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SIMULATION AND FLIGHT RE-NUMBER TESTING OF HIGH-LIFT SYSTEMS

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A major aim of the EC funded project DeSiReH (Design, Simulation and Flight Reynolds Number testing for advanced High Lift Solutions, 2009-2013) had been the demonstration of a changed design philosophy for high-lift systems aerodynamics targeting directly the real aircraft scale conditions and making use of high-fidelity numerical methods and optimization. The main objectives of the demonstration were to show the benefits of this design methodology in terms of design cycle time reduction and feasibility of the design while avoiding intermediate low Reynolds number investigations both in numerics and experiment, which are usually performed during the design evolution within the present design methodology.

In order to elaborate the overall benefit, a design case was chosen where no previous knowledge on the possible design space and a priori best guess information was available. Providing additional benefits of the project, the design of a high-lift system for a natural laminar flow wing was targeted for the design work. No other baseline information than the clean wing shape and the high-lift performance targets from overall aircraft design considerations were available for the project.

Within the project the consortium performed a complete design cycle, beginning with the concept design and selection based on numerical optimization applying 2D-RANS, feasibility studies regarding kinematics, and finalizing by 3D-RANS based numerical optimization of the complete high-lift wing. Finally the optimized design was realized into a wind tunnel model and the design was verified by high Reynolds number tests in ETW at the targeted real aircraft flow conditions. Accompanying CFD simulations applying fluid-structure coupling and considerations of wind tunnel walls established pre-test knowledge about expectable deviations of free air predictions and measurement data.

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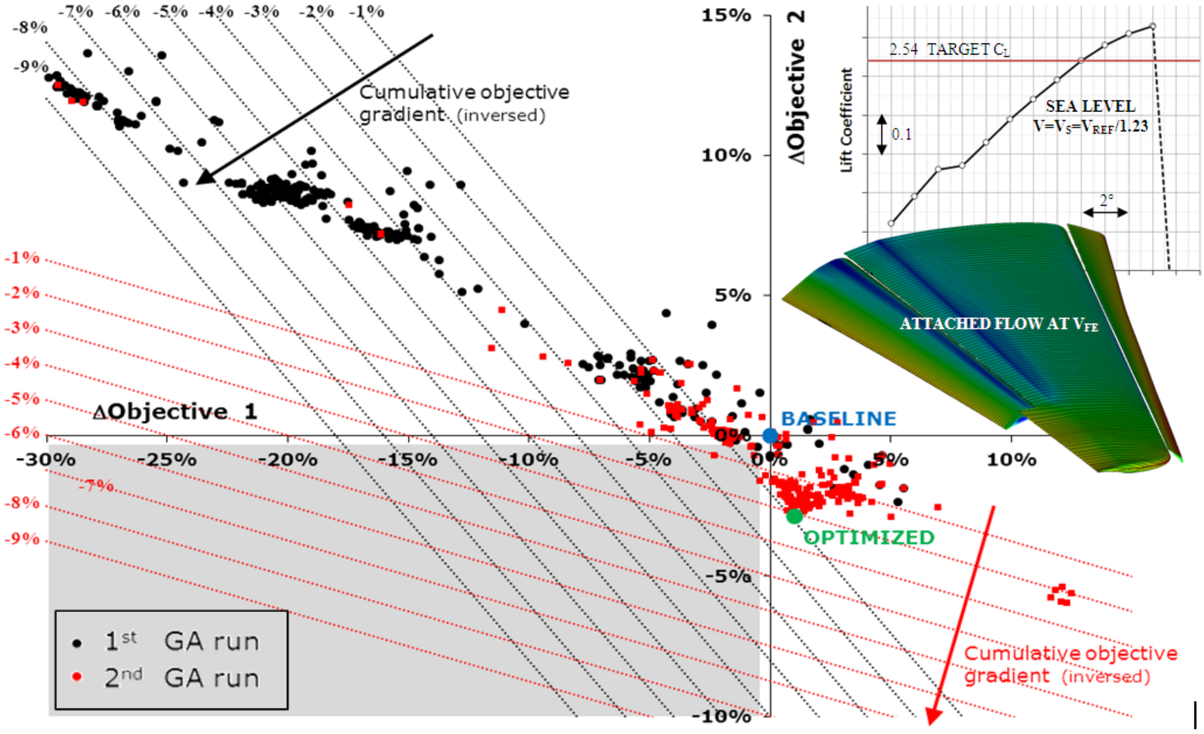

Figure 1: Numerical 3D design optimization of the high-lift system for a natural laminar wing applying genetic optmization algorithm and RANS CFD

Figure 2: DLR-F11-DS21 model mounted in ETW wind tunnel