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# THE LISA PATHFINDER MISSION IN-ORBIT EXPERIENCE AND OUTLOOK FOR LISA

**Abstract**

LISA Pathfinder (also known as SMART2) was launched by a VEGA rocket (VV06) from the Guiana Space Centre (CSG) in French Guyana on 3-Dec-2015. The mission has validated a significant part of the novel key technologies that will be required to realise ESA's scientific LISA mission, the first gravitational wave observatory in space planned for launch in the 2030's. The aim of the LISA Pathfinder mission has been to demonstrate that two test masses can be controlled in free fall to an accuracy of two orders of magnitude better than any past, present, or planned mission. The new technology to be tested in space environment in an orbit around the sun-earth Lagrange point 1 (L1) included: inertial sensors, a laser metrology system, a drag free control system and micro-Newton proportional thrusters flown previously on the Gaia mission. The LISA Pathfinder spacecraft was composed of a Science and a Propulsion Module. Following successful launch, orbit raising and transfer to L1 the propulsion module was separated and the science module commissioned. This included the release of the payload launch caging mechanism and a first release of very sensitive test masses. Routine operations of the European experiment of this "physics lab" in space began in March 2016 and the planned science runs during this phase were executed successfully in very close collaboration between the scientists and mission and science operations teams, which were collocated at ESOC during this period. After this a second experimentation phase with the NASA provided Disturbance Reduction System was performed. The science phase was to extended to Jun-2017 . During the extended phase the spacecraft was de-orbited from its large quasi-halo orbit around L1 into a heliocentric orbit that minimises the probability of return to the earth-moon system for at least 100 years. Before final passivation of the spacecraft on 18-Jul-2017 the flight control team with support from industry and principal investigators had conceived a 3 weeks technology phase, which exercised tests with the payload and service module that would have been either incompatible with the science mission or simply too risky.

This paper provides an overview of the LISA Pathfinder mission, the space and ground segment and the mission operations as well as some of the technology and scientific results of the mission. Some lessons learnt applicable to other missions are presented. The paper concludes with a short outlook to ESA's LISA mission and its operations.