Pre-assembly and Vacuum Test for One Unit Cell of the SPring-8 Storage Ring Vacuum System

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1. Introduction

In order to confirm the specifications of the Spring-8 storage ring vacuum system[1] from various points of view prior to the manufacture of whole vacuum system of the storage ring, the pre-assembly test of the vacuum system of one unit cell was carried out in the test room [2] which was temporarily constructed in the experimental hall.

The assembly test has the following aims:

1) to confirm that all vacuum components can be assembled with the required level of accuracy
2) to confirm that there is no interference between chambers and magnets
3) to measure the deformation of the chamber due to the pressure difference between the atmospheric pressure and the vacuum (especially at the BPM section)
4) to measure the position reproducibility of the BPM due to bakeout cycle
5) to check the ultimate pressure of this system

The details of the chamber deformation at the BPM section due to the evacuation and the chamber displacement due to the bakeout is reported in this issue of the Annual Report by H. Saeki et al. In this report, the results of the chamber assembly, installation test and vacuum performance estimation before and after bakeout at 150 ℃ is described.

2. Vacuum chambers and pumping system

The vacuum system of normal unit cell consists of three straight section chambers, two bending magnet chamber, two crotches, four bellows chambers, two gate valves, one dummy chamber where the insertion device will be installed in future, and two photon shutters for synchrotron radiation (SR) extracted from the ring. Figure 1 shows a layout of one unit cell of the vacuum system. The chambers are extrusions made from aluminum alloy (A6063-T5), which are equipped with water channels for cooling and bakeout. Supporting structure of a straight section chamber is composed of a leaf spring and a support with a rotational bearing, making it possible to accommodate thermal expansion of the chamber in longitudinal direction during the bake cycle.

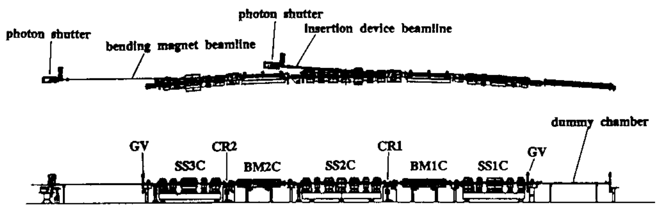

Fig.1. A layout of one unit cell of the vacuum system.

The main pumping system is based on non-evaporable getter (NEG) strips which are installed in the straight section and bending magnet chambers. In addition, the distributed ion pumps are installed in the bending magnet chambers. Lumped NEG (LNP) and sputter ion pumps are used at the crotch and absorber locations where the photon-desorbed gas are generated.

3. Installation

After the 150 ℃ pre-bakeout, the chambers were installed together with magnets in the test room. To avoid the interception of SR from the insertion device, the installation errors of photon absorber of the crotch and of the slot of the bending magnet chamber must be less than 0.3 mm and 2 mm, respectively. The offsets of bellows in horizontal and vertical directions must be less than 1 mm since bellows assembly contain the RF slide fingers.

The crotches were installed with an accuracy of less than 0.3 mm. The bending magnet chambers were installed with an accuracy of less than 0.53 mm. For the longest straight section chamber (5.7 m long), maximum displacement error was 2.3 mm near the center of the chamber. Displacement errors in other places were less than 0.6 mm. The offsets of bellows in horizontal and vertical directions were less than 0.9 mm and 0.32 mm, respectively. Furthermore, it was confirmed that clearance space between the magnet inner surface and the vacuum chamber outer surface were more than 2 mm.

4. Vacuum performance

The chambers were baked by means of super heated water pumped through the water channels of the vacuum chambers [3]. During the bakeout and NEG activation, mobile type rough pumping system which consists of a turbo molecular pump and a rotary pump, was used. Bakeout procedure was performed at three different temperatures. At the first bakeout procedure, all parts of the vacuum system were baked at the temperature of 150 ℃ During three months period after first bakeout, the vacuum system was exposed to dry nitrogen gas several times. Then second bakeout was done at the temperature of 120 ℃. At the third bakeout procedure, aluminum parts of the vacuum system are baked at the temperature of 150 ℃, and stainless steel parts at 250 ℃. Stainless steel parts are located at the crotch and absorber section. Figure 2 shows the baking temperature and pumping down curve of the vacuum system.

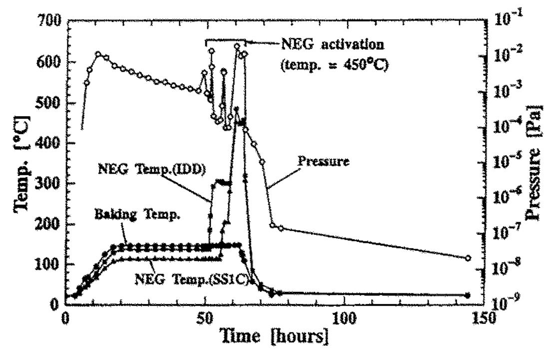

Fig.2. Temperature and pump down curve of the v acuum system during bakeout.

The vacuum system was baked for about 50 hours at the maximum temperature. The NEG strips and lumped NEG were activated simultaneously for approximately 60 minutes at the last stage of bakeout. Activation temperature was about 450 ℃.

The comparison of ultimate pressure over one unit cell for three different baking temperature is shown in Fig 3. An average pressure of 2.4×10^{-8} Pa has been achieved in this one unit cell. H_2O peak dose not exist in the residual gas spectrum which was measured after the bakeout.

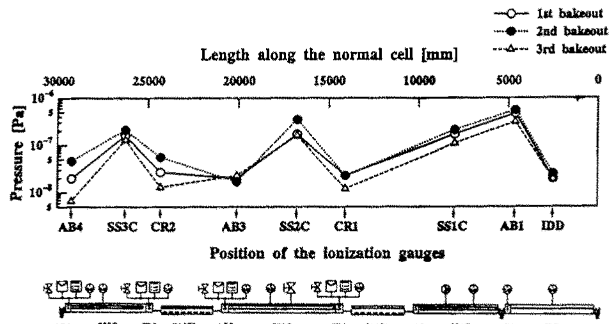

Fig.3. Comparison of ultimate pressure over one unit cell for three different baking temperature.

5. Conclusion

The pre-assembly of the vacuum system of the storage ring together with the magnet system was successfully carried out without any serious problem. The vacuum system evaluation was also performed. Based on these results, we are going to proceed the mass production of the vacuum system of the 47 cells of the rest.

References

[1] H. Ohkuma et al., in Proc. of the 9th. Meeting on Ultra High Vacuum Techniques for Accelerators and Storage Rings, KEK, March 3-4, 1994, KEK Proceedings 94-3, p.29

[2] K. Watanabe et al., in Proc. of the International Conference on Vacuum Science & Technology and SRS Vacuum Systems, Indore, India, January 30- February 2, 1995, in press.

[3] H. A. Sakaue et al., in this issue of the SPring-8 Annual Report.