Present status of the Vacuum System of KSR

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Abstract

KSR(Kaken Storage Ring) is to be operated as an electron storage ring and a pulse stretcher. The average vacuum pressure of about 10^{-9}Torr is needed in order to storage the electron beam and utilize the synchrotron radiation. The rate of out gas could be decreased with baking the chambers. But the thermal out gas rate is large in the RF-cavity and the ESS(electrostatic septum). The out gas for photon stimulated desorption is serious for the electron storage mode. So the vacuum system is needed to be improved.

1 Introduction

The electron accelerator in ICR consists of an electron storage ring, KSR(Kaken Storage Ring), and an electron linac as its injector. KSR is a compact ring with the racetrack lattice, whose circumference and length of the long straight section are 25.6m and 5.6m, respectively.

KSR is utilized as the light source whose synchrotron radiation from the bending magnets has the critical wave length of 17nm with 300MeV [1]. There are plans to install an insertion device or a beam cooling device in a long straight section. Also KSR is utilized as a pulse stretcher of the output beam from the electron linac whose beam energy is 100MeV. It is possible to improve the duty factor from 2 $\times 10^{-5}$ to ~90%[2].

The constructions of KSR and the injection line had already been finished as shown in Fig. 1. A septum magnet(SM), an electrostatic septum(ESS), a bending magnet are used in the extraction line in order to utilize the extraction beam with the pulse stretcher mode. The installation is proceeding to prepare for the beam injection and circulation test[3].

The enlargement of the beam life time is very important in order to utilize KSR as the light source. The vacuum systems of KSR and beam transport lines are divided to attain the vacuum pressure lower than 10^{-9}Torr in KSR. In the present paper, the status and study of vacuum system are described.

2 status of the vacuum system

In case that the beam life time depends only on the vacuum pressure, the beam life of KSR is estimated as

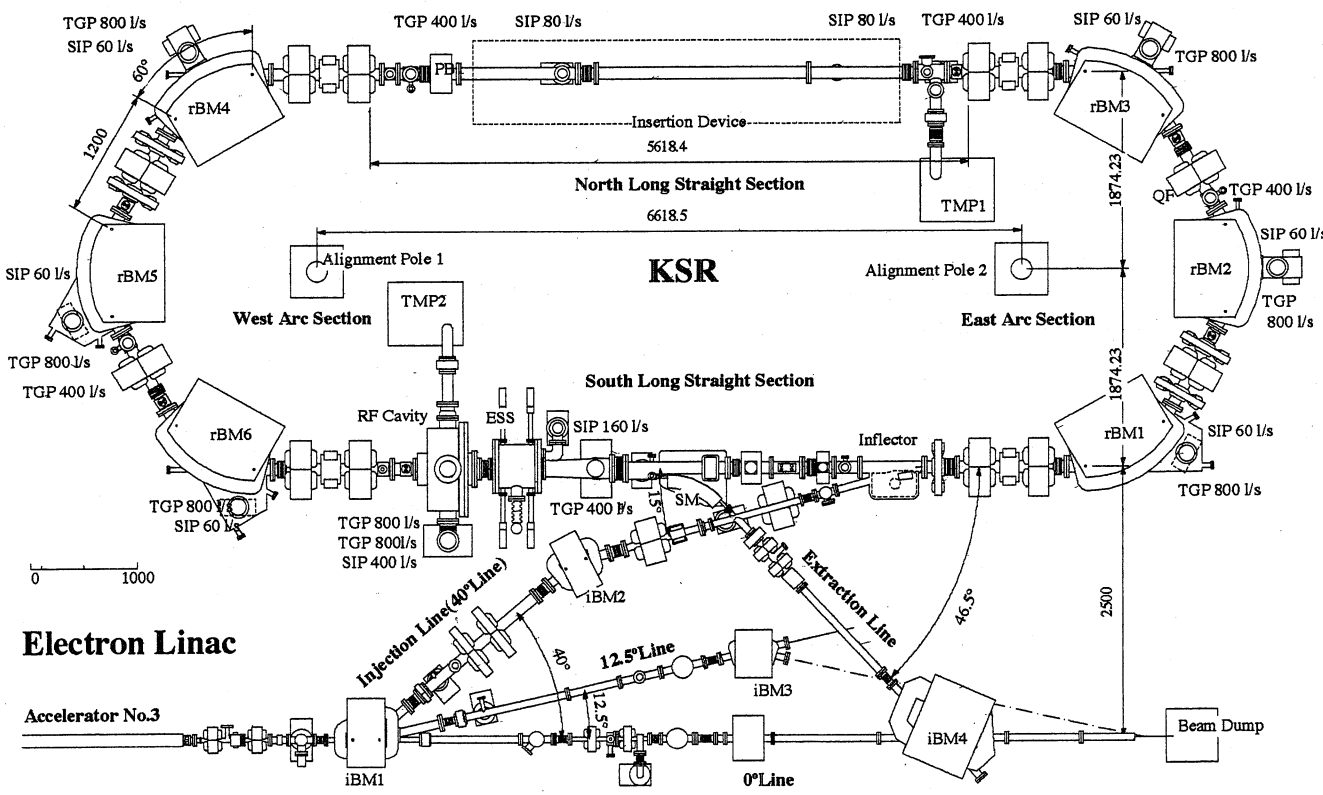

Fig. 1 Layout of KSR and the beam transport section

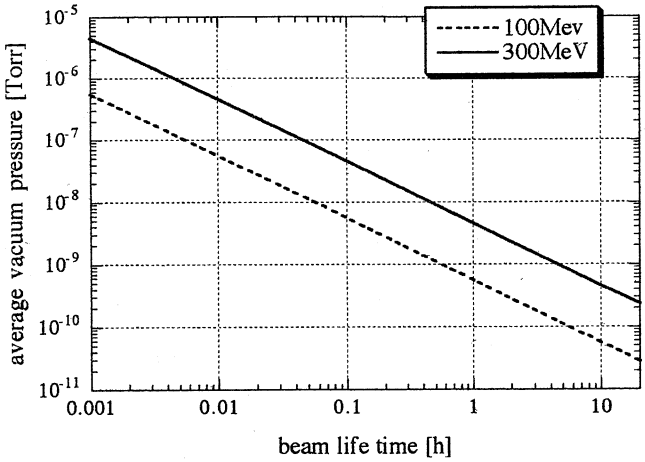

Fig. 2 Vacuum pressure for the beam life time with the electron storage mode assuming that the residual gas is CO from Fig.3 and RF bucket height is 1%

shown in Fig. 2. For example, the average vacuum pressure of about 4×10^{-9}Torr is required to attain the beam life time of a hour in the storage mode with 300MeV.

2.1 Baking

With a pumping unit which consists of a turbo molecular pump and a rotary pump, the average pressure of about 1×10^{-6}Torr is attained. The baking of the vacuum chambers is one of the most effective methods in order to improve its pressure.

The baking temperature of the normal parts is 170±20°C. The bellows and the aluminium chambers are paid special attention an are baked out with temperature of 120±20°C. The baking process of KSR had been applied twice up to now. The bake-time were 100 hours and 90 hours. The mass spectra of the residual gas before and after these baking process are shown in Fig. 3. The partial pressure of H_2O, CO, CO_2 and hydrocarbon decreased largely. But this partial pressure is as high as H_2. The partial pressure of H_2 did not change at all through the baking processes. The bake-time of KSR was not long enough because its bake out temperature is low. As the baking temperature is difficult to be raised, we need much longer bake-time.

2. 2 Vacuum Pressure

The main pumping system consisting of 13 units of titanium sublimation pump(TGP) and 10 units of sputter ion pumps(SIP) had been installed as shown in Fig. 1. The evacuation system have been operated with SIP and few times sublimation of TGP. The ultimate vacuum pressure of KSR is estimated as shown in Fig. 4. The out gas by photon stimulated desorption is serious on an electron storage ring. However 300MeV is relatively low enough as an electron storage ring. So as shown in Fig. 4, thermal out gas in RF-cavity and ESS which have very large inside surface is more serious. The measured values of vacuum pressure are shown in Fig. 4. These data are measured at places a little apart from the beam path by ionization gauges. This results and the estimated vacuum pressure have the same tendency namely the vacuum pressure is higher at places near the RF-cavity and ESS.

3 Summary

It is difficult to estimate the vacuum pressure correctly at beam path. When it is possible to storage the circulation beam, the average vacuum pressure can be estimated more correctly from the beam life time which can be used for proofreading of the ionization gauges.

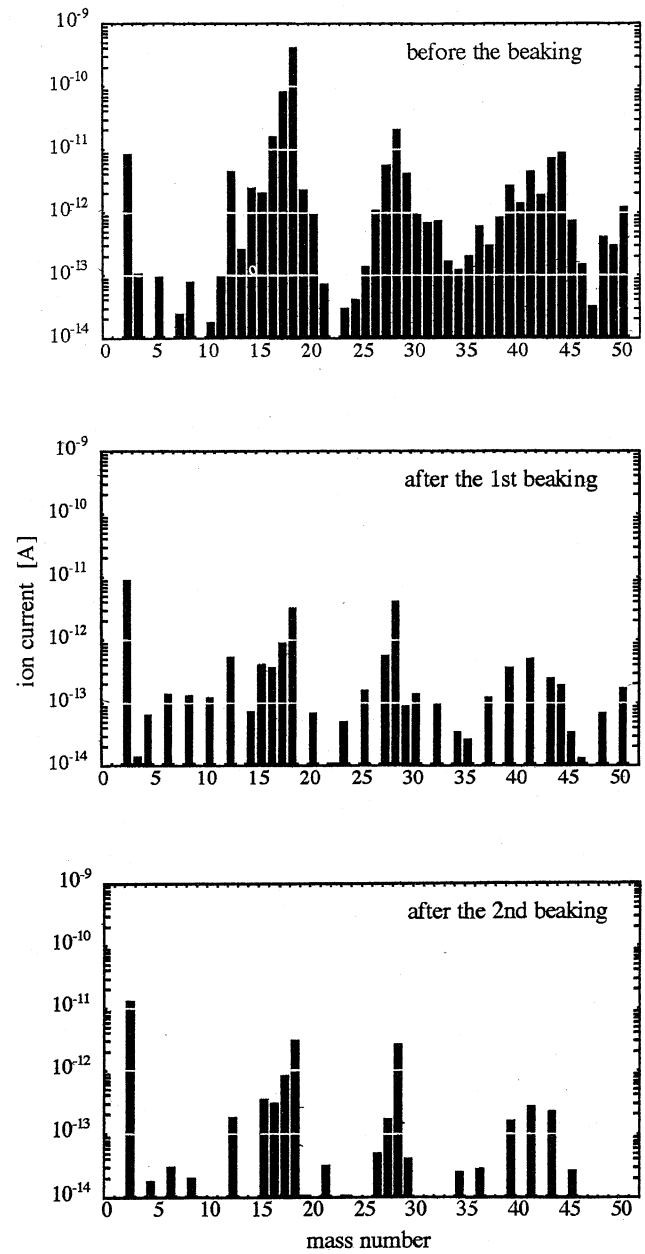

Fig. 3 Mass spectrum of the residual gas

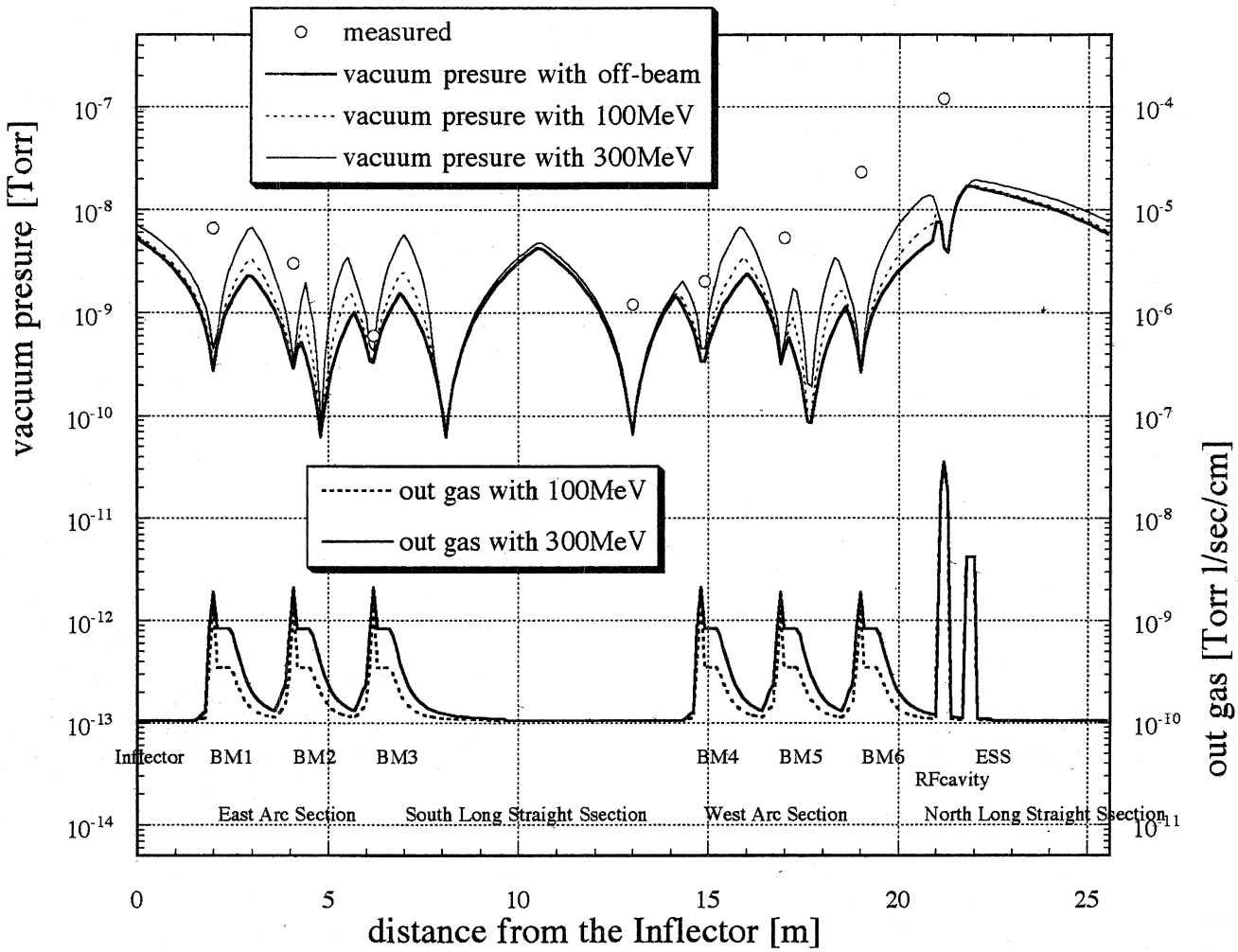

Fig. 4 Estimated the Vacuum Pressure and the Out Gas rate in KSR

And the decrease of out gas rate at the RF-cavity and the ESS is needed to improve the average vacuum pressure. So the baking of long time and installation of Nonevaporable Getter(NEG) pumps which have large pumping speed for H_2, CO are studied.

References

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[3] T. Shirai, "First Beam Circulation Test of an Electron Storage/Stretcher Ring, KSR", Proc. of 1999 PAC.