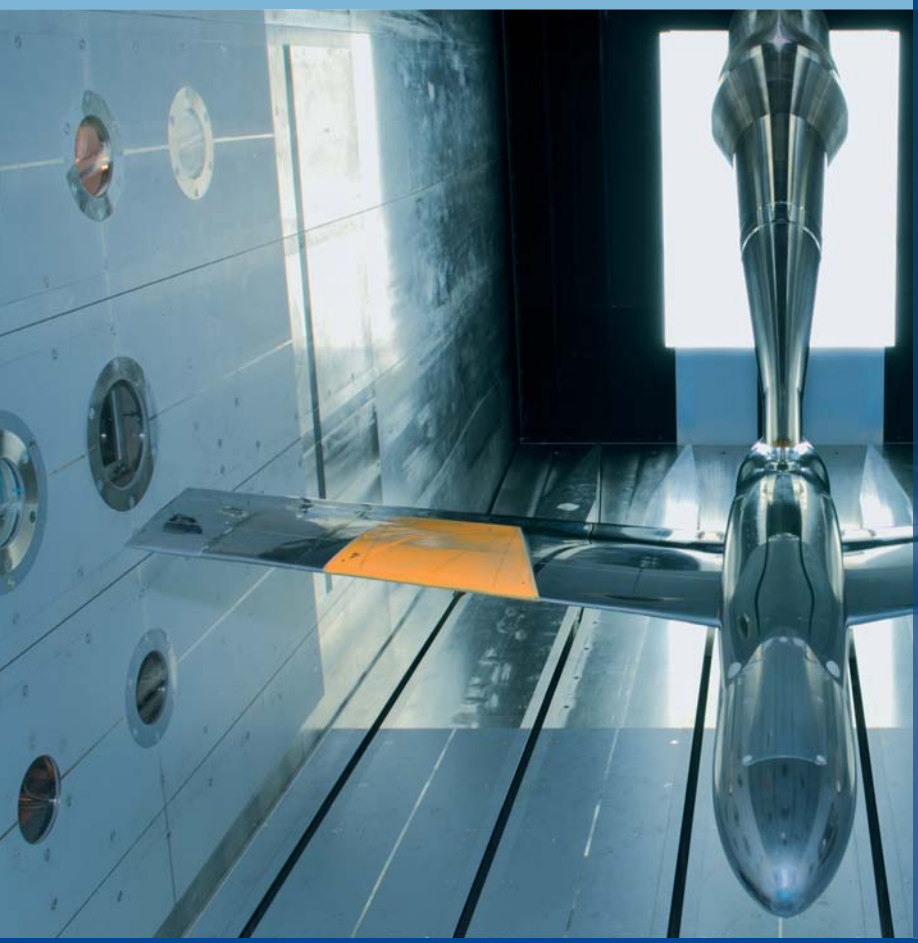
EUROPEAN TRANSONIC WINDTUNNEL

# NEWS 16

MAY 2010



# ETW's new appearance

To mark more than 20 years of its existence, ETW has revised its corporate design. The aim of the re-launch is to standardize the company's image and presentation with an emphasis on the quality of the brand - by the way, in March 2010 ETW has been successfully audited to comply with ISO9001:2008. The new corporate design has been developed by Design Union in Cologne. The capabilities to accurately predict maximum lift, lift breakdown, and drag distinguish ETW from conventional wind tunnels and computer simulations. The visual around ETW´s logo on the front page is meant to indicate this by generic lift and drag polars.

Please visit our new web site for more information, or ask for the new info brochure.

# 01 | LuFo

Research supported by Germany

## Preparing ETW for the Development of the „Green Aircraft“

To react on the environmental challenge to society in time, a prompt revolutionary step in aircraft technology and operation is mandatory. An accelerated technological progress includes radically new aircraft design, significantly improved fuel efficiency, flow control, reduced noise, lighter structures and higher capacity. It requires close cooperation between science and industry using appropriate tool sets such as cutting-edge computational and experimental simulation.

ETW has been operational for 15 years. For ETW to continue to provide the service required by the European society and aeronautics industry with respect to European climate protection targets, it must enhance, expand and upgrade its facilities and add new key capabilities which are relevant for the development of future generations of new low-emission “green” aircraft.

Consequently, ETW is involved in the following projects of the “Luftfahrtforschungsprogramm LuFo”:

### LuFo – ITS (2009-2011)

Development of new test technology for simulation of open-rotor engine concepts in ETW.

### LuFo – Cryo PIV (2007-2010)

The particle image velocimetry (PIV) measuring technique is to be developed and demonstrated for applications under the cryogenic conditions of the ETW.

### LuFo – ALSA (2010-2013)

Development and validation of an innovative non-intrusive measurement system to locate flow separations based on a microphone-array technique.

### LuFo – HINVA (2010-2013)

Detailed comparison of data from ETW and flight testing with Navier-Stokes simulation data for the A320 configuration at high-lift conditions.

### Luftfahrtforschungsprogramm LuFo

The German Government promotes innovation processes in the aviation industry by research and technology funding in the context of the Aerospace Research Programme LuFo from 2007 to 2013.

REGIERUNGonline, 30 April 2008:
“German support is based on the strategic research agenda, Vision 2020, launched by the European aviation industry. The programme aims to reduce the environmental impact of air traffic and to further work on air safety. The German Government is focussing on the following priority areas:

- increasing transport capacity,
- more eco-friendly air travel, safety and passenger friendliness,
- more efficient aircraft, and
- maintenance and servicing.”

“A total of 200 million Euros in funding will be available during the first funding period of the current Aerospace Research Programme, LuFo IV, from 2007 to 2010. A total of around 240 million Euros in funding will be available for the second funding period (2009 to 2012). Another 140 million Euros are to be made available in the third funding period (2009 to 2013).

The new funding will primarily go to projects developing the technological building blocks for climate-friendly air traffic in the future. New projects can fall back on the numerous results produced by previous programmes. The majority of past funding was spent on developing energy-efficient engines and systems, as well as aerodynamic, powerful aeroplanes.“

# 01 | LuFo

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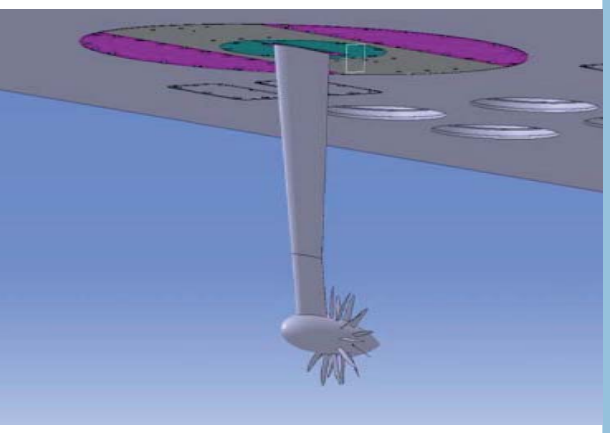
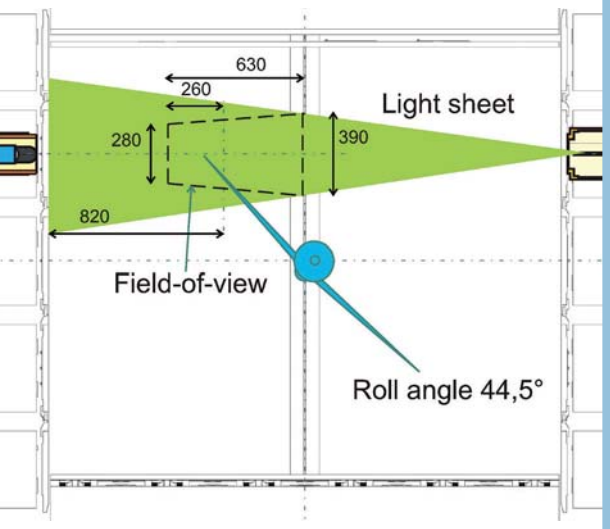


**ITS** - **I**nnovative Konzepte zur **T**riebwerks-**S**imulation

**Cryo PIV** - **Cryo**genic **P**article **I**mage **V**elocimetry




## LuFo – ITS

Innovative concepts for engine simulation ITS is a joint project of the partners machtWissen.de AG and the European Transonic Windtunnel GmbH in co-operation with the Technical University of Darmstadt, the Bremen Centrum for Mechatronik/University Bremen and the Oswald electric motors GmbH, as subcontractors. Future energy-efficient aircraft have the potential to increase fuel efficiency using open rotor engines. One design challenge is the aerodynamic interference between these engines and the airframe. ETW would like to provide support, however a simple adaptation of Turbine Powered Simulators to the cryogenic test conditions is not feasible. Thus, the main goal of this project is a successfully running of a Counter-Rotating Open Rotor (CROR) demonstrator in ETW. The demonstrator will be based on an electric motor, and should be close to a real test application. Since the power density of such motors is limited, the concept will be a balanced compromise between test requirements and available technology capabilities.

## LuFo – Cryo PIV

Detailed validation of numerical simulation for aircraft flow close to reality requires laboratory testing at flight Reynolds numbers, namely ETW testing. Recent developments enable recording of the instantenous velocity fields by means of the PIV technology even at cryogenic conditions. The DLR Institute for Aerodynamics and Fluid Engineering has coordinated the development, preparation and performance of PIV demonstration campaigns in ETW. Complex technical questions, such as the production of tracer particles or special optical devices for highly productive testing under pressurised, cryogenic conditions needed to be solved. Preliminary investigations were performed with different tracer particles in the smaller Pilot-ETW (PETW) compatible with the overall operating conditions. Tests with various seeding systems, and the appropriate installations of the pulse laser light and the recording cameras were performed ahead of the final verification tests in ETW.

# LuFo – ALSA

Up to now at ETW, the so-called mini-tufts technique has been used to show the aircraft designers with a limited spatial resolution where the flow is not further willing and able to follow their designed shapes. ETW and DLR in cooperation with TU Berlin are heading for an innovative, non-intrusive measurement technique which is able to locate boundary-layer flow separation at the flight-envelope limits in high lift and close to the buffet boundary. The acoustic signature of the detached boundary layer is recorded by a microphone array at the wind-tunnel wall. From these measurements the data processing will identify separation locations. In contrast to conventional methods, this new method could be a fixed wind-tunnel installation which is able to be activated on short notice.

**ALSA** - **A**kustische **L**okalisation von **S**trömungs-**A**blösung

# LuFo – HINVA

The design of high lift systems of modern aircraft still significantly depends on wind-tunnel measurements. Within this project, DLR and its partners ETW and Airbus will perform wind tunnel and flight testing as well as Navier-Stokes simulations for a detailed and direct comparison of high-lift performance data. The DLR ATRA (Advanced Technology Research Aircraft A320) and an ETW model with exactly the same flight shape configuration will be tested at identical Mach and Reynolds numbers. Complex installations and simultaneous operation of advanced measurement techniques will provide the basis for an efficient, industrial test arrangement which allows the direct comparison to flight data. DLR and Airbus will cooperate in planning and preparation of the model assembly and measurement techniques, such as Cryo PIV and advanced deformation measurement techniques.

**HINVA** - **Hi**gh-Lift **IN**-Flight **Va**lidation

# 02 | CLIENT TESTING

Business as usual

## Aerion

conducted wind-tunnel tests in supersonic conditions using a Natural Laminar Flow (NLF) wing for performance measurements at full-scale Reynolds number for cruising altitude. Dr. Richard Tracy, Aerion's Chief Technology Officer, who supervised the tests, gave the following statement after the completion of the test campaign: "These were historic tests, demonstrating for the first time supersonic natural laminar flow in a wind tunnel on a wing-like model at full-scale Reynolds numbers. We are therefore unequivocally delighted with the results of these tests". Further statements in Aerion's publications quoted that "ETW is the only facility with the demonstrated low noise level and low free-stream turbulence level needed to assess supersonic natural flow at such high Reynolds numbers". Aerion goals to demonstrate the amount of NLF required to achieve performance on the Aerion SBJ, to validate transition prediction design codes and to qualify ETW as suitable for further NLF work were all achieved by providing excellent test results.

## Airbus

performed test campaigns in low speed test conditions with the A350 XWB to assess performance data for take-off and landing configurations. Test points over the entire test envelope of ETW were covered to distinguish between Reynolds-number and aeroelastic effects due to varying wing deformation. The ETW deformation measurement system was used extensively, not only to measure the twist and bending of the complete wing, but also to assess the actual flap gap dimensions over the entire load range of the model at high Reynolds numbers. In addition important data were obtained on the boundary-layer development of the individual wing components by means of TSP (Temperature Sensitive Paint).

# Bombardier

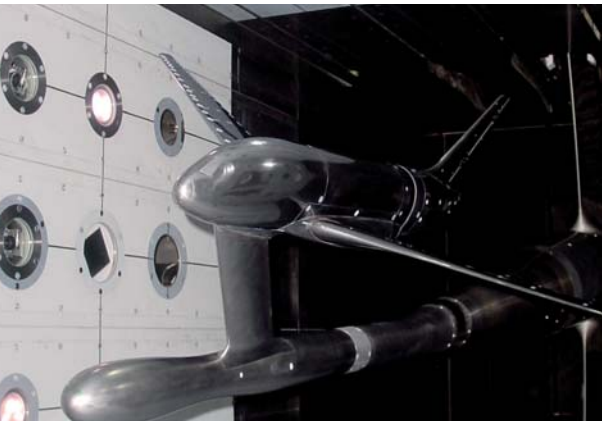
performed a test at flight Reynolds numbers to assess performance of a 4.7% scale model of a twin-engine transport aircraft. The model was designed and manufactured at Deharde GmbH in Varel and equipped with an ETW designed remotely controlled horizontal tail plane, which was successfully operated in the test envelope up to 360 kPa and down to 115 K. This offered a significant increase in test efficiency and productivity. A typical configuration was tested with 6 different settings of the tail plane at low and high speed conditions at flight Reynolds numbers within a 3 hour test run. ETW offers individually adjusted concepts of the remotely controlled system for horizontal tail planes even for sting supported models. The remote control indexing mechanism allows testing at high aerodynamic loads with stable tail plane positions over the complete temperature range of ETW. Using a resolver at the motor drive unit and a separate inclinometer the control of the positioning was achieved with high accuracy.

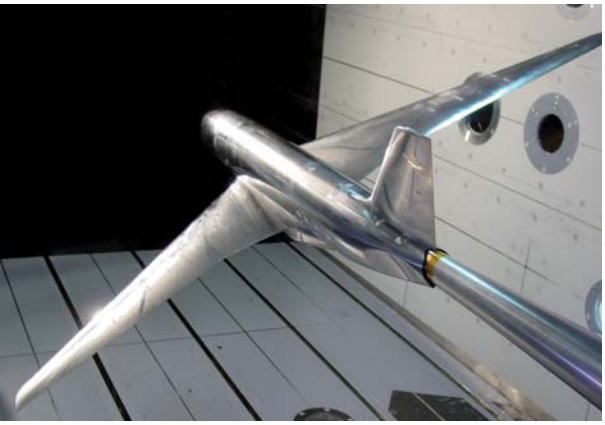
# Gulfstream Aerospace Corporation

performed a test campaign with a 9% scale GVI half span model to acquire performance data at both low and high speed conditions, using the complete tunnel test envelope. Model design and manufacture for the test assembly with high speed and high lift wings was performed at Tri Models Inc. in Huntington Beach, US. The test campaign was performed with high levels of productivity, especially using the advanced tunnel control for achieving the most efficient set point changes during the extensive Mach series. Using maximum power and injection capabilities of the facility a very precise and short duration of set point achievements are prerequisites for attaining maximum efficiency. Taking into account the ETW standards on excellent data quality the Client was very impressed not only with data quality and productivity achieved, but also with the professional team work experienced at ETW: “Best in industry”.

# 03 | FLIRET

**FLI**ght **RE**ynolds Number **T**esting





14 partners from aviation industry and research institutions/universities located in 7 European countries have as an international consortium advanced the accuracy of performance measurements at flight Reynolds number in pressurised cryogenic testing conditions. This specific research project was funded under the Sixth Framework Programme of the European Commission. Flight Reynolds number wind-tunnel tests are indispensable for predicting the aerodynamic performance of new aircraft designs. In order to produce realistic results the test has to guarantee an optimal similarity to the real flying aircraft. ETW can perform such tests creating the Reynolds numbers needed for a realistic simulation of medium to large sized aircraft. The high quality flow conditions provided in the test section require extremely accurate testing tools for the aerodynamic measurements using the most advanced model supports.

## Objectives

The major objectives of FLIRET were:

- Improved quality of aircraft performance prediction
- Advanced design rules for wind-tunnel model-mounting devices
- Improved scaling / data correction procedures
- Understanding of flow phenomena
- Understanding the impact of model-mounting devices.

The project focuses intentionally on model-mounting techniques under cryogenic conditions. Model-mounting devices have a significant influence on high Reynolds number performance measurements, which are currently compensated by using experimental correction methods.

10 test campaigns were performed during February 2005 to July 2008 defined within the following three Work Packages managed by its leading partners: WP 1: Dassault - Advanced Model Supports, WP 2: Airbus France - Buffet Onset at Flight Re, WP 3: DLR - High Lift at Flight Re.

## Conclusion

The efficient cooperation of 14 European partners led to an improved understanding of support interference effects at flight Reynolds number testing. Using advanced CFD tools new or modified support systems were designed and validated at ETW. Their application provides an enhanced capability ensuring the confidence of tunnel to flight comparison at reduced costs.

# 03 | TELFONA

**TE**sting for **L**aminar **F**low **O**n **N**ew **A**ircraft

The 2020 Advisory Council for Aeronautics Research in Europe ACARE targets present a challenge to the aircraft manufacturers to reduce CO2 emissions through engine efficiency and aircraft design improvements. A "pro-green" aircraft configuration has been proposed that has a significantly higher aspect-ratio wing and lower wing sweep than today's standard designs. The wing is designed for natural laminar flow (NLF). Such a wing could enable 20% wing drag reduction compared to today's designs.

The main objective of TELFONA was to demonstrate the ability to predict NLF aircraft performance in flight based on wind-tunnel tests and CFD results. This capability will allow industry to validate the design of such an environmentally friendly aircraft concept.

The first phase of this project involved the calibration of laminar-to-turbulent transition prediction methods for the ETW facility. This was done using a new wind-tunnel model with a wing shape especially designed for this calibration activity. This wind-tunnel model is known as the TELFONA Pathfinder model.

The second phase of the project consisted of the design and wind-tunnel test of a NLF wing for a large commercial aircraft. This model, known as the TELFONA Performance model, has been used to validate the predicted benefits of the pro-green aircraft concept.

In addition to these two main activities, a number of supporting activities were also undertaken. These included the development of new measurement techniques for the ETW facility, the development of advanced transition prediction methods and the modification of existing performance prediction methodologies to account for laminar flow.

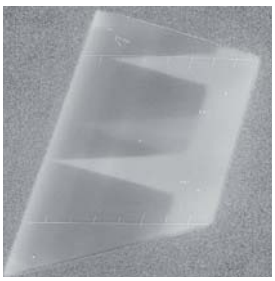
The TELFONA consortium consisted of 17 organisations from 9 different European countries whose researchers had significant experience in the areas of wing design, laminar flow technology and wind-tunnel testing.

The project was structured into five technical work packages and a dedicated work package for project management and exploitation activities.

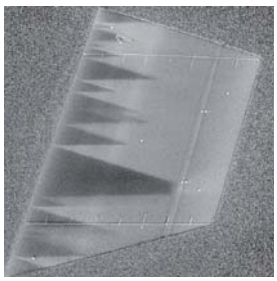
The project objectives have been achieved in two major ETW test campaigns, using a Pathfinder and a Performance Model. Thorough evaluation of the high quality flow characteristics of ETW provided the solid basis for future developments, although disturbances still occurred due to attachment of micro particles at the wing leading edge generated by the Solimide foam of the facility. The lessons learned led to ETW introducing dedicated "laminar testing procedures" including adopted clean-room procedures in certain parts of the facility. Further improvements such as a Solimide protection coating are in preparation.

The results achieved provided aircraft manufacturers within TELFONA confidence that the flight performance of such a new aircraft can be predicted prior to aircraft project launch.

$Re_\infty$ = 10mio | $T_0$ = 175K



$Re_\infty$ = 18mio | $T_0$ = 117K



$Re_\infty$ = 23mio | $T_0$ = 117K

# 04 | FURTHER NEWS

ETW Internal

## 04 | 01
## Keeping healthy at ETW

All engineers know how stressful and demanding a wind-tunnel test campaign can be. This is in particular true for a high-productivity facility such as ETW. Consequently, ETW is keen to support Clients and Staff in their efforts of healthy living: Being physically active is one of the most important things one can do to improve health.


Physical activity is linked with many positive benefits, including lowering the risk of early death and a number of chronic diseases and conditions. It is widely recognised that some physical activity is better than none, and both endurance and muscle-strengthening activities are beneficial. This is why ETW has recently provided a Gym for Client and Staff usage. The use of the Gym is at own risk, and the users are advised to seek medical advice and appropriate instructions before using the equipment. If you have trained enough and enjoy running, you may also join our marathon team, who achieved rank 55 of 295 during the 10th Bonn Half-Marathon in April 2010.

In a move to improve survival rates for cardiac arrest a series of portable automated external defibrillators (AEDs) have been installed close to the Main Tunnel Control Room (MTCR) and in the tunnel building. The ETW First Aiders have been trained in cardiopulmonary resuscitation (CPR) and operation of the AEDs. However, the installed devices may also be used by non-trained people. If an individual suffering a heart attack is treated within three minutes with the AED followed by CPR, the recovery rate is better than 70%. ETW hopes that this will make Clients and Staff feel even safer during their stay at ETW.

## 04 | 02
### 4th Truck for Nitrogen Supply

In March 2010 a 4th truck for nitrogen delivery from the supplier entered into service. Based on this investment ETW is now able to continously provide Clients with up to 3,600 tons of liquid nitrogen per week.

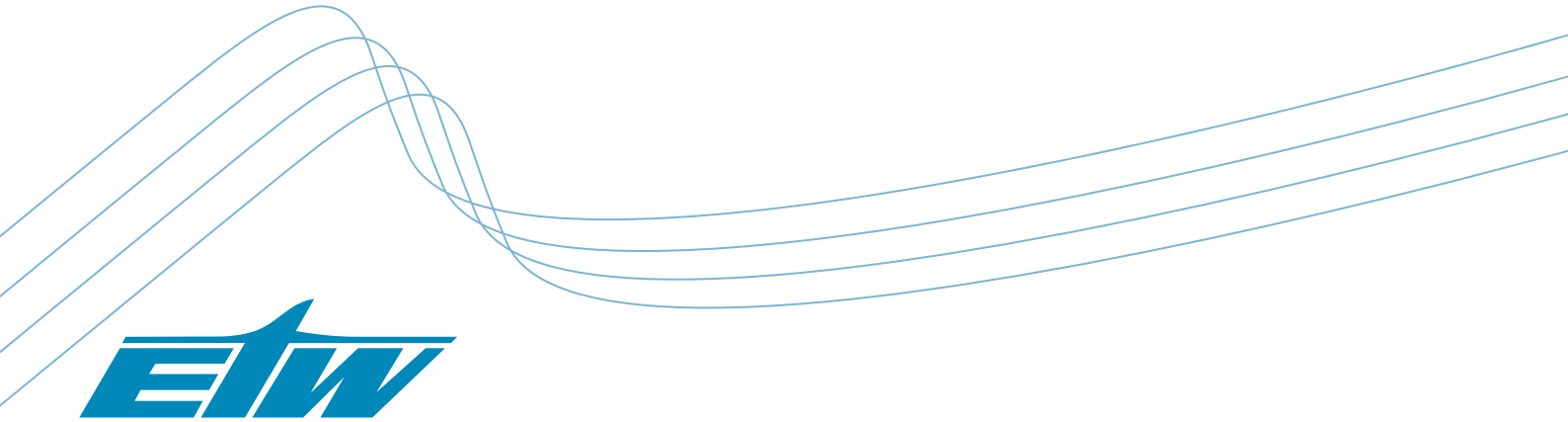

## 04 | 03
### Encouraging young talents

No one can deny the importance of encouraging talented young engineers to get used to future-oriented tools and processes. This is why ETW continuously cooperates with European universities, and offers opportunities to perform a bachelor or master thesis. Recently, C. Deters conducted a promising Hybrid Laminar Flow Control HLFC test in PETW using a 2D airfoil model encorporating a suction area designed by A. Vree, another student. Using a sintered material together with controlled levels of suction the laminar-turbulent boundary-layer transition could be displaced downstream over a range of cryogenic conditions.

## 04 | 04
### ETW/NLR cooperation on Smart Cryo Wind-Tunnel Models

The national aerospace research institute of the Netherlands NLR and ETW signed a cooperative agreement on advancing Smart Cryo Wind-Tunnel Models. For many years NLR has been involved in the design and manufacture of complex, high precision models for wind-tunnel tests at ETW. This service is provided within the European Cooperation on Cryogenic Models E2CM together with DLR (Germany), and ONERA (France). The combined design and workshop facilities and manpower of the three institutes with over 100 staff guarantee competitive model lead-times as low as 5 months whilst maintaining the highest levels of quality.

NLR and ETW are now heading to equip these models with robust micro-mechanics for providing remotely controlled (R/C) control surfaces such as rudders for testing at flight-Reynolds numbers. Both partners are determined to increase by Smart Cryo Wind-Tunnel Models the quality, efficiency and productivity of close-to-reality wind-tunnel tests at ETW even further.



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