

Low drift optical accelerometer for vibration compensation in an Absolute Quantum Gravimeter

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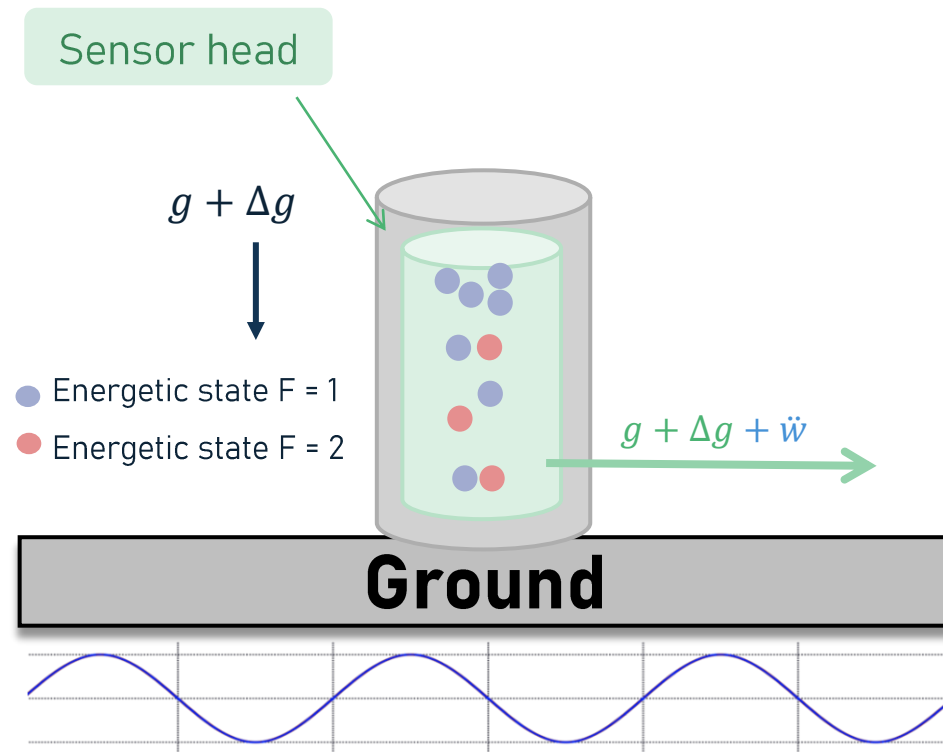
LGWA 2026 – Liège

28th septembre – 2nd octobre 2026

Quantum gravimetry

AQG (Absolute Quantum Gravimeter)

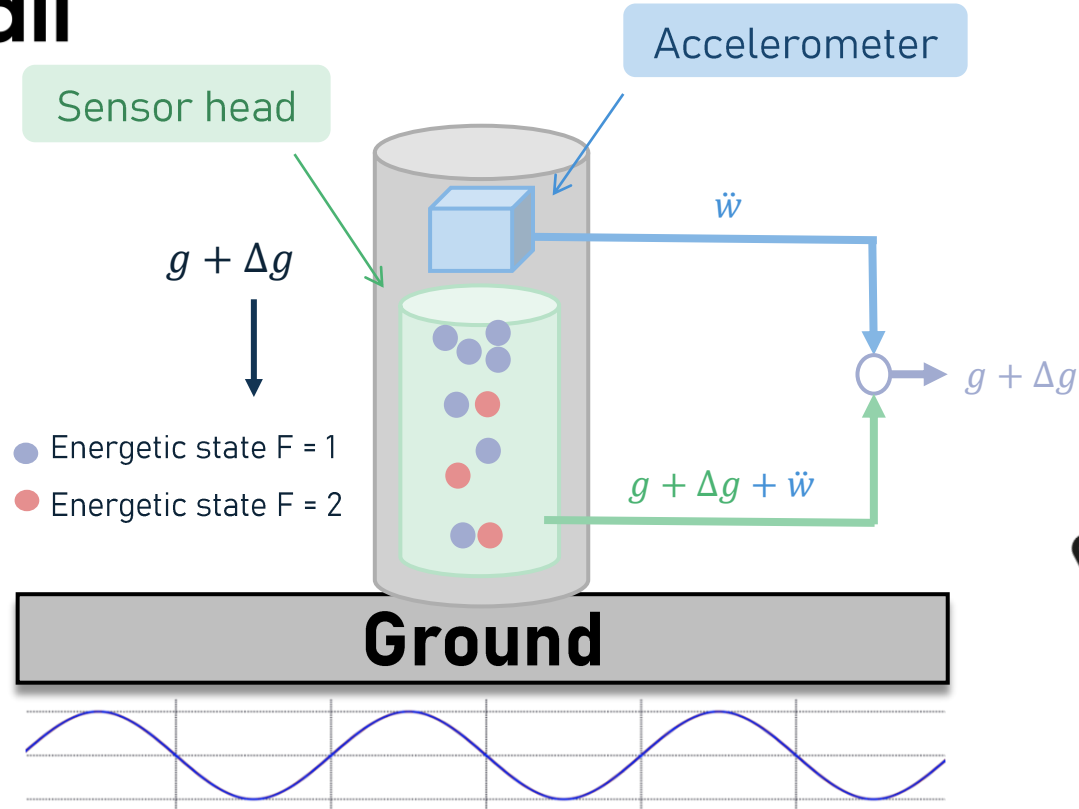
exail



Vibration compensation in AQG

exail

AQG (Absolute Quantum Gravimeter)



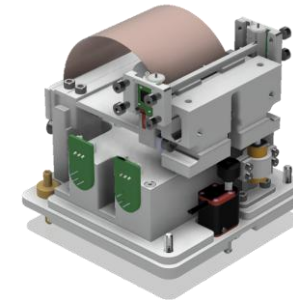
Vibration compensation with accelerometer
(10 mHz-100 Hz)

Requirement for high resolution field AQG

- ☐ Broadband
- ☐ High resolution
- ☐ Low drift
- ☐ Low cross-axis sensitivity
- ☐ Field ready
 - Robust
 - Remotely operable
 - Compact

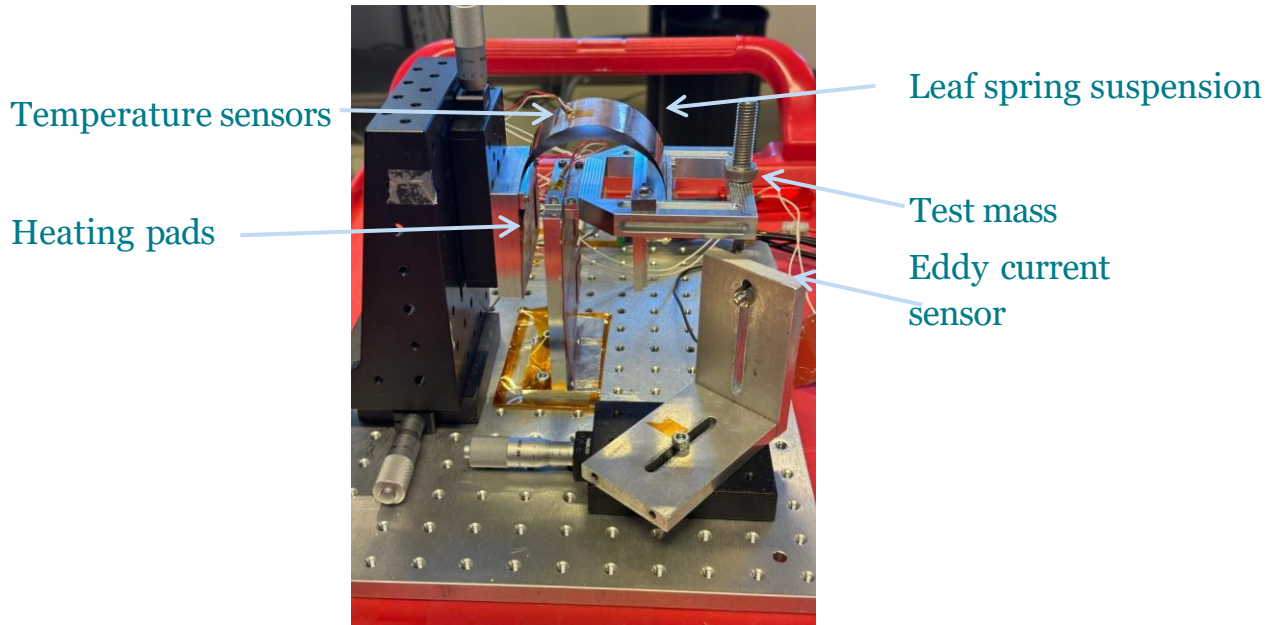
FIQUGS

μ Vins



Compact interferometric
vertical inertial sensor

Low drift: Suspension thermal stability

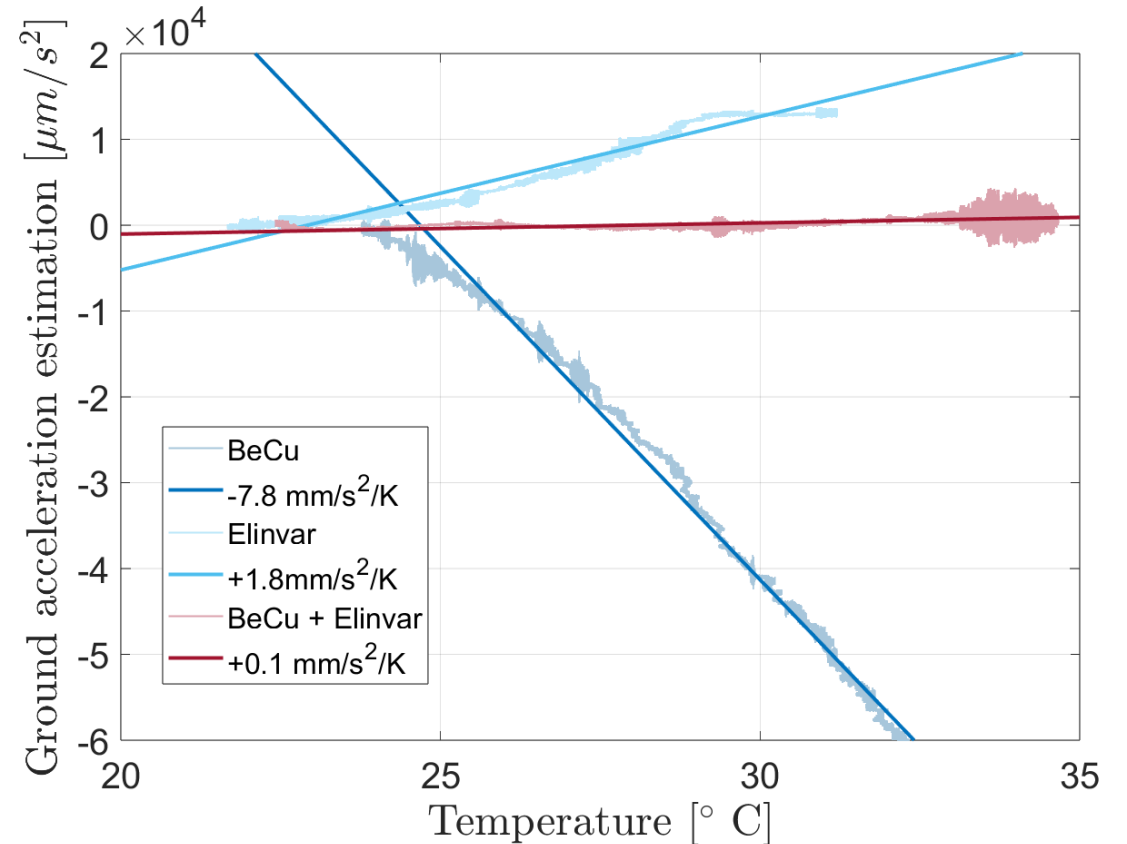


Drift (m/K) $\propto$ (CTE+TEC)

$TEC = \frac{\Delta E}{E}$ (ThermoElastic Coeff.)

$CTE = \frac{\Delta L}{L}$ (Coeff. Of Thermal Expansion)

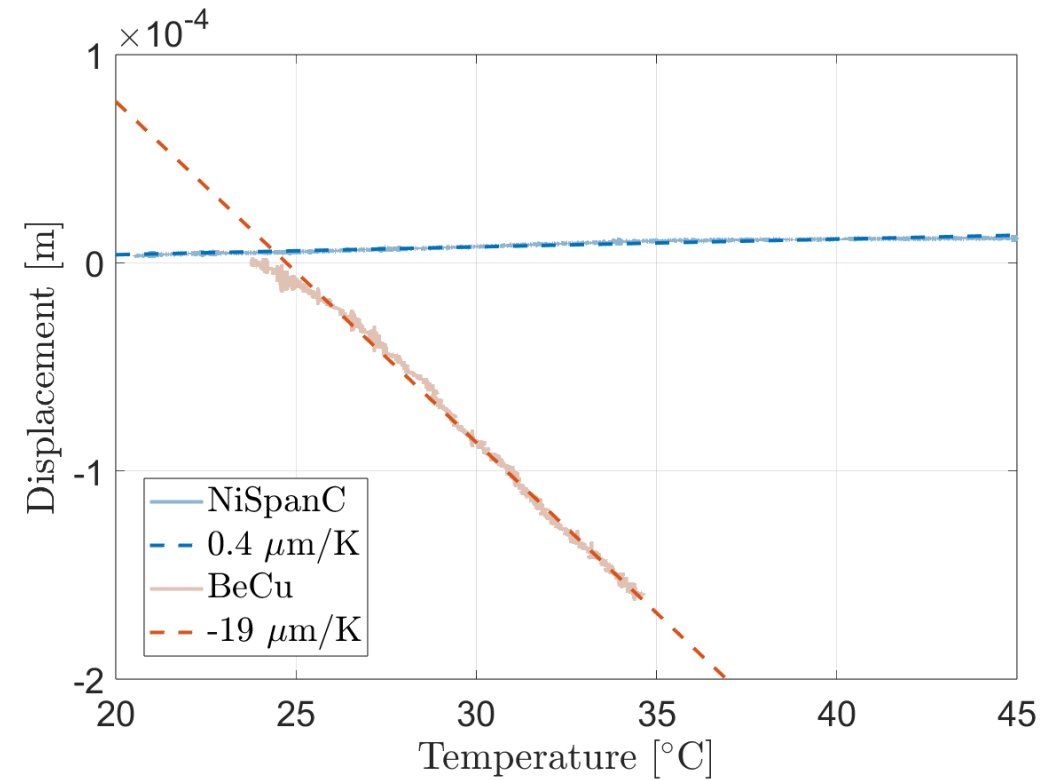
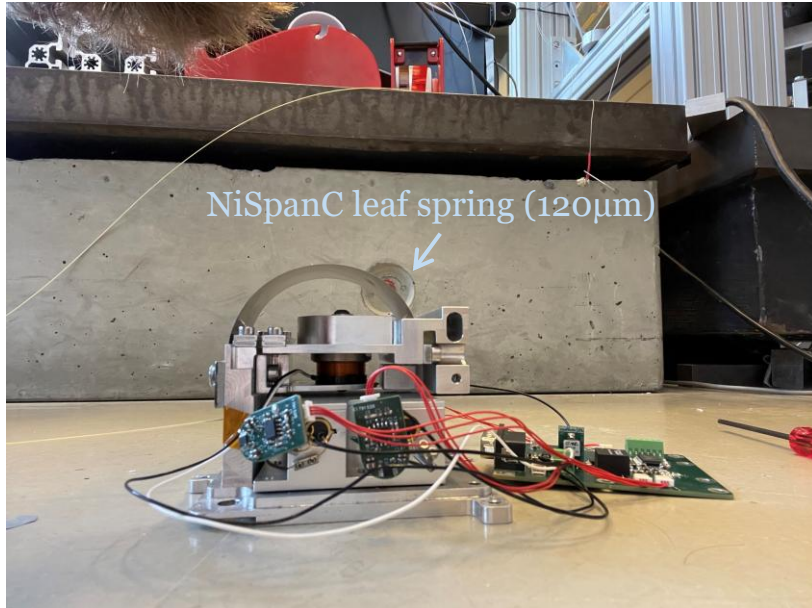
Mutual drift compensation of CuBe+Elinvar



Configuration	Materials	Ground acc. [mm/s ² /K]
Single blade	CuBe	-7.8
Single blade	Elinvar	1.8
Double blade	CuBe + Elinvar	+0.1

Low drift: Suspension thermal stability

Test on sensor

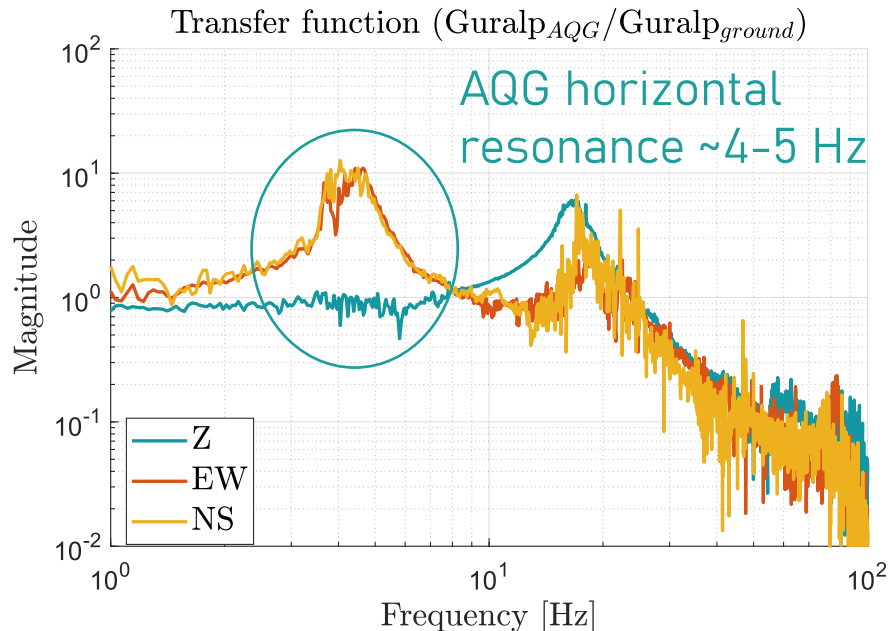
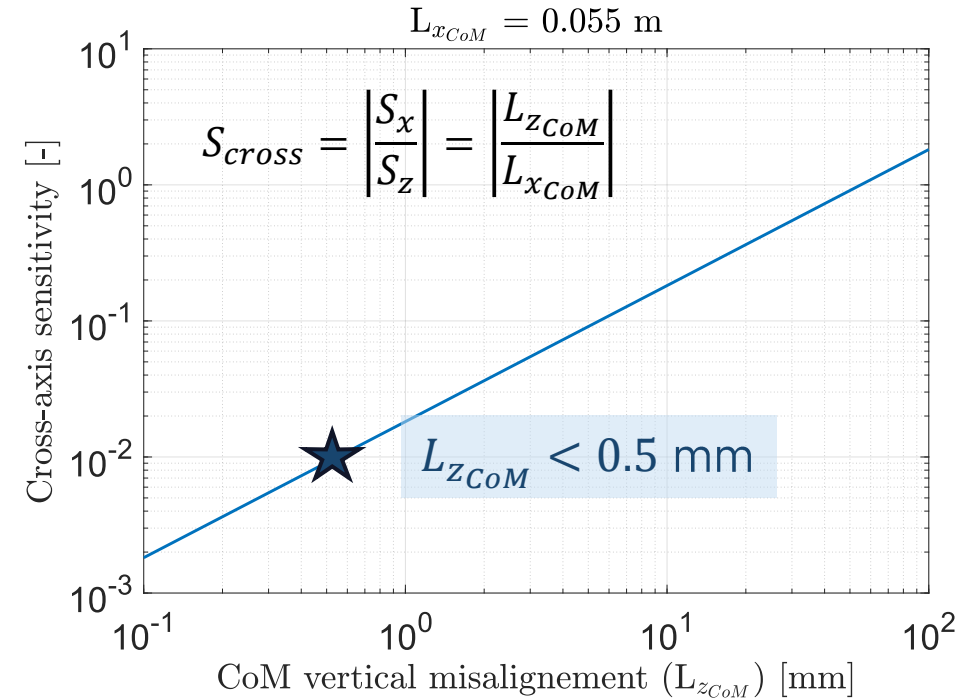
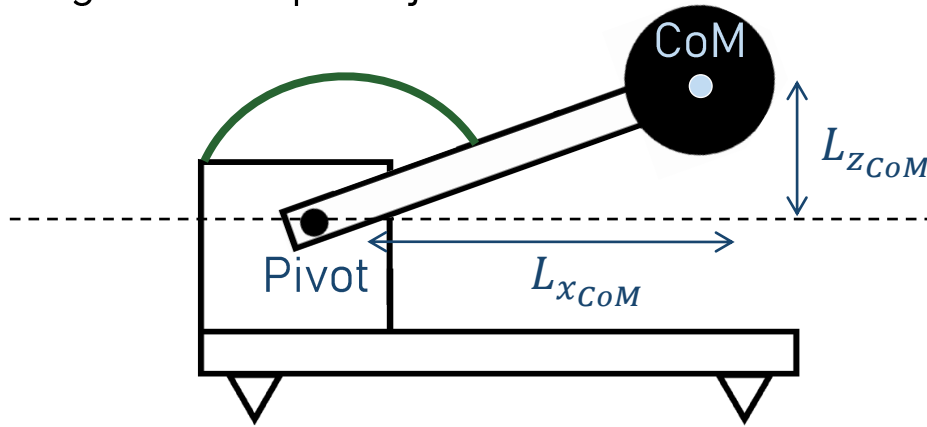


Reduced thermal sensitivity by a factor of 20 !!

Configuration	Materials	f_0 [Hz]	Sensitivity at LF [(m/s ²)/m]	Mass disp. [μm/K]	Ground acc. [mm/s ² /K]
Single blade	CuBe	2.8	0.0058	-19	-5.1
Single blade	NiSpanC (120 μm)	4	0.0016	0.4	0.25

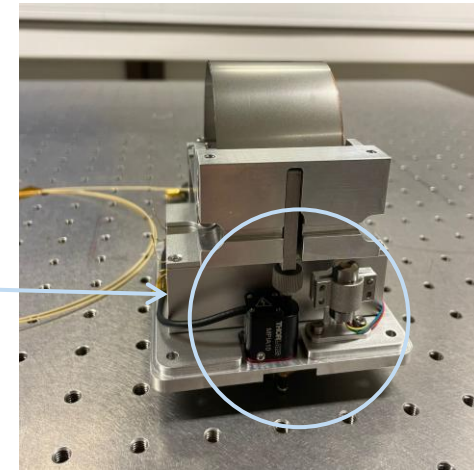
Low cross-axis sensitivity

Sensitive to horizontal motion when CoM not aligned with pivot joint

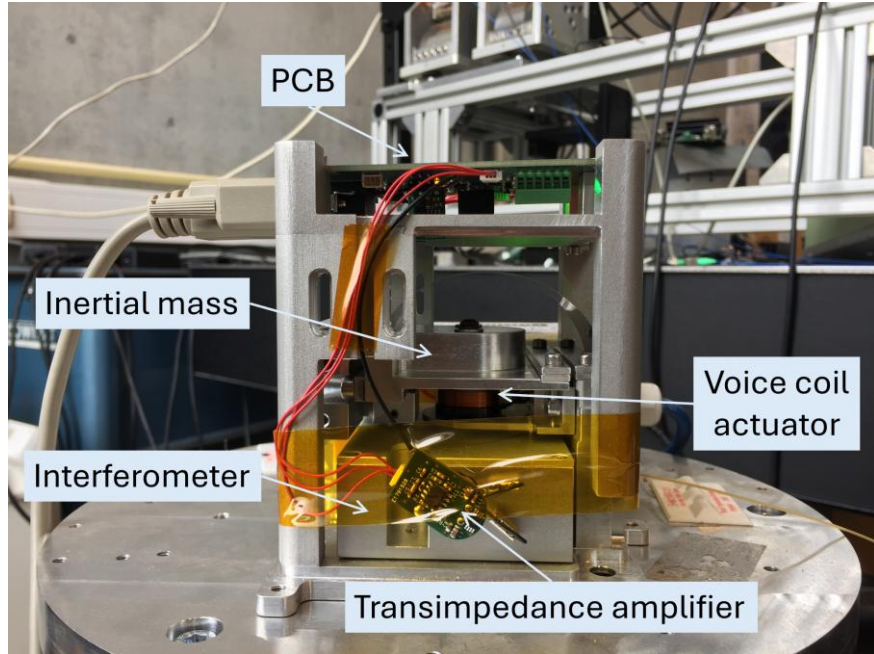


- I. Carefully design of the inertial mass
- II. Characterisation of optimal position
- III. Automatic stabilisation system to keep it there

└─ LVDT + Piezo leveling screw



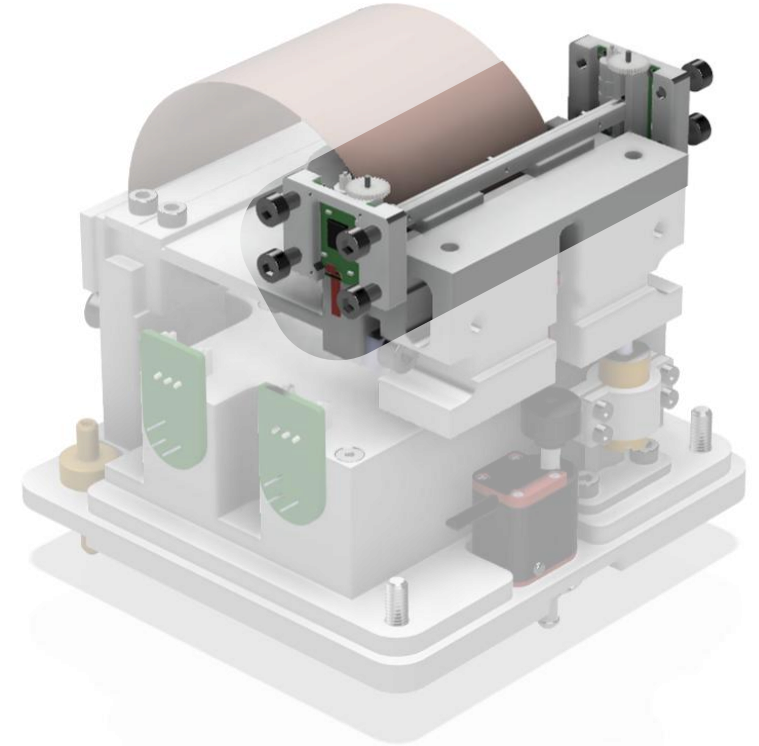
Compact and robust



Laser source

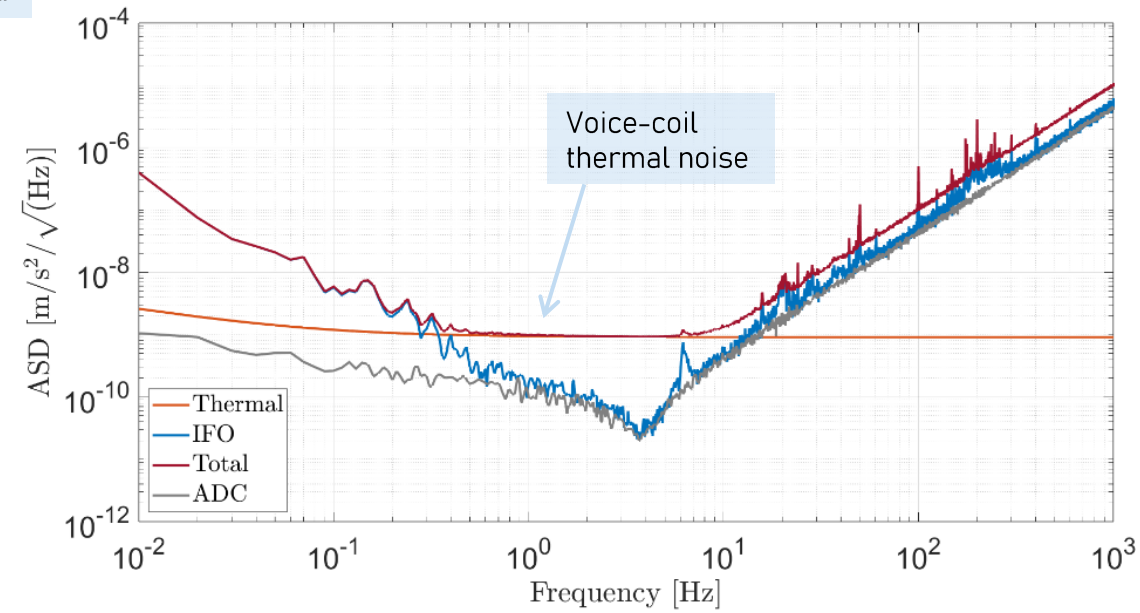
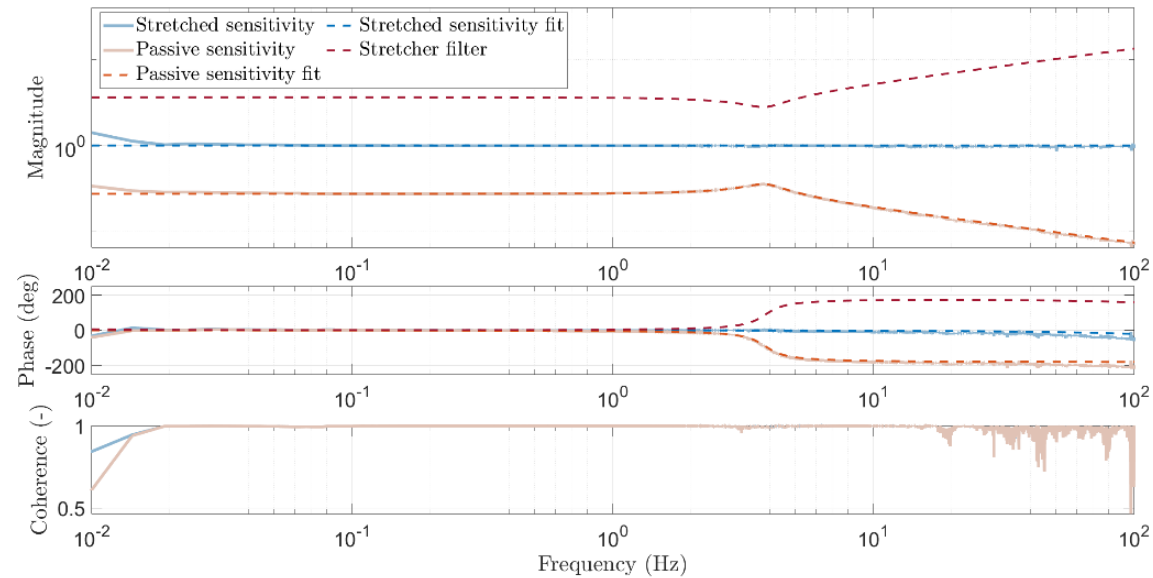
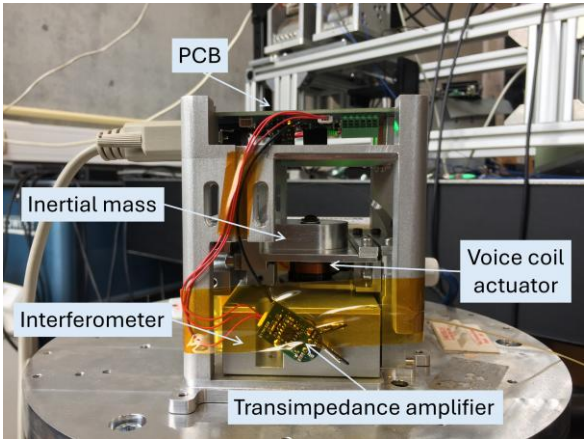


Dimensions (w/o laser source): 11x12x13 cm³
Weight (w/o laser source): 960 g



Robust to transportation with remotely controllable mechanism to lock the inertial mass

Performances



Low noise		
Bandwidth [Hz]	[0.5 : 10]	[0.01 : 100]
Noise level [$\text{m/s}^2/\sqrt{\text{Hz}}$]	10^{-9}	$< 10^{-7}$

Broadband (flat transfer function from 10mHz to 100 Hz)

Conclusion

Not moon ready..

BUT Important features for lunar mission



- **Vacuum compatibility**
- **Cryogenic compatibility**
- **Sensitivity**
→ designed for high terrestrial vibration level

Suspension thermal stability

Low thermally induced drift

Remote locking mechanism

Safe for transportation

Automatic mass levelling

Remote recalibration capability →
low cross-axis sensitivity

Compact design

Optimized payload volume and
launch cost

