Clean Sky Info Day

Green Regional A/c - ITD

A.B. Podsadowski GRA-PO

Politechnika Warszawska

12 & 13 September 2011, Warsaw

www.cleansky.eu

CLEANSKY

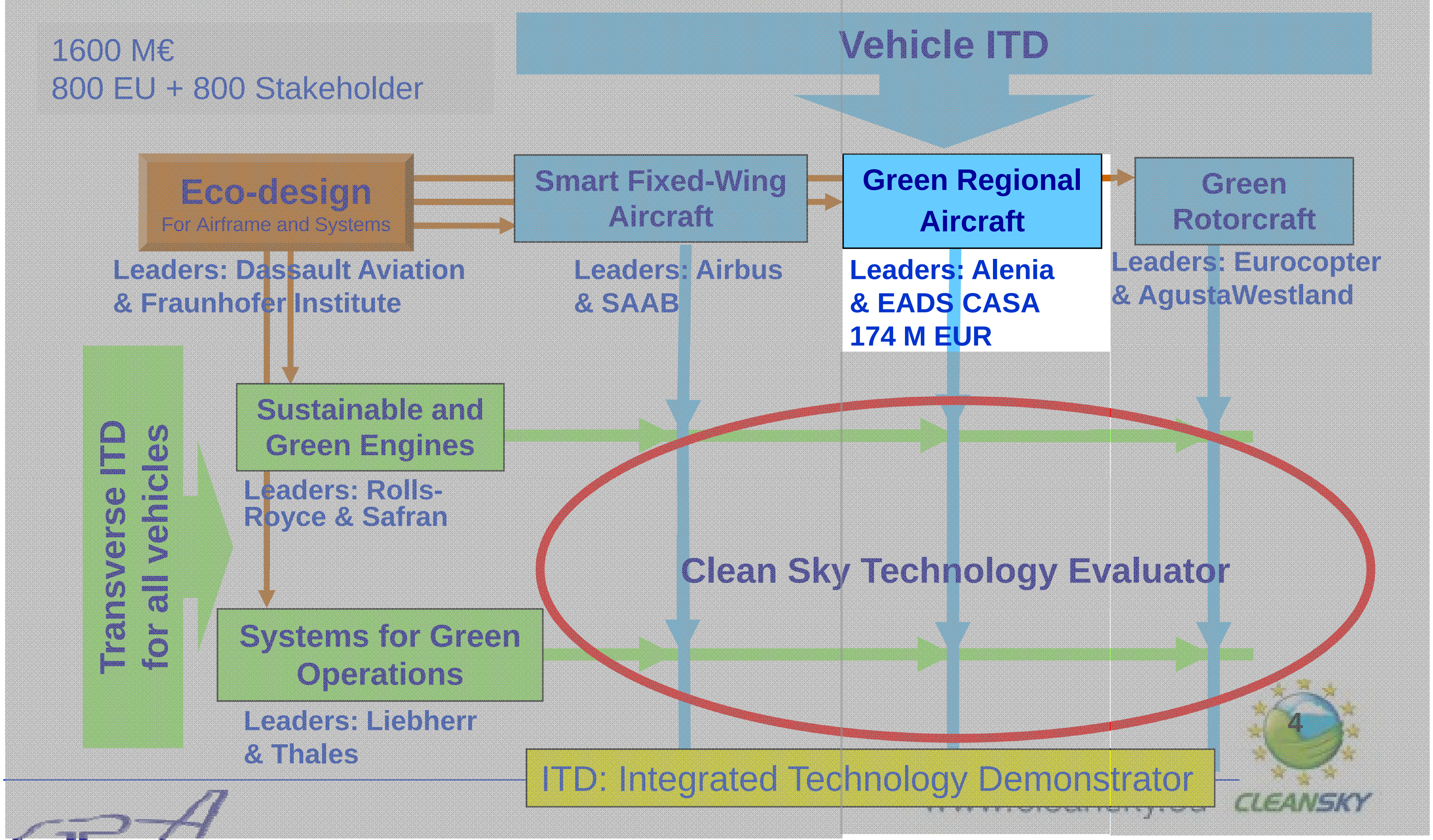
Green Regional Aircraft

OUTLINE

- ✓ GRA – High Level Objectives, Interdependencies and planning
- ✓ GRA - Team
- ✓ GRA – (5) Technological Domains
- ✓ GRA – Year 2011 Batch#3 Calls for Proposals

✓ GRA - High Level Objectives, Interdependencies and planning

Green Regional Aircraft ITD



GRA ITD - Contribution to environmental Targets

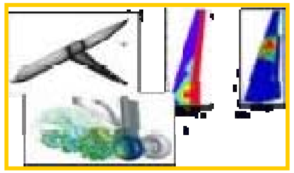
ACARE Goals	Technology Domains
Reduced fuel consumption (CO_2 & NOx reduction)	➢ Power plant ➢ **Loads & Flow Control** ➢ **New Aircraft Configurations** ➢ **Low Weight** ➢ **Aircraft Energy Management** ➢ **Mission & Trajectory Management**
External noise reduction	➢ Power Plant ➢ **Mission & Trajectory Management** ➢ **Configurations** ➢ Rotorcraft Noise Reduction
"Ecolonomic" life cycle	➢ Aircraft Life Cycle

GRA High Level Objectives and contents

By means of :

- 1 - **LWC** (**L**ow **W**eight **C**onfiguration):
  - ✓ advanced structures and materials.

- 2 - **LNC** (**L**ow **N**oise **C**onfiguration):
  - ✓ mature, validate and demonstrate advanced aerodynamics.

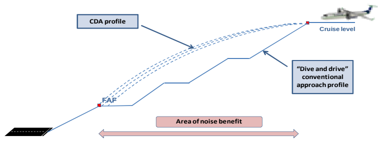


- 3 - **AEA** (**A**ll **E**lectric **A**ircraft):
  - ✓ **m**ore electric Aircraft architectures.

Electrical Generators & Controls

ECS Electrical Compressor

- 4 - **MTM** (**M**ission & **T**rajectory **M**anagement)
  - ✓ advanced avionics architectures.



- 5 - **NC** (**N**ew **C**onfiguration)
  - ✓ integration of such technologies in advanced aircraft configurations… by interfacing new powerplants types.

GRA High Level Objectives and contents

…by interfacing new powerplants types and through the integration with other Clean Sky technical platforms, using a multidisciplinary approach to integrate, in the Demonstrators of the Green Regional Aircraft, technical solutions from:

- **SGO** – (Systems for Green Operations)
  energy management, mission & trajectory management

- **ED** - (Eco Design)
  more green airframe and systems test bench results

- **SAGE** - (Sustainable And Green Engines)

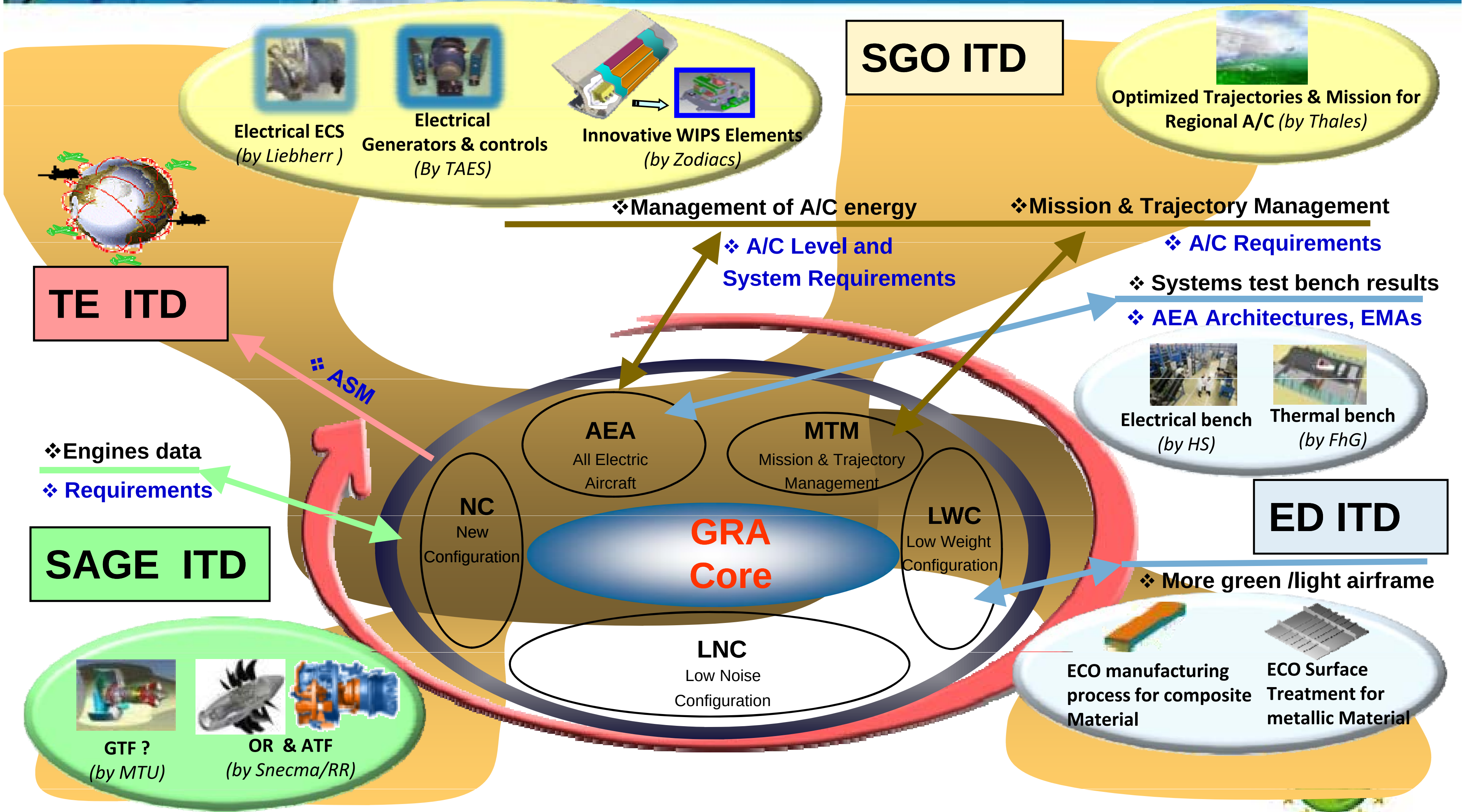
  Engines

- **TE** - (Technology Evaluator)

  Aircraft Simulation Model (ASM)

GRA High Level Objectives and contents

Relationship with other ITDs



GRA-ITD Planning example … LWC

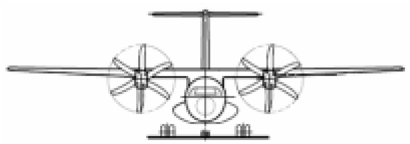
Objective: to demonstrate the applicability of advanced CFRP, metallic alloys & process and structural health monitoring systems to achieve the expected structural weight reduction for Regional A/C

2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015

Concepts Studies

Coupons and large panels tests activities

Flight Test

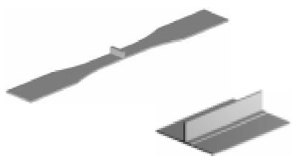


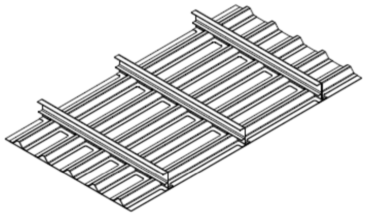
Technologies development: req’s, design, manufacturing, assembly & test

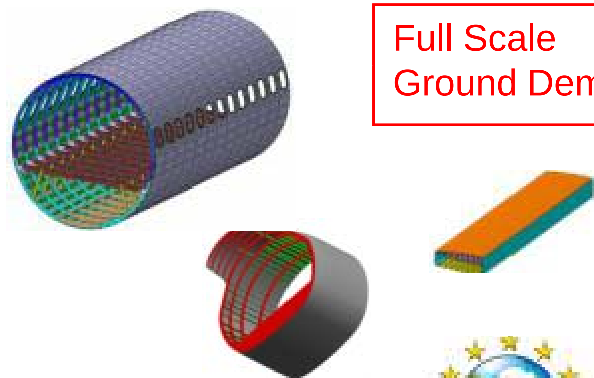
1st Down Selection

2nd Down Selection

Full Scale Ground Demo

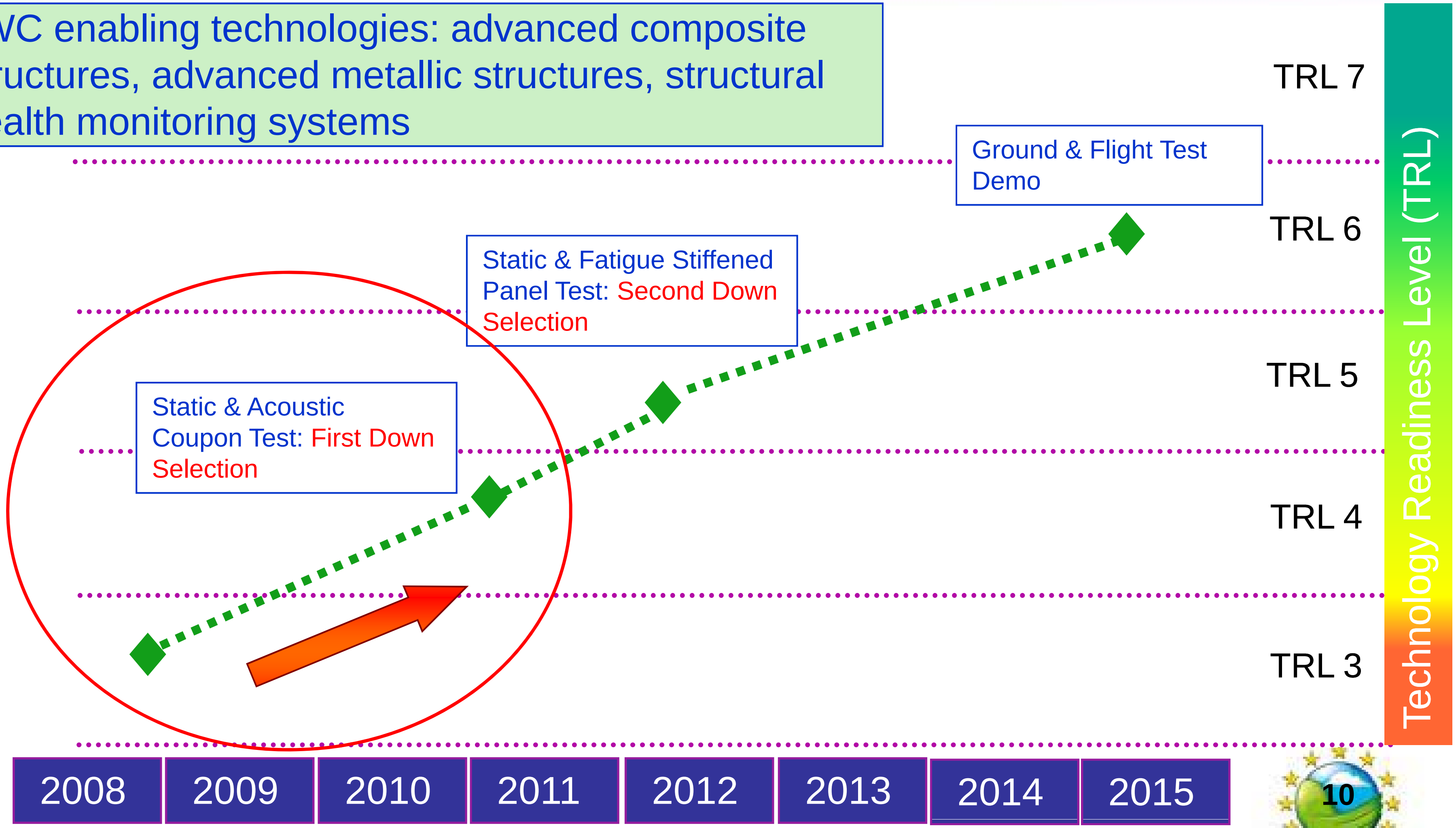






LWC Technology Development Plan

LWC enabling technologies: advanced composite structures, advanced metallic structures, structural health monitoring systems

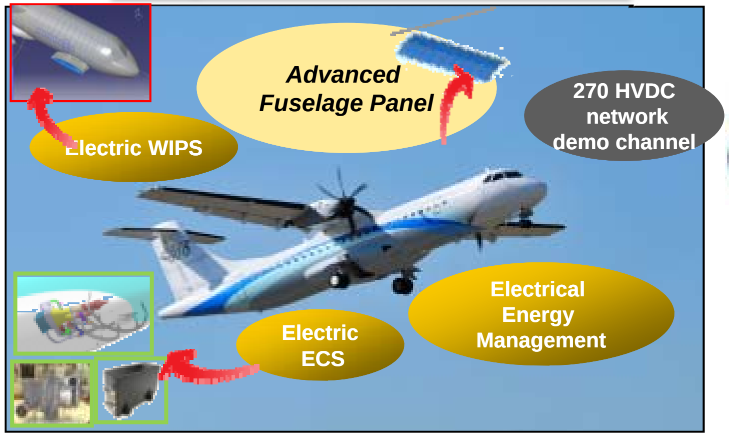


Demonstration

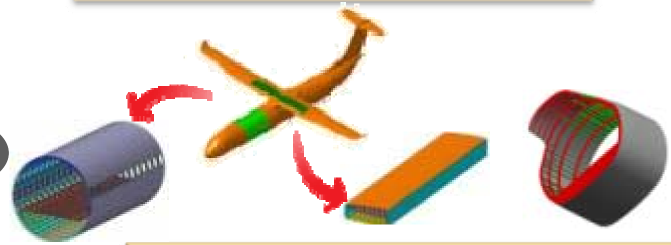
- ➢ Advanced technologies will be assessed through a cost effective mix of ground and flight tests covering the technical solutions of integration of airframe, systems and engines at aircraft level.
- ➢ In this respect, full scale structural ground tests, large scale aerodynamic and aero-acoustics wind tunnel tests, and flight simulators have been considered.

❖ With reference to the generic regional aircraft type, the following Demonstrators will be produced:

Flight Demo on ATR-72



Ground Demonstrators



Static and Fatigue tests on:

- ➢**Fwd Fuselage Section**
- ➢**Wing Box Section**
- ➢ **Cockpit Section** (rear area, almost cylindrical)

Aerodynamic & Aeroacoustic WT test

GRA - Team

✓ GRA - Team

GRA Team : ITD Leaders

- ALENIA AERONAUTICA
- EADS - CASA
- Fraunhofer-Gesellschaft
- LIEBHERR
- ROLLS – ROYCE
- SAFRAN
- THALES

ALENIA AERONAUTICA affiliates:
- ✓Alenia Aermacchi
- ✓Alenia Sia
- ✓Alenia Improvement
- ✓SuperJet International

ROLLS ROYCE affiliate:
- ✓Rolls Royce Deutschland

SAFRAN affiliates:
- ✓Snecma
- ✓Messier-Dowty
- ✓Hispano-Suiza

THALES AVIONICS affiliate:
- ✓Thales Avionics Electrical System

GRA Team : Associates

❖ **AIR GREEN Cluster**

- with following members:
  - Piaggio, Italy, single-voice Cluster's representative
  - Polo delle S&T, Univ. Naples, Italy
  - Centro Sviluppo Materiali (CSM), Italy
  - IMAST, Italy (technological district)
  - FoxBit, Italy
  - Sicamb, Italy
  - Politech. Turin, Italy
  - Univ. Bologna/Forlì, Italy
  - Univ. Pisa, Italy

❖ **ATR**

❖ **CIRA PLUS Cluster**

- with following members:
  - CIRA, Italy, single voice Cluster's representative
  - Dema, Italy
  - Aerosoft, Italy
  - INCAS, Romania
  - Elsis, Lithuania

❖ **HELLENIC AEROSPACE INDUSTRY**

❖ **ONERA**

A sizeable amount of activities are reserved to Call for Proposals open to European Institutions and Industry: so far 92 winners has been selected as potential partners

For end of this year, we foresee about 100 participants involved in GRA!!

Green Regional Aircraft ITD _ members and associates

GRA ITD – 5 Technological Domains

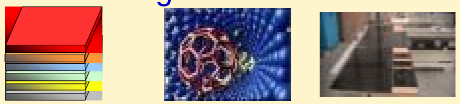
✓ GRA – (5) Technological Domains

GRA ITD – 5 Technological Domains

Innovative structures (Low Weight Configuration)

- ✓ Lower weight
- ✓ Lower maintenance costs **through**

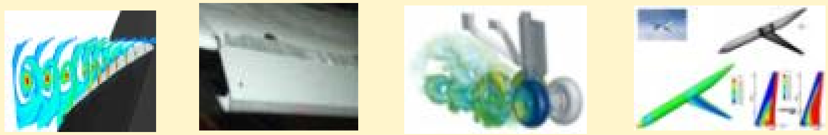
multifunctional composites, advanced metallic materials, structure health monitoring



Advanced aerodynamics (Low Noise Configuration)

- ✓ Improved aerodynamic efficiency
- ✓ Drag reduction
- ✓ Airframe external noise **through**

innovative solutions for wing and high lift devices and landing gears



Innovative systems (All Electrical Aircraft)

- ✓ Lower fuel consumption **through**

Bleed less architectures, Limited hydraulics, Energy management

Evaluation of new avionics architecture in MTM domain for

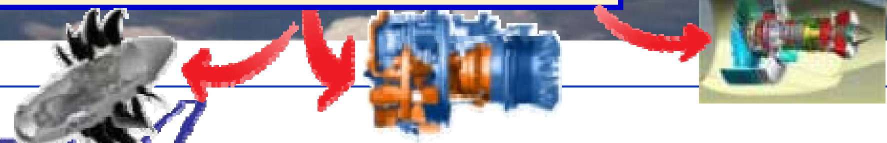
- ✓ Fuel & noise reduction
- ✓ Lower Maintenance costs **through**

Upgraded capabilities for MTM

New aircraft configurations (NC)

- ✓ Lower fuel consumption
- ✓ NOx & CO2 reduction **through**

Integration of Advanced turboprops, Open Rotors, Advanced turbofan, GTF



GreenRegionalAircraft

Enabling technologies (1/2)

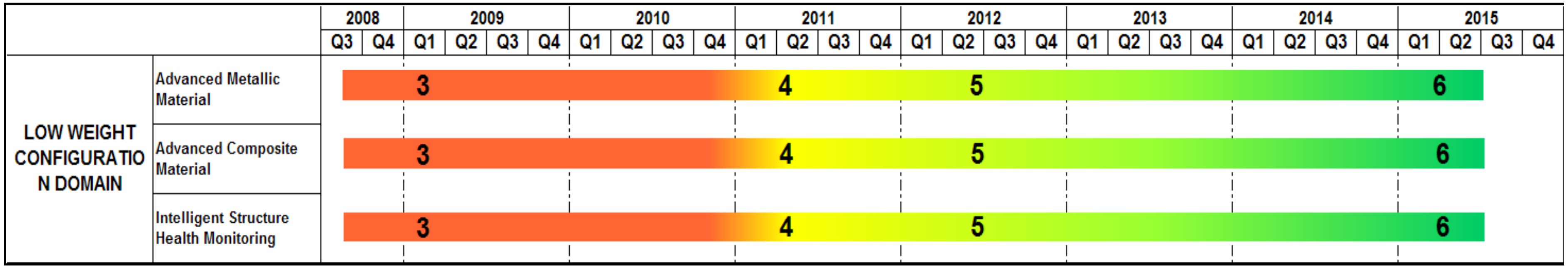
LWC - Advanced Technology		Enabling Technology
Advanced Metallic Material	AMM	Laser Beam Welding
Advanced Composite Material	ACM	Composite Layer Multi-Objective Material
		Composite Multilayer Multifunction Materials
		Composite Nano-Materials
Intelligent Structure Health Monitoring	iSHM	Sensor Technologies
		Design Methodologies
		Technologies for Maintenance
LNC - Advanced Technology		**Enabling Technology**
Low Noise & High Efficiency High Lift Devices	LN – HLD	Side Edge Fence
		Full-fowler single-slotted flap
		Drooped nose
		Krueger Slat
		Synthetic Jets
		Morphing Trailing-Edge Devices
		Acoustic Liner
Drag Reductions	DR	2D Micro - riblets
		3D Micro - riblets
		Artificial Micro Roughness
Natural Laminar Flow Wing	NLF-W	
Load Control / Alleviation	LC/A	
Low Noise MLG & NLG	LN – LG	Aerodynamics Shape Optimization & Vortex Dissipation

Enabling technologies (2/2)

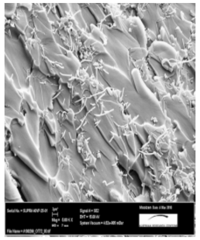
AEA - Advanced Technology		Enabling Technology
Electrical Power Generations and Distribution System	EPGDS	High power / high speed electrical machines
		Power electronics for starting and conversion
		Electrical distribution - 270 HVDC network
		HLVDC converter
		Electrical Power Center for Energy Management
Electrical Environmental Control System	EECS	Electrical Motor Compressor
		Double Function Inverter
Wing Ice Protection System	WIPS	Power electronics / Pulse Generator
		Power actuator
FCS (EMA actuation)	FCS – EMA	Electromechanical Actuator
Landing Gear Systems Electrical Actuation	LGSEA	Electromechanical actuator
		Electrical Brakes
		Electrical Steering

M&TM - Advanced Technology		Enabling Technology
Green Flight Management System (FMS)	G - FMS	Advanced Continuous Descent Approach (A-CDA)
		Steep Approach
		Optimized Climb Departure
		En-route optimization (green cost index)

LWC – Technology maturity (1/3)

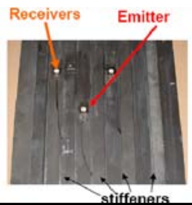


Multi-functional Materials to improve material capabilities and functionalities (lightning, hail protection,…)

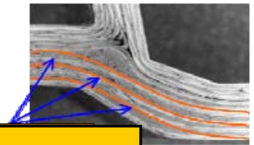


Nanomaterials: Carbon nanofibres dispersed in resin to improve mechanical characteristics

Hail Impact" is limiting factor for the design of an innovative composite fuselage



Acoustic Ultrasonic Sensors

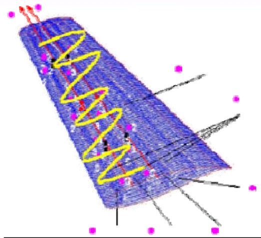


Structure integrated optical fibres

Sensors Technologies to detect accidental damage, environmental effects and consequent structural degradation during service

LWC – Technology maturity (2/3)

Development of a numerical environment to asses effectiveness of methodologies for damage detection



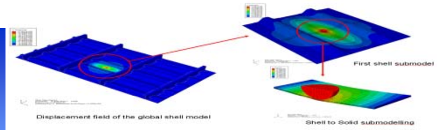
Sensors location

Design Methodologies

Defining optimal locations of sensors for effective detection of the level of damage

Structural Health Management

FEM Simulation of damage evolution and evaluation of monitoring capacity of the sensor system

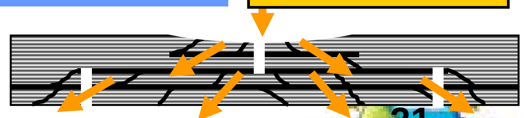


Impact simulation process

Maintenance Technologies

New approaches for maintenance and repair needed for the presence of sensors and multifunction layers

Liquid Resin Infiltration (LRI)



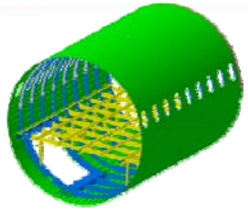
Advanced methodologies for definition of inspection intervals

LWC – Technology maturity (3/3)

Technical solutions for Regional A/C

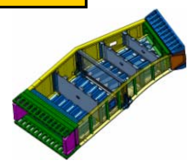
Ground Demonstrator Full Scale Test

Fwd Fuselage Section: Static (limit loads, residual strength) and Fatigue tests on pressurized barrel



Fuselage Barrel

Wing Box: Static (limit loads, residual strength) and Fatigue tests on wing box section



Wing Box

Flight Test

Validation in flight for advanced structural technologies that require data acquired in an actual operating environment

Panels to be replaced

LWC - Nanocharged prepreg Technologies (CfP example)

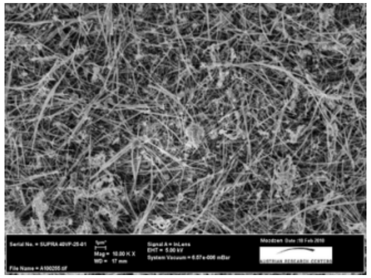
"Nanocharged prepreg" – WP 1.3.5

Objectives:

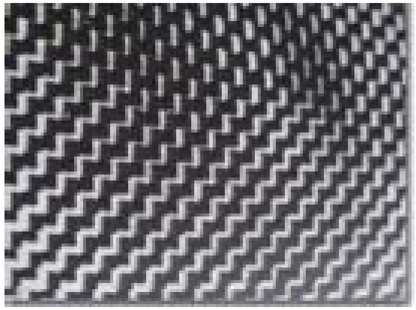
- Improvement of lightning resistance
- Improvement of electrical properties

Members: Alenia, Airgreen

CfP winners: Austrian Institute of technology; Cytec



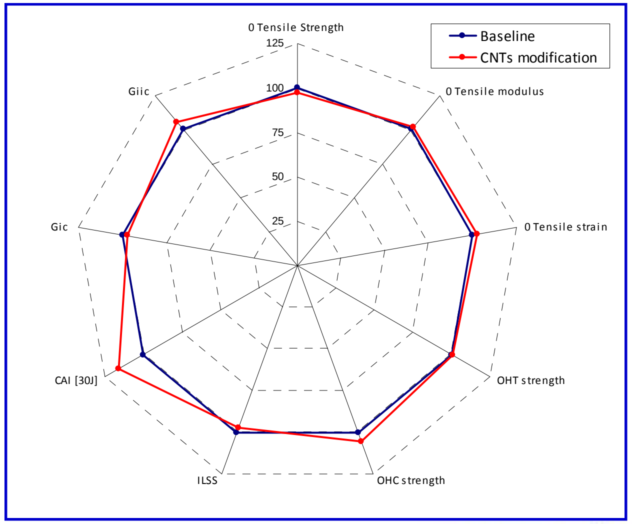
CNTs Dispersion evaluation



Nanocharged prepreg

Experimental Test:

- Tensile strength & modulus,
- Compression strength & modulus,
- Fracture Toughness Energy, FST
- etc.



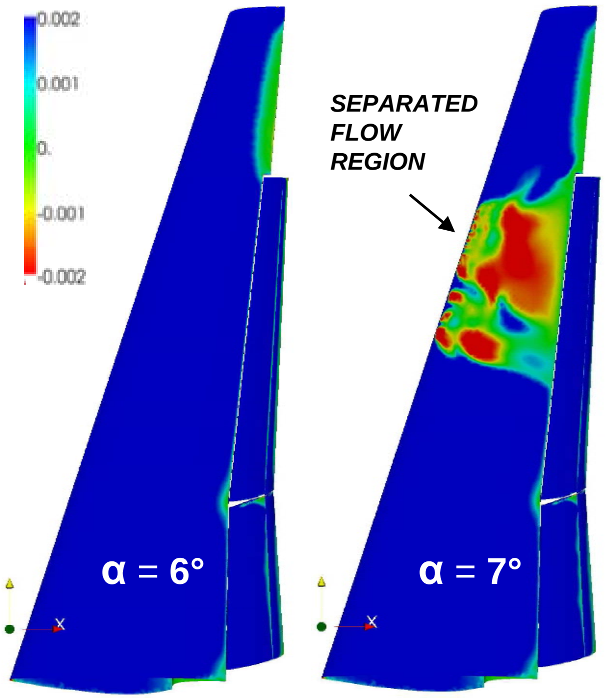
LNC - NLF Wing HLD Technologies   Double-Slotted Flap

by ALA

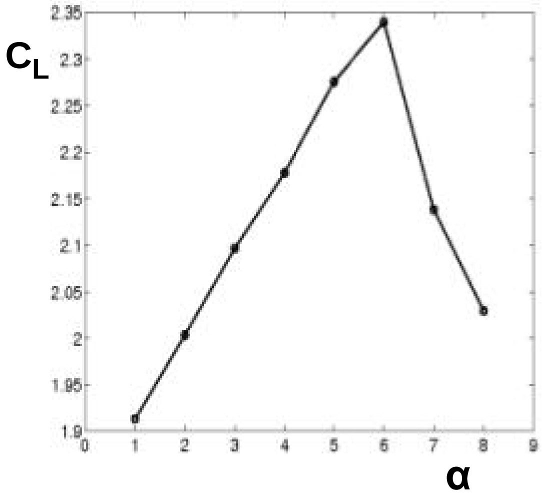
High-Lift CFD 3D Analysis - M = 0.20   *by FOI*

(ALONOCO - CfP)

RANS Flow solver



Skin Friction @ stall and post-stall

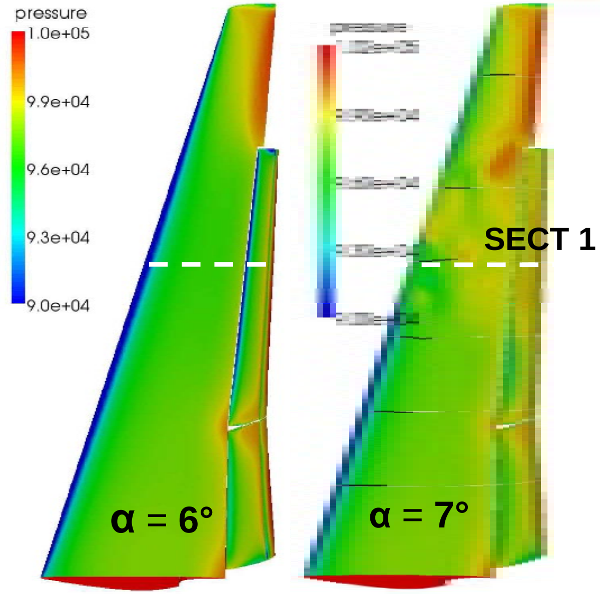


C_{Lmax} = **2.35**

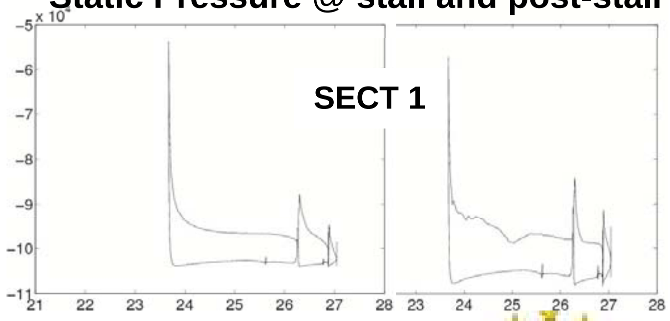
Vs **TARGET = 2.65**

α_{STALL} = **6** deg

Abrupt stall due to
L/E flow separation over the
outboard wing
flapped region



Static Pressure @ stall and post-stall



AEA - E-WIPS ARCHITECTURE DESCRIPTION

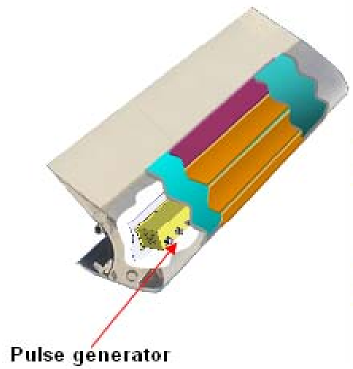
GRA AEA – E-WIPS architecture overview

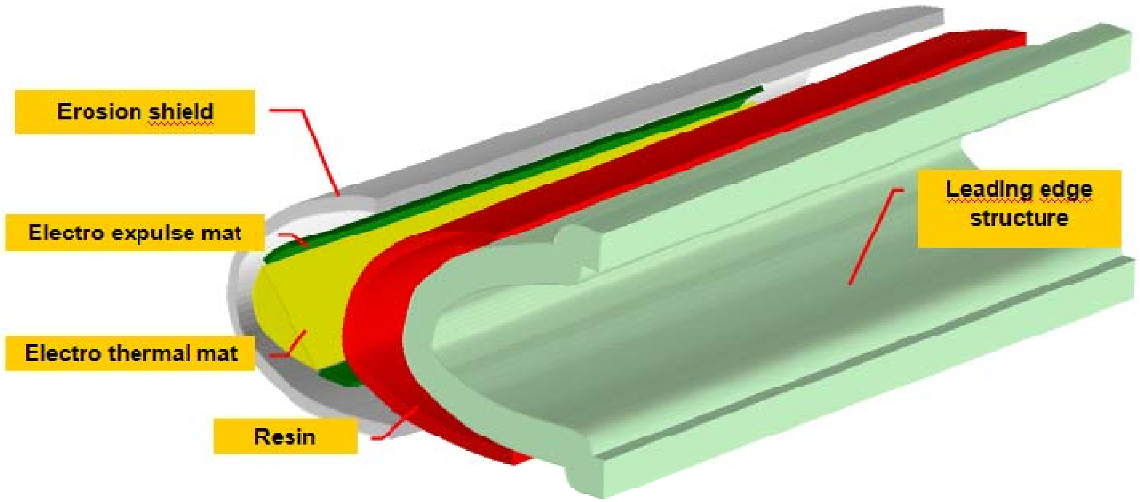
Definition of an innovative hybrid, low-power Electrical Wing Ice Protection System (E-WIPS), for the 90-pax TP All-Electric Aircraft (bleedless) platform.

The E-WIPS will guarantee the wing protection requirements using the combination of:

- Electro-thermal mats: to avoid ice build-up or allow ice detachment
- Electro-expulsive actuators: to debond and eject the refreezing water.

System technologies development is performed with the support of the SGO ITD, within the SGO WP 2.3.4.3.4 dedicated to the Ice Protection System for Regional Aircraft, with the participation of **Zodiac-Intertechnique and Alenia Aeronautica.**

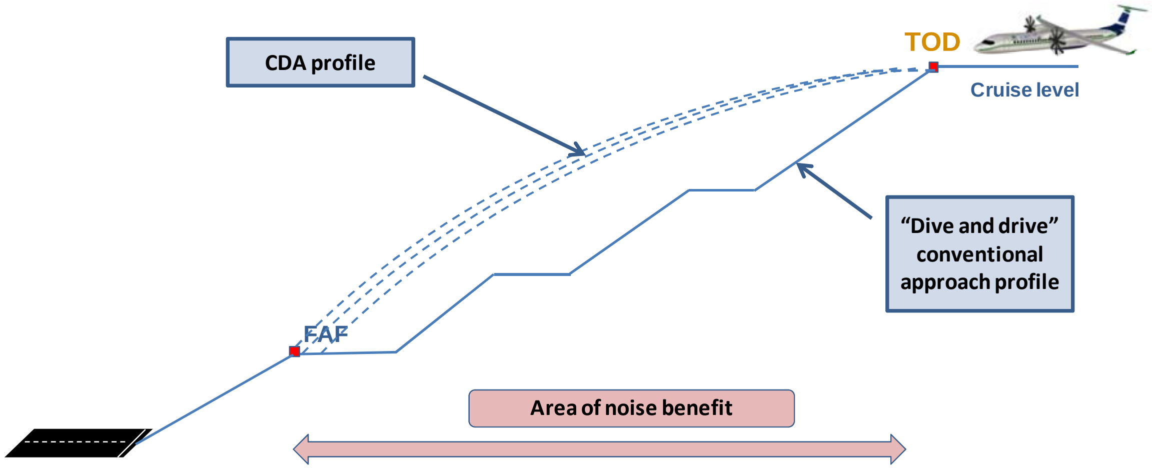




(by Zodiac)

MT&M - CDA - Concept and benefits

❖ Substitution of conventional profile with a continuous descent profile.



ICAO (*) - Advantages:

a) more efficient use of airspace and arrival route placement;
b) more consistent flight paths and stabilized approach paths;
c) reduction in both pilot and controller workload;
d) reduction in the number of required radio transmissions;
e) cost savings and environmental benefits through reduced fuel burn;
f) reducing the incidence of controlled flight into terrain (CFIT);
g) operations authorized.

(*) ICAO doc. 9931 Manual - para 1.1.3.1

NC - NC Activities

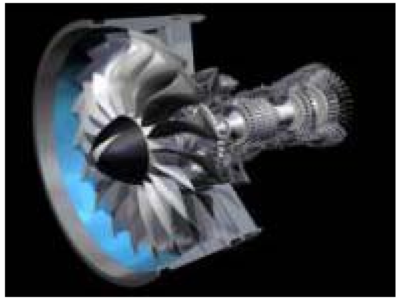
Snecma Groupe SAFRAN

Rolls-Royce

SAGE4 GTF

MTU

GEARED TURBOFAN



PUSHER OPEN ROTOR

LOW SPEED TURBOPROP

ADVANCED TURBOFAN

Loop 2

- ❑Rear engine installation
- ❑Under wing engine installation
- ❑Under wing engine installation
- ❑Rear & Under wing engine installation

- ❑Engine data updating (AEA hypothesis)
- ❑All Electric Aircraft and More Electric Aircraft Systems architectures trade-off studies
- ❑Aerodynamic Improvement (Wing design and HLD studies)
- ❑New materials improvement & Preliminary Structural layout definition

Loop 3

- ❑ Engine data updating (AEA or MEA hypothesis)
- ❑ Feasibility studies under Structural and Systems points of view
- ❑ Best configuration choice for WTT

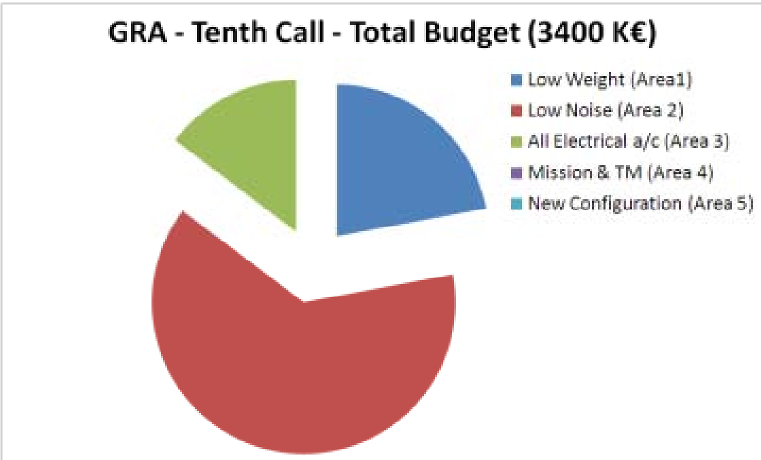
JTI-CS-2011-3-GRA Calls for Proposals

✓ GRA – Year 2011 Batch#3 Calls for Proposals

Clean Sky JTI – GRA–ITD : 10th Call

GRA – 10th Call for Proposals breakup view

Identification	ITD - AREA - TOPIC	topics	VALUE	MAX FUND
JTI-CS-GRA	**Clean Sky - Green Regional Aircraft**	8	3.400.000	2.550.000
JTI-CS-GRA-01	*Area-01 - Low weight configurations*		**750.000**	
JTI-CS-2011-3-GRA-01-039	Hybrid laminates Industrialization for a/c nose fuselage/cockpit		300.000	
JTI-CS-2011-3-GRA-01-040	Nose Fuselage/Cockpit dynamic characterization for internal noise attenuation		200.000	
JTI-CS-2011-3-GRA-01-041	Optimal tooling system design for large composite parts		250.000	
JTI-CS-GRA-02	*Area-02 - Low noise configurations*		**2.150.000**	
JTI-CS-2011-3-GRA-02-017	Advanced low noise Main and Nose Landing Gears for Regional Aircraft -Trade off concept studies, large-scale mock-ups design, manufacturing & WT testing.		2.000.000	
JTI-CS-2011-3-GRA-02-018	Low Noise Devices aeroacoustics numerical Simulation		150.000	
JTI-CS-GRA-03	*Area-03 - All electric aircraft*		**500.000**	
JTI-CS-2011-3-GRA-03-006	Development and manufacturing of Programmable Electrical Loads and advanced Power Supply Modulation for Electrical Energy Management testing in Flight Demo		100.000	
JTI-CS-2011-3-GRA-03-007	Improvement of numerical models for JTI/GRA Shared Simulation Environment		150.000	
JTI-CS-2011-3-GRA-03-008	Control Console and Electrical Power Center for In-Flight Demo		250.000	
JTI-CS-GRA-04	*Area-04 - Mission and trajectory Management*			
JTI-CS-GRA-05	*Area-05 - New configurations*			



JTI-CS-2011-3-GRA-01-039

Title: "Hybrid laminates Industrialization for a/c nose fuselage / cockpit"

Status: The subject of this CfP is to produce a set of curved panels representative of the structure that conforms the nose fuselage stiffened skin with hybrid configuration to anticipate manufacturing problems for the integration of twisted stringers of different shape section. These panels will be used to consolidate some test results highlighted on flat specimens.

Main objectives: The job will be based on a quick prototyping of a curved panel with stiffeners with architecture representative of the stiffened skin that conforms the nose fuselage. Skin lay-up and material must reproduce the selected one for flat panels manufactured within the same WP 1.3.7. Acoustic characterization tests will be performed therefore the size must be compatible with the rig used for this purpose. The specimen will be used for low, medium energy impact & anti-erosion testing through the extract of structural portion or directly on the whole specimen.

Special skills required:

- Experience in composite design, manufacturing and NDT
- Experience in tooling design
- Experience in CFRP laminates testing

Effective duration: 15 months

Topic Value: not to exceed 300,00 K€

JTI-CS-2011-3-GRA-01-040

Title: "Nose Fuselage/Cockpit dynamic characterization for internal noise attenuation "

Status: The subject of this CfP is to evaluate by means of numerical models the acoustic performance of a CFRP nose fuselage in relation to a conventional metallic baseline configuration.

Main objectives:

- Development of a basic numerical model suitable of estimating noise radiated by the nose fuselage into the cockpit.
- Two different variants of the basic model will be refined for the purpose of the research based on existing FEM used for strength check-stress, these will correspond to:
  - Reference metallic construction
  - Hybrid fuselage with multifunctional laminates and advanced architecture.
- The developed models will be used for determining main contributions to interior noise in terms of modes and areas (i.e windows, floor etc).

Special skills required:

- Experience in simulation of coupled vibro-acoustic problems.
- Use of commercial software.

Effective duration: 15 months

Topic Value: not to exceed 200,00 K€

JTI-CS-2011-3-GRA-01-041

Title: "Optimal tooling system design for large composite parts"

Status: The thermal and mechanical properties of the tooling and the mechanical interaction between composite part and tooling influence the curing process. The mismatch between coefficients of thermal expansion of the composite part and tooling induces residual stresses during autoclave manufacturing. The factors that are responsible for composite part deformation (warpage and spring-in / out) need to be evaluated in order to identify the optimum values that would ensure the best geometrical and dimensional stability of the final part.

Main objectives:

- Definition of all the necessary steps to complete the design and manufacture of a large tool for a composite complex structural part (representative of a fuselage stiffened section / panel with co-cured stiffeners - typically 2-3 m length).
- Manufacturing of the composite structural part using above mentioned tool. By comparing the "as designed" and "as manufactured" composite part, the correctness of the designed and manufactured tool can be proved and validated.

Special skills required:

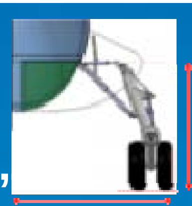
- Expertise in tooling design and manufacturing (multi-part tooling) for aerospace quality composite parts.

Effective duration: 12 months

Topic Value: not to exceed 250,00 K€

JTI-CS-2011-3-GRA-02-017

Title: "Advanced low noise Main and Nose Landing Gears for Regional Aircraft – Trade off concept studies, large-scale mock-ups design, manufacturing & WT testing."



Main objectives:

- The objectives of the activity under this CfP are the conceptual design and experimental validation of low-noise devices for main and nose landing gears (MLG and NLG) sized to a high-wing regional aircraft configuration. Complete MLG and NLG architectures will have to be considered, including gear strut, wheel pack, bay cavity, bay doors and belly fairing. To this aim the Applicant will design and manufacture a 1:2 scale mock-up of MLG and a full-scale mock up of NLG integrating respective low-noise devices selected at previous stage. Such test articles will have to be realistic representations of the complete gears architectures as above described (gear strut, wheels, bay, doors, fairings). Then, the Applicant will perform aero-acoustic wind-tunnel tests on both the above MLG and NLG test models installed in a proper experimental aero-acoustic facility to assess relevant low-noise solutions against respective baseline/benchmark configurations and will release measured data and final test report.

Special skills:

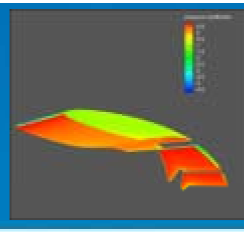
✓ Skills in aero-acoustics and previous expertise on landing gear noise assessment.

Effective duration: 24 months

Topic Value: not to exceed 2.000,00 K€

JTI-CS-2011-3-GRA-02-018

Title: "Low Noise Devices aeroacoustics numerical Simulation."



Main objectives:

Within GRA Low Noise domain several concepts for noise reduction have been proposed and evaluated. For many of such concepts, numerical CFD simulations have been performed. Within the present CfP the applicant will carry out aeroacoustic numerical simulations starting from the CFD data provided by the CfP proposer. Steady RANS solutions of

1. **a wing segment about the side-edge**
2. **a landing-gear**

will be provided to the applicant. Then the applicant will employ a stochastic noise generation method to **respectively** compute the broadband noise generated by the turbulent flow

1. **close to the flap side-edge.**
2. **about the landing gear.**

Three configurations will be considered:

Special skills:

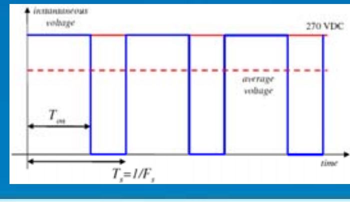
✓ aeroacustic skill and previous expertise on numerical noise assessment.

Effective duration: 18 months

Topic Value: not to exceed 150,00 K€

JTI-CS-2011-3-GRA-03-006

Title: “ Programmable Electrical Loads for in Flight Demo”



Main objectives:

Design, developing, manufacturing, testing and delivery of Programmable Resistive Electrical Load

Design, developing, manufacturing, testing and delivery of an Advanced Power Supply Module featuring capability to properly modulate input voltage to the above equipment

The equipment will be used for the scope of the in-flight demo activities of the AEA domain of the GRA ITD. Therefore, it will be qualified for installation in the passenger cabin of the Demonstrator Aircraft, selected to be an ATR-72

Special skills required:

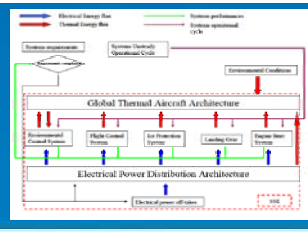
- ✓ expertise in electrical system design
- ✓ knowledge of Industrial/Aeronautical field constraints and procedures
- ✓ experience in system simulation methods and modeling

Effective duration: 16 months

Topic value: not to exceed 100,00 k€

JTI-CS-2011-3-GRA-03-007

Title: "Improvement of numerical models for JTI/GRA Shared Simulation Environment"



Main objectives:

Design and implementation of an object oriented simulation platform for the improvement of a simulation code called Shared Simulation Environment. The SSE is devoted to the analysis of the electrical loads during typical missions of the all-electric regional aircraft and integrates the simulation models of the static and dynamic performances of on-board electrical systems. The improvement shall cover all S/W quality aspects (user interface, S/W stability, S/W documentation, computational time), in order to develop an high-quality simulation environment having the features of an industrial S/W, to be applied for the design, the testing and the validation of the energy management logics used for the optimal sharing of the total on-board electrical power.

Special skills required:

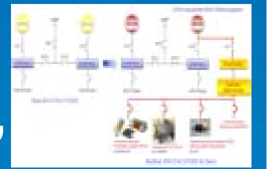
✓proven experience in dynamic modeling and simulation of aircraft systems.
✓capability of managing system simulation models written in different languages

Effective duration: 10 months

Topic value: not to exceed150,00 k€

JTI-CS-2011-3-GRA-03-008

Title: "Control Console and Electrical Power Center for In-Flight Demo"



Main objectives:

To design, develop, manufacture, test and deliver an Electrical Power Center (EPC) and its dedicated Control Console (CC) for the in-flight demo activities of AEA domain of the Clean Sky GRA ITD

For this purpose, the EPC and the CC will be installed in an ATR-72 (GRA selected flying demonstrator) passengers cabin, being able to interface with the aircraft overall Electrical Power Generation System (EPGS)

Special skills required:

- ✓ expertise in electrical system design
- ✓ knowledge of Industrial/Aeronautical field constraints and procedures
- ✓ experience in system simulation methods and modeling

Effective duration: 16 months

Topic value: not to exceed 250,00k€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Thank You all indeed.
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