

Optimize the performance
of **ultrashort pulse**
laser processes

High-peak power beam shapers for laser micro processing such as cutting, drilling, surface functionalization and thin film layer ablation.

Optimum beam shaping quality

Extended depth of field

Preserved pulse duration

Passive beam stabilization through mode-cleaning

Compatible with standard industry equipment



CANUNDA-PULSE is dedicated to ultrashort pulse (USP) laser micro processing. It provides high-quality beam shaping: micrometer-sized dimensions in the machining plane, exceptional depths of field, and sharpness at the diffraction limit.

The fully reflective design of the shaping modules handles the high peak power and energy (up to 100 μJ). Thanks to the lack of refraction through glass, the pulse duration is maintained. Moreover, the mode cleaning feature stabilizes the laser, which allows a steady beam shaping in the processing plane.

CANUNDA-PULSE beam shaping modules are compatible with industrial setups and can be easily integrated into micromachining machines. They have proven their ability to maintain their performance over the full field of view of an F-theta lens, combined to a galvo-scanner.

CANUNDA-PULSE modules are available at two different wavelength ranges: green (515 nm, 532 nm) and near-infrared (1030 nm, 1064 nm).



CANUNDA-PULSE
for near-infrared wavelengths
(p. 3-7)



CANUNDA-PULSE
for green wavelengths
(p. 4-7)



CUSTOM USP
beam shaping solutions
(p. 8)

Different shapes available:

- Square
- Round
- Line
- Stabilized Gaussian beam


Benefits:

- Preserved depth of field
- Sharpness down to diffraction limit
- Micrometer-sized dimensions in the processing plane

A custom CANUNDA-PULSE system can be designed to generate any required shape (symmetrical or asymmetrical) upon request. Beam shaping and splitting combination is also possible, as well as higher power and others wavelengths handling.

Benefits:

- Tailored solution
- Adaptable to any environment



CANUNDA-PULSE beam shaping modules provide high-quality ultrashort laser beam shaping, with different shapes and wavelength available.

CANUNDA-PULSE *for* USP laser beam shaping

High quality top-hat shaping

- Different shapes available: **square, round and line**
- **Micrometer-sized** dimensions in the processing plane
- High **sharpness**, down to 0.1
- Exceptional **depth of field**

High peak power handling

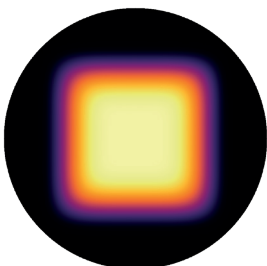
- Fully **reflective** design
- Up to **100 μ J energy** for femtosecond pulses
- Transmission higher than **90%** for a TEM00 input
- Pulse duration **preserved**

Integrable into an industrial environment

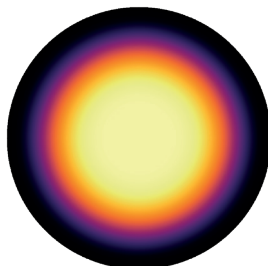
- Compatible with **galvanometric scanners**
- Possibility to use **F-theta lens** or **microscope objectives** to focus the beam on the processing plane
- Standard **M6** breadboard compatibility

Mode cleaning functionality

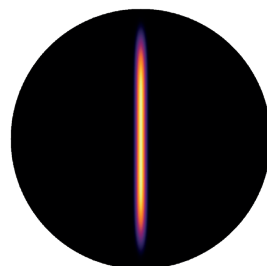
- **Stabilizes** the laser, allowing a robust beam shaping in the processing plane
- **Compensates** for laser imperfections
- Implemented in a **passive way**
- CANUNDA-PULSE is available with the **mode cleaning feature only**



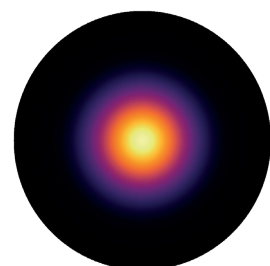
Square top-hat



Round top-hat






Line top-hat

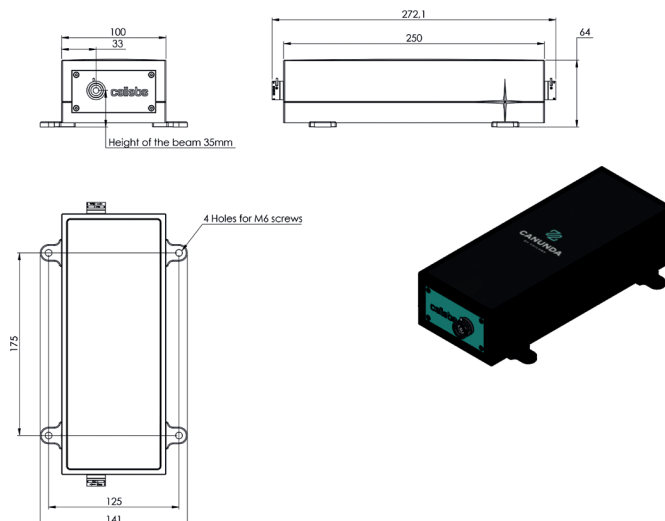


Mode cleaning only


CANUNDA-PULSE Infrared specifications

SHAPE CHARACTERISTICS						
SHAPE CODE	S-03301	S-01001	R-03301	R-01001	L-01004	G-00003
Shape	 Square top-hat		 Round top-hat		 Line top-hat	 Gaussian (Mode cleaning only)
Output shape dimensions ($\pm 10\%$)	500 x 500 μm^2		500 μm diameter		3000 x 150 μm^2	500 μm waist
Sharpness (± 0.05)	0.33	0.10	0.33	0.10	0.10	N/A
Plateau uniformity (ISO 13694-2018)	<0.20					N/A
INPUT LASER CHARACTERISTICS						
Central wavelength	1030 nm or 1064 nm					
Nominal input waist	500 μm					
Nominal input M^2	<1.3					
Pulse duration	300 fs (typical)					
Pulse energy	<100 μJ @300 fs					
Average power	<60 W					
SYSTEM CHARACTERISTICS						
Transmission with TEM_{00} input	>90%					
Tilt stability	Output stable with tilt <0.35 mrad					
Transmission with tilt	>70% of maximum transmission with tilt <0.35mrad					
Shift stability	Output stable with shift <250 μm					
Output stable with shift < 250 μm	>70% of maximum transmission with shift <250 μm					
Size stability	Output stable with input beam size <1.6x smaller or bigger					
Transmission with size variation	>70% with input beam size <1.6x smaller or bigger					
Module overall dimensions	272.1 x 141 x 64 mm ³					
Module weight	2 kg					

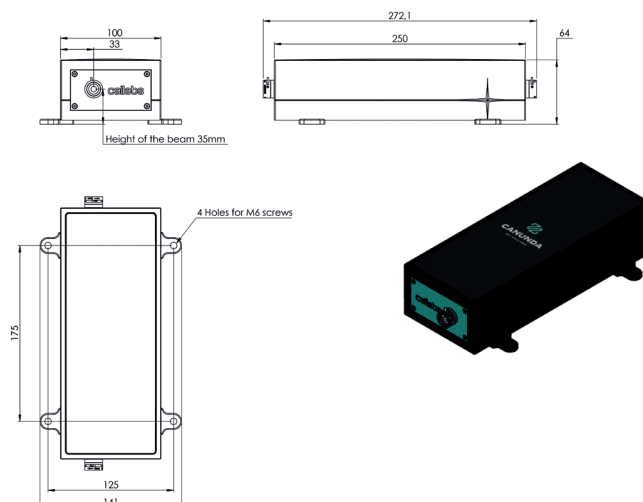
Physical dimensions



CANUNDA-PULSE Green specifications

SHAPE CHARACTERISTICS			
SHAPE CODE	S-03001	R-03001	G-00003
Shape	 Square top-hat	 Round top-hat	 Gaussian (Mode cleaning only)
Output shape dimensions ($\pm 10\%$)	500x500 μm^2	500 μm diameter	500 μm waist
Sharpness (± 0.05)	0.33	0.33	N/A
Plateau uniformity (ISO 13694-2018)	<0.25		N/A
INPUT LASER CHARACTERISTICS			
Central wavelength	515 nm or 532 nm		
Nominal input waist	500 μm		
Nominal input M^2	<1.3		
Pulse duration	300 fs (typical)		
Pulse energy	<50 μJ @300 fs		
Average power	<30W		
SYSTEM CHARACTERISTICS			
Transmission with TEM ₀₀ input	>75%		
Tilt stability	Output stable with tilt <0.16 mrad		
Transmission with tilt	>70% of maximum transmission with tilt <0.16 mrad		
Shift stability	Output stable with shift <250 μm		
Transmission with shift	>70% of maximum transmission with shift <250 μm		
Size stability	Output stable with input beam size <1.6x smaller or bigger		
Transmission with size variation	>70% with input beam size <1.6x smaller or bigger		
Module overall dimensions	272.1 x 141 x 64 mm ³		
Module weight	2 kg		

Physical dimensions



Case study

Line top-hat laser beam shaping for fast surface texturing with ALPhANOV

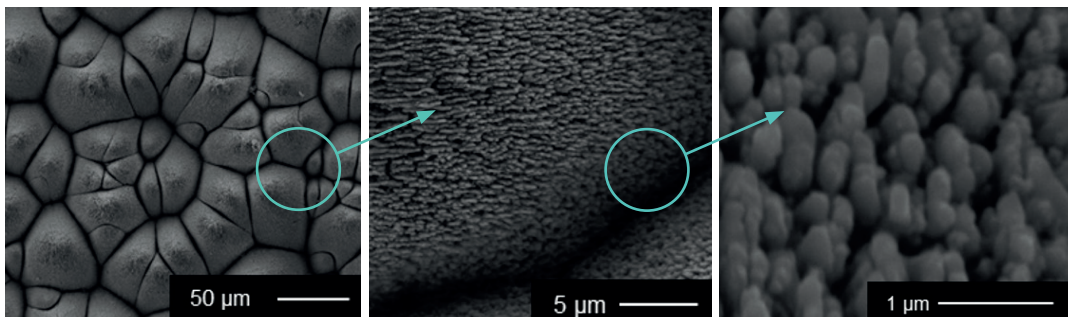
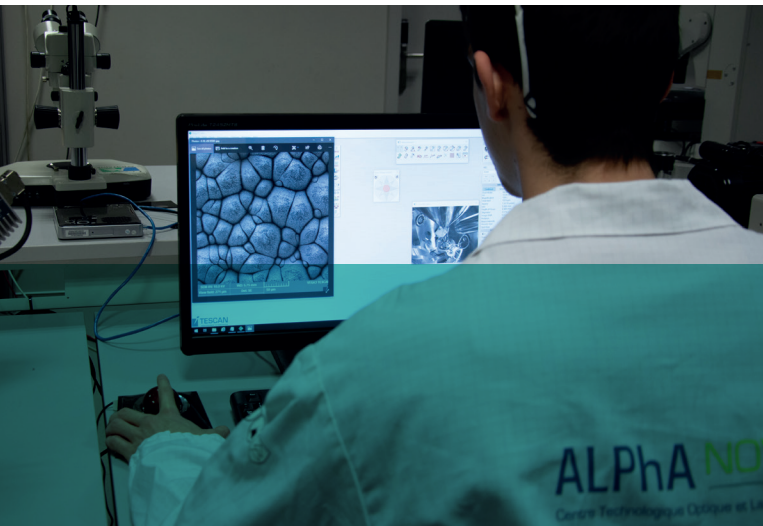
ALPhANOV is a research center based in Bordeaux that studies and develops different laser processes.

Surface functionalization is one of the topics it studies. This process is used to create effects or to give new properties to the surface of a material, by generating **micro or nano structures**. The main challenge is to improve the **speed** and **efficiency** of the process through the use of new techniques.

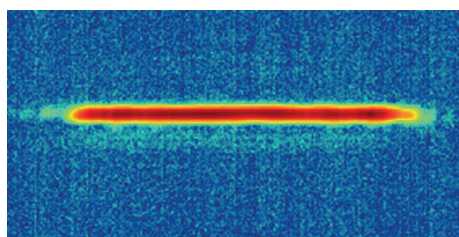
ALPhANOV called on Cailabs for its **femtosecond** laser compatible shaping technology to optimize the generation of **LIPSS** (Laser Induced Periodic Surface Structures). For this purpose, an innovative solution is to shape the beam intensity profile as a line that can irradiate a larger area than a Gaussian beam. This allows **higher processing speeds**, especially when combined with a polygonal scanner. Furthermore, a homogeneous **“top-hat”** energy distribution in the line direction provides a more regular energy deposition, and thus **highly uniform generated structures** on the surface of the material.

A CANUNDA-PULSE module was installed at ALPhANOV on a femtosecond micromachining station to produce a **600 μm x 30 μm line** (aspect ratio 20). Associated with a **galvanometer scanner**, the module was able to generate structures acting as a light trap, giving the sample a black color, with a **reflectivity lower than 5%**.

The line shape allows to machine a **larger surface area**, thereby reducing the laser repetition rate to potentially increase the process **speed** by a **factor of 20**. This opens the way for high-speed, **large-area** machining, and reduces the production costs associated with this process.

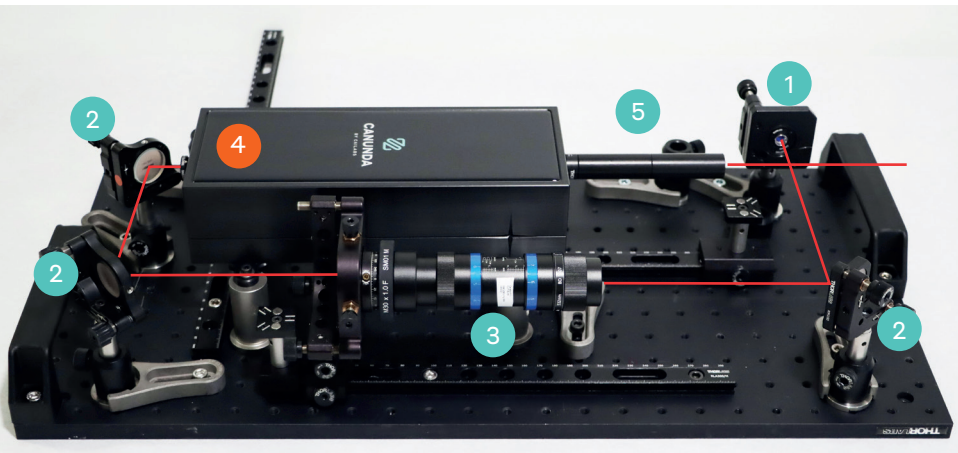


Laser Induced Periodic Surface Structures Generation by femtosecond laser and Multi-Plane Light Conversion beam shaping



Integration

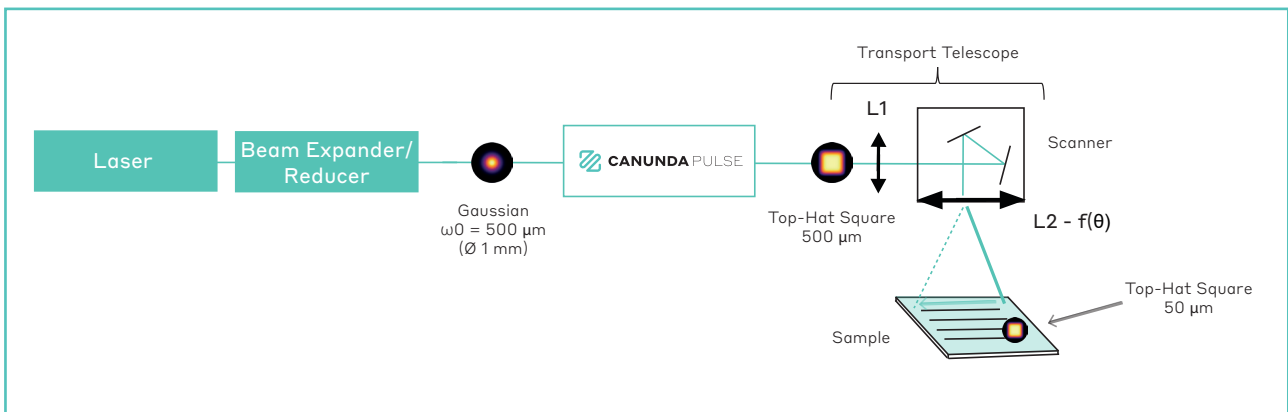
in an industrial environment



- 1 **Input source**
- 2 **Alignment mirrors**
- 3 **Beam expander**
- 4 **CANUNDA-PULSE module**
- 5 **Telescope** (for installation only)

Possible use configurations

In order to perform micro-processing with a USP laser, the following configuration may be used (all details of lens choice and tuning are given in the installation procedure):



The injection telescope aims at magnifying the beam waist to 500 μm and adjusting its position to the module. The transport telescope aims at imaging the top-hat beam onto the sample through a standard F-theta lens.

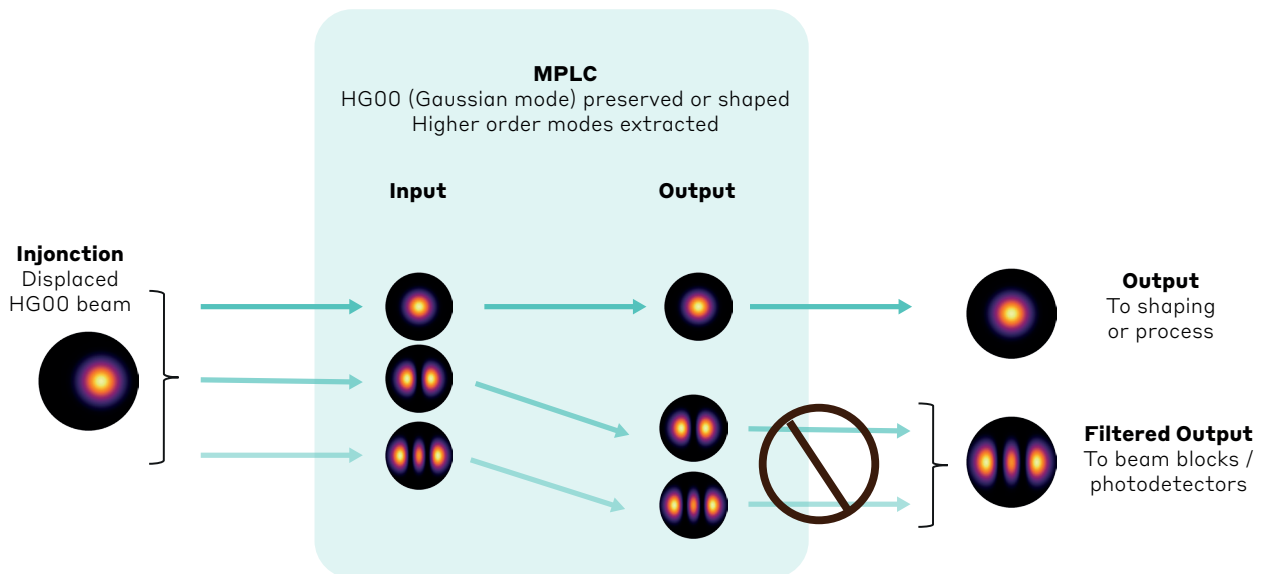
Many dimensions onto the sample are possible depending on the set-up to be used, some are given in the below table, other possibilities might be advised by Cailabs on request:

Square / Round dimensions (μm)		F-theta focal length (mm)				
		50	80	100	160	250
L3 focal length (mm)	500	50	80	100	160	250
	750	33	53	67	107	167
	1000	25	40	50	80	125

Line length/width (μm)		F-theta focal length (mm)				
		50	80	100	160	250
L3 focal length (mm)	500	350/18	560/29	700/36	1120/58	1750/90
	750	230/12	375/19	470/24	750/39	1170/60
	1000	175/9	280/14	350/18	560/29	875/45

Principle of mode cleaning

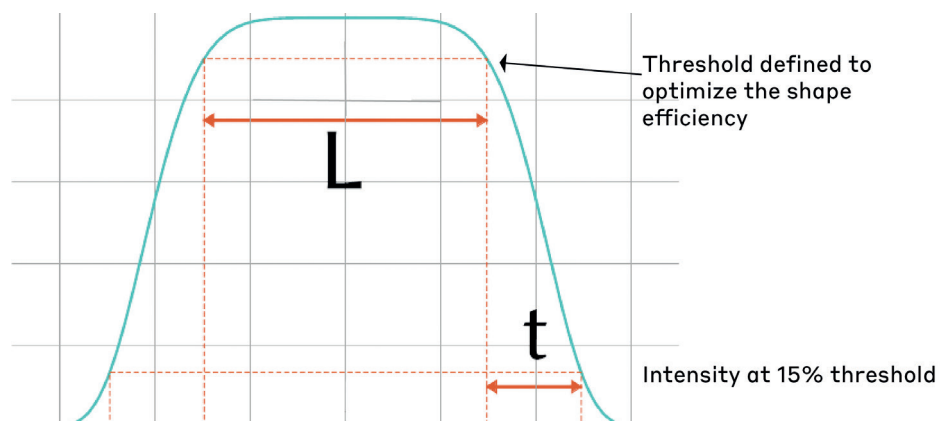
The mode cleaning feature is a passive laser beam stabilizer that procures a unique solution against the various fluctuations of single mode laser beams, such as tilt, shift, astigmatism, etc. It efficiently suppresses beam instabilities and provides a perfect and steady Gaussian or top-hat beam. This allows for more reliable and robust industrial processes where precision is crucial.

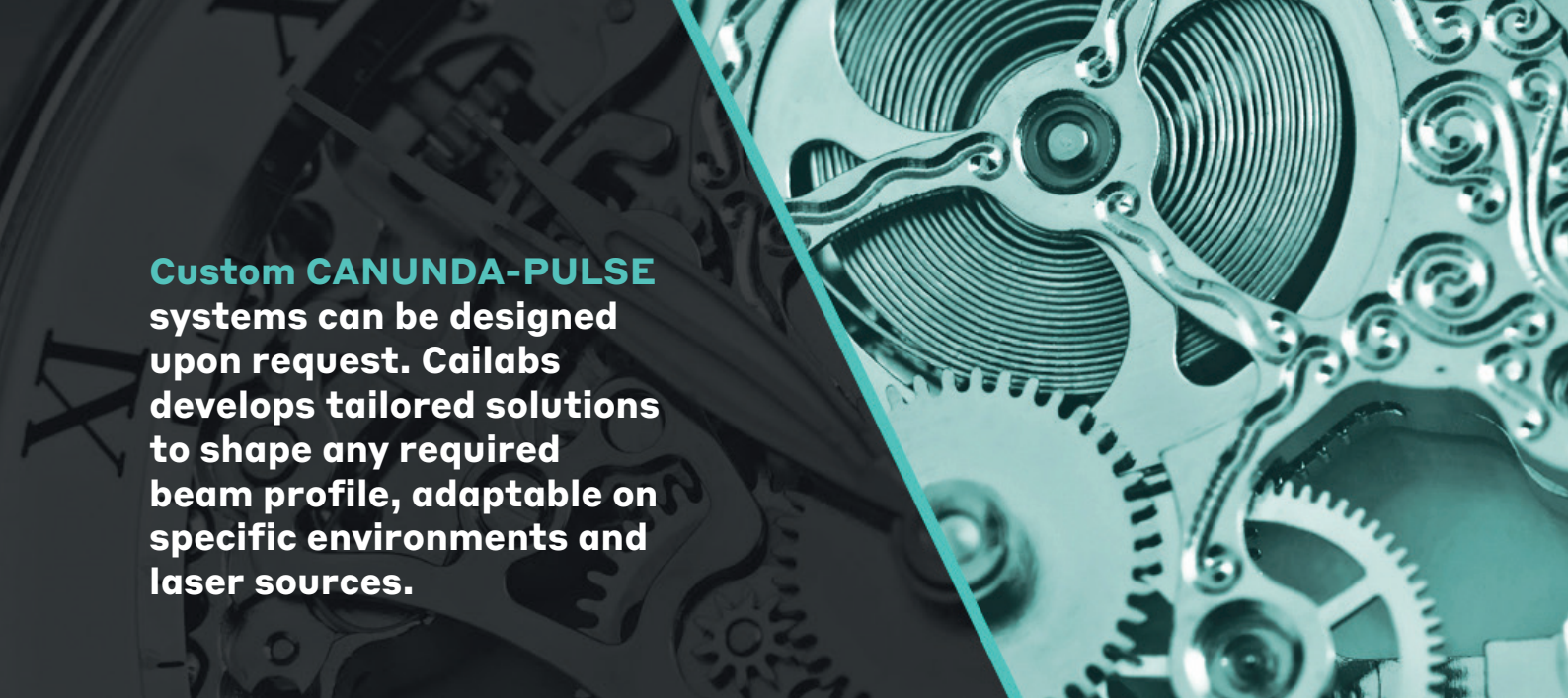


Top-hat shape characteristics

The shape quality is given by the following metrics:

- Plateau uniformity: per ISO standard 13694-2018.
- Shape efficiency: the maximum ratio between the energy contained in an ideal 3D shape (cuboid, cylinder, etc.) inscribed in the beam shape and the total energy of the beam shape.
- Dimensions L: the dimensions of the base surface of the inscribed 3D shape used in the computation of the shape efficiency.
- Sharpness: the t/L ratio as defined in the scheme below.





Custom CANUNDA-PULSE systems can be designed upon request. Cailabs develops tailored solutions to shape any required beam profile, adaptable on specific environments and laser sources.

Custom CANUNDA-PULSE systems *available* upon request

Cailabs can develop beam shaping systems to suit your needs:

- **Custom beam shaping:** complex beam shaping can be achieved with Cailabs' MPLC technology, such as separate or asymmetrical shapes, or small or large top-hat profiles
- **Combination of beam splitting and shaping:** take advantage of benefits of both solutions and improve the yield and quality of your processes
- **High power & energy:** custom modules can be specifically designed to handle higher energy or power compared to standard versions
- **Broad spectrum:** other wavelengths than green or infrared can also be addressed upon request
- **Adaptation to all environments:** it is possible to develop compatible beam shaping systems for all your machines, such as integrated machines, roll to roll, etc.

Example of CANUNDA-PULSE custom project by Cailabs:

Square beam shaping at **high power** (500 W) and **high energy** (2.5 mJ per pulse) for **large surface pickling**.

Benefits of laser beam shaping

In partnership with **LASEA**:
microfluidic chip welding speed

x9

In partnership with **GLOphotonics**:
laser depointing

÷16

In partnership with **ALPhANOV**:
surface texturing speed

x20




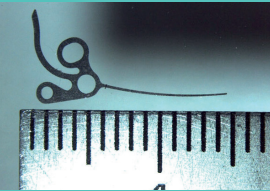
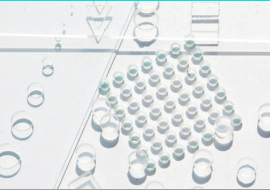
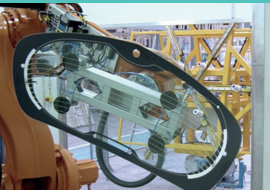
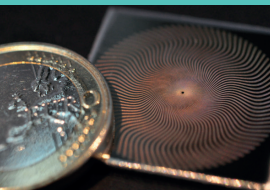

In partnership with **Amplitude**:
drilling ablation efficiency

x2

Applications

Today, the main challenge in ultrashort pulse laser micro processing is to increase the yield while preserving sufficient quality. Indeed, the last generation of femtosecond lasers offers a high energy reserve, while scanners seem to reach an upper limit in terms of speed. Beam shaping and splitting are therefore the right solution to fully exploit the high energy available from these lasers.

This is what the CANUNDA product line dedicated to USP lasers tackles: having the capacity to improve every material processing application. It is composed of CANUNDA-PULSE, CANUNDA-SPLIT (beam splitter) and CANUNDA-AXICON (high quality reflective axicon).

APPLICATION	 CANUNDA PULSE	 CANUNDA SPLIT	 CANUNDA AXICON
 <p>Cutting</p>	Reduce the number of poor-quality parts to increase the overall yield	Athermal cutting of several parts in parallel	
 <p>Drilling</p>	Manufacturing taper-free holes	Full use of the energy provided by last generation USP lasers	
 <p>Thin film ablation</p>	Improved quality	Ablate several parts in parallel	
 <p>Surface texturing</p>	Improve efficiency of processes	Enable mass-production surface texturing	High aspect ratio structures, single shot drilling and increased processing area
 <p>Glass processing</p>		Lower operating costs	Complex and selective glass processing

Find out about all our CANUNDA solutions

The CANUNDA product line aims at improving all types of laser processes:

- **High-power continuous** laser processes such as laser beam welding or additive manufacturing with CANUNDA-HP

CANUNDA HP

CANUNDA-HP laser heads for high-power beam shaping

- **Ultrashort pulsed** processes such as micro-machining, glass processing or surface texturing with:

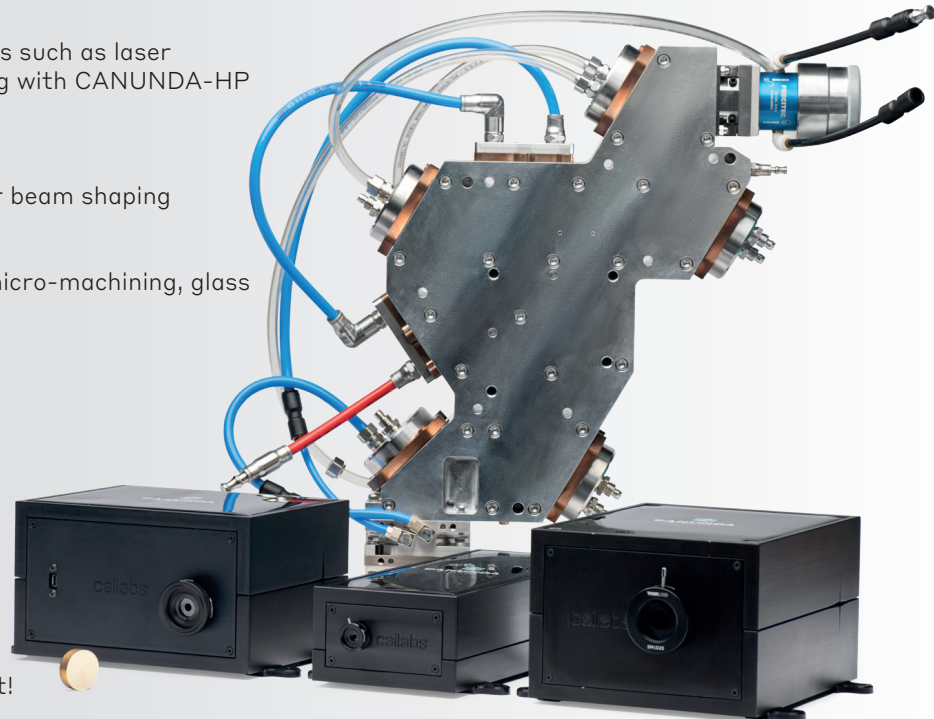
CANUNDA AXICON

CANUNDA-AXICON for Bessel beams

CANUNDA SPLIT

CANUNDA-SPLIT for beam division

All CANUNDA products are providing a high quality beam shaping and a compatibility to any industrial environment!



Ordering information

All the product presented in this document are available off the shelf with the following information.

For a **CANUNDA-PULSE** module:

Product number: **CAPU-X-YYYYY-ZZZZ**

- CAPU: CANUNDA PULSE
- X-YYYYY: shape code (see specifications p.3-4)
 - X: S – Square; R – Round; L – Line; G – Gaussian
 - X-YYYYY: 03301 sharpness of 0.33; 01001 sharpness of 0.10 (IR square and round); 01004 sharpness 0.10 (IR line); 00003 mode-cleaner only
- ZZZZ: central wavelength – 0515, 0532, 1030 or 1064 (nm)

Customized systems are available on demand, contact us to get a quotation!

cailabs

SHAPING THE LIGHT

Founded in 2013, **Cailabs** is a French deep tech company which designs, manufactures and distributes innovative photonic products for telecommunications, free space transmission, industrial lasers, and LANs. A global leader in complex light shaping, its technology is currently protected by 19 patent families. Its innovative optical components are used in a variety of sectors and have contributed to several world records (notably the optical fiber bandwidth record achieved by the Japanese operator KDDI).

38 boulevard Albert 1er
35200 Rennes, France

www.cailabs.com
canunda@cailabs.com

 @CAILabs



PEFC® 10-31-1238 / PEFC Certified / This product is from sustainably managed forests and controlled sources. / pefc.org

01/2022 – Cailabs reserves the right to modify the specifications without prior notice. Visuals non-contractual products
Photo credits: Atypix - Cailabs