

HiLamBiz

High Speed Wind Tunnel Test of a Laminar Configuration Bizjet

State of the art – Background

The “Vision 2020” goals, introduced in 2001 by the European Union, require breakthrough achievements related to drag reduction and propulsion efficiency. Laminar flow technology was identified as a promising candidate to contribute to this objective, as the extended laminar flow region allows a strong decrease in skin friction drag. Laminar flow may be achieved by shape modification (Natural Laminar Flow, NLF) or surface -suction (Hybrid Laminar Flow Control, HLFC).

In the past, a number of flight demonstrators were successfully used in the USA and Europe. Flight tests were selected as they allow full system demonstration at flight Reynolds numbers, which were not achievable in conventional wind tunnels, e.g. the maximum chord Reynolds number in a transition test in transonic flow in the ONERA S1MA wind-tunnel facility was about 10 million. On the other hand, such flight tests were much too expensive to allow for extensive parametric exploration and optimization.

As the ETW cryogenic wind tunnel allows for full model testing chord Reynolds numbers up to 50 million by combining testing at cryogenic temperatures (down to 110 K) and increased pressures (up to 4.5 bar), the European Research project TELFONA, led by Airbus, was launched to demonstrate the use of ETW for NLF wing design validation at high Reynolds numbers.

Objectives

The HiLamBiz project aims to move existing NLF flow control technology up to higher Technology Readiness Levels (TRL) with the overall aim of validation in a flying test bed and subsequent implementation in next generation aircraft. ETW, with its TELFONA background in laminar testing, aims to contribute to these goals by applying and further developing its

associated capabilities. Within HiLamBiz these capabilities will be used to visualise the extent of laminar flow on the wings, to quantify the drag improvements and assess the buffet boundaries of an innovative laminar configuration Bizjet.

Description of work

HiLamBiz covered the preparation and performance of a wind tunnel test using an innovative business jet configuration with two sets of NLF wings and a remotely Controlled HTP.

Model design, manufacturing and instrumentation were supported in order to achieve a high quality model suitable for a test in a cryogenic environment. The wind tunnel was instrumented for performance tests of a Z-sting mounted full model acquiring forces, moments as well as steady and unsteady pressure data.

The transition location on the wings was assessed using the mature cryogenic Temperature Sensitive Paint technique (cryo-TSP), which has been developed and tuned for industrial application at ETW in cooperation with DLR over the last 8 years.

The wing shape was determined with the ETW stereo camera system SPT.

Results

Within the HiLamBiz tests the NLF design of two different wing shapes was validated at flight Reynolds numbers. The full model set-up enabled the assessment of the overall drag improvements achieved by the NLF design. The tests considerably enhanced the knowledge about the sensitivity of laminar flow over the wings at high lift coefficients for cruise Mach numbers. The experimental data acquired during the tests will be used as a unique platform for the validation of modern industrial CFD codes which incorporate prediction of the laminar/turbulent boundary layer transition.

Since the complete chain from model design via manufacturing up to the test performance at flight conditions in the cryogenic environment has been tracked, unique experience was gained regarding the processes to be adopted for future aircraft models as well as real aircraft equipped with NLF wings.

With regard to the wind tunnel the experiences gathered will help to improve both the model preparation and the test procedures for such types of laminar flow investigations and therefore expand the unique competence of the wind tunnel facility.

a) Timeline & main milestones

The test campaign started at the end of September 2015 and was completed after five weeks of testing. Preliminary test results, including TSP images, were delivered directly after the tests. Model deformation results and fully corrected data were delivered two months after the end of the wind tunnel entry.

The main work package definitions and project milestones are defined below:

WP number	Work Package title	Start month	End month
WP 1	Management & Coordination	1	29
WP2	Provision & Support for Model Design, Manufacturing & Instrumentation	21	26
WP3	Test Preparation (Model & Facility)	22	26
WP 4	Wind Tunnel Test Performance	26	27
WP 5	Data Provision & Reporting	26	29

MS number	Milestone	WP number
MS 1	Model accepted for testing	WP 2
MS 2	Model & wind tunnel ready for testing	WP 3
MS 3	Wind tunnel test completed	WP 4
MS 4	Project completion	WP 5

b) Environmental benefits

The development of aircraft with large extents of natural laminar flow (NLF) represents the most promising aspect for a substantial reduction of drag and, hence, fuel consumption for future aircrafts. This test highlighted the potential of major drag reductions for a generic NLF business jet configuration and marks a major contribution towards the achievement of the ACARE 2020 goals.

c) Dissemination, communication and exploitation of results

With regard to confidentiality constraints ETW has released information about this project in its profile list of European research activities which is publicly accessible on the ETW website.

Press releases and an “ETW News” article will update clients and researchers about the project results, which will also be published in papers presented at international conferences.

A video overview was prepared to inform prospective clients about ETW’s enhanced capabilities in the field of laminar flow testing, also indicating the Clean Sky funding for this upgrade. It is intended to publish this video on the ETW website and public video platforms.

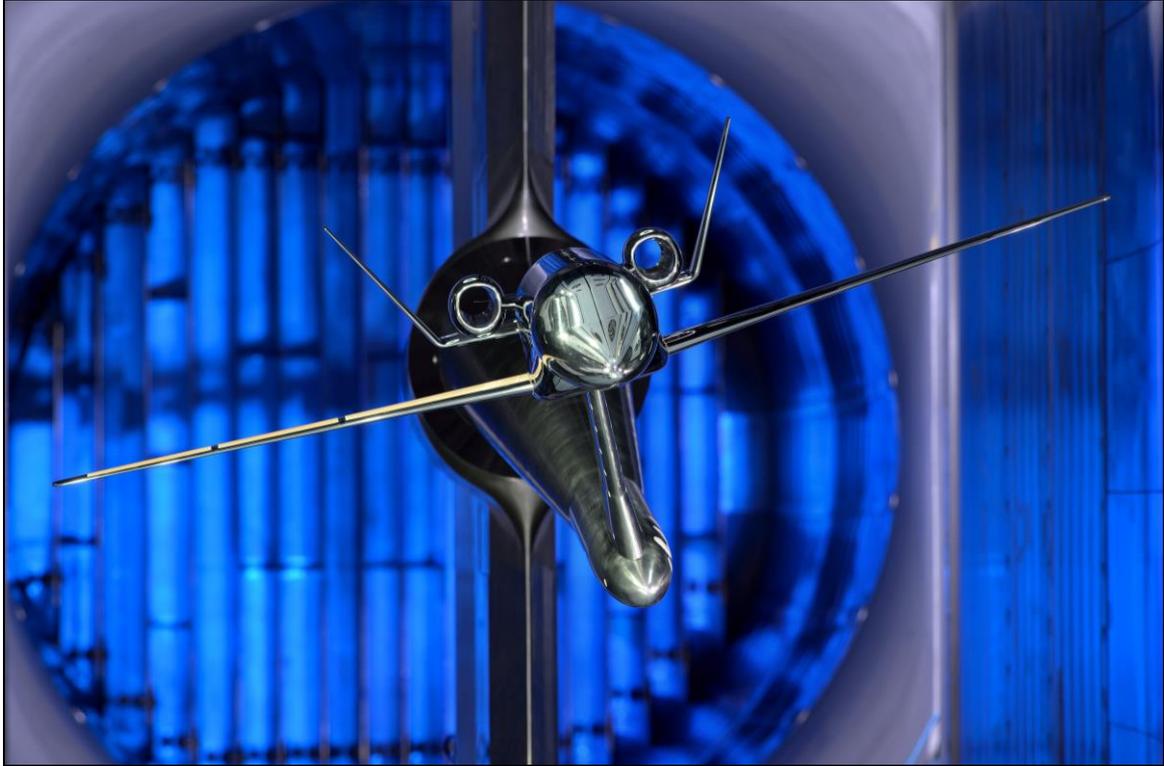


Figure 1: HiLamBiz model in the ETW test section

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Project Summary

Acronym: HiLamBiz

Name of proposal: High Speed Wind Tunnel Test of a Laminar Bizjet Configuration

Involved ITD Smart Fixed Wing Aircraft ITD

Grant Agreement: no 338517

Instrument: Clean Sky

Total Cost: EUR 1 962 900

Clean Sky contribution: EUR 1 472 175

Call: SP1-JTI-CS-2012-03

Starting date: 2013-08-01

Ending date: 2015-12-31

Duration: 29 months

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