Increased power burden on NSLS x-ray beamline optics, brought about by recent increases in ring current as well as planned new insertion devices, has led us to consider alternatives to water-cooled silicon crystal monochromators which presently operate at the limits of their effectiveness on our highest power wiggler beamlines (few hundred Watts total power, >~10 Watts/mm$^2$). Under high power, and especially high power density loading, silicon crystals at room temperature suffer thermal distortions which compromise their x-ray diffraction efficiency and consequently spoil the inherent brilliance of the synchrotron beam. Silicon crystals at cryogenic temperatures (close to 120 K) suffer no thermal distortions under high power density loading conditions. We have designed a channel-cut crystal monochromator which is cooled to cryogenic temperatures (down to ~50 K) using a commercial helium refrigerator and recirculation system and a custom-designed crystal heat exchanger, for implementation on the NSLS X13B IVUN (in-vacuum undulator) beamline where >100 Watts of power can be incident on the crystal. We will present engineering design details, including finite-element analysis, and test results for this monochromator system obtained on X13B as well as the higher power X25 wiggler beamline, for which a similar system is being designed. The choices of monolithic construction of the crystal monochromator (with both diffracting surfaces cooled to the same cryogenic temperature), as well as the relatively maintenance-free helium circulation system, make this a promising and reliable x-ray monochromator system for high power x-ray beamlines at synchrotron radiation sources.

This work was supported by the US Department of Energy Office of Basic Energy Sciences through Contract No. DE-AC02-98CH10886.

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