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RF Cavity with Co-based Amorphous Core

Motivation

Tests with small cores

Large cores for the cavity

High power test of the cavity

Beam test

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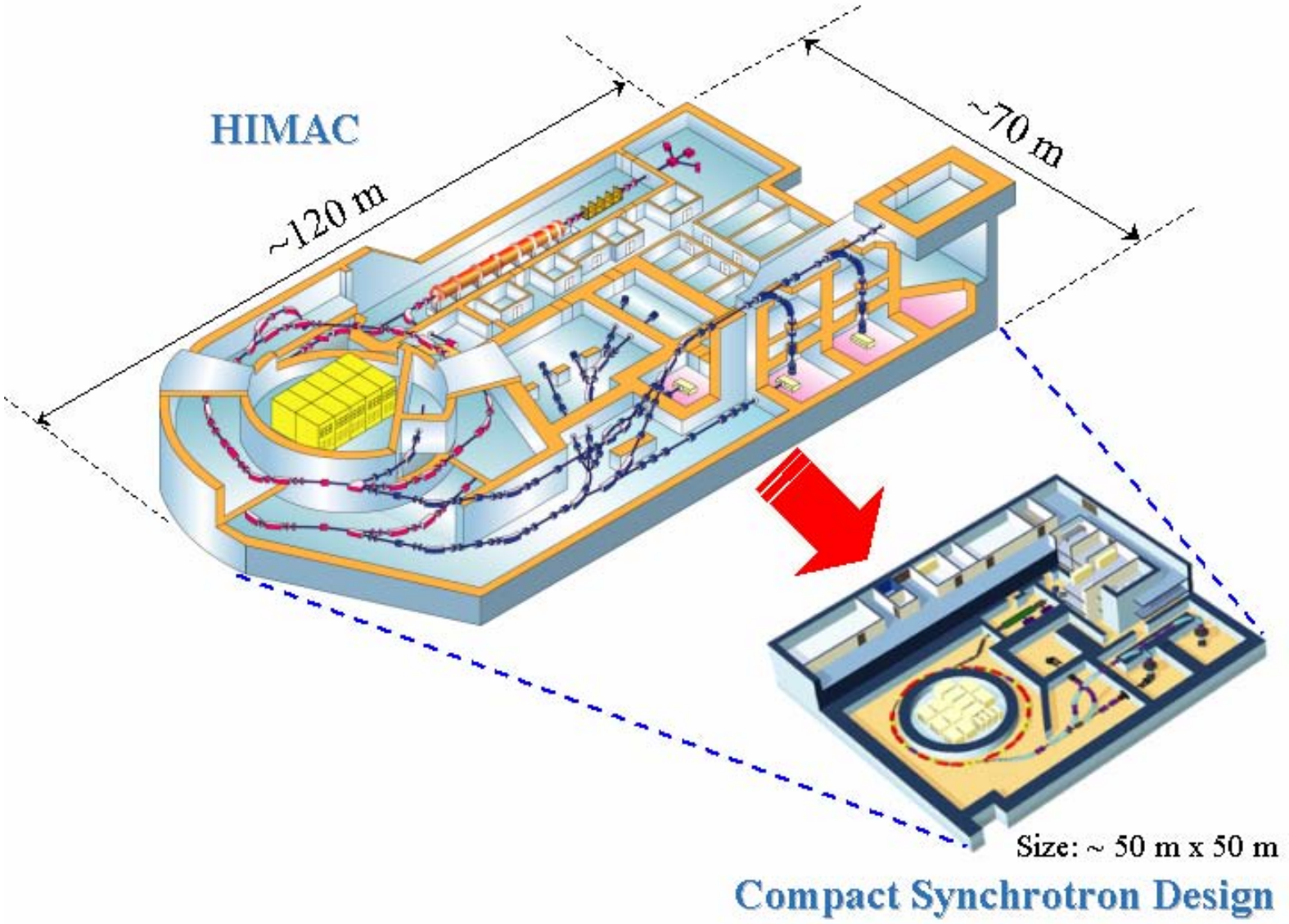
Requirement for compact synchrotron



Requirements for RF system in the compact synchrotron

frequency : 0.4 — 3.5 MHz (0.8 – 7)
h = 1 or 2

Available straight section : < 2m

Acceleration voltage : 3.2kV + α

RF control : simple system
[no tuning system,
no beam feed back,
DDS(adjustable arbitrary wave function)]

RF power : solid state amplifier (**4 × 2 k W**)

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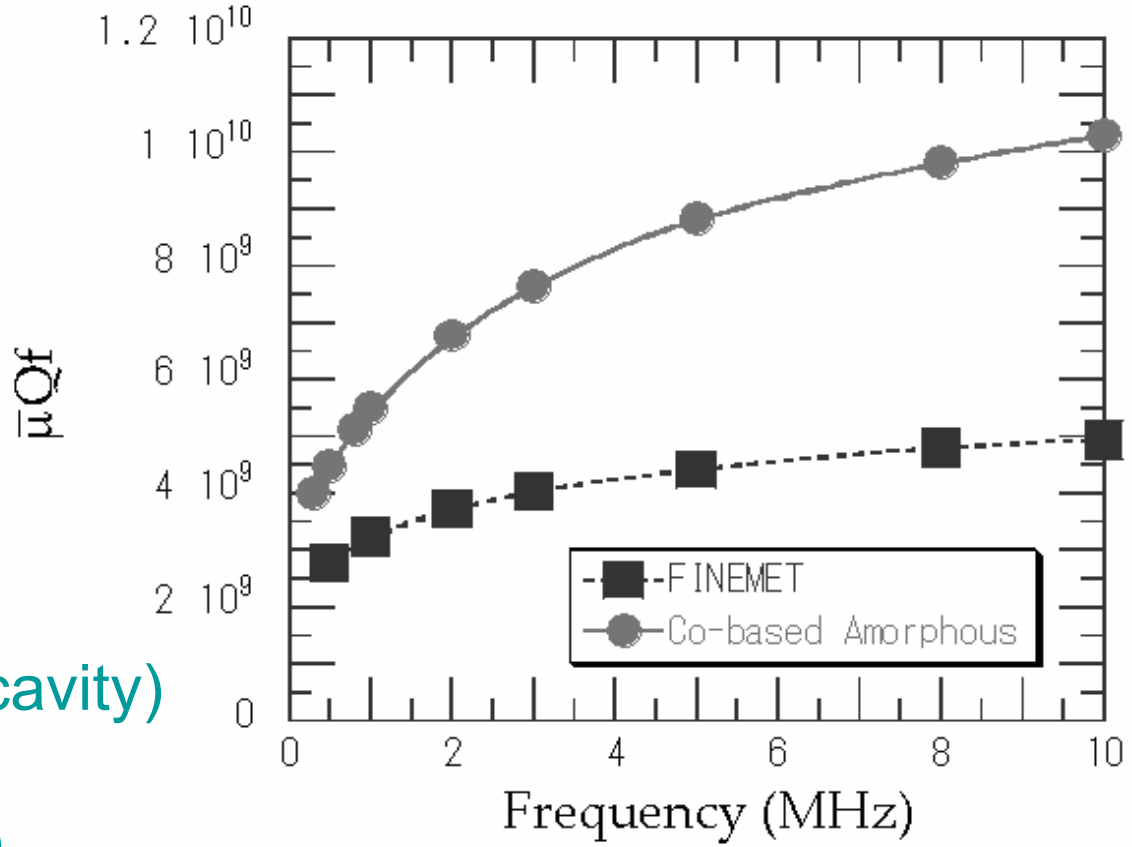
Co-core (small test core)

Co based amorphous core

(processed in magnetic field)

High permeability (compact cavity)

Low Q value (no tuning)



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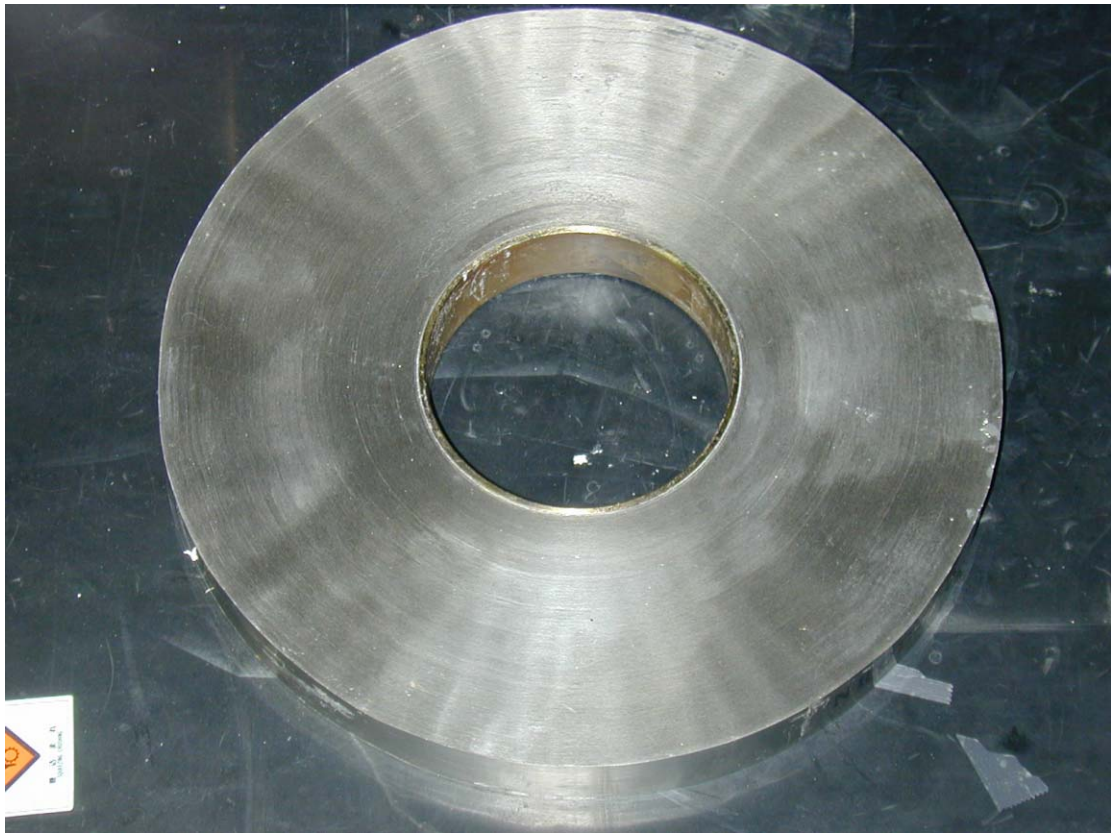
Test the half size core

OD : 300 mm
ID : 150 mm
Thickness : 30 mm



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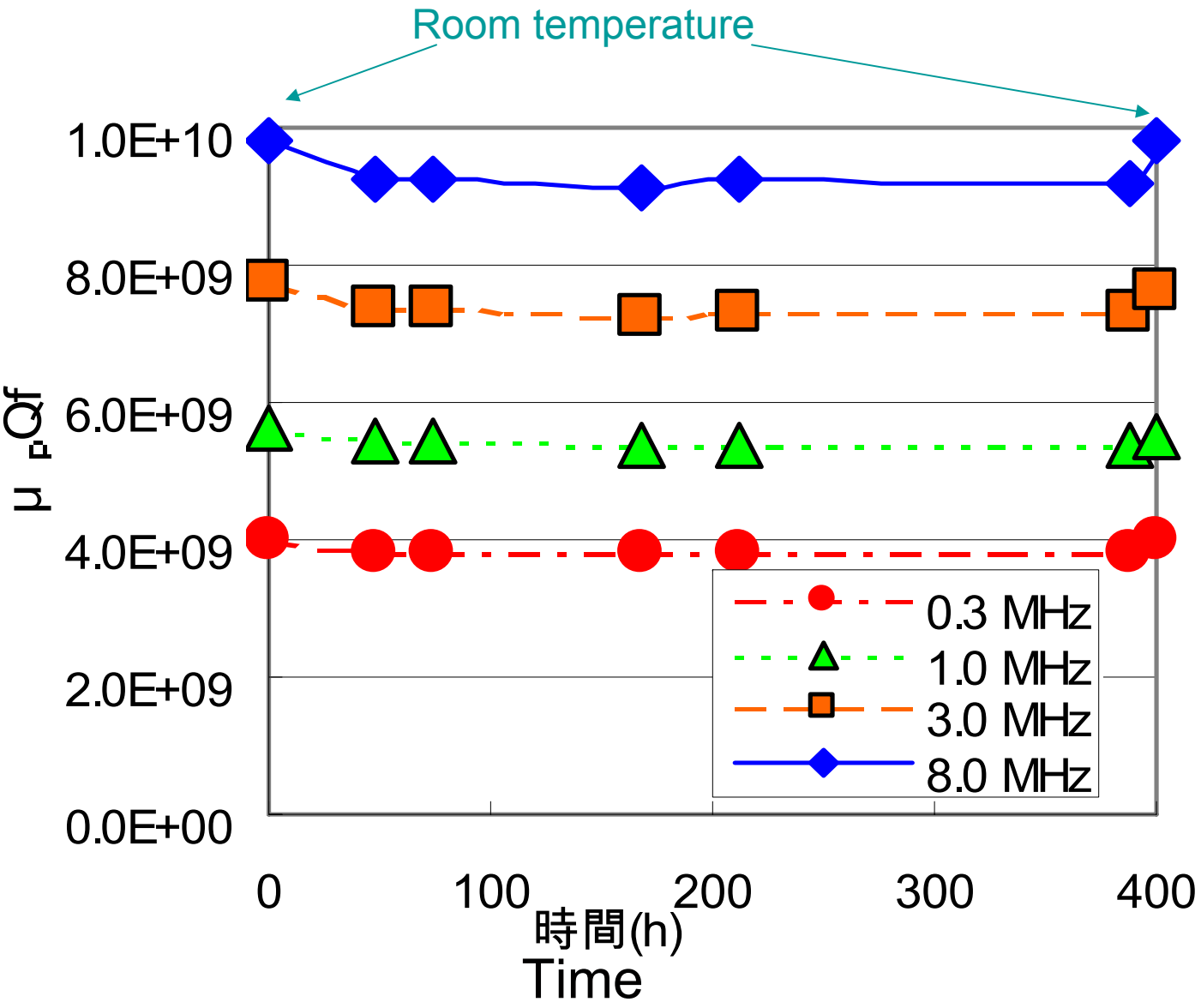
Test in high temperature (１００℃)



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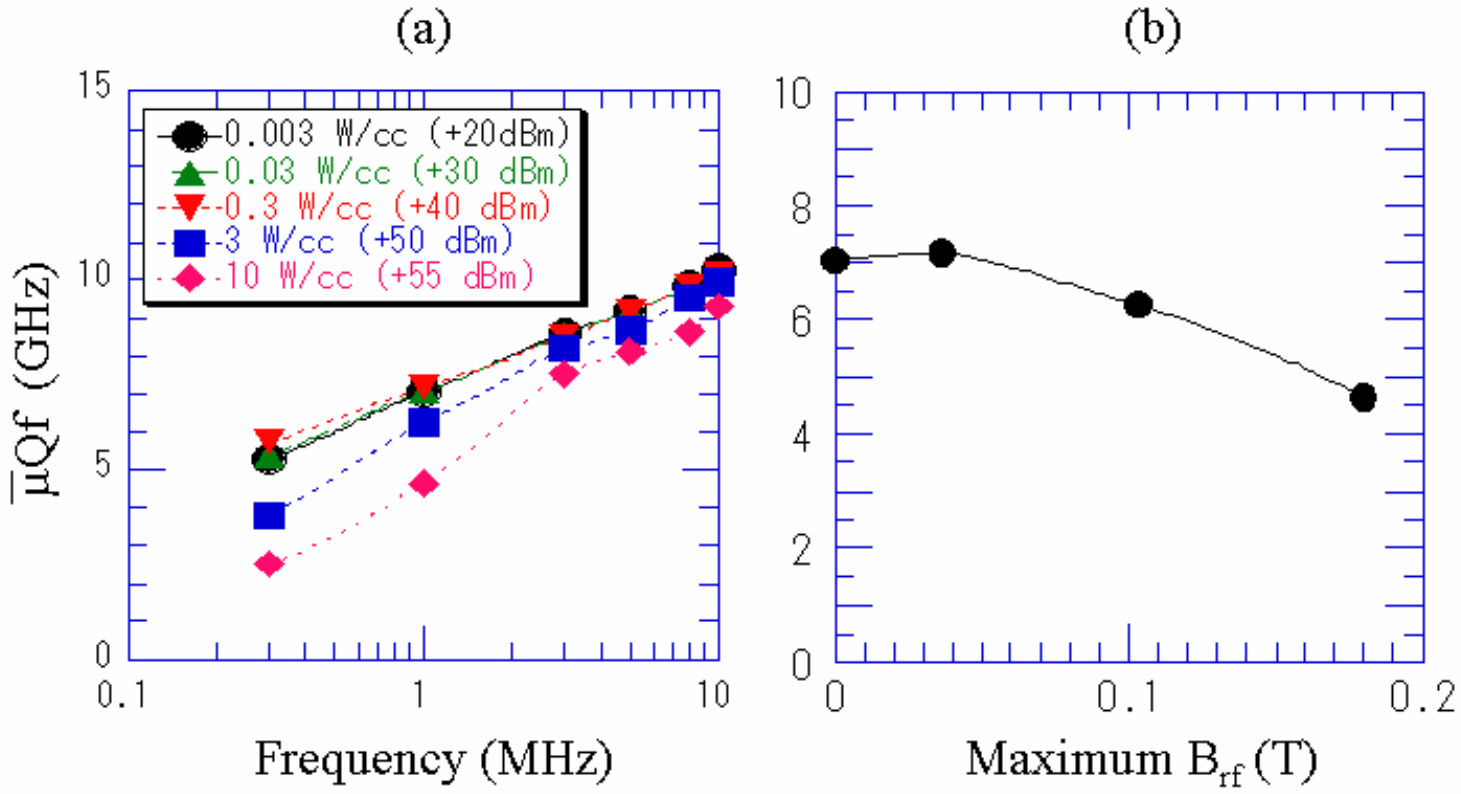
Dependence on Brf at 1MHz



No degradation up-to 0.3W/cc

Brf up-to 0.03T

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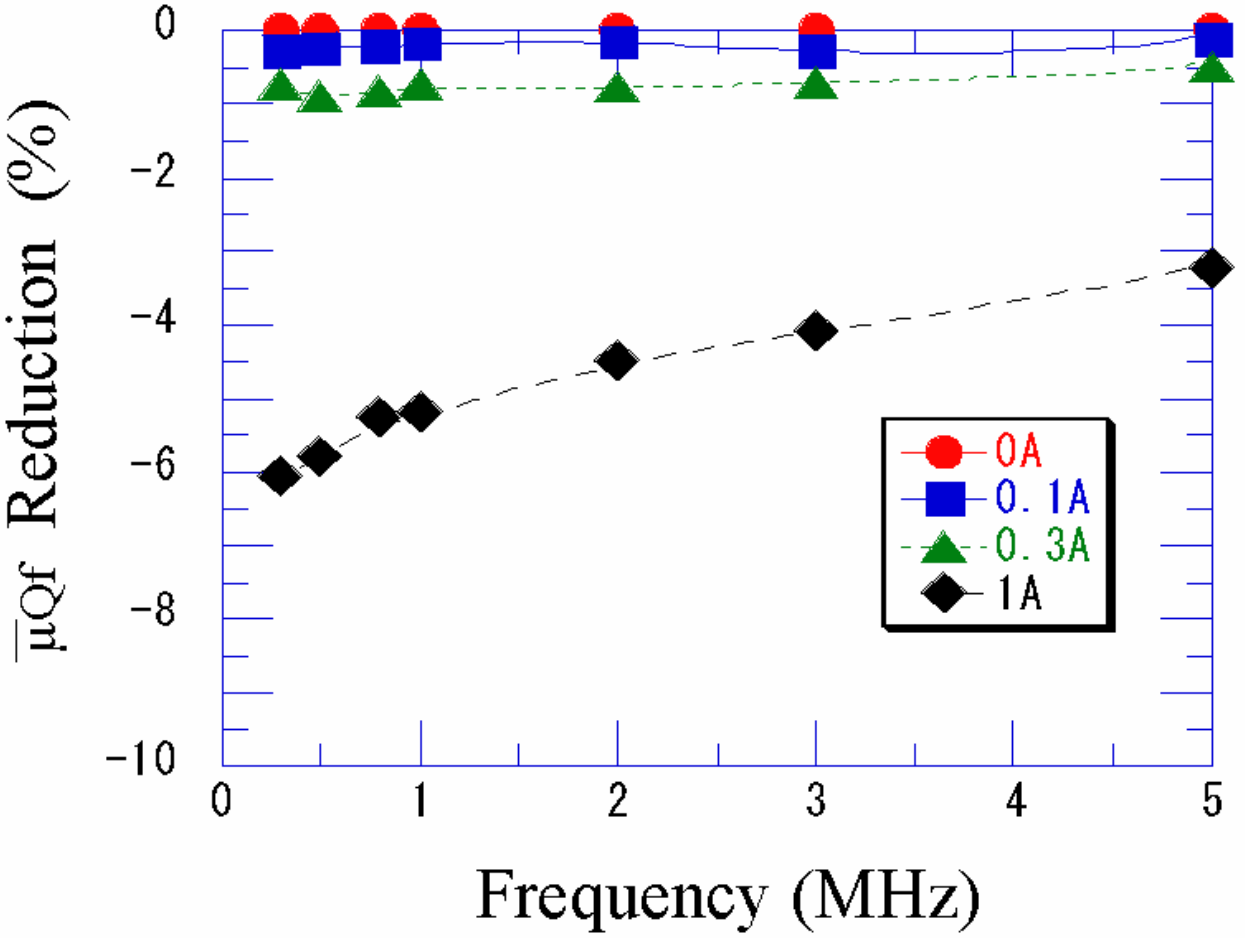
Reduction with bias current



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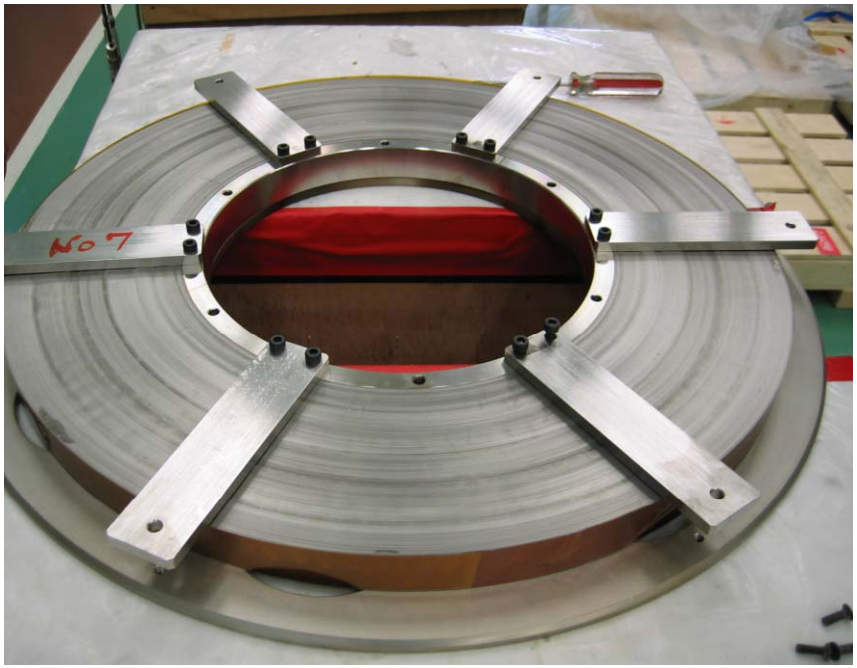
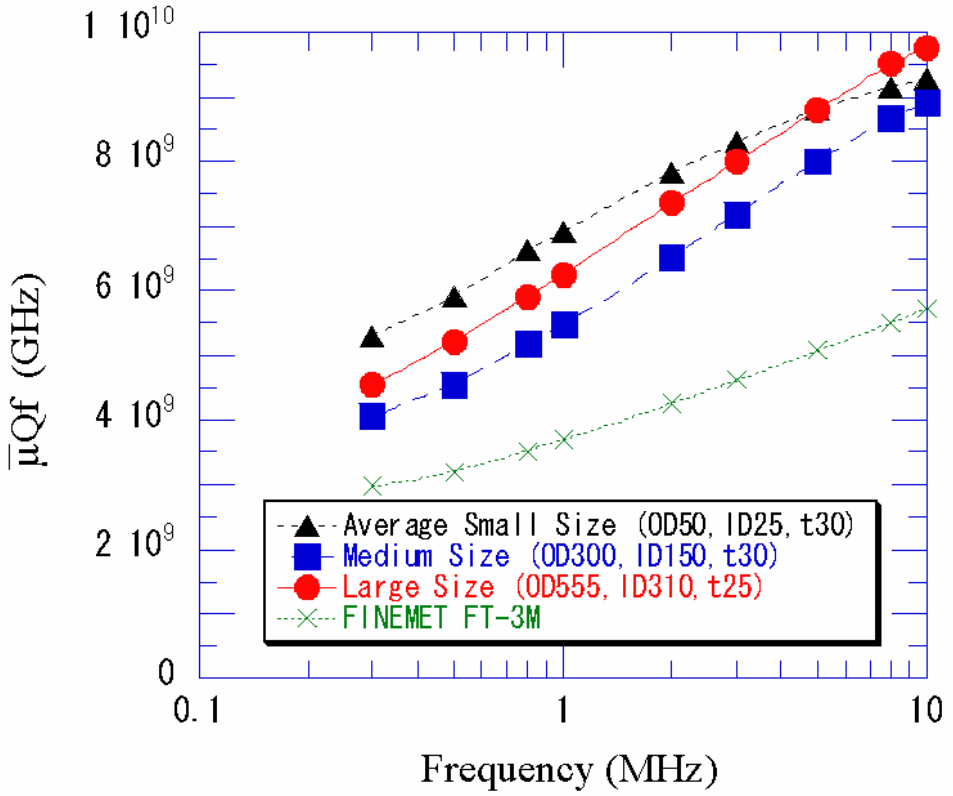
Size dependence



Full size core

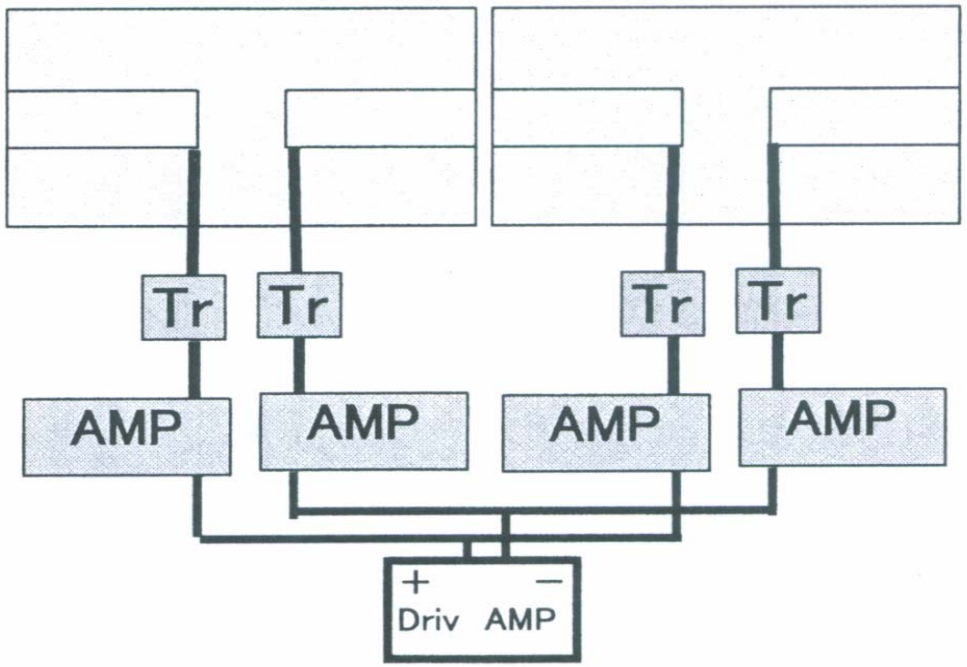
OD : 555 mm

ID : 310 mm

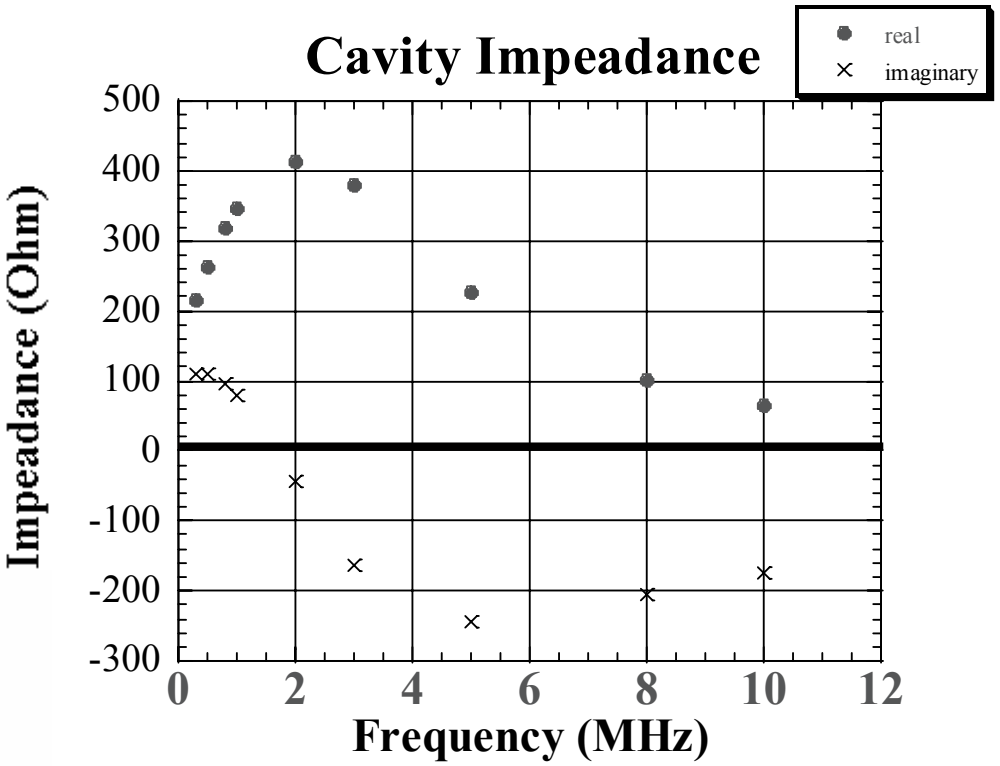


Cavity Impedance

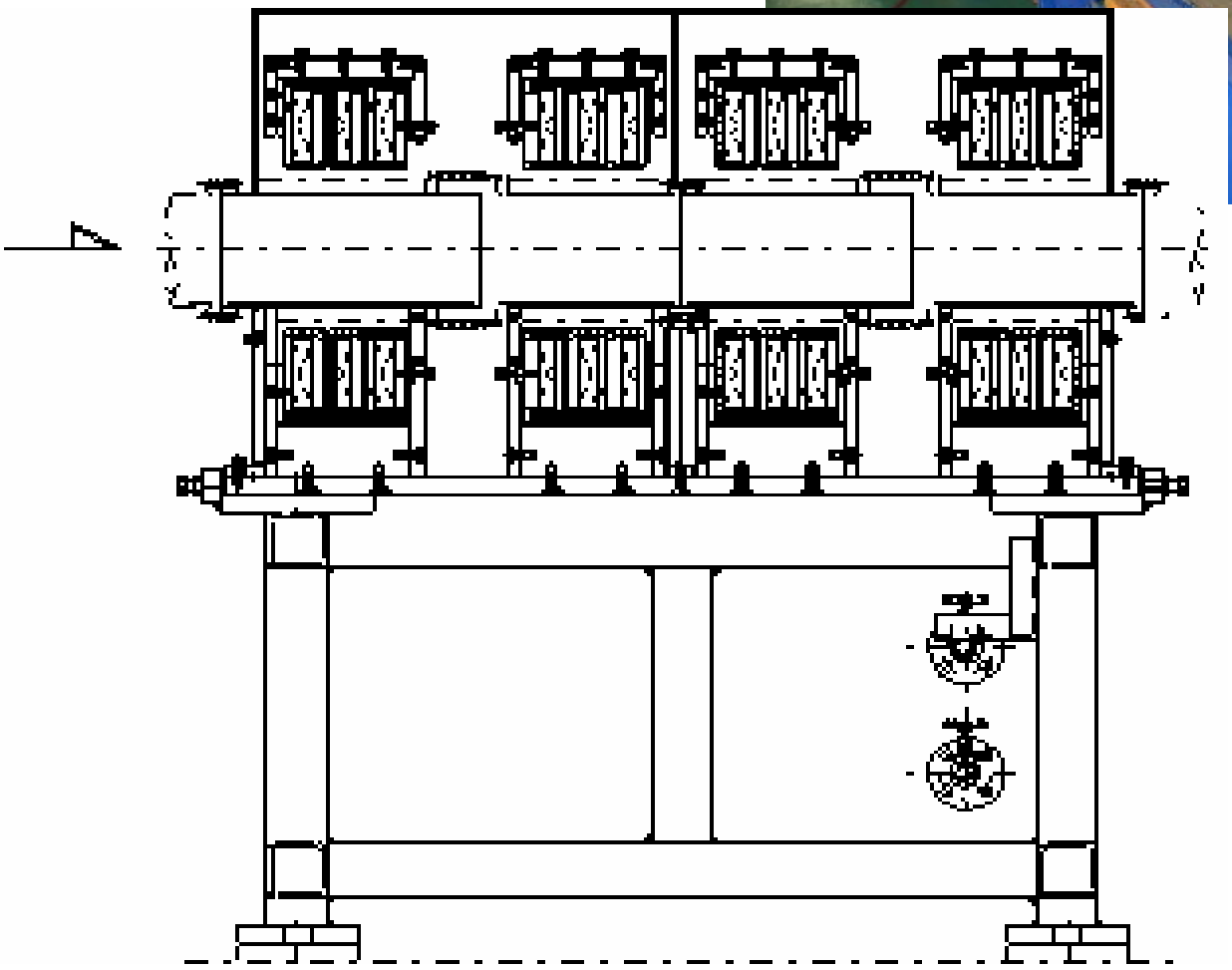
Tr : transformer (1:9)



Impedance of one resonator (λ/4)



Cavity structure



Size of
Co amorphous cores

ID : 310mm
OD : 550mm
thickness : 30mm

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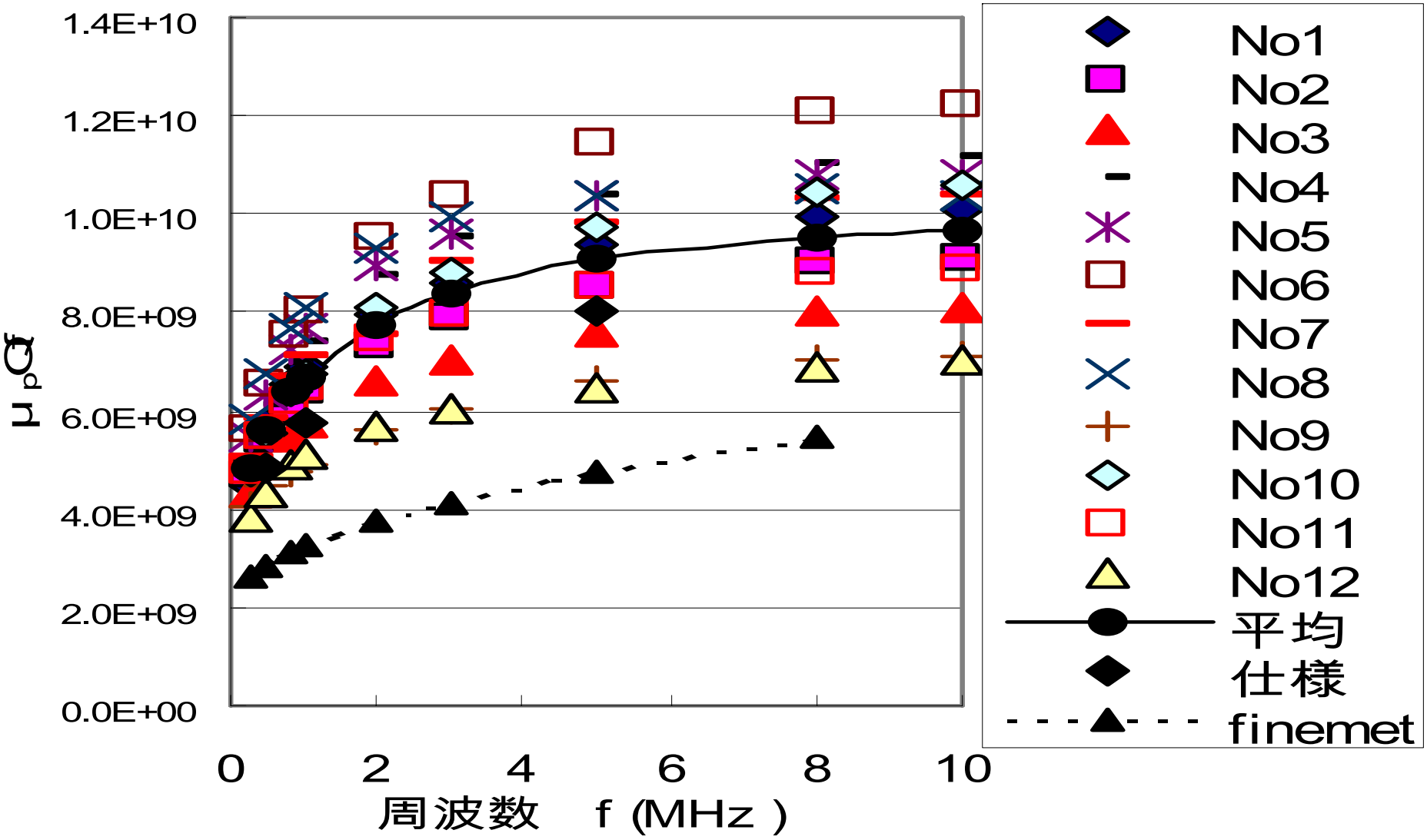
μQf values of twelve cores



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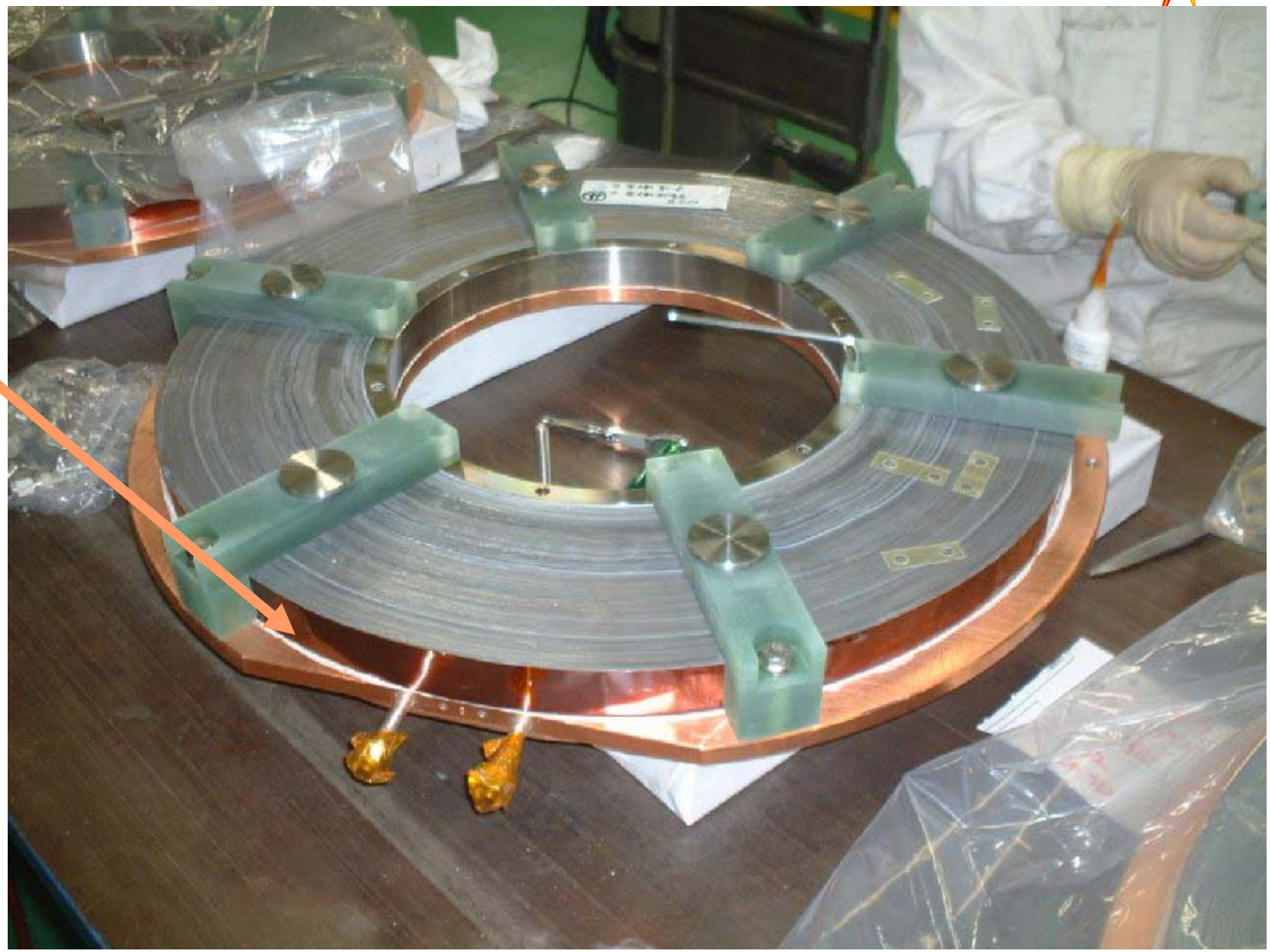
Gluing the cooling plate

Gluing with

epoxy resin (mixture of alumina)



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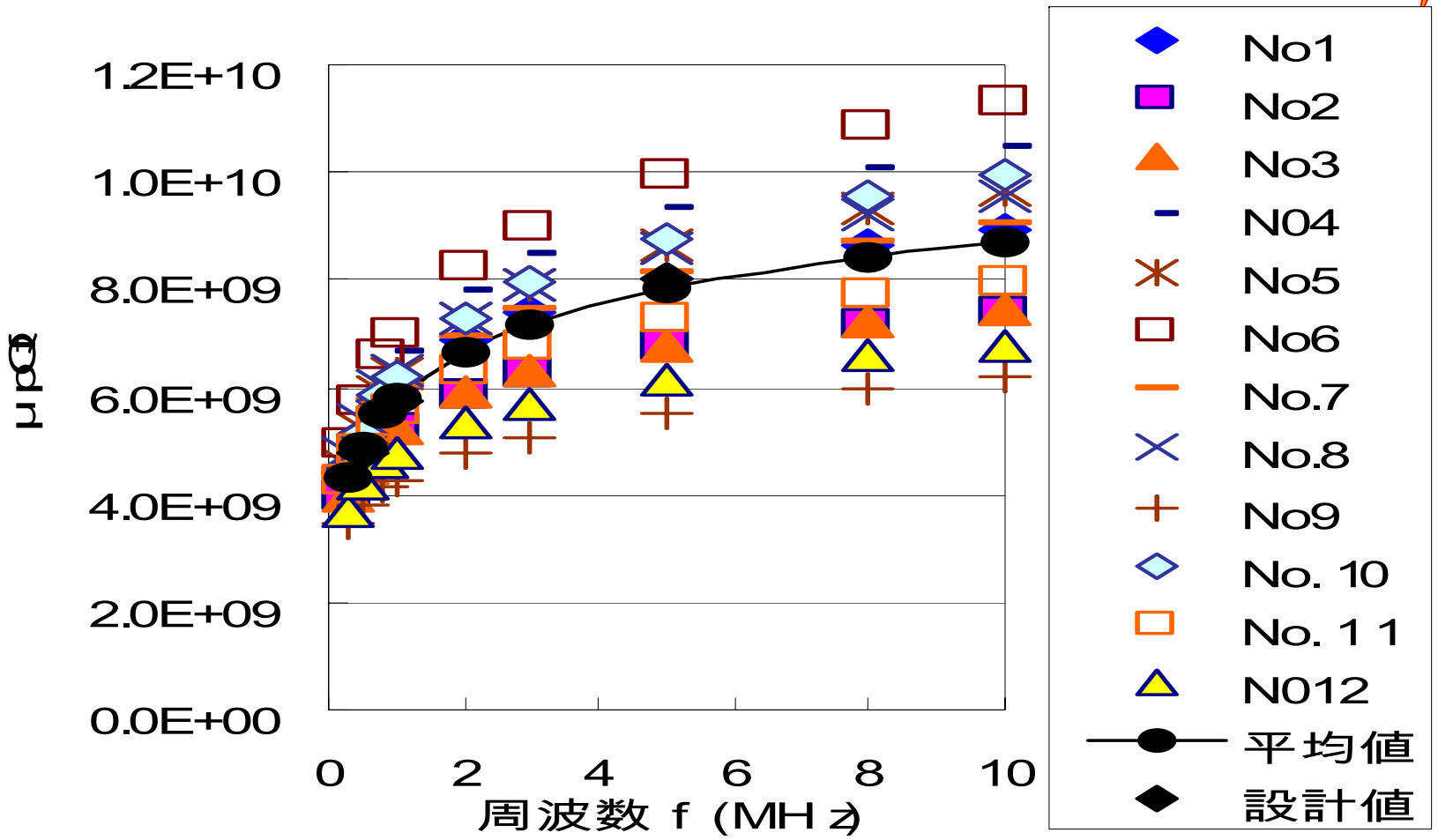
1 2 cores (after gluing the cooling plate)



Decrease of μQf about 10%

Different insulation materials in poster session (TUPCH124)

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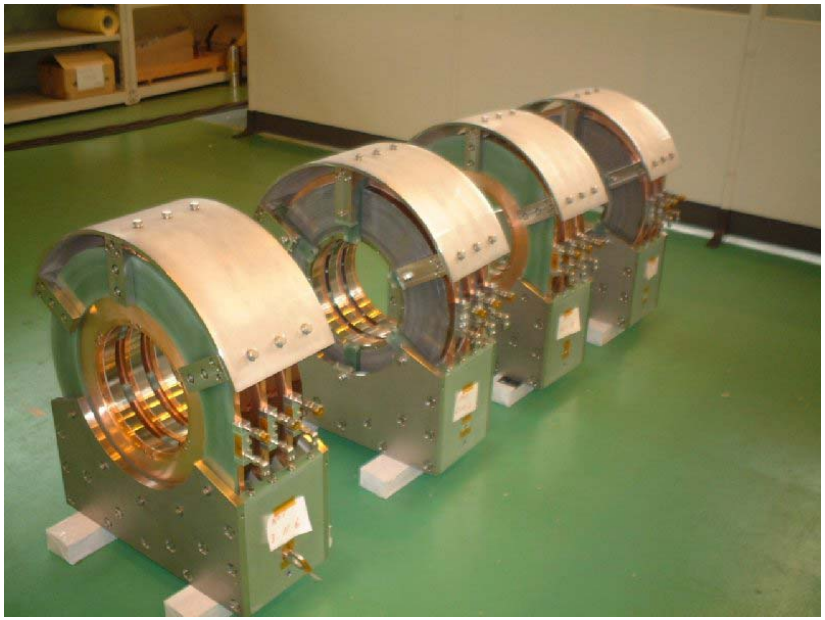
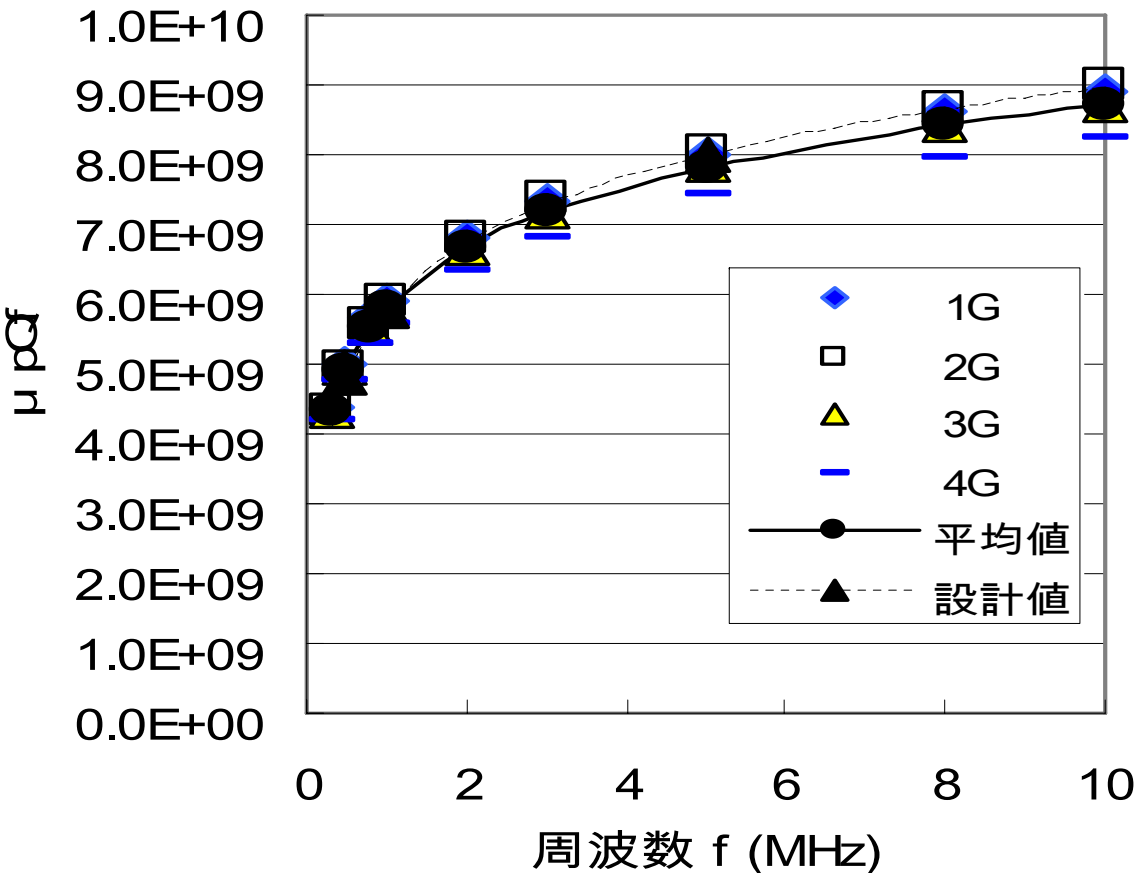
Averaged values of each group





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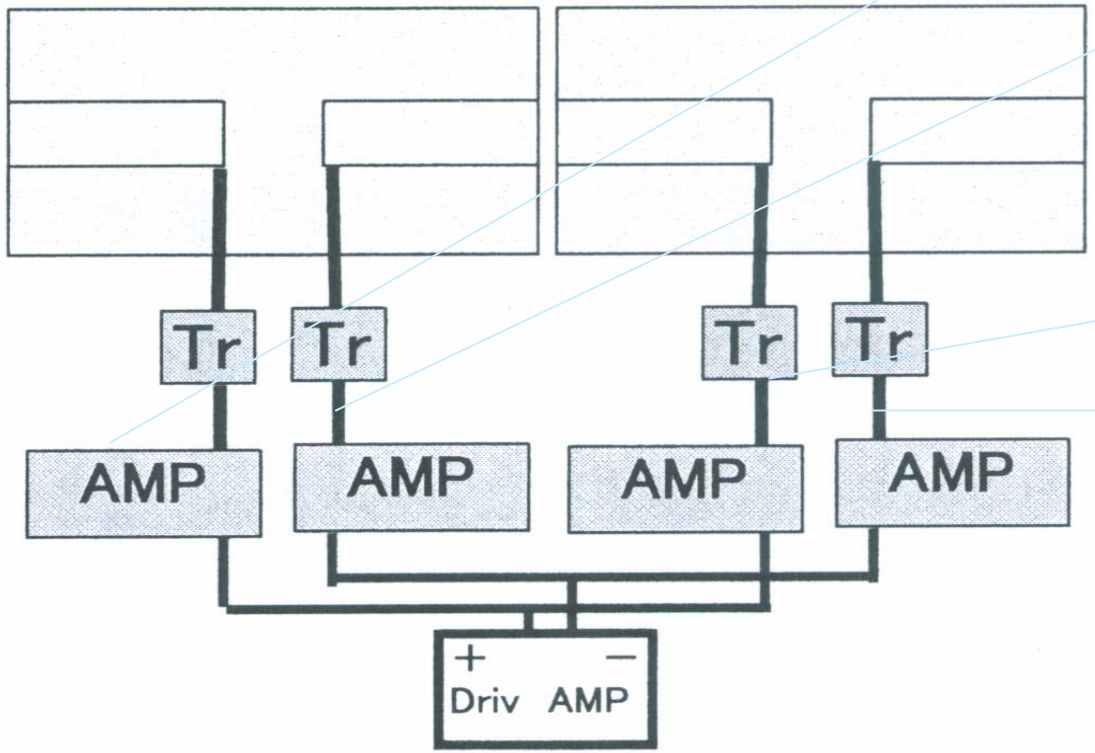
R F amp

4×2kW (peak : 3.5kW)

Water cooling



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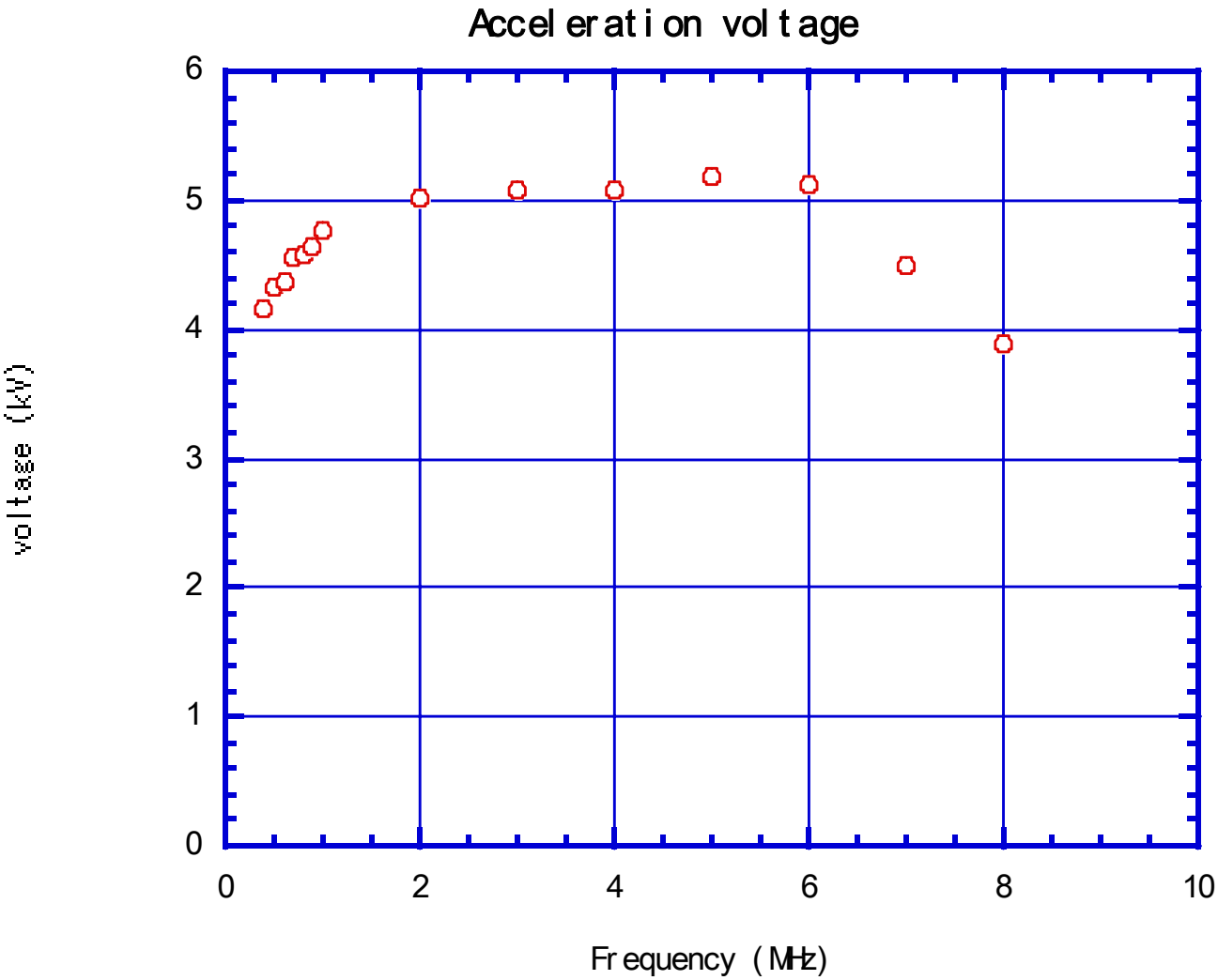
Obtained voltage with max. r f power



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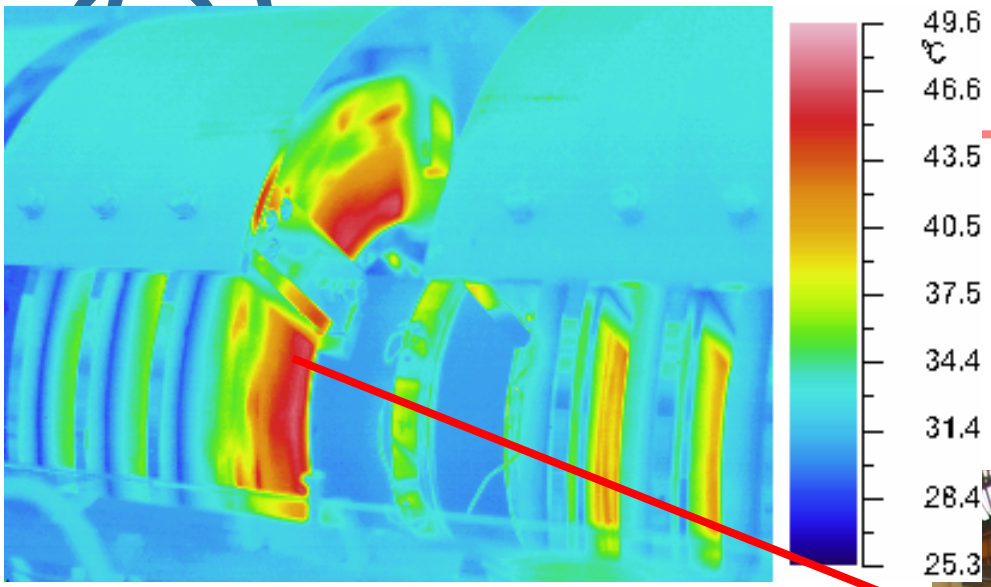
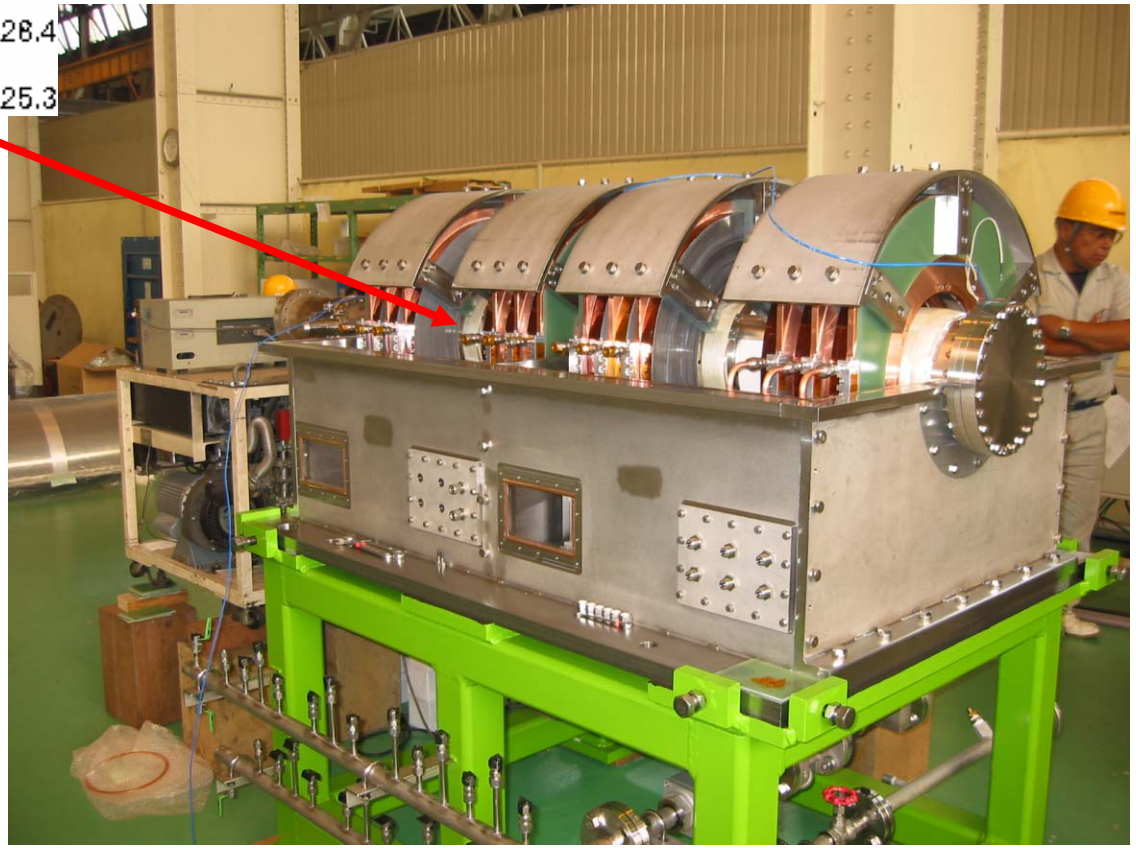
High power test



Radiation thermometer

Maximum power operation
(4 × 2kW)



Max. temp. < 50°

well below the tested temperature of 100°

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New Cavity in HIMAC synchrotron

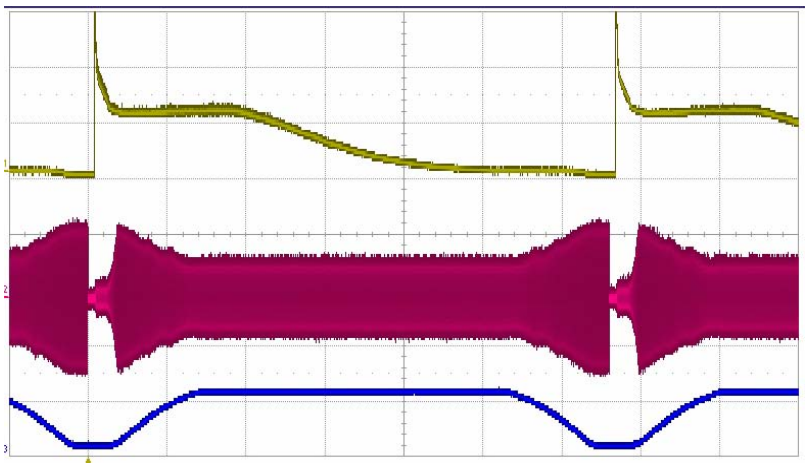
Acceleration tests in HIMAC

Carbon beam

T : 6 → 400 MeV/u

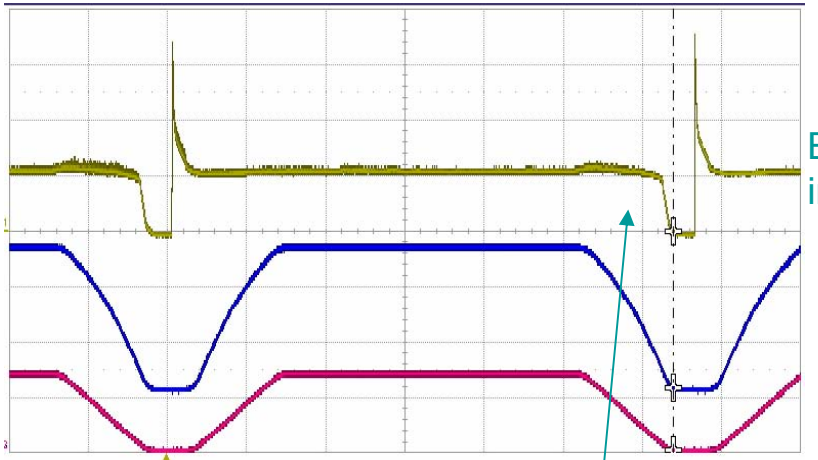
f : 1 → 6.6 MHz

Acceleration



Synchrotron cycle 3.3 second

Deceleration (in the respiratory gated extraction)



deceleration

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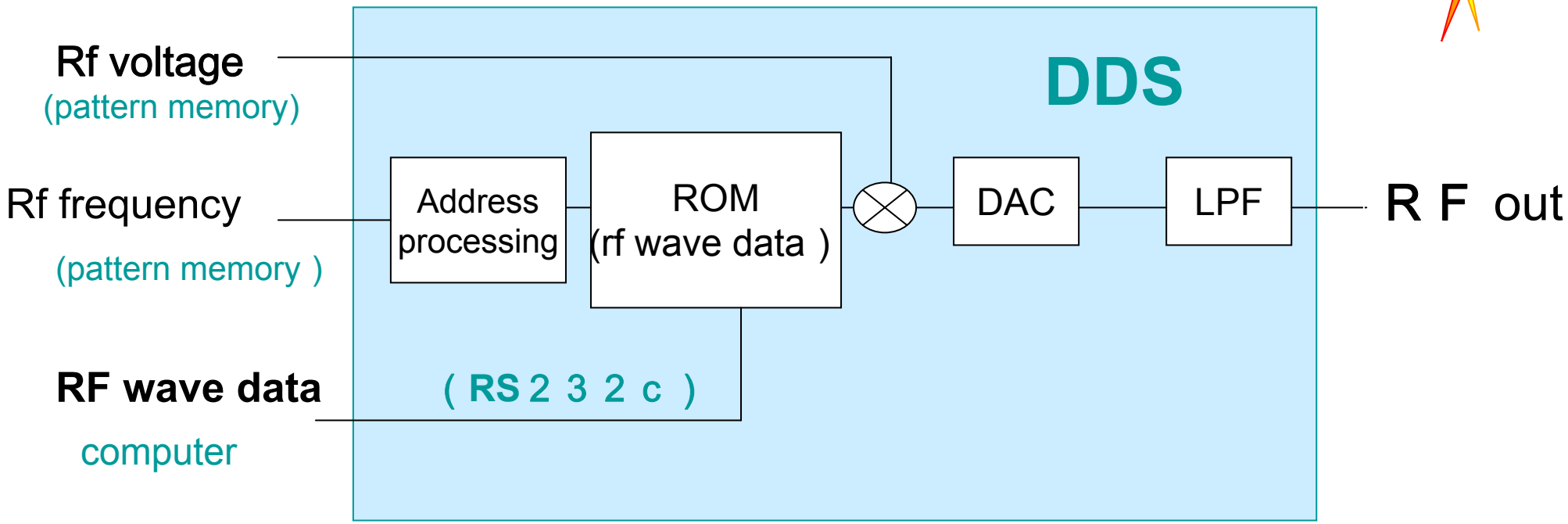
DDS with mixed harmonic waves



Adjust the mixed harmonic waves (amplitude and phase)
to get higher beam intensity

Acceleration with mixed higher harmonic wave

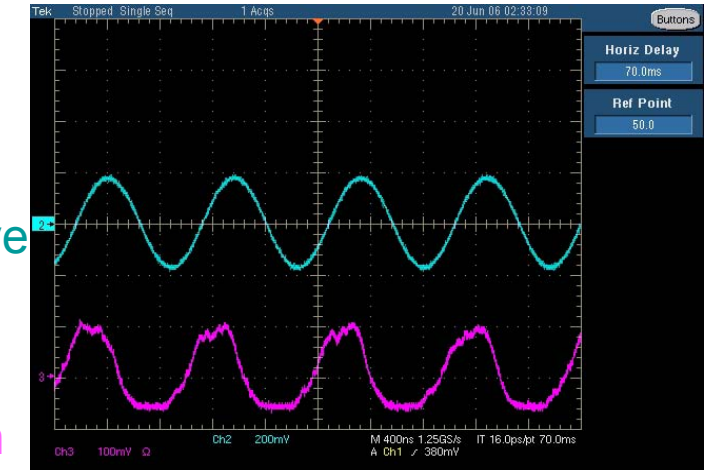
Flat base

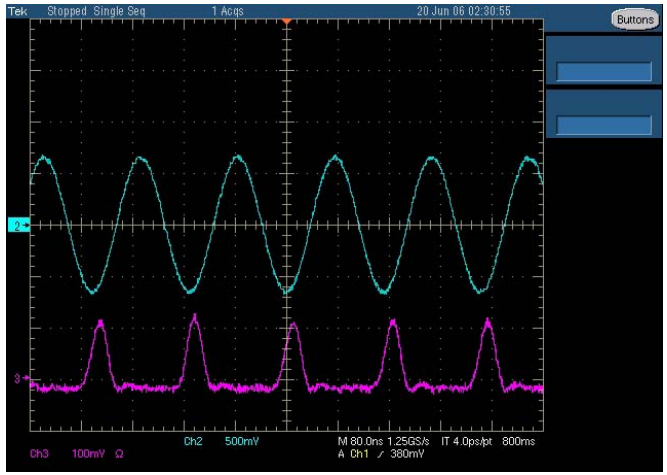
Flat top

Without mix

rf wave

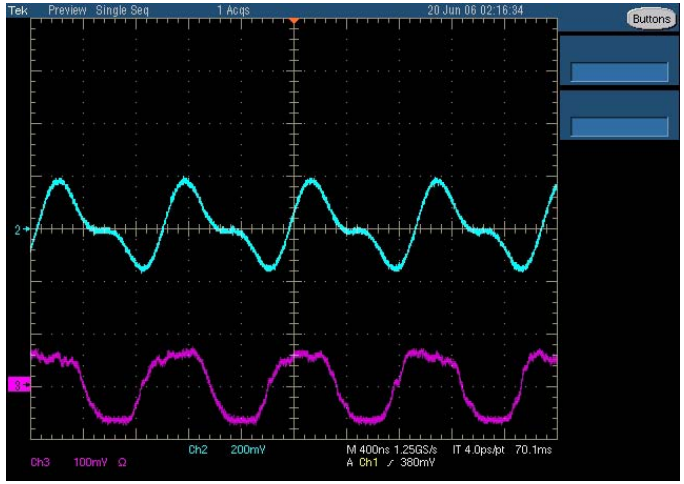
Beam bunch

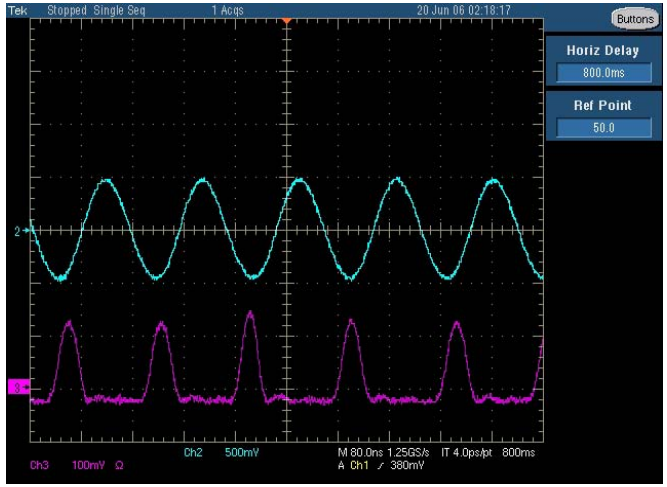




Mixed second harmonic

30% up





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We have confirmed the performances of the developed high-power rf system.

Thank you for attention

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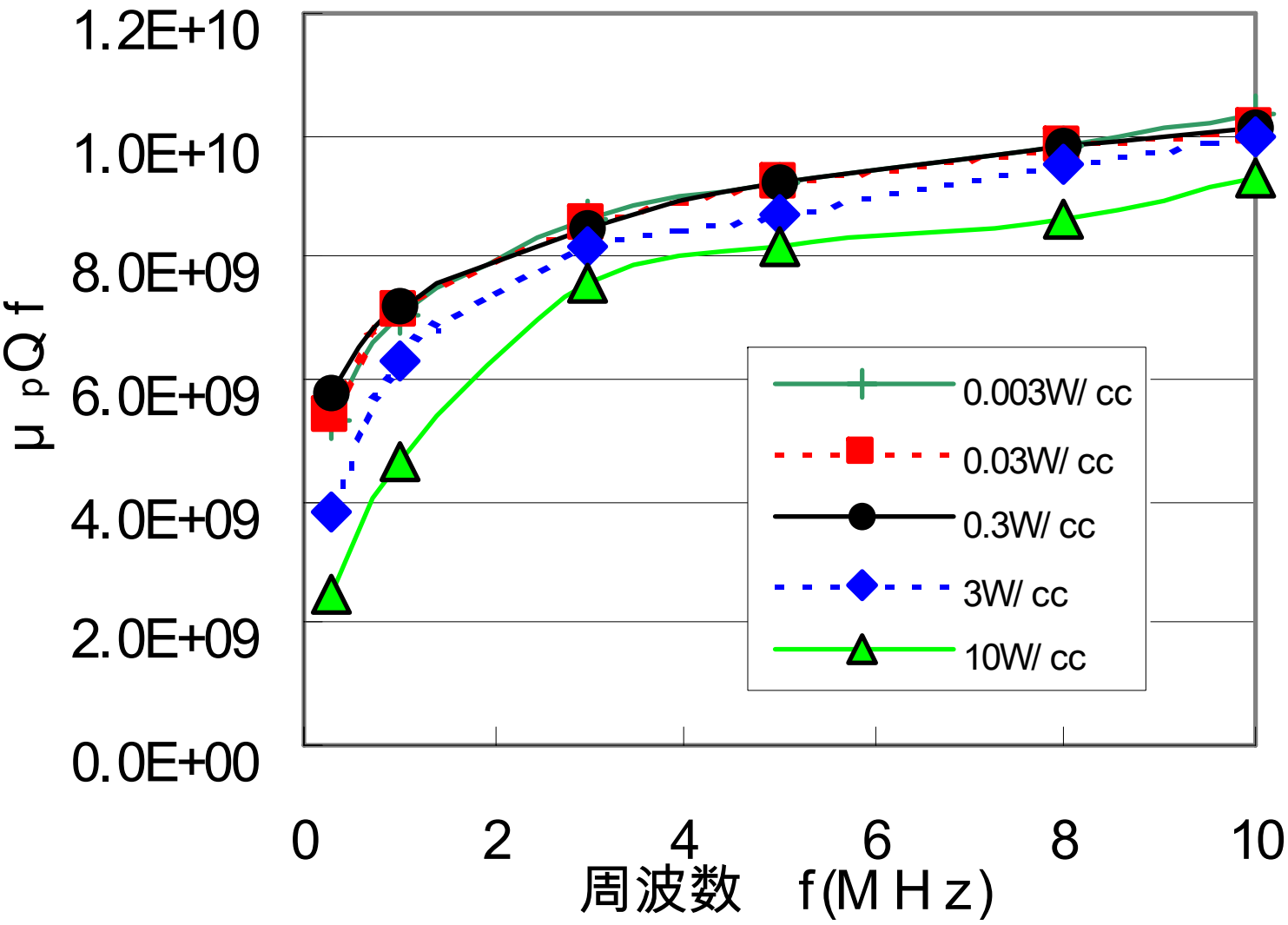
Dependence on power density



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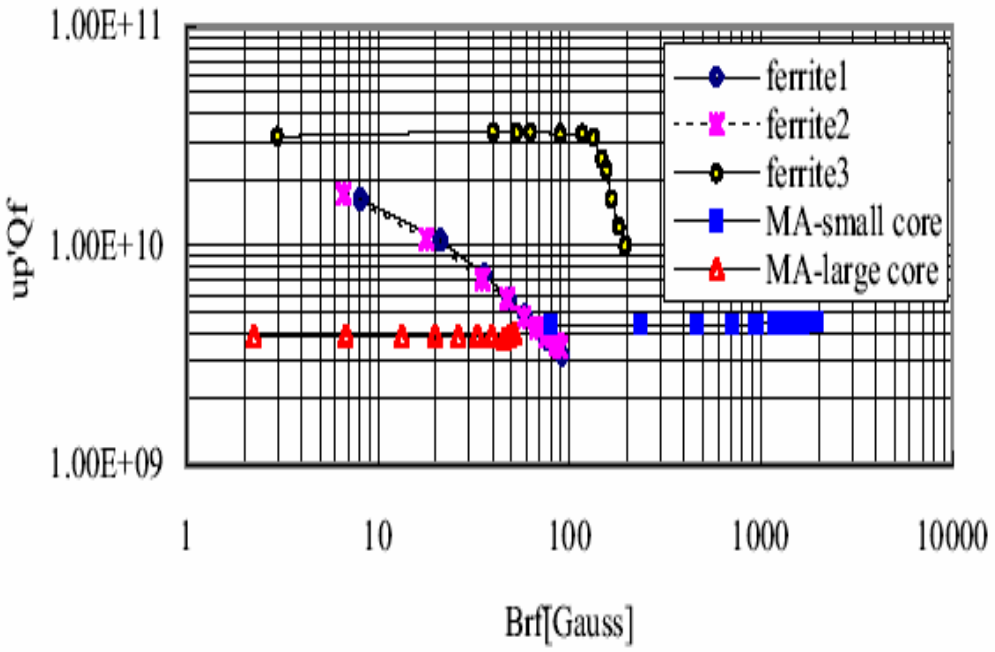
Finemet (FT-3M)

Characteristic features

high Brf
low Q
high permeability
(high μQf)

Compact acceleration cavity
without tuning



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Co-based amorphous

Curie temperature , Saturation flux density

	Bs (T)	T c (℃)
Finemet (FT-3M)	570	1.2
Co-amorphous (FS)	240