DataRay Inc.

WinCamD + M2DU M^2 system

Add M^2 Capability to your WinCamD

Applications

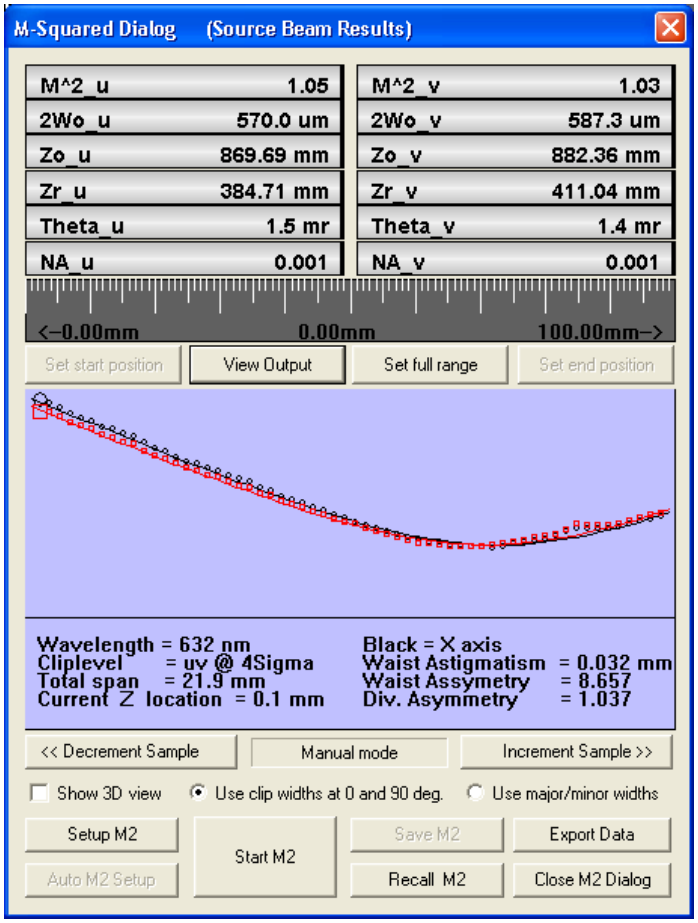
- M^2 measurement of CW & pulsed lasers
- M^2 measurement of focused beams
- Focus position of laser assemblies

Features

- **ASR™** *Auto Scan Range* for ISO compliant scan
- USB 2.0 for field service applications
- Fast, Compact, Portable system

  L x W x H: 8 x 2.9 x 4.3" (200 x 109 x 74 mm)

  Total weight 4 lb, (1.8 kg)
- Field-replaceable lens options



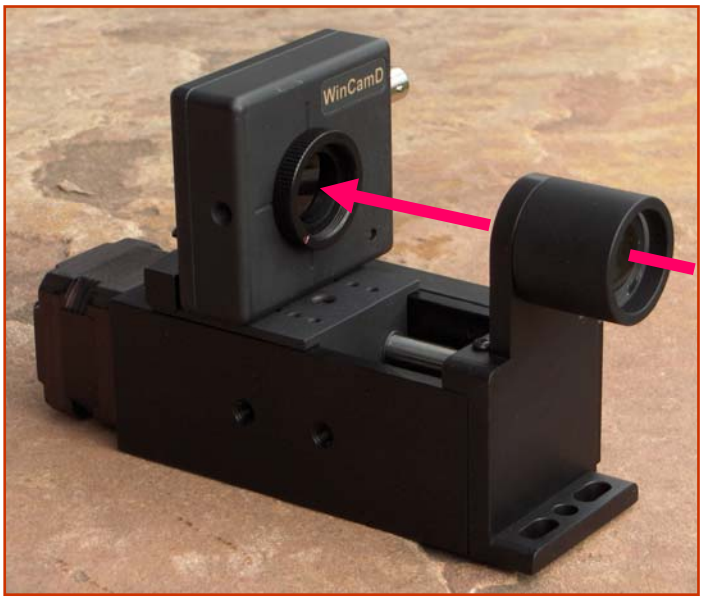
Description

The USB 2.0 interfaced **M2DU** accessory converts any WinCamD series beam profiling camera into a compact, fully ISO 11146 compliant, M^2 measurement system.

The **M2DU** system comprises a lens fixed to the front of a 42.5 mm travel moving stage on which the WinCamD is carried.

An achromat refocuses an input beam to a waist within the stage travel range. The standard is 100 mm focal length. Alternative lens focal lengths and coatings will be recommended/supplied for some lasers. A spreadsheet simplifies the choice.

Auto-sampling measures the hyperbolic region about the waist and at zR>2 in accordance with the ISO 11146 standard. A least squares hyperbolic fit to the second moment diameter data allows calculation of the M^2 value and related parameters for both the focused beam and the source beam.



M^2 Beam Quality Factor - *explained*

M^2, or Beam Quality Factor, is a dimensionless parameter that characterizes the degree of imperfection of a real-world laser beam. The closer the M^2 value is to 1.0, - i.e. the closer the beam is to TEM_{00} Gaussian perfection - the closer the beam can be focused to its diffraction limited spot size.

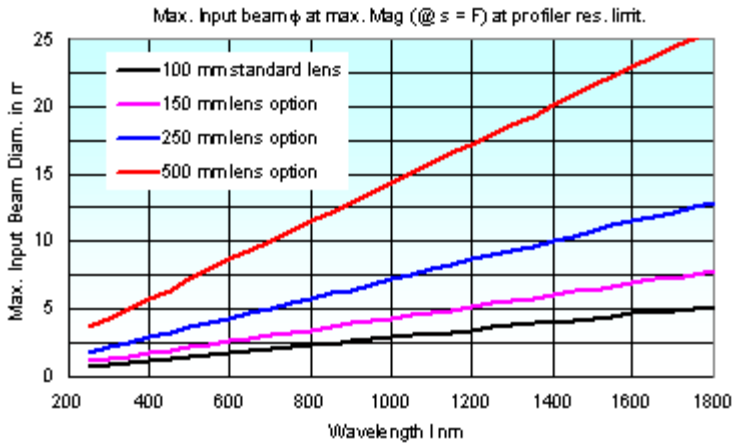
At its simplest M^2 may defined as: *The ratio of the divergence of the actual beam, to that of a theoretical, diffraction-limited TEM_{00} beam with the same waist diameter.*

Due to limitations of the optical cavity, the lasing medium, and/or the output/ancillary optics, most beams are not the 'perfect', diffraction-limited, Gaussian profile, pure TEM_{00} mode described in textbooks. Complex beams can contain multiple TEM_{xy} contributions leading to high values of M^2.

Specifications

- **Max. beam diams.**: See graph right.
- **400 to 800 nm** with standard lens
- **355 to 1150 nm** with optional lenses
- To **1350 nm** on high power beams with optional lenses
- **M^2 Range*** 1 to TBA
- **M^2 Accuracy*** ± 5% typical
- **M^2 Repeatability*** ± 2% typical

*Beam dependent. Achieving absolute accuracy better than ±5 % is possible, but can be difficult.



Beam modeling for Lens selection. An intuitive Excel spreadsheet simplifies lens selection.

- **Input data fields**

	User Entered Input	
Select Profiler:	WinCamD-UCD12	46.5 μm Min. beamwaist
Stage Model	M2DU	42.5 mm Stage range
Beam Quality Factor M^2 =	1.05	
Wavelength λ =	633	nm
Input beamwaist diam. $2W_0$ =	0.54	mm
Select Lens. Focal length F =	100	mm
Input beamwaist to lens dist. s =	550	mm

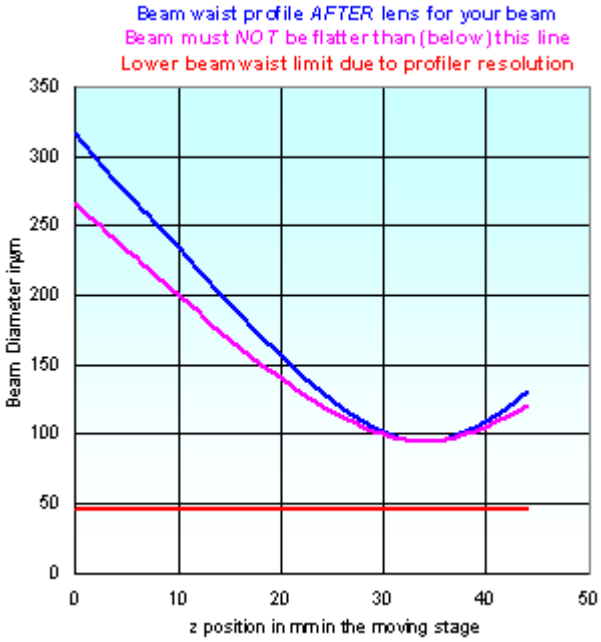
Clicking on the Excel cell offers both input advice and the selection of options where appropriate

- **Output data fields**

Results for Your Inputs		
Lens mount to desired zero plane. =	96	mm
Max. Rayleigh range for stage =	13	mm
Input Far Field Divergence, θ =	1.57	mrad
Input Rayleigh Range, zR =	345	mm
Beam Diameter at lens =	1.02	mm
Min. clear lens aperture =	2.0	mm
Req'd lens diameter =	**25**	**mm**
Magnification =	0.176	
f# of beam after lens =	112.1	
Output beamwaist, 2Wo" =	95.3	μm
Output Rayleigh Range, zR" =	10.73	mm
Output waist to lens dist., s" =	114.0	mm
Output waist position in scan =	54.0	mm
Focal plane to beamwaist =	14.0	mm
Estimated -3.zR Scan Start position =	1.8	mm
Estimated +0.5.zR Min. Scan Stop position =	39.4	mm
Add this length of spacer(s) after lens:	**20**	**mm**
60 Sample interval in μm =	715.1	μm

Degrees	NA
0.09	0.706

If a **red message** appears below, you should follow the guidance. **Optimize #1** &**#2** are in cells A11 & AI2.



The user enters the source beam details and chooses a lens focal length and the source to lens spacing.

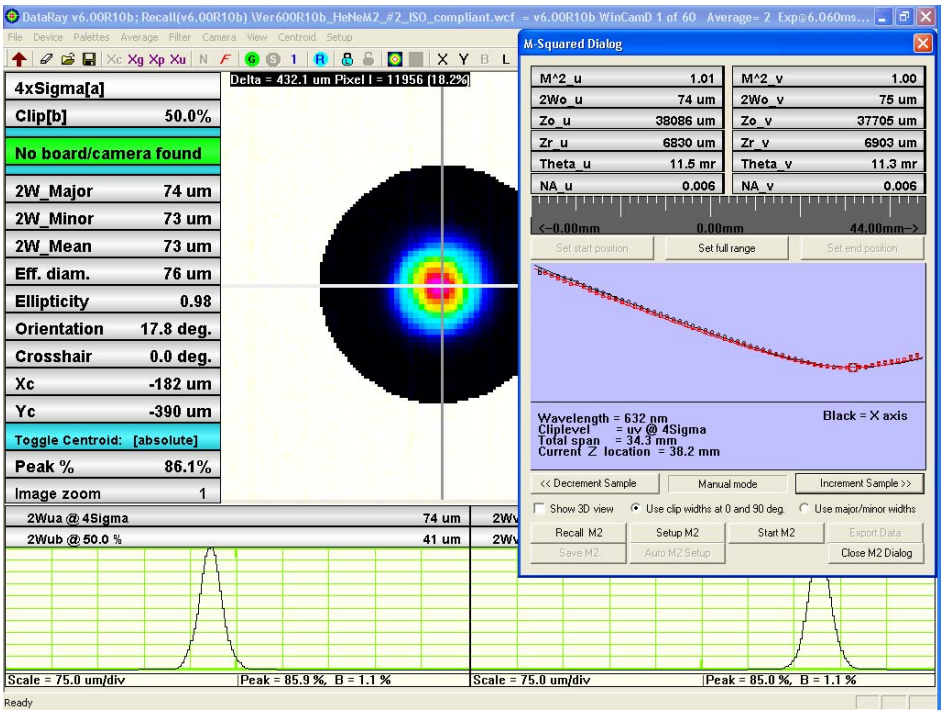
The output data fields show several factors and highlights in yellow the required lens diameter plus the length of spacers required to place the beamwaist within the range of the stage. The lines on the (auto-scaled) graph show:

The estimated beamwaist profile after the lens.

The calculated flattest acceptable beamwaist (maximum Rayleigh Range) for this stage.

The minimum allowed beam waist for the chosen profiler.

Download http://www.dataray.com/files/Lens_choice_for_M2_measurement.xls from the Application Notes section at the website and model your beam in order to ensure that it can be correctly measured with the received system.

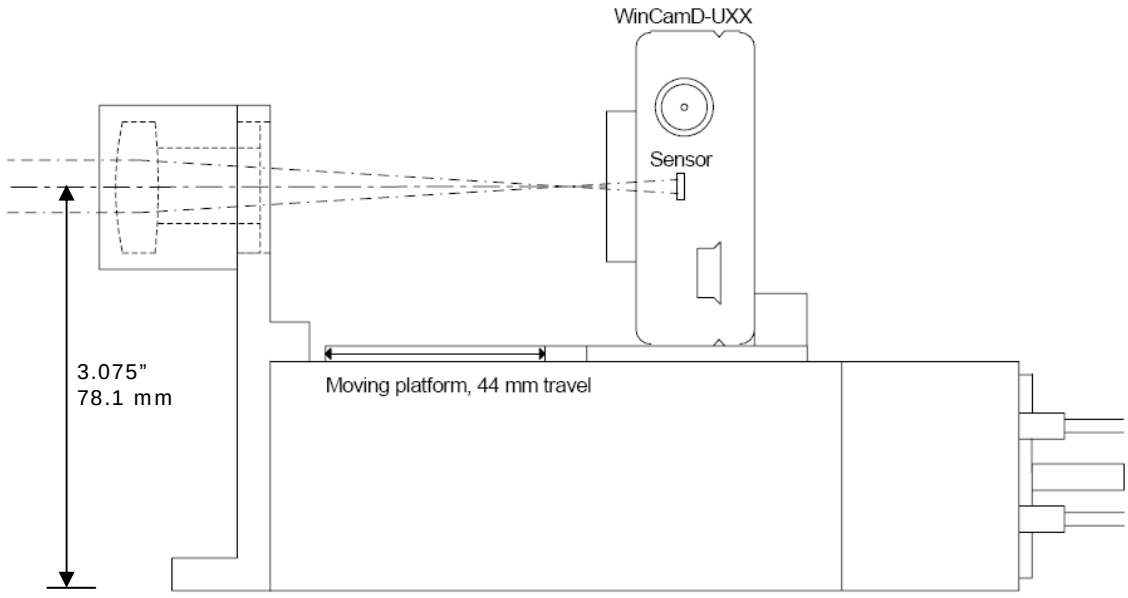


Operation

Operation includes an Auto scan range mode which simplifies scanning a range in accordance with the ISO standard, and is described fully in the Application Note which accompanies the stage.

An initial 20-point scan with an Average of 2 images at each positioned is performed over the total range of the stage. The software then establishes the optimal scan range for M2 measurement in accordance with the Standard. Averaging is set to 5 images per position and 60 equispaced positions in z about the beamwaist.

A typical full scan takes 5 minutes, but coarser scans may be performed faster.



Applicable Standards

ISO 11146 is the applicable standard: 'Test methods for laser beam parameters: Beam widths, divergence angle, and beam propagation factor.' (Available from http://webstore.ansi.org/ansidocstore/default.asp). It requires:

- Use of the Second Moment (4σ) definition of the beam diameter.
- Averaging of 5 samples at each position in z.
- A minimum of ten samples in z. '… half of them shall be distributed within one Rayleigh length on either side of the beam waist and half of them should be distributed beyond two Rayleigh lengths from the beam waist.' (DataRay offers from 10 to 60 samples in z).
- A hyperbolic fit to the data.

Ordering:

Model using the on-line spreadsheet and choose from the following:

- **WinCamD-UXXX** series head. The recommended head is the **WinCamD-UCD12** (plus **–UV** for <350 nm).

plus:

- **M2DU-WC-LNZ-XXX-XXX** system comprising the following options:

Standard System Options e.g. **M2DU-WC-LNZ-250-NIR**

	Lens focal length options	Wavelength options
M2DU-WC-LNZ Comprising: USB 2.0 M2DU Stage 2.5 μm steps, 44 mm travel 3 m flexible cable Lens mount bracket Mounted lens Power brick	**-100** 100 mm focal length 22 mm aperture **-150** 150 mm focal length 22 mm aperture **-250** 250 mm focal length 22 mm aperture **-250-50** 250 mm focal length 47 mm aperture **-500** 500 mm focal length 47 mm aperture	**-UV** Fused silica singlet for 250-450 nm **-VIS** Achromat for 400-800 nm **-NIR** Achromat for 630-1100 nm **-TEL** Achromat for 1000-1800 nm

-KIT option To receive the system in a rugged Travel Case with shoulder strap suitable for field service use and airplane hold shipping, add **–KIT** to the part number above. See pictures below,