Additive Manufacturing in Milling Quality
The unique combination of laser deposition welding with a powder nozzle and milling on the LASERTEC 65 3D, is an innovative generative machining method. It allows a faster production of complex geometries and individual 3D-parts. Especially large components up to ø 500 mm can be produced cost-effectively with this hybrid solution. The flexible changeover between laser and milling operations enables the direct machining of areas that can no longer be reached later on the finished part. The laser process uses a metal powder feed, which allows the additive manufacture of parts without a processing chamber nor the need for a supporting structures. The additive process is up to 10 times faster than the generation in a powder bed. DMG MORI is offering the complete process chain, starting with the NC-programming in the hybrid CAD / CAM system, via the usage of proven technology parameters coming from a material data base, through to machining operations, process monitoring and documentation.
LASERTEC 65 3D

Applications.

**PRODUCTION**
- Aerospace: Turbine Casing
- Engineering: Nozzle
- Vacuum Technology: Cooling Tube
- Mould Making: Cooling Element

**REPAIR**
- Aerospace: Blisk
- Energy: Pelton Wheel
- Mould Making: Injection Mould
- Engineering: Bearing Block

**COATINGS**
- Oil & Gas: Drill Bit
- Energy: Impeller
- Plant Equipment: Drive Shaft
- Vacuum Technology: Flange

The video of the Lasertec 65 3D:
If your mobile phone is equipped with a QR code recognition software, then this link will take you to the video. Current brochures can be found under [www.dmgmori.com](http://www.dmgmori.com).
LASERTEC 65 3D

Additive Manufacturing with Unique Technological Features.

Highlights

+ The flexibility of the generative process combined with the precision of milling technology
+ Laser generation of the workpiece with intermediate milling
+ High buildup rates due to coaxial powder nozzle
+ Large machining area for workpieces up to Ø 500 mm × 400 mm height
+ Reduced material usage
Basics
Laser Deposition Welding.

Working Principle
Using a coaxial nozzle the metal powder is welded to the base material in layers (non-porous and crack-free melting). Thereby the metal powder is joined with the surface in a high strength bonding. The coaxial nozzle shielding gas protects against oxidation during the build-up process. After cooling the metal layers can be machined mechanically.

Materials
Tried and tested materials:
+ Stainless Steel
+ Nickel-Based Alloys (Inconel 625, 718)
+ Tungsten Carbide Matrix Materials
+ Bronze and Brass Alloys
+ Chrome-Cobalt-Molybdenum Alloys
+ Stellite
+ Tool Steel (weldable)

Metallurgy
Continuous process development in consideration of the following material characteristics:
+ Inspection of the powder material
+ Density measurement, structural analysis
+ Mechanical tests (tension, stress, bending)
+ Measurement: Surface quality, hardness, corrosion
+ 99.8% achievement of the density of the casting (e.g. Stainless Steel 316L / 1.4404)

<table>
<thead>
<tr>
<th>Characteristics 316L / 1.4404</th>
<th>Material Requirements Conventional</th>
<th>Results Laser Welding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elastic Limit [(R_{p0.2})] Mpa</td>
<td>(\geq 200)</td>
<td>229.5</td>
</tr>
<tr>
<td>Tensile Strength [(R_m)] Mpa</td>
<td>500–700</td>
<td>506</td>
</tr>
<tr>
<td>Elongation [(\Delta)] %</td>
<td>(\geq 40)</td>
<td>53.05</td>
</tr>
<tr>
<td>Impact Test [(K_{V2})] J</td>
<td>(\geq 100)</td>
<td>126–132</td>
</tr>
<tr>
<td>Hardness [H] HVS</td>
<td>(\leq 230)</td>
<td>160</td>
</tr>
</tbody>
</table>
Hybrid CAD / CAM
for Additive and Subtractive Programming.

1: CAD / CAM data of the customer; separation in additive and subtractive areas; slicing of the single workpiece sections

2: Generation of the NC-paths for the laser process and milling in the post processor; definition of the program order

3: 3D-simulation for collision protection with consideration of the integrated laser head

4: Laser Deposition Welding and Milling combined on the LASERTEC 65 3D (flexible changeover possible)

5: Finished workpiece ready for quality inspection

Highlights

+ One software package for the complete process (design, programming, simulation)

+ Unique SAUER LASERTEC build-up strategies - fully integrated in the CAD / CAM software

+ The workpiece can be built up in several steps, while flexibly switching between laser deposition welding and milling operation in only one clamping set-up
Complete generation of 3D-parts

Application Examples.

**Turbine casing**
- Material: Stainless steel
- Laser Deposition Welding: 230 min.
- Milling: 76 min.
- Dimensions: ø 180 mm x 150 mm

**Fan Wheel**
- Material: Stainless steel
- Laser Deposition Welding: 312 min.
- Milling: 240 min.
- Dimensions: ø 160 mm x 160 mm

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1: Basic set-up of the cylinder
2: 90° swivel: Generation of the flange
3: 90° swivel: Milling of the plane surface and the outer contour
4: Continuation of the cylinder generation with conical funnel
5: Manufacturing of the 12 connectors
6: Finishing of the inner and outer contour
1: Building a cylinder
2: Completions of the conical taper
3: Milling
4: Finish machining the cylinder
5: Building the vanes on the cylinder
6: Finish milling the vanes
Additive Manufacturing
SAUER LASERTEC – Buildup Strategies.

“Internal Feature”
Feasibility of channels within a solid part structure e.g. cooling channels as well as similar complex, internal structures as cooling elements and other similar cooling components for injection moulds

“Multi Material”
Combination of two different materials in one part. Two individually selectable powder feeders allow the combination of various materials, even the building of "Sandwich" workpieces

“Build on Curve”
The basis for this operation is an existing part (build-up by additive manufacturing or with an alternative production process) "Flanging" of an additional 3D contour onto the existing part

“3D-Coating”
Metal deposition of partial or complete coatings for corrosion protection and wear resistance. “3D-Coating” on 3D-parts as a material coating or a repair
Unique Technology Integration

+ Intelligent combination of Laser Deposition Welding and Milling for highest surface quality and part precision

Laser Deposition Welding with a Powder Nozzle

+ 10 x faster compared to powder bed; 3D-parts up to Ø 500 mm also with undercuts and without supporting structure

Hybrid CAD / CAM Module for Laser and Milling Process

+ One universal programming solution for the laser and milling process incl. design, additive and subtractive programming, post processing and simulation in one software package

“Closed Loop” - In-Process Regulation, Analysis and Control

+ Continuous measuring and monitoring of the laser buildup process
+ Automatic regulation of the laser power guarantees a high quality “Closed Loop” build in real-time
+ Ensuring of a uniform laser welding process
+ Process monitoring for highest process safety and homogeneous part qualities

Flexible Integration of the Laser Head via the HSK Milling Taper

+ The laser head is handled by a fully automatic shuttle - without manual intervention
+ Coaxial nozzle for the uniform distribution of the metal powder
+ Independent of the laser buildup direction
+ Integrated safety glass monitoring
+ Optimal powder volume supply
+ During milling operations, the laser head is protected against dust, coolant and chips, outside the working area

Additive Manufacturing Material Data Base for Users

+ Basic parameter suggestions for users of the hybrid CAD / CAM in various materials
+ Customer development of process parameters for surfaces, ridges as well as 3D-parts in various materials
+ Influencing factors: Surface quality, process speed, powder efficiency
+ Customer specific material development in one of our 4 Additive Manufacturing Technology Centers Worldwide
LASERTEC 65 3D

Layout Plans

LASERTEC 65 3D
Front View

LASERTEC 65 3D
Top view
# LASERTEC 65 3D

## Technical Data

<table>
<thead>
<tr>
<th>Working area / drives</th>
<th></th>
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<tbody>
<tr>
<td>Traverse X / Y / Z mm</td>
<td>735 / 650 / 560</td>
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<table>
<thead>
<tr>
<th>Work table / workpieces</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Dimensions (NC swivel rotary table) mm</td>
<td>ø 650</td>
</tr>
<tr>
<td>Maximum workpiece dimensions (Additive Manufacturing) mm</td>
<td>ø 500 x 400</td>
</tr>
<tr>
<td>Maximum workpiece weight (NC swivel rotary table) kg</td>
<td>600</td>
</tr>
<tr>
<td>Rotary axis (C axis) Degrees</td>
<td>360</td>
</tr>
<tr>
<td>Swivel range (A axis) Degrees</td>
<td>−120 to +120</td>
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<tr>
<td>P\textsubscript{max} under VDI / DGQ 3441 (C axis / A axis) Ws</td>
<td>7 / 9</td>
</tr>
</tbody>
</table>

### Milling spindle

<table>
<thead>
<tr>
<th>Maximum speed (standard / optional) rpm</th>
<th>10,000 / 18,000</th>
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<tbody>
<tr>
<td>Output 40 % DC / 100 % DC (standard spindle) kW</td>
<td>13 / 9</td>
</tr>
<tr>
<td>Torque 40 % DC / 100 % DC (standard spindle) Nm</td>
<td>83 / 57</td>
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<table>
<thead>
<tr>
<th>Laser source</th>
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<tbody>
<tr>
<td>Fibre laser diode (standard) Watt</td>
<td>2,500</td>
</tr>
<tr>
<td>Focal length (fixed) mm</td>
<td>200</td>
</tr>
<tr>
<td>Laser spot diameter 1 (standard) mm</td>
<td>3</td>
</tr>
<tr>
<td>Laser spot diameter 2 (optional) mm</td>
<td>1.6</td>
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</table>

### Linear axes (X / Y / Z)

<table>
<thead>
<tr>
<th>Rapid traverse speed mm</th>
<th>40 / 40 / 40</th>
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<tbody>
<tr>
<td>Maximum acceleration on X / Y / Z m/sec(^2)</td>
<td>6 / 6 / 6</td>
</tr>
<tr>
<td>P\textsubscript{max} under VDI / DGQ 3441 mm s(^{-1})</td>
<td>0.008</td>
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<table>
<thead>
<tr>
<th>Tool change system</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Standard / optional tools Number</td>
<td>30 / 60 / 90</td>
</tr>
</tbody>
</table>

### Machine data

<table>
<thead>
<tr>
<th>Width x depth x height (basic machine) mm</th>
<th>4,180 x 3,487 x 2,884</th>
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<tbody>
<tr>
<td>Machine weight kg</td>
<td>11,300</td>
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</tbody>
</table>

### Control system

- CELOS® from DMG MORI with 21.5" ERGOline® Control
- with Operate 4.5 on SIEMENS 840D solutionline

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**SAUER LASERTEC Excellence Center in Pfronten**

- > 25 years of experience in laser precision machining
- > 600 LASERTEC machines installed (worldwide)
- Application expertise: Training, customer support, complete turnkey solutions
- Regular LASERTEC Technology Seminars
Customer First –
Our service promise!

“We have good news for you: Our service and spare parts prices have been completely revised. With our service commitments, we want to meet your high demands with the highest service quality.” Please contact us – your sales and service team is at your disposal!

Top quality at fair prices. It’s a promise!

Best Price Guarantee for Original Spare Parts. Should you get a spare part offered by us at least 20% cheaper elsewhere, we will refund the price difference up to 100%.*

Spindle service at best prices. The highest level of competence from the manufacturer at new and attractive prices – DMG MORI spindle service!

Up to 50% lower service costs. New Flat Call-Out Rate – without travel expenses or any additional costs!

Our protective shield for your productivity. Reduced operating costs, highest machine availability and maximum precision – DMG MORI ServicePlus!

*All information and price advantages for Customer First are available at: customer-first.dmgmori.com