

## SINGLE-FREQUENCY LASER *for research*

### Features

- ▶ High-output power
- ▶ Broad-wavelength coverage
- ▶ Narrow-linewidth single frequency
- ▶ Excellent beam quality

### Applications

- ▶ Laser cooling
- ▶ Rydberg transitions
- ▶ Optical traps
- ▶ Qubit gates
- ▶ Optical clock transitions
- ▶ Resonant excitation of quantum dots



*Vertical-external-cavity surface-emitting laser (VECSEL)  
a.k.a. Optically pumped semiconductor laser (OPSL)*

|                                           | VALO SF                                                                         | VALO SHG                                                             |
|-------------------------------------------|---------------------------------------------------------------------------------|----------------------------------------------------------------------|
| Architecture                              | Direct emitting VECSEL                                                          | Intracavity doubled VECSEL                                           |
| Gain                                      | Optically-pumped semiconductor gain mirror                                      |                                                                      |
| Target wavelength <sup>1</sup>            | 700 – 2150 nm                                                                   | 350 – 800 nm                                                         |
| Free-space output power <sup>2</sup>      | 0.5 – 10 W with integrated pump laser                                           | 0.01 – 3 W with integrated pump laser                                |
| Coarse tuning <sup>3</sup>                | 5 – 100 nm                                                                      | 0.5 – 10 nm                                                          |
| Mode-hop free tuning range <sup>4</sup>   | > 1 GHz                                                                         | > 2 GHz                                                              |
| Free-running linewidth                    | < 10 kHz (10 $\mu$ s), < 100 kHz (100 $\mu$ s)                                  |                                                                      |
| Slow modulation                           | Piezo actuator, 10 kHz bandwidth                                                |                                                                      |
| Fast modulation (optional)                | Intra-cavity electro-optical modulator (EOM), 1 MHz bandwidth                   |                                                                      |
| RMS RIN (typical, unlocked)               | < 0.05 % (10 Hz – 3 MHz)                                                        |                                                                      |
| Power stability (typical, unlocked)       | < 0.1 % (1.5 h)                                                                 |                                                                      |
| Beam quality                              | $M^2 < 1.1 \text{ TEM}_{00}$                                                    | $M^2 < 1.2 \text{ TEM}_{00}$                                         |
| Beam diameter and divergence <sup>5</sup> | Up to 2 mm, up to 5 mrad                                                        |                                                                      |
| Polarization, linear                      | Horizontal, p-polarized                                                         | Vertical, s-polarized                                                |
| Secondary output beam                     | Not applicable                                                                  | Secondary output of fundamental wavelength (horizontal, p-polarized) |
| Polarization extinction ratio (PER)       | > 20 dB, linear polarization                                                    |                                                                      |
| Laser head dimensions                     | 320 mm x 190 mm x 101 mm (6.1 L)                                                |                                                                      |
| Control electronics <sup>6,7</sup>        | Control Unit for CW operation, height 3U + 1U for ventilation                   |                                                                      |
| Cooling <sup>7</sup>                      | Water-to-air chiller, height 4U. Water-to-water and other form factors optional |                                                                      |

<sup>1</sup> Target wavelength is selected within the wavelength range.

<sup>2</sup> Output power is wavelength dependent. See the next page for typical power levels. Single-stage isolator is recommended for applications with back reflections.

<sup>3</sup> Coarse tuning range is wavelength and output power dependent. Maximum 10 THz tuning range corresponds to the typical gain bandwidth.

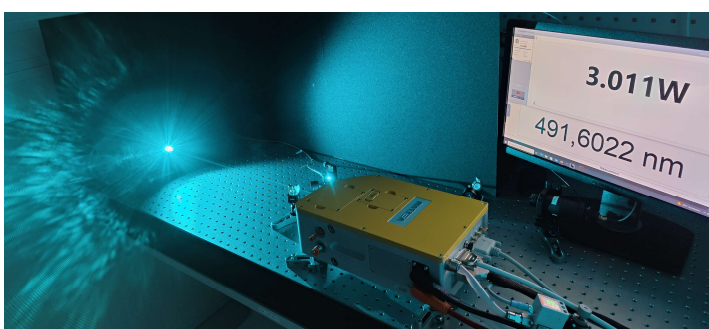
<sup>4</sup> Mode-hop free tuning range corresponds to the laser cavity free-spectral range scanned with piezo voltage control. Larger tuning range can be reached by adjusting other tuning elements simultaneously.

<sup>5</sup> Typical values at the laser exit aperture. Beam diameter = full width at 1/e<sup>2</sup> level of the beam. Divergence = full mean divergence angle. Values depend on the laser cavity configuration, i.e. the wavelength.

<sup>6</sup> The control unit includes a low noise laser diode driver for the pump laser, and up to 5 cavity element temperature controllers, which can be used for wavelength tuning and power optimization.

<sup>7</sup> The control unit and the standard chiller unit are 19" rack mountable.

## Turnkey single-frequency laser system for AMO research



### Versatile VECSEL platform

- ▶ Designed to meet the diverse needs of the atomic, molecular and optical (AMO) physics research community
- ▶ High output power with excellent beam quality, with small SWaP-C, thanks to simple disk laser geometry
- ▶ Efficient ("3-in-1") intracavity second harmonic generation (SHG) for unparalleled visible power and simplicity
- ▶ Proven sub-Hz linewidth using intracavity EOM
- ▶ Tunable for spectroscopy

