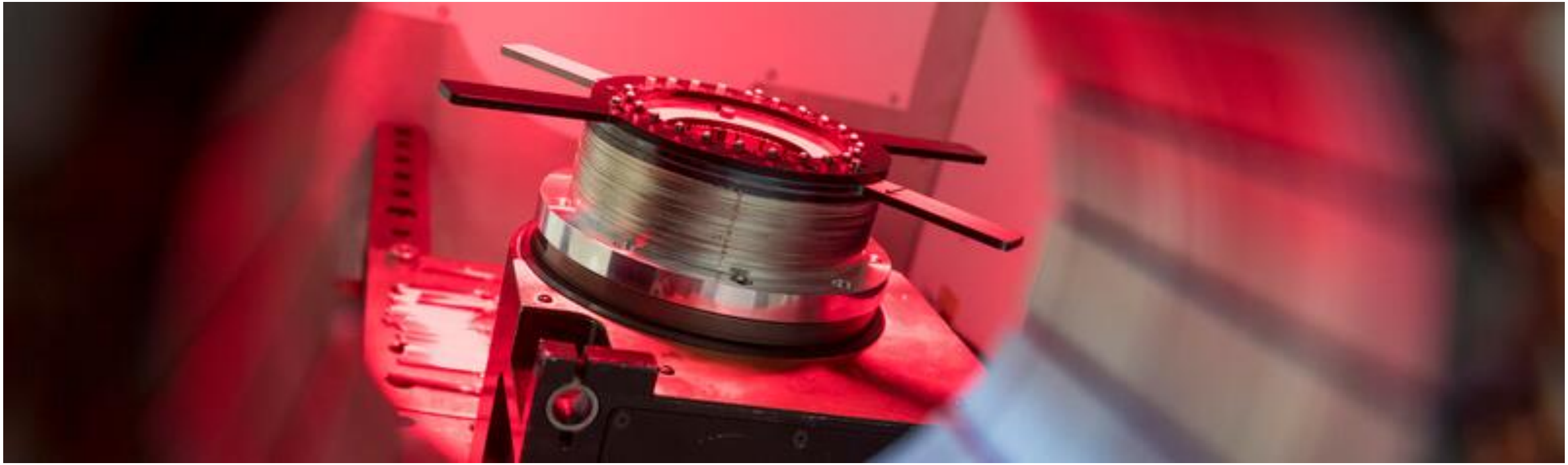


Trumpf - Soluzioni per la mobilità elettrica: dalla consulenza applicativa alle sorgenti laser e sensori di controllo

18-11-2020

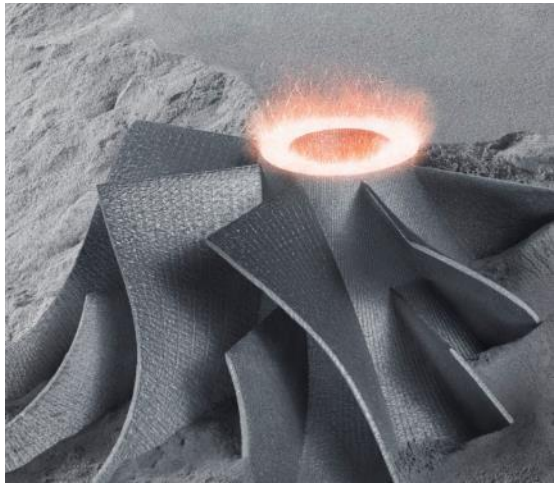
TRUMPF

TRUMPF is…

Family business since 1923

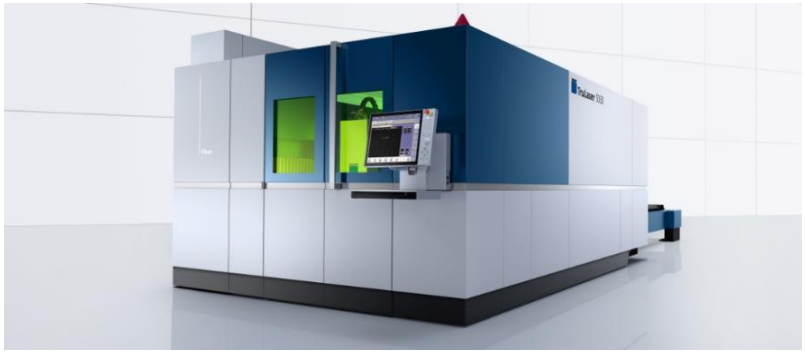
Technology leader in two business divisions

Close to its customers with 77 subsidiaries

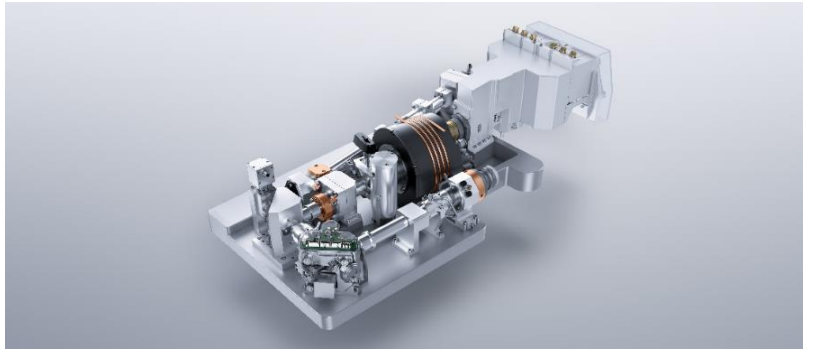


Innovation promise – holistically and constantly

Machine tools for flexible sheet metal processing



Laser technology



- Laser Beam Sources
- Optics & Waveguides
- Sensor Systems
- Process Development

At a Glance

Company figures 2019/20

Sales 2019/20 (Mio. €)*

3.487

R+D Expenditures (Mio. €)

377

Orders received 2019/20 (Mio. €)*

3.278

Income before Taxes (EBIT) (Mio. €)

309

R+D Quota

10,8%

Employees as of 30.06.2020
(Number of persons)*

14.300

Net operating margin

8.9%

Investments (Mio. €)

194

TRUMPF

E-cars made by Laser

Welding | Cutting | Heat Treatment | Surface Treatment

Batteries

Battery Pack

Prismatic Cell

Can Cap

Car Body

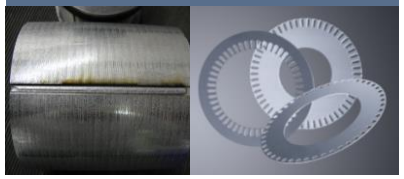
Interior Design

Electrified Powertrain

Rotor Shaft Welding

Stator with Hairpin

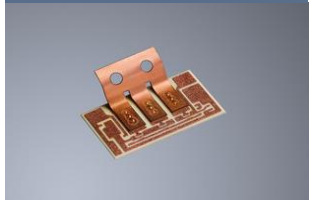
Stator Package



Low and High Power Electronics

Electronic Control Unit

Direct Copper Bonding



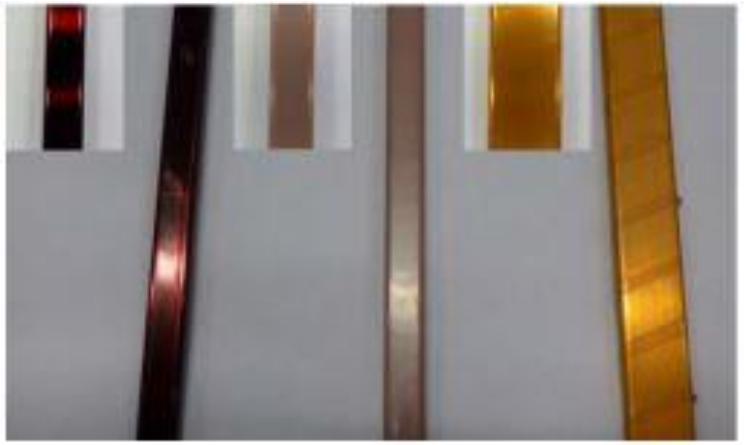
TRUMPF

CONTACTING TECHNOLOGY
HAIRPIN DECOATING & WELDING

REMOVAL OF THE ISOLATION

Hairpin Build

Examples for different coatings

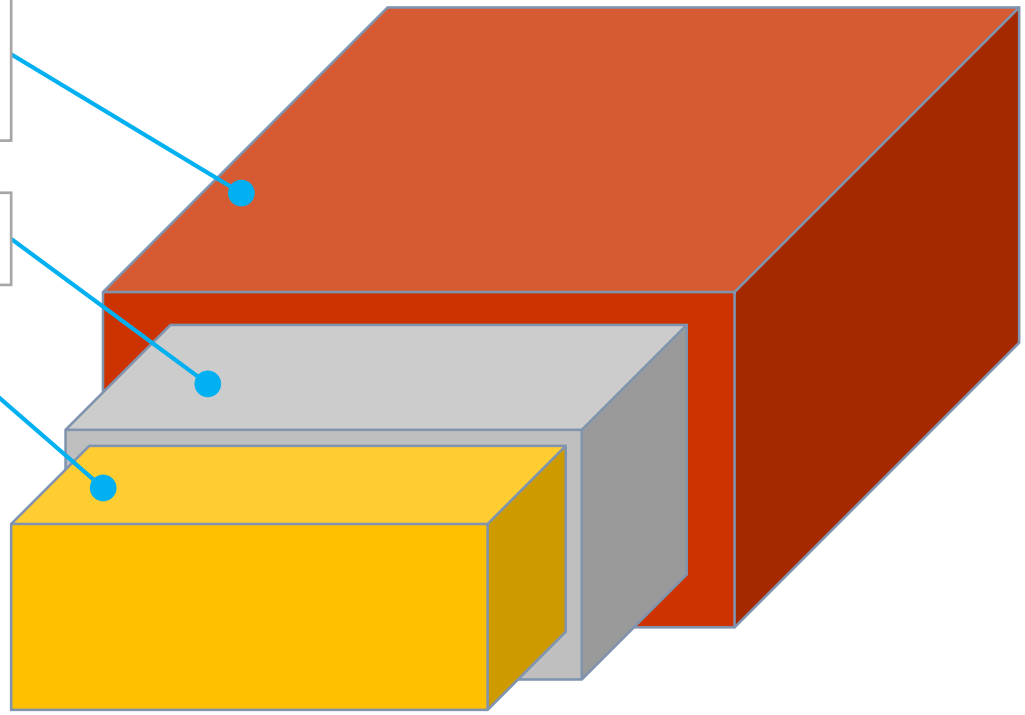


Isolation Layer

- Prevents Electrical Short-Circuit
- Different Materials are used
- PAI (Polyamid-Imid)
- PEEK (Poly-Ether-Ether-Keton)
- PI (Poly-Imid, Kapton)
- PEI (Poly-Ester-Imid)
- Mixed Systems (PEEK over PAI)

Copper Wire

Bonding Layer



All mentioned coating types work with the TRUMPF laser decoating process at comparable cycletimes

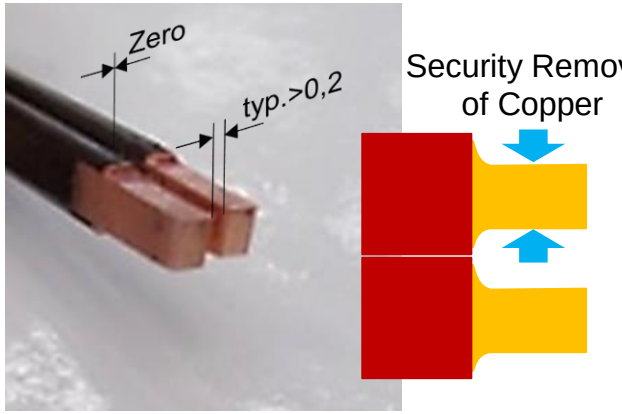
E-drives: Laserdecoating of Hairpins

State of the Art Welding Preparation using High Peak Power ns pulsed Lasers

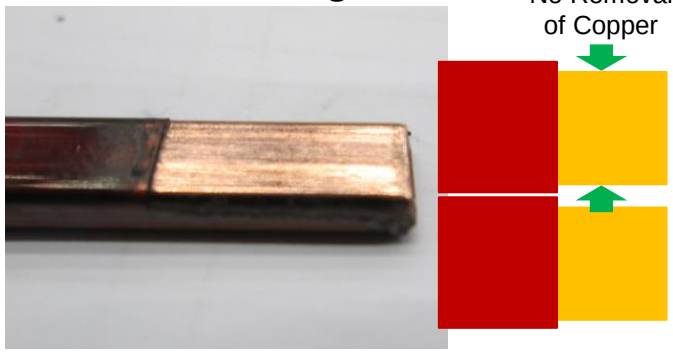
Insufficient Decoating

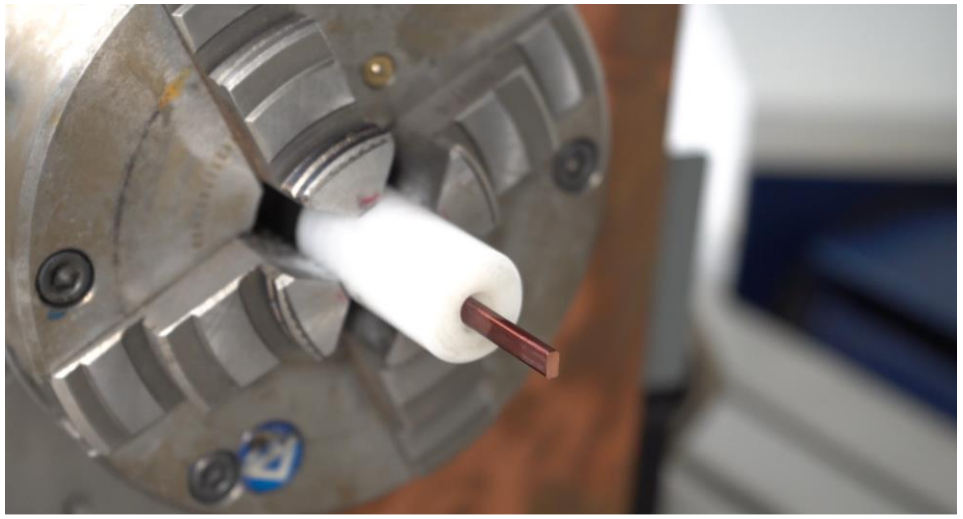
Remains of coating- or bonding materials lead to burnings and bad welding quality.

Mechanical Decoating



Laser decoating





No loss of copper material, Selective processing

No remains of coating/bonding materials

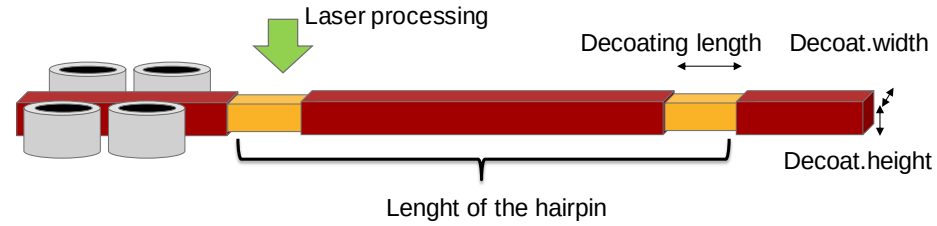
Cycle times <0.5 s

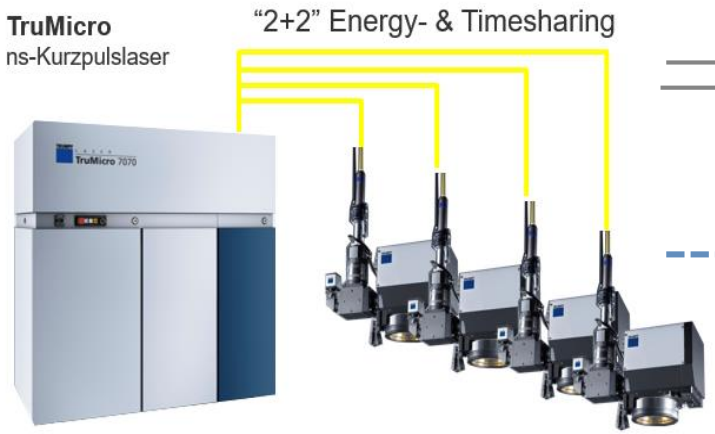
TRUMPF

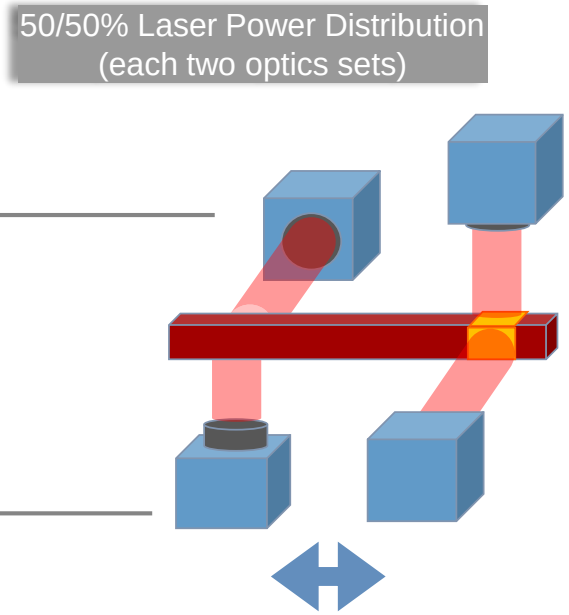
Proposed Optical Setup for Hairpin Decoating

Scalable to single or multi-wire specifications through flexible beam management

Most versatile solution





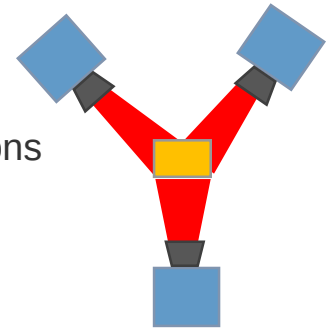


- Fastest processing times
- Works with all coating types (comparable processing times)
- For large wire cross sections

Tailored solutions

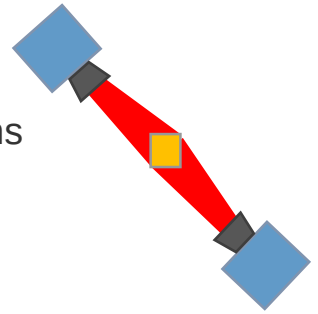
Medium
Wire cross sections

or moderate
Cycle times



Small
Wire cross sections

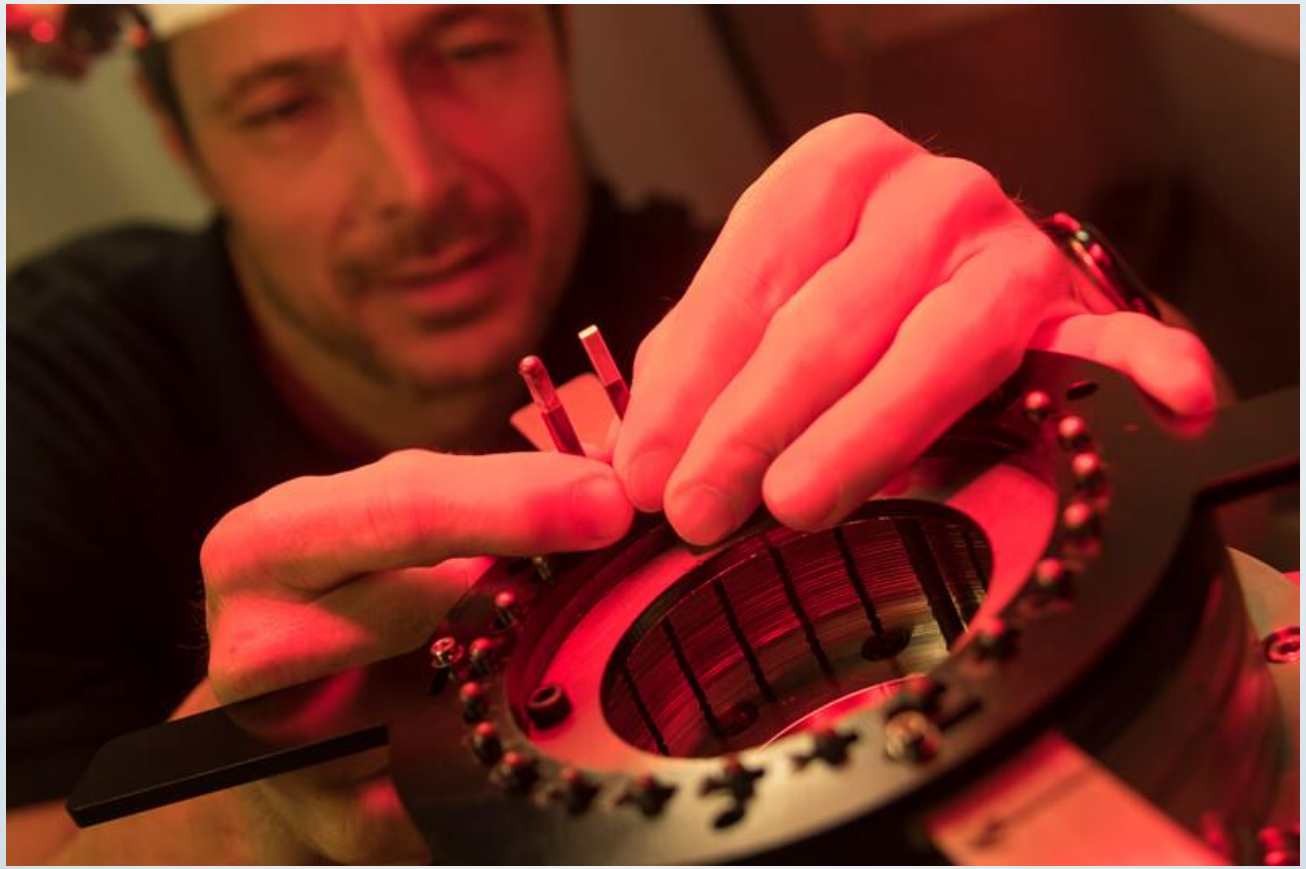
or long
Cycle times



Key feature: high pulse energy enables high fill factor & spot size resulting in high speeds

CONTACTING TECHNOLOGY
HAIRPIN DECOATING & WELDING

HAIRPIN WELDING

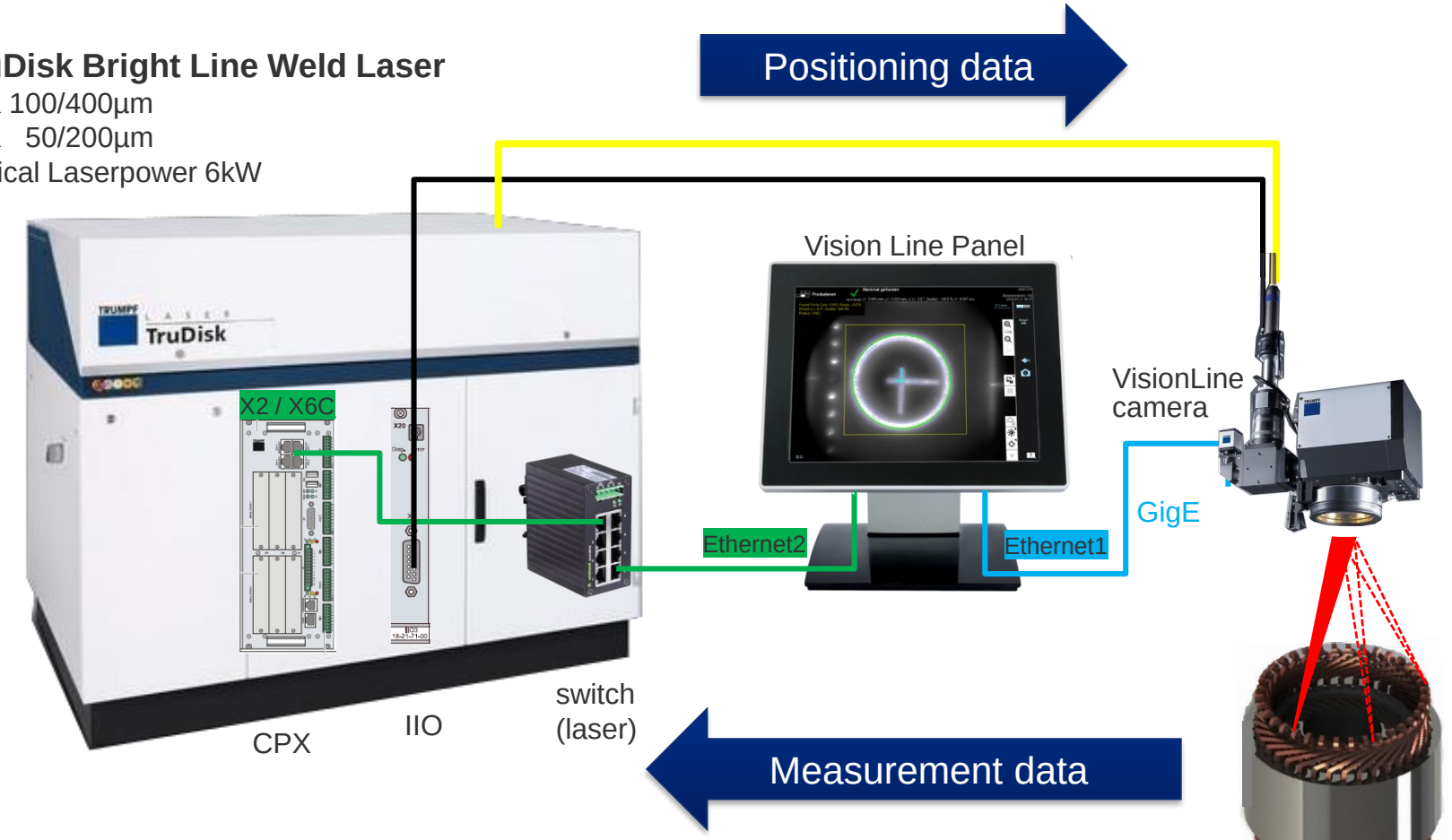


Solution Bundle for Hairpin Laser welding
State of the Art Process Control

Welding time per weld
25 to 200ms
(depending on geometry)

Welding time as function of weld volume

TruDisk Bright Line Weld Laser
LLK 100/400µm
LLK 50/200µm
Typical Laserpower 6kW



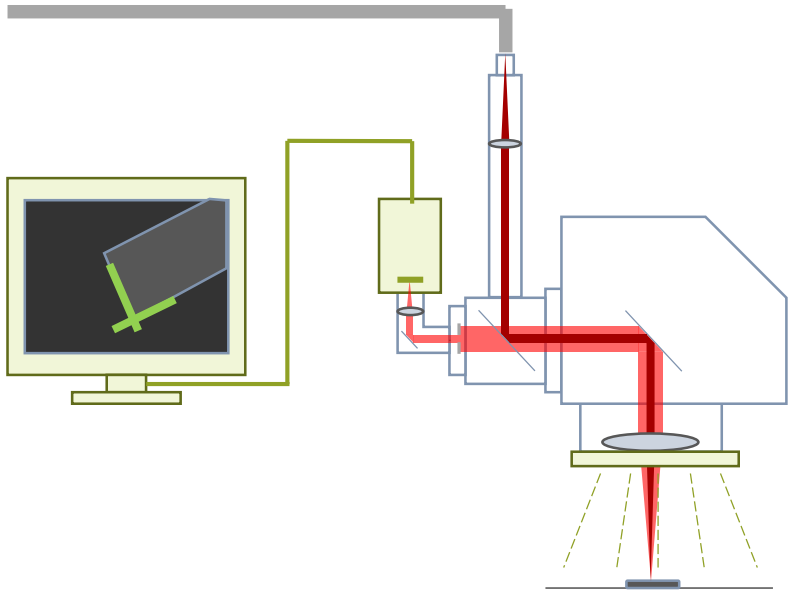
- Closed Loop Real Time processing based upon 100% position measurement
- Freely programmable (weld shape)
- Ready to run, Easy to integrate
- Beam Management allows to use one lasersource for multiple workstations/optics

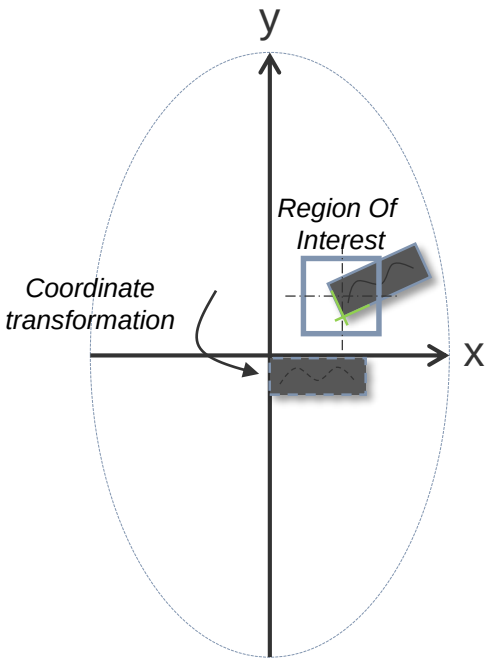
https://www.youtube.com/watch?v=xwtlLkxYei4

CONTACTING TECHNOLOGY
HAIRPIN DECOATING & WELDING

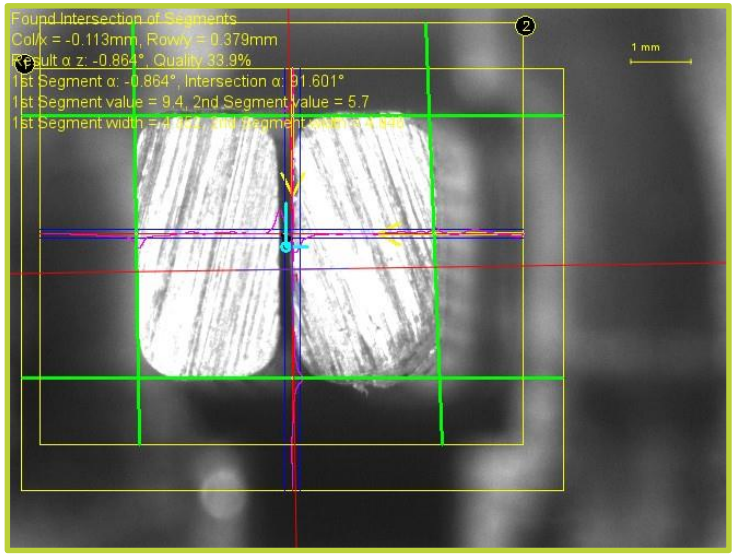
INTEGRATED SENSOR TECHNOLOGY FOR HAIRPIN WELDING

An important use case is position correction





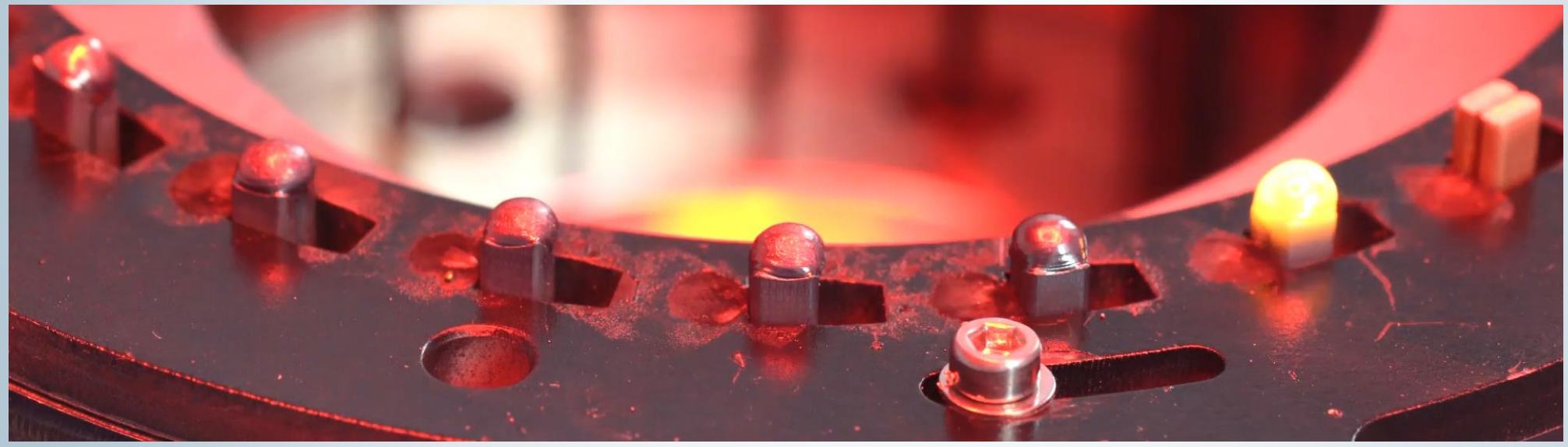
Working field of the PFO



High process reliability → Visualization of welding points and correction of eventual error displacement.
Intuitive operation → Intuitive user interface and predefined pattern library. Easy to integrate.
Tailor-made solutions (VisionLine Project) → VisionLine can also be easily enhanced for complex image processing tasks.

CONTACTING TECHNOLOGY
HAIRPIN DECOATING & WELDING

HAIRPIN WELDING, Bright Line Weld Multi-Spot welding

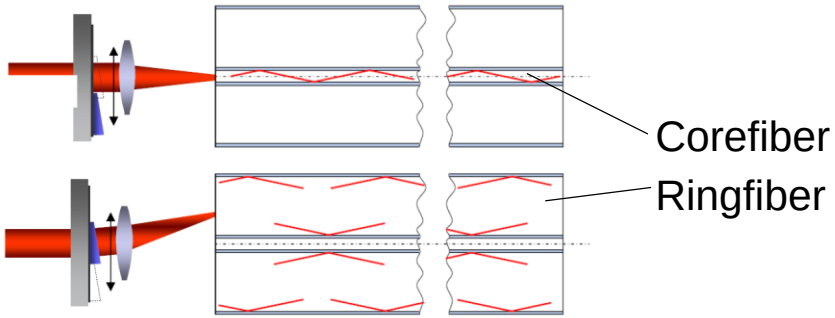


Bright Line Weld - solution for spatter reduction using IR for copper welding

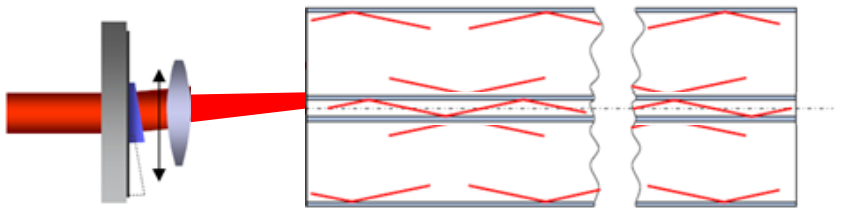
BrightLine Weld is based on the TRUMPF technology of the 2in1-fiber.

Attributes:

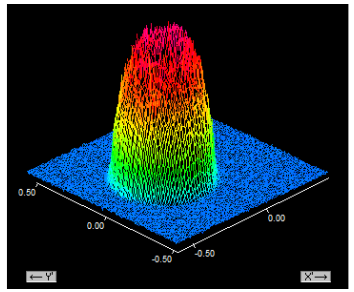
- **Patented** waveguide lay-out of **TRUMPF *2in1*-fiber**
- Full flexible superposition of two beams into the process zone
  ➔ Optimum applicable to the welding task
- Basic principle optical wedge 2in1-fiber:



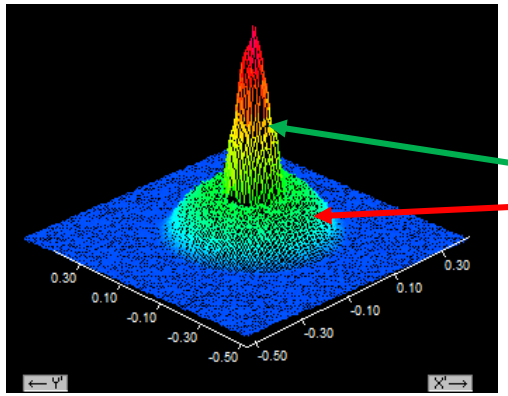
- Optical wedge Bright Line Weld



Comparison: SingleSpot



Bright Line Weld



100% Laserpower

0 100%

400µm
100µm

200µm
50µm

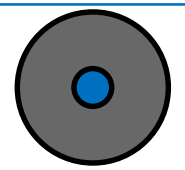
Two alternative versions for Hairpin Welding

Workpiece

New welding parameter: Power distribution

Definition of power distribution

m_{Pav} = Core : Ring [%]



Patent protected

Bright Line Weld Technologies for Hairpin Welding

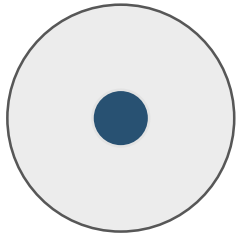
TruDisk and option BrightLine Weld

Optics: BEO, PFO

2in1-fiber

Fiber diameters

50µm/200µm



100µm/400µm

Typical Power for Hairpin Welding

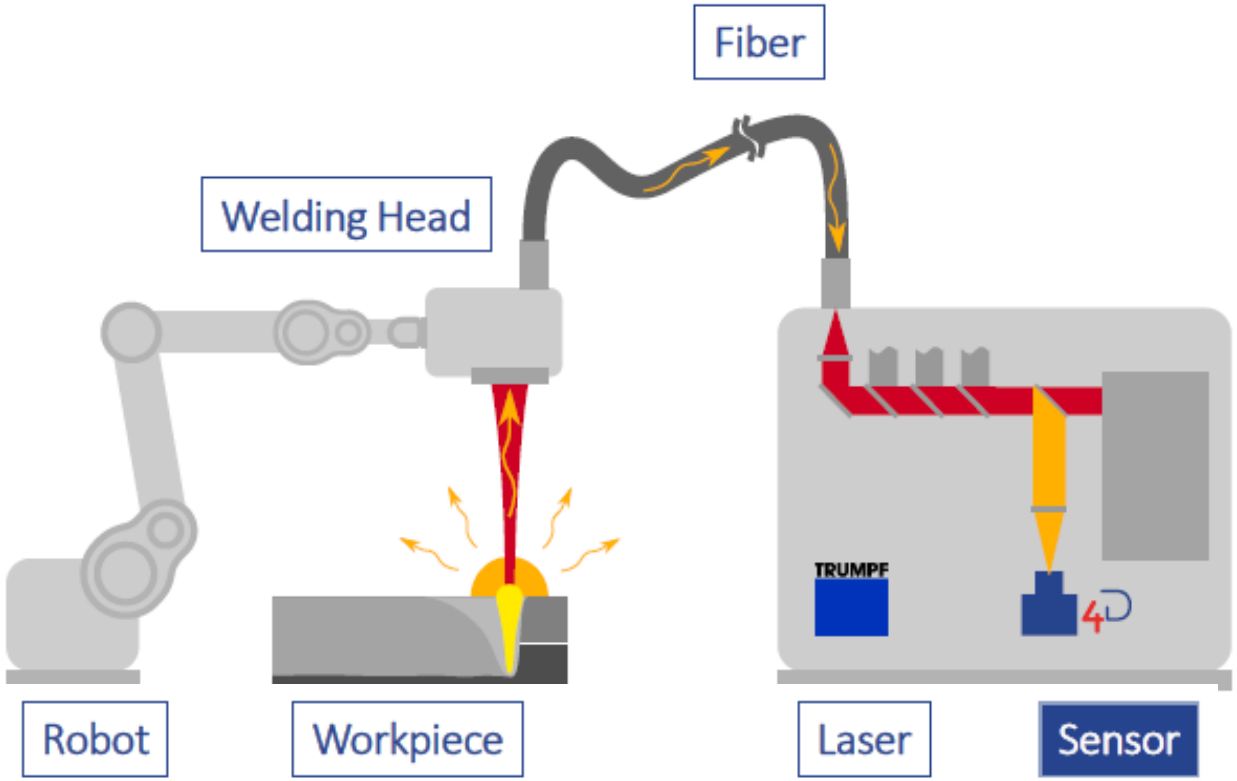
3kW, 4kW, 5kW, 6kW

4kW, 5kW, 6kW, 8kW

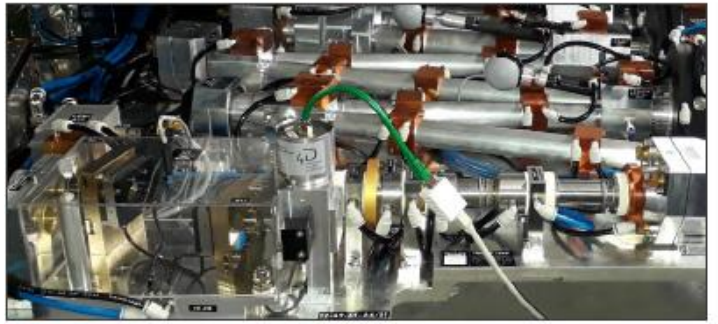
50µm Lasers available from 1 to 6kW
100µm Lasers available from 1 to 8kW

TRUMPF

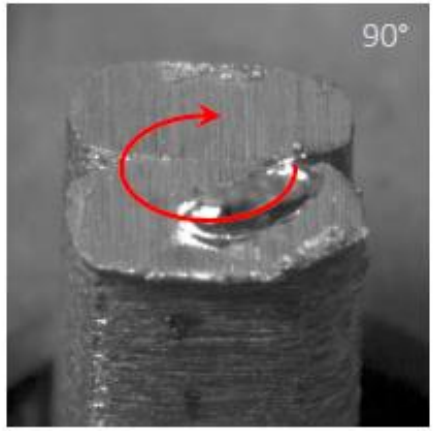
Quality Monitoring – Example 4D Weldwatcher

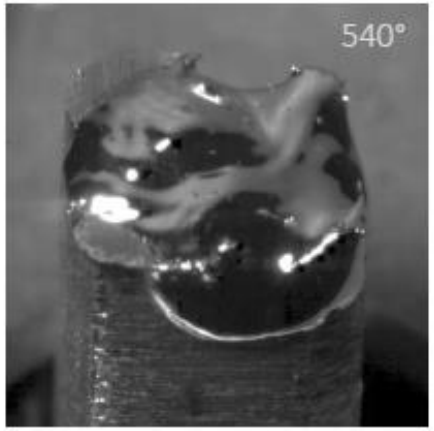


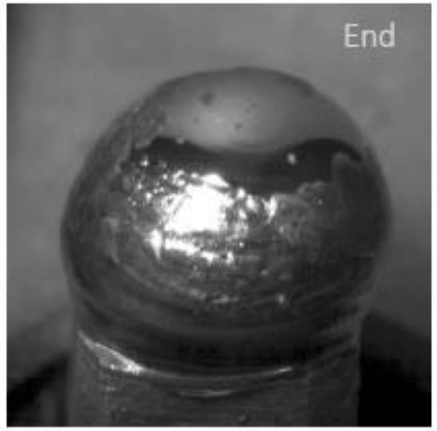
- Integration of the sensor into the laser source via Trumpf adapter
- Installation in less then 30 min
- Monitoring of all optical paths
- Quick trials/tests possible

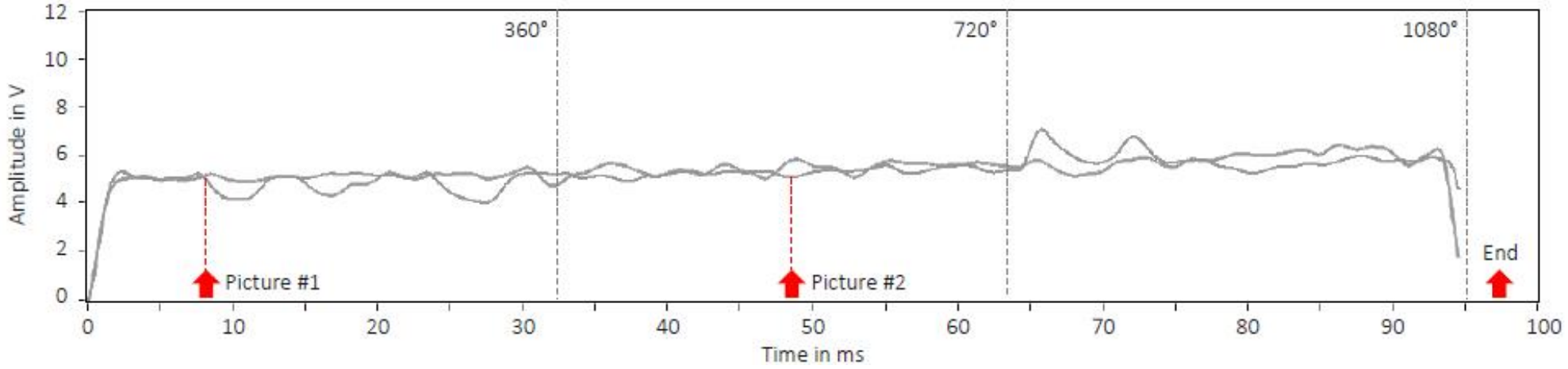


Hairpin Welding – References

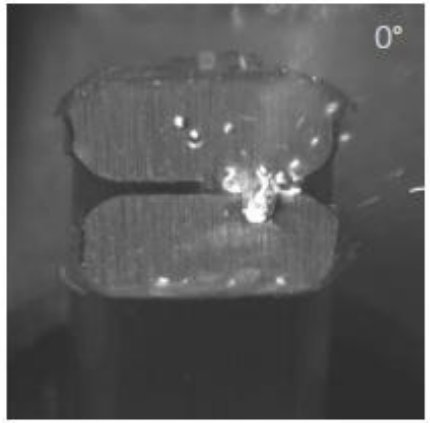


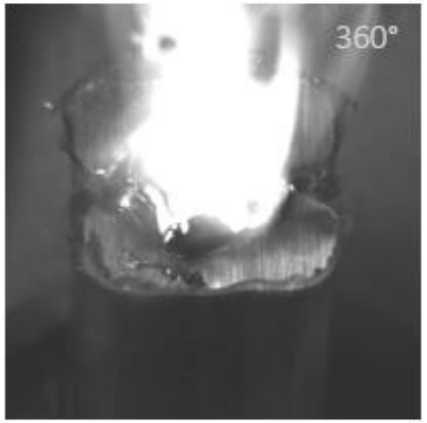


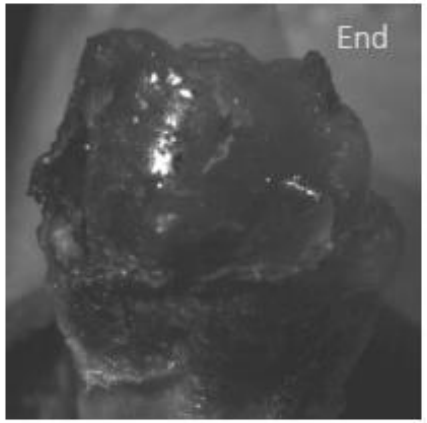


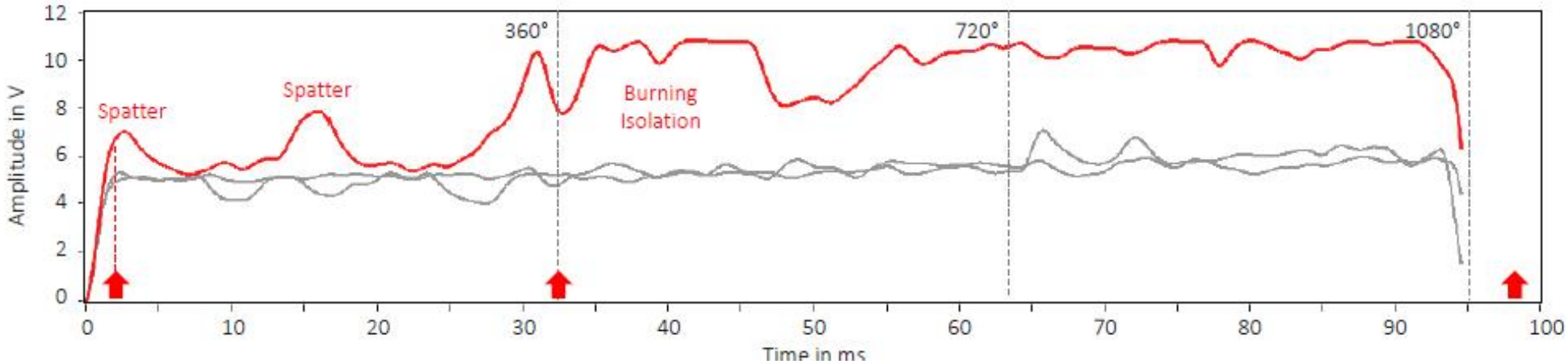


Hairpin Welding – Remaining Insulating Coating-Bonding

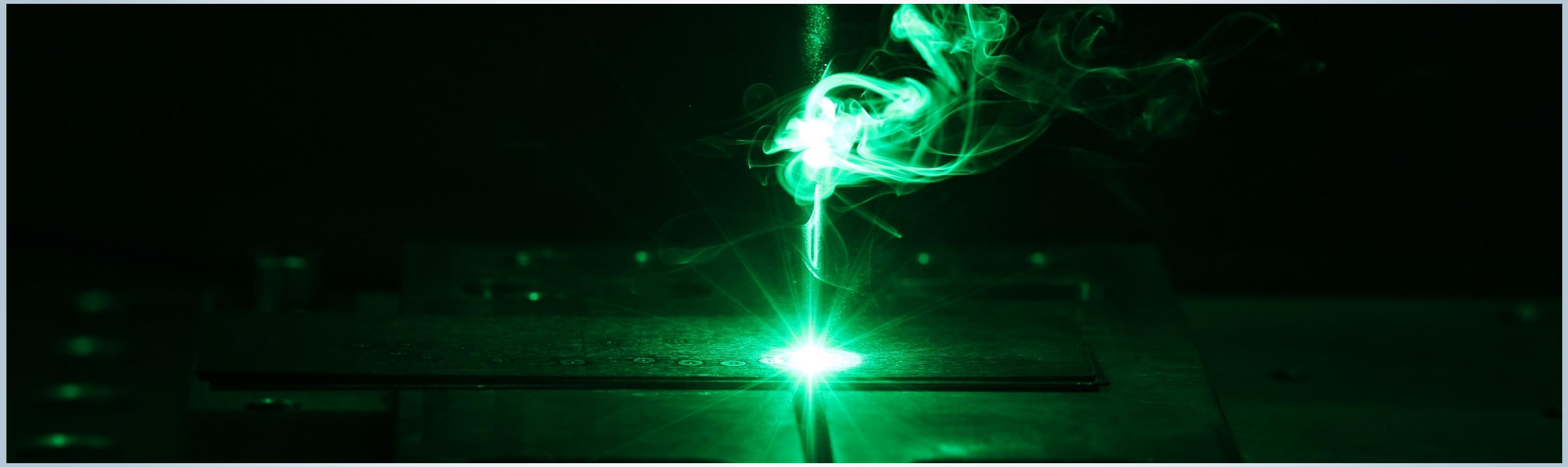




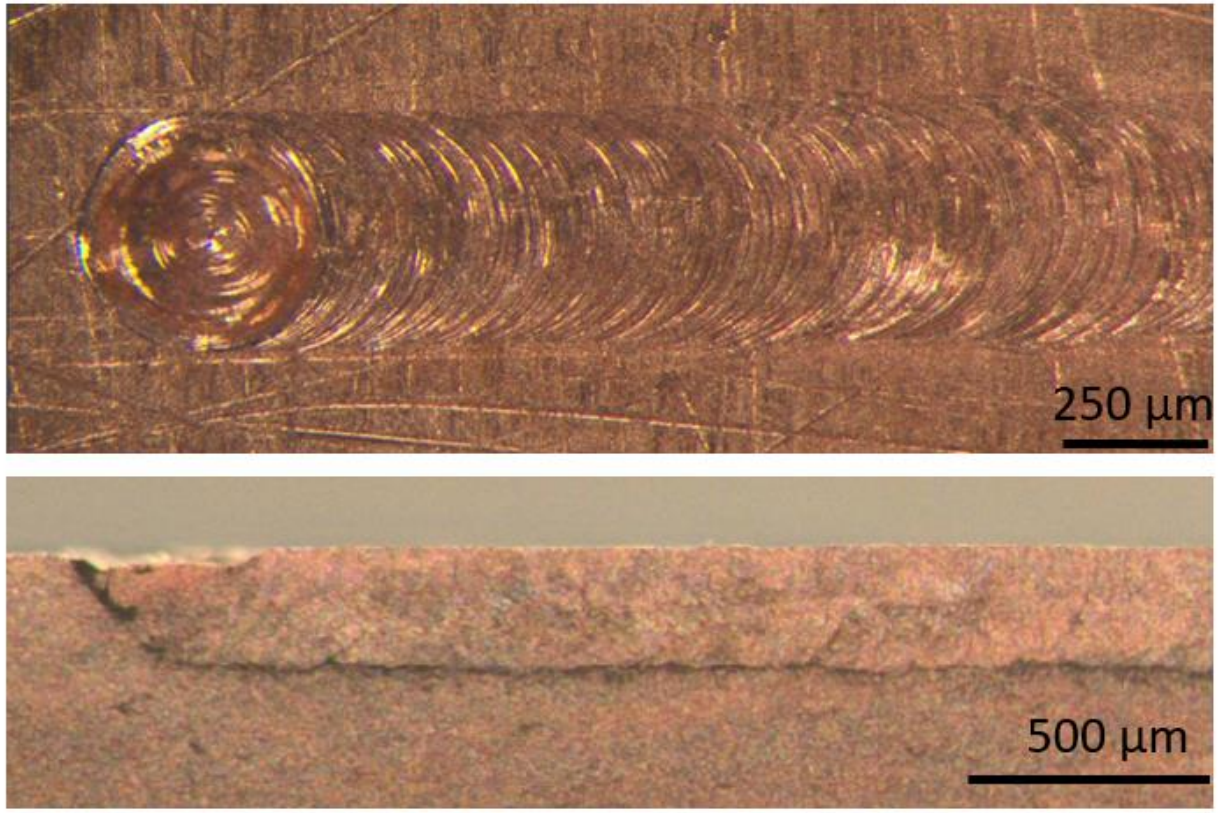




TruDisk with Green Wavelength (cw)
Processing on the green side of light



Hairpin Welding – Remaining Insulating Coating-Bonding



https://www.youtube.com/watch?v=aUsWFSOf95Y

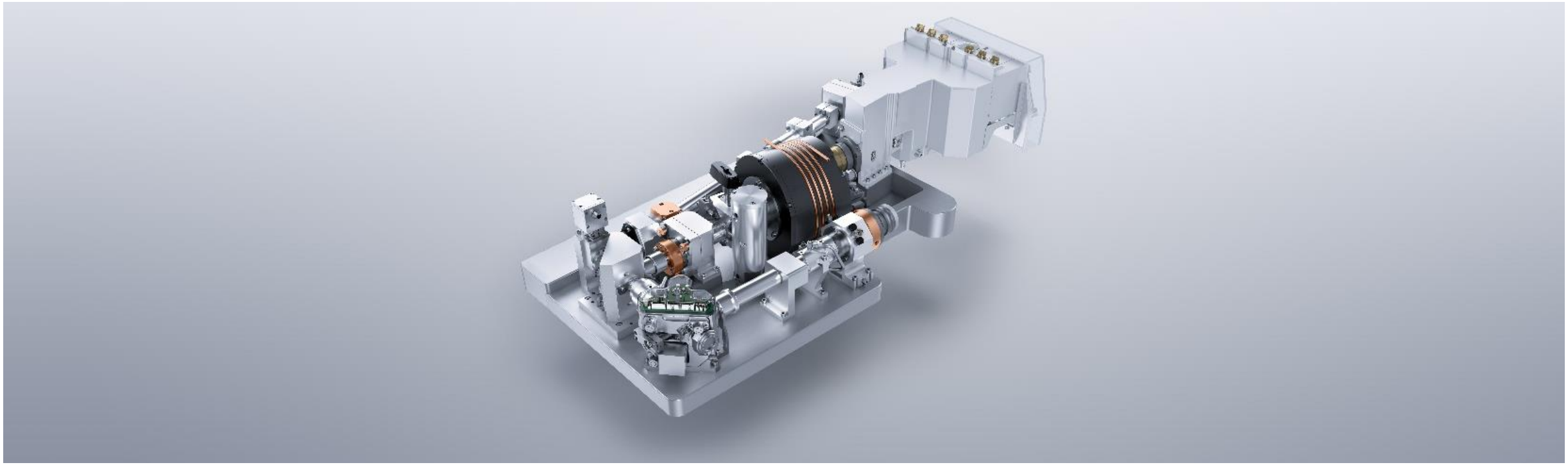
- Ideal tool for heat conduction welding of copper
- Foil or sheet thickness of up to about 2 mm
- Stable and reproducible process
- No spatter formation
- Highest weld seam quality
- High productivity due to high feed rates
- No beam oscillation required
- Constant weld depth

Trumpf at a glance: E-cars made by Laser

Partner for your solution

- Worldwide service
- Optics
- Trainings
- Lasers
- Consulting
- Application supports
- Machine tools
- Software

- Monitoring systems
- Quality systems
- Products innovation
- Integrated solutions



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