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A New High-Speed X-ray Beam Chopper*

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A new high-speed x-ray beam chopper using laser scanner technology has been developed and tested on the SRI-CAT sector 1 beamline at the Advanced Photon Source (APS) storage ring (1). As illustrated in figure 1, it is compact in size and has two sets of transmission windows: BK-7 glass for visible light transmission and 0.23-mm-thick Be for the transmission of x-rays. The rotor is made of aluminum and has a diameter of 50.8 mm. A 0.5-mm-wide and 2.29-mm-tall slit is cut through the center

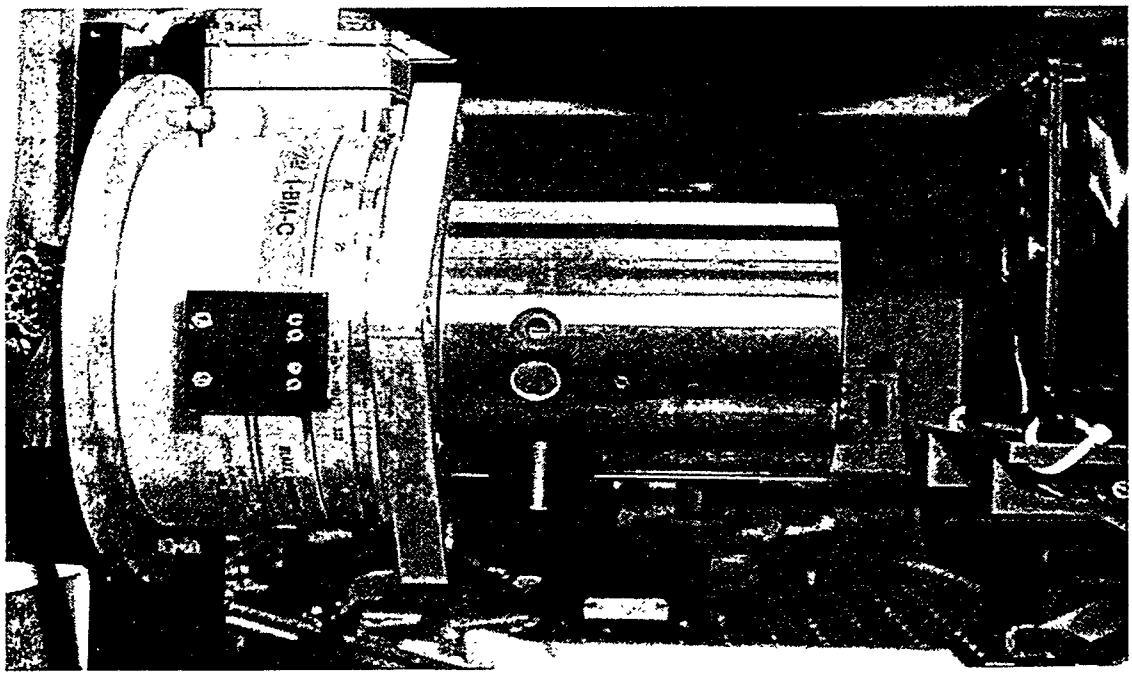

Figure 1. High-speed beam chopper mounted in the horizontal position. It may be operated in any orientation.

of the rotor. The circumference of the rotor has a coating of 1-mm-thick Ni, which gives an attenuation of 10^8 at 30 keV. Turning at nearly 80000 RPM, this beam chopper has an opening time window of 2450 ns, corresponding to 67% of the revolution time of the APS storage ring. The primary feature in selecting laser scanner technology to develop into an x-ray beam chopper was the high level of rotational speed control of the rotor that makes up the beam chopper element (2). By using an optical feedback circuit to sample the rotational speed four times each revolution, the jitter in the position of the transmission open time window is only 3 ns at the 3 standard deviation level. The APS storage ring orbital frequency, supplied by the control room, is divided down to provide the appropriate drive frequency for the beam chopper motor controller. By this means, both the storage ring and the beam chopper are operating off the same master clock. After a turn-on time of about 15 to 20 seconds, the rotational precision of the motor results in immediate phase locking to

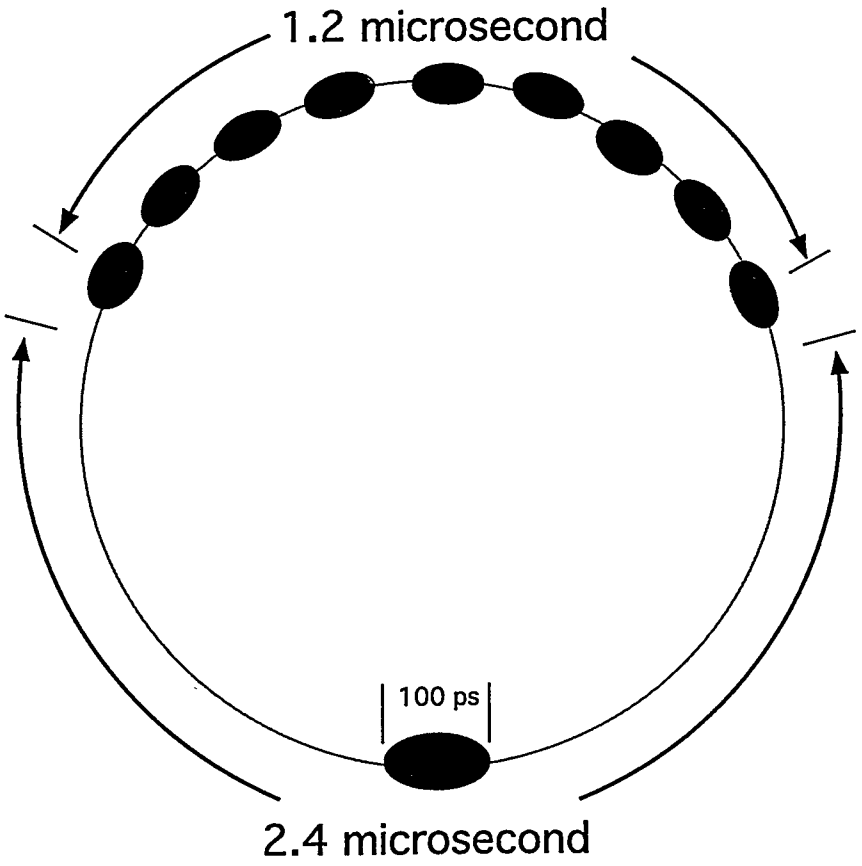

Figure 2. Asymmetric fill pattern for the APS storage ring that would facilitate 100 ps time resolution experiments with this new beam chopper.

the temporal structure of the APS storage ring. By inserting a Stanford delay generator between the frequency divider and the beam chopper motor controller, the phase between the storage ring temporal structure and the beam chopper rotation can be adjusted to position the transmission time window of the beam chopper on any desired part of the storage ring fill pattern. If an asymmetric fill pattern is used in the APS storage ring, as illustrated in figure 2, such that only one bucket falls within the transmission time window of the beam chopper, then time resolution as short as 100 ps becomes possible with this new compact beam chopper.

ACKOWLEDGMENTS

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REFERENCES

1. McPherson, A., Wang, J., Lee, P. L., and Mills, D. M., "A New High-Speed Beam Chopper for Time Resolved X-ray Studies", submitted to The Journal of Synchrotron Radiation.
2. The design for the beam chopper is based upon a laser scanner marketed by Speedring Systems, Inc., of Rochester Hills, Michigan.