

Improve the **quality**
and **efficiency** of
glass machining processes

CANUNDA-AXICON and CANUNDA-AXICON Z-FLAT are beam shaping solutions that generate high-quality Bessel beams for ultrashort pulse laser glass machining.

High quality transformation

Resistant to high peak power

Tailored complex Bessel beams

Preserved pulse duration

Compatible with standard industry equipment



The CANUNDA product line offers a complete range of Bessel beam generation solutions. Three options are available, with different level of complexity to perfectly match every need in glass processing applications.

CANUNDA-AXICON is a reflective axicon that generates high-quality Bessel beams. This element is available stand-alone for a tailored integration into any setup, or in a turnkey module thanks to the EASY-BESSEL option. The most advanced Bessel beam generation system designed by Cailabs is the CANUNDA-AXICON Z-FLAT. It produces a highly homogeneous Bessel beam over the propagation axis.

In every option, beam shaping is implemented in a reflective way, allowing it to handle high peak power and energy. Thanks to the lack of refraction through glass, the pulse duration is maintained. The high manufacturing precision of the reflective axicon also widely reduces the intensity oscillations over the propagation axis, and then offers a theory-like Bessel beam.

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



CANUNDA-AXICON
(p. 2-5 and 8)

CANUNDA-AXICON is a stand-alone reflective axicon available at different angles for a wide range of wavelengths (blue to near infrared).

Benefits:

- Great stability
- Versatility
- Available in an integrated module with the EASY BESSEL option

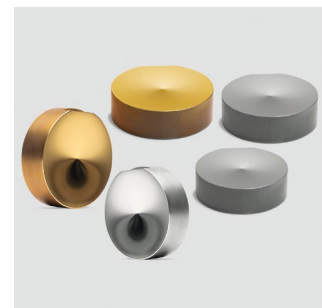


CANUNDA-AXICON
Z-FLAT
(p. 6-8)

CANUNDA Z-FLAT is a module that generates a tailored high-performance Bessel beam.

Benefits:

- Best Bessel beam performances
- Constant energy distribution over the propagation axis
- Higher energy efficiency



CANUNDA-AXICON
Custom
(p. 9)

Custom CANUNDA-AXICON systems are also available upon request to fit any industrial need.

Benefits:

- Tailored solution to tune every parameter (wavelength, axicon angle and diameter, off-axis)
- Tailored Bessel beams are available upon request

CANUNDA-AXICON generates stable and high-quality Bessel beams, thanks to a unique reflective design.

CANUNDA-AXICON *for* high-precision glass processing

High-quality Bessel beam

- Bessel beam close to theory and without oscillations
- Versatile Bessel beam dimensions
- Great beam spatial quality over every axis

Benefits of reflective design

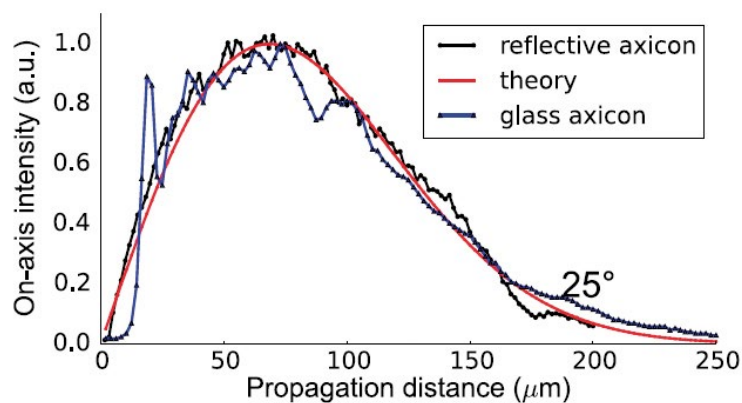
- Highly reflective coatings: improved Laser Damage Threshold of 0.2 J/cm^2 @1030 nm @500 fs
- Designed for a use over long periods of manufacturing
- Preserved pulse duration and no chromatic dispersion

Appropriate to any industrial need

- Compatible with galvanometric scanners and f-theta lenses
- A broad range of standard products from 0.25° to 3° apex angle
- Different coatings available: large bandwidth from blue to infrared

Available with EASY BESSEL option

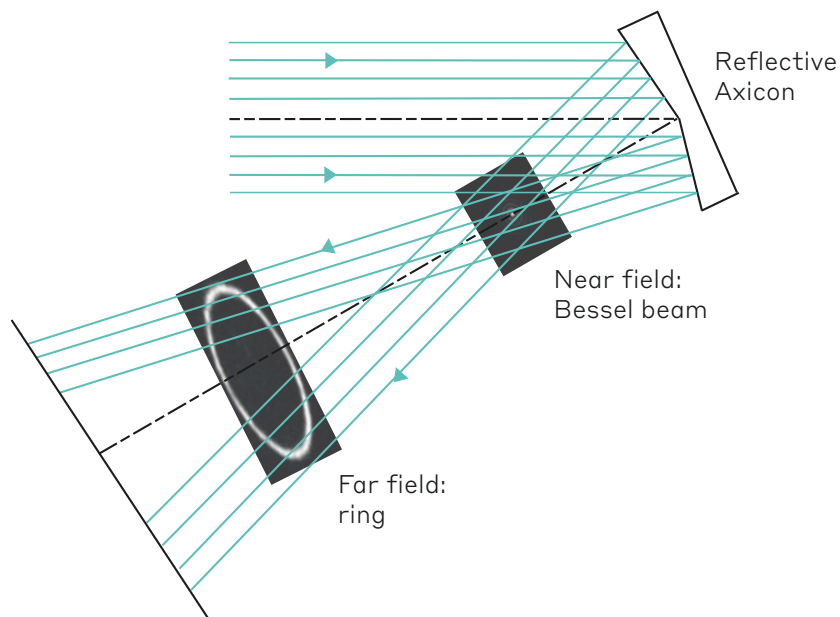
- A turnkey module to easily change from an axicon to another.
- For more information see page 5.



Source: Generation of high conical angle Bessel-Gauss beams with reflective axicons (Pauline Boucher, Jesus Del Hoyo, Cyril Billet, Olivier Pinel, Guillaume Labroille and Francois Courvoisier)

CANUNDA-AXICON specifications

PARAMETER	SPECIFICATION
Axicon angle	0.25°, 0.5°, 1.0°, 2.0°, 3.0°
Axicon angle tolerance	± 1.5%
Off-axis angle	30°
Diameter	25.4 + 0.0/-0.1 mm
Clear aperture	> 90% of diameter
Edge thickness	8.0 + 0.0/-0.15 mm
Scratch & Dig	40-20
Wavefront error	< 15 nm RMS
Roughness	< 4 nm RMS
Coating reflectivity	> 99% over bandwidth for dielectric
Coating LIDT	0.2 J/cm ² @1030 nm @500 fs
Wavelength	Dielectric [480 nm ; 580 nm], [750 nm ; 850 nm] or [1000 nm ; 1100 nm] Silver coating [500 nm ; 2000 nm]



Reflective Axicon way of working

Case study

High-precision glass cutting in collaboration with **Laser Zentrum Hannover e.V.**

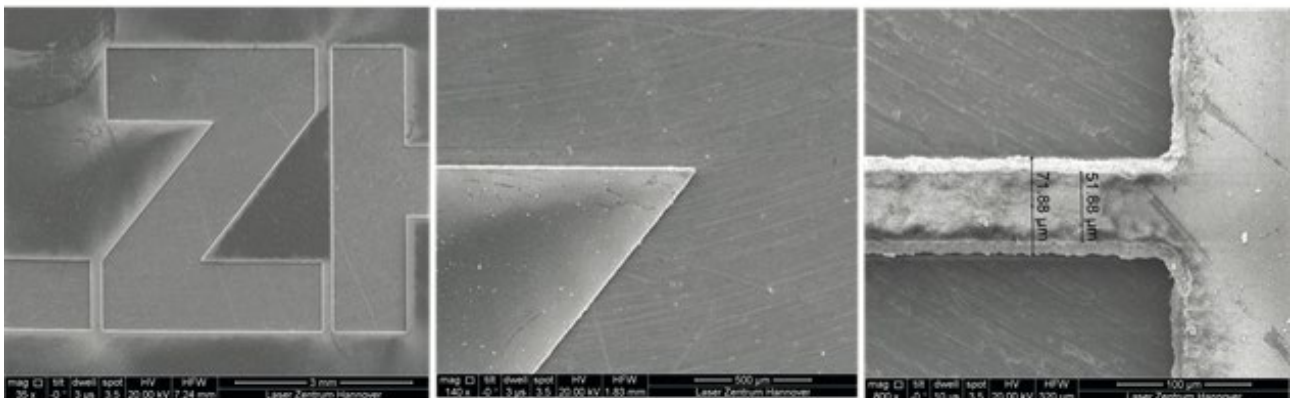
Based in Hannover, Germany, **Laser Zentrum Hannover (LZH)** is a research institute working on laser technologies, including innovative manufacturing processes using **ultrashort lasers**.

LZH needed an industrial solution to process glass over large areas using Bessel beams and this motivated the collaboration between Cailabs and LZH.

These beams are particularly well suited for this application, as they have a central focus that is **10 to 100 times longer** compared to conventional focusing optics. However, they can suffer from stability problems when generated from transmissive axicons. This prevents them from passing through galvanometer scanners, which is the only solution that opens the way to **machining on large surfaces**.

Indeed, the dimensional accuracy of transparent axicons is not optimal due to the curvature of their tip, which has the effect of generating intensity oscillations in the beam direction. Moreover, they are subject to dispersion and chromatic aberrations, as well as focus shift.

The reflective axicon proposed by Cailabs has solved all these problems. Therefore, it enables their use on an industrial scale, for example **combined with galvanometer scanners and F-theta lenses**. The very homogeneous energy distribution, close to the theoretical ideal, allowed processing a **50 mm x 50 mm surface**. The glass sheets were cut and separated in a single pass, with a transition zone lower than 10 μm . This was achieved **without a micrometric plate**, using a configuration that included a galvanometer scanner.



High quality Bessel beam generation through reflective axicon for femtosecond laser glass micro processing, Antonin Billaud et al.

CANUNDA-AXICON EASY BESSEL is a turnkey module that facilitates the industrial integration of **CANUNDA-AXICON**.

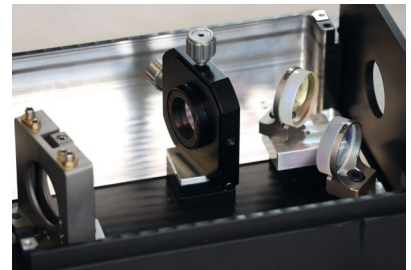
An integrated axicon solution *with* the EASY BESSEL option

The most flexible solution for using **CANUNDA-AXICON**

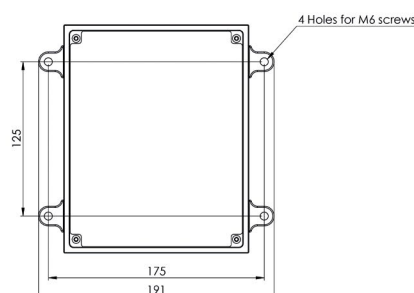
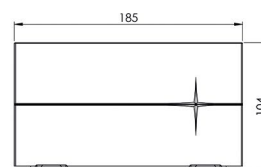
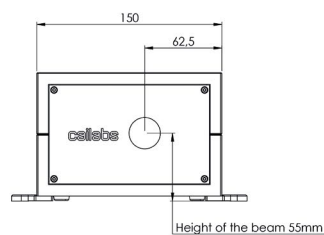
- Ready to use module
- Integrated alignment tools
- Possibility to quickly change from one axicon to another
- Same optical performances as a stand-alone axicon

Designed for an industrial integration

- Adapted to an industrial environment
- Colinear input and output
- Standard M6 breadboard compatibility



Physical dimensions



CANUNDA-AXICON Z-FLAT is a beam shaping module that generates a tailored Bessel beam. It fully exploits the advantages of reflective axicons and Cailabs' knowhow in optics.



The most advanced solution **for** Bessel beam generation

Cutting edge solution

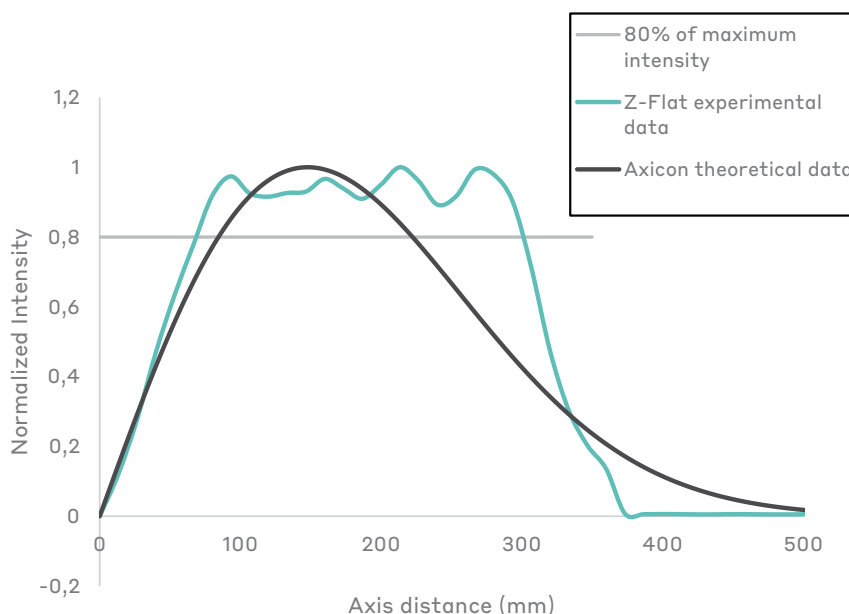
- High homogeneity of the Bessel beam over the propagation axis
- Tailored Bessel beam: +60% of useful energy for the process
- Reflective design: preserved pulse duration and no chromatic dispersion

Compatible with industry standards

- Compatible with galvanometric scanners and f-theta lenses
- Standard M6 breadboard compatibility
- Tunable factory-set axicon angle to fit with process needs

Optimum optical performances

- Transmission over 97%
- Designed for a use over long periods of manufacturing
- Great stability with no focus shift



CANUNDA Z-FLAT specifications

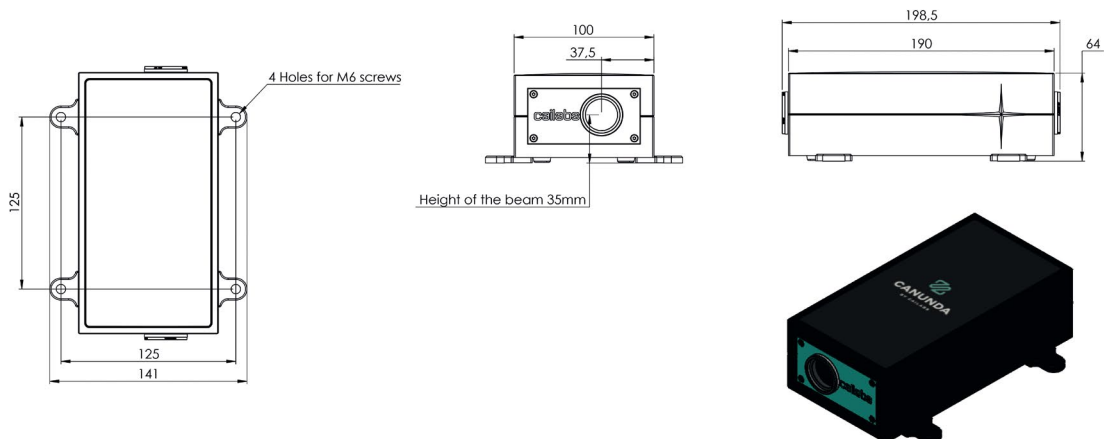
PARAMETER	UNIT	SPECIFICATION
SHAPE CHARACTERISTICS		
Axicon angle available	degrees	0.25 – 2
Output shape diameter	µm	From 5.5 to 43 (typical)
Homogeneity		± 5% of maximum intensity
Output shape depth of focus	mm	From 5 to 245 (typical)
INPUT LASER CHARACTERISTICS		
Nominal input beam waist	mm	1 to 3
Nominal input M²		<1.2
Central wavelength	nm	1030, 1064 (other wavelengths possible upon request)
Pulse duration	fs	300 (typical)
Pulse energy	mJ	<1
Average power	W	<100
SYSTEM CHARACTERISTICS		
Transmission	%	97
Z-FLAT module overall dimensions	mm x mm x mm	198.5 x 141 x 64
Module weight	kg	1.6

We can help you to define the set of parameters that perfectly fit to your needs.

Example of configurations

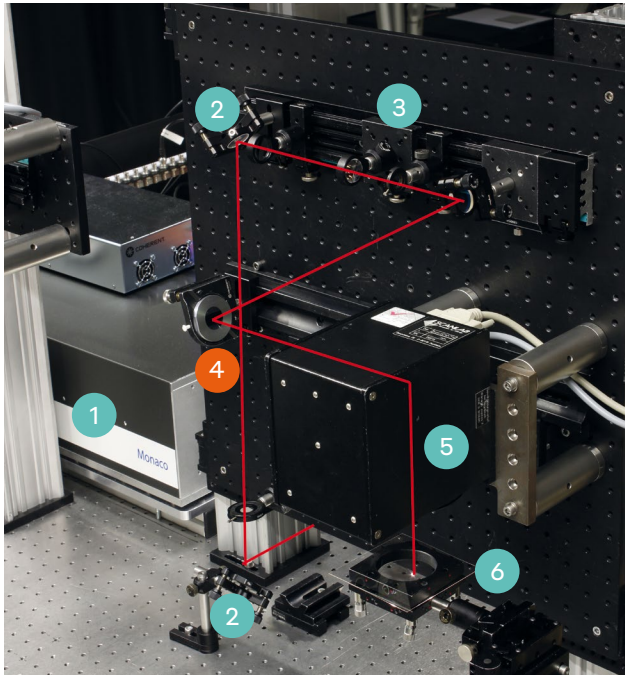
Beam characteristics	Diameter at Full Width Half Maximum	Length at Full Width Half Maximum over the propagation axis
After the module	25 µm	300 mm
After a 10x objective	2.5 µm	3 mm
After a 50x objective	0.5 µm	0.12 mm

Physical dimensions



Integration in an industrial environment

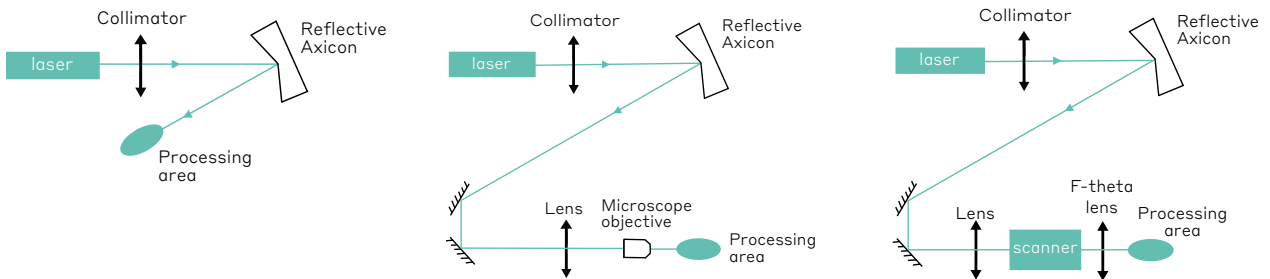
for all CANUNDA-AXICON products



- 1 **Laser**
- 2 **Periscope**
- 3 **Collimator and alignment mirrors**
- 4 **CANUNDA-AXICON**
- 5 **Galvanometric scanner & F-theta lens**
- 6 **Processing plane**

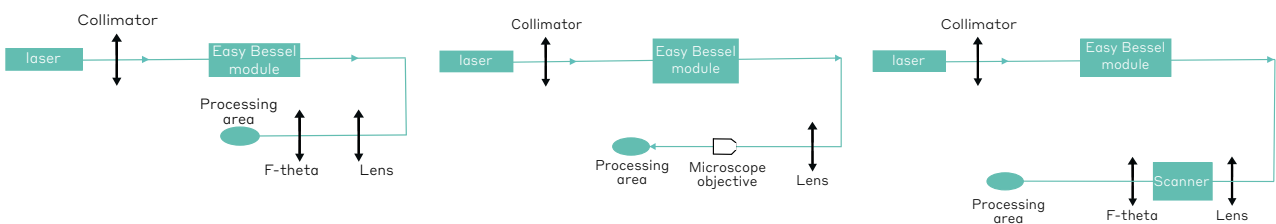
Possible use configurations

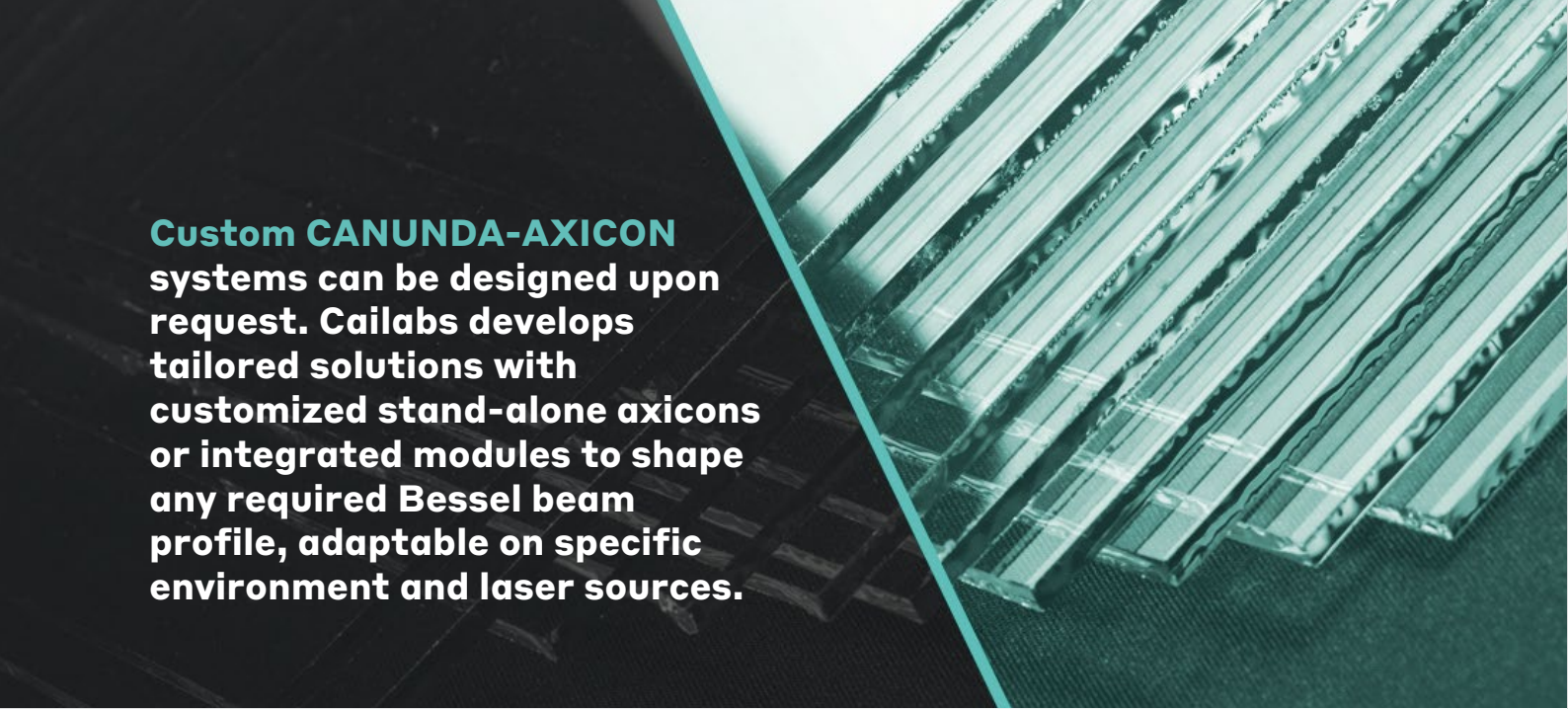
Depending on the targeted application, the reflective axicons are compatible with many configurations:



In order to find out the configuration based on standard optics (Microscope objective and F-theta lens) that best suits your needs, use our online calculator!

With EASY-BESSEL the integration is even facilitated with collinear input and output:





Custom CANUNDA-AXICON systems can be designed upon request. Cailabs develops tailored solutions with customized stand-alone axicons or integrated modules to shape any required Bessel beam profile, adaptable on specific environment and laser sources.

Custom CANUNDA-AXICON systems *available* upon request

Cailabs can develop Bessel beam solutions to suit your needs:

- **Axicon angle and diameter:** it is possible to manufacture a reflective CANUNDA-AXICON with specific dimensional requirements upon request if the required angle or diameter is not available in standard specifications
- **Off-axis angle:** for an easier integration in your setup, a custom axicon can be designed to work with a different off-axis angle
- **Broad spectrum and specific coatings:** other wavelengths from UV to mid-IR can be addressed upon request thanks to custom coatings
- **Tailored Bessel beam profile:** specific processes can require tailored Bessel beam profiles. Customized modules can be designed to answer these needs, just like the CANUNDA-AXICON Z-FLAT.

Applications

Glass cutting and drilling

The challenge with glass cutting using Bessel beams is the instability and lack of process robustness. Using CANUNDA-AXICON, the generation of the Bessel beam is done in a reflective way, which allows much better quality, efficiency and stability because of the high-dimensional accuracy of the optical element and the absence of thermal effects.

CANUNDA AXICON Z-FLAT also enables a selective glass processing. Thanks to high homogeneity and reduced transition zones, it is now possible to select the depth or a certain layer of the processing zone.

Bessel beams can also address other specific applications such as:

- Ring generation for surgery
- Atom guiding
- Optical trapping
- 2-photon polymerization

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:

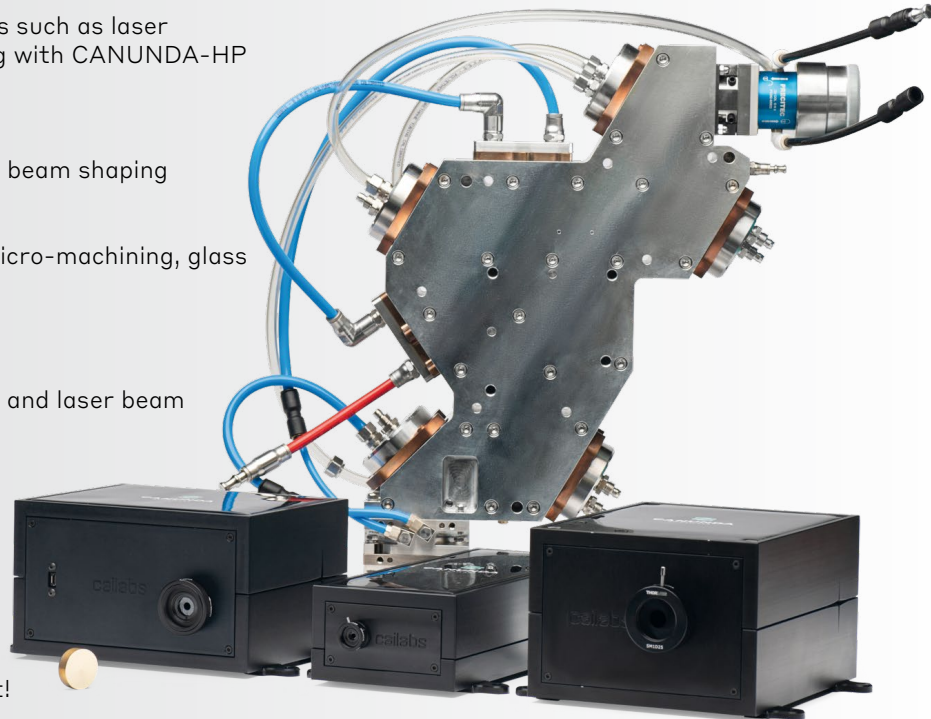
CANUNDA PULSE

CANUNDA-PULSE for top-hat generation and laser beam stabilization

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

For a stand-alone **CANUNDA-AXICON**, available off-the-shelf with the following information:

Product number: **AX-XXX-YY-Z**

- AX: CANUNDA-AXICON
- XXX: Axicon angle, 025, 050, 100, 200 or 300
- YY: diameter in mm (25 for 1 inch)
- Z: coating, B (480-580 nm), C (750-850 nm), D (1000-1100 nm), S (silver: 500-2000 nm)

For a ready-to-use **axicon with the EASY BESSEL option**, available off-the-shelf with the following information:

To facilitate ordering of one module with multiple axicons, the axicons are delivered in their mounts:

- AX-XXX-YY-Z-M

CANUNDA-AXICON EASY-BESSEL module

product number: **AX-EB-Z**

- AX-EB: CANUNDA-AXICON EASY BESSEL
- Z: coating, B (480-580 nm), C (750-840 nm), D (1000-1100 nm), S (silver: 500-2000 nm)

CANUNDA-AXICON Z-FLAT module is configurable (upon validation from Cailabs) with the following information:

Product number: **AX-ZF-XXX-YYYY**

- AX-ZF: CANUNDA-AXICON Z-FLAT
- XXX: setting of configurable parameters defined by Cailabs
- YYYY: central wavelength

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