THE LATEST TRUMPF INNOVATIONS

focused on optics and optical components

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Product Management

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Agenda

1. BrightLine Weld: the new way to design welding processes

2. BEO D50 Basic: robust and compact

3. Intelligent PFO: the smartest solution for welding on the fly mode
**BrightLine Weld**

The new way to design welding processes

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**TruDisk Laser with BrightLine Weld option**

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**Optics series**
- BEO, PFO

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**2in1 laser light cable**
# BrightLine Weld

## Technical data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
<td>1030 nm</td>
</tr>
<tr>
<td>Max. power</td>
<td>6 kW</td>
</tr>
<tr>
<td>Beam quality</td>
<td>2 mm · mrad, 4 mm · mrad</td>
</tr>
<tr>
<td>Beam sources</td>
<td>TruDisk</td>
</tr>
<tr>
<td>Diameter 2in1 LLK</td>
<td>50/200 µm, 100/400 µm</td>
</tr>
<tr>
<td>focusing optics</td>
<td>BEO, PFO</td>
</tr>
</tbody>
</table>
BrightLine Weld

Principle

**BrightLine Weld** is based on the TRUMPF technology of the *2in1-fiber*.

- Patented waveguide layout of **TRUMPF 2in1-fiber**
- Flexible distribution of laser power into inner and outer fiber core
- Superposition of two beams into the process zone

→ Adjustment to application specific optimum

1: laser beam coupled into an inner fiber core
2: laser beam coupled into coaxial outer fiber core
BrightLine Weld

Welding of steel

- BrightLine Weld allows for constantly high weld-seam quality – even at high welding speeds of up to 20 m/min
- Comparable welding depth as in the state of the art
Copper Welding with BrightLine Weld

Higher welding depth / lower welding speed possible with BrightLine Weld

- High weld seam quality even at low speed / high welding depth
- All seams are pore and crack free
- Spatter formation significantly reduced
BrightLine Weld
Copper welding: less spatters

Standard Setup vs. BrightLine Weld
E-Mobility Power Electronics

Welding of copper contacts with BrightLine Weld

Requirements:
- Copper & copper tin-coated
- Weld depth 1,7mm
- 1mm + 1mm overlap joint
- Large connection cross section with low energy input
- No thermal load on the plastic component
- “Spatter free”

Setup:
- TruDisk 6001 with BrightLine Weld
- 100/400 µm LLK
- PFO33-2 with f255 (1,7:1 image ratio)
E-Mobility Power Electronics
Welding of copper contacts with BrightLine Weld

**Parameters:**
- Laser Power $P_{av} = 5.5$ kW
- Weld depth $= 1.7$ mm
- Feed rate $v = 10$ m/min
- Welding time $t = 200$ ms

**Results:**
- Pore free weld seams
- Regular seam surface
- Minimal spatter formation
BrightLine Weld

Customer value

- **High Productivity**: Significantly increased feed rates
  - Up to 300% increased feed rate in mild steel
  - Up to 100% increased feed rate in stainless steel

- **Reduced CoO**: Reduced spatters and less contamination
  - Less rework of parts
  - Less downtime
  - High life time of cover slide glasses

- **High Efficiency**: Reduced laser power at same welding depth
  - Up to 40% savings in energy at the same welding depth and improved quality at the same time

- **High Quality**: High-quality weld seams and parts
  - No undercuts and no end grates (at high feed rates)
  - Less part deformation due to reduced energy input
BEO D50 Basic
Robust and compact

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength</td>
<td>920 – 1070 nm</td>
</tr>
<tr>
<td>Max. power</td>
<td>8 kW</td>
</tr>
<tr>
<td>Beam sources</td>
<td>TruDisk, TruDiode, TruFiber, TruPulse</td>
</tr>
<tr>
<td>Collimation focal lengths</td>
<td>35 mm, 100 mm, 125 mm</td>
</tr>
<tr>
<td>Lens focal lengths</td>
<td>150 mm, 200 mm, 250 mm, 300 mm</td>
</tr>
</tbody>
</table>
BEO D50 Basic
Cassette module

- Easy changing protective glass
- Double cassette system
BEO D50 Basic

Crossjet, MDE nozzle and smoke protection

- 8x45° mountable
- Small MDE nozzle
- Smoke protection
Crossjet / MDE tests

Crossjet angle 0° ↔ Crossjet angle 5°

![Crossjet angle 0°](image1)

![Crossjet angle 5°](image2)

![Bar chart](chart)

- Crossjet angle 0° vs. 5°
  - Pressure: 3 bar, 5 bar
  - Spatters: 0° vs. 5°
  - Details:
    - P = 3 kW
    - l = 125 mm
    - f = 150 mm
    - z = 0
    - Spaltbreite 0,3 mm
    - 16 Schweißnähte

THE LATEST TRUMPF INNOVATIONS, Dr. Andrey Andreev and Stefanie Feuchtenbeiner
Crossjet / MDE tests
Interaction between Crossjet and MDE nozzle

Directional influence of the welding depth:

- f = 200 mm
- 0.5 mm gap
- 5 bar CJ
- 35 l/min MDE

- f = 200 mm
- 0.3 mm gap
- 2 bar (120 l/min) CJ
- 50 l/min MDE

Bottom side

Metal vapor disturbed, on the left smaller than on the right

Constant metal vapor

The welding direction and the Crossjet position impact the MDE nozzle efficiency.
Crossjet / MDE-Tests

Possible parameter settings for Crossjet and MDE nozzle

**BEO D50**

Laser power 2500 W
Focus diameter 240 µm

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Crossjet</th>
<th>MDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focal length</td>
<td>f150</td>
<td>f200</td>
</tr>
<tr>
<td>Crossjet angle</td>
<td>5°</td>
<td></td>
</tr>
<tr>
<td>Fokus position</td>
<td>-2 mm</td>
<td></td>
</tr>
<tr>
<td>Crossjet gap width</td>
<td>0,5 mm</td>
<td>0,3 mm</td>
</tr>
<tr>
<td>Crossjet pressure</td>
<td>≥ 3,5 bar</td>
<td>≤ 3,5 bar</td>
</tr>
<tr>
<td>Crossjet flow</td>
<td>333 l/min</td>
<td>213 l/min</td>
</tr>
<tr>
<td>MDE flow</td>
<td>35 l/min</td>
<td>50 l/min</td>
</tr>
<tr>
<td>Smoke protection</td>
<td></td>
<td>6 l/min</td>
</tr>
<tr>
<td>Test in the lab</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1000 welds</td>
<td>1200 welds</td>
</tr>
<tr>
<td></td>
<td>cover slide</td>
<td>cover slide</td>
</tr>
</tbody>
</table>
Different gas supply possibilities

Crossjet fixture with magnet coupling

With aerator nozzle

With linear nozzle

With linear nozzle and lateral MDE-nozzle

Magnet coupling

→ Flexibel with 7 different positions
BEO D50 Basic

Customer value

- Reliable process results through robust optics and intelligent monitoring
- Modular concept: flexible and modularly adaptable optics
- Small footprint: compact design
- Ready for industry 4.0
- Cost reduction through integrable additional functions (e.g. sensor systems)
Intelligent PFO
The smartest solution for welding on the fly mode
Intelligent PFO

Motivation: what means “On-The-Fly” processing of big parts?

1) Elimination of non-productive travelling times
2) Maximization of beam-on share time
Intelligent PFO

PFO3D-2 as remote welding tool

Technical data example

<table>
<thead>
<tr>
<th></th>
<th>PFO 3D-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. laser power</td>
<td>8000 W (cw)</td>
</tr>
<tr>
<td>Weight</td>
<td>ca. 35 kg</td>
</tr>
<tr>
<td>Collimation</td>
<td>138 mm</td>
</tr>
<tr>
<td>Focal length</td>
<td>450 mm</td>
</tr>
<tr>
<td>Working distance to cover slide</td>
<td>525 ± 2,5 mm</td>
</tr>
<tr>
<td>Max. stroke z axis</td>
<td>140 mm</td>
</tr>
<tr>
<td>Max. field size x, y (elliptical)</td>
<td>190x320 mm²</td>
</tr>
</tbody>
</table>
Intelligent PFO

Intuitive teach in mode for fast changes in the cell

- Put the geometries in the right position, trigger and simulation
- Robot path will be created
- Simulation and test
Intelligent PFO

Customer value

- Cycle-time reduction through flexible production
- Movement calculations in real time
- Intuitive programming
- Modular concept: flexible sensor integration possible
THANK YOU

Dr. Andrey Andreev and Stefanie Feuchtenbeiner, Product Management
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