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LaBS : development of Lattice Boltzmann Solver
for Complex Flow Simulation

LaBS is

- a **collaborative research project** started in 2009
  Renault is leader of consortium
- supported by FUI-8
- *labelled by the competitiveness clusters*
  Mov’eo, Systematic, LUTB
- strong partnership for scientific expertise, establishing best-practices

Motivations behind LaBS

- high-performance software for complex flow simulations
- *evolutive numerical platform for academic and industrial research*
- « opensource module » for *multi-physics integration*

→LaBS is a *commercial software with preferential conditions for academic (non-commercial) research*

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**Features → advantages**

- Lattice Boltzmann algorithms → elegant and computationally-efficient method for fluid dynamics: direct acoustics, thermal flow, multi-phase flow, complex fluid/mixture, reactive flows, etc.
- Optimized for massively parallel computing (MPI, Linux cluster) → large-scale simulation
- Immersed boundary conditions → flows in complex geometry
- Fast (automatic) parallel mesher with grid refinement → multi-scale resolution

- Graphical User Interface
  - rapid setup (scriptable)
  - standard output format: Paraview, Ensight

- Opensource physics module → code customization
  - Turbulence modeling
  - direct and large-eddy simulation
Original Lattice Boltzmann scheme that integrates « grid refinement and turbulence modeling »

Validation: turbulent channel flow at $Re_\tau=180$ (academic test case)

$\Delta y^+=5.3$ in bulk

$\Delta y^+=2.7$ near wall!

Excellent agreement with high-resolution simulation by pseudo-spectral method!
Validation: turbulent channel flow at $Re_t=395$

LaBS compares very well with (best) results obtained with Finite-Volume LES solver at comparable grid resolution!
Validation: flow past a circular cylinder at $Re=47000$

Reference test for complex flow (recommended by Advisory Group for Aerospace Research and Development)

Large-Eddy Simulation

6.3 millions grid points run on 128 cores

Experiment at LMFA

$Psd[U_x]$ (m²/s²/Hz)

Strouhal = 0.20
LaBS is in the early stages of integration in design process (aerodynamics and aero-acoustics features) at Renault

LaBS is intensively assessed on industrial test-cases by Airbus and Alstom

Future developments of the physics module:

• wall law to reduce mesh resolution close to solid boundaries…
• thermal effects ; Boussinesq approximation and beyond…
• multi-phase flow, multi-component mixture, reacting flows, …

Labs should be viewed as an evolutive numerical platform for academic and industrial research… that can most probably integrate features of interest for your research activities