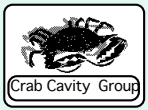


Crab Cavity

Crab Cavity R&D Group
K. Hosoyama, K. Hara, A. Kabe, Y. Kojima, Y. Morita,H. Nakai

KEKB and Superconducting Crab Cavity

Characteristics of KEKB Crab Cavity

Fabrication and Surface Treatment of Crab Cavity

RF Performance Test

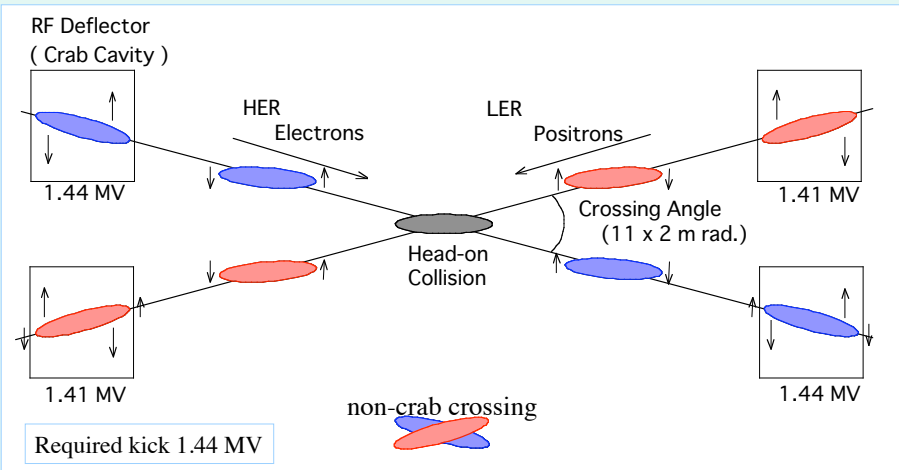
Horizontal Cryostat for KEKB Crab Cavity

- Jacket-type Liquid Helium Vessel
- Frequency Tuning
- R&D Efforts Nb-Cu Spattering / Cu Bellows

KEKB Crab Crossing

The crab crossing scheme allows a large crossing angle collision without introducing any synchrotron-betatron coupling resonances. [1, 2)]

1) R.B.Palmer, SLAC-PUB-4707,1988
2) K.Oide and K.Yokoya, SLAC-PUB-4832,1989



Characteristic of KEKB Crab Cavity

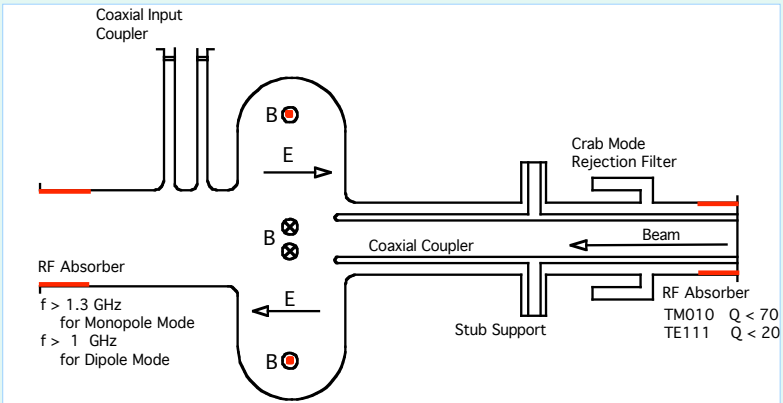
RF Issues

Higher Operation Field Esp = 21 MV/m
Squashed Cell Shape Cavity operating at TM110
Higher Order / the Lowest Order Mode Damped Cavity
- Large Beam Pipes for Higher Order
- Coaxial Coupler for TM010
- Multipactoring

Mechanical Issues

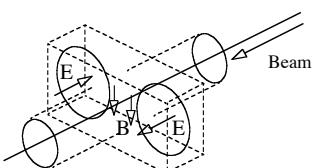
Non-axial Symmetric Weak Structure
- Thickness of 4.5 mm Nb Cavity
- Reinforced by Ribs

Conceptual Design of KEKB Crab Cavity



Squashed Cell Shape Cavity

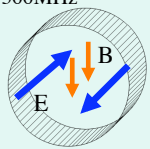
Higher Operation Field Esp = 21 MV/m
Squashed Cell Shape Cavity operating at TM110
Higher Order / the Lowest Order Mode Damped Cavity
Large Beam Pipes for Higher Order
Coaxial Coupler for TM010 Mode
Multi-pactering



Why squashed cell shape cavity?

TM110

500MHz

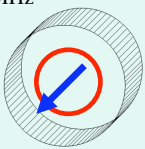


Crab Mode

Unwanted Mode

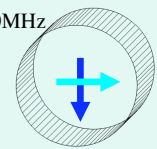
TM010

324MHz



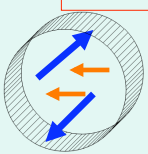
TE111

720MHz



TM110

500MHz



TM110 - like Mode

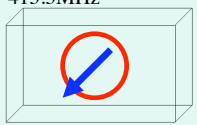
500MHz

Crab Mode

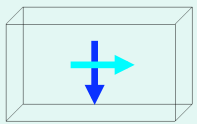
Unwanted Mode

TM010 - like Mode

413.3MHz



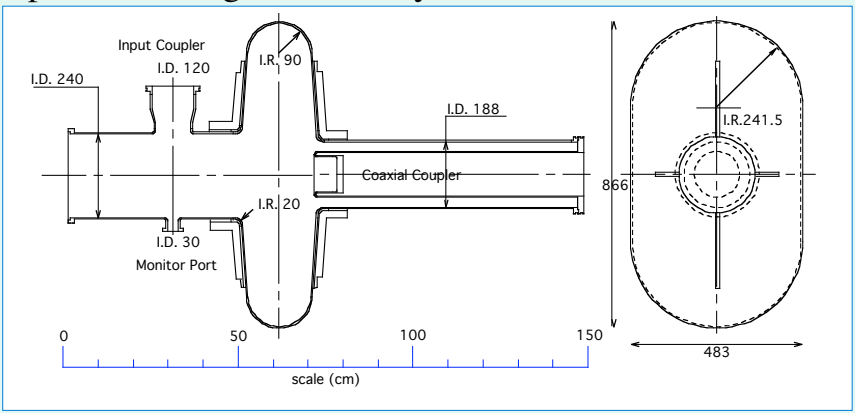
650.5 MHz / 677.6MHz



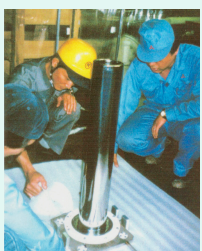
700MHz

The squashed cell shape cavity scheme was studied extensively at Cornell in 1991 and 1992 for CESR-B under KEK-Cornell collaboration.

Superconducting Crab Cavity

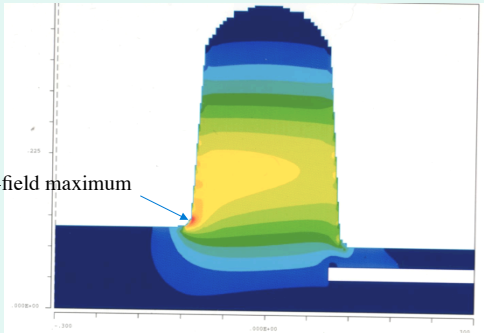


Non-axial Symmetric Weak Structure
Thickness of 4.5 mm Nb Cavity
Reinforced by Ribs



Electromagnetic Field in Crab Cavity by MAFIA

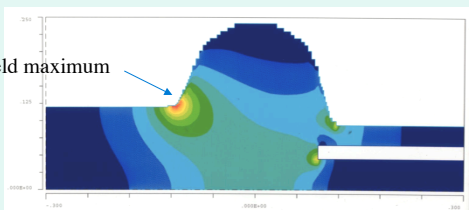
Electric Field in Crab Cavity



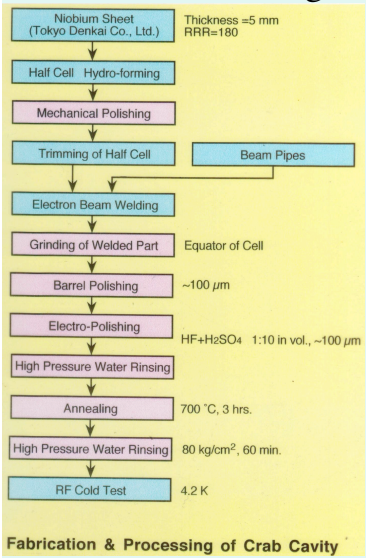
RF parameters for Crab Cavity

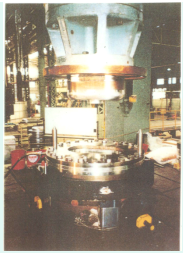
Frequency	501.7 MHz
R / Q	46.7 Ω
G	220
Esp / Vkick	14.4 MV / m / MV
Hsp / Vkick	Oe / MV

Magnetic Field in Crab Cavity

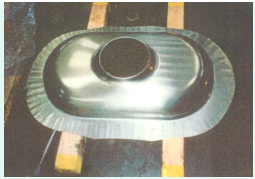


Fabrication & Processing 1

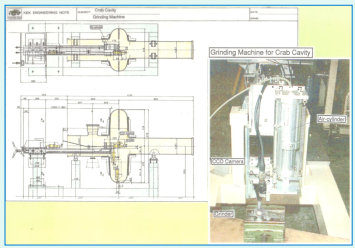




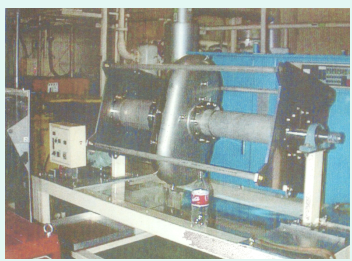
Hydro-forming



Nb
Half Cell

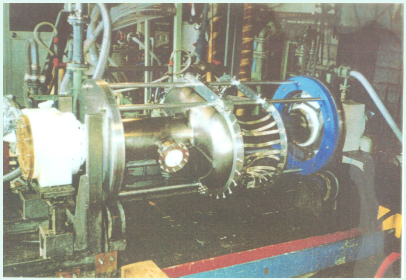


Grinding of
Welding Part

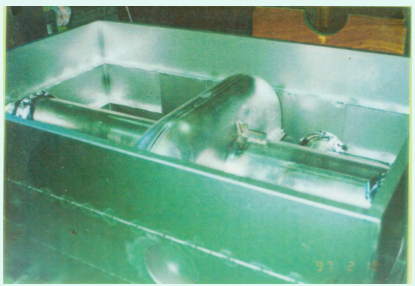


Barrel
Polishing

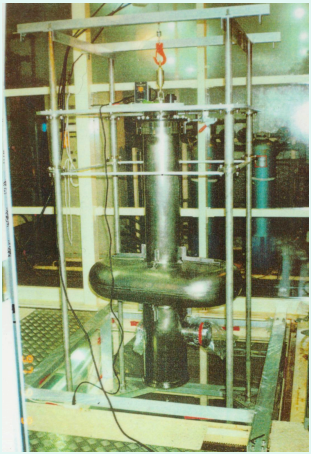
Fabrication & Processing 2



Electro-Polishing

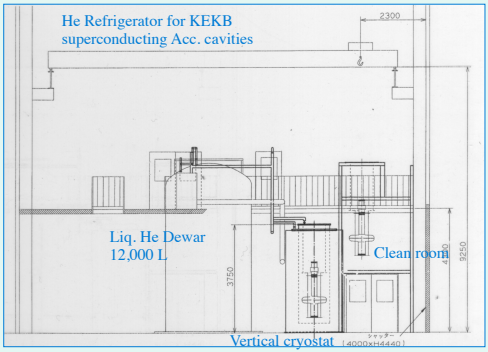


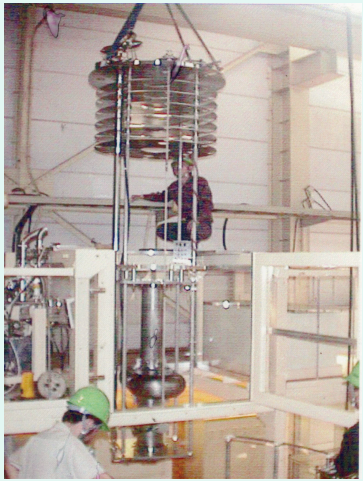
Annealing at 700^0C for 3 hours



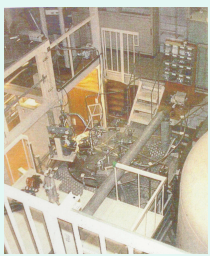
High Pressure Water Rinsing
by 80 bar Ultra-Pure water

Cold Test Stand for KEKB Crab Cavity



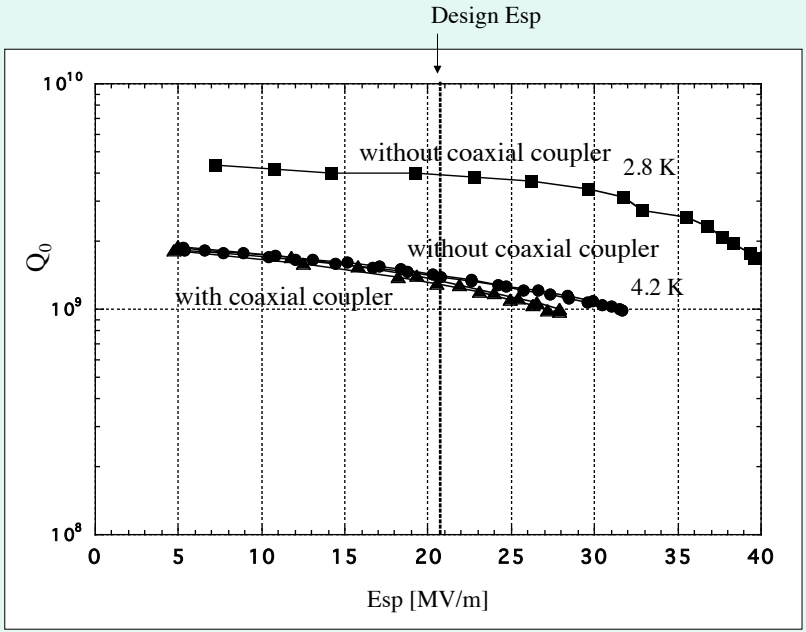


The crab cavity is taken out from clean room to install into the vertical cryostat.

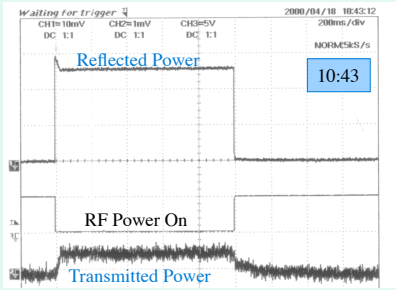


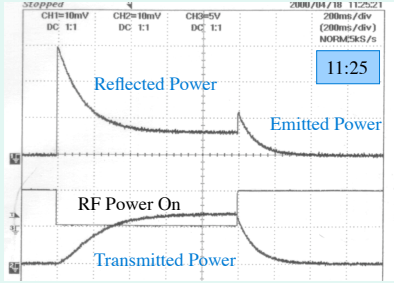
The crab cavity is set in the vertical cryostat

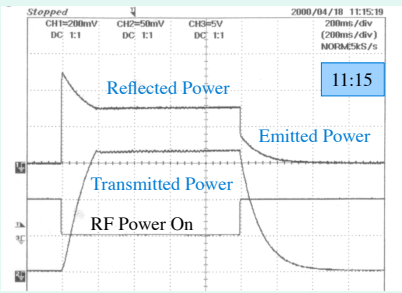
Test Result of KEKB Crab Cavity #1

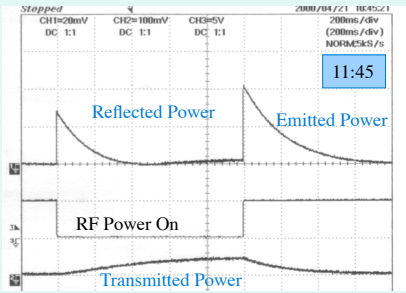


Multipactoring in Crab Cavity with Coaxial Coupler



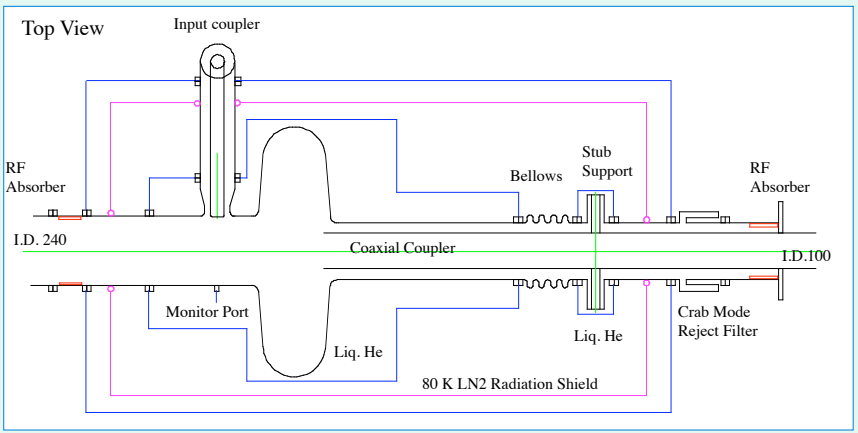




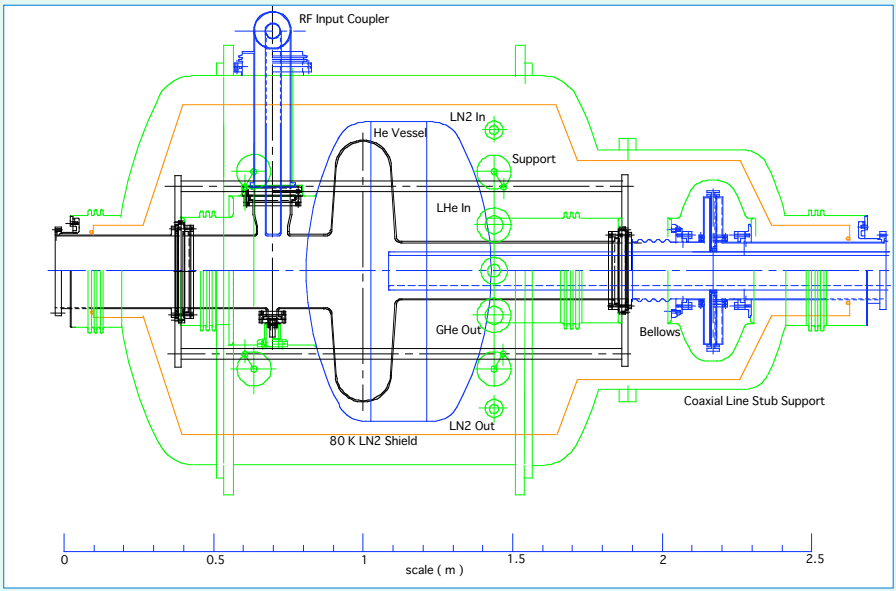


Conceptual Design of Cryostat for KEKB Crab Cavity

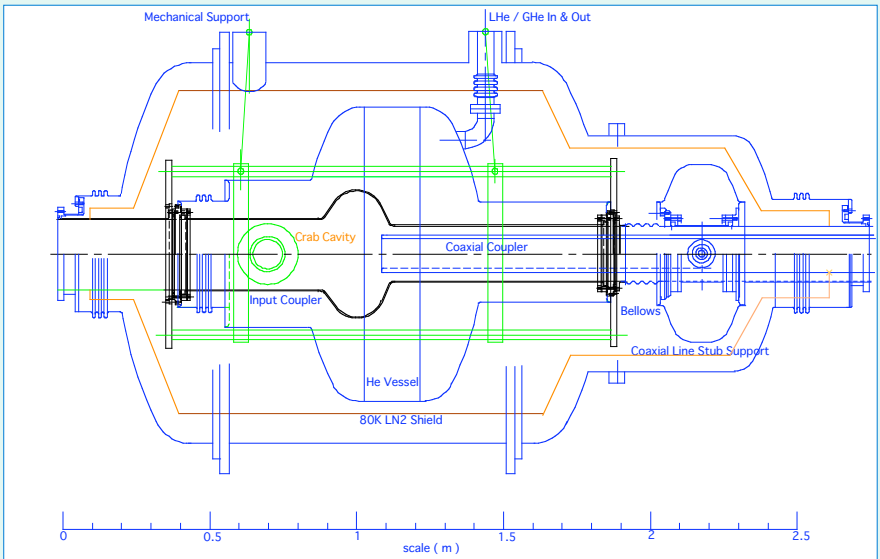
Frequency tuning by Coaxial Coupler 28.3 kHz / mm
Stub-Support ---- Mechanical Support & Cooling Coaxial Coupler Tip
Jacket-type Helium Vessel



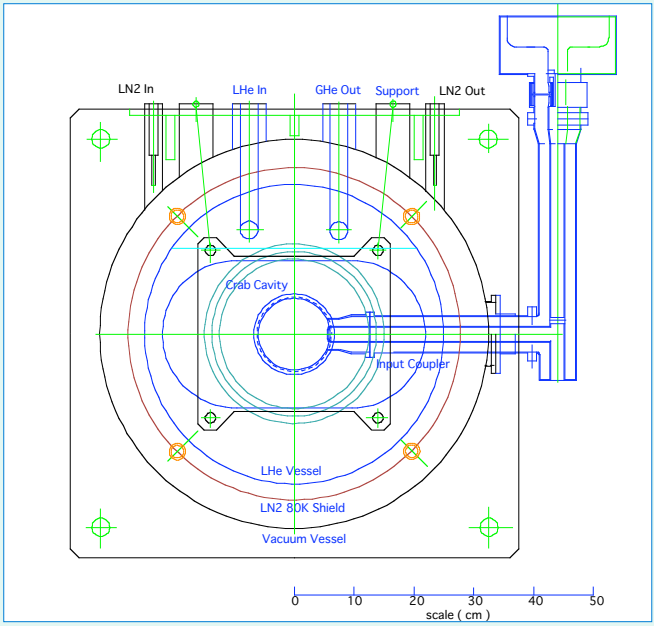
Cryostat for KEKB Crab Cavity (Top View)



Cryostat for KEKB Crab Cavity (Side View)



Cryostat for KEKB Crab Cavity (Front View)



R&D Efforts

Coaxial Coupler Nb --> Nb-Cu

(Designing and Fabrication is very easy !)

To Establish Nb spattering technique

1.5 GHz Nb-Cu Cavity ---- Fabricated and Cold Tested

Seamless Cu Bellows

For Frequency Tuning --- Thin wall (0.4mm) Cu Bellows

(Nb-Cu)

Forming of Thin Plate

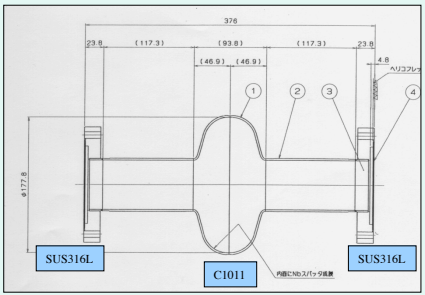
End Plates for Cryostat

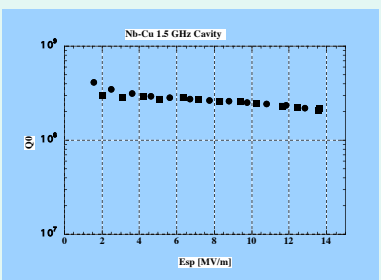
Notch Filter

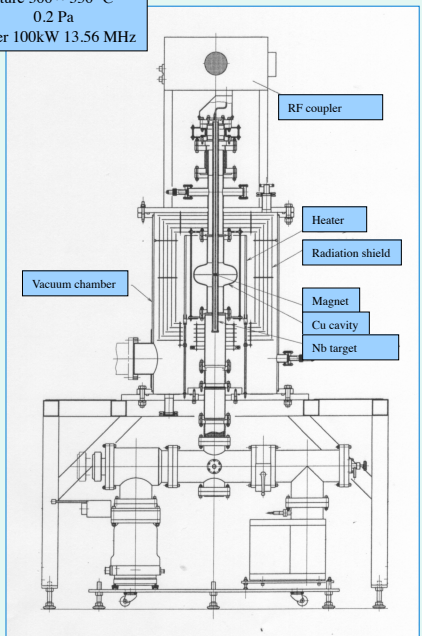
Nb-Cu spattering Cavity

1.5 GHz Nb-Cu Cavity

Temperature 300 ~ 350 °C
Ar Gas 0.2 Pa
RF Power 100kW 13.56 MHz





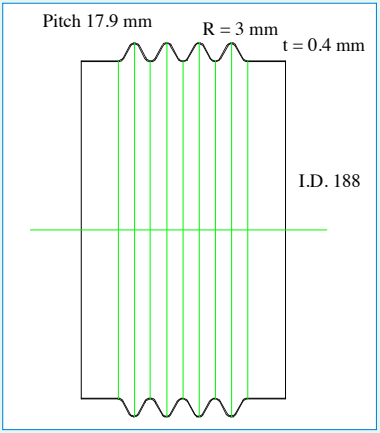


Nb-Cu Cavity

Spattering Chamber for Nb-Cu Cavity

1.5 GHz Nb-Cu Cavity

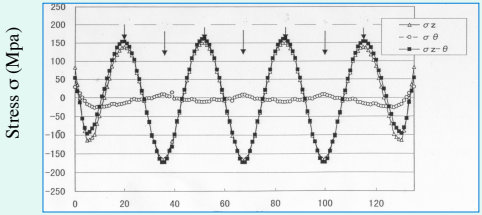
Cu Bellows



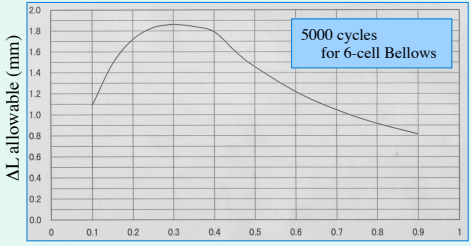
Stress Analysis by ABAQUS

Young's Modulus
E = 127,000 Mpa
Poisson Ratio
ν = 0.34

t = 0.4 mm, Δ L = 1 mm



Allowable Deformation ΔL of Bellows



Thickness of Bellows (mm)

Fabrication of Bellows -Seamless Pipe-

Thin Wall thickness Cu Pipe I.D. 188 mm t = 0.5mm
Seamless Pine

Mandrel, Die and
Fabricated Cu-pipe

Drawing Bench Capacity 30 t

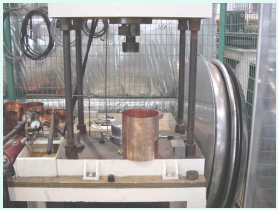
Cu Disk
t = 2mm

Forming

Drawing
Side wall

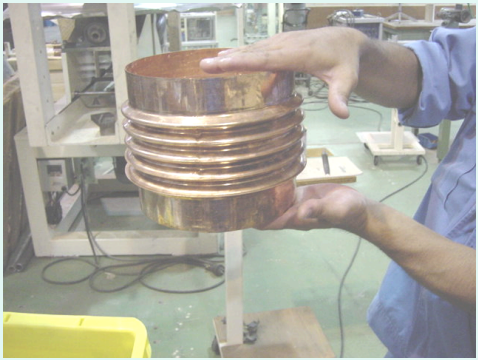
Drawing;
using smaller dies
step by step
without annealing

Fabrication of Bellows



Press Unit and
Pressure Water Pump

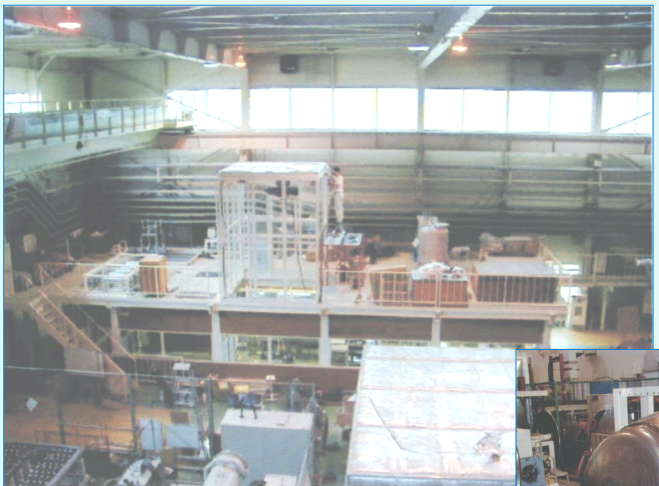
Set the Female Die



Fabricated 5-cell Bellows

Female Die
and Outer
Guide Pipe

Clean Room for Cavity and Cryostat Assembling



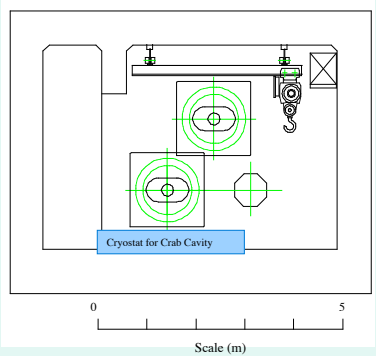
Clean Room (Class 100)
for Cavity Assembling

High Pressure Pure
Water Rinsing

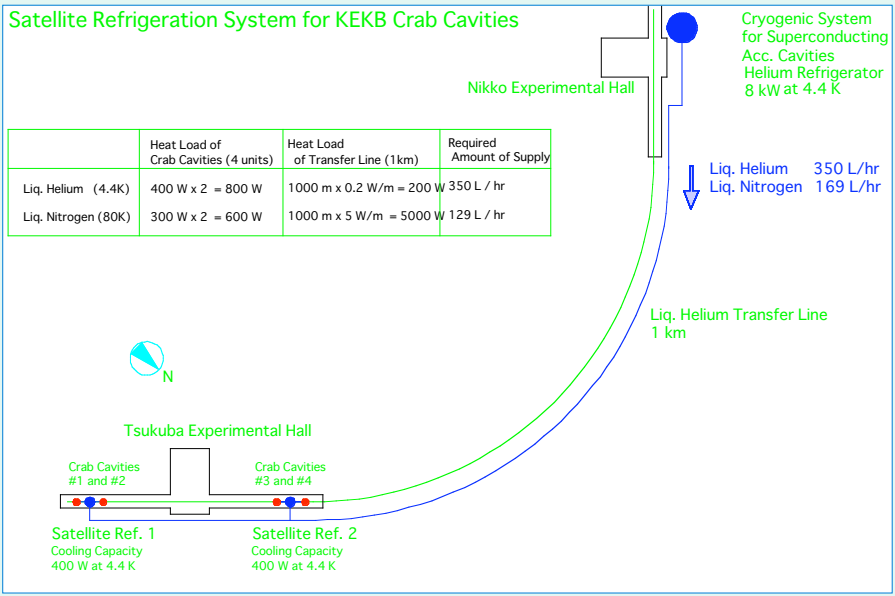
Clean Room
for Cryostat Assembling

End Plate of Vacuum Vessel for Cryostat
made by Spinning

Installation of Crab Cavity into KEKB Tunnel



Cryogenic System for Crab Cavity



Satellite Refrigeration System for Crab Cavities