

LEISTER

Beam Shaping and Simultaneous Exposure by Diffractive Optical Element in Laser Plastic Welding

AKL`12

9th May 2012

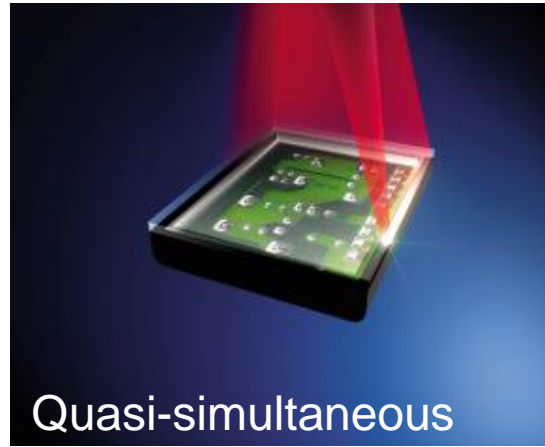
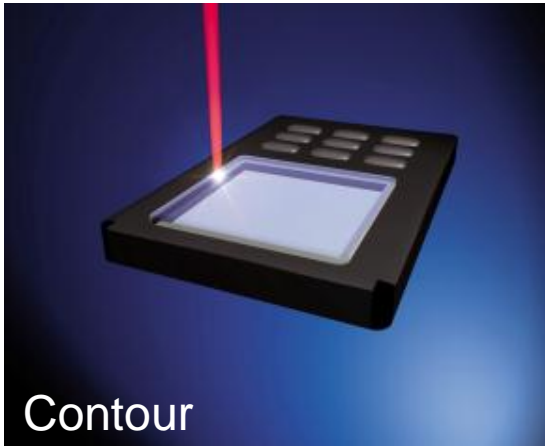
Dr. Daniel Vogler

**POLY
BRIGHT**

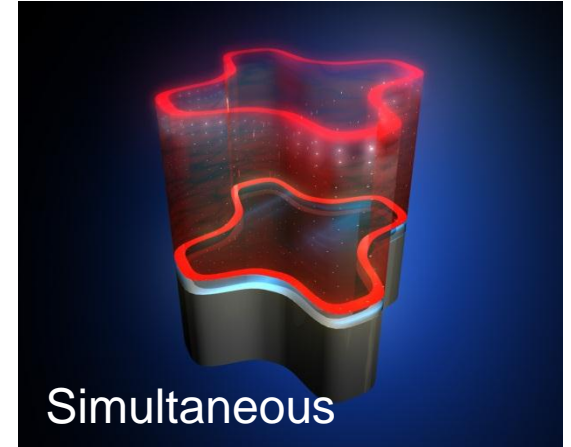


Motivation: Quality and flexibility

diffractive spot shaping



diffractive contour shaping



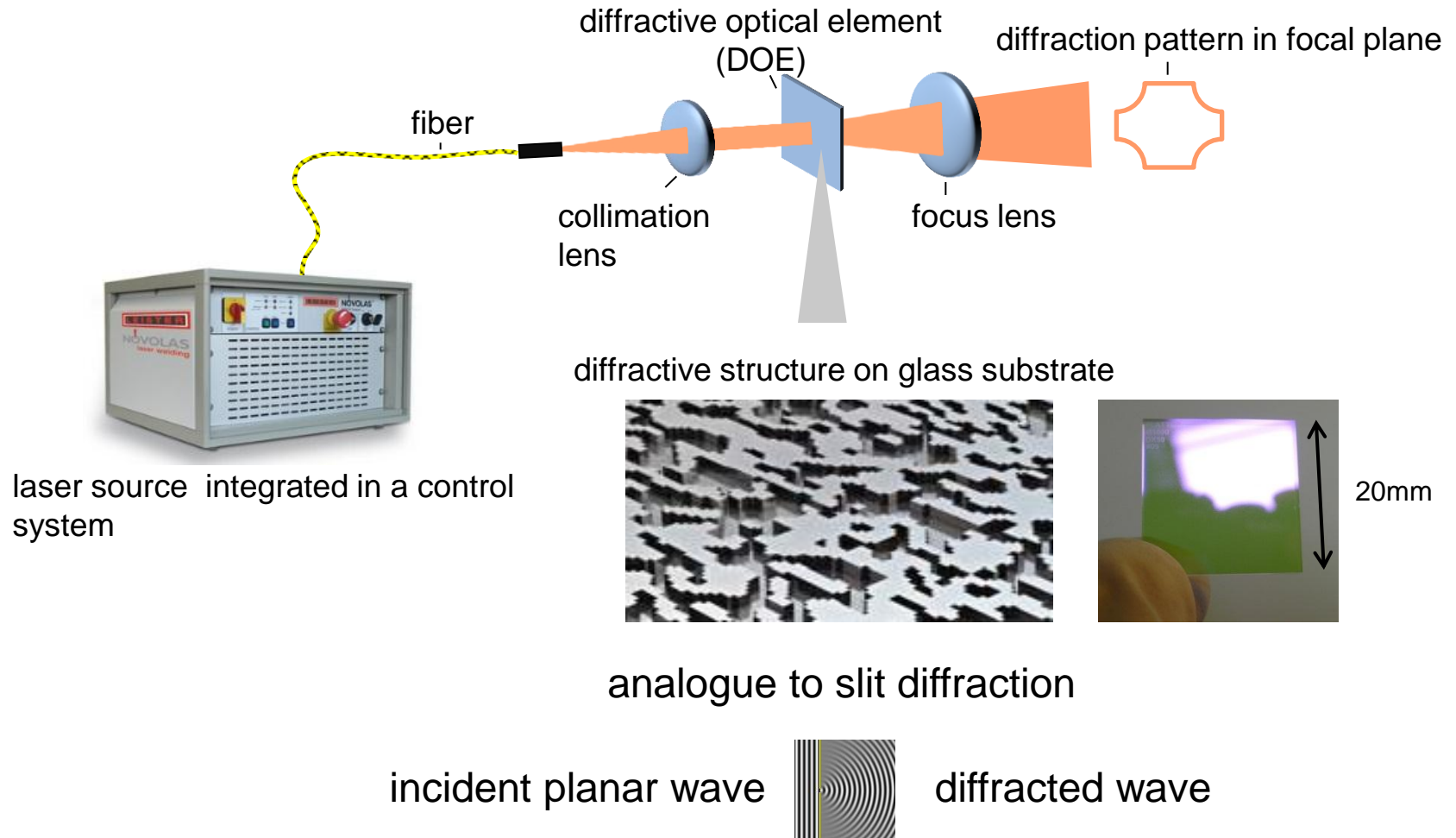
Quality & flexibility improvement in polymer laser welding by diffractive beam shaping technique

- Optimization of intensity profiles for strong weld seams
- Easy modification of laser spot sizes
- Customer-specific contour shaping for simultaneous welding

Content of presentation

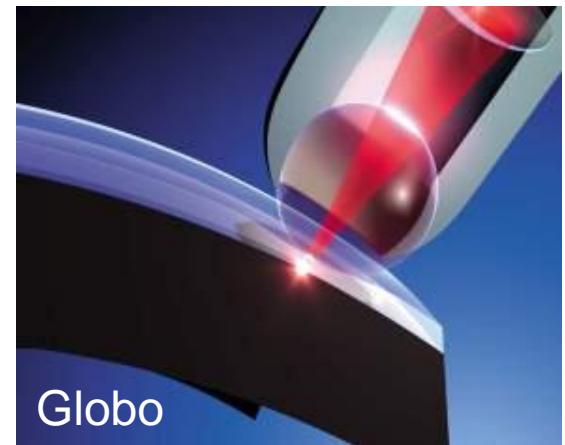
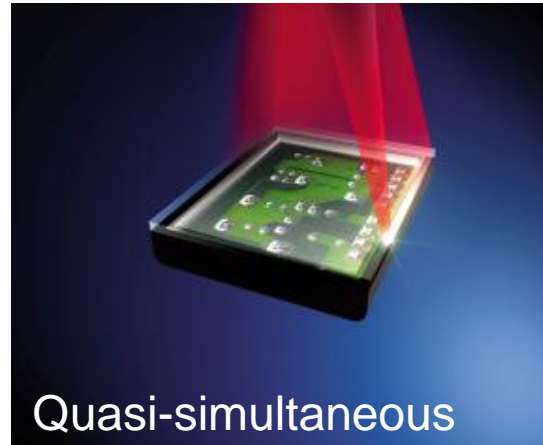
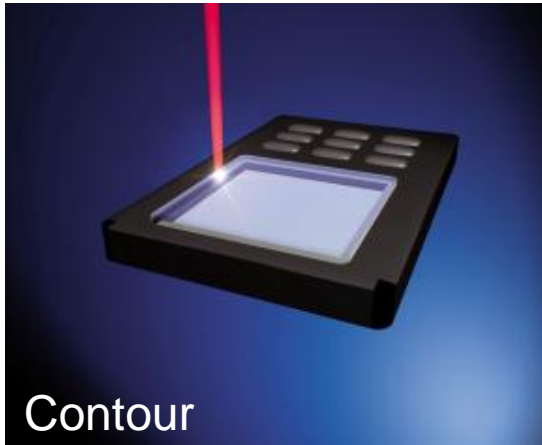
- 1. Diffractive beam shaping technique**
- 2. Application of diffractive optical elements in polymer laser welding**
- 3. Implementation of diffractive optical elements**
- 4. One shot (simultaneous) welding**
- 5. Summary and outlook**

1. Optical setup for diffractive beam shaping

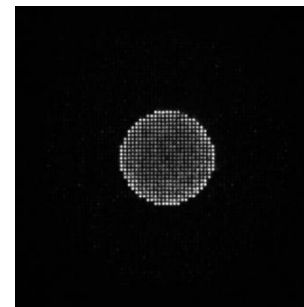


First application in polymer laser welding

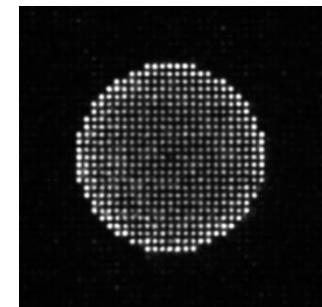
diffractive spot shaping



Diffractive shaping of spot sizes without changing fiber, lenses and working distance.



1 mm spot

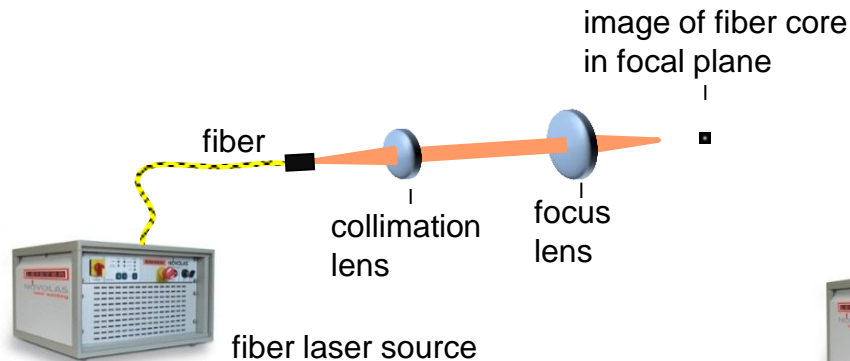


2 mm spot

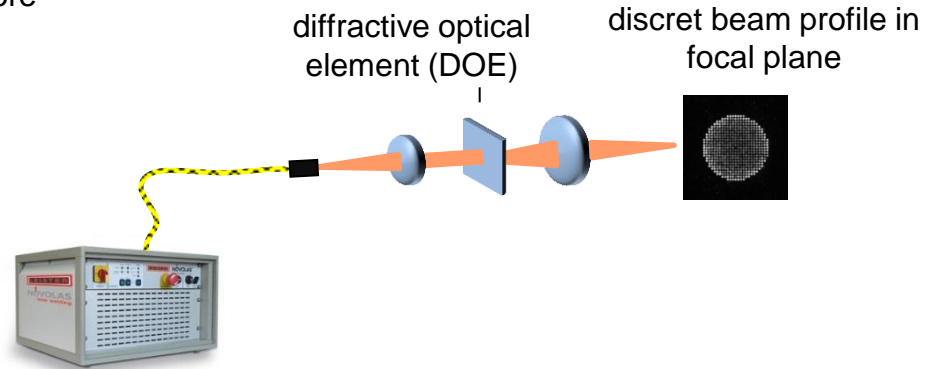
measured intensity profiles of diffractive-shaped laser spots

Diffractive beam splitting technique

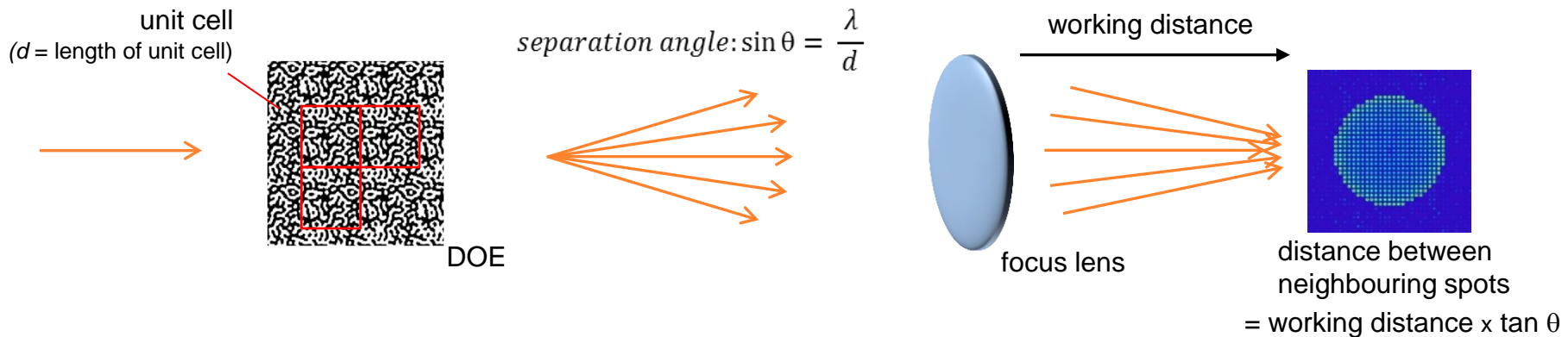
Fiber laser setup for laser welding



Diffractive setup

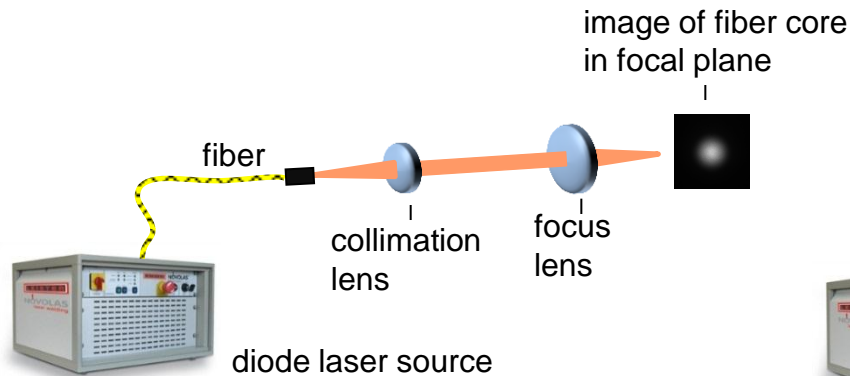


DOE acts as a diffraction grating, i.e. as a beam-splitter imaging original laser spot in an array. Each of the imaged laser spots is weighted with a DOE-defined factor.

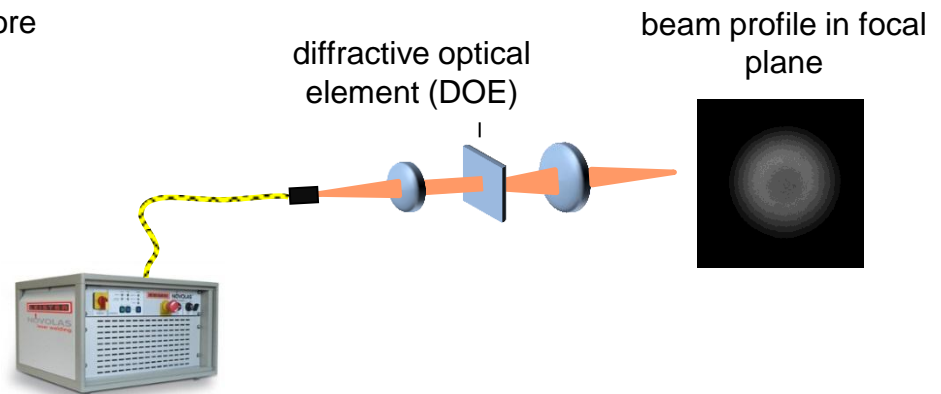


Diffraction beam splitting technique

Diode laser setup for laser welding



Diffractive setup

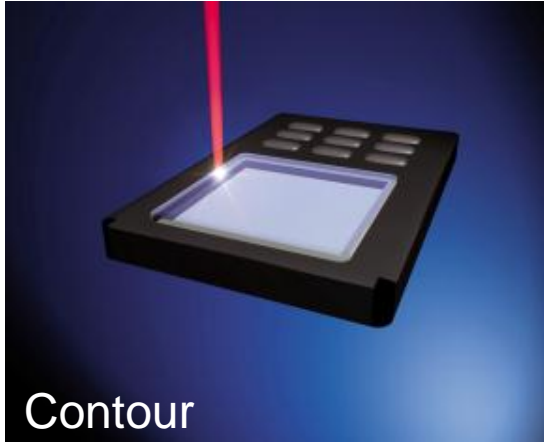


Characteristics of diffractive beam splitting technique

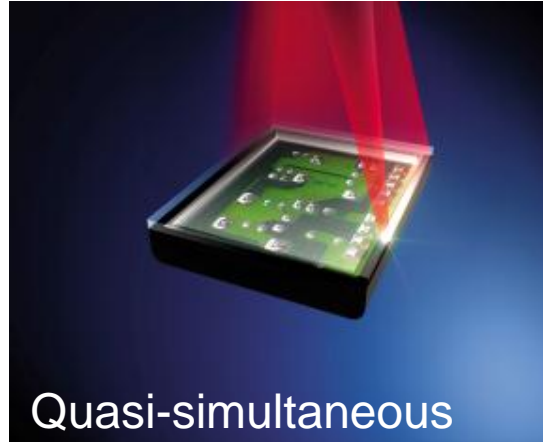
- no alignment is required between DOE and laser beam
- DOE is designed for one wavelength (highest efficiency)
- size of the diffraction pattern depends on wavelength and focus lens
- Resolution of the diffraction pattern is given by the size of the unit cells (about 9 cells should be illuminated) and the brilliance of the laser source

2. Application in polymer laser welding

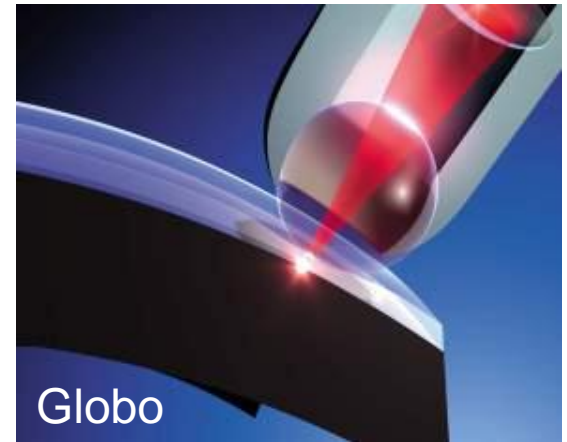
diffractive spot shaping



Contour

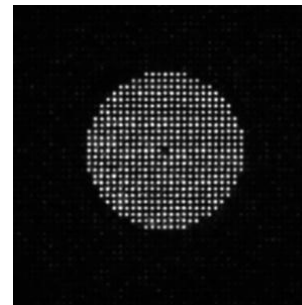


Quasi-simultaneous

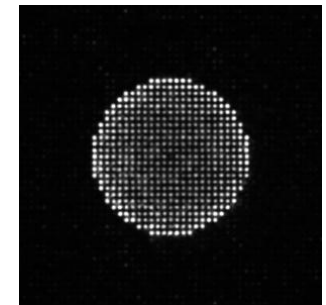


Globo

Diffractive shaping of intensity profiles without changing laser, fiber cable and/or optic head.



top-hat profile



m-shaped profile

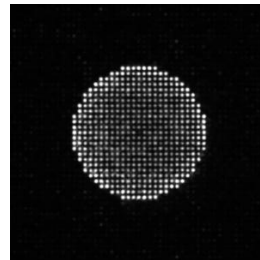
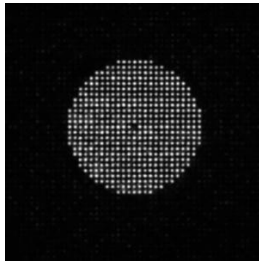
measured intensity profiles of diffractive-shaped laser spots

DOE application in polymer laser welding

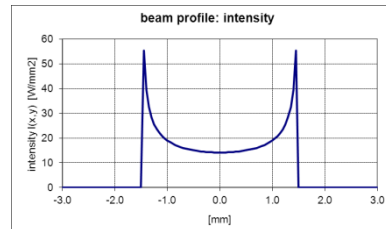
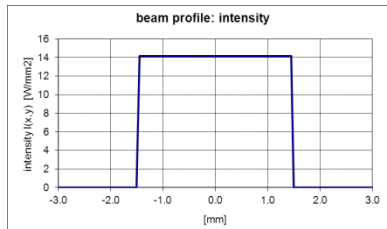
top-hat profile

M-shaped profile

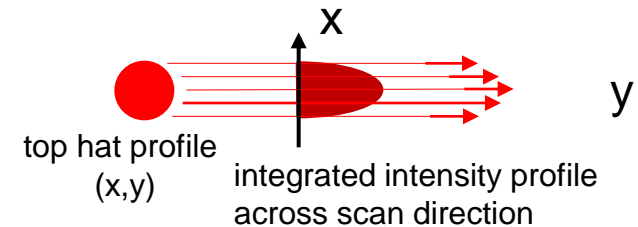
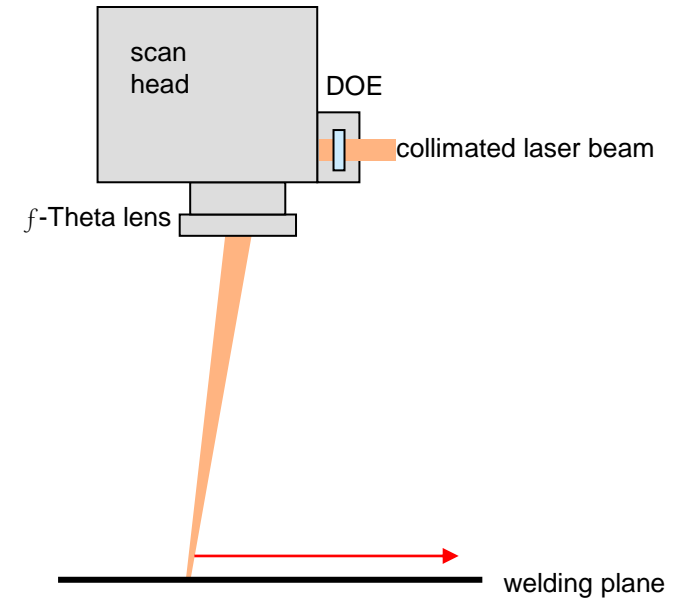
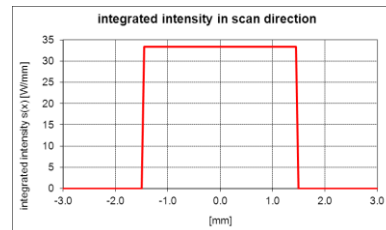
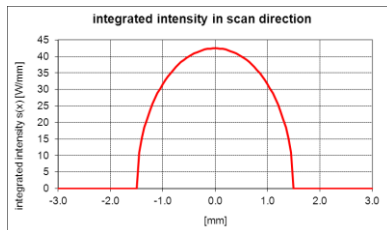
measured profile



intensity profile



integrated intensity profile of laser spot

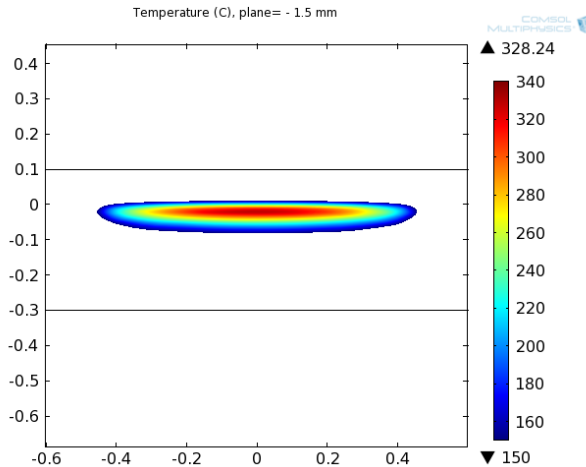


Diffractive shaping of laser spots

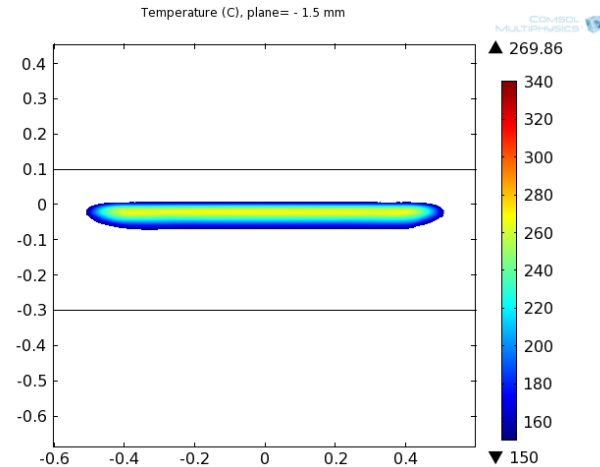
simulated heat distribution after laser absorption in polymer across scan direction

PC (0.4% carbon black)
power = 50W; $v = 1\text{ m/s}$

top-hat profile

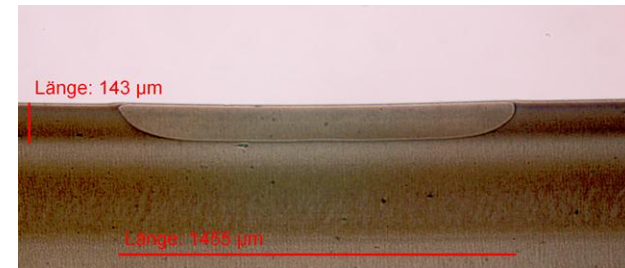
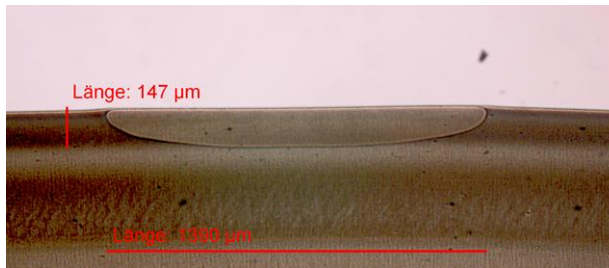


M-shaped profile



heat affected zone in polymer

PP (0.5% carbon black)

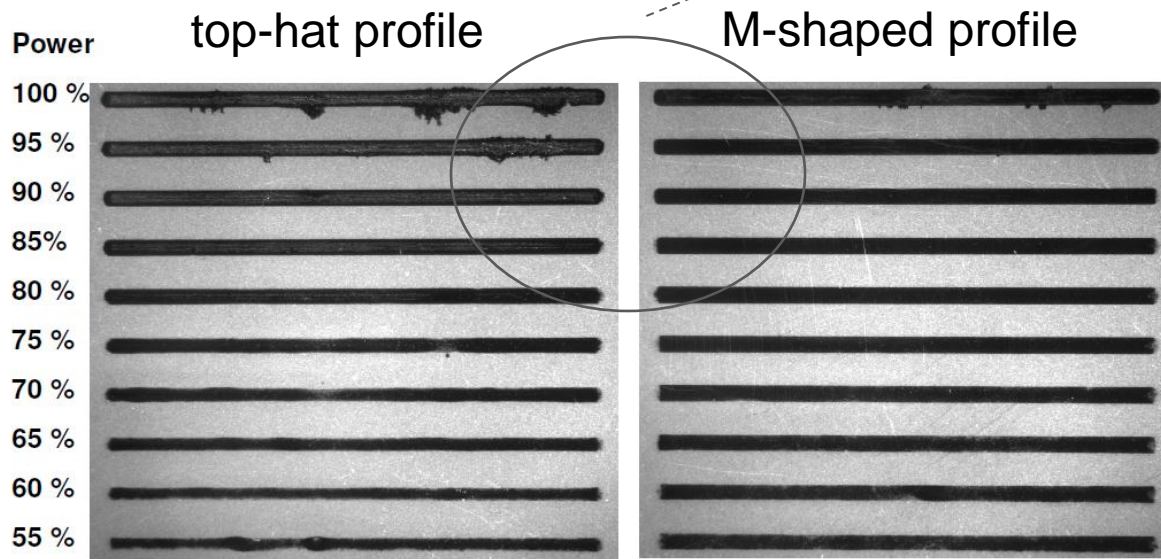


[Simulation and microtones by ILT]

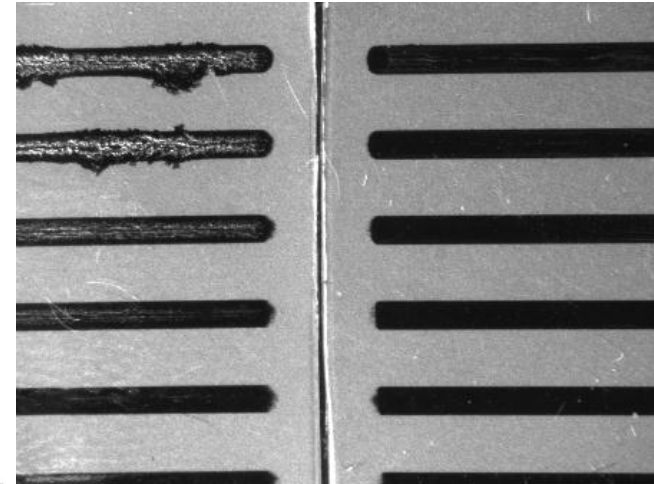
Intensity profile influences the heat distribution during weld process.

Diffraction shaping of laser spots

M-shaped intensity profile yields larger process window and ensures a defined edge of weld seams.

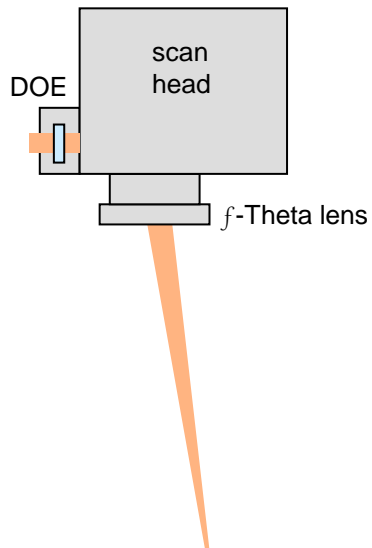


Contour welding: 100% Power = 53 Watt (fiber laser @ 1070nm) 500 mm/s



3. Implementation of spot shaping technique

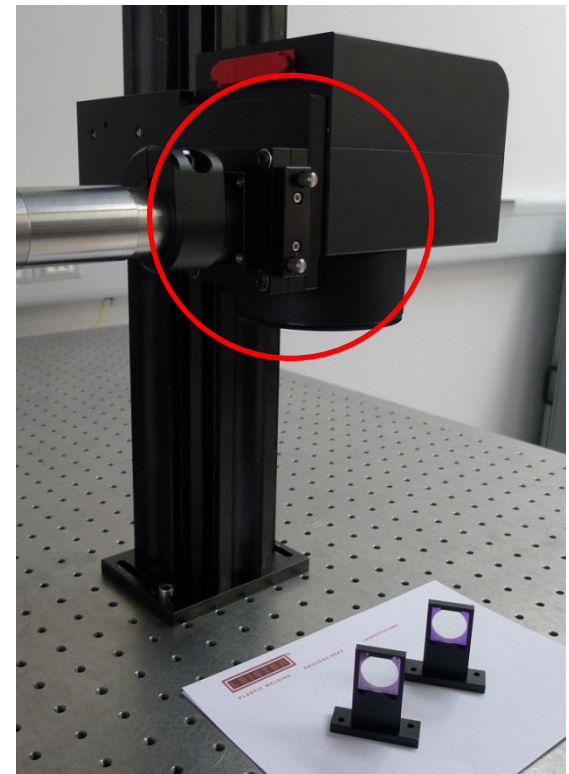
Scan head with DOE drawer system



scan head

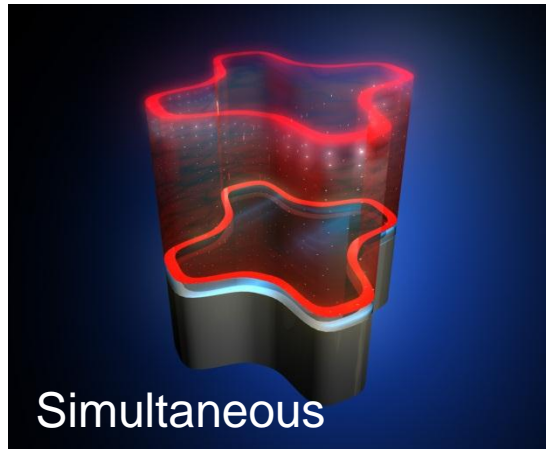


with open slot for DOE

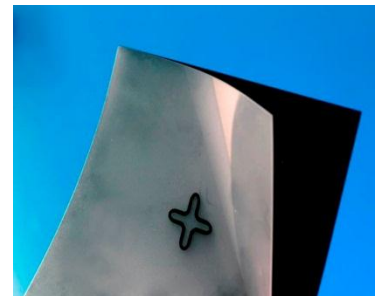


equipped with DOE

4. One shot (simultaneous) welding



- any 2D contours, preferably centrosymmetric
- short welding time
- no moving parts
- suited for mass production



polycarbonate foil samples

Advantages and disadvantages of DOE

Advantages

- any 2D contours
- no alignment required between DOE and laser beam \Rightarrow easy and quick exchange of DOE

Disadvantages

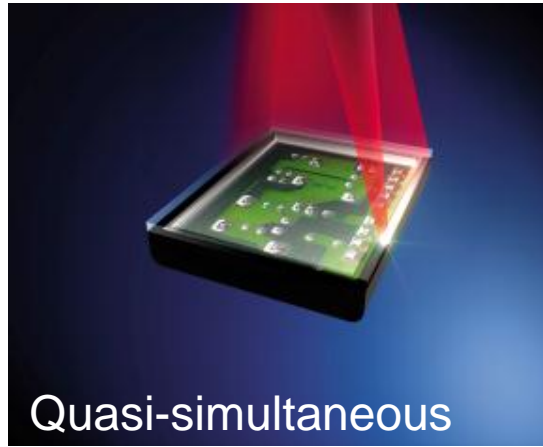
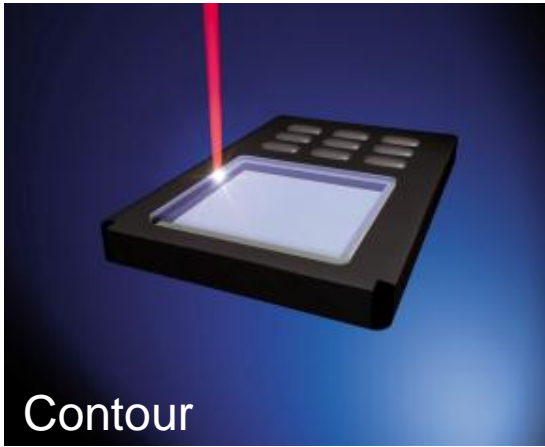
- efficiency
Two phase level DOE: 70 - 80 % efficiency, higher efficiency on multi-level DOE
- price – high tooling costs, mass production affordable

Characteristics of diffractive beam splitting technique

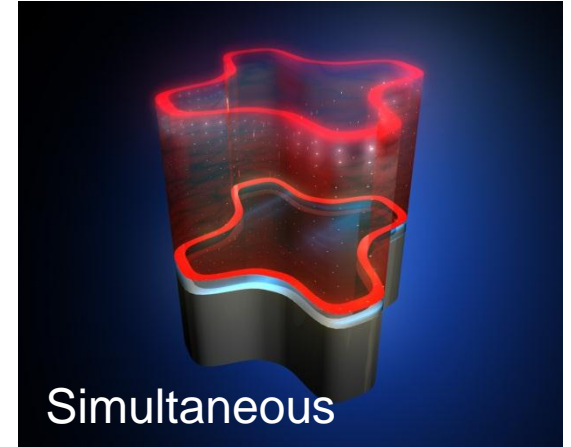
- DOE is designed for one wavelength (highest efficiency)
- size of the diffraction pattern depends on wavelength and focus lens
- resolution of the diffraction pattern is given by the size of the unit cells (about 9 cells should be illuminated) and the brilliance of the laser source

Summary: Quality and flexibility

diffractive spot shaping



diffractive contour shaping

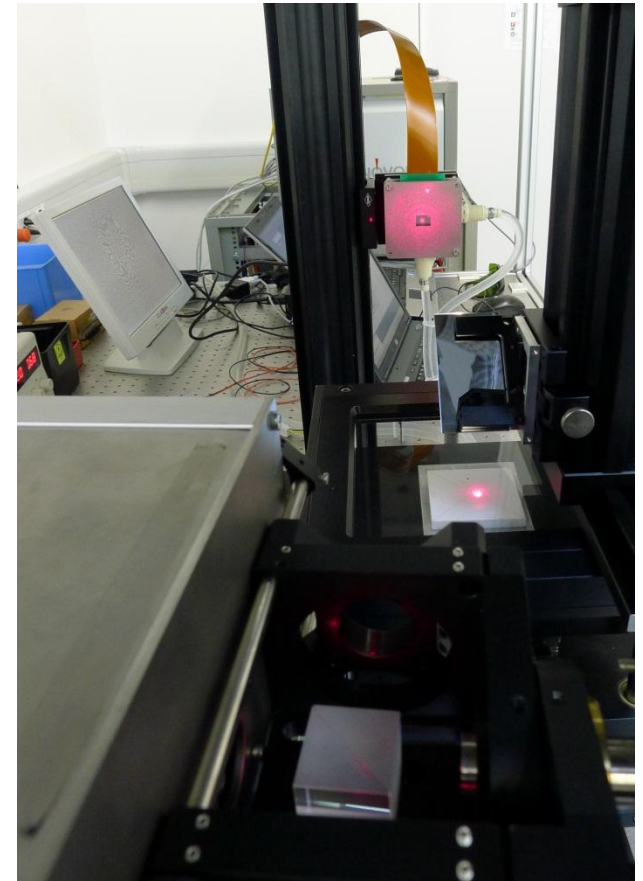
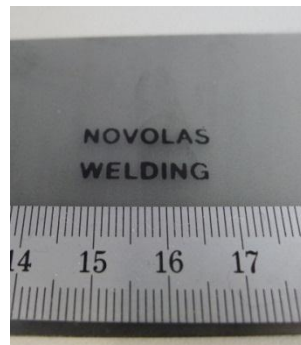
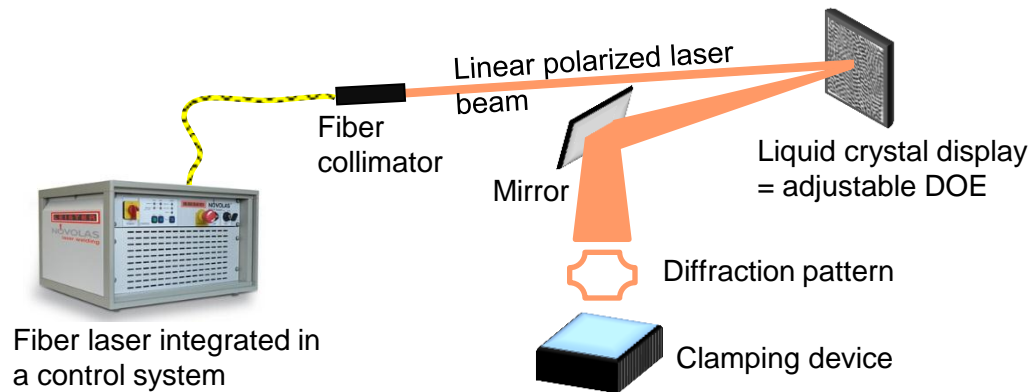


Quality & flexibility improvement in polymer laser welding by diffractive beam shaping technique

- Optimization of intensity profiles for strong weld seams
- Easy modification of laser spot sizes
- Customer-specific contour shaping for simultaneous welding

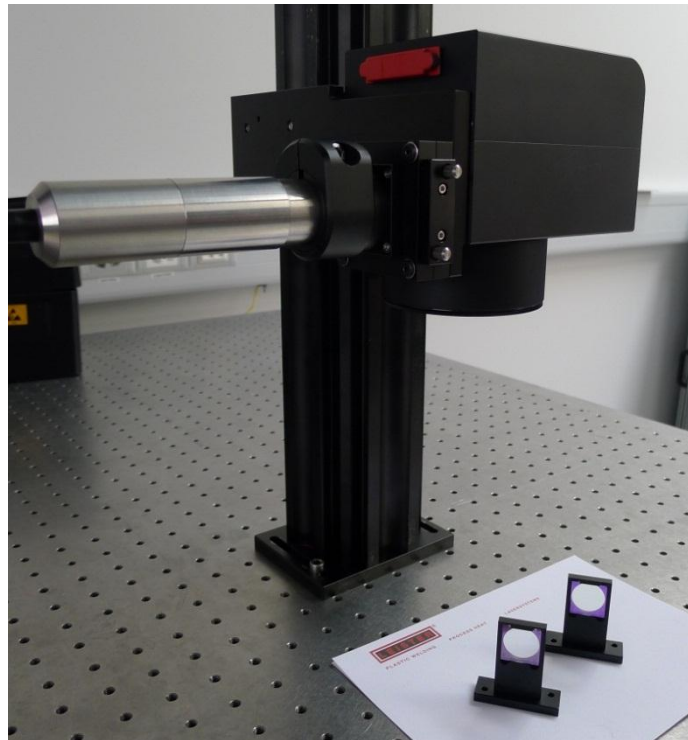
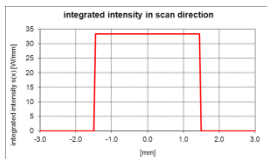
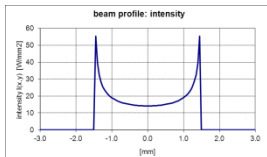
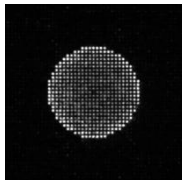
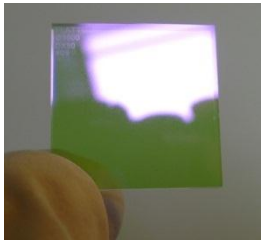
Outlook: Adjustable DOE

Spatial light modulators for polymer laser welding



Diffractive beam shaping for polymer welding

Thank you for your attention



⇒ for further information visit our booth in exhibition