Andreas Werthmueller, 27 November 2015

Factsheet

LISA Pathfinder poised for launch into space

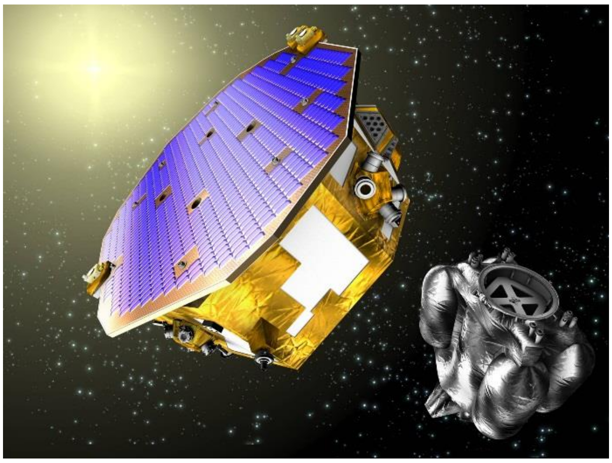
Almost a century ago, Albert Einstein predicted the existence of gravitational waves in his work on the Theory of General Relativity. The observation and detection of gravitational waves is expected to bring about a huge leap forward in our understanding of physics. But the LISA Pathfinder satellite, launched by the European Space Agency (ESA), is unlikely to solve the puzzle just yet. This space mission is more about confirming that we now have the technology to detect gravitational waves. Following a successful launch, which is scheduled for 2 December, the satellite, or rather two free-floating test masses, are set to demonstrate over a period of 12 months whether the technology designed by physicists and engineers and built in Europe allows gravitational waves to be detected. Swiss science and industry have made some small yet important contributions to the LISA Pathfinder mission, both for the actual vehicle and for the payload.

LISA Pathfinder (LPF)

The European Space Agency ESA and its member states decided to carry out a SMART-2 test mission back in late 2000. SMART-2 subsequently became LISA Pathfinder, as the idea was to use this mission to prepare for a later one: the Laser Interferometry Space Antenna (LISA). EADS Astrium in Friedrichshafen, which is now part of Airbus DS, was commissioned to build the satellite. Although EADS was responsible for delivering a fully integrated and launch-ready satellite, it put together an industrial consortium, also based on ESA requirements, in order to ensure the design, development and construction. The original schedule turned out to be too optimistic due to the ambitious technological goals. So instead of 2008, LISA Pathfinder is due to launch on 2 December 2015 from Europe’s Spaceport in Kourou, in French Guiana. The satellite will then enter a 12-month detection phase during which it will show whether the high expectations can be met and whether planning of the actual LISA scientific satellite can begin, or whether it is still impossible to observe gravitational waves.

Mission data and technical parameters of LISA Pathfinder:

Planned launch:	2 December 2015 Kourou, French Guiana
Launch vehicle:	Vega launcher
Orbit:	Halo orbit around the first Sun/Earth Lagrangian point, around 1.5 million km from Earth
Nominal mission:	12 months, including 6 months in drag-free operating mode
Probe mass:	475kg payload module/1900kg launch mass
Outer probe dimensions (payload module):	2.1m x 1.0m
Lisa Technology Package (LTP) mass:	140kg
LTP dimensions:	64cm x 38cm x 38cm
Power consumption:	typically 150W
Telemetry data rate of the probe:	1.7kbit/s (X-band)

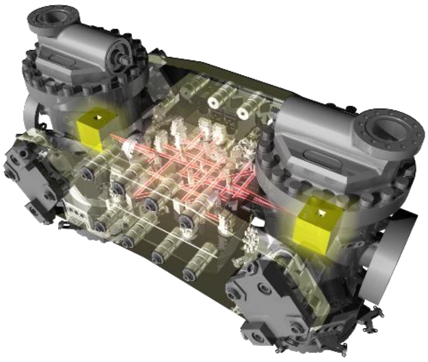


An illustration of the LISA Pathfinder satellite, showing the mission phase just after the satellite has split from the last rocket stage (silver object in the bottom right-hand corner). (Image: ESA)

The LPF technology

LISA Pathfinder measures the distance between two reference bodies (around 40cm) inside the satellite. To do this, the payload consists of the Lisa Technology Package (LTP) measuring 64×38×38 cm and weighing 150kg.

The LTP is equipped with various measurement and control systems. It also features two vacuum enclosures each containing a 46mm cube made of gold-platinum alloy. While the test masses will be subjected to intense vibrations during the launch and transport phases, during the detection phase they will float freely around 40cm apart. The distance between them, or more precisely any changes in this distance, will be measured using laser technology. Fibre optics will also be used to control and process the laser light. So as not to interfere too heavily with the measurement, the satellite's attitude will be precisely controlled using novel, very weak ion thrusters, i.e. electric propulsion systems, with a propulsion force that can vary between 0.1 and 150µN.



The scientific payload with the two gold-platinum cubes, which will float freely on the gravitational waves in space. A high-precision laser measuring system will be used to measure the movements of the cubes towards each other caused by the waves. (Image: ESA).

Einstein's legacy: the science behind LPF

Gravitational waves are one of the few phenomena predicted in Einstein's Theory of General Relativity that have yet to be directly proven. The first conclusive measurement will therefore further corroborate Einstein's theory and potentially disprove other misleading explanations in modern physics. At the same time, gravitational waves contain information about processes in the Universe that cannot be obtained any other way. While gravitational waves are emitted by all accelerating bodies, their existence can only be proven through the most energetic processes in the Universe. By detecting gravitational waves, high-energy gamma rays and neutrinos, astrophysicists are opening up new 'windows into space', which will offer insights into previously unexplored areas. This may eventually provide answers to questions about the nature of dark matter and dark energy, and ultimately about the basic principles of physics and our understanding of them.

Swiss technology on board
The LISA Pathfinder mission shows once again that Switzerland is at the forefront in the field of space science. The contributions, services, components and systems supplied by Switzerland feature in the rocket, satellite and payload. The interconnectedness of space science players in Switzerland is also impressive, with industrial companies, universities, federal institutes of technology and universities of applied sciences (APCO, ETH Zurich, the HES-SO-Valais-Wallis, RUAG Space and the University of Zurich) working together to share their expertise and experience to strengthen their own and their project partners' competitiveness. To successfully master the challenges of space science, the transfer of knowledge, skills and technology is a key priority. And, like in the history of CERN and in the history of the internet, developments often occur in high-technology environments that could be interesting and therefore marketable in other, everyday fields of application – and the same applies to Switzerland.

Swiss contributions:
The key contributions from Swiss academic and industrial actors include for instance, the structural panels (carbon fibre) of the science module and "grabbing, positioning and release" mechanism from Ruag Space Switzerland, who also provided the payload fairing for the rocket. APCO in Aigle has provided mechanical ground support equipment, the ETHZ and University of Zurich provided significant scientific and technological contributions and project management while the HES-SO Valais performed tests on complex analog electronic elements.

Link for further information:

http://sci.esa.int/lisa-pathfinder/

http://www.esa.int/spaceinvideos/Videos/2015/07/Inside_LISA_Pathfinder

http://sci.esa.int/lisa-pathfinder/49592-industrial-team/

http://www.seg.ethz.ch/research/aerospace-electronics-and-instruments.html
http://www.hevs.ch/media/document/0/brochure_isi_2013_fr_light-3.pdf

http://www.ruag.com/space/ruag-space-switzerland/

http://www.apco-technologies.ch/space.php

http://www.arianespace.com/news-press-release/2015/11-25-2015-VV06-launch-announcement.asp

For further information, please contact:
Andreas Werthmueller
Scientific advisor
Space Sciences and Instruments
State Secretariat for Education, Research and Innovation SERI, Space Office
Einsteinstrasse 27, CH-3003 Bern

Tel. +41 58 483 35 95
Fax +41 58 464 96 14
andreas.werthmueller@sbfi.admin.ch
www.sbfi.admin.ch