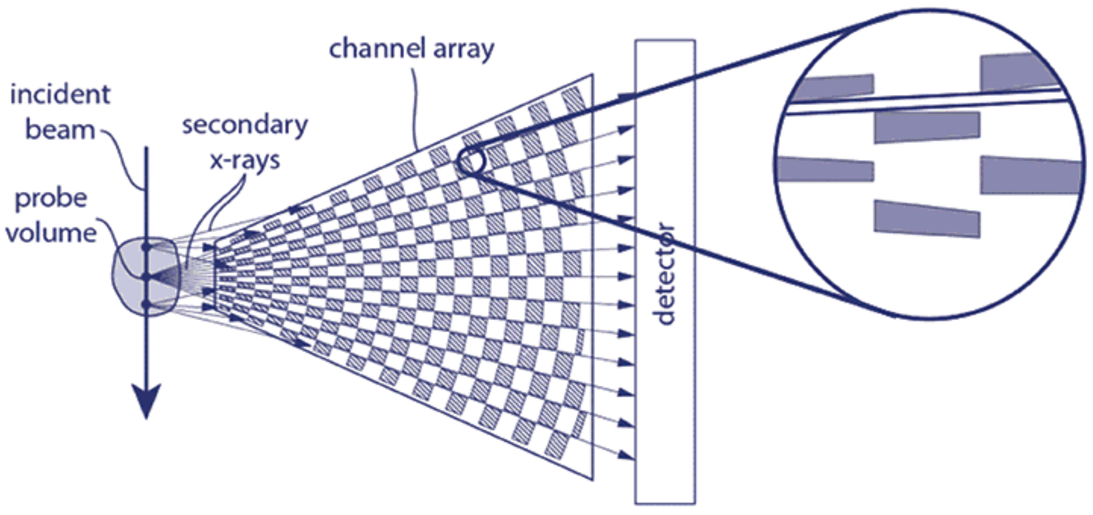
The Advanced Photon Source

A New Instrument for Confocal Microscopy

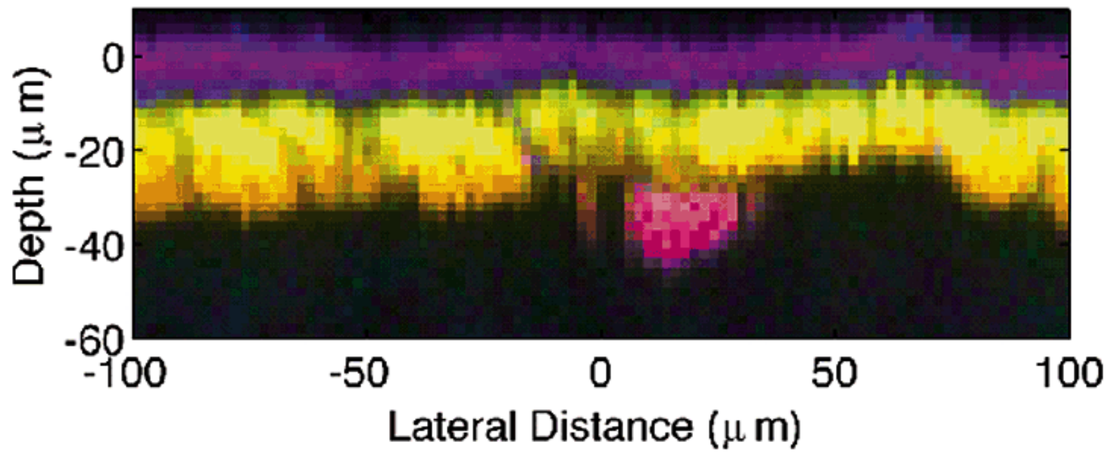
Non-destructive 3-D confocal microspectroscopy, which allows users to image small volumes with high resolution in order to build up 3-D microspectroscopy images, is now available at the 2-5-µm scale on the X-ray Science Division (XSD) beamline 20-ID-B at the U.S. Department of Energy's Advanced Photon Source (APS) at Argonne. This addition to the suite of experimental tools available at the beamline results from a collaboration of researchers from Cornell University and including the University of Saskatchewan, the Canadian Light Source, and Argonne. The Cornell group developed and supplied new devices based on micro-scale collimating channel arrays, which replace polycapillaries as the collection optic in confocal geometry.



Schematic illustration of CXRF configuration using collimating channels that are formed from a set of staggered, absorbing pillars. From A.R. Woll et al., J. Phys. Conf. Series **493**, 012028 (2014). Published under license by IOP Publishing Ltd.

The new confocal microscopy capabilities enabled by the collimators improve depth resolution from 30 µm to 2 to 5 µm and can improve the signal-to-noise ratio by rejecting background scattering. In contrast to polycapillaries, the traditional collection optic used for confocal 3-D x-ray microscopy, the collimating channels provide both an overall improvement in resolution and, importantly, spatial resolution that is invariant with the x-ray fluorescence energy. The improvement in resolution over standard polycapillary optics is roughly from 30 µm to 2 µm.

This capability has applications in environmental science, biology, and anthropology. Recent experiments include studies on mineral inclusions, fish embryos, insects, and cultural artifacts.



Virtual elemental cross-section of an un-thinned grain of brown rice obtained by confocal XRF using micro-channel arrays as the collection optic. Red, green, and blue in the image represent K-alpha intensities of potassium, phosphor, and manganese, respectively. Both prominent layers are rich in potassium, while the purple and yellow regions reflect increased Mn concentration in the outer layer, and elevated phosphor below the surface. From A.R. Woll et al., J. Phys. Conf. Series **493**, 012028 (2014). Published under license by IOP Publishing Ltd.

See: Arthur R. Woll*, David Agyeman-Budu, Sanjukta Choudhury, Ian Coulthard, Adam C. Finnefrock, Robert Gordon, Emil Hallin, and Jennifer Mass, "Lithographically-fabricated channel arrays for confocal x-ray fluorescence microscopy and XAFS," J. Phys. Conf. Series **493**, 012028 (2014). DOI: 10.1088/1742-6596/493/1/012028
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