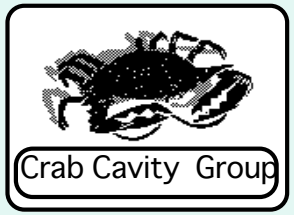


Crab Cavity Overview

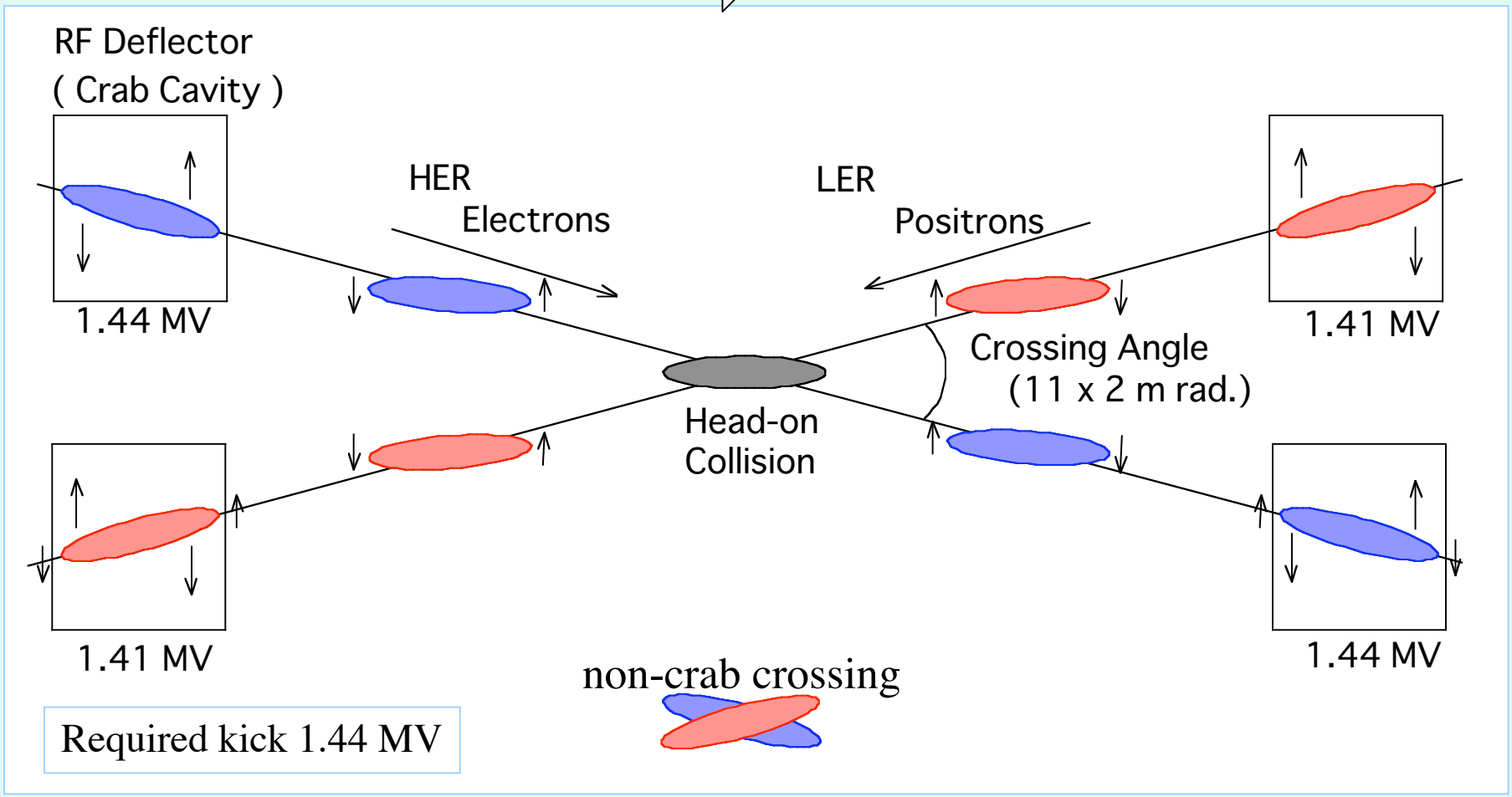
KEK Crab Cavity R&D Group
Task Force
K.Hosoyama

KEKB Crab Crossing
New Crab Crossing Scheme
KEKB Superconducting Crab Cavity
RF Performance Test
Cryostat for KEKB Crab Cavity
Cryostat
R&D Efforts Nb-Cu Coaxial Coupler
Construction Schedule

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



New Crab Crossing Scheme

Installation of 2 Crab Cavities in “Nikko Straight Section”!

Advantage :

We can use existing cryogenic system for acc. S.C. cavities

Cooling power of the cryogenic System 8 kW at 4.4K

Heat Load of Acc. Cavities ~ 3kW

Enough cooling power for Crab Cavities

We decided installation of 2 Crab Cavities in “Nikko” on Feb. 2006.

FY 2004

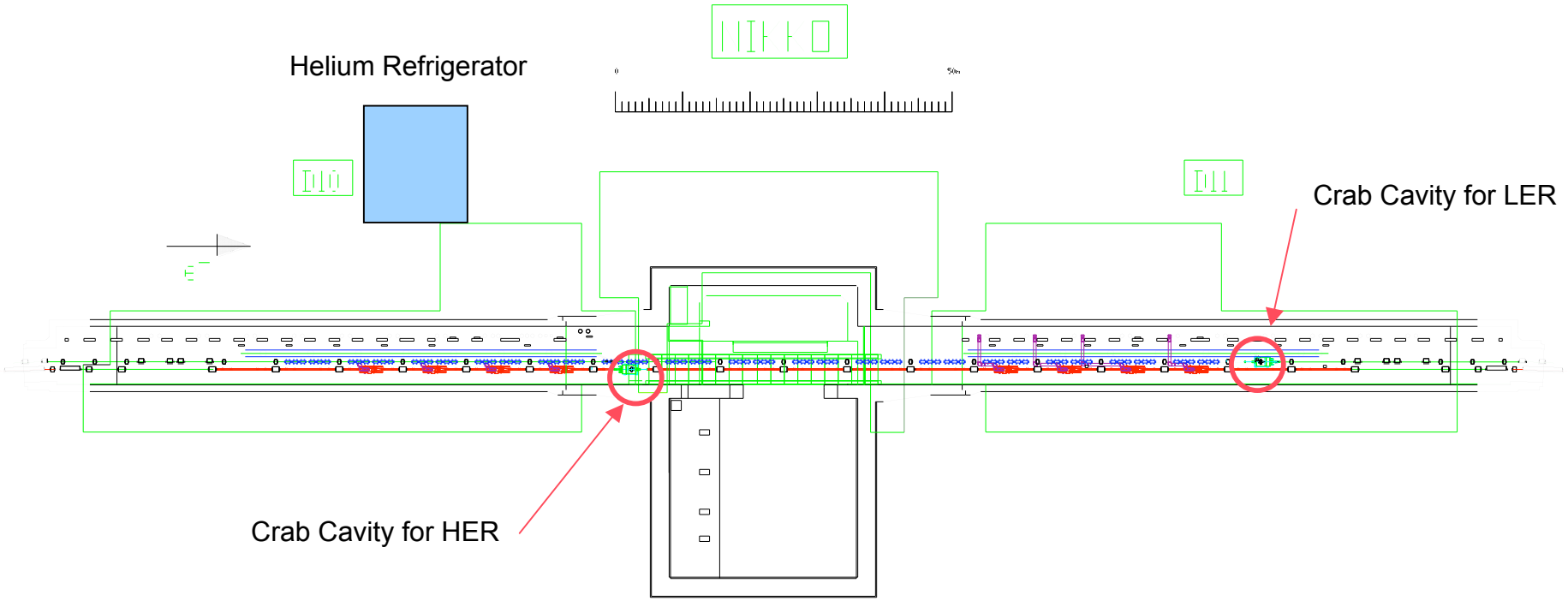
We ordered 2 Crab Cavities from MHI.

Task Force was established!

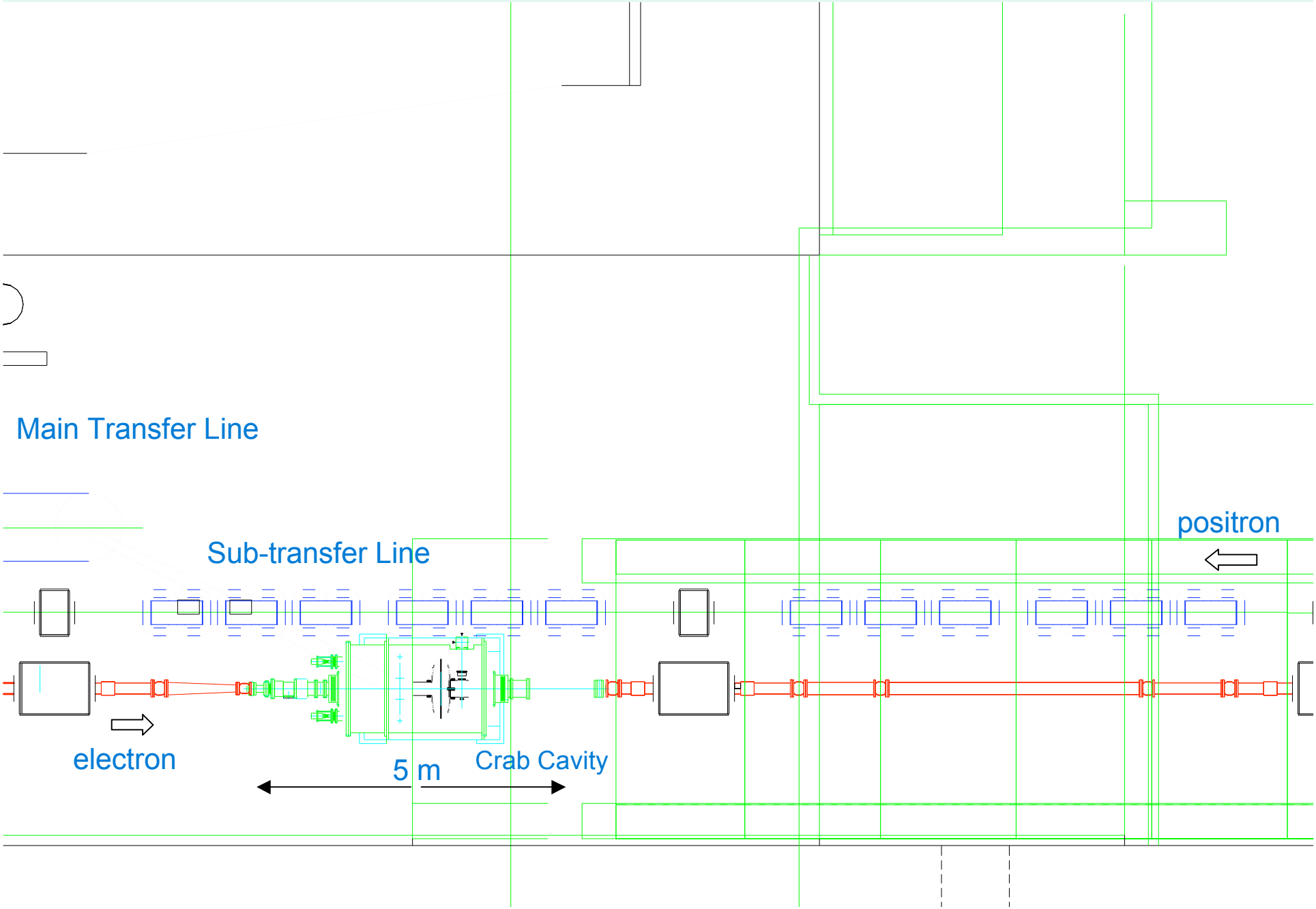
FY 2005

We will order 2 cryostats and for the Crab cavities.

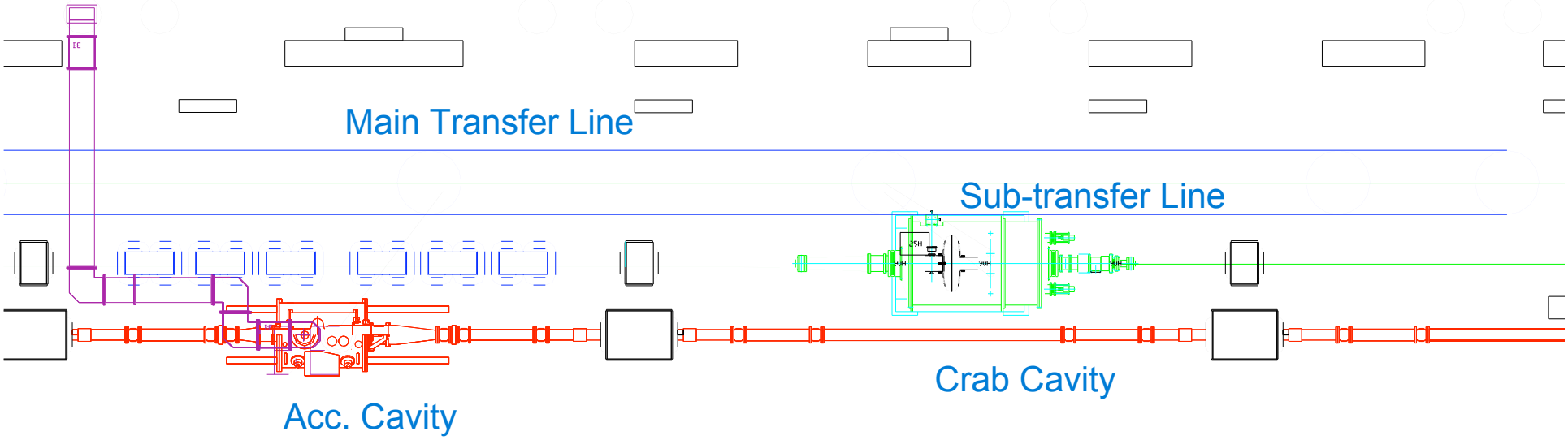
Layout of Crab Cavities In Nikko



Crab Cavity in HER

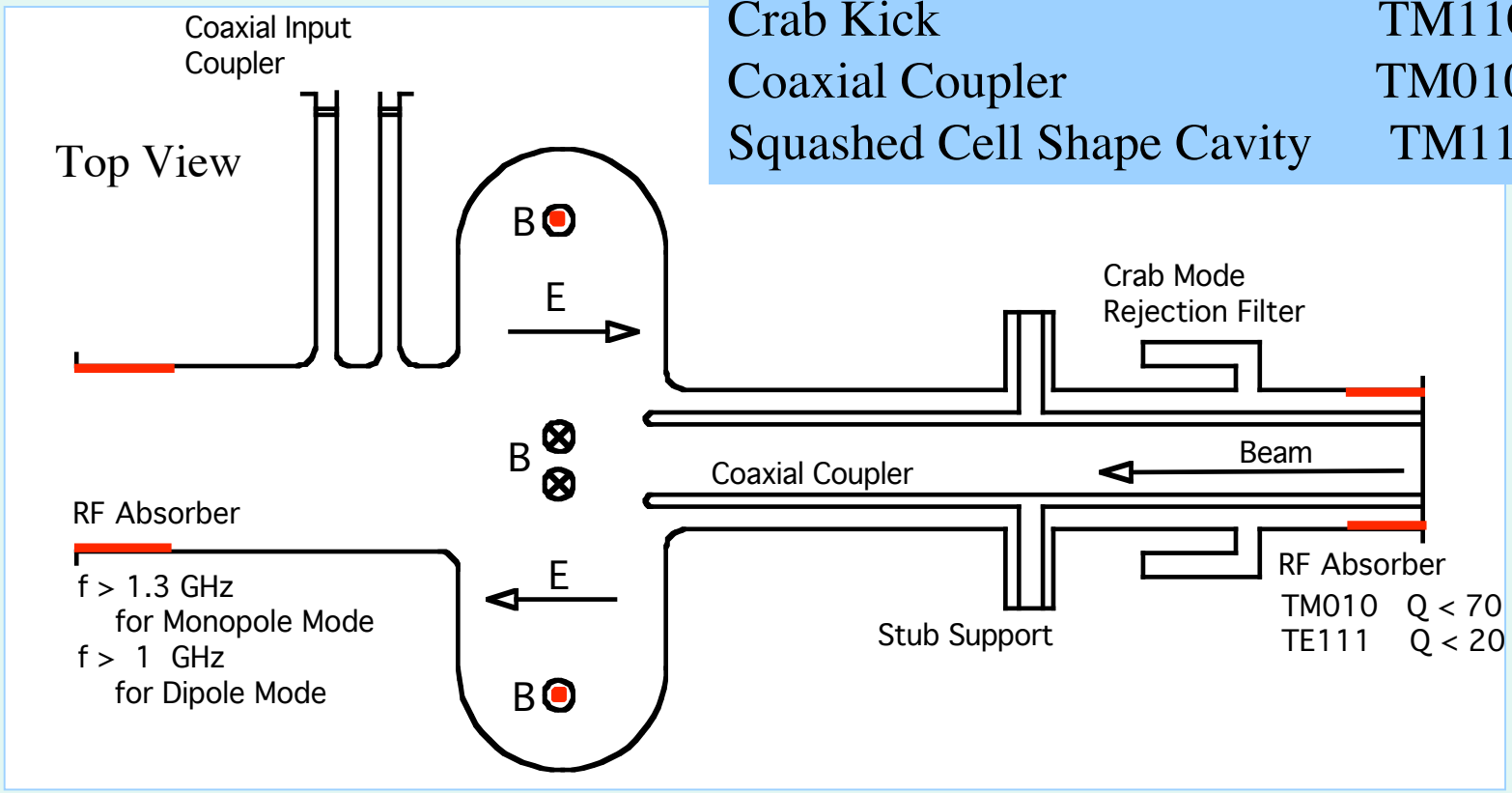


Crab Cavity in LER



Conceptual Design of KEKB Crab Cavity

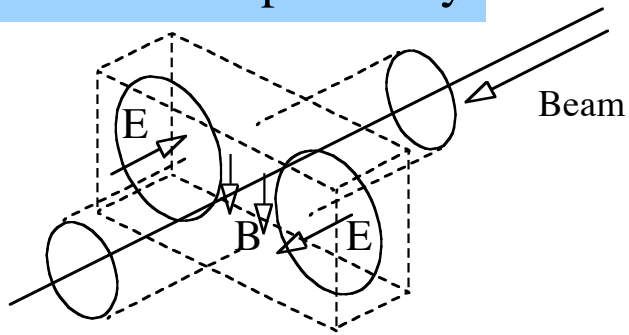
Crab Kick	TM110 B-field
Coaxial Coupler	TM010, TE111
Squashed Cell Shape Cavity	TM110*



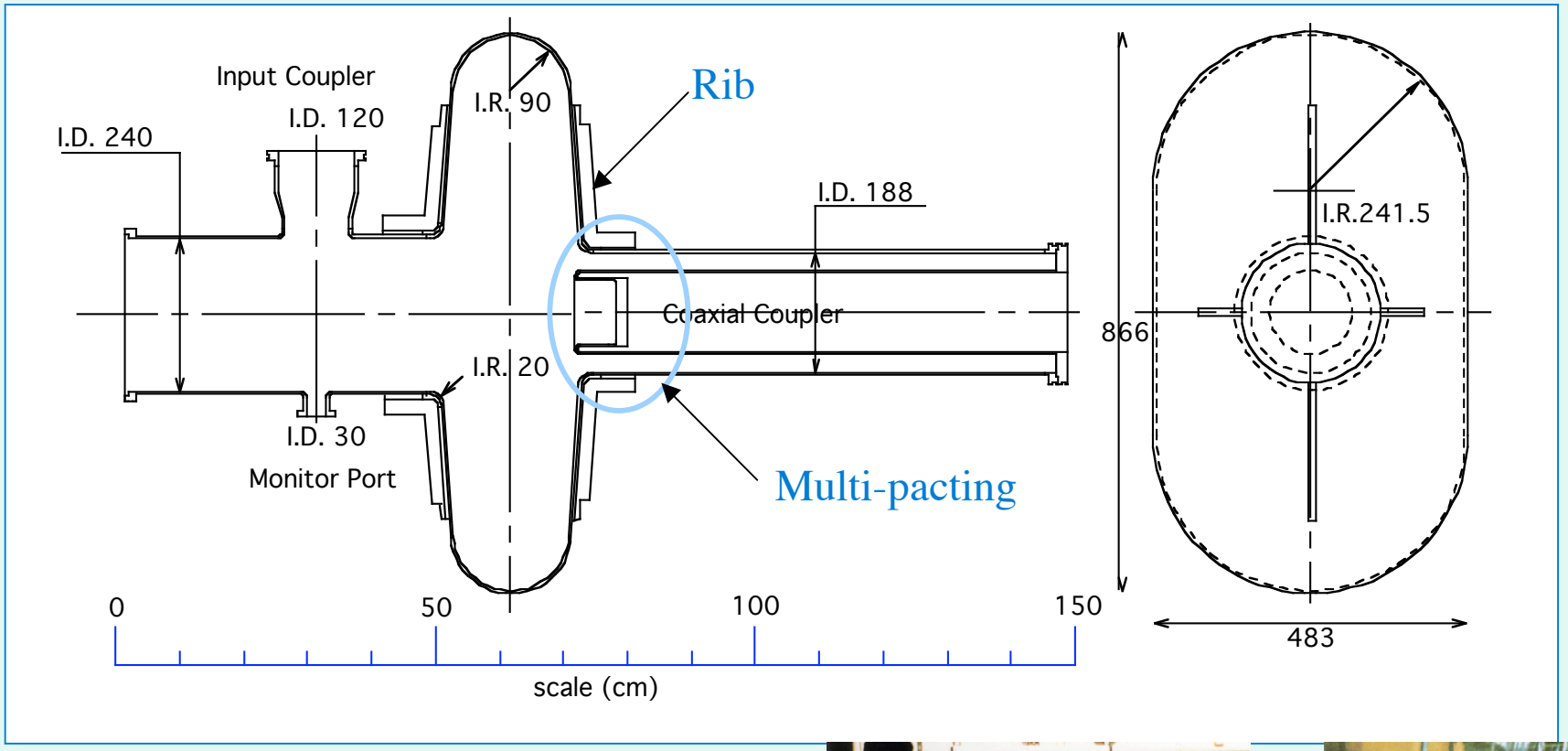
⇨ The squashed cell shape cavity scheme was studied extensively by Akai at Cornell in 1991 and 1992 for CESR-B under KEK-Cornell collaboration.

We adopted this design as “base design”!

Squashed Cell Shape Cavity

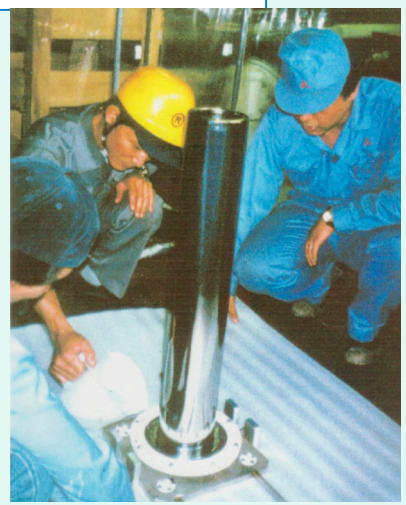


KEKB Superconducting Crab Cavity

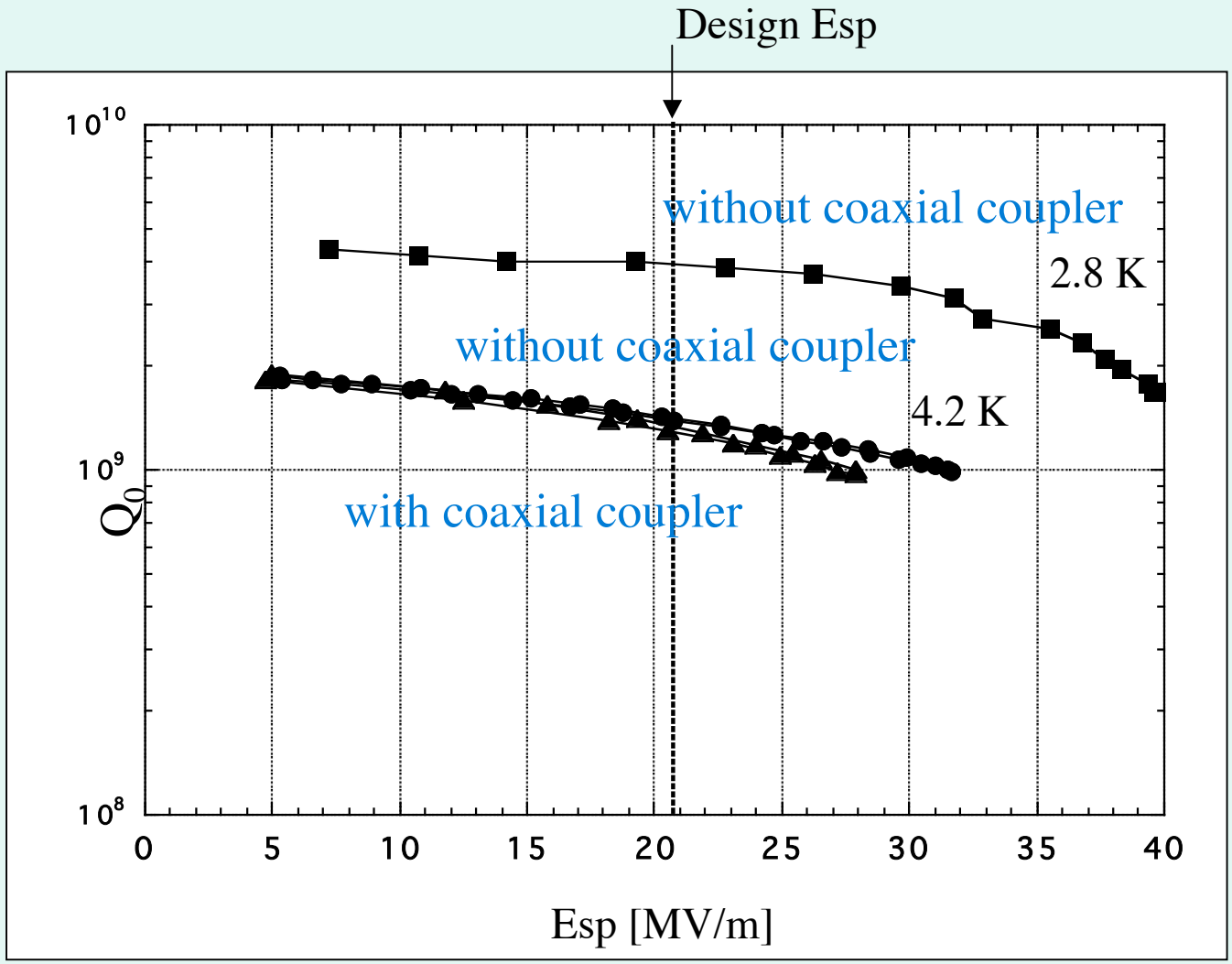


⇨ Non-axial Symmetric Structure
Thickness of 4.5 mm Nb Cavity
Reinforced by Ribs

Simplified Coaxial Coupler



Test Result of KEKB Crab Cavity #1



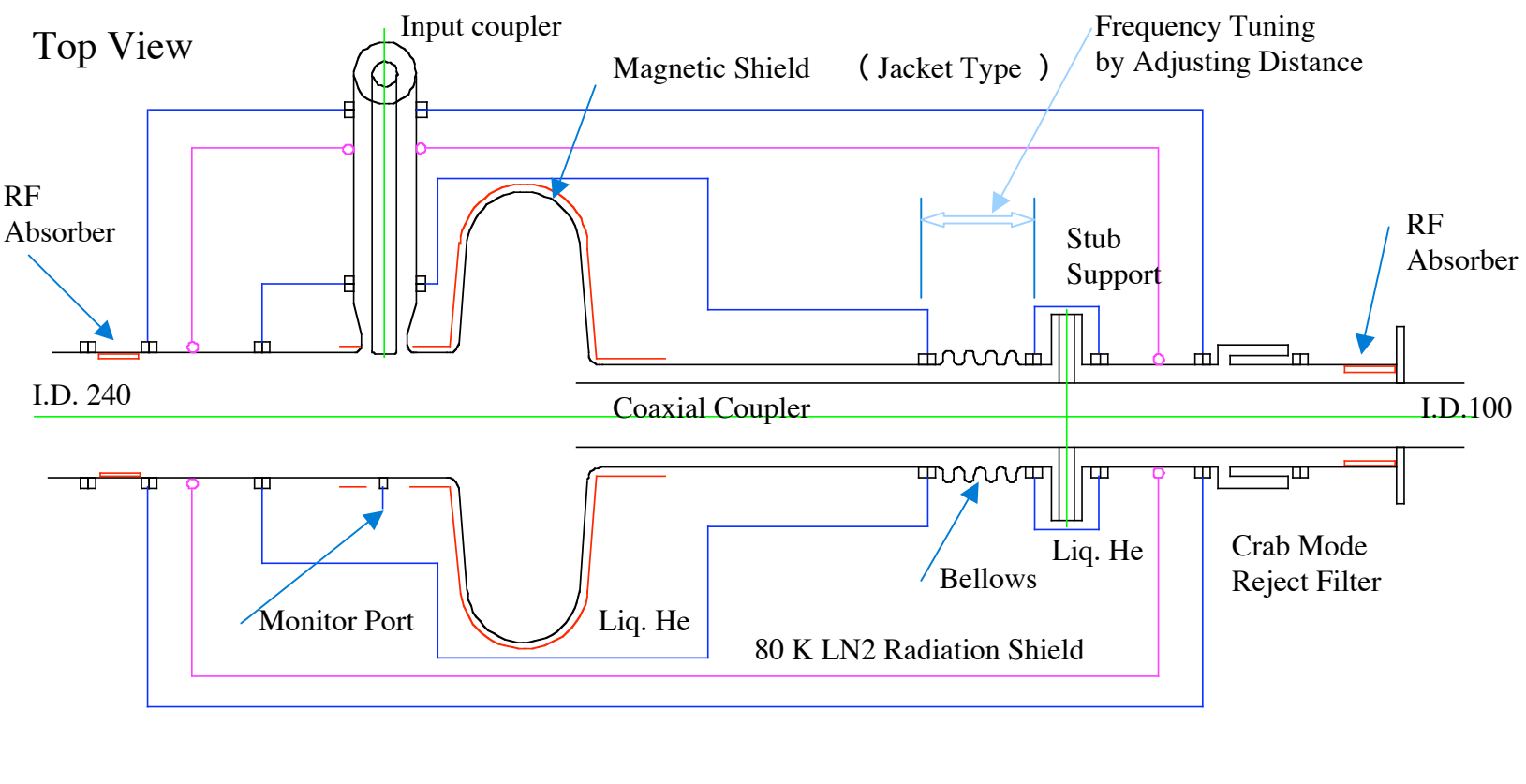
Fabrication and Surface Treatment

RF Performance Test with a Coaxial Coupler

Multipacting could be overcome by RF process.

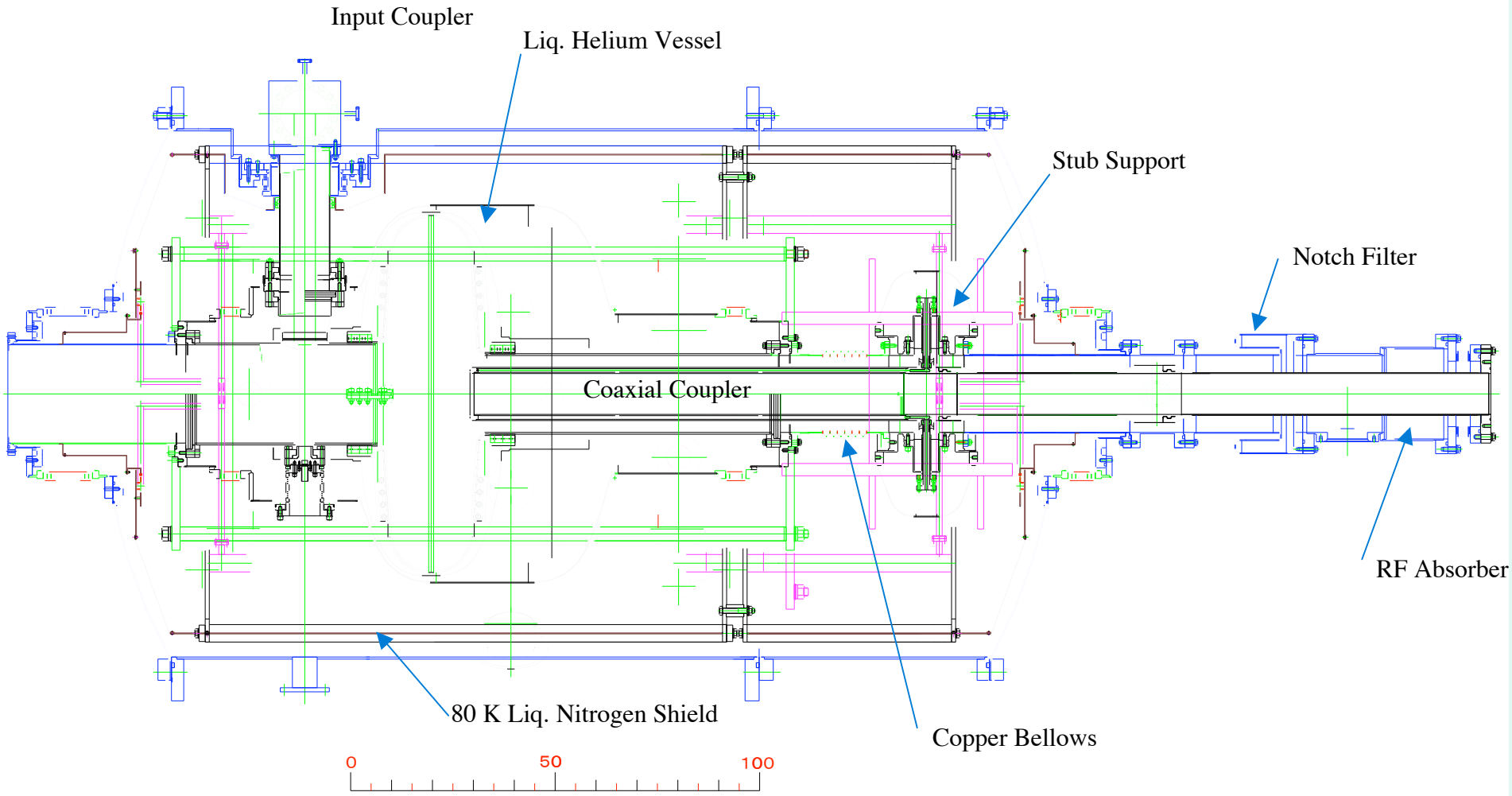
Conceptual Design of Cryostat for KEKB Crab Cavity

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

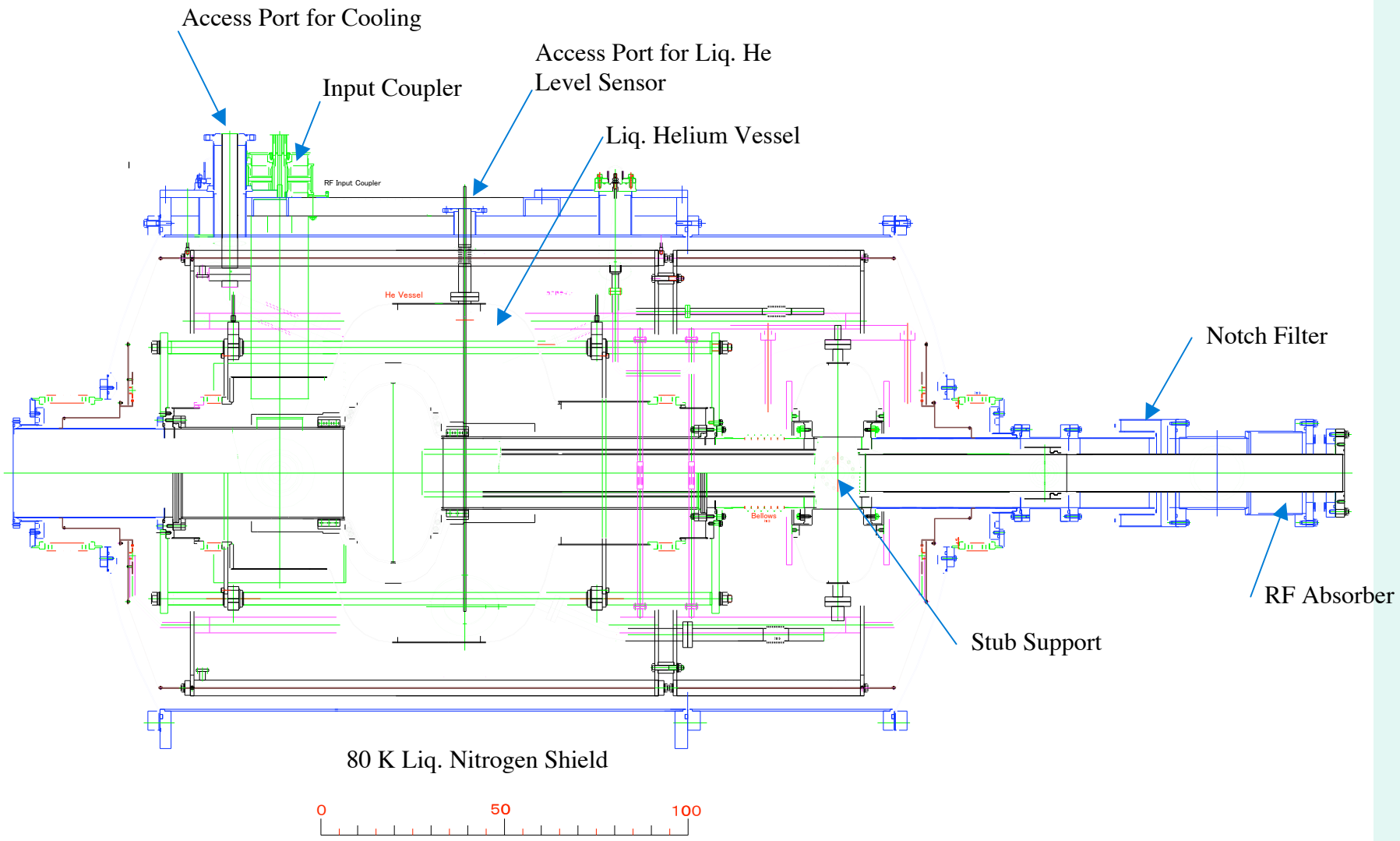


Crab Cavity in Cryostat Top View

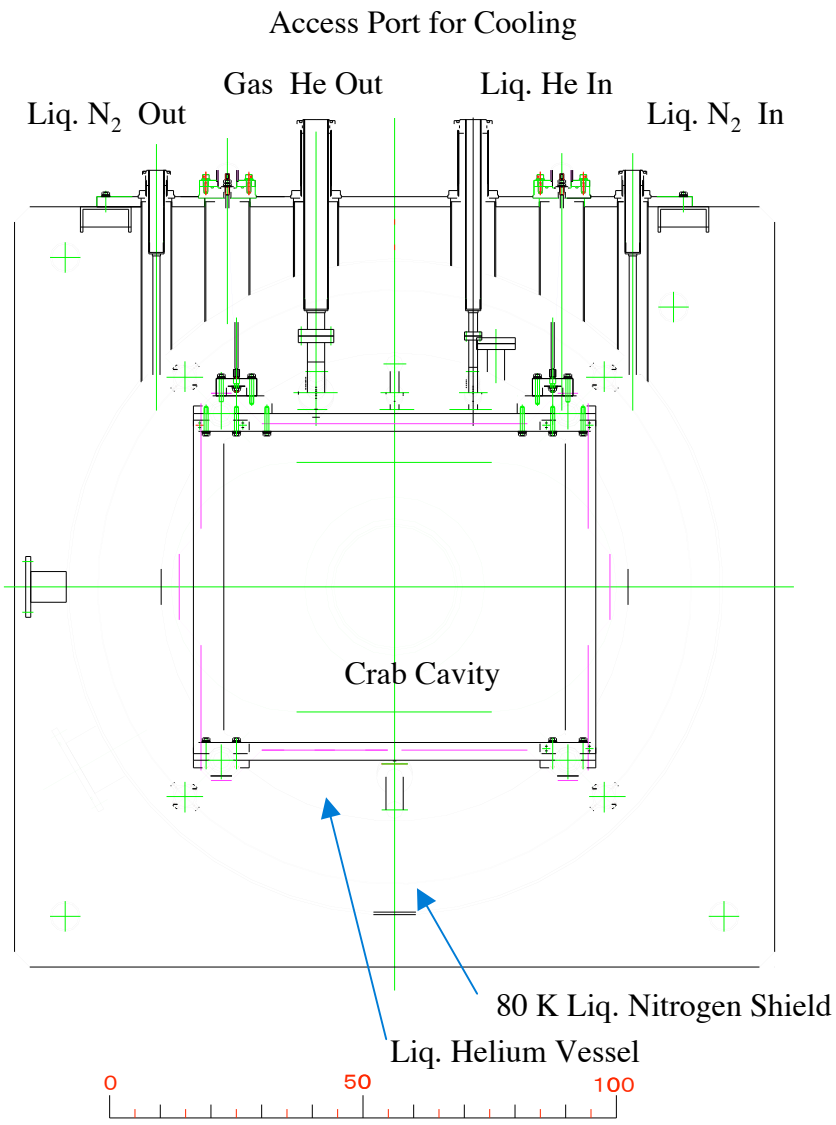
Heat Loss
80K 110 W
4.2K 15 W

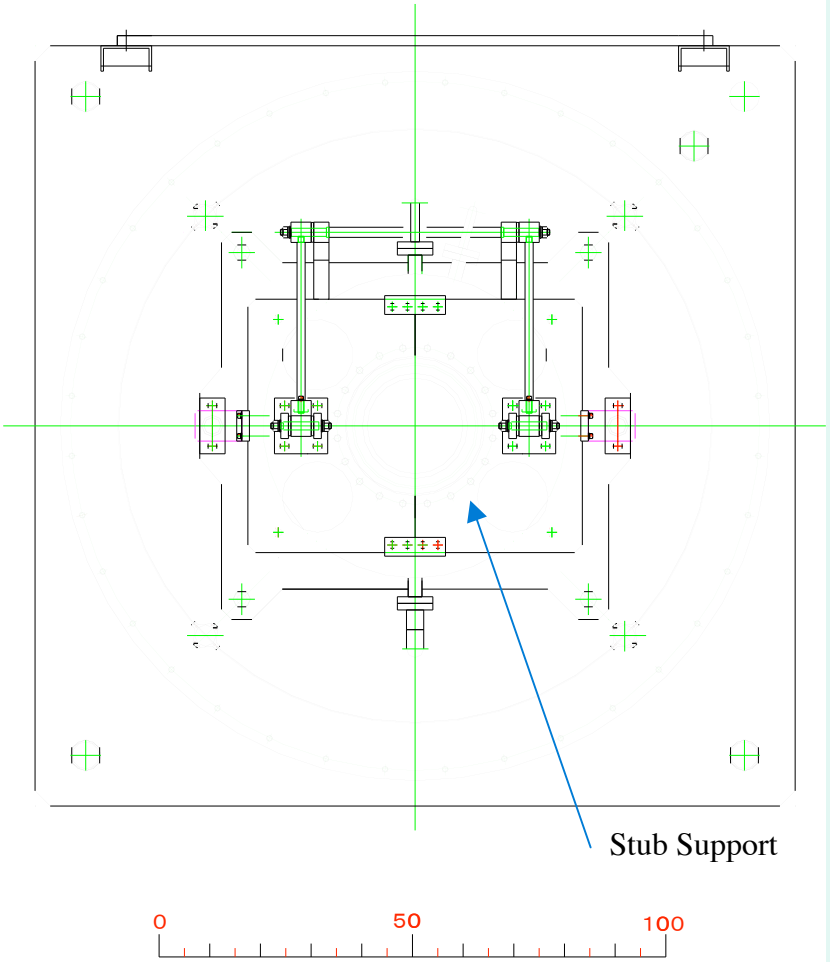


Crab Cavity in Cryostat Side View

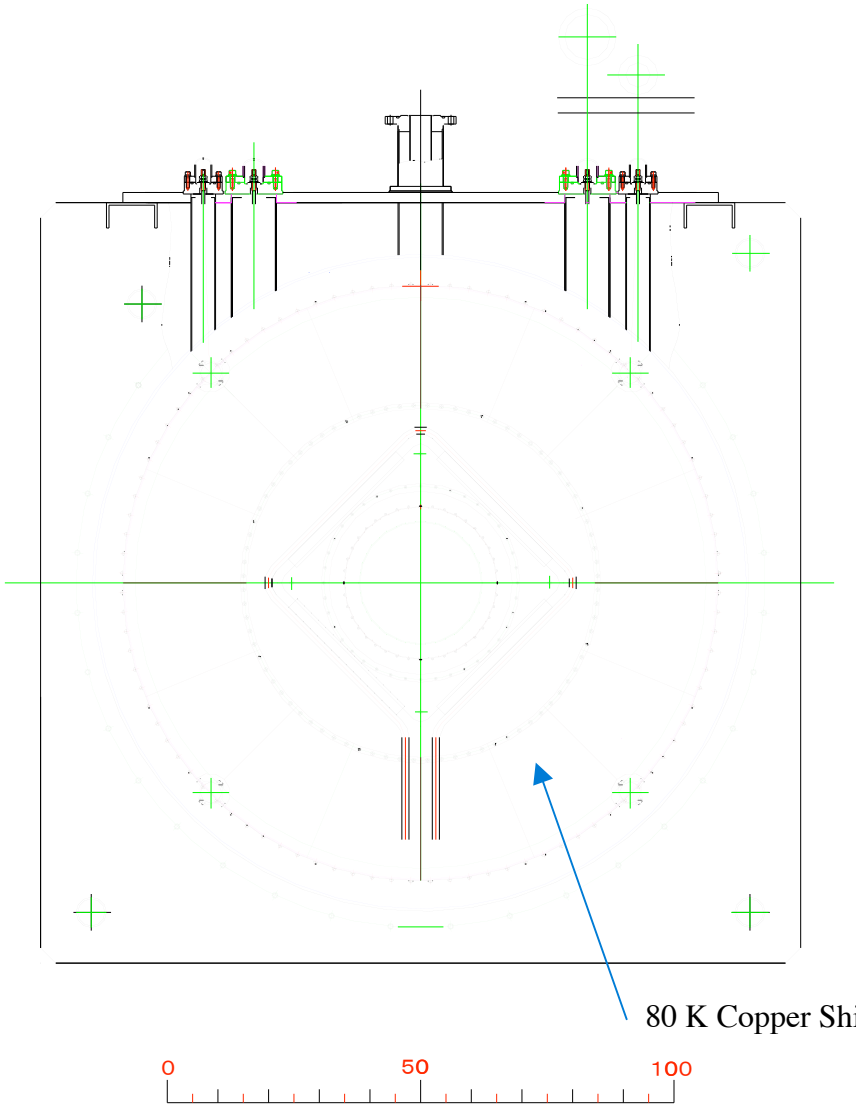


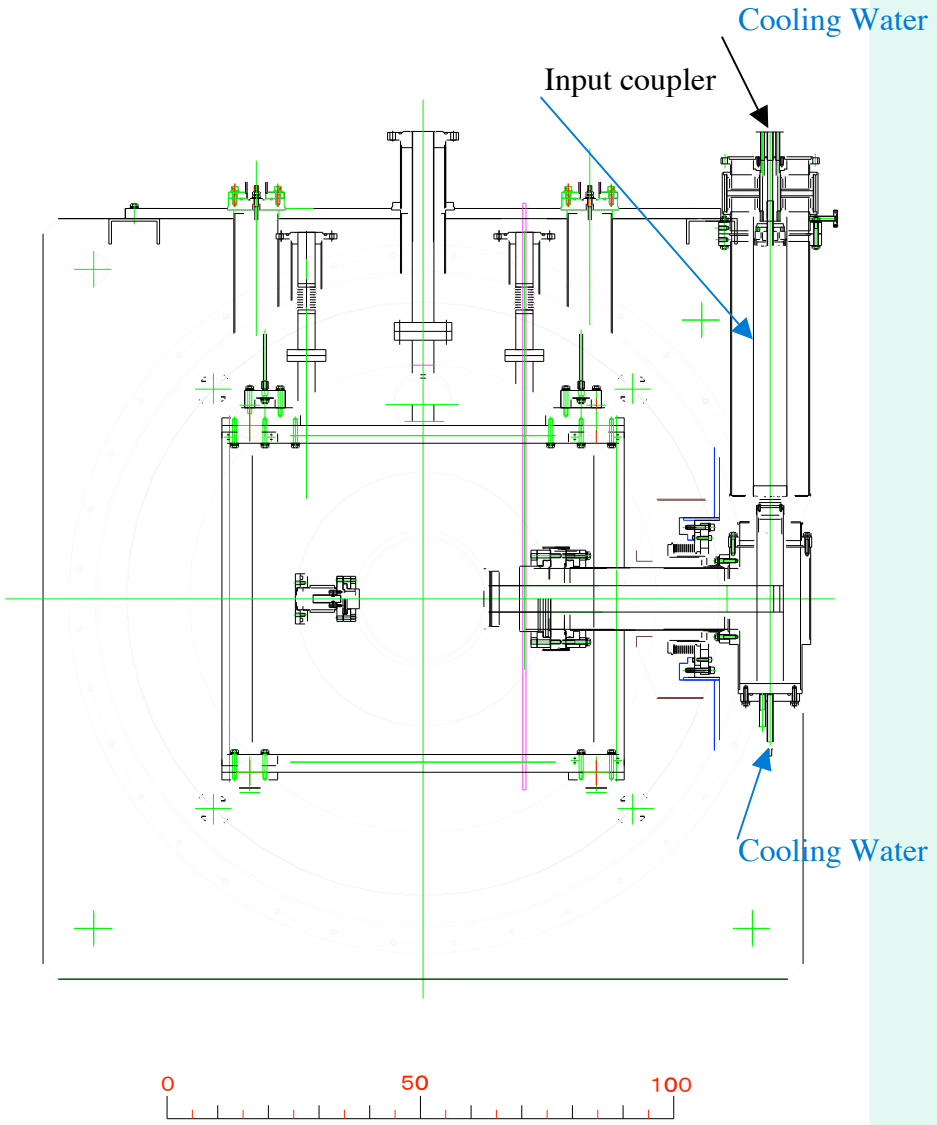
Crab Cavity in Cryostat Front View 1



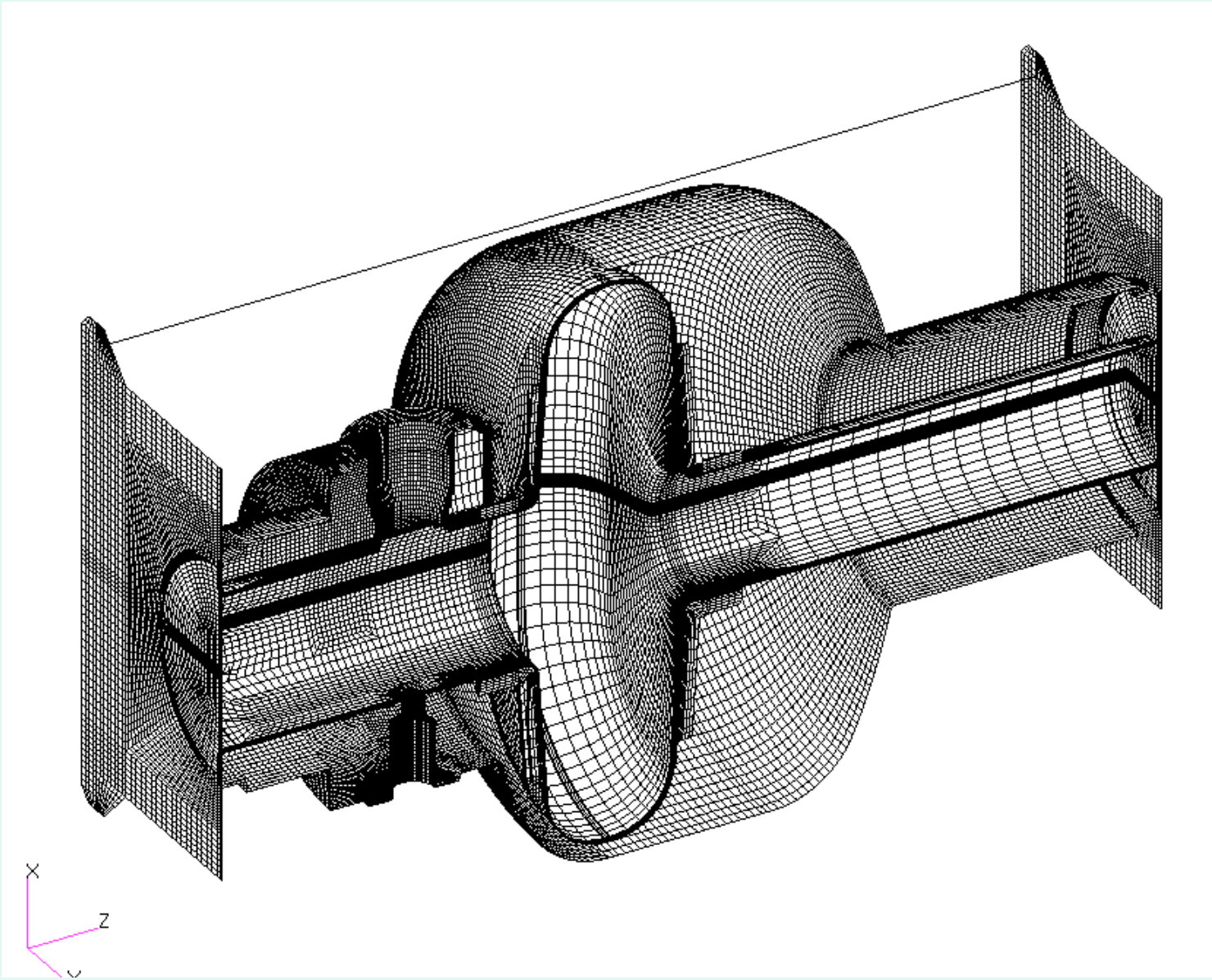


Crab Cavity in Cryostat Front View 2

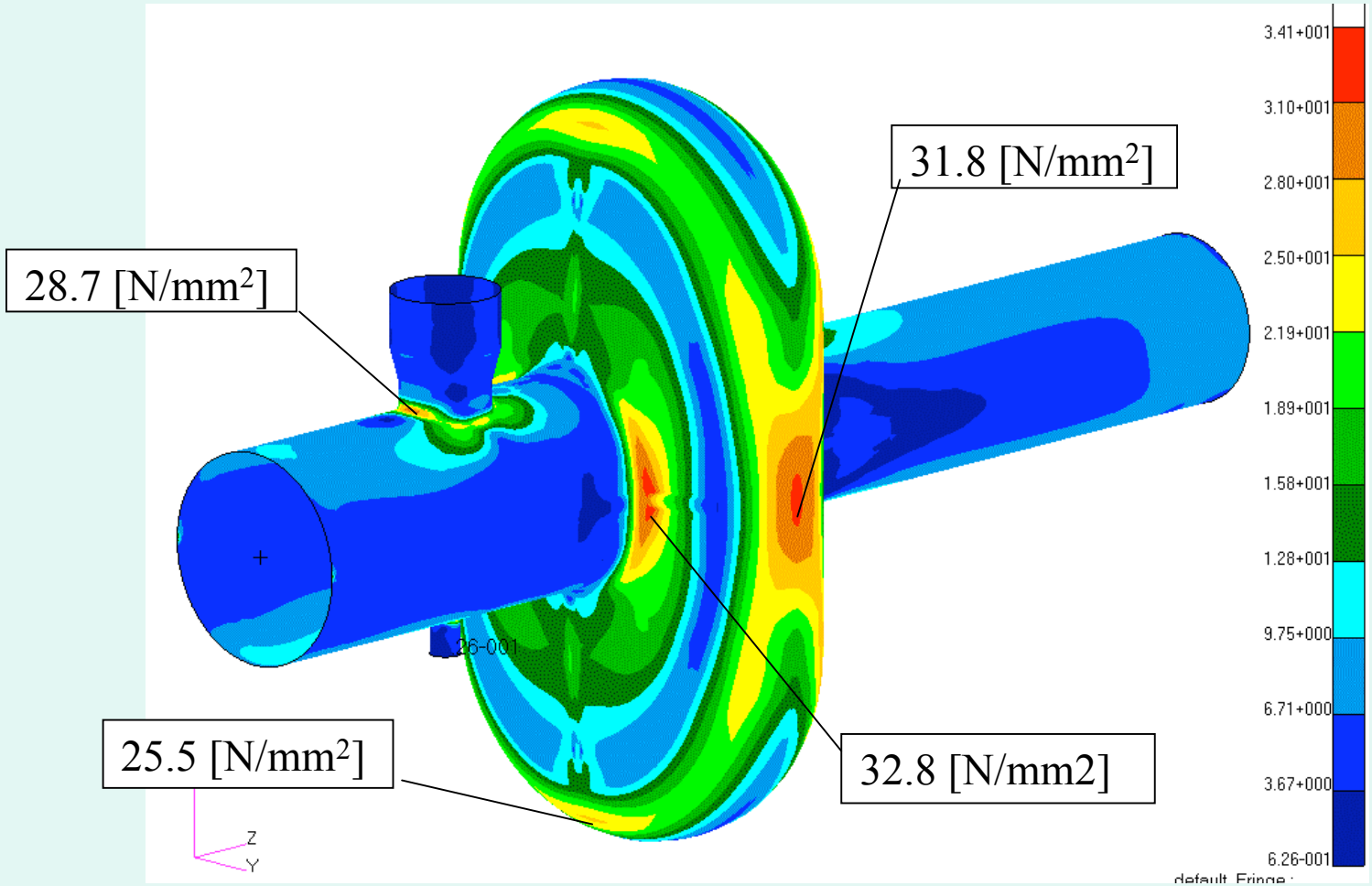




Model for Stress Analysis

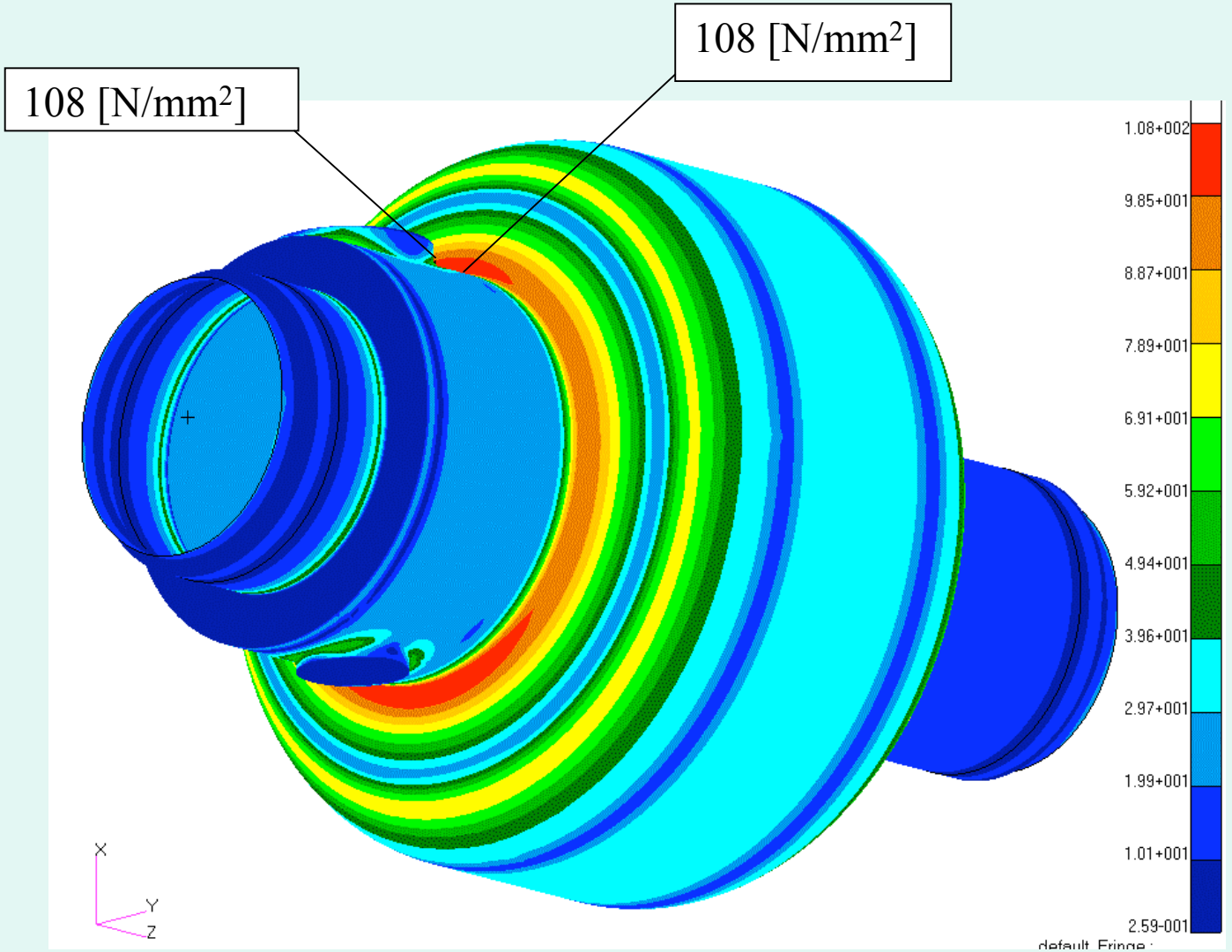


Stress Analysis Crab Cavity



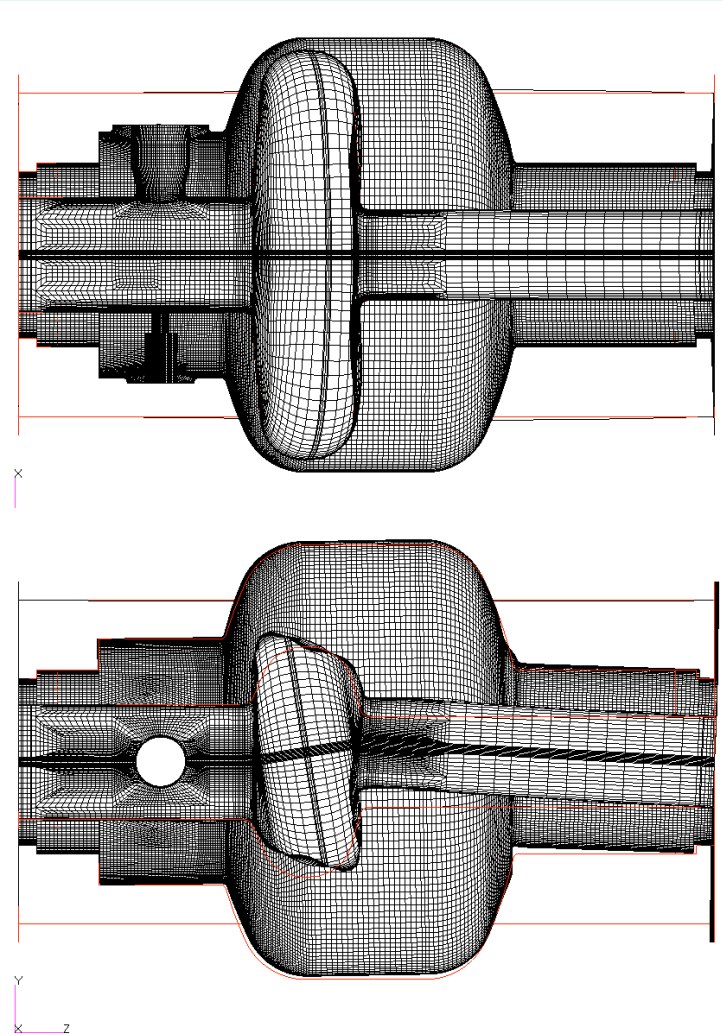
Tresca Stress

Stress Analysis Helium Jacket



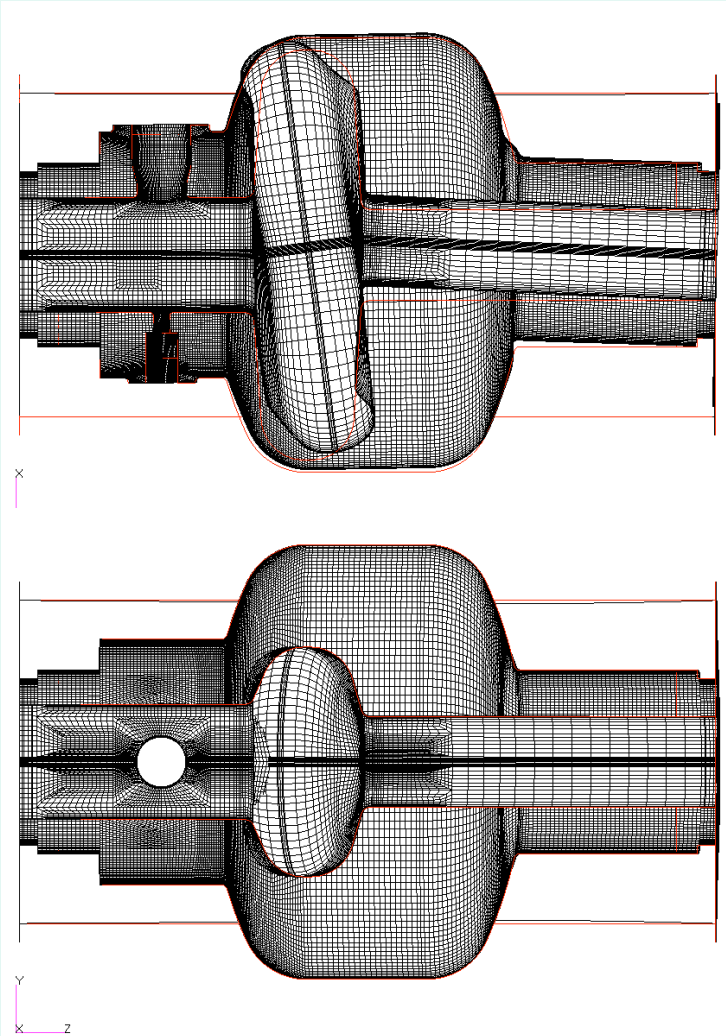
Tresca Stress

Buckling Crab Cavity



1st Mode

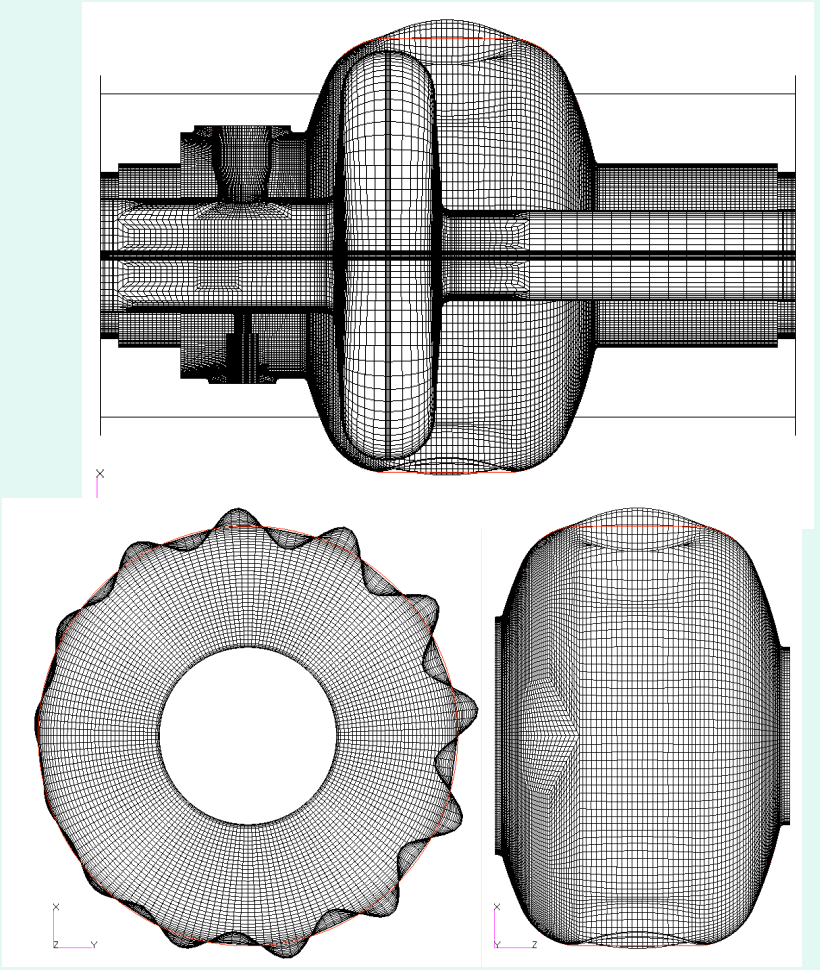
Buckling Load : 0.7772 [MPa]



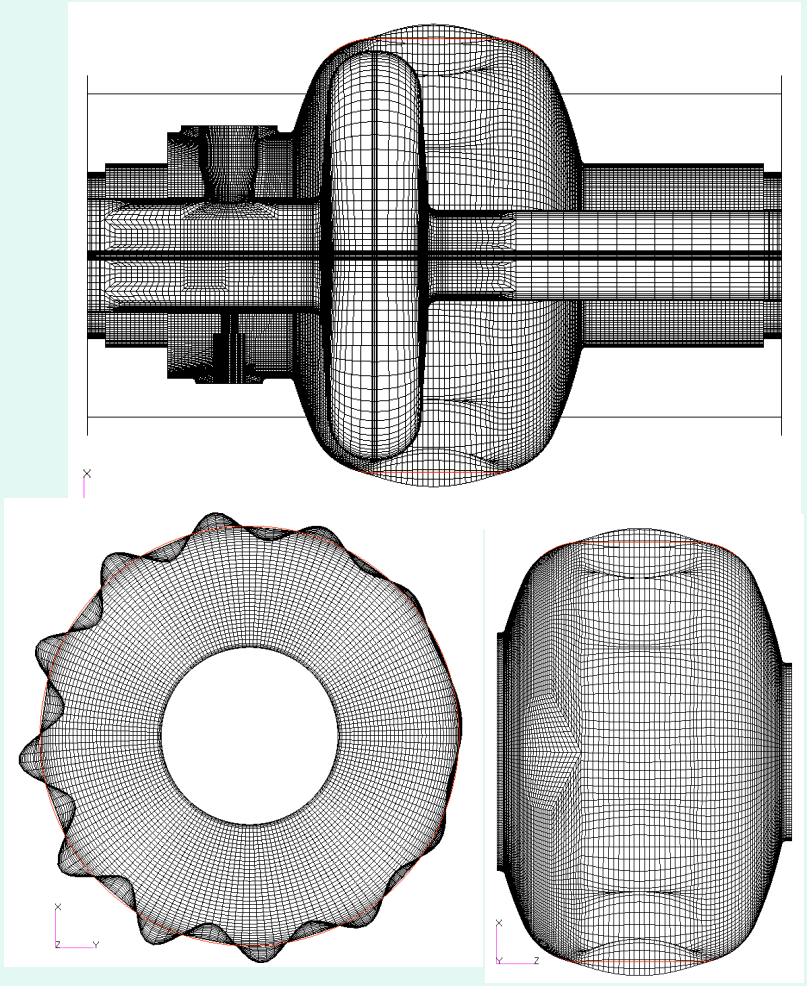
2nd Mode

Buckling Load : 0.8500 [MPa]

Buckling Helium Jacket

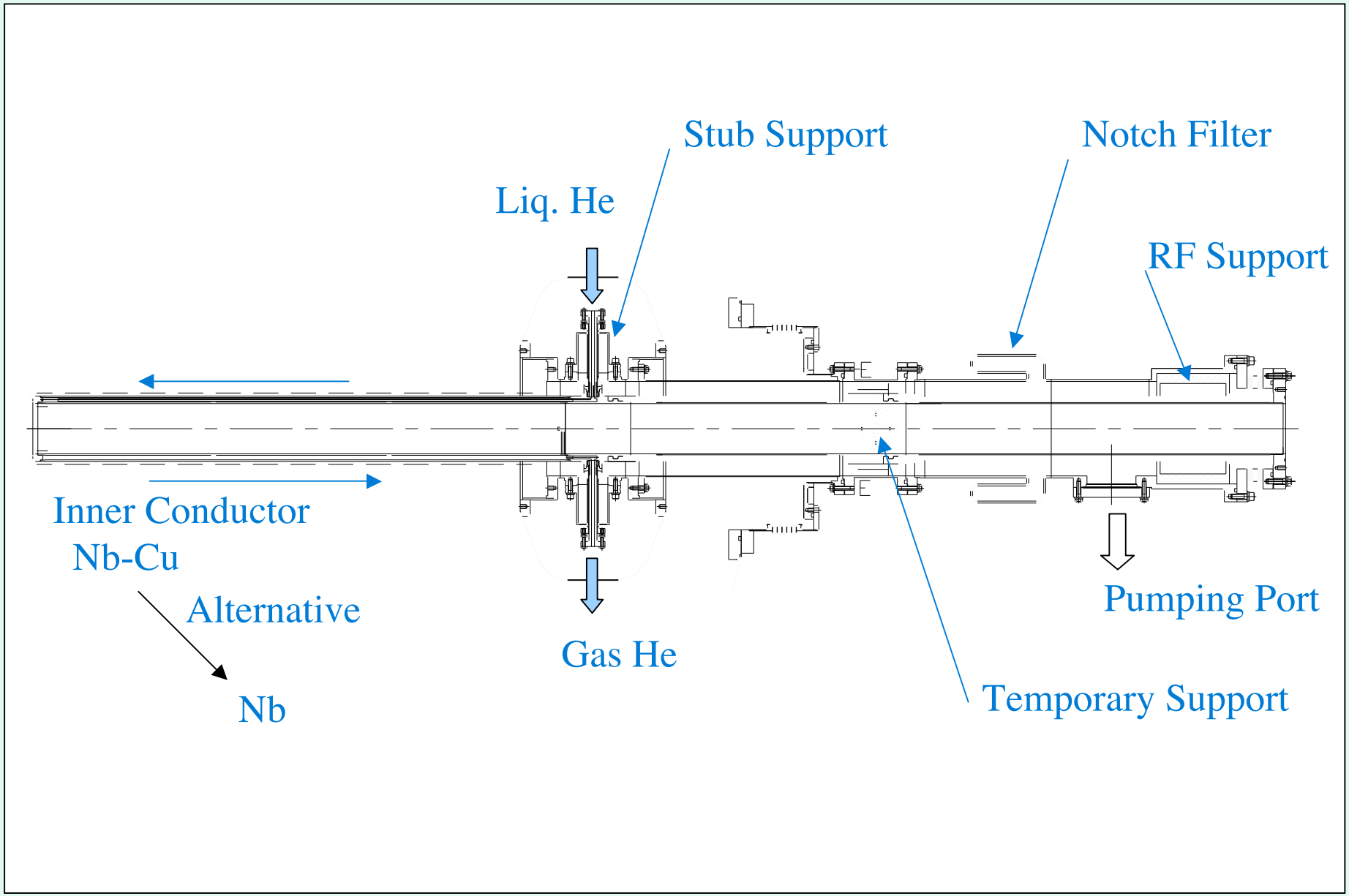


1st Mode
Buckling Load : 0.3218 [MPa]

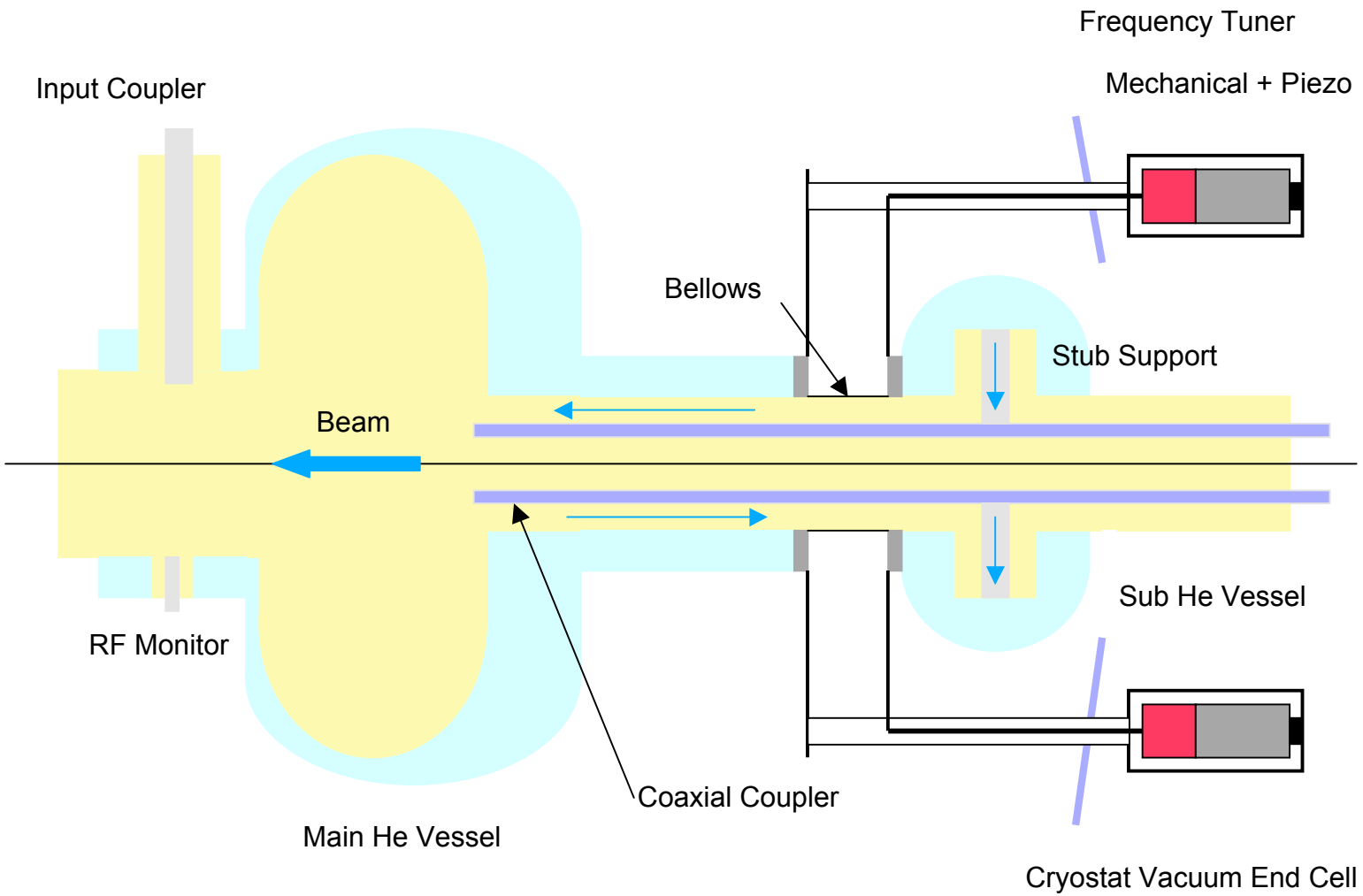


2nd Mode
Bucking Load : 0.3219 [MPa]

Coaxial Coupler

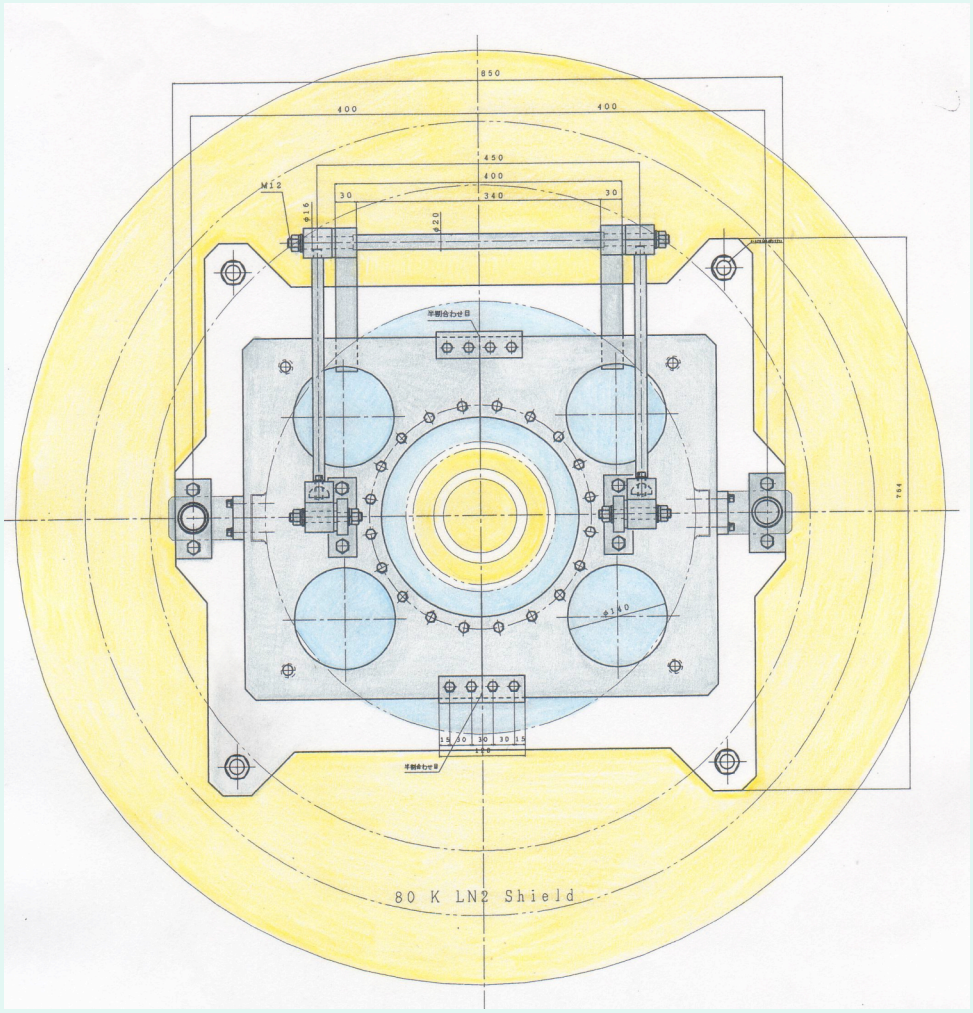


Frequency Tuning

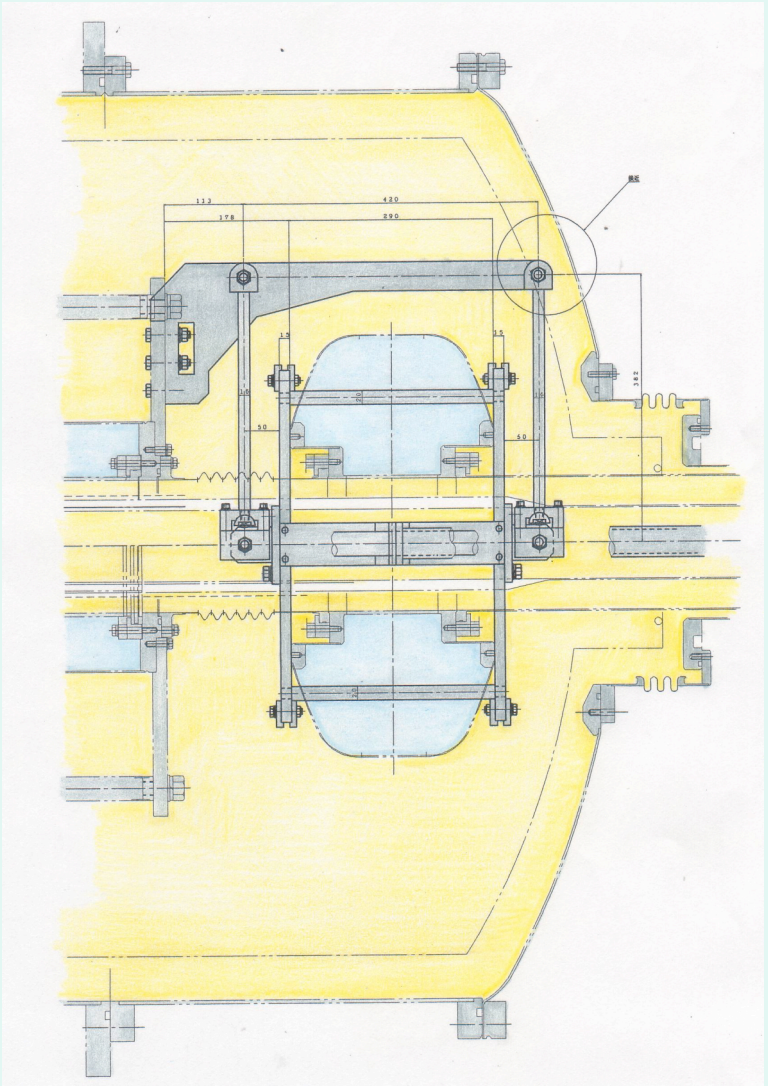


Frequency Tuner

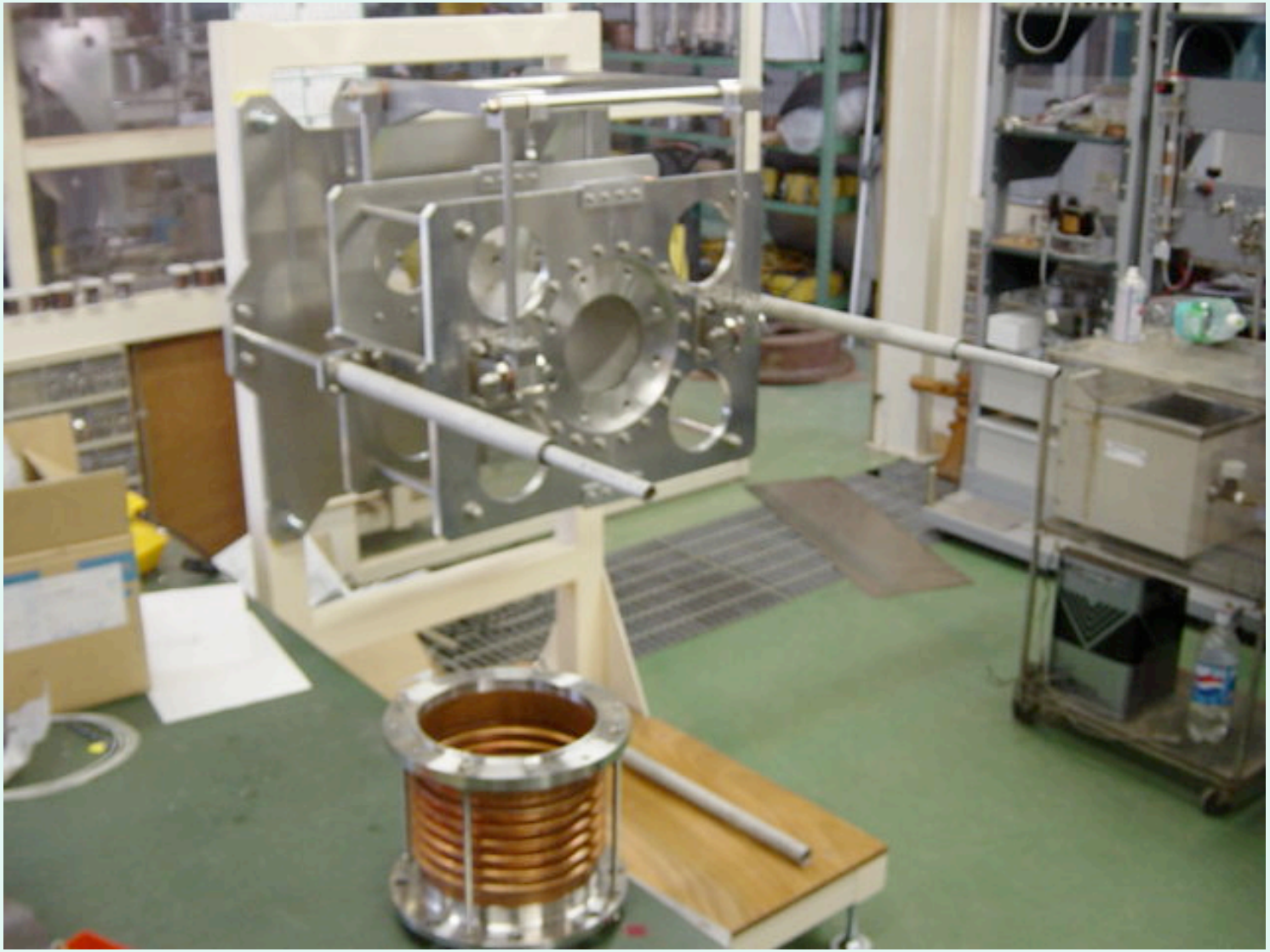
Front View



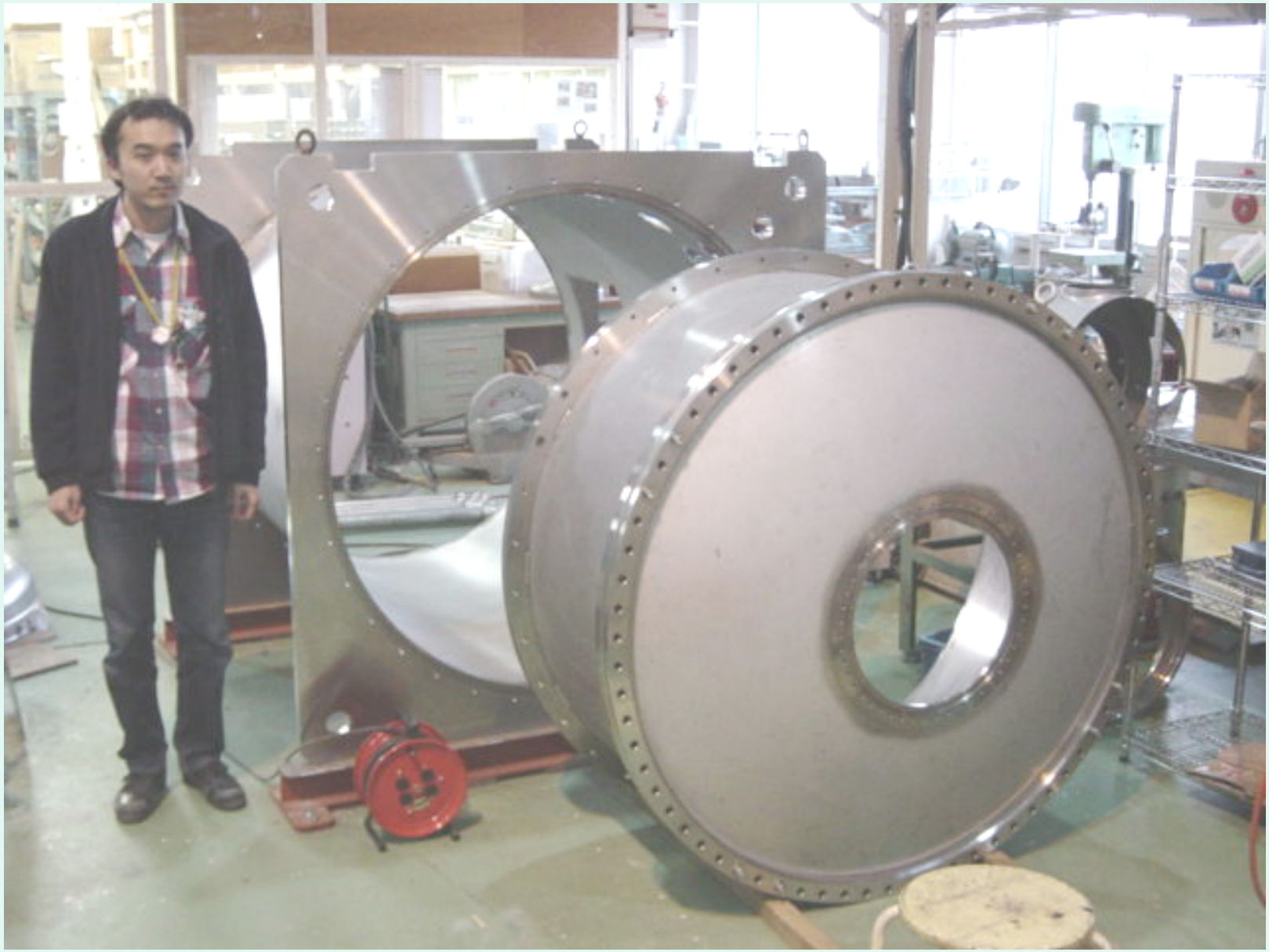
Side View



Test Stand for Frequency Tuner



Cryostat Vacuum Chamber



R&D Efforts Nb-Cu Coaxial Coupler

Nb-Cu Coaxial Coupler

Good cooling characteristic

Copper pipe (130 mm in Dia.) Commercially available

Designing and Fabrication of coaxial coupler are very easy

Full Size Nb-Cu Simplified Coaxial Coupler

RF Characteristic Test with Nb Crab Cavity

Full Size Nb-Cu Coaxial Coupler

Installed in Horizontal Cryostat

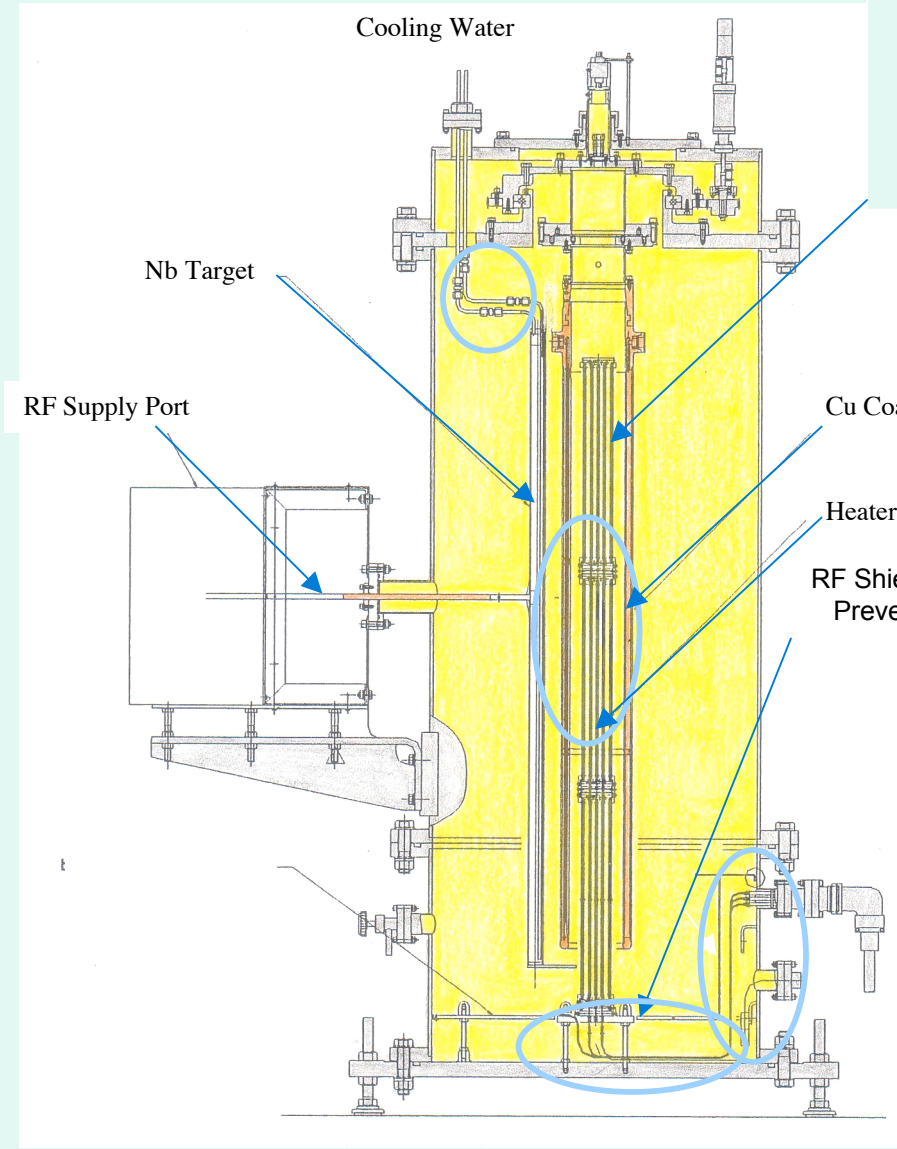
Design change

More R&D time is needed

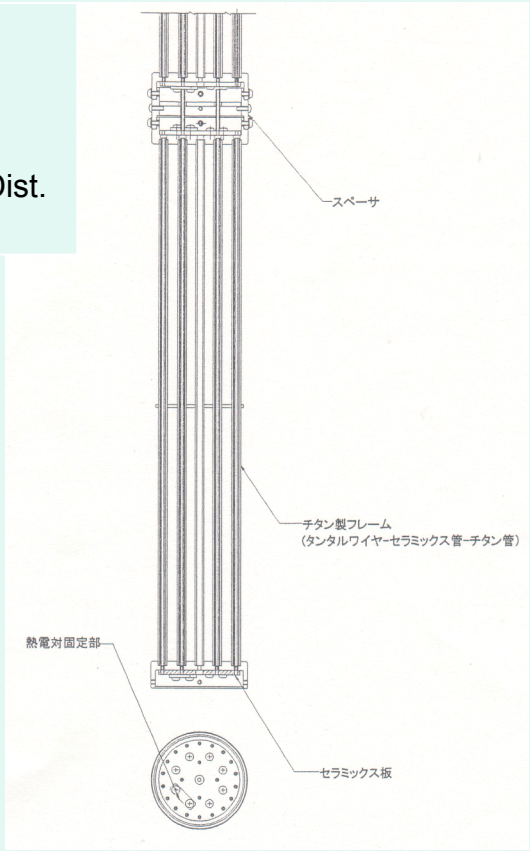
to complete the Nb-Cu Coaxial Coupler!

Nb Coaxial Coupler

Nb Spattering Setup (Improved)



New Heater
- Ti Sheath Heater
- Ta Wire & Ceramics Pipe
- 3 Heater Sections
  - Uniform Temperature Dist.



Problems

Shortage of Heater Power

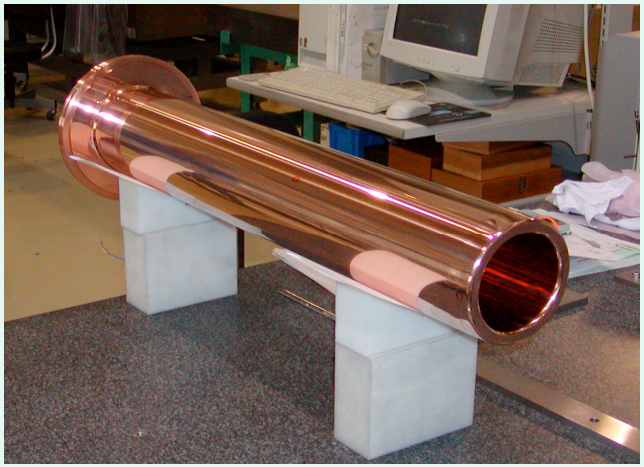
Electric Insulation

Discharge at Cooling pipe

Discharge at Cabling

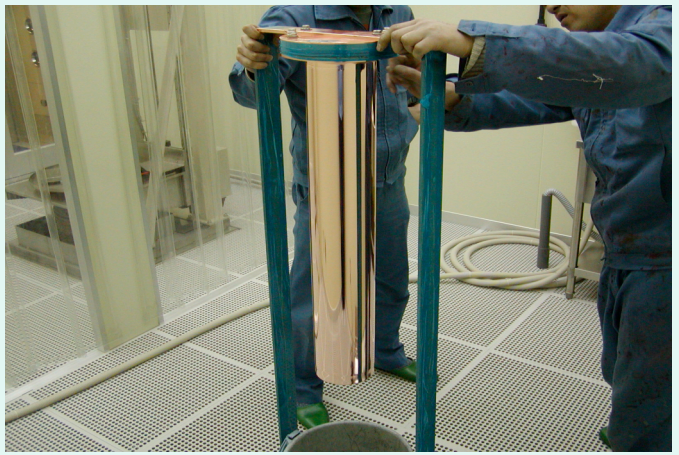
Cooling Water

Simplified Nb-Cu Coaxial Coupler



Assembled Cu Coaxial Coupler

Electro-polishing



Electro-polished Cu Coaxial Coupler

High Pressure Rinsing

Nb Spattering

High Pressure Rinsing

RF Test with Crab Cavity in V-cryostat

Nb-Cu Coaxial Coupler (Simplified Type)

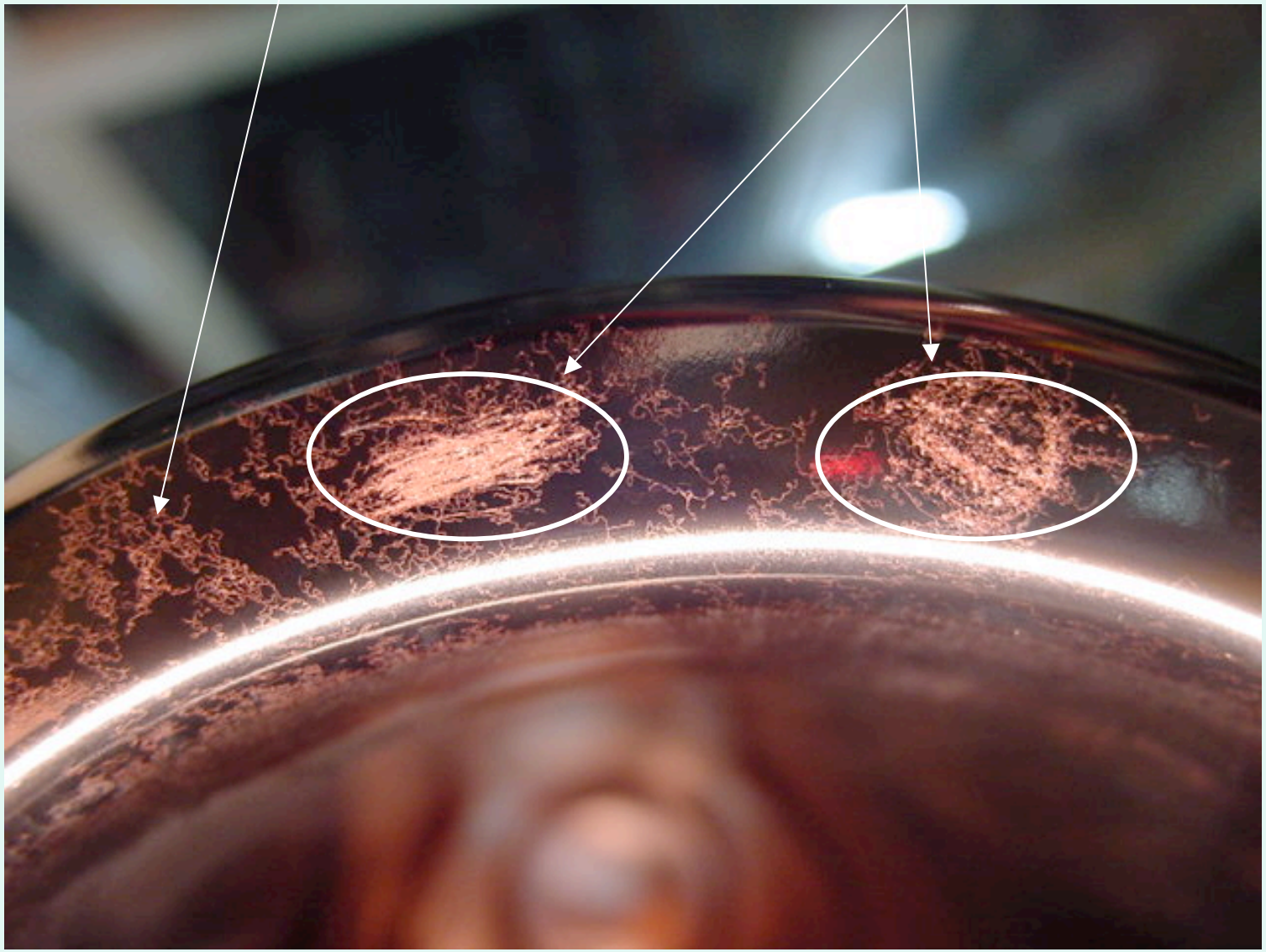
Before Nb Spattering

After Nb Spattering

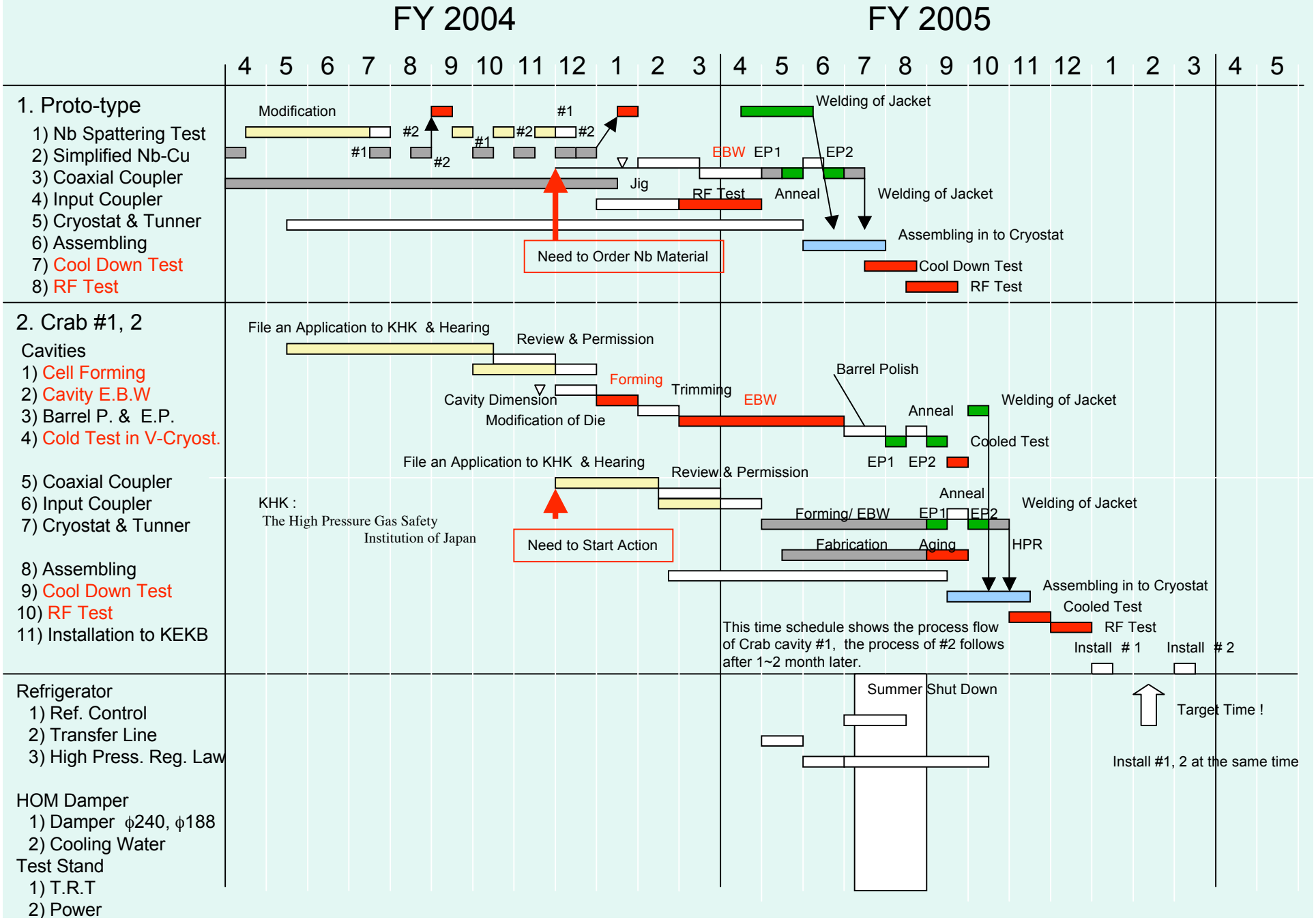
Degradation of Nb-Cu Surface

Scratch by metal scraper

Capillary vessel shape pattern

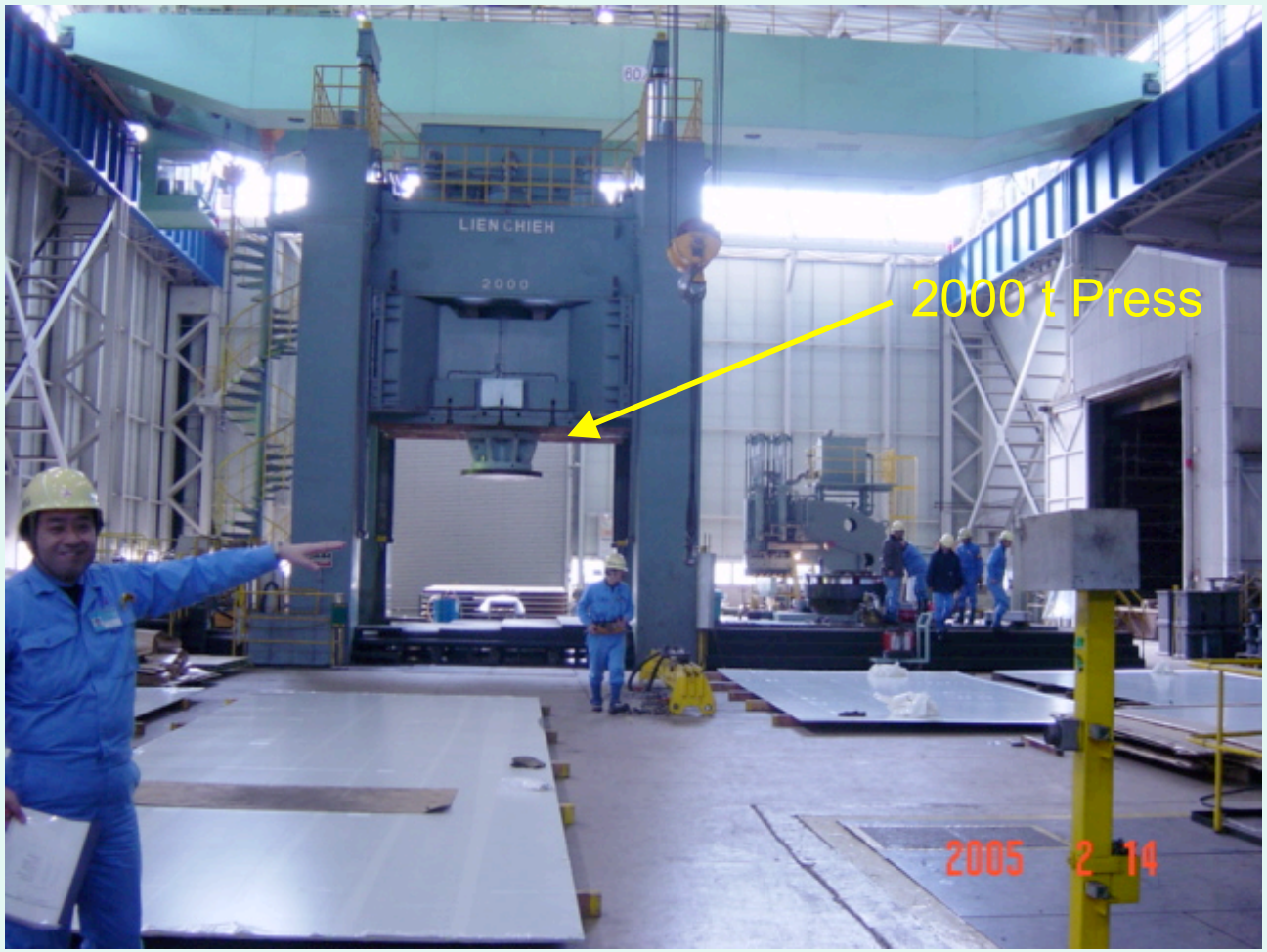


Time Schedule for KEKB Crab Cavities



Crab Half-Cell Forming at MHI

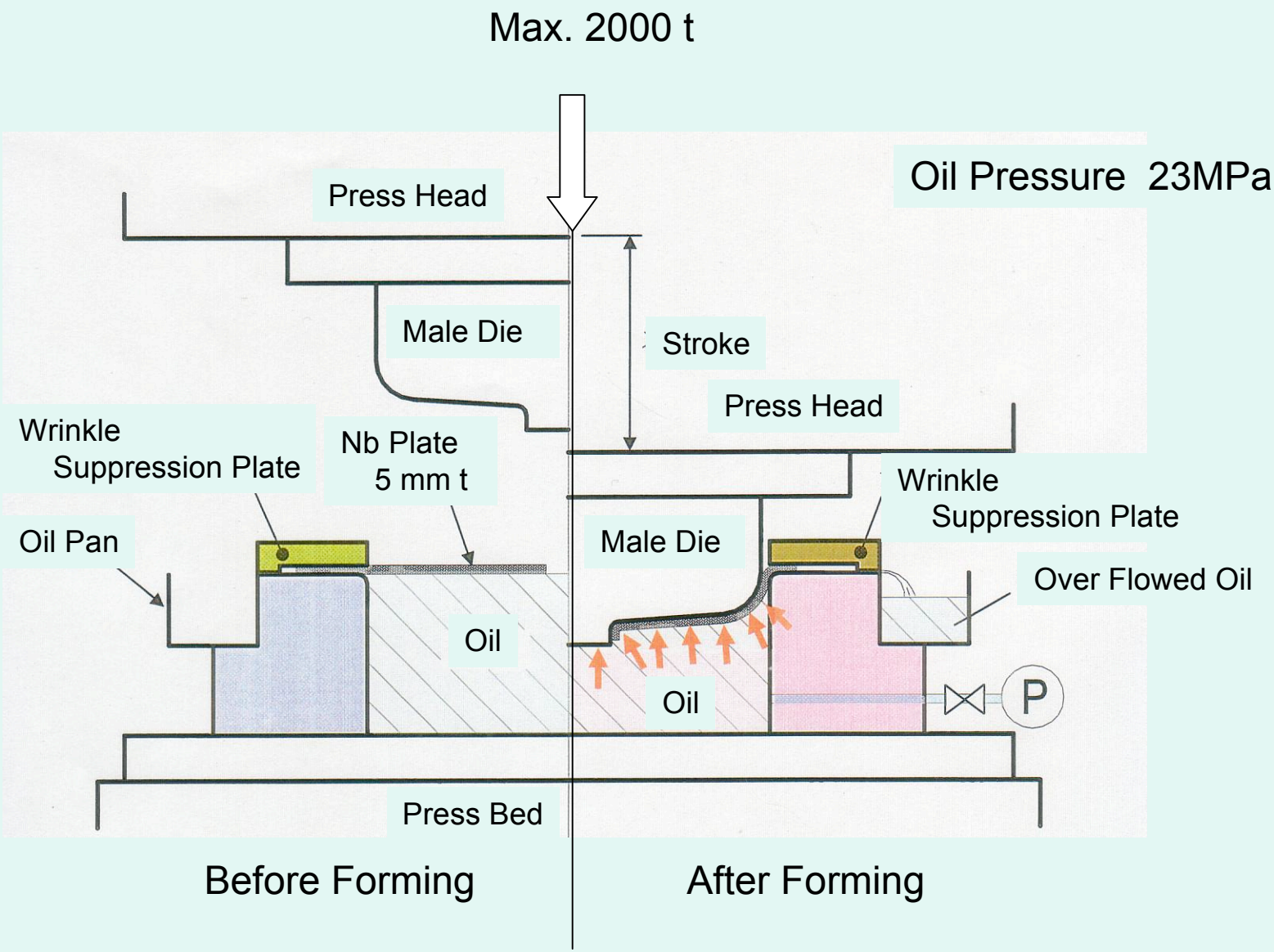
From Y. Yamamoto Report



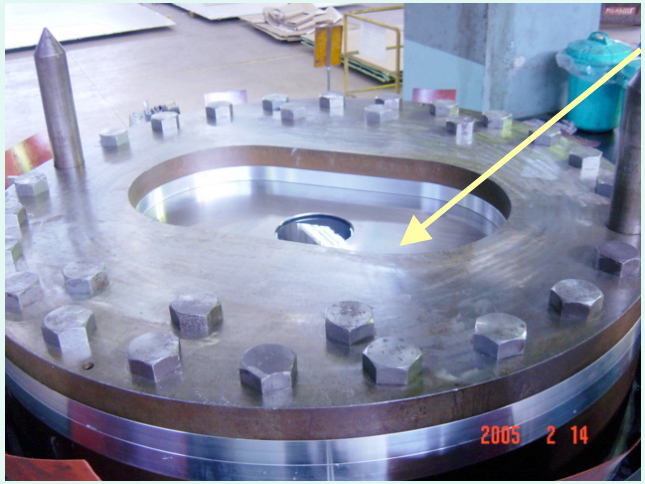
Forming of 4 Half-Cells for Crab # 1 and # 2

Finished on Feb. 14, 2005 at Mitsubishi Heavy Industries, LTD. Kobe

Principle of Hydro-forming



Hydro-forming of half-Cell



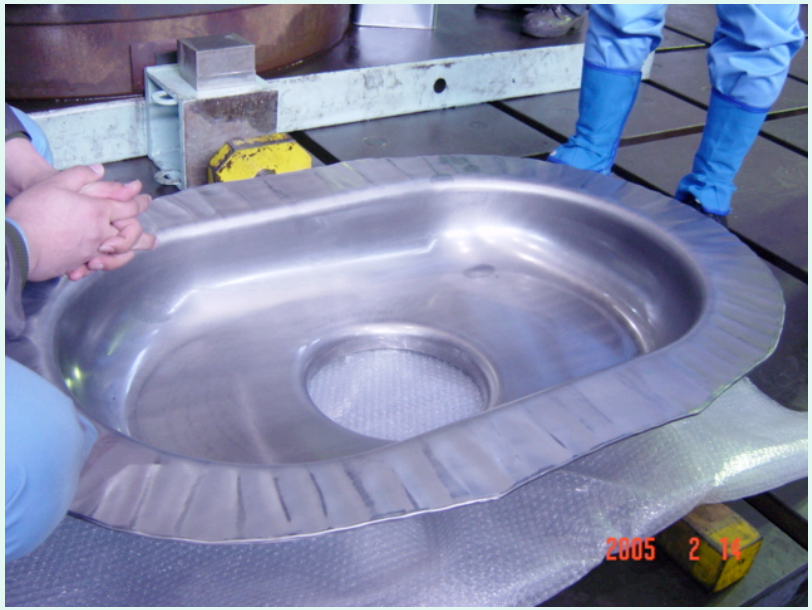
Nb Plate
5mm t

Female Die : Oil

Male Die : Aluminum

It takes about 5 minutes to form a half-cell

Finished half-cell



After forming, the shape was checked.

The dimension of the cavity was measured by 3-D measurement system.