

3DMP®

Fast | Simple | Economic

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3DMP® - 3D Metal Print
fast | simple | economic



GEFERTEC

GEFERTEC GmbH

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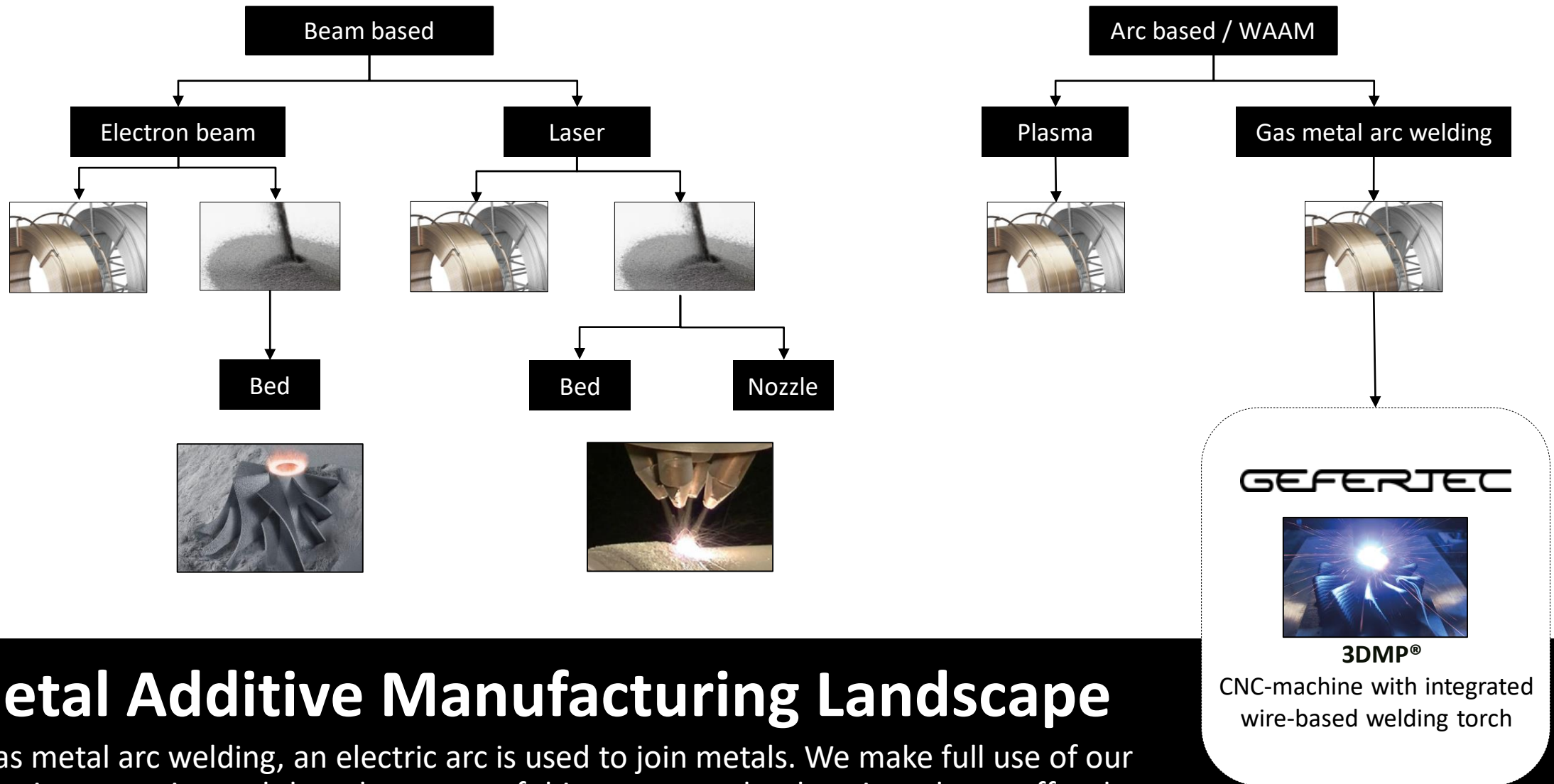


- Founded January 2015
- Part of [BERLIN.INDUSTRIAL.GROUP](#) and [EMAG Gruppe](#)
- 40 employees (R&D, product development, application center, sales) Status 09/2018
- References:
 - FIT AG
 - Siemens
 - flying-parts GmbH
 - Rolf-Lenk Werkzeug- und Maschinenbau GmbH
 - NingBo XJ Aerotech Co., Ltd
 - IMN - Instytut Metali Nieżelaznych
 - Harlow Group Ltd.
 - SLV Halle

3DMP® Application Center

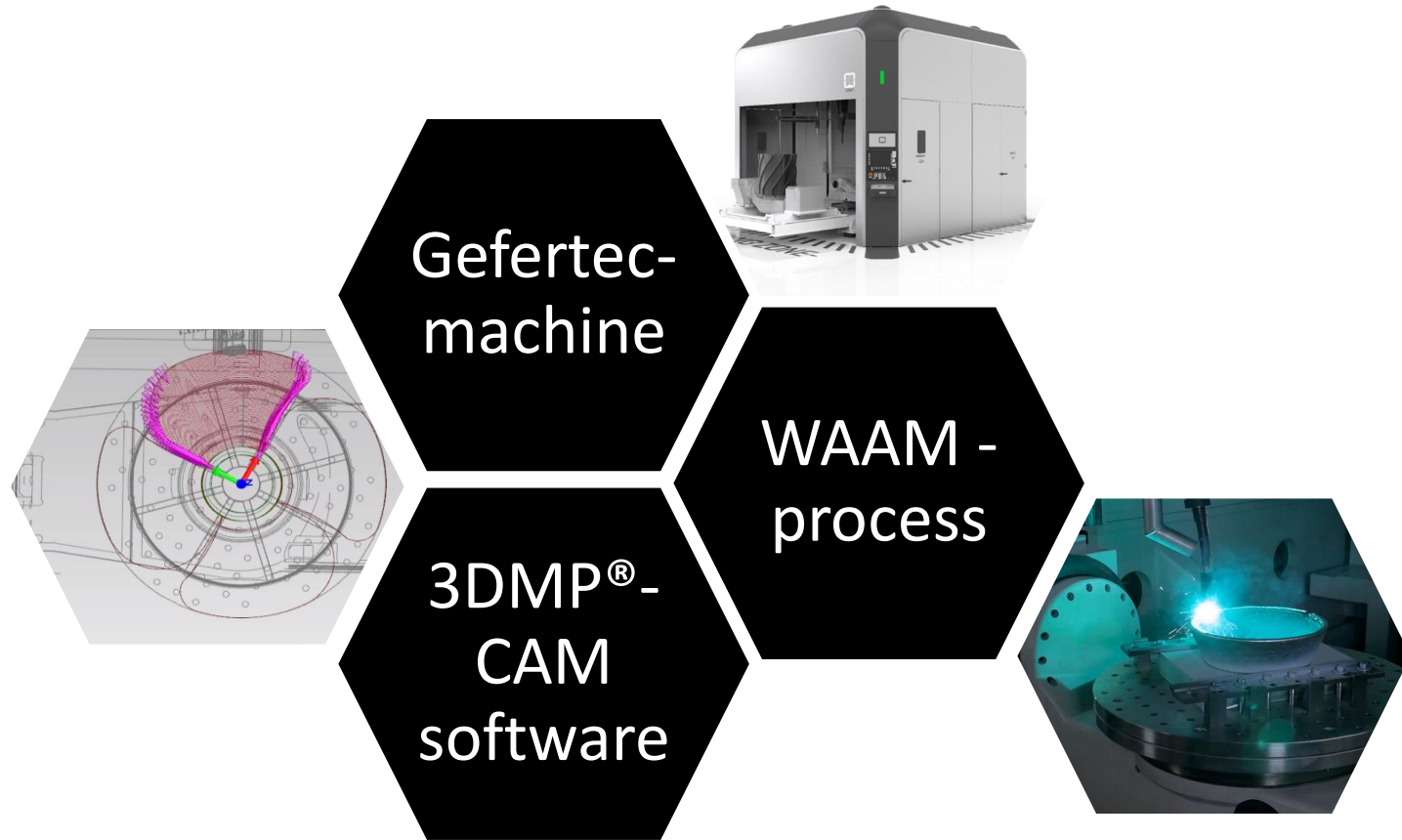
- Project based work
- Process development
- Live machine and process demonstration
- 3x arc400 and 2x arc600 machine series





Metal Additive Manufacturing Landscape

In gas metal arc welding, an electric arc is used to join metals. We make full use of our extensive expertise and the advantages of this mature technology in order to offer the layered printing of several metal layers in a fully automated, digitally controlled and easy to use manner.



What Is 3DMP®?

Due to the integration of a simple WAAM process, an easy to use CAM software and the GEFERTEC machinery, a revolutionary as well as sustainable solution for manufacturing is provided.

Arc instead of laser

- No laser nor electron beam technology
- Matured process
- Digitally controlled and easy to use
- Fully automated





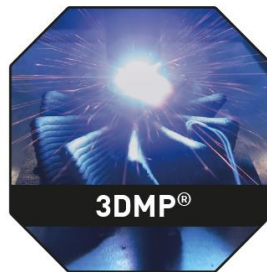
Wire instead of powder

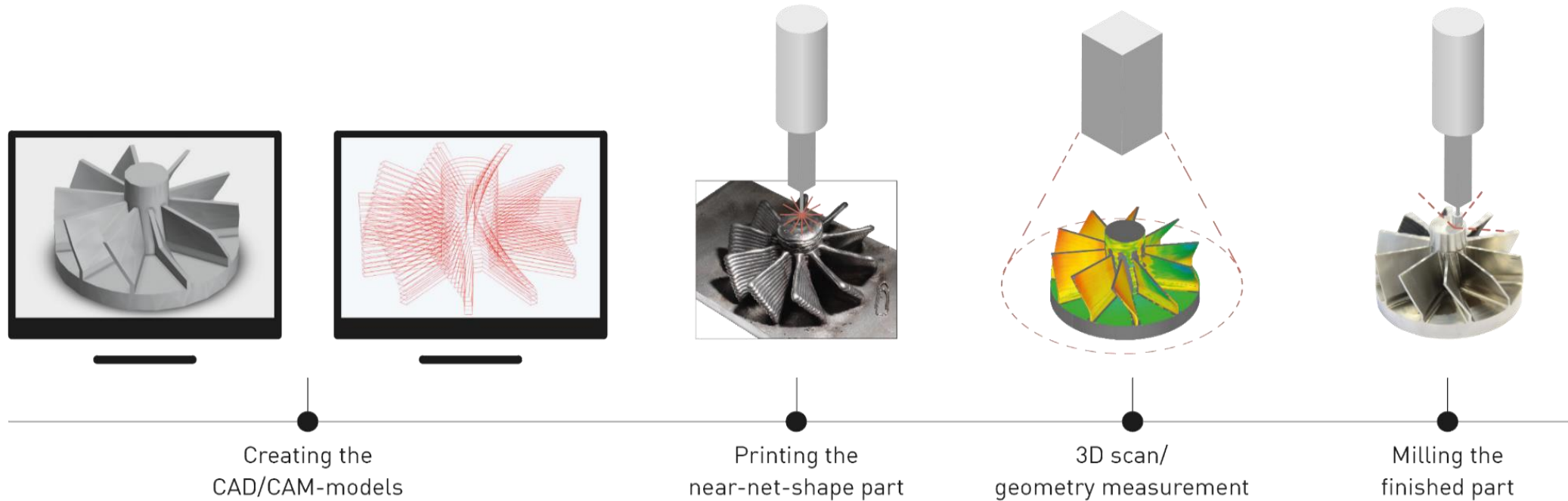
- Nearly 100 % material utilization
- Low material costs
- Easy handling
- Uncomplicated storage
- Extensive selection of materials



3DMP® is...

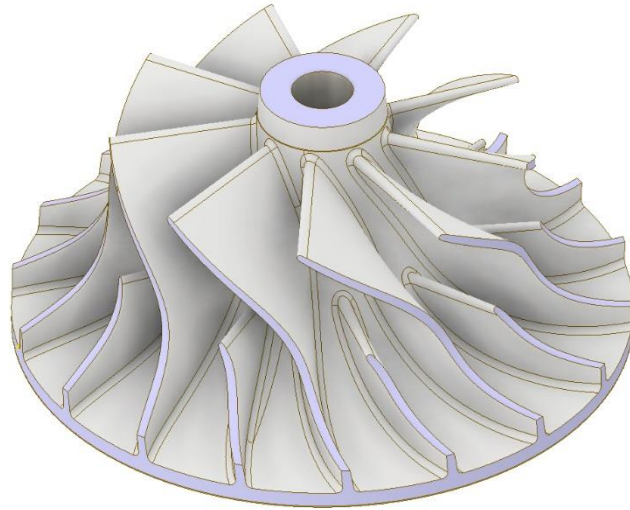
Fast. Simple. Economic.



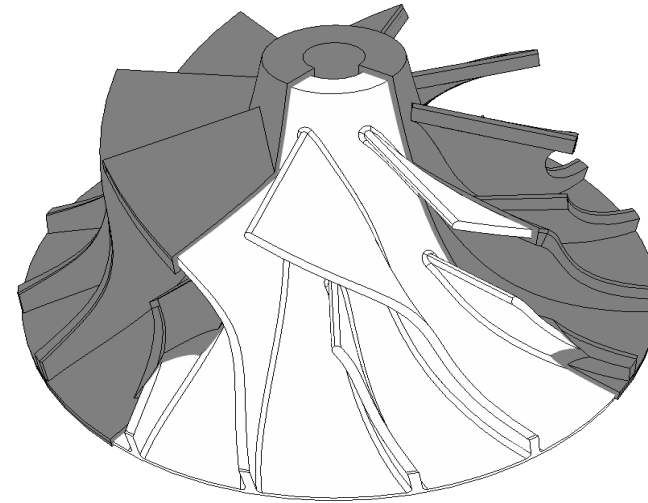


The 3DMP® Process Chain

3DMP® combines the technically mature and highly reliable arc welding method with the CAD data of the metal parts that are to be produced. The CAD data will be converted into individual digital printing layers, the so-called CAM models. Then, the blank part is printed fully automatically and in a controlled manner. This step is followed by a 3D scan for quality control and finally the milling of the finished part.



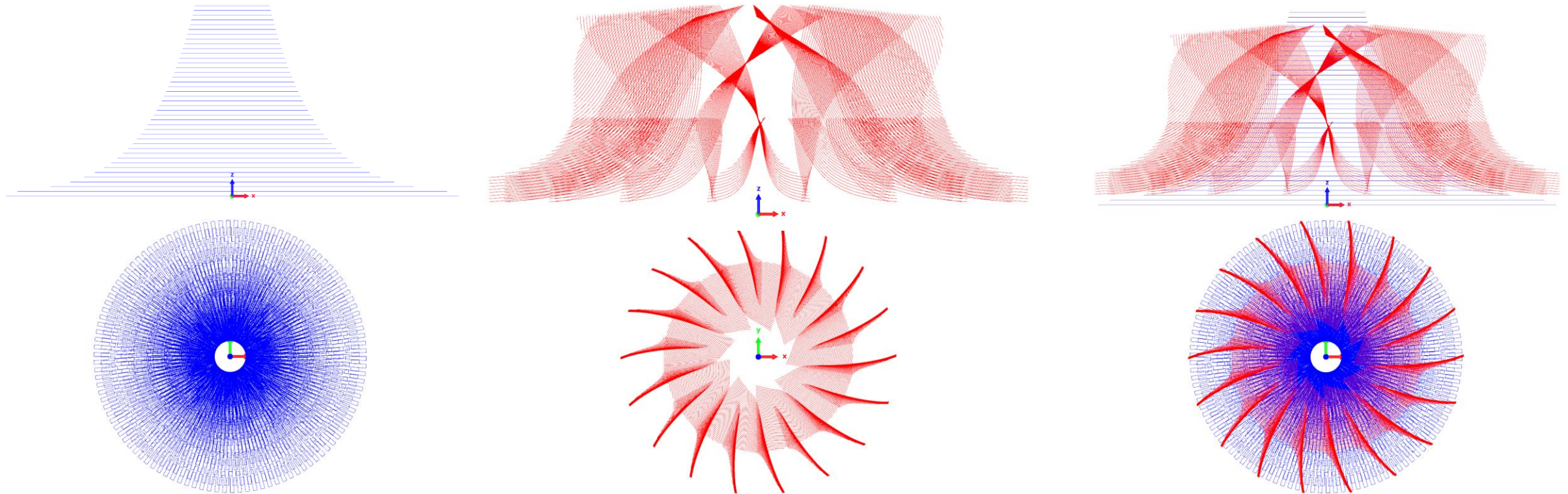
CAD model (final part)



Offset model vs. final part

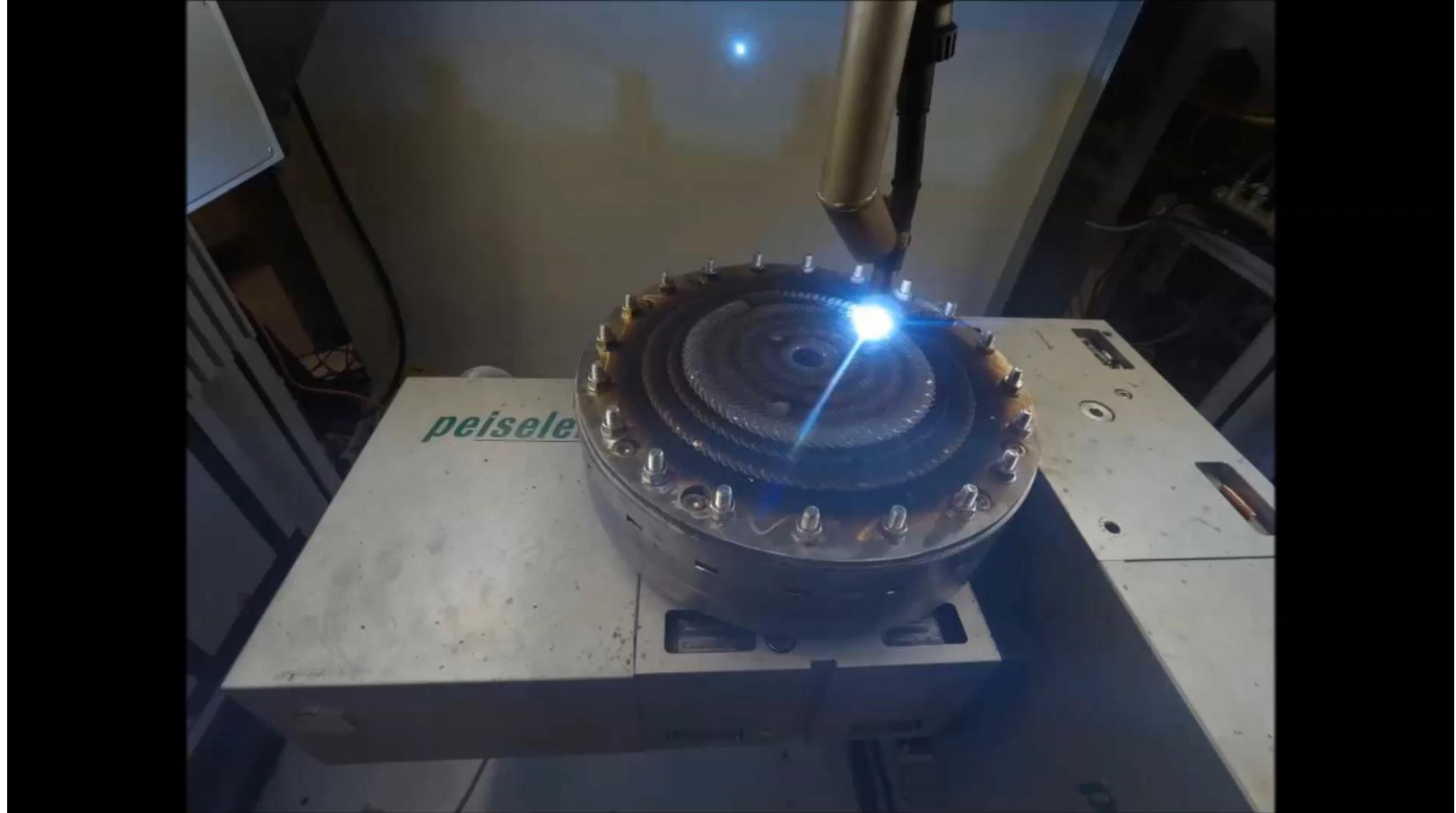
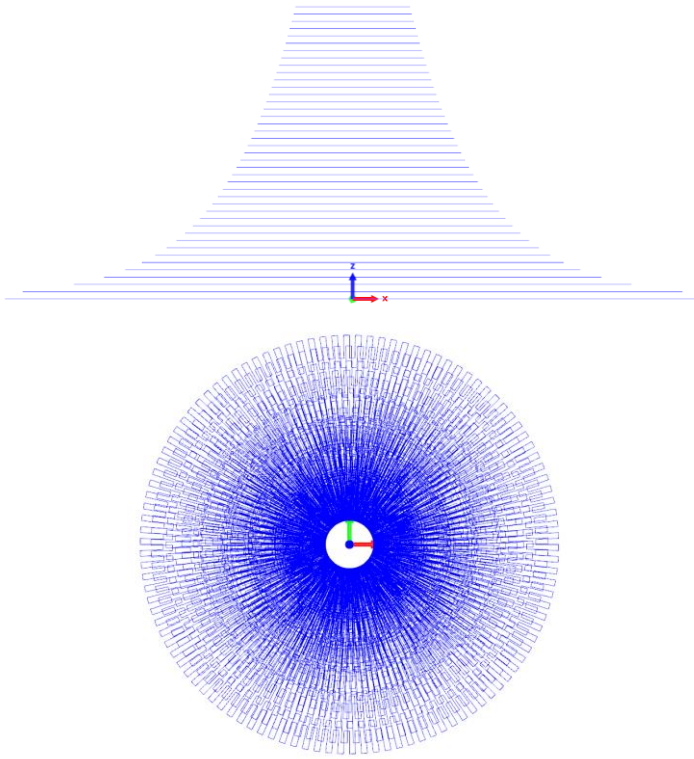
The 3DMP® Process Chain: The Offset Model

Due to the final milling operation and the clamping during the process a slightly oversized CAD model (offset model) is required. Compared to the raw material block in conventional manufacturing, 3DMP® leads to less wasted chipping material in the end.



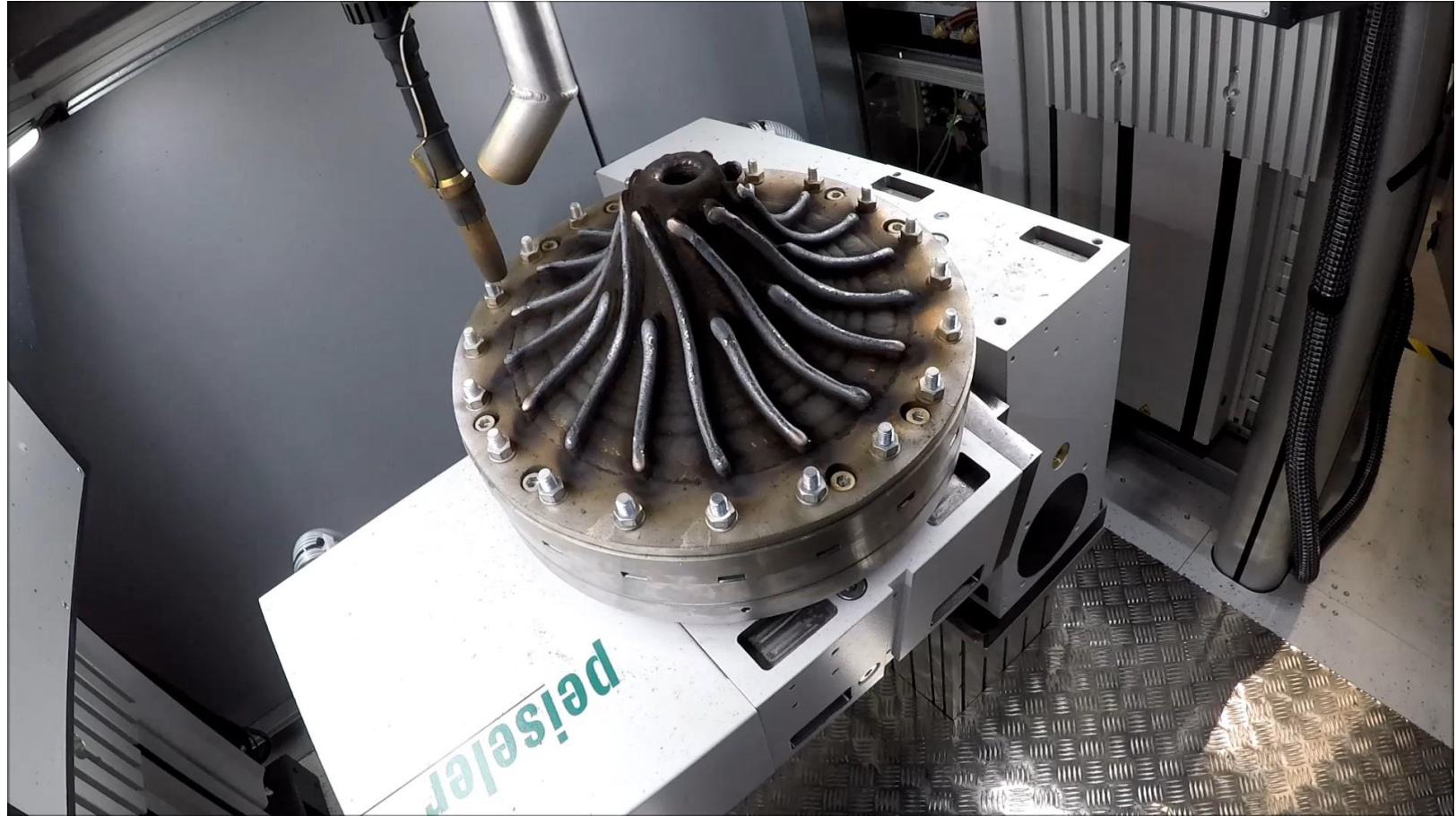
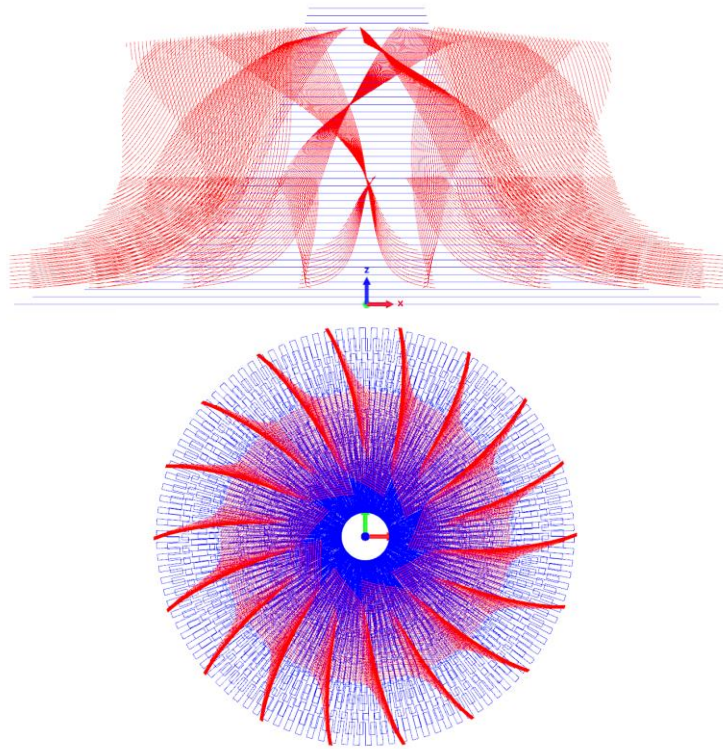
The 3DMP[®] Process Chain: Generating The CAM Model

In order to create a NC-Code, the offset model is converted into a CAM model by slicing layer by layer.



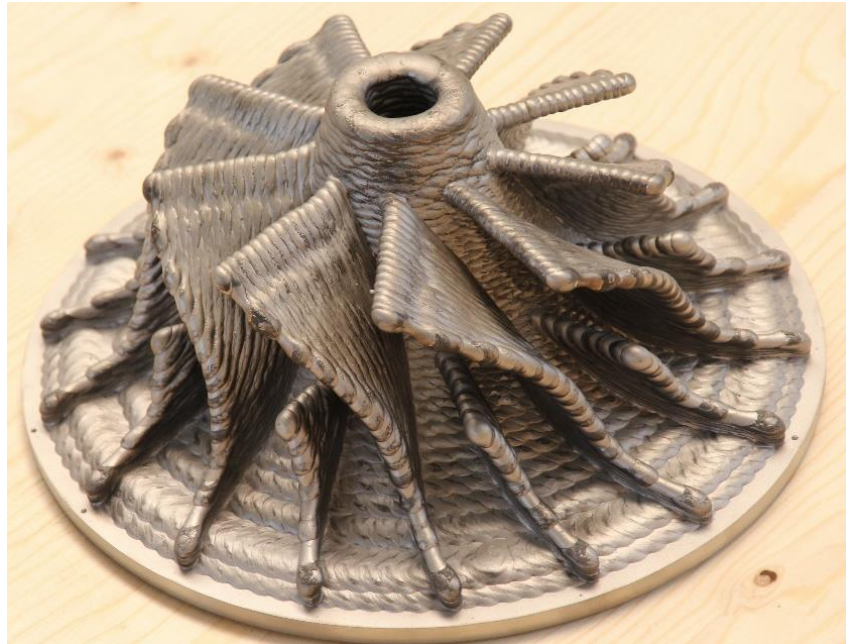
The 3DMP® Process Chain: Printing

First, the cone is printed in a 3 axis machine.



The 3DMP® Process Chain: Printing

Afterwards, the impeller blades are printed onto the cone.

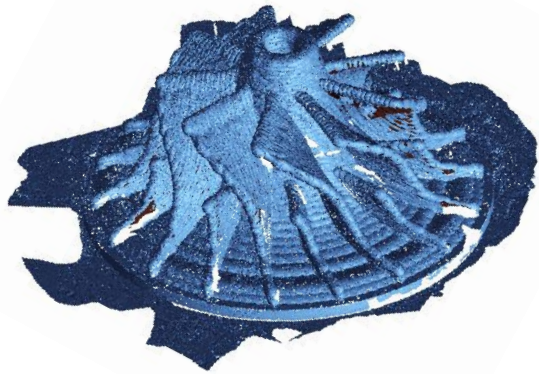


Printed part

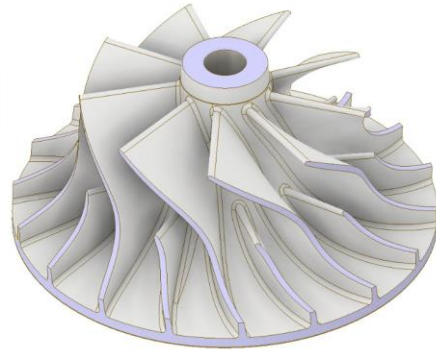
- Material: 1.4370
- Build-up rate: 350 cm³/ h (21 in³/ h)
- Printed volume: 2450 cm³ (150 in³)
- Printed mass: 19,4 kg (43 lb)
- Mass incl. base plate: 29 kg (64 lb)
- Printing time: 7 h

The 3DMP[®] Process Chain: Printing

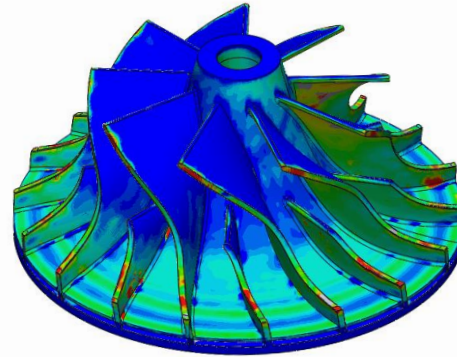
Printing the near net shape part by using a wire-based arc welding process. Build-up rate depends on material as well as geometry.



3D-Scan



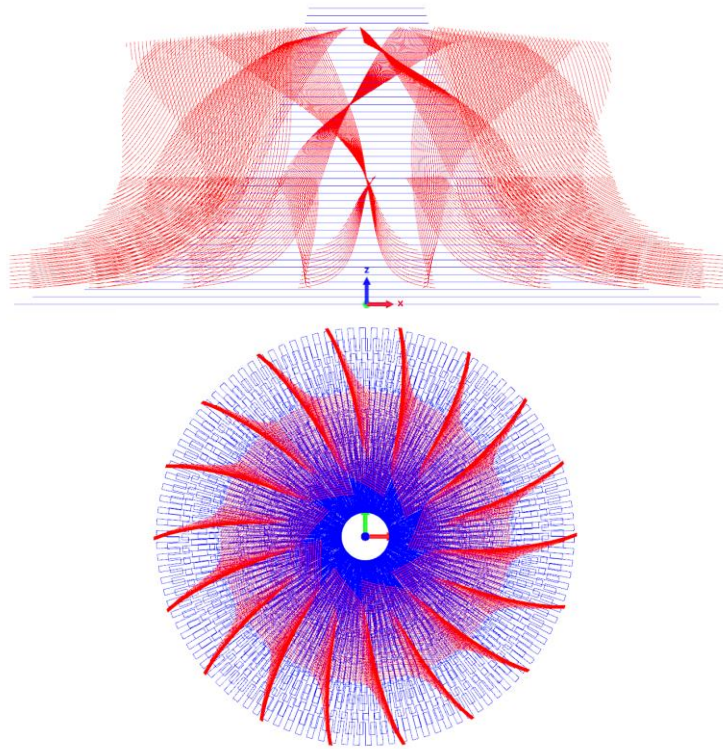
Target geometry

Comparison actual /
target geometry

Finished part

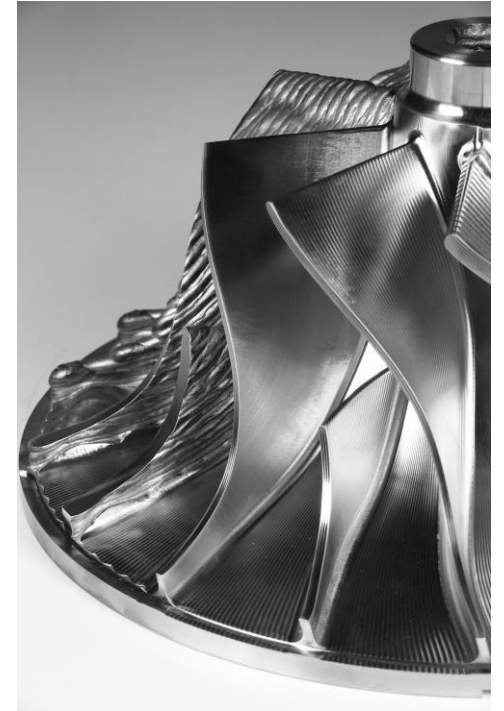
The 3DMP[®] Process Chain: 3D-Scan And Milling Operation

The printing operation is followed by a quality control in terms of 3D-Scan to measure the distortion. Therefore, the actual geometry is compared to the target geometry according to the drawing. Based on the geometry comparison the finished part is machined.



The 3DMP® Process Chain: Finishing

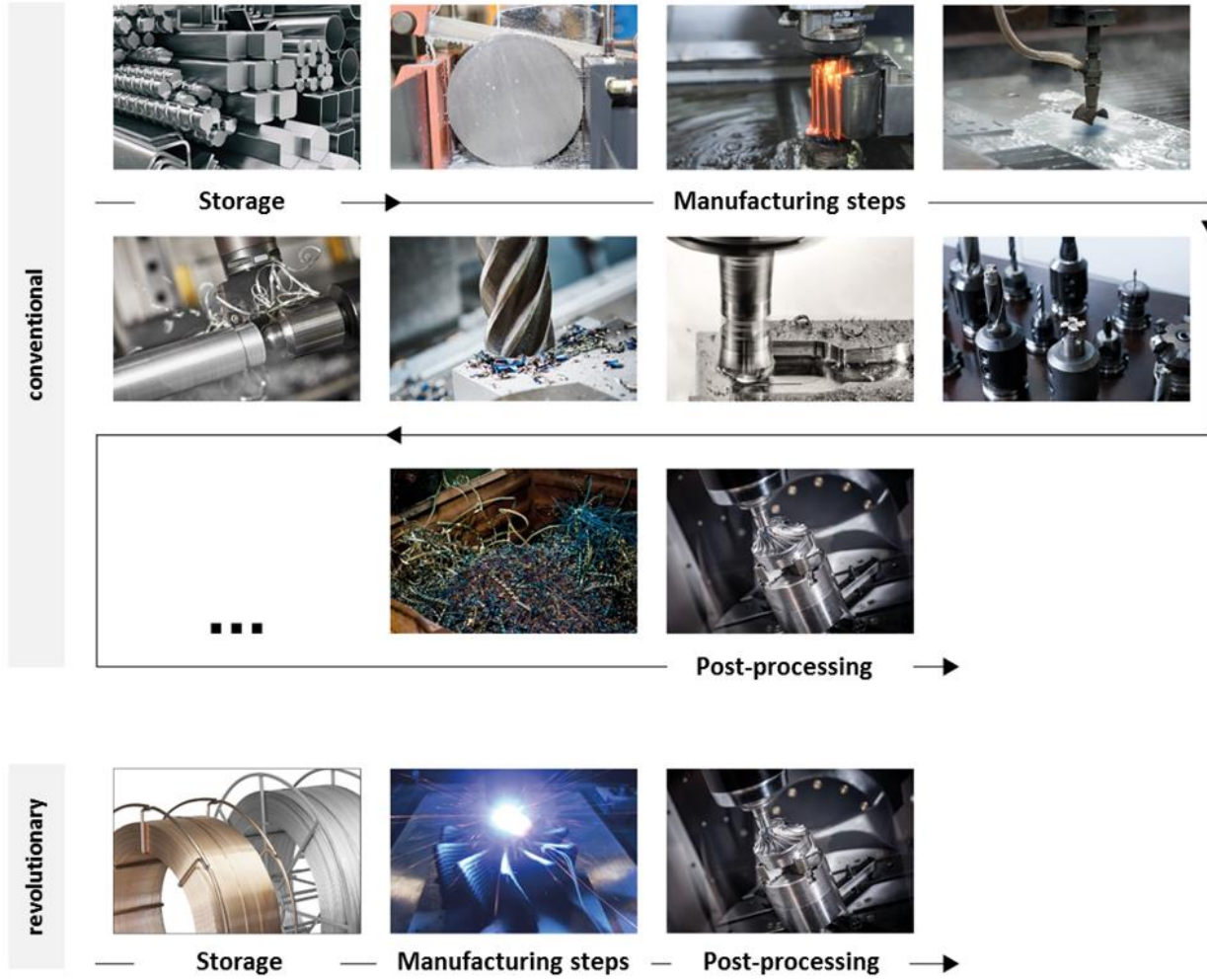
After the printing process the part is generally finished applying milling or turning operations.



Partly finished part as demonstration sample

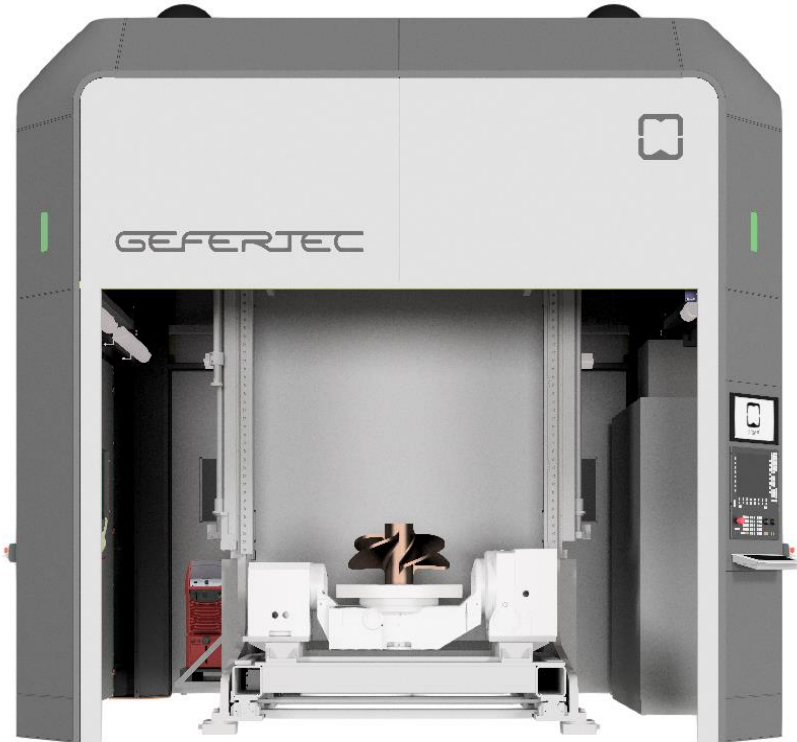
The 3DMP[®] Process Chain: Finishing

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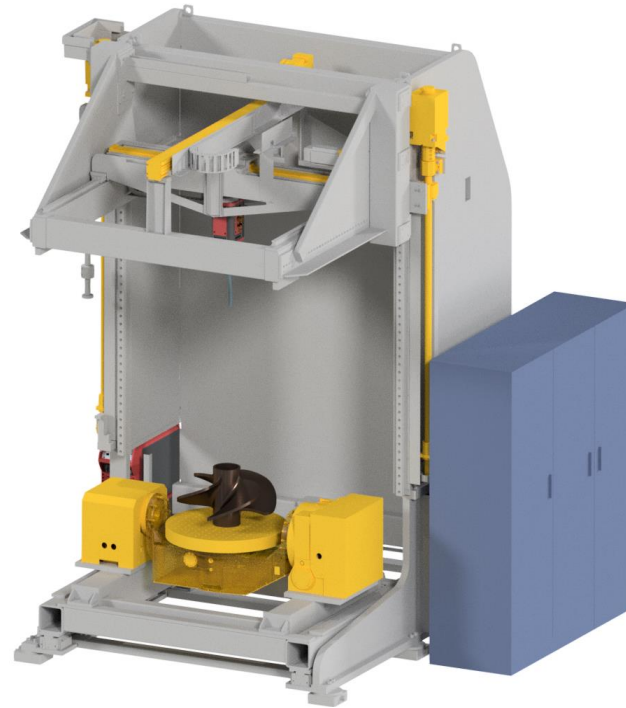
Conventional manufacturing versus 3DMP®

- Reduced material storage facility
- Reduced number of manufacturing steps
- Lower handling costs
- Less tool wear and material waste
- Complementing conventional manufacturing
- Focusing on core competences

**arc605:**

Outer dimensions: 4,5 x 4,5 x 4,5 m

Max. printed volume: 800 l

**arc605: 5-axes****arc605: Control interface**

GEFERTEC Arc Series

Either 3 or 5 motion axes offer maximum flexibility in terms of component volume up to 3000 l.
The machine scalability allows additive production of either small and large high-quality metal parts.

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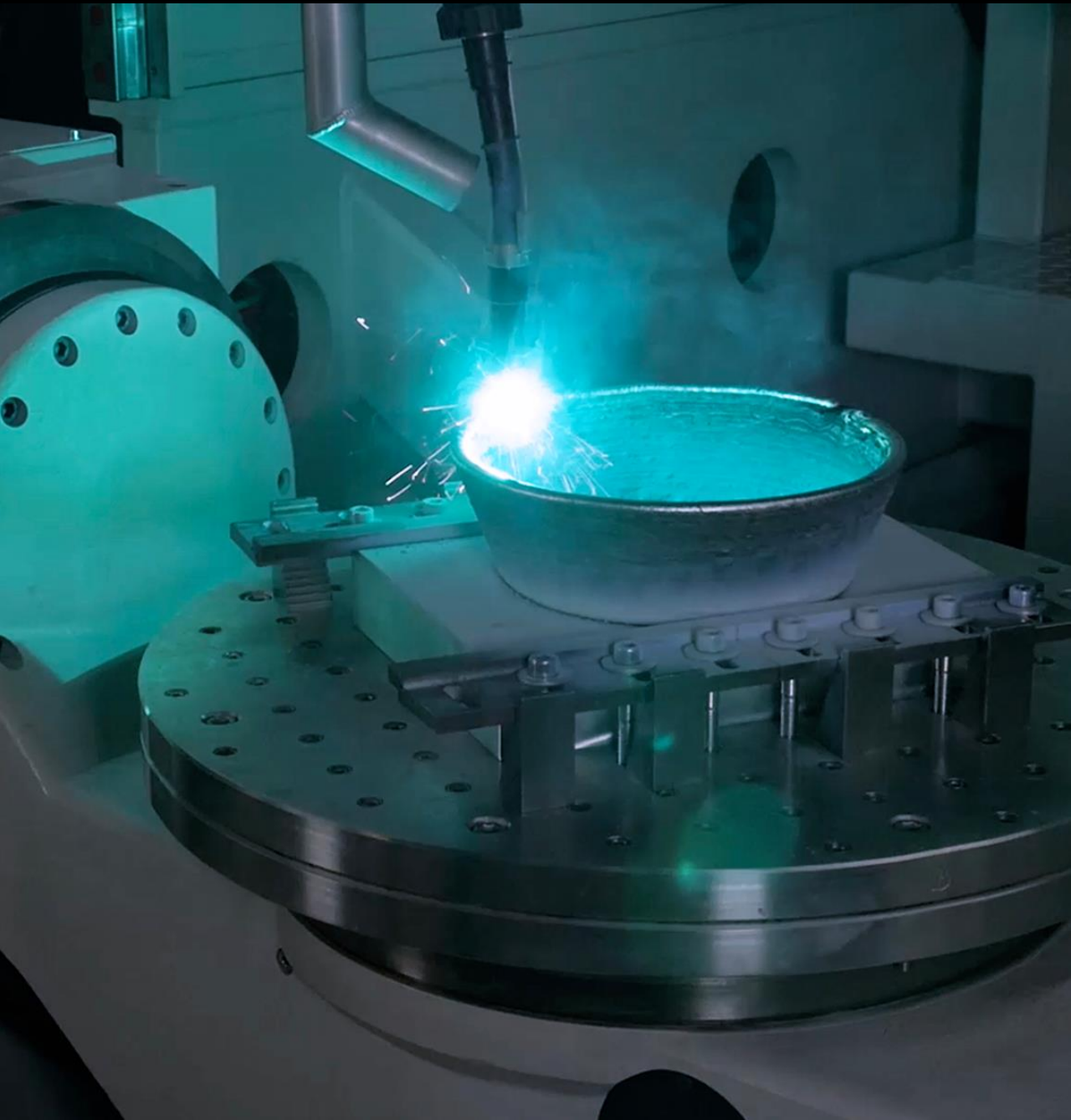
arc405:

Outer dimensions: 3,0 x 2,3 x 3,1 m
Max. printed volume: 120 l
Axes: 5



arc403:

Outer dimensions: 3,0 x 2,3 x 3,1 m
Max. printed volume: 600 l
Axes: 3



3DMP[®] is fast

- Aluminum: 600 cm³/ h (1,6 kg/ h)
- Steel: 450 cm³/ h (3,5 kg/ h)
- Ni-Based: 450 cm³/ h (3,5 kg/ h)
- Titanium: 450 cm³/ h (2,3 kg/ h)

Process-oriented

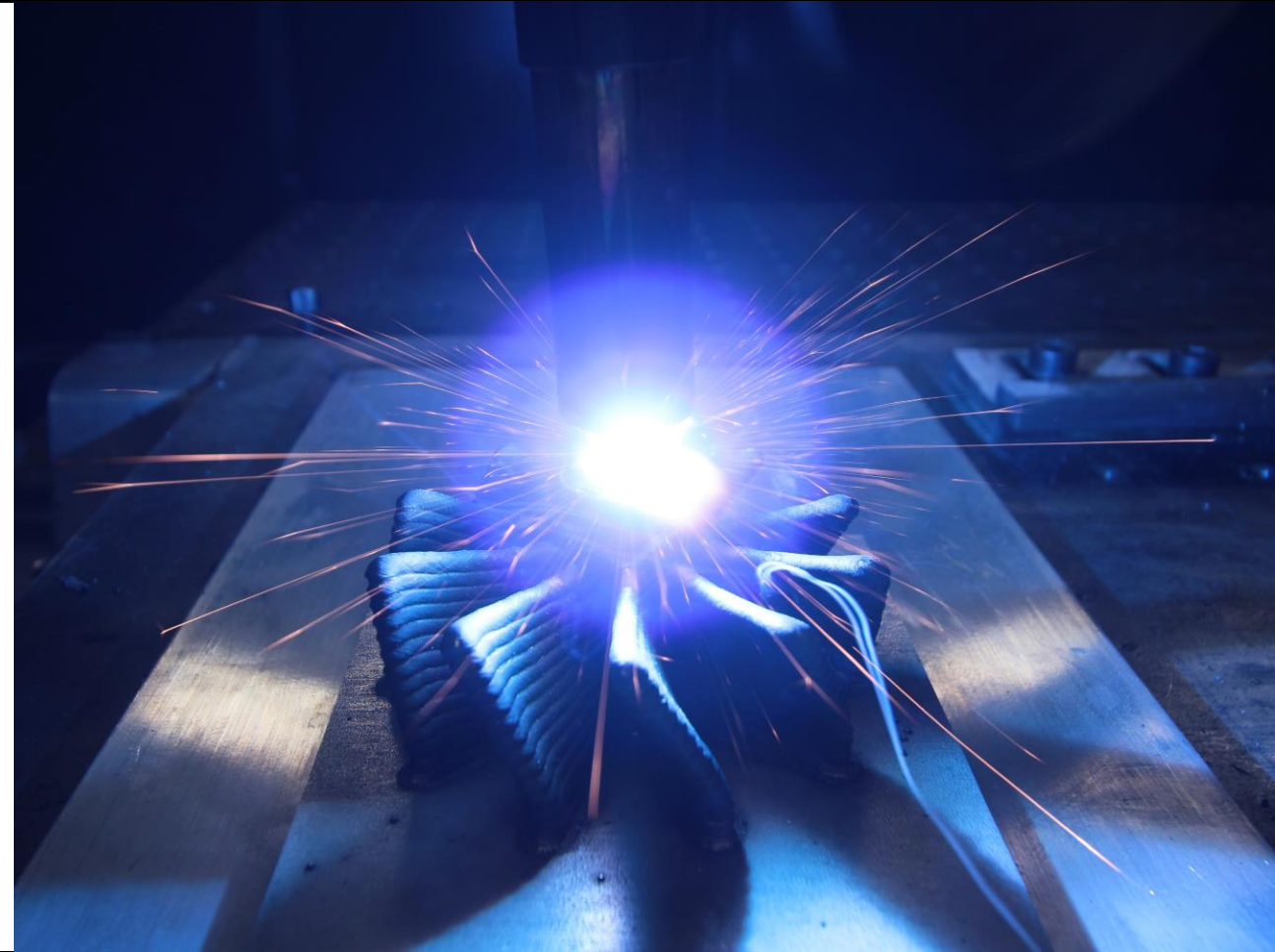
- High cost chipping
- Forging
- Ineffective Casting

Application-oriented

- Prototypes & Repair
- Small batches
- Tool making

Component-oriented

- Multi-materials
- Freedom of design
- Inner structures



3DMP® Application Scenarios Are Diverse

Replacing Milling Operations

- Reducing chip volume
- Saving high-cost materials
- Reducing tool wear
- Reducing lead time

Conventional Manufacturing

Material: 1.4305



Raw Material
85 kg
Blank costs: 1.000 €



Milling
Chips: 67 kg (80%)
Milling costs: 3.500 €



Finished Part
18 kg
Total costs: 4.500 €

3DMP®

Material: 1.4316



Printed Blank (6.5 h)
25 kg (printed volume: 17 kg)
Blank costs: 750 €



Milling
Chips: 7 kg (28%)
Milling costs: 1.250 €



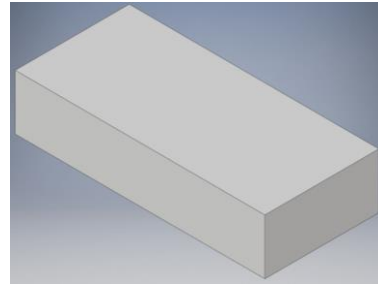
Finished Part
18 kg
Total costs: 2.000 €

AM Of Titanium

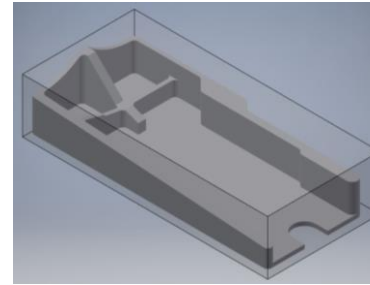
- Reducing high chip volume
- Saving high cost materials
- Reducing tool wear
- Reducing lead time
- Replacing forging operations

Conventional Manufacturing

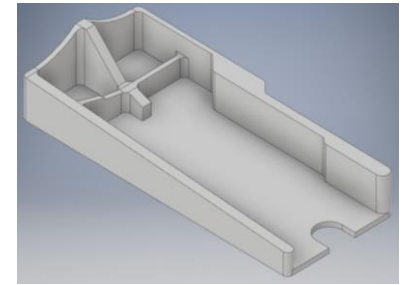
Material: Ti6Al4V



Raw Material
14.4 kg



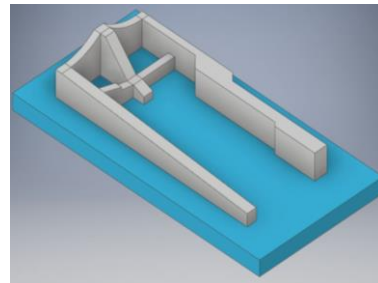
Milling
Chip mass: 12.3 kg



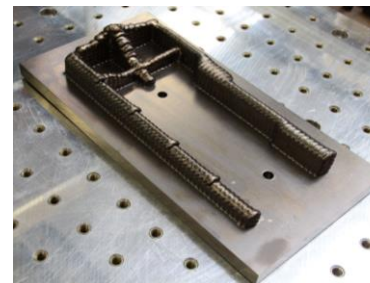
Finished Part
2.1 kg

3DMP®

Material: Ti6Al4V



Offset model for 3D-Print
Mass Printing: 1.7 kg
Mass base plate : 2.8 kg



Milling
Chip mass: 2.4 kg



Finished Part
2.1 kg

3DMP® For Small Batches And Prototypes

- Replacement of casting operations
- Cost savings
- No moulds and tools required
- Increase of flexibility
- Economically efficient as of a batch size of 1



[1]

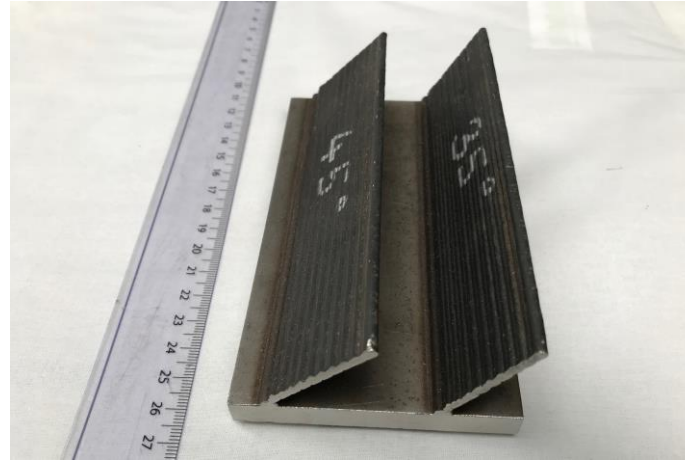
3.3548 | AL 5183 | AlMg4,5Mn0,7



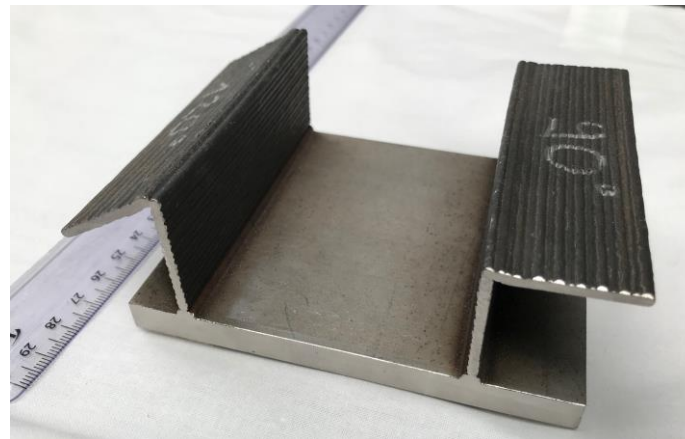
2.0921 | CuAl8

3DMP® To Enlarge Design Freedom

- Manufacturing complex geometries
- Outstanding build-up rates
- Manufacturing bigger parts



Feasible overhang on 3-axis machine



Feasible overhang on 5-axis machine



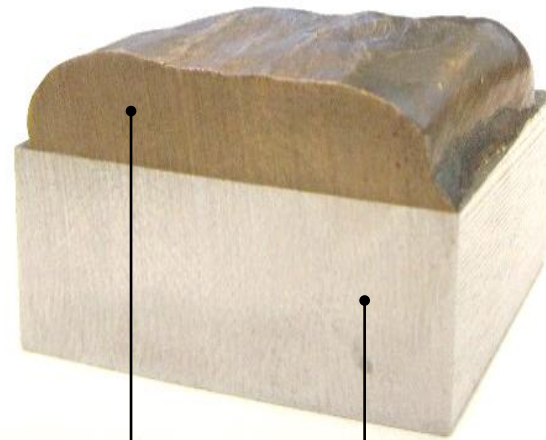
1.5125 | G3Si1 | Mild Steel



1.2367 | X38CrMoV5 3
Hot Work Tool Steel

3DMP® Tool Making

- Fast implementation of design changes
- Multi-materials
- Wear- resistant coatings
- Inner structures for cooling



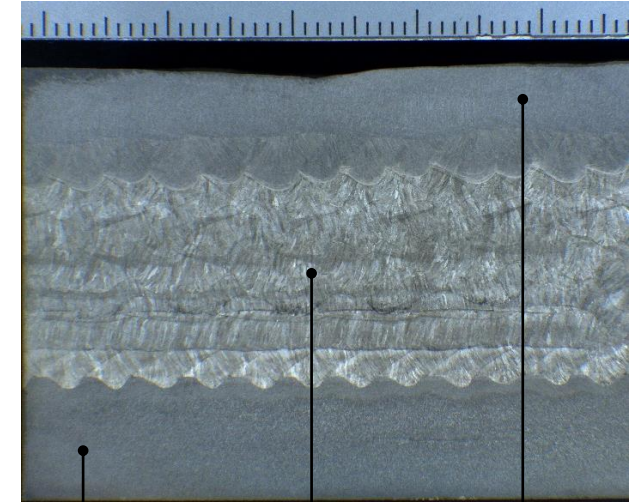
Copper
Base
(2.0921)

Stainless
Steel
(1.4301)



Duplex Steel
(1.4462)

Mild Steel
(1.0045)



Mild Steel
(1.0045)

Stainless
Steel
(1.4370)

Hardfacing
(1.4718)

Functional Structures

- Water cooling channels
- Circular channels (figure 1) extremely challenging
- Figure 2 and 3 ensure high process reliability due to the geometric structure

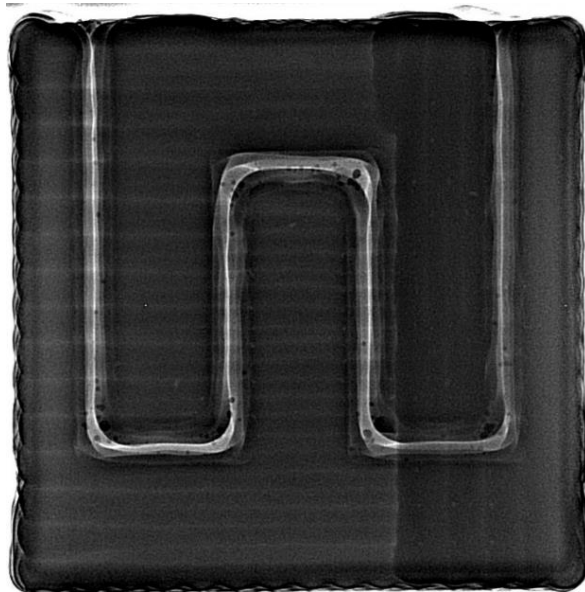


Figure 1

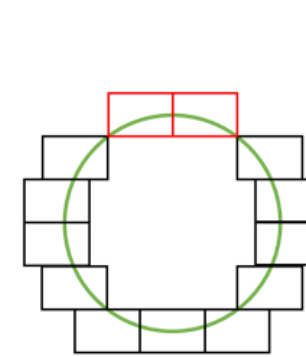


Figure 2

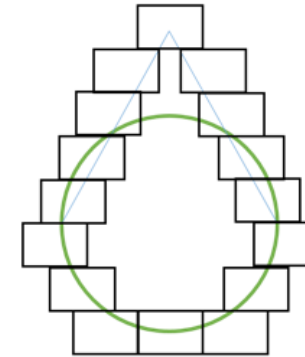
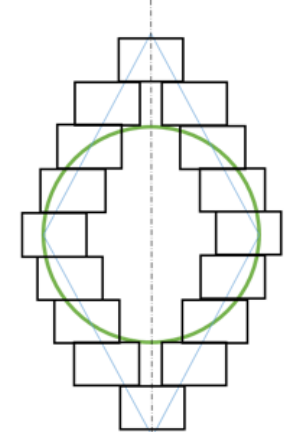


Figure 3



Cross section cooling channel

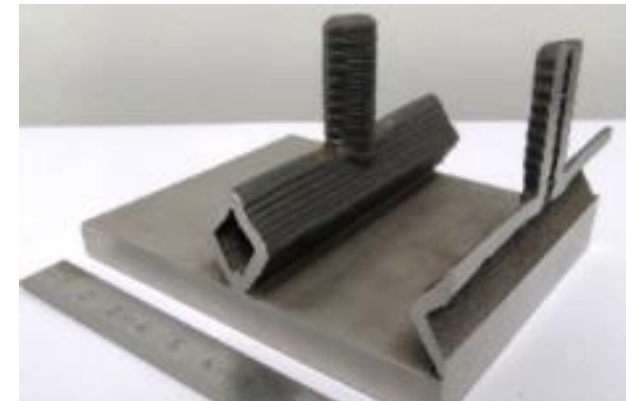


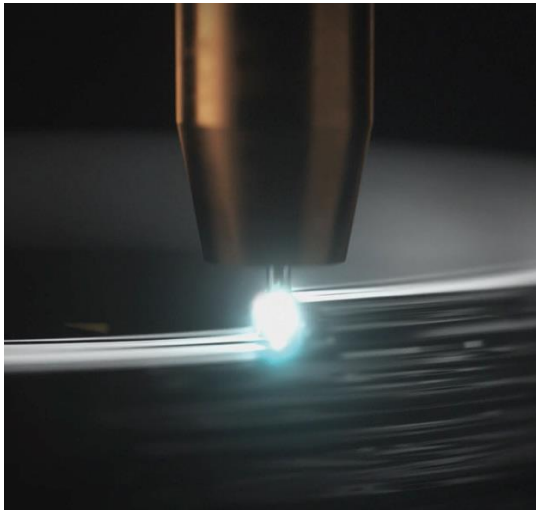
Alternative geometry



Cross section weld bead (simplified)

30°...45°



**Steel**

1.2343 (tool steel)
1.2367 (tool steel)
1.3346 (hard-facing steel)
1.4718 (tool steel)
1.4316 (stainless steel)
1.4370 (stainless steel)
1.4332 (stainless steel)
1.4430 (stainless steel)
1.4462 (high-alloyed CrNi – Duplex)
1.4551 (stainless steel steel)
1.4718 (hard-facing)
1.5112 (mild steel)
1.5125 (mild steel)
1.5130 (mild steel)
1.6834 (low-alloy)

Ni-Based:

1.3912 (Nickel 36)
2.4856 (Alloy 625)
2.4668 (Alloy 718)*

Non Ferrous Metals:

3.7165 (Ti6Al4V/ Grade 5)
2.0921 (Copper based)

Aluminum:

3.0805 (Al99,5Ti)
3.2245 (4043 AlSi5)
3.2315 (6082 AlMgSi1)*
3.2371 (4018 AlSi7)
3.3206 (6063 AlMgSi0,7)
3.3536 (5754 AlMg3)
3.3548 (5183 AlMg4,5Mn)
3.3556 (5356 AlMg5)
3.3546 (5087 AlMg4,5MnZr)

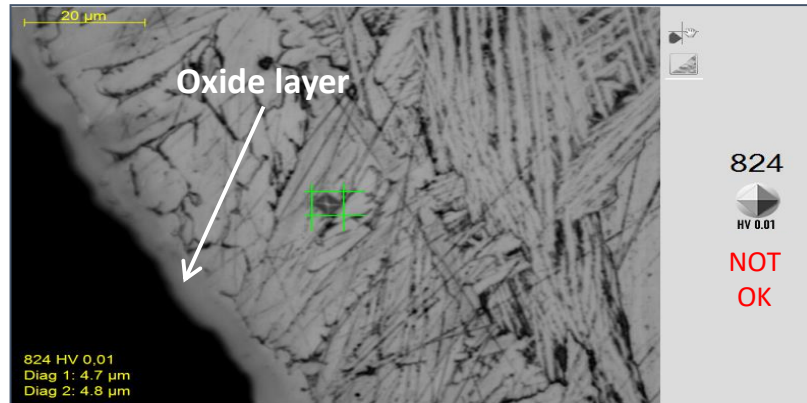
* under examination

Processable Materials

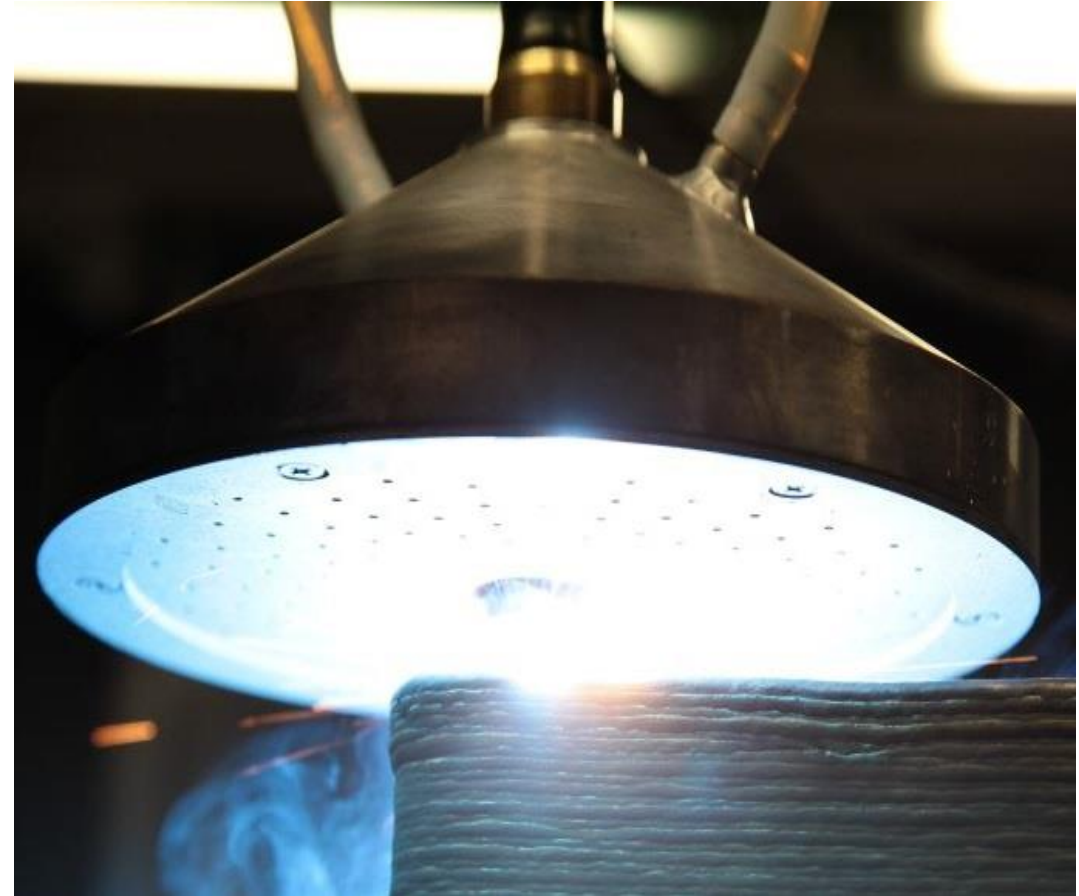
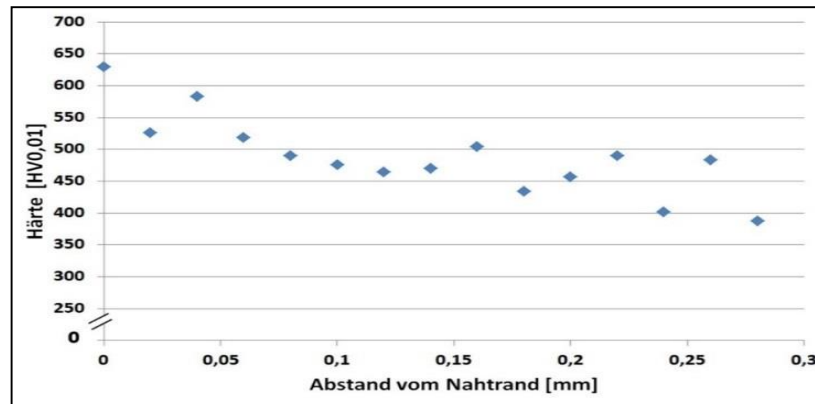
There is an extensive selection of processable materials for 3DMP®.

Basically every weldable material available as wire can be applied in GEFERTEC arc machine centers.

Standard Shielding

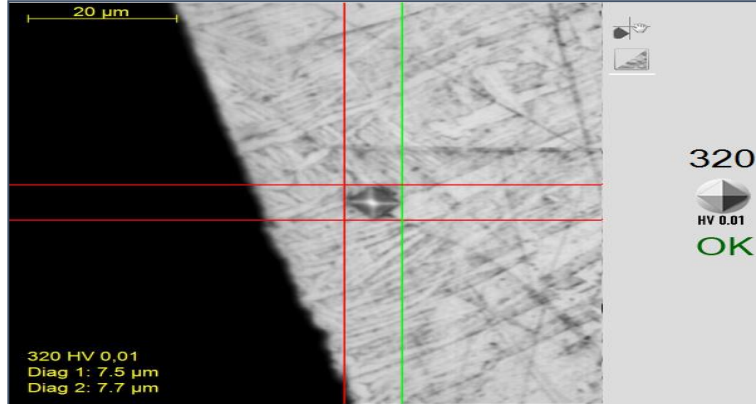


Hardness > 400 HV0,01; surface area up to 824 HV0,01

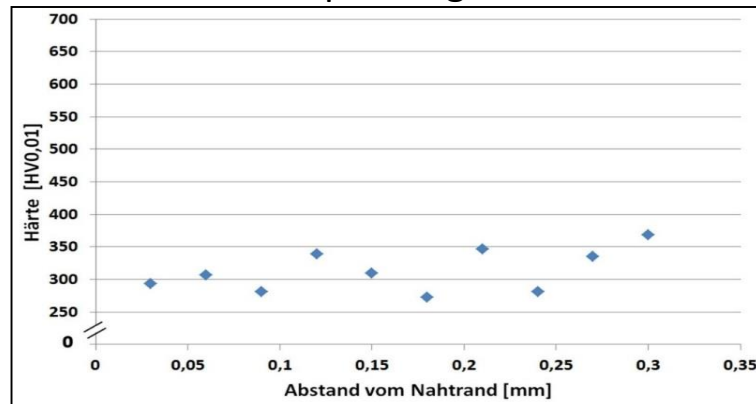


How To Counteract Titanium Oxidation Issues?

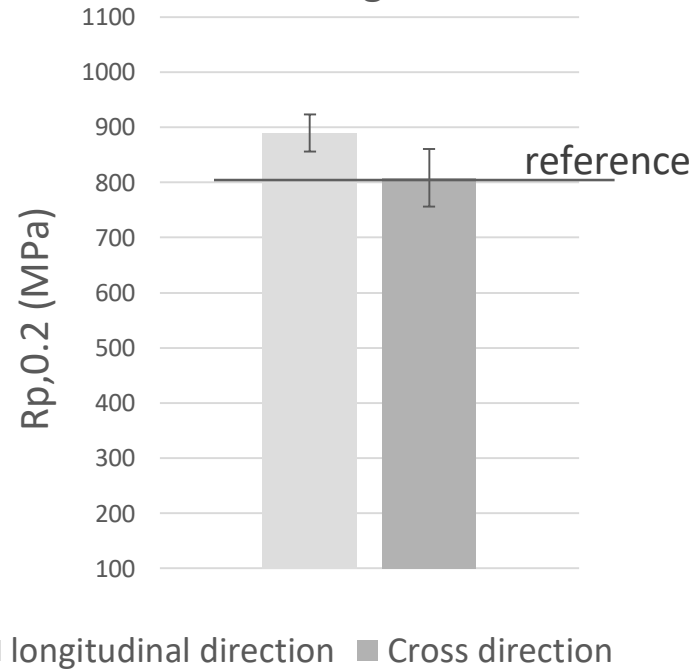
Improved Shielding



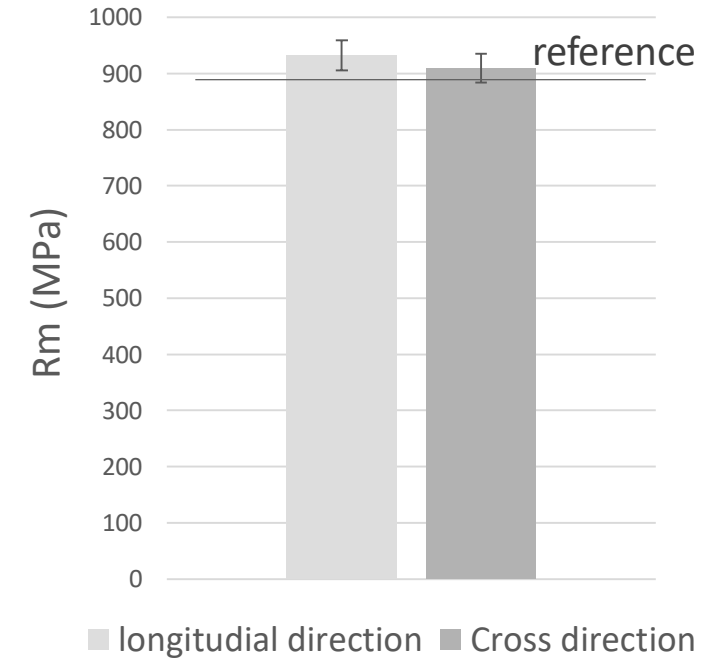
Hardness corresponding to base material



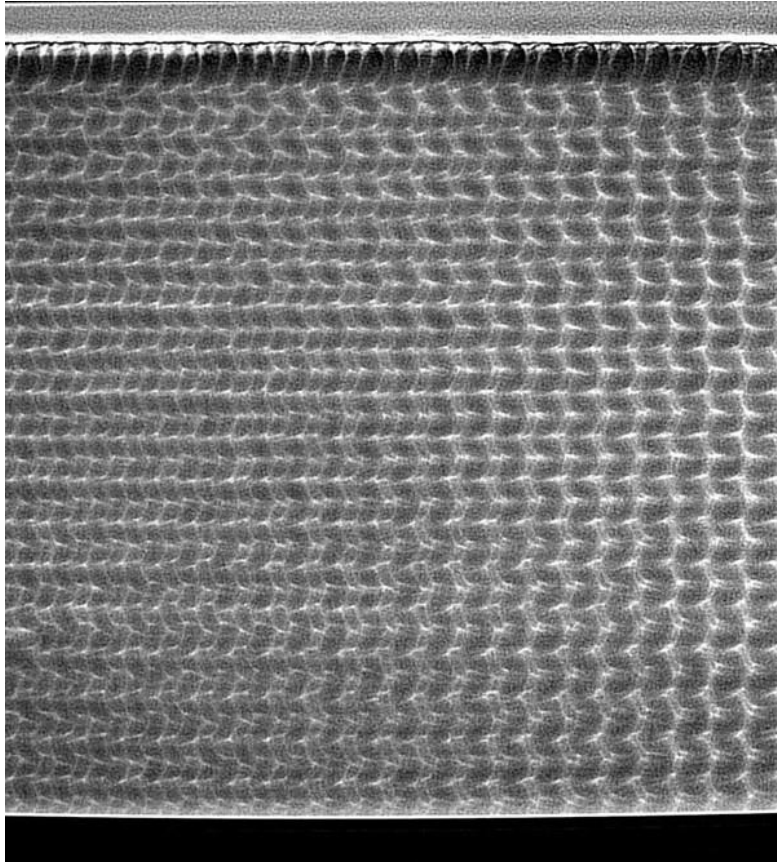
0,2-%- Yield Strength - average



Tensile Strength - average



Titanium Alloys - Mechanical Properties Ti6Al4V



No Cracks, lack of fusion or voids detectable

Titanium Alloys – X-Ray Analysis TiAl6V4

R&D Aerospace project – REGIS

Subproject "3D metal
printing of large integral
components made of
titanium and aluminium
for aviation"

Project partner:

- Airbus operations GmbH
- Premium Aerotec GmbH
- BIAS - Bremer Institut für angewandte Strahltechnik

The Airbus logo, consisting of the word "AIRBUS" in a bold, black, sans-serif font.

Milestones:

- Concept for 3D printing of components larger than 1m x 1m
- Process/design strategy for distortion minimization



3DMP® Potentials

- Outstanding design freedom
- Higher deposition rates, Greater diversity of materials
- Improved mechanical properties
- Large parts up to 3000 l (100 ft³)
- Reduction of manufacturing costs by up to 60%
- Reduced number of manufacturing steps
- Maximum material utilization...

3DMP® Limitations

- Surface finish, Structure resolution
- Geometric complexity

Make The 3DMP® Benefits Your Benefits!

Thank you for your attention!

GEFERTEC GmbH

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