PHAROS

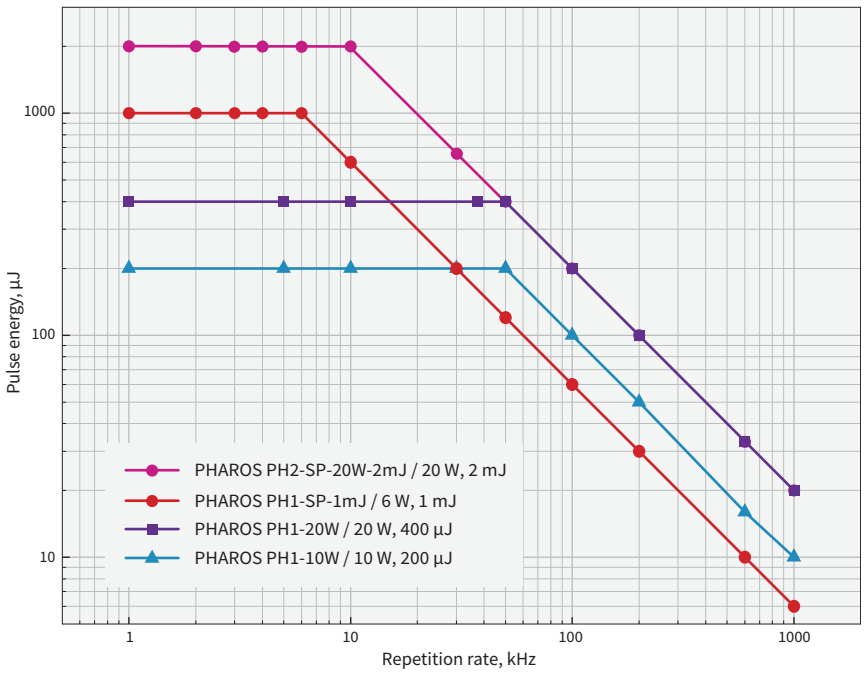
High Power and Energy Femtosecond Lasers

FEATURES

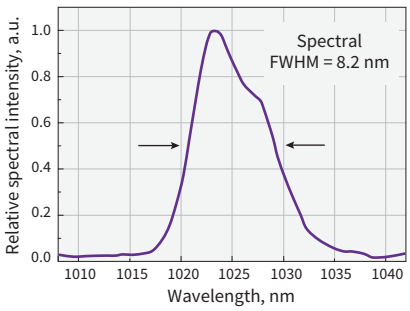
- 190 fs – 20 ps tunable pulse duration
- 2 mJ maximum pulse energy
- 20 W output power
- 1 kHz – 1 MHz tunable base repetition rate
- Pulse picker for pulse-on-demand operation
- Rugged industrial grade mechanical design
- Automated harmonics generators (515 nm, 343 nm, 257 nm, 206 nm)
- Optional CEP stabilization
- Possibility to lock oscillator to external clock

PHAROS is a femtosecond laser system combining millijoule pulse energies and high average powers. PHAROS features a mechanical and optical design optimized for industrial applications such as precise material processing. Compact size, an integrated thermal stabilization system, and sealed design allow PHAROS integration into machining workstations.

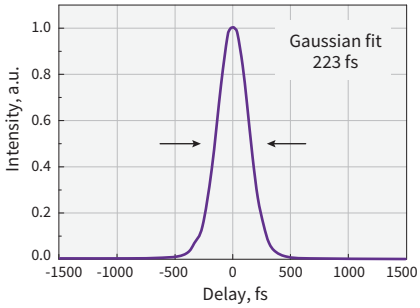
Laser diodes pumping Yb medium significantly reduces maintenance costs and provides a long laser lifetime. Software tunability of PHAROS allows the system to cover applications normally requiring different classes of laser. Tunable parameters include pulse duration (190 fs – 20 ps), repetition rate (single pulse to 1 MHz), pulse energy (up to 2 mJ) and average power (up to 20 W). Its power level is sufficient for most material processing applications at high machining speeds. The built-in pulse picker allows convenient control of the laser output in pulse-on-demand mode. PHAROS compact and robust optomechanical design features stable laser operation across varying environments.



Pulse energy vs base repetition rate for PHAROS



Typical spectrum of PHAROS



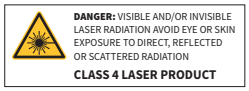
Typical pulse duration of PHAROS

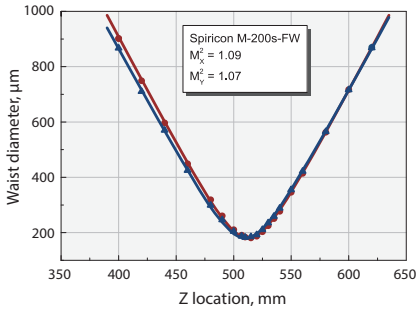
SPECIFICATIONS

NEW

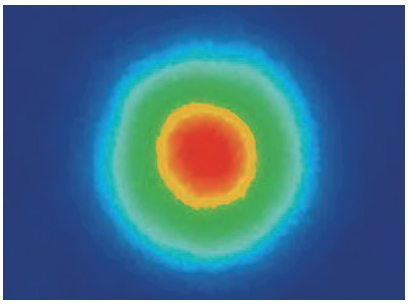
Model [1]	PH1-10W	PH1-15W	PH1-20W	PH1-SP-1mJ	PH2-SP-20W-2mJ
OUTPUT CHARACTERISTIC					
Max. average power	10 W	15 W	20 W	6 W	20 W
Pulse duration (assuming Gaussian pulse shape)	< 290 fs			< 190 fs	
Pulse duration range	290 fs – 10 ps (20 ps on request)			190 fs – 10 ps (20 ps on request)	
Max. pulse energy	> 0.2 mJ or > 0.4 mJ			> 1 mJ	> 2 mJ
Beam quality	TEM_{00} ; M^2 < 1.2			TEM_{00} ; M^2 < 1.3	
Base repetition rate [2]	1 kHz – 1 MHz				
Pulse selection	Single-Shot, Pulse-on-Demand, any base repetition rate division				
Centre wavelength	1028 nm ± 5 nm			1033 nm ± 5 nm	
Output pulse-to-pulse stability [3]	< 0.5 % rms over 24 hours				
Power stability	< 0.5 % rms over 100 h				
Pre-pulse contrast	< 1 : 1000				
Post-pulse contrast	< 1 : 200				
Polarization	Linear, horizontal				
Beam pointing stability	< 20 µrad/°C				
OPTIONAL EXTENSIONS					
Oscillator output	Optional. Please contact *sales@lightcon.com* for more details or customized solutions				
Typical output	1 – 6 W, 50 – 250 fs, ~1035 nm, ~ 76 MHz, simultaneously available				
Harmonics generator	Integrated, optional *(see page 8)*				
Output wavelength	515 nm, 343 nm, 257 nm, 206 nm				
Optical parametric amplifier	Integrated, optional *(see page 15)*				
Tuning range	640 – 4500 nm				
BiBurst mode	Tunable GHz and MHz burst with burst-in-burst capability, optional *(see page 9)*				
GHz-mode (P)					
Intra burst pulse separation [4]	~ 200 ± 40 ps			~ 500 ± 40 ps	
Max no. of pulses [5]	1 . . 25			1 . . 10	
MHz-mode (N)					
Intra burst pulse separation	~ 16 ns				
Max no. of pulses	1 . . 9, (7 with FEC)				
PHYSICAL DIMENSIONS					
Laser head [6]	670 (L) × 360 (W) × 212 (H) mm				730 (L) × 419 (W) × 233 (H) mm
Rack for power supply & chiller	642 (L) × 553 (W) × 673 (H) mm				PS integrated in the laser head
UTILITY REQUIREMENTS					
Electric	110 V AC, 50 – 60 Hz, 20 A or 220 V AC, 50 – 60 Hz, 10 A				
Operating temperature	15 – 30 °C (air conditioning recommended)				
Relative humidity	< 80 % (non condensing)				

[1] *More models are available on request.*
[2] *Some particular repetition rates are software denied due to system design.*
[3] *Under stable environmental conditions.*
[4] *Custom spacing on request.*
[5] *Maximum number of pulses in a burst is dependent on the laser repetition rate. Custom number of pulses on request.*
[6] *Dimensions might increase for non-standard laser specifications.*

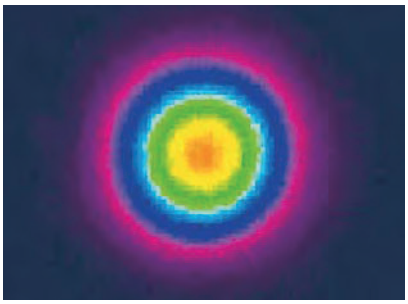




Typical M^2 measurement data of PHAROS

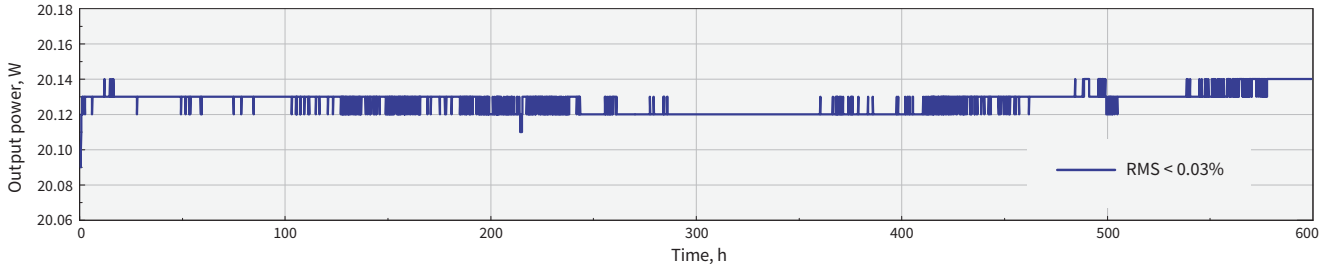


Typical near-field beam profile of PHAROS at 200 kHz

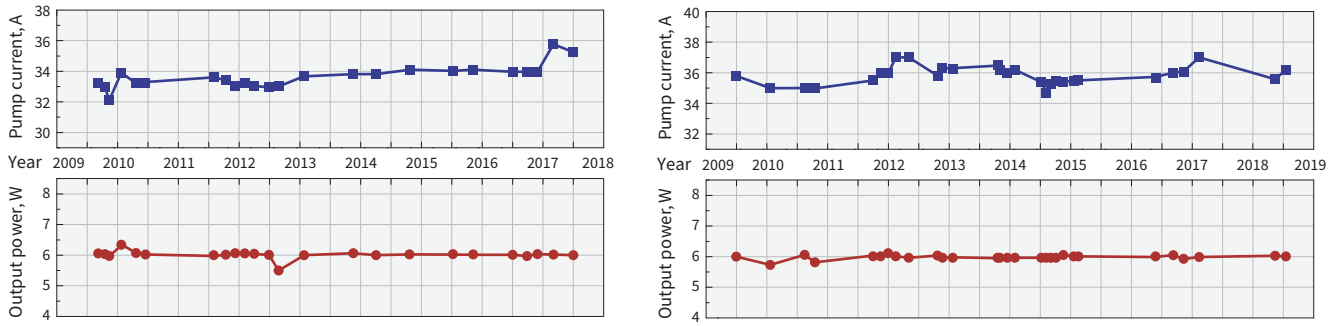


Typical far-field beam profile of PHAROS at 200 kHz

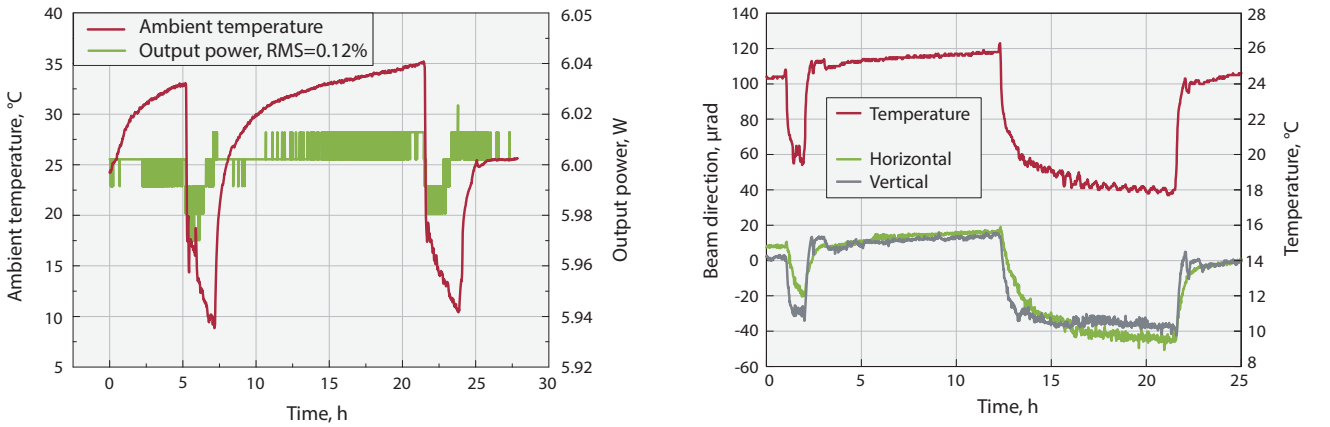
STABILITY MEASUREMENTS



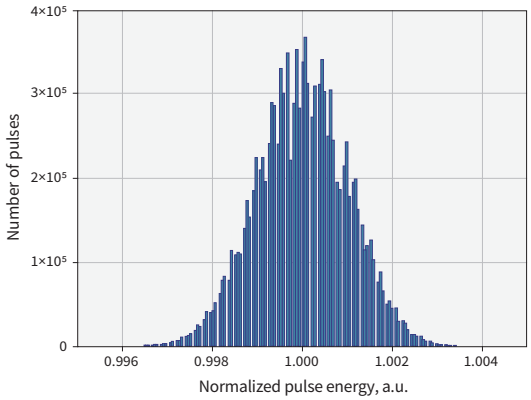
Long term stability graph of PHAROS



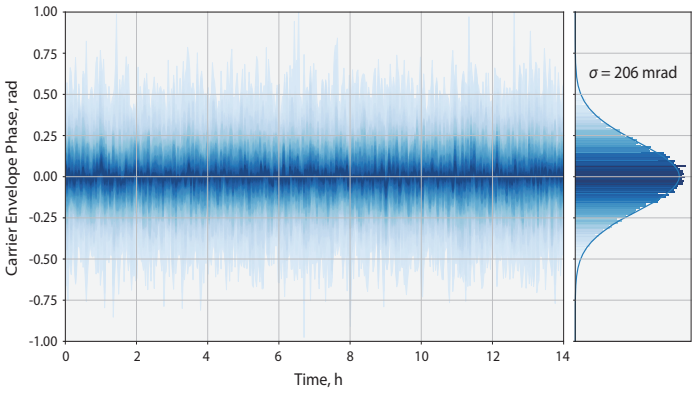
Output power of industrial PHAROS lasers operating 24/7 and current of pump diodes during the years



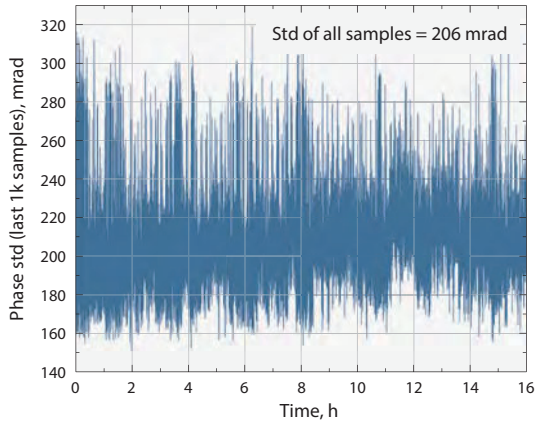
PHAROS output power with power lock enabled under unstable environment



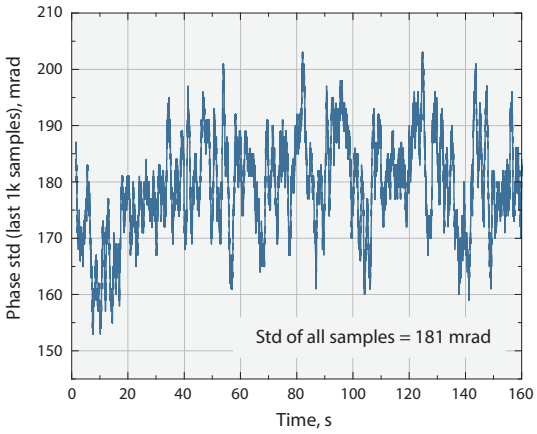
Short term pulse-to-pulse energy stability of PHAROS lasers. 1.2×10^7 pulses (1 min at 200 kHz), STD < 0.11%, peak-to-peak < 1%



Carrier-envelope phase (CEP) over the long period with active phase stabilization system



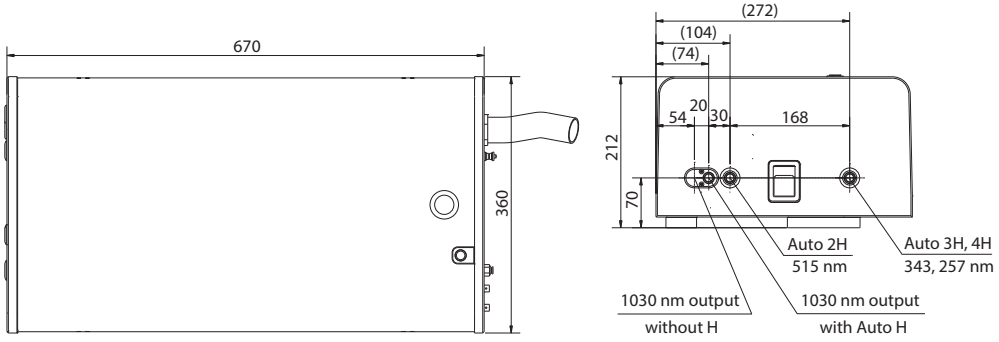
CEP stability over a long time scale



CEP stability over a short time scale

PHAROS CEP stability when laser is isolated from all noticeable noise sources – vibrations, acoustics, air circulation and electrical noise. System can achieve < 300 mrad std of CEP stability over a long time scale (> 8 hours) and < 200 mrad over a short time scale (< 5 min)

OUTLINE DRAWINGS



PHAROS PH1 laser outline drawing

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HG | PHAROS

Automated Harmonics Generators

Harmonics generator module attached to PHAROS

FEATURES

- 515 nm, 343 nm, 257 nm and 206 nm
- Output selection by software
- Mounts directly on a laser head and integrated into the system
- Rugged industrial grade mechanical design

PHAROS laser can be equipped with automated harmonics modules. A selection of fundamental (1030 nm), second (515 nm), third (343 nm), fourth (257 nm) or fifth (206 nm) harmonic outputs are available through software control.

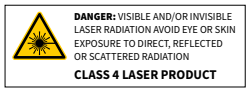
Harmonics generators are designed to be used in industrial applications where a single output wavelength is desired.

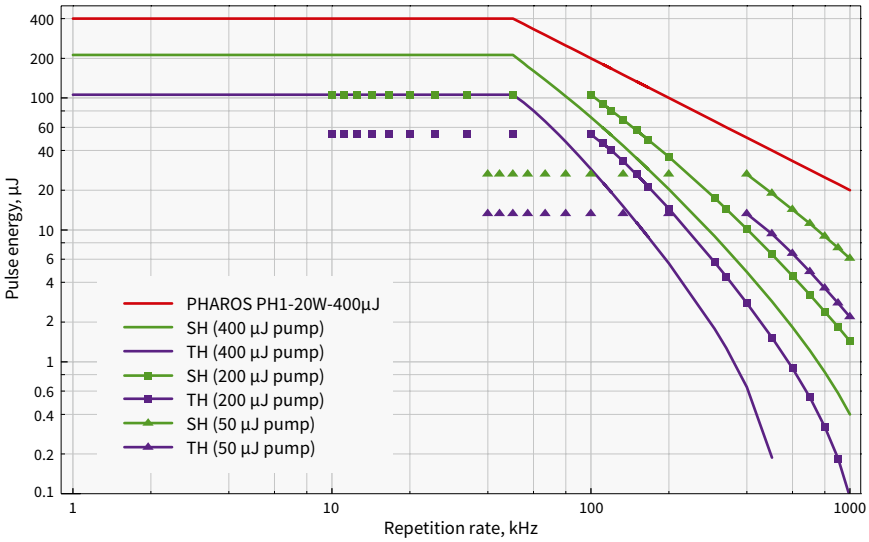
Modules are mounted directly on the output of the laser and integrated into the system.

SPECIFICATIONS

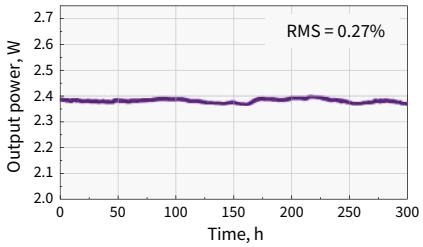
Model	2H	2H-3H	2H-4H	4H-5H
Output wavelength [1] **(automated selection)**	1030 nm 515 nm	1030 nm 515 nm 343 nm	1030 nm 515 nm 257 nm	1030 nm 257 nm 206 nm
Input pulse energy	20 – 2000 µJ	50 – 2000 µJ [2]	20 – 2000 µJ [2]	200 – 1000 µJ
Pump pulse duration	190 – 300 fs			
Conversion efficiency	>50 % (2H)	>50 % (2H) >25 % (3H)	>50 % (2H) >10 % (4H) [3]	>10 % (4H) [3] >5 % (5H) [4]
Beam quality (M^2) ≤ 400 µJ pump	<1.3 (2H), typical <1.15	<1.3 (2H), typical <1.15 <1.4 (3H), typical <1.2	<1.3 (2H), typical <1.15 n/a (4H)	n/a
Beam quality (M^2) > 400 µJ pump	<1.4 (2H)	<1.4 (2H) <1.5 (3H)	<1.4 (2H) n/a (4H)	

[1] *Depends on pump laser model.*
[2] *High energy versions are available, please contact Light Conversion for specifications.*
[3] *Max 1 W output.*
[4] *Max 0.15 W output.*

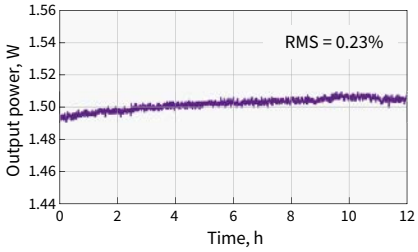




PHAROS harmonics energy vs pulse repetition rate



3H output stability



4H output stability

LIGHT CONVERSION
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BiBurst

Tunable GHz and MHz burst with burst-in-burst capability

PHAROS and CARBIDE 40W (CB3) have an option for tunable GHz and MHz burst with burst-in-burst capability – called BiBurst. The distance between burst packet groups is called nanosecond burst, N (MHz-Burst). The distance between sub-pulses in the group is called picosecond burst, P (GHz-Burst).

In single pulse mode, one pulse is emitted at a time at some fixed frequency. In burst mode, the output consists of several picosecond burst packets each separated by an equal time period between each packet. Each packet can contain a number of sub-pulses which are also separated by an equal time period between each pulse.

High pulse energy femtosecond laser with flexible BiBurst functionality brings new production capabilities to high-tech manufacturing industries such as consumer electronics, integrated photonic chip manufacturing, stent cutting, surface functionalization, future displays manufacturing and quantum computing.

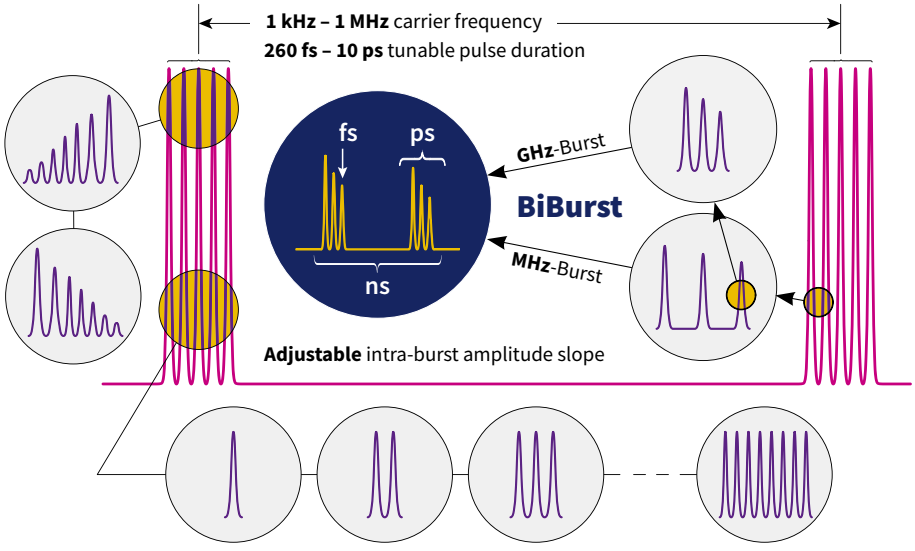
BiBurst material fabrication areas cover:

- brittle material drilling and cutting
- deep engraving
- selective ablation
- transparent materials volume modification
- hidden marking
- surface functional structuring.

SPECIFICATIONS

Model		CARBIDE-CB3 (40 W)	PHAROS	PHAROS-SP
P, GHz-mode	Intra burst pulse separation [1]	~440 ± 40 ps	~200 ± 40 ps	~500 ± 40 ps
	Max no. of pulses [2]	1 . . 10	1 . . 25	1 . . 10
N, MHz-mode	Intra burst pulse separation	~16 ns		
	Max no. of pulses	1 . . 10	1 . . 9, (7 with FEC)	1 . . 9, (7 with FEC)

[1] *Custom spacing on request.*
[2] *Maximum number of pulses in a burst is dependent on the laser repetition rate. Custom number of pulses on request.*



Adjustable number of pulses in GHz and MHz burst

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