Development of High Spatial Resolution Imaging Plate Detector

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Introduction

Many scientific user groups of synchrotron radiation facility utilize the imaging plate as a 2-dimensional area detector[1]. The imaging plate is particularly important for protein crystallographers because they can record many Bragg reflections at a time. The spatial resolution, readout time and effective area size of conventional IP-detectors are insufficient for the high resolutional protein crystallography with the high brilliance and low emittance X-ray source of SPring-8 and are the targets of improvement. The first step we concentrated on the improvement of the spatial resolution.

Development of a new detector

To improve the spatial resolution, we selected a new type of imaging plate, Fuji Photo film Co. BAS-UR, called "Blue-IP". The Blue IP is a new blue-colored IP for recording transmission electron microscopic (TEM) images. It can be read out with a pixel size of 50 μm square and has a high spatial resolution for TEM images. Our preliminary experiments by using a conventional IP-detector showed that the spatial resolution of Blue IP and a conventional IP, called "White-IP" [2], were estimated to be 100 μm and 180 μm, respectively. This result suggested the spatial resolution of Blue IP has twice higher than that of White IP. We developed the high spatial resolution IP system optimized for Blue-IP. The readout mechanism of Blue-IP was based on the Rigaku R-Axis IIc[3]. The pixel size for readout photo-stimulated-luminescence: PSL, was changed from 100 μm square to 50 μm square and the Laser optics was improved for the higher PSL efficiency [3].

Spatial resolution

All experiments were carried out by using a conventional X-ray generator with Cu-target. The spatial resolution of the newly developed system was checked by using 20 μm wide line-shape slit. Figs. 1a and b show typical intensity profiles in the horizontal and vertical directions. The horizontal and vertical spatial resolutions were estimated to be 53 μm and 78 μm (FWHM), respectively.

Sensitivity and dynamic range

Experiments were carried out by measuring intensity of PSL for various uniform X-ray exposures. Fig. 2

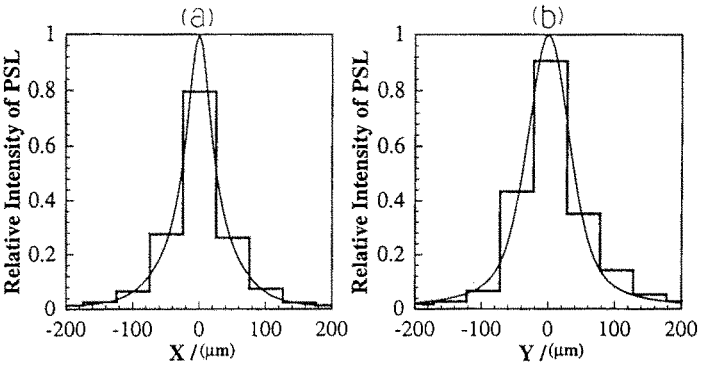

Fig. 1 The measured intensity profile along a) the horizontal direction (x) and b) the vertical direction (y) of the imaging plate detector.

shows the result for the Blue and White IP PSL intensities at various X-ray exposure levels. The sensitivity of the Blue-IP (BAS-UR) has no difference from these of White-IP (HR-V). The response of the PSL was linear at least in the range from 5 to $5x10^4$ X-ray photons per pixel.

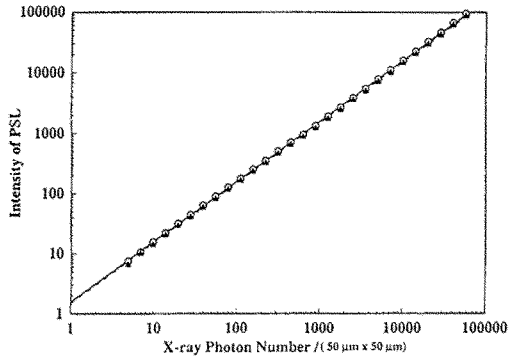

Fig. 2 The intensity of photostimulated luminesence vs. various integrated X-ray photon number. Circle and solid line indicate the measured intensity and fitted intensity of the Blue IP, and triangle and dashed line show mesured intensity and fitted intensity of the White IP.

Conclusion

The experimentally measured spatial resolution, 53 μm, was three times higher than those of conventional IP detectors. Using the same pixel size of 50 μm square, no significant difference in the sensitivity and dynamic range was observed in comparison with conventional IPs. These results for the newly developed imaging plate detector point out that the Blue-IP can be used as a hight spatial resolution detector in SPring-8 with no loss of sensitivity[4].

References

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