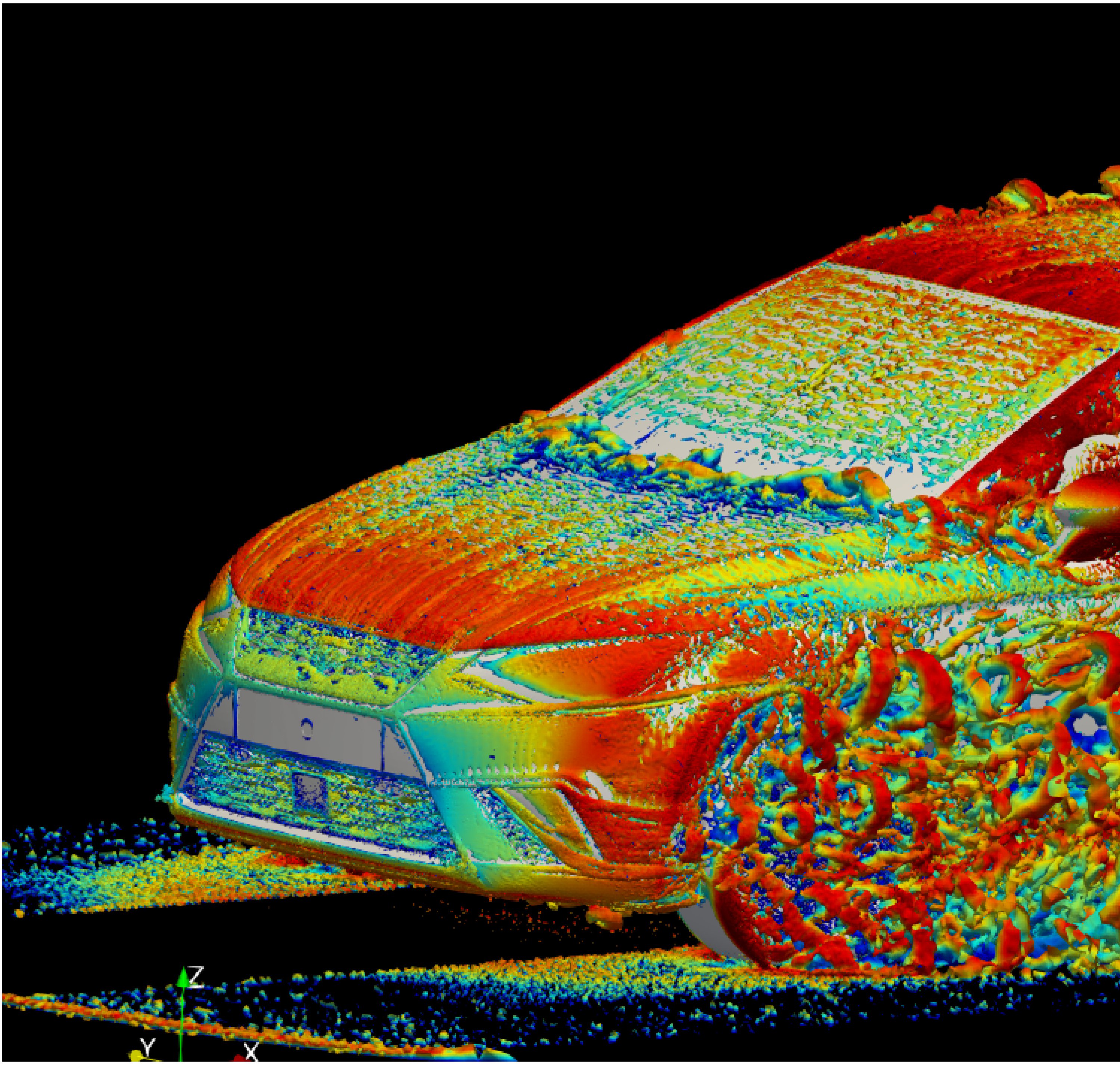
Published on *BSC-CNS* (https://www.bsc.es)



# Large-scale Computational Fluid Dynamics




**There is a need to increase the capabilities of current Computational Fluid Dynamics tools for engineering design by re-engineering them for extreme-scale parallel computing platforms.** The backbone of **the Large-scale Computational Fluid Dynamics (LS/CFD) team** is centred on the fact that, today, **the capabilities of leading-edge emerging HPC architectures are not fully exploited by industrial simulation tools. Current state-of-the-art industrial solvers do not take sufficient advantage of the immense capabilities of new hardware architectures**, such as streaming processors or many-core platforms. A combined research effort focusing on novel numerical methods, more accurate physical models, algorithms and HPC application is the only way to make possible to develop and advance simulation tools to meet the needs of the European industry. The LS/CFD team will focus on the development of numerical tools, turbulence models, multi-physics algorithms, data driven methodologies and large-scale industrial simulations.

## Objectives

1. **High-fidelity numerical methods for scale-resolving CFD.**
    1. Incompresible low-dissipation schemes with conservative discretisation.
    2. Low-mach low-dissipation schemes with conservative discretisation.
    3. Compressible low dissipation schemes by means of entropy stable arguments.
    4. Multi-phase numerical methods for turbulent flows.
    5. High-order methodologies compatible with physical-based LES methods.
2. **?Large-eddy simulation methods for high-Reynolds and complex geometries.**
    1. ?SGS closures for complex geometries.
    2. Wall-modelling strategies for LES solvers (equilibrium wall models, two layers models, FEM vs FVM strategies, etc.).
    3. Data-driven wall models for LES (NN, reinforce learning strategies, etc.).
    4. Mesh adaptivity methods for LES.
3. **?Algorithms for data management and data driven modelling in the context of CFD.**?
    1. Feature detection by means of statistical methods (POD, DMD, etc.).
    2. Feature detection by means of machine learning algorithms.
    3. Reduced order methods by means of DMD and POD.
    4. Machine learning algorithms to improve turbulence models.
4. **Direct numerical simulations and large-eddy simulations of boundary layer development and wake instabilities on bluff bodies from subcritical to industry relevant Reynolds numbers.**
    1. **?**Fundamental studies of turbulent flows with massive separation around bluff bodies at moderate and high Reynolds numbers.
    2. Pasive flow control of boundary layers (surface roughness, dimples, surface morphing, etc.).
    3. Active flow control of boundary layers (syntetic jets, active surface, etc.).
    4. Vortex induced vibrations for flow control and energy harvesting.
5. **Scale-resolving simulations of industrial relevant applications.**
    1. Large-eddy simulation of practical aeronautical flows with near wall modelling (JSM High-lift configurations, NASA-CRM, etc.).
    2. Large-eddy simulation of practical automotive flows with near wall modelling (DrivAer, sliding mesh effects, full car geometries, etc.).
    3. Large-eddy simulation of wind energy applications (LES of wind turbine blades and airfoils, LES wind resource assessment, VIV wind turbines, etc.).
    4. Scale-resolving simulations of air pollution in urban environments at micro-scale level.