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The novel IP conveyor belt Weissenberg mode data collection system with multi-readers for macromolecular crystallography

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Introduction

IP is one of the most powerful detectors for collecting diffraction data in the sense of a wide detection area, high sensitivity, large dynamic range, high accuracy, and reasonable pixel size. We have designed (Sakabe et al. 1997) and developed a totally new type of fully automatic Weissenberg data-collection system called "Galaxy" and installed it at the PF (Sakabe, 2000). Galaxy is a high speed and high resolution data collection system by using fully cylindrical two IP cassettes with 400.0mm radius, which can be rotated to exchange a frame. The frame exchange speed is only a few seconds but a cassette exchange takes 4 minutes. The symmetric or asymmetric setting can be selected for an exposure. In time resolved crystallography, 12 shots of diffraction image up to 2A resolution can be recorded in a cassette using both 1A x-ray and asymmetric setting. Assuming 6 shots being enough for one set of data by the Weissenberg mode, we can collect two different time scale data set using one cassette. However, maximum number of image in one cassette is limited. Furthermore the 450mm width of the cassette is not enough to collect data for the structure analysis using SAD of sulfur atom. In the course of using Galaxy, we have found the way to breakthrough the above limitations and have designed a novel IP conveyor belt Weissenberg mode data collection system called Super Galaxy.

Super Galaxy

Instead of movable fully cylindrical IP cassette in the Galaxy, Super Galaxy adopts a fixed half cylindrical IP cassette, on which a part of an IP conveyor belt (IP belt) is fixed by evacuation while it is exposed. After finishing exposure of a frame, the IP belt is moved to the first IP belt reservoir, which can store the same length as the full length of the cassette. Following the reservoir, many flat type IP readers are arranged in an equal distance along the IP belt. When the reservoir becomes full with the exposed IP belt, the IP belt moves to the readers successively. However, at least the last reader should remain to be unoccupied by the recorded IP belt. Recorded Images are read out by the all readers at the same time. After that, IP belt moves to an eraser, an uniform exposure device by an conventional X-ray generator for the positional sensitivity correction, a second IP reservoir successively and come back to the position of the cassette.

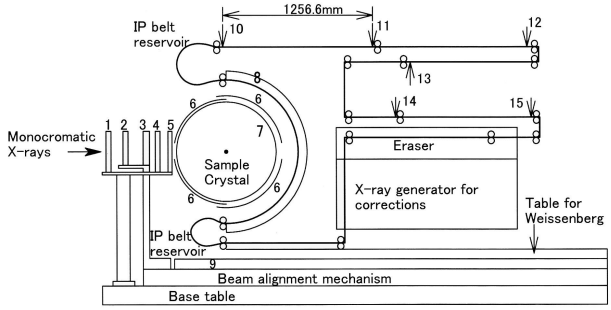

Figure 1. Schematic expression of Super Galaxy viewed from the side 1,4; Quadrant slit, 2,3; PSPC, 5; Shutter, 6; Screens to select a frame size, 7; Helium chamber, 8; IP-cassette, 9; μ rotation table, 10-15; Head position of IP-image-readers

Comparison with Galaxy, Super Galaxy will be able to record three times more images and read about 30 times higher speed, those are proportional to the number of IP readers (Sakabe 1991).

Conclusion

The feature of our designing of data collection system for macromolecular crystallography is to bring out the characteristics of detector IP in consideration of knowledge of X-ray crystallography and the nature of macromolecular crystal in order to construct time-resolved data collection system. Super Galaxy, which evolved from proto-type Galaxy, has an ability to produce a very high-resolution data set; at maximum resolution at 0.7A using 1A incident x-ray beam. The appearance of Super Galaxy will be open a new frontier of Enzymology, called electron–Enzymology and bio-nano-chemistry

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