

## LAMINAR WING MANUFACTURING DEVELOPMENTS AND DEMONSTRATORS FOR VALIDATION

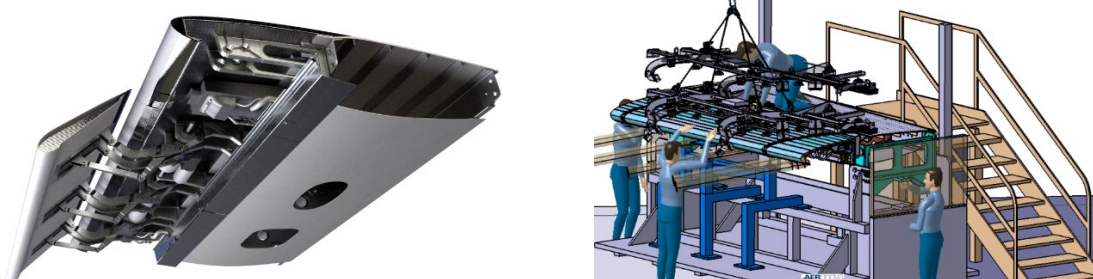
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Aernnova, together with Airbus as industrial leader, and partners within Cleansky 2 (CS2) H2020 (EU 8th Framework Program), is developing ground Hybrid Laminar Flow Control (HLFC) demonstrators. There are studies within LPA (Large Passenger Aircraft) for HLFC application into empennage and wing commercial transport aircraft components. These studies aim intermediate TRL validation through ground structural and functional demonstrators. This contribution provides a summary of the manufacturing trials and demonstrators that are serving for the purpose of HLFC validation up to Technology Readiness Level (TRL) 4 for wings by the end of 2023 and TRL 6 for empennage platforms in selected technologies. The key aspects of these developments are highlighted, together with the associated research and technology developments, in particular in relation to the new design concepts, the related manufacturing processes, their numerical simulations, and final demonstrators. All these aspects are key enablers to achieve laminar flow requirements.



### REFERENCES

- [1] Knörzer J.P., Warsop, C. & Diaconescu, C. (2015). D. G. for Research and Innovation, European Commission Aviation in Europe Innovating for Growth: proceedings of the seventh European Aeronautics Days, 20-22 October 2015, London, UK.
- [2] Mei, B., Zhu, W., Zheng, P. & Ke, Y. (2019) Variation modeling and analysis with interval approach for the assembly of compliant aeronautical structures. *Journal of Engineering Manufacture*, 233 (3) 948–959.
- [3] Chiminelli, A. (2015). Methodology for the analysis of tolerances in the assembly process of a wing torsion box through FE simulations, Simulia Community Conference, May 18-21, 2015 | Berlin, Germany.
- [4] Martín de la Escalera, F. (2017). Methodology for Tolerance Analysis of Assemblies through the Numerical Simulation of the Process By Means of FEM - Smart Fixed Wing Aircraft Torsion Box Analysis,” NAFEMS World Congress, Stockholm, Sweden.
- [5] Bagchi, T. P. & Templeton, J. G. C. (1993) Constrained optimization: An effective alternative to Taguchi’s two steps to robust design. *Opsearch*. 30 (3), 204-222.