Introduction

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On behalf of the staff of the Photon Factory (PF) we are pleased to present Photon Factory Activity Report 2013. This report covers the research activities carried out in the fiscal year 2013 (April 2013 - March 2014). The inter-university research program has been going well and the number of proposals is steadily increasing. This year there were about 900 active approved proposals, 3,400 registered users, and more than 600 publications. The PF leadership has been partially changed. Prof. Kenji Ito retired from the Head of Synchrotron Radiation Science Division 1 and Prof. Reiji Kumai was nominated in his place (from April 2013). Prof. Masao Kimura joined us as the head responsible for industrial application of synchrotron radiation (from October 2013).

Operation and upgrades of the PF and the PF-AR

The PF was constructed as a second-generation synchrotron radiation source and the first photon came out in 1982. During the intervening 32 years the PF underwent two large upgrades of the ring. In the 1997 upgrade the emittance was reduced from 130 to 36 nmrad. During the shutdown in 2005 the number of straight sections was increased from 10 to 14, among which 4 short straight sections were created and 10 straight sections were lengthened. In the long straight sections we have reconstructed Vacuum Ultraviolet (VUV)/Soft X-ray (SX) beamlines (BL-2, -13, -16, -28) with undulators in recent years. BL-16A was already operated as a variable polarization soft X-ray spectroscopy station, which provides circular and elliptical polarizations mainly to investigate magnetic materials, especially thin films. BL-28A is dedicated to high-resolution Angle-Resolved Photoemission Spectroscopy (ARPES) in order to study strongly correlated electron systems. An undulator covering the energy range of 30–300 eV will be installed during January to March 2015. BL-13B has been mainly used for the study of surface chemistry using ARPES, X-ray photoelectron spectroscopy (XPS), and X-ray absorption spectroscopy (XAS). A compact scanning transmission X-ray microscope (STXM) was installed at BL-13A and opened to users in October 2013. An undulator covering the energy range of 50–2000 eV will be installed during January to March 2015. BL-2 is under construction. The beamline has two types of undulators in tandem alignment for the VUV region (30–300 eV) and for the SX region (250–2000 eV). These undulators enable us to use wide energy-range light with high brilliance and high energy resolution. Moreover, BL-2B has an additional double-crystal monochromator with the energy range of 2000–4000 eV by using the wiggler mode of the SX undulator. This beamline was built in collaboration with a private company, Hitachi, Ltd.

Meanwhile, we have upgraded the X-ray beamlines (BL-1, -3, -17) by installing short gap undulators in the short straight sections to gain long-term competitiveness in the field of X-ray science. The last short straight section in which a short gap undulator was installed is in BL-15 which produces high-brilliance X-rays ranging from 2.1 keV to 15 keV. This beamline is dedicated to both Small Angle X-ray Scattering (SAXS) experiments using collimated softer and hard X-rays and X-ray Absorption Fine Structure (XAFS)/X-ray Fluorescence (XRF)/X-ray Diffraction (XRD) studies using semi-micro focus beams. This beamline will be opened to general users in October 2014.

BL-18A and BL-19A/B were operated by the Institute for Solid State Physics (ISSP) of the University of Tokyo for more than 20 years. BL-18A was an ARPES beamline for surfaces and interfaces, while BL-19A was dedicated to experiments using spin-resolved PES. These beamlines were shut down at the end of fiscal 2013 for reasons of the ISSP. We are now discussing the future of these beamlines; BL-19B will be used as a test beamline by PF staff for the time being at least. Meanwhile, the new operation of BL-4A was started by a user group. Though experiments using the multi-layer monochromator have ended, micro-beam experiments using a double crystal monochromator are continuing in this beamline. BL-6C, which is also operated by a user group, was upgraded in the available energy region up to 18 keV by reforming the focusing mirror. This improvement enables experiments such as fluorescence X-ray holography of various samples.

Future plan of the PF

KEK published a draft of the KEK roadmap at the end of August 2012 and solicited the opinions of user communities. KEK then modified the roadmap based on the opinions for the roadmap from the Photon Factory User Association (PF-UA) and the Japanese Society for Synchrotron Radiation Research (JSSRR). The KEK roadmap was reviewed by the international review committee

in April and finally published in May 2013. Based on the discussion in the international review committee, KEK made the following additional statement in October 2013: "After publication of KEK Roadmap 2013, the Japanese Society for Synchrotron Radiation Research submitted its proposal for a 3-GeV class high-brilliance light source to be incorporated in the Master Plan of Large Research Projects which is to be prepared by the Science Council of Japan. With inputs from the synchrotron radiation user community concerning this proposal, KEK is adding the following statement to the part of photon science in KEK Roadmap 2013. While KEK is engaged in a long-term effort to construct a 3-GeV ERL (Energy Recovery Linac) facility, KEK will play a leading role in the realization of a low-emittance storage ring as a high-brilliance light source in the mid-term. KEK is now beginning specific studies on this possibility in view of the value of this nationwide effort. Such a light source facility with high brilliance, currently not present in Japan, is strongly desired by user communities in a wide range of academic and industrial fields, and is considered to be an indispensable research platform in the near future."

We will intensively discuss this storage ring through collaboration across Japan and the ERL Project in the meetings of the Committee for Future Plans of the PF, which is established under the Advisory Committee for IMSS in 2014. The Committee for Future Plans of the PF will announce the mid-term summary and report the results to the steering committee at the end of financial year 2014.

Collaboration among universities and institutes

KEK is promoting inter-university collaboration to activate joint research projects. In particular, the IMSS is pursuing joint research projects using synchrotron radiation, neutrons, muons, and positrons in collaboration with universities such as Hokkaido University, Tohoku University, University of Tsukuba, and the University of Tokyo. In addition to these inter-university collaborations we strongly support nanotechnology research and education in the Tsukuba area, namely the Tsukuba Innovation Arena for Nanotechnology (TIA-nano). TIA-nano is striving to build a global nanotechnology research and education center with the support of the government and is expected to serve as an engine of innovation. TIA-nano had been led by the National Institute of Advanced Industrial Science and Technology (AIST), the National Institute for Materials Science (NIMS), and the University of Tsukuba as the core institutes, together with industry. KEK joined TIA-nano as a core institute in April 2012. The PF will be used as one of the Nanotech Open User Facilities to promote advanced nanotechnology research in the research collaboration domains of TIA-nano in the future.

International collaboration

The Australian beamline BL-20B was closed in March 2013 after completing its mission. The first synchrotron light in BL-20B was produced in October 1992. For about 20 years (more than 3,000 days of experiments), more than 2,500 Australian researchers used this beamline and some 900 proposals were made. The beamline was actively used and about 1,000 papers were published during this period. This great success led to the construction of the Australian Synchrotron in Australia. We greatly appreciate all those involved with this beamline for their remarkable accomplishments.

The first users' meeting of the Indian beamline BL-18B was held on October 7-8, 2013 at the Saha Institute of Nuclear Physics in Kolkata, India. The Indian beamline BL-18B was established in 2009 after the Department of Science and Technology of India (DST) and KEK signed a Letter of Intent in July 2007, and both Indian and Japanese prime ministers welcomed it in a joint statement in 2007. The aim of this project is to provide a substantial amount of quality beamtime for the use of Indian scientists. BL-18B is conceived as a multipurpose beamline, allowing experiments on powder diffraction under extreme conditions, reflectivity and diffuse scattering from solid and liquid surfaces and interfaces and so on. This beamline is opened to general users in April 2014. We expect that further progress of this project will enhance the collaboration between India and Japan.

Photon beam platform

At present, a top-priority issue in Japan is how to focus on research and development and achieve further innovation. In order to promote networking among cutting-edge fundamental research bases and encourage the use of synchrotron radiation and laser by industry, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) established a new operation for the collaboration of synchrotron radiation and laser facilities: the Photon Beam Platform. This platform consists of seven implementing facilities (Osaka University Institute of Laser Engineering, Kyushu Synchrotron Light Research Center, University of Hyogo New Subaru, Ritsumeikan University SR Center, Aichi Synchrotron Radiation Center, Tokyo University of Science Infrared Free Electron Laser Research Center and KEK/ISSS/PF) and one collaborative facility (SPring-8). The PF serves as an administrative facility in this platform. We expect users of this platform to open new research fields of industrial use through this unique collaboration of synchrotron radiation and laser facilities. This platform for innovation in many industrial fields will continue to play an important role in the decade ahead.

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