

Hydroforming SRF cavities from seamless Nb tubes

KEK-FNAL-LNAL colaboration

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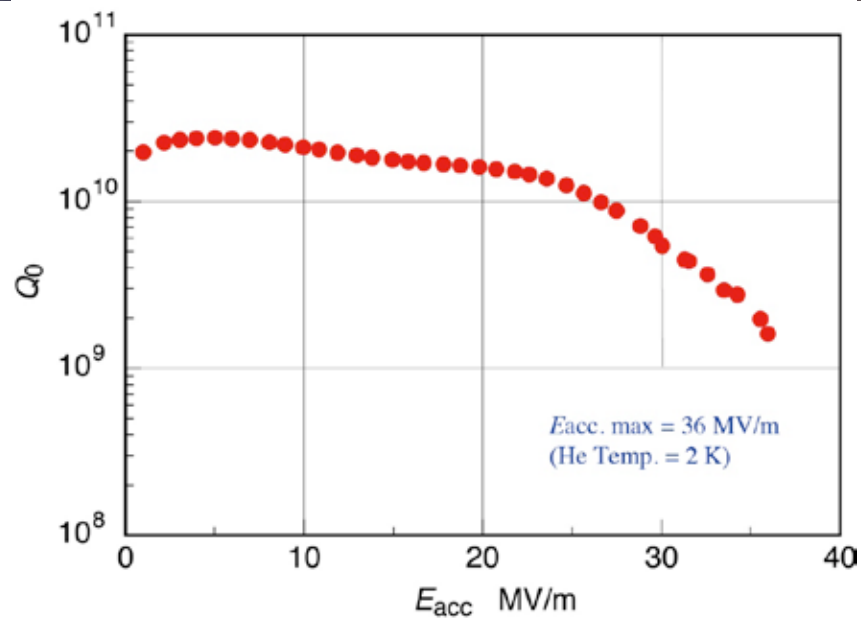


1-cell cavity made by hydroforming



Nb seamless tube was manufactured by **ATI Wah Chang** and supplied by **FNAL**

Size: $\phi 130\text{-}\phi 123$ (t3.5) \times 450
 RRR of ingot Nb: 387 (top)
 Hardness: 46 HV

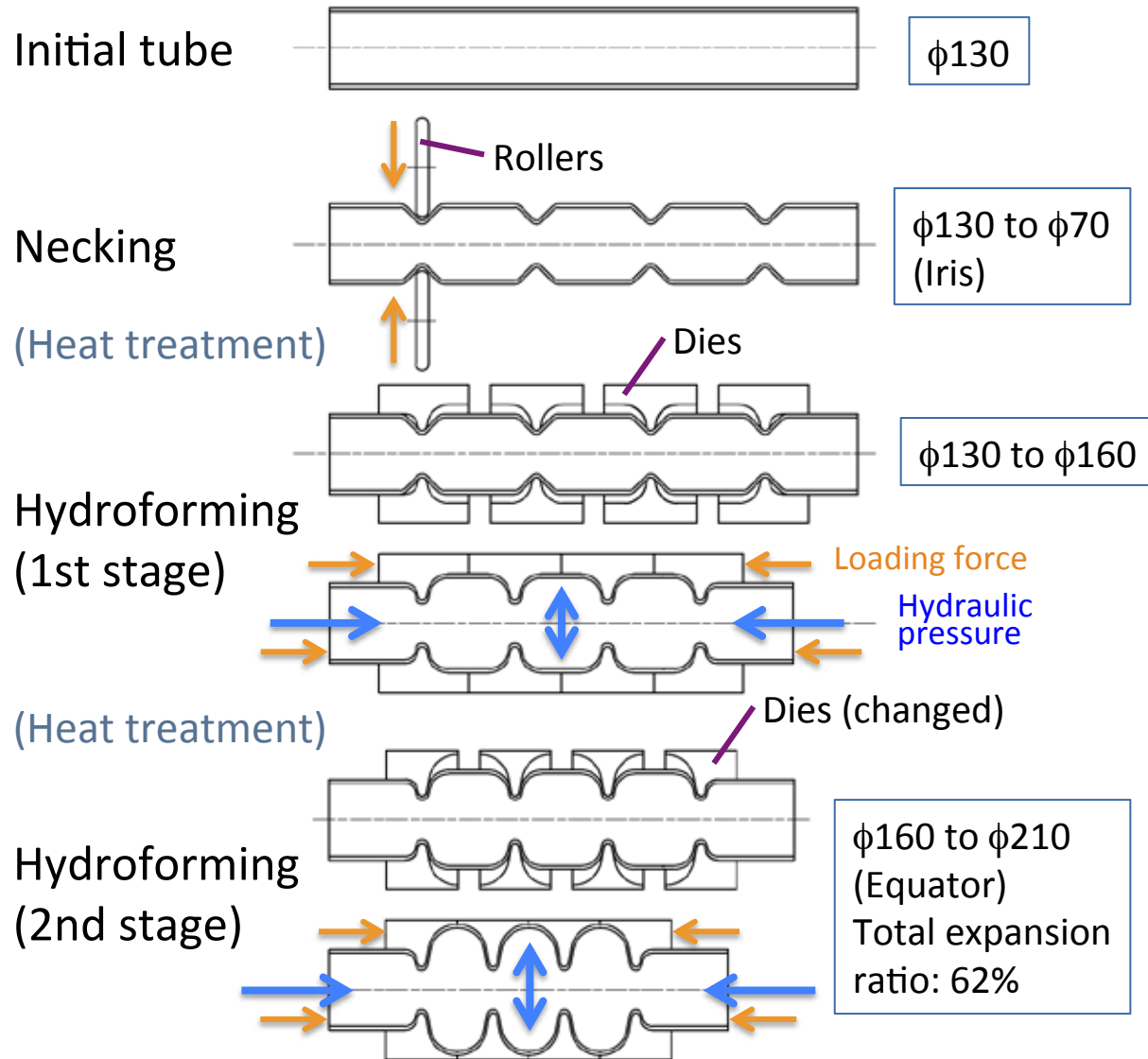


Hydroforming and finishing to cavity were held by **KEK**

Vertical test was also held by **KEK**

Maximum E_{acc} : 36 MV/m

Fabrication of cavity



Necking machine



Hydroforming machine
(Final hydraulic pressure: 25 MPa)

Process (detail)

- Received the tube
- Inspection of thickness distribution (Ultrasonic measurement)
- Necking
- Chemical Polishing (CP) and Anneling (750 degree, 3 hr)
- Hydroforming, 1st stage
- Visual inspection
- Light CP and Anneling (750 degree, 3 hr)
- Hydroforming, 2nd stage, interrupt at half
- Visual inspection
- Light CP and Anneling (750 degree, 3 hr)
- Hydroforming, 2nd stage (continue) to finish
- Inspection of thickness distribution (Ultrasonic measurement)
- Finish to cavity
- Inspection inside (Kyoto camera)
- Ship to **FNAL**
- Barrel polishing (~120 μm , mirror finish)
- Ultrasonic cleaning, High pressure rinse
- Ship back to **KEK**
- Leak check
- Inspection of thickness distribution (Ultrasonic measurement)
- Inspection inside (Kyoto camera)
- Electric polishing (EP) (~5 μm) : Pre-EP
- Anneling (750 degree, 3 hr)
- Inspection inside (Kyoto camera)
- EP2 (~15 μm)
- High pressure rinse
- Baking (120 degree, 48 hr)
- Vertical test



Just after forming

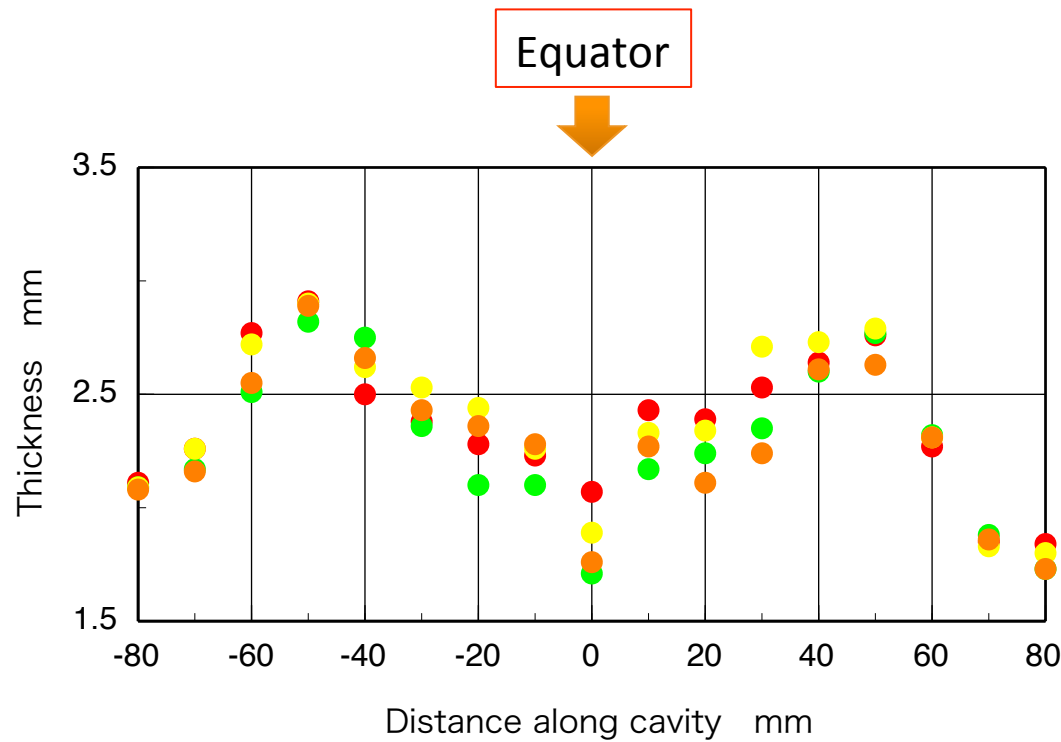


Barrel polishing

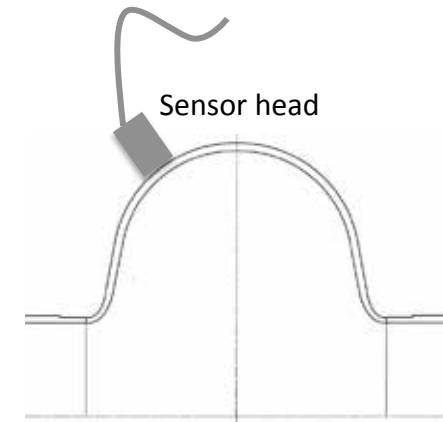
Courtesy of C A Cooper@FNAL



Thickness distribution after forming



- 0 deg
- 90 deg
- 180 deg
- 270 deg



Thickness around equator becomes small (thin)



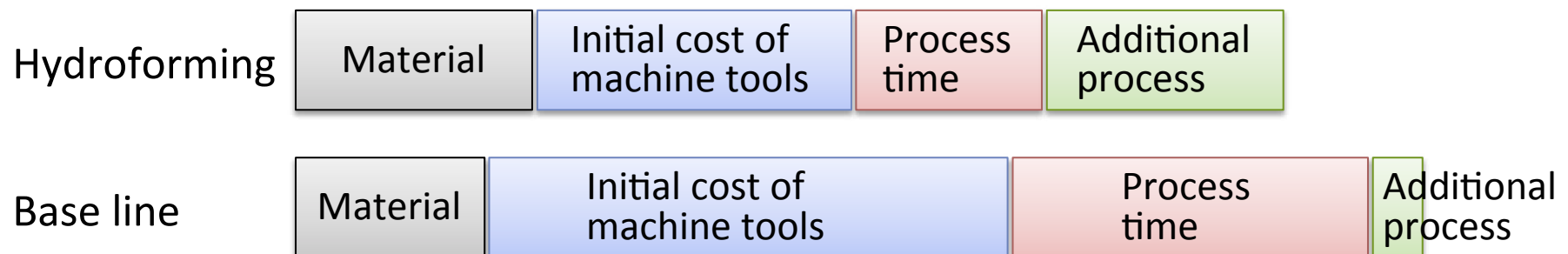
Measured by ultrasonic measurement device

Merits of hydroforming

- Eliminating EB welding beads at equator and iris >> High performance
- Decrease manufacturing cost

	Hydroforming	Base line (EBW based)
Material	>>	
Initial cost of machine tools	<<	
Process time	<<	
Additional process - Heat treatment - Mechanical polishing	>>	

Comparison of total cost (Just image, need to evaluate precisely!)



1-cell cavity

