

THE INSTALLATION OF ONE 14 METER CELL OF TPS VACUUM SYSTEM

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Abstract

The construction of a new 3 GeV synchrotron facility, Taiwan Photon Source, is ongoing. The vacuum system has been designed with off-site baking for arc section from sector gate valve to sector gate valve. There is no flange used in this arc section besides the two ends connected to sector gate valves. It is a tedious works for install such long vacuum system with aluminium chambers. In this paper, all the detailed installation procedures will be described. All the precaution inspection procedures for all vacuum components to prevent failed components to be installed will also be described. Every three weeks, one cell will be assembled and stored. Experience is being learned and could be used for the vacuum system of future new accelerator like FEL and others.

INTRODUCTION

The Taiwan Photon Source (TPS) which is under construction will provide a low-emittance 3-GeV synchrotron light source. The vacuum system in the TPS electron-storage ring comprises 24 unit cells. The design of the vacuum system is described in the other paper in the same conference [1]. This paper is focused on the assembling procedures. The main purposes of the assembling procedures are to achieve the following:

1. Precise dimensions alignment to avoid any space conflict with adjacent system including magnets and girders.
2. Clean and leak free vacuum system to achieve lowest pressure possible and to avoid any delay on pumping down process.
3. Make sure all components aligned correctly to be able to function as designed.

With all above goals in mind, procedures have been designed and followed with great cautions. Both designed procedures and the practice of these procedures are described in the following sections.

VACUUM COMPONENTS PREPARATION

Vacuum Components List

One unit cell vacuum system includes the following vacuum components, as shown in Figure 1:

1. Two aluminium bending chambers (B-Ch) and two aluminium straight chambers (S-Ch).
2. Two section gate valves (SGV, VAT comb-type RF finger and all metal), two beam line valves

(BLV, VAT all metal), two pumping gate valves (PGV, VAT all metal) for large turbo molecular pumps (TMP), one variable leak valve (VLV, Brooks Automation) for system venting, and four angle valves (VAT).

3. Four sputtered ion pumps (SIP, Agilent 200L/s Starcell), two large TMPs (Edwards STP451), and ten non-evaporable getter pumps (NEG, SAES CapaciTorr MK5).
4. Two photon stoppers (copper) and two crotch absorbers (copper).
5. Five beam position monitors (ten flanges with two feedthroughs on each flange).
6. Three vacuum gauges (IG, Oerlikon Leybold extractor gauge) and one residual gas analyzer (RGA, Pfeiffer).

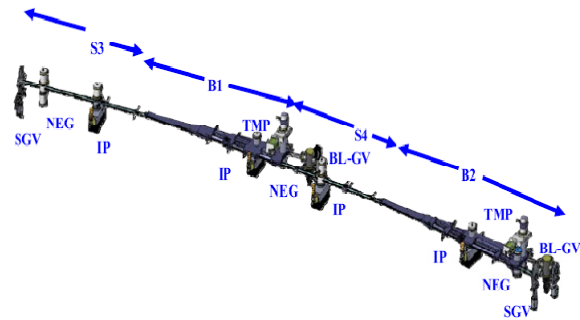


Figure 1: Assembly drawing of a vacuum system in one unit cell arc section[1].

Test before Actual Installation

There are a number of tests need to be done before the component to be installed on the system. These main tests are:

1. Functioning test for SGV, BLV, and PGV to make sure they can open and close correctly. Be sure to secure them before this test. Before ordering them from VAT, make sure they are baked before shipping.
2. Measure current and pressure of SIP at highest applicable voltage with its own controller, and magnetic field leakage from SIP before open the sealed SIP to make sure they arrived safely.
3. Turn on TMP when sealed to make sure they will function correctly and can reach full speed.
4. Measure the resistance of the NEG pump to make sure they are functioning correctly (no open loop).

5. Bake and operate the photon stoppers under vacuum to make sure the bellows are not twisted and have the designed lifetime. Twisted bellows will have a much shorter lifetime.
6. Measure the resistance on gauge head to make sure they will function correctly.

VACUUM SYSTEM INSTALLATION

Figure 2 shows the PERT chart for the installation procedures of one unit cell arc section. After all the required tests in the above section were done, the preparation jobs are finished and the actual installation works can begin.

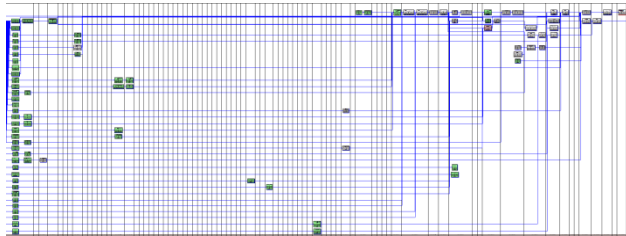


Figure 2: Installation procedure PERT chart for one unit cell arc section installation. The left half is for components preparation and the right half is for actual installation.

The installation work was done on a three-girder set system (Figure 3) which was aligned to within 0.1mm measured by laser tracker (FARO or Leica). All the supports for this cell were then put on girders and aligned to within 0.3mm (also measured by laser tracker).



Figure 3: Girder system.

The first step is to put two B-Ch on supports and fixed at BPM locations by position pins. Then these two B-Ch were aligned with laser tracker to get minimum overall position deviation when the BPM position still fixed (B-Ch can only rotate around the pin). The first B-Ch electron outlet port has to be aligned with the second B-Ch inlet port to have them aligned and welded together with a S-Ch sandwiched in between. Then the first S-Ch was placed and the three welds were welded on site, followed by deformation check by laser tracker.

SGV and their supports were installed with SGV cylinder on the bottom (upside down) and BPM flanges were also installed with two groups of workers. BPM flanges were aligned carefully and seal tightened to no more than 80 kgf-m. Our BPM flanges were sealed by aluminium diamond-shape gasket. At this point, the system was sealed and pumped for leak check. If all

welds and installed components had no leak, the system was vented and went to the next step.

PGV and their supports were installed. Crotch absorbers were installed with the assistance from a specially designed fixture standing on the ground so the long and heavy absorber was installed to deviate less than 0.04mm (we measured the thickness of the sealed flanges in one circle and the thickness won't deviate more than 0.04mm, see Figure 4).



Figure 4: Installation fixtures for crotch absorber installation.

Four SIP were installed. The distance between SIP and supports were measured to make sure the SIP were parallel to support. Otherwise they will have space conflict with magnets. Two large TMP were installed above PGV and dry mechanical pumps were connected to them. Photon stopper supports, photon cross chambers, and photon stoppers were installed in that order, following by the installation of FEV (also upside down, see Figure 5). The fixtures connecting the 14 meters crane and the four main vacuum chambers were installed at this time on the cell and were aligned with laser tracker.



Figure 5: Photon stopper and FEV.

IG, RGA, VLV, and angle valve were installed on the reducer flanges installed on SIP. Small TMP (Agilent 80 L/s) were installed on angle valves for temporary pumping during installation with dry pumps connected.

The ten NEG pumps were installed lastly because it's better for them to be exposed in air for shortest period of time. Then the whole cell was pumped down and leak checked. At the same time, the fixtures to connect the crane with SIP and photon stopper chambers were installed.

The next step was to seal all valves and disconnected the small TMP. The system could be baked before this step and was opted not to do so due to the time constrain

of the assembly site rental contract. We plan to finish the assembly first and bake them afterwards.

Then the crane was taken in and installed on the cell. The cell was then lifted off the girders and moved out the assembly room. The last step was to put the cell on storage supports (see Figure 6). Leak check was applied again to make sure the system was not damaged during transportation.



Figure 6: Cell on storage support.

CONCLUSION

Most recent synchrotron light sources have high demand on vacuum system design to reduce the impedance experienced by electrons. This demand leads to produce a vacuum system as smooth as possible, in other word, less obstacle. Less flanges, smoother RF fingers for bellows and SGV, narrower and shallower gaps etc. To achieve these goals, an innovative design concept at TPS was realized through carefully designed, machined, and welded chambers. Also through the well planned assembling procedures, a cell was carefully assembled. The rest cells will be assembled with the same procedures and will be installed in TPS tunnel when they are finished.

REFERENCES

- [1] G. Y. Hsiung, C. K. Chan, C. H. Chang, C. C. Chang, C. L. Chen, C. M. Cheng, Y. T. Cheng, S. N. Hsu, H. P. Hsueh, C. S. Huang, I. T. Huang, T. Y. Lee, I. C. Sheng, L. H. Wu, H. Y. Yan, Y. C. Yang, J. R. Chen, TUODB01 submitted to IPAC2011.