CURIOUSER AND CURIOUSER: DO WE REALLY UNDERSTAND HIGH NA OBJECTIVE LENSES?

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The quality of optical imaging achieved with any microscope depends crucially on the properties of objective lenses employed. Yet it is remarkable how little we know about how these lenses work, both in terms of theoretical understanding and in realistic appraisal of performance achievable in real life with practical lenses. This is not helped by common perception of lens design as a black art and lens manufacturers, perhaps understandably, being rather secretive about the actual lens designs and their test data. It appears that the only realistic way to gain any significant insight here is to built the test machinery in-house and, while treating the lens as a ‘black box’, do as much testing as one can afford.

In this talk we will describe work we have done as continuation of our earlier efforts in this field [1]. Whereas previously we employed small sub-resolution scatterers to generate high-NA spherical waves required for testing, our new setup uses a micromachined pinhole. In practical terms this led to a massive increase in light levels available in the system. This not only led to faster and more reliable measurements of on- and off-axis aberrations but also allowed us to make detailed investigation of apodisation and polarisation effects in objective lenses. Of particular interest is out-of-focus behaviour of certain lenses, which may hold the key to explaining puzzling axial responses exhibited by them.

We have also made significant improvements on the chromatic aberration measurement setup [2]. This now includes a photonic crystal fibre based supercontinuum source and a high-speed spectrometer. With this setup we were able to extend both the transmittivity and axial colour measurements up to 1000 nm in the spectral region of particular interest for multi-photon and nonlinear microscopy.

References