



HAL
open science

Improvement of ONERA Electrostatically suspended torsion pendulum

Nolwenn Portier, Bruno Christophe, Marine Dalin, Vincent Lebat, Françoise Liorzou, Manuel Rodrigues

► **To cite this version:**

Nolwenn Portier, Bruno Christophe, Marine Dalin, Vincent Lebat, Françoise Liorzou, et al.. Improvement of ONERA Electrostatically suspended torsion pendulum. EGU 2024, Apr 2024, Vienne, Austria. pp. EGU24-8931, 10.5194/egusphere-egu24-8931 . hal-04893028

HAL Id: hal-04893028

<https://hal.science/hal-04893028v1>

Submitted on 17 Jan 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

EGU24-8931, updated on 17 Jan 2025

<https://doi.org/10.5194/egusphere-egu24-8931>

EGU General Assembly 2024

© Author(s) 2025. This work is distributed under the Creative Commons Attribution 4.0 License.



Improvement of ONERA Electrostatically suspended torsion pendulum

Nolwenn Portier, Bruno Christophe, Marine Dalin, Vincent Lebat, Françoise Liorzou, and Manuel Rodrigues

DPHY/IEA, ONERA, Châtillon, France (nolwenn.portier@onera.fr)

In order to meet the objectives of the Next Generation Gravity Mission (NGGM), the French Aerospace Lab ONERA is developing a new accelerometer concept MicroSTAR with three sensitive linear and three true angular acceleration measurements (Dalin et al., session G4). This instrument benefits from previous developed accelerometers which flew in the well-known gravity space missions: CHAMP, GRACE, GOCE, GRACE-FO.

The principle of operation of these accelerometers is to maintain motionless a proof-mass with respect to the surrounding electrodes using a control loop. The applied electrostatic forces needed for this control, are proportional to the accelerations suffered by the proof-mass. The proof-mass is polarized with a very thin (few micrometer) wire in order to measure precisely its position by capacitive detection with the electrodes and to avoid charging in orbit. The stiffness and damping induced by the polarization wire impact the performance of the accelerometer at low frequencies. To quantify on-ground the performance limitation due to the wire, an electrostatically suspended torsion pendulum (PTSE) is used (Willemenot 1997, Willemenot and Touboul 2000).

The PTSE is a six-axes servo-controlled accelerometer, optimized for the measurement of angular accelerations about the vertical axis. The torque noise spectral density is $1.3 \cdot 10^{-14}$ Nm/ $\sqrt{\text{Hz}}$ around 0.05 Hz with a $1/\sqrt{f}$ increase at lower frequency, corresponding to 10^{-8} rad/s²/ $\sqrt{\text{Hz}}$, and $2 \cdot 10^{-10}$ ms⁻²/ $\sqrt{\text{Hz}}$ with a lever arm of 2cm. For instance, regarding a gold wire of 7.5 μm diameter and 1.7cm length, we use it to measure theoretical stiffness of $2.5 \cdot 10^{-5}$ N/m i.e. a torsion of 10^{-8} Nm/rad. In our presentation, this instrument will be described before sharing ideas for its improvement.

Willemenot, P. Touboul; *Electrostatically suspended torsion pendulum*. *Rev Sci Instrum* 1 January 2000a; 71 (1): 310–314. <https://doi.org/10.1063/1.1150198>

Willemenot, P. Touboul; *On-ground investigation of space accelerometers noise with an electrostatic torsion pendulum*. *Rev Sci Instrum* 1 January 2000b ; 71 (1): 302–309. <https://doi.org/10.1063/1.1150197>

Willemenot, *Pendule de torsion à suspension électrostatique, très hautes résolutions des accéléromètres spatiaux pour la physique fondamentale*. Ph.D. thesis, Université Paris 11, France, 1997