

Optical investigations

Dr. J. van Zuylen († 1995) and Dr.ir. J.C. Deiman

A number of important optical parameters of the microscopes in the collection of the Historical Microscopy Foundation have been investigated, notably the focal length and the magnification (eyepieces and the objective lenses) and the numerical Aperture and the resolving power (objective lenses).

The methods of measuring these parameters and the instruments used have been developed and partly described by Van Zuylen^[4]. Van Zuylen and Deiman did work together in the Utrecht University Museum during some 10 years, investigating and describing the microscopes from that collection. A chapter of [Deiman's thesis](#)^[1] deals with this subject as well.

Focal length of lenses and optical systems have been measured using a small focal-collimator. The method has been described by Van Heel^[3].

For investigating the relevant parameters of objectives a Bleeker type S microscope was used, the length of its body tube was made adjustable. The microscope was used with two Huygenian eyepieces, with magnifications of either 5 or 10 diameters (H5 and H10). In some cases it was more convenient to use the original microscope with its own eyepiece, this has been stated in the text.

The resolving power of the objective lenses has been investigated with a special test plate, it is an object slide covered with a very thin layer of aluminum (ca. 10 μm) in which regular patterns of lines have been scratched with a diamond. The distance between the series of lines is known, it ranges from 1 μm to some 11 μm .

There are tiny holes in the aluminum as well, these are used as artificial stars for the star-test^[2]. The diffraction pattern of the light around these artificial stars is influenced by the aberrations of the objective lens under test - spherical correction, astigmatism, coma.

A number of objective lenses could be investigated using a Möller diatom test.

To be able to resolve the diatom *Stauroneis phoenicenteron* into dots an objective lens must have a numerical Aperture of ca. 0.44, its resolving power is in that case ca. 0.73 μm .

To be able to see the dots of the diatom *Pleurosigma angulatum* a numerical Aperture of at least 0.73 is required, the resolving power is in that case ca. 0.44 μm .

Immersion objectives with a numerical Aperture of 1.30 or more can resolve the diatom *Surirella gemma* into dots, the resolving power is in this case ca. 0.23 μm .

Literature

[1.] Deiman, Dr. ir. J.C., *'Microscope Optics and J.J. Lister's Influence on the development of the Achromatic Objective, 1750-1850'*, diss. University of London, Imperial College, 1992. See especially chapter 2.5.

[2.] Fletcher, J.R., 'The Star Test for Microscope Optics', *Microscopy*, 36 (1988), 154-159.

[3.] Heel, A.C.S. van, *Inleiding in de optica*, (Den Haag, 1946), pag. 222.

[4.] Zuylen, Dr. J. van, 'The Microscopes of Antoni van Leeuwenhoek', *Journal of Microscopy*, 121 (1981), 309-328.