Clean Sky Info Day

The CleanSky “Smart Fixed Wing Aircraft Integrated Technology Demonstrator” (SFWA-ITD)

Brussels, 20th of January 2012

Helmut Schwarze (SFWA-PO)

The CleanSky “Smart Fixed Wing Aircraft Integrated Technology Demonstrator”

Presentation Content

- Introduction
- SFWA-ITD key objectives
- SFWA-ITD large ground and flight demonstrators
- Actual status of work and planning selected demonstrators
- Conclusion
- Call#11-Research Topics

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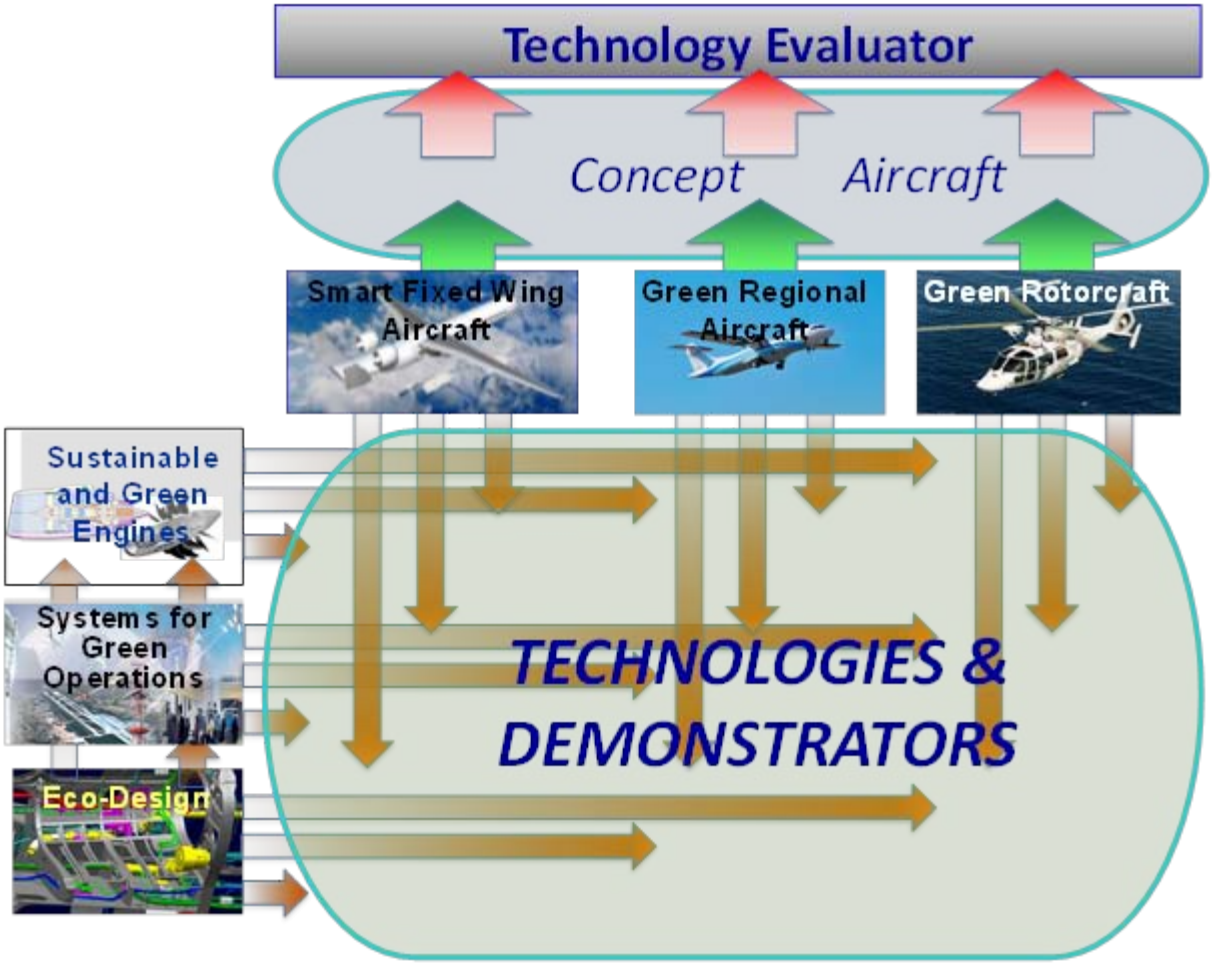
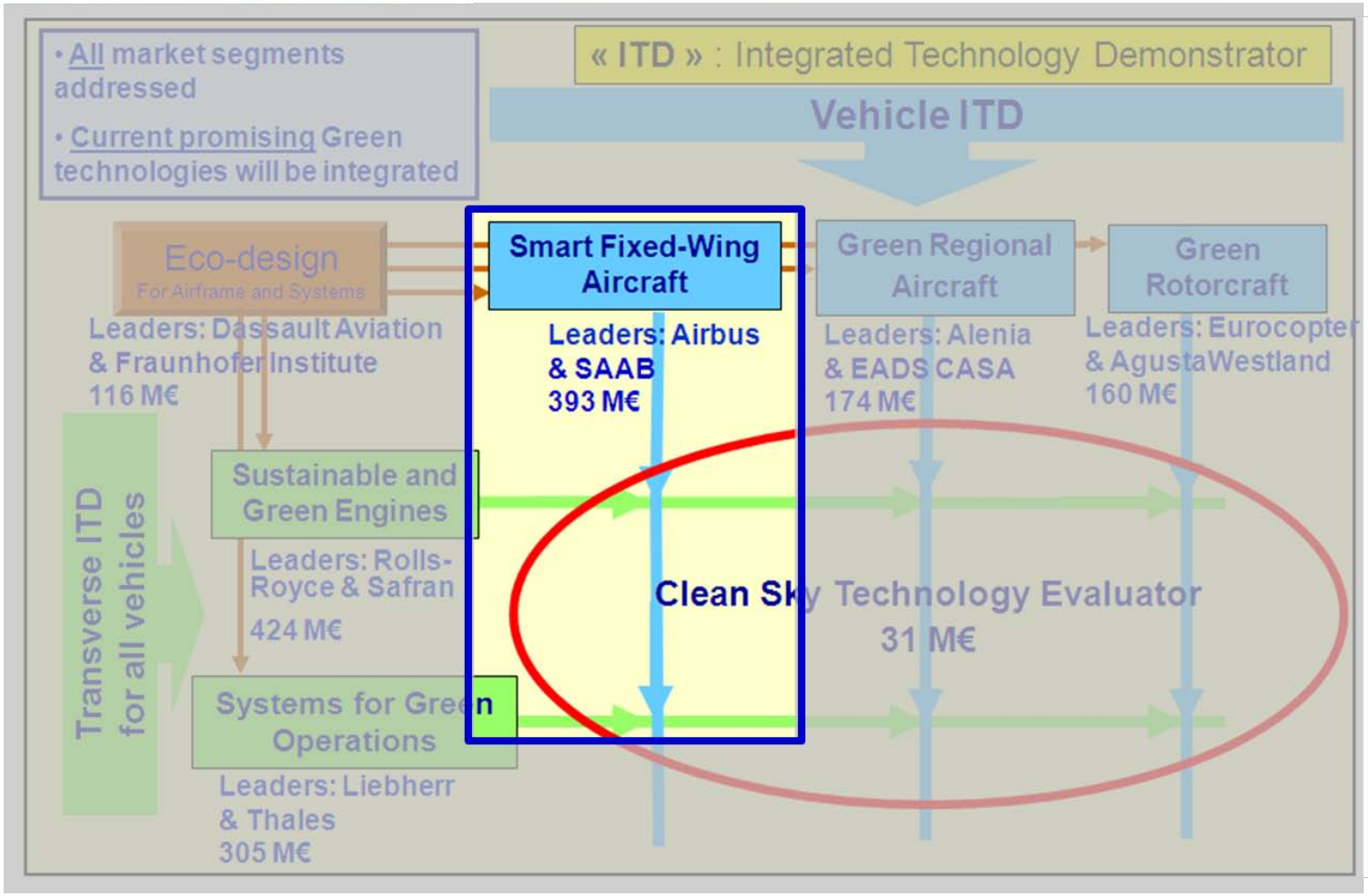
Clean Sky Concept



SFWA-ITD organisation and setup



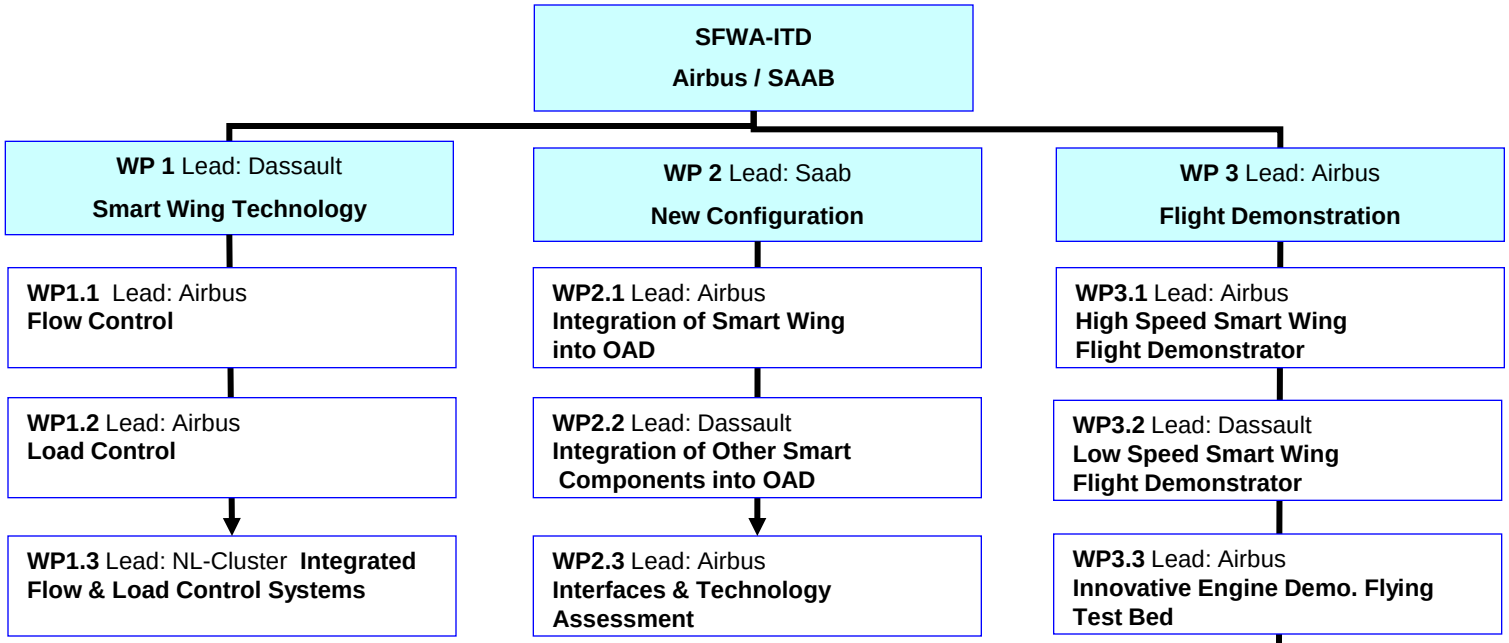
The SFWA Leadership

SFWA-ITD counts 37 beneficiaries, i.e. leaders and partners with their affiliates (Jan 2011)

- **8 SFWA ITD Leaders**
  - Airbus Operations
  - Saab AB
  - Dassault Aviation
  - EADS-Casa
  - Fraunhofer-Gesellschaft e.V.
  - Rolls-Royce
  - Safran Group
  - Thales Group
- **7 SFWA Associate partners**
  - Aernnova Aerospace
  - DLR
  - INCAS-Cluster
  - Netherlands-Cluster
  - Onera
  - QinetiQ
  - RUAG Switzerland Ltd

Organisational Structure

Smart Fixed Wing Aircraft ITD



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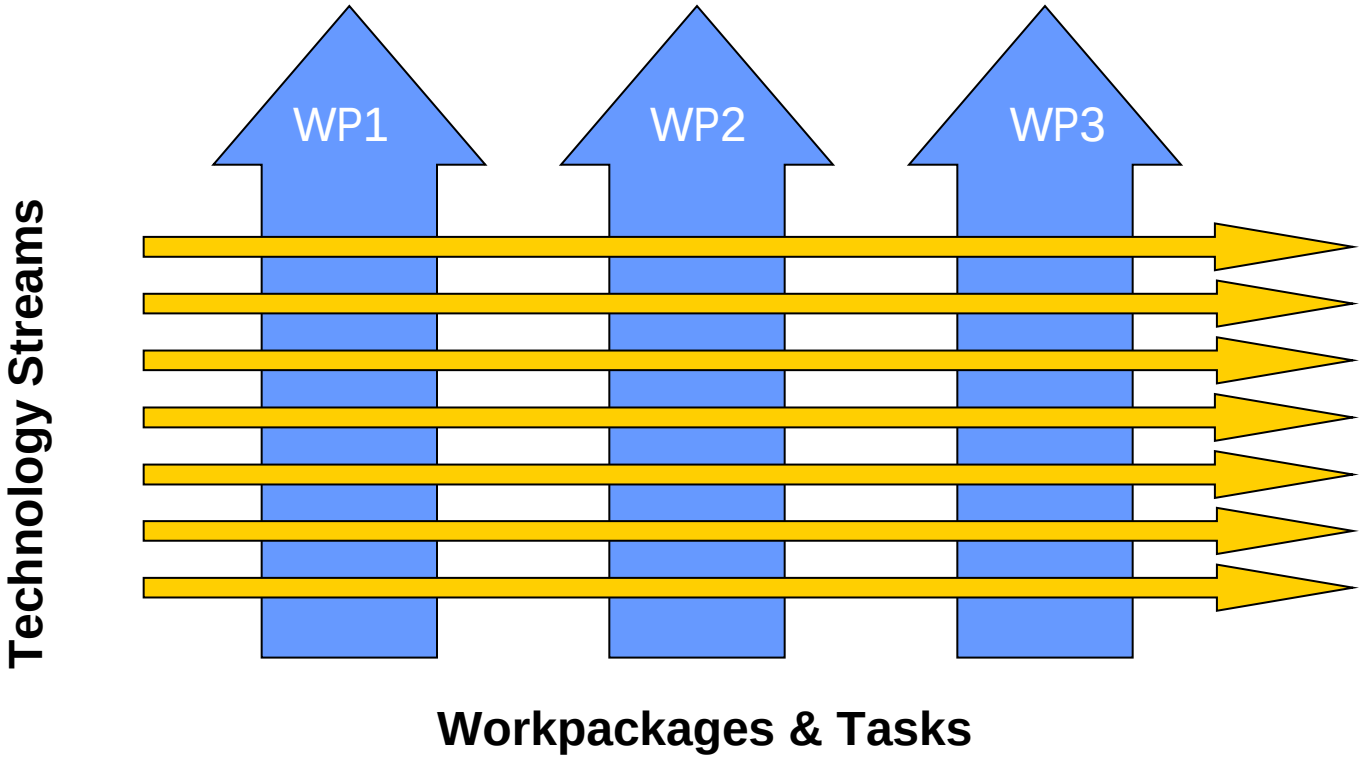
Aircraft Concepts

- **The aircraft concepts represent a “virtual” aircraft environment for maturing SFWA technologies. The concepts are:**
  - High Speed Demonstrator Passive (HSDP)
  - Low Speed Demonstrator (LSD)
  - Short Range Aircraft Concept (SRA)
  - Low Sweep Bizjet Concept (LSBJ)
  - High Speed Demonstrator Active (HSDA)
  - Long Range Aircraft Concept (LRA)
  - High Sweep Bizjet Concept (HSBJ)
  - CROR Engine Demo FTB

- **For bundling aircraft concept related technologies nine Technology Streams have been defined**

  - Natural Laminar Flow (NLF)
  - Hybrid Laminar Flow (HLFC)
  - Innovative Control Surfaces (ICS)
  - Fluidic Flow Control (FFC)
  - Load Control Functions and architectures (LCFA)
  - Buffet Control (BC)
  - CROR Engine Integration (CROR-EI)
  - Integration of innovative turbofan engines to bizjets (IITE)
  - Advanced Flight Test Instrumentation

The Technology Streams define requirements & collect the respective RTD results from the Workpackages



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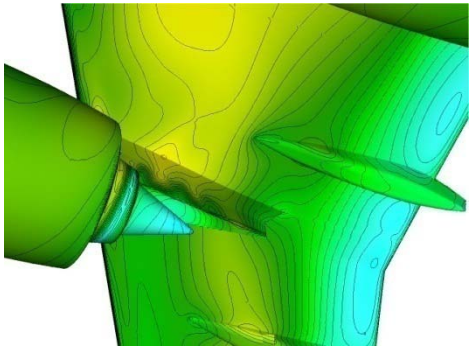
Mature technologies to achieve ACARE ambitious targets

→ 50% cut in CO2 emissions

Aircraft manufacturers 20-25%

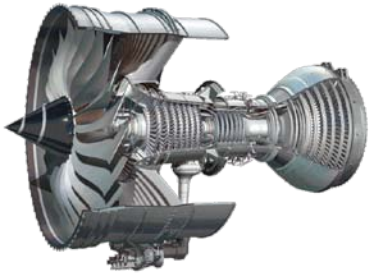


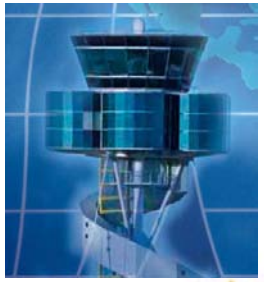
Integration

Engine manufacturers 15-20%

Operations 5-10%
Air Traffic Management

Technologies are key towards ACARE targets, but can only deploy their benefits through smart integration





ACARE: Advisory Council for Aeronautics Research in Europe

Key Smart Fixed Wing Aircraft technologies
Technology Streams Integration and Demonstration

Input interfacing with:

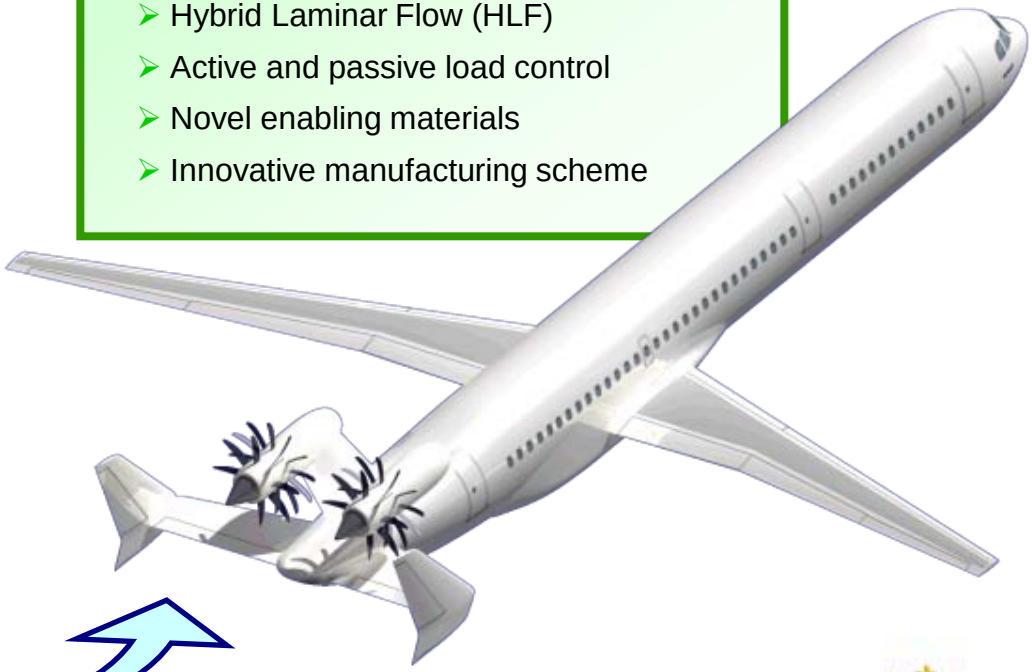
- SAGE ITD – **CROR engine**
- SGO – **Systems for Green Operation**

Smart Wing Technologies

- **Technology Development**
- **Technology Integration**
- **Large Scale Flight Demonstration**
  - Natural Laminar Flow (NLF)
  - Hybrid Laminar Flow (HLF)
  - Active and passive load control
  - Novel enabling materials
  - Innovative manufacturing scheme

Innovative Powerplant Integration

- **Technology Integration**
- **Large Scale Flight Demonstration**
  - Impact of airframe flow field on Propeller design (acoustic, aerodynamic, vibration)
  - Impact of open rotor configuration on airframe (Certification capabilities, structure, vibrations...)
  - Innovative empennage design



Output providing data to:

- TE– **SFWA technologies for a Green ATS**

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Flight Demonstrator Options

1. High Speed Flight Demonstrator

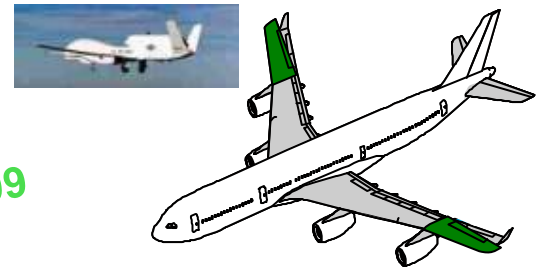
Objective: Large scale flight test of passive and active flow and loads control solutions on all new innovative wing concepts to validate low drag solutions at representative Mach and Reynolds Numbers. Envisaged to be used at least in two major phases of the project.

Option 1: UAV

Option 2: Alpha-Jet

Option 3: Airbus A340 with modified wing

Selected in April 2009



2. Low Speed Flight Demonstrator

Objective: Validation flight testing of High Lift solution to support / enable the innovative wing low drag concepts with a full scale demonstrator.

Option 1: Dassault Falcon

Option 2: Airbus A320

Selected

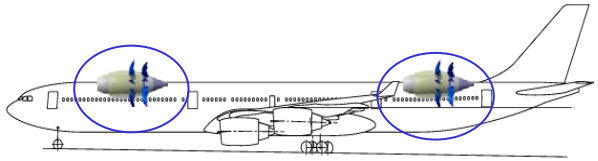
End of 2011

3. Innovative Engine Demonstrator Flying Testbed

Objective: Demonstrate viability of full scale innovative engine concept in operational condition

Options under investigation

Preferred solution



4. Long Term Technology Flight Demonstrator

Objective: Validation of durability and robustness of Smart Wing technologies in operational environment

Option 1: In Service Transport Aircraft

Option 2: Airbus A300 “Beluga”

Option 2: Airbus A320

Selection(s) part of technology roadmap

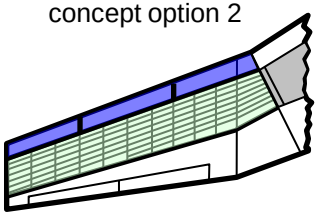
SFWA- High Speed Demonstrator Passive (HSDP)

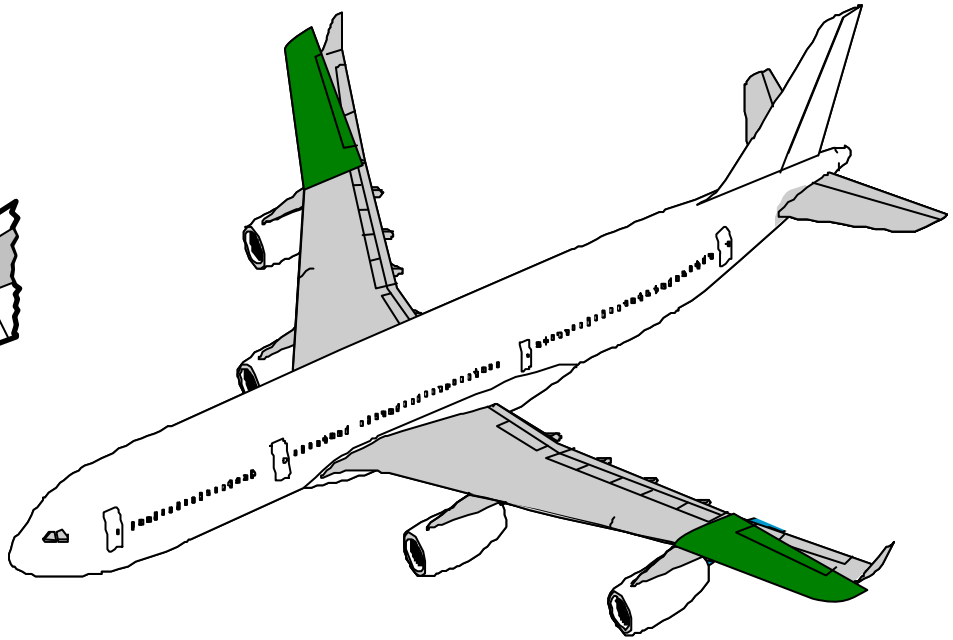
Smart Passive Laminar Flow Wing

- Design of an all new natural laminar wing
- Proof of natural laminar wing concept in wind tunnel tests
- Use of novel materials and structural concepts
- Exploitation of structural and system integration together with tight tolerance / high quality manufacturing methods in a large scale ground test demonstrator
- Large scale flight test demonstration of the laminar wing in operational conditions

Port wing

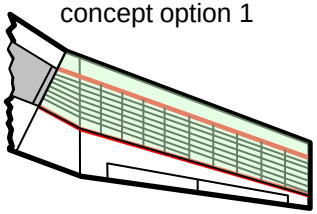
Laminar wing structure concept option 2



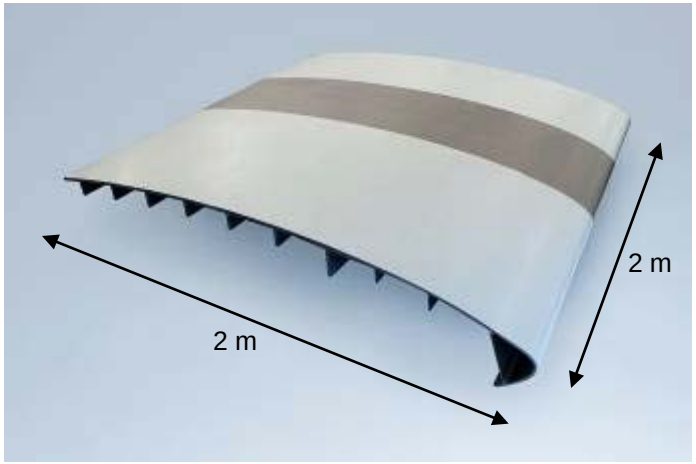


Starboard wing

Laminar wing structure concept option 1

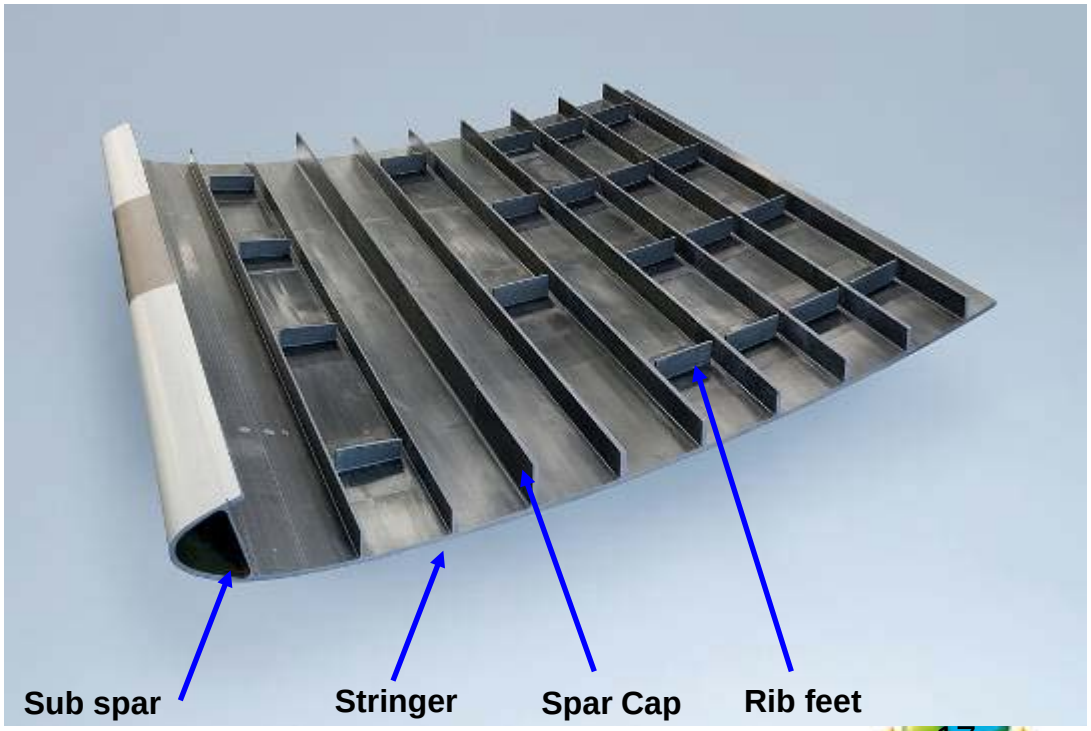


SFWA - Laminar Wing upper panel demonstrator



Test/Trial Panel

– **A test/trial panel manufactured and being used** for several purposes, i.e. evaluation design concepts, tooling, surface measurement etc.

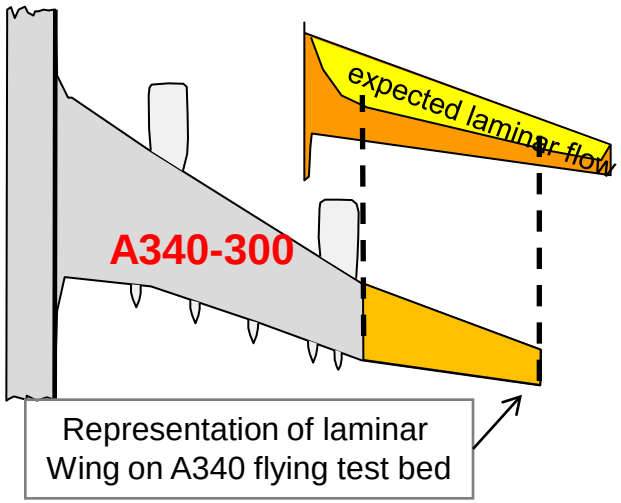


Complexity

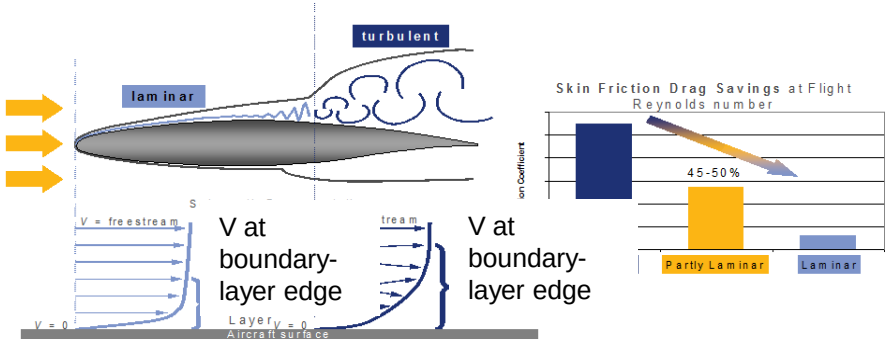
–The panel combines several advanced design principles into an fully integrated solution, co-cured in one step.

–Fulfilling very challenging requirements regarding surface quality

SFWA - Measurement of “Laminarity”



Representation of laminar Wing on A340 flying test bed



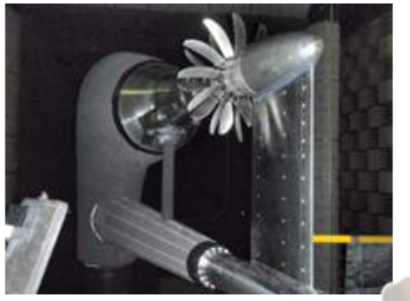
Schematic Representation

December 2010: Measurement of laminarity extension using FLIR IR camera for:

- Qualification of measurement system to be used on A340
- Calibration of transition criteria

SFWA- ITD integration of the CROR engine concept

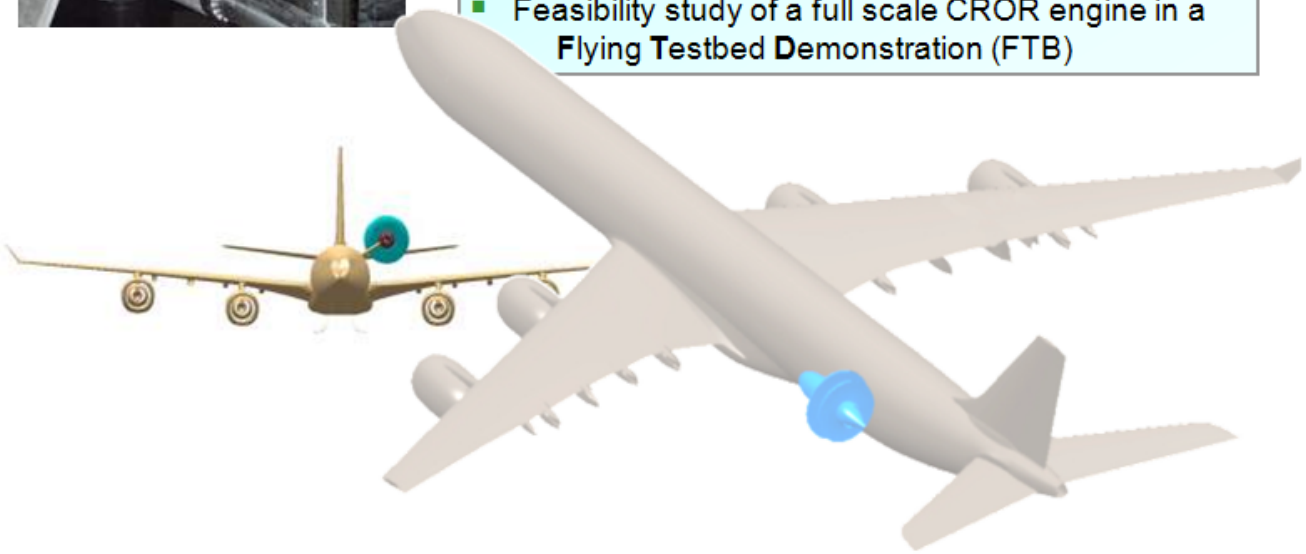
CROR Aero -Acoustic experimental characterization



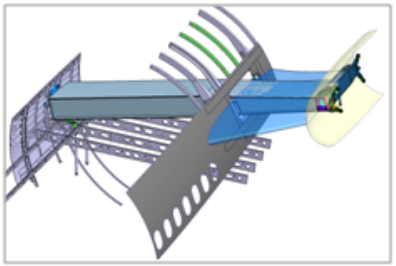
Innovative Power-Plant Integration

- Design of innovative CROR blades and pylon
- CROR installation effects: aero, noise, vibrations, handling qualities
- CROR propeller kinematics, study of fragment impact depending on size and propeller and fuselage materials
- Structural technologies for armour and shielding
- Feasibility study of a full scale CROR engine in a **F**lying **T**estbed **D**emonstration (FTB)

CROR design study: interference with HTP



Airbus A340-600 Flying Test Bed with CROR engine



CROR structural integration concept

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SFWA- ITD Main Activities in 2012

Envisioned major activities, achievements and milestones for 2012

- Completion of detailed design activities for the “High Speed demonstrator Passive” (HSDP)
- Completion of the CROR feasibility study.
- Preliminary Design Review for CROR-engine demonstrator Flying Test Bed (CROR demo-FTB)
- Start of manufacturing for the Low Speed Demonstrator Passive
- Conduct of wind tunnel test for low speed handling quality as part of the flight clearance process for the HSDP.
- Conduct of major wind tunnel test to select a CROR engine – blade target design.

SFWA- ITD Main Activities in 2012

Envisioned major activities, achievements and milestones for 2012 (cont.)

- Completion of the smart wing leading edge structural feature demonstrator, preparation for testing
- Conduct of wind tunnel tests with concepts for the integration of innovative engines in Business Jets.
- Wind tunnel tests with 2.5D active flow control high performance high lift concepts for laminar wings.
- In flight testing of surface coatings for laminar wings

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Aeronautics priority R&T in CleanSky

Smart Fixed Wing Aircraft ITD

CLEANSKY

is of major importance for European Aeronautics R&T

to fulfil on the ambitious targets of ACARE

The special priority R&T needs for large commercial Aircraft are covered in SFWA-ITD

- *by developing an all new smart low drag wing*
- *by integration of innovative power plants*
- *through large, representative flight test demonstration*
- *engaging a wide range of partners from all over Europe*

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List of Call#11 Topics of SFWA

Topic Number	Topic Titel	No	Budget/€/	Total/€/
JTI-CS-SFWA	**Clean Sky - Smart Fixed Wing Aircraft**	**15**	**11,350,000**	**8,512,500**
JTI-CS-SFWA-01	***Area01 – Smart Wing Technology***		**4,500,000**	
JTI-CS-2012-1-SFWA-01-041	Icephobic coatings – development of test methods		350,000	
JTI-CS-2012-1-SFWA-01-042	Flow control actuator with fast switching elements; unsteady operation with mass transfer		400,000	
JTI-CS-2012-1-SFWA-01-043	Testing the operational performance and robustness of Active Flow Control hardware		400,000	
JTI-CS-2012-1-SFWA-01-044	MEMS Gyrometer – Maturity assessment of performance and integration		800,000	
JTI-CS-2012-1-SFWA-01-045	MEMS Gyrometer – Miniaturisation of the analogue electronics in an Asic		800,000	
JTI-CS-2012-1-SFWA-01-046	MEMS Accelerometer – Miniaturisation of the analogue electronics in an Asic		800,000	
JTI-CS-2012-1-SFWA-01-047	High Lift Actuator Electronics		700,000	
JTI-CS-2012-1-SFWA-01-048	Magnetic Gearbox		250,000	
JTI-CS-SFWA-02	***Area02 - New Configuration***		**6,850,000**	
JTI-CS-2012-1-SFWA-02-020	Development of an automated gap filler device		550,000	
JTI-CS-2012-1-SFWA-02-022	Design and manufacturing of an innovative cryogenic wind tunnel model with motorized empennage		1,800,000	
JTI-CS-2012-1-SFWA-02-024	Laminar Wing Optimisation using Adjoint Methods		250,000	
JTI-CS-2012-1-SFWA-02-025	Development of ice-fracture criteria for different ice-cases in an electro-mechanical deicing system		300,000	
JTI-CS-2012-1-SFWA-02-026	Experimental and numerical investigation of acoustic propagation through a boundary layer in high speed conditions (refraction and scattering)		750,000	
JTI-CS-2012-1-SFWA-02-027	Transonic High Reynolds Number Testing of a Large Laminar Wing Half Model		1,200,000	
JTI-CS-2012-1-SFWA-02-028	Low speed aerodynamic test of large CROR aircraft model in a closed test section		2,000,000	
JTI-CS-SFWA-03	***Area03 – Flight Demonstrators***			

JTI-CS-2012-01-SFWA-01-041

CfP Topic Number	Title		
JTI-CS-2012-01-SFWA-01-041	ICEPHOBIC COATINGS – DEVELOPMENT OF TEST METHODS	Start Date	June 2012
		End Date	June 2013

Topic description: Budget,Objective headlines

Budget: **350.000,-- €**

Applicants for this topic will be expected to develop reliable test methods to characterise the anti-ice performance of coatings and surfaces. Suitable tests must include a level of artificial ageing to show how various surface properties may change over the service life of the coating with particular attention paid to icing performance. Work will be carried out with the support of the other partners involved in this particular work package.

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-01-042	**Flow control actuator with fast switching elements; unsteady operation with mass transfer**	**End date**	***Oct 2015***
		Start date	***Oct 2012***

Topic description: Budget,Objective headlines

Budget: **400.000,-- €**

A mock-up of a flow control actuator subsystem has to be developed, designed, manufactured and tested. The mock-up shall simulate a flight-ready actuator prototype for controlling flow separation on the high lift devices of transport and business aircraft.

Such a subsystem typically consists of one central or several distributed devices which create(s) a pulsed flow from a steady, pressurized supply (e.g. fast switching valves).

JTI-CS-2012-01-SFWA-01-042

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-01-043	**Testing the operational performance and robustness of Active Flow Control hardware**	**End date**	***June 2014***
		Start date	***Dec 2012***

Topic description: Budget,Objective headlines

Budget: **400.000,-- €**

The aim of this CfP topic is to enable a detailed characterisation of the operational performance of Active Flow Control (AFC) technology and its specific components as developed in the Smart Fixed Wing Aircraft Integrated Technology Demonstrator (SFWA-ITD). This is required for the evaluation of the Technology Readiness Level (TRL) of the particular AFC technology. The objective within the SFWA-ITD is reaching a TRL level of 6

JTI-CS-2012-01-SFWA-01-044

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-01-044	**MEMS Gyrometer– Maturity assessment of performance and integration**	**End date**	***31/01/2014***
		Start date	***02/07/2012***

Topic description: Budget,Objective headlines

Budget: **800.000,-- €**

The purpose of this CfP topic is the assessment of parameters such as cost, power consumption, weight, integration and variability, all of which have to meet critical values in order for the expected performance level to be reached, while keeping the degree of miniaturisation and sensor accuracy very close to the intrinsic level of accuracy of the cell containing the Micro Electro Mechanical System (MEMS)'s sensitive element. The applicant has to demonstrate a TRL of 5, i.e. component validation in relevant environment.

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-01-045	**MEMS Gyrometer – Miniaturisation of the analogue electronics in an Asic**	**End date**	***31/01/2014***
		Start date	***02/07/2012***

Topic description: Budget,Objective headlines

Budget: **800.000,-- €**

The purpose of this CfP topic is the miniaturisation of the Gyrix analogue and mixed-signal electronics in an Asic. The applicant shall demonstrate compliance with the specifications through a characterisation plan including functional tests, tests on regulated voltages and tests on power consumption.

Activities to be performed by the applicant include:
Design of the Asic;
Manufacturing and validation of dies.

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-01-046	**MEMS Accelerometer – Miniaturisation of the analogue electronics in an Asic**	**End date**	***31/01/2014***
		Start date	***02/07/2012***

Topic description: Budget, Objective headlines

Budget: **800.000,-- €**

The purpose of this CfP topic is the miniaturisation of the Accix analogue and mixed-signal electronics in an Asic. The applicant shall demonstrate compliance with the specifications through a characterisation plan including: functional tests, tests on regulated voltages and tests on power consumption.

Activities to be performed by the applicant include:
Design of the Asic;
Manufacturing and validation of dies.

JTI-CS-2012-01-SFWA-01-047

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-01-047	**High Lift Actuator Electronics**	**End date**	***April 2014***
		Start date	***July 2012***

Topic description: Budget, Objective headlines

Budget: **700.000,-- €**

This CfP topic addresses the design and manufacturing of an electronic controller for slat or flap surfaces which are part of the aircraft's high lift system. The controller is linked to two aircraft slat/flap computers and is to be designed with two legs (one Master and one Slave). It is intended to provide power to electrical units which will replace conventional hybrid systems (hydraulic and electrical) and to control redundant motors (two to three coils).

JTI-CS-2012-01-SFWA-01-048

CfP topic number	Title		
JTI-CS-2012-1-SFWA-01-048	**MAGNETIC GEARBOX**	**End date**	***April 2014***
		Start date	***July 2012***

Topic description: Budget, Objective headlines

Budget: **800.000,-- €**

This application targets new generation aircraft actuation systems. A magnetic gear is analogous to a mechanical planetary gear. It is able to transmit high torque in a volume that is similar to that of a mechanical gear by using an array of powerful rare earth permanent magnets. With the exception of its bearings, it does not have any contacting parts.

JTI-CS-2012-01-SFWA-02-020

CfP Topic Number	**Title**		
JTI-CS-2012-01-SFWA-02-020	**DEVELOPMENT OF AN AUTOMATED GAP FILLER DEVICE**	**Start Date**	**June 2012**
		End Date	**June 2013**

Topic description: Budget, Objective headlines

Budget: **550.000,-- €**

The applicant has to develop a prototype of an automated gap filler device. The device should be configured to demonstrate its function on the assembled ground based demonstrator. Typical gap widths are of the order of 3mm with depths in excess of 4mm and it is required that the final step height of the filled gap be within the tolerance of +/-0.1mm. The joint may be positioned in a region of mild double curvature. The device should be capable of operation within an assembly line and also as part of remote site maintenance. Full details of the surface requirements will be provided to the successful applicant.

JTI-CS-2012-01-SFWA-02-022

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-02-022	**Design and manufacturing of an innovative cryogenic wind tunnel model with motorized empennage**	**End date**	***Dec 2013***
		Start date	***Jan 2013***

Topic description: Budget, Objective headlines

Budget: **1.800.000,-- €**

The subject of this topic is the design and manufacturing of a full aircraft model for high speed high Reynolds wind tunnel test (WTT) in a cryogenic facility.

Both the configuration and testing techniques are innovative. The model will be used for an ambitious WTT of a high speed business jet at flight Reynolds number. The evaluation of the overall gain of laminarity on a representative aircraft configuration is to be done in a cryogenic facility to ensure the potential of the technology and to consolidate the choices.

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-02-024	**Laminar Wing Optimisation using Adjoint Methods**	**Start date**	***1st Sep 2012***
		End date	***31st Dec 2013***

Topic description: Budget, Objective headlines

Budget: **250.000,-- €**

The objective of this CfP topic is to develop and mature an optimisation method based on the Reynolds-Averaged Navier-Stokes (RANS) flow equations together with an accurate transition model using e.g. a robust Problem Solving Environment (PSE) method, for laminar wing design. Corresponding adjoint equations to the RANS and PSE, or equivalent, will provide the optimisation gradients of the total drag at a computation cost which is not dependent on the number of design parameters and which is accurate enough for use in gradient-based optimisation. The wing shape optimisation procedure must demonstrate the capability to carry out design in a realistic industrial context, e.g. dealing with realistic aircraft wing geometry including constraints.

JTI-CS-2012-01-SFWA-02-025

CfP topic number	Title		
JTI-CS-2012-1-SFWA-02-025	**Development of ice fracture criteria for different ice cases**	**Start date**	***T0***
		End date	***T0+18 M***

Topic description: Budget, Objective headlines

Budget: **300.000,-- €**

The subject of this CfP topic is the development of fracture criteria for ice, used in an ElectroMechanical Expulsion Deicing System (EMEDS). The criteria should be implemented and validated in a commercial Finite Element (FE) code.
The ice accretion and break-up behaviour is typically validated via an Ice Wind Tunnel (IWT) test, but in this case the ambition is to conduct simulations on a given profile and to analyse the data using an FE program (for example LS-DYNA, an explicit FE program) in order to better understand the dynamic behaviour and mechanical stresses in the ice and the adhesive interface between ice and skin. With ice fracture/ice adhesive criteria it is possible to predict the amount of pulse energy needed in order to remove the ice to given requirement. This energy has to be minimized.

JTI-CS-2012-01-SFWA-02-026

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-02-026	**Experimental and numerical investigation of Turbulent Boundary Layer (TBL) effects on noise propagation in high speed conditions**	**End date**	***June 2014***
		Start date	***June 2012***

Topic description: Budget, Objective headlines

Budget: **750.000,-- €**

Within the SFWA Integrated Technology Demonstrator, a specific Work Package is addressing the problems raised by the integration of the Counter Rotating Open Rotor Engine (CROR) to the aircraft in terms of aerodynamic performance and acoustic signature. The CROR noise transmission into the aircraft cabin in cruise conditions encompasses several complex phenomena, including some refraction due to the fuselage Turbulent Boundary Layer (TBL).

The aim of this CfP topic is (i) the acquisition of an experimental database and (ii) the development and assessment of numerical aero-acoustics methods able to predict TBL refraction and scattering effects on noise reaching an aircraft fuselage in high speed conditions.

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-02-027	**Transonic High Reynolds Number Testing of a Large Laminar Wing Half Model**	**End date**	***Dec 2012***
		Start date	***June 2012***

Topic description: Budget, Objective headlines

Budget: **1.200.000,-- €**

Objectives of WT experiment:

At high Reynolds number the experiment should:

Provide transition data with respect to allowable manufacturing tolerances for surface steps and surface waviness over a range of Mach number and angles of attack.
Provide data to validate CFD predictions on NLF wing designs.
Provide the necessary information to assess the feasibility of using large half models for transition studies applicable to NLF configurations.

JTI-CS-2012-01-SFWA-02-028

CfP topic number	**Title**		
JTI-CS-2012-1-SFWA-02-028	**Low speed aerodynamic test of large CROR aircraft model in a closed test section**	**End date**	***Dec 2012***
		Start date	***Aug 2012***

Topic description: Budget, Objective headlines

Budget: **2.000.000,-- €**

The applicant shall develop optimised engine feed and return lines (minimized pressure losses) to assure availability of maximum engine power.

The applicant shall test the model in a large low speed WT of their choice. This must be able to cover the following conditions:

Mach number ≥ 0.22;
Closed test section with a suitable wall correction methodology;
The test section should be larger than 8m of width by 6m of height;
The test section should allow the coverage of a full range of incidences up to deep stall and sideslip;
The model support shall allow full incidence and yawing angles at associated loads;
The applicant shall apply advanced steady and unsteady aerodynamic measurement methods.

Thank you for your attention!

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