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Hochschule Mittweida

HOCHSCHULE MITTWEIDA
University of Applied Sciences

LPBF-XXL

The solution for m³ metal parts

Prof. Dr.-Ing. André Streek

Martin Erler, M.Sc.

Michael Pfeifer, M.Sc.

Sebastian Weinhold, M.Sc.

Andreas Kotsch, M.Eng.

www.laser.hs-mittweida.de

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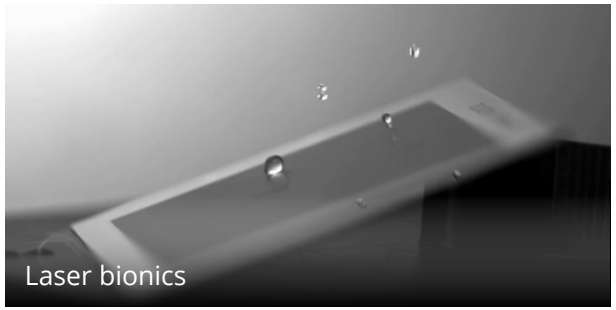
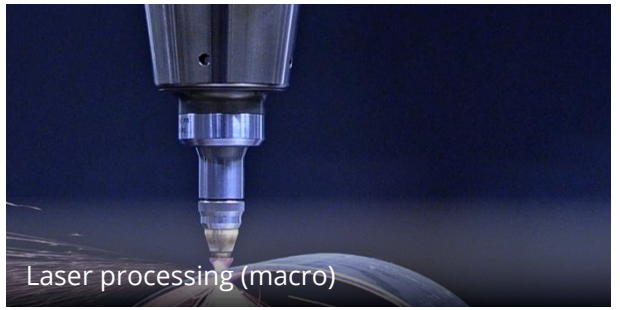
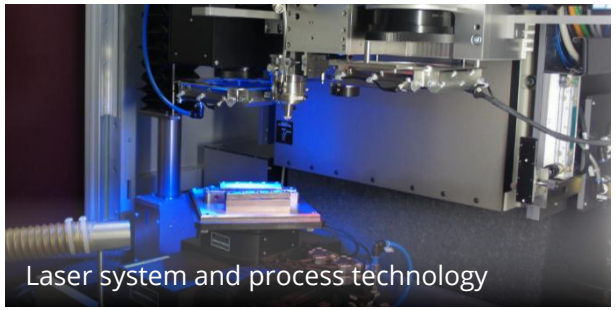
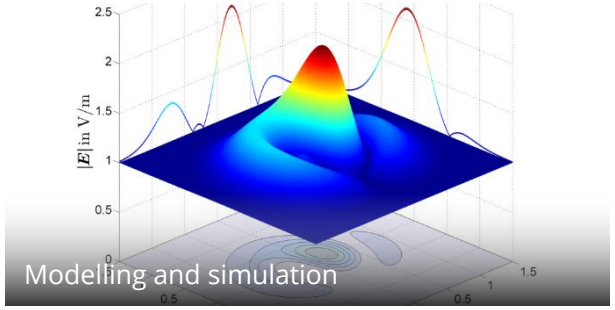
Laserinstitut Hochschule Mittweida

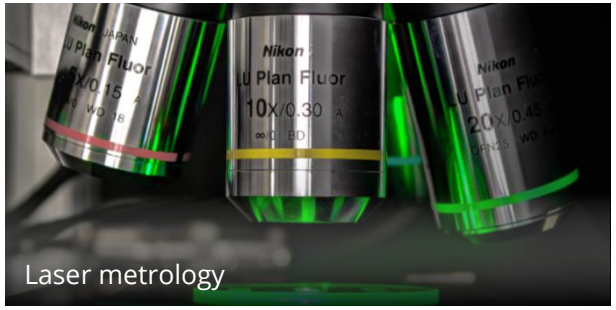
- Application-oriented research and development in the field of laser technology
- 50 years of experience in laser research
- 6 professors and over 50 employees
- Over 50 research facilities

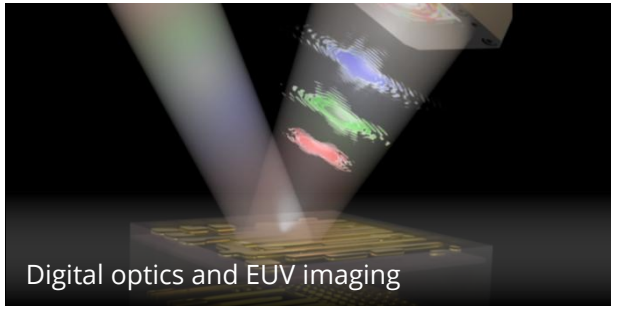












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Inspiration

Inspiration

in cooperation with: AS Fakultät Architektur und Sozialwissenschaften HTWK

FLEX Forschung Lehre Experiment

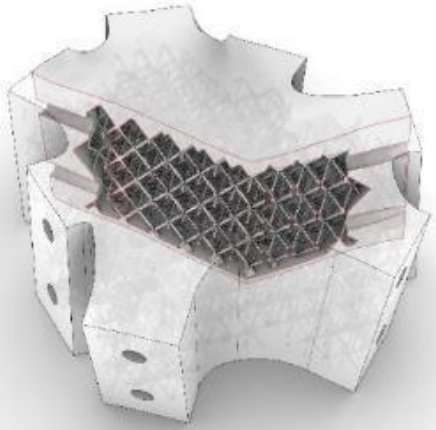
One of many possible applications:
Individual node facades

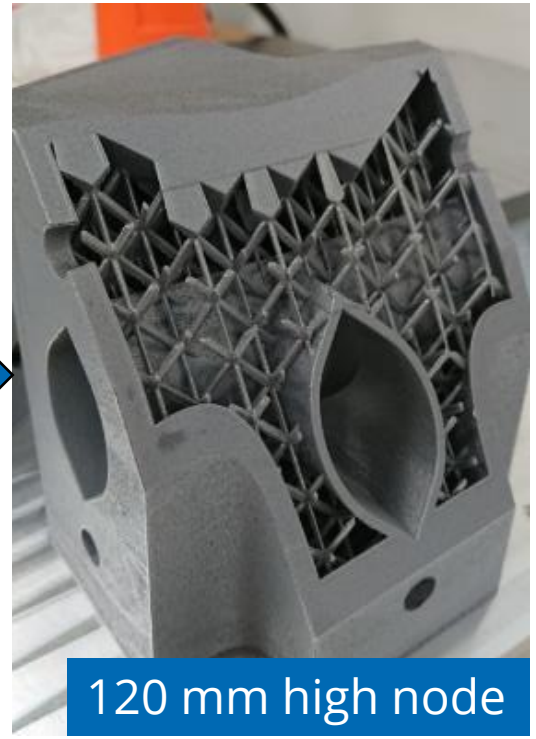
Problem:
each node unique → **expensive**

first solution:
AM & parameterized design

Standard-LPBF
still expensive:
~ 80 h
~ 1000 € material cost


facade


design


120 mm high node

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LPBF-XXL process

Concept

Laser Powder Bed Fusion (LPBF)

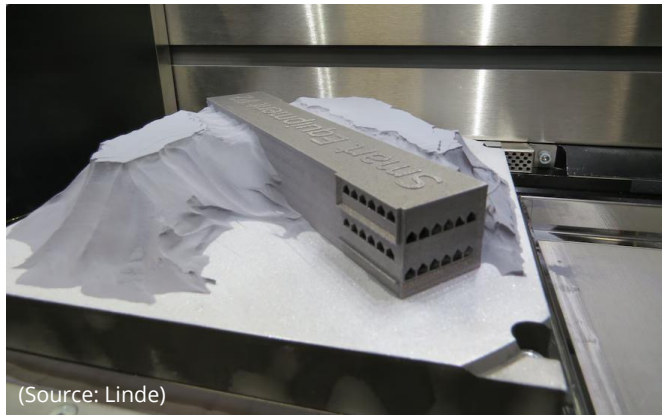
design freedom

Direct Energy Deposition (DED)

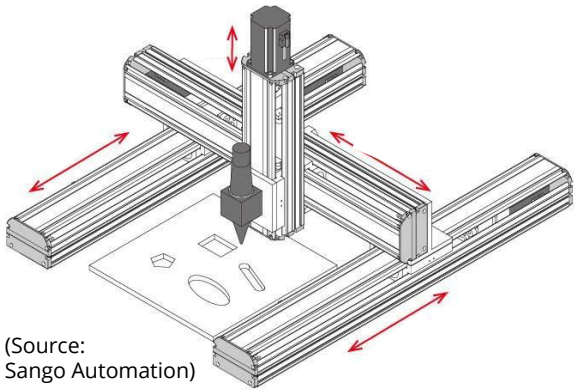
affordability **build rate** **part size**

LPBF-XXL

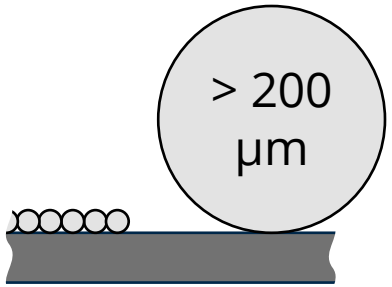
powder bed



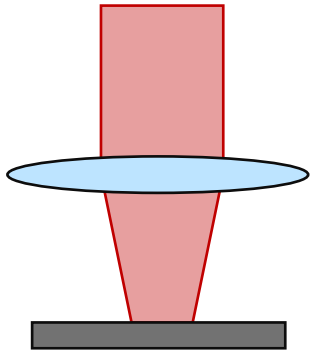
gantry setup
→ no scanner



coarse material



single
laser beam



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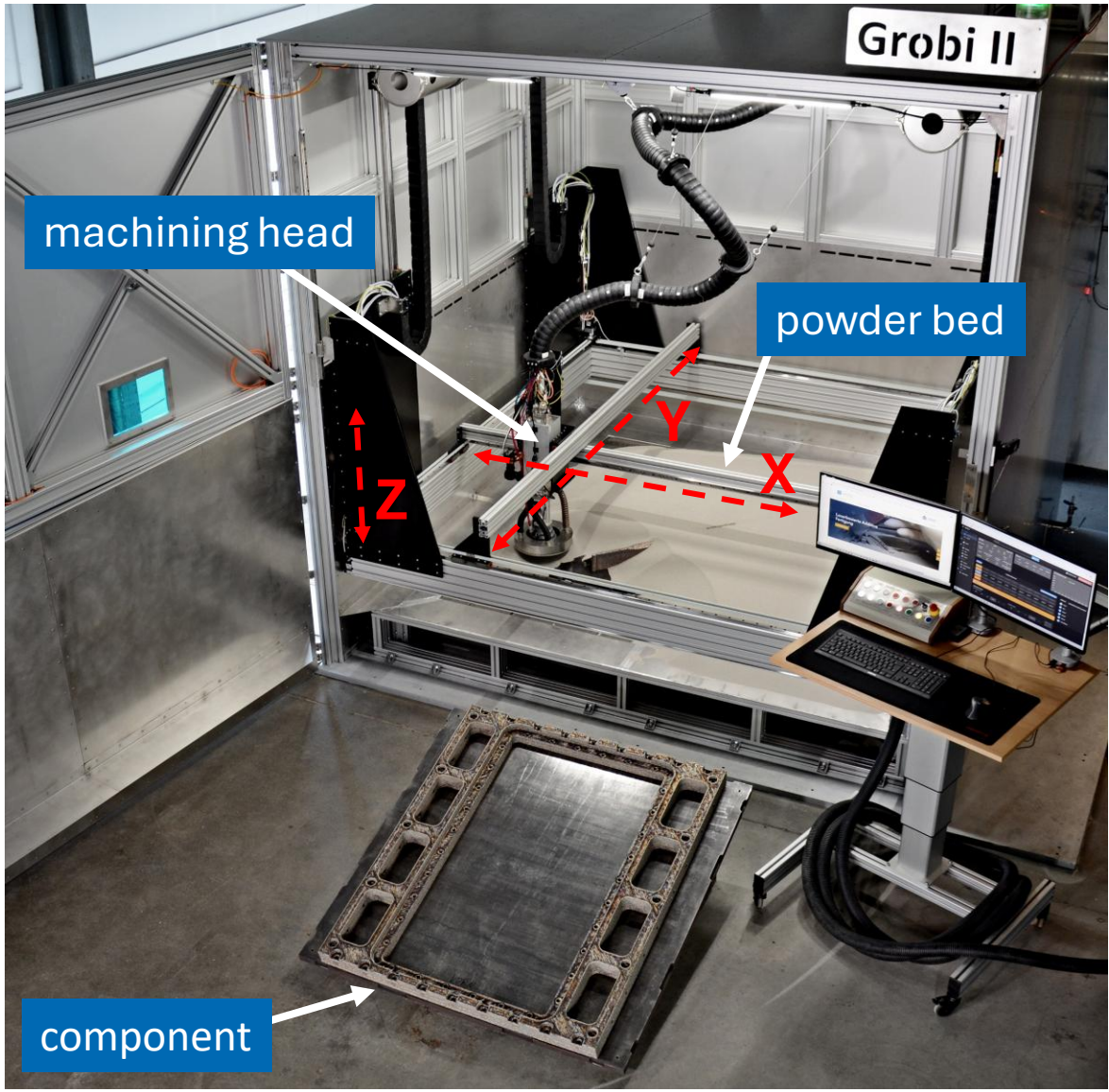
LPBF-XXL setup

in cooperation with: Kobra Formen GmbH

- Scalable system concept
- Laser power up to 8 kW (single laser)
- Metal granulate with grain diameter > 200 µm
- Layer thickness: 0.5 - 2 mm
- Min. structure size: > 3 mm
- Building volume: 2 x 2 x 1 m³
- Melting rate up to 10 kg/h (@ *8 kW*)
- Adjustable beam diameter for various requirements
- Easy handling (no explosion or health hazard)



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LPBF-XXL process demonstration

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Stainless steel 1.4301

results & use cases

Density

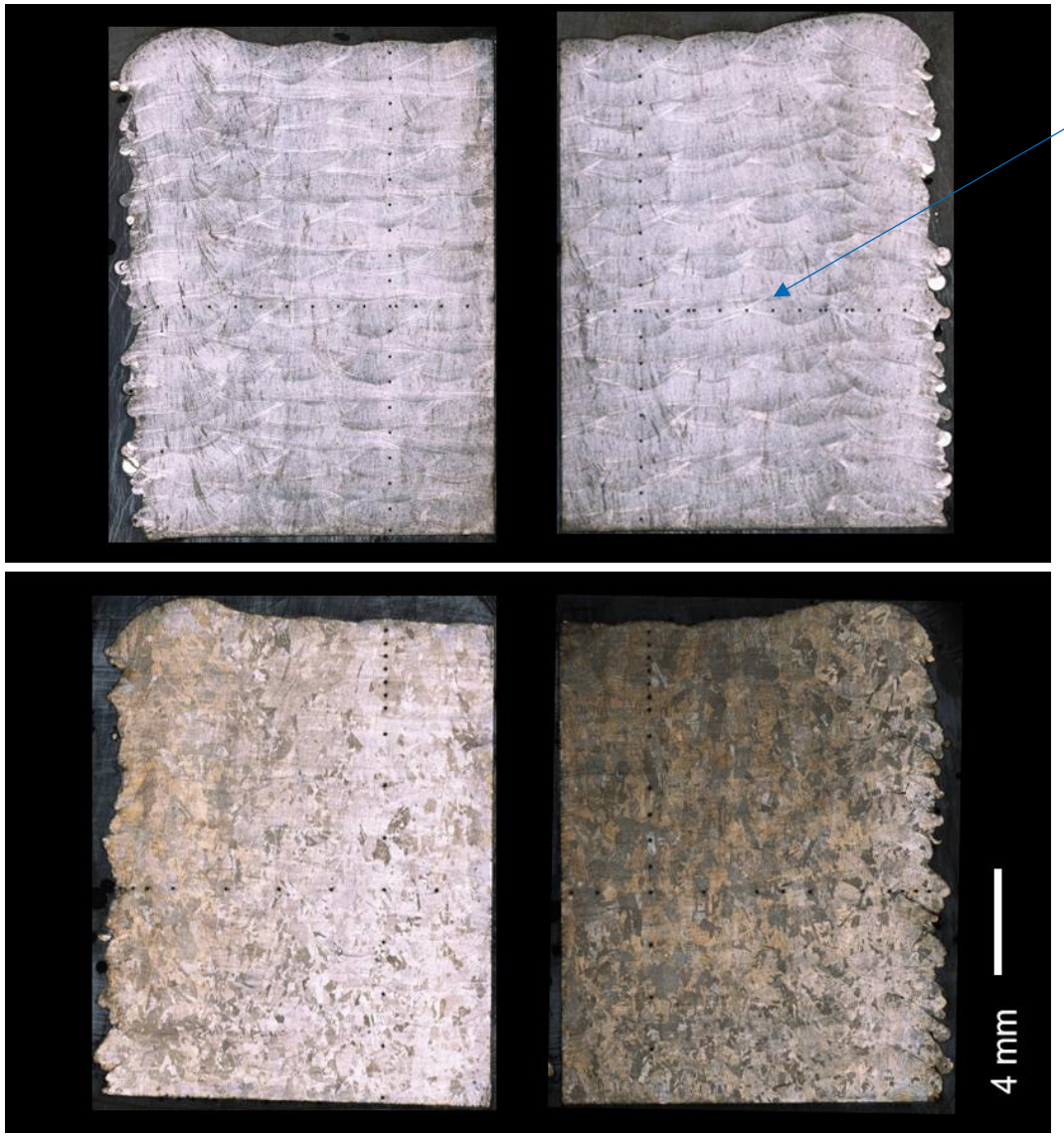
Image analysis:

$\rho_{rel.}$ = 99.8 %

Archimedes:

ρ = 7.81 … 7.83 g/cm³

→ close to 100 %



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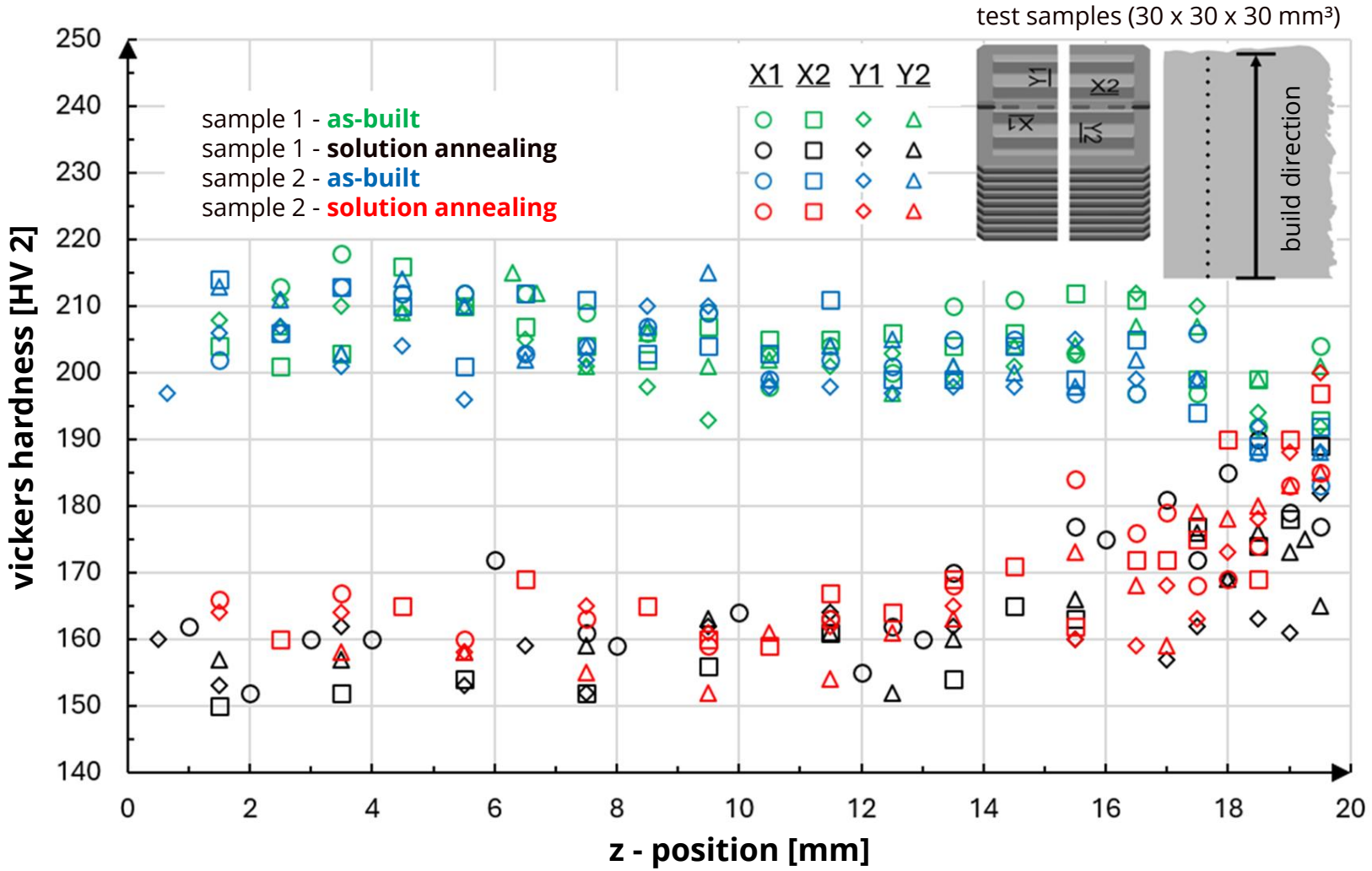
Hardness

as-built

solution annealing



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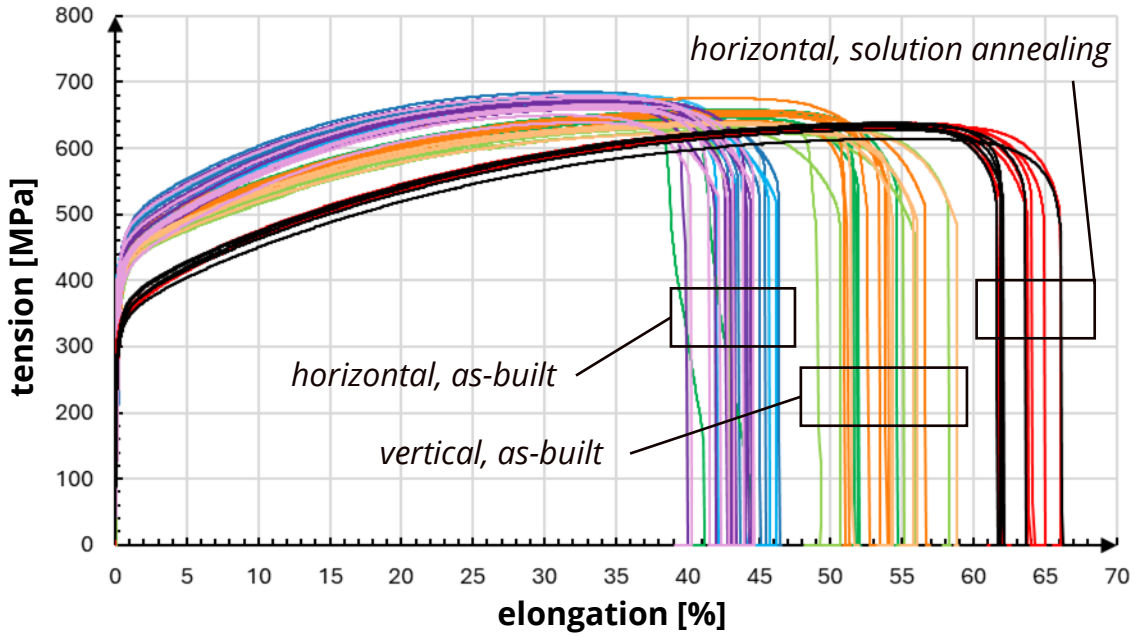
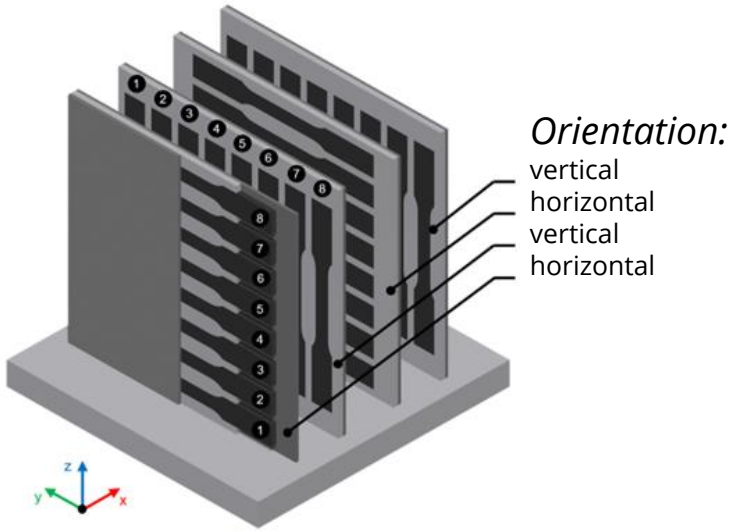
Mechanical properties





	1.4301 (DIN EN 10088-3)	LPBF-XXL (horizontal, as-built)	LPBF-XXL (vertical, as-built)	LPBF-XXL (horizontal, solution annealing)
tensile strength, R_m	500 - 700 MPa	670 ± 3.6 MPa	653 ± 2.6 MPa	630 ± 2.2 MPa
elongation at break, A	≥ 45 %	43.5 ± 1.8 %	52 ± 4.5 %	63 ± 1.6 %

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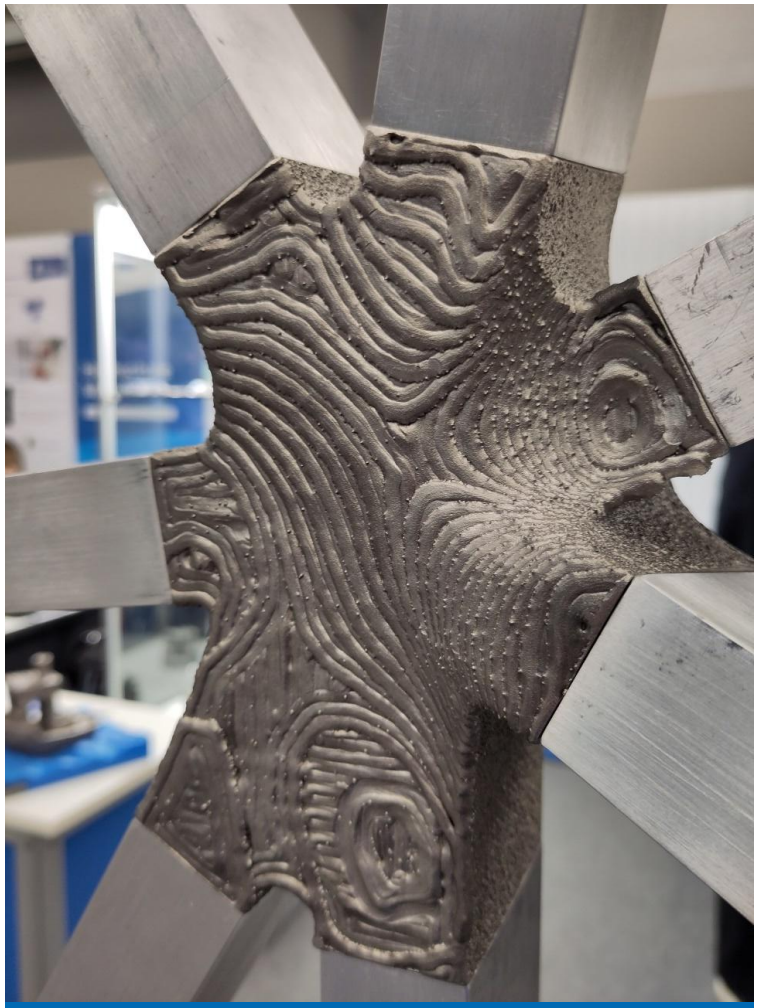
in cooperation with: AS Fakultät Architektur und Sozialwissenschaften HTWK

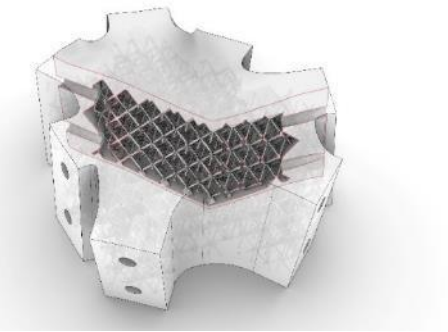
FLEX Forschung Lehre Experiment

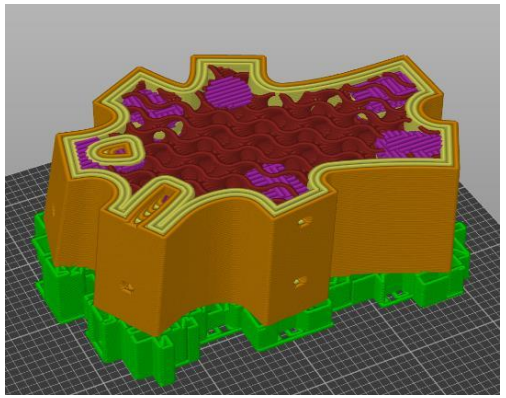
Individual node facades



250 mm high node | 4 h

frame structure





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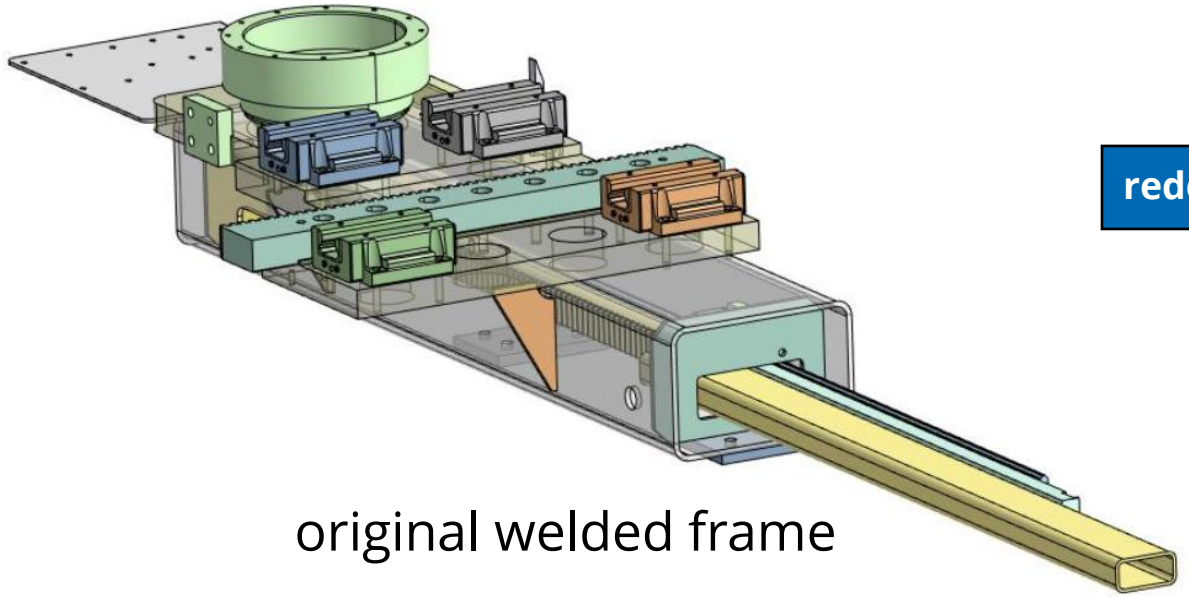
Machine carrier

in cooperation with:

DREHER AUTOMATION · Fraunhofer IWU · ERVIN

production tool **50 kg**

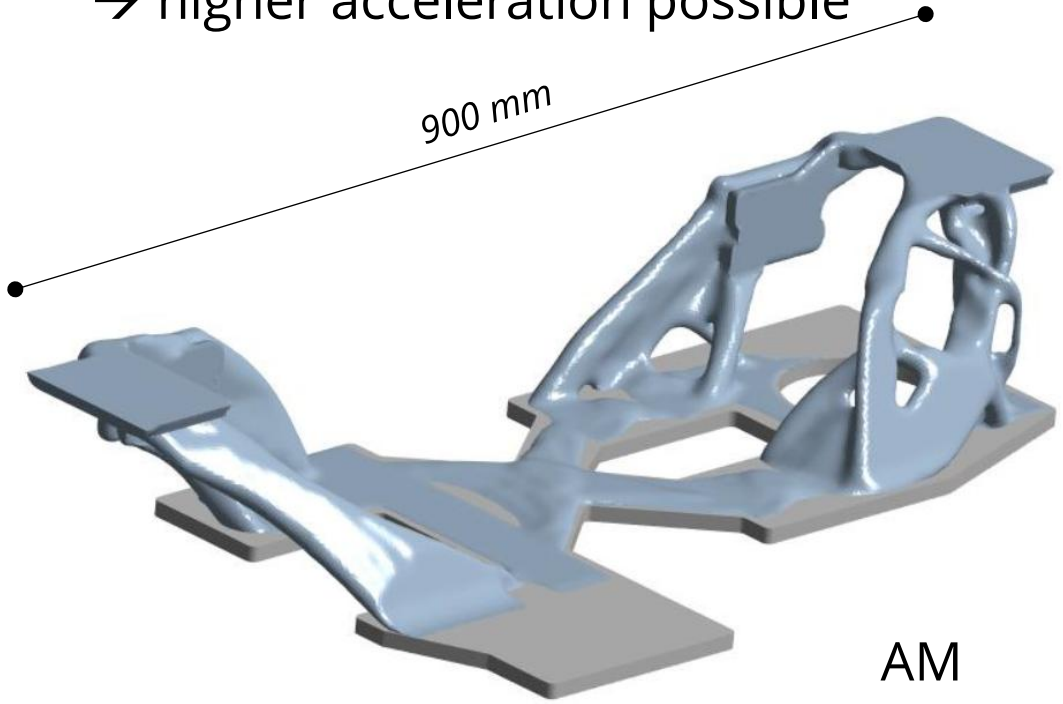


original welded frame

redesign

reduced mass: **30 instead of 50 kg**

→ higher acceleration possible



AM

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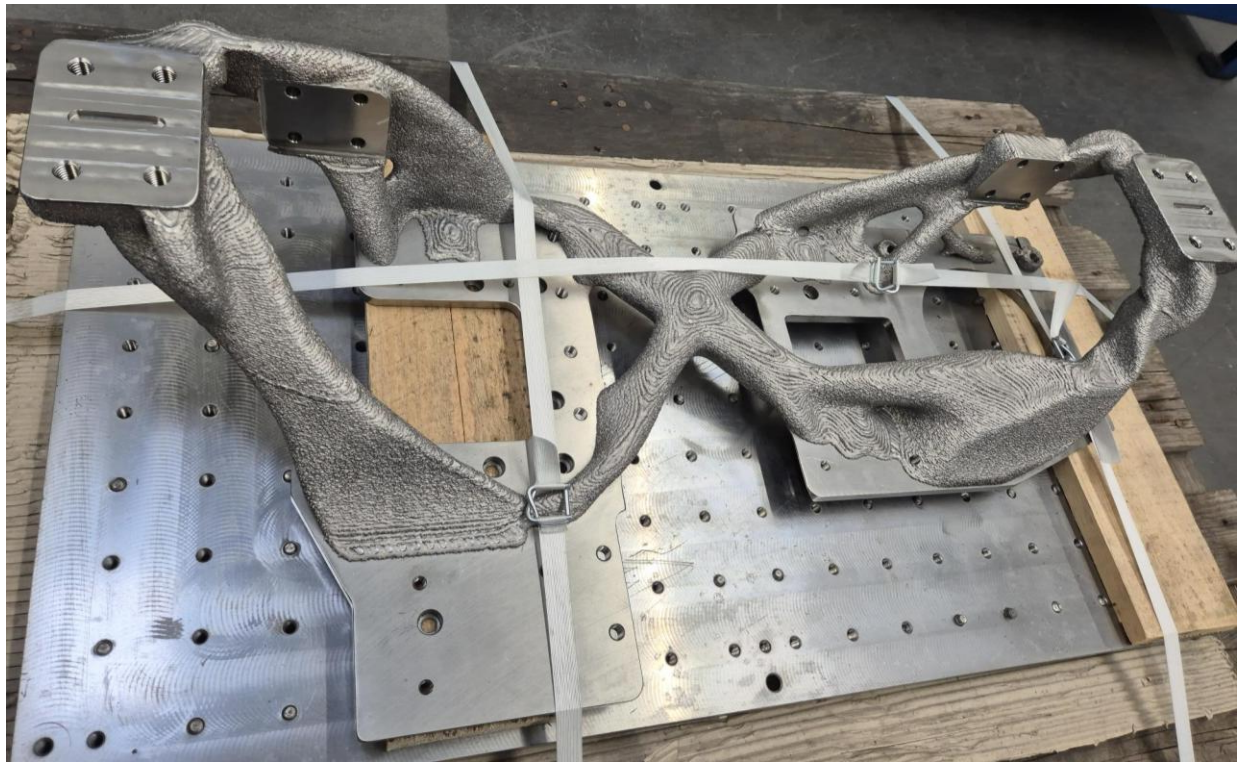
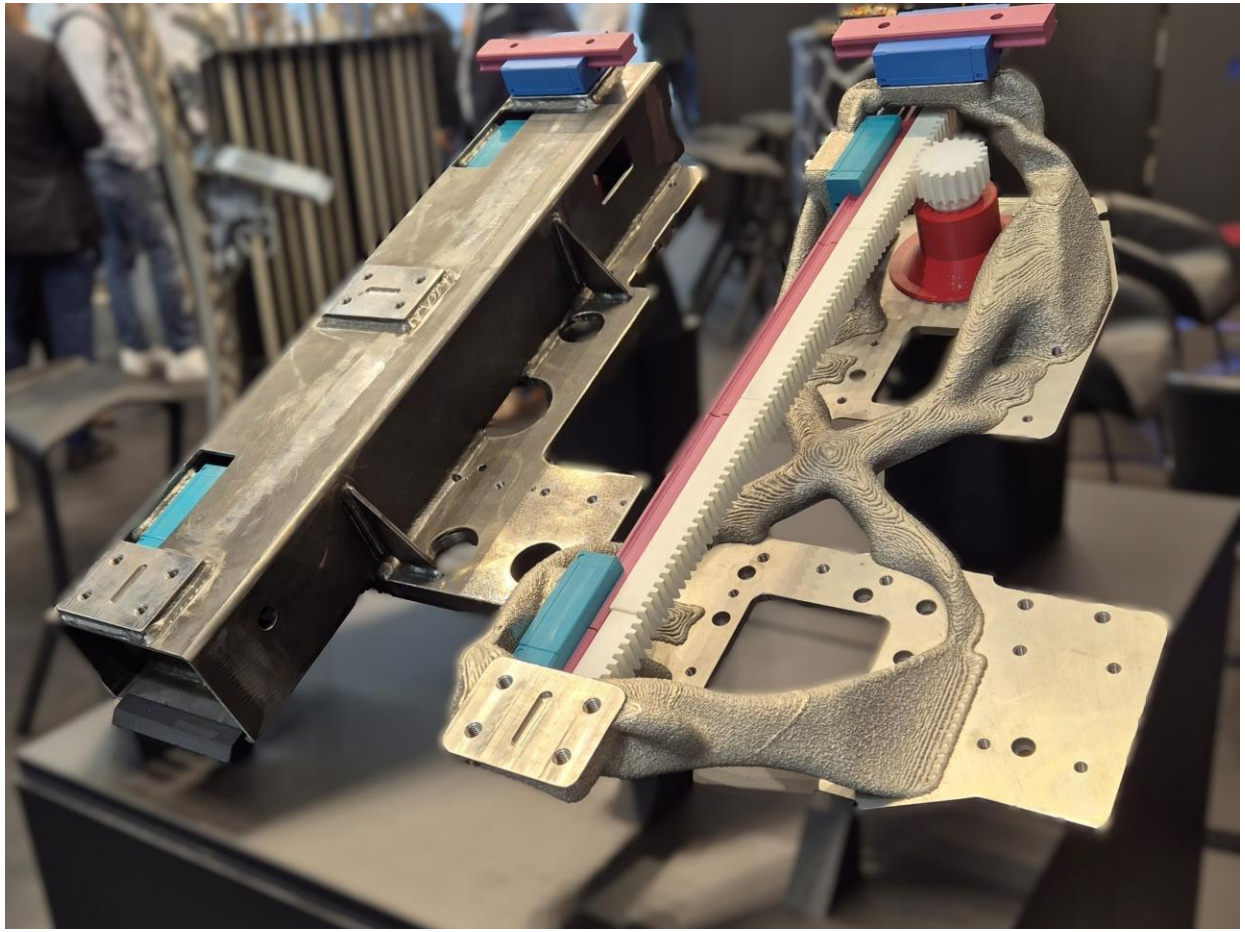
Machine carrier

in cooperation with:

DREHER AUTOMATION · Fraunhofer IWU · ERVIN





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Case hardening steel 1.7131

results & use case

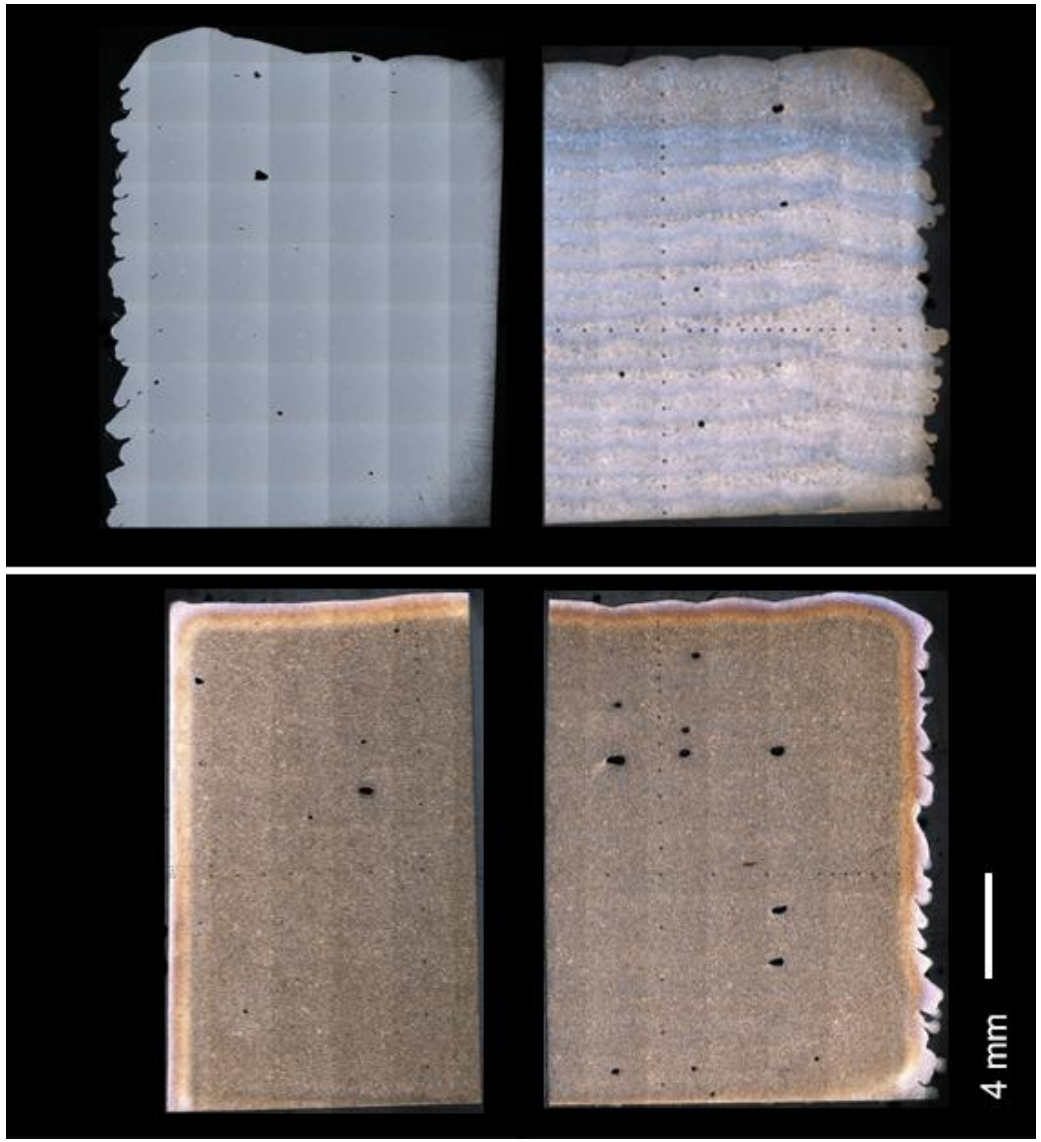
Density

Image analysis:

$\rho_{rel.}$ = 99.3 %

Archimedes:

ρ = 7.79 … 7.81 g/cm³



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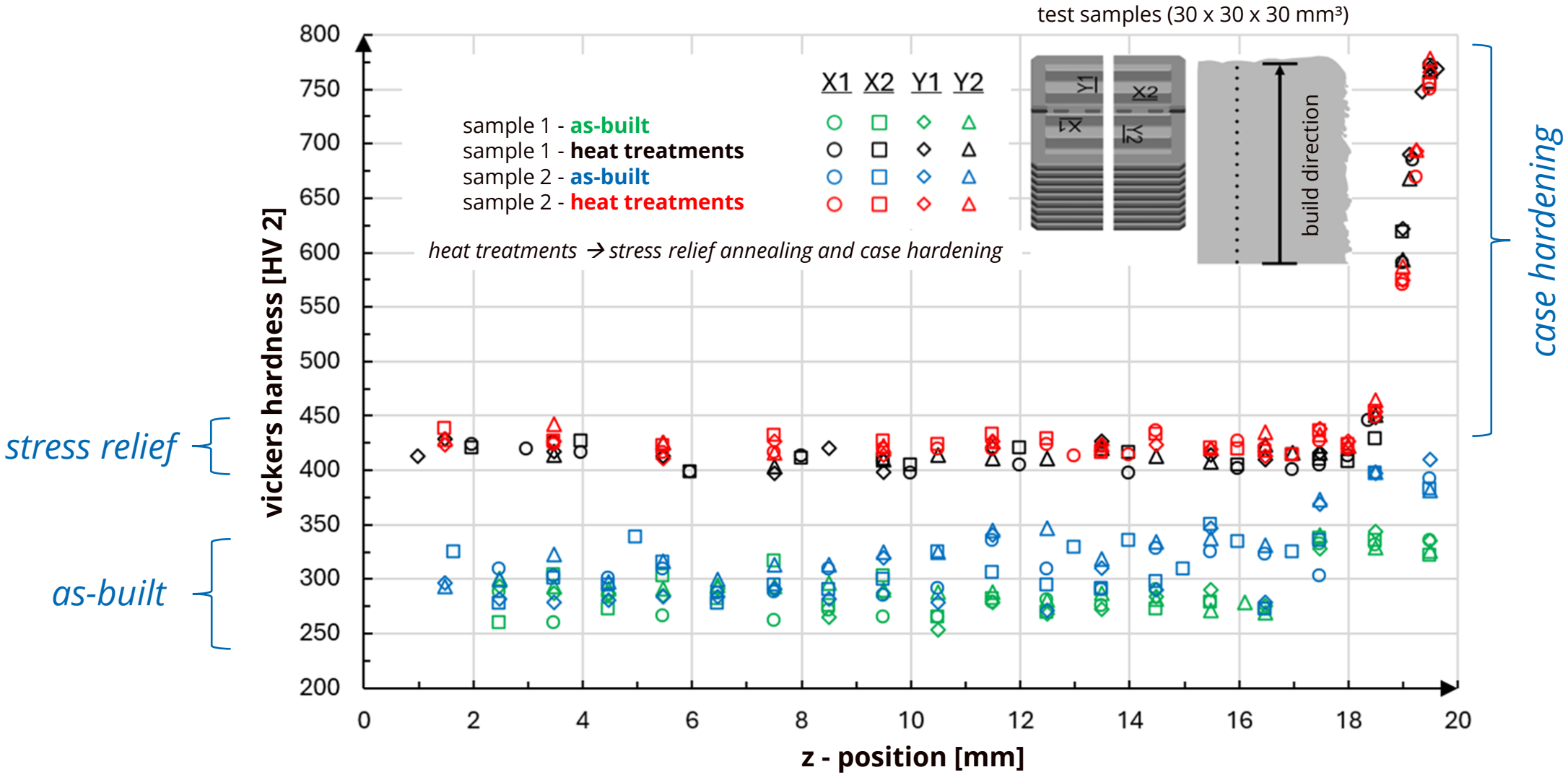
Hardness



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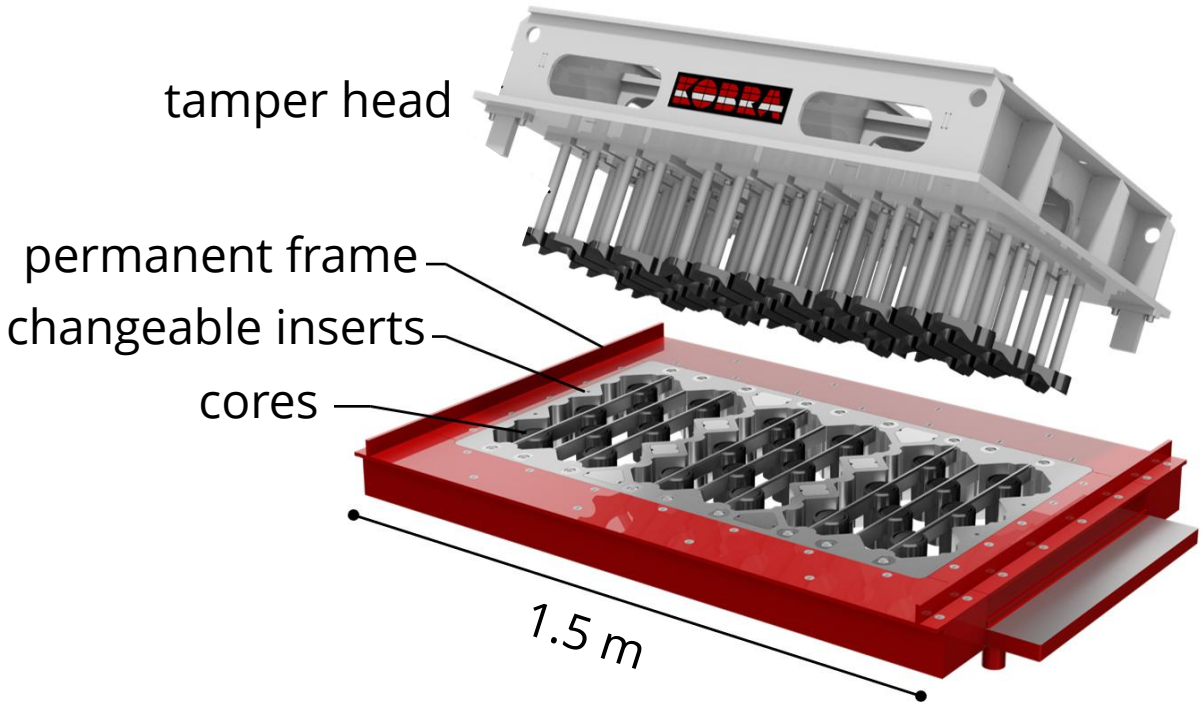
Mold for concrete blocks

in cooperation with:

Kobra Formen GmbH

- Case hardening steel 16MnCr5 / 1.7131
- Traditional milling: 70 … 90 % waste



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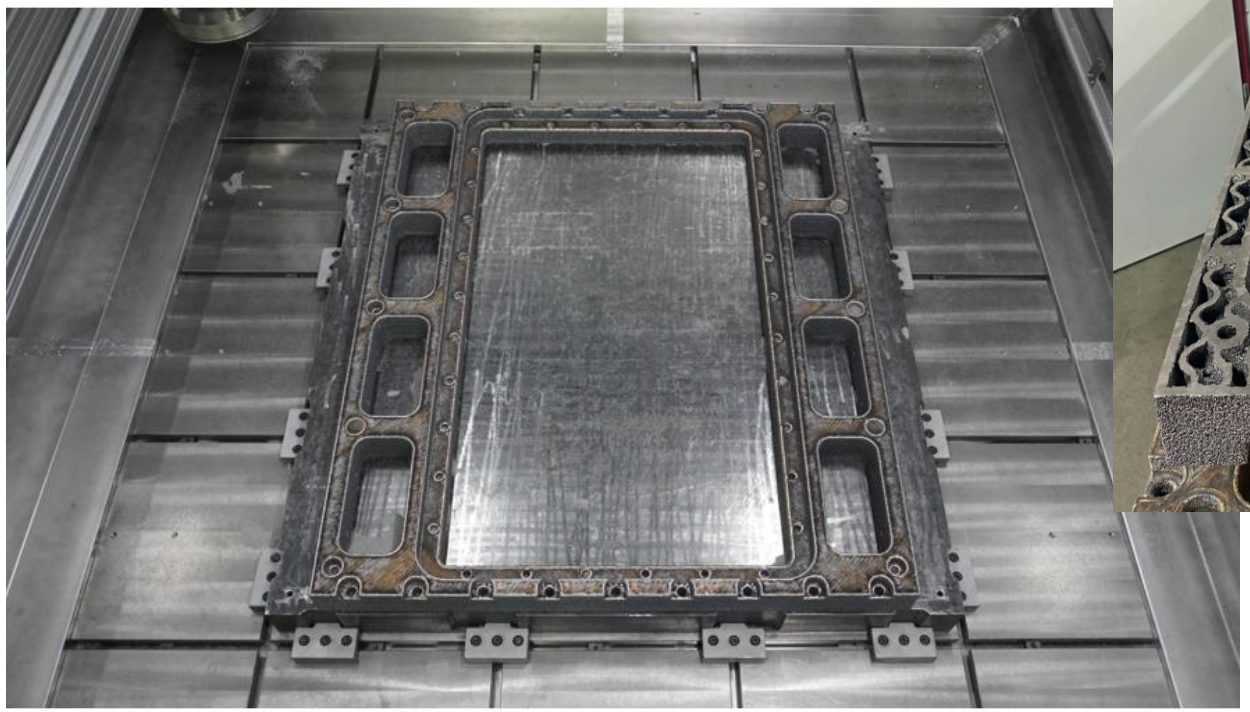
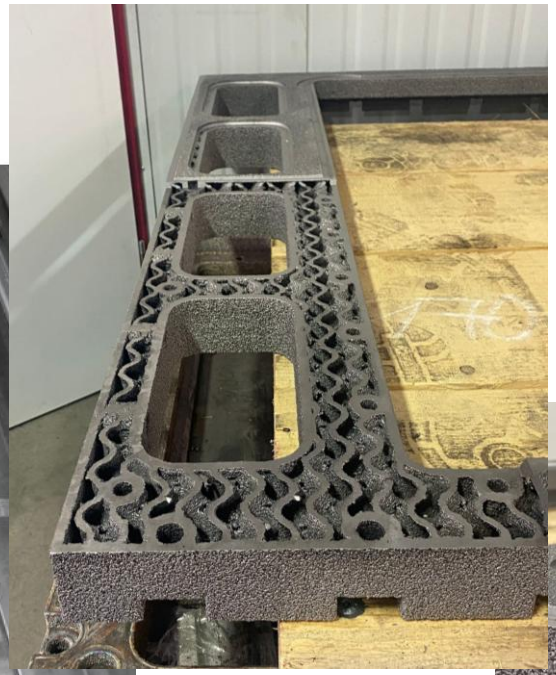
Mold for concrete blocks

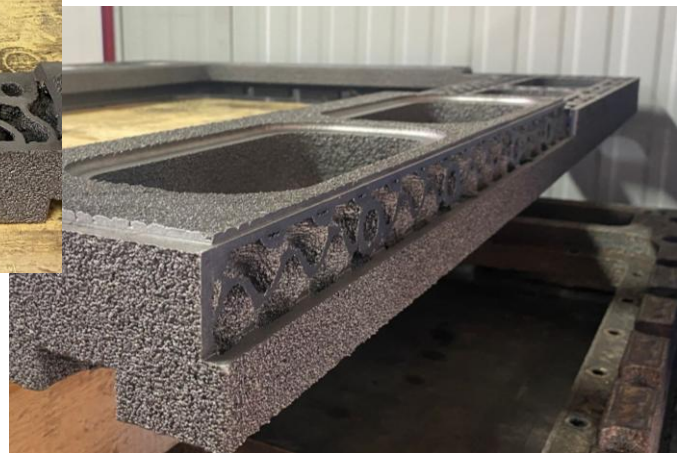
in cooperation with:

Kobra Formen GmbH

- Printed weight: 120 kg *(30 % Infill → 40 % reduced weight)*
- Build time: 43 h







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Low alloy steel

use case

Machine carrier

in cooperation with:

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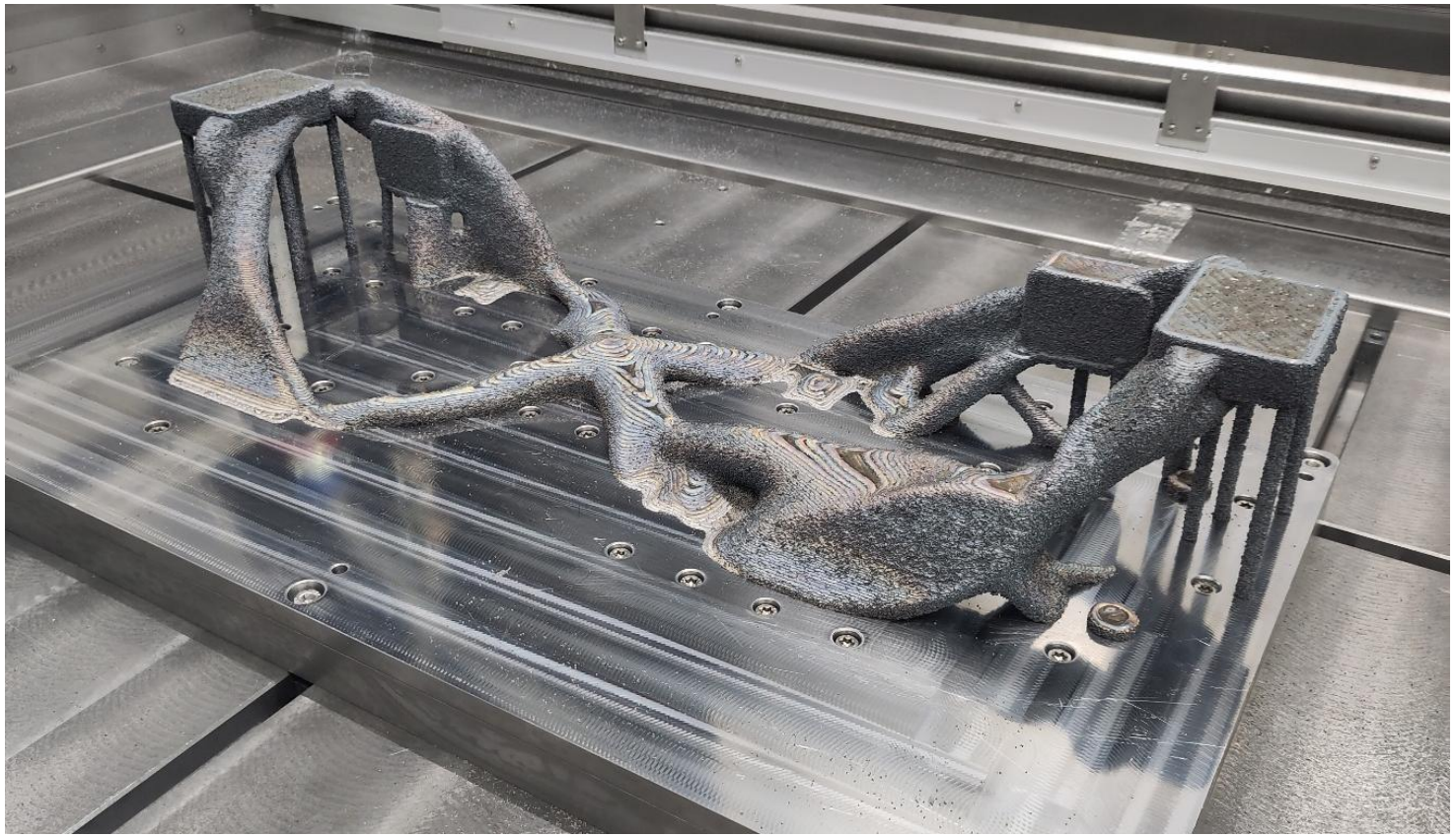
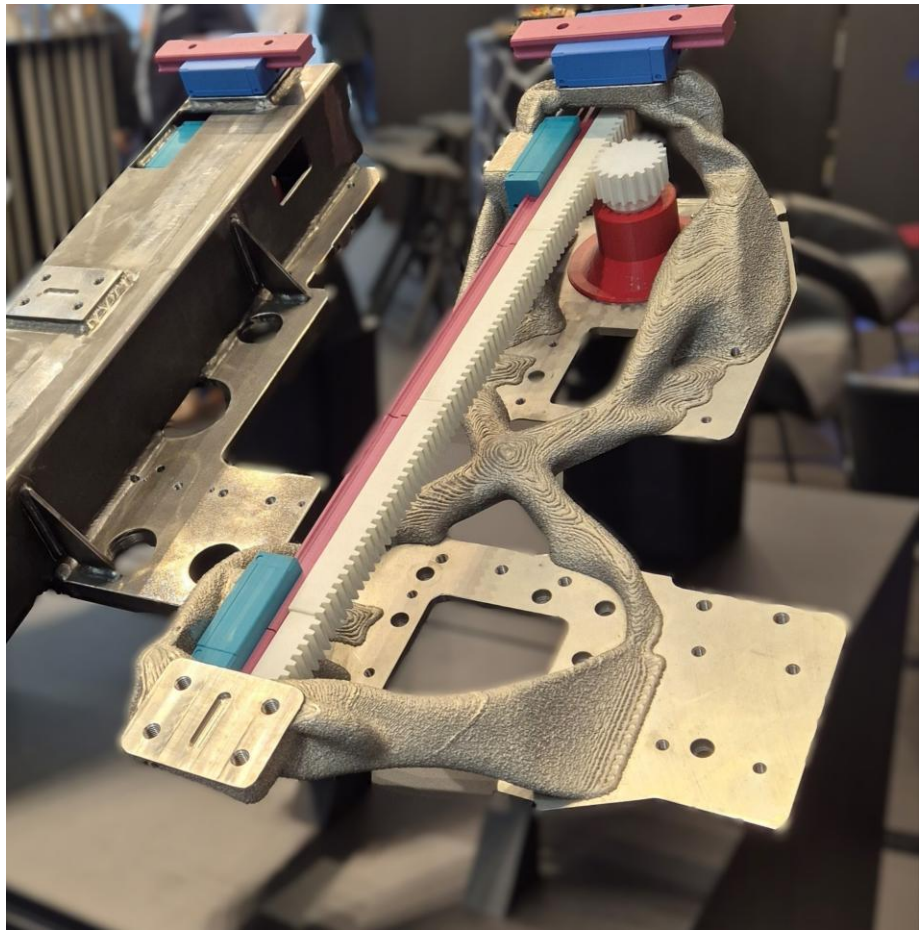
low alloy steel with 0.9 % carbon
30 kg, 13 h build time





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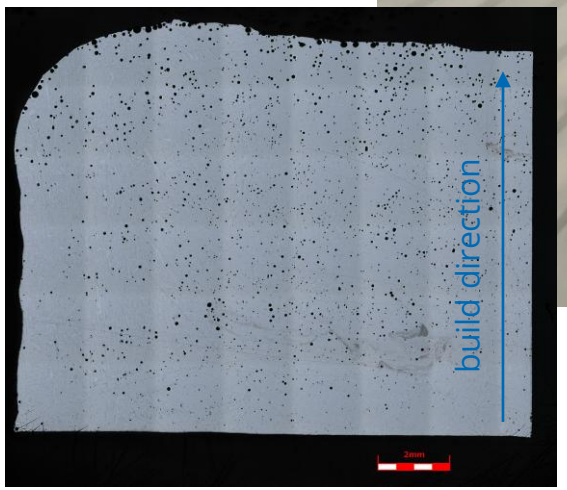
Aluminum

Aluminum

AlSi10Mg

- Lower T_m → 60 % higher volume rate than steel
  → 5.5 kg/h theoretical build rate
- Porosity due to hydrogen
- Closed & spherical porosity
- $\rho \leq 2.63$ g/cm³
- $\rho_{rel} \approx 97$ %
- Hardness “as-built” 90 ± 5 HV0.5



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Conclusion

Conclusion

- Combines advantages of LPBF (complexity) and DED processes (build rate)
- 20 x faster than classic LPBF
- Multiple m³ build volume
- Coarse-grain metal particles → factor 10 cheaper than standard LPBF powder
- Melting rate up to 10 kg/h (@ 8 kW and stainless steel)
- Fast production of near-net-shape and complex components
- ≥ 99.3 % rel. density (stainless steel and case hardening steel)
- Tensile tests results for stainless steel exceed the required standards
- Alternative to metal casting and milling
- Post-processing of the functional surfaces required
- Applications: full size prototypes, tools, molds, structural elements ...

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Get in touch with us

HOCHSCHULE MITTWEIDA
University of Applied Sciences

Michael Pfeifer, M.Sc.
Technology Transfer

Laserinstitut Hochschule Mittweida
Technikumplatz 17 | D-09648 Mittweida

P +49 (0) 3727 58-1396
pfeifer@hs-mittweida.de
www.laser.hs-mittweida.de

Laserinstitut Hochschule Mittweida
Schillerstrasse 10 | D-09648 Mittweida

www.laser.hs-mittweida.de