



3.2 Seamless by Hydroforming

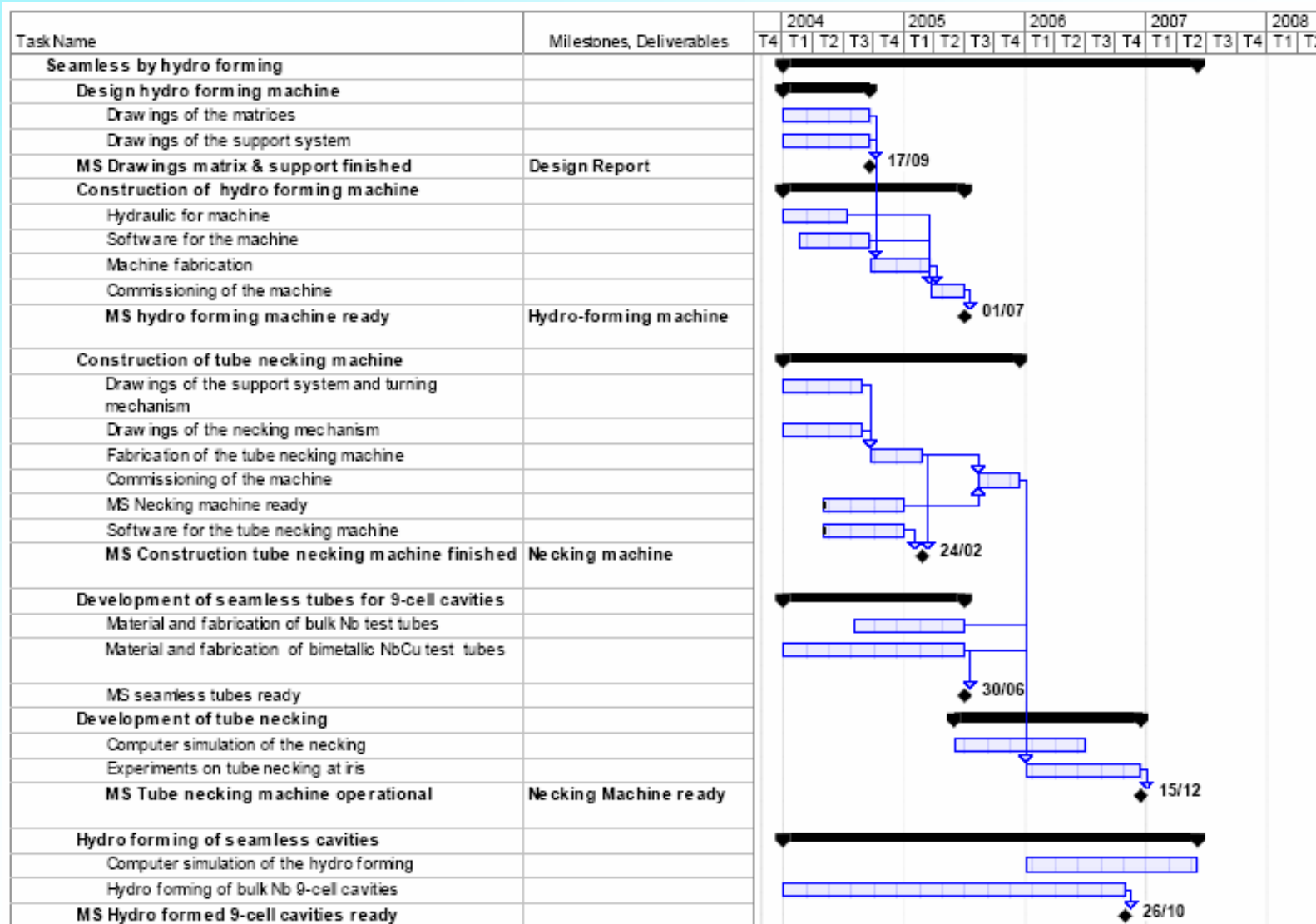


W. Singer

- Necking device
- Hydroforming machine
 - Seamless Nb tubes
- Hydroforming of three cell units



We are in time in all positions

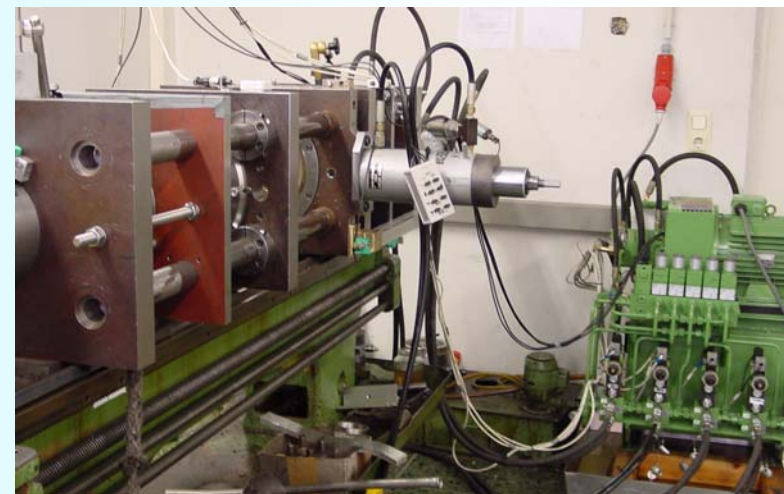
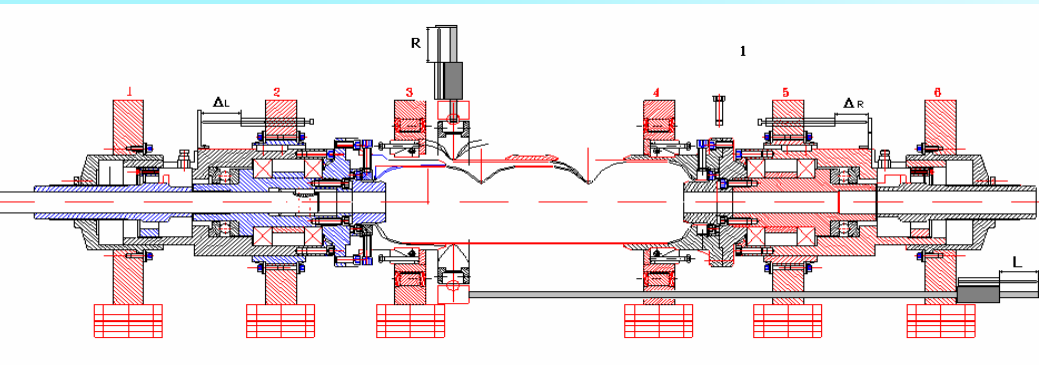




Fabrication technique

The main technical problems of the fabrication of seamless single cell and multi cell by hydroforming are solved.

The main remaining task is improvement of the fabrication technique to the industrially applicable level.



Principle of tube diameter reduction in the iris area

Reduction mechanism.

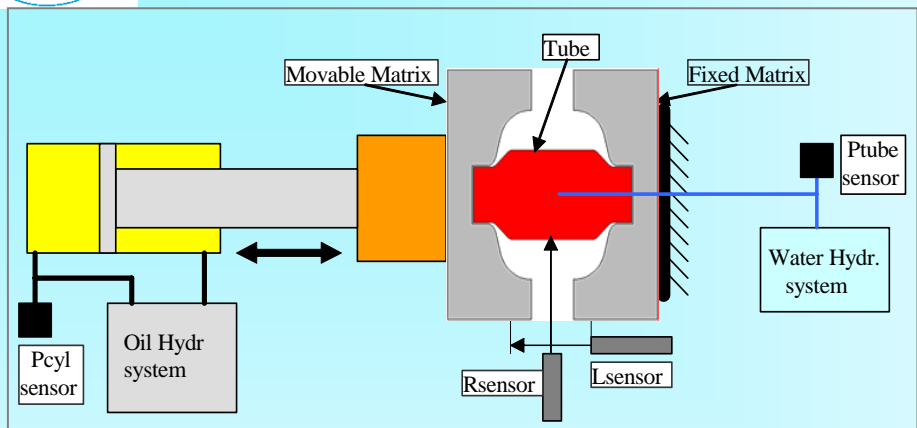


DESY Necking machine: new PC controlled necking procedure

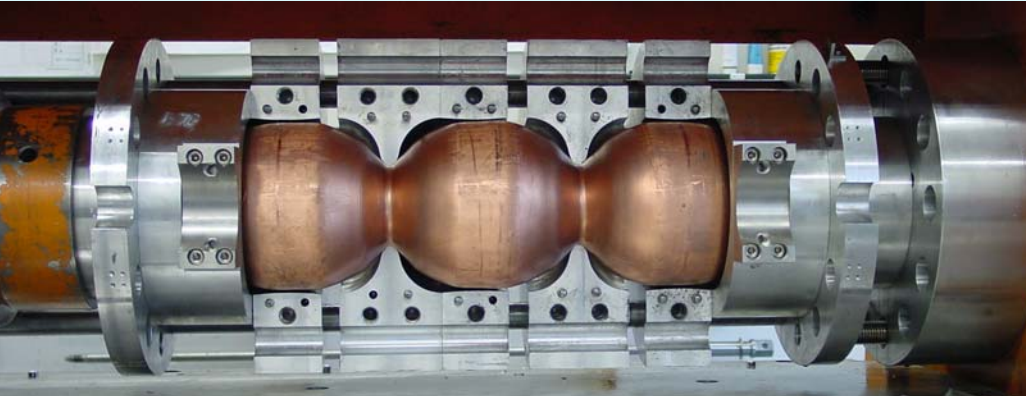
Tubes after reduction



Seamless technique by hydroforming: step 2- expansion

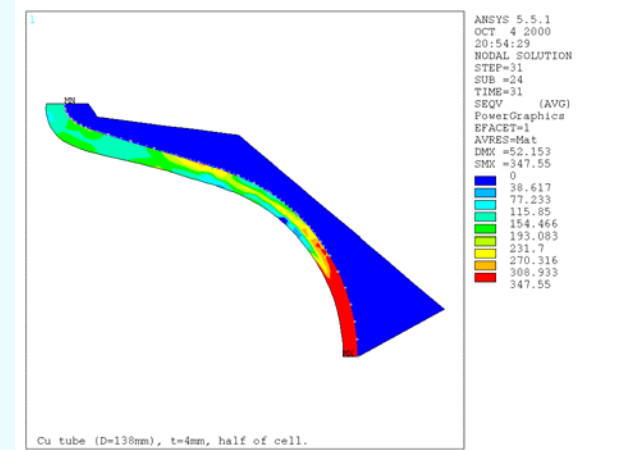
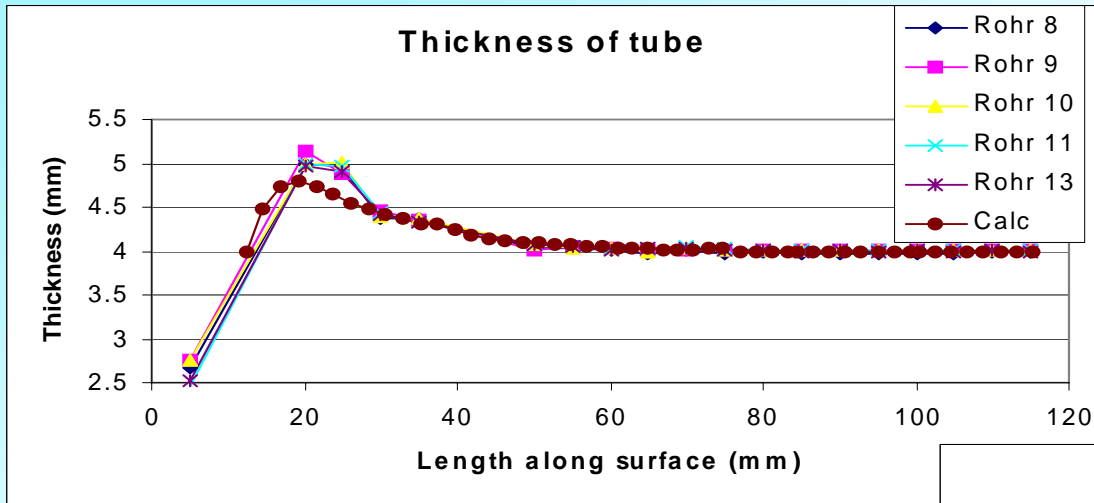


Principle of hydroforming

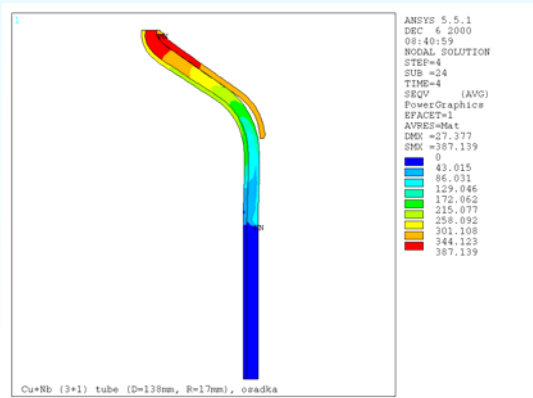
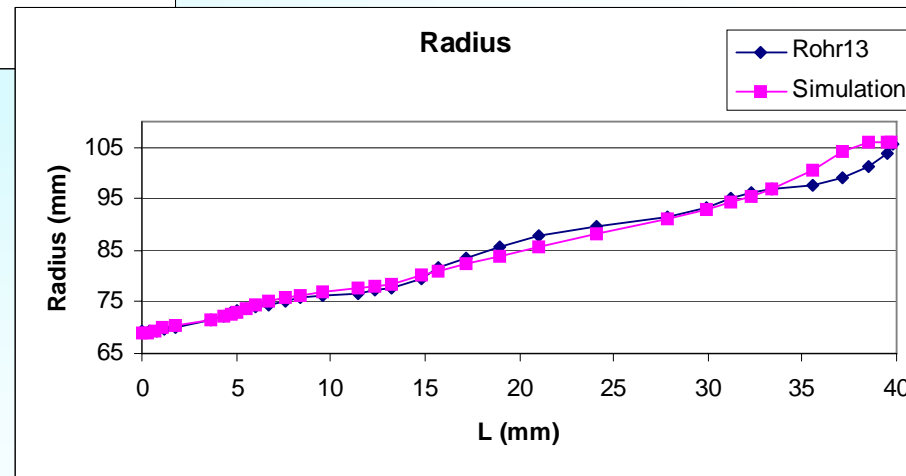


Moulds for hydroforming

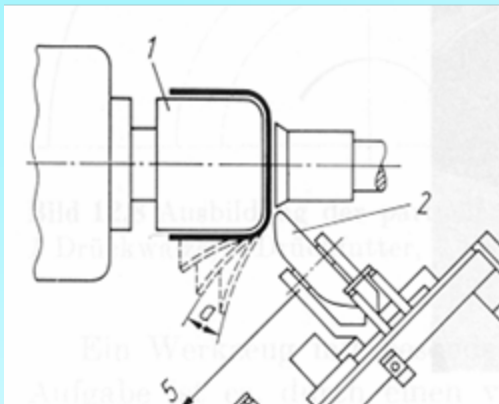




Comparison of simulated and experimental wall thicknesses after necking.



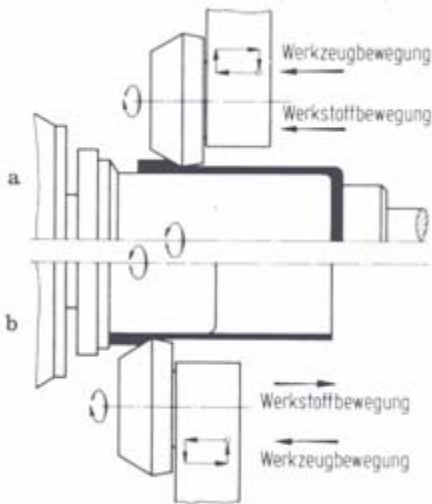
Simulation of radius growth during hydroforming in comparison with experiment



Pot with thick wall by spinning

The multi cell seamless bulk Nb cavities 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.

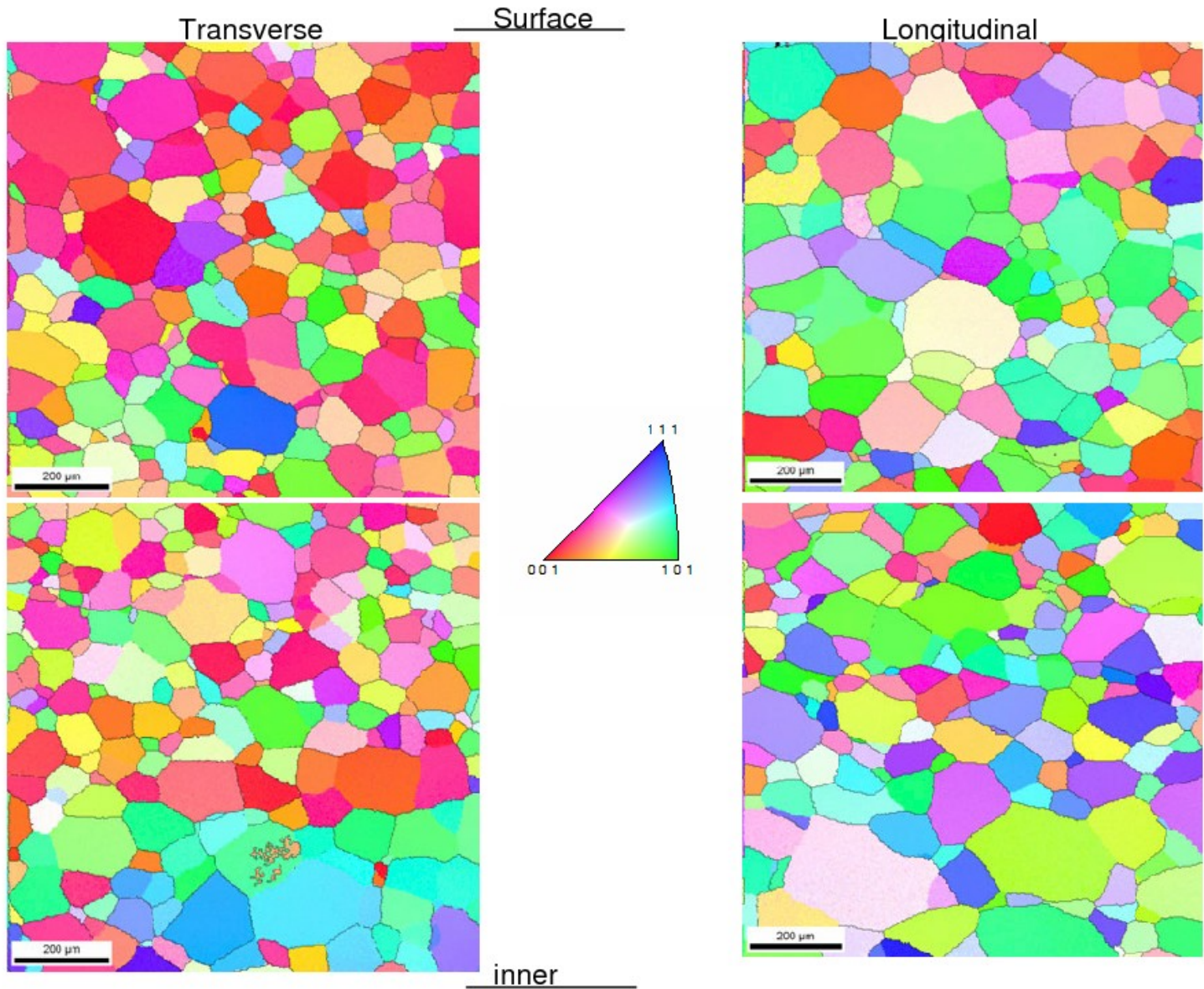


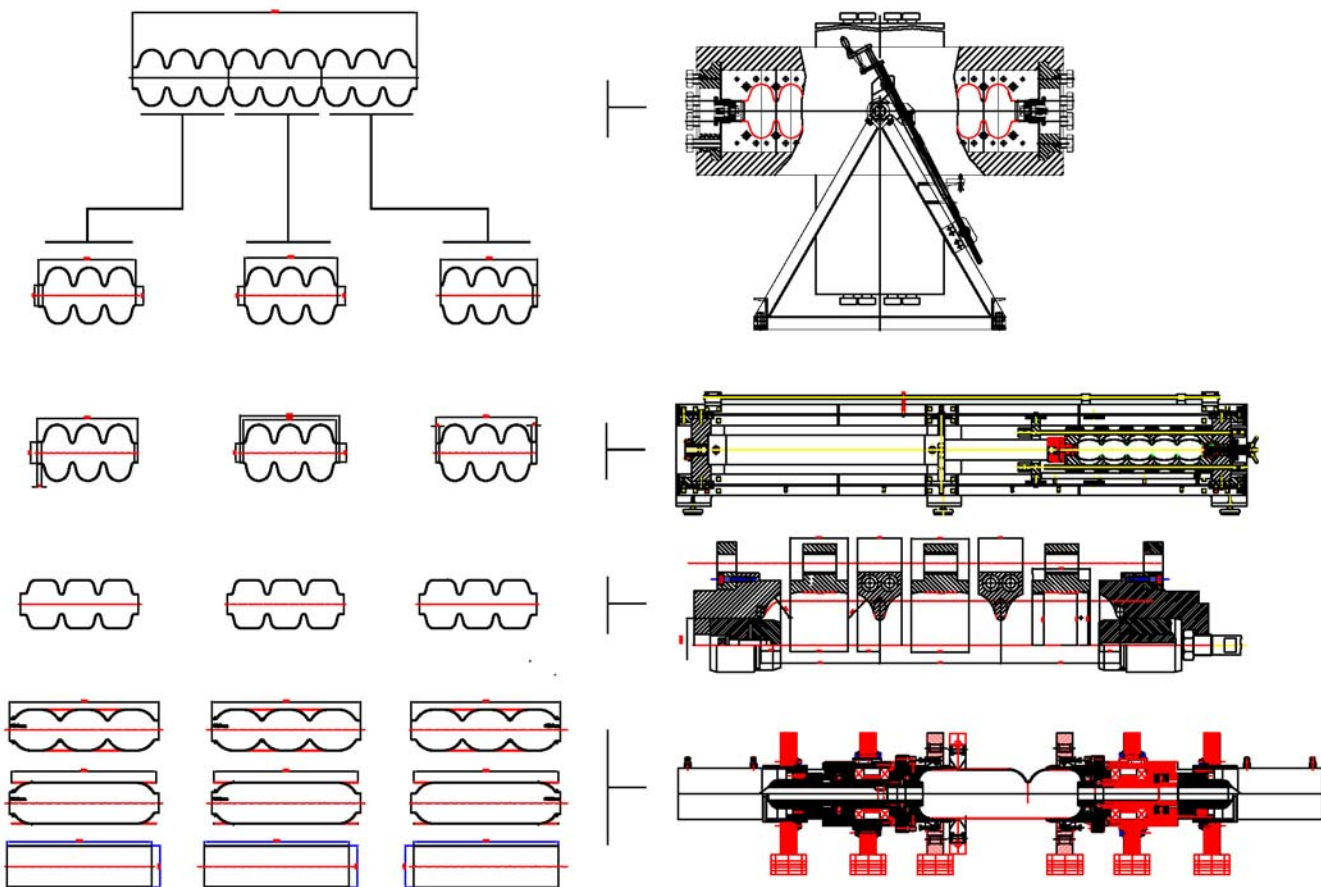


Flow forming

Flow forming was done in forward direction. Length is ca. 800 mm. Wall thickness tolerances of the tubes: ± 0.15 mm what should be sufficient for subsequent hydroforming.

Microstructure and orientations of the seamless tubes using for hydroforming of the three cell units





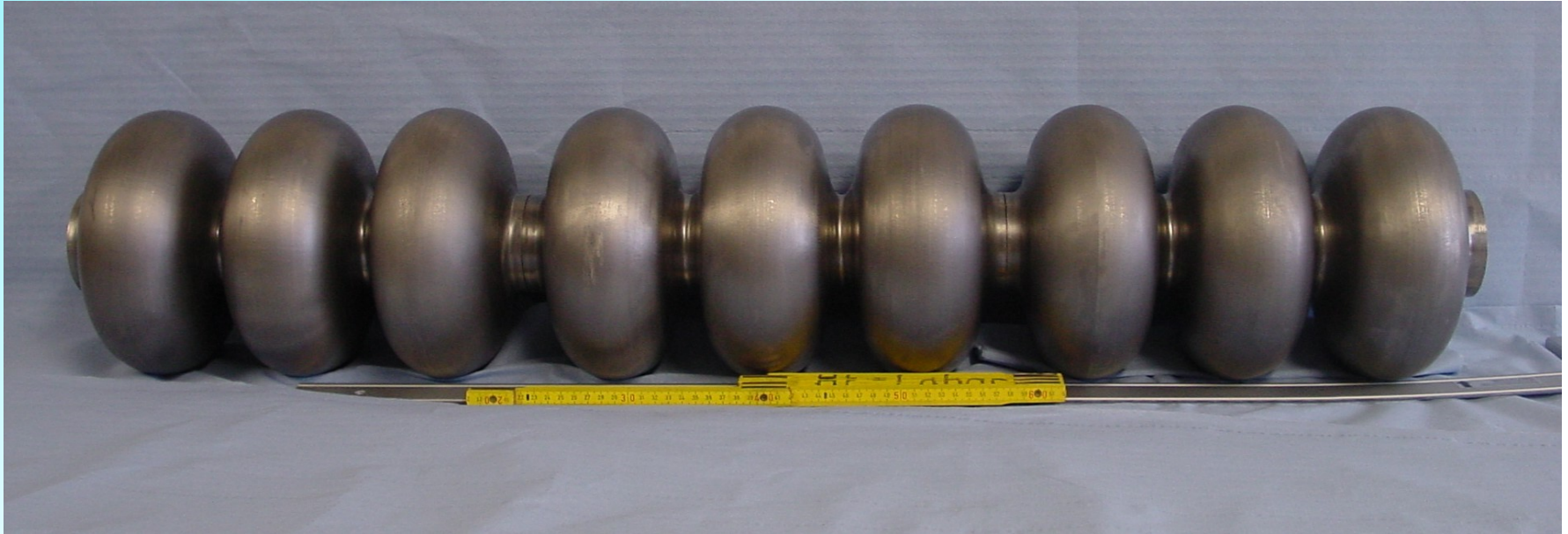
Barrel polishing, 800°C annealing, EP (KEK recipe) seams to be a most appropriate treatment for seamless cavities



Seamless cells (three three cell units)
for two 9-cell cavities have been
produced at DESY by hydroforming



First 9-cell hydroformed cavity is in final fabrication at ZANON



Fabrication of a seamless cavity (without equator welds) includes following steps:

- Fabrication of the long and short end groups connected with three cell units
- Machining, preparation and welding of three units together in a 9 cell cavity (two iris welds done from outside)
- Machining, preparation and weld on of the stiffening rings

Three cell units for second cavity are in Centrifugal Barrel Polishing CBP at DESY