

# Carmina

## Tunable IR Light-source

### IR Light-source for the Combination with s-SNOM and AFM-IR Microscopes

- APE offers an automated IR light-source with a tuning range of 1.45  $\mu\text{m}$  ... 15  $\mu\text{m}$ . Carmina provides unique capabilities in near-field IR spectroscopy - including s-SNOM and AFM-IR - by combining broadband spectroscopy and narrowband chemical imaging to advance new nanoscale chemical applications.



### At a Glance

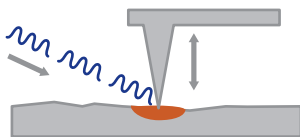
- Spectroscopy & Imaging of organic & inorganic samples with a single laser-source
- Complementary nanoscale IR-techniques covered: s-SNOM and AFM-IR
- Narrowband ( $\sim 20 \text{ cm}^{-1}$ ) and broadband ( $\sim 300 \text{ cm}^{-1}$ ) operation
- High output power level up to 500 mW
- Continuous sweep mode for fast scanning
- User friendly turnkey operation incl. automated wavelength tuning
- Wavelength tuning broadband: 1.46  $\mu\text{m}$  ... 15  $\mu\text{m}$  ( $6850 \text{ cm}^{-1}$  ...  $670 \text{ cm}^{-1}$ )
- Wavelength tuning narrowband: 5.0  $\mu\text{m}$  ... 15  $\mu\text{m}$  ( $2000 \text{ cm}^{-1}$  ...  $670 \text{ cm}^{-1}$ )

# Spectroscopy & Imaging

## Application Examples

- The fully automated IR-source sets new standards in terms of flexibility and tuning range thanks to its OPO/DFG architecture. With the unique combination of  $\sim 300 \text{ cm}^{-1}$  broadband and  $\sim 20 \text{ cm}^{-1}$  narrowband emission, the complementary nanoscale IR techniques s-SNOM Imaging, Spectroscopy and AFM-IR are now covered with a single light-source. A triggered pulsed mode is available for AFM-IR applications.

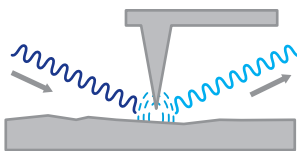
### AFM-IR Photothermal AFM



- IR pulsed**

Available for broadband & narrowband  
Pulsed mode (burst mode) with 50% duty cycle  
Continuous wavelength sweep in narrowband mode  
( $> 100 \text{ cm}^{-1}/\text{s}$ ) for fast spectroscopy

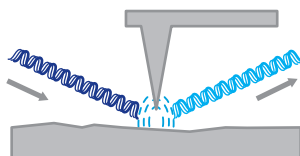
### s-SNOM Imaging



- IR narrowband quasi-cw**

Narrowband mode  $\sim 20 \text{ cm}^{-1}$   
Wavelength tuning  $5.0 \mu\text{m} \dots 15 \mu\text{m}$  ( $2000 \text{ cm}^{-1} \dots 670 \text{ cm}^{-1}$ )  
Fast continuous sweep mode in less than 10 seconds for scanning  
 $1000 \text{ cm}^{-1} \dots 1800 \text{ cm}^{-1}$

### s-SNOM Spectroscopy

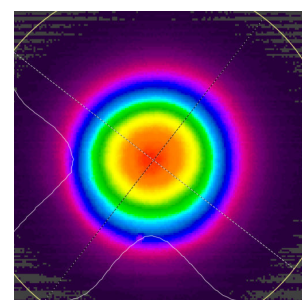


- IR broadband quasi-cw**

Broadband mode  $\sim 300 \text{ cm}^{-1}$   
Wavelength tuning  $1.46 \mu\text{m} \dots 15 \mu\text{m}$  ( $6850 \text{ cm}^{-1} \dots 670 \text{ cm}^{-1}$ )

## Beam Profile

- Carmina offers an excellent output beam profile. Here is an example measurement at  $1600 \text{ cm}^{-1}$ .



beam profile at  $1600 \text{ cm}^{-1}$

# Carmina Broadband & Narrowband Specifications

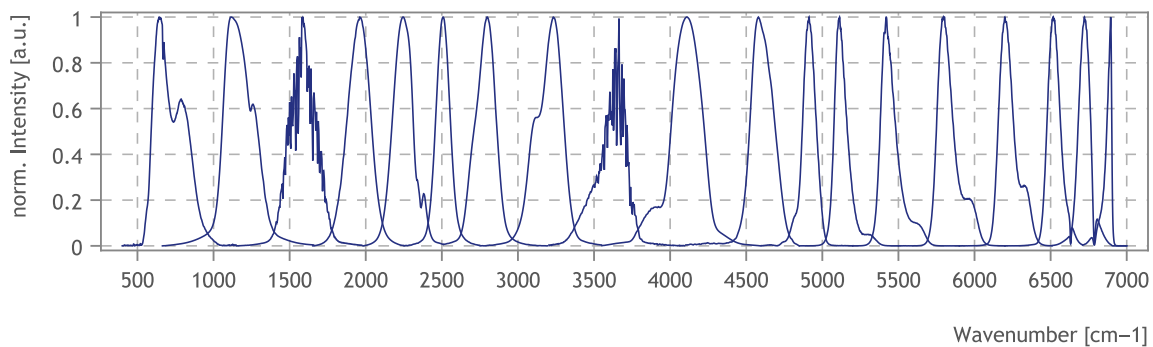
## Available Configurations

	Version A	Version B	Version C
Broadband quasi-cw	■	■	■
Narrowband quasi-cw	■	■	-
Broadband Pulsed Mode	■	-	-
Narrowband Pulsed Mode	■	-	-
Additional 1032 nm Output Port	Available for all Configurations		

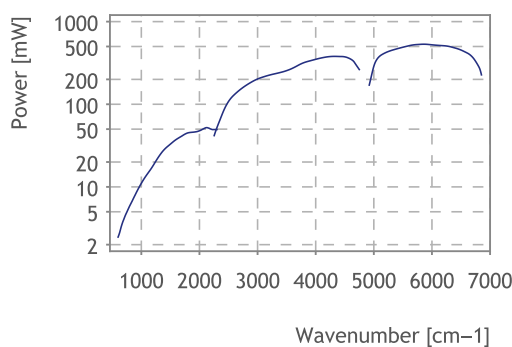
## Broadband Operation

Tuning Range	2.15 $\mu\text{m}$ ... 15 $\mu\text{m}$ ( $4650\text{ cm}^{-1}$ ... $670\text{ cm}^{-1}$ ) + 1.46 $\mu\text{m}$ ... 2 $\mu\text{m}$ ( $6850\text{ cm}^{-1}$ ... $5000\text{ cm}^{-1}$ )
Wavelength Tuning	Fully automated, no user adjustment required
Step- and Settle Time	Typ. 2 s
Power	> 15 mW at $1600\text{ cm}^{-1}$
Bandwidth Typical	- 300 $\text{cm}^{-1}$ (FWTM, 10 dB level), 170 $\text{cm}^{-1}$ (FWHM)
Beam Quality $M^2$	< 1.3 at $1600\text{ cm}^{-1}$ , typ. < 1.3 over complete tuning range
Polarization	Horizontal < $4850\text{ cm}^{-1}$ , Vertical > $4850\text{ cm}^{-1}$
Beam Diameter at Exit	Typ. 5 mm at $1600\text{ cm}^{-1}$

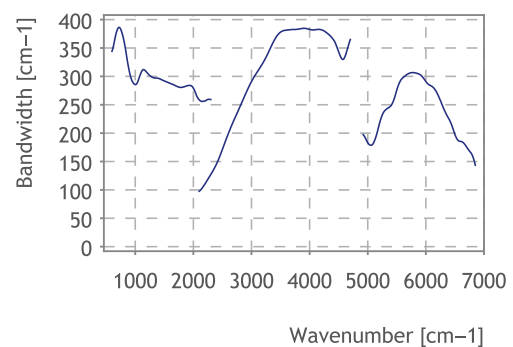
Broadband Operation Spectra (typical)



Broadband Operation Power (typical)



Broadband Operation Bandwidth (typical)

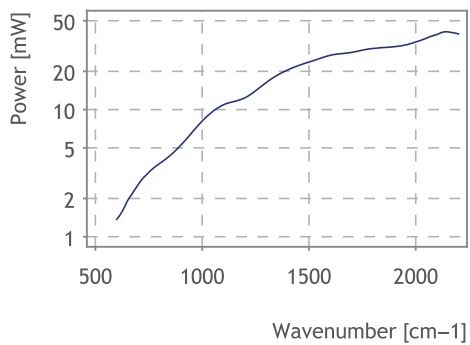


# Carmina Broadband & Narrowband Specifications

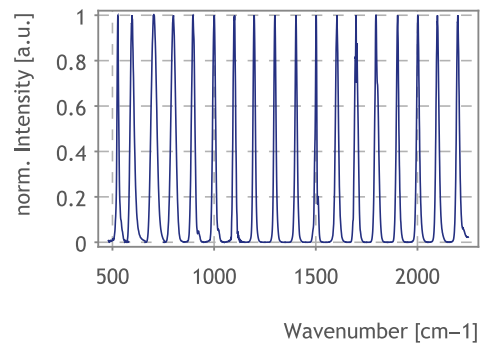
## Narrowband Operation

Tuning Range	5 $\mu\text{m}$ ... 15 $\mu\text{m}$ (2000 $\text{cm}^{-1}$ ... 670 $\text{cm}^{-1}$ )
Wavelength Tuning	Fully automated, no user adjustment required
Step and Settle Time	Typ. < 2 s
Sweep Mode	Continuous sweep Max. speed > 30 $\text{cm}^{-1}/\text{s}$ , speed and range software adjustable
Power	> 15 mW at 1600 $\text{cm}^{-1}$
Bandwidth	Typ. 20 $\text{cm}^{-1}$ (FWHM) for 1000 $\text{cm}^{-1}$ ... 1800 $\text{cm}^{-1}$
Beam Quality $M^2$	< 1.3 at 1600 $\text{cm}^{-1}$ , typ. < 1.3 over whole tuning range
Polarization	Horizontal
Beam Diameter at Exit	Typ. 5 mm at 1600 $\text{cm}^{-1}$

Narrowband Operation Power (typical)



Narrowband Operation Spectra (typical)



# ...Specifications

## Quasi-cw Mode

Repetition Rate 40.5 MHz  $\pm$  0.5 MHz

## Pulsed Mode

Frequency Modulation 50 kHz ... > 1.5 MHz externally triggered via TTL signal (BNC)

Duty Cycle 50%

Energy per Cycle > 15 nJ at 1600 cm<sup>-1</sup> at 500 kHz

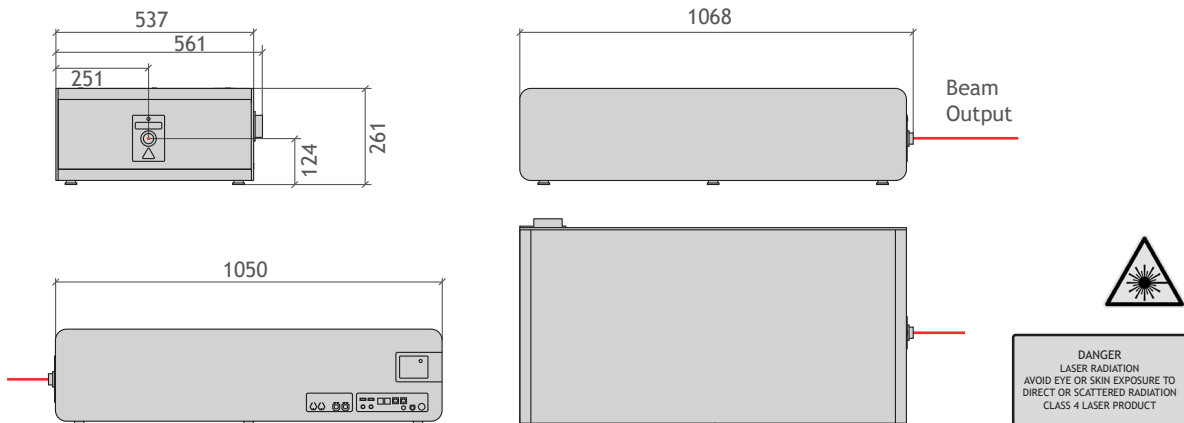
## Further Specifications and Requirements

Dimensions & Weight Laser: 537 mm x 1068 mm x 261 mm, 105 kg  
Electronics: 3U x 482.5 mm x 389.5 mm, 11 kg

Electrical Supply 110 - 240 V, 50 - 60 Hz, max. 4.5 A (at 110 V)

Cooling Unit (Included) Water cooling ~ 22°C, max. 6 A (at 110 V)

Purging Unit (Included) Purging gas for H<sub>2</sub>O and CO<sub>2</sub> removal



## Contact

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