FRAUNHOFER INSTITUTE FOR NONDESTRUCTIVE TESTING IZFP

PRESS RELEASE

Outer space mission *LISA Pathfinder:* Fraunhofer IZFP puts two gold/platinum cubes to the acid test

Until a few days ago – when the long-awaited epochal breakthrough of direct proof of gravitational waves was proclaimed at a press conference – in spite of intensive research scientists and researchers failed to verify the existence of gravitational waves as predicted by Albert Einstein's theory of general relativity. Just on this account, the European Space Agency has sent a satellite into space which is to perform the preparatory work for the direct detection of gravitational waves predicted by Einstein. The central experiment of the mission involves two virtually identical high-precision cubes made of a gold-platinum alloy. These cubes were tested by engineers at Fraunhofer IZFP for their suitability and accuracy, both prerequisites for their smooth operation in space.

LISA Pathfinder is a pre-project of a possible LISA-like mission, which is to track down both, gravitational waves and, in particular, their sources in deep space: Since December 2015, the *LISA Pathfinder* satellite (Laser Interferometer Space Antenna) was traveling in the outer space to its final orbit. Mid-February, approximately one and a half million kilometers from Earth, *LISA Pathfinder* carried out the last function tests of the scientific payload. In early March, the actual, six-month mission is to begin. *LISA Pathfinder* has been approved by the "Science Programme Committee" of the ESA in November 2000 and launched on December 3, 2015.

Amongst others, two gold-platinum cubes serving as test masses are on board, each being held in a separate vacuum vessel. After reaching the final position in space they are released and then, positioned in zero gravity, floating freely. Their respective positions – the cubes float in 38 cm distance from each other – have to be stable with considerable precision and must be monitored accordingly. The measurement of the relative accuracy of the positioning in the picometer range is crucial for the success of future gravitational wave experiments.

Another serious criterion for measuring the gravitational waves is given by the shape accuracy of the cubes' surface structure: Both cubes must have one extremely precisely shaped surface whose deviation from the ideal shape is subject to extremely narrow

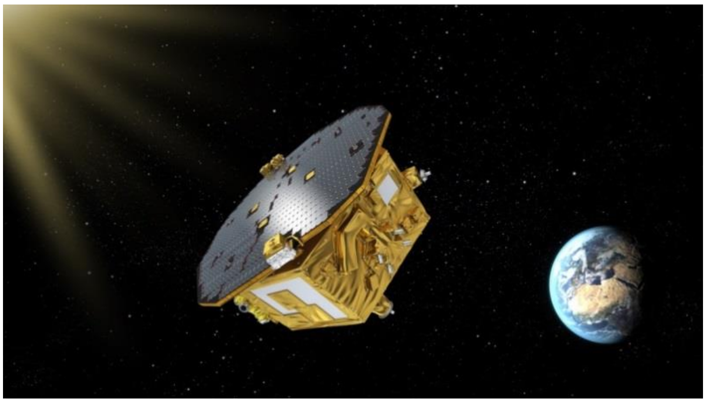
PR Officer / Editorial Notes:

Dipl.-Übers. Sabine Poitevin-Burbes | Fraunhofer-Institut für Zerstörungsfreie Prüfverfahren IZFP | Phone +49 681 9302-3869 | Campus E3.1 | 66123 Saarbrücken, Germany | www.izfp.fraunhofer.de | sabine.poitevin-burbes@izfp.fraunhofer.de

limits. Only within these limits the provided measures can succeed. With regard to the fulfillment of these extreme requirements both two kilogram cubes were put to the acid test by Fraunhofer IZFP's engineers and scientists: In the test laboratories of this Saarland Institute high-frequency ultrasound examinations of the gold cubes' near-surface regions were carried out, which are able to detect hidden cavities and inclusions down to a scale of 50 micrometers. These investigations resulted in insights concerning the question of whether the cubes' gravitational homogeneity is sufficient. Likewise, they substantially affected the decision of which side of each cube is to be processed further to "specular surfaces".

Background information concerning LISA Pathfinder and gravitational waves:
Beside ESA research institutes and industrial enterprises from Italy, Germany, UK, Spain, Switzerland, France and Netherlands participate in LISA Pathfinder (information by Deutsches Raumfahrtzentrum DLR).

*As a space systems company **Airbus Defence and Space GmbH (Friedrichshafen)** is responsible for system integration and verification of the "LISA Technology Package" (LTP) instrument. The subsystems and modules of LTP are provided via the national space agencies and the European Space Agency by a consortium of European companies and research institutes such as the Max Planck Institute for Gravitational Physics or the Albert Einstein Institute in Hannover (AEI).*



LISA Pathfinder in outer spacel
Copyright: ESA–C. Carreau

What at all are gravitational waves?
Following Albert Einstein's general theory of relativity, gravity is no force in the traditional sense, but a property of the geometry of space and time. Matter bends space-time, with the bend's degree being proportional to the mass of a body and inverse to its distance. According to Einstein the accelerated motion of masses such as planets or stars in a gravitational field spawns gravitational waves that move through space at the speed of light.

Even when only jumping up and down on a trampoline, a person loses energy and causes waves in space-time. Now, a person has a low mass and bounces relatively slowly. Hence, the gravitational waves emitted by this bouncing are immeasurably small. In deep space, on the other hand, large masses can be found - and even a trampoline: space-time. In space-time everything is in motion, because not a single celestial body remains at rest in one place. So in its orbit around the sun the earth bulges the space-time and radiates gravitational waves at a power of 200 watts. But even these gravitational waves are still too weak to track them down with a detector. (Source: www.max-wissen.de)

Further information:

Dipl. Ing. Thomas Schwender | Fraunhofer-Institut für Zerstörungsfreie Prüfverfahren IZFP | Phone +49 681 9302-3657 | Campus E3.1 | 66123 Saarbrücken, Germany | www.izfp.fraunhofer.de | thomas.schwender@izfp.fraunhofer.de