Introduction

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On behalf of the staff of the Photon Factory (PF) we are pleased to present Photon Factory Activity Report 2012. This report covers the research activities carried out in the fiscal year 2012 (April 2012 - March 2013), which is my first year as the Director of the PF. The PF leadership has partially changed: Prof. Reiji Kumai (from April 2013), Prof. Shinichi Adachi (from April 2012) and Prof. Toshiya Senda (from January 2013) join us as Heads of Division 1 & 2 of Synchrotron Radiation (SR) Science and as Head of the Structural Biology Research Center, respectively.

Organization of the Photon Factory

The organization of the SR Science Division 1 & 2 was changed in order to carry out inter-university research efficiently and to enhance the SR research with limited budget and manpower. The divisions consist of three group layers: the beamline group layer, engineering and administration group layer, and working group layer (http://pfwww.kek.jp/orgchart/indexe.html). The beamline group layer has five scientific groups (Gs): electronic structure G, condensed matter G, material chemistry G, life science G, and slow positron G. These groups operate and maintain their respective beamlines. The engineering and administration group layer has two groups: one group responsible for beamline engineering, technical service and safety, and the other group responsible for user support and publicity work. The working group (WG) layer has two groups at this stage: ultrafast dynamics WG and advanced detector R&D WG; the WGs have definite goals and are time-limited. In the future some new WGs such as coherent X-ray WG, nano-beam WG, and inelastic X-ray scattering WG will be proposed to underpin the developments in the PF.

KEK roadmap and future light source

Inter-University Research Institute Corporation of the High Energy Accelerator Research Organization (KEK) published a draft of the KEK roadmap at the end of August 2012 and solicited the opinions of user communities. The Photon Factory User Association (PF-UA) and the Japanese Society for Synchrotron Radiation Research (JSSRR) expressed their opinions concerning photon science in the KEK roadmap. The communities also made specific proposals on the role that KEK should play as a leading institute for SR research. We then modified the roadmap to reflect their proposals and finished it in March 2013. The KEK roadmap was reviewed by the international review committee in April and finally published in May 2013. The part concerning photon science states the following: “KEK will continue to advance photon science by upgrading the PF and Photon Factory Advanced Ring (PF-AR) to improve their performance and efficiency. At the same time, KEK will construct and then operate the compact energy recovery linac (cERL) and will demonstrate the key technologies required for the ERL. By proving the potential of the ERL as a new accelerator to open new scientific frontiers, KEK will work toward construction of a 3 GeV ERL facility. In addition, KEK will continue to play a leading role in the development of SR research in Japan.” The international review committee provided the following advice regarding the roadmap: “The construction of the cERL, building on the outstanding accelerator expertise existing at KEK, is making great progress. The completion of this project to demonstrate and gain experience of the key ERL technologies is very important. In the long term the ERL is an interesting prospect for a future light source and should be kept in the plans at KEK. The issue is for the mid-term gap: the community as represented by the Japanese Society for Synchrotron Research has identified the immediate need for a low-emittance, state-of-the-art storage ring. Both from geographic and technical points of view, KEK is ideally positioned to realize the needs of the community.” The ‘low-emittance, state-of-the-art storage ring’ mentioned in the review report is the future light source proposed for the master plan of the Science Council Japan by the JSSRR in March 2013. We are now discussing the realization of this storage ring through collaboration across Japan.

Upgrades of the PF and the PF-AR

The operation of the PF started in 1982. After two large upgrades in 1996 and 2005 the emittance was reduced from 130 to 36 nmrad. The top-up operation with constant electric current in the PF ring has been working well since 2009. As the PF ring is operating with the relatively low energy of 2.5 GeV and large current of 450 mA, we have an important advantage for science in the energy range of vacuum ultraviolet (VUV) and soft X-ray (SX). Actually, the PF has four VUV/SX beamlines (BL-2, -13, -16, -28) with undulators in the long straight sections. We have been focusing on upgrading these beamlines to

maintain our international competitiveness in the field of VUV/SX science. We are planning to complete the installation of the undulators and the reconstruction of these beamlines by the autumn of 2014. These beamlines, BL-2, -13, -16, and -28, are used to study solid state physics at surfaces/interfaces, surface chemistry, frontier science of SX spectroscopy with polarization switching, and strongly correlated electron materials. Meanwhile, we 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 is to be installed is in BL-15. This beamline will be dedicated to small-angle X-ray scattering and X-ray absorption fine structure/X-ray fluorescence analysis measurements to study soft matter materials, environmental science, and new energy source materials such as for batteries.

Operation of the PF-AR started in 1987 as a parasite SR of the booster synchrotron for high-energy physics and was dedicated to SR operation in 1998. The PF-AR is operating with the energy of 6.5 GeV to supply relatively high-energy X-rays for high-pressure science, crystal structure analysis with high-energy X-rays, and so on. The PF-AR is characterized by operation in full-time single-bunch mode; the single-bunch mode is advantageous for time-resolved experiments. We are planning to construct a direct beam transport line for the PF-AR to manage both the injection to the PF-AR and superKEKB for high-energy physics. This upgrade of the PF-AR will make it possible to inject with the full energy of 6.5 GeV and also to operate with a top-up mode. As a result of this upgrade, the brilliance will be increased.

PF Science Advisory Committee

The 7th PF science advisory committee (PF-SAC) held a meeting in February 2013. This committee is very important for us to gather various advice from an international perspective. The PF-SAC evaluates and advises on our light source, beamline developments, facility operation, science outputs by users and the PF staff, and the PF management and strategic plans. The PF-SAC is comprised of nine distinguished scientists, and has been chaired by Prof. Ingolf E. Lindau of Stanford University since 2011. We have seven subcommittees to give more specialist evaluations and advice; each subcommittee consists of experienced scientists including a member of the PF-SAC. In this 7th PF-SAC we reported on the present status of the PF and showed our future plans including upgrades of the PF and PF-AR. In the executive summary and closing remarks, the PF-SAC commended the PF management for its initiative to upgrade beamlines, supported our future plans, and appreciated the establishment of a new PF user's community, PF-UA. The SAC also found the individual meetings with young scientists extremely valuable.

Inter-university collaboration

KEK is promoting inter-university collaboration to activate joint research projects. Hokkaido University and KEK held a symposium at Sapporo in October 2012 to discuss collaboration in research using SR, neutrons, muons, and positrons. The symposium yielded new ideas for scientific co-development. Tohoku University and KEK have been promoting joint projects for the last several years. Actually, KEK is constructing a polarized neutron spectrometer in collaboration with Tohoku University at J-PARC (Japan Proton Accelerator Research Complex). In order to drive the project, Tohoku University is planning to set up a center for conducting science using quantum beams on the basis of the inter-university agreement. In order to establish the center, Tohoku University held a symposium to discuss quantum beam science. Meanwhile, Tsukuba University has established the KEK research promotion office in Tsukuba Research Center for Interdisciplinary Materials Science. The office provides advice on the use of beamlines of the PF and J-PARC/MLF (Materials and Life Science Experimental Facility). In this joint project, staff of Tsukuba University form a research team in collaboration with staff of KEK. The KEK also collaborates with the Graduate School of Frontier Science of the University of Tokyo, and held joint seminars in September 2012 and February 2013.

New projects

Two new research grants of the Ministry of Education, Culture, Sports, Science and Technology (MEXT) which are expected to use quantum beams were launched in 2012. One is the project concerning the platform for Drug Discovery, Informatics, and Structural Life Science, which was started in order to build a creative process for medical procedure and drug discovery through the development and common use of research infrastructure. KEK plays an important role as the core institute of structural analysis. The other project is the Element Strategy Initiative, which promotes the creation of innovative alternatives to such materials as rare elements which underpin Japan's industrial competitiveness, through close collaboration among materials design, development, and evaluation in the core research center. KEK/IMSS is promoting this MEXT project, with KEK/IMSS staff serving as the principal investigators for electronic materials and magnetic materials in collaboration with the Tokyo Institute of Technology and the National Institute of Materials Science, respectively.

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