# Clean Sky Joint Undertaking

# Airframe ITD

# Background

eco DESIGN

- Greener Airframe Technologies
- More Electrical a/c architectures

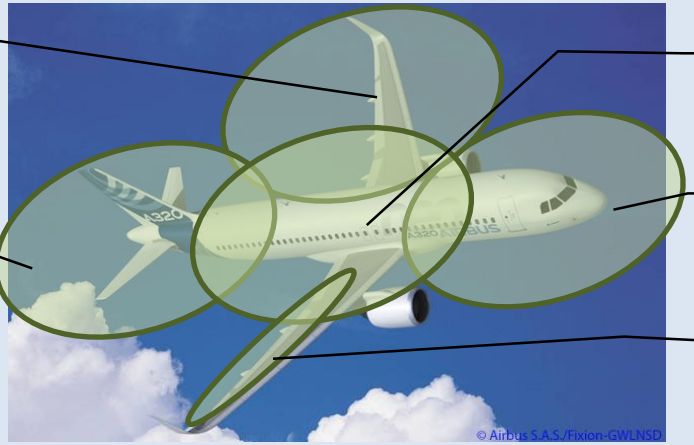

- More efficient wing
- Novel Propulsion Integration Strategy
- Optimized control surfaces

GRA GreenRegionalAircraft

- Integrated Structures
- Smart high lift devices

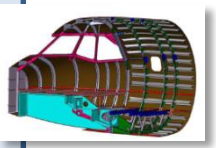
Re-think the wing

Re-think the a/c architecture




Re-think the cabin

Re-think the fuselage



Re-think the control

**Step changes in the "efficiency" of all airframe elements by the means of a systematic "re-thinking"**

Clean Sky JOINT UNDERTAKING

# Key General Objectives

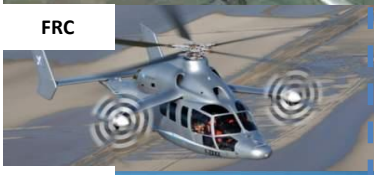
**More Efficient Airframes** ✓ Weight ✓ Drag ✓ Cabin ✓ Noise ✓ New Materials ✓ Maintenance

**Efficiency of the engineering & manufacturing process** ✓ Manufacturing Cost ✓ Time to Market (lead Time)

**IADP/Integrated Demonstrators**

REG

FRC



LPA

AIR Bizjet

SAT

**SUPPORT TO IADP**: Maturate technologies **up to TRL 6**

| High Performance & Energy Efficiency | | | | | High Versatility & Cost Efficiency | | | |
|---|---|---|---|---|---|---|---|---|
| Innovative Aircraft Architecture | Advanced Laminarity | High Speed Airframe | Novel Control | Novel travel experience | Next generation optimized wing | Optimized high lift configs. | Advanced integrated structures | Advanced Fuselage |

AIR Bizjet

LPA

REG

FRC

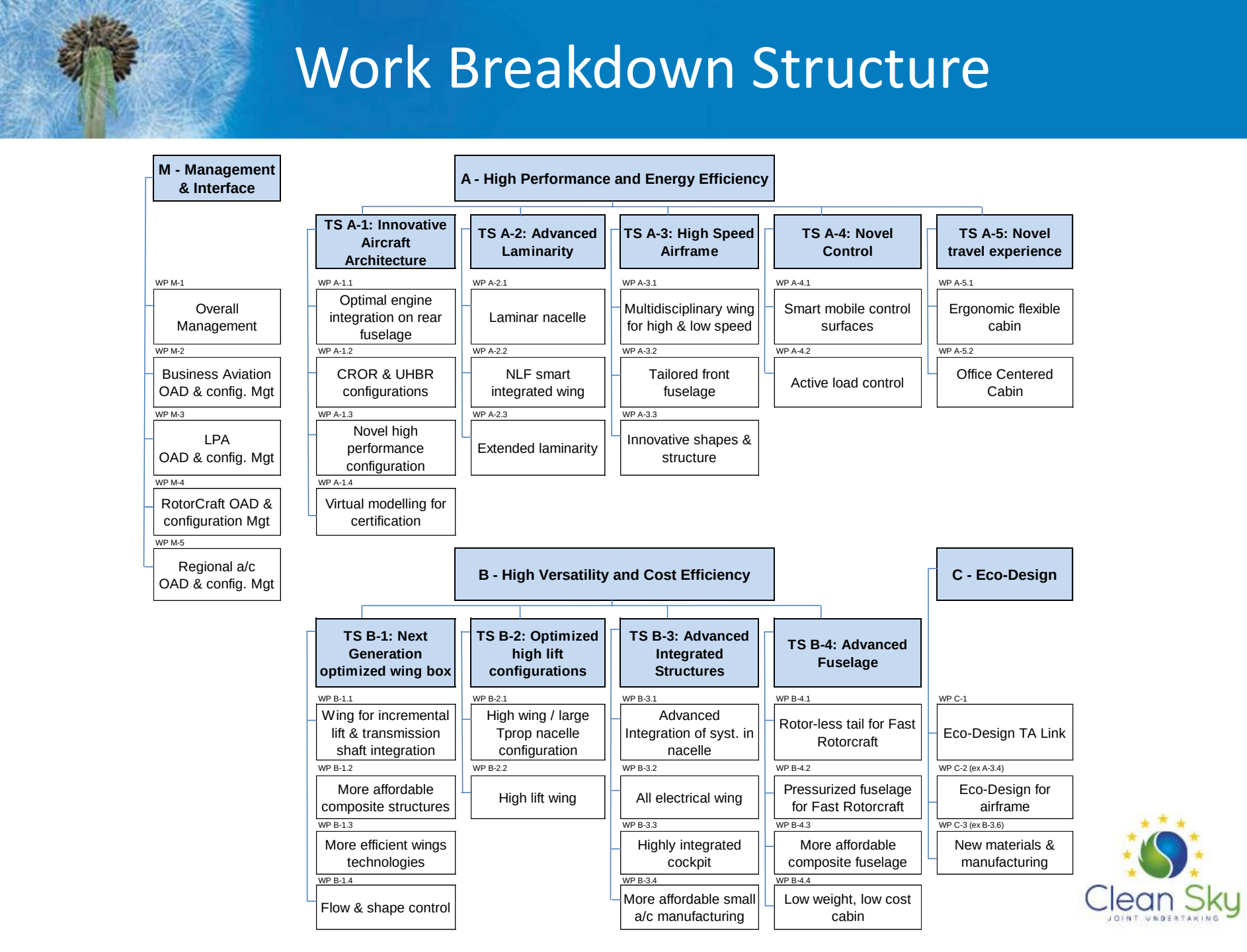
SAT

**TRANSVERSE** **Eco-Design** for Airframe & **Modeling to certification ability**

**FUTURE**: De-risk novel generation product in the prospect of changing step by 2030+

Clean Sky
JOINT UNDERTAKING

# Work Breakdown Structure




Clean Sky
JOINT UNDERTAKING

# Broad Participation: e.g. AIR (till CfP07)

| | Share of funding foreseen | Participants to date | Countries involved to date |
|---|---|---|---|
| Leader | 16.7% | 4* | 4 |
| Part. Leaders | 23.2% | 13* | 6 |
| Core Partners | 30.0% | 76* | 12 |
| Partners | 30.1% | 124** | 16** |

*incl. Affiliates and Third Parties
** till CfP04

**CfP PROJECTS**

DIMES RYTHMS DAHLIAS RADIANT PANEL BALANCE ACCURATE DADIYSO COMP DEMOS BRIDAS ADDAPTA SEALS NEODAMP FRCDOORDEMONSTRATOR IIAMS ASPIRE SHERLOC QSP HEFESTO SIMCODEQ TESTCONCERT LIGHTAIR RESET CIRA HAIRMATE NEWCORT Noesis Solutions NV MOTIVATE VULCAN DISTRACTION OPTIMORPH IAWAS C-JOINTS BLADEOUT PSIDESC FLEX RIB-ON INSCAPE AMTRAS COMBUSS REDISH ARIESS BINCOLA ERACLE MISSP EULOSAM II HEPODIS CRISTA MAF CRORTET FORMIT DILECO ELEMENT RODEO ASTRASY CRO-INSPECT CORDIAL ADD-ON COFRARE 2.0 COBOMEGA AFPMET PILOT OLFITT SMART-LAYUP AMULET TR4EMACS PIPS HAIRD I3PS WIN-TOOL E2S2A2 TAMI OASIS ADDMAN INDUCTICE WINBOXTOOL OPTIWIND SPECTRAL IMCA LABOR INNOHYBOX MEPAFUS OLTITA PASSPORT DOVER PRODIGE TRANSITION WINNER

## CORE PARTNERS

**AERNNOVA ENGINEERING DIVISION SAU (ATP)**
AERNNOVA Aerospace S.A.U. (ATP)
AERNNOVA Aerostructuras ALAVA, S.A. (ATP)
AERNNOVA Composites ILLESCAS S.A. (ATP)
Internacional de Composites SAU (ATP)
Fibertecnic SAU (ATP)
INTEC-AIR (ATP)
Componentes aeronauticos SA (ATP)

INVENT Gesellschaft mit beschränkter Haftung
PGA Electronic
SZEL-TECH
CT Ingenieros A.A.I. S.L.
Barcelona Supercomputing Centre
ALTRAN Deustchland SAS & Co KG
**INSTYTUT LOTNICTWA**
Polskie Zaklady Lotnicie sp zoo
SIEMENS Industry Software NV
Aero-Magnesium Limited ACS
Ultra Electronics LTD
Testing and Engineering of Aeronautical Materials and Structures SL
EUROTECH
Stichting Nationaal Lucht- en Ruimtevaartlaboratorium
DANOBAT S.Coop
**Israel Aerospace Industries Ltd.**
TECHNI-MODUL ENGINEERING
University of Sheffield
**Imperial College of London**
**ONERA**
TU DELFT
ZAKLADY LOTNICZE MARGANSKI & MYSLOWSKI SA
Università degli Studi di Napoli "Federico II"
Alma Mater Studiorum-Università di Bologna
University of Patras
**University of Nottingham**
Vrije Universiteit Brussel
Universitaet Stuttgart
Politecnico di Torino
Universidad Politécnica de Madrid
Fundación Centro de Tecnologías Aeronáuticas
Fundación Tecnalia Research & Innovation
Deutsches zentrum fuer Luft und Raumfahrt EV
Fundación Andaluza para el Desarrollo Aeroespacial
Fundacion para la Investigacion, Desarollo y Aplication de Materiales Compuestos
**FOKKER Aerostructures B.V.**
Fokker Technologies Holding B.V.
P.W Metrol Dabkowski Dariusz
RAMAL srl
CORIOLIS Composite Technologies
ACUMEN Design Associates Ltd
**MEGGITT Aerospace LTD**
Precision Micro Limited (ATP)
INtegrated Aerospace Sciences COrporation
ASCO Industries N.V.
Meggitt A/S
**CAETANO AERONAUTIC SA**
ALMADESIGN CONCEITO E DESENVOLVIMENTO DE DESIGN LDA
CRITICAL MATERIALS SA
EDISOFT-EMPRESA DE SERVICOS E DESENVOLVIMENTO DE SOFTWARE SA
GMVIS SKYSOFT SA
OPTIMAL STRUCTURAL SOLUTIONS Lda
CENTRO PARA A EXCELENCIA EINOVACAO NA INDUSTRIA AUTOMOVEL
TEKEVER - TECNOLOGIAS DE INFORMACAO, S.A.
Instituto de Ciencia e Inovacao EM Engenharia Mecanica e Engenharia Industrial
Instituto de Soldadura e Qualidade
AERTEC Ingenieria y Desarollos SLU
AVIAERTEC LDA
ARTUS SAS
**GEVEN Spa**
ULTRATECH Sp zoo
LORTEK S.COOP
AEROTEX UK LLP
GE Aviation
Akzo Noble Car Refinishes BV
Design Manufactoring Spa

## PARTICIPATING LEADERS**

AIRBUS HELICOPTERS
Fraunhofer
LEONARDO AIRCRAFT
PIAGGIO AEROSPACE
LEONARDO HELICOPTERS
AIRBUS

## LEADER

AIRBUS DEFENCE & SPACE
DASSAULT AVIATION
evektor
SAAB

**incl. Affiliates and Third Parties

[Project] = related to Small Air Transport

# AIR ITD - CfP Status – CfP09

**11 Topics**
**10.25 Meuro**

| | | | | |
|---|---|---|---|---|
| JTI-CS2-2018-CFP09-AIR-01-40 | Anticontamination Coatings and Cleaning Solutions for Laminar Wings | RIA | 2.00 | Airbus |
| JTI-CS2-2018-CFP09-AIR-02-68 | Spring-in prediction capability for large integral wing structure [SAT] | IA | 0.75 | Israel Aircraft Industries |
| JTI-CS2-2018-CFP09-AIR-02-69 | Biphasic Heat Transport Integration for Efficient Heat Exchange within Composite materials Nacelle | RIA | 0.80 | Airbus Defence & Space |
| JTI-CS2-2018-CFP09-AIR-02-70 | Development and application of an innovative methodology devoted for high temperature characterization of high efficient composite structures | RIA | 0.70 | Airbus Defence & Space |
| JTI-CS2-2018-CFP09-AIR-02-71 | Model Manufacturing and Wind Tunnel Testing of High Lift System for SAT Aircraft [SAT] | RIA | 0.80 | Piaggio Aero |
| JTI-CS2-2018-CFP09-AIR-02-72 | MEMS sensors, wireless and innovative measurement systems for validation of HVDC system Structure integration and for new SHMS architectures | IA | 0.60 | Airbus Defence & Space |
| JTI-CS2-2018-CFP09-AIR-02-73 | Material modelling platform for generation of thermoplastic material allowable | RIA | 1.25 | Airbus |
| JTI-CS2-2018-CFP09-AIR-02-74 | Development of a multipurpose test rig and validation of an innovative rotorcraft vertical tail | IA | 0.70 | Fokker Aerostructure |
| JTI-CS2-2018-CFP09-AIR-02-75 | Design Against Distortion: Part distortion prediction, design for minimized distortion, additive manufactured polymer aerospace parts | RIA | 0.75 | Airbus |
| JTI-CS2-2018-CFP09-AIR-02-76 | Cost analysis software platform for evaluating innovative manufacturing technology for SMART fuselage | RIA | 0.40 | Imperial College London |
| JTI-CS2-2018-CFP09-AIR-03-06 | Calibrating Ultrasonic Sensors for atmospheric corrosion. | RIA | 1.50 | Dassault Aviation |
| JTI-CS2-2018-CFP09-AIR: 11 topics | | | 10.25 | |

Clean Sky
JOINT UNDERTAKING

# AIR-01-40: Anticontamination Coatings and Cleaning Solutions for Laminar Wings

| Funding | 2000 K€ | Duration | 29 months |
|---|---|---|---|
| Type of action | | RIA | |

**Rationale:** Anticontamination is one of the key parameters to ensure a successful laminar wing application on a commercial aircraft. Therefore, the contamination must be removed from the wing to avoid boundary layer transition to turbulence.

**Objectives:** Understand the Insect's biochemistry, bio fluids rheology and complex interactions with surfaces and environmental conditions to allow the precise design and development of anti-contamination solutions and low adhesion coatings, targeting the key factors that cause the contamination of wings leading edge by insects.

**Main activities:**

a. Understand the biochemical modification of hemolymph in its environment
b. Identify the physico-chemical key factors of surface contamination
c. Develop the Surface coating solutions and Self-healing surface
d. Develop pre or post contamination cleaning solution
e. Wind tunnel test and/or flight test the developed anticontamination and cleaning solutions, with particular attention to erosion tests.

Smooth surfaces of laminar wings must be kept free from insect contamination

**Competences requested:**

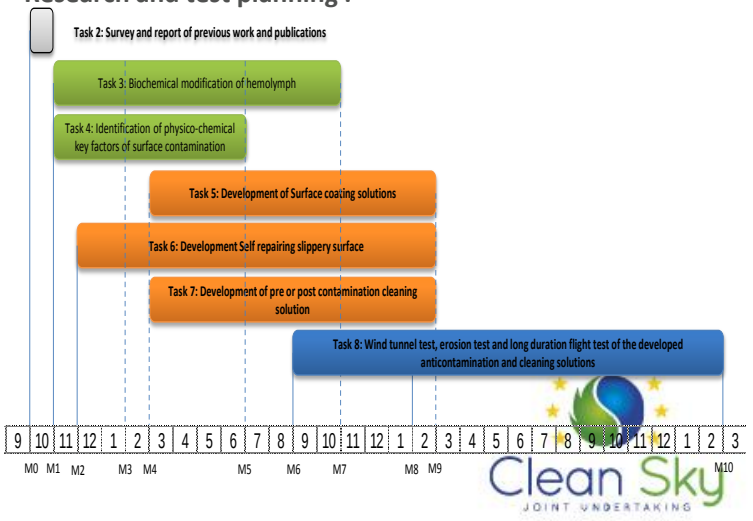
Materials and complex fluids (soft matter):
- Adherence
- Flow of complex fluids
- Visco-Elasticity

Non linear physics:
- Wetting, capillarity
- Hydrodynamics

Physical-Biology-interface:
- Mechanics of cells and tissues
- Tissue engineering
- Morphogenesis
- Intracellular Nano rheology

Complex System Modeling and Engineering :
- Complex system dynamic modeling
- System biology
- Synthetic biology

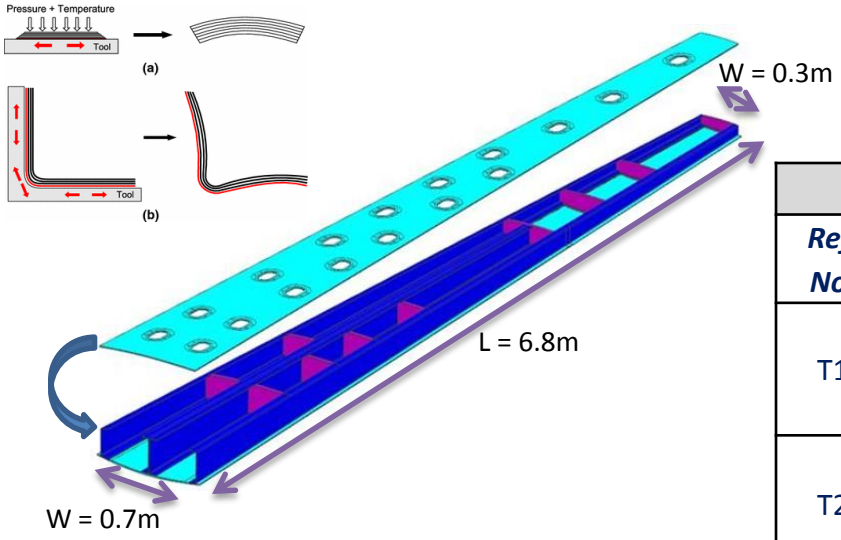
**Research and test planning :**



# AIR-02-68: Spring-in prediction capability for large integral composite wing structure.

**Large 7 Meter lower skin bonded to integral upper skin and 3 spars. Spring in deformations can challenge the success of part assembly**

| Funding | 750 K€ | Duration | 14 months |
|---|---|---|---|
| Type of action | | IA | |




| Objective/Activities | | |
|---|---|---|
| ***Ref. No.*** | ***Title - Description*** | ***Due Date*** |
| T1 | **Preferred Spring-in simulation method**: Optimum simulation approach will be chosen, improved and/or further developed | T0+5 |
| T2 | **Coupon manufacturing and testing** to understand the dominant factors which effect the spring-in phenomenon and to verify that the simulation tools | T0+10 |
| T3 | **Further Validation of Numerical model** The topic manager will provide a down scale demo representing a section of the integral OPTICOMS 7M wing box. The applicant will use his simulation approach to validate/calibrate his numerical approach. | T0+12 |
| T4 | **Implementation of the chosen simulation approach to the full OPTICOMS 7M wing-box demonstrator** | T0+14 |

**Competences Requested**

- ✓ Analytical Capabilities to understand and calculate complex deformations and residual stresses
- ✓ Coupon test manufacturing and testing capabilities
- ✓ Understanding of complex composite material behavior



Clean Sky JOINT UNDERTAKING

# AIR-02-69: Biphasic Heat Transport integration for efficient heat exchange within Composite materials Nacelle

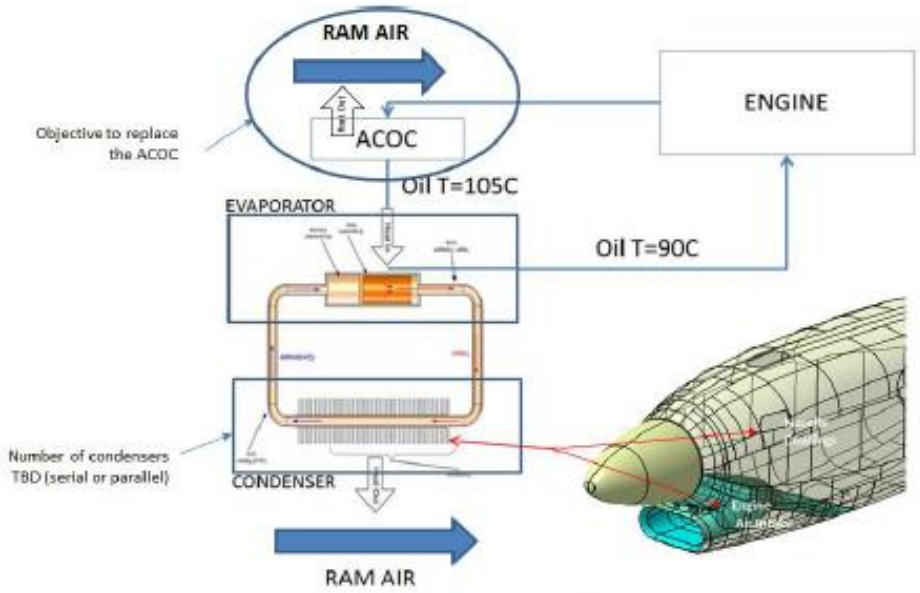
| | | | |
|---|---|---|---|
| Funding | 800 K€ | Duration | 30 months |
| Type of action | | RIA | |

## Objectives of Topic /Main Activities

To define and test a prototype, and validate a two-phase capillary pumped heat transport technology application able to replace (totally or partially) the usual powerplant oil cooling ACOC heat exchangers. In addition, it has to be able to provide (whether in series or parallel with the oil cooling) ice protection in a full composite engine air intake.

For the cooling purpose, the condenser is to be integrated with the nacelle doors and cowls manufactured in composite structure exposed to external air.

Final demonstration will end up with wind tunnel testing of a prototype in dry air and icing conditions.




## Competences Required

- Heat Transport devices
- R&T aerospace systems and structures.
- Fluid and thermal simulations
- Wind tunnel models

# AIR-02-70: Development and application of an innovative methodology devoted for high temperature characterization of high efficient composite structures

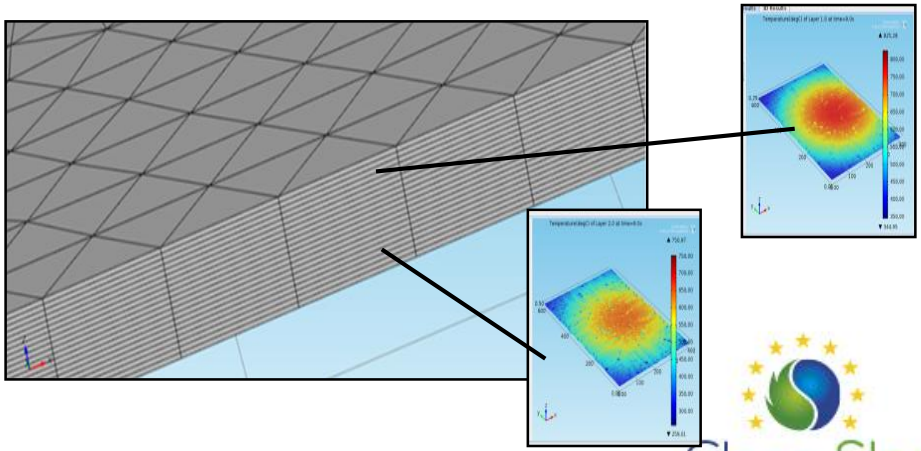
| Funding | 700 K€ | Duration | 24 months |
|---|---|---|---|
| Type of action | | RIA | |

## OBJECTIVES

- Provide an innovative testing lab environment for:
  - thermal events monitoring by innovative passive filtering techniques applied to termography
  - composite thermal properties characterizationby flash method or equivalent
- Evaluate thermo-mechanical behavior of thermoplastic loaded structures submitted to fire and high temperature air exhausts

## COMPETENCES

- R&T management of complex and international projects for aeronautical composite & metalic components
- Fast track trial and error methodology
- 3D Design SW, Structural Analysis
- Thermomechanical FEM competences
- Thermoplastic & thermosetting manufacturing and assembly processess
- Thermoplastic Raw materials internal development
- Fast NDI
- Material physico-chemical analysis



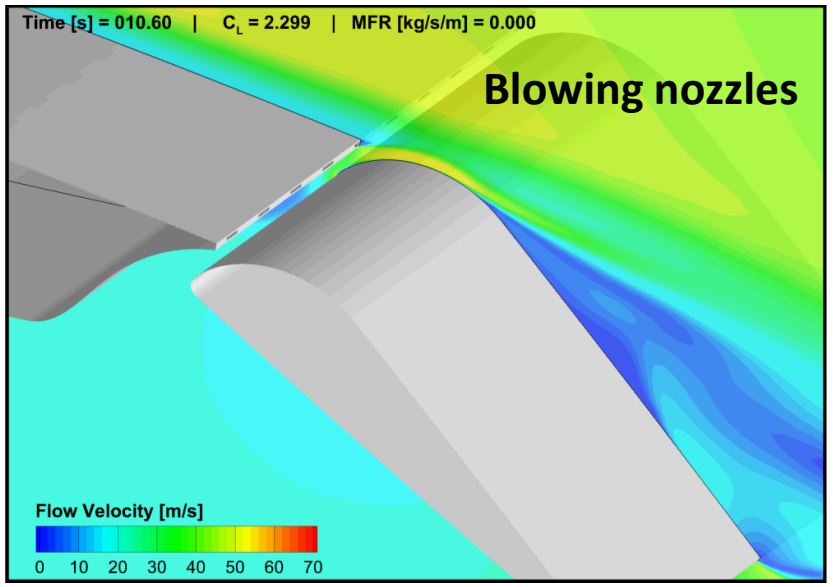
Clean Sky
JOINT UNDERTAKING

# AIR-02-71: Model Manufacturing and Wind Tunnel Testing of High Lift System for SAT Aircraft

| | | | |
|---|---|---|---|
| Funding | 800 K€ | Duration | 15 months |
| Type of action | | RIA | |

**Objectives of the topic/ main activities**

To validate the theoretical design of high lift systems developed for SAT aircraft through experimental tests, considerably reducing the risk of pure theoretical analysis.




**Competences requested**

- Wind Tunnel model design, manufacture and instrumentation setting capability.

- Availability of:

- force and moment balance
- pressure pipes
- pressure transducers
- data acquisition system

- Well proven experience in wind tunnel tests regarding flapped system in 2D configuration



Clean Sky
JOINT UNDERTAKING

# AIR-02-72: MEMS sensors, wireless and innovative measurement systems for validation of HVDC system Structure integration and for new SHMS architectures

## OBJECTIVE

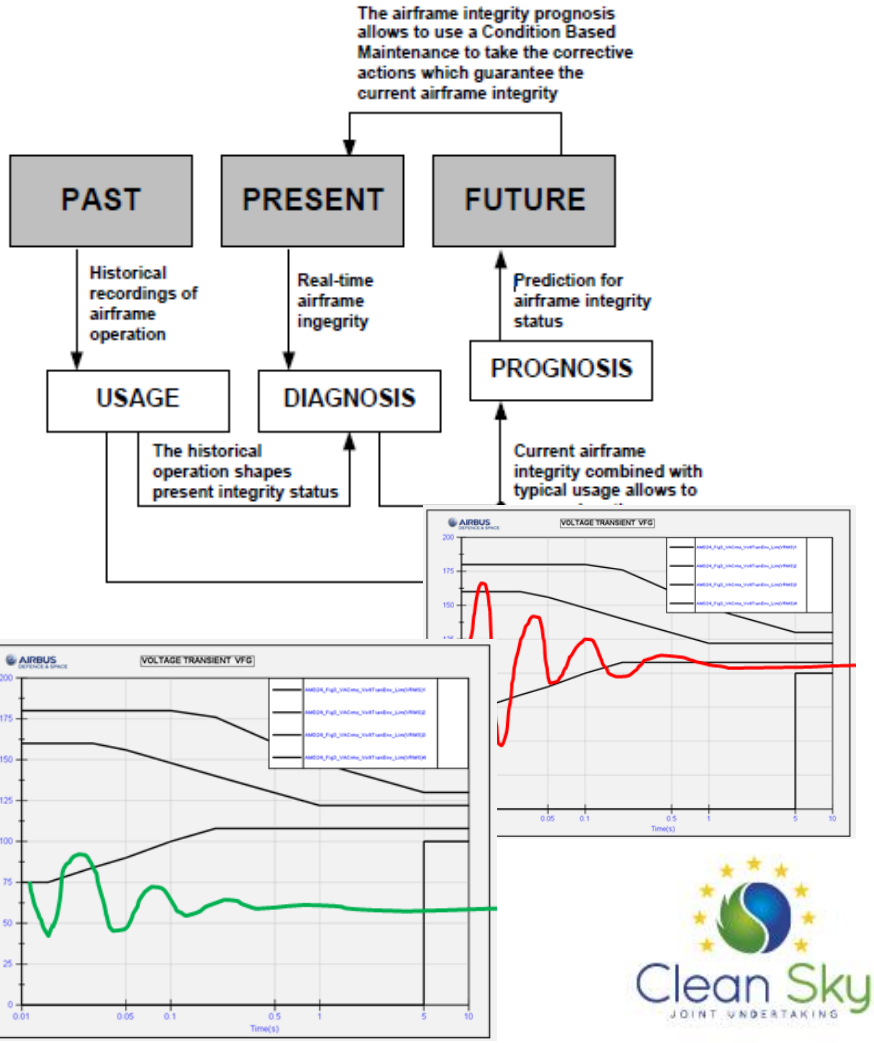
To demonstrate the feasibility of a common development for structure health monitoring , and electrical power quality, considering the integration of a unique validation test environment and equipment for:

- ❑ Structural event and damage diagnosis.
- ❑ HVDC electrical network diagnosis.

## COMPETENCES

- ❑ Directives/guidance: DEF-STAN 00-970 Part1 Sect3, SAE-ARP-6461, MIL-STD-704, AMD-24, DO-160, ABD100.1.8, DO-178C, DO-254.
- ❑ Test environment Design and manufacturing capabilities, including MEMS-based, energy harvesting and wireless technologies.
- ❑ Knowledge of structural Health Monitoring
- ❑ Computer Aided Design (CAD) capabilities.
- ❑ Knowledge of National Instruments HW
- ❑ National Instruments SW development capability
- ❑ Modelling capabilities using Matlab/Simulink tools
- ❑ Experience in aircraft structural and systems tests.
- ❑ Experience in structure/systems reliability assessment.

| | | | |
|---|---|---|---|
| Funding | 600 K€ | Duration | 24 months |
| Type of action | | IA | |




Clean Sky
JOINT UNDERTAKING

# AIR-02-73: Virtual Allowable Platform for thermoplastics

**Objectives**

- Replace a significant amount of physical tests (material screening/characterisation & certification phases)
- Reduce lead time for material data availability for design (early phases of A/C development)

**Main activities**

- Thermoplastic material test characterization at ply and interface level in order to observe main damage and failure mechanisms
- Creation of a novel thermoplastic material damage and failure model to be implemented in ABAQUS solver
- Parametric coupon models creation for virtual design allowable automated generation (eg. Open hole tension/compression)
- Uncertainty Quantification and Management principles definition for virtual design allowable (B-values)
- Platform/tool encompassing all above activities with a friendly user interface

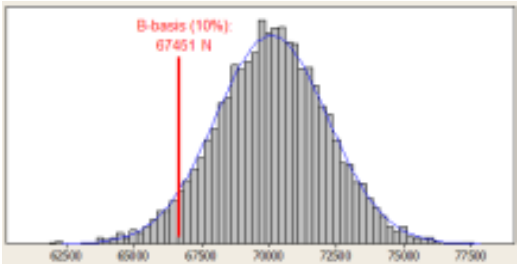
**Competences requested**

- Specialist in advanced structural numerical analysis with advanced skills in composite failure modelling.
- Experience with probabilistic methods (e.g. Monte Carlo, Latin Hypercube, Mean Value Method, 1st and 2nd order Reliability Methods, etc.).
- Track-record in having material models selected to be implemented in commercial Finite Element codes.
- Track-record in defining best-practice guidelines for the use of analysis methods at industry level.
- Experience in high strain rate testing of polymer composites using Hopkinson Bars.
- Track-record in manufacturing thermoplastic composites.
- Nadcap and ISO17025 accredited lab to perform experimental characterization of non-metallic materials.

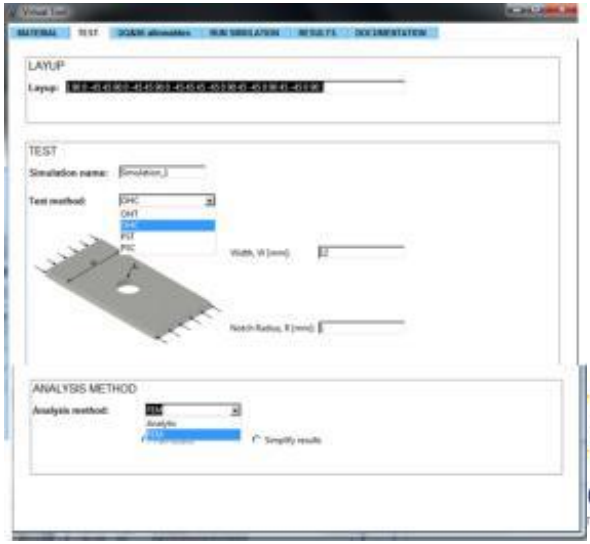
| Funding | 1250 K€ | Duration | 36 months |
|---|---|---|---|
| Type of action | | RIA | |

Open-hole coupon

B-values




Tool prototype



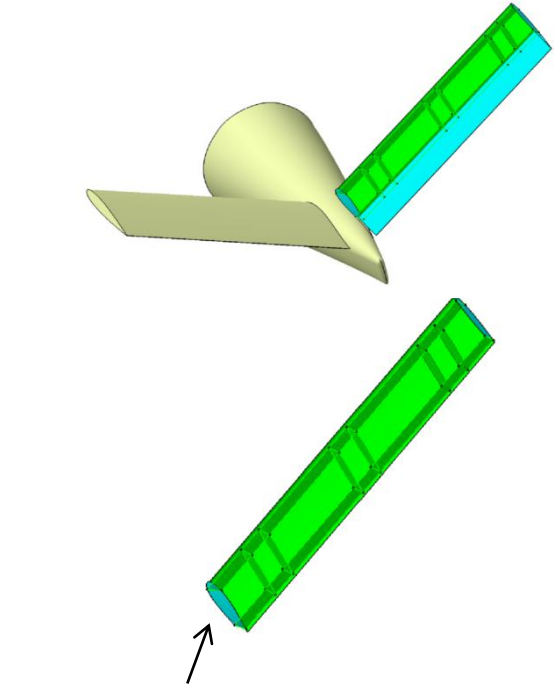
# AIR-02-74: Development of a multipurpose test rig and validation of an innovative rotorcraft vertical tail

| Funding | 700 K€ | Duration | 30 months |
|---|---|---|---|
| Type of action | | IA | |

**Short Description**

The goal of this Call for Proposal is to support activities towards a 'Permit to Fly" for test flights by supplying test evidence to the airworthiness authorities to ensure safe and reliable operation of the aircraft. The envisioned tests and tasks are:

- Spar to skin joint test
- A full scale component test including Fin to Aft body attachment or equivalent test
- Design and manufacturing of innovative experimental test set-up
- Numerical validation & correlation
- Simulation and analysis of spar to skin joint




**Special skills / Capabilities:**

- The applicant shall have experience with providing convincing evidence to airworthiness organizations.
- The applicant will have a demonstrated experience in advanced simulations and testing for interface disbond analysis.
- The applicant should have work-shop facilities in line with the proposed deliverables and associated activities or, if such equipment is not available, have existing relation with institutions or companies that accommodate such equipment.

| | 2019 Q4 | 2020 Q1 | 2020 Q2 | 2020 Q3 | 2020 Q4 | 2021 Q1 | 2021 Q2 | 2021 Q3 | 2022 Q1 | 2022 Q2 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Design & manufacturing of multi-purpose test rig** | | | | | | | | | | |
| **Test Execution** | | | | | | | | | | |
| **Numerical Validation & correlation** | | | | | | | | | | |
| **Simulation and analysis of spar to skin join** | | | | | | | | | | |

# AIR-02-75: Design against Distorsion: Part distorsion prediction, design for minimized distorsion, additive manufactured polymer aerospace parts

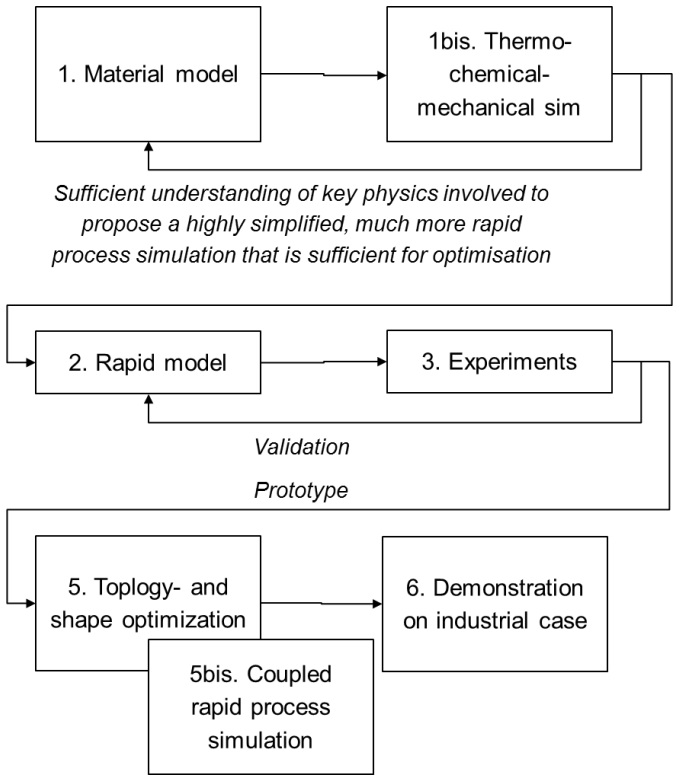
| Funding | 750 K€ | Duration | 36 months |
|---|---|---|---|
| Type of action | | RIA | |

**Objectives:**

- Develop rapid methods to predict material degradation, crystallinity and distortion of additive manufactured PAEK parts, with or without fibre reinforcement;
- Develop methods and tools for topology and shape optimization accounting for distortion;
- Fused Filament Fabircation and ThermoMELT (has certain similarities with Selective Laser Sintering).

**Required:**

- Experience with non-linear simulation of polymer transformation processes, such as moulding, welding, selective laser melting: coupled thermal-chemical-mechanical analysis.
- Fused Filament Fabrication machine, capable of building PAEK test articles. Laboratory-type environment: experiment with build strategies, measure shape distortions accurately.
- Experience with topology-, shape- and fibre reinforcement optimisation, the corresponding sensitvity analysis (both for shape- as well as for topology optimization) and prior work on design optimisation algorithms for 3D cases involving process simulation and optimization with uncertainties.



# AIR-02-76: Cost analysis software platform for evaluating innovative manufacturing technology for SMART fuselage

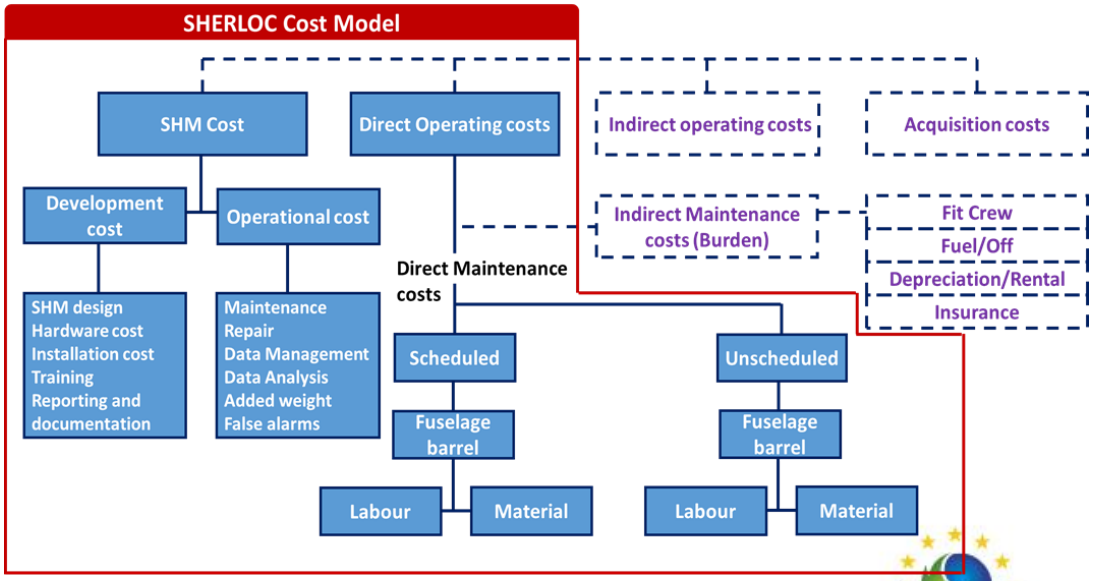
| Funding | 400 K€ | Duration | 24 months |
|---|---|---|---|
| Type of action | | RIA | |

**Objectives of the topic/ main activities:** to develop an open source software to allow full cycle cost analysis for innovative composite manufacturing for sensorized fuselage barrels.
The software should provide platform to adopting different cost estimation strategies generally adopted within the aeronautics industry , namely:

- Analogous cost estimation (based on actual historical data with cause and effects understood)
- Parametric cost estimation (statistical uncertainty of the forecast; allows for scope of quantifying risk)
- Bottom-up estimation frame work for all new products and manufacturing routines.

**Competence:**

- Expertise in developing cost models for composite parts
- Expertise in development of open-source modular software platforms
- Experience and knowledge of multi-disciplinary optimization
- Experience and knowledge of non-linear finite element analysis
- Knowledge of composite manufacturing, repair and maintenance processes and costs
- Knowledge of estimating operative cost for transport aircraft



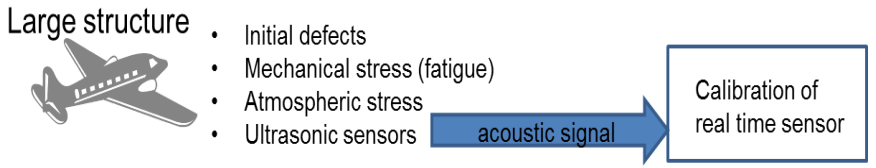
# AIR-03-06: Calibrating Ultrasonic Sensors for atmospheric corrosion

**Objectives of the topic**

Make corrosion sensors reliable assets for maintenance decisions

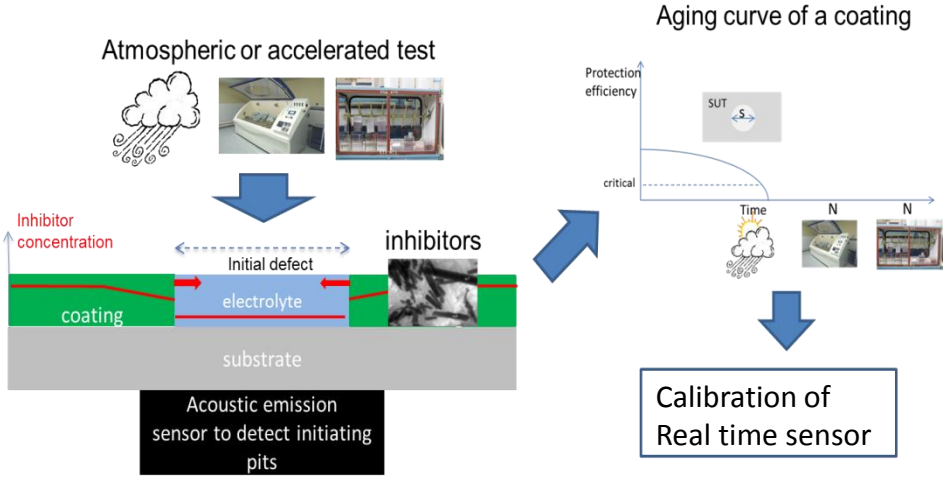
- Corrosion sensors are not new !
- There are already commercial offers
  Ex: AIRCORR (FR), Luna Box (US), BAe SENTINEL (AU)
- Yet, quite few aircraft operators use them
- They still don't know what to do with information provided.
- Connecting sensor's signal to real damages on flying structure is what we call calibration in this project.

| Funding | 1500 K€ | Duration | 36 months |
|---|---|---|---|
| Type of action | | RIA | |




**Competence:**

- Expertise in corrosion of coated aluminum alloys.
- Expertise in aircraft coatings and protection schemes.
- Machining capacities.
- Background in mechanical testing (fatigue, stress).
- Background in corrosion monitoring and accelerated tests.
- Background in non-destructive testing
  - high energy methods (X rays, neutrons, etc.)
  - acoustic sensors (active and passive).
- Background in structural health monitoring in general.
- Background in advanced signal analysis and pattern recognition.




Clean Sky
JOINT UNDERTAKING

# Thank You

Clean Sky 2

AIRBUS

AIRBUS HELICOPTERS

FINMECCANICA HELICOPTER DIVISION

FINMECCANICA AIRCRAFT DIVISION

DASSAULT AVIATION

DLR

AIRBUS DEFENCE & SPACE

evektor

Fraunhofer

LIEBHERR

MTU Aero Engines

PIAGGIO AEROSPACE

Rolls-Royce

SAFRAN AEROSPACE · DEFENCE · SECURITY

SAAB

THALES

Clean Sky JOINT UNDERTAKING