High Performance Production Through 3D-Printing Pilot

# 3DVLE – 3D Double Vortex Liquid Engine

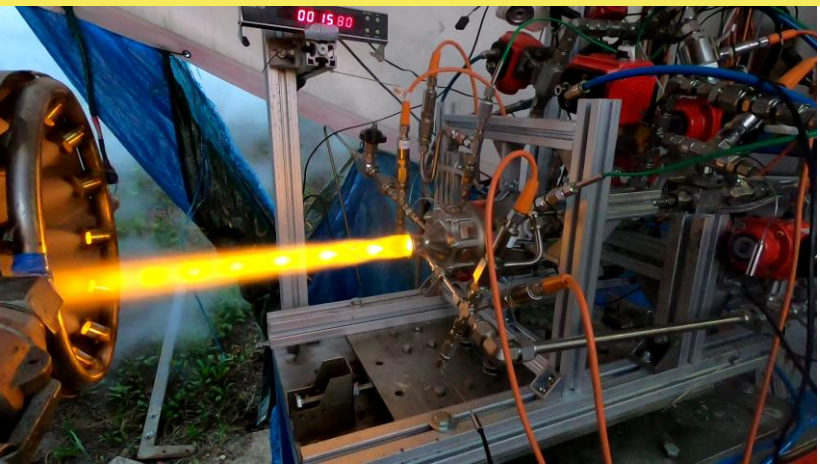
VANGUARD INITIATIVE

T4i TECHNOLOGY FOR PROPULSION AND INNOVATION

## Challenges

- Designing a proper combustion chamber for thrusters
- Realising a heat-rejection insert

Project duration: **7 months**
Industrial sectors: **Aerospace**
Consortium coverage: **Italy, France**



T4i – Technology for Propulsion and Innovation is an Italian SME operating in the New Space domain. Founded in 2014, T4i designs and manufactures innovative propulsion systems for micro-satellite access to space and in-space mobility. Specifically, T4i focusses on the design and development of chemical propulsion systems (mono and bi-propellant motors and hybrid rockets for aeronautics and space applications) and electric propulsion systems (space thrusters based on radiofrequency magnetically enhanced source technology).

## The Challenge

The challenges related to the development of components to be used within the aerospace and space domains are largely associated with the extremely demanding technical requirements which components need to comply with. Within the production of new engines and thrusters which are to be used within these domains, some of these technical requirements are related to the rejection of the enormous heat which is generated by a thruster when operational. In order to overcome these challenges, T4i has turned to additive manufacturing technologies to realise the complex shape of the engine and to reduce the overall number of components. Furthermore, additive manufacturing enables the production of engines with heat-rejection inserts and micro-channels which optimise the overall performance.

## The Project

Trough the 3DVLE project, T4i aims to utilise metal additive manufacturing processes and technologies to improve the performance of a double vortex liquid thruster based on HTP (highly concentrated hydrogen peroxide)/kerosene for space applications. The main objectives of 3DVLE were to design a proper combustion chamber, the production of the components using metal additive manufacturing and to develop the methodologies to enable the shielding of the base material in the high temperature zone through the integration of heat rejection inserts during the printing process. Finally, the post-production finishing will allow precise and reliable pressure drop and fuel atomisation through micromachining.

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## Role of the Facility Centres

In order to meet the set objectives, T4i partnered up with Aidro, an Italian high-tech company specialised in the design and additive manufacturing of metal devices, and La Precision, a French firm specialised in the manufacturing of high-precision micro-mechanical parts. Within the 3DVLE project, Aidro initially supported T4i in the design of the fuel injection section of the thruster as well as the inclusion of the heat rejection insert. After finalising the design, Aidro printed the metal components, starting with a set of samples which would be subsequently tested by both Aidro and La Precision. La Precision's role in the project was focused on the micro-machining of the component, specifically the fuel injection holes and the investigation of the samples. Aidro also took care of the de-powdering of the components, specifically of the internal channels. La Precision's role in the project was focussed on the de-powdering and micro-machining of the component, specifically the fuel injection holes and internal channels. This step in the process was crucial in order to achieve a proper, homogenous flow of fuel. In order to understand the reliability and quality of the thruster, both Aidro and La Precision conducted tomographic investigation of both the prototype sample as well as the final motor. Once the components had been printed, tested and their quality had been determined, T4i assembled the final version of the complete engine. This final version was successfully evaluated following firing tests.

## Results achieved

The further development of this engine represents the creation of a new product in T4i's portfolio, allowing them to play a key role in providing a green alternative to currently used engines. The innovative cooling system of the combustion chamber allows for the construction of the engine using more common and affordable materials instead of more exotic and expensive materials that can withstand the high temperatures of the gases produced by the combustion reaction. The impact of the project on the aerospace sector is high as this new type of thruster will enable a wider range of mission scenario's which require a long-term duration of thrust from the engine. The life of the thruster and the subsequent satellite movement in space will no longer be limited by the thermal aspects within the combustion chamber, but rather by the quantity of on-board propellant which can be carried. The knowledge gained through this project could also be applied to other industrial sectors to improve the performance of products by understanding how to properly design and post-process internal paths and channels to achieve a proper distribution of the internal flows.

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New growth through smart specialisation

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aidro Desktop Metal Company

la précision industry