STATUS OF THE NSRL STORAGE RING UHV SYSTEM AFTER PROJECT-II

Y. Wang, W. Wei, J. P. Wang, L. Fan, F. Y. Zhao, D. M. Jiang, C. Y. Guan
National Synchrotron Radiation Lab., University of Science and Technology of China,
P. O. Box 6022, Hefei, Anhui 230029, P. R. China

Abstract

The NSRL project-II has been finished in December 2004. The UHV system of storage ring has undergone improvement and now provide long beam lifetime and stable operations, the average pressure of ring is better than 2×10-8 Pascal without beam and 1×10-7 Pascal with beam, The typical beam lifetime is 12 hours at 300 mA and 800 MeV without wiggler and 8 hours at 300 mA and 800 MeV with wiggler on. The improvements and status of NSRL storage ring are described in this paper.

INTRODUCTION

The 800 MeV Electron Storage Ring of the National Synchrotron Radiation Laboratory (NSRL) is a dedicated VUV and soft X-ray synchrotron radiation light source. The construction of NSRL facility began on November, 1983 and its commissioning is to end in December 1991. The typical beam lifetime of the NSRL stored beam was over 600 minutes at 200 mA and 800 MeV. In 1999, a 6 Tesla superconducting wiggler magnet and a pure permanent magnets Transverse Optical Klystron (TOK) have been design and constructed for the Storage Ring FEL (free electron laser) as two insertion devices have been installed into the ring. In 2003, the vacuum system of storage ring was shutdown to be improved again in order to reach the Phase II project object of long-term reliability, stability and reliable operation [1]. During this operation, 13 sets of NEG pump which each has the pumping speed of 240 l/s for H_2 and 85 l/s for CO, was put in the downstream of every bending chamber to reduce dynamic pressure difference. Gas leakage of some welded bellows had been found after the system had been baked for several times, so the oil pressured bellows with the RF shields had been installed instead of the welded bellows. The vacuum measure, analyses and interlock system has been improved too. Now vacuum pressure monitor points by Bayard-Alpert type ionization gauge have been increased from 7 points to 21 points. An Industrial PC is used as Input/Output Controller (IOC) and it connects the 7 Varian vacuum Multi-Gauge controllers with serial communication (RS485 mode). The pressure values are displayed in a PC with Linux, which is used as operator interface (OPI). The four ceramic chambers of kick in the same straight section for injection have been set up instead of three kick chambers in the three straight section of the former injection scheme. A new RF cavity has been installed. The cooling loop of the new cavity will be more reasonable and the frequency tuning capability will be larger than the old one. The RF power of the new transmitter will be larger than the old one. A 29-period gap-variable NdFeB permanent magnet Undulator as an insertion device is being designed and installed in ring. The photon beam ports of the two new bending chambers were changed to 0 degree to provide the radiation from the injected devices. The all metal valves with RF shields have been installed at each end of RF cavity, division point of phase II and phase III and that of phase IV and injection chamber, to make the future vacuum system maintains and components installation easier. The vacuum system had been exposed to air for 40 days, after the long exposure to air, the new equipments of ring vacuum system were assembled and the whole system was baked out by passing a large current through it. The average pressure without beam and RF power was 2×10^{-8} Pa, which is better than that before this improvement.

OPERATION

We started on the designing the UHV system of the NSRL in April 1983. The principal parameters for the storage ring vacuum system are shown in Table 1. The vacuum chambers of the ring were made of stainless steel pipes and plates (SUS304l, SUS316l). The whole system was baked out by passing a large direct current through it. The average pressure without beam and RF power was 5×10^{-8} Pa . We welcomed the first synchrotron radiation light in April 1989.

NSRL Storage ring UHV system has been operating for fourteen years. The typical beam lifetime of the NSRL stored beam was over 600 minutes at 150mA and 800 MeV. The total accumulate beam dose is about 400A·hr every year. Based on operating results, we have determined the experimental relation of beam dose for NSRL to be [2]:

$$P/I=1.06\times10\text{-}6\cdot D\text{-}0.61 \quad [\text{ Pa/mA }]$$

The storage ring vacuum system had been exposed to atmosphere eight times due to unexpected leaks and five times due to controlled venting with dry nitrogen at the end of last year. After vacuum system baked out and 75 A hrs of beam cleaning, the dynamic average pressure of general storage ring exposed to atmosphere had reached the design goals, and the beam lifetime over 600 minutes at 150 mA and 800 MeV was acquired. If only SIP pumps were baked out, the same result could be gotten after 100 A·hrs of beam cleaning or more.

For the improved storage ring UHV system, only 70 hours beam cleaning after whole system bake out, beam lifetime over 600 minutes at 300mA and 800 MeV could be acquired. If only SIP pumps baked out, the same result could be gotten after 90 A·hrs of beam cleaning or more.

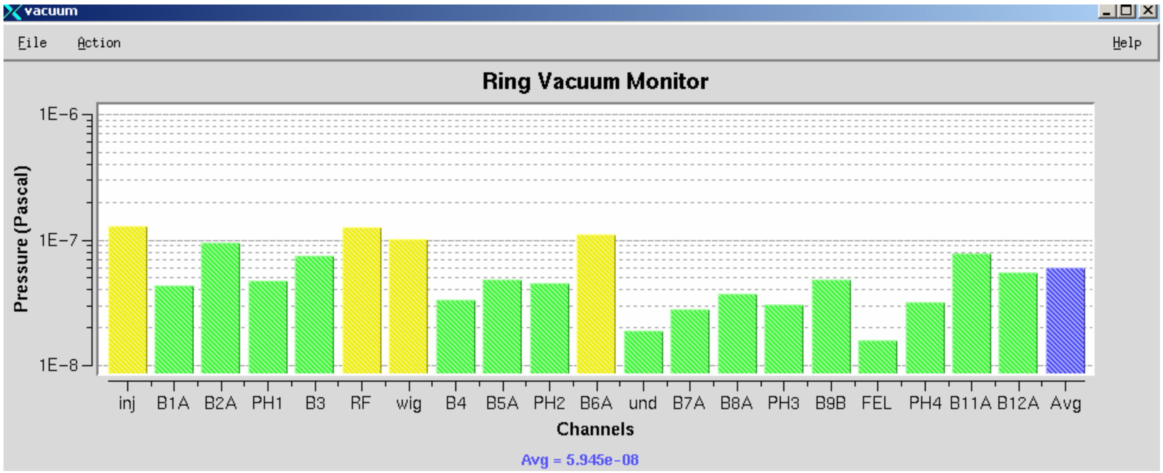

Figure 1: Display window of NSRL storage ring vacuum measure system.

PRESSURE CHARACTERISTICS AFTER IMPROVEMENT

In the end of 2003, all the new vacuum equipments had been installed and the vacuum system improvement had been finished. During the installation period the whole storage ring vacuum system had been exposed to air for 40 days. After the vacuum chambers were connect and evacuate, and whole system was baked out in 200℃ for 48 hrs by passing a large direct current through it, the lower static average ring pressure of 2×10^{-8} Pa without beam had been gotten. Figure1 shows that the distribute pressure in the beam orbit of ring of improved vacuum system. According to this picture, the pressure distribution in the beam orbit is very small, due to the NEG pumps in the downstream of the bending chambers. So the improved vacuum system can provide the necessary vacuum environment for the high beam current, and its pumping speed with the NEG pumps is sufficient for the PSD (photon stimulated desorption) in the downstream of the bending chambers. With beam cleaning at 300 mA and 800 MeV, the beam lifetime is more than 500 minutes after 70 A.hrs, and more than 600 minutes after 100A.hrs beam cleaning, as shown in Fig.2. Because of the replacement of the former photon absorber of wiggler SR light, the whole ring was exposed to air for about 6 hrs, with only baking SIP 48 hrs at 250℃, the beam lifetime of 500 minutes at 300 mA and 800 MeV has been acquired after 90 A·hrs beam cleaning.

The improved UHV system has been operated for about 2 years, the average pressure of ring is better than 2×10^{-8} Pascal without beam and 1×10^{-7} Pascal with beam at 300 mA and 800 MeV. The reactivation of NEG pumps normally are performed every 100 A·hrs.

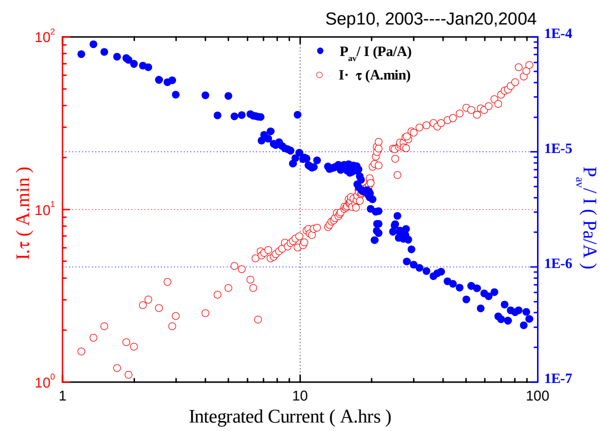

Figure 2: Progress of Beam Cleaning and Growth of Beam Lifetime.

CONCLUSION

The design of RF shield oil pressured bellows chamber design has been proved to be successful by the low static vacuum pressure , which is necessary to long-term reliability, stability and reliable operation. NEG pumps can pump the PSD gas effectively, and the four all metal gate valves with RF shields will benefit to the future maintain, new components installation and the system safety.

The improvement of NSRL storage ring UHV system has been proved to be very successful with the orbit average pressure lower than 1×10^{-7} Pa with beam, now the beam lose process is primarily Touschek effect. With the increment of photon dose, the beam lifetime will be 1000 minutes with 300 mA and 800 MeV beam.

0-7803-8859-3/05/$20.00 ©2005 IEEE

REFERENCES

[1] Zuping LIU, Xinyi ZHANG, NSRL PHASE II PROJECT Proc. 1st Asian PAC KEK JAPAN 1998

[2] Li Guihe, et al. The dynamic pressure and beam cleaning in HLS. Annual Report 1992-1993.