SPring-8 BL04B1 Evaluation Report

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1. Preface

The SPring-8 BL04B1 Evaluation Committee meeting was held on November 5 and 6, 2003 in SPring-8. Before the meeting, each committee member received the BL04B1 Beamline Report and related materials, on which every committee member wrote a preliminary comment. On the meeting date, four evaluation committee members except Dr. Rubie and Dr. Weidner attended the meeting, and inspected the beamline first. The four committee members were then given an overview of the facilities and the beamline by Dr. Kikuta, Deputy Director of JASRI, Dr. Suematsu, Director of Materials Science Division, and Dr. Takada, group leader. The four members were given further detailed descriptions of equipment and research results by Dr. Funakoshi, who is in charge of the beamline. They participated in a

question-and-answer session, and had discussions with each other. On the basis of these sessions, the committee presents the following evaluation report.

2. Beamline and experimental devices

The beamline combines two large-volume high-temperature high-pressure generating devices with high-brilliance white X-rays from a third-generation synchrotron radiation source. Undoubtedly, this experimental equipment achieves the highest level of performance in the world. In particular, the high-temperature high-pressure X-ray apparatus of the beamline is a distinctive system, featuring two powerful 1500-ton presses in tandem arrangement, an imaging system using high-speed CCD cameras, and an oscillating mechanism. The research that is carried out utilizes these features.

It is difficult for people who do not know the history of its construction to understand why two 1,500-ton powerful presses are in a tandem arrangement. At present, the use of the two presses for separate purposes effectively improves the performance of the entire beamline. In the future, more effective uses will be enabled by assigning SPEED-1500 specifically to large-volume and physical-property experiments, by assigning SPEED-MkII to sintered-diamond anvil experiments, by upgrading the systems suitable for these presses and by switching appropriate beams.

With radiography, the imaging system has already enabled quite a distinctive experiment that would be very difficult without SPring-8. The system is expected to

be further upgraded so that it can show its abilities more significantly.

3. Research activity

A high level of research based on the features of the beamline has shown results. The beamline has made a great contribution to the increased use of high-temperature high-pressure precision experiments. In addition to the research results obtained at APS and at ESRF, the beamline is helping to spread, internationally in geoscience, the “common knowledge” that the use of synchrotron radiation is essential for research on deep earth. Some researchers, however, have pointed out a mismatch between various pressure scales, and other problems to be solved. In order to clearly establish its distinctive abilities, the beamline should have a reliable pressure scale which scientists must establish as soon as possible. The SPring-8 staff are also expected to take positive steps. It is not easy to establish an absolute scale. The reliable comparison of relative scale values could be a valuable development. We propose that every user be requested to conduct an experiment of simultaneously pressurizing two or more pressure markers, MgO, Au, Pt or the like, at least once during each machine use, and that data be stored and published. It is anticipated that it will take approximately a year to accumulate crucial data that can be used even in statistical analysis. Such data could help scientists to improve the reliability of SPring-8 experiment results.

As unique research based on the advantage of the large-volume apparatus, viscosity measurement using radiography is especially highly appreciated. Other

research studies based on the feature of a large volume, such as structural analysis of molten material and ultrahigh-temperature experiments would be worth promoting. The user group should discuss such research.

An acceptable number of papers have been published regarding the beamline. Although already published, many papers have not yet been registered in the database. A rule should be made that stipulates that past achievements registered in the database must be considered for new subject examination. Under the user group's leadership, people are expected to work towards complete database registration.

4. Support for sharing

It is acceptable that the past and present adoption rates of proposals have produced moderate competition and an atmosphere of tension. If we make a long-range plan, use of such a beamline by only regular users is problematic. It is necessary to take positive steps to develop and increase new users. The opening of examination criterion to the public, provision of travel expenses to users who submit excellent proposals, and invitations to the public to be researchers on intensive subjects selected under the SPring-8 staff's leadership could be used to increase new users. In promoting new research subjects, the provision of travel expenses to small groups as well as influential users will play an important role. All SPring-8 staff are expected to take positive steps. Following such a policy, it is necessary to make a substantial efforts to develop new users not only in geoscience but also in materials science.

An increasing number of foreign researchers are using the beamline because it is a distinctive advanced device of world-class level. Instruction manuals and computer software are expected to be translated to English so that researchers can conduct experiments by themselves. Outsourcing can save the staff translation time and labor. It would contribute to labor-saving among the internal staff regarding experimental support.

It is true that the two giant experimental devices really resemble each other; however, despite as many as two devices, only one person is in charge of the beamline. It is very difficult to run the beamline because of the lack of permanent staff. In order to keep the equipment in effective operation, and to make ceaseless efforts to advance beamline technology, an increase in staff is strongly desired. The permanent staff member who supports technical aspects, especially around such devices, plays a very important role. People are expected to make special efforts to increase the permanent staff.

On the whole, the beamline is ease to use. Great loss of time results from the distance from the beamline to a shop where people can make items associated with experiments. It is desirable to build, near the beamline, a shop provided with hand tools and small machine tools.

5. Future device, research and development

At present, it is necessary to emphasize scientific research results because the

BL04B1 experimental system is in the forefront of research on high-pressure physical properties. At the same time, developmental research should be advanced regarding intensive subjects, based on the prospects for a new generation of science.

The present imaging system is a distinctive feature of the beamline. The use of monochromatic radiation as incident light will enable clearer imaging, the contrast method using the absorption end, and other new applications. The introduction of a monochromator is strongly desired because monochromatic radiation can be expected to push back the frontiers of science: measurement of higher viscosity of substances, and three-dimensional tomography, for example. In terms of long-range prospects, the use of high-brilliance light in a Wiggler beamline should be studied.

The simultaneous measurements of physical properties and X-rays are a distinctive experiment subject that would be very difficult without the feature of a large volume. Because it often takes a long time to prepare experiments on physical properties, it is necessary to consider the effective use of machine time, and to be careful when making experiment plans. From the effective use of machine time, it is judged that the two presses in tandem arrangement is of great significance. We recommend that users be organized into subgroups that study ultrasonic elastic wave measurement, thermal conduction, electric conduction, metarheological experiments in the stress field, and other experiments. The SPring-8 hardware is expected to be improved according to the subgroups' research and requests.

Japanese high-pressure science leads the world in ultrahigh-pressure

high-temperature generating technology using sintered diamond. The development of advanced high-pressure technology is an important subject. SPEED-MkII is a device designed for such an area of knowledge. The most intensive developmental research should be advanced using the features of SPEED-MkII.

6. Summary

A very high level of system development has been conducted using of SPring-8. Accordingly, scientific research has shown results which are highly appreciated by the geoscience community. In order to maintain such a high level of work, and to advance technology, researchers are expected to deal with the following points as soon as possible.

(1) Performance of the entire beamline should be improved by specifically assigning the two large presses to different experiments (large-volume apparatus for measuring physical properties and sintered-diamond ultrahigh-pressure generating apparatus), and by upgrading them with suitable systems.

(2) In order to improve performance, an increase is urgently required in the number of permanent staff engaged in technical support.

(3) It is necessary to enhance support for sharing, as described in Section 4, and to take positive steps to publicize the high performance of the entire beamline, among domestic and foreign researchers. The increasing number of users who carry out a high level of research should share the beamline.