Beamage-XXXXX + M2DU M^2 system

Preliminary Datasheet

Add M^2 Capability to your Beamage camera

Applications

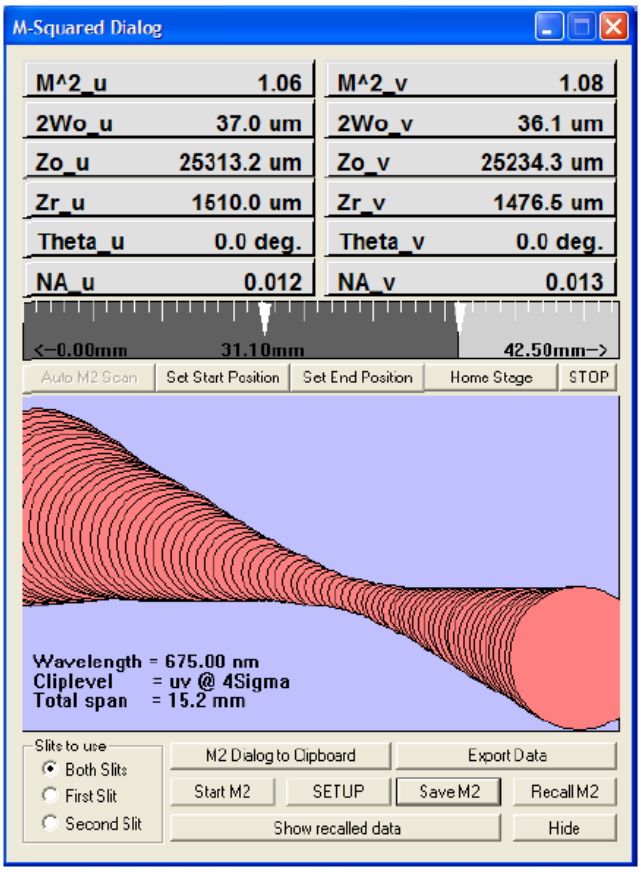
- M^2 measurement of CW & pulsed lasers
- M^2 measurement of focused beams
- Focus position of laser assemblies

Features

- USB 2.0 for field service applications
- Compact portable system

  8" L x 3" W x 4.5" H (200 x 110 x 70 mm)

  Total weight 4.4 lb, (2 kg)
- Field-replaceable lens options



Description

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

The **M2DU** system comprises a lens fixed to the front of a moving stage on which the Beamage camera moves up to 44 mm.

An 85 mm focal length, 400 to 900 nm, achromat refocuses an input beam to a waist within the stage travel range. (Alternative lens focal lengths and coatings will be recommended/supplied for some applications.)

Sampling in accordance with the ISO 11146 standard measures the hyperbolic region about the waist. A least squares hyperbolic fit to the second moment diameter data allows calculation of the M^2 value and related parameters.

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.

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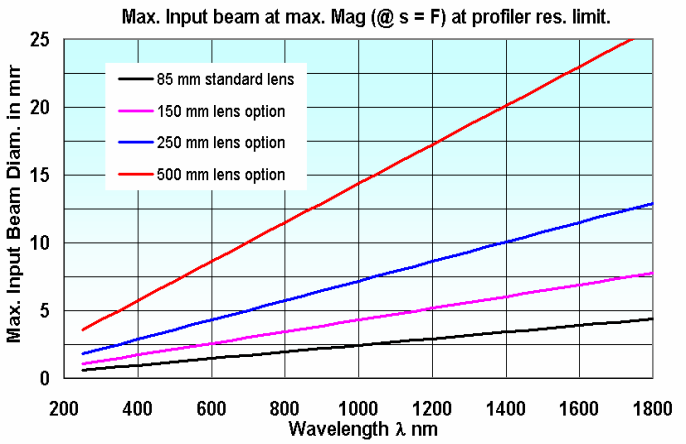
Specifications

- **Beam diameters:** See graph right.
- **400 to 900 nm** with standard lens
- **355 to 1150 nm** with optional lenses
- To **1350 nm** on high power beams with optional len
- **M^2 Repeatability** +/- 2% (beam dependent)



Beam modeling for Lens selection

It will be our pleasure to model your beam for you to determine the best choice of lens for your system. Below are details of the program used to model your beam.

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 beam waist within the range of the stage. The lines on the (auto-scaled) graph show:

The estimated beamwaist profile after the lens.

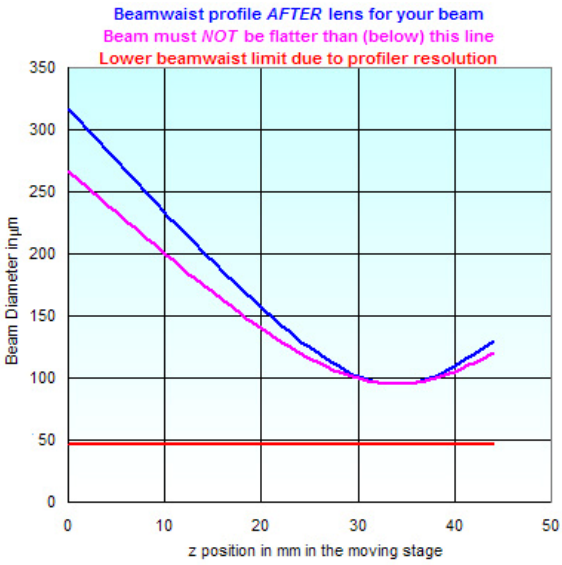
The calculated flattest acceptable beamwaist (maximum Rayleigh Range) for this stage.

The minimum allowed beam waist for the chosen profiler.

Click for ISO 11146 criteria

	User Entered Input	
Select Profiler:	Beamage-USB	
Stage Model	M2DU	
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 =	50	mm

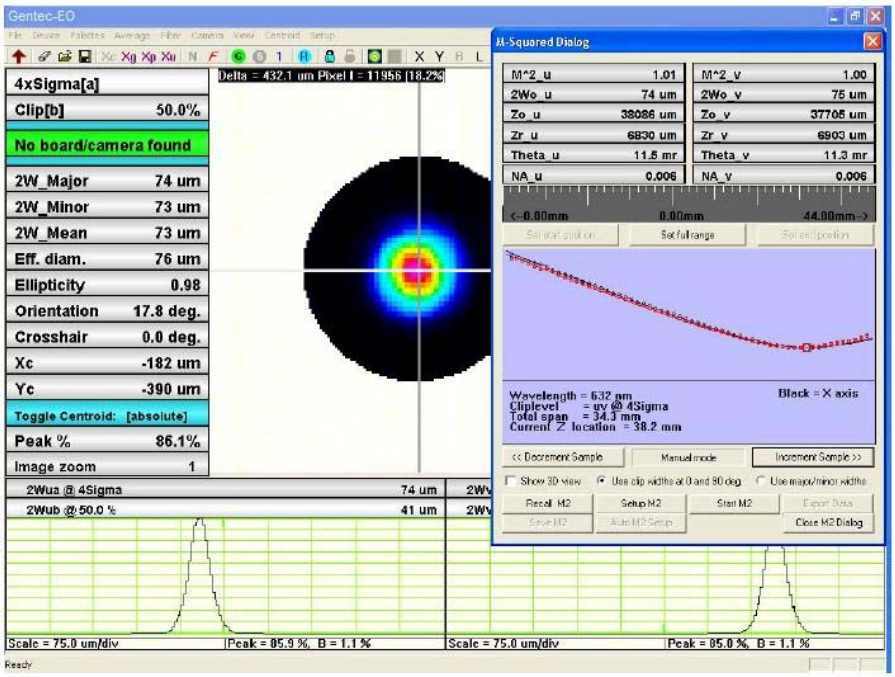
Results for Your Inputs		
Lens mount to desired zero plane. =	86	mm
Max. Rayleigh range for stage =	13	mm
Input Far Field Divergence, θ =	1,57	mrad
Input Rayleigh Range, zR =	345	mm
Beam Diameter at lens =	0,55	mm
Min. clear lens aperture =	1,1	mm
Req'd lens diameter =	**25**	**mm**
Magnification =	0,287	
f# of beam after lens =	175,7	
Output beamwaist, 2Wo" =	155,1	µm
Output Rayleigh Range, zR" =	28,42	mm
Output waist to lens dist., s" =	95,9	mm
Output waist position in scan =	35,9	mm
Focal plane to beamwaist =	-4,1	mm
Estimated -3.zR Scan Start position =	-49,4	mm
Estimated +0.5.zR Min. Scan Stop position =	50,1	mm
Add this length of spacer(s) after lens:	**10**	**mm**
60 Sample interval in µm =	1894,9	µm



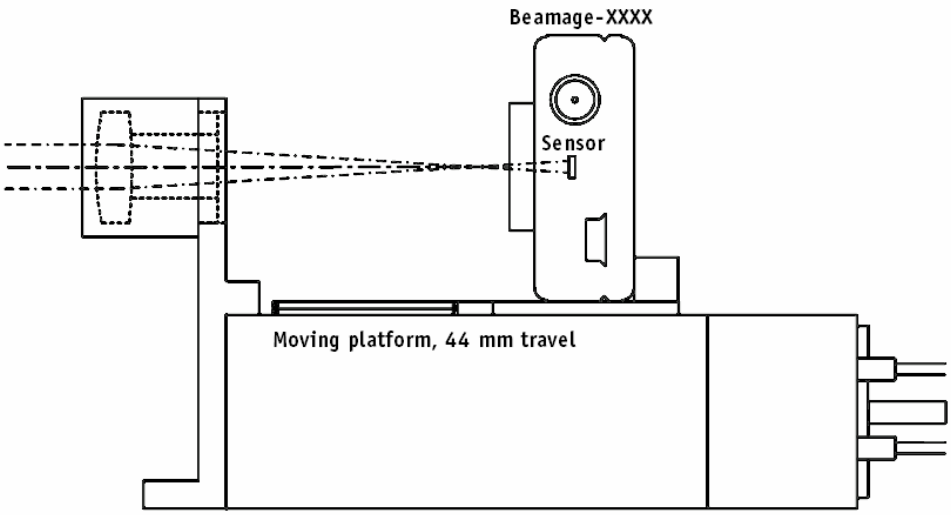
Clicking on the Excel cell offers the user both input advice and the selection of options where appropriate

Please call us and we will be happy to model your beam for you, 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 equi-spaced positions in z about the beam waist. 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.' (Gentec-EO offers from 10 to 60 samples in z).
- A hyperbolic fit to the data.

Accuracy and Repeatability

Operated properly with a stable beam, you can achieve absolute M^2 accuracy of ±5 to ±10 %, and repeatability of ±2%. Achieving absolute accuracy better than ±5 % is possible, but can be difficult.

Ordering

1. **Beamage-XXXX** series head
2. **M2DU** system comprising the following items:

   Beamage-Series USB 2.0 M2 Scan Stage with lens & adaptor plates: 2.5 µm steps, 44 mm travel + 3 m cable + Mounted 100 mm focal length fused silica singlet (17.5 mm aperture) for:

   - 185-450 nm → UV
   - 400-800 nm → VIS
   - 630-1100 nm → NIR
   - 1030-1350 nm → TEL

3. Available lenses* (focal lengths) for all wavelength ranges:
   - 100 mm, 25 mm Ø (comes standard)
   - 150 mm, 25 mm Ø
   - 250 mm, 25 mm Ø
   - 500 mm, 50 mm Ø

   * All lenses include appropriate adapters and spacers.