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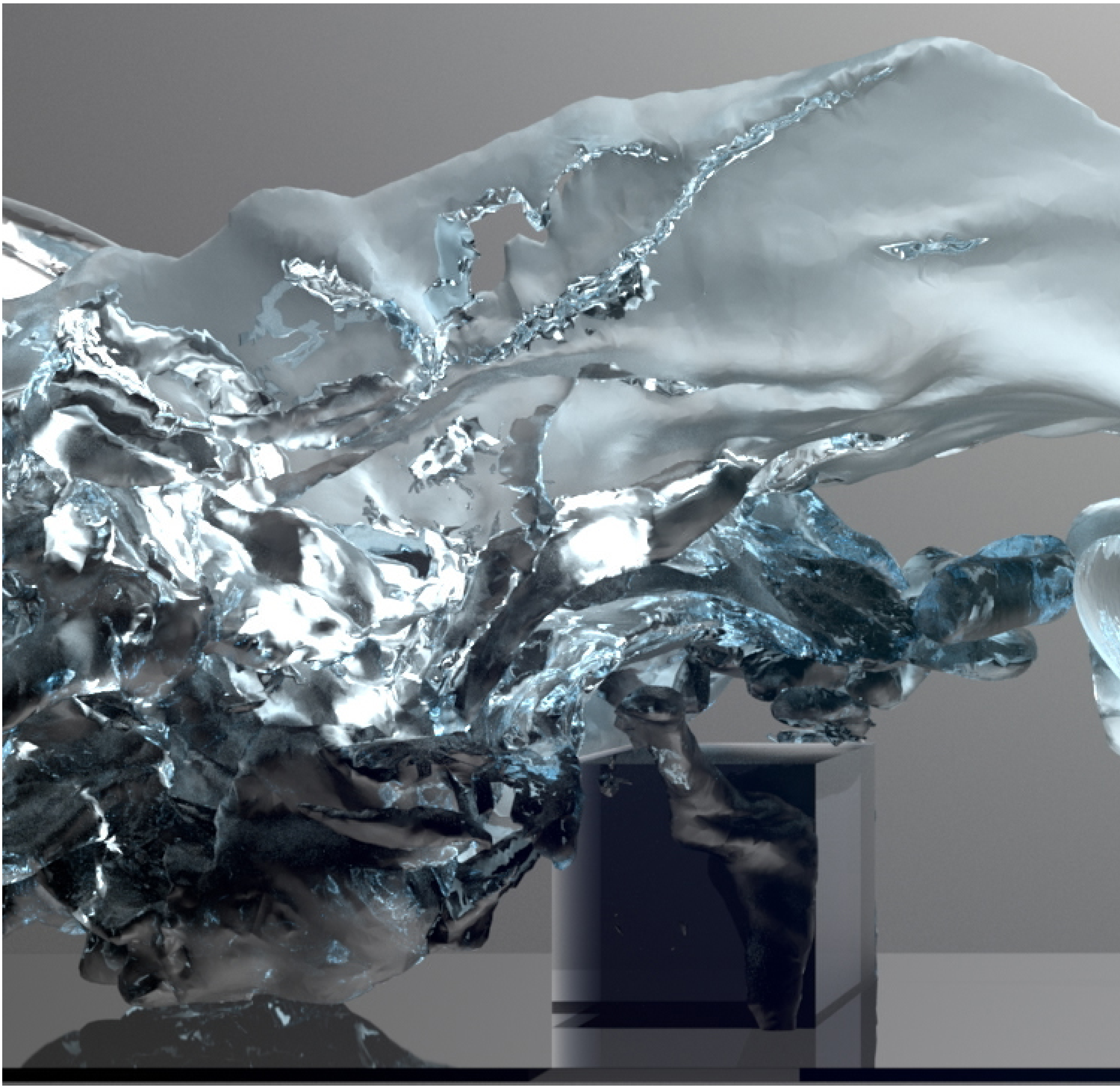

The simulations of coupled mechanics problems involving incompressible flows require continuous developments of physical and numerical algorithms to take into account all the physical aspects present in multiphysics problems, and to accurately solve these fluid equations.

Summary

The accurate and efficient modeling of incompressible flows involves mathematical aspects of the discretization method, physical aspects according to the physical process to be simulated, and computer science aspects to solve the resulting equations efficiently on supercomputers. In particular, the following topics are treated:

- *Mathematical aspects*
  - Stabilization strategies (variational multiscale VMS)
  - Subgrid scale tracking
  - Algebraic solvers and preconditioners
- *Physical aspects*
  - Turbulence modeling
  - Low Mach models
  - Free surface flows
  - Lagrangian particle transport
  - Multiphysics coupling
- *Computer Science aspects*
  - Loop parallelization (OpenMP/OmpSs)
  - Task parallelism (OpenMP/OmpSs)
  - MPI3 parallelism
  - Dynamic load balancing
  - Accelerators

Objectives

The objective is to provide a Navier-Stokes solver to solve extremely large engineering problems involving incompressible or low Mach flows. Among the problems that have been solved recently, let us mention:

- Respiratory system (350M elements on 16000 CPUs)
- Combustors using LES and URANS (CopaGT EC project)
- Wind farm modeling (IBERDROLA renovables)
- Free surface flow for plastics removal in the ocean (Ocean Cleanup)
- Vehicle aerodynamics
- Yacht hydrodynamics (JyD)

The Navier-Stokes solver is present in the PRACE benchmark suite, and usually used by the Computer Science community of PRACE to test new supercomputers. Ti fulfill these objectives, internal as well as external co0llaborations are necessary. Among others:

- Denis Doorly (Imperial College, UK): large airways.
- Shahrouz Aliabadi (Jackson State University, UK): small airways.
- Charles Moulinec (STFC, UK): multi-physics coupling, PRACE.
- Bruno Koobus (Université de Montpellier, France): implicit solvers, HPC.

- Frédéric Magoulès (Ecole Centrale de Paris, France.): parallel algebraic solvers.
- Seid Koric (University of Illinois and NCSA, USA): HPC and code optimization.
- Romain Aubry (Sotera Defence Solutions, USA): meshing, HPC.
- Emmanuel Jeannot (INRIA-Bordeaux): Performance enhancement of Alya.
- Luc Giraud, Pierre Ramet (INRIA-Bordeaux): Highly scalable direct and iterative solvers (PASTIX).
- Yacine Ould-Rouis, Julien Derouillat (CEA, France): Optimization of Alya.
- Marta Garcia, Jesús Labarta (BSC, Spain): Dynamic load balance.
- Vishal Mehta, Paul Carpenter (BSC, Spain): GPU acceleration of iterative solvers.