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Numerical simulation of a morphing wing of A320 type, through multi-parametric wobulation in the vicinity of the trailing edge in subsonic regimes

Clément Rouaix[1,2], César Jimenez – Navarro[1], Abderahmane Marouf[1,3], Mateus Carvalho[1,2], Horia Hangan[2], Jean – François Rouchon[4] and Marianna Braza[1]

[1] IMFT - Institut de Mécanique des Fluides de Toulouse UMR 5502 CNRS-INPT-UT3, Allée du Professeur Camille Soula, 31400 Toulouse, FRANCE
[2] ACE Climatic Wind Tunnel, Ontario Tech University, CANADA
[3] ICUBE - Laboratoire des sciences de l'ingénieur, de l'informatique et de l'imagerie, UMR 7357 CNRS-Univ.Strasbourg-ENGEES-INSA, Strasbourg, FRANCE
[4] LAPLACE - Laboratoire Plasma et Conversion d'Énergie UMR 5213 CNRS-INPT-UT3,

clement.rouaix@imft.fr

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Bioinspired electroactive morphing around an A320 wing at high Reynolds number in subsonic regime is investigated through vibrations applied in the near trailing edge region. Effects of morphing on the flow and on the aerodynamic performances are studied numerically through the Navier Stokes Multi-Block (NSMB) code as well as experimentally in the S4 wind tunnel of IMFT on the so-called Reduced Scale (RS) prototype of the H2020 N° 723402 EU project SMS:"Smart Morphing and Sensing for aeronautical configurations", www.smartwing.org/SMS/EU, of 70 cm chord and 60 cm span, at 10° of incidence and for Reynolds number of 1 Million. This study focuses on constant actuation frequency and on the modulation of this frequency following a linear evolution over time – hereafter called wobulation. To the knowledge of the authors, wobulation is new in the state-of-the-art in respect of morphing wings. Experiments are led in synergy with numerical simulations using highly sensitive pressure sensors located at strategic positions and enabling to highlight aerodynamic benefits. A large 2D numerical parametric study has been carried out, enabling to target optimal morphing parameters. The actuation frequency is included in the range $f_a = [60 - 568]Hz$ and the amplitude of vibrations is in the order of 1mm. The High Fidelity CFD simulations used the ALE method for mesh deformation and the Organised Eddy Simulation (OES) turbulence modelling approach, [1] sensitized to the coherent structures physically correct development. A thorough understanding of physical phenomena in both constant actuation frequency and wobulation is undertaken. By beneficially manipulating the surrounding turbulence, constant actuation increases mean lift and decreases mean drag as well as aerodynamic sources reduction in specific actuation ranges. Wobulation allowed detection of optimal frequency ranges providing a reduction of the variance.

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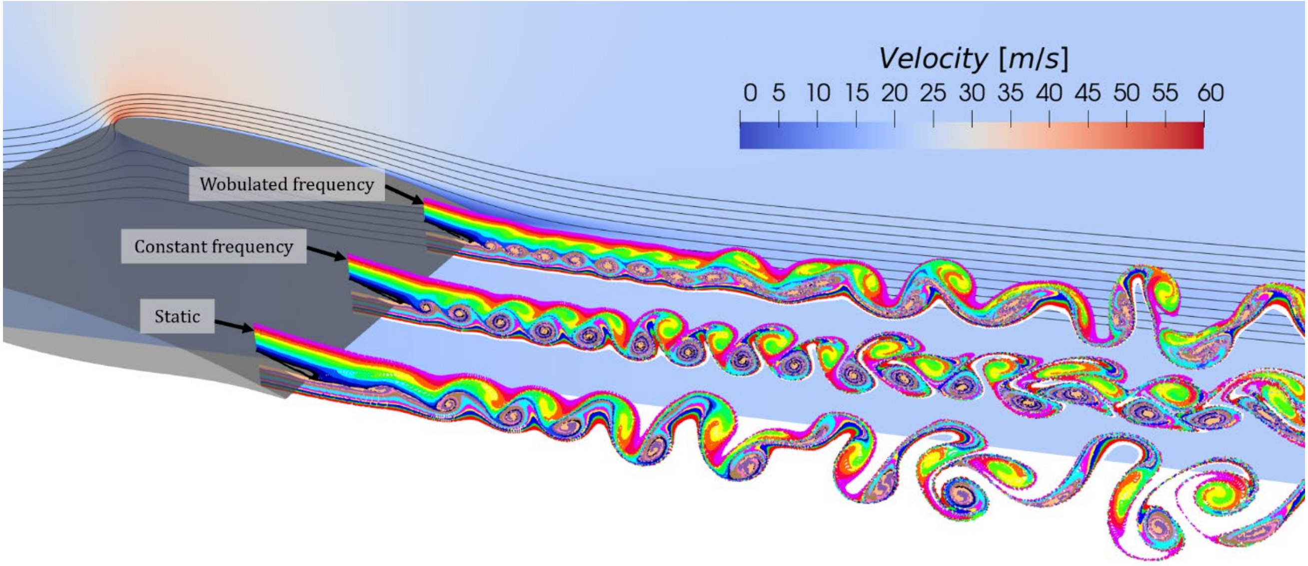

Figure 1 - From simulations : effects of the wobulation on the separated area, the shear layers and the near wake coherent structures. The actuation frequency is in the range $f_a = [80 - 450] Hz$. The static case means no morphing. The constant frequency means a monochromatic vibration frequency. All cases apply a constant vibration semi amplitude of 0.35mm *and a slight deformation of the trailing edge region,* the same as in the experiments.