WinCamD Visible & Telecom Near-Field Reimaging - Rev.0901A

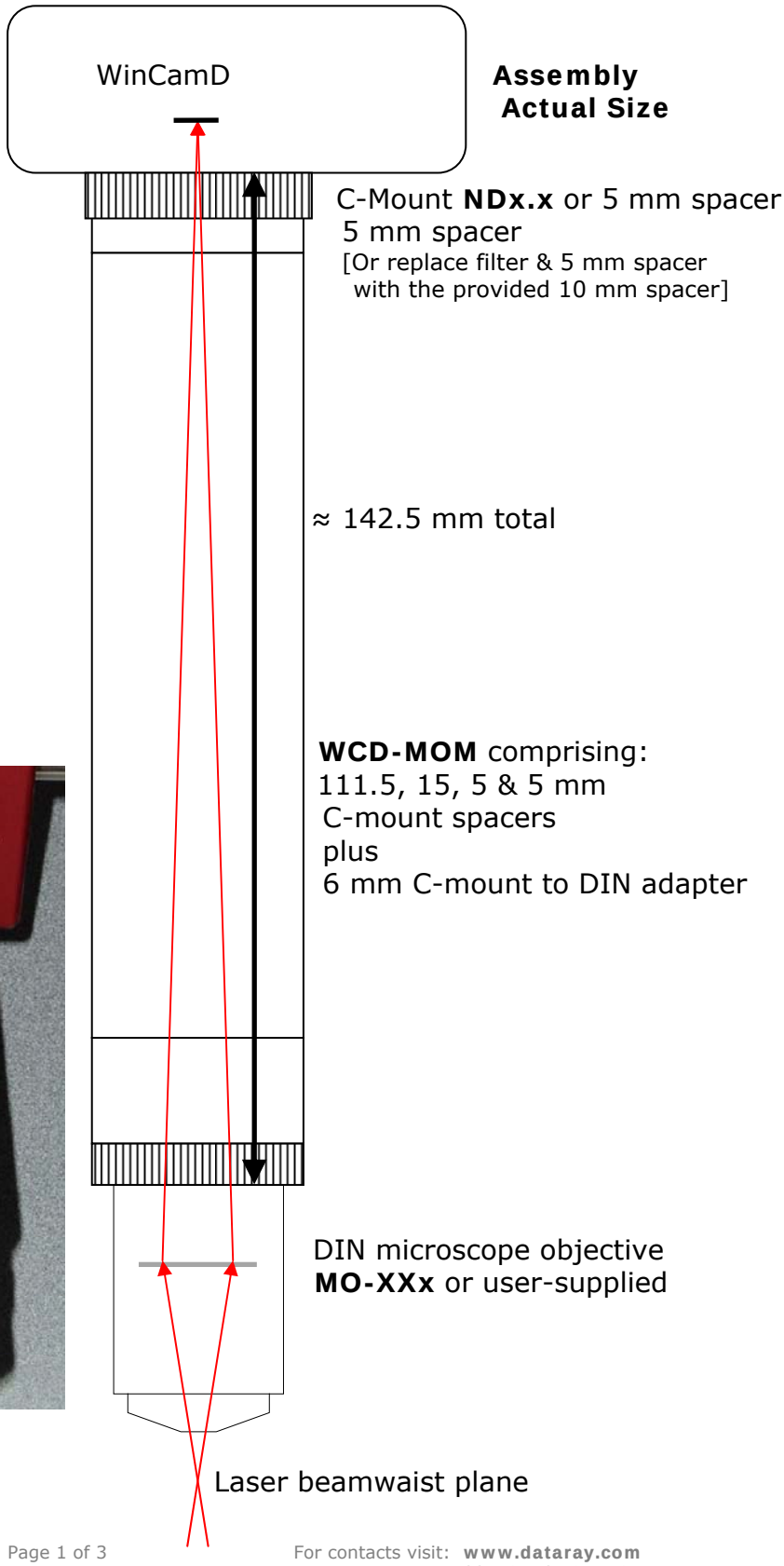
Introduction

WinCamD cameras may be used with microscope objectives to perform near-field re-imaging. For example, to magnify and reimage an LED/Laser facet or a beamwaist. Purists may object that re-imaging is never a perfect solution to such measurements. They are strictly correct, but it is often the best affordable solution, and is frequently a very good and economical solution.

1) Mounting Schemes

Standard microscope objectives conforming to the RMS (DIN) standard require a total optical distance of 150 mm between the objective's RMS threaded mounting flange and the objective's image plane. This ensures working at their design optical distances corresponding to optimal imaging.

With WinCamD, the image plane must coincide with the CCD array which is located ~7.5 mm below the surface of the case. The suggested arrangement is shown actual size in the diagram right.



The camera saturation power will be M^2 higher than the curves shown in the User Manual, where M is the objective magnification. If the calculated power means that you will not need to use the ND4 filter, replace it with the additional spacer ring.

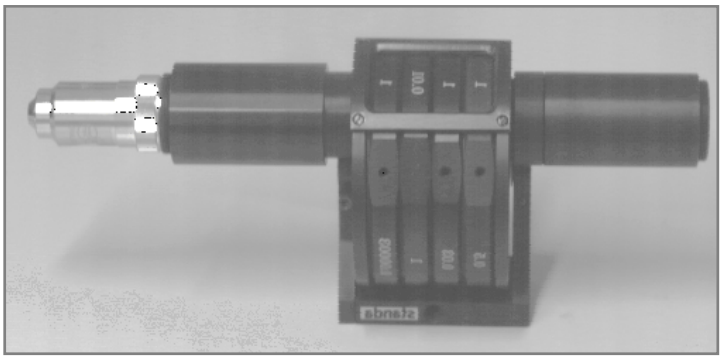
If you need to holder the front end near the objective for mechanical stability, the **WCD-MOM** kit include a mounting ring with ¼"-20 thread.

To summarize, you need:

- **WinCamD-Uxx** camera; **-UC12** preferred
- **WCD-MOM** **M**icroscope

Objective **M**ount [Comprises 132.5 mm tube, (111.5, 15, 5 & 5 mm + 6 mm C-mount male to DIN female)]

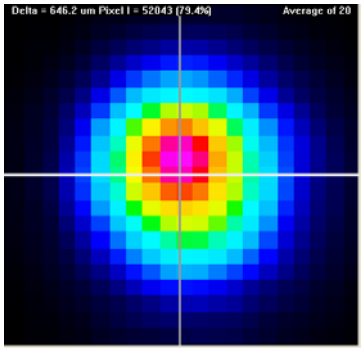
– **MO-XXx** Microscope objective: **MO-4x**, **MO-10x**, **MO-20x** or **MO-50x** Please specify your wavelength when ordering.



NFAO Near-Field Imaging Optic

If it is necessary to add additional and possibly variable beam attenuation, consider the **NFAO** arrangement shown.

A **N**ear **F**ield **I**maging **O**ptic consists of an **EAM-2** variable attenuator, an **ETCM-2** Tube set, plus a Microscope Objective. This allows near field analysis of fibres, integrated optical devices, laser diode chips, laser and LED arrays, etc.

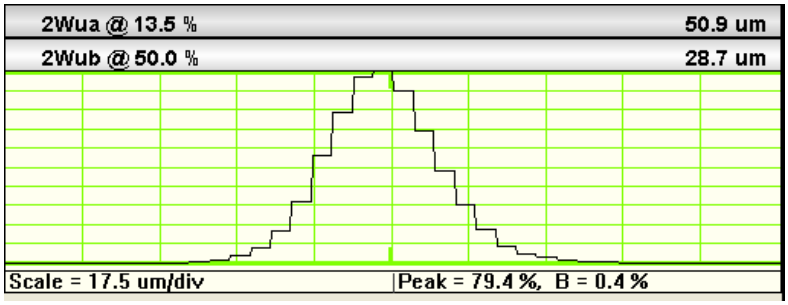


2) Other Considerations

Limitations include pixel size, residual lens aberrations, lens NA limitations on collected light and resolution, and residual multiple reflections if the lens AR coating does not adequately address the wavelength(s) of interest.

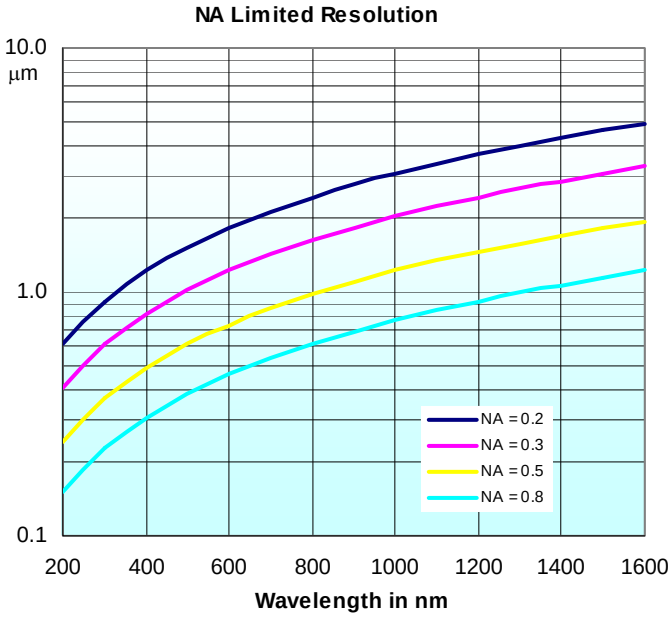
Attainable Resolution.

The first limit is the pixel size. The image and profile shown for a 50 μm beam show that eventually the pixel size limits the accuracy with which the beam can be resolved. We normally recommend approximately ≥10x the pixel size.



E.g., to image a 5 μm spot requires *at least* 10 pixels across the 13.5% diameter, ~50 μm on the camera, meaning a x10 objective is good, x20 is better.

The second limit is the objective's NA. For an objective magnification 'M', the resolution in the 'object' plane will either be the pixel resolution, (4.65/M) μm, or (0.61.λ/NA), whichever is larger, where NA is the Numerical Aperture of the beam or the microscope objective, whichever is smaller. Note that irrespective of the theoretical resolution, WinCamD interpolation allows the system to read out both beam dimensions and centroid position to 0.1 microns. On small beams, these can be quantized as coarsely as the sampling limit of (4.65/M) μm.



Reimaged Area. WinCamD-UC12, the preferred camera option for reimaging due to its small pixel size, uses what is termed a '½-inch" CCD chip, with an active area of 4.8 x 6.3 mm. The imaged beam waist or facet area will be (4.8/M) x (6.3/M) mm.

For different pixel sizes and chip sizes, simply use the appropriate dimensions in the calculation.

No Filtering. In the **Filter** pull-down menu, select No Filtering in order to avoid smoothing and broadening of the beam profile, important when looking at small beams.

Alignment and Mounting. For an objective magnification 'M', the alignment difficulty is frequently a factor of M higher than the measurement would be with no magnification. Take care to ensure that a camera plus objective system is solidly mounted. At high magnifications, even vibrations from acoustic and mechanical noise and the infra-sound vibrations of air-conditioning systems can cause poorly mounted systems to resonate.

If the flange to image plane distance is substantially different from 150 mm, the imaging will degrade from diffraction limited in some un-quantified matter which is worse at higher magnifications. When in doubt, reimage a high resolution grid pattern to determine the quality of the imaging.

When is the source in focus? The source is in focus when the magnified diameter is a minimum. Move source or camera in z to set this; only then measure the lens magnification as detailed below.

3) Measuring and Entering Lens Magnification

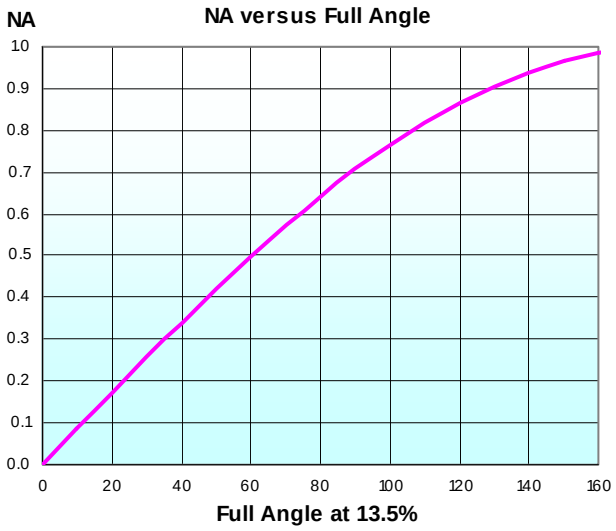
The software can compensate for known magnifications entered in the **Pixel Multiply Factor** (PMF) box in WinCamD **Setup**.

To calculate this factor, move either the source or the camera plus lens assembly a known transverse distance and measure the transverse change in the position of the image centroid **Xc**, **Yc** on the screen. The software makes this simple since the relative centroid dimension can be measured.

E.g. You move the source or camera laterally by 10 μm & the image centroid moves 400 μm. The magnification is (10/400) = 0.04. Enter 0.04 as the PMF factor for X and Y. The on-screen dimensions will then be correct.

4) Alternative microscope objectives.

For legal liability reasons these are 'suggestions' as to vendors rather than 'recommendations'.



- Buy the best objective that you can afford. i.e. Plan (Flat-field) or Semi-Plan rather than simple achromatic or 'standard' objectives.
- Ensure that the NA of the lens is sufficient for your application.
- Buy an objective coated for your λ's of interest. [Reflecting objectives are truly achromatic but unsuitable for near-field reimaging, due to central-field obstruction.]
- Infinity-corrected objectives do not form an image unless you add an ancillary lens.
- Avoid objectives that are cover glass corrected or 'Immersion' objectives.
- Most objectives use the RMS (DIN) mounting thread standard of 0.8" x 36 TPI. The JIS standard is the same thread but assumes a different tube length. Mitutoyo objectives use a 26 mm x 0.706 mm pitch thread. The Edmund Industrial Optics catalog has an excellent write-up on all this.

Catalog companies in the US & other countries that one might approach (alphabetical order):

www.edmundoptics.com	Wide range. M Plan NIR series are corrected for 480 to 1800 nm and have NA up to 0.50. Includes excellent but expensive long working distance infinity corrected lenses. Many relevant C-Mount accessories.
www.cvi-mellesgriot.com	Visible range, + up to 0.65 NA coated for use at FO telecom λ's.
www.optosigma.com	
www.thorlabs.com	