Introducing The 3D Leaf Cell

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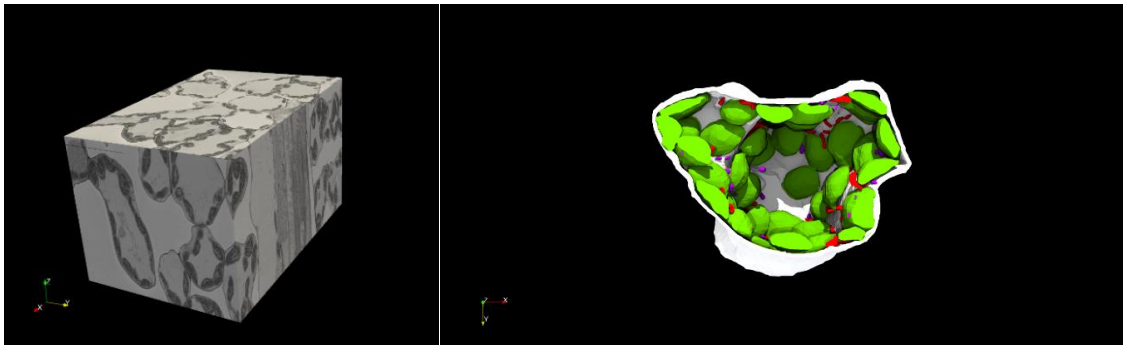
IMC 19 Abstract:

Cell ultrastructure is predominantly studied by transmission electron microscopy (TEM), providing the user detailed two-dimensional (2D) information. Recent advances in microscopy have streamlined the acquisition of three-dimensional (3D) images. Scanning electron microscopy with an automated microtome (SBFSEM) produces serial micrographs that can be stacked and segmented to produce a three dimensional volume data set. We are using SBFSEM on leaf cells to explore organelle size, shape and position, along with cell density and packing. The 3D anatomical data produced is being used to explore the relationship between leaf form and functionality. Models of key leaf processes, such as photosynthesis, sit at the heart of crop productivity and climate change models but include significant assumptions regarding the structure of leaves that ignore 3D complexity. We don't know if our understanding of leaf function is biased by our simplified 2D representations. SBFSEM allows us to challenge the idea of "textbook" leaf cell.

Raw SBFSEM Volume Data Set & Segmented Leaf Cell:



The organelles we can identify with confidence are chloroplasts, mitochondria and peroxisomes. Efficient leaf function depends on cooperation between cellular organelles. That is, by optimising the position of the organelles relative to each other and their adjacent environment a cell's capacity is greater than the sum of its parts. The diverse size and shape of cells and intercellular airspace in leaves influences light absorption affects the intra-leaf transport of carbon dioxide and water. Therefore, morphological properties such as cell surface area, cell volume, cell shape, connectivity of cells, cell wall thickness and the size, shape and connectivity of air spaces will be significant to physiological processes and will therefore drive relative organelle positioning. As size, shape and distance become critical in addressing leaf form and function, the over simplification from 2D quantification becomes evident. Using volume microscopy we can demonstrate uniform geometry assumptions can no longer be made in plant physiology.