TU Clausthal

Institut für Technische Mechanik

DSC
Drilling Simulator Celle

Modelling and numerical simulation of the multiphase transport in deep drilling technology

Motivation

Drilling is the main cost parameter in subsurface energy resources recovery.

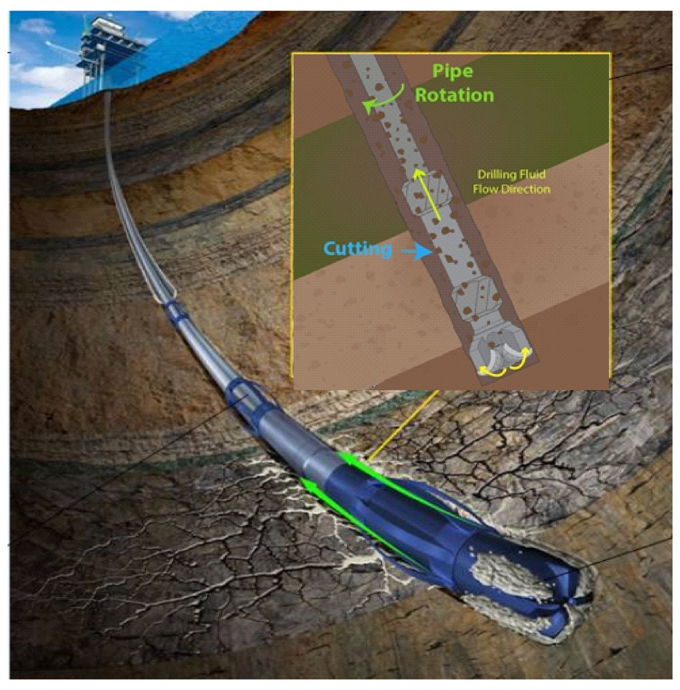
Poor hole cleaning can cause stucked pipe, higher drag and torque, formation fracturing and inefficient wellbore steering.

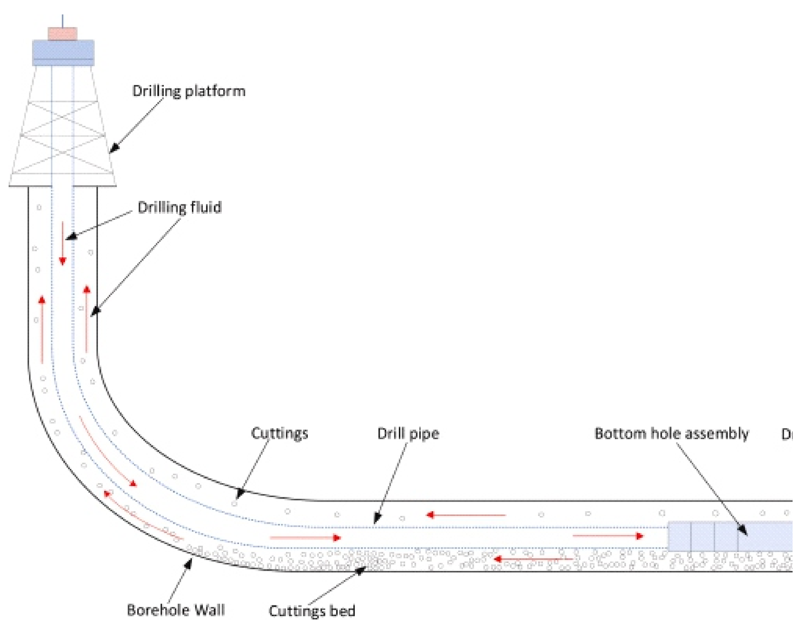
Conceptually new computational methods support the understanding of drill cuttings transport and hence, the automation and optimization of the drilling process.

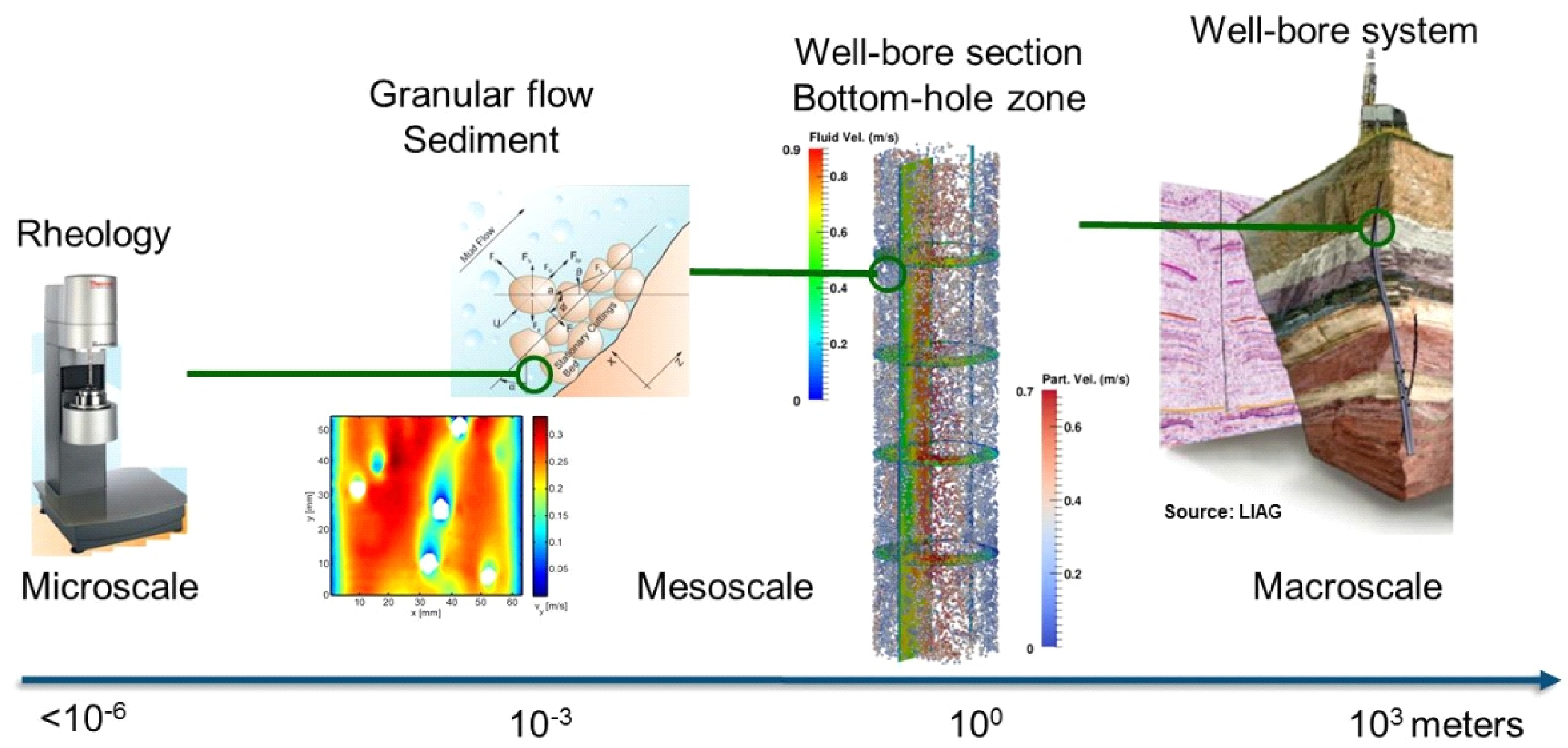
Research Questions

Simulations, complementary to experimental results, provide data for a better understanding of the interaction of the principal parameters:

- Drilling fluid rheology
- Well bore inclination and pipe rotaion
- Downhole conditions (temperature, pressure)
- Cuttings concentration, size and shape
- Secondary flow, i.e. Taylor vortices, may reduce transport efficiency







Approach

A new computational method, the Immersed Boundary Method (IBM), is applied to model the transport of drill cuttings without empirical assumptions that would compromise the reliability of predictions.

IBM allows to determine particle transport in dilute and dense suspensions, also considering fluid rheology and particle shape.

Typically, a section of the pipe is considered while resolving all relevant parameters as shown in the figure below.

Scales in multiphase flows

In deviated wells different multiphase flow regimes occure and require appropriate and validated computational models.

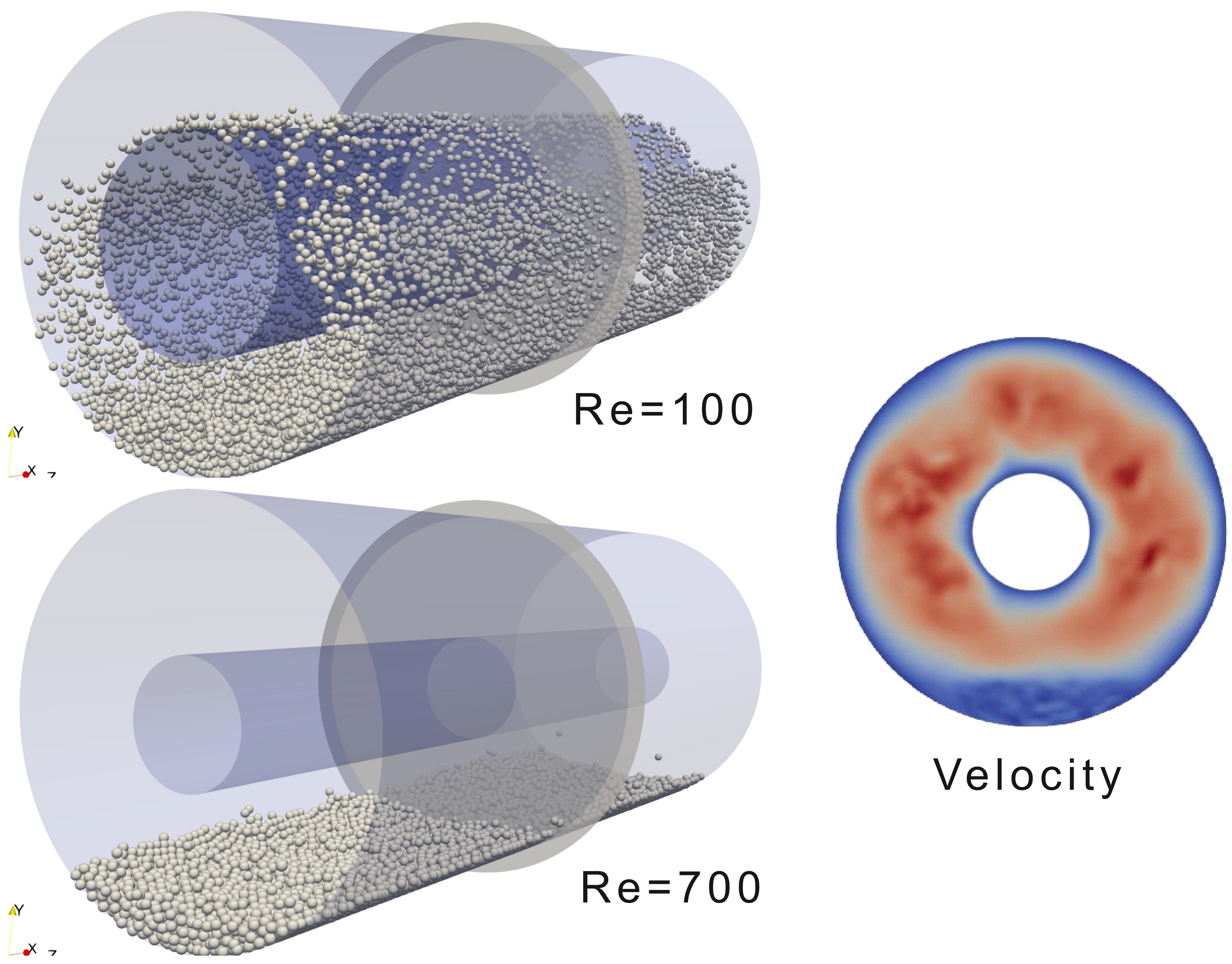
Classical Euler Lagrange Methods are suitable only for dilute multiphase flows.

Dense multiphase flows require scale resolving methods, such as the Discrete Element Method.

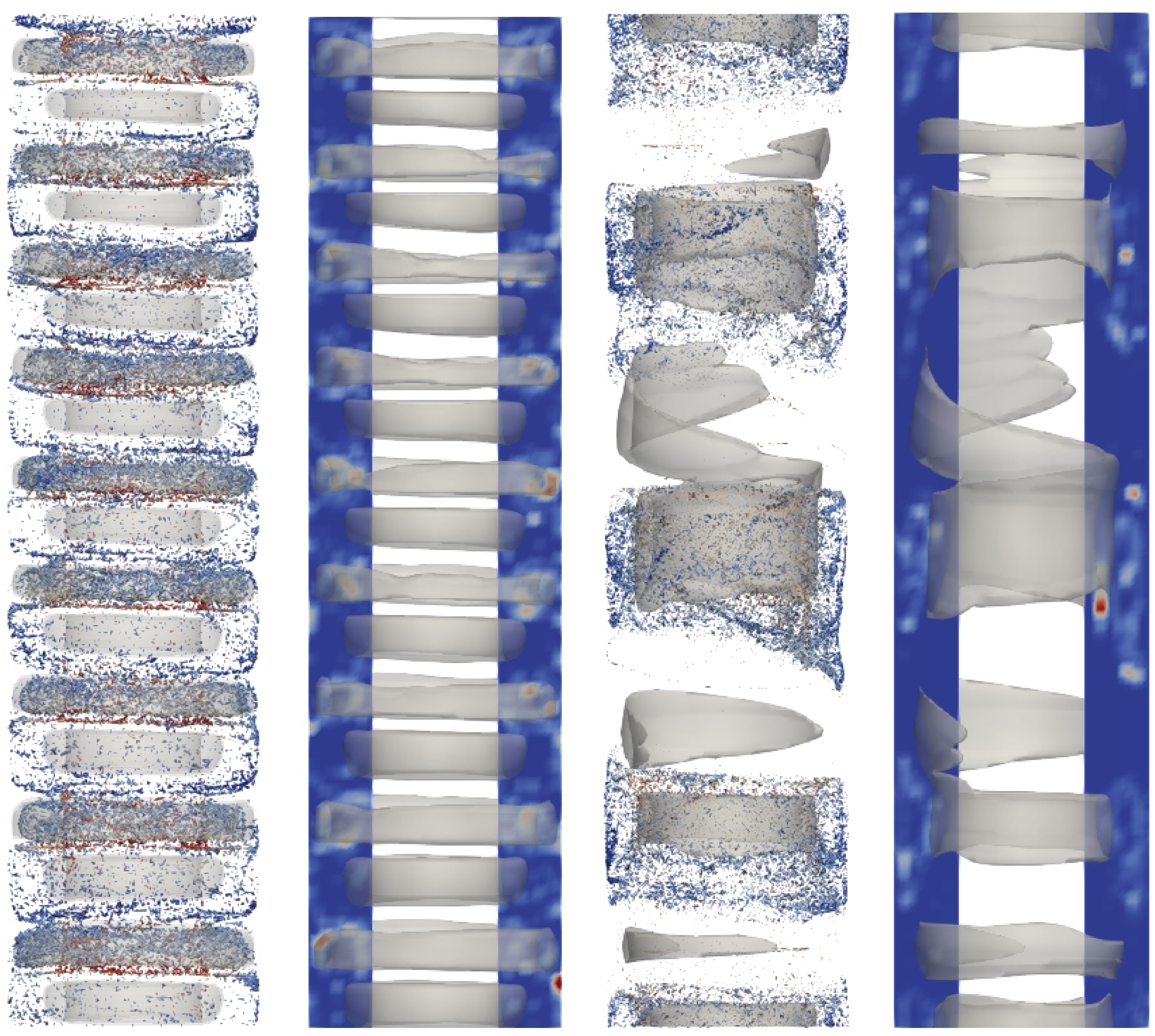
Modelling of the entire drill system requires aggregated models at a macroscale.

Results

Particle transport in a section of a horizontal well
Influence of viscosity



Particle transport in a vertical well
formation of Taylor vortices



$Ta^{0.5} = 357$, $Re_{ax}=28$
100 rpm

$Ta^{0.5} = 714$, $Re_{ax}=280$
200 rpm

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