ID de Contribution: **4** Type: **Non spécifié**

FOGOB: an optical setup for TTL estimation in LISA

lundi 20 novembre 2023 14:40 (15 minutes)

The now dismissed FF-OGSE was aimed at measuring the Tilt-To-Length coupling on LISA's benches. Its "active" core is the so-called FOGOB optical bench. It delivers a reference beam (REF) and an angular jittering beam (Rx), which are used to probe the longitudinal optical path length variations induced by the Rx tilt at the MOSA level. Such coupling is connected to the internal misalignments of the MOSA.
At ARTEMIS we developed a demonstrator (FOGOB_Demo) aimed at providing a FOGOB scheme proposal through the demonstration of the critical functions the FOGOB.

The functions to be demonstrated were the following:
- Provide a flat-top intensity profile and flat wavefront to mimic the Rx beam
- Provide an angular jittering Rx beam on the associated pivot point, centered at the FOGOB_Demo's pupil within +/-15 um, with a stability better than 1 um over few hours.
- Center the REF beam on the pivot point with a precision of 2 um.
- Get a phase-lock between the two beams.
- Demonstrate a residual TTL coupling coefficient at the output pupil of less than 10 um/rad.

To reach such goals we adopted several original procedures and techniques based on the use of servo loops and lithography masks for position control, a dedicated optical setup for the realization of the flat-top, the design of optical supports with the required stability, the realization of dedicated electronics for servo-loops and signal reading.
Optical simulations made with different optical software (FRED, IfoCAD) corroborated and guided the measurements.

The setup shows a residual TTL within the specification of < 5 um/rad, with a stability better than 1 um/rad over 130 hours.
We generate a flat-top with wavefront (lambda/80) and intensity profile compliant with a negligible TTL coupling coefficient.
In addition to these remarkable performances, the demonstrator makes use of standard components, metallic breadboard (instead of zerodur based one). It allows for remote beams position control within a precision better than 0.1 microns and in a straightforward way. It is operated in a normal environment laboratory.

The prototype demonstrated the feasibility of the FOGOB and provided useful insight and techniques for future similar applications.

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Classification de Session: Session 2