

**SPring-8 BL20B2 Review Committee Report**  
**on**  
**Medical and Imaging I**  
**(BL20B2)**

**Report for Director General of**  
**Japan Synchrotron Radiation Research Institute**

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## 1. Introduction

The SPring-8 beamline review committee meeting on the Medical and Imaging I Beamline (BL20B2) was held at the SPring-8 site on November 25-26, 2004. The following written materials were provided to the committee members:

- (1) Beamline Report BL20B2 (Medical and Imaging I),
- (2) SPring-8 Overview 2004.

The committee members then submitted their review reports to the chair prior to the meeting. Four Japanese members attended this meeting. They heard JASRI's explanation of the beamline review and the SPring-8 facility and organization, and then had a beamline tour. After the tour, they heard detailed explanations on the beamline facility, research results, and future plans from beamline scientists, and then participated in a question-and-answer session. This review report was put together based on the discussion among the Japanese members, referring to the report from Professor Wilkins.

## 2. Executive Summary

### 2.1 Technical achievement of beamline facility and experimental stations

#### \*Evaluation

The features of the BL20B2 beamline are a long coherent length, a large cross-sectional area (300mm in width) of the x-ray beam, and a wide range of available x-ray energy (4.4 keV - 113 keV). The effort in providing a stable, high-quality beam is highly evaluated.

- (1) In accordance with the aim of experiment, a CCD-based detector, an x-ray SATICON, a CMOS flat-panel detector, and an imaging plate and reader system are used. The detector lineup meets the basic requirements for x-ray imaging: large area, high resolution, high speed, and high sensitivity. This beamline excels in the detector lineup and the detector technology.
- (2) Using monochromatic x-rays, quantitative CT experiments have been performed on bones, extracted organs, rocks, and minerals.
- (3) This is the only beamline for which an infrastructure for experiments using animals has been built in the synchrotron radiation facilities.

#### \*Recommendations

- (1) A detector for high-energy x rays should be developed.
- (2) Enlargement of the beam along the vertical direction should be considered.
- (3) In the future, research using middle-size animals toward regenerative treatment is promising. To this end, installation of new equipment and an increase in the number of staff members are necessary. A faster detector with a larger area is also required.

## 2.2 Research Activity

### \*Evaluation

Publications are highly evaluated in terms of quality and in terms of the number of papers published.

(1) Basic research on x-ray imaging, including medical applications, has been carried out, and some results have influenced other beamline activities.

(2) As the death rates of both cancer and cardiovascular diseases have reached 60 percent in Western nations and Japan, the microcirculatory ailments have attracted the attention of people involved in research on the growth of cancer cells, necrosis, and regenerative treatments for cardiovascular diseases. The three-dimensional structural analysis of microcirculatory organs is useful for these studies. The developments of imaging technology, devices, and analytical methods, and the observations of microcirculatory organs, all have greatly contributed to the research field of microcirculatory ailments.

(3) Research on medical applications has been performed in this beamline: for examples, early detection of cancer, and microangiography of veins and arteries. At present, the development of a basic angiography technique for large area and high resolution observation is almost complete. Over the years, other imaging technologies for diagnosis in the field of medical applications, e.g. MRI and CT, have progressed beyond researchers' and clinicians' expectations. Such progresses in other techniques lead to revision of a strategy which pushes toward the early detection of cancer and the diagnosis of veins and arteries. On the other hand, lung disease has been studied using an embryo of a small animal in this beamline. This basic research has demonstrated possible development of this research toward ailments afflicting premature neonates. The CT observation of middle-size animals as well as small animals, will open a new field for research related to regenerative medicine.

(4) Collaboration with foreign research groups is highly evaluated.

(5) Demonstrations of both large-area topography using a 300 mm wide beam and ultra small-angle scattering experiments are highly evaluated.

(6) BL20B2 is the first medium-long beamline in SPring-8. As a pilot beamline, the beamline contributes to the construction of a long beamline.

### \*Recommendation

(1) The R&D of synchrotron-based clinical diagnoses reveals a serious problem of x-ray irradiation. The synchrotron-based diagnosis is behind with the technological development compared to other imaging methods. Therefore, instead of diagnosis, on-going basic research should be developed to contribute to the field of medicine. For this, JASRI should improve the infrastructure by restructuring the building, for example.

(2) It is required to advertise the results to the medical society and the medical industry. The suggestion of an image archive deserves consideration.

## 2.3 User Support

### \*Evaluation

User support is well organized to reduce the user's workload regarding the change of experimental setups and the treatment of experimental animals.

(1) Sufficient efforts have been expended to support various experiments in different fields.

### \*Recommendation

(1) The committee recommends that JASRI should increase the number of staff members and post-doctoral fellows, including personnel that can treat experimental animals, in order to support various experiments in each field.

(2) It is required to import image processing technology from other research fields, particularly the field of medical science in which considerable progress of image analyzing technology is expected.

(3) It is required to strengthen collaborative efforts between the medical and engineering divisions under a cooperative graduate school system.

## 2.4 Future Development and Research Direction

### \*Evaluation

Future plans concerning the large-field real-time imaging technique and the rapid CT technique are appropriate for vitalizing the research activity. The direction of detector improvement is also suitable under these plans. The strategy of focusing on life sciences with research on x-ray imaging of small- and medium-sizes animals is also reasonable for creating a new research field of the BL20B2 beamline.

### \*Recommendation

(1) It is required to extend the scope of research toward materials science, making the best use of the variety of techniques and detectors available in the BL20B2 beamline.

(2) The difference between the BL20B2 beamline and other undulator beamlines should be clarified, regarding high-resolution imaging and ultra small-angle scattering experiments.

(3) It is important to encourage collaboration among domestic and foreign users in the future.

## 3. Summary

The BL20B2 beamline has contributed to the development of basic techniques of medium-long beamlines, and many unique results have been produced making the best use of the strengths of this beamline. These are highly commendable at an international level. As a whole, the committee judges that BL20B2 is one of the successful beamlines in SPring-8. In the future, further development toward new goals is expected based on the results of the past investigations. Finally, the

committee recommends that JASRI implements the above-mentioned suggestions for further development of the beamline.