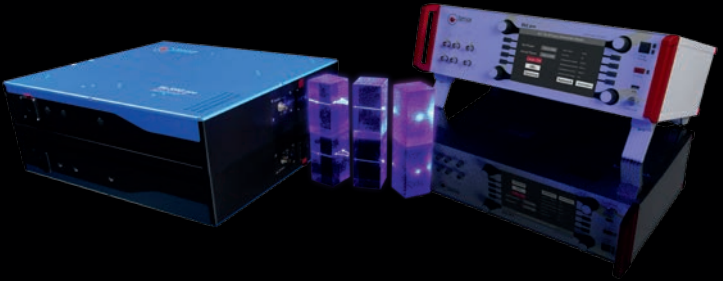
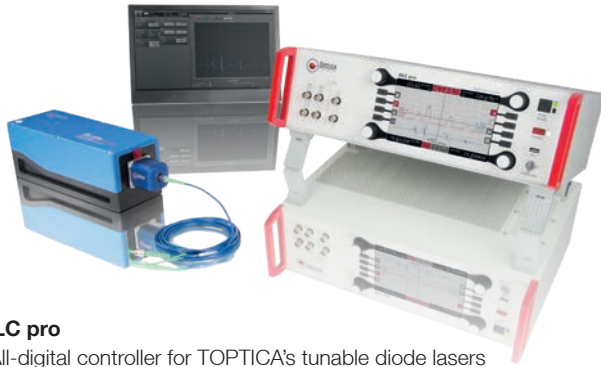


# Solutions for Rydberg Atoms

Diode Lasers, Frequency Combs & Electronics



## Tunable Diode Laser Systems



### **DLC pro**

- All-digital controller for TOPTICA's tunable diode lasers
- Extremely low noise and precise control
- Convenient dials & multi-touch user interface
- Includes computer control program and Python support
- Includes active power stabilization
- Software option enables intelligent frequency locking features

### **(M)DL pro**

- Extended Cavity Diode Laser (ECDL)
- Ultra-stable patented resonator design (DE 10 2007 028 499 and US 7970024)
- Optimized virtual pivot point
- Convenient alignment-free coarse-tuning from outside the laser head
- Fast current AC & DC modulation with protection
- At some wavelengths high power available with DL pro HP
- DLC DL pro = DL pro + DLC pro

### **(M)TA pro**

- MOPA system with DL pro seed laser (see above) and tapered amplifier in one laser head
- Powers up to 4000 mW
- Excellent beam quality: typical  $M^2 < 1.5$
- DLC TA pro = TA pro + DLC pro

## Frequency Converted Diode Lasers



### **(M)SHG pro**

- TA pro diode laser + SHG pro second harmonic generator in one box
- UV, blue, green, yellow or red wavelength
- Up to 2000 mW output power\* (depends on wavelength)
- PowerLock included, AutoAlign included in MSHG pro
- Up to 20 nm coarse tuning (wavelength dependent)
- (Raman) Fiber amplifier available for higher output powers\*
- Without amplification stage available as DL-SHG pro
- With DLC pro: DL/TA-SHG pro

### **TA-FHG pro**

- TA pro diode laser + two subsequent second harmonic generators SHG pro in one box
- At DUV wavelengths Super UV (SUV) version available for more power and increased lifetime
- Wavelength in the UV region
- Up to 700 mW output power available (depends on wavelength)
- PowerLock included, AutoAlign optional
- 1 nm .. 4 nm coarse tuning (wavelength dependent)
- (Raman) Fiber amplifier available for higher output powers
- Without amplification stage available as DL-FHG pro
- With DLC pro: DL/TA-FHG pro

\* higher output power available with fiber amp solutions

## DFC - Difference Frequency Combs



### Compact, Robust, High-end and Convenient

- Comb spacing: 80 MHz or 200 MHz
- Stability:  $8 \cdot 10^{-18}$  in  $1 \text{ s}^*$ ,  $5 \cdot 10^{-20}$  in  $1000 \text{ s}^*$
- Accuracy:  $1 \cdot 10^{-18}$  for  $\tau > 100 \text{ s}^*$
- Integrated phase noise  $f_{\text{CEO}}^*$ :  $< 65 \text{ mrad}$  [70 mHz - 20 MHz]
- Linewidth:  $< 1 \text{ Hz}$  (locked to optical reference)
- Wavelength coverage 420 - 2200 nm

### Convenient

- Control everything from a single window



### DFC LOCK UNIT: PFD & FALC

- Robust phase and frequency lock
- Remote control and locking
- Convenient Software interface with DFC
- Tunable RF source for offset generation
- Beat signal conditioning
- 10 MHz reference input



## T-RACK - Laser Rack Systems

### All Wavelengths.

### More Power.

### Maximum Modularity.

- Highly modular rack integration of modular laser systems and units MDL pro, MTA pro, MSHG pro, MDFC, MOM, Wavelength Meter, and locking electronics
- Broad wavelength coverage 330 .. 1625 nm with output power up to 2W ex fiber
- Fiber coupled and polarized optical output
- Convenient remote control
- Industry-grade appearance and operation



## Locking Electronics

All systems may be combined with versatile and high performance frequency locking solutions:

### DLC pro Lock

#### Versatile locking option built into DLC pro

- two feedback channels with independent PIDs
- side-of-fringe and top-of-fringe locking

### FALC pro

#### Fast Analog Linewidth Controller

- Digitally controlled fast laser locking module
- $\text{PI}^2\text{D}^2$  regulator
- 10 ns delay

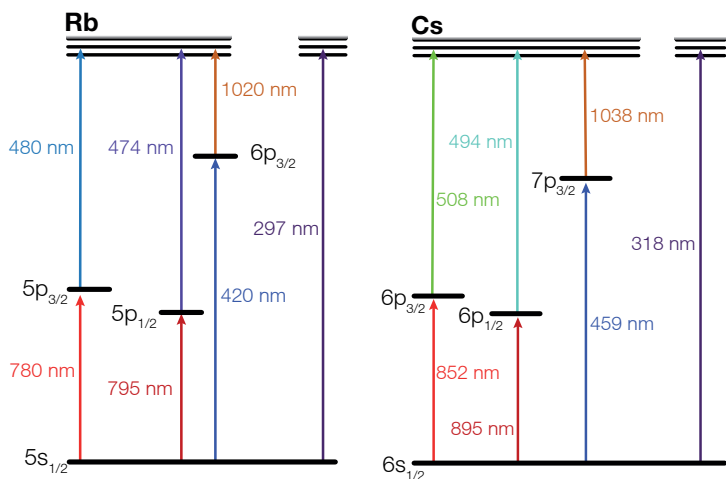
### PDH/DLC pro

#### Pound-Drever-Hall Detector

- generates dispersive error signal via modulation/demodulation
- two channels

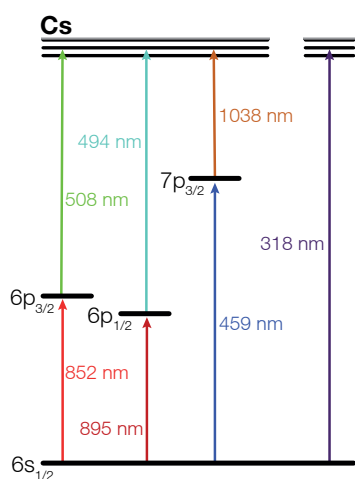


## Rubidium



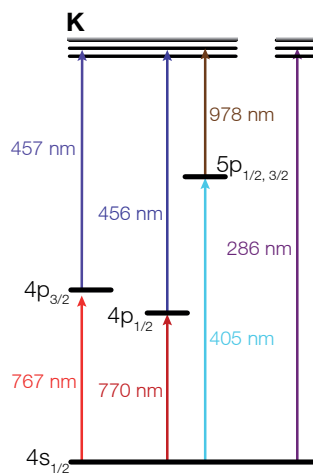
Rb	Wavelength	Product	Power
MOT cooling, 1 <sup>st</sup> step	780 nm	DLC TA pro 780	4000 mW
		DLC DL pro 780	75 mW
2 <sup>nd</sup> step after cooling	480 nm	DLC Rydberg Rb II	1000 mW
1 <sup>st</sup> step via 5p <sub>1/2</sub>	795 nm	DLC TA pro 795	3000 mW
		DLC DL pro 780	105 mW
2 <sup>nd</sup> step via 5p <sub>1/2</sub>	474 nm	DLC Rydberg Rb I	1000 mW
		DLC DL pro HP	40 mW
1 <sup>st</sup> step alternative	420 nm	DLC TA-SHG pro	800 mW
		DLC DL pro HP 420	70 mW
2 <sup>nd</sup> step alternative	1020 nm	DLC TA pro	3000 mW
		DLC DL pro	200 mW
Direct excitation	297 nm	DLC TA-FHG pro	300 mW

## Cesium



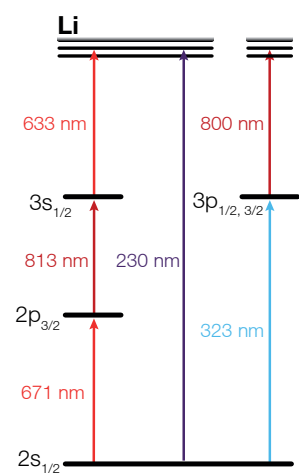
Cs	Wavelength	Product	Power
MOT cooling, 1 <sup>st</sup> step	852 nm	DLC TA pro 850	3000 mW
		DLC DL pro 850	70 mW
2 <sup>nd</sup> step after cooling	508 nm	DLC TA-SHG pro	800 mW
		DLC DL pro HP	40 mW
1 <sup>st</sup> step via 6p <sub>1/2</sub>	895 nm	DLC TA pro	1500 mW
		DLC DL pro	120 mW
2 <sup>nd</sup> step via 6p <sub>1/2</sub>	494 nm	DLC TA-SHG pro	1100 mW
		DLC DL pro HP	40 mW
1 <sup>st</sup> step alternative	459 nm	DLC TA-SHG pro	1300 mW
		DLC DL pro HP 461	170 mW
2 <sup>nd</sup> step alternative	1038 nm	DLC DL pro	200 mW
Direct excitation	318 nm	DLC TA-FHG pro	300 mW

## Potassium



K	Wavelength	Product	Power
MOT cooling, 1 <sup>st</sup> step	767 nm	DLC TA pro 765	2000 mW
		DLC DL pro	100 mW
2 <sup>nd</sup> step after cooling	457 nm	DLC TA-SHG pro	600 mW
		DLC DL pro HP 461	170 mW
1 <sup>st</sup> step via 4p <sub>1/2</sub>	770 nm	DLC TA pro 765	2000 mW
		DLC DL pro	80 mW
2 <sup>nd</sup> step via 4p <sub>1/2</sub>	456 nm	DLC TA-SHG pro	800 mW
		DLC DL pro HP	170 mW
1 <sup>st</sup> step alternative	405 nm	DLC TA-SHG pro	1500 mW
		DLC DL pro HP	110 mW
2 <sup>nd</sup> step alternative	978 nm	DLC TA pro	3000 mW
		DLC DL pro	300 mW
Direct excitation	286 nm	DLC TA-FHG pro	100 mW

## Lithium



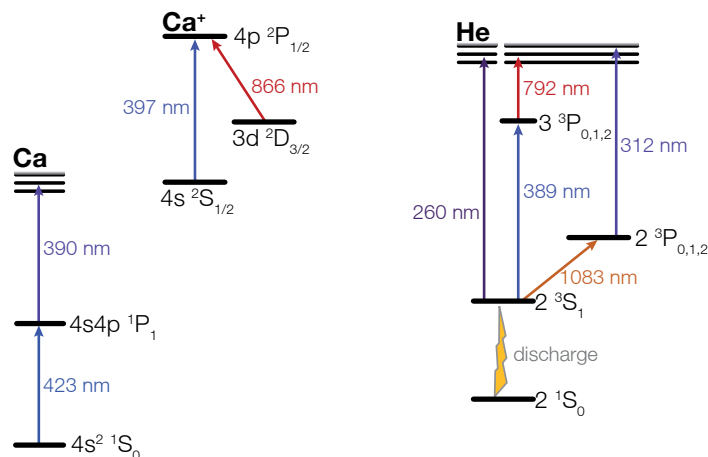
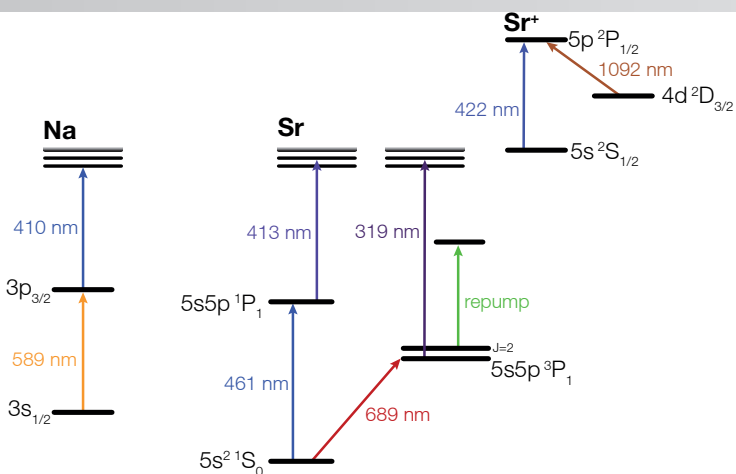
Li	Wavelength	Product	Power
MOT cooling, 1 <sup>st</sup> step	671 nm	DLC Lithium Cooling	1000 mW
		DLC TA pro 670	500 mW
		DLC DL pro 670	15 mW
2 <sup>nd</sup> step after cooling	813 nm	DLC TA pro	3000 mW
		DLC DL pro	60 mW
3 <sup>rd</sup> step after cooling	633 nm	DLC DL pro 633	40 mW
1 <sup>st</sup> step alternative	323 nm	DLC TA-FHG pro	300 mW
		DLC TA pro	3000 mW
2 <sup>nd</sup> step alternative	800 nm	DLC DL pro	160 mW
		DLC DL pro	160 mW
Direct excitation	230 nm	DLC TA-FHG pro with SUV	80 mW

## Sodium

## Strontium

## Calcium

## Helium



Na	Wavelength	Product	Power
MOT cooling, 1 <sup>st</sup> step	589 nm	SodiumStar	22000 mW
		DLC Sodium Cooling	1000 mW
2 <sup>nd</sup> step	410 nm	DLC TA-SHG pro	700 mW
		DLC DL pro HP	50 mW

Ca	Wavelength	Product	Power
MOT cooling, 1 <sup>st</sup> step	423 nm	DLC TA-SHG pro	1000 mW
		DLC DL pro HP 420	70 mW
2 <sup>nd</sup> step	390 nm	DLC TA-SHG pro	1200 mW
Ion / Rydberg cooling, detection	397 nm	DLC Ca <sup>+</sup> Cooling	1500 mW
		DLC DL pro HP 397	65 mW
Repump Ca <sup>+</sup>	866 nm	DLC DL pro 850	70 mW

Sr	Wavelength	Product	Power
Strong cooling and 1 <sup>st</sup> step singlet excitation	461 nm	DLC Sr Cooling	1300 mW
		DLC DL pro HP 461	250 mW
2 <sup>nd</sup> step singlet excitation	413 nm	DLC TA-SHG pro	800 mW
		DLC DL pro HP	60 mW
Narrow cooling and 1 <sup>st</sup> step triplet excitation	689 nm	DLC DL pro, narrow linewidth option	35 mW
		DLC TA pro, narrow linewidth option	200 mW
2 <sup>nd</sup> step triplet excitation	319 nm	DLC TA-FHG pro	300 mW
Repump	497 nm	DLC TA-SHG pro	600 mW
		DLC DL-SHG pro	30 mW
Repump alternative	481 nm	DLC Rydberg Rb II	1000 mW
		DLC DL pro HP	60 mW
Ion / Rydberg cooling transition	422 nm	DLC DL pro HP 420	70 mW
Repump Sr <sup>+</sup>	1092 nm	DLC DL pro	130 mW

He	Wavelength	Product	Power
Excitation to metastable states	discharge	lightning not available from TOPTICA	
Slowing, MOT, 1 <sup>st</sup> step	1083 nm	DLC DL pro	200 mW
2 <sup>nd</sup> step	312 nm	DLC Be <sup>+</sup> Cooling	700 mW
Alternative MOT, 1 <sup>st</sup> step	389 nm	DLC TA SHG pro	1000 mW
Alternative 2 <sup>nd</sup> step	792 nm	DLC TA pro 795	3000 mW
		DLC DL pro 780	75 mW
Direct excitation	260 nm	DLC TA-FHG pro	60 mW

TOPTICA also provides lasers for other cooling and Rydberg excitation schemes, e.g. for excitation via three photons. Moreover, solutions for elements not shown here are available as well. Examples are ytterbium, neon and many more.



For laser classifications and further safety information concerning the mentioned laser products please refer to our product catalogs and our website.

TOPTICA is active partner in various research projects.

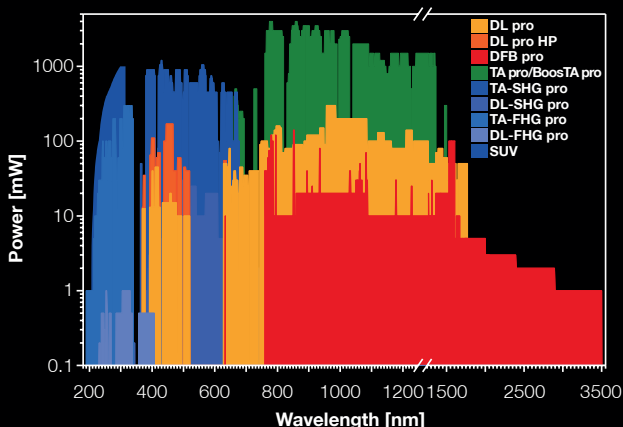
## PASQuans

Programmable Atomic Large-Scale Quantum Simulation

[www.pasquans.eu](http://www.pasquans.eu)



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