Introduction

Soichi Wakatsuki

The highlights of the activities of the Photon Factory in its 26th year are summarized in this activity report. During fiscal year 2008, April 2008 to March 2009, Photon Factory stays active as a national facility to serve 3100 unique users including over 1400 graduate students of the synchrotron radiation science community. It was also the third year of this management team and the beamline refurbishment program has progressed steadily while keeping the machine operation with ca. 5000 hours, and more than 4000 hours of beam time for user experiments. In particular, we are pleased to report that the top-up project of PF 2.5 GeV ring progressed well in FY2008. Owing to the close collaboration between the PF Light Source Division and the KEK Accelerator Laboratory, the test of top-up operation has started for both the multi-bunch and single-bunch operations at 2.5 GeV since April 2009, which greatly helps user experiments.

The preparation for establishment of Condensed Matter Research Center (CMRC) went into the final stage in FY2008. The Institute of Materials Structure Sciences (IMSS) organized the first IMSS symposium on October 16 & 17, 2008 in Tsukuba featuring the four areas of sciences, strongly correlated electrons, materials under extreme conditions, surface and interface, and soft condensed matter. These are the areas which the CMRC decided to concentrate on. The symposium attracted many outstanding scientists including some from overseas. Each section was summarized by a discussion leader who added their own views on the prospects of the CMRC sciences. The Center was then established in April 2009 when Prof. Youichi Murakami assumed the position and started to recruit new members. To date, it has 15 members within the Photon Factory, 7 from the neutron and muon divisions of IMSS, and about 20 collaborators from a number of universities and institutes. The CMRC has also started intensive discussions with some universities for additional collaborative projects in the chosen areas.

The beamline refurbishment program has gone into its third year and has accelerated the process including the construction and initial operation of BL-16A, a soft X-ray (SX) beamline with the first of the two Apple-II undulators, starting the construction of BL-13A, another SX beamline for investigation of electronic properties of organic thin layers and novel materials, completion of an Astellas Pharma protein crystallography beamline AR-NE3A, construction of another protein crystallography beamline BL-1A for long wavelength SAD experiments, and relocation of high pressure and imaging beamlines from the PF-ring to the PF-AR.

The BL-16A project is aimed at providing circularly polarized soft X-ray beams for XMCD and other techniques to investigate spintronics, magnetic properties of thin materials and diluted magnetic semiconductors. It will house two APPLE-II type undulators with 5 kicker magnets for fast polarization switching. Our goal is that this will become a flagship SX beamline of the Photon Factory. Very fortunately, an application for additional funding within the framework of “Quantum Beam” program has been successful, which helps procurement of the second undulator to be installed in 2010. With the kicker magnets already tested for 10 Hz and faster switching rate, the beamline will acquire much improved capability with rocking amplification at 10 Hz for very sensitive XMCD measurements.

The other major development was the Astellas Pharma Beamline AR-NE3A. We have had highly successful industrial use program in structural biology beamlines. While individual companies can use PF Structural Biology beamlines, a consortium with pharmaceutical and food industries had been established. One of the consortium member companies, Astellas Phara Co. Ltd. expanded recently its research institute in Tsukuba, and approached the PF whether they can use thousands of hours of beam time each year. For this purpose, we decided to collaborate on building a new high-throughput protein crystallography beamline AR-NE3A. Once completed in March 2009, it has already proven to be the strongest and most efficient protein crystallography beamline at the PF. Typically they collect circa 500 diffraction data in 3 days each week. The rest of the beam time can be used by general as well as other industrial users.

The long wavelength SAD protein crystallography beamline BL-1 is part of the national project Target Protein Research Program. This is in collaboration with

SPring-8 who is building BL32XU to produce 1 by 1 micron high brilliance beam for micron sized protein crystals. Within the same framework, three groups from Hokkaido, Kyoto and Osaka Universities are developing associated novel technologies for microfocus and long wavelength protein crystallography experiments as well as developing sample environment compatible between the two facilities. Both beamlines are scheduled to become available for experiments from April 2010. BL-1A will enable experiments at around 4 keV (wavelength of about 3 Angstroms) to exploit the anomalous signals from low Z elements such as sulfur, phosphorus, and chlorine for phase determination. This will help phasing crystallographic data from very challenging targets where heavy atom labeling or selenium substitution of sulfur atoms is impractical.

We would like to welcome Prof. Kunio Miki of Kyoto University who succeeded Prof. Youichi Murakami, then Professor of Tohoku University, as President of Photon Factory Users Organization (PF-UO) in April 2008. PF-UO functions as the central vehicle for communications between the Photon Factory and the user community. Prof. Murakami served as the PF-UO President for two years in 2006 and 2007 during when he reinvigorated the PF-UO activities. For instance, meta user groups were created to facilitate discussions with the PF concerning the beamline refurbishment projects. This process is vital because the refurbishment project affects multiple beamlines and a wide range of disciplines even for a case where it is only one beamline to be relocated or closed down. The PF-UO also played a key role to increase the number of participants in PF Symposia. Prof. Miki has followed up this and in the PF Symposium held in the end of FY2008, March 2009, both number of participants and poster presentations have reached the highest ever in the history of PF; 322 participants and 285 presentations. The PF-UO has also discussed extensively how to increase the number of PF-UO members. To this end they have proposed various measures to make the PF-UO membership more attractive.

The third International Science Advisory Committee was held on December 16 & 17, 2008. This time the committee concentrated on the preparation of the Condensed Matter Research Center, BL-16 with fast polarization switching, ERL project, and the merger between the Light Source Division with the KEK Accelerator Laboratory. The advice given by the PF-ISAC has been extremely valuable to the Photon Factory. A subcommittee on life sciences was held on March 4 & 5, 2009. This subcommittee reviewed the activities in structural biology and radiation biology. Prof. Keith O. Hodgson chaired the subcommittee. Other members are Drs. Paul Adams (Physical Biosciences Division, Lawrence Berkeley Lab), Otsura Niwa (National Institute of Radiological Sciences), Peter O'Neill (Gray Institute for Radiation Oncology and Biology, Oxford University), Mamoru Sato (Yokohama City University), Marjolein Thunnissen (MAX Lab, University of Lund), and Tomitake Tsukihara (University of Hyogo Prefecture). The structural biology program was evaluated very highly based on the successful developments and operation of the state-of-the-art protein crystallography beamlines. It is pointed out that the R&D efforts are rather wide spread for the size of the team and must be prioritized carefully to maximize the outputs by forming collaborations with other synchrotron facilities to implement other groups developments where possible. The radiation biology programs cater fairly small user community and the long term strategy needs to be carefully established. In particular, synergy between the two life science divisions is weak and if this to be strengthened major efforts need to be invested. The summary of the PF-ISAC meetings are presented in the PF Symposium and available on the web (http://pfwww.kek.jp/publications/review_isac.html).

During 2008, we had extensive discussions with Department of Science and Technology (DST) and Prof. Milan Sanyal to set up an Indian beam line at the 2.5 GeV PF ring. Their goal is to establish a base for Indian scientists to perform scattering and reflectivity measurement experiments on surfaces, especially air-liquid interfaces and in-situ grown thin films, powder diffraction, and small angle X-ray scattering. After long preparatory discussions, it was decided to set up it at PF BL-18B. A group of Indian scientists and engineers will stay for extended periods of time to assist users from India. Office spaces are now available in Ni-Go-Kan Building for the staff scientists and Indian users. The liquid surface scattering capability currently does not exist in the PF, and we strongly encourage new collaborations between Japanese and Indian scientists using this beamline.

Towards the end of FY2008, we intensified the discussion on the merger of the Light Source Division with the Accelerator Laboratory. The purpose of the merger was to rearrange resources for the future light source projects. Initially there were lot of anxieties and concerns that the merger will affect the operation of the PF-ring and the PF-AR.

Incidentally, SLAC has reorganized its accelerator related sections into one large division. Their light source section is now part of the accelerator division which is responsible for the entire range of accelerator activities at SLAC. We consider this a natural migration of large scale accelerator laboratories in which merger of accelerator activities brings cross fertilization of different accelerator technologies and efficiency in developing and operating large facilities with a wide range of research areas.

So far, our experiences show that the merger has brought several notable benefits. First of all, it has strengthened the compact ERL project by adding several new positions, with successful recruitments of experts in the electron gun development. The new division, now called the seventh division, is responsible for the operation and further developments of the two rings. The synergy between various sections in the accelerator sciences has strengthened. In addition, several KEK-wide projects have burgeoned recently. One example is the detector development where a group of experts in Institute of Particle and Nuclear Studies recently expanded their scope substantially and collaborated with the scientists in IMSS, in particular, on the data acquisition for neutron and muon experiments at J-PARC. This collaboration has expanded recently to synchrotron experiments with several new development of data acquisition systems based on avalanche photo diode and pixel array detectors.

The other remarkable benefit of the merger is the initiation of a new light source project, which we named as KEK-X. It aims to use the two B-factory rings for synchrotron experiments simultaneously with high energy experiments. The B-factory is planning a major upgrade, called Super KEKB, to increase luminosity by a factor of 40 by adopting the nano-beam scheme whereby high energy ring (HER) at 7 GeV electrons and low energy ring (LER) at 4 GeV positrons, both with extremely high current of 2000 to 4000 mA and very low emittance of 2 to 3 nm rad, will collide at the collision point. These beam characteristics combined with their large circumferences of 3 km make the HER/LER ideal synchrotron light sources. Based on this idea we started to investigate the possibility of installing insertion devices in the symmetry points of the two PF rings from spring 2009. While the HER will provide extremely strong hard X-ray beams extending to 100 keV or above, the LER will be able to deliver beams starting from the soft X-ray beams, several hundreds of eV. A joint working team has been formed between the Photon Factory and the Accelerator Laboratory to find solutions where both Super KEKB and KEK-X projects can be accommodated. The KEK-X will not only provide exciting possibilities for new experiments using extremely high brilliance soft and hard X-rays but also will serve as an important milestone for the 5 GeV class ERL.

As this activity report goes into press, the Nobel Prize in Chemistry was awarded to three scientists, Ada Yonath, Venki Ramakrishan, and Thomas Steiz for the determination of the ribosome structures. Prof. Ada Yonath was one of the first three users of Prof. Sakabe's Weissenberg camera which was installed on BL-6A of the PF ring in 1987. She was one of the main users of the beamline for about ten years and brought her homemade cryogenic cooling device to the PF. We are extremely delighted and honored to have had her as a distinguished user in those days. She has kindly agreed to give a special Nobel lecture in our next Photon Factory Symposium on March 9th, 2010.

Director
Soichi Wakatsuki