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Beamlines at Siam photon laboratory

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Abstract

This report provides the up-to-date information on the present and future beamlines at the Siam Photon Laboratory. The first two beamlines, BL-4 and BL-6, have already been installed, and are now in commissioning. BL-4 is a VUV beamline to be used for investigating the electronic structures of solids and solid surfaces using the angle-resolved photoemission experimental technique. BL-6 is a beamline for electron beam monitoring. Future beamlines utilizing synchrotron light generated by a planar undulator and a superconducting magnet wiggler are discussed.

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1. Introduction

The Siam Photon Source is a 1.0 GeV synchrotron light source [1]. The storage ring has eight beam channels. To utilize the synchrotron light in the initial stage operation of the Siam Photon Source, a VUV beamline (BL-4) has been constructed for investigations of the electronic structures of solids using the angle-resolved photoemission experimental technique. An electron beam monitoring beamline by the use of synchrotron light (BL-6) has also been constructed. The installation of insertion devices such as undulators and superconducting magnet wigglers is considered. The present report describes the installation work and the current status of the present beamlines. Discussion about the future beamlines to be constructed at the Siam Photon Laboratory is also presented.

2. BL-4: Photoemission beamline

BL-4, shown in Fig. 1, is the first beamline to utilize the synchrotron light generated by the Siam Photon Source. The beamline will be used for investigating electronic structure of solids and solid surfaces, and phenomena pertaining to processes of materials syntheses or materials modifications. The beamline may be divided into three main parts, i.e. the front-end, the optical beamline and the experimental station.

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Fig. 1. Photo of BL-4 installed in the experimental hall of the Siam Photon Laboratory.

The front-end of the beamline serves primarily to prevent damage to the storage ring and radiation hazards to the users of the beamline. Fig. 2(a) and (b) show the top-view and the side-view of the design drawings of the front-end, respectively. The main components of the front-end are vacuum valves, a light absorber (ABS), masks, and a beam shutter (BS). The major components of the front-end are installed inside the radiation shield wall and along a line tangential to the designed electron orbit in the storage ring. The tangent point has been chosen to be 10° downstream from the entrance of the BM4 bending magnets.

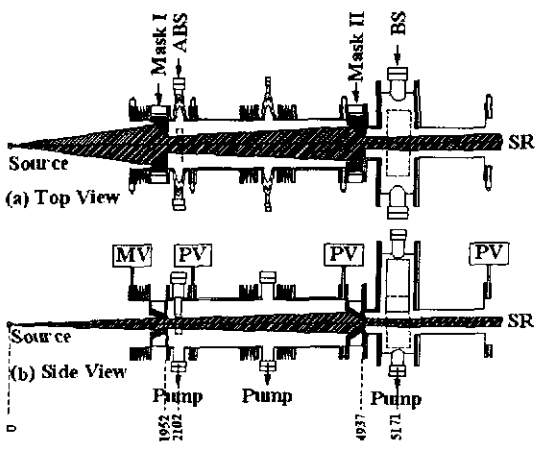

Fig. 2. Top view (a) and side view (b) drawings of the front-end of BL-4 showing main components such as masks, ABS and BS. The acceptance angle of synchrotron radiation (SR) BL-4 is defined by Mask II. The scale in the direction along SR is different from the scale in the direction perpendicular to SR.

The optical beamline employs a varied line-spacing plane grating monochromator, pre- and post-focusing toroidal mirrors [2]. It can deliver photons with energies between 20 and 240 eV with the average designed resolving power of approximately 5000. The detailed information of the optical beamline is published elsewhere [2,3]. The mechanical parts of the beamline have been manufactured by Toyama Co. Ltd., and the optical elements are supplied by Carl Zeiss Laser Optics' GmbH. The installation of the front-end and the optical beamline has already been carried out. The alignment of the manipulators and the holders of optical elements has been carried out using dummy optical elements made of aluminum. A laser theodolite, a level and a total station have been used as important tools for the alignment. However, the beamline will be aligned again with the synchrotron light after a stable electron orbit in the storage ring is obtained.

The vacuum system of the beamline has been designed for ultra-high vacuum. Most of the components are made of stainless steel. The magnitudes of the pressure in the whole beamline are in the range of 10^{-10} Torr. To obtain such a good vacuum condition, long degassing procedures have been carried out. After the vacuum components were installed and before the optical elements were placed in the chambers, the mechanical parts of the whole beamline have been baked at 200 °C for 72 h. It is noted that some heat-sensitive components were baked at lower temperatures. After the gratings and the mirrors were installed, only the sections where the optical elements are located have been baked further at 120 °C for 25 days. Sputter ion pumps are used in combination of titanium sublimation pumps to generate ultra-high vacuum condition. The residual gases in the system have been analyzed by quadrupole mass spectrometers. The major residual gases after baking are H_2, CO, CO_2, CH_4 and Ar.

The basic concept of the interlock system is illustrated in the diagram shown in Fig. 3. The system comprises of an OMRON CS1 series programmable logic controller with input and output units and interface units. The status of the ion

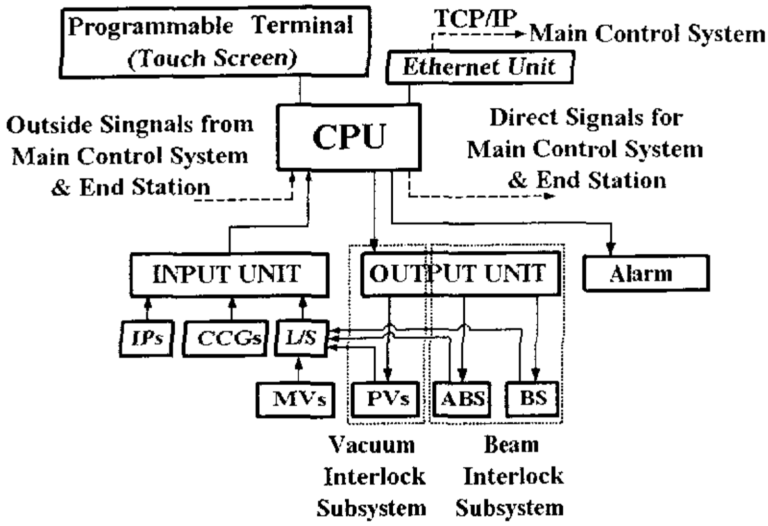

Fig. 3. Schematic diagram of the interlock system for BL-4 and BL-6 at the Siam Photon Laboratory.

pumps (IPs), the storage ring, status of utilities, the vacuum pressure and the manual and pneumatic valves (MV, PVs), ABS and BS are displayed on a touch screen. The touch screen is also used as a man–machine interface to control the actions of ABS, BS and PVs.

The interlock system has two sub-systems, i.e. vacuum interlock sub-system and photon beam interlock subsystem. The vacuum interlock subsystem involves with the closing and opening actions of the pneumatic valves. The beam interlock sub-system is for monitoring and controlling ABS and BS. There are three modes of operation for the interlock system: interlock on, interlock off and user modes. The first two modes will be used only for beamline maintenance and development, while the user mode has been designed for the users of the beamline. The interlock system has been examined after a good vacuum state of the beamline was obtained. The test inspection showed results as expected from the system design.

The monochromator of the beamline will be optimized using photoionization experiments after sufficient photon flux can be obtained from the Siam Photon Source. Then, the associated experimental station, an angle-resolved photoemission system made by Thermal VG Scientific [3], will be connected to the beamline. The experimental station is also equipped with various surface analysis tools, a laboratory UV lamp and an X-ray source, enabling UPS, XPS, AES and LEED measurements. The beamline is expected to be opened to the users by the end of the year 2002.

3. BL-6: Photon beam monitoring beamline

BL-6 has been installed along a line tangential to the designed electron orbit. The tangent point is 10° downstream from the entrance of the BM6 bending magnet. The beamline is for characterizing the electron beam in the storage ring. The design of the beamline is rather simple, consisting of two main parts, i.e. the front–end and the monitoring system. The mechanical parts, the vacuum system and the interlock system of the front–end of BL-6 are similar to that of BL-4. The differences are the openings of Mask I and Mask II. In the monitoring system, a flat SiC mirror is installed in the monitoring chamber to reflect light toward the direction making 90° from the original direction to a CCD camera, which is located outside the vacuum chamber. The data from the CCD camera may be stored or analyzed by using a computer imaging software. The vacuum system of the beamline has been operated in a similar way as that of BL-4. The beamline is now in use for monitoring the electron beam in the operation of the light source.

4. Future beamlines

More beamlines are planned to be constructed at the Siam Photon Source. The new beamlines will be constructed along with the development of the light source. At present, a planar undulator has been designed to enable the light source to generate more brilliant light. The maker of the undulator will soon be selected. The installation of the undulator is expected to be in the end of 2003. In parallel with the construction of the undulator, the construction of a soft X-ray beamline to utilize synchrotron light generated by the undulator is carried out. The beamline will be designed for micro-beam high-resolution spectroscopic research. The optical element of the beamline will be designed to provide the photon beam at the sample with the diameter less than 100 μm. The monochromator will cover photon energies between 70 and 700 eV.

An ambitious plan to install a 7.5 T supercoducting magnet wiggler is being studied. The wiggler will be used to generate useful photons with the energies up to 25 keV. This will pave a way for more research fields to be carried out at the Siam Photon Laboratory, and especially this will satisfy a growing demand of scientists in the fields of bioscience, life science, materials science, applied chemistry and engineering in Thailand. Two kinds of measurement techniques are now being considered to utilize hard X-rays generated by the superconducting magnet wiggler, i.e. the X-ray diffraction measurement technique for protein crystallography and the X-ray absorption fine structure measurement technique.

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ผลงานโครงการหนึ่งอาจารย์หนึ่งผลงาน : *สิ่งตีพิมพ์ของผลงานวิจัย*

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สาขาวิชาฟิสิกส์

สำนักวิชาวิทยาศาตร์

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