Q 48: Laseranwendungen: opt. Messtechnik

Time: Thursday 14:00–16:00 Location: V38.01

Group Report Q 48.1 Thu 14:00 V38.01

Development of a test setup for the Grace follow-on laser ranging instrument — •Daniel Schütze, Vitali Müller, Benjamin Sheard, Oliver Gerberding, Christoph Mahrdt, Marina Dehne, Gunnar Stede, Nils Brause, Gerhard Heinzel, and Karsten Danzmann — Max-Planck-Institut für Gravitationsphysik / Leibniz Universität Hannover (Albert-Einstein-Institut)

GRACE (Gravity Recovery and Climate Experiment) is a joint NASA/DLR mission which successfully collects data about spatial and temporal variations in the gravity field of the earth. In 2016, a GRACE follow-on mission will be launched. In addition to the conventional microwave ranging system, the GRACE follow-on satellites will also contain a laser ranging instrument to improve the inter-satellite distance measurements. Essential parts of the laser ranging instrument are a triple-mirror-assembly to establish an interferometric racetrack between the satellites and a steering mirror setup to account for satellite pointing. A laboratory test setup of the GRACE follow-on interferometer is presented with which these key components shall be tested.

Q 48.2 Thu 14:30 V38.01

Optical fiber sensors for simultaneous temperature und mechanical stress monitoring of medium voltage power cables — •Alexander Doering[1], Wolfgang Schippers[2], Martin Angelmahr[1], Jörg Burgeier[1], and Wolfgang Schade[1,2] — [1]Fraunhofer Heinrich Hertz Institut, Am Stollen 19B, 38640 Goslar, Germany — [2]Technische Universität Clausthal, Institut für Energieforschung und Physikalische Technologien, Am Stollen 19B, 38640 Goslar, Germany

The monitoring of power cables in industry complexes and power plants is getting more and more important due to the increasing automatization level and the resulting system relevance of the cable. For the determination of the failure probability, two parameters are mainly of interest: the thermal and the mechanical stress the cable is exposed to. For monitoring these influences, a fiber optical sensor system based on two physical measuring principles is presented. The distributed temperature sensing (DTS) is realized by measuring the anti-stokes-/stokes intensity ratio of Raman backscattering signal. The attenuation difference in the fiber between the Stokes and anti-Stokes signal is compensated by an innovative measuring system. The mechanical stress is monitored by applying fiber Bragg grating (FBG) sensors integrated within the voltage cable.

At the moment the system is employed in rail mounted gantry cranes - first measurement results are presented.

Q 48.3 Thu 14:45 V38.01

GEO600, a second generation gravitational wave detector — •Holger Wittel — AEI Hannover

GEO 600 is a ground based gravitational wave detector that is set up as a big Michelson interferometer. Currently, GEO600 is being updated with the goal of increasing the sensitivity by a factor of ten. Central parts of the upgrade are the increase of the circulating light power to above 20kW and the introduction of squeezed light. Both will introduce new challenges: high power operation will make thermal compensation necessary, while squeezing requires a tight loss budget.

Q 48.4 Thu 15:00 V38.01

Dynamic tuning for a signal recycled interferometer. — •Dmitry Simakov — Albert Einstein Institut

The chirp signal has increasing in time frequency. We propose to follow the signal with the tuning of the signal recycled interferometer. By moving the SRM we going out of the steady state. It cannot be simulated by usual frequency domain. In order to simulate the dynamical tuning, a time-domain linear model of GEO600 interferometer was created. The shot noise in time-domain was studied for a different configuration: with homodyne detection and DC-Readout. The ground state and squeezed noises are studied. The simple model of radiation pressure noise was considered. The responses of the GEO 600 operating in different regimes to the chirp signal was simulated.

Q 48.5 Thu 15:15 V38.01

Grace follow-on laser ranging instrument — •Vitali Müller, Daniel Schütze, Benjamin Sheard, Oliver Gerberding, Christoph Mahrdt, Marina Dehne, Gunnar Stede, Nils Brause, Gerhard Heinzel, and Karsten Danzmann — Max-Planck-Institut für Gravitationsphysik / Leibniz Universität Hannover (Albert-Einstein-Institut)

The joint NASA/DLR mission GRACE (Gravity Recovery and Climate Experiment) provides monthly solutions of Earth's gravity field since 2002. Variations of the geopotential are caused by various geophysical effects like tides, mantle conversion or melting glaciers. Hence these models have a wide range of applications in geosciences.

To ensure a continuous data stream of Earth's large scale mass fluctuations, a GRACE follow-on mission is being prepared to be launched in 2016. Additionally to a microwave ranging system between the two satellites, an inter-satellite laser link will be established to perform interferometric distance measurements with a precision of 50 nm/sqrt(Hz) in the interesting frequency band. An overview about the mission will be given, particularly about the laser ranging instrument, which will be the first inter-satellite laser interferometer in space.

Q 48.6 Thu 15:30 V38.01

Hochleistungs-LG33-Moden — •Christina Bogan[1], Ludovico Carbone[2], Andreas Freise[2], Benno Willke[1] und Karsten Danzmann[1] — [1]Albert-Einstein-Institut Hannover — [2]University of Birmingham

Ein viel versprechender Ansatz, den negativen Einfluss von thermischen Effekten auf die Sensitivität zukünftiger Gravitationswellendetektoren zu reduzieren, ist der Einsatz von Laguerre-Gauss-Moden in den Präzisionsinterferometern. Insbesondere die LG33-Mode weist eine sehr günstige räumliche Intensitätsverteilung auf, so dass durch thermische Fluktuationen verursachte Ungleichmäßigkeiten auf den Spiegeloberflächen weniger ins Gewicht fallen.

Eine Möglichkeit LG33-Moden mit hoher Effizienz und Reinheit zu erzeugen ist der Einsatz von strukturierten Phasenplatten. Zusätzlich ist das Filtern mit einem Modecleaner notwendig, um die im Interferometer benötigte Strahlqualität gewährleisten zu können. Dazu eignen sich im Fall von LG33-Moden jedoch nur Resonatoren mit einer geraden Anzahl von Spiegeln, da in diesen auch helizentrische LG33-Moden resonant sind.

In diesem Vortrag zeigen wir, dass LG33-Moden nicht nur mit der benötigten Strahlqualität erzeugt werden können, sondern auch mit hohen Leistungen. Dies ist gerade für den möglichen Einsatz in Gravitationswellendetektoren entscheidend, da deren Empfindlichkeit mit der eingestrahlten Lichtleistung skaliert.

Q 48.7 Thu 15:45 V38.01

Simulating and optimizing laser interferometers — •Evgenia Kochkina, Gudrun Wanner, Christoph Mahrdt, Sönke Schuster, Michael Tröbs, Gerhard Heinzel, and Karsten Danzmann — AEI Hannover, Germany

Designing complicated optical systems often requires simulations to create the most efficient setup. There are dozens of optical software tools available, but to the author's knowledge none of them incapsulates all of the subsequent features:

- tracing different types of Gaussian beams (simple and general astigmatic Gaussian beams or Hermite modes) through an arbitrary optical setup,
- heterodyne signal calculation (for instance longitudinal pathlength signal or differential wavefront sensing signal),
- optimizing interferometers in a given way.

On the other hand, most of the tools concentrate on classical optics effects, that might not be critical for laser interferometers. Therefore, we created a software tool called IfoCad specifically for the purpose of designing and investigating laser interferometers. During the talk we are going to give an overview of this program and it's real-life applications. We will present the models and algorithms we used to simulate simple astigmatic and general astigmatic Gaussian beams, Hermite modes, their tracing through complicated misaligned 3D systems, and optimizing interferometers to fulfill given requirements. We will also talk about heterodyne signals that we are using and the information that can be extracted from them.