3.7.2 Slit - Based Beam Propagation Analyzer: M²

3.7.2.1 NanoModeScan

The NanoModeScan combines the flexibility and speed of the NanoScan with dedicated M^2 measurement hardware and software. The NanoModeScan provides an automated measurement of M^2 using either the ISO 11146 or the Rayleigh method.

The ISO Method software and hardware report the ISO 11146 parameters:

- Times diffraction limit: M^2
- Beam propagation factor: K
- Beam waist size: d_0
- Beam waist location: Z_0
- Divergence: θ
- Rayleigh range: Z_r

By adding the capabilities of the NanoScan to the ModeScan, the range of possible measurable lasers is greatly expanded and the speed of the measurements dramatically improved. The NanoScan's software controlled variable scan speed allows the measurement of both CW and kHz pulsed lasers with any NanoScan scan head, covering the entire wavelength range from UV to FIR. The NanoScan's rapid beam finding and autoranging speed up the total M^2 measurement to ~20 seconds for CW lasers. NanoModeScan comes with two user selectable lenses to generate the proper artificial waist for the laser source under test. For ease of alignment, there is an entrance iris on the optical axis of the NanoModeScan and a precision alignment stage for horizontal and vertical positioning.

NanoModeScan

The ISO 11146 Method

The ISO 11146 method for measuring the propagation of a laser source calls for the measurement of the beam diameter for at least 10 positions through the waist created by a test lens inserted in the beam path. Five locations should be within ±1 Rayleigh range of the artificial waist and at least five more points beyond two Rayleigh ranges from this waist. These measurements are then used to compute the laser propagation parameters. Once points are selected properly, the ISO Method is the fastest measurement method and best for volume testing of lasers.

The Rayleigh Method

The ISO method requires the user to manually select the measurement points, and changing one or two of the selected points can yield different M^2 values. The Rayleigh method is completely automated, selecting its own measurement points based on mapping the Rayleigh range of the beam waist. This method is fully discussed in the user manual. In addition, the Rayleigh method can yield more consistent results for M^2 values for lasers that are not exactly like those for which the ISO standard was written, such as fiber lasers, lensed diode lasers, and VCSELs.

The NanoScan Difference

With the NanoScan-equipped NanoModeScan, all scan heads can measure pulsed beams with repetition frequencies down to 10kHz. The silicon and germanium detectors will measure less than a milliwatt of power. The pyroelectric detector-equipped NanoScan head can analyze higher power lasers at all wavelengths. The increased dynamic range of the NanoScan enhances the signal to noise ratio of the system and allows a much broader range of laser powers to be analyzed with one instrument setup.

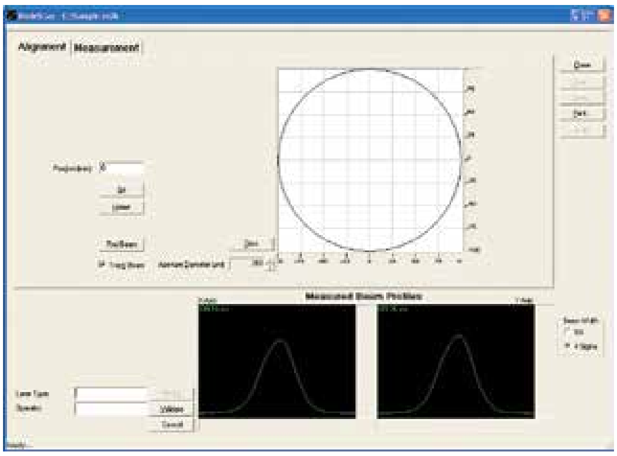
Real-Time Divergence Measurement

By monitoring the divergence angle θ, it is possible to make a measurement that will be directly proportional to M^2. This enables the adjustment of the laser performance in real time at the NanoScan's rapid update rate (up to 20Hz). To use this feature, the scan head is moved to a position one geometric focal length from the test lens. Divergence is the beam diameter divided by the focal length, and the measured divergence is equal to M times the embedded divergence.

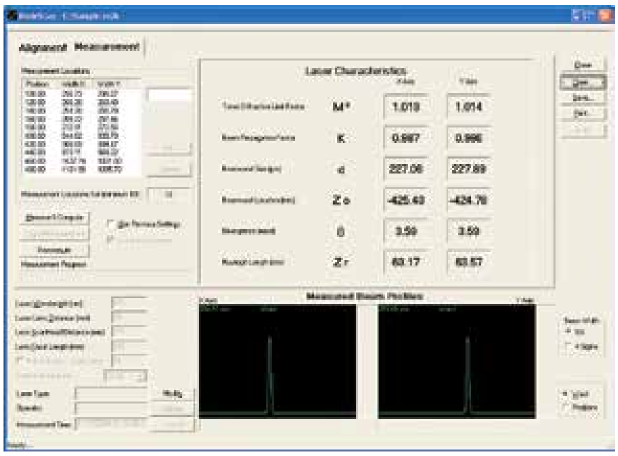
Therefore when the beam diameter at this location is minimized, the divergence is at its minimum and the M^2 of the laser should then be optimized. After this real-time adjustment, the full M^2 measurement can be done to generate the required parameter values. This method makes the NanoModeScan an even more valuable tool for the final setup of lasers on the manufacturing floor by decreasing the time it takes both to adjust the laser system and to make the measurements required for quality control documentation.

Specifications

Sensor/Detector	
Scan head Travel	500mm
Optical Axis Height	140-170mm
Lens	See ordering chart
Minimum Spot Size	See scan head specifications
Computer/Electrical	
Source Power	See scan head specifications
File Saving and Data Logging	Data files, ASCII Files
AC Power	110V, 60Hz standard 220V, 50Hz optional
Communication	RS-232 Interface or USB to RS-232 adapter provided
General	
NanoModeScan Linear Stage	812mm x 102mm x 78mm
Photon Motion Controller	273mm x 89mm x 57mm
Weight	
NanoModeScan Linear Stage	8.4kg
Photon Motion Controller	1.5kg
Compliance	CE, UKCA, China RoHS



Alignment screen in ModeScan software



Measurement results screen in ModeScan software

Ordering Information

All NanoModeScan Systems include (unless otherwise noted):

- High-resolution scanhead with rotation mount
- Two user selectable lenses come with the NanoModeScan
  - 200 mm focal length VIS coated for 430–700nm (not for use with Germanium detector)
  - 400 mm focal length VIS coated for 430–700nm (not for use with Germanium detector)
  - NIR Near IR: 650–1000nm
  - LIR Long IR: 1000–1550nm (not for use with Silicon detector)
  - VLIR: Very long infrared >1550nm. (for use with NMS-NS2s-Pyro/9/5 only)
  - UV: 200 mm focal length lens coated for UV wavelength

Item	Description	P/N
NanoModeScan M² Systems		
NMS-NS2s-Si/9/5	Model 1740 ModeScan with NanoScan 2s Silicon (Si) Detector 9mm aperture 5µm slits Si detector, 63.5mm diameter head, 9mm entrance aperture, and matched pair of 5.0µm wide slits. Use from 190 to 1100nm wavelengths.	PH00477
NMS-NS2s-GE/9/5	Model 1740 ModeScan with NanoScan 2s Germanium (GE) Detector 9mm aperture 5.0µm slits. Germanium detector, 63.5mm diameter head, 9mm entrance aperture, and matched pair of 5.0µm wide slits. Use from 700nm to 1.8µm wavelength.	PH00478
NMS-NS2s-Pyro/9/5	Model 1740 ModeScan with NanoScan 2s Pyroelectric Detector 9.0mm aperture 5µm slits. Pyroelectric detector, 63.5mm diameter head, 9mm entrance aperture, and matched pair of 5µm wide slits.	PH00479
NanoModeScan Accessories		
NanoModeScan comes with two user selectable, must specify at time of order		
LENS 200mm VIS	200mm focal length lens for use 400-700nm wavelength	PH00237
LENS 400mm VIS	400mm focal length lens for use 400-700nm wavelength	PH00238
LENS 100 VIS	100 mm focal length lens for use 400–700nm wavelength	PH00093
LENS 100 NIR	100 mm focal length lens for use 650–1000 nm wavelength	PH00094
LENS 200mm NIR	200mm focal length lens for use 650-1000nm wavelength	PH00239
LENS 400mm NIR	400mm focal length lens for use at 650-1000nm wavelength	PH00240
LENS 100 LIR	100 mm focal length lens for use 1000–1550nm wavelength	PH00095
LENS 200mm LIR	200mm focal length lens for use at 1000-1550nm wavelength	PH00241
LENS 400mm LIR	400mm focal length lens for use at 1000-1550nm wavelength	PH00242
LENS 400 2um	400mm focal length lens for use at @2µm wavelength	PH00224
LENS 190 10.6	7.5-inch focal length lens for use at 10.6µm wavelength	PH00092
LENS 200 UV-XXX	200mm quartz lens for use between 245–440nm wavelengths. Specify use wavelenght in the XXX item description.	PH00090
LENS 350 UV-XXX	Optional 350mm quartz lens for use between 245–440nm wavelengths. Specify use wavelenght in the XXX item description.	PH00091
1740 LENS MNT	Lens mount for users wanting to use their own 25mm diameter lens	PH00075
Model 1740 ModeScan	Rail w/o scan head	PH00447