Innovation Takes Off

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Clean Sky 2 Information Day

AIRFRAME ITD

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From *Clean Sky* towards *Clean Sky 2*

- Greener Airframe Technologies
- More Electrical a/c architectures

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

- Integrated Structures
- Smart high lift devices

**Step changes in the “efficiency” of all airframe elements by the means of a systematic “re-thinking”**
### From the Impact Perspective

<table>
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<tr>
<th>From the</th>
<th>Expected Impacts</th>
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<tbody>
<tr>
<td><strong>Environmental Perspective</strong></td>
<td>• More resource efficient aircraft : challenging targets for up to&lt;br&gt;• ( \leq 30% ) cumulative ( CO_2 )&lt;br&gt;• ( \leq 10 ) EPNdB&lt;br&gt;• Eco responsible industrial capabilities</td>
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<tr>
<td><strong>Smart &amp; Efficient Mobility Perspective</strong></td>
<td>• Increased operational flexibility (flight domain)&lt;br&gt;• Access to dense populated areas : low noise and low speed performances&lt;br&gt;• Access to remote areas performances : short take off and landing, reduced a/c ground infrastructure, remote repairing&lt;br&gt;• Travelling Time not as a wasted Time : passenger well-being&lt;br&gt;• Sustainable traffic growth</td>
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<tr>
<td><strong>Industrial Leadership Perspective</strong></td>
<td>• Cost efficient Products&lt;br&gt;• Strong Product Differentiators&lt;br&gt;• Cost efficient engineering, manufacturing &amp; life cycle support processes (up to recycling)&lt;br&gt;• Reduced time to market&lt;br&gt;• Sustainable industrial capability</td>
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# Overall Technical Overview

<table>
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<tr>
<th>Focused Integrated Demonstrations</th>
<th>Innovative Aircraft Architecture</th>
<th>Advanced Laminarity</th>
<th>High Speed Airframe</th>
<th>Novel Control</th>
<th>Novel travel experience</th>
<th>Next generation optimized wing</th>
<th>Optimized high lift configs.</th>
<th>Advanced integrated structures</th>
<th>Advanced Fuselage</th>
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<tbody>
<tr>
<td>Investigate advanced engine integration &amp; novel overall architecture</td>
<td>Laminar nacelles; NLF smart integrated wing fitting the industrial environment</td>
<td>High efficient multi-disciplinary flexible wing; fuselage changes in shapes, &amp; structure</td>
<td>Smart multi-function control surfaces &amp; load &amp; flutter alleviation</td>
<td>Passenger friendly cabin; ergonomic &amp; flexible, new volume utilisation</td>
<td>Low cost composite structures</td>
<td>Efficient architectural concept for turbopropeller high wing – composite nacelle &amp; adaptative wing</td>
<td>New structural paradigm for optimised integration of systems in airframe, electrical wing</td>
<td>Novel composite fuselage &amp; tailless or pressurized fuselage for rotorcraft</td>
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<tr>
<th>Transverse Enabling Capability</th>
<th>Novel Certificate®</th>
<th>Extended Laminarity</th>
<th>Eco Design</th>
<th>More Efficient Wing</th>
<th>Advanced Manufact.</th>
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**CW1 : AIRFRAME ITD ST List**

- **6 Strategic Topics (ST)**
- **Total funding of 43,5 M€**

<table>
<thead>
<tr>
<th>Activity Line</th>
<th>Identification</th>
<th>Title</th>
<th>Leading Company</th>
<th>Funding (M€)</th>
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<tbody>
<tr>
<td>A, B</td>
<td>AIR-01-01</td>
<td>New Innovative Aircraft Configurations and Related Issues</td>
<td>DAv, Airbus, A-H</td>
<td>14</td>
</tr>
<tr>
<td>A</td>
<td>AIR-01-02</td>
<td>e-WIPS integration on novel control surface</td>
<td>DAv, Airbus</td>
<td>5</td>
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<tr>
<td>B</td>
<td>AIR-02-01</td>
<td>New wing and aircraft systems design and integration for Turboprop regional aircraft</td>
<td>CASA</td>
<td>5</td>
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<tr>
<td>B</td>
<td>AIR-02-02</td>
<td>Wing and Tail Unit Components Multifunctional Design and Manufacturing (including Out of Autoclave composite)</td>
<td>CASA, A-H</td>
<td>7,5</td>
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<tr>
<td>B</td>
<td>AIR-02-03</td>
<td>Advanced technologies for more affordable composite fuselage</td>
<td>ALENIA</td>
<td>6,5</td>
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<tr>
<td>B</td>
<td>AIR-02-04</td>
<td>Design and manufacturing of an advanced wing structure for rotorcraft additional lift</td>
<td>A-H</td>
<td>5,5</td>
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</tbody>
</table>
HPE Related WPs

A - High Performance and Energy Efficiency

TS A-0: Management & Interface
WP A-0.1 Overall Management
WP A-0.2 Business Aviation OAD & config. Mgt
WP A-0.3 LPA OAD & config. Mgt
WP A-0.4 Eco-Design Manag' & MPR technologies

TS A-1: Innovative Aircraft Architecture
WP A-1.1 Optimal engine integration on rear fuselage
WP A-1.2 CROR configuration
WP A-1.3 Novel high speed configuration
WP A-1.4 Novel certification processes

TS A-2: Advanced Laminarity
WP A-2.1 Laminar nacelle
WP A-2.2 NLF smart integrated wing
WP A-2.3 Extended laminarity

TS A-3: High Speed Airframe
WP A-3.1 Multidisciplinary wing for high & low speed
WP A-3.2 Tailored front fuselage
WP A-3.3 Innovative shapes & structure
WP A-3.4 Eco-Design for airframe

TS A-4: Novel Control
WP A-4.1 Smart mobile control surfaces
WP A-4.2 Active load control

TS A-5: Novel travel experience
WP A-5.1 Ergonomic flexible cabin
WP A-5.2 Office Centered Cabin

AIR-01-01 New Innovative Aircraft Configurations and Related Issues
AIR-01-02 e-WIPS integration on novel control surface

Note: a coloured square means a contribution of the ST to the WP
HVCE Related WPs

Air-01-01  New Innovative Aircraft Configurations and Related Issues

Air-02-01  New wing and aircraft systems design and integration for Turboprop regional aircraft

Air-02-02  Wing and Tail Unit Components Multifunctional Design and Manufacturing (including Out of Autoclave composite)

Air-02-03  Advanced technologies for more affordable composite fuselage

Air-02-04  Design and manufacturing of an advanced wing structure for rotorcraft additional lift

Note: when 2 coloured squares are on the same WP, the ST contribution are different
• Leading Companies: Dassault Aviation, Airbus, Airbus Helicopters
• Estimated Funding: 14 M€
• Duration: 8 Years
• Start date: 01/04/2015
• SoW Overview:
  – TS A-1 - Contribution of Core-Partners to engine relevant integration studies and to novel high efficiency configuration
  – TS A-2 – Contribution for part design optimization & manufacturing especially at level of technologies for laminar surfaces (wing and nacelle external surfaces)
  – TS A-4.2 - Development of methodology and system for the load, vibration and flutter active control, ground test and in flight tests and validation. Definition of an approach to certification.
  – TS B-1.1 - Aerodynamic design of compound rotorcraft wing and interaction with propellers, including effect on noise emission
  – TS B-4.1 - Aerodynamic design of compound rotorcraft tail surfaces
• A-1.1 - Rear Fuselage integration (examples)
  – Buried engines
  – BLI
  – High BPR engine
  – Vectored thrust

• A-1.3 - Novel High Efficiency Configurations (examples)
  – Innovative wing such as rhomboidal concept
  – Non-cylindrical fuselage
  – Flying wing

• A-2 – Advanced Laminar Flow
  – Laminar nacelle: aerodynamic design, structural concept for NLF, HLFC
  – NLF smart integrated wing
  – Extended laminarity: aerodynamic design and structural design for NLF, suction for HLFC
• **A-4.2 – Active Load Control**
  - Gust load alleviation
  - Counter-act flutter initiation or vibrations

• **B-1.1 – Wing for incremental lift and transmission shaft integration**
  - Wing surface design integrating interactional effects
  - Propeller surface design integrating interactional effects
  - Noise shielding effect of the wing and fuselage
  - Validation of aeroacoustic models

• **B-4.1 - Rotor-less Tail for Fast Rotorcraft**
  - Tail unit aerodynamic design
The capability of the CP shall be on a large range of areas as it is required to act at aircraft level. It means a multi-disciplinary set of skills. Important are:

- **Flow simulation and analysis** including capability to develop new methodologies,
- **A/C configuration design**, sizing and optimisation, MDO
- **Aero-structure design** (loads & flutter evaluation) and modelling
- Acoustic, fuel consumption and NOx emission **analysis and assessments**
- Development and demonstration of **active noise reduction** systems
- **WTT** specifications and result analysis including modelling correlations
- Abilities to organise and perform **distortion measurement in WTT**
- Development of methodology and system for the load, vibration and flutter **active control**, ground test and in flight tests and validation
- Aerodynamics: CFD modelling, Aero elasticity skills, Laminar flow technology, Flow control simulations
• Leading Companies: **Dassault Aviation, Airbus**

• Estimated Funding: **5 M€**

• Duration: **8 Years**

• Start date: **01/01/2015**

• SoW Overview:
  
  – This topic addresses all the aspects of **leading edge slat ice protection system technology**, design and certification for N+1 generation.

  – For the N+2 generation, continuation of exploration of **de-icing schemes** including the ability to create accurate computer models of their operation. The goal would be to develop completely the **processes and tools** needed to optimise the design of such systems.

  – For the N+3 generation (entering service in the 2030s) laying the foundation of **radically new approaches** to ice protection, offering opportunities to study technology with lower maturity.
• **Electro-thermal** and **mixed air/electric** running wet anti-ice wing inner section demonstrator, focused on a **business jet** wing with a polished aluminium leading edge
  – Development and demonstration to TRL 6 (IWTT, integration to Copper Bird)
  – Associated theoretical and experimental study of **manufacturing techniques**
  – **Flat samples** of various heating mat fabrications including polished aluminium erosion shield and heating element assembled

• **3D simulation of accretion and operation** of a running-wet anti-ice system in the context of the **air intake** to the embedded central engine in a **three-engine business jet**

• Development of a TRL 5 prototype of a **travelling wire bundle or similar device** to connect heaters on a movable leading edge slat to the electrical harness

• Integrate accurate models of ice shedding and ice fracture in general purpose ice protection simulation tools, and achieve the **simulation capability** of:
  – **Electro-thermal de-icing systems** consistent with a development at TRL 4
  – **Electro-mechanical de-icing systems** consistent with a development at TRL 3

• In liaison with the SYSTEMS ITD, study to define and **optimise the electric architecture** compliant with power availability requirements common to all **large jets** in conjunction with a suitably designed ice protection system

• **Innovative materials and coatings** for surfaces equipped with passive ice protection

• Technology down-selection process applied to breakthrough approaches to **ice-protection** for jets entering service in the **2030s**.
• Leading Companies: **EADS CASA**
• Estimated Funding: **5 M€**
• Duration: **7 Years**
• Start date: **01/01/2015**
• Overview:
  Design, manufacturing and qualification for flight adapted for new wing for an aircraft of the size of the regional turboprop:
  – FCS: EMA and associated ECU
  – EPDS: Electrical distribution unit
  – IPS: Anti-ice technology solution integrated on a representative surface
  – SATCOM:
    • RF Unit (radiating element, amplifier…) integrated on a representative surface
    • Integration of an antenna system on structure
  – Landing Gear:
    • Instrumented bolt
    • Electrical valve and shock absorber
For each component:

- Support to WAL in performing the **trade-off** between different alternatives
- **Detailed specifications and requirements** of equipment based from the high level requirements received from WAL
- **Preliminary definition** of equipment (including the integrated concept) → PDR
- **Detailed design** of equipment → CDR
- Validation and Qualification **Test Plan** Definition
- Definition of **Laboratory Test Bench** Specification
- **Manufacturing, Assembly and Tuning** of equipment
- **Validation and Qualification Tests** realization and results
- Component **documentation** and support to obtain the FTB2 Airworthiness
- **Support to flight testing** campaign.
Main Skills, certification and equipment expected:

- Capacity to support documentation and means of compliance to achieve prototype “Permit to Fly” with Airworthiness Authorities (FAA, EASA...)
- Capacity to specify components and systems tests along the design and manufacturing phases of aeronautical equipment
- Capacity to provide support to system functional tests of large aeronautical equipment: Definition + Preparation + Analysis
- Product Organization Approvals (POA)
- Capacity to support to structural and functional tests of antenna system
- Certified facilities for the antenna measurement
For each component:

<table>
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<tr>
<th>Milestones</th>
<th>Year 2015</th>
<th>Year 2016</th>
<th>Year 2017</th>
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</table>
• Leading Companies: **EADS CASA**, Airbus Helicopters
• Estimated Funding: **7,5 M€**
• Duration: **7 Years**
• Start date: **01/01/2015**
• Overview:

Design and manufacture aeronautical components for Clean Sky 2 demonstrators: **Regional Aircraft FTB2 → wing components**; **LifeRCraft → tail unit**. These components will include the state of the art in:

– Composite manufacturing (i.e. out of autoclave processes)
– Innovative materials (i.e. thermoplastics)
– Adaption of structural architectures to host highly integrated systems

With optimisation criteria such as Eco-Design, Low Cost, High Quality and Low Weight objectives and requirements

Sharing is 66% wing, 33% tail
Components to be developed, manufactured and validated to TRL 6 are:

For the **Regional Aircraft FTB2**:
- Outer External Wing – Upper Skin: innovative materials and manufacturing process
- Winglet: morphing design to improve a/c performance
- Out-Board Flap: new design to improve a/c performance
- External Wing Leading Edge: morphing design to improve a/c performance
- Outer External Wing – Ribs: innovative materials and manufacturing process

For the **LifeRCraft**:
- Tail Boom: innovative materials, manufacturing process and light weight structures.
- HTP: innovative manufacturing process and design to improve R/C performance and light weight structures
- VTP: innovative manufacturing process and design to improve R/C performance and light weight structures
- Surface Control: innovative manufacturing process and design
Main Skills, certification and equipment expected:

- Design and manufacturing of structures of composite materials (thermoset and thermoplastic) and innovative metallic components
- Experience in collaborating with reference aeronautical companies with industrial air vehicle developments with “in–flight” components
- Capacity of providing large aeronautical components within industrial quality standards
- Capacity to support documentation and means of compliance to achieve experimental prototype “Permit to Fly” with Airworthiness Authorities (i.e. EASA, FAA and others which may apply)
- Design Organization Approval (DOA)
- Product Organization Approvals (POA)
- Qualification as Material and Ground Testing Laboratory of reference aeronautical companies (i.e. ISO 17025 and Nadcap)
• For each component:

<table>
<thead>
<tr>
<th>Year</th>
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**MILESTONES Regional Aircraft FTB2 Wing components**

- Kick-off
- FDR: Feasibility Design Review
- PDR: Preliminary Design Review
- Tooling
- CDR: Critical Design Review
- TRR: Test Readiness Review
- Assembly
- Delivery
- FLIGHT

**MILESTONES LifeRCraft Tail Unit components**

- Kick-off
- FDR: Feasibility Design Review
- PDR: Preliminary Design Review
- Tooling
- CDR: Critical Design Review
- Assembly
- Delivery
- TRR: Test Readiness Review
- FLIGHT
Leading Companies: Alenia Aermacchi

Estimated Funding: 7,5 M€

Duration: 7 Years

Start date: 01/04/2015

Overview:

Improvement of advanced technologies and methodologies coming from the Clean Sky - GRA ITD, FP7 MAAXIMUS, FP7 SARISTU to make them ready for the industrialization phase of a new regional aircraft fuselage.

2 lines of activities to be performed the CP:

- Development of advanced methodologies and technologies for maintenance, repair, non-destructive inspection and structural health monitoring;
- Fuselage components design, manufacturing and testing for verification and validation of new methodologies and technologies
Advanced methodologies and technologies for maintenance, repair, NDI and SHM

• Related technologies:
  – Self-monitoring and self-repairing of composite structures
  – Health monitoring and inspection interval determination
  – Residual strength assessment
  – Structural degradation assessment
  – Advanced repair technologies aimed at improving safety and reducing service costs

• Tasks:
  – Maintenance and repair
  – SHM methodology and technology maturation to TRL 6

Manufacturing & testing for Verification and Validation

• Skin/stringers: pre-preg technique shall be used with technologies for inclusion of new functionalities (examples):
  – Embedded damping veil for acoustic improvements
  – Embedded EME and Lightning features (as well as nano-materials or further suitable solutions)
  – Integrated thermal protection

• For fittings, aft. pressure bulkhead, windows frames: advanced processes such as RTM, thermoplastic forming to be improved for industrialization.
AIR-02-03: Advanced Technologies for More Affordable Composite Fuselage (3/3)

SKILLS and SCHEDULE

• Special skills, capabilities

| Leadership | International proven experience leading in European project with wide expertise in management of research first level work package. |
| Designer and Stress Analyst | Proven competence in leading large-scale structural analysis, with emphasis on damage, impact, wave propagation. |
| Manufacturer | Proven experience from manufacturing of substructures in form of a real scale A/C panels and integration of SHM systems. |
| Optimizer | Internationally leading specialists in numerical optimization. |
| Massive computation | Internationally leading HPC-specialists in HPC, large-scale dynamic non-linear structural analysis and advanced damage modelling. |
| NDI specialist | Proven experience on non-destructive inspections. |
| Experimentalist | Appropriate experience in experimental testing and in particular in impact and residual strength testing of stiffened composite panels. |
| Repair specialist | Proven experience in composites A/C repair. |
| Certifier | Proven experience in A/C certification and setting up inspection schemes. |

• Schedule

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<tbody>
<tr>
<td>B-HVE</td>
<td>Advanced Fuselage</td>
<td>Feasibility development, manufacturing</td>
<td>TRL 3/4</td>
<td>TRL 4</td>
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<td>TRL 5: Components validated for IADP integration testing</td>
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TRL 3/4, TRL 4, TRL 5, TRL 6

large full-scale demonstrators, support to IADPs
• Leading Company: **Airbus Helicopters**
• Estimated Funding: **5,5 M€**
• Duration: **5,5 Years**
• Start date: **01/04/2015**
• Overview:

  Development, manufacturing and test of wings for Fast Rotorcraft (Compound). The wings consist of:
  - Main structure (Spars, skins, fuselage attachment)
  - Flaps over full wing-span (20% to 30% of chord)
  - Structural provisions for Landing Gears, Propeller Gear Boxes, Flaps actuation, Propeller Drive Shafts, Landing Gears (TBC)
  - Maintenance openings/covers
  - Fairings: interface fuselage/wing, Propeller Gear Box, landing gear doors (TBC)
• **Development** of the wing-concept within the boundaries of the AH-overall specification of IADP Fast Rotorcraft WP 2 LifeRCraft
  – Development of the structural concept
  – Selection of materials and manufacturing processes (harmonized with AH)
  – Detailed layout and design
  – Substantiation file (incl. tests)
  – Contributing to permit to fly
  – Support to ground- and flight tests

  Note: the external shape of the wing and the fairing will be an input given by AH specification

• **Manufacturing** of all the Single Parts of the Wings for ground tests and flying demo \([B-1.1.2]\)

• **Assembly** of wings for ground tests and flying demo \([B-1.1.3]\)
SCOPE OF WORK

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Final Demo Review