Crab Cavity Overview

K. Hosoyama

Crab Crossing Scheme New Crab Crossing Scheme
KEKB Superconducting Crab Cavity
Construction Schedule
Fabrication of Crab Cavities for LER & HER
RF Performance Test
Cryostat for KEKB Crab Cavity
HOM Damper
Input Coupler
Frequency Tuner
Connection of Inner Conductor / Coaxial Structure
Summary

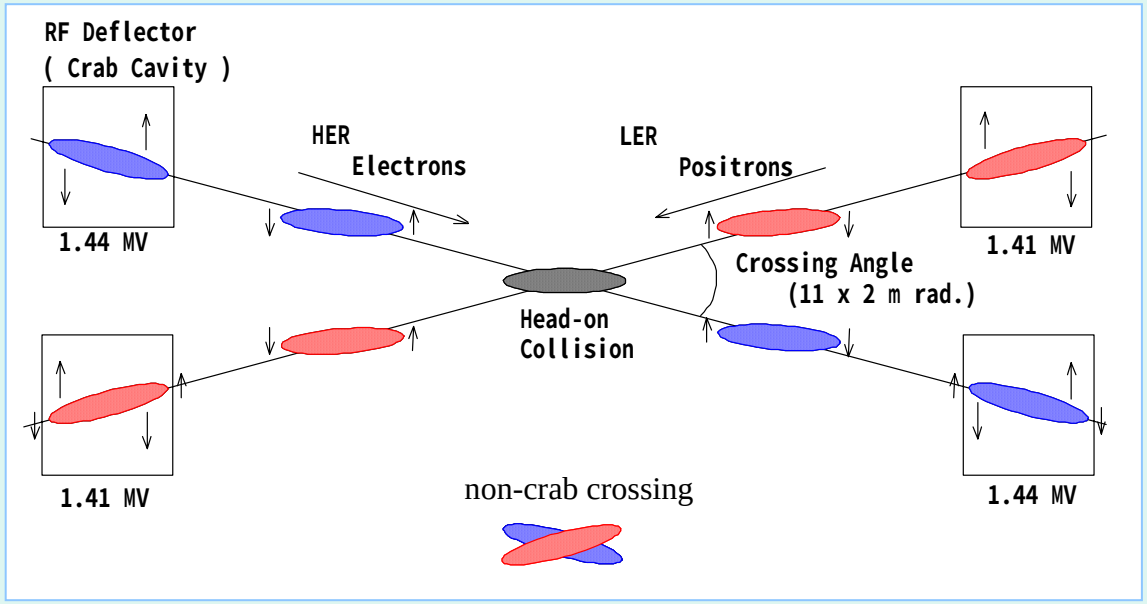
KEKB Crab Crossing

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

Original Crab Crossing Scheme

4 Crab Cavities
at Colliding Section



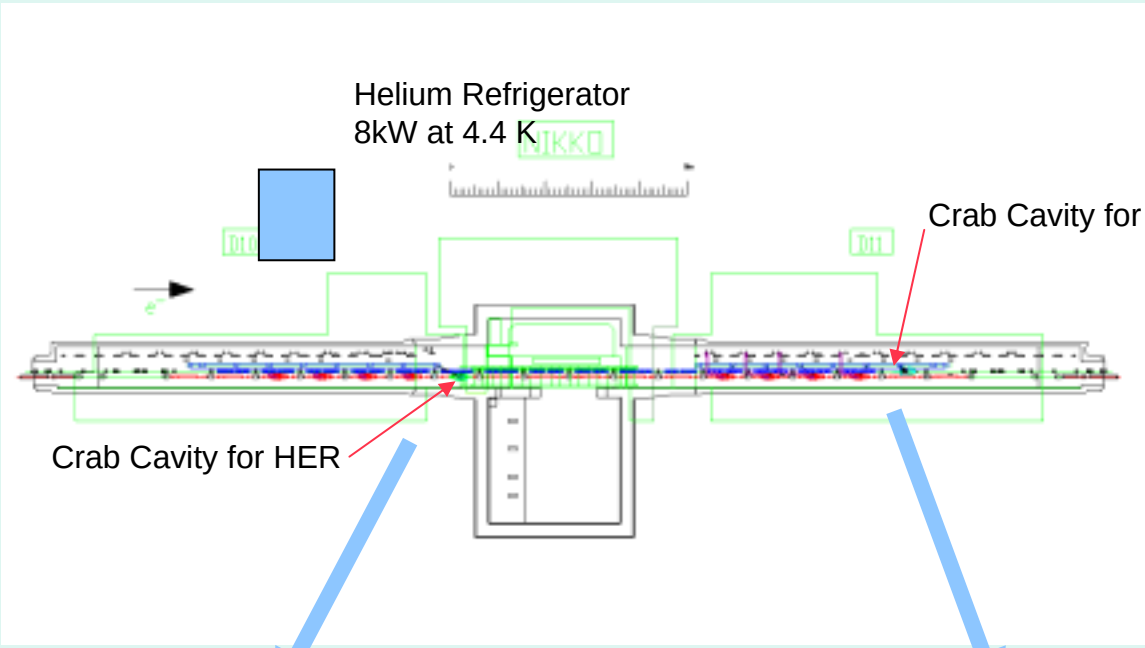
New Crab Crossing Scheme

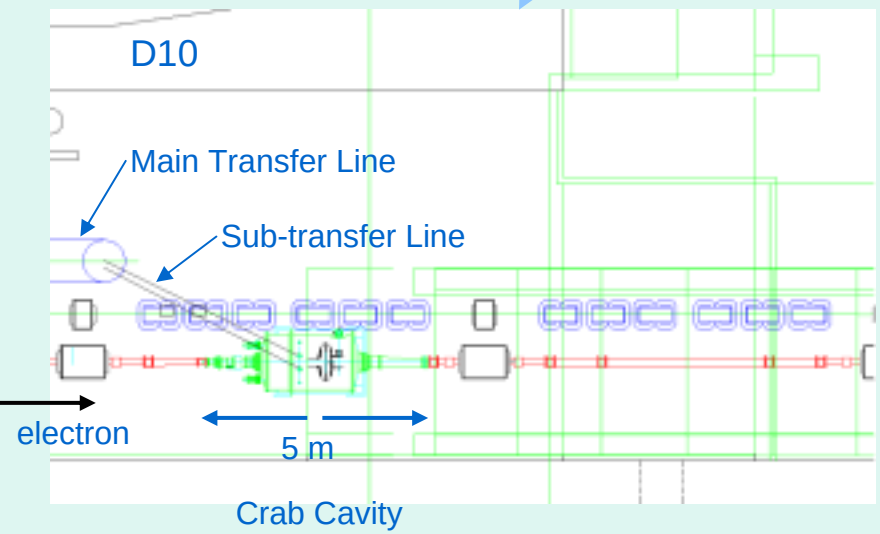
2 Crab Cavities
at "Nikko" Section

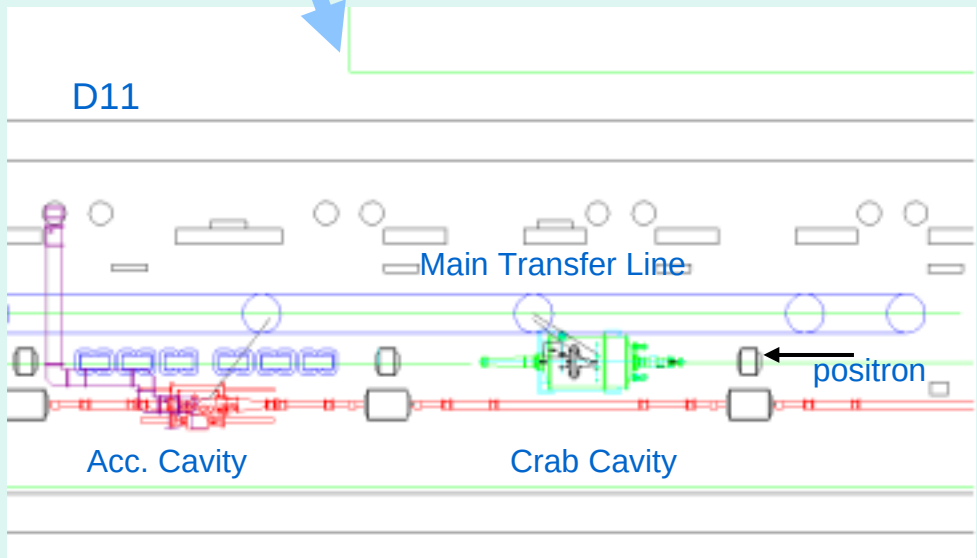
Beam-bunch wiggle around the whole ring!

Advantage: We can use existing cryogenic system for Acc. S.C. cavities

Layout of Crab Cavities In Nikko

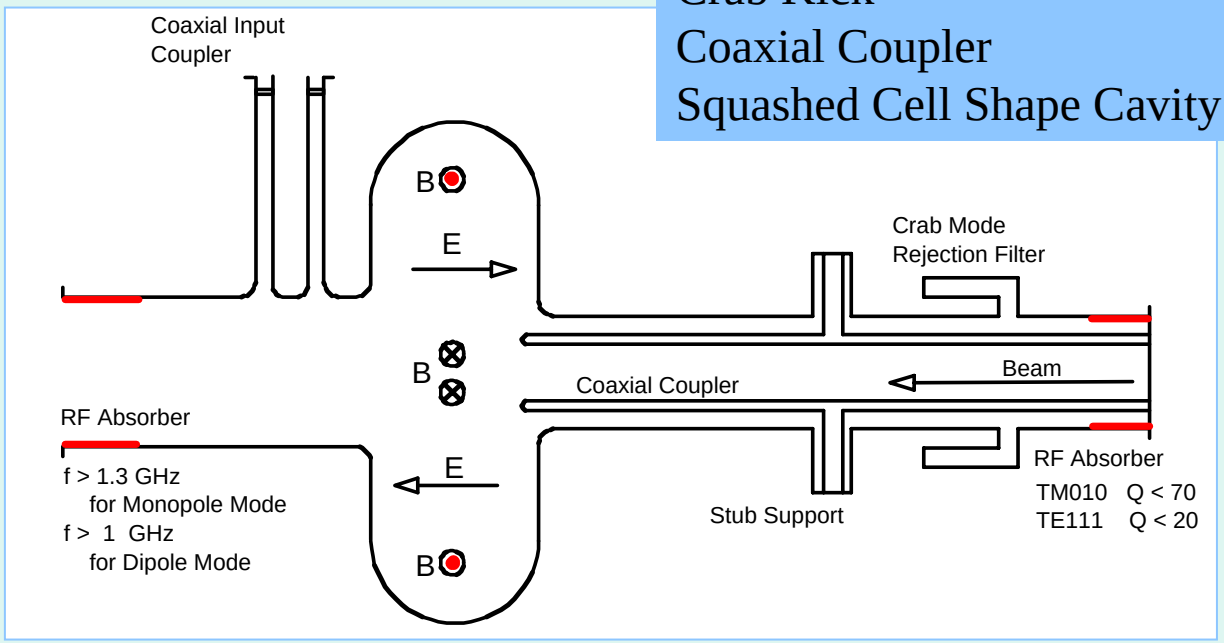






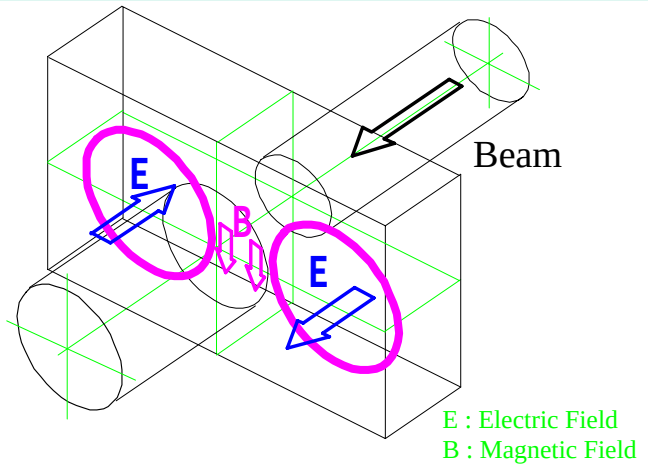
Conceptual Design of KEKB Crab Cavity

Top View



Crab Kick	TM110 B-field	1.44 MV
Coaxial Coupler	TM010, TE111	
Squashed Cell Shape Cavity	TM110*	

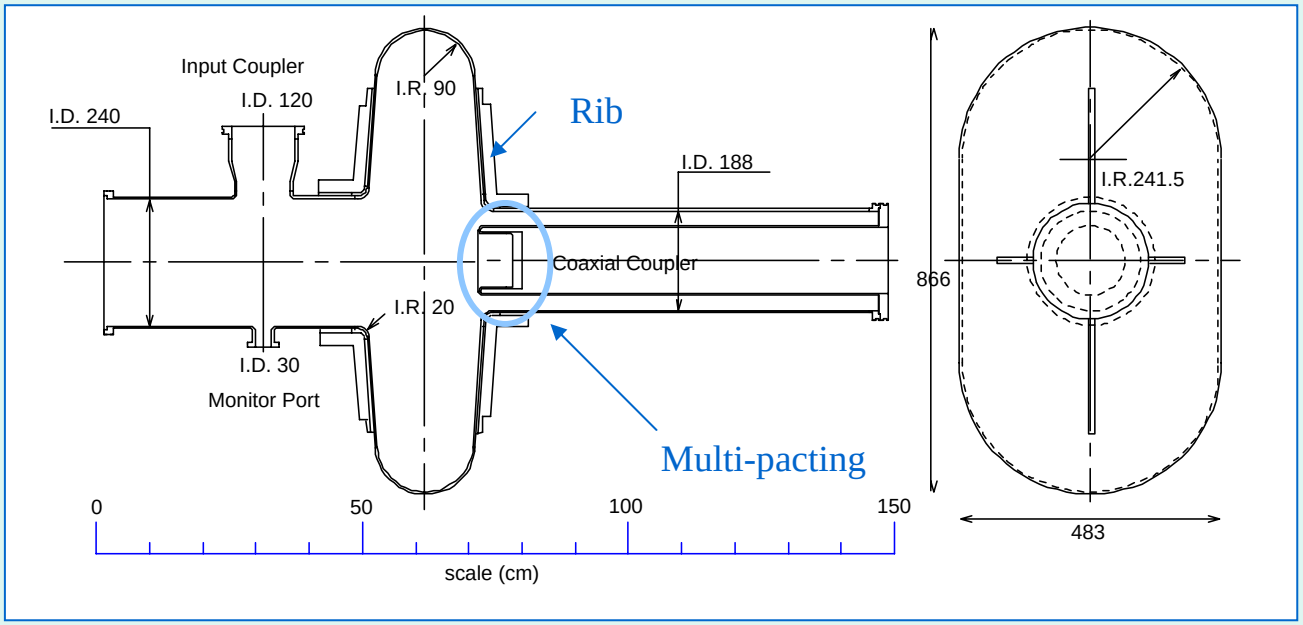
Squashed Cell Shape Cavity



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

We adopted this design as “base design”!

KEKB Superconducting Crab Cavity



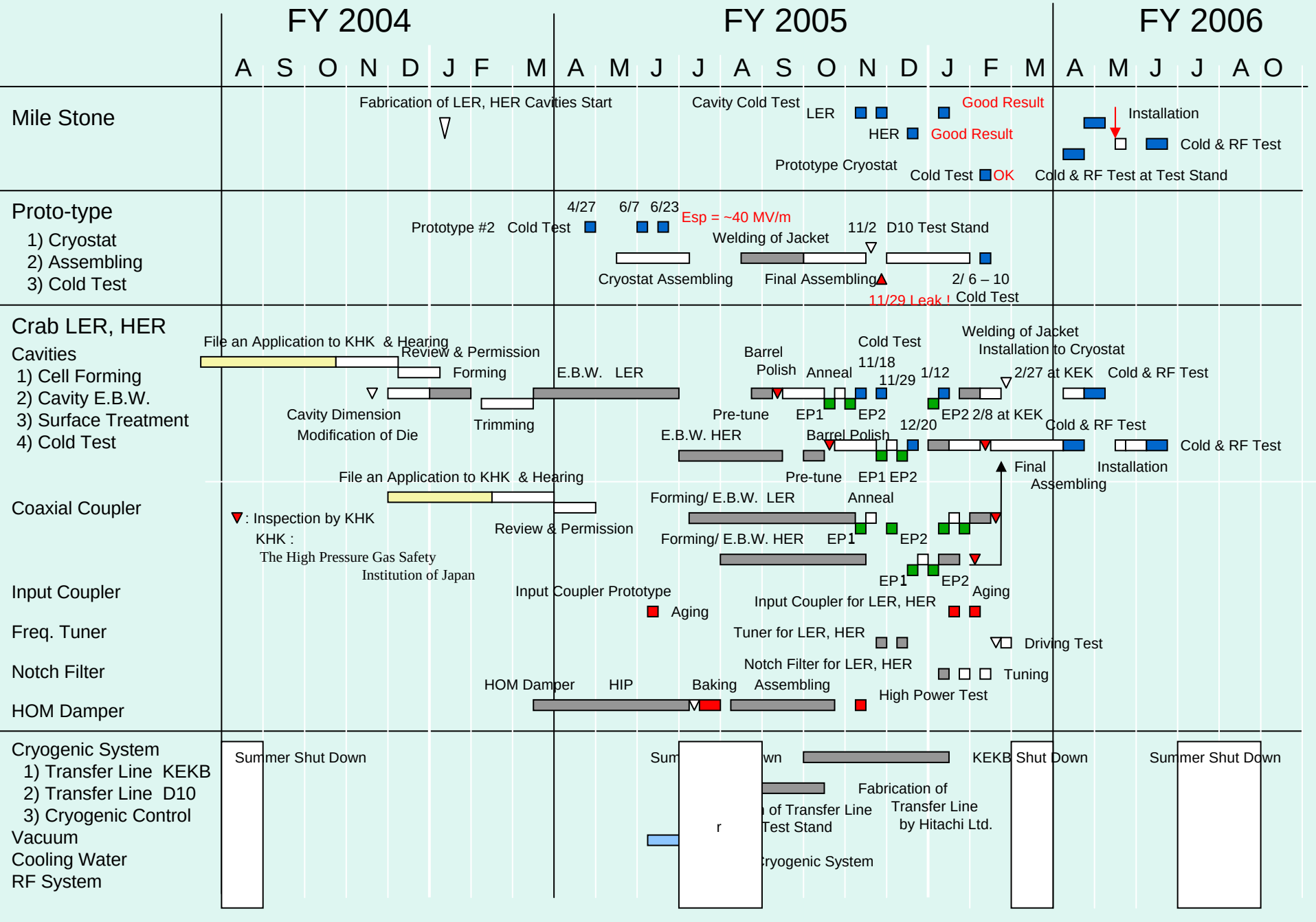
Frequency	501.7 MHz
R / Q	46.7 Ω
G	220
Esp / Vkick	14.4 MV / m / MV
Hsp / Vkick	415 Oe / MV

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

Simplified Nb Coaxial Coupler

Construction Schedule of KEKB Crab Cavities

March 19, 2005 K. Hosoyama



Related Talks

• RF characteristics of crab cavity	Y. Morita
• FR couplers of crab cavity	K. Nakanishi
• Cryostat, jacket, etc.	H. Nakai
• Peripheral devices	H. Nakai
• HOM absorbers	Y. Morita
• Horizontal test of crab cavity	Y. Yamamoto
• RF system for crab cavity	K. Akai
• Installation of crab cavity	M. Ono

Fabrication of Crab Cavity

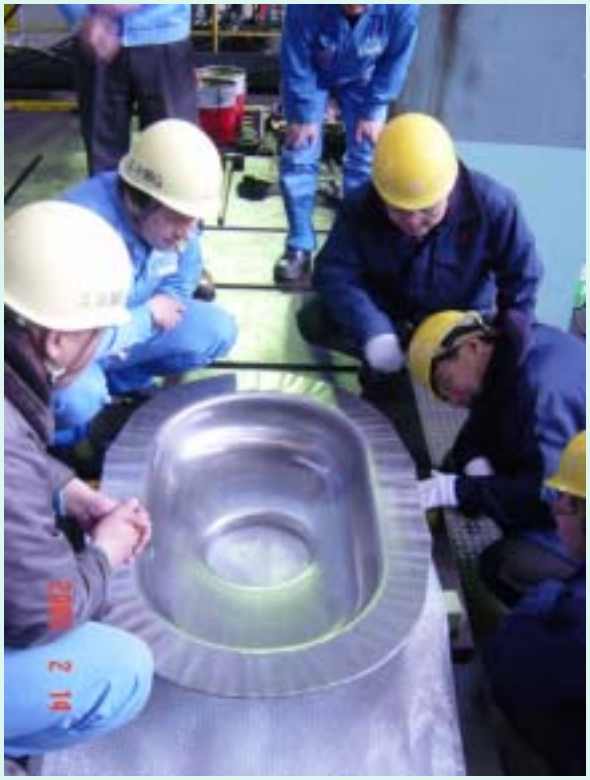
1) Full Scale Prototype Crab Cavity 500MHz

2 Nb Cavities # 1 & # 2
2 has was Installed
into Horizontal Prototype Cryostat

2) KEKB Crab Cavity 509MHz

2 Nb Cavities for LER, HER
Finished the Fabrication
Cold Tested in Vertical Cryostat
Now under Installation into Horizontal Cryostat

Forming at Electron Beam Welding at MHI



Beam Pipes were
Fabricated by E.B.W.

Forming of 4 Half-Cells for
Crab # LER and # HER
Finished on Feb. 14, 2005 at
Mitsubishi Heavy Industries,
LTD. Kobe

Full-Cells for Crab # LER, # HER

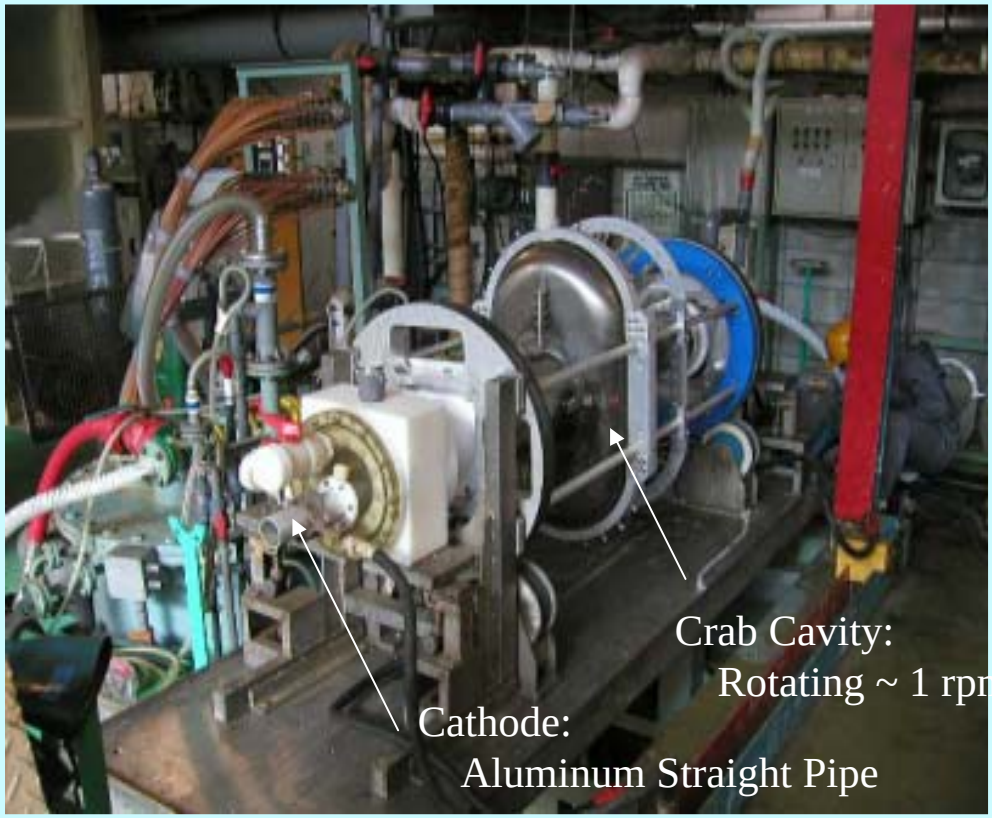
Barrel Polishing at KEK

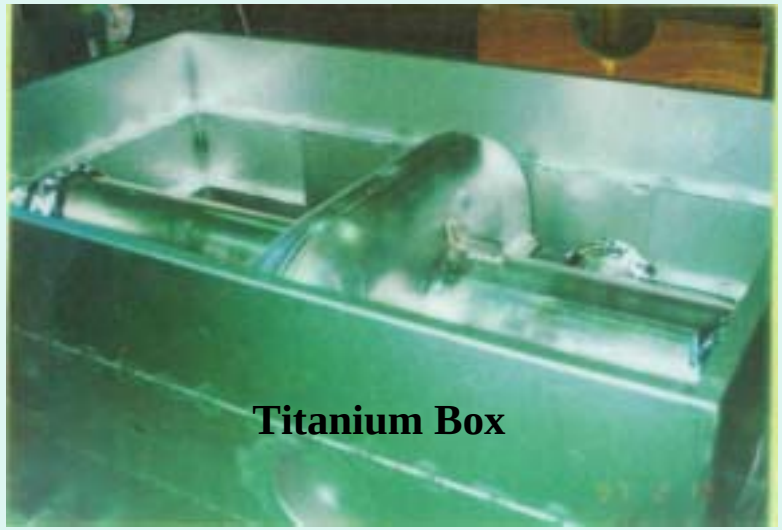
Polishing Time 312 Hr

Remove about 0.15 mm along the cell equator

Measurement of Resonant Frequency

Electro Polishing & Annealing





Annealing at 700^{0}C for 3 hours
at Kinzoku Giken Ltd.

Transport & Assembling for Cold Test

Arrive in KEK from Nomura Plating Ltd.

Assembling in Clean Room in AH

High Pressure Rinsing at KEK

High Pressure Water Rinsing by 80 bar Ultra-Pure water

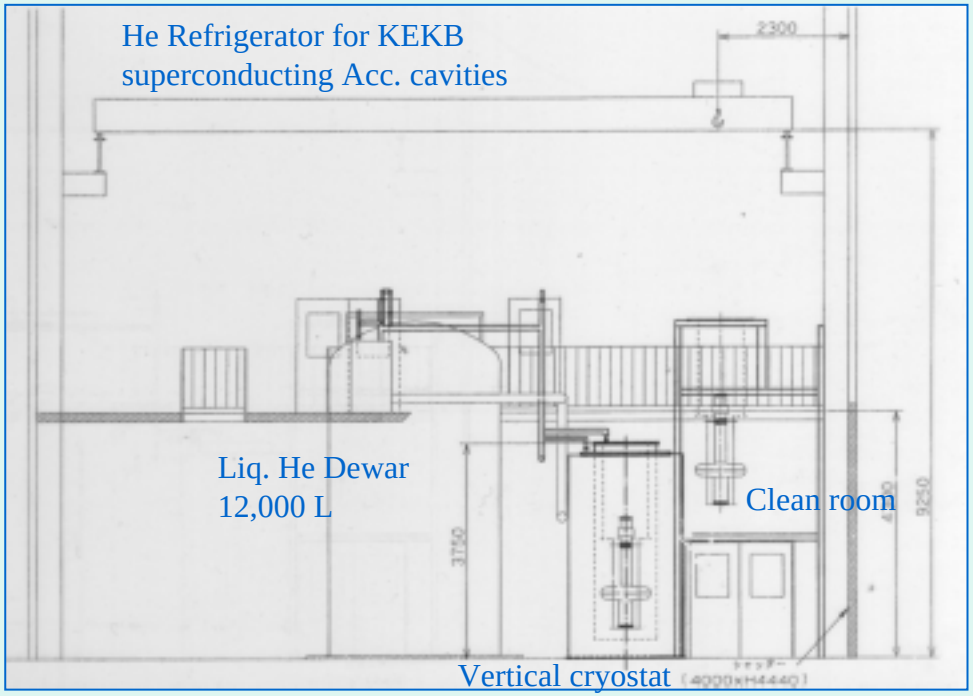
Rotation & Up-Down Motion

New HPR Facility at KEK

Transition Flange

Transition Flange

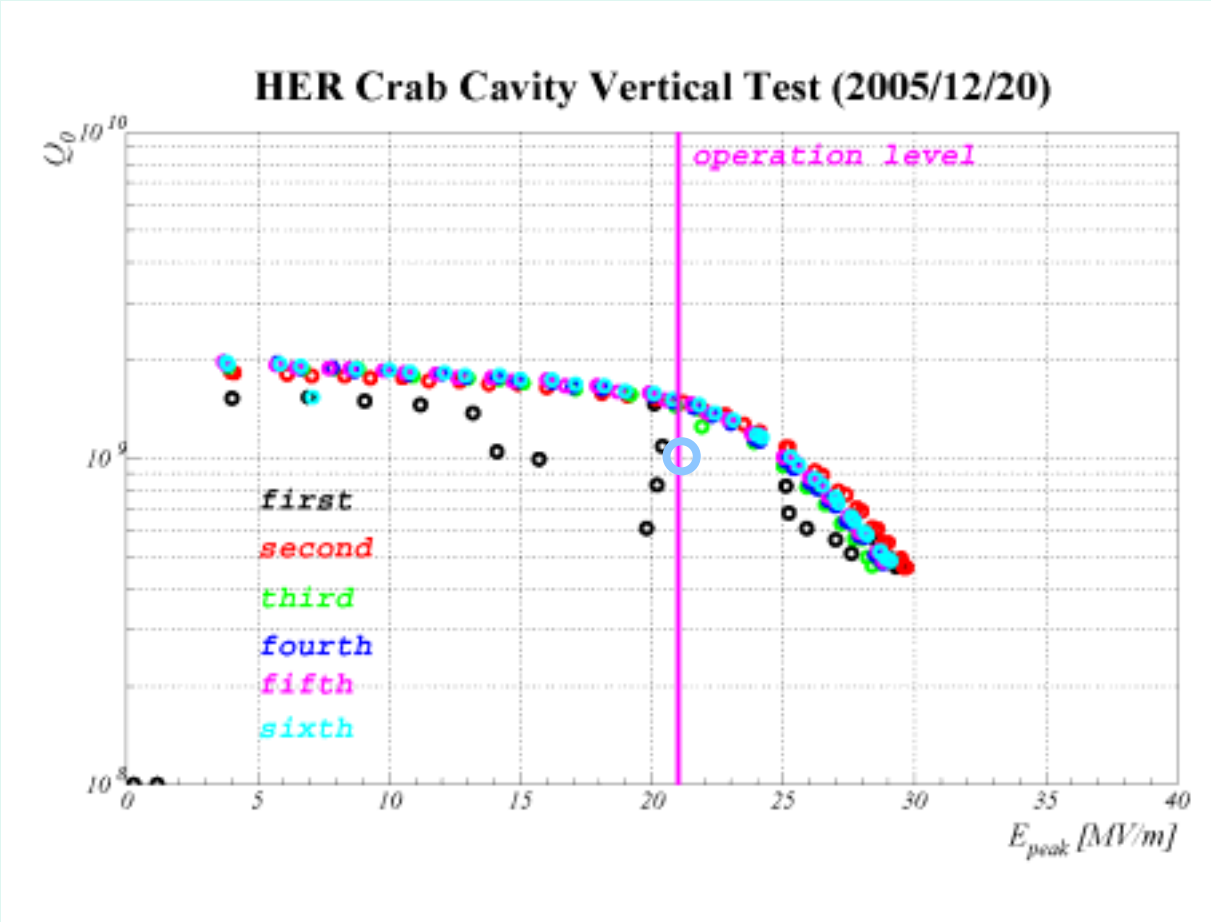
Cold Test Stand for KEKB Crab Cavity

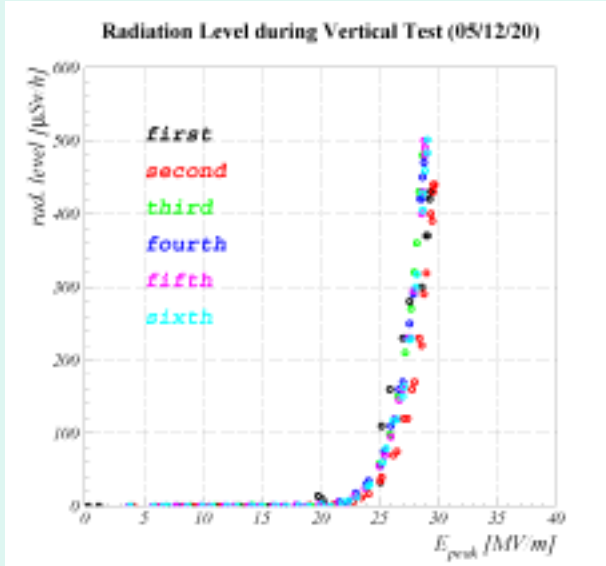


The crab cavity is taken out from clean room to install into the vertical cryostat.

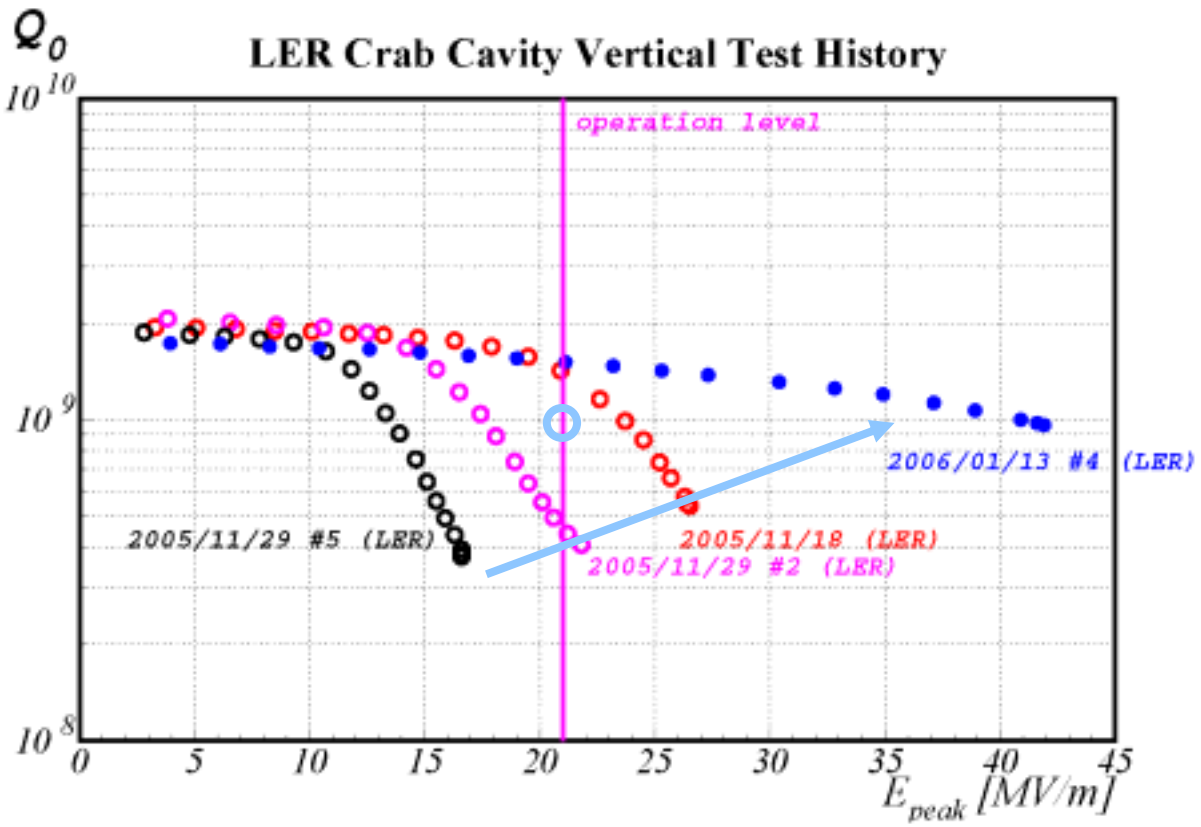
The crab cavity is set in the vertical cryostat

Test Result Crab Cavity #HER

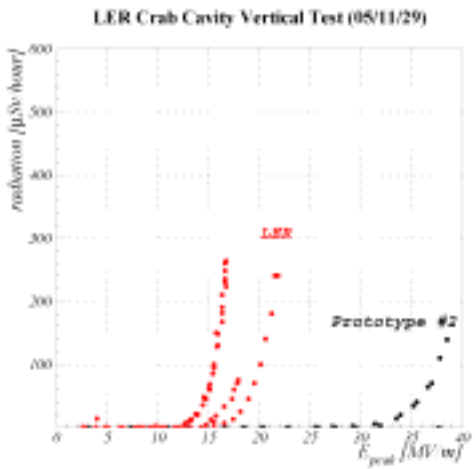




Test Result Crab Cavity #LER



X-Ray



Nov. 18 1st Test

↓ H.P.R.

↓

Nov. 29 2nd Test

Field Emission

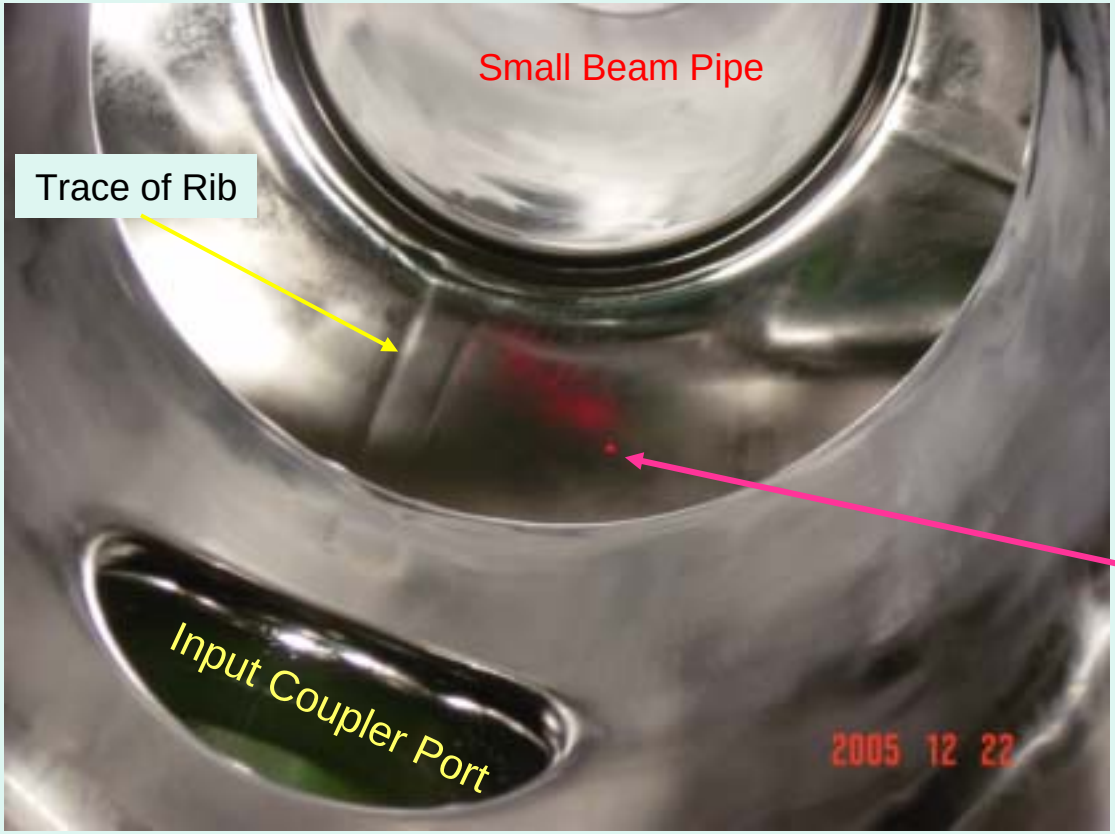
EP2

↓

Jan. 13 Test

Recovered !

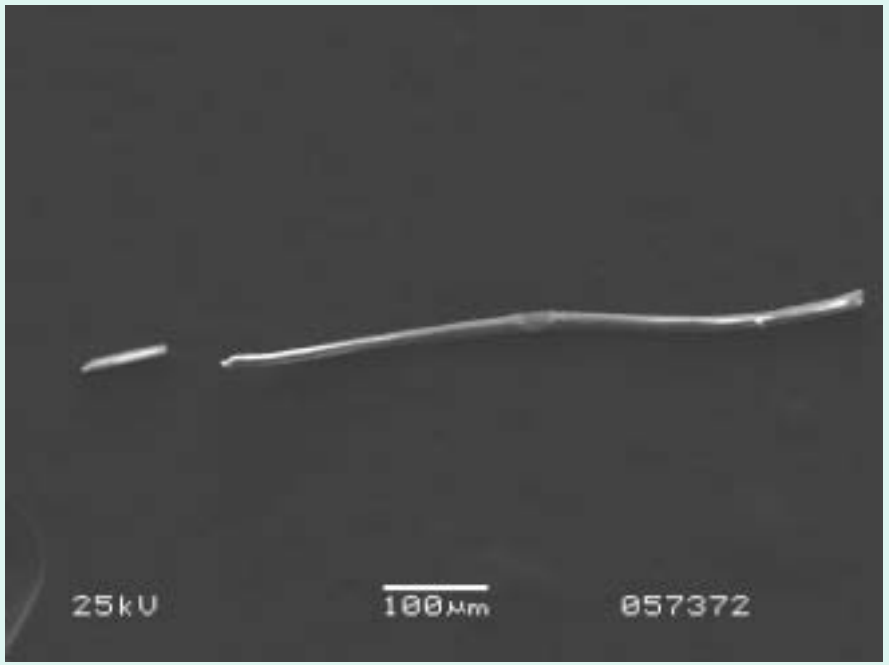
Inspection Inside the Cavity



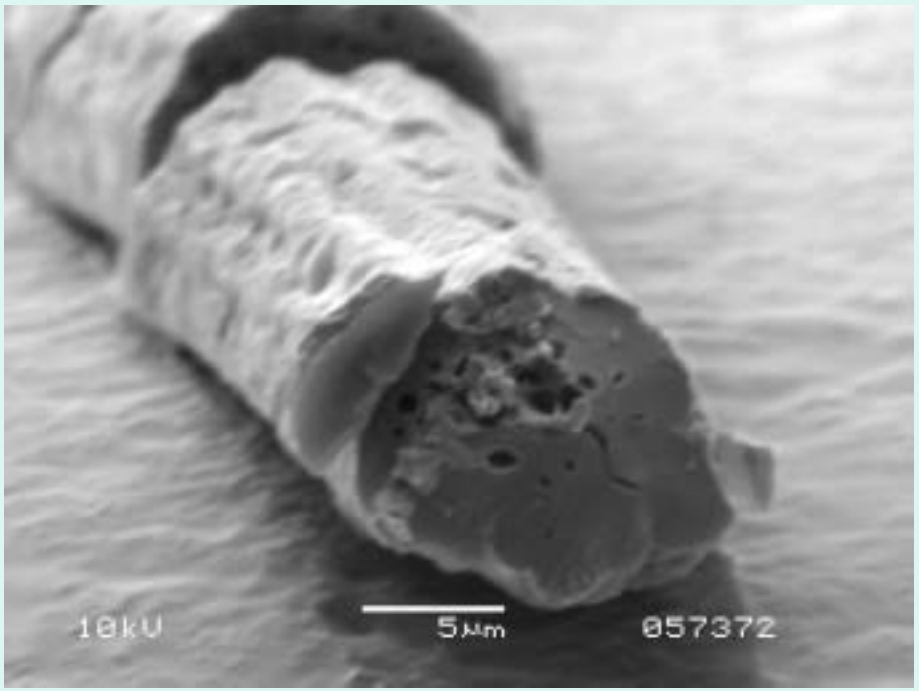
A Whisker Like Foreign Material
was found at the heating spot !

Pictures of Electron Microscope

Lint of Cotton Wiper?

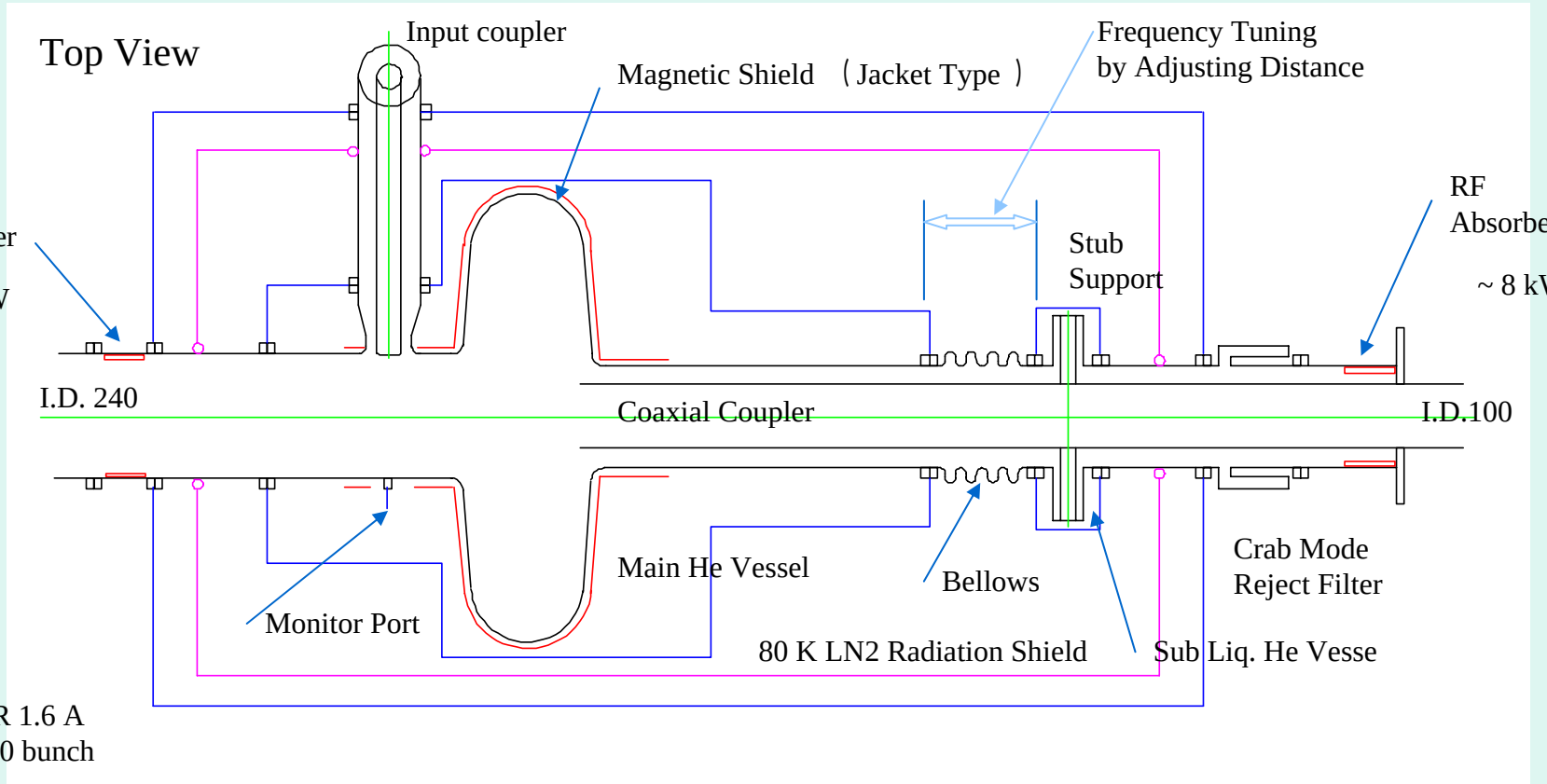


［断面］加速電圧：10kV

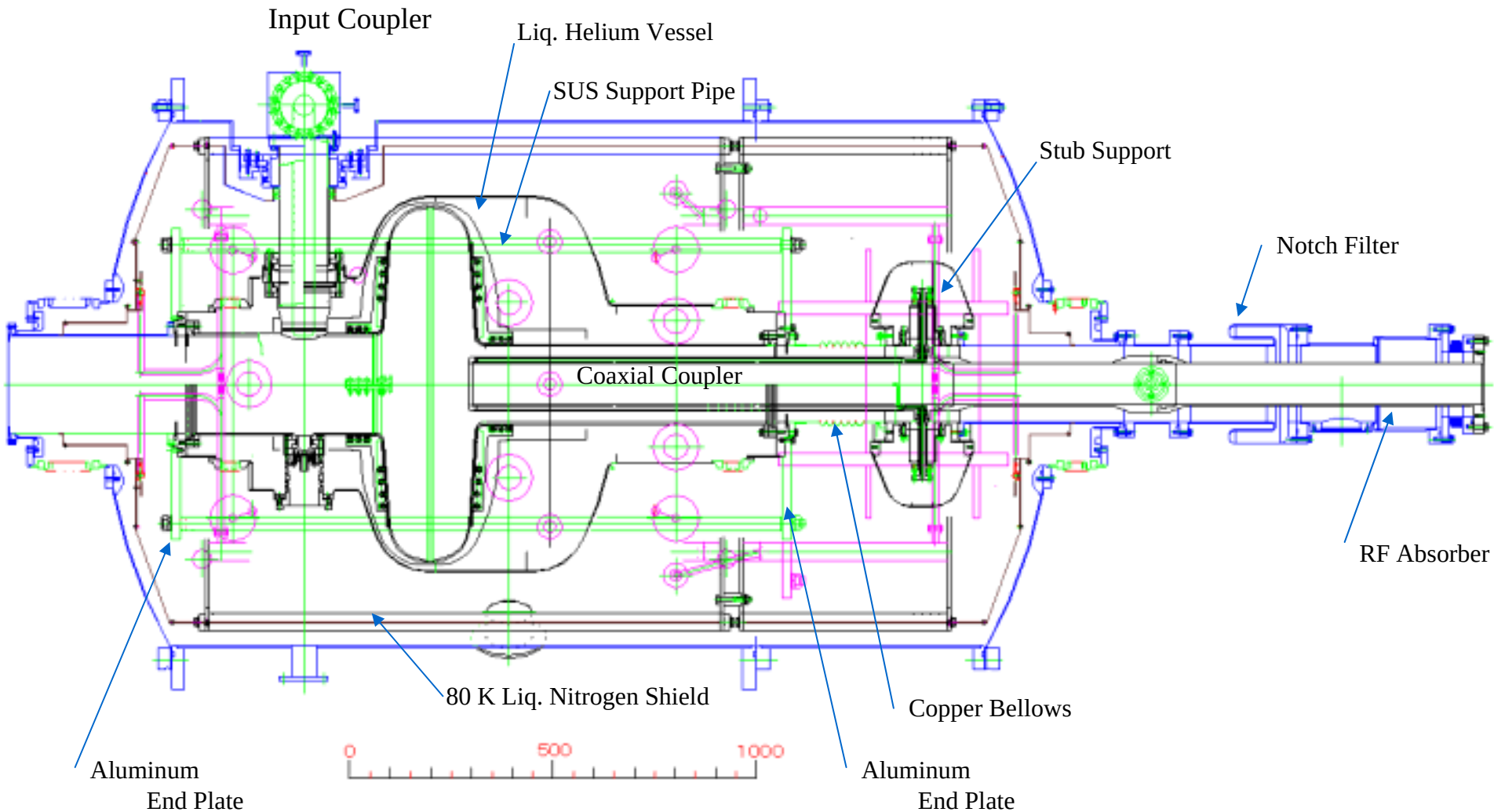


Conceptual Design of Cryostat for KEKB Crab Cavity

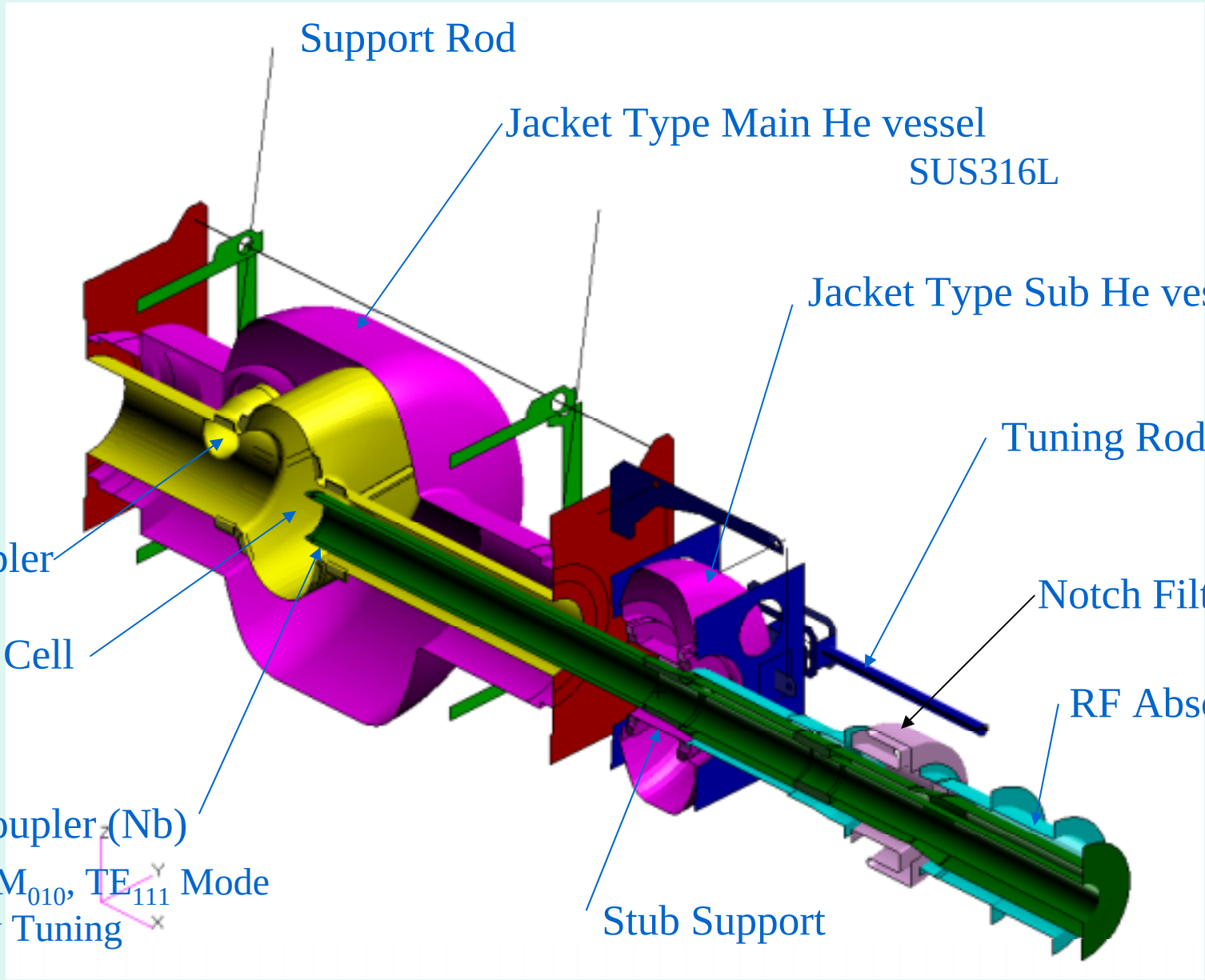
- ⇨ *Frequency Tuning Coaxial Coupler **28.3 kHz / mm***
- ⇨ *Stub-Support -- Mechanical Support & Cooling of Coaxial Coupler*
- ⇨ *Jacket-type Helium Vessel*
- ⇨ *Jacket-type Magnetic Shield*



Cryostat for Crab Cavity Top View



Crab Cavity in He Vessel (3D)



Prototype Cryostat

1) Jacket Type Helium Vessel — to Check the Leak Tight

2) Input Coupler — to Check Thermal Contraction

3) Without Coaxial Structure

Assembled in KEK

Leak at In-Seal of Beam Pipe Flange!

Nov. 29, 2005

⇩

Disassemble and Reassemble

⇩

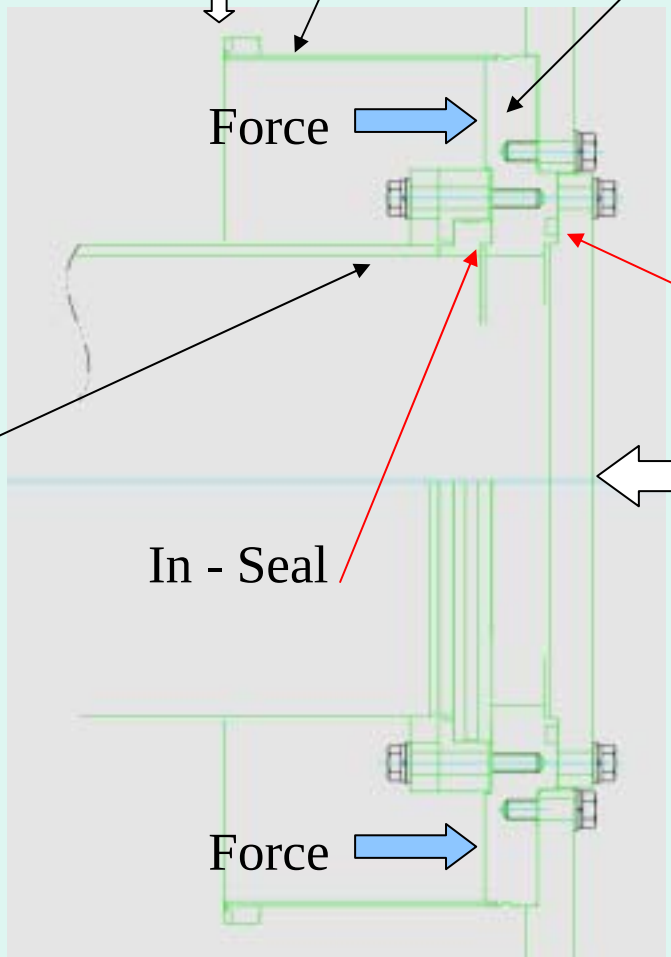
Cool Down Test — OK !

Feb. 6-10, 2006

What cause the Leakage?

Transition Flange

Niobium – SUS
by Indium Seal

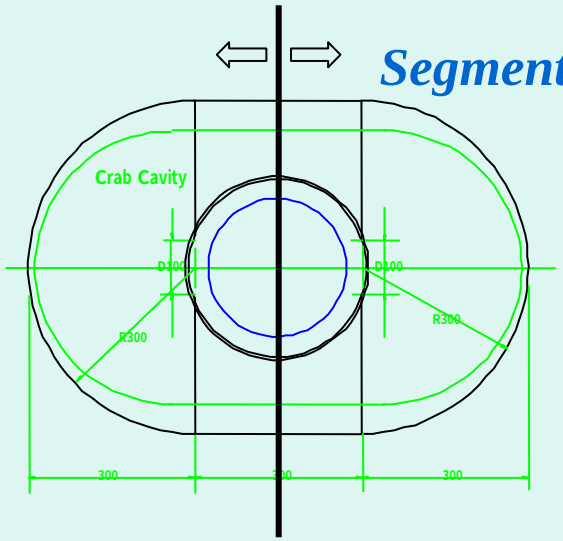


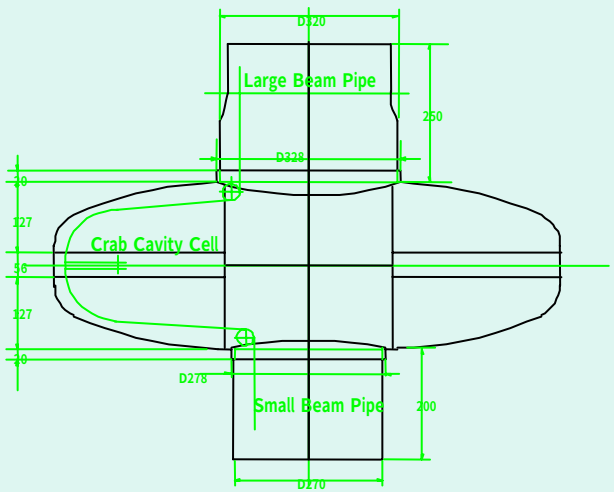
In the Case of Jacket Type Cryostat

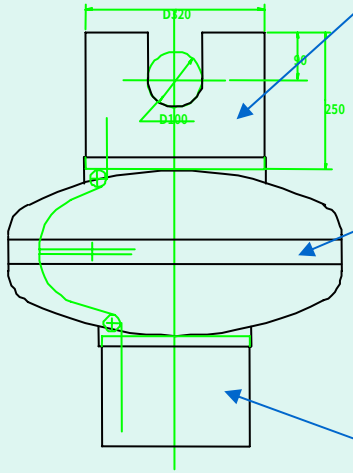
Magnetic Shield (Jacket Type)

Permalloy 3t

Segmentation







Large Beam Part

Cell Part

Small Beam Part

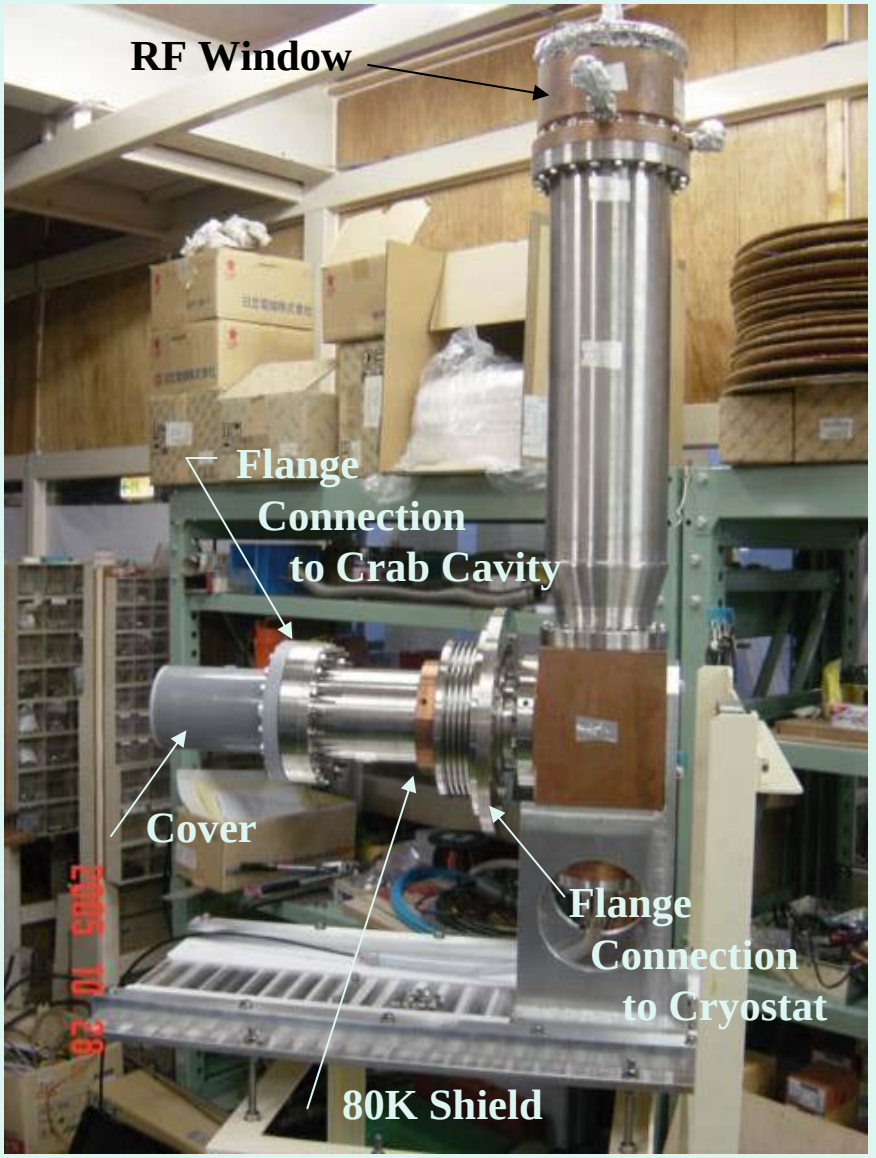
Jacket Type Helium Vessel

Prototype

Helium Vessel for Small Beam Pipe

Helium Vessel for Large Beam Pipe

Installation of Input Coupler 1



Input Coupler for KEKB Crab Cavity (Prototype)

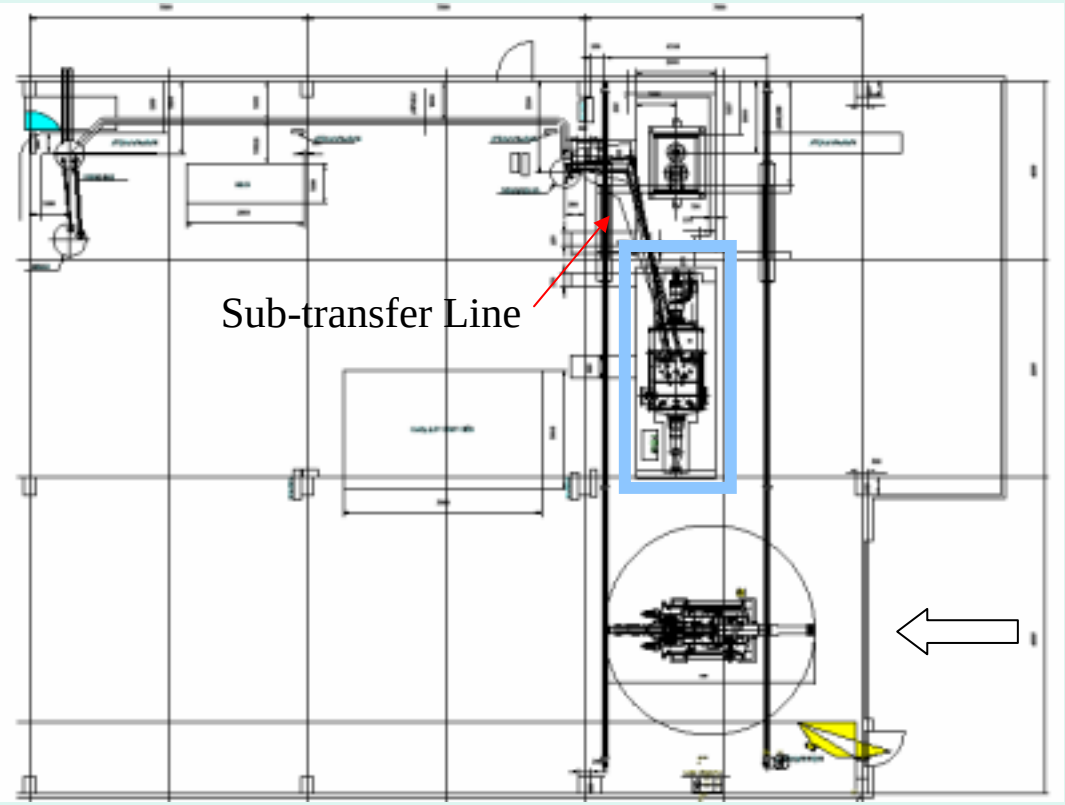
Simulation for Installation of Input Coupler

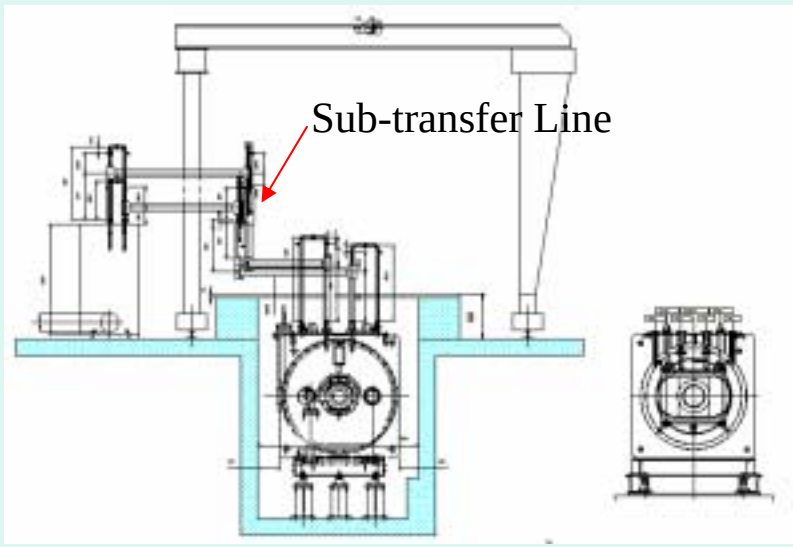
Assembling of Large Beam Pipe

Prototype Cryostat

Took a Picture after finish a Good Job.

Test Stand for Crab Cavity at D10 Station





HOM Damper Ferrite RF Absorber

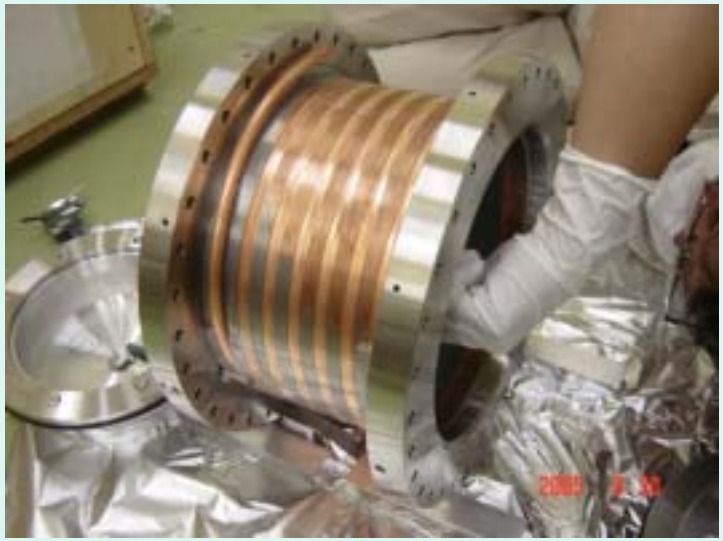
by Y.Morita

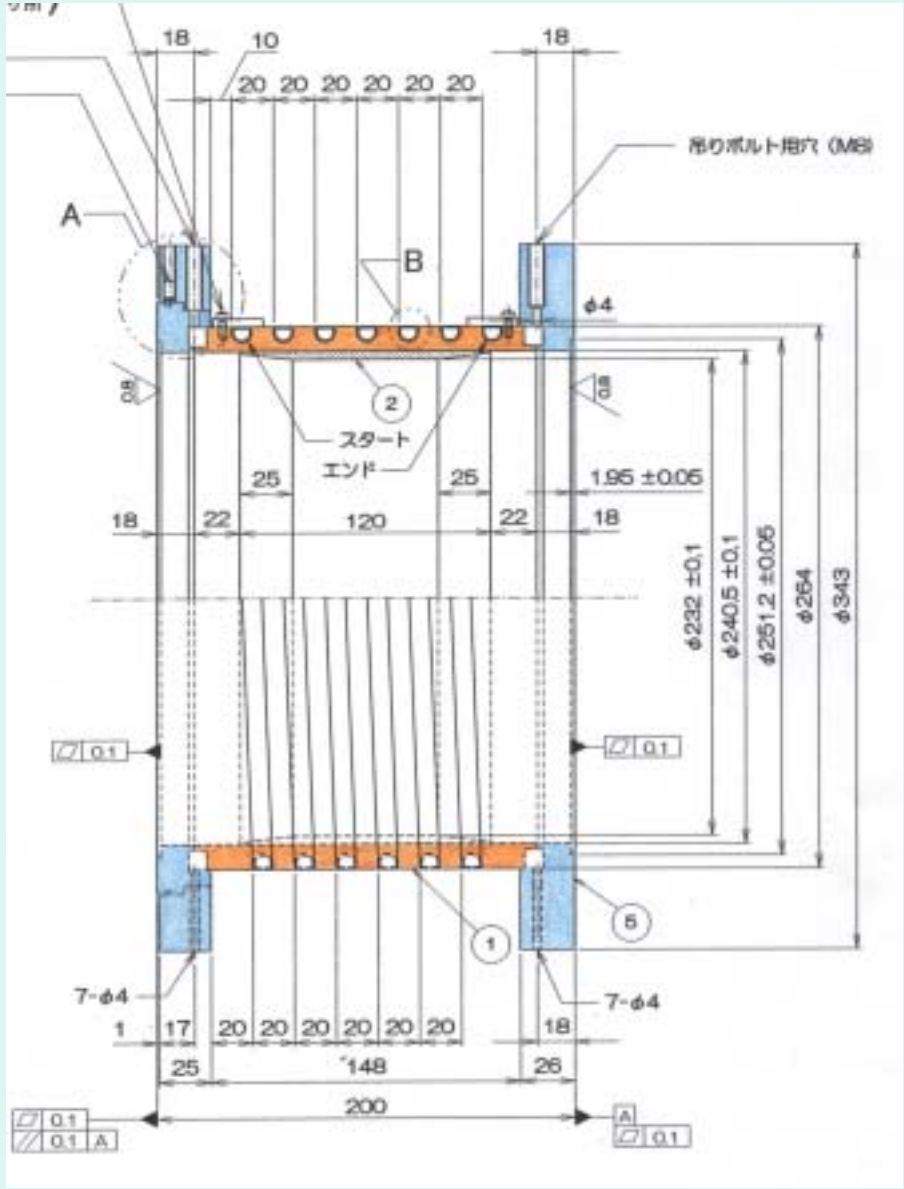
Supported by Acc. Cavity Group
T. Furuya

Same as HOM Damper
for KEKB Acc. SC cavity

Baking and High Power Test
have been finished

Cavity 0.7 V/pC
Taper 0.04 V/pC
Damper 0.3 V/pC
Total: 1.04 V/pC
HOM power: 20.5 kW
(1.6 A, 1300-bunch)

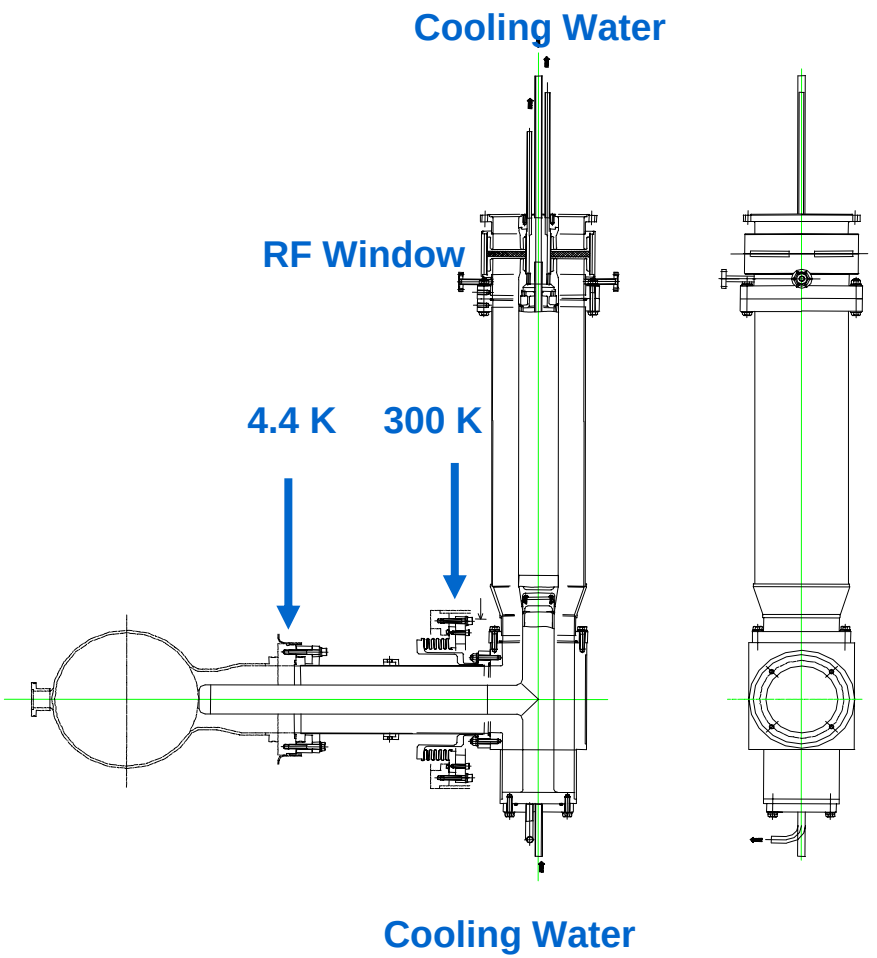




Input Coupler

by K.Nakanishi and Y. Yamamoto

Supported by Acc. Cavity Group
S. Mitsunobu



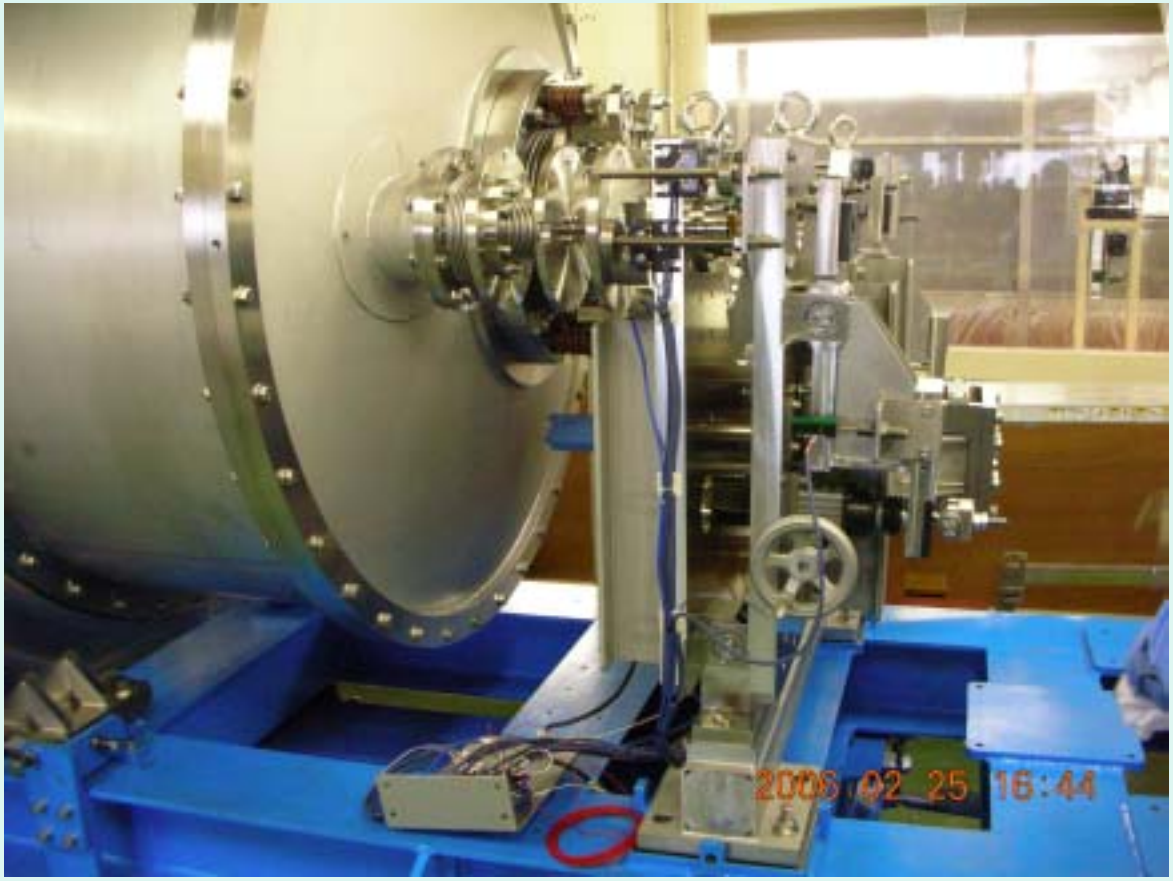
3 input couplers were high power tested

one is installed in Prototype

one in Crab Cavity #HER

TW: 200kW
SW: 100kW

Frequency Tuner



Frequency Tuning

Piezo + Motor Drive
Piezo 0.3 mm
Motor 6 mm
Under 600 kg Load

Position of
Coaxial coupler

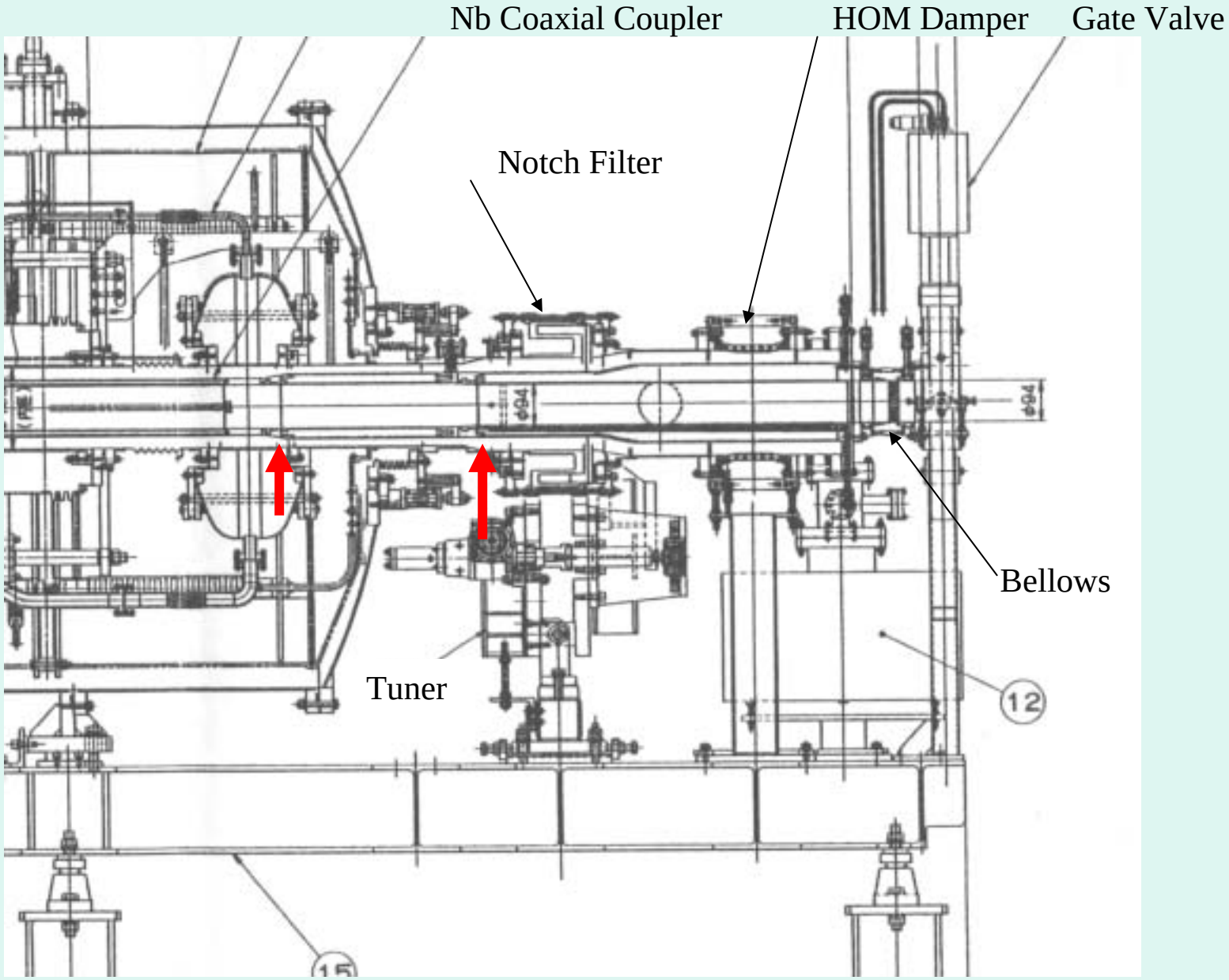
Motor Drive

Coaxial Structure Stub Support

Assembling of Stub Support Part

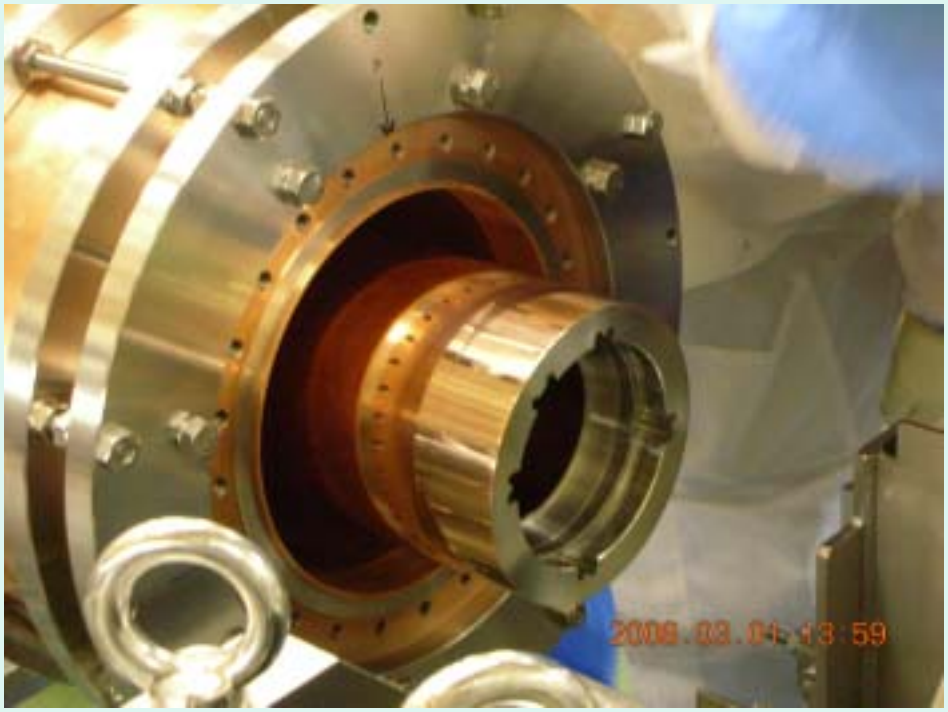
Helium Jacket for Stub Support

Coaxial Structure　　Connection of Inner Conductor



Connection Part

Crab Cavity (Cryostat) Side



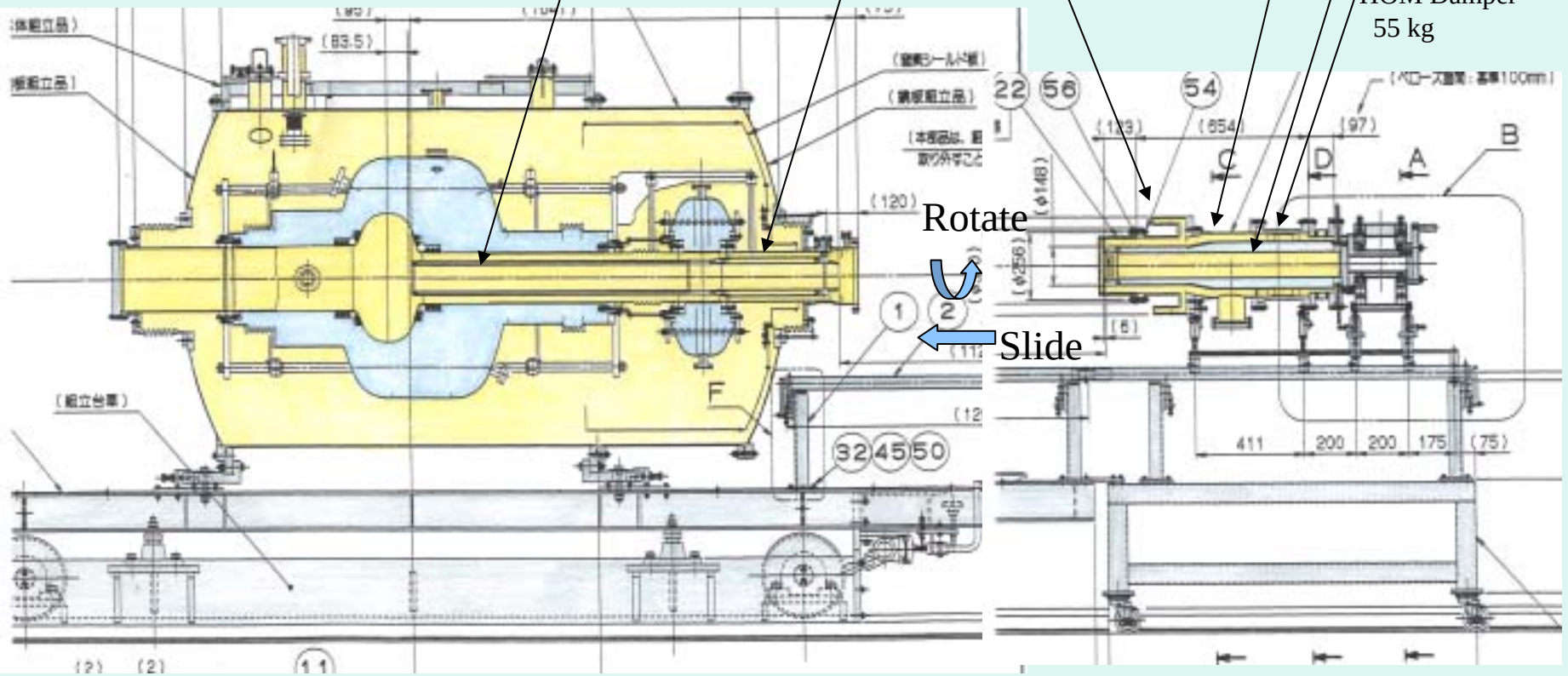
Notch Filter Side

How to connect inner conductor

Step 1 Insert

Step 2 Rotate Clockwise 30 degree

Set Up for Connection of Coaxial Structure



Could not connect !

The Coaxial Structure is Heavy.

Need Precise Alignment
- Position of Axis
- Direction Axis

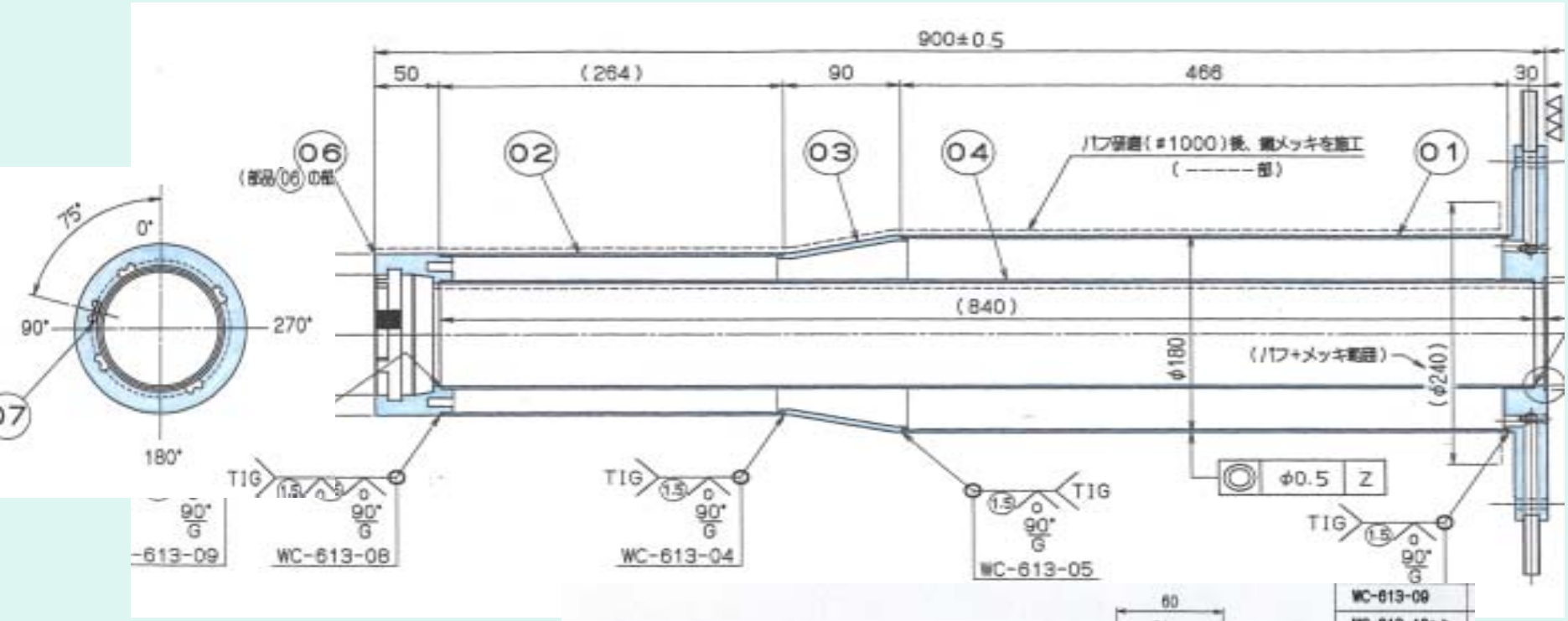
⇨

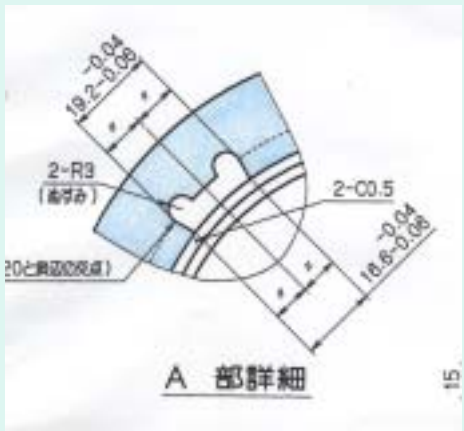
Insertion Tool
- Not Strong Support Structure
- No Precise Adjustment Knob

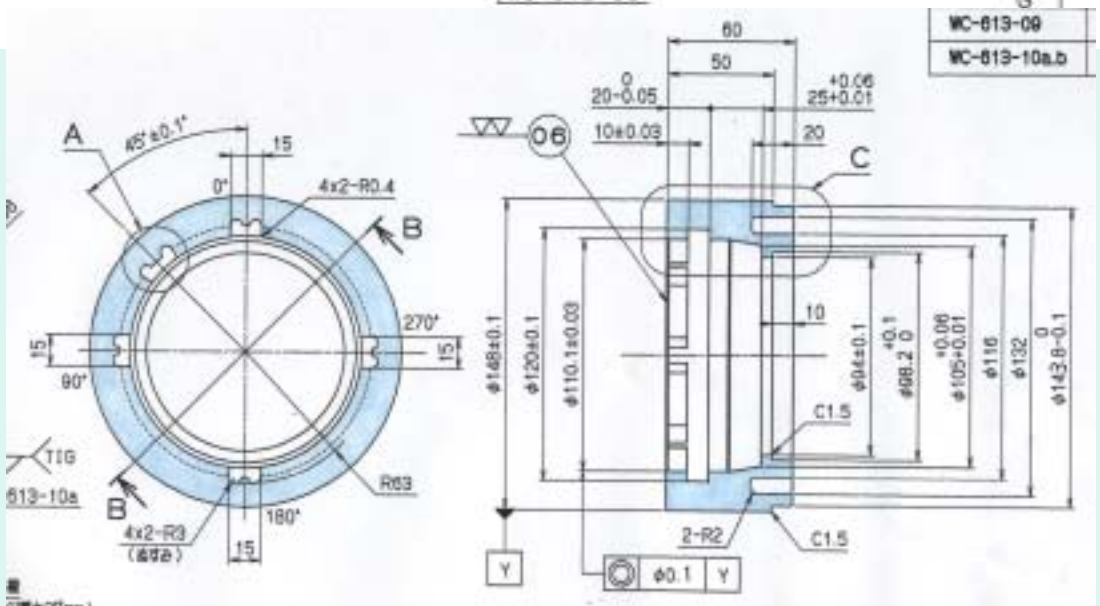
⇨ Need Modification

Inner Conductor (Room Temperature Part)

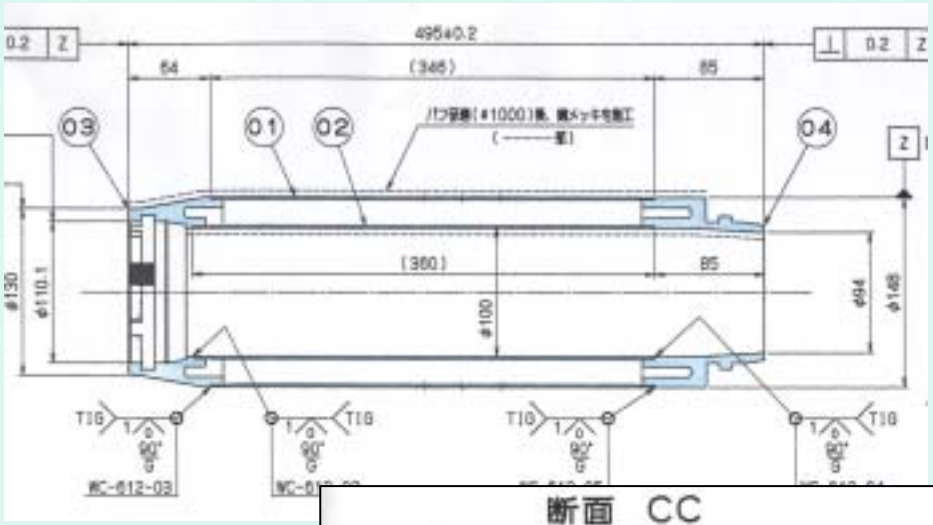
36 kg

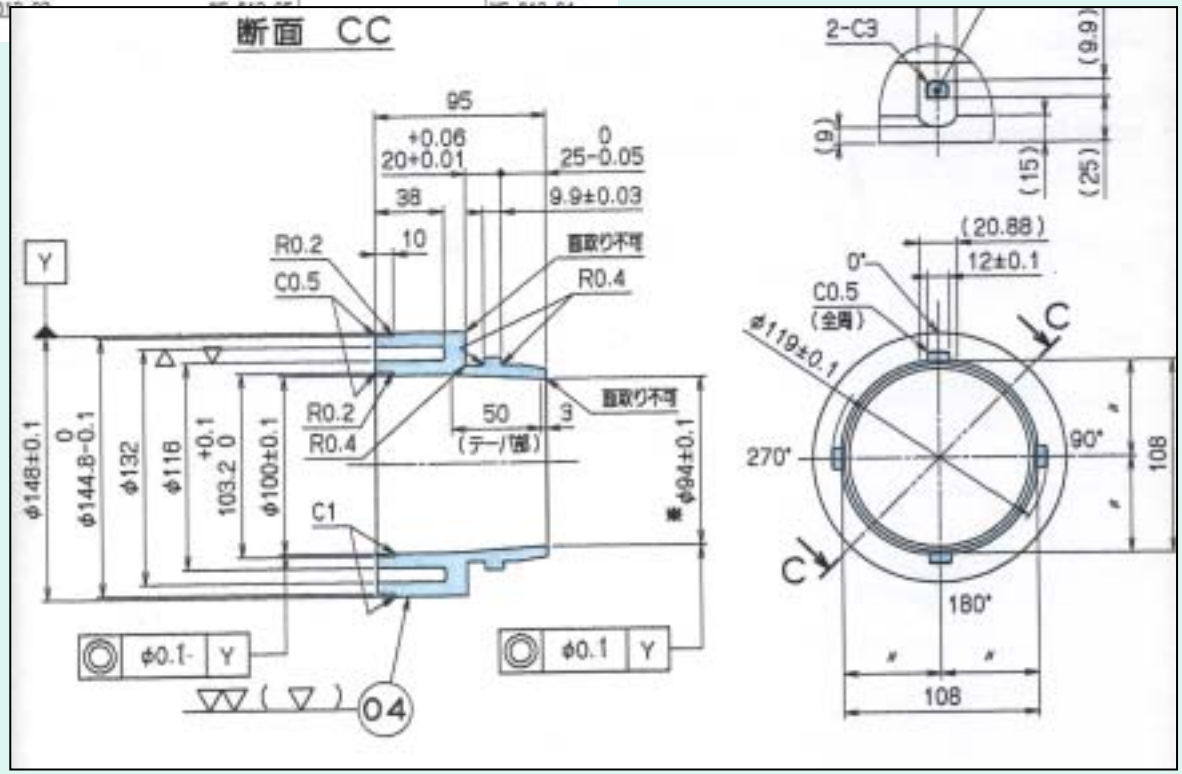






Inner Conductor (Cold Part)





Problem at connection part

Good RF Contact ?

Need Finger Contact ?

Summery

- We could fabricate and cold tested 2 full size crab cavities which have satisfactory RF performance for KEKB crab.
- A prototype cryostat for crab cavity was fabricated and cold tested at D10 test stand.
- A cryostat of crab cavity HER was fabricated.
- Insertion of the coaxial structure to the cryostat is now underway. We are struggling with this job.

  We need modification of insertion tool !
- The other key components; input coupler, HOM damper, taper chamber, tuner, vacuum system, transfer lines, cooling water, … are ready to integrate to the crab cavity.
- These 2 crab cavities will be installed in KEKB after cool down and high power test at D10 test stand.