ENGINE

ZERO-DEFECT MANUFACTURING FOR GREEN TRANSITION IN EUROPE

HORIZON-CL4-2021-TWIN-TRANSITION-01-02

Co-funded by the European Union

The Manufacturing Partnership Day 2024

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The challenge

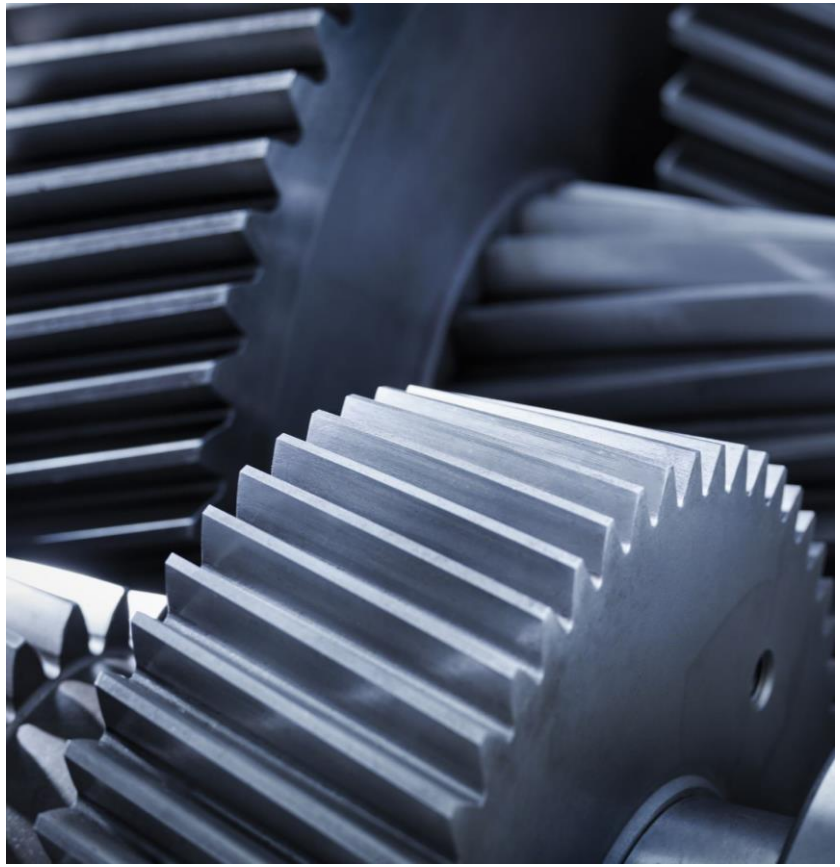
The manufacturing process of different metal products, such as valves and engines of heavy industry, is energy-intensive and requires substantial amounts of natural and financial resources. Moreover, defective components and engines cannot be easily reworked or recycled without significant effort.

The objectives

The overall goal of the ENGINE project is to reduce the environmental impact and improve competitiveness of metal product manufacturers by developing a novel metal product design and manufacturing system, which integrates life-cycle analysis and business decisions, reduces defects, waste, and shrinks product time-to-market.

The project will develop a first-time-right and zero-defect metal product design and manufacturing system, which will be applied on marine engine supply chain.

1. Create and demonstrate a novel metal product design and manufacturing system
2. Develop computational modelling toolbox for product and process design, non-destructive diagnostic tools for production monitoring, and data solution for seamless integration of the whole supply-chain
3. Research methodologies for first-time-right and zero-defect manufacturing
4. Investigate life-cycle analysis and life-cycle cost methods for design and business decisions
5. Present strategy for employee skills development
6. Transform innovations into promising business cases



The project

ENGINE system

The metal product design and manufacturing system that integrates the separate modules to enable sustainable-by-design product development and first-time-right and zero-defect manufacturing.

ENGINE exchange

Data management solution for industrial data storage, sharing and seamless, multiple-location integration of software and hardware tools.

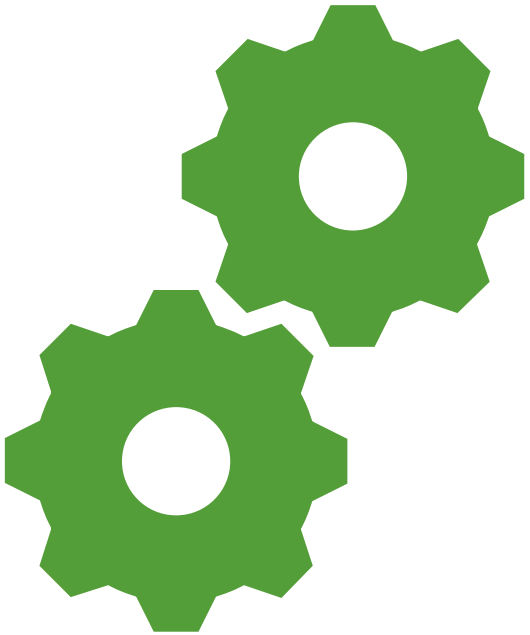
ENGINE toolbox

Software suite for sustainable-by-design product development and first-time-right manufacturing.

ENGINE production

Production control, diagnostics, and monitoring solution enabling zero-defect manufacturing.

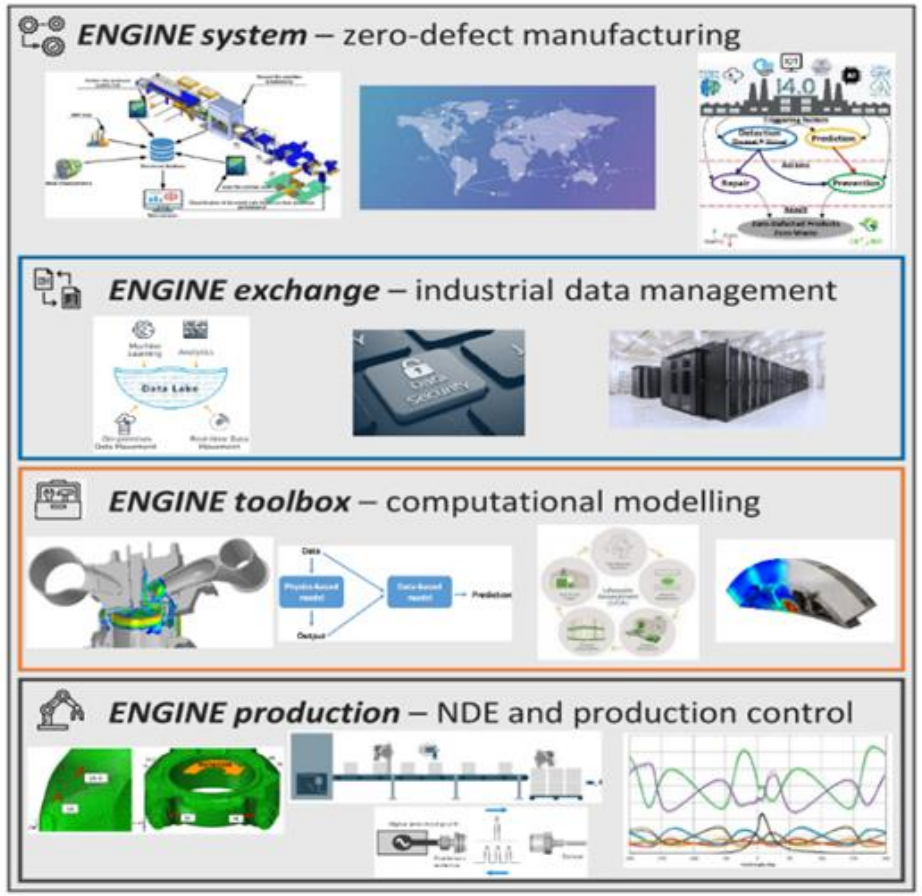
Showcase the developed technologies on marine engines

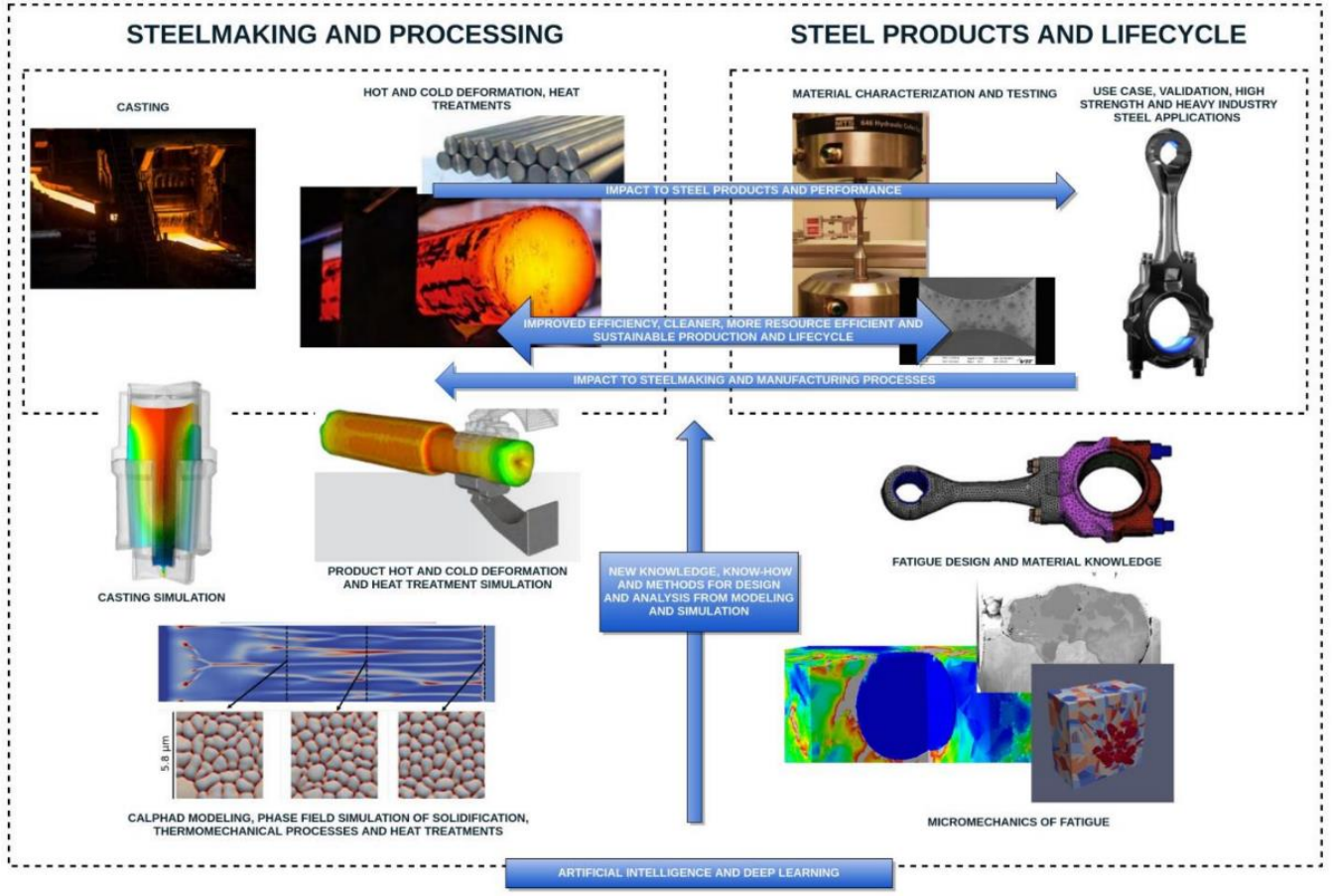


Key Exploitable Results

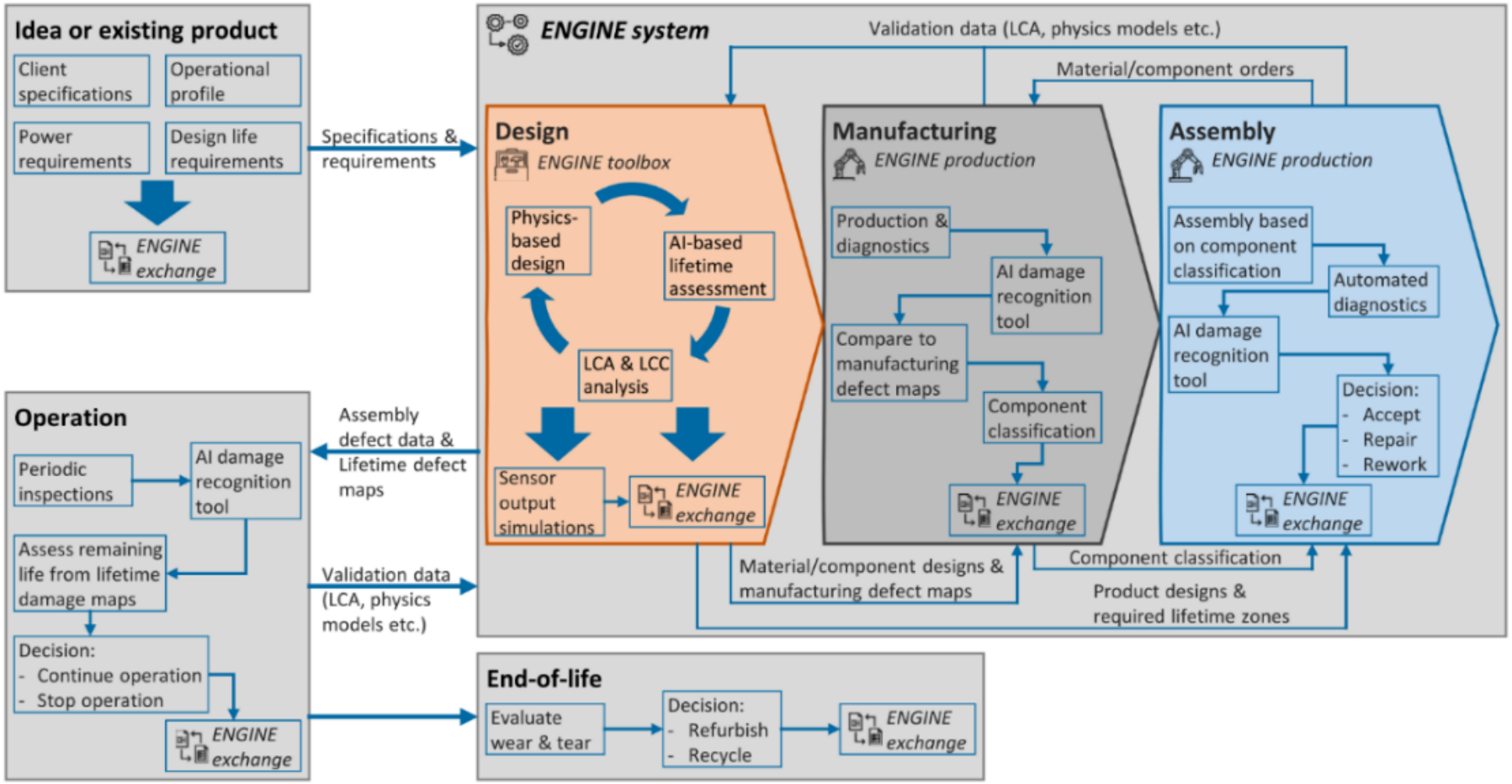
1. ENGINE system
2. ENGINE exchange
3. ENGINE toolbox
4. ENGINE production
5. AI & data analytics tools
6. Data security tools
7. LCA model, sustainability data and digital LCA tool
8. Sensors, and respective NDE techniques
9. NDE methods
10. Methodologies
11. Experimental testing
12. Repair and refurbishment strategies
13. Skills development materials and website
14. Standardization materials
15. Publications

The ENGINE concept

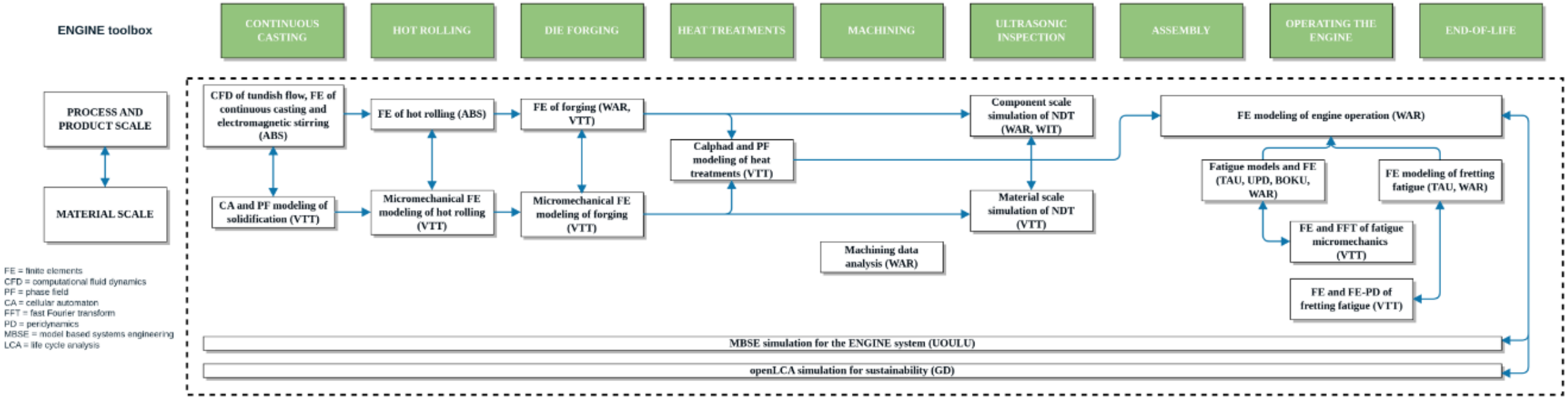




Novel metal product design and manufacturing system



The ENGINE toolbox across manufacturing, operation and end-of-life

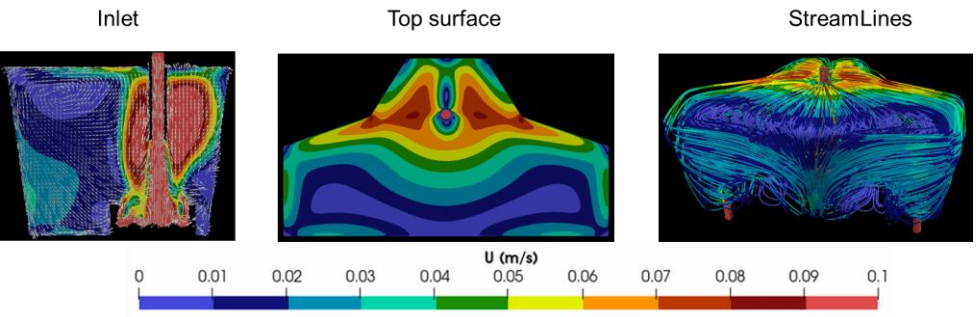


- The ENGINE concept is implemented by covering everything from material manufacturing, product manufacturing, product operation, and product end-of-life.
- Provide both a physics-driven workflow to provide a predictive capability and an AI surrogate for fast inference, optimization and discovery.
- Validation by way of project demonstrator and experimental activities.

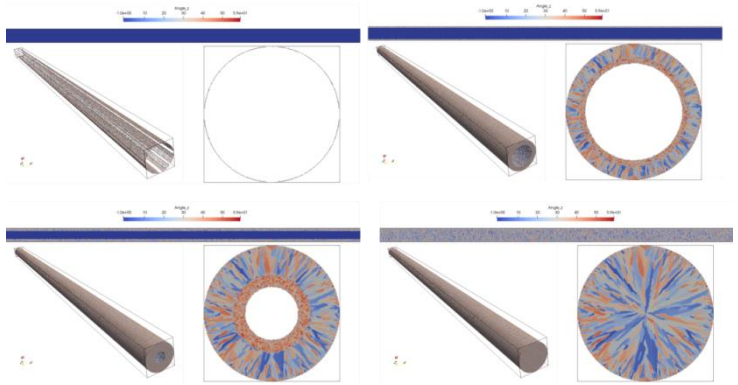
The ENGINE toolbox: examples of the different steps

ENGINE

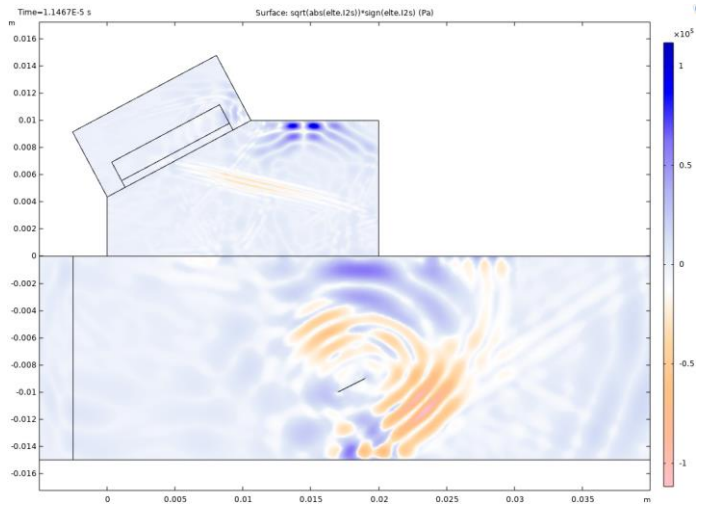
Steelmaking

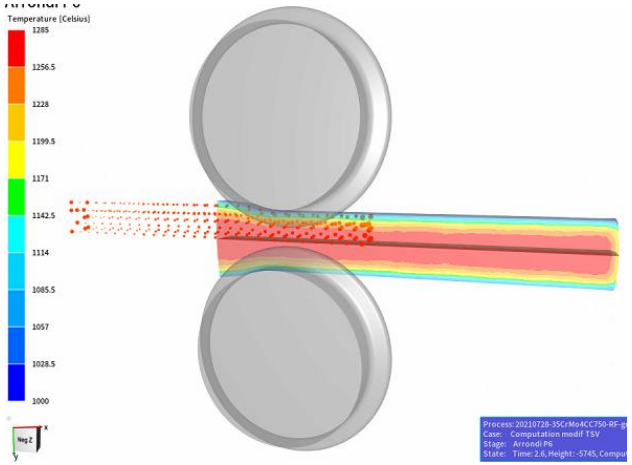


Defect generation during solidification

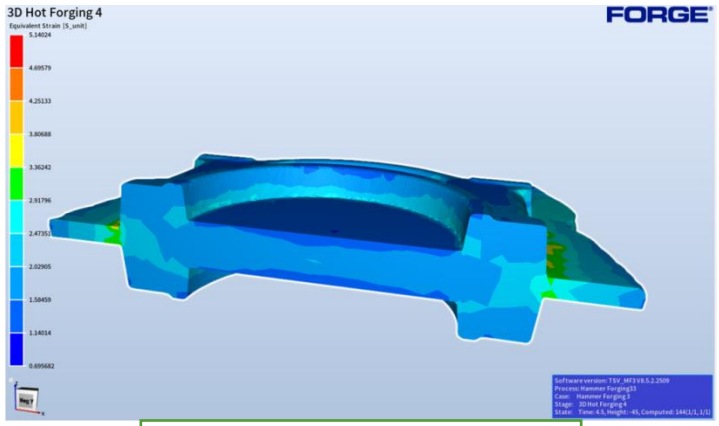


Simulation of inspection

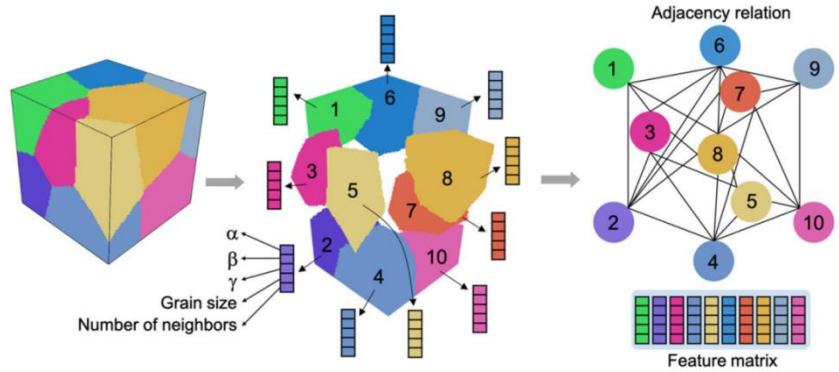




Hot rolling



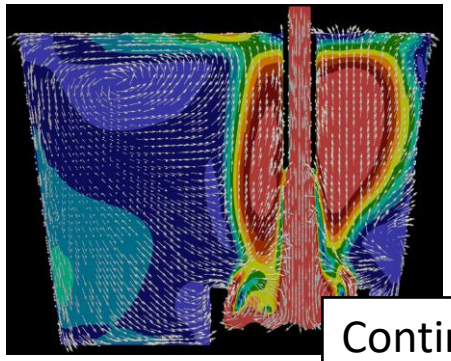
Forging



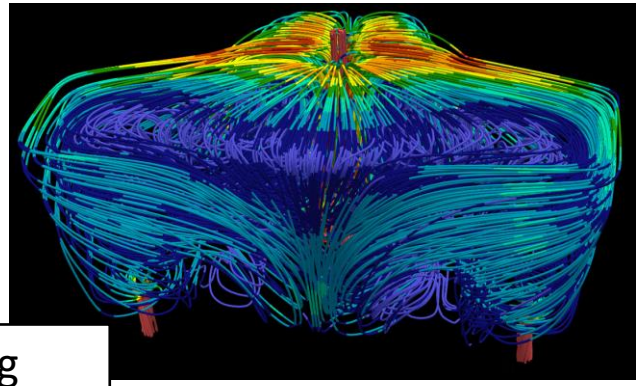
AI for modeling the effect of defects on lifetime

The ENGINE toolbox: example from physics-based modeling of material and component manufacturing

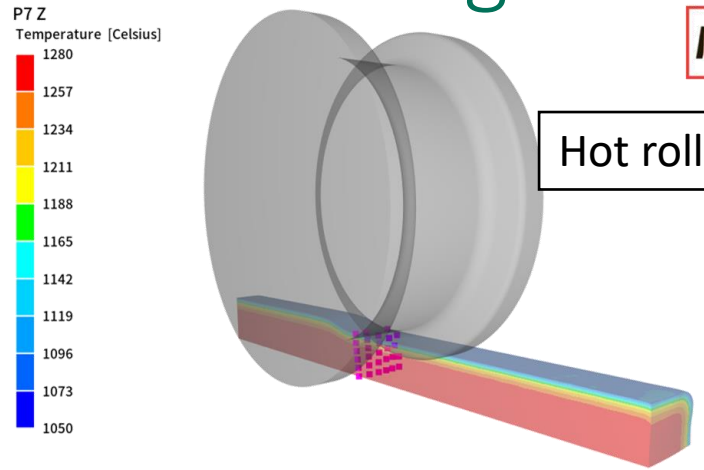
Inlet



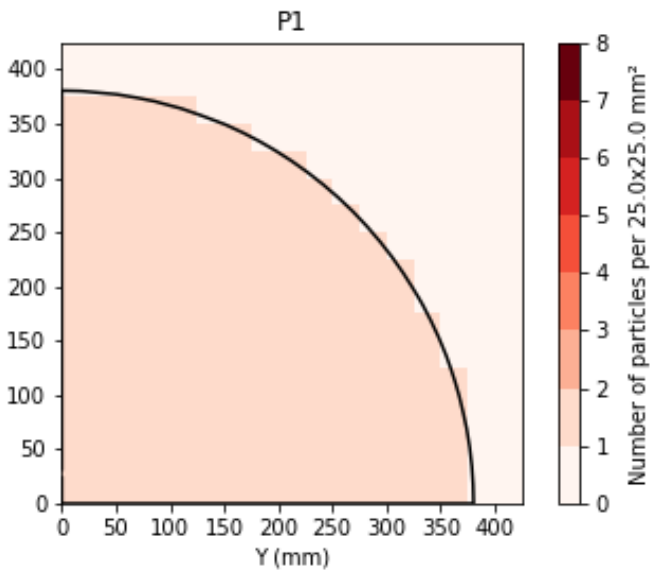
StreamLines

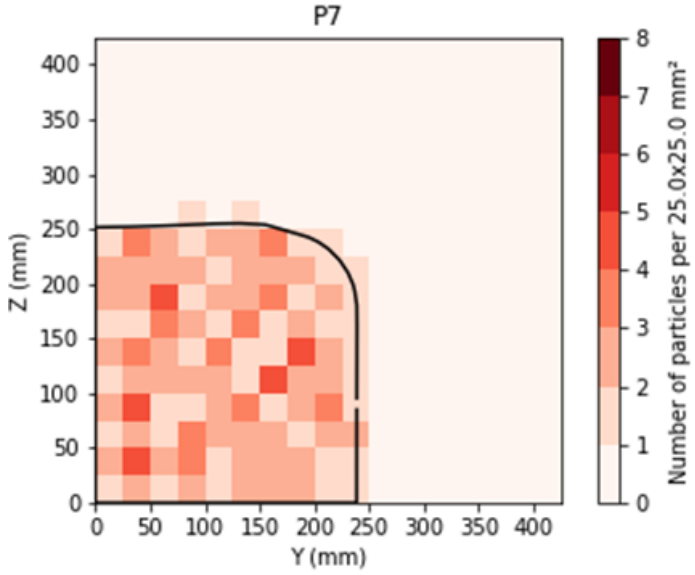


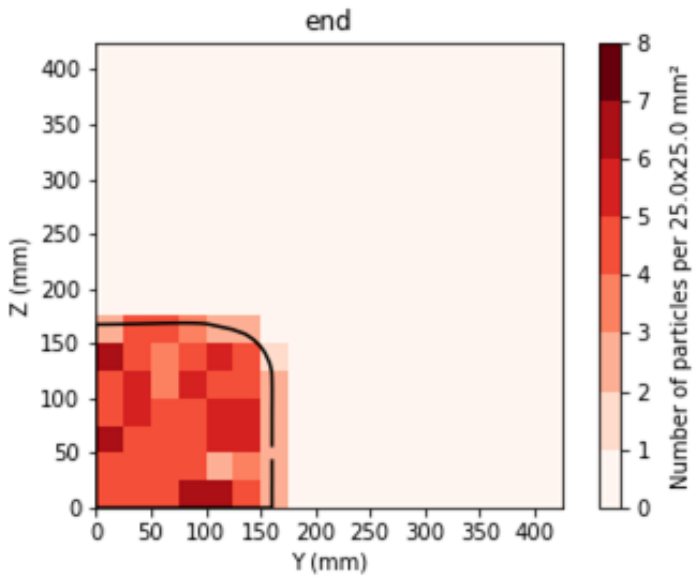
Continuous casting



Hot rolling

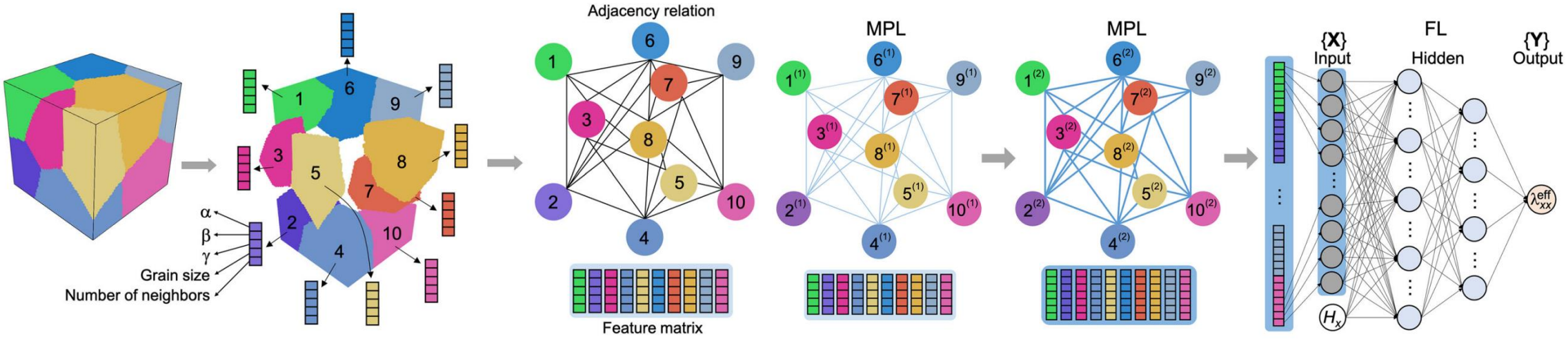


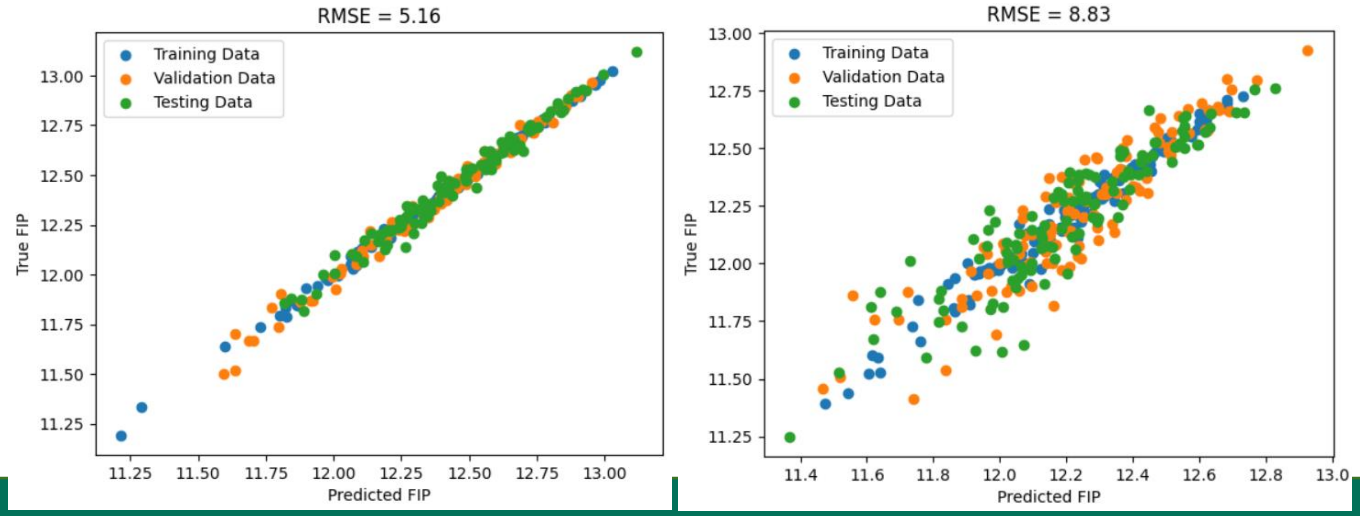




Defect density following hot rolling

The ENGINE toolbox: example from AI driven assessment of product lifetime

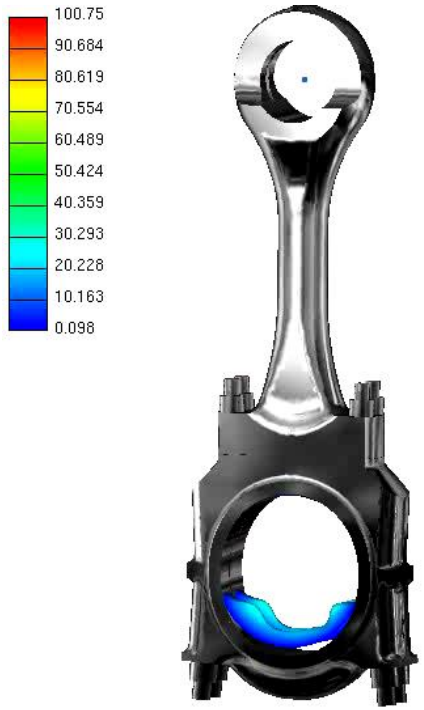




Modeling fatigue lifetime by way of recurrent graph neural networks

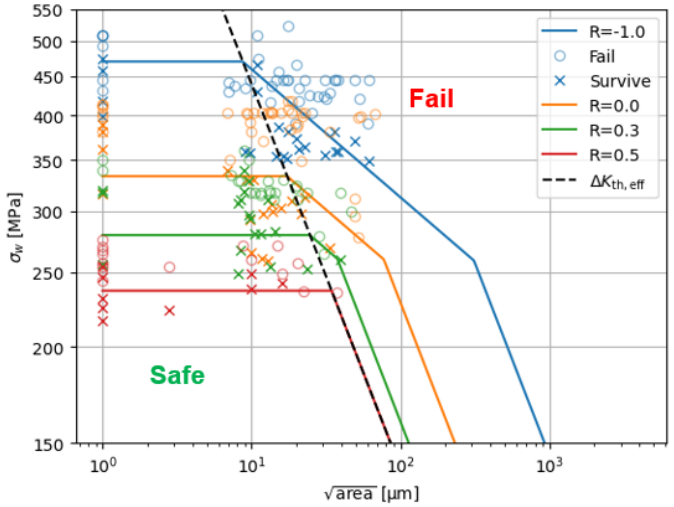
ENGINE system deployment and demonstrator example:

FEM + MBD = Operative loading

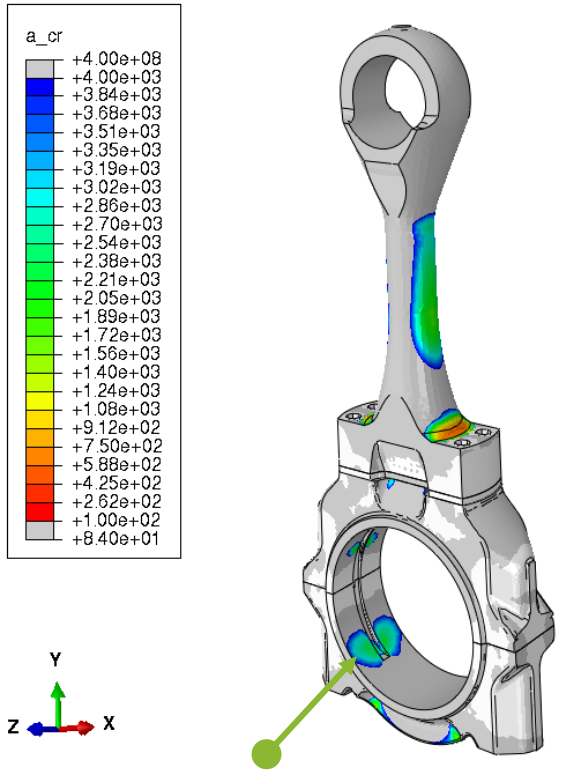


Fatigue tests + defect-based theory of fatigue

Kitagawa-Takahashi diagram (updates from WP5)
Murakami-Endo-Schönbauer model



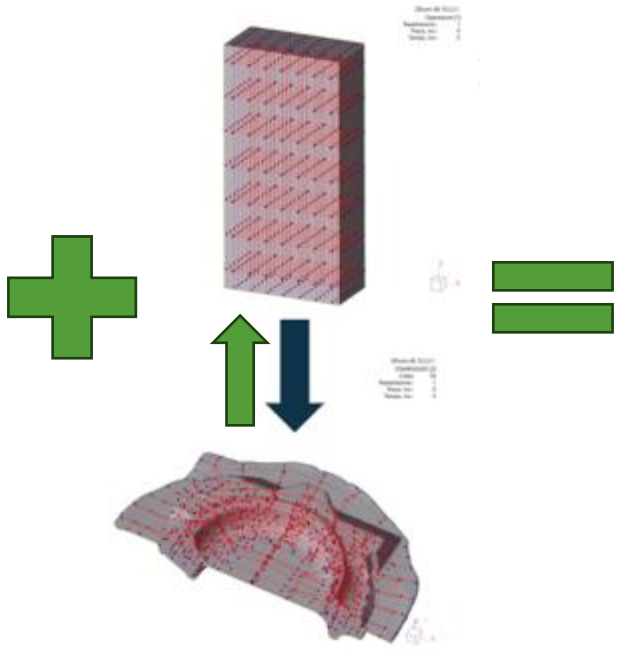
Critical crack size map



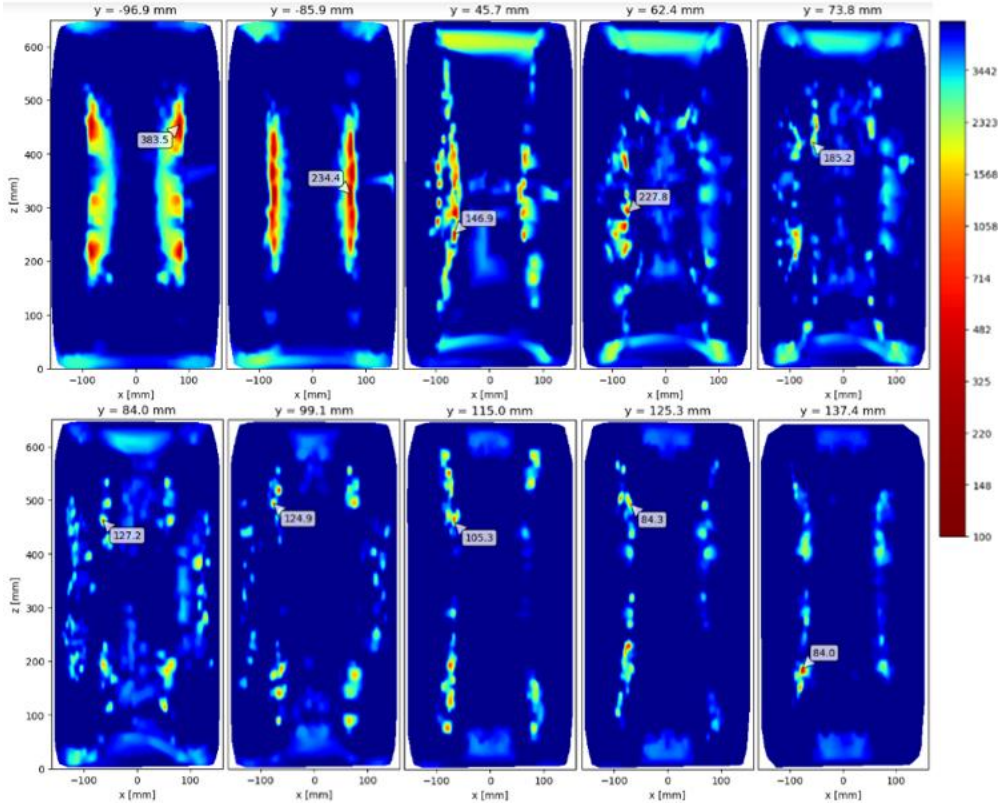
Fretting-susceptible area

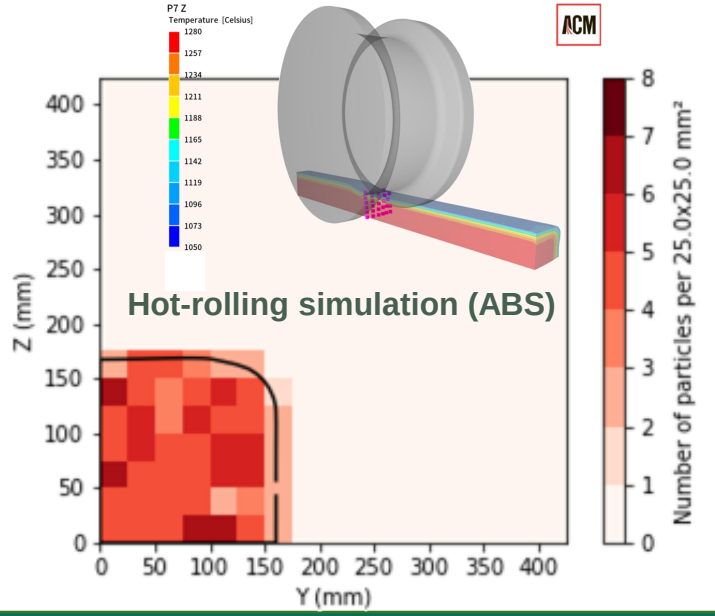
ENGINE system deployment and demonstrator example:

- Forging simulation (SFR)



Critical crack size map in hot-rolled bar





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Thank you for your attention

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