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P33 - Resolution intercomparison in microscopy and lithography using light and ion beam imaging

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An important question for MeV ion beam microscopy and lithography is how the spot size in MeV ion beam microscopy relates to the Franhofer-diffraction (FD) limited resolution of an optical microscope or lithography tool. The comparison is not straightforward because not only are the resolving powers measured in different ways but also the achievable contrast depends on the imaging mode.

We have undertaken a numerical study of the broadening of edges by numerical convolution of 2D symmetric Gaussian, rectangular box, and Airy disc shaped PSFs. They correspond to the extreme cases of objective aperture size as in programmable proximity aperture lithography (PPAL); and aberration limited resolution in a MeV ion microprobe and FD limited light microscopy/lithography. The test objects were grid bars, δ-functions and gratings as well a natural sharp image of neural cells. These correspond to common objects for focussing MeV ion microscopes, optical microscopes, determining the modulation transfer function in an image and a real common object.

The results reveal that in general the shape of the PSF does not have a strong influence on the image. The Gaussian and Airy disc PSD approximate each other and the fwhm measured from edge broadening is a factor 1/3 of the measured fwhm of the central peak in the PSF measured using a δ-function object. However, the Airy disks for FD have a notable effect with fringe effects and give a background at large distances from the open region of a gridbar. The statistical noise from counting statistics has a very significant effect on the visible perceived resolution.

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