tion position or direction depends only on the position or direction of the electron beam in undulators, the orbit should be corrected to ensure that the positions and angles of trajectory at ID1 and ID2 are consistent within a tolerance which is 10 % of the electron beam size and divergence. Therefore, at TPS case, the axes of the two wave packets of undulator radiation should fit within ± 1.6/1 μradiana (horizontally and vertically), ± 16/0.5 μm (horizontally and vertically).

Finite kick on the electron orbit can be expected from triplet quadrupole magnet because not all the electrons pass through magnet center and misalignment by triplet qadrupole magnets may cause another kick on electron beam orbit. As a result, two photon beams separate in space can be expected if no orbit correction is applied. For orbit correction between double undulators, two slits/XBPMs are necessary to define the position of the photon beam, maybe one in the front end section and the other in front of the monochromator. The centers of the photon beam can be determined by measuring spectra of photons emitted from individual undulators for different slit transverse positions. Those positions can be converted to the angles and positions of the electron beam injected to individual undulators. These positional errors, thus, can be corrected by two steering magnets installed between segments of IDs.

The drift of a COD or the quadrpole magnetic center due to magnetic aging or ground sink may cause mismatch of two superimposed radiation cones. Orbit correction scheme of double undulator configurations is under development. (Reported by Jui-Che Huang)

Reference

1. J.-C. Huang, H. Kitamura, C.-H. Chang, C.-H. Chang, and C.-S. Hwang, Nucl. Instr. Meth. Phys. Res. **775**, 162 (2015).

Construction and Commissioning of TPS Phase-I Beamlines

Taiwan Photon Source (TPS) is designed to emphasize electron beams of small emittance and great brilliance to generate extremely bright photon beams. These superior characteristics of the TPS have opened avenues of novel scientific opportunities for scientists in several diverse research areas to reveal structures, electron interactions, functions of materials and their dynamics using various spectrometric tools, imaging methods and scattering techniques. At the TPS, seven beamlines in phase I are under construction with advanced techniques including protein microcrystallography (05A), temporally coherent X-ray diffraction (09A), X-ray nanodiffraction (21A), X-ray nanoprobe (23A), coherent X-ray scattering (25A), resonant soft X-ray scattering (41A) and submicron soft X-ray spectroscopy (45A). Listed in Table 1 is a summary of specifications of beamlines in phase I.

After installation of ten undulators and two superconducting RF-cavities in September, the TPS storage ring achieved a stored-electron beam current up to 520 mA, above its design value 500 mA, on Dec. 12, 2015. Beamline optics and experimental end stations of seven beamlines in phase I have been intensively and concurrently installed at the TPS.

While the TPS ramps to its target value of stored current, three beamlines—for protein microcrystallography, for temporally coherent X-ray diffraction and for coherent X-ray scattering—are being commissioned. Up to December 2015, TPS-05 has delivered monochromatic X-rays with beam sizes a few tens of microns and obtained experimental data. X-rays from two collinear IUs installed in the same 12-meter straight section with a double mini-β_y lattice have been monochromatized and transported to the 8-circle diffractometer at beamline TPS-09. At another 12-meter straight section, X-rays from two collinear IUs have been made monochromatic and spectra have been recorded at

Table 1: Summary of specifications of beamlines, phase I.

		05A Protein μ-crystallography	09A Temporally Coherent XRD	21A X-ray Nanodiffraction	23A X-ray Nanoprobe	25A X-ray Coherent Scattering	41A Soft X-ray Scattering	45A Sub-μm Soft X-ray Spectroscopy
Insertion devices		IU22	Tandem IU22	Tapered IU22	IU22	Tandem IU22	Tandem EPU48	EPU46
Energy range		5.7–20 keV	5.6–25 keV	7–25 keV	4–15 keV	5.5–20 keV	400–1200 eV	280–1500 eV
Experimental techniques								
Imaging (CDI)					•	•	•	
Scattering	Structural diffraction	•	•	•	•	•	•	
	Scattering					•	•	
Spectroscopy	XAS		•	•	•	•	•	•
	XEOL			•	•			•
	RIXS						•	•
	PES							•

CDI: coherent diffraction imaging
XAS: X-ray absorption spectroscopy
XEOL: X-ray excited optical luminescence
RIXS: resonant inelastic X-ray scattering
PES: photoemission emission spectroscopy

(a) (e) (b) (f) (c) (g) (d)

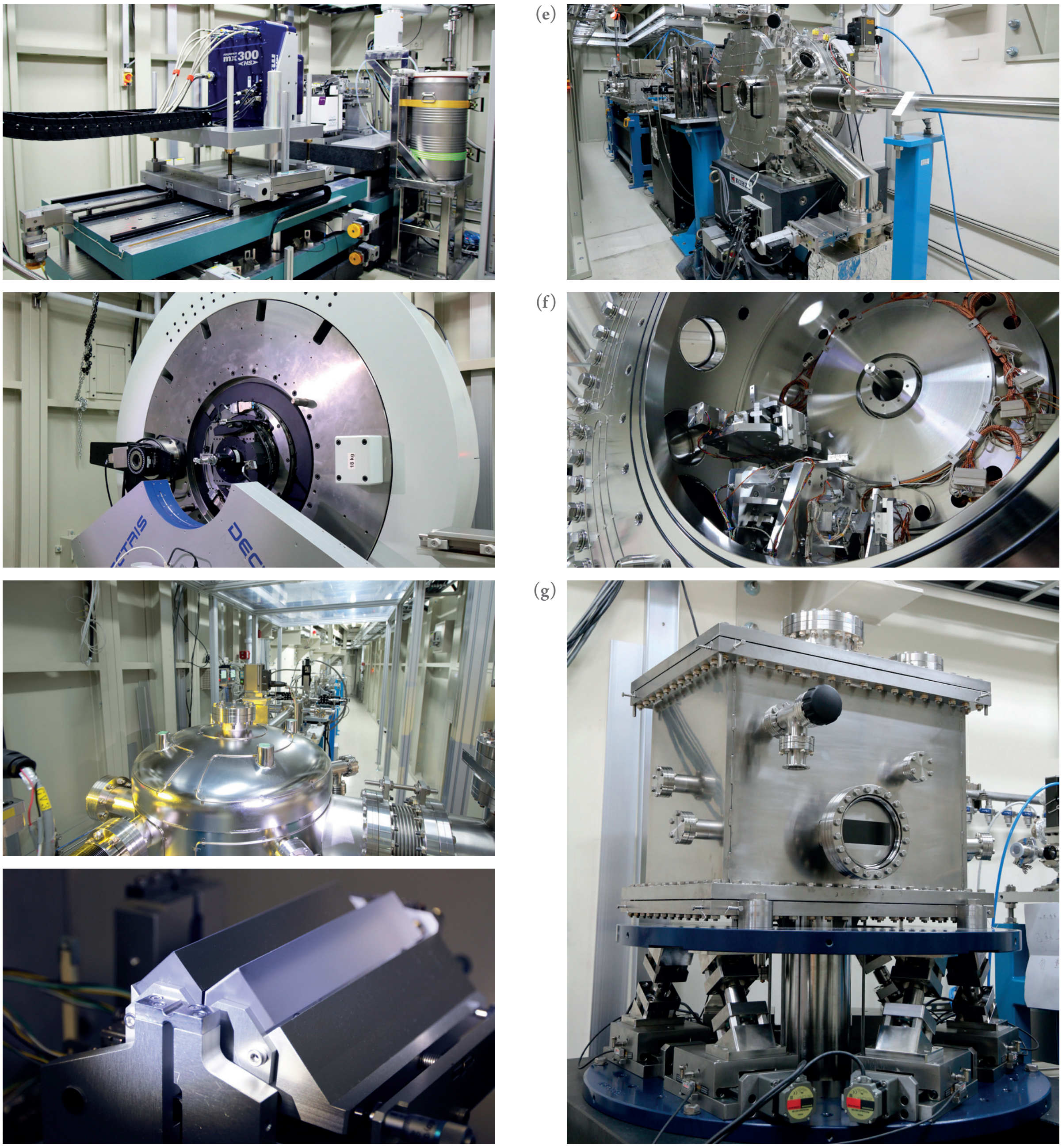

Fig. 1: Pictures of phase-I beamlines. (a) TPS-05A: microcrystallography endstation, (b) TPS-09A: endstation of high-resolution powder X-ray diffraction, (c) TPS-21A: mirror chamber of beamline, (d) TPS-23A: nested K-B mirrors, (e) TPS-25A: monochromator and mirror chamber of beamline, (f) TPS-41A: endstation of resonant soft X-ray scattering, (g) TPS-45A: mirror chamber with precise alignment table.

beamline TPS-25. Furthermore, three beamlines of X-ray nanodiffraction 21A, soft X-ray scattering 41A and submicron soft X-ray spectroscopy 45A are due to be in commissioning from March 2016. The six beamlines are scheduled to be opened for users from September 2016. The construction of the seventh beamline of X-ray nanoprobe 23A will be completed for its commissioning in November 2016. The seven pictures of phase-I beamlines are shown in Fig. 1. More detailed information is available at http://tpsportal.nsrrc.org.tw/tps/preactivity.aspx. (Reported by Yu-Shan Huang)

Beamline Plan in Phases II and III at Taiwan Photon Source

During operation over two decades since the first light of the TLS in 1993, the NSRRC has evolved into a light-source facility well known internationally. With increasing demands from users for bright X-rays to facilitate their innovative scientific experiments, the NSRRC has completed the commissioning of its newly constructed 3-GeV low-emittance synchrotron light source, TPS. The TPS has accomplished storage of electron current at 520 mA in its storage ring on December 12, 2015 after its first photon beam in December 2014.

TPS will open avenues for novel scientific opportunities and experimental techniques. Seven TPS phase-I beamlines are being constructed for commissioning, including for protein microcrystallography, temporally coherent X-ray diffraction, X-ray nanodiffraction, X-ray nanoprobe, coherent X-ray scattering, resonant soft X-ray scattering, and submicron soft X-ray spectroscopy. These phase-I beamlines will be completed in 2016. To use fully the superior characteristics of the TPS, the NSRRC proposes a plan of 18 TPS