LIGHT SOURCE

VACUUM SYSTEM OF UVSOR STORAGE RING

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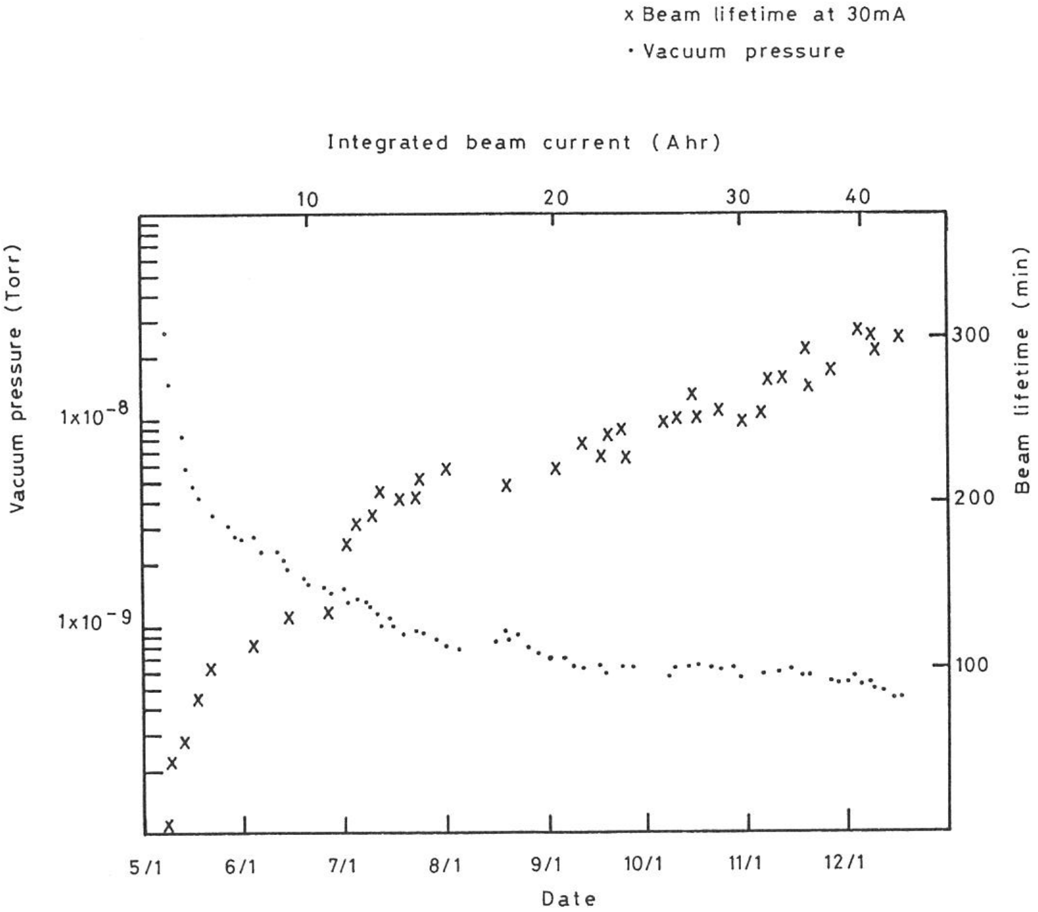
After all beam ducts were connected, leak test by a helium leak detector was finished for the whole ring on April 12 and there was nothing wrong. We baked the vacuum system of the whole ring for seventy two hours from April 15. On April 19, cooling water leaked into the vacuum system from one of two tuners of the rf cavity. We took out the tuner from the cavity and evacuated the ring. We found small leak from a welding part of ceramics and stainless steel pipe at a DCCT chamber and fixed it by "VAC seal". After the repair we could not detect leak from it. Average vacuum pressure was 1.3×10^{-8} Torr in the morning on April 23 and we began to store the electron beam and the maximum stored current was 50 mA on the day. Average vacuum pressure at the beam current of 30 mA was 3.9×10^{-8} Torr and the beam lifetime was only 7.4 minutes. The maximum stored current was 150 mA on the second day, 190 mA on the third day and 250 mA on the fourth day. Before injection, average vacuum pressure was 3.4×10^{-9} Torr on May 7. When stored beam current was 30 mA, average vacuum pressure was 4.7×10^{-9} Torr and the beam lifetime was 68 minutes. After about 30 minutes from start of injection, a glass of view port on a 70 mm flange was cracked and air leaked when stored bream current became 330 mA.

We exchanged the view port and evacuated the ring again on that day. On May 8, average vacuum pressure was 2.7×10^{-8} Torr before injection and 4.4×10^{-8} Torr at the stored current of 30 mA and the lifetime was 6.9 minutes. We decided that beam current kept below 150 mA. For seven days after the vacuum accident, the beam current of 150 mA was kept in the ring about seven hours per day in order to improve the vacuum pressure by synchrotron radiation. Average vacuum pressure was 3.6×10^{-9} Torr before injection and beam lifetime at 30 mA became 100 minutes. So we began to use synchrotron radiation for experiments. Injection was two times in a day at nine and thirteen o'clock. The beam was kept in the ring from nine o'clock till eighteen o'clock. Figure shows average vacuum pressure before injection and lifetime at 30 mA from May 8 to December 20. According to improvement of the vacuum pressure, we increased stored beam current gradually. It was 35 mA in May, 50～60 mA in June, 70 mA in July, 110 mA in October. During August 20 and September 6, beam was accelerated up to 750 MeV. As average vacuum pressure did not become good after September, we exchange filaments of titanium getter pumps in December and average vacuum pressure improved about 10 persents.



ION-TRAPPING EFFECT IN STORAGE RING

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When the storage ring was first put into operation, the most serious problem was the enlargement of the vertical beam size. This effect was investigated in detail, and it was found that the enlargement was accompanied by positive tune shifts in both the horizontal and vertical planes. The positive tune shifts in both planes suggest a focusing force acting on the electron beam due to positive ions. It is another remarkable aspect in the tune diagram that no stabe area except for a few small areas exists above the sum resonance line $Q_H+Q_V=6$, and the lifetime of the stored beam is long in the region below the sum resonance line except along the third resonance line $Q_V=8/3$, but the vertical beam size grows at the high beam current in almost every part of the region. These aspects are explained by the tune shifts due to ions trapped in the beam and the coupling of horizontal and vertical oscillations near the sum resonance line. If the operating point (Q_H, Q_V) is located below the sum resonance line, i.e. $Q_H+Q_V<6$, then the operating point moves toward the resonance line, as the tune shifts in both planes are positive. When the operating point approaches the resonance line, the coefficient of coupling grows larger, and the vertical beam size becomes large. The growth of the vertical beam size decrease the focusing force due to ions and the tune shift becomes small. Thus, if the operating point is located below the resonance line the tune shift is suppressed by the negative feedback mechanism at the cost of the beam size. In contrast to this, if the operating point is positioned above the sum resonance line, the tune shift is energized by the positive feedback effect.

Various attempts were made to clear ions. First, a DC clering voltage was applied to the electrodes. Though the vertical beam size was reduced slightly, the improvement was not satisfactory. The excitation of the transverse oscillation of the electron beam was also tried. When the frequency and amplitude of the excitation were appropriate, the beam size became almost perfect. These two ion-clearing techniques are used together in the routine operation of the ring. (Improvement of the beam profile by the ion-cleraring is shown in Fig.5 of p. 9 .)

LOW ENERGY OPERATION

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The wavelength range of quasi-monochromatic light from the undulator is between 500 Å and 230 Å at the electron energy of 600 MeV. When quasi-monochromatic light of about 1000 Å is necessary, the storage ring must be operated at lower energy than the ordinary energy.

The currents of the magnet system can be changed keeping trackings between the quadrupoles and the bending magnets constant. Electron beam is injected and stored at the 600 MeV and decelerated down to an required value. Down to 300 MeV, survival ratio of the stored beam was about 70 %, when the initial stored current was 50 mA. However, as the control system of the power supplies is not suitable to search the best operating points along the deceleration, the injection at required electron energy must be tried.

The electron energy influences on beam characteristics. Variations of some nominal parameters are roughly estimated as to those of the 600 MeV electron beam as shown in Fig. 1. In this figure integers and half-integers are the powers which show the energy dependence of the beam characteristics. With this figure it is apparent that the lifetime of the stored beam is rigorously restricted with the Touschek effect, which depends strongly on the electron beam energy.

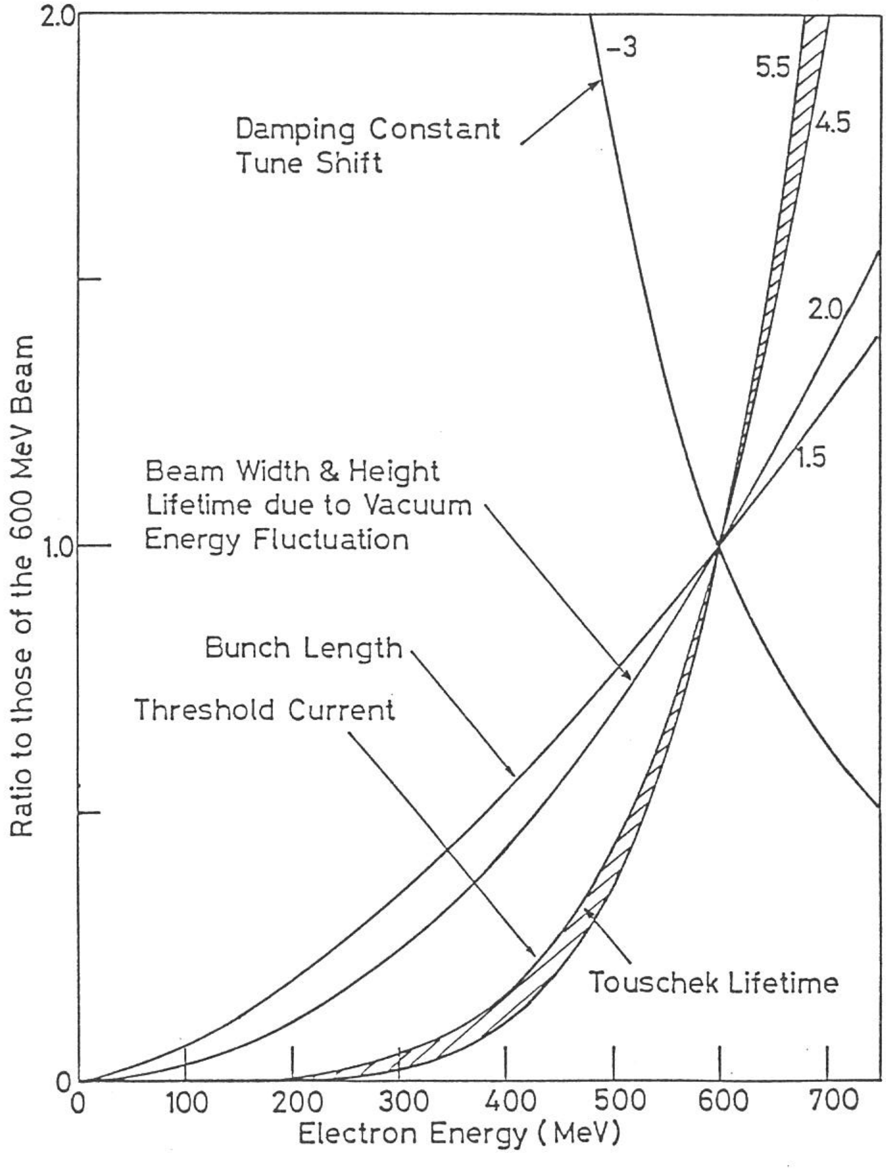

Fig.1 Variations of Beam Characteristics due to Electron Energy

UNDULATOR

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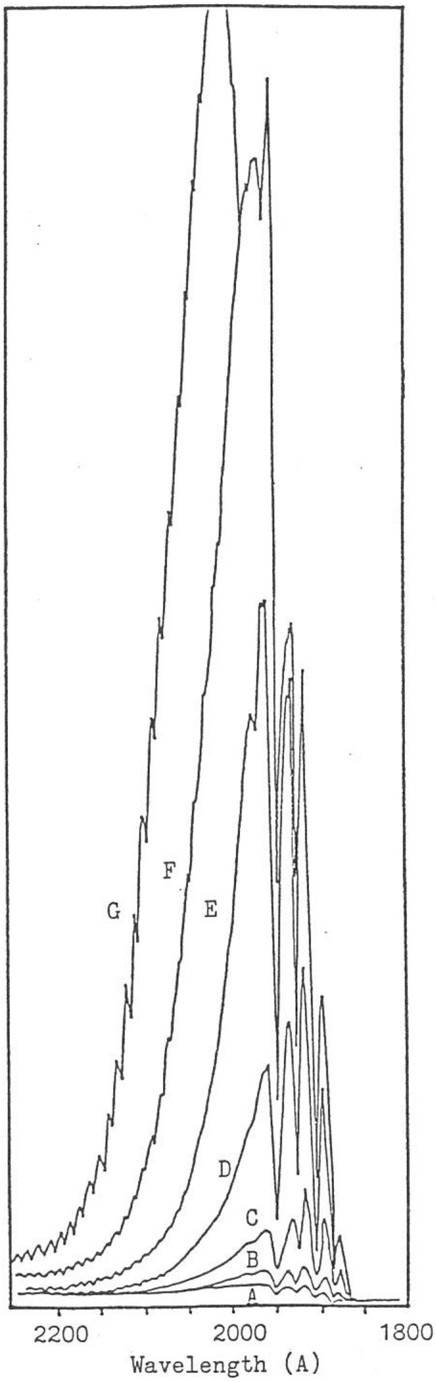
A permanent magnet undulator was installed at the long straight section S3 of the storage ring, which produces a quasi-monochromatic light between 500 Å and 230 Å with the 600 MeV electron. The wavelength of the light is usually selected with varing the undulator gap. When the electron is accelerated up to the maximum energy of 750 MeV, the undulator light is expected to be available down to 150 Å. The bandwidth of the quasi-monochromatic light from the undulator was measured at about 2000 Å with the 300 MeV electron as shown in Fig. 1. The light was extracted through a sapphire window into atmosphere and taken into a monochromator. In this figure undulator gap was chosen between 32.0 mm and 29.0 mm, and shorter wavelength region the light was absorbed. The gap is narrower, the parameter K is bigger and wavelength of undulator light is longer. The bandwidth of the light, $\Delta\lambda / \lambda$, was gained as 6 % in FWHM. Moreover the electron energy was decelerated down to 180 MeV, and a coloured ring which is expected as following equation

$$\lambda = \frac{\lambda_0}{2\gamma^2}\left(1 + \frac{K^2}{2} + \gamma^2\theta^2\right)$$

was observed in the visible wavelength range.

The closed orbit distortion due to the undulator was corrected with the orbit correction systems in the almost all gaps and the experiment with the undulator light can be utilized at the same time with some experiments using synchrotron radiation from ordinary bending sections.



Electron Energy 300 MeV

Gap A ; 32.0 mm

B ; 31.5 mm

C ; 31.0 mm

D ; 30.5 mm

E ; 30.0 mm

F ; 29.5 mm

G ; 29.0 mm

$$\frac{\Delta\lambda}{\lambda} = 5.4 \%$$

Fig. 1 Spectra of the Undulator Light

WIGGLER

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A superconducting wiggler was installed at the long straight section S7 of the storage ring, which can supply synchrotron radiation to the BL-7A. Its maximum magnetic field strength is 4 Tesla. With exciting the wiggler field up to about 3 Tesla, the 600 MeV beam from the synchrotron can be injected in the ring easily. To make possible to store the beam at the 4 Tesla operation, a quadrupole and a z-steering magnet are installed to suppress the effects of the wiggler field on the beam, and appropriate currents of the sub-coils and these correction magnets were measured at some excitation levels between 2 Tesla and 3.9 Tesla operation of the wiggler field. These are shown in Fig. 1. These parameters were chosen to keep the position and shape of the beam profile which is monitored with an ITV system. With this figure, the increasing rate of correction magnets for the wiggler are recognized to be not the same behaviours of the sub-coils of the wiggler. Moreover the vertical and horizontal tune shifts, and the closed orbit distortions due to the wiggler magnetic field were measured, and the results are shown in Fig. 2. The vertical closed orbit distortion was steeply grown to be more than 3 mm at some points of the ring at about 3.2 Tesla.

Some efforts will be paied to suppress these tune shifts more precisely and COD with the normal quadrupole magnet system and with the vertical and horizontal orbit correction magnet systems.

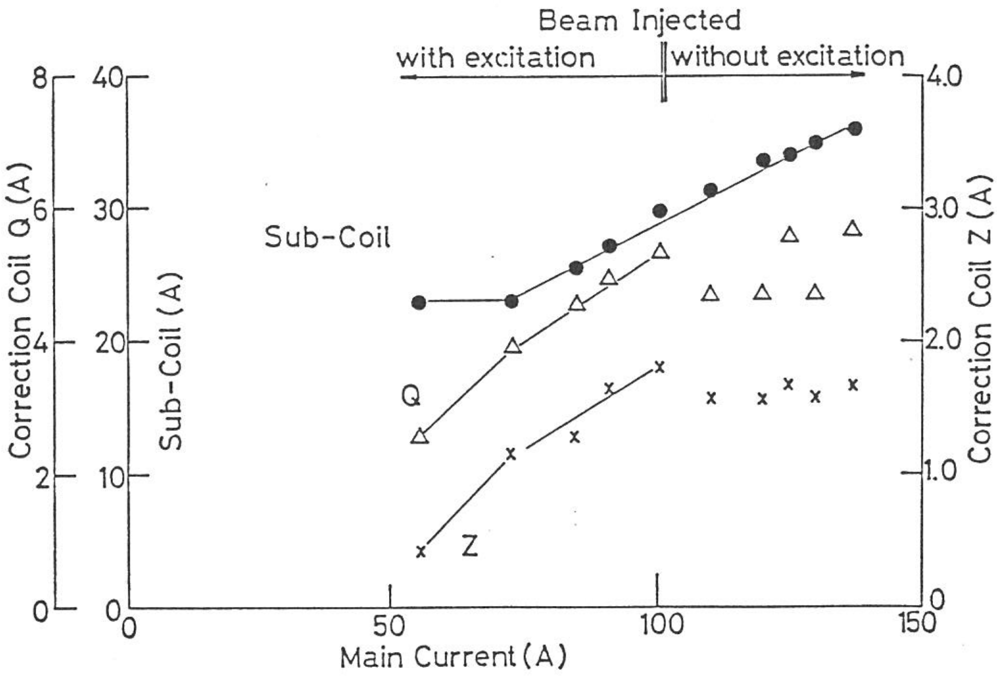

Fig. 1 Parameters of Wiggler Excitation

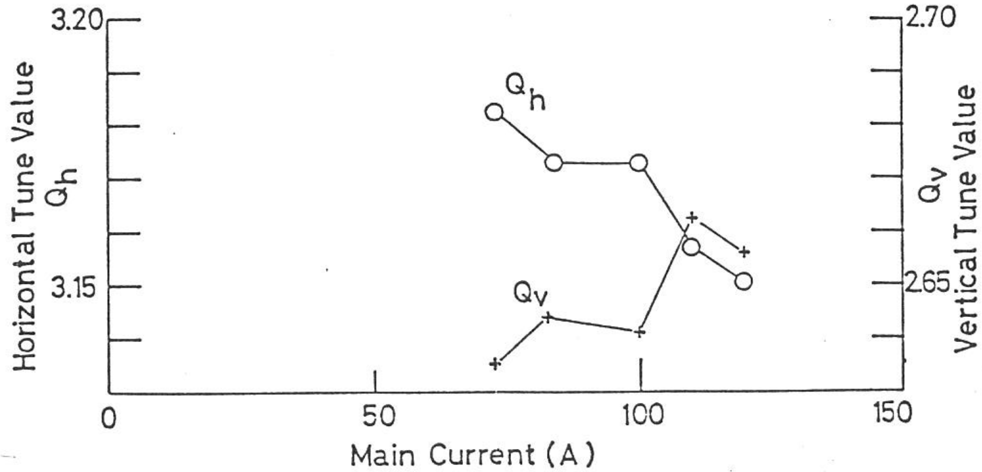

Fig. 2 Vertical and Horizontal Tune Shifts