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Application of earth tides instrumentation in the measurement of the universal constant of gravitation G, technical description of our prototype

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Work on earth tides instrumentation at the Royal Observatory of Belgium has provided us with a large body of expertise and knowledge in the development and operation of pendulums. From this expertise, we develop a new experiment dedicated to the measurement of the universal constant of gravitation G. This prototype is currently in work with nano-Newton resolution in the “Walferdange Underground Laboratory for Geodynamics” (Luxembourg).

Our experiment is based on a vertical pendulum with a second pendular mass above the axis of rotation in order to increase the mechanical sensitivity of the pendulum. Knowing that the earth’s gravitational field provides the main contribution of the restoring torque of the pendulum, mechanical restoring torque coming from the suspension with bias such as inelastic effects can then be lowered and adjusted with a very high accuracy (depending on the second mass position).This geometry provides only one degree of freedom of movement and a low sensitivity to micro seismic acceleration.

The gravitational force induced by the change of the attractive masses position around the pendulum can be calibrated by two independents ways:

- in free deflection mode using the transfer function of the gravitational balance.

- in feed-back loop mode using electrostatic forces as calibration force applied in order to keep the pendular masses at same position.

We also use a specific mass geometry which minimizes the sensitivity of the gravita-

tional force to the pendular masses position.

We propose to present the first results of our experiment and to detail the technical solutions we have developed for this prototype (specific sensors and actuators, numerical PID controller, remote control, numerical simulation, specific data treatment with stacking method (Hicum) and custom software we have developed to compute the gravitational force for any geometry of masses).