Experimental investigations of an inertial reference sensor with spherical test mass and optical read out

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Motivation

An alternative eLISA payload concept with In-Field Pointing (IFP) was proposed which aligns the line of sight of each telescope by an actuated mirror, the IFP-Mechanism, compensating for orbital driven geometrical changes of the satellite formation:
- In-Field Pointing replaces Telescope Pointing
- Single active test mass concept with reduced guiding
- Single optical bench without back-link fibers

Potential performance improvements could be achieved by combining the IFP concept with a spherical test mass:
- No test mass guiding during science runs
- Larger gap between test mass and housing
- Enabling an all optical read out of test mass

Levitation Test Bed

A levitation test bed is currently under construction to get some experience of levitating a spherical test mass. An electro-magnetic system is the chosen principle using a controlled electro-magnet and a magnetizable test mass. Starting point is a levitation system with 1 DoF guidance:
- Spherical test mass:
  - Diameter: ø40 mm
  - Surface quality (before coating): 60 nm (rms)
- Levitation of test mass via two level electro-magnet:
  - Dual-coil with 500 and 6000 windings for test mass height control
  - Controlling via FPGA based cascade control loop system
- Optical height sensing system by light barrier principle:
  - Two beam system for detection of lateral test mass movements

Inertial Sensor Setup

As a first step Airbus is developing a setup to characterize the surface of the spherical test mass and to gain experience with the optical read out. Therefore the test mass will be mounted on a rotation table while its surface is measured interferometrically.
- Principal tests with non levitated test mass
  - Test mass mounted on a highly precise rotation table
  - Optical read out using two heterodyne interferometers
  - Mode match of output laser beams onto test mass

Next steps:
- Extension of height sensing by tilt signal (DWS) of the optical read out
- Implementing additional electro-magnets for 3 DoF guidance
- Implementing a system to apply a defined torque onto test mass