5. Niobium Cavity Fabrication

5.1 Deep Drawing

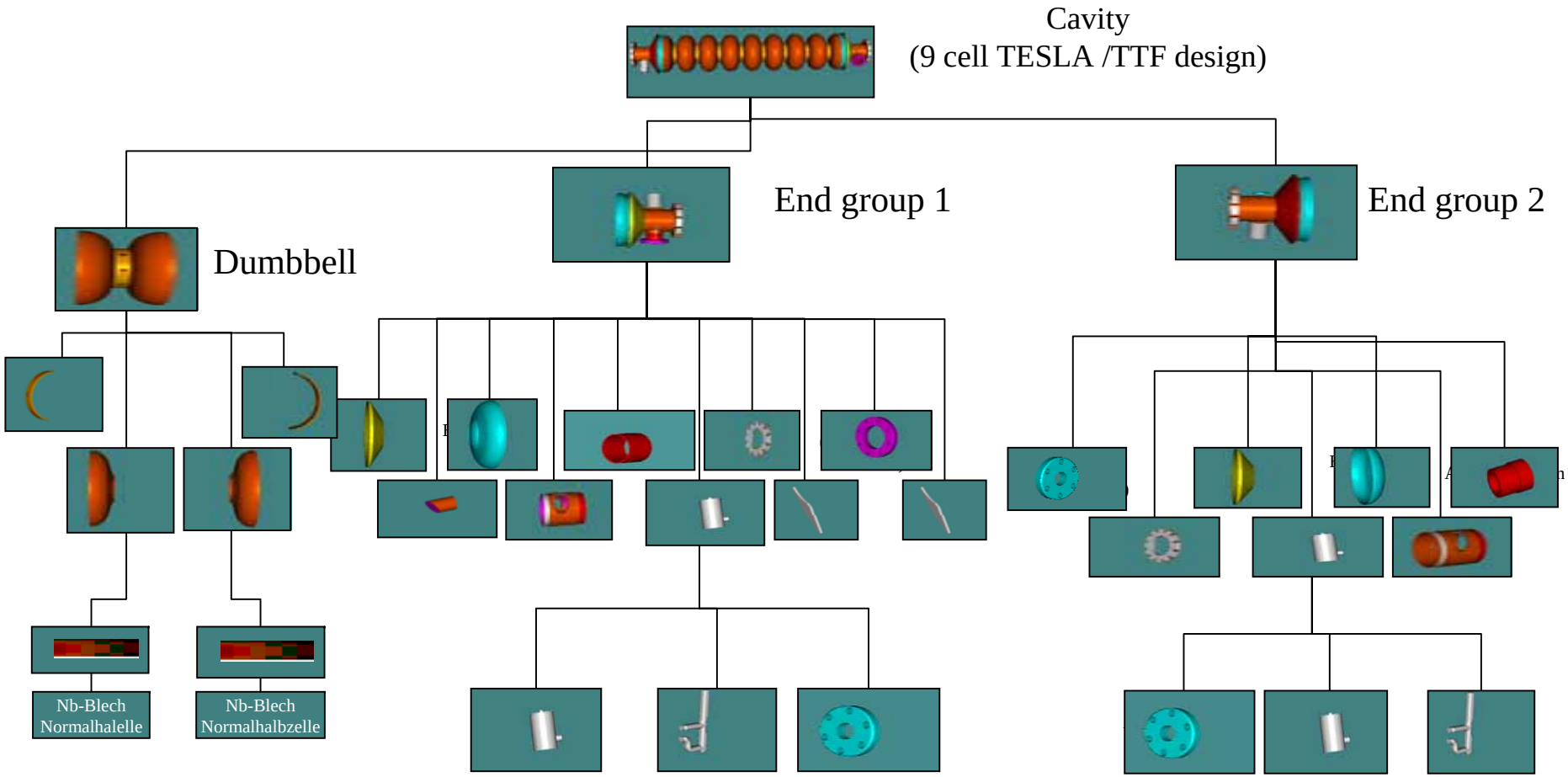
5.2 Trimming of half cell

5.3 END group fabrication

5.4 Final EBW assembly

5.5 Nb film coated cavity

Overview on cavity fabrication



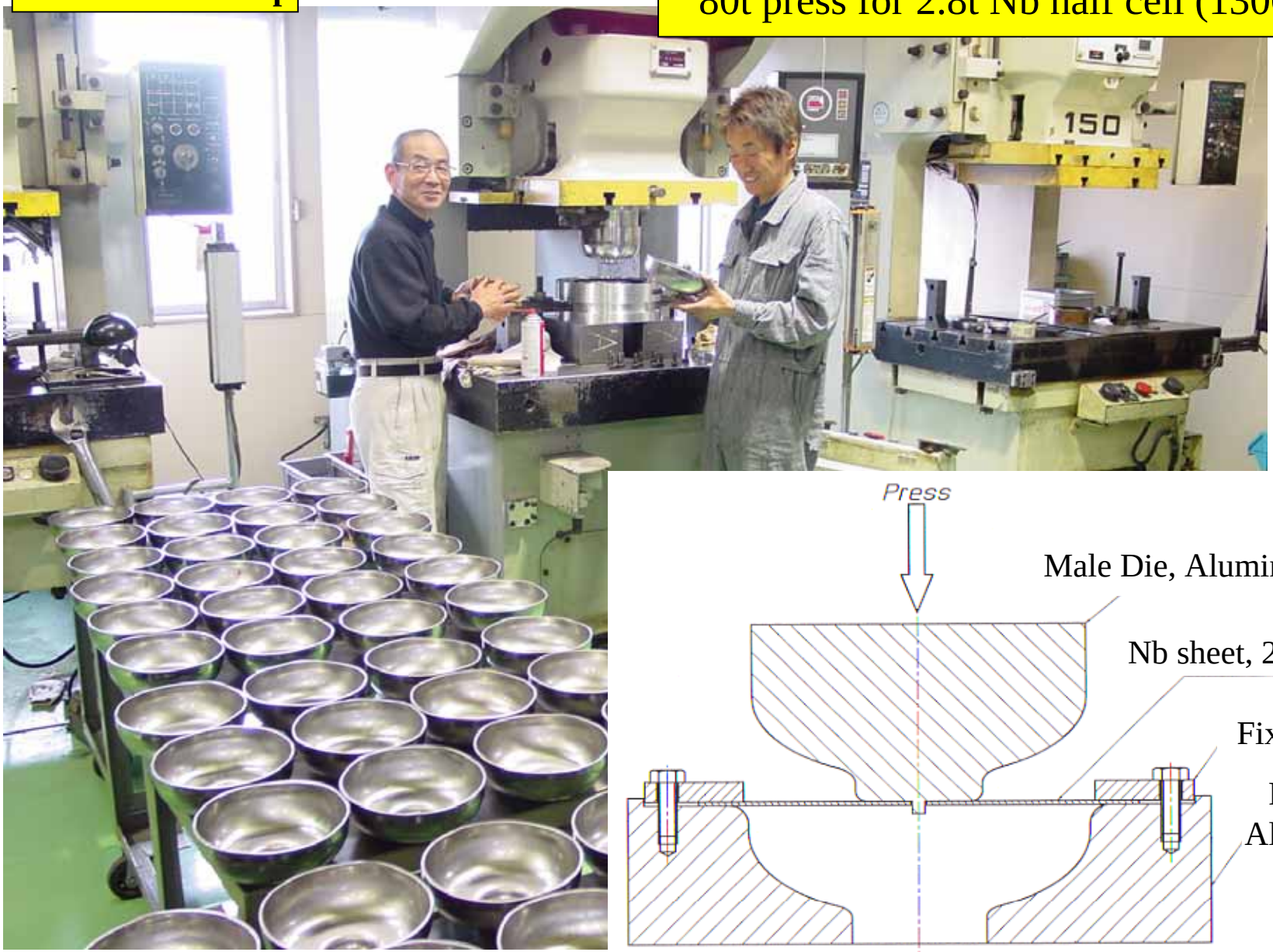
Cavity fabrication and preparation sequences
for the TESLA / TTF cavities at DESY

1st ILC workshop at KEK Tsukuba Japan
A.Matheisen
for DESY and the TESLA Collaboration

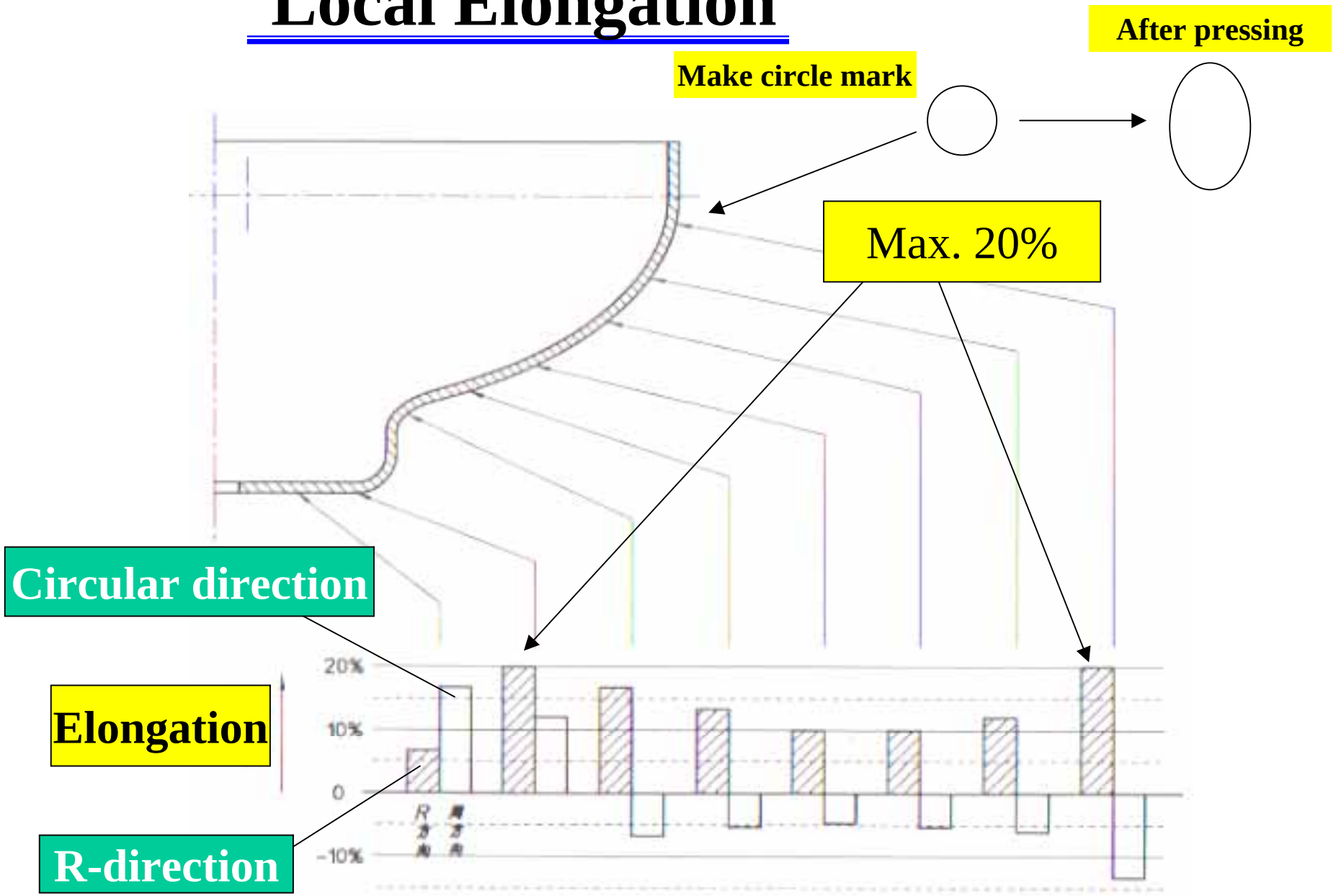
5.1 Deep Drawing

Kikuchi Workshop

80t press for 2.8t Nb half cell (1300MHz)



Local Elongation



5.2 Trimming

Ishizuka Workshop

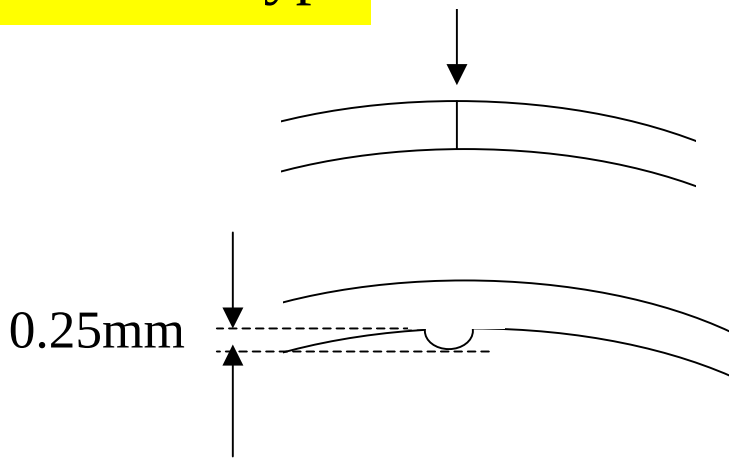
Iris Trimming

Equator Trimming

Trimming Configuration at Equator section

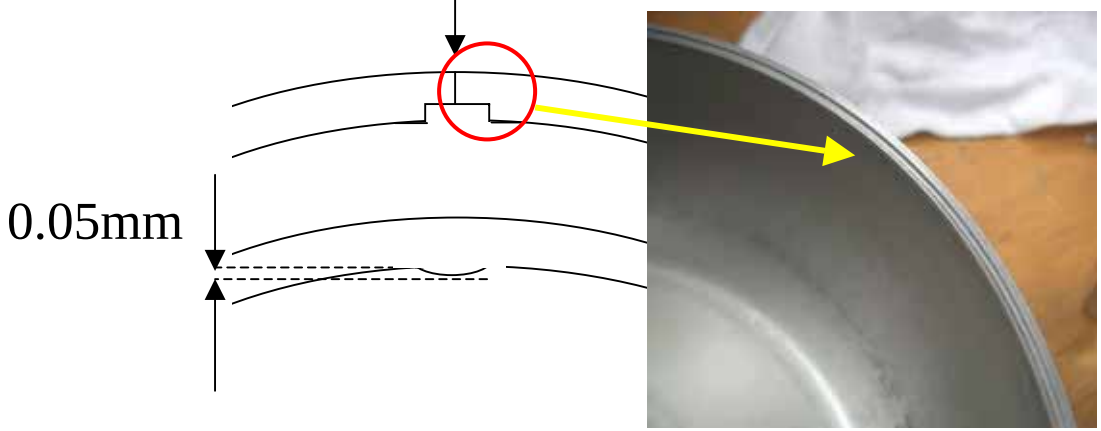
So far, KEK has used CBP 100-200μm to make smooth the equator EBW seam. The left trimming shape needs CBP 10 times, and the right trimming configuration needs only CBP twice.

KEK old type



Needed CBP ~10 times

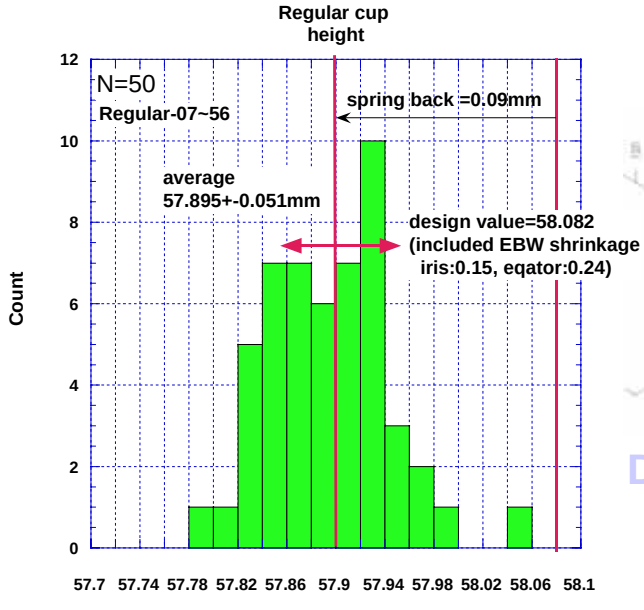
Cornell type

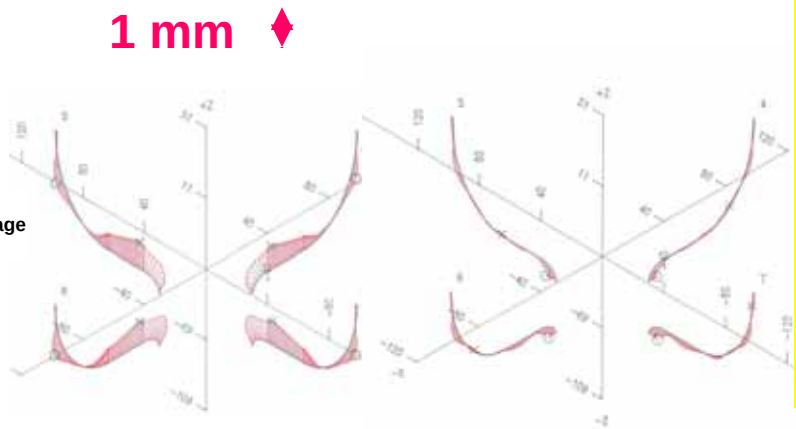


CBP only twice!

Cornell trimming configuration is very useful to smooth the EBW seam by less CBP.

Fabrication Error on half-cell cup

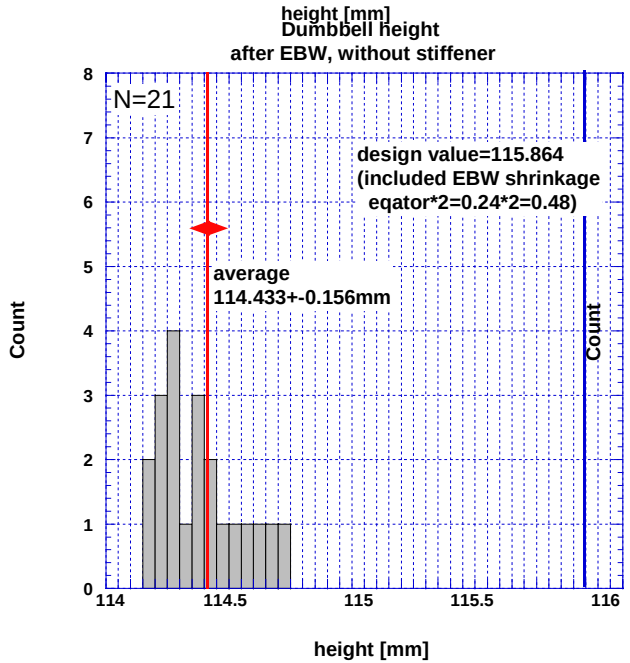


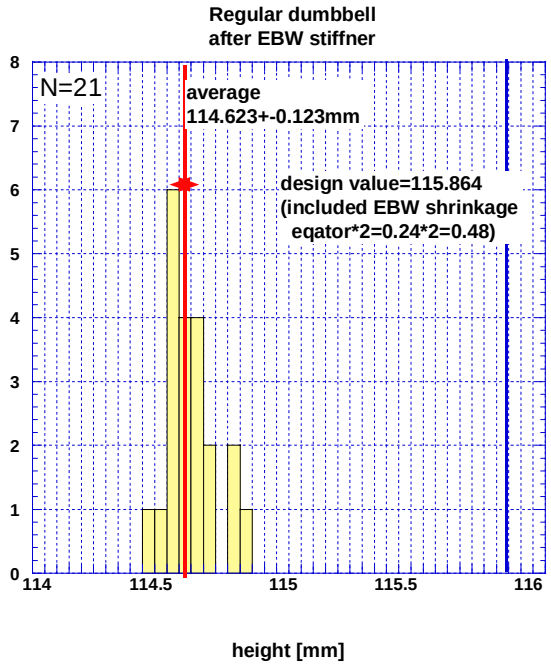


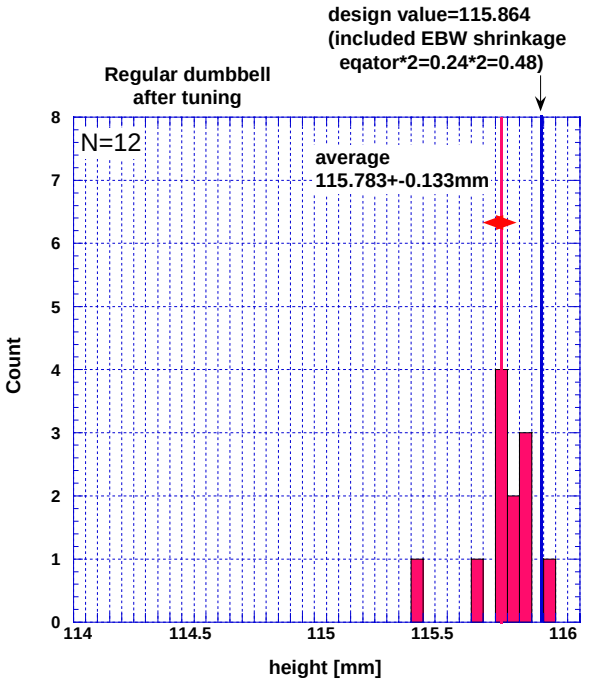
Dumbbell EBW

After stiffener EBW on dumbbell and tuning

Machining error: 50μm
Half cell spring back:90μm
EBW shrinkage
(old trimming configuration)
0.42 ± 0.13mm @ equator
0.15 ± 0.04mm @ iris
Dumbbell fabrication error ~80μm after tuning
9-cell length error:0.7~0.1mm





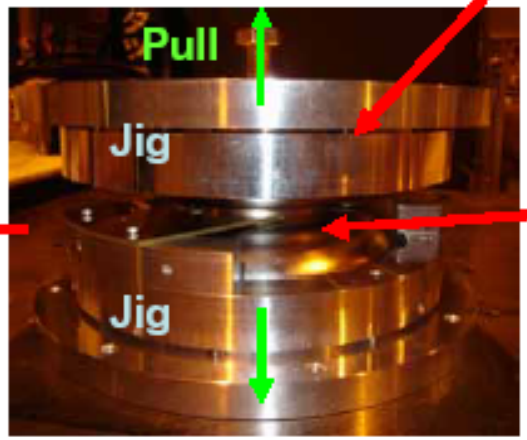


EBW of Dumbbell with stiffener

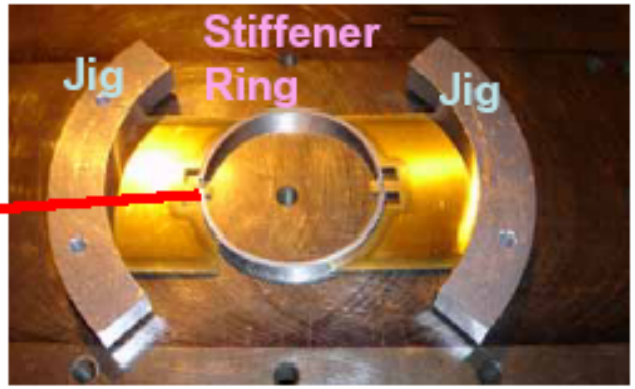
Electron Beam Welding (EBW)
In KUROKI corporation

Dumbbell

Dumbbell with stiffener-ring after EBW.



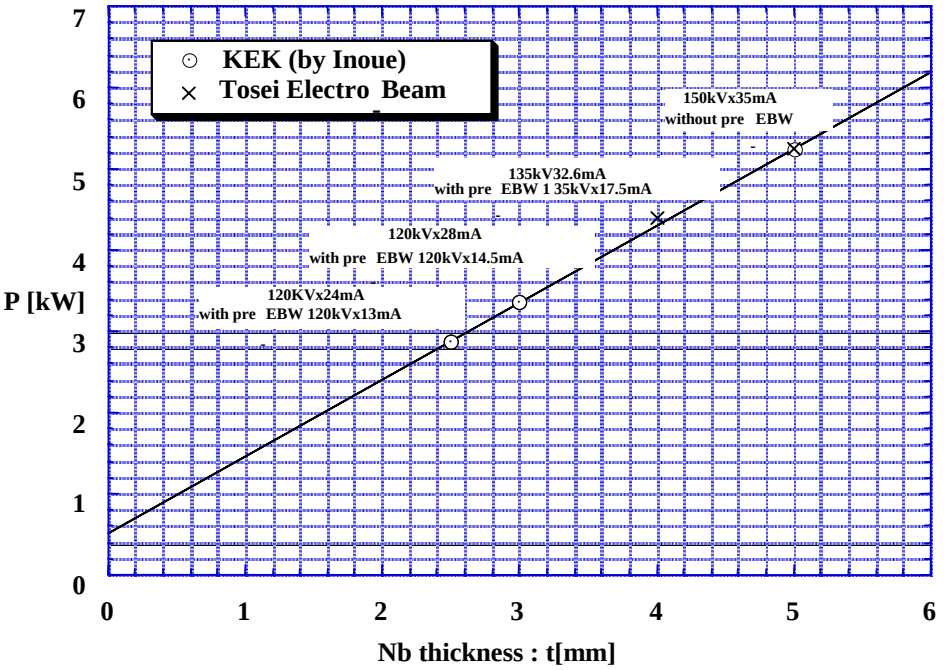
Pull and extend dumbbells to insert stiffener-ring.
=> EBW (dumbbell + ring)

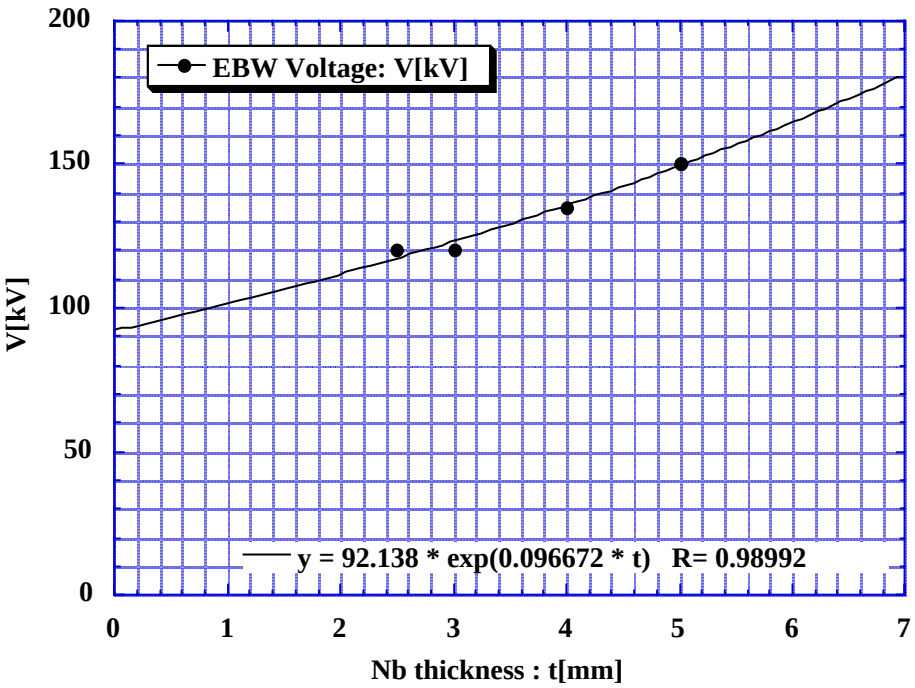


Insert stiffener-ring into the iris part of dumbbell.

EBW Conditions at KEK

KEK Data





Dumbbells and END Cups

PAL

5.3 END Grope fabrication
-Beam Pipe fabrication (thicker Nb tube case)-

Rounding ends

Bending

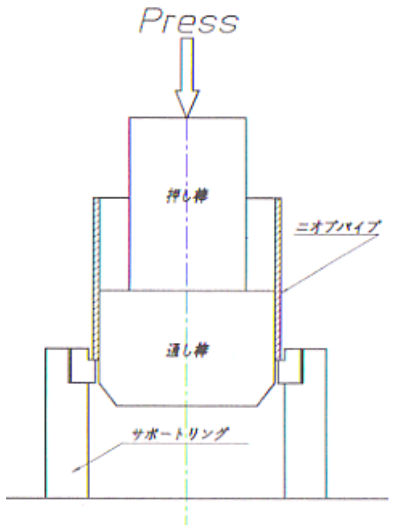
Closing

After EBW

Thickness: 4t ~ 6t

Circular die

Oil pump

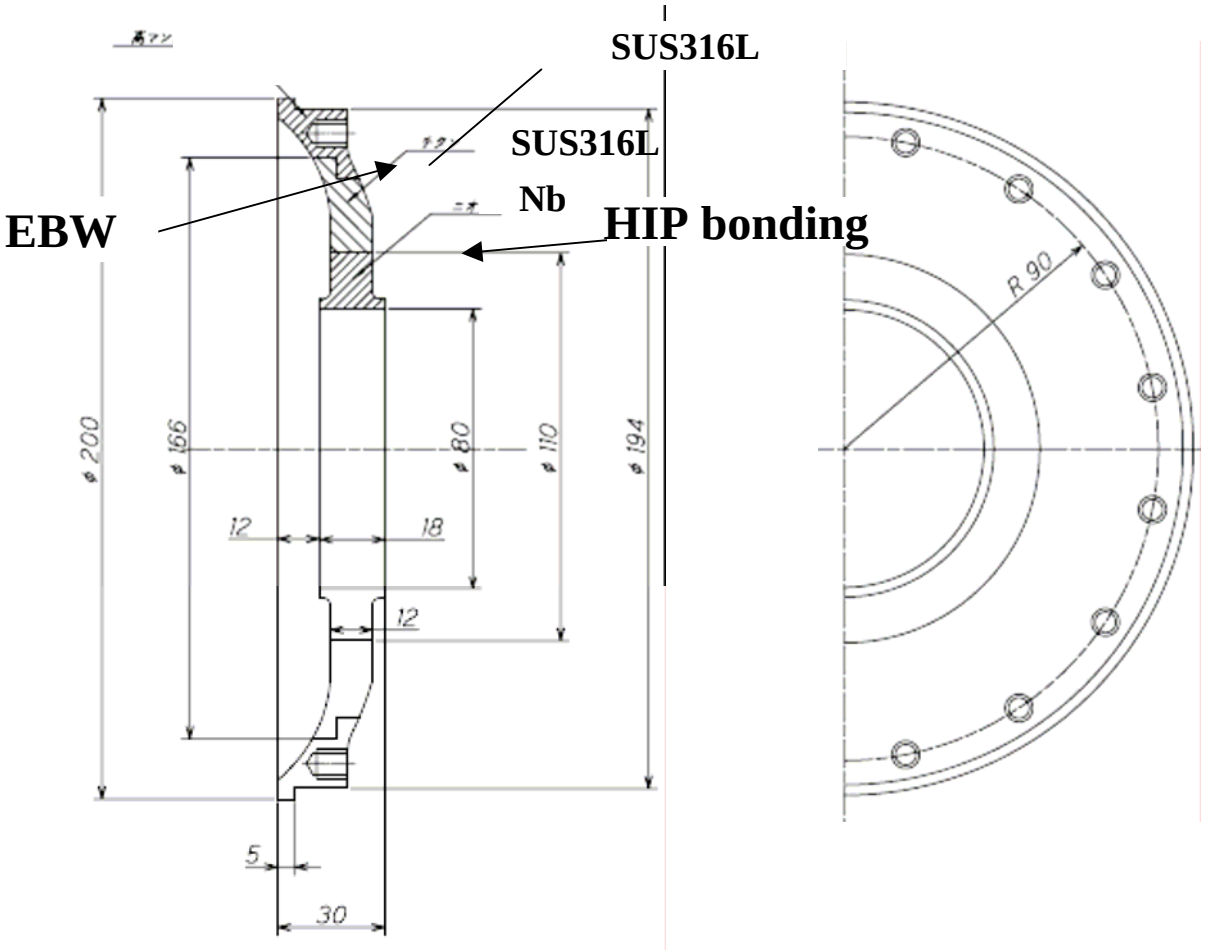


Drawing

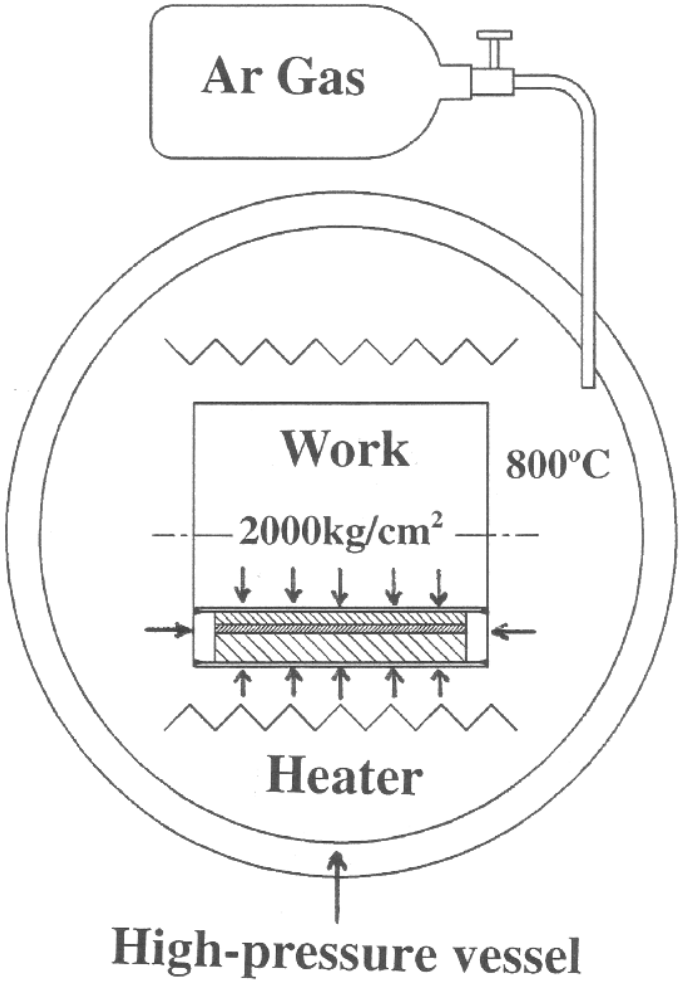
Circular tube

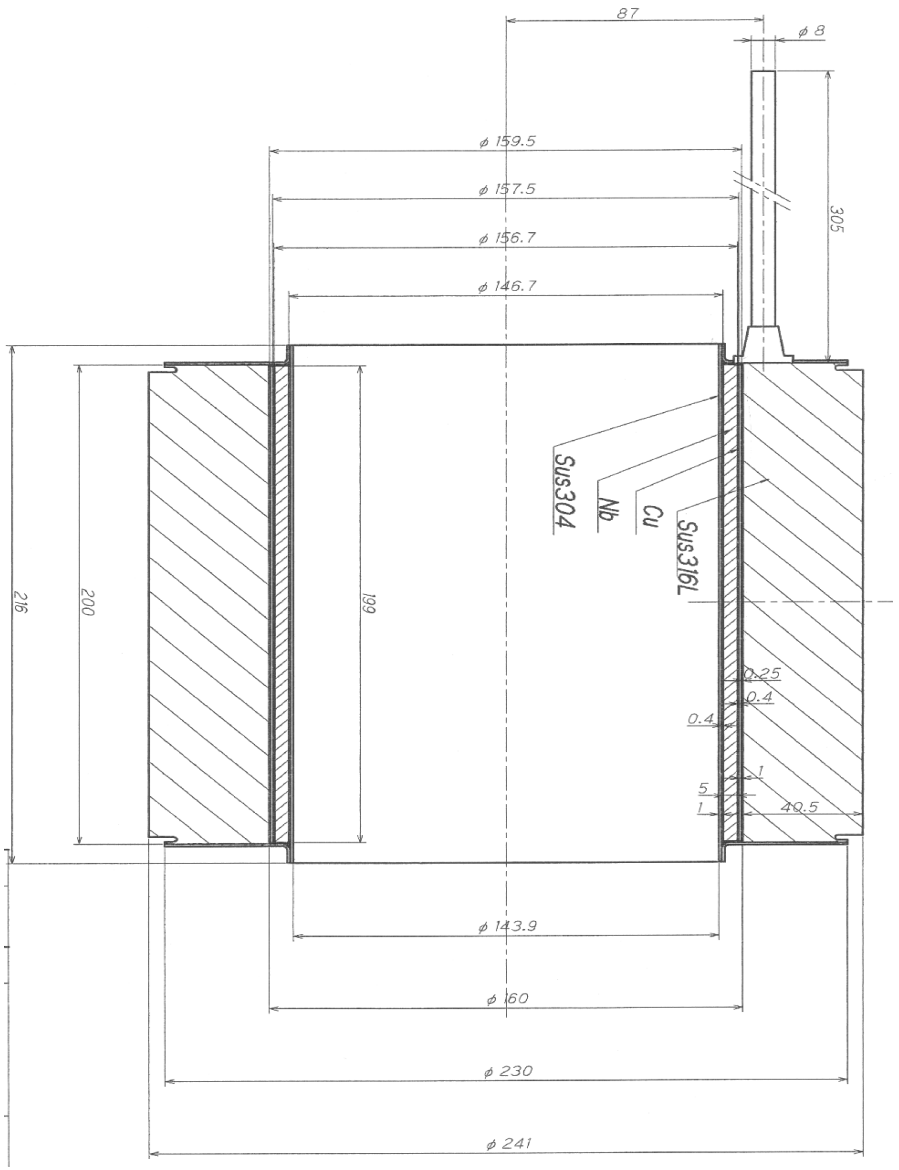
HOM Coupler Parts

END base plate for Helium Vessel



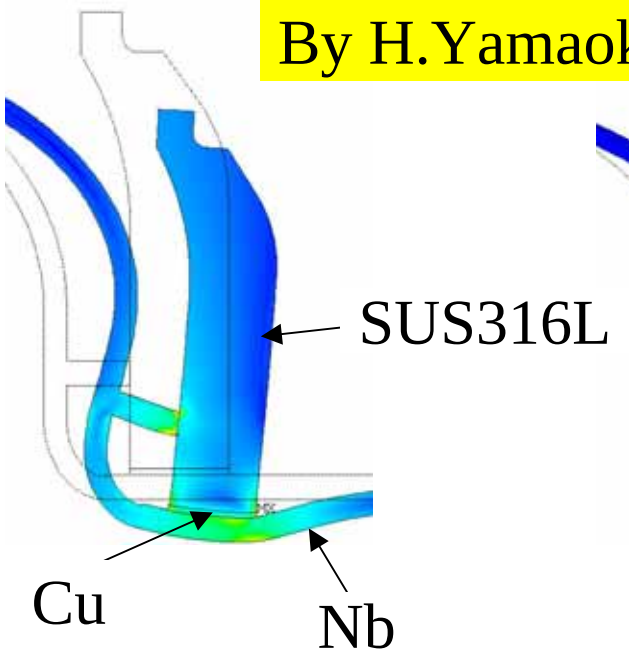
Nb/SUS bonding by HIP



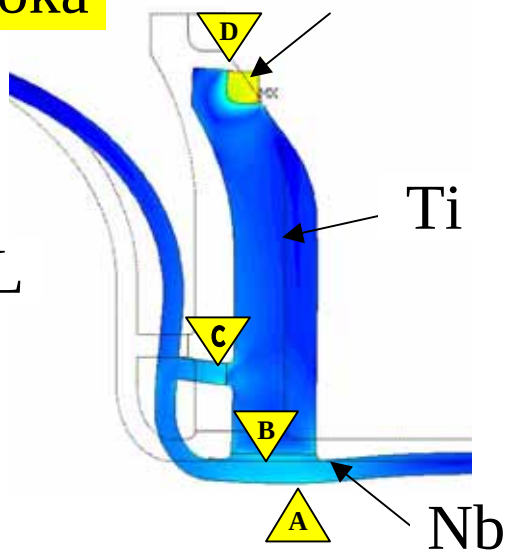


Care for the thermal stress at the base plate

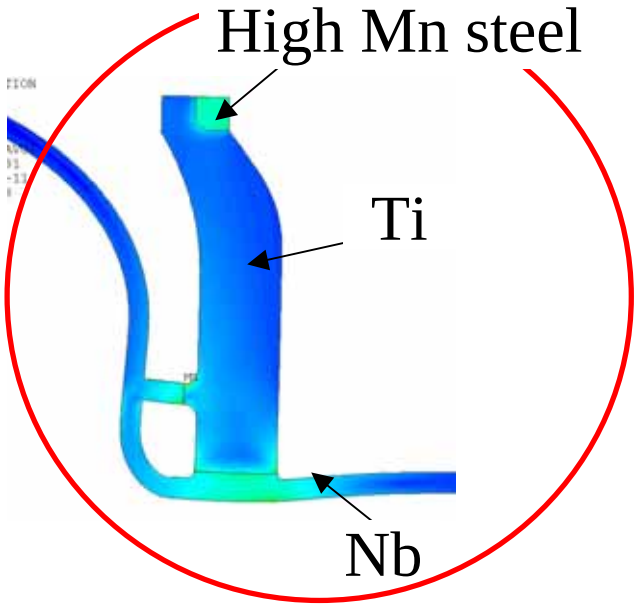
By H.Yamaoka



Nb/Cu/SUS316L



Nb/Ti+SUS316L



Nb/Ti+High Mn steel

Stress concentration

	A [MPa]	B [MPa]	C [MPa]	D [MPa]
Nb/Cu/SUS316L	250	500	500	
Nb/Ti/SUS316L	100	100	200	470
Nb/Ti/High Mn Steel	100	100	200	80

Thermal expansion coefficient

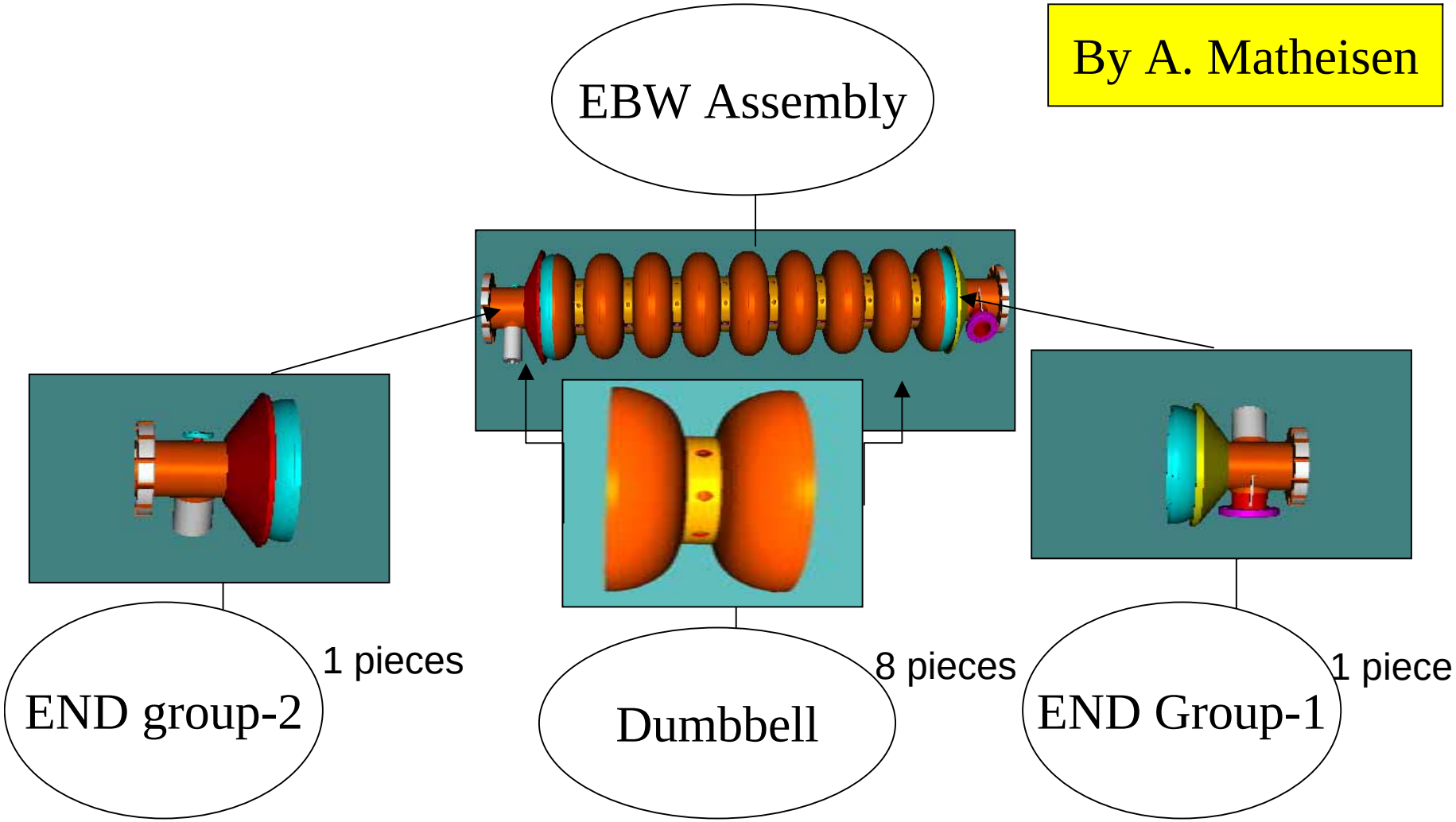
	$\alpha = \frac{\int_{77K}^{300K} \alpha(T)dT}{300-77}$ [E-6/K]
SUS316L	16.0
Cu	17.0
High Mn steel	9.8
Ti	8.4
Nb	5.0

EBW of END Group

SFC

5.4 Final EBW Assembly

By A. Matheisen



EBW Assembly of Cavity

EBW of dumbbells

Beam

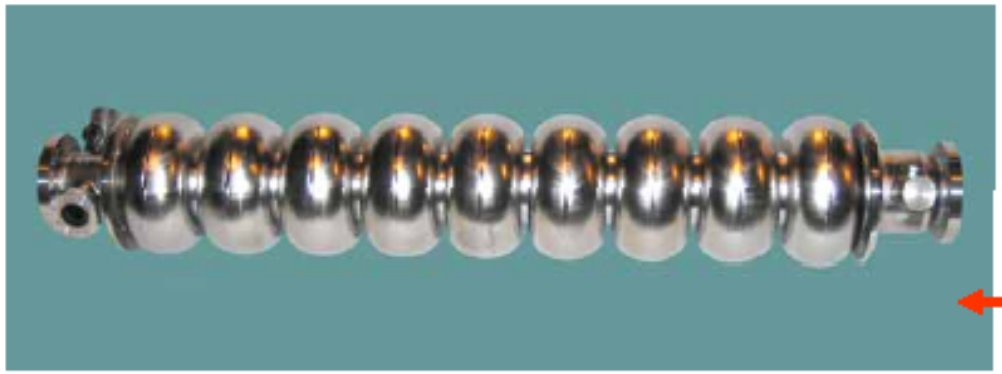
EBW of end-beam-pipe

Beam

End-beam-pipes with HOM and flanges

Beam

EBW of end-beam-pipes and cell-part



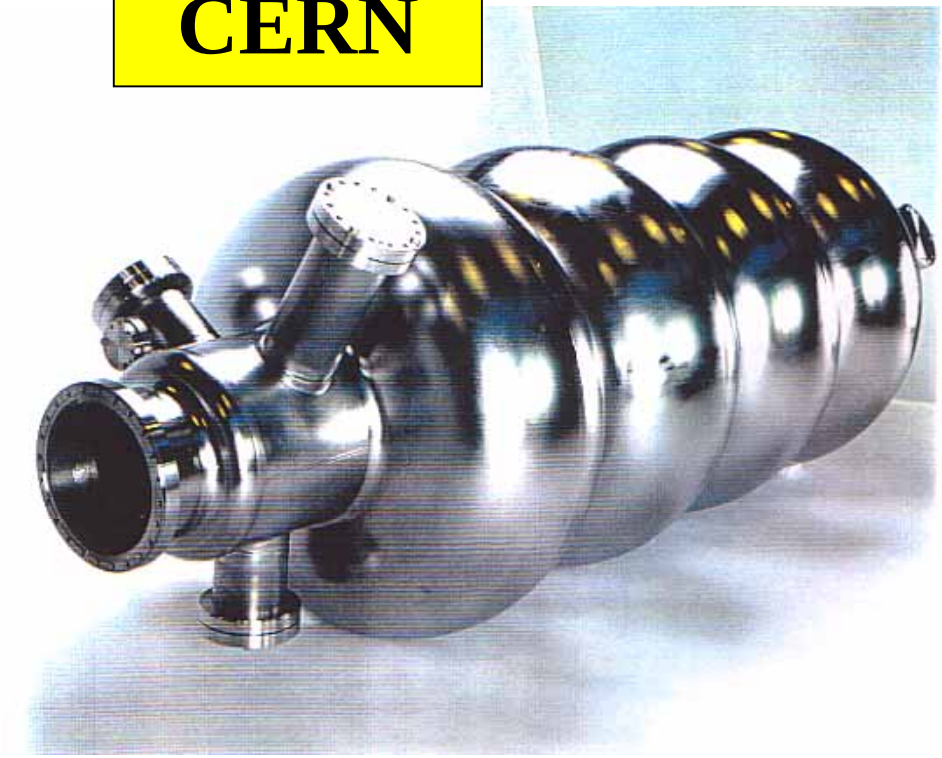
Four 9-cell ICHIRO high-gradient LL Cavities were successfully delivered to KEK ! (4 July 2005)

Completed Ichiro 9-cell Cavity

Kuroki Welding Company

5.5 Nb film coated cavity

CERN



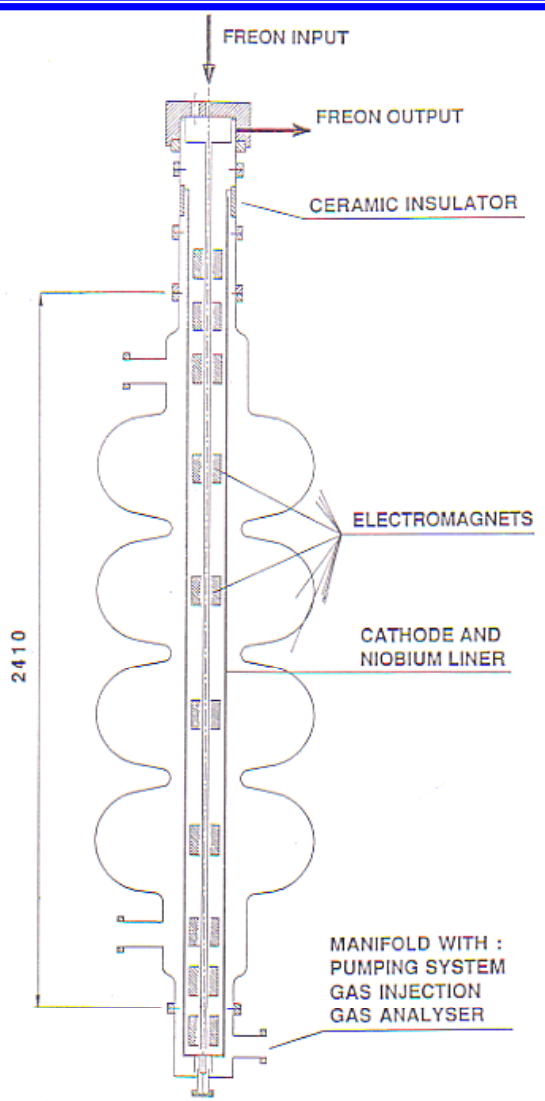
LEP-II 352MHz

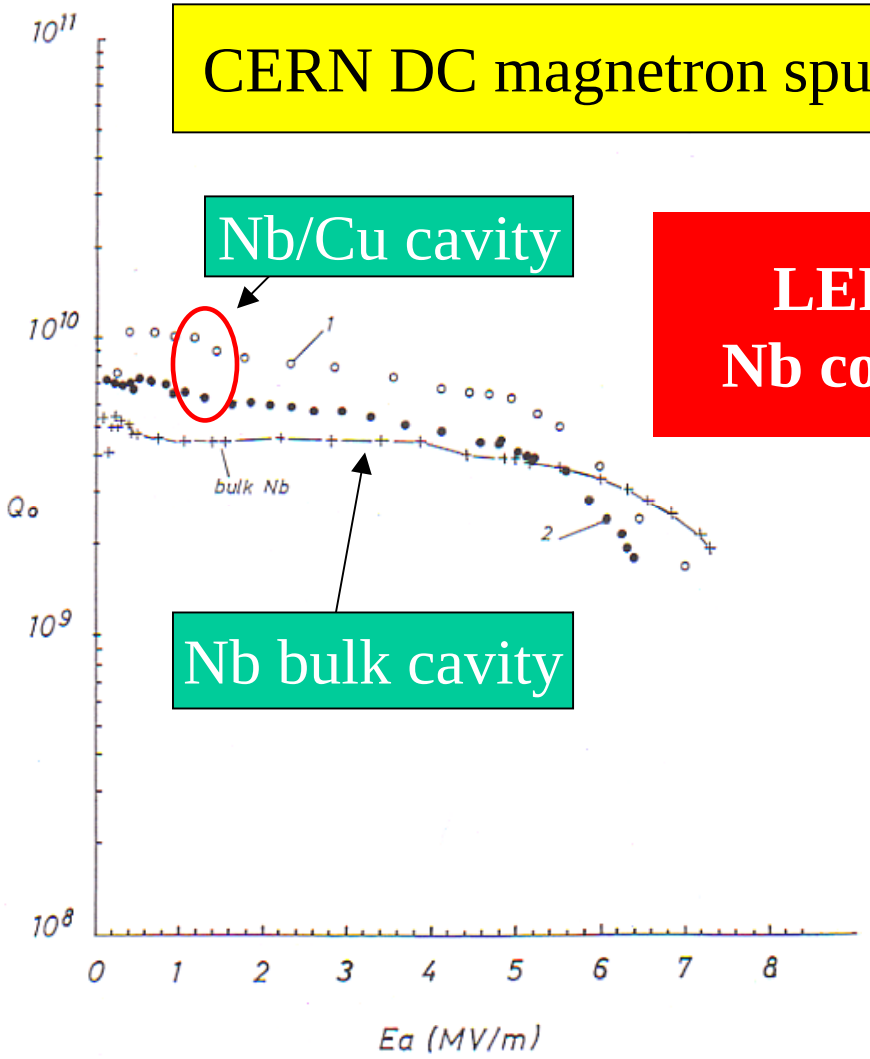
niobium bulk cavity

Copper half cell before Nb coating

(electropolished)

Nb Coating Method at CERN





CERN DC magnetron sputtering

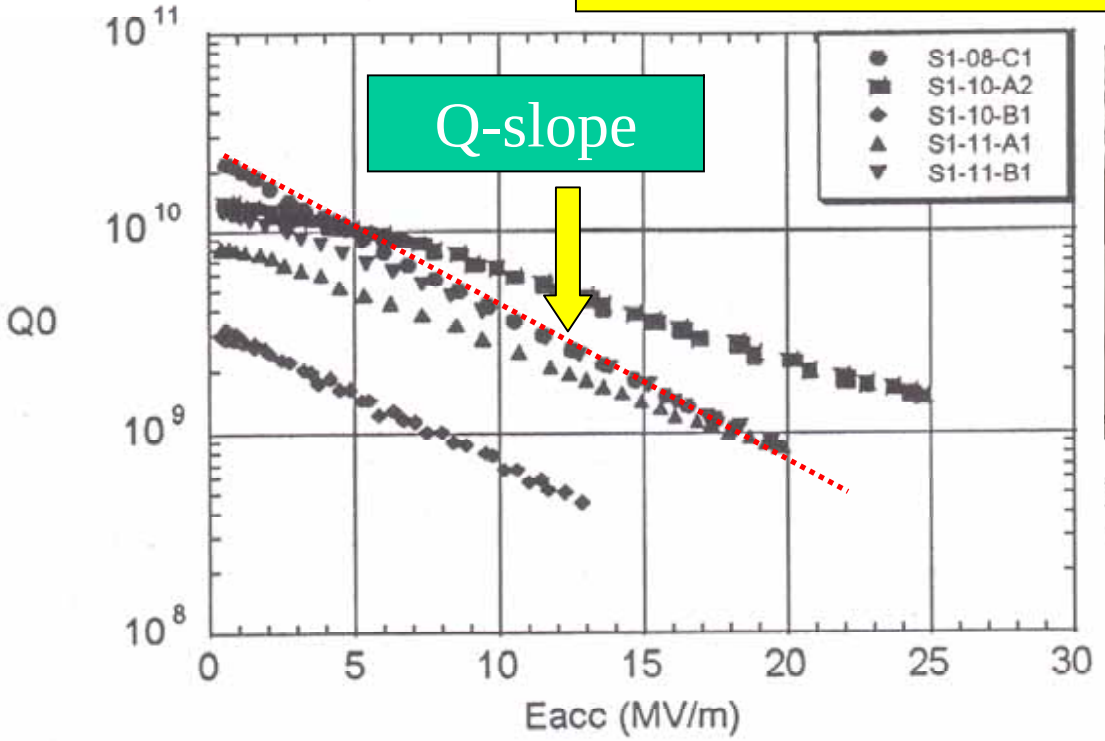
Nb/Cu cavity

Nb bulk cavity

LEP-II used
Nb coated cavity

Q-slope in Nb coated cavities

Saclay 1500MHz



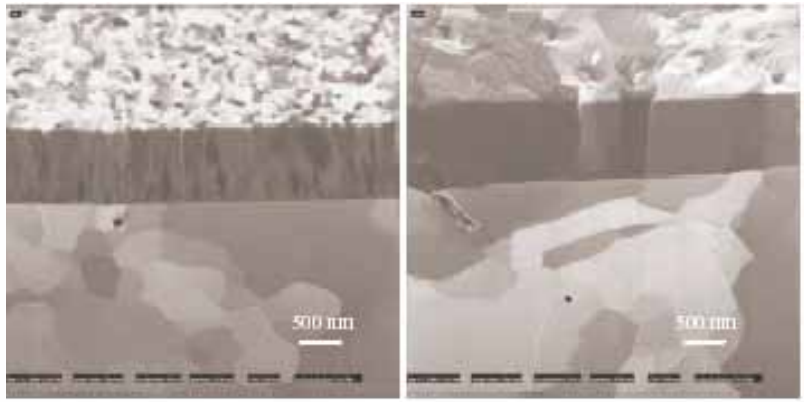


Figure 4: Cross sectional FIB images of niobium films on oxidised (left) and oxide-free (right) copper substrates

Problem: Q-slope
It is no problem at low gradient 5-10MV/m. It brings a serious Q dropping at high gradient. Many studies are under way but so far application of this technology has no hope for ILC.