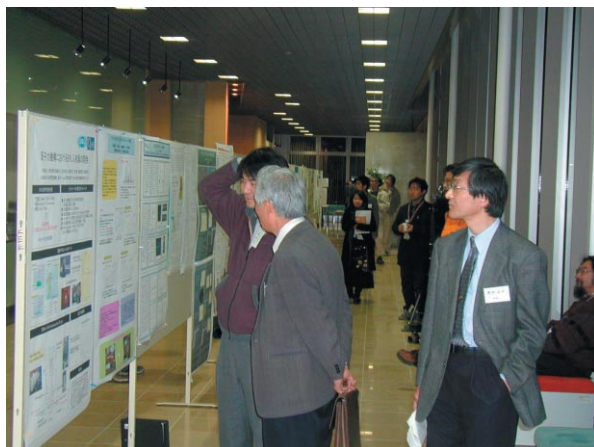


3

Workshops and Seminars

3-1 PF Symposium

The 23rd PF Symposium, the annual users' meeting, was held on March 23-24 2005 at the KEK campus. More than 130 users and PF staff participated in the Symposium. The main purpose of the PF Symposium is to discuss the present status and future projects of the PF. In addition, users and the PF staff promote mutual friendship through scientific presentations and discussion. In the first part of the symposium, eight members of the PF staff reported on the status and recent progress of the facility. We invited six speakers for special lectures: five from outside and one from inside the PF. Two oral sessions were held on two important topics: the extension and improvement of insertion devices and beamlines following the completion of the Straight-Section Upgrade Project, and the Energy Recovery Linac project. There were 61 user poster presentations, with results presented from 7 S-type, 1 U-type, and 53 G-type proposals. There were a further 19 presentations from the staff of the Accelerator Laboratory of KEK and the PF staff, resulting in a total of 80 poster presentations.



3-2 PF Workshops

Six PF workshops were held in FY2005 with the approval of the PF Program Advisory Committee (PF-PAC). Anyone can propose such a workshop. Free discussion is made upon a specific scientific topic in synchrotron-radiation research and its related application fields. The proceedings of the workshops are found in the KEK Proceedings, which are available at the Research Cooperation Division of KEK.

(1) "Future prospects for studies of condensed matter physics using undulator radiation" held on April 12-13, 2005 at the PF.

The construction of a renovated VUV undulator beamline BL-28A and an experimental station for high-resolution, angle-resolved photoemission spectroscopy (ARPES) was almost complete as of April 2005. A new soft X-ray undulator beamline BL-16 had been under investigation for the previous 8 years, with planning reaching the final stages as of April 2005. The most important feature planned for BL-16 was the ability to produce rapidly reversible, variable polarized radiation by alternately deflecting the two light beams emitted from two tandem-arranged APPLE II undulators. This would allow high-sensitive lock-in detection. The soft X-ray, planar-undulator beamline BL-2 had been under continuous operation for about 10 years. BL-2 delivers a horizontally linearly polarized, highly energy-resolved beam to the experimental station. The purpose of the workshop was to discuss the future development and prospects in condensed matter physics using high-intensity synchrotron radiation including reversible- and variable-polarization properties. Another aim of the workshop was to examine the feasibility of new insertion devices and related beamlines.

Several high-resolution ARPES experiments were proposed for BL-28A. The main target materials of the studies were highly correlated electron systems, such as high-temperature superconducting cuprates and perovskite manganese oxides exhibiting colossal magneto-resistance. The use of low-energy photons was emphasized for detailed studies of the electronic states near the Fermi level. Several essential improvements to the performance of BL-28A were highlighted. It was agreed that the most pressing improvement was to increase the overall available energy resolution, i.e., the convoluted resolution of the monochromator and the electron energy analyzer.

Concerning the planned BL-16, much discussion was made on the feasibility of rapidly switching (~10 Hz) the polarization state between left-right circular or horizontal-vertical linear polarization. Talks and discussion

were made with emphasis being put on the prospect of new experimental studies using such polarization-controlled radiation. Many scientific proposals were presented, such as highly-sensitive X-ray natural circular dichroism (XNCD) studies of chiral molecules, highly-sensitive X-ray magnetic circular and linear dichroism (XMCD and XMLD) studies of nano-scale magnetic materials and of phase-transitions in highly correlated electron systems, highly accurate XMCD investigations of spintronic materials such as diluted ferromagnetic semiconductors, polarization-dependent soft X-ray scattering and diffraction experiments, and photoelectron-emission-microscope (PEEM) studies of magnetic surfaces.

For BL-2, scientific proposals concentrated on soft X-ray emission (XES) experiments of various materials. Emphasis was put on the fact that an ultra-high vacuum is unnecessary for XES measurements and also on the ability to element-selectively probe the partial-density-of-states (PDOS) of the occupied bands. Since the linear polarization is confined to the horizontal plane in the present BL-2, the second emission monochromator of the XES apparatus must be rotated by 90° to observe polarization-dependent XES. Its renovation will be an important issue in the near future.

(2) "[Recent development of methodology based on an X-ray phase II](#)" held on May 12-13, 2005, KEK Proceedings 2005-6 (in Japanese).

Consensus has already been obtained that the production, control, and utilization of coherent X-rays is one of the most important issues in X-ray science. Recent progress in this field includes (1) the activation of diffraction-microscope studies, (2) prospects for the realization of free electron lasers (FEL), and (3) development and applications of phase (refraction) contrast techniques. This workshop was held with the purpose for giving researchers the opportunity to give talks and to make hot discussions on these topics and related fields.

A talk was given on the FEL project currently being pursued at RIKEN/SPring-8. The successful development of an FEL will undoubtedly promote the development of coherent X-ray optics. An X-ray diffraction microscope has been proposed as one of the potential applications for the X-rays emitted from the new FEL. This imaging technique is based on measurements of the complex amplitude of X-rays scattered from non-periodic materials, and ultimately molecular-scale spatial resolution is expected to be achieved.

The session was followed by presentations on hard X-ray Fourier spectroscopy. Important possibilities include the application of X-ray interference to spectroscopic techniques, with not only hard X-rays but also soft X-rays being important in the near future. Excellent data from an X-ray intensity interference study was also presented, a technique which is expected to be of use for characterizing the performance of FELs. A talk was given on a unified theory of coherence propagation

through crystal optical elements. With the increasing coherence of X-rays available, the observation of speckles becomes possible, and research fields utilizing speckles are steadily progressing. Such studies were reported for the hard X-ray region. The active use of X-ray phases is no longer limited to the synchrotron-radiation field. A study was reported on the development of the "MIRRORCLE" table-top synchrotron radiation source for high-potential imaging. Another achievement was reported in the manufacturing of imaging-technique products using X-ray phase techniques, successfully incorporating an X-ray refraction technique into a diagnostic apparatus for mammary cancer. The talk stressed the importance of applying phase-imaging techniques based on synchrotron radiation to situations outside synchrotron-radiation facilities. A differential-interference-imaging technique based on an X-ray Talbot interferometer was proposed, and a presentation was given on a project to combine imaging techniques with small X-ray sources. The utilization of the X-ray phase has increasingly become important for X-ray microscopes. An interesting proposal was presented detailing new approaches with optics using an X-ray prism. Modified optics using Fresnel-zone plates have previously led to studies of phase-difference microscopes and interference microscopes using several zone plates. It is possible to obtain contrasts based on the refraction effect in scanning-X-ray microscopes. A study was also reported on the development of fluorescence X-ray holography that affords atomic-level resolution.

The final session of the workshop was devoted to applications of synchrotron-radiation imaging with the X-ray phase. These included: applications to living tissues and polymer blends using an X-ray phase CT based on crystal interferometers; results of imaging live organic tissue using a separated-type X-ray interferometer; observation of hydrogen-storage alloys with a refraction-contrast technique; and studies of the diagnosis of life joints using the refraction-contrast technique.

(3) "[The present status and future progress of materials structure studies using synchrotron radiation](#)" held on September 8-9, 2005 at the PF, KEK proceedings 2005-15 (in Japanese).

The S1-type proposal "Construction of a beamline for searching for new materials and for clarifying the origin of their various properties in highly correlated electron systems" was scheduled to be completed in March 2006. The proposal had been effective for 4 years, producing remarkable scientific output. The purpose of the workshop was to report the scientific achievements made under the proposal and to discuss future progress and prospects for materials structure science. A total of 45 researchers participated in the workshop. Beamline BL-1A was commissioned under the proposal based on two projects from outside the PF - "Studies of highly correlated electron systems based on a new research network" supported by the Japan Society for the Pro-

motion of Science and Culture, and "Accurate structure analyses of highly correlated electron materials using synchrotron radiation" supported by the Correlated Electron Research Center at the National Institute for Advanced Industrial Science and Technology (CERC-AIST).

In addition to reports on the research output achieved using BL-1A, presentations were given on the results of frontier studies performed at SPring-8 and on experimental ideas for future projects at the PF. Achievements were reported in areas including molecular condensed matter, highly-correlated electron materials, and nano-materials. The studies covered a wide range of target materials. The studies were high-quality and challenging, making a strong impression of activities in this research field to the participants. Besides the general oral presentations, Y. Tokura gave a special talk.

From the point view of the future developments in the structural analyses of matter with focus on the planning of future projects at the PF, presentations were given by researchers from SPring-8 in fields such as non-resonant inelastic X-ray scattering, non-resonant X-ray magnetic diffraction, speckles, and X-ray scattering under pulsed high magnetic fields. S. Koshihara gave an impressive talk about the present status and future prospects for time-resolved X-ray scattering, introducing experimental results obtained by his group at the PF-AR.

In the final session, talks were given on the construction schedule and expected specification of X-rays emitted from the short-gap undulators which were planned to be developed in the near future for new X-ray sources at the PF. Talks were also given about future plans for materials structure analyses at the PF.

(4) "New prospect of surface studies using LEEM/PEEM" held on October 12-13, 2005 at the PF.

This workshop was the third in a series of workshops. The first was held at SPring-8 in 2003, and the second at the Institute for Solid State Physics, University of Tokyo in 2004. A number of low-energy electron microscope (LEEM)/photoelectron-emission microscope (PEEM) apparatuses have been developed in or introduced to Japan, resulting in a large number of LEEM/PEEM apparatuses compared to other countries. However, because Japanese researchers joined this field only recently, they are behind those in Europe and the USA in terms of the quality of their achievements, despite fundamental results being attained. This workshop was held to allow researchers to discuss scientific and technological issues in the field. Another object of the workshop was for Japanese researchers to prepare for "The 5th International Conference on LEEM/PEEM" to be held in October 2006. Results of surface studies using LEEM/PEEM were presented, followed by discussion. Sixty-two researchers from various fields participated in the workshop. Eighteen talks and eight poster

presentations were given.

K. Koike gave a special talk on the present status of the development of the spin-SEM technique and recent scientific output achieved using it. A talk on the development of spin-polarized electron sources and their applications to LEEM was given by T. Nakanishi. M. Oshima gave a talk entitled "Nano-imaging and nano-spectroscopy using photoelectron-emission microscope with synchrotron radiation", describing anticipated problems associated with the future development of apparatuses. Talks were given by T. Kimura on nano-scale magnets, by H. Hibino on the "Creation and annihilation processes of nano-structured gold silicides using LEEM", and by K. Ono on the "Observation of ultra-high-speed phenomena using a photoelectron-emission microscope with synchrotron radiation". New results were reported in both the contributed oral and poster sessions. An important proposal was presented on the measurement of the energy resolution of LEEM/PEEM. Young students were active in presenting and discussing their achievements at the poster sessions, highlighting the brilliant future of surface studies using LEEM/PEEM.

(5) "Medical applications of synchrotron radiation –The road to clinical applications–" held on November 5-6, 2005 at Tsukuba Gakuin University

This workshop was held at Tsukuba Gakuin University, which is located near the center of Tsukuba science city. The purpose of the workshop was to share information about the current status of various imaging techniques, including X-ray phase-contrast imaging methods, IVCAG, micro-angiography, and monochromatic X-ray CT.

The research field of X-ray imaging has advanced remarkably in recent years. Particularly highly developed techniques are X-ray phase-contrast-imaging methods such as X-ray phase-contrast CT using an X-ray interferometer, X-ray diffraction-enhanced imaging (DEI), X-ray dark-field imaging (DFI), and X-ray coherent-diffraction microscopy. Both the improvements in a two-dimensional imaging system for intravenous coronary angiography (IVCAG) and a higher ring current with a longer lifetime of the electron beam obtained by efforts of the accelerator group have now made it possible to perform more practical clinical examinations than before at PF-AR NE1A2. The topics of the workshop also included up-to-date information about the related beamlines BL-14C1, PF-AR NE1A2, and PF-AR NE5A stations. Future plans and scientific prospects for each imaging method were proposed in oral presentations, which were followed by active discussions. Discussion was also made on possible improvements and renovation of the experimental stations, which will be crucial for the effective utilization of synchrotron radiation in the X-ray imaging research field.

(6) "Studies of material properties using X-ray inelastic scattering III" held on January 17-18, 2006 at the PF,

KEK Proceedings 2005-17 (in Japanese).

This workshop was the third in a series of workshops on the same theme, with the first one being held in 2002 and the second one in 2003. One of the most important purposes of this workshop was to prepare for the 6th International Conference on Inelastic X-ray Scattering (IXS2007) to be held in western Japan in 2007.

Depending on the value of the energy transfer in the scattering process, "X-ray inelastic scattering" can be divided into "high-resolution X-ray inelastic scattering" (HRXIS), "nuclear-resonant inelastic scattering" (NRIS), "resonant X-ray emission spectroscopy" (RXES) (resonant inelastic X-ray scattering), and Compton scattering (CS). The HRXIS and NRIS scattering processes can be used to probe lattice vibrations, RXES the electronic states, and CS the linear-momentum density of states of the valence electrons.

Talks on resonant X-ray emission (resonant inelastic X-ray scattering) were given by far more researchers than by those in other categories, indicating that this technique is now one of the most rapidly developing experimental methods. To correctly interpret the physical implications of experimental data requires theoretical calculations in many practical cases. Close cooperation between experimentalists and theorists is thus very important. In addition, there is strong competition between the theorists, making a significant contribution to activating this research field. Results of X-ray emission experiments on targets including transition-metal oxides, B-doped diamond, liquids and solutions were reported. Theoretical studies of X-ray emission were also presented, with a focus on oxides. A remarkable development was reported by M. Hayashi who proposed a technique combining XAFS spectroscopy with resonant inelastic X-ray scattering. This new technique is expected to be developed further, and to have potential applications to many problems in physics and chemistry.

Two apparatuses for resonant inelastic X-ray scattering experiments are permanently attached to BL-11XU and BL-12XU (Taiwan SRRC) at SPring-8. The beamlines have the remarkable features of enabling high-resolution scattering experiments and low-temper-

ature or high-pressure experiments. The final session of the workshop, "Potential applications of X-ray inelastic scattering", was predominantly focused on resonant X-ray emission studies. In particular, S. Nozawa found a UV-light-induced effect at the pre-edge in the Ti K-core edge absorption spectra of SrTiO₃. Since the penetration depths of X-rays and UV light differ by orders of magnitude in condensed matter, this observation could be attributed to a near-surface effect, indicating an interesting new phenomenon. Presentations were given on X-ray scattering studies of mineralogy based on experiments under extreme conditions, applications of X-ray scattering to geophysics, and two-hole spectroscopy using an X-ray laser. High-resolution X-ray inelastic scattering experiments allow studies of lattice vibrations, and have reached energy resolutions of several meV. The targets of the studies were dynamical structures in liquid Se, lattice vibrations and thermo-electric properties in skutterudite, high-temperature superconductors, and the Kohn anomaly near the CDW phase transition in BaVS₃.

3-3 PF Seminars

Twenty-one PF seminars were held in FY2005. They were given either by PF staff members or by visitors, and a list is given in Table 1. The topics of the seminars covered a wide range of science, mainly related to synchrotron-radiation research. Topics included the electronic states and structure of condensed matters and their surfaces, X-ray diffraction analyses of solids and bio-molecules, ultra-fast time-resolved dynamics, high-resolution real-space imaging, new interesting materials, structural analyses of matters under extreme conditions, new light sources and insertion devices, electron-beam stabilization, and electron- and light-beam monitoring.

The final part of each seminar is exclusively devoted to questions from participants, and the speaker's responses, often resulting in hot discussion. Participants are also allowed to ask questions at any time during the seminar.

Table 1 A list of PF seminars held in FY2005.

Electronic Structures of B 2p and C 2p in B Doped Diamond Using Soft X-ray Absorption and Emission Spectroscopy NAKAMURA Jin (Univ. of Electro-Commun.) Apr. 12, 2005
Functional Analysis of Adaptor Protein (AP) Complexes, a Key Component of Clathrin-Mediated Vesicular Transport OHNO Hiroshi (RIKEN) Apr. 22, 2005
Glycosyltransferases and Congenital Muscular Dystrophies ENDO Tamao (Tokyo Metropolitan Institute of Gerontology) Apr. 26, 2005
Magnetic Imaging of Mesoscopic Magnetic Substances ONO Kanta (KEK-PF) Apr. 27, 2005

Structural Basis of Actin Regulation by Formins and Rho GTPases OHTOMO Takanori (Univ. of Texas Southwestern Medical Center, USA) Jun.17, 2005
Development and its Applications of Highly Brilliant X-Ray Sources by Laser-Compton Scattering SAKAI Fumio (Sumitomo Heavy Industries, Ltd.) Jun.21, 2005
Intensity Standards of Vacuum Ultraviolet Rays to X-Rays at AIST SAITO Norio (AIST) Jul. 14, 2005
Mirror Vibration Issues at NSRRC D. J. Wang (NSRRC) Sept. 7, 2005
Present Status of INDUS-I and INDUS-II SAHNI Vinod (CAT, Indore,India) Oct. 5, 2005
Superconducting Material Search in the C32-Type Silicides and Related Materials IMAI Motoharu (NIMS) Oct. 17, 2005
Diamond and the Phase 1 MX Beamlines DUKE Liz (Diamond Light Source) Oct. 19, 2005
Diamond Beamline I24: An Instrument for Macromolecular Micro-Crystallography EVANS Gwyndaf (Diamond Light Source, Rutherford Appleton Laboratory) Oct. 19, 2005
Development of Materials Science Using Nuclear Resonant Scattering of Synchrotron Radiation SETO Makoto (Kyoto Univ. Research Reactor Institute) Oct. 28, 2005
Controlling Vibrational and Electron Wave Packet Motion with Attosecond Time-Resolution Using Intense Laser Pulses NIIKURA Hiromichi (JST, PRESTO/ NRC) Nov. 18, 2005
Time-Resolved Diffraction of Molecular Excited States COPPENS Philip (Department of Chemistry, SUNY) Dec. 12, 2005
Photocrystallography of Complexes Which Undergo Thermal or Photo Excited Phase Transition: Domain Structure and Charge Density Analysis LECOMTE Claude (LCM3B, UMR CNRS 7036, University Henri Poincare-Nancy 1) Dec. 15, 2005
Structure of Penta-EF-Hand Calcium Binding Protein ALG-2 and Membrane Traffic Regulation MAKI Masatoshi (Nagoya Univ.) Jan.11, 2006
Construction Progress of the Australian Synchrotron Light Source VORSOVSKII Igor (Electrical Engineer, Australian Synchrotron Project) Jan.16, 2006
Protein Crystallography at the Australian Synchrotron ADAMS Julian (Protein crystallography beamline scientist, Australian Synchrotron) Feb. 2, 2006
Status of the Australian Synchrotron GARRETT Richard (Director, Australian Synchrotron Research Project) Feb. 8, 2006
TRIM5 α , a Lentivirus Restriction Factor SHIODA Tatsuo (RIMD, Osaka Univ.) Feb. 24, 2006
Progress in Experimental Phasing and in Structure Refinement BRICOGNE Gerard (Global Phasing Ltd.) Mar. 3, 2006