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Submission Template

2016 National Research Infrastructure Roadmap Capability Issues Paper

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Thank you for the opportunity to respond to the NCRIS Capability Issues paper. As Director and Deputy Director of the Centre of Excellence for Translational Photosynthesis and Research Group Leaders, many researchers in our labs, depend on access to state-of-the-art microscopy and microanalysis instrumentation for undertaking ARC -funded research to achieve highest quality outcomes in the fields of improving and *raising yields in crop plants*. In recent years our research has more and more relied on access to highest end microscopy tools.

Environment and Natural Resource Management

Question 18: Are the identified emerging directions and research infrastructure capabilities for Environment and Natural Resource Management right? Are there any missing or additional needed?

Emerging trends should include state of the art microscopy and microanalysis tools essential for many researchers at the ANU.

As researchers of the ARC CoE for Translational Photosynthesis, we are trying to incorporate cyanobacterial bicarbonate transporters into the chloroplast envelope of higher plants in order to improve photosynthesis efficiency and ultimately crop yield. We also study cyanobacterial carboxysomes filled with the CO₂-fixing enzyme, Rubisco. Many carboxysomes are less than 100 nm in diameter and are icosahedral structures not unlike some viral particles. The proposed advanced cryo TEM with tomography capabilities would provide the following benefits: (1) very versatile and offers a range of options for plant biologists (i.e. tomography and 3D reconstruction of thicker resin-embedded samples AND frozen hydrated samples). These techniques will be essential to analyse how different membrane layers interact with each other within an organelle, without introducing artefacts linked to tissue dehydration. (2) offers great contrast (direct detection systems), which is a critical point when looking at membrane architecture. While you can achieve excellent results by tweaking standard TEM sample preparation protocols, these changes often come at the expense of versatility as these preparations are usually incompatible with immunolabelling.

In our other projects, cryo tomography will enable 3D measurements of the leaf mesophyll in frozen hydrated sample sections with no shrinkage due to chemical fixation. Cell wall thickness and ultrastructure of chloroplasts and membranes can be investigated on tomograms from thick sections of resin embedded samples on the same instrument. These enhanced capabilities in quantitative anatomy will be combined with parameters derived from gas exchange and stable isotope instruments to investigate and understand CO₂ diffusion during photosynthesis. Superresolution imaging provided at the AMMRF nodes can then be correlated to ultrastructural information acquired on the same section in the proposed TEM (CLEM).

The ANU AMMRF node is equipped with some cryo electron microscopical applications but the addition of a high end platform as proposed above would mean a quantum leap in addressing questions related to improving crops and adjusting yields to the changing environment.

The AMMRF node at ANU has an open-access model and invaluable expert AMMRF staff. Therefore we would like to advocate for the continued support of these microscopy and microanalysis facilities through a national open-access model in the 2016 NCRIS roadmap.



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