5 The ERATO Non-Equilibrium Dynamics Project

5-1 Outline

The Non-Equilibrium Dynamics Project under the Exploratory Research for Advanced Technology (ERATO) program of Japan Science and Technology Agency (JST) was launched at the northwest experimental hall of the PF-AR in October 2003. It was a five-year project lead by Professor Shin-ya Koshihara (Tokyo Institute of Technology), and was successfully completed in March 2009. The KEK branch of the project was mainly devoted to the construction of beamline NW14A at the PF-AR and the development of 100 ps time-resolved X-ray applications. The total project cost was about 15 M$ over the 5 years, and more than half of the budget was used for beamline construction and applications development.

5-2 Beamline Construction and Development

The design and construction of NW14A for time-resolved X-ray diffraction, scattering and absorption experiments was started in 2003, and finished in summer 2005. NW14A has been fully operational since autumn 2005. The technical details of the beamline have been published elsewhere [1]. In brief, synchrotron radiation and laser pulses are synchronized using the PF-AR RF clock at 508.58 MHz, and the laser and X-ray pulses hit the sample with a well-defined timing delay in the picosecond time regime. The time-dependent signal of X-ray photons emitted from the sample at energies of around 5-20 keV is monitored using X-ray choppers and fast X-ray detectors.

5-3 100 ps Time-Resolved X-Ray Applications

Time-resolved X-ray techniques utilizing the pulsed nature of synchrotron radiation are now general and powerful tools for exploring structural dynamics in materials and biological sciences. The technique can be applied to most of the synchrotron radiation methodologies, and we have been applying it to wide range of subjects as follows.

(1) laser-induced shockwave generation and ultrafast compression of materials studied by time-resolved diffraction [2].
(2) the light-induced response of photosensitive protein molecules.[3]
(3) photochemical reaction dynamics in liquids studied by time-resolved XAFS and solution scattering [4,5].
(4) photo-induced cooperative phenomena in strongly-correlated electron systems.[6]

We are also planning to develop time-resolved X-ray imaging and X-ray emission spectroscopy techniques in the near future. The experimental results mentioned above have been carefully analyzed and successfully published. Although the project has ended, we hope to expand the capabilities of time-resolved X-ray applications, and continue to be at the world center of time-resolved X-ray sciences.

REFERENCES

[1] S. Nozawa, S. Adachi, J. Takahashi, R. Tazaki, L. Guerin, M. Daimon, A. Tomita, T. Sato, M. Chollet, E. Collet, H. Cailleau, S. Yamamoto, K. Tsuchiya. T. Shioya, H. Sasaki, T. Mori, K. Ichiyanagi, H. Sawa, H. Kawata and S. Koshihara, *J. Synchrotron Rad.,***14** (2007) 313.
[2] K. Ichiyanagi, S. Adachi, S. Nozawa, Y. Hironaka, K. G. Nakamura, T. Sato, A. Tomita and S. Koshinara, *Appl. Phys. Lett.,* **91** (2007) 231918.
[3] A. Tomita, T. Sato, K. Ichiyanagi, S. Nozawa, H. Ichikawa, M. Chollet, F. Kawai, S. -Y. Park, T. Tsuduki, T. Yamato, S. Koshihara and S. Adachi, *Proc. Natl. Acad. Sci. USA*, **106** (2009) 2612.
[4] K. Ichiyanagi, T. Sato, S. Nozawa, K. H. Kim, J. H. Lee, J. Choi, A. Tomita, H. Ichikawa, S. Adachi, H. Ihee and S. Koshihara, *J. Synchrotron Rad.*, **16** (2009) 391.
[5] T. Sato, S. Nozawa, K. Ichiyanagi, A. Tomita, M. Chollet, H. Ichikawa, H. Fujii, S. Adachi and S. Koshihara, *J. Synchrotron Rad.,* **16** (2009) 110.
[6] H. Ichikawa et al., in preparation.

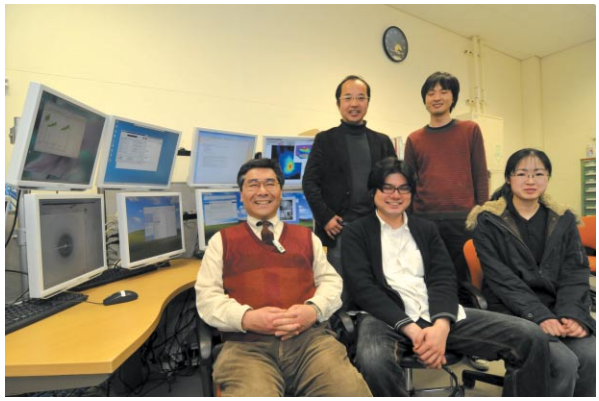

Figure 1
Members photo at beamline NW14A. (Courtesy of JST News)