SPring-8 BL20XU Review Committee Report
on
Medical and Imaging II
(BL20XU)

Report for Director General of
Japan Synchrotron Radiation Research Institute

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1. Introduction

The BL20XU beamline review committee meeting was held at SPring-8 on December 14 and 15, 2006. The committee members received “Beamline Report BL20XU (Medical and Imaging II) and “SPring-8 Overview 2006,” and then submitted individual reports before the meeting. Over the two days, four domestic members attended the meeting. After the general explanation of the beamline review and the SPring-8 facility, the committee members were invited on a beamline tour. After this, the committee received explanations from beamline scientists about the beamline facilities, research outcomes and future plans, and held a question-and-answer session. This review report was put together on the basis of discussion among the domestic members and the individual report from Professor Janos Kirz.

2. Status of Beamline and Experimental Apparatuses

BL20XU is a unique public beamline with a highly brilliant undulator light source and a 260m-long beam path, and its uniqueness makes the beamline of great value. The beamline was designed to include many new ideas for delivering coherent X-ray beams, such as the use of optical element as few as possible, a Kapton window, a fast closing valve and a virtual light source. It is notable that research at the BL20XU beamline is focused on X-ray micro-imaging.

The monochromator is the heart of this beamline and is designed to have minimum adjustment for the high beam stability, and thus, the standard deviation of angular fluctuation has been achieved to be considerably smaller than the vertical angular divergence of the electron beams. This is one of the ideas that has made X-ray microimaging experiments possible at this beamline. The performance of the monochromator has also been improved by installing a cooled radiation shield. In the future, the long-term stability should be improved by controlling its temperature since many experiments such as CT measurements require many hours.

BL20XU satisfies the requirements for an X-ray imaging beamline since users can choose the most suitable detector among various X-ray imaging detectors prepared at this beamline. Fluorescence analysis can be also carried out using an energy-dispersive X-ray detector, and this beamline is fully equipped for this purpose.

The multipurpose apparatus for experiments using X-ray microbeams and the feasibility studies of new imaging optics provides skilled users with the flexibility to select their experimental setup.

However, this flexibility is not always beneficial to new users, and this situation may hinder new users from applying for beamtime. Under the current situation of beamtime allocation, the loss of time for setting up the apparatus is inevitable. An effective lineup of experimental apparatuses is desirable to make the best use of available beamtime.

In the future, half the total beamtime should be assigned to continuing R&D on X-ray optics for the best use of the high-coherence property, which represents the characteristics of BL20XU. In parallel with this, a more efficient environment for producing outcomes from application research should be constructed by setting up user-friendly apparatuses for the main experiments at BL20XU such as phase-contrast- and micro- imaging. The application research should be carried out in closer collaboration with other related beamlines (BL37XU, BL47XU, BL20B2, BL28B2).

3. Research Activities

Studies using X-ray microbeams are leading the research in the related fields in Japan. A zone plate fabricated by electron-beam lithography has achieved a beam size of 31 nm in collaboration with a manufacturing company. These studies are almost competing to those at ESRF and APS. In collaboration with a manufacturing group, kinoform zone plates have been fabricated using the sputter-slice method. This work has been highly evaluated in the international community as unique research. This fabrication has led to the success of producing high-energy X-ray microbeams, which exemplify the characteristics of SPring-8.

A series of studies on new imaging optics have been performed and are regarded as highly original research in the X-ray region.

Phase tomography has been carried out in collaboration with skilled users and has been highly evaluated worldwide in terms of both instrumentation and application. The three-dimensional observation of the phase separation in polymer blends is one of the highest-impact outcomes because of its convincing visualization.

In microtomography, several attractive results have been produced by main users. Among them, the time-resolved observation of voids under a tensile force has been achieved for visualizing the breaking process of metallic materials.

A combination of ultrasmall-angle scattering at BL20XU and small-angle scattering at BL40B2 was

used in unique research for understanding the total structure of materials in the scale range from nanometer to micrometer and deserves high evaluation.

Noteworthy results have been produced in various fields as mentioned above. However, the results have not necessarily led to applications and most of them have not gone beyond demonstration. Instrumentation for optics and devices should be aimed at the development of new analysis apparatus for the public use, and future R&D should be conducted toward the application of techniques to science with a coherent strategy.

4. Public-Use Support System

It is appropriate that most of the beamtime has been assigned to the development of X-ray optics since this beamline was constructed for the use of coherent X-ray beams. In recent years, the beamtime assignment has shifted its weight from X-ray optics to X-ray imaging, which means that the number of application research studies has been gradually increasing while that of studies related to instrumentation has been decreasing. This trend is viewed favorably.

Innovative experiments have been mainly performed at this beamline. We judge that this direction is appropriate for the best use of the characteristics of a medium length beamline. To achieve outcomes effectively in the future, we recommend that JASRI should enhance the research coordination at BL20XU when drawing up and implementing plans for user research.

5. Instrumentation and Research Direction in Future

JASRI should give top priority to the development of X-ray optics, particularly techniques for creating nanobeams, to maintain the international presence of SPring-8. These techniques will be beneficial not only to research at BL20XU but also to various kinds of user research throughout the SPring-8 beamlines. To enhance the productivity at BL20XU, promoting application research is essential in parallel with R&D on nanobeams.

The development of new imaging techniques or devices is important, and such efforts should be made toward encouraging experiments by users so as to accomplish the goal of the public-use facility. On the basis of this recommendation, it is required that BL20XU is used to produce the outcomes of application research more efficiently by maintaining the beamtime for instrumentation,

preparing user-friendly apparatuses as early as possible, and using the beamtimes as efficiently as possible. For this, close collaboration with user communities is important.

6. Summary

(1) BL20XU is a unique beamline because of its long beam path, and its beamline facilities are well prepared. This beamline is evaluated highly worldwide. Instrumentation research on X-ray optics has been active and has achieved sufficient outcomes. To maintain the international competitiveness of SPring-8, R&D on X-ray optics is important in the future.

(2) JASRI should continue to assign approximately half the beamtimes to R&D on X-ray optics using high-coherent X-ray beams, which exemplifies the characteristics of BL20XU. In parallel with this, JASRI should improve the user-friendliness of the main apparatuses, such as those used for phase-contrast- and micro- imaging, and enhance the productivity at BL20XU.

(3) Although the BL20XU beamline is oriented to the feasibility study of new synchrotron radiation experiments, the committee recommends that JASRI should enhance the role of research coordination so as to be more productive by drawing up and implementing a strategic plan. Further, close collaboration with user communities is also important.

Finally, “Medical” is inadequate for the name of BL20XU, and JASRI should change its name along with its future strategy.