VACUUM SYSTEM OF THE ELECTRON STORAGE RING IN THE PF

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1. Introduction

The electron storage ring (ESR) in the Photon Factory is a dedicated machine for synchrotron orbit radiation (SOR) with the beam energy of 2.5 GeV. The whole shape of the ring is an ellipse with 187 m in circumference, with a majour axis of 68 m and with a minor axis of 50 m. Ducts of the ring are made of aluminum alloy (A-6063) in ca. 80% in its length, and the rest part i.e. flanges, bellows and some magnet chambers are made of stainless steel. The reason why we use the aluminum alloy are that 1) production of the ducts which have complicated cross section is easy by using extrusion procedure and 2) good thermal conductivity is possible to protect the duct wall irradiated by the SOR.

2. Vacuum System of the Electron Storage Ring

Among 28 ducts in the bending magnet sections, 20 of them have light exit ports of which aperture is 40 mrad in width. Four of them have different type of exit ports for an undulator and a wiggler. The rest of 4 ducts have no light exit ports. Each of 28 ducts (B-duct) has a distributed ion pump (DIP), and the designed value of their pumping speed is 150 ℓ/s at 5 kV and 10 kG. The B ducts also have fixed 2 electrodes for discharge cleaning beside the shield electrode of the DIP. The cross section of the ducts (Q-duct) in the steering magnet sections is different from that of the B ducts. Both B- and Q-ducts were connected by field-welding on the magnets. The Q-ducts have the pumping port for the holding pump with slit in order to minimize the excitation of RF power in the pump. Every pumping port has two auxiliary ports which are used for a titanium getter pump and a vacuum gauge head. When the getter is flashed, the effective pumping speed at every pumping port is increased to 530 ℓ/s limited by the slit conductance. The maximum pumping speed in the whole system is 32000 ℓ/s by using the 52 getter pumps and holding pumps and 28 distributed ion pumps. The whole ring was evacuated by 6 roughing pump units. A unit is composed of an oil-sealed rotary pump (260 ℓ/min), a turbo molecular pump (270 ℓ/s), valves and the chamber, which is built in the slit construction by the same reason as other pumping ports.

Pressures in the ring were measured by the inverted magnetron gauges (CCG) which were installed every ca. 16 m in the ring. The gauge is suitable for the measurement of pressures in low and high vacuum range because it has no hot filament. The gauge also makes the measuring system very simple by concentrating the controllers in a single rack because it is enough to lay single high tension cable with average length of 90 m between a gauge head and a controller. The output from the controllers were connected to a micro-computer and displayed.

3. Pumping-down of the Electron Storage Ring

The electron storage ring was evacuated by 6 roughing pump units. As the ducts had not been baked, the residual gas was mainly H_2O. When the holding pumps were used together with roughing pump units, H_2O decreased and H_2 increased ca. 10 times. Each component of CO, CH_4 and CO_2 was also increased. These changes of partial pressures caused little change of total pressure.

The first pumping-down curve is shown in Fig. 1, where "CCG" stands for the cold cathode gauge and "HCG" stands for the Bayard-Alpert type ionization gauge (HCG). The CCG was set at the roughing pump unit and the HCG was installed halfway between the roughing pump units. The arrow in the figure represents the period of the beam experiments where pressure rise (ΔP) occured because of the photo-desorption of adsorbed gas molecules. The change of residual gas components in the presusre rise resembled to the change of the components when the holding pumps added to the roughing pump units.

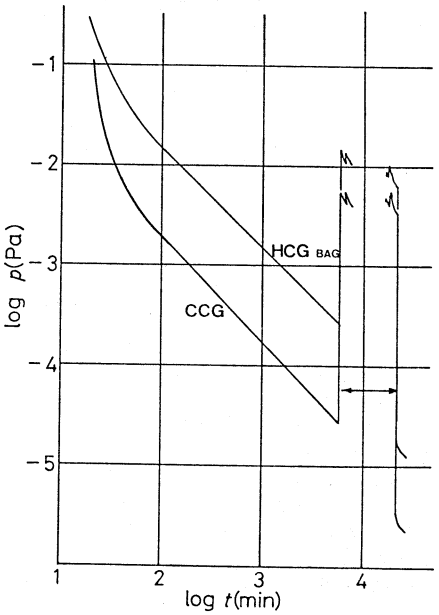

Fig.1 First pumping-down curve.

After the ring was exposed to air, the ring were baked for 2 days though the baking temperature was not enough. Beam experiments were continued after baking, and variation of pressure rise normalized by stored current (I_S) is shown in Fig. 2 as a function of accumulated stored current. The pressure rise decreased and beam life time was increased to 1 hour at 40 mA stored. When the ring is baked enough and titanium getter pumps operate, the life time of the beam can be increased 10 times longer than the latest value.

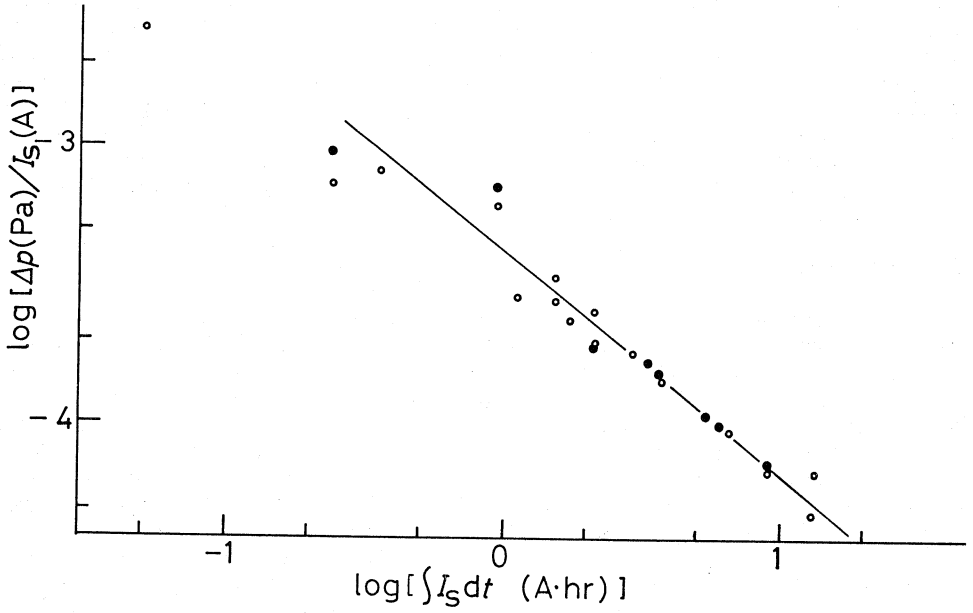

Fig.2 Self cleaning of the ring.

References

1) M. Kobayashi, G. Horikoshi and H. Mizuno, Nucl. Instrm. Methods 177(1980)111.