THE COMPARISON OF VACUUM PERFORMANCE IN THE UNDULATOR CHAMBERS INSTALLED AT THE TAIWAN LIGHT SOURCE

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Abstract:

The U5, EPU, U9 undualtor chambers have been installed at Taiwan Light Source (TLS) since 1997. One sheet of non-evaporable getter was inserted into each of the undulator chamber. The basic designs in these undulator chambers are almost the same except the length and the geometry of pumping systems. The comparison of vacuum performance in these undulator chambers will be described.

1. INTRODUCTION

Several insertion devices (ID) have been built in the straight sections at Taiwan Light Source (TLS) to obtain coherent and high brightness photons. A W20 wiggler and a U5 undulator were installed in February of 1995 and March of 1997, respectively [1]. A U9 and an EPU5.6 undulator are to be installed in the April of 1999. Prior to the installation of insertion devices, U9 and EPU5.6, the ID chambers for these undulators have been installed during several previous shutdown periods. The comparison of vacuum performance in these undulator chambers, the effective pumping speed and the impact to the beam lifetime, etc., are described in this article.

2. VACUUM SYSTEM

The chamber designs in the undulator chambers, U5, EPU5.6 and U9 are similar [2]. The specifications for these insertion devices and chambers are shown in Table 1. The plane view and the cross section view of this type chamber are shown in Figs. 1(A) and 1(B), respectively. The inner cross section for the electron beam channel is an elliptical shape with 13 mm vertical height and 80 mm horizontal width. A pumping channel of 16 mm in height and 46 mm in width for assembling the NEG strips is located on other side. In the pumping configuration, the U5 and EPU5.6 have the same geometry. In addition to the NEG strip of ID chambers, a combination of two sets of 350 l/s NEG pumps and 400 l/s sputter ion pumps which were located at the upstream and the downstream is used to evacuate the whole system. Owing to the limited space in the straight section, the two sets of NEG pumps and sputter ion pumps were withdrawn in the U9 system. The configuration of vacuum systems for U5, EPU5.6 and U9 are shown in Fig. 2.

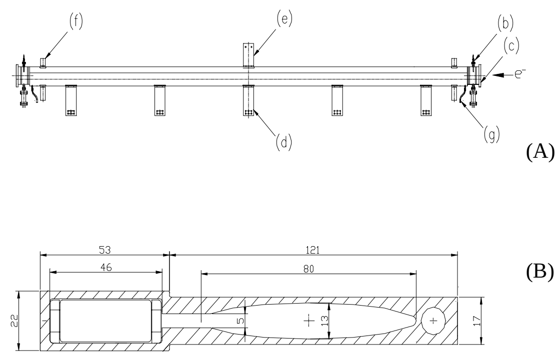

Fig.1. (A) Plane view and (B) crosss section view of the undulator chamber. In Fig. 1(A), names of the indicated parts are (a) aluminum pipe, (b) taper piece and current feedthrough for NEG, (c) aluminum conflat flange, (d) and (e) supporting pads, (f) pad for limiting switch contact, and (g) water cooling pipe.

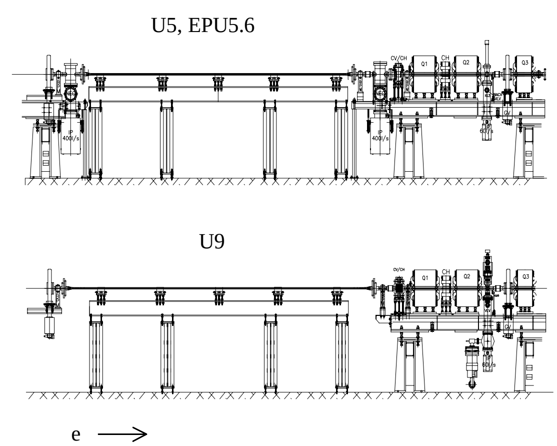

Fig. 2. The configuration of vacuum systems for U5, EPU5.6 (top) and U9 (bottom) respectively.

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Table. 1 The specification of insertion devices and vacuum chambers.

Straight Section	R2	R3	R6
Insertion Device	EPU5.6	U5	U9
Period Length (λu)	5.6cm	5.0cm	9.0cm
No. of Poles (N)	66	76	48
Minimum Gap	18mm		
Undulator Chamber	B type		
Chamber Length	4.16m	4.16m	4.76m
Outside Vertical Height	17mm		
Inner Cross Section for Electron Orbit	13mm×80mm(H× W)		
Chamber Material	A6063T5 aluminum alloy		
Fabrication	Extrusion		
Flatness on Outside	< ±0.2mm		
Distributed Pumping Inside ID Chamber	Non-Evaporabl Getter (st707)		
Dimension of NEG (L×W)	3.54m×3cm	3.54m×3cm	4.14m×3cm
Installation Date	1997/03	1997/03	1998/06

3. DISCUSSION

The static pressures after installation and baking of the ID chambers are about ~0.3, ~0.2, and ~0.9 nTorr for U5, EPU5.6, and U9 respectively. In this article, the vacuum performance of U5 and U9 is compared only because the vacuum systems of U5 and EPU5.6 have the same configuration. Owing to the same dimension in the cross section and the similar length, the estimated conductance (~0.56 l/s for U5, ~0.6 l/s for U9) and the pump speed of NEG strip (390 l/s for U5, 455 l/s for U9) in the ID chambers is similar [2]. We thought the ratio of pressure in the center regime of U5 and U9 system is nearly one by this similar effective pumping speed. The additional pumping speed of 750 l/s of sputter ion pump and NEG pump at both of the upstream and the downstream regime in the U5 system could further lower the pressure at the regime far away from the center of ID chambers. This effect was more obvious in the pressure rise by the photon stimulated desorption during initial commissioning. Figure.3 shows the normalized pressure rise versus the accumulated beam dose after the installation of these undulator chambers. The pressure rise (measured by an upstream gauge) was about ~50 nTorr/mA for U9 system, but about ~2 nTorr/mA for U5 and EPU5.6 system at the beginning. For the high pressure rise in U9 system, the reactivation process (450°C, 30 min) of NEG strip was proceeded after an accumulated beam dose up to 10 Ah. The slightly steep slope of pressure rise after 10 Ah for U9 system was attributed to this reactivation process. The ratio of the pressure rise in U9 and U5 system was about ~25 at the beginning and gradually decreased to 10 at the final. When an accumulated beam dose up to 200 Ah, the values of pressure rise in these ID chambers were decreased by three orders of magnitude. The beam self-cleaning effects in the above ID chambers are the same as the previously installed W20 wiggler chamber [1]. The ratio of pressure rise in U9 and U5 is dominated by the division of the outgassing rate and the effective pumping speed, i.e.,

$$R = P_{U9} / P_{U5} = (Q_{U9} / S_{U9}) / (Q_{U5} / S_{U5})$$

where Q is the outgassing rate of the chamber, and S is the effective pumping speed, the ratio of the pressure value R is estimated to 2. This estimated value is much smaller than the value of 25 at the beginning and the value of 10 at the final. We thought several factors were contributed to the phenomena: (1) limited diffusion rate of NEG strips when large amount of photon stimulated desorption was occurred, (2) the shortage of the pumping speed at the upstream and downstream region in U9 system.

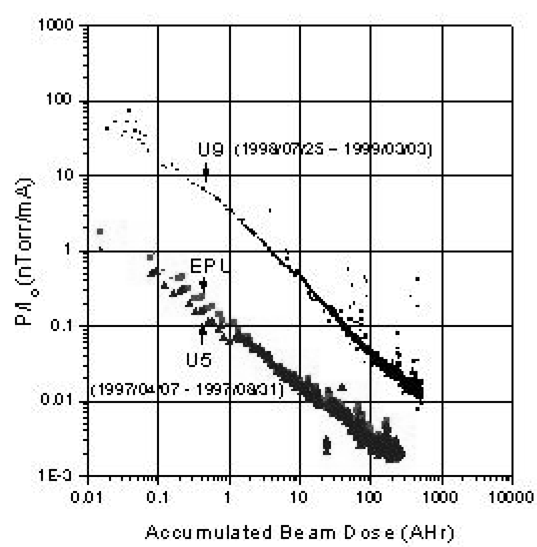

Fig. 3. The normalized pressure rise versus the accumulated beam dose in the upstream regime of U5, EPU5.6 and U9.

Figure. 4 shows the product of the electron-beam current and the lifetime versus the accumulated beam dose. The similar behavior of beam lifetime versus accumulated beam dose in this two systems was observed. A beam lifetime of 5 h at a beam current of 200 mA was achieved after an accumulated beam dose of 10 Ah for these two systems. However, the impact of the high pressure rise due to U9 ID chamber on the electron beam lifetime was small. For achieving better performance, the upgrade plan of U9 ID chamber will be proceeded in the future.

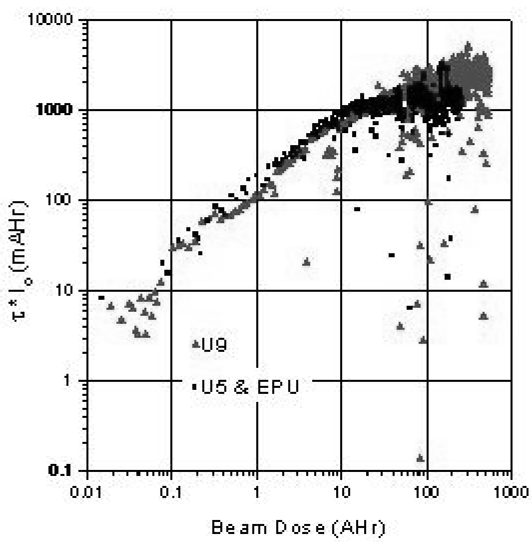

Fig. 4. The product of the beam current (Io) and beam lifetime (τ) vs the accumulated beam dose.

4. SUMMARY

The chamber design, vacuum configuration and commissioning results of U5, EPU5.6 and U9 ID system are described in this article. The normalized pressure rise per mA in U9 system was one order magnitude higher than U5 and EPU5.6 system due to the shortage of the pumping speed at the upstream and downstream regime. However, the reduction of the electron beam lifetime was negligible due to this pressure rise.

5. ACKNOWLEDGMENTS

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6. REFERENCES

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