

# Seismic disturbances compensation by differential deconvolution in nanoforce sensing using diamagnetic levitation

## Research framework

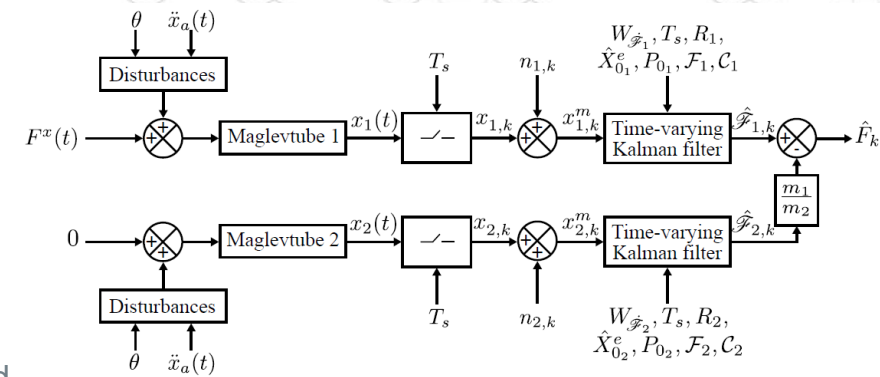
Nanoforce sensors using passive magnetic springs associated to a **macroscopic seismic mass** (several milligrammes) are known to be a possible alternative to force sensors based on elastic microstructures if the nanoforces that have to be measured are characterized by a bandwidth limited to a few Hertz. Despite their high performances, such force sensors are extremely sensitive to low frequency environmental **mechanical disturbances**, like the residual seismic vibrations that are not filtered by the anti-vibration table supporting the device. These variations induce a permanent low frequency disturbance in the force estimation (done by deconvolution) that need to be compensated.

## Proposed approach

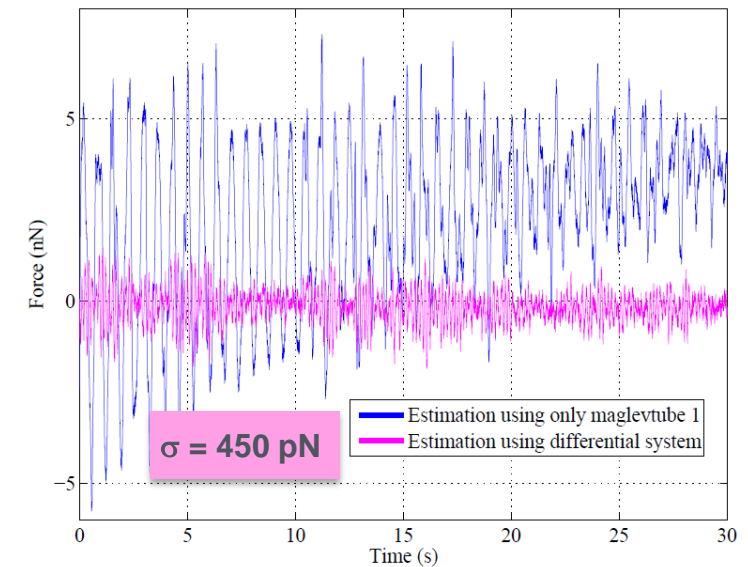
A passive compensation strategy of the low frequency seismic vibrations using a **differential deconvolution** is proposed. This approach does not necessitate to add a very high resolution and low frequency accelerometer in the measurement chain. It is based on two nanoforce sensors using diamagnetic levitation (developed in the last decade). the first one is used classically for force measurement, while the second one estimates the seismic disturbance (table acceleration) in order to reject it in the first one. To be effective, the rejection scheme must consider the **masses ratio** of the two force-displacement transducers. This ratio can be easily determined using a precision balance. In term of performances, the standard deviation of the force estimation remains **below the nanonewton** level after compensation over periods of time of several minutes when external temperature remains constant.

**Major article:** M. Billot, E. Piat, J. Abadie, J. Agnus, P. Stempflié, External mechanical disturbances compensation with a passive differential measurement principle in nanoforce sensing using diamagnetic levitation, Sensors and Actuators: A Physical, to be published in 2016.

Contact: [emmanuel.piat@ens2m.fr](mailto:emmanuel.piat@ens2m.fr), [joel.abadie@femto-st.fr](mailto:joel.abadie@femto-st.fr)



Differential deconvolution principle using two nanoforce transducers with masses  $m_1$  and  $m_2$



Force estimation (using and not using differential principle) versus time with seismic influence for an external force  $F(t) = 0$ .



# SPECIMeN team

## Sensing strategies, Perception and Characterization at Micro- and Nano-scales

AS2M Dep<sup>t</sup> – Automatic Control and Micro-Mechatronic Systems



<http://www.femto-st.fr/fr/Departements-de-recherche/AS2M/Accueil/>