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VERIFICATION OF FOTEC'S NEW HIGH-DYNAMIC LOW-NOISE THRUST BALANCE VERSUS THE NGGM/LISA THRUST NOISE LIMITS

Abstract

For future Earth observation and science missions, electric propulsion systems will play a key role in the next decades. These not only provide an increased total impulse compared with other propulsion systems, such as cold gas, but also feature a broader thrust range, a lower thrust noise and a lower impulse bit. The Next Generation Gravity Mission (NGGM) aims to map the Earth gravity field with increased spatial and temporal resolution by using pairs of satellites equipped with ultra-sensitive accelerometers and a laser-based interferometric distance determination system in the nm range. Electric thrusters providing thrust in the range from 50 N to 2.5 mN enable proper alignment of the spacecraft and compensate for the drag at the low target orbit of 400 km or below.

FOTEC has been developing FEEP-based electric propulsion systems throughout the last decades. The core element of such a thruster is the so-called porous Tungsten crown emitter featuring 28 needles acting as ion emission sites. It is wetted with the liquefied metal indium and due to the application of high voltage, atoms are pulled out from the liquid film, ionized and accelerated. FOTEC's FEEP thrusters provide a wide thrust range (sub-N to 1 mN) and specific impulse (2000 to 6000 s) whereas the operating point can be selected by the variation of the emitter and extractor voltages. Due to their excellent performance and long-term stability, these thrusters are being considered as a possible candidate for the NGGM mission.

FOTEC has been developing direct thrust measurement test stands during the last two decades for measuring performance, stability and noise for in house testing their FEEP-based propulsion systems and for general use in the space industry. Such a thrust balance is designed as a horizontal pendulum with the thruster on one side and the counterweight on the opposite side. The force generated by the thruster is compensated by a high-precision magnetic force actuator to keep the beam of the balance in resting position. This high-speed force feedback approach (¿ 100 Hz) not only allows high dynamic range (10 N to 1 N) but also reduces the response time due to the reduced mechanical inertia of the system. For upcoming Earth observation and science missions NGGM and LISA respectively, the required noise spectra of the anticipated thrusters were obtained from ESA, and the thrust measurement system was tested against the limits.