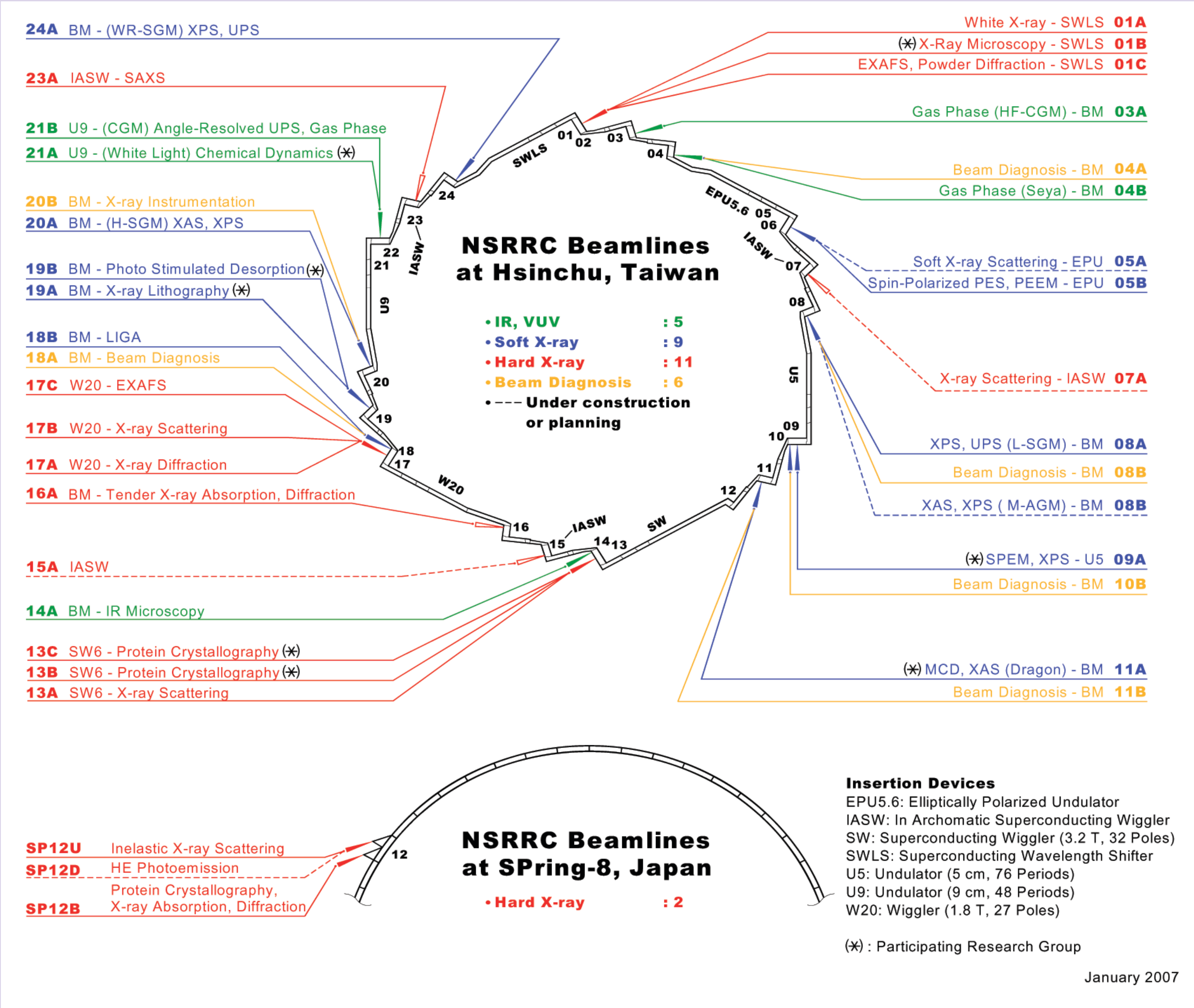
Beamlines and New End Stations



Currently there are 25 beamlines in operation and 5 beamlines under construction at the TLS storage ring. Twelve beamlines utilize the output from 10 bending magnet sources, and 13 beamlines share the output from 6 insertion devices. These beamlines cover a spectral range from infra-red to hard X-ray up to 33 keV. For applications requiring higher photon energy, NSRRC has two hard X-ray beamlines in operation at SPring-8, one from bending magnet and the other from undulator source, and an ID side-branch beamline under construction. Altogether these 27 beamlines have supported domestic and foreign users from a diversity of academic and industrial backgrounds for fundamental research and technological development.

In the summer of 2006, the world's first active grating monochromator (AGM) beamline, the AGM-AGS beamline (BL05A), was constructed and commissioned. The AGM monochromator surpass the performance of conventional spherical grating monochromator used in Dragon-type beamline by virtue of its active grating, which has an aspherical-shaped surface and a continuously adjustable curvature. The grating radius can be precisely tuned to eliminate the defocusing term, thus obliterating the need to move the exit slit. Moreover, the surface of active grating can be correctly adjusted into a proper aspherical shape to effectively minimize the coma aberration, and hence raising the energy resolution. Using the output from an elliptical-polarized undulator (EPU), this new AGM-AGS beamline provides an excellent photon source for inelastic soft X-ray scattering experiments. A second AGM beamline (BL08A) was designed in 2005 to provide users with another high performance soft X-ray source and to alleviate the loading of existing soft X-ray beamlines. BL08A shares the bending magnet output with the existing LSGM beamline and started commission in July 2007. As for hard X-ray beamlines, the small angle X-ray scattering beamline (BL23A) has completed construction and started commission in March 2007, with photon source from the newly installed in-achromatic superconducting wiggler (IASW).

The contract beamline 07A, adopting the hard X-rays generated from a second In-Achromatic Superconducting Wiggler (IASW), is under construction and starts commissioning in March 2008. Led by an Associated University Team (AUT) co-chaired by professor Shih-Lin Chang (National Tsing Hua University) and professor Wei-Fong Pong (Tamkang University), the beamline is designed to operate in the energy range of 5 to 23 keV, and dedicated for X-ray scattering and X-ray absorption spectroscopy. Associated with micro-focusing capability as well as non-ambient experimental environment, such as low temperature, high pressure, high magnetic field and polarized incident light, the beamline provides unique opportunity for investigating condensed matter structures in the atomic, electronic and magnetic aspects. Additionally, the beamline is partly to serve as a base for developing new X-ray optics for the future Taiwan Photon Source (TPS).

At SPring-8, a new branch beamline of BL12XU beamline is also under construction, utilizing a diamond monochromator (DM) to monochromatize X-ray photons, followed by a high resolution monochromator to raise the energy resolution to 60 meV. The photon beam is focused to 30 μm x 30 μm (H x V) at the sample position. The whole section of the beamline following the DM will be supported by a platform that is capable of swinging with the outgoing beam of the DM at different photon energies. This branch beamline will deliver photons from 6 keV to 12 keV, with scheduled operation by the end of 2007.

To continue the improvement of performance on existing beamlines, during the year end shutdown in 2005, we moved beamline BL15B to beam port 16 and installed a new collimating mirror, resulting a five-fold increase in flux at the sample position. At the SPring-8 ID beamline BL12XU, we implemented a micro-focusing system using a set of Kirkpatrick-Baez mirrors that are compatible with the existing optical system and improved the focusing to 13 μm x 16 μm (H x V), as well as the transmission to 80%. With improved focusing, high-pressure experiments on SiO_2, liquid, and solid He have been performed successfully on this beamline.

New and noteworthy end station developments include a full-field, nano-transmission X-ray microscopy (TXM) system at beamline BL01B, and a vacuum-ultraviolet circular dichroism (VUVCD) system at beamline BL04B. The TXM end station provides 2D image and 3D tomography from 8 to 11 keV, with a spatial resolution of 30-45 nm, with Zernike-phase contrast capability for imaging light materials such as biological specimens. The spatial resolution of tomography for the gold spoke pattern is estimated at about 60 nm. The phase contrast tested with plastic zone plates of 1 μm thickness is estimated at 12%, with absorption contrast almost invisible at 8 keV, at about 0.01%. Several research endeavors are now in progress at this end station. For IC devices, the layer depth of interest is about several microns, which is within the field of view of the microscope, and the system is well suitable for tomography. In life science, the X-ray microscopy has been successfully applied to investigate the location of specific proteins by means of immunolabeling the interest proteins with contrast agent such as gold nanoparticles.

The vacuum-ultraviolet circular dichroism (VUVCD) is a powerful tool for bio-science research, and many synchrotron radiation circular dichroism (SRCD) end stations have been built for VUVCD application in recent years. In 2006, the beamline group began to modify the SEYA (BL04B) beamline to accommodate the first SRCD end station in NSRRC. The system will provide flux at the sample point greater than 1×10^9 photons/s/0.1% bandwidth with ring current of 300 mA, with a spectral range from 120 nm to 300 nm, and a focal size about 2 mm x 1 mm (H x V, FWHM). In March 2007, an SRCD system based on LiF photoelastic modulator (PEM) was constructed and tested, and we have obtained CD spectrum of (1s)-(+)-10-camphorsulphonic acid (CSA) in the spectral range of 180 - 300 nm. In the future, we will fine-tune the system to improve S/N ratio and its scanning performance.