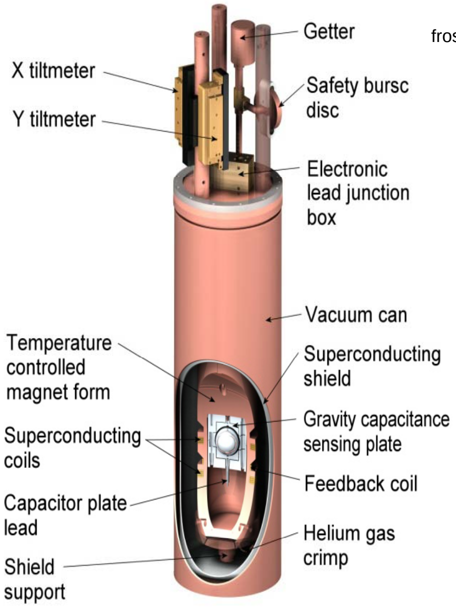
The Superconducting Gravimeter

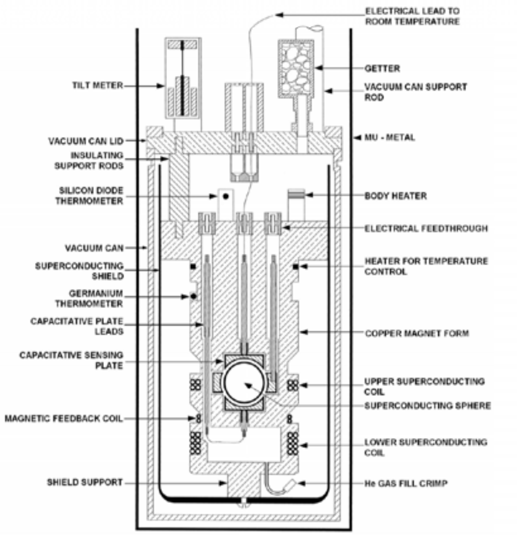
at Chalmers / Onsala Space Observatory

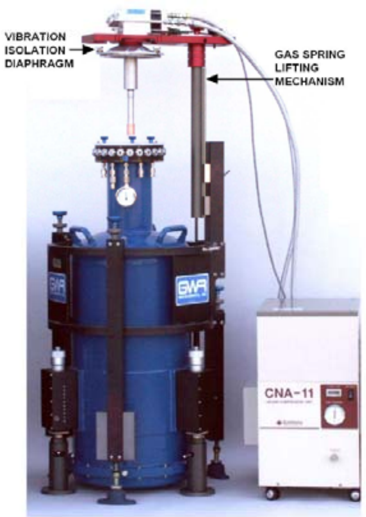
froste.oso.chalmers.se/hgs/SCG

GWR 054

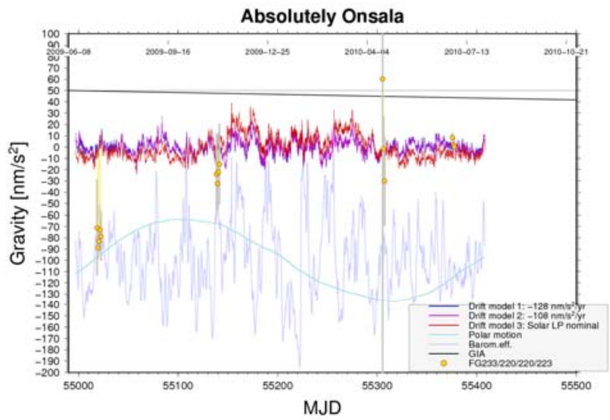
The primary purpose **for this station and its permanent monitoring of gravity change is maintaining a reference point as one component of the Onsala Fundamental Geodetic Site, owing to the close coordination with the permanently operating space geodetic techniques, GNSS and VLBI.**







www.gwrinstruments.com



Absolute gravity measurements and the gravity variations at this site.
The figure shows gravity variations after subtraction of tides, polar motion, and air pressure related effects. The polar motion and barometer records are shown in light gray. Instrumental drift sets a principal limitation for the inference of gravity change over long periods. A drift model must be determined empirically. In our case, instrumental drift appears to have two components, an intial exponential decay with a retardation time of 500h and a linear trend of 13 (nm/s²)/yr. Reducing for both leaves a final variation of ±30 – 40 nm/s².
Four campaigns of absolute gravity are depicted as colour-filled symbols. First and third epoch: Lantmäteriets AG 233, a.k.a. Greta, second and fourth epoch: Leibniz University, Hannover, its AG 220.

Gravity sensor:

Superconducting Niobium sphere held soaring in a magnetic field. The position of the sphere is sensed by a differential capacitor. A feedback loop adjusts the strength of the supporting magnetic field so that the position of the sphere is kept constant. Thus, the strength of the electric current in the magnetic coils is a measure gravity.

The sensor can detect changes of less than 1 nanometer per second-squared.

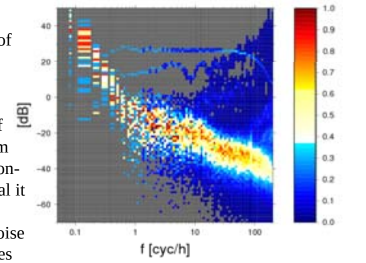
Tilt control loop (automatic leveler):

The gravity forces act along the vertical – this is a tautology. However, the platform on which the instrument rests may change its orientation with respect to the vertical; this is called tilt. In order to keep the instrument aligned with the vertical, two of the three feet are automatically adjusted. Deflections of the vertical are measured with pendulums inside the gravimeter case. An error signal is amplified and fed into heating coils that let a liquid inside a piston expand, bringing the instrument back into the vertical.

Deviations of the vertical are in the range of 0.1 arc seconds.

Noise

Periodograms of 12 consecutive days in histogram fashion. As a method of Power spectrum analysis of a non-stationary signal it shows that the instrumental noise floor approaches most of the time -40 to -42 dB relative to 1 (nm/s²)²/Hz at 18s period (below the inset of micro-seismic noise. Singular days with high noise are due to earthquakes.



Long-period Seismology

Low noise level, sensor stability and sensitivity concoct to providing observing capability for the earth's free oscillations excited by strong earthquakes like the ones at Maule, Chile, 2010-02-27 (M_w 8.8) or Sendai, Japan, 2011-03-11 (M_w 9.0).

BELOW: The slow decay of the "breathing mode" $_0S_0$ owes to the unimportance of shear deformation in this particular mode in the earth's mantle; it meets extremely little internal friction.