# Clean Sky2 Additive Manufacturing research activities

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EASA European Aviation Safety Agency

**Additive Manufacturing Workshop**
**Cologne, 28-29 September 2016**

www.cleansky.eu www.easa.europa.eu

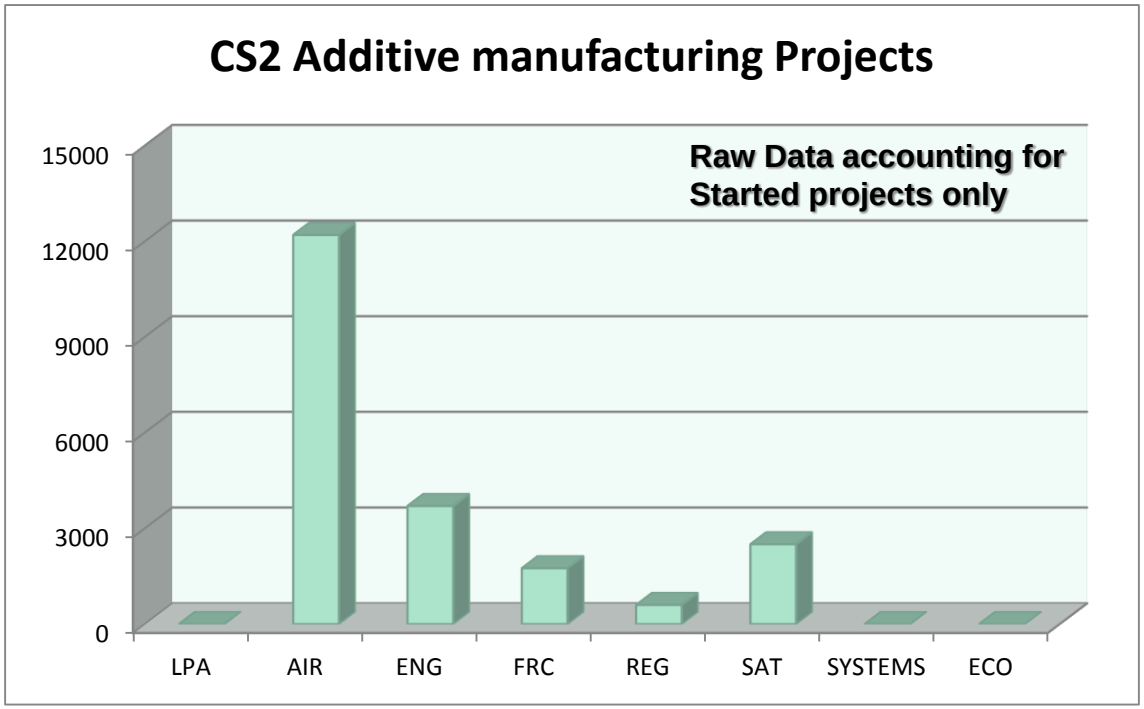
# AGENDA

- Introduction to CleanSky2 Initiative
- Integrated Technology Demonstrators
- Example of activities / projects concerning new manufacturing methods
- Way forward

# CleanSky2 Additive Manufacturing research activities

# CleanSky2 Additive Manufacturing research activities

- On the first three CfP calls, more than 14 CleanSky2 projects have been already selected for funding dedicated to innovative manufacturing processes (e.g. Additive Manufacturing)
- Compared to CleanSky, research activities are more focused on industrial applications (high TRL).

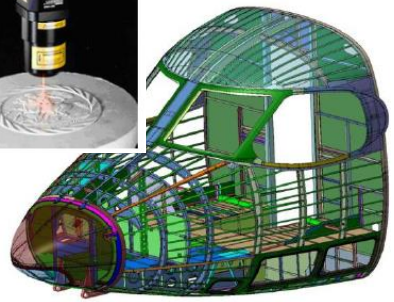


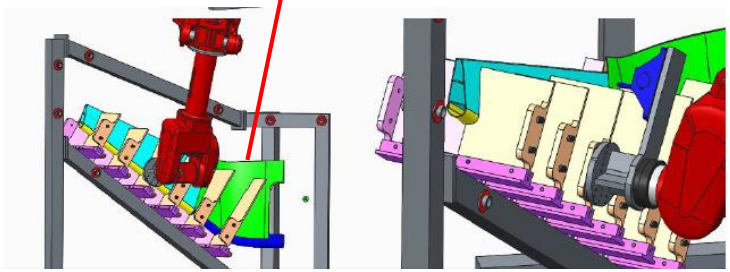
# CleanSky2 Additive Manufacturing research activities

## Some examples of research fields funded within the CS2 framework

**Novel Tiltrotor Drive System housing, by means of Additive Layer Manufacturing (ALM)**

**manufacturing lighter and cheaper airframes for Small Aircraft**





**Assembly and Transport of the Morphing Winglet and Multifunctional Outer Flaps of the next generation optimized wing box.**

**Wing airframe components**

**Components for Automatic assembling of wing upper skin and external wing leading edge**

# CleanSky2 Additive Manufacturing research activities

*Examples of Research Activities aimed to develop consolidated process for designing aircraft components made with Additive Manufacturing…*

# CleanSky2 Additive Manufacturing research activities

**CfP** : **JTI-CS2-2014-CFP01-AIR-02-07**

**TITLE**: **Design Against Distortion: Part distortion prediction, design for minimized distortion, metallic aerospace parts**

**Project Start Date**: **01/01/2016** **Duration: 36 month**

## Background

During last years, advanced computer aided design (CAD) and optimisation methods have been implemented in order to achieve weight reduction and short development time. **However, current design tools and methodologies do not account for part distortions in manufacturing.**

Distortion of aerospace parts is a significant burden on the European aerospace industry, in terms of recurring costs, and in terms of waste production / avoidable impact on the environment.

A specific WP (WP B-4.3.4 ) in CS2-AIR ITD is dedicated to design again distortion topic in composite fuselage

JTI-CS2-2015-CFP02-AIR-02-15: Design Against Distortion: Part distortion prediction, design for minimized distortion, carbon-epoxy aerospace parts

*** http://cordis.europa.eu/project/rcn/199353_it.html**

# CleanSky2 Additive Manufacturing research activities

The selected project copes with the development and application of rapid distortion prediction numerical methodologies applicable to machining and additive layer manufacturing (ALM - selective powder sintering of metals, laser or e-beam) technologies of metallic parts and the development of concurrent topology optimisation codes capable of accounting for part distortion during design phase

The following geometries will be considered as reference

| Manufacturing process | Geometry | Bounding box size | Alloys |
|---|---|---|---|
| Machining | Wing-box, pylon-box rib or similar representative part | 500 x 500 x 50 mm | Aluminium (AA7050 T7451) and titanium (Ti-6Al-4V) alloys. |
| Additive layer manufacturing | Bracket or fitting | 250 x 250 x 250 mm | Titanium (Ti-6Al-4V) alloy |


**metal innovative bracket design manufactured by ALM (prototype for A350 XWP aircraft)[*]**

**DISTRACTION** project

| Participant nº | Participant organisation name | Participant short name | Country |
|---|---|---|---|
| 1 RTD (Coordinator) | LORTEK S. COOP. | LORTEK | Spain |
| 2 UNI | DELFT UNIVERSITY OF TECHNOLOGY | TUD | The Netherlands |

**(*) "http://www.3dprinter.net/airbus-incorporate-3d-printing-technology-aircraft-manufacturing."**

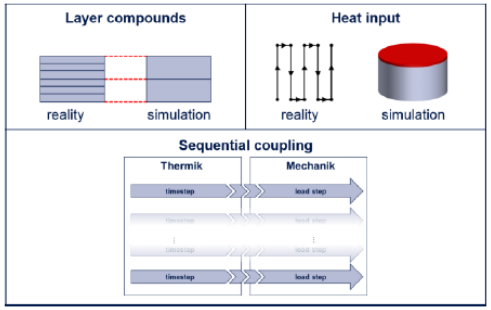
# CleanSky2 Additive Manufacturing research activities

**CfP** : **JTI-CS2-2015-CFP02-ENG-02-02**

**TITLE**: **Integration of Laser Beam Melting Simulation in the tool landscape for process preparation of Additive Manufacturing (AM) for Aero Engine applications**

**Project Start Date: 01/08/2016**

**Duration: 36 month**




## Objectives

project aims to integrate a suitable simulation-based process chain into the tool landscape for AM process preparation that enables a prediction of distortions with high accuracy in reasonable time to generate benefit for AM users.

The main focus lies on the **metal-based layered manufacturing process of LBM as this is the most widespread approach to generating three-dimensional parts from powder material suitable for engine components**

**Ascent AM** project

**Coordinator:** TECHNISCHE UNIVERSITAET MUENCHEN (DE)

# CleanSky2 Additive Manufacturing research activities

**CfP** : **JTI-CS2-2016-CFP03-AIR-01-16**

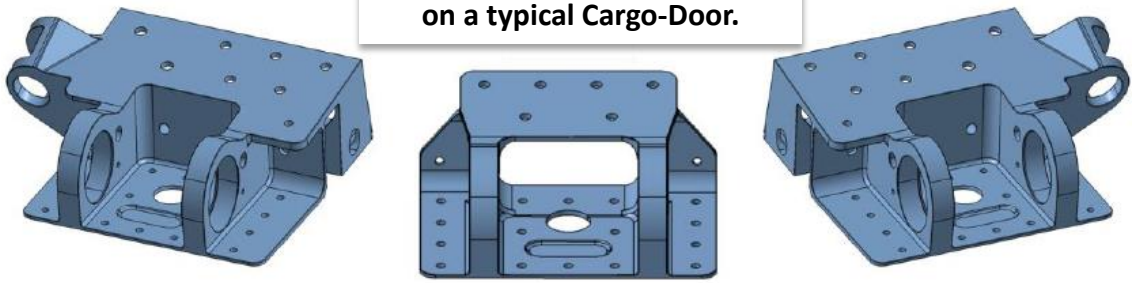
**TITLE: Design Guide Lines and Simulation Methods for Additive Manufactured Titanium Components**

## Objectives

- Material characterization. Effect of geometry and surface roughness and optimize fatigue performance by cost effective surface post processing.
- Validation of design solutions and creation of design rules.
- To verify material models and computational tools used in AM development by experimental testing on AM manufactured parts, both in lab environment and industrial settings.

**Examples of Geometry for validation**

**Shear fitting and Latch fitting on a typical Cargo-Door.**



Direct collaboration between SAAB and FhG on Aluminium within AIR ITD.

# CleanSky2 Additive Manufacturing research activities

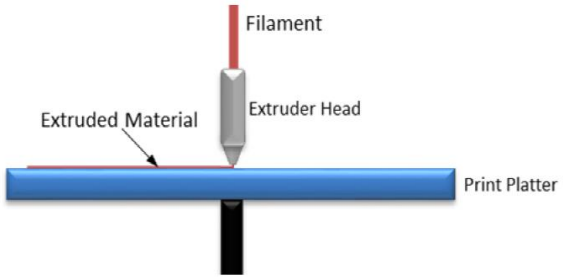
## Expected Outcomes

- A 30% weight reduction target in comparison with current designs of use case geometries thanks to the implementation of topology optimisation.
- Reduction of manufacturing costs of new fuselage and engine parts by 20% due to introduction of distortion analysis during the design phase.
- Reduction of time-to-market of new fuselage and engine parts by 25% due to the design optimisation accounting for distortions as alternative to current trial and error approach.
- Reduction of computational times by 30% for predicting distortions in machined and ALM parts thanks to the development of computationally efficient methodologies (rapid distortion prediction tools)
- Reducing scrap ratio of fuselage and engine parts during prototyping and ramp up phases by 50%.

# CleanSky2 Additive Manufacturing research activities

**CfP** : **JTI-CS2-2016-CFP03-AIR-02-20**

**TITLE: Low cost Fused Filament Fabrication of high performance thermoplastics for structural applications**




## Objectives

FFF method (Fused Filament Fabrication) is a promising technology deploying simple machine setups and low cost materials hence further reducing the overall manufacturing costs. Within this context, the topic aims to

- develop functional prototype printers capable to fabricate components using technical thermoplastics such as PEEK with the FFF method.
- to produce small test coupons (max. 100x100x100 mm) for material characterisation (structural, thermal, and functional testing).
- to prove the capability of the developed printer to produce the items (like pulsed jet actuator) repeatedly for assembly and structural testing.

# CleanSky2 Additive Manufacturing research activities

*Cleansky2 programme is pushing the application of Additive Manufacturing for large Aircraft/Helicopter Components…….*

# CleanSky2 Additive Manufacturing research activities

**CfP** : **JTI-CS2-2015-CFP02-FRC-01-03**

**TITLE: Development and validation of an optimised gearbox housing structural design and manufacturing process, based on additive layer manufacturing concept leading to a flight cleared demonstrator.**

**Project Start Date: 01/08/2016 Duration: 36 month**

## Background

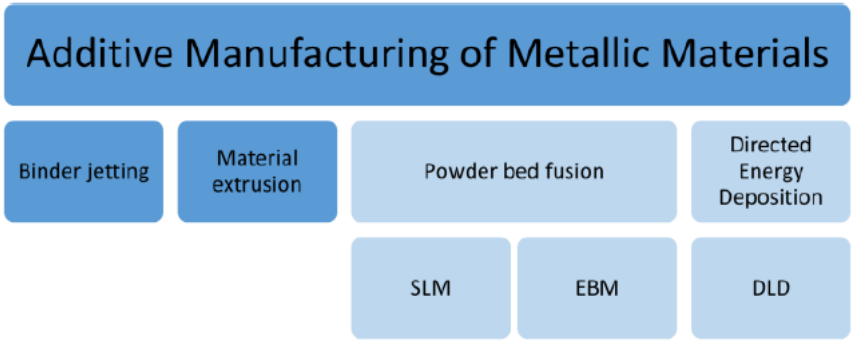
TiltRotor drive system housing is a very complex structural component of Tilt rotor vehicles. The main characteristics /requirements of a typical r/c main drive system housing are:

- large dimensions (about **2 m** length)
- complex and thin-walled shapes
- high specific stiffness and high specific strength
- capability to sustain moderately high temperatures
- capability to endure possibly corrosive fluids
- capability to comply high-cycles fatigue

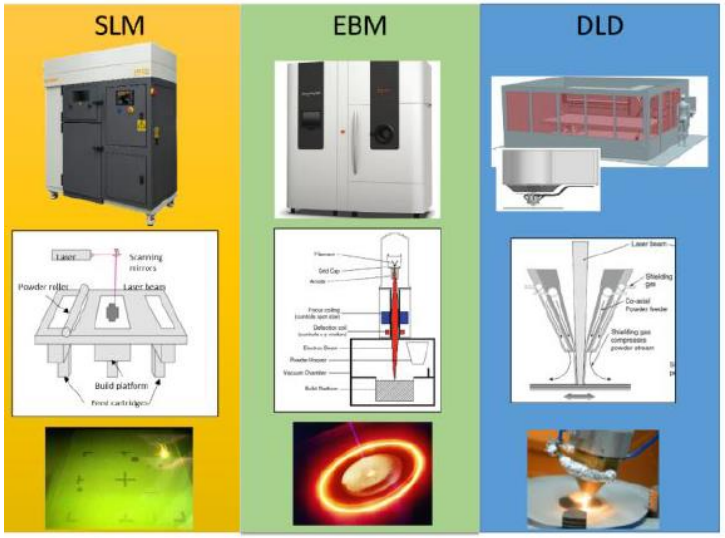
# CleanSky2 Additive Manufacturing research activities

The objective of project is to develop a novel TiltRotor main drive system housing produced by additive manufacturing (AM) technology.

For additive manufacturing of metallic materials five groups of technologies will be considered in this project according to ASTM F42 standard.




A main drive system housing is a large part, not easily to be produced by AM commercial machinery like selective laser melting - SLM or electron beam melting – EBM; **so alternative, innovative approach will be investigated, in the field of Directed Laser Deposition DLD.**



# CleanSky2 Additive Manufacturing research activities

## Expected Outcomes

- to develop, assess and produce a TiltRotor main drive system housing compliant to these requirements, exploiting the features of innovative AM techniques.

- Demonstrating the feasibility of large component manufacturing directly via AM processes to open up new possibilities in the aeronautical field as well as in other sectors such as naval, energy and oil and gas.

- to trade-off among production processes EBM, SLM, DLD and their joining and machining techniques, in view of the optimization process and to allow sound and reliable mid-term industrial choices

### AMATHO project

| Participant Organisation Name | Country |
|---|---|
| Politecnico di Milano | Italy |
| SUPSI Department of Innovative Technologies | Switzerland |
| Prima Industrie SpA | Italy |

# Clean Sky Additive Manufacturing research activities

*Next Call for Proposals…..*

# Clean Sky Additive Manufacturing research activities

**CfP** : **JTI-CS2-2016-CFP04-REG-01-07**

**TITLE: Innovative alloy development for structural part fabrication with Additive Manufacturing Technology**

**Publication date: 21 June 2016; Deadline: 05 October 2016**

**Topic indicative Funding: 0.6 Me; Project Expected duration: 36 months**

## Objectives

- to develop, by powder technology and Additive Manufacturing process, a new aluminium alloy with performances similar to structural alloys (7000 series).
- Mechanical characterization of the new material is deemed necessary for component structural validation
- Definition of the heat treatment cycle that gives the best performances of the selected alloy
- To manufacture two demonstrators for destructive and non-destructive tests

# Clean Sky Additive Manufacturing research activities

**CfP** : **JTI-CS2-2016-CFP04-SYS-02-23**

**TITLE: ECO-design based techniques and machinery for improved racking and distribution boxes**

**Publication date: 21 June 2016; Deadline: 05 October 2016**

**Topic indicative Funding**: **1.0 Me; Project Expected duration: 30 months**

## Objectives

- to specify, design and develop additive manufacturing tool-machinery based on the use of electrical conductive and non-conductive materials applied to innovative electrical distribution boxes.
- to adapt conventional electrical cabinet manufacturing process specifications to hybrid additive manufacturing process specifications.
- to manufacture sample geometries and perform associated qualification test plans.
- To manufacture the machinery prototype to be equipped with electrical network

# Thank you
# for your attention

## See more information
## on www.cleansky.eu

HORIZON 2020

THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION

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Clean Sky 2

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DASSAULT AVIATION
DLR
AIRBUS DEFENCE & SPACE
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Fraunhofer
LIEBHERR
MTU Aero Engines
PIAGGIO AERO
Rolls-Royce
SAFRAN
SAAB
THALES

## Disclaimer

The content of this presentation is **not legally binding.** The proposed content/approach is based on the consultation with the "National States Representative Group" and the "Task Force " of the *Clean Sky 2* Programme Proposal