A New Readout System of Imaging Plate Utilizing Line-shaped Laser Beam and Charge-coupled Device

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The Bio-Crystallography I (MIR-OAS) beamline will be available from early 1997 at the SPring-8 [1]. This beamline is constructed for the routine structure analysis of macromolecular crystallography by the MIR-OAS phasing [2]. The X-ray energy range will be 9 - 38 keV and the photon flux at the sample position 10^{13} - 10^{14} phs/sec at the storage ring current of 100 mA. The high energy and high flux characteristics of the beamline require detectors of solid phase and of integration type such as the imaging plate (IP) and CCD camera [3]. Another requirement for the detector in macro-molecular crystallography is a large active area. The IP system is chosen because the active area over 400x 600 mm can be easily achieved. However, a problem is how to shorten the long readout time for the large IP. The readout time of IP systems is at present limited by the lifetime (0.7 μsec) of photostimulated luminescence (PSL) emitted from the IP phosphor, and at least 5 μsec is needed for one pixel to attain a high spatial resolution. By the point by point readout mechanism usually used, the total readout time will become over 5 min or more for the large IP with a pixel size of 100 μm. It must be less than one minute for one photograph, which will be the longest exposure time on our beamline, since the routine structure analysis of macromolecules requires data acquisition in parallel with the X-ray exposure.Our basic idea is based upon a scanning of line-shaped laser beam (length is about 20 mm). The PSL stimulated by the line-shaped laser beam is focused on a CCD through an optical lens system of a large numerical aperture and is read out by a 430 kHz CCD. In this one-dimensional readout mechanism, the PSL signals are stored on the CCD for a relatively long period of 1 msec/line. Therefore, the lifetime problem of PSL is overcome and the readout time for one pixel is reduced to 2.3 μsec which is shorter than 5 μsec achieved by the point by point readout mechanism.

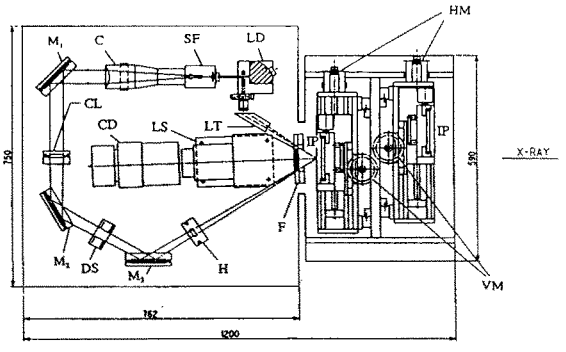

Fig. 1 Prototype imaging plate reader for high-speed readout. LD: laser diode, SF: spatial filter, C: laser collimator, Mn: mirror, CL: cylindrical lens, DS: Double slits, H: homogenizer, F: filter, LT: laser trap, LS: lens system, CD: CCD, IP: imaging plate, HM/VM: horizontally and vertically driving

According to this idea, a prototype reader has just been fabricated by RIGAKU, and the performance test has been started. The actual reader on the SPring-8 beamline will read the 400x600 mm IP within one minute by using two readout systems tested on the prototype reader, or by using one readout system with a faster CCD (e.g. 1 MHz).

References

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[2] N. Kamiya, N. Tanaka, and K. Miki, in this volume.

[3] J. Miyahara et al., Nucl. Instrum. Methods A246, 572 (1986).