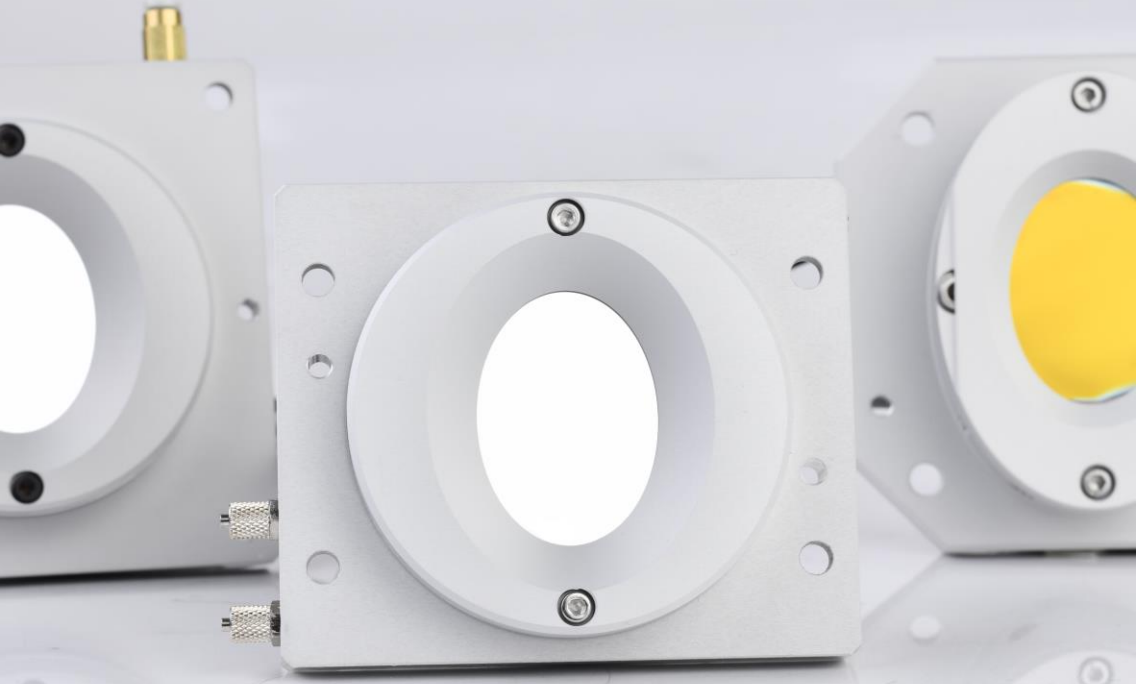
ROBUST AO

Home of the Zwobbel®



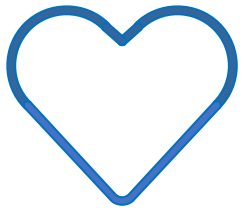
W3+
14.03.2024| Wetzlar, Germany

Dynamic beam shaping technology that accelerates laser cutting speed and improves cut quality.

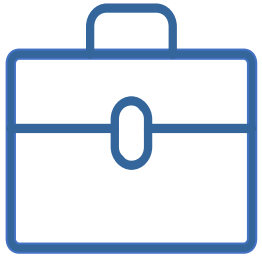
I. Burkhardt (CTO)
Dr.-Ing. C. Reinlein, S. Ulrich, M. Fischer, F. Lübke

ROBUST AO GmbH
Hans Knöll-Straße 6
07745 Jena

About ROBUST AO GmbH



High power adaptive optics



> 40 years of experience

Technology originated at Fraunhofer

Technologie entwickelt am Fraunhofer-Institut für Angewandte Optik und Feinmechanik (IOF)

TOP 50 START-UPS 2021

ThEx Thüringen

ThEx AWARD
Der Thüringer Gründungspreis

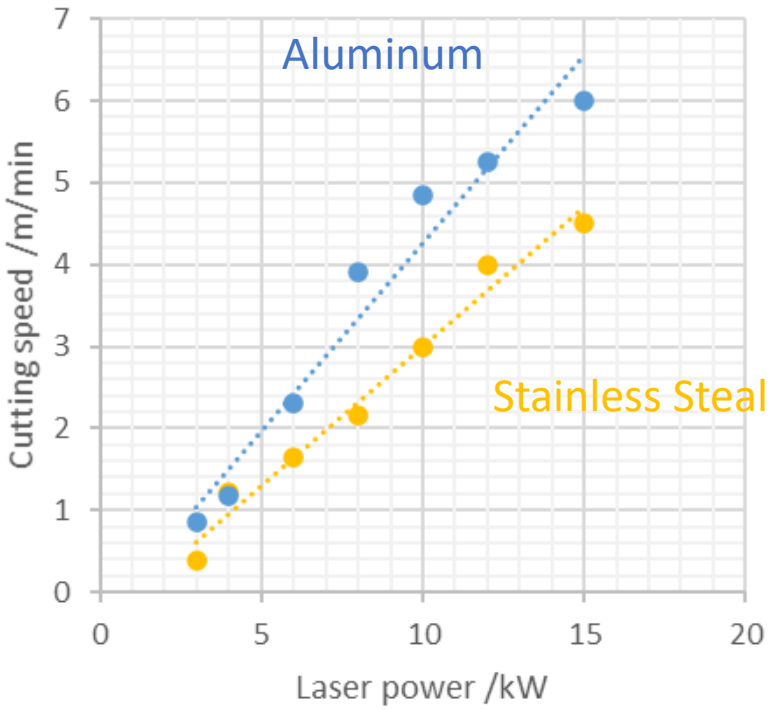
VORSPRUNG
Der Preis des OWF
für Unternehmerinnen und Unternehmer

Innovative technologies

Outline

1. Zwobbel-technology
2. System Integration
3. Application results
    1. Fine metal cutting
    2. Bevel cutting
    3. Thick metal cutting
4. Summary

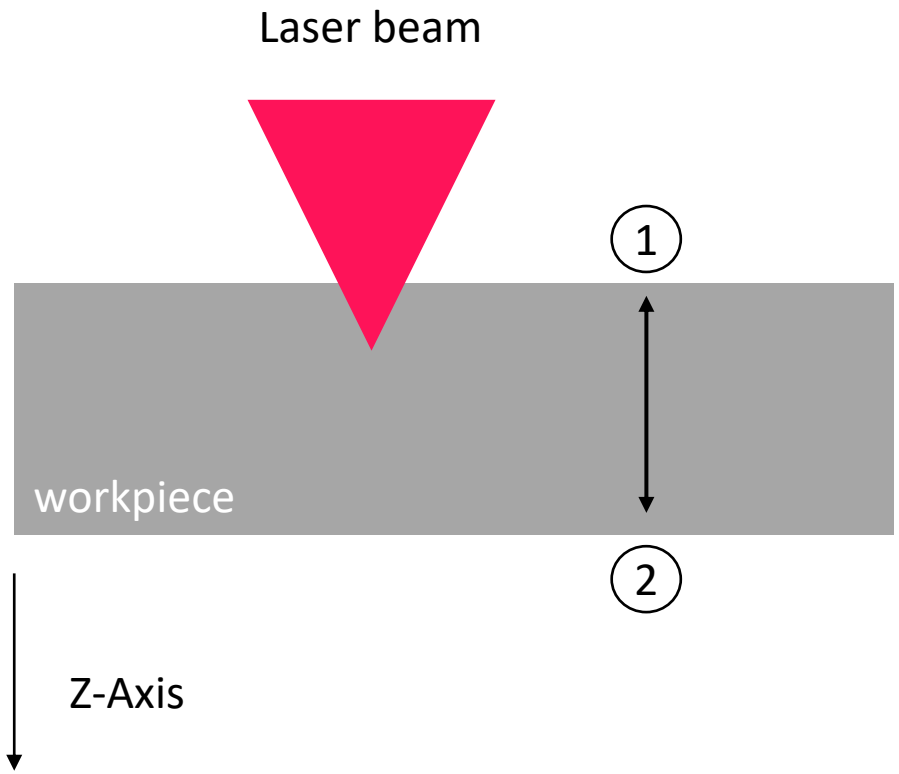
Problem: Laser power increase for faster cutting



Higher power gives higher speed but costs more.

How to accelerate cutting speed & increase quality & reduce waste of energy?

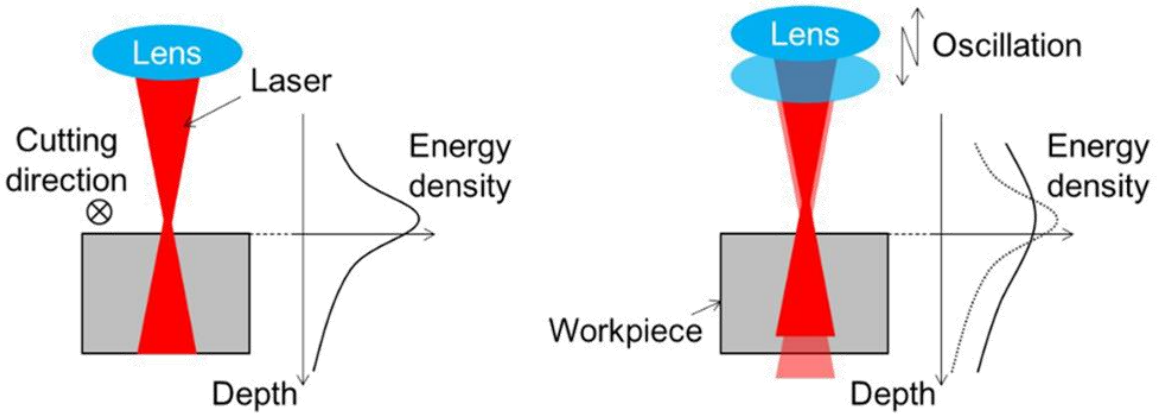
Our solution: dynamic beam shaping



Beam focus oscillates quickly between 1 ⟷ 2

ZWOBBEL® technology

Dynamic beam shaping requirements



Assumption of uniformizing laser energy density distribution (side view, time average) [MHH15]

Challenge/Goal

- Steep radiale temperature gradient + increase in interaction time to increase the melt loss
- Decreases dross and burr & roughness of the cut surface

Aim

- Adjustment of the interaction cross-section and time between material and laser
- Influencing the energy distribution in the workpiece
- Improvement of the melting process by oscillation

Zwobbel© Technology

Design is filed for patent
DE 10 2021 102 096.4

Lightweight, compact
& Ready-to-use

100 x faster
(process enabler)

All wavelengths,
High power mirror

System integration

Mechanics:

- 90° folding mirror
- Stand alone Z-stage or with sensor integration
- Weight <500g (plus adapter)

Optics:

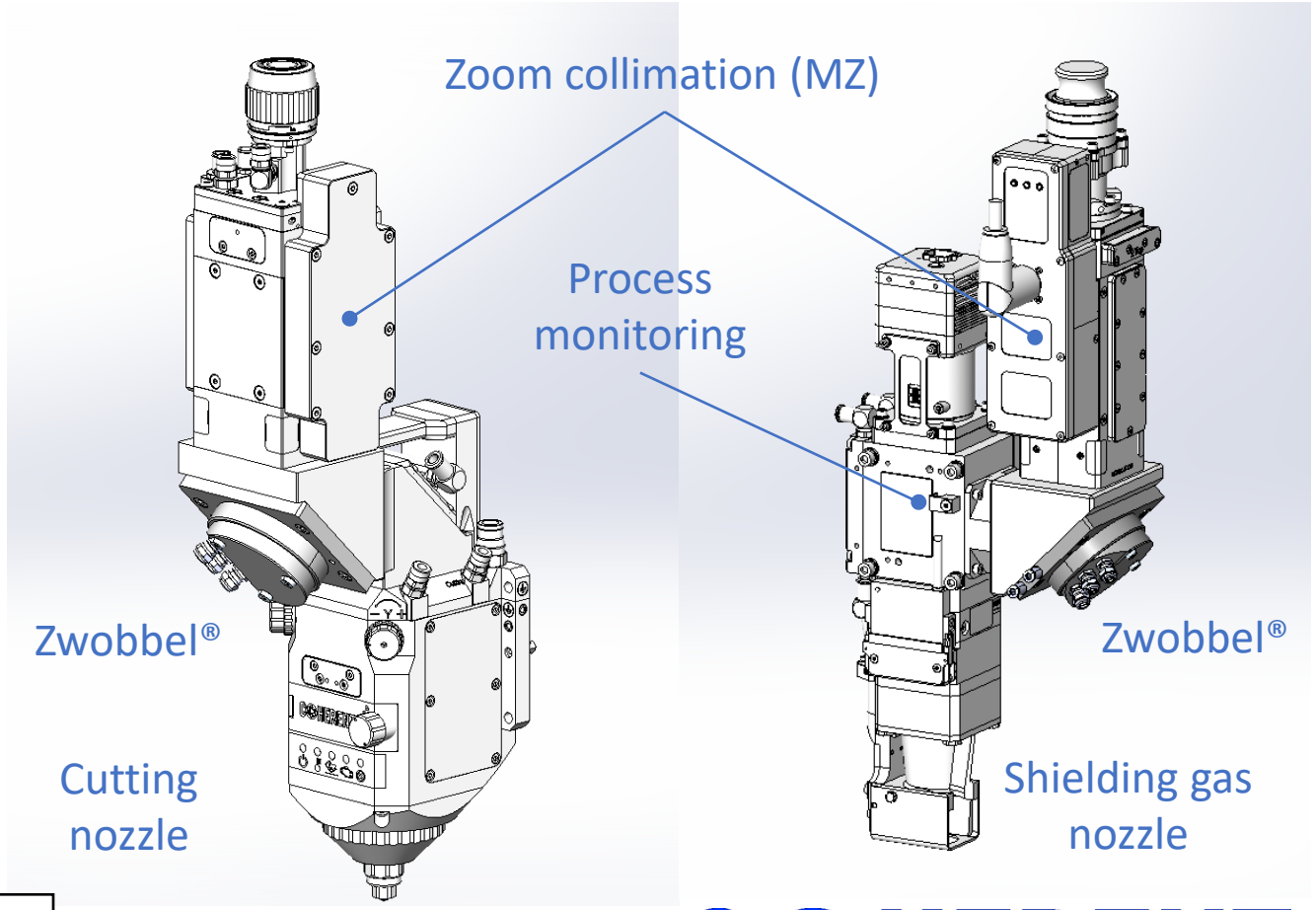
- 1/e² aperture: 10mm - 25mm
- High-power coating: Power level **> 8kW**

Information technology

- Analog input
- Analog/USB output
- Digital interface (DI) f.e. EtherNET

CUTTING HEAD
BIMO FSC3

WELDING AND BRAZING HEAD
BIMO LPH2



Machine controller	DI	→	DI	Function generator	→	Zwobbel®

Joint work with COHERENT

System integration

Mechanics:

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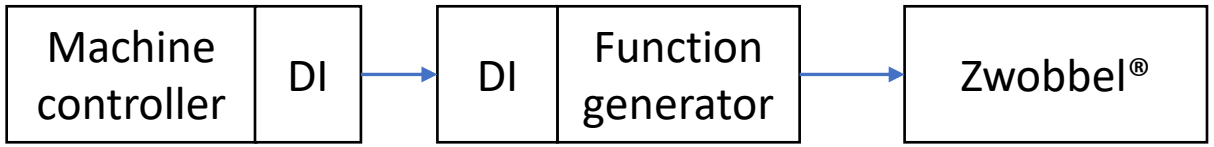

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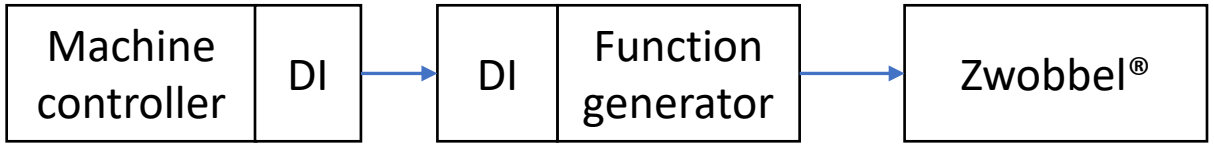
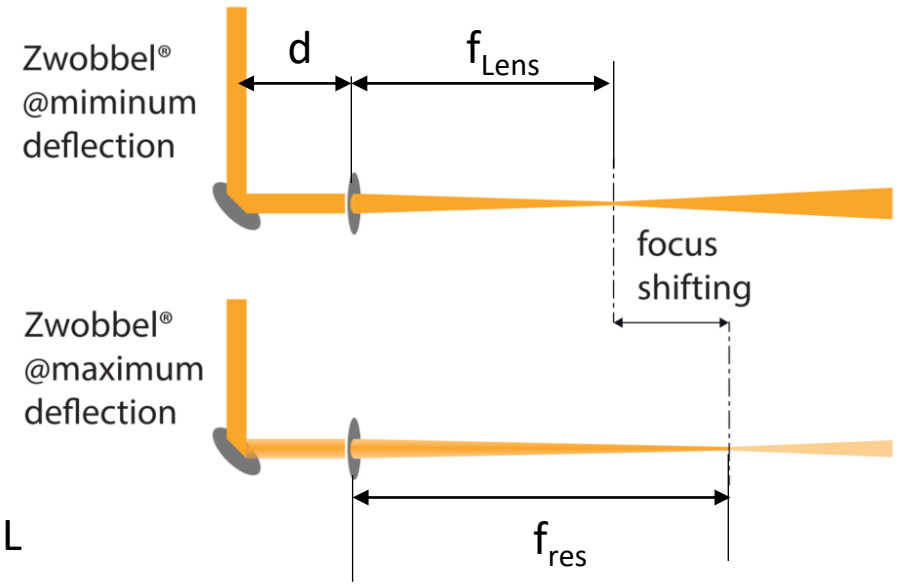


Optical capability

- Zwobbel – deformable mirror changes the systems focal length
- Long focal length may be changed strongly
- No moving parts just hinges



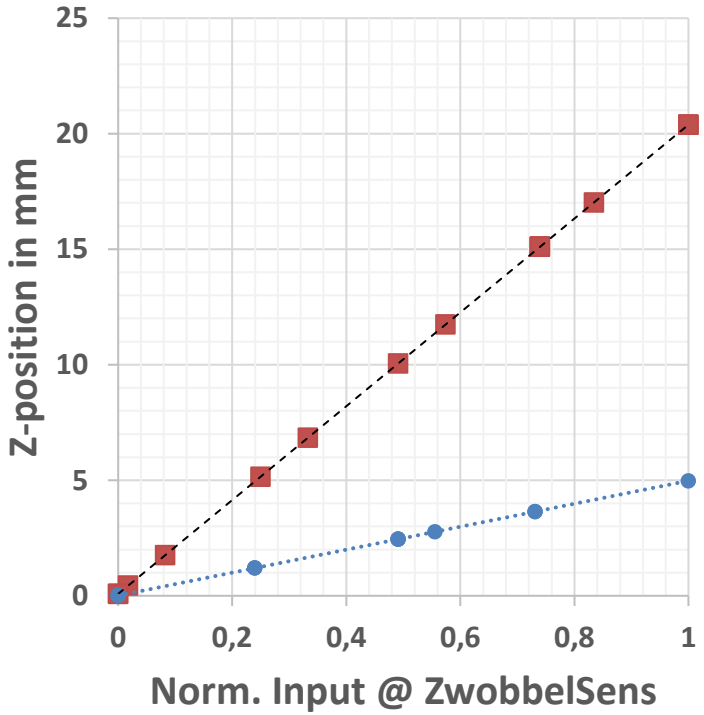
The resulting focal length $fres$, optical power of the ZWOBBEL D=-0,45dpt, focal length of the focusing lens f_{lens}

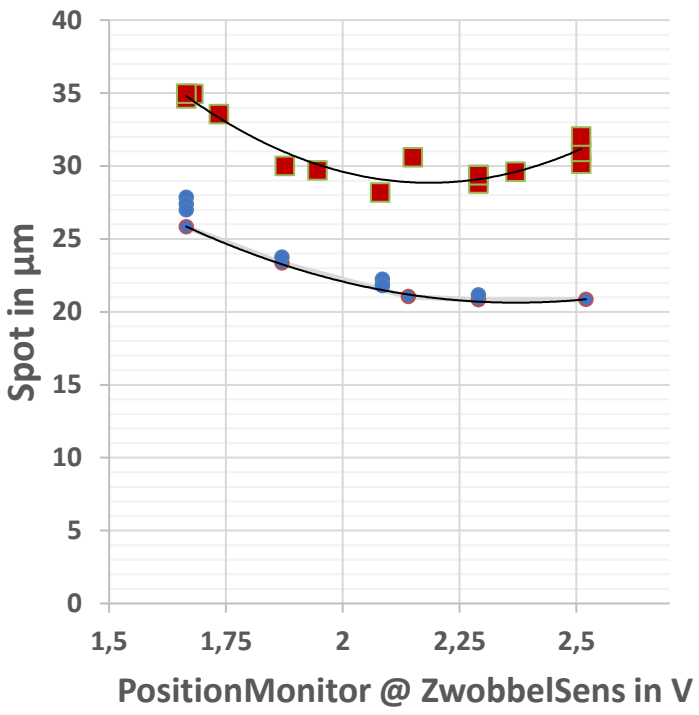
$$\frac{1}{f_{res}} = D + \frac{1}{f_{lens}}$$

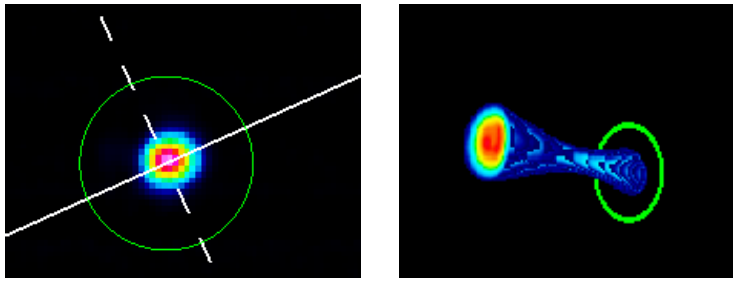
f_Lens=500mm → f_Res=645 mm
f_Lens=200mm → f_Res=220 mm
f_Lens=100mm → f_Res=104 mm

The optical power D is ¾ convex and ¼ concave.

Optical capability







Measurement results:
M^2-Set-up
$1/e^2$ beam diameter= 6,5mm
λ = 632 nm
M^2=1.2– 1.4

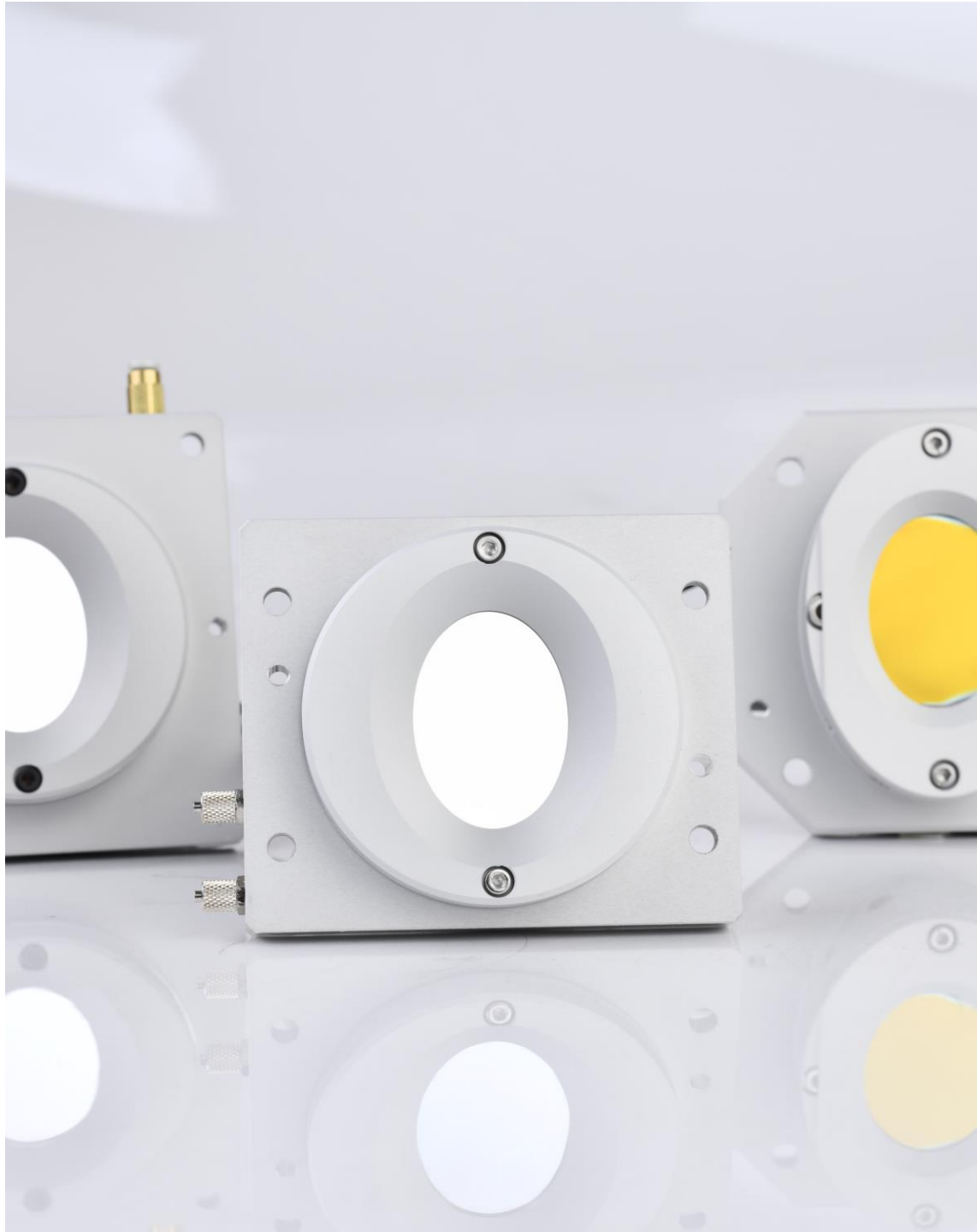
Øspot accuracy:
± 1 µm rms (@f=250mm lens)
Δz-accuracy
± 0.10 mm rms (@f=200mm lens)
± 0.05 mm rms (@f=100mm lens)

f_L=200mm

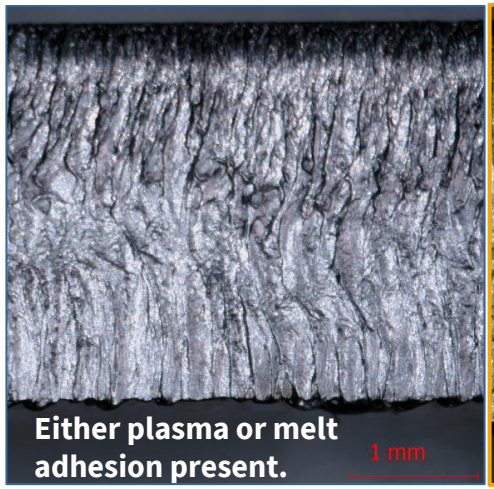
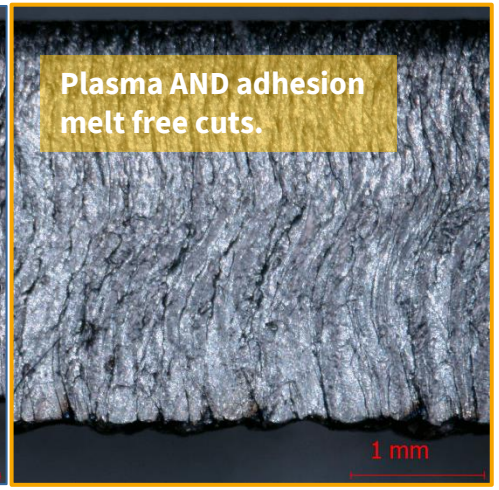
f_L=100mm

Application results

1. Fine metall cutting
2. Bevel cutting
3. Thick metall cutting



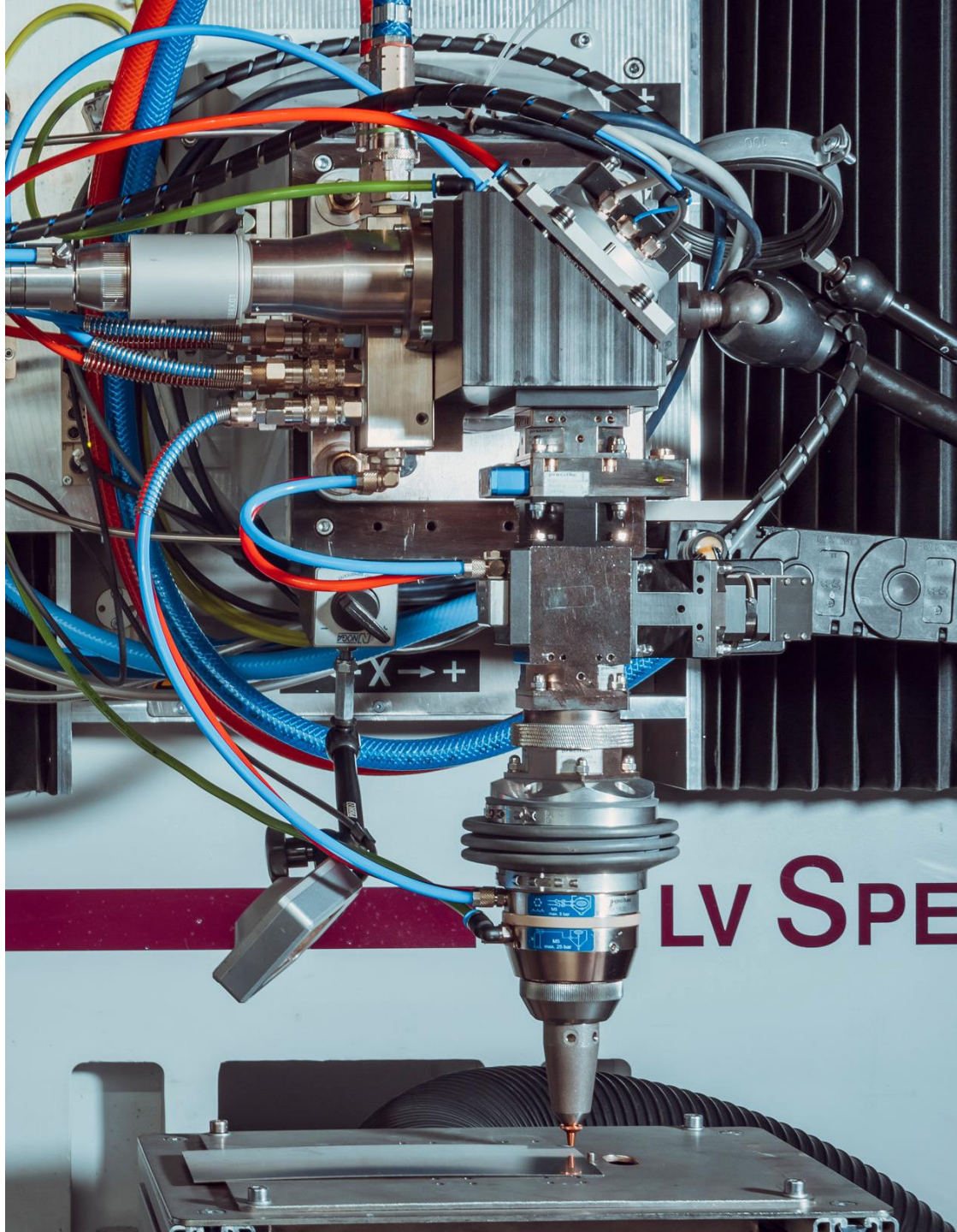
Fine metall cutting

Reference	Zwobbel-Technology
	
Either plasma or melt adhesion present. 1 mm	Plasma AND adhesion melt free cuts. 1 mm

Value	
Mild steel, S355MC, t=3 mm	
P=2 kW	
3 m/min	6.25 m/min

DOUBLED SPEED NO PLASMA

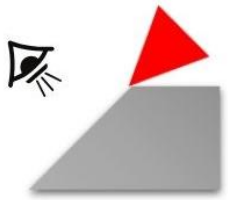
Based on economic viability calculation: **after 2 months the customer earns money with the Zwobbel!**

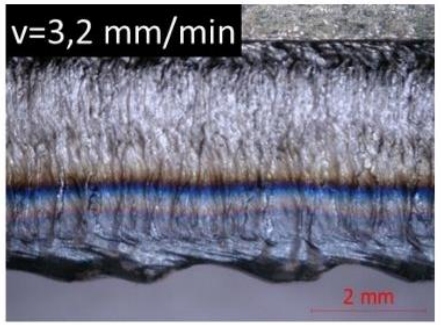


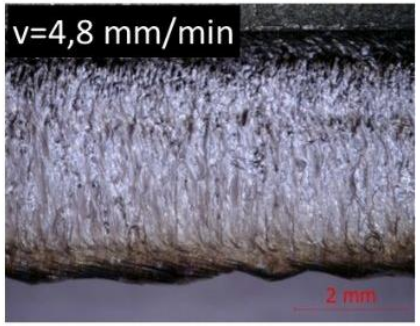
Bevel cutting

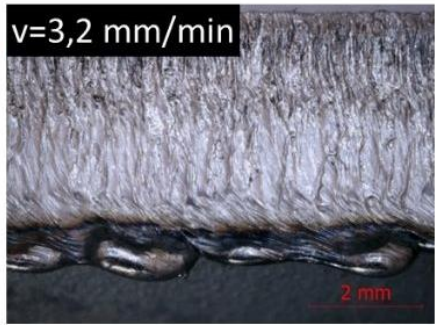
Reference

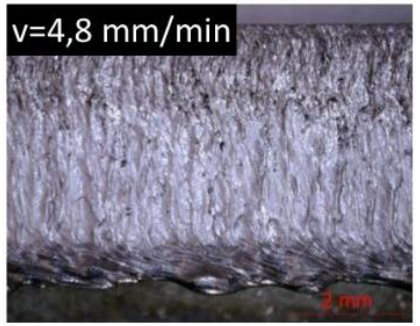
Zwobbel-Technology











33% faster cutting & better quality

Thick sheet cutting
production results mild steel t=10 mm

Baustahl: Laser 250C, Blechstärke=10 mm: bei 6 kW Laserleistung und Fokusdurchmesser 267µm
Laser: Trumpf Scheibenlaser, Typ: TruDisk 12001

QUALITY IS MUCH BETTER AND LESS/NO REWORK IS NECCESARY.

Referenzschnitt ohne Zwobbel, vmax=1,7 m/min

Gas: N2
Düsendurchmesser=3,0mm
Schneidgasdruck 20 bar
Volumenstrom ca. 93m³/h

Referenzschnitt mit Zwobbel, vmax=1,9 m/min

Gas: N2
Düsendurchmesser=2,5mm
Schneidgasdruck 23 bar
Volumenstrom ca. 81m³/h

Summary

- Dynamic beam shaping as a novel process for laser cutting
- Experimental data show dross reduction & speed improvement
- Less influence of focus accuracy on cutting quality → larger processing field for ZWOBBEL cutting.
- Variation and increase of working distance possible.
- Availlable in commercial machines and for robots.