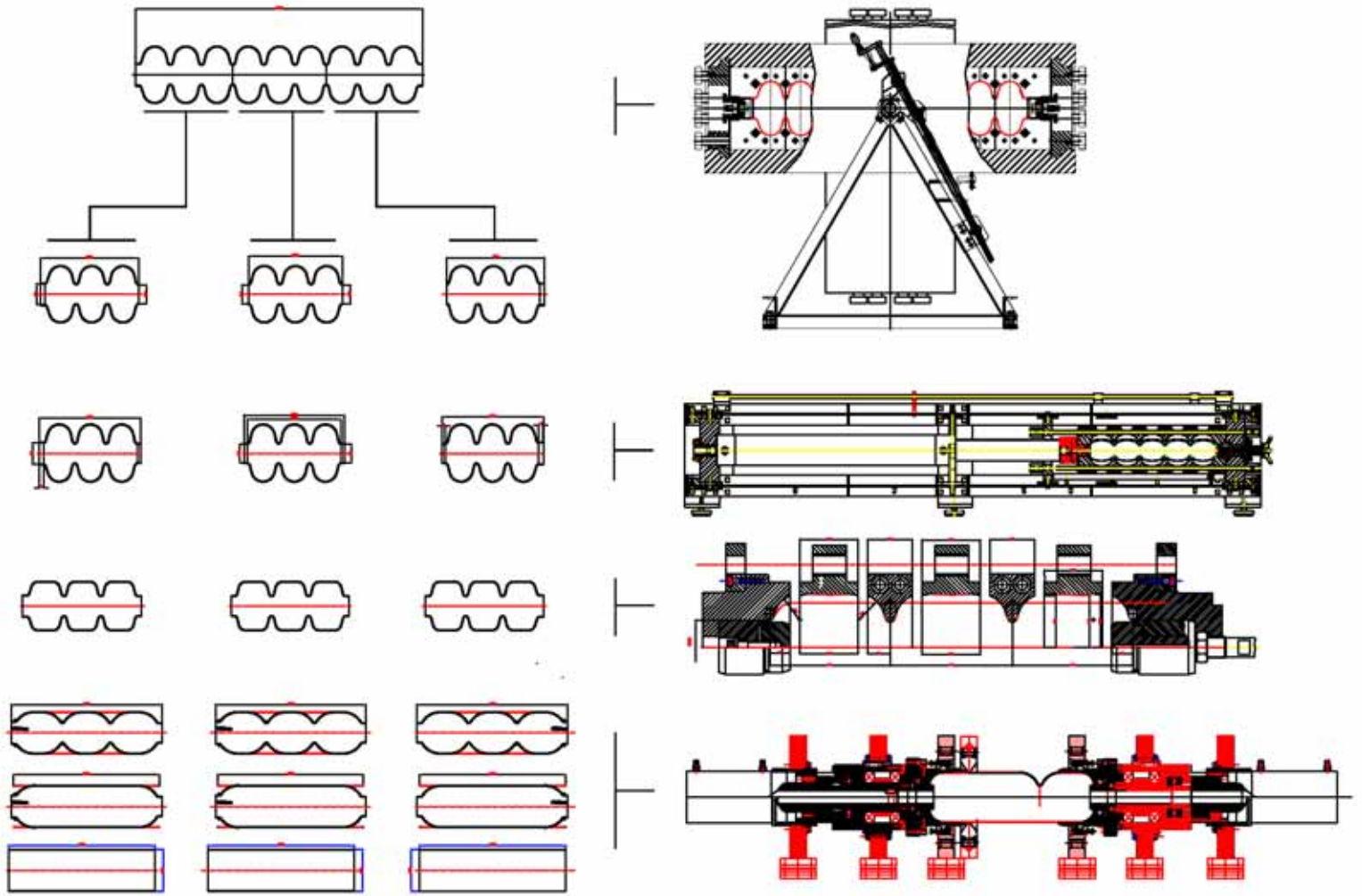
The multi cell seamless bulk Nb cavities are planned to be fabricated starting from the tube with inside diameter of ID=150 mm. The seamless tubes built starting from the thick sheet. Tubes are produced by combination of spinning and flow forming.



Flow forming

Flow forming was done in forward direction. Wall thickness tolerances of the tubes: +/- 0.15 mm what should be sufficient for subsequent hydroforming.

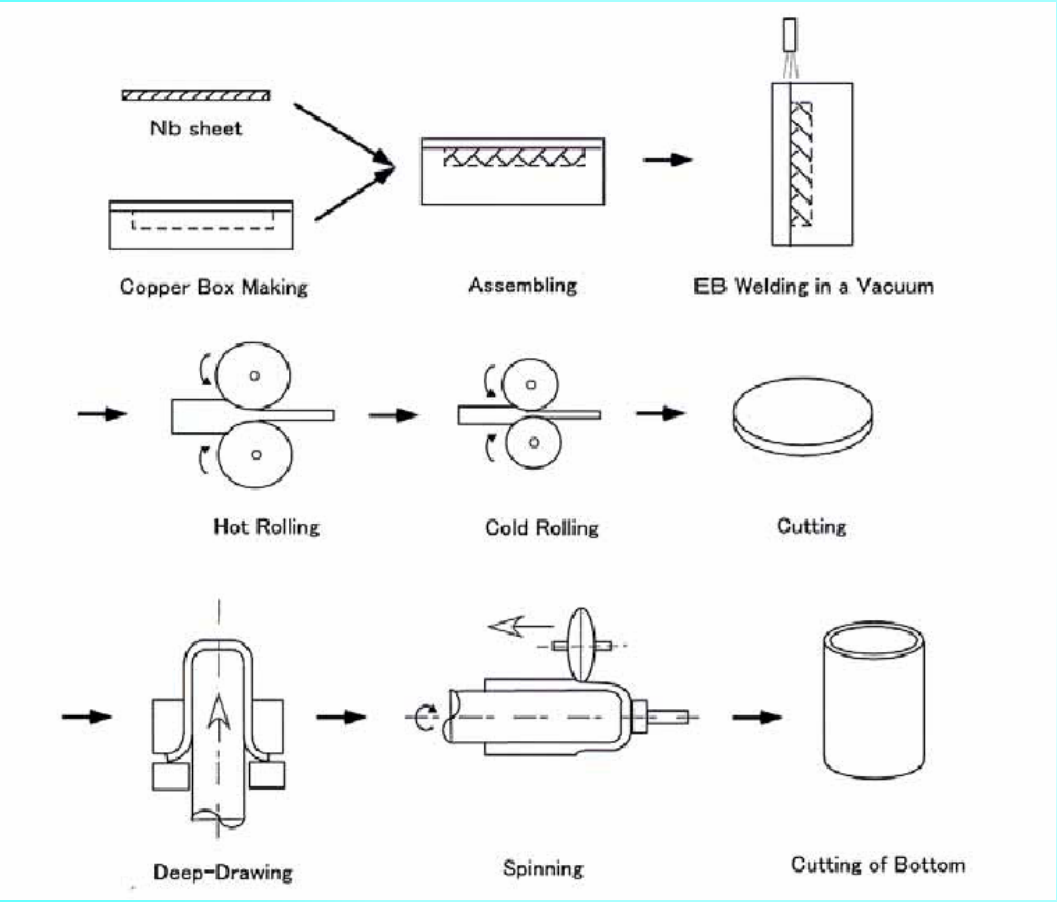
Fabrication steps of 9 cell cavity by hydroforming as option 3x3



Barrel polishing, 800°C annealing, EP (KEK recipe) seams to be a most appropriate treatment for seamless cavities

NbCu clad cavities

Hot bonded NbCu tubes

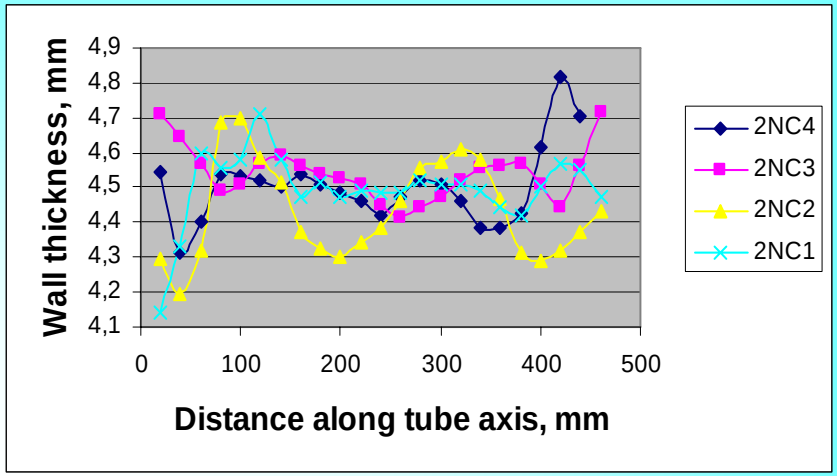


Hot roll bonded Cu-Nb-Cu tube produced at Nippon Steel Co.

Fabrication principle of sandwiched hot rolled Cu-Nb-Cu tube (KEK and Nippon Steel Co.)

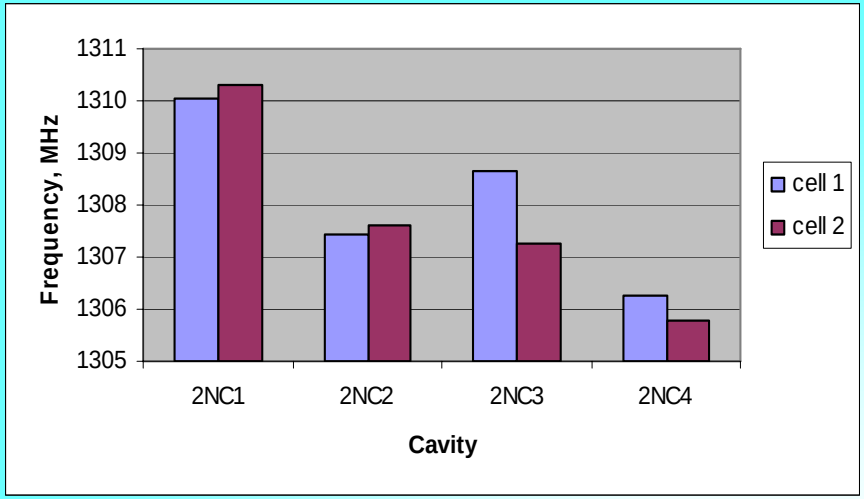
Multicell NbCu clad cavities, produced in frame of the CARE project

4 NbCu clad tube of KEK

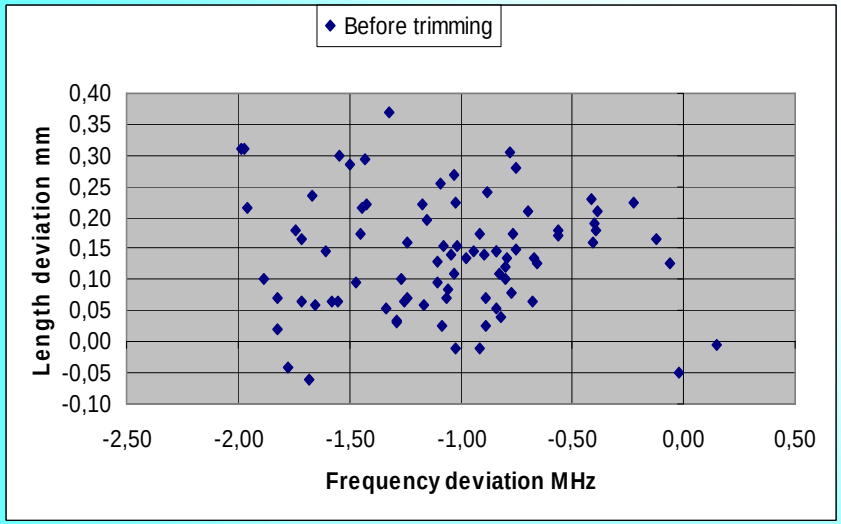


Wall thickness distribution

Four 2 cell NbCu clad cavities recently produced at DESY from KEK tubes (no cracks on the inside surface)



Frequency distribution in cells



Example of dumb bells frequency for standard cavity fabrication

Frequency measurement (G. Kreps)

Small frequency deviation between the cells can be achieved. Warm tuning seems to be unavoidable

Difficulties in NbCu technology

1. Dangerous of cracks appearance in iris area during fabrication (because of big difference in recrystallization temperature of Nb and Cu)

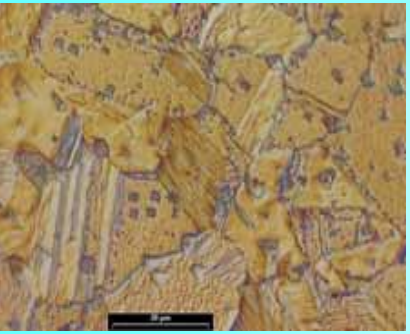
Microstructure of Cu and Nb after annealing at 560°C for 2 hours. Nb is not recrystallysed (hard).

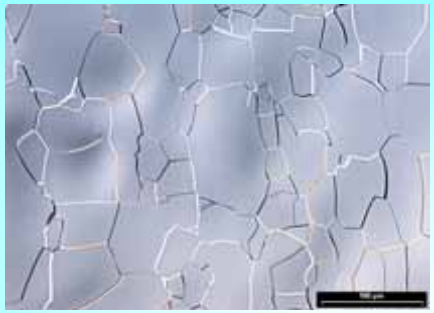
Two ways to defeat the cracks*

a) Sandwiched tube (Nb is between two Cu layers. Cu layer on both sides prevent creating of cracks in Nb); removing of inside Cu layer on the cavity after forming (K.Saito). The option was checked, it works

* Improvement of the necking technique allows reducing the cracks danger

b) Cu only outside: Cu0.15%Zr special Cu with high recrystallization temperature





Microstructure of Cu0.15%Zr and Nb after annealing at 800°C for 2 hours.

The Cu0.15%Zr will be tested as candidate for replacing of pure Cu in NbCu clad tubes

NbCu0.15%Zr tube is fabricated. The shipment of the tube is expected beginning of November 2005

The End