AFLoNext

2ND GENERATION ACTIVE WING

NEWSLETTER °2

September 2014

Welcome to the second newsletter from the AFLoNext project!

AFLoNext gathers forty European partners from fifteen countries for a period of four years, until May 2017. Our fundamental goal is to mature highly promising flow control technologies and to show their potentials for advanced eco-efficient aircraft design.

Our public newsletters will regularly keep you up-to-date on progress made within AFLoNext. Whats' more, you will be given a possibility to discover how the consortium partners cooperate to achieve the project objectives. You will also find out how and when we disseminate the AFLoNext results. This is in case you feel like meeting with us!

A WORD FROM THE COORDINATOR

Dr. Markus Fischer, former AFLoNext coordinator, has left the project coordination to discover new horizons within Clean Sky 2. It is with great pleasure and eagerness that I take over AFLoNext to lead it to success with collaboration of all consortium partners. Our AFLoNext adventure has been lasting for over a year now. During this time, we have established a good team spirit and cooperation practices. This has let us go forth and obtain first encouraging results.

In this second issue of our newsletter, you will find feedback from the AFLoNext first Review Meeting which took place in June. You will further get to know how the work progressed within the project work packages. The "Get together" section will inform you about the upcoming major events to take place in the aeronautics field. Last but not least, the interviews will let you discover the day-to-day life of the people involved in achieving the AFLoNext goals.

I wish you all a good reading!

Dipl.-Ing. Martin Wahlich
Flight Physics Research and Technology
Airbus Operations GmbH

News & Events

AFLoNext initial video has been released >> See video

ILA 2014

AFLoNext was promoted during the ILA Berlin Show 2014. DLR displayed, among others, the test vehicule in AFLoNext.

>> Read more

ECCOMAS 2014

AFLoNext was promoted via a video, presentations and leaflets at the large European event involving the 11th World Congress on Computational Mechanics (WCCM2014), the 5th European Conference on Computational Mechanics (ECCM V) and the 6th European Conference on Computational Fluid Dynamics (ECFD VI).

>> Read more

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FEEDBACK FROM THE FIRST ANNUAL REVIEW MEETING

Figure 1 – The AFLoNext consortium during ARM1

The first AFLoNext Review Meeting took place on 11-13 June 2014 in Tel Aviv, Israel. The Review Meeting was hosted by the partner Tel Aviv University and gathered 49 consortium participants as well as the AFLoNext Scientific Officer, the Reviewers and the Advisory Board members. The meeting was a perfect occasion to present and discuss the project progress and major achievements. One of the outputs of the meeting was valuable feedback and recommendations concerning the future steps provided to the partners by the Reviewers.

WORK PROGRESS WITHIN THE PROJECT

HYBRID LAMINAR FLOW CONTROL

The work package “Hybrid Laminar Flow Control” (HLFC) aims a highly efficient and integrated HLFC design applied on fin and wing. The engineering feasibility of this design is demonstrated by flight test for the fin case and by means of large scale testing for the wing.

The main objectives of this technology for the last twelve months were mainly the definition of the requirements for a simplified HLFC system for the A320 VTP. The final chamber layout of the system will based on the results of the ongoing computations with respect to the cases for the relevant side slip angles, rudder deflection angles and HTP setting angles.

Furthermore, aerodynamics has started to work with preliminary pressure distribution to define the surface smoothness requirements. Within the next period, a consolidation of the different structural concepts will be done in order to propose a simplified structure for the HLFC system, which can be produced with less manufacturing effort.

The initial design phase has been reached by completion of the preliminary design of the monitoring and measuring system.

Amongst others, the work on the application of simplified HLFC to the leading edge of a wing has been started. The initial geometry for an outer wing of a long-range aircraft is finalized and the design of a combined suction and de-icing system which respects the space allocation requirements for the Krueger high-lift system has started. The work on the high-lift system has progressed well and the partners have developed two Krueger systems with the same aero requirements but different kinematics. One of the Krueger systems will be selected and further developed within the project.

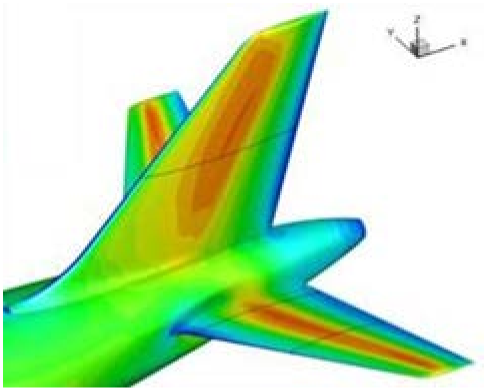

Figure 2 - A320 VTP

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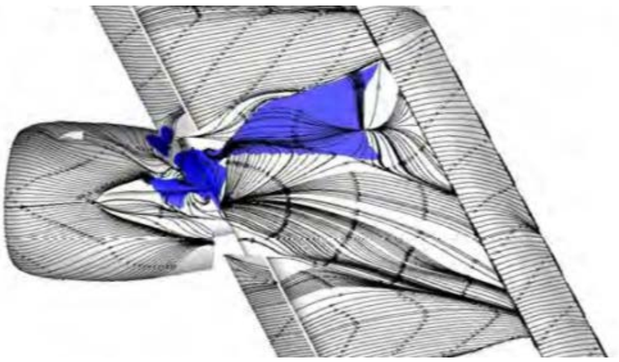
ACTIVE FLOW CONTROL ON AIRFRAME

Novel aircraft configurations and wing designs are always a compromise. As a result, certain high-speed or low-speed/high-lift configurations offer room for improvement. Here, we want to give the focus to local separated areas in the high-lift configuration: at the wing/pylon junction when integrating upcoming Ultra High By-pass Ratio "UHBR" engines, and at the outer part of an "aggressive" wing-tip in the vicinity of the missing slat. Figure 3 illustrates the computed flow topologies in these two areas, respectively.

In order to open the design space, the AFLoNext work package "Active Flow Control on Airframe" is investigating different **A**ctive **F**low **C**ontrol (AFC) technologies such as: pulsed jet with net mass flux, pulsed jet without net mass flux (i.e. synthetic jet) or suction & oscillatory blowing actuators.

The first year of the project was dedicated to the definition of the baseline configuration, the aerodynamic characterization of the baseline flow (cf. Fig. 3) and some first actuator integration studies. As a preparatory step for the latter two aspects, industrial requirements were provided in the first months of the project. Comprehensive numerically studies will help to complete these requirements in terms of optimal actuator characteristics (position, hole, slot, flow rate, pulsed frequency…) in year 2. Besides, the preparation of laboratory ground tests devoted to the assessment of AFC actuators robustness in harsh environment and of wind tunnel tests to assess the aerodynamic efficiency of such actuators is on-going.



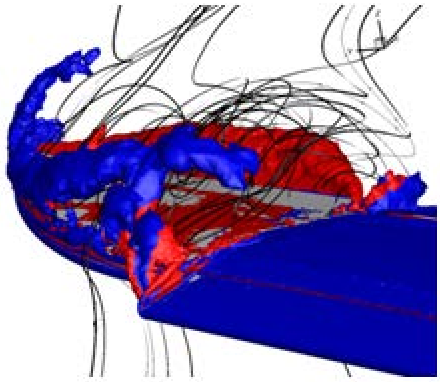


Figure 3 - Computed Flow Topology: left) wing-pylon junction with integrated UHBR engine; right) outer wing part in the vicinity of the leading edge.

CONTROL MEANS FOR VIBRATION AND AEROELASTIC COUPLING

On the Computational Fluid Dynamics (CFD) side, the aircraft, landing gear, cavity and door geometries have been successfully cleaned-up. Steady computations have been performed by most partners and first unsteady results are also already available. Two landing gear positions have been defined, one fully extended and one with the main landing gear bogey in the vicinity of the inboard main landing gear door. Two flight conditions have been defined, representing a typical landing and take-off case. The unsteady simulations will cover configurations with and without the nose landing gear, in order to determine the influence of the nose landing gear on the main landing gear inboard door vibrations. The first available unsteady results are for the configurations without nose landing gear and show low levels of unsteadiness. This suggests the nose landing gear to have significant contribution to the door vibration.

The FE community has performed first calculations to ensure model conformity over all partners. Close cooperation is ongoing between the CFD and Finite Element (FE) community to ensure a smooth transfer of results.

The planning of the Ground Vibration Test (GVT) and Flight Test (F/T) is succeeding with the Flight Test Instrumentation (FTI) being completely defined. The GVT will most likely be performed in January 2015.

Several designs for the monolithic nose landing gear door have been assessed and close cooperation with Airbus has been established to ensure a smooth certification of the new door for flight.

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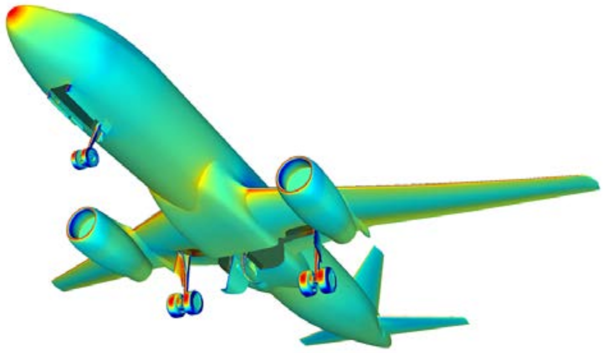

Figure 4 - Distribution from a steady RANS simulation performed by the partner Kungliga Tekniska Hoegskolan.

NOISE CONTROL ON AIRFRAME

Within the preparation of landing gear and flap side edge related noise reduction technology for the AFLFoNext flight test, three important results were achieved. The first one, and the most interesting from a scientific point of view, an acoustic wind tunnel test on flap side edge noise was conducted by EADS-IW, Airbus and DLR in the Acoustic Wind Tunnel Braunschweig of DLR. The scope of this test was to identify the major noise sources on a realistic Airbus A320 type flap side edge and to define certain design criteria of porous treatments for noise reduction. On basis of the acquired noise data it turned out that apart from pure side edge noise the fish mouth and certain whistling cavities are the major noise sources to be tackled for the flight test. Furthermore, it could be demonstrated that the spanwise extent of a porous side edge treatments should be in the order of 50% of the maximum flap thickness. With respect to the flight test preparation these wind tunnel results are of particular importance since they helped to define all necessary design constraints for the porous flap side to be tested in flight.

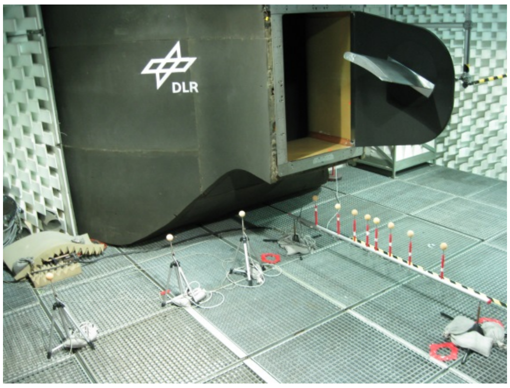

Figure 5: Flaps Side Edge Noise Test Setup in AWB

MULTIFUNCTIONAL TRAILING EDGE CONCEPTS

There is an increasing need to maximise the aerodynamic performance of the wing over the entire operating envelope. Small changes to the flow at the trailing-edge of the wing can significantly affect the flow over the whole of the wing. The multi-functionality of trailing-edge flow devices are expected to generate benefit to the aircraft once cost, weight, power, maintainability and reliability considerations have been resolved. Recent developments in a number of miniaturisation technologies and the associated manufacturing techniques also mean that it is now becoming possible to package a flow control actuator and its support equipment into the limited space available at the trailing-edge region of a wing.

To support the project objectives, AFLoNext work package “Multifunctional Trailing Edge Concept” is undertaking an appraisal and analysis of multi-functional trailing-edge device (TED) flow control systems with the aim of reaching TRL 2 for the most promising concepts so that they can be further matured in future projects.

An initial numerical analysis is being conducted to study the potential aerodynamic benefits of a variety of trailing-edge devices to achieve micro-circulation or buffet control such as fluidic Gurney flaps. This will enable us to determine the key design and performance requirements of such devices. This numerical analysis is based upon baseline data from the previous EC project ‘AVERT’. This baseline data has been validated and published by ONERA in a technical note to the partners, and used to produce a number of test cases which forms the framework of the numerical analysis. So far, the results look promising with a reasonable correlation seen for the 2D test cases.

We are also performing an experimental evaluation and technology demonstration of two different TED concepts. Work has been started on the design of an aerofoil tile to house a matrix of flow control actuators that will be laboratory benchtop tested later in the project.

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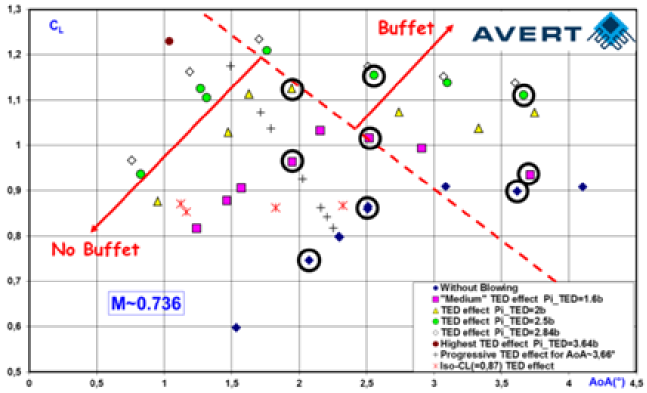

Figure 6: 2D Test cases

Figure 7: Experimental airfoil in assembly process

GET-TOGETHER

The full list of scientific and technological events related to the AFLoNext research areas can be found on our website. Don't hesitate to inform us of any event likely to interest the members of the AFLoNext community.

ICAS 2014 — 7-12 September 2014

ICAS, the International Council of the Aeronautical Sciences, organizes every two years an International Congress covering all aspects of aeronautical science and technology and their application to both military and civil aviation. The ICAS 29th Congress will take place for the first time in Russia, in Saint Petersburg. We have the pleasure to announce that one of the AFLoNext partners, TsAGI, is the organizer of the ICAS-2014. Source: http://www.icas2014.com/

EASN WORKSHOP ON FLIGHT PHYSICS — 27-29 October 2014

The 4th EASN Association International Workshop on Flight Physics and Aircraft Design will take place in Aachen, Germany. Source:http://workshop.easn-tis.com/

ACARE / DGLR CONFERENCE — 4-5 November 2014

The European Aviation Technology Convention will take place on 4-5 November 2014 in Berlin, Germany. Source: http://www.acare2014.dglr.de/

INTER.NOISE — 16-19 November 2014

The 43rd International Congress on Noise Engineering will take place on 16-19 November 2014 in Melbourne, Australia. Source: http://www.internoise2014.org/

DAGA 2015 — 16-19 March 2015

The 41st conference for on acoustics will take place on 16-19 March 2015 in Nürnberg, Germany. Source: http://www.daga2015.de/en/

CEAS 2015 — 7-11 September 2015

The 5th CEAS Air & Space Conference 2015 will be a joint event combining the 5th CEAS (Council of European Aerospace Societies) Air & Space Conference, the 12th European Workshop on Aircraft Design Education (EWADE) and the 5th Air Transport and Operations Symposium (ATOS). Source: http://www.ceas2015.org/

INTERVIEW

AFLoNext newsletters offer you the possibility of getting to know some of the project partners a little better… Thus, the Interviews section will let you discover the day-to-day life of the people involved in achieving the AFLoNext goals.

In this edition of the AFLoNext Newsletter # 2, we propose you three tags which will lead the interview: **Hybrid Laminar Flow Control (HLFC) - Permit to fly - Computational Fluid Dynamics (CFD)**.

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DR.-ING. HEIKO VON GEYR

Head of Transport Aircraft Department, German Aerospace Centre (DLR)

Q1: The consortium has been working on specification of sensors of the **HLFC** Verification System. Could you please describe us the strategy followed for selection of the sensors? Which parameters have been taken into account?

A1: The HLFC Verification System (HVS) will be an autarkic measurement system required to record all sensor data and transmit selected sensor data to an in-flight data monitoring system installed in the cabin during flight test (F/T) which allows the assessment of the functionality of the HLFC-system. We will measure chamber pressures and temperatures, pressure and temperature in the pressure duct as well as the humidity in each chamber and in the pressure duct. The identification of appropriate sensors depends on the requirements with respect to environmental conditions, expected data accuracy, geometrical size of the sensors as they have to fit into the HLFC-structure, as well F/T qualification issues, etc. The selection process naturally starts by completion of the sensor requirements and specifications. From here we screen available sensors and defined related system architectures. As not much space is available inside the HLFC-suction system, sensor size and robustness by maintaining high accuracy and responds times equivalent to specifications had been the main challenges. Especially the humidity sensors gave us some headache but promising sensor candidates have been identified. However, we will have a HVS which will record and transmit data during flight test as specified but can be extended in future for HLFC-system control, but this is not subject of AFLoNext. The HVS allows us to compare the measured status of each suction chamber and the pressure duct with the predicted status at the current operating point of the system. Icing, chamber blockage, leakage etc. can be identified during F/T which allows almost instantaneous corrections, for example of the flight path in case of indicated risk of chamber icing. Besides these scientific benefits the HVS will save time and budget in F/T.

Q2: Several partners have been involved in the F/T coordination in order to prepare the ground for obtaining the **"Permit to fly".** How is the consortium setting up the appropriate roads towards the Permit? Could you present the stakes of this planning and the necessary coordination amongst the workpackages?

A2: The F/T will be performed on the DLR A320 ATRA (Advanced Technology Research Aircraft) with DLR as operator of the aircraft. As the Flight Tests covers experimental modifications across three work packages involving a lot of different partners contributing to flight test instrumentation and other hardware as the HLFC-system, Nose landing gear door, etc. the procedure for F/T qualification had to be identified and consolidated among the partners and the responsible design organization of the aircraft operator. The size and constitution of the F/T-team is challenging especially considering that not all partners do have an airworthiness design organization which requires a precise definition of the root to "Permit to fly", but we are on good track.

Q3: A **CFD** grid generation has been successfully performed. What was the objective of performing this grid generation? What results did it produce? How will the results be useful for the project activities?

A3: Now, the aerodynamic design of the HFLC system will lead to a target suction velocity distribution sufficient to achieve the desired downstream shift of the transition at a minimum required suction power. To achieve this goal the pressure distribution and boundary layer development on the vertical tail plane (VTP) and its dependence on horizontal tail plane (HTP) -setting angles within the HLFC operation envelope has to be known precisely. The flow field at the VTP is influenced by several parameters such as the aircraft configuration, the HTP trim angle, angle of attack, side slip angle, engine settings, etc.. Hence, we perform numerical simulations of the complete flight test aircraft within the complete HLFC-envelope at various flow conditions and parameter settings of the aircraft. The results serve further as input for the structural design activities of the HLFC-system. Structural displacements are passed back into the aerodynamic analysis resulting in new aerodynamic loading of the VTP which will be brought to convergence. The CFD-data are further used to design the anti-contamination-device installed at the first leading edge segment of the VTP. Boundary layer stability analysis including optimized suction velocity distributions will be analysed for transition predictions a priori to the flight test. So we will have pre-calculated test data for flight test to directly compare test data with predictions. This will not only answer the question of the level of functionality of the HLFC-system but will give us clear validation of our design methodology, applied processed and tools. As it is clear that the real flight test points might differ from the pre-calculated test data points (w.r.t. side slip angle, rudder deflection angle, Reynolds number etc.) the grid generation is done in a way, that grid deformation techniques can be applied to set HTP trim angle and the VTP rudder deflection angle. With this methods all generated grids are of the same "family" which allows the setup of Reduced Order Models (ROM). The ROMs enable us to identify the CFD-solution even an intermediate CFD-point between the computed ones to match flight test data as close as possible. This technique allows us to rapidly post-process flight test data close to real time with respect to predicted and detected transition locations. This is an advantage for flight test as corrections to the flight test points can be applied during the flight test almost instantly which saves costs and time.

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