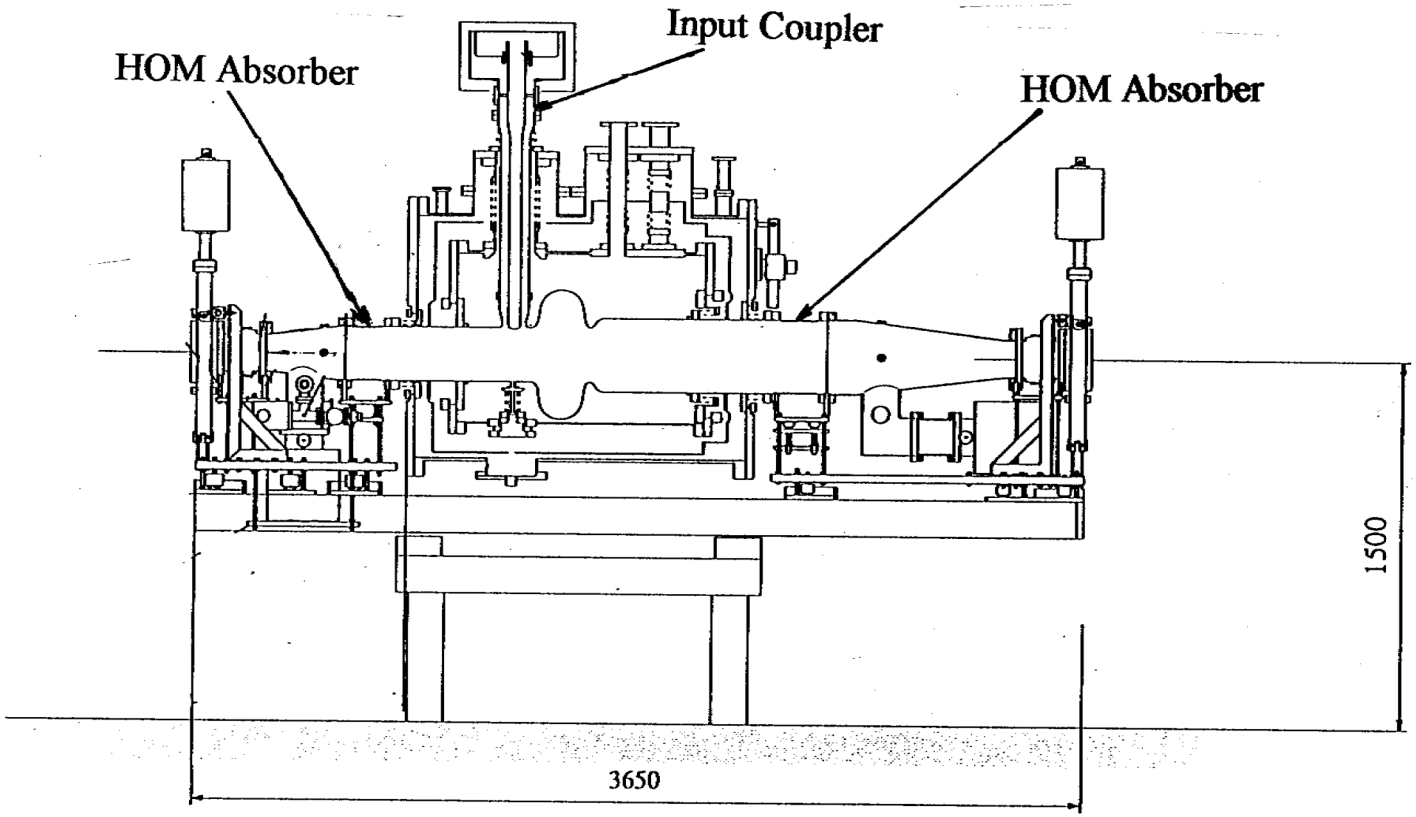
Superconducting Cavities for Super-KEKB

S. Mitsunobu


HOM Absorber
Input Coupler
HOM Absorber
1500
3650

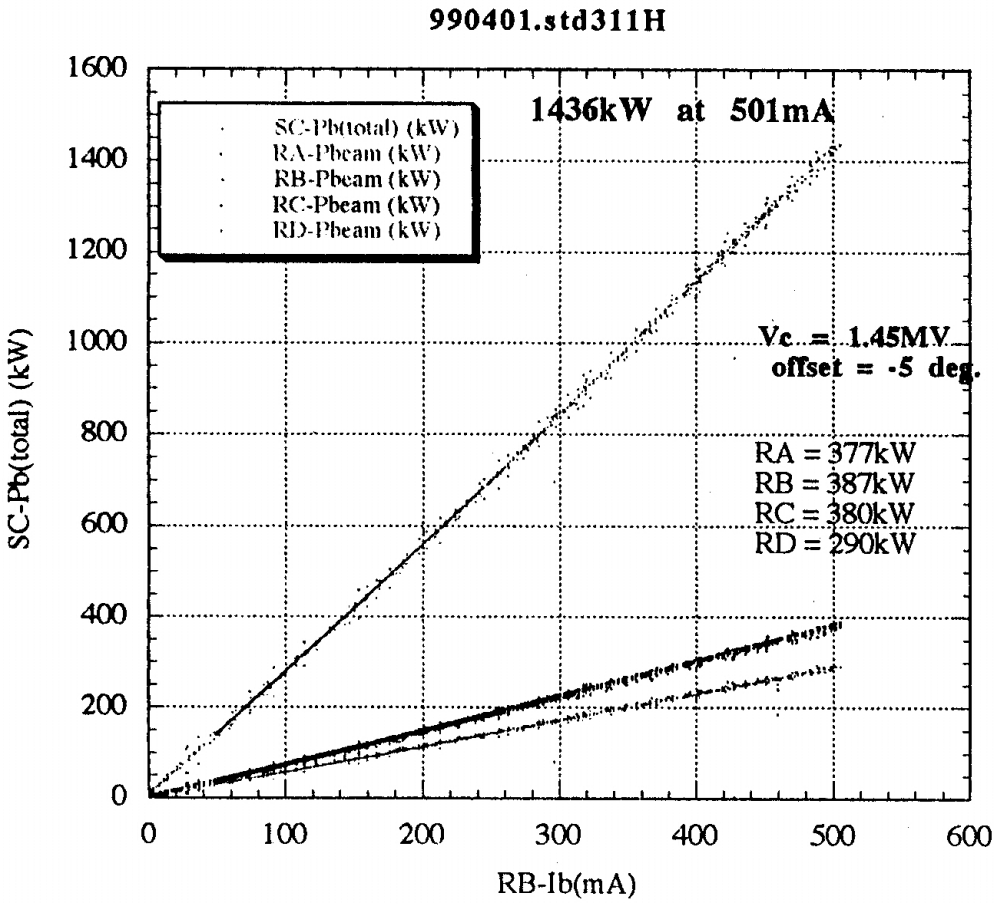
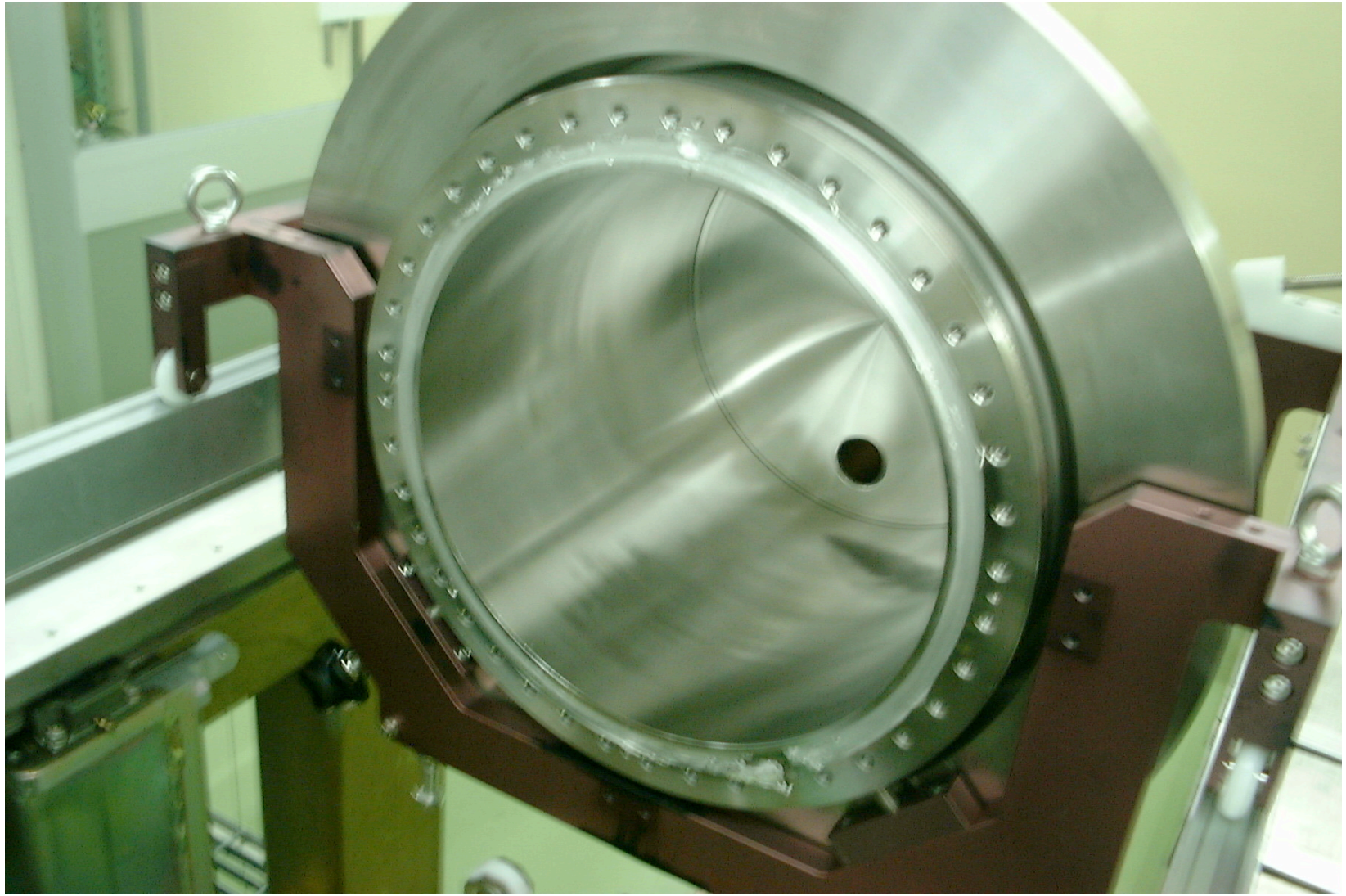


Fig.3 Power transferred to the beam and beam current.

Summary of KEKB SCC Operation

- Max. Current 1100mA
- Max. Power for Beam 380kW
- HOM Power 10kW
- Operation Voltage 1．4－2．0 MV
- Average Trip rate is once per month for good vacuum condition.
- D10C Cavity reeked at Indium joint. Baking Temperature should decrease to 50 ℃.



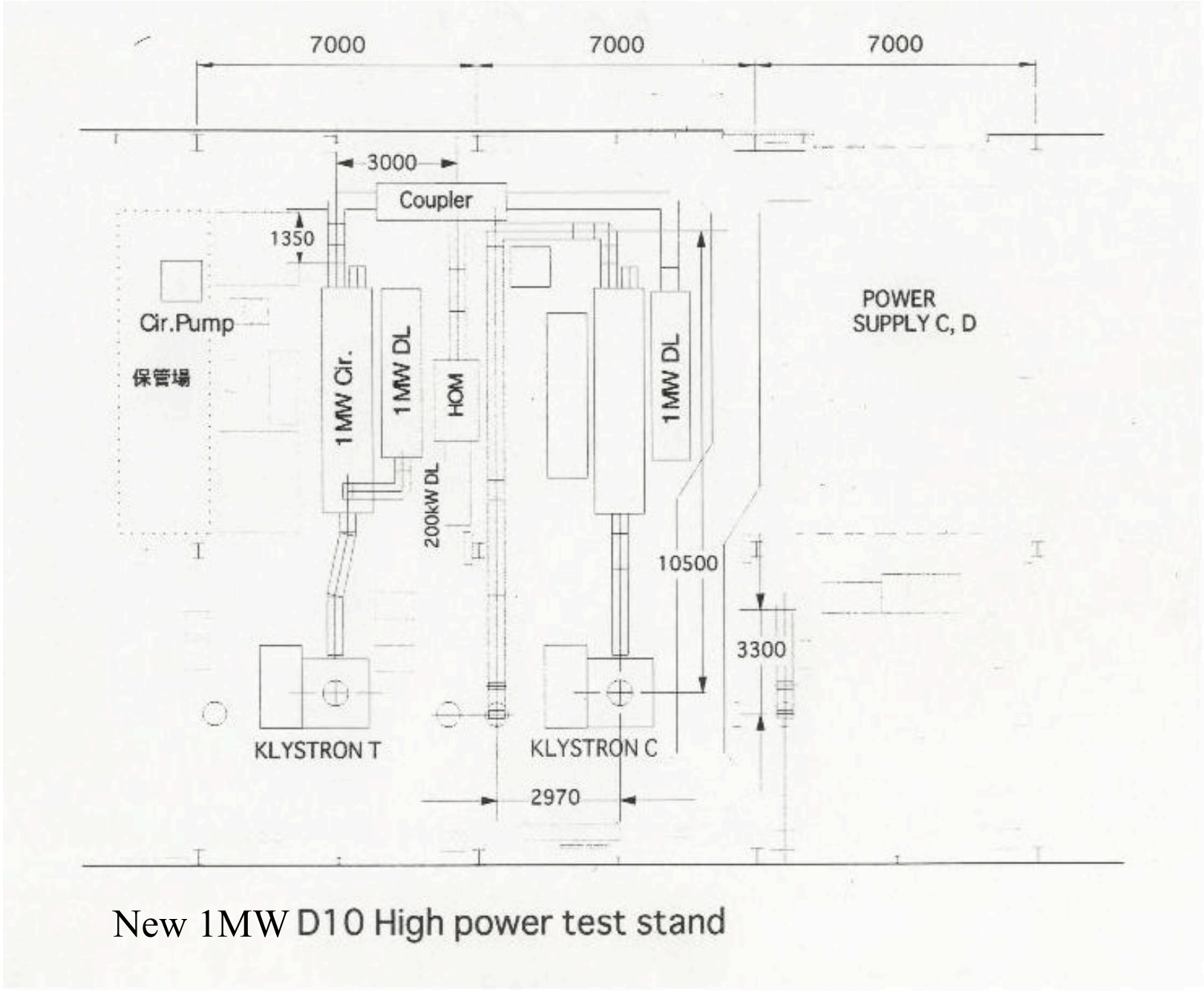
KEKB SC → Super-KEKB SC

- Cavity Field 1.4-2.0MV OK
- Input Coupler 380kw → 460kW OK(test)
- HOM Power 10 kW → 60kW to be solved
- Large Gate Valve D=220mm to be solved
- Add 4 Cavities
- Larger Sigma z should be studied

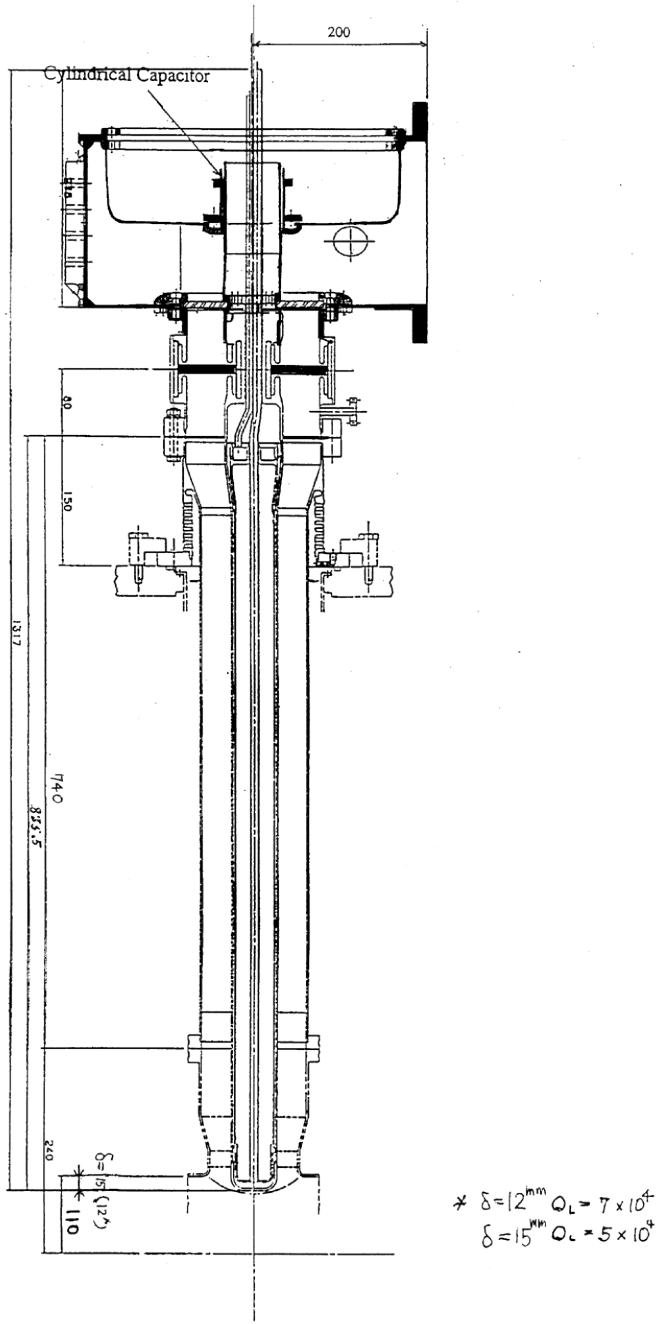
Dedicated 1 MW klystron system for coupler test bench

Testing high power coupler, at D10 area new 1MW klystron power supply and klystron system have been constructed.

One of limitation of high power operation for KEKB coupler is heating at capacitor for bias voltage. An air duct is added near this capacitor to increase cooling power. Couplers could operate more than 500 kW.



New 1MW D10 High power test stand

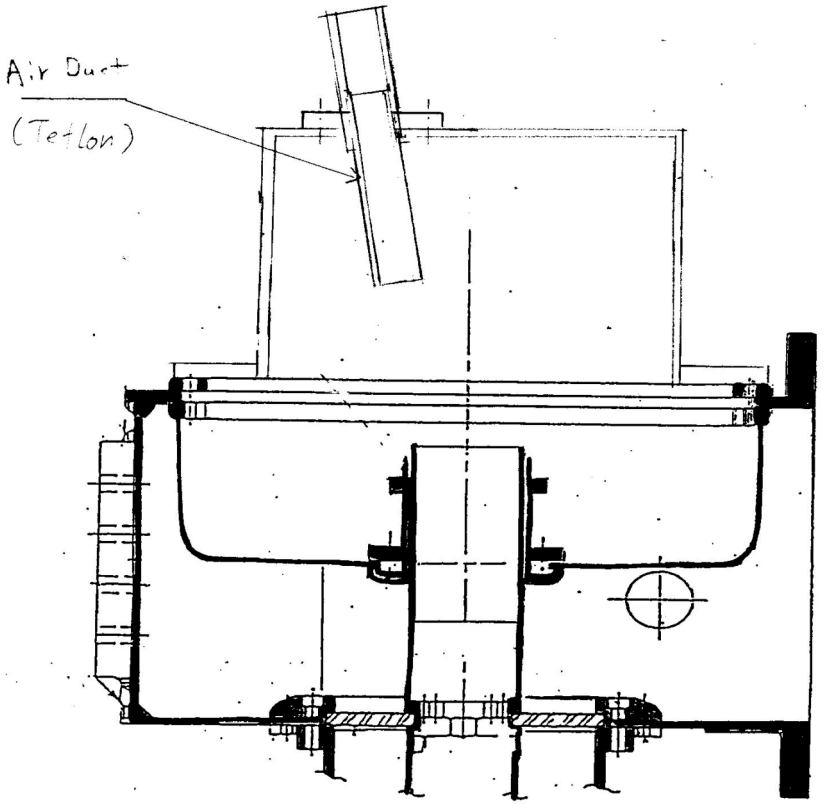


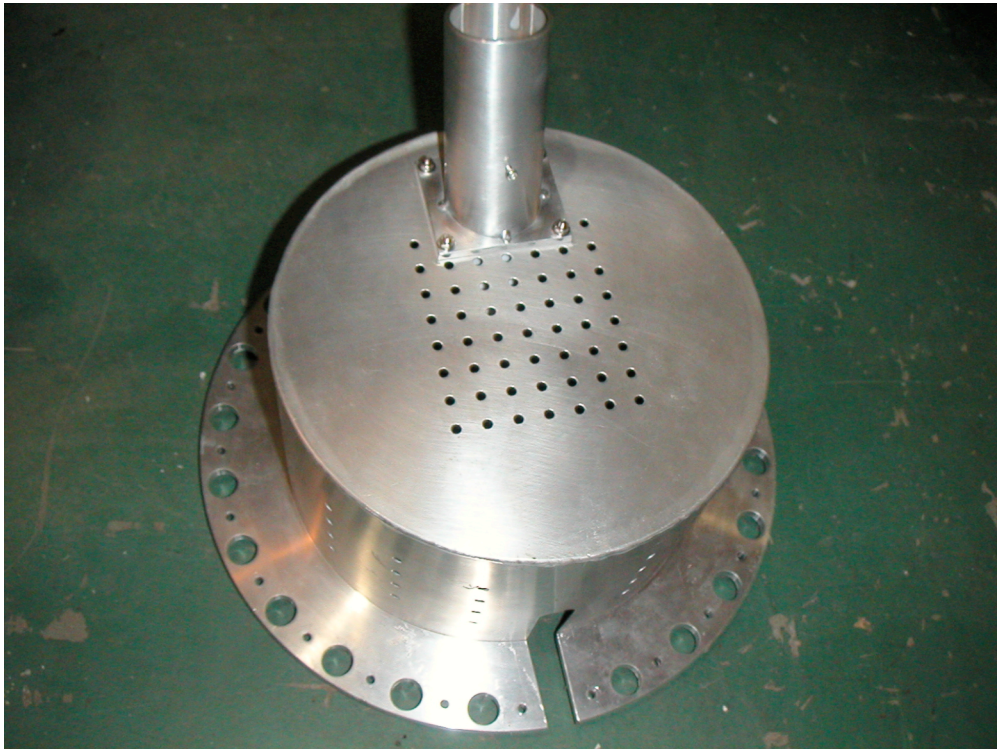
* $\delta = 12^{mm}$ $Q_L = 7 \times 10^4$
$\delta = 15^{mm}$ $Q_L = 5 \times 10^4$

High Power Input Coupler for KEKB SC Cavity

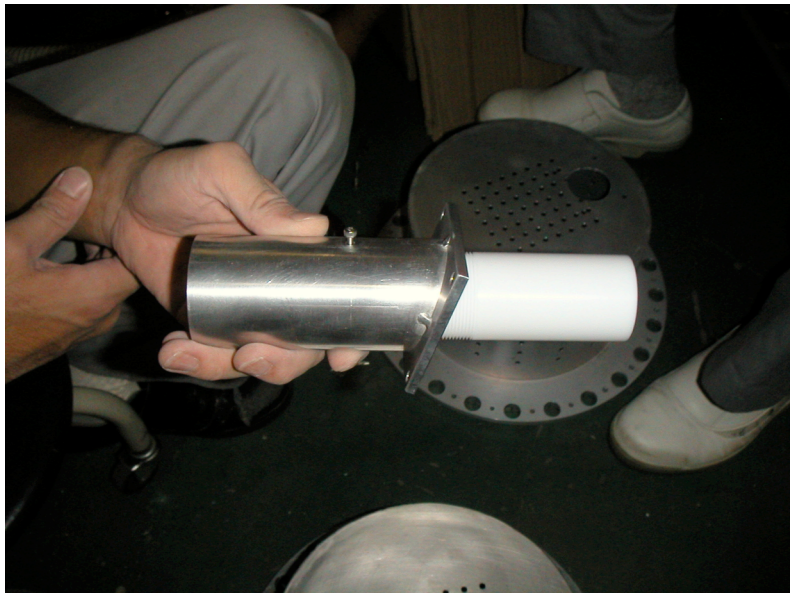
Biased Type Doorknob Transition for KEKB SC cavity
(with Air Duct)

500 kW

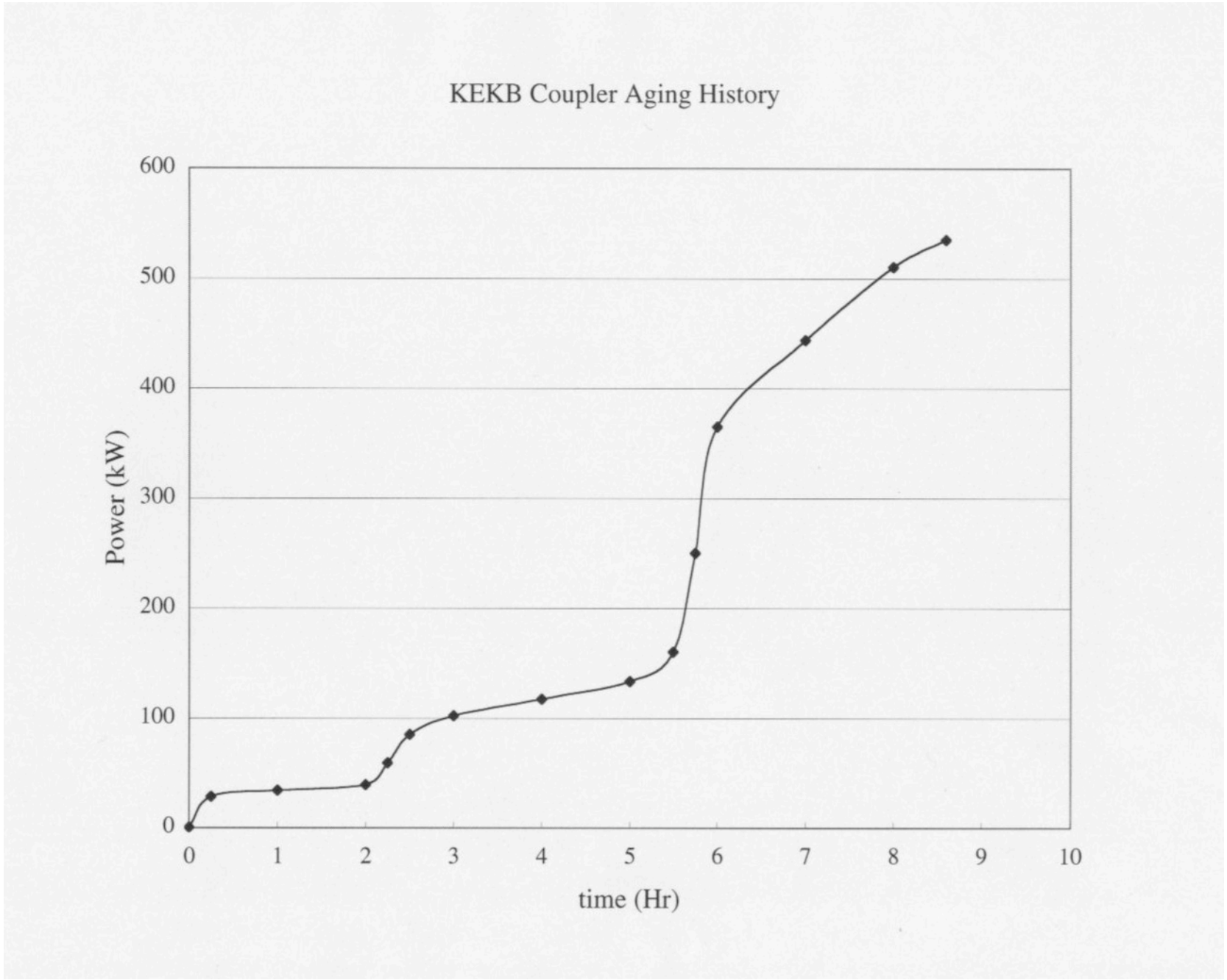


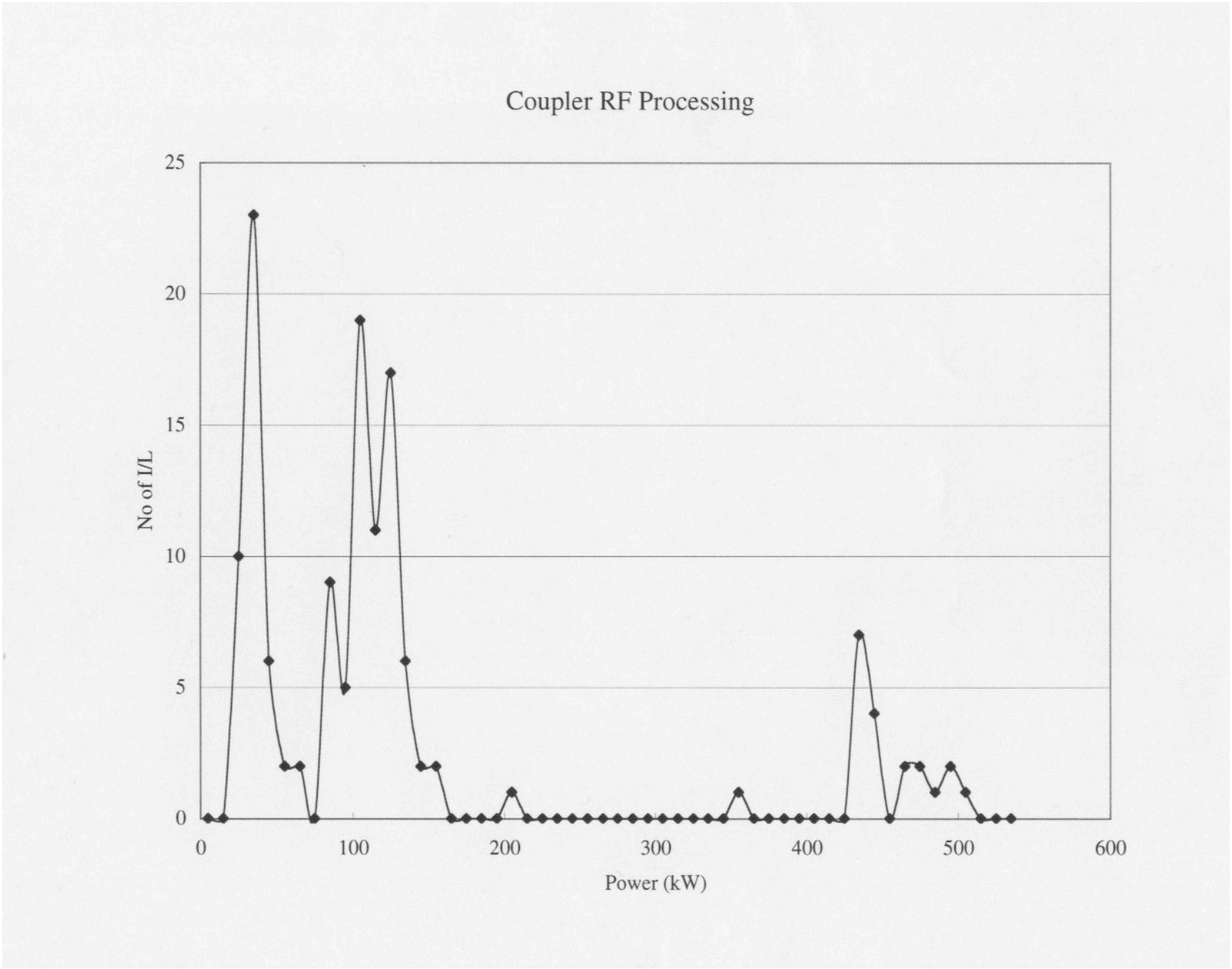


Cap of Doorknob



Air Duct

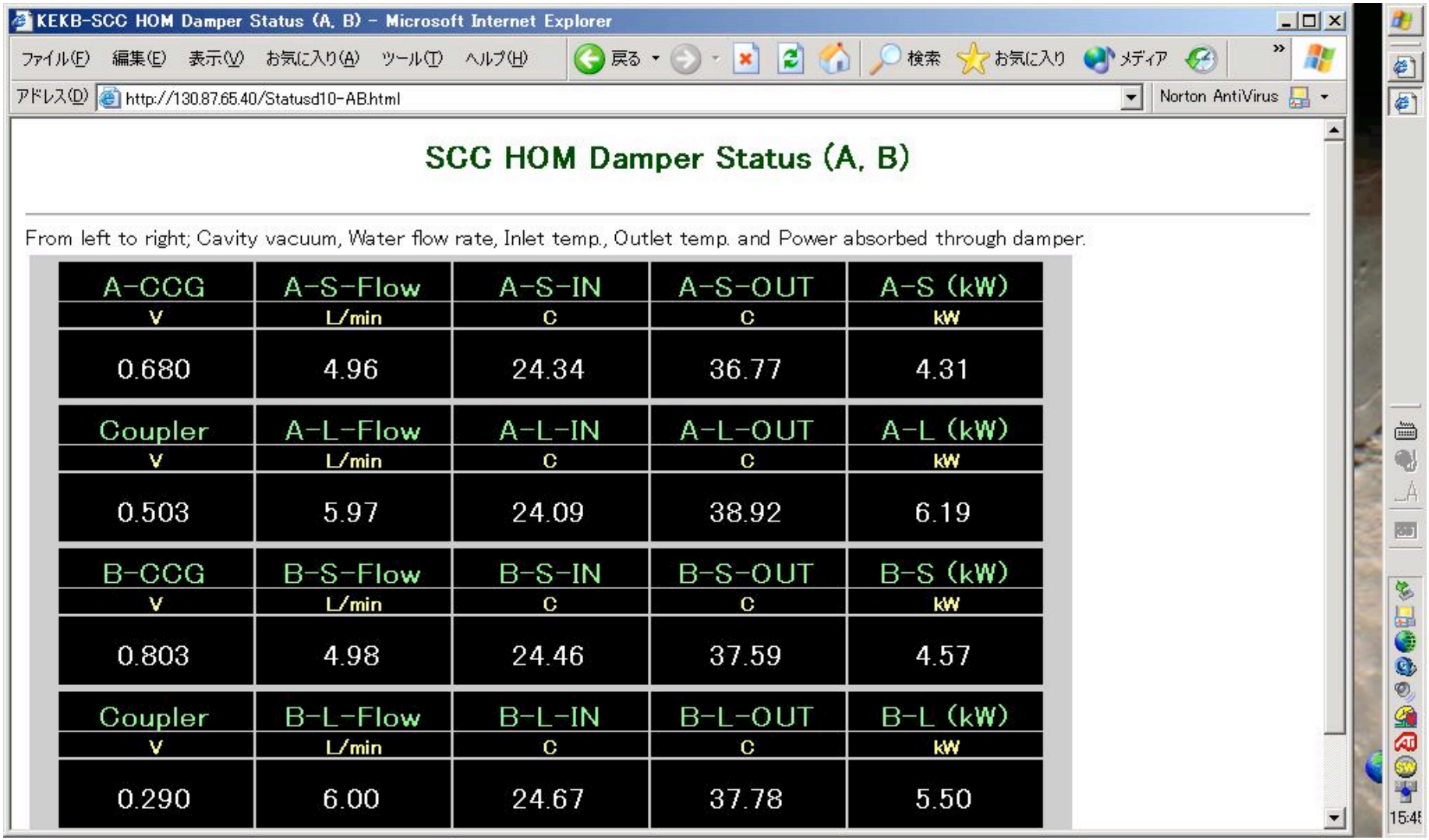

KEKB Coupler Aging History
Power (kW)
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
time (Hr)


Coupler RF Processing
No of I/L
25
20
15
10
5
0
0
100
200
300
400
500
600
Power (kW)

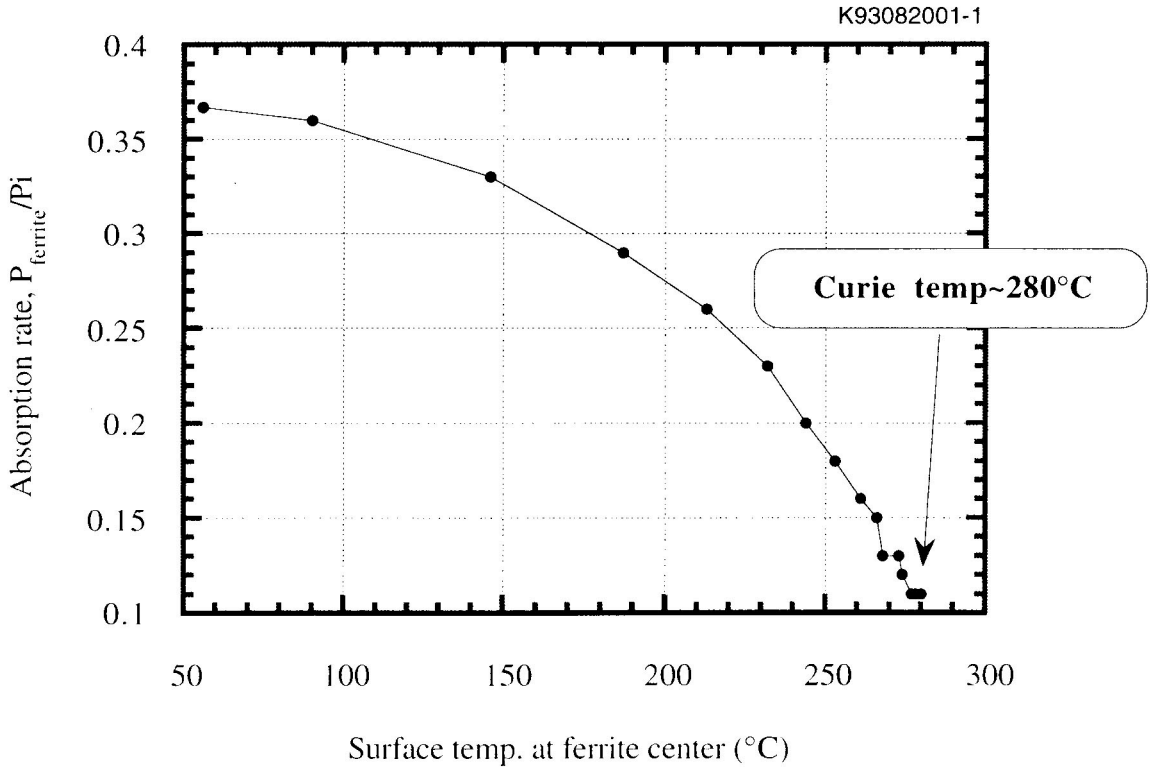
HOM Damper

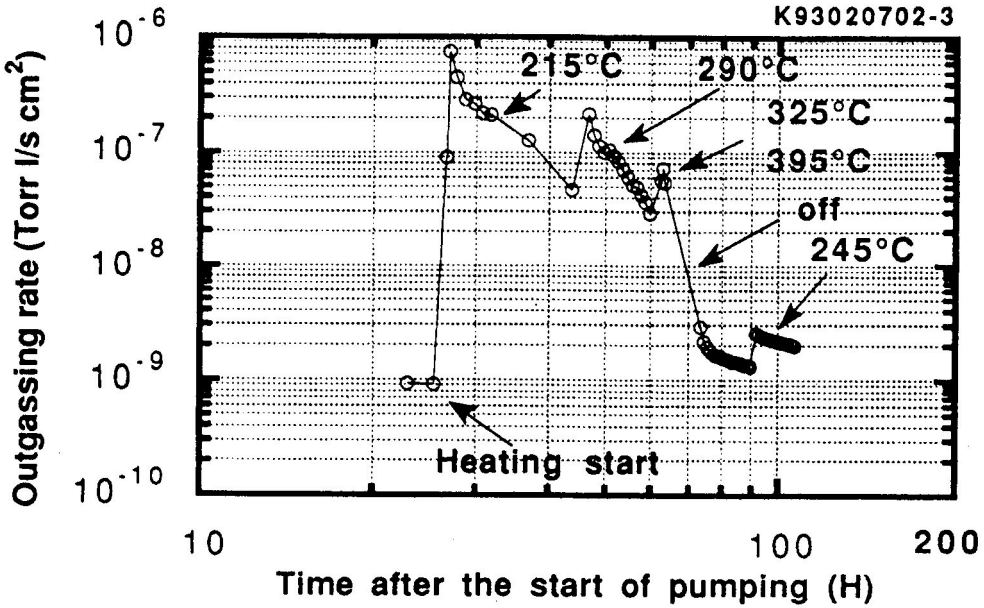
- Cooling limit (4.0m/sec) 60kW
- Inner Surface Temperature Limit 200 ℃
- KEKB 80kw with 4A at 3mm BL(2.5pC)
- D=220 mm Beam Pipe 56 kW(4A,3mm)
- KWKB could be operate (4A, 4MM, 1.8pC)

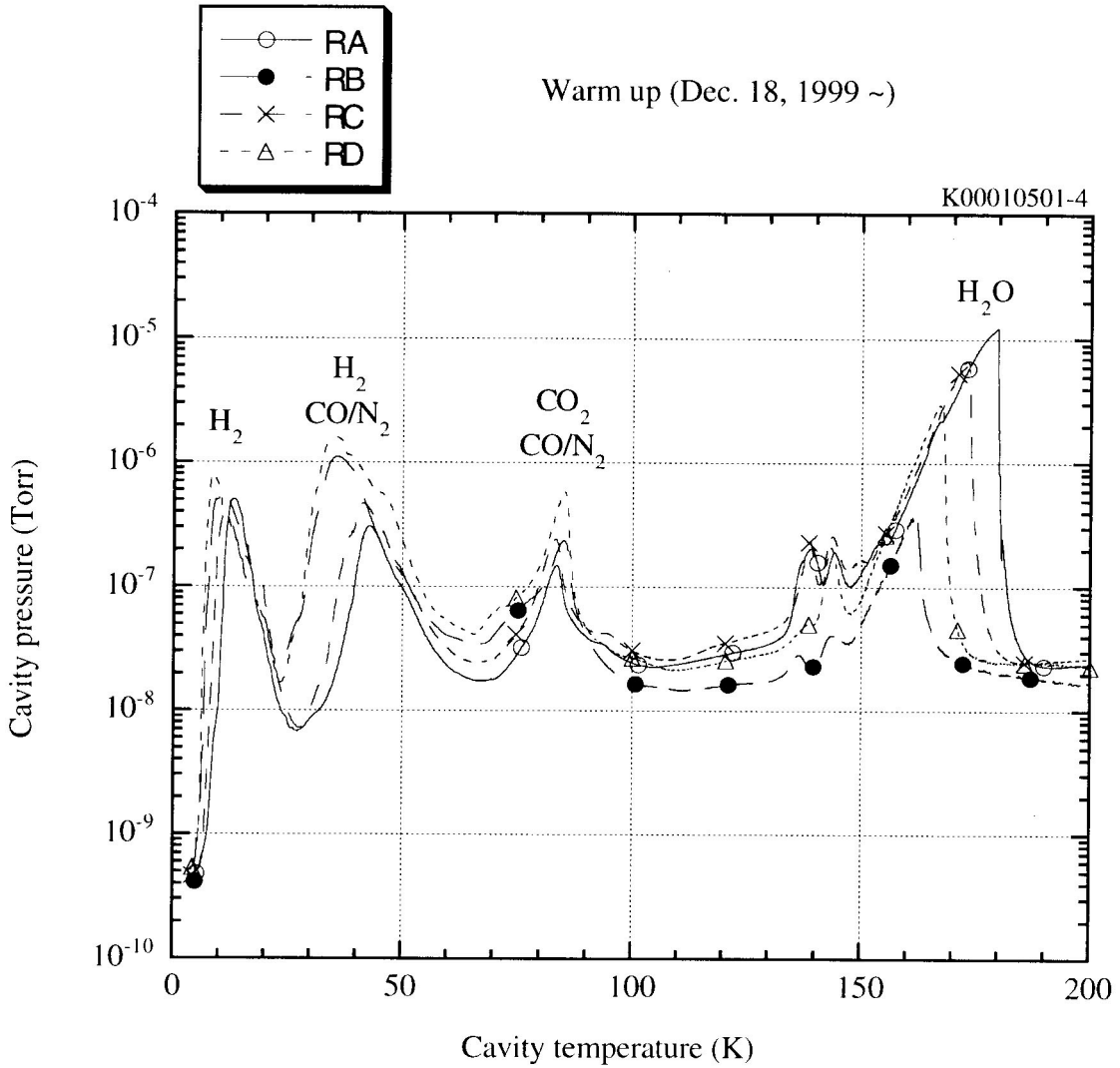
  $P=k(\sigma z)\cdot I^{**}2/frev/Nb$

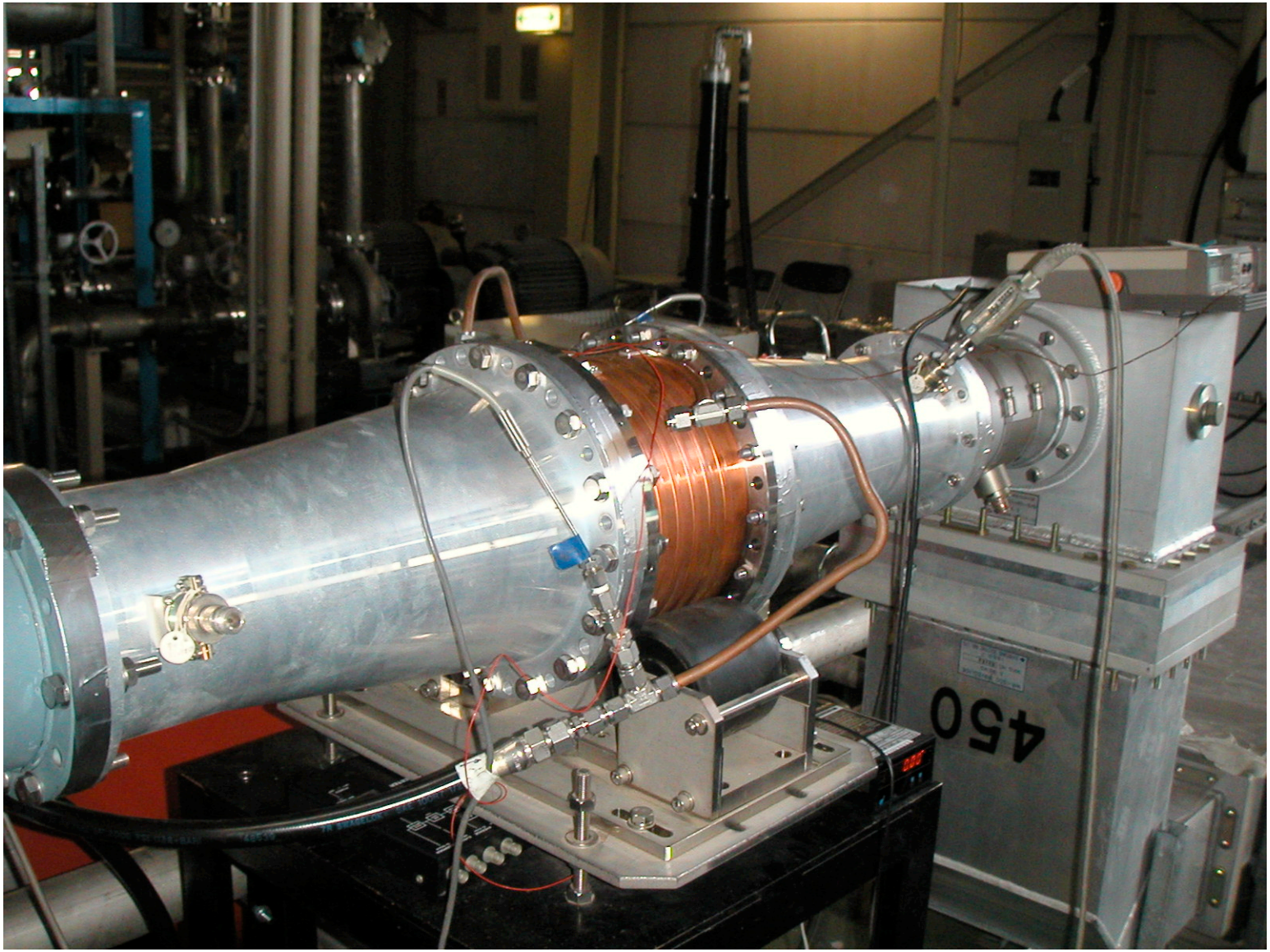


D10 HOM Power at 1.053A

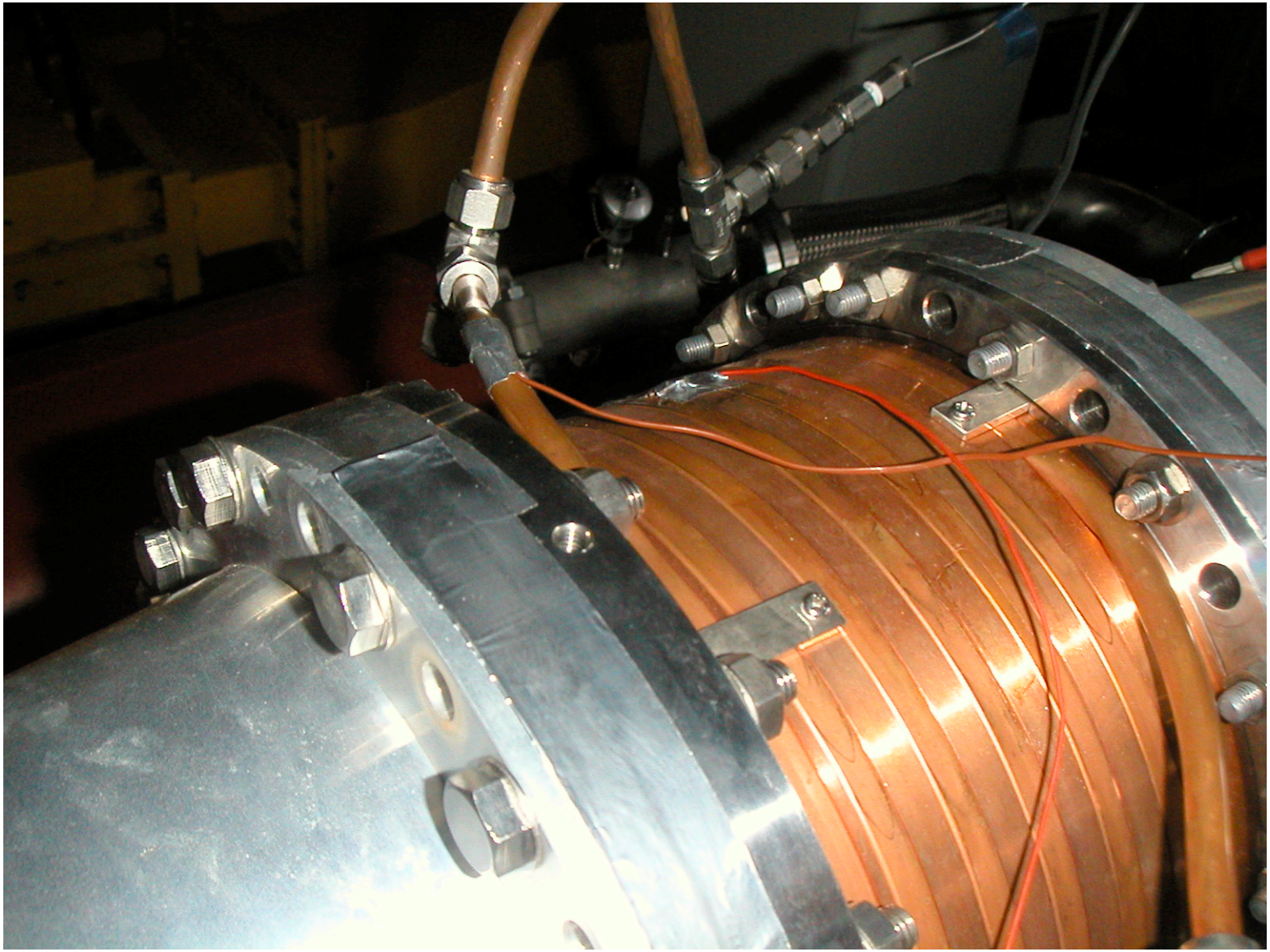

K93082001-1
0.4
0.35
0.3
0.25
0.2
0.15
0.1
Absorption rate, $P_{ferrite}/Pi$
Curie temp~280°C
50
100
150
200
250
300
Surface temp. at ferrite center (°C)


K93020702-3
Outgassing rate (Torr l/s cm^2)
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
215°C
290°C
325°C
395°C
off
245°C
Heating start
10
100
200
Time after the start of pumping (H)

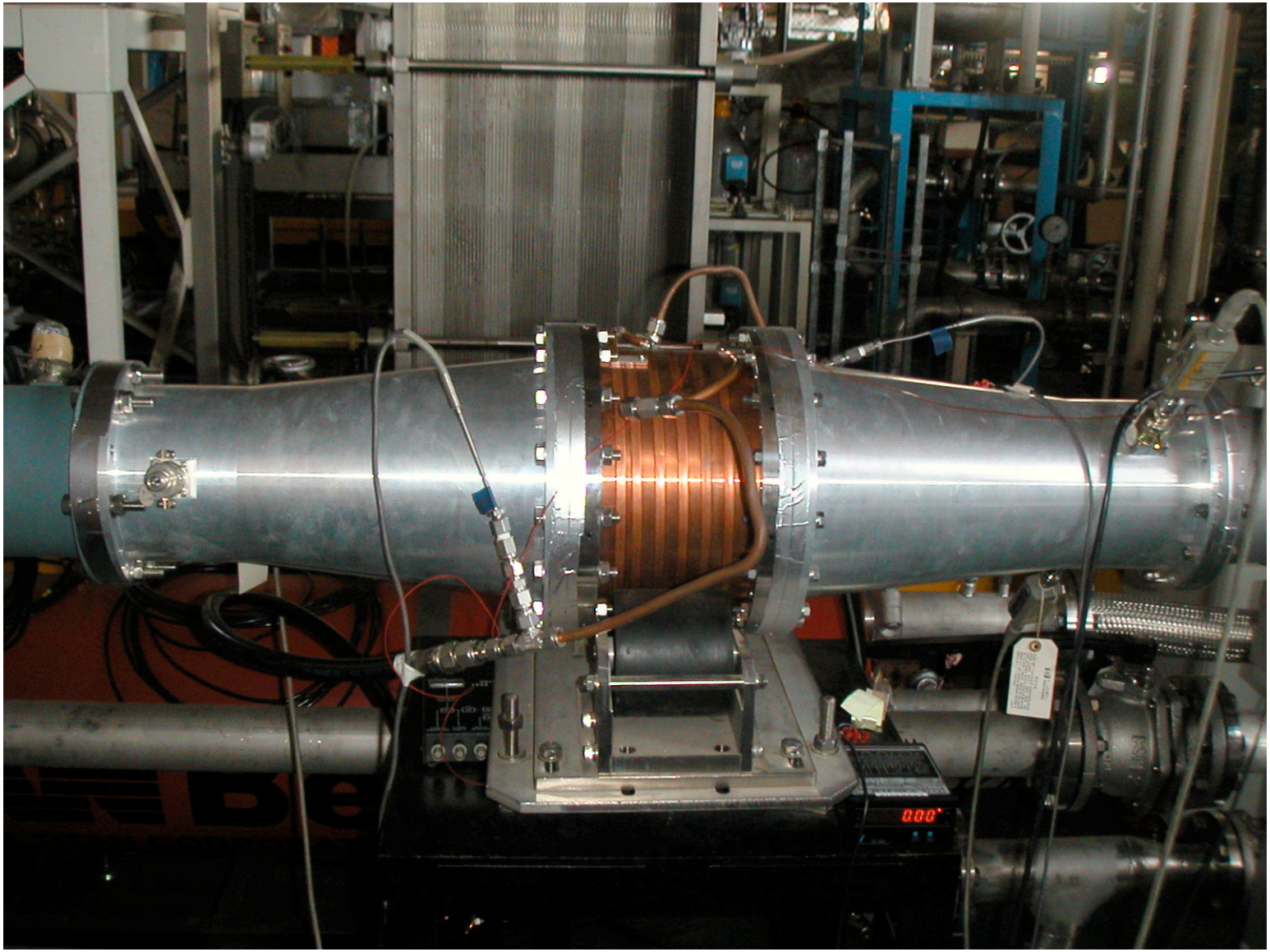

RA
RB
RC
RD
Warm up (Dec. 18, 1999 ~)
K00010501-4
Cavity pressure (Torr)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
H_2
H_2 CO/N_2
CO_2 CO/N_2
H_2O
0
50
100
150
200
Cavity temperature (K)



Layout of HOM damper test bench



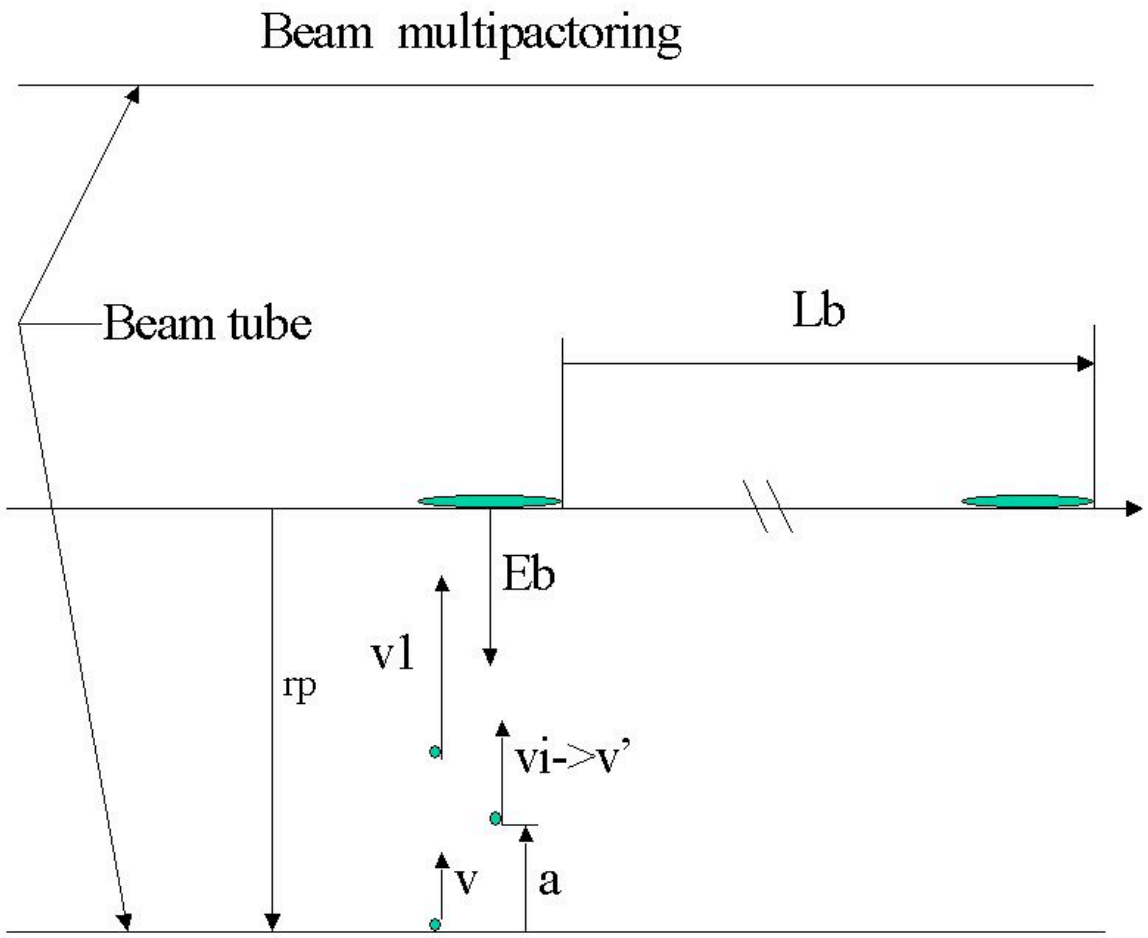
Acoustic monitor attached



A SBP HOM damper have been tested up to 5.8 kW .

Higher Order Beam Multipactoring and Single Side Beam Multipactoring

- High current application of superconducting cavity, some electron energy depositions affect to not only cavity performance but also cryogenic load of refrigerators. The threshold current formula for tow sides beam multipactoring derived by O. Grobner is easily extended to higher order beam multipactoring and single side beam multipactoring. Estimations of the threshold current of positive and negative charge beams in the field free beam tube are given for high current application or small bore beam tube application such as KEKB and TESLA.


Beam multipactoring
Beam tube
Lb
Eb
v1
rp
vi->v'
v
a

Higher Order Beam Multipactoring

- Second order beam multipactoring
-
- Nb2nd= (1-1/2**0.5)rp2 /re/Lb
- ~ 0.292 Nb1st ~1/3 Nb1st
- For KEKB LER or positron for HER
- LER beam pipe and coaxial HOM damper of Crabcavity 2.5 A ($Nb_{LER}=1.3x10^{11}$)
- rp= 0.05 m
- Lb= 2.4 m
- Nb1st=$3.6x10^{11}$ > Nb_{LER}
- Nb2nd= $1.05x10^{11}$ < Nb_{LER}
- KEKB HER positron case for SCC (Charge switching)
- rp =0.105
- Np2nd= $4.7x10^{11}$ > $5.72x10^{10}$ (1.1A)

Single side multipactoring

- For secondary electron yield higher than one and finite initial velocity
- Nb=rp*lrp+-al/2*re*Lb
- a : vi*Lb/c
- vi : initial velocity of secondary electron(~5eV)
- \+ : positive charge beam
- \- : negative charge beam
- a < 2*rp
-

- For KEKB superconducting cavity
- rp= 0.105 m
- Lb= 2.4 m
- a= 0.0104 m
- re=2.82×10^{-15} m
- Nb= $0.105(0.105-0.0104)/re/2.4/2=7.3 \times 10^{11}$
- $>5.73 \times 10^{10}$ (1.1 A)
- ***No single side multipactoring for KEKB SC.***

Summary

- KEKB SC will be used with small modification for Super-KEKB.
- Coupler already tested more than 500kW(800kW in short time),beam test will be done.
- HOM damper is most important issue for Super-KEKB SC.
- If possible 4mm bunch length is help full reducing HOM problems and saving cost. This option is important for increasing integral luminosity before completion of super-KEKB.