



# CW-MHF™

## TUNE > 30 CM<sup>-1</sup> WITHOUT MODE HOPS

The CW-MHF™ Mid-IR Laser is the ultimate tool for high-resolution, mid-IR spectroscopy. If you need high spectral resolution, phase-continuous tuning to avoid jumping over spectral lines, or both, the DRS Daylight CW-Mode-Hop-Free laser will meet your needs. Narrow-linewidth operation and MHF tuning is a high bar to reach in any laser system. Unique in the industry, the CW-MHF system provides open-loop linewidths of  $\leq 5$  MHz (over 100 ms) and MHF tuning to  $> 30$   $\text{cm}^{-1}$ , and often to  $> 100$   $\text{cm}^{-1}$ . Drawing on years of precision engineering and manufacturing experience, the CW-MHF laser achieves this performance with a highly stable laser cavity that, guided by finite element analysis, was designed to reduce susceptibility to acoustic perturbation. The CW-MHF laser also includes two ways to modulate wavelength: via a PZT or current modulation. This exclusive combination of wide MHF tuning, narrow-linewidth operation, and modulation capability enables high-resolution spectroscopy and/or locking to a wavelength reference.

### HIGHLIGHTS

- Wavelength availability: 3-12  $\mu\text{m}$
- MHF tuning range:  $\geq 30$   $\text{cm}^{-1}$  ( $\geq 60$ -100  $\text{cm}^{-1}$  typical)
- CW power  $> 70$  mW typical\*
- Linewidth FWHM  $< 5$  MHz (10 ms) and  $< 10$  MHz (1s)
- Wavelength accuracy of  $\pm 0.5$   $\text{cm}^{-1}$  ( $\pm 15$  GHz), unidirectional
- Wavelength modulation using PZT (up to 1  $\text{cm}^{-1}$ , DC-350 Hz) or current (up to 0.05% of center wavelength, 200 Hz-1 MHz)
- Ultra-quiet, with RIN as low as -140 dBc/Hz, enables higher-SNR spectroscopy
- Superb TEM<sub>00</sub> beam quality, low beam pointing

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## APPLICATIONS

- Environmental monitoring
- Fence line monitoring
- Combustion diagnostics
- TIC, VOC, GHG, and explosives detection
- Process control
- Nanoscale imaging
- Biomarker detection in breath
- Chemical and biological agent sensing
- IR sensor development

## SPECIFICATIONS

PERFORMANCE	
Operation	Continuous wave, mode-hope-free (CW-MHF) and extended CW <sup>2</sup> tuning <sup>3</sup>
Center Wavelength	Availability 3 - 12 μm

OPTICAL PARAMETERS	
MHF Tuning Range	>30 cm <sup>-1</sup> (>60 cm <sup>-1</sup> typical) <sup>4</sup>
Average Power	> 70 mW at peak of tuning curve, typical <sup>4</sup>
Power Stability	< 1% rms (over 5 mins)
Linewidth	<5 MHz (over 100 ms) <10 MHz (over 1s)
Beam Divergence	<4 mrad (full angle, 1/e <sup>2</sup> intensity) <sup>5</sup>
Polarization	Linear, Vertical; >100:1
Pointing Stability	<1 mrad per 100 cm <sup>-1</sup> tuning
Beam Waist	<2.5 mm (1/e <sup>2</sup> intensity diameter)
Beam Waist Location	30 to 50 cm (typical)
Beam Quality	TEM <sub>00</sub> (nominal)

OPTICAL PARAMETERS	
Scanning	Programmable uni- and bi-directional survey scan. Start, stop, step, pause, auto/manual scanning
External Interface	USB 2.0, Ethernet 10/100
Current Modulation	≥0.02 cm <sup>-1</sup> , 200 Hz to 500 kHz; 1 MHz bandwidth
Piezoelectric Modulation	≥0.05% of nominal center wavelength [cm <sup>-1</sup> ] at 100 Hz, 350 Hz bandwidth <sup>6</sup>

MECHANICAL PARAMETERS	
Tuning Speed	<3 s for 30 cm <sup>-1</sup> scan
Wavelength Accuracy	±0.5 cm <sup>-1</sup> uni-directional
Cooling Requirements	Water cooling
Ambient Temperature Range	15 to 30°C
Head Size (L x W x H)	6.75 x 4.40 x 5.73 inches 17.2 x 11.1 x 14.6 cm

1. Unless stated otherwise, all specifications: are defined at the peak of the tuning curve only; apply to operation of the laser under typical laboratory conditions; after a 5-min warm up; are subject to change without notice.

2. This laser is an inherently CW laser, and cannot provide pulsed output.

3. Mode hops may occur when tuning across "extended" CW range.

4. Depends on center wavelength selected - please inquire.

5. Measured at 4 μm; scales with wavelength - please inquire.

6. Example: at 6 μm (1667 cm<sup>-1</sup>), specification would be 0.05% x 1667 = 0.8 cm<sup>-1</sup>. Requires PZT driver approved by Daylight Solutions - please inquire.

## MODE HOP-FREE DESIGN

An external cavity laser will only tune without mode hopping when the two tuning elements—the grating and the cavity length itself—operate absolutely synchronously. The change in cavity length must precisely match the grating filter function as the laser tunes. By careful placement of the grating pivot point this condition can be met, but it requires highly precise engineering and exacting assembly. Only Daylight Solutions has mastered both the engineering and building of such fine mechanics in the mid-IR. The new TLS-41000-MHF has been completely redesigned for higher stability and increased versatility. Guided by an exhaustive Finite Element Analysis (FEA) of the vibrational modes of the tuning elements, the cavity is now highly resistant to acoustic perturbations and vibrations. The new design allows for narrower open-loop linewidth (<5 MHz in a 100-ms integration time) and reduced jitter both at a single wavelength and while scanning.

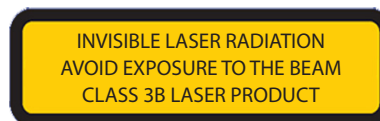
## EXPANDED MODULATION FUNCTIONALITY

Standard on each TLS-41000-MHF, a piezoelectric tuning element (PZT) allows the wavelength of the laser to be modulated or finely adjusted. The enhanced mechanical stability of the TLS-41000-MHF allows for an increase in the PZT bandwidth to 350 Hz.

The TLS-41000-MHF also features a redesigned current modulation circuit optimized for high-resolution spectroscopy. The circuit has a widened bandwidth (200 Hz to over 1 MHz) with low phase delay. The overlap of the PZT and current modulation bandwidths allows the implementation of a traditional two-stage locking circuit to minimize the center linewidth drift and jitter.

41000-MHF series lasers ship with Daylight solutions' next-generation SideKick™ laser controller. Replacing our TLC series control electronics, the new SideKick is a compact, low-noise design ideally suited to driving MHF laser heads. SideKick provides flexible, precise USB/Ethernet control of MHF laser: power; wavelength; temperature; and scan speed.

Higher resolution, smoother tuning, and the ability to lock the source tightly to a reference are hallmarks of the new 41000-MHF series. These lasers enable research in high-resolution spectroscopy, greenhouse gas sensor development, the detection of biomarkers in breath, and the detection of chemical and biological agents. Please contact us to learn more.



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Rev 1-2018