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LISA Pathfinder

Mission overview

LISA Pathfinder is a European Space Agency satellite that is testing technologies for the eLISA space mission scheduled for 2034.

Over a period of 12 months, LISA Pathfinder will test key measurement technologies designed to detect gravitational waves – a phenomenon that Albert Einstein predicted as a consequence of his general theory of relativity.

The launch of LISA Pathfinder is planned for Wednesday, 2 December at 5 am (CET). The project is an international collaboration; ETH Zurich and the University of Zurich are the major participants from Switzerland.

What are gravitational waves?

According to Albert Einstein's general theory of relativity, when mass is accelerated – for example, when a star explodes or black holes coalesce – gravitational waves are generated. With frequencies in the audible range, gravitational waves not only represent the sound of the universe, but may also provide insight into previously unknown areas of the universe, such as the big bang or the formation of black holes.

To date, it has not been possible to prove the existence of gravitational waves from Earth. In space, a complementary method could yield a breakthrough – the eLI-

SA mission, for which the LISA Pathfinder is testing key technologies, was conceived with precisely this objective in mind.

LISA Pathfinder facts and figures

Start date:	2 December 2015
Launch location:	Kourou, French Guiana
Mission duration:	approx. 12 months
Launch weight:	1,910 kg incl. fuel
Orbit:	Halo orbit around Lagrange point L1
Objective:	Testing technologies for detecting gravitational waves
ETH contribution:	Control electronics and drive mechanism
UZH contribution:	Astrophysical applications

How can the existence of gravitational waves be proven?

The proof that gravitational waves exist is based on the observation of two bodies in free fall. As long as all interference factors are kept to a minimum and the bodies are moving only due to the force of gravity, it would be possible for a gravitational wave to pass between them and change their distance from one another.

The objective of LISA Pathfinder is to demonstrate whether the planned technology makes it possible to put two masses into an almost-perfect free fall by reducing interference factors to a minimum, and whether it can measure the relative motion of the two masses with unprecedented precision.

How are ETH Zurich and the University of Zurich involved in LISA Pathfinder?

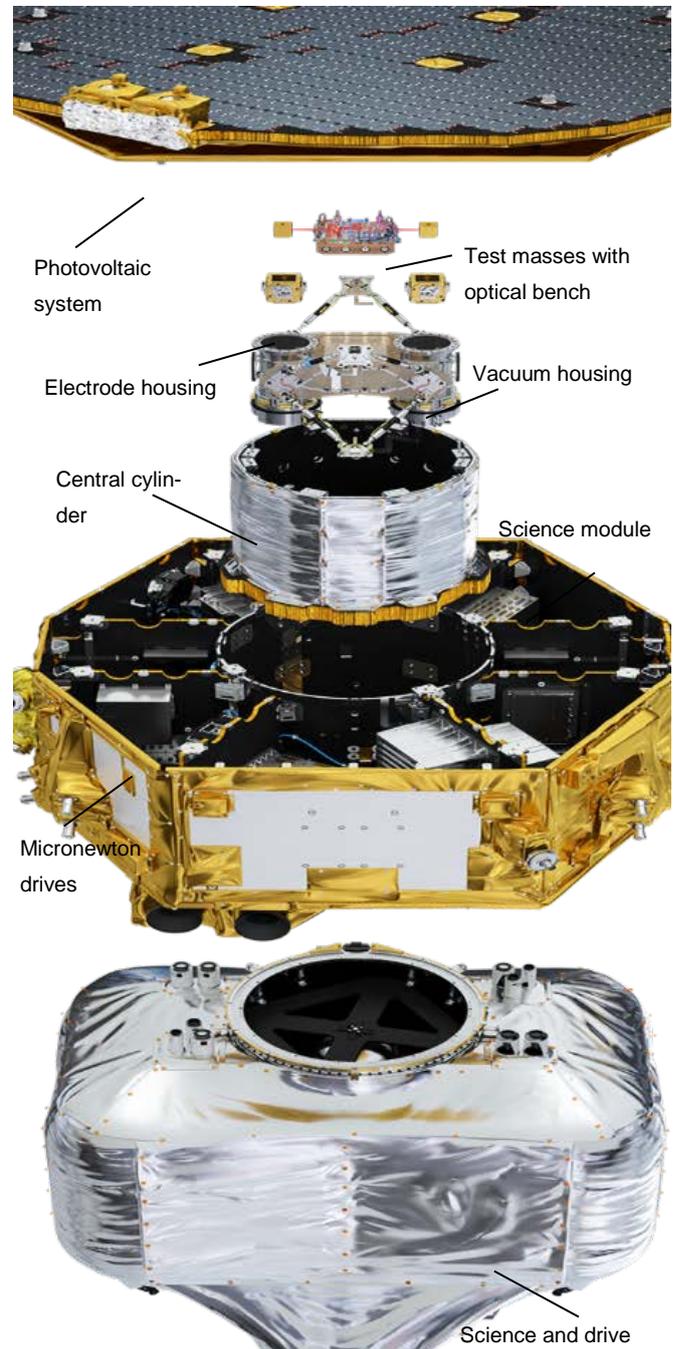
ETH Zurich is responsible for the measurement and control electronics for the reference gravitation sensor, a central component of the LISA Pathfinder space probe. The electronics are designed to measure and control the position of the two test masses – two cubes comprised of a gold-platinum alloy – in relation to the electrode housing in which they are located. Once the probe has reached its satellite position in space, the two test masses are released by the holding mechanism into a state of free fall. At this point, the satellite software uses the electronics to measure and control the position and orientation of the test masses with electrical fields and also ensures that the masses do not touch the walls of the housing. The electronics were specified at ETH Zurich's Institute of Geophysics by a team led by Prof. Domenico Giardini and in collaboration with international partners. They were then developed and produced by the Swiss company RUAG Space. The ETH team is also involved in the mission preparation, monitoring the electronics during the mission and the final data analysis.

Philippe Jetzer, Professor of Physics at the University of Zurich, and his team are investigating the astrophysical applications in relation to the general theory of relativity. As members of the ten-member eLISA Consortium Board, Domenico Giardini and Philippe Jetzer will participate in the analysis of the gravitational waves that it is hoped eLISA will ultimately detect.

How will the LISA Pathfinder mission proceed?

LISA Pathfinder will be launched into a slightly elliptical parking orbit from the European space centre in Kourou, French Guiana on 2 December 2015. Using its

own drive module, the space probe will enlarge its orbit around the earth gradually over a two-week period

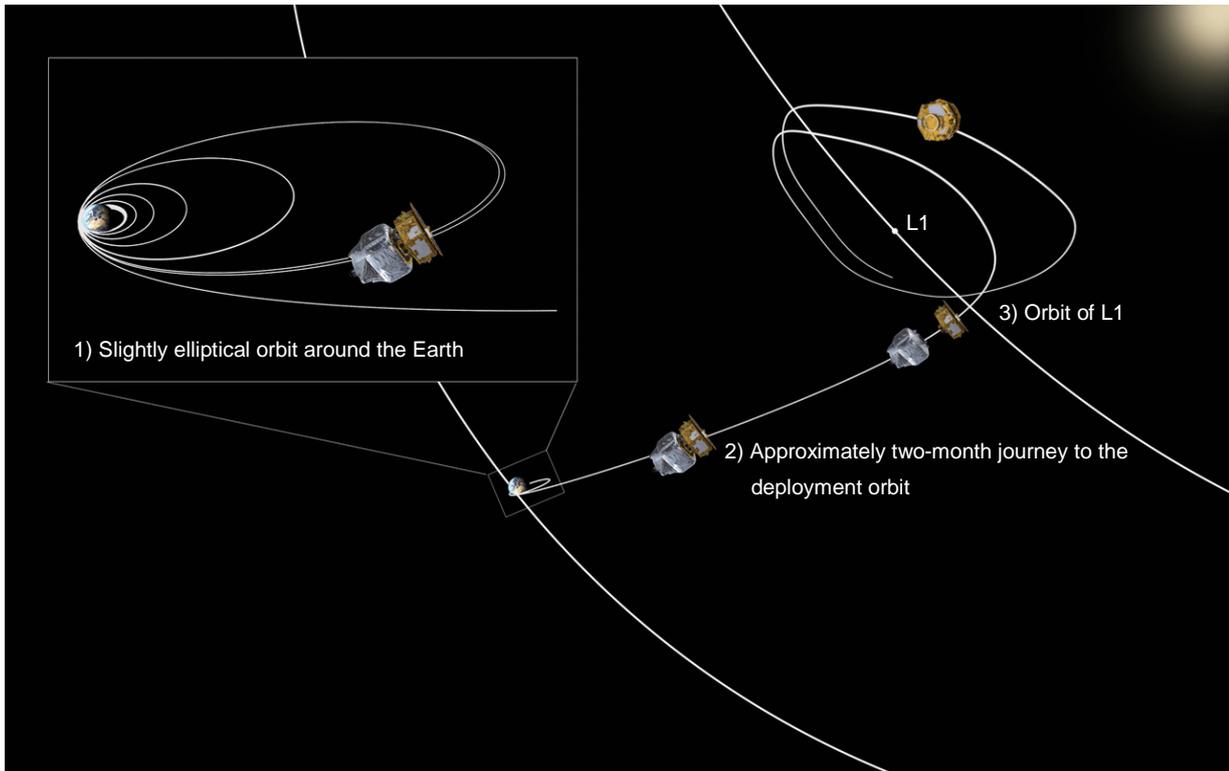


Structure of the LISA Pathfinder (graphic: ESA/ATG medialab)

before beginning its two-month journey to its deployment orbit.

There, the LISA Pathfinder will orbit the inner Lagrange point L1 in a uniformly curving path known as a Lissajous orbit. Lagrange point L1 is approximately 1.5 million kilometres from Earth

and positioned such that the gravitational forces of the sun and the Earth cancel each other out. This makes an orbit around L1 ideal for testing the technologies on board LISA Pathfinder.



LISA Pathfinder's journey through space (graphic: ESA/ATG medialab)

Contact:

ETH Zurich
Franziska Schmid
Media office
Tel: +41 44 632 41 41
franziska.schmid@hk.ethz.ch

ETH Zurich
Prof. Domenico Giardini
Institute for Geophysics
Tel: +41 44 633 26 10
domenico.giardini@erdw.ethz.ch

University of Zurich
Prof. Philippe Jetzer
Institute of Theoretical Physics
Tel: +41 44 635 58 19
jetzer@physik.uzh.ch