Present Status of the Pohang Light Source

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1. Introduction

The Pohang Light Source (PLS) is a third generation synchrotron radiation facility which generates photons in the VUV to hard x-ray region. Its 2.5 GeV storage ring with full energy injection from LINAC has been operated since 1994, and provides beamlines with intense photon beams. At present 23 beamlines are operational or under commissioning while 4 new beamlines are under construction.

2. Accelerator

Construction of the PLS was completed in 1994 and user service began after a year of commissioning period with 2.0 GeV operation mode. While most of other synchrotron radiation facilities use booster synchrotrons as their main injectors, the PLS injects directly from its LINAC. In 2000 the storage ring began ramping its energy from 2.0 GeV to 2.5 GeV in order to provide higher flux in hard x-ray region, and 2.5 GeV full energy injection started in 2002 for smaller injection-to-injection jittering of photon beam positions. In order to achieve this, two more 80 MW Toshiba klystrons were installed to increase its LINAC energy to 2.5 GeV. The PLS is currently operated at 2.5 GeV/180 mA. The RF system is composed of four single cell cavities each one powered by a 500 MHz/60 kW power plant. In order to satisfy the increasing requirements (2.5 GeV/250 mA) due to the installation of new insertion devices, RF system upgrade program which replaces 60 kW klystrons with 75 kW ones and adds one more 75 kW station. Timing system upgrades and conversion of control system using EPICS have been just completed. The stability of the beam orbit still remains to be solved. Especially, the operation of several undulators causes movements of the orbit during changing their gaps or phases of EPU. In order to improve the orbit stability, upgrades of corrector magnet power supplies and beam position monitors are implemented. Orbit feedback systems as well as RF frequency feedback systems have been tested and are going to be implemented this summer. Orbit feedforward systems for undulators are under development. Hydrostatic leveling system has been just installed to monitor ground motions under the storage ring and will be extended to cover experimental floors in the near future.

There are twelve straight sections in the storage ring and 10 of them are available for ID's. U7, U10 and EPU6 have been installed for VUV/soft x-ray programs and two multipole wigglers are installed for protein crystallography and materials science beamlines, respectively. The ring energy of the PLS, 2.5 GeV, is not high enough to generate hard x-rays from normal undulators. In order to overcome this, an in-vacuum undulators developed by SPring-8 was installed at one of its straight section. The undulator is a revolver-type which has four periods to cover 1-10keV x-ray region continuously.

3. Beamlines and scientific programs

The PLS has 23 beamlines which are operational or under commissioning and 4 new beamlines are under construction at present. It served more than 1300 users and 430 experiments were carried out in 2003. Its scientific program consists of VUV/soft x-ray,
x-ray scattering including SAXS, x-ray absorption spectroscopy, protein crystallography, and others.

For VUV/soft x-ray program, there are 3 bending magnet beamlines and 1 undulator beamline in operation. Bending magnet beamlines, 2B1(SGM), 3B1(NIM) and 4B1(VLS), are for PES&MCD, gas phase measurement & VUV reflectivity, and PEEM measurements, respectively. 8A(U7) undulator beamline has 2 experimental stations, for high resolution PES dedicated for Si surfaces and SPEM, respectively. The high resolution PES station is PRT station of Yonsei University. EPU6 (2A) and U10(3A) undulator beamlines are under commissioning. The EPU beamline is equipped with experimental stations for magnetic PEEM, spin-resolved PES and XAS. U10 beamline has two experimental stations for ARUPS and micro-spot PES studies, respectively. A new bending magnet beamline(7B) is constructed by KIST. The beamline has two experimental stations for PES and NEXAFS & soft x-ray reflectivity.

The PLS has five generic bending magnet beamlines with double crystal monochromators (3C2, 4C2, 5C2, 8C1 and 8C2) and two beamlines with multilayer monochromators (4C1 and 5C1) for x-ray scattering studies. Most of them are public beamlines while 4C1(KJIST1), 4C2(KJIST2) and 8C2(POSCO) are PRT beamlines. 8C1 beamline is dedicated for high resolution powder diffraction. 4C1 and 4C2 beamlines are for SAXS studies. 4C1 beamline is mainly for kinetic measurements requiring high flux photons from the multilayer monochromator while conventional SAXS measurements and GISAXS are carried out at 4C2 beamline. A multipole wigglar beamline (5A) for surface/interface studies is under construction. It will meet the demands for higher flux photons in characterizing interface structures. As mentioned above, a revolver in-vacuum undulator has been installed and its beamline (11A) is under construction. It is going to have three experimental stations for microscopy(11A1), x-ray diffraction (11A2) and SAXS(11A3). Microdiffraction measurements are routinely carried out at microprobe beamline 1B2. Laue patterns from single crystals less than 50 microns are routinely taken and two dimensional mapping of crystal domain orientations in ferroelectrics and other materials can be done.

Protein crystallography is a fast growing research area in Korea since its first dedicated beamline 6B began its service in 1999. Many exciting results have been generated and its user community has expanded rapidly. Its detector has been replaced from an image plate to a Bruker CCD detector and update of sample-uploading system using robotics is under development for higher throughput of data acquisition. Two new beamlines, one multipole wigglar (5A)and one bending magnet (6C), are under construction. Both of them are PRT beamlines. 5A beamline is partially funded by a consortium of university-industry-national laboratories while 6C is also partially funded by KRIIBB, a national laboratory for biotechnology and bioengineering.

There are two bending magnet beamlines for hard x-ray XAS, 3C1 and 7C. Both beamlines are generic XAS beamlines covering x-ray energy range of 3 - 15 keV and 5 - 20 keV for 3C1 and 7C. A multi-element Ge detector is used for dilute element analysis. A multipole wigglar beamline dedicated for XAS is going to be constructed in 2005 in order to meet users' demands for high flux beamline required for analysis of biological samples and catalysts.

There are beamlines for microprobe R&D (1B2), microfabrication (10C) and lithography(11C). The beamline 11C was constructed for x-ray lithography in 1997 but it is now being converted for EUVL studies. A planview of the experimental floor of the PLS is shown in Figure 1.
4. Future plan for next generation light sources

The PLS has two linacs, a 2.5 GeV unit as a main injector and a 80 MeV unit for R&D of linac technology. Recently, as linac-based light sources are proposed as the next generation sources, the PLS is going to develop the light sources using its two linacs. A femtosecond-IR source can be constructed using coherent synchrotron radiation or optical transition radiations from sub-picosecond pulse width electron bunches out of 60-80 MeV linac. Since a 2.5 GeV linac stays in a stand-by mode except the injection period of 15 minutes twice a day, it is natural to utilize it as a source for FEL. With upgrade of the linac up to 3.5 GeV, soft x-ray FEL is available from conventional undulators and hard x-ray FEL, up to 1.5 Angstrom, may be possible using in-vacuum undulators and 3rd harmonic generation scheme. Feasibility study for the scheme is being proposed to MOST. Development program for ultra short electron gun, required for both of fs-IR source and FEL, is about to start this year. When these two projects are completed, the PLS remains as a competitive light sources in the areas of femto-second science as well as nanotechnology.