

# A Transient And Highly Resolving Multiphase Approach For Blast Furnaces Based On The XDEM Technology

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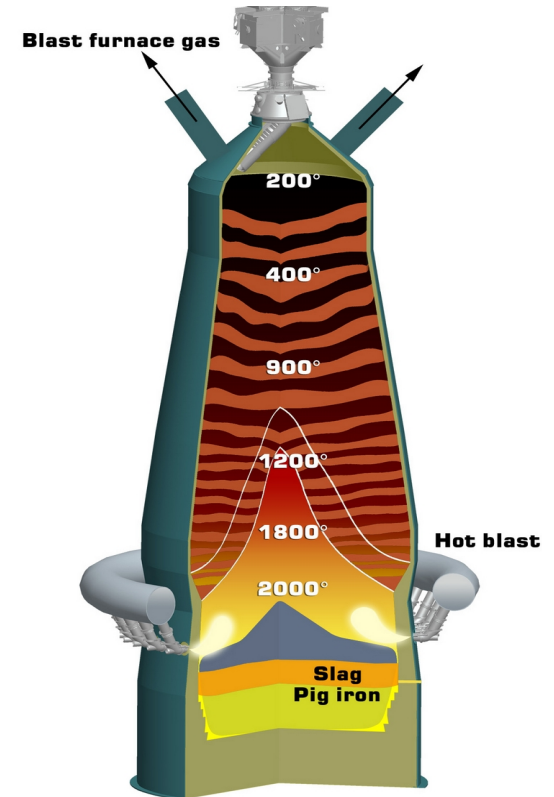
19th Multiphase Flow Conference & Short Course  
June 19 - 23, 2023 Dresden

# Content

- Key Aspects
- Comparison with Experimental Data
- Cohesive Zone
- Summary

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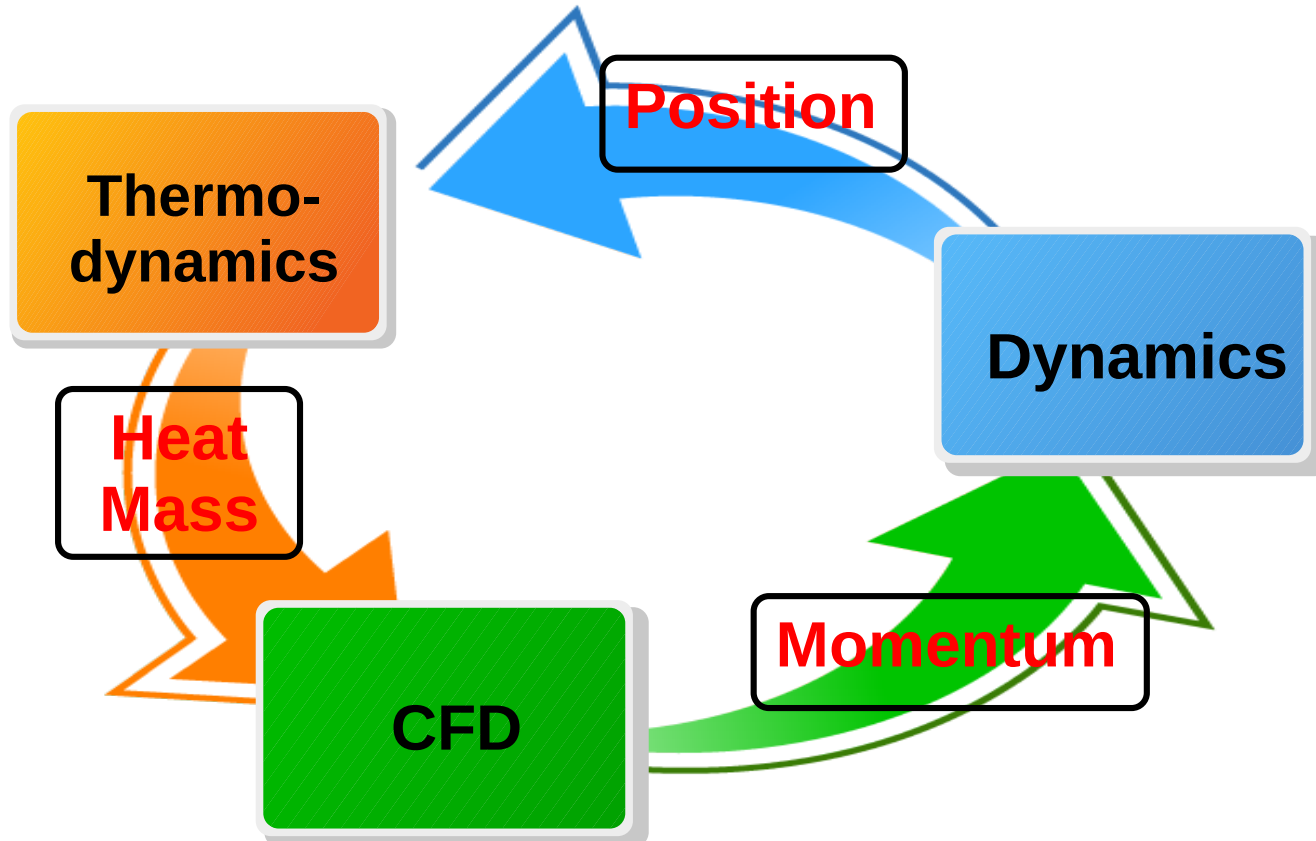
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# Extended Discrete Element Method (XDEM)

- Based on the classical Discrete Element Method (DEM) to describe motion of granular materials (discrete phase) and **extended by thermodynamics for particles**
- Interface to Computational Fluid Dynamics (CFD) and Finite Element Analysis (FEA) with data exchange
- Coupling to external commercial/OpenSource software e.g. Fluent, OpenFoam, Calculix, etc.
- Wide ranging validation over multiple scales

# Key Modules of XDEM



# Key Features: Gas/Liquid Phases

- Liquid and gas phases as Euler multi-phase flow described by CFD
- Resolution of each phase yielding individual volume fraction, temperature, velocity, etc.
- Transfer between particles and individual phases:
  - Heat and species transfer
  - Melting iron transferred to liquid iron CFD phase
  - Melting slag transferred to liquid slag CFD phase
- Interaction between phases: heat, mass and momentum exchange

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# Setup

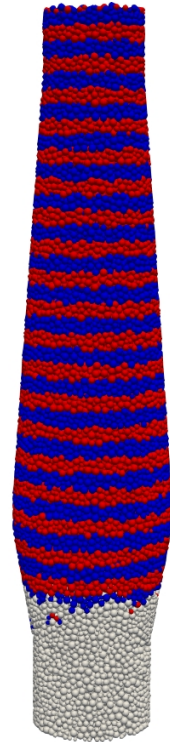




# Setup



# Setup



June 22, 2023

Blast Furnace Digital Twin

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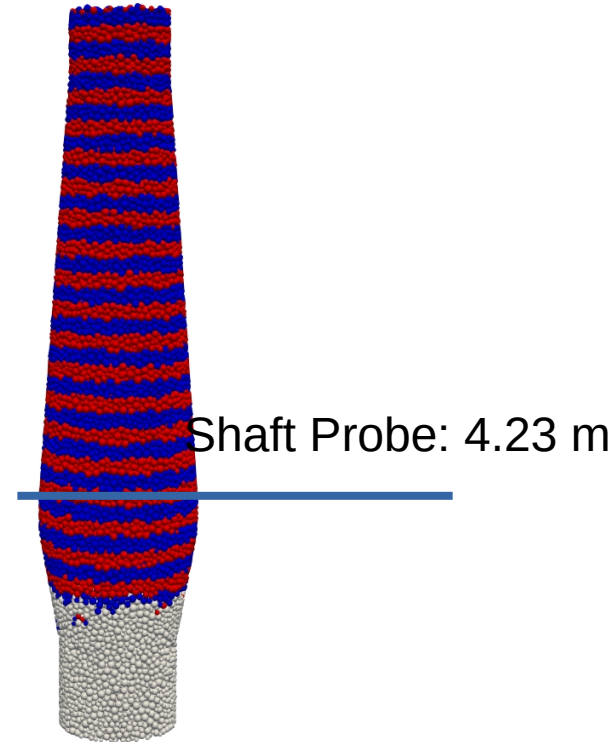
# Measurement Levels



June 22, 2023

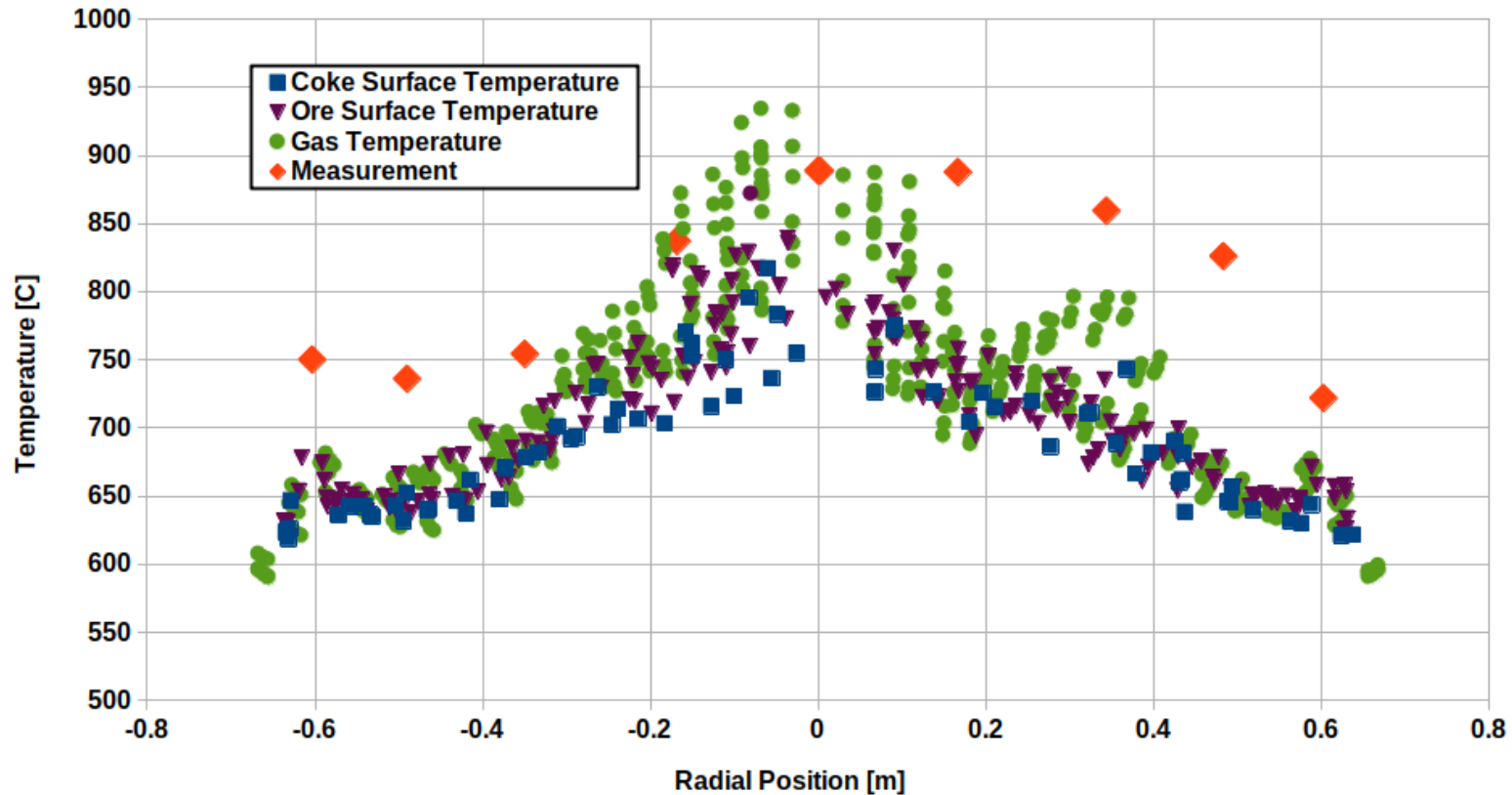


Blast Furnace Digital Twin

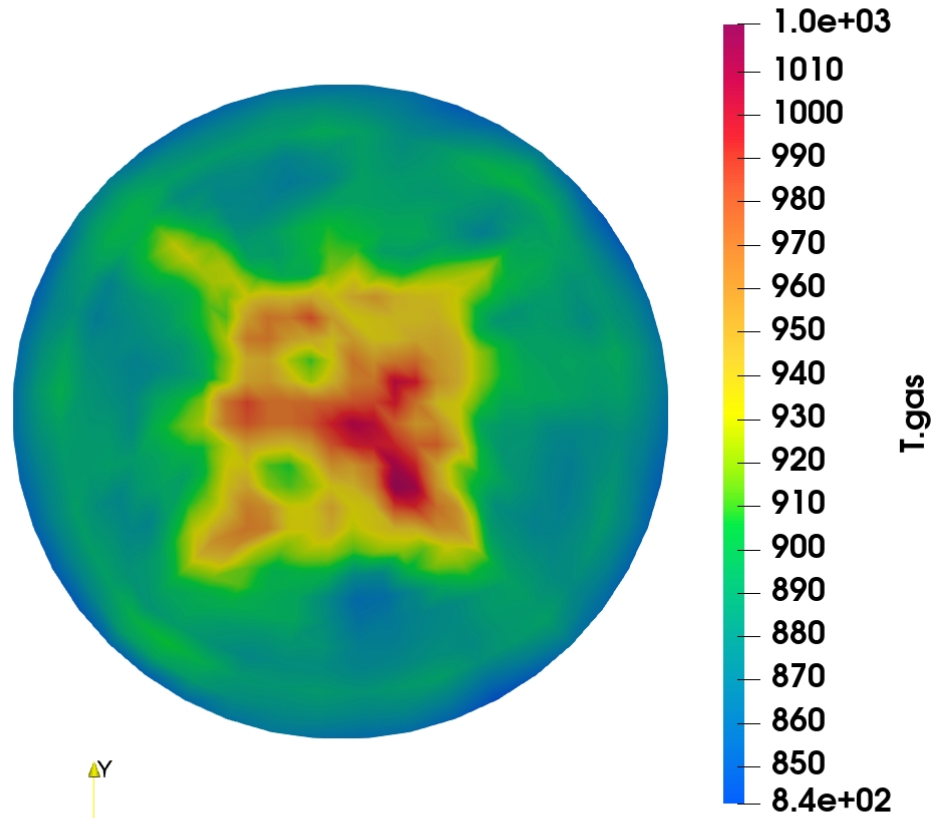


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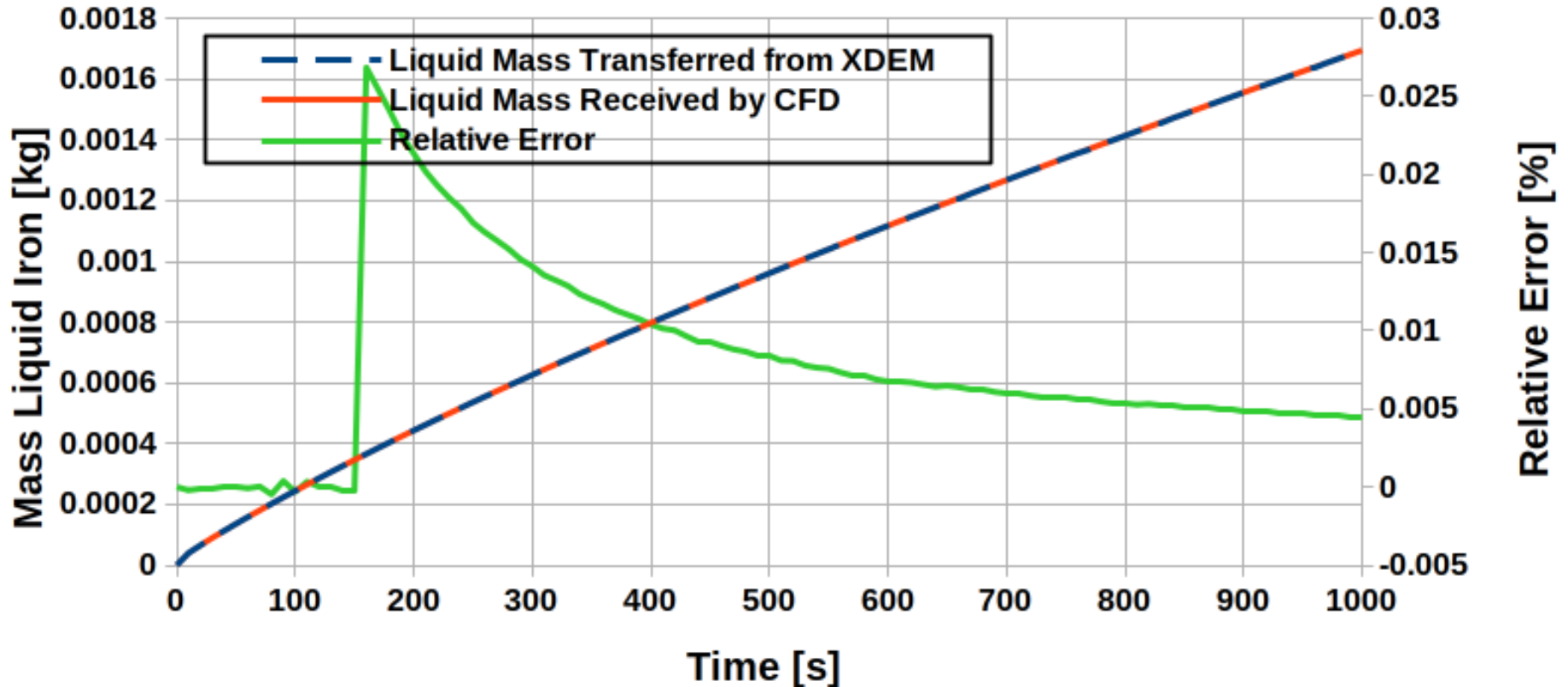
# Probe Temperature Validation



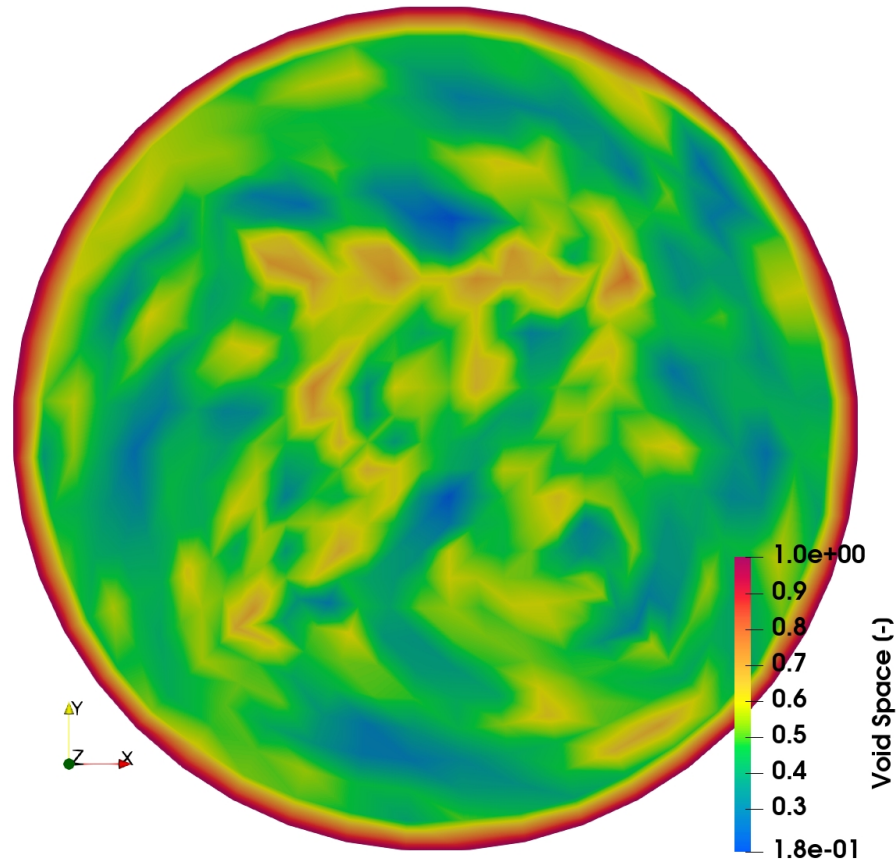
# Temperature Distribution



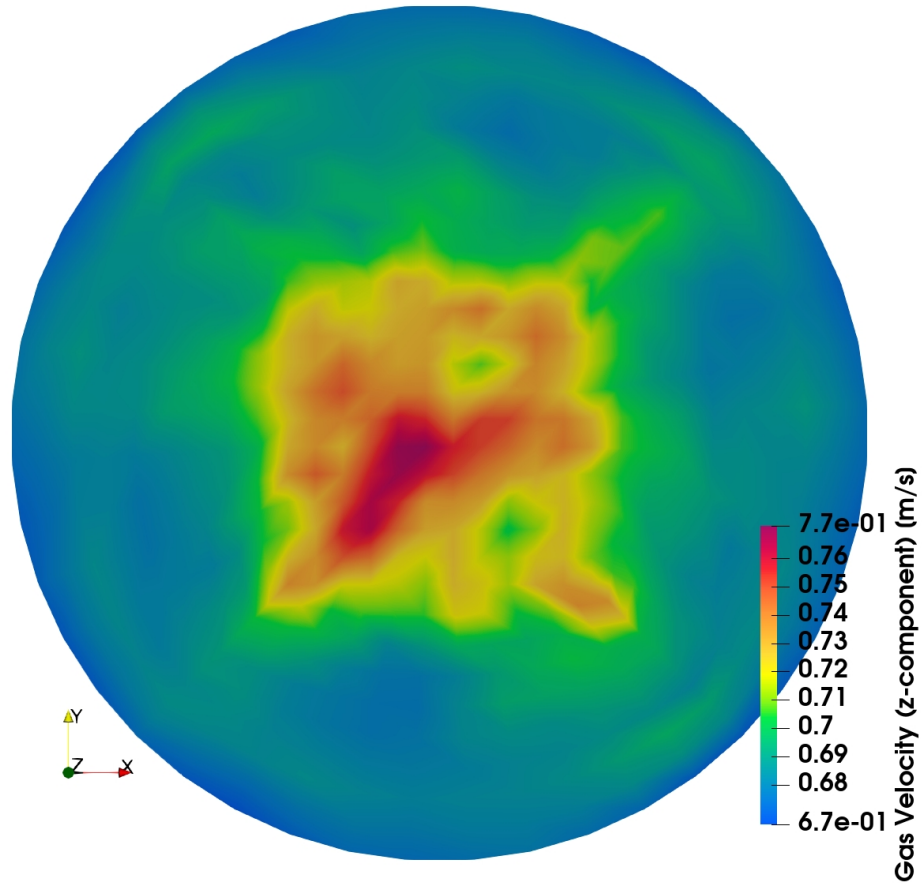
# Liquid Mass Transfer



# Void Space Distribution



# Gas Velocity

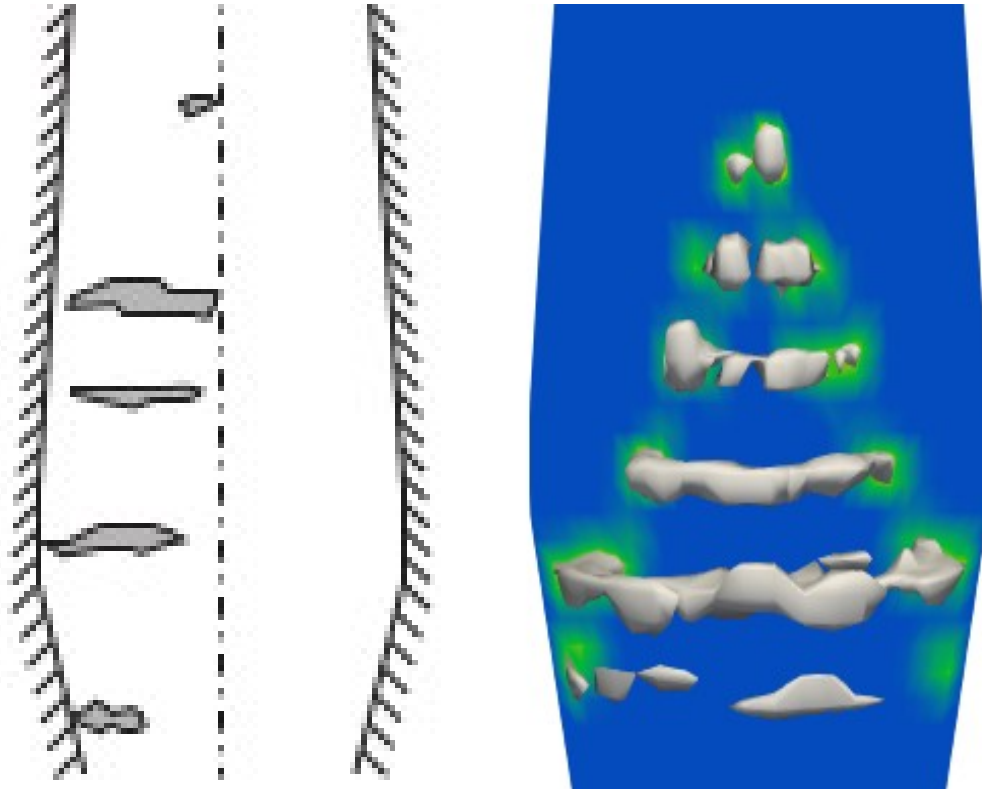




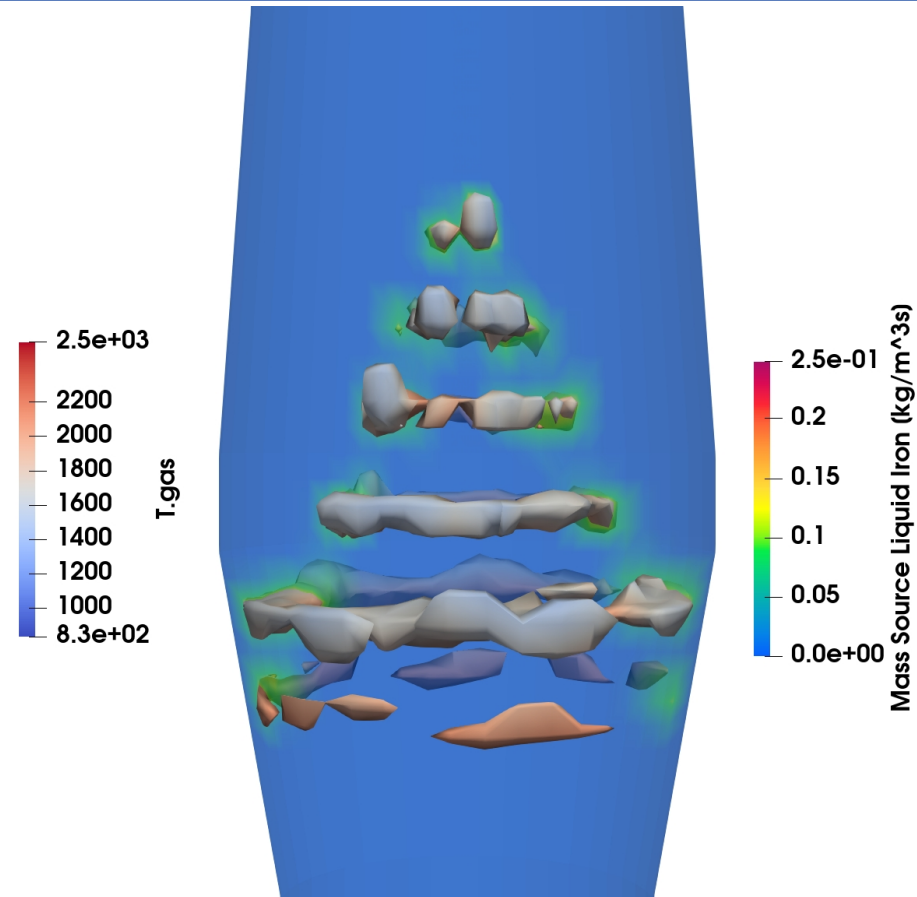
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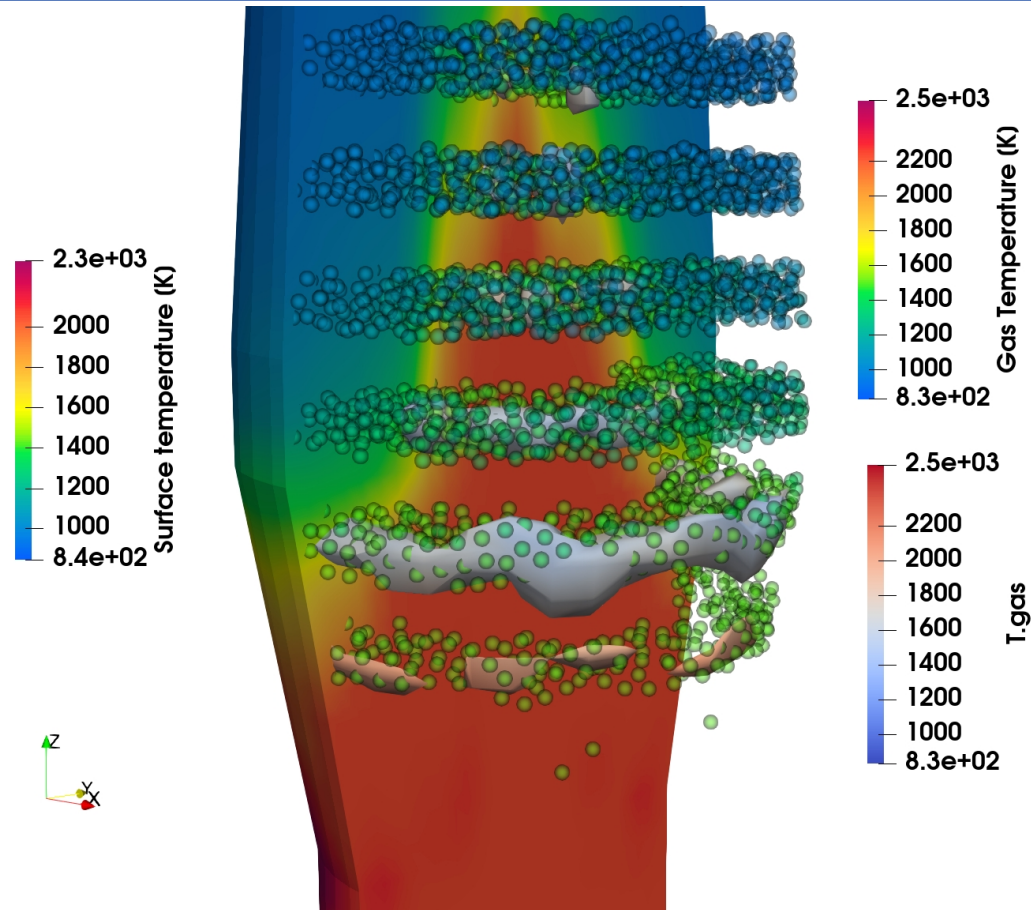
# Comparison of Location of Cohesive Zone



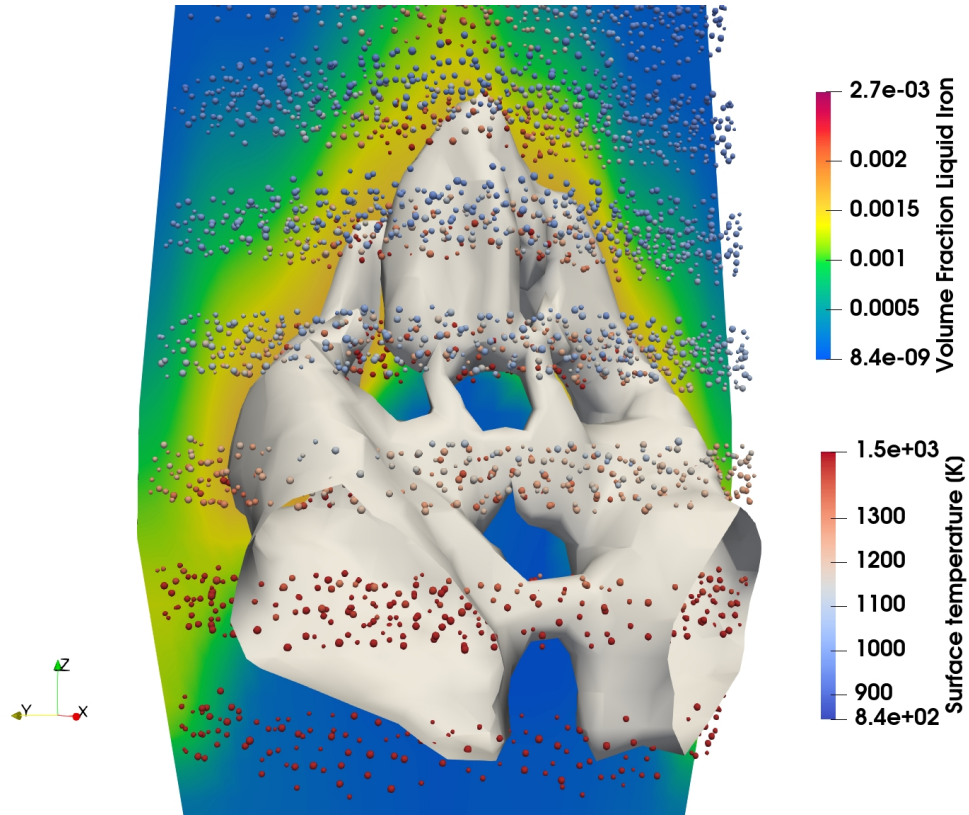
# Location of Cohesive Zone



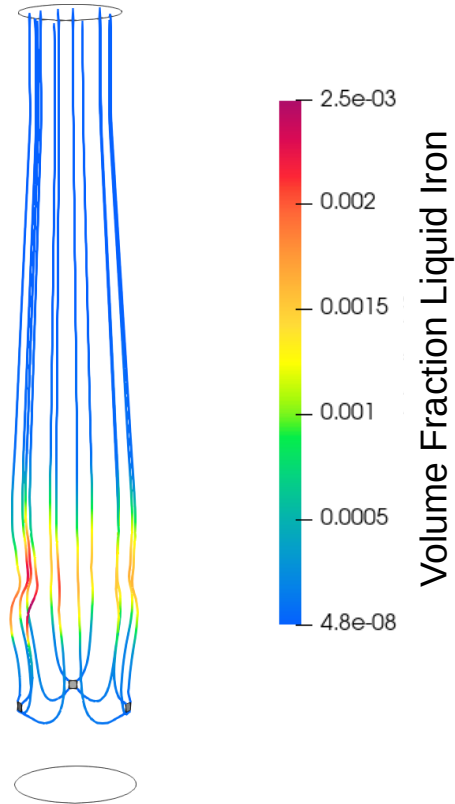
# Temperature of Cohesive Zone



# Liquid Iron Distribution



# Streamlines Gas



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# Summary

- Accurate representation of blast furnace multi-physics by a HPC digital twin
- Good agreement between predictions and measured temperature distribution
- Clear identification of cohesive zone through formation of liquid iron and its transfer
- Allows for in-depth process analysis and optimisation



# Content

Thank you very much for your attention !

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