A New System to Control the Cavity Voltage at SOR-RING

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Abstract

A new control system for the RF cavity has been developed and tested at the 500 MeV electron storage ring, SOR-RING. This upgrade can keep the cavity voltage almost constant within the range of less than 2 %.

1. Introduction

SOR-RING[1] is an electron storage ring for synchrotron radiation experiments in the region of vacuum ultraviolet (VUV) and soft X-ray. It is 17.4 m in circumference and consists of eight bending sections and four quadrupole triplets. The ring is normally operated at 500 MeV and the stored current is about 200 mA in the routine operation. The 1.3-GeV Electron Synchrotron (ES), which belongs to the Tanashi Branch Laboratory of the High Energy Accelerator Research Organization (KEK), is used as the injector of SOR-RING. Electrons with an energy of 308 MeV are extracted from ES and injected into SOR-RING. The injected electrons are accelerated up to 500 MeV in the ring and then stored until the next injection.

The RF frequency of SOR-RING is 120.9 MHz, and the corresponding harmonic number is seven. The RF cavity of SOR-RING is a re-entrant type cavity with three RF tuners. Figure 1 shows a schematic view of the cavity and the tuners. Each RF tuner, called 'flapper', is one-turn short-circuited loop made of copper. The main parameters of the RF cavity are listed in Table 1.

Two small flappers (No. 2 and 3 in Fig. 1) had been previously used to compensate for the beam loading of the RF cavity. The resonant frequency of the cavity is variable over the range of 500 kHz using the two flappers. The loop angles of the two flappers are controlled by an analog circuit to keep constant the cavity voltage, which is monitored at a pickup loop. The cavity voltage is maintained within the range of 10 % in this system.

A large flapper (flapper No. 1 in Fig. 1) were installed in 1993 to make the frequency adjustment of the cavity quickly. The tuning range of the large flapper is about 700 kHz. Recently, the control system of the large flapper has been developed and operated successfully. It is a computer-controlled system based on the graphical development language, HP-VEE. By the new system, precise control of the cavity voltage becomes possible. Thus the cavity voltage can be kept constant within the range of less than 2 %.

Table 1 Main parameters of the RF cavity

RF frequency	120.9 MHz
Generator power	5 kW (typical)
Cavity power	0.5 kW (typical)
Cavity voltage	22 kV (typical)
Accelerating voltage	4.9 kV (at 500 MeV)
Shunt impedance	1.1 MΩ
Unloaded Q-value	6400
Loaded Q-value	2900
Coupling coefficient, ß	1.22
Total tuning range of two small flappers	500 kHz
Tuning range of a large flapper	700 kHz

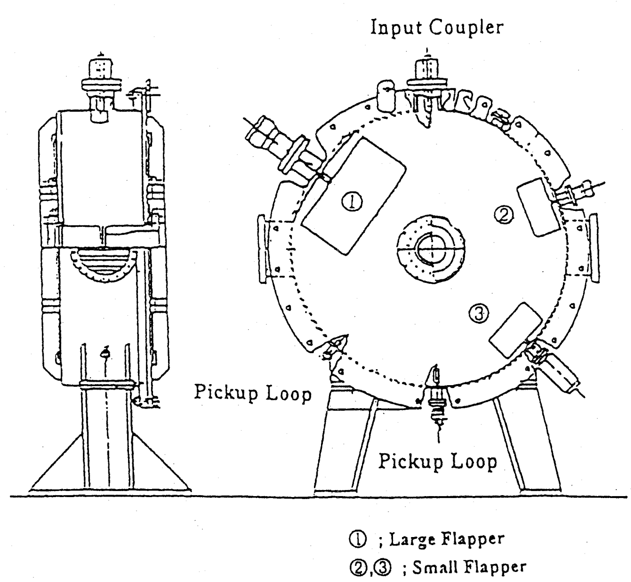

Fig. 1 SOR-RING RF cavity

In the following part of this paper, the new system to control the cavity voltage using the large flapper is described in detail. The relation between the cavity voltage and the beam lifetime is also presented.

2. The New Cavity Voltage Control system

In the old system using two small flappers, the tuning angles of the flappers were controlled by an analog circuit. Since the cavity voltage was controlled only with the accuracy of 10 %, the behavior of the beam lifetime was unsteady. In the new system using the large flapper, the tuning angle is controlled precisely by a computer.

Figure 2 shows a schematic view of the control system. The cavity voltage is monitored by measuring RF power induced at the pickup loop of RF cavity. This measurement is made by a power meter which is connected to a computer (Work Station) through the GP-IB bus. The control system, the program of which has been developed with HP-VEE (see Fig. 3), compares the measured cavity voltage and the reference voltage and then generates pulse signals for the large flapper to compensate for the voltage difference. A limit switch put on the flapper restricts the angle within 90 degrees which corresponds to 2000 pulses.

There are three operation modes (injection, acceleration and storage modes) in SOR-RING. In the old system, the cavity voltage was changed manually for injection and acceleration modes. The new control system runs automatically for all modes.

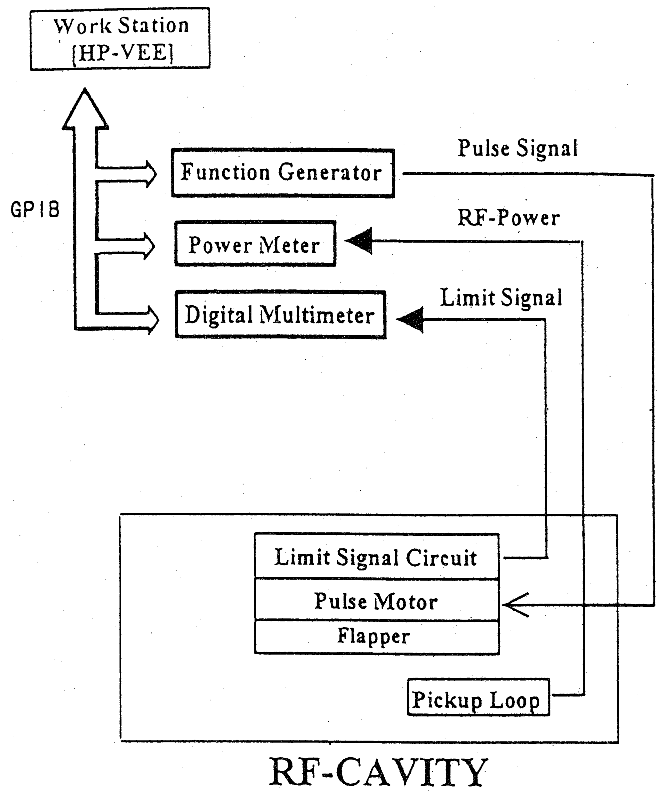

Fig. 2 Schematic view of the control system.

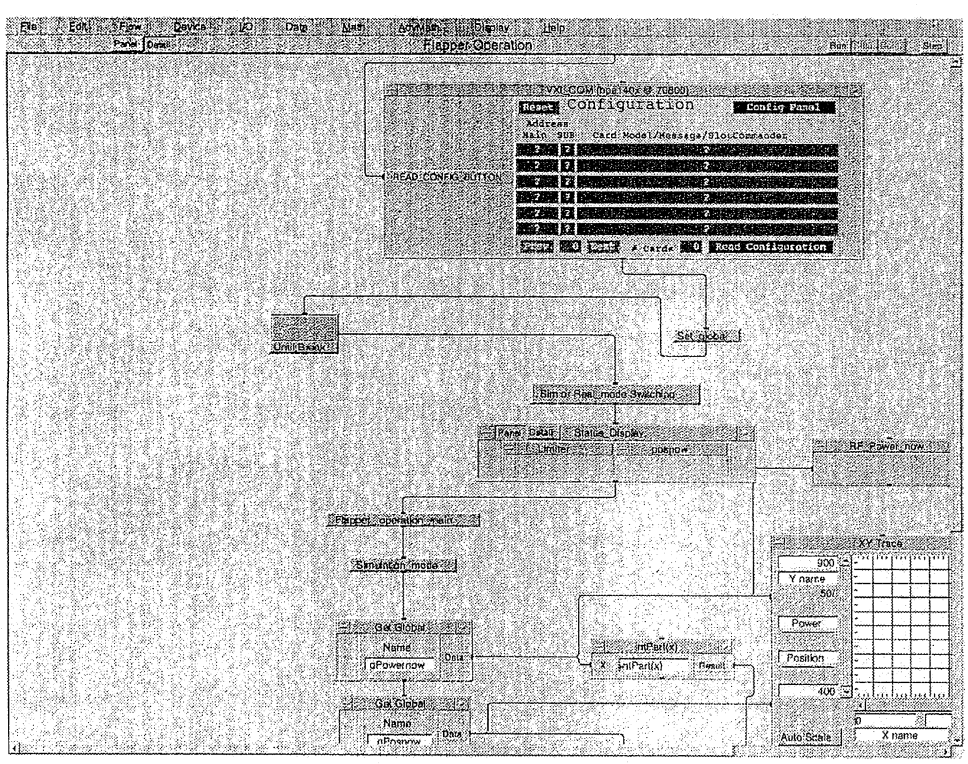

Fig. 3 HP-VEE

3. Measurements and Results

The stability of the cavity voltage have been measured in both old and new systems. In the case of the new system, the cavity voltage monitored by the pickup loop was almost constant at a value of 400 [in arbitrary unit] (see Fig. 4), which corresponds to 22 kV. However it was varied between 350 to 400 in the old system.

In Figs. 5 and 6, the relation of the cavity voltage and the beam lifetime is shown. The behavior of the beam lifetime is apparently improved in the new system.

4. Reference

[1] H. Kudo *et al.*, "Present Status of SOR-RING", Proc. the 9th Symposium of Accelerator Science and Technology, August, 1993, p44.

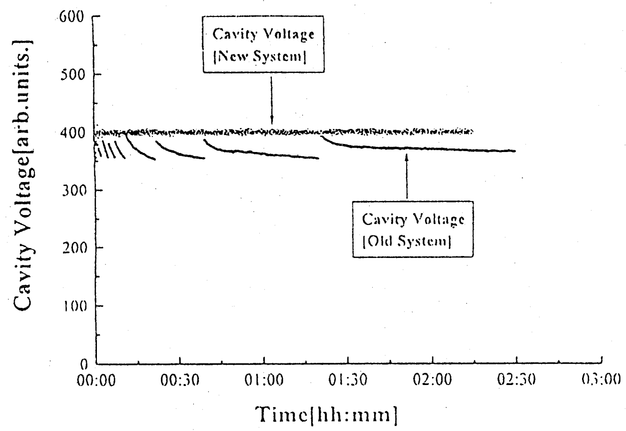

Fig. 4 The cavity voltage.

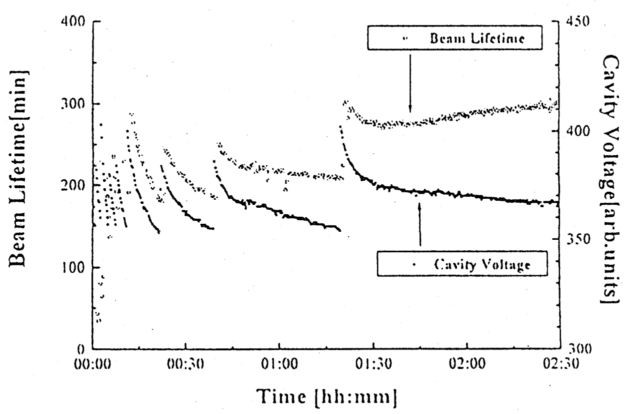

Fig. 5 The beam lifetime and the cavity voltage in the old system.

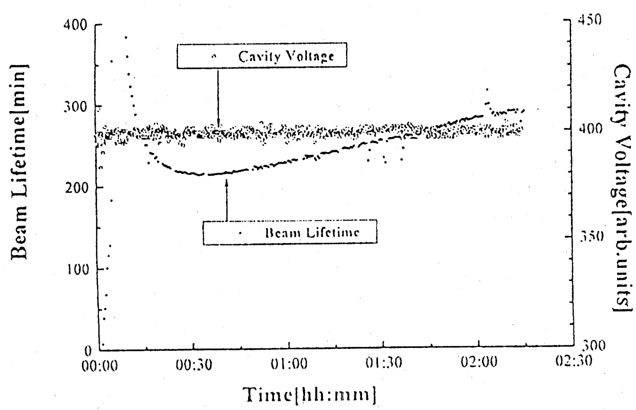

Fig. 6 The beam lifetime and the cavity voltage in the new system.