Instrumentation & Methodology

Although nine years have passed since the inauguration of SPring-8 in 1997, the development of new instrumentations and methodology continues. One reason for this is the request for more user-friendly instrumentations by many new users in the synchrotron radiation. With more experience of users and facility members, more improved instrumentations to the source performance have been developed, or the adaptability of existing techniques has been enhanced. In addition, perpetual improvement of the source has increased its brilliance more than 1000 times since 1997. The progress with the light source naturally resulted in parallel progress with the users' instrumentations and new methodologies. The availability of much greater photons in a much smaller localized region in the sample facilitates photon-hungry measurements such as inelastic scattering with a small cross-section. With the development of ultra-fast X-ray detectors, time-resolved diffraction measurement with pico-second resolution became feasible and nuclear phenomena related to the electron excitation were clearly demonstrated. Now many users enjoy the heart of the third generation source, distinguished by its extremely high brilliance and very small source size, but some users require higher performance than the third generation source is capable of delivering. This demand will be a strong driving force for new generation light sources, such as X-ray Free Electron Lasers (XFELs).

Eight interesting articles are selected for the "Instrumentation & Methodology" chapter of this volume. Dr. Go Ueno and his coauthors present the mail-in system and beamline automation developed for protein structure analysis. This is an expanding field that many researchers who are not yet familiar with the synchrotron radiation business want to break into. Recently, it has become a common view that most protein structures can be solved once a single, high quality crystal is obtained. One question naturally raised is whether or not the powder diffraction technique is useful for protein crystallography. Dr. Toshihiko Oka partially addresses this question by using powder diffractometry to determine the structure of the purple membrane. The availability of much greater numbers of photons has expanded the capabilities of spectroscopy. Two new methodologies, having been difficult to realize because of the small signal level, are introduced: one is hard-X-ray excited photoelectrons as reported by Dr. Yasutaka Takata and Prof. Yosuke Kayanuma; the other is resonant inelastic X-rays as reported by Dr. Atsushi Higashiya and his coauthors. The increased number of photons has enabled research into ultrafast phenomena. Dr. Yoshihito Tanaka and Dr. Yujiro Hayashi report their studies of pico-second time-resolved diffraction on laser-induced lattice deformation in semiconductor crystals. Prof. Shunji Kishimoto reports very convincing Nuclear Excitation by Electron Transition (NEET) data as a result of the improvement of the detector system for NEET measurement. FY 2006 was a great year for novel undulator development using the low temperature technique, as reported by Dr. Takashi Tanaka. In conjunction with another milestone project in 2006, Dr. Makina Yabashi presents a single-shot characterization technology for X-ray pulses to be used for the XFEL.

We hope we will have excellent development in instrumentation and methodology in the following years as well.

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