Objective Lens Markings and Interior Lenses

60x Plan Apochromat Objective

- Manufacturer
- Flat-Field Correction
- Lateral Magnification
- Specialized Optical Properties
- Tube Length
- Coverslip Thickness
- Nosepiece Mounting Thread
- Aberration Correction
- Numerical Aperture
- Immersion Medium
- Working Distance
- Magnification Color Code
- Spring-Loaded Retraction Stopper

LWD Plan Infinity-Corrected Apochromat Objective

- RMS Thread (20.32 mm)
- Manufacturer
- Objective Specifications
- Magnification Color Code
- Front Lens Assembly Housing
- Objective Rear Aperture
- Objective Doublet Group
- Objective Barrel
- Objective Triplet Group
- Hemispherical Front Lens

http://micro.magnet.fsu.edu/
NA (Numerical Aperture) is EVERYTHING

$NA = n \sin(\theta)$

$0.25 = 1.0 \sin 15.0^\circ$

$0.62 = 1.0 \sin 38.4^\circ$

$0.78 = 1.0 \sin 51.6^\circ$

$0.95 = 1.0 \sin 72.1^\circ$

http://micro.magnet.fsu.edu/
NA and Resolution

Abbe = \( d = \frac{\lambda}{2 \text{ NA}} \)

Rayleigh = \( d = \frac{0.61\lambda}{\text{ NA}} \)

See also [http://micro.magnet.fsu.edu/](http://micro.magnet.fsu.edu/)

See also [http://www.olympusfluoview.com/java/resolution3d/index.html](http://www.olympusfluoview.com/java/resolution3d/index.html)
Effects of Wavelength and NA on Resolution

Decrease wavelength = Increase resolution

Increase NA = Increase resolution

http://micro.magnet.fsu.edu/
Air vs. Oil Objectives

Numerical Aperture (NA) = n \sin(\theta)

- NA = 1.00 \sin (65^\circ)
- \theta = 65^\circ

http://micro.magnet.fsu.edu/
Effects of Confocal Pinhole Aperture Sizes

http://micro.magnet.fsu.edu/
A digital image is acquired through a process often referred to as sampling. The accuracy of each sample depends upon the size of the sampling interval, which is determined by the number of pixels in the image and the distance between each pixel. Each image sample is taken as an average of the image brightness over the sampling interval. The Nyquist Criterion requires a sampling interval equal to just over twice (actually 2.3 times) the highest spatial frequency occurring in the image to avoid losing spatial information. If the sampling interval is larger than the Nyquist limit, then undersampling occurs, and spatial information is lost. Undersampling has the effect of distorting image details, resulting in a phenomenon termed aliasing, which occurs when undersampled high spatial frequencies masquerade as (or "alias" to) lower spatial frequencies.

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Nyquist Sampling Criterion: Acquire samples at 2.3 X the highest spatial frequency (resolution) in the image

http://micro.magnet.fsu.edu/
Nyquist Sampling Criterion

Sampling Frequency Effects on Image Fidelity

Figure 3

http://micro.magnet.fsu.edu/