



# Measurement Instrumentation

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## Hand Held Laser Power Meter for YAG & CO<sub>2</sub>

### FIT Series

Fit is a fully automatic, broadband, hand held laser power meter designed for low to mid power range lasers.

Fit features a microprocessor based patent pending measurement technique of temperature dynamics through a broadband thermopile sensor; measurement and data acquisition are fully automatic making this technique virtually free from operator induced errors.

Two models cover from 500mW to 150W.

Their innovative measurement concept reduces the time of measurement and display down to 4s providing excellent accuracy ( $\pm 3\%$ ), repeatability ( $\pm 1\%$ ), high resolution (10mW up to 50W full scale) associated with a wide range of power measurement (down to 1% of full scale).

Fit features a large multifunction LCD that simultaneously indicates the measured power, wavelength of calibration (CO<sub>2</sub>, Nd-YAG), probe model and low-battery warning. Furthermore a moving bar shows the actual sensor temperature; this informs the operator whether he can still perform one or more measurements before the sensor reaches its maximum allowable temperature. Additionally the probe status is displayed by a two colour LED: the sensor is ready for measurement (steady green few seconds), the measurement is in progress (flashing green), the measurement is over (steady red few seconds), cooling is needed (flashing red).

Fit is operated by a single button, it shuts off automatically after 5 minutes of non operation and always stores its last measurement in memory. Two common AA batteries allow a minimum of 4000 measurements.

Fit has been ergonomically designed in all its details: the low profile thermopile sensor head connected to the display body by 1m extensible cord with a Lemo connector, allows remote testing even in tiny spaces. The LCD display is angled to secure an optimum visibility to the operator. The range of sensors feature broadband low reflection coatings with high damage threshold and are factory replaceable for cost saving.



**For YAG & CO<sub>2</sub> Lasers in the 1 - 500W Range!**

### Specifications

Parameter		FIT1	FIT3
Maximum Measurable Power	W	50	150
Minimum Measurable Power @ $\pm 3\%$ Accuracy	W	1**	3**
Absolute Minimum Measurable Power	W	0.5	1.5
Power Density Damage Threshold @ Full Scale at CO <sub>2</sub> Wavelength	W/cm <sup>2</sup>	2500	
Measurement Accuracy		$\pm 3\%$	
Resolution	W	0.01	0.1
Repeatability		$\pm 1\%$	
Maximum Allowable Probe Head Temperature	°C	70	
Time to Measure and Display Data	s	4	
Power Consumption in On Status	mW	26	
Power Consumption in Off Status	$\mu$ W	25	
Power Supply (2 x AA Batteries)	V	3	
Continuous Operation Without Battery Replacement	h	200	
Operating Temperature Range	°C	10 to 40	
Storage Temperature Range	°C	-10 to 60	
Weight (body)	g	336	
Weight (Sensor with Cable)	g	178	200
Size (body) L x W x H	mm	95 x 71 x 46	
Size (head) L x W x H	mm	50 x 50 x 20	

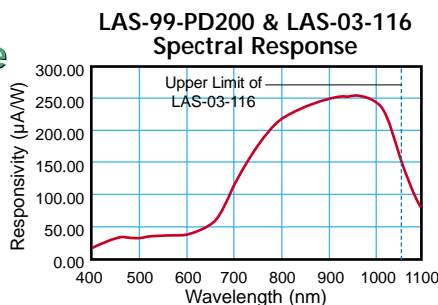
\*\* Individually calibrated against a NIST reference



For Visible Lasers in the  
 $\mu\text{W}$  - MW Range

Subnanowatt  
Resolution!

LAS-99-PD200



Submicrowatt  
Resolution!

## High Resolution Laser Power Meter

### LAS-99-PD200

- 400-1100nm
- Subnanowatts to 200mW
- $\pm 3\%$  Accuracy

High Sensitivity Power Meter Solutions  
- Call **01933 461 666** for the Latest Information

#### Standard model calibrated for 633nm, 650nm and 675nm

The Model LAS-99-PD200 laser power meter offers a cost effective solution for measuring one or two laser wavelengths at powers of up to a maximum of 200mW. The power meter is simple to operate and gives an accurate measurement of laser powers in a compact package. The single wavelength calibration data for each head is stored within the head itself. As a result, heads and readout units can be inter-changed without any loss of calibration accuracy. The system is also designed so that end users can recalibrate each head themselves.

The LAS-99-PD200 has advanced circuitry that delivers excellent sensitivity, a high signal to noise ratio, accuracy and a fast response time. It also includes special circuitry to reject the effects that electromagnetic interference would otherwise produce on the accuracy of the unit.

Each head can store up to two individual calibration points so that up to two different wavelengths may be measured with a high degree of accuracy. Alternative wavelengths may also be read by the unit, but the accuracy will be reduced depending on the responsivity of the silicon detector to the laser wavelength. For higher accuracy of readout over a wider range of wavelengths, the R-752, DUO and TPM300 offer better performance.

The calibration wavelengths that are available for the LAS-99-PD200 are 488nm, 532nm, 633nm, 650nm, 670nm, 780nm, and 820nm. Other wavelengths are available on special request. The sensitivity/calibration data are provided for each head, allowing users to extrapolate the calibration data to other wavelengths for measurements where lower accuracy may be tolerated.

The unit is provided as standard with the ability to autorange, particularly useful for variable power outputs. This function can also be manually over-riden for those applications where autoranging is not desired. In addition, the power meter is provided with an electronic backlight which is switch operated. As the backlight is significantly more power consuming than normal unlit operation, this option is only available when the unit is being operated from mains electricity.

Specifications	LAS-99-PD200
Spectral Range	400 - 1100nm
Available Calibrated Wavelengths	488, 633, 670-675, 780 or 820nm
Power Measurement Ranges (6 decades)	200.0mW, 20.00mW, 2.000mW, 200.0µW, 20.00µW, 2.000µW
Background Noise Level	<1nW
Calibration Accuracy at Wavelengths of Calibration	$\pm 3\%$
Linearity	$\pm 1\%$
Response Time	0.2s
Damage Threshold	50W/cm <sup>2</sup>
Maximum Pulse Energy	500µJ
Aperture	10mm x 10mm
Head: Swivel mount head for handheld or stand use. Dimensions LxWxD	122 x 17 x 9mm
Compact, portable display unit with backlight for use in low light environment. Dimensions LxWxD	203H x 95W x 37D
Electromagnetic compatibility	CE approved
Cable Length	1.5 metres
Analogue Output	2.5mm mono jack. Sensitivity 1Volt full scale
Backlight	EL type. Operates with charger plugged in only
Lifetime (between charges)	20 hours
Charger	DC: 12V, 3Watt. Battery charge time 10-14Hrs

## Laser Power Probe

### LAS-03-116

- 400nm to 1064nm
- 0.5 micro-Watts to 1 Watt
- $\pm 5\%$  Accuracy

This is the most versatile, compact, and affordable laser power meter available today. Controls & indicators: power/wavelength display select switch, wavelength select increment and decrement buttons, sample/hold button, 3-digit LCD with units indicator, attenuator position indicator, attenuator position control slide and over-range tone generator. Automatic functions: power range, wavelength correction, peak sample & hold, shut-off, over-range detect, and attenuator position detect. Additional features include an over-range indication, pocket clip, and storage case. CE marked.

Specifications	LAS-03-116
Sensor Type	Silicon Cell
Spectral Response	400nm to 1064nm
Accuracy	$\pm 5\%$
Max. CW Power	10mW; 1W with built-in attenuator
Max. CW Power Density	0.5W / cm <sup>2</sup> ; 30W / cm <sup>2</sup> with attenuator
Min. Full Scale Power	9.99 µW
Min. Power Resolution	0.01 µW
Min. Detectable Power	0.5 µW
Aperture Size	8.0mm
Built-in Range	1mm thick; NG-10
Step Attenuator	Schott filter glass
Measurement Display	3 digit LCD with power unit indicator
Displayed Power Range	9.99 µW, 99.9 µW, 999 µW; 9.99 mW, 99.9 mW, 999 mW
Display Power Indicator	µW, mW
Wavelength Selection Display	400 to 999 (for 400 to 999nm); 000 to 064 (for 1000 to 1064nm)
Peak Sample Time	2 sec.
Meas. Hold Display Time	10 sec.
Battery Life	180,000 samples at 12 sec / sample
Battery Type	Lithium (factory replaceable)
Size (max. dimensions)	6.59" L x 0.92" W x 0.78" thick
Weight	1.54 oz.



**For Visible & IR Lasers in the mW - kW Range**

## Power & Energy Monitors

- **Dual Channel**
- **Wide Dynamic Ranges:  $\mu$ W to Kw, mJ to 100J**
- **Graphic Display**
- **Autorange & Statistical Functions**
- **Fast Analogue Bargraph**
- **Compatible with all Laser 2000's Detectors**
- **Line and Battery Operated**
- **Analogue & Digital RS232 Outputs**

DUO and TPM300 are microprocessor-controlled readout units designed to be used with the full line of detectors detailed opposite for a full coverage of the spectrum, from UV to far IR.

They can be used in any set of field or laboratory laser applications ranging from R&D to optical testing, process control and spectroscopy.

Both instruments are compact, light-weight, battery and line-operated readouts using on the highest performance electronics available for this kind of instrument currently commercially available.

The units recognise the head in use using IIS (intelligent identification system), accurately read their signal outputs, negate baseline variations, apply the calibration factors and the algorithm for the response time acceleration reducing thereby the intrinsic time constants of each head by a factor up to several decades.

### DUO

DUO is a sophisticated power and energy meter available in the same instrument. Depending on the application it can read one or two detector heads at the same time, providing the possibility of comparing both signals directly. If you need to do optical testing, like evaluating the transmission of beamsplitters, coatings, filters, or if you are concerned in knowing what is happening on a side arm of your system, then you can work in radiometric mode.

Even better, you have two independent monitors at the cost of one: each channel is independent so you can switch back and forth to have power or energy measurements, instantly.

If statistical data are needed to verify the stability of a source or in quality testing procedures, DUO calculates and displays the average value, the standard deviation or the min/max in real time.

For your convenience, we adopted a 100 x 80mm graphic LCD display that shows current readings, a high resolution histogram and a highly visible bar graph to be used in the alignment of your laser. Should you require to collect data for complex manipulation, we have provided an RS232 port; alternatively, for oscilloscope readings or chart recording, two analogue outputs - one for each channel - can be used.

### TPM 300

The TPM is great value for your money. It accepts all standard Laser 2000 power measuring heads via the standard intelligent connector which houses all information needed for auto-calibration. The double display - analogue and digital - allows measurement readings and laser alignments with total ease. A software-controlled speed-up circuit reduces the intrinsic response times of detectors of several times. It also features 12 scales (30mW to 10kW), a zero adjustment potentiometer and a low battery LED indicator.

The TPM300 also has a standard 0-1V full scale analogue output and an RS232 connector port.

**The DUO and TPM 300 readout units are designed solely for use with the sensor heads detailed on the opposite page.**

Power & Energy Monitors		TPM300	DUO
Wavelength range		Select head from page 77, options range from 190nm up to 11 $\mu$ m	
<b>Power measurement</b>			
Range	W	30mW to 10kW	30 $\mu$ W to 10kW
Resolution	% of range setting	0.3	0.01
Accuracy	$\pm$ %	0.5	0.5
Response Time	sec	1	1
<b>Energy measurement</b>			
Range	J	-	300 $\mu$ J to 100J
Resolution	% of range setting	-	0.05
Accuracy	$\pm$ %	1	
Internal trigger	%	2	
Software trigger	%	2 to 99	
<b>General</b>			
Bar graphs	# Divisions	240	
Analogue Output	V	0 to 1 $\pm$ 1%	0 to 1 $\pm$ 1%
Display		91mm x 40mm analogue display and 4-digit LCD display	100mm x 80mm 100mm x 80mm
Display refresh rate	Hz	-	3
Battery Lifetime	Hours	8	5
Electrical Input	V/A	12VDC, 800mA	12VDC, 800mA
Dimensions	mm (W x H x D)	245 x 125 x 90	210 x 174 x 60
Mass	kg	1.6	1.2



Power Measurement Heads

### Milliwatt Resolution!

The sensor heads detailed here are compatible for use with the DUO, TPM 300 and the PLUS readout units detailed on pages 2 and 3

High Sensitivity Power Meter Solutions  
- Call **01933 461 666** for the Latest Information

### Sub - millijoule Resolution!

## Energy and Power Measurement Heads

A-3 / A-10 / A-20-V / A-40  
A-150 / W-50 / W-100 / W-200

The present series of power detectors includes high sensitivity thermopiles, computer modelled for optimum thermal conductivity. Each head is individually calibrated and corrected for maximum accuracy and speed of response. The full range of options is detailed below.

A-02/2

The A-02/2 head is designed primarily for use as a power measurement head for low power lasers up to 2W output power. It has a resolution of 0.1mW and a wavelength range from UV to FIR and so is suitable for general use with almost all laser types. In addition, when used with the PLUS power meter the A-02 also measures energy.

10 UV-C/10 UV-A/10-BB  
20 UV-C/20 UV-A/20-BB

This series is designed to measure a single shot or event in a high repetition rate train of pulses, even up to 20J. Different materials are used to optimise the detector head performance at different wavelength ranges (see below). Using this series, both power and energy can be measured.

### Power Measurement Heads

Specifications		A-02/2	A-3	A-10	A-40	A-150	A-300	W-100	W-200	W-1000	W-1500	W-3000	W-6000
Max. Continuous Power	W	0.2 / 2	3	10	40	150	300	100	200	1000	1500	3000	6000
Min. Power Resolution	W	10 <sup>-4</sup>	10 <sup>-3</sup>	10 <sup>-3</sup>	10 <sup>-2</sup>	10 <sup>-2</sup>	10 <sup>-1</sup>	10 <sup>-2</sup>	10 <sup>-2</sup>	10 <sup>-1</sup>	1	1	1
Overload Power (2 min)*2	W	-	4.5	15	60	225	450	150	300	1500	2250	4500	9000
Max Rated Irradiance	W/cm <sup>2</sup>												
- Broadband		200	200	200	200	500	500	500	500	-	-	-	-
- CO <sub>2</sub> (TEM00 at 1/e <sup>2</sup> point) (High Power)		-	-	200	500	1300*3	1300*3	1300*3	1300*3	1300*3	1300*3	1300*3	1300*3
Spectral Bandwidth	microns	.19 - 40*6	.25 - 25	.25 - 25	.25 - 25	.19 - 11	.19 - 11	.19 - 11	.19 - 11	.19 - 11	.19 - 11	.19 - 11	.19 - 11
Response Time Constant (1-1/e)	sec	-	13	1.1	1.1	11	11	1.2	1.5	4.5	4.5	9	6.5
Waiting Time 0-90% w. monitor	sec	3	3	<1	<1	3.5	3.5	<1	<1	1	1	2.7	2
Nominal Responsivity	mV/W	-	250	7.5	1.5	0.36	0.18	0.6	0.3	0.075	0.050	0.030	0.012
Non-Linearity with readout unit	%	±1	±1	±1	±1	±1.5	±1.5	±1.5	±1.5	±2	±2	±2	±3
Calibration Uncertainty*4	%	±3	±3	±3	±3	±3	±3	±3	±3	±5	±5	±5	±5
Spatial Change of Responsivity	%	-	±1	±1	±1	±2	±2	±1	±1	±2	±2	±3	±5
Effective Sensitive Diameter	mm	12	12	20	20	60	60	20	20	40	40	55	55
Head Dimensions (dia. x depth)	mm	40 x 67.5	40 x 67	70 x 31	100 x 55	120	120	80 x 35	80 x 35	115 x 52	115 x 55	140 x 56	140 x 56
Min. Cooling Flux (lit/min;water;22°C max.)		Air	← Air →		← Air →		← Air →		Water Cooled →				
NEP (Noise Equivalent Power)	µW	20	-	-	-	-	-	-	-	-	-	-	-
Energy Threshold	mJ	0.5	-	-	-	-	-	-	-	-	-	-	-
Max. Energy	J	2 (long pulses)	-	-	-	-	-	-	-	-	-	-	-

\*2 At 1.5 times the Min. Cooling Flux. \*3 Ratings depend on real applied power: at low powers damage occurs at >26KWcm<sup>2</sup> \*4 Detector centrally irradiated at 50% of useful surface (IEC1040)  
\*5 Two connectors \*6 Calibrated up to 10.6µm. \*7 Detector centrally irradiated @ 50% of useful surface Two connectors

### Energy and Power Measurement Heads

Specifications		10UV-C	10UV-A	10-BB	20UV-C	20UV-A	20-BB
Max Energy	J	10	10	10	20	20	20
Min Energy Resolution	J	10 <sup>-4</sup>	10 <sup>-4</sup>	10 <sup>-4</sup>	10 <sup>-2</sup>	10 <sup>-2</sup>	10 <sup>-2</sup>
Max Continuous Power	W	10	10	10	20	20	20
Min. Continuous Power Resolution	W	10 <sup>-4</sup>	10 <sup>-4</sup>	10 <sup>-4</sup>	10 <sup>-2</sup>	10 <sup>-2</sup>	10 <sup>-2</sup>
Max Rated Irradiance (Peak)**	W/cm <sup>2</sup>	10 <sup>8</sup>	10 <sup>8</sup>	10 <sup>11</sup>	10 <sup>8</sup>	10 <sup>8</sup>	10 <sup>11</sup>
Max Radiant Exposure**	J/cm <sup>2</sup>	1.5	1.5	3.3	1.5	1.5	3.3
Calibration Spectral Bandwidth	microns	0.19 - 0.25	0.25 - 0.4	0.4-1.2	0.19 - 0.25	0.25 - 0.4	0.4 - 1.2
Response Time Constant (1-1/e)	sec	26	26	26	3.5	3.5	3.5
Nominal Responsivity	mV/W	100	100	100	1.5	1.5	1.5
Calibration Uncertainty	%	±2	±2	±2	±3	±3	±3
Non-Linearity with readout unit	%	±1.5	±1.5	±1.5	±1.5	±1.5	±1.5
Effective Sensitive Diameter	mm	25	25	25	19	19	19
Head Dimensions (diameter x depth)	mm	60x100	60 x 100	60 x 100	100 x 55	100 x 55	100 x 55
Cooling		still air	still air	still air	still air	still air	stil air

\*\* Ratings are wavelength dependent

Thermopile Surface Absorber - Mod.: A-3; A-10; A-40; W-100; W200 General Purpose Scientific - Medical - Industrial: Laser Diodes, Argon, Dye, YAG, Copper Vapour, CO<sub>2</sub>, KTP

Thermopile Excimer Absorber - Mod.: A-150; A-300 Industrial: Excimers, CO<sub>2</sub>, Large Aperture Beams

Thermopile Surface Absorber - Mod.: W1000; W-1500; W-3000; W-6000 High Power CO<sub>2</sub> and YAG

Thermopile Volume Absorber - Mod.: 10UVx; 20UVx Dermatology - Ophthalmic - Scientific: High Energy Pulsed Lasers



## Product Selection Guide

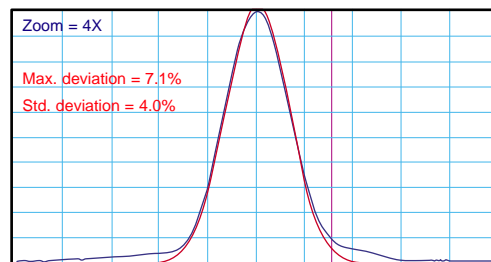
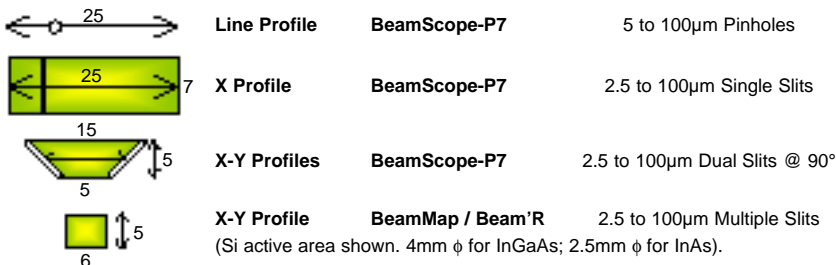
### Beam Imaging / Profiling / Focusing / Alignment / Collimation / Pointing / M2

The Broadest Selection of Beam Diameters and Measurement Options

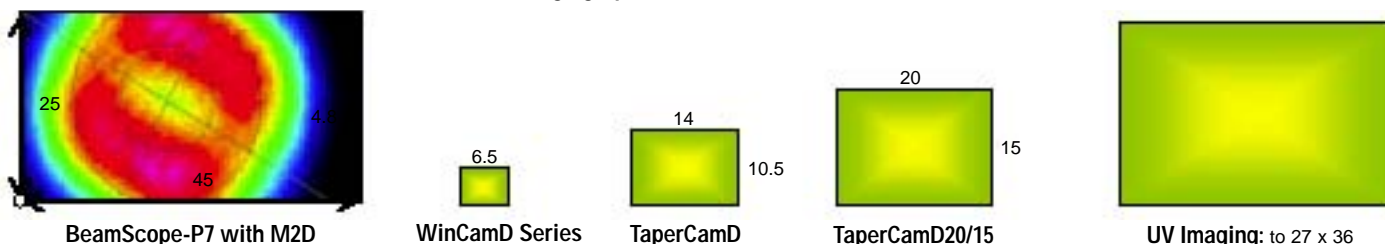
- This summary guides you to the correct profiler for your beam.
- All systems feature comprehensive 1D, 2D & 3D beam profile displays, beam wander, & ISO 11146 compliant analysis.

Select:		BeamScope™-P7				BeamR™		BeamMap™		WinCamD™		
		Scanning slits or pinhole: Probe head for narrow spaces: Rotating head mount option				Scanning X-Y slits Slit & Knife-Edge modes		X-Y-Z plus $\theta-\phi$ real-time profiling 14-bit ADC		Digital 1.4 MPixel CCDs Visible, UV & IR		
Profiling or Imaging	Precise, 0.1 $\mu$ m resolution, 12-bit PROFILING								IMAGING			
	Versatile XY probe head 2D + M <sup>2</sup> option				Precise XY		Focusing, Pointing, Collimation, M <sup>2</sup>		The single plane preference when beam size is appropriate			
<b>CW or Pulsed</b>	CW. Pulsed >5kHz, high duty cycle				CW. Pulsed >100kHz, high duty cycle				CW. Any Pulsed Laser			
1 - 350nm									WinCamD + UV converter			
190 - 1150nm	Si detector, 10 x 10mm								WinCamD / UV, WinCamD, TaperCamD™ series			
190 - 1350nm									WinCamD / 1310			
800 - 1800nm	Ge detector 5 x 5mm				InGaAs detector, 5mm diam.							
1475 - 1600nm									WinCamD / IR, CamIR Adaptor			
1.5 - 4 $\mu$ m	3mm diam. InAs detector				5mm diam. InAs detector							
2 - 14 $\mu$ m	II-VI detector (Pinhole scans only)											
<b>Area (max. in mm) Profiles</b>	Pinhole $\phi$ x 25	X Slit 7 x 25	X-Y Slits 5 x 5/15	Image 25 x 45	X-Y Slit Scanned Area Silicon: 5 x 6mm (InGaAs 4 x 4)				Area Imaging 4.8 x 6.5 to 15 x 20mm			
Line Profile	Yes				Yes				Yes to All			
X Profile												
X-Y Profiles					Yes							
X-Y-Z Profiles, plus $\theta-\phi$									Yes: unique patented capability			
Area Image					Yes				Yes			
<b>Best Resolution</b>			0.1 $\mu$ m	0.2%			0.1 $\mu$ m	0.1 $\mu$ m readout, 4.65 $\mu$ m pixel				
<b>Smallest Beam</b>			5 $\mu$ m	20 $\mu$ m			0.5 $\mu$ m	<50 $\mu$ m diam.				
<b>Largest Beam</b>	See scanned and imaged areas below this table											
<b>Power Handling</b>	See detailed data sheets or contact Laser 2000 for advice. With accessories you can handle almost any power											
<b>Update Rate</b>	1 to 2Hz (2-D stage, 0.01Hz)				3.6Hz (Real-time)				Few to 25Hz			
<b>M<sup>2</sup> Measurement</b>	Yes, with M2D Accessory								Yes, automatic for focused beams		Basic, with lens	
<b>Locate Focus</b>					Must move source or head						Move source or camera or use live export of multiple camera outputs into Excel	
<b>Pointing / Divergence</b>	Must move source or head											
<b>Collimation</b>									Collimate™ head			
<b>Optical Range</b>	44dB								45dB		CW: 53.5dB   Pulsed: 7.5	

#### Scanned & Imaged Areas Shown Actual Size. Dimensions in mm



#### Area Imaging Options - Shown Actual Size in mm





## BeamScope™-P7 Beam Analyser, 3µm to 45 mm

### BeamScope™

All Beam Profiling should be this simple...

#### Real-time:

- X-Y Profile Measurement
- Angular Divergence
- Ellipticity, Centroid, Gaussian fit
- Relative Power

#### Features:

- Beam dimensions 3 µm to 45 mm
- Resolution 0.5 µm or 0.5 %
- 190 nm to 12 µm options
- M 2 measurement accessory
- ISO 11146 Compliant
- Narrow probe for confined spaces
- Front mounted apertures
- Wide dynamic range
- Powerful, intuitive software

#### Typical Applications:

- Laser/Diode Laser characterisation
- Laser assembly development, alignment, characterisation, production test & QA
  - e.g. Lasers And Laser Assemblies for
    - Disk/Wafer Characterisation
    - Laser Printing/Marking
    - Medical Lasers
    - Bar Code Scanners ... etc.

#### Accessories & Options:

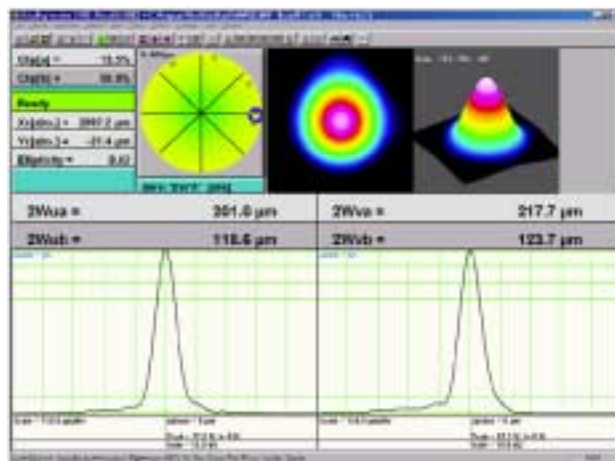
- M<sup>2</sup> Measurement Accessory
- 2-D Scan Stage for 23 x 45 mm profiling
- Magma™ CB1H for portable use with a Notebook PC

#### Principle of Operation

A linear scanning probe carries either a single pinhole, a single slit, or X-Y slits at 90°. The linear scan satisfies the strict requirements of the ISO 11146 laser profiling standard. Light passing through the slits falls onto a Silicon (190 to 1150 nm), Germanium (800 to 1800 nm), Indium Arsenide (1.5 to 4µm) or II-VI detectors for 3 to 12 µm.

BeamScope comprises a compact head & a single PCI card for Windows 98, Me, NT, 2000 & XP compatible.

Until the introduction of the DataRay BeamScope-P7 Beam Profiler, no commercially available slit scan or knife-edge scan beam profiler met the ISO 11146 Standard. The Standard requires that the scan be performed in a plane orthogonal to the propagation axis. Drum style scanners cannot meet the Standard. DataRay's unique linear scan probe is designed to fully comply with the Standard.



#### Acquire Beam Profiles In Constricted Areas

BeamScope-P7 has made the measurement of once inaccessible beam profiles not merely possible, but simple. The unique probe-style scan head easily peers into confined axial gaps between lens, mirrors, and filters. Its ability to probe along-axis spaces as narrow as 12mm creates a whole new world of applications.

#### No Beam Distortion From Optics Or Filters

There's no distortion of the beam due to ancillary optics or filters because the BeamScope-P7 doesn't need them when analysing most type of lasers. The AUTO GAIN feature can continually adjust the detector amplifier gain to ensure full use of the 55 dB (300,000:1) dynamic range. Spot dimensions from 3 µm to 23 mm can be measured from a single scan head. Scan beam areas up to 23 x 45 mm with the new 2-D stage accessory.

#### Front Mounted Apertures

Front mounted apertures enable you to see precisely where the beam is being measured. Rapidly diverging and fast focusing beams are simple to capture if you can get close to your source. Now it's easier than ever to measure laser diode arrays, micro-lensed sources, broad stripe lasers, etc. Available apertures can accommodate power densities up to 100 W/mm<sup>2</sup> onto small pinhole apertures. (Max. Total power = 0.5 W) Change apertures in minutes from slits to pinholes. This makes the BeamScope-P7 an unbeatable value in beam analysers.

#### Notebook PC Portability

BeamScope can also work with your notebook PC to give a portable unit with a small footprint. The CB1H from Magma™ interfaces the BeamScope head and its PCI Card to the Cardbus port on your Notebook PC.

#### Perfect For R&D, QA & Production

R&D users will appreciate the comprehensive range of analytical functions. QA & Production engineers will appreciate the ability to save test configurations as JOB files, and to indicate Pass/Fail on-screen.

#### Unparalleled M<sup>2</sup> Measurements

The BeamScope™ P7 optional M<sup>2</sup> accessory is unlike any other on the market. There are no complicated adjustments, yet the user can achieve highly repeatable measurements. The software automatically takes more frequent measurements in the waist area in order to accurately determine the true waist diameter.





#### 23 x 45 mm 2-D Scan Stage

DataRay's latest beam profiling innovation offers extraordinary 0.2% (512 x 512 pixels) resolution, down to 5 x 5 µm (HxV), over beam areas up to 23 x 45 mm. 2-D scan results display in the integral imaging software for area image analysis.





### BeamScope-P7 Product Specifications

Measurable Sources	CW Pulsed sources: >5kHz Pulse Repetition Rate @ 5% duty factor. Higher PRR is better.
Measured Beam Powers	See the graph in the Notes, below. E.g. 6 μW to 3W, for a 1mm diameter (1/e <sup>2</sup> ) Gaussian beam @ 633nm, 5μm slit.
Optical Dynamic Range	55dB (= 300,000:1) [75dB with Neutral Density 2.0 film (3.5" diskette cut-out) after slit]
Shape of Maximum Scanned Area	Important: For accurate measurements, beamwidth should be <0.5 x Scan Dimensions With /EPH extended probe head, dimension 23mm below, becomes 35mm.
Pinholes (PA series)	 Shape <u>Cross Scan x Scanned Length</u>
Single Slits (SS series)	Line Scan Pinhole diameter x 23mm
X-Y Slits (XY series)	Rectangle 7* x 23mm, (*5 for Ge, 3 for InAs, 1 for II-VI)
2-D Stage (M2B)	Trapezoid 5* x 15/5mm, (*3 for Ge, 2 for InAs; 0.7 for II-VI; 3.5 x 13.5/6.5 for XYPI5) Rectangle 45 x 23mm scanned area image. Scans a pinhole over this area.
Measured Beam Diameters/Widths	0.5μm to ~25mm (Defined as the 1/e <sup>2</sup> diameter, = 13.5% of peak for Gaussian beam)
Measurement Resolution	0.5μm, or 0.5% of the measured beam diameter, whichever is greater
Measurement Accuracy	±1μm ±2% of measured beam diameter
Measured Beam Profiles	X & Y Linear & logarithmic profile display modes
Measured Profile Parameters	Gaussian beam diameter Gaussian fit Second Moment beam diameter Knife-Edge beam diameter Centroid position, relative and absolute Ellipticity + Orientation of Major Axis Beam Wander display
Displayed Profiles (Note 1)	X only, Y only, X & Y 2-D plot (10,16 or 256 colours) 3-D plot (10,16 or 256 colours)
Update Rate	1 to 2 Hz. Depends upon the PC Processor Speed, Scanned Profile & Selected Options
Data Analysis	Pass/Fail Averaging Standard Deviation
Power Measurement	On all measured parameters, on-screen, in selectable Pass/Fail colours Beam Diameter Running Average and Accumulating Average options On Accumulation Averaging Screen
Source to Slit Distance	Units of mW, dBm, dB, % or user entered (relative to a reference measurement provided by the user.)
Aperture sizes (Note 2 )	1.0 mm minimum
Slits	Important: See Scanned Area (above ) for measurable beam dimensions 2.5, 5, 10, 25 and 100 μm wide 7mm long (Planar version of 5μm slits are 5mm long)
Pinholes	5, 10, 25 and 50μm diameter (Larger or smaller pinholes to special order)
Wavelength Range	
Silicon Detector	190 to 1150nm
Germanium Detector	800 to 1800nm
Indium Arsenide Detector	1.5μm to 4μm
II-VI Detector	3μm to 12μm
Dimensions	
Probe Style Head	Across axis width x Height x Along axis depth 115 x 51 x 62mm (4.5 x 2.0 x 2.5 inches) [Probe fully extended width: 140mm (5.9")] Dual slit centre-to-centre separation 10mm Bottom end separation 5mm for 7mm long slits.
Dual slit separation	
Mounting	<sup>1</sup> / <sub>4</sub> -20 & M6 threaded mounting holes
Weight Probe Style Head	540 gm (1.2 lb)
Temp. Range (inc. Accessories)	
Operating	10° to 35°C
Storage	5° to 45°C
Minimum PC Requirements	300 MHz Pentium III (500 MHz or better preferred) running Windows 98, Me, NT, (Mac version is not available) 2000, XP; 4 MB RAM; PCI Half-Slot; 10 MB Hard Drive space; SVGA (600x800) monitor.

**Notes:** 1. The 2-D and 3-D profiles are 'reconstructed' from the X-Y scan, making the assumption that the measured X beam profile is the same for all values of Y, and that the measured Y beam profile is the same for all values of X. 2. In Slit (or Pinhole) mode, the slit/pinhole width should be ≤1/3rd of the diameter of the beam under measurement. For X-Y slit pairs inclined at ±45°, the ratio is approximately 1/5<sup>th</sup>. E.g., for any beam below 20 μm diameter, use the 2.5 μm slits wherever possible. In Knife-Edge mode, the slit width should be ≥3x the beam diameter. For X-Y slit pairs inclined at ±45°, the ratio is ≥4.3 times the beam diameter.

#### Power Limit

The graph allows you to simply determine the approximate maximum optical power that BeamScope can measure without additional attenuation. **PxS** is the **Power Limit in Watts**.

To calculate the power limit at the laser wavelength:

1. Read **PxS** off the graph: \_\_\_\_\_ **W** @ \_\_\_\_\_ **nm**
2. Calculate **S**. Take care to use the same units for aperture & beam:

Sampling Factor **S** is given by:

a) Pinholes: **S** = (Pinhole diam./Beam diam.)<sup>2</sup>

b) 1/e<sup>2</sup> Beam Diam.<Slit width: **S** = 1.0

c) 1/e<sup>2</sup> Beam Diam.>Slit width:

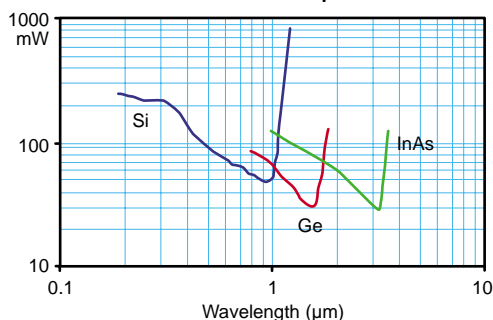
**S** = -1.8 x (Slit width/Beam diam.)

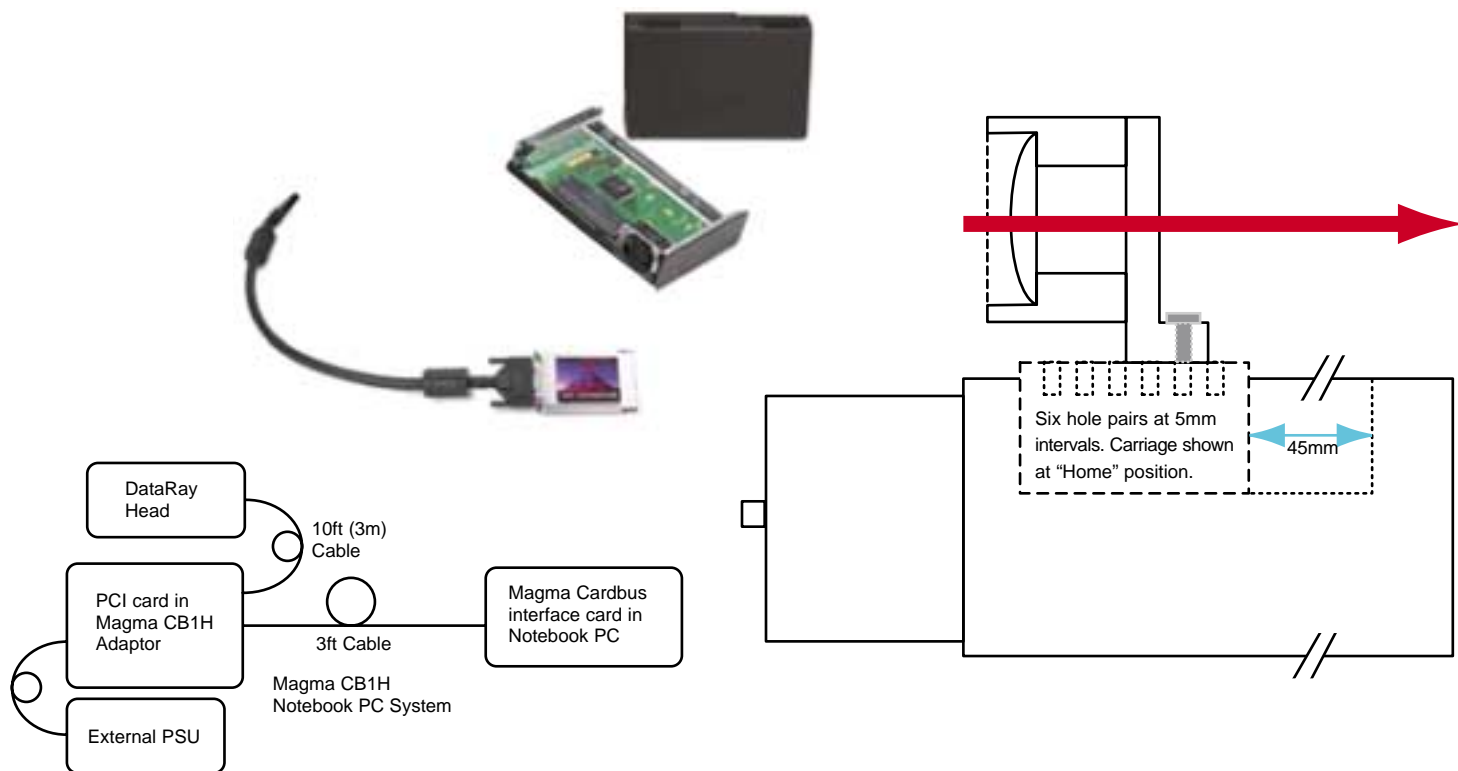
**S** = \_\_\_\_\_ for a \_\_\_\_\_ μm/mm slit/pinhole and a \_\_\_\_\_ μm/mm beam

3. Calculate **(PxS)/S** to get an answer in **Watts**

Add neutral density film\* behind the slit for higher power densities. (\*3.5" diskette material is ND ~2.0)

#### Approximate Saturation Beam Power 100μm Beam Diameter, 5μm Slit



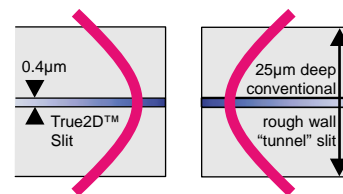
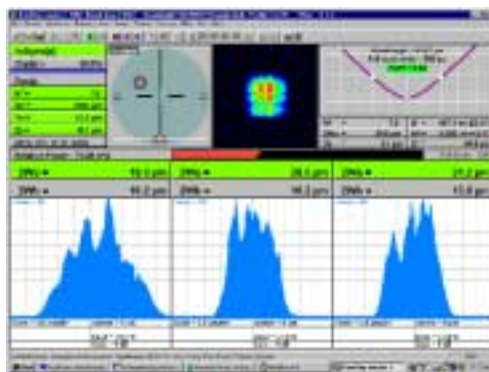


<b>M<sup>2</sup> Accessory / 2-D Stage Specifications</b>	
<b>Lens</b> (Detached for 2-D Stage Operation)	Coated Achromat, λ/4 @ 550 nm Focal Length 85 mm ( ±1.5 mm or ±2 %) Clear Aperture 17.5 mm
<b>Stage Travel / Step Size</b>	45 mm / 2.5 μm
<b>Dimensions</b>	Across axis width x Height x Along axis depth
M <sup>2</sup> Accessory / 2-D Stage	71 x 87 x 140 mm (2.8 x 3.5 x 5.6 inches)
M <sup>2</sup> Accessory Plate	50.4 x 6.3 x 127 mm (2.0 x 0.25 x 5.0 inches)
<b>Weight M<sup>2</sup> Accessory</b>	680 gm (1.5 lb)

<b>Part Numbers</b>	<b>BeamScope Products &amp; Accessories</b>
<b>Specifying a system</b>	You will need a <b>PCI-BS7</b> , a <b>7___</b> head, plus additional apertures & accessories as necessary. E.g. PCI-BS7 + 7XY5 for 5μm XY slits E.g. PCI-BS7 + 7GPA10 for a 10μm Pinhole with a Germanium Detector Software + Half-slot PCI Card + 3m long cable with D-15 connectors
<b>PCI-BS7</b>	Software + Half-slot PCI Card + 3m long cable with D-15 connectors
<b>Head examples</b>	
<b>7XY5</b>	Head, Probe Style, Silicon Detector, with <b>XY5</b> 5μm X-Y Slits
<b>7GY5</b>	Head, Probe Style, Germanium Detector, with <b>XY5</b> 5μm X-Y Slits
<b>7IXY5</b>	Head, Probe Style, Indium Arsenide Detector, with <b>XY5</b> 5μm X-Y Slits
<b>/EPH</b>	Suffix for +10mm Extended probe head, for probing deeper recesses
<b>PA5</b>	Pinhole 5μm diameter
<b>PA10</b>	Pinhole 10μm diameter
<b>PA25</b>	Pinhole 25μm diameter
<b>PA50</b>	Pinhole 50μm diameter
<b>SS2.5</b>	Single Slit 2.5μm wide x 3mm long
<b>SS5</b>	Single Slit 5μm wide x 7mm long
<b>SS10</b>	Single Slit 10μm wide x 7mm long
<b>SS25</b>	Single Slit 25μm wide x 7mm long
<b>SS100</b>	Single Slit 100μm wide x 7mm long
<b>XY2.5</b>	X-Y Slit 2.5μm wide x 3mm long @ ±45° Planarity ± ~40μm
<b>XY5</b>	X-Y Slit 5μm wide x 7mm long @ ±45° Planarity ± ~40μm
<b>XY10</b>	X-Y Slit 10μm wide x 7mm long @ ±45° Planarity ± ~40μm
<b>XY25</b>	X-Y Slit 25μm wide x 7mm long @ ±45° Planarity ± ~40μm
<b>XY100</b>	X-Y Slit 100μm wide x 7mm long @ ±45° Planarity ± ~40μm
<b>XYPI5</b>	Dual planar X-Y Slit 5μm wide x 5mm long, planarity set to ± 4μm (for tightly focused beams).
<b>M2D</b>	M <sup>2</sup> Accessory/2-D Stage, 45mm scan/2.5μm steps, + 3m long RJ-45-style cable + M <sup>2</sup> lens Includes M2-AAP and 2D-AAP
<b>M2-AAP</b>	M <sup>2</sup> Accessory Adaptor Plate + Screws. (Attaches M2D to BeamScope for M <sup>2</sup> scan)
<b>2D-AAP</b>	2-D Scan Stage Adaptor Plate + Screws. (Attaches M2D to BeamScope for 2D Scan)
<b>CB1H</b>	Magma CB1H interfaces PCI card to Notebook PC via Cardbus interface



BeamMap / Beam'R Head



## Laser Beam Profiling ... the Next Generation

### Beam'R™

- 0.1µm Resolution Beam Profiling

### BeamMap™

- RealTimeM<sup>2</sup>, Profiling, Divergence, Focusing, & Alignment

#### ... Next Generation Thin Slits

Profile tightly focused beams more accurately with 0.4 µm thin, True2D™ slits.

#### ... Next Generation Dual Mode

High dynamic range Slit mode plus 0.1 µm resolution Knife-Edge mode, in one head.

#### ... Next Generation Stability

Virtually jitter-free fine beam profiling at a 5 Hz update rate.

#### Beam'R combines all this with single plane scanning

of 2.5 & 50 µm slit pairs (wider slits for longer wavelengths):

- Real-time linear & log X-Y profiles, plus centroid
- Resolution <0.1µm or 0.05%, 1µm to >3mm
- Detectors for 190nm to 4µm

#### BeamMap adds patent-pending, multi-plane scanning to measure:

- Focus position & Waist diameter
- Real-time M<sup>2</sup>, Divergence and Collimation

By measuring in multiple planes, BeamMap identifies the direction of the focus position. It dramatically simplifies the diagnosis of focusing and alignment errors & the setting of multiple assemblies to the same focus. Each unit comprises a compact head, a single PC card and Windows® 95, 98, NT compatible software. Evaluate precision laser & fibre optic assemblies in R&D, QA & Production.

#### Typical Applications:

- Laser & Laser Assembly Verification

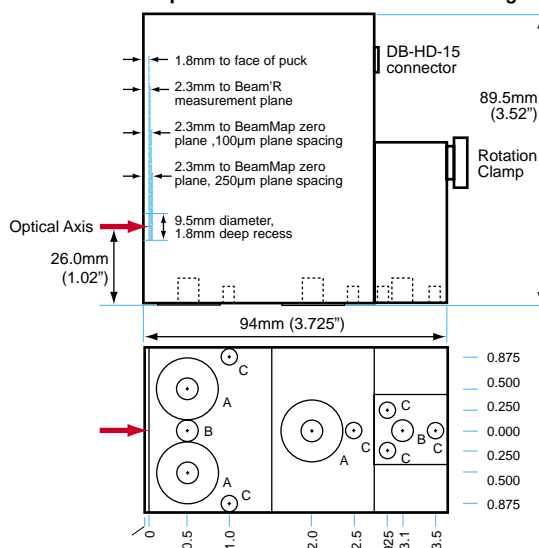
e.g. Precision Focused Assemblies for

- Disk/Wafer Characterisation
- Laser Printing/Marking
- Medical Lasers
- Diode Laser instruments ... etc.

- Lens Focus Testing for short focal lengths

- Fibre Optic Telecom assembly focusing BeamMap/Beam'R head

#### BeamMap/Beam'R Head Outline & Mounting



[Dimensions in inches. Specified accuracy ± 0.003" [ ± 0.1 mm ] 1" = 25.4 mm]  
 Holes 'A' Tapped 1/4-20 x 0.30" deep on a pedestal 0.75" diameter, 0.020" high.  
 Holes 'B' Tapped 1/4-20 x 0.30" deep.  
 Holes 'C' 0.128" diameter x 0.30 inches deep, dowel pin location hole.  
 Overall Head Dimensions: 94.0 x 89.5 x 50.8 mm (3.725" x 3.52" x 2.00")

#### BeamMap

BMS250/Si	Complete system, PC-BM plus BMH250/Si
BMS250/IGA	Complete system, PC-BM plus BMH250/IGA
BMS250/IA	Complete system, PC-BM plus BMH250/IA
PC-BM	PC-BM: PC Card + Software + Cables + Manual
BMH250/Si **	Silicon detector head, 2.5 µm slits, 250 micron plane separation
BMH250/IGA **	InGaAs detector head, 5 µm slits, 250 micron plane separation
BMH250/IA **	Indium Arsenide detector head, 10 µm slits, 250 micron plane separation

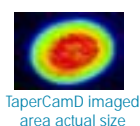
\*\* Standard unit has 250µm plane spacing. 100µm, 500µm or 5mm (3 plane collimation version) plane spacing equally available.

#### Beam'R

BR/Si	Silicon detector; 2.5 µm & 25 µm XY dual axis Slits
BR/IGA	InGaAs detector; 5 µm & 50 µm XY dual axis Slits
BR/IA	Indium Arsenide detector; 10 µm & 50 µm XY dual axis Slits

Parameter	Specification	BeamMap	Beam'R	Technique
Wavelength options:	190-1150nm; 800-1750nm; 1-3.5µm	Yes	Yes	Si, InGaAs, InAs detectors
Scanned beam diameters:	0.5µm to >3mm (2mm for InAs)	Yes	Yes	Si, InGaAs, InAs detectors
X-Y Profile & Centroid	-	Yes	Yes	Slit scan
Resolution:	0.1µm or 0.05% of range	-	-	-
Accuracy:	± <1% ± <0.5µm	-	-	-
X-Y-Z Focus Finder:	± 2µm over up to 1mm z range	Yes	X-Y only	Multi-plane profiles
Beam alignment:	± 2mrad over ± 100mrad	Yes	-	Multi-plane profiles
M <sup>2</sup> measurement:	1 to >20, ± 5%	Yes	-	Multi-plane profiles
Real-time update:	5Hz	Yes	Yes	Custom stepper motor
Maximum Power & Irradiance:	1W Total & 1mW/µm <sup>2</sup>	Yes	Yes	Sapphire slits
Optical Dynamic Range:	Si:38 dB; InGaAs: 36 dB; InAs: 28 dB	Yes	Yes	Auto & Manual gain modes
Display graphics:	X-Y position; Profiles, Zoom x1 to x16. BeamMap only: M <sup>2</sup> , Focus; Divergence, Axial misalignment			
Measurement Analysis:	On-screen, for values & graphics, in selectable Pass / Fail colours			
Averaging:	User selectable running average (1 to ∞ samples)			
Statistics:	Min., Max., Mean, Standard Deviation. Log data over extended periods.			
Waist diameter measurement:	Second moment (4σ) diameter to ISO 11146; Fitted Gaussian; 1/e <sup>2</sup> (13.5%) width; User selectable % of peak; Knife-Edge mode for very small beams			

[Specifications are subject to change without notice.]



## WinCamD™ Digital CCD Beam Profiling

### WinCamD™

#### 1.4 MegaPixel plus 14-bit ADC

- 14-bit ADC is standard
- 48 dB optical dynamic range from software slider electronic shutter, 16 μs to 1 s, 16 μs steps
- Accepts Pulsed laser TTL trigger
- Variable capture region, 1 x 1 to 1200(H) x 1024(V) pixels
- Window removed - no fringing
- For Windows 98, Me, 2000, XP No IRQ's. < Half-size PCI card
- UV & IR system options
- Notebook PC option

Actual imaged areas: 300 - 1150 nm Silicon CCDs:

- WinCamD™ 6.3(H) x 4.8(V) mm (1/2" format) progressive scan CCD with 1.4 MPixels, 4.65 μm square.
- WinCamD/IR IR version for Telecom C & L bands. 45 μm FWHM Point-spread function.
- TaperCamD™ 14.4(H) x 10.8(V) mm with 2.27:1 fibre optic taper\* on 1M4 CCD;
- TaperCamD20/15 19.6(H) x 14.8(V) mm with 3.1:1 fibre optic taper\* on 1M4 CCD;  
\* +/- 2% barrel/pincushion distortion, some fibre bundle structure

**DataRay Innovation** - The company that brought you the first Windows-based CCD beam profiler profiler, the first thin camera for confined beam spaces, the first software slider controlled continuous electronic shutter, the first standard window-free CCD for no fringing, and the first auto-orientation on the beam ellipse ... has done it again:

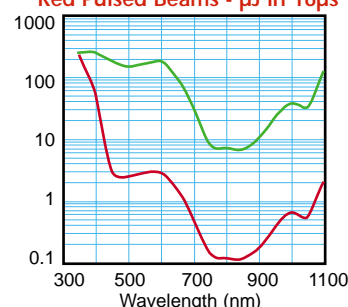
WinCamD is the digital beam profiling camera you have been waiting for:

- 14-bit ADC standard in the head – always more than enough
- TTL input trigger for pulsed lasers
- Compact camera head
- High electronic shutter dynamic range, 6x10<sup>4</sup> : 1
- IRQ-free operation under Windows 98, Me, 2000, XP
- Digital head-to-card cable for low EMI pick-up
- Flexible 6-pin FireWire-style serial cable, length to 10 m.
- Large area TCam™ options up to 20 x 15 mm
- XY profiles and centroids, Gaussian and Top Hat fits.
- Ellipticity: Auto-orientation, Major, Minor & Mean Diams.
- Background capture and subtraction
- User-set Spatial and Intensity Zoom plus smoothing filter
- Image Averaging, 1, 5, 10, 20 & Continuous.

- 3 year warranty
- Free software upgrades
- 30 day sale or return evaluation

Part Number	Description
WinCamD	Complete working system for 355 to 1100 nm
TaperCamD	Complete working system for 355 to 1100 nm 14.4(H) x 10.8(V) mm. 10.6 μm pixels
TaperCamD20/15	Complete working system for 355 to 1100 nm. 19.6(H) x 14.8(V) mm. 14.4 μm pixels
WinCamD/UV	Complete working system for 266 to 355 nm
WinCamD/1300	Complete working system for 355 to 1350 nm
WinCamD/IR	Complete working system for 1480 to 1680 nm
TaperCamD/IR	Complete working system for 1480 to 1680 nm 14.4(H) x 10.8(V) mm. 10.6 μm pixels
Cameras	Additional cameras are available separately. The standard PCI card has two inputs.
ND1.0 to ND 4.0	Neutral density filters in ND 1 steps in stackable C-mount threaded holders

Saturation Limits: 1mm Beams  
Green: CW beams - mW  
Red Pulsed Beams - μJ in 16μs



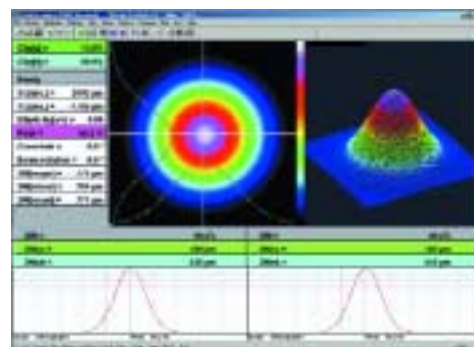
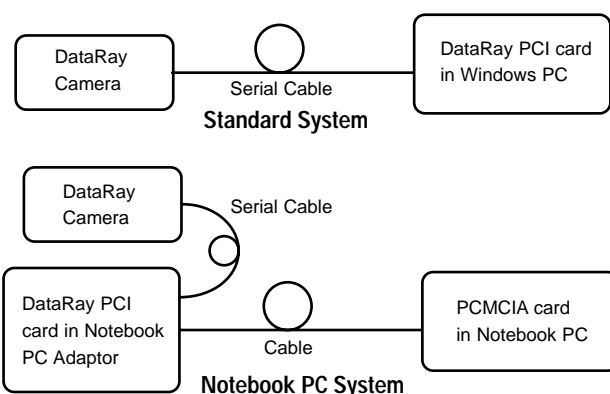
### Maximum Power Graph

The graph allows you to simply determine the approximate maximum optical power that WinCamD can measure *without additional attenuation*. In both cases the Saturation Limit assumes:

- A 1/e<sup>2</sup> (13.5% clip level) beam diameter of 1mm
- The provided ND 4.0 filter in place
- The electronic shutter set at 16μs, its lowest value
- The CCD amplifier gain set at 1, its lowest value
- The total power does not exceed 1W total

**CW Laser:** The upper (green) line is the Limit for CW Lasers in mW. E.g. At 633nm the Saturation Limit for a '1mm HeNe' is ~150mW. For a 0.1mm diameter beam the limit is 10<sup>2</sup> less at ~1.5mW. For a 3mm diameter beam the limit *would* be 3<sup>2</sup> greater at ~1.35W, but since this exceeds the 1W total, the limit would be 1W.

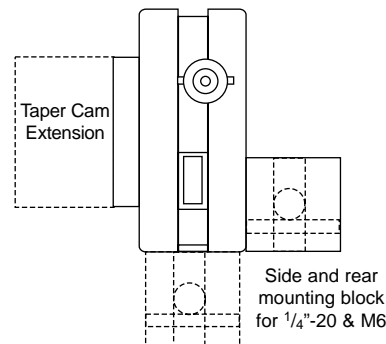
**Pulsed Lasers:** The lower (red) line is the Limit for Pulsed Lasers in μJ of energy within 16 μs (the minimum shutter period). E.g. At 1064nm the Saturation Limit for a '1mm Nd:Yag' is ~1 μJ in 16μs. If the Pulse Repetition Rate is ≤6kHz this is 1μJ per pulse. If the Pulse Repetition Rate is >6kHz this is <1μJ per pulse. For a 0.1mm diameter beam the limit is 10<sup>2</sup> less at ~0.01μJ in 16μs. For a 3mm beam the limit rises by 3<sup>2</sup> to 9μJ per pulse...except that the 1W limit means that the PRR must not exceed ~50kHz.





## WinCamD Series Specifications

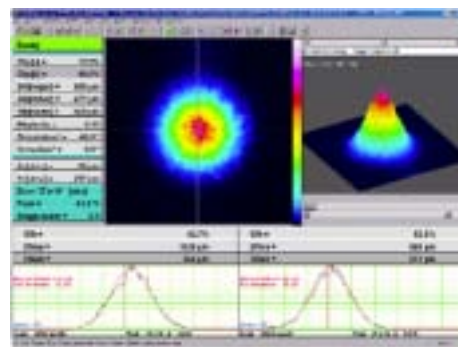
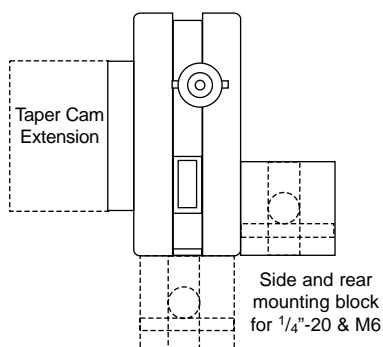
Measurable Sources	CW beams, Pulsed sources. 1Hz to ~50 kHz with single pulse isolation User configurable Synchronous, Asynchronous & Variable Delay trigger options. Software programmable trigger input, +ve or -ve edge, 50 Ω or 1 k Ω
Measured Beam Powers	See the Maximum Power Graph and Notes, below. E.g. ~2 μW to 100 mW, for a 1 mm diam. Gaussian beam @633 nm. (ND4 filter on)
Wavelength Range:	
WinCamD	350 to 1150 nm [Works down to 190 nm, but degrades over time.]
WinCamD/1300	Response to 1350 nm.
WinCamD/IR	1480 to 1680 nm
WinCamD/UV	<266 to 1150 nm. Also Startech UV imaging plate cameras for <350 nm are available from DataRay, with options down to X-ray. Contact DataRay.
Electronic Dynamic Range	
CW beams	48 dB (60,000:1) for ~30 dB SNR, using variable electronic shutter + 7.5 dB (5,7:1) for ~30dB SNR, using CCD gain control only.
Pulsed, Pulse-width <5 μs	7.5 dB (5,7:1) for ~30 dB SNR, using CCD gain control only.
Pulse-width >5 μs	7.5 dB + [Pulsewidth /5 μs]:1
Manual Beam Attenuation, all beams:	Provided ND 4.0 C-mount Neutral Density filters. [ND 4.0 at 546 nm, higher in blue and UV, lower in near IR.]
Options:	EAM-2 4-wheel stepped variable attenuator, 0 to 90 dB CUB and CUB-UV 3 to 10 % beam samplers for high power beams 1% and 0.05% Holographic Beam Samplers (by gentec electro-optics) See additional data sheets at website and User Manual.
ADC converter	14-bit ADC in head. All models.
Imaged Beam Dimensions	For the best results, beam diameter should not exceed half the array dimensions.
WinCamD	Directly: 50 μm diameter to 6.32 x 4.76 mm 1360 x 1024 pixels, 4.65 μm square
TaperCamD	Directly: 120 μm diameter to 14.2 x 10.7 mm. Effective pixels 10.5 μm square 2.27:1 fibre optic taper on 1M4 CCD.
TaperCamD20/15	Directly: 150 μm diameter to 19.6 x 14.8mm. Effective pixels 14.4 μm square 3.1:1 fibre optic taper on 1M4 CCD. Smaller, or indefinitely larger beam diameters can be imaged. Contact DataRay.
Measurement Accuracy	<1 μm processing resolution
Measured & Displayed Profile Parameters	Beam Diameter: Diameter at user defined Clip level Gaussian & Second Moment beam diameters Equivalent diameter above a user defined Clip level Equivalent Slit and Knife Edge diameters Beam Fit: Gaussian profile fit & % fit Top Hat profile fit & % fit Equivalent Slit profile Ellipticity: Major, Minor & Mean diameters. Auto-orientation of axes. Centroid Position: Relative and absolute Intensity Weighted Centroid and Geometric Centre Beam Wander Display and Statistics Filtered profile: 0 to 1 % triangular running average to smooth noisy profiles
Displayed Profiles	X & Y with superimposed Gaussian or Top Hat fit. Zoom x1 to x10 User set curves showing % acceptable deviation from Gaussian
Displayed Plots	2-D & 3-D plots (10, 16, 256 or max. colours or gray). Colour contours at 10% intervals
Processing Options	Zoom x1 to x32 Image & profile averaging, 1, 5, 10, 20, Continuous Background Capture and Subtraction User set rectangular or elliptical Capture region
Update Rate	*.job files save all WinCam custom settings for particular test configurations >5 Hz maximum for full frame, full screen on 1M4 chip (no interlacing) >20 Hz for 512 x 512 pixels Higher rate for smaller capture regions.
Data Analysis	
Pass/Fail display	On-screen, in selectable Pass/Fail colours. Ideal for QA & Production.
Averaging	Beam dimension running average up to 50 samples
Power Measurement	Units of mW or user choice (relative to a reference measurement input) Fluence, within user defined area
Sensor Depth	~14 mm optical distance from front of ND filter holder to CCD chip. ~7.5 mm optical distance from camera face to CCD chip.
Dimensions	Across axis width x Height x Along axis depth [inc. ND filter, 5.7 mm (0.23") thick]
Camera Head (See drawing)	115* x 61 x 22 mm (4.5 x 2.4 x 1.07 inches) *~150 mm (~6") with cable connected.
Mounting	Universal mounting block •-20 and M6 threaded and clearance mounting holes
Weight, Camera Head	230 gm (0.5 lb); 310 gm (0.7 lb) with Mounting block
Recommended Minimum PC Requirements:	700 MHz Pentium III running Windows 98, Me., 2000 or XP; 256 MB RAM; PCI Slot; 10 MB Hard Drive space; 1024 x 768 monitor.
(Mac version is not available)	Notebook PC Third party adaptor available. Contact factory.



## The Advantages of 14-bit Analog to Digital Conversion and 'Digital' cameras

**ADCs.** The first CCD beam profilers (in the early 90's) were relatively noisy. 8-bit (256 level) ADCs could adequately sample the signal and the noise if the peak signal was close to saturation. As CCD noise & ADC prices decreased in the late 90's, some manufacturers offered 10-bit (1024 level) and 12-bit (4096 level) ADC options, though for a significant price increase. With WinCamD, DataRay deletes the 'How many ADC bits can I afford?' dilemma from the buying equation. Taking advantage of the latest lower noise Sony CCD chips (10 to 11-bit equivalent noise) and of ADC price reductions, we provide a 14-bit (16,384 level) ADC on all WinCamD systems. For the customer this gives ultimate room temperature performance at no extra cost.

**"Digital" cameras.** In WinCamD, the software talks directly to the CCD chip, avoiding the limitations of the manufacturer's driver chipset. This enables external trigger, wider shutter speed control and user-defined image capture regions with higher update rates. Placing the ADC in the head allows a digital link from head to PC card, insensitive to the EMI (Electro-Magnetic Interference) problems that can plague analog video links in high power pulsed laser measurements.



## WinCamD/IR™ Telecom Beam Digital Imaging

### WinCamD/IR™

- 14-bit ADC is standard.
- 48 dB optical dynamic range with software slider electronic shutter, 16µs to 1s, 16µs steps.
- CW & Pulsed lasers; TTL trigger.
- Variable capture region, 1 x 1 to 1360(H) x 1024(V) pixels
- Window-free CCDs – no fringes.
- Windows 98, Me, NT, 2000, XP No IRQ's. < Half-size PCI card.
- UV & Visible system options.
- Notebook PC option.

#### Actual imaged areas:

1310 & 1475 - 1600 nm, IR phosphor-on-Silicon CCD. 25 µm FWHM point spread function.

- **WinCamD/IR** 6.3(H) x 4.8(V) mm (1/2" format)  
progressive scan CCD for Telecom C & L bands
- **TaperCamD/IR™** 14.4(H) x 10.8(V) mm with 2.27:1  
fibre optic taper; < +/- 2% barrel/pincushion distortion

- **Notebook PC option**
- **3 year warranty**
- **Free software upgrades**
- **30 day sale or return evaluation**

Part Number	Description
WinCamD/IR	Complete working system
TaperCamD/IR	Complete working system
WCamD/I R	Additional WcamD/IR camera only
TCamD/IR	Additional TCamD/IR camera only
ND0.5 to ND 4.0	ND filters in stackable C-mount holders

#### WinCamD/IR Additional Product Specifications

Measured Beam Powers/Irradiance	E.g. ~20 µW to 100 mW, for 1 mm diam. @1550 nm. (0.02% @ 1550 nm ND filter on)
See website for graphs	See wavelength response for other λ's. Exposure is 16 µs to 1000 ms.
Manual Beam Attenuation, all beams:	Provided C-mount Neutral Density filters, blocks lab light
Options:	<b>EAM-2</b> 4-wheel stepped variable attenuator, 0 to 90 dB See website.
Imaged Beam Dimensions	For the best results, beam diameter should not exceed half the array dimensions.
WinCamD	Directly: 50 µm diameter to 6.32 x 4.76 mm 1360 x 1024 pixels, 4.65 µm square
TaperCamD	Directly: 120 µm diameter to 14.2 x 10.7 mm 1360 x 1024 pixels, 10.5 µm square 2.27:1 fibre optic taper on 1M4 CCD
<b>Data Analysis</b>	
Pass/Fail display	On-screen, in selectable Pass/Fail colours. Ideal for QA & Production.
Averaging	Beam dimension running average up to 50 samples
Log data and statistics	Min., Max., Mean, Standard Deviation. Up to 4096 samples
Power Measurement	Units of mW, dB, dBm (relative to a reference measurement input) Fluence
Source to Camera Distance	~14 mm optical distance from front of ND filter to CCD chip.
Dimensions	Across axis width x Height x Along axis depth [inc. ND filter, 5.7 mm (0.23") thick]
Camera Head (See drawing)	115* x 61 x 22 mm (4.5 x 2.4 x 1.07 inches) *~150 mm (~6") with cable connected.
Mounting	Universal mounting block 1/4-20 and M6 threaded and clearance mounting holes
Weight, Camera Head	230 gm (0.5 lb); 310 gm (0.7 lb) with Mounting block
Recommended Minimum PC Requirements:	750 MHz Pentium IV running Windows 98, Me, NT, 2000 or XP; 128 MB RAM; PCI Slot; 10 MB Hard Drive space; 1024 x 768 monitor.

WinCamD/IR is the digital telecom beam imaging camera system you have been waiting for:

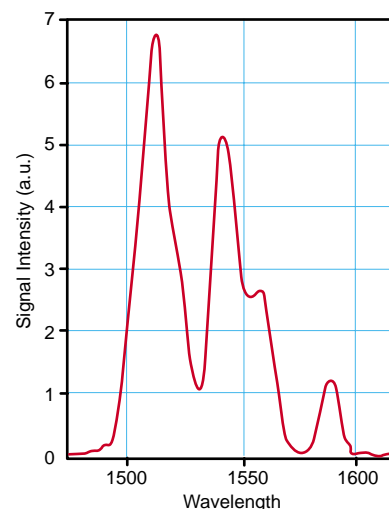
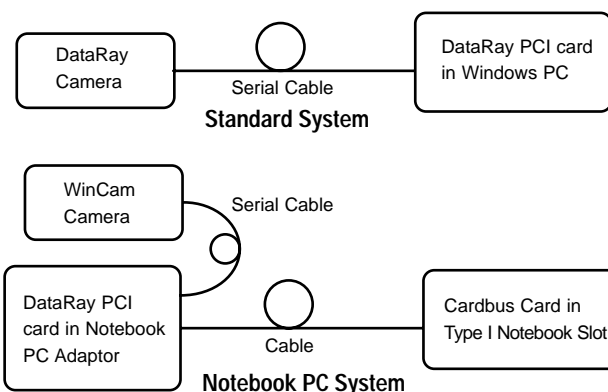
- Auto-exposure mode simplifies setup
- XY profiles and centroids, Gaussian and Top Hat fits.
- Ellipticity: Auto-orientation, Major, Minor & Mean Diams.
- Background capture and subtraction
- User-set Spatial and Intensity Zoom plus smoothing filter
- Image Averaging, 1 to continuous
- Flexible 6-pin FireWire-style serial cable
- <1µm processing resolution

λ Response: 1475 to 1600 as shown. Signal = (Incident Irradiance)<sup>γ</sup>

1310 nm response is ~2 % of 1550 nm response.

Sensitivity: 10 ms exposure on 1 mW, 1 mm beam at 1550 nm.

Corrections: γ correction & response non-uniformity correction.





## LensPlate™

### LensPlate™

#### Applications

- Waveguide reimaging
- Lensed fibre focal spot reimaging
- Fibre end reimaging

LensPlate™ reimages an external beamwaist onto the zero plane of a BeamMap or Beam'R. It employs a pair of diffraction-limited aspheric lenses coated for the wavelengths of interest. These lenses are designed for use with the small beams typical of fibre optics, and are diffraction limited when used at their design distances. The resolution (Rayleigh Resolution) of a lens is defined as  $\sim 0.61 / \text{NA}$ . These numbers are plotted in the table above.

These plates are attached to the front of a Beam'R or low plane spacing BeamMap. They are factory or user attached, & are demountable by the user. The actual magnification 'M' is determined during factory or user calibration and marked on the unit.

#### Important:

- 1) **BeamWaist position.** Note that use of a lens normally implies that it is necessary to focus the minimum of the reimagined beamwaist on the '0' plane, since the factory established magnification is for this condition, and the lens is only diffraction limited within a small range of magnifications.
- 2) **Single mode fibre divergence.** The 1:3.4 lensed units are generally not appropriate for measuring beam divergence from a single mode fibre, since, in general, the re-imagined beamwaist is too flat for accurate far-field divergence determination based on a fitted  $M^2$  curve - see the example below. Use the 1:1 unit if you need to reimage the fibre output, or lensed fibre output. DataRay has also sold the unlensed BMS4XY500/IGA units for such applications.

#### Data Correction for the LensPlate™

Currently the software does not correct these issues. A version which does will be available sometime in Q2 2002.

**Diameter.** Consider a beam with diameter  $2W$  in the measurement plane. It will have a diameter  $M \times 2W$  in the head side. The on-screen beam diameters must be corrected by the factor  $1/M$ .

**Divergence.** In the head plane, this beam diverges by a factor  $1/M$  less than in the measurement plane, so the if the divergence is  $\phi$  mr in the measurement plane, then it will be  $\phi/M$  mr. in the head plane.

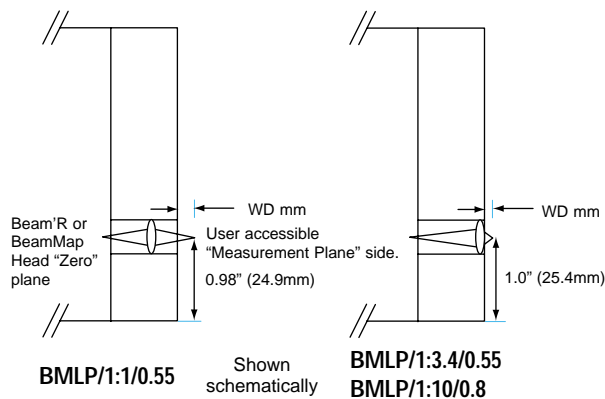
Therefore, in the measurement plane, the beam diameter increases by  $\phi \cdot z$   $\mu\text{m}$  for a distance  $z$  along the propagation axis. In the measurement plane. In the head plane, the beam diameter increases by only  $\phi \cdot z/M$   $\mu\text{m}$  for a distance  $z$  along the propagation axis.

Therefore, the Divergence and NA measurements must be corrected by a factor  $M$ .

**Pointing.** In the head plane, the centroid positions are a factor  $M$  greater than in the measurement plane, so if the divergence is  $\theta$  mr in the measurement plane, then it will be  $\theta \times M$  mr. in the head plane.

Therefore, in the measurement plane, the beam diameter increases by  $\theta \cdot z$   $\mu\text{m}$  for a distance  $z$  along the propagation axis. In the measurement plane. In the head plane, the beam diameter increases by only  $\theta \cdot z/M$   $\mu\text{m}$  for a distance  $z$  along the propagation axis.

Therefore, the Divergence and NA measurements must be corrected by a factor  $M$ .



**Zo.** The calculated Zo value is too high by a factor of  $M$ .  
**Zr.** The calculated Rayleigh range is too high by a factor of  $M$ .  
 **$M^2$ .** Since  $M^2$  is the product of beam diameter and divergence,  $M^2$  in the measurement and head planes are nominally identical. In practise, even though an excellent lens pair is used, the measured  $M^2$  is always going to be some undefinable small factor worse than the actual  $M^2$  of the beam prior to reimaging. To minimise the error, ensure that the beam is well centred in terms of **Xc[abs.]** and **Yc[abs.]**.

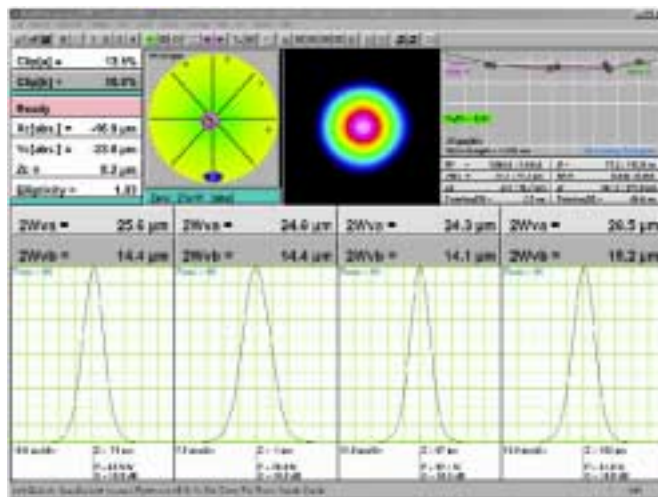
**Xc, Yc.** These numerical and centroid display values are reversed by the lens. Reverse the Xc, Yc values.

#### Summary:

- 1) The **Beam Diameters** must be divided by the magnification  $M$  marked on the unit.
- 2) The **Divergence** and **NA** must be multiplied by  $M$ .
- 3) The **Pointing** must be divided by  $M$ .
- 4) The **Zo** values must be divided by  $M$ .
- 5) The **Zr** values must be divided by  $M$ .
- 6) The  **$M^2$**  values require no correction.

**Example.** The screen on shows an example of a reimaged fibre end at 1310 nm. The actual magnification with the mounted LensPlate was determined as '3.9' by traversing the source by 100  $\mu\text{m}$  and noting the change in the centroid position of 390  $\mu\text{m}$ .

On this basis, the diameter of the fibre end is  $24.7/3.9 = 6.3$   $\mu\text{m}$  at the 13.5% Clip Level ( $1/e^2$ )



#### Specifications

Part # Specify: .../λ in nm	LP/1:1/0.55/λ	LP/1:3.4/0.55/λ	LP/1:10/0.80/λ
Description	0.55 NA LensPlate/1:1	0.55 NA LensPlate/1:3.4	0.80 NA LensPlate/1:10
WD in mm (Working Distance)	2.5	2.5	0.23
Resolution in $\mu\text{m}$ @1550/675 nm = 0.61 /NA	1.7 / .75	1.7 / .75	1.2 / 0.5
Magnification Image/Object	1:1	3.4:1	10.6:1
Applications	1:1 reimaging	Fibre end reimaging	Waveguide & Lensed fibre reimaging



## Laser Sampling & Attenuation Solutions

A line of high performance beam sampling & attenuation accessories which simplify the task of reducing laser beam irradiance (W/cm<sup>2</sup>) to levels suitable for laser beam profilers.



### EAM-2 Variable Attenuator

#### EAM-2

**EAM-2** is a simple-to-use variable attenuator. It consists of a bank of four filter wheels, each with three different filters ranging from 100% transmission down to 0.003 %. This filter bank offers almost continuous attenuation from 0 to more than 93 dB (Optical Density > 9).

The **EAM-2** has three M6 mounting holes and can also connect directly to the C-mount port of a camera. Addition of the **CUB** or **CUB-UV** beam splitter cube allows you to sample light from lasers with higher power density.

**EAM-2** uses Schott NG absorbing filter glass (NG). The filters are laser grade polished to 10-5 scratch-dig and  $\lambda/10$  finish. All filters are mounted at a 4° angle to suppress back-reflection interference fringes.

#### Specifications:

Max. attenuation:	93 dB (OD=9)
Min. attenuation:	0 dB
Max. Power Density:	Power: 1W/cm <sup>2</sup> Energy: 100mJ/cm <sup>2</sup>
Transmission of filters:	See table
Wavelength range:	350 to 2200 nm *
Clear Aperture:	18mm
Angle:	4°
Mounting:	3 x M6 threaded C-Mount thread

\* Attenuation is specified at 516 nm; all absorbing glasses are highly wavelength dependent, particularly into the UV.

#### Attenuation in dB/ Transmission in %:

Wheel #	1		2		3		4	
Filter #	dB	%	dB	%	dB	%	dB	%
1	0	100	0	100	0	100	0	100
2	0.5	90	5	30	20	1	35	0.03
3	1	80	10	10	25	0.3	40	0.01
4	3	50	15	3	30	0.1	45	0.0003

#### Part numbers:

<b>EAM-2</b>	Variable Attenuator
<b>CUB</b>	Beamsplitter
<b>CUB-UV</b>	UV-Beamsplitter
<b>ETCM-2</b>	Tube set with 2 tubes (2 x 50mm tubes + 4 adaptor rings)
<b>ETCM-3</b>	Tube set with 3 tubes (3 x 50mm tubes + 4 adaptor rings)



CUB shown with one ETCM tube mounted.

### CUB & CUB-UV Beam Splitter Cubes

#### CUB / CUB-UV

The **CUB** beam splitter cube takes a fixed ratio beam sample. It uses the front surface reflection from an uncoated laser mirror to achieve a reflection of 3% to 10% of the main laser beam for further analysis. The surface is polished to 10-5 scratch-dig and 1/10 wave finish, wedged at 10 arc-min to avoid interference fringes and can take power densities up to 2MW/cm<sup>2</sup>. Like the **EAM** attenuator it has C-mount ports and can be connected to the **EAM** and your camera with the **ETCM** connecting tubes. It can post mount from an M6 threaded post.

#### Specifications:

Attenuation:	3% to 10% (polarisation dependent)
Spectral range:	CUB: 350-2200nm CUB-UV: 190-2200nm
Clear Aperture:	19mm
Damage Threshold:	50J/cm <sup>2</sup>

#### Application Examples:

##### HPLS High Power Laser Set

A High Power Laser Set consists of a **CUB** or **CUB-UV** beam splitter and the **EAM-2** variable attenuator using the **ETCM-2** tube set.



##### NFAO Near-Field Imaging Optic

A Near Field Imaging Optic consists of an **EAM-2** variable attenuator plus 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.



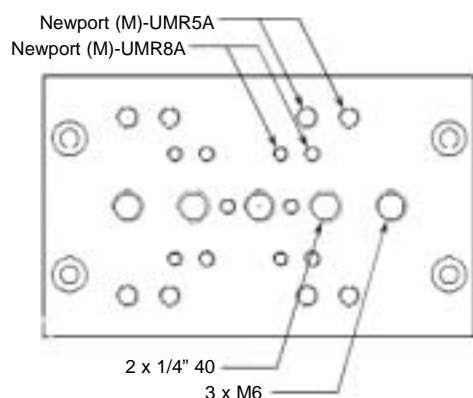


## Shearing Interferometer Device

### SID4

- **Ultra-high transverse resolution (128 x 128)**
- **Easily tunable high dynamic range**
- **Achromatic**
- **Ergonomic**
- **Compacity: IEEE 1394 interface with a laptop (included)**
- **Triggered one-shot, continuous, batch acquisition modes**
- **Multi-user, multi-device interface**

The SID4 wave front sensor product line combines high resolution and dynamic range from interferometry with compacity from self-referencing (shearing). This new ONERA-patented technique\* will allow you to add a new spatial dimension to your laser beam characterisations: the phase.



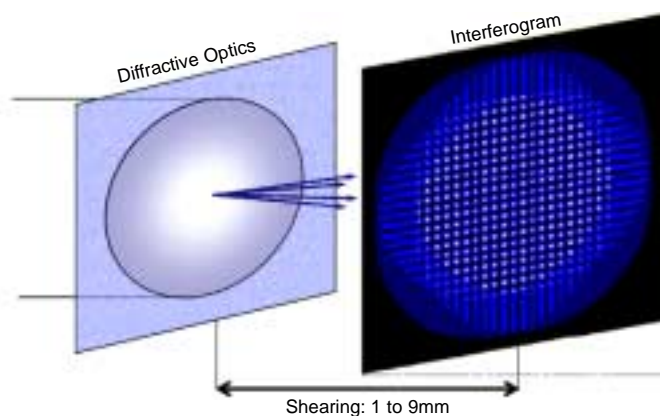
### Specifications

Aperture Dimension	1/3" CCD Chip	
Spatial Resolution	29.6µm	
Phase And Intensity Sampling	128 x 128 (>15000 Points)	
Wavelength Range	SID4-800	800nm ± 300nm
	SID4-1000	1000nm ± 300nm
Tunable High Dynamic Range	From λ/500 To 150 λ Ptv	
Acquisition Frequency	60fps	
Real-Time Processing Frequency	>1Hz	
Dimensions	49 x 35 x 110mm	
Weight	250g/0.5lb	

\* License ONERA & Patents; License Ecole polytechnique/CNRS/CEA/Paris VI

### Principle

The incident beam is split into 4 beamlets which propagate along 4 different wave vectors. Therefore they separate and interfere. A Fourier transform analysis of the interference pattern recovers wave front gradients along 2 orthogonal axes.



### Software Features

#### Beam Analysis:

- **Phase**
- **Intensity profiles**
- **Zernike polynomial**
- **Strehl ratio**

#### Wavefront Reconstruction:

- **Wavefront display:**  
*3D View of phase intensity*

#### Output File Format:

- **Binary**
- **tiff, jpg**
- **Miró**

#### Shooting Modes:

- **Continuous**
- **Real-time**
- **One-shot**
- **Software controlled trigger mode**

