iChrome Family

Fully Featured Multi-Color Laser Engines

Microscopy

Flow Cytometry

High Throughput Screening

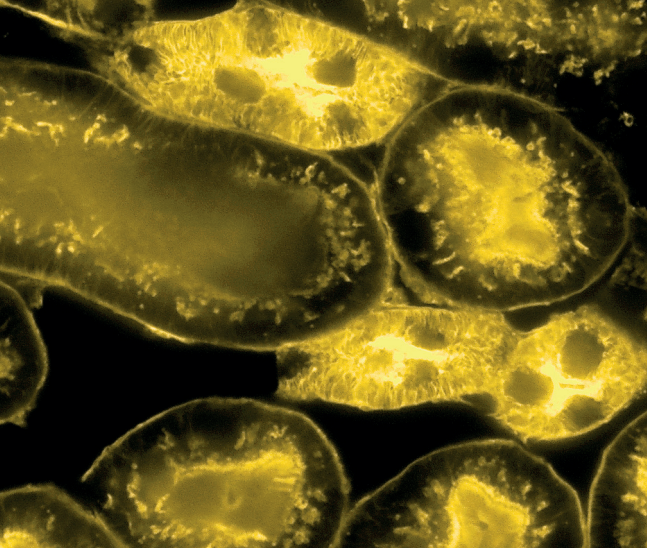
Microplate Reader

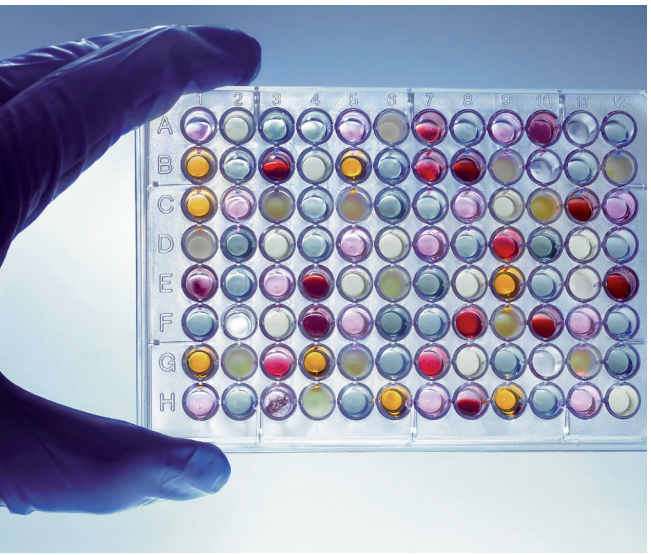
Metrology

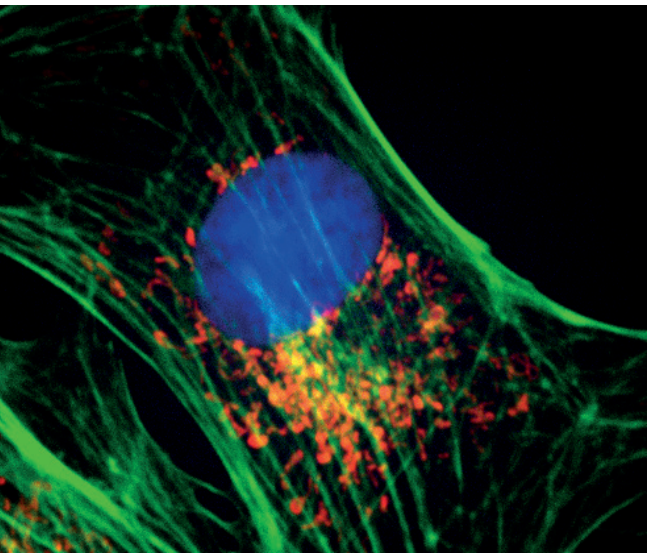
Life Sciences

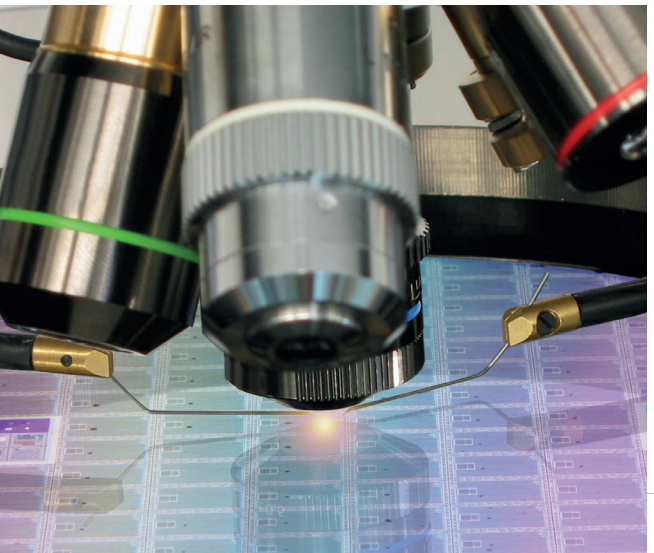
TOPTICA PHOTONICS

A Passion for Precision.









Contents

Next Generation Laser Technology
Fully Featured Multi-Color Laser Engines

The iChrome family addresses the need for multi-color lasers in biophotonics (microscopy, cytometry, DNA sequencing etc.) and metrology (e.g. scatterometry, ellipsometry). These applications require a flexible laser source that provides several wavelengths from one optical fiber. The compact and reliable iChrome systems replace cumbersome and maintenance-intensive “breadboard solutions”.

With TOPTICA’s proprietary COOL^{AC} technology all lasers can be perfectly aligned with just one push of a button. The systems can provide up to four different wavelengths from UV to IR. Individual lasers are efficiently combined and delivered via up to two single-mode, polarization-maintaining or multi-mode fibers.

The iChrome family currently consists of two different laser engines. The iChrome CLE, a compact and cost-effective laser engine with four fixed lines, and the powerful iChrome MLE with a flexible setup of up to 4 laser lines, including one DPSS.

With microprocessor-control the iChrome systems enable flexible OEM integration. High speed analog and digital modulation allows fast switching of laser wavelengths in arbitrary patterns for complex experiments. In addition, the systems provide high-end features like direct modulation (no external AOM/AOTF required), “complete off” and speckle management, which all can be conveniently controlled via one electronic (RS232, USB, Ethernet) interface.

The iChrome family offers all the features and the necessary flexibility to address even challenging imaging and measurement techniques, either as standalone multi-laser source or fully integrated into existing instruments. At the same time, the systems offer easy and convenient operation for beginners and experienced users as well as “no-screwdriver” installation and alignment.

Applications

- Confocal microscopy
- Light sheet microscopy
- CLEM
- STORM / PALM
- TIRF
- Spinning disk microscopy
- High throughput screening
- High resolution microscopy
- Fluorescence lifetime imaging (FLIM)
- FRAP
- FRET
- Scatterometry
- Ellipsometry

Integrated Features

A well-adjusted instrument is essential for biophotonics as well as in test & measurement and other demanding applications. The iChrome family supports all the necessary operation modes, such as pulsing, emission of several colors simultaneously and µW to 100 mW output power levels after fiber delivery. The unique COOL^{AC} technology, a fully automatic beam alignment, ensures that the iChrome family is always perfectly aligned. The iChrome multi-laser engines are easy to operate and at the same time enable the most demanding research and measurements.

	iChrome CLE	iChrome MLE
Number of wavelengths	4	4 (+1*)
Max. Power level	20 mW	100 mW
Switching principle	Direct	Direct / AOM
COOL^{AC}	Yes	Yes
Number of fibers	1	1 (2**)
Size (H x W x D mm)	110 x 201 x 248	110 x 295 x 248

*additional external iBeam smart
** 2 SM, SM/PM or 2 MM fibers possible

COOL^{AC} automatic realignment
› Ready to use
› No manual alignment
› Automatic recalibration (just a push of a button)
› Always maximum fiber output power

The iChrome family will operate with maximum output power from the first day on. The installation is as easy as the push of a button. Misalignment during shipment will be corrected by COOL^{AC}. Even when the lab environment changes (temperature, vibration, shocks), the unique autocalibration feature keeps the multi-laser engines at top performance.

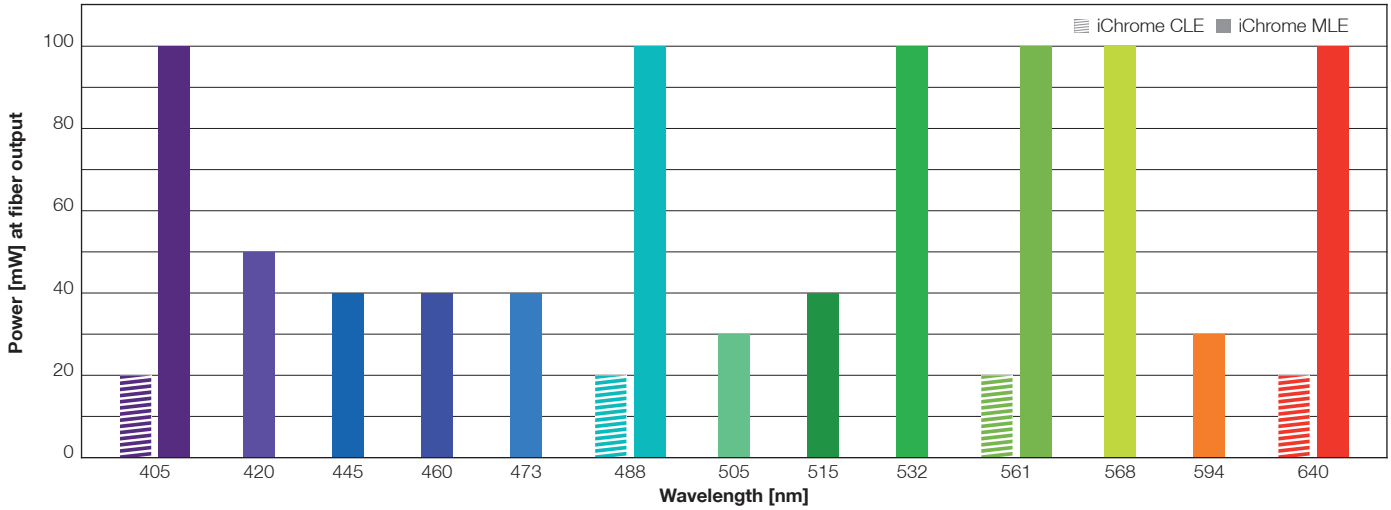
Highest output power
› Up to 100 mW per laser line

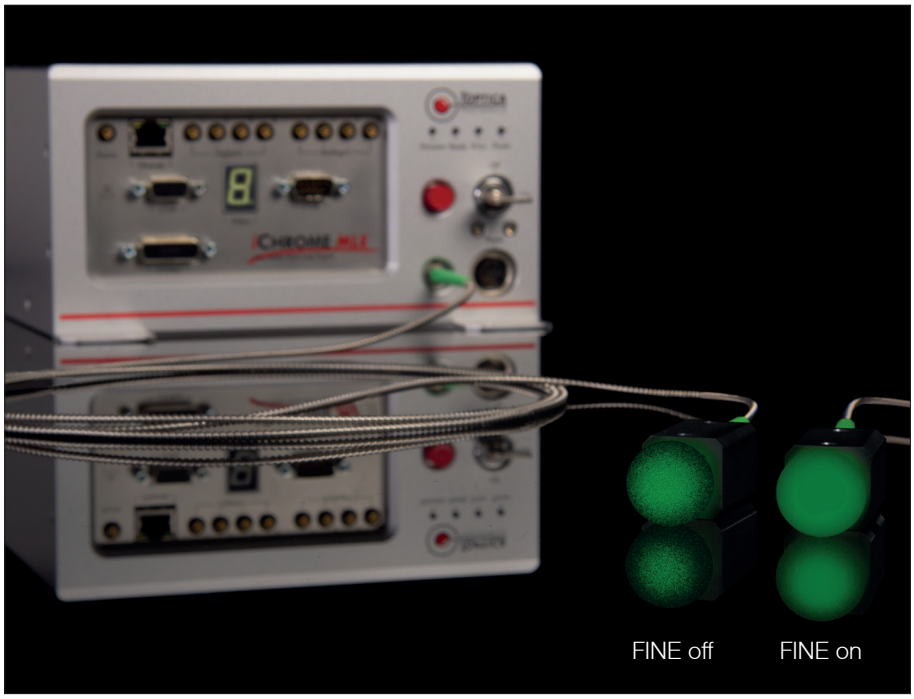
For power-hungry experiments (high resolution techniques, spinning disk microscopy, light sheet microscopy, etc.) the iChrome systems provide highest fiber output powers.

Models that integrate high-power laser diodes and DPSS lasers are available. Along with high coupling efficiencies and the proprietary COOL^{AC} technology they provide constant and long-term fiber output powers of up to 100 mW.

Complete off
› True “zero photon” off-state, up to 20 MHz modulation
› Rise and fall times with “complete off” in 5 ns
› High signal-to-noise ratio

The iChrome systems allow “complete off” modulation up to 20 MHz for applications that require a true “zero photon” dark state (e.g. photoactivated localization techniques, like SMLM), and to increase the signal-to-noise ratio for better image quality and less photo damage.





Speckle management for best image quality

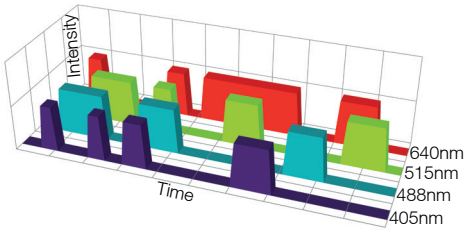
› FINE – reduces speckle artifacts (proprietary)
› Purely electronic feature
› Reduced coherence length

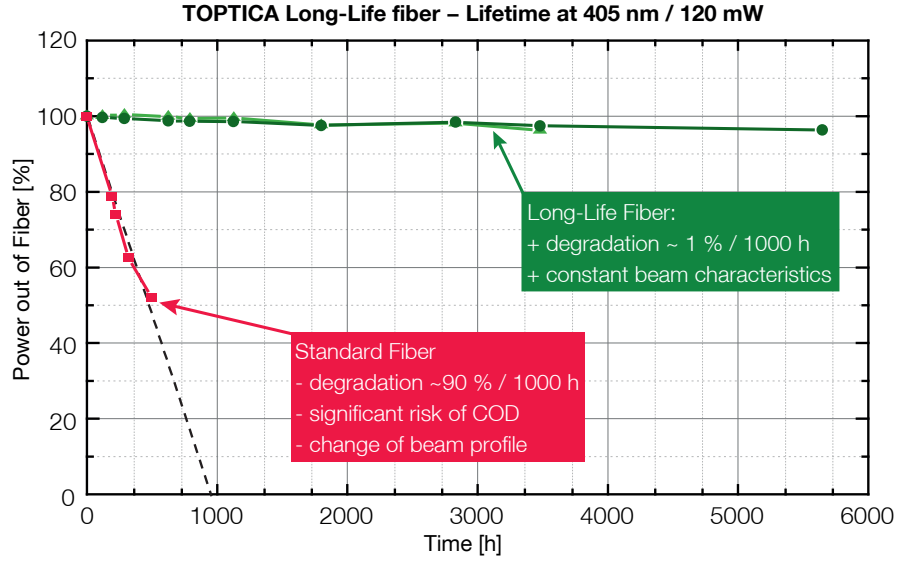
Annoying speckle noise on detectors and imaging systems caused by long coherence lengths is lowered to a minimum. TOPTICA's FINE (Feedback Induced Noise Eraser) feature reduces the coherence length by purely eletronic means and is integrated in the iChrome CLE/MLE. FINE helps to improve the image quality by reducing the mutual interference of wavefronts.

Direct modulation for complex illumination patterns

› No extra hardware (AOM/AOTF) required
› 20 MHz digital modulation speed; excellent rise and fall times (< 5 ns)
› up to 100 mW continuous power setting
› Mixed mode triggering (analog & digital modulation simultaneously)
› Independent, simultaneous triggering with asynchronous pulses

The iChrome systems incorporate an analog and a digital modulation input. With mixed mode triggering (analog and digital modulation simultaneously) and the asynchronous TTL trigger input, the system can perform arbitrary pulse patterns for complex experiments.





Long-term high UV power

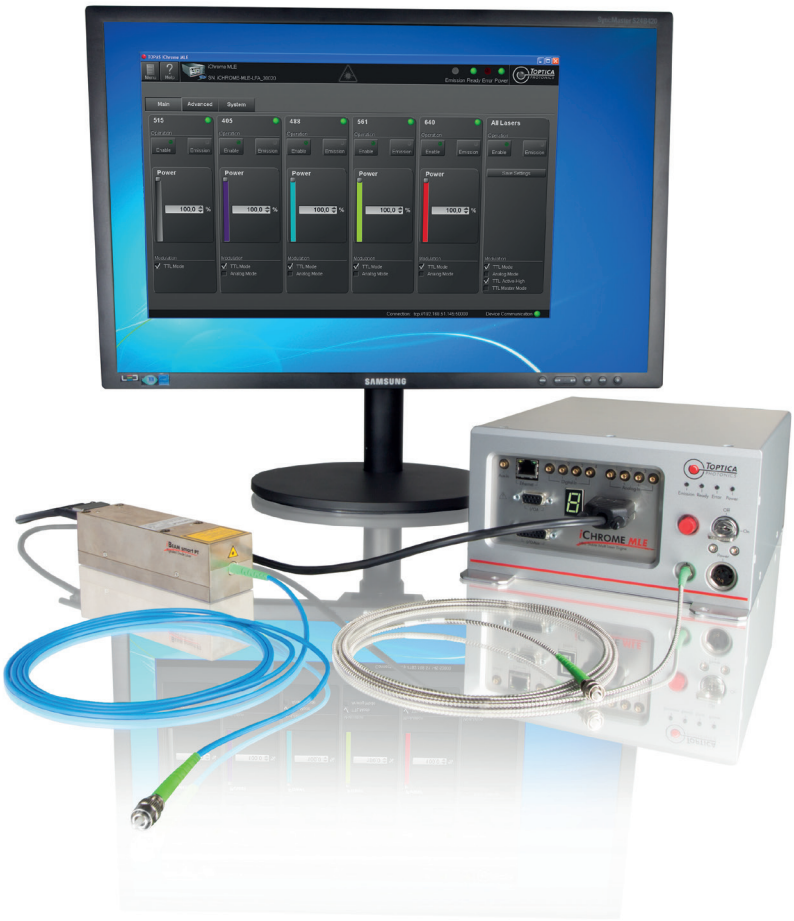
› Superior lifetime with proprietary Long-Life fiber @ 405 nm
› Long-Life fiber typical lifetime: > 10.000 h

Specially selected Long-Life fibers ensure high output powers also for UV-wavelengths. With these special fibers, the known degradation at 405 nm belongs to the past. Even at 120 mW of 405 nm there is close to no degradation of the optical fiber transmission.

User Interfaces

Stand alone use:
Graphical user interface

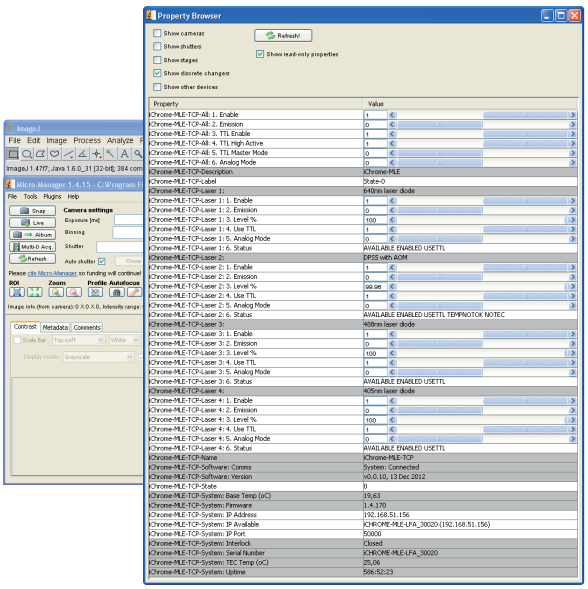
The microprocessor-controlled system enables flexible OEM integration into instruments such as microscopes or flow cytometers. Researchers and developers that want to operate their iChrome system as stand-alone unit however can control all laser parameters conveniently by a graphical user interface (TOPAS). With this software they can configure system settings, control all parameters of each laser individually and fully control all advanced features like COOL^{AC} and FINE. The software can also run scripts to automate more complex custom setups. The TOPAS software also detects an iBeam smart that is connected to the iChrome MLE system. This iBeam smart can also be conveniently controlled via the TOPAS graphical user interface.



Control up to 5 lasers from 2 fibers

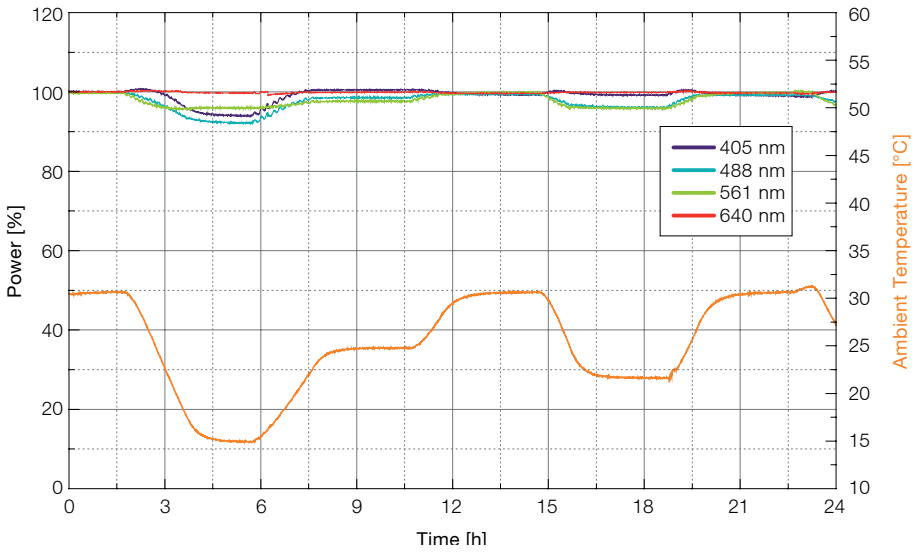
The iChrome MLE can control an external iBeam smart or iBeam smart PT diode laser. This way complex experiments with up to 5 colors and 2 fiber outputs can be easily realized.

All laser lines can be conveniently operated via the iChrome MLE graphical user interface. The iBeam smart will be completely supplied and controlled through the iChrome MLE, even the interlock is handed over to the iBeam smart.



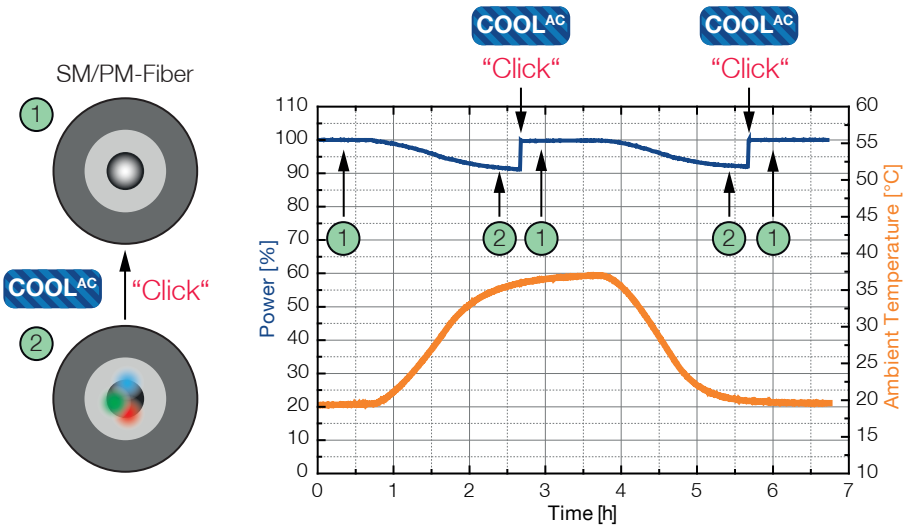
Open source software:
Integration into micromanager

Users that already use the open source software µ-Manager to control their automated microscopes will appreciate that the iChrome MLE is already integrated into µ-Manager. With this integration, it is possible to fully control the iChrome MLE within the familiar µ-Manager environment.



Passive stability

Even in changing environmental conditions the iChrome systems show an excellent passive stability. The different colors maintain a very high coupling efficiency and show no hysteresis – they return to 100 % output power each time the temperature returns to its initial value.



Severe temperature changes may decrease the output power after fiber delivery (2). COOL^{AC} brings back the system to perfect alignment and maximum power (1) with just one click.

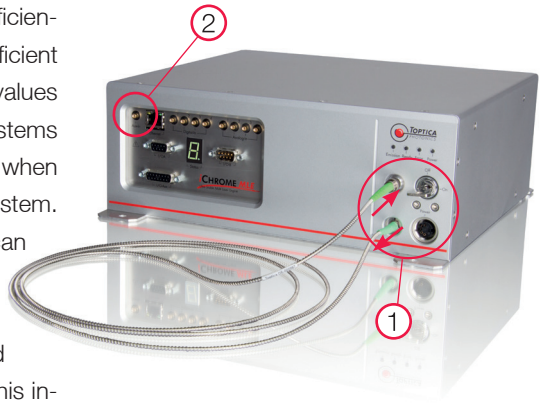
High fiber output powers

The iChrome systems deliver fiber output powers of up to 100 mW per color. The secret in high output powers after fiber delivery lies in very efficient and stable fiber coupling. This is achieved by high passive stability and active realignment.

Active realignment – COOL^{AC}

High passive stability may not be sufficient to ensure maximum output power after transportation of the iChrome system or to keep it stable during severe changes of the lab environment (temperature, vibrations). In these cases TOPTICA's proprietary COOL^{AC} (Constant Optical Output Level with Auto-Calibration) technology resets the lasers to maximum output power by just one push of a button.

COOL^{AC} even allows for a "no-screwdriver"-installation: with just one click, the iChrome systems are perfectly aligned and ready for operation. The auto-calibration realigns all laser lines into the single-mode fiber and reliably restores the fiber coupling efficiency. For situations where it is not sufficient to restore the last known optimum values (after transportation), the iChrome systems can find a new optimum position when the fiber is fed back into the system. Alternatively the same procedure can also be performed with external signals (e.g. PMT detectors, powermeter etc.) that are connected via the electrical Aux-in input. With this input, customers can also realize feedback loops from sensors that are already part of their instrument setup.



For self-calibration the user can feed back the laser light via fiber input (1) or use external signals via Aux-in (2).

iChrome CLE
Compact And Efficient Four-Color Laser Engine

TOPTICA's iChrome CLE is a compact laser engine that combines four laser lines in one box. All integrated colors are provided via one polarization-maintaining single-mode fiber. It is available with 405, 488, 561 and 640 nm at a 20 mW guaranteed output power level out of the fiber.

The iChrome CLE incorporates TOPTICA's proprietary FDDL (Frequency Doubled Diode Laser) for the 561 nm line. This technology provides unique advantages for the user. For the first time, a 561 nm line can be treated as „diode" with its superior modulation properties, including fast response times, low power consumption and complete off (zero photon) in the off state.

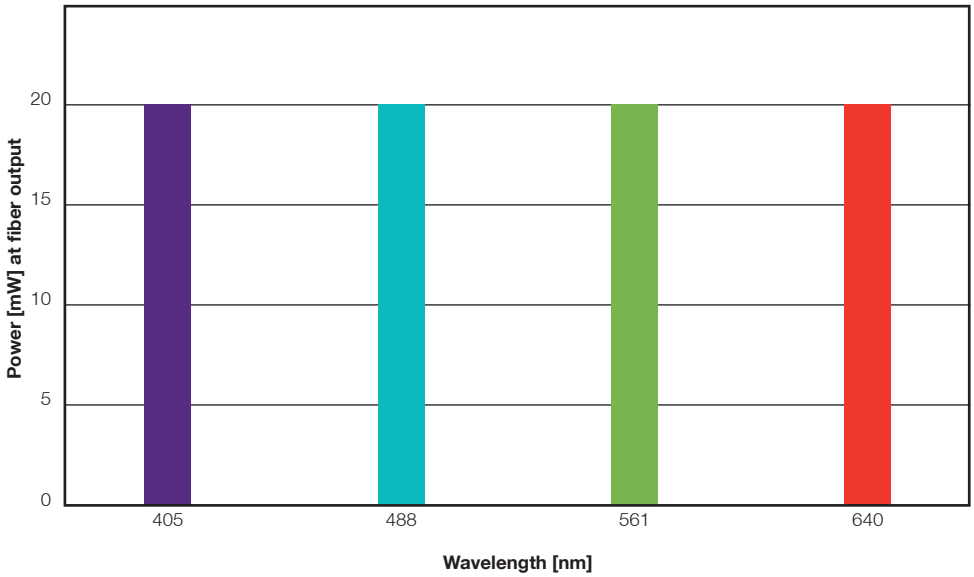
The system guarantees a plug & play installation as the included COOL^{AC} automatic alignment technology will restore full fiber coupling efficiency at the push of a button.

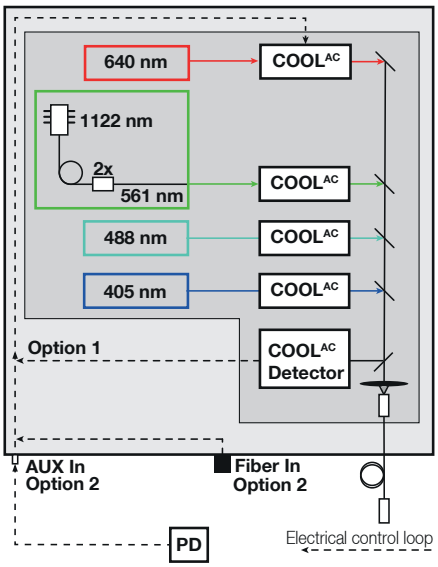
OEM integration is easy via the fully unified user interface. All features can be addressed and programmed via RS232 or Ethernet. Compatibility to existing setups is achieved with the industry standard analog and digital interfaces, which can be used to trigger and control laser power for each individual laser line.

The iChrome CLE represents the easy to use entry point for a fully integrated and automized laser engine. Customers can take care of their research without the need to ever manually align their illumination source.

Key Features

- Four colors in one box
- 405, 488, 561, 640 nm with > 20 mW each
- COOL^{AC} – hands-free, self-aligning system
- Unique modulation capabilities
- Unified user interface

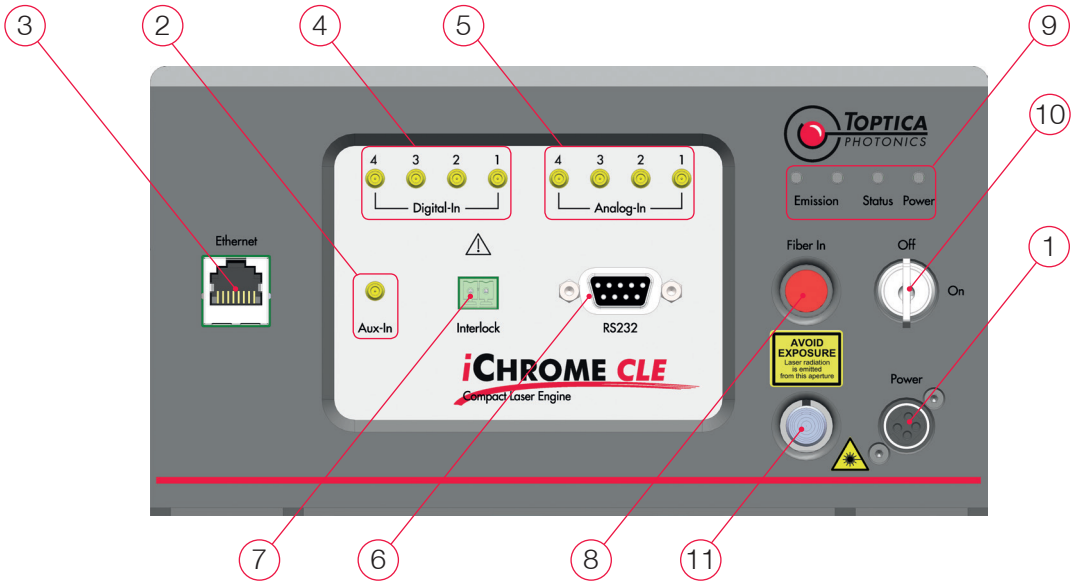




The mechanical design of the iChrome CLE fully integrates all laser lines (laser diodes and FDDL) plus fiber coupling and COOL^{AC} into one solid block, which is temperature stabilized for added stability. This design ensures safe and stable operation almost independent from external influences.

For installation or maintenance purposes, the CLE is equipped with two methods for COOL^{AC} optimization. The internal COOL^{AC} detector (option 1) can be used to re-optimize fiber coupling purely by internal means.

After transport and installation of the system, COOL^{AC} can also be performed via either an external sensor (option 2, AUX in) or the integrated photo diode (option 2, fiber in). With these options it is possible to optimize the power from the fiber output and thus reset the COOL^{AC} for future internal optimization.



CONNECTORS			
1	Power input	KPJX-4	
2	Aux input	SMB-connector	Analog, 0 .. +5 V, for laser power calibration
3	Ethernet	RJ45-8P8C	
4	Digital input (laser 1 - 4)	SMB-connector	TTL
5	Analog input (laser 1 - 4)	SMB-connector	Analog, 0 .. +5 V
6	RS232	DB-9 female	
7	Interlock	Phoenix-connector	
8	Self-calibration fiber input	FC-input	Input for fiber output (#11)
INDICATORS			
9	LEDs for general system status (emission, status, power)		
GENERAL			
10	Key switch		
11	Fiber output		

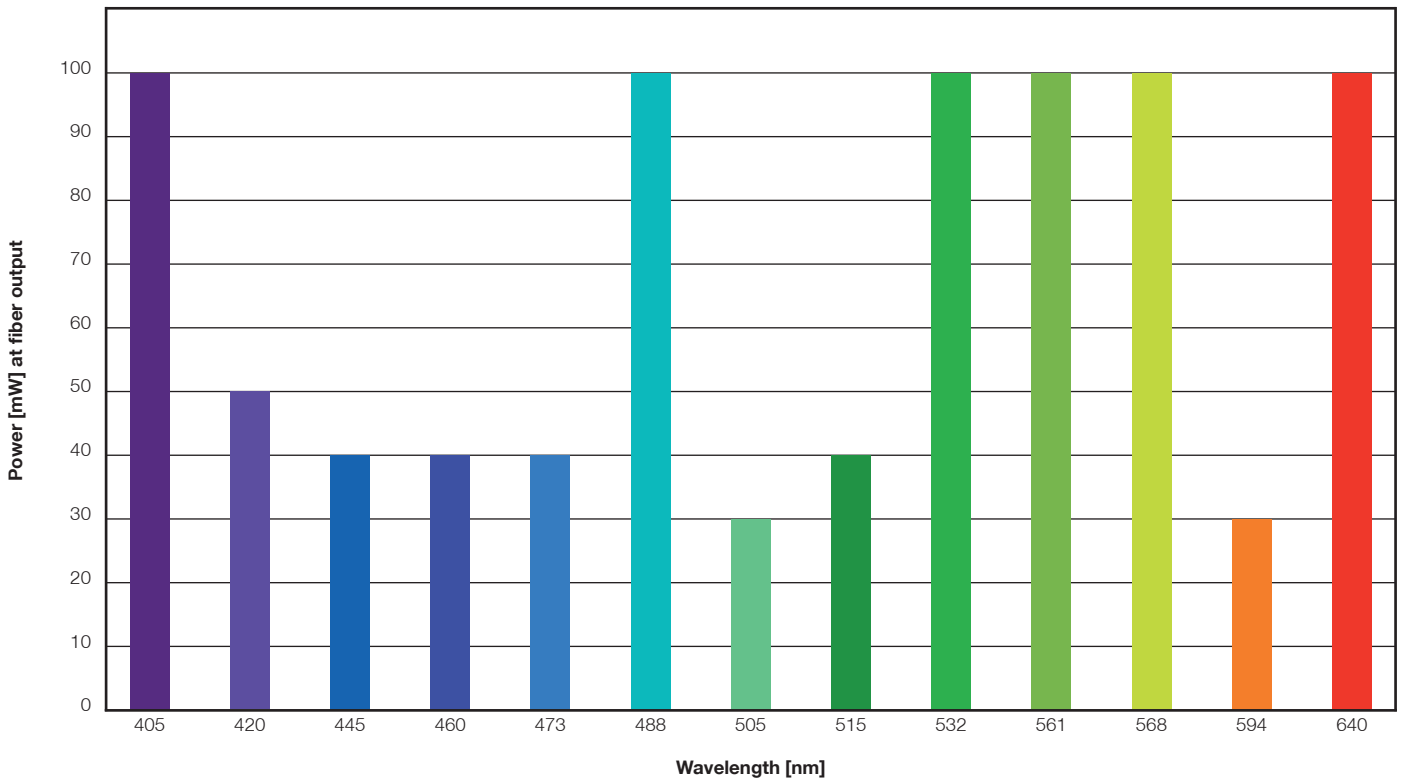
iChrome MLE
Ultra-Stable Multi-Laser Engine

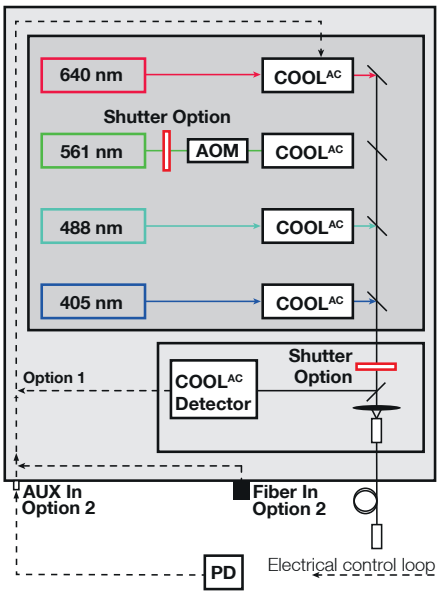
The iChrome MLE can contain up to four different diode lasers, or three diode lasers plus one DPSS laser fully integrated into one compact box. The individual lasers are efficiently combined and delivered via an all-in-one PM/SM fiber output. The microprocessor-controlled system enables flexible OEM integration. High speed analog and digital modulation allow fast switching of laser wavelength and intensity.

Being the more flexible and powerful version of TOPTICA's multi-laser engines, the iChrome MLE can be customized in many ways. With standard wavelengths ranging from 405 nm to 640 nm it can be built exactly to customer requirements. Many colors are available up to 100 mW output power. Options such as a shutter, either for the DPSS laser only, or for all wavelength simultaneously, heat sinks and output collimators complete the building blocks that are available for your customized iChrome MLE. TOPTICA's ingenious COOL^{AC} (Constant Optical Output Level with Auto-Calibration) technology automatically aligns the system with a single push of a button. This feature ensures a constant optical output level even under strongly varying ambient conditions and completely eliminates the need for manual realignment – making the iChrome family the most advanced multi-line laser systems on the market.

Key Features

- Perfect choice for microscopy and flow cytometry
- Up to 4 laser lines
- COOL^{AC} – hands-free, self-aligning system
- Direct modulation up to 20 MHz
- Supported by µ-Manager microscopy software

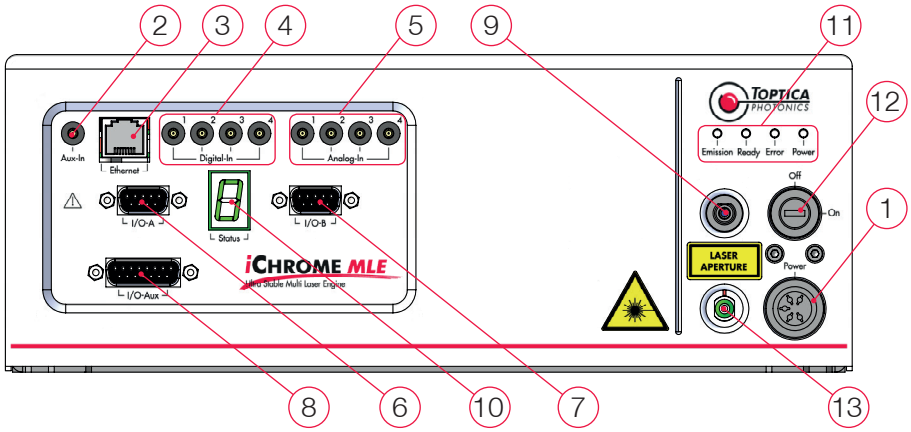




The iChrome MLE fully integrates all laser lines (laser diodes plus DPSS), fiber coupling and COOL^{AC} onto one solid base plate. With temperature-stabilized laser combiner and fiber coupling units it ensures safe and stable operation almost independent from external influences.

With its laser beam position detector it can easily and quickly reset fiber coupling to a saved „Home" position. This procedure can be extremely helpful for multi-hour measurments, where a perfectly stable laser power is required.

For installation the iChrome MLE offers two different COOL^{AC} optimization procedures. The system can either optimize directly to the fiber output (by plugging the fiber back into the MLE) or on the reading of a power meter, that may already be installed in the customers instrument setup (via the Aux-in input).



Flexible integration:
Electrical connectors

Thanks to different electrical connectors, the iChrome MLE can be conveniently integrated into existing setups and instruments. A fully digital comunication can be realized via RS 232 or Ethernet connection. For better compatibility to excisting setups, dedicated TTL and analog inputs are available for each wavelength. Furthermore, programmable pins are available, that can be linked to commands according to customer needs.

CONNECTORS			
1	Power input	KPJX-4	
2	Aux input	SMB-connector	Analog, 0 .. +5 V, for laser power calibration
3	Ethernet	RJ45-8P8C	
4	Digital input (laser 1 - 4)	SMB-connector	TTL
5	Analog input (laser 1 - 4)	SMB-connector	Analog, 0 .. +5 V
6	I/O-A	DB-9 female	RS 232 input
7	I/O-B	DB-9 male	RS 232 output (for iBeam smart)
8	I/O-Aux	DB-15 female	Interlock, programmable in-/ and outputs
9	Self-calibration fiber input	FC-input	Input for fiber output (#13)
INDICATORS			
10	LEDs for general system status (laser, ready, error, power)		
11	Display for laser specific status		
GENERAL			
12	Key switch		
13	Fiber output		

Specifications iChrome CLE

Optical Specifications				
Wavelength	405 nm	488 nm	561 nm	640 nm
Center wavelength range	± 4 nm	± 4 nm	± 2 nm	+ 3 / - 5 nm
Fiber coupled cw output power	20 mW	20 mW	20 mW	20 mW
Power stability (drift over 8 h @ room temperature +/- 3 °C)	< 5 %			
RMS noise (10 Hz - 10 MHz)	< 0.2 %			
M^2	< 1.1			
Ellipticity	< 10 %			
Polarization ratio (typ.)	> 100:1, linear			
Polarization orientation tolerance	± 3° (slow axis aligned to index key)			
Fiber Specifications				
Fiber output connector	FC/AFC (8° angled) as standard, others like FC/PC, FC/APC, FCP8 or SC on request			
Fiber cable length (max.)	2 m			
Fiber cable type	3 mm stainless steel reinforced			
Fiber minimum bend radius	50 mm			
Fiber type	Single-mode, polarization-maintaining			
Fiber numerical aperture (5 %) (typ.)*	0.072	0.069	0.066	0.062
Mode-field diameter (typ.)*	3 µm	3.5 µm	3.5 µm	4.2 µm
Electronic Specifications				
Digital Modulation				
Supported digital signal levels	TTL			
Maximum digital modulation frequency	1 MHz			
Rise / Fall time (10 % - 90 %) (ns)	< 0.2 µs			
Trigger to light (typ.)	< 1 µs			
Digital modulation extinction ratio	inf.			
Analog Modulation				
Maximum modulation frequency	1 MHz			
Analog trigger to light (typ.)	< 1 µs			
Analog modulation extinction ratio	inf.			
General and Environmental Specifications				
Certification	CE compliance, RoHS compliance, CDRH			
Laser class	Class 3b			
Digital communication interface	RS 232 (≤ 115.200 baud), Ethernet			
Operating ambient temperature range	15 .. 40 °C			
Storage temperature range	-10 .. 60 °C			
Operating relative humidity	< 90 %, non-condensing			
Dimensions laser head (H x W x D)	110 x 205 x 250 mm^3			
Weight	4.6 kg			
DC input requirements	12 V DC, < 6 A			
Power consumption	< 70 W			

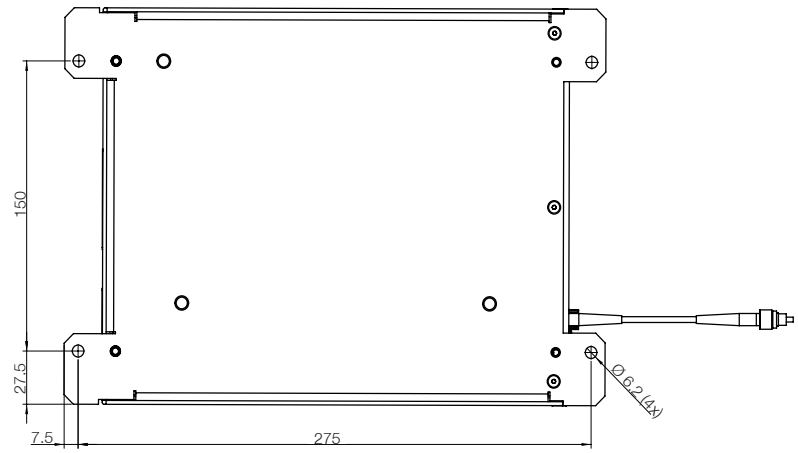
*subject to change

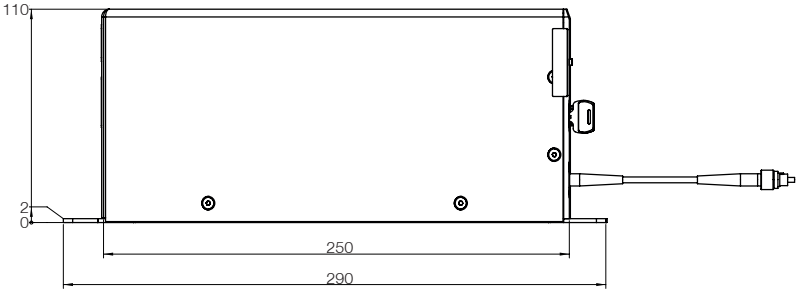
Optical Specifications													
Wavelength* (nm)	405	420	445	460	473	488	505	515	532	561	568	594	640
Center wavelength range (nm)	± 4	± 5	± 5	± 5	± 5	± 4	± 5	± 5	± 2	± 2	± 2	± 2	+ 3/- 5
Fiber coupled cw output power (mW)	50	50	40	40	40	40	30	40	40	40	65	30	50
Fiber coupled cw output power - high power version (mW)	100	50	40	40	40	100	30	40	100	100	100	30	100
Power stability	± 2 % (drift over 24 h @ room temperature +/- 3 °C)												
RMS noise (10 Hz - 10 MHz)	< 0.2 %												
Long-term output power average	<= 5 % / 1000 hrs												
M^2	< 1.1												
Ellipticity	< 10 %												
Polarization ratio (typ.)	> 100:1, linear												
Polarization orientation tolerance	± 3° (slow axis aligned to index key)												
Fiber Specifications													
Fiber output connector	FC/AFC (8° angled) as standard, others like FC/PC, FC/APC/FCP8 or SC on request												
Fiber cable length (max.)	2 m												
Fiber cable type	3 mm stainless steel reinforced												
Fiber minimum bend radius	50 mm												
Fiber type	Single-mode, polarization-maintaining												
Fiber numerical aperture (5 %) (typ.)**	0.072	0.072	0.071	0.070	0.070	0.069	0.068	0.068	0.067	0.066	0.065	0.064	0.063
Mode-field diameter (typ.) (µm)**	3	3	3	3.3	3.3	3.5	3.5	3.5	3.5	3.5	3.5	3.9	4.2
Electronic Specifications													
Digital Modulation													
Supported digital signal levels	TTL												
Max. digital modulation frequency	20 MHz												
Rise/Fall time (10 % - 90 %) (ns)	< 5 ns								< 15 ns				< 5 ns
Trigger to light (typ.)	< 50 ns								< 500 ns				< 50 ns
Digital modulation extinction ratio	inf.								10^6				inf.
Analog Modulation													
Maximum modulation frequency	1 MHz												
Analog trigger to light (typ.)	500 ns												
Analog modulation extinction ratio	inf.								10^6 (typ.)				inf.
General and Environmental Specifications													
Certification	CE compliance, RoHS compliance, CDRH												
Laser class	Class 3b												
Digital communication interface	RS 232 (≤ 115.200 baud), Ethernet												
Operating ambient temp. range	15 .. 40 °C												
Storage temperature range	-10 .. 60 °C												
Operating relative humidity	< 90 %, non-condensing												
Dimensions laser head (H x W x D)	110 x 295 x 250 mm^3, (high power version: 110 x 295 x 300 mm^3)												
Weight	7.5 kg, (high power version: 9.5 kg)												
DC input requirements	12 V DC, < 6A, (high power version: 12 V DC, < 11 A)												
Power consumption	< 70 W, (high power version: < 120 W)												

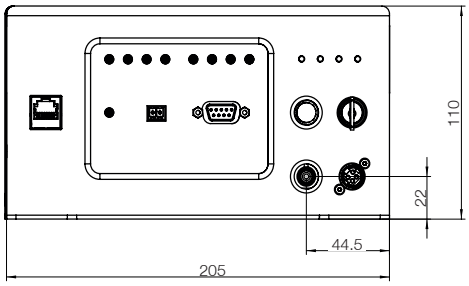
*other wavelength on request **subject to change

Technical Drawings

iChrome CLE

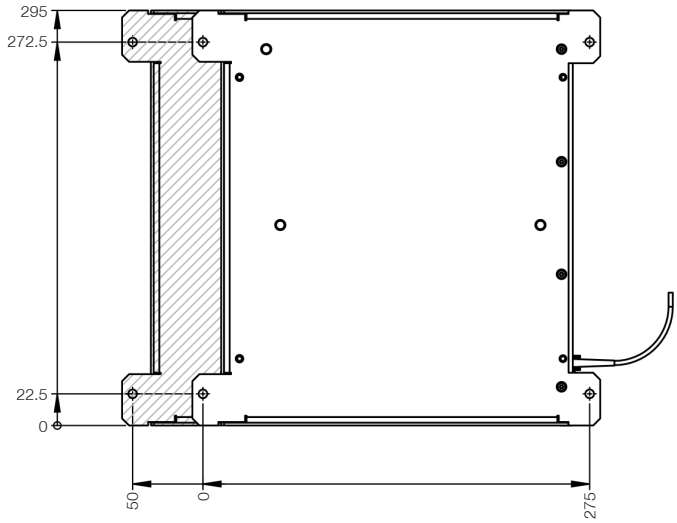


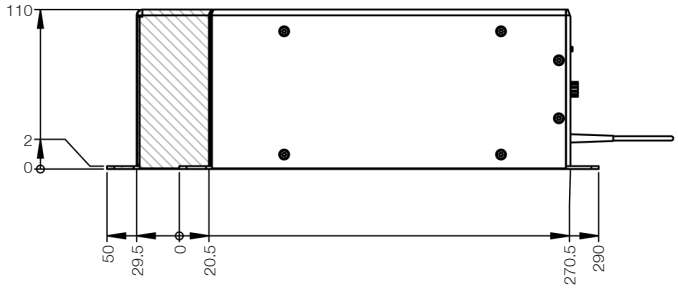


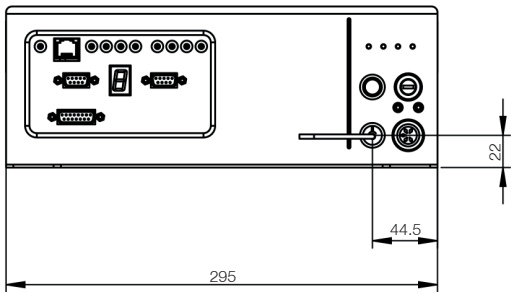


All dimensions given in mm

iChrome MLE-L and iChrome MLE-HP







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