Multi-Physics, Multi-Scale Simulations Using CIAO

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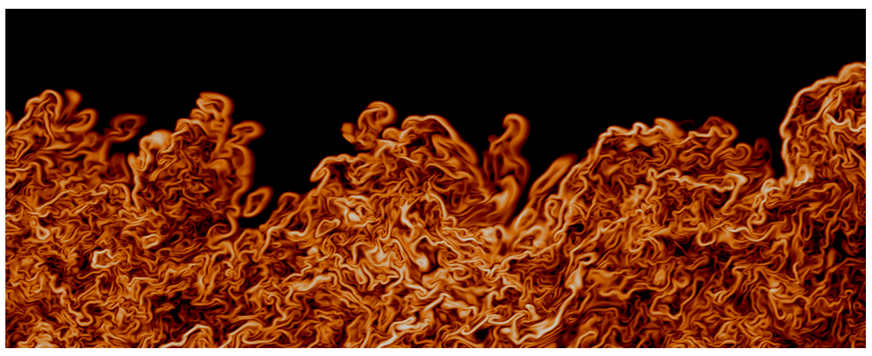
Motivation

- Many applications in energy science feature concurrent and complex physical phenomena
- Resolution of all relevant scales in DNS addressing multi-physics configuration not possible with current supercomputers
- To lower computing cost, LES resolves only the large scales of a flow while modeling small-scale effects
- The lack of reliable LES small-scale models prevents its application to predictive multi-physics simulations
- Thus, new LES models are developed by means of DNS focusing on only one phenomenon and resolving all relevant scales at the ITV, RWTH Aachen Univ.

CIAO

- Multi-physics, multi-scale Navier-Stokes solver (LES and DNS) for turbulent flows in complex geometries
- Fortran & MPI
- Structured FD
- Low Mach & Compressible
- Moving meshes
- Overset for local mesh refinement
- Immersed boundary methods
- In-Situ visualization
- Finite chemistry & Combustion models
- Interface tracking methods & Multiphase models
- Lagrangian particle methods

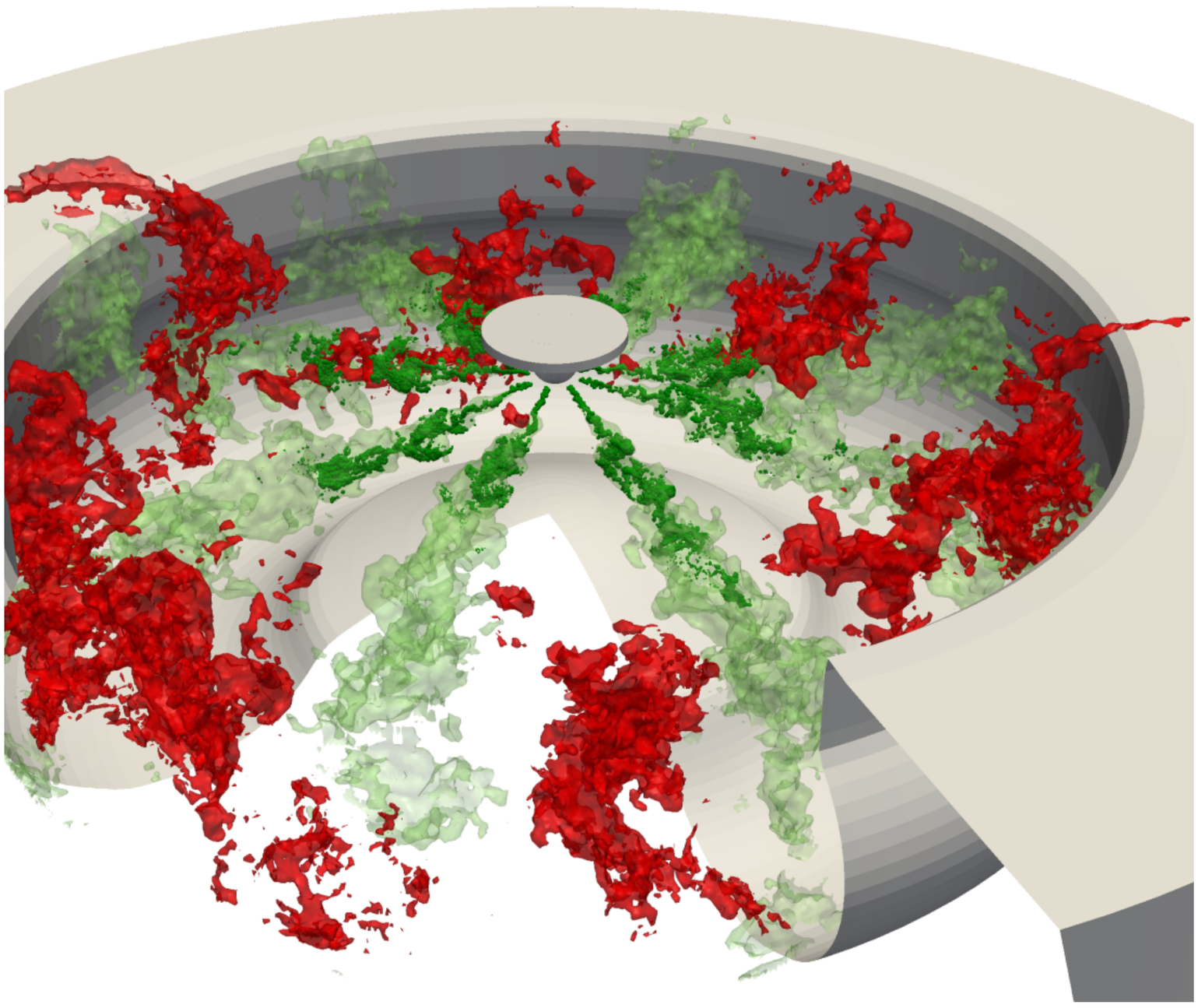
Simulation Results



DNS for modeling turbulent/non-turbulent interfaces

DNS for modeling liquid/gas interfaces

DNS for modeling non-premixed combustion



Multi-physics LES: Injection of liquid DnBE into engine cylinder using models for atomization, ignition, and emission formation. Liquid and gaseous fuel shown in green; CO is shown in red.

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