Test of the Small-angle Beamline for X-ray Diffraction Experiments on Skeletal Muscles.

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Time-resolved X-ray diffraction measurements were made on frog sartorius muscle at the RIKEN beamline (BL45XU) small-angle station of SPring-8. The X-ray energy was 12.4 keV and the beam size at the focus was about 200 μm horizontally and 400 μm vertically (full-width at half-maximum measured with the "beam monitor"). The specimen-to-detector distance was approximately 220 cm. The ring current was 60-15 mA giving a flux in the order of 10^{11} cps.

The X-ray detector was an X-ray image intensifier (Hamamatsu Photonics V5445P) with a 15-cm diameter beryllium window. The phosphor in the window was CsI. Two types of image intensifiers with different phosphors in the output window were tested: one was with P20 (ZnS:Ag) and the other was P43 (Gd_2O_2S:Tb). The output image was viewed through a tandem lens by a fast CCD camera (Hamamatsu Photonics C4880-82) which records 28 656×494-pixel images per second. The images were directly stored in the memory of a computer running Windows95.

The time-resolution of the detector system can be improved by reducing the number of vertical lines of the image. Using this technique, the persistence in the X-ray image intensifier was examined in collaboration with Mr. Oka of Osaka University. The half-time of decay of intensity after shutting off an X-ray beam was about 10 msec for P20 and 1 msec for P43.

The time course of the intensity changes of several X-ray intensity peaks in the diffraction from the frog muscle was measured during an isometric contraction at a 10-msec resolution using P43 phosphor. Intensity of reflections up to the 5.9-nm actin layer-line can be followed with a reasonable signal-to-noise ratio in a single contraction. This demonstrates that this beamline and the detector system are a powerful tool to investigate the dynamical molecular changes in muscle upon contraction.