The Sub-Micron Resolution X-Ray Spectroscopy Beamline at NSLS-II

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Abstract:

For many research areas as life, environmental or material sciences, novel analytical resources have to be developed to advance understanding of complex natural and engineered systems that are heterogeneous on the micron to submicron scale. NSLS-II at Brookhaven National Laboratory will be a source of synchrotron radiation with an ultra-low emittance of less than 1 x 0.01 nm-rad^2 (H x V at 12 keV), delivering a high current of up to 500 mA. This facility will be ideally suited for experiments using coherent radiation. One of the first six beamlines to be constructed at NSLS-II will be the sub-micron resolution X-ray spectroscopy beamline (SRX), dedicated especially as an analytical tool to study complex systems on a submicron length scale. When completed, SRX will comprise two branches thanks to a canted setup with two undulators: the first branch will cover the energy range of 4.65-23 keV, using Kirkpatrick-Baez mirrors as focusing optics. Thanks to a set of slits located on the secondary source, the spot size will vary from 100 x 100 to 100 x 1000 nm^2, providing a certain adaptability concerning the observation scale. Concurrent with a horizontally deflecting double crystal monochromator with maximum stability, spectroscopy with very high spectral and spatial resolution will be achieved. The covered energies will allow for XANES experiments with a great many of elements, starting with Ti and reaching up to the K-edge of Rh. An in-vacuum undulator with 21 mm period length and a length of 1.5 m will serve as a light source. The expected photon flux in the spot on the sample will reach respectively 5.10^{12} and 7.10^{13} ph/s at maximum and lowest resolutions. This flux in a submicron-spot, combined with the use of state of the art energy dispersive detectors like *Maia* (Ryan et al., 2010) will open new possibilities for spectromicroscopy of trace elements. The 2nd canted undulator will serve as an independent light source for the second branch, designed for experiments with X-ray energies in the range of 2-15 keV. Using Fresnel zone plates, the spatial resolution aimed for is in the range of 30 nm with up to 7.10^9 ph/s in the spot. It is expected that this branch would be attractive for many biological applications from life and environmental science due to elements of interest like phosphorus, sulfur, chlorine or calcium within that energy range. In both experimental stations X-ray fluorescence will be used for imaging, spectroscopy and tomography experiments. µ-diffraction and coherent diffractive imaging experiments will be possible as well. Commissioning of this beamline will start in early 2014; therefore a detailed design description will be presented here.

References:

[1] C. G. Ryan, D. P. Siddons, et al., Proceeding of AIP Conf. Proc., **1221**, 9-17, (2010).

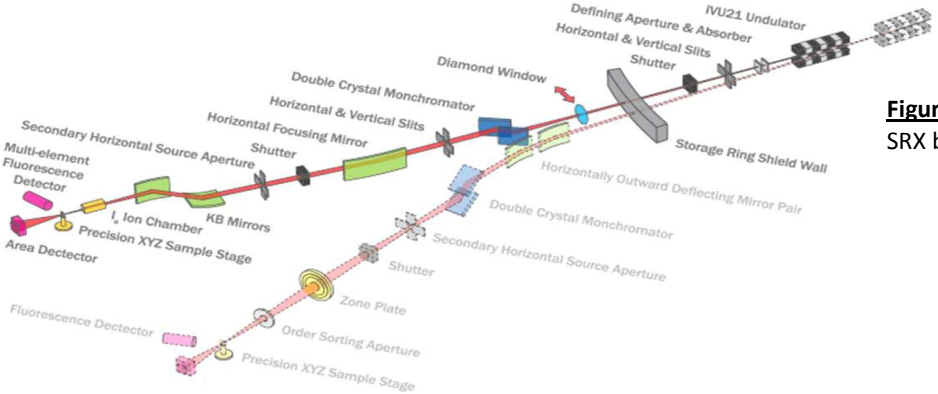

Figure 1: Optical layout of SRX beamline.