

3.9 Goniometric Radiometers

LD 8900, LD 8900R Far-Field Profilers

Profiling divergent light sources presents many challenges, but Photon's far-field profilers characterize the angular radiation intensity of light simply and accurately in real time. Both the LD 8900 and LD 8900R (wide dynamic range Goniometric Radiometer) provide full 3-dimensional measurements of the far-field pattern in minutes or less, with far better resolution than a CCD camera. The LD 8900 far-field profiler provides direct real-time far-field measurements with >24dB dynamic range, while the wide dynamic range LD 8900R has a dynamic range of >36dB, which provides greater detail in the "tails" of the far-field pattern. Both models have an angular sampling resolution of 0.055° and a field-of-view of ±72° (144°), and are ideal for characterizing the light flux from many sources, including VCSELs, laser diodes (LDs), optical fibers, optical waveguides, and more. With the LD 8900R, measurement of the mode field diameter of optical fiber is possible in real time with greater than 5% accuracy. The LD 8900 and the LD 8900R are available with either a silicon or InGaAs detector and have a standard entrance aperture of 2mm, with an optional 10mm entrance aperture for use with larger sources such as LEDs and LD bars.

LD 8900 and LD 8900R complete systems include:

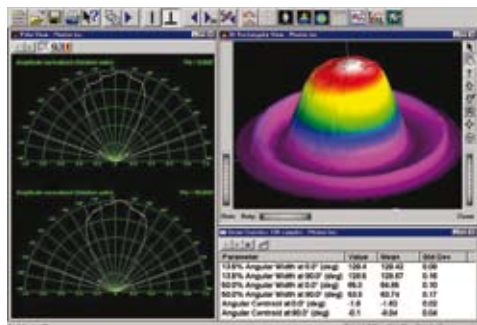
- The Scan Unit
- The Motion Control Module
- Goniometric Radiometer Acquisition and Analysis Software for Microsoft Windows operating systems
- PCI Interface Box
- Power and instrument cables
- An optional semi-custom source mount, specifically designed to meet your application needs, can be quoted upon request for either the LD 8900 or the LD 8900R



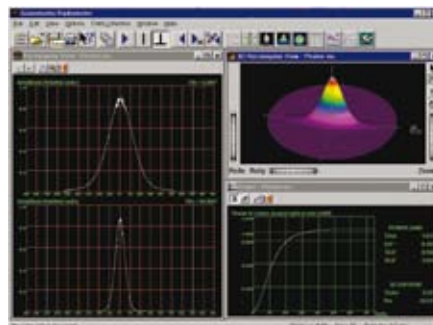
Mode Field Diameter in Real Time with LD 8900R

The LD 8900R allows for real-time measurements of Mode Field Diameter (MFD) with an accuracy of $\pm 5\%$ * for a nominal 10μm single-mode fiber. Mode Field Diameter (MFD) of single-mode optical fiber is measured using the methodology described in the Telecommunication Industry Association/ Electronic Industries Association (TIA/EIA) Standard FOTP-191. Specifically, the MFD is calculated using the Petermann II integral, with data sampled at angular resolution of 0.055° and collected over an angular extent of ±72° (144° viewing angle).

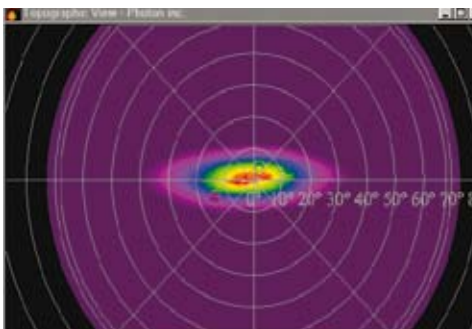
*If greater accuracy is required, Photon's LD 8900HDR is specifically designed to measure MFD and A_{eff} to greater than 0.5%



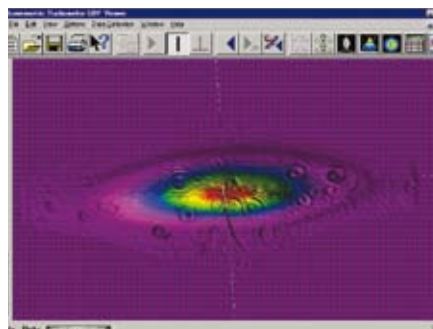
Polar View (left); 3D View (top); Beam Statistics (bottom) with LD 8900R



Windows Showing Uniformity of a Laser Diode



Topographical View - LD 8900R



Laser Diode Diffraction Rings

LD 8900/LD 8900R System Specifications

Sensor/Detector	
Scan Radius	84mm
Pinhole Size	1000µm (options available)
Entrance Aperture	2mm standard (optional 1cm)
Field of View	±72° (144 degrees)
Azimuthal Scans	1, 2, 10, 20, 50, 100, or 200
Spatial Sampling Resolution	0.055 degrees, 3241 points/scan
Spectral Range	
Silicon detector	320-1100nm
InGaAs detector	800-1700nm
Optional UV	190~1100nm
Source Input Power for >400nm	
Mirror Damage Threshold CW	900 W/cm ²
Mirror Damage Threshold Pulsed	1 J/cm ²
LDs, multi-mode fiber w/ NA >0.5	10's of µW to 10's of W*
Single-mode fiber	1µW to 1W**
For wavelengths <400nm	Contact Factory
Higher power options available	Contact Factory
Source Output	CW or Pulsed (rep rates >10kHz)
Parameters Measured	
Angular Widths	FWHM, 5%, 13.5%, 2 user-specified clip levels
Numerical Apertures	FWHM, 5%, 13.5%, 2 user-specified clip levels
Angular Width Ratios	FWHM, 5%, 13.5%, 2 user-specified clip levels
Angular Position	Centroid, Peak
Intensity or Amplitude	Centroid, Peak, 2 user-specified locations
Mode-Field Diameter	LD 8900R only
Relative Integrated Power	Relative Power in user-specified cone angles about an arbitrary axis
Data Update Rates	
Single scan updates:	~ 5Hz
Perpendicular Scan updates	~ 0.5Hz
3D Profile Acquisition Time*	* Times are PC dependent
10 azimuthal scans	~7s
20 azimuthal scans	~14s
50 azimuthal scans	~35s
100 azimuthal scans	~70s
200 azimuthal scans	~140s
File Saving and Data Logging	
	Program Data and Setup Configuration Files
	ASCII file Profiles and Summary Parameters
	Raw 3D Scan Data in binary format
	Screen Captures: BMP, JPG, GIF, TIFF, PNG
	Log to Files and COM Ports
Communications	
	RS-232 Serial COM port required
	ActiveX Automation
Electrical/Mechanical	
AC Power Required	110V ~ 60Hz standard, 220V ~ 50Hz optional (Installation Category: Class II)
Main supply voltage fluctuations:	Not to exceed ±10% of the nominal voltage; Transient overvoltage according to Installation Category II; Pollution Degree 1 or 2 in accordance with IEC 664.
Dimensions mm	
Scanning Unit	318 × 228 × 241
Scanner	203 × 165 × 165
Motion Controller	51 × 89 × 248
Environmental Conditions	
	Indoor use
Temperature	5°C – 40°C
Altitude	Up to 2000m
Maximum relative humidity	80% for temperature up to 31°C decreasing linearly to 50% relative humidity at 40°C

Ordering Information - Goniometric Radiometer Far-Field Profilers

All Goniometric Radiometer LD 8900 Far-Field Profiler Systems include the Scan Unit, PCI Controller Interface, Current MS Windows software, including ActiveX Automation commands.

All LD 8900R systems include the above as well as a dynamic range >36dB with 0dB source. System incorporates 16-bit digitizer, light scatter control and special amplifiers to achieve higher dynamic range than standard LD8900. For pulsed operation, please consult the factory.

Item	Description	P/N
LD8900/InGaAs	Goniometric Radiometer for characterizing the angular radiation intensity from a laser diode between 800nm and 1700nm wavelength. Entrance aperture 2mm.	PH00173
LD8900/Si	Goniometric Radiometer for characterizing the angular radiation intensity from a laser diode between 320nm and 1100nm wavelength. Entrance aperture 2mm. Full 3D capability. Features dynamic range >36dB with 0 dB source.	PH00174
LD8900R/InGaAs	Wide Dynamic Range Goniometric Radiometer for characterizing the angular radiation irradiance from a fiber optic, wave guide, laser diode, VCSEL, or LED between 800nm and 1700nm wavelength.	PH00175
LD8900R/Si	Wide Dynamic Range Goniometric Radiometer for characterizing the angular radiation irradiance from a fiber optic, waveguide, laser diode, VCSEL or LED between 320nm and 1100nm wavelength. Full 3D capability.	PH00176
Options		
WL-O	Wavelength option	PH00183
Pulsed InGaAs Option	Failsafe operation for pulsed sources operating at repetition rates >10kHz with pulse widths >500ns. For operation below 10kHz, there are possible gain saturation states, dependent on repetition rate, pulse width, and source power. Consult the factory when operating under these conditions for failure mode assessment. When questionable, pulsed source operation should be verified against CW operation.	PH00185
Pulsed InGaAs Upgrade Option	Pulsed Upgrade Option to an existing Goniometric Radiometer InGaAs system. Failsafe operation for pulsed sources operating at repetition rates >10kHz with pulse widths >500ns. For operation below 10kHz, there are possible gain saturation states, dependent on repetition rate, pulse width, and source power. Consult the factory when operating under these conditions for failure mode assessment. When questionable, pulse source operation should be verified against CW operation. Includes software upgrade. Contact Factory for details.	PH00186
PCI Controller Upgrade	Interface to allow use with standard PCI interface of desktop PC. Includes an interface box for 9180 controller card, PCI Interface card and cable, and factory calibration and realignment. System should be returned to Photon for installation. Includes software upgrade.	PH00187
Optional Mount of User Device -LD 8900 Mount	Photon will provide one semi-custom mount of customer's laser diode device. Submit device particulars for specific quote. With this option, the instrument can be used immediately and provides one example test fixture.	PH00181
LD8900 Software Viewer	Goniometric Radiometer Software Viewer for LD8900 models (8-bit). Allows users to open, review and re-analyze files that are saved using any PC computer. The Viewer has all the data processing features of the software. You can read files saved.	PH00181
LD8900R Software Viewer		PH00439
Fiber Mount - /FC	Plate and mount for a single mode fiber with FC connector. Label on plate includes reference distance between source and datum plane.	PH00189
Fiber Mount - /SC	Plate and mount for a single mode fiber with SC connector. Label on plate includes reference distance between source and datum plane.	PH00190
Fiber Mount - /ST	Plate and mount for a single mode fiber with ST connector. Label on plate includes reference distance between source and datum plane.	PH00191
Fiber Mount -/BF	Plate and mount for a single mode fiber without connector. Label on plate includes reference distance between source and datum plane.	PH00192
Option to Fiber Mount /BF - / Ribbon	Optional 4-Fiber Ribbon Cartridge for the Fiber Mount /BF (Bare Fiber). Requires /BF.	PH00193
Extended Cable Option - EXT Cable	Cable lengths extended.	PH00184
NIST Reference Standard	N.A. Reference Standard: traceable to NIST for use with Goniometric Radiometer/Far-Field profilers; i.e. LD8900 and/or LD8900R. Data provided: N.A. and Angular Widths at 50%, 13.5% and 5% clip levels, with standard deviation [with a recorded, exact source to aperture distance]. NIST reference standard includes: LD source Single Mode Test Fiber Required Mounting Plate in a storage case.	PH00188

LD 8900HDR Far-Field Profiler

The photonics community needs a method for very high dynamic range measurements of optical fiber, waveguide and other optical components. Advances in DWDM technology, deployment of standard fibers, and the development of specialty fibers all require more accurate characterization. These high-dynamic-range measurements of irradiant light flux have been very difficult to obtain. Photon has the solution: our Goniometric Radiometer, the LD 8900HDR Far-Field Profiler.

Measurement Parameters

The LD 8900HDR Far-Field Profiler uses goniometric methodology to measure true 3-dimensional profiles of optical components with up to 93 dB dynamic range. All measurements are taken with the emitting fiber, planar waveguide, laser diode or LED inserted directly into the center of the instrument's radial measurement area. For optical fiber, the far-field distribution pattern is acquired without bending the fiber. Bending the fiber can cause analysis and reporting inaccuracies. Parameters measured for optical fiber are:

- Mode Field Diameter (MFD) – used to evaluate losses due to mismatch at connections of fibers and fiber components.
- Effective Area (A_{eff}) – used to assess non-linear effects
- Numerical Aperture (NA) – a measure of the angular width of the fiber output. NA is equal to the sine of the half angle ($\sin \theta/2$) at a specified percentage of the peak value.

The Model LD 8900HDR analysis software calculates these optical fiber parameters from the far-field profile, the method described in the TIA/EIA FOTP-191 standard for MFD requiring a minimum of 50dB for proper measurement. The TIA/EIA FOTP-132 standard for A requires a minimum of 50dB for proper measurements as well.

This wider dynamic range provides greater signal-to-noise detail in the tails of the far-field pattern. Real-time data gathering and reporting of sample optical fibers or other sources is valuable for manufacturing and quality assurance evaluation.

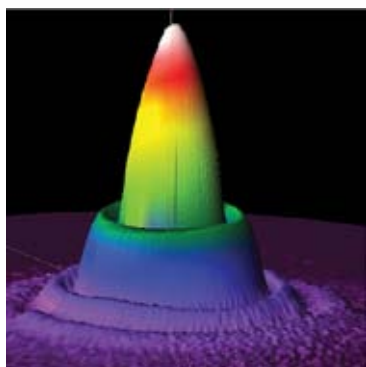
Hardware and Computer

The LD 8900HDR is a modular system that allows either one-dimensional or three-dimensional measurements.

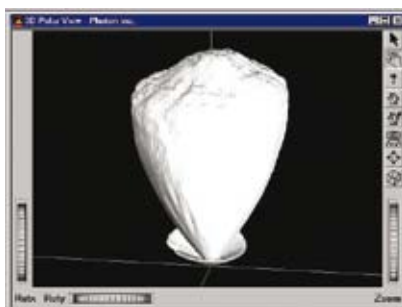
The 3D module is easily exchanged with the 1D hardware, and the system can be purchased with the 1D hardware, the 3D hardware or both. There are specially designed fiber mounting clips available for both the 1D and 3D configurations with a specially modified fiber cleaver and clip that guarantees proper fiber alignment. In addition, custom mounting devices are available for high dynamic range measurements of waveguides, laser diodes and LEDs.

The controller comprises the PC microprocessor, data acquisition card, scan-control card and LD 8900HDR acquisition and analysis software. A reference calibration standard (NIST traceable), 1310nm, 0dBm LD Light Source is also available. This is the measured reference at the time of original manufacture that can be used for unit verification by the user at a later date. For high dynamic range measurements in the visible spectrum, a silicon detector can be substituted with a spectral range of 320-1100nm and even higher 103dB dynamic range. Maximum light source unit size for direct measurements is approximately 12.7mm by 12.7mm.

In the 3D configuration the LD 8900HDR includes the 3D Motion Control Module and is capable of full 3D measurements with up to 200 azimuthal planes through the source.



3D profile of a SMF-28 optical fiber using the LD 8900HDR



3D polar view of LED light emission



LD 8900 HDR

LD 8900HDR Specifications

Specifications	1D Single-Scan Data	3D Multi-Scan Data
Parameters measured	MFD; NA; Aeff	MFD; NA; Aeff; Angular Width; Angular Centroid; Angular Aspect Ratios, Angular Peak Position, Relative Integrated Power, Relative Power in user-specified cone angles (NA), Cone Angles (NA) in user-specified % Relative Power
Accuracy		MFD: $\pm 0.5\%$ (for nominal 9mm diameter fiber) NA: $< \pm 1\%$ Aeff: $< \pm 1\%$
Scan range		$\pm 90^\circ$
Scan radius		13.26(cm); 5.22(in.)
Scan time		<20 seconds
Dynamic range		>93dB InGaAs (103dB Si); input power and distribution dependent; 0 dBm (1mW) minimum for >50dB dynamic range
Spatial sampling resolution		0.055°
Spectral range		InGaAs detector: 800-1700nm / Silicon available (350-800nm)
Software		Windows (32/64) Laptop or Desktop; ActiveX Automation server capability
Software views	Single scan rectangular profile plot; Fields for operator name, fiber type, date, and user comments	Polar profile plot - single or dual orthogonal scans; Rectangular profile plot - single or dual orthogonal scans 3D Polar view; 3D Rectangular View; 2D Topographic View; Beam parameter statistics; Time statistics charts; Relative angular power distribution; Notes window for appending user comments
Scan unit dimensions		267 H x 305 W x 362 L (mm); 10.5 x 12 x 14.25 (in.)
Scan unit weight		~13.6kg; 30lbs.
Maximum light source unit size for direct measurements		~12.7 x 12.7(mm); 0.5 x 0.5(in.)

Ordering Information

Item	Description	P/N
LD8900 HD	Very high dynamic range Goniometric Radiometer designed to measure Mode Field Diameter (MFD) and Effective Area (Aeff) of single mode fiber.	PH00198
1P	Mount for fiber cartridges Interface plate that mounts to the Scan Unit. Accepts all Photon Fiber Cartridges. The cartridges insert into an opening in the plate and are held in the proper meas.	PH00201
CC	Photon Fiber Clip and Clip Cartridge. The Photon Fiber Clip mounts in a modified Fitel Furukawa Cleaver. The fiber is cleaved and positioned simultaneously. Cartridge inserts into the 1D Cartridge.	PH00202
FFC	Fiber Cleaver for use with the Photon Fiber Clip.	PH00203
REF	Standard reference cartridge Includes a Photon Standard SMF-28 Reference Cartridge and a 1310nm-0dBm LD Light Source.	PH00204
BFC	Bare fiber connector for LD8900HDR Cartridge has a v-groove and clamp for holding fiber. Fiber is positioned manually to a visual reference position. Intended for use with specialty fibers that cannot.	PH00205
3D	3-D scan module for HDR Interchangeable accessory adds full 3-dimensional measurement capability with up to 200 cuts through the fiber. Includes a 3D Scan Module and Motion Controller.	PH00206
CFP	Connectorized fiber mount for HDR Adapter plate for mounting connectorized fibers. Standard ST, FC, and SC connectors are held by the ferrule tip. Call for other types.	PH00208
Case	Rugged shipping case for LD8900HDR.	PH00209
MfgSoft	Software interface designed for manufacturing. Simple interface screen shows the high dynamic range 1D profile and reports MFD, Aeff, and NA. Includes fields for time stamps, serial numbers, and notes.	PH00210
1W Mount	1-D waveguide mount Waveguide mount for use with 1D Interface Plate.	PH00215
3W Mount	3-D waveguide mount Waveguide mount for use with 3D Scan Accessory.	PH00216
1CustomFxt	Custom mnt for 1-D vers of HDR/LED Prof Custom designed fixtures for mounting novel sources for 1D scans.	PH00217
LED Profiler	A goniometric profiler designed to rapidly measure true 3-dimensional profiles of LEDs providing a ± 130 degree measurement around the source, with 0.05-degree resolution.	PH00199
LED profiler w/3180	Same as above but includes state-of-the-art PC running Microsoft Windows operating system with Photon LED Software installed. Configuration required for international sales.	PH00200
3D(LED)	3-D scan module for LED Profiler.	PH00207
3LED Mount	Standard LED mount for use with packaged LEDs. Price dependent on configuration. (Must be quoted for specific device.)	PH00211
3CustomFxt	Photon can provide custom and semi custom device mounts for LED devices, including TE-cooled vacuum chucks for bare chip testing. Mounts are designed to take advantage of the 260 degree field-of-view available in the LED Profiler. Mounting hardware that is compatible with automated test operations can also be designed and supplied by Photon.	PH00214
UV	Allows the use of the LED Profiler with sources emitting at wavelengths below 380nm.	PH00212
PO	Pulsed Operation for LED Profiler.	PH00213