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Session:

Advanced Numerical Strategy for the Prediction of Unsteady Flow Aerodynamics around Complex Geometries

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One of the future challenges in Computational Fluid Dynamics deals with the ability to simulate quantitatively the physical phenomena driving the multi-scale physics of turbulent flows around complex geometries. Considering this frame, the present work focuses on an advanced numerical methodology named ZIBC standing for Zonal Immersed Boundary Conditions [1,2,3] enabling to account for realistic configurations [4,5,6,7] at high Reynolds numbers. The numerical strategy allowing the coupling between a modelling method (e.g. RANS, URANS, ZDES, LES or DNS) and IBC (Immersed Boundary Conditions) is detailed. In this paper, the modelling method retained is the Zonal Detached Eddy Simulation (ZDES) which has reached a high level of maturity on turbulent separated flows [8,9,10]. Then, the numerical strategy can be applied to complex configurations dealing with internal or external Aerodynamics such as a full space launcher configuration. As an example, Fig. 1(a) illustrates the feasibility to simulate the interactions between the technological details, treated with IBC, and the simplified afterbody, modelled with a body-fitted (BF) approach consisting in classical adiabatic no-slip boundary conditions, in the turbulent flow field surrounding the main stage of the space launcher afterbody. In particular, the ZIBC simulation allows to return the salient unsteady features of the flow field such as the wall pressure fluctuations (see Fig. 1(b)).

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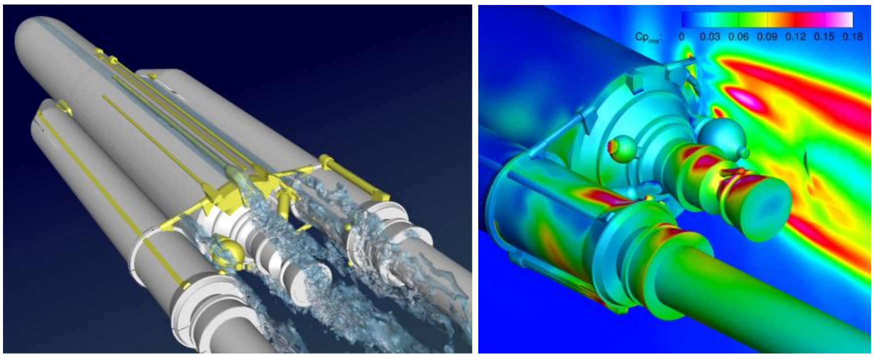

Fig. 1 (**a)** Thick slices of the instantaneous streamwise velocity field of the ZDES simulation around a full space launcher modelled with ZIBC : grey parts (‘clean’ configuration) are modelled with a body-fitted (BF) approach, yellow parts (technological details) are taken into account using an immersed boundary (IB) method. (**b)** Contours of the fluctuating pressure coefficient Cp_{rms} at the wall and in the flow field.

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