Future Trends in Digital Additive Manufacturing

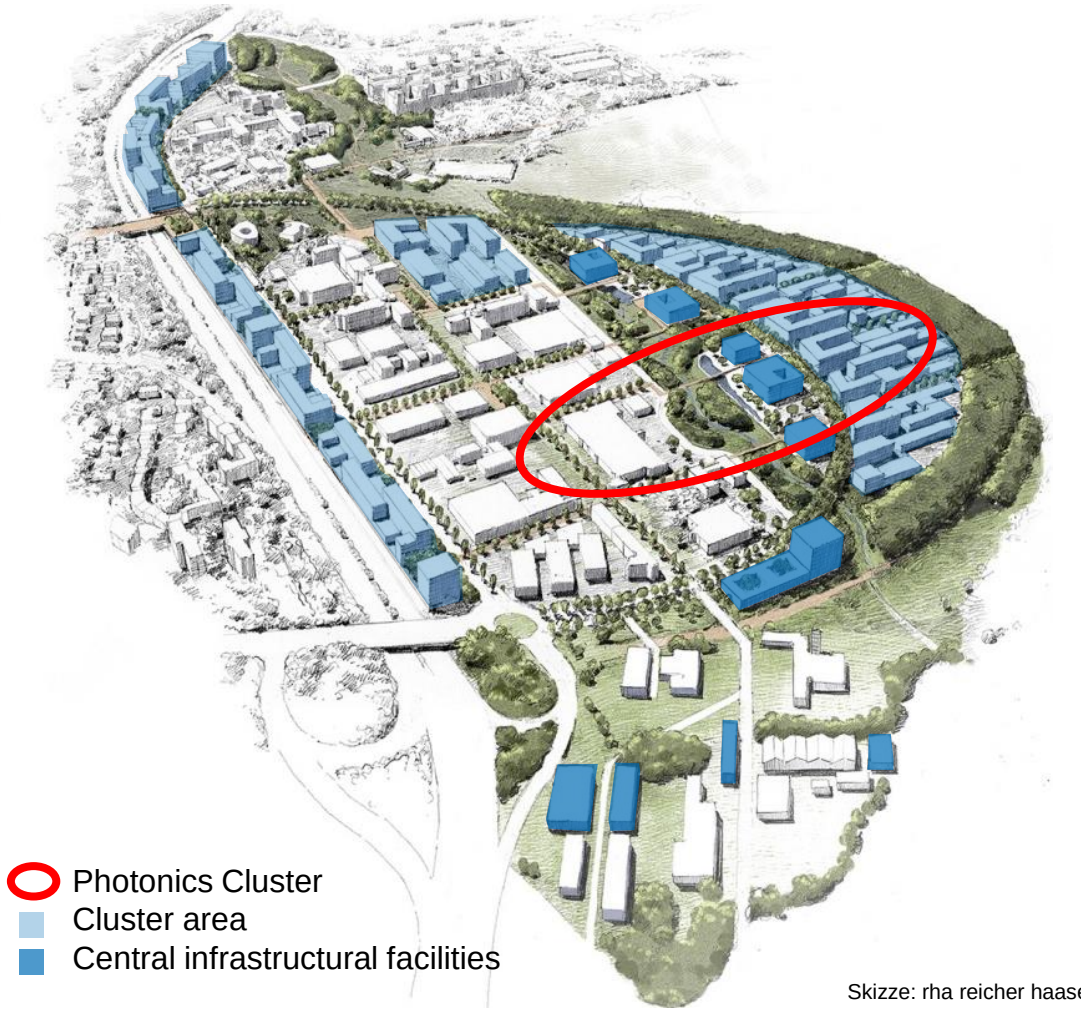
Univ.-Prof. Dr.-Ing. Dipl.-Wirt. Ing. Johannes Henrich Schleifenbaum

RWTH Aachen University – Digital Additive Production DAP
Fraunhofer Institute for Laser Technology ILT
www.dap.rwth-aachen.de
www.ilt.fraunhofer.de

Fraunhofer ILT | DAP Digital Additive Production | RWTH AACHEN UNIVERSITY

RWTH Aachen Campus

- Idea: investors rent out space in so-called ‘Clusters’
  - Shared lab & office space for
    - industrial R&D partners
    - research chairs
  - University infrastructure
- Background of RWTH Aachen
  - Among best technical universities worldwide
  - Large-scale interdisciplinary research projects
  - Innovation hub and incubator for start-ups
  - Vast amount of industry cooperations
  - Very strong background in photonics



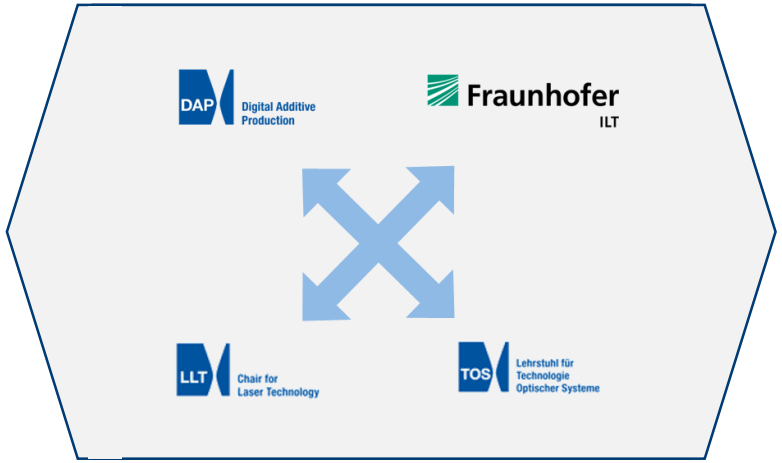
Skizze: rha reicher haase + associierte, Aachen

RWTH Aachen University – Digital Additive Production DAP

Photonics Cluster: Vast network, in-depth know-how, excellent solutions.

- Research Center Digital Photonic Production

- Fundamental interdisciplinary research:
  - Material science
  - Physics
  - Medicine
  - Engineering
  - Economics



- Digital Photonic Production DPP

- Industry partners:

SIEMENS, MTU Aero Engines, TRUMPF, BMW, PHILIPS, SLM SOLUTIONS, AMPHOS, INNOLITE TAILORED MOLDS AND OPTICS, AACHEN CENTER FOR ADDITIVE MANUFACTURING

Fraunhofer ILT | DAP Digital Additive Production | RWTH AACHEN UNIVERSITY

Market situation and potential

Global metal AM systems market by end industry and region in 2020

The **aerospace and healthcare** industries are expected to remain the most important sectors of growth for metal AM systems

Aerospace	Healthcare	Tooling	Automotive	Universities	Other
443[1]	**415**	**322**	**196**	**180**	**175**
+ 32.3%[2]	**+ 33.9%**	**+ 31.3%**	**+ 30.9%**	**+ 27.7%**	**+ 23.7%**

Chinese market is assumed to **grow strongest** based on gov. plan.
The **largest market** for metal AM systems is in the **US**

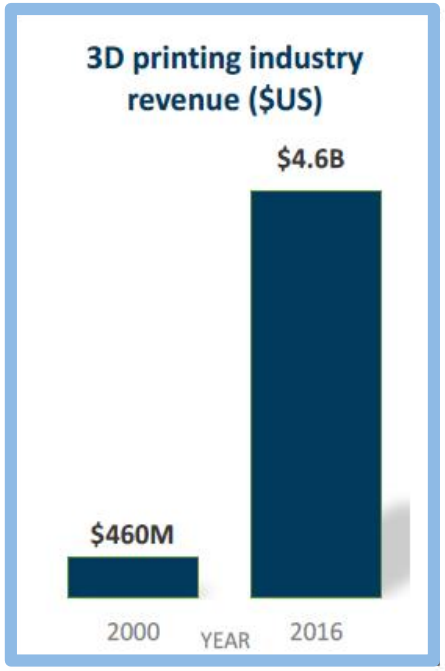
US	Europe	RoW	China
676	**465**	**419**	**170**
+ 30.3%	**+ 30.6%**	**+ 29.8%**	**+ 36.2%**

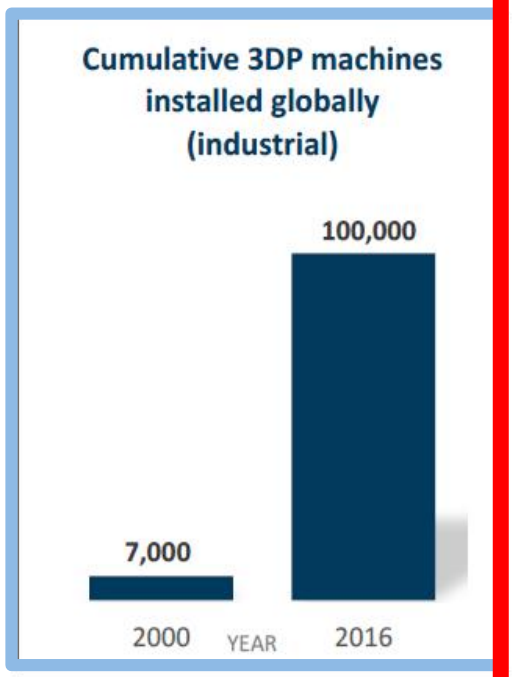
Source: Interviews with market participants; Canalys; MarketsAndMarkets; TechNavio; Smartech; BIS Research; Wohlers Associates; Roland Berger

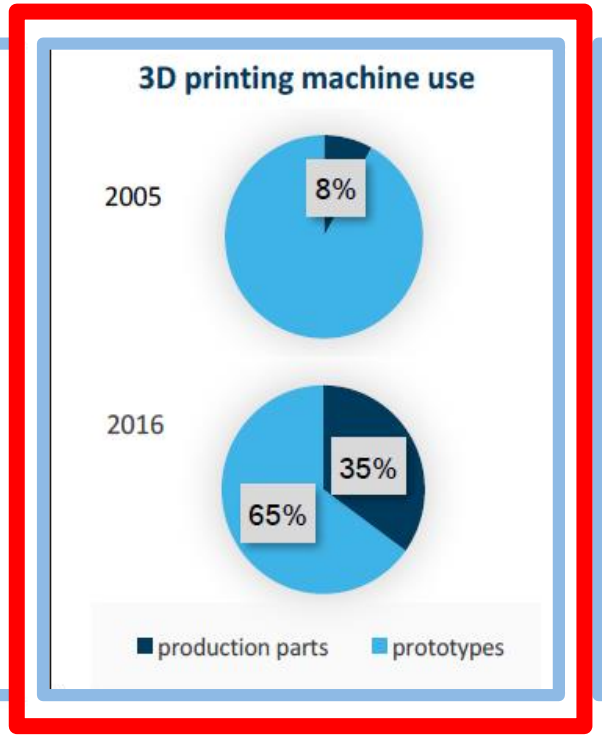
[1] [EUR m] [2] CAGR 2015-20

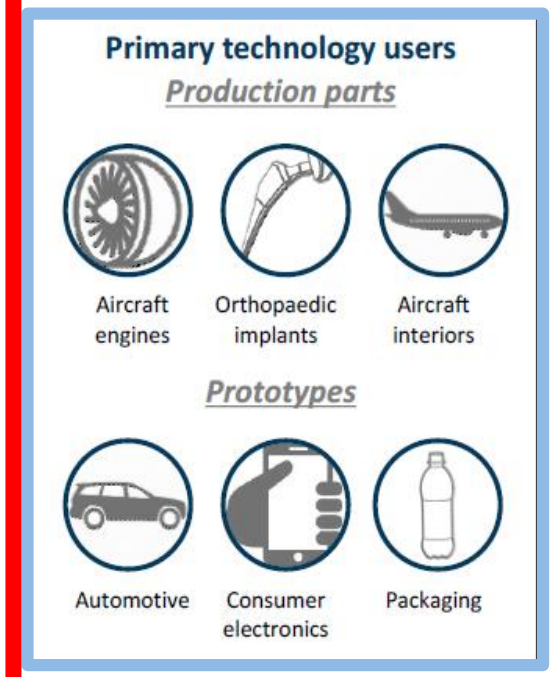
Fraunhofer ILT | DAP Digital Additive Production | RWTH AACHEN UNIVERSITY

The numbers behind 3D printing indicate that…



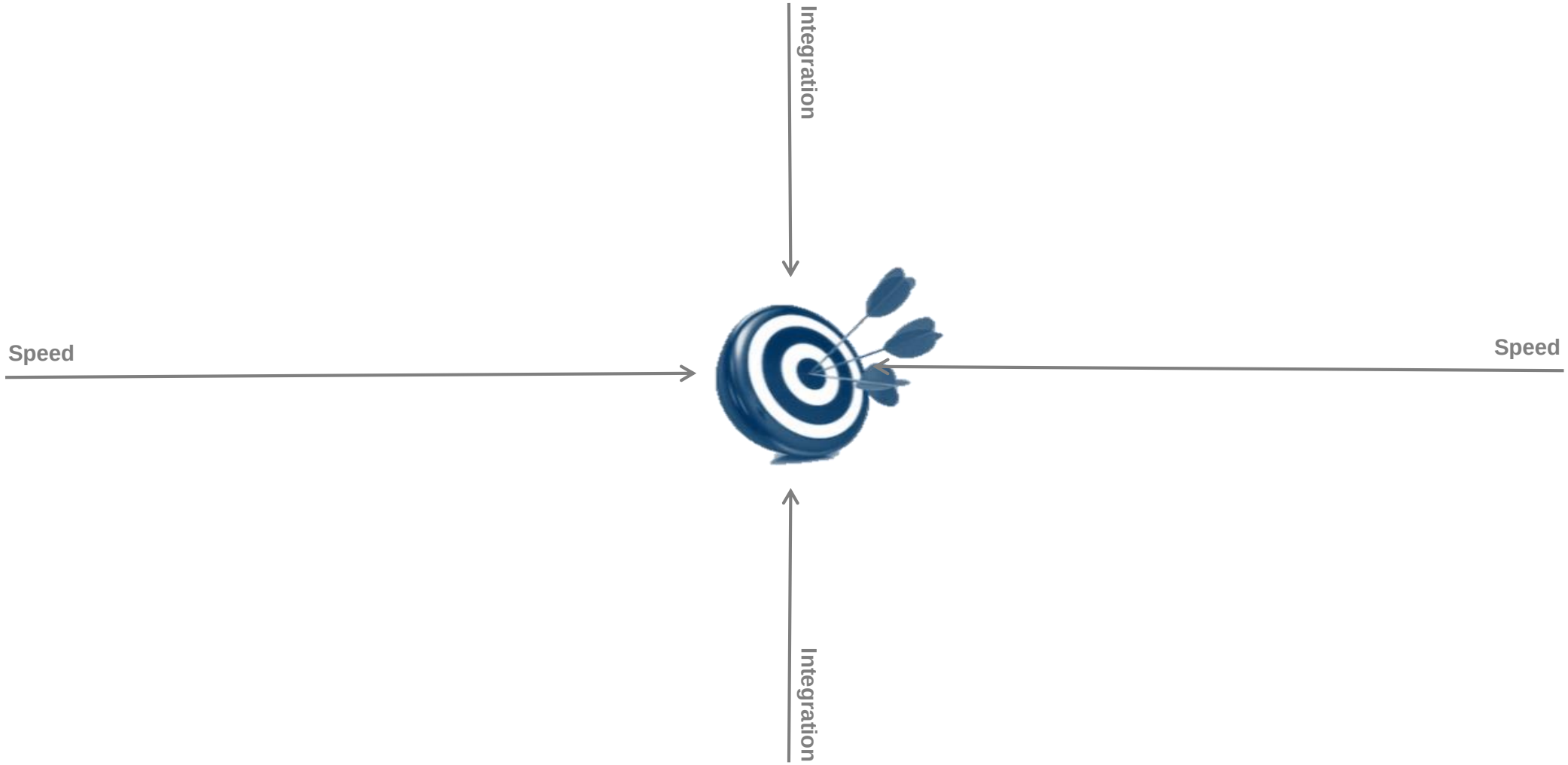




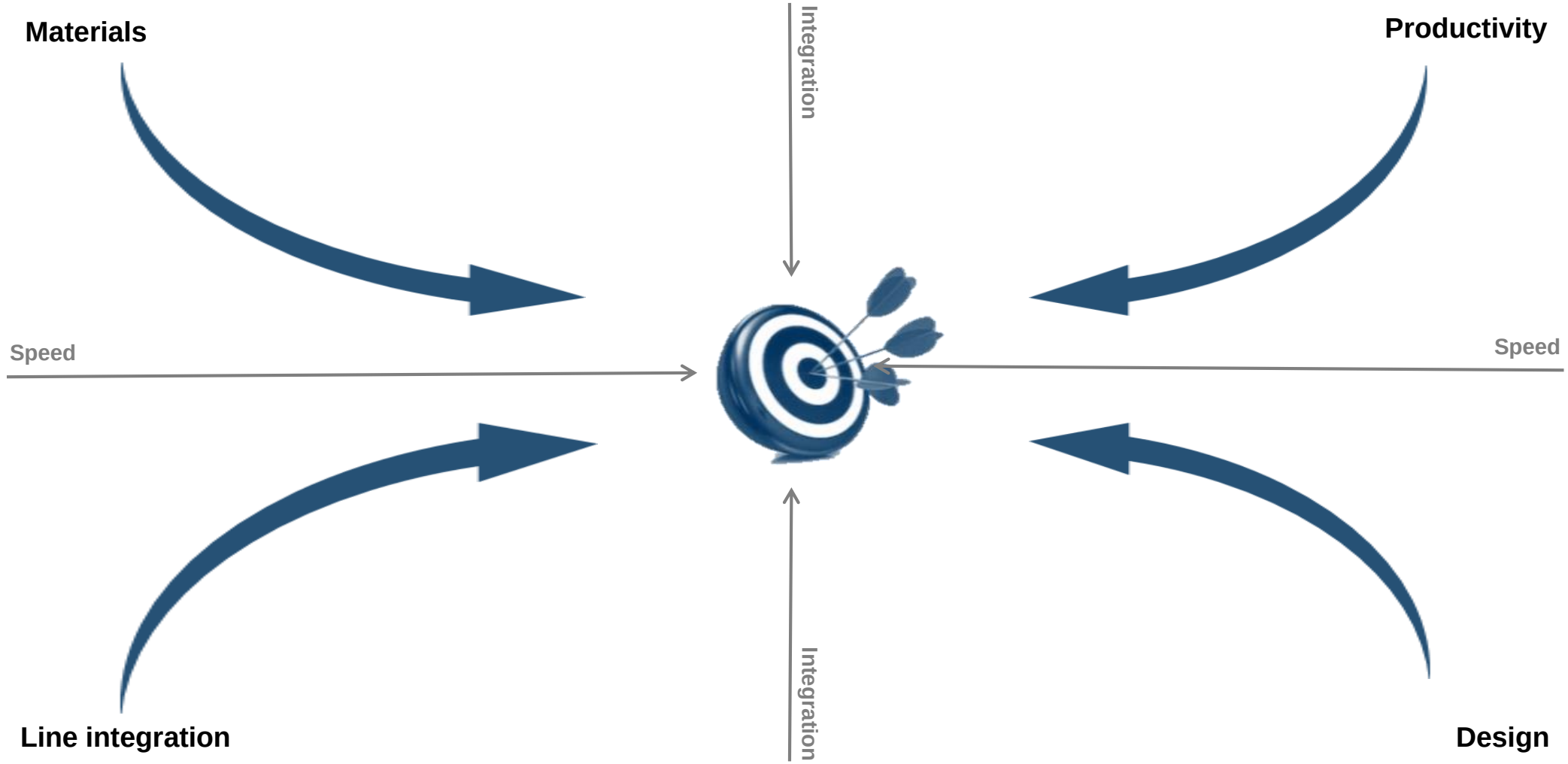


Source: Stratatsys Market Analysis

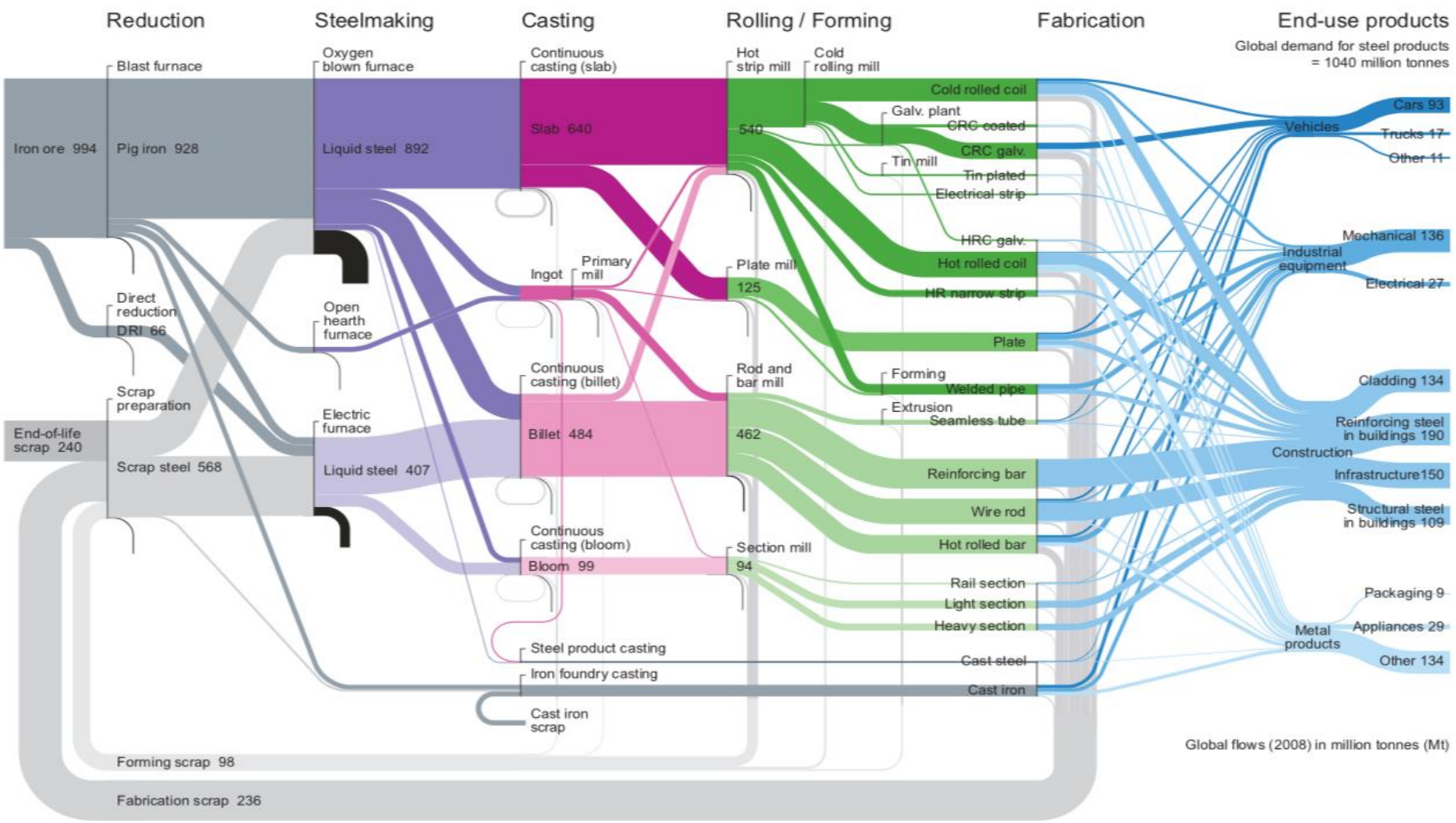
... speed and integration of AM need to be significantly enhanced for series production.



Speed and integration of AM need to be significantly enhanced in 4 domains!

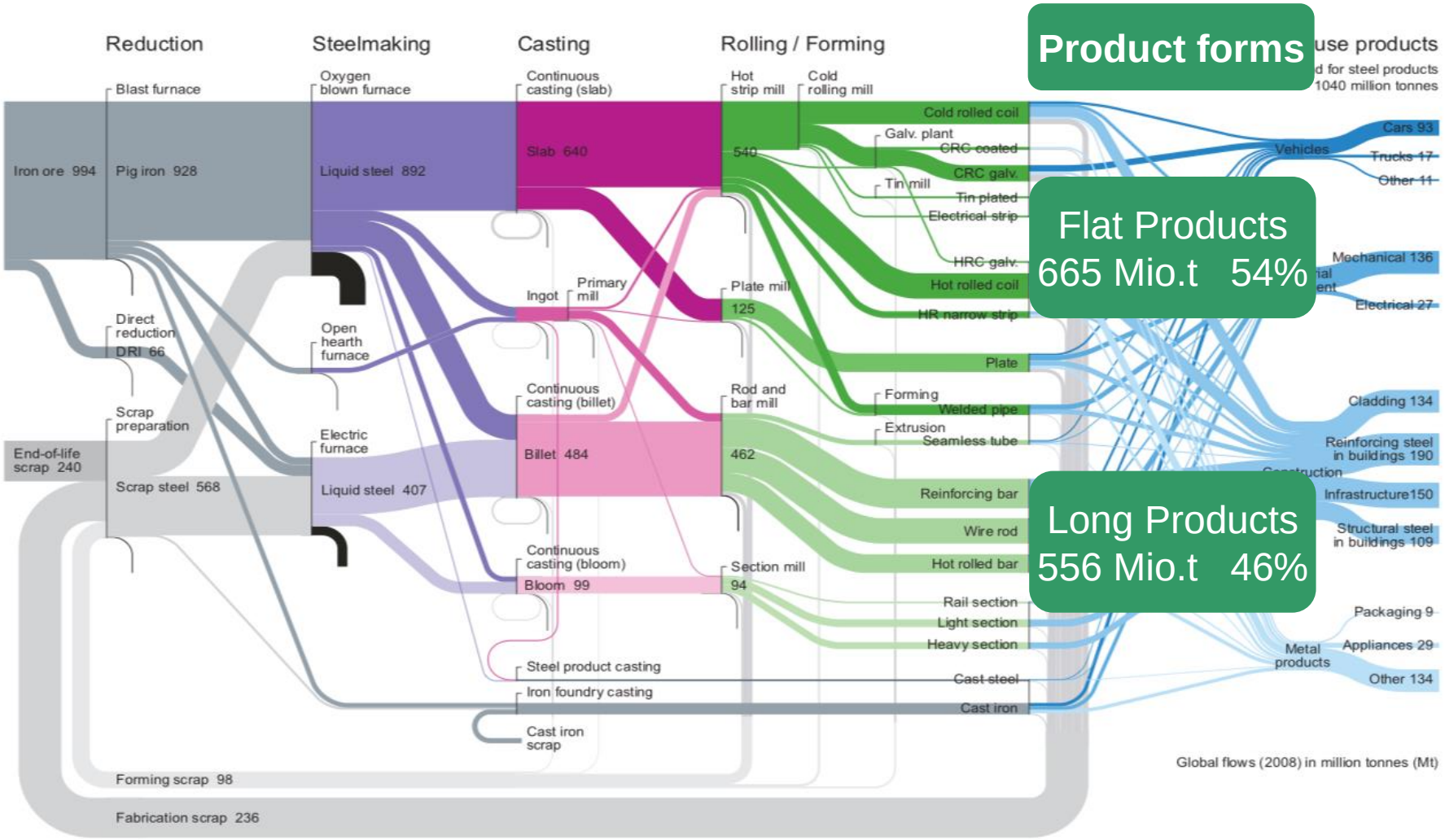


Steel product catalogue (2008; global demand 1,040 Mio. t)



Source: J. Allwood, J. Cullen, Sustainable Materials - with both eyes open

Steel product catalogue (2008; global demand 1,040 Mio. t)

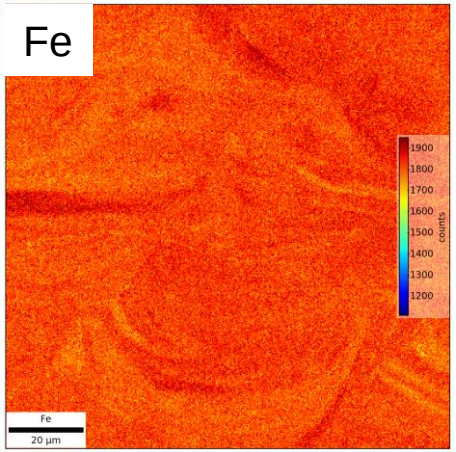


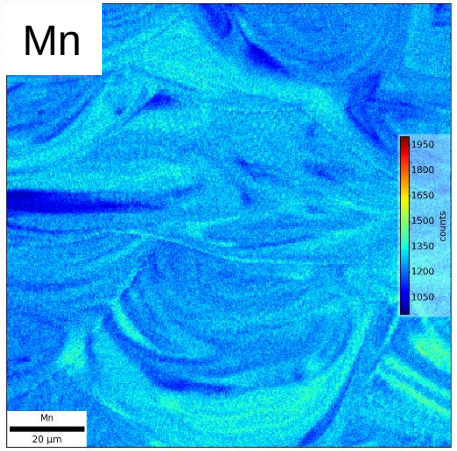
Source: J. Allwood, J. Cullen, Sustainable Materials - with both eyes open

New degree of freedom in alloyability

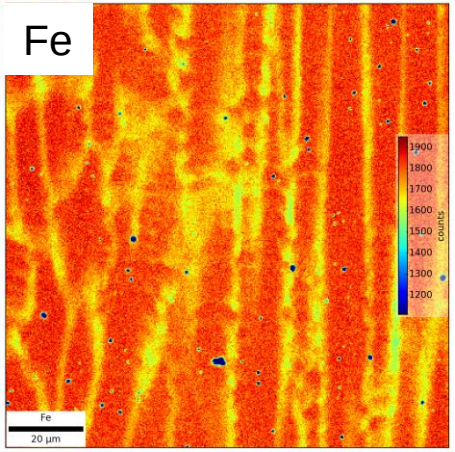
Steel development: High Mn alloyed steels for **damage tolerant components**.
Challenge: Impact of manufacturing on Fe and Mn local segregation.

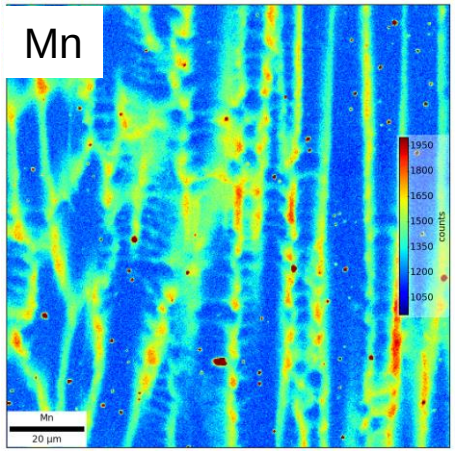
SLM

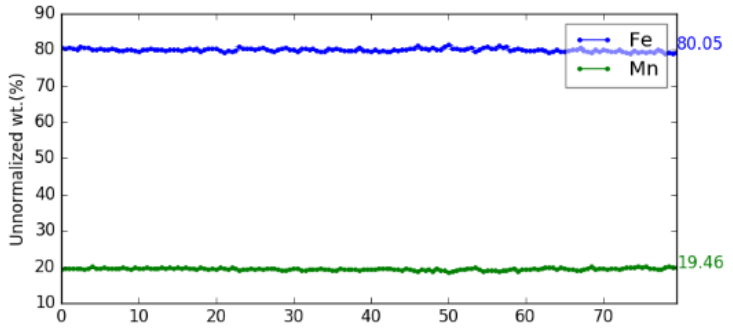


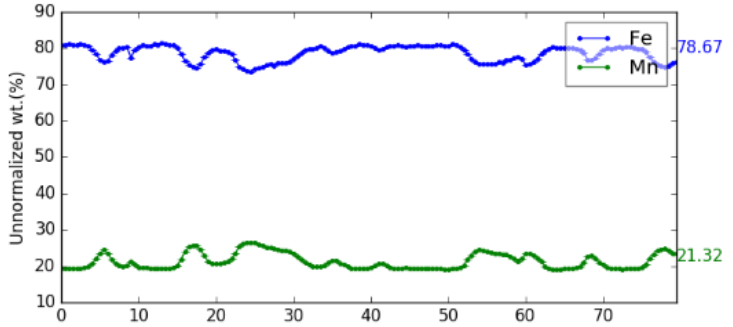


LMD







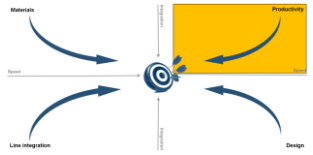


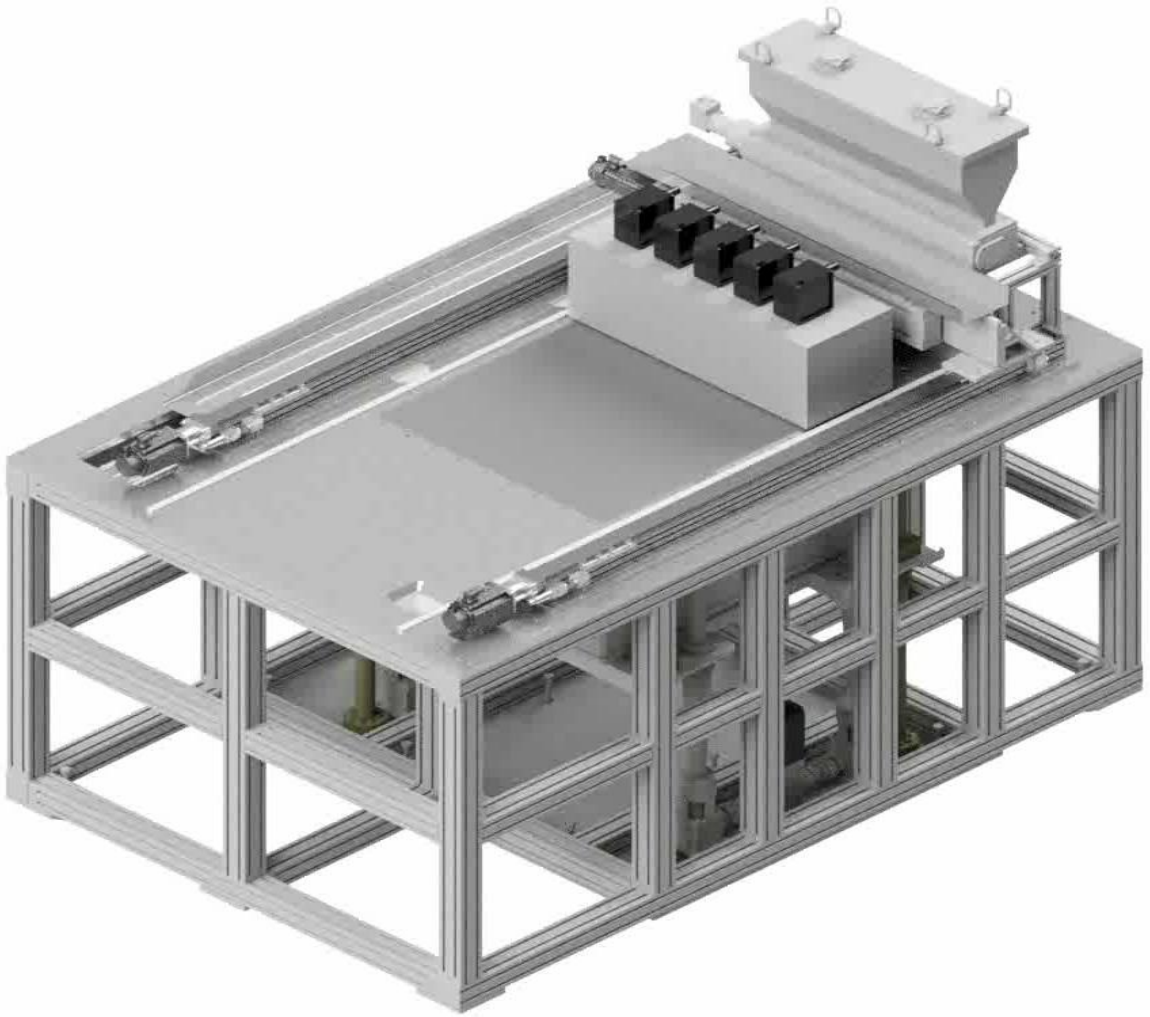
Material: X30Mn22
Method: ESMA-
area- and line scan

Source: RWTH Aachen University - Steel Institute

Fraunhofer ILT | DAP Digital Additive Production | RWTH AACHEN UNIVERSITY

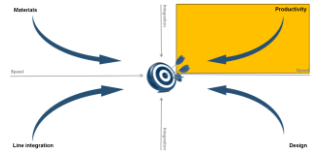
Upscaling the productivity of AM systems is a necessary step to overcome cost hurdles in series production

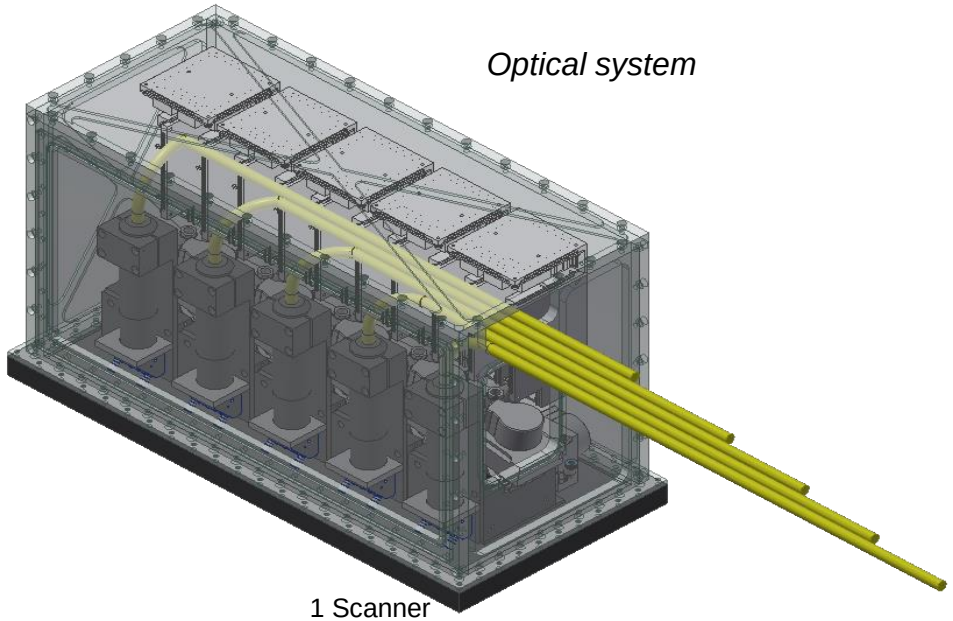




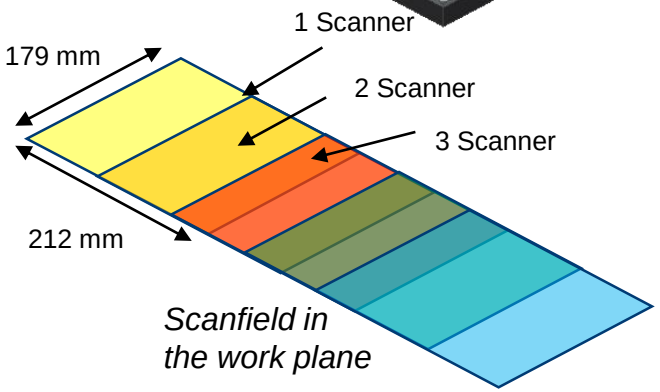
- **Specs**
- Effective build volume:
  1000 mm x 800 mm x 500 mm
- Movable process head offers nearly unlimited scaling
  - Build volume
  - Optical output (start configuration 5 x 400 W)
- Out of the shelf machine components, e. g.
  - Siemens Sinumerik 840D sl
  - Siemens Servo motors

The development of a flexible optical system is one of the key features for a scalable AM machine

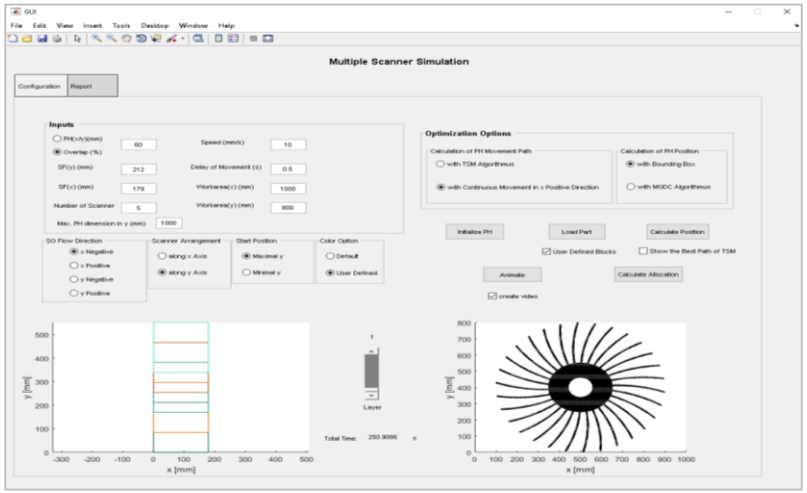




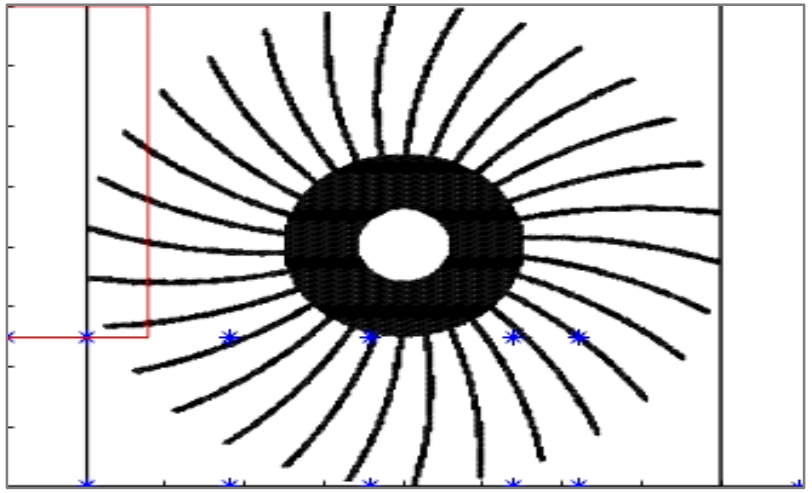
Optical system



Scanfield in the work plane



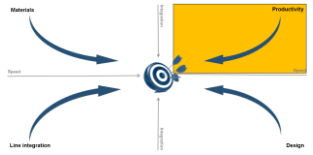
Scanning

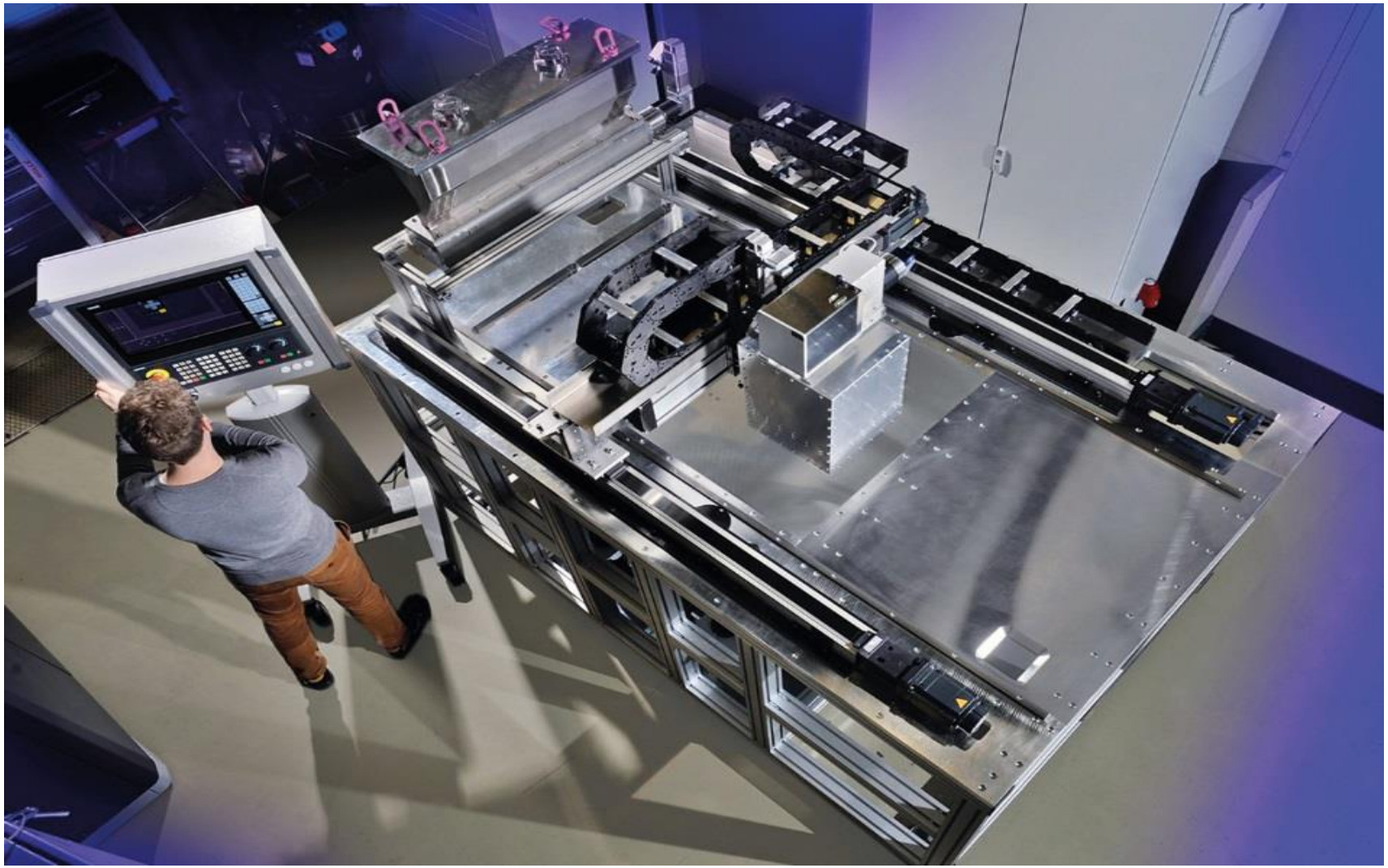


Working head
Scanner 5
Scanner 4
Scanner 3
Scanner 2
Scanner 1

Fraunhofer ILT
DAP Digital Additive Production
RWTH AACHEN UNIVERSITY

Upscaling the productivity of AM systems is a necessary step to overcome cost hurdles in series production



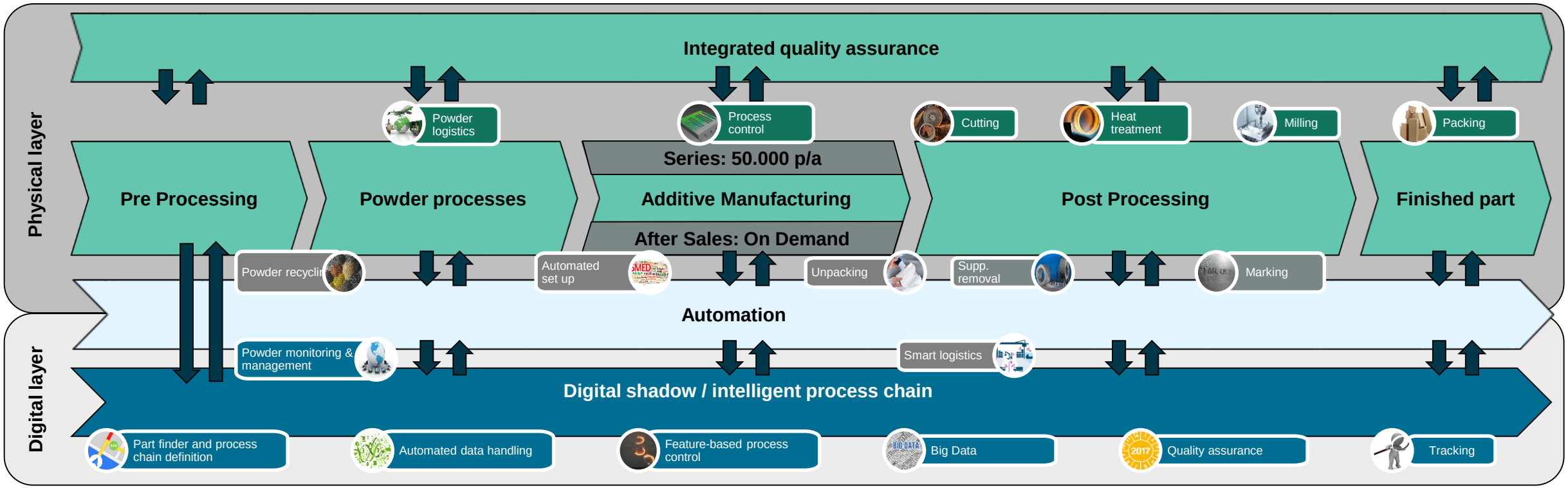


Fraunhofer ILT

DAP Digital Additive Production

RWTH AACHEN UNIVERSITY

Line integration of AM is a core element of R&D activities in Aachen



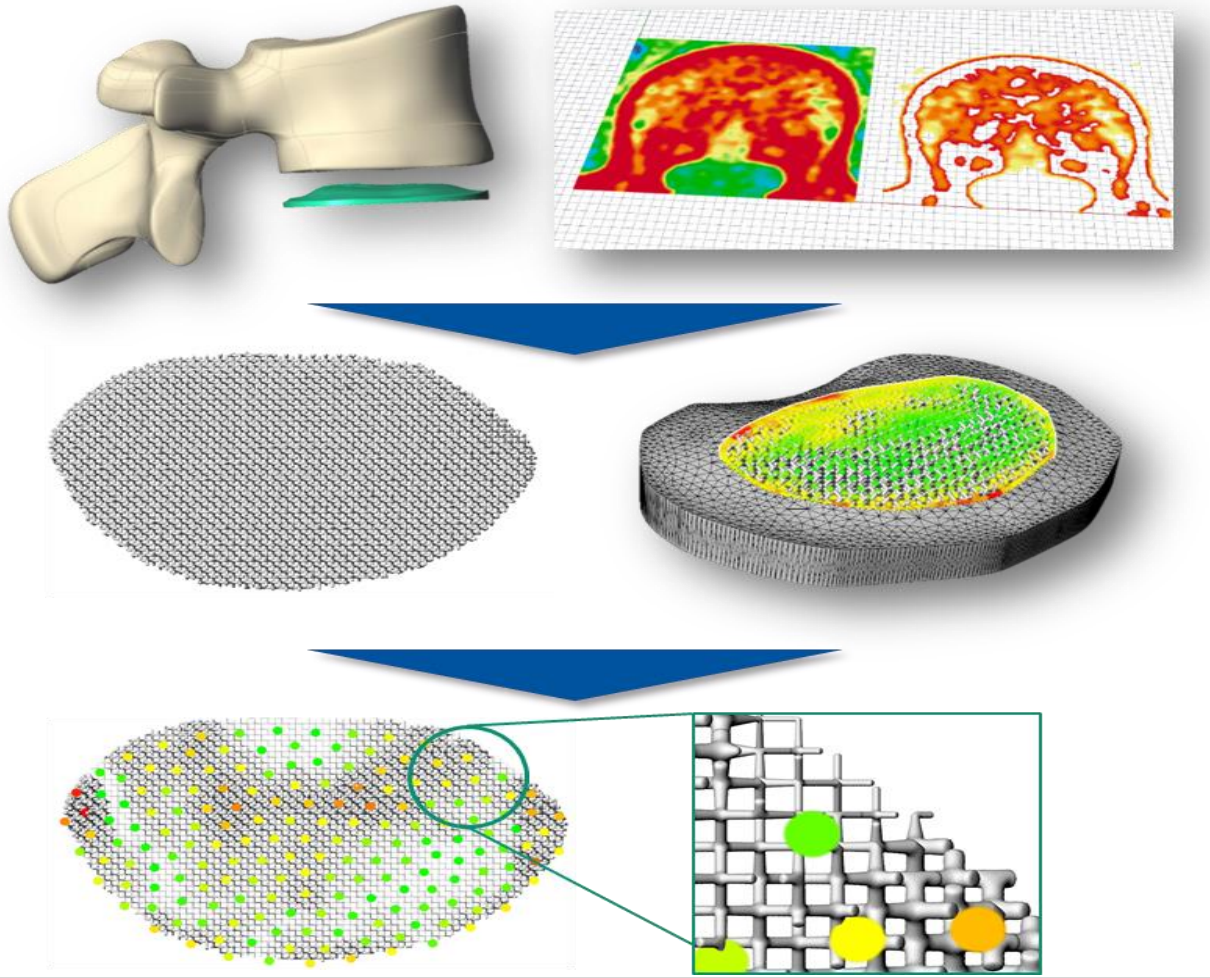
Fraunhofer ILT | DAP Digital Additive Production | RWTH AACHEN UNIVERSITY

„Digital Material“ is a key element in AM-enabled design

Quelle: Adidas

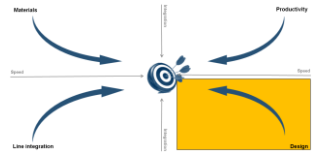
The full exploitation of AM is levered by freedom of design

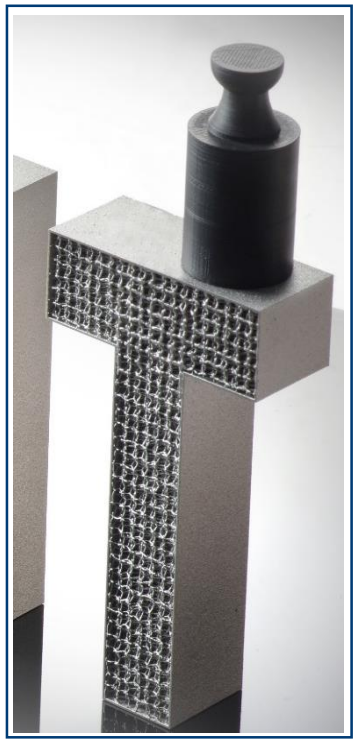
- Bone stiffness varies in x-, y- and z-direction
- Risk of local overload
- Aim: homogeneous load on implant
- Evaluation of stiffness via CT scan
- Calculation of E-Modules via FEM
- Mapping of required stiffness and implant structure

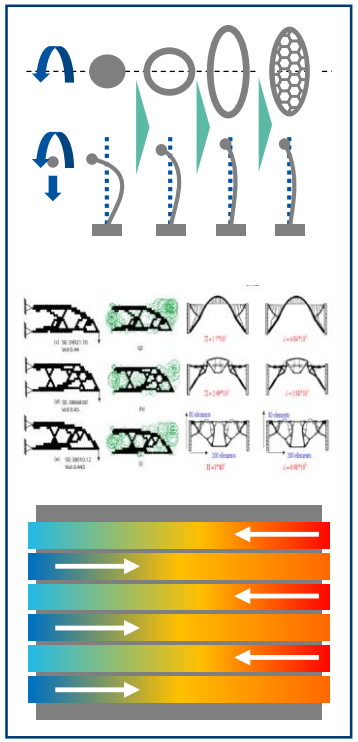


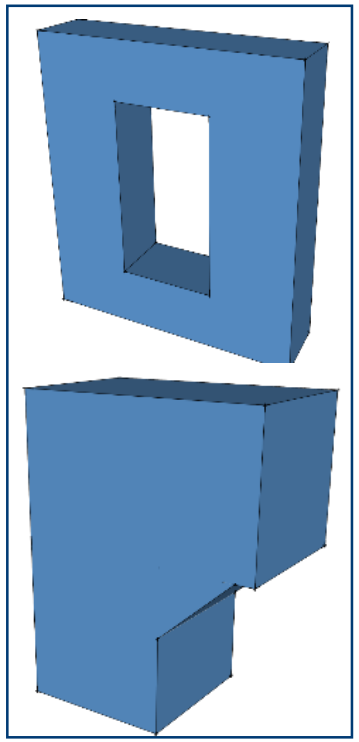
Sources: RWTH-DAP, Fraunhofer -ILT

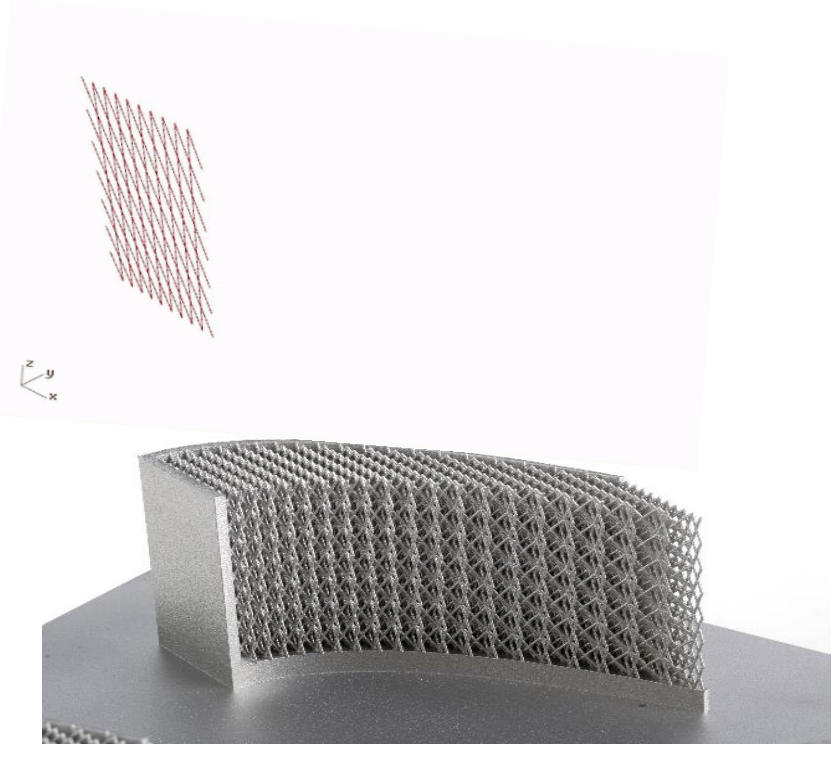
Algorithm-based design and additive manufacturing will enable holisitic “digital engineering”











Load constraints | Design constraints | Bionic design | Mfct. constraints

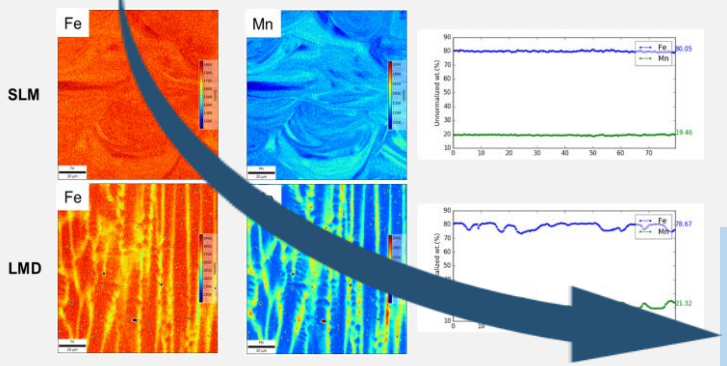
Algorithm-based lattice structures

Sources: DAP/ILT

Fraunhofer ILT | DAP Digital Additive Production | RWTH AACHEN UNIVERSITY

Speed and integration will be significantly enhanced!

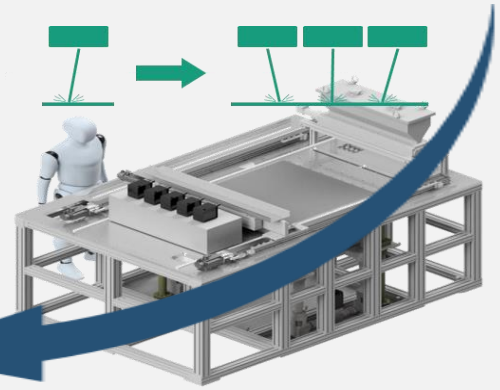
Materials



Speed

Integration

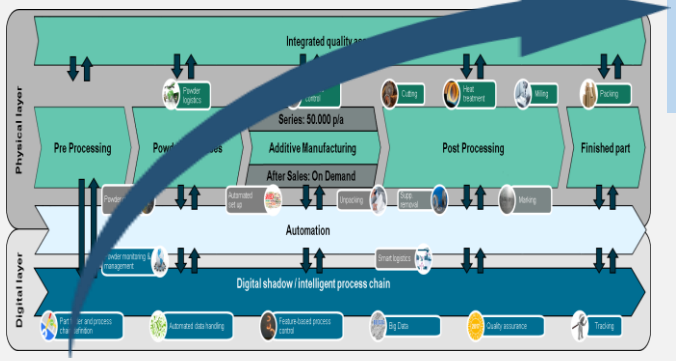
Productivity



Speed

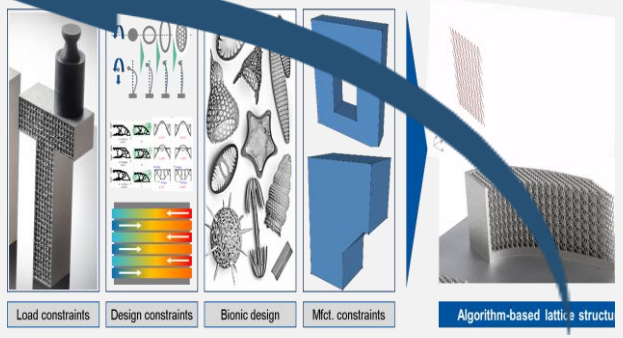
Speed and integration are the

main drivers for future AM applications!



Line integration

Integration



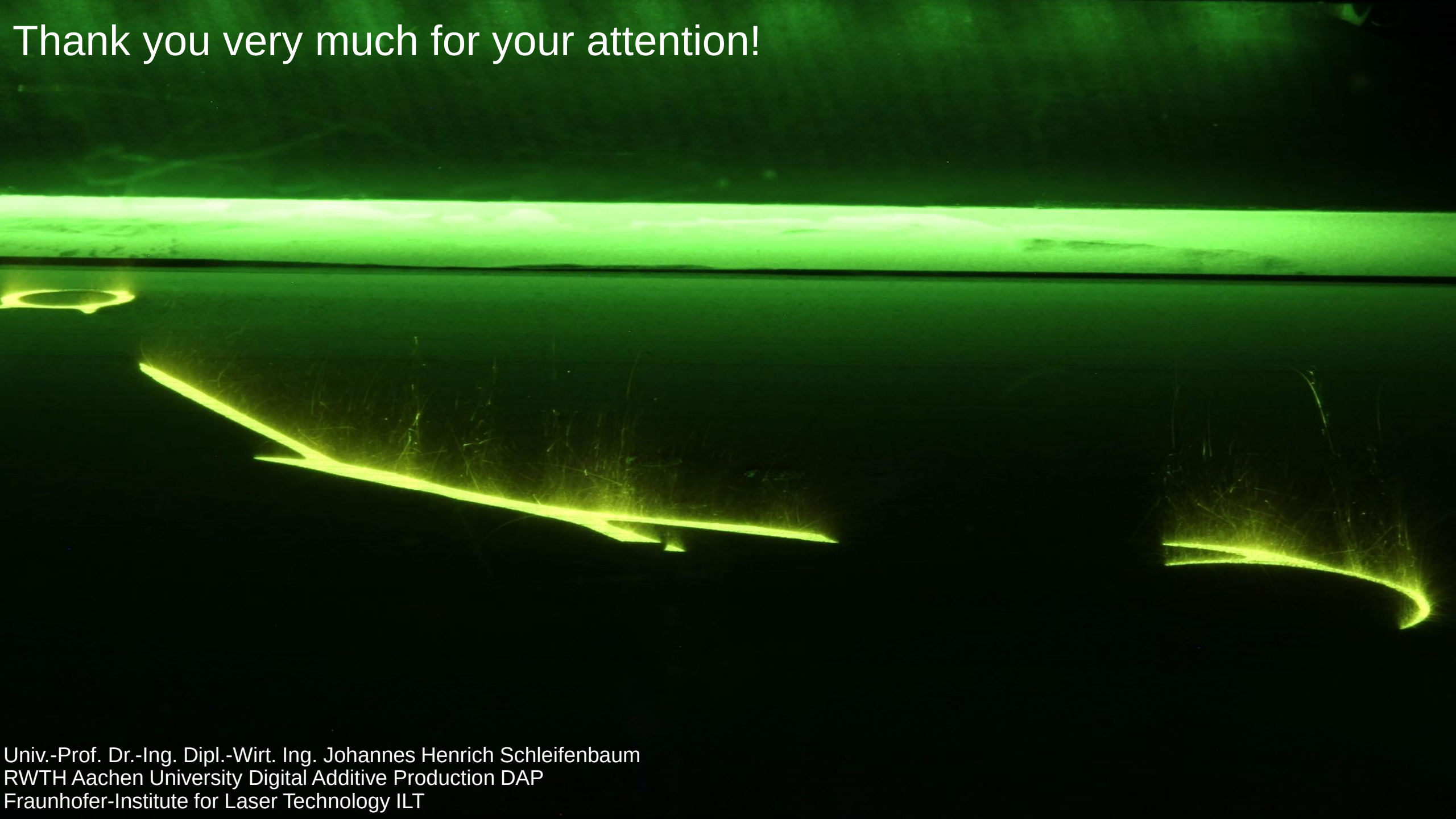
Design

Fraunhofer ILT

DAP Digital Additive Production

RWTH AACHEN UNIVERSITY

Thank you very much for your attention!



Univ.-Prof. Dr.-Ing. Dipl.-Wirt. Ing. Johannes Henrich Schleifenbaum
RWTH Aachen University Digital Additive Production DAP
Fraunhofer-Institute for Laser Technology ILT