Dedicated Synchrotron Infrared Facility for Earth and Environmental Science Research at the NSLS-II

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This proposal outlines plans for an integrated synchrotron infrared facility at the National Synchrotron Light Source II (NSLS-II) dedicated to the full spectrum of problems in Earth and environmental science (ESS) research. Infrared (IR) spectroscopy is a long-established tool in EES, and developments over the past 2-3 decades have demonstrated the significant advantage and potential of synchrotron-based IR methods for this field. This has been prominently demonstrated by the impacts of synchrotron infrared NSLS beamlines U2B/U2A and their successor the Frontier Synchrotron Infrared Spectroscopy Beamline under Extreme Conditions (FIS) at NSLS-II 22-IR-1-A and 22-IR-1-B. Beamline FIS 22-IR-1 is an integrated optical facility with unique capabilities for far-IR to UV absorption and reflection spectroscopy using synchrotron and conventional sources, together with laser Raman and photoluminescence spectroscopy, which collectively enable a wide variety of experiments. End station 22-IR-1-A is dedicated to general optical studies under extreme *P-T* conditions with diamond anvil cells and cryogenic, and external/laser heating techniques. It also supports a wide range of micro-spectroscopic studies for ambient to high *P-T* conditions and provides diffraction-limited IR measurements in diamond-anvil cells from cryostat to external/laser heating conditions from the far to mid-IR spectral range. End station 22-IR-1-B has a user-friendly environment and provides access/support for all high-pressure users at NSLS-II. Moreover, the facility will include MET 22-IR-2 with which FIS 22-IR-1 shares the cabin but which is not formally a part of the current geoscience-supported facility. This station will be used for synchrotron-based near-field IR nanospectroscopic imaging techniques, which are powerful tools for ambient pressure studies (e.g., for environmental science). This instrumentation is being installed at MET 22-IR-2, so no additional instrumentation is immediately requested. To support the additional capabilities and expanded scientific scope, a junior beamline scientist with spectroscopic experience in the new geoscience areas is proposed to join the current senior beamline scientist, who has extensive high-pressure geoscience experience, in managing the beamline for the EES community. As for the current FIS facility, DOE/NNSA will contribute funds to support operations through CDAC.

These capabilities will support strong Earth and environmental user activities at the NSLS-II. Thus, this state-of-the-art integrated synchrotron IR facilities at NSLS-II will be not only an important part of the portfolio of the new NSF organization but also a unique resource for the broad EES user communities. The proposed facility will provide new opportunities for advancing Earth and environmental sciences research and training over the coming decade. The proposed program can also realize the potential of synchrotron IR – already established in high-pressure geoscience and planetary science – in low-temperature geochemistry, geobiology, environmental science, and rock physics. The facility will directly tackle critical societal challenges associated with climate change, geohazards, environmental justice, and sustainability, including mobilizing current and next generation synchrotron-based tools for mitigating problems facing the nation and planet as a whole, as articulated in the 2020 NAS *Earth in Time* report. The proposed plan will also enhance engagement at all career levels, including students, early- to mid-career scientists, and established professionals, and to increase education, training, diversity, equity, inclusion, and belonging – all established priorities of the managing institution, the University of Illinois Chicago, which is a federally designated Minority Serving Institution.