Smart Fixed Wing Aircraft
Integrated Technology Demonstrator

Publishable Progress Report

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Content

1 Introduction

This progress report of the Smart Fixed Wing Aircraft Integrated Technology Demonstrator (SFWA-ITD) covers the 2013-activities respectively year 5 of SFWA-ITD.

SFWA ITD focusses on developing, integrating and testing technologies required for the industrial realisation of the smart laminar wing and the integration of the counter-rotating open rotor (CROR) into future highly fuel efficient commercial passenger aircraft. Both, natural laminar flow wing and CROR, stand for significant fuel saving technologies. An up to 35% fuel saving potential is predicted for the combined application of the advanced wing and CROR based on a year 2000 reference. Reaching a Technology Readiness Level of 6 is targeted for most of SFWA-ITDs key technologies. In SFWA-ITD the smart laminar wing will be demonstrated in an A340 flight test (BLADE demonstration)

The organisation of the technical work in SFWA-ITD is given by the work break down structure shown in Figure 1. It was established at the operational start of SFWA along three major work packages, namely Smart Wing Technology, New Configuration and, subsequently, Flight Demonstration. Each workpackage is led by an aircraft manufacturer with a strong interest in the know-how produced.

The development of the CROR core engine is done the SAGE-ITD of the Clean Sky Joint Undertaking while SFWA-ITD focusses on the outer aerodynamics as pylon and cowling and rotor of CROR. The rotor/propeller is traditionally developed by the airframe manufacturer.

For guiding the technical work performed in the workpackages nine SFWA Technology Stream leaders have been identified who guide the approach taken along the roadmaps defined as described in the following chapters.

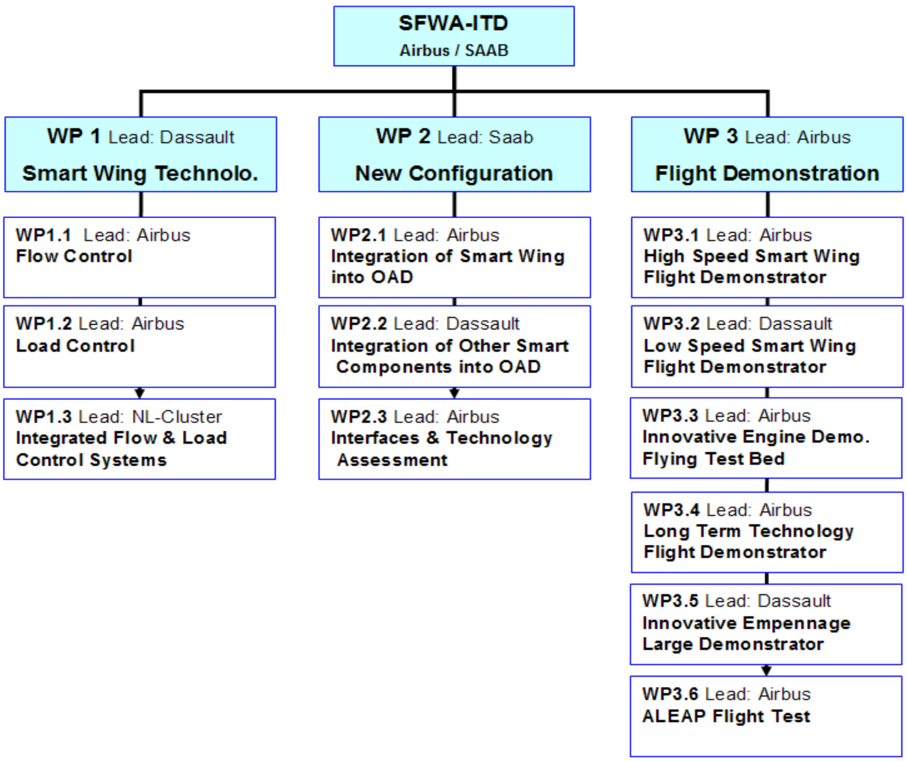

Figure 1: Structure of SFWA-ITD

2 Progress

2.1 Technology Streams

The nine technology streams are the technological back-bone of SFWA-ITD. They manage the technological objectives and its translation into the work of each work package. The work of 2013 as related each of the Technology Streams and respective results are summarised below.

TS 1 "Natural Laminar Flow Smart Wing" (NLF Smart Wing)

The key elements of this technology stream is a set of coordinated major activities that consists of a Ground Based Demonstrator, large scale wind tunnel tests, various aircraft concepts (SRA and LSBJ) and of course, the BLADE flight test in 2016.

In 2013 significant progress was made in the NLF Technology Stream as evidenced by the successful pass of TRL4 in both the Structural Concept and the Wing Integration topics. The skin of a wing has to meet the NLF surface quality requirements while providing ice and erosion protection. The baseline solution is shown below as aluminium, PEEK and steel erosion shield bonded component. Closing rib and spar attachments and skin stiffness requirements are met by the design shown.

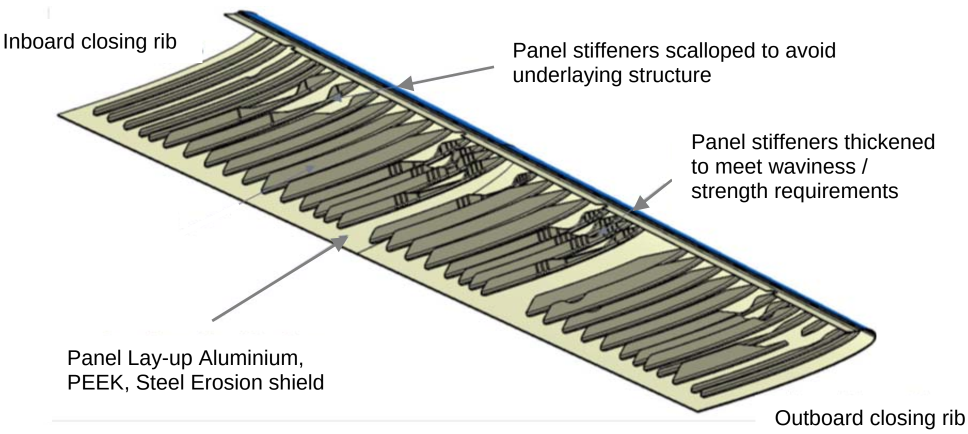

Figure 2: Integrated Skin panel for NLF

Much work also concentrated on the integration of the Krueger mechanism. An example of this is shown below for the Krueger 5 zone.

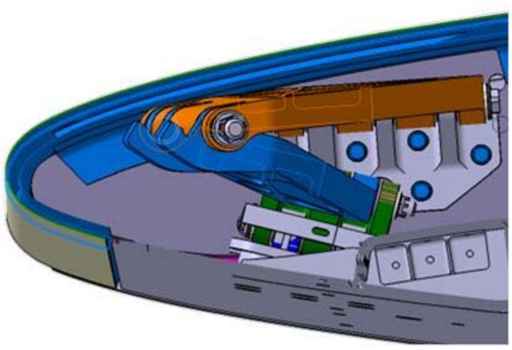

Figure 3: Integration of the Krueger mechanism

The fully integrated wing was evaluated with all necessary systems and features enable including a revised Krueger span-wise layout and an updated ice protection strategy. Figure 4 shows the outboard Krueger flaps in both retracted and deployed positions. A full assessment of the SRA to meet the low speed performance targets was completed and the high lift system was shown to be acceptable, meeting the TLARs.

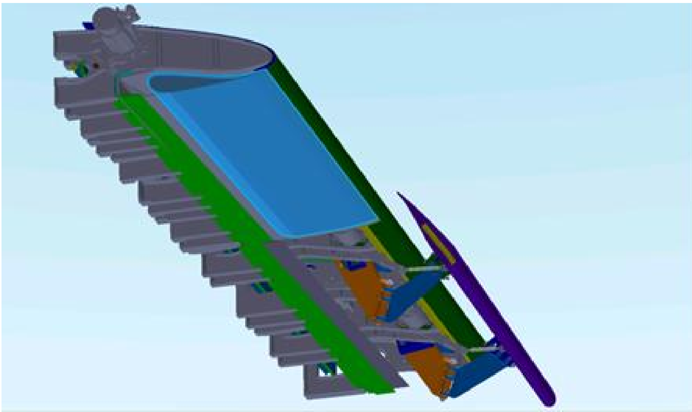

Figure 4: Outboard Krueger flaps in retracted and deployed positions

Limited financial resource availability in 2014 and beyond will inevitably result in a slowdown of TRL maturation within SFWA. The precise impact of this change is yet to be confirmed.

Good progress towards the evaluation of NLF for Business Jet applications was achieved by performing important wind tunnel and ground based demonstrations.

BLADE flight test demonstrator

The largest amount of activities in SFWA in 2013 were dedicated to complete the detailed design of the various components associated to modify the Airbus A340-300 test aircraft with the laminar wings and to conduct further ground tests, wind tunnel tests and other flight clearance relevant activities and measures with the test aircraft.

Major components for which the detailed design could be closely accomplished by the end of 2013 were the structure of the wings, trailing edge and ailerons, the wing tip pod, the so-called “aero-fairing”, the fixed Krueger flaps and the diffusion zone, connecting the datum wing with the new NLF wing. Components of particular challenge were, as expected, the NLF wing upper-cover and leading edges, which are being developed by SFWA Consortium Members SAAB and GKN.

Figure 5: Graphic Art of the BLADE flight test demonstrator with main contributing partners to the project displayed at the bottom

In parallel, a large diversity of activities in 2013 were directed to prepare the tools for manufacturing, assembly of the wing, the tooling to attach the wing to the aircraft, and to ensure that the quality of the NLF wing is maintained and controlled through all steps of the further preparation of the flight test aircraft and the flight test itself.

Associated work packages for design, manufacturing and assembly of parts and components of the wing, but also the tooling, flight test and other instrumentation are taken by a large number of further project partners, many of them through “Call for proposal topics”, as displayed in the bottom of the “BLADE” picture.

At the end of 2013, the decision was taken to change the test aircraft layout by replacing the large, middle-class car sized camera pod mounted on the center of the fuselage by a smaller pod at the top of the aircraft vertical tailplane.

In December 2013 the preparation towards the definition for the location of the “Final Assembly” of the test aircraft and the place to conduct the flight test campaign was completed, the decision was taken to allocate the facilities at the airport in Tarbes. As the Airbus A340-300 test aircraft will be exclusively assigned to the SFWA BLADE work package for at least two years, a hangar in Tarbes will be entirely dedicated to BLADE for the lifetime of the project.

TS 2 "Hybrid Laminar Flow Smart Wing" (HLF Smart Wing)

HLFC systems tested in the past showed that hybrid laminar flow can be applied to delay the laminar-turbulent transition on aerodynamic surfaces of large transport aircraft at high Reynolds numbers. However, previously tested systems were too complex and too heavy. Therefore, the emphasis of this Technology Stream is on simplification of the suction systems for wings and nacelles and eventually developing suction solutions other than micro-perforated metallic sheets.

In 2013 Airbus defined a suction system for the highly critical leading edge between engine and fuselage indicated by the black trapezoid in
Figure . The boundary layer in this area is three-dimensional, hence difficult to laminarize without suction.

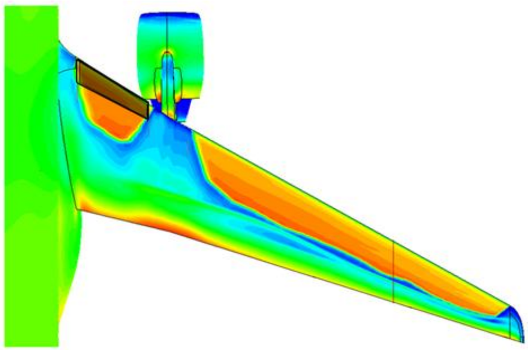

Figure 6: HLFC suction system to laminarize the flow between engine & fuselage

For BizJet type aircraft an HLFC design study for an infinitely-long swept wing of an “High Sweep Business Jet” (HSBJ) was performed by designing a simplified HLFC system based on the ALTTA double-skin concept and provided a specification for the manufacturing of the outer suction surface.

TS 3 "Innovative Control Surfaces" (ICS)

By decision of the Management and Steering Committee, activities on innovative control surfaces are embedded in the individual other different technology streams where relevant (NLF SW, BC, LCFA).

TS 4 "Fluidic Control Surfaces" (FCS)

This Technology Stream consist of 4 sub-streams. In 2013 progress was made in each one as reported below.

<u>Shape design concepts, smart surfaces and materials</u>

A high lift smart flap configuration was defined with 70% of flap chord extension. This numerical work contributed to the definition of the smart flap configuration to be tested in the low speed wind tunnel ONERA F1 in 2015.

To avoid the parasitic drag penalty of vortex generators (VG, rigid ones), when they are not in use, so-called adaptable VGs were designed and down-selected in 2012. In 2013 a detailed design was conducted in order to optimize the system regarding space requirements, Figure . First parts of the system were manufactured.

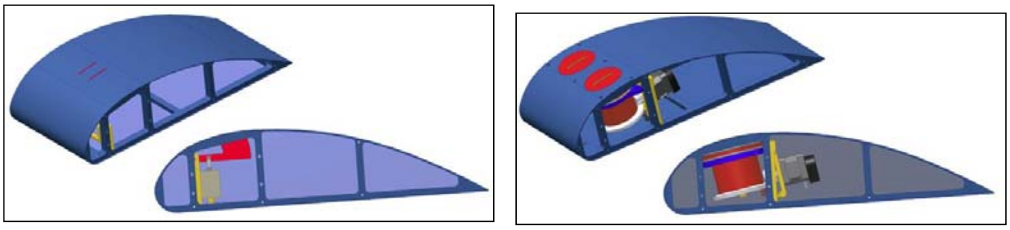

Figure 7: Two final designs for lab model fabrication of vortex generators embedded in a typical flap

The droop nose integration studies continued in 2013 with a focus on structural aspects, making use FEM models developed in 2012 for the so-called FNG wing ("Flügel Neuer Generation"), a NLF- research wing concept which was adopted from a preceding German research and technology project.

Leading edge (LE) flow control for slat-less wing

The synthetic jet actuation systems developed in 2012 and matured 2013. A second specific actuator developed for this application with improved hardware was installed and tested resulting in an improved design reducing the gaps and increasing the stiffness of the kinematics.

A micro valve was pre-designed based on existing flow control hardware. Figure shows the actuator as installed inside the wing's leading edge.

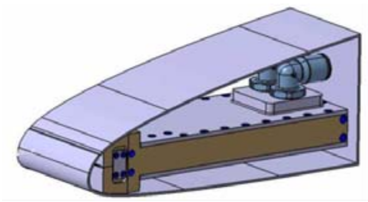

Figure 8: VIPER-project prototype predesign for a leading-edge

Trailing edge (TE) flow control for high performance

The extensive and detailed flow control system ground testing (including simulation) combined with studies in R&T partner projects continued in 2013.

Detailed ground tests were conducted to analyse the performance of the Active Flow Control (AFC) system. Results will be compared to those obtained for the generic flap in 2012 with integrated AFC system.

Pulsed jet actuators exploiting new opportunities of micro valve technologies were further developed applying new bonding concepts. Prototyping and testing were performed to characterise the performance and robustness of the systems.

In order to further mature flow control technologies, operational aspects have been studied in an R&T partner project. As an example the below figure shows the actuation system installed on top of an vibrational cylinder as key element of a test rig dedicated to a harsh environmental test campaign.

Figure 9: Actuation system installed on cylinder for vibrational testing

The actuator was exposed to various frequencies for 30 minutes. A large data base has been recorded; the analysis has just started at the end of the reporting period.

Active flow control to support load control functions

Numerical and experimental studies were performed in an R&T partner project, the goal being to reduce the loads at off-design conditions. Initial concept surveys were reported in 2012, in 2013 detailed numerical studies and detailed concept designs were done for the “fluidic spoiler” and the “trailing edge jet” concept; at end of the reporting period the concept for the planned wind tunnel test was frozen.

TS 5 "Load Control Functions and Architectures" (LCFA)

The objective of this Technology Stream is to alleviate manoeuvre or gust loads through active loads control and passive loads alleviation while optimising the structural composite design. The work is divided into five sub-streams.

Active Load control

Advanced Loads Alleviation for BizJet and single aisle aircraft were develop to reach maturity levels around TRL3. This included

- The use of a multifunctional adaptive flap trailing edge for manoeuvre and gust loads alleviation.
- control surface characterisation for advanced gust loads alleviation with application to SRA.
- Loads protection control law design and gust load control respectively.
- Developing gust load alleviation using remote wind sensors, and secondly, investigating feedback based load alleviation design methodologies.

Capability development

The capability development sub-stream intends at supporting the development of the technologies developed in the other sub-streams such as extreme loads computation and a/c response confinement and the use of high fidelity CFD approaches for gust loads prediction and control.

Passive load control

In the passive load alleviation stream, the SFWA consortium members and associated CfP-partners are mainly building enabling capabilities for passive wing design such as the application of the aero-elastic design processes on a New Short Range aircraft configuration, aerodynamic tailoring for loads alleviation, CFD based aircraft dynamic loads calculation and increased order modelling for low frequency aircraft response. The activities in 2013 were focussed on high wing deformation and the assessment of the overall benefits and drawbacks due to high wing flexibility.

Vibration control

Progress was made on the improvement of the robustness of the vibration control law with respect to flight point, aircraft mass case, systems delays and aeroelastic modelling uncertainties including the development of anti-vibration controller. A full scale test on a Falcon aircraft was designed and the PDR of that complex test passed.

Loads (fatigue) monitoring

Studies were performed finding an optimum set of sensors – number and location- to enable real time monitoring of the loads acting on specific components of an aircraft. Methodologies and algorithm - previously studied for real time loads monitoring- were tested on a scaled, simplified wing model test bench including data processing methods for fatigue and vibration analysis.

TS 6 "Buffet Control" (BC)

This Technology Stream has defined 3 sub-streams. The research activities performed in 2013 lead to the following conclusions

Buffet Characterisation for Laminar Aerofoil / Wings & Turbulent Wings

Data of the testing campaigns for 3D turbulent wings were analysed with various signal processing tools to understand the 3D buffet phenomenon

The analysis of buffet onset for 2D LSBJ aerofoils from ONERA S2MA WT tests (03/12) for natural and tripped transition was completed.

The buffet characterisation for 3D laminar wings as well as for off-design conditions from Phase I (02-04/13) & Phase II (09-12/13) test campaigns were finalised. A significant amount of data has been acquired from steady and unsteady pressure sensors, accelerometers and strain gages. Analysis is in-progress.

The BUCOLIC program (CfP) started on predict transonic wing buffet; ii) then, numerical simulations for the clean wing configuration, including the prediction of buffet onset. ARA was taking care of model inspection and refurbishment to be ready to run the tests in the 2nd semester of 2014.

Passive Buffet Control for Laminar and Turbulent Wings

Next Wing project had worked on design guidelines related to wave drag bumps and buffet control with wave drag bumps.

Numerical investigations on the Buffet onset and several flap deflections were simulated.

Numerical investigations were performed looking at the ability of a deformable Trailing Edge device to modify the buffet onset.

Active Buffet Control for Turbulent Wings

Phase II of the transonic Test Campaign (09-12/13) related to buffet control was completed; analysis is in progress.

Key deliverables on “Preliminary Specifications of Active Buffet Control devices for Turbulent Wings applications” was completed. This deliverable was a starting point for the SFWA 1.3.8 partners performing the first integrations of active fluidic devices into a wing design.

Thus the activities conducted so far in this Technology Stream would allow reaching TRL 3 values. The important high-quality work allowed making several publications and communications in conferences

TS 7 "CROR Engine Integration" (CROR-EI)

The objectives are the characterisation of acoustic signature and aerodynamic performance of an installed CROR and to define solutions to enhance the aerodynamic performance and reduce the acoustic signature such that the feasibility and the viability of the CROR Aircraft concept are ensured. This Technology Stream is divided in 3 groups of activities.

2013 has been a key year for the CROR EI TS because during that year, all the technical inputs developed within the project have been assembled into a CROR Aircraft Feasibility dossier. This dossier has been reviewed and led to the following conclusions:

- The CROR concept is confirmed as technically feasible; the basis for aircraft certification was established, while the economic viability is not yet achieved.
- The technical challenges associated with CROR (acoustics, performance, weight, etc.) show no “showstoppers”.
- A decision was taken to proceed to the next phase of the technology development; however, the significant additional work required e.g. for certification related issues on the CROR flying demonstrator will require to perform next steps in the proposed new phase of CleanSky 2.

Aerodynamics and acoustics

Several open rotor scale models have been tested and subsequent numerical analysis and comparison with experiments was performed.

Aircraft certification

During 2013, good progresses have been achieved in the Aircraft certification sub-stream, contributing to CROR Aircraft feasibility with a safety equivalent to Turbofan. This addressed Propeller Blade Release trajectory modelling, investigation of technological solutions for hybrid armour to protect the aircraft fuselage and the investigation of reduced Aircraft threat blade technologies

In flight demonstration

The flight test objectives were converged in a concept review workshop to assure reaching TRL6. Requirements and engine specifications were transmitted and discussed with the SAGE-ITD which is the domain in which the CROR full scale ground test engine is under development. A conversion of the full scale ground test engine to a flight worthy test engine is planned to be conducted in the CleanSky 2 program in close connection to the preparation of the flight test aircraft.

Specify FTD(Flight Test Demonstrators ?) related measurement techniques were defined and discussed with the Technology Stream number 9 (Advanced Measurement).

TS 8 "Integration of Innovative Turbofan Engines to BizJets" (IITE)

The main objective of the IITE Technology Stream is to investigate innovative integration of conventional turbofans on business jet aircraft concepts. The final goal is to bring this turbofan-fitted innovative aft-body to TRL 5.

The aim of this work is to perform the detailed design of the two selected after body concepts, a U-tail and a V tail concept, Figure .

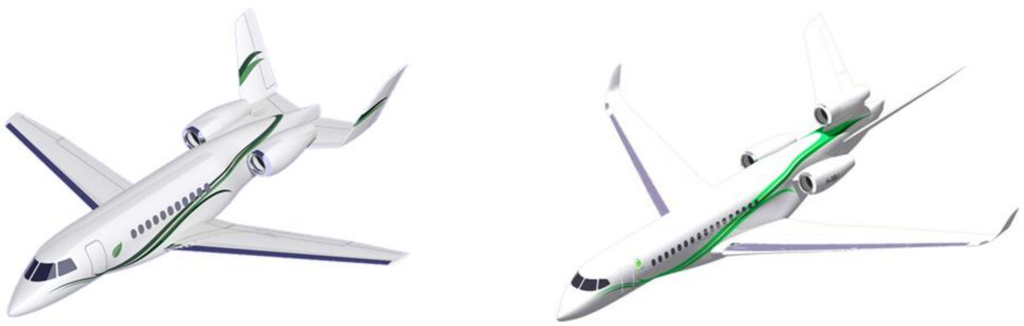

Figure 10: Low Speed U-tail (left) and high speed V-tail

By the end of the year 2013, a study on the optimised size of the U-tail concept has been completed aiming at reducing drag and mass penalties. The V-tail concept focusses on emission reductions and noise. Shapes of the aft bodies have been optimised with various CFD simulations and a wind tunnel test performed by outside of CleanSky.

The detailed design and the sizing of the V-tail have been performed studying the integration into the rear fuselage and the integration of the central engine integration / engine mounting system.

In parallel a Wind Tunnel Model has been manufacturing for the turbofan tests. The delivery of the model is scheduled for May 2014. The tests will take place by the third quarter of 2014. Numerical simulations have been started.

For ground testing two aft body demonstrators have been initiated in 2012, a full scale model for investigating noise, acoustic/fatigue and thermal aspects and a second aero-elastic model to validate the numerical flutter model in a transonic wind-tunnel

In 2013, progress was made on the test rig and the mock up designs. Stress evaluation of the test rig and structure currently designed for the Aft Body Ground Demonstrator has requested more iterations on the design than expected. The final loop is expected in early 2014 with sufficient results for completing a preliminary design review.

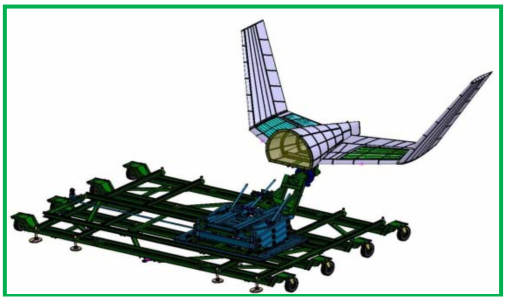

Figure 11: Full scale after body demonstrator

For the U-tail design the flutter test has successfully passed the Preliminary Design Review in June 2013, Figure . The Critical design review is scheduled for early 2014, leading to a test in November 2015.

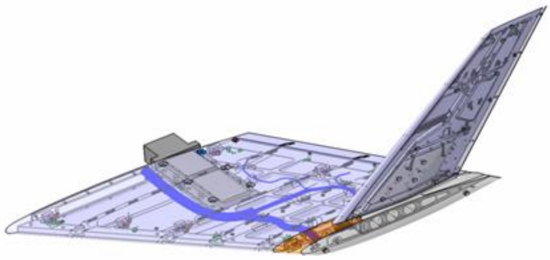

Figure 12: Detailed design of the flutter mock up

TS 9 "Advanced Flight Test Instrumentation" (AFTI)

Advanced Flight Test Instrumentation Technology Stream aims to support the development of innovative measurement technologies to optimize the return on investment of the Flight Test Demonstrators (FTDs).

The development of six technologies has been launched focusing on CROR and BLADE flight test demonstrations.

<u>In-flight PIV (Partical In-flight Velocimetry)</u>

Achievements performed in 2013 are:

- Development of simulation tools including:
  - Optical environment using ray tracing techniques
  - Models of camera, lens and laser system
  - Light scattering model
  - Synthetic images generator
  - Uncertainty calculations
  - Operational limit predictions

PIV measurements in-flight have not been done before, particularly the seeding of the air, which required comprehensive testing of PIV on a Do228 aircraft in applying the setup and test procedure developed by DLR in the context of the AIM² project, see 13.

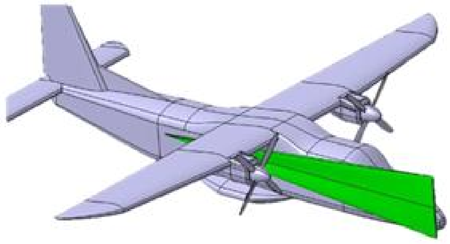

Figure 13: In-flight PIV test on DLR Do228 Aircraft

Blade deformation

The kick-off meeting was held in April 2013. First studies led to the delivery of a Bibliographic Review and identification of IPCT (Image Pattern Correlation Technique) technology bricks and start the familiarisation of the CROR FTD environment. In 2014, it is intended to define a first set of specifications

Acoustics

Two areas of work have been identified: signal processing and data analysis and instrumentation of a chase aircraft, possibly on a special boom.

Pylon effort measurements

The main objective is to provide means to accurately assess the engine thrust in cruise flight conditions. A first draft of specifications has been delivered, as a first step before the set-up of the project requirements. Initial investigations have been conducted on concepts linked to the FTD CROR configuration.

Wireless sensor nodes

A consortium of Call for Proposal partners composed of CSEM, Imperial college of London and SERMA has started work in June 2013. The main objective is now to finalise requirements, to define an associated concept and to identify the potential show stoppers in order to reach a TRL 4 maturity mid of 2014.

Reflectometry

Manufacturing tolerances or in-flight wing deformations can cause local imperfections on wing upper surface. To check the location of transition from laminar to turbulent flow or understand unexpected premature transition, in-flight waviness measurements are highly requested on the BLADE FTD laminar wings.

The waviness of the wing is measured via the distortions of an illuminated pattern set perpendicularly to the wing, reflecting on its surface and seen tangentially by high resolution video cameras, Figure . In 2013, the complete system and video architecture has been frozen, designed and integrated into the BLADE DMU (Digital Mock-Up).

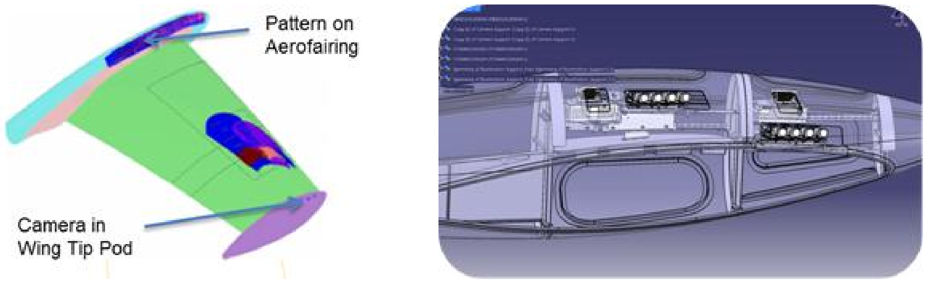

Figure 14: (a) Reflectometry integrated in laminar wing, (b) cameras in wing tip pod

2.2 Overall Progress

In 2013, a major share of activities in SFWA-ITD focused on the detailed design and manufacturing of the large flight test demonstrators. This is particular true for the realisation of the left and right A340 laminar wing sections, called the “High Speed Demonstrator Passive” or BLADE demonstrator. The target was to bring all major components through the “C Maturity” before the end of 2013. This is equivalent to passing the Critical Design Review.

However, the large number of involved partners and interfaces, and the complexity of the tasks caused significant difficulties for achieving full coherence in the design concepts of components and part’s geometries, loads and stresses. Particularly the detailed design of the NLF laminar wing section’s upper cover and leading edges appeared critical with respect to loads and stress capabilities, e.g. at panel to rib feet connections. The partial incompliance of test and manufacturing processes with standard flight clearance procedures caused unforeseen problems and delays.

The position of the infrared camera pod on top of the fuselage caused problems because of its complex installation and its impact on the low speed behaviour of the aircraft. Although this location provided the best possible optical access for infrared diagnostics of the laminar surface, in December 2013 the decision was taken to relocate the camera pod. In January 2014 it was decided to go for a much smaller camera pod on top of the fin.

Based on the progress made in 2013 the BLADE roadmap was reviewed and updated in December 2013. MAT C shall now be accomplished in summer 2014 with the test aircraft assembly to start in January 2015 pushing the start of the flight test campaign into the 4th quarter of 2016.

In July of 2013, Technology Readiness Level 3 was accomplished for the integration of the CROR engine concept into large passenger aircraft. This demonstrates that no principle technical showstopper was found in this concept and it underlines the potential for the substantial fuel savings seen in this technology.

The focus of the updated work plan is centring on verifying the economic viability of the concept. That requires developing and maturing the technology in order to prove that a CROR propulsion system can be produced, operated and maintained with an economic benefit as compared to conventional engine concepts. A key role in this study is dedicated to the CROR ground test engine, which is under development in SAGE 2.

Based on extensive wind tunnel testing in 2012 and 2013 in SFWA, the technical readiness on acoustic and aerodynamic aspects of the CROR engine is approaching now TRL4. The seamless transfer and continuation of CROR activities into CleanSky 2 is prepared for mid-2014. While the engine related research and development work is mainly covered in CleanSky SAGE 1 and SAGE 2, the development schedule will continue to be jointly harmonized between SAGE-ITD and SFWA-ITD, later also with CleanSky 2. Most of the experimental SFWA-ITD testing on CROR in wind tunnels has jointly been undertaken by Airbus, Snecma and Rolls-Royce in coordination with the relevant SAGE technical planning.

As the further planning of the flight test is supposed to be part of CleanSky 2, the related activities in SFWA were reduced to a minimum in 2013.

The wind tunnel demonstrator related to the Innovative Rear Empennage Design for Business Jets, has successfully passed its PDR in June 2013. Reaching the CDR-milestone is planned for April 2014. The model, being heavily loaded with instrumentation and new developed TPS engine simulators, will undergo an extensive noise and aerodynamics-related test program.

In 2013, the Ground Demonstrator was still in the preliminary design phase. The PDR is targeted before mid-2014.

Interactions and ways of working between SFWA and SAGE have been reviewed and improvements introduced in the second semester of 2013 as consequence of a technical audit of the CleanSky Technology Evaluator. The audit looked at activities related to the Short and Medium concept aircraft “Advanced Platform 1” and “Advanced Platform 2” (APL1 and APL2) in April 2013, in particular on the delays of model deliveries to the Technology Evaluator (TE).

In 2013 two major aircraft model updates have been delivered to the TE: one update of the PANEM BizJet model of the HSBJ concept as well as one long range and one short and medium range PANEM Airbus technology concept model.

The interface with SGO ITD has significantly been intensified during 2013 for launching the cooperation in the area of more electric aircraft. The focus is on electrical power distribution, electrical wing ice protection (E-WIP), electrical environmental control system (E-ECS), the definition of optimized trajectories and smart operations on ground.

In 2013 a number of research and industry type wind tunnel tests have been prepared and performed in SFWA. Four large tests with pre-selected CROR engines were completed in January 2013. 50 days of testing in the DNW-LLF wind tunnel were done with 1/7-scale models equipped with instruments measuring a wide range of noise and aerodynamic data. The tests with typically three different CROR blade designs have jointly been undertaken by the SFWA-partners Airbus, Snecma and Rolls-Royce relying on SAGE’s technical planning. This covered the engine installation, testing and de-installation.

A number of smaller research type wind tunnel tests have been prepared for maturing various passive and active flow control technology concepts for the smart wing, new loads control concepts, and the design of Riblet coating. One wind tunnel test on advanced active flow control flap design has been completed in early 2013. It will be exploited in cooperation with a CfP partner.

An endurance flight test campaign employing two in-service A340-300 Lufthansa long-haul aircraft was completed in summer 2013. The campaign was extended by 12 months because of the very good success targeting the long term robustness of selected innovative surface coatings against wear and aging. The campaign, conducted in the frame of a CfP-topic with CleanSky partner Lufthansa Technik (LHT), started in 2011. Evaluation and analysis of the results continues into 2014.

Early in 2014, phase four of the large scale ground “feature” demonstrators for the smart wing nears completion. Phase four and the previous “phase” demonstrators cover a series of integrated structural demonstrators equipped with all major systems required for the leading edge. Test articles for the bird strike and lightning strike tests as well as repair concepts have been and will be prepared. Many of the activities for the ground demonstrators have been carried out with strong support of Call for Proposal partners who joined in the years 2010, 2011 and 2012.

At the end of 2013 a total of twenty-nine topics (projects) from CfP #11, #12, #13 and #14 are alive and running. Three topics from these calls are still in the negotiation phase. The CfP topics cover a wide scope of research including design and testing of individual components and systems for the laminar wing, surface coatings and repair methods, contributions to design and manufacturing of laminar wing ground demonstrator parts, and preparation and qualification of new flight test instrumentation.

In the 2013 four more topics were published in CfP#15 and ten in CfP #16. The majority is related to R&T work supporting the NLF wing activities in BLADE and in work package 2.1.

The 2013 and 2014 Call topics will perform essential design work and will contribute parts for the laminar wing wind tunnel and ground testing in preparation of the flight test.

3 Management Status of SFWA-ITD

The SFWA-ITD work packages at levels 1, 2 and level 3 are carrying a strong role and responsibility of the technical management, i.e. push the technical progress along the SFWA work plan. This role is taken by the individual Work Package Leader.

The Technology Stream leaders oversee the implementation global objectives and planning for their area. They make up the Management Committee. Management and Steering Committee met each 6 weeks in 2013. Each second meeting is organised as virtual conference.

A monthly report provides the status of each WP level 3 of SFWA with respect to deviations from the annual Consortium Plan is report. Quarterly reports are prepared based on the procedures requested in the JU’s management manual. The preparation of a midyear status report of the ITD is a mandatory delivery for each ITD

Cost

The available budget for SFWA-ITD in 2013 was 58.304 MEuro.

During the last two years it became clear that the available funding for SFWA-ITD would not be sufficient for completing all originally foreseen activities. This concerned in particular the CROR demonstrator, but also the BLADE laminar wing demonstrator.

The CROR project suffered from additional technical requirements caused by certification issues because such propulsion system was never before certified. Hence, more time and more resources are needed to prepare the complex flight test demonstrator. It was proposed to stretch the preparation and testing work of CROR into the Clean Sky follow-on project (Clean Sky 2).

Despite easing the cost on CROR, there is not enough funding in SFWA-ITD for the BLADE demonstrator. This is partly due to the fact that less than originally planned work for the flight test can be subcontracted due to certification issues. Nevertheless, industry partners have decided in 2013 that they will complete BLADE in SFWA-ITD/Clean Sky providing the missing resources either form their own budget or funding from third sources. The major share of additional resources will be brought into the project by Airbus.

Time Schedule

While there are minor delays on workpackage level, there is a delay in completing the large demonstrators, BLADE and CROR, due to additional, unforeseen technical work. The BLADE flight test demonstration is scheduled to start in 2016 while the CROR flight test demonstration will take place after SFWA-ITD is finished.

Quality and Risk Management

The identification and management of risks in SFWA-ITD is organized along the CleanSky Management Manual Applicable Version V3, Sep 2013, Chapter 3.

In line with the structure of the SFWA-ITD, risks are being identified within the SFWA-ITD Technology Streams, as through these the key technologies are implemented in the program by technology roadmaps, which manage all interfaces within the work packages, but also other CleanSky ITD´s, CleanSky external projects. Inherently the quality as well as the scheduling of deliverables, milestones, gates and reviews are planned and managed through the Technology Streams. By means of a Correlation Matrix, the risks and eventual mitigation plans are cascaded to the related work packages at level three.

3.1 Call for Proposals

In 2013, like in previous years, a significant amount of work and contribution to the progress of the SFWA project were provided by Call for Proposal partners. With a few projects being technically completed already and a few being in the negotiation phase towards contracting, more than 70 projects and over 100 partner were involved in a large variety of research areas associated to the SFWA work program.

In 2013 16 topics have been launched in Clean Sky Call for proposals #14 to 16. Publication and evaluations have been successful for 4 of these topics, 10 topics will be evaluated in May 2014. 4 unique partners should work on the 4 projects, including 2 new partners. 1 new partner chose to join the Consortium, 1 decided to sign the implementation agreement.

Table 1 List of topics and partners selected via Calls for Proposals in 2013

WP	Topic Title	Beneficiary	CfP partners	Call
2.1.3	Design and manufacturing of a representative new generation business jet model for high and low speed tests	Dassault	Vallet SAS CMA	14
2.2.2	Blade trajectory testing	Airbus	Topic failed	14
2.2.2	Advanced measurement for low speed high scale CROR Wind Tunnel Test	Airbus	Stichting Duits-Nederlandse Windtunnels	15

WP	Topic Title	Beneficiary	CfP partners	Call
3.1	Low speed Wind tunnel test for laminar wing demonstrator	Airbus	Stichting Duits-Nederlandse Windtunnels	15
3.3.5	Vibration reduction systems in pylon area	Airbus	Mag Soar Sl	15
2.1.4	In-Service Monitoring of LE Contamination	Airbus	Topic failed	15
1.3.6	MEMS Accelerometer – Miniaturisation of the analog electronics in ASIC(s)	Sagem	Application phase ongoing	16
1.3.6	Miniaturization of digital processing function for a MEMS pendulous accelerometer	Sagem	Application phase ongoing	16
2.1.3	NLF Wing High Speed Performance Test	Airbus	Application phase ongoing	16
2.1.4	Camera Development for In-Service Monitoring of LE Contamination	Airbus	Application phase ongoing	16
2.1.4	In-service monitoring of Leading Edge Contamination and Damage	Airbus	Application phase ongoing	16
3.1	Jigs and Fixtures for Assembly of the Laminar Wing at the “BLADE” Flight Dest Demonstrator Final Assembly Line	Airbus	Application phase ongoing	16
3.1	Blade wing measurement campaign	Airbus	Application phase ongoing	16
3.1	In-Flight Local Surface Deformation Measurements by Means of Reflectometry and Shadow Casting	Airbus	Application phase ongoing	16
3.1	Design, Manufacturing, Qualif.& Assy of an improved NLF Wing LE & Upper Cover Flight Test Article	Airbus	Application phase ongoing	16
3.3	Miniaturized remote acquisition unit for optical sensors	Airbus	Application phase ongoing	16

3.2 Dissemination

SFWA-partners published fourteen papers in journals. SFWA-ITD participated in the following exhibitions and conferences:

- Deutscher Luft und Raumfahrtkongress 2013, 10.- 12. September 2013, Stuttgart
- IFASD 2013 conference, 24-27 Jun 13, Bristol
- 18th STAB-Symposium, 6/7 Nov 2012, Stuttgart
- AIAA/ASME Joint Propulsion Conference, 29 July – 1 Aug 13, Atlanta, USA
- 7th AIAA Flow Control Conference, 16-20 Jul 14, Atlanta, USA
- IFAC World Congress 2014
- IUTAM-ABCM Symposium on Laminar-Turbulent Transition 2014
- 11th IFAC Workshop on Advanced Learning on Control and Signal Processing (ALCOSP'13), Caen, France, July, 2013, pp. 199-204
- SFWA Display at the CleanSky Booth at Paris Airshow Le Bourget June 2013

4 Summary of Major achievements of the year 2013

The major achievements of the year 2013 are:

- Significant progress is made in the BLADE flight test demonstrator detailed design; MAT B is closed for all components except camera pod.
- MAT C close to accomplishment for the first two BLADE components (Krueger flap and aero-fairing).
- Manufacturing of major tooling components started to assemble the BLADE wings star-board and port-board NLF wing sections.

- The contract for the design of the BLADE assembly and operation hangar in Tarbes was signed.
- Major milestone of CROR feasibility study was reached; TRL 3 is fully accomplished.
- Major wind tunnel tests on the full span 1/7 model were completed contributing experimental data for selection of a CROR engine - blade design.
- Phase four smart wing leading edge structural demonstrator is close to completion.
- The PDR for the “Innovative Rear Empennage” complex wind tunnel test was successfully passed.
- The PDR for the Low speed vibration control ground demonstrator was successfully passed.
- The flap drive kinematic for the Low Speed “Smart Flap” Demonstrator was re-designed.
- Wind tunnel tests for passive and active buffet control were accomplished.
- Parts for the wind tunnel tests with gust generator are manufactured and ready for installation in ONERA tunnel.
- Wind tunnel tests with 2.5D active flow control high performance high lift concepts for laminar wings were completed.
- In-flight testing of surface coatings for laminar wings is completed (with CfP partner LHT).
- Evaluation, selection and contracting of new CfP-partners continues.
- The concept aircraft models for evaluation of SFWA and other ITD technologies, primarily SAGE, have been updated. Implementation of the first batch of SGO technologies has started for use by the Technology Evaluator.
- The SFWA-ITD Annual Progress Review meeting took place on 09th - 11th April 2013 hosted by DLR Braunschweig. An intermediate Progress Review was held on 16th October at Airbus in Filton
- The 2014 Consortium Plan was prepared

The work specified in SFWA Consortium Plan of 2013 was performed including envisaged milestones and deliverables

5 Acknowledgements

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