

COMSOL  
CONFERENCE  
2020 EUROPE

SYNOPSYS®  
*Silicon to Software™*

# Synopsys Simpleware - From 3D Images to Models

3D Inspection of AM Components Using CT: Linking Rapid Defect Detection with Thermal Performance Simulation in COMSOL

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Dipl.-Ing. Denis Feindt, Synopsys



# Simpleware Product Group

## Overview

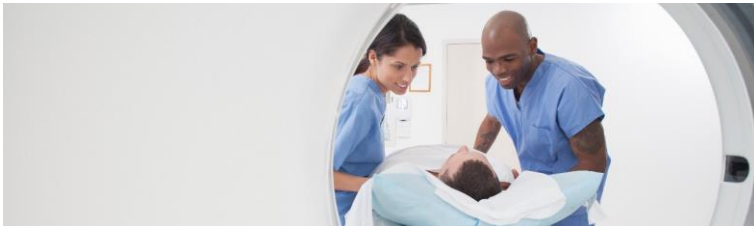


# Simpleware Product Group

- Developers of high-end 3D image processing software
- Dedicated sales, support and service teams
- Global presence
- Clinical and broader **life sciences**, **materials** and **manufacturing** applications



**SYNOPSYS**<sup>®</sup> | SIMPLEWARE PRODUCT GROUP



# How to inspect complex AM parts?



# What is image-based modelling & Simulation?



AM part

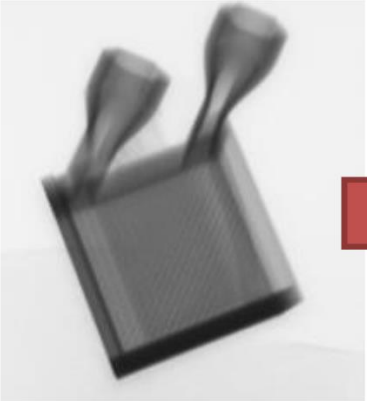
&



Nikon MCT225 metrology X-ray CT



Scan



A single radiograph



Reconstruction

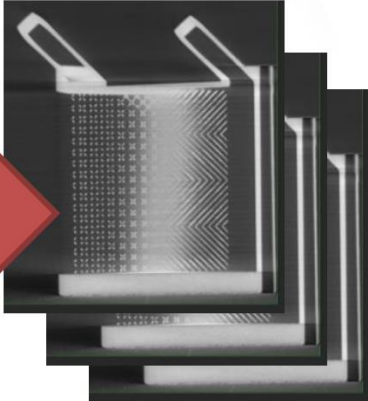
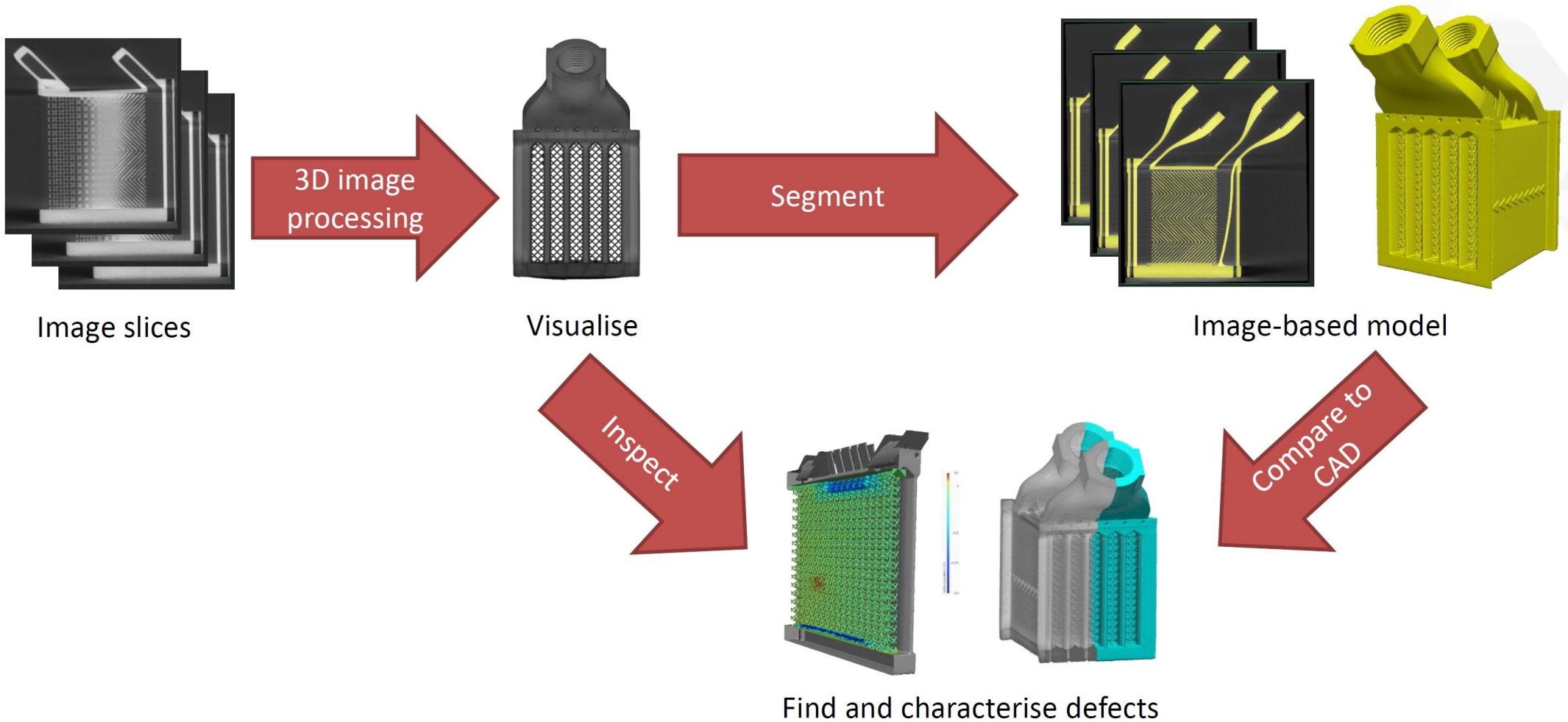


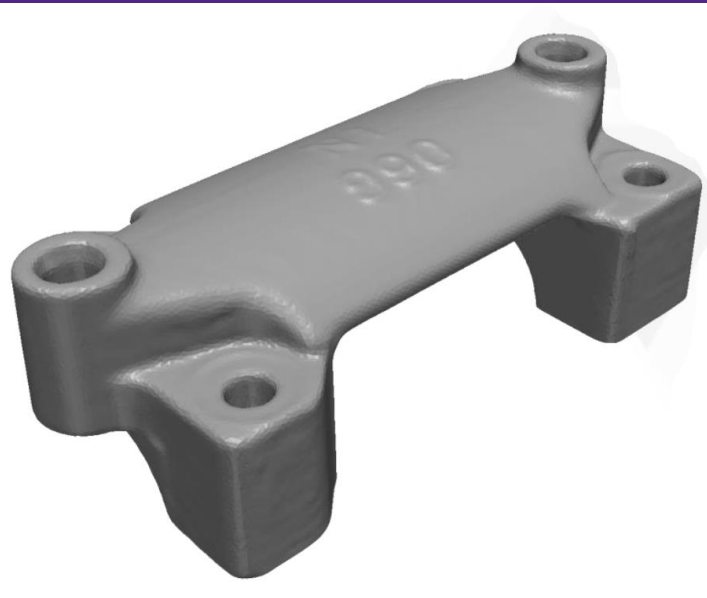
Image slices

# What is image-based modelling & Simulation?



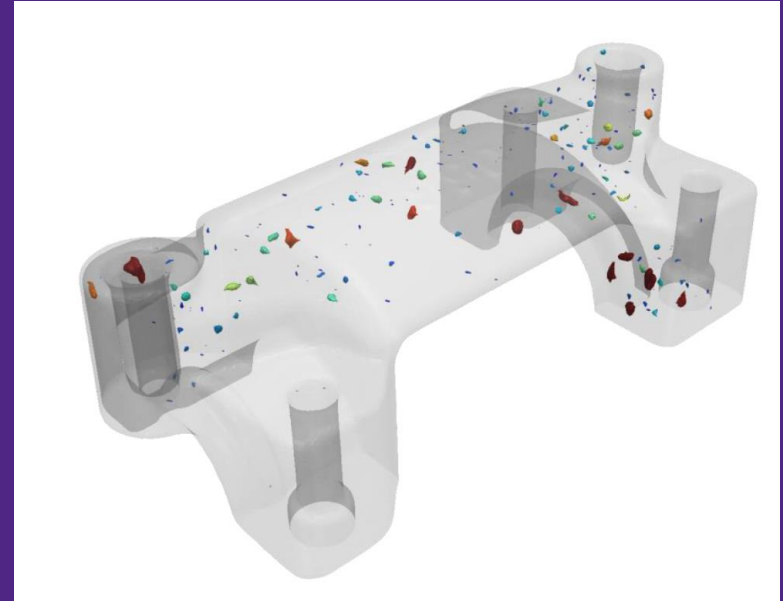
# BIG QUESTIONS

As-Designed



VS

As-Built

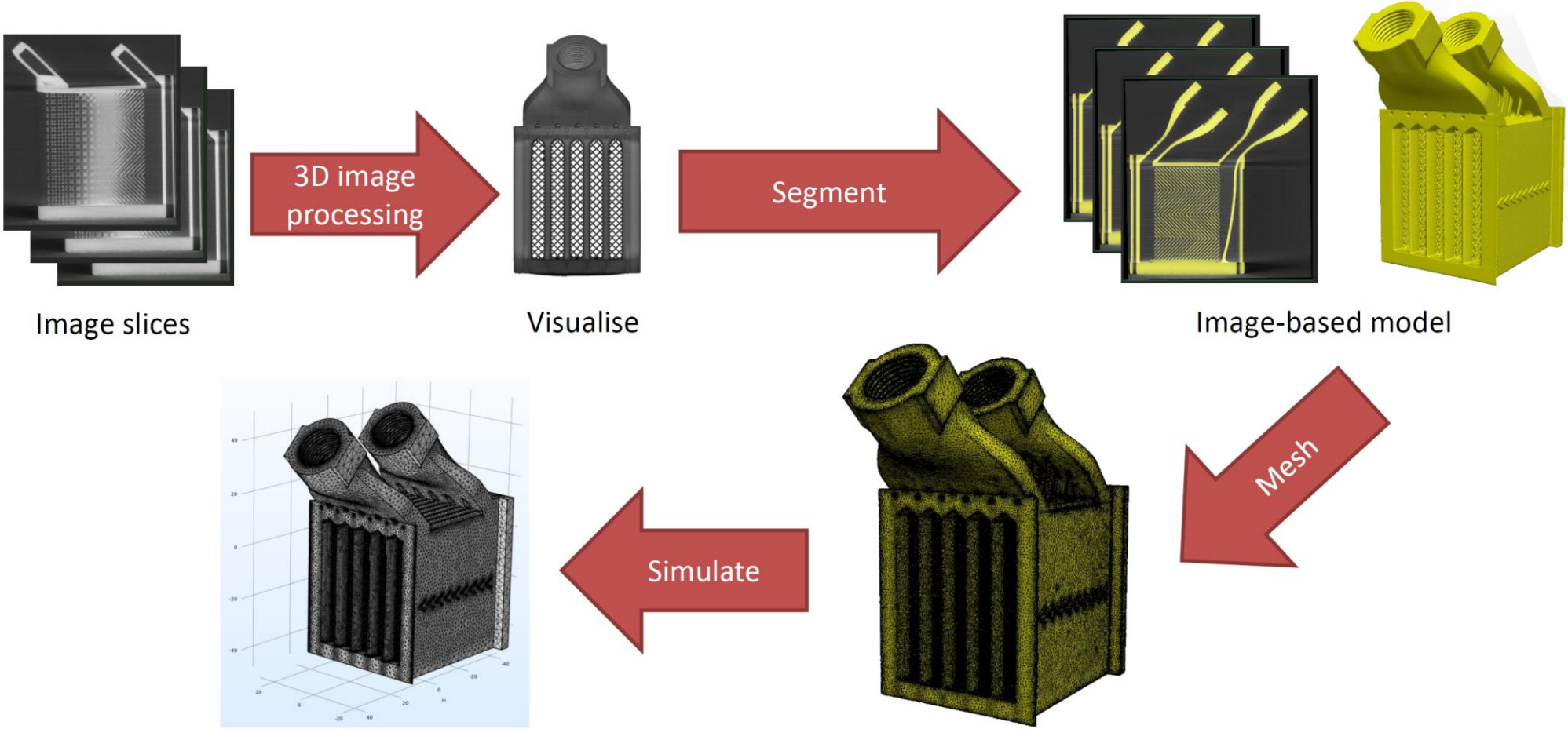


What are the differences?

How do these differences affect **performance**?



# What is image-based modelling & Simulation?





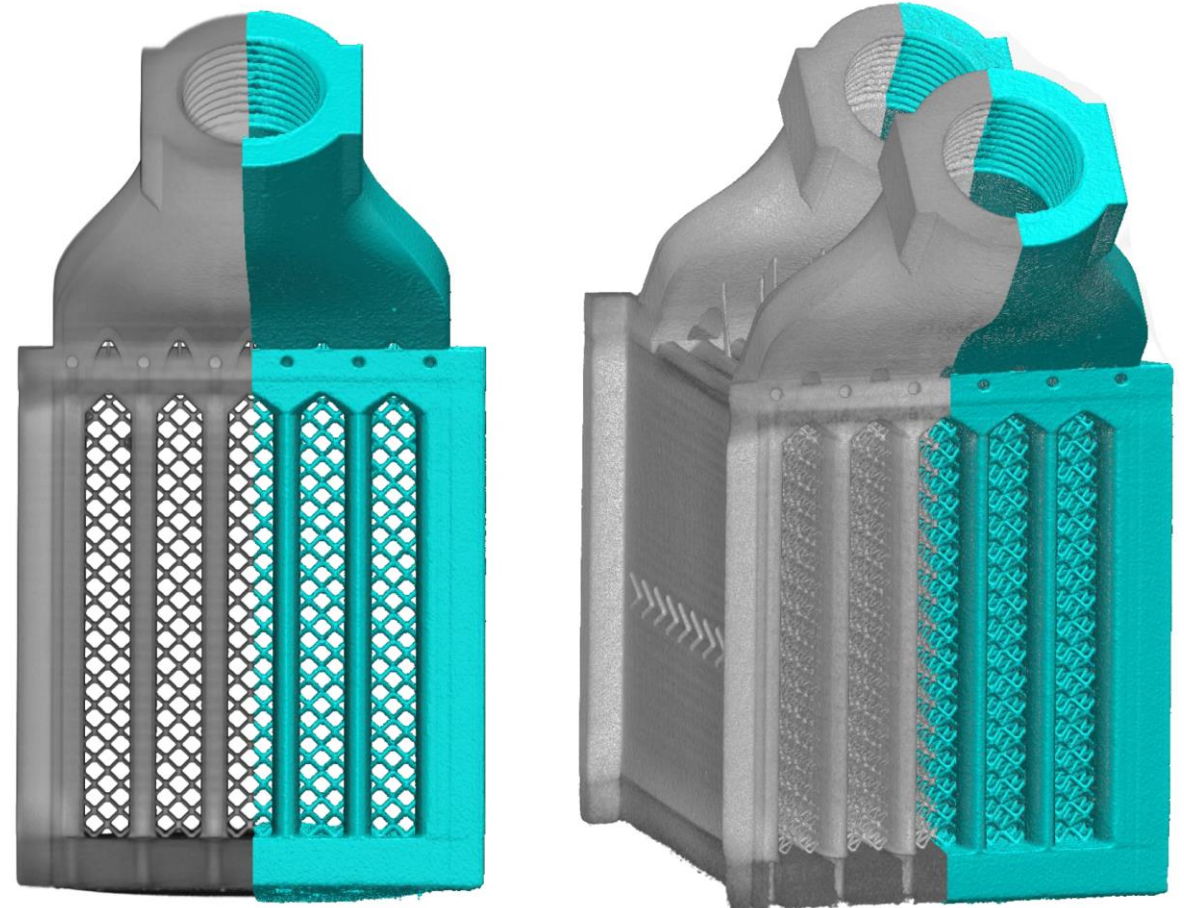
# The “Hot Box”

- Test jig designed to test performance of topologies before being integrated into bespoke heat exchangers.
- Design includes:
  - Five sections of lattice structure which air flows through separated by six fins
  - Liquid coolant flows through cross corrugated channels within the six fins
- Designed and manufactured by Hieta Technologies Ltd (UK)
- Manufactured in AlSi10Mg



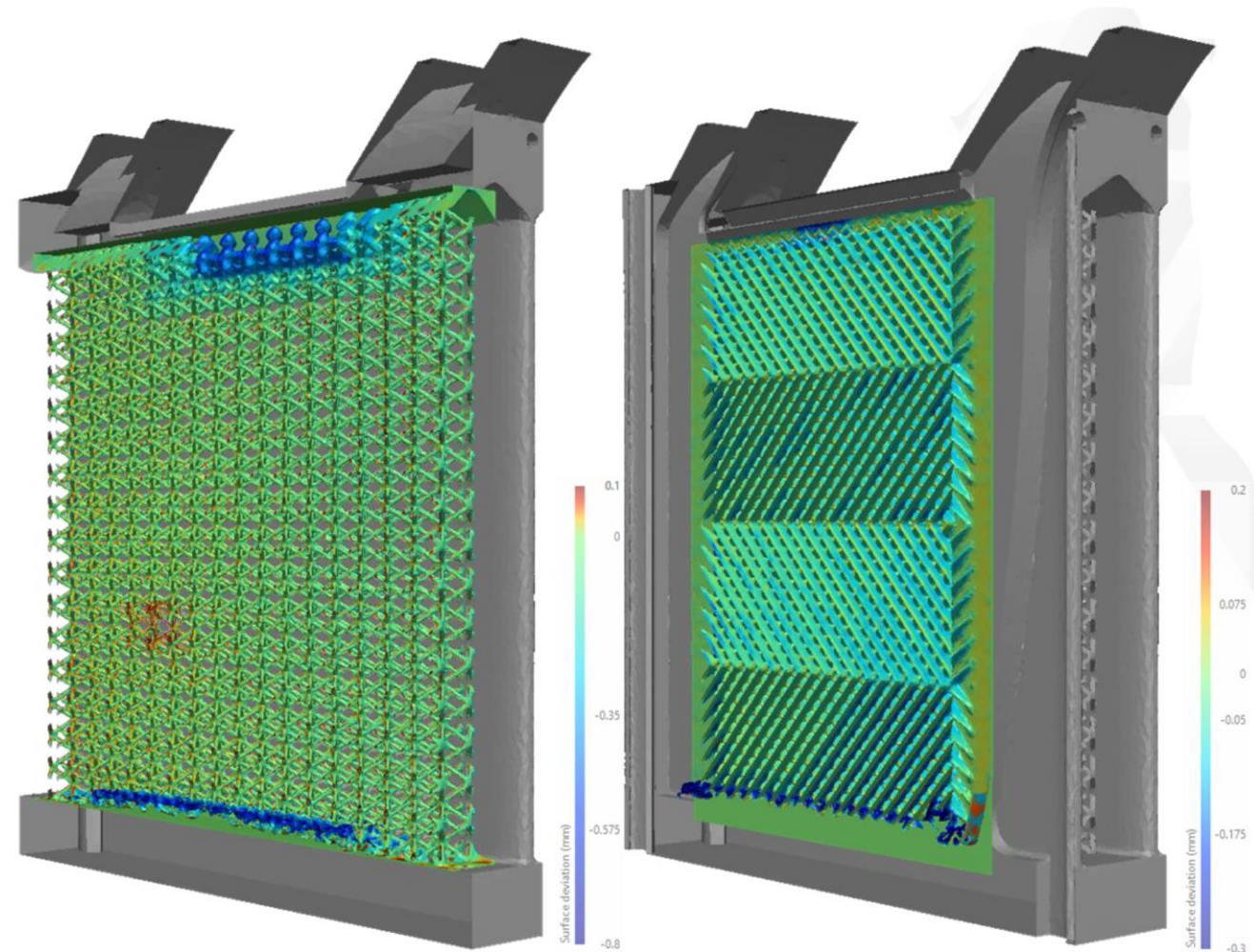
# Image based model in Simpleware ScanIP

- Stack of image imported into Simpleware ScanIP
- Volume rendering (grey) used for initial inspection showing powder build up in the base of the Hot Box
- Automated Segmentation tools used to generate the initial Image based model (blue)



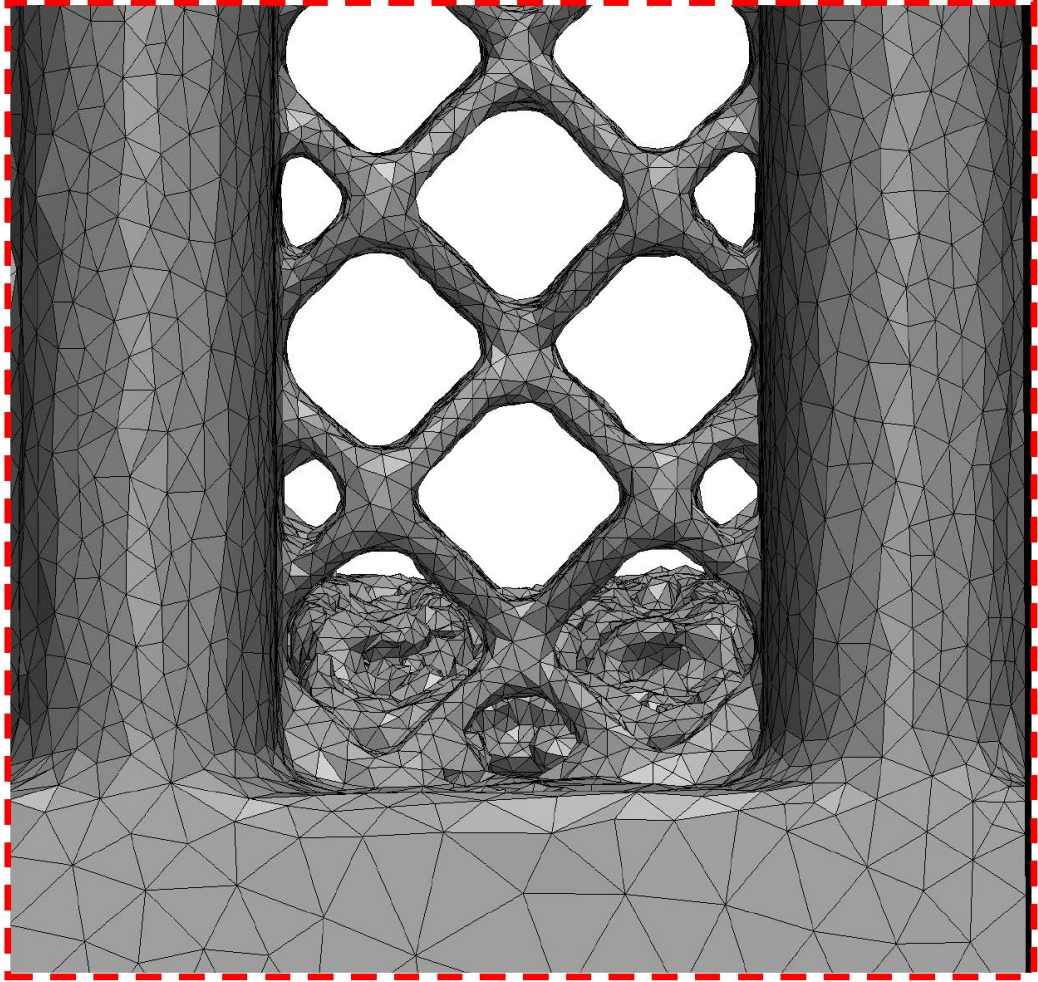
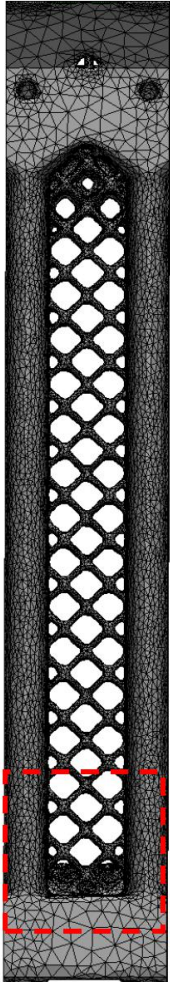
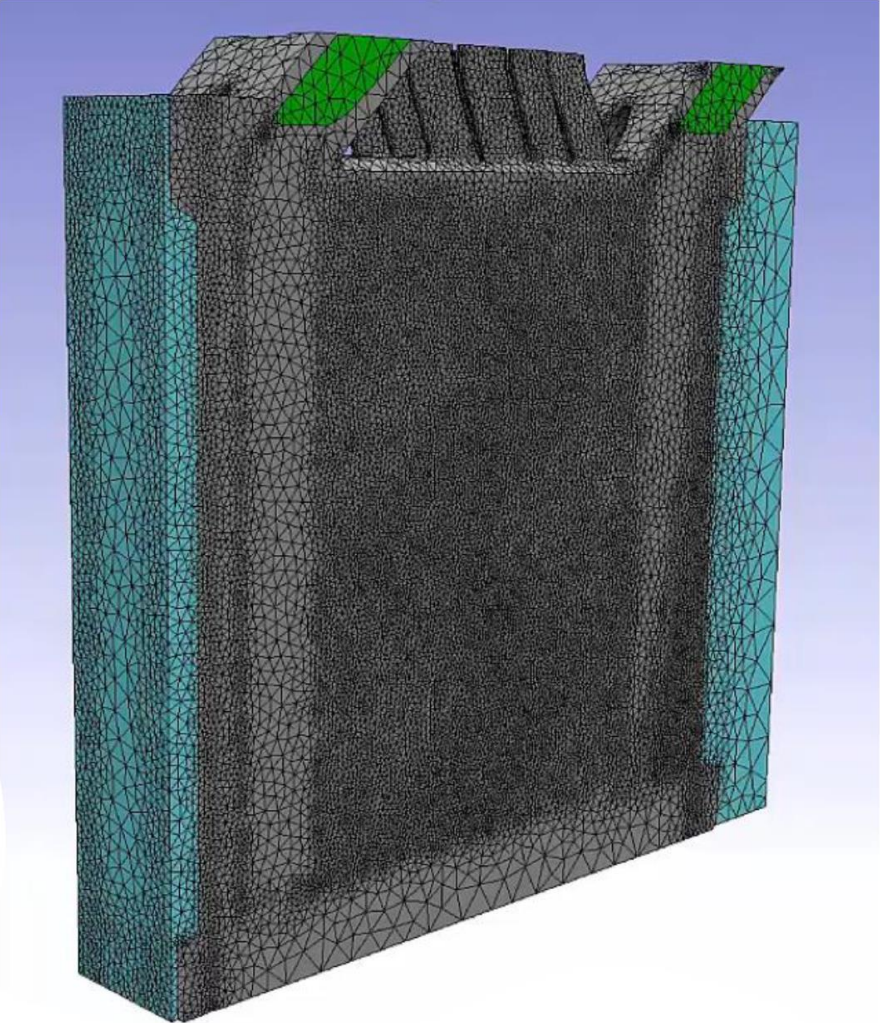
# Inspection

- Using the deviation tool, defects were found when comparing the “as designed” CAD part to the “as built” image based model.
- A series of example defects are down in the images on the right:
  - Lattice struts too thick (dark blue, top of left image)
  - Lattice struts too thin (red region, middle of left image)
  - Powder build up ( dark blue regions, bottom of both images)





# Image-based simulation

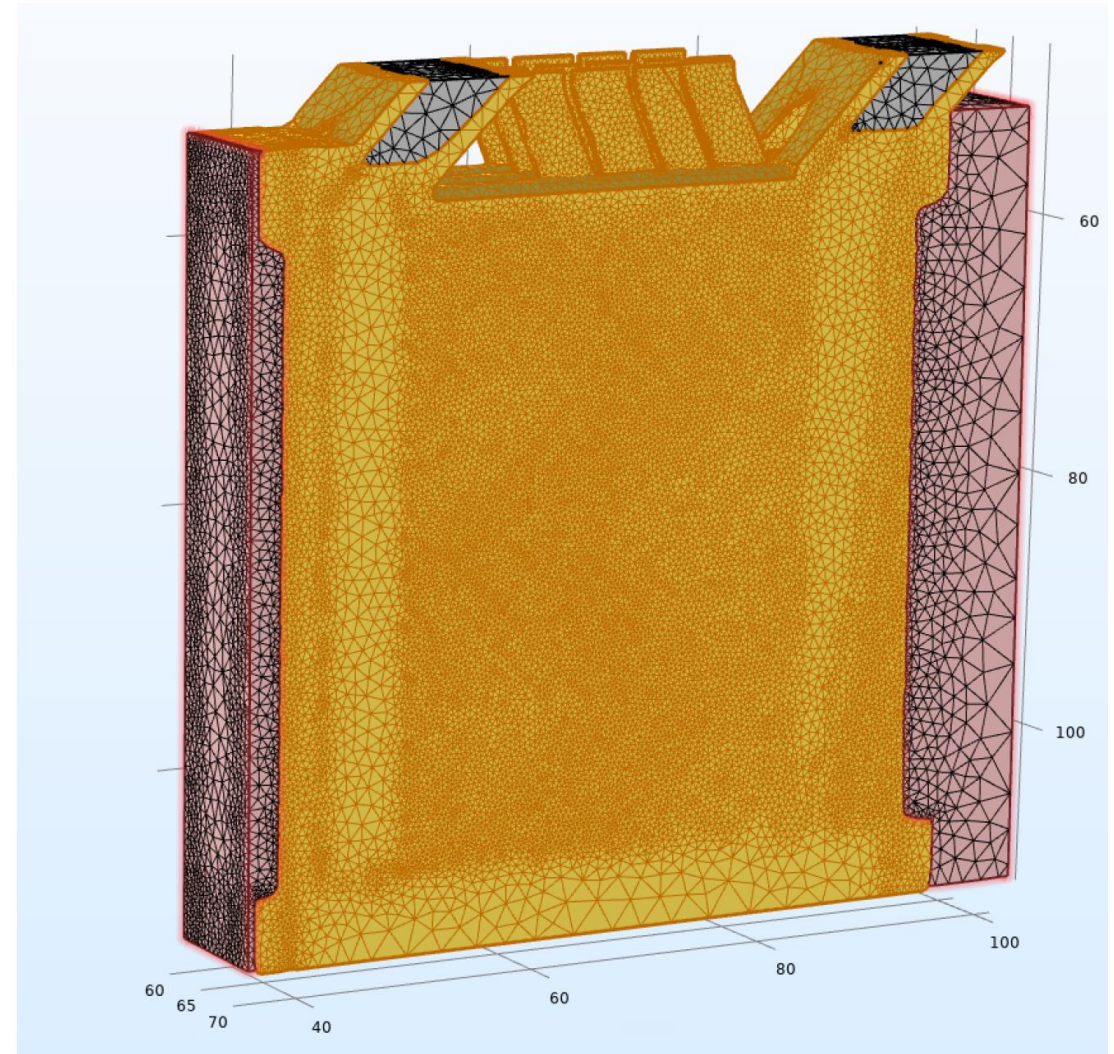




# Thermal simulation in COMSOL

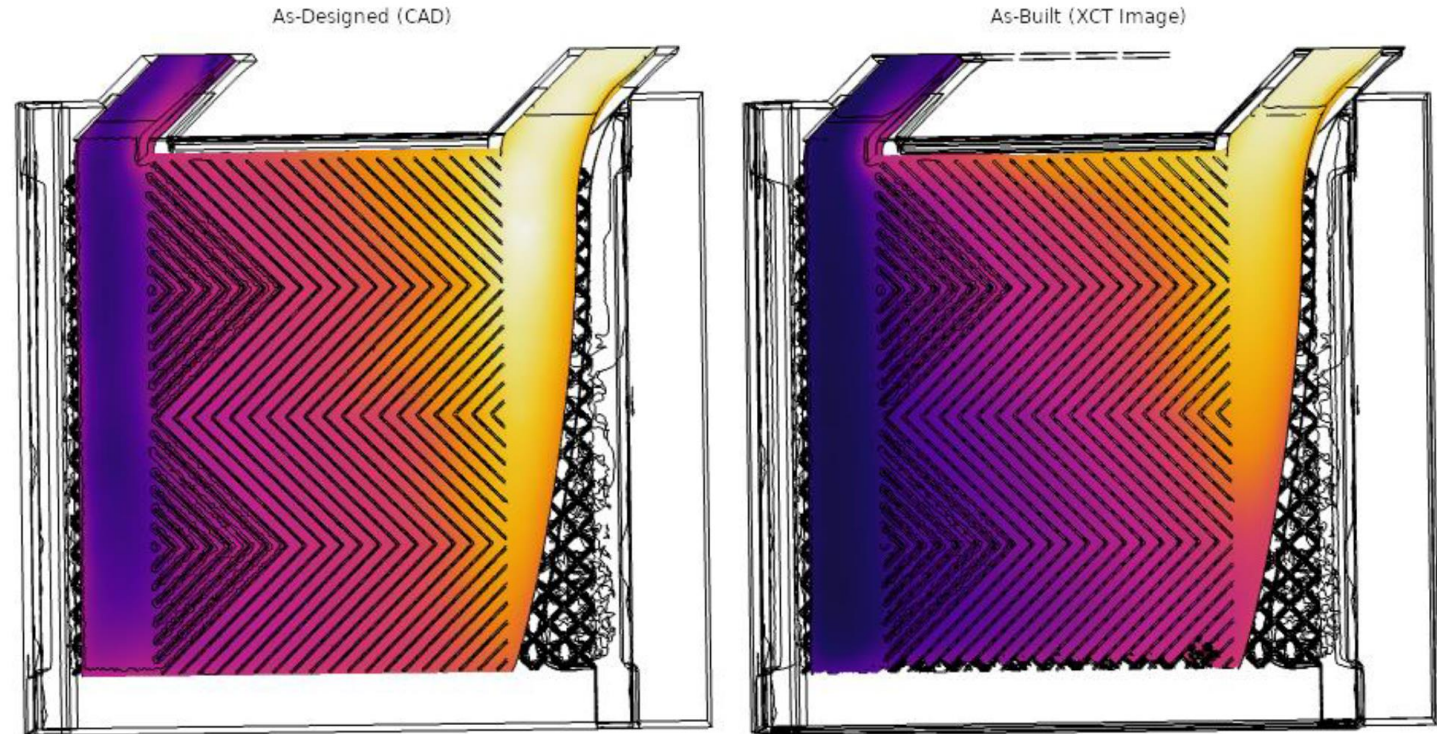
## Subsection of full design chosen containing:

- Centre lattice and two fins containing cross corrugated channels
- 3 Phases modelled:
  - Metal (yellow)
  - Air (grey)
  - Fluid (red)
- Full volumetric mesh exported from Simpleware ScanIP to COMSOL Multiphysics
- Simulation of thermal behavior, coupled heat transfer and laminar flow.



# Thermal simulation results

- Thermal simulation of “as-built” image shows less uniform heat dissipation.
- “as-built” part performs worse than the “as designed” due to geometrical deviations (blocked channels, imperfect lattice)
- This means the “as-built” part is not as efficient at heat dissipation compared to the initial design.



Left: Heat map from thermal simulation of “As-designed” part (from CAD part)

Right: Heat map from thermal simulation of “As-built” part (image-based simulation)



# Conclusion

- This workflow demonstrates how to use X-ray CT, image based modelling and simulation as a non-destructive test method to:
  - find defects in the manufactured part
  - determine the impact on real world performance
- This allows better allocation of time and physical test resources

# Project Partners

Innovate UK: 3in1 X-ray CT Inspection



# See and Try Simpleware Software

- **Get a 30-day free trial**
  - Receive a *fully functional trial version* of the full Simpleware product suite
  - Sign up to the Synopsys Eval Portal: <https://eval.synopsys.com/>
  - **Contact support with any questions**, for advice or help in setting up your workflow
- **Visit our resources website for case studies, webinar recordings, datasheets & videos**
  - <https://www.synopsys.com/simpleware/resources.html>
- **Visit our workshops, webinars and exhibitions booths**
  - See our list of upcoming events: [www.synopsys.com/simpleware/news-and-events/events.html](http://www.synopsys.com/simpleware/news-and-events/events.html)
- **Arrange a personal software demonstration**
  - Get in touch with us to arrange a personalized software demonstration via WebEx with one of our expert Application Engineers using your own data

# Thank You

Denis Feindt – Synopsys, Business Development Manager

Phone: +49 89 993 20250, +49 151 155 39112

Email: [denis.feindt@synopsys.com](mailto:denis.feindt@synopsys.com)

Social: <https://www.linkedin.com/in/denisfeindt/>

