

Absolute Gravity Measurements with the Austrian FG5 Absolute Gravimeter at the Conrad Observatory (CO): Results and Problems

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Since 2010 absolute gravity measurements have been performed with the absolute gravimeter (AG) FG5/242 at the CO. The FG5 gravimeter was acquired in cooperation between BEV and ZAMG. The measurements are mainly used for the calibration of the superconducting gravimeter (SG). Although the FG5 gravimeters represent the latest standard in absolute gravimetry, the measurements were affected by a Helium concentration in the gravity lab of the SG.

Absolute gravity measurements have been performed at the CO since 2010 with the AG FG5. The AG uses a laser to track the free-fall position of an object that forms one arm of an interferometer. The timing of the optical fringes is measured using a commercial rubidium atomic clock (Symmetricom SA.22c). These clocks are very robust and have a low drift rate (a few mHz per year).

Both the laser and the clock are calibrated regularly at the BEV metrology department. The calibration of the clock in October 2011 showed that there was a strong drift of 50 mHz in one year, which is unusual for such clocks. This led also to some small changes in gravity, which did not coincide with the SG signal. The next calibration in December 2011, immediately after measurements at COBS, showed again a large drift and an increased measurement uncertainty.

Therefore, this clock was replaced by a new one. After storing the AG in the gravity lab the new clock was again outside the normal drift rate (Fig. 1).

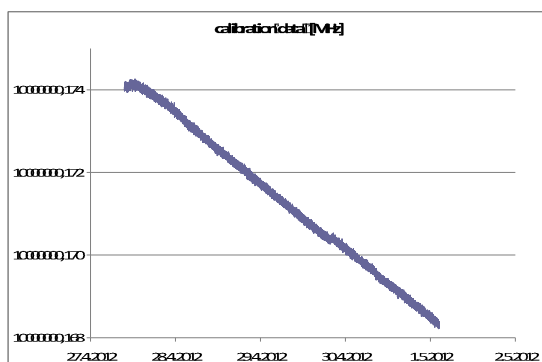


Figure 1: Drift rate of the rb-clock (5 mHz in 4 days), after storing the AG for a few months at CO gravity lab (calibrated at BEV).

After a lot of investigations, a specialist from the firm that manufactured the clock, Dr. R. Michael Garvey (Symmetricom®, Inc. Consulting Scientist), told us: "Helium is known to permeate the Rubidium cell and causes excessive frequency offset. Once removed from the Helium environment, the Helium is discharged and the Rubidium returns to normal operation".... "the sensitivity of Rubidium standards to Helium is extreme. It is very difficult to quantify in most situations (who knows how much Helium is in the atmosphere of a particular lab at any given time?) but exposure to Helium gas in almost any concentration is very detrimental to the long term performance of the device." Another clock was purchased and is now operated outside the gravity lab and the calibration results are correct now.

The manufacturer (Microg LaCoste) of the AG-FG5 presented some quantitative investigations about the influence of Helium on the clocks of their AG's for the first time at the IAG SYMPOSIUM ON TERRESTRIAL GRAVIMETRY in St. Petersburg 2013.

Therefore all gravity measurements of the Austrian FG5/242 were checked carefully for the clock influence. The drift rate of the clock was used to reprocess the gravity data, which was regularly detected at the BEV metrology department. Fortunately a lot of results, especially outside the gravity lab of CO, are within the usual measurement uncertainty of the AG-FG5, which was also demonstrated at ECAG 2011.

References:

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