

The Royal Observatory of Belgium gravitational balance G4 dedicated to the monitoring of gravitational interactions

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With our Tidal instrumentation expertise, we have designed a series of symmetrical vertical balances to meet the metrological requirements for determination of the gravitational constant G .

Since gravitational constant will be determined by comparing the gravity modulation torque $\Gamma(G)$ induced by moving masses acting on the pendulum with a calibrated torque $\Gamma(w)$ with periodicity of 720sec, this is a very significant property for such sensible instrument since long series are required to eliminate noisy signals by stacking averaging.

The torque $\Gamma(w)$ is induced by needles of a watch fixed horizontally on the pendulum and turning with in the gravity field of the Earth.

To calibrate the watch, we compare on a dedicated balance the torque $\Gamma(w)$ of the clock with a torque $\Gamma(m)$ induced with a well-known mass linearly moving at a constant speed in a site where g was precisely measured.

We separate by stacking on respectively the $\Gamma(G)$ and the $\Gamma(w)$ periodicities.

Resulting of previous prototyping's, some main questions are well addressed by the new design named G4:

- 1. Our axis of rotation allows the use with enough stability pendulum weighting few kg.
- 2. Electrostatic feedback keeping the mass in a constant position could rejects all the flexure influences.
- 3. The one degree of freedom for the pendulum motion dramatically simplifies the computation of the theoretical torque

From these conclusions, we have evaluated patterns of this new G4 systems installed at the ROB.

G4 is equipped of an heavy long pendulum submitted to modulated gravitational effects induced with two heavy masses displacement. An original elevator moves symmetrically two containers up & down on both sides of the pendulum. The theoretical amplitude of gravitational torque acting on the containers which is constant, is only 0.0338 μ Newton x Meter.

We introduce inside the containers the masses with various material we want to experiment in term of gravity. For example, the torque induced for two copper mass, is 0.188 μ Newton x Meter.