The Horizontal Test of the Prototype Crab Cavity

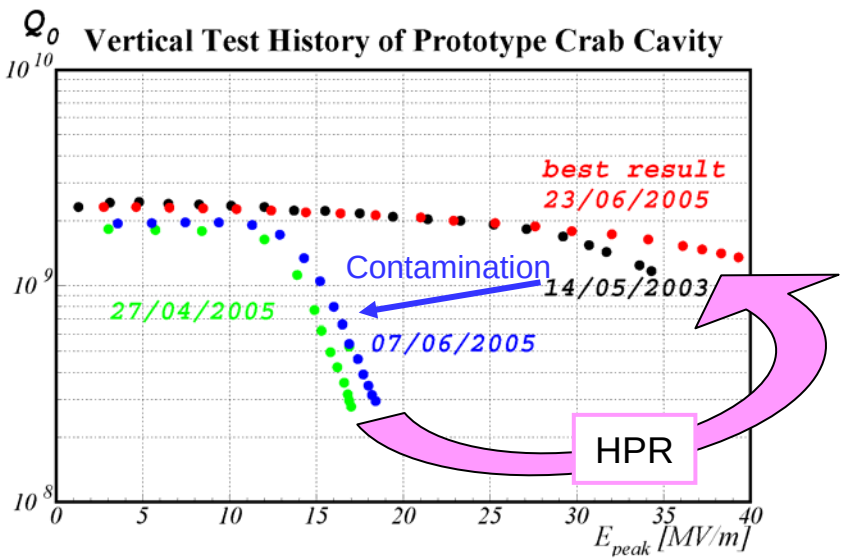
Purpose

- Check the assembly of the cryostat
  - although the coaxial beam pipe is not installed
- Check whether the leak occurs or not
  - during cool-down and warm-up
- Check the mechanical strength for the vibration
  - during moving it to the experimental site
- Measure the coupling @ 4.2K
- Measure the static loss of the cryostat

This time not using the high power from Klystron, but we did the low power test.

After the vertical test for the prototype crab cavity …

After HPR, the vertical test was succeeded.



After pulling up the cavity from the cryostat …

A few screws at the indium flange loosened after the vertical test.
Then we re-tightened them.

The leak trouble occurred.

After setting the cryostat into the pit, we started the vacuum evacuation, but …

Unfortunately, the leak was found at the indium seal.

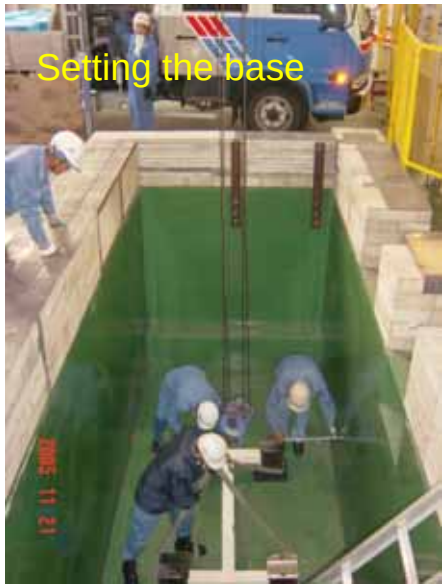
We must break up the helium jacket.
Then we must re-assemble the cryostat including re-welding the helium jacket etc.

Although we could not observe the exact leak point,
we presumed that the screws were not firmly tightened
and the indium seal was detached,
because the holes for them were a little shallow totally.

And, we exchanged the screws for the shorter ones by 5mm.

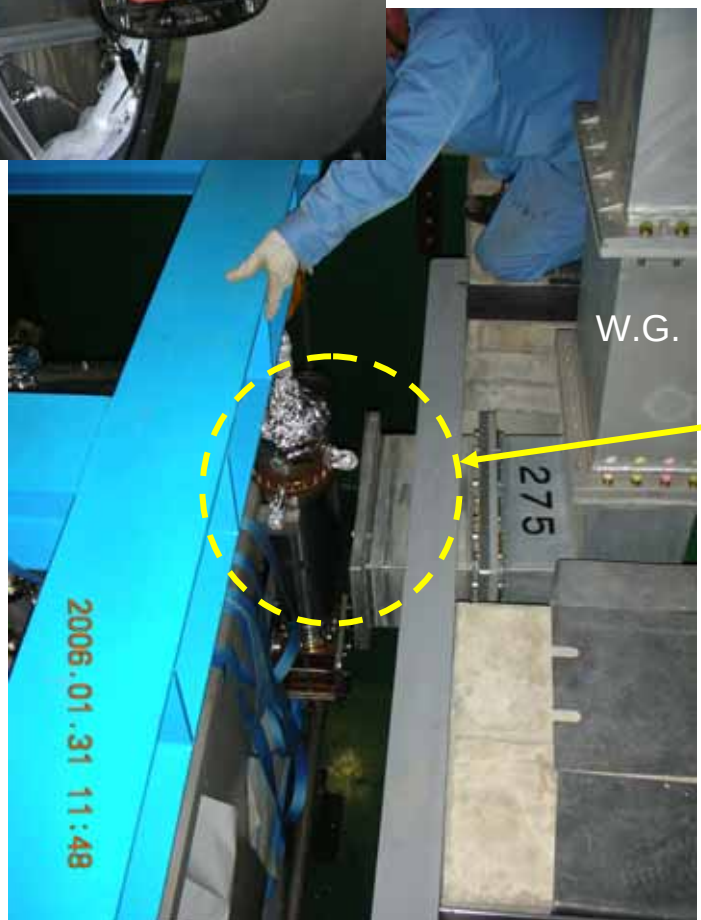
In the end of January, the cryostat was moved to the pit again.

Carrying the cryostat into the pit @D10 (1)



Carrying the cryostat into the pit @D10 (2)

The center of gravity for the cryostat is high.



Almost hitting the input coupler when pulling down to the pit

The measurement during the cold test

- Static loss

  ⇒ about 30W (calculated by Nakai-san)
- The resonant frequency (later)
- Q_L (later)
- Check the cable length for the pick-up probe using TDR

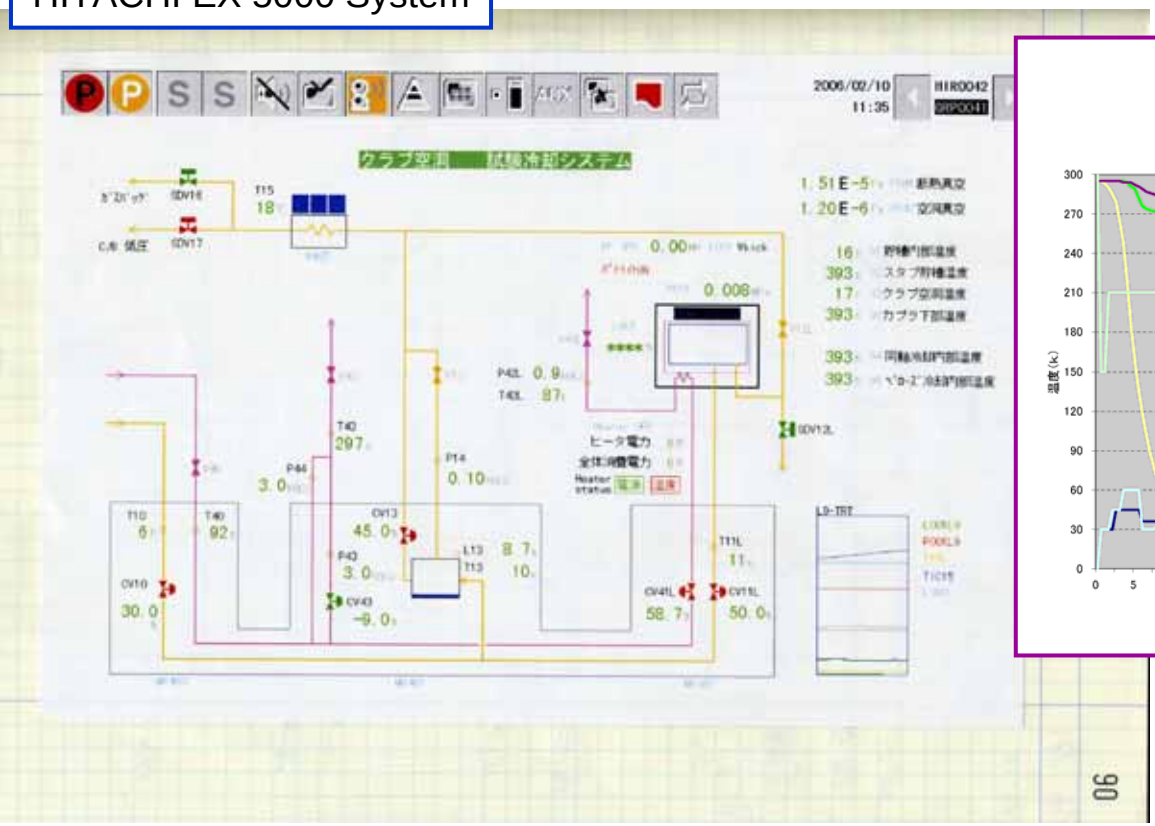
  ⇒ no problem
- Check the cable attenuation using the signal generator

  ⇒ no problem

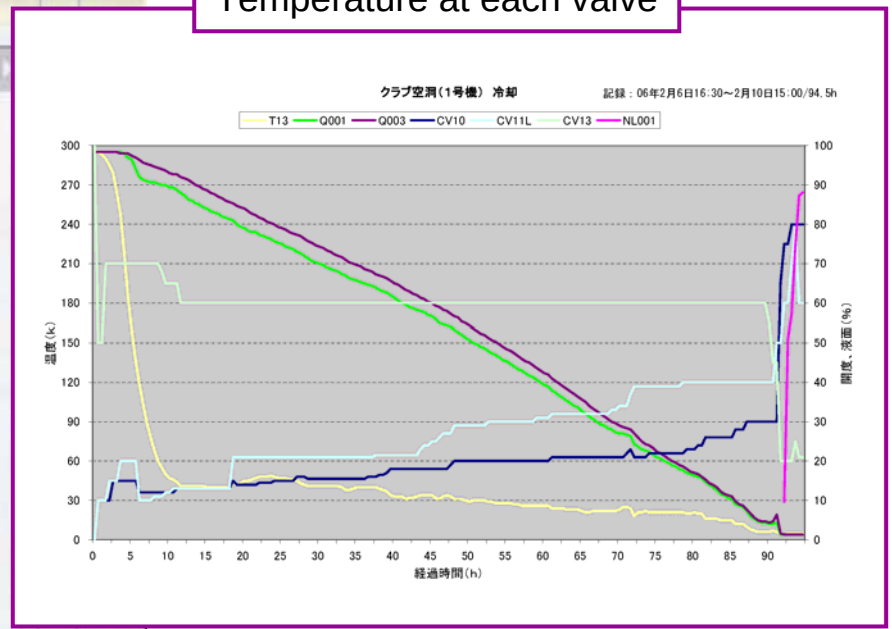
The cryostat stayed at 4.2K for about 8 hours.

HITACHI Display at the Refrigerator Control System

HITACHI EX 5000 System



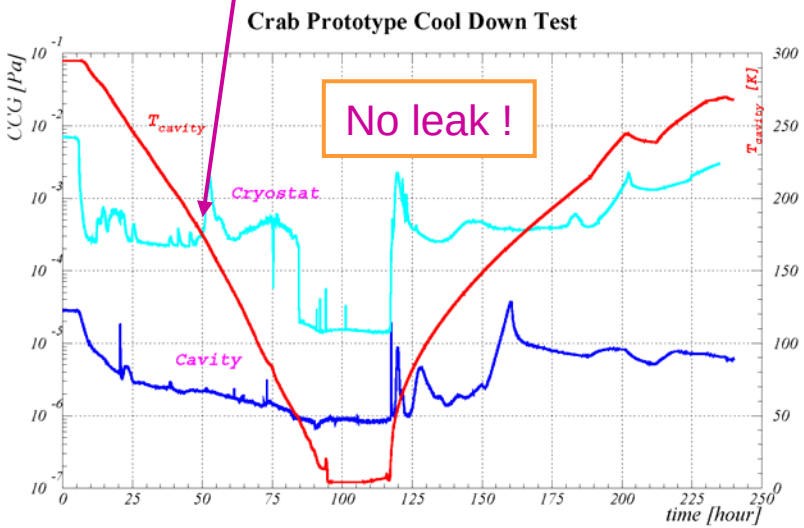
Temperature at each valve



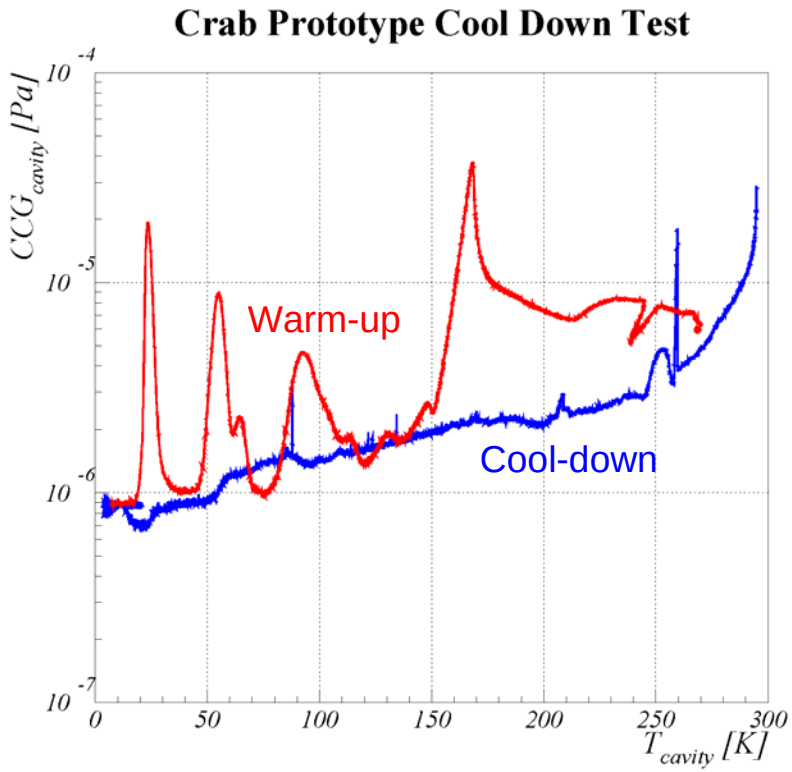
HITACHI refrigerator group enabled the cryostat to cool down all day.
And, they recorded each measurement value per 1 hour during the cold test.

The Vacuum and the Temperature during the cold test

The cooling down rate was increased from 2.8K/hour to 3.5K/hour.



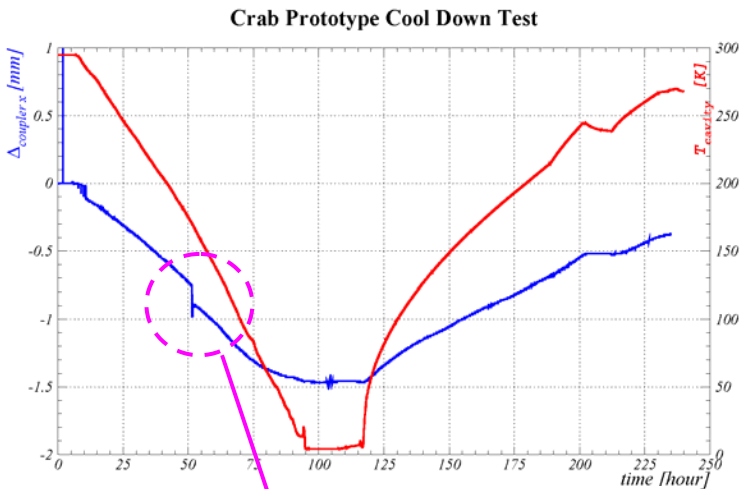
10 days



The bad vacuum due to the outgas during warm-up
Outgas sources are H_2, N_2, CO, H_2O and CO_2 etc.

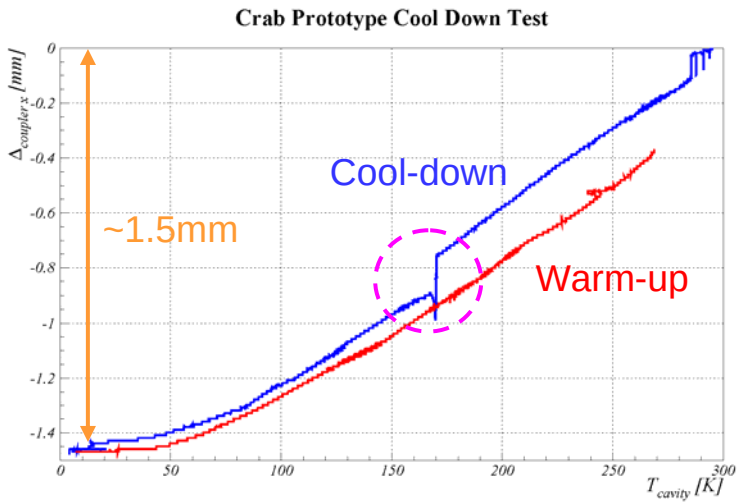
The displacement along the horizontal axis of the input coupler

The input coupler was pulled down to the cavity side, because the cavity shrank during cool-down.
The sudden change occurred during the cool-down, and it was the continuous change, not accidentally.



Sudden change

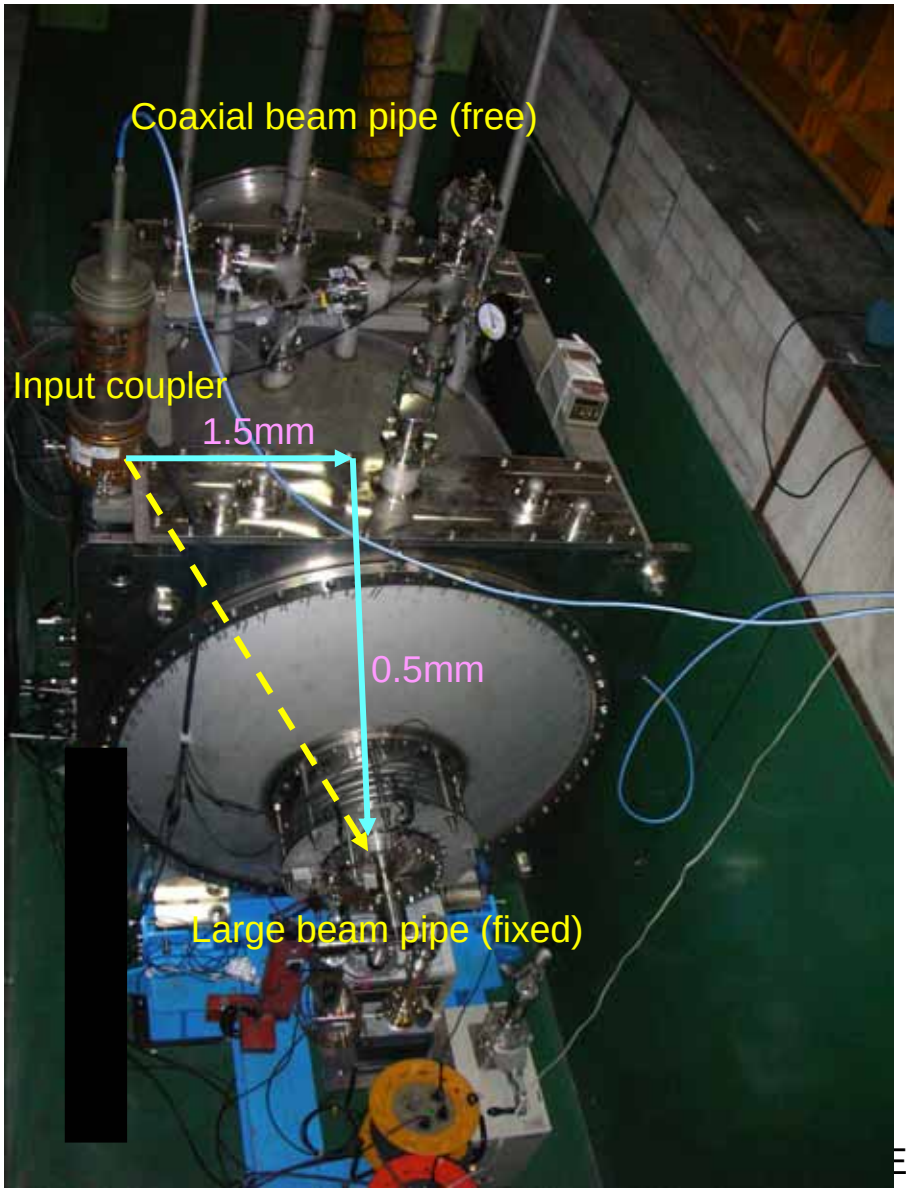
Changing continuously !

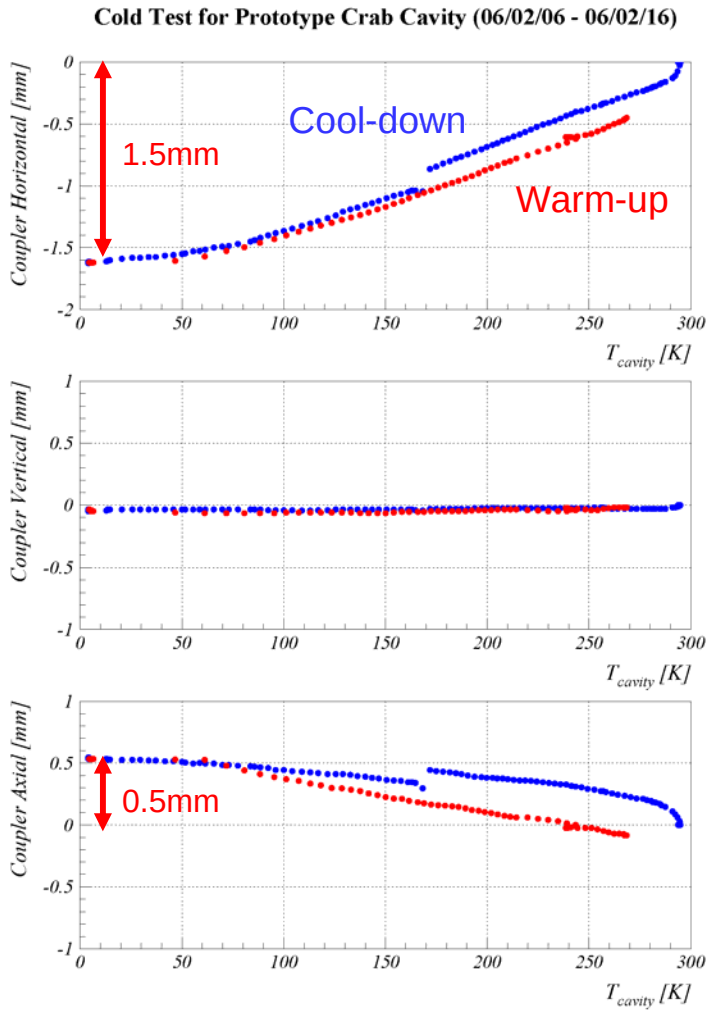


The cool-down rate was changed from 2.8K/hour to 3.5K/hour around this time.
And the cryostat vacuum also became bad.

The displacement of the input coupler along 3 axes

The input coupler was pulled down to the large beam pipe totally.



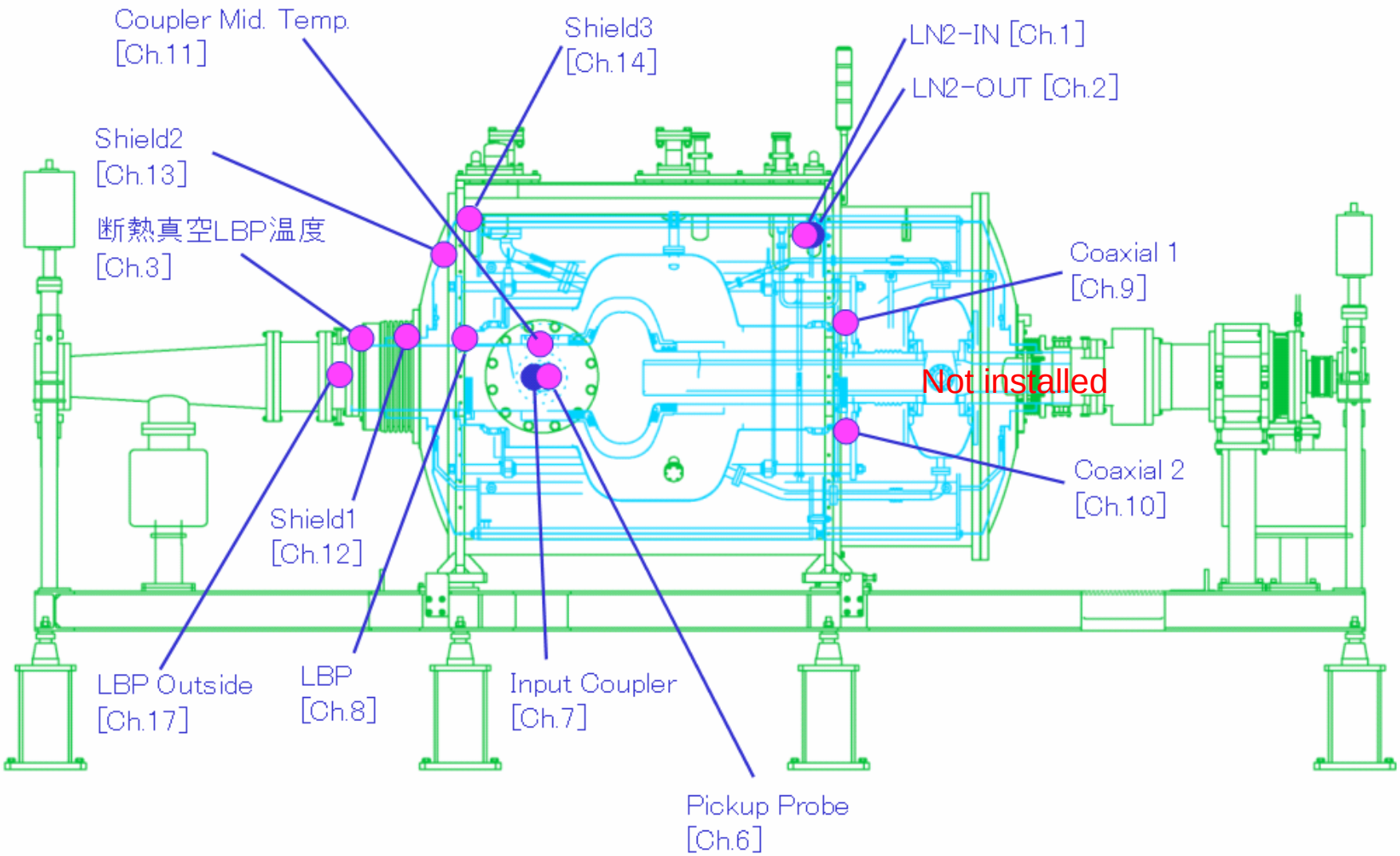


LBP was not moved due to the fixed end.

Temperature channel assign

LER

The thermocouples were attached to the various sites.

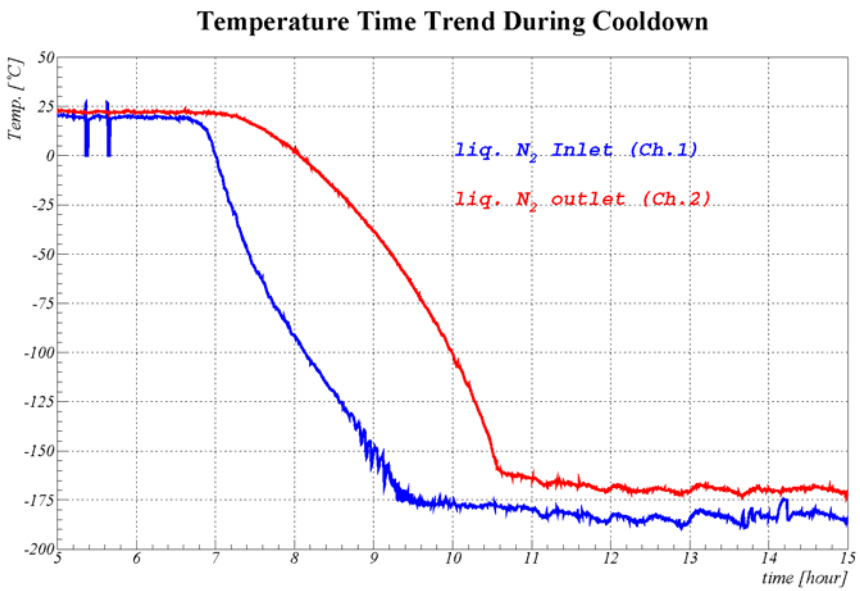


H.Nakai

SIDE VIEW

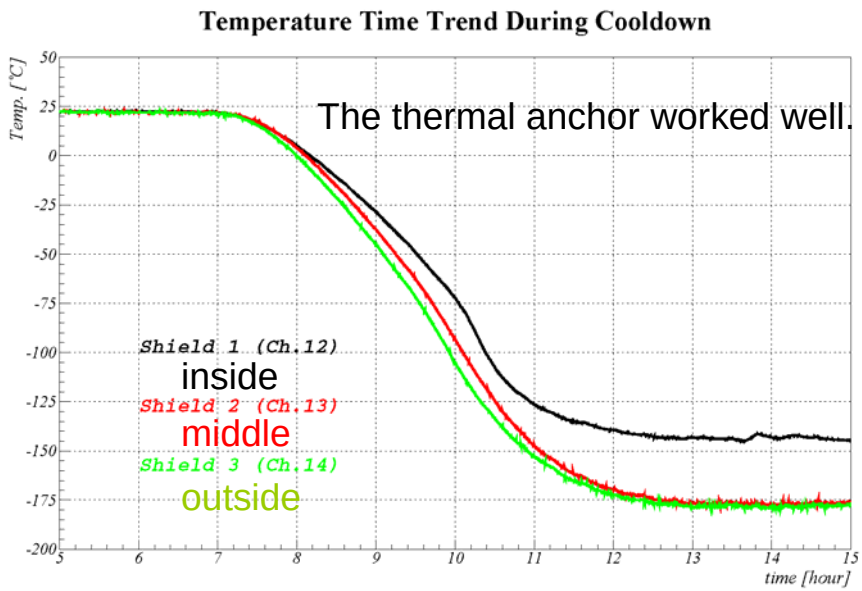
The temperature @ each thermocouple

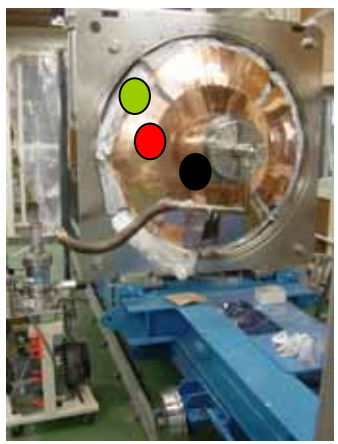
Inlet / outlet of N_2 line



N_2 line had no problem.

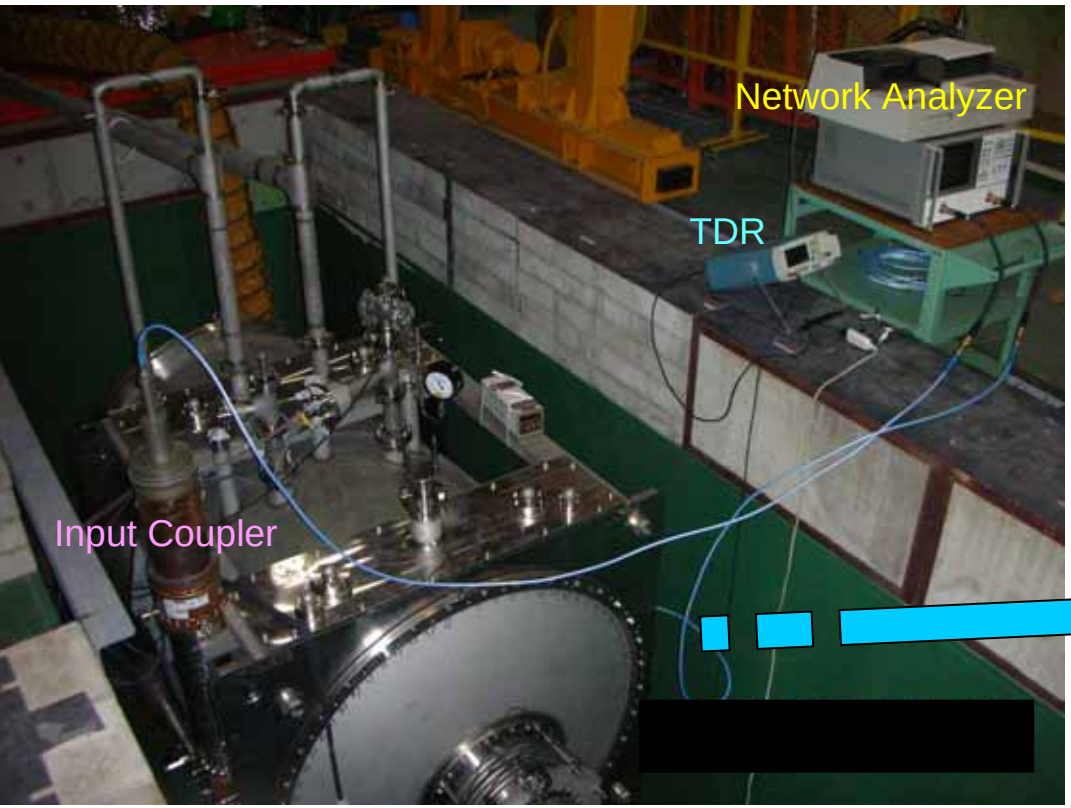
Temperature on the thermal anchor

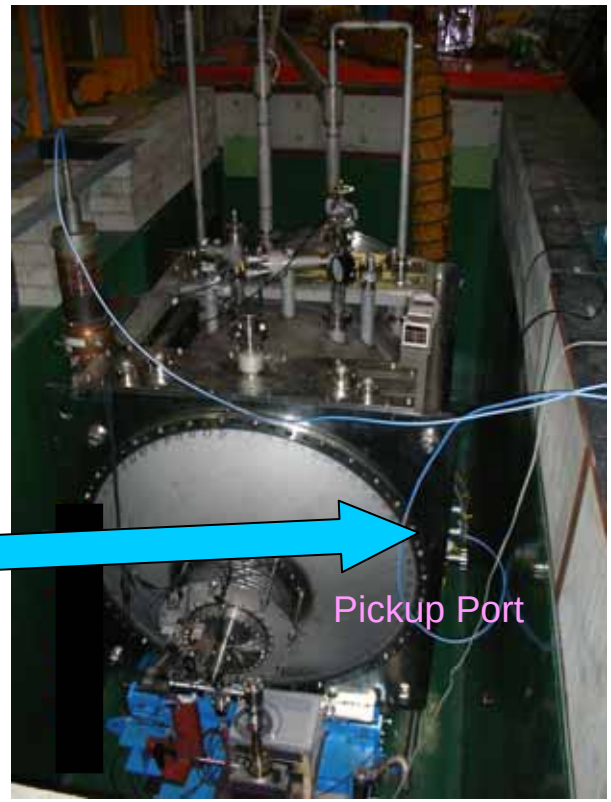




Beginning to cool down from outside to inside

The measurement of the resonant frequency and Q_L using network analyzer

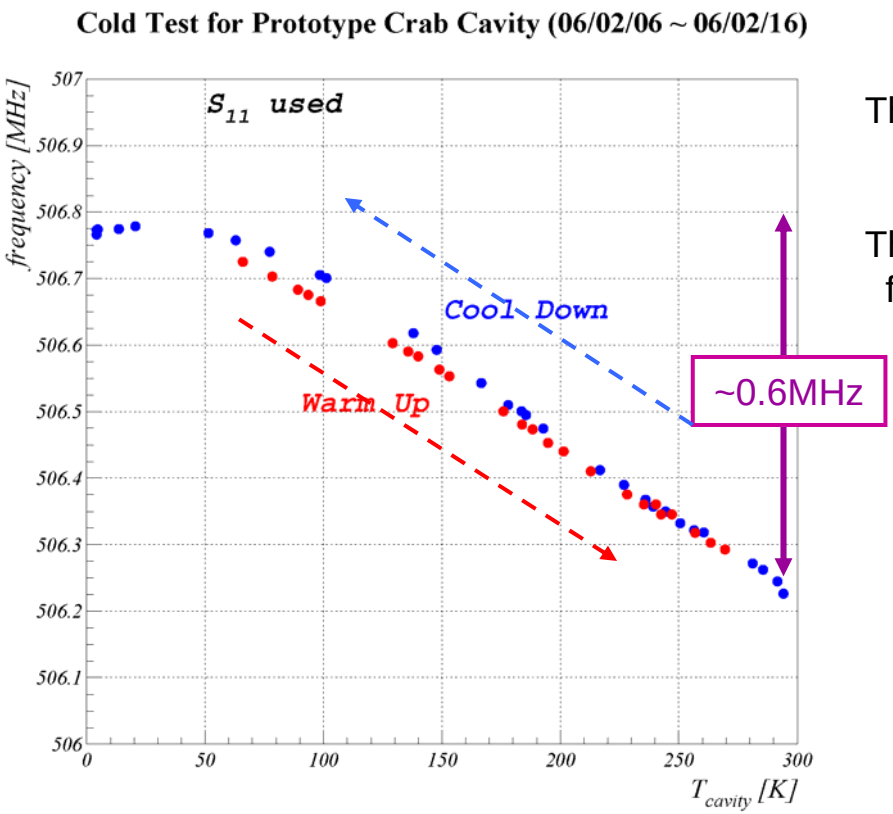




- The change of the resonant frequency due to the cavity shrinking
- Q_L @ 4.2K

The resonant frequency trend

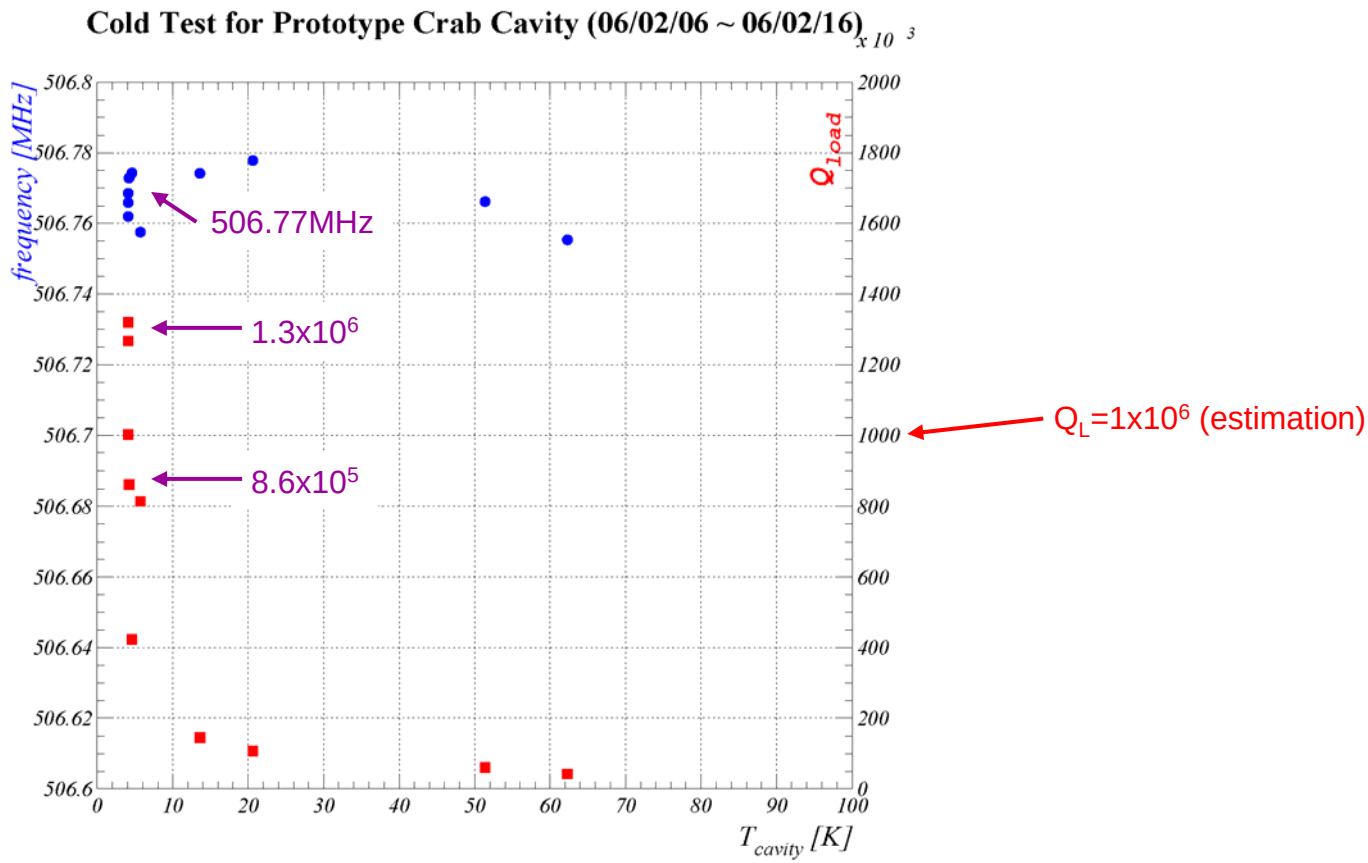
The cavity was not pre-tuned, because it is not used for the operation.
The resonant frequency was changed by about 0.6MHz from the room temperature to 4.2K.



The measurement by S_{21} also became possible below T_{cavity}=60K.

The both resonant frequencies were same below T_{cavity}=60K for the measurement used by both S_{11} and S_{21}.

The resonant frequency and Q_L below T_{cavity}~60K

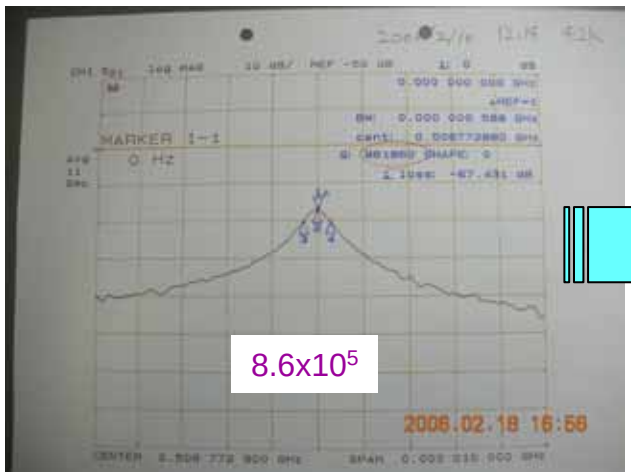


After the cavity reached 4.2K, the resonant frequency and Q_L were changed considerably (8.6×10^5 → 1.3×10^6).

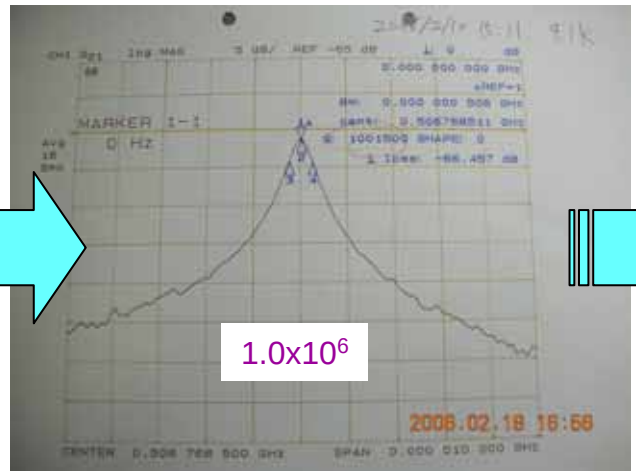
The inner conductor of the input coupler was cooled down ?

The spectrum of the Network Analyzer @ 4.2K

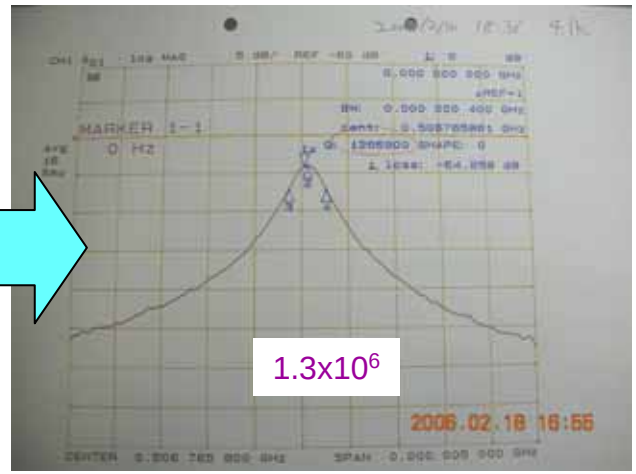
12:14



15:11



18:36



Normally, such a phenomenon is not observed for the accelerating cavity.
From slowly changing, the temperature effect is supposed.

But, we don't understand this phenomenon clearly !

Moving from D10 site to STF

Passing in front of TSUKUBA site

Setting it below the helium gas bag

completed

Summary

- The cold test was completed successfully without the leak.
- The resonant frequency was changed by about 0.6MHz from the room temperature to 4.2K.
- Q_L=8.6x10^5~1.3x10^6 @ 4.2K (estimated 1.0x10^6)

We don't understand the reason for the changing Q_L.

- Static loss was about 30W.
- The input coupler was drawn to the fixed end (LBP).
- The refrigerator system had no problem.