SPring-8 BL19B2 Review Committee Report on Engineering Science Research (BL19B2)

Report for Director General of Japan Synchrotron Radiation Research Institute

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1. Introduction

This review committee meeting was held on November 27 and 28, 2006 at SPring-8. The committee members received the "Beamline Report BL19B2 (Engineering Science Research)" and "SPring-8 Overview 2006," and submitted individual reports before the meeting. Over the two days, three domestic members attended the meeting. The meeting began with JASRI's guidance on the beamline review, followed by their presentation on the overview of the SPring-8 facility and a tour of the BL19B2 beamline. After the tour, the committee received explanations of the beamline facilities, research outcomes and future plans from the beamline staff, followed by a question-and-answer session. The report was compiled on the basis of discussion among the three domestic members and the reports from Dr. Takahashi and Mr. Castellano.

2. Technical Status of Beamline and Experimental Facilities

2.1 Evaluation

The committee judges that the development of BL19B2 for industrial use has been well organized by making the best use of the characteristics of the 120-m-long beamline with three experimental hutches. BL19B2 is a user-friendly beamline since one staff member is assigned to each experimental hutch for user support. The experimental setups of XAFS and XRF measurements, multiaxis diffractometer, Debye-Scherrer camera and various apparatuses for X-ray imaging are well prepared, in excellent considtion and are used effectively for industrial applications. Some software programs for sample positioning, data conversion and data analyses have been coded by the beamline staff, which has contributed to the user-friendliness of BL19B2.

In the first hutch, XAFS measurement is operational in fluorescence mode as well as transmission mode, and a Lytle detector and a 19-element Ge SSD are available, which make it possible for users to choose the best setup in accordance with their samples and experimental purposes. In addition, low-angle X-ray incidence is realized with high angle accuracy and the apparatus for XAFS measurement meets the growing demand in industry for the accurate analyses of thin films. XRF measurement has been developed as a nondestructive technique with sensitivity as small as the order of ppm, using X-ray beams with a size of 0.5x0.5 mm^2. For the multiaxis diffractometer in the second hutch, various improvements for acquiring high-quality data have been achieved such as (1) the extension of the angle-scanning range, (2) the measurement of stress at a depth, (3) the development of a He-filled Kapton dome as a sample container for reducing X-ray background

(patent pending), (4) a solar-slit system for an X-ray detector and (5) time-resolved measurements using an IP system. In particular, the depth profile measurement of stress has provided high-quality data that is unobtainable using conventional X-ray apparatus. The measurement of a radial distribution function in amorphous materials for the research of corrosion has provided useful data for structural analyses. For the imaging experiments using refractive-contrast topography or CT in the third hutch, in-site observations are possible under stress, heating or cooling condition, and these apparatuses are well prepared for industrial use so that various kinds of materials have been evaluated.

In general, BL19B2 has achieved its designed performance and has developed a variety of experimental techniques, such as sample positioning and dynamical evaluation at low temperatures, to overcome its lomitations. From the large number of proposals and the results of the user survey on BL19B2, the committee judges that BL19B2 has supported R&D activities in the industry.

2.2 Recommendations

BL19B2 occupies an important position in R&D for science and technology in Japan, and its presence will become increasingly important in the field of industrial R&D in the future. The committee recommends that JASRI should upgrade the apparatuses and improve their performance for R&D, and increase the number of the staff at this beamline.

3. Research Activities

3.1 Evaluation

By making the most use of the characteristics of a bending magnet beamline, research activities have been performed efficiently in the priority fields, such as displays, metals and new materials. The activities have also been extended to various targets such as low-k semiconductors, biological materials, archeological samples, tools and winter tires. In recent years, the fields of catalysts, fuel cells, secondary batteries, surface treatment, cement and health care have been growing. The in-site observation of winter tires, which shows persuasive evidence that the tires firmly grip the surface of ice, has been an example of commercially led research, which helps to generate publicity for SPring-8. The identification of the place and age of production of ancient mirrors (Sankaku-buchi Shinjyu-Kyo) by element mapping has attracted public attention. Generally, the committee judges that the BL19B2 beamline has been actively utilized. This beamline has succeeded in developing

new users, and we highly evaluate staff efforts at increasing the number of industrial companies that use the SPring-8 facility.

The combination of national projects (the Trial Use program and the Advanced Large-Scale Research Facilities Strategic Utilization Program) and JASRI's efforts has worked well, and the industrial use of SPring-8 is growing. For example, (1) the industrial use of beamtimes has increased by up to 70~80 % since 2003B, (2) 200 new industrial companies have used the SPring-8 facilities since the implementation of the national projects.

3.2 Recommendations

Forty-seven publications, four patents and six awards during the period from April 2003 to May 2006 are average compared with other beamlines. The number of publications is not necessarily a major criterion for the evaluation of BL19B2 since the main duty of the staff at this beamline is to support industrial research. One view on the outcome of industrial use is that the research becomes successful when its results have been used for production. Some results are difficult to publish because of commercial confidentiality. Therefore, the committee recommends that expressions of usefulness from project leaders in industry should be regarded as one of the criteria for evaluation.

4. Public-Use Support System

4.1 Evaluation

The committee is satisfied with the situation that the accepted proposals have not been concentrated on specific institutions and the research outcomes have been achieved from small and medium-size companies as well as large companies. The percentage of proposals that have been accepted is 52 % and should be increased further. It is sensible that the activities of XAFS will be moved to the new beamline, BL14B2.

The user survey has revealed that users' satisfaction is quite high, showing that user support is sufficient from initial consultation to experiment. The fact that new users can obtain satisfactory data, shows that the beamline is user-friendly in general. Such successful expansion for industrial use has not been realized without the contribution from the coordinators and staff members in the Industrial Application Division in JASRI.

4.2 Recommendations

The survey shows that many of the users are satisfied with the distribution of beamtimes. The users request more opportunities to perform their experiments with feedback for the next experiment for each proposal. The committee recommends that JASRI should consider the following measures: (1) increase the opportunities to submit proposals from twice a year to four times a year for highly flexible beamline operation, (2) increase the length of the validity of one proposal up to one or two years.

The survey shows that 17 % of users are dissatisfied with the availability of operation manuals for apparatuses. Regarding the manuals, more improvements are needed, although they have been partially completed.

JASRI should prepare a budget that the staff can use for developing apparatuses as their own research theme.

The effects of the “Strategic Use of Advanced Large-Scale Research Facilities (SUALRF)” program on industrial use at SPring-8 are recognized. On the other hand, this program has adversely affected other beamlines since many of the general proposals have been given to those beamlines. JASRI should consider a new beamilne to meet the needs of users.

5. Instrumentation and Research in Future

5.1 Evaluation

Industrial applications using synchrotron radiation should be strategically expanded in the future. With this viewpoint, the launch of the SUALRF program in FY2005 is highly evaluated.

The future plans for ultrasmall angle scattering using all the hutches, refractive- contrast tomography, CT imaging, as well as technical improvements to the multiaxis diffractometer, and plans for the large Debye-Scherrer camera and imaging apparatus, are appropriate. In particular, the proactive attitude toward improving the efficiency of measurement by installing a multi-axis diffractometer and providing users with data-analyzing tools are evaluated highly. CT imaging will provide the industry with valuable data since it realizes the three-dimensional visualization of an object. We expect more efforts toward overcoming technical challenges, such as the improvement of spatial

resolution, applications to organic materials and time-resolved experiments.

5.2 Recommendations

JASRI claims that a new undulator beamline is needed for local structure analyses using microbeams, distortion analyses, highly sensitive X-ray fluorescence analyses and local electronic-state analyses. The future plan for constructing a new undulator beamline is a persuasive proposal. The committee expects a variety of R&D studies to be performed at BL19B2 focusing on innovative development and pioneering research, such as atomic-level observation for ULSI and nanotechnology in the future.

In the future, JASRI should consider a flexible budget system so that the staff in the Industrial Application Division can contribute to the industry by improving the beamline facilities and experimental apparatuses or by creating more data-analyzing programs.

Currently, research using synchrotron radiation is contributing to the success of many national projects. Collaboration among the projects led by central and local government will improve the quality of outcomes from the projects. JASRI should propose that the central government creates a system for such collaboration.

6. Summary

The Engineering Science Research beamline consists of three experimental hutches and makes the best use of the characteristics of the medium-length beamline. The current overall performance of the beamline is evaluated highly. The survey shows that most of the users are satisfied with the beamline, and the contribution to industry over the past five years deserves high praise. Regarding its outcomes, JASRI should work with industry to improve their publications in terms of quality and quantity, since they use cutting-edge apparatuses.

In the future, it is important to continue enhancing the contribution to industry through the construction of a new beamline and the extension of technical support in accordance with industrial needs, by carefully monitoring the trends in technology, such as electronics, new materials (polymers, metals, etc.), biological products and consumer goods. The committee hopes that this beamline can continue to operate stably under a self-supporting budget and reduce the influence of governmental budgeting by obtaining funding from other sources.

The SUALRF program under MEXT is continuing for a second year. This program has been successfully promoting industrial use at SPring-8. The committee expects continuing support to industry by the coordinator and staff in the Industrial Application Division under the program.