# Energy Filtered Scanning Confocal Electron Microscopy

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Confocal microscopy using light optics is widely used throughout the physical and life-sciences. However the electron-optical analogue, the confocal electron microscope, has rarely been implemented. Spherical aberration inherent in electromagnetic round lenses severely restricts the numerical aperture of electron optical lenses resulting in a depth resolution that is little better than the light optical confocal microscope. With the development of spherical aberration correctors for both transmission electron microscopy (TEM) and scanning transmission electron microscopy (STEM), the spatial resolution in 2D images has been dramatically improved. This is because the correction of spherical aberration allows a larger probe forming aperture thus forming a finer probe. In addition to increasing the lateral resolution, a larger convergence angle also leads to a reduced depth of field, which is likely to approach a few nanometres with the latest aberration-corrected microscopes. Having such a narrow depth of field offers the feasibility of depth sectioning of samples in similar fashion to confocal scanning optical microscopy (CSOM).

In this work we demonstrate the current experimental implementations of an energy filtered scanning confocal electron microscope (EFSCEM) using a microscope fitted with two spherical aberration correctors. A method for establishing EFSCEM electron trajectories in the presence of uncorrected chromatic aberration is described and by collecting inelastically scattered electrons with a characteristic energy-loss we show that three-dimensional chemical mapping at the nanoscale can be performed. We also demonstrate, using both experiment and calculations, that uncorrected chromatic aberration does not limit the depth resolution in the confocal configuration, and moreover that chromatic aberration performs an energy-filtering role, eliminating the need for a dedicated energy filter.