SGO Call for proposals presentation

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January, 20th

Clean Sky Info Day on 11th Call for proposals

Systems for green operations

Management of Aircraft Energy

- The use of all-electric equipment system architectures will allow a more fuel-efficient use of secondary power, from electrical generation and distribution to electrical aircraft systems.
- Thermal management will address many levels, particularly relating to electric aircraft, from hot spots in large power electronics to motor drive system cooling, to overall aircraft solutions.

Management of Trajectory and Mission

- Systems and procedures will be designed to perform high precision optimised trajectories to minimise noise and emissions impact in airport areas.
- New aircraft systems for Smart Ground Operations will optimise use of engine power when aircraft is on ground and provide silent taxing capabilities
- Aircraft will be able to fly green missions from start to finish, thanks to technologies which allow to avoid fuel consuming meteorological hazards and to adapt flight path to known local conditions

Validation by ground based rigs and flight testing

Overview of Calls proposed by SGO

- 14 topics

CfP Nbr	Description	Est. Cost [k€]
JTI-CS-2012-1-SGO-04-003	Multi-channel SSPC load rig and acquisition module	250
JTI-CS-2012-1-SGO-03-014	Smart Operations on Ground power electronics with energy recycling system	1390
JTI-CS-2012-1-SGO-02-038	Passive cooling solution validation	300
JTI-CS-2012-1-SGO-02-039	Optimisation of heat pipe to cool high speed motorised turbo-machine	300
JTI-CS-2012-1-SGO-02-040	Compressor air inlet protection for electrical ECS	600
JTI-CS-2012-1-SGO-02-041	Identification of a fluid for diphasic cooling adapted to aircraft applications (	550
JTI-CS-2012-1-SGO-03-017	Real time optimiser for continuous descent approaches	200
JTI-CS-2012-1-SGO-02-042	Study and development of a carbon sleeve made by filament winding and directly wound on an electric motor rotor	200
JTI-CS-2012-1-SGO-02-043	Aerospace housing for extreme environment	300
JTI-CS-2012-1-SGO-02-044	Bus system housing for extreme environment	300
JTI-CS-2012-1-SGO-02-045	Regenerative Snubber & innovative control algorithm	400
JTI-CS-2012-1-SGO-02-046	High Dense Smart Power Capacitor	600
JTI-CS-2012-1-SGO-02-021	Development of key technology components for high power-density power converters for rotorcraft swashplate actuators	350
JTI-CS-2012-1-SGO-02-035	Development, prototyping and validation of special mechanical drive-train elements: safety device for passivation of major mechanical failures (locking or disconnect mechanism)	800
	Nbr topics	14
	Total cost / funding	6540

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Overview / grouping of topics

- Electrical
  - in general
    - SGO-02-043: hermetical sealed (aerospace) housing for power electronics
    - SGO-02-044: bus system housing for extreme environment
    - SGO-02-045: Snubber - power converter in aerospace environment
    - SGO-02-046: High Density Smart Power Capacitor (discussed on 19 January)
  - Cooling
    - SGO-02-038: Passive cooling
    - SGO-02-041: diphasic cooling liquid (discussed on 19 January)
  - Helicopter - electrical (electrical swash-plate actuation)
    - SGO-02-021: High power density power converters
    - SGO-02-035: Disconnect device

- Management of trajectory and missions
  - SGO-03-014: SOG; Power Electronics with Energy Recycling (discussed on 19 January)
  - SGO-03-017: Fast optimiser for Continuous Descents

- Various topics
  - SGO-02-039: Optimisation of heat pipe to cool high speed motorised turbomachine
  - SGO-02-040: Compressor air inlet protection for electrical ECS
  - SGO-04-003: Solid State Power Controllers test benches

Development of key technology components for high power-density power converters for rotorcraft swashplate actuators

- Topic #: JTI-CS-2012-1-SGO-02-021 :

- Work with a team looking at Helicopter Swash Plate Actuation Systems
  - Technical input during the power converter design process.
  - Develop suitable power modules to fulfil the reliability and weight requirements
  - Develop / demonstrate suitable sensor technologies to enable the rapid detection of faults within the circuit.
  - Construct single motor output drive power converters for use in the demonstration system
  - The final design may be integrated into the motor-actuator structure so close co-operation with the team will be necessary
  - Suitable heat-sinking / cooling arrangements will need to be identified, designed and manufactured by the partner.
  - Partner will also be responsible for manufacturing, component testing and support during system verification tests

Development of key technology components for high power-density power converters for rotorcraft swashplate actuators

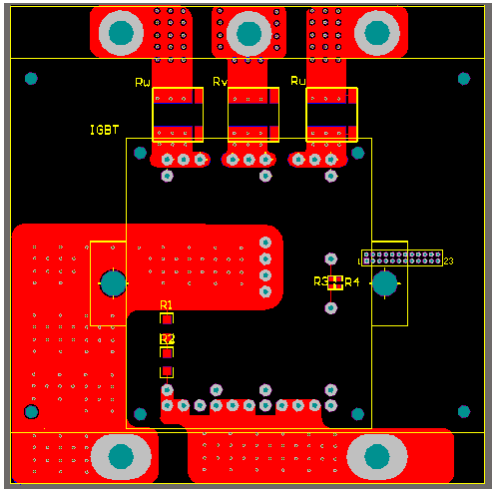
- Topic #: JTI-CS-2010-3-SGO-02-021 :

- Skills required
  - A track record in manufacturing high performance electrical power converters.
  - Experience in design and manufacture of power modules for high reliability applications.
  - Flexible manufacturing facilities to enable alternative power converter topologies and design concepts to be used in the project.
  - Experience in the drive, control and monitoring of IGBT and/or related switching devices

Development of key technology components for high power-density power converters for rotorcraft swashplate actuators

- Topic #: JTI-CS-2010-3-SGO-02-021 :

- Outputs
  - Preliminary design review (PDR)
  - Production of 2 prototype power modules together with sensor/failure detection techniques for experimental evaluation.
  - Critical design review of whole power converter design.
  - Delivery of 2 prototype power converters for test and evaluation
  - Delivery of remaining Power Converter Units.



- Topic value
  - 350k€ maximum budget

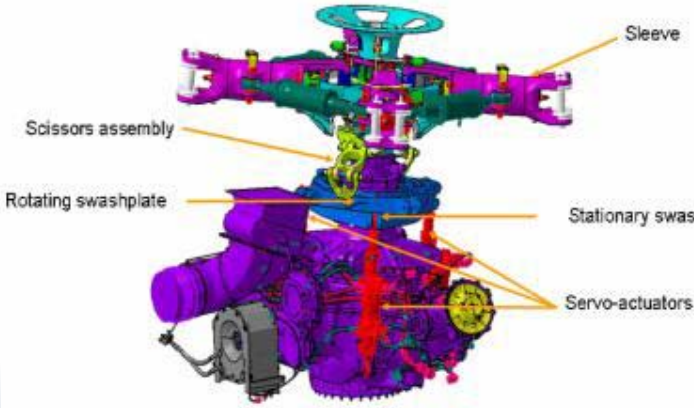
Disconnect device for jam-tolerant linear actuators SGO-02-035

WP Context:
- Development of all-electric actuation system for helicopter swash plate and tail rotor
- Jam-tolerant high availability swash plate actuation
  → TRL4 (system), TRL5 (key components)
- Provide demonstrator to GRC (Green RotorCraft)

Benefits:
- Compatible with all-electric or hybrid h/c vision
- Maintenance friendly
- Reduction of unscheduled maintenance
- Improved safety / dispatch reliability

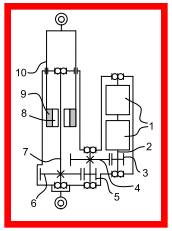
WP Objective(s) / Main Deliverable(s):
- Development and evaluation of fault tolerant system topologies
- Implement technology demonstrator for TRL4 (system) and TRL5 (selected components)
- Input to cost-benefit-analysis of more elec. h/c

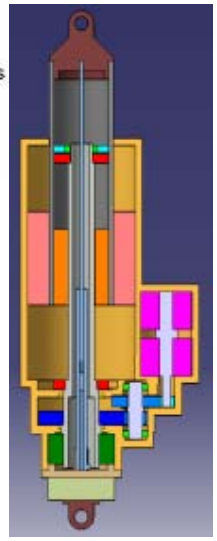
Main Achievements up to now:
- HEMAS concepts assessed in terms of weight, envelope, integration issues, power supply connection
- Concepts validated in terms of safety
- Design currently at PDR level

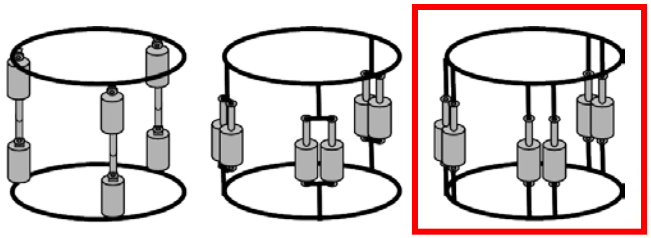


Swashplate system with conventional hydraulic actuators

DD closely related to actuator packaging and envelope compliance







Jam-tolerant actuator arrangement selected

Disconnect device for jam-tolerant linear actuators

1. Context and technical challenges
   - SGO aims to develop EMAs for h/c swash plate actuation
   - Jamming of any actuator of a conventional swash plate system is catastrophic
   - Free-wheel and jamming are credible & relevant failure modes of EMAs

   → Redundant parallel actuators are provided in case one actuator fails

   - Any jammed actuator needs to be disconnected not to jam the redundant one

   → Disconnect Device (DD) required: fast, reliable, compact, light weight, robust

2. Expected feedback

Good proposals should combine

- Capability to perform a broad study and evaluation of functional principles for DDs in the described context
- Design Study covering single-shot to fully reversible and testable designs. Pyrotechnical solutions are taken into consideration.
- Demonstrated industrial capability to develop, build and test meaningful (TRL 4-5) demonstrators of 2 selected concepts (8 each)

Disconnect device for jam-tolerant linear actuators

3. Additional information

Del	Title	Description (if applicable)	Due date
D1	Concepts developed and evaluated. Solution concept(s) selected.	Concept design review prepared and held together with caller. Corresponding documentation available.	Jul-2013
D2	Solution concept validated by analysis, simulation and/or development tests	Specification compliance matrix established, means of compliance and design confidence indicated. Corresponding documentation delivered.	Jan-2014
D3	First prototypes available for validation testing		Jul-2014
D4	Validation testing completed	Validation testing completed and test reports delivered.	Jan-2015
D5	Prototypes delivered to caller		Mar-2015
D6	Documentation completed and delivered	All documentation available including design trade stu-dies, prototypes documenta-tion, test analysis and derived design recommendations.	May-2015

Consortium of applicants should include:

- Universities/research institutions. Focus: Design study, methodical product development
- Manufacturer(s) of couplings/machine elements; aerospace experience desirable
- Expertise in pyrotechnical elements/actuators should be present in consortium

4. Topic value

800k€ maximum budget

Passive cooling solution validation SGO-02-038

1. Context and technical challenges

- SGO aims to develop passive cooling solution for high power density application in harsh environment with a target maturity level of 6. Passive solutions under investigations, based on two phase fluid capillary pumped system, are focused on heat spreading issue, in order to reduce / suppress dedicated cooling system and save weight.
- The main difficulties to be met in developing such a system are :
  - Ensure technical performance (weight, thermal efficiency) in harsh environment (temperature, acceleration, …)
  - Developing a system compliant with aeronautical environmental rules

Passive cooling solution validation

2. Expected feedback

- Provide a passive cooling base plate prototype for a typical power electronics equipment compliant with expected performance
- Get feedback on two phase fluid capillary pumped system ability to operate in aircraft environment for high power density electronics

3. Additional information

Deliverable	Title	Due date
D1	Synthesis of bibliography and justification of technology and fluid selection	T0 + 6 m
D2	Modelling results: justification of design	T0 + 18m
D3	Prototype definition	T0 + 24m
D4	Experimental characterization	T0 + 36m

4. Topic value

300k€ maximum budget

Identification of a fluid for passive two phase fluid cooling adapted to aircraft application: SGO-02-041

Detailed presentation on 19th which will be published on www.cleansky.eu, including Q & A

1. Context and technical challenges

- Equipment cooling is one key design driver for integration and weight saving. Passive two phase fluid cooling is an opportunity to reach such challenge, in particular using capillary pumped technology.

- Efficiency of two phase fluid capillary pumped cooling system is highly linked to fluid physical properties. New rules and ecological friendly challenges required to dispose of new thermal fluid, in particular when phase change is involved.

- The main difficulties to be met in this topic are :
  - Identify/define a fluid composition compliant with two phase fluid passive cooling technologies and aeronautic specifications
  - Synthesis of fluid sample

Identification of a fluid for passive two phase fluid cooling adapted to aircraft application

2. Expected feedback

- Provide a sample of fluid compliant with specification
- Physical properties validation
- Risk mitigation on new Two phase heat transfer fluid
- Identify main technological bottleneck and associated road map

4. Topic value

550k€ <u>maximum budget</u>

High Dense Smart Power Capacitor (HDSPC) For Next Generation of Aircraft Converters

Detailed presentation on 19th which will be published on www.cleansky.eu, including Q & A

1. Objectives topic-*SGO-02-046*:

- To **develop, build and test** a **H**igh **D**ense **S**mart **P**ower **C**apacitor able to operate at > 200° C and suitable with objective of size & weight reduction, electrical performances, Reliability, service life … and cost objective.
- The Applicant shall explore **polymer chemistries(*)** to withstand **high temperatures & rugged environments**, while novel processing chemistry is improving the breakdown resistance and losses of high permittivity of selected materials.
- Additionally, the applicant shall develop an electronic circuit & sensors able to monitor capacitor's parameters for health diagnostic of this component.
- This CFP is a scientific & industrial challenges which provides opportunity of competitiveness on this important improvement part for European partners of Cleansky

2. Technical Challenges:

- Volume and Weight reduction rate expected : minimum of 30% (*)
- Maximum operating temperature : 200° C or more
- HVDC breakdown voltage suitable with aircraft network
- High service life and reliable component

(*): compared to existing PPY capacitor technology

High Dense Smart Power Capacitor (HDSPC) For Next Generation of Aircraft Converters

3. Scope of the work: Following activities are identified:

- **Select & analyze** minimum **of two** potential capacitors techno suitable with the spec.
- **Verify compatibility of suggested solutions** with aeronautic environment including performances at physical, electrical and thermal levels
- **Modelisation and optimisation** of geometrical shape of selected solution
- **Verification & validation** of suggested solutions through tests of preliminary demonstrators (including performances and ageing tests)
- **Description of final design of capacitors and its monitoring circuit**
- **Validation tests at component and converter** levels

4. Main information on CFP activities & deliverables:

- Activities of CFP limited to **36 months**
- Maximum value of this Topic **is 600k€**
- At T0+12M : **Set of 20 samples; at** T0+24M **set of 20 demonstrators, at T0+36M:** Delivery of **Final Report**

Regenerative Snubber and Innovative control algorithm for high efficient aircraft converter

1. Objectives of *Call For Proposal N° : JTI-CS 2012-1-SGO-02-045* :

- to explore **innovative topologies of regenerative snubbers** more adapted for aircraft power converters (like Power Suppliers, Static Inverters, Motor Controllers …) using large gap semiconductors in order to reuse power losses and increase highly their efficiency. .

- to investigate on more robust and efficient control algorithm of aircraft converters with using regenerative snubbers .

- Important part of this study will be : criteria of compactness, weight reduction and conformity with EMC and harsh aeronautic environment

- This CFP is a scientific & industrial challenge which provides opportunity of competitiveness on this important improvement part for European partners of Cleansky

2. Technical Challenges:

- Volume and Weight reduction rate expected : minimum of 30% (*)
- Maximum operating temperature : 200° C or more
- HVDC breakdown voltage suitable with aircraft network
- High service life and reliable component

(*): compared to existing PPY capacitor technology

Regenerative Snubber and Innovative control algorithm for high efficient aircraft converter

3. Scope of the work: Following activities are identified:

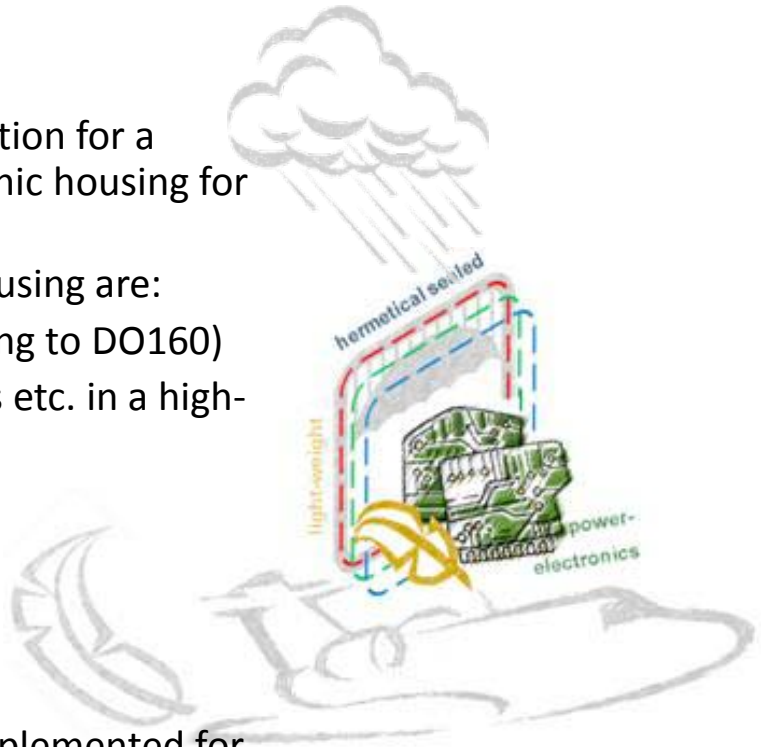
- **State of the art & trade study of existing** and advanced topologies of regenerative snubbers & control algorithms .
- **Selection and study** of limited topologies of regenerative snubbers and innovative control algorithms adapted to a specific aircraft converter
- **Description of final hardware** design solution proposed for snubber and control algorithm
- **Modelisation and optimisation** of geometrical shape of selected solution
- **Validation tests of demonstrators applied on existent and specified aircraft converter**
- Manufacturing and delivery of minimum five hardware samples for internal verification and validation at aircraft converters levels.

4. Main information on CFP activities & deliverables:

- Activities of CFP limited to **36 months**
- Maximum value of this Topic **is 400k€**
- At T0+9M : **Preliminary Design Review ; at** T0+18M **Critical Design Review , at T0+36M:** Delivery of **Final Report**

Aerospace housing for extreme environment SGO-02-043:

1. Context and technical challenges
   - Aim of the proposed work package is an integrated solution for a hermetic sealed low weight and low cost power electronic housing for unpressurised area (DO160).
   - Objects of the optimization packages for this type of housing are:
     - ✓ sealing (withstand salt spray, humidity levels according to DO160)
     - ✓ fixing-technologies for PCBs, chokes, power modules etc. in a high-level vibration area
     - ✓ connectors and their bonding
     - ✓ alternative cooling concepts



2. Expected feedback

After the conceptual design prototype housings should be implemented for an example application.

- bibliography / concepts of materials and construction technologies and their evaluation against the state of art
- risk mitigation: setting up samples and tests for critical issues
- construction of housing for example application
- verification tests

Aerospace housing for extreme environment

3. Additional information

Special skills from the applicant:

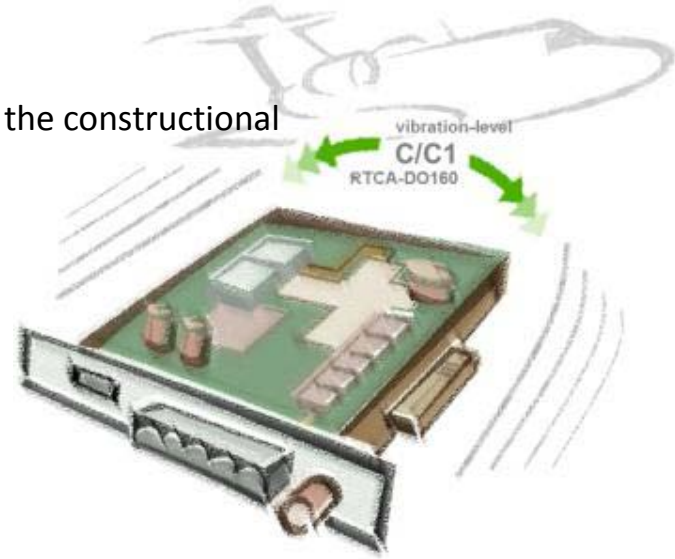
- ability to perform structural, thermal and fatigue analysis
- experience with hermetical sealed (aerospace) housing for power electronics
- special knowledge of bonding, corrosion protection, thermal management, screw fixing-technologies, voltage protection measures for housings

4. Topic value

300k€ maximum budget

Bus system housing for extreme environment SGO-02-044:

1. Context and technical challenges
   - Aim of the proposed work package is an "open box" ARINC-housing (ARINC-standard) for vibration levels C/C1
   - Development of a light-weight and low cost solution
   - The optimized design should consider:
     - ✓ effective area for the PCBs, which ideally should not suffer from the constructional constrains due to the high vibration level
     - ✓ bonding requirements
     - ✓ corrosion
     - ✓ thermal management
     - ✓ fixation technologies
     - ✓ high voltage protection
     - ✓ connector requirements



2. Expected feedback
   - bibliography / concepts of materials and construction technologies and their evaluation against the state of art
   - risk mitigation: setting up samples and tests for critical issues
   - construction of housing for example application
   - verification tests

Bus system housing for extreme environment

3. Additional information

Special skills from the applicant:

- experience with **open box (aerospace) housing for signal electronics**
- ability to perform structural, thermal and fatigue analysis
- special knowledge of bonding, corrosion protection, thermal management, screw fixation technologies, voltage protection measures for housings

4. Topic value

300k€ maximum budget

Compressor air inlet protection for electrical ECS SGO-02-040

1. Context and technical challenges

- In the frame of Clean Sky SGO ITD, one of the project members is developing an electrically driven air system enabling both air conditioning and thermal loads management
- On an electrical ECS pack (MSP), the outside air is injected directly into the compressor via a scoop air inlet located on the belly fairing of the aircraft
- In order to protect the turbo-compressor and electrical pack against such debris and consequently prevent degraded performances or even failure of these components, the outside air shall be cleaned.

2. Expected feedback

The successful partner will have a significant :

- knowledge of particle behaviour and/or filtration for aerospace applications
- experience on CFD modelling and simulation
- experience on engineering and demonstrator development capabilities

Compressor air inlet protection for electrical ECS

3. Additional information

- The specification defining the debris and pollution potentially ingested at scoop air inlet and to be considered for the purpose of this work will be established with the support of the CFP member.
- Airflow modelling from entrance of scoop air inlet to compressor should be carried out basing on pollution specification and by considering various aircraft attitudes and speeds
- Trade-off to allow choice of one technology, preliminary design/sizing of the selected of the selected filtration device and manufacturing of a functional demonstrator will be carried out by the selected applicant(s)

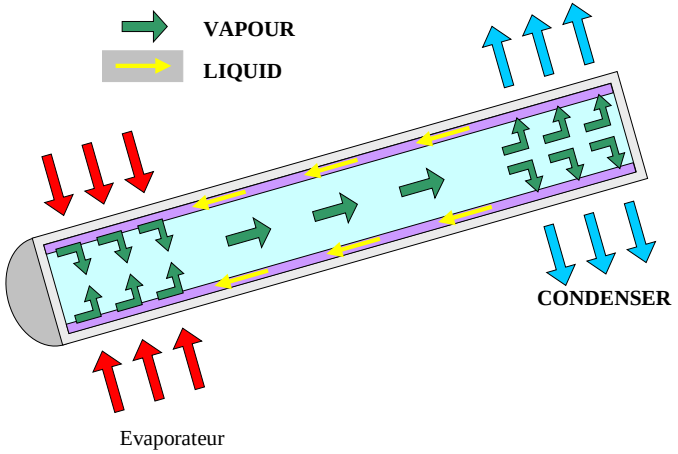
4. Topic value

600k€ maximum budget

Optimisation of heat pipe to cool high speed motorised turbomachine: SGO-02-039

1. Context and technical challenges

- To achieve a high reliability, the air cycle machine must be cooled (bearings). Fresh air (turbine) is used: a dedicated air circuit is defined inside the air cycle machine (thrust and bearings).
- This call for proposal aims to develop a rotational heat pipe optimized for high speed (> 60 000 rpm) an air cycle machine
- A model representative of heat pipe functioning will be developed, and will contribute to design a special closure system of the heat pipe compatible with high rotational speed .



Optimisation of heat pipe to cool high speed motorised turbomachine

•2. Expected feedback

- **<u>Laboratory of University</u>** having significant experience in:
  - Heat pipes
  - Infra red camera (thermography)
  - Air cycle machine
  - Thermal Nodal Models
  - Model performances validation through experimental tests

3. Additional information:

- At the end of this study, thermal demonstrator on Air Cycle Machine will be used to validate laboratory results.
- The applicant should be able to integrate the test bench in a special secured space (rotational speed from 0 to 60 000 rpm)
- The test bench must include special instrumentations to measure the heat flux and temperatures on rotational parts of the machine.

4. Topic value

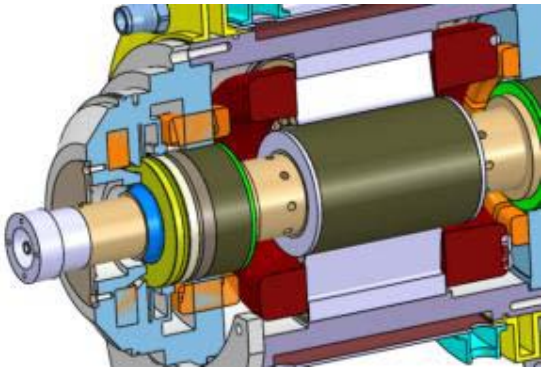
300k€ <u>maximum budget</u>

Development of a carbon sleeve made by filament winding and wound directly on an electric rotor.

- Topic #: JTI-CS-2012-1-SGO-02-042:
- **1. Context and technical challenges**

  - In the frame of SGO ITD the topic manager aims to develop an electrical driven air conditioning system for aircraft application. Such air system requires high speed motocompressor based on permanent magnet rotor technology.

  - The objective is to **develop a direct filament winding process** on a mandrel such that the filament has enough tensile strength to apply a preload on the mandrel find the best system resin/fibre that could withstand the operational conditions (Temperature, Humidity) and suitable for filament winding process.



Development of a carbon sleeve made by filament winding and wound directly on an electric rotor.

2. Expected feedback

- The applicant (company, university, SME) should have :
  - Extensive experience on composite winding machine and composite calculation.
  - Strain gauge measurement tooling for instrumentation.

3. Additional information:

- The topic manager will be responsible of :
  - The direct winding process concept and the validation. Test conditions have to be discussing with the topic manager. An innovative approach would consist in the replacement of current metallic sleeve by composite ones.
  - The furniture of 10 prototypes rotors without carbon sleeve
  - Comparative development tests to valid the electrical rotor wound directly.

4. Topic value

200k€ maximum budget

SOG; Power Electronics with Energy Recycling SGO-03-014

Detailed presentation on 19th which will be published on www.cleansky.eu, including Q&A

Context & Technical Challenges

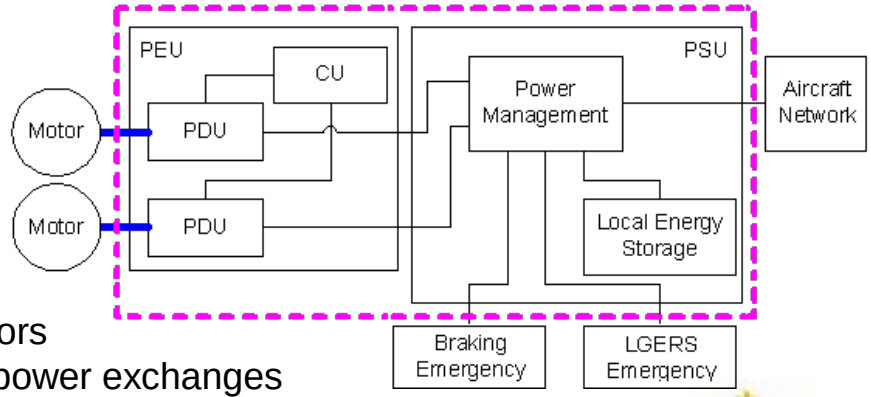
- Development of new aircraft function with economic and ecological goals
- Wheel actuators integration in aircraft landing gears driven by power electronics

Main difficulties

- Developing a complex power electronics which includes energy recycling system
- Using a technology and a design compliant with aeronautical rules

Power Electronics with Energy Recycling System

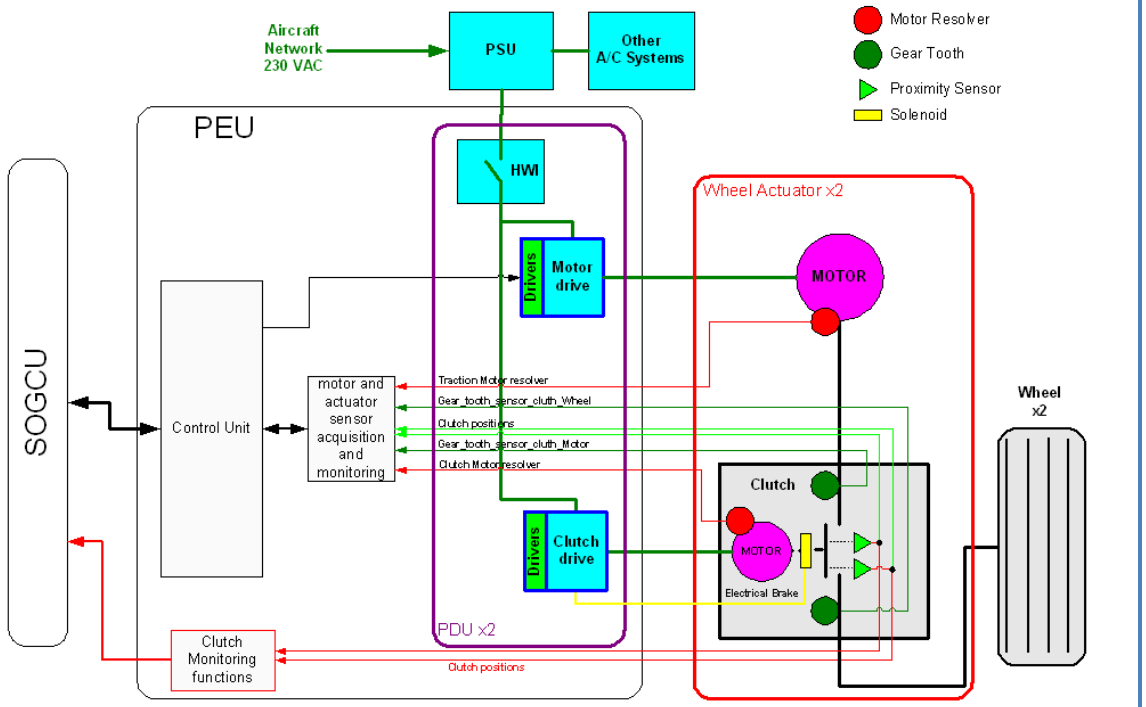
- Increase SOG System efficiency
- Develop and manufacture a double function system:
  - A power electronic which drives wheel actuators
  - An energy recycling system which manages power exchanges between aircraft and SOG System



Smart Operations on Ground
Power Electronics with Energy Recycling System

Expected feedback

- Provide a prototype of a power electronics which will be able to drive Wheel Actuator motor topology and reach the expected performances based on the specification
- Get feedback of system behaviour during regenerative power phases (stability) in order to implement cruise control function



Additional Information

- Participation of a partner aware of aeronautical constraint and consortium organisation would be an asset

Topic value

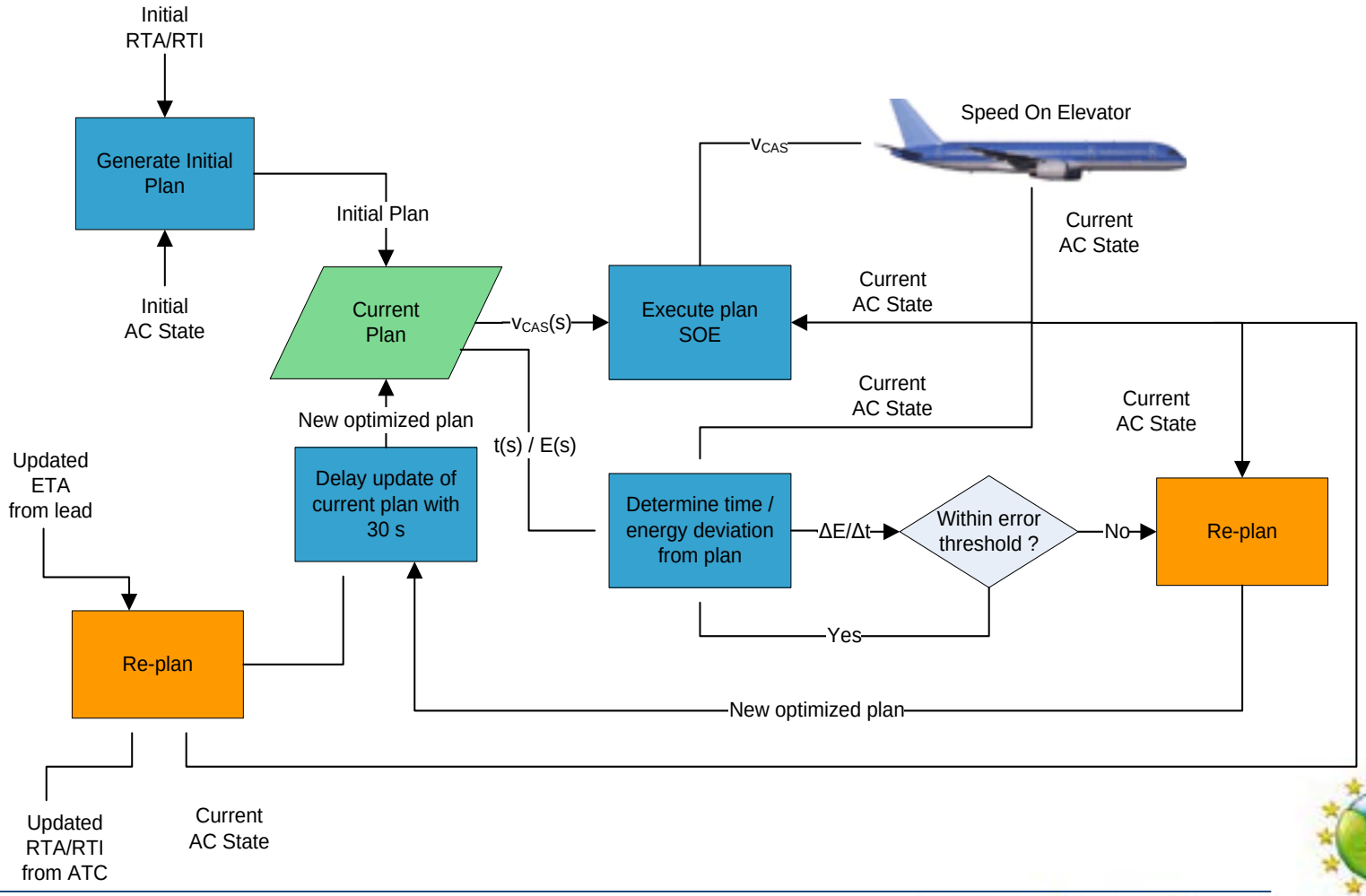
- 1390 k€ maximum budget

Fast optimiser for Continuous Descents SGO-03-017

- Introduction to TEMO
  - TEMO under development by Clean Sky members
    - Time and Energy Managed Operations (TEMO)
  - Based on Idle Continuous Descent Approaches
    - Contributes to reducing Noise and Emissions
  - Time-Constraints at IAF and at Runway Threshold
    - Improvement with current CDA's (high traffic density)
  - Energy management
    - Dissipation from Top-of-descent to Final approach
    - Exchange Kinetic (speed) and Potential (altitude) Energy
  - Re-planning function with optimiser
- This CfP: "Real Time Optimiser"
  - Find optimised re-planned trajectory within seconds
  - Meeting Time and Energy constraints
  - Optimised for minimum fuel
- Topic value: 200k€

Fast optimiser for Continuous Descents

General overview of the TEMO concept



Solid State Power Controllers test benches SGO-04-003

1. Context and technical challenges

Introduction of new SSPCs technologies on aircraft electrical network drive to develop new tests benches technologies in order to be able to test the entire advanced distribution systems.

The interest and the need of these specific test benches are to give more confidence on the advanced distribution systems design.

The system tested using these load test benches are the new technologies SSPCs developed in the frame of the More Electrical Aircraft.

Solid State Power Controllers test benches

2. Expected feedback

The purpose of this call for proposal (CfP) is to design specific load test benches dedicated to the tests of SSPCs

These load test benches will be used to simulate a range of aircraft electrical loads in order to test different types of SSPCs.

The load bench shall be able to **emulate A/C equipment power consumption** on A/C electrical network: three-phase 115VAC, three-phase 230VAC, 540VDC or 28VDC.

3. Topic value

250k€ maximum budget

Contact us

For further information:

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www.cleansky.eu