TRUMPF laserlassen

Gert van Wakeren | Sales Engineer Laser Technology

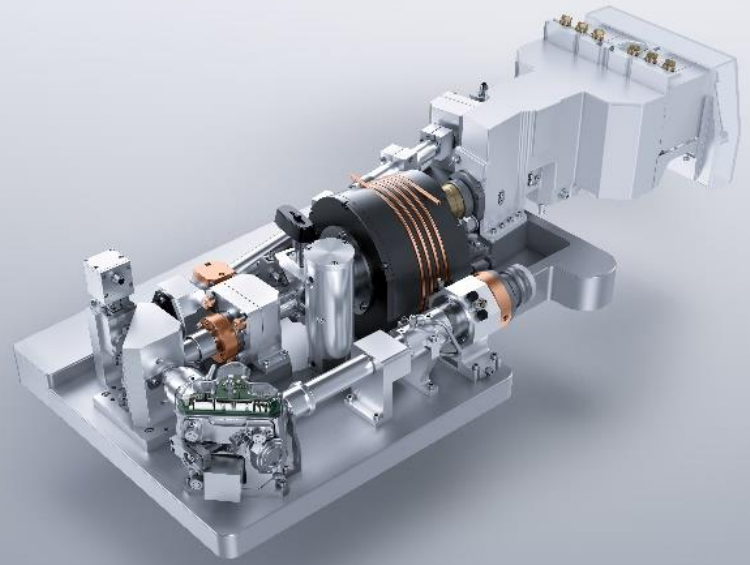
TRUMPF

Agenda:

- Wat is laser?
- Principes laserlassen
- Voordelen laserlassen
- Voorwaarden laserlassen
- Toepassingen laserlassen
- Conclusies

PAUZE

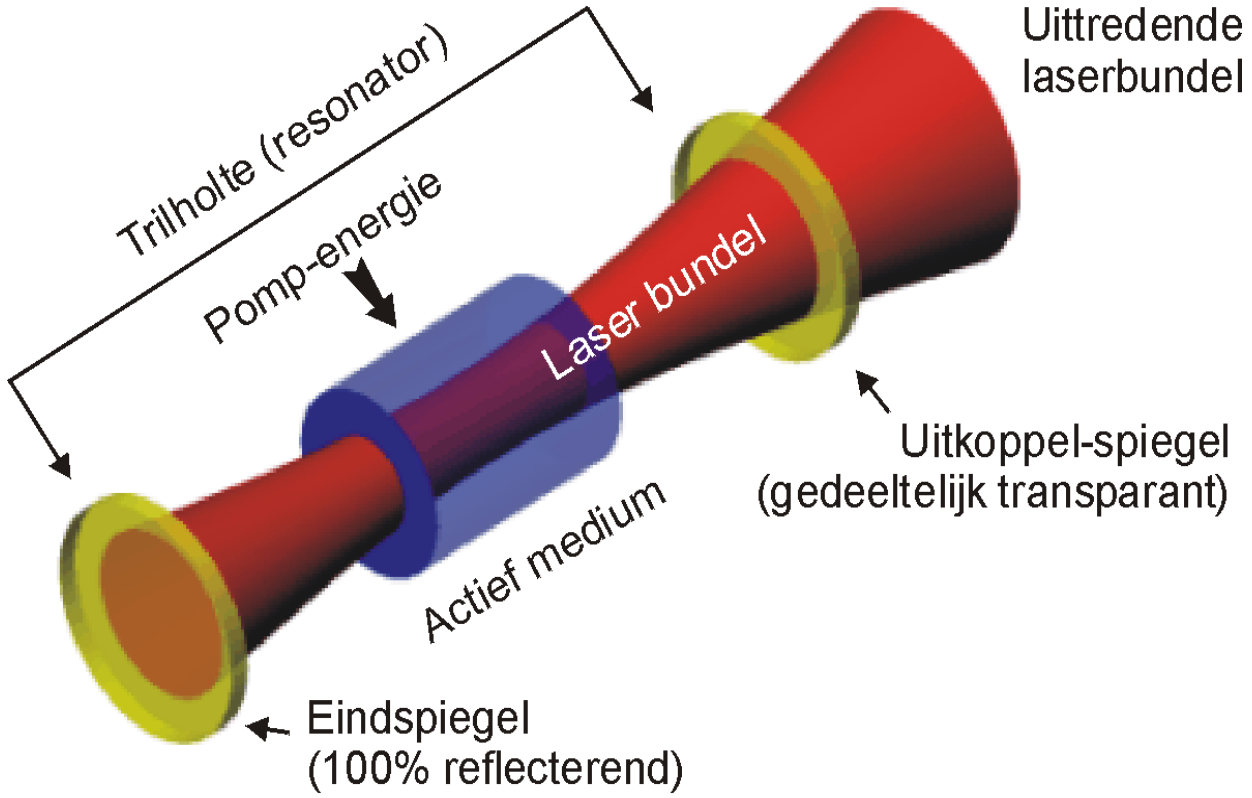
- Inkijk 3D metaalprinten



Wat is laser?

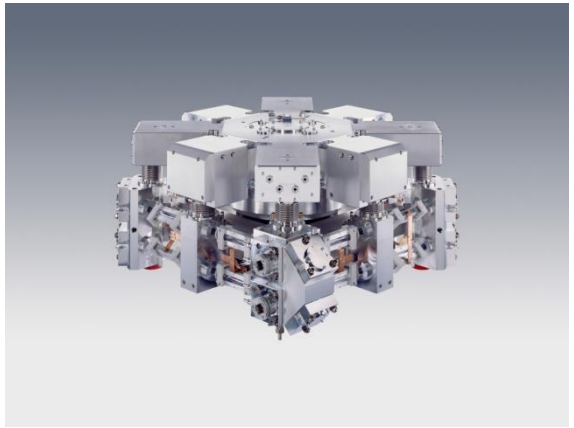
Opbouw laserbron

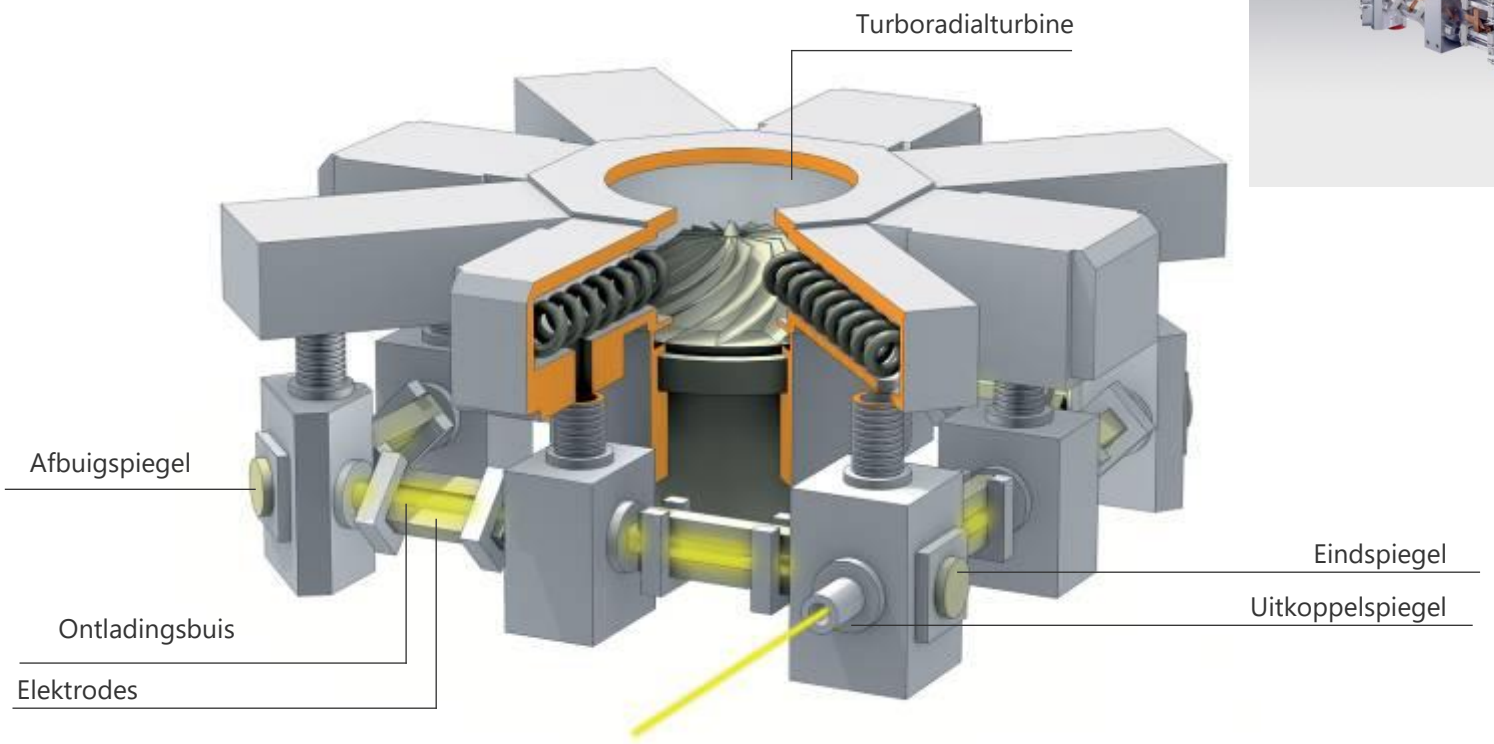
Werkingsprincipe



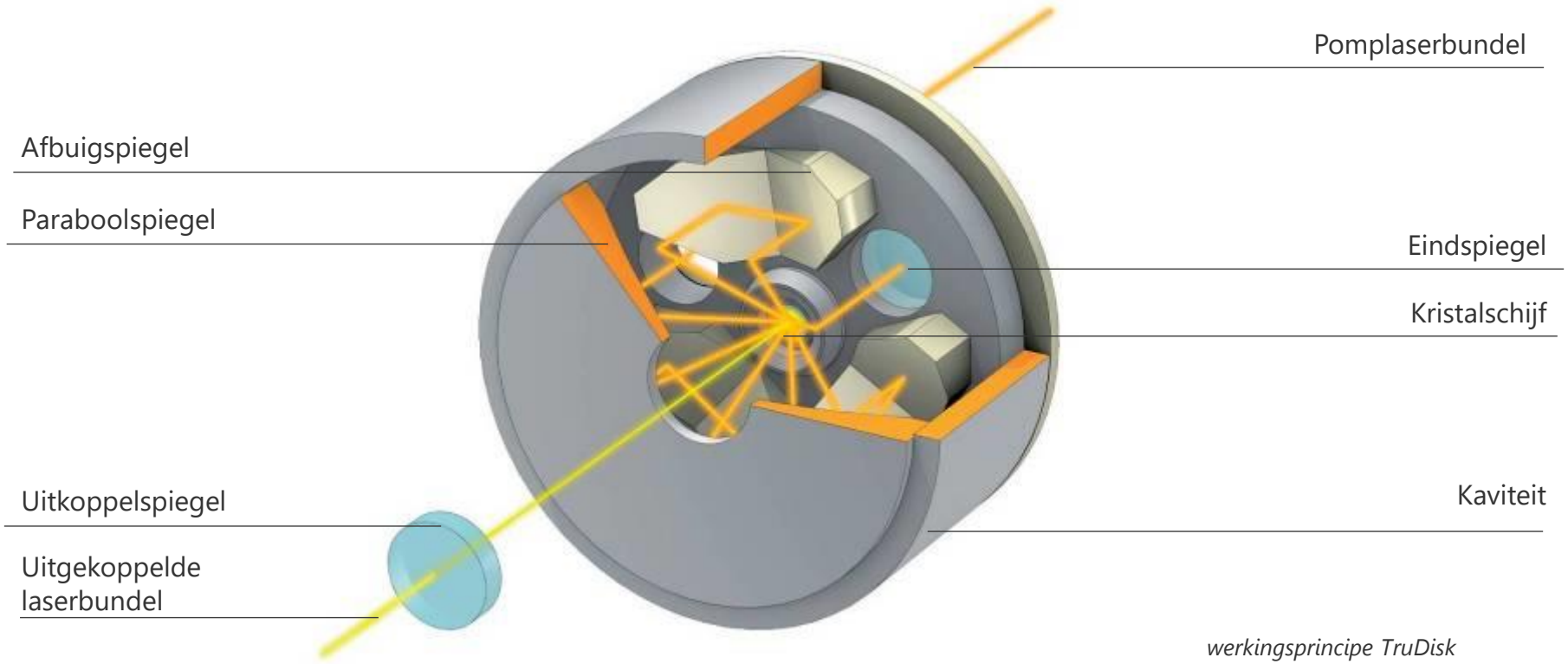
Gaslaser – TruFlow CO_2 laser

Werkingsprincipe



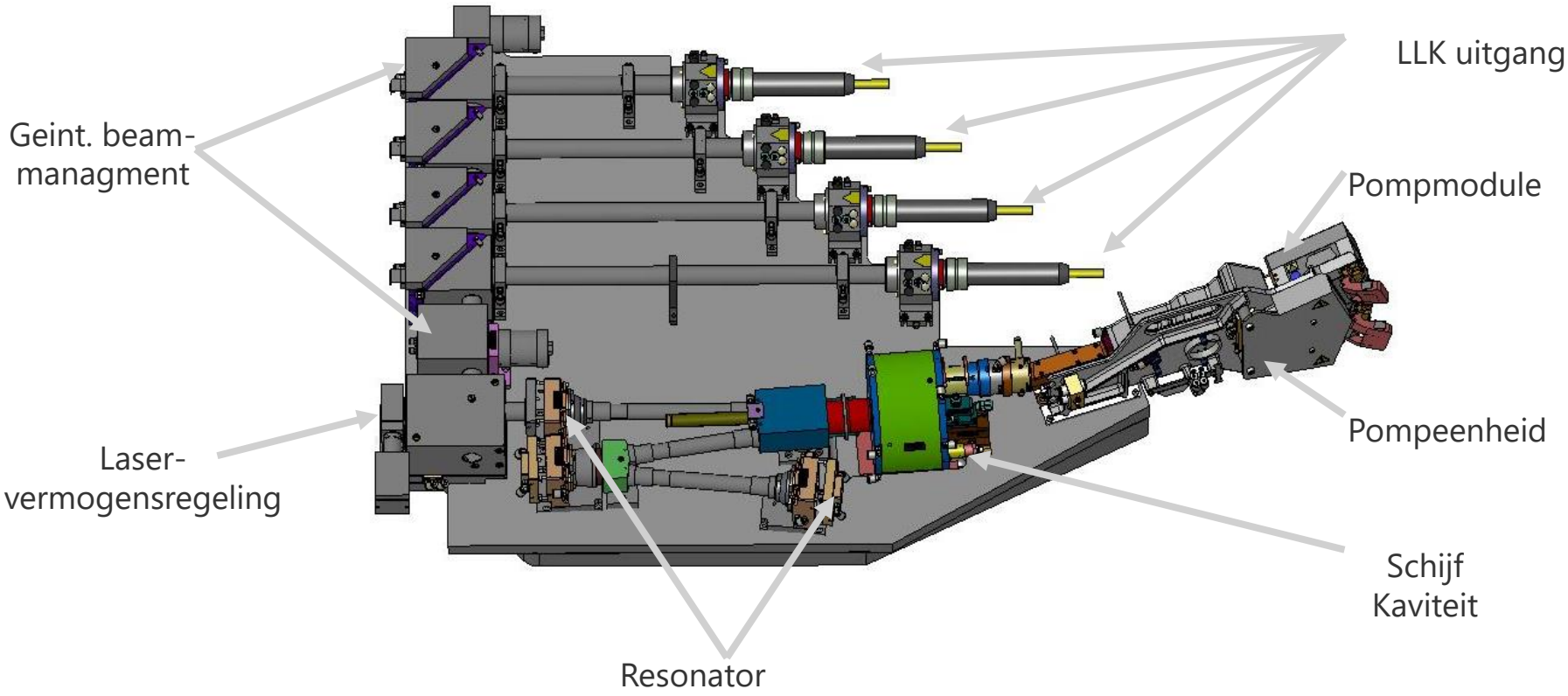


Vaste Stof Laser (VSL): TruDisk

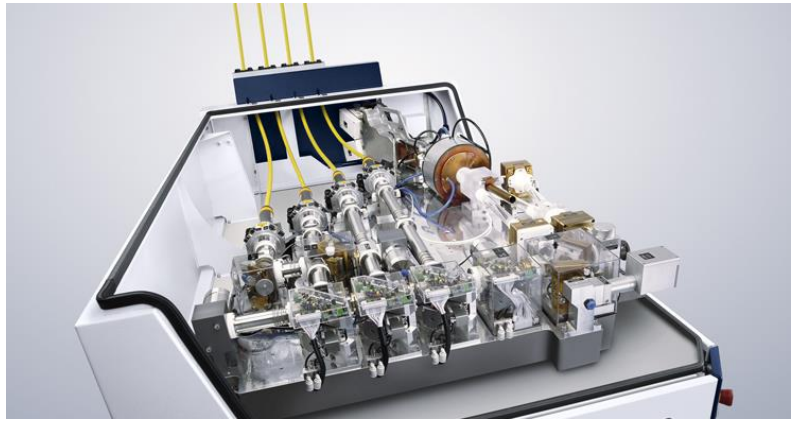


werkingsprincipe TruDisk

Opbouw van een disklaser



Vaste-stof lasertechnologie van TRUMPF



TruDisk

TruMicro

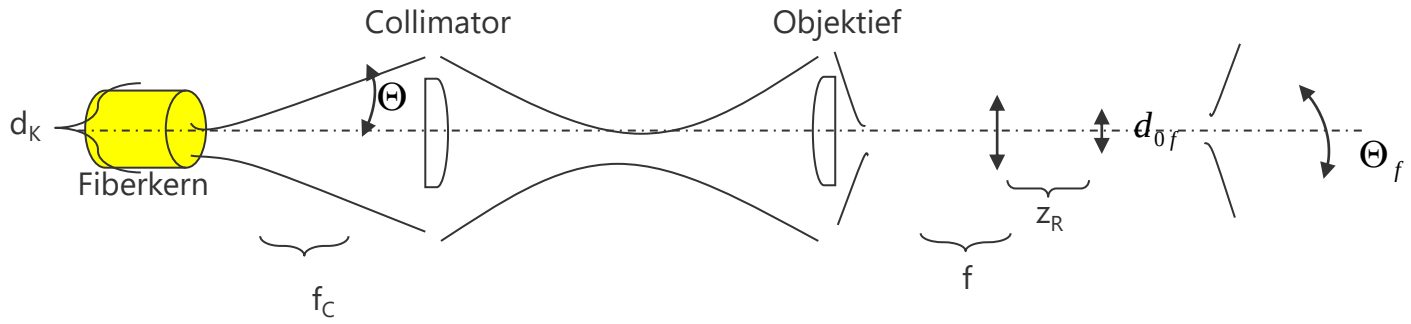
TruFiber

TruPulse

TruMark

TruDiode

Van glasvezel naar laserspot: principe

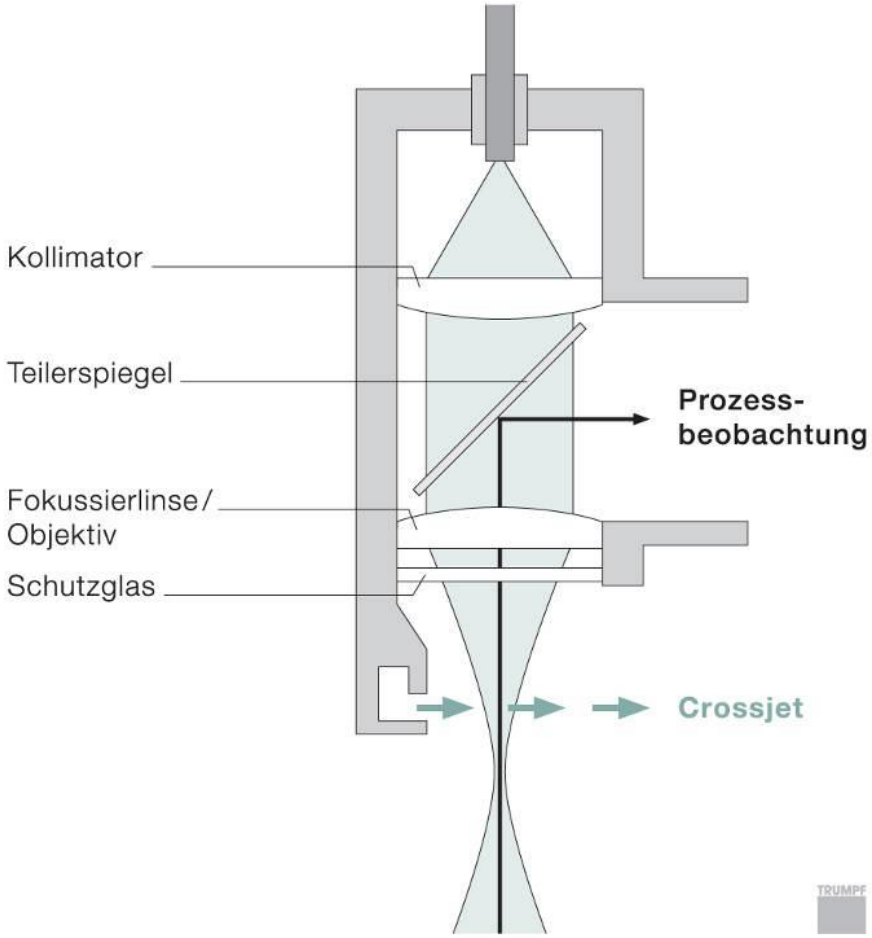


- Fiberdiameter wordt afgebeeld op plaatmateriaal
- Focusdiameter: $d_{0f} = d_K \underbrace{\frac{f}{f_C}}_{=M}$

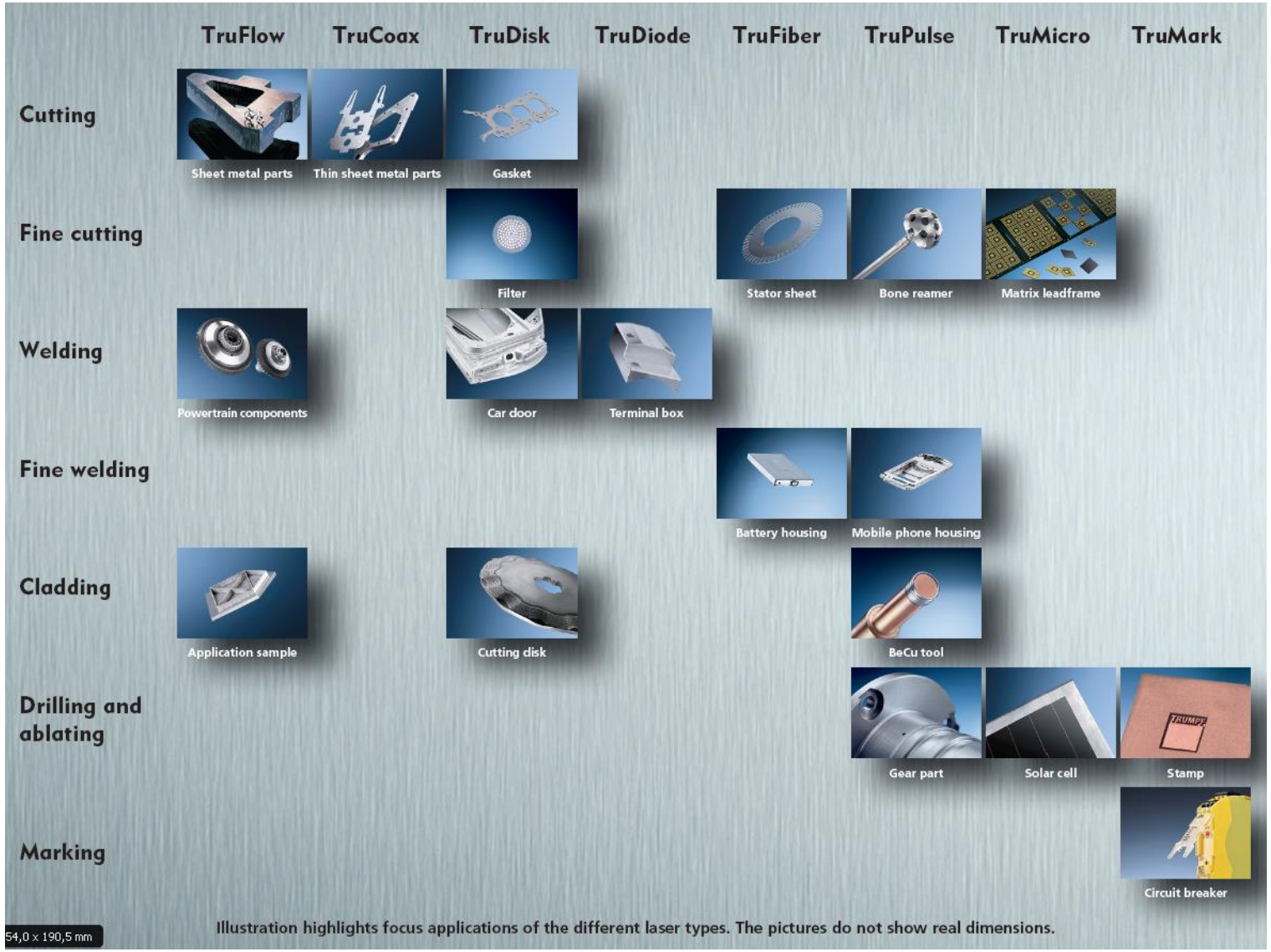
Legenda:

d_K	Fiberkerndiameter
f_C	Collimatorbrandpuntsafst.
f	Objectiefbrandpuntsafst.
d_{0f}	Focusdiameter
M	Afbeeldingsverhouding

Opbouw TRUMPF laserbewerkingskop BEO D70



Power of choice



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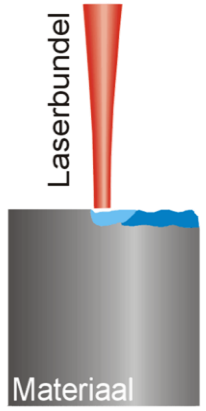
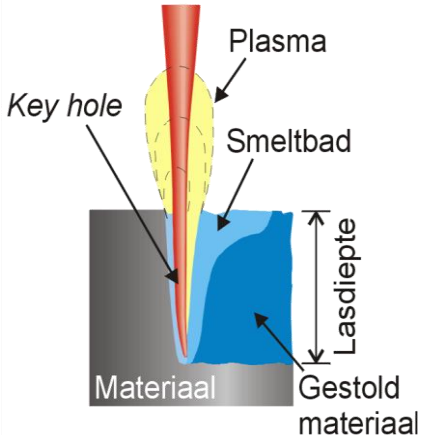
Principes laserlassen

Principe laserlassen

Geleidingslassen

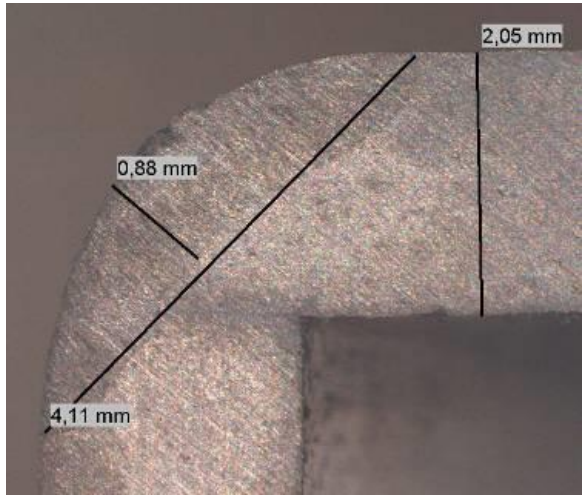


Key hole-, of dieplassen

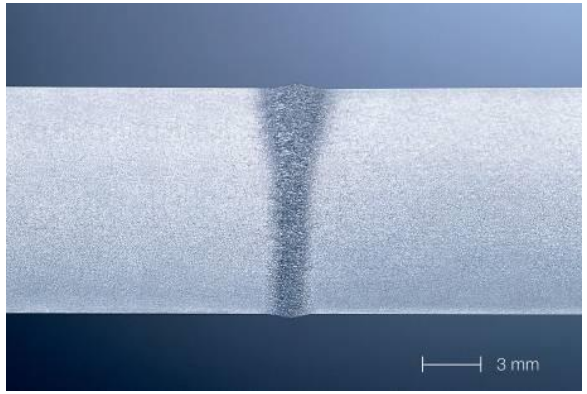


(Warmte)geleidingslassen

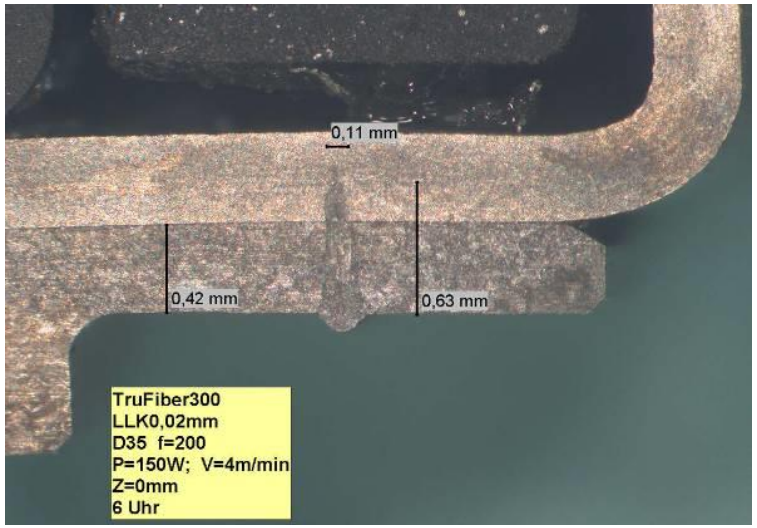
$I < 10^8$ W/m^2

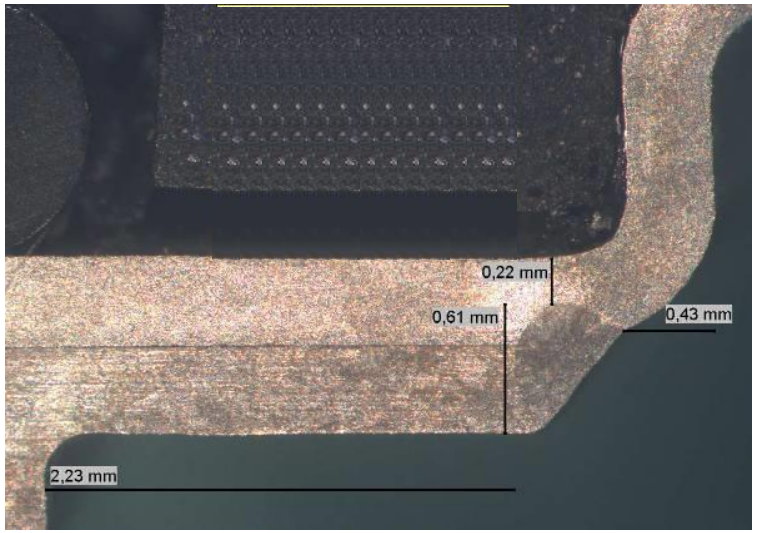


- Keyhole lassen
  - $I > 10^8$ W/m^2



Verschil inzetbereik TruPulse und TruFiber





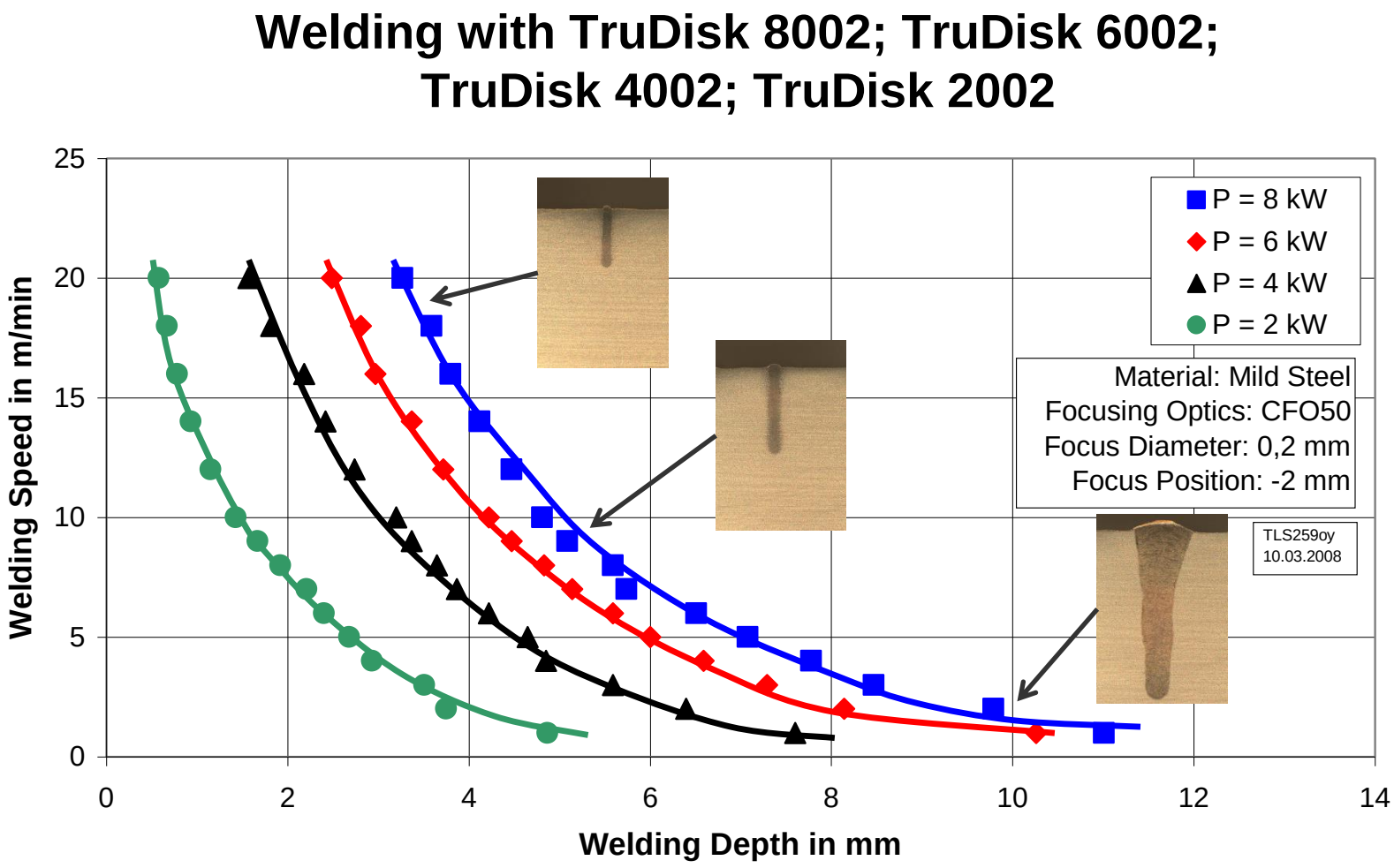
Case: Laserlassen sensorbehuizing

TruFiber 300
- Überlappnaht
- d_{of} = 35 µm
-150 W cw
→ 4 m/min, geringer Verbindungsquerschnitt

TruPulse 203
- Kehlnaht
- d_{of} = 800 µm
- 700 W, 3 ms, 70 Hz
→ 1 m/min, großer Verbindungsquerschnitt

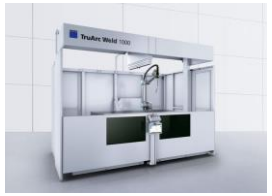
→ Laserauswahl erfolgt nach Abwägung Geschwindigkeit vs. Festigkeit

Laserlascurve



Overview of the TRUMPF welding portfolio

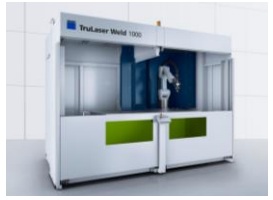
Laser and arc welding solutions



TruArc Weld 1000

Arc welding

- **Easy entry into fully automated arc welding with extremely simple operation and programming**



TruLaser Weld 1000

Laser welding

- **Easy entry into fully automated laser welding with extremely simple operation and programming**

TruLaser Station 7000

Laser welding

- **Cost-efficient laser welding system with smallest footprint**

TruLaser Cell 3000

Laser cutting,
Laser welding
LMD

- **Productive and universally applicable, also for individual customer solutions and automation**

TruLaser Cell 5030

Laser cutting
Basics in Laser welding

- **Low-cost entry into flexible laser processing, specialized for small batch sizes due to the low hourly machine rate**

TruLaser Weld 5000

Laser welding

- **Specialized laser welding system with best accessibility for applications with best seam quality**

TruLaser Cell 7040

Laser cutting
Laser welding
LMD

- **Highly flexible laser processing machine with extensive functions and excellent precision even with high dynamics**

Voordelen laserlassen

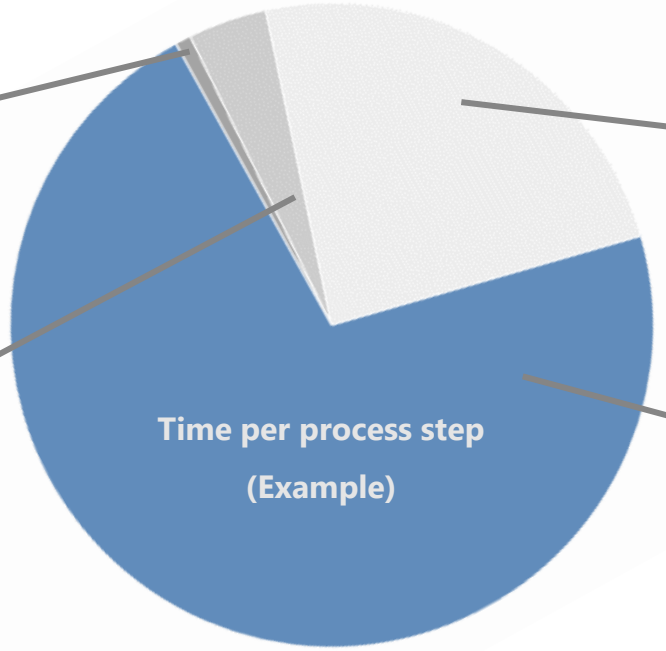
Typical sheet metal production

This is how you loose time

You spend some seconds cutting, a few minutes bending, several minutes welding and about half an hour grinding.

Cutting

Bending



Welding

Grinding

➔ LASER WELDING WILL BRING YOU MANY BENEFITS.

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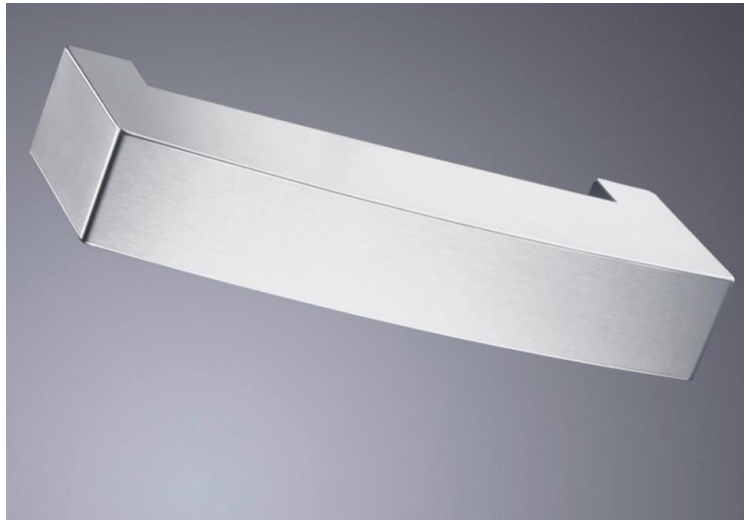
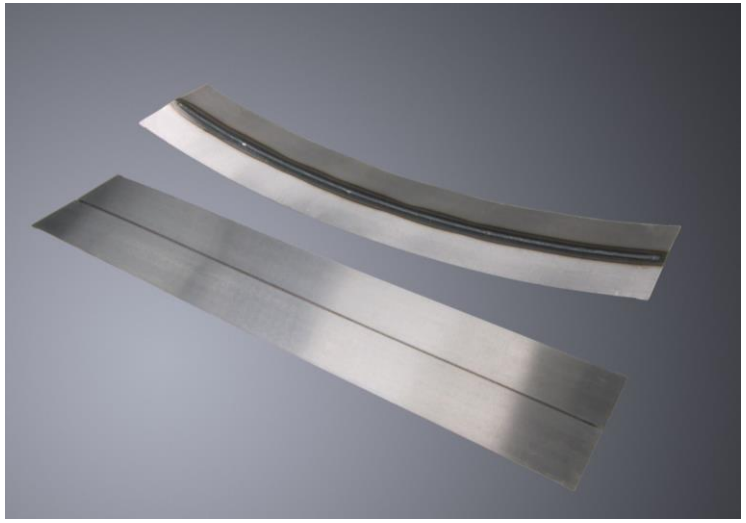
Laser welding brings: high part quality...



Visible seams of the highest optical quality



Minimal component distortion

High-strength seams

➔ **REDUCED COMPONENT COSTS**

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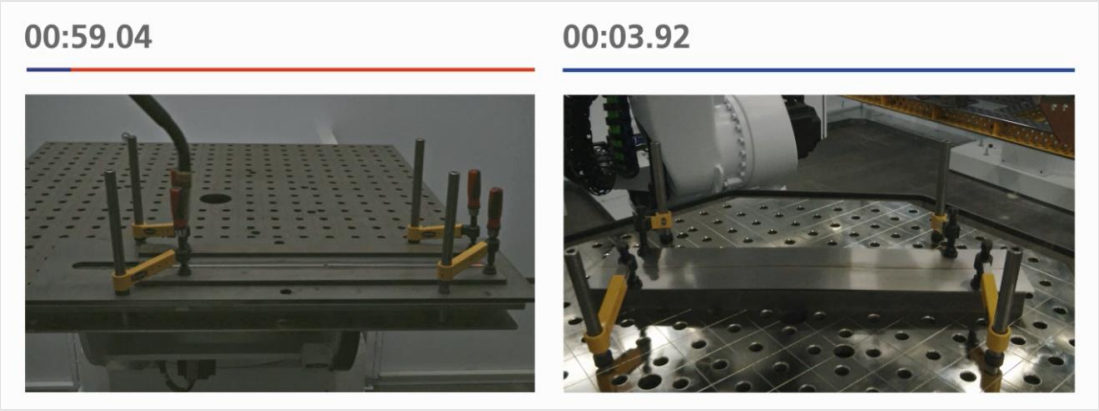
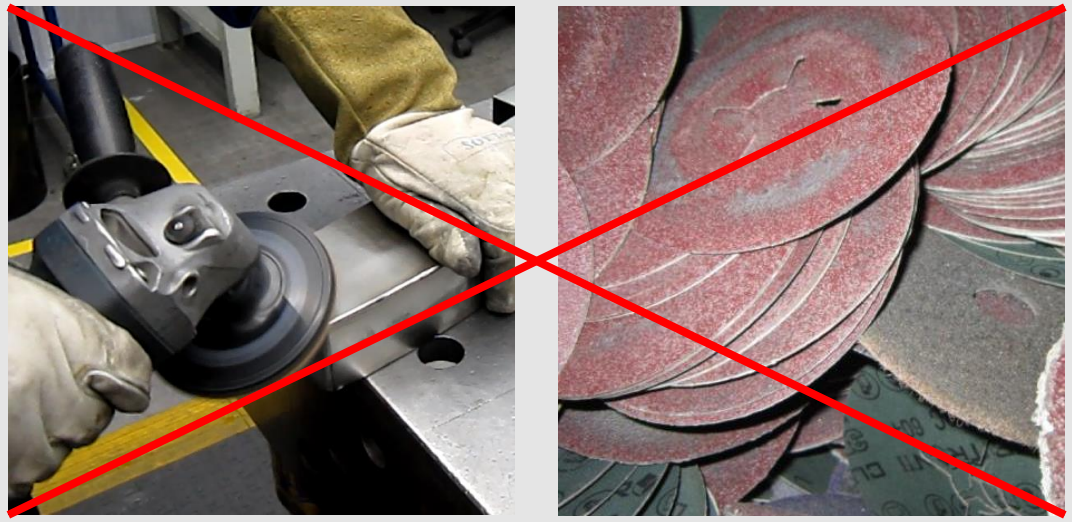
…high productivity…

Time comparison in seconds

MAG **vs.** **Laser**



High process speed when welding



Significantly reduced reworking

➔ REDUCED COMPONENT COSTS

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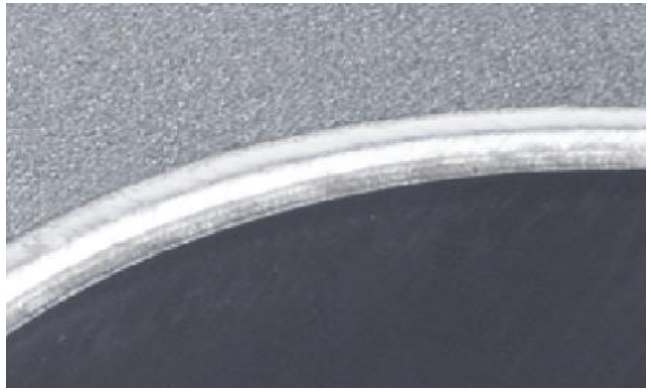
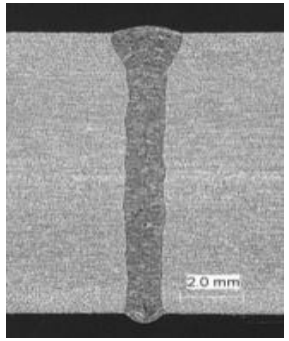
… and a high degree of flexibility

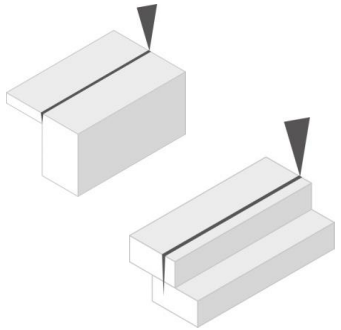
Different welding processes in one machine, new designs



Deep welding:

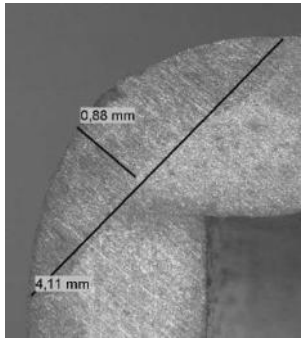
- Highest productivity
- More designs possible

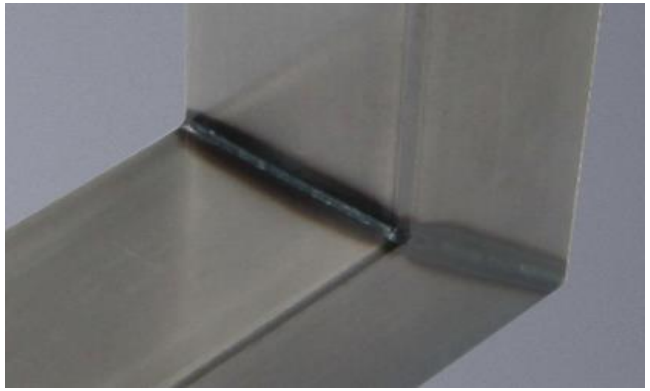




Heat conduction welding:

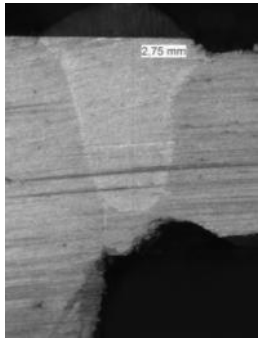
- Highes optical seam quality
- Radius without welding





FusionLine:

- Bridging of gaps
- Welding with filler material



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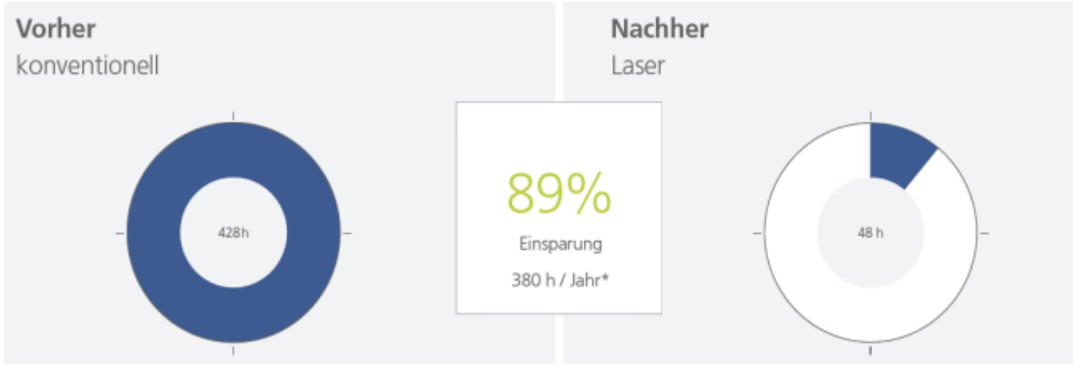
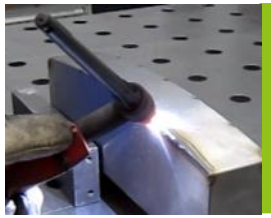
Laser welding in sheet metal processing

For which components is laser welding a good idea?

Laser welding pays off
- since **significant time savings** can be achieved





The longer the **welding time** and/or the longer the **reworking**, the sooner laser welding pays for itself.

Welding time is usually long for
- components that have a high proportion of welding seams

Reworking is usually long for components with
- special design requirements
- high functional requirements (no distortion, low tolerances, tightness)

Voorwaarden laserlassen

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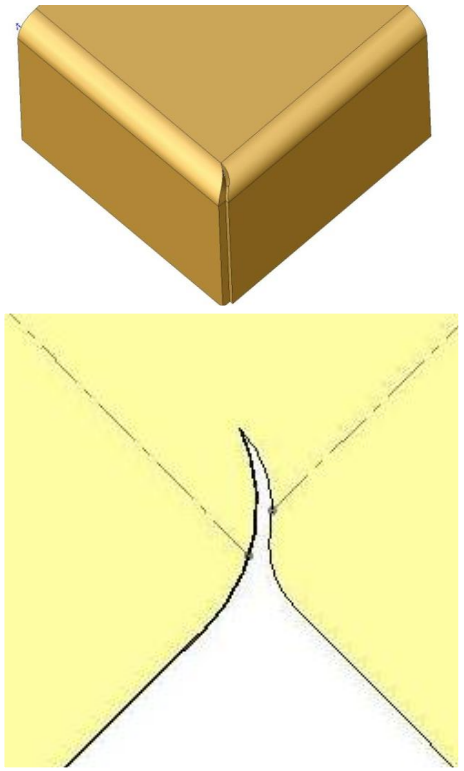
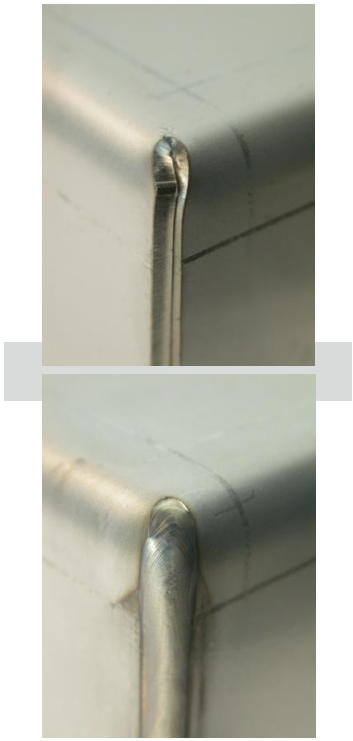
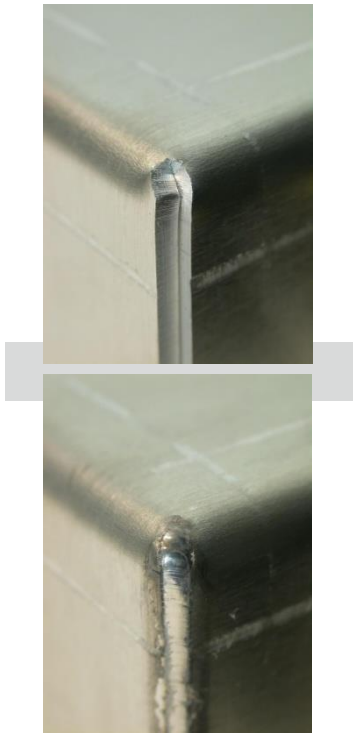
Vertrekpunt laserlassen: optimalisatie vanuit de procesketen

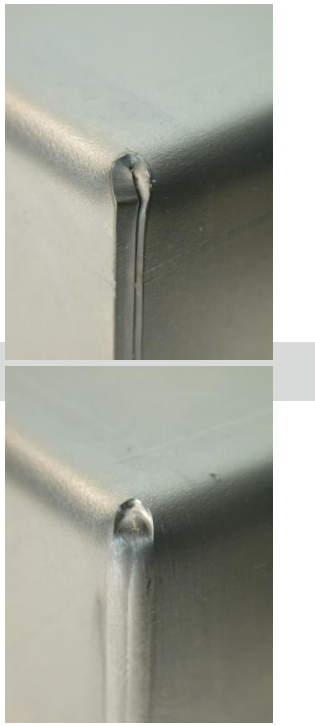




VA 1,5mm



S235 1,5mm



AlMg3 1,5mm

Opspantechniek niet vergeten

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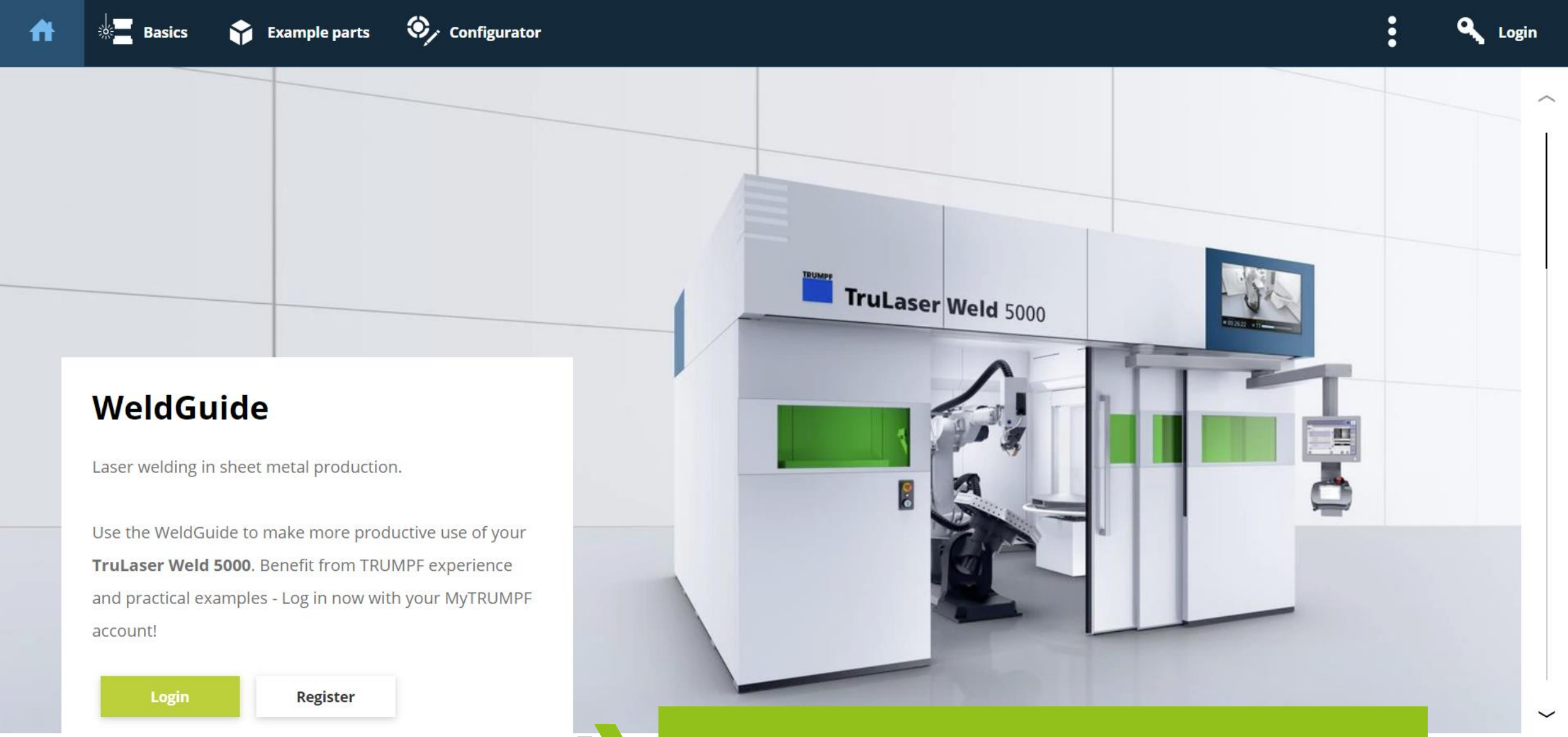

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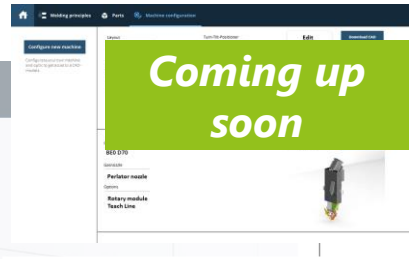
WeldGuide

Highlight Features

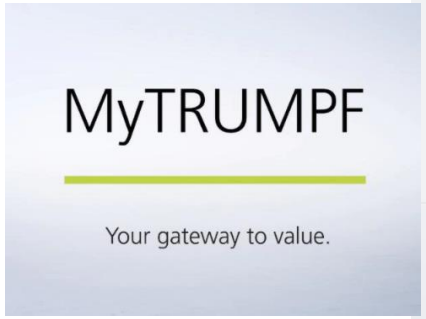
For Free!

CAD machine models

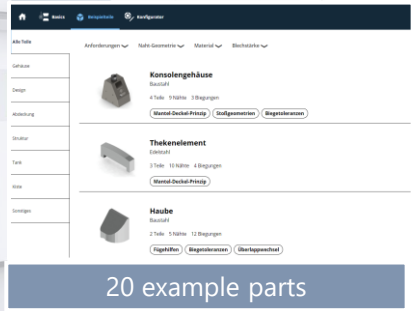
CAD optical models



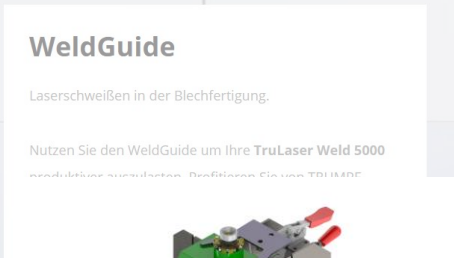
configurator



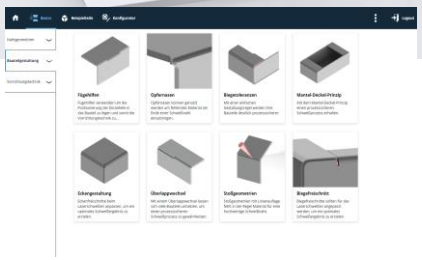
MyTRUMPF user administration



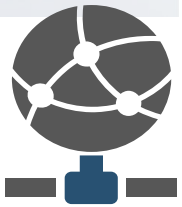
20 example parts



Real fixture models



TRUMPF know-how



Cloud technology - Easy Patches

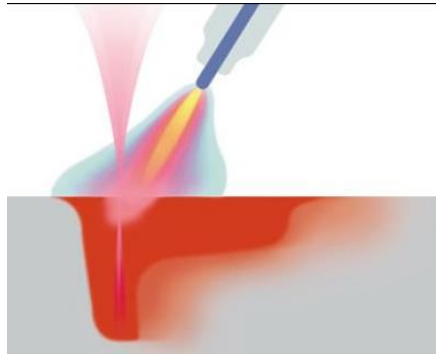
Toepassingen

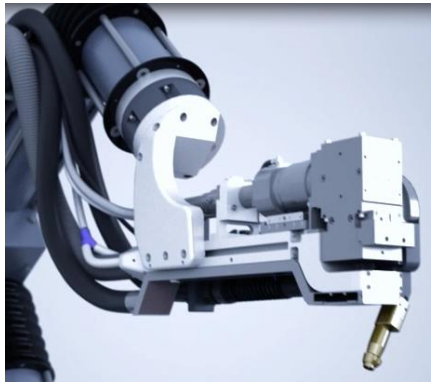
Application strategies

Laser welding

Laser welding with filler wire

Hybrid welding





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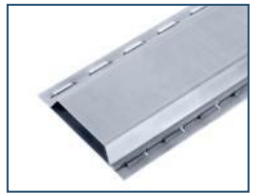
Cars made by laser

- Remote applications
- Laser welding and brazing

Welding and Remote

- Cutting hotforming parts
- Softening
- Inductive heating
- 3D cutting tubes / sheets

Cutting and Hotforming



Lightweight Design

- Flange reduction
- Linear sheet metal design
- Integrated functions
- New materials

E Drives

- Battery production
- Electric engines
- Fuel cells

Powertrain

- Gear welding
- Clutches
- Differentials
- Shifting forks

- Day/Night designs
- Marking
- Drilling
- Surface treatment

Interior and assembly

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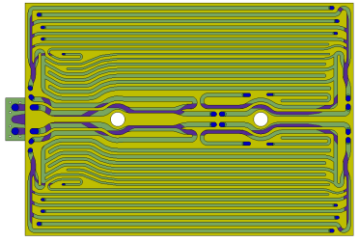
Excerpt of Applications and Technologies for Battery Packs

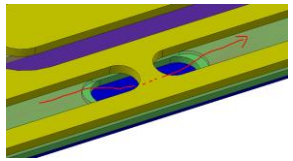
Battery modules
Laser-Welding (e.g. Laser-Remote-Welding

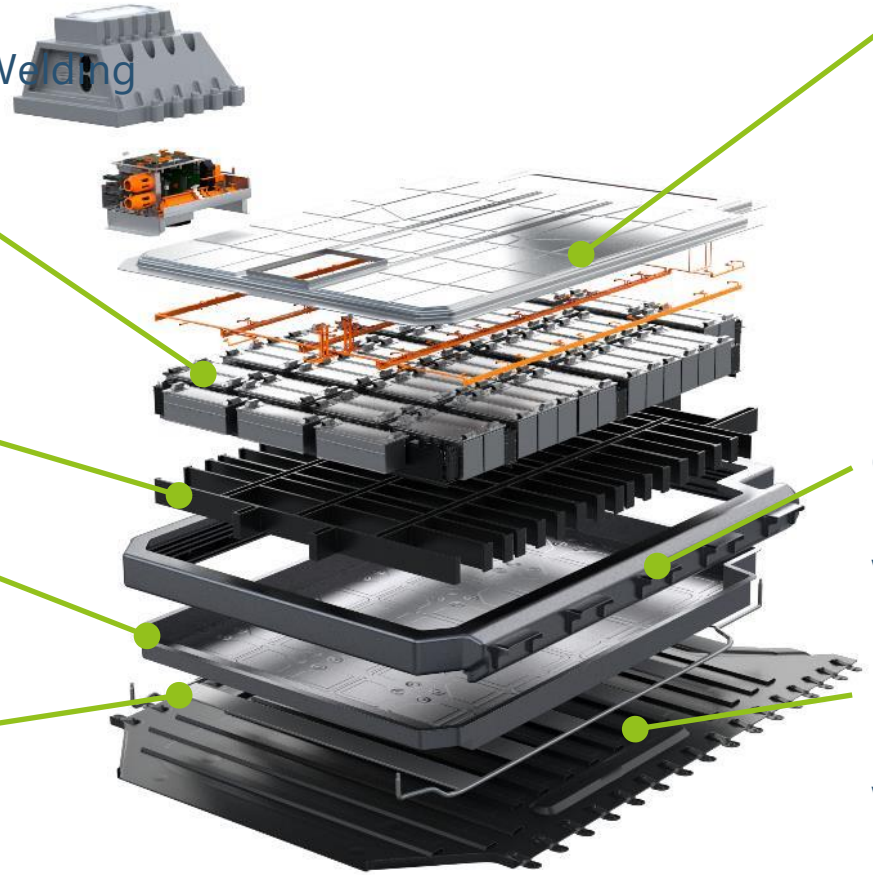
Framework structure
Welding processes

Battery Tray
Laser-Welding (e.g. Laser-wf-Welding)

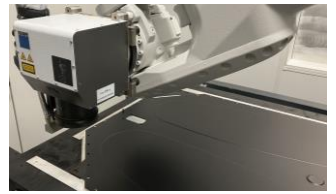
Thermal Management
Various Applications





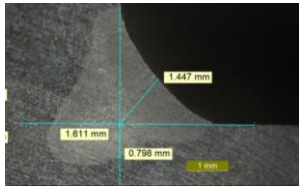


Cover Sheet
Laser CP[1] removal



Crash structure
Laser-Welding (e.g. Laser-Hybrid-Welding or Gas Metal Arc welding)

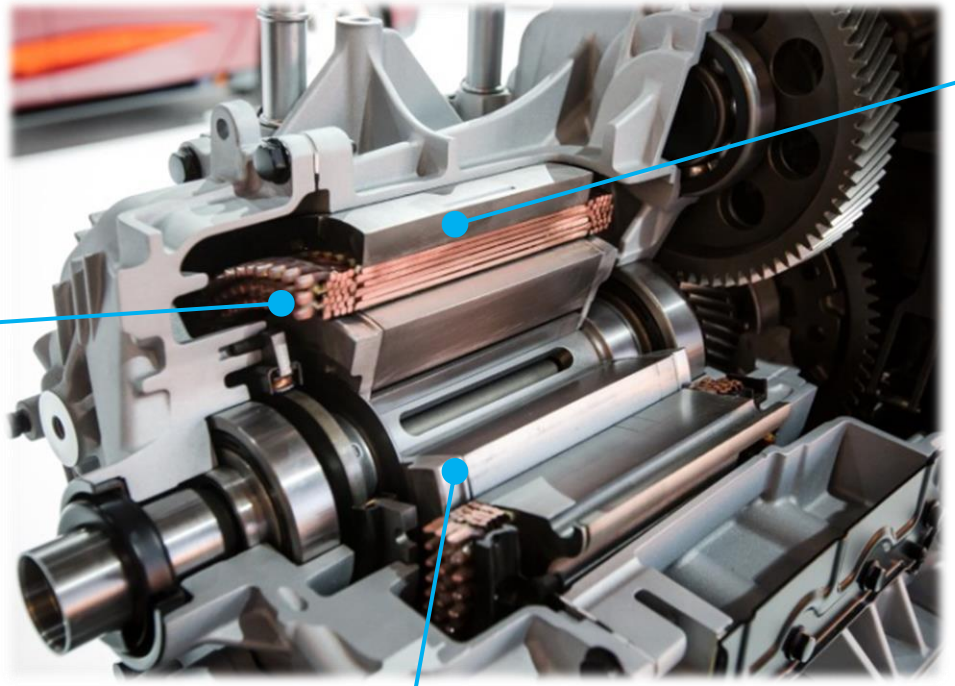
Underride protection
Laser-Welding (e.g. Laser-Remote-Welding)



[1]Cataphoretic paint

TRUMPF

Excerpt of Applications and Technologies for E-drives



Steel Stator Core

Stator Package Welding
Single Sheets Cutting

Hairpin Winding

Hairpin Stripping
Hairpin Welding
Powerrail welding (U,V,W)

Rotor Shaft

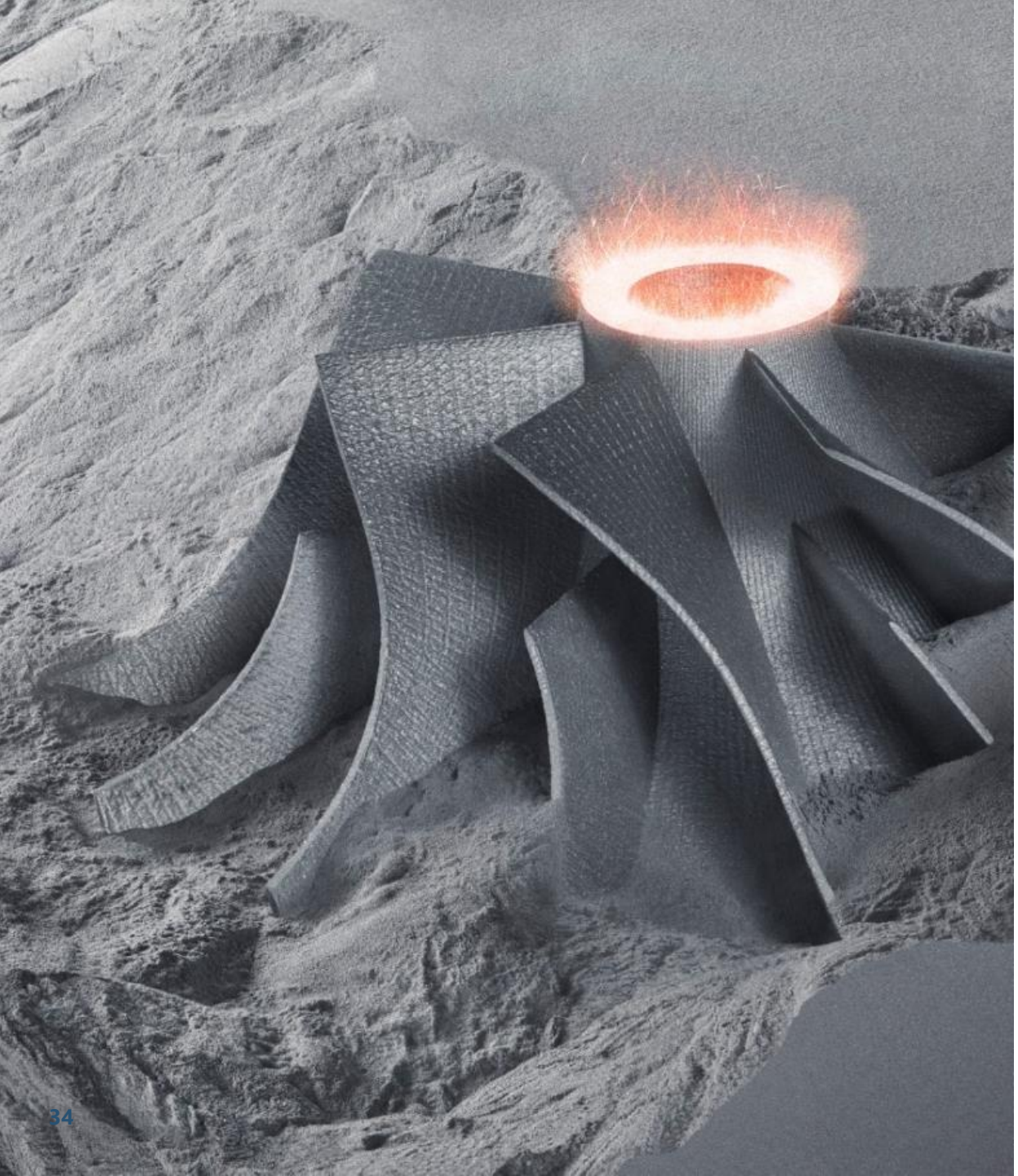
Rotor Shaft Welding

See also:
https://www.youtube.com/watch?v=8bbjb7_jX6c

TRUMPF

Conclusies

- **De applicatie is bepalend in de keuze van laserbron, optische configuratie en manipulatiesysteem.**
  Vertrekpunten:
  - materiaal(dikte)
  - kwaliteitseisen
  - productiviteitseisen (laservermogen, beam-switch, fixed/scanning optics)
- **Er is geen laserbron welke geschikt is voor alle applicaties en bijbehorende –eisen.**
- **Systeemoplossing en keuze laserbron is een complex samenspel.**
  Aandachtspunten:
  - nauwkeurigheidseisen
  - eisen wat betreft flexibiliteit
  - seriegroottes
  - logistieke keten
  - cyclustijdeisen
- **Laserlassen is slechts succesvol indien de volledige productieketen is afgestemd op de verbindingstechnologie**



Inkijk 3D metaalprinten

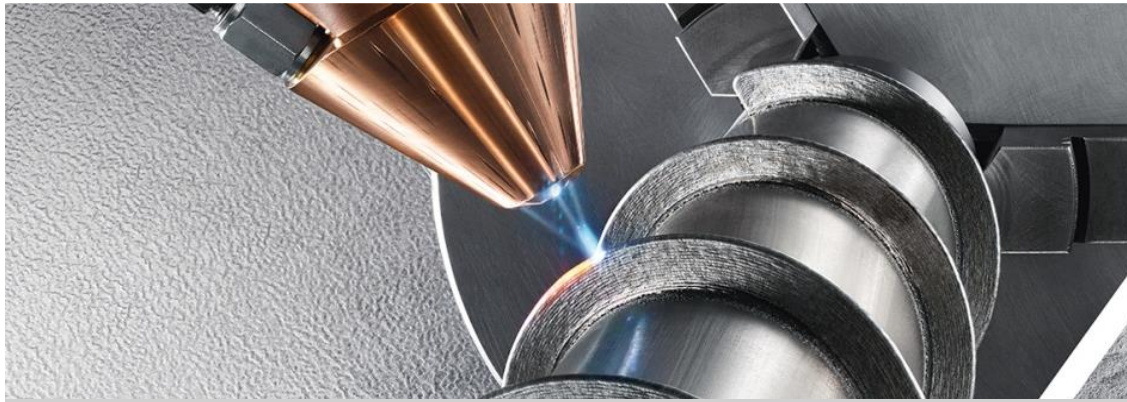
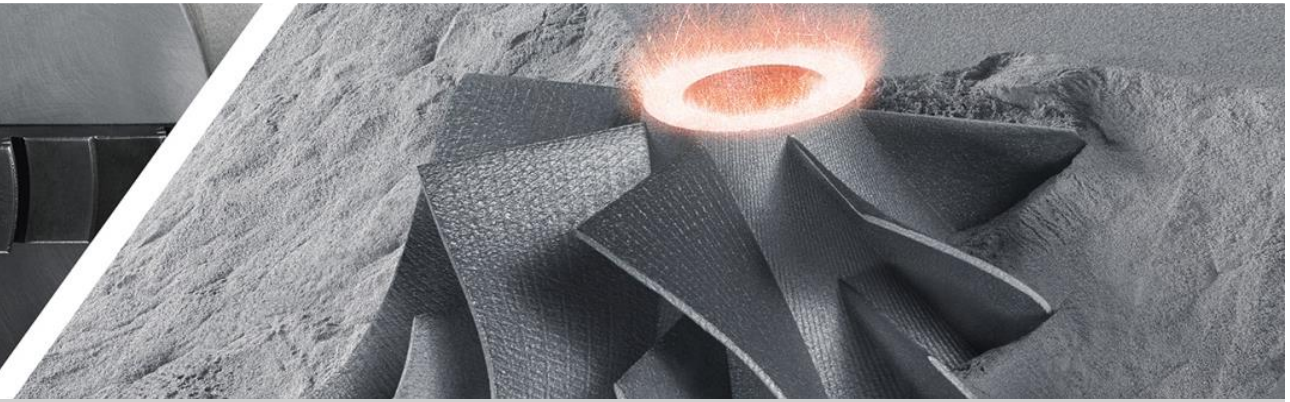
Agenda

1) Technology and Process
2) Benefits
3) Applications

TRUMPF

Technology comparison of LMF and LMD

TRUMPF combines the two most important metal technologies under one roof

Laser Metal Deposition (LMD)		Application	Laser Metal Fusion (LMF)	
				
Productive method for **repairing, coating** and **generating** components			**Precise** method for generative fabrication of **complex** parts out of a **powder bed**	
-	★★★	**Geometric complexity**	★★★★★	(pre-heating if needed)
-	★★★★★	**Building on top of existing parts**	★★★	(only on flat surfaces)
-	★★★	**Material bandwidth**	★★★	-
(10 - 600 cm^3 / h)	★★★	**Build rate**	★★	(2 - 180 cm^3 / h)*
(< 0.5 mm)	★★	**Level of detail / accuracy**	★★★★	(< 0.1 mm)
(Ra 10-20 µm)	★	**Surface quality**	★★★	(Ra 5-10 µm)

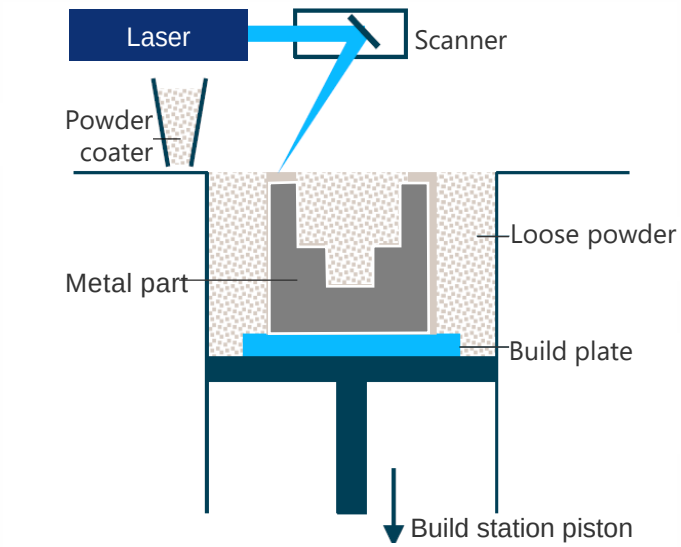
* depending on system configuration, process parameters, material & filling degree

TRUMPF

TRUMPF Additive Manufacturing

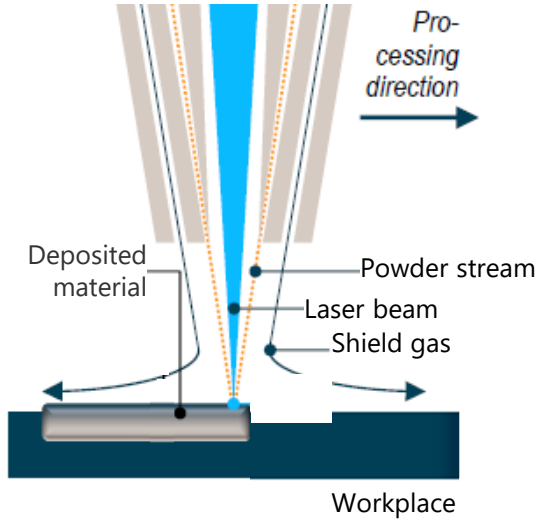
Two complementary methods for metal

Laser Metal Fusion (LMF)



- Additive manufacturing of near net shape parts
- Small, complex parts

Laser Metal Deposition (LMD)



- Modification, coating and repairing of workpieces
- Build on existing (big) parts

Source: Roland Berger

Central Benefits

The use of LMF can achieve many different goals

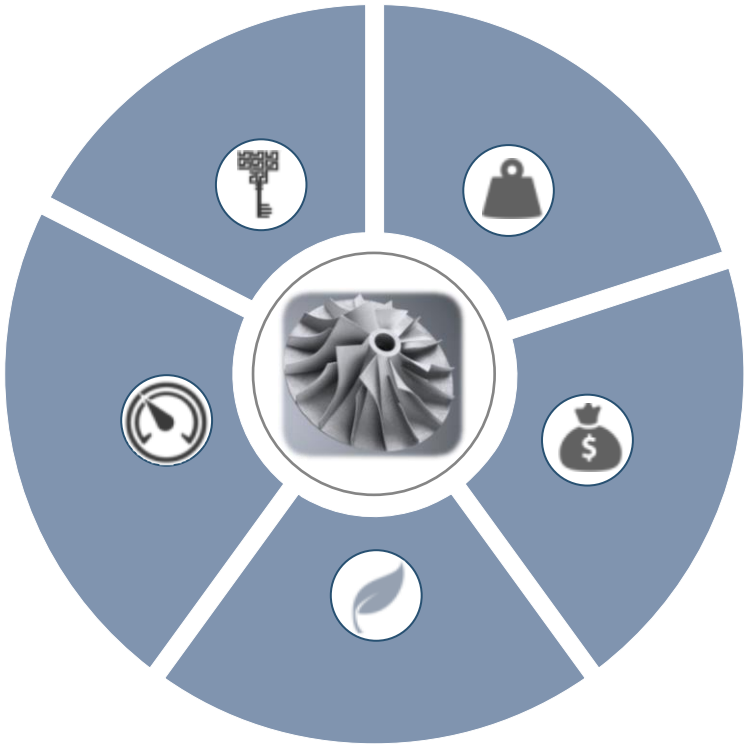
Geometric complexity

Maximum geometric design freedom offers 3 major advantages:

- New geometries that cannot be produced with other methods
- Integration of functionalities
- Monolithic design

Speed

Reduction of production steps (e.g. tool-free production)



Weight reduction

Robust lightweight construction through hollow spaces, grid structures or bionic design

Cost reduction

Cost-effective production of small and mid-sized components, starting with lot size 1. Especially for complex structures (“complexity for free”) e.g. small series and prototyping

Sustainability

Protection of resources through low material and energy consumption – in both the production and in operation of the finished parts

LMF Machine Portfolio

Re-Entry with small size machine TruPrint 1000 up to high-end machine TruPrint 5000

TruPrint 1000

Compact and robust 3D printing

- **Build cylinder:** Ø 100 x H 100 mm
- **Max. laser power at the workpiece (TRUMPF fiber laser):** 1 x / 2 x 200 W
- **Beam diameter:** 30 / 55 µm

TruPrint 1000 Green Edition

Green laser: 3D printing of copper and other precious metals

- **Build cylinder:** Ø 97 x H 100 mm
- **Max. laser power at the workpiece (TRUMPF fiber laser):** 1 x 500 W
- **Beam diameter:** 200 µm

TruPrint 2000

Economical 3D printing with premium quality

- **Build cylinder:** Ø 200 x H 200 mm
- **Max. laser power at the workpiece (TRUMPF fiber laser):** 1 x / 2 x 300W
- **Beam diameter:** 55 µm
- **Preheating:** up to 200 °C
- **Inert powder handling:** yes

External powder management

Powder management on an industrial scale

TruPrint 3000

Flexible solution for industrial 3D printing

- **Build cylinder:** Ø 300 x H 400 mm
- **Max. laser power at the workpiece (TRUMPF fiber laser):** 1 x / 2 x 500 W
- **Beam diameter:** 80 µm
- **Preheating:** up to 200 °C

External part and powder management

Part and powder management on an industrial scale

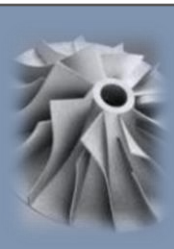
TruPrint 5000

Highly productive 3D printing for industrial serial production

- **Build cylinder:** Ø 300 x H 400 mm | Ø 290 x H 400 mm (reduction if preheating is >200 °C)
- **Max. laser power at the workpiece (TRUMPF fiber laser):** 3 x 500 W
- **Beam diameter:** 80 µm
- **Preheating:** up to 500 °C (optional)
- **Automatic process start: yes**

Industry overview

LMF meets the manifold requirements of a wide range of industries

	Aerospace	Energy & turbines	Automotive	General Industries	Tool & die making	Medical	Dental	Development & Institutes	Fashion & Lifestyle	Jewelry	Job Shops
Materials	Titanium, aluminum, nickel-based alloys	Nickel-based alloys	Aluminum, steels	Aluminum, steels	Tool steel	Titanium, cobalt-chrome	Cobalt-chrome	Various	Bronze, steel, titanium	Precious metals, bronze	Various
Applications	Structural parts, brackets	Turbines, nozzles	Prototypes, tools, small series	Various	Dies, tools, tooling inserts	Implants, medical instruments	Dental crowns, bridges	Material developm., R&D for parts	Accessories, design objects	Rings, brooches, necklace pendants	Suppliers for multiple industries
Sample parts											

TRUMPF

General Industry

Absorber cooler (use case)

Serial production

TruPrint 3000

CONVENTIONAL DESIGN

Possible leakage points	30
Parts	27
Manufacturing costs	100%

AM DESIGN

Possible leakage points	2
Parts	2
Manufacturing costs	100%

- EASIER ASSEMBLY
- FEWER PARTS
- CONFORMAL COOLING
- INCREASED EFFICIENCY

Highlight

TRUMPF does not just produce 3D printing machines for the additive manufacturing branch. It also uses additive manufacturing in production to produce its own components. The absorber cooler is installed in high-performance CO2 lasers (30 kW).

Created by TRUMPF Consulting for TRUMPF

„AM enables a quick adaptation of the through-flow optimization making the mounting of the aluminum core possible as a simple joining procedure."

Jürgen Mornhinweg, TRUMPF

More information

TRUMPF

General Industry

Diode cooler

Serial production

TruPrint 1000

CONVENTIONAL DESIGN

Weight	138 g
Parts	27
Manufacturing costs	100%

AM DESIGN

Weight	40 g (-71%)
Parts	3 (-70%)
Manufacturing costs	97%

- EASIER ASSEMBLY
- FEWER PARTS
- BETTER COOLING
- INTEGRATED ELECTRICAL SHIELDING

Highlight

- This diode cooler is part of a moving sensor unit
- The lower weight results in lower G-Forces
- Conformal cooling increases the diodes lifetime
- Additionally electrical shielding is integrated

Created by TRUMPF Consulting

With the help of AM we were able to integrate multiple features in one part while simultaneously reducing the weight significantly. Additionally, assembly time could be reduced by 2 min.

More information

TRUMPF

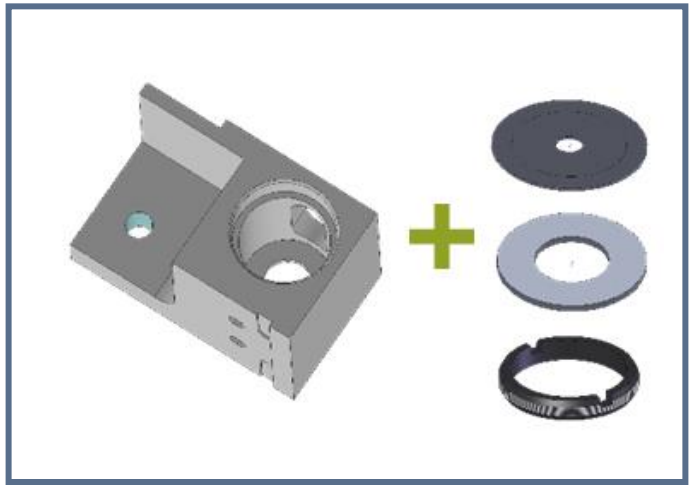
General Industry

Lens holder

Serial production

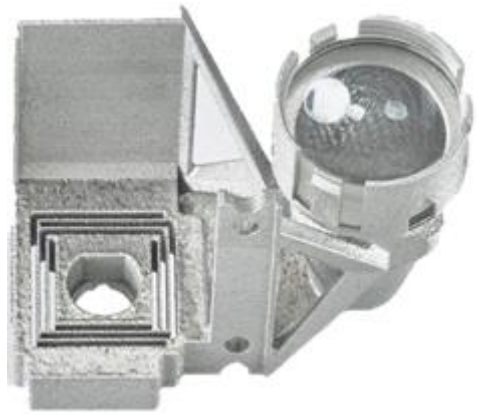
TruPrint 1000

CONVENTIONAL DESIGN



Weight	49g
Parts	4
Manufacturing costs	100%

AM DESIGN



Weight	18 g (-65%)
Parts	1
Manufacturing costs	97%

- EASIER ASSEMBLY
- FEWER PARTS
- FLEXIBLE HINGE

Highlight

- Solid-state joint integrated
- Flexible hinge compensates assembly tolerances
- Integrated lens mounting
- Integrated aperture

Created by TRUMPF
Consulting for TRUMPF

More information

TRUMPF

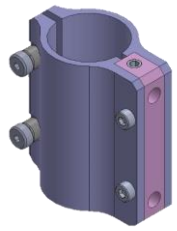
General Industry

Motor cooler

Serial production

TruPrint 3000

CONVENTIONAL DESIGN



Weight	76,5 g
Volume	19 cm³
Parts	10 pieces
Costs	100% + Assembly

AM DESIGN

Weight	40 g = - 48%
Volume	5 cm³ = - 73%
Parts	1 = - 90%
Costs	60% + Assembly

- SIMPLIFIED ASSEMBLY
- PROFITABILITY
- WEIGHT REDUCTION

Highlight

The serial product is only made out of one component instead of a complete assembly. That way, the economic efficiency could be increased by 30%.

Created by TRUMPF Consulting for TRUMPF

„The successful establishment of our own series applications demonstrates the time-demanding but sustainable use of this technology in our company."

Klaus Parey, TRUMPF

More information

TRUMPF

General Industry

Fully stacked engine cooler build job

Serial production

TruPrint 5000

FULL PLATE

Parts	47
Build Time	32 h
Setup Costs per part	100%

FULL BUILD ENVELOP

Parts	7x47=329
Build Time	90 h with TruLaser 3000 new Dual-Laser
Setup Costs per part	15 %

COST REDUCTION

OPERATOR COST REDUCTION

Highlight

- Reproducable part quality of the whole build plate and build height
- Smart support structure between the parts to allow easy and save part separation
- Machine handling time per part is reduced by 85%

By stacking 7 parts on top of each other 7 times more parts can be produced in one build job. Additionally, the build time is reduced by 48% by using 2 instead of 1 laser

Max Boulter, TRUMPF

More information

TRUMPF

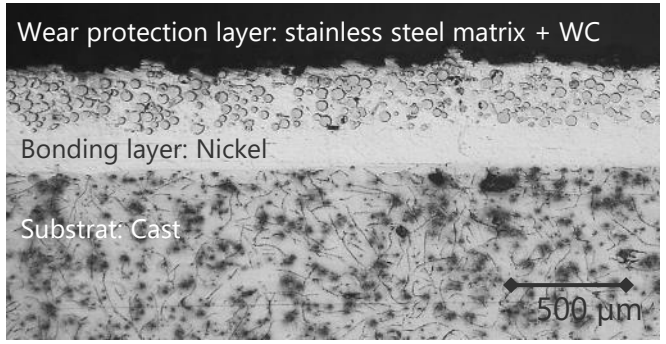
General Industry

HS-LMD on a Break disc

Laser Metal Deposition Cladding

TruLaser Cell 3000

Part size (H, Ø)	Demo part: 300 mm, 120 mm Real parts: several meters
Surface rate	> 600 cm²/min
Layer thickness	100 µm



Material	Ceramic and metal composite coating system

This use case shows the coating by HS Laser Metal Deposition on a break disc.

- WEAR AND CORROSION PROTECTION
- HIGH PRODUCTIVITY
- METALLURGICAL BOND OF SUBSTRATE AND CLADDING

Highlight

HS Laser Metal Deposition is used to clad a break disk with a wear and corrosion resistant layer. This results in a longer lifetime of the break disc and the emission of less fine dust.

More information

TRUMPF

Summary

TRUMPF as a reliable partner offering a full-service solution within AM

Experienced industrial partner

Global market leader for
machine tools and laser technology

Pioneer in 3D printing

LMD **LMF**

1999 — 2021

More than 15 years of experience
in additive technologies

High-performance LMF portfolio

TruPrint Series

Robust AM machines
for industrial series production

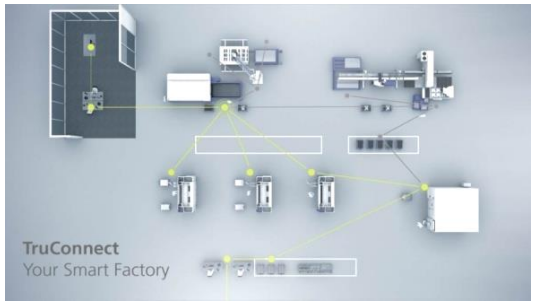
Global proximity to customers

International sales
and service network

Comprehensive solution offerings

Complete solution provider
for machines and services

Progressive in Industry 4.0



Connected machines
and technologies

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