

Modelling and Simulation of Concrete 3D Printing Based on a Massively Parallel Multi-Phase, Multi-Component LBM Approach

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Project aims of 2nd funding period

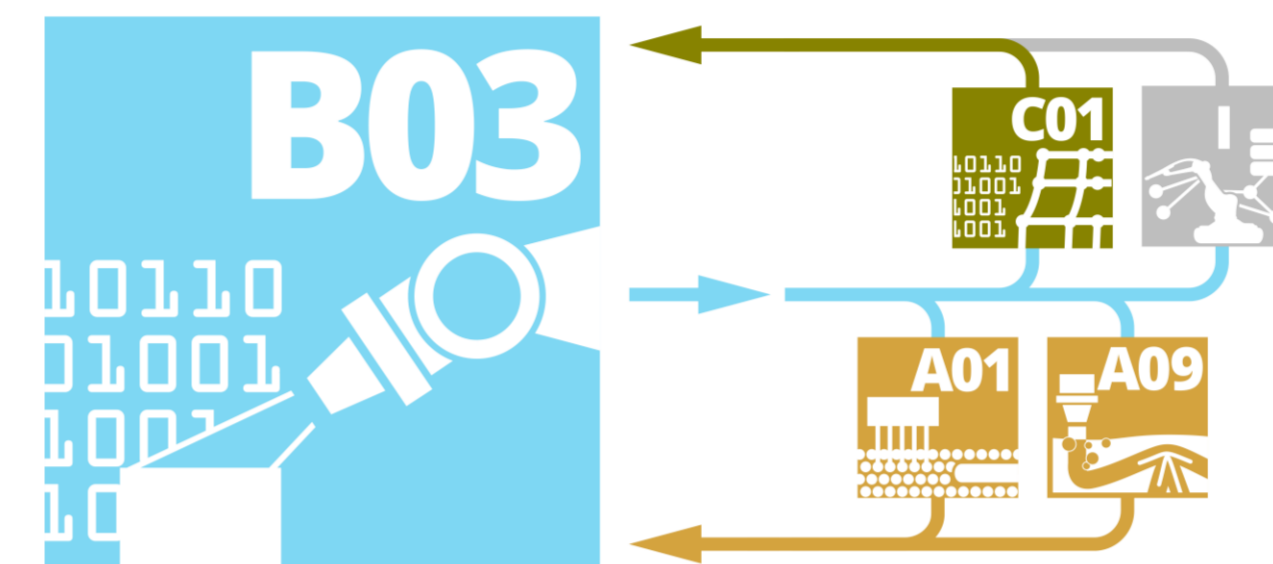
Selective Cement Activation (SCA) simulation

- Develop a methodology to simulate the penetration of water into the SCA particle bed matrix considering the presence of the aggregate phase: The effective resolution and the resulting bond quality between successive layers are highly dependent on the penetration dynamics of water into the particle bed. Unfilled pores are expected to have a negative impact on the mechanical properties of the printed structure.

Injection 3D Concrete Printing (I3DCP) simulation

- Identify sensitivities of the printing quality on the process parameters: A particular focus will be on the quality of joints. To enable such simulations the prescribed movement of the printing head based on the printing commands must be included in the simulation framework.

Key collaborations in 2nd funding period

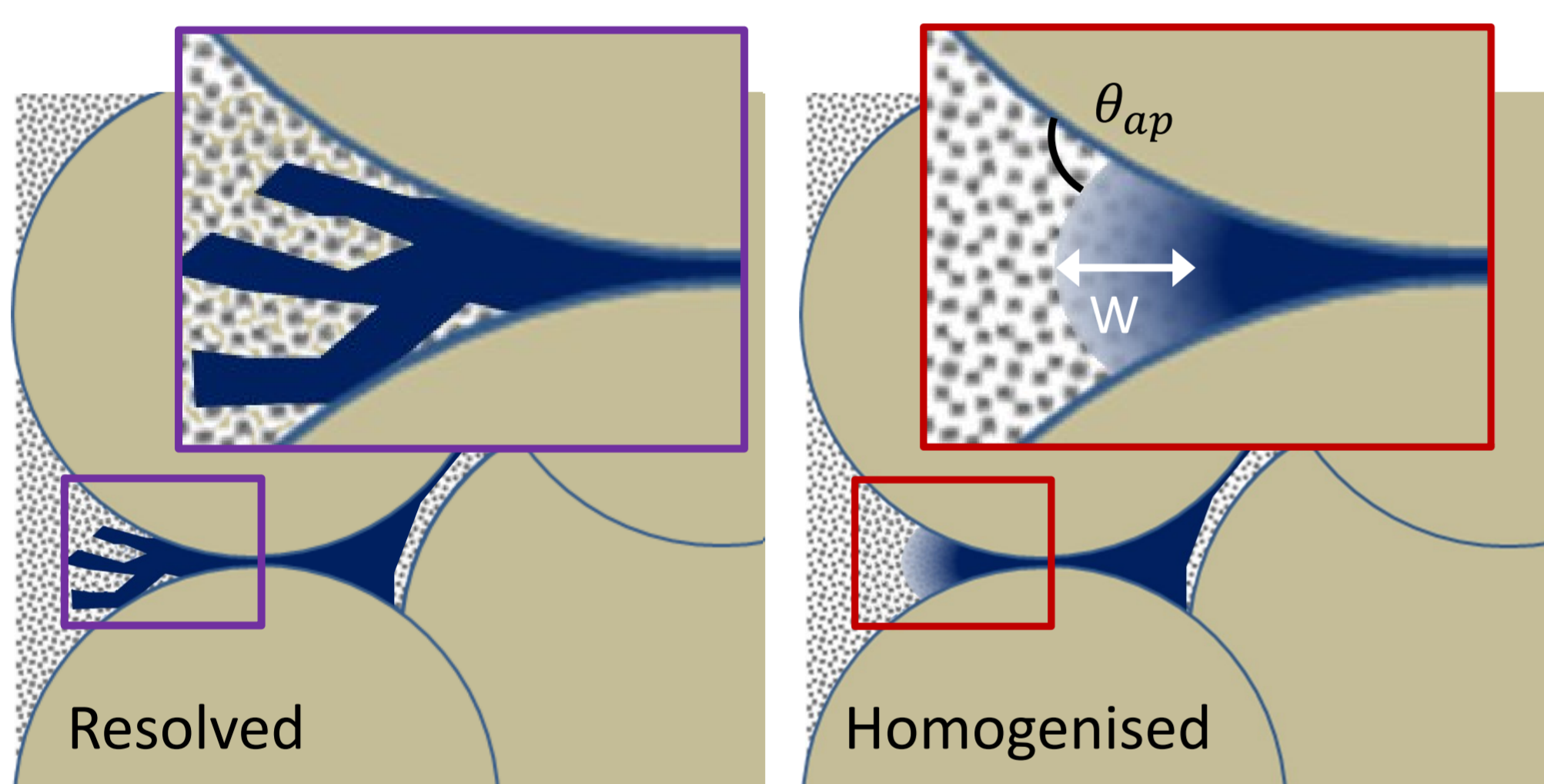


- A01: SCA simulation permeability and water distribution of the cement matrix
- A09: I3DCP simulation single strand, multi-strand and joint benchmarks
- C01: I3DCP shape prediction mechanical properties of the as-predicted printed structure

Methods

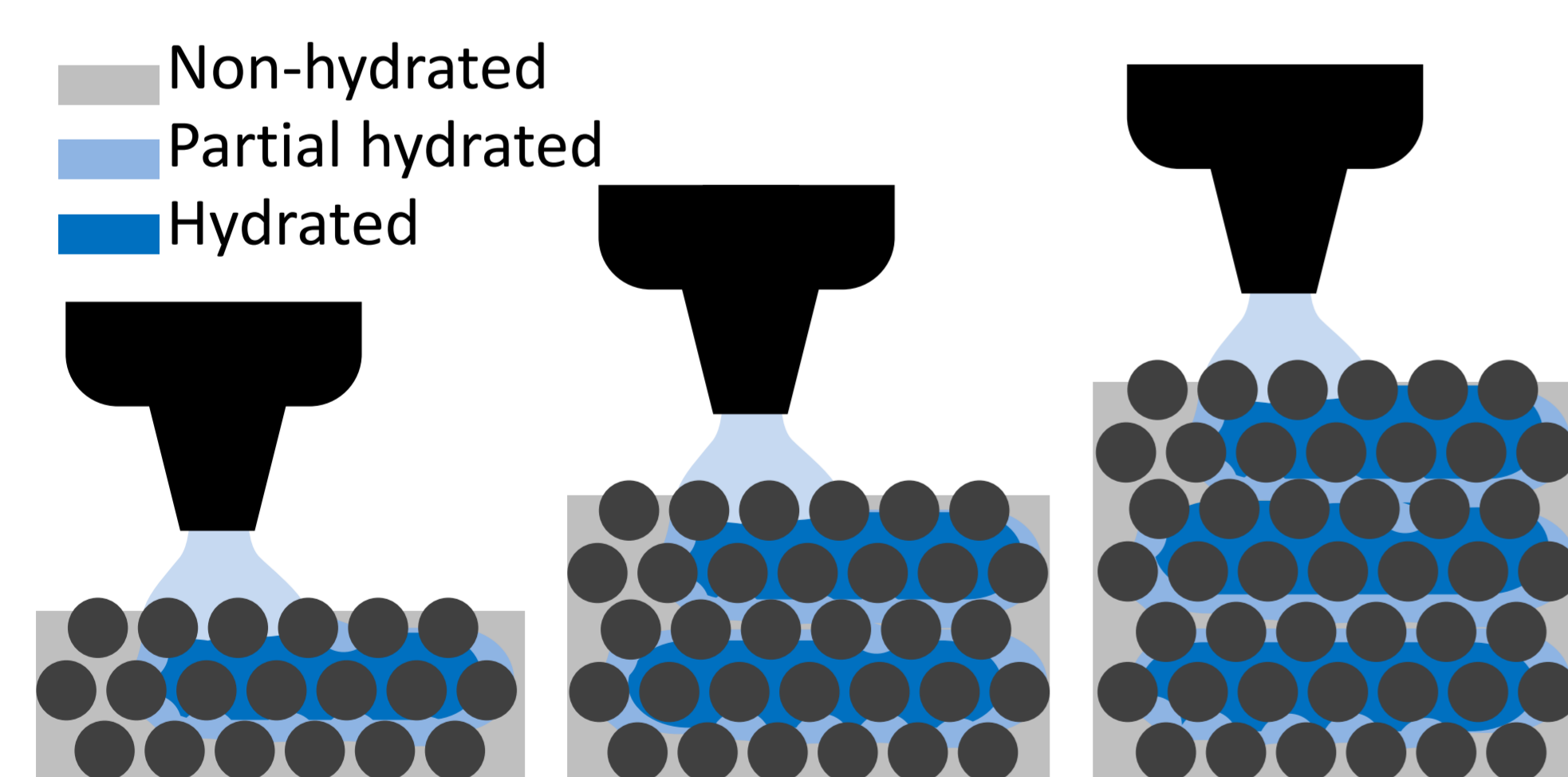
Homogenized infiltration model for SCA (WP 1)

- Homogenized Navier-Stokes equation for unresolved cement powder matrix
- Resolved aggregate phase
- Conservative phase field equation with effective interface width, mobility and contact angle



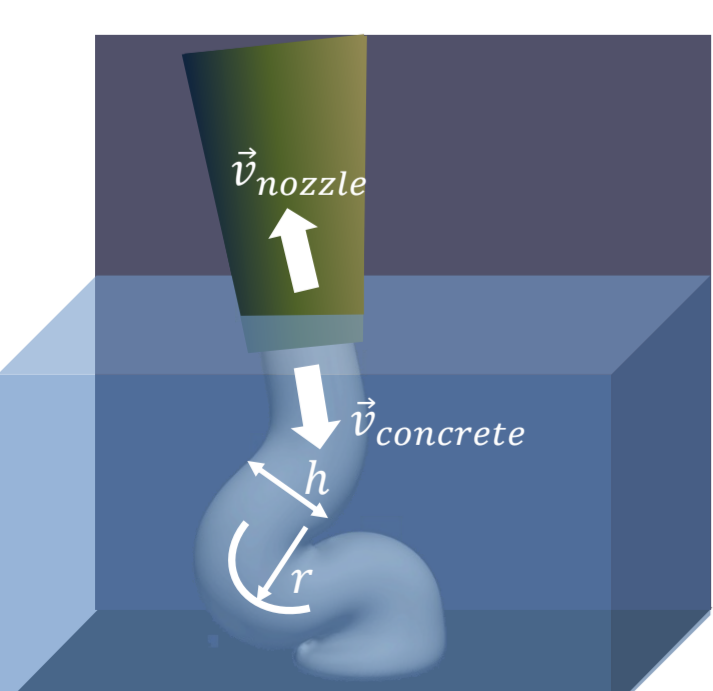
Infiltration simulations (WP 2)

- Outcome: hydration distribution



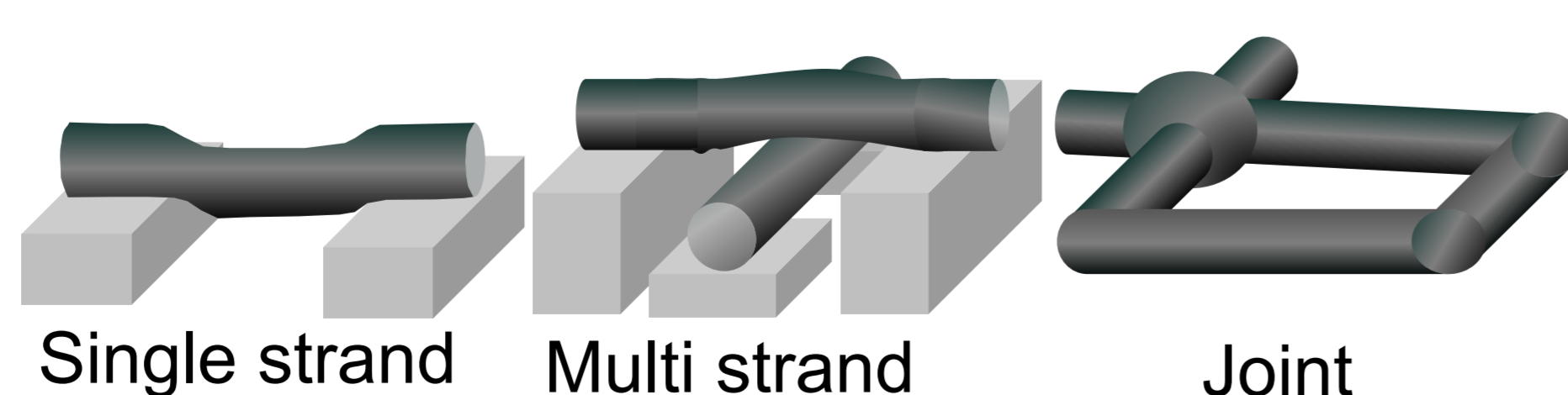
I3DCP model (WP 3)

- Suspension: Bingham fluid
- Concrete: Flocculation model
- Print-head: FSI



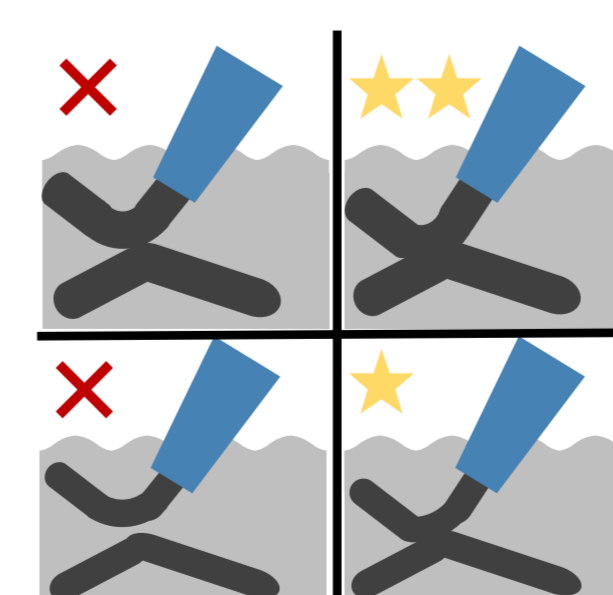
I3DCP benchmark (WP 4)

- Outcome:
 - deformation
 - bond quality

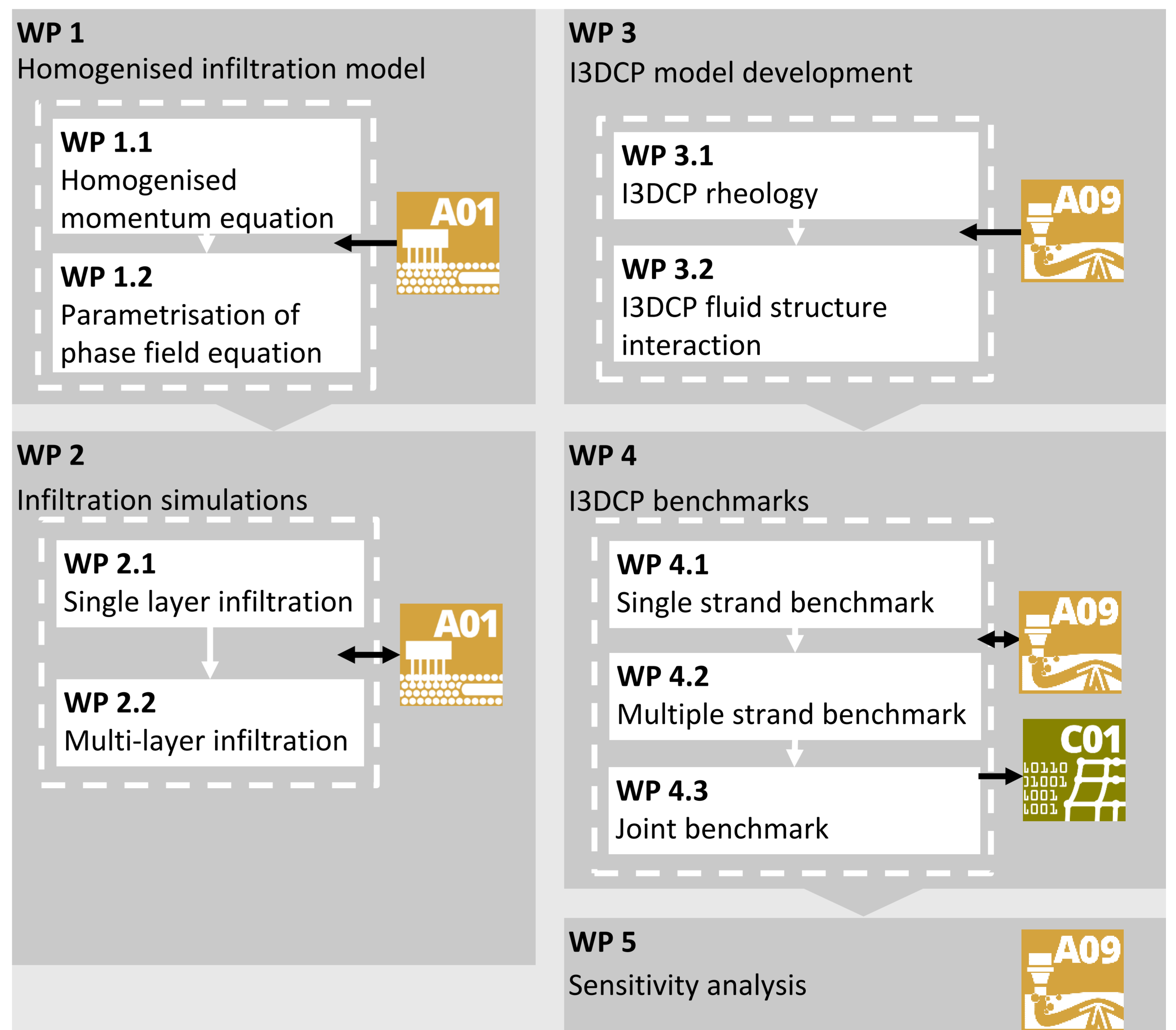


Sensitivity analysis (WP 5)

- Outcome: Joint quality depending on process parameters



Work programme



Outlook 3rd funding period

- Simulation of concrete in concrete printing
- Part-scale simulation for optimal path planning
- Consideration of environmental factors on the printing process

