# CfP09 Proposed Topics: ENG ITD

| JU Topic # | Title | Work Package | Project Duration | Strategic Topic Leader | Action Type | Topic Value (€) |
|---|---|---|---|---|---|---|
| JTI-CS2-2018-CFP09-ENG-01-39 | **Measurement of rotor vibration using tip timing for high speed booster certification and quantification of associated uncertainties** | WP2 | 36 | Safran Aero Boosters | RIA | 600k |
| JTI-CS2-2018-CFP09-ENG-01-40 | **Turbulence modeling of heat exchange and roughness impact** | WP2 | 36 | Safran Aero Boosters | RIA | 500k |
| JTI-CS2-2018-CFP09-ENG-01-41 | **Ground vortex caracterization & simulation** | WP2 | 24 | Safran Aircraft Engines | RIA | 750K |
| JTI-CS2-2018-CFP09-ENG-01-42 | **Additive manufacturing boundary limits assessment for Eco design process optimization (ECO)** | WP9 | | Safran Aircraft Engines | RIA | 1500k |

# JTI-CS2-2018-CFP09-ENG-01-39

# Turbulence modeling of heat exchangers and roughness impact

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http://www.cleansky.eu/content/homepage/about-clean-sky-2

# JTI-CS2-2018-CFP09-ENG-01-39

- **WP 2.5.4: Oil Equipments**
  - Leader : Safran Aero Boosters
  - Contributor : Safran Aircraft Engines

- **Title:** *Turbulence modeling of heat exchangers and roughness impact*

- **Objective:** For geared turbo fan engine architectures, the thermal management will be one of the most important challenge to face. The heat exchangers are the main products that drive the performances of the thermal management system and the additive manufacturing (*AM*) has a great potential to optimize their global efficiency. However, new numerical modellings are needed to predict correctly the aerothermal performances of these *AM* innovative geometries with unusual roughness. Thus, the aim of this call proposal is to manage the turbulent behavior and the roughness in *AM* heat exchangers in order to optimize their aero performances.

- **Volume:** 600 k€ funding

# JTI-CS2-2018-CFP09-ENG-01-39

- **Schedule/Milestones**

| | | Year 1 | | | | Year 2 | | | | Year 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| **WP 1** | **Identification of physical parameters and CFD modeling** | ■ | ■ | ■ | | | | | | | | | |
| **WP 2** | **Modelization of test cases incompressible internal rough flow** | | | | ■ | ■ | ■ | | | | | | |
| **WP 3** | **Modelization of test cases compressible internal rough flow** | | | | | | ■ | ■ | ■ | | | | |
| **WP 4** | **Modelization of two fluids *AM* heat exchangers** | | | | | | | | | | ■ | ■ | ■ |
| **WP 5** | **Benchmark of LES modelization on test cases rough flow** | | | | | | | | ■ | ■ | ■ | ■ | ■ |

- **Targeted applicant:** Applicants will be experts in Computational Fluid Dynamics (CFD) and particularly in turbulent flow modelling with multi-physics interactions. They shall demonstrate their skills detailing their activities, own bibliographic references and description of relevant past projects.
- **Required skills:**
  - Strong expertise in fluid numerical simulations and analysis is required :
    - Aerodynamic, Fluid Dynamics and Aerothermal
    - High Performance Computing for Computational Fluid Dynamics (CFD) simulations
    - Large Eddy Simulation
    - Aerothermal simulation coupling conduction
    - Laminar to turbulent flow simulations
  - Knowledge of AM process and impact on geometries
- **Required capabilities:**
  - In-house computing facilities to performs the tasks
  - In-house CFD tolls : for RANS simulations, the ANSYS-Fluent solver (version>18.1) and for LES simulations, the YALES 2 solver .

# JTI-CS2-2018-CFP09-ENG-01-40

## Measurement of rotor vibration using tip timing for high speed booster certification and quantification of associated uncertainties

**Innovation Takes Off**

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# JTI-CS2-2018-CFP09-ENG-01-40

- **WP 2.5.5: Booster**
  - Leader : Safran Aero Boosters
  - Contributor : Safran Aircraft Engines

- **Title:** *Measurement of rotor vibration using tip timing for high speed booster evaluation of associated uncertainties*

- **Objective:** Build and validate a complete chain of sensors, acquisition system and tools to permit measurement of rotor vibration for high speed booster blades. To sustain certification of high speed booster using this measurement topology, uncertainties have to be quantified.
  - These uncertainties remain important/unknown for low pressure compressors,
    - due to the numbers of (known or unknown) parameters (clearances, axial positioning, temperature,…) which are not taken into account by actual systems, methodologies or algorithms
    - and also due to the quality of the acquired signal, not homogeneous and down-sampled resulting in a complex post processing.
  - With the goal of avoiding telemetry/slip ring system to perform certification, those uncertainties have to be known and quantified to insure safety and margin of the low pressure compressor.
  - A validation test should be performed on a representative low pressure compressor rig test vehicle provided by the Topic manager organisation.

- **Volume:** 500 k€ funding

# JTI-CS2-2018-CFP09-ENG-01-40

- **Schedule/Milestones**

| | | Year 1 | | | | Year 2 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| **D1** | **Identification of physical parameter (intermediate)** | | | | | | | | |
| D1.1 | Identification of physical parameter (intermediate) | ■ | | | | | | | |
| D1.2 | Identification of physical parameter (final | | ■ | | | | | | |
| **D2** | **Modelization of physical parameter influences (intermediate)** | | | | | | | | |
| D2.1 | Modelization of physical parameter influences (intermediate) | | ■ | ■ | | | | | |
| D2.2 | Modelization of physical parameter influences (intermediate) | | | | ■ | | | | |
| **D3** | **Tip-timing chain design and implementation** | | | | | | | | |
| D3.1 | Tip-timing chain design | | | | ■ | ■ | | | |
| D3.2 | Tip-timing chain implementation | | | | | ■ | ■ | ■ | |
| **D4** | **Tip-timing chain validation** | | | | | | ■ | ■ | ■ |
| D4.1 | Tip-timing chain validation | | | | | | ■ | ■ | |
| D4.2 | Tip-timing chain uncertainties determination | | | | | | | | ■ |

- **Targeted applicant:** Applicants will be experts in tip timing and especially in processing and analyzing its signals. They shall demonstrate their skills by detailing their activities, their own bibliographic references and by describing their relevant past projects.
- **Required skills:**
  - Knowledge on non-homogeneous under-sampled signals
  - Knowledge on synchronous & asynchronous phenomena observed in boosters
  - Knowledge on uncertainties quantification
  - Capability to build analytical and semi-empirical models of vibration behavior of blades
  - Capability to adapt acquisition system and associated softwares (mainly Human Machine Interface)
  - Capability to design post-processing softwares
- **Required capabilities:**
  - Test bench & representative high speed rotor
  - Software development tools

# JTI-CS2-2018-CFP09-ENG-01-41

## Ground vortex caracterization & simulation

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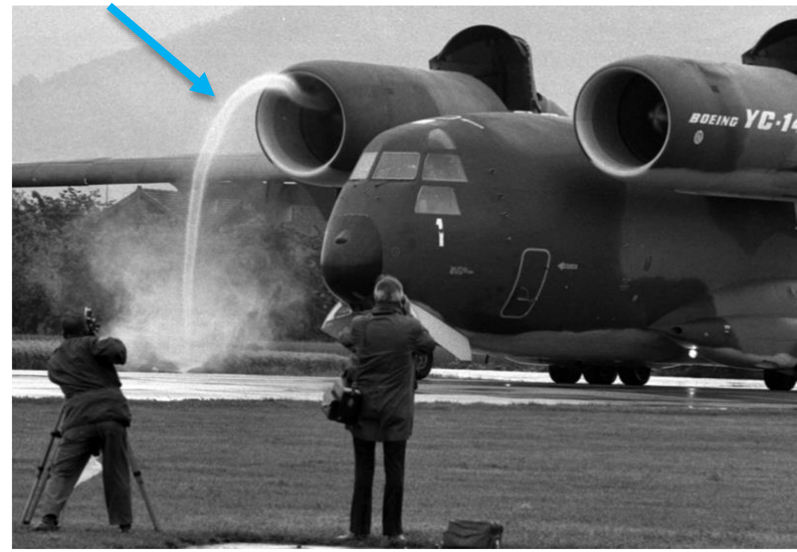
http://www.cleansky.eu/content/homepage/about-clean-sky-2

Clean Sky 2

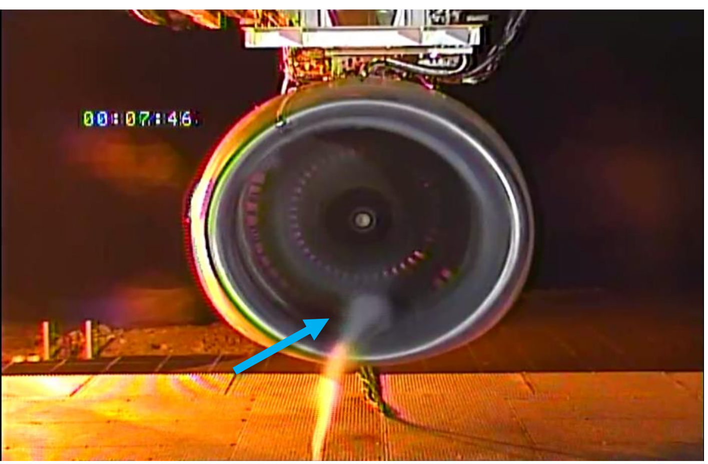
# JTI-CS2-2018-CFP09-ENG-01-41

When a turbojet engine operates at ground conditions, ground vortices can form and be **ingested** by the engine intake. This is typically the case with high crosswinds.



Knowing the **characteristics** of these vortices is critical for the aeromechanical design of fan blades :

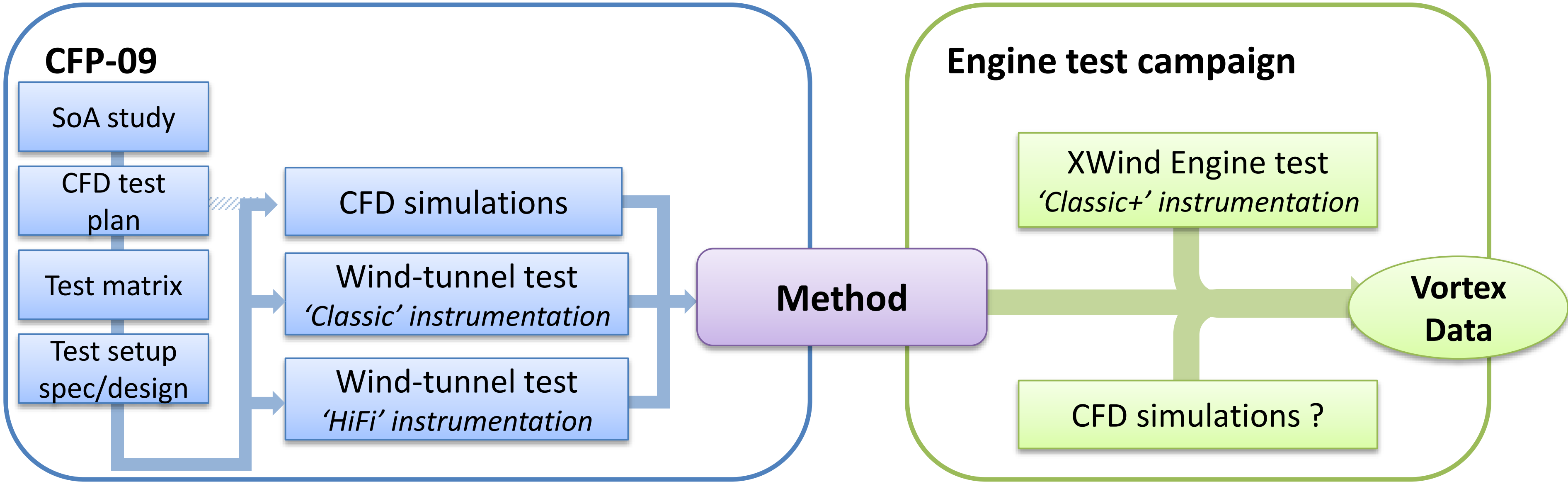
- Vortex strength (vorticity, tangential speed)
- Appearance conditions (wind speed, massflow)



Eventhough ground vortices can be simulated and analyzed with CFD tools, **validation** of such studies is **challenging** : deploying the necessary instrumentation tools on an engine test survey is incompatible with the **integration constraints** (stress, intrusiveness, cost)

# JTI-CS2-2018-CFP09-ENG-01-41

**Goal of this CFP topic :** to develop a methodology to characterize a ground vortex during an engine test survey, with tools compatible with the test constraints (stress, intrusiveness, cost)




- Wind-tunnel facility has to be compatible with characteristics provided in the topic description document
- Test setup : inlet geometry will be provided by Safran; a metallic model can also be provided (scale 6.5 used in Onera F1 WT). No fan is required, provided targeted inlet massflows are effectively generated
- CFD simulations will be made at different stages of the project to i) define the test matrix and instrumentation location, ii) mature the targeted methodology and iii) produce numerical data to compare with test results

# JTI-CS2-2018-CFP09-ENG-01-42

## Additive manufacturing boundary limits assessment for Eco design process optimization (ECO)

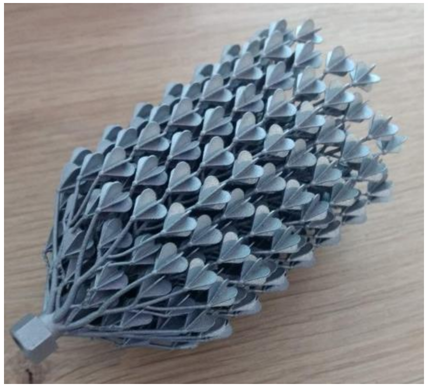
**Innovation Takes Off**

http://www.cleansky.eu/content/homepage/about-clean-sky-2

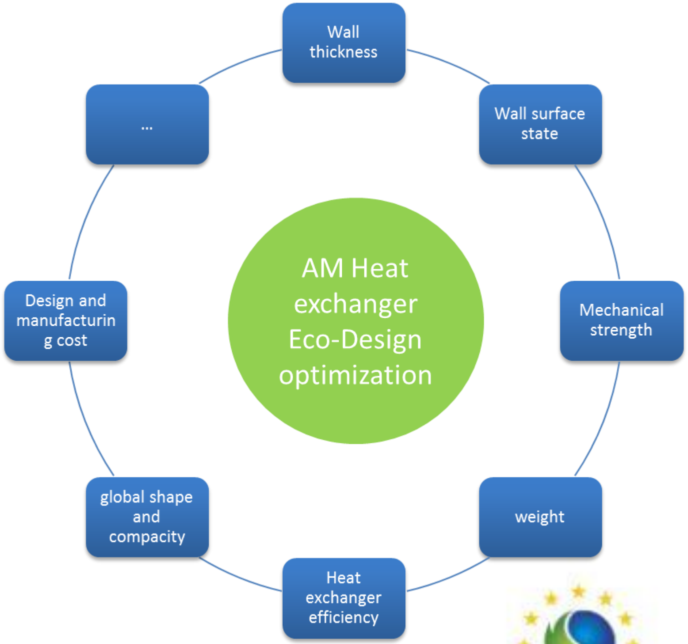
Clean Sky 2

# JTI-CS2-2018-CFP09-ENG-01-42

- Additive manufacturing (AM) is a key technology for improved design and production process of aviation parts
- Applied to heat exchangers, it could dramatically improve global eco-efficiency through access to radically new designs and open new horizons in terms of shape, weight, efficiency…
- Nevertheless, a lot remains to be done in order to perfectly master all the design and manufacturing process, as heat exchangers are complex and critical parts. Key questions such as capability of AM to manufacture thin walls, resulting surface roughness, resulting mechanical strength
- The objective of this CfP, proposed by Safran in the frame of EITD ECO-topics, is to **enhance the basic knowledge of AM capability to manufacture thin layers, and consequently be able to optimize heat exchanger design process**



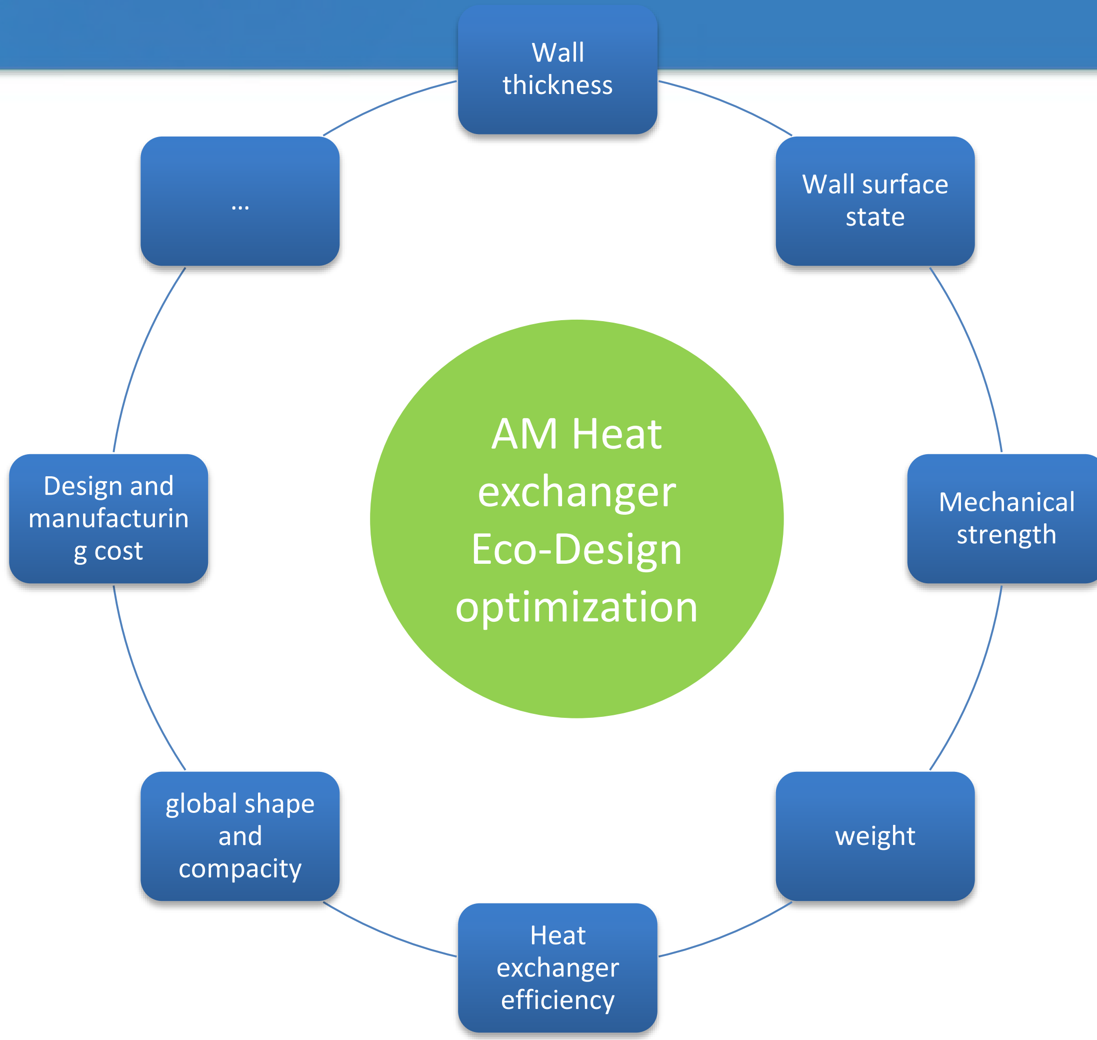
Source : 3Dprintingindustry.com March 2018 (design by Bremen University and printed by the MetalFAB1)



# JTI-CS2-2018-CFP09-ENG-01-42

- CfP content :
  - Manufacturing and characterization of selected samples based on a DOE approach
  - Variation of selected parts characteristics such as wall thickness, layer thickness, finishing process, wall orientation, scanning strategy, scanning speed…
  - Various parts geometry (from basic geometry to more complex one) according to the type of characterization. Geometries to be finalized with the contractor.

- Skills needed :
  - single partner or Consortium gathering additive manufacturing capability, part characterization.
  - Expertize in material properties modelling would be a plus


AM Heat exchanger Eco-Design optimization
Wall thickness
Wall surface state
Mechanical strength
weight
Heat exchanger efficiency
global shape and compacity
Design and manufacturing cost
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