Agriculture Research at the Biomedical Imaging and Therapy (BMIT) Beamline

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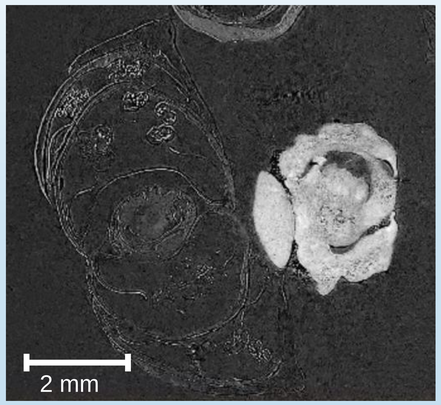
Introduction

Agriculture research at the Canadian Light Source (CLS) has been an ever-increasing area of focus since 2016, and rapidly expanding since 2018. Various synchrotron-based techniques are extremely well suited for novel research in the agriculture world and provide unique ways to assess plant chemo-phenotypes to the investigation into physical tissue structures that support fields from modern crop development to detailed soil composition and mineralogy analysis. Synchrotron-based micro computed tomography at the BMIT beamlines have been used in agriculture research regularly since 2016, however, have been limited in scope due to long scan times and low pixel resolution making larger scale projects not feasible. Since 2018, improvement in imaging technologies allowing for faster scan times while simultaneously improving on detector resolution now make BMIT a practical solution for large scale agriculture research projects wanting to use computed tomography in investigating their research questions.

Progression of the BMIT beamlines Imaging Technology



Wheat Spikelet: 13 µm pixel size monochromatic beam at ~20 KeV. 30 min scan time

2016 Orca Flash4 Camera w/ AA60 Optics

2017 PCO 4000 Camera w/ 50 mm + 105 mm tandem lenses

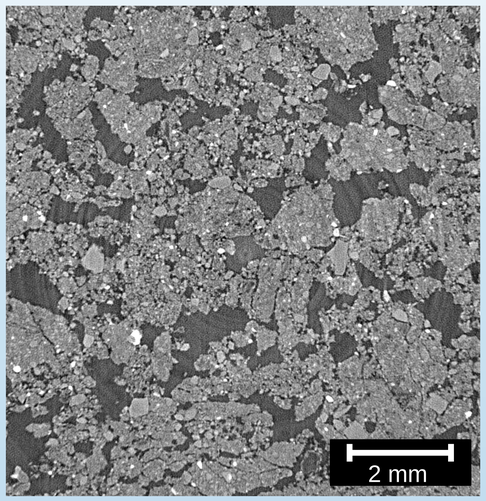
2018 PCO Edge 5.5 Camera w/ Optic Peter 2x Objective

2019 PCO Edge 5.5 Camera w/ Optic Peter 10x Objective

2020 PCO DiMax Camera Coupled w/ Optic Peter 10x Objective

2021 and beyond

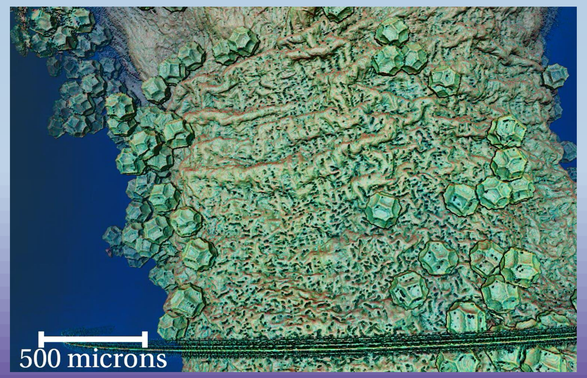
Agriculture Soil Core: 4.3 µm pixel size monochromatic beam at ~65 KeV. 20 min scan time



*Wheat Spikelet: 3.61 µm pixel size, filtered white beam at ~20 KeV. 5 min scan time

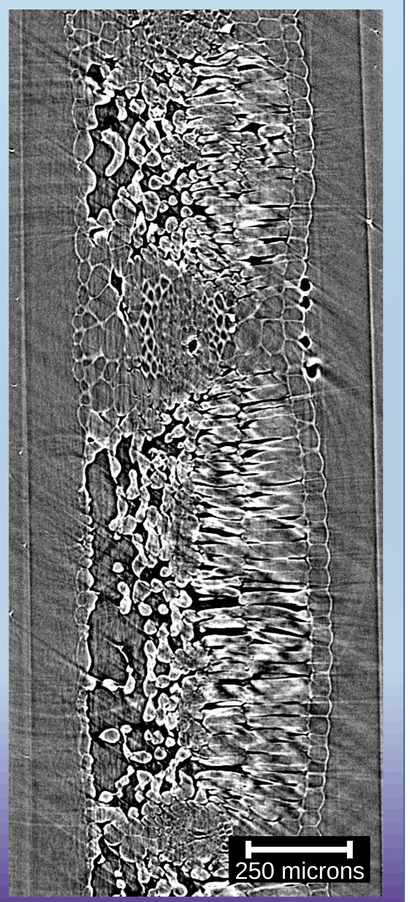
*zoom in to observe quality improvement between wheat spikelet's

Pollen grains at the base of a flower of the Saskatchewan Prickly Pear Cactus (Opuntia polyacantha): 1.2 µm pixel size, filtered white beam at ~20 KeV, 12 second scan time



A double magnification microscope for fast switching between low and high magnifications to investigate the same region while preserving alignment

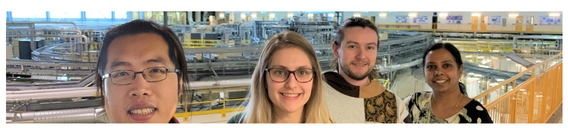
Poplar tree leaf: 0.72 µm pixel size, filtered white beam at ~20 KeV. 5 min scan time



Conclusion

Phase contrast computed tomography provides internal 3D structures from micron to sub-micron pixel resolution being more sensitive to similar density soft tissues found in plants compared to standard absorbance based laboratory based CT. This combined with the vast improvements in imaging technologies at the BMIT facility since 2018 allowed for faster scans times while simultaneously improving on detectors resolutions that now make BMIT a practical solution for large-scale agriculture research projects. These projects include investigation of disease in plants, interconnected porosity in agriculture core samples to non-destructive seed quality imaging. Agriculture at the BMIT facility has a far-reaching applicability in many more areas than shown and only expanding with the continual improvements on the beamlines usability and staff support. Many more planned upgrades will only push the practically of the facility in the agricultural arena.

Canadian Light Source | Centre canadien de rayonnement synchrotron



Special Thanks to the Plant Imaging Group

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