The Thermo-Mechanical Stability at TPS

J-R Chen[1,2)], M-L Chen[1)], W-Y Lai[1)], Z-D Tsai[1)], and I-C Yang[1)]

1) National Synchrotron Radiation Research Center, Hsinchu, Taiwan

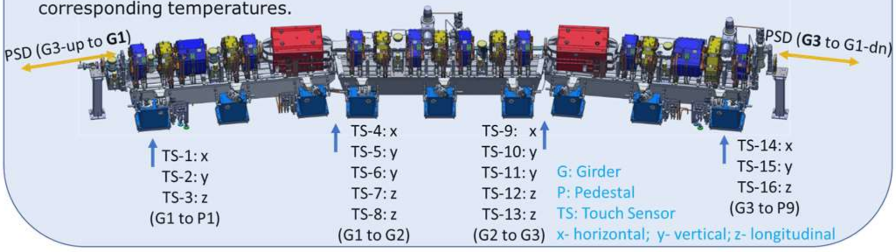
2) Department of Medical Engineering and Environmental Sciences, NTHU, Hsinchu, Taiwan

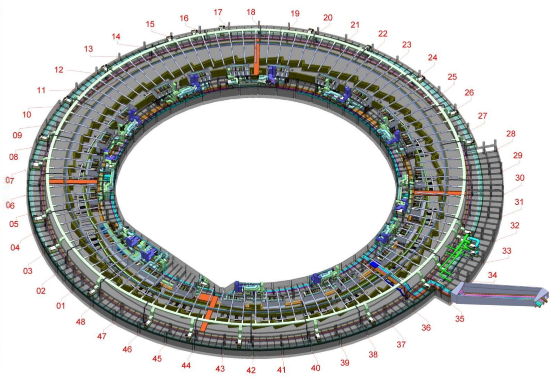
Introduction

The mechanical stability in a synchrotron light source, via a variety of routes, affects the beam performance in many ways. For a low-emittance machine, the criteria on the mechanical stability became much stringent. [1] Among many factors, the temperature stability is one of the key issues for the machine operation with high stability and high reliability. A temperature fluctuation of 0.1˚C is widely adopted as the fundamental requirement in many machines. At the Taiwan Photon Source (TPS), several mechanical sensors had been installed for the alignment purpose during the installation stage. [2] These sensors were switched as the real time monitors to monitor the displacements of the girders in the operation period. The results of the mechanical sensors, the temperature sensors, and the beam position monitors of TPS were analyzed in order to figure out the details of the correlations.

The Sensors

Sixteen mechanical touch sensors were placed at each arc section to measure the relative displacements between the adjacent girders and between the first/third girder and the first/last pedestal in the arc section. (Fig.1) A laser position-sensitive detector (PSD), located at each long straight section, was utilized to measure the relative transverse movement between the two girders at the opposite sides of the long straight. The thermocouples, widely distributed around the TPS building, located at the floor, on the girder, the vacuum chamber, and in the air, were used to measure the corresponding temperatures.





Results and Discussions

	Condition: unstable beam current	Discussions
Z	1. T-tunnel-air (Fig.1a) → Z displacement (Fig.1b) 2. (Short term) Less correlated to the T-girder (Fig.1c). 3. Long term drift (G to P, fig.1d) ← T-tunnel-floor (Fig.1e)	Stable temperature control. Temperature stabilization to the whole facility (incl. T-floor).
Y	1. Strongly correlated among the beam current (Fig. 2a), T- tunnel-air (Fig. 2b), T-vac-chamber (Fig. 2c), and the vertical beam orbit (Fig. 2d). 2. Less correlated to the T-girder (Fig. 2e).	Beam current → T-vac-chamber (& its support) → Chamber expansion/contraction → Beam Y-orbit. Stabilization to the beam current control.
X	1. X reading (Fig. 3a) correlated to Z reading (Fig. 3b).	X could be coupled from Y or/and Z. More efficient kinematic mounting. Stable temperature control.
	Condition: stable beam current	***Discussions***
Z	1. T-outdoor (Fig. 4a)→ T-tunnel-air (Fig. 4b) → Z displacement (Fig.4c) 2. Less correlated to the T-vac-chamber (Fig.4d) 3. G to P(Floor) (Fig. 4e) correlated to T-tunnel-air (Fig.4b)	Structure expansion/contraction caused by the T-tunnel-air. More stable air-temperature (<0.1C) or/and using thermal insulation would be helpful.
Y	1. T-tunnel-air (Fig.5a) → Y displacement (G-G) (Fig.5b) 2. Less correlated to the T-vac chamber (Fig.5c) 3. Component (& floor) heated up → Long term drift (G-P) (Fig.5d)	Y could be an effect of "buckling" caused by Z. More efficient kinematic mounting. Stabilization to the machine equipment and temperature control.
X	1. T-tunnel-air (Fig.6a) → X-reading (Fig.6b) 2. Long term drift.	X could be coupled from Z or/and Y. More efficient kinematic mounting. Stable temperature control.

References

1) J.R. Chen et al., "Low-Emittance Engineering – an Overview," MEDSI 2008, Saskatoon, Canada, June 10-13, 2008.
2) T-C Tseng et al., "Installation and Implementation of an Auto-Alignment Girder System for TPS Storage Ring", MEDSI 2014, Melbourne, Australia, 20-24 October 2014.

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