KEKB ARES CAVITY SYSTEM STATUS

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KEKB ACCELERATOR REVIEW

2/23/2001

- OVERVIEW
- FAULTS & PROBLEMS
- HOM POWERS
- SUMMARY

KEKB ARES CAVITY OERATION SUMMARY

LER	Sta D7E		Sta D7D		Sta D7C		Sta D7B		Sta D7A				Sta D8C		Sta D8D		Sta D8E	
Kpwr	ON		ON		OFF		ON		ON				ON		ON		ON	
ARES	#2	#1	#2	#1	#2	#1	#2	#1	#2	#1			#1	#2	#1	#2	#1	#2
SC / IC					(1)													
CC / CCD																		
AC																		
Vc / MV	0.43	0.43	0.43	0.43	0.0	0.0	0.43	0.43	0.43	0.43			0.43	0.43	0.43	0.43	0.43	0.43

e^+

Total Vc = 6 MV / 7 NC Stations

HER	Sta D4C		Sta D4B				Sta D5A		Sta D5B		Sta D5C	
Kpwr	ON		ON				ON		ON		ON	
ARES	#2	#1	#2	#1			#1	#2	#1	#2	#1	#2
SC / IC	(3)											(2)
CC / CCD	(3)											
AC												
Vc / MV	0.32	0.32	0.32	0.32			0.32	0.32	0.32	0.32	0.32	0.32

SCC

e^-

Total Vc = 11 MV (3.24 MV / 5 NC Stations + 7.76 MV / 6 SC Stations)

(1) Vacuum pressure rise due to RF contact failure between CC and SC. The station has been shut down from 11/17/2000.

(2) A window failure of the input coupler.

(3) Leaks into vacuum from the cooling water circuits for the CCD and IC windows.

IC : Input Coupler

CCD : Coupling Cavity Damper

AC, CC and SC => See Appendix.

① Abnormal Vacuum Pressure Rise with RF power @ LER D7C2

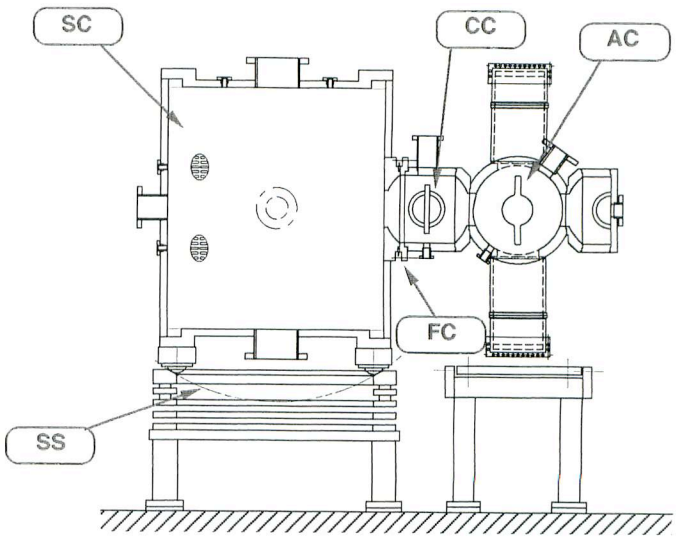
11/17/2000 00:30 ~

Cavity vacuum faults occurred during the cold start-up after the biweekly maintenance on 11/16/2000.
Finally, the RF conditioning failed to bring the cavity into operation.

The vacuum faults were probably caused by an RF contact failure at the rectangular flange connection (FC) between the coupling cavity (CC) and the storage cavity (SC).

It will take about two weeks for on-the-spot inspection and repair.
In the worst case it will take about one month to replace the cavity with a good one.

The comeback of station D7C is scheduled in the summer of 2001.

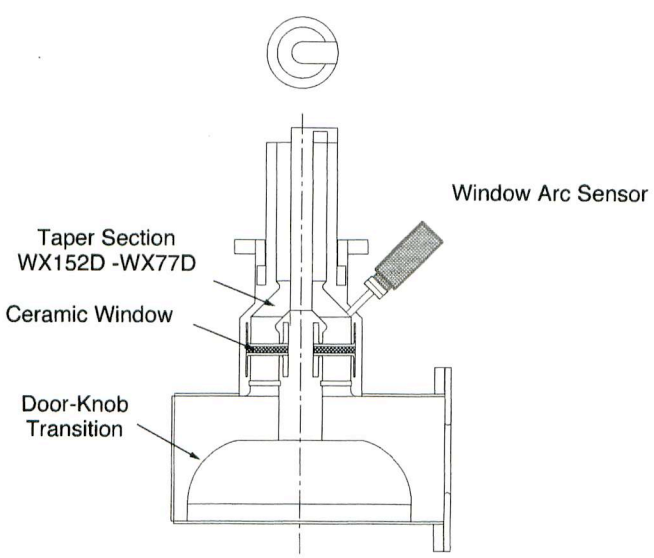


② A Window Failure of the Input Coupler @ HER D5C2

11/24/2000 22:30 ~ 11/26/2000 10:00

The window failure @D5C2 resulting in an air leakage were caused by the following:

- The arc sensor had been installed in the wrong port with a blank flange instead of the view port.
- Recovery operations were repeated without attention to the abnormal reflected RF power trips.



③ Leaks into Vacuum from the Cooling Water Circuits

for the Coupler Windows @ HER D4C2

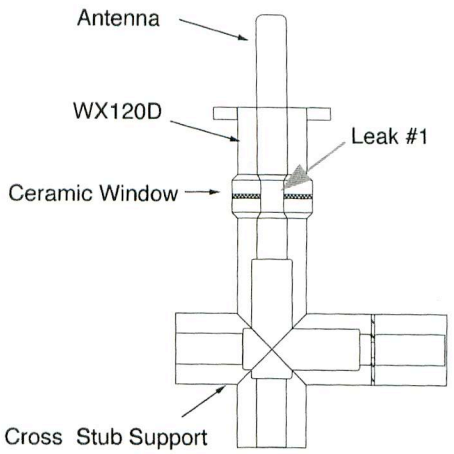
1/10/2001 10:30 ~ 1/18/2001 17:00

A sudden vacuum pressure rise occurred at the station HER D4C on 1/10/2001 in the last scheduled winter maintenance period. The station had not been operated from 12/28/2000.

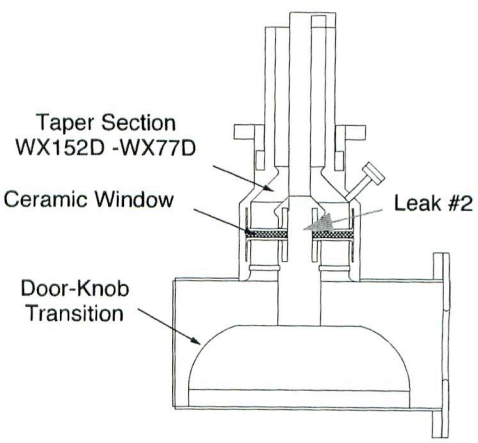
First, a leak was located at the inner cooling water circuit for the ceramic window of the coupling cavity damper (CCD) @ D4C2. After replacing the bad CCD with a new one, another leak was found and also located at the inner circuit of the input coupler @ D4C2.

Those serious leaks were probably caused by erosion-corrosion of copper tubes. Erosion-Corrosion arises from a combination of chemical attack and the physical abrasion as a consequence of the fluid motion. Aggressive waters do not allow a protective film (oxides) to form inside the copper tube.

What makes the water so aggressive ?



Coupling Cavity Damper (CCD)



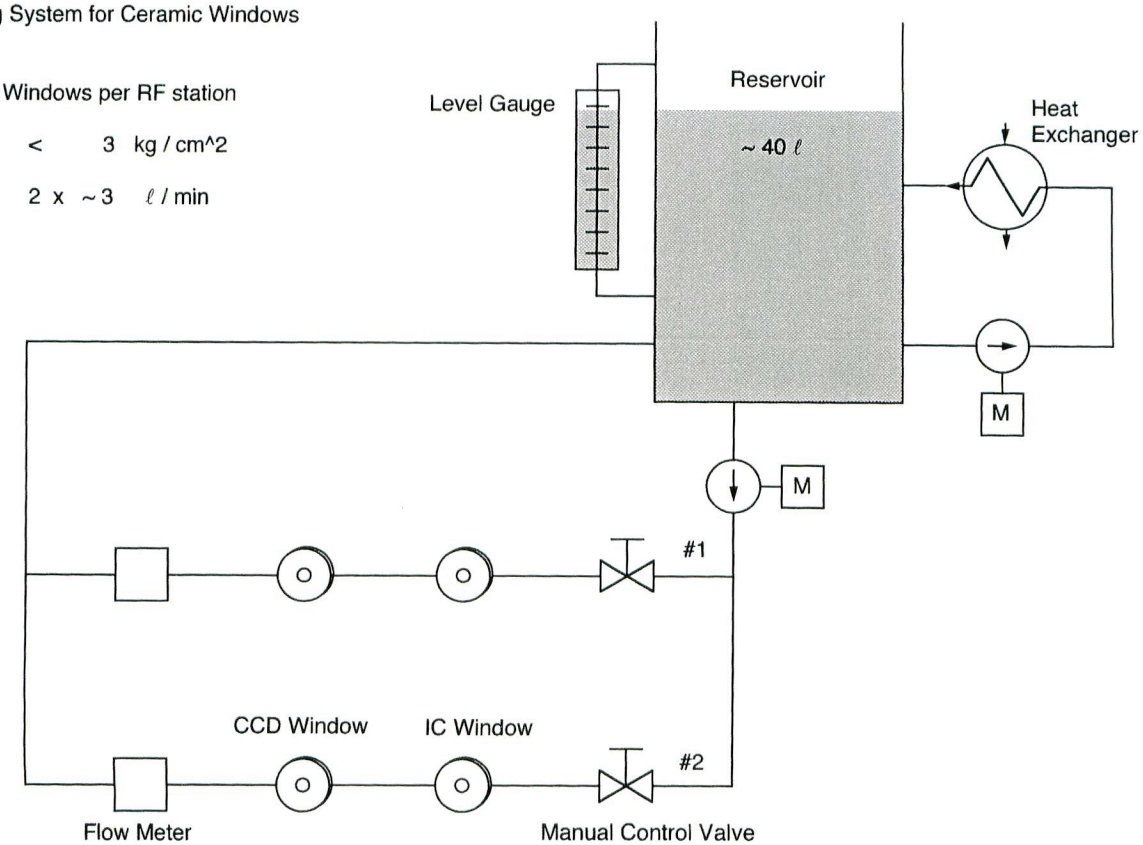
Input Coupler (IC)

Water Cooling System for Ceramic Windows

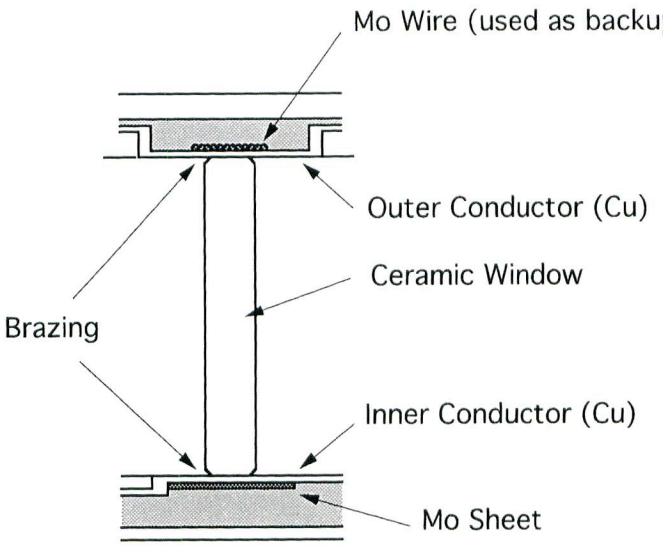
Four Ceramic Windows per RF station

Inlet Pressure < 3 kg / cm^2

Flow Rate 2 x ~3 ℓ / min



Cooling Water Channels for Ceramic Window

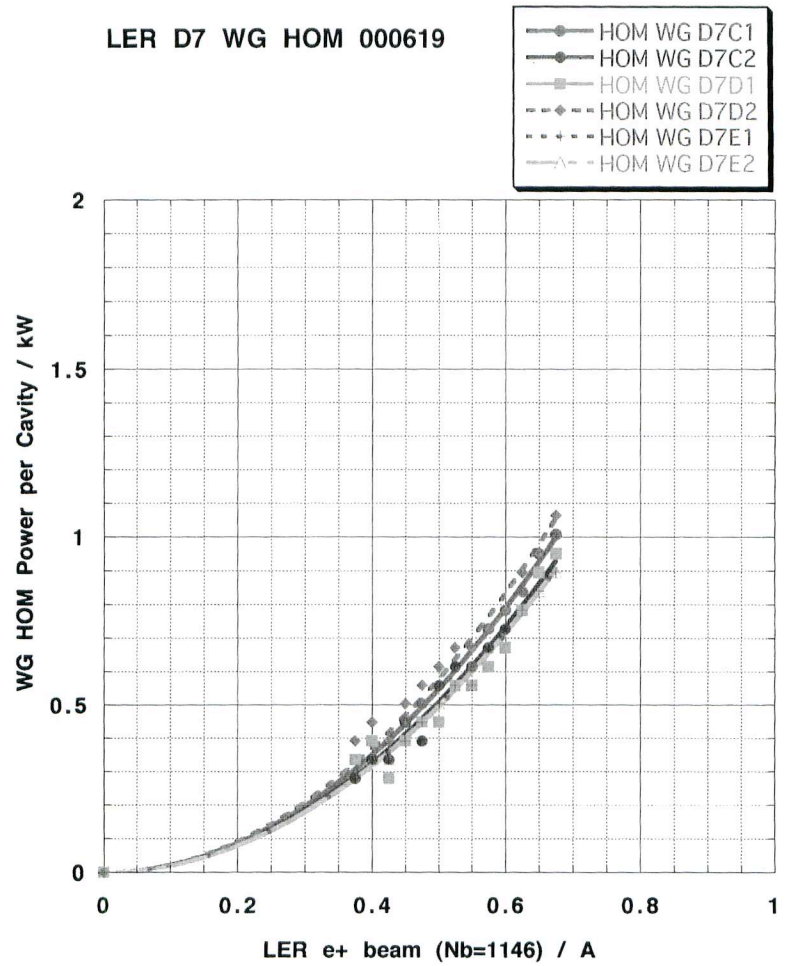


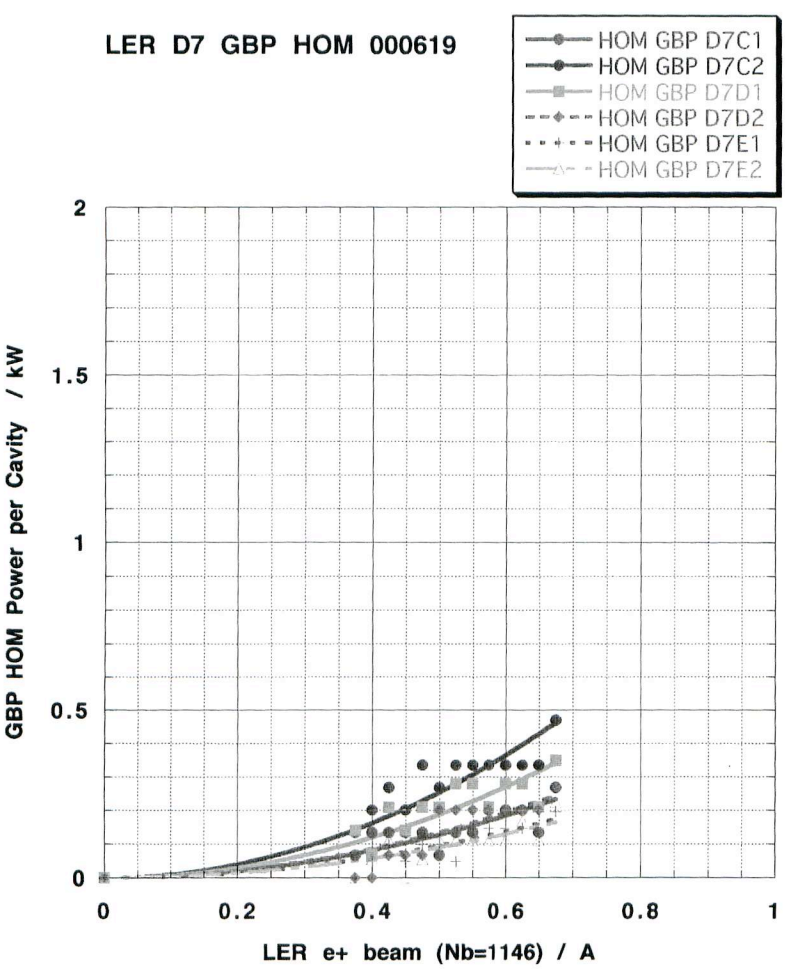
- Liquid velocity ~ 1 m/s
- Erosion-corrosion is probably accelerated by the presence of molybdenum oxide produced from the Mo wire exposed to the cooling water with dissolved oxygen gas.

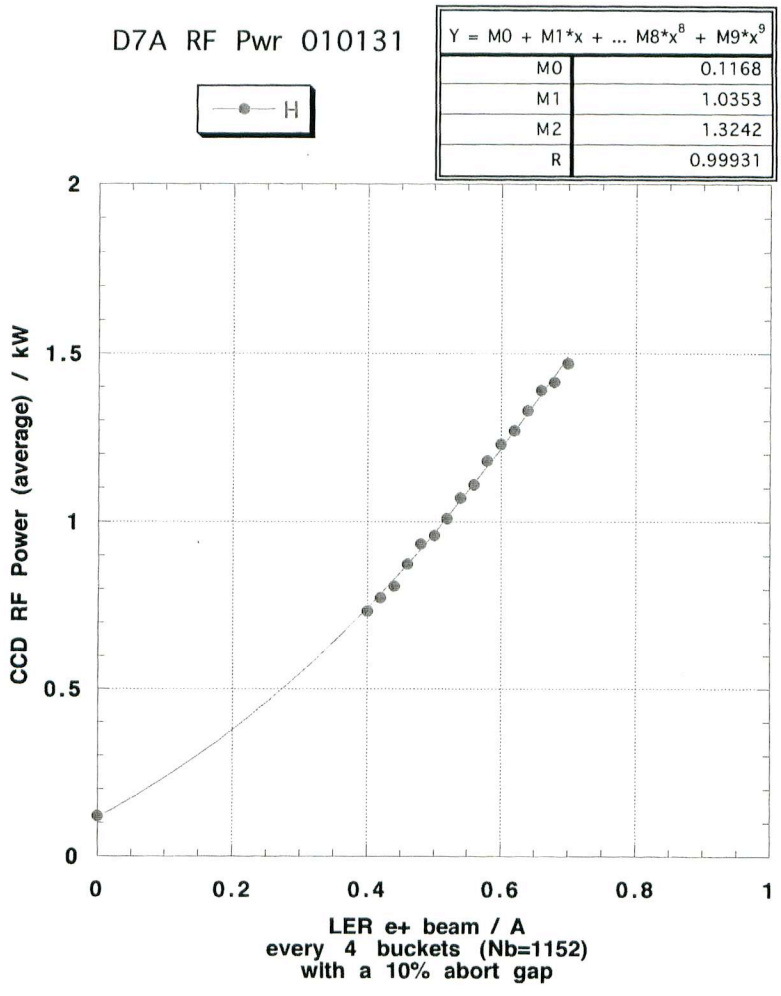
HOM Powers

HOM loads and CCD have been operating well up to ~700 mA (Nb=1152, every four buckets with a 10% gap).

- WG HOM power ~ 1 kW per cavity
- GBP HOM power ~ 0.5 kW per cavity
- CCD power ~1.5 kW per cavity


LER D7 WG HOM 000619
HOM WG D7C1
HOM WG D7C2
HOM WG D7D1
HOM WG D7D2
HOM WG D7E1
HOM WG D7E2
WG HOM Power per Cavity / kW
0
0.5
1
1.5
2
0
0.2
0.4
0.6
0.8
1
LER e+ beam (Nb=1146) / A


LER D7 GBP HOM 000619
HOM GBP D7C1
HOM GBP D7C2
HOM GBP D7D1
HOM GBP D7D2
HOM GBP D7E1
HOM GBP D7E2
GBP HOM Power per Cavity / kW
0
0.5
1
1.5
2
0
0.2
0.4
0.6
0.8
1
LER e+ beam (Nb=1146) / A



SUMMARY

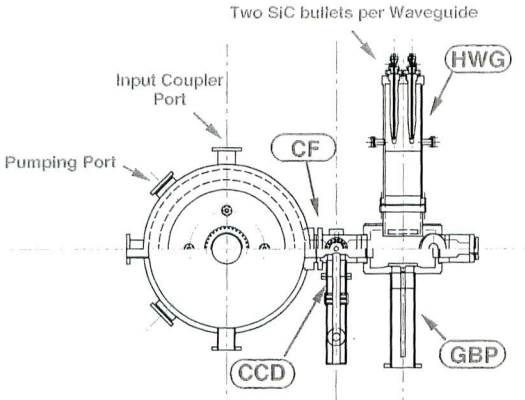
On the whole the ARES cavities have been operating well so far.

We are faced with a couple of problems emerging in the long-term operation of more than two years:

• An RF contact failure at FC between CC and SC @ D7C2.
=> Inspection and repair (or replacement in the worst case) are scheduled in the summer of 2001.

• Erosion-corrosion of copper surfaces is probably accelerated by the presence of molybdenum oxide in the water cooling system for the coupler windows. => The investigation is under way.

STRUCTURE AND RF CHARACTERISTICS



RF Parameters of the π/2 Accelerating Mode

$Ua : Us = 1 : 9$
$R / Q = 15\ \Omega$
$Q = 1.1 \times 10^5$

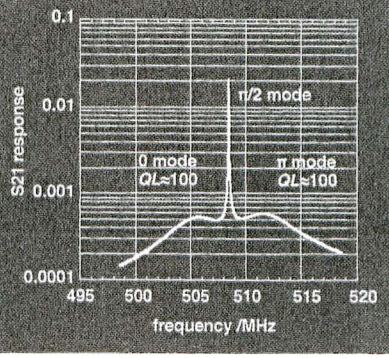
π / 2 - mode basics

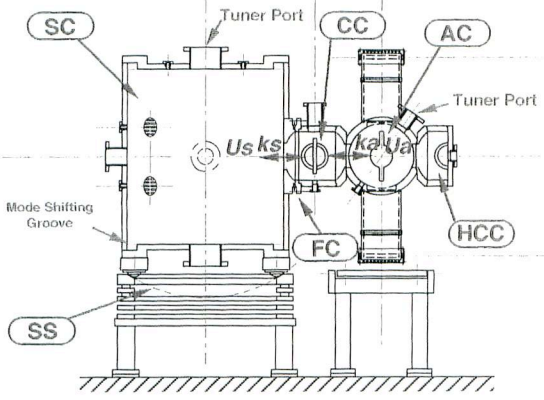
$Ua / Us = ks^2 / ka^2$

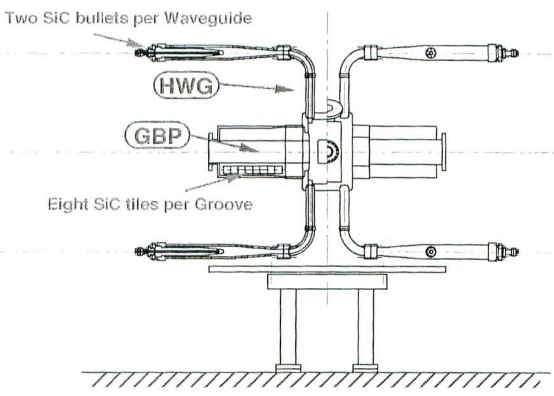
High-Power Performance

Pc = 150 kW / ARES Cavity generating
Vc = 0.5 MV (KEKB Design)

Maximum Continuous
Pc = 380 kW
Maximum for 20 minutues
Pc = 450 kW







LEGEND

(AC) Accelerating Cavity
with four HOM rectangular waveguides (HWG's) for damping monopole and dipole-V HOM's,
with two Grooved Beam Pipes (GBP's) at both end plates for damping dipole-H HOM's.

(CC) Coupling Cavity functions as the keystone of the ARES structure
and equipped with a Coupling Cavity Damper (CCD) to damp the parasitic 0 and π modes.

(CCD) Coupling Cavity Damper for reducing the impedances of the parasitic 0 and π modes.
The π/2 coupling mode is damped about $Q_L \approx Q_{ext} \approx 50$.
Both 0 and π modes are damped about $Q_L \approx 100$.

(FC) Flange Connection
The Storage Cavity (SC) and the Coupling Cavity (CC) are mechanically connected at rectangular flanges
with bolts, and vacuum-sealed by TIG-welding the lips around the flanges.

(GBP) Grooved Beam Pipe selectively lowers the cutoff frequency of the TE11 traveling wave
and damps dipole HOM's in the acclerating cavity.
Each groove has 8 SiC ceramic tiles brazed to a water-cooled copper plate.

(HCC) Half-cell Coupling Cavity restores the symmetry of the accelerating cavity (AC)
with respect to the mid vertical plane including the beam axis.

(HWG) HOM Wageguide (240 mm x 28 mm) for damping monopole and dipole-V HOM's.
Two bullet-shape sintered SiC ceramic absorbers are inserted from the end plate of each waveguides.

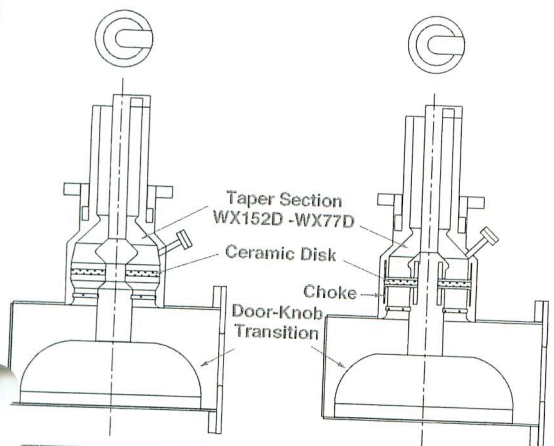
(SC) Storage Cavity is a cylindrical steel cavity with electro-plated copper surfaces.
The operating mode is the TE013 mode with $Q_0 = 165000$.

(SS) Supporting Strucutre allows the storage cavity (SC) the x- and y-parallel motions in the horizontal plane
and the pitch-, roll- and yaw-motions with respect to the connecting flange (CF) direction.

Ua : the stored energy In AC
Us : the stored energy In SC
ka : the coupling factor between AC and CC
ks : the coupling factor between SC and CC

INPUT COUPLER

- Input couplers with two different window matching structures (OUC and CHK) have been developed.
- Both types have been tested over the design RF input power of 400 kW and up to 950 kW.



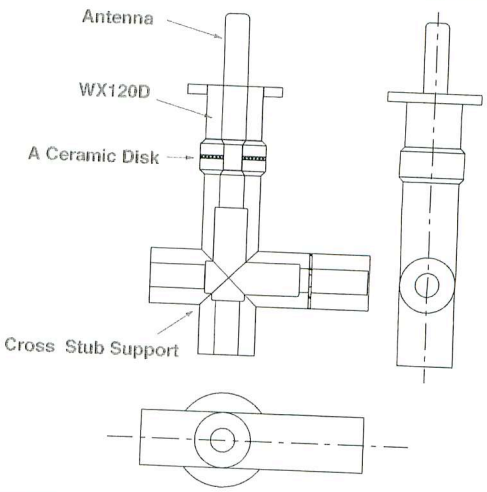
Type OUC
over- and under-cut

Type CHK
choke

COUPLING CAVITY DAMPER

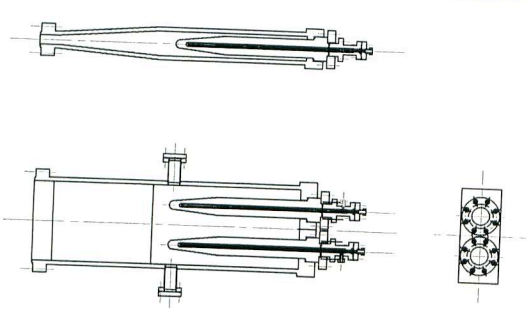
RF power is extracted from the coupling cavity (Qext ~ 50) through a coaxial waveguide (WX120D) with a disk-type ceramic window and a cross stub support.

Power capability (design < 1 kW CW)
tested up to ~ 20 kW CW



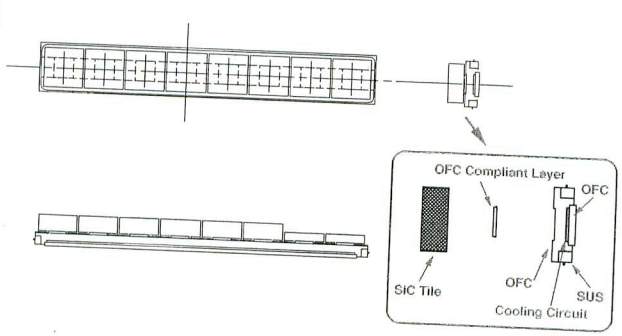
HOM LOADS

Bullet-shape sintered SiC Ceramic Absorber



- Two absorbers (ø55mm x 400mm) per HOM waveguide.
- Power capability tested up to 3.3 kW (CW) per absorber.

SiC Ceramic Tiles for GBP HOM Load



- Eight SiC tiles (48mm x 48mm x 20mm or 10mm) per groove.
- Power capability tested up to 0.5 kW (CW) per groove