Present status of RF cavity vacuum system

Hiroyasu EGO, Masahiro HARA, Naoyasu HOSODA, Yoshitaka KAWASHIMA, Yuji OHASHI,
Takashi OHSHIMA, Hiromitsu SUZUKI, Takeo TAKASHIMA and Hiroto YONEHARA

SPring-8, Kamigori, Ako-gun, Hyogo 678-12, Japan

Twenty-four bell-shaped single-cell RF cavities were fabricated and installed in three straight sections of the SPring-8 storage ring. Figure 1 shows the cavity assembly in one of the sections. The assembly consists of the cavities, the vacuum instruments, RF waveguides, RF input couplers and frequency tuners. The cavities are connected to each other with special vacuum vessels; three vacuum manifolds and four bellows made of stainless steel. Figure 2 shows the cut-view of the manifold. Since two cavities at both sides of one vacuum vessel are connected smoothly by the slit copper pipe fixed in the vessel, the parasitic impedance at the vessel is reduced [1]. Rings made of beryllium-copper alloy or silver with a diameter of 100 mm are used as RF contacts between the cavity and the vacuum vessel. The cavities at both ends of the assembly are connected to the vacuum chambers, which are mounted in the quadrupole magnets, by a tapered pipe made of stainless steel and transforming the shape of cut-view with a diameter of 100 mm to the elliptical one with a semi-major radius of 50 mm and a semi-minor radius of 20 mm. The cavities are evacuated through their beam ports with a diameter of 100 mm connected to the manifolds. A cold cathode gauge and the main vacuum pumps, a sputter ion pump (its pumping speed of 400 litters per second for N^2 gas) and a titanium getter pump (its pumping speed of 800 litters per second for N^2 gas), are attached to the ports of each manifold. A thermocouple gauge, an extractor ion gauge, a mass-spectrometer and a roughly pumping system are connected to the manifold in the center position of the assembly. The roughly pumping system consists of a turbo molecular pump (its pumping speed of 285 litters per second for N^2 gas) and a dry pump (its pumping speed of 7.5 litters per second for N^2 gas).

After the success of a helium-leak test, the cavity assembly was evacuated to less than 1×10^{-5} Pa by the roughly pumping system and was baked at 150˚C for more than 100 hours. After completion of baking, we started to operate the main pumps. The attained value of pressure in the assembly was about 1×10-7 Pa. The mass-spectrometer showed that there was only H2 gas in the cavity assembly after baking.

We conditioned the cavity assembly in high and CW RF power operation. RF power up to 90 kW was successfully put into each cavity with the power control system aided by a computer [2][3].

Figure 3 shows the time chart of the output power from a klystron and the pressure in the assembly. The left vertical axis shows the RF power from the klystron. About 89 % of the power was consumed in

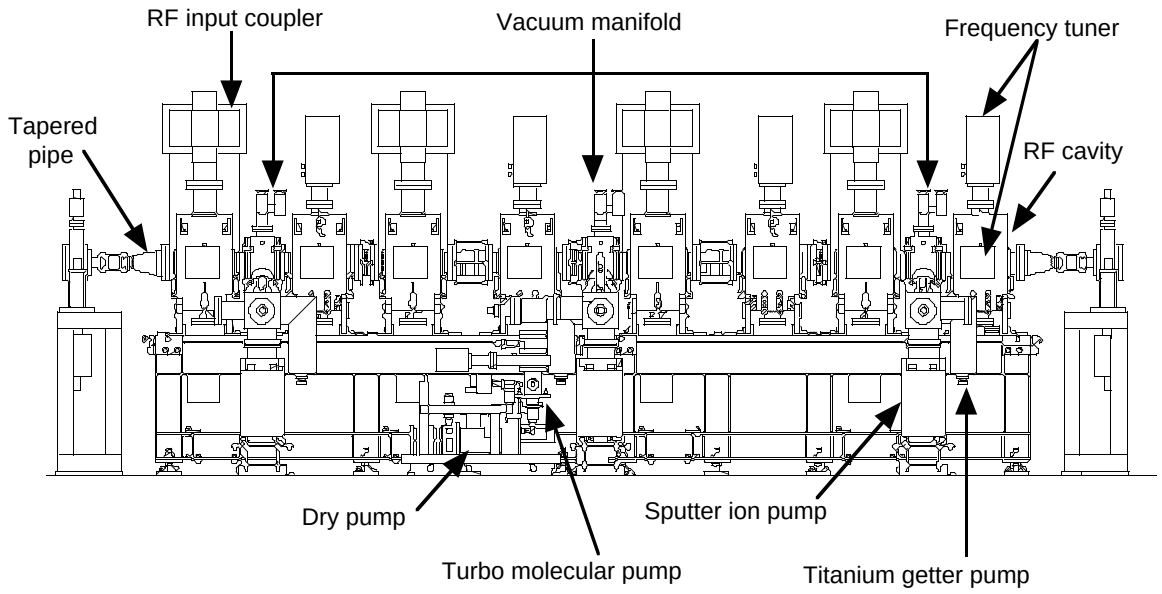

Fig. 1 Cavity assembly of the SPring-8 storage ring.

the eight cavities. The rest of the power was reflected from the cavities and flew into 50 kW dummy loads through magic-Ts and a 300 kW dummy load through a 1.2 MW Y-type circulator. The right vertical axis shows the pressure in the manifold between the first cavity and the second cavity at the right-hand side in Fig. 1. In the beginning of feeding RF power into the cavities, the values of pressure became a higher one over 1×10^{-5} Pa at small RF power by the out gas from the inner surface of the cavities exposed to the excited electric field. The out gas was gradually reduced by the continuous exposure of the surface to the electric field. Finally the value of pressure reached to about 5×10^{-7} Pa while the RF input of 90 kW was put into all cavities. The value of pressure without feeding RF power was also improved to about 6×10^{-8} Pa.

References

[1] T.Nakamura, SPring-8 Annual Report, 151 (1995).
[2] T.Oshima et al., SPring-8 Annual Report, 125 (1995).
[3] T.Ohshima et al., Proc. of the 5th European Particle Accelerator Conf., SITGES (Barcelona), 2047 (1996).

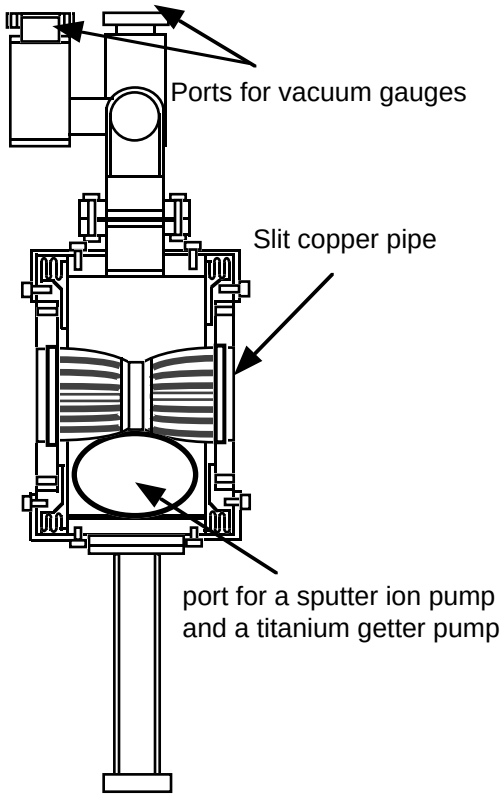

Fig. 2 Cut-view of the vacuum manifold.

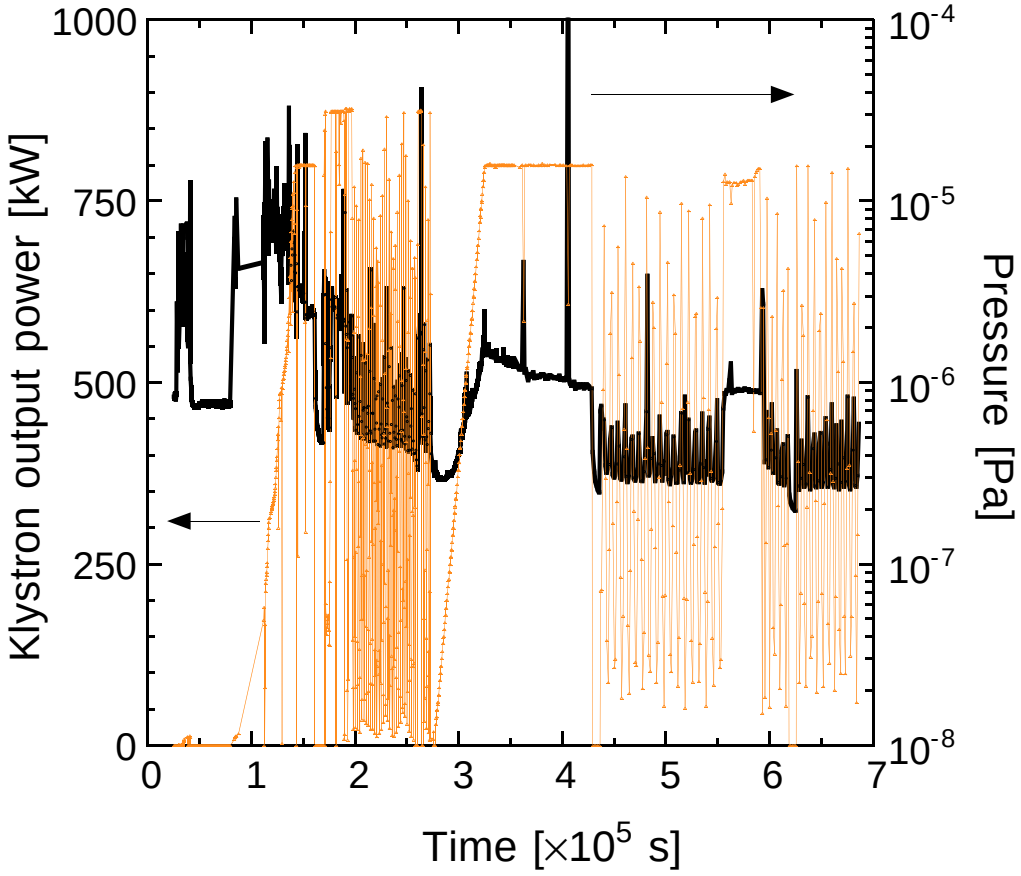

Fig. 3 Result of the conditioning by feeding the RF power into the cavities. The thin dotted line shows the output power from a klystron. The thick solid line shows the pressure in the manifold at the right-hand side in Fig. 1.