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XLEAP: An x-ray fluorescence and spectroscopy microfocus beamline at CHESS for life sciences, environmental sciences, plant sciences, and agriculture research

LOUISA SMIESKA[1], MATTHEW REID[2], ARTHUR WOLL[1], JU-CHEN CHIA[2], OLENA VATAMANIUK[2], CARLOS CABRERA[3] AND JOEL BROCK[2]

[1]Cornell High Energy Synchrotron Source
[2]Cornell University
[3]University of Texas at El Paso

Supported by the U.S. National Science Foundation, a new x-ray beamline customized for the study of biological systems is under construction at the Cornell High Energy Synchrotron Source (CHESS). This project, X-rays for Life, Environmental, Agricultural, and Plant sciences (XLEAP) will specialize in x-ray fluorescence microscopy and spectroscopy, enabling quantitative imaging of micronutrients in biological systems at length scales ranging from whole tissues to cells. The science priorities for XLEAP include (1) fundamental mechanisms in plant sciences, such as micronutrient uptake, transport, and storage; (2) how plants respond to external stimuli including nanoparticles, bacteria, and fungi, and environmental stresses; (3) mechanisms of elemental transport and cycling at the root-soil interface and soil degradation processes; and (4) mechanisms of elemental uptake and cycling in aquatic organisms.

We will present the planned x-ray capabilities of the XLEAP beamline, which include x-ray fluorescence microscopy (2D mapping, 3D computed tomography, and 3D confocal imaging), x-ray absorption spectroscopy, and x-ray diffraction, with tunable spatial resolution from >100 µm to <1 µm, incident energies from 3-80 keV, and high-flux or high-energy-resolution modes. XLEAP will also offer users complementary optical microscopy, plant growth, and sample preparation facilities, as well as the potential for in-situ x-ray measurements with a custom plant growth environment directly on the beamline. We will illustrate the planned experimental modes and describe new possibilities for flexible access to accommodate experiments with longer time scales. During construction, graduate students and faculty from the University of Texas at El Paso will collaborate with CHESS staff and Cornell faculty on pilot experiments that develop future user capabilities and workflows for XLEAP.

The CHESS XLEAP beamline will be constructed over the next three years with user operations planned to begin in 2028. The community is invited to shape the user experience at XLEAP by participating in workshops and designing pilot experiments during this construction phase.

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