Development of the inertial sensor for DECIGO Pathfinder

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1. Abstract
This article reports on the development of inertial sensors for DECIGO Pathfinder (DPF), which is the precursor of DECIGO, spaceborne gravitational-wave (GW) antenna of Japan in future. To achieve drag-free control, DPF will have micro thrusters and inertial sensors which sense external force on the satellite structure. The inertial sensor comprises a proof mass (test mass: T.M.) and position controllers which consist of capacitive sensors and electrostatic actuators. The position controller will sense the relative position between the proof mass and its housing, and control the proof mass motion with the actuator. We achieved the control of translational motion and yaw motion. We will report on the feedback.

2. DECIGO Pathfinder (DPF)

3. Control

4. Control of Test Mass with Capacitive sensors and Electrostatic actuators

4.1 Principle

Capacitive sensor
We can sense the displacement of the T.M. as the difference of the capacitance.

Electrostatic actuator
We can actuate the T.M.'s DOFs by charging the electric filed around the T.M.

4.2 Experiment system

4.3 Two DOFs control

Transitional motion (X)

- Noise
- Gain
- Transfer Function
- Phase margin ~45 degrees
- UGF ~0.2Hz
- Suppressed

Yaw motion (θ)

- Noise
- Gain
- Transfer Function
- Phase margin ~45 degrees
- UGF ~0.2Hz
- Suppressed

The noise of the transitional motion and that of the yaw motion were suppressed in the same time period.

These transfer functions (transitional motion and yaw motion) have gains under 0.2Hz. The phase margins are approximately 45 degrees.

We could suppress two DOFs fluctuations of the test mass via our feedback control system.

5. Conclusion
We have controlled the translational and yaw motions of a suspended test mass which is the same size as a test mass of DPF. We could suppress the fluctuation of the test mass under 0.1Hz.

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