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IMPROVEMENTS IN AIRFRAME NOISE PREDICTION METHODS

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VALIANT is a Collaborative Project addressing the external noise challenges raised by the development of green aircrafts. The consortium includes the following partners: VKI (Belgium, Coordinator), KIAM (Russia), ECL (France), TUB (Germany), ONERA (France), TsAGI (Russia), NLR (Netherlands), DLR (Germany), CIMNE (Spain), NTS (Russia), NUMECA (Belgium) and LMS (Belgium) [1]. VALIANT focuses on broadband airframe noise (AFN) by tackling both landing gears and high lift devices, which are the two main contributors to AFN of an aircraft at approach. Amongst various other important aspects, the fulfilment of the ACARE objectives involves the improvement of accurate and fast prediction techniques to enable virtual prototyping and shorten development cycles. While previous research programs dealing with AFN, such as RAIN, SILENCE(R), AWIATOR, TIMPAN, CLEANSKY and OPENAIR, studied realistic rather than generic configurations, VALIANT is rather aimed at validating / improving noise prediction tools tested on generic but representative configurations. Having generic configurations permits to establish very complete and accurate experimental databases that can be used for the unambiguous validation of the prediction tools, which is an essential step towards their improvement.

Four specific flow configurations revealing the basic mechanisms of AFN generated by the most relevant elements of a real aircraft are selected in VALIANT for a thorough investigation aimed at validating and improving the broadband AFN predictive tools: gap turbulence interaction, a flap+wing configuration, a slat+wing configuration,and a two-struts configuration (see Figure 1).

The first half of the project was focusing on measurements, especially to obtain the necessary measured data for the simulations, and on the first-pass simulations of state-of-the-art simulation techniques. Since numerical simulations (especially LES and DES) are very sensitive to boundary conditions, some measurements providing these inputs had to be conducted in the early stage of the project to permit a timely start of the simulation work. The second half of the project was focusing the theoretical developments of flap noise prediction, as well as the improvements of the existing tools based on the experiences gained through the first pass simulations. The last part of the project finalized all the developments and demonstrated their effect on the noise predictions.

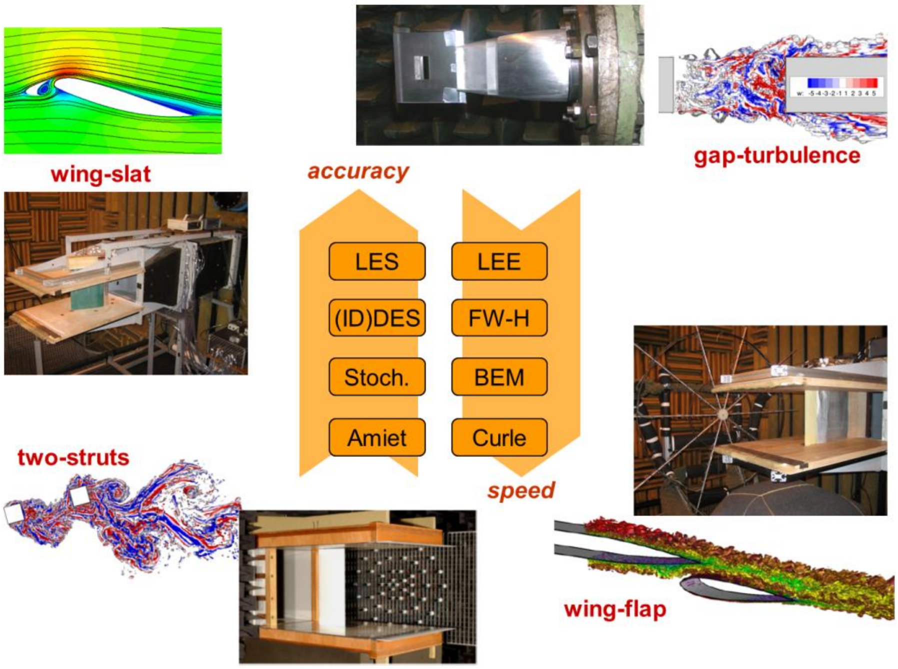

Figure 1: four configurations, experimental facilities and range of modeling approaches developed in VALIANT (pictures and results courtesy of ONERA, TsAGI, ECL, NLR, KIAM and NTS).

One of the key outcomes of the project was the development of specific procedures aimed at permitting the unambiguous validation of the simulations by the experiments. Indeed, in spite of the geometrical simplicity of the selected configurations, achieving a one-to-one comparison is a difficult task due to installation effects or the need to prescribe realistic boundary conditions from experimental data. For the slat case for example, even though the downstream part of the airfoil was de-resigned to minimize the wind tunnel free jet deflection, simulations and experiments were matched using different angles of attack [2,3,4]. Corrections were also brought to account for the refraction of the acoustic waves by the free jet shear layers. For the wing-flap case, numerical as well as semi-analytical models were applied, highlighting the complexity of the mutual hydrodynamic and acoustic installation effects in different wing-flap geometrical arrangements [5].

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