Simulation-Driven Design for Additive Manufacturing with CAESES and Simcenter

CAESES User Conference 2022
Michael Hajduk

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Introduction

- M.Sc. Naval Architecture and Ocean Engineering at TU Berlin
- **2018 – 2021**
  Research engineer in Design for Additive Manufacturing at Siemens Energy
- WP-Lead HTA.AM-3 (AM-specific design optimization)
- **Since 2022**
  Technical Product Manager for
  Simcenter Additive Manufacturing Simulation at
  Siemens Digital Industries Software

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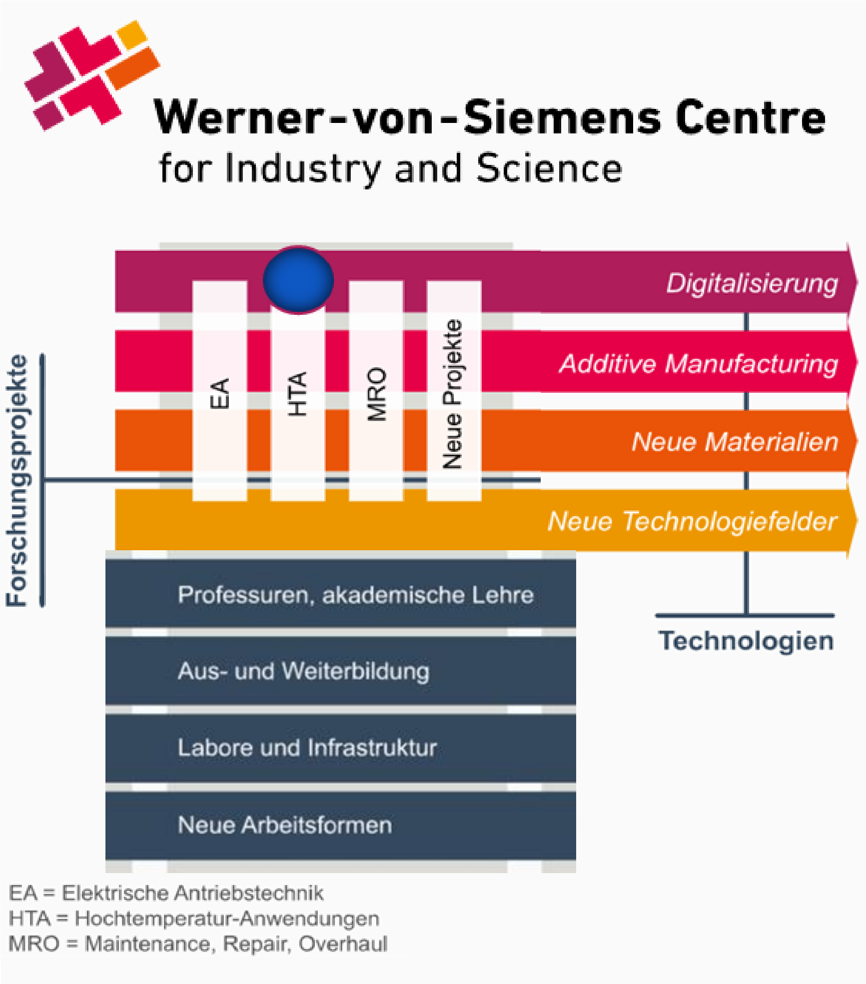
WvSC and the HTA program



ca. 13Mio.€
total budget

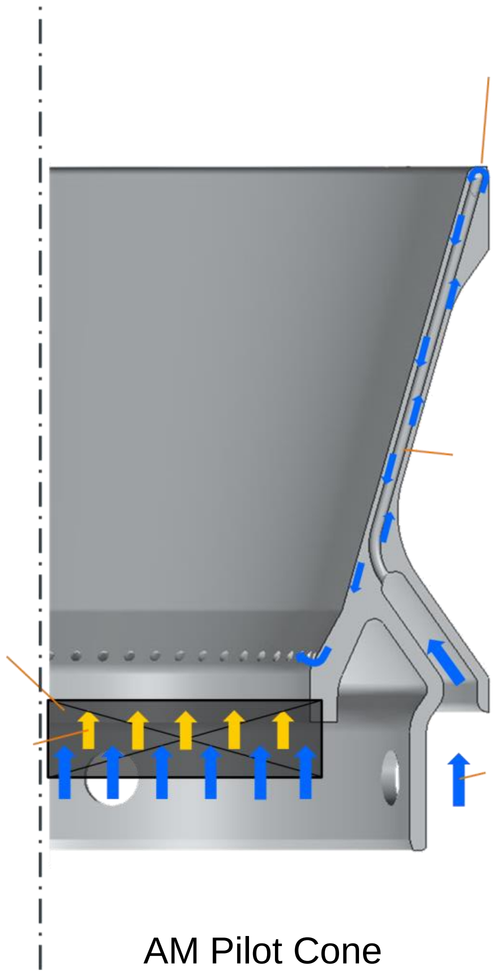
3 Research fields
12 Work-packages
73 Sub work-packages

EUROPÄISCHE UNION
Europäischer Sozialfonds

This work has been partially financed by the European Regional Development Fund (ERDF), ProFIT HTA High Temperature, Application No. 10167478

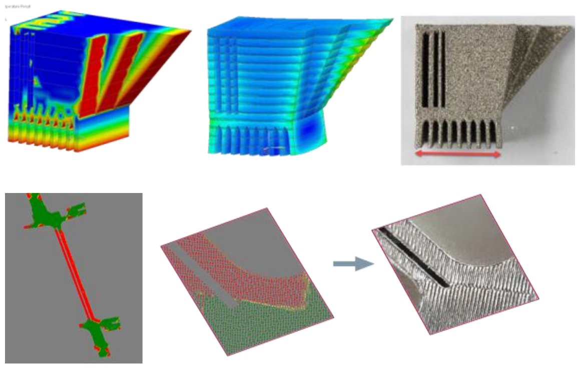
AM-specific design optimization (HTA.AM-3)

Overview

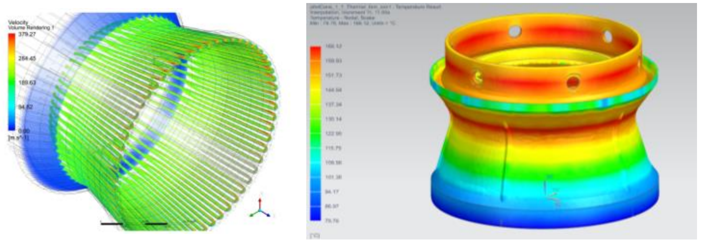


AM Pilot Cone
(HTA Use Case)

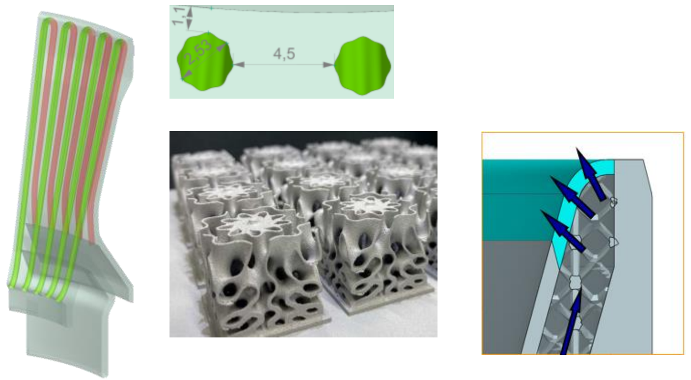
HTA.AM3.1 L-PBF Process Simulation
Integration of macro- and mesoscale L-PBF simulation for Haynes 282 into the design process for component and support structures



HTA.AM3.2 Multi-criteria optimization
Integration of H282 L-PBF process boundaries into automated design optimization tools to improve DfAM for component and support structures



HTA.AM3.3/4 New cooling structures
Development of new cooling structures for In- and On-wall cooling of combustion components to improve efficiency



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L-PBF process simulation on a macro-scale

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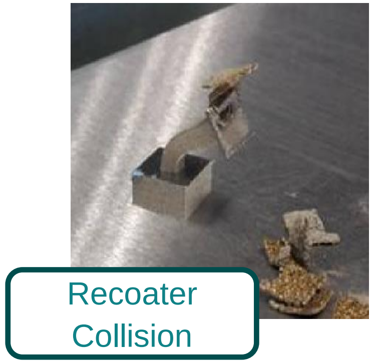
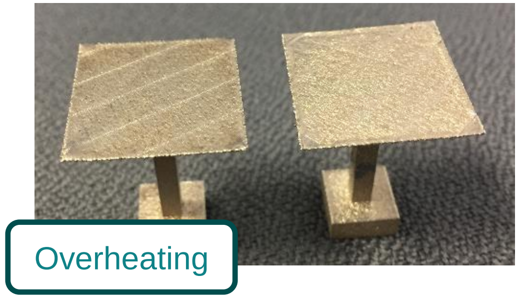
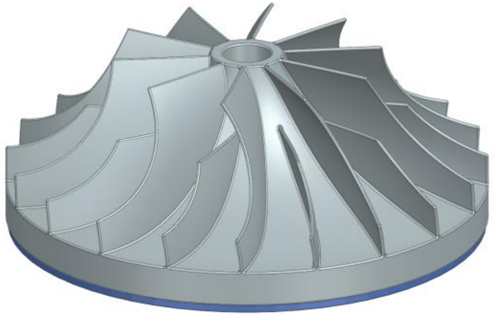
L-PBF process simulation
Introduction

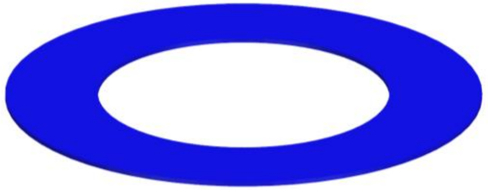
Problem
- The powder bed fusion process induces thermal shrinkage and hence thermo-mechanical stress in each printed layer
- That stress can cause the part to distort during the printing process
- Large distortions may lead to a fatal recoater crash or to a final part geometry that is out of part specification

Solution
- With Simcenter for PBF we simulate these distortions and allow users to either change build job design or to change part geometry by compensating the distortion









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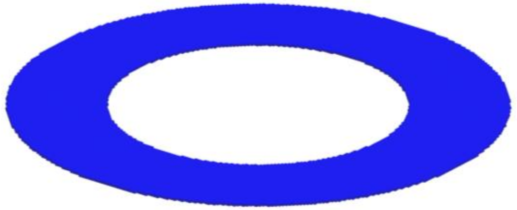
L-PBF process simulation
Simcenter PBF and Advanced PBF Solution

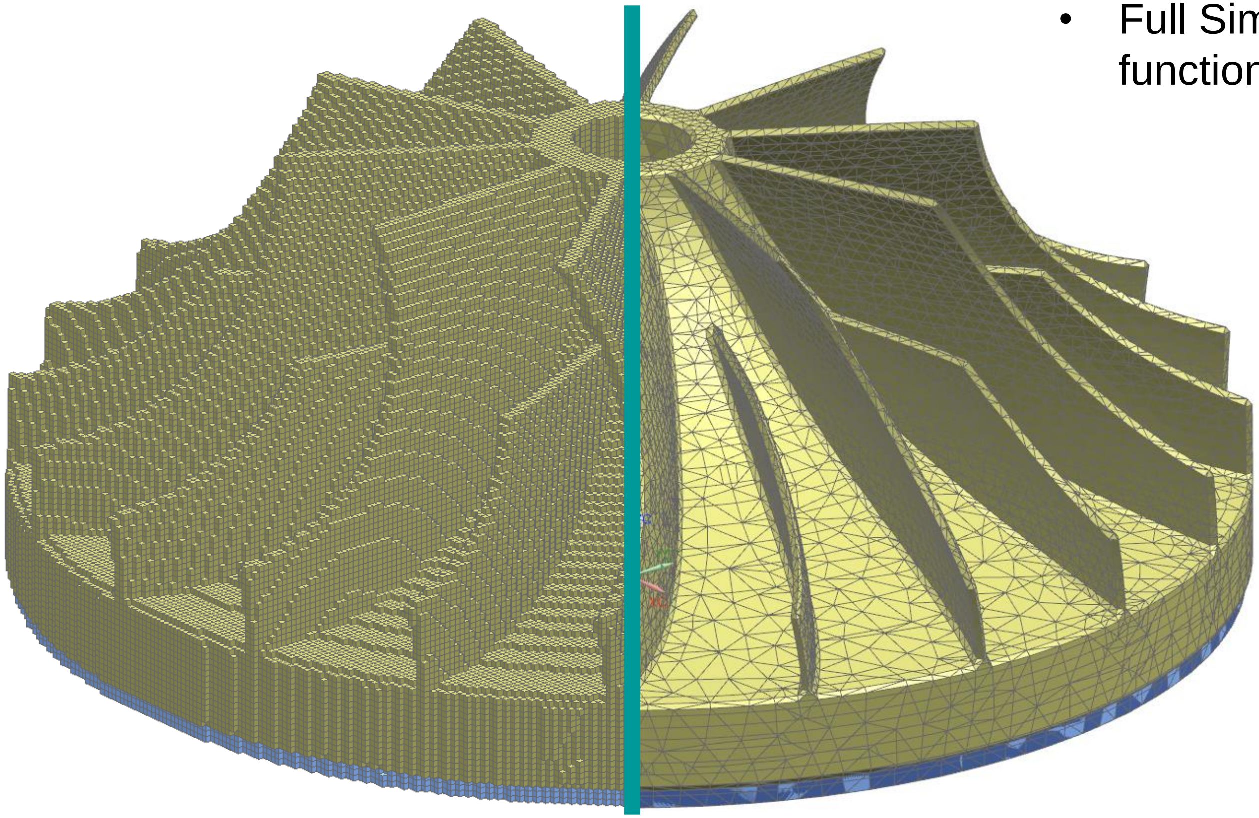
Simcenter PBF

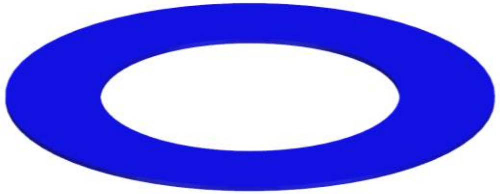
- Voxel-based mesh
- Purely mechanical solution
- Easy to use for non-CAE engineers

Simcenter Advanced PBF

- Tetrahedral mesh based
- Thermal + Mechanical simulation
- Full Simcenter Pre/Post functionality for CAE engineers







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L-PBF process simulation
Compensation with CAESES and Simcenter

Problem

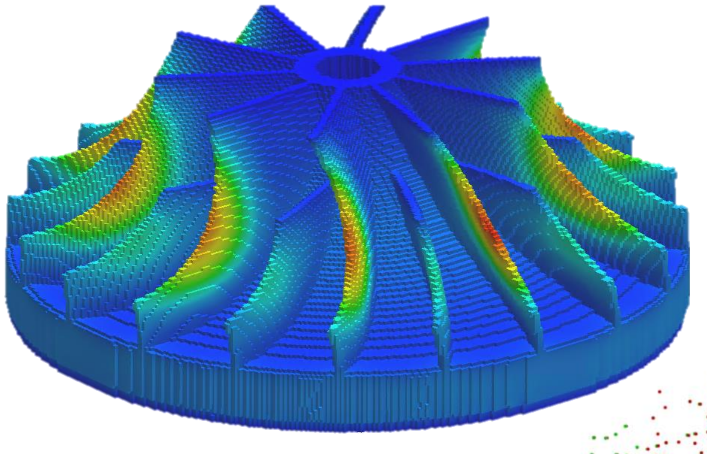
Both, solutions generate distortion and compensation results based on the FE model (voxel- or tet-mesh). These models are very rough and can not directly be printed in that state.

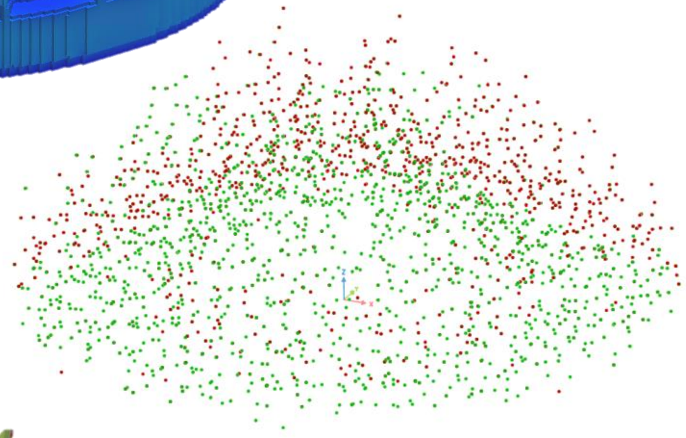
Solution

The distortion and/or compensation results can be extracted and used in CAESES to morph the original B-Rep solid model to fit the compensation results of the simulation.

The resulting solid model then can be sent to the PBF printer.

Integration into Simcenter PBF planned for Q2 2023





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AM-specific cooling structure designs for high temperature applications (HTA.AM-3)

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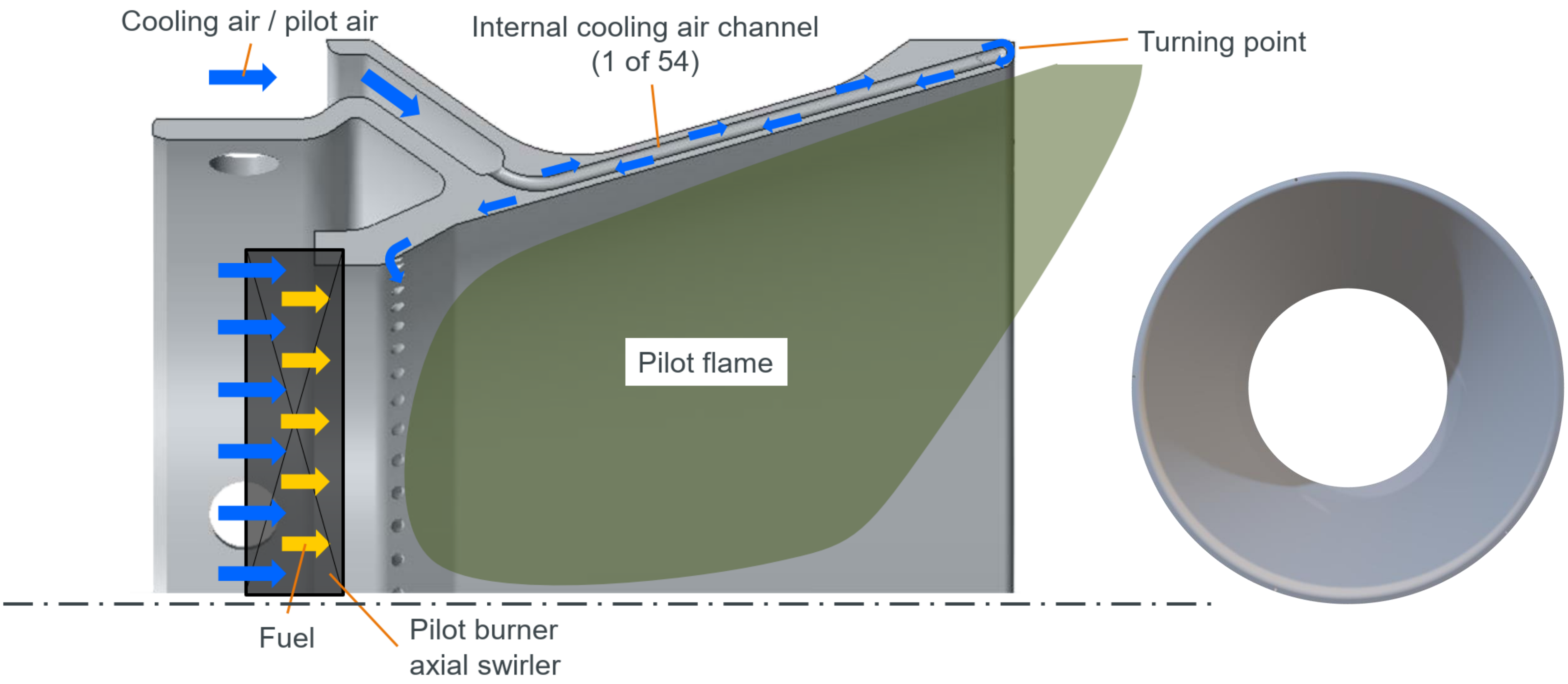
AM-specific design optimization (HTA.AM-3)
Pilot Cone Use Case



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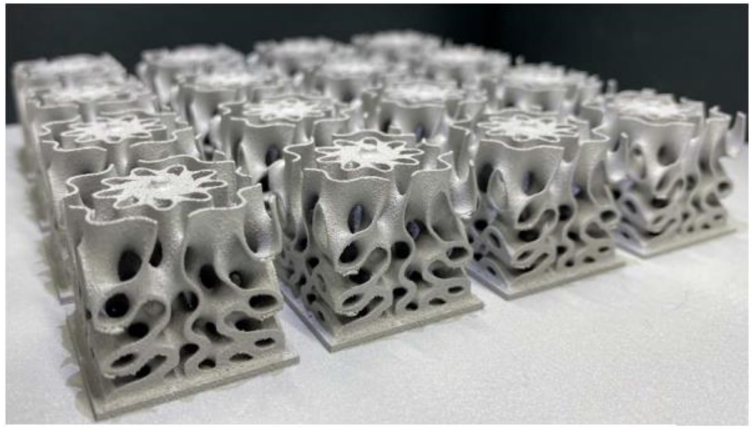
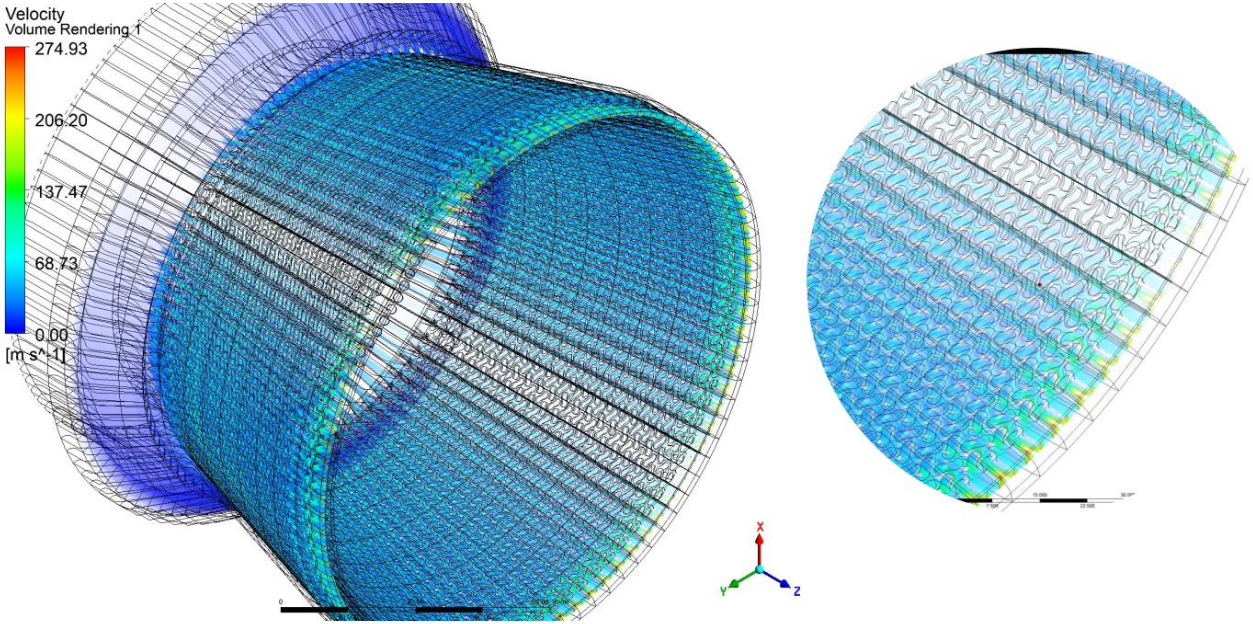
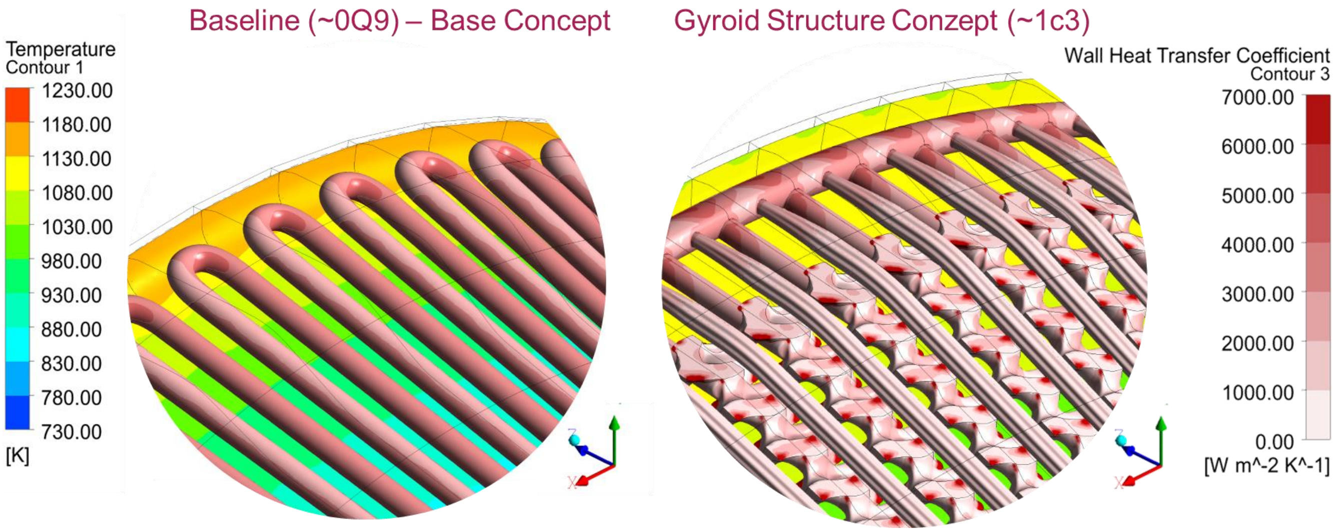
AM-specific design optimization (HTA.AM-3)
Gyroid structured wall







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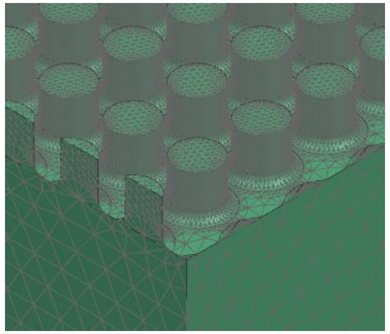
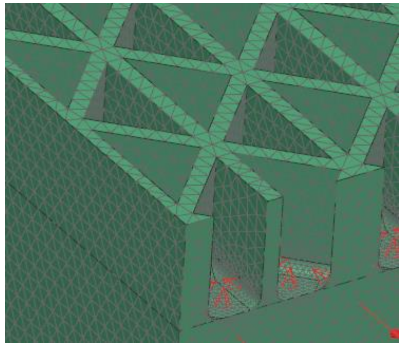
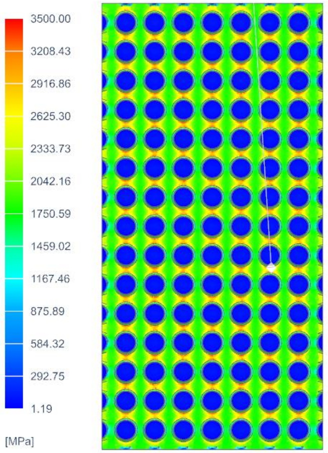
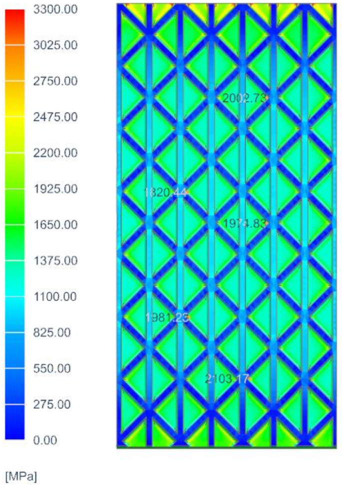
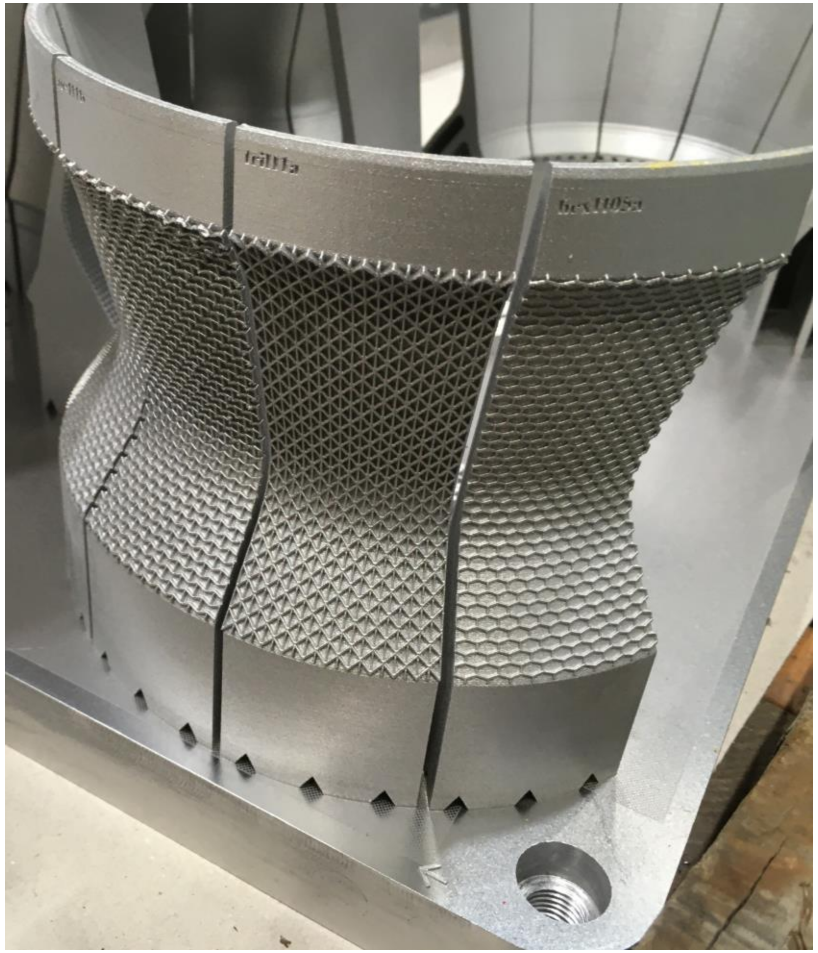
AM-specific design optimization (HTA.AM-3)
Surface augmentation for cooling and hybrid coating

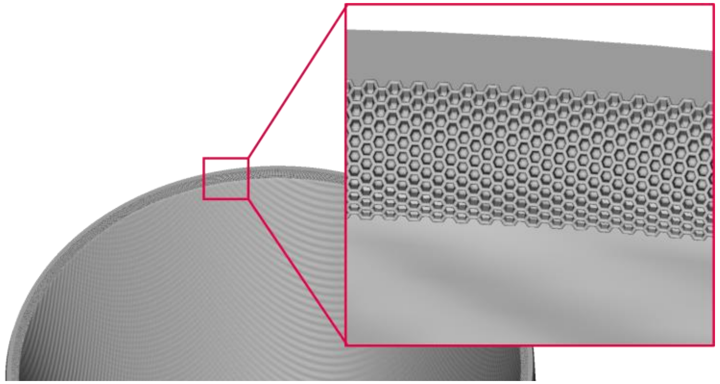


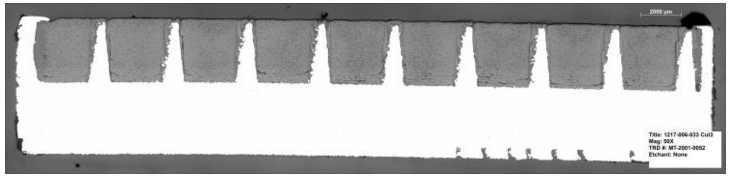


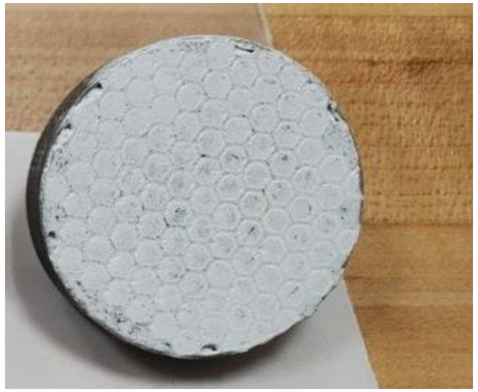












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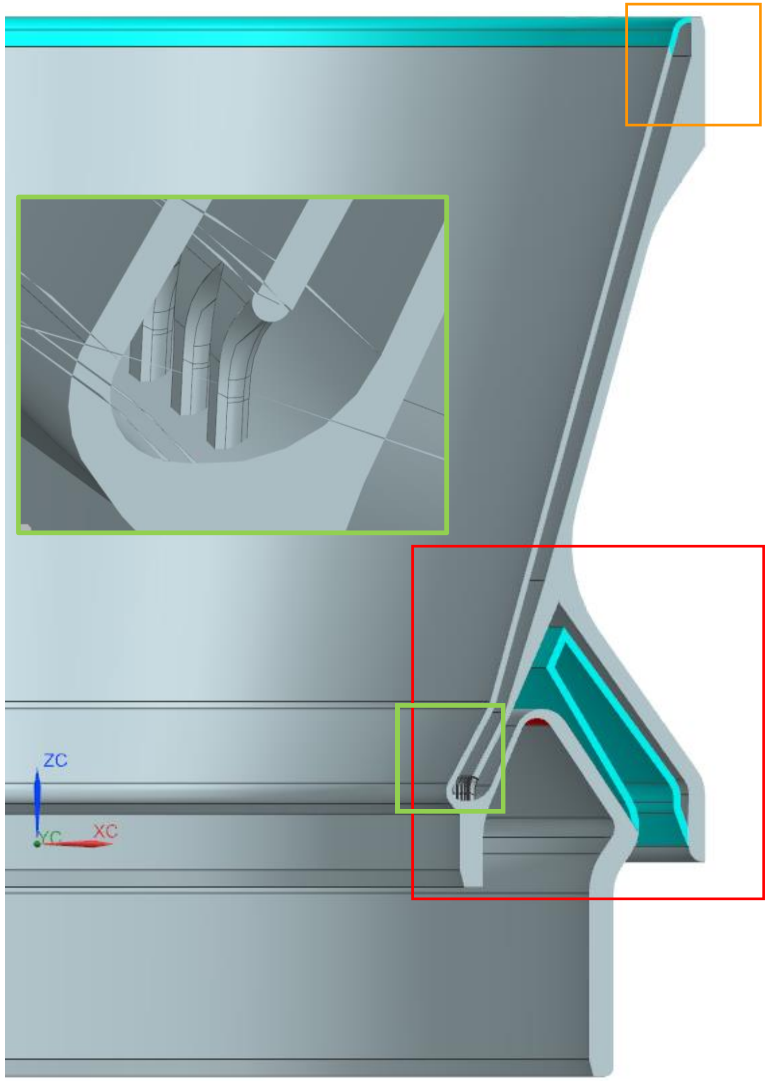
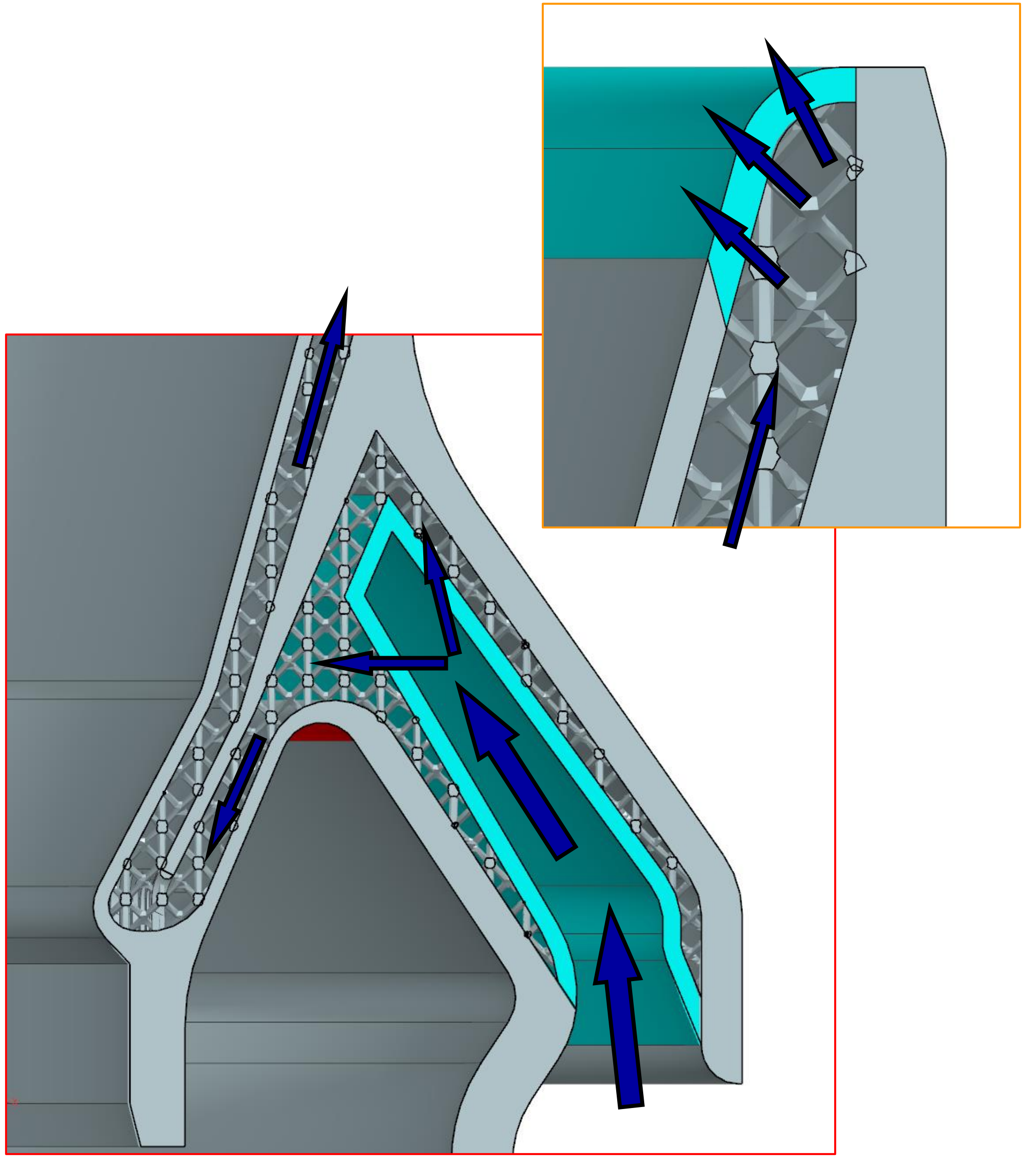
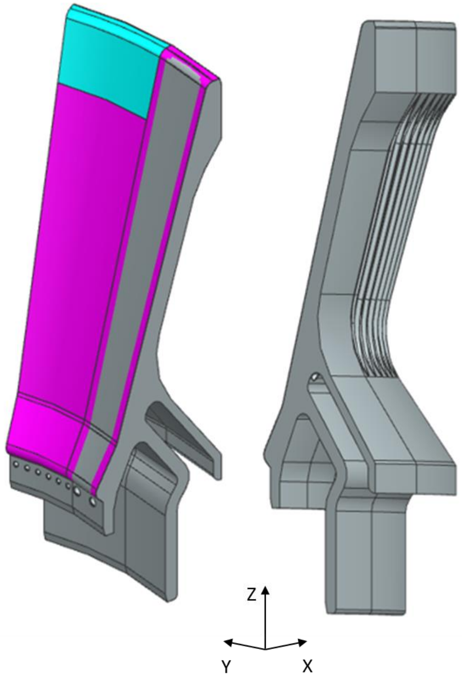
AM-specific design optimization (HTA.AM-3)

Effusion cooling via Designed Materials







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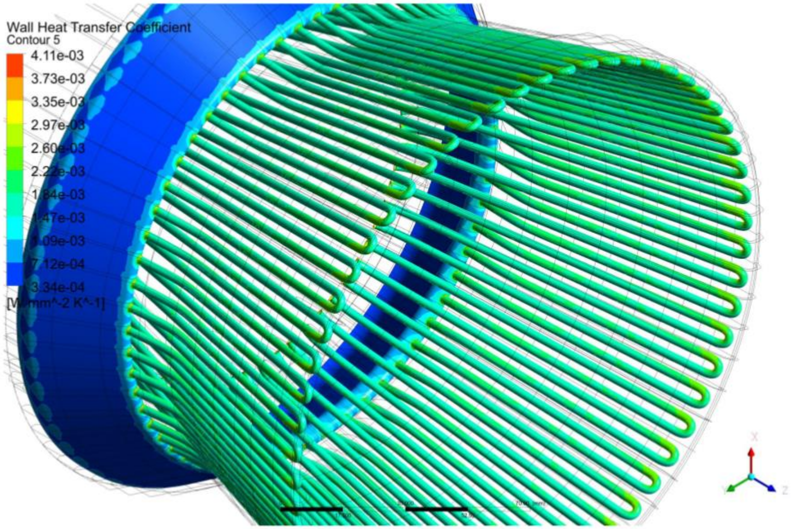
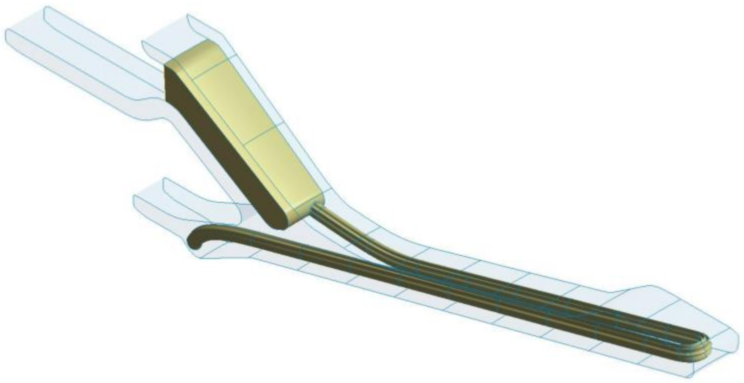
AM-specific design optimization (HTA.AM-3)

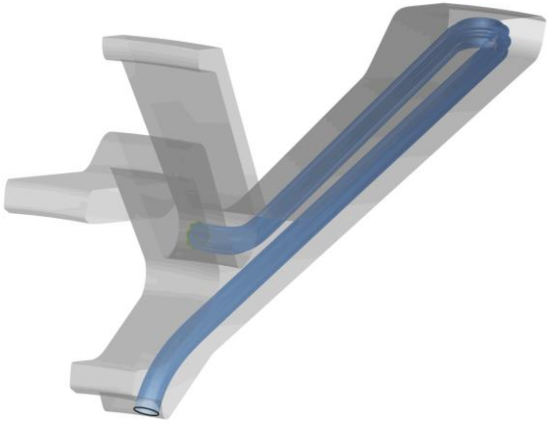
Adaptive channel cross-section

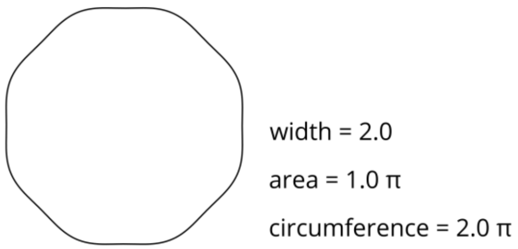
Standard round channel

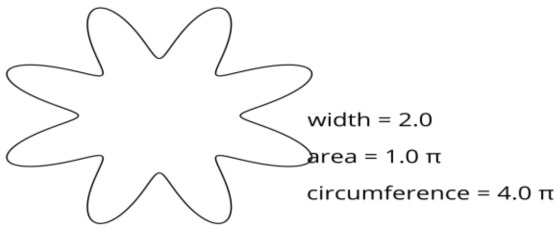


Adaptive channel cross-section









→ Fully parametric channel geometry optimization through CAESES

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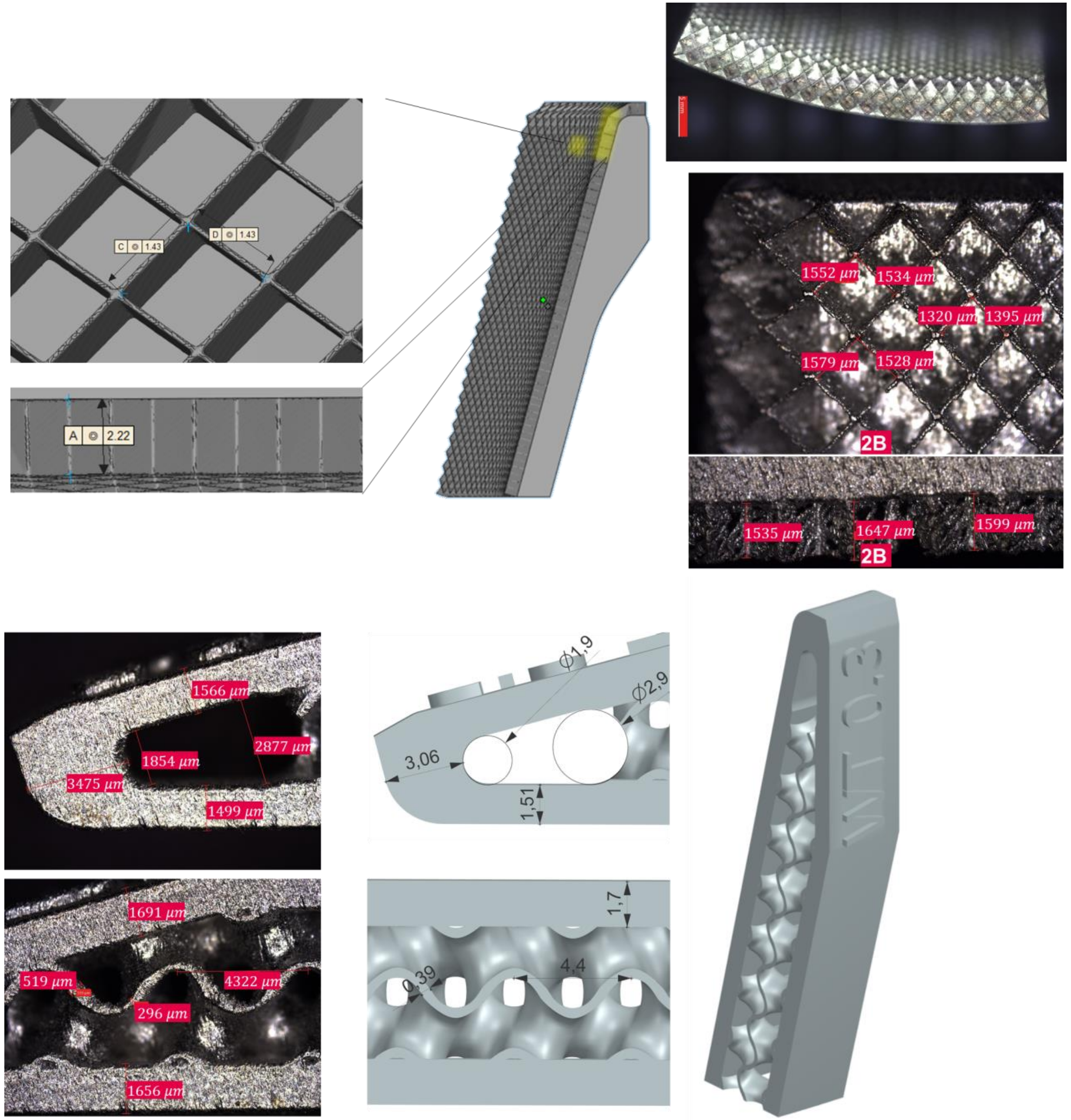
AM-specific design optimization (HTA.AM-3)
Manufacturability tests



Thanks! Questions?

Are you a student in engineering and interested in #simulation and #additivemanufacturing? Then you should come join us!
Our product management team is looking for a student to support us in developing our Simcenter Additive Manufacturing simulation tools!

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Contact

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