Introduction

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The most important event for the Photon Factory in FY2003 (April 2003-March 2004) was the decision by Prof. Totsuka, the director general of KEK to approve the budget for the straight-sections upgrade project for the 2.5 GeV ring. The shutdown of the 2.5 GeV ring for this upgrade project has now been scheduled for the period March-September 2005. During the upgrade the number of straight sections available for insertion devices (ID's) will be increased from the currently available seven (excluding the section used for injection) to thirteen, and eight existing straight-sections will be lengthened. The project is described in more detail in chapter 3-2 of the Accelerators section of this report. With the possibility of reducing the emittance of the 2.5 GeV ring to the 28 nmrad level (as described in chapter 3-3 of the Accelerators section), the capabilities of the Photon Factory will approach those of typical medium-energy third-generation synchrotron radiation sources. During FY2003 forty-six new quadrupole magnets for the upgrade were manufactured. In FY2004 the necessary vacuum ducts and power supplies will be manufactured.

Four of the six new straight sections will have low beta functions and be suitable for housing short-period narrow-gap undulators for the generation of X-rays. The construction of an in-vacuum undulator beamline is currently under discussion.

By also adding five new straight sections for IDs to the 6.5 GeV ring, the Photon Factory will have a total of 18 ID straight sections. Some of the current activities on multi-pole wiggler beamlines at the 2.5 GeV ring will be transferred to the in-vacuum mini-pole undulator beamlines which will be constructed in the near future. This will increase the number of vacuum ultraviolet and soft X-ray beamlines on the 2.5 GeV ring to five.

The reconstruction of BL-28 for dedicated high energy-resolution soft X-ray photoelectron spectroscopy studies is currently underway, and is described in chapter 1-2 of the experimental facilities (EF) section of this report. The reconstructed beamline will cover a photon energy range of 30-300 eV, and will be used for studying the electronic properties of nano-materials. When the funds are available for renewing the existing undulator the energy range will be extended to cover 30 eV to 1 keV. The old beamline components will be dismantled and removed and the new beamline installed during the summer shutdown of 2004, and commissioning of the optics and beamline will begin in October 2004.

Also related to the above project, Professor Shinya Koshihara of the Tokyo Insitute of Technology has received ERATO (Exploratory Research for Advanced Technology) funding from the Japan Science and Technology Agency, and a new X-ray undulator beamline will be constructed at AR-NW14 of the 6.5 GeV ring for 100 pico-second time-resolved diffraction and scattering studies of rapid structural changes in photo-induced phase changes in materials. This project is described in chapter 1-4 of the EF section of this report. This research project will make full use of the pulsed nature of the X-ray beam emitted from the 6.5 GeV ring which operates in single-bunch mode. To create space for the AR-NW14 undulator, two of the four RF cavities in the west straight section of the 6.5 GeV ring will be moved to the east section during the summer shutdown of 2004. Installation of a new in-vacuum undulator and the beamline components is planned for summer 2005, and beamline commissioning for autumn 2005.

Further efforts have been made to construct and refurbish insertion device beamlines. A multi-pole wiggler beamline for structural analysis studies of proteins has been constructed in the straight section between bending magnets B4 and B5 - the last remaining vacant straight section in the current lattice. The new beamline was successfully commissioned in November 2003, and a number of protein structures have already been solved using data recorded at this beamline (see chapters 1-1 and 2 of the EF section of this report), and the beamline is now available to general users. Together with the in-vacuum X-ray undulator beamline AR-NW12, the Photon Factory now operates two insertion-device beamlines for structural studies of protein crystals, in addition to the four

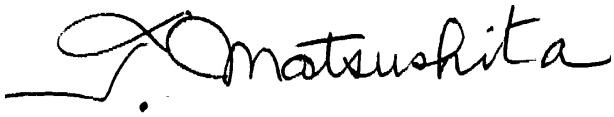
bending-magnet beamlines also used for protein crystallography.

In FY2003 both the 2.5 GeV and the 6.5 GeV rings performed satisfactorily well, and were operated for 5,200 hours (2.5 GeV ring) and 5,400 hours (6.5 GeV ring). In addition to the efforts to reduce the emittance of the 2.5 GeV ring, machine studies were also conducted on the 6.5 GeV ring in efforts to reduce the emittance to half of its current value. These studies are described in chapter 4-2 of the Accelerators section of this report. The lifetime of the stored beam in the 6.5 GeV ring was improved to 15 hours, and injection has been made twice daily since December 2003. Users have been satisfied with the improved performance of the ring, and the number of experimental proposals for studies at 6.5 GeV ring beamlines has almost tripled compared with FY2001.

User experimental programs continue to evolve steadily. The number of active proposals in FY2003 was 653, and the number of registered users was 2710. Half of the proposals originate from universities and institutes in the Kanto area (including Tokyo), and the remaining half from the rest of Japan and abroad. A detailed breakdown shows 16% from the Kinki area, 8% from Chubu, 7% from Tohoku, 5% from Chugoku/Shikoku, 4% from Hokkaido, 4% from Kyushu, and 6% from abroad, revealing that the Photon Factory is predominantly a national centre, with some emphasis towards the eastern parts of Japan.

During FY2003 a great deal of scientific output over a diverse range of research areas resulted from experimental work performed at the Photon Factory. It is worth mentioning the several scientific awards presented to Photon Factory users during FY2003. These include the IBM Science Prize awarded to Professor Youichi Murakami of Tohoku University and a former Photon Factory staff member for his work on the development and application of an anomalous scattering method for the study of electron orbital ordering in crystals. Professor Murakami's work has both directly and indirectly stimulated the use of synchrotron radiation by a number of groups studying highly-correlated electron systems, examples of which can be found in chapters 5-1, 5-3 and 11-3 of the "Highlights" section of this report. In November 2003 Professor Yasuhiro Iwasawa of the University of Tokyo, one of the most active users of the X-ray absorption fine structure (XAFS) beamlines at the Photon Factory, received the Medal with Purple Ribbon from the Japanese government for his contributions in the catalytic and surface sciences. A time-resolved dispersive XAFS study of surface Rh-clusters by his collaborative team is reported in chapter 2-2 of the "Highlights" section of this report.

As reported in chapter 8 of the "Highlights" section, a number of protein structures were solved during FY2003. The number of proposals for protein structural analysis studies increased in FY2003, reflecting the high performance of the two recently constructed insertion-device beamlines AR-NW12 and BL-5. When appropriately organised, time-resolved experiments with time resolution on the second to microsecond scale are still useful for elucidating the course of chemical and physical transitions in materials, as reported in chapters 2-1, 5-2, 5-5 and 2-2 of the "Highlights" section. A number of succesful experiments were also carried out where careful control of the sample environment (2-3, 7-1), very precise and extended data collection (3-1, 4-2, 6-1), and the choice of novel specimens (4-1) was the key factor for success. At the Photon Factory we will continue to invite such experimental proposals and give as much support as possible towards their success. It should also be noted here that efforts to observe new physical processes through instrumental and/or methodological developments (4-3, 11-3) are also expected to open up possibilities for developing new tools for studying the atomic and electronic nature of materials.



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