CANUNDA

CASE STUDY

CANUNDA-PULSE enables high precision micro-machining with a square top-hat

The partner's issue

Amplitude Laser, world leader in the field of femtosecond lasers, is investigating ways to increase the performance of industrial processes, and in particular using top-hat beam shaping to optimize energy delivery. They needed a beam shaping technology able to produce a square top-hat for **fast, precise and efficient micro-machining, while handling the many constraints** that come with femtosecond lasers.

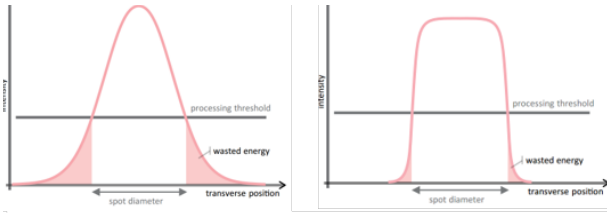
The CANUNDA-PULSE solution

Cailabs' CANUNDA-PULSE is a beam shaper based on our patented, efficient and flexible Multi-Plane Light Conversion (MPLC) technology. **Completely reflective by design**, it is conceived to handle high-energy femtosecond pulses with **great stability** thanks to its mode cleaning feature, and is able to produce a high quality square top-hat for efficient and consistent micro-machining of copper, aluminum and invar.

New trends for improving microprocessing quality and speed

The Amplitude Laser Group is a French manufacturer of USP (Ultra-Short Pulse) lasers for scientific, medical and industrial applications. Being the world leader in the field of industrial femtosecond lasers, the Group is involved in many strategic markets where there is a high demand for precision and machining quality (watchmaking, stent manufacturing, mold making, photovoltaic cells, etc.). They are confronted with the many challenges of these demanding markets. Processes need to be **fast** and **efficient** while maximizing **accuracy** and **quality**. One area of research which is considered key for process optimization by Amplitude Laser is the use of **laser beam shaping for optimizing laser energy deposition.**

In particular, "top-hat" beam shaping is known to achieve processing improvement. It allows optimizing energy distribution to have a homogeneous "plateau" and a steep transition zone, which **minimizes energy losses**, and **reduces imprecisions and irregularities** of the ablation profile. Moreover, it allows decreasing the needed pulse overlap (overlapping area between two consecutive pulses) leading to **faster processing rates.**



Comparison between standard Gaussian energy distribution (left) and top-hat energy distribution (right)

Need for an adapted, rugged and precise beam shaping technology

The more conventional beam shaping technologies (Spatial Light Modulators, DOEs, ROEs, etc.) have however limitations. They typically present a limited working depth, are sensitive to misalignment and beam defects, and are usually unable to handle high-power and high-energy lasers such as the ones developed by Amplitude Laser. This prevents their use on an industrial scale. Additionally, conventional beam shaping technologies are transmissive (transparent) optical components, causing undesirable phenomena when working with high-power/high-energy ultra-short pulse lasers, such as chromatic dispersion, chromatic aberrations and focus shifts, further preventing their use on an industrial scale.

Amplitude

cailabs
SHAPING THE LIGHT

Cailabs' solution: CANUNDA-PULSE, a reflective beam shaper

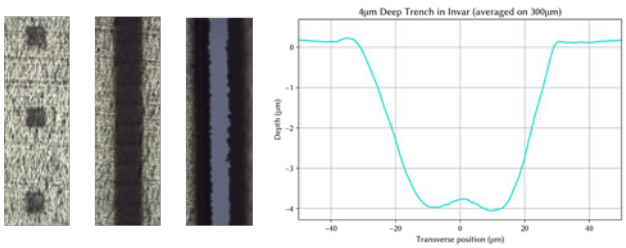
The solution proposed to Amplitude is CANUNDA-PULSE, a laser beam shaping module specifically designed for Ultra Short Pulse (USP) laser requirements and tailored to micro-machining constraints. It is based on Cailabs' proprietary beam shaping technology, the Multi-Plane Light Conversion (MPLC), which passively shapes the phase and amplitude of a laser beam through successive reflections on phase masks.

The reflective design of this beam shaper allows it to **withstand high energy** pulses and **high average powers** from the input laser. This makes it suitable for demanding material processing use. It also avoids many undesirable phenomena such as chromatic dispersion, chromatic aberrations and focus shifts, making it a **perfectly stable and robust solution** to work with Ultra-Short Pulse lasers for industrial processing. Moreover, a unique and patented technology was developed in order to ensure the CANUNDA-PULSE module would be compatible with beam instabilities: **modal cleaning**. By removing the light in perturbation modes, this technology compensates all USP laser output beam fluctuations, which usually deteriorate shaping with these lasers, in order to **maintain a perfect shape** on material.

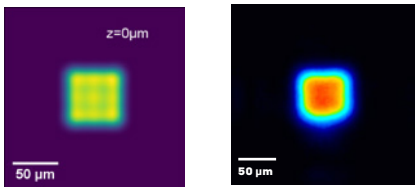
CANUNDA-PULSE, an ultrafast laser beam shaper

Square top-hat beam shaping for high-precision micro-machining

A CANUNDA-PULSE beam shaper was used at Amplitude Laser's premises to produce a 50 µm x 50 µm square top-hat. The beam shaper was **integrated in a galvo scanner and f-theta setup** in order to drill and cut various materials (aluminum, stainless steel, copper and invar).



View of machined aluminum (left) and ablation profile (right) of aluminum samples



Theoritical profile (left) and experimental profile (right) of the top-hat generated by CANUNDA-PULSE

The high quality of the top-hat allowed for an **energy homogeneity over 95%**, and sharper edges compared to a Gaussian beam. The stability of the beam shape on material allowed for a consistent ablation depth, with a minimum transition zone. Overall the machining was particularly efficient, with an **ablation efficiency up to two times higher** than with a conventional Gaussian beam.

Cailabs: beam shaping made easy

Cailabs is a leading provider of innovative solutions designed to enhance performances of laser-based systems for many applications, such as research, optical telecommunication and material processing.

With the CANUNDA product line, we develop and manufacture a range of robust and easy to integrate light shaping components improving the quality and speed of laser processes. From additive manufacturing and metal welding and cutting with high-power lasers, to transparent material processing and micro-processing with USP lasers, CANUNDA products by Cailabs will provide you with a perfect beam shaping solution.

> *"The value of our cooperation with Cailabs is clear: the micro-machining markets that Amplitude Laser Group is targeting are extremely diversified, and we need to be very responsive in terms of innovation in order to effectively serve these markets. Our cooperation with Cailabs will enable us to meet significant business challenges by providing new solutions."*
>
> **Vincent Rouffiange,**
> Sales Manager
> Amplitude Laser Group

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