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Fast Fluorescence Tomography: Challenges and Opportunities

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The promise of non-destructive 3D elemental imaging using x-ray fluorescence tomography is alluring, but the technique is not widely utilised due to the extremely long scan times required for modest tasks. Accordingly, the technique is often applied to imaging of small specimens at low definition. Our first 3D demonstration on a 10-m estuarine diatom, Cyclotella meneghiniana achieved a resolution of around 400 nm over 1003 voxels (1 Mvox) with 24 projections. More recent developments at the Australian Synchrotron have used a KB mirror pair and the Maia detector system to achieve extremely high pixel rates. In addition to its extremely high speed, the Maia detector is very efficient, employing a novel back-scatter geometry to achieve a very large 1.2-sr solid angle. Using the Maia detector system, measurements can properly sample the sinogram and have achieved 175 Mvox with scan times of around 14 hours.

Detailed tomographic measurements of large (mm-scale) and whole organisms are now routine. Reductions in measurement time and radiation exposure further enable imaging of a whole class of specimens that are susceptible to radiation damage and/or intolerant of measurement conditions. We have recently demonstrated fast cryo tomography and XANES tomography on biological specimens, with tantalising results. We present several applications and describe several challenges that face this growing field.

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Summary

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