

SURVEY AND ALIGNMENT FOR TAIWAN PHOTON SOURCE STORAGE RING

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Abstract

The Taiwan Photon Source (TPS) is a 3-GeV synchrotron light source located in Hsinchu, Taiwan. The commissioning of the beam began on December 2014, and the phase 1 stored current of 100mA was achieved on March 2015. Then the installation and alignment of insertion device were complete during the shutdown from April to July, and also the scheduled maintenance of survey control points was complete in the meantime. This report presents survey alignment results and experience of the TPS.

INTRODUCTION

Taiwan Photon Source was completely installed in August 2014. The commissioning of beam on December 2014, and the phase 1 stored current of 100mA was achieved on March 2015. Then the 10 insertion devices and RF were installed from April 2015 to July 2015 for phase 1 beam line used. Now the beam current of TPS storage ring can be up to 300mA for beam line used. The survey and alignment is the important foundation work in the construction of accelerator. The precise and stable survey network could supply a good base for alignment work in the storage ring and experiment area. According to the survey network, now the variation of girders is about to 0.5mm in storage ring. Then the girders would be the base for aligning the other following devices like insertion devices and extended elements of beamlines. This paper describes the TPS survey network status and the installation process of insertion device in TPS storage ring.

THE TPS SURVEY NETWORK STATUS

The survey network of TPS was constructed using GPS, theodolite, laser tracker gradually [1]. Now the survey network of TPS is survey by an outdoor laser tracker (Leica AT401) when the roof of building was constructed and the enhancement of environment. The survey network of TPS is divided two parts, one is in the storage ring and another one is in experiment area. We use the part of the storage ring to be the base part, and the fiducial near the viewport on each shall wall can connect the survey network of experiment area and the storage ring. So the survey network can extend from storage ring to experiment area.

As the more beamline constructed, it would more hard to a rigid survey network in experiment area, and it will also block survey of the connected fiducial points through

the view hole as shown in Figure 1. It will be a serious problem to align the elements in the experiment area when between the experiment area and the storage ring is unconnected gradually, or the earthquake leads the large variation of the TPS survey network.

To solve this problem, there will be several new fiducial points installed on the second floor. The new fiducial points and the parts of original fiducial in the experiment area will be form a new survey network in the experiment area. The roofs of storage ring can be opened to solve the connecting between storage ring and experiment area when the more beam line will be constructed.

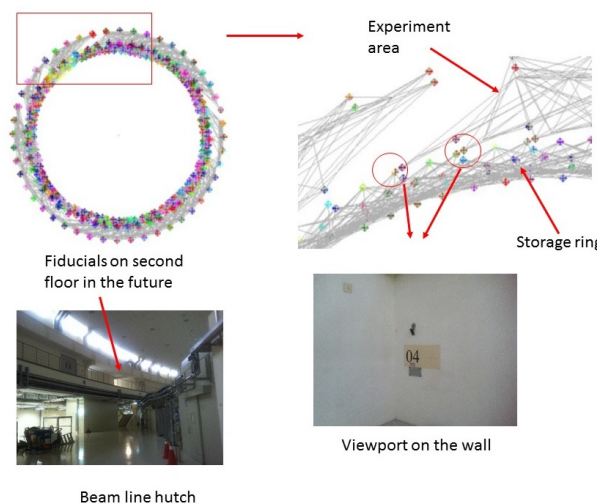


Figure 1: The survey network in TPS.

Figure 2 shows the variation of the TPS survey network with change of temperature in a year. Before the air conditioner of the TPS is operated, the variation of the survey network is up to 5mm. When the air conditioner is operated and let the temperature be 25°C the variation the survey network is reduced to 1mm in a year even the change of outside temperature is up to 20°C.

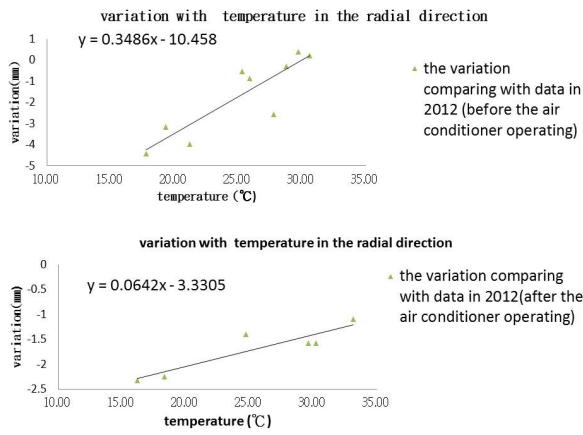


Figure 2: The variation of survey network.

THE STATUS OF STORAGE RING

According to this data, the survey network of the TPS seems to be stable within 1mm per year. Then we do fine tune to those girder in TPS storage ring in May 2014. We checked the positions of girders in June 2015 again and there are few parts of girder needed to be adjusted. Consider the accuracy of the survey instrument; there are not all of girders needed to be adjusted. There are few protruding girders needed to be adjusted to make the position of girders smoothly in the storage ring. After correcting the position of those girders, the stand deviation value of positions of the whole ring girder are reduce from 0.27mm to 0.19mm and 0.33mm to 0.31mm in the transverse and vertical direction respectively as shown in Figure 3.

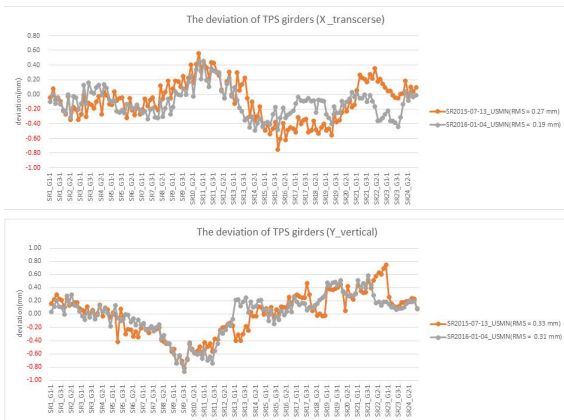


Figure 3: The alignment result of girders.

The beam position monitors are critical element to measure and control beam position stability, to confirm the positions of the beam position monitors system in the storage ring is important. The alignment of the beam position monitors had be completely in august 2014, and we confirm the deviation of then in the every long shut down of storage ring. Those results of survey can be information to correct the position of the beam position monitors when the monitors are used for diagnosing the electric beam in the storage ring. Figure 4 shows that the beam position monitors system are surveyed again in

January 2016, and the most deviation of BPM are still within 0.5mm since the BPM system had been installed. The survey results of beam position monitors and the TPS survey network all show that the TPS building are very stable, and it is good for constructing and aligning the new equipment in the TPS.

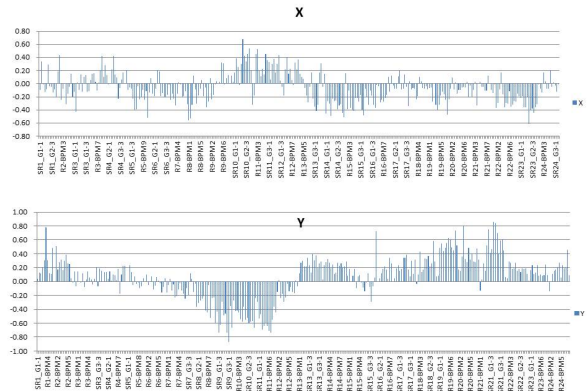


Figure 4: The alignment result of beam position monitor.

THE INSTALLATION WORK

The TPS of insertion devices are planned to be installed in July 2015. The insertion devices are assembled by the manufacturer in Japan. Considering the follow up installation work in Taiwan, there are 4 fiducial points and a datum plane on the insertion device for assembling and alignment job jointly as shown in Figure 5. The traditional theodolite and laser tracker can observe those fiducial points in community. Two of fiducials at the same altitude as the electron beam are used for alignment in the vertical direction, and the another two fiducials right above the electron beam are used for alignment in the transverse direction. The datum plane of insertion devices can make sure the levelling of the equipment is the same as the manufacturer when the equipment is installed in Taiwan.



Figure 5: The insertion devices.

Before insertion devices are conveyed to TPS, we set out marks on the ground for primary alignment in the beginning. Then the insertion devices are installed and aligned roughly according to those marks. The apparatus is quite long, so we use two laser tracker on the ends of an insertion device for alignment at the same time. A bubble-levelling (20µm/m) is used to adjust the levelling of an insertion device is the same as the manufacturer. Considering that the whole building becomes to be stable,

and the uncertainty of the survey network. The follow up equipment should be aligned along with the position of storage ring girders. The whole equipment of storage ring can be aligned smoothly as shown in Figure 6.

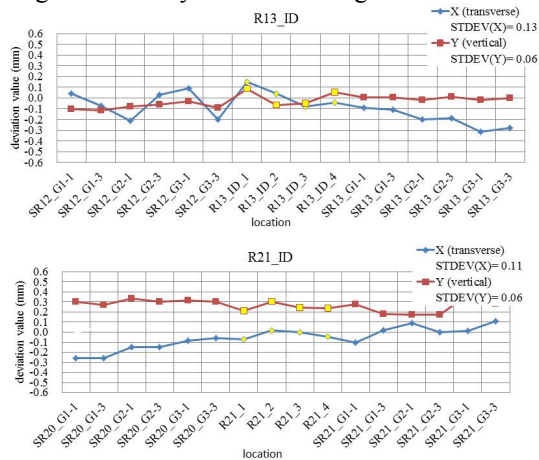


Figure 6: The part alignment result of insertion devices.

MONITOR OF STORAGE RING

Taiwan Photon Source is a new 3-GeV synchrotron ring and the major building finished construction in 2013 at Taiwan. Considering the frequent earthquake in Taiwan and instable the building, it is necessary to monitor the status of storage ring. The magnets on girders are the fundamental apparatus of accelerator, so we use the absolute length gauges (Heidenhain AT 1218) to monitor the position of girders. There are 16 touch sensor installed on three girders in one section to monitor the position of girders and can be feedback control sensors for adjustment of girders. The suffix of each touch sensor name means the monitor direction. “x”, “y” and “z” is transverse vertical and longitudinal direction respectively as shown in Figure 7.

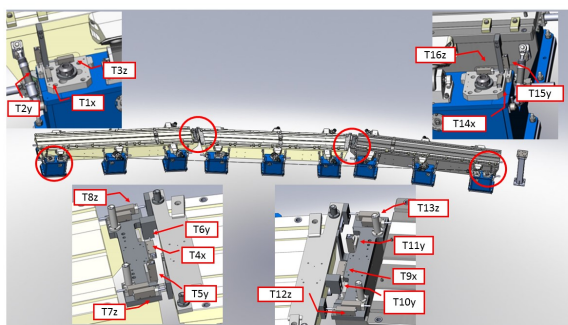


Figure 7: The placement of touch sensors.

A magnitude 6.4 earthquake struck south Taiwan on 6 February 2016. Figure 8 shows that the two extreme different kind variations of touch sensors in TPS storage ring when the earthquake struck Taiwan. The slightest displacement is less than 1um after the earthquake, and even the most serious one is still less than 5µm. According to those results, the girders are not adjusted again after the earthquake. The locking system of girders is actuated in the transverse direction, so the most serious

variation of touch sensors are in the longitudinal direction when the earthquake occurred.

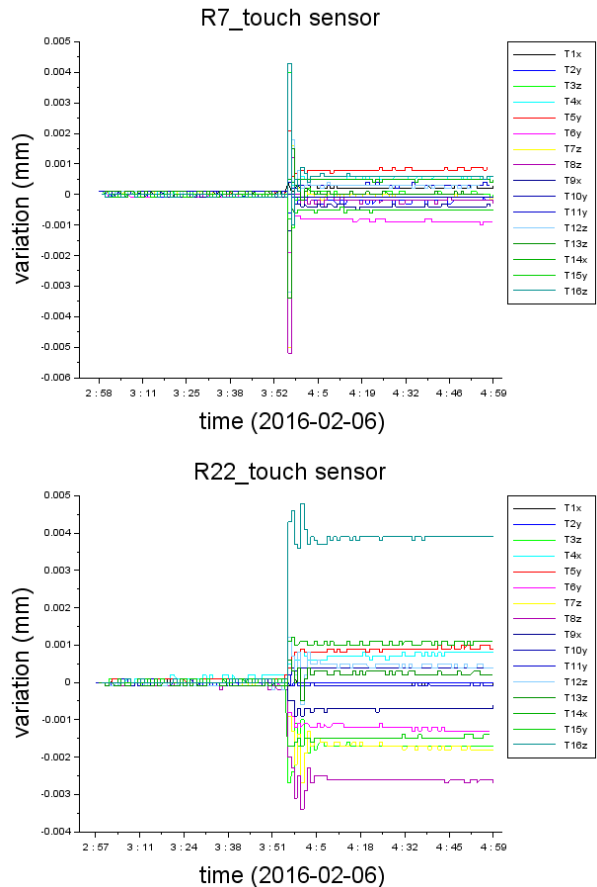


Figure 8: The variation of touch sensors when the earthquake occurred.

CONCLUSION

The survey network of Taiwan photon source is very stable after finishing the construction of TPS and the temperature control system operating. The most serious variation of the survey network is about 1mm in a year, so we can base it to align following equipment in storage ring and experiment area precisely. To make sure the relative position of girders is not changed, there are 16 touch sensors with high accuracy on each girder. It can confirm and adjust the position of girders at all time conveniently and quickly. Now the global position of girders is still survey by the laser tracker. The sensors system will be improved to ascertain the global position of girders in the future.

REFERENCES

[1] W.Y. Lai and others, “Alignment design and status of Taiwan photon source,” IPAC 2015, pp.3212-3214, paper WEPHA044.