*ARES Cavity System for SuperKeKB**

KEKB Machine Review

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* *SuperKeKB* stands for Nano Beam Scheme / *SuperKEKB* for High Current Beam Scheme in my presentation.

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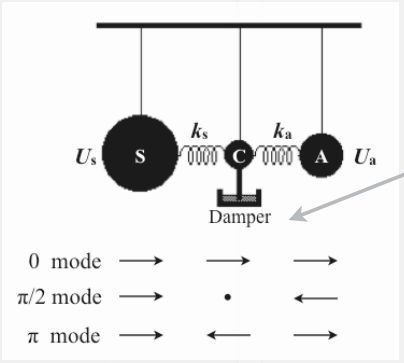
    - RF accelerating structure for DR (Talk by T. Abe)

†Coupled Bunch Instability

ARES Cavity System for KEKB

Flywheel energy ratio
$U_S / U_A = 9$

$\Delta f_{\pi/2} = \Delta f_{AC} / (1 + U_S/U_A)$



Parasitic (0 & π) Mode Damper

Four HOM Waveguides (HWG) at the upper and lower sides of AC. Two SiC bullet-shaped absorbers per HWG.

Two Grooved Beam Pipes (GBP) at both ends of AC. Eight SiC tiles per groove.

Storage Cavity (SC)

Coupling Cavity (CC)

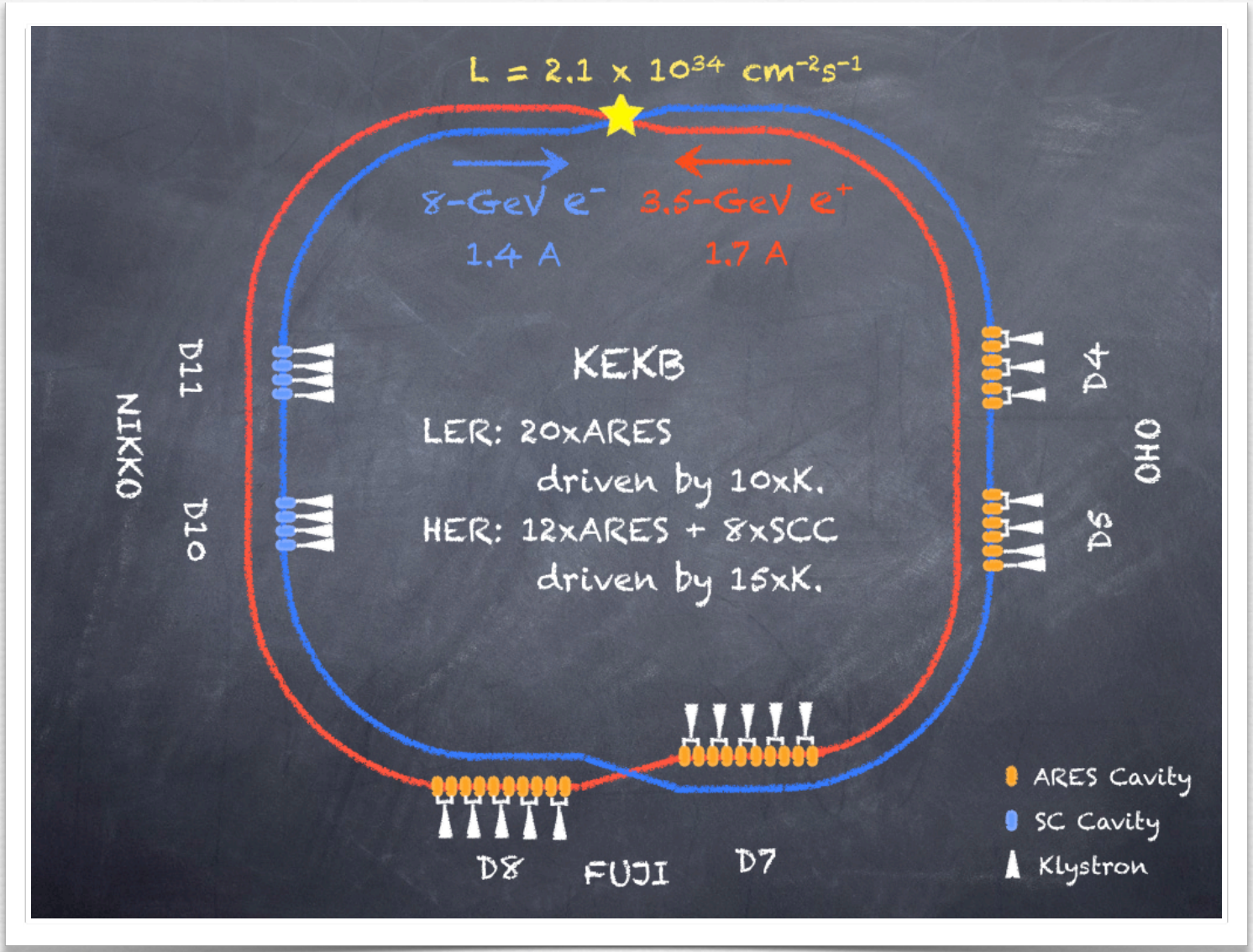
Accelerating Cavity (AC)

Input Coupler

400 kW,
β = 3.0 ~ 3.6

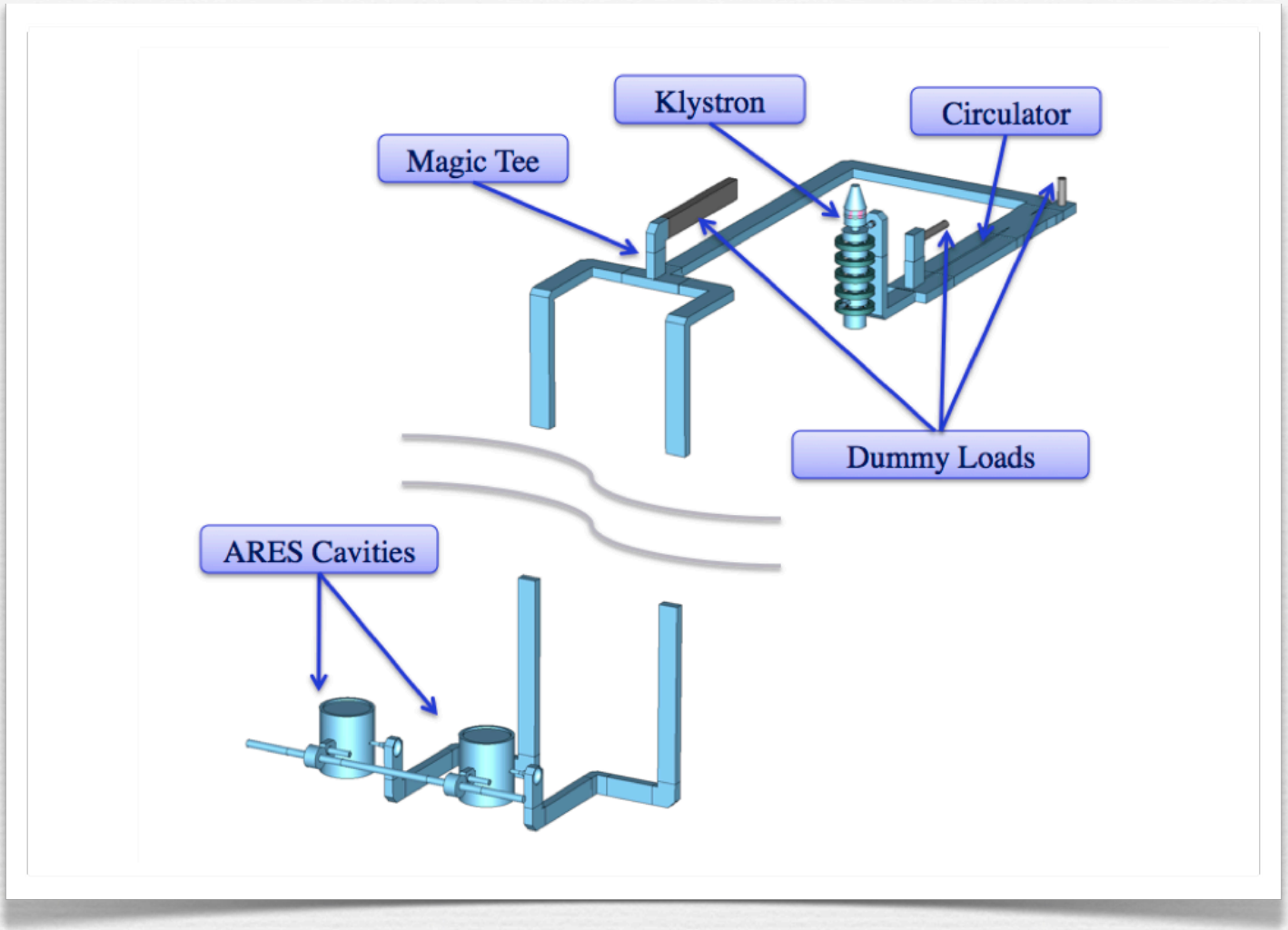
3D Schematic View of ARES Cavity System

KEKB RF System

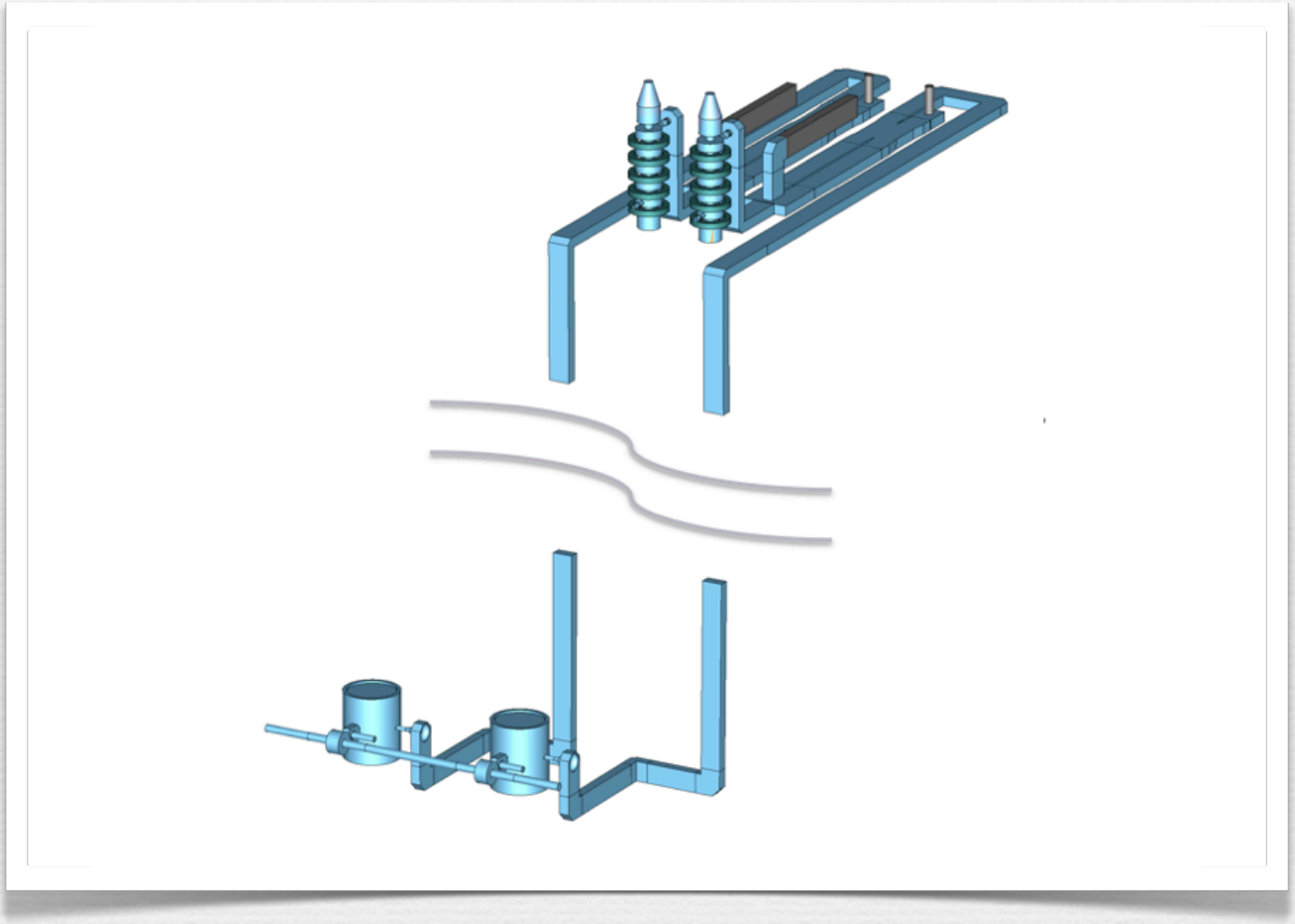


At present, 32 ARES cavities in operation, 20 for LER and 12 for HER.

Regular Configuration of NC RF System for KEKB

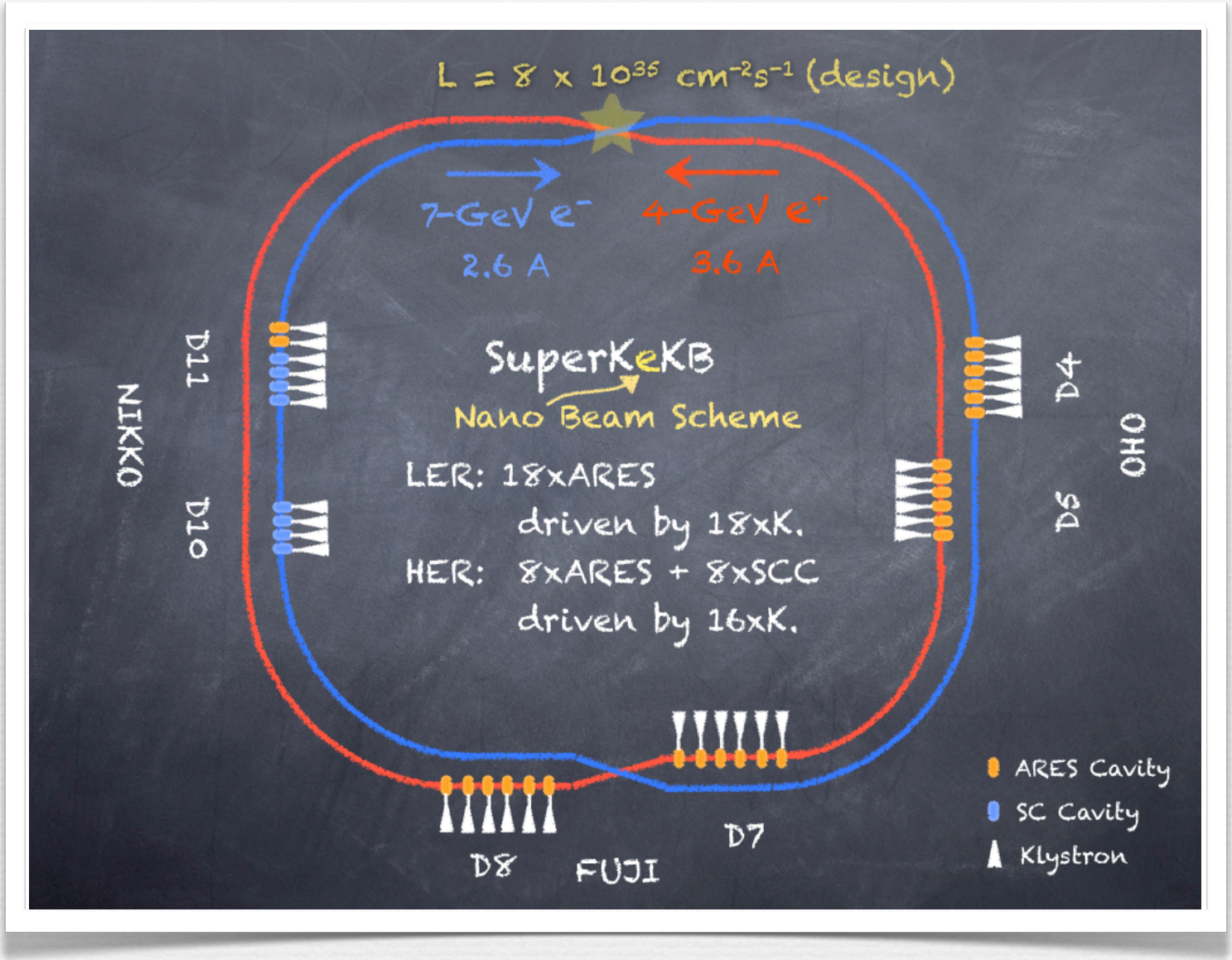


NC RF System Configuration for SuperKeKB



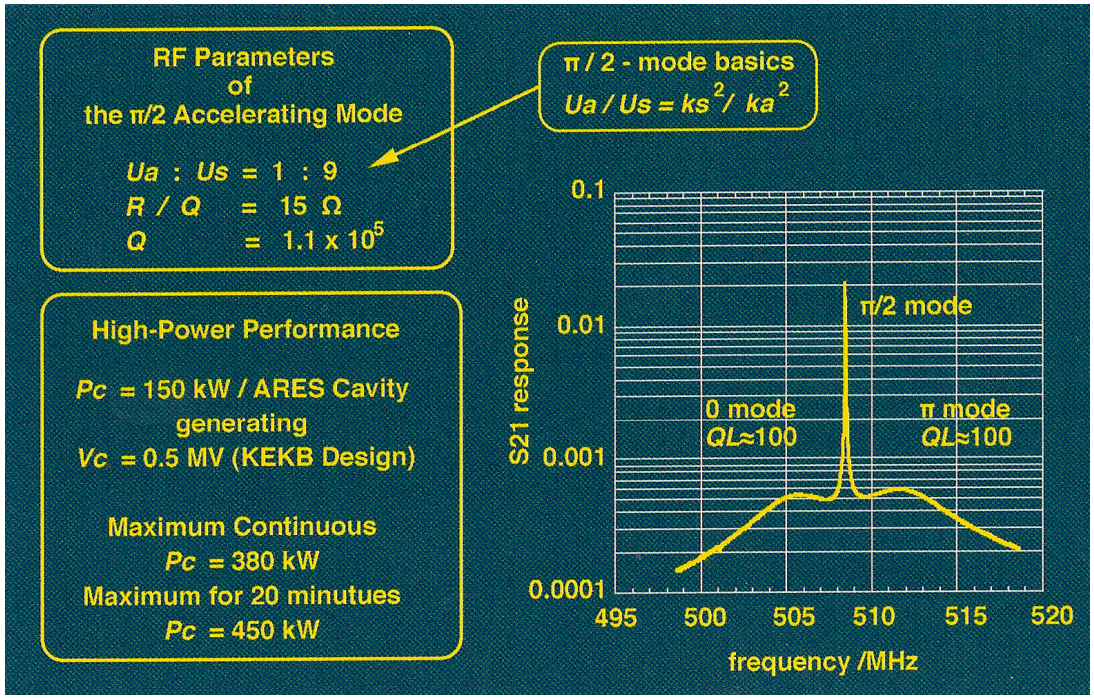
Two OHO RF stations (D5C and D5E) already have this configuration to support the HER beam, where the total current has reached 1.35 A.

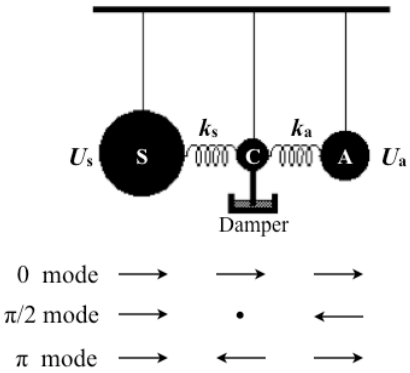
Conceptual Sketch of SuperKeKB RF System



Reuse 26 out of the 32 ARES cavities, 18 for LER and 8 for HER.

Fundamentals of ARES Cavity System



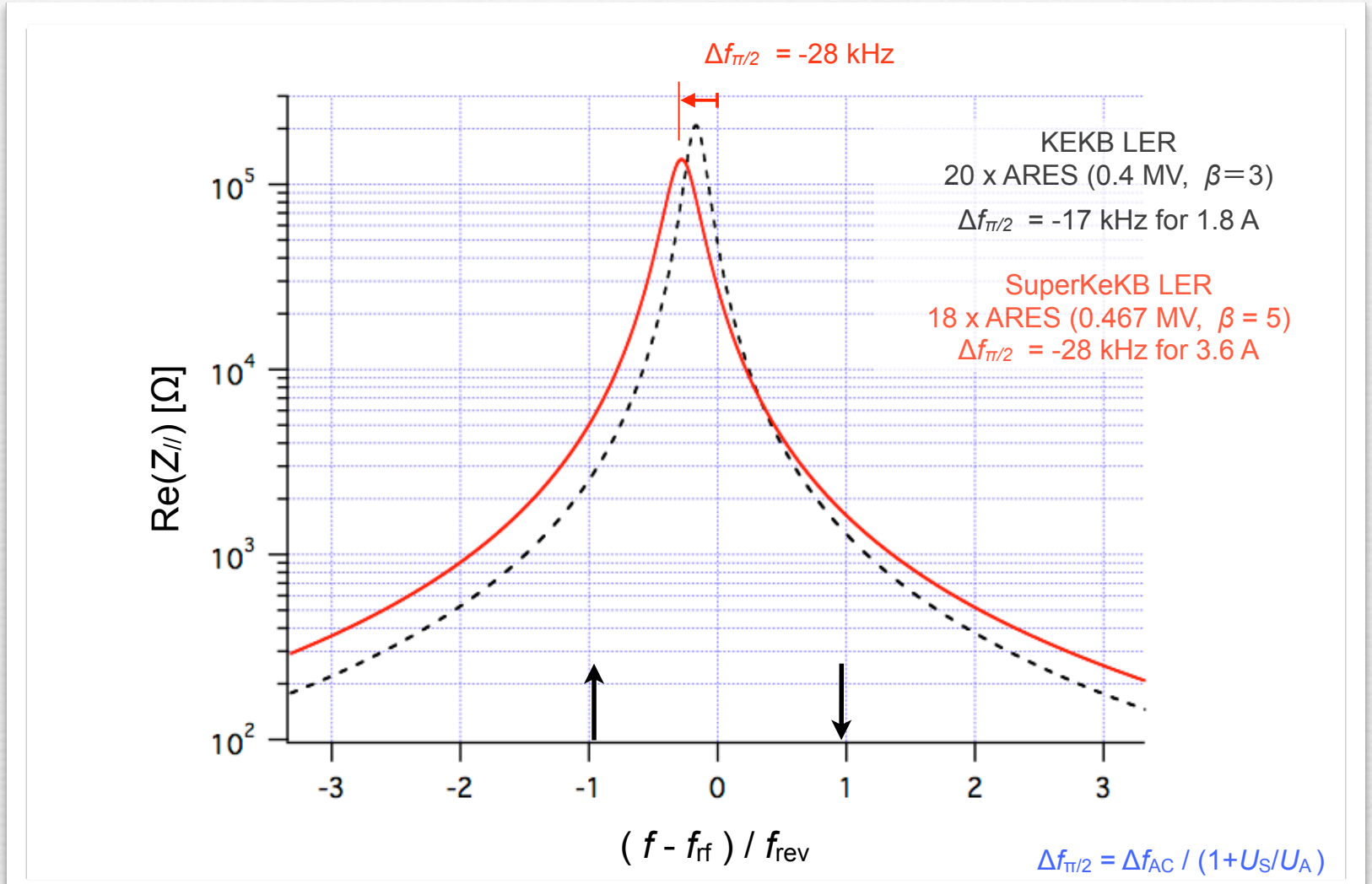


The flywheel energy ratio $U_S/U_A = 9$ unchanged for SuperKeKB.

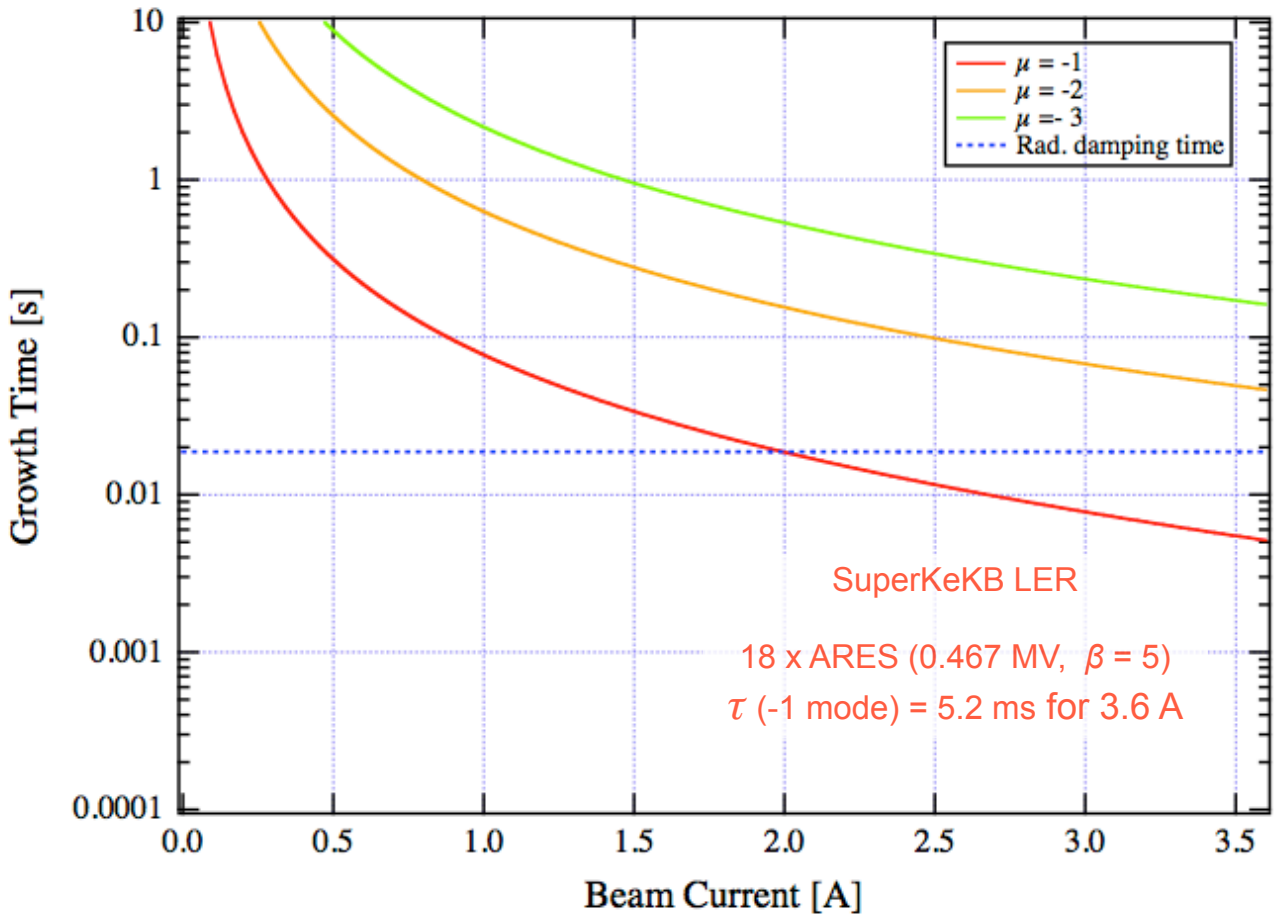
Operation of ARES Cavity System for SuperKeKB LER (3.6 A)

Flywheel Energy Ratio U_S / U_A	9	
Cavity Voltage V_C	0.47 MV	
Detuning Frequency $\Delta f_{\pi/2}$ / Δf_{AC}	-28 kHz / -280 kHz	
Input Coupling Factor β	5.1	
CBI due to the Acc. mode	τ = ~ 5 ms	RF feedback
CBI due to the 0 and π modes	τ = ~ 30 ms	
CBI due to the HOMs (the fastest longitudinal driven by ~300 Ω at 1.85 GHz)	τ = ~ 15 ms	bunch-by-bunch FB

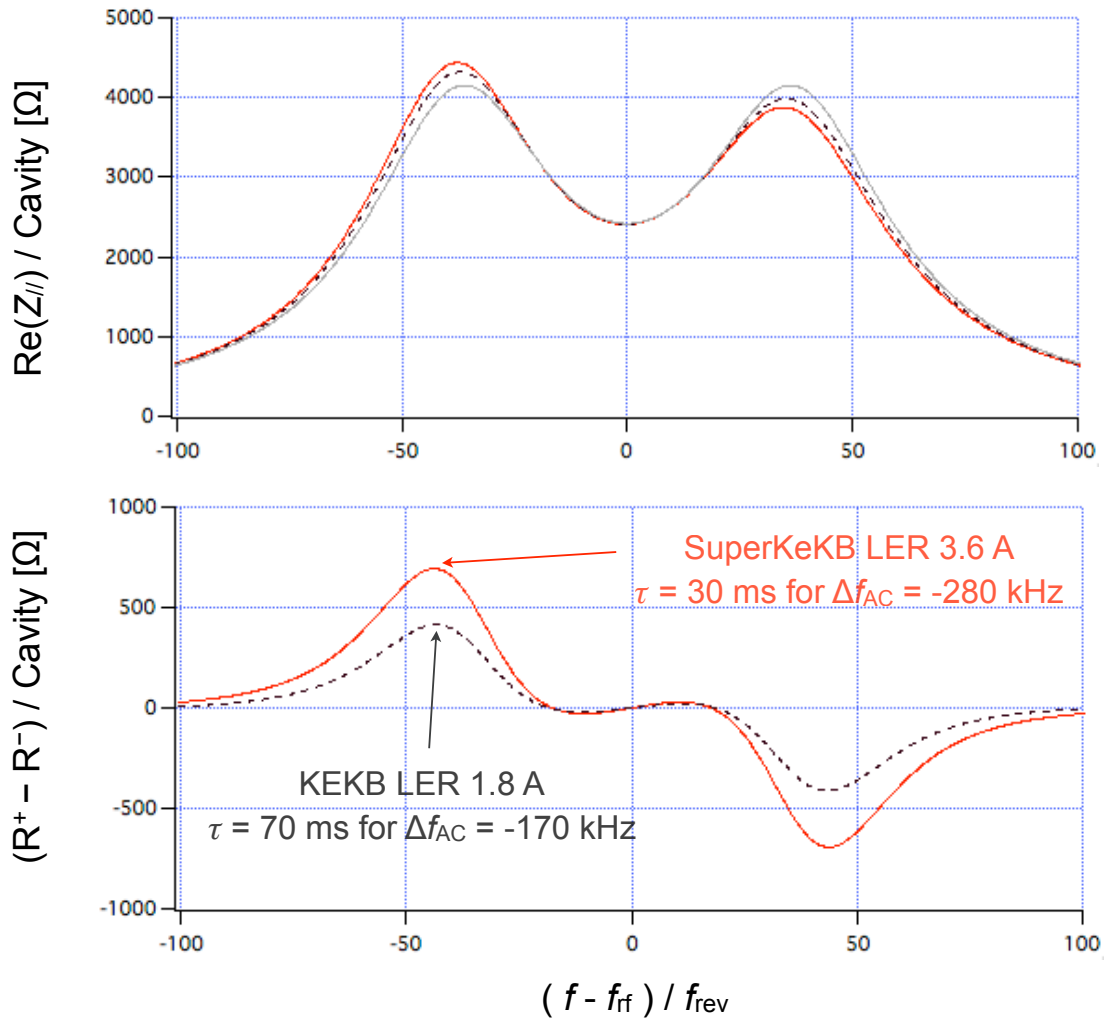
CBI due to the Accelerating Mode (π/2)



CBI due to the Accelerating Mode (π/2)

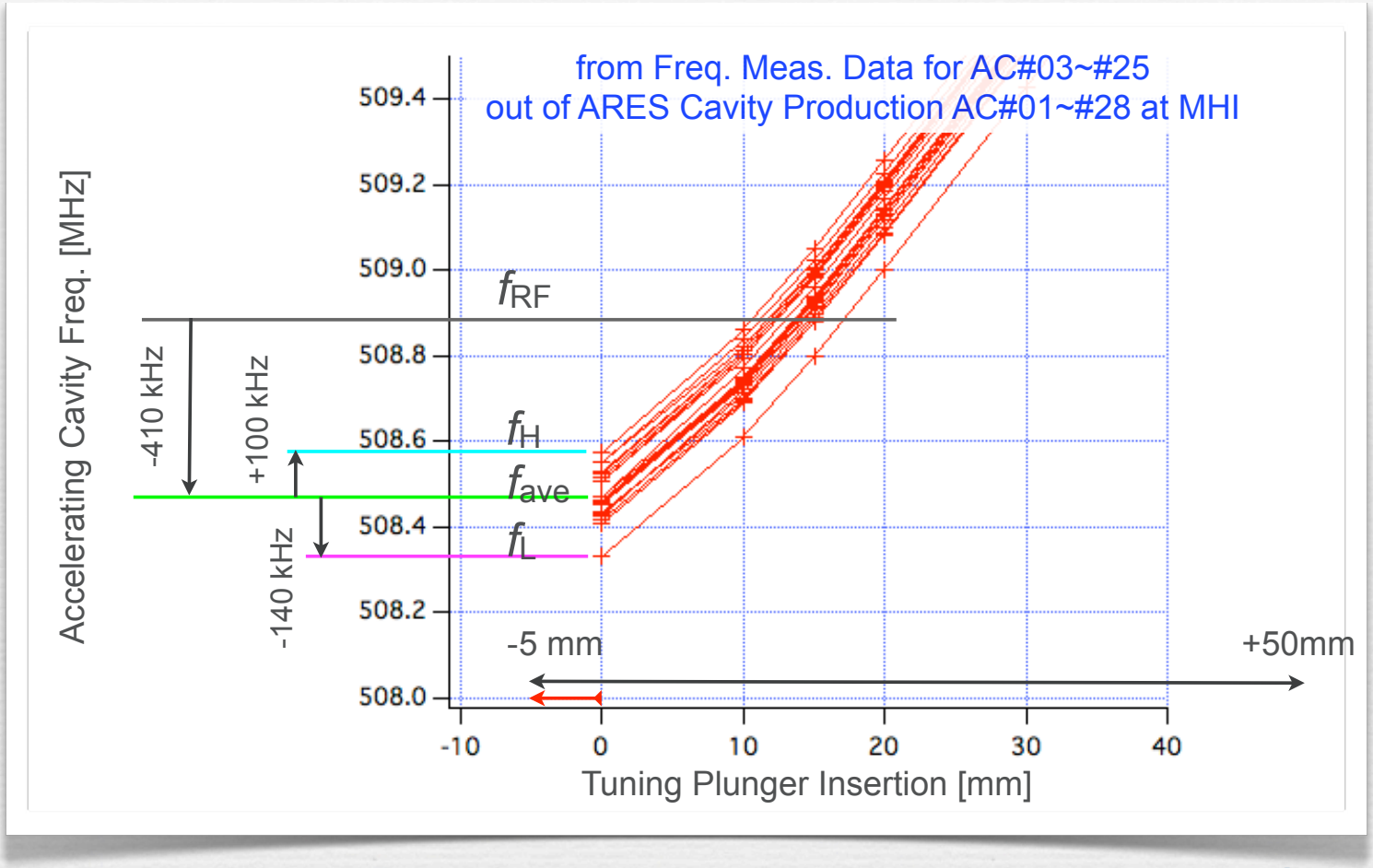


CBI due to the Impedance Imbalance between the Parasitic 0 and π Modes



$\Delta f_{AC} = (1+U_S/U_A)\,\Delta f_{\pi/2}$

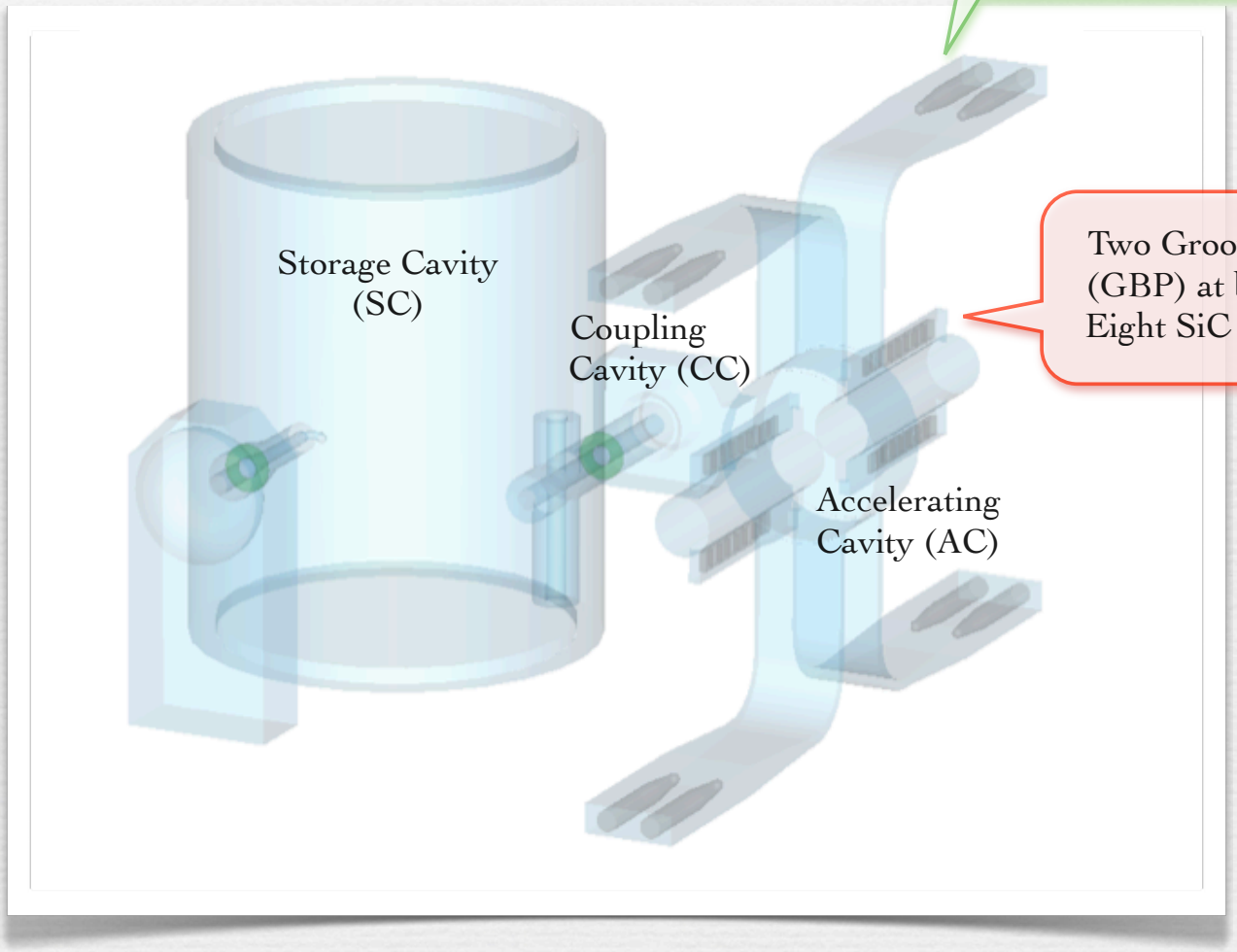
Tuning Range for the Resonance Frequency of the Accelerating Cavity



Min | $\Delta f_{tuner} + \Delta f_{thermal}$ | = 390 kHz > $|\Delta f_{AC}|$ = 280 kHz

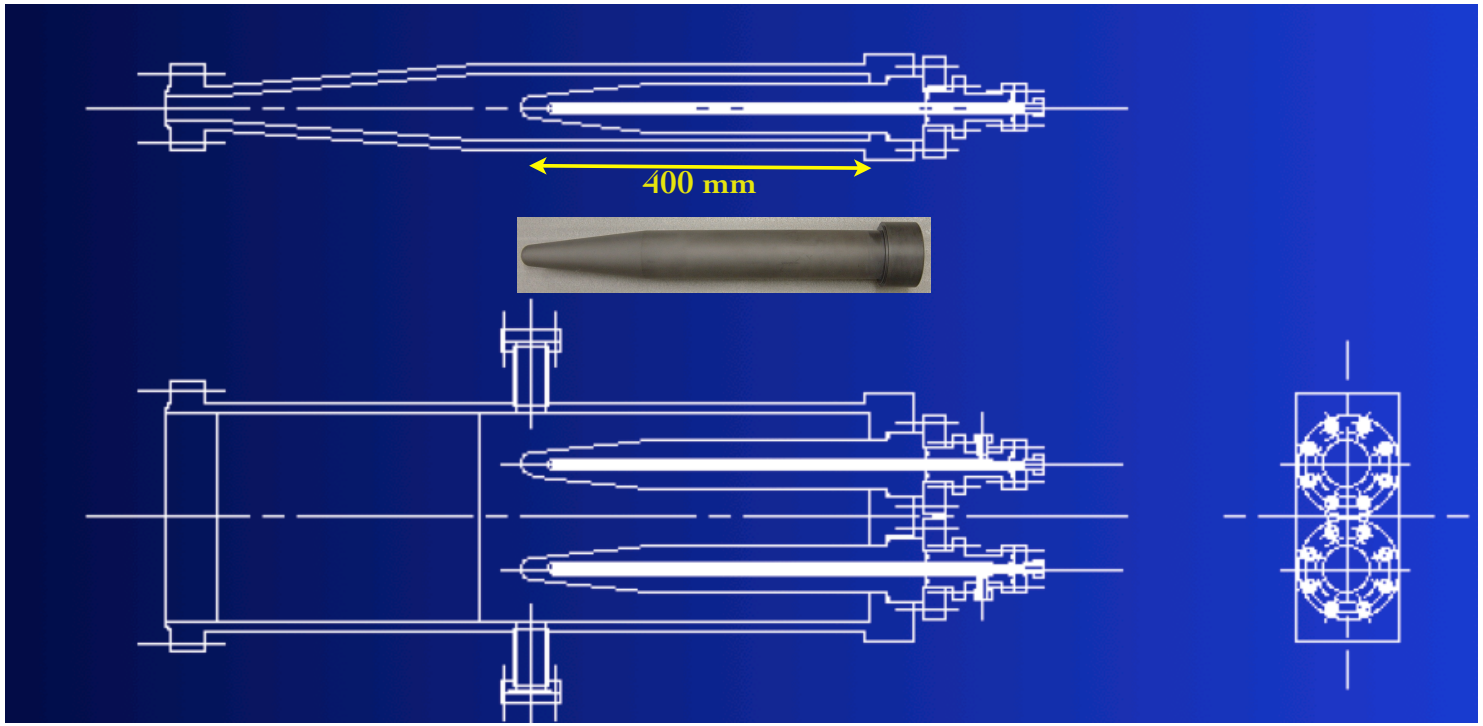
Δf_{tuner} = -310 kHz ~ -550 kHz
$\Delta f_{thermal}$ = -80 kHz for ΔT = +10 K
not include Δf (tuner travel from 0 mm to -5 mm) = ~ -100 kHz

HOM Power Absorbers



3D Schematic View of ARES Cavity System

HWG Load

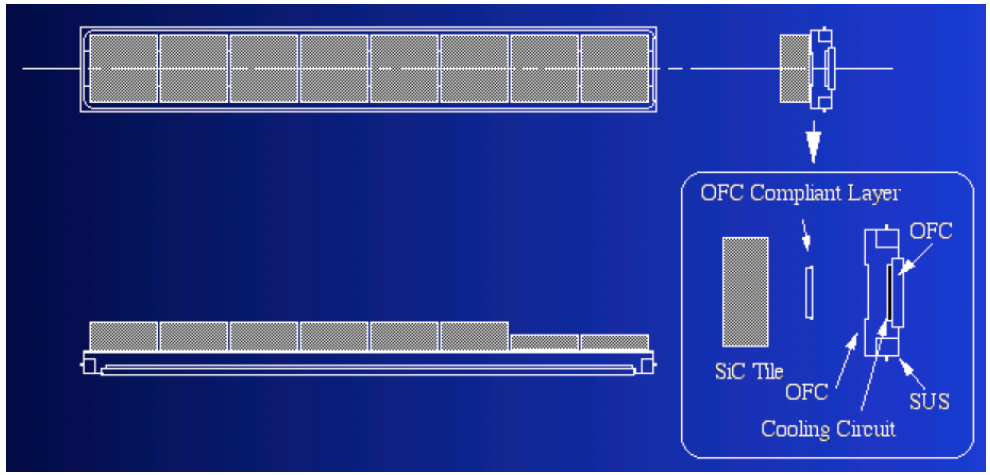


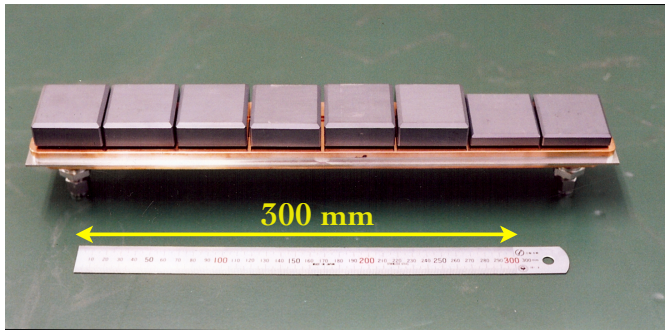
Y. Takeuchi

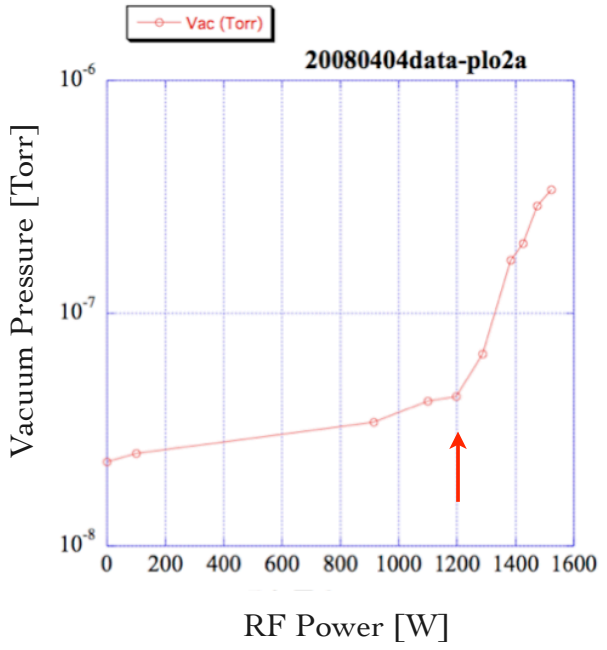
Each HOM WG (HWG) is terminated with two bullet-shaped SiC absorbers.

The power handling capability = 2.5 kW / bullet (5 kW/HWG, or 20 kW/cavity).

GBP Load







Abnormal vacuum pressure rise observed above ~1.2 kW.

Y. Takeuchi

Each groove has eight SiC tiles brazed to a water-cooled copper plate.

The power handling capability = 1.0 kW per groove,
80% of the power level where the abnormal vacuum pressure rise starts.

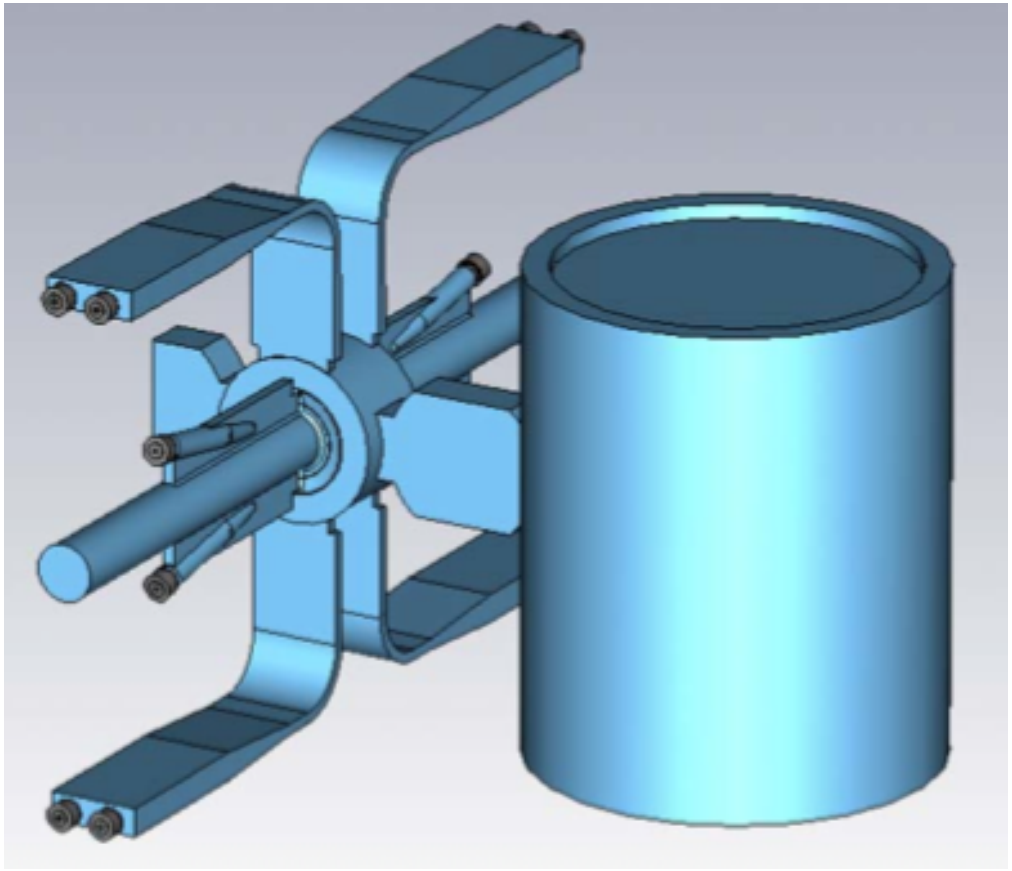
HOM Power Estimation for SuperKeKB

	KEKB LER Sep. 21, 2004	SuperKeKB LER	RF Power Handling Capability verified at 1.3 GHz	Factor of Safety
I_{beam} [A]	1.6	3.6	-	-
N_{bunch}	1293	2503	-	-
σ_z [mm]	7	6	-	-
k [V/pC]	0.40 (0.39†)	0.44	-	-
P_{HOM} /ARES [kW]	5.4†	17	-	-
P_{HOM} /HWG [kW]	1.05†	3.3	5.0	5.0/3.3 = 1.5
P_{HOM} /Groove [kW]	0.3†	0.93	1.0	1.0/0.93 = 1.1

†calorimetric measurement

Backup Design for HOM-damped AC (originally studied for SuperKEKB)

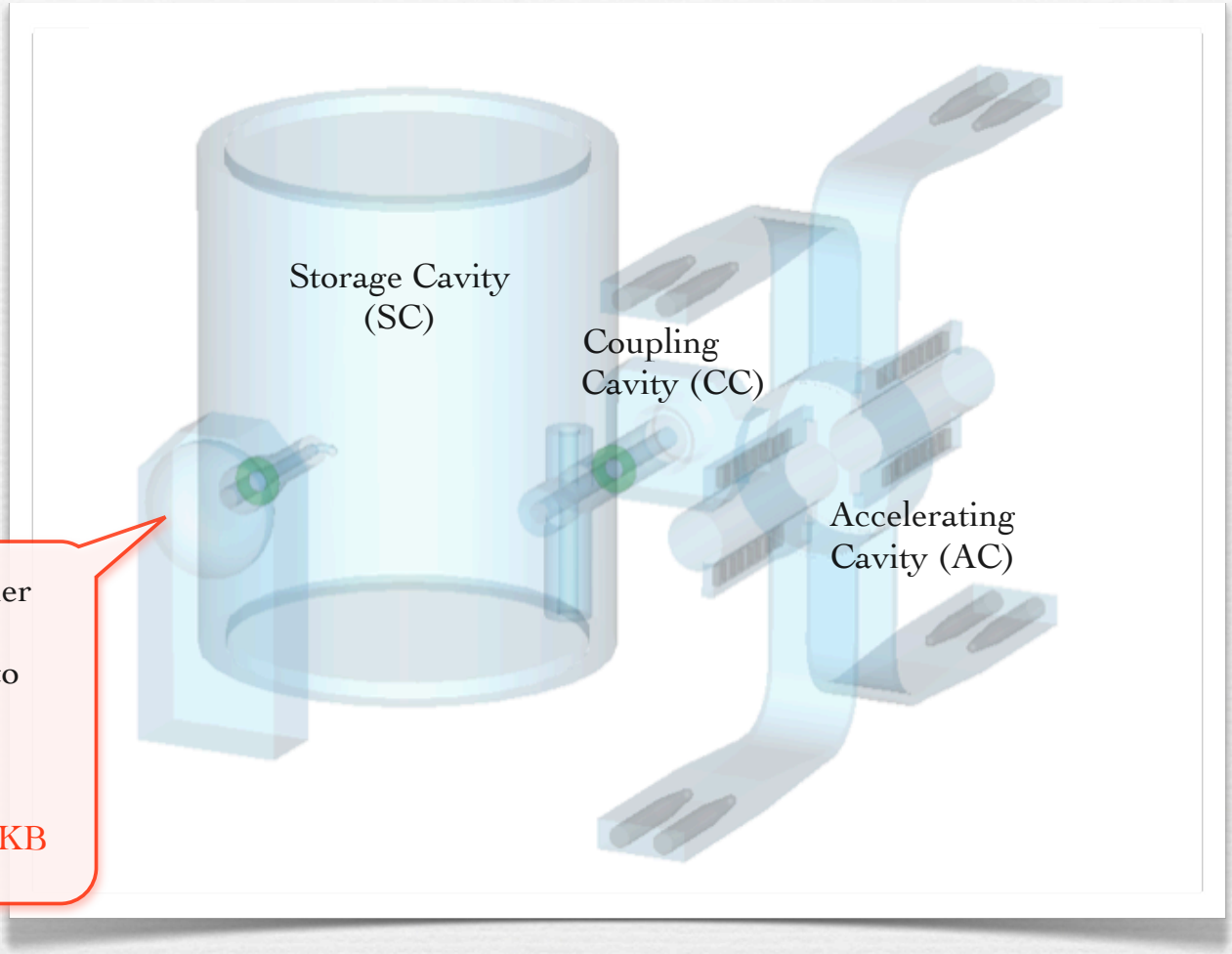
R&D being continued as a side business of the development of the accelerating structure for DR.



T. Abe and Y. Takeuchi

Replace the grooved beam pipes with winged chambers.
Each wing equipped with a bullet-shaped SiC absorber.

Input Coupler Upgrade



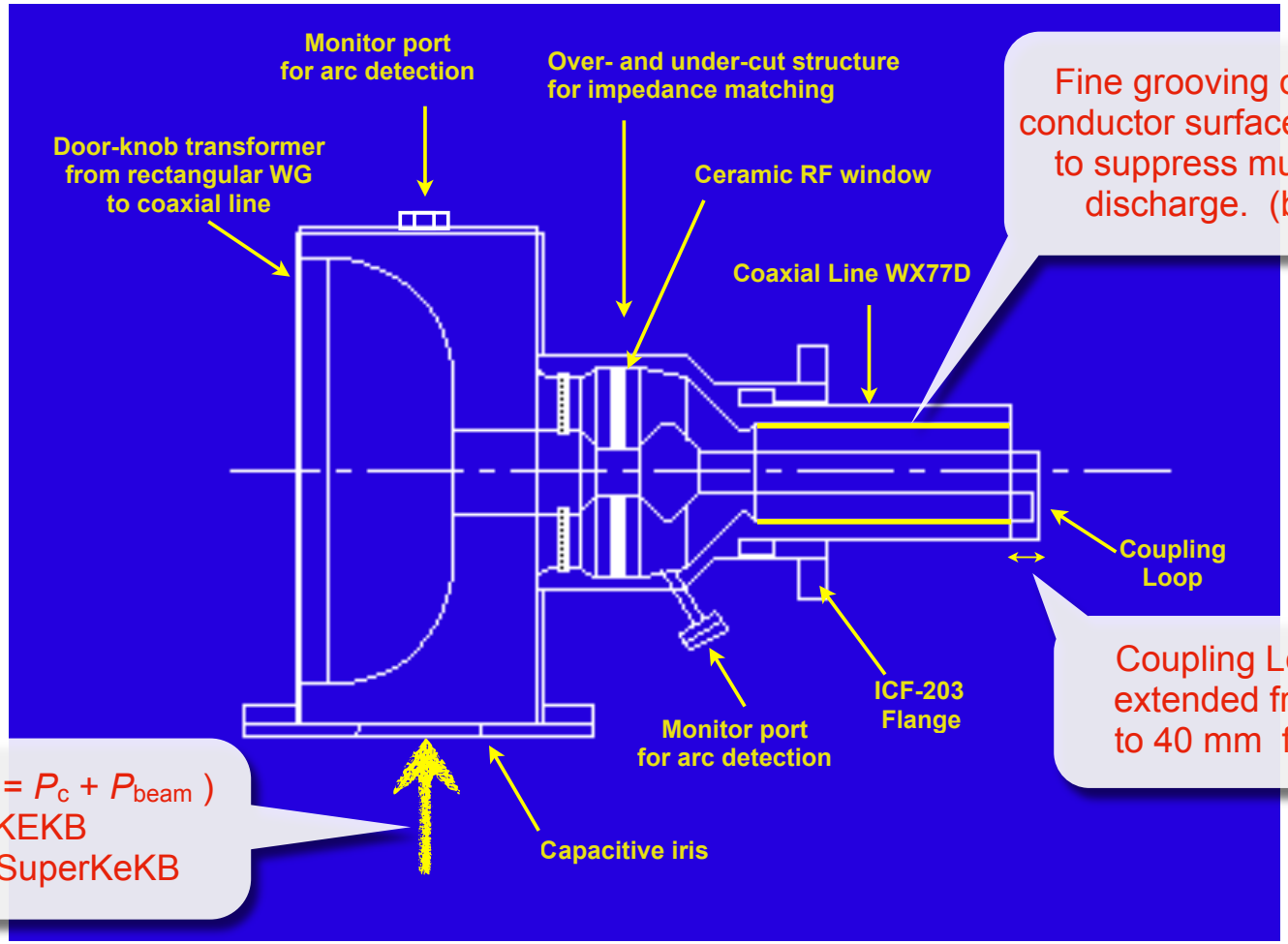
Input Coupler

upgraded to

800 kW
β_{max} = 6
for SuperKeKB

3D Schematic View of ARES Cavity System

Input Coupler Upgrade

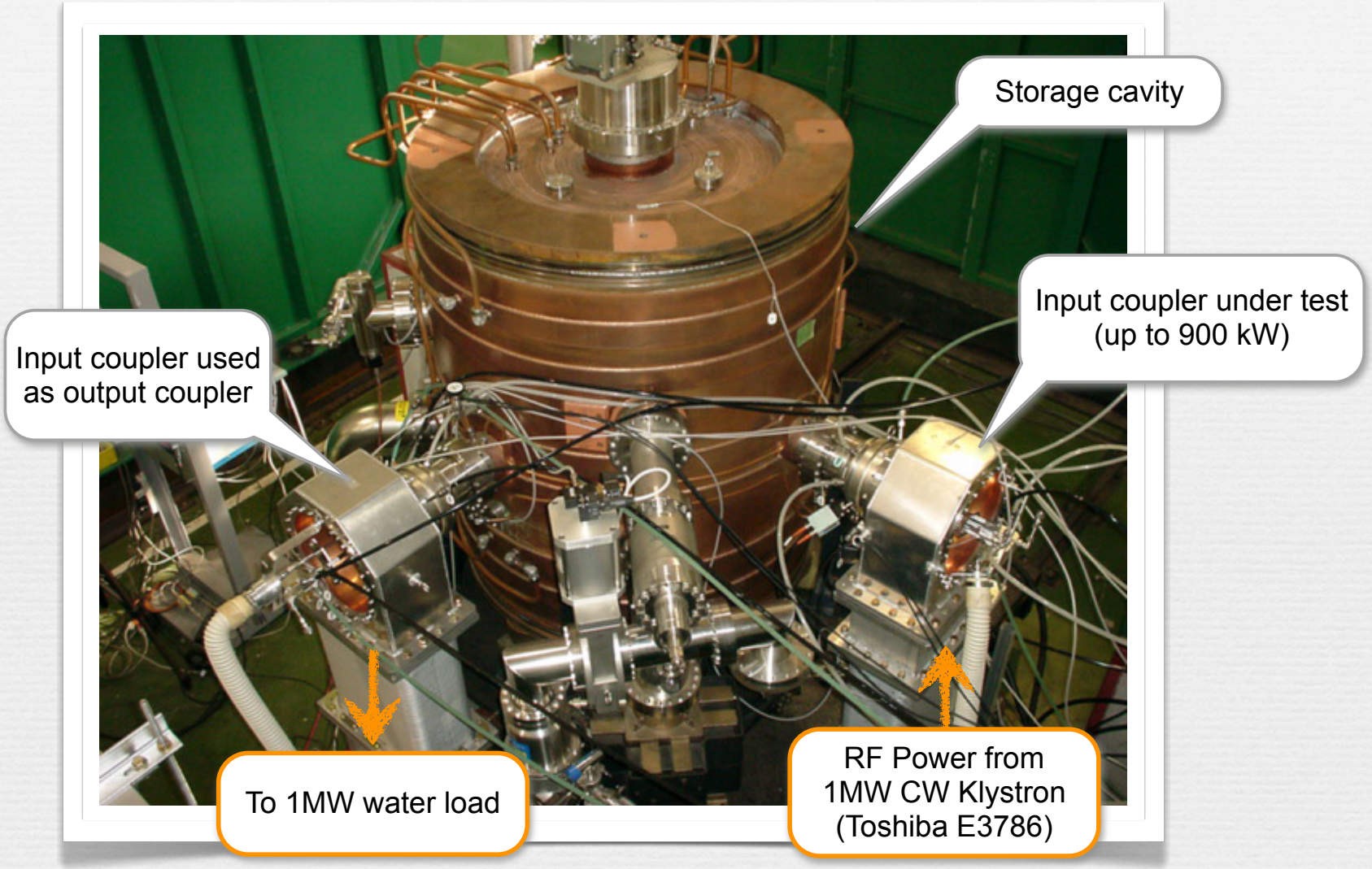


Fine grooving on the outer conductor surface (yellow part) to suppress multipactoring discharge. (by T. Abe)

Coupling Loop Height extended from 20 mm to 40 mm for $\beta_{max} = 6$.

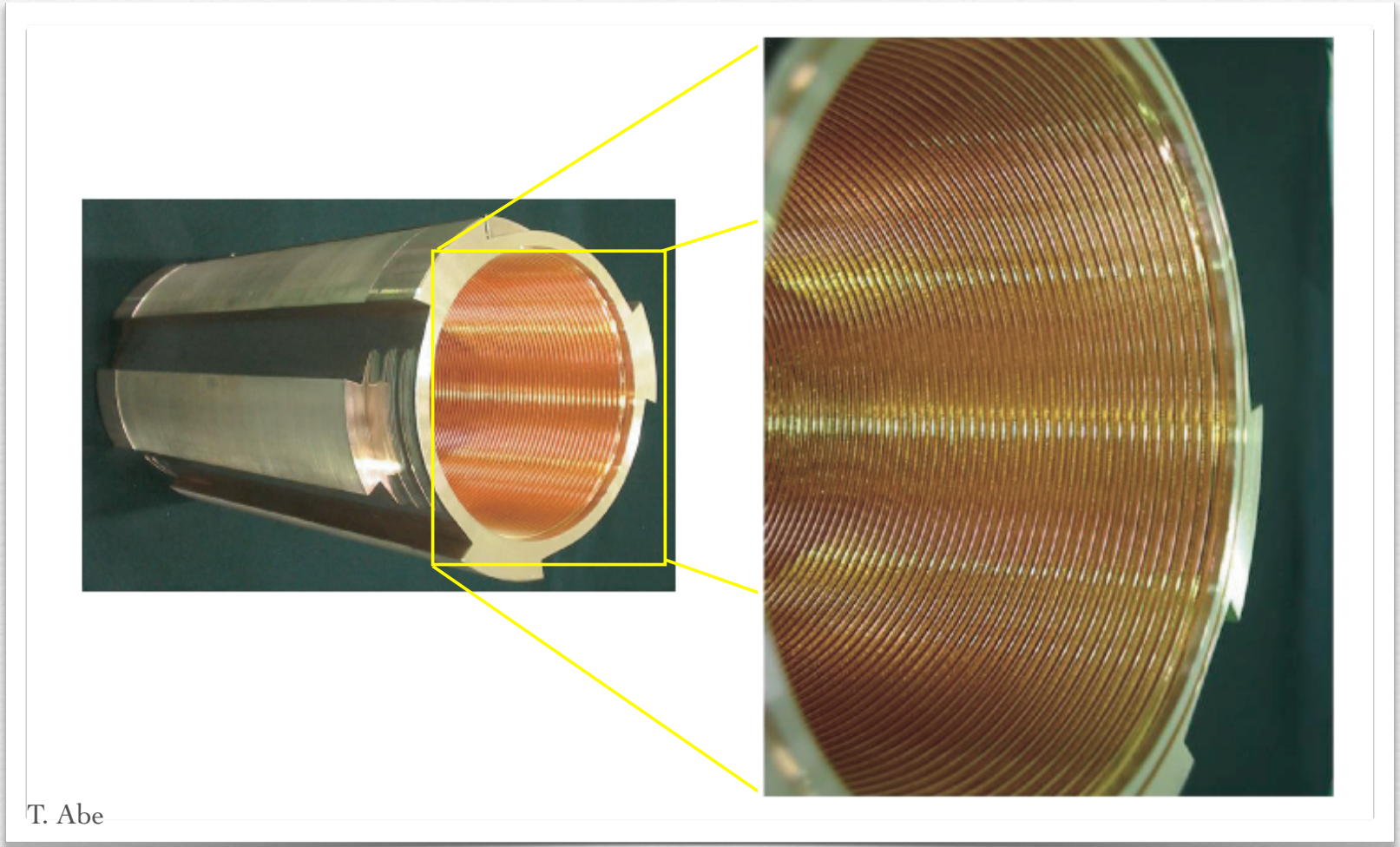
RF Power (= $P_c + P_{beam}$)
400 kW for KEKB
800 kW for SuperKeKB

High Power Test Stand for the Input Coupler



Power handling capability over 800 kW has been demonstrated for the current type of input coupler for KEKB.

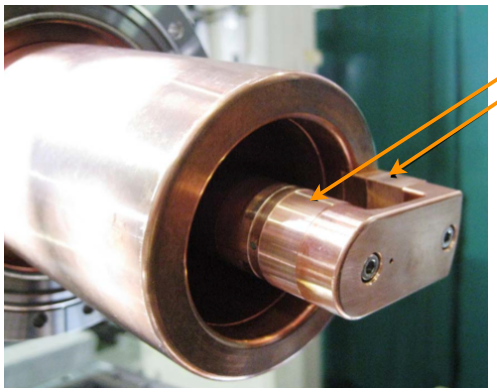
Fine grooving on the outer conductor surface of the coaxial line
in order to suppress the multipactoring discharge.

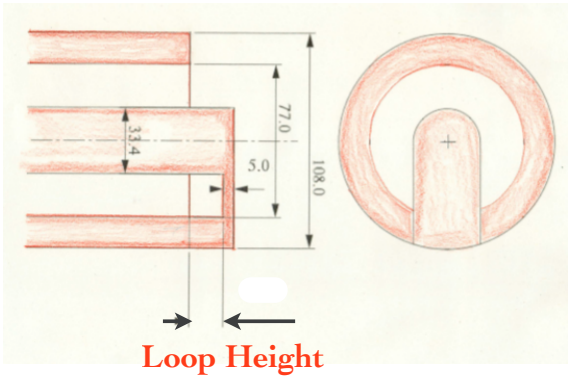


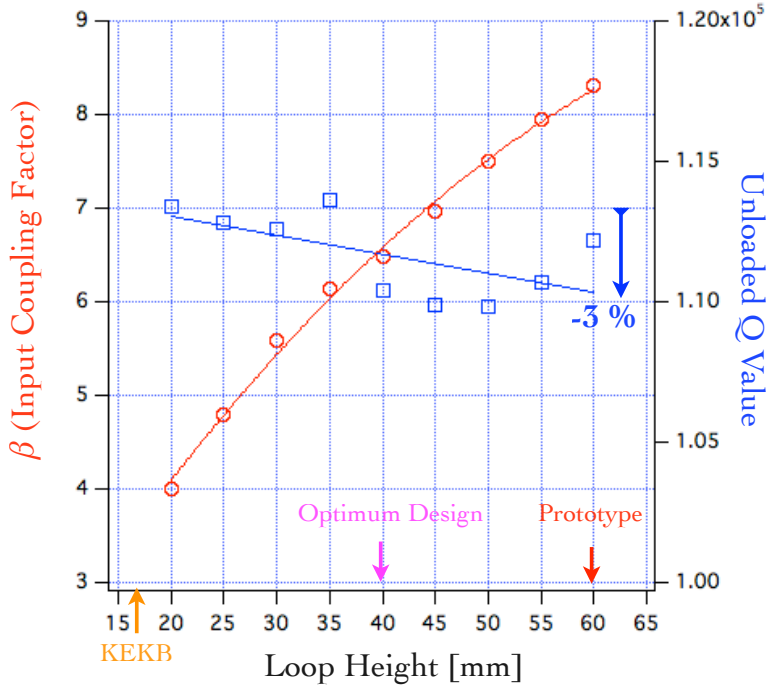
T. Abe

Successfully demonstrated at the test stand first,
and in the actual operation for KEKB.

Input Coupling Factor vs. Loop Height







K. Yoshino, H. Sakai, T. Kageyama

A prototype coupler with a loop height of 60 mm is under fabrication. High power testing is scheduled in April. If the test results are OK, it will be installed on the ARES cavity at D5C in May.

THANK YOU SO MUCH
FOR
YOUR ATTENTION.