GSTP AM4ALL
Executive summary

CITD-ESA-RP-AM4ALL-003

Issue 01

30th January 2024

AUTHOR	CHECK	APPROVED
CiTD Team **08/01/2024**	**Lidia Hernandez** **08/01/2024**	**Marta G-Cosio** **30/01/2024**

CHANGE RECORD

Issue	Date	Pages Modified, added or deleted	Changes Description
1	30/01/2024	-	Initial Issue

1. CONTEXT

The space industry is one of the most promising industrial sectors for the implementation of additive manufacturing technology as there is a confluence of different issues that make AM processes attractive for developing a large family of metallic parts for launcher and satellite applications:

- the fabrication of unique products or short series
- necessity for weight reduction through topology optimization
- structural components but not subjected to intensive fatigue loads, etc.,.

CiTD team has been investing and developing this technology since 2013, and in the space sector dedicated to metallic pieces of flight since 2017. This work has focused mainly on the realization of parts flying on satellites and launchers made by Airbus, thanks to the MINECO grants (RETOS program) and the GSTP call (Novel structural components for launchers/satellites applications using additive manufacturing technologies, awarded to Star3 consortium) that allowed to fly in JUICE satellite 11 brackets) in addition to the research investment of CITD, CATEC and Airbus.

CITD and FADA-CATEC have developed a strategic alliance in the field of additive manufacturing in the space sector, allowing the industry sector the development and rapid adoption of new products that improve their competitiveness in the international scenario.

Within the framework of this alliance both entities seek to bring additive manufacturing to the spatial actors of the national fabric. FADA-CATEC is the only technology center that has developed flight components for additive manufacturing, and that have all their manufacturing and verification processes qualified for flight by the European Space Agency. In recent years, FADA-CATEC has developed, together with CITD, a large list of components of primary and secondary structure for additive manufacturing, which have enabled the Spanish industry to be positioned as one of the European benchmarks in technology for development of flight pieces. These developments have been made through ESA financing by GSTP programs and private subcontracting. CITD is an engineering company with a unique knowledge in aeronautical and space design, and with practical knowledge of additive manufacturing technology, being one of the few Spanish companies that have designed flight components for space with this technology, for the CHEOPS satellite (AIRBUS DS) and the space missions JUICE (ESA).

2. OBJECTIVES

This GSTP project provides continuation based on the success achieved in the past and with the actors that already possess sufficient knowledge and maturity to achieve new successes in additive manufacturing, also promoting the transfer of these results to large Spanish companies and SMEs. **The main object of the current project is to approach the technology to different Space actors by developing products based in AM technology.**

The Spanish companies participating in this GSTP project have actively collaborated in the development of AM products which are meaningfull for them in terms of performance, cost or schedule. The GSTP project is split into different stages, covering the whole product development and verification stages according to ECSS standards.

Task	Tittle	Resp.
WPx.00	Project management and coordination	CITD
WPx.01	Selection of structural elements and requirements stablishment	CITD
WPx.02	Design for AM of the selecterd elements. Justification and test plan for qualification	CITD
WPx.03	AM Manufacturing process and manufacturing of the structural parts	CATEC
WPx.04	Postprocessing and verification	CITD
WPx.05	Qualification Test	CITD
WPx.06	Evaluation and reporting	CITD

3. RESULTS

The technology developments made for the spanish companies focus on six different applications, developed from the initial stage with the requirements gathering up to qualification of the parts. The main outcomes of the GSTP project are:

SOLARMEMS polymeric baffle

A new design of baffle based on high performance polymeric materials for Additive Manufacturing has been developed and qualified. It has been demonstrated that the new baffle proposal successfully fulfils the established requirements demonstrating its feasibility from a technical point of view. Additionally, the Ultem9085 T16 printing process in a Materialise production system 400MC-08 has been qualified according to ECSS-Q-ST-70-80C (for powder bed fusion technologies).

ULTEM 9085 BAFFLE

Mass	0.0167 kg
Stiffness	> 1000 Hz

This new design shows opportunities in terms of mass, schedule and cost saving.

DOMAIN	TRADITIONAL	AM ULTEM
Performance	OK	OK – same as traditional
Mass	30 g	17 g
Cost	163 €	40 € (20 units batch)
Schedule	5 weeks	2 weeks

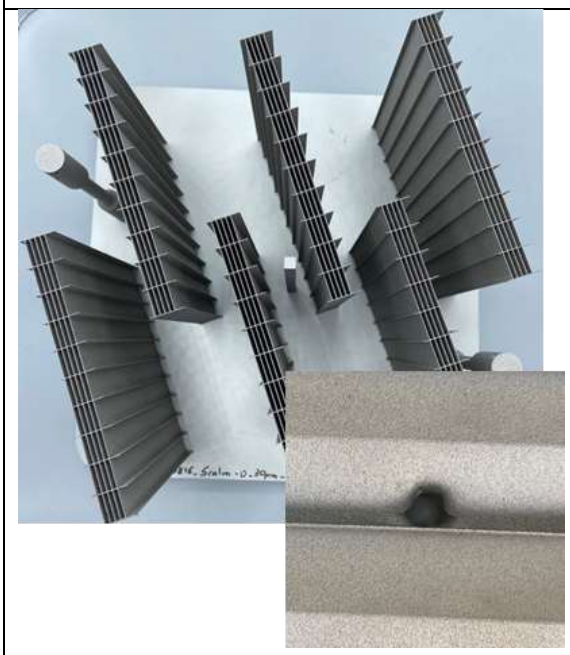
The material and process is widely used in non-critical systems in aviation. The qualification of the process opens the possibility of using the technology in parts with certain mechanical and thermal requirements.

DEIMOS Comet interceptor

Two different configurations for a new sandwich core concept aiming to be applied in COMET INTERCEPTOR mission have been developed. The core is designed to play two functions: the traditional structural function and the shielding one. Both concepts were designed and manufactured by PBLF using Scalmalloy.

The core is optimized for stopping ice-dust fragile particles resulting from the impact through the bumper and stuffing layers of a traditional multilayer shield. At the same time, the technology offers

the possibility to integrate structural interfaces such as inserts or fittings. The two different configurations have been selected, manufactured and tested at laboratory scale. This new design shows opportunities in terms of operation and shielding capacity and energy absorption.

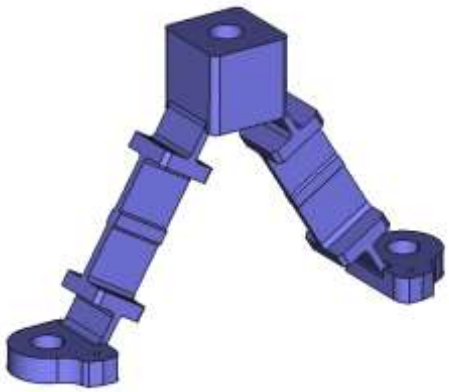
Scalmalloy core-shield – FLATCORE	**Scalmalloy core-shield – TREECORE**
	

LIDAX PLATO mission bipod

There are two main outcomes for LIDAX isostatic mount bypods: the AM design for these parts whose traditional manufacturing is extremely complicated and the qualification of the process for Ti6Al4V in PBLF without HIP treatment as well as associated post-processes (annealing, sandblasting, machining…).

The AM process has been completely qualified according to ESA and Airbus standards with very good results in terms of material performance and alpha case avoidance. Instead of the traditional HIP, a high temperature stress relieved is qualified. Sandblasting and machining of the part is also qualified.

TRADITIONAL DESIGN



AM DESIGN

With regards to the design, the AM part has the same capabilities as the traditional one but the machining operations are reduced and so does cost.

DOMAIN	TRADITIONAL	AM ULTEM
Performance	OK	OK – same as traditional
Mass	OK	OK – same as traditional
Cost (3 units)	12000 €	9000 € (3 units batch)
Schedule	8 weeks	4 weeks

The parts were successfully tested in an ambient representative of the operational environment and were subjected to qualification random load input. The parts were able to withstand the load without any damage and hence could be considered as qualified for flight according to ECSS-ECSS-Q-ST-70-80C.

ANTERAL radiating chain

The main outcomes of the radiating chain are:

- AM design oriented that comprises the whole radiating chain in one single part that provides better performance than the traditional solution
- Manufacturing of a complex slender shape with very thing walls and with strong accuracy requirements
- Chemical etching qualification for two different materials: Scalmalloy and ALSi10Mg for additive

The prototype has been manufactured and tested in Scalmalloy although RF tests were performed with additional coupons using also AlSi10Mg.

Radiating chain

DOMAIN	TRADITIONAL	AM DESIGN
Performance	OK	OK
Mass	OK	80% wrt traditional
Cost (3 units)	4500 € (5 units)	3000 € (5 units batch)
Schedule	5 weeks	5 weeks

The parts were successfully tested in an ambient representative of the operational environment and were subjected to qualification random load input. The parts were able to withstand the load without any damage and hence could be considered as qualified for flight according to ECSS-ECSS-Q-ST-70-80C

SENER ERO mission TPM main bracket

There are two main outcomes for SENER TPM Main bracket: the qualification of the process for Ti6Al4V in PBLF without HIP treatment as well as associated post-processes (annealing, sandblasting, machining…) and the manufacturing of a massive titanium part.

The part has been manufactured despite its high mass and constraints in the manufacturing strategy. The part was successfully printed after some redesign aiming to reduce the mass of the part as well as some changes in the manufacturing parameters (lower energy).

The part was successfully tested and subjected to low level input in order to verify its dynamic behaviour. The main modes are captured accurately in frequency and amplification. The analyses can then be considered representative of the part performance under operation loads.

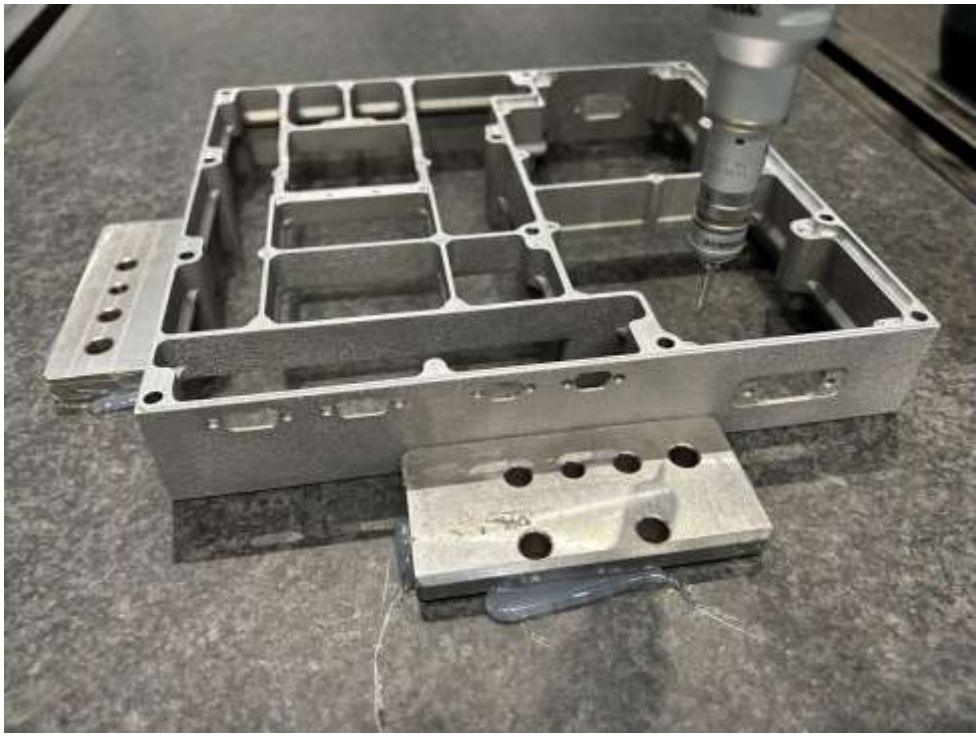
AIRBUS –CRISA: EM model

The main outcomes of the LSTM Stiffener EM model are:

- EM successfully produced through additive manufacturing with improvements mainly in lead time
- The material electrical and mechanical properties are good enough for most electronic units application

AM oriented design and heat dissipation integration could be key for further use of the technology in the domain. Some modifications were already made with respect to nominal design in order to easy AM technologies application.

The prototype has been manufactured and tested in AlSi10Mg and the assembly has been verified in AIRBUS Crisa facilities with representative components (PCBs).



EM stiffener verification

The model was manufactured though PBLF and the interfaces including PCBs supporting surfaces were machined in a CNC machine in order to achieve the required tolerances. Connector interfaces were machined manually aided by templates.

DOMAIN	TRADITIONAL	AM DESIGN
Performance	5 mO	< 200 mO
Mass	OK	Same as traditional
Cost (3 units)	4000 €	Similar to traditional
Schedule	16 weeks	4 weeks

The assembly of the electronic unit stiffeners was successfully tested and additional electrical resistance tests were conducted giving results aligned with the hypotheses. Assembly images cannot be shown due to confidentiality issues.