

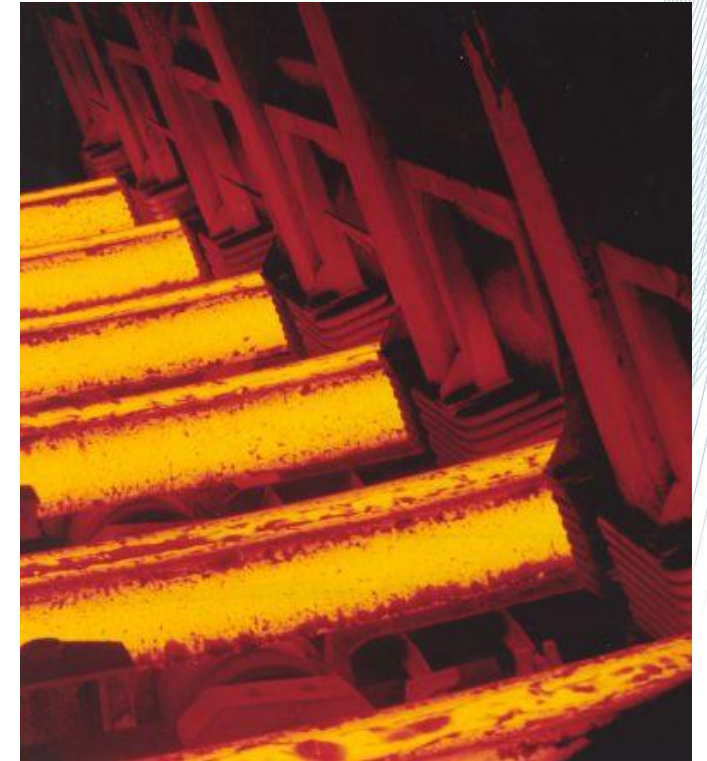
# RealTimeCastSupport (RTCS)

Embedded real-time analysis of continuous casting  
for machine-supported quality optimisation

Webinar on 8<sup>th</sup> of September 2023

## Outlook

K. Marx, B. Palm, [M. Köster](#), Y. Kaymak, Z. Kargar (BFI)



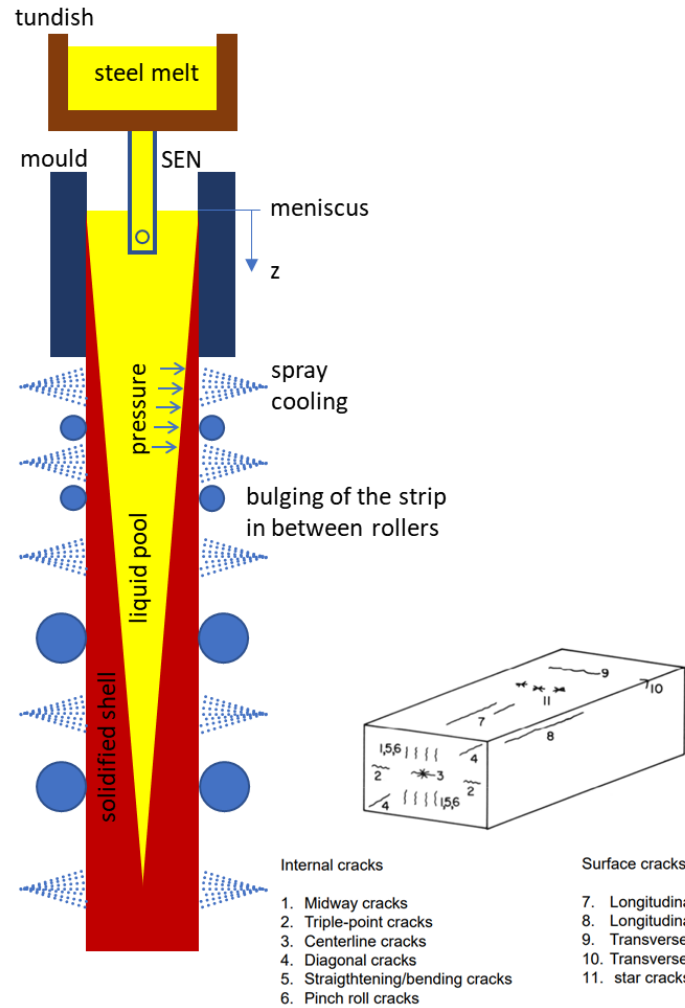
- › Transferability to other applications of the monitoring and support systems is given for:
  - › Casting powder monitoring system (Cameras easily placed at different positions; lenses/cooling devices can be adapted; software is modular)  
→ different sizes (bloom or billet caster), aggregates (tundish), or materials (casting oil or slags)
  - › FOTS temperature measurement in mould (Sensors adaptable regarding number and positions; software must be adapted for different sensor layouts)  
→ different sizes (bloom or billet caster), aggregates (any mould)
  - › CFD-based Digital Twin (Possibility to adapt geometry and parameters)
  - › Data-driven solution (Common process characteristics of plants, such as ladle and tundish configurations and casting parameters, serve as the basis for a transfer; model adaptable to plant-specific data; regular adjustments with new data from target plant increase transferability)  
→ different sizes (bloom or billet caster)

- › As quality requirements are high demanding in continuous casting the plant operation should be improved to increase the quality and avoid product waste

## **Topics for future research projects:**

- › CFD+FEM: Extension of models to compute thermal stresses within the solidified shell, parameter studies, sensitivity analysis and surrogate model development
- › FOTS measurement system for monitoring of mould temperatures and inference on melt/strand behaviour in mould
- › Monitoring of crater end position using laser vibrometry
- › Online supervision of the strand surface using cameras and enhancing a defect detection with supervised machine learning

} Not topic  
of RTCS



Short summary of working steps for follow-up project:

- › 1) literature survey for constitutive model
- › 2) development of FEM for stress/deformation
- › 3) FEM + CFD combination
- › 4) parameter studies + online surrogate model

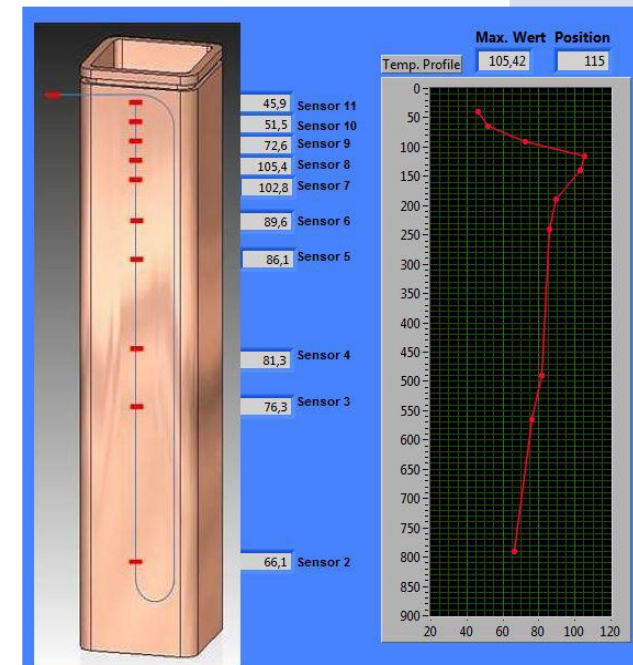
Task 1: Extension of an existing mould CFD-model by FEM module for solidification and thermal stress in solidified steel (6-7 PM)

Task 2: Parameter sensitivity studies to determine influences on product quality using combined model (4-5 PM)

Task 3: Exploitation of digital twin for online monitoring (PM 5-6)

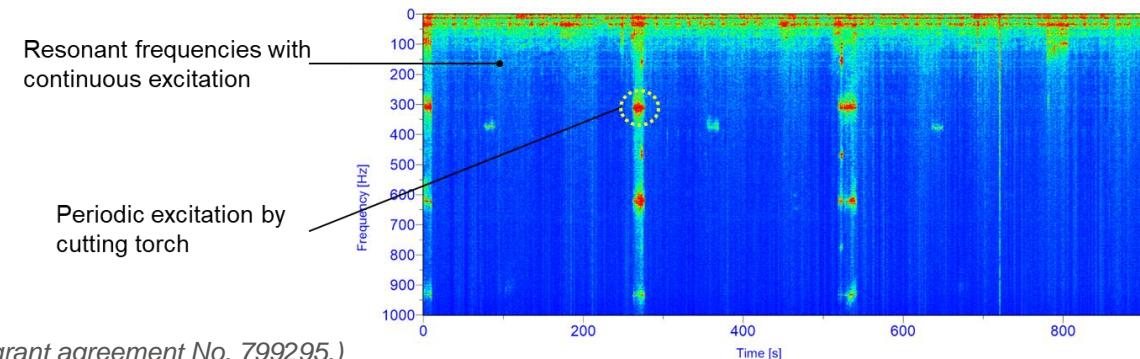
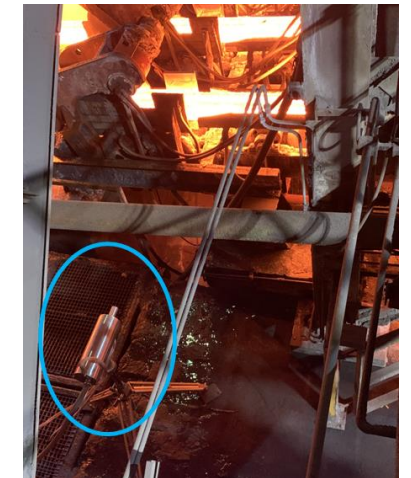
# Outlook FOTS

- › FOTS measurement system for monitoring of mould temperatures and inference on melt/strand behaviour in mould
  - › Instrumentation of two moulds at DH caster with in total 32 fibres with 32 sensors per fibre
  - › High spatial resolution vertical to casting direction
  - › Extensive monitoring of casting process to identify parameters which have an influence on shell deformation and crack formation
  - › Further test and optimization of newly developed reusable sensors



# Outlook laser vibrometry

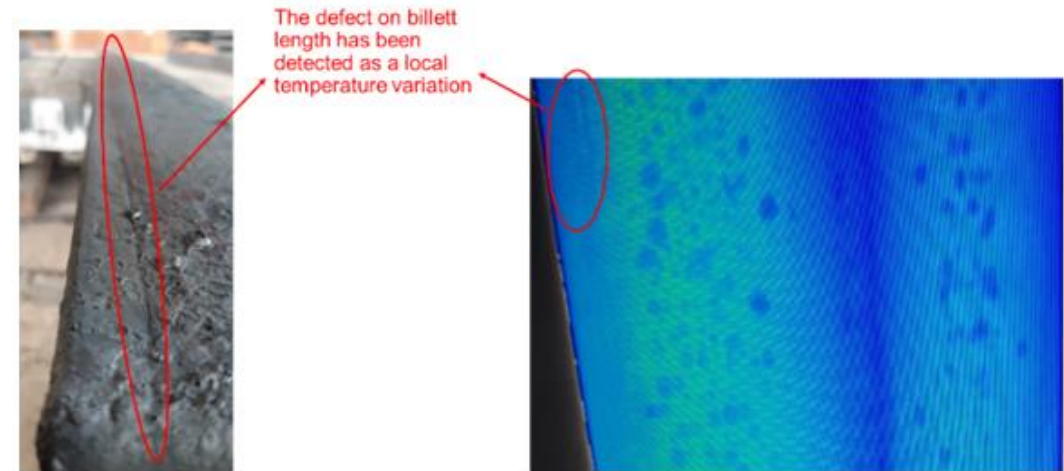
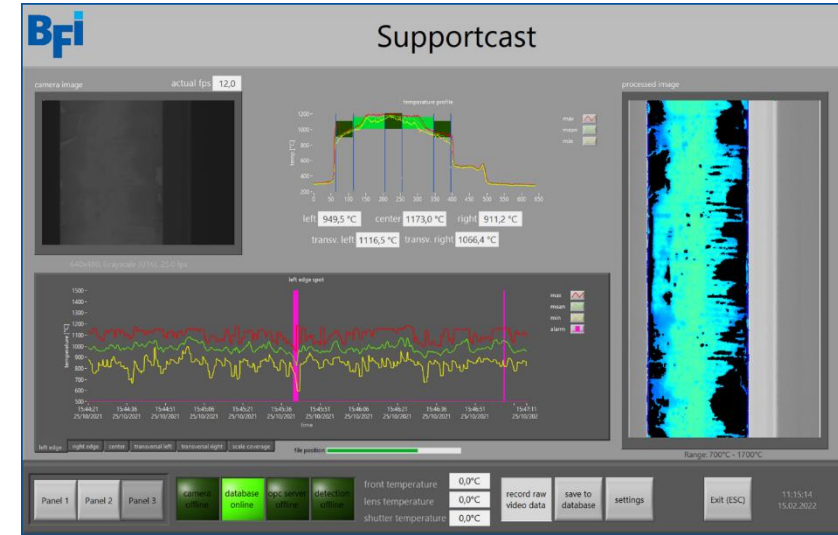
- › Innovative laser vibrometry method\* for non-contact measurement of the degree of solidification in the strand
  - › in combination with dynamic online temperature and solidification model as well as visualisation of casting conditions and model results
- Comprehensive monitoring of casting conditions and strand quality in terms of T profile, shell growth and crater end position
- Reduction of strand breakouts and increase in product quality and productivity of the continuous casting process
- › Planned next steps: Further development and validation of the presented methods for other casting machines with other strand formats and steel grades
- › General transferability given, possible limitations:
  - › Accessibility of the measuring position with laser beam
  - › Signal degradation due to splash water and steam
  - › Teaching of the AI-based classification for each casting machine and each measuring position



\*developed in ConSolCast (The project has received funding from the Research Fund for Coal and Steel under grant agreement No. 799295.)

# Outlook strand supervision

- › Online supervision of the strand surface using cameras and enhancing a defect detection with supervised machine learning
- › With the software\*\* for displaying and evaluating the strand surface temperature and the scale coverage, the following quality-relevant situations can be detected:
  - › abnormal casting conditions (such as strong fluctuations in the mould) due to strong fluctuations in the average temperatures
  - › the amount of scale as a result of the casting process
  - › abnormal average temperatures in the billet section or at the corners, which may indicate abnormal casting conditions and cause defects
  - › defects on the strand surface after appropriate teaching
- › Generally applicable for other steel grades and formats, as adaptable functions were implemented
- › Still open whether software is also suitable for round products; would have to be tested



\*\*developed in SupportCast (The project has received funding from the Research Fund for Coal and Steel under grant agreement No. 754130.)