



# WELKIN REUSABLE LOX/KEROSENE ROCKET ENGINE MANUFACTURING POWERED BY FARSOON METAL 3D PRINTING



Figure 1: The 3D printed turbo pump assembly for hydraulic test (*image courtesy: Falcontech*)

## ↓ Project Overview

<b>CHALLENGES</b>	Design-to-prototype cycle Cost-control of product development process Customer-specific solutions
<b>SOLUTION</b>	Farsoon metal LPBF system FS621M
<b>KEY BENEFITS</b>	Flexible internal manufacturing supply chain Reduce number of parts & assembly Significantly reduced part lead-time

# Adopting Additive Manufacturing for the new frontier

On March 2022, Galactic Energy Space Technology Co., Ltd. (referred to as Galactic Energy), one of China's leading commercial aerospace companies, announced the first successful full-system test flight of its WELKIN 50-ton Reusable LOX/Kerosene Engine. To date, this is the highest thrust LOX/kerosene engine in the Chinese commercial aerospace playing field which has officially entered the engineering & manufacturing phase.

The reusable WELKIN 50-ton LOX/Kerosene Engine is the first large-thrust liquid rocket Chinese engine which adopts the pintle injection technology. Featuring variable thrust capability, the WELKIN engine is the best option for vertical recycling of 200–300-ton liquid rockets. Several of the key components in the rocket engine including the turbo pump and the LOX/kerosene main valve housing are 3D-printed by aerospace manufacturing service provider Falcontech using Farsoon's metal laser powder bed fusion solution.



**WELKIN REUSABLE LOX / KEROSENE ENGINE**

<b>&gt;30</b> Metal 3D Printed Components	<b>-80%</b> Optimized Production Cycle
<b>50 - ton</b> Rated Sea Level Thrust	<b>50</b> Designed Reuse times

- Variable Area Pintle Type Injector
- Film Cooling+ Regenerative Cooling Combination
- Co-axial Double-pump
- Multiple Counterflow Vortex Unique Configuration Gas Generator
- Integrated Design of Multifunctional Combination Valve
- Light-weight 3D Printing

Figure 1: WELKIN Reusable LOX/Kerosene Engine (Image Courtesy: Galactic Energy)



Figure 2: An array of Farsoon's FS421M metal systems are installed at Falcontech Super AM Factory. (Image courtesy: Falcontech)

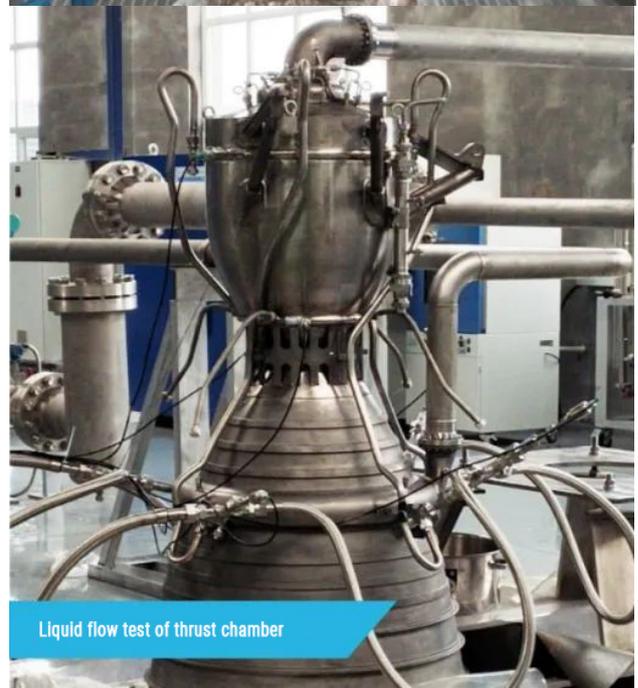
The aim of Galactic Energy's full system test is to verify the engine operation, structural design, and the coordination of each assembly. During the test flight, the engine's ignition, starting, and the transition were strenuously tested for performance with gathered data showing that each component worked as expected. The combustion process was shown to be stable, and the major performance parameters observed were consistent with the calculated data values. The test achieved complete success with the engine remaining intact, and in re-usable condition, after the test.

### **Customized metal 3D Printing processes for Rocket Engine Application**

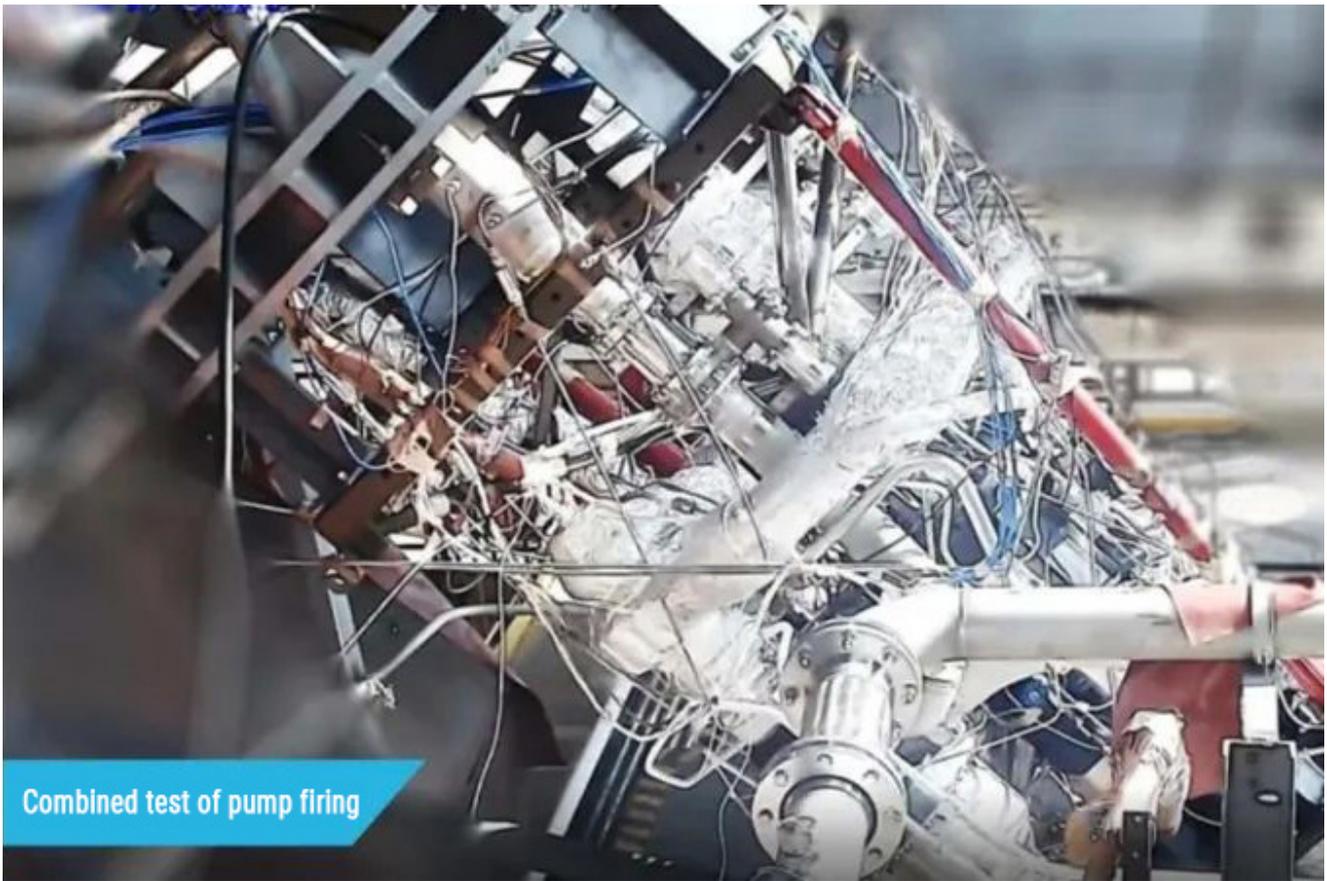
In July 2019, Galactic Energy partnered with Falcontech on this manufacturing project with a total of more than 30 parts of various sizes. All parts are produced and accepted by Galactic Energy in 4 months. Based on Farsoon's large-frame metal 3D printing solution, Falcontech's engineering team developed multiple sets of customized production processes targeting rocket engine production workflow including laser beam welding, 5-axis machining, dynamic balance test, anodizing treatment, pneumatic and hydraulic tests, etc. This innovative approach using 3D printing as a part of a larger manufacturing process has been a true breakthrough in the development of commercial rocket engines in China.



Cold test of pintle injector



Liquid flow test of thrust chamber



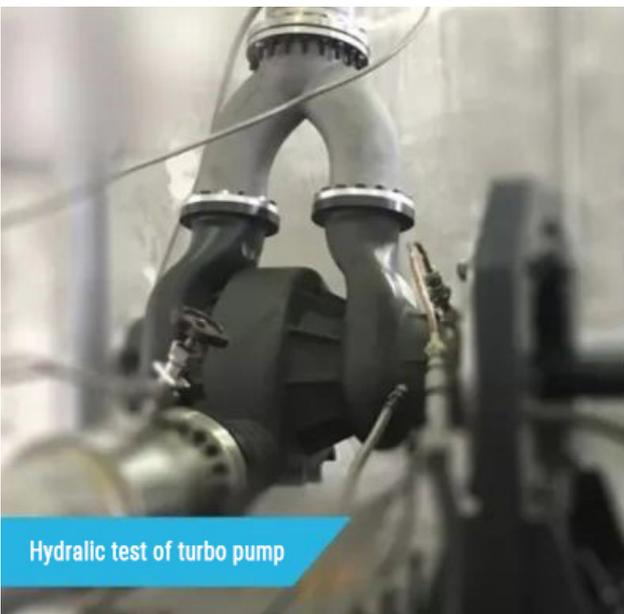
Combined test of pump firing

### Optimized production cycle by 80%

The thrust chamber of a high-thrust liquid rocket engine usually adopts active regenerative cooling for the combustion chamber thermal protection. With conventional manufacturing technologies, the manufacturing process of thrust chamber components is extremely complicated and usually takes several months. A slight production variation in one single component may lead to the functional test failure of the whole thrust chamber.

During the design phase of the turbo pump, the Galactic Energy engineering team compared the efficiency of two models: one designed according to traditional machining process and the other with optimized profile for 3D printing solution. The new design showcased improved production efficiency by 5%. In design & manufacturing solutions for turbine disk, the traditional machining will take 20-25 days whereas only 3-4 days for 3D printing – a significant shortened manufacturing cycle by 80%, and reduction in production cost.

Galactic Energy is committed to technology innovation in rocket engines. In the future development of the WELKIN reusable LOX/ kerosene engine for Edge orbit control systems, Galactic Energy sees many opportunities to use 3D Printing targeting lightweight design, high strength component and improved part reliability.



Hydraulic test of turbo pump

## About Falcontech:

Founded in August 2012, Falcontech is located close to Shanghai with a current manufacturing space of over 12,000 square meters. Being one of the leading metal additive manufacturing service providers in China for the aerospace industry with AS9100 certification, Falcontech is established with 3 business units including Metal AM Powder, Metal AM Solution, and Advanced Manufacturing. Falcontech offers high-quality components for the aerospace, medical, logistics, chemicals, and automobile industries. Falcontech is a qualified supplier of COMAC metal additive manufacturing parts. Falcontech is equipped with an EIGA titanium alloy powder production line with an annual output of 90 tons of aviation-grade powder with CAAC certification.

Since its cooperation with Farsoon in 2019, Falcontech has been expanding its additive manufacturing capability by installing a fleet of medium to large format metal 3D printers. In 2022, with multiple FS621M system installation, Falcontech's Super AM Factory had started a new journey manufacturing over-sized parts for aerospace industry.

## About Galactic Energy:

Founded in 2018, Galactic Energy is a leading commercial aerospace company in China. Galactic Energy has an established R&D team with more than 100 staff including 8 doctors and 20 masters with years of working experience in the aerospace industry. Galactic Energy offers the launch service for CERES-1 solid commercial carrier rocket and PALLAS-1 liquid commercial carrier rocket and is dedicated to the development of the LIGHT YEAR solid rocket engine, WELKIN reusable LOX/kerosene engine, and Edge Orbit Control System.

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