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Small-Gap Insertion Device Development At The National Synchrotron Light Source

J.M. Ablett, L.E. Berman, C.C. Kao, G. Rakowsky, and D. Lynch (BNL, NSLS)

Beamline(s): X13B

Introduction: The National Synchrotron Light Source (NSLS) continues to set high standards in insertion device research and development. The Chasman-Green NSLS lattice design provides for dispersion-free long straight sections in addition to a very small vertical beta function. As the electron beam size is proportional to the square root of the beta function, a program to exploit this feature was undertaken more than one decade ago by implementing small-gap insertion devices in the NSLS storage ring. The possibility of utilizing existing moderate-energy synchrotron facilities to produce coherent high-brightness x-ray beams into the higher energy x-ray regime, at moderate cost, have been realized using in-vacuum undulators. In this abstract, we report the operation of the latest small-gap undulator in the X13 straight section. This mini-gap undulator (MGU) has a 1.25 cm period, and can operate down to a gap of 3.3 mm. At this setting, the fundamental energy is ~ 3.7 keV with an on-axis brightness of $4x10^{17}$ photons/sec/mm^2/$mrad^2$/0.1%BW/300 mA.

Methods and Materials: The MGU spectrum was recorded using a water-cooled single-crystal spectrometer. This instrument was located in the X13B (white-beam) experimental end-station and housed within a purgable tank. The spectrometer consisted of a silicon (111) crystal and ionization chamber mounted on a Huber theta/2theta two-circle diiffractometer, to record the Bragg-diffracted x-ray beam. All flight paths, and the ionization chamber, were either purged with helium gas, to record the lower energy first harmonic, or nitrogen for the higher order harmonics. In addition, a set of motorized Huber entrance slits were positioned in the tank, and upstream of the crystal, to carefuly define the beam dimensions in order to record the on-axis undulator brightness.

Results: Fig. 1 shows the comparison with theory of the on-axis spectrum at an MGU gap setting of 3.3 mm. The good agreement with theory confirms the quality of the magnetic design. Fig. 2 shows a series of measurements that were performed at several MGU gap settings (3.3, 3.7, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5 mm). These data represent the first, second and third harmonics, and emphasize the tunability of the device.

Conclusions: A mini-gap undulator has been successfully installed in the X13 straight-section and tested in the X13B experimental end-station. This device replaces the in-vacuum undulator, IVUN, providing a greater tunability for the experimentalist.

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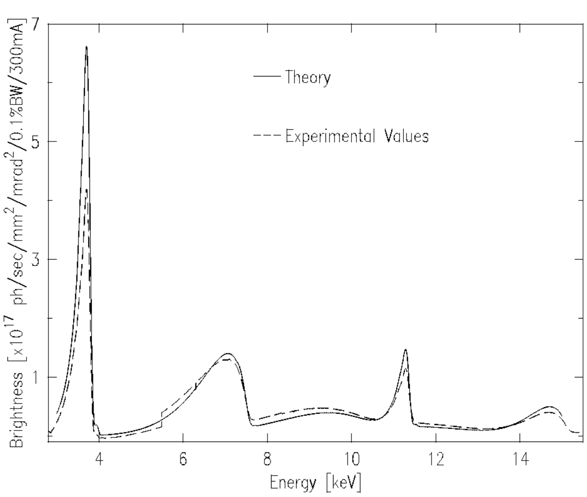

Figure 1. Experimentally recorded and thoretical on-axis MGU spectra at a gap of 3.3 mm.

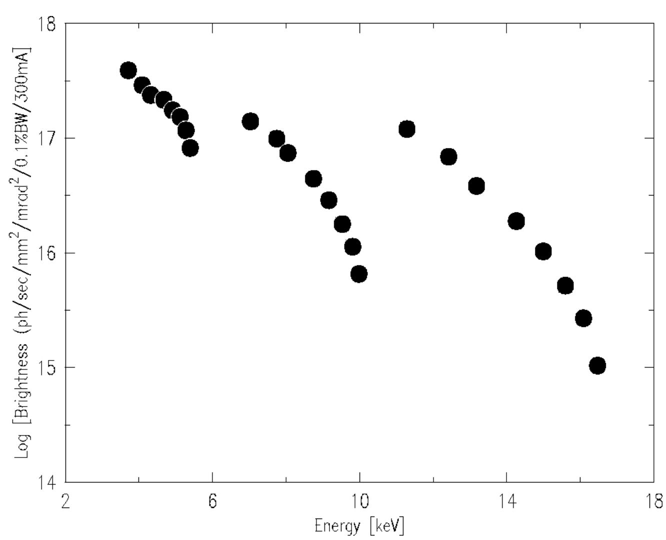

Figure 2. Peak-value on-axis brightness measurements recorded at gaps of 3.3, 3.7, 4.0, 4.5,5.0, 5.5, 6.0, 6.5 mm.