Contribution ID: **19** Type: **not specified**

Modeling Alveolar Structures and Surfactant: Hands-On Session with ExaDG

Wednesday, December 10, 2025 11:45 AM (45 minutes)

Mechanical ventilation is a critical method for patients with impaired pulmonary function, but it can cause ventilator-induced lung injury. Clinicians must balance effective respiration with strategies that protect lung tissue. However, the local effects of mechanical ventilation are challenging to measure or observe by medical imaging. Computational models promise physics-based forecasts on the impact of different ventilation maneuvers on patient-specific geometries. Yet, most models fail to incorporate many crucial effects in respiratory mechanics, surfactant being among the most notable. Surfactant molecules in the fluid lining of the alveoli reduce surface tension, thereby increasing lung compliance. To understand surfactant effects and integrate them into patient-specific reduced-order or homogenized models, we require numerous highly resolved simulations of delicate and complex alveolar structures. We perform these simulations using the open-source ExaDG software project. ExaDG is based on deal.II and provides highly efficient solvers for problems in fluid mechanics, solid mechanics, and fluid-structure interaction. The extensible software architecture enables us to implement surfactant dynamics in the matrix-free hyperelasticity solver. The exceptional performance allows us to handle the high resolution and the large number of different setups required to extract information from the fine-scale alveolar structure simulations.

Primary author: TEMÜR, Bugrahan (TU München)

Presenter: TEMÜR, Bugrahan (TU München)

Session Classification: HANDS-ON TUTORIAL