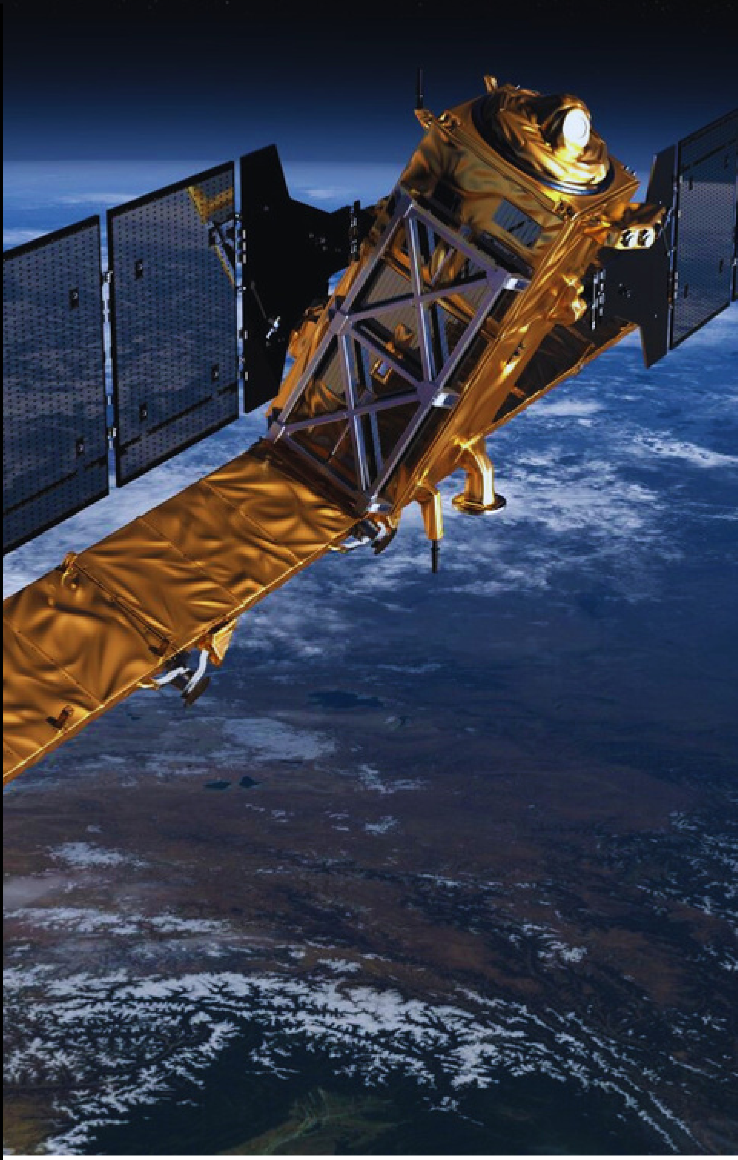
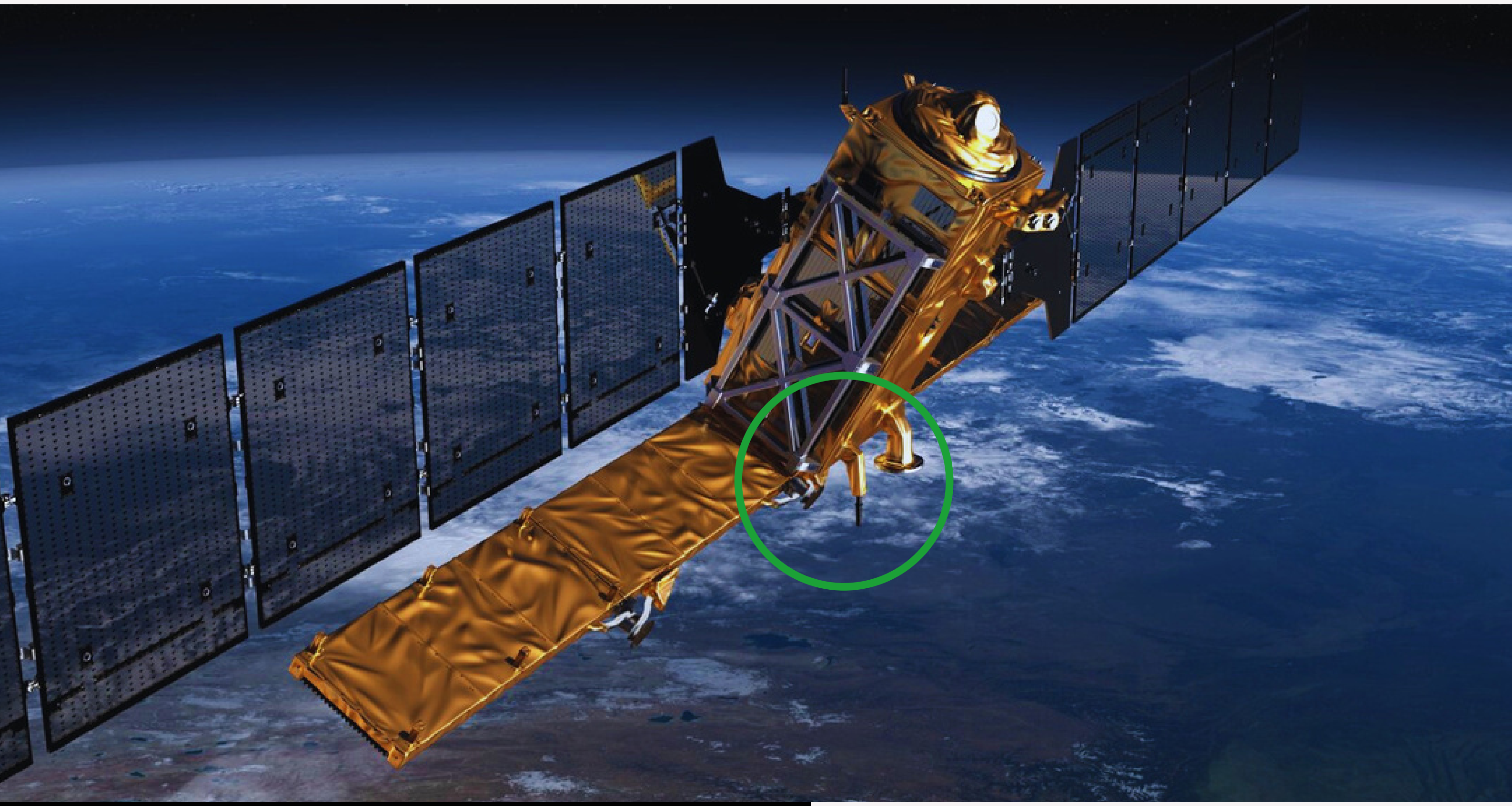
REINFORCE3D



BUSINESS CASE

REDUCING WEIGHT AND COST OF SATELLITE STRUCTURES WITH CFIP

www.reinforce3d.com



REINFORCE3D

BUSINESS CASE

Satellite structures with CFIP

Industry: Aeroespace

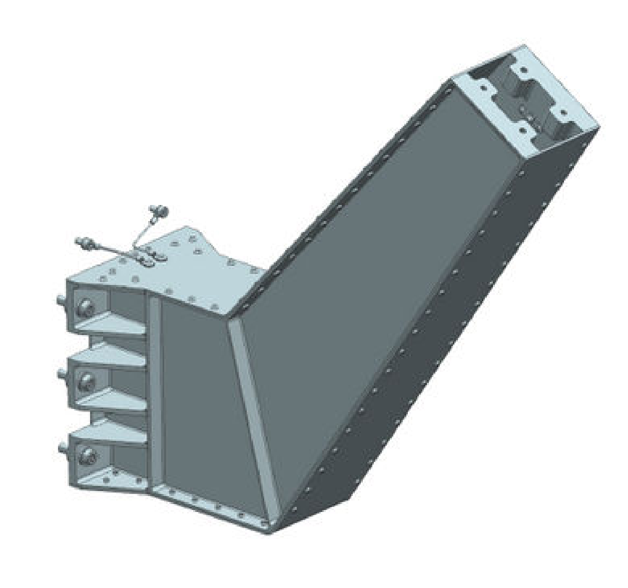
Added Value: Lightweighting, mechanical performance, cost reduction.

Material: Carbon fibre, PA12, Aluminium

Weight reduction is a crucial factor in the space industry; the lighter a satellite is, the less it costs to send it into space. While the cost of launching satellites depends on various factors, such as the orbit and space vehicle used, according to the Aerospace Security Project (ASP) a cost of $10.000 per kilogram of payload launched is considered a reasonable average value, indicating the importance of lightweighting for the sector.

As well as being as light as possible, satellite components must also be stiff enough to perform under extremely harsh conditions in space and during the launch procedure. Aerospace manufacturers are therefore looking to utilise new design techniques and manufacturing methods, such as additive manufacturing, in order to save as much weight and material as possible when producing their components.

Original Design



Evaluating the 3D printed RUAG satellite antenna support

Leading space equipment supplier RUAG Space has been conducting R&D into the use of 3D printing for manufacturing space structures since 2013. One particularly well-known case study*1* involved the production of a satellite antenna support component using topology optimisation and metal 3D printing technologies to reduce the weight of the component while keeping its strength and modal vibration frequencies above the defined limits.

Taking this case study as a reference, we applied our patented Continuous Fibre Injection Process (CFIP) technology to further **reduce the resulted weight of the 3D printed antenna support by 48%**, while also keeping its strength and modal vibration frequencies above the limits. This case study demonstrates the **lightweighting advantages of CFIP**, and the subsequent cost benefits of utilising the technology for the manufacturing of aerospace components.

Specification

Material	Aluminium
Mass-Bracket	1.626 kg
Mass-Antena	0.783 kg
Dimensions	385x345x115 mm
1.Eigenfrequency	>70Hz
Static Load	20g / 25g
Allowable Stress	163 MPa

1. Mouriaux F. (2015), Motivations, Opportunities and Challenges of Additive Manufacturing for Space Application, RUAG Space

Reducing weight and manufacturing costs with CFIP

CFIP provides a revolutionary approach to lightweighting and composite fibre reinforcement. The technology works by injecting continuous fibres simultaneously with liquid resin inside tubular cavities within a 3D printed part to achieve an **ultra-high mechanical and lightweighting performance.**

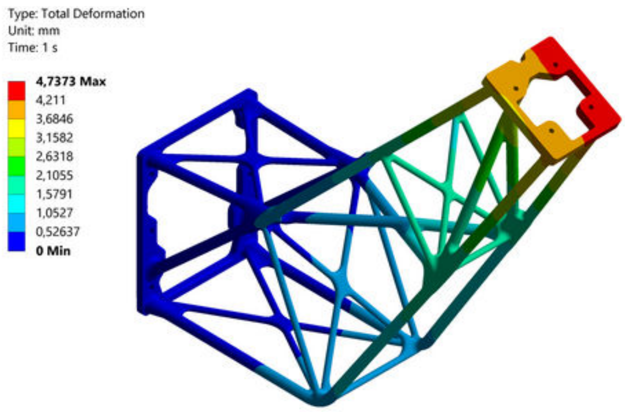
CFIP is the first technology based on **reinforcing the part after its manufacturing instead of during it.** This breakthrough approach enables new features unimaginable before, such as the capability of to reinforce parts made by any existing manufacturing technology and materials, including metals and ceramics.

The technology enables to place the **continuous fibres in all directions following complex trajectories, even through printing layers**, allowing the fibres to be aligned in the most efficient directions to produce highly optimised lightweight structures with improved mechanical performance.

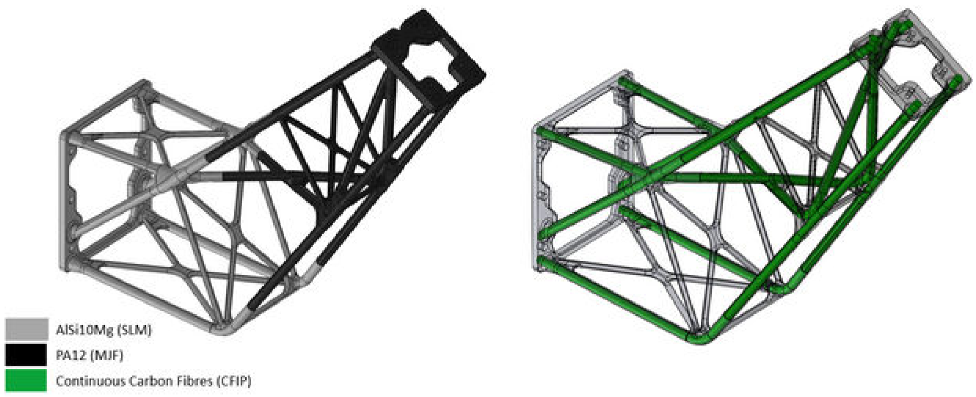
In addition, the technology also enables the **integral joining of different parts by providing fibre continuity from end to end.** This allows to use the most efficient material and manufacturing technique in each zone of the structure according to mechanical requirements but also to cost and production targets.

REINFORCE3D

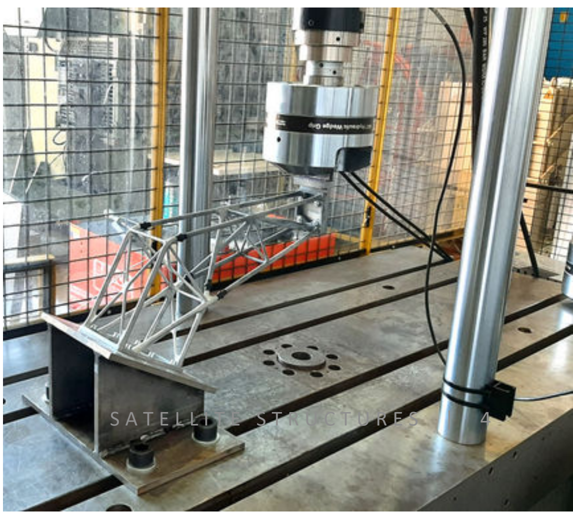
A **new methodology** specifically developed for our CFIP technology was implemented in order to design and optimize the antenna support. The **optimal distribution of fibre trajectories and 3D printed material** was determined by topology optimization to further enhance the performance of the part. Finite element simulations were also performed in order to validate the final design in terms of strength, stiffness, modal vibration frequencies and buckling modes.



The structure was made up of **two 3D printed parts, one manufactured in polyamide 12 by Multi Jet Fusion (MJF) and the other in aluminium alloy via Selective Laser Melting (SLM)**. Both parts were reinforced and integrally joined with continuous carbon fibres and epoxy resin by CFIP.

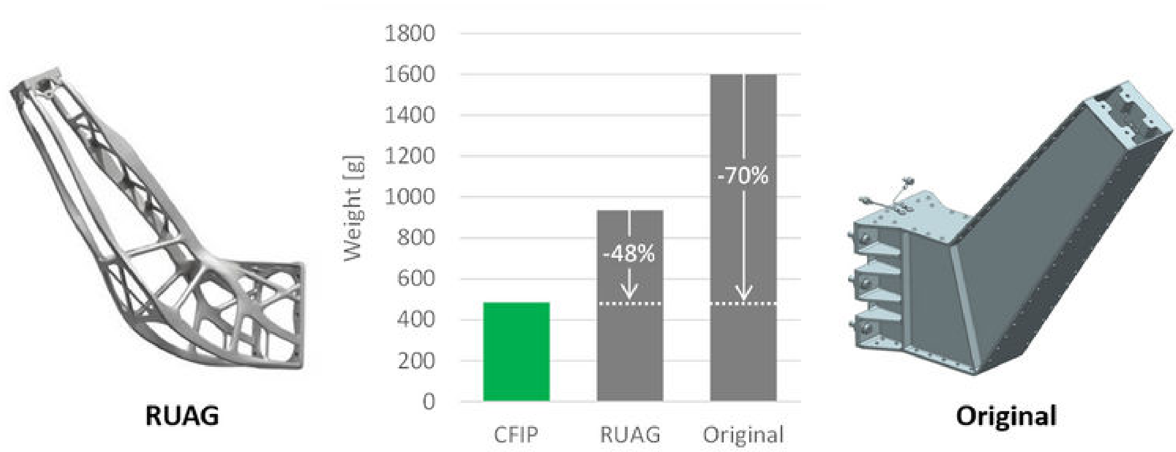


Tests in laboratory were performed in order to characterise its mechanical performance in terms of strength and stiffness. The test results were in line with the simulation results, confirming that the structure was able to resist the required loads.

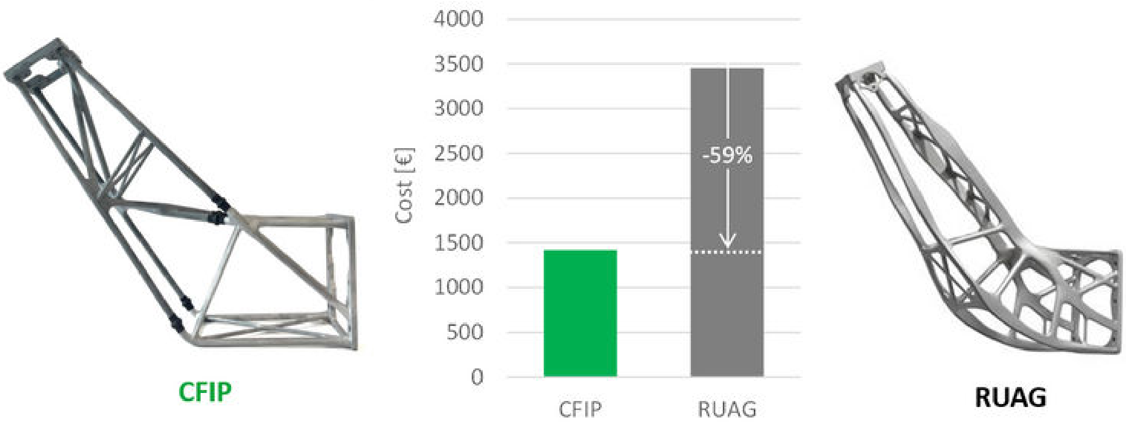


Most significantly, the results obtained by Reinforce3D demonstrated a **drastic weight reduction of 48%** compared to the topology optimised RUAG structure, weighing just 484,4 g. The CFIP-enabled structure was also confirmed to be **70% lighter than the original structure** produced by traditional manufacturing methods, which weighed 1.600 g. As a result, the manufacturing **costs** of producing the antenna support with CFIP were **59% less than the full 3D printed metal structure** (based on estimated costs), mainly thanks to the lower size of the metallic parts which could be manufactured in a common SLM machine and with a higher packing density.

Weight reduction



Cost reduction



Enabling low-cost space travel

Until now, it had been unachievable to reinforce a 3D printed titanium or aluminium part with continuous carbon fibres. With CFIP technology, this is now possible, opening up many new opportunities for aerospace manufacturers to produce **lighter, stronger and more cost-effective components.**

Historically, the perceived high cost of space transportation has generally been viewed as one of the biggest obstacles to the growth of space commercialisation and exploration. However, the ongoing development of commercial launch systems has substantially reduced the cost of space launch in recent years.

Now, innovative manufacturing technologies like Additive Manufacturing and CFIP can help manufacturers to unlock even greater lightweighting and cost benefits for the critical components that make up these systems. Stronger, stiffer and lighter structural components contribute enormously to reducing launch costs for space vehicles and satellites. Therefore, with more and more space missions and flights taking place, CFIP is expected to play a critical role in the future of low-cost and sustainable space travel.