Q 68: Laser Applications: Optical Measurement Technology II

Time: Friday 14:00–15:30 Location: F 342

Q 68.1 Fr 14:00 F 342

Neue Konzepte und Ergebnisse bei der Leistungsstabilisierung von Lasern — •Patrick Kwee, Benno Willke und Karsten Danzmann — Albert-Einstein-Institut Hannover

Optische Präzisionsexperimente, unter anderen z.B. interferometrische Gravitationswellendetektoren, benötigen häufig eine Laserquelle mit sehr hoher Leistungsstabilität, die sich nur durch eine aktive Stabilisierung erzielen lässt. Diese Stabilisierungen sind durch die Empfindlichkeit des verwendeten Leistungssensors limitiert. Zwei sich ergänzende Wege werden vorgestellt, um die Empfindlichkeit dieser Leistungssensoren zu steigern: Einerseits wird ein hoch empfindliches Array aus Photodioden mit einer Sensitivität für relatives Leistungsrauschen im Bereich von $2 \times 10^{-9}\,\mathrm{Hz}^{-1/2}$ bei 10 Hz und andererseits eine neuartige Detektionstechnik, die wir *optical ac coupling* nennen, vorgestellt. Diese Detektionstechnik ermöglicht die Empfindlichkeit von Photodetektoren um etwa eine Größenordnung mithilfe eines optischen Resonators zu erhöhen. Damit sind neue Leistungsstabilisierungskonzepte möglich, die neben technischen Vorteilen sogar das theoretische Quantenlimit traditioneller Leistungsstabilisierungen um bis zu 6 dB schlagen können.

Q 68.2 Fr 14:15 F 342

Characterisation and Data Analysis for the LISA Pathfinder Mission — •Martin Hewitson — AEI, Hannover, Germany

The LTP (LISA Technology Package) is the core part of the LISA Pathfinder mission. The main goals of the mission are to study the sources of any disturbances that perturb the motion of the freely-falling test masses from their geodesic trajectories and to test various technologies needed for LISA. The LTP experiment is designed as a sequence of experimental runs in which the performance of the instrument is studied and characterised under different operating conditions.

The software developed for the LTP Data Analysis is a comprehensive data analysis tool which uses an object-oriented approach to data analysis, allowing the user to design and run data analysis pipelines, either graphically or via scripts. The output objects of the analyses contain a full history of the processing that took place; this history tree can be inspected and used to rebuild the objects.

This talk summarises the main experiments of the LISA Pathfinder mission from the point of view of data analysis. In addition, the data analysis software infrastructure will be introduced, together with details of the various test campaigns that are being carried out in order to test the analysis procedures and tools.

Q 68.3 Fr 14:30 F 342

LISA Pathfinder interferometry: Space hardware tests at the AEI — •Heather Audley[1], Antonio Garcia Marin[1], Frank Steier[1], Miquel Nofrarias[1], Gerhard Heinzel[1], Karsten Danzmann[1], Vinzenz Wand[2], Peter Luetzow-Wentzky[2], Gerald Hechenblaikner[2], and Dominico Gerardi[2] — [1]Albert-Einstein-Institut Hannover: Max-Planck-Institut für Gravitationsphysik und Universität Hannover, Deutschland — [2]EADS Astrium Satellites GmbH, Friedrichshafen, Deutschland

The Laser Interferometer Space Antenna (LISA) is a joint ESA-NASA mission for the first space-borne gravitational wave detector, operating in the measurement band from 0.1 mHz to 1 Hz. A precursor satellite, LISA Pathfinder, will be used to demonstrate core LISA technologies that cannot be tested on the ground. Tests of the engineering model of the LISA Pathfinder optical metrology system (OMS) have recently been undertaken in the Albert Einstein Institute, Hannover, in conjunction with ESA and EADS Astrium. Significantly, they represent the first complete integration and testing of the space-qualified hardware. The results and test procedures of this campaign will be utilised directly in the ground-based flight hardware tests, and subsequently within in-flight operations. This talk presents an overview of this test campaign, with specific focus on calibration of the OMS outputs and optimisation of key measurement sensitivities.

Q 68.4 Fr 14:45 F 342

LISA Pathfinder - An interferometric drag-free sensor with picometer accuracy in space — •Frank Steier[1], Antonio Garcia Marin[1], Heather Audley[1], Miquel Nofrarias[1], Gerhard Heinzel[1], Karsten Danzmann[1], Vinzenz Wand[2], Peter Lützow-Wentzky[2], Gerald Hechenblaikner[2], and Domenico Gerardi[2] — [1]Albert-Einstein-Institut Hannover: Max-Planck-Institut für Gravitationsphysik und Universität Hannover, Deutschland — [2]EADS Astrium Satellites GmbH, Friedrichshafen, Deutschland

LISA Pathfinder is a drag-free system that will be able to measure a differential acceleration of two freely falling test masses with an accuracy of a few $\mathrm{fN}/\sqrt{\mathrm{Hz}}$ in the mHz range. It is a technology demonstration mission for the planned gravitational wave detector LISA.

We present the recent progress in the project. The entire optical measurement system has undergone performance tests with so-called Engineering Models that are copies of the real flight hardware. These units have already been verified to be compatible with space applications. The same tests are presently being repeated on the Flight Models at the AEI Hannover.

Q 68.5 Fr 15:00 F 342

Alignment simulations for LISA Pathfinder — •Gudrun Wanner[1], Antonio Garcia[1], Frank Steier[1], Dave Robertson[2], Harry Ward[2], Felipe Guzman[3], Gerhard Heinzel[1], and Karsten Danzmann[1] — [1]Albert-Einstein-Institut, Hannover, D — [2]Institute for Gravitational Research, Glasgow, UK — [3]NASA Goddard Space Flight Center, Greenbelt, USA

LISA Pathfinder, the technology demonstration mission for the space borne gravitational wave detector LISA, will carry two free floating test masses whose position and attitude will be measured by an interferometric readout. The interferometer consists of about 20 elements assembled on one optical bench. Each of these elements will have alignment precisions in the order of $10\,\mu$m and $50\,\mu$rad. These alignment tolerances influence the measurement precision, cause cross coupling of the heterodyne interferometer signals and contribute to the static test mass attitude in flight. We will present results from various alignment investigations for LISA Pathfinder and experimental results.

Q 68.6 Fr 15:15 F 342

Development of RF Low Noise Quadrant Photo Detectors for Optical Translation and Tilt Metrology — •Steffen Wälde[1,2], Martin Maurer[1,2], Martin Gohlke[1,3], Thilo Schuldt[2,3], Ulrich Johann[1], Dennis Weise[1], and Claus Braxmaier[2] — [1]EADS Astrium — [2]HTWG Konstanz — [3]Humboldt-Universität zu Berlin

The LISA (Laser Interferometer Space Antenna) mission is a space-based gravitational wave detector aiming to detect gravitational waves in a frequency band from 0.1 mHz to 1 Hz. Three satellites arranged in a nearly equilateral triangle with an edge length of about 5 million km will fly in an earth-trailing orbit arround the sun in a distance of 20 °. The distance between the satellites will be measured with an interferometer setup. During the mission the distance between the satellites vary with about 50000 km. This breathing of the constellation causes a Doppler shift of the Laser frequency in a range of 2 to 19 MHz.

In this context EADS Astrium developed a RF low noise quadrant photo detector which is suited for high precision phase measurements in a sub-Hz LISA measurement band. It uses an Indium Gallium Arsenide (InGaAs) quadrant photodiode with a total diameter of 1 mm. The detector as a position sensitive device can also be used for the technique of differential wavefront sensing. With respect to the mission requirements the detector has a constant frequency response and a linear phase response for frequencies between 2 and 20 MHz. It has also a path for frequencies between DC and 45 kHz for each quadrant.

In the presentation the setup will be explained and the results of our current measurements will be shown.