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# IN-ORBIT MICRO-PROPULSION DEMONSTRATOR FOR PICO-SATELLITE APPLICATIONS

**Abstract**

The Delft University of Technology is working on the design and development of the picosatellite platform Delfi-PQ, based on the PocketQube standard (5 cm x 5 cm x 5 cm).The opportunities are in pursuit of lower-cost, flexible and low development time satellite design as well as university space research. The first technology demonstration payload is a dual thruster micropropulsion system based on the use of water as propellant. Two concepts will be tested in this dual thruster demonstrator. The first one is based on pressurising liquid water, which is fed through several expansion slots in a chip, then passes through Microelectromechanical systems (MEMS) - manufactured heat exchangers and is finally accelerated in a convergent-divergent nozzle (Vaporising Liquid Microthruster, VLM). The second one is based on the acceleration of vapour molecules generated by the sublimation of water ice (Low Pressure Micro-resistojet, LPM). The demonstrator will be able to test both concepts in a single PocketQube platform, thus requiring a high level of integration and miniaturization.

The demonstrator is based on a common propellant storage for the two micro-propulsion concepts, which use the capillarity properties of water in a small diameter tube connecting two separate MEMS chips with their own dedicated valves. The target thrust level for both thrusters is in the range from 0.1 to 3 mN. The entire system including its dedicated control electronics shall have a maximum wet mass of 75 g, a designated volume of 42 mm x 42 mm x 30 mm and a peak power consumption of 4 W.

The paper will describe the final design of the complete micro-propulsion demonstrator as well as some of the systems engineering challenges faced in producing such a small system including structural analysis, thermal analysis, and finite element modeling of the demonstrator. The operational envelope of the demonstrator and its in-orbit functional testing including firing modes and phases, analysis of various performance evaluation parameters like thruster characterization, satellite acceleration levels resulting from the thrust produced by a thruster will also be presented. This will be the first complete micro-propulsion payload ever flown on a picosatellite platform