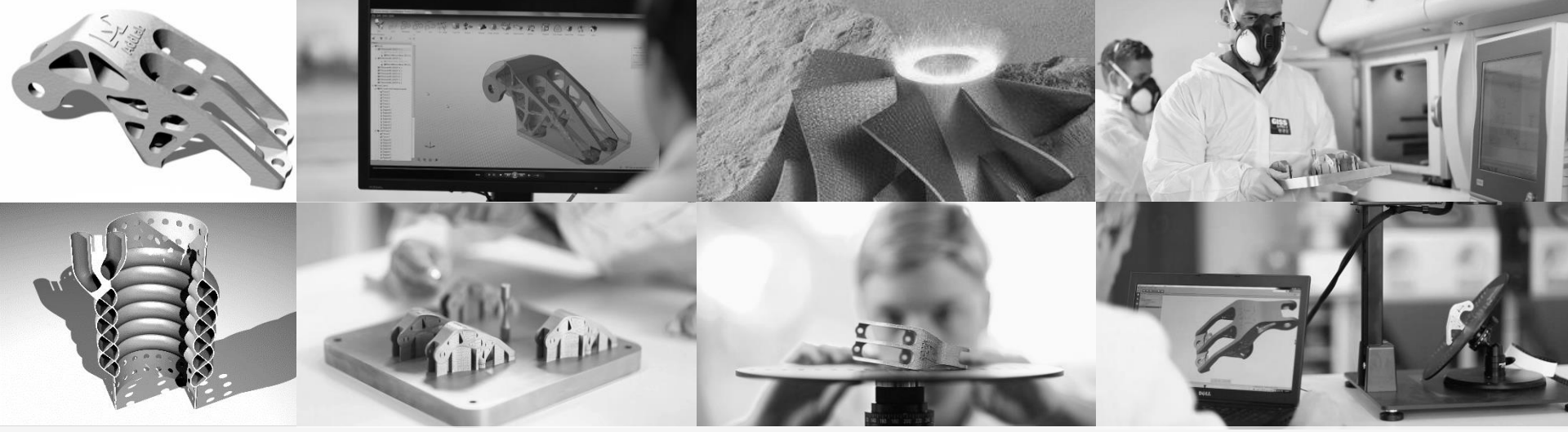


ADDFAB

3Dmetalsfabricated

3D Metal Printing

"The challenges it creates for NDT in Aerospace"

Rijen, November 13, 2018

Introduction

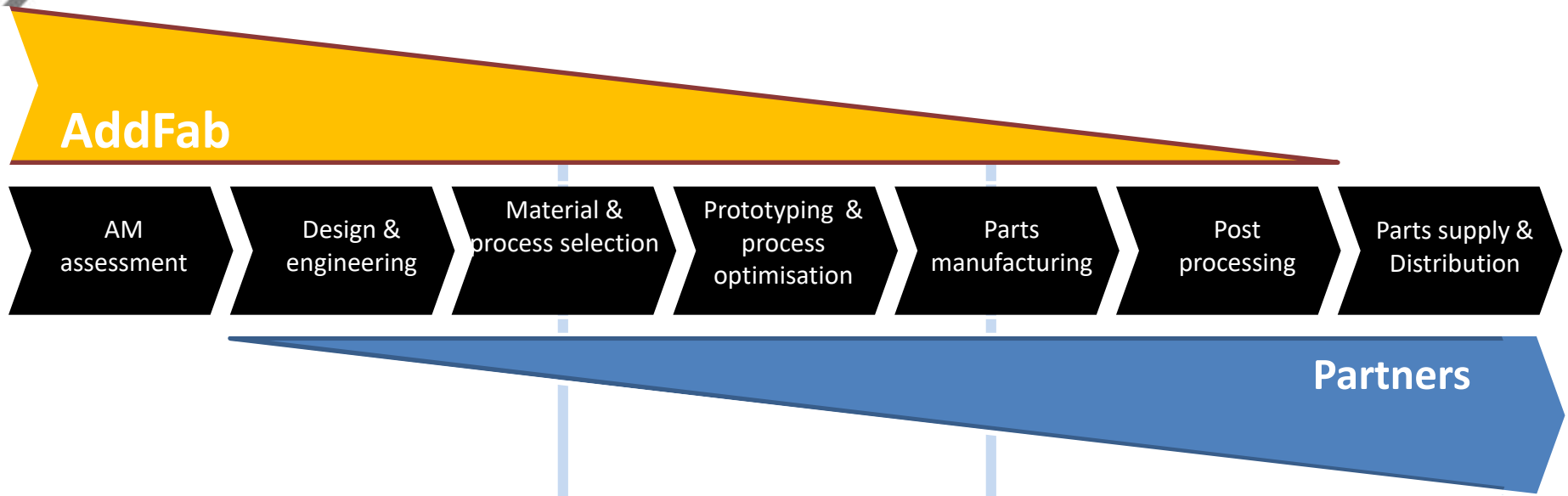
- AddFab
- Additive Manufacturing
- Powder Bed Fusion
- Possibilities
  - Design
  - Material
- Challenges
  - Design
  - Material
- Future

AddFab

ADDFAB offers **engineering** and **3D metal printing services** and **supports** its customers in the technical and commercial trade-off between the **unique 3D printing feasibilities** and the established machining technologies.

- **Current Partners**
  - KMWE
  - NTS Group
  - Machinefabriek De Valk
- **Origin**
  - Started as AddLab in 2013 as a 3 year project
  - In 2016 KMWE, NTS & De Valk agreed to continue for at least another 3 years under the new name AddFab
- **Location**
  - Eindhoven, Strijp-T

AddFab



3D Design & Engineering:
- Design for Additive Manufacturing
- Redesign
- Digitization/scanning
- Topology optimization
- Technology consulting
- …

AddFab: Shared lab facility:
- Demand pooling
- Materials research
- Prototyping
- Process optimization
- Building strategy development
- Quality testing
- …

Post processing & Supply (through partners):
- Production
- Assembly
- Supply
- Distributed printing
- …

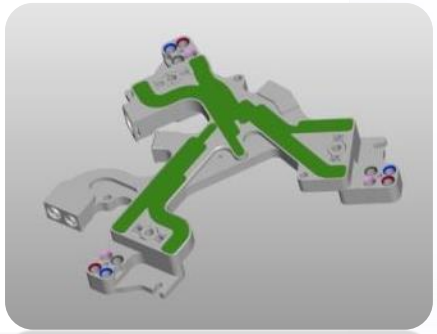
AddFab

- **Equipment**
  - SLM Solutions SLM280HL
    - Stainless Steel 316L
  - 3D Systems ProX300
    - Titanium Ti-6Al-4V Grade 23 ELI
  - Shot Peening
  - Oven for Heat Treatment
  - Phenom World
    - Electron Beam Microscope
  - Microscope
  - GOM 3D Scanner
    - Reverse Engineering
    - Analyzing products

- **Knowledge**
  - Team of Engineers with a combined knowledge concerning 3D metal printing of over 20 years

AddFab

- **Markets**
  - Semicon
  - Aerospace
  - (Petro)chemical, oil & gas
  - Machine Building
  - Printing
  - Medical
  - Awards



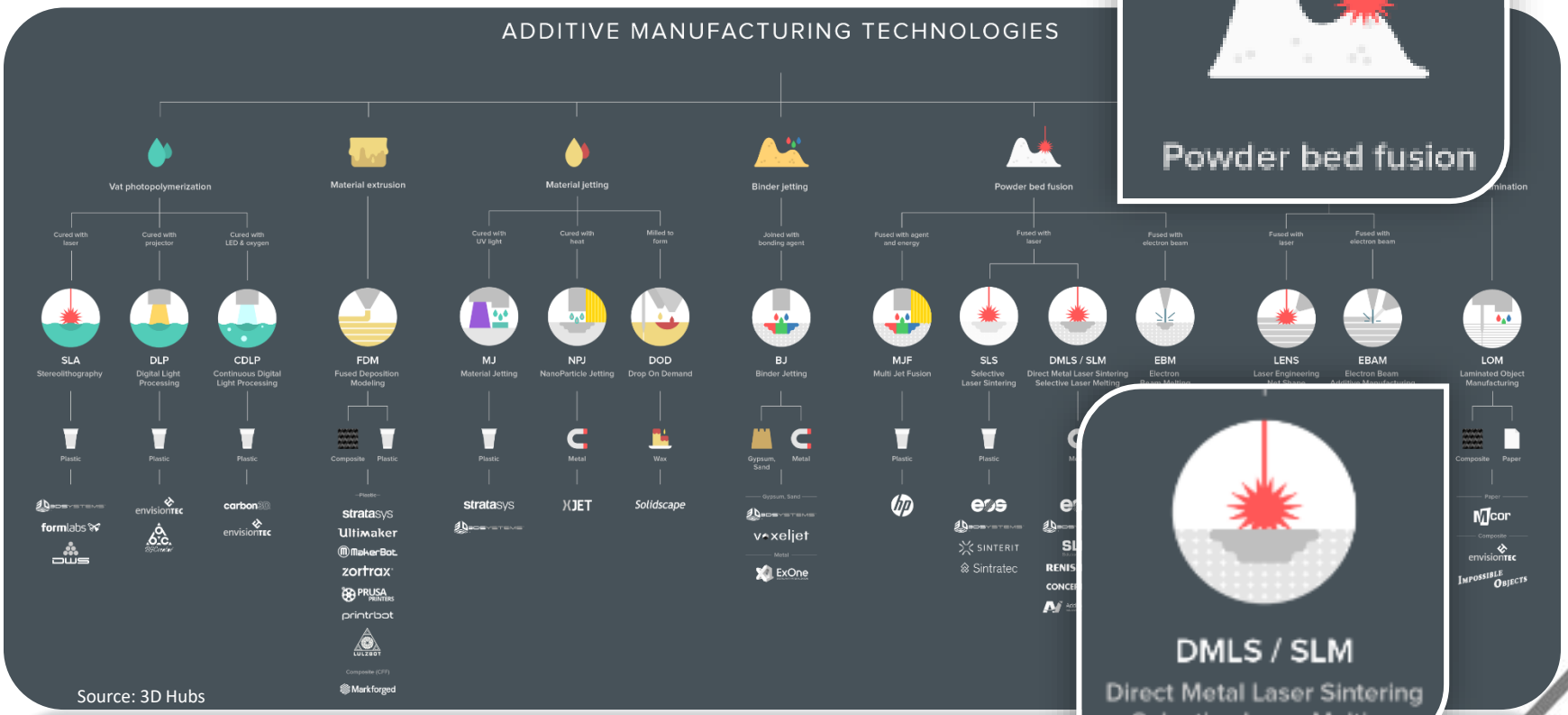
Source: KMWE

Source: KMWE

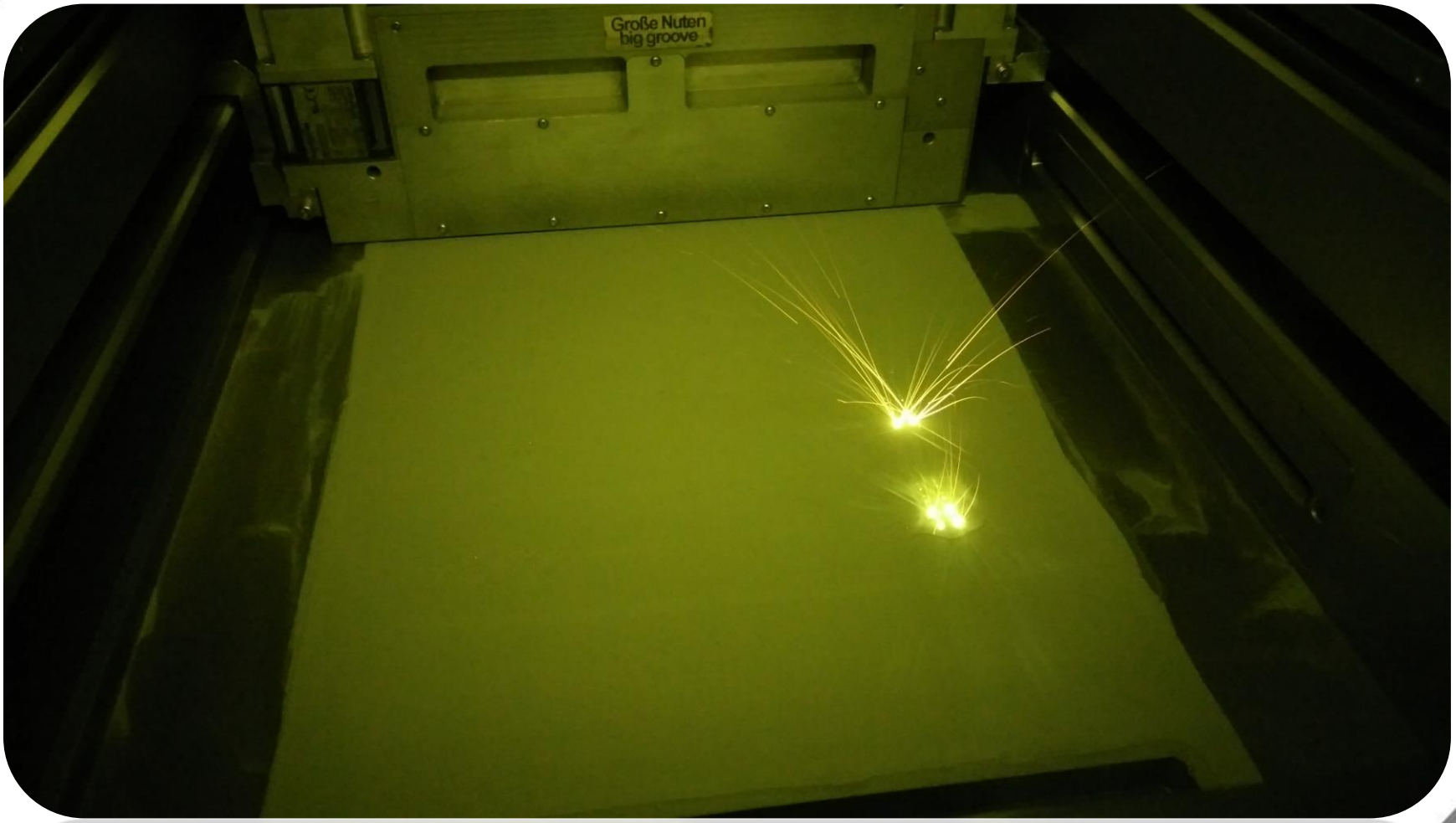
Source: KMWE

Additive Manufacturing

- Additive instead of subtractive
- Powder Bed Fusion & Selective Laser Melting



Additive Manufacturing



Source: KMWE

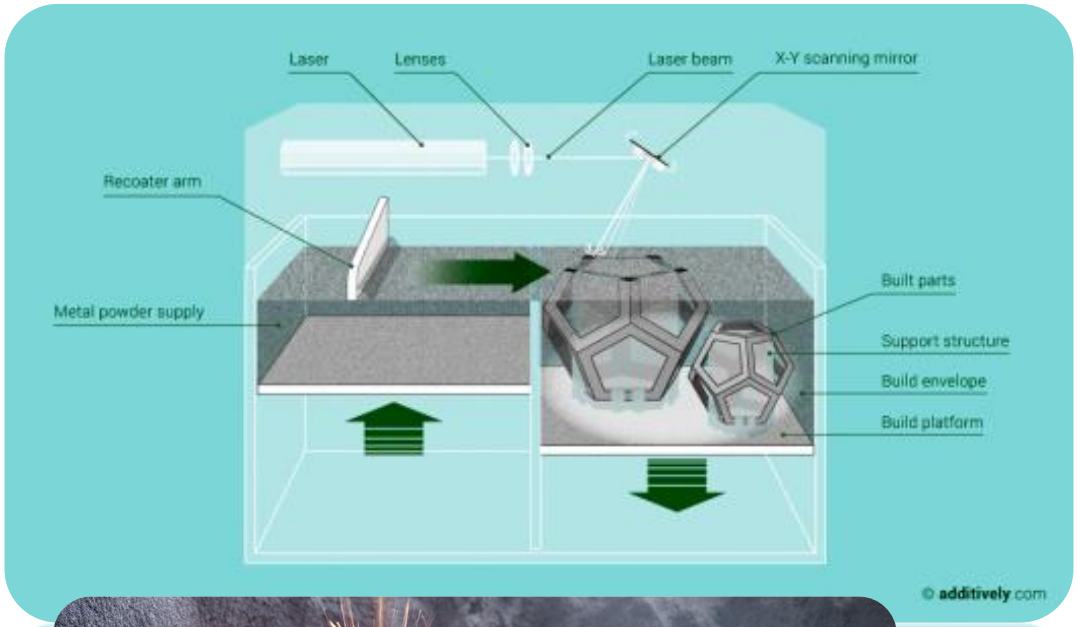
Powder Bed Fusion

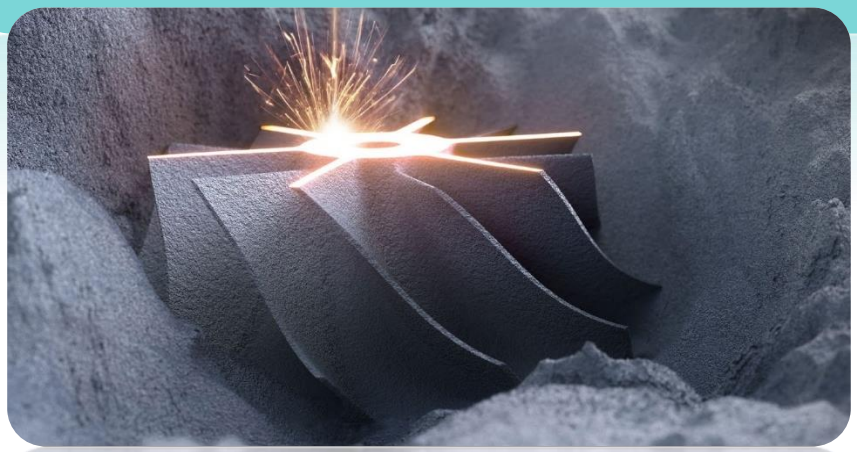
- **Building Chamber**
  - Closed system
  - Inert environment
    - Less than 0,05% oxygen
  - High power laser
- **Building plate**
  - Same material as powder
  - Provides strength and surface area for dissipation of heat
- **Metal Powder**
  - Particle size between 0 and 60µm
  - Virgin and recycled powder
- **Models**
  - 3D Engineered models in .stl file format
  - Virtually placed on a building plate
  - Sliced to create 2D images for the laser

Source: KMWE

Powder Bed Fusion

- **Recoater**
  - Places a layer of fine powder on the building plate
  - ± 30 to 50µm thick
- **Laser**
  - Uses a set of mirrors to locally melt the powder
  - Laser beam is ±80µm in diameter
- **Platform**
  - Building plate is lowered according to set layer thickness
- **Repetitive process**
  - The process repeats itself, until all the layers are completed

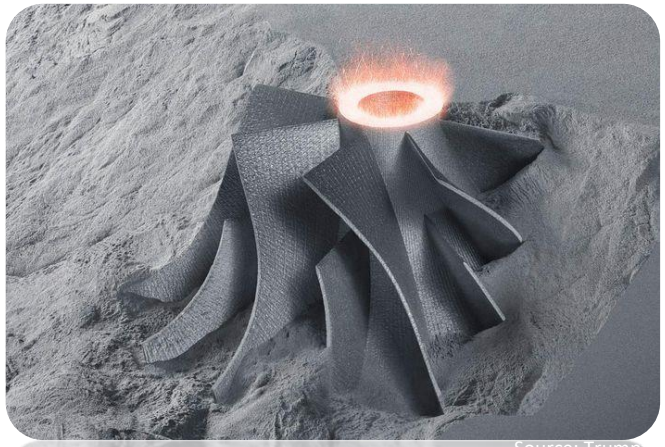




Source: Trumpf

Powder Bed Fusion

- **Removing powder**
  - After the machine is finished the products are buried within powder
- **Building plate**
  - Required for the dissipation of heat, products are attached to a building plate
- **Heat Treatment**
  - Relieve products from stress build up during production
- **Post-production**
  - Removing of support
  - Machining



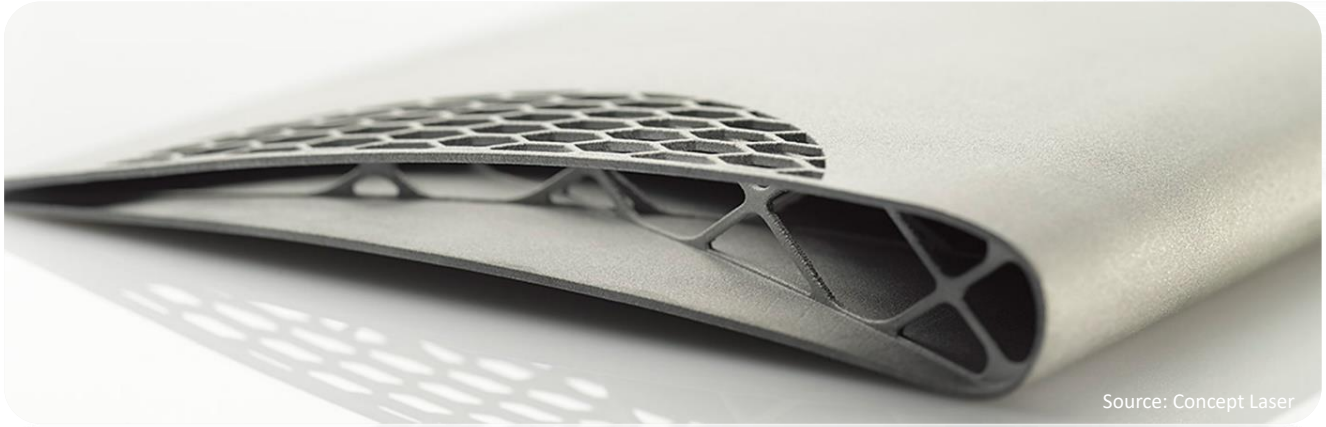
Source: Trumpf

Source: KMWE

Possibilities - Design

- **Complex shapes**
  - No longer restriction by tooling options
- **Internal structures**
  - Channels for coolant or acting as heat exchangers
  - Fuel nozzles
- **Product Behavior**
  - With different structural design, one element could be stiff and strong, while another can provide damping (or any other feature) within 1 component

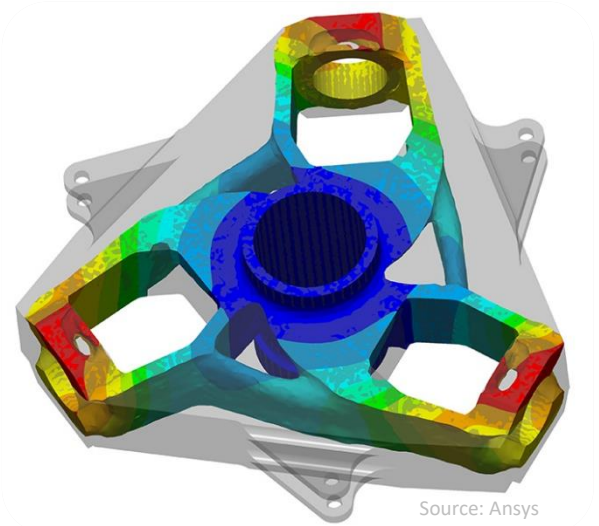
Source: GE



Source: Concept Laser

Possibilities - Design

- **Weight Reduction**
  - Optimization with Topology
  - Cost-effective
- **Combining parts**
  - Reduce amount of parts in system
  - Save assembly time
- **Combining Features**
  - Flow & Filtering

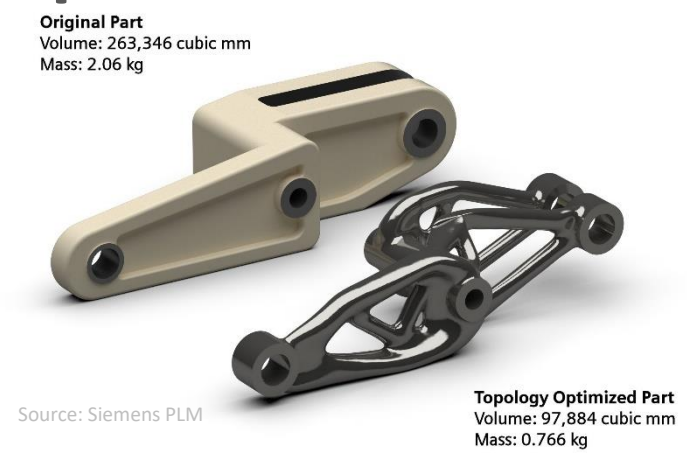

Source: Ansys


Source: KMWE


Source: Nottingham EPSRC

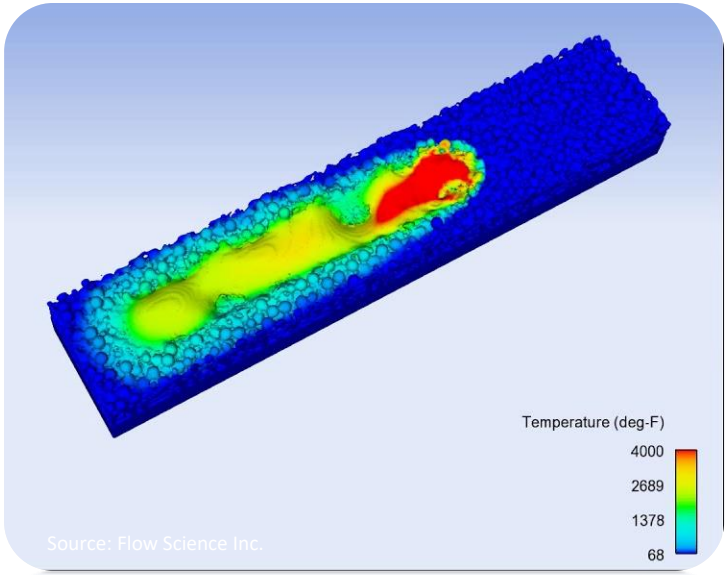
Possibilities - Examples

- Fuel Nozzle
- Brackets & Hinges
- Blades
- …

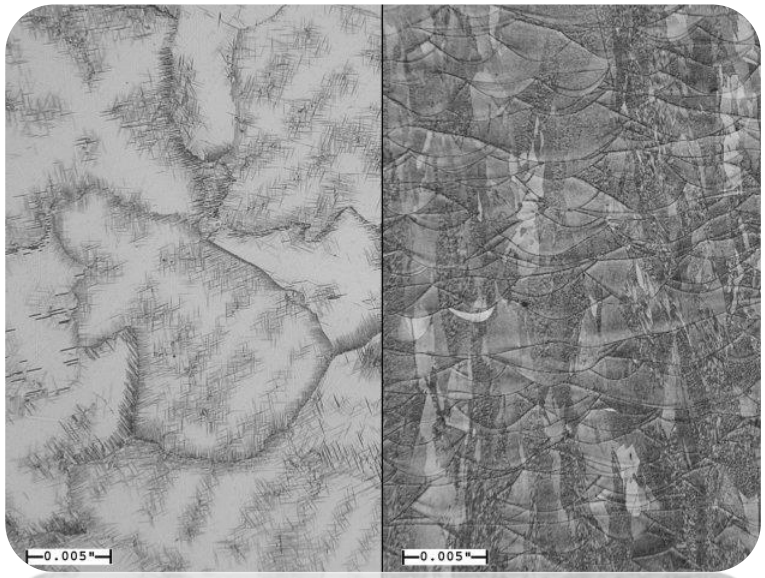


Possibilities - Material

- **Unique microstructure**
  - Fast cooling rate during solidification
  - Tunable with scanning parameters
- **Unique alloys**
  - Possibility to develop high performance materials specifically for additive manufacturing
  - Capable of tailoring the mechanical properties



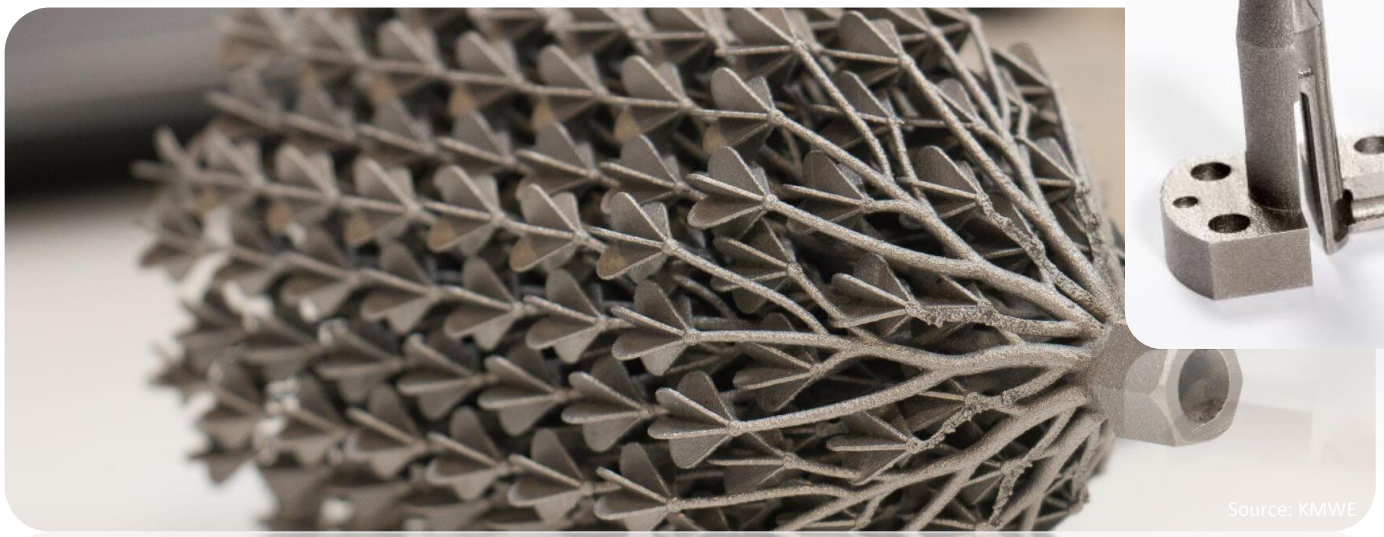
Source: Flow Science Inc.



Source: 3ders.org

Challenges NDT - Design

- **Lower visibility**
  - More complex designed parts with a increase in internal structures that are not visible to the viewing eye
- **More ‘flowable’ products**
  - Increased design freedom and the increased use of software solutions like Topology Optimization will create more ‘flowing’ designs


Source: KMWE

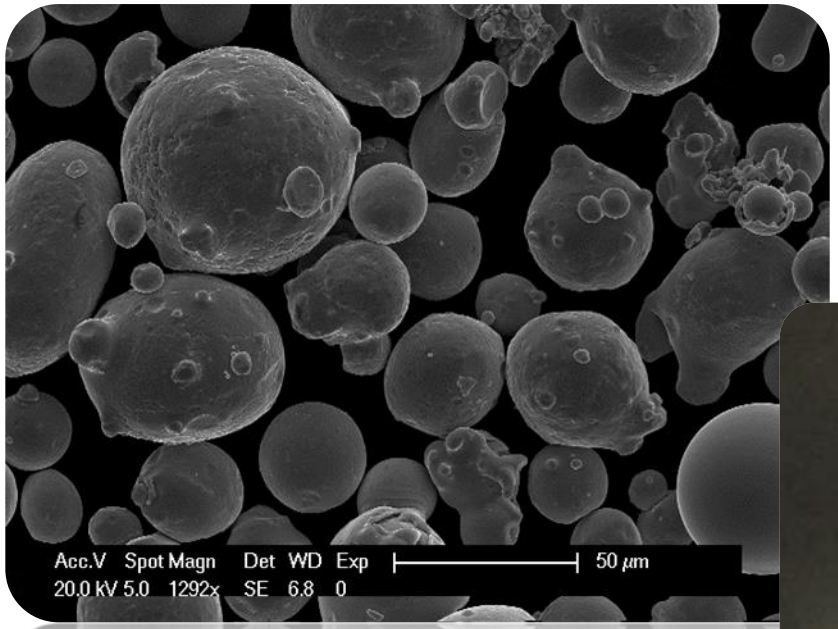

Source: KMWE

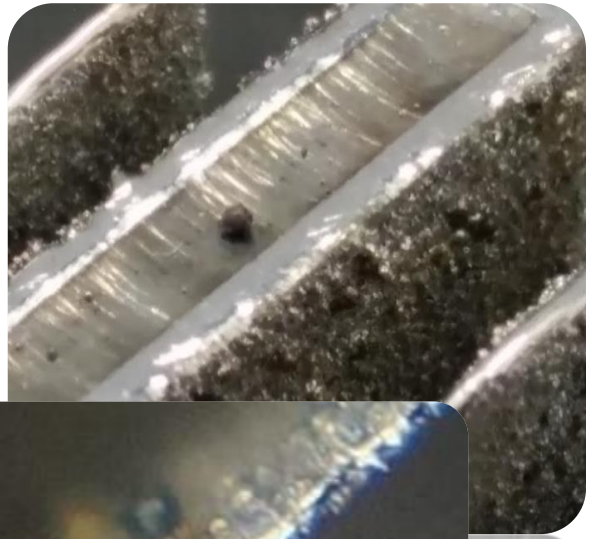
Challenges NDT - Design

- **Internal Channels**
  - Complex internal channels which wrap around each other to redirect gas or liquid
  - Channels are not necessarily round, but can be shaped as is required by its function
- **Combination of functions & parts**
  - Combining functions and/or parts results in the requirement of multiple different testing techniques on a single component
  - Component reduction

Challenges NDT - Material

- **Unique products**
  - Every product is unique due to the powder and changing conditions inside the build chamber
  - Meltpool behavior is tunable, but not 100% repetitive
  - Risk of contamination by gas or particles

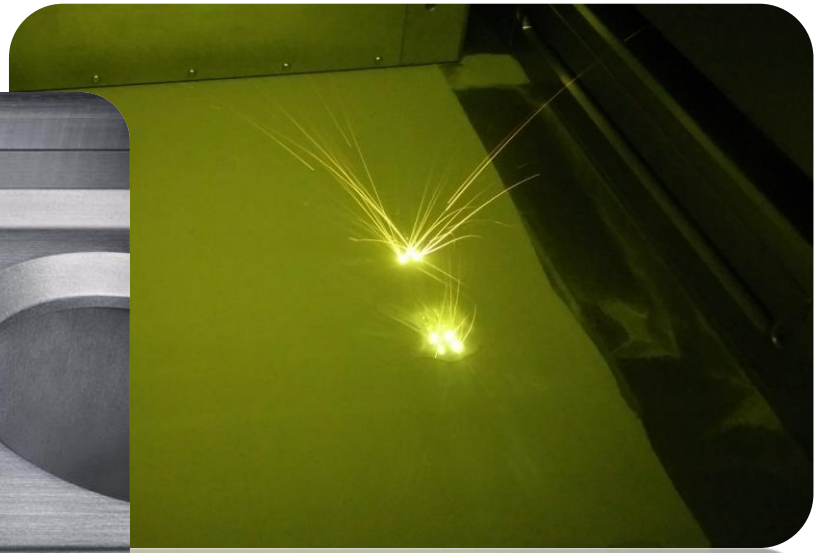




Challenges NDT - Material

- **Different material characteristics**
  - The mechanical properties of the material can be altered and is not homogenous across every single component despite them being produced simultaneously
  - Laser parameters can be altered which results in a non-homogenous material and less predictable weight and balance

Source: Trumpf

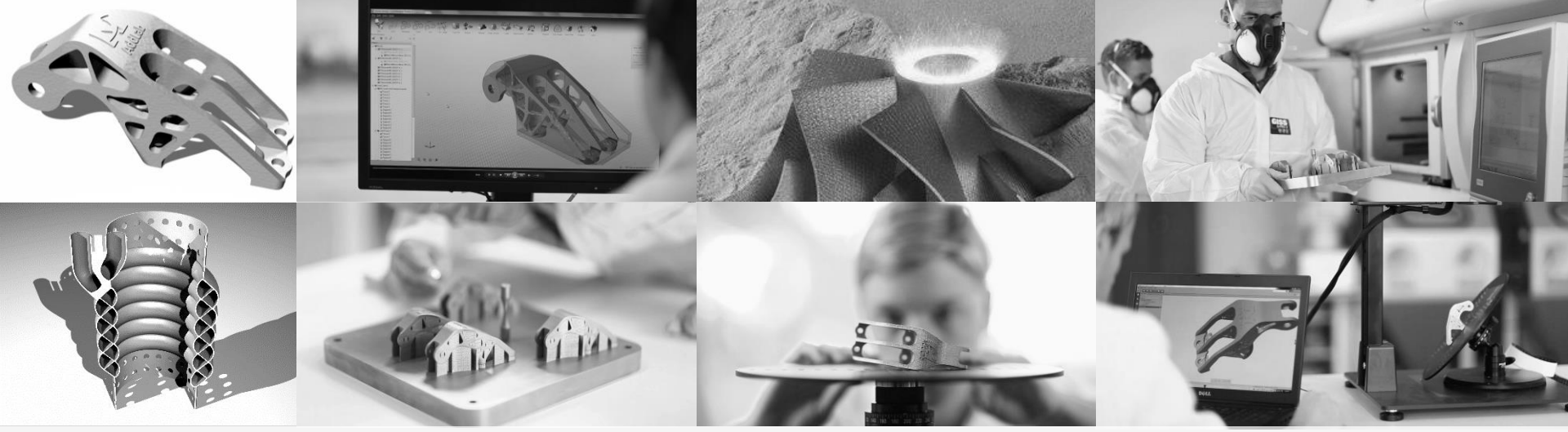


Source: KMWE

Future

- **Increase in knowledge**
  - Better understanding the behavior of production
  - Increased knowledge concerning melt behavior materials
- **Machine size**
  - Multi-laser machines already in the market
  - Demand for bigger components in the market justifies larger machines
- **Complexity**
  - Combining several parts in to a single component
  - Topology and other optimization methods
- **Material developments**
  - Mechanical characteristics optimized for use in a specific product
  - Specially engineered alloys for use in the Aerospace industry

'Additive Manufacturing brings an already challenging world even more opportunities!'



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Thank you for your attention!

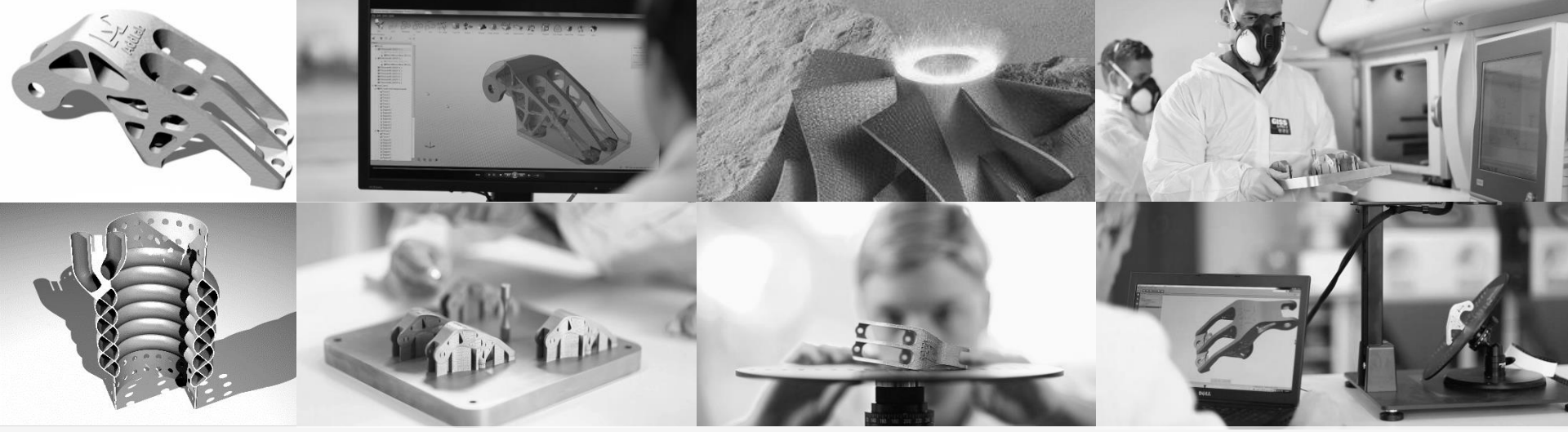
Precision Systems

KMWE

Precision Components

machinefabriek DE VALK

NTS GROUP



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