
Fabrication of one-cell vacuum system for Taiwan Photon Source

C. L. Chen, C. C. Chang, C. K. Chan, C. M. Cheng, C. Y. Yang, L. H. Wu, H. P. Hsueh, C. K. Kuan, J. C. Syu, G. Y. Hsiung and J. R. Chen

Diamond Light Source Proceedings / Volume 1 / Issue MEDSI-6 / October 2011 / e50
DOI: 10.1017/S2044820110000791, Published online: 05 January 2011

Diamond Light Source Proceedings, Vol 1, e50, page 1 of 3
MEDSI-6 2010

doi:10.1017/S2044820110000791

Poster paper

Fabrication of one-cell vacuum system for Taiwan Photon Source

C. L. CHEN[1]†, C. C. CHANG[1], C. K. CHAN[1], C. M. CHENG[1], C. Y. YANG[1], L. H. WU[1], H. P. HSUEH[1], C. K. KUAN[1], J. C. SYU[1], G. Y. HSIUNG[1] AND J. R. CHEN[12]

[1]National Synchrotron Radiation Research Center, 101 Hsin-Ann Road, Hsinchu Science Park, Hsinchu 30076, Taiwan

[2]Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University, 101, Section 2, Kuang-Fu Road, Hsinchu, 30013, Taiwan

(Received 14 June 2010; revised 4 November 2010; accepted 10 November 2010)

A vacuum system of 3 GeV Taiwan photon source (TPS, with circumference 518.4 m), is designed for low-outgassing aluminium beam ducts, low-impedance structure, oil-less pumping system and oil-less fabrication. A prototype (total length 14 m) of the TPS vacuum system has been fabricated. This one-cell prototype vacuum system consists of two bending-magnet chambers (~4 m long each), two straight chambers (~3 m long each), supporting stands, five beam positioning monitors and pumps. Two bending-magnet chambers were made by computer-numerical control machining, which was lubricated with ethanol to protect the surface from oil contamination. Next, these two bending chambers were cleaned with ozonated water to decrease the rate of thermal outgassing and photo-stimulated desorption. The rest chambers were also cleaned by chemical cleaning method. An automatic welding system then was used to implement the side-welding seams of bending chambers in a temperature- and humidity-controlled cleanroom. The bending and straight chambers were welded into one piece by 'on-site welding'. After baking at 150°C for 24 h, an optimizing pressure could be achieved at 4.9 nPa.

1. Introduction

Taiwan Photon Source (TPS) will provide a low-emittance 3 GeV synchrotron light source. The vacuum system in the TPS electron-storage ring comprises 24 unit cells. Each unit cell has two bending chambers and four straight chambers. Aluminium alloy is chosen as the material of the 48 bending vacuum chambers. Aluminium bending chambers (length ~4 m) of these large size have the following advantages (Chen *et al.* 2006): (i) a large triangular chamber to confine almost all sources of outgassing, which arises from photon-stimulated desorption inside the

† Email address for correspondence: clchen@nsrrc.org.tw

bending chamber; (ii) absorbers located as far from the photon beam source as practicable to decrease the density of the heat load deposition on the absorbers; and (iii) vacuum pumps arranged in an antechamber and near the most important sources of outgassing to increase the effective pumping speed and to decrease the numbers of on-axis pumping ports (Chen *et al.* 2006; Kuo *et al.* 2006; Hsiung *et al.* 2008*a*,*b*).

2. Fabrication processes

With the above advantages, oil-free manufacturing and cleaning with ozonized water have been implemented to fabricate a clean surface for ultra-high-vacuum chambers. A full-scale functional prototype (length ~14 m) of a unit cell has been constructed for the evaluation of the whole assembly flow, including fabricating, cleaning, welding and assembling. This construction and pumping down of the prototype provide valuable information from fabrication until final installation and allow modifications to be made before all 24 unit cells are built.

Figure 1 illustrates the layout of the vacuum system in one unit cell. The unit cell of a vacuum chamber comprises two straight chambers, two bending chambers and other components such as a beam position monitor, pumps, ion gauges, gate valves and non-evaporable getters. Two bending chambers, named B1 and B2, have length ~4 m; they are computer-numerical control (CNC) machined with pure alcohol, then cleaned in an ozonized water bath.

After the bending chambers are cleaned with ozonized water, the chambers are moved to a welding room which is a class 1000 cleanroom with the temperature controlled at 25°C and less than 50 % humidity. The welding is separable into two parts: one is manual welding for pumping ports, curved sides, end ports and cooling tubes, and the other involves automatic welding. An automatic welding system has been fully developed by NSRRC to weld both non-parallel straight sides, with six torches ignited simultaneously, as shown in figure 2.

3. Results and discussion

A full scale functional prototype (length ~14 m) of a unit cell has been established for the evaluation of the entire assembly flow, including fabricating, cleaning,

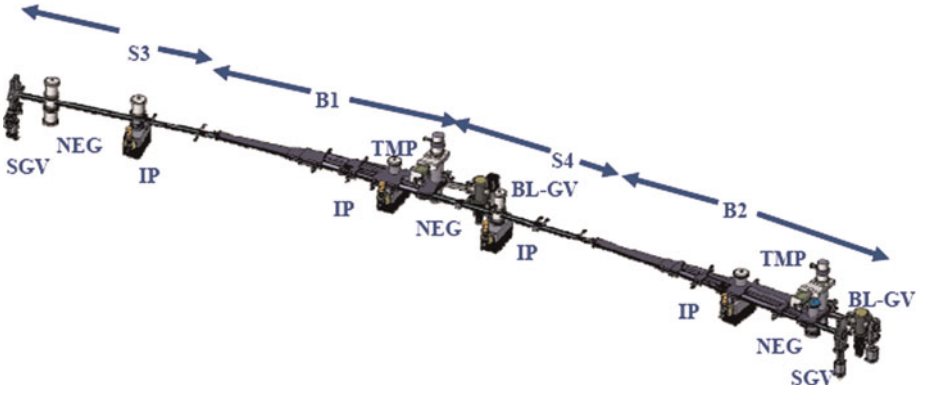

FIGURE 1. Assembly drawing of vacuum system in one unit cell.

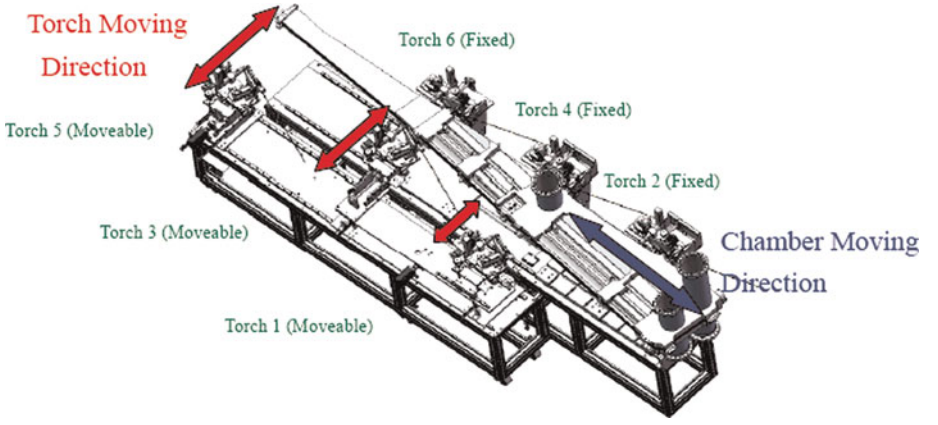

FIGURE 2. Engineering drawing for auto-welding system.

welding and assembly. Before the system is baked, a deformation test was conducted after evacuation. The maximum deformations for bending chambers B1 and B2 are 0.16 and 0.52 mm, respectively.

With oil-free CNC machining and ozonized water cleaning, a minuscule rate of outgassing was obtained. A welded chamber, constructed with an auto-welding system, is verified to be free of leakage and the maximum deformation is controlled to be less than 0.52 mm. According to the pumping data and the prototype of length 14 m, the manufacturing processes fulfil a promise of building a complete aluminium vacuum system for TPS.

REFERENCES

CHEN, J. R., HSIUNG, G. Y., CHAN, C. K., YANG, T. L., KUAN, C. K., HSU, S. N., CHANG, C. C., YANG, C. Y., HSUEH, H. P. & CHEN, C. L. 2006 Vacuum system developments at the National Synchrotron Radiation Research Center – from the 1.5 GeV TLS to the 3.3 GeV TPS. *J. Vacuum Soc. Jpn* **49**, 748–753.

HSIUNG, G. Y., CHAN, C. K., CHANG, C. C., HSUEH, H. P., TSAI, Z. D. & CHEN, J. R. 2008 Vacuum design of the TPS relates to the beam effects. EPAC'08, THPP143, p. 3699.

HSIUNG, G. Y., CHAN, C. K., CHANG, C. C., CHEN, Y. B., HSUEH, H. P., CHEN, C. L., YANG, C. Y., SHU, S. N., CHENG, C. M., KUAN, C. K., SHENG, I. C. & CHEN, J. R. 2008 Vacuum design for the 3 GeV TPS synchrotron light source. *J. Phys.: Conf. Ser*. **100**, 092014.

KUO, C. C., CHANG, H. P., CHOU, P. J., JHAO, H. J., LUO, G. H., TSAI, H. J., WANG, M. H. & CHEN, C. T. 2006 Design of Taiwan future synchrotron light source. EPAC'06, THPLS068, p. 3445.