

## 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 μs), < 100 kHz (100 μs)	
Slow modulation (typical)	Piezoelectric element on cavity mirror, 10 kHz bandwidth, 50 MHz/V modulation depth	
Fast modulation (optional, typical)	Intra-cavity electro-optical modulator (EOM), 1 MHz bandwidth, 50 kHz/V modulation depth	
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; 3U height requirement, breadboard mountable)	
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.

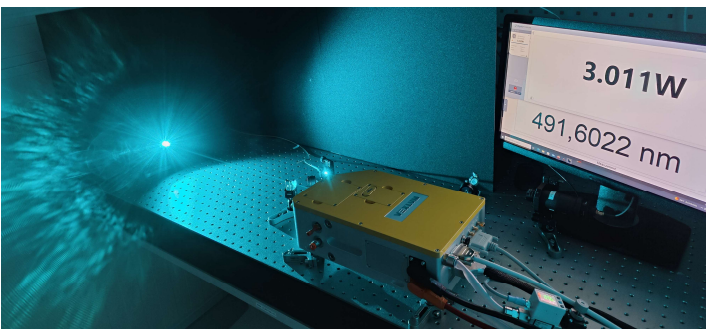
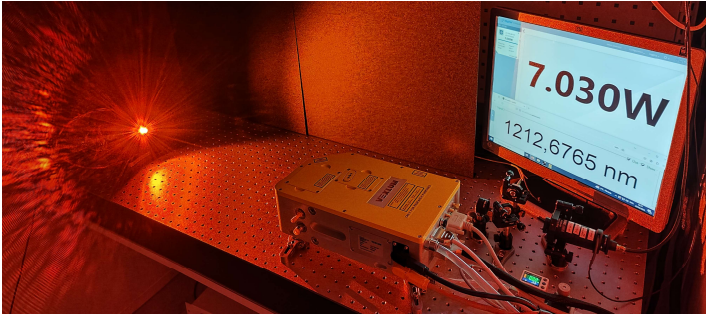
<sup>4</sup> Mode-hop free tuning range corresponds to the laser cavity free-spectral range scanned with piezo voltage control. Larger tuning range can be reached by adjusting other tuning elements simultaneously.

<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.

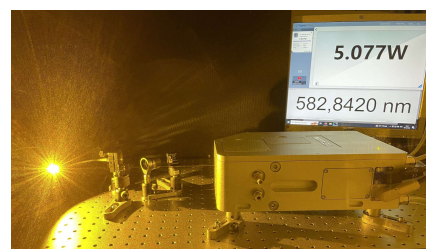
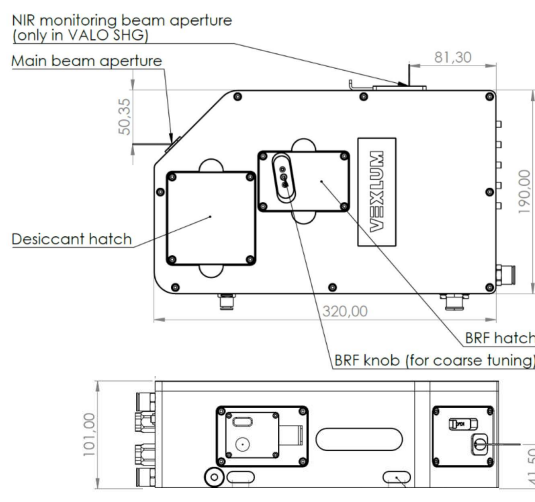
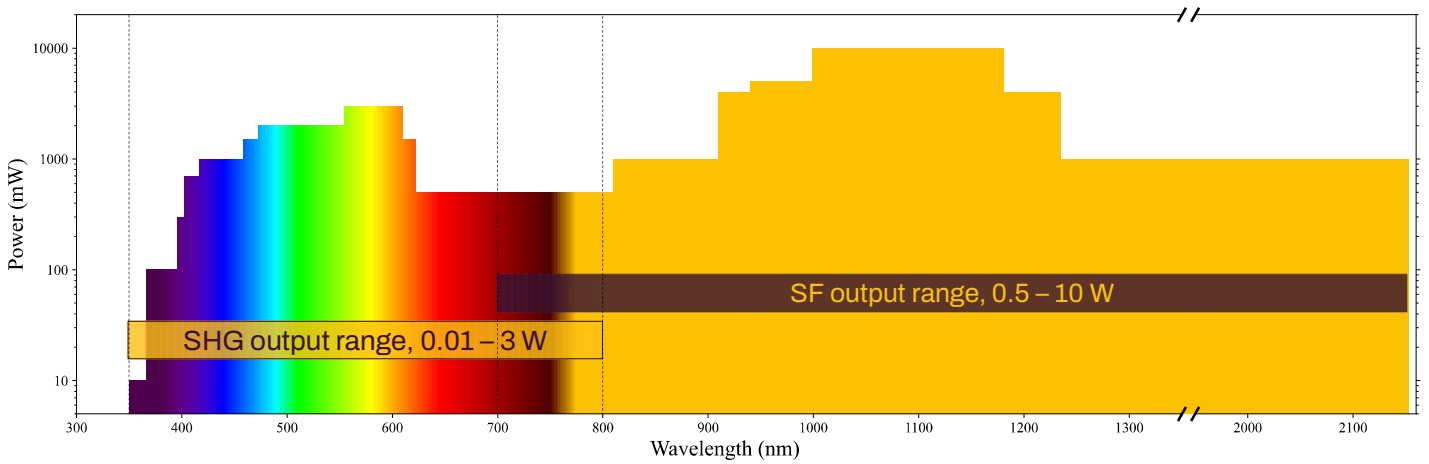
<sup>7</sup> The control unit and the standard chiller unit are 19" rack mountable.

**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



**⚠ DANGER - VISIBLE AND/OR INVISIBLE LASER RADIATION AVOID EYE OR SKIN EXPOSURE TO DIRECT OR SCATTERED RADIATION CLASS 4 LASER PRODUCT**