Contribution ID: **854** Type: **Contributed talk**

The Development of Technologies for Coherent Soft X-ray Science at the Advanced Light Source

Tuesday 27 August 2024 18:15 (15 minutes)

The upgrade of the Advanced Light Source will provide an almost fully coherent soft x-ray beam to the users, increasing the ALS brightness by 100x. Such a beam places extraordinary demands on every beamline optical element. To maintain the beam's coherence and wavefront properties in the presence of high power loads, mechanical drift, and manufacturing errors, we have developed a suite of technologies to monitor, preserve, and correct the wavefront dynamically, to ensure optimal performance in routine operation.
We will present recent results on cryo-cooled mirrors [1], where our highest-power mirrors will be cryocooled silicon to reach the 125K zero-point of thermal expansion, and be supported from one side in a unique, cantilevered design. To enable continuous monitoring of the beam quality, we have developed a fast, intermittent, wavefront sensor [2] based on shearing interferometer placed after the final focusing mirror. The device uses a binary amplitude reflection grating used at glancing incidence in a conical geometry. To compensate for eventual aberrations, each new beamline design includes a pre-figured adaptive x-ray optic to correct wavefront errors and restore optimal beam properties. We have studied the dynamic behavior of piezo-bimorph adaptive mirrors, and apply machine learning to overcome hysteresis and creep [3]. To ensure diffraction-limited performance during regular user operation, we recently deployed an automated alignment method for the whole photon transport system based on bayesian optimization [4]. We will also present our work on the design and simulation of high-coherent-flux beamlines, including efforts toward the creation of effective digital twins. And finally, we will present some potential applications of wavefront engineering.
[1] Experimental testing of a prototype cantilevered liquid-nitrogen-cooled silicon mirror
G. Cutler, D. Cocco, B. Bentley, M. Cervantes, P. Chavez, J. Chrzan, S. DiMaggio, R. Hussey, J. Ilmberger, J. Lindsay, E. Lizotte, K. McCombs, S. Morton, G. Paulovits, K. Pearson, C. Redding, N. Smith, K. Tokunaga, D. Zehm, E. DiMasi and H. Padmore Journal of Synchrotron Radiation 30, 1 (2023) https://doi.org/10.1107/S1600577522010700
[2] X-ray wavefront sensor development at the Advanced Light Source
K. A Goldberg, A. Wojdyla, D. Bryant, X. Shi, L. Rebuffi, M. Frith, M. Highland, L. Assoufid, Y. Ichii, T. Inoue, K. Yamauchi; Proceedings of SPIE 12695, Advances in Metrology for X-Ray and EUV Optics X; 126950B (2023) https://doi.org/10.1117/12.2679136
[3] Data-driven modeling and control of an X-ray bimorph adaptive mirror
G. Gunjala, A. Wojdyla, K. A. Goldberg, Z. Qiao, X. Shi, L. Assoufid and L. Waller; J. Synchrotron Rad. (2023). 30, 57-64 https://doi.org/10.1107/S1600577522011080
[4] Latent Bayesian optimization for the autonomous alignment of synchrotron beamlines
T. W. Morris, Y. Du, M. Fedurin, A. C. Giles, P. Moeller, B. Nash, M. Rakitin, B. Romasky, A. L. Walter, N. Wilson, A. Wojdyla; Proceedings of SPIE 12697, Advances in Computational Methods for X-Ray Optics VI; 126970B (2023) https://doi.org/10.1117/12.2677895

I plan to submit also conference proceedings

Primary authors: ISLEGEN-WOJDYLA, Antoine (ALS Lawrence Berkeley National Laboratory); BRYANT, Diane (ALS Lawrence Berkeley National Laboratory); CUTLER, Grant (ALS Lawrence Berkeley National Laboratory); ALVAREZ, Henry ((ALS Lawrence Berkeley National Laboratory)); GOLDBERG, Kenneth A. (ALS Lawrence Berkeley National Laboratory); LAFLECHE, Kyle (ALS Lawrence Berkeley National Laboratory); BERGERET, Maxime (ALS Lawrence Berkeley National Laboratory)

Presenter: ISLEGEN-WOJDYLA, Antoine (ALS Lawrence Berkeley National Laboratory)

Session Classification: Mikrosymposium 11/2: SR facilites: Updates and New Facilities

Track Classification: 11. Synchrotron radiation facilities: Facility updates and new facilities