TDR Part 1:
3.4 Cavity Integration (15pages)

Write-up is not yet started, but plans are presented.

H. Hayano

Write-up contents will be;

(1) Tuner R&D

- Blade tuner development (INFN papers)
- detail description of S1-Global tuner studies (from S1-G report)

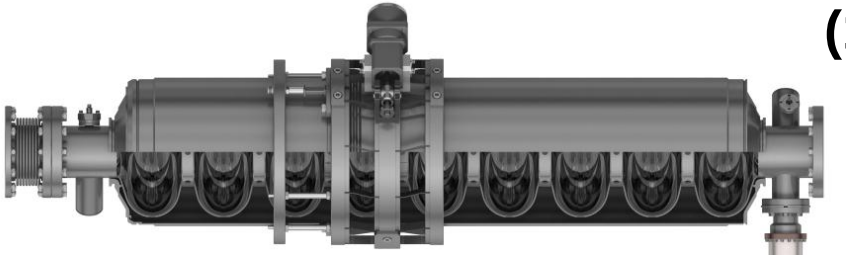
(2) Coupler R&D

- XFEL coupler development (DESY papers)
- KEK coupler development (KEK papers)
- detail description of S1-Global tuner studies (from S1-G report)

(3) Magnetic shield R&D

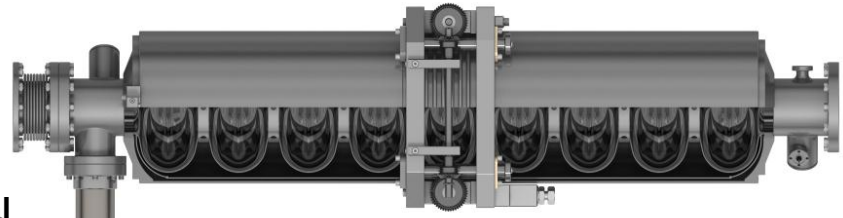
- KEK magnetic shield test (KEK papers)

(1) Tuner



FNAL cavity

at S1-Global



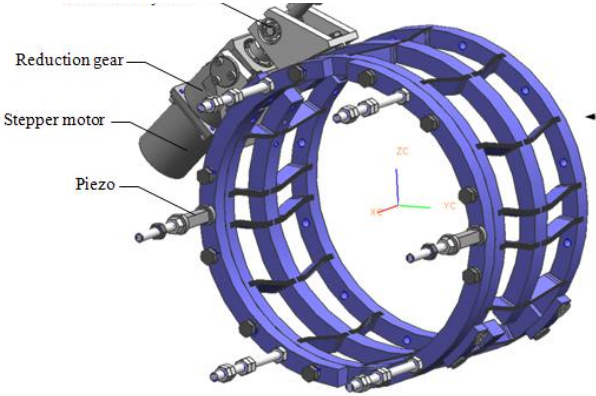
KEK-type1 cavity

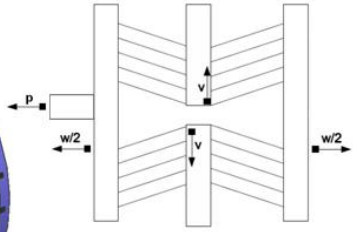
Blade tuner

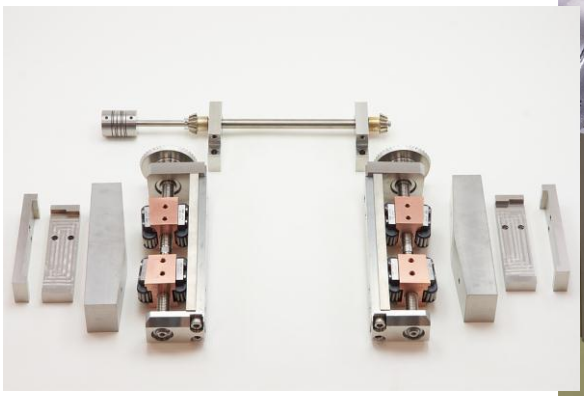
TTF-III coupler

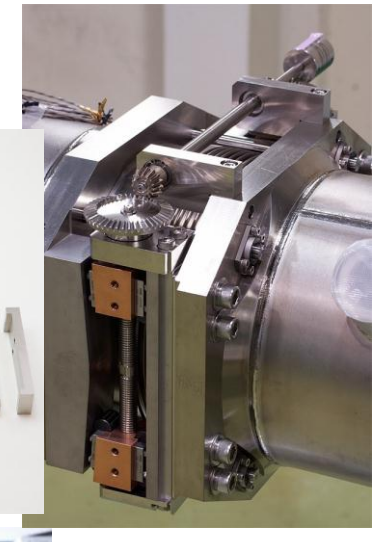
Slide-jack tuner

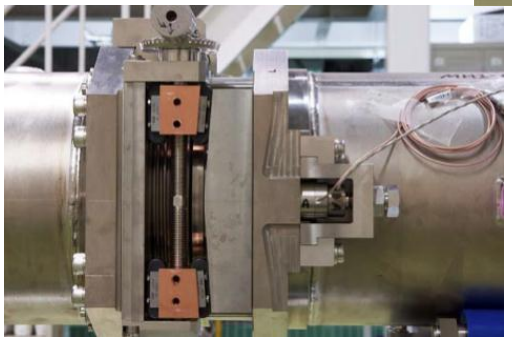
KEK coupler







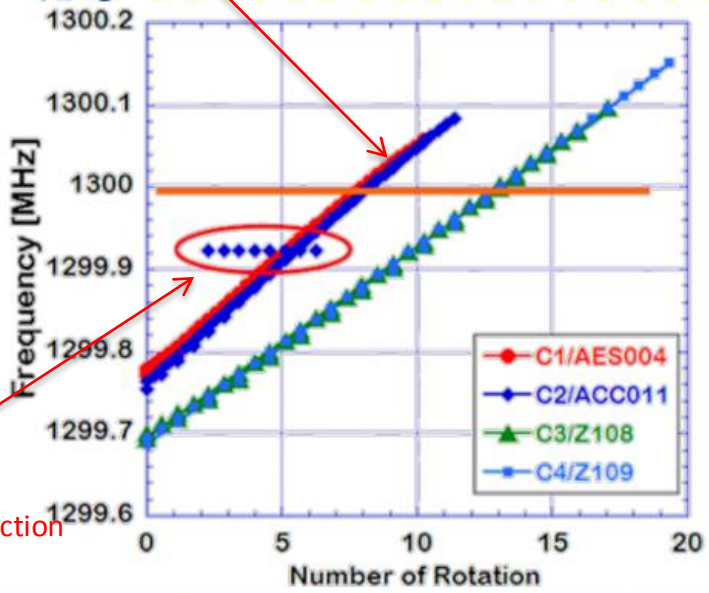


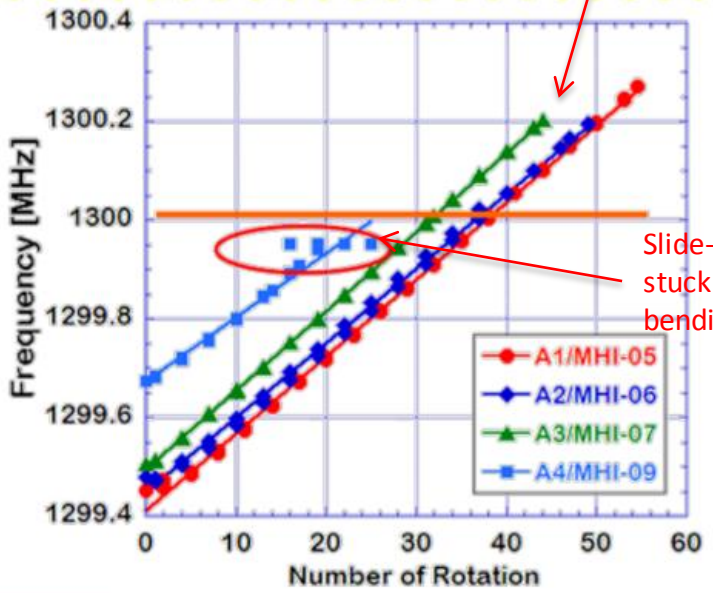


blade tuner

Slide-jack tuner

Static tuning range at cold





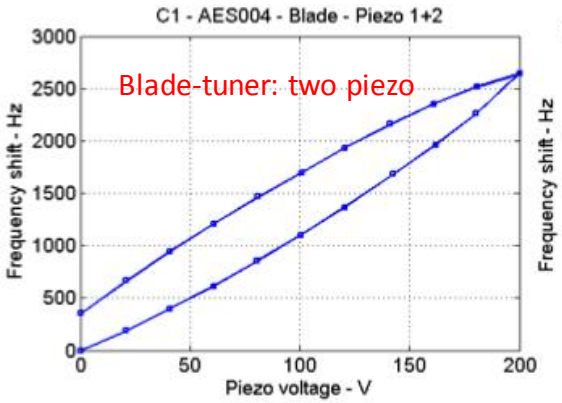
Blade tuner:
slip on gear connection

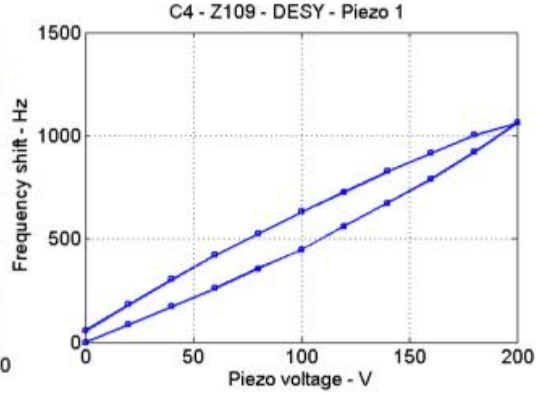
Slide-jack tuner:
stuck by slide-slope bending

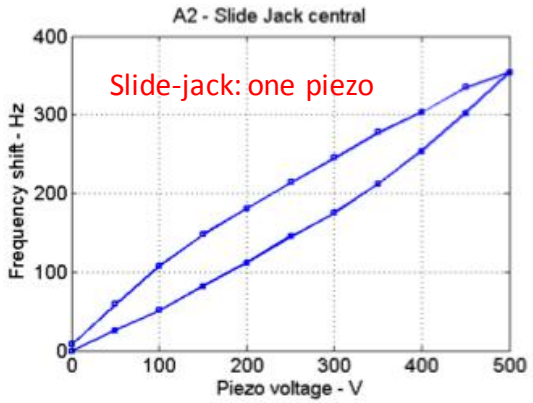
	Blade Tuner (C2)	DESY tuner (C4)	Slide-Jack tuner (A1)
Coarse tuning range measured (expected value)	330 kHz 12/22 turns (600 kHz)	450 kHz 19/23 turns (500 kHz)	800 kHz 54/60 turns (900 kHz)
Tuning sensitivity at 1.3 GHz (expected value)	25 kHz/spindle turn	20 kHz/spindle turn	15 kHz/spindle turn
	1.4 Hz/step (1.5 Hz/step)	1.1 Hz/step (1 Hz/step)	3 Hz/step (3 Hz/step)

- Issue with Blade Tuner in cavity C2:
  - **during the second cycle the frequency resulted to be stacked at 1299.92 MHz.**
- Issue with Slide-Jack Tuner in A4:
  - **Failure in the driving shaft joint and frequency stacked at 1299.95 MHz.**
- Under investigation …

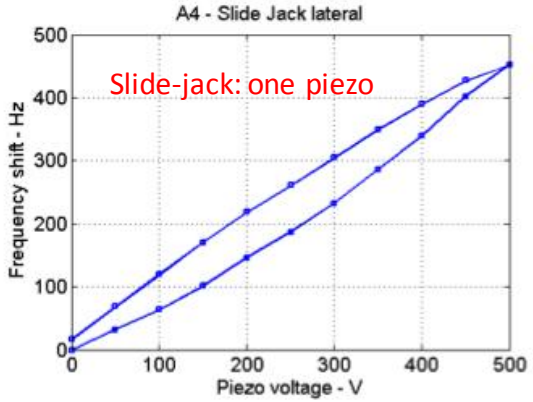
Selection of piezo DC response curves





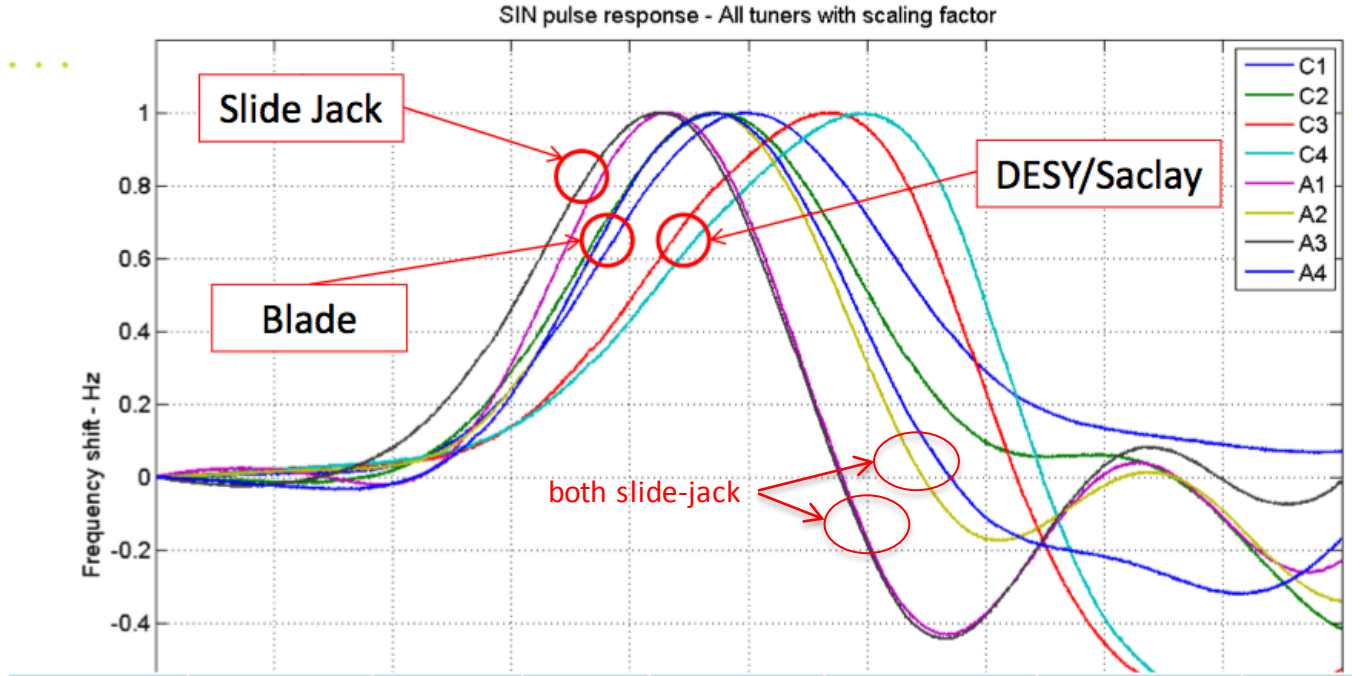


Cavity	Maximum nominal piezo voltage [V]	Piezo configuration	Maximum applied voltage [V]	Frequency shift [Hz]
C1-Blade	200	1+2	200	2650
C2-Blade	200	1	200	610
C3-DESY	200	2	200	1010
C4-DESY	200	1	200	1060
A1-S.J cent.	1000	-	500	190
A2-S.J cent.	1000	-	500	350
A3-S.J lat.	1000	-	500	210
A4-S.J lat.	1000	-	500	450



variation within Slide-jack

Half-sine-wave pulse response



Cavity-Tuner	Max. piezo voltage [V]	Load C at 2 K [μF]	Piezo Config.	SIN pulse amp. [V]	Max. Freq. shift in 1 ms [Hz]	Best lead from pulse start [ms]	Dyn. over Static detuning ratio
C1-Blade	200	4.1	1+2	135	1040	1.31	0.6
C2-Blade	200	3.9	1+2	100	590	1.24	1
C3-DESY	200	2.0	2	180	1100	1.58	1.2
C4-DESY	200	1.9	1	170	1170	1.64	1.3
A1-S.J cent.	1000	0.19	-	470	270	1.10	1.5
A2-S.J cent.	1000	0.21	-	470	450	1.26	1.4
A3-S.J lat.	1000	0.20	-	470	270	1.03	1.3
A4-S.J lat.	1000	0.21	-	470	450	1.22	1.1

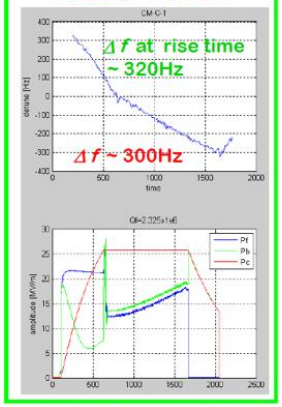
Lorentz Force Detuning Compensation

KEK Piezo Control System

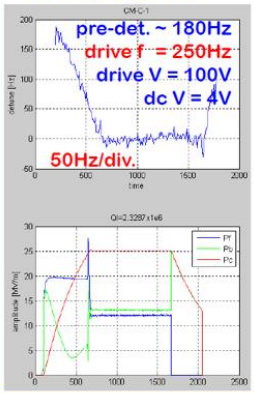
Selected material from a review of system and results from Eiji Kako (KEK)

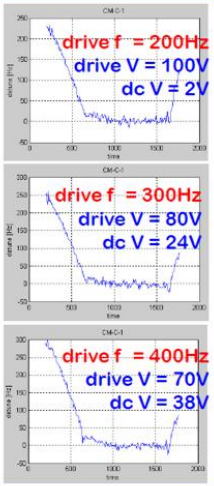
Compensation of Lorentz detuning (C1)

C1/AES004
25.6 MV/m
FB/on, Piezo/off



C1/AES004 (Blade Tuner)
25.6 MV/m
FB/on, Piezo/on





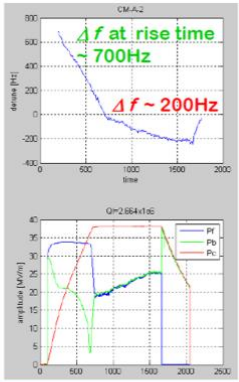
Blade-tuner at 25.6MV/m

KEK Piezo Control System

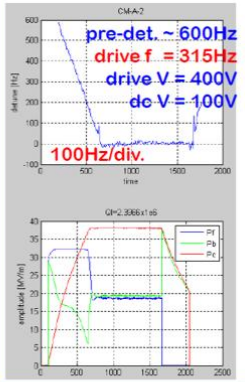
Selected material from a review of system and results from Eiji Kako (KEK)

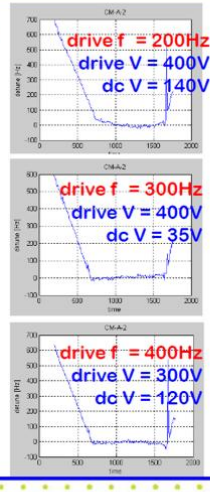
Compensation of Lorentz detuning (A2)

A2/MHI-06
38 MV/m
FB/on, Piezo/off



A2/MHI-06 (Slide Jack)
38 MV/m
FB/on, Piezo/on

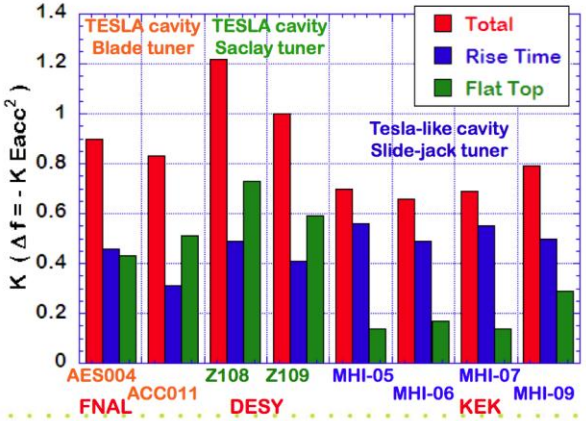




Slide-jack-tuner at 38MV/m

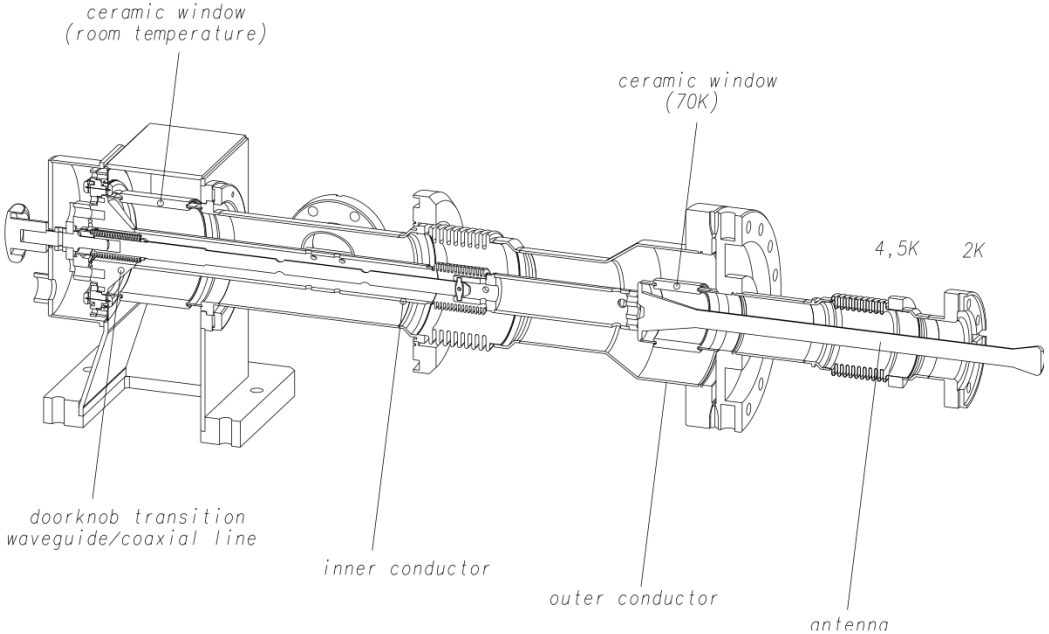
LFD coefficient: k

Comparison of Detuning Frequency by LFD

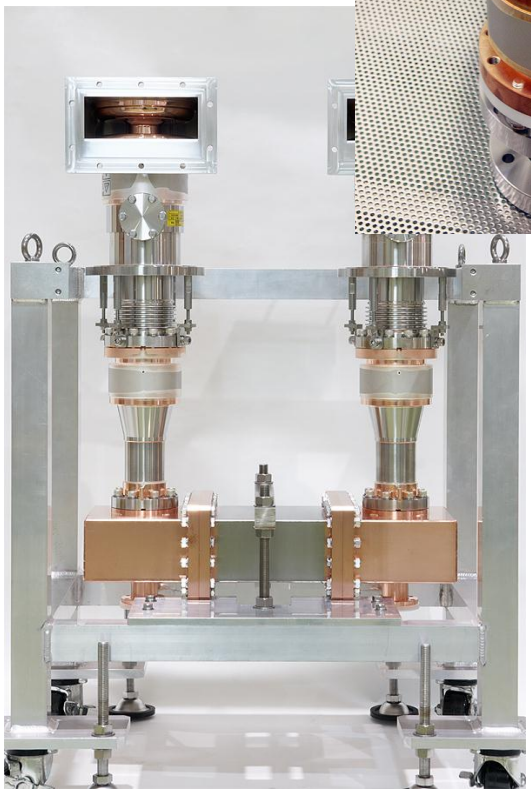


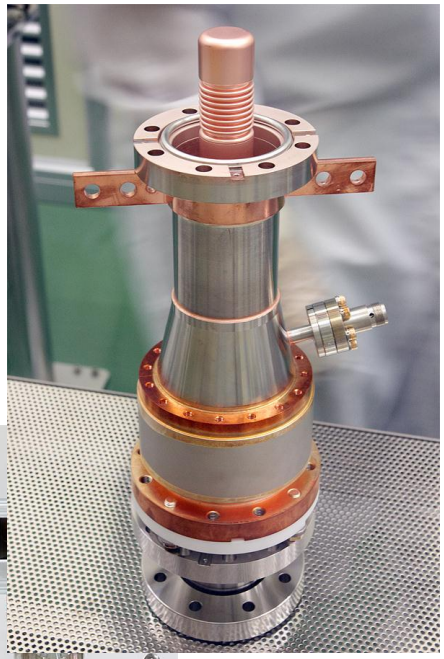
(2) Coupler

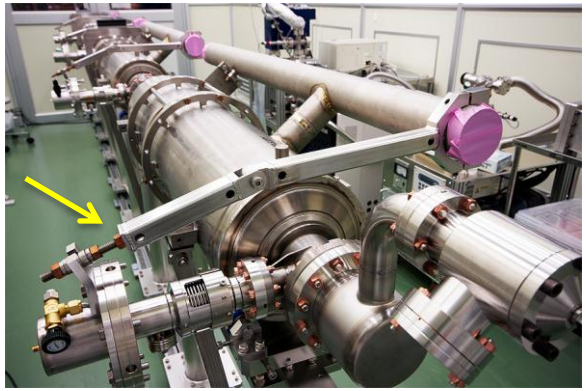
TTF-III Coupler

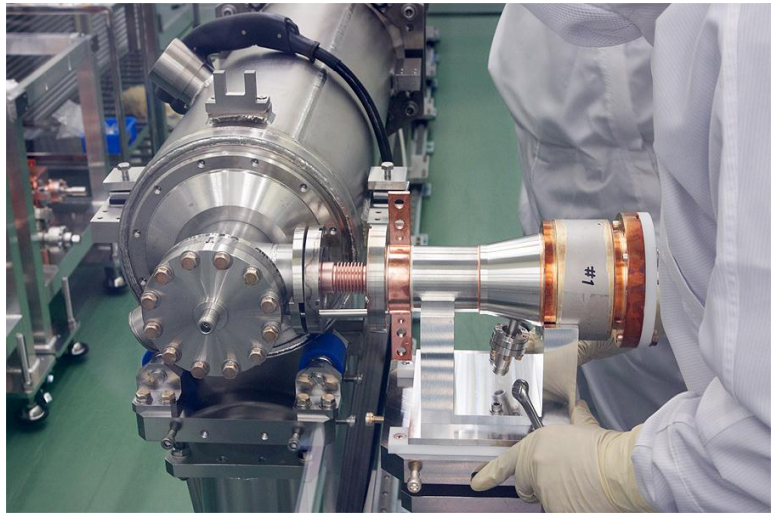


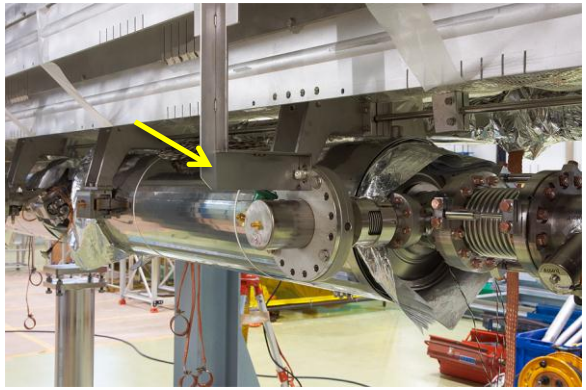
KEK STF Coupler



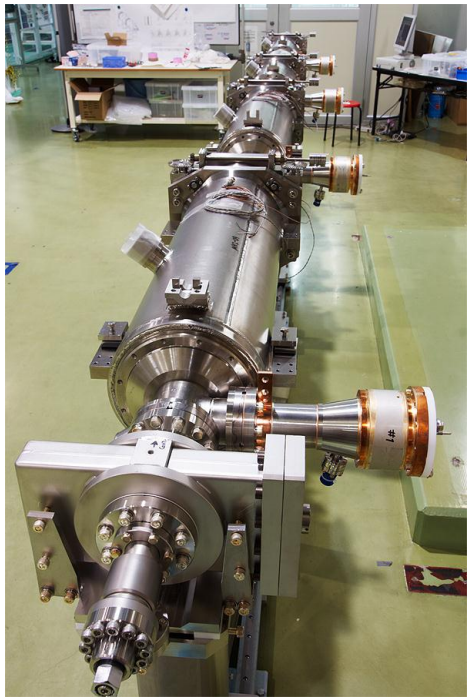


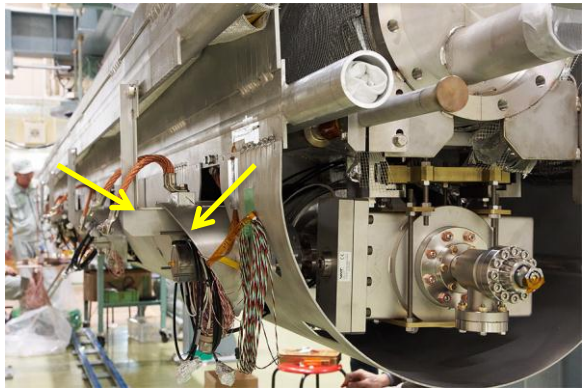


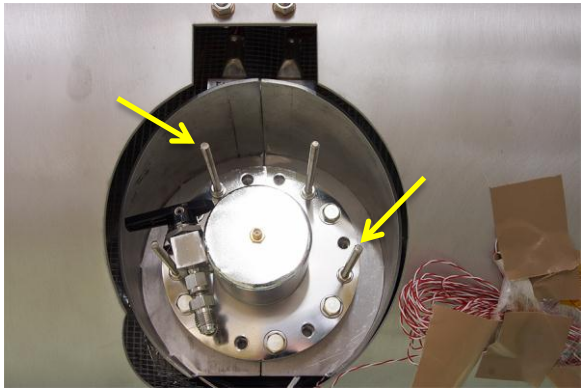




coupler assembly





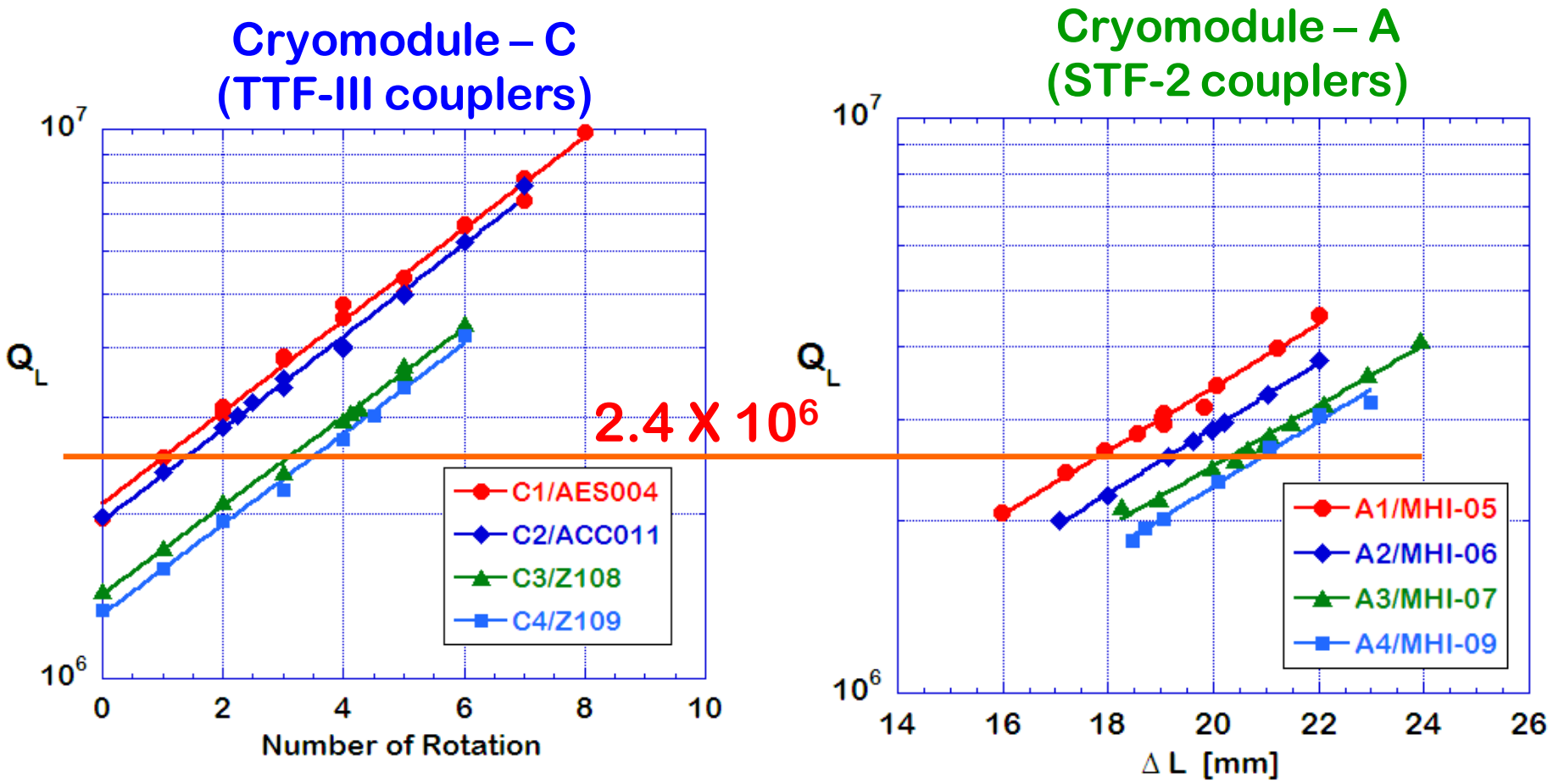


TTF-III Coupler: various support jigs are required.

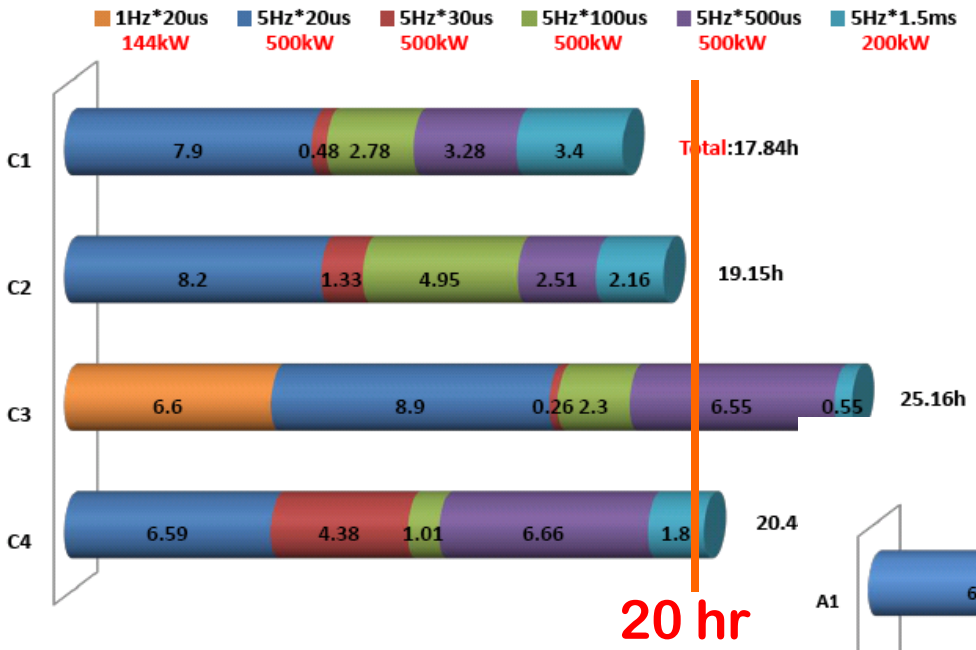
KEK STF Coupler:self standing

Q_L of Variable Input Coupler

$$Q_L = 2.4 \times 10^6 \qquad \Delta f_{bw} = 542\ \mathrm{Hz}$$



RF Processing Time of Input Couplers



at room temperature

Cryomodule-A (STF-2 couplers)

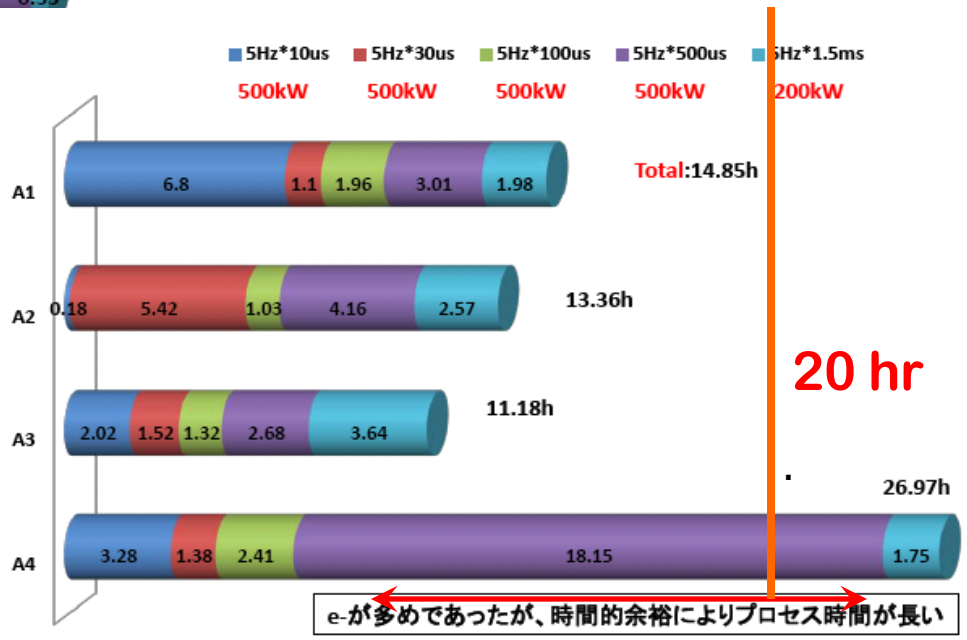
ave. processing time

~ 13 hours

Cryomodule-C (TTF-III couplers)

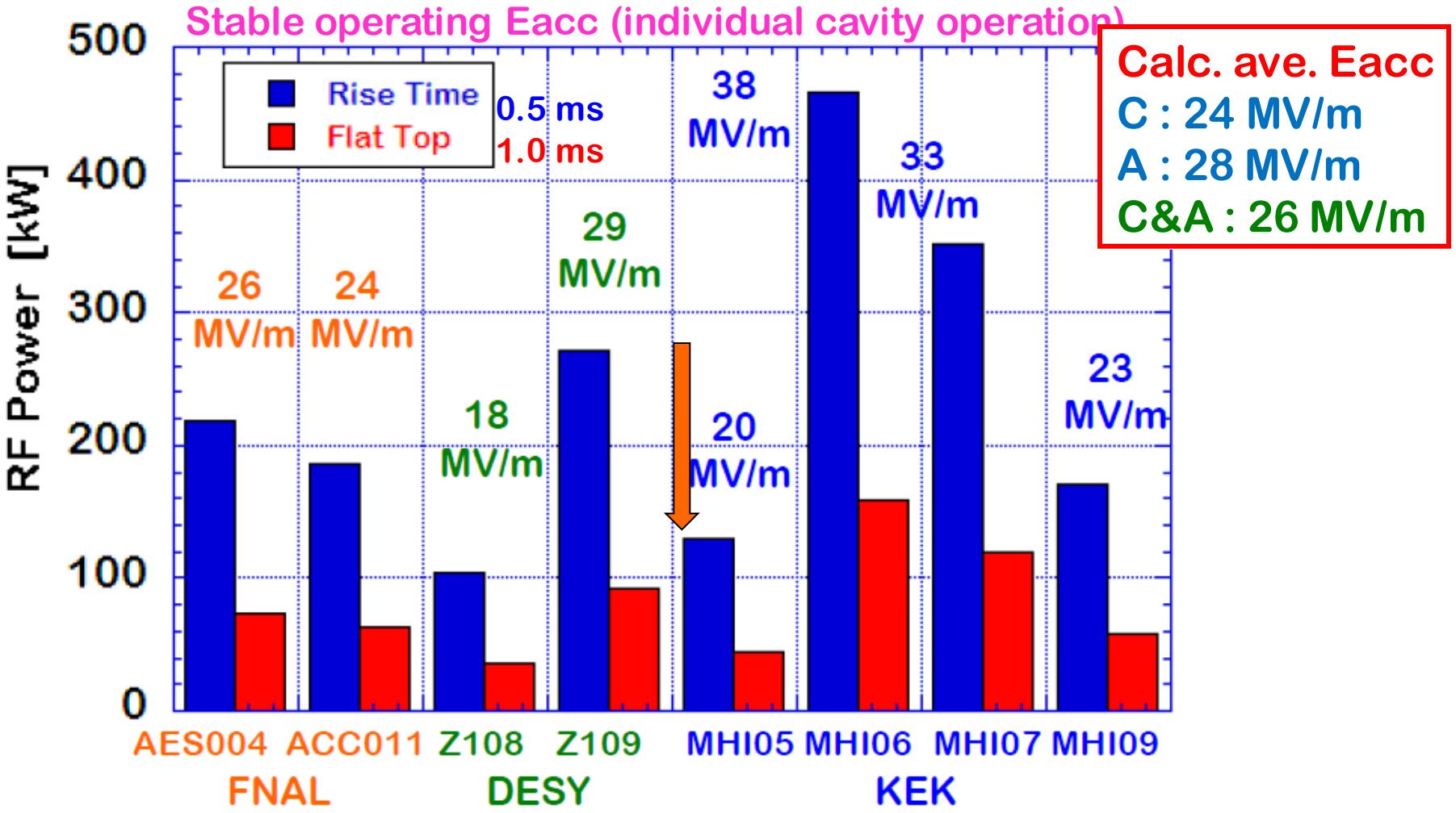
ave. processing time

~ 21 hours



Vacuum I/L ; $2.x10^{-4}$ Pa

Operational RF power level for 8-cavity operat



After warm-up to an intermediate temperature due to the trouble of cryogenic system, deterioration o
vacuum pressure was suddenly occurred in A1 coupler, and operational RF power level was reduced

coupler heat-loss measurement at S1-G

from N. Ohuchi, et al "Thermal performance of the S1-Global cryomodule for ILC", IPAC11

Static loss

	compornent	module-A(KEK) design	module-C (TTF-III) design
2K	4 couplers	0.29 W	0.08 W
	tuner drive shafts	0.48 W	N.A.
5K	4 couplers	4.00 W	0.92 W
80K	4 couplers	9.60 W	7.28 W

Table 3: Measured Static Heat Load

	Module-A	Module-C
2K	7.2 W [6.8 W]	
5K	7.3 W [7.2 W]	5.3 W [4.1 W]
80K	48.7 W [44.3 W]	34.4 W [35.3 W]

static loss : KEK couplers > TTF-III couplers

Dynamic loss

Table 6: Dynamic Loss at Four and Seven Cavities

	MC 4 cav.	MC 4 cav.	MA 4 cav.	MA 4 cav.	MC-MA 7 cav.
G_{ave}, MV/m	20 (average)	32 (detune)	26.9 (average)	32 (detune)	25.4 (average)
Q_D, W	2.7	NA	6.9	NA	9.6
$Q_{D\text{-}det}$, W	0.2	0.5	2.5	4.6	2.6
$Q_{D\text{-}cav}$, W	2.5	NA	4.4	NA	7.0

MC: module-C
(DESY, FNAL cavities)

MA: module-A
(KEK cavities)

KEK couplers

TTF-III couplers

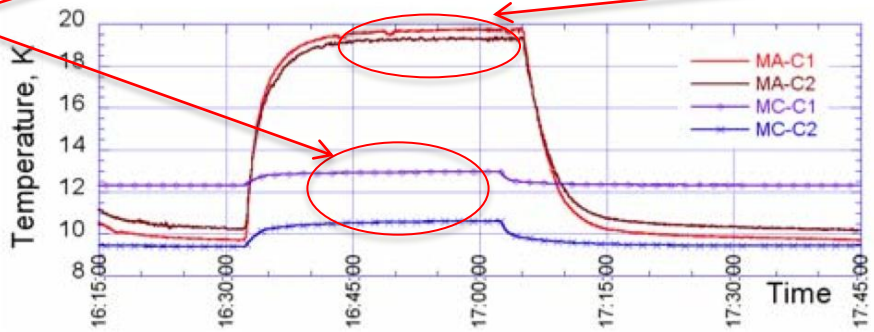


Fig.7: Temperature changes of the connection flanges of input couplers at detuned 32 MV/m. MA-C1 and C2: STF-2 couplers, MC-C1 and C2: TTF-III couplers.

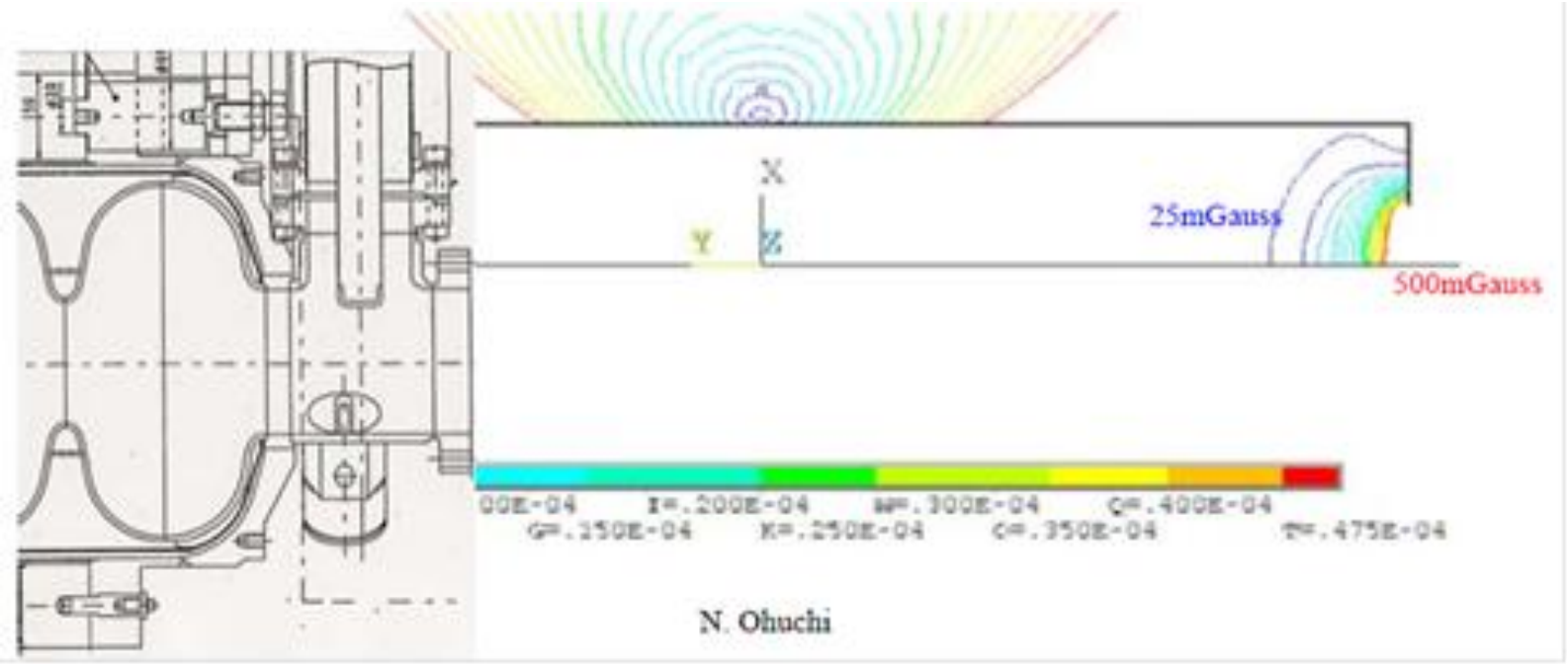
Dynamic loss :
KEK couplers > TTF-III couplers

(3) Magnetic shield

Magnetic Shields of KEK Cavities

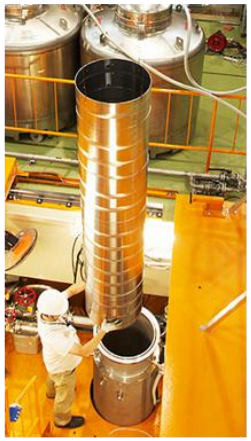
4 Components per 1 KEK Cavity

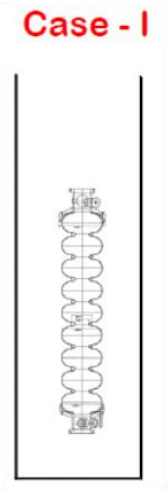
Calculation of Magnetic Fields in KEK Cavity



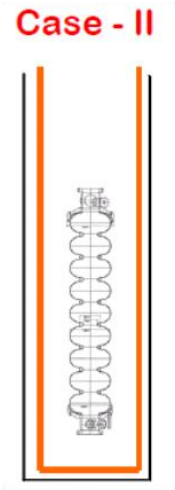
by N. Ohuchi (KEK)

Tests of Magnetic Fields in KEK Cavity (1)

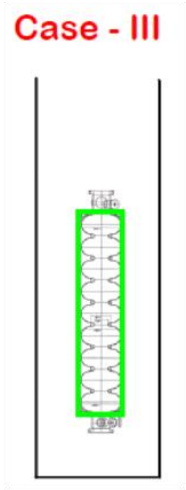




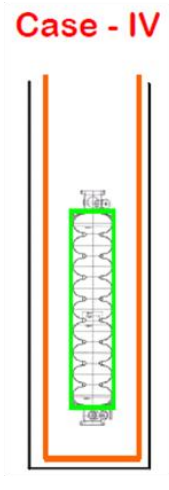
no
mag. shield



Cryostat
mag. shield

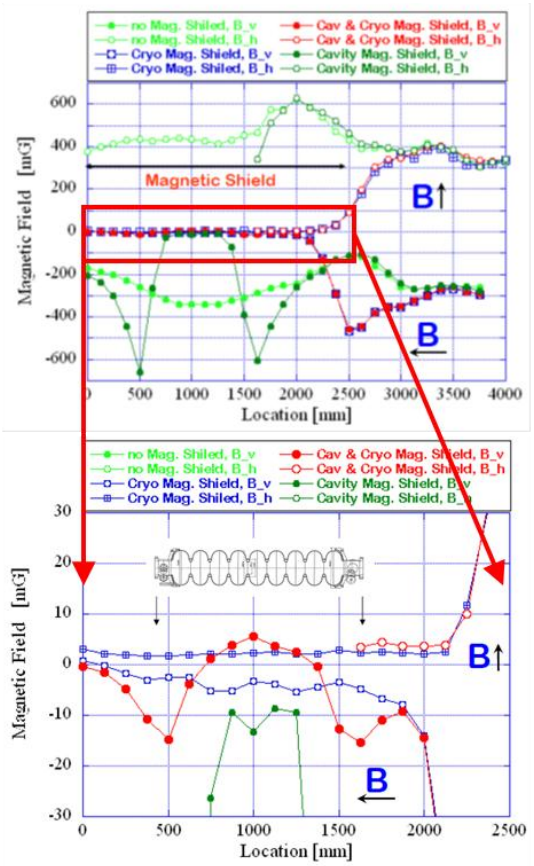


Cavity
mag. shield



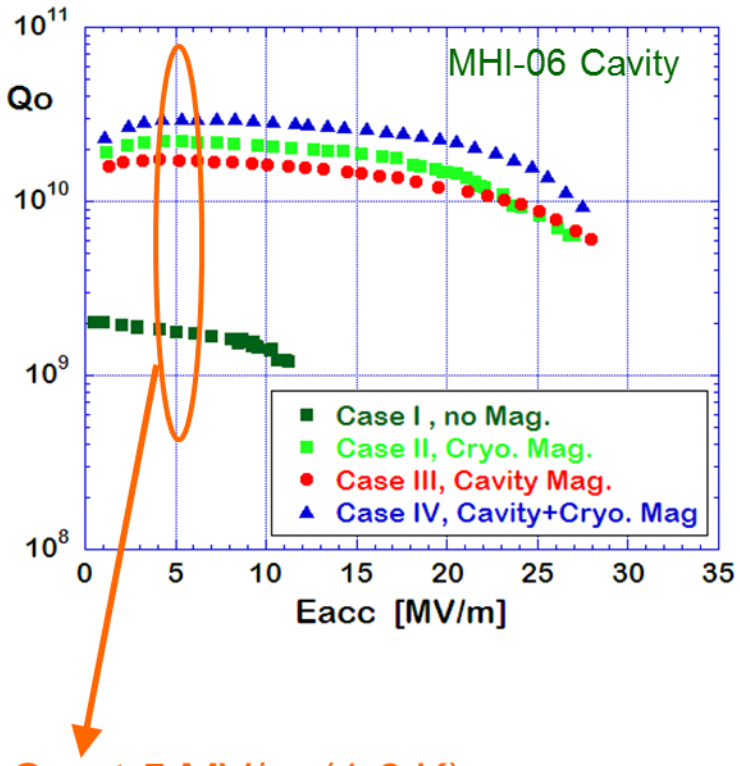
Cavity + Cryostat
mag. shield

Residual magnetic field (B)
inside the vertical cryostat



no mag. shield, B ~ 400 mG
with mag. shield, B < ~10 mG

Tests of Magnetic Fields in KEK Cavity (2)



Qo at 5 MV/m (1.8 K)

Case I, Qo = 0.2 x 10^{10}

Case II, Qo = 2.2 x 10^{10}

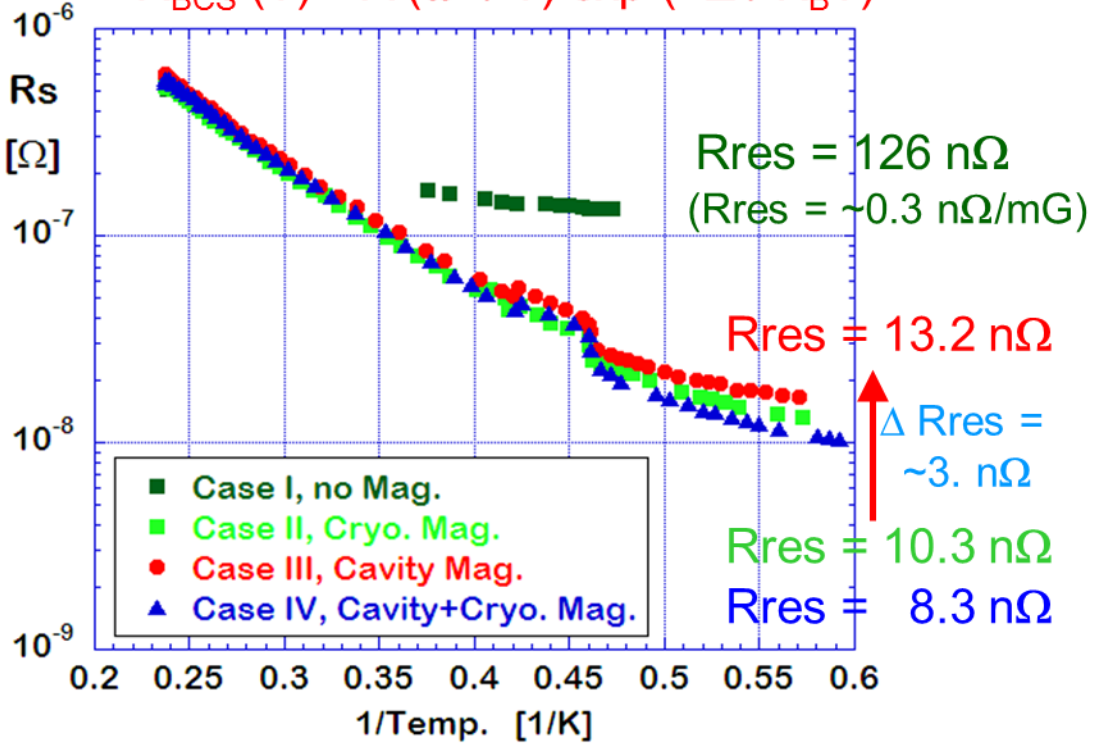
Case III, Qo = 1.7 x 10^{10} , OK

Case IV, Qo = 3.0 x 10^{10}

Temperature Dependence of Surface Resistance (Rs)

$Rs(T) = R_{BCS}(T) + Rres$

$R_{BCS}(T) = A(\omega^2 / T) \exp(-\Delta / K_B T)$



Tests of Magnetic Fields in KEK Cavity (3)

Qo measurement by dynamic rf losses in cryomodule (STF-1)