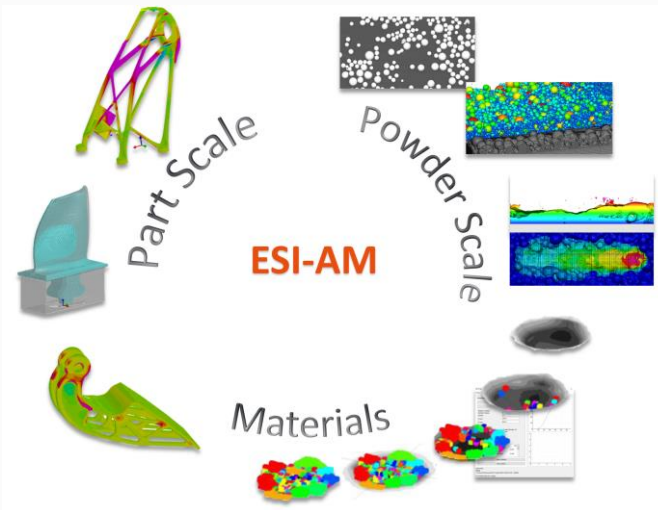


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Process Simulations



Introduction

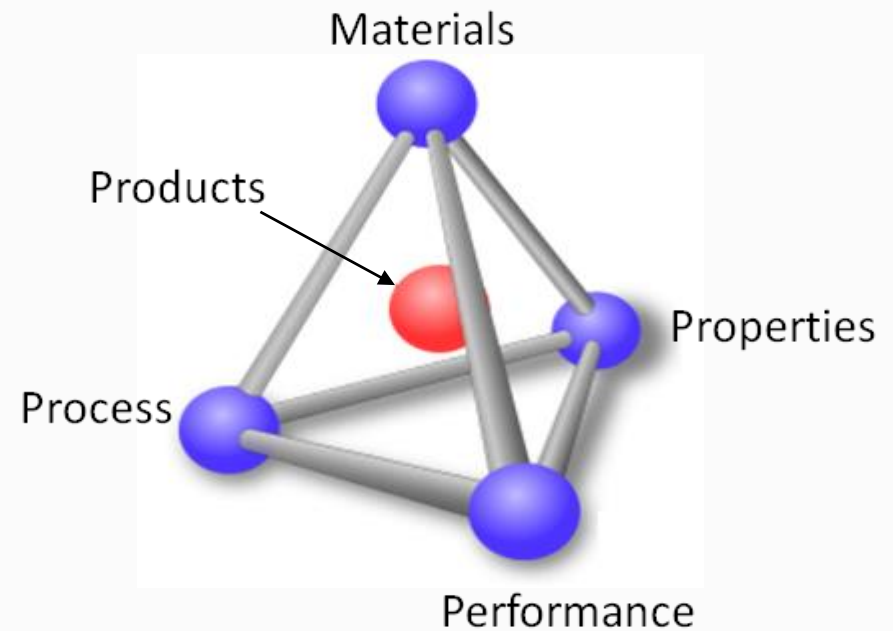
Modelling Challenge

Direct Energy Deposition

ESI Additive Manufacturing

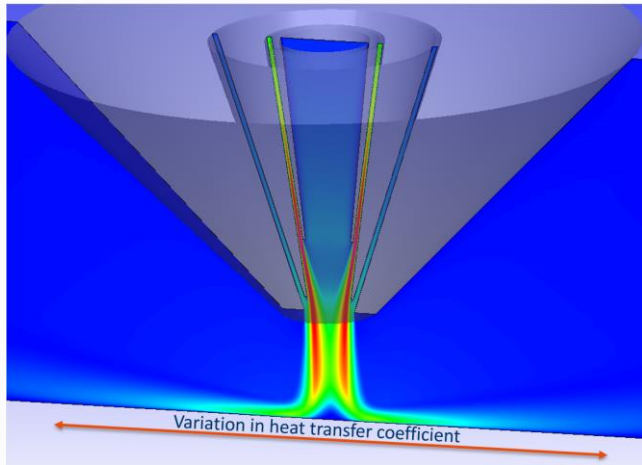
Additive Manufacturing Modelling Challenge

- Powder size distribution $\sim 10^{-6} - 100^{-6} \text{ m}$
- Microstructures $\sim 10^{-9} \text{ m} \Rightarrow \dots$
- Work piece $\sim 10^{-2} - 1 \text{ m}$
- Scan length $\sim 10^{+2} - 10^{+3} \text{ m}$
- Laser interaction time $\sim 10^{-6} - 10^{-3} \text{ s}$
- Build time $\sim 10^{+3} - 10^{+5} \text{ s}$



Integrated Computational Material Engineering (ICME)

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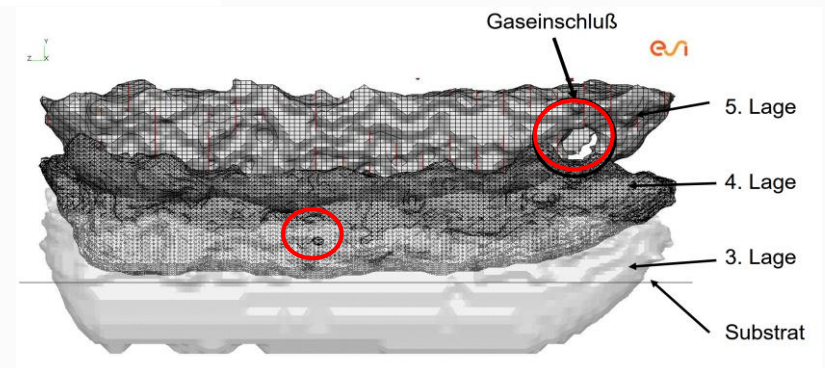
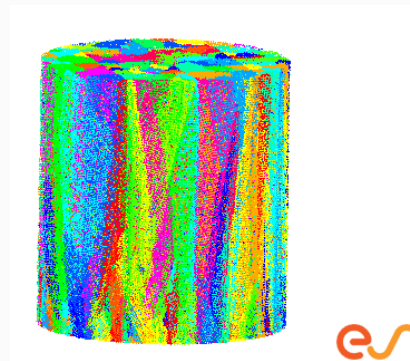
4

- Metal Additive Manufacturing
 - Powder Bed Fusion
 - Direct Energy Deposition
- ICME for Additive Manufacturing
 - Manufacturability
 - Material quality
 - Qualification

■ **Verify**

■ **Understand**

■ **Optimize**

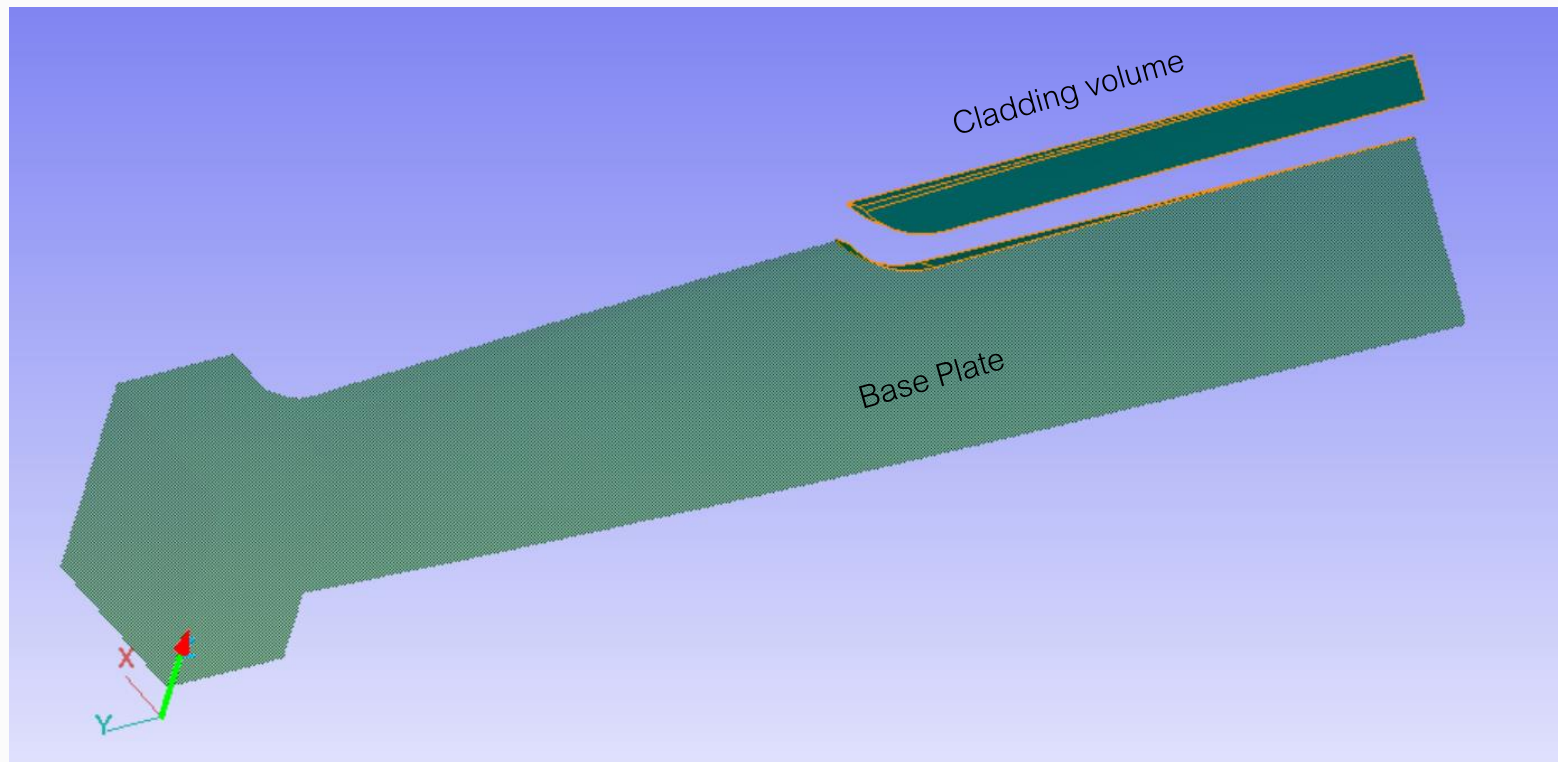


Distortion Module

Blade Use Case

Geometry Definition

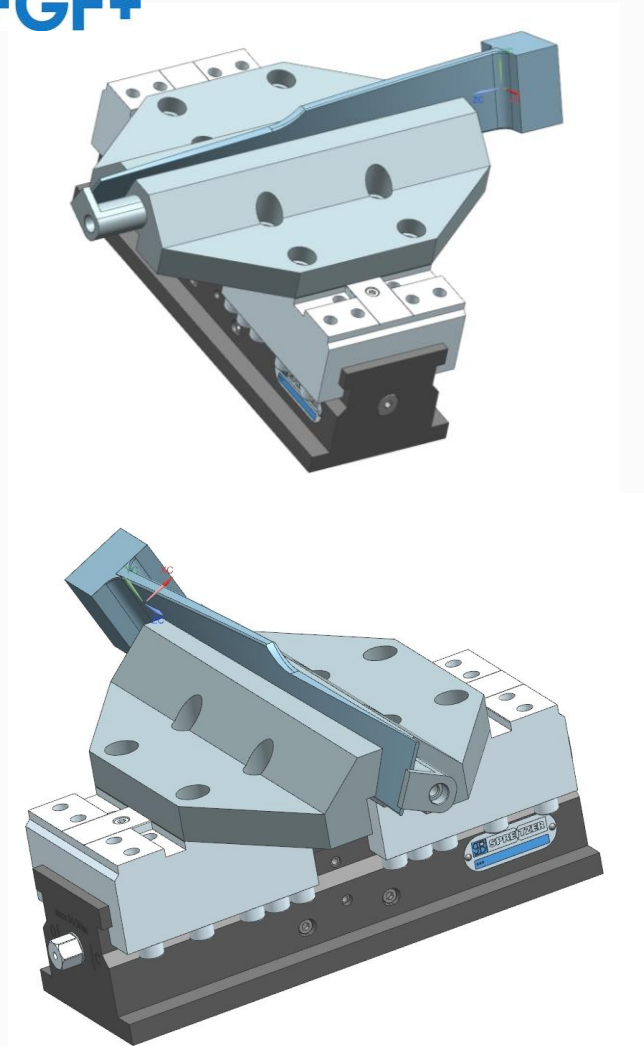
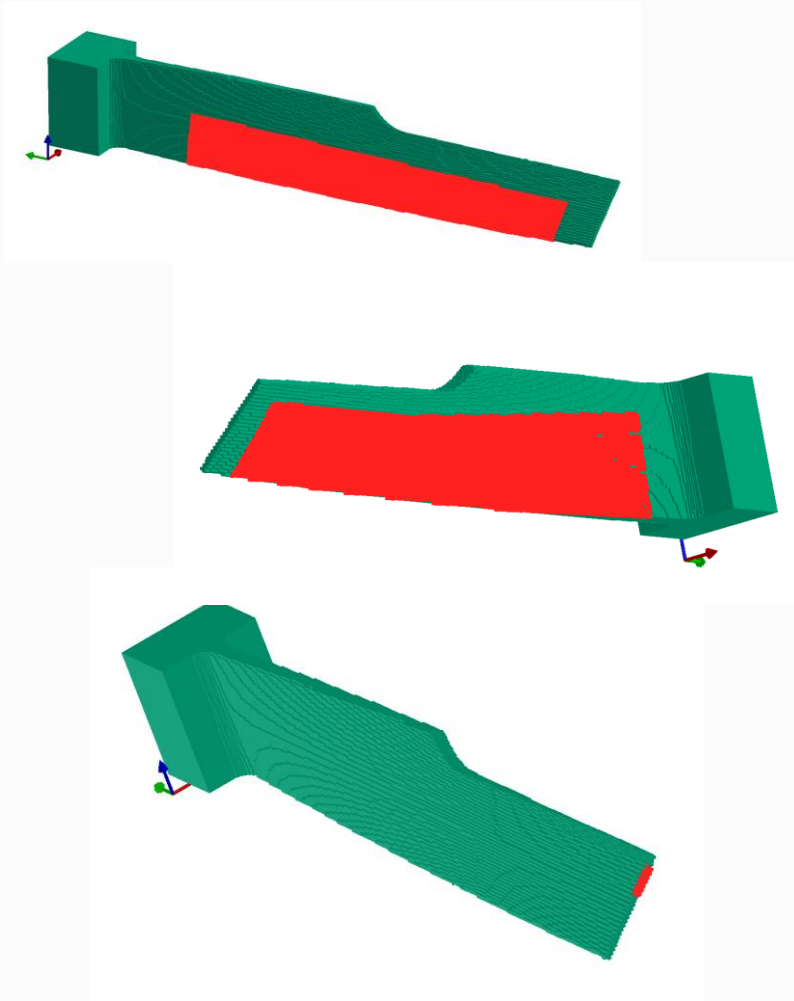
- Blade to be repaired: Considered a base plate
- If needed intermediate layer (not required here)
- Cladding volume



Clamping

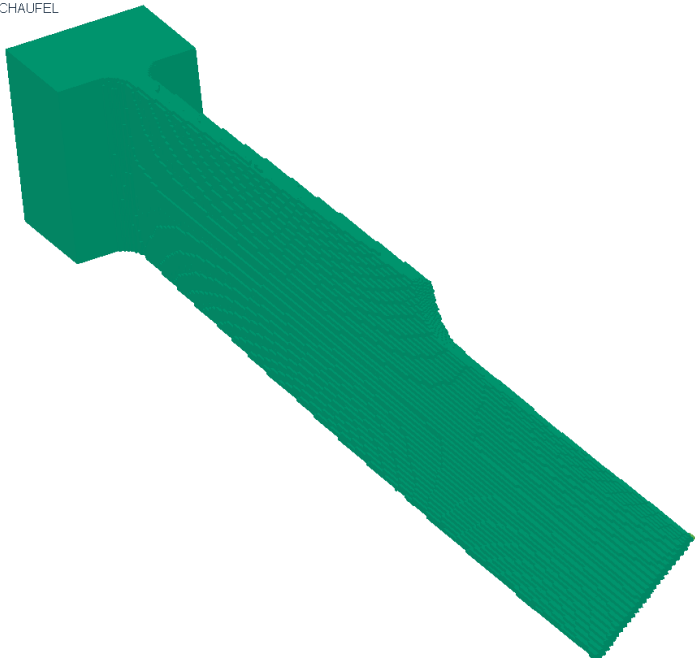
+GF+

esi
get it right®



SCHAUFEL

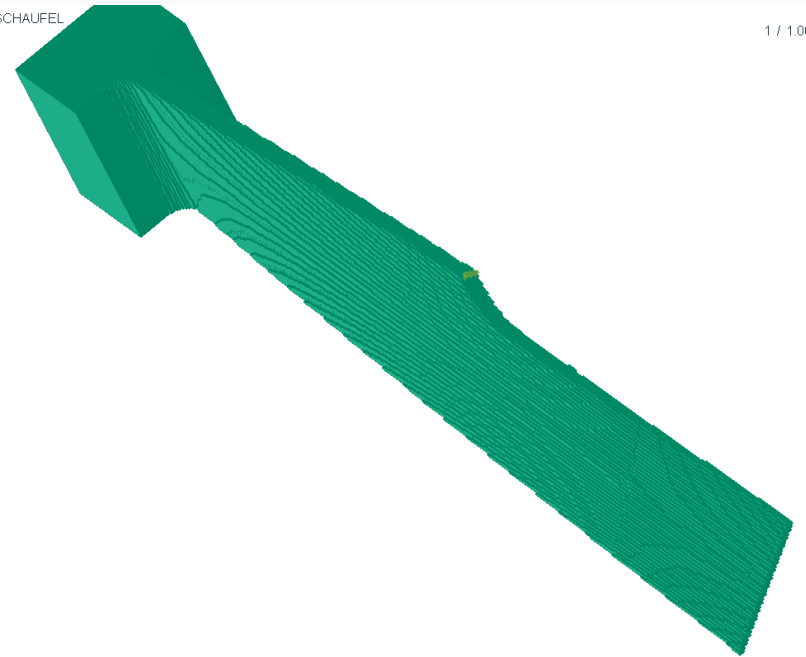
1 / 1.000000



Long beads

SCHAUFEL

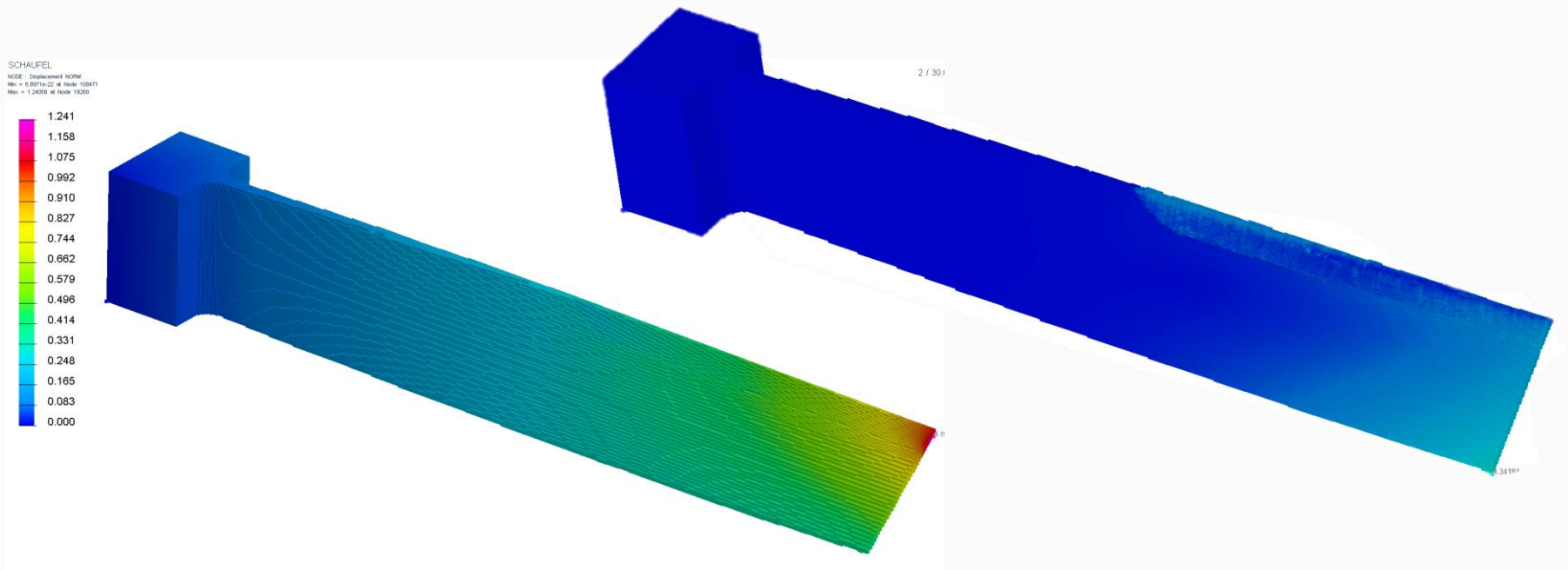
1 / 1.000000



Short beads

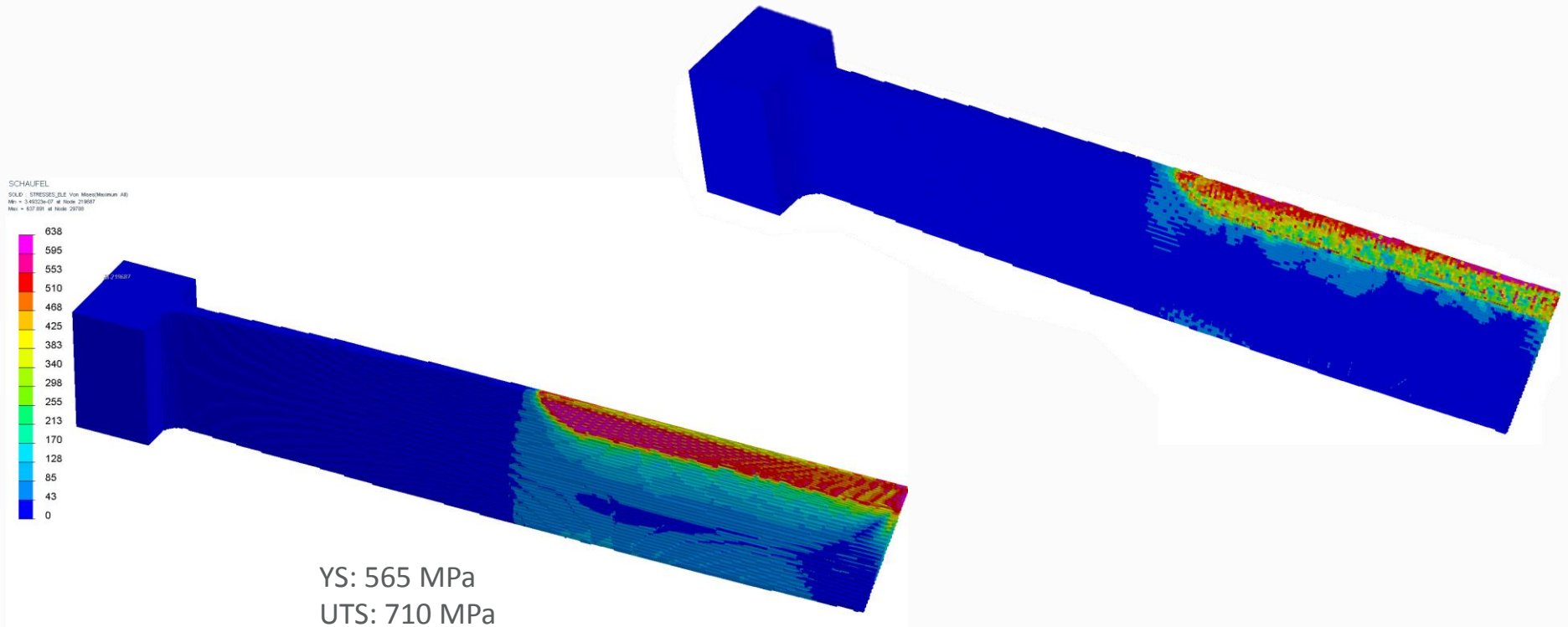
Distortion [mm]

- After Clamp Release



Von Mises Stresses [MPa]

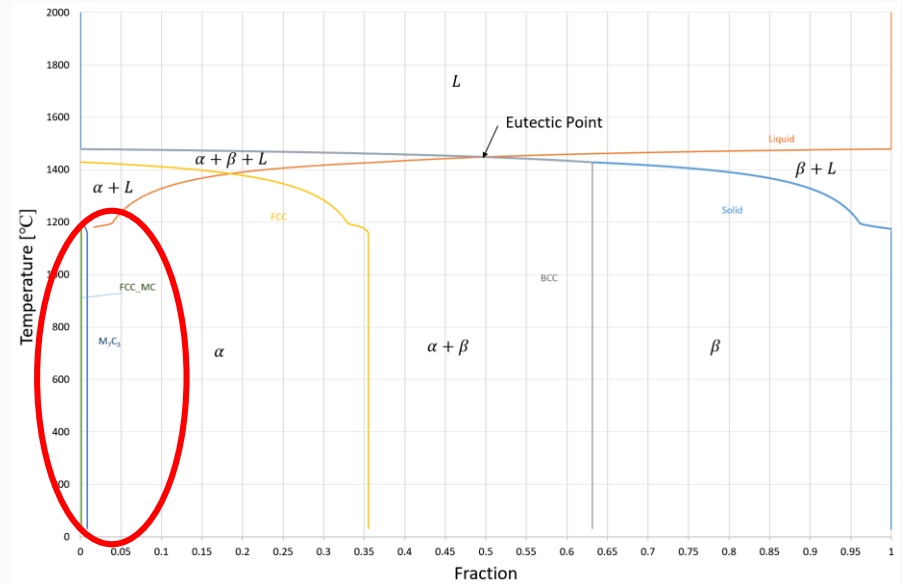
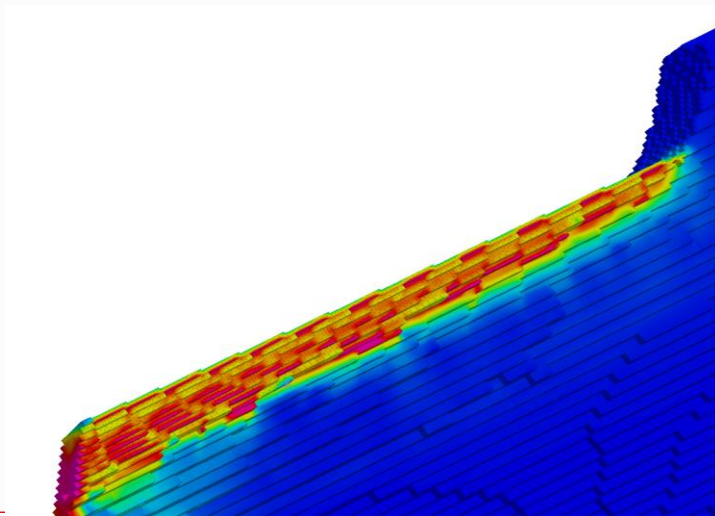
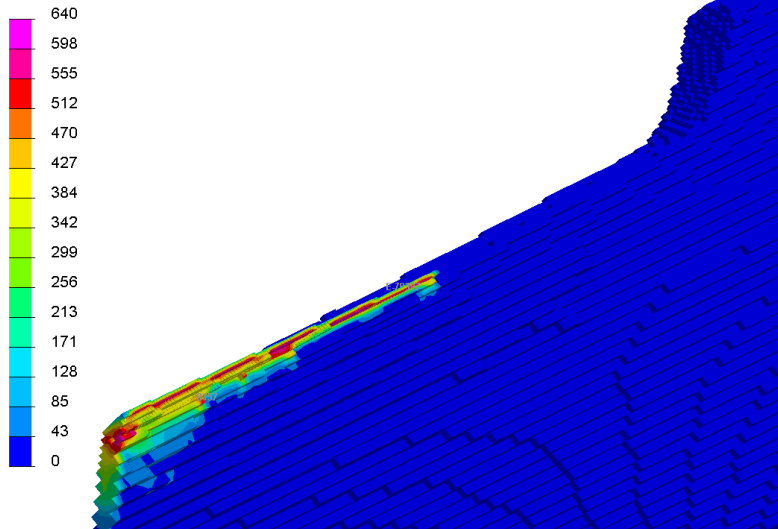
- After Clamp Release



Crack Susceptibility

Results so far

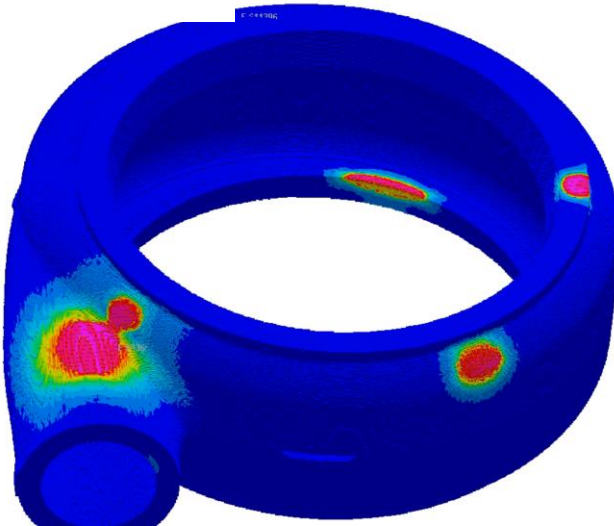
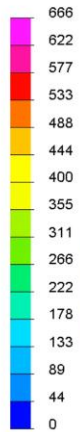
Van Mises
Stress [MPa]



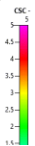
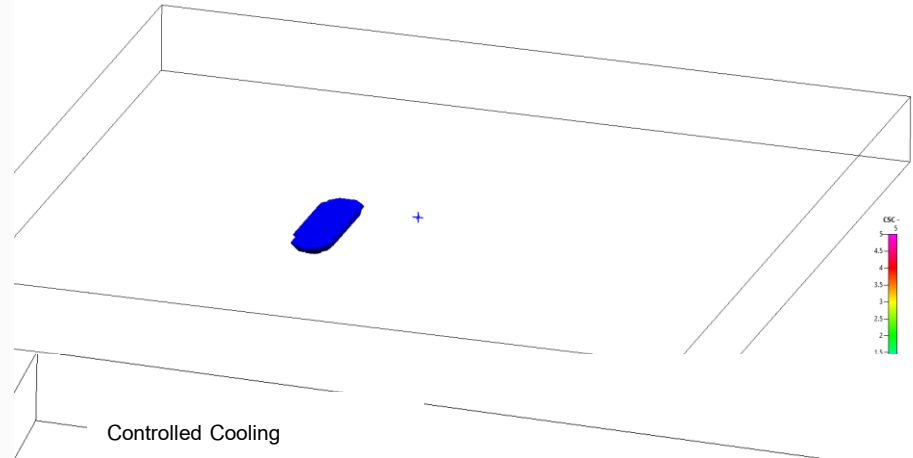
Weir Use Case

Von Mises Stress [MPa]

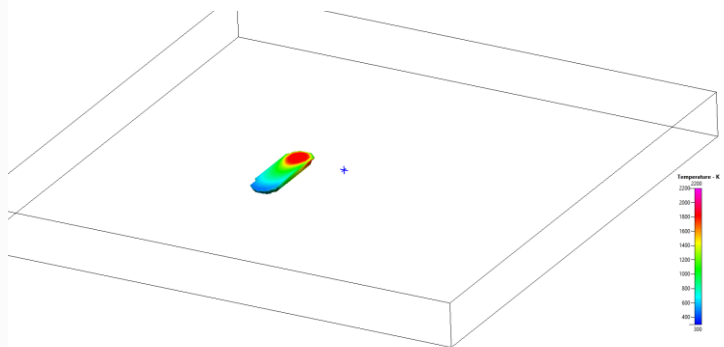
79 / 79.000000



Crack Susceptibility [-]



Temperature [K]

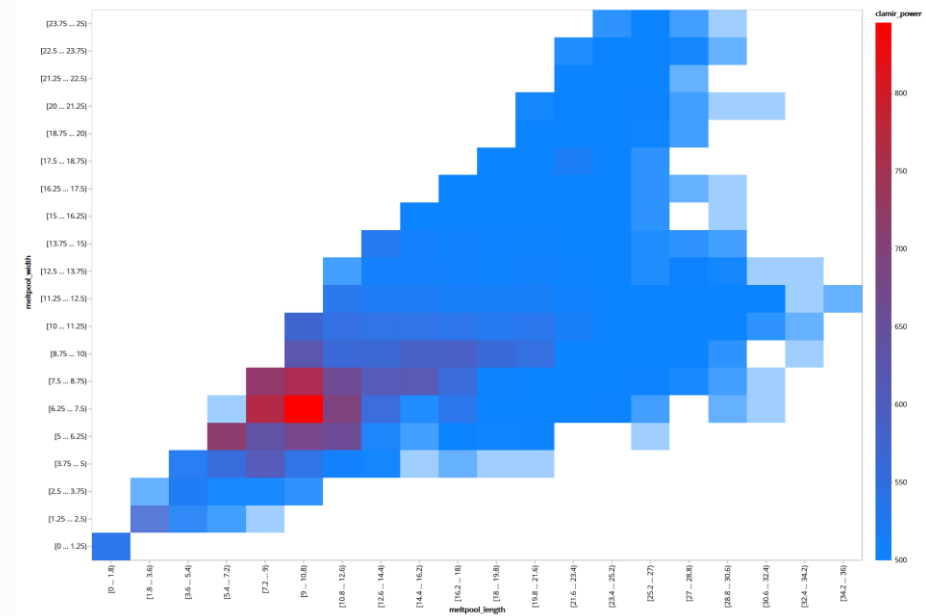
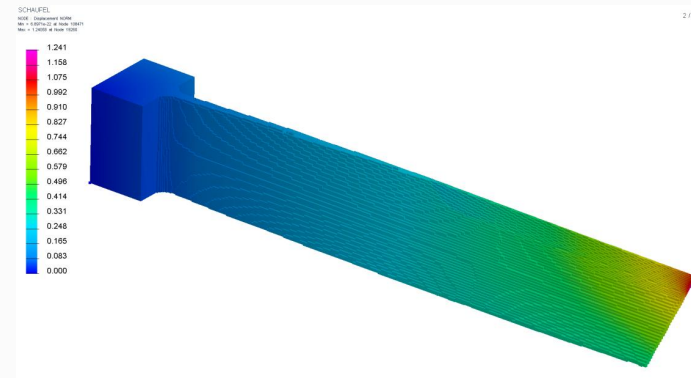


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- Metal Additive Manufacturing
 - Powder Bed Fusion
 - Direct Energy Deposition
- Process Parameter Optimization
 - Melting pool characteristics
 - Thermal history
 - Defect assessment
 - Distortion and Residual Stresses
 - Uncertainty Quantification
 - Data Analytics & Machine Learning



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Process Simulations

