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The operation of SSRF storage ring vacuum system

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Abstract: The storage ring of SSRF began to commissioning at the end of 2007, and have past 2 years so far .Many problems about vacuum system were found and resolved during this period. Residual gas scattering beam lifetime is more than 100 hours, and Touschek beam lifetime is 17hours,the total beam lifetime is about 16hours （200mA/3.5GeV）.These indicate that Touschek effect is the main limitation to total beam lifetime but not residual gases. Beam current reached the designed target 200mA/3.5GeV in October 2008,the average pressure of storage ring is 1.52×10^{-7}Pa.After running for several months, the dynamic pressure went down to 6.8×10-8Pa,which is much lower than the designed target.

Keywords: SSRF, Beam lifetime,vacuum system

1. Introduction

The residual gas scattering beam lifetime in SSRF must be long enough to ensure a beam lifetime of 10 hours for which an average pressure of 1nTorr in the beam channels of chambers with a beam of 300mA and an energy of 3.5GeV is required. Many TSPS and (SIP+NEG) combined pumps[1], are located near absorbers to be close to gas loads. Beam channels of chambers form a thoroughfare for an imaging current and must possess very low impedance .In situ baking is not ready for the vacuum system due to high

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efficiency of photon cleaning effect for absorbers and due to the limited gaps between chambers and magnets. A layout of the vacuum system in one cell is shown in Fig.1[2]

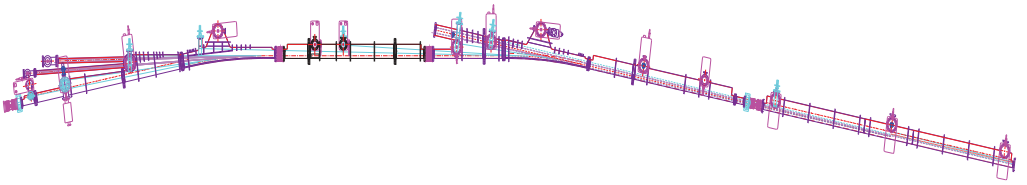

Figure 1: Layout of vacuum system in one cell

2.Pressure distribution in storage ring

A pressure of 5~7×10^{-9}Pa has been reached in all long chamber segments after vacuum pre-testing. In order to speed up machine commissioning, vacuum chambers in straight sections and all pumps on the ring are baked in situ, and a pressure of 2×10^{-8}Pa in the ring is quickly reached. Residual gas components mainly are H_2 (70%) and CO (13 %) and H_2O (13%), seeing Fig 2. It seems a degas effect during annealing in the vacuum furnace is obvious.

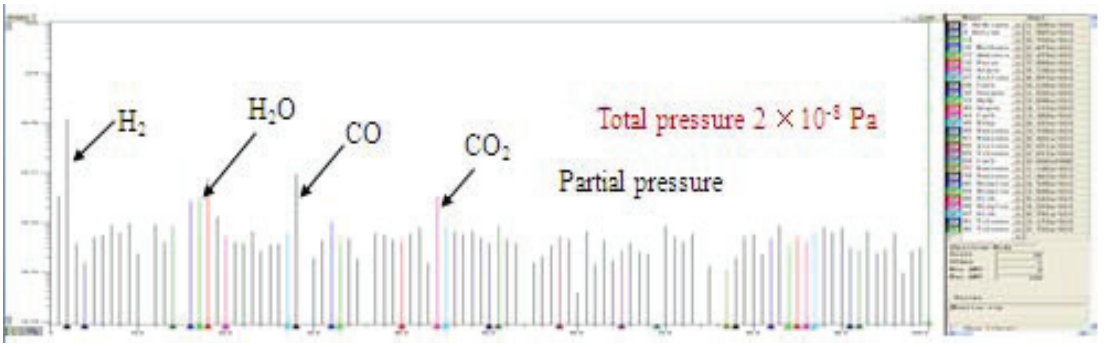

Fig 2 :Total and Partial Pressure in the Ring without

Total and partial pressure in the ring with beam of 3.5GeV/200mA and without IVU are showed in Fig 3. the total pressure of 6.8×10^{-8} Pa is lower than designed target (1 ntorr).

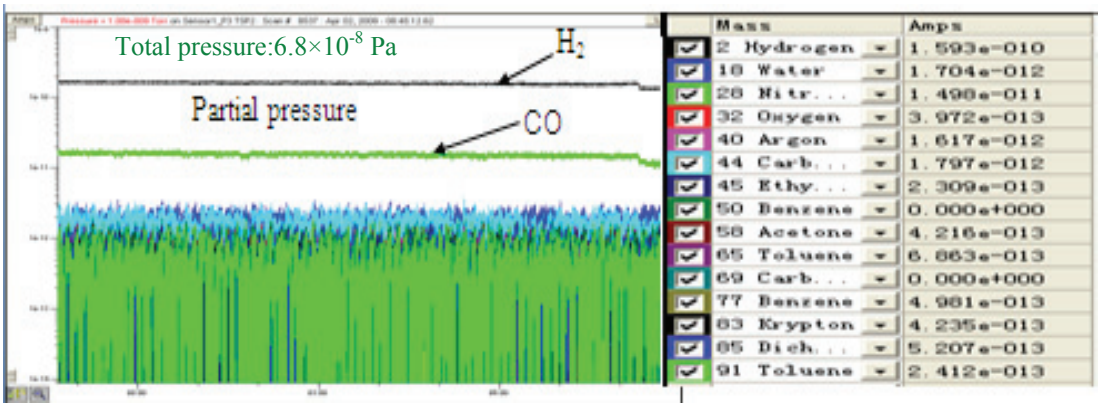

Fig 3 :Total and Partial Pressure in the Ring with Beam (3.5GeV/200mA)

Fig 4 shows a pressure distribution in a cell B with beam of 3.5GeV/200mA, the practical pressure is lower than calculated value.

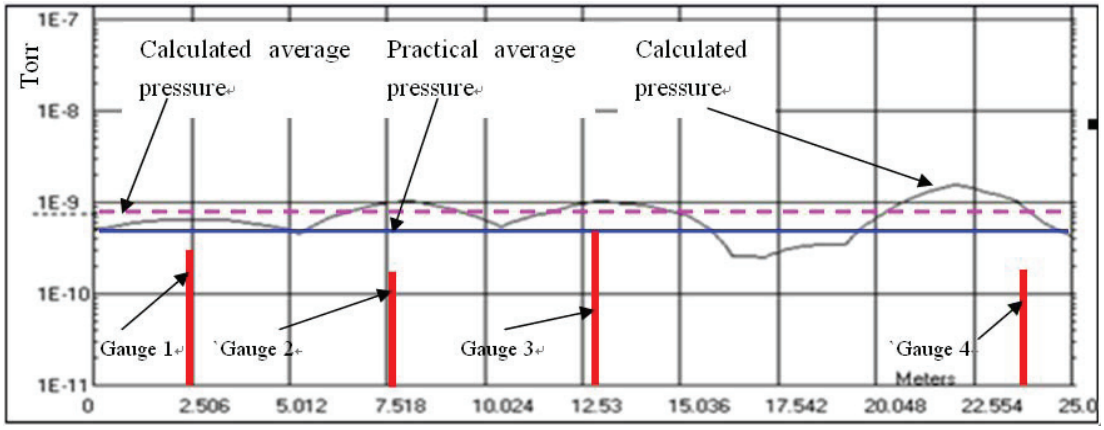

Fig 4 :Pressure Distribution in a Cell B

3. In vacuum undulator (IVU) influence to pressure and lifetime

After installing IVU pressure with beam of 3.5GeV/200mA is influenced little by IVU, because pressure in IVU is about 4×10^{-7}Pa in 15U/17U, which increased the average pressure in the whole ring, seeing Fig 5.

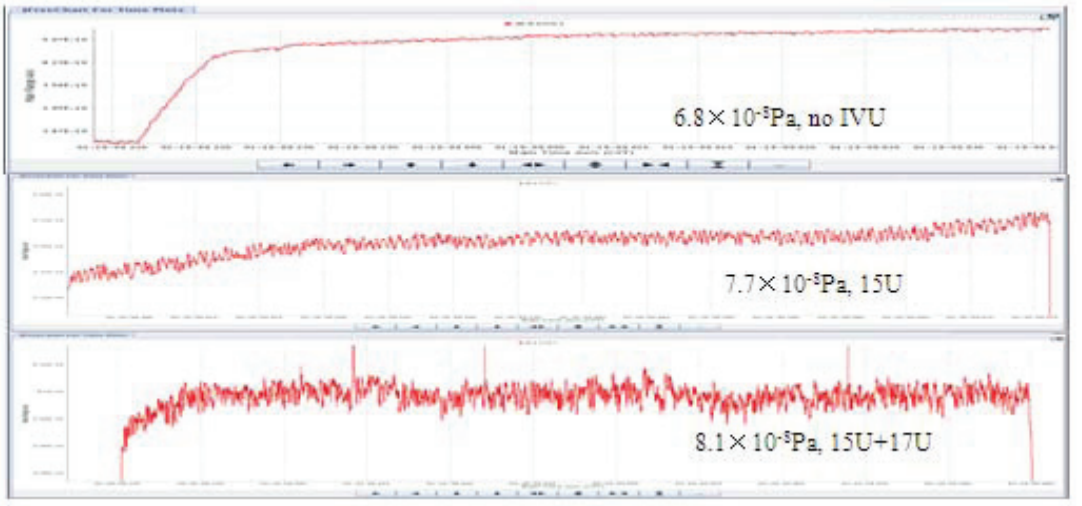

Fig 5 : Pressure with IVU

The pressure is lower than design target and beam lifetime reached 36 hours without IVU, which means the gas scattering beam lifetime τsc is very larger. After installing IVU the pressure increased little, this little rise of average pressure did not influence badly the beam lifetime, but the beam Lifetime is influenced badly by the impedance of IVU, which is involved to the gap of IVU, seeing Fig 6.

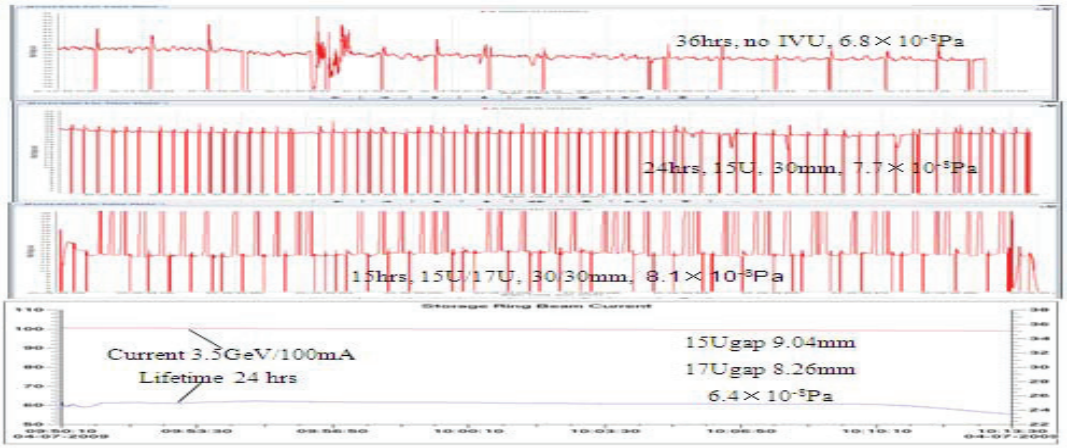

Fig 6 : Relationship between Lifetime and Pressure and IVU Gap

4.Beam cleaning effect and beam lifetime

The storage ring of SSRF began to commissioning at the end of 2007, and have past 2 years so far .Residual gas scattering beam lifetime is more than 100 hours, and Touschek beam lifetime is 17hours,the total beam lifetime is about 16hours （200mA/3.5GeV）.These indicate that Touschek effect is the main limitation to total beam lifetime but not residual gases.(showed in Figure 7)

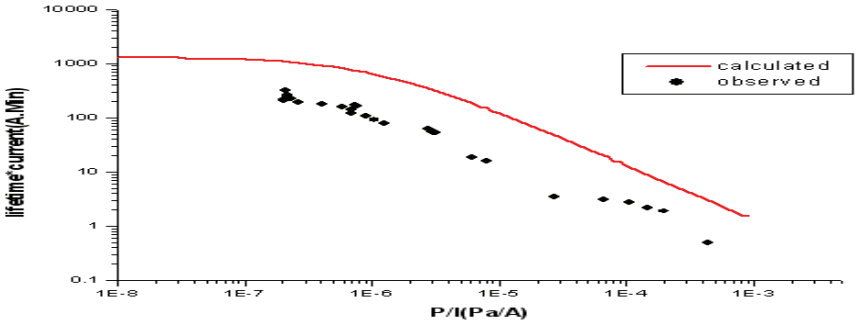

Fig 7 : The influence of residual gases to beam lifetime

The pressure is reduced along with integrated current dose , the relationship between Pav/I and A.h(0~1200 A•h) is showed in Fig 8.

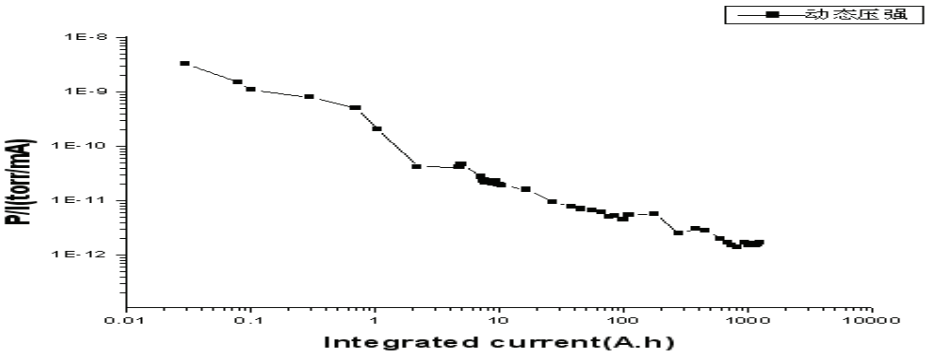

Fig 8 :Relationship between Pressure Pav/I and Dose (0~1200Ah)

5.Problems during operation

5.1 Temperature rise greatly somewhere

The temperature of chambers is 30~40℃ commonly with beam of 3.5GeV/200mA, but maximum temperature of 80℃ appeared somewhere photons reflected greatly by some absorbers landed.（Figure 9)

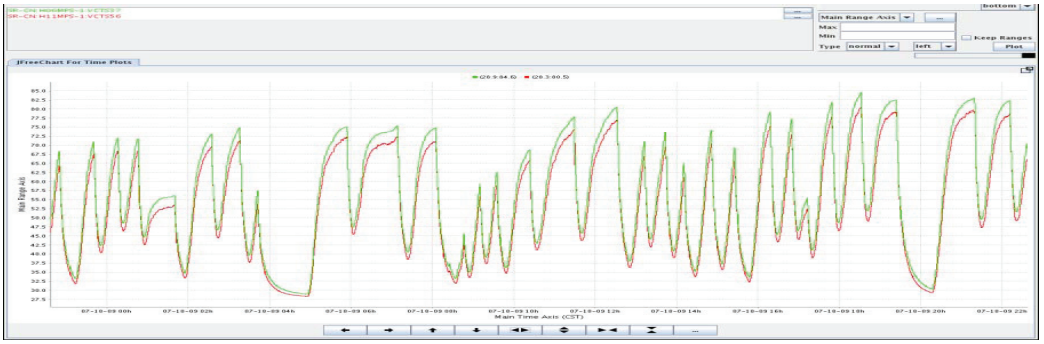

Fig 9 :Temperature of vacuum chamber rise greatly somewhere

5.2 Some of the ionization vacuum gauge filaments break off

The ionization vacuum gauges in the storage ring of SSRF have been running for almost 3 years so far .Now nearly 1/3 of all the filaments broke off which is shown in Figure 10.

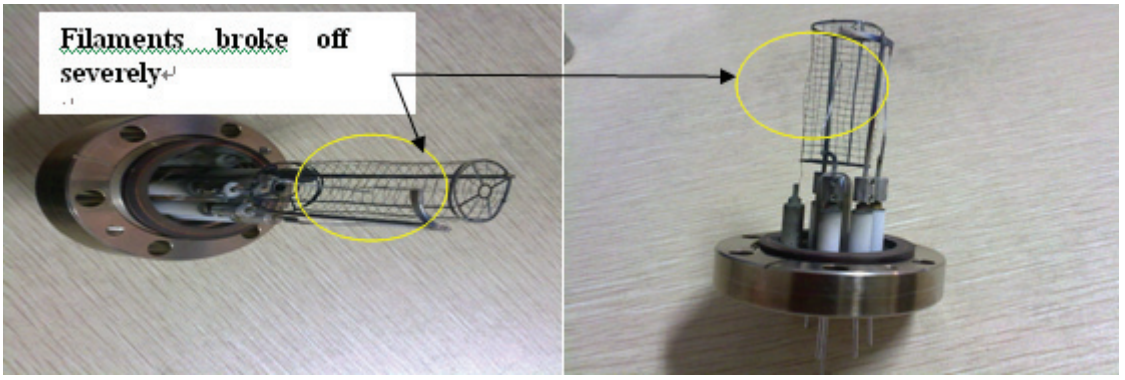

Fig 10 : Ionization vacuum gauge filaments break off

6.Conclusion

The storage ring of SSRF began to operate at the end of 2007. Now Many problems about vacuum system were found and resolved during this period. Residual gas scattering beam lifetime is more than 100 hours, and Touschek beam lifetime is 17hours（200mA/3.5GeV）.These indicate that Touschek effect is the main limitation to total beam lifetime but not residual gases.The dynamic pressure is 4×10^{-8}Pa after beam cleaning(1200mA.h),which is much lower than the designed target. So the vacuum system of SSRF storage ring is running well.

References

[1] D.Jiang, L.Chen, L.Yin, Integration of Commercial SIP with Non-Evaporative Getter, J Vac Sci Technol., 2004, No.3, Vol.24, 222-224.
[2] D.Jiang, Y.Chen, L.Chen, Y.Liu et al, Vacuum System for SSRF Storage Ring, EPAC'08.