In-Orbit Demonstration of GO-2 Field Emission Electric Propulsion with 40 Individual Thrusters

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The in-orbit demonstration mission (IOD) from Morpheus Space, a satellite mobility provider based in Germany and USA, is the first space-based qualification test of its new Electric propulsion system, GO-2. It is hosted onboard D-Orbit's ION carrier spacecraft, which has a payload capacity of roughly 200 kg, launched into a sun synchronous (SSO) low Earth orbit (LEO) of approximately 510 km in March 2025. The GO-2 system is designed to meet the demands of satellites ranging from 10 – 250 kg both as a primary propulsion system while also having the flexibility to adapt to applications such as high precision attitude maneuvers and orbit keeping as a secondary system. It does so by leveraging the traditional simplicities of FEEP technology such as safe propellant feed and simple accelerator mechanism while introducing novel design concepts like 40 thrusters with individual thrust control. The goal of the IOD is to validate the system performance in LEO.

The working principle of Field Emission Electric Propulsion (FEEP) is simple. Ions are generated by applying a high voltage potential between a sharp needle or capillary, wetted with liquid metal propellant, and an extractor electrode. The same electric field is used to accelerate the ions to gain thrust. Albeit the many benefits of FEEP, prior attempts at safe and mass producible products from manufacturers had its fair share of challenges. The GO-2 system addresses these challenges of the past such as – thermal, power demand, hardware integration, software interface, producibility and utilization of precision thrust into useful applications. It solves them through several new design elements and learnings from past products. A few such examples are the replacement of Indium with our proprietary propellant, adding multiple redundancies and individual thruster control.

Prior to in-orbit testing, the GO-2 system has undergone extensive ground testing. It underwent environmental testing including thermal cycling in a thermal vacuum chamber, dynamic vibrational loads on a shaker apparatus, thrust measurements using a high-resolution torsion balance and several long-term emission tests. The system performance was validated on ground by a maximum specific impulse of over 2000 s, maximum thrust of 0.4 mN, minimum thrust of 10 µN, minimum total impulse of 4 kNs and maximum total system power consumption of 40 W. The in-space test plan consists of analyzing the system performance for different operation modes using health monitoring and carrier satellite data.

The next planned tests push the system further to demonstrate the novel aspects of the GO-2 system. With a high specific impulse, throttleable thrust, component redundancy, thrust biasing capabilities, easy to store metallic propellant and compact design, its first IOD is expected to pave the way towards simpler, safer and repeatable space mobility solutions for the future.