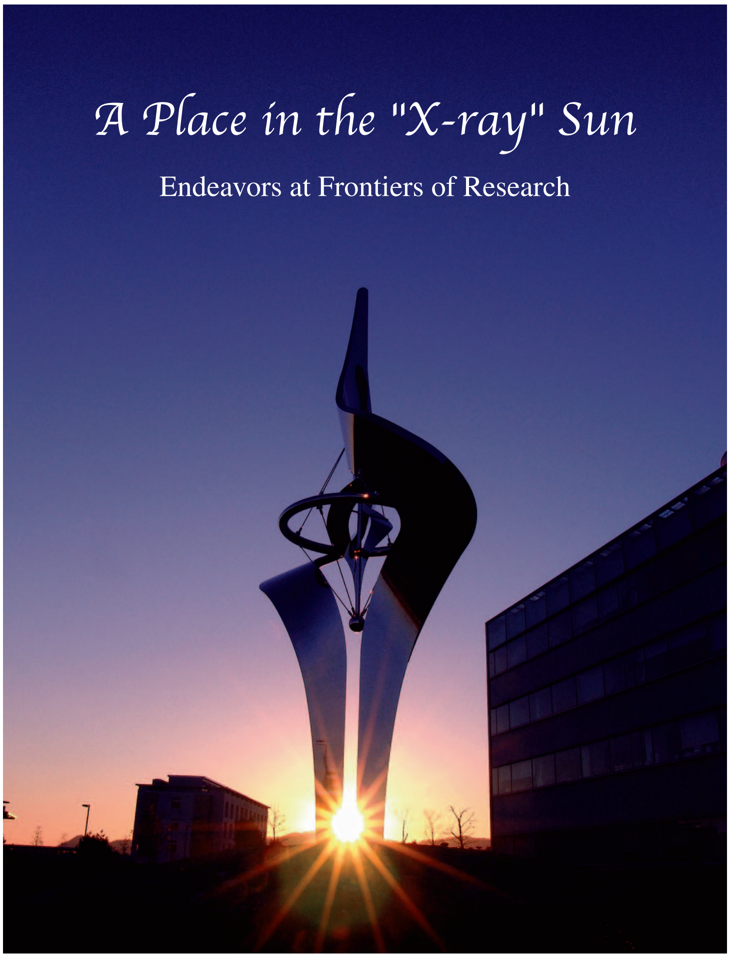

I. Innovations Supporting Activities at SPring-8

Each year, SPring-8 continues to make extensive progress, lead excellent research activities and promote new fields of research, including those presented below.

Top-up Operation has remarkably improved the quality and reliability of science research at SPring-8. One of its biggest contributions is the removal of incident X-ray intensity variations. The monitoring of incident X-ray intensity has not always been completely reliable. In experiments, it has been confirmed that the Top-up Operation eliminates this problem and has enabled great research success such as the findings presented in “The Structural Basis for Fast Phase Change of DVD-RAM” by Shinji Kohara, appearing in Materials Science, Structure. The virtually constant incident X-ray intensity produced by the Top-up Operation precludes the ambiguity resulting from the correction of the time dependence of X-ray intensity and allows for more reliable, precise structure analysis. The time-resolved experiment, one of the most promising techniques for visualizing of the kinetics as well as the dynamics in chemical reaction phenomena, will significantly improve data reliability, particularly in the analysis of the subtle features inherent in chemical reactions. Now, a research group called the “X-ray Pinpoint Structural Measurement Project Group” is attempting a time-resolved experiment on a submicron-scale area in order to reveal the crystal amorphous phase change mechanism in DVD media.

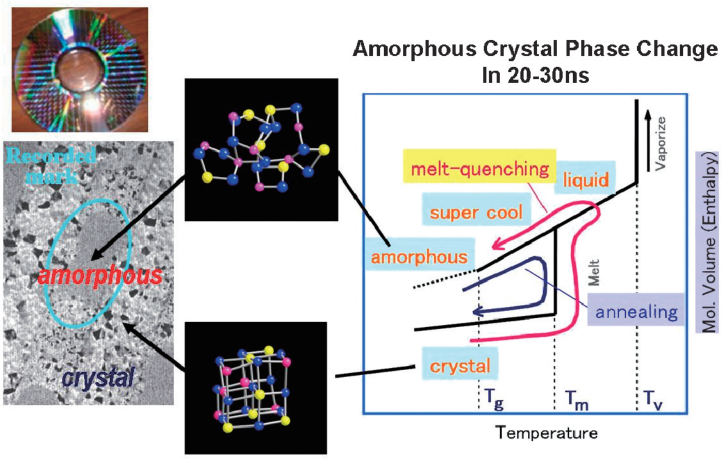

Fig. 1. Challenge of uncovering the ultrafast amorphous crystal phase change mechanism in DVD media.

Long-Term Proposals to allow the continuous use of the beamtime for up to three years is another good example of SPring-8's support of leading-edge scientific activities. This system was implemented to (i) promote research that is expected to generate outstanding results in the field of science and technology, (ii) pave the way for new research areas and methodologies, and (iii) improve industrial-based technology by making the best use of the unique characteristics of SPring-8.

As listed in Table 1, sixteen proposals have been completed successfully, after progressing rapidly through their challenging objectives in advanced research at SPring-8.

In "The Crystal Structures of a Bacterial Multi-Drug Transporter Reveal a Functionally Rotating Mechanism" by Prof. Satoshi Murakami, a typical achievement of the long-term proposal system is presented. The work described in his proposal (Table 1, [10]) is introduced in the Structural Biology section. In 2002, Prof. Murakami's group published the first report on "The Crystal Structure of Bacterial Multi-Drug Efflux Transporter AcrB" (Fig. 2), which adorned the cover of Nature **419** (2002). In Prof. Murakami's work, "plan-do-check" research on various drugs and experimental conditions was required to reveal the multidrug transport mechanism. The three-year beamtime allowed Prof. Murakami's team to conduct systematic experiments, which eventually led to their great success. Consequently, his long-term proposed experiment resulted in the discovery of a drug export mechanism by adroit three-step functionally rotating. This work was reviewed in the "News & Views" section in Nature **443** (2006) 156. In the section with the heading "The Ins and Outs of Drug Transport," Prof. Shimon Schuldiner (Institute of Life Sciences, Hebrew University) describes the importance of this work: "the structures may prove to be essential tools in tackling the serious problems posed by drug resistance and the diseases caused by mutations in the human versions of these transporters."

In addition, Prof. Makoto Seto's proposal (Table 1, [1]) promoted Prof. Stephen Cramer's proposal (Table 1, [9]) and led to the research "Nuclear Spectroscopy of Nitrogenase and Hydrogenase" by Prof. Cramer *et al.*, which is presented in the Chemical Science section. Dr. Yoshiyuki Tatsumi's proposal (Table 1, [8]) resulted in the research, "Post-Perovskite Phase Transition in Earth's Deep Mantle" by Kei Hirose, as reported in the Earth & Planetary Science section. The long-term proposals have produced distinguished achievements, which are all reported in Research Frontiers.

Table 1. List of Long-Term Proposals

[1] "Study on Local Vibrational Densities of States Using Element and Site Specific Nuclear Resonant Inelastic Scattering and Development of the Measuring Methods" by Prof. Makoto Seto (Kyoto University)

[2] "Studies on Static and Dynamic Structures of Metallic Fluids in the Supercritical Region" by Prof. Kozaburo Tamura (Kyoto University)

[3] "Development of Spectromicroscopy using a Hard X-ray Microbeam" by Prof. Shinjiro Hayakawa (Hiroshima University)

[4] "Development of Experimental Techniques for Charge Density Studies under High Pressure" by Prof. Masaki Takata (Nagoya University/ JASRI)

[5] "Bulk Sensitive Angle Resolved Photoemission Spectroscopy of High T_c Cuprates and Related Materials" by Prof. Shigemasa Suga (Osaka University)

[6] "Study of Electronic and Orbital State in Colossal Magnetoresistance Materials by High Resolution and Magnetic Compton Profile Measurement" by Prof. Akihisa Koizumi (University of Hyogo)

[7] "Investigation on Photoninduced Phenomena by Means of SR X-ray Powder Diffraction under Photoirradiation" by Prof. Yutaka Moritomo (Nagoya University)

[8] "Technical Development for High-Temperature In-Site Observation above 100 GPa and Study of Phase Transitions in the Earth and Planetary Interiors" by Dr. Yoshi-yuki Tatsumi (Japan Agency for Marine-Earth Science and Technology)

[9] "Nuclear Resonance Vibrational Spectroscopy (NRVS) of Hydrogen and Oxygen Activation by Biological Systems" by Prof. Stephen Cramer (University of California)

[10] "X-ray Crystallographic Analysis of Multi-Drug Efflux Transporter Proteins" by Prof. Satoshi Murakami (Osaka University)

[11] "Characterization of Hard X-ray Imaging System on Board Flight Experiment" by Prof. Yasushi Ogasaka (Nagoya University)

[12] "Measurements of SuperRENS Optical Memory Material Properties" by Dr. Paul Fons (National Institute of Advanced Industrial Science and Technology)

[13] "Phase-Contrast Imaging of Lungs" by Prof. Lewis Rob (Monash University)

[14] "Study of Filler Aggregate Structure in Rubber by Time-Resolved Two-Dimensional Ultra Small- and Small-Angle X-ray Scattering" by Prof. Yoshiyuki Amemiya (University of Tokyo)

[15] "Hard X-ray Photoelectron Spectroscopic Accurate Analysis of Next Generation Nano-Scale Devices for Post-Scaling Technology" by Prof. Shigeaki Zaima (Nagoya University)

[16] "Functions and Structure Woven by Coexisting Charge-Ordered Domains: Time- and Space-Resolved X-ray Diffraction from Fluctuating Charge Orders" by Prof. Ichiro Terasaki (Waseda University)

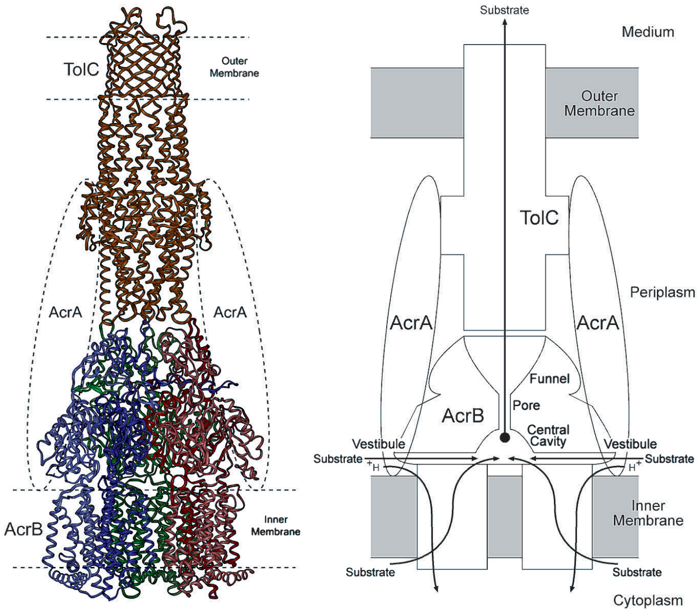

Fig. 2. First report on proposed model of AcrB-AcrA-TolC complex published in 2002 by Satoshi Murakami. Nature **419** (2002) 587.

II. Winds of Change

New Beamline Construction at the 14 currently unutilized ports in the storage ring has been recognized as a top priority. RIKEN has been able to build more than 40 SPring-8 beamlines in a short period of time because of the systematic adoption of standardized components. RIKEN recognizes these beamlines as milestones in the ultimate completion of SPring-8. We, however, will not consider the facility to be complete until all of the currently unused ports are occupied by working beamlines. The unused ports are located in the bending magnet (ports 14B2, 22B2, and 29B2) and the insertion device (ports 03IN, 07IS, 21IN, 28IN, 31IS, 32IN, 33IN, 34IN, 36IN, 43IS, and 48IN).

As the first step towards the completion of SPring-8, Japan Synchrotron Radiation Research Institute (JASRI) is funding the construction of a new beamline at BL14B2. This beamline will allow users to conduct experiments using X-ray absorption fine structure (XAFS) and powder diffraction analyses for industrial applications (Fig. 3).

In order to exploit the full potential of SPring-8, JASRI will continue to make every effort to complete the construction of the beamlines at the vacant ports. Recently, six proposals for the construction of new beamlines were submitted by a specific industry-university complex group, an industry research institute, and a university group. Each plan is appealing and is expected to soon come to fruition. These plans will nurture new research fields at SPring-8 in 2 or 3 years.

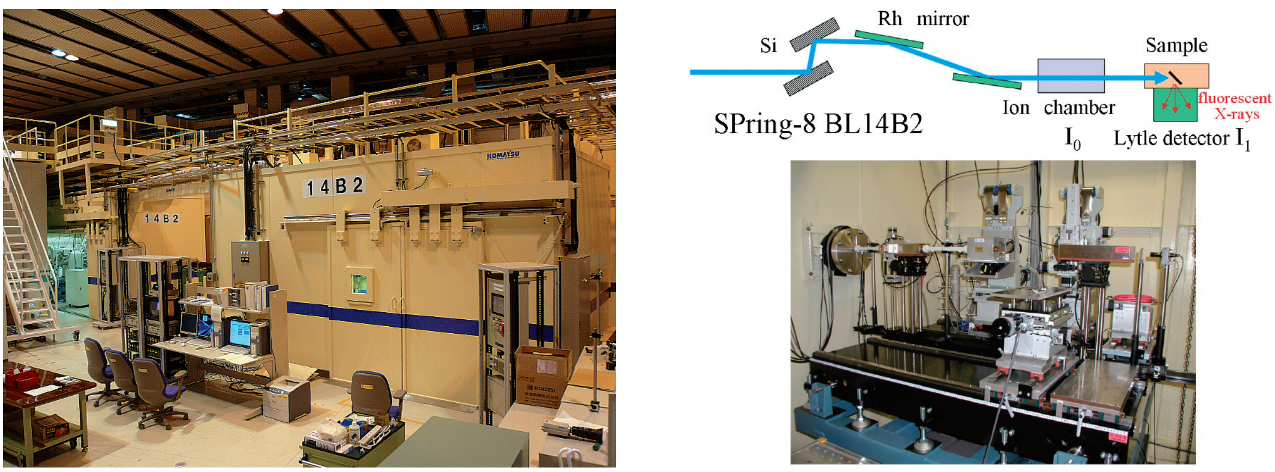

Fig. 3. Experimental hutch of new industrial application beamline BL14B2. The right-hand figure shows one of the EXAFS measurement configurations using the Lytle detector.

Fig. 4. Joint-Project Team, on the day when lasing at 49 nm was achieved.

III. New Horizon

The Launch of the X-ray Free Electron Laser (XFEL) Project was the most exciting news of the year at the SPring-8 campus. On June 20, 2006, the SPring-8 Compact SASE Source (SCSS) reported that the RIKEN-JASRI Joint XFEL Project Team (Fig. 4) at SPring-8 had succeeded in generating laser pulses at 49 nm VUV light at the prototype 250 MeV. The XFEL project was approved to start this year by the Japanese Ministry of Education, Culture, Sports, Science and Technology with a five-year funding plan. The 800-m-long 8 GeV XFEL will be constructed in the south area of the SPring-8 campus, adjacent to the 1 km SPring-8 beamline (Fig. 5). The first phase of the construction plan is to complete the accelerator shield, the linear accelerator, experimental hall, office building, XFEL Beamline 1, and Wide-Range FEL Beamline 1. For more details, please visit the SCSS web site: http://www-xfel.spring8.or.jp [see J. Synchrotron Rad. **13** (2006) 289].

Masaki Takata

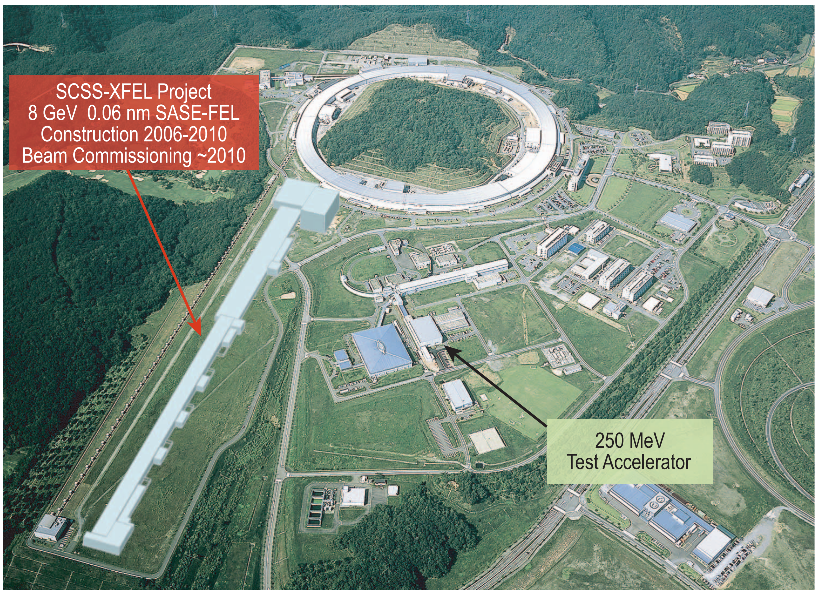

Fig. 5. Building design of 8 GeV XFEL facility.