APPLICATION OF GRAVITATIONAL FORCES TO MICRO-FORCES BALANCES

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We present our work on a new kind of gravitational balance dedicated to "G" measurement based on our metrological expertise (EDAS) and our Earth tide instrumentation know how.
Our balance principle is based on an astatic vertical pendulum (see Figure 1) where the Earth's gravitational field provides the main contribution to the restoring force of the pendulum. The mechanical contribution of the suspension is then very low and can be adjusted with a high accuracy. This geometry provides only one degree of freedom of movement and a low sensitivity to micro seismic acceleration.
-We use a specific mass geometry which minimizes the sensitivity of the gravitational force to the position of the test mass.
-The gravitational force induced by the change of the attractive masses position can be calibrated by two independents ways:

- in free deflection mode using the transfer function of the gravitational balance.
- in feed-back loop mode where electrostatic forces are applied in order to keep the test mass at same position.

These electrostatic forces can be precisely related to fundamentals physical units.

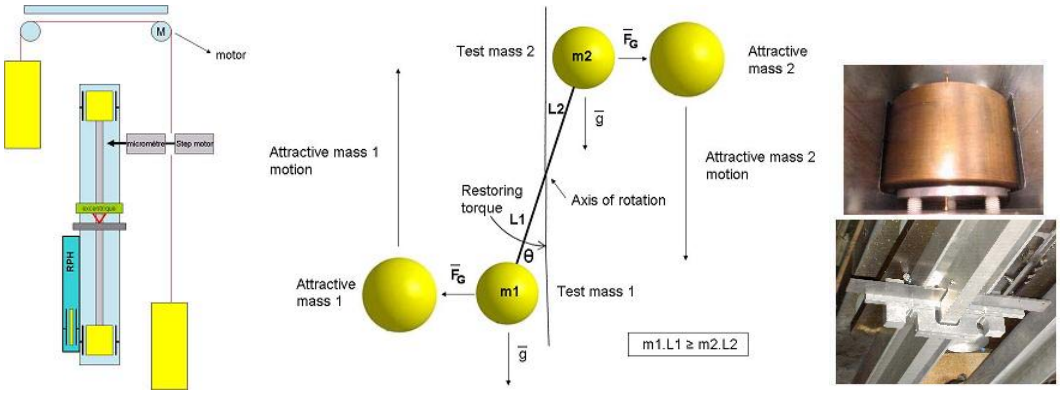

Figure 1: Schematic principle and picture of our Astatic vertical pendulum

Specific electrostatic sensors and actuators have been designed for this prototype.

We have also designed custom softwares to compute the gravitational force for any geometry of masses (see Figure 2). Additional softwares have been developed to optimize the mass geometry with objective criteria (see Figure 2b).

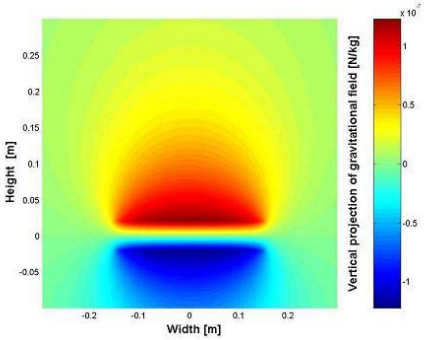

Figure 2: Example of vertical projection of gravitational field around a cylindrical mass computed by our softwares

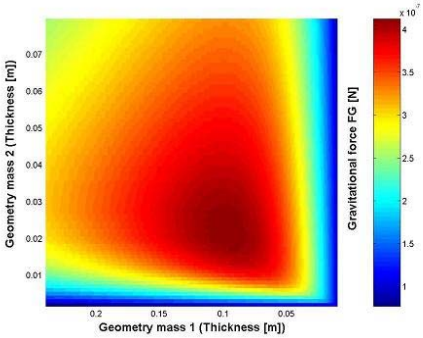

Figure 2b: Gravitational force between the test mass and the attractive mass function of the test mass and the attractive mass geometry

The first results of our work confirm the basic choice of our specific approach.
This specific design should eliminate the main source of error in the current experiments that are based on torsion balance and should provide considerably different systematic uncertainties.

Acknowledgments

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