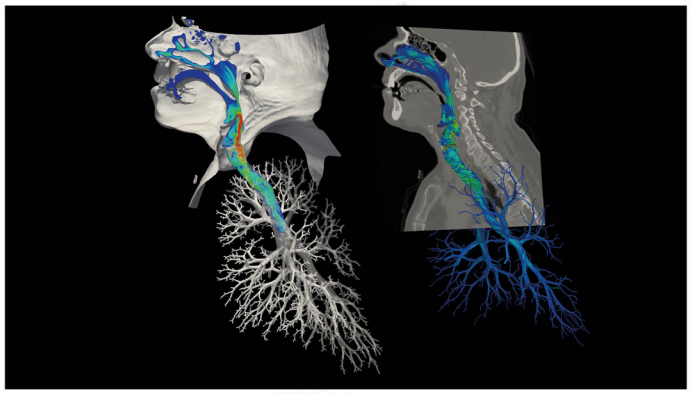
JARA Jülich Aachen Research Alliance

AN INITIATIVE OF

JÜLICH Forschungszentrum | RWTH AACHEN UNIVERSITY

Simulation & Data Laboratory

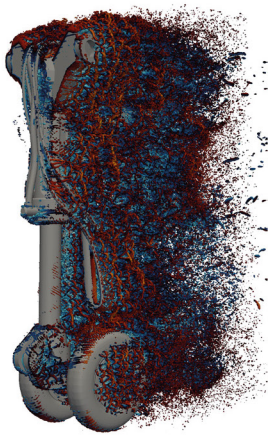
Highly Scalable Fluids & Solids Engineering



- Large-scale multi-physics simulations on HPC systems
- Performance engineering for peta- and exascale computing
- Porting and scaling of CFD applications and tools
- Method development for parallel PDE solvers
- Research on AI methods for fluids and solids engineering
- Support for large-scale engineering applications

Know-How

- FE, FV, LB, and DG methods[1]
- Multi-level parallelization techniques
- Cartesian grid-based methods
- Parallel mesh generation and partitioning
- Shape optimization
- Fluid-structure interaction
- Multi-physics coupling
- Coupling of CFD simulations and AI methods



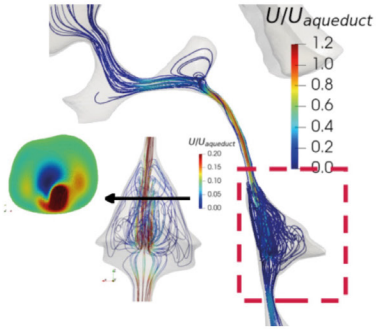
Flow around a VTOL landing gear

Technical Applications

- Prediction of the flow field in fuel cell gas diffusion layers (FZJ, IEK-3)
- Comparison of meshing and CFD methods for accurate flow simulations on HPC systems (JLESC[2])
- Deep Neural Networks for CFD (DNN-CFD):
  - Automation of CFD workflows such as mesh generation from computer tomography images
  - DNN to build surrogate models for fast predictions of flow fields

Biomedical Applications

- Collaboration projects with the Institute of Aerodynamics (RWTH)
- Simulation of the flow in the human nose and lung to understand respiratory pathologies
- Simulation of the particle deposition in respiratory airways
- Shape optimization to increase breathing capacities
- Evaluation of the functional performance of nasal cavities
- Machine learning for medical decision support
- Developments towards virtual surgeries
- Simulation of brain fluid oscillation in cardiac cycles to assess mechanical treatment used in neurosurgery
- Geometry extraction using Artificial Neural Networks



Simulation of the cerebrospinal fluid inside the human central nerve system

HPC Projects

- Large-scale mesh decomposition
- Octree-based multi-physics methods
- CFD code benchmarking (3 codes)
- Peta-scaling of XNS and m-AIA (RWTH)
- Adaptive refinement and load balancing
- Computations with one billion degrees of freedom on 450,000 cores
- Center of Excellence: Research on AI- and Simulation-Based Engineering at Exascale[3]

CoE RAISE

[1] FE = Finite Element, FV = Finite Volume
LB = Lattice-Boltzmann, DG = Discontinuous Galerkin

[2] Joint Laboratory for Extreme Scale Computing

[3] https://www.coe-raise.eu

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